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हिमाचल प्रदेश

FOREST DEPARTMENT

HIMACHAL PRADESH

# FOREST MANUAL

## Volume-IV

## (Technical Matters)

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VIRBHADRA SINGH

CHIEF MINISTER
HIMACHAL PRADESH
SHIMLA-171 002

# MESSAGE

Forests, constitute the essential life support system besides being source of timber, fuel, fodder, medicines etc. Besides their aesthetic and cultural value, forests are rich repository of biodiversity and recognized for their role in regulation of air quality and climate, soil formation and nutrient recycling and in hydrological cycle. Almost 66% of the area of the state is legally defined as forest land. This underscores the importance of forests in the lives of people of Himachal Pradesh and burdens Forest Department to shoulder responsibility.

The importance of a Departmental manual can scarcely be overstated. It lays down the manner in which the department transacts its business and must therefore internalize the elements of propriety, simplicity and procedural clarity along-with the need for efficiency. I am sure the Forest Department in its endeavour has inked best ideas and practices. I wish the Department all the success and hope that the Manual will prove to be a handy tool for forest officials and officers.

**(Virbhadra Singh)**

THAKUR SINGH BHARMOURI

Forest Minister
Himachal Pradesh

# MESSAGE

The state of Himachal Pradesh is blessed with natural resources. Forests of the State are important catchments for five major rivers i.e. Beas, Chenab, Ravi, Sutlej & Yamuna that flow through it. Out of the total geographical area of 55,673 $Km^2$, about 37,000 $Kms^2$ is forest land and is managed by the Forest Department.

Forest Department of Himachal Pradesh is one of the oldest department and one of the biggest in terms of its vast spread. The Department performs multifarious functions and its character has changed over the decades from being a regulatory entity into an organization that is aligned with development, while fulfilling the needs of the community.

The changes in Government orders and notifications etc. are required to be reflected in a compiled form easily accessible to all. Against this backdrop, it gives me great satisfaction to know that Department has thoroughly revised and updated the Forest Manuals as a set of 4 Manuals relating to various aspects of forest administration and management like Acts & Rules, Service matters, Budget & Accounts and Technical matters.

It shall be the Department's endeavor to make full use of the new Manuals in their day to day working.

**(Thakur Singh Bharmouri)**

**TARUN SHRIDHAR I.A.S.**

हिमाचल प्रदेश सरकार

**Additional Chief Secretary (Forests)**
**Government of Himachal Pradesh**

# MESSAGE

Forest Department of Himachal Pradesh, apart from fulfilling its traditional role of a regulator and protector, is now being called upon to take up the emerging challenges relating to management of forests, climate change, fulfilling the aspirations of various forest dependent communities and other stakeholders and generally being in sync with the changing times.

These changes are also reflected in the various facets of forest administration and have called for a thorough and comprehensive revision and compilation of Forest Manuals in the form of Acts & Rules, matters relating to Budgeting, matters relating to Establishment and those relating to Technical issues.

It gives me immense satisfaction to know that Forest Department has brought out a set of Forest Manuals which are a revision of earlier Manuals and I congratulate the officer Shri P.K. Sinha, APCCF (Rules & Manuals) and also the staff working with him who have painstakingly gone over each Act/Rule/Order & Notification and Technical matter and brought out the new set of Forest Manuals.

The utility of such a compilation can hardly be emphasized and it is my hope that the new Manuals would be used by all the officers and staff, resulting in clarity and ease of operations.

**(Tarun Shridhar)**

**SUSHIL SRIVASTAVA** I.F.S.

हिमाचल प्रदेश सरकार

Principal Chief Conservator of Forests &
Head of Forest Force, Himachal Pradesh

# PREFACE

Forest Department had brought out compilation of Acts & Rules, Budget & Accounts, Service Matters and Technical Matters in the form of four Manuals in the mid-eighties under the guidance of Dr. M.P. Gupta, CCF, Himachal Pradesh.

Since the last almost three decades many new Acts & Rules have been enacted-service matters have undergone sea change, changes have taken place in the way budgets are prepared and there have been revised delegation of financial and other powers, economy instructions etc. A need was felt to revise and update the existing Forest Manuals.

The task of revising and updating the Forest Manuals was entrusted to Shri P.K. Sinha, Addl. Pr.CCF and the present revision/updation is an elaborate effort carried out under his vast experience and guidance.

I appreciate the hard working that has gone into revision and for bringing out the revised Manuals. I congratulate all who have contributed in compiling these Manuals, which shall be of great help to officers and staff in their day to day working in coming years.

If there are any suggestions to supplement the information/ manuals the same may be sent to the Head Office so that it could be incorporated in future editions/revisions.

**(Sushil Srivastava)**

**P. K. SINHA** I.F.S.

Addl. Principal Chief Conservator of Forests
(Finance) and (Rules & Manuals)
Himachal Pradesh

# FOREWORD

It is my pleasure to present the first revision/updation of Himachal Pradesh Forest Manual which was brought out earlier in mid-eighties.

I had been assigned the task of revision/updation of Forest Manuals in the year 2013 and it took me almost two years to accomplish this mammoth task.

The document makes available all updated Acts, Rules, Policies and technical instructions related to Forest Department's working at one place and should prove quite useful for reference, record and general day to day working.

I would like to express my gratitude to Sh. Sushil Srivastava IFS, Principal Chief Conservator of Forests (HOFF) for his constant guidance, support and motivation for enabling me to successfully complete this challenging task.

I am particularly indebted to Sh. Rajnish Ahluwalia, who not only assisted me for preparation of manuals even sitting late hours, but also took the responsibility on his shoulder for carrying out the typing, setting, designing and also formatting in printable form plus whatsoever help he could have rendered. I am also indebted to Sh. Brij Thakur P.A., who carried out lot of typing works and also helped me in many ways.

I am thankful to Shri Surinder Kumar Addl. PCCF, Sh. D.P. Sinha Addl. PCCF, Sh. Harsh Mittar Addl. PCCF, Shri Nagin Nanda Addl. PCCF and Sh. R. K. Sood CCF (WL) all of whom provided relevant materials pertaining to their subjects. Thanks are especially due to Sh. D. K. Vij ACF, who always helped me and remained with me during work and was of great assistance. I place on records my appreciation for Sh. Laiq Ram and Shri Mohinder Singh Peon who rendered all possible logistical support to me and my staff. I am generally indebted to all the staff at Mist Chamber Forest Complex who assisted me in every possible way. I am also indebted to Sh. Harish Gupta, Registrar (Budget) and all the staff of Budget, Accounts, Management & Sales Sections of Talland Office for providing copies of relevant records incorporated in the compilation.

I am thankful to Sh. J. S. Walia, PCCF (Wild Life) for allowing me to incorporate the write up on Soil and Water Conservation in the manual on technical matters.

Last but not the least, I convey my sincere gratitude to Shri Anish Sharma, DFO, Publicity, Shri Dinesh Gupta, Superintendent and Shri Vishnu Sharma, Photographer in Publicity Division for making all-out effort to get the manuscript published in the shape it has taken.

I hope this compilation would be useful to not only to forest staff but also to academicians, researchers and all others who is concerned with the working of the Forest Department.

**(P. K. Sinha)**

VOLUME IV

# INDEX

## Technical Matters



** H.P. Forest Manual (Vol. IV) on Technical Matters approved vide H.P. Govt. Letter No. FFE-B-C (1)-7/2013 dated 21st February, 2014.*

# CHAPTER I

## THINNINGS

### A- General

In order to ensure the general application of the principles of thinnings in the various types of forest found in Himachal Pradesh, which experience has shown to be the best; and to ensure continuity of policy in the matter of time and manner in which thinnings should be performed, it has become necessary to lay down standing instructions regarding the conduct of this operation for the guidance of everyone concerned.

Thinning is a necessary cultural operation for the proper development and growth of forest crops. Execution of this operation to the desired extent at correct time is of paramount importance, Heavy thinnings, light, early or delayed thinnings can be harmful for the crop and lead to serious loss in production. It is, therefore, necessary to lay down some basic instructions regarding the execution of this important operation for uniform adoption in the State.

Aforestation is being done both for Commercial and Social Forestry Programme. The principles underlying thinnings under these two types of crops will be different.

Crops in many cases are already open and do not need thinnings. An untrained Forester tends to carry out marking even in such crops. It has been observed that regeneration ignored for want of cleaning and thinnings and suppressed crops do not respond to the late thinnings. Huge investments made in getting regeneration are, thus, lost.

A thinning consists in lessening the crowded condition of the crowns of the best trees in a canopy so as to favor their development. Thinnings among crops below 4 cm in diameter are called ‘cleanings’ while thinnings among crops of 10 cm up to 20 cm in diameter (usually made semi automatically with a stick of appropriate length to give the desired average espacement) are designated "early Thinnings", the principles underlying all thinning operation however remain the same.

The necessity for thinnings has long been recognized, the importance of thinning among the dominant and dominated and diseased trees have been especially realized, for while the removal of suppressed and dead or moribund trees may have an appreciable effect upon root competition, such removal is distinctly undesirable when the cut material cannot be removed from below the crop without unjustifiable expenditure since not only is money wasted in felling such material, but the fire hazard is greatly increased by the mass of dry wood lying under the standing crop.

Thinnings are made not only to increase increment but also as a measure of fire protection, woods which are well thinned at an early date and which are free from an excess of suppressed and inflammable material, are much less subject to fire damage than unthinned corps

Thinnings should commence early and be repeated as often as necessary, subject only to consideration that inflammable material is not to be left lying on the forest floor, ‘Cleanings’ and “Early thinnings” must be considered essential in overdense crops for the establishment of vigorous sturdy Crops and for encouragement of increment from the earliest age, but in older crops where material cannot be disposed of without expenditure, true thinnings should ordinarily be postponed until the cut material can be disposed of either free or at a price. However in areas under concentrated regeneration (e.g. P.B.I. and youngest P.B. under the

Shelter wood system) early and repeated thinning are so important for the optimum development of the crop that periodical thinnings must be carried out even though the disposal of the cut material involves expenditure of considerable sums of money, such expenditure will undoubtedly be repaid in course of time by accelerated maturity of the crops. However thinnings in young woods must not be so heavy as to prevent the production of long clean boles when timber production is an object of management.

In case of artificial reproduction, whether by sowing or planting the number of plants should be reduced to the minimum necessary and their spacing increased to the maximum permissible to obtain the crop required. Thus money is not expended in growing plants which only have to be cut out a few years later in "cleanings" or "early thinnings".

"Cleaning" should aim at the gradual spacing out of natural seedlings (or sowings where the original stocking has been too dense), until the young trees are spaced approximately 1.2 x 1.2 m when 2 m high. "Early thinnings should cease, when the sapling crops have average diameter of over 20 cm when the espacement should be about 2.5 m.

The standard thinning cycle is 10 year but after 20 cm diameter "early thinnings" stage is over and until the cut material can be disposed of without cost of Govt. the instructions given in paragraph 1.5 above must be complied with.

It is now necessary to consider the standard of thinning to be prescribed in even aged crops. In cases, where crops are thinned for the first time a moderate ordinary thinning, 'B' grade, will be carried out. In all other cases up to 50 cm a heavy ordinary thinning "C" grade, will be done. Where preparatory fellings are prescribed under the Uniform System, these will in the majority of cases, consist of a very heavy ordinary thinning, 'D' grade, though in a number of cases a "C' grade thinning will be sufficient.

Turning now to the case of un-evenaged crops managed under the Selection System, it is difficult to standardize thinnings practice to the same extent as in even aged woods. The guiding principle must be the maintenance of a canopy of undulating profile characteristic of such un-evenaged crops and all thinnings will be made in favour of the best grown and most vigorous trees of the crop irrespective of age or size. Normally the same grades of thinnings will be applied as have been prescribed for even aged, crops, in paragraph, 1.9 above, each group of trees being treated on its merits, great caution must be exercised, however, in reducing the number of trees approaching maturity on which, the future yield, depends, consequently, thinning among trees, over 50 cm diameter should not usually be carried out; but this does not, of course, preclude the removal of, suppressed, dead or moribund and diseased trees.

**B Practical hints on thinnings in coniferous woods.**

In case of coniferous crops which have been thinned once, the grade of thinnings will generally be 'C'. The unthinned crops should receive attention in the first instance and the first thinnings in such congested crops should conform to 'B 'grade to be followed by second thinning after about 10 years corresponding to 'C/D' grade.

**General-** A thinning to be effective must be of sufficient intensity to afford to the crowns of the dominant trees room for development; at the same time opportunity must not be given to the lower side branches to persist. The object must be the production of trees with clean boles and well developed crowns, which do not extend

more than one third down the total height of the tree when it has completed the major portion of its height growth. Side branches naturally persist, for sometime on young trees but gradually die in close woods with the advancing age of the tree.

**Cleanings**-In cleanings suppressed and dominated saplings must be cut.

**Chil thinnings**- In Chil forests, dominant and suppressed trees must be cut as their retention aggravates the effects of forest fire, which is liable to extend to the crowns; a crown fire kills the trees whereas a ground fire rarely does much damage. The dominant trees must be so spaced as to afford ample room for crown development as the crowns of Chil trees will not develop in crowded woods.

**Deodar thinnings**- In Deodar woods the retention of some dominant trees is desirable both because they help to clean the boles of the dominant trees and because the dominant trees are able to replace casualties due to snow break amongst the dominant trees.

Suppressed trees should be marked for felling in the first instance along with dry, dead and dying trees. Now a day's all outturn from forest crops is saleable except in very remote areas. There is an acute shortage of timber and fuel in the face of ever increasing demands.

In early youth saplings should be thinned to an average espacement of 2 to 2.50 m.

Crops should then be left unthinned for ten or twelve years until the lower side branches die in order that the boles may furnish timber of high quality. Thinnings should not, however, be delayed, unduly as the crowns soon become constricted. Thinnings should then take place at intervals of about 10 years until the trees have completed the greater part of their height growth. At each thinning, crowns must be given sufficient space to develop, but there should be no permanent interruption in the canopy, such as would strengthen the side branches. After thinnings the branches of neighboring trees should not be touched but the cover should close within 3 years.

The average espacement between neighboring trees should be about four times their average girth, a 'rule of thumb' method which has been tested for years and which is to be used as a guide to subordinate as to the intensity of thinning required in the first half of the rotation. Naturally the escapement varies in localities of different quality, but the rule is sufficiently correct for practical use.

By the time trees have reached or slightly passed mid rotation age when they should be of about 40 to 45 cm diameter, their crowns should be confined to the upper third or half of the trees. Himachal Pradesh lies in sub tropical zone where the intensity of solar radiation is higher than that in tropical and temperate zones and this leads to the persistence of branches when trees grow on steep hill sides.

As the trees increase in size, the removal of each tree leaves a gap between its neighbors. Consequently, at half rotation age the canopy does not close up after thinning for a number of years, if at all. The necessary interval between thinnings increases to a minimum of 15 years. It is considered that an interval of at least 25 years required in Woods approaching maturity. There is no need to fear the development of side branches, the, time for forming a clean bole has passed and thinnings afford the trees room to develop large crowns and rapid volume increment.

In choosing trees to be left to grow to maturity the vigour of the tree is all important. All suppressed and dominated trees should be cut and vigorous trees with well developed crowns should be retained as they alone are capable of rapid

increment. The distance between neighboring trees after thinning is from 5 to 6 times the girth at breast height.

**Kail thinnings**-The Kail tends to thin itself naturally, but unthinned woods suffer severely from snow break. Early thinnings permit of the strengthening of the dominant trees. The intensity of thinnings is intermediate between that of Chil and Deodar. Suppressed trees should always be marked, for the satisfaction of demands of right holders.

**Thinnings in mixed Kail and Deodar woods**- The Kail, and Deodar show very different rates of growth. Kail outstrips the Deodar in youth and must be cut back so as to favour the Deodar; later on in life the Deodar easily holds its own.

The natural effect of thinnings is to convert the mixed forest to Deodar. In unthinned woods the Kail tends to form a complete canopy below which the Deodar is hopelessly suppressed. The object of thinnings is to favour the Deodar by the removal of Kail suppressing the Deodar. Care must, however, be taken not to open out gaps in a forest, and the object of management should be to obtain groups of pure Deodar and Kail, or of Deodar mixed with Kail of more or less even height. The mixed character of the crop must be maintained and the average age should not be decreased.

When Kail trees occur isolated or scattered over compact groups of Deodar saplings, the Kail trees must invariably be cut out when of not more than III class size (1.37 m girth). No compact over wood of Kail, may, however, be cut or the canopy interrupted for the sake of a few suppressed Deodar. Special attention is invited to paragraph 1.29 on “common mistakes in thinnings”. The lopping and girdling of Kail, spruce and fir in improvement fellings is strictly prohibited; the subordinate executing thinnings must make up his mind definitely either to cut out Kail trees over groups of Deodar, or to leave them standing.

Treatment of spruce and silver fir in admixture with Deodar, Kail and Spruce and silver fir are very important species because of ever increasing demands of packing cases for horticultural produce and other packing material. When mixed with Kail and Deodar so as to occupy a definitely lower place in the canopy they form a most useful admixture as they clean the boles of the more valuable Deodar and Kail, keep the ground moist and favour the improvement in the quality of the locality. They must be cut out when they suppress more valuable species capable of development, but must be retained when they do no considerable harm to Deodar and Kail or when they only form a small proportion of the crop. Care must, however, be taken not to make permanent gaps in the canopy.

**Treatment of conifers mixed with broad leaved trees:** Conifers under certain conditions tend to invade areas occupied by broad leaved trees; and must be favoured in youth by lopping the broad leaved trees. Once however, the conifers get their heads free the broad leaved trees must be retained as a very superior grade of timber is produced in mixed conifer and broad leaved forest. The broad leaved trees not only improve the soil and the quality of the locality but they facilitate the natural regeneration of mature woods. Broad-leaved trees form a valuable source of local fodder supply which cannot be neglected; no attempt whatever should be made to exterminate them.

**Common mistakes in thinnings**

(a) **Deodar thinnings-** There is a tendency for thinning to be too light. Young trees in favourable localities grow rapidly and when the thinnings are too light the

crops again become very dense in a year or two. The intensity of cleanings and thinnings must be such that the plants benefit definitely from the operation and will not require further attention for the next ten years.

On the other hand crops on poor ground grow slowly and the thinning must be appreciably higher than in crops growing in favourable localities.

Remember the better the crop, the faster does it close up.

(b) In natural forest the density of the stocking varies from place to place. The denser portions require thinning but when the person marking the thinning enters the more open portion there is a tendency to take out more trees than are needed. Mistakes arise and it is better not to attempt to thin the more open portion at all. No harm can be done by leaving open portions of the crop unthinned.

(c) Small blanks occur in every forest and must never be extended. If any tree is removed on the edge of a blank, the area of the blank is thereby increased. Even when the tree cut is dominated or suppressed its removal permits of the development of side branches of the dominating trees which is not wanted. Consequently do not thin on the edges of small blanks or gaps.

(d) **Removal of suppressed trees:** A suppressed Deodar, spruce or fir tree does not harm and it should never be cut except when suppressed Deodar and Kail are wanted by right holder. It is wrong to cut it and let it lie on the ground as it increases the damage from fire. On the other hand it is necessary to cut suppressed Chil land Kail trees to prevent a fire reaching the crowns of dominating trees. But it is wrong to allow the cut material to remain on the ground. It must be thrown into nullahs or removed outside the forest.

(e) Mistakes are common in thinning mixed Deodar and Kail woods. The removal of isolated Kail above groups of young Deodar is very necessary; but it is quite wrong to cut Kail trees from compact groups for the sake of a few scattered suppressed Deodar.

Thinnings in plantations raised under Social Forestry, ordinarily no thinnings. Only salvage markings will be done. The purpose of such plantations is to produce maximum biomass in the form of fodder fuel and small timber. The quality of timber is of not much consequence.

**Markings in broad leaved species:** Broad leaved species have acquired great economic importance in the recent past. Pure plantations of Khair are being raised on large scale in low lying areas. The principles for the thinnings for such crops will be the same as adopted for Chil.

**Cardinal principle:**

It is reiterated that proper hygienic conditions in the forests must be maintained. Salvage markings comprising of removal of dry, dead and dying trees must be carried out at the first available opportunity in accordance with the thinning programme. The investments made on raising of plantations must not be allowed to go waste by ignoring cultural operation in the form of cleanings and early thinnings. CFs and DFOs must ensure that adequate funds are secured for such operation and no crop is allowed to suffer on this account.

Cleanings or early thinnings as per prescriptions of the Working Plans should be carried out.

# CHAPTER II

## NATURAL REGENERATION OF CONIFERS

This chapter covers the economically important coniferous species of Himachal Pradesh Chil (Pinus roxburghii), deodar (Cedrus deodara), Kail (Pinus wallichiana), spruce (Picea smithiana), silver fir (Abies pindrow), Chilgoza pine (Pinus Gerardiana).

**Factors governing successful regeneration**

Successful regeneration of a forest crop depends upon a number of factors, of which, soil, light, moisture, grazing and fire are the most important. Manipulation of the canopy and judicious use of grazing and fire are potent weapons in the armoury of the forester for modifying the site factors and for ensuring the regeneration of valuable species. The soil conditions can also be altered within certain limits by changing the composition of the crop, by draining and soil working etc.

**Soil:** The adverse effect of excessive undecomposed litter or its absence/shortage has been widely commented upon in forest literature. The experience has amply demonstrated that this adverse effect is operating in the coniferous forests of Himachal Pradesh. The fir forests, where the site conditions are wet and the forest are not heavily grazed, regeneration is a problem in such areas because of heavy weed growth and thick layer of humus. About 20% of fir forest fall under this category.

Excessive grazing compacts the soil and alters its physical properties to an extent which inhibits natural regeneration. No regeneration in such areas is possible without proper soil working. The adverse effect of grazing can be seen everywhere where the forest adjoins large villages and where no closure has been made.

While the farmer takes into consideration, only the top 15-20 cm layer of the soil which he can modify through the use of manures and fertilizers, the forester in dealing with forest crops, the roots of which go deep down into the soil, has got to take into view the whole soil profile starting from the layer of organic matter on the top to the parent rock.

The concept of maximum sustained yield upon which scientific forestry is practiced, implies the maintenance of site fertility till perpetuity and this has to be achieved not by the use of fertilizers and manures as in agriculture and horticulture but by maintaining the continuous availability of essential nutrients so that the forest is able to live and grow year after year and for ever through the product of the decay of its own organic matter.

The physical, chemical and biological conditions of the soil have to be maintained so that these are favourable for the regeneration. Little can be done to alter the chemical composition of the soil. The forest soils of the Himachal Pradesh are capable of producing high quality pine, deodar or fir, provided that the factors of locality other than chemical are favourable for this. Apart from soil acidity, which is of utmost importance in spruce and silver fir forests, the chemical condition of the soil is not a cause of anxiety.

The physical condition of the soil, more particular proper aeration, is of very great importance in forestry. After the completion of the regeneration fellings, all the felling refuse together with any other undesirable material will be collected into heaps and burnt as essential measure in winter. Care is taken the heaps of debris are small so that the fire does not damage the trees.

Nitrification is the most important of the biological processes in the soil. In view of the cool temperature and highly acidic conditions, there is always the possibility of a break down in the nitrogen cycle in the temperate coniferous forests. Under such conditions, the continuity of the cycle can be ensured by planting some broad leaved species with high foliar ash content. Leguminous species should be raised for increasing the nitrogen status of the soil

Much has been learnt regarding the significance of the plants comprising the ground flora in gauging the suitability or otherwise of the soil conditions for obtaining regeneration. Where plants such as Straw–berry, Ainslia, Viola, ground ivy, maiden hair fern etc. predominate on the ground it may be accepted that all the factors of the locality are favourable for natural regeneration, when on the other hand, Iris, Balsam, Strobilanthese, Plectranthus and Spirea sorbifolia dominant in the ground flora, conditions are quite unsuitable and until such conditions are ameliorated regeneration will only be obtained with difficulty, if at all.

**Light:** In practical operations the term "Light" is considered to include not only light as measured by a photometer but also the inseparable factors of those soil and moisture conditions which are directly caused by fellings in the forest crops for the purpose of admitting light on the soil. By regulating the intensity of such temperature and moisture contents of the soil are altered and consequently the conditions of the soil and the ground flora. For germination, neither the deodar nor the blue pine make heavy demands upon light, while the silver fir will germinate in and probably prefers for this purpose shade. The Chil pine, on the other hand, will germinate under, and possibly prefers for this purpose, exposure to direct light. Subsequent to germination want of sufficient light will under normal circumstances entirely destroy deodar seedlings, though in the somewhat abnormal conditions prevailing in deodar forests on the dry locations, protection from the direct light and heat generated by the afternoon sun is essential to the survival of deodar seedlings. A deficiency of light retards the growth and often kills blue pine seedlings, while Chil pine seedlings demand full light except at the lowest limits of their natural zone, spruce seedlings approximate in their demand for light to the deodar, while silver fir seedlings will stand a very considerable degree of shade for many years without permanent deterioration.

**Moisture:** Next to heat and light, moisture plays an important role in tree and crop physiology. Moisture is also very largely dependent on account of light admitted to the forest floor. Excessive moisture in a locality under regeneration may often be decreased by the admission of more light than would normally be admitted. Though this does not, of course apply where the excessive moisture is due to water springs and streams.

**Establishment of Fir regeneration**: Fir has been failing to regenerate and this particular problem has been engaging the attention of foresters for quite a long time. Factors inhibiting fir regeneration are, thick layer of raw humus, dense weed growth uncontrolled grazing, debris accumulation, bad drainage and infrequency of good seed years. Raw humus dry up during summer months before the roots of tiny seedlings are able to reach the mineral soil for moisture. Dense weed growth is detrimental for natural regeneration as the weeds offer severe root competition besides suppressing the seedlings. Heavy grazing adversely affects the regeneration as the seedlings are killed by trampling.

A good deal of experimental work has been carried to tackle the natural regeneration problem of fir forests. The results of experiments showed that: -

i. Weeding helped the establishment and height growth of natural regeneration of silver fir.

ii. In order to induce and establish natural regeneration, the canopy should not be opened wider than 11 m X 11 m. In case of wider gaps, weeding may not be done to provide shade to young seedlings. Clear felled strips should be wider when running in east-west direction than in case of strips running in north south direction.
iii. Removal, scraping of raw humus helped in bringing natural regeneration much more than its mixing with soil.
iv. Introduction of poplars and other broad leaved species with silver fir pointed their efficacy in reducing the thickness and acidity of raw humus, which may be helpful in inducing natural regeneration of silver fir and spruce.
v. Shelter wood system seemed more suitable than clear felling in strips which in turn appeared better than the Selection System for bringing natural regeneration of silver fir.

A large number of exotic and indigenous species have been tried. The results indicated that out of the exotic species tried only Larix europea and Larix laptolepis are suitable for introduction in fir areas. Among indigenous species growing in the area, only Acer caesium, Aesculus indica, Juglans regia, Prunus padus and Populus ciliata were found suitable in specific sites.

**Importance of canopy manipulation:** It is evident that the manipulation of the canopy of the forest crop has most important results on the composition of the soil, the light reaching the ground the temperature and the moisture contents of the soil. In all methods or regeneration under a shelter wood the, seeding felling is a compromise between:-

i. The necessity for retaining sufficient trees to maintain the soil, light and moisture conditions necessary to successful regeneration and to give an ample crop of seed.
ii. The, necessity of removing, all cover not absolutely necessary so that the subsequent fellings of the overwood will do as little damage as possible to the young regeneration.
iii. The Prevention of rank weed growth.

**Root competition:** Another factor to which prominence has been given is root competition between the mother tree and this regeneration. Experimental plots were laid out in deodar forests of Kullu Division to study the effect of root competition (by trenching) on regeneration. Though the plots were not laid out statistically, yet, broadly speaking, it was apparent that trenching had beneficial effect on survival and height growth of deodar seedlings. The extension of such an experiment on a large scale is obviously out of question; but the result of the experiment emphasize the importance of the heaviest seeding felling compatible with the principle of conserving all favorable locality factor enunciated in the preceding paragraphs. They also point to the advisability of so tending the new seedling and sapling crop obtained regeneration areas that each plant has sufficient freedom from unnecessary root competition to grow to the highest standard of vigour compatible with the quality of the locality. While root competition may not be of much consequence in areas with a monsoon climate, it will certainly operate in the dry zone where the fullest utilisation of the small amount of moisture available by the crop of the future is a matter of paramount importance. The whole technique of regeneration is therefore, dependent of carrying out the seeding felling on correct principles.

Experience proves that in Himachal Pradesh coniferous forests as they exist today, it is not always necessary to delay the commencement of the regeneration of an area until some sort of felling has been made. Many forest crops particularly Chil pine

crops are naturally sufficiently openly stocked to permit the establishment of great deal of regeneration without the felling of a single tree. All that is required for the regeneration of such areas is closure against grazing and grass cutting and perhaps a proper manipulation of the under growth. The importance of this aspect of regeneration work can not be too strongly emphasised. Having dawn attention to this important point in practical forest management, the method of carrying out seeding felling is dealt with in the next paragraphs.

**Seeding felling:** Professor Troup in his monograph on Pinus roxburghii writes as follows:-

> "The chil pine is one of the most light demanding species and under favourable conditions the more light admitted the more successful and complete will be the regeneration. It may be said that in ordinary favourable circumstances 12 to 20 seed–bearers per hectare are ample for effecting regeneration; and that a greater number are not only unnecessary, but may even be detrimental to the establishment of a healthy young crop. This statement, however, should not be taken to apply universally. Thus on hot slopes where the soil is stiff and the seedlings are liable to suffer from isolation, protective shade is essential; and the demand for such protection may outweigh the demand for light. Where protection against drought is necessary the number of seed bearer per hectare may have to be increased very considerably".

It may also be stated that on southern slopes as a rule a larger number of seed bearers is required than on northern aspects. It must be remembered that some of the mother trees invariably die of isolation and that only large crowned mature trees produce regeneration. It is, therefore, laid down that:

(i) not less than 20 mother trees per hectare to be retained;
(ii) only large crowned past mid aged trees are desirable as mother trees;
(iii) only straight fibre trees that are above average in resin yield are to be kept.

An initial espacement of 20 25 metre apart will fulfil all the required conditions when the factors of the locality are average for chil pine, but the necessity of variation in treatment when the factors are adverse must never be lost sight of.

**Pinus wallichiana, Cedrus deodar:** The deodar and the blue pine are commonly associated together and their regeneration is generally carried out simultaneously. The deodar is less of a light demander than the blue pine, the standard specification in the seeding felling is to leave a space of one crowns width between the mother trees.

The width of the crown of an average blue pine mother tree is 12 to 15 metres, leaving a space of one crowns width between the trees will, therefore, give a spacing of 24 to 30 metres or 30 to 35 trees per hectare which will in future be taken as the standard average spacing for blue pine. Wide spacing down to 12 trees per hectare has been attended with disastrous consequence in some of the valuable forests.

Deodar has a narrower crown than blue pine and the standard distance for the mother trees is 20 metres, a distance which has given excellent results. This will give 50 trees per hectare. All seed bearers of both deodar and blue pine must be well developed trees of past middle age and not mere poles which are useless for the purpose of regeneration. Remembering that certain casualties always occur among the mother trees and that caution in opening the canopy is always desirable, it is laid down that minimum number of well grown mother trees to be kept in seeding felling are deodar 50 and blue pine 30.

**Picea smithiana, Abies pindrow:** The natural regeneration of spruce and silver fir has not yet been standardised. Spruce will, however, require almost as much light as deodar, while silver fir requires fairly heavy shade for regeneration.

The spruce has a much wider crown than the silver fir and the same standard spacing of one crown s width will apply to both these species, giving for the spruce 40-50 trees and for the silver fir 70-90 trees per hectare.

**Pinus gerardiana:** (chilgoza pine) is a strong light demander. It grows on dry, steep, rocky slopes. Annual precipitation varies in the area from 250 to 670 mm and is mainly in the form of snow. It grows in the dry zone of Kinnaur District and also grows over a small area in Pangi Valley.

Local people have rights for the collection and sale of chilgoza seed. The right holders practically pluck every cone from the trees, leaving no seed to fall on the ground for germination. Natural regeneration of chilgoza pine is thus practically absent. Factors responsible for poor natural regeneration are:-

(i) Unrestricted and complete collection of cones by right holders, thus leaving no seed for germination.
(ii) Seed being edible is damaged by birds, rodents and reptiles.
(iii) Inhospitable climatic conditions hamper the survival of whatever seed germinates or survives.
(iv) Heavy and unrestricted sheep and goat grazing does lot of damage to young seedlings.

Inspite of the factors mentioned above and rampant damage to seed by insects and rodents some plants do appear in the sheltered places. Efforts have to be made to protect such plants.

Selected areas where bush growth is not very heavy, need to be fenced with the consent of the right holders, so that natural regeneration has a chance to develop. It has to be understood that all the existing Chilgoza pine forests have in reality come in through natural regeneration. The development of such areas will depend upon the public co-operation and ingenuity of the staff, if they take interest good pockets of natural regeneration can be created.

**Quality of Mother Trees:** It is necessary to consider also the quality of the mother trees from which will be derived the next crop. That the characteristics of the mother trees are transmitted to their off springs, is a well established fact. Twist in chit pine is reported to be hereditary and is transmitted through the seed. The importance of selecting healthy vigorous mother trees free from defects and of good form is, therefore, of great importance.

**Importance of mixed crops:** The importance of growing mixed crops must be impressed on all foresters. In particular, pure blue pine crops are most under suitable on account of the fire hazard, while a mixture, with more shade bearing conifers such as silver fir and spruce has the great advantage of assisting clean the boles of the pine on which branches persist for a very long time in all but the densest pure crops. Thus a mixture of deodar or silver fir or spruce is most desirable, especially of deodar which is more resistant to fire than blue pine and reduces the amount of inflammable litter on the ground. Apart, however, from particular examples, all mixtures, including the mixture of conifers with such broad leaved trees as oak, maple and bird cherry are to be preferred to pure crops, where conditions are such that it is possible to grow a mixed, crop, and the promiscuous cutting out of so called, inferior species is not permitted.

Under existing economic conditions the only tree which should be artificially introduced in pure crops is deodar, in the case of other trees mixture must depend, for the present, upon natural seedlings. Thus artificial mixtures will only be aimed at in the deodar blue pine zone and under favourable circumstances in the spruce or spruce silver fir zone. For the purpose of introducing deodar in mixture, the patches of burnt felling refuse will be sown up and surplus plants transplanted when big enough. A proportion of 25 to 33% of deodar in mixed crops is sufficient

**Grazing:** Excessive grazing and grass cutting is always injurious in areas under regeneration. Light grazing may do no harm and may in some cases be beneficial, but in areas brought under regeneration, rights to grazing and grass cutting should always be suspended, where legally possible, by closure under the Forest Act. The grazing is then under the Divisional Officers control and he can open and close as may be expedient in the interest of forest work. Once grazing and grass cutting can be permitted without detriment to the young regeneration the area can be opened for these purposes at the discretion of the Divisional Forest Officer. This will reduce the fire hazard, a matter of vital importance, especially in the case of Chil pine.

**Tending and supplementing natural regeneration:** As a result of closure, with or without fellings in the mature crops as circumstances may require, natural regeneration will appear with the fall of seed from the mother trees and this will be tended as required and supplemented to the extent necessary by sowing and planting. The importance of a proper mixture of species is again emphasised.

The standard essential tending operations in regeneration areas are:-

(i) Collection and disposal (generally burning) of felling refuse ;
(ii) Weeding of excess under growth;
(iii) Cleaning of dense natural regeneration with a view to spacing young plants about I to 1.5 m apart;
(iv) Cleanings sometimes called early thinnings with a 1.75 m stick in young sampling regeneration with a view to giving the best saplings an espacement of between 2 x 2 m and, 2.5 x 2. 5 m according to size;
(v) B grade thinning in young pole crops retained as part of the new crop.

In particular cases other tending operations may be required and foresters will use their discretion in applying them: the standard method must, however, never be neglected.

Secondary fellings will be the next operation necessary, their number is never prescribed and they are carried out at the marking officer`s discretion. The number of secondary fellings should not be more than is really necessary. The final felling should be deferred in the case of Chil pine until the young crop is 2 m high and has been burnt departmentally and in all cases the final felling should be deferred so that the mother trees may put on the maximum increment. The final felling may even be delayed to a subsequent period always subject to the proviso that the young crop is not suffering thereby. Before the final felling is made the young crop should always be of sufficient age and height to permit of logging and sawing being carried on below its canopy and not on the top of it. Many instances have occurred where the final felling was unduly hurried on to the detriment of the young crop and the loss of very valuable increment.

The attention of all members of the executive staff is drawn to the necessity of under standing and carrying out the correct technique of natural regeneration as laid down in this order which may be summer up as

1) Correct felling in the overwood;
2) Correct treatment of the soil;
3) Regulation of grazing and grass cutting;

If these instructions are properly carried out the difficulties of obtaining regeneration will be minimized.

Finally, it is necessary to impress most strongly upon all officers that working plans for the coniferous forests in Himachal Pradesh are not based upon purely text book and theoretical silvicultural systems. It is therefore, of utmost importance that working plans should be thoroughly studied and understood before any regeneration marking are actually made.

It is further necessary to emphasise the fact that no marking officer can depart from the principles of management and the methods of treatment prescribed in working plans unless and until the plan has been duly amended by the authority who have technical approval thereto, namely, the Chief Conservator of Forests.

Even where methods of concentrated regeneration are prescribed in working plans, it is to be remembered that coniferous forests are under a process of conversion from the uneven aged/selection type to more or less even aged woods characteristic of the uniform system and its various modifications. Consequently all recent working plans embody radical modification of text book methods by which all marking officers are bound, whatever their personal views of the suitability of such modifications may be. In particular, attention is drawn to two modifications of the standard Uniform System, which appear in the vast majority of H.P. working plans dealing with coniferous forests namely:

(i) The retention of pole crops as part of the new crop;
(ii) The intentional prescription of a considerable degree of irregularity in areas under conversion to comparative uniformity;

In connection with modification (i) it must be clearly understood that the diameter fixed for retention applies to the diameter at the time of the introduction of the working plan. Consequently once pole crops have been retained at the first (or seeding felling) marking in a regeneration area no future marking can permit of the regeneration of such pole crops merely because the pole crop is then of greater diameter than that fixed in the working plan. It follows that when seedling fellings are delayed for a considerable time after the introduction of working plan the marking Officer is at liberty, and indeed should, raise the diameter limit to cover the increase in diameter put on by trees since the plan was prepared. Experience has proved that it is most necessary to draw forcible attention to this point as many regeneration areas have been seriously spoiled by misunderstandings in the past.

As regards modification (ii) the irregularity aimed at covers two circumstances: firstly the retention of mature trees even beyond the period of regeneration in order to grow some selected trees to large size and secondly to maintain pole crops retained as part of the now crop in the degree of un-even-agedness which they have naturally attained. Such pole crops will probably in the majority of cases, contain a larger or smaller proportion of trees above the diameter fixed for retention but it is bad forestry, which is strictly forbidden, to remove such trees with disregard to the silvicultural requirements of the crop as a whole. Pole crops retained will only be thinned in the manner Prescribed for other pole crops outside regeneration areas in Technical Order No. 1, that is to say thinnings in the retained pole crops will be in favour of the best grown and most vigorous trees of the crop irrespective of age or size and bearing in mind the principle of Gayer's line. Here again experience has proved the point prominently to the notice of all marketing officers, and it must be clearly departure from the principles now laid down will be considered deliberate and unjustified departure from the rnanagement laid down for Himachal Pradesh

# CHAPTER III

## NURSERY WORK

### Introduction

The plantation targets are increasing every year. According to the Perspective Plan for afforestation and Soil Conservation drawn up by Himachal Pradesh Government, 50 %, of the total geographical area in the State is to be brought under forests by the year 2000 A.D. Afforestation of degraded, blank and under stocked areas will be an essential ingredient of this programme. Nursery raised plants will be required in large quantities. There are species whose seedlings take more than one year in the nursery before they are fit for planting in the field. Silver fir seedlings, stays for 4½ years in the nursery beds. In such cases, the requirement of nursery stock has to the worked out many years in advance and action to raise it initiated accordingly. Any laxity in this direction is bound to cause failure of the future plantation programme. Good forest nurseries, permanent or temporary are, therefore, absolutely necessary for successful forest management. Permanent nurseries must be formed when large areas of forest have to be stocked artificially. The temporary nurseries are located close to or actually in the planting area. In case of container plants, the nursery should be as near as possible to the planting site to cut down the transportation cost.

It is essential that areas under regeneration be completely and rapidly restocked and for this purpose an adequate supply of vigorous plants of right size is available at the beginning of the planting season. The delay in planting results into invasion of the felled areas by noxious weeds and bushes which make planting of such areas difficult. In the past, the planting could not keep pace with the felling in the silver fir and Spruce areas mainly because of non availability of nursery plants. As a consequence, such areas are full of weeds and bushes and have become problematic areas. The importance of good organised nursery work cannot, therefore, be overemphasized.

**Organization:** Lack of organisation is one of the main defects in nursery work. In the first place, it is essential to know what areas in the scheme of regeneration should be stocked artificially by planting and what areas can be conveniently planted up annually and what number of plants will be required for this purpose. The species, class of stock, whether seedlings or transplants, its size and age, and the number required annually for planting, are for the Divisional Forest Officer to determine. This prevents great losses through raising wrong species or the wrong class of stock, and is a check against growing more than is needed at one time and too little at another. Arrangements should be made to raise approximately the requisite number of plants year after year.

A journal should be maintained for each nursery. This should contain a detailed plan of the nursery and show after actual count by the Range Officer once a Year, say in April, exactly what numbers of plants of each species, as regards age, size, quality and class (seedlings or transplants) are in the nursery. This annual inventory of the nursery stock will form a basis for drawing up annual plans as regards the disposal of existing stock and the raising of more stock.

The following tools (minimum) are required for nursery works:-

Pick axe, spade, ordinary hoe, pronged vine hoe, garden rake, drilling board, wooden roller, scateur, grafting knife, pruning saw, sprayer, watering can with rose, weighing balance, measuring tapes, aluminum label slips, axe, string, pegs etc.

**Irrigation** - There should be adequate arrangement of irrigation in the nursery. Modern technology available in the form of sprinkler irrigation and drip irrigation should be made use of. It is indicated that where sprinkler irrigation is adopted, use of gravity force should be made. The layout of the nursery should be such that irrigation can be arranged most economically. This aspect is to be kept in view while deciding the lay out of the nursery.

The order in which the various nursery operations should be carried out and the exact time when they should be done are most essential for successful nursery practices. The exact time of sowing, weeding, watering, shading, transplanting etc. all require the careful and personal attention of the Range Officer or the subordinate in-charge of nurseries; delay or neglect in any of these operations may mean a considerable loss in nursery work.

**Size of nursery** - The size of nursery depends on the number, size, species and the class of plants (seedlings or transplants) required annually for planting purposes. If the areas to be planted up are scattered and the number of plants required in each is small, it is sufficient to prepare temporary nurseries on the spot in each area under regeneration. But temporary nurseries, though cheap, are often unsatisfactory as they cannot be properly attended to and supervised. Where a large area has to be planted, permanent nurseries on standard lines should be started and maintained at each working centre from which plants can be quickly and cheaply distributed to the planting areas.

**Selection of the nursery site** - Careful attention to the selection of nursery site amply repays all the efforts involved. The nursery should be centrally situated as regard the forest region in which planting is to be done. Nurseries of silver fir and spruce were attempted on lower elevation of about 1200 to 1800 m to take advantage of the longer growth period on these elevations. The rate of growth of the seedlings in low level nurseries, was however, not found to be markedly better than that in the nursery in it natural zone. The advantage of earlier germination and slightly better growth during the first season in low level nurseries is more than off-set by high mortality in these nurseries. Low level nurseries, thus, offer no advantage and need not be established for raising spruce and silver fir.

The nursery should be easily accessible to the Range officer and located, as far as possible near a Range quarter, a range rest house, a Deputy Rangers quarter or a Guard`s hut, so that it can be constantly and closely supervised by the staff. It is also important to locate the nursery near a big village so that sufficient labour is available and much time is not wasted in going to and returning from work. The nursery should be easy to irrigate.

To ensure steady output from forest nurseries, the soil must be sufficiently acidic for the crop being raised and sufficiently light and well drained. High nutrients reserve and high organic matter are useful but any consequences of deficiencies in these properties can largely be made good. Exposed ridges, frost holes, natural blanks, badly drained pockets, grassy blanks, steep slopes should be avoided. Nursery should be near assured water supply. Nursery sites served by road offer an advantage in transport of seed, manure, fertilizer, labour and planting stock on economic costs.

**Preparation of soil** - In establishing new nurseries, all stones, stumps and roots should be removed. First bushes and herbaceous weeds should be uprooted and burnt. The ground should then be ploughed or hoed to a depth of about 30 cm. This work should be done at least six months before the actual sowing of the species. The soil should be left fallow till the actual sowing operations are about to be taken in

hand, when all lumps should be thoroughly broken up, small stones, grass and other vegetation removed and the soil smoothed for laying out the nursery beds. In re-preparing beds in old nurseries it is merely necessary to dig up the beds, remove all small stones, roots, grass etc. and smooth the soil.

**Manuring**- Organic matter is not taken into account in the standard soil texture classification. Never the less, humus in the soil holds moisture and nutrients as clay does, but without its stickiness. Soils low in clay but relatively high inorganic matter are probably ideal from the point of view of texture for forest nurseries. In a new nursery, especially when it is located in a recently felled over area, manuring is generally not necessary. This must, however, be done when it is required, especially in an old nursery, which has been impoverished by raising stock year after year without leaving the land fallow. Light soils can be improved by the addition of cow manure and heavy soils by the addition of leaf mould. Vegetable litter, cow dung and wood ash are the best manures for forest nurseries, they can be easily and cheaply obtained and should be used whenever necessary. It should, however, be noted that fresh straw manures should not be used, it should be allowed to rot for a year or more in a pit before use. The manure should be spread over the bed 5-10 cm thick and dug into the soil. All bushes, grass and other vegetable litter should be burnt over the bed and the ashes mixed with the soil. In all permanent nurseries where cow dung, vegetable litter and wood ash is not cheaply available such as most of the nurseries in the plains and low hills each part of the nursery should be green manured (by cultivating govara, sun-hemp, velvet beans, Egyptian clover or Soya beans) in rotation. In high hills green Manuring is not of much use because other manures are easily available and due to the rigours of the climate, growth of the green manuring crop is very poor,

Raising of legume species improves nitrogen level of the soil. It is, therefore, considered necessary to raise leguminous plants in a portion of the nursery by rotation. It has also been claimed that incorporation of bulky green crops improves humus content of the soil and provides readily available nutrients.

**The shape and lay out of the nursery and the size of nursery beds:-**

The nursery should be compact and whenever possible should be rectangular or square. Every large nursery should be permanently divided by paths and cross paths into blocks whether square or rectangular in shape. The blocks should then be properly laid out into definite rectangular beds with paths in between with a string and pegs. The main paths should be one meter wide and the paths between the beds 40 to 60 cm. The shape and size of beds would differ with the species and locality. In the hills the standard size of a nursery bed is 2 m X I m. the beds are raised 15 cm above ground level by throwing the earth from the intervening paths on the beds. The long side of the beds should be towards the hottest sun; e.g., on southern aspect the long side should be from east to west. This will facilitate shading of the beds if it is necessary.

The actual seed beds should be well dug up the soil thoroughly loosened and beds prepared just before sowing. The surface of the bed should be absolutely flat and not raised in the centre; otherwise all the seed will be washed off the sides. The sides of the beds should be consolidated by ramming or with planks or saplings pegged down. The beds should be serially numbered by means of wooden or iron plates. The nursery should be effectively fenced and gates constructed at suitable points.

**Collection and pre- treatment of seed**:-Details of the extraction, drying, testing, storage and pre-treatment of seeds are given in Technical Order No. 4

Here it is enough to state that the quality of nursery stock and the success of plants squarely depend upon the quality of seed. This aspect is the most important and cannot be overlooked. Any extra amount spent on the collection of quality seed will be an investment worthmaking. The Seed Banks are being established to ensure

sustained and regular supply of seed even in poor seed years for important species so that afforestation programme does not suffer.

For the maintenance of ecological balance, plants of many unimportant shrubs, bushes and trees species shall have to be raised in the nurseries. Even species which are important as feed for different species of wild life shall have to be raised for stocking wild life sanctuaries and intensively managed wildlife areas.

**Control against damping off:-** Damping off is one of the first diseases appearing in newly sown beds. Many fungi cause damping off but those most commonly encountered are, Fusarium, pythium and Rhizoctonia species. Only very young seedlings are attacked. After the stems begin to develop woody tissue, perhaps in 4-6 weeks after seed germination, susceptibility declines rapidly. In some cases the seedlings die before they emerge from the soil. Such pre-emergence damping off may go undetected and be explained away as poor seed. Post emergence infection occur, first at the ground line and the seedlings become flaccid and topple over. Damping off is most severe in excessively wet nursery soils. Application of nitrogen fertilisers during the period of susceptibility may also increase the losses.

Damping off can be controlled through suitable changes in nursery practices and by chemical means. Losses are reduced by practices by which seedling stems develop woody tissues before the moisture in the soil is very high. Regulation of soil moisture also reduces the losses. The seed protection fungicide Thiram is some times effective in reducing losses in conifer beds. Drenching soil with fungicide Captan is also effective but once the symptoms become evident it is usually too late to drench.

Good results have been obtained by soil fumigation with formaline prior to sowing. The beds are dugout and prepared to the desired size. Formaline treatment is given about 15 days before sowing. 200 cc of formaline in about 4 liter of water per $M^2$ of bed area is applied. The quantity of water added should be sufficient to soak the soil upto at least 15 cm depth. The beds are immediately covered with Polythene sheet which is removed 3 days after the formaline application and soil is raked to allow fumes to escape. While raking the soil, care must be taken that untreated soil does not get mixed up with the treated soil in the top 15 cm. Sowing is then done after about 10 days when toxic effect of formaline is over. Spring sowing coupled with soil fumigation has proved very effective in controlling demping off in case of spruce.

**Mycorrhizal inoculation of nursery beds** - Mycorrhizal association is necessary for healthy growth of seedlings. Mycorrhizal fungi help in nutrient uptake. Nurseries located in natural zone of the species do not need artificial inoculation of mycorrhiza.

**Sowing in the nursery beds** -Sowing in the nursery beds will be done in drills. In no case broad cast sowings will be done. The density at which seed should be sown depends upon seed quality, productivity of the nursery and the period for which the seedlings will stay in the beds. After sowing, seed when covered with coarse sand or fine grit germinates more quickly and gives higher yields than if nursery soil in used.

The approximate quantity of seed to be sown per bed can be found by out by the following formula:

$$W = \frac{A \times D}{P X. N} \times 100$$

where W = Weight of seed required in gms.
A = area of bed in Sq. cm.
D = number of plants required per Sq. m.
P = Plant percent of the seed.
N = Number of seeds per gm.

The following table gives the months in which seed of important species are collected, Number of seeds per kg, approximate germination percentage of the seeds and the time of sowing of each species :-

| Species | Month in which seed is collected | No. of seeds per Kg. | Germination percentage | Month in which sowing is done |
|---|---|---|---|---|
| Abies pindrow | Sept.-Oct. | 16,500 | 30-40 | Preferably early in December otherwise on the melting of snow. |
| Acacia nilotica | Feb. –May | 7,700 | 50-90 | End of June or early in July. |
| Acacia catechu | Jan.- Mar. | 38,500 | 80 | End of June or early in July. |
| Acer caesium | Jul. – Oct. | 12,000 fruits | - | Early in December |
| Aesculus indica | Sept.-Oct. | 50 | 90 | Early in December |
| Albezzia procera | Jan.-April | 23,000 | 70 | Spring |
| Albizzia stipulata | Dec.-Mar. | 2,75,000 | - | Spring |
| Bauhinia variegata | May | 3,200 | - | As soon as the seed is collected |
| Bombax ceiba | Apr. – May | 28,000 | 50-70 | Immediately after seed collection |
| Cedrela toona | May – July | 3,50,000 | 60-80 | As soon as the seed is collected |
| Cedrus deodara | Sept.- Nov. | 7,900 | 50-60 | Preferably early in December otherwise on melting of snow. |
| Dalbergia sissoo | Nov.-Mar | 14,000 pods | 80 | Early in March. |
| Dendrocalamus stirctus | May-June | 55,500 | 60-80 | As soon as the seed is collected. |
| Eugenia jambolona | May-Aug. | 1100 | 50-60 | As soon as seed is gathered. |
| Grewia oppositifolia | Oct.-Dec. | 12,000 | - | Early spring |
| Juglans regia | Oct.-Nov. | 90-100 | 70 | December to February |
| Melia azedarach | Jan.-Feb | 2000 Fruits | 65 | Soon after the seed is gathered |
| Melia indica | June-Aug. | 3000 Fruits | 60 | Immediately after seed collection |
| Morus alba | April-May | 4,50,000 | - | Immediately after seed collection |
| Picea smithiana | Oct.-Nov. | 60,000 | 50-70 | Preferably early in December otherwise on snow melting |
| Pinus wallichiana | Sept.-Nov. | 20,000 | 70-85 | Preferably early in December otherwise on snow melting |
| Pinus roxburghii | Jan.-Mar. | 12,500 | 75-85 | September/October or March |
| Prosopis Juliflora | May-June | 15,000 Pods | 90 | Immediately after collection of the seeds |
| Quercus incana | Dec.-Feb. | 500 | 60 | Early spring in nursery. The winter or early spring for direct sowing. |
| Terminalia arjuna | Dec.-Feb. | 80 | 34 | Early spring in nursery. The winter or early spring for direct sowing. |
| Terminatia bellerica | Feb. | 150-300 | 85-95 | Early spring in nursery. The winter or early spring for direct sowing. |
| Terminalia chebula | Jan.-Mar. | 150 Fruits | 40-50 | Early spring in nursery. The winter or early spring for direct sowing. |

**Transplanting in the nursery lines**:-The objects of transplanting are to provide greater space for young plants to develop and to encourage the formation of a fibrous and compact root system, together with a higher ratio of root to shoot than would develop if seedlings were allowed to grow undisturbed in seed beds.

Under-cutting and wrenching of seedlings in site in the seed beds is sometimes practiced with similar objects.

Seedlings are lifted from the seedbeds and transplanted either at the end of their first or second growing season. Deodar when 6 months old and silver fir and spruce when 18 months old are transplanted. The transplanting is done at a spacing of 15 x 8 cm with the help of the transplanting boards. The undersized and weak seedlings should be culled. Roots of all plants to be transplanted must at all time be protected from drying by covering them with damp moss or hessian cloth. Root pruning, leaving about 10 cm root length intact at the time of transplanting checks root coiling in case of deodar, spruce and silver fir.

**Tending of nurseries** - (i) **Birds and insects** -Immediately after sowing the beds should be covered with thorny branches to keep away the birds from damaging the seed. As soon as the germination is complete, the thorns placed on the beds should be removed. To protect seedling against ravages by cut-worms, the beds should be given a dressing of lime, ashes etc.

(ii) **Weeding soil working and thinning out**:- The nursery beds should be kept thoroughly weeded and the soil well worked up. Congested lines in beds should be thinned out. The object is to produce vigorous healthy plants as early as possible and therefore no delay in thorough weeding, soil working or thinning out, especially at the beginning of first rains, should be tolerated. One weeding in June and another in August should be done. Soil should not be worked when wet.

(iii) **Watering:**- Nursery beds should be watered whenever necessary, especially in the hot dry weather before and after the rains. Irrigation by percolation or by sprinkling should be adopted using in the latter case only cans with the finest possible rose. Care should be taken that over-watering is not done, as it is most harmful. It is one of the commonest failings of the malis. The beds should be kept fresh but not wet.

(iv) **Shading:**- Nursery beds should be shaded whenever necessary, either to protect them against heavy rain immediately after sowing or against the hot sun after germination or pricking out. The shades can also be used for protecting seedlings and transplants against the sun in the hot weather and frost in the cold weather. No shading is required during the rains. Proper shades which do not leak in holes and which can be rolled up should be used. Thatch shades are not good as they leak and cannot be removed. Screens made of nirgal chicks, kana grass or wooden battens designed to give 50 to 60 per cent shade are the best. They should be placed over the beds lengthwise sloping towards the sun and raised about 60 cm above ground level on the lower side, so as to give shade but not to prevent lateral light and sun. The shades should be removed on cloudy days and in the rains after germination, and they should be entirely dispensed with when the plants are strong enough to stand the Sun. When used as against frost, they should be removed during the daytime.

**Lifting and bundling the nursery plants and preparation of stumps:**-Plants should not be pulled up by the roots with the hand, but should be properly lifted so that they come out without their roots injured. The best method of lifting the plants is to dig trench of depth equal to the length of roots along the outside of the first line of plants and then to throw the line of seedlings or transplants backward into the trench with a spade. The plants should then be picked out of the trench, separated by hand, sorted and tied in bundles of 50 or 100 and their roots moistened by dipping the bundles in a bucket of clay and water. All inferior plants should be thrown away. Culling of about 20% plants may have to be done. No effort should be made to plant undersized inferior plants. Only as many plants should be lifted every morning or evening as can be planted the same day or transported during the night for planting the next day.

In case of certain species (Shisham, mulberry) and in unfavorable localities stump (8 cm of shoot and 25 cm of root) planting possesses definite advantages over transplanting of seedlings. Shoot and root development from stumps in these species is more rapid in the first few years. In unfavorable or in areas with uncertain moisture conditions there is greater certainty of successful stocking by planting stumps. The stumps regenerate their root system from near the bottom of the cut tip and so draw on deeper moisture layers of the soil as soon as their roots get developed. Where weed growth is likely to be heavy and more rapid height growth determines the degree of success, stumps are preferable to transplanting. Stumps avoid adverse factors in the top

layers of the soil and are more successful where soil is likely to be eroded. Stumps are easier and quicker to handle than seedlings; and stump planting is a foolproof and quick operation.

When the seedlings are about a year old (or of the thickness of an average thumb at ground level) many of them will be fit for being made into stumps. To take out the seedlings the beds are flooded. When the soil is wet and soft plants are pulled out by hand. Only such seedlings are taken out as have the requisite size of thumb thickness at ground level; other are kept in sites till these become fit till later in the season or in the following year.

**Transport to planting site** -The bundles of seedlings and stumps (each bundle of 100 stumps or so) should be covered with damp moss or moist grass and carefully packed in a kilta or tied. They should be carried to the planting site without unnecessary delay and planted immediately.

If the distance is great, the bundles should be carefully covered with damp moss or moist grass and sewn up in matting before dispatch. On arrival at their destination, the plants or stumps should be at once unpacked, laid in a temporary ditch and covered over with moist earth until they are planted out.

**Exotics**- In the case of exotics or expensive seed of small size, sowing is done in pots or shallow boxes rather than in nursery beds; the seedlings being pricked out in nursery beds when large enough to be handled. The treatment regarding soil, watering and shading is the same as for nursery beds.

**Maintenance of nursery records** -It is essential that proper records of each nursery are maintained in a standard method. The following forms I to 3 are prescribed to be maintained in each nursery.

**FORM NO. 1**

1. Name of nursery.

2. Its location.

3. Soil.

4. Area in hectares.

5. Manner in which fenced.

6. Year in which started.

7. Initial cost on clearance and lay out, etc.

S. Means of irrigation.

9. Rent, if any.

10. Map of the nursery showing lay out and plot numbers, etc.

**FORM NO. 2**

**PLANT STATEMENT (FOR EACH YEAR)**

(To be prepared during June and December)

| **Species** | **No of beds** | **Age** | **Total number of plants** | **Number of plants available** | | **Number of plants disposed of** | | **Given to other department** | **Distributed to public** | **Total** | **Remarks** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Current Year | Next Year | Used Locally | Sent to other Divisions | | | | |
| | | | | | | | | | | | |

**FORM NO. 3**

**COST STATEMENT (FOR EACH YEAR)**

| **Cost upto date preparation and maintenance** | **Cost during the Year** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Month | Tools | Rent | Establi-shment | Fencing | Soil preparation | Manuring | Irrigation | Sowing including cost of Seed | Weeding | Pricking in the Nursery | Miscella-neous | Total | Remarks |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | 1. Jan<br>2. Feb.<br>3. Mar.<br>4. Apr.<br>5. May<br>6. June<br>7. July<br>8. Aug.<br>9. Sept.<br>10. Oct.<br>11. Nov.<br>12. Dec.<br><br>Total | | | | | | | | | | | | | |

**Nursery Technology of Chil (Pinus Roxburghii)**

**Selection of Nursery Site:**

Temporary nurseries either within the planting area or as near to it as possible are preferred to permanent nurseries because transportation of plants raised in the polythene bags is a costly operation and there are chances of the root system of the plants getting damaged during transportation to the planting site. The nursery is raised preferably within the plantation area if sufficient water is available. Availability of sufficient water during the driest period of June is the most important factor governing the selection of nursery site. In case sufficient water is not available within the plantation area the nursery is raised near the permanent source of water and as near to the plantation area as possible. Easy accessibility of the nursery site from the plantation area is important to facilitate transport of polythene bags raised plants at economic cost. Nursery should not be located under the shade of trees, which affect the growth of plants adversely through shade and through the effect of drip. Nursery area of about 10 sq. metres is needed to raise plants sufficient for planting one hectare of area at a spacing of 3 x 3 m.

**Seed Collection:**

The seed is collected from healthy, well grown, twist free, self pruned trees of Chil during the month of February/March. The cones are dried in the sun and the seed is separated and cleaned. About one quintal of green cones are required to give 2 Kilograms of seed. The cones are spread in the sun to open and to separate out the seed. The cones should not be dried on fire as this operation reduces the viability of the seed considerably.

Cleaning of seed from all the impurities is very essential as the quantity of foreign material such as cone scales, wings, bits of twigs, needles etc. present in the seed increases its cost. Special care is, therefore, necessary in winnowing and cleaning of seed.

**Filling of polythene Bags**:

The filling of Polythene bags is done at the nursery site. The soil is dug and sieved to remove stones, stubble's, clods etc. Well rotten farm yard manure or humus collected from forest floor is sieved separately. The soil and the manure are mixed in 2:1 ratio. Mixing of some sand may also be necessary if the soil is clayey. Some soil collected for the Chil forest is also mixed to acts as inoculum for Chil mycorrhiza if the nursery site from where soil has been collected for filling the polythene bags is outside Chil forest. About 5 grams super phosphate and application of 5 grams of CAN per bag is recommended for better growth of plants. Superphosphate is mixed thoroughly in the soil before the Polythene bags are filled.

The Polythene bags are then filled and the soil is compacted properly so that the soil column in the Polythene bag does not slump subsequently on watering. It should be ensured that the Polythene bags have been perforated before filling in order to avoid water logging and ensure aeration to the roots of the plants.

**Pre- Sowing Seed Treatment and sowing:**

Sowing is normally done in the latter half of March. Seedlings obtained from late sowing do not become fit for planting in July and late sowing should, therefore, be avoided. In some forest divisions, sowings are done in September or October to produce plants for July planting. Though the plants produced from September/October sowings are taller than those produced from March sowings, but the cost per plant increases thereby increasing the cost of plantation; As the plants

raised from March sowing become big enough for planting through the application of fertilizer and proper care and have given as high survival percentage as the seedlings raised from September/October sowings, the sowing of Chil in Polythene bags in September/October needs to be discouraged.

The general practice at present is to sow two Chil seeds in each bag without any pre treatment. As the germination takes from about 12 to 15 days, direct sowing results in loss of valuable period which can otherwise be utilized for the growth of plants. In cases where both the seeds fail to germinate this practice results in wastage of expenditure on the cost of polythene bags and their fillings. Resowing of failed polythene bags does not produce plants of plantable size by July. Uncertainty of germination necessitates filling of much larger number of Polythene bags than actually required and it increases the nursery cost. To overcome these difficulties the sowing of pre-germinated seeds was tried and has been found to be more advantageous.

Chil seed is put in a bucket of water in which some salt has been dissolved. The seeds, which float, are rejected as these are of poor quality and give low germination percentage. The remaining seeds which settle down at the bottom of the bucket are taken out and mixed in cow dung. Cow dung containing Chil seeds is wrapped in gunny bags and is put inside a pit. Water is sprinkled on the gunny bags daily to keep the seeds inside, moist. Chil seeds sprout in about 10 to 12 days time depending upon the atmospheric temperature. The bag is examined after about 10 days. The sprouted seeds are taken out and sown in the polythene bags. After taking out the pregenerated seeds for sowing the gunny bag is wrapped again and kept in the pit. It is taken out again the next day to select sprouted seeds. This operation is repeated for about a week till most of the seeds have sprouted and are sown in the Polythene bags. The seeds which do not sprout within a week from the start of sprouting are rejected.

**Watering and After Care:**

The Polythene bags are watered with rose can frequent and light watering is required and over watering should always be avoided, as Chil is very susceptible to water logging. Frequent weeding is necessary to remove weeds from the Polythene bags. Experience has shown that during summer months weeding once a month is enough. Extreme care is necessary in weeding so that the roots of the seedlings are not injured and tiny chil seedlings are not pulled out during weeding.

**Nursery Technology of Spruce (Picea Smithiana) and Silver Fir (Abies Pindrow)**

**Introduction**

Spruce and silver fir are the main species felled for supply of wood for fruit packing cases. The regeneration of these species did not keep pace with their fellings, with the result large extent of areas could not be regenerated. The extent of such un-regenerated areas will continue to increase further, till adequate measures are taken to plant the felled areas in time. Extensive research trials have been carried out in the past to standardize the nursery and plantation technology of these species. The technology so developed is given below

**Selection of Nursery Site**

Nurseries should be located towards the lower limit of the natural zone of the species. Exposed ridges, frost holes, natural blanks, badly drained pockets, steep slopes and southern aspects should be avoided in selecting nursery site. Nursery site should preferably be selected on aspects other than southern, on moderate slope and

near assured water source. The soil should be deep, fertile, well drained and loam. Stiff clayey soil with impeded drainage offer poor nursery site. Nursery site served by road offers an advantage in transport of seed, manure and fertilizers, labour and planting stock at economic costs.

It is estimated that a nursery area of about 100 $m^2$ (5$m^2$ for germination beds + 95 $m^2$ transplant beds) will be needed to produce 1,000 plantable plants annually

**Seed Collection and Storage**

Seed cost is a very small proportion of the total plantation cost. Thus the use of good quality seed at higher cost is a good investment for the future. Seed should be collected from healthy middle aged trees of good form and not from over mature trees which generally produce seeds of low germinative capacity. Earmarking of plus stands and plus trees for seed collection pays dividends. Seeds of silver fir should not be collected from higher elevations because of free hybridisation between Abies pindrow and Abies spactabelis. Such a seed source not only gives poor seedling growth in the nurseries but also poor growth in the plantations.

Cones are collected during first fortnight of October before their opening on the trees. These are spread in the sun to open. Cleaning of seed is important as otherwise the impurities which consist mainly of scale, wings and twigs may constitute a sizeable proportion of the seed.

Silver fir and spruce seed losses viability if not properly stored. Exposure of these seeds to high temperature even for short period reduces the viability of geed appreciably. So long as there are no proper seed storage arrangements the surplus seeds for use in subsequent years should be stored in air tight containers in a dry and cool place

**Treatment against Damping Off**

Damping off takes a very heavy toll of nursery seedlings of spruce and silver fir. Only very young, seedlings are attacked and susceptibility declines rapidly after the stems begin to develop woody tissue. Attack on the developing radicle may kill the seedling before it emerges from the soil. Such pre-emergence damping off may go undetected and be explained away as poor seed. Post emergence infection occurs just at the ground line and the seedlings become flaccid and topple over. Damping off is most severe in excessively wet nursery soils.

Soil fumigation with formaline, before sowing, has proved helpful in controlling damping off. The beds are dug out and prepared to the desired size. Formaline treatment is given about 15 days before sowing. 200 cc of formaline is about four liter's of water per square metre of bed area is applied. The quantity of water added should be sufficient to soak the soil upto at least 15 cm depth. The beds are immediately covered with Polythene sheet. The Polythene sheet is removed after three days of the formaline application and the soil raked to allow the fumes to escape. While raking the soil, it should be ensured that the untreated soil does not get mixed up with the treated top soil. The beds are kept as such for about ten days before sowing to avoid toxic effect of formaline on seed. After the germination of seeds, the beds are drenched with 0.2% solution of Blitox every fortnight for three months.

**Mycorrhizal Inoculation in Nurseries**

Mycorrhizal association is necessary for healthy growth of seedlings. Mycorrhizae help in nutrient uptake. Artificial inoculation of mycorrhiza is however, not necessary in nurseries located in the natural zone of the species.

**Sowing in Nursery**

Sowing is done in raised beds of 2m x 1m size in autumn before snowfall. Sowing is done in lines 8cm apart. The quantity of seed to be sown per unit area of nursery bed will depend upon the germination percent of the seed lot to be sown. The germination percentage of freshly collected silver fir seed has been found 30 to 40 percent and that of spruce 50 to 60 percent. About 150 gms of silver fir seed with 40% germination and 50gms of spruce seed with 60% germination is sown per sq. metre of nursery area. The quantity of seed to be sown shall however vary depending upon the germination percent of the seed lot. Depth of sowing is normally 15 mm. Before sowing, seed is soaked in water for about 24 hours. In case of spruce the seed which floats over water is discarded. Seed is covered with humus or good texture soil. Watering is to be done regularly. It may be ensured that there are no water stresses during the germination period of the seed.

**Shading**

Shading of germination beds against high temperature is essential. Shades made from wooden battens of 125 x 2 x 0.3 cm dimensions provide suitable shading material. The wooden battens are fastened together with the help of nylone thread or steel wire. The gap between two consecutive battens is kept approximately 0.7 cm. This type of shading permits about 30 to 40 percent direct sunlight on the beds. These wooden shades can be rolled and removed when no shading is required.

**Weeding**

Regular weeding is necessary to save the seedling from being smothered by weeds. Weeding is not done till the germination is complete. In the germination beds, weeding is done manually. Pulling out of weeds from nursery beds during germination periods causes high morality and is, therefore, to be done very carefully.

**Transplanting**

Transplanting of seedlings in the nursery is necessary to encourage fibrous root development and to make the seedlings sturdy to withstand the planting shock. Only one transplanting at the age of 1½ years is done. Transplanting should be done during rainy season after onset of monsoon. Seedlings which are less than 10 cm in height should not be transplanted. Transplanting is done at a spacing of 15 x 8 cm with the help of transplanting boards. Furrows for transplanting are not always dug sufficiently deep which results in root coiling and consequent root deformity. Root pruning, leaving about 10 cm of root length intact at the time of transplanting has been found helpful against root coiling. Root pruning has been found to improve root/shoot ratio and it does not affect the survival and growth of transplanted seedlings.

Shading of transplanted beds is essential during the 1st year. The planting are ready for planting out in the field after 2 years of transplanting in case of spruce and 3 years in case of silver fir.

**Lifting and Sorting of Plants**

Plants are vulnerable to damage by drying out while they are being lifted and transported to the planting site. The more the fine roots are retained at the time of lifting the better are the chances of survival after planting. Care during lifting is directed the maximum amount of short fibrous roots, avoiding stripping of bark of the roots and breaking of the roots. At the time of lifting, beds are worked from an outside edge. Spade is inserted vertically to the full depth of the blade and the handle is

pressed down. The movement is repeated until the soil is loose. Then the plants are gently lifted by grasping the top of the plants and soil is shaken from the roots.

After lifting, sorting of the plants is done by culling the substandard plants. Sorting can be done directly in the nursery eliminating and leaving all substandard plants on the soil. Culling up to 20% of the stock should be considered as normal. No effort should be made to plant substandard plants to avoid heavy mortality after planting.

**Transportation of Plants**

When the young plants are lifted from the nursery they are susceptible to damage by drying out. Drying out is particularly serious when the time gap between the lifting of plants from the nursery and their planting in the field is very long. Efforts should be made that time gap between lifting of the plants from the nursery and their final planting in the field is minimum. The roots of the plants have to be properly covered with moss kept moist during transportation. At the planting site the plants should be kept in cool shady places and in no case be kept under sun. Drying out of the roots before planting is considered one of the major causes of mortality after planting.

## Containerized nursery technique of Conifers and important cold desert species *

Although there are biological and production advantages to be realized from growing seedlings in containers, the key to success depends on field performance. Comparisons of container grown and nursery seedlings that are outplanted at the same time in many species indicate that container-grown seedlings can perform as well or better when high quality stock is used. There are recorded proofs that after five growing season, containerized longleaf pine seedlings survived better and grew faster than 1+0 nursery seedlings when planted on hill sites. Under drought conditions container-grown seedlings survived and grew better than nursery bare-root stock. The container seedlings have many advantages over bare-root plants when the particular species, site or situation warrants their use. Although the initial investment in container stock is higher than bare-root, this cost is quickly repaid with improved survival and growth of the container seedlings. Various containerized seedling production systems are in use in the country:

a. Conventional Polybag Production System
b. Root-trainer Production System

**a. Conventional Polybag Production System:**

In India, large number of plants is raised in polybags especially in tropical areas. The major advantage of conventional polybag seedling production system is that the polybags carry some amount of nutritious potting mixture and moisture with them to the planting site, which is often critical for survival of seedlings in the field. The other advantage is that the method is well established, reliable and cheap. It does not expose roots at the time of planting. For most species, polybag production system is in practice since early sixties and its efficacy and efficiency has been standardized. Mostly transparent and black colour polybags are being used in the nursery. However, the practice suffers with the following disadvantages:

- Polybag seedling is bulky to transport
- Large amount of inputs are required for raising seedlings
- Poor aeration
- There is always a possibility of root distortion especially when bigger seedlings are to be planted
- It discourages lateral root development

- Roots, many a times struck to the ground and results into non-uniformity of the stock

**b. Root-trainer Production System:**

Root-trainers are increasingly being introduced to deal with the problems of root-coiling and distortion. Root-trainers are the containers usually made of High Density Polyethylene and designed with various kinds of attributes. These specialized containers are certainly advantageous over existing polybag system. Some of the advantages are:

- Root trainers require lesser inputs in terms of water, potting mix, space etc.
- Roots are trained vertically downwards and do not coil & at the same time get air pruned on exposure which encourages lateral root development
- Root-trainers do not require shifting operations
- They are easy to handle and transport with in the nursery and facilitate control over infection

Besides these advantages, there are certain disadvantages of root-trainer production system as pointed out by Gera *et al* (1996):

- Root-trainer when kept in open, requires frequent watering
- The limited space in root-trainer results in filling of lesser amount of potting mix leading to nutrient stress in the plant
- Though the root development is better in root-trainer grown seedlings, the collar diameter and height growth is not proper
- Root-trainers made of HDPE are said to be durable but they do not last long when kept in open or recycled material is used

For establishing model nursery for root-trainer production system, the following facilities will be needed to develop at the nursery site:

- Root-trainers (for raising at least 50,000 plants)
- Potting mixture shed.
- Composting Unit
- Shade house
- HDPE micro sprinkler system

**Major Findings of root-trainers trials carried out at HFRI Shimla:**

Trials were conducted to find out the optimum size/type of root-trainers for nursery production of *Abies pindrow, Picea smithiana*, *Cedrus deodara* and some broad leaved species such as *Alnus nitida, Grewia optiva* and *Quercus dilatata*. The result thus obtained revealed that the growth performance of all these three conifer species was found to be the best when raised in single cell root trainers of the size 500 cc followed by 300cc. Similarly, for *Alnus nitida* and *Grewia optiva* nursery stock when raised in different sized root-trainers showed that stock raised in 500cc single cell excelled in various growth parameters.

The following size/type of root-trainers, polybag and nursery bed as control were used as treatments in one the trial on *Abies pindrow*:

| Treatments | Container Used |
|---|---|
| **$T_1$:** | Hiko Pots, 150cc |
| **$T_2$:** | Hiko Pots, 250cc |
| **$T_3$:** | Hiko Pots, 300cc |
| **$T_4$:** | Single Cell Bullet type, 300cc |
| **$T_5$:** | Single Cell Bullet type, 500cc |
| **$T_6$:** | Polybag 23x15cm. |
| **$T_7$:** | Nursery bed |

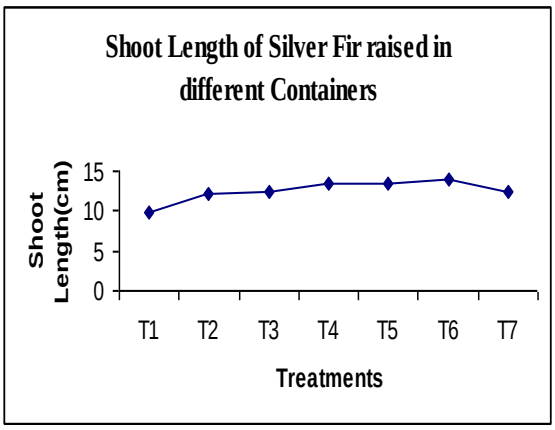



Figure-1

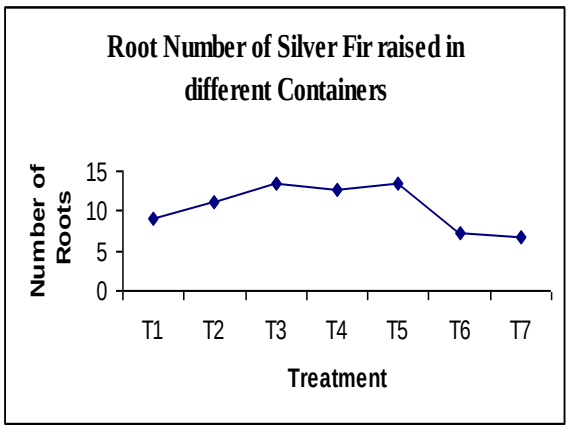



Figure-2

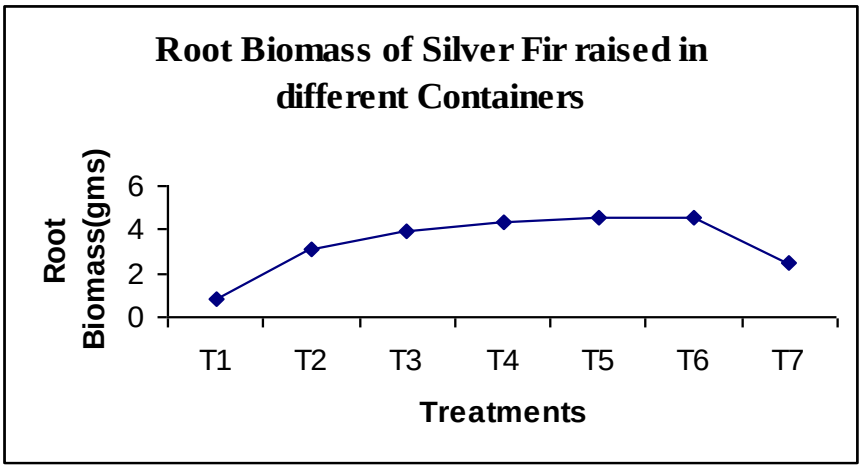



Figure-3

**Graph (Fig.-1-3) showing Growth Parameters of *Silver Fir* raised under different treatments**

Appraisal of graphical data indicates that 500cc Single Cell Bullet type excelled over other treatments in various growth parameters such as shoot length, number of roots and root biomass followed by 300cc Single Cell Bullet type in *Abies pindrow* seedlings raised in different containers.

**Nursery stock production of Silver Fir in root-trainers**

Similarly, a trial was conducted to find out the optimum size/type of root-trainers for nursery production of *Picea smithiana*. The following size/type of root-trainers and polybags along with nursery bed as controls were used as treatments:

| Treatments | Container Used |
|---|---|
| **$T_1$:** | Hiko Pots, 150cc |
| **$T_2$:** | Hiko Pots, 250cc |
| **$T_3$:** | Hiko Pots, 300cc |
| **$T_4$:** | Single Cell Bullet type, 300cc |
| **$T_5$:** | Single Cell Bullet type, 500cc |
| **$T_6$:** | Polybag 23x15cm. |
| **$T_7$:** | Nursery bed |

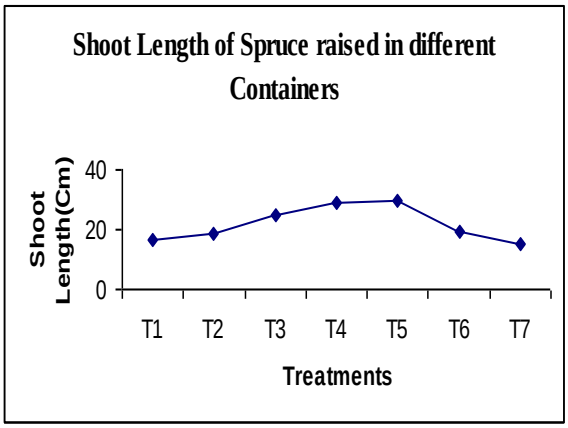



Figure-4

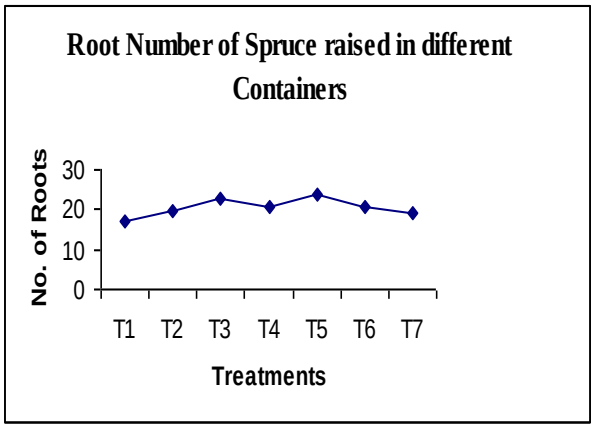



Figure-5

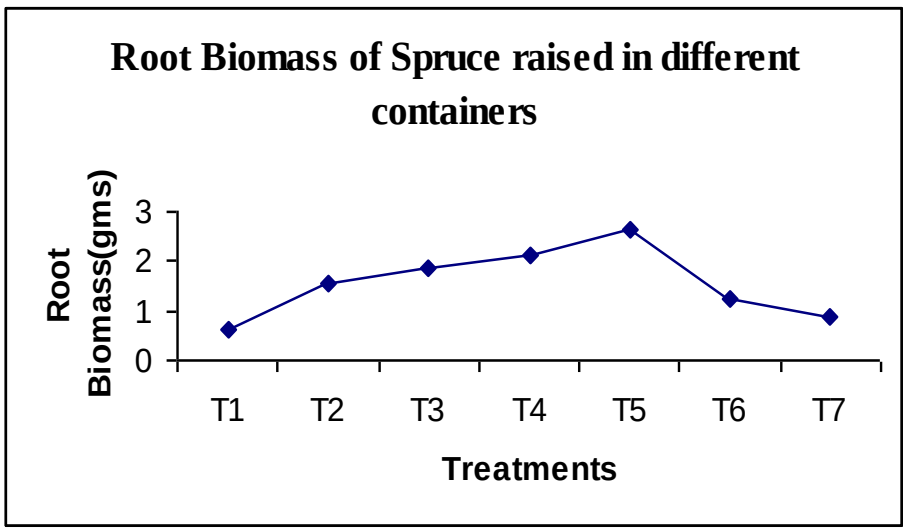



Figure-6

**Graph (Fig.-4-6) showing Growth Parameters of *Picea smithiana* raised under different treatments**

Appraisal of graphical data indicates that 500cc Single Cell Bullet type excelled over other treatments in various growth parameters such as shoot length, number of roots and root biomass followed by 300cc Single Cell Bullet type in *Picea smithiana* seedlings raised in different containers.

**Nursery stock production of Spruce in root-trainers**

Similarly, a trial was conducted to find out the optimum size/type of root-trainers for nursery production of *Cedrus deodara.* The following size/type of root-trainers and polybag were used as treatments:

| Treatments | Container Used |
|---|---|
| **$T_1$:** | Hiko Pots, 150cc |
| **$T_2$:** | Hiko Pots, 250cc |
| **$T_3$:** | Hiko Pots, 300cc |
| **$T_4$:** | Single Cell Bullet type, 300cc |
| **$T_5$:** | Single Cell Bullet type, 500cc |
| **$T_6$:** | Polybag 23x15cm. |

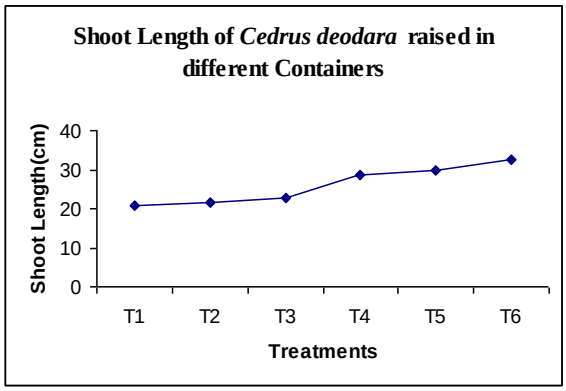



Figure-7

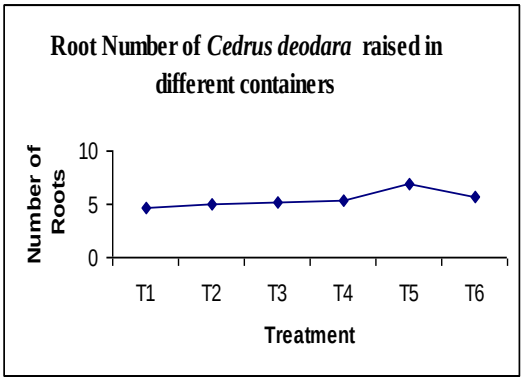



Figure-8

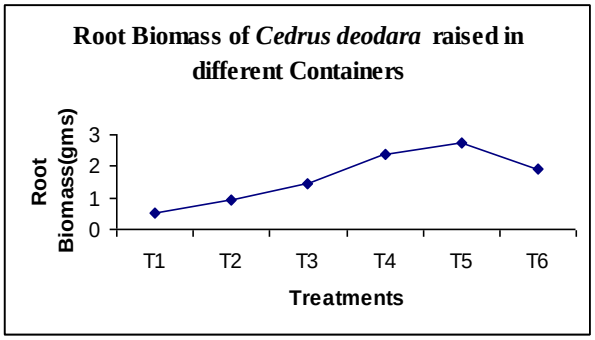



Figure-9

Graphs (Fig.-7-9) showing Growth Parameters of *Cedrus deodara* raised under different treatments

**Nursery stock production of Deodar in different types of root-trainers**

Appraisal of graphical data indicates that 500cc Single Cell Bullet type excelled over other treatments in various growth parameters such as shoot length, number of roots and root biomass followed by 300cc Single Cell Bullet type in *Cedrus deodara* seedlings raised in different containers.

A trial was conducted to find out the optimum size/type of root-trainers for nursery production of *Alnus nitida.* The following size/type of root-trainers and standard size polybag as control were used as treatments:

| Treatments | Container Used |
|---|---|
| **$T_1$:** | Hiko Pots, 150cc |
| **$T_2$:** | Hiko Pots, 250cc |
| **$T_3$:** | Hiko Pots, 300cc |
| **$T_4$:** | Single Cell Bullet type, 300cc |
| **$T_5$:** | Single Cell Bullet type, 500cc |
| **$T_6$:** | Polybag 23x15cm. |

Appraisal of data indicates that 500cc Single Cell Bullet type excelled over other treatments in various growth parameters such as shoot length, number of roots and root biomass followed by 300cc Single Cell Bullet type in *Alnus nitida* seedlings raised in different containers.

Similarly, a trial was conducted to find out the optimum size/type of root-trainers for nursery production of *Grewia optiva.* The results indicates that 500cc Single Cell Bullet type excelled over other treatments in various growth parameters such as shoot

length, number of roots and root biomass followed by 300cc Single Cell Bullet type in *Grewia optiva* seedlings raised in different containers. Besides root-trainer studies, experiments were also carried out on plug+2 in Spruce (*Picea smithiana*) and plug+3 in Silver Fir (*Abies pindrow*) for raising nursery stock of these species first in containers and then as bare roots. In case of plug+2 experiment in Spruce, root plug formed in 250 cc block type root-trainer of one year old and subsequently planted in nursery beds for $2^1/_4$ years resulted in better root biomass and root/shoot ratio over control. In another trial on Silver Fir i.e. plug+3 nursery productions, suitable root-plug formation was achieved in 150 cc block type root trainer after $1^1/_4$ years, which when subsequently planted in the nursery beds for 3 years resulted in better root biomass and root/shoot ratio over control.

**Brief description of package & practices of important conifer species evolved**

The trails were conducted mainly for studying 'Root-trainer seedling production system' in raising nursery stock of conifers namely Deodar (*Cedrus deodara*), Silver Fir (*Abies pindrow*) and Spruce (*Picea smithiana*) so that their nursery period could be reduced. Traditionally, these conifers are raised in the nursery as bare root seedlings and require $4^1/_2$ years (Silver Fir); $3^1/_2$ years (Spruce) and $2^1/_2$ years (Deodar) respectively as nursery period for producing sizable stock for better outplanting success. Therefore, to reduce the nursery period of these conifers, the idea of intervention with root-trainer seedling production system was kept in mind while initiating these trials. The root-trainers are special containers usually made up of High Density Polyethylene, designed with various kinds of root training attributes to overcome root development deficiencies and to boost up the quality and rate of growth. In the world of nursery production, root-trainer may be reckoned as 'Force Multipliers'. They are made of virgin material with an UV inhibitor added for increased life expectancy. All cavities have vertical root training ribs. The vertical ridges help developing roots to grow down straight without getting entangled with the adjoining roots. When the roots reach the bottom they are exposed to light & air and stop growing. The exposed roots get air-pruned and this signals the plants to send out fresh roots and thus root fibrosity increased.

**Package of practices for raising nursery stock of Silver Fir in root-trainers:**

Traditionally Silver Fir is raised as bare root nursery stock. It usually takes $4^1/_2$ years to become ready for transplanting in the nursery owing to very slow growth. However, nursery stock of this species can be raised in $3^1/_2$ years through root-trainer seedling production system by adopting following practices evolved during the course of this project:

- Root-trainer of size 500cc or 300cc with vertical length more than 20cm should be used.
- Potting media comprised of compost: soil: sand in the ratio of 3: 1:1 should be filled in the root –trainers. Compost should be preferably prepared from nursery weeds or Deodar, Kail needles. Soil must be obtained from natural zone of Silver fir to facilitate mycorrhizal association of root–trainers raised seedlings.
- Before filling potting media in to root-trainers, it should be treated with Formaline to disinfect it and to protect germinating seedlings from damping off diseases.
- The sowing should be done in the month of March directly in the root-trainers.
- Two seeds per root-trainer should be sown so that even aged stock in all cells could be produced.

- There is no seed treatment required before sowing in root trainers. However, winnowing of seed is required for separating the impurities.
- The seed should be sown at 1.5 cm depth in root trainers.
- Germination of seed is observed after 15-20 days of sowing and it completes within one month.
- After one month, cells without germinants should be filled by transplanting seedlings from cells where two seedlings emerged.
- Transplanting should be done in early morning hour or in late evening hours and care should be taken not to expose roots of the germinants in the air for more than 30 seconds. This will keep the casualty to bare minimum.
- Agro-shade net that provides 50% shade is required for Silver fir nursery stock.
- The shade is required from April to October to protect the seedlings from scorching Sun during entire nursery period of the root-trainer grown stock. The shade should be removed during last 1-2 months of nursery period i.e. just before out planting. However care should be taken to protect root system from sudden buildup of soil temperature in plastic containers.
- Each cell of root-trainer should be top refilled with similar type of potting media in the ratio of 3(compost): 1(soil): 1(sand) at every 6 months during entire nursery period of Silver fir. This will replenish nutrients for better growth and development.
- Daily light irrigation through water canes having fine holed flower attachment is required. This will help in prevention of loss of precious potting media from the top of root trainer or otherwise irrigation should be provided through micro sprinkler system.
- Frequent soil working with small iron rod or wooden stick is needed to avoid crust formation and removal of weeds at the top of root trainer media and it will also keep the potting media well aerated.
- Plants are ready for transplanting when 3 ½ years of age with average height of around 13cm.
- Care should be taken while transplanting root- trainer plants in the field. Fir plants should be extracted with the help of wooden stick by gently inserting it from lower opening of root-trainer cells while ensuring/keeping the ball of earth intact with roots.
- Root trainer plants should be immediately planted after extraction from the cell.

**Package of practices for raising nursery stock of Spruce in root-trainers:**

Traditionally Spruce is raised as bare root nursery stock. It usually takes $3^1/_2$ years to become ready for transplanting in the nursery owing to slow growth. However, nursery stock of this species can be raised in $2^1/_2$ years through root-trainer seedling production system by adopting following practices evolved during the course of this project:

- Root-trainer of size 500cc or 300cc with vertical length more than 20cm should be used.
- Potting media comprised of compost: soil: sand in the ratio of 3: 1:1 should be filled in the root –trainers. Compost should be preferably prepared from nursery weeds or Deodar, Kail needles. Soil must be obtained from natural zone of Spruce to facilitate mycorrhizal association of root –trainers raised seedlings.
- Before filling potting media in to root-trainers, it should be treated with Formaline to disinfect it and to protect germinating seedlings from damping off disease.
- The sowing should be done in the month of March directly in the root-trainers.

- Two seeds per root-trainer should be sown so that even aged stock in all cells could be produced.
- Pre-sowing treatment of Spruce seeds with tap water for 24 to 48 hours is required that would also help in elimination of empty floating seeds for obtaining better germination percentage.
- The seed should be sown at 1.0 cm depth in root trainers.
- Germination of seed is observed after 15-20 days of sowing and it completes within one month.
- After one month, cells without germinants should be filled by transplanting seedlings from cells where two seedlings emerged.
- Transplanting should be done in early morning hour or in late evening hours and care should be taken not to expose roots of the germinants in the air for more than 30 seconds. This will keep the casualty to bare minimum.
- Agro-shade net that provides 50% shade is required for Spruce nursery stock.
- The shade is required from April to October to protect the seedlings from scorching Sun during entire nursery period of the root-trainer grown stock. The shade should be removed during last 1-2 months of nursery period i.e. just before out planting. However care should be taken to protect root system from sudden buildup of soil temperature in plastic containers.
- Each cell of root-trainer should be top refilled with similar type of potting media in the ratio of 3(compost): 1(soil): 1(sand) at every 6 months during entire nursery period of Spruce. This will replenish nutrients for better growth and development.
- Daily light irrigation through water canes having fine holed flower attachment is required. This will help in prevention of loss of precious potting media from the top of root trainer or otherwise irrigation should be provided through micro sprinkler system.
- Frequent soil working with small iron rod or wooden stick is needed to avoid crust formation and removal of weeds at the top of root trainer media and it will also keep the potting media well aerated.
- Plants are ready for transplanting when 2½ years of age with average height of around 22cm.
- Care should be taken while transplanting root- trainer plants in the field. Spruce plants should be extracted with the help of wooden stick by gently inserting it from lower opening of root-trainer cells while ensuring/keeping the ball of earth intact with roots.
- Root trainer plants should be immediately planted after extraction.

**Package of practices for raising nursery stock of Deodar in root-trainers:**

Traditionally Deodar is raised as bare root nursery stock. It usually takes $2^1/_2$ years to become ready for transplanting in the nursery owing to slow growth. However, nursery stock of this species can be raised in $1^1/_2$ years through root-trainer seedling production system by adopting following practices evolved during the course of this project:

- Root-trainer of size 500cc or 300cc with vertical length more than 20cm should be used.
- Potting media comprised of compost: soil: sand in the ratio of 3: 1:1 should be filled in the root –trainers. Compost should be preferably prepared from Deodar, Kail needles. Soil must be obtained from natural zone of Deodar to facilitate mycorrhizal association of root–trainers raised seedlings.
- Before filling potting media in to root-trainers, it should be treated with Formaline to disinfect it and to protect germinating seedlings from damping off disease.

- The sowing should be done in the month of December directly in the root-trainers.
- Two seeds per root-trainer should be sown so that even aged stock in all cells could be produced.
- There is no seed treatment required before sowing Deodar seeds in root trainers.
- The seed should be sown at 1.5 cm depth in root trainers.
- Germination is initiated in early spring i.e. February and completes within one to two months.
- During the end of March, cells without germinants should be filled by transplanting seedlings from cells where two seedlings emerged.
- Transplanting should be done in early morning hour or in late evening hours and care should be taken not to expose roots of the germinants in the air for more than 30 seconds. This will keep the casualty to bare minimum.
- Agro-shade net that provides 50% shade is required for Deodar nursery stock in root-trainers during first growing season (March to October) and subsequently net that provides 35% shade during hot summer months of second growing season (April to June). However care should be taken to protect root system from sudden buildup of soil temperature in plastic containers.
- Each cell of root-trainer should be top refilled with similar type of potting media in the ratio of 3(compost): 1(soil): 1(sand) at every 6 months during entire nursery period of Deodar. This will replenish nutrients for better growth and development.
- Daily light irrigation through water canes having fine holed flower attachment is required. This will help in prevention of loss of precious potting media from the top of root trainer or otherwise irrigation should be provided through micro sprinkler system.
- Frequent soil working with small iron rod or wooden stick is needed to avoid crust formation and removal of weeds at the top of root trainer media and it will also keep the potting media well aerated.
- Plants are ready for transplanting when 1½ years of age with average height of around 28cm.
- Care should be taken while transplanting root- trainer plants in the field. Deodar plants should be extracted with the help of wooden stick by gently inserting it from lower opening of root-trainer cells while ensuring/keeping the ball of earth intact with roots.
- Root trainer plants should be immediately planted after extraction.

**Seed & Nursery Technology of *Juniperus polycarpos* (Himalayan Pencil Cedar)**

*Juniperus polycarpos* C. Koch syn. *Juniperus macropoda* Boiss. is an important conifer of North-Western Himalayan Region. It is commonly known as "Himalayan Pencil Cedar". It is one of the indigenous Junipers found in the cold arid areas of Himachal Pradesh and Jammu and Kashmir. The natural regeneration occurs only in those areas where biotic pressure is low and protective measures have been carried out by the local communities. The low regeneration in their natural habitat can be also attributed due to its seed which do not germinate owing to seed dormancy even in the presence of favourable environmental condition. The threat status of *Juniperus polycarpos* was assessed during the CAMP workshop organized at Himalayan Forest Research Institute, Shimla during 2003 based on IUCN Threat categories and it was categorized as endangered species for North-Western Himalayan region. The seed technology of *Juniperus polycarpos* (Himalayan Pencil Cedar) developed at HFRI during last 5 year has been summarized in the following heads:

**Seed Collection**

- The berries of *Juniperus polycarpos* should be collected directly from the tree and seed collection from the ground should be strictly avoided as most of the berries found to be infected with various insect pests and pathogens.
- Collection of infected berries even from trees of *Juniperus polycarpos* should be avoided as such collections contain large number of empty seeds which ultimately result in poor or no germination.
- Berries should be collected during the month of November (preferably second fortnight) as most of the seeds get ripened by this period and germination percent has been found to be maximum. It was observed that seed collected during the month of September and October though morphologically exhibited fruit maturation, but germination was found to be nil indicating probably the physiological immaturity of embryo.
- Utmost care should be taken during seed collection because immature and mature berries easily get mixed together during collection. Therefore, always avoid picking of immature berries which are greenish in colour.
- The colour of the mature berries at the time of collection is Black Group 203A (Royal Horticulture Society Colour Chart, London 2007) whereas the colour of seed is Grayed Orange Group 164B (RHS Colour Chart, London).
- Avoid pruning of branches for collection of berries as it will harm future fruit setting as well as growth of the plant.

**Seed Processing:**

- *Juniperus polycarpos* berries should be dried in the shade for a week immediately after collection from the field.
- Because of sticky nature of berries, it becomes difficult to separate seeds from the berries, hence, berries should be soaked in luke warm water containing 5% Lye solution (Na OH) for 3 days for easy seed extraction.
- Berries become soft after soaking in water and seeds can be separated from the pulp by macerating the berries on wire mesh with the help of some oval or round shaped stone.
- After maceration, seeds contain large number of inert material such as parts of crushed berries, empty seeds etc., hence, repeated soaking and rinsing in water is essentially required so that inert materials and empty seeds float on surface of water where as mature and healthy seeds remain at the bottom of container.
- Separate the seeds from the unwanted materials and spread them on the filter paper after separation from the berries and then dry for 7-10 days in shade under room temperature.
- *Juniperus polycarpos* seeds contain large number of impurities besides empty seeds; hence precaution must be taken during seed extraction to avoid mixing of impurities with pure seeds. The impurities can be separated from the seeds with the help of seed blower.
- Discard empty and infested seeds of Juniper completely during seed processing.
- The purity percentage to the tune of 91.30 percent in *Juniperus polycarpos* seed is achievable after following procedure.

**Seed Storage and Processing:**

- The seeds of *Juniperus polycarpos* being orthodox in nature require low moisture and temperature during storage for maintaining seed viability. Hence, the best range for storage of *Juniperus polycarpos* seed is between 5-10% moisture content at 0-5$^0$C temperature.
- The moisture content of the berries and seeds is 26.69% and 9.20% respectively after complete drying in the laboratory.

- The seeds of *Juniperus polycarpos* should be stored in air tight moisture-proof polysac containers under low temperature (<5$^0$C) in refrigerated condition for maintaining seed longevity.
- The seed stored in air tight moisture-proof polysac containers under low temperature retains more than 70% viability after one year of storage and 55% viability after two years of storage.
- It has been observed that heavy seed exhibits more viability compared to lighter seed.
- The storage of seeds under ambient room condition should be strictly avoided as seed losses viability completely within one year of storage.

**Pre-sowing treatments:**

- The seeds of *Juniperus polycarpos* exhibits morpho-physiological seed dormancy and it requires appropriate pre-sowing treatments before sowing in the nursery.
- The morphological dormancy is due to the presence of hard seed coat whereas physiological dormancy might be due to immature embryo or presence of certain inhibitors.
- The study conducted for breaking seed dormancy in *Juniperus polycarpos*; seeds were treated with different pre-sowing and stratification treatments viz., citric acid, cold moist stratification in cowdung, sand and goatdung. The results revealed that seeds stratified in cowdung and placed in pits for 60 days duration during winter recorded maximum 70% germination, which was followed by soaking in Citric acid 8000ppm for 4 days that registered 62 % germination where as untreated seeds registered 40% germination under Polyhouse condition in the nursery.
- Hence, it is recommended that seeds should be stratified in cowdung for getting maximum germination. Besides this, soaking in Citric acid 8000ppm for 4 days is also suggested as an alternative treatment for getting better seed germination when less time period is left for stratification.
- It is also noticed that seeds heavier than water recorded good germination. Therefore, seeds that float in the water during seed treatment should be discarded immediately and only submerged seed should be used.

**Seed sowing and production of nursery stock:**

- The best medium found for germination is sand bed, hence, seeds should be sown in line at a spacing of 2cm x 4cm in sand beds for better germination.
- Depth of sowing should be kept at 1.5 cm.
- Watering should be done as and when required preferably with inverted rose cane to avoid damage and to keep the germination beds moist.
- Avoid seed dehydration in nursery during germination stage as it induces secondary dormancy after sowing.
- Provide frequent irrigation in winter to prevent seed desiccation.
- It takes around 10 months time after proper stratification in nursery to get good germination. That means one has to wait quite long in nursery before the initiation of germination in sand beds.
- Keep the germinated seedlings in sand beds for one growing season and then transplant them in polybags filled with Soil, Sand and FYM in the ratio of 2:1:1in the second growing season.
- The seedlings will attain 20-25cm shoot length after 4 years of seed sowing in the nursery and can be used for planting in the field.
- This year in March, HFRI has supplied 1000 no. Plants of this speices to Kinnaur Forest Division.

**Title of the Technology:**

**Nursery Technology of Indigenous Cold Desert Species**

**The Rationale Behind:**

The Cold Deserts refers to the areas where the climate has characteristic and great extremes of heat and cold combined with excessive dryness. The temperature in these tracts normally ranges from -40$^0$C during winters to + 40$^0$C in summers. Water deficiency and dryness conditions exist primarily because of absence of monsoon rains. Precipitation is mainly in the form of snow during winters and if at all rainfall is there it is well below the limits otherwise required for the proper growth and development of the vegetation. The terrain consists of plains, plateaus, hills and valleys and the soils are generally grey and light, characterized by its low fertility status coupled with the poor water retention capacity and with scanty plant cover. Summers (June to September) -the major growth period for the plants growing over there- are quite short and because of this underlying fact the plants require more time to establish themselves in such harsh areas. Besides, to ward off the high velocity winds, almost all the plant species remain stunted and also develop other specific mechanisms to survive in the xeric conditions. Because of these extremities the entire region of Cold Deserts, wherever they occur, remains underdeveloped.

The land use statistics reveal that only 31 per cent of the total land of the inhabited villages are under cultivation, which amounts to only 0.2 per cent of the total geographical area of the region. The per capita cultivated land is very low (0.15 ha.) with the area under cultivation being confined only to the flatter portions of the valley land with possibilities of irrigation. Animal husbandry is the second most important sector in the region which magnifies the fodder problem.

In the past a major programme the Desert Development Programme (DDP) with cent per cent central assistance and aiming at arresting the development of deserts with schemes relating to afforestation including pasture development besides other related activities was launched by the Government of India with the objective to harness the local resources to their optimum utilization but suffered and were unable to make the desired impact.

**The Issue:**

Standardization of nursery technologies of indigenous species and also of the species those have adapted to a very limited, unusual environments or very harsh climate or to exceptional soil conditions in a given region.

**Initiation of the Efforts:**

With all this in view, Himalayan Forest Research Institute, Shimla made a beginning and carried out detailed floristic surveys in the cold deserts covering the states of Himachal Pradesh and Jammu & Kashmir. As a result of it, some region specific indigenous and other prominent plant species and also having socio-economic relevance for the local populace and ecological significance for this specific region, ultimately benefitting the end users were identified. Once the species were shortlisted, specific ways and means to propagate them further came in the way and this was how the research need of this unique area threw a challenge to the scientists at the institute for devising strategies to make the best use of ecologically available areas for eco-restoration of these fragile sites by making use of the indigenous flora thereby, withstanding the multi-faceted vagaries of the region.

The institute started nursery trials on the species like *Elaeagnus angustifolia, Rosa webbiana, Colutea nepalensis, Ribes orientale, Capparis spinosa, Caragana gerardiana,*

*Crataegus songarica* and *Hippophae rhamnoides* with special reference to standardization of their Nursery Techniques at Field Research Station, Tabo.

Out of the above identified species only three species (***Elaeagnus angustifolia***: a Sacred Tree for the people; ***Rosa webbiana***: A bush with fruits important to the Wildlife and as a fence to the farmers and ***Colutea nepalensis***: A Shrub having ecological significance and playing important role in the daily lives of people of the area) keeping in view their relevance to the area are being taken up for studies.

## A. Nursery Technology

*1. Elaeagnus angustifolia* L., is a small deciduous tree belonging to the family Elaeagnaceae and commonly known as **Silver Berry** and locally as Gaandhae in Spiti. Its wood is an excellent fuel, flowers offered in the Monastery to appease Lord Buddha and the juice extracted from flowers, cures malignant fevers.

New growing shoots of 20 to 25cm length of *Elaeagnus angustifolia* collected from healthy mature plants during April treated with 5000 ppm to 6000 ppm concentrations of IBA using quick dip method in soil and sand medium gave more than 90% rooting in poly-house. Whereas 6000 ppm to 7000 ppm concentrations in open nursery conditions in soil medium gave more than 70% rooting. After rooting, all the plants kept in beds in open nursery during next growing season for hardening. The stock gets ready for out planting in the third growing season.

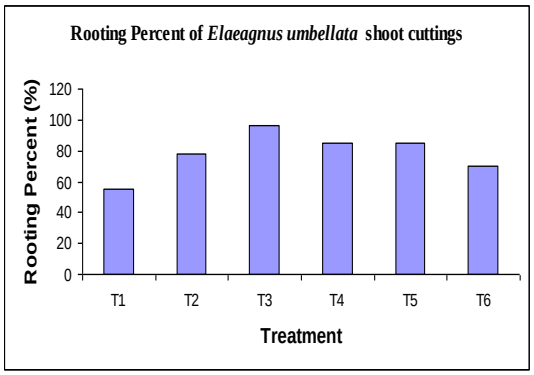
***2. Rosa webbiana*** Wall. ex Royle belonging to family Rosaceae, commonly known as Sia in Spiti, is an important shrub of the Cold Desert. It is suitable for bio-fencing to protect the agricultural crops of the farmers and effectively used for reclamation of degraded sites. Seeds of the species mature by first week of October and after its collection and processing must be sown immediately in poly house for best germination (80%) and 60% in open nursery condition. Whereas, the germination declines if the seeds are sown during the following March/ April. The plant can also be propagated by root cuttings of 12 - 15 mm thickness. However, one should prefer the propagation of the plant through seeds.


***3. Colutea nepalensis* (Sims) Baker**, locally known as Milky in Spiti valley, is another important shrub of the cold desert and occurs in mountain slopes and riverside gravel. The species is of high economic value to the local population, where people make ropes out of its bark and its sticks are used during construction of houses. Seeds of the species mature by mid of September hence, should be collected and processed. Sowing should be done during April in the nurseries to obtain maximum germination (upto 80 per cent) in poly house condition. The seedlings kept in poly house during first growing season and during the second growing season shifted to open nursery condition in the beds for subsequent hardening. The stock is ready for out planting in the third growing season.

**Vegetative Propagation Studies:**

Vegetative propagation trials of potential cold deserts species viz. *Elaeagnus umbellata*, *Colutea nepalensis* and *Rosa webbiana* were conducted under semi controlled condition in mist chamber. The *Elaeagnus umbellata* shoot cuttings were treated with following treatments:

**$T_1$ :** {Control (Talcum powder only)};
**$T_2$ :** {0.05% IBA + 0.05% Captan + 0.1% Sucrose};
**$T_3$ :** {0.1% IBA + 0.05% Captan + 0.1% Sucrose};
**$T_4$ :** {0.15% IBA + 0.05% Captan + 0.1% Sucrose};
**$T_5$:** {0.2% IBA + 0.05% Captan + 0.1% Sucrose};
**$T_6$:** {0.25% IBA + 0.05% Captan + 0.1% Sucrose}

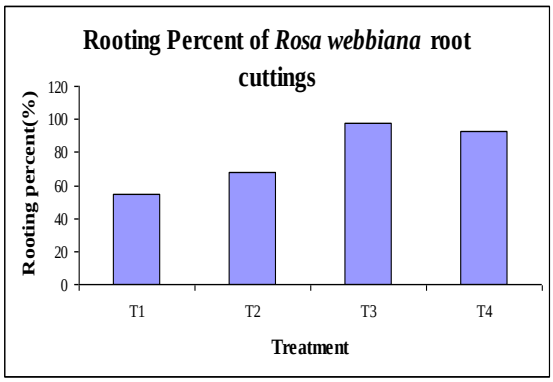


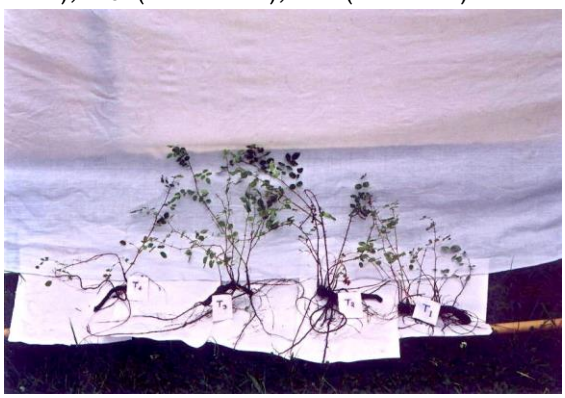

**Rooting Percent of *Elaeagnus umbellata* Shoot cuttings under different treatments**

Appraisal of graphical data indicates that shoot cuttings of *E. umbellata* treated with IBA 1000ppm in talc having 0.05% captan and 0.1% sucrose produced significantly greater adventitious roots i.e. 96.30% as compared to 55.56% in untreated cuttings under semi-controlled conditions.

Similarly, the *Colutea nepalensis* shoot cuttings trial was conducted at HFRI. It was found that the shoot cuttings of *Colutea nepalensis* treated with IBA 1000ppm in talc having 0.05% captan and 0.1% sucrose found economically best treatment for the production of adventitious roots i.e. 93.33% as compared to 53.33% in untreated cuttings under semi-controlled conditions.

In *Rosa webbiana*, root cuttings of following diameter classes were used for vegetative propagation purposes.$D_1$: (12-14mm), $D_2$: (10-12mm), $D_3$: (8-10 mm), $D_4$: (6-8 mm)



**Rooting Percent of *Rosa webbiana* Root cuttings under different diameter classes**

Appraisal of graphical data indicates that root cuttings of *Rosa webbiana* with dia-class 8-10mm and length 15cm recorded 95% success after one year of planting.

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**Source:* ***Himalayan Forest Research Institute,*** *Conifer Campus, Panthaghati, Shimla-171 009 (H.P.)*

## NURSERY TECHNIQUES OF IMPORTANT TEMPERATE MEDICINAL PLANTS*

For initiating commercial cultivation of temperate medicinal plants, availability of Quality Planting Material (QPM) is essential prerequisite. Mostly the farmers who are producing food crops, vegetable and horticulture crops can easily produce medicinal plants crop in their fields. However, simple nursery techniques as evolved at HFRI-Shimla for raising nursery stock of important species in large quantity are described as follows:

**Nursery techniques evolved for raising *Picrorhiza kurrooa* (Kutki)*:***

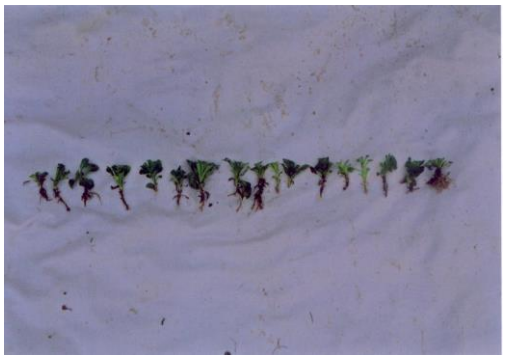
- Best time for collection of Kutki from natural habitat was found second fortnight of May with maximum survival.
- It is difficult to propagate through seeds and even collection of seeds is problematic.
- It was found that the species could be propagated vegetatively with >95% success during rainy season in sand beds.
- Through macro-proliferation technique a mature Kutki plant can be multiplied 8-10 times in every two & half year's period.
- Macro-proliferation can be done successfully under poly-house conditions from March to November in higher temperate climate.
- Nursery plants require 35% shade during summer months.
- Nursery stock of Kutki should be produced in raised beds and over watering and water logged conditions must be avoided.

**Macro-proliferation technique developed for raising *Picrorhiza kurrooa*:**

**Macro-proliferation:**

- It is low cost simple technique based on Bamboo macro-proliferation technique developed by FRI-Dehradun. This method ensures that each propagule possess some part of shoot along with rhizome parts & some roots at the time of separation from mature healthy plant.
- Through macro-proliferation technique Kutki/Karu plant can be multiplied 8-10 times in every two & half year's period.

Mature Plant



Macro-proliferated propagules

Propagules planting in poly-house

Raising nursery stock in poly-house

**b. Nursery techniques evolved for raising *Valeriana jatamansi* (Mushakbala):**

- *Valeriana jatamansi* can be collected from March to November from natural habitat for nursery/field planting.
- It is easy to propagate through seeds as well as vegetative means.
- Through macro-proliferation technique mature Mushakbala plant can be multiplied 12-15 times in every two years period.
- The best period for macro-proliferation of Mushakbala was found to be June but under poly-house conditions it could be done from March to November.
- Nursery stock should be produced in raised beds and over watering and water logged conditions must be avoided.

Mature Plant

Macro-proliferated propagule

Propagules ready for planting

Mushakbala in field

- For the best growth in nursery optimum spacing for planting *Valeriana jatamansi* is 9 plants/m2. A Multiple Nursery Planting Bar has been designed and fabricated for this purpose

**Multiple Nursery Planting Bar**

**Nursery techniques evolved for raising *Aconitum heterophyllum* (Atish):**

- It is easy to propagate through seeds. November sowing was found to be better than April sowing. A seed rate of 2gm/sq m was found good for obtaining maximum germination under nursery conditions.
- For obtaining better germination and subsequently better survival of germinants 75% shade was found suitable in the nursery.
- Transplanted nursery plants required 50% shade during summer months.

- For vegetative propagation, the species could be propagated through disc with 15.62% survival.
- For best growth, optimum spacing for planting *Aconitum heterophyllum* in nursery was obtained 16 plants/sq m.

**Atish in the nursery**

**Nursery techniques evolved for raising *Angelica glauca* (Chora):**

- It is moderate to propagate through seeds. Sowing of seeds in pre and post winter was found to be equally good.
- For biomass production November sowing was found to be better than April sowing.
- A seed rate of 4gm/sq m was found good for obtaining maximum germination.
- For best growth optimum spacing for planting Chora in nursery was obtained 9 plants/sq m.
- For obtaining better germination and better survival of germinants 35% shade was found suitable in the nursery.
- For vegetative propagation, the species could be propagated through disc with >50% success under polyhouse conditions.


**Chora production in the nursery**

**Commercial Cultivation Prospects:**

As on date, there is no inventorization of medicinal herbs in the state. The information about potential areas of medicinal herbs is also not well documented based on studies. Species potentials and species specific zones yet to be identified. Therefore, lot of information regarding medicinal herbs of the state need to be collected/complied. The in depth studies are required to quantify medicinal wealth of the state based on sample plots in every potential forest areas. Besides these, the work on standardization/improvement of agro-techniques and various management practices of economically important species of medicinal plants is urgently required to be completed so that so that farmers could be trained for adopting cultivation of medicinal plants in their agricultural fields in Himachal Pradesh. It is also an important issue to be looked into that how the chemical composition of medicinal herbs changed under cultivated conditions vis-à-vis wild production and its effect on marketable produce. For that medicinal herbs have to be grown under different sets of climatic conditions and the variation in their biomass production and chemical composition need to be estimated, documented and compared with wild produce collected from their natural habitat. But overall, the prospect for commercial cultivation of selected temperate medicinal plants species viz. *Aconitum heterophyllum*, *Picrorhiza kurrooa*, *Angelica glauca*, *Valeriana jatamansi*, *Swertia chirata* etc. is quite high as the raw material demand from these plants by industry has been increasing rapidly. The National Medicinal Plants Board has given no. of projects to various organizations including HFRI-Shimla for the production of quality planting material of these temperate medicinal plants species, so that commercial cultivation can be initiated on farmers' field. The HFRI- Shimla has produced around eight lakhs quality

planting material of *Picrorhiza kurrooa, Valeriana jatamansi, Aconitum heterophyllum* and *Angelica glauca* in various nurseries of the institute under NMPB funded projects for its distribution among local communities. It is a good option available with temperate farmers for the diversification of hill agriculture/horticulture. Still individual farmers are not coming forward for initiating commercial cultivation of medicinal plants on their fields because of marketing of produce and not much reliable data of economics of medicinal plants cultivation in hills viz a viz as vegetable crops. To boost growth of medicinal plants sector, govt. is now providing up to 70% of grant to cultivators/growers under various schemes.

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**Source:* ***Himalayan Forest Research Institute,*** *Conifer Campus, Panthaghati, Shimla-171009 (H.P.)*

# CHAPTER IV

## FOREST SEED

The genetic make of the seedling is embodied in the seed. The use of well filled viable seed of good inherent quality provides a sound basis for raising of vigorous and healthy forests capable of producing wood of high quality. Seed cost is minute proportion of the total sum needed for raising a plantation. Thus the use of seed from sources, which give even small increases in growth rate, is a good investment for the future. This aspect has not been paid as much attention, as it deserves. It is, therefore considered expedient to issue separate instructions in this regard.

**Quantity of Seed**

Quantity of seed of different species require should be worked out by the Divisional Forest Officer for a period of at least 3 years well in advance, keeping in view the quantities used in the past and the likely allocation of funds/targets for subsequent years. The quantity required will thereafter be consolidated by the Conservator of Forests concerned.

**Seed production areas**

Seed stands or seed production areas are formed to produce superior quality seed. Seed stands are formed by selecting vigorous, healthy and well formed trees as seed trees. In seed stands degree of improvement depends upon effective isolation of seed trees from inferior sources of pollen through removal of phenotypically inferior trees from the stands.

Proper record of each seed production area should be maintained in each. Division indicating its location, species, area etc.

**Seed Collection**

Every effort should be made to collect sufficient seed in good seed years because not only are cones and, fruits plentiful but the quality of seed is also good. When the seed crop is sparse, the germination capacity of seed is low. Most of the conifers growing in the State have a marked periodicity in seeding, a good seed year occurs only once in 3 to 5 years.

The time of seed collection also affects its germination capacity. The germination percentage of seed collected too early is low and often does not store well. If collection is delayed, the seed falls down and its germination capacity is lost.

Seed is generally collected by the agency of Forest Guards through unsupervised labour from easily approachable, deformed or crooked trees. Much improvement is, therefore, required in seed collection. Each seed sample should be labelled, indicating the species, area and date of collection.

**Seed Bank**

In order to ensure sustained seed supply, it is necessary to have seed banks at suitable places.

**Seed extraction**

The ease of extracting seed from the cones varies with species. Silver fir and deodar cones require no special steps because the cones break up soon after

collection. However, the cones of Chil, Kail and Spruce have to be dried and tumbled in drums to free seed. The cones received in the extractory have high moisture content and, therefore, need drying by spreading in the extractory for some weeks. After initial drying of a few weeks, the cones are dropped in the dryer having a temperature of about 30-50$^{o}$ C. After drying the cones, seed has to be separated by rotating them in a wire mesh drum. A hot drought of air at temperature varying from 30 to 45$^{o}$ C is sent through the drum. The freed seeds will then fall through the mesh and collected in a container.

**Seed drying**

The moisture content of the seed has to be brought to the desired level before it is stored. This is best achieved by passing a regulated stream of warm dry air through the seed until the desired moisture, content is reached. The spruce seed is stored at 5 6% moisture content but moisture content of deodar, silver fir seed cannot be brought below 10-12% as it loses its organic vitality at moisture contents below this. Oak acorns have high moisture content at the time of ripening. The moisture contents of acorns should not go below 35% in order to preserve their organic vitality.

**Seed Purification**

The seeds where the seed wings are detachable should be dewinged by gentle rolling around between cloth sheets. Wings, cone scales and other impurities are then separated from the seed by winnowing.

**Seed Testing**

The purpose of seed testing is to provide accurate estimate of the germination capacity of a given seed lot. Seeds should always be tested before sowing to determine the quantity of seeds to be sown per unit area. There are some tests which provide quick evaluation of seed viability. They are usually not reliable as germination tests but provide necessary information when time is limited. Some of such tests are Tetrazolium test, Excised embryo test and X-ray test.

**Seed Stores**

Most species of conifers can be stored without loss of viability for several years, given proper control of the moisture content of the seed and the correct temperature of storage. Pine and spruce seed can be best stored at temperature between 2$^{0}$ to 0$^{0}$ whereas deodar and silver fir seed at -5$^{0}$ to -10$^{0}$ C Storage of Oak acorns and horse chest nut is difficult and efforts should be made to sow them immediately after collection

The storage will be of two types, short term and long term storage. Short term storage will be upto a period of two years and long term for a period exceeding two years. The cold rooms for short term storage will have a temperature of about 0$^{0}$ C and that for long term storage upto -10$^{0}$ C. There will be two rooms one for short term storage and the other for long term storage.

Clean seed is stored in airtight plastic bottles. Transparent containers are preferred for storage of seed as one can see the quantity of seed inside them without opening. Opening of containers during storage may allow moisture to enter into the containers and thereby deteriorate the seed. Plastic bottles are preferred to glass bottles as the former are non-brittle and light in weight.

**Annexure – VII A**

**Seed Stands & Seed Production Areas in Himachal Pradesh***

The State Forest Department has set up **Seed Stands** for various species. Circle-wise summary of these Seed Stands is as under:

| Circle | Division | Species | | | | |
|---|---|---|---|---|---|---|
| | | **Deodar** | **Chir** | **Kail** | **Fir/ Spruce** | **Ban Oak** |
| **Rampur** | Kinnaur | 3 | | | 2+1 | |
| | Spiti | | | | | |
| | Rampur | | | 1 | | |
| | Kotgarh | | 2 | 1 | 2 | |
| | Ani | | 2+2 | | | |
| **Shimla** | Shimla | 1 | 3 | | | |
| | Chopal | 3 | 2 | | 1 | |
| | Theog | 3 | | 2 | 1 | |
| | Rohru | | | 1 | | |
| **Nahan** | Solan | 2 | 4 | | | |
| | Rajgarh | 1 | 1 | | | |
| | Renuka | | | | | |
| | Paonta Sahib | | | | | |
| | Nahan | | 2 | | | |
| **Bilaspur** | Bilaspur | | 1 | | | |
| | Nalagarh | | | | | |
| | Kunihar | | 4 | | | |
| **Mandi** | Suket | 1 | 1 | | 1 | |
| | Nachan | 1 | 3 | 3 | 2+2 | 2 |
| | Mandi | | 2 | 1 | 2 | |
| | Jogindernagar | | 2 | | | |
| | Kasrsog | | | | | |
| **Kullu** | Kullu | 3 | | 3 | 2 | |
| | Parvati | | 1 | 2 | 2 | |
| | Seraj/ Banjar | | 1 | 2 | 2 | |
| | Lahoul | | | | | |
| **Dharamsala** | Dharamsala | | 3 | | | |
| | Palampur | | | | | |
| | Nurpur | | 4 | | | |
| **Hamirpur** | Una | | | | | |
| | Hamirpur | | 7 | | | |
| | Dehra | | | | | |
| **Chamba** | Chamba | 22 | | 6 | 3 | |
| | Dalhousie | 4 | 13 | | 3 | 3 |
| | Bharmour | 1 | | 3 | | |
| | Churah | 1 | | | | |
| | Pangi | | | | | |
| **Total:** | | **46** | **60** | **25** | **26** | **5** |

In addition, the following three **Seeds Production Areas** of Chir Pine (*Pinus roxburghii*) have been developed by the Himalayan Forest Research Institute and transferred to the State Forest Department in 2002-03:

| | | | |
|---|---|---|---|
| 1 | Kopra DPF | 10.52 ha | Nurpur Forest Division |
| 2 | Dibkan DPF | 18.44 ha | Jogindernagar Forest Division |
| 3 | Bairkot DPF | 22.00 ha | Suket Forest Division |

**Annexure – VII B**

**Division-wise/ Species-wise detail of Seed Stands (based on information given in Working Plans):**

| Name of Circle/ Division | S. No | Range/Block/Beat | Name of Forest & Compartment No. | Area in ha. for seed production/ seed stand |
|---|---|---|---|---|
| **DEODAR** | | | | |
| **Rampur Circle** | | | | |
| Kinnaur | 1 | Nichar/Tranda/ Tranda | C.70-A | 66.36 |
| | 2 | Tranda | C-69-C | 69.60 |
| | 3 | Bhawa/Bhawa/Nagar | C.71(b)1, Tranda Solding | 40 |
| **Shimla Circle** | | | | |
| Shimla | 4 | Mashobra/Mashobra/ Naldehra | D.70 Naldehra C5 | 19.00 |
| Chopal | 5 | Chopal/Chopal/Chopal | Chopal C.3 | 48.05 |
| | 6 | Sarain/Sarain/Chiuna | Chiuna C.2 | 56.65 |
| | 7 | Kanola/Kanola/Kanola | Kanola C.4 | 21.85 |
| Theog | 8 | Theog/Cheog/Cheog | R.11 Cheog C.2 | 28.40 |
| | 9 | Kotkhai/Gohach/Nihari | Jarahi C.3 | 29.05 |
| | 10 | Kotkhai/Gawarag/Ratnari | DPF Sonabatota, C.2(b) | 76.89 |
| **Nahan Circle** | | | | |
| Solan | 11 | Chail | 1/23 Binoo C.1 | 26.00 |
| | 12 | Taradevi | 1/12 Tallgui C.2 | 17.00 |
| Rajgarh | 13 | Habban | R-16 Dalmu Dev Kikaltar C.2 | 21.62 |
| **Mandi Circle** | | | | |
| Suket | 14 | Baldwara/Jhungi | DPF Bairkot C.III, Khobla, Kamrah & Kanon | 30 |
| Nachan | 15 | Thachi/Bali/Panjain | OD.70-ropa-karot.C.2 | 33.52 |
| | | | | |
| **Kullu Circle** | | | | |
| Kullu | 16 | Manali/Vashishat/ Vashishat | 1/4 Dudlu C4 | 78.23 |
| | 17 | Naggar/Naggar/Naggar | 1/19 Nagarjhir C2 | 18.34 |
| | 18 | Kullu/Kais/Borsu | 1/31 Borsu C2 | 36.42 |
| **Chamba Circle** | | | | |
| Chamba | 19 | Masrund/Chhatrari/Chhatrari | Chattari R.F.C.I | 20 |
| | 20 | Masd/Chhatrari/Saloh | Saloh R.F.C-II | 10 |
| | 21 | | Dhand-RFC-II | 10 |
| | 22 | L/Chamba/Sahoo/Kiri | Banjal R.F. | 10 |
| | 23 | | Talliu R.F. | 5 |
| | 24 | L/Chamba/Chamba/ Gudda | Gudda DPF C-I | 10 |
| | 25 | L/Chamba/Chhabaru/ Chhabaru | Chhabaru West DFP C-1-a | 10 |
| | 26 | U/Chamba/Bakani/Loa | Loa RF | 12.55 |
| | 27 | U/Chamba/Chhatrari/Troni | Troni RF | 23.88 |
| | 28 | U/Chamba/Chhatrari/Troni | Sakral RF | 12.95 |
| | 29 | U/Chamba/Kundi/Kundi | Kundi RF C-II | 48.56 |
| | 30 | U/Chamba/Kundi/Kundi | Kundi RF C-III | 82.31 |
| | 31 | U/Chamba/Kundi/Kundi | Kundi RF C-IV | 3.24 |
| | 32 | U/Chamba/Kundi/Brehi | Bharyala C-I | 17.08 |

| | | | | |
|---|---|---|---|---|
| | 33 | U/Chamba/Kundi/Brehi | Bharyala C-II | 2.75 |
| | 34 | U/Chamba/Kundi/Darkund | Kathwara I | 29.14 |
| | 35 | Tikri/Thalli/Bara | Bara RF | 165 |
| | 36 | Tikri/Thalli/Bara | Danga Makwa RF | 135 |
| | 37 | Tikri/Tassor/Deola | Chamarchuna RF | 70 |
| | 38 | Tikri/Jassor/Deola | Khajriala RF | 10 |
| | 39 | Tikri/Chanju/Sundri | Sundri | 125 |
| | 40 | Tikri/Jassor/Sundri | Duari RF | 105 |
| Dalhausie | 41 | Chawari/Kaintly/Kaintly | Kaintly RF C-X | 10 |
| | 42 | | Kaintly RF C-1 | 10 |
| | 43 | Dalhausie/Dalhausie/ Bathrii | Dodra RF | 5 |
| | 44 | Dalhausie/Drada/Drada | Naghuin DPF | 5 |
| Bharmour | 45 | Bharmour/Sandi/ Pranghala | Prangala RF 146 CI | 50.59 |
| Churah | 46 | Chakloi/Pango/Jamia | Khakri RF R-IIIC-II -V | 9.47 |

| **Name of Circle/ Division** | **S. No** | **Range/Block/Beat** | **Name of Forest & Compartment No.** | **Area in ha. for seed production/ seed stand** |
|---|---|---|---|---|
| **CHIL** | | | | |
| **Rampur Circle** | | | | |
| Anni | 1 | Arsu (Kurpan) | 1/8 Lohar C.2 | 295.12 |
| | 2 | Anni | 1/17 Gawan C.3 | 14.97 |
| Ani | 3 | Neither/Magi/Nove | 1/8 Lohar C-2 | 295.12 |
| | 4 | Neither/Dalash/Dalash | 1/17 Gown C-3 | 14.97 |
| Kotgarh | 5 | Kumarsain | UF Deha (whole) | 128.00 |
| | 6 | Nogli | DPF Kubban C.2 | 42.00 |
| | | | | |
| **Shimla Circle** | | | | |
| Shimla | 7 | Mashobra/Mashobra/ Naldehra | D-C9 Sawankior C.1 | 29.60 |
| | 8 | Mashobra/Bhajji/ Manalorghal | D.I Ratia C.2 | 39.00 |
| | 9 | Bhajji | D.2 Mahasaser C.1 | 60.20 |
| Chopal | 10 | Throach/Throach/Bharanu | Bharanu C.2 | 60.00 |
| | 11 | Karnala/Sainj/Bag Manjlohi | UPF Bag Whole | 450.23 |
| | | | | |
| **Nahan Circle** | | | | |
| Nahan | 12 | Jamta/Banethi/Banethi | RF East Banethi C.4 | 05 |
| | 13 | Jamt | East Banethi C.1 (d) | 23.00 |
| Solan | 14 | Chail | 1/22 Chaklian C.1 | 29.00 |
| | 15 | Subathu | DPF Kothi (whole) | 87.60 |
| | 16 | 1/34 Chabil-kj- | C.4 | 42.00 |
| | 17 | Taradevi | 1/12 Tagri C.1 | 54.00 |
| Rajgarh | 18 | Sarahan | Argusna C.1 | 61.60 |
| | | | | |
| **Bilaspur Circle** | | | | |
| Bilaspur | 19 | Swarghat/Swarghat/Swargh at | C1a & b Swarghat | 71.60 |
| Kunihar | 20 | Arki | Majathu C.5 | 22.50 |
| | 21 | Kuthar | Baragaon C.2 | 22.80 |
| | 22 | Ramsnana | Kotkahii C.2 | 14.57 |
| | 23 | Dhami | R-16 Shalli (Whole) | 18.80 |

| | | | | |
|---|---|---|---|---|
| **Hamirpur Circle** | | | | |
| Hamirpur | 24 | Barsar/Bumbloo/Jandrer | C3b and C3d Am Palatu | 1.5 |
| | 25 | Hamirpur | P 49 Chauara C.1 | 20.00 |
| | 26 | -do- | Dhar Chabutra C.2 | 34.40 |
| | 27 | Aghar | P-8 Samatana C.2 | 38.40 |
| | 28 | -do- | Dhar-J-Jakh C.8 | 7.20 |
| | 29 | Bijri | P.23 Chaisai C.4 | 16.00 |
| | 30 | -do- | Dhar Chabutra C.4 | 16.00 |
| **Mandi Circle** | | | | |
| Mandi | 31 | Drang | DPF Dibkan Whole | 124.24 |
| | 32 | Panarsa | DPF Naudogri whole | 123.40 |
| Suket | 33 | Baldwara/Jhungi | DPF Bairkot C.IIIm Khabola, Kamrah & Kanon | 30 |
| Joginder -nagar | 34 | Urla/Urla/Gwali | DPF Dibkan C-1(a&b) | 18.44 |
| | 35 | Jogindernagar | DPF Sayuri C.3 | 238.76 |
| Nachan | 36 | Pandoh/Pandoh/Pandoh | OD-495-Dhumadevi C.1 & C.2 | 79.25 |
| | 37 | Nachan/Bassa/Kharsi | ND.384.Mahithana-C.1 to C.5 | 181.3 |
| | 38 | Nachan | DPF Mahithana (Part) | 81.00 |
| | | | | |
| **Kullu Circle** | | | | |
| Parvati | 39 | Sainj/Sainj/Sainj | 1/47 Chaliala | 46.54 |
| Banjar | 40 | Inner Seraj | 1/28 Sairoopa C.2 | 28.28 |
| **Dharamsala Circle** | | | | |
| Nurpur | 41 | Nurpur/Nurpur/Nurpur | R-16 N Bindravan C2 | 12.96 |
| | 42 | Kotla/Mastgarh/Mastgarh | R-6 Mastgarh C2 | 60.70 |
| | 43 | Kotla/Bhaili/Bhaili | R-15 Bhaili C1a | 25.90 |
| | 44 | Nurpur | R-16 Bindradan C.1 | 23.47 |
| Dhara-msala | 45 | Nagrota | P.19 Chelidhar C.1 | 50.58 |
| | 46 | Kangra | P.37 Kharat C.1 (g) | 13.00 |
| | 47 | Jwalamukhi | U.3 D Habroi (whole) | 148.49 |
| | | | | |
| **Chamba Circle** | | | | |
| Dalha-usie | 48 | Bakloh/Mamul/Mamul | Bara RF CII | 5 |
| | 49 | | Muntla DPF | 3 |
| | 50 | Chawari/Manuhta/ Manhuta | Baila RF C. III | 15 |
| | 51 | Chawari/Raipur/Raipur | Phagot DPF C-I | 15 |
| | 52 | Bhattiyat/Motla/Motla | Rehal Ban DPF | 10 |
| | 53 | | Dharta DPF | 5 |
| | 54 | Bhattiyat/Tundi/Tundi | Talai DPF C.V.a | 5 |
| | 55 | Dalhausie/Surkhighatta/ Nagali | Dabrain DPF | 5 |
| | 56 | | Bagdhar NDPF | 5 |
| | 57 | Dalhausie/Surkhighatta /Sherpur | Chhamb NDPF | 5 |
| | 58 | Dalhausie/Surkhighatta/ Sherpur | Ghangidhar DPF | 5 |
| | 59 | Dalhausie/Surkhighatta/ Banikhet | Baderu CII | 5 |
| | 60 | Surkhi Kallan | DPF Dradha C.2 | 32.66 |

| Name of Circle/ Division | S. No | Range/Block/Beat | Name of Forest & Compartment No. | Area in ha. for seed production / seed stand |
|---|---|---|---|---|
| **Kail** | | | | |
| **Rampur Circle** | | | | |
| Kotgarh | 1 | Kumarsain | Dowala C.1 (b) | 22.00 |
| Rampur | 2 | Nogli | Punau C.2 | 102 |
| | | | | |
| **Shimla Circle** | | | | |
| Theog | 3 | Balson/Deha/Deha | D.131 Deha C.3 | 44.60 |
| | 4 | Kotkhai/Kotkhai/Kotkhai | R.13 Chambikupper C.2(a) | 56.20 |
| Rohroo | 5 | Tikkar/Tikkar/Tikkar | DPF Tikkar C.6(b) | 108.05 |
| | | | | |
| **Mandi Circle** | | | | |
| Nachan | 6 | Thachi/Thachi/Deothach | ND105.Deothach (Protection) | 13.35 |
| | 7 | Seraj/Janjehli/Baila | ND-236 Lahrisilh C.2 | |
| | 8 | Seraj | DPF Tharani Part | 55.85 |
| Mandi | 9 | Panarsa | Saran Kalyala C.2 | 29.14 |
| | | | | |
| **Kullu Circle** | | | | |
| Kullu | 10 | Naggar/Naggar/Jana | 1/24 Ledi Chalon C2 | 16.19 |
| | 11 | Naggar/Hallan/Barashai | 1/14 Padradhanoch whole | 33.47 |
| | 12 | Naggar/Hallan/Sarasai | 1/18 Jhangar Kalon C2 | 40.36 |
| Seraj | 13 | Seraj | R.5 Sochli C.2 | 57.87 |
| | 14 | Hurla | 1/18 Khanorunal C.2(a) | 81.34 |
| Parvati | 15 | Jari/Dhara/Shat | 1/18 Khanorunal CII(a) | 81.34 |
| | 16 | Jari/Jari/Jari | R/6 Bindrahan C2 | 28.20 |
| | | | | |
| **Chamba Circle** | | | | |
| Chamba | 17 | U/Chamba/Chhatrari/Chhatrari | Nanhoon C-1 | 51.37 |
| | 18 | U/Chamba/Kundi/Kundi | Kundi RF C-II | 48.56 |
| | 19 | U/Chamba/Kundi/Kundi | Kundi RF C-III | 82.31 |
| | 20 | U/Chamba/Kundi/ Darkund | Kathwara I | 29.14 |
| | 21 | Tikri/Thalli/Bara | Taun RF | 50 |
| | 22 | Bhandel | DPF Bhandend whole | 61.00 |
| Bharmour | 23 | Bharmour/Sandi/ Pranghala | Prangala RF 146 CII | 52.81 |
| | 24 | U/Ravi Bharmour | RF. 146 C.2 Brangala | 52.61 |
| | 25 | Chatrari | RF 156 Rakhani Chobu C.2 | 78.10 |
| | | | | |

| Name of Circle/ Division | S. No | Range/Block/Beat | Name of Forest & Compartment No. | Area in ha. for seed production/ seed stand |
|---|---|---|---|---|
| **FIR/SPRUCE** | | | | |
| **Rampur Circle** | | | | |
| Kotgarh | 1 | Kumarsain | Mattu C.3 | 108.00 |
| | 2 | Kotgarh | Bhagat C.1 | 132.00 |
| | 3 | | | |
| Kinnuar | 4 | Nichar | Kundluchaunda C.68 | 65.65 |
| | 5 | -do- | Bundo Kutang C.73 | 375.95 |
| | 6 | Bhawa/Bhawa/Nagar | C.73 | 375.95 |
| **Shimla Circle** | | | | |
| Chopal | 7 | Chopal/Jhikarpul/Shillikan | Kungunali C.8 | 102.79 |
| Theog | 8 | Kotkhai/Kotkhai/Garawag | R.13Chambikupper, C.10 | 137.06 |
| **Mandi Circle** | | | | |
| Nachan | 9 | Thachi/Gadagusain/Bagra | OD-I Bagra | 863.66 |
| | 10 | Seraj/Janjehli/Rahakot | OD-255-Kalakamleshwar | 333.97 |
| | 11 | Nachan | DPF Lotapukhar Part | 269.97 |
| | 12 | Raigarh | DPF Raigarh Part | 649.52 |
| Mandi | 13 | Drang | Gramangahai C.1 | 828.39 |
| | 14 | Panarsa | DPF Rawala C.1 | 95.61 |
| Suket | 15 | Jhungi | D.90, Babasti C.1 | 83.10 |
| **Kullu Circle** | | | | |
| Kullu | 16 | Lower Kullu | 2/32 Matikochar C.1 | 71.22 |
| | 17 | Naggar | 2/24 Parol C.2 (a) | 93.48 |
| Seraj | 18 | Inner Seraj | 2/38 Thachgarh C.2 | 121.41 |
| | 19 | Kurpan | 1/19 Bajiri C.1 | 233.91 |
| Parvati | 20 | Tirthan/Plach/Bandal | R/3 Reunshi C2 | 42.49 |
| | 21 | Sainj/Sainj/Dhaugi | 2/38ThachagaharC 2 | 121.41 |
| **Chamba Circle** | | | | |
| Chamba | 22 | Masd/Chhatrari/Sikri | Sikri R.F.C.-II | 10 |
| | 23 | U/Chamba/Chhatrari/Gehra | Miraror DPF | 163.15 |
| | 24 | Tikkar | RF Sikkari C.2 | 204.00 |
| Dalhousie | 25 | | Riyali Rakhar | 10 |
| | 26 | | Kharadanda NDPF | 10 |
| | 27 | Dalhousie/Dalhousie/ Gharatgalla | Gharatgalla DPF | 5 |

| Name of Circle/ Division | S. No | Range/Block/Beat | Name of Forest & Compartment No. | Area in ha. for seed production/ seed stand |
|---|---|---|---|---|
| **Ban/Oak** | | | | |
| **Mandi Circle** | | | | |
| Nachan | 1 | Nachan/Bassa/Chailchowk | ND.436.Dopha C.9 | 31.12 |
| | 2 | Nachan/Pandoh/Chhapran/ Dalikar | OD-474 Dalikar C.1 to C.2a | 49.85 |
| **Chamba Circle** | | | | |
| Dalhousie | 3 | Bakloh/Mamul/Kahri | Dhuri Sandhar DPF | 10 |
| | 4 | | Banaru DPF | 5 |
| | 5 | Chawari/Kaintly/ Kharlanda | Bankot DPF | 5 |

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** Source:* ***APCCF (FM, NTFP & SILVA) Forest Department, H.P., Sh. G. S. Goraya, IFS.***

# CHAPTER V

## ARTIFICIAL REGENERATION

### Introduction

Natural regeneration should be preferred to artificial regeneration wherever it can be accomplished with reasonable expedition, certainty and cost. Natural regeneration, though generally superior to artificial regeneration, cannot be relied upon for complete and rapid regeneration of an area. Where reliance is mainly placed on natural regeneration, it has been found that it is rarely possible to obtain adequate stocking over the regeneration area uniformly within a reasonable period of time, a varying proportion of its proving difficult, slow or even impossible to regenerate naturally. Artificial reproduction is required to restock burnt areas, clear felled areas, abandoned cultivation, land slips and areas under erosion, to introduce more valuable species and where natural regeneration fails to come up.

Artificial reproduction is at present used on a large scale and with intensive forest management, it is likely to increase. The present methods of sowing and planting differ in different divisions. The technique of artificial reproduction in all, its aspects, therefore, discussed here and the procedure to be followed in future is hereby standardised.

### Organization of labour and field work

The success of artificial reproduction largely depends upon the proper Organisation of labour and work. The closest attention should be given to every detail of work and this should be constantly supervised. The subordinates should understand the technique and practice of artificial regeneration and should be able to guide the labour exactly how to sow and how to plant, and the trainees at the Forest Training School should be fully instructed in these methods both in the class rooms and field.

### Selection of suitable species

It need hardly to be emphasized that the species selected for cultivation should be site specific. It should be done on the economically valuable species of the locality and silviculturally suited to the area. The choice is easy in the case of supplementing natural regeneration. Deodar should by all means be introduced in pure kail and in fir forests where conditions are favourable and its proportion increased in mixed deodar and kail or deodar and fir forests, but when doing this, in low and medium level kail forests, deodar should always be put on the cooler aspects and in fir forests, only on the well drained warm aspects. On the outer range of Himalayas, where deodar is not indigenous (Kangra and Lower Solan) particular attention must be paid to site conditions. Deodar should not be planted on hot, dry bare hill sides, nor should whole sale conversion of kail forest into deodar be attempted, such attempts in the past have invariably resulted in failure and waste of money. Bare, dry, hot slopes are more suited to kail and Cupressus torulosa, especially on limestone rocks. Damp, low lying and, flat sites, specially, in, the middle and high level zones, are entirely unsuited to conifers, and such sites should be restocked artificially with broad leaved trees like ash, walnut, maple, poplar, horse-chest-nut, alders etc.

The various species that can be raised under farm and social forestry programme are:-

**Lower Zone**

Albizzia spp., Ailanthus excelsa, Artocarpus lakoocha, Bauhinia variegata, Bombax ceiba, Cedrela toona, Dendrocalamus hamiltonii, D. strictus Cinnamomum tamala, Mangifera indica, Quercus serrata, Grewia optiva Dalbergia sissoo, Sapindus mukorossi Populus deltoides, Morus spp., Terminalia bellerica, T.chebula, T. arjuna Emblica officinalis, Melia azedarach, Eucalyptus spp. Leucaena Leucocephala.

**Middle Zone**

Ulmus wallichiana, Alnus nitida, Populus deltoides Salix spp. Morus spp., Dendrocalamus hamiltonii, Albizzia stipulata, Bauhinia variegata, Grewia optiva, Celtis australis, Cedrela serrata, Quercus incana, Robinia pseudoacacia, Sapindus mukorossi, Bombax ceiba, Prunus persica, Prunus armeniaca, Prunus padus, Melia azedarach, Ailanthus glandulosa, Ehretia Laevis, Juglans regia.

**Higher Zone**

Acer spp., Fraxinus floribunda, Robinia, pseudoacacia, Juglans regia, Cedrela serrata, Populus ciliata, Ulmus wallichiana.

**Collection, Storage and Pretreatment of seed.**

The productivity in forestry ventures can be considerably increased through use of superior quality seed. The use of viable seed of good inherent quality provides a sound basis for raising of vigorous and healthy crops. Seed cost is only a minute proportion of the total sum needed for establishing a plantation. Thus the use of seed from sources which give even small increases in growth rate or improved timber quality, is a good investment for the future.

The quality seed germination percent and vitality of the seed are markedly better in a good geed year than in a poor seed year and so maximum use should be made of good seed years, as it is one of the advantages of artificial regeneration that the benefit can often be extended over a number of years with appropriate measures of seed storage or nursery techniques. The quantities required must be carefully worked out well in advance and adequate quantity of seed should be collected after giving liberal margin against possible needs for resowing the failed areas.

To obtain success in artificial regeneration, perfectly ripe, and sound seed of good quality should be used. It should be collected from dominant, well shaped, vigorous, straight fibred trees, which have reached middle age. Seed collected from trees too young or too old and from suppressed and unsound trees is generally, bad. Seed from twisted trees should on no account be used and in the case of chil special are should be taken that cones are not collected from areas where twist is common; this defect is inherited by the off springs of twisted parents. Twist is common in the chil forests of Una region; this seed should never be used. In selecting the parents it should be seen that these when required for artificial regeneration at high levels should not be selected from medium or low levels and vice versa.

The time of Seed collection also affects its germination capacity. The germination percentage of seed collected too early is low and often does not store well. If the collection is delayed, the seed falls down and is lost. Deodar ripens in October – November. Kail in October and Chil after 15$^{th}$ December. The seed should be collected from the seed production areas from phenotypically superior trees. In no case seed should be collected from malformed and branchy trees.

The seeds of broad-leaved species can generally be stored without any loss of viability for over a year. The seeds of species like horse chestnut; oaks, sal & tun however should be sown soon after collection as they lose viability very quickly under ordinary storage conditions. Seeds of species like khair, kikkar, siris, kachnar, semul, amaltas, khirak, shisham, eucalyptus, beul, leucaena, bakain, prosopis, Robinia, ritha, sain, behera, and harar should be stored in tin canisters or tin lined boxes in cool and dry places. Care should be taken that seed is dry before placing it in tin and / or boxes. Large quantities can be kept in bags, but these must be stored in dry airy place. Under these conditions, storage of these seeds can be further prolonged under low temperature and controlled humidity.

Coniferous seeds cannot be stored for long periods without proper storage arrangements. Under ordinary storage conditions, the seed should be utilised during season of collection and any surplus seed should be stored in air tight containers in cool and dry place if proper storage facilities are not available.

Seeds of various species should be pre-treated before sowing to enhance and improve germination capacity. The pre- germinated seed of chil pine is also used to get better success. The seeds are mixed with wet cowdung and kept in a gunny bag for 10-15 days and kept moist. The soaking of seeds, in cold or hot water for 24 to 48 hours may be done to soften the hard seed coats and hasten germination.

Deodar and silver fir seeds contain oil in its resinous pockets. In autumn, when the seed of fir and deodar disseminate, moisture and temperature conditions are favourable for germination. Germination is, however, blocked by oil. During winter the seeds lose their oil through evaporation and dormancy gradually, diminishes until spring. There is also another method, known as prechilling before sowing, the seeds are soaked in water for about 12 hours and are put into plastic bags. These bags are kept at $+2^0$C for about 4 weeks. The bags should be turned every week. This treatment hastens the germination. The method of stratification is also followed with seeds that naturally lie dormant on the soil over the cold months. The seed is spread in layers 1-2 cm deep alternating with layers of sand, or charcoal about 5-7 cm deep in boxes or baskets of convenient size, stored in pits dug in the ground. This method is used in the higher hill forests.

**Sowing versus planting**

An area may be regenerated artificially either by direct sowing or by planting. The choice between sowing and planting depends upon the site to be stocked and/or the species used. Now -a -days, direct sowing is restored to only in limited areas with favourable agro-climatic conditions. Planting in general is much more certain and less expensive than direct sowing on difficult areas, such as poor exposed soils, hot dry localities sites over grown grass, heavy shrubs, steep slopes, land slips etc.

In high hills, broad-leaved species such as walnut, poplar, maple, ash, bird cherry, Castenea sativa, willow should be planted because the growth period is limited due to long cold spell and by planting, the plants have a definite initial advantage. Kail is generally sown and not planted as direct sowing is more certain in case of silver fir and spruce planting is preferred to sowing as in the first place the paucity and cost of seed does not allow of sowing on any large scale and the growth of the young seedlings is very slow. Secondly spruce and silver fir areas are generally infested with luxuriant and tall weeds and direct sowing have little chance of success.

**Introduction of species of greater value**

There are large areas of kail forests on sites suited to deodar. In many localities kail is infested, with Trametes pini and conversion to deodar is prescribed in working plans. The kail forest is gone over under shelter wood felling and after conversion is complete slash is collected in small heaps and bushes are cut and burnt. Deodar is either sown in patches or planted according to the conditions available. The patches in direct sowing form temporary nursery beds, from where seedlings are transplanted in subsequent years. The distance between the deodar transplants should be from 2.5 to 3 m as it is sufficient to obtain small proportion of deodar in the future crop. The kail seeds profusely and an ideal mixture of deodar and kail is obtained.

Valuable broad leaved species such as walnut, alder, maples, ash, bird-cheery, horse-chestnut, poplar should be introduced in fir and spruce and other areas along nallahs and ravines, which in spite of seeding fellings do not regenerate themselves and get invaded by worthless weeds. Transplanting at a spacing of 5 x 5 m would give ideal results. In low hills, chil and khair, are valuable species and should be introduced in areas occupied by poor scrub and blanks depending on site conditions along with siris, semal, prosopis, shisham etc.

**Restocking Burnt Areas**

Forest fires have done much damage in the past and burns sometimes extend to over hundred of hectares in one place.

The bushes and dead trees are cut and the area is isolated to prevent fire spreading to neighboring forests and the whole area is then set on controlled fires when dry.

The planting of the area is taken up in subsequent years. It is essential to tackle the area as soon as possible after the forest fire, as otherwise bushes and weeds invade the area. The planting of broad leaved species along nallahs should be given preference in chil areas as they act natural lines for preventing spread of fires.

Seed beds and pits on cool aspects must be weeded regularly, but on hot exposed aspects it is advisable not to weed the young deodar seedlings during the first year as they suffer severely from drought.

**Pure versus mixed crops**

In artificial regeneration mixed crops should be the rule. The mixture should not be by single trees or lines but by groups of suitable sizes. In higher hills valuable broad leaved trees like ash, maple, walnut, poplar etc. should be planted in fir / spruce and deodar forests. Similarly in chil areas, suitable broad leaved species should be planted along nallahs or on cooler aspects.

**Direct Sowing**

Direct sowings now – a -days are carried out only on very limited scale. Direct sowings are done in patches. Broadcast sowing are no longer in vogue. Patches 45 x 45 cm are prepared, 3 M apart from edge to edge. The seeds in patches should be dibbled and lightly covered by stirring up the soil.

**Planting**

**Planting Stock, its Size and Age:**

The planting stock will usually be nursery raised seedlings, transplants, container plants and stumps.

Surplus seedlings from direct sowing, wherever practised may also be used for planting. Planting wild stock has generally proved unsatisfactory and should be avoided.

As a general rule seedlings i. e. which have not been pricked out in nursery, should be planted on average sites and transplants i. e. plants pricked out in nursery, on difficult sites.

The size and age of the stock for planting varies with the site and the species. No plant with a shoot less than 20 cm in length should ordinarily be used. Exposed areas and sites subject to drought and excessive weed growth must be planted up with large plants. Ordinarily deodar seedlings should be planted out when 1½ year old, but in difficult and weedy areas, 2 ½ years old transplants pricked out once should be used. Silver fir, under 4 ½ years should not be planted and spruce under 2 ½ years. If kail has to be planted, 2 years old kail transplants should be used. Chil plants of 8 to 12 months old raised in Polythene bags are planted out. Chilgoza plants raised in Polythene bags are planted in the field when they are 3 to 4 years old.

**The time of Planting:**

Planting of conifers should always begin immediately after the first heavy rain in July and finished by the first or second week of August at the latest as late planting are generally unsuccessful. Chilgoza pine is, however planted during December, before snowfall. Chil can be planted during winter also.

Cloudy and rainy days should be selected for planting work and bright sunny days avoided. On hot southern slopes to ensure success, transplants should be put on upper side of bushes.

Planting of broad-leaved species of deciduous nature should be done in December January when plants are leafless. The stumps however should be planted in early spring, wherever irrigation is possible, planting can be done both in the monsoons and in early spring, the latter gives more satisfactory results.

**The Spacing and the preparation of Planting Areas**

The standard planting distances are

(i) 2. 5 x 2. 5 m for coniferous species.

(ii) 5 x 5 m for broad leaved species.

Square planting will be adopted on average sites and line planting in areas of excessive weeds and bushes.

Closer spacing may be adopted depending upon the species and object of plantations. In felled over areas, the felling debris should be burnt before planting. In other areas the bushes and undesired trees may be cut down and burnt or removed. In light soils, pits (30 x 30 x 30 cm) should be made just before plants are put out or if there are no labour difficulties, simultaneously with the planting. In the case of heavy clay soils and weedy areas, the pits should be made well in advance of planting and the earth left in unbroken clods. This allows soils to get weathered.

**Method of Planting:**

The following standard methods of planting will be used:-

(i) Planting of entire plants with naked roots,

(ii) Stump planting and

(iii) Planting entire plants with ball of earth (raised in Polythene bags).

**(i) Planting with naked roots:**

The actual method of planting is well known to every trained forester. It is, however, essential to emphasize that in planting (i) the roots should not be crowded together or doubled up, (ii) the collar should neither be below the soil level nor above it. It should be in the same position with reference to the surface soil after it has been planted as it was in the nursery, (iii) the plants should never be put out in the pits below the surface level of the soil where water will stand. It must be remembered that after planting the earth sinks consequently the surface of the soil after planting should be above that of the ground in the neighbourhood, (iv) the earth must be firmly pressed round the roots and stamped down round the collar, (v) thick humus should be entirely removed from the actual planting sites before planting holes are made, and it should be seen that only good mineral soil is placed in contact with the roots and not the litter an organic matter of the upper soil layer and (vi) in weedy areas transplants should be staked.

**(ii) Stump planting**

Planting of stumps is simple operation. On sites with loose porous soil, the stumps are pushed in by hand. If the ground is hard, the stump is completely driven into the soil (i.e. about 20 to 25 cm), stem part (about 5 8 cm) is left above ground. Similar method can be used in areas where irrigation facility is available after saturating the soil fully. After planting the hole is closed and the earth around it, is pressed gently with hand.

**(i) Planting entire plants with ball of earth:**

This is undoubtedly the best method of raising certain species, such as chil, chilgoza, Eucalyptus and other species particularly under adverse conditions of moisture and/or soil. The plants, with ball of earth should be carefully taken out, after tearing away the Polythene bag and inserted into the pits. Soil is then put around, and pressed well to avoid sinking after heavy rains.

**Tending**

To guarantee success in artificial regeneration both sowing and planting, it is absolutely essential that the plants should be properly weeded and cleanings and thinnings, carried out as and when required.

**(i) Weeding: -** Thorough weeding should be carried out in both sowing and plantings. Where weeds are excessive on cool slopes and moist areas, weeding should begin on 1st June and should be repeated in August. In places where undergrowth is not aggressive, one weeding early in the rains is sufficient. Chil seedlings are not harmed by grass, especially in the lower limits and are best left unweeded except in cases of exceptional herbaceous weed growth in burnt areas. Tall weeds like Strobilanthes and Balsam in deodar, kail, spruce and silver fir areas must to be cut back in the rains from the upper side of the plants to a distance equal to about their height, so that they may not be flattened over the plants by snow, if this happens the plants will be smothered.

Weeding will generally be required for 3 to 4 years. It is most essential that proper weeding should be carried out thoroughly during the first year.

**(ii) Cleaning: -** Cleanings are essential to keep the stock in full vigour and health. The surplus plants should be removed from dense sowing in 2nd or 3rd year. Cleanings should be carried out so that the plants are spaced approximately 1. 25 x 1. 25 in when 15 cm high.

**(iii) Thinning: -** This operation is carried out when the crop has crossed the sapling stage. Early thinnings may be carried out by mechanical method. Subsequently the crop should be thinned in accordance with Technical Order No. 1.

The nursery and plantation technology of spruce, silver fir and chil has been described in the following paragraphs.

**Plantation Technology of Chil (Pinus Roxburghii)**

Till recently natural regeneration was the rule in chil forests and sowings were attempted in very small patches only as a soil conservation measure. When chil forests produced only timber and resin tapping was not being done for want of the necessary infrastructure, the cost on raising chil plantations wag not justified. The rising prices of wood and of resin and comparative faster growth have now made chil a very valuable species among the conifers.

Because of the location of chil forests in the lower tracts which have been opened by roads, the utilization of chil in some areas is now so much complete that everything out of the over ground portion of the tree except the leaves and small twigs is extracted and transported to the market. Extraction from such areas is mostly in the form of billets, the bigger ones of which are sold for the manufacture of packing cases or matches while the smaller and inferior types of logs and the branches are sold as pulpwood and for manufacture of activated carbon. Sawing in situ is resorted to only in case of forests situated away from roads. Fuller utilization is reflected through increased stumpage value obtained for standing chil trees.

Resin, which was considered to be only as a secondary product from chil (%) rests, the primary produce being the wood, has now become equally important. As the income from resin is spread over a longer period and, unlike timber, is not concentrated towards the end of rotation, it is an important factor in deciding the economics of chil plantations.

The expected income from chil plantations justifies the expenditure on plantations and has consequently rendered the raising of chit plantations as economical proposition. Large scale plantations of chil are now being raised in the state.

**Scope of Chil Plantations**

Chit grows well between an elevation of about 600 and 1800 metres. At lower elevations the competing claims of khair and tropical pines which may give as good or even better economic returns than chil will have to be kept in view.

**Necessity of Artificial Regeneration**

Within its natural range chil is required to be raised in extensive areas not carrying chil crop. In areas under its natural forests, chil regenerates naturally without much difficulty except in the transitional areas along the lower most and upper most limits. In the lower most belt khair and the bushes like Carissa and Dodonea invade the areas and inhibit natural regeneration. In the upper transitional belt, chil areas tend to revert back to oak type vegetation which is the climax vegetation of the region and which does not allow natural regeneration to come in. While natural regeneration is aimed at in chil areas found in its normal range, artificial regeneration has to be resorted to in chil areas of transitional belt where natural regeneration does not come in and in such areas within the natural zone of chil where chil crop does not at present exist. In view of the fact that there are extensive areas of the latter category, artificial regeneration is required to be taken up on a very large scale in this State.

**Methods of Raising Chil Plantations:**

Chil plantations are raised mainly by two methods, namely (i) patch sowing and (ii) planting of Polythene bag raised plants.

**Patch Sowing**

Patch sowing consists of sowing chil seeds in patches prepared with the onset of rains. Patches of about 60 x 45 cms spaced at 3 metres X 3 metres are prepared after cutting the bushes required to be removed to make room for the patches and sowing of chilling done simultaneously. About 25 seeds are sown per patch which means a seed rate of 3 Kgs per hectare. The patches are covered with bushes to ward off birds and rodents. These bushes are removed after the germination is complete. The patches are weeded once in August so that the seedlings are not smothered by weeds.

**Planting of Polythene Bag raised plants**

To save, the young chil seedlings from being nibbled by birds and also to reduce the chances of failure because of poor monsoons and poor soil working in case of patch sowing, plantation of Polythene bag raised plants was tried on experimental basis during 1966. This method gave very encouraging results and has now become the standard method of raising chil plantations in this State. The plants raised in Polythene bags have sufficiently strong shoot and well-developed root system by the time these are planted in the field and have thus better chances of survival. The rich soil of Polythene bags give a good start to the plants and well developed root system helps the plants to ward off any dry period during monsoons.

Various operations in raising the plants in Polythene bags and planting them in the field are briefly discussed in the following paragraphs.

**Site Clearance**

As already explained, the area where chil plantations are proposed to be raised are either blanks, or carry scrub growth or scattered tree growth of miscellaneous broad leaved species of less economic value. The amount of work involved in site clearance will depend upon the type of the area to be tackled. Site clearance is more expensive in areas where bush growth to be removed is not saleable. Site clearance consists of putting the bushes and burning the cut material. This work is generally done during the winter to reduce fire hazard and to ensure start of pit digging work in March. In area having thick bush growth the bushes are cut only along the lines where pits are to be dug and not from the whole of the area. The bushes left in the intervening spaces are kept under control by subsequent cutting and pruning so that these do not shade the chil plants.

**Spacing**

Spacing depends upon the object of raising the plantations. Somewhat closer spacing may be desirable for chil to be raised for pulpwood as compared to the plantations to be raised for timber or resin production. Closer spacing will increase the cost of plantations while too wide spacing will reduce the yield expected from the area. Spacing to be adopted should, therefore, be so adjusted as to ensure closer canopy in the shortest possible period but at the same time ensuring that first thinning to be done in these plantations produces saleable material. If the first thinning is non-commercial, extra expenditure on raising plantations on closer spacing may not be justified. Judging from the N/D curve of quality 2-chil spacing of 3 x 3 metres has been adopted for chil plantations in this State.

**Alignment and Digging of Pits**

Pits are aligned in lines running along the contour spaced at 3 metres from each other. Bushes if any along these lines are cut as discussed in para 20. The pits are dug at a spacing of 3 metres along the lines cleared.

Pits of the size 30 cm x 30 cm x 30 cm are dug from March to May. Digging of pits should be completed by the end of May to allow weathering of the soil. Pit digging should in no case be allowed simultaneously with the work of planting because it is difficult to ensure that the pits of dimensions prescribed have been dug.

**Transport of seedlings**

Transport of seedlings from the nursery to the plantation site is an important and costly operation. Extreme care is necessary in the transport of seedlings to ensure that the roots of seedlings are not damaged. At the same time the seedlings should be transported at, the minimum possible cost. The seedlings are transported by manual labour in wooden trays of the size 30 cms x 35 cms in which the seedlings are properly placed to keep them in upright position. Twenty Polythene bags are accommodated in each tray. Loose packing of Polythene bags in the trays may result in breaking of soil column and injuring the root system of the plants. The Polythene bags are watered before these are transported because the dry soil column is more liable to crack and damage the root system.

The seedlings are transported and delivered at each pit in the plantation area as their collection at a central place in the first instance and then their further distribution for planting will increase the chances of damage to the roots of seedlings and will also unnecessarily increase handling cost. In case of manual carriage, the transportation of plants to the plantation area is a costly operation. The nursery should, therefore, be raised as near to the planting site as possible to reduce the cost of transport of seedlings.

**Planting**

Two men form a planting party. While one man holds the Polythene bag gently in his hands, the other one cuts the Polythene sheet and removes it carefully, removal of Polythene bag is very necessary because if it is left intact it does not allow the root system of the plants to develop and establish contact with the soil of the pit outside the Polythene bag. Rotting of Polythene bags takes a long time and the plants die during drought period if the Polythene bags are not removed.

After the removal of the Polythene bags the plant is lowered carefully in the pit and the pit is gradually and carefully filled with soil and rammed properly. The pit is filled to about 5 cm higher than the ground at the centre so that the soil in the pit after setting is not lower than the level of the ground as otherwise the water may stagnate near the seedlings. Stagnation of water results in the death of seedlings, as chil does not withstand water logging. The Polythene bags removed from around the soil column of the seedlings is put on the pit. It acts as mulch and reduces weed growth. The plants should be handled with utmost care during planting as even the slightest carelessness may result in breaking the soil column and their death.

**Time of Planting**

Planting of chil is mostly done during second week of July and is completed by the end of the month. Late planting does not give good results.

Planting done in winter has also given satisfactory results. Winter planting should be done either towards January and should coincide with winter rains. Late

winter planting results in failures as the plants do not get established before the drought of the summer month starts.

**Weeding and after care of Plantations**

Weeding and bush cutting are necessary to save the plants from being smothered by weeds and bushes. One weeding preferably in the month of August is, therefore, necessary for the first three years after planting. Care should be taken that the seedlings are not injured during weeding. The bushes growing near the plants should also be cut exception exposed southern aspects where plants may be benefited from light shade of such bushes.

**Plantation Technology of Spruce and Silver Fir**

**Size of plantable stock:**

In view of tall weed growth in plantation areas, planting of small seedlings often ends in failure. Planting out of 4½ years old silver fir and 2½ years old spruce plants is done in the field. Planting out of less than 15 cm tall seedlings should not be done.

**Time of planting out:**

Trials were conducted both in Kullu and Chhachpur forests to compare the success of planting in rainy season (July), autumn (November) and spring (March/ April). Rainy season planting turned out to be better than autumn planting which in turn was better than spring planting. Planting should preferably be completed within the month of July because late planting results in poor survival percentage.

**Debris Burning:**

After the logging operations are over, debris is collected in small heaps and burnt in November/December before snowfall. Bushes whenever occurring in thickets are cut and burnt along with the debris. During debris burning, care is taken that the trees and poles retained as seed bearers or advance growth are not damaged.

**Pit Digging**

Among the pits of different sizes tried, the pits of 30 $cm^3$ gave as good results as those of 45 $cm^3$ or 60 $cm^3$. Pits of 30 $cm^3$ are accordingly used. The pits should be dug during summer months to allow soil weathering.

**Hoe Planting:**

Planting hoe is a special type of planting tool used for planting in Europe. Some trials were conducted to study the possibility of planting silver fir and spruce with hoes imported from West Germany. Encouraged by the results of the trials about 20 thousand plants of silver fir and spruce were planted with the help of hoes indifferent Forest Divisions during 1985. The plant survival percent in case of hoe planting compares well with that of pit planting. In case of hoe planting, a Labourer can plant about 200 to 250 plants per day as against about 20 to 30 plants in case of pit planting. Hoe planting is, therefore, more than 10 times cheaper than pit planting. Keeping in view the low cost of hoe planting, the present planting spacing of 3 x 3 m can be reduced to 2 x 2 m. More and more areas of spruce and silver fir should be planted with hoe.

**Spacing**

Spacing adopted in silver fir and spruce plantations at Chhachpur varies from 1. 5 m x 1. 5 m to 3 m x 3 m; the latter is the spacing adopted at present. Studies conducted on crown: DBH relationship for silver fir showed that a spacing of 3 m x 3

m is too much on the wider side. In view of this, spacing of 2.5 X 2.5 m should be adopted. But in case of planting with hoe the spacing can be further reduced to 2X2 m.

**Planting**

Cloudy days are preferred for planting. The seedlings are taken out of the bundles and their roots are separated out very carefully to avoid injury. The seedlings are then planted in the pits already dug. The soil is gradually filled and compacted. The pits are filled to the ground level and it is ensured that water does not stagnate in the pits as the seedlings are susceptible to water logging.

**Weeding**

Thick weed growth is one of the most important factors affecting the success of plantations. Working of silver fir forests under shelter wood or concentrated regeneration fellings increases the density and height growth of noxious weeds. Control of weeds for first few years after planting is a pre-requisite for successful raising of silver fir and spruce plantations. One weeding in first year, two weeding (one in June and another in October), during each of second and third year, and one weeding during each of the fourth and fifth year are considered necessary on the basis of experience gained so far. Preliminary trials on the use of weedicides indicate that spraying of 0.25 per cent solution of Agromore Brush killer 64 or of Gramaxone in June can keep weeds under control.

**Beating up of Failures**

Failures are beaten up in July of the year following the year of planting. In Kullu the casualties in silver fir plantations were reported to be about 15 per cent in the first year and the casualties continued for five years when the survival percentage was only 56 per cent. In Chhachpur plantations the mortality has been assessed to be about 20 to 30 per cent during the first year and 10 to 15 per cent during the second year. Beating up is done in two subsequent years only after planting, when all the dead or apparently dying seedlings are replaced.

# CHAPTER VI

## CLOSURES

**Public Reaction to closures**. There appears to be a complete Misunderstanding in some quarters as to the meaning and intention in constituting reserved forests free of rights and in imposing closures (other than punitive closures) in protected and other forests. The time has come when further misunderstanding and misinterpretation in this matter must be placed to the discredit of all responsible forest officers concerned.

**Closures and Rights of the people**: - It must be taken as a fundamental principle of forest policy that the reasonable requirements of local inhabitants are, so far as the forests concerned can satisfy them without imperiling their permanency to be met in full before any forest produce is exported from the tract. This applies equally to right holders and non right holders, though the former must of necessity be given first consideration when the quantity of forest produce available is insufficient to meet more than right holders requirements. It is not the intention that forest produce should be given to non-right holders free or at concessional rate. It is correct to charge such persons at the local market rates prevailing from time to time.

There are many parts of the Himachal Pradesh where the village forest lands (e.g., III class Protected Forests in the Kullu and demarcated protected forests in Kangra proper) are unable to meet the fall legitimate demand of the local population for timber and fuel, but where quite extensive resources exist at reasonable distances from the source of demand in the Reserved and Demarcated Protected Forests under the control of the Forest Department. It is far preferable to safe guard the continued existence of the village forests in such cases by a liberal policy of grants to meet the real and reasonable domestic requirement of the people from other Government forest lands than to permit the complete and rapid exhaustion of the resources of the village forests by adopting the attitude that no timber or firewood is available from reserved and demarcated forests except to right holders.

**Enforcement of closures**. In particular it is necessary to emphasise most strongly the principle that closure (whether permanent as in the case of Reserved Forests free of all rights or temporary as in the case of areas in Protected Forests closed for regeneration purposes) does not mean that neither man nor beast may under any circumstances set foot in a closed area or receive any sort of forest produce there from. A punitive closure is, of course, on a different footing as its name infers and it is perfectly legitimate to do everything possible to enforce the lesson that forest offences, inviting punitive Closure lead to real inconvenience and discomfort to the guilty. But in the case of closures imposed for silvicultural reasons, the policy of all forest officers must be to permit anything that is not harmful to the closed area and to use the closure as his servant and not as his master. When an area is legally closed to the exercise of rights, it means that no person can demand to do any act or to receive any forest produce there from; but it most emphatically does not mean that he can

not be permitted to do specific acts or to receive specific forest produce in a closed area when such act or removal is unharmful to the forests and even, as will be the cases in many instances, beneficial to the objects of forest management. It must, therefore, be an axiom of forest management in all forest divisions that restrictions in reserved forests and in areas closed for other than punitive reasons shall be as few as is compatible with the objects of forest management from time to time. It may be desirable to enforce strict and complete closure for part of the period of closure, but all concerned must be ready to relax restrictions and to grant concessions in closed areas as soon as this is not disadvantageous to the interests of the forest and whenever there is a legitimate and reasonable demand for such concessions at the same time the forest officer will always be careful to impose such control over the exercise of such concessions as he knows to be necessary in the circumstances of each case.

But nothing in this order shall be taken as permitting the introduction of buffaloes, goats and sheep into areas not burdened with those animals as of right. It is most undesirable to encourage any increase of these animals in forest tracts.

While the Conservator will often be able to judge whether the policy laid down in this order is being acted upon in the course of his inspections, it is not possible for him to inspect and enquire into the position prevailing from time to time in every closed area. Divisional Forest Officers will therefore, append to the note on the progress of Working plans prescriptions, which accompanies the annual Control Forms.

These instructions are to be brought to the notice of All Range Officers, who are responsible to see that the policy prescribed is not nullified by the action or in action of lower subordinates.

# CHAPTER VII

## THE BURNING OF SLASH

**Forest Sanitation**. The proper sanitation of the forest is just as important as that of the town. Diseases of fungi and attacks of insects are spread by decaying wood. A little of slash adds enormously to the fire hazard and by covering the ground, it prevents the seed from reaching the soil. The only real remedy against epidemics of insects is cleanliness in forests and proper attention to silvicultural operations, whereby the trees are kept in the vigorous growing condition. The burning of slash was introduced in the State sometimes in the beginning of twentieth century when natural regeneration under the uniform method first began to receive attention and this work has now become routine in practically every division. In the past wherever a mass of rotting wood was left lying on the ground in regeneration areas the result usually was that such areas were destroyed by fire. It is standing order that regeneration areas are to be kept clean and all slash of the seeding felling collected and burnt if no other use can be made of the debris. Sometimes this can be sold for firewood; very often neighbouring villagers are glad to remove it in which case they should be given a reasonable time to collect what they want before departmental burning is commenced. The principles underlying the collection and disposal of slash may be summarised as follows:-

i. Start collection from the top of the compartment and work downhill.
ii. Lop the branches, roll logs away from seed bearers and stack larger slash by hand in open places in moderate heaps of about 20 Qtls. each.
iii. Rake the chips and humus downhill on to the heaps of slash.
iv. Burn the heaps downhill.

**Collection and Disposal of Slash.** The smoke does not interfere with the men working below and there is less risk of fire. Burn the heaps in rotation to reduce the heat. Women and Boys can be employed on raking up the smaller chips. One Forest Guard can hardly control more than 6 labourers and the same man should be employed year after Year. A great saving in cost can be effected by attention to the details of how the work is done. For instance it is easier to throw branches downhill than to carry them uphill. It has been found that in the case of chil pine, logs are the most dangerous form of slash and these must be disposed of. For piling the most economical unit is a gang of 6 men. These should be armed with 3 levers 2:8m long and 3 axes. The logs should be levered down hill away from the seed bearers and regeneration to the nearest open place where they can be burnt in small heaps. Piling gangs have nothing to do with firing.

Provided the logs are dry, they can be completely burnt without splitting or cutting by covering them with branches and smaller felling refuse. The work of their complete destruction can, if necessary, be completed in two operations; first fire the pile green one, this will render it much less inflammable and in the following autumn burn again when the logs will be completely consumed.

**Time of Slash burning.** The proper time for the collection and burning of slash in chil pine forests is the winter. In the higher hills collection can go on from the melting of the snow and burning is best done in October and November as the risk of damage at that time is very much less. Also a good seed bed is available for immediate sowing. Burning in June should generally be avoided as accidents have occurred due to burning slash at this time. However in very wet fir forests it may be necessary to burn

in June, in which case special precautions will be taken. Under all circumstances the strictest attention must be paid to the preservation of the mother trees. Chil will stand a good deal of heat, deodar less, kail still less and silver fir will not stand any at all. The subordinate in charge of the work is responsible for the safety of the mother trees and the forest. In chil forests after burning the heaps of slash a fire may be run downhill over the whole compartment under the same orders and procedure as in the departmental burning of chil forest. This will finally clean up the area ready for natural regeneration. Steps will of course be taken to see that chil advance growth or pole crops retained as part of the future crops are not damaged in any way by this operation. As mentioned above silver fir is very susceptible to fire hazard and there is a serious risk of the trees being scorched unless the greatest care is exercised in debris burning.

Considerable attention has lately been paid to the humus layer of the forest floor and its effect on success in natural regeneration. There is hardly any doubt that the failure of regeneration in the high lying forests, especially in the case of spruce and silver fir, is due to the large accumulation of undecomposed litter. In all operations connected with slash disposal therefore an effort should be made to get rid of as much of this litter as possible by raking it up with the smaller chips and burning it on the heaps of slash. It is recognized that once regeneration has been obtained the slash from the secondary fellings cannot be burnt. All the same it should receive attention and every effort made to get rid of it. In some cases it has been piled on the stumps of felled trees or thrown into nullahas. Owing to great differences in the amount of slash obtained in secondary feelings and the varying nature of the existing reproduction and local conditions each compartment must be treated on its merits.

It has already been ordered that slash from unsaleable things is not to be left lying about on the forest floor. In most cases less harm is done by leaving trees standing than by felling them and littering the forest with refuse which not only encourages insects but constitutes a continual menace from fire. Steps should be taken to make it a condition of sales of trees locally or to right holders or of grants to free grantees that these people collect their refuse into heaps or remove it from the forest. In roadwork a mass of inflammable rubbish is often thrown immediately below road which is not only most unsightly but constitutes a menace from fire. In short, Divisional Forest Officers, Forest Rangers and all ranks of the staff will conduct all their operations with a view to cleanliness and the proper sanitation and protection of the forest estate from fire.

# CHAPTER VIII

## FOREST MAPS

Maps are essential tools in the hands of the Foresters, to ensure proper management of forests, monitoring and evaluation of different, operations. Maps are of following types:-

**Types of Maps**

(a) Maps prepared by Survey of India for the country as a whole, with periodic revision on scales I : 1000000, I : 100000 and I : 15000.

(b) Special Surveys: These surveys are got done by different Departments on different scales which are 1 : 5000, 1 : 15000, 1 : 25000. Forest Surveys are carried out on a scale 1 : 25000, but the maps are printed on 1 : 15000 scale.

Special surveys are done by the Survey General of India for paying and non-paying departments. Paying departments are to pay the amounts for the surveys and are entitled to get any number of copies of the maps along with negatives. In case of non paying departments, the maps are maintained by Survey of India after recovering cost of special surveys carried over by them. Himachal Pradesh Forest Department is a paying department and the maps are maintained through a Map Office headed by a Forest Map Officer. The Survey of India has established a Directorate office at Chandigarh for meeting the Survey requirements of North Western States. Each Division must procure a set of maps available for their area on different scales for day to day use. C.F. Working Plan is the indenting Officer for all type of maps from Survey General of India. All requirements of maps should be sent to him. Maps on 1:15000 scale can also be purchased from the Sale Office of Survey of India maintained in the office of Director, North Western Circle, Survey of India, Chandigarh on cash payment.

(c) **Working Plan Maps**: Following maps are prepared in connection with the revision and preparation of new Working Plan

i. Stock Maps on 1:15000 scale.
ii. Management maps on 1: 50000 scale...
iii. Regeneration maps on I: 15000 scale.
iv. Fire Maps on 1:15000 scale.
v. Maps for Exploitation areas on 1:15000 scale.
vi. Forest Maps on 1: 50000 scale.

All the areas of Himachal Pradesh have not yet been covered on 1: 15000 scale map. The old maps on 4″= l Mile scale are being used. The responsibility for preparing all such maps will be that of the Working Plan Officer and CF Working Plan Circle.

Symbols and other legends used for preparing the maps are standardised as those given in the Code for Working Plan Procedure, Second Edition. The detailed instructions for the preparation of different types of maps given in the Working Plan Code will be strictly followed.

(d) **Restricted Maps:** All maps prepared by survey General of India of certain areas of all scales are restricted maps. Indents for these maps will only be placed through CF Working Plan Circle in prescribed proforma. These maps have to be issued against proper receipt to DFO/CF. These maps if, required to be maintained and kept carefully. The certificate to be furnished every year by CF, W.P.C. is given below: -

1 ----------(Name) agree that the supply to me by the Pr. Chief Conservator of Forests (HoFF), Himachal Pradesh, Shimla of the above mentioned 'Restricted Forests Sheets/maps is/are subject to the following conditions which I hereby undertake to observe.

(i) The sheets will be treated as very confidential and I will take every reasonable precaution to prevent their being lost or being seen by, or afforded access to in any manner to unauthorised persons;

(ii) No sheet will be reproduced in part or in whole either by photography or by any other means.

(iii) I will maintain a proper record of all the restricted maps issued to me and undertake to periodically check these physically. I will furnish an annual certificate to the Pr. Chief Conservator of Forests (HoFF), Himachal Pradesh Shimla on the 31st December every year to the effect that all restricted maps issued to me have been physically accounted for and are in safe custody. Proper precautions for their security are being ensured by me.

(iv) If called upon to do so, I will return the sheet/sheets to Defence, New Delhi, Chief Secretary to the Government of Himachal Pradesh, Pr. Chief Conservator of Forests (HoFF) Himachal Pradesh, Conservator concerned. I will report the loss of map / maps to the nearest Police Station and the Survey of India for investigation and report to the Ministry of Defence. I have understood that the loss of the Restricted Forest Map may amount to an offence under the official secret Act and that I am legally bound to give information about the offence immediately upon receiving knowledge about the loss of the said maps. I have also understood that failure to report about the loss would render me liable for prosecution under section 202 of the Indian Penal Code.

(vi) I also undertake not to export maps abroad.

(e). **Soil Survey Working Plan Maps** : In case of preparation of working Plan for Soil, Conservation, survey has to be carried out by taking into Consideration the ownership and the existing Khasra numbers. The use of Patwari Shajra Akash cannot be avoided. The scales of such maps vary from district to district and sometimes in the same district. They are generally on 1: 4000 scale. Management Soil Conservation Maps may be prepared from Patwari maps to a scale of 1: 12000 or 1: 15000 so that all the areas requiring treatment can be clearly shown.

**Aerial Photographs:** Aerial photographs are an essential tool in the hands of Foresters for proper management. Country is being surveyed through aerial photography periodically and the, photographs are available on different scales starting from 1: 20000 to 1: 60000. The procedure for the procurement of aerial photographs is quite lengthy and in case aerial photographs are required, process for the procurement of such prints has to be started much in advance. A clearance from the Ministry of Defence is also required.

Utmost care is required to be exercised in the maintenance of aerial photographs.

**Interpretation of aerial photographs**: A large number of officials/officers in the Department have been ,got trained in the interpretation of aerial photographs, A Cell in the Forest Map Office at Shimla is being established for the interpretation of aerial photographs and to transfer the details on stock/management maps of Forests & Soil Conservation Working Plans.

**Landsat Imageries**: Landsat imageries are now available on the scale of 1: 1000000 can be blown up and used for micro planning operations. A set of such imageries both on the different scale as available with National Remote Sensing Agency, Hyderabad should be obtained. A number of officers, are being got trained in the use of land sat imageries.

It may be mentioned that for proper management, survey maps are the best available tools. The details, which have not appeared on survey maps, should be collected from aerial photographs/ land sat imageries to update the available maps.

**Wild Life Management maps**: These maps are prepared on 1: 50,000 scales indicating Wild Life areas as such as National Parks, Sanctuaries, game reserves, distribution of wild life water regime, vegetation, etc. For intensive management separate maps for the objective/activity are also now being prepared.

# CHAPTER IX

## PROTECTION AGAINST DAMAGE BY FIRE

**Introduction**

Forest fires are a calamity for forests in view of the fact that the damage they cause to the forest economy is considerably greater than all the damages caused by harmful insects and diseases of wood taken together. Forest fires retard the vital activity of forest crops, subsequently encouraging the multiplication of pests and fungal diseases. Therefore, the problem of controlling forest fires has been and remains a most urgent issue in the forest economy of our country.

The following instructions are issued for the guidance of Forest Officers, their application will necessarily vary from place to place according to the locality and the type of forests. On the one hand chil is fire resistant but still needs protection in the seedling stage, and is destroyed by incendiary fires in the hot weather. On the other hand deodar and still more so, blue pine, spruce and silver fir are not resistant and the silver fir is killed merely by heat from a burning pile of slash. There is less danger of fire in mixed crops especially in a mixture of broad leaved trees and conifers and in deodar and blue pine, scrub areas may escape damage for years but after a heavy frost they may become very inflammable. In Himachal Pradesh strict preventive measures are essential in case of all the forests and it is necessary to evolve effective means and methods of detecting and liquidating forest fires.

**Causes of Forest Fires**

The causes of forest fires can be classified

(a) **Natural:** Lightening and friction between quartzite stones and dry bamboo culms cause some times forest fires. However such natural incidents of forest fires are rather few and far between.

(b) **Accidental:** The following incidents are responsible for accidental forest fires:-

i. Throwing of burning cigarette/Bidi pieces in forest areas by the passersby without visualising possibility of causing forest fire there from.
ii. Burning fire left behind in forests by hunters, workers, fuel wood collectors and graziers again without contemplating possibility of incidence of fire therefrom.
iii. The scintillas fallen from wooden torches, used as source of light during dark nights also cause forest fires.
iv. Honey from honey comb of wild bees in the forests is extracted by villagers during night hours, by burning wooden torches. The embers of burning torches fall on dry grasses and leaves and become cause of forest fires.
v. Coal driven railway engines sometime cause fire in forests on either side of railway track by throwing/sprinkling live embers from the furnace in the forest area. However with the coming into use of diesel engines, risk of forest fires in this manner has been minimised to the extent, coal driven engines have been dispensed with.
vi. Villagers burn pastures/ panwies for bringing about new flush of grasses. From these pastures/panwies fire spreads into adjoining forests.
vii. The forest fires are also sometimes caused from the spread of embers/scintillas from the charcoal kiln, if proper supervision/precaution is not exercised/taken during burning of charcoal kilns in forest areas.
viii. Uncontrolled/ill supervised departmental debris burning also cause forest fires.

ix. Control burning of chil forest, during February if not properly supervised goes out of control and cause forest fires.

(c) **Incendiarism**-The general motives observed behind cause of incendiarism in forests are given below:

i. In case of illicit feelings and illicit resin tapping, the defaulters maliciously burn such forests to conceal/cover their illegal actions/ misdeeds.
ii. Hunters/Poachers burn forests to facilitate killings.
iii. Disgruntled villagers burn forests/plantations, if their genuine demands/requirements of pastures, fuel and timber are not catered judiciously by the department.
iv. Sometimes land grabbers/encroachers intentionally burn forest areas, adjacent to their cultivation lands, orchards to extend their holdings illegally in Government forest areas. Sometime land hunger and deficiency of pastures also allure people, to do black deed of destroying forests by incendiarism.

As the proverb goes 'Prevention is better than cure'. It is thus of utmost significance to prevent fire accident and if occurs to check it from spreading. The causes of forest fires have been tabulated above and to prevent occurrence of forest fire all these causes will have to be eliminated by suitable actions.

**Fire Season**

The greatest danger from fire occurs during the months of April, May and June and until the south West monsoon breaks in early July. During the autumn there is ordinarily less danger from fire but the forests are not safe until after the first heavy fall of snow.

**Classification of forest fires.**

The forest fires are of two types: (i) ground fire. (ii) Crown fire. In ground fire dry grass, lichens, needles, litter humus, deadwood, stumps, surface undergrowth and bushes burn up. A rapid ground fire does not usually damage full grown trees, but it often poses a danger of being transformed into a crown fire in forest, plantations., Crown fires include those in which the upper story tree, crown burns. This type of fire advances from top to top of trees. They are the fastest spreading of all the forest fires. A stubborn ground fire may be fanned into a crown fire in a hot City and windy situation.

The intensity of combustion in a forest is affected by many factors: nature of the combustibles, (structure, volumes, calorific value, humidity, meteorological conditions (wind velocity, temperature and humidity of the atmosphere, solar intensity, rainfall) and even the topography.

**Relation of Forest Staff with People**

The practice of scientific forestry is impossible when there is enmity between the local populace and the Forest Staff, as the forests are so inflammable that the results of years of efforts can be destroyed by one fire. Establishment of healthy relations: by the forest staff with the local inhabitants is a sinequo-non for ensuring the safety of forests. The Divisional Forest Officer and Range Officer must tour the interior areas through forests and must be accessible to local villagers and listen to their grievances and deal comments on the spot. The rights recorded in Forest Settlement should be satisfied keeping in view the need of forest conservancy and the Silvicultural requirement of the crop. A contented peasantry and willing cooperation between them and the forest staff are the first essentials to, successful fire protection.

**Allotment of periodic blocks**

The Chief demand of the villagers is of grazing particularly in the areas close to villages. It is essential, to allot periodic blocks in forests under a regular system of management so as to afford reasonable facilities for grazing by the flocks and herds of all right holders.

**Closures**

Closures to grazing are necessary in the interest of regeneration, but care must be taken to enforce closures against practices which are definitely harmful, the cutting of grass and bushes should be permitted as soon as the seedlings are established, the grazing by limited number of cattle, but not by sheep and goats, should be allowed when the plants are about a meter high in order to reduce inflammable undergrowth. As soon as the plants have grown sufficiently to be out of the reach of sheep and goats these animals should be admitted where they have recorded rights, but not elsewhere. Buffaloes should never be allowed in areas free from rights. The removal of fallen pine needles for litter should be allowed in pine forests as the inflammability of the soil covering is thereby reduced.

The harmful effects of fires in pole woods and semi mature forests where grass and bushes are kept in check by cattle grazing are markedly less than in forests closed to grazing, and it is now recognised, that a lowering in the quality of the locality and a consequent retardation in the growth of the crop due to grazing are far to be preferred to the risk of complete destruction by fire. Excessive grazing and browsing are however, definitely harmful and lead to serious erosion and cannot be countenanced.

**Fire Prevention Measures**

A study of how fire started in each case is the key to remove or prevent ignition causes and focus attention on things that should and should not be done, particularly, in case of accidental fires or those caused due to negligence. On the other hand the study of location and timing of the forest fire may prove useful in identifying the actual causes of fire, through the process of elimination, apart from planning the prevention and extinguishing strategy.

Detailed information about the causes and thorough understanding of the motives behind the forest fire, provide the back ground for fire prevention work. The people to be approached are generally those, who may be responsible for setting fire to the forests accidentally, through negligence or deliberately. Thus the essence of prevention strategy in respect of people responsible for setting fire through negligence could be, to demonstrate to them the safer way of performing different operations like how to burn debris, make camp fire and extinguish them after purpose is served, not to throw live pieces of cigarette in forests.

Thus two types of measures are available for risk reduction and fire prevention. Fire prevention education and various forms of compulsions.

(a) **Fire Prevention Education:** The main aim of fire prevention education is to create keen awareness in the public about damages caused by fires and the necessity of fire prevention safe ways of performing certain operations, without causing forest fires. An educated public opinion may help to create strong social pressure for need to preserve/conserve forest resources. The methods that can be used for fire prevention education are as under:

(i) **Training:** Formal training in fire prevention and control is necessary for preparing a nucleus of people for guiding fire prevention and control programs. Such, training must form a part of in service training of Forestry personnel at all levels.

Short courses may be organised for not only the Forestry personnel, but also extension workers, voluntary organisation, Gram Panchayat members, and in schools. Seminars and group discussions can also be useful for selected groups of people, having direct and in direct concern with the forests.

(ii) **Erection of signboards, posters, advertisements exhibits and devices of all sorts:** These can be made use in many ways. They are characterised by giving a short and pointed story/message. They require seeing and often some reading. The first need is to gain attention. Eye catchers, shockers and gimmicks of all sorts can be employed to gain attention. Catchy slogans or symbols of some sort can be made - like "Only you can prevent forest fire," "Be careful with every fire," "Keep Himachal Green" etc.

(iii) **Circulation of printed material:** Elaborate information about various aspects of fire preventive measures could be educated through booklets, pamphlets, leaflets magazines, newsletters, newspaper articles and comic, books etc. Scientific information and statistics about fire causes, effects, behavior etc. under Indian conditions are not available at present. Necessary steps in this direction are required to be taken. A beginning could be made with the general fire effects already known and leaflets pamphlets, calendars etc. can be brought out to bring home message to the educated people and school going children.

(iv) **Audio Visual Aids:** Radio, television, cinema slides and motion pictures are effective available media for reaching large number of people. Advantage of these media should be taken for disseminating fire prevention education, as widely as possible. Television is expansive and not accessible to many groups of people. Portable projectors could be taken even to remote areas for this purpose.

(v) **Individual and group contacts:** The key feature is direct personal contacts with individuals or groups. This may often be found a very useful method in transmitting a fire prevention message to a group. People responsible for such contacts should be able to communicate in local dialect.

(vi) **Special programmes and campaigns:** Special, programmes should be organised for fire prevention. This could be done in the form of celebration "Fire Prevention week" / "fire Protection Week" on the pattern adopted for "Wild Life Week" or "Van Mahotsava".

(b) **Compulsions:** When persuasion fails to yield desired results, various forms of restrictions and compulsions have to be imposed/used. The main compulsions exercisable are as under:

(i) **Legal provisions:**

The first and the most important form of compulsion is direct legal action. The National Forest Policy, 1952 does not lay down any general policy regarding fire protection or for that matter even the forest protection in general, except indicating the need for enlisting people's co-operation for protection of forests and tree lands. Some provisions regarding forest fires are available under Indian Forest Act. Setting fire to a Reserve Forest is punishable under section 26 (1) with imprisonment upto six months or fine upto rupees five hundred or both in addition to such compensation for damage done to the forests as may be decided by the convicting court. Similar provision exists with regard to Protected Forests under section 33(i) of Indian Forest Act. Similarly under section 26(3) and 33(2) there is a provision that whenever fire is caused willfully or by gross negligence in a reserved or protected forests, the State Government may (notwithstanding that any penalty has been inflicted under these sections), direct that in such forests or any portion there of the exercise of all rights of pastures or to forest produce shall be suspended for

such period as it thinks fit. Further, section 79 (1) of the Indian Forest Act makes obligatory on every person, who exercises any right in a reserved or protected forests to furnish without unnecessary delay to the nearest Forest Officer or Police. Officer any information he may possess in respect of the Commission of, or intention to commit, any forest offence and to assist and take steps to extinguish any forest fire. Any violation of the provision of this section is punishable under 79(2) with imprisonment for a term which may extend to one month, or with fine which may extend two hundred rupees, or with both.

Under section 35 of the Indian Forest Act, the State Government, may by notification in the official gazette, regulate or prohibit, in any, forest or waste land not being the property of the Government, the firing or clearing of the vegetation.

**Enforcement of Legal Provisions:** Having a law on statute books is not enough. Enforcement of law is in indispensable part of forest protection. All endeavours should be made to invoke the provisions of law whenever it is expedient to do so.

**Fire Lines**

(a) **Exterior fire lines:** The fire lines should be kept clear of undergrowth and inflammable materials either by cutting or by burning regularly every year. They form lines from which the firefighting operations can be initiated.

(b) I**nterior Fire Lines:** The sub division of large blocks of forests and the isolation of plantations by cut lines are essential in order to render it possible to localise fires. Interior fire lines in the hills must run along ridges and along them must be constructed small footpaths these must be connected by level footpaths; as thereby, is not only the area divided into units of manageable size, but a labour force is rendered mobile and enabled to proceed with speed to the site of the outbreak of fire. A fire can usually be extinguished provided the persons can reach the spot before the fire has spread over a wild area and speed of movement is the first essential to successful fire extinguishing. These contour paths and fire lines along ridges also serve as bases from which counter fires or back fires can be started with the object of confining the outbreak to a definite limits.

All roads open to traffic traversing the forest should be swept of needles during the hot weather. Inspection paths and bridle paths in forests be also constantly kept clear of leaf litters, twigs, grasses, which serve as miniature fire lines and fire breaks in the forests.

In case of forest plantations, one to one and half metre wide fire break should be constructed throughout the outer periphery of the plantation which will serve as a direct barrier and to impose some obstacle to the spread of fire. The inspection paths within the plantation areas should also be kept clear of all inflammable materials.

**Reduction of Inflammability**

The reduction of inflammability of a forest throughout its life is essential, and the foundations of immunity from the more serious effects of fire are laid with the first seeding felling, which must be in accordance with the silvicultural requirements of the species. This would allow of the burning of the very extensive refuge from conversion. A clean seedbed is essential to subsequent fire protection. Seeds of most tree species, conifers especially grow best on mineral soil surfaces. Where it can be used, fire is often the most efficient means of seedbed preparation. It will consume surface litter and duff exposing mineral soil, and also reduce competition from grass and other subordinate vegetation.

The refuge from secondary and final feelings cannot ordinarily be burnt in situ but must be removed by hand, thrown into nullah beds or burnt on banks and left to decay.

**Special measures of fire protection in Chil Forests**

The chil forms a thick bark at a very early age which enables it to resist the effects of a slow fire and this property has been taken advantage of during the past years which have witnessed the introduction and development of control burning.

**Control burning of areas under regeneration:** All regeneration areas must be isolated by fire traces until they are sufficiently advanced to be fired departmentally. Interior fire lines must be cleared of grass in order to enable fires to be localised. The chil seedling develops a thick bark by the time it is one to one and half metre in height which enables it to resist the effects of a slow fire during the winter. The foundations of successful fire protection are laid with the first seeding fellings, which must extend evenly over the whole compartment under regeneration, apart from compact groups of poles, which are left intact.

When seedlings are about one metre in height the grazing by cattle should be permitted in order that the inflammable grass may be reduced; grass cutting may be allowed when the seedlings are considered by the Divisional Forest Officer to be large enough not to be cut alongwith the grass; that is when they have developed a corky base. But it must be noted that very young seedlings are normally cut by grass cutters and this has proved to be a reason for the failure of some areas to regenerate. The young plants must be thinned to a distance of one metre when about one and half metre in height and cut material removed from the regeneration areas.

After the foregoing means of reducing inflammability have been employed and the plants have developed a thick bark, a controlled fire shortly after winter rains must be constrained to travel only in a downhill direction. Any patches of young seedlings being protected from being burnt. The age and height which the plants must attain before they can resist the effects of a slow fire vary, according to the moisture contents of the soil which again depends on aspect and elevation. Winter is the best time, the burning season extending from middle December to about middle or end of February. All control burning, therefore, must be completed by the end of February. Burning usually should precede seed fall as closely as possible.

**Control burning of forests not under regeneration**

Burning must be thoroughly planned and organised. A competent man must be in full charge. Safety precautions taken, a specific ignition schedule prepared, and sufficient men and equipment be on hand for burning and more quickly available for emergency.

Along ridges and level paths narrow traces are cleared of needles and fire is started on the lower side and made to burn downhill only. Sufficient men must be present armed with small branches for beating out the fire in the event of its jumping the trace. The fire burns slowly downhill and after it has burnt a few metres the trace may be left under the watch of only a very few men and a fresh trace started some little way down the hill and a second fire started below it in order to expedite operations. Subsidiary ridges are used as base lines for starting similar fires. Throughout the operation the line of fire should be kept as straight as possible, and a few men must remain below it, particularly where the ground is steep, in order to extinguish at once fire caused by rolling cones. Operations must be so planned as to cease by nightfall or to then be confined to places where the fire can burn itself out without fear of extending to other forests, and two or three men must keep watch. Burning is safe during the winter months, December to February and should commence as soon as the soil covering has dried out sufficiently after winter rain. Villagers are glad to give help during the day as they benefit from the improved growth of grass after fire and they should be consulted as to the dates when firing is convenient and as to the areas to be burnt as it is undesirable to burn the whole of a villages grazing ground until there is no further need of winter fodder.

No consistent timetable can be given for burning. Burning for fire control may be done at five to seven year interval or longer. In forests tapped for resin it is difficult to

prevent the blazes catching fire. Throughout the tapping season the bases of the trees must be cleared of needles, chips and resin by tapping mazdoors and at the end of the season the ground at the bases of the trees must be left absolutely clean to a radius of one and half metre.

**Fire Observatory Towers**

Detection of forest fire can be carried out from stationary fife observatory posts. Such a method of fire detection is most effective in mountainous country. The observation post should be established at the commanding spot at the centre of an elevation in order to avoid uncovered zones and ensure widest observation.

The location of a fireman be fairly accurately determined from one tower and the fire protection staff pressed into action and fire combated / prevented from spreading,

Twelve to fifteen metre high wooden fire observation towers should be constructed at a suitable site in each Range, the number would of course depend on the availability of funds. Wooden fire observation towers have the advantage of simplicity and availability of material for constructions at site. In order to increase the durability their props should be treated with preservatives and erected on concrete foundations.

**Organisation for fighting fire**

During the fire season and particularly where the season has been very dry, the forest should be frequently patrolled by the whole of the forest staff; occasionally the night patrolling should also be organised and everyone found moving in the forest should be questioned. Every Forest guard should look on his beat as his own property and should be considered personally responsible for its safety. Frequent visits to forests should be made by the Range Officers, Divisional Forest Officers and occasional visits by the Conservator of Forests during the fire season.

When a fire is observed Forest Guards and Fire Watchers at “lookout” points should at once send a message to the Forest Ranger and the nearest other. They should immediately inform the President and members of the local panchayat as well the staff and Institution stationed near the vicinity to land necessary help in the firefighting operation. The senior officer present will immediately take command of the operation. He should know the local geography. Should a five get beyond control, it is necessary to localise it by counter firing or back firing. Counter Firing should only be done under orders of the senior office incharge of operation and should only be attempted from a definite line such as road path of a ridge or a fire line. A line is formed along a ridge by clearing the soil covering and cutting bushes from which a fire is started so as to consume the fuel in advance of the oncoming forest fire.

Successful counter firing calls for the highest degree of fire behaviour knowledge and accurate appraisal of fuel and burning conditions. The fire and its potential must be considered as a Whole. Counter firing also requires a high degree of skill timing and coordination in its executions. In-aptly applied, it may be disastrous and serve only to spread fire, discourage and demoralize the staff and in general makes a bad situation worse.

After fire has been brought under control, a patrol is to be kept on duty until all danger of the fire spreading has been removed.

Each Range should have a written plan of operations in case of an outbreak of fire and every member of the staff should have definite instructions exactly what is expected of him until the arrival of his senior Officer.

Arrangements for the transport of food, water and adequate firefighting tools are essential.

# CHAPTER X

## TIMBER EXTRACTION WORKS

With the nationalization of timber extraction works, felling of trees, extraction and sale of timber both, in Govt. and private areas is required to be done departmentally through H.P. State Forest Corporation. Numerous instructions already stand issued on the subject. It is necessary to consolidate the same for ensuring uniformity in working and control.

**Felling Programme:**

Each Conservator of Forests will ensure that felling programme for a Division is prepared at least three years in advance so as to plan works in a systematic manner with respect to arrangement of finances, creation of necessary infrastructure, allocation of works etc.

In case of feelings to be done in private areas, the proposal should be finalised by the Divisional forest office in accordance with 10 years Felling Programme and timely action should be taken to ensure completion of this operation.

It has been observed that details of areas to be worked in a particular year are made available very late and the works cannot be properly planned and executed. This had resulted in numerous complications leaving to less out turn, delay in execution of works.

**Markings**

Markings are to be done by the territorial staff in accordance with the instructions issued by Pr. Chief Conservator of forests (HoFF) and Conservator of forest concerned. The marking lists should be obtained by the Divisional Managers in triplicate. The marking lists should contain following information:-

(i) Division, Range, Forest, Compartment, Sub compartment,
(ii) Type of markings, PBI, thinnings, salvage etc,
(iii) A note by the Marking Officer indicating the points kept in view while carrying out the markings.
(iv) A map of the area showing the sections into which the compartment or the marked area can be divided to facilitate planning of timber extraction works.
(v) Name of the Marking Officer.
(vi) Facsimile of the hammer used in marking.
(vii) The gist of the markings.

The areas should be taken over after joint inspection. A note should be prepared by the Forest working Division after taking over the area indicating the details that he observed during inspection which are likely to be helpful in planning timber extraction works.

In case of salvage markings, the event (fire, wind, now etc.) should be clearly mentioned. The year on which the trees in question got felled or damaged should be estimated or ascertained from the territorial staff and recorded on the marking lists. This information is very necessary to plan the works and subsequently fix the floor price of the extracted timber. Floor price of the timber cannot be fixed just on the basis of species and sizes, but the quality of trees from which timber has been extracted has also to be kept in view.

In case of Khair, Chil, Fuelwood coppice, Bamboo etc. lots, the marking lists must be obtained by 31st August for the year in which the work has to be started. The period of working will depend on the date on which the marking lists are made available.

In case of fir, spruce, deodar, kail, temperate broad-leaves species etc., the marking lists have to be made available by 30th of November of the year preceding the one in which exploitation works have to be started.

The trees, which are standing on a very steep and rocky portions, are likely to be damaged during fellings or conversion should not ordinarily be marked. If marked, they should not be taken over. The trees which require special attention during felling by way of roping, lopping or other special precautions should be distinguished by putting a word "L" near the marking hammer fascimile for the guidance of the felling labour. The fascimile of the hammer mark has to be affixed on the marked trees on the lower-most portion of the tree on down-hill so that no difficulty is felt while carrying out the fellings. If marking hammer or marking numbers are higher, these should be got re- fixed in accordance with the needs before taking over the lot.

**Preparation of plan of operations**

A plan of operations for the exploitation of the area has to be drawn up by the Forest Working Division. The area has to be divided into suitable sections capable of being delineated by natural features like ridges, spurs, roads and nullahs etc. The extent of such sections should be so fixed that, the timber extraction works in a section can be finished in a single working season. The works have not to be spread over more than one working season in a particular section as far as practicable. The tentative location of ropeway spans, ropeway heads, launching depot etc. shall be decided while planning.

Similarly leads for manual and mechanized carriage etc. have to be determined and fixed during planning. The leads will find mention while inviting tenders or allotting work. It has been observed that serious disputes arise in the measurement of lead and many officials had to suffer for not measuring the lead correctly. No change in the length of lead will be allowed after it has been measured in advance and indicated in the work order.

**Handing over and taking over of the marked forests**

The marked forests should be taken over by the Forest Working Division against a proper receipt. The receipt should be given after the forests have been inspected and the discrepancies in respect of illicit fellings or other deficiencies in the markings should be pointed out. Any discrepancy noticed after proper taking over will be to the account of Forest working Division.

**Fellings**

Fellings are a very important operation and need special attention. Any laxity during felling can cause appreciable decrease in the converted timber. The standard of feelings will depend upon the quality of supervision and control being exercised by the timber extraction staff. Following points are brought out in particular in this regard

(i) A Forest Guard should be incharge of felling for supervision of each tree on the spot.
(ii) All stumps of felled trees will be enumerated by putting a fresh serial number over the felled surface of the stump with coaltar dissolved in Kerosene oil or 'Geru' in oil.

(iii) Felling register will be maintained as per proforma attached and entries made in it daily.
(iv) Any discrepancy in size or the species of trees found on the ground and those entered in the marking lists shall be reported to the Divisional Manager for necessary action.
(v) Directions of felling and special instructions in respect of roping and lopping shall be given by the forest guard. Felling will be done up hill, when it is not possible, it should be done along the sides.
(vi) Any tree standing on steep slope or rocky location and likely to get split during felling should not be felled. All such trees should be got inspected from gazetted assistant for final decision.
(vii) Felling should be done with saw only as low as possible.
(viii) Special attentions should be paid to the "phati" given to the feller.
(ix) Felling work should not be left to the forest guard only. A part of it must be supervised and got done in their presence by the Range Assistants, Forest Rangers and ACFs.
(x) The persons inspecting fellings should record their observations in the felling register.
(xi) Special rates for lopping and use of ropes should be allowed. In case a tree has been damaged during felling due to the carelessness of felling labour, apart from denying them payment for felling, a fine up to the felling charges payable to them may also be levied.
(xii) Usual safety measures during fellings should be adopted to avoid damage to men and material.
(xiii) Fellings must be got done from experienced felling labour and got from Sawyers etc. Record of trees damaged should be maintained and reported to the Range Assistant.
(xiv) Fellings should proceed systematically from top to bottom.
(xv) Fellings should not be carried out much in advance of actual, conversion and all the felled trees should be converted within one month of their felling.

**Cross Cutting**

(i) Cross cutting should be straight. Cross cut must start form the butt end of the tree.

(ii) Splitting of bigger logs by use of explosive, should be scrupulously avoided. The logs which cannot be manipulated by saws should be inspected by the Assistant Manager and splitting permitted only after thorough enquiry and scrutiny.

(iii) The length of logs have to be specified in advance and not left to the discretion of the sawing labour. This item has been discussed in next section.

(iv) The standard size for deodar logs will be 3.05m and for fir and kail 3.7m. If there are any special sizes to be sawn, specific instructions shall be issued. for the same by the Sub. Divisional Manager.

(v) Logs should not be rolled down to central places to have concentration of sawing. Sawing of logs may be done as near to the stump as possible.

(vi) Sawing of kail and fir beam will be avoided. Deodar hakries may be made only when no useful sawn timber can be extracted. Sizes of fir hakries should be kept as big as possible as they bring good price. Deodar dimdimas are also in demand in the market.

**Common Sizes**

The sizes which fetch the best price in the market shall be decided by the Forest Working Division in the beginning of the year after studying the results of the auctions. The usual sizes can be converted subject to marketable sizes as under.

| Sr. No. | Trade Name | Dimensions (Cms) | Volume in cum |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 1 | Beams | 366X31X16 | 0.182 |
| 2 | Gattus | 305X31X16 | 0.151 |
| | | 275 X31X16 | 0.136 |
| | | 244 X31X16 | 0.121 |
| | | 183X31X16 | 0.091 |
| | | 122X31X16 | 0.061 |
| 3 | Large | 427X26X13 | 0.144 |
| | Sleepers | 366X26X13 | 0.124 |
| 4 | B.G.s | 305X26X13 | 0.103 |
| | | 275X26X13 | 0.093 |
| 5 | Small | 244X26X13 | 0.082 |
| | Sleepers | 183X26X13 | 0.062 |
| 6 | M.G.s | 183X21X13 | 0.050 |
| 7 | Scantlings | 427X21X13 | 0.117 |
| | | 366X21X13 | 0.100 |
| | | 305X21X13 | 0.083 |
| | | 275X21X13 | 0.075 |
| | | 244X21X13 | 0.067 |
| 8 | Other scants | 366X16X10 | 0.059 |
| | | 305X16X10 | 0.049 |
| 9 | Karries | 427X18X18 | 0.138 |
| | | 366 X18X18 | 0.119 |
| | | 305 X18X18 | 0.099 |
| | | 275 X18X18 | 0.088 |
| | | 244 X18X18 | 0.079 |
| | | 427X16X16 | 0.109 |
| | | 366 X16X16 | 0.094 |
| | | 305 X16X16 | 0.078 |
| | | 275 X16X16 | 0.070 |
| | | 244 X16X16 | 0.062 |
| | | 427X13X13 | 0.072 |
| | | 366X13X13 | 0.062 |
| | | 305X13X13 | 0.052 |
| | | 275X13X13 | 0.046 |
| | | 244X13X13 | 0.041 |
| 10 | Slabs | 427X26X8 | 0.089 |
| | | 366 X26X8 | 0.076 |
| | | 305 X26X8 | 0.063 |
| | | 275 X26X8 | 0.057 |
| | | 244 X26X8 | 0.051 |
| 11 | Round Ballies | 366X50 – 59 | 0.069 |
| | | 305X50 – 59 | 0.058 |

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| | | 244 X50 – 59 | 0.046 |
| | | 183 X50 – 59 | 0.035 |
| | | 152 X50 – 59 | 0.029 |
| | | 366X40 – 49 | 0.046 |
| | | 305 X40 – 49 | 0.039 |
| | | 244 X40 – 49 | 0.031 |
| | | 183 X40 – 49 | 0.023 |
| | | 152 X40 – 49 | 0.010 |
| | | 366 X30 – 39 | 0.028 |
| | | 305 X30 – 39 | 0.023 |
| | | 244 X30 – 39 | 0.019 |
| | | 183 X30 – 39 | 0.014 |
| | | 152 X30 – 39 | 0.012 |
| 12 | Hakries | l.183 CM. & Mid girth | 0.093 |
| | | 90cm. & above | |
| | | L. 152 Cm. Do | 0.077 |
| | | L. 122 Cm. Do | 0.062 |
| | | L. 92 Cm. Do | 0.047 |
| 13 | Dimdimas | 183X23X23 | 0.097 |
| | | 152X25X25 | 0.095 |
| | | 122X31X31 | 0.117 |
| | | 923X6X36 | 0.119 |

**Length, Thickness and Width allowance**

(a) Length allowances 7 cm.
(b) Width for all species I cm.
(c) Thickness allowance I cm.

sawing of over and undersized timber should be avoided.

**Wane**

The wane allowance for standard sizes should be 4 cm. on one side, in Karies I. 5 cm from one side and in axed ballies 4 cm on all sides. This will not apply to timber extracted from side slabs where higher wane can be allowed.

**Pachhan or Squaring of Logs**

(i) This should be done carefully. The finished surface should be smooth. Special care has to be taken where knots ate present.

(ii) Labour should be persuaded to do the squaring by sawing after nominal pachhan for stabilizing the logs so that side slabs can be used. Use of saws for squarring is being adopted in J& K on a large scale. Labour in Himachal Pradesh is yet to be persuaded to adopt this technique.

(iii) Sawing should be smooth and even. Wavy surface should be discouraged.

(iv) Making of squarred logs into sleepers and scants should be done by experienced Mistries to have maximum utilization. Centre heart should be avoided in sleepers but no undue wastage should be caused in this attempt,

(v) Sleeper with rot, shake and other serious defects likely to cause their rejection should not be sawn. Setting up of saw mills powered by diesel engine should also be examined for sawing of logs. This can be adopted on a large scale in convenient location where a trolly and a band saw with an engine can be installed.

(vi) Shipping should be (lone by cutting edges upto 3 cm on all the 4 sides and without rounding. This will make the ends look regular in shape.

(vii) The 'Karpas' or measuring gauge with the sawing labour should be made out of dry wood and checked once a week y the timber exploitation staff.

**Passing of Timber**

There should be special Forest Ranger or Deputy Ranger for the passing of timber in the forest. Passing should be done immediately after conversion takes place. The timber extracted by a particular group of sawyers must be inspected at least once a week Forest Rangers and A.C.Fs must pay special attention to this important, work and carry out super inspection up to 20&1.0 percent respectively. There is a tendency with the passing staff to enter less number of pieces to provide for damage and losses, which may take place subsequently. This tendency has to be seriously checked.

**Carriage**

(1) Carriage leads should be measured in advance before allotting the work. The fixing of rope-way heads is also very necessary. Undue carriage, on human backs should be avoided. Maximum use of Donald Gravity rope-way should be made.

(ii) Carriage should start immediately after the timber has been passed.

(iii) Converted timber should not be allowed to be dragged.

(iv) The timber should always be properly stacked at rope-way heads or in transit depots. This will facilitate checking.

(v) The leads are measured at 1:6 gradient and should be accounted for as under:-

a. From the top most/bottom most stump to the carriage depot end.
b. Wet lead downhill 1/2.
c. Dry downhill full length.
d. Dry up hill double length.
e. Wet uphill full length.

**Roping**

The detailed instructions for the use of Donald Gravity Ropeway should be strictly followed. Salient points are, however, mentioned below:-

(i) Roping should be entrusted to an experienced mate only.

(ii) Lines for ropeways should be cleared carefully and the trees marked during the process properly accounted for and converted.

(iii) Roping operations should be done carefully to avoid breakage in transit. Account of all breakages should be kept and recoveries made, from the roping contractors if this is due to his carelessness. Timber for roping should be handed over to the roping contractor after proper counting. Record of unavoidable breakages should be kept and the broken pieces converted into suitable sizes.

(iv) The ropeway span should vary from 500 to 1200 metres as far as possible in length and on slopes up to 45 degrees.

(v) The maximum load per trip should be equivalent of about 2 B. G, sleepers.

(vi) The history of ropes must be properly maintained in the following form:-

a. Specifications
b. Length
c. Date of Purchases
d. Cost.
e. Present location where being used.
f. Number of scants roped with its help.
g. Any splicing etc. done to remove the damaged position.

Ropes are a costly item and they have to be maintained with utmost care. The history sheet of the ropes must be kept up to date and all the portion which need condemnation must be withdrawn from use after work in a forest is over. Immediate steps must be taken to write off all unserviceable portions. Undue accumulation of unserviceable ropes must be avoided. Writing off must be done, wherever possible every year. Ropes should not be given on rent to private contractors without the permission of Director.

**Launching Depots:**

The timber should be stacked size and species wise at the launching depot. The timber at the launching depot should be properly looked after to avoid theft.

Depot forms should be always posted up to date. The launching depots should be a well-defined piece of land above the highest flood level and otherwise protected from all kinds of damage.

**Timber Forms**

Timber forms No. 5, 6 and 7 must be kept up to date. The bills should be paid only when form 7 is presented along with a bill. The bills should not be sanctioned on the basis of entries made in Measurement Books only.

Since payments are to be made on the basis of entries made in the timber forms, it is necessary that different operations, for which payments are made, are shown distinctly. Form No. 5 shall be maintained by the staff in charge of felling. This will show the number of trees and their standing volume. In form No. 6 they will show the logs of different species and sizes got as a result of felling. The staff in charge of sawing shall maintain Form No. 5, 6 & 7 showing the details of the logs, sawn and round timber species wise and size wise. Similar forms shall also be maintained for carriage and roping. Thus there will be 4 set of forms for 4 operations for which payment is to be made.

**Fire Protection:**

(i) Proper fire protection measures have to be adopted in areas where timber extraction works are in operation, especially near the depots, may that be a launching, transit, ropeway head etc. The surroundings of all locations where timber has to be stacked after extraction for whatsoever purpose must be control burnt and cleared before the timber is stacked there.

(ii) Fire should be lit in well-defined places by labour and not in the open near the timber. The fire must be extinguished every evening to avoid its spreading.

(iii) The Forest paths etc. should be kept clear of inflammable material and debris, Fire watchers should be appointed in such areas.

(iv) Loose earth heaps may be kept near the depots area. Where water is available, a kuhal may be brought near to the timber stacks, if economical.

**Work Bills**

The necessity of preparing the bills of the labour supply mates in time and labourers speedily, does not need any reiteration. The bills for all works must be prepared every month and submitted to the Divisional Office along with timber forms. The staff responsible for the preparation of such bills may be called to the headquarters of the S.D.M. for expediting the submission of, such bills.

The bills must be submitted on behalf of the labour supply mates / labourers. The present practice of having the bills only from the forest staff without bringing the agency executing the works in the picture is not proper.

**Work Advances**

According to the present, procedure work advances up to 90 percent of the work done can be given by the officer in charge of Forest working Division. The work advances should be given only against the works, which have been executed and accounted for in the books. These advances should be given through the A.C.F. so that he is also in the know of the amounts outstanding against different labour supply mates/contractors. The present practice of granting such advances on the basis of reports without supporting forms etc. should be discouraged. The advances must be recovered from the next regular bill. No advances should be granted for long periods and advances must be recovered before the close of financial year. Any advance made against these instructions shall be the personal responsibility of the officer making such advances.

**Godown Supply**

(i) The godown for good stuffs must be maintained as close as to the site of works as possible.

(ii) The supply of material should be adequate and regular throughout the period of work.

(iii) The staff incharge of timber extraction works must inspect the depots regularly to ensure that the quality of the food stuffs is strictly in accordance with the approved samples. Results of such inspections must be entered in the register kept in the depot. The terms of the contract for the supply of godown must be strictly enforced.

It has been observed that local labour draw godown from such depots but consumes it at their residences. This should be checked. Godown should be supplied to the labour actually residing and working in the forests. The godown supplying contractors will submit a monthly statement duty acknowledged by the work mate and Forest Ranger or A. C. F. giving the details of the material supplied by him to the labour. These will be forwarded to the divisional office for deduction from the bills of the mate. These statements will accompany the work bills direct payment by the work mate to the godown supply contractors are not to be permitted.

**Maintenance of Tools**

All the tools like axes, cross cut saws etc. should be regularly sharpened and maintained by the engaging saw filers and blacksmiths. The condition of these tools must be proper throughout the duration of timber extraction works. All the timber extraction staff must pay special attention to these important aspects.

**Execution of agreements**

No work should be allowed to be started by any contractor / labour supply mate till he has been formally allotted the work and has executed the prescribed agreement. There should be a clause for compensation for bad work in all such agreements.

**Stacking of Timber**

(i) Timber must always be stacked species wise and size wise.

(ii) The depot where stacking is done must be free from all type of damages. Water logged areas should be avoided. Areas liable to flooding should also not be selected.

(iii) The axed surface of a scant should not be exposed only sawn surface should be kept exposed. Wherever possible timber may be kept in shade. Strict fire protection measures are essential.

(iv) Stacking should be done in such a way that there is space in between the stacks for the inspection and counting of timber. Rotten, broken and otherwise inferior timber should be stacked separately.

**Handing over of Timber for Ghall**

(i) All timber to be handed over in Ghall should be stacked as per instructions given above and kept ready for launching at least one month in advance of the date of launching.

(ii) All stacks must be numbered seriously and sizes and species of pieces entered thereon.

(iii) Five copies of launching lists should be prepared.

(iv) The launching depot must be checked by the Forest Ranger and A.C.F. completely. The timber should be handed over for launching against proper receipt from the officer in charge of the ghall and the contractor from the officer in charge of the ghall, and the contractor handling the ghall. These lists should be sent to the Divisional Forest Officer in triplicate by A.C.F. after retaining a copy.

**Handing over of forests after exploitation work**

As soon as the conversion works are completed the forests should be formally handed over to the territorial divisions. There are complaints from the territorial staff that areas are not formally handed over to them for regeneration purpose while the timber extraction staff feels that the areas have since been cleared and are fit for regeneration operations.

**Handing over of charge by exploitation staff on transfer**

Whenever any member of staff on timber exploitation work is transferred, he should hand over charge to his successor along with timber forms posted up to date. The timber in different stages of conversion must be properly checked and accounted for. A certificate will be recorded in all the forms and Measurement Books that the formal transfer of charges has taken place after physical verification of the balances.

**Use of modern basic logging tools**

A large number of modern basic logging tools have been procured. A large number of members of the staff have, also been got trained in their use. It is necessary that such tools are property and extensively used for timber extraction works. Divisional Forest Officer and A.C.F. should ensure that all such tools are actually used for timber extraction work.

**Conversion data and completion report**

On the completion of timber extraction works in any forests compartment following information should be collected:

(i) Total number of trees and volume marked species wise.

(ii) Yield

| | | | | |
|---|---|---|---|---|
| (a) | Swan timber | Size | No. | Volume |
| (b) | Round timber. | ,, | ,, | ,, |
| (c) | Dimdimas | ,, | ,, | ,, |
| (e) | Hakries | ,, | ,, | ,, |

(iii) Conversion percentage in terms of standing volume:-

(a) Sawn.
(b) Round.
(c) Pulpwood
(d) Firewood
(e) Total.

Data about the timber of different sizes extracted from trees of different diameter classes should also be collected for each species. This information should be available at least for 50 trees of each diameter classes after the works in an area are completed.

**Inspection of Exploitation works**

The timber exploitation works must be inspected as frequently as possible. Forest Ranger in charge must inspect each forest once in a fortnight, ACF once in a month and D.F.0 at least twice during the working season.

**Costing Statement**

The detailed instructions for preparing the costing statements of timber extraction works should be followed. It has been observed that lot of expenditure not directly connected with timber, extraction works is charged to these heads and the costing statements prepared at the end are not realistic and factual. It is necessary that D.F.O. should prepare detailed budget head wise included in the costing statement. All the items of expenditure should be clearly defined. Only temporary roads and buildings should be constructed and maintained under this budget. Economics of such operations has always to be kept in view and the works so organised that they are executed at the lowest possible cost.

**Fellings from private areas**

The lots of standing trees from private areas are taken over after following the procedure as outlined under H.P. Forest Produce Regulation of Trade Act, 1982 and the rules framed therein. This is a social work. Special attention is to be paid to this work to ensure remuneration returns to the owners of the trees.

At the end of the completion of work, the economics of the lots should be reworked out for future guidance for similar situated lots.

**Working of geltu lots**

The areas which are marked for the extraction of geltus /dimdimas will be taken over after following the procedure indicated above. The trees in such lots are primarily made available for extracting material for the manufacture of packing cases. No attempt has to be made to extract sawn or other type of timber. Any tree, which is not capable of being converted into geltus because of its big size, should be allowed to stand.

In case some sleepers/scants have to be extracted for preparing sites for fixing ropeways etc., special permission should be obtained from the Conservator /D.F.Os. Concerned, giving the number of scants required. Such permission may not be forthcoming in time. Under these circumstances, sending of intimation to the D.F.O. concerned will suffice. This aspect should be taken into consideration while working out the economics.

In some cases round geltus have to be split into 2, 3 or 4 portions, their volume is also calculated by quarter girth formula as for logs. A reduction of 20% in the volume of such split pieces may be given.

The geltu lots have to be worked on No profit and No loss Basis. It is necessary to prepare detailed accounts for each lot immediately after the work in the lot is complete.

**Extraction of pulpwood and fuel wood**

All the standing volume cannot be converted into geltus. Some volume may have to be converted into hakries, pulpwood and fuel wood to the barest minimum. The disposal of such material should only be done after it has been inspected jointly by the D.F.0 territorial and Forest Working Division and the sale proceeds should be taken into consideration while preparing the accounts.

The requirement of geltus for a particular year should be worked out realistically. The responsibility for making adequate standing volume available lies with the Forest Department.

Each lot, which is handed over as far as practicable, be worked in one season by dividing the area into suitable sections. The work in one area should not be spread over a large number of years, keeping in view the necessity of proper control over costs, out turn and supplies.

**Damage Bills**

Some damage is likely to occur to the forest growth during extraction operations. The damage bills have to be received and verified by D.F.0 exploitation or his authorised representative not below the rank of Forest Ranger. He should insist that the damage bills are received only when they have been counter signed by the D.F.O. (Territorial).

**Sale**

All wood extracted by the Exploitation Divisions should be dispatched to, the Sale Depot as may be notified from time to time accompanied by a challan which should give species quality, size and number. The Depot Officer will acknowledge the receipt of timber immediately on receipt and return one copy of the challan to the Exploitation Division and retain one copy for use in his Depot. The timber as received should immediately be entered in Timber Form No. 5.

Timber when received should be stacked. Each piece of timber in a stack is to be given a hammer mark indicating the Division and the quality and species of the timber. The stack will also be assigned a number, which will not be changed till the stack is finally sold and lifted by the buyer.

The classification and measurement of timber in the department is ordinarily left to the labour and Forest Guards/Timber Watchers. The Range Office and Depot Officer must check at least 10 % to 15 % of such work to satisfy that classification and measurements have been correctly done.

List of lots to be put for auction should be prepared division wise for smudha and rejected timber etc. separately.

The sales should be properly advertised as per instructions available on the subject.

In rare cases it may be necessary to sell timber by calling tenders or through negotiations. The prescribed procedure in this regard may also be followed.

The upset Prices should be fixed on the basis of rates got in the last three auctions and the prevalent market rates. Upset Prices must be got approved before the lots are put for auction. Upset Prices are an indication for the likely rates, which are to be got in the auction.

The conditions of sale have to be drawn up carefully and enforced uniformally. Action to convey sanction within the stipulated period has to be ensured to avoid reselling by the highest bidders.

Bid papers have to be prepared for each lot separately. All the bids have to be recorded. The highest and the second highest bid have to be recorded in particular along with signatures of the auctioning authority. The amount of earnest money has also to be entered in the bid paper.

In case a bid is not sanctioned, the old bid papers will also be kept in view while holding auction subsequently.

The conditions of sale should be got signed from all the bidders attending the auction after paying specified entry fee but each successful bidder should also sign conditions of sale to ensure subsequent enforcement.

**APPENDIX- I**

FELLING REGISTER OF _____Forest _____ COMPARTMENT _____ BLOCK _____ RANGE FOREST WORKING DIVN.

DATE OF START OF FELLINGS _____

DATE OF COMPLETION OF FEELINGS _____

| Date | Marking No. | Species | Marking dia at B.H. | Sl. No. of Slump | Stump dia. | Felling directions | Lopped or not | Roped or Not | S. No. of Trees |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | | | | | | | | |

| Kind of trees | Dia of damaged tree at B.H. | Type of damage | Whether damaged tree will survive or not | Phati correct or wrong | Felling by axe or saw or combined | Name of feller | Name of felling mate |
|---|---|---|---|---|---|---|---|
| 11 | 12 | 12 | 14 | 15 | 16 | 17 | 18 |
| | | | | | | | |

| Signature of F.G./I.C. | Signature of Dy. Ranger Incharge | If enhances rates of felling to be paid or not | Stump height above ground level on uphill side | Remarks |
|---|---|---|---|---|
| 19 | 20 | 21 | 22 | 23 |
| | | | | |

# CHAPTER XI

## CONSTRUCTION AND REPAIR OF BUILDINGS

A number of books on engineering are available. The instructions contained in the Standing Order are primarily meant for the execution of ordinary works of engineering connected with the construction and repair of forest buildings. These instructions may be supplemented by consulting any standard book on engineering where in doubt and when considered necessary. The contents of this standing order are identical with the Standing Order No. 10 of the Himachal Forest Manual Volume - III.

**Earth Work**

The excavation of foundations, trenches must be in exact accordance with the drawings. The trenches must be taken out to the exact width of the lowest step of the footings. Care must be taken that the bottom of the trenches are truly level in all directions that any steppings ordered are strictly attended to, and that sides are kept plumb where the soil admits of it. We must note that the design of foundation vanes with the nature of Soil and the bearing capacity of soil.

The bottom of all trenches must be well watered and rammed, care being taken that too much water is not used. Soft and defective places are to be brought to the notice of the D. F. 0 or R.O. incharge and holes are to be filled with sand or concrete.

On the completion of the excavation the work must be measured up and passed by the Range Officer, and the measurement agreed to by the contractor. A report must be made to the D. F.O. who will, if possible, inspect the foundations before building is commenced.

The ground in the immediate neighborhood will be cleared of all jungle and all hollows filled. Trees will not be cut without the order of the D.F.O.

On the completion of the building, the ground all round to a distance of 15 meters is to be cleared of all debris, and be given a slope of I in 40 outwards. The foregoing does not apply to buildings in the hills.

**Earth Filling**

As soon as a building has reached plinth level the space between the masonry and the side of the trenches is to be cleared of all debris and filled with earth laid in 15 cm layers watered and rammed.

All earth filling should be carried out in successive horizontal layers well consolidated, water being used if necessary.

**MORTARS**

**(i) Portland Cement Mortar**

Ingredients: Portland cement, sand and water.

**Mixing: -** The quantity of water to be used must be decided on the spot; too much water must not be used. First of all, the cement and sand must be thoroughly mixed together on a clean platform in a dry state so that the colour of the cement is evenly distributed throughout the sand. The smallest amount of water should be used which will give a sufficiently plastic mixture for the work in hand.

Small quantities should be mixed sufficient for about 15 - 20 minutes work.

**Laying: -** The mortar having been mixed should be applied at once, trowel worked quickly into place, smoothed over and not touched again. In the plains during the hot weather, stones and bricks to be set in cement mortar must be well soaked in water.

The following proportions by measure are generally suitable: -

| | | |
|---|---|---|
| (i) | Masonry not requiring great strength | Cement -1, Sand 4 |
| (ii) | Strong masonry | Cement -1, Sand 3 |
| (iii) | Repairing surface defects in concrete cement, painting and grouting | Cement 1, Sand 2 |
| (iv) | Waterproof washes | Cement 1, Sand 2 |

**Precautions: -**

(i) Portland cement improves by age, if kept away from moisture.
(ii) The longer Portland cement takes in setting the stronger will it be.
(iii) The cleaner and sharper the sand the greater the strength.
(iv) The less water used in mixing up the cement the better.
(v) Cement setting under still water will be stronger, than if kept dry.

**(ii) Lime Mortar**

Lime stone or lime kankar should be burnt to form lime, in such kilns and with such fuel as is locally found. Wood and charcoal, are both very good departmental manufacture is preferable; but if lime is supplied by a contractor its manufacture should be supervised; in either case the lime must be tested periodically.

**Storage of lime:** As a rule lime should be used within 24 days of its manufacture. If it is to be stored it must be placed on boards raised a few inches above the ground, and must be kept dry. Fat lime should be stored in an enclosed space in a large heap, and air excluded in every possible way, or it may be kept in tanks and covered with water.

**Ingredients**: Lime, surki, if necessary, sand or cinders and water, the proportions depending on the work in hand.

**Mixing:** The mortar should be mixed (by measure) on a clean platform close to the mill. For measuring wooden boxes 30 cm cube may be used.

Where surki or cinders are used with, fat lime, the lime, and surki, must be thoroughly mixed dry in the first instance.

The ingredients should be turned over dry on the platform placed in the mill, and water added as required; Case being taken that too much water is not used. The mortar should be ground for 4 hours, being stirred uncontinually during the process.

The blow of lime can only be prevented, by fine screening and keeping wet for at least 24 hours before it is used.

Lime mortar should be kept ready for use in troughs and in hot weather be protected with mats. Mortar which has once set, or which has lain for more than 24 hours on the ground, is unfit for any use. When using kankar lime for plastering however, it is better to leave it for some time to sour.

**Laying:** With hydraulic lime mortar, the bricks and stones should be well soaked in water.

The following proportions (by measure) are usually suitable:

| | MORTAR FOR MASONRY | | | MORTAR FOR CONCRETE | | |
|---|---|---|---|---|---|---|
| | Lime | Sand | Surki | lime | sand | Surki |
| Hydraulic coarse | 1 | 3 | -- | 1 | 3 | -- |
| Hydraulic fine | 1 | 2 | -- | 1 | 2 | -- |
| Mod Hydraulic | 1 | 2 | ½ | 1 | 2½ | ½ |
| Mod Hydraulic fine | 1 | 1 | 1 | 1 | 2 | 1 |
| Fat coarse | 1 | 1½ | 1 | 1 | 2 | 1 |
| Fat fine | 1 | -- | 1½ | 1 | 1 | 1 |

**Precautions**

In using hydraulic limes the necessity of thoroughly soaking the bricks or stones in water before laying them in mortar should be carefully observed. If the moisture is suddenly drawn off from any hydraulic mortar it will not harden. Dry bricks and most stones absorb a large quantity of water, and, if laid dry, take it up from the mortar between them, which crumbles into powder. In the case of compact stones it is sufficient to water their surfaces just before use, but porous materials such as sand stone and bricks should be allowed to soak in water for some hours before use.

Lime mortar should be used as stiff as it can be spread. All joints should be well filled.

The work should be kept well wetted for a week or ten days after it has been laid, to prevent the rapid drying of the mortar especially in hot weather.

**(iii), Mud Mortar**

Mud mortar should be prepared from stiff clay (to be, approved by the Range Officer) which is broken up into file powder and freed from grass, stones, etc. The clay should, be mixed with clean water in a clean platform and worked up to the consistency of clay for brick making.

Before use the mud mortar should be moistened with water to than required consistency.

**CONCRETE**

**Portland Cement Concrete** - Mixture of concrete varies from 1:2:4 to 1:3:6.

**Ingredients**: Portland cement, sand, gravel of broken stone, and water. The proportions depend on the nature of the work in hand and the ingredients.

**Consistencies**: The consistency of the mixture depends on the quantity of water used.

**Hand mixing:** The coarse aggregate should be kept in water for 4 hours before using. The sand measured and levelled on the clean platform, the cement measured in top of the sand. The dry sand and cement will be turned over 3 or 4 times until the colour is uniform. The mixture of sand and cement will be placed on top of the coarse aggregate. The measured quantity of water, will be gradually added, with Rose watering cans (never splash water on by hand) and the material turned until properly mixed. Six men are required to do the turning and one supplies the water. Thorough mixing will give better plasticity. Mixing must be so timed that the concrete will be placed in position within half an hour of adding water. Cement having a flash set should not be used. For minor path repairs retempered mortar or cement is better than such material as it hardens better.

**Placing:** After mixing, the concrete must be handled rapidly, and in as small masses as possible placed in the final deposit. Never throw concrete into foundations, etc., it must be carefully placed into position. When deposited, the concrete should be thoroughly compacted until all the ingredients have settled and the surplus water forced to the surface. Excessive tamping should be avoided and should be completed within 20 minutes of the addition of the water in mixing. Special care is to be taken to prevent formation of honeycombing and latticing.

When the Placing of concrete is suspended, any necessary grooves for joining future work, must be made before the concrete has set. When work is resumed, the concrete previously placed must be thoroughly cleaned, roughened, watered and then slushed with mortar consisting of 1 part Cement to 1 part sand.

**Freezing**: On no account must concrete be allowed to freeze, but must be protected with matting or grass or wet used bags.

Proportions:- The following proportions are usually suitable:--

| **Kinds of Mixture** | **Sand** | **Aggregate** | **Cement** | **Dry Hyd. Lime** |
|---|---|---|---|---|
| Rich mixture for Pillars and other structural Parts; or | 1 | 3½ | 1 | 4% of weight of cement |
| Those requiring water- tightness above ground | 1½ | 3 | 1 | |
| Standard Mixture for Re-inforced floors arches, water tanks and works below ground | 2 | 4 | 1 | 8% of weight of cement |
| Medium mixture for ordinary machine foundations, retaining walls, building walls, ordinary floors, paths. | 2½ | 5 | 1 | 12% of weight of cement |
| Leen mixture for mass concrete in heavy walls for large foundations, and for backing stone masonry | 3 | 6 | 1 | 16% of weight of cement |

**Mud Concrete:**

Is prepared from stiff clay in a similar manner as for mud mortar, to which is added brick ballast made from well burnt or over burnt brickbats of 5 cm. Maximum gauge and well graded as far as possible to secure a minimum of voids.

**Mixing:**- The mortar and brick ballast should be mixed together in suitable proportions, usually 1 to 2 or 3 on clean platforms and laid in 15 cm. Layers and rammed to the extent necessary to consolidate the mixture only, similar to lime concrete. Care must be taken not to use too much water.

**Lime Concrete**

**Ingredients of lime concrete**: - Lime mortar aggregate and ballast as specified.

**Proportion**: - From 1 part by measure of lime mortar to 2 parts ballast, to 1 part by measure of lime mortar to 3 parts of ballast according to the work.

## BRICK-WORK

**General**

All walls of buildings should be carried up as far as possible at the same level throughout, and no step left temporarily during construction should ever exceed ten courses. When steps are left the junction must be racked back in regular steps of one course each. Cross walls and buttresses should be always built simultaneously with the main walls and must never be juggled in afterwards.

All iron work, wood blocks, and outlets for water should as for as possible be built in as the work proceeds. Whenever timbers are to be embedded in the walls they must be either completely embedded so that no air space exists next to the wood or an air space of 2 cm must be left on all sides and on the top. In the plains all timber placed in buildings must be treated with Creosote or coaltar.

Double rows of scaffolding poles be used, and ordinarily no holes are to be left in walls to support the scaffolding. Where necessary Headers (not stretchers) may be

used, for the scaffolding. The height of the scaffolding must be kept within a few feet of the top of the finished work.

The joining of new work to old requires a good deal of care, as the new work is bound to settle and crack. A good method is to cut a vertical groove in the old and to build the new masonry with a tongue fitted into the groove. This method can be used with first class pointed work or where sundried masonry is joined to burnt brick-work.

Bats must be used when it is necessary to make a closure, that is, to finish the end or a corner of a wall, or side of an opening, and even then no piece smaller than half a brick should be used.

The beds of the courses must be perpendicular to the direction of the pressure which they have to bear, and bricks in each course must break joints with those of the courses above and below it, by overlapping to the extent of from on-quarter to one-half of the length of a brick.

**Materials and bonds:-** First class bricks will consist of stock made bricks of uniform shape, size and colour, and thoroughly well burnt. Each brick must be free from defects, quite straight and rectangular, ring clearly when struck and be perfectly sound in all respects. No brick should absorb more than $1/6^{th}$ of its weight of water when soaked. This is the degree of porosity essential, since it encourages adhesion with mortar. The usual size of a brick is (22.5 X 11.25X 6.25 cm.)

**Second class bricks**: - will only differ from $1^{st}$ class in that the colour and shape is not so good or uniform.

**Third Class bricks**: - May include over-burnt and distorted bricks but never under burnt or pillar bricks. Under this class come Kumhar or courtry bricks, which must be well burnt ad sound, and should not be smaller than 20 X 12.5 X 3.75 cm generally used as an aggregate in foundations or crushed to powder from to be used as surkhi in mortar.

**Sundried bricks**: - May be made from stiff clay thoroughly worked up, exactly in the same way as for $1^{st}$ class bricks. For good work, they should be sand moulded for inferior work slop moulding will do.

**Mortar:** - Burnt bricks may be laid in cement, lime, or mud mortar. Sundried bricks will be laid in mud.

**Bond:** - All bricks will be laid in English bond. No half bricks or bats may be used except where necessary to complete the bond.

Each course must be perfectly level, and every brick must be well - embedded in the mortar, and all joints well flushed up. The faces of all walls must be perfectly plumb.

Bricks must be carefully handled by coolies and cart men other wise the edges and corners will be damaged.

**Brick work in Lime**

Mortar as previously described.

**Standards:** - $1^{st}$, $2^{nd}$, and $3^{rd}$ class brick work are the same as regards specification, except as noted below:-

**Laying**: - No broken, cracked or under burnt bricks may be used. In walls that are not plastered, bricks of the most uniform colour and shape must be selected for the face work. For $1^{st}$ and $2^{nd}$ class work all bricks must be soaked for two hours before use. For 3rd class brick work the bricks may be dipped into a tub of water (not

soaked) before use special care must be taken in 3rd class brick work on account of the difficulties caused by the disproportionate and irregular shape of the bricks. In walls, two bricks thick, the central longitude point in each header course will often be necessarily very vide for the above reason. This should be minimised by selecting the longest bricks for the header courses. Particular care should be taken that vertical joints on faces break joint properly.

**Joints**: Are to be of uniform thickness, not exceeding 1.25, 1.8 and 1. 75 cm. for 1st 2nd and 3rd class brick work, respectively. In 1st class brick work the vertical joints must be quite symmetrical and truly plumb.

The joints in faces, which are to be plastered or pointed should be racked out while the mortar is green, i.e. not later than 24 hours after the work is done. Where faces are not going to be plastered, or pointed, the joints must be struck flash with the edges of the bricks and smoothed flat as the work proceeds.

**Watering:** - Walls as they progress will be kept thoroughly well watered on their faces and tops. When work is left off for the night, a fillet of mortar about 2.5.cm. high will be laid round the edge of the last course so as to form a trough, which will be filled with water.

All new work will be kept watered and damp for at least 7 days. Old work is to be kept wetted for 2 days before any new work is put on to it.

**Brick arches**

Arches will invariably be laid in lime or cement mortar; they will generally be either segmental, sub tending an angle of 60 degrees, or semi circular.

**Construction: -** Arches are to be built in English Bond, the arch rings being bonded together. All bricks for each course of an arch must be carefully and regularly summered, the whole of the bricks for any particular arch are to be prepared on the ground. Before the building of an arch the whole of the bricks and skewbacks should be examined and passed by the Range Officer in charge. The skew backs must be formed of bricks correctly kept to radiate truly from the centre of the curvature, and must not be packed up with chips of bricks and mortar. The abutments must be exactly at the same level, and a vertical line through the centre of the span must pass through the middle of the key brick.

Arches are not to be built until the abutments have been built up level, for a distance of 1.8m from the arch. Arch work is to be carried up evenly from either abutment and as soon as the arch is completed, the masonry is to be built up to the height of the crown, so as to load the haunches. Care is to be taken that the masonry is carried up evenly on either side.

**Joints:** - Lime mortar for arches should be ground especially fine. No joint in an arch is to exceed 0.75 cm. in thickness, and joints must be of the same thickness throughout the course.

**Centering:** - Should be approved by the Divisional Forest Officer and in his unavoidable absence by the Range Officer. It must be strong enough to bear the weight, without deflection. Its surface must be correctly struck to the curvature of the arch. The centerings are to be struck to the curvature of the arch. The centerings are to be struck within 24 hours of the completion of the arch; in the case of semi-circular, semi elliptical, or pointed arches they should not be struck until the adjacent brick work has reached 2/3rds of the height of the arch. The centering of arches of over 1.5 m. span should be made on double wedges, to admit of easing the centering before striking it.

**Keystone**: The keystone must be driven firmly into position with a wooden mallet.

**Watering:** The completed arch should be kept well watered for 7 days.

**External Joints:** Should be struck flat and smooth as the work is done, but it is to be covered by plaster the joints should be raked out within 24 hours of the completion of the work.

The joints should be carefully kept to the required thickness, and bad work done in the interior will be immediately disclosed by the large joints in the extrados.

**Sundried brick work**

**General:** The general specification for sundried brick work in clay mortar will be similar to that for brick work in lime, except that the bricks are to be the best unburnt sand or slop moulded bricks procurable. The bricks are not to be wetted before use.

**Plastering: -** After completion, sundried brick walls will be plastered and leeped.

Sundried bricks must be protected from the weather until dry.

**Arches etc:** Arches doors and windows Jambs sills, etc, in sundried brick buildings may be made of burnt brick work in clay or lime.

**Kacha Pakka brick work General**

**General:** In kacha pakka brick work the exterior faces will be faced with burnt brick in mud, and cement pointed.

**Plinth, Pillars, arches etc.:** The plinths and top 2 or 3 courset of the wall should be burnt brick laid, in mud or lime, and where loaded beams or trusses rest on walls, burnt brick pillars are to be built up in the wall from the foundations,. Arches, jambs, etc. should be built of burnt brick in mud.

**Limitations:** Kacha pakka brick work is as a rule only adopted for inferior buildings in a dry climate. Case must be taken as previously explained to see that sundried and burnt bricks are of the same size, and that joints are of the same thickness and that sunburnt and burnt brick work are properly bonded together in the work. The sundried bricks must be absolutely dry. The height of wall of this type should never exceed 5.5 m.

**Drip course:** The bricks will be laid on edge. Each brick will be cut with a chamfer 4 cm deep on the outer corner of the upper edge and a throating 1.25 cm deep on the lower.

## MASONRY

**(i) Stone Masonry:**

There are 2 types s Ashlar masonry, Rubble masonry. They are termed according to the quality of dressing on and, types of surface finish etc.

**General Rules:** The general rules for masonry work given for brick work apply equally to stone masonry.

**Mortar:** Stone masonry may be laid in cement lime or mud according to the clast of work,

**Stone masonry in lime:** Will be rubble or as specified.

**Mortar:** The same as for brick - work in lime.

**Watering:** Stone masonry in lime will be kept wet after laying as specified for brick- work. The stones will be soaked for two hours, before laying.

**Coursed Rubble Masonry**

It consists of a series of horizontal courses varying from 15 to 45 cm. in thickness, each of which is correctly levelled before another course is built upon it. The side joints are not necessarily vertical, the thickness of course varies, but the thickest course should always be placed at the bottom and the thinner courses high up in the work. Each course is usually the thickness of the stone, but occasionally the whole or portion of a course is made with a depth of two or more stones. All headers, must, however, be of one stone thickness. Coursed rubble masonry is commonly used for all kind of large and important buildings. If the material is good and the work carefully carried out it is suitable for every kind of work except Cornices, Coping arches and ornamental works.

**Stone:** - The hardest stone procurable should be used. All stones must have a clean section; distorted, dis-coloured, cracked or stones showing signs of delay, must be rejected. Stones with round surfaces are not to be used.

**Construction: -** Coursed Rubble will be laid in courses varying in height as may be most convenient and economical according to the nature of the stone procured from the quarry. No courses may be less than 15 cm. and more than 45 cm. in thickness and no course may be of a greater depth then the, one below it.

**Joints: -** Will be 0.6 cm thick. As a rule no stone in the face of a wall should be less than 0.015 $m^3$ in size, and in walls over 0. 5m thick not more than half the stones should be legs than 0.02 $M^3$.

No face stone may be narrower and shorter than its depth, its length tailing into the wall must be at least one and a half times its height, and a 3rd of the face stones must tail, in at least twice their height.

The bed of each stone must be horizontal, and it must be in one line dressed, true and square for at least 7.5 cm back from its face. The vertical joint will be dressed back not less than 5 cm. The vertical joint need not be at right angles to the face of the wall, but it must be truly vertical, and at an angle of not less than 60 degrees to the face of the wall.

**Through Stones** Or headers will fulfil all the conditions of face stones, except as regards their length which must not be less than 48 cm. They should be inserted every 1.5 M. apart in the clear, in every course and must run right through the wall when the wall is not more than 0. 6 cm thick, in thicker walls a line of two or more headers must be laid from face to back, over lapping each other by set less than 15 cm. Through stones must not be in the same vertical plane in successive courses, they must be marked to facilitate checking.

**Hearting:-** The heartings, or interior filling between the front and back stones, will consist of rubble stones not less than 15 cm. in size, carefully laid, hammered down and solidly bedded down in mortar, chips of stones being wedged in whenever necessary, so as to avoid thick beds, or joints of mortar; care being taken that dry work or hollow spaces are left in the masonry. The hearting should be laid nearly level with each course except that at about 1 m. intervals vertical plums protecting 15 to 22cm. will be firmly embedded to form a bond between the successive courses. The hearting must not be brought out to the same level as the back and front stones by the use of chips, the use of the latter being entirely restricted to wedges in the hearting.

| | |
|---|---|
| Random squared coursed Rubble Masonry<br>Random course Rubble Masonry<br>Random Rubble Masonry | As for coursed Rubble Masonry |

**Stone Masonry in Arches**

An elevation of the arch should be drawn out on this ground and voussoirs of different widths according to the stone to be used are to be marked. Light templets should then be cut out and stones dressed according to the templets.

The arch stones should be fitted together on the ground. The stones must be specially selected, they should give a clear metellic ring when struck with a chip of the same stone.

**Through stones: -** The arches in walls, the key stones, the two outside stones, and a due proportion of the stones, must be through stones. In 45 cms. walls a suitable proportion is every third stone in the face.

**General: -** The front and back faces must be square to the plans of the side faces. The height of each stone must be equal to the thickness of the arch up to 37 cm. above this two stones may be used, but no stone may be less than 15 cm high, and no stone may overlive a circumferential joint by less than half the extrados width. The intrados of any stone must not be less than 10 cm and in each stone the exposed face of the intrados must be rectangular.

All stones put in arches must have their ends inside the wall squarely dressed. The joints must break joint with each other. No small stones on any account should be allowed.

**Centering: -** Should be passed by the Range Officer before the archway is commenced. The centering must be wedged into position so that it can be eased as soon as the arch has been turned and the haunches filled in. The centering must not be removed until the mortar has set.

**DRY, RUBBLE MASONRY**

**General**

All classes of rubble masonry wall can be built dry. This class of wall is most suitable for breast and retaining walls.

**Through Stones**: - Through bonds front to back, consisting of a single stone or of several stones put end to end must be given in every course at intervals of 5 feet. Single through stones should always be used when available.

The limit of height of stone walls depends on the quality of stone and the space available at the base. High walls should be strengthened with bands of stone in lime at every 1.2 m in height.

**Filling:-** The filling immediately behind a dry stone wall should consist of stone refuse and chips. Earth should not be used unless unavoidable. Suitable arrangements for drainage must be made.

**Dry rubble masonry with wooden binders**

In the inner hills mortar is not available and building are erected with dry rubble walls Strengthened with wooden binders.

The foundations are of concrete and stone masonry, Coursed rubble masonry walls of hammer dressed stones and specifications already described are built to a height of 0. 6 to 0. 8 m. and the first wooden binders are then laid horizontally and morticed together in pairs. On them are laid further courses of rubble masonry, and at vertical intervals of, 0.8 m other wooden binders are laid. The walls should be raised progressively and binders laid at the same level in each course. It is wrong to lay the binders first and then fill in the intervening spaces with, stones. The wooden binders should be of deodar, Kail may be used only when no deodar is available, and

the kail binders must be Well coal tarred on all sides. All wood must, be thoroughly seasoned before use.

The binders should be 15 cm. in width and 10 to 15 cm in thickness, of sawn or axed timber. Sapwood should be avoided.

The thickness of the binders in one and the same course should be the same. The binders should, when practicable run throughout the entire length of a wall. If two or more pieces have to be used to make up a length the end should be joined by a simple scarf and wooden or iron nails. At corners, the ends of the binders should be joined in a similar manner. The front and back binders should be kept in position by means of wooden cross tie pieces of suitable dimensions, fastened by dovetailed joints to the binders at 1.2 to 1. 8 M. intervals in the length of the wall and about a 0.3m away from the joint on either side of all the joints between any two pieces of binders.

**Dhajji Walling**

Dhajji walling consists of rough light timber frame work filled with small boulder or rough stones in mud. The main frame for small buildings such as seed godowns servant's quarters, etc. should be 10x 10 cm. For walls over 2 m. high and for larger buildings 12. 5 x 12.5cm posts are generally suitable.

The frame work will be filled in with stone in mud, and plastered both sides level with the posts, wood being nicked to make the plaster adhere.

In high unprotected walls a rendering of lime plaster may be given on the outside.

**II. POINTING, PLASTERING AND WHITEWASHING**

**1. Pointing**

Preparing walls:- All joints are to be first raked out with a hook (not hammered) to a depth of 1. 25 cm. Cement mortar for pointing is made by 1 part cement and 1 part sand. In new work the joints must be raked out before the mortar sets. In old work the wall must be thoroughly wetted first. After raking out the joints, the surface to be pointed must be cleaned down and kept wet for two days before pointing is commenced. All dust must be brushed out of the joints after raking out old work. The raking out of joints and surface cleaning should be kept at least 1.2 m ahead of the pointing.

Cement mortar only should be used, composed of 1 part cement to 2 parts sand- The cement and sand to be mixed dry and only sufficient for 10 or 15 minutes work to be made at a time.

**Applying:-** The mortar will be placed in the joints well pressed in, rendered smooth and flush with the surface of the wall, care being taken that it does not spread over the masonry.

The horizontal lines will be struck back with the trowel along the upper edge. The vertical joints should be struck semi-circular or V shaped by means of a round iron tool, 0.6 cm in diameter. For interior walls, which are not to be plastered, the joints should be finished flush as the work proceeds.

When rough stone masonry is to be pointed the mortar is struck of with a trowel and left, showing frankly such irregularities as are produced by the corresponding irregularities in line and surface of the stones themselves.

After pointing the work should be kept thoroughly wet for not less than 7 days.

**Plastering**

**Preparation of walls** -- Walls should be prepared as for pointing. Walls will be plastered with lime, cement or mud plaster. The plaster may be applied in 1, 2 or 3 coats, but no single coat must exceed 1.25 cm in thickness

On very rough walls a preliminary coat must be given to fill up the hollows, before the first coat is laid on.

Before work is started patches of plaster 15 X 15 cm should be put on at 3 m apart to act means an even thickness is obtained. Cement plastering must be done in squares or strips, cracks will appear if large surface are done.

Scraping walls which comprises removing white or colour wash and making good the surface for the plaster becomes necessary, usually not less than 5 years.

Rags of gunny or husks or coconuts sawn in two should be used for scraping.

**Lime plaster:-** Lime plaster mist consist of lime mortar as specified previously. It should be ground fine until it contains no lumps of grit. Fat limes make the best plaster as any unslaked nodules in hydraulic lime will cause blisters.

The addition of 4 kg. of gum boiled in water to 3 $m^3$ of mortar improves the plaster, as also a small quantity of chopped hemp.

**Superior lime plaster: -** Consists of rough cast and floating coat. One coat floated will usually suffice in good brick - work for ordinary purposes.

**Rough cast:-** The basis of lime plastering consists of one or more coats of rough cast. It should be laid on sufficiently thick to cover all projection of masonry by 0.6 cm. of plaster. An average thickness of 1.25 cm will usually be sufficient to effect this in all classes of brick walls, 2.0 cm will usually be sufficient for stone masonry. No coat of plaster should be more than 2.5 cm. thick uneven, that the in order to cover all projections by 0.6 cm, the plaster must be applied in two or more coats, each coat being not more than 1.25 cm. thick. In the case of old walls being out of plumb the walls should not be brought to plumb with plaster.

The plaster will be applied with trowels and will be well pressed into the joints until the necessary thickness has been obtained. It will then be beaten with long thin laths until no impression is made on the surface.

Each coat must be allowed to set before the next is applied and the surface should be left rough and freely scored with the edge of a trowel to give a key to the next coat.

**Floating coat: -** The lime mortar on the surface coat must be ground specially fine and smooth; this can be done by rubbing between two stones.

The final surface, when it has become quit firm and before it has set, will, be floated by means of a straight edge drawn backwards and forwards until it is quit smooth. The finished plaster must be watered for 3 or 4 days after it has been put on. In hot weather any wall exposed to the sun must be protected with matting.

**III. Cement Plastering**

**Mortar**:- Portland cement plaster consists of fine cement mortar, as specified for stiff consistency; one part cement to two parts sand is the, normal suit able mixture. For water tight cement, plaster the proportions are 1part cement to 1 part sand. Cement plaster should be kept wet for at least 7 days.

**IV. Mud Plastering**

**Composition:-** -Mud plaster is composed of stiff clay to, which is added; if ordered, an equal bulk of chopped straw or pine needles. In certain cases it is necessary; to add sand. The clay after being excavated should be spread out in the sun and powdered; the chopped straw or pin needles should then be added and thoroughly mixed in the dry state with phowrahs. Afterwards water should be added

and the whole should be left to soak for 2 days. It should then again be mixed with phowrahs and water added until the consistency of stiff clay is obtained.

**Application** – The plaster should be spread evenly over the surface usually 2.5 cm thick on the roofs and 0.6 to 2.0 cm on the walls and floated with a straight edge until the surface is perfectly smooth. Any cracks that appear during drying must be filled in with liquid cowdung.

When the plaster has dried it will be leeped with a mixture of cowdung, clay and sand.

The leeping is prepared as follows. The cowdung is steeped in water to free it from grass etc. One cubic foot (.028 $m^3$ ) of finely powdered clay is added to every cubic foot of cowdung and the whole well mixed in tub.

For plastering the inside of chimneys a mixture of three parts cowdung to one part lime should be used

**V. White Washing**

**Whitewash –** The lime of whitewash is usually kankar or shell lime, brought to the site in an unslaked condition. It is then slaked with an excess amount of water and allowed to remain under water for 2 days. The mixture of, lime and water is then drawn off and placed in a tub and clean water is added to bring the mixture to a consistency of thick cream. The wash should then be strained through a coarse cloth into another tub; to each tub full of wash must be added water obtained from I kg. of rice. The ingredients are prepared by boiling the rice and gum, then straining through a thick cloth. The whole is then stirred together and boiled.

**Preparation of the surface -** The surface to be whitewashed must be clean and smooth before the whitewash is applied, and be quite dry. All greasy spots (if any) should be given a coat of rice water and sand before the application of the whitewash. If old whitewashed surfaces are dis-coloured by smoke, it is advisable to apply a wash of a mixture of wood-washes and water, before the new coat of whitewash is applied. Any patches of new plaster should receive an extra coat of whitewash before the regular coats are applied, whitewash must not be applied until the new patches are quite dry.

**Application** – The wash should be put on with a clean brush, each coat consisting of one vertical stroke, followed by one horizontal stroke, each coat must be allowed to dry before the next is applied.

Three coats will be given on new work, and on scraped surface. The ordinary annual whitewashing will consist of one coat. The surface when completed must not be powdery or readily come off on the hand when rubbed.

**Plinth filling** – The plinth filling underground flooring should be watered and rammed in 15 cm. Layers until it is thoroughly consolidated and will not yield to a heavy blow with a rammer. The surface then should be brought to the level shown on the drawings. Inner floors must be perfectly level and verandah floors must be given an outward slope of 1 in 40. Any old bricks form an excellent filling, if properly rammed.

**BRICK AND TILE FLOORING**

**Composition** - The form of flooring consists of 1st class bricks or second, according to the class of building, laid in lime or mud, either flat or on edge or on tiles laid on 7.5 cm of lime concrete.

**Laying bricks or tiles**

The bricks or tiles must before use be soaked in water for 2 hours. They should be laid true and level either in parallel rows breaking joint or inherring bone bond; and all joints must be true and level.

The joints must not exceed 0.6 cm. in thickness, the sides of the bricks being rubbed as necessary. The joints must be finished off flush and no mortar must be allowed to spread over the bricks or tiles. If they are to be pointed the joints should be not less than 0.6 cm. thick, they should be raked out while the mortar is still damp and the floor pointed as specified for pointing.

The floor must be kept wet for 4 days after laying and 6 days after cement pointing.

**Earth Flooring**

**Composition** - The earth used must be a loam or a clay; sandy soil or ordinary mould are unsuitable. If earth is fresh and damp no water should be added, otherwise a little water is to be sprinkled on by hand. The less water used the better the floor will be.

**Laying** - The earth will be thoroughly consolidated in 15 cms. layers until a very faint mark can be made with the heel of the boot. In the case of renewals the whole of the old earth must be dug up and removed before any new earth is put down.

**Chimneys and Fireplaces**

Three plans are attached herewith. It is not intended that this is the only shape of fireplace, which will burn well; but it has been shown by experience to draw well, and to throw out heat, and may therefore be generally adopted.

The following points are to be observed

A. Position of fireplace

(i) It should not be in the corner of a room, for

a. The corner is more useful for other purposes.
b. The Chimney will generally not pass through the centre of the roof in a pent roofed buildings.
c. The masonry takes up more room in the corner than in any other place.
d. The fire does not throw out heat so well, and the heat has further to go to reach the diagonally opposite corner than it would have to reach the farthest part of the room if the fireplace were in one of the sides;

(ii) A fireplace should never be put in an outside wall if it can be placed elsewhere, as it is obviously economical to utilise the heat to warm another room and not to waste it, on the outside air.

(iii) In locating a fireplace the need for a sufficient length of blank wall to place a bed is to be borne in mind,

(iv) If the wall common to two rooms two fire places are to be built, they should be placed side by side not back to back as obviously they take up less room, and masonry is economised in the former mode.

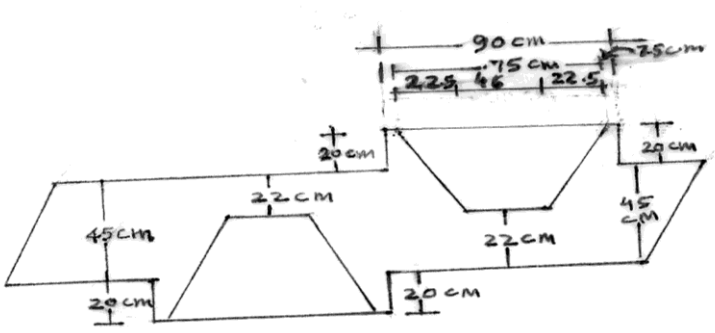


Fig 11.2

**II. The fireplace: -**

(i) The plan shows plainly what is required. The sides should slope towards each other and the back should have a slight slope or cushion of 7 cm in one metre, these slopes all help to throw out heat.

(ii) The hearth should not be more than 10 cm above the level of the floor of the room because;

(a) as hot air rises, the higher the hearth, the deeper the layer of cold air on the floor; and also

(b) the higher the hearth the greater the chances of burning wood and sparks being shot out in to the room,

(ii) The plainer the front of the fire place the better. Indian masons are very found of making wonderful beadings and flatings, etc. which are always in need of repair, and at the best are only places for dust to lodge on. A perfectly plain front with a carbel to support a straight mantelpiece is the simplest. The usual shape effected in India is particularly objectionable.

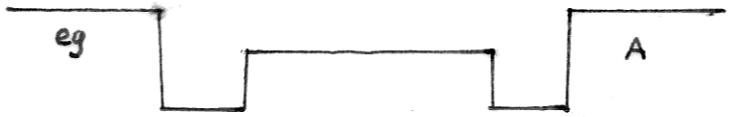


Fig 11-3

Very good mantelpiece may be made by letting a plank of wood 5 cm thick 30 cm or so broad a little may into the wall.

(iv) In the small rooms generally built in our Rest Houses the mantelpiece should not be more than 5 m above the floor level.

**III. The Chimney: -**

(i) In pent roofed houses in the hills the chimneys should always be taken through the, ridge, for

(a) it is easier to make the roof water tight then when the chimney goes through the slope of the roof;

(b) the draught is better as there is no downward current of air.

A position noticed in one of the Forest Rest House is particularly to be avoided.

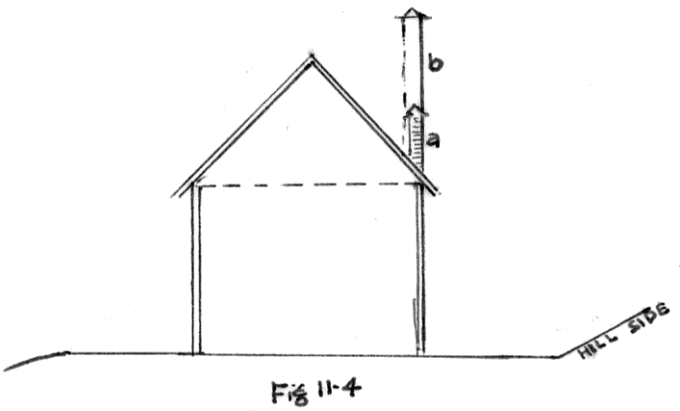


Fig 11-4

Here as in (a) the smoke is almost invariably met by a down current from one side or the other, and the fire smokes so badly that it is impossible to sit in the room with it.

In cases of this nature the chimney must be taken well clear of the ridge as in (b). The bottom of the flue outlet must be at least 60 cm above the top of the ridge.

The chimney must be secured to the roof member by 2.5 cm. dia iron bars to prevent it being blown down in high winds.

(ii) The interior area of every chimney must be 0.09 m2 for the ordinary 45 cm. wall a convenient size of fire is 40 cm x 22.5 cm.

(iii) Every fire should be kept separate to the top go that each chimney has its own separate stock.

(iv) The chimney stack should have a projecting course in the masonry, under which the zinc or other flashing may be placed, and wrapped round the chimney.

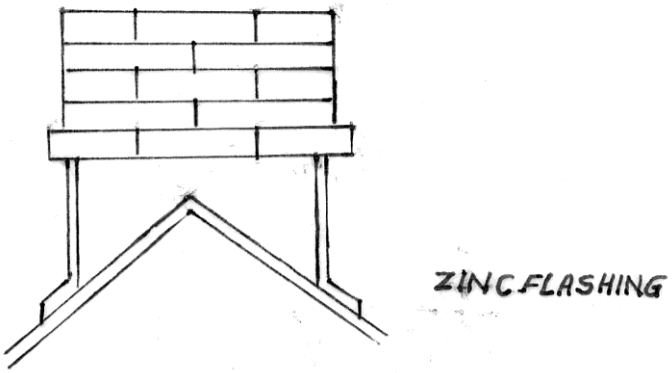


Fig. 11-5

(v) The inside of the chimney must be plastered smoothly, as the building arises, otherwise the rough surface hinders the accent of the smoke, and causes soot to lodge.

It is most important that the total areas of the outlet must not be less than 0.09 m7, preferably it should be increased by at least 12½ percent. The most satisfactory design is to keep the openings narrow and high, they should be at least 10 cm. through. This prevents down draughts and birds from entering the chimney. A very simple method is to stand country tiles on end, 6 either side and 2 at each and 2.5 cm. apart.

## ROOFING

### (1) Mud Roofing

**Composition -** Mud roofing consists of rammed clay from 15 to 22.5 cm. thick laid on tiles in lime carried on battens.

**Laying:**- The tiles should be 30 x 15 x 5 cm., and should be well soaked before being laid on mortar on the battens. The upper and lower surface should be pointed.

The mud should be stiff clay. After being excavated it must be spread out in the sun for several hours. It should then be stacked in heaps of convenient size, i.e. 1 to 2 cum, Water should be added and the clay well mixed by treading in with the feet, until the whole assumes a consistency of stiff mortar. The clay should then be laid on the

roof and beaten until quite hard. It will be finished off with a coat of, mud plaster and finally leeped. A small slope is necessary on all flat roofs, i.e. 1 in 40.

**(11) Corrugated G.I. Roofing**

**Corrugated Iron: -** The G.I. will be 18 BG to 24 S.W.G. The surface of the sheets will be quite clean, bright and free from iron rust. Any sheet showing a white powdery deposit must be rejected.

**Laying** - The sheets will be laid on horizontal wooden or iron purlings. There must be one at each, end and one in the middle of each sheet. Each sheet should be laid with a 15 cm. lap in its length over the sheet below it. The side laps will extend over to corrugations, and will be turned away from the rainy quarter. The sheets may be either rivetted or joined by means of limpet washers. The sheets will be secured to the timbering by means of G.I. screws, slips or hooked bolts passing through the sheets and round the timber. Each sheet will be held down to the purlin by two or more screws or 1cm. bolts. Bolts will always be placed at the corners where four sheets overlap each other. Excellent, rounded iron clips, with little bolts are provided by the makers for fixing the sheeting to steel purlins. All clips and bolts must be galvanised. The bolt holes must be slightly larger than the bolts so as to allow for the expansion and contraction of the sheeting.

The ridges and hips must be covered with plain G.I. sheeting which will be rivetted or fastened to the G.I. sheeting with limpet washers. The sheeting will be laid in lengths with an overlap of at least 22.5 cm, the joints being set in white lead. All rivets, bolts, etc., will be set in white lead.

Wind ties will be fixed along the eaves of the roof and ventilators and will consist of iron bar 4.x 1.25 cm. The wind ties will be bolted down to the rafters in the same way as has been described for the sheeting, the holes in the corrugated iron being also made water tight in the same way.

**(III) Mud Roof in the Hills Dry - Zone only**

The walls having been raised to the proper height, the space to be roofed is crossed by beams at suitable intervals. Over the beams 5 cm. thick planks are laid, over which sheets of Bhoj puttar, birch (Betula utilis) bark are spread, which are then covered with wet and about 15 cm. thick and well, beaten down. Over the rammed earth a coat of mud plaster should then be applied. The mud used must be well prepared and applied with care. It must not be a hard stiff clay which soon cracks in the sun's heat, nor a lose sandy soil which rain will readily penetrate and wash down. Such roofs required frequent heating to consolidate the layer or earth and should properly drained. As a bed for the covering of earth a blanket of reeds, twigs of straight branched shrubs etc, should be used instead of planks. Such roofs are very good for places where the rainfall is light, such as in Kanawar.

**Slate roofs**

Slates are generally used as a roof covering material in the hills; their qualities and dimensions very considerable. Slates are hard, non-absorbent and heavy roof covering.

**Varieties of Slates -** The Kanihara Slates in the Kangra valley are about the best available in the Himachal Hills, but the cost of their carriage being prohibitive, they are seldom used in the high hills.

The Tahu slates found in Bashatr are strong and of rough texture. The so called slates in Kullu, Shimla and sometimes in Bashatr, are nothing but stone flags; but being available in large quantities are used in preference to other slates.

**Selection of Slates -** The slates should be sound with smooth and even surface, uniform in colour, free from cracks, scales, fissures and other imperfections. They should be rectangular and be gauged to the required dimensions. All slates with broken corners or cracks must be rejected.

**Dimensions -** The common dimensions used are 0.6 to 0.8, m length, 0.3 to, 0.6 m width and 4 to 6 m. thickness. The smaller the slates used the more difficult it is to keep the roof water tight, because of the larger number of joints. Smaller slates are more suitable for the steep roofs and have an additional advantage, in that they do not exert so heavy a pull on the nails.

The pitch for the slate varies 22 (for larger slates) to 45 (for smaller slates).

**Laying of Slates** - The common rafters of ordinary roofs are too far apart to receive the slates without some intermediate support. The rafters, therefore, are covered with boards (Laid either horizontally or obliquely), or with battens about 5 cm. x 3.75 cm. in 3.75 x 2.5 cm. section nailed on to them. Battens are laid in horizontal lines at fixed distance apart equal to the gauge of the slates to be used. Battens are placed at 23 cm. overlap of slates 7.5 cm. This distance from centre to centre is measured down the roof. Boarding is the more expensive, but helps to keep out moisture. In order to make the roof, water tight the battens on either side of the ridge should be thicker to allow the top most slates to be nailed projecting over the ridge. A thicker batten is also to be used at the eaves to give the lower layer a slight tilting. In the case of 'boarding' a tilting fillet has to be provided at the eaves.

The slates to be laid out are to be of equal dimension, but, if for any reason the full number is not available in one dimension, the longer slates may be used in the lower rows and smaller ones in the upper rows. Whole slates should be used throughout except at the gables where it may be necessary to break joints.

The actual laying commences from the lower most end. The slates are laid first and nailed on to the battens by one or two nails, 5 cm to 7.5 cm from the head. The trapezoidal slates are then laid breaking joints with the lower rectangular slates laid with rough side up, except in the lowest course where they are laid smooth side up so that they bed properly. Every course of the slates should break joint with course below and above it. They should be laid in such a manner that, there are three thickness at, the lips and two elsewhere. The side joints should be kept as close as possible and arranged so that each comes over the centre line of the slate below. The upper course of the slates should overlap the lower one by 8 to 10 cm (7. 5 m usual).

**Fixing of States -** The slates are to be secured with galvanized iron nails. The nails to be used must be 5 cm or more (depending on the thickness of the slates). They are to be fixed, through holes, punches in the slates, on to the boarding or battens below. The, nailing may be done in the centre or the head; in the Himachal Hills nailing at the head is usually adopted.

**Zinc sheeting the ridge**

In order to make the ridge water-tight it should be covered with zinc sheeting. The sheet should over lap each other for at least 7.5 cm. and be bent over the ridge pole (which should project three inches above the, top of the roof) and to lap at least 15 cm. over the top course of slates at each side of the ridge. They are to be prevented from blowing off or buckling up, by straps of hopped iron, painted with hot coal tar, and bent over the sheets at intervals of 0. 6-m apart. The whole (including the hoop iron, ridge sheeting and the wooden ridge pieces) to be belted through. Sometimes wooden or stone capping is used to cover the ridges.

The hips should also be covered just as the ridges. In slated roofs, joints are, generally made water tight by cutting the slates obliquely to fit the angles and by inserting galvanized iron sheeting below the slates. A tilting fillet raising, the edge of the adjacent slates is fixed about 15 cm. from the angle at each side and galvanized iron sheets dressed on the boards at the intersection, over the tilting fillet and 7.5 cm. beyond the latter at each side,.

**Open slating**

In the hills sometimes the open slating method of laying is adopted. An equal number of rectangular and trapezoidal slates are indented. The rectangular slates are laid first and nailed on to the bottom by one or two nails 5 to 7.5 cm. from the head. The trapezoidal slates are then laid breaking joints with the lower rectangular states, the narrow end of the trapezoid forming the tail. The overlapping is 7.5 to 10 cm. on the sides. The next course is then commenced overlapping the lower course by 7.5 cm. to 10 cm. Thus covering all the nail holes of the lower course. The upper ends of the rectangular slates are so dressed that they leave a little gap in the joint to admit the nails of the overlapping trapezoidal slates.

**Shingle roofs**

Shingles are rectangular places of split wood and are used for roof covering where slates or other better roof covering materials are not available. Being split, not sawn, surface lasts, longer than planks. The conifers of the Himachal Hills are not well suited to a regular splicing and thereby do not reader good Wit shingles. Therefore split, shingles are substituted by sawn shingles in better types of buildings. The exposed surface must be planned common size 30 X 12.5 X 1.25cm thick, 1.25cm to 37..5cm long, 22.5 to 12.5 cm long 1.25 cm. thick.

The shingles may be 0.6 m to 0.9 m in width. The thickness in the case of split shingles may be 2.5 to 5. 0 cm and in cages even more, but in the case of sawn shingles it is as a rule 2. 5cm. They should be thoroughly seasoned wood and of deodar so far as possible and must be made in a very careful manner.

A shingle roof is prepared much in the same manner as the slate roof. Ridges, hips, valleys, chimneys and eaves are to be treated in the same manner as in the slate roof.

Where sawn shingles axe used their backs may be grooved (section of the groove 1. 25 cm. wide and 0. 8 cm deep) along the lengths leaving 2.5 cm space from either edge to avoid water coming into the side joints and facilitate its quick flow. When shingles are to be, laid betters 6x4 cm. are laid across common rafters. Distance between battens; 1/3 length of shingle. Shingle, are fastened to battens by nails; only 1/3 of each full size shingle is visible, usual pitch from 26º to 42º.

The shingle roofs may be given greater pitch than the slate roofs. It may be any thing between 1 in 1½ to 1 in 1 according to local conditions.

## WOOD WORK

**General**

The timber will be deodar, kail, chir or other sound timber found in the locality. It should be well seasoned, free from sap-wood, shakes, cracks and large knots. The scantlings must be sawn square and straight, and planned. The flames or timbers will be dressed and planned to the dimensions shown on the drawings. Unseasoned timber need not be planned.

All mortice and tenon joints must fit and fully and truly without wedging are filling. All joint must be as simple as possible, and the bearing faces exposed to view if possible to, ensure, good fit.

Timber to be buried in the ground is to be well coated with solignum or tarred. Wood work exposed to the weather should be painted or treated with solignum, if seasoned, otherwise it should be allowed to remain until seasoned, as a coating of paint will do more harm than good if applied to unseasoned timber. The ends of the all beams, etc., which are to be embedded in walls, and sides of timbers which are to about against walls, are to be treated with solignum or tar. No wood work or any, kind should be laid within 0.6 in of a fireplace or flue.

**Wood Flooring**

The floor boards will be as specified, well seasoned, free from knots and shakes. They will usually be 3 to 4 cm thick, 10 to 1.5 cm wide and 2 to 4m long. Maximum span of single joisted floor is 3 to 4 metres. Timber splitting through nails should be avoided especially when jointing is required.

The floor boards will rest on joist 37.5 cm. apart which in the case of ground floors will be fixed on pillars on foundation 10 cm lime, concrete on rammed earth. Free ventilation under the floor must be given.

Necessary ventilation may be obtained by the insertion of iron grids or terra cotta bricks at intervals along the outer walls. The grids should be placed so as to allow a free current of air to circulate under all floors. In double storied buildings the ventilators are to be placed between the ceiling and the floor boards.

The boards should be dressed and planned square and true, with sides and ends parallel. They will be laid parallel to the long walls of the room. The ends will always rest on, a joist and break joint.

Nails or screws will be given 2 at each end and one at every intermediate joint alternately on opposite sides of the plank. The planks are to be forced together with carpenter`s camps of wedges. The cramps will not be removed until the screws or nails have all been fixed. After it has been laid the floor will be planned and made perfectly true and smooth.

**Door and windows**

Doors should not be less than 75 cm. wide and 2 meters high. Doors of greater width than 1. 15 mtr. will be generally made in two leaves. The size of doors and windows is the size of the clear opening between the frames, no allowance being made for rebeting. Outside doors should open inwards.

The Joinery will be of the best wood obtainable. The planks should be cut from the log some months before being used. Framing will be usually 5 cm thick.

The styles, rails, panels, sash bars must be accurately cut and fitted to the measurements given on the drawings. The width for door rails should not be less than 10 cm and for windows not less than 8 cm. Before being put together all joints will receive a printing coat.

Weather boards must be provided on external doors and windows unprotected by verandahs.

**Chowkats / Frames**

For ordinary doors and windows the chowkats should not exceed 10 X 8 cm in section. Chowkats will be properly framed and morticed together. The head and sills will be horned 15 cm long buried into the masonry. The chowkats should be rebated on one side 3/4" or 1/2" deep and to the full width of the door or windows, and have a return head on the other side, to be chambered as directed. Width of chowkats -full thickness of shutter.

**Windows**

Will usually be made of 5 cm thick wood. The styles, top and bottom rails should be moulded on one side and rebated 1cm on the other to receive the glass. The size of the rebates must be little larger than the size of the glass to prevent it touching the pane. Sash bars should be moulded and positioned on one side and rebated 1. 25 cm. on the other to receive the glass. Modern trend is to provide wider windows i.e. width greater than height. Usual sizes are, 60 X 90cm, 75M X 1.20M, 1.20m x 1.5m, 1.35m x l.80m, 1.35m x 2.20 m. It is desirable to provide ventilators on top of windows.

**GLASS WORK**

**Glazing**

The glass should be sheet glass free from flaws, specks or bubbles. Standard size panes should always be used. For doors and windows of Rest houses 21 oz. seconds should be used and for other buildings 15 oz. thirds.

**Fixing**

The whole sash bar, but especially the rebated, which is to receive the putty, will first be well primed to prevent the wood drawing the oil out of the putty. The back putty is then drawn along the inner edge of the rebate for the glass to bed on, the pane is then put in well bedded in the back putty, and secured in the rebate with 4 or more small nails and by the front putty which should slope from the inner to the outer edge of the rebate. The putty must always be put on with a proper putty knife. Both back and front putty (where exposed) must then be covered with paint to protect it from the air, otherwise it will shrink and become loose as the oil dries out. Putty is made as follows. Take one kg finely powdered whiting, 50 gms. dry white lead, 300 gm raw linseed oil, 16 cm total litharge, mix well together and beat with a wooden mallet. If putty becomes hard it can be restored by heating it slightly and working it up while warm.

In reputtying panes of glass all the old putty is to be carefully removed and the rebates are to be thoroughly cleaned with linseed oil before being reputtied.

**PAINTING**

(A labour can paint 32.5 sqm. area in a day)

**Painting**

All exposed wood-work should be painted unless otherwise ordered, and it is also desirable to protect interior wood work by painting and oiling or varnishing.

Painting should as far as possible be carried out in dry weather. Painting is best done departmentally or by piece work. In all cases all the materials should be supplied and mixed departmentally, and precaution must be taken that cheap bazar oils are not mixed in with the paints.

Where more that one coat of paint is required each coat must be of a slightly different tint, i.e. if the 3rd coat is to be white, the first coat will be of red lead, and the second will be slightly tinted with red lead. The first coat should always be mixed thinner than the following coats:-

It is better to purchase ready-made paint from a good reliable firm (not from the bazar) rather than allow a painter to mix his paints. Before effecting purchase from a rate contract firm, all efforts should be taken to ensure that specifications are met with.

**Composition of paints**

(a) Base

(b) Carrier

(c) Drier

(d) Colouring matter or pigment

(e) A solvent.

The base always determines the colour of the paint.

(a) Base: The base of all lead paints is either white or red lead. White lead paints are not suitable for delicate work, as the lead becomes discoloured. White lead has a good body, permanent, and is the base which is mostly used. It is obtained in the market either dry or ground in oil. It is a common practice to adulterate white lead with sulphate of baryta whiting, etc. The presence of sulphate of baryta can be detected by the addition of nitric acid, which will dissolve the lead but not the baryta.

Red lead is largely used for painting iron work and also for a drier. It is sometimes adulterated with brick dust, the presence of which may be detected by heating in a crucible and treating with dilute nitric acid. The lead will be dissolved and the brick dust will remain.

Oxide of zinc is the base of most zinc paints. It has the advantage over lead paints that it is not liable to discolouration by sulphur, but it has the disadvantage that it has less body than white lead, is difficult to work and less durable. Lead driers must not be used with zinc paints.

**(b) Carriers: -** Linseed oil is generally used. It oxidises and becomes thick on exposure to air. It is used either raw or boiled. Raw lineseed oil is paler than boiled oil and is used for inside work but is inferior in drying qualities. The drying of raw linseed oil may be improved by adding 1/2 kg. of white lead to every Itr, of oil, and allowing it to settle for at least a week.

Boiled linseed oil is thicker and more darkly coloured than raw oil and cannot be used for delicate colours. When country linseed oil is used it must be boiled for 2 or 3 hours with red lead and litharge in the proportion of 1/2 kg. of each to every gallon of oil.

**(c) Driers:-** Litharge or lead oxide is the drier generally used, the proportion being 100 gm./5 Itr, of oil. It has however, a tendency to injure the colour of the paint and should not be used in the finishing coat.

**(d) Pigments:** Only standard colours are to be used.

**(e) Solvents:** Spirits of turpentine is used to thin prepared paints to make them work more smoothly. If used in excess it flattens the colours, which are then not durable, as the spirit evaporates, leaving an excess of colour not mixed with the oil.

**Proportions**

The proportions in which paints should be mixed depends upon the nature of the pigments, climate, etc. The following proportions are given as a guide, but the correct mixture must be determined on the work.

**Normal Proportions**

| | 1st Coat | 2nd Coat |
|---|---|---|
| Paint Stiff | 3 Kg. | 3 Kg. |
| Boiled linseed oil | 2 Ltr. | 2.5 Ltr. |
| Drier | 500 gms. | 500 gms. |
| Turpentine | 1 Ltr. | Nil |

**Lead point proportion**

| | Lead paint White, Red or Slate | Boiled linseed oil | Raw Linseed oil | Turpen-tine |
|---|---|---|---|---|
| Inside work | 12 Kg. | 2.5 Kg. | 2.5 Kg. | 0.5 Ltr. |
| Outside work | 12 Kg. | 2 Kg. | 3 Kg. | 0.5 Ltr. |

**Priming coat**

A priming coat should be given, of red lead, or red and white lead mixed in boiled linseed oil only (3 kg. lead to 2 ltrs. Boiled linsted oil). When dry, all holes and cracks must be filled in with putty and the whole surface rubbed down with pumice-stone or sand-paper and well dusted.

**Second coat**

The second coat will be of the desired colour, mixed as directed, and will be laid on in exactly the same manner as the priming coat. When dry the surface should be rubbed down with pumice stone and glass paper.

**The correct application or paint**

The paint should be applied with a brush (NOT RAGS) and spread as evenly and as smoothly as possible. To effect this, as soon as the whole or a convenient quantity is covered, the brush should be passed over it in a direction contrary to that in which it is finally to be laid off; this is called crossing. After crossing the brush should be laid off softly and carefully in the direction contrary to crossing, but with the grain of the wood, taking care that none of the cross brush marks are left visible. The criterion of good workman ship is that the paint is laid evenly and the brush marks are not observed. In laying off the brush should be laid in that portion of the work already done so that the joints may not be perceived. Every coat must be perfectly dry, and be passed by the Range Officer in charge of the work, and all dust must be carefully removed before the next coat is applied.

Paint must not be allowed to settle in cans, to prevent this the painters must have a small smooth stick with which they must be made to stir the paint occasionally. If paint has to be laid on one side for a time in an open vessel, it should be covered with water.

**Flat painting**

When the work to be painted is subject to strong light, and is not of a very high finish, oil painting shows up every defect. In such cases it is desirable to use turpentine in the paint, the result being a flat instead of a shiny surface. The proportions to be used are I Ltr. of white zinc 5 Ltr. turpentine and 209 gms. boiled linseed oil

**Repainting old wood work**

The old paint should be carefully examined. If firm and sound the surface of the wood is to be rubbed down with pumice stone or soap-stone and washed with Dhobi's earth and water, until all dirt, grease, blisters have been removed.

To prepare dirty surfaces such as; kitchen ceiling, doors, etc. for painting, a coat consisting of 1/2-kg glue and 50 gms unslaked lime boiled in 1 ltr. of water should first be given. The best method to remove old paint is to burn it off with blow lamps or some good paint remover.

**Painting Iron and Steel Work**

All iron and steel work must have its surfaces protected from rust. Once metal begins to oxide it is most difficult to prevent paint or any other protecting coat will peel off if applied, to a surface containing any particles, of rust. When ever possible the metal should not be black and immersed in a trough of boiled linseed oil. If this is not possible the metal must be thoroughly cleaned from, rust and dirt by scraping and brushing with a wire brush, and then coated with boiled linseed oil or a priming coat. Iron and steel can be temporarily protected from rust by painting it over with wash (lime), or by covering it with slaked lime.

Iron work which is to be embedded in walls must be coal tarred. (See Note on Coat Tarring).

Red lead paint must be used for important structural iron work, mixed in the following proportions:-

| | |
|---|---|
| Red lead | 45 kg. (see below). |
| White zinc. | 9 Kg |
| Raw Linseed Oil | 22 Ltr. |
| Turpentine | 2 Ltr. |

For 3 coat work, 20 kg for the first coat, 10 kg for the second, and 5 kg for the third.

For important iron work of roofs, red oxide of iron paint should be used. A gallon of red-oxide, paint, mixed, in the following proportions:

Red oxide powder, dry. 10 parts by weight.

| | | |
|---|---|---|
| Linseed oil, dry, | 4 | do |
| Linseed oil, raw. | 1 | do |
| Turpentine. | 1 | do |

The inside of water tanks should be painted white for which the following proportions may be used:

| | |
|---|---|
| White lead, dry | 12 Kg. |
| Boiled linseed oil | 2. 0 Ltr. |
| Raw linseed oil | 3. 5 Ltr. |
| Turpentine. | 0. 5 Ltr. |

**Brushes**

New brushes must be placed in water for 2 or 3 hours before use, then taken out, shaken free from water and allowed to dry for a short time before being put, into the paint, When a brush is to be used for another colour or to be put away, it should be cleaned at once by dipping into Kerosene oil, which must afterwards be shaken out. A brush in which paint is allowed to dry is spoilt. Old brushes should be kept in water or raw linseed, oil.

**Varnishing**

Varnish must not be used on structures, which are to be exposed to the weather. Hard drying copal or oak varnishes are most suitable for the interiors and furniture. It is advisable to thin copal varnish with one quart of turpentine to one gallon of varnish. The surface to be varnished must be thoroughly cleaned, sand prepared and first painted with a coat of glue size. This will be made of good clean glue of a consistency to run freely off the brush when hot. Two kg. of glue boiled in 10 litres of water is about correct. 1 kg. of glue in 5 kg. of water). Glue is dried for a day and ten vanish applied

One pint of varnish should cover about 15 square metre.

**Oiling**

It is more economical than varnishing or painting, but with it, it is much more, difficult to obtain good results. Good boiled oil spread in a thin film on glass should become quite firm within 24 hours.

The following forms a good coating for wood work:

3 kgs. Boiled linseed oil of good quality.

1 kg. Turpentine.

1 kg. Bees wax.

The oil and way to be heated over a slow fire until, the wax is melted, and, after the mixture has cooled turpentine to be added and the mixture to be applied in two or more coats as desired.

## COAL TARRING

**General**

Coal tar must not be applied to green wood. All wood must be well seasoned and dry before tarring.

Before applying, the surface of the wood, or iron be well cleaned.

**Ingredients**

The tar will be thinned with kerosene oil or country spirit in the following proportions:

(a) Four parts tar to one part, kerosene.

(b) 5 Itr. tar to 0.25 Itr. country spirit.

The above proportions may be altered to suit conditions.

To prevent tar running free add I kg. of unslaked lime to every gallon of tar.

**Application**

The tar and kerosene should be mixed together cold and then heated to nearly boiling point. The safest methods to accomplish this is to use 2 tins of different size. The mixture is poured into the smaller, and the larger is half filled with water. The smaller tin is placed inside the larger, which is then heated until boiling, when immediately the tin containing the mixture is removed.

Immediately after application the tarring should be dusted over with fine coal dust, if possible.

Best results are obtained by dipping the article in the hot tar. Iron work must always be well-heated before the tar is applied.

Not less than 4 kg. tar should be used per square metre of surface tarred.

## APPENDIX

## GLOSSARY OF USEFUL TECHNICAL TERMS

**Lime**

Fat lime is pure lime, which will not set in water. Hydraulic, lime is one that will set within 7 days under water.

**Brick work**

**Bed Joints**

The mortar joints normal to pressure:

(a) In walls with vertical faces the bed joints would be horizontal.

(b) In batter walls they should be at right angles to the batter.

(c) In arches the joints would be normal to the arch.

**Quoins**

The external corners of the building. The same is sometimes applied to bricks or stones which form the Quoin e.g. quoin brick quoin stone.

**Perpends**

The vertical joint on the face of the wall. In plain walling, it is necessary for good bond that these joints in alternate courses should be vertically one above the other.

**Stretchers**

Bricks or stones laid with their greatest lengths parallel to the face of the work.

**Headers**

Bricks or stones laid with their greatest length perpendicular to the face of the work.

**Bats**

Pieces of bricks usually known, according to their fraction of the whole brick as ¼ or ½ or ¾ bats.

**Lap**

The horizontal distance between the vertical joints in two successive courses. This should be one forth of the length of a brick.

**Queen Closers**

Bricks made the same length and thickness as ordinary bricks, but half the width, placed usually next to the quoin header to obtain the lap.

**King Closers**

Bricks cut longitudinally in half or specially moulded bricks of this size.

**Toothing**

The usual method of leaving a brick wall, which is to be continued at some future time, is to tooth it. This consists of leaving each header projecting 5. 5 cm. beyond the stretching course above and below to allow the new work to be bonded to the old.

**Racking**

Racking is the term applied to the method of arranging the edge of a brick wall, part of which is unavoidably delayed while the remainder is carried up. The

unfinished edge must not be built vertically or simply toothed, but must be set back 5.5 cm. at each course.

**Bond**

Is the name given to the arrangement of bricks or stones of each course so as to ensure the greatest possible amount of lap, and also to prevent the vertical joints between any two courses marking a continuous straight line.

**English Bond**

Consists of one course of headers and one course of stretchers alternately. In this bond bricks are laid as stretchers only on the boundaries of courses, thus showing on the face of the wall, and no attempt should be made to break joints in a course of running through from back to the front of a wall. That course which consists of stretchers on the face is know as the stretching course and all in course above and below it would be headers with the exception of the closer brick, which is always placed net to the quoin header to complete the bond, and these courses would be called heading courses.

**Herring boned Bond**

The bricks in this method are laid at an angle or 45 degrees, commencing at the centre line and working towards the face bricks. Herring-bone bond is used for walls four bricks and upwards in thickness.

**Jambs**

The vertical sides of door and window opening are known as jambs.

**Squint Quoins**

If two walls meet and enclose an angle other than a right angle in plan the junction is known as Squint Quoin.

**Plinth**

A horizontal and usually projecting course built at the base of walls to protect walls from injury and to give additional strength and to improve the appearance of the structure.

**String course**

The name given to horizontal courses, sometimes projecting and moulded, built in the faces of walls to act as a tie and architecturally to emphasise the horizontal divisions in a building.

**Technical Terms used in Connection with Arches**

**Voussoirs**

The bricks or stones usually wedge shaped on the face, which compose the courses of the arch.

**Springers**

The extreme or lowest voussoirs of an arch.

**Skew backs**

These are the upper surfaces of the abutments or piers from which an arch springs and are so formed as to radiate from the centre of the arch springs and are so formed as to radiate from the centre of the arch.

**Key**

The uppermost or central brick or stone of the arch.

**Intrados or soffit**

The under or concave side of the arch.

Extrados or back

The upper or convex side of an arch

**Impost**

The upper part of the pier of abutment on which an arch rests, or from which it springs.

**Springing points**

The points from which, the curves of an arch commence, as seen in elevation.

**Ring courses**

The name given to these courses of brick-work that partake of the circular form as seen in the face of the wall.

**Label courses**

The name given to a course of bricks laid flat wise on an arch and depending it. These sources usually project, and are moulded and weathered on their upper side to throw all rain water clear of the arch.

**Rough Arch**

Arches constructed of ordinary uncut bricks are known as rough arches.

**Inverted Arches**

These are rough arches inverted springing from piers or abutments upon which the bulk of the weight is concentrated and with which there would be a possibility of unequal settlement with the remainder of the wall due to the body of the wall or ground under the foundation being subjected to a non- uniformly distributed stress. Their effect is to distribute the pressure uniformly over the whole of the wall or along the whole length of the foundation.

**Trimmer Arches**

These are a form of rough arch adopted for supporting hearths in front of chimney breasts, and having an abutment against the trimmer or trimmer joist.

**Gauged Arches**

All arches in which bricks are cut to definite sizes and shapes are known as gauged arches.

**Springer**

The lowest stone in an arch.

**Technical Terms in Masonry**

**Apex or Saddle Stone**

The highest stone of a gable and cut to form the termination of two adjacent inclined surfaces.

**Bed surface**

The surface of a stone perpendicular to the pressure, whose surfaces must be worked into one plane surface.

**Blocking surface**

A course of stones erected on the cornice. The object being to gain extra weight to tail down the cornice, to form a parapet.

**Bonders**

Long stones placed through from front to back of a wall to tie the wall transversely. These may be either headers or through stones.

**Copping**

The highest and covering course of masonry, forming a water proof top, to preserve the interior of the wall from wet.

**Cornice**

A moulded course of masonry crowing buildings, generally having a large projection to throw off the rain water.

**Grout**

This is a thin mortar, which is poured over stones when brought up to a level surface to fill up any interstices between the stones in the hearting of the walls.

**Drip stone**

Is a projecting stone having a throated under surface, to throw water clear off walls, doors, windows, etc.

**Ashlar**

Ashlar is the name applied to stones that are carefully worked, and are usually over 30 cms deep, and have joints not more than 3 mm thick.

**Some Technical Terms used in Steel Girder Work**

**Clearspan**

The horizontal distance between the abutments

**Effective span**

The distance between the centres of the bearing surfaces, of the girder on the supports. This is taken for purposes of calculation as the girder is usually cambered to prevent the bearing surface of the girder resting on the outer edge of the stone template.

**Effective load**

The effective span in metres multiplied by the weight of the distributed load per mtr. run.

**Bearing surface**

The part of the lower face of the girder which when loaded rests upon the support.

**Camber**

This is a vertical curve in an upward direction from the bearing points. Beams are cambered to allow for the deflection of a beam when loaded. Cast Iron beams should have a camber of 2.25 cm every 3 m of span steel girders I cm. in 3 m.

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# CHAPTER XII

## THE STORAGE OF EXPLOSIVE AND METHODS OF BLASTING

The explosives used in the Forest Department are blasting powder and dynamite (or gelignite). The storage of explosives is controlled by the Indian Explosives Act, 1884 and the rules made under this Act in 1940. Each Forest Division and Range must possess this Act and Rules. Every Divisional Forest Officer and every Range Officer should go through these very carefully and the instructions given must be followed. Licence should always be procured for the storage of explosive and applications for such licences wherever necessary should be submitted to the Inspector of Explosives, North Circle Agra. The following general instructions are, however, given which should be strictly followed and Divisional Forest Officers and Conservators of Forests should ensure during office inspections that these instructions and orders in the Act and Rules are being acted upon.

**Storage**

A. In godown: (i) On no account, whatsoever, is any explosive to be stored in godowns attached to rest houses or to any other dwelling house (s).

(ii) Explosives should be stored in a special godown situated at least 200 m from any dwelling house. The godown should be fenced and not exposed to great variation of temperature. It is a good thing to cover the godown with earth to maintain an equable temperature.

(iii) No metallic material may be stored in the explosive godown.

(iv) Detonators must be kept separately and must not be stored in the same place with explosives.

(v) The key of the explosive godown must be kept by the Range Officer especially as villagers are likely to steal gun powder at the first opportunity.

B. **When at work**- (vi) Dynamite should not be exposed to the sun as, if heated above 75° C, it is liable to explode by concussion.

(vii) Care should be taken when the temperature is low, as dynamite when cooled down below 5° C, explodes very easily by concussion.

(viii) Dynamite and detonators must not be kept together when not in position for firing.

(ix) Explosives should never be entrusted to a work mate or a Laborer the officer in charge of the work must always keep them in his own personal charge. Under no circumstances should explosives be stored where subordinates live or where fires are lighted

(x) While on works, explosives must be kept under lock and key in small separate wooden boxes, a temporary magazine must be built wherever large works are in progress. One room to be set aside for fuse; and detonators and another for dynamite and gun powder.

(xi) Where there is danger from forest fires the ground must be kept clear of all inflammable material to a distance of 20 m all-round the magazine.

**Points to be observed in the construction of an explosive magazine**

(i) Gun powder, dynamite, gelignite and safety fuse may be stored in the same room, but detonators and fuses for blasting which are not safety fuses, must be kept in a separate room and if the number of detonators exceeds 40,000 they must be stored in a separate building at some distances from the magazine.

(ii) The size of the magazine will depend on the quantity of explosives to be stored. The floor, however must be at least 30 cm above ground, the outer wall 45 cm thick, the walls between the magazine and the detonators room 60 cm thick, and the outer walls of the detonators room 38 cm thick.

(iii) The door and any windows in the magazine must be of at least 0.6 cm thick steel plate faced on the inside with wood. They must open outwards, and as there should be no uncovered steel or iron, inside a magazine bolts, hinges and other internal fitting must be of brass or gun metal.

(iv) The interior of the magazine floor, walls and roof must be cement plastered, worked to a smooth surface.

(v) Dynamite and similar explosive must be cool dry and well ventilated. To ensure this, boxes of explosive must be kept away from the walls and off the floor on trestles 30 cm high. The magazine will be ventilated through shaft 20 cm square, and according to law. They will be protected outside with wrought iron grantings, built into the masonry, and inside with brass or copper wire netting (3 meshes to I cm) fixed in a wooden frame and secured flush with the plaster.

(vi) A space not less than ten metre wide round every magazine will be enclosed with a strong fence provided with a single gate, which will be kept locked. This space will be kept clear from trees, bushes and grass.

(vii) Magazine must be kept away from roads and buildings, and unless there is high ground intervening, no magazine, intended to hold 250 kg or more of explosives, should be built with 15 m of a road or within a 100 m of a dwelling house. More space is required for longer magazines and the table attached to the rules framed under Indian Explosives Act, 1884 should be consulted before selecting a site for a new magazine.

(viii) Every magazine should be provided with one or more efficient lightning conductors depending upon the size of the building.

**General Rule to be observed in explosives magazines**

(i) The magazine must be at all times kept scrupulously clean.

(ii) No unauthorised person is at any time to be admitted into the magazine.

(iii) The person in charge of the magazine is to take care that the magazine is well and securely locked.

(iv) The magazine is on no account to be opened during, or on the approach of a thunderstorm, and no person should remain in the vicinity of the magazine during such a storm.

(v) Magazine shoes without nails must be kept at all times in the magazine, and a wooden tub or cement trough, about 30 cm high and 45 cm in diameter, filled with water, is to be fixed near the door of the magazine.

(vi) People wearing shoes, before entering the magazine must but on the magazine shoes provided for the purpose, and be careful: -

a. not to put their feet on the clean floor unless they have the magazine shoes on.
b. not to allow the magazine shoes to touch the ground outside the clean floor, and
c. not to allow any dirt or grit to fall on the clean floor.

(vii) People with bare feet will, before entering the magazine dip their feet in the water and then step direct on to the clean floor.

(viii) A brush or broom is to be kept in the magazine for cleaning out the magazine on each occasion it is opened for the receipt, delivery or inspection of explosives.

(ix) Neither lights nor smoking are to be allowed inside or near the magazine.

(x) No person having any matches, or articles, of steel or other metal is to be allowed to enter the magazine.

(xi) Oiled cotton rags and waste or any articles liable to spontaneous ignition must not be taken into magazine.

(xii) No tools or implements other than those or copper, brass, gun metal or wood are to be allowed inside the magazine. Tools must only be used with great gentleness and care.

(xiii) Boxes of explosives are not to be thrown down or dragged along the floor. They must be stacked on wooden trestles. Where there are white ants, the legs of the trestles must rest in shallow copper, lead or brass containing a little water.

(xiv) Empty boxes are not to be kept in the magazine nor any loose packing material stored there.

(xv) A space of 10 m wide all round the magazine is to be kept clear of grass, jungle and trees.

(xvi) The following are to be hung up in the magazine

(a) A copy of these rules.
(b) A statement showing the stock in the magazine
(c) Certificate showing the last date of testing the lightning conductors.

**Transport**

(i) Detonators must never be transported at the same time as dynamite. Detonators must always be very carefully handled. Any kind of explosive when in transit must be accompanied by a Forester. In no case, should the transport be allowed through public places and streets or a special permit has to be obtained.

(ii) Blasting powder should be used only for blasting soft rocks, such as sandstone or for obtaining stone for building.

(iii) Dynamite or gelignite is usually used for the harder rocks, such as schists and gneisses met with in the construction of roads.

(iv) The standard breadth of the blast hole is 5 cm (the diameter of the, jumper used by the Forest Department is 3.75 cm) and the depth according to the size of the rock to be blasted usually from 30 cm to 90 cm. The blast hole should always be drilled at right angles to the rock strata and should always be placed in round rock without cracks. Fissures and cracks in rocks to be blasted must be carefully avoided so that the charge is not nearer than 30 cm to a crack.

**The Charge**

Usually a handful of blasting powder or one dynamite, cartridge for every 30 cm depth of blast hole, but more should be used when specially hard or large rocks are to be blasted. In case of doubt, a charge should always be too large rather than too small.

**Loading the blast hole**

A. **With dynamite**

(i) It is usually better to do blasting in the summer, as then the dynamite is in a fit condition to put the detonator in, without first warming the dynamite. Whereas in

winter the dynamite is so hard that it is impossible to put the detonator in it without first, softening it by heating it, in special cans or in the trouser pocket and never before a fire.

(ii) If more than one cartridge is used, the lower cartridge should be broken into pieces and gently rammed, down. A hole should be made in the tip cartridge about the length of the detonator 3.0 cm and rather wider than its diameter and the detonator gently pushed into it. Before the detonator is pushed too far into the cartridge, the fuse may set fire to the latter before the explosion of the detonator and loss of power with, dangerous fumes will be the consequence. If the detonator is to be used in damp places or under water, the junction must be made water tight with grease or tar. The dynamite should be gently lowered into the hole. The rest of the hole should be filled up with earth; pour in the earth gently at first, but the top layers may, be rammed fairly hard. The mouth of the hole must be, tightly rammed with clay carte being taken that the fuse is not cut. Note that the ramming must never be done with iron, use the tamping bars supplied for the purpose, which have a brass end. Failing special tamping bars, wooden handles must be used. The length of the fuse to be used depends on the place being blasted; if there is no cover near at hand and the "get away" is difficult, a long length of fuse must be used. There is nothing to be gained by using a short length of fuse.

B. with blasting power. The gun power is poured in, with the fuse inserted and tamped gently; above the gun powder a wad of dry earth or sand is packed tight with a special brass or copper tamping bar or wooden handle. When water finds its way into the bore hole it must be dried with quick lime and the powder will then be poured into the hole by funnel or a tube.

**Precautions**

(i) If blasting operations are being carried out near a road, traffic must be stopped until the "all clear" signal is given. More blasts than the number actually required results in considerable loss of explosives and sometimes in accidents. It is safer to fix the number of blasts to be exploded, beforehand as it has in practice been found impossible to take a complete account of what number, if any, have failed to fire when too many are fired at one time.

(ii) If more than one blast is being fired at a time great care must be taken to notice if all have gone off before returning to the site. If a blast does not explode the greater care must be taken. It is safest to avoid the spot for some hours and then drill a separate hole and explode the second charge. The fresh hole must be bored not less than 15 cm from the old one and loaded and fired in the usual way. The explosion in the new hole will nearly always explode the first charge. Should the first hole be of considerable depth, it will be necessary to make the new hole 15 cm lower than the top of the dynamite in the old hole. If gun powder is being used for blasting and the charge does not explode the hole should be filled with water, left for 24 hours and then a fresh hole drilled and exploded. Men have been blinded by pulling out fuses thought erroneously to be extinct.

(iii) Do not drop dynamite in cold water. Don't leave it in the sun. Do not warm it at a fire, special hot water cans are provided. Do not leave dynamite and detonators together. Do not carry detonators in the waist coat pocket and drop them in a fire. Do not pullout the fuse from an unexploded charge for several hours. Do not use iron jumpers for tamping.

# CHAPTER XIII

## RESIN TAPPING INSTRUCTIONS AND RULES

### SECTION 1 - INTRODUCTORY

The instructions of resin tapping are contained in Punjab Forest leaflet No. 13 which is being followed in Himachal Pradesh. Many changes and improvements have since taken place. This technical order is intended to replace all previous orders and to standardise all resin operations.

### SECTION 2 - GENERAL CONSIDERATIONS

In the Himachal Pradesh, resin can be obtained from Pinus roxburghii (long leaved pine: vern: Chir, Chil), from Pinus wallichiana (blue pine: Vern: Kail, biar) and from Pinus gerardiana (Gerard's pine Vern: chilgoza neoza). Gerard's pine is found in the remote tracts of the inner Himalayas lying beyond the influence of the south west monsoon and can not be economically tapped for resin. The blue pine produces a turpentine of simple construction and high quality and a resin with a high percentage of the higher grades, but the forests are generally so remote and grow at elevations where the tapping season is so short that it has not hither to been profitable to tap this pine. At present, however, the resin industry in the Himachal Pradesh entirely is dependent upon the long leaved pine.

Members of the controlling and superior executive staff are expected to be acquainted with the structure of the wood of Pinus roxburghii and the distribution of the resin vessels therein and to make themselves acquainted with the latest information on the subject.

The wood of Pinus roxburghii is nonporous and is composed mainly of tracheides. It exhibits clearly marked annual rings, conspicuously differentiated into two portions, the spring wood containing thin walled cells and layer cavities and the summer wood having denser walled cells. A varying number of the outer most annual rings make up the sapwood, which is of somewhat lighter colour than the heart wood which contains but little resin. The outer most layers of the sapwood are richest in resin. The part richest in resin is the rootwood and the poorest is the heart wood.

In Chir pine, the resin canal system includes vertical and horizontal resin canals with epithelium. The vertical canals are irregularly distributed and confined for the most part of the middle or outer portions of the ring. The frequency of the vertical canals varies from 21-33 per 100 sq. mm and size from 204 microns to 260 microns. The horizontal canals are smaller, solitary and inserted in the fusiform rays. The frequency varies from 44 to 60 per sq. mm and the size from 45 to 59 microns. The epithelium is 1-2 cells thick. Average diameter of the canal within a growth ring along the different radii, as well as in different growth rings at anyone level shows considerable variation from 180 to 250 microns. However, the average diameter of canal of 15-20 growth rings along 2 radii and height varies within narrow limits ranging from 204 to 230 m crons. The size of the horizontal canals remains more or less constant throughout the free.

The size as well as frequency of resin canals varies little, with the resin yielding capacity of the tree. As a result of tapping both the frequency and size of resin canals undergo changes but the effect is confined only to the wood formed after tapping, maximum effect being just above the blaze upto 15 cm and does not extend laterally.

Upto a height of 6 m, resin content of the wood has been found to vary from 4.4 to 5% and above this height, it increases slightly to 5.4-6%. On destructive distillation, Chir, pine log showed recovery of 2.5 to 3.5% turpentine and 3-10% of pine tar on weight by weight basis of wood. With solvent extraction, the recovery of resin %, on weight by weight basis, was 13 - 15% for logs cut into chips 7 - 10% for roots and 6 - 7% from stump wood. The recovery of turpentine was 2 2.5% and 1.2% respectively.

When tapped on a weekly freshening cycle, average percentage of resin exuded daily were found to be 50%, 16.0%, 10.5%, 9%, 6.5%, 6% and 2% on first day, second day to seventh day respectively. It is also dependent on temperature and exudation rises steadily from 10 am and reaches its peak between 1-2 pm thereafter decreases gradually.

The process of resin tapping is not merely drawing out of resin already formed: it is the collection of resin which is constantly being manufactured by the tree, when the sapwood is wounded the bulk of resin appears to be produced most profusely within a few centimeters of the wound and not far above it. The wound must, therefore, be a perfectly clean cut which fully opens the resin ducts and wounding must be recurring as otherwise the resin at the cut end of the duct solidifies and prevents further flow.

A resin blaze correctly freshened shows clean white wood and a generally uniform distribution of exudation of resin in small clear honey coloured drops. A blaze not systematically freshened, shows patches of faint dark streaks from which no resin exudes owing to the resin ducts being blocked with solidified resin. The flow of resin is greatest immediately after wounding or re-wounding, the flow gradually decreasing in the process of time until it practically ceases owing to the plugging of the ends of the ducts with solidified resin. The plugged ducts immediately above the wound then become full and the resin tends to diffuse itself over the surrounding wood: this diffused resin does not drain out when the wood is re-wounded.

Frequency of freshening exercises a very significant effect on yield and the yield with one day tapping cycle may be as high as 2.5 to 3 times the yield from 7 days cycle. Even when the height of freshening is so adjusted that the total height freshened in a year is the same under different frequencies of freshening, the yield increases with a shorter frequency of freshening. However, keeping in view the cost of freshening and other factors in view, freshening of blaze at 6 days interval appear to be the most economical.

From the above short resume, certain fundamental deductions can be made in regard to the principles of resin tapping, namely:

(i) Resin production will be improved if crops under tapping are maintained in a somewhat open condition.

(ii) The blaze should be placed as low down on the stem of the tree, as possible, while the nearer it is to the south face of the tree, the better will be the yield of resin.

(iii) Deep blazes extending beyond the outer layers of the sapwood and even into the heart wood of the trees do not mean a greatly increased yield of resin: on the other hand such deep blazes almost invariably result in the wounds not occluding.

(iv) The blazes must always be made with a very sharp instrument so that the wound has a perfectly clean surface.

(v) The blaze must be freshened by the removal of a very thin shaving of wood from the open part of the blaze at regular intervals of about 6 days.

(vi) Blazes should not ordinarily be continued in length for more than 5 years otherwise the yield of resin will materially decrease. A fresh blaze should therefore be started at the base of the tree after 4 or at most 5 years tapping.

(vii) The whole face of the blaze must always have a clean smooth surface over its whole length to ensure the rapid flow of resin to the collection cup.

Since the last orders on resin tapping in the Punjab were issued much has been learnt by experimentations. The system of continuous light tapping has been adopted and it has been necessary to introduce more stringent regulations as regards the length, width and depth of the channels.

## SECTION 3 - ENUMERATION

### Preliminary Operations

The practice of enumerating tapping areas after every four years should be continued. However, at the time of such enumerations all the trees which have no space for tapping or which have becomes susceptible to wind damage, should be taken out to tapping. Health of the trees should over weigh the revenue earning consideration. Areas with very sparsely scattered trappable trees (8 or less per ha) should not be taken up for tapping.

Large scale chil plantation have been raised in the past. Some such plantations are becoming fit for tapping every year. At, the time of enumerations such plantations should be gone over and should be included for tapping, if the trees have attained trappable diameter. The trees in these plantations should be tapped under rill method, which has been prescribed at the end of this technical order.

As trees marked for felling other than P.B.I. are ordinarily to be tapped to death, the marking of such trees should be done as far as possible before the resin enumeration is carried out, so that a proper estimate of the number of blazes in a block or sub block can be made. Except in areas under regeneration, trees to be felled should be marked 3 to 5 years ahead of the year in which these are intended to be felled, so that the heaviest possible yield of resin may be obtained from such trees before these are felled.

No trees will be enumerated for tapping within 4 meters on either side of a foot path or road, where considerable wastage of resin pots is likely to take plate through the mischief of way farers.

### Enumeration work

In the enumeration work, the trees to be tapped to death will be classified from the original marking lists for entry in Abstract Resin Form 'A' such trees will not be enumerated again, so that only trees to be lightly tapped will be counted, the results being abstracted from the enumeration note books for the purpose of Abstract Resin Form 'A'.

### Number of blazes per tree

For light continuous tapping, the following limits are fixed, girth measurements being taken at breast height over bark, measured on the uphill side of the tree

(1) 1.2 to 1.9 m girth, one blaze 10 cm wide.

(2) above 1.9 m girth, two blazes 10 cm wide.

For heavy tapping the general idea is to put on as many blazes as possible, leaving at breast height at least 10 cm of bark between every two blazes.

For badly shaped, twisted, trees, or those damaged at the base by fire, falling stones, villagers etc. the number of blazes will be less than this. The minimum girth of a tree which it pays to tap to death is 0.6 m.

**Punch Marking**

Every tree shall be serially numbered and the number of blazes indicated: thus 567/2, the upper figure showing the serial number and the lower figure the number of blazes permissible. The unit of enumeration will be the compartment (or the sub - compartment where such exists). For marking these numbers the bark, is smoothed on the north side of a tree at about 1.5 m from the ground and the numbers are punched in lightly with 3 cm figure punches.

**Summary of Enumeration Form "A"**

Resin Form "A" (See Appendix 11) will give the result of enumeration of compartments or sub-compartments where such exist and will be a permanent record of work actually done. The form will be abstracted as follows:

**ABSTRACT RESIN FORM "A"**

Division
Range — Year of commencement of
Block — tapping or re-enumeration
Compartment (or sub compartment)

| Girth Class | Light tapping | | Heavy tapping | | Total | |
|---|---|---|---|---|---|---|
| | No. of trees | No. of blazes | No. of trees | No. of blazes | No. of trees | No. of blazes |
| 0.6 to 1.2 m | Nil | Nil | | | | |
| 1.2 m to 1.9 m | | | | | | |
| Over 1.9 m | | | | | | |
| Total | | | | | | |

The abstract will be entered in a register kept in the Range office a copy being sent for record to the Divisional Office, where this information shall be entered in Compartment History Files (or Forest Journals) where such are maintained. Non-Government forest areas tapped should be shown separately in Resin Form A.

**Time of enumeration**

Marking of trees for tapping to death must be completed during the summer. Re-enumeration work when done must be taken in band immediately after tapping season is over, viz. by 1st of November and completed by the 1st of December. When enumerations is done in a forest for the first time this work can be taken in hand earlier and finished by 1st of December. One Forest Guard with three labourers can enumerate 400 trees a day.

## SECTION 4 - TOOLS AND STORES

**The scale of tools and stores**

The following is the scale of implements required:

| Articles | Specifications | Remarks |
|---|---|---|
| 1 | 2 | 3 |
| Conical tin | Top external diameter 12 cm | |
| Tin, G.I. or iron lips are made from old erosene tins | 20 W.G. to 24 W.G. 15 x 5 cm | Scale 1" per channel can be locally prepared. See Note 2 |
| Iron Nails of wooden pegs to support the pots | 4 cm to 5 cm wire nails about 300 to 350 per kg. | Scale, 1 per blaze<br>See Note 3 |
| Curved adzes 6 cm edge back to be used as hammer. Edge to be kept of razor like sharpness. | Mild steel, standard Pattern. | Scale, 1 per labourer that is 1 per 1,000 blazes |
| Gwalior sandstone hone to sharpen adze. | - | 1 per labourer. See Note 4 |
| Curved chisel, 12 cm. edge to made incision to receive lip | Mild steel standard pattern | Maximum 1 per 1,000 blazes |
| Piliers to pull out lips Iron or mild steel 1 per 1,000 channels. | Iron or mild steel | |
| Hammers | Iron or mild steel | - |
| | | |
| Flat wooden scrapers for scraping out resin from the pots | - | Made by lapping labourers, (1 per labourer) themselves free of cost |
| Clean empty kerosene tins for collecting and storing resin | Free from rust and with only bung hole open | Scale 1 tin per labourer and 5 tin per quintal of resin collected. See Note 5 |
| Solder and soldering irons | - | Scale 1 set to each forest depot. |
| Scale for weighing resin | - | Scale, 1 set to each forest resin depot. |
| Drums | Capacity 40 kg. | See Note 6 |

**I Pots --** Conical tin pots are mostly in use now.

**2 Tin lips** -- Tin lips are much cheaper and can be easily prepared locally from old tins or they can be obtained from other divisions where surplus. Tin lips for about 5 years and G.T. lips for 10 years.

**3. Nails** -- It is advisable to use wooden in preference to iron nails. Iron nails are often removed by the villagers. Wooden nails are cheaper and they can be locally made from hard woods such as Khair (Accacia Catechu), Kao (Olive) or sanatha. Sometimes the heart of chil is used.

Wooden nails should always be ordered from a carpenter. If this is not done, Forest Guards ordinarily leave the supply of wooden nails to the labourers who make use of all sort of wood and the nails are never of standard size and strength.

**4. Hones** -- The labourers have now taken to stones locally obtained. The preliminary sharpening is done on a rough stone and later completed on a small hard stone (carried in pocket).

**5. Tins --** It is essential that no more tins are ordered than the required during the season as they rust very rapidly and become unserviceable.

**6. Drums -- D**rums had been introduced to reduce the cost of containers. Their life has been estimated at 6 years. The number of 40 Kg drums required for any resin depot depends on--

(1) the average daily output of resin during May, July and August; and

(2) the number of days the filled drums spend in transit to their destination and back.

The following scale of stores is laid down for use in resin depots. The indent and consumption of these stores will be based on this scale:

Solder 400 gms. for 100 tins.
Noshadar 50 gms. for 100 tins.
While paint 150 gms. for 100 tins.
Oil tins for soldering 4 per 100 tins,
Charcoal 5 Kg. for 100 tins.
Charcoal for repairs of tools 0.4 Kg. per tool.
New tins for soldering 2 per 100 tins.
Old tins for soldering 4 per 100 tins.

**Time and method of indent**

The indent for tools should be made in good time, stating clearly the definite quantities required and the maximum permissible gross weight per package.

**Writing off unserviceable tools**

Much confusion results in indenting for stores if the unserviceable tools in forest depots are not examined annually and written off. It will also save correspondence between the Divisional Officer and Range Officers if unserviceable tools can be examined by the Divisional Forest Officer on tour so that by the end of the tapping season each depot is in a position to prepare a correct indent for the following year's supply.

**Disposal of Unserviceable stock**

It is essential that effective methods be employed in destroying unserviceable stores and if this is not done they are, liable to be presented, over and over again for writing off. Certain articles can be broken or burnt, others can be thrown into a river. Old tins cannot be destroyed in either of these ways they can either be converted into lips if these are required or a hole punched in the bottom centre of a tin will permanently put it out of, use. Other methods may be devised by the local Divisional Officers. The method employed must be effective. Sell if there is a demand for old scrap iron, otherwise the only effective method of disposing of such tools is to throw them into a river.

**SECTION 5 - FASTENING OF LIPS AND POTS**

**Cutting new channels**

Scrape the rough bark over a width of 15 cm and to a height of 5 cm over that part of tree which will be tapped during the year leaving only 0.6 cm thickness of bark. This operation probably increases the output of resin as the rays of the sun have a letter play on the resin ducts. Moreover the application of the adze becomes easier during refreshening. Then mark the lower end of the channel by a chisel or adze so that in the process of cutting a new channel unnecessary injury to the cambium below, the lip is avoided. Cut the channel I0 X 10 cm, and 1.25 cm deep in the middle.

**Fixing of lips**

At the lower end of the channel drive a chisel to a depth of 2 cm. Allowing 1.25 cm for the depth of the channel, this leaves 0.6 cm of depth for the lip. The shape of the chisel is such that it gives the cut a slope as the chisel is driven in with the hammer so that when the lip is fixed it assumes a sufficient slope to allow the resin to flow into the pot. But to ensure sufficient slope for the lips it should be seen that the chisel cut is at an angle of not less than 45 otherwise the resin will evaporate as it drips slowly and will collect on the lip.

Before the chisel is taken out, a lip is placed on it and with a light stroke of the hammer bent to give it a curve similar to that of the chisel and of the cut. The chisel is then pulled out and the lip is turned up. If the lip is not driven immediately after the chisel is withdrawn the cut meets again and it is not possible to drive the, lip home without reopening the cut.

It is essential that the lip should be driven home to, the full depth of the cut, if this is not done a gap will be left between the lip and the tree and resin will run to waste. For the same reason chisels should not be rounded at the corners, as a shallow cut at the comer will not permit the lip to be driven home. Before commencing the second or subsequent years, work the lips are pulled out, collected, burnt (to remove old dry resin ) straightened and then the lip nail and pot, are moved up the length of the old channel leaving 10 cm from the top. This ensures the minimum distance of resin flow and prevents evaporation and solidification of resin on its way to the pot.

**Fixing of nails**

The nails are driven into the bark immediately above the cambium on one side of the channel so that pot bangs in position to receive the resin dripping from the lip.

**Size of pots**

Earthen pots will be of uniform size, 16 cm deep 12 cm in external diameter at the top 9 cm at the bottom. Conical tin pots are mostly in use now.

**Preparation of pots**

Pots should be prepared as near to the forest, as, possible and, delivery should be taken in the depot or in a central place in the forest. Counting should be done by a reliable person and he must furnish a certificate on the bill, that the pots were counted in his presence. The rate for the preparation of pots includes cost of transport to the forest or resin depot.

**Season of making pots**

First November to 15th December is considered the best season for making pots. They should be ready before winter rains. It this is not done, potters will not be able to make them until the middle of March and tapping will be delayed.

A potter can make 500 pots a day and the same number can be baked at a time. It takes a week to complete the whole operation.

**Collection of pots**

In old work the pots are safer on the trees and collection is an unnecessary expense except where breakage are heavy or in localities of heavy snow. In the latter case the collection and storage in a dry place is necessary. By leaving pots hanging on the trees much winter resin is collected which will otherwise be wasted and the surroundings will be kept less inflammable. Where pots are not collected along with the lips a lower rate for raising the lips and pots should be paid.

**Hanging of pots**

In new work the hanging of the pots is done after the lips are placed in position as the labourers cannot carry about baskets full of pots along with a number of tools and lips, consequently, this is paid for separately.

In old work pots are already on the trees and the labourers merely put them up after refixing the nails. In this case the broken pots must be replaced at the same time. The hanging of pots in old work forms part of the routine, and is not separately paid for.

**Replacement of broken pots**

In setting up crops it is a common practice to hold over the replacement of broken pots to the beginning of the tapping season with the result that very often this is neglected for a long time and considerable wastage of resin takes place. This work must be done immediately after raising the lips and labour should not be paid until this has been certified.

**Duration and season of setting up the crop**

This work can be done in one month in any depot provided one labourer is employed per section. If other departmental works do not require the Forest Guard's attention elsewhere this work can be taken in hand on 15th February, and completed by 15th of March. Otherwise it should be started on 1st of December and partly before the winter rains and partly after.

**Rate of work**

A man can pull out 400 lips a day. He can complete 60 channels per day, including fastening of the lips refreshening or opening of new channels, fixing of nails and hanging of pots.

## SECTION 6 - TAPPING WORK

**Tapping Unit**

A tapping unit consists of a section worked by one labourer. Ordinarily, it contains 1,000 channels. The number of trees per section varies from 600 to 700. Each labourer therefore refreshens 1000/6 which equals 167 channels daily and collects resin from then, so that he can go over the section once in 6 days and thus refreshen each channel 5 times a month.

In order to accomplish this a labourer sub divides a section into 6 parts by artificial or natural boundaries so that he can go over each sub section in a day. The average number of sections in a resin depot is 10 to 15, but a large number of sections can be attached to a depot if the configuration of the ground justifies easy control. The seasonal outturn for a full working season (15th March to 15th October) should be about 30 quintets per section. This outturn however varies a good deal. It has been more than 35 quintals per section.

**Tapping Season**

The initial expenditure on setting up a crop remains the same whether the tapping work is carried out for a longer or a shorter period. In other words the cost of resin per quintal for the season will be less if tapping is continued for the longest period possible and this should always be done.

Ordinarily tapping should begin on 15th of March and should continue for seven months ending on 15th of October and in warmer localities to 15th of November. There is a tendency both among the subordinate staff and labourers to start late and

wind up the operations earlier. This must be strictly forbidden and the tapping season should not be reduced without the express sanction of the Divisional Forest Officer. During September and October harvesting and grass cutting is likely to interfere with the supply of labour in some localities (not everywhere) and local variations in the tapping season may be necessary.

In cooler localities the resin flow begins late and falls off earlier and in such localities the working season may be shortened by a few weeks. This may be done under the express sanction of the Divisional Forest Officer.

**Spacing between the channels**

The points of the stem most favourable for resin production are those directly facing the Sun. Starting with a girth of 1.2 m and spacing each successive channel with an interval of 12 cms of bark in between it should be possible to tap the tree for 35 years omitting all considerations of occlusion. The channels must be cut vertically upwards and where necessary a vertical line will be marked with a scribe beforehand. The taper in the tree will not permit a uniform spacing of 12 cms above breast height. In order not to reduce unduly this allowance of bark the standard width of 10 cm is to be reduced to 7.5 cm in the 5$^{th}$ year of tapping. It sometimes happens that the annual quota is completed before 15th of October and tapping operations are brought to an end forth with. This should not be allowed as output per thousand blazes for the season will be low.

**Refreshening of channels**

The pot should be removed before refreshening as otherwise it is likely to be filled with bark, chips and shavings.

A thin shaving is removed from the top curved part of the channel in order to open up closed ducts. In doing so the channel is lengthened by 8 to 12 mm. The total length of the channel to be refreshened will be 10 cm for the purpose, of opening closed ducts and another 5 cm lower down to smoothen up the surface.

**Thickness of shaving**

The thickness of the shaving varies from 1.5 to 0.75 mm. The shaving must not ordinarily be too thin or it will not open clogged resin ducts. During May and June when the greatest heat prevails the shaving can be as thin as possible. The cut must be clean and not torn or gagged particularly in the neighbourhood of the cambium and must taper to a feather edge where the cut and the cambium meet. If this is neglected healing will be retarded. However, it is not always possible to avoid this in trees with twisted fibre.

**Depth of channels**

All the sapwood in chir contains resin. The size of the longitudinal resin ducts is far larger than that of transverse ducts. Consequently deeper channels in sapwood give definitely more resin than shallow ones. But channels deeper than 12 mm do lasting damage and considerably delay the process of healing.

It is a common fault to cut deep channels to obtain a greater yield. This is due to the following reasons

(1) Untrained labour. It is the duty of the staff to see that the labour is properly instructed.

(2) An excessive curve in the cutting edge of the adze. This should always be checked. Worn out corners of the cutting edge also tend to deepen the channels. This can be prevented in repairing; adze with badly worn corners should be written off.

(3) A channel gauge with graduated scale can be profitably introduced for the use of all concerned. This can be fixed to the handle of the scraper for the use of labourers.

**Application of chemical stimulant**

**Effect of chemicals on resin yield:** The Application of mixture of sulphuric acid and nitric acid after freshening has been found to increase the resin yield significantly. In the experiments conducted in Himachal Pradesh and U.P., it has been found that the increase as high as 50% in some cases. The method of preparation of acid solution, along with material and equipment required is described as below:

| | | |
|---|---|---|
| Measuring cylinder | (500ml) | 1 No. |
| Do | (50 ml) | 1 No. |
| Beaker | (I000 ml) | 1 No. |
| do | (500 ml) | 1 No. |
| Funnel | | |
| Containers for acid | (10 litres) | 2 NO. |

Requirement of acids for 1000 trees for 8 months tapping per season (32 freshenings) as under

| | |
|---|---|
| Sulphuric acid | 2.5 litres |
| Nitric acid | 3.5 litres |

**Preparation of stimulant**

The stimulant used on the blazes is a 20 percent solution of the mixture of sulphuric and nitric acids mixed in equal proportion w/w. To prepare the solution take 875 ml of pure water in a beaker and add to it 55 ml of concentrated sulphuric acid little by with constant stirring. Then add 70 ml of nitric acid. Precaution should be taken to add the acids to water slowly and in no case, water should be added to the concentrated acids.

Pour the solution in the spray bottle to fill it up to two third of its capacity. Never fill the bottle to full capacity.

**The Interval and number of refreshenings**

Refreshenings must be done at regular intervals at the rate of 5 refreshenings per channel per month and the total number of refreshenings carried out during the year on one channel will vary according to the length of the season and will be 30 during 6 months tapping and 35 during 7 months. It has been found in practice that some trees give an abundant yield of resin in the month of June without being refreshened. Others are poor yielders and are neglected by the labourers. A channel which is not, refreshened at short intervals ceases to give any yield of resin.

The colour of the channels over the section will show if the labourer has been working regularly or has neglected his duty.

It is also easy to determine from the length of the channels at any time of the year whether the refreshing has been done regularly or not.

With five refreshenings a month the channel will be lengthened by 5.3 cm a month, so that if tapping is continued from 15$^{th}$ March to 15th October, the length of the, channel at the end of 7 months will be 37.5 plus 10 cm its original length at the beginning of the season or in all 47.5 cm. In subsequent years the channel will be lengthened by 37.5 every season.

**Maximum height to which a tree should be tapped**

In the Landes tapping is done to a height of 3.5 m. The determination of the height to which tapping should be done depends on the importance of resin versus timber production. The best course seems to her carry out tapping so that its adverse effect on timber Production is reduced to a minimum.

The yield of a new channel is low for the first year and it continues to increase during the 2nd and 3rd years and gives a maximum out-put during the 4th year. It begins to fan in the 5th year by which time the height of the channel has reached to about 2.10 m.

It is possible to tap this height without the use of a ladder, even when the channel is on the downhill side of a tree by piling a few stones to stand on.

A good deal of timber in the butt logs is wasted as the height to which trees are tapped varies. It is, therefore, necessary to limit tapping so that the timber in the tapped butt log can be utilised. For this purpose 2.10 m is a very desirable length as it is possible to convert the butt log into planks (210 30 2.5 cm) or scantlings which can be converted into bahis (sides of bed 210 5 6.5 cm) it is consequently uneconomical to tap a channel for more or for less than 5 years.

A very objectionable practice is to start a new channel without tapping the old channel to its maximum height. Sometimes a channel is tapped beyond 2.10 m with the result that a further length of the butt log is wasted. In order to prevent individual labourers tapping to various heights it is necessary to cut a belt round the hole 2.10 in from the ground level so the each channel is carried to that height. In the case of trees having partially worked channels, it should be seen that all channels are worker to their maximum height one after the, other before any new channels are cut.

**Collection of resin from pots**

Ordinarily a pot should be emptied into a clean collecting tin once every 6 days, in other words, this is done as refreshening proceeds.

During the month of heavy flow in June the pots are filed in about 4 days and the mazdoors go round collecting resin every 4 days. In such cases as refreshening work cannot keep pace with the collection they do not refreshen the heavy yielders and only remove a very thin shaving from other trees. Sometimes they place an extra pot on the ground to receive the over flow. This leads to wastage and dirty resin.

The best course to follow during the month of June is to continue the refreshening and collection at regular intervals, but the mazdoors should go round once in 4 days collecting from the heavy yielders only. This is not difficult as with practice the mazdoors soon recognise such trees.

**Adulteration of resin**

Sometimes resin is adulterated with mud grit and stones. This is done by labourers and depot guards to increase the weight or to make up deficiencies. If the cleaning of resin and filling of tins in depots is conducted under proper supervision, this can be, avoided. The depot guard is responsible. The inspecting staff should examine a large percentage of tins before they are soldered. The present system of marking tins is a safeguard against adulteration and should be continued.

**Tapping to death**

All trees marked for felling except in P.B.I. should be tapped to death for 3 to 5 years before felling. It is not possible to fix lips on trees below 45 cm in girth and 60 cm is a suitable minimum girth for tipping to death.

**Yield**

The graph attached shows the yield during the season. As yield varies from place to place according to locality local tables may be prepared to show the yield per 1,000 blazes so that the progress of the yield month by month can be checked.

**Resting period**

No resting period is necessary under light continuous tapping except where sufficient space is not available to permit a spacing of 12 cm at breast height between channels.

Sometimes on rocky and poor soil trees begin to die. In such cases the question of stopping tapping should be considered.

**Period of healing**

Very little is, known about the rate of occlusion and further observations are absolutely necessary on this vital question. Mr. Champion records the following in the united Provinces Forest Bulletin No. 51 -

> "The rate of occlusion of resin channels in Pinus depends primarily on the general vigour of the trees as indicated by its degree of maturity, the development of its crown and its height growth and secondarily on an adequate supply of water and good material reaching the edges of the wound, conditions being optimum on the north side of a tree an northern aspects at about 1,500 m altitude at foot of the tree and in the case of a left handed twist tree on the left hand side."

It has however, been proved in an experiment conducted in Rawalpindi East Forest Division, that tapped tree put on less increment than untapped trees. Deep and burnt channels take much longer time to heal

## SECTION 7 - STORAGE AND TRANSPORT

**Resin Depots**

Resin depots will be located as far as possible within or near this tapping area. They will be easily accessible to transport animals.

Depots will be kept neat and clean and no grass or other inflammable material may be stored nearby. As a precaution against fire a clean belt will be, kept all round. Empty tins will not be stored in the open for any length of time, as they become rusty leak and rapidly deteriorate.

**Collection and storage** -- After collection the labourers bring their resin to the depot where it is passed through a sieve and then filled into empty tins which are then weighed, closed and soldered. Each depot is assigned distinguishing letters and each tin is numbered serially so that it is easy to check the receipts of any particular depot. If drums and tins are too full leakage occurs during transport in the hot sun owing to expansion. It is strictly for bidden to heat resin for transfer into tins & drums and tins should not be left uncovered for any length of time as the turpentine evaporates and the quality of the resin deteriorates.

**Road transport**

It is a common practice with pack transport to take charge of a larger number of tins and drums, store them in their homes and then gradually transport them to rail head, or cart depot at their leisure. This practice is open to objection as tins remains in transit for months.

This practice is resorted to by the transport to ensure continuous work for their animals and by the resin guards to show quick dispatch. Depot Guards should therefore have instructions to hand over no more resin than can be carried by the animals available, to give over no more until the previous challan has been returned duly accepted.

**Penalty for delay in transport**

The difficulty mentioned above can be overcome by imposing graded scale of penalties for delay in transport in all carriage contracts.

**Transport**

Resin collected in the forest depots should not be stored for long. It should be transported forthwith to rail-head or tart depot or sale depot. Where drums are used speed in turnover is essential to economical working.

## SECTION 8- FIRE PROTECTION

Tapped areas are liable to fire, and if the resin channels are badly burnt the death of the trees frequently follows.

**Departmental burning of tapped areas**

Ordinarily most of the chir areas are prescribed under working plans for departmental winter burning. During this operation all highly inflammable material found in the area must be disposed of.

**Disposal of needles, chips and earth saturated with resin**

A certain, quantity of resin flows down the old channels and saturates the earth, needles and chips lying at the base of a tapped tree. During the winter departmental burning operations, this must be disposed of in. one of the following ways:

(a) The needles and chips are swept clear to a distance of 1 m to 2 m from the tapped trees and the saturated earth is dug up and burnt or otherwise destroyed.

(b) Refuse is burnt under supervision in situ to a distance of 1 m to 2 m round every tapped tree.

After all tapped traces have been thus dealt with the, area is burnt departmentally in accordance with standing orders. It is to be remembered that if the pine needles are partially wet the fire only travels on the top of the leaf layers leaving the lower layer unburnt or duly scorched. Burning should therefore, be done at a time when complete combustion and be insured.

**Summer Precautions**

During the tapping season the resin labourers must clear all needles, chips and inflammable material to a distance of 1 m all round tapped trees on the level and to 1m above and 2 m below on the sloping ground.

At the close of tapping operations in September and October it is necessary to see that the trees are left clean all round. If a Labourer is slack and does not carry out this work payments should be withheld until his areas are clean.

At the close of the working season the Resin Guard should certify on the bills for the Collection of resin that the trees had been left clean before the mazdoors are finally paid off.

## SECTION 9 – DUTIES OF STAFF

**Duties of Resin Guards**

(1) They will see that the size of pots brought is correct. For this purpose a specimen must be made over to the potter.

(2) At the time of setting up the crop they are responsible that the channels are properly cut to depth and shape, that the lip is properly fixed so that the resin trickles into the pot, that the pots do not contain dirt and chips, that the ground surrounding the tree is clean, and that it is so kept during the tapping season. They will go on the work at frequent intervals to see that all labourers are not tapping too deep and to instruct them in their duties. They are to replace all incompetent labourers who refuse or are incapable of learning their work.

(3) That the attendance of workmen is regular and that refreshening and collection is done systematically, and at the regular prescribed intervals.

(4) That all broken and unserviceable pots are replaced and that all pots are properly covered.

(5) That all persons employed in the forests are acquainted with their orders on the outbreak of fire.

(6) That all tapping adges are kept sharp and in good order.

(7) That all workmen are fully instructed in all their duties and made competent in the execution of their work.

**Duties of Range Officers and Assistants**

(1) To see that the tapping rules are strictly observed by all concerned

(2) That the Forest Guards and labourers carry out all duties assigned to them.

(3) During the months of April, May and June to examine depot stores and sort out personally all unserviceable tools and to have them examined by the Divisional Forest Officer.

(4) That all the registers are properly kept and entered daily; and that the stock register tallies with the stock in depot.

(5) That a reasonable reserve of pots is maintained for replacing broken ones, and that excessive breakages are brought to the notice of controlling officers.

(6) That the transport of resin to cart depots or rail head or sale depot is keeping pace with the outturn.

(7) Every range officer will inspect every tapping area and resin depot at least once every two months and will record his remarks in the inspection register.

**Duties of Divisional Forest Officer and Gazetted Assistants**

The Divisional Forest Officer will inspect each depot and the tapping areas attached thereto at least once during the season, and will see that all orders, regarding resin tapping are being properly carried out; he will inspect and check the depot books, see that the yield per 1,000 channels is up to the standard, that transport is not delayed and that all the resin tools are in good order. He will inspect unserviceable stores and have them destroyed in his presence. He will record the results of his inspection in the inspection book.

## SECTION 10 - RILL METHOD OF RESIN TAPPING

### Introduction

In most of the European and Asian countries where 'Lip and Cup' method was being practiced in the past, it has now been replaced by improved methods. In India the tapping technique has not under gone any change since its inception. Recently an improved method, commonly known as 'Rill method', has been evolved at Forest Research Institute. Its important features may be summarised as under:

(1) The guide provided in the freshening knife controls the depth of blazes to 2 mm in live bark and sapwood. This eliminates the damage to the heartwood.
(2) Fast healing up of shallow blazes will make it possible to tape the trees for a second cycle thereby increasing the tapping life of tree.
(3) The essential use of stimulant will facilitate a prolonged tapping season resulting in increased resin production and employment to the tappers for almost the whole year.
(4) About 25 per cent more yield of resin per tree per season.
(5) There being practically no crape resin, the loss of turpentine is negligible,

The important operations involved in rill method as described in the Forest Research Institute publication entitled, "Field Guide" to Modern Methods of Resin Tapping by V.P.S. Verma & others are reproduced below

### Tools

The following set of tools would be required for each labour engaged on resin tapping work

| S. No. | Particulars | Quantity/No. required |
|---|---|---|
| 1. | Bark shaver | 1 No. |
| 2. | Blaze frame | 1 No. |
| 3 | Spray bottle | 1 No. |
| 4. | Pot | According to the number of blazes worked by the labour. |
| 5. | Hammer cum nail puller | 1 No. |
| 6 | Pot Scraper cum groove cleaner | 1 No. |
| 7 | Groove cutter. | 1 No. |
| 8 | Lips | According to the number of blazes worked by the labour. |
| 9 | Freshening knife | 1 No. |
| 10. | Marking gauge (Kanghi) | 1 No. |
| 11. | Bullockshoe nails (2 cm long) | 1.25 kg. |
| 12. | Wire nails (5 cm long) | 1.00 Kg. |
| 13. | Collection can (Balti) | 1 No. |

**Maintenance of tools** - Proper freshening of the blaze requires a sharp blade of the freshening knife. The blade should be sharpened daily with the help of a sharpening stone. Sharpening should be done on the outer surface of the cutting edge with a final rubbing on the inside of the bend. Groove cutter should also be freshened before use.

**Protection of pots and lips against acid--** The low concentration of the acid mixture is not likely to corrode the pots and lips. However, as a further precaution against the corrosive action of the acids the pots should be coated with lacquer. Alternatively a thin layer of resin should be applied on the pot in the beginning of tapping season. Thereafter, the resin collected during the tapping operations will protect the pots and lips against the acid.

**Setting up during First Year**

**STEP 1** - **Shaving the bark** - With the help of the bark shaver remove the loose and rough bark over a surface area of about 45 cm x 30 cm leaving a space of about 15 cm from ground level. The surface should be made fairly smooth and the thickness of the bark left should not be more than 2 mm to facilitate freshening of the blaze. At this stage no crevices are left in bark and it is reddish in colour. To save labour costs it is preferable to remove the bark over the surface area to be covered in two years.

**STEP 2 - Marking the position of blaze & groove -** Put the blaze frame on the stem in the vertical position so that the lowest point of the frame is 15 cm above the ground level and mark the position of blaze with marking gauge. Also mark the position of the central groove with the help of the wooden board and marking gauge.

**STEP 3 - Cutting the central groove -** Cut the central groove with the help of the groove cutter, drawing the cutting tool from above downwards. During first year of lapping, when the blaze is very close to the ground level, it becomes necessary to cut the groove by moving the tool from down upwards. However, in subsequent years the groove may be cut from top of the blaze downwards.

**STEP 4 - Fixing the lip -** The lip should be fixed to the trees with two bullockshoe nails. Pound the lip properly so that it fits snugly against the tree. A 5 cm long wire nail should be driven into the tree about 2 cm below the, midpoint of the lip for hanging the collection pot on it. The nail should be driven at a slight angle so that the pot hangs snugly against the tree.

**STFP 5 – Freshening -** For freshening a blaze the tapper should stand near the tree on one side of the blaze and hold the freshening knife at the lowest point of the central groove. Then the knife should be pulled by the tapper along the blaze line marked on the tree. The same operation should be repeated on the other side of the groove. For second and subsequent freshening which are repeated at weekly interval the guide of the freshening knife should move touching the upper side of the previous rill. The rills should be parallel to each other and should neither extend beyond the limits of the blaze nor fall short of it. (Fig. 13.1 & 13.2). Similarly equal space should be left between consecutive rills.

Rills extending beyond blaze limit.

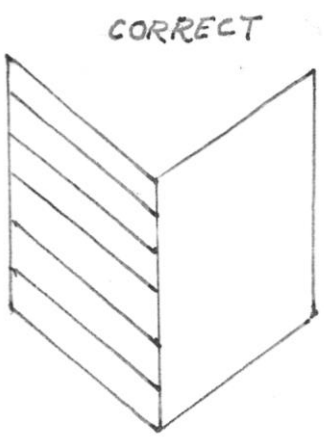



Fig 13-1

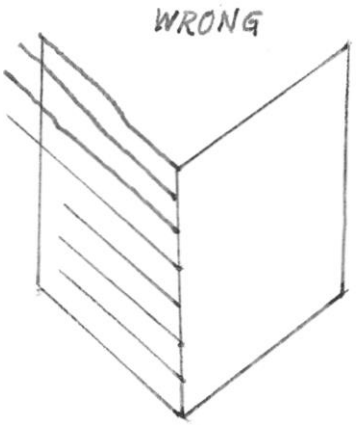



Fig 13-2

Rills falling short of blaze limit.

(Fig. 13.3 & 13.4). The average width of the bark left between consecutive rills is 5 mm and the average width of the rill is 6 to 7 mm. The blaze attains a height of 35 to 38 cm in one season of tapping. The depth of the rills is about 2 mm into the wood.

**STEP 6 - Treating the blaze with stimulant -** After making a freshening on both arms of the blaze, the chemical stimulant should be sprayed on the freshly cut rill by squeezing the plastic bottle and moving its nozzle in a steady motion along the rill. For obtaining good spray the plastic bottle should be held at 45 angle to the tree and its nozzle should be kept about 3 to 5 cm away from it. Enough acid should be sprayed on the rill. The acid should be discharged from the bottle in the form of a spray. Precaution should be taken to hang the pot on the nail only after the extra acid has run down the lip.

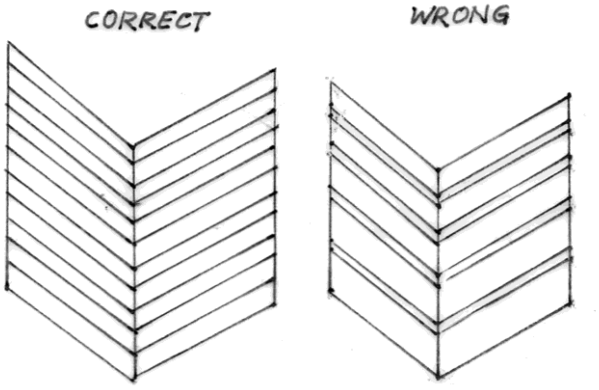



Fig. 13·3 Fig. 13-4

**Collection of Resin and Cleaning of Groove**

The pot should be removed from the tree and the resin should be poured into collection can (Balti). The resin still adhering to the pot should be removed with the help of the scraper. Central groove should also be cleaned with each collection with groove cleaner to avoid accumulation of resin in it. For improving labour output collection of resin from the pots should be done with alternate freshening in March, April and August to October. If necessary, the pots bigger size may be used. However, from May to July, collection may be done with each freshening.

**Cleaning of lips and Pots**

At the end of the tapping season the nails should be pulled out and lips removed. The lips and pots should be washed with warm water containing washing soda.

**Installation during Subsequent Years**

For installation during second year of tapping the position of the blaze is marked above the top of the, first year blaze and other operations of first year and repeated.

After tapping for two years the blaze reaches a height at which it is not possible to pull the freshening knife upwards. Hence during third year freshening is given by pushing the freshening knife upwards (from the central groove) towards the outer edge of the blaze.

Like this the blaze is extended upwards for four years. During fifth year it may be necessary to use a ladder particularly in the hills.

During sixth year of tapping a new blaze is made at the bottom of the, trees in the same manner as in first year, leaving 7.5 cm wide space along the girth of the tree from the edge of the first blaze as shown in Fig. 13-5.


Fig 13-5

During 20 years of tapping the average diameter of a tree of average quality will be 35 cm which will accommodate four blazes of 20 cm width as shown in Fig. I1.

**Resin Yield and Labour Productivity**

When Rill method was tried on experimental basis in New Forest, Dehra Dun, average yield of resin from 30 cm and above diameter trees was 3.211 kg/tree per season, i.e., March to October against 2.52 kg by, Cup Lip method. However, on practising this method on large scale (9,320 trees) the yield was 3,849 kg/blaze for the period of April to October. Continuation of tapping in November and December resulted in an additional yield of 0.447 kg/blaze giving a total of 4.296 kg/blaze per season.

The time studies based on figures of first year's commercial tapping at FRI, & Colleges, Dehra Dun have shown that a tapper can work on 650 trees working six days a week by Rill method. He has collected 12.85 kg. resin per day. The efficiency will however increase in subsequent years when he is well versed with operations of new method.

## SECTION 11 -- RESIN RECORDS, REGISTERS AND FORMS

**General Forms**

In order to organise resin work properly and to enable a permanent record of operations and their cost to be maintained the following forms will be maintained:

**Resin Form A** is shown in Appendix – I and its abstract already referred to in paragraph -23.

**Resin Form-B** showing the monthly account of resin operations range by range, each block or group of forests concerning one resin depot being entered separately for purposes of statistical record and check of costs. Combined abstract forms, A and B is suggested for adoption.

**Resin Form -C** which is a modified Form-7.

**Resin Form -D** on 15th March each year Divisional Forest Officers will send a report of resin operations for the past season to their territorial Conservators with explanatory notes explaining fluctuation in figures. The object of this form is to check costs and any tendency to uneconomical work.

All these forms are shown in Appendix I.

**Depot Forms**

The following forms will be maintained in Resin Depots:

(1) Register of daily collection (in current use).
(2) Form 5 showing daily receipts.
(3) Form 6 showing disposals.
(4) Inspection Register (Append x 1).
(5) Stock Register (in current use).

**Fortnightly Progress Report**

Fortnightly Progress Report (Appendix I) will be submitted by Range Officers to Divisional Forest Officers. They will show output for each depot separately comparing the same with the out-put per 1,000 blazes. If the output in any depot is low as compared with the other resin depots or as compared with the out-put of the previous year for the, same fortnight it means that the work of refreshening and collection is not being systematically carried out. Factors such as newly tapped areas usually wet and cold season responsible for such differences may be stated in the remarks column.

**APPENDIX I**
**RESIN FORM A**

Division
Range — Year of commencement of
Block — tapping or re-enumeration
Compartment (or sub compartment)

| Girth Class | Light tapping | | Heavy tapping | | Total | |
|---|---|---|---|---|---|---|
| | No. of trees | No. of blazes | No. of trees | No. of blazes | No. of trees | No. of blazes |
| 90 cm to 119 cm | | | | | | |
| 120 cm to 180 cm | | | | | | |
| Total | | | | | | |

**RESIN FORM B**

Range Monthly account of Crude Resin (net for 20_____20_____

| Name of Range | Locality and year of tapping | No. and class of trees | | Channels | Yield in Qtls. Per month (net) | | | Cost | Export to Actual weight at rail head (net) | | Balance in Forest at the end of month (net) | | Additional notes to be filled at the end of the year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ha. Tapped | | | | | | | | | | | |
| | | Class | No. | | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | | 8 | 9 | | 10 | | 11 |
| | | | | | Months | Qtls | Kg. | Rs. | Qtls | Kg. | Qtls | Kg. | Average yield per 1000 trees |
| | | I | | | March | | | | | | | | |
| | | II | | | April | | | | | | | | 1000 channels |
| | | III | | | May | | | | | | | | |
| | | IV | | | June | | | | | | | | Rate Paid for carriage to rail head per Qtls. |
| | | Ha | | | July | | | | | | | | |
| | | | | | August | | | | | | | | |
| | | | | | September | | | | | | | | |
| | | | | | October | | | | | | | | |
| | | | | | November | | | | | | | | |

**APPENDIX I – contd.**
**RESIN FORM C**

Forest Department, H.P. _____ Division.
Receipts and Issue of produce in depots during the month of _____20

| Name of Depot | Description of produce | On hand net | Received during the month, net | | | Disposed during the month | | Balance net |
|---|---|---|---|---|---|---|---|---|
| | | | When received | Quantity net | Total | How disposed off | Quantity net. | |
| | | | | | | | | |

NOTE:- This form can also be used for receipt and issue of resin materials on which a very careful check has to be kept.

Station_____ Officer-in-charge

Dated _____ _____Depot.

**RESIN FORM D**
**APPENDIX I – contd.**

1. Year
2. Division.
3. Hectares tapped
4. No. of trees tapped
5. Total blazes
6. Average per tree
7. Total resin obtained
8. Average per tree.
9. Average per 1,000 blazes.
10. Cost of labour's wages per maund net resin collected.
11. Cost of bonus to labour per maund net resin collected.
12. Cost of carriage of resin per maund net forest to rail head.
13. Cost of carriage resin per maund by rail to destination.
14. Total cost column 10 to 13
15. Total charges for setting up new crops in the year inclusive of pots.
16. Total charges for raising lips inclusive of pots.

17. Total cost of packing crude resin e.g. carriage and cost of tins, soldering, solder etc.
18. Total cost of tools, stores and plant supplied not included in columns 15-17
19. Total cost of permanent and temporary establishment or resin works and charges.

19 (a) Cost of establishment per 1,000 blazes.

20 Rent and other B charges not entered in Column 19.

21 Average per maund net of resin collected of costs given in Columns 15-20.

22 General remarks on climate and nature of season labour supply, etc. and information which may be used for striking a fair average- vide Column 21.

23 Grand total average cost of delivery of a maund net of resin at sale depot.

Note – As for Column 21.

| Name of resin Depot | Forest | | (Note 1) Estimated yield for the season | Labourer | | Last Balance | | | | During the Fortnightly | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of compartment | Blazes | | Number of labourer | Average attendance | Qts. | Kgs. | Grams. | Qtls | Kgs. | Grams |
| 1 | 2 | 3 | 4 | 5 | | 6 | | | | 7 | |
| | | | | | | | | | | | |

| Total up-to-date | | | (Note 2) –Fortnightly cost per Qtls | | Daily average collection of Resin per Labourer during the Forth nightly | | Average Fortnightly collection of resin per 0% blazes | |
|---|---|---|---|---|---|---|---|---|
| Qtls. | Kgs. | Grams | Current year | Previous year | Current year | Previous year | Current year | Previous year |
| | | | | | | | | |

Note (1) -Estimated yield shall be worked out from the number of blazes in the forest and average outturn per thousand blazes for the division, range, or locality as may be settled by Divisional Forest Officer.

Note (2)–Columns of cost need not be filled where collection is done on contract at fixed rate.

**APPENDIX I – contd.**

**COMBINED ABSTRACT FORM 'A' AND FORM B**

Depot Range Division

Years of commencement of tapping (when tapping first began

| Date | Name of Forest | Enumeration | | Light Tapping | | Heavy Tapping | | Total | | Year | Annual Alteration | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Girth | Class | Number of trees | Number of blazes | Number of trees | Number of blazes | Number of trees | Number of blazes | | Number of trees | Channel | Total to date |

| Year | Name of Forest | March | April | May | June | July | August | September | October | Total | Total cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Output cost | Output cost | Output cost | Output cost | Output cost | Output cost | Output cost | Output cost | | |

# CHAPTER XIV

## ROAD CONSTRUCTION

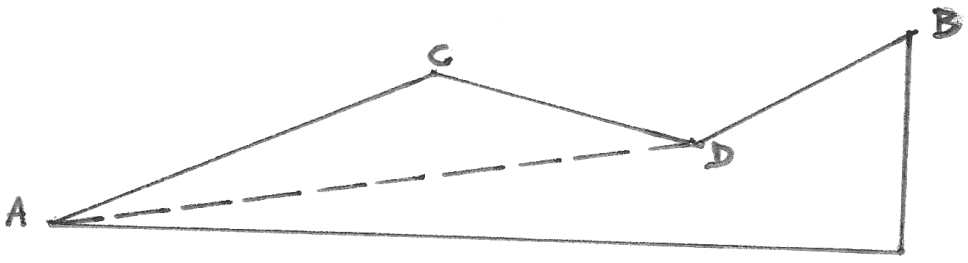
**Introduction**

Roads are essential for forest management. Inspection and contour paths, mule track & bridle paths, jeepable and truckable roads are constructed in forests to facilitate forest exploitation and inspection of forests. The ruling gradients available for all such construction should be the same as are prescribed by Indian Road Congress from time to time and should be obtained from the Public Works Department. It has been observed that forest roads in many cases ultimately are converted into truckable roads. The amount spent in the first instance can subsequently be utilised if due attention is paid to the grade, alignment and the strata.

Roads are made in order to facilitate the carriage of passengers and goods from place to place with the least expenditure of motive power consistent with economy of construction and maintenance. The traffic can pass easily over some gradients or longitudinal slopes, on the road, but is checked by others. Over a rough country the tracks made by the inhabitants for themselves and their cattle are as direct as possible, but they have to deviate from the straight line where they encounter ground which slopes at an angle steeper than men or cattle can negotiate. Also considerations of gradient compel a deviation from the direct route.

In the layout of a road two principal points must be considered (a) the line or direction in the horizontal plane and (b) its gradient or slope, i.e., its direction in the vertical plane. The first consideration in laying out a road connecting two points is that they should be joined by the shortest route, and if this does not involve too steep a gradient, a straight line between the two places, the road has to join, would be the best alignment of the road. In the hills however this is seldom possible as a straight road may need steep gradients or deep cuttings or high banks where valleys have to be traversed. So in hills it is generally better to go round a hill than straight over it, for in this way easier grades can be secured, but cases may arise in which it would be better to improve the gradients on a straight road by excavation as the main idea is to avoid too lengthy a road as well as to avoid over exertion of animal power. It is also inadvisable to carry a road into low lying land where high banks are necessary, if by a moderate deviation it can be run on to a ground where good gradient can be secured. As a matter of fact easy gradients are more important than a badly graded direct route, a fact which must always be borne in mind, but at the same time, excessive length must be avoided for if there is unnecessary increase in the length of the road, time will be wasted in travelling over it, and there will be unnecessary expenditure on its construction and maintenance. Within certain limits rise or ascent is more objectionable than extra length, since ascent reduces the carrying or tractive power of every pack or draught animal using the road. So much so that it is generally considered to be permissible to lengthen the road by 20 metres for every 2 metres of rise or ascent thereby avoided. This however, applies more to roads which are much used, generally it is best to make the track as short as possible, and consequently at the gradient permissible for that particular type of road. The ruling gradient of a road is steepest grade that occurs in it, since it rules the maximum load that vehicles or pack animals can carry along it i.e. animals drawing a load can traverse for short distances by exerting about double the energy that is needed to move on the same road on the level. This is called the ruling gradient, or the limiting gradient. For if a horse can draw a load of 1 tonne on the level, it can only draw 3/4 tonne up to a

gradient of 1 to 40, and only 1/2 tonne up to 1 in 25 and 1/4 tonne upto 1 in 10, so that on a road which has 15 kms of 1 in 30 and 1.6 kms of 1 in 10, the maximum load that one horse vehicle will be able to take along that road will be 1/4 tonne and no more i.e. the maximum load being fixed by the maximum or ruling grade of the road viz. 1 in 10 in this case. It therefore, follows that it is useless to lay out a road for a greater part of its length at an easy gradient if a steep gradient has necessarily to be used for a portion of its length. It is better in such cases, if possible to lay it out at one uniform slope (between the two gradients) for its whole length. For instance in the above case the road with 15 kms at 1 in 30 and 1.5 km in I in 10 might be laid out for the whole 16.5 kms at a uniform gradient of 1 in 25 (the total rise would be the same in either case), and 1 in 25 being ruling gradient now instead of 1 in 10 every one horse vehicle using the road could take ½ tonne in place of 1/4 tonne previously; an obvious advantage as the capacity of the road is at once doubled. In laying out a line of a road in the hills there are three cases, which may have to be treated. First, two places to be connected may be situated in a valley and on the same side of it, that is, they are not separated from each by the main stream, which drains the valley. This is the simplest case. Secondly, though both points are in the same valley, the two places may be on the opposite sides of the valley, being separated by the main river. Thirdly they may be situated in different valleys, separated by an intervening ridge of ground more or less elevated. In laying out an extensive line of road it frequently happens that all these cases have to be dealt with and each will have to be treated on its merits for the numerous and diverse circumstances met within the construction of roads are such that no definite rules can be laid down to embrace all cases. The main idea should, therefore, be to avoid any unnecessary rise and it is a very bad fault for a road that must ascent from A to B to descent even for a short distance between A and B thereby adding a rise to be negotiated (Diagram).




The fault of switch back grading is a very common one in village hill tracks, which descend into almost every nallah they cross, only to ascend again on the other side. It should be a general rule that a road ascending from one point to another should usually not descend even for a short distance between these two points. This however cannot always be done owing to the great increase in length, which would take place, when the points to be connected may be situated in different valleys. So if the road, when laid out at an even grade between two such points as A and B is found to be obstructed by cliffs, etc. which it is desirable to avoid, rather than descend from C to D in order to do so, it would be better to layout the road at a slightly easier grade from A to D so as to pass under or above the cliffs at D and then to make it a slightly steeper gradient from D to B, the road would thus ascend the whole of the way. Switch back grading shows bad work by the person who lays out the road. However, consideration will show that the choice of a road alignment while depending on

principles stated above requires judgment and the exercise of much common sense. In level country there are not, as a rule, many alternative routes between two points, but in hilly country there may be several. One line may give good gradients but may prove to be too long, another may be more direct but may have to descend after a long ascent. The main object should, therefore, be to eliminate the superfluous rise and yet to secure as direct a route as possible without great cost.

The gradient on those portions of a road which have to pass through solid rocks on the face of a vertical precipice will ordinarily be level or as near level as possible. On sharp bends and at turns at zig zags the gradient will be as level as practicable.

It sometimes can be foreseen at the time of alignment that an inspection path will subsequently be converted into a bridle path, or a bridle path converted into a cart road. In such cases an inspection path will be aligned through with a gradient suitable for a bridle path while a bridle path that will probably be converted at some later date into a cart road will be aligned on the gradient for a cart road.

In order to localise out breaks of fires in forests it is necessary to sub divide forests by means of contour paths about a third or below the lower or upper boundaries with connecting links down prominent spurs.

These contour paths will serve to localise out breaks of fires, and to enable labour gangs quickly to reach the sites of fires, they will also serve as inspection paths. The width of these contour paths should be 1 metre except on very rocky surfaces where it may be reduced to 60 cm.

The maximum of ruling grade is settled before a road is made to suit the traffic that will use it. The orders for making the road should always specify the ruling gradient and the clear width, besides any other important points that may be required.

The maximum (steepest) gradients that should be used for tracks in hills are as follows:

| | |
|---|---|
| Inspection paths | 1 in 4 |
| Bridle path | 1 in 8 |
| Mule road | 1 in 10 |

For a horse it has been found that on a gradient of 1 in 44, it can drag ¾th the weight on a level ground, in case of 1 in 24, it is half and in case of 1 in 10, it is ¼th of the weight on level ground.

The minimum width of the roads and paths in the clear should be:

| | |
|---|---|
| For mazdoors | 1 m |
| For riding or pack mules (unimportant tracks) | 1.50 m |
| For pack mules or ponies (unimportant tracks) | 2 m |
| For pack mules or ponies at passing places For mules and bullock carts | 3.50m<br>5 m |
| For a jeep/car | 4 m |
| For a truck/buses | 5 m |

Where possible fields and cultivated land should be avoided.

**STANDARD CAMBERS**

| Road surface | Recommended Camber | Remarks |
|---|---|---|
| Timber (Conduvoy Road) | 1 m 20 Road) | Animals, cart and vehicles tend to slip, if this is exceeded. |
| Earth Roads | 1 in 16 to 1 in 24 | Depending on nature of soil. |
| Gravel or water | 1 in 36 | |
| Tar or Bituminous Macadom | 1 in 48 to 1 in 60 | |
| Concrete | 1 in 72 | |

On curves, camber should be changed to super elevation on the roadway on the outer side of the curve. This is to balance the centrifugal force of the vehicle.

The rule is super elevation per 30 cm of width on curves of 100 m or less, radius. Super elevation of 12 mm per 30 cm of width on curves of 100m to 300m radius. A common tangent of 70m to be kept between a curve and a reverse curve for allowing super elevation to be changed from one side to the other. Curve on hill roads or paths should be generally laid out by the eye alone or by simple curves. Not less than 15 m radius is desirable for smooth traction. Curve shall be widened preferably on the inside to allow traffic to flow smoothly. No widening of curves is required for a radius of 300 m or more.

**Contours and Gradients**

A good map is of great help in the choice of the preliminary Line of a road and if the map is a contoured one a good deal of work in the field will be saved. Contours are lines of equal altitude and represent imaginary lines running round a hill or a valley or a lake at the same level all the way at certain height above a known fixed point termed the datum, these heights being indicated by the figures written on the lines. The vertical intervals between the consecutive contours are equal.

The horizontal distance apart of the lines representing them depends on the slope of the ground. When the lines are far apart the slopes they represent are easy when they are close together they represent steep slopes. Contour lines by their greater or smaller distance apart on a drawing have the effect of shading and show at a glance ridges, spurs, drainage lines, steep, slopes and easy slopes. The heights of points on the drawing can be calculated by counting the number of contour lines from any convenient level when the contour heights are not at all marked in figures on the plan. The difference in level between two places is found by multiplying the number of intervening contours by the vertical height between contours. A rough trace of a road at any gradient can be marked out rapidly on a contoured plan. For instance, if the contours are at 5 m interval and the gradient is 1 in 30 or 5 in 150 it is necessary only to separate the points of a divider to a distance apart representing 150 m, on the scale of the drawing to place one point of the divider on a contour line, and the other on an adjacent contour line and a trace of 1 in 30 is indicated. If it is necessary to ease the grade, this can be done by scaling off more than 150 m on the dividers. In dealing with contoured maps it is necessary to understand the use of a scale of slopes. Gradients may be, expressed by the difference of level which occurs in a certain horizontal length compared with that horizontal length, as for example 1 in 20 or 5 per cent, or the slope may be expressed in degrees of elevation above a horizontal plane. A slope of 1 represents a rise of one metre vertically in a horizontal distance of

17.2 metres and so, for 2, 3, 4, 5 and 6 the distances are 8.60 m, 5.75 m 4.30 m and 3.40 m, 2.90 m respectively. For all practical purposes of rough calculations:

| | | |
|---|---|---|
| 1° | is equivalent to a slope of | 1 in 60. |
| 2°. | do | 1 in 30 |
| 3° | do | 1 in 20 |
| 4° | do | 1 in 15 |
| 5° | do | 1 in 12 |
| 6° | do | 1 in 10 |
| | and so on. | |

From a contoured plan a longitudinal section can easily be drawn along any given line on the plan by noting where the given line cuts the contour lines and setting up ordinates at these points on which the heights of the points can be marked and connected by lines which will represent the surface of the ground. Roads in plains should not be quite level and they are made as far as possible with a minimum longitudinal slope for purposes of good drainage. The slope should be between 1 in 80 to 1 in 125 while it is easy to secure a minimum gradient on undulating contour or in country that has a natural uniform slope in their direction of the road greater than the fixed minimum gradient. Case may arise where the slope of the country in the direction of road is less than the grade of 1 in 125 indicated above it would, therefore, be necessary in such cases, in order to secure a minimum gradients of 1 in 125 to make series of alternate slopes or reverse gradients. In these cases the minimum slope cannot well be worked out. The adoption of a Minimum grade in flat country such as we plains of India is not always practicable, but at, the same time long stretches of flat road should be avoided especially in cuttings, for, while an approximately level road, does not seriously affect traction, an accurately level road is either not properly drained or has in towns, gutters and side drains which require to be made to slope to inconvenient depth below ground. Sight gradients maintain a better road surface than does a dead level a result, which is generally to be attributed to the better drainage on the incline. Moreover on level roads the consumption of materials for repairs compared with that of a similar length of road on a slight incline and subject to the same amount of traffic is some 15 to 25 percent greater in the former case than in the later. The cross slope of a road from the centre to the edge is intended to assist drainage but as the road surface tends to wear into longitudinal ruts or tracks which interfere with this drainage water lies on the surface where, it is on a dead level longitudinally and damage results. Whether alternative slopes of slight gradient are less fatiguing to horses than a dead level is a matter on which opinions differ, but it is accepted that an approximately level road does not affect traction appreciably and drains better and costs less to maintain than truly level roads. Steep gradients on the other hand, affect traction greatly, and the question of maximum gradients is of great importance. This question is closely connected with the character of the road its alignment and the sort of traffic that preponderates in the particular district under consideration. Although a ruling gradient may be laid down as per above instruct for a road in a flat country one may be able to choose a cheap and short line and yet may not be obliged to adopt gradients nearly as steep as the ruling gradient except in special places such as for example as some bridge approaches. Formation level to be kept 1.2 m above water level. For earth roads keep the formation at least 30 cm above H.F.L.

**Hill Roads**

Before deciding on the alignment of a road in the hills the Range Officer should get a good contoured map and study it carefully, and see if he can mark on it the general alignment he would select, assuming that there is nothing in the geological

features to prevent the adoption of this line. He should then go over the ground to see whether the line could be followed. He should be accompanied by a subordinated whose usefulness will be great if he has a good eye for country and, has previously been employed on work in the hills. Together they should study the locality, examine the suggested alignment, see if it leads them into difficult situations, try alternative alignments if it does, and fix an obligatory points which the road or path must pass through. No map can make up for personal knowledge and the more thoroughly the reconnaissance is made the better will be the final survey and the alignment. Sometimes the first reconnaissance has to be made in new country to ascertain the relative heights of the hills that the road must cross. Geological features should be carefully noted, existing and old established lines should not be hastily abandoned, the question of water supply should also be examined and if the alignment chosen appears possible, the Range Officer should proceed to mark it out on the ground.

In aligning a hill road, width of which is completely in cutting, the trace of alignment is out of road thus length of centre line of road will be smaller length than outer side i.e. outer curved length is longer than centre curve length. In laying out a hill road as far as possible the height gained should not be lost. We must note that in hill the road should never rise or fall unnecessarily. It should be taken round either below the obstacle or above the obstacle without exceeding the maximum gradient. The gradient must be made as generally uniform and as low as possible, Zigzags need to be avoided. The sunny side of a valley or, the side which is exposed to drying wind must be chosen for road position whenever practicable. Gradients of road should be most carefully maintained and the maximum gradient should never be exceeded. Moreover long stretches of same gradient should be avoided. Land-slide areas need to be avoided. A hill road should not be taken all the way round a ravine, which runs for into the hill side but descend the road line till ravine is crossed and then ascend to the level desired.

**Instruments**

The De Lisle Level or clinometer, is much the best on the whole, especially for rapid work in rough ground. Abney's level is perhaps the best instrument for both surveying, and road work. Clinometers may be divided into two classes (a) those which depend on the spirit level, i.e. the Abney's level and (b) those. which utilise the principle of the plumbob such as De Lisle Level and Watkins Clinometer Generally speaking class (a) is more accurate and class (b) less liable to breakage, and better for road work. A simple, road tracer, which can be made by a carpenter, can also serve the purpose.

**Methods of laying out the line of a road in plains**

The particular instrument to be used having been chosen, and tested to see if it is correct, the following will be found the best, quickest and the simplest way of marking out the line of hill roads on the ground. This system has the advantage that both the line of the road as regards direction and its gradient and therefore its level at every point of is length are both given by a single operation and by the means of one line . In this method the line marked out is not the centre line of the road, but the outer edge i.e. the, line where the road cuts the surface of the hill side. The observer and 6 men are required for this work.

It will be, convenient to use a sight rod with a sight vane. This consists of straight light rod or bamboo, with a crosspiece nailed on it at the height of the observer`s eye), especially for bushy or jungle country where it is often difficult to see a man when taking a long shot. The best form of sight rod is about 2 in long by 3 cm square; the sight vane being a piece of board about 30 cm x 23 cm which slides up

and down the rod and can be clamped at any convenient height, so as to suit the observer (the 30 cm. side of the board being horizontal); the board is painted black with a 5 cm wide white line horizontally across its centre; for use, the board is clamped so that the top edge of the white line is at the height of the observer`s eye. It is well to have two sight vanes and rods for quick work. There should be two men with each sight rod. In addition it is necessary to have a couple of men carrying white wash as the marks, when whitened can very easily be picked up afterwards when working parties are strung out on the work. In bushy country 2 to 4 men or more will be required to clear the line of sight.

Opinions differ whether the work of aligning the roads should be started up hill or downhill. Some are of that opinion that the work should be started up hill, especially if the country has not been gone over before as the nature of the ground can then be seen in front and any precipice or bad ground better avoided than when working downhill. But others incline to the view that the work should begin from an obligatory point on the top of a hill, e.g., a pass through which the road must go and work down the spur which had been selected after the first reconnaissance, putting in pegs at 30 in apart, or 20 m apart, or at a smaller intervals according to the configuration of the ground and connecting them by a daghbel, i.e. a furrow (narrow trench) in the ground. The reason in this case for starting work at the top of a hill is that the ground gets easier as the lower slopes are reached and diversions and deviations can be made to enable the road to reach any point in the valley, while these could not be made with ease if the observer worked upwards towards the pass. The chances in working up are that the road would be either too high or too low for the pass. In the former case the grade could be eased which would increase the length to some extent but in the latter case it would be necessary to make a zigzag. It is not always necessary to look for a pass as an obligatory point; for very often a hill can be turned and the road may be able to go round it without being any longer than the road that would go over it, thus saving rise and fall, and even if it is somewhat longer, the alignment round the hill may be better than the other, assuming always that both roads are equally suitable in other respects, viz. which has the best shade, which passes a forest or village that must be near the road, which has the best water supply, which is easier to maintain. These are questions for consideration. Others will be suggested by the circumstances of each case, but they will not affect the main fact that the survey should start from the highest point chosen and worked downwards.

The observer should, as he proceeds, collect information as to the soil and the, slope of the hill side, at each station, and on the correctness of the information he gathers will depend the correctness of the estimate subsequently made. He should judge how much of the road width will be cut of the hill side and how much will be in bank, for it may not be necessary to cut the full width except in a few places. He should note where retaining walls are needed and where, the soil needs breast wall.

**Methods of laying out the line of a road in hills**

The Range Officer, if he can do so, get a subordinate, who has an eye for country and with him he should make a preliminary reconnaissance of the ground to be traversed. The oftener he can go over it, the better perhaps his other duties will prevent more than one or two visits, but he should do his best. During his reconnaissance he should, make as full notes as possible of every matter that may have a useful bearing on the project. If a good map is available he should mark on it points through which the road, must pass as, for example, a part of a river suitable for a bridge or that the road should, if possible avoid, such as valuable trees, and he should select one or more trial lines from which the final route will be chosen. He should then make a survey embracing the selected trial line and should record in his

field book full details of existing roads, railway lines, canals, irrigation channels that come across the selected trial line. He should locate prominent points by compass bearing where they are too far to be measured by offsets. He should also ascertain the low water level and the high flood level of all streams or flooded land, the drainage area of streams, the slope of their beds and the nature of the soil. While doing so care should be taken to place the bridge at right angle to the direction of the stream, etc. when in flood, even if the road has to come on the bridge by a double curve in fixing the alignment of the road he should take care not to introduce sharp curves into any part of it. The alignment should be marked at intervals by masonry pillars. Where, the final direction of the, road can be fixed upon in the field, or from existing maps, the traverse line of the survey may follow the centre of the road.

The observer stands where the road begins to ascend or descend the hill facing the direction the road has to take. He adjusts the instrument to the gradient which he means to use and clamps the index vane to it. Having adjusted the sight vane to the height of his eye he sends two men with the vane along the bill to a convenient spot where they are visible to him, this will generally be at a spur, re-entrants or nullah. One man rests the sight vane on the ground facing the observer, who looks through the instrument and directs the man to move up or down the hill until he, sees the horizontal line on the sight vane is opposite the reflection of his own eye in the mirror, he then signals to the sight vane holder who marks the spot where his rod rests on the ground, the second man with him drive in the peg firmly to mark it permanently, or make a heap of stories on the spot. The ground where the sight vane rests and the ground under the observer`s feet now have the required gradient between them (See Fig. 14 1). The ground in between should be approximately a straight slope as between A and B where A is the observer and B the sight vane; if there is a hollow or re-entrant in the ground between A & B (such as C between B and D), the sight vane must be sent to that spot first and B afterwards, as the road will almost certainly be made too low at the re-entrant unless the working parties have a mark placed there to guide them.

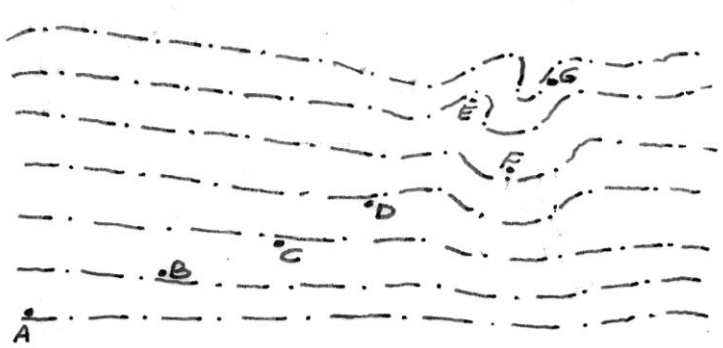



Fig. 14 -1

A mark must always be fixed at every nullah or re-entrant or hollow however slight, and every spur. Nullahs are especially important, as if no mark is given in a nullah, the road will of a certainly be made descending into the nullah slightly and ascending to the next spur on the other side. If there is a pronounced nullah running into the hill as E the further spur F must be fixed from E in the nuhhah and not from D, as the straight line DF would give a wrong gradient. It is most important the spots on the ground determined by the instrument area so marked that they cannot be

shifted or lost, these are the only marks to guide the working parties afterwards; a peg driven 30 cm into the ground with 15 cm sticking up is the best, it is as well to heap stones or earth round it on which to sprinkle the white, wash. The point B being marked, and the ground on which the observer stands similarly marked, the two men with the sight vane are sent to the next convenient spot C, and the observer still standing at A directs the sight vane holder as before, until the sight vane as in the line of the sight of the instrument and appears level with the observer's eye reflected in the mirror, then the point C is similarly marked. This process is repeated till either the sight vane has got too far forward for the observer to see it distinctly or a spur, etc., prevents him seeing it, or a nullah comes, between. For example E is probably invisible from A; and F must be fixed from E and not front D owing to the nullah between D and E; when, this happens the observer walks along the line to the last place D, where he has fixed a point, and standing at D behind the peg, he stands on the sight vane to any convenient spot E and fixed F, from D just in the same way as he fixed B, etc. from A. He then puts on as many more pegs from D as he can (only one here on account of the nullah at E), and then moves forward again and stands at E, the last point he has fixed from D, and so he continues until the whole line is pegged out. The white wash party follows up and white wash the stone placed round the pegs. If on arriving at any point the observers sees that the road must go below a certain rock, or cliff, lie must look through the instrument at the bottom of the rock or cliff and if his line of sight cuts above this point, he must evidently lay out the road at a latter grade till he has passed the rock ; so he must, therefore, alter the index arm to the flatter gradient required and go on laying out the points as before until he has passed the rock or cliff, when the former gradient is resumed. The second sight vane and man come in useful to send on ahead in such places to make trial shorts, or sometimes owing to such obstacles, found that the previous 4 or 5 points may have to be altered a little lower down the hill so as to get below an obstacle the second sight vane can be sent back to re- align these marks, thus saving time.

The line of the proposed road must now be marked out with pegs at convenient intervals, i.e. up straight slopes not further apart than 50 metre or so, also in every important hollow or re-entrant and on every spur. The top of the ground at these points (and not the top of the pegs or heaps of stones) is the level of the road bed at these points and the marks thus show both gradient and direction of the road. The pegs may be taken as the centre of the road or the outer edge. On very precipitous hill sides thee pegs must be taken as the outer edge, and on flat country as the centre. In order to facilitate estimating pegs or stakes 45 cm long will mark every 30 metre length and stakes one metre long will mark every 300 metres length. On the completion of the whole of the alignment, the surface of the ground will be spit locked or dagbeled from stake to stake.

When the men of the working Party are put on to the work, they must be shown the marks thus fixed and told that the TOP OF THE GROUND ITSELF AT THE PEGS (or under the stone heaps) is the level of the road bed, i.e. that the road must be cut inside the marks into the hill and that the outer edge must coincide in level with the top of the ground at the marks. The final level of the road must be made by boning which must be undertaken by the officer in charge who is also responsible for seeing that only the proper width is executed. It must be particularly impressed on all concerned that the marks must be left until the road is completed: if this is not done the, road becomes an up and down affairs which cannot be restored to its proper grade afterwards ; and without the pegs it is impossible to check who is at fault and the quantity of work done.

If possible, before starting get on a hill opposite the one on which the road is to be constructed and study it with field glasses if available. It is then possible to see which line will probably be best; where ravines, cliffs, etc., must be crossed and what places must be avoided, and how to do so whether by going above or below. Any such, points and also passes or cols where the road must necessary go are called Ruling points. Then lay out the line as already described beginning at the bottom and working uphill if possible as in this case it is easier to see bad ground in time, and avoid, than when working down from the top. Rocky ground must be avoided wherever possible, especially cliffs the ground must be blasted out.

Whenever possible, Zigzags should be avoided; but they are very useful sometimes and do not matter for narrow tracks, especially if each return is long.

As a rule a road must be laid out with the Clinometer fixed at the steepest gradient allowed for that class of road, unless it is certain that the hill top can be reached with an easier one. It is a safe plan to begin with a ruling gradient from the very beginning only easing it where absolutely necessary to pass under obstacles. Where the hill is very steep and high, and the top will only be reached by keeping the maximum possible gradient all the way the shorts taken with the instrument when laying out Must be kept short so as to follow the curves of the ground closely, and long shots from spur to spur must be avoided.

**General Orders on road construction**

In the preceding instructions to the alignment of roads the, minimum width of road and path beds are given; in a road round a hill the cross section should have slope inclining inwards, with a ditch on the inside: this is to prevent the road being washed away at its edge (which often has to be built up) and to avoid the danger, especially in turning a corner, of the passenger falling over the precipice. So if drain is to be made along the inside the width must be increased from 30 cm to 60 cm to give room for the drainage water, flowing from the hill above is also intercepted by the ditch on the inside, which has cross-drains at intervals leading under the road way to the face of the cliff. It is very important for roads 1, 20 meter wide (riding and loading mules, etc.), to see that the width, is nowhere less than the width laid down, and that no stones, or roots etc. are left sticking out of the bank on the side which may catch in the loads used by mules and camels especially, all sharp stones must be removed from the road bed. On the whole on the narrow type of roads it is better to omit the drain and give the road bed a slight slope outwards making the outer edge 2 cm lower than the inner. The advantage of this method is to save the excavation of the extra width of the inside drain. The disadvantage of providing the inside drain is that when the slightest fall of earth slips from the hill face on to the inside of the road, it frequently chokes the drain, and the whole of the water in the drain floods across the road, often cutting it very deeply. If in any case the road is made with a side drain the water in the drain must be carried across the road at frequent intervals by cross drains, Irish bridges or culverts etc. so as to empty ,the water down the hill ; there must be a cross drain atleast every 50 metre. The road surface must slope in towards the side drain at a slope, of 1 in 20 if, the road is 5 meter wide and over, it must be barrel shaped, The best places for cross drains are at spurs, and not in small re-entrants, because at spurs there is , more natural hard ground below the edge of the road for, the, water to wash away before it can cut away, the road the slope of the natural ground will be more gentle also; while at a hollow or re-entrant the ground will usually be at a much steeper slope than on a spur. Where a nullah crosses the road, there must necessarily be a culvert or Irish bridge, so that the side drain can run into the nullah itself at such places above the culverts. Where there are zig zags,

the side drains must be run out on the natural ground slope at the ends of the straights; if the straights are long more than 60 metre, cross drains must be added between the turn.

The side drain must be made straight, or in large, radius curves and with no sharp turns in it. No roots or stones should be left in it nor should it be taken round any stones or roots, such stone must be removed by blasting if necessary. The drain need not follow the exact foot of the inside or hill face of the road; very often in rocky places, the road may be wider than necessary for a few meters the side drain can be cut straight across such a place. Provided the full, width exists between the drain and the road. The side drain must be made 8 cm to 15 cm deep and from 25 cm to 60 cm wide. The cross drains, if, open, most be paved with stones about 4 to 15 cm below the level of the r6ad, the sides must slope gently, down to the centre. Where nullahs cross the road Irish bridges must be constructed. There are depressions lined with paving stones made in the road to a depth of about 30 cm depending on the size of the nullah. The paving must be from 1 to 4 metres wide. On all such bridges it is advisable to construct a drop wall on the downstream side, the wall first being made of dry stones and the paving then added the wall prevents the paving being washed away.

If covered cross drains are required, provided that plenty of large stones are available, very good ones can be made in dry, stones without, mortar up to spans of one metre or so, by giving a joint of 15 to 20 cm; these are fit for light carts. These drains must always have a paved floor carried out well beyond the edge of road also a drop wall on the downstream side of the road must be provided. Sometime a catch water drain is also constructed on hill slope considerable above the road, to intercept the drainage and lead it to ravines and water courses.

When however, a road is carried through forests, the ordinary barrelled surface of, road may be adopted, with small cuts from the outer drain at every 10 to 12 metres as the thick, vegetation softens the rainfall and prevents the hill side being Carried away by the drainage but on hill sides which are bare such a section would be unsuitable and a slope inwards should be given more or less pronounced according to the steepness of the side slope of the hill and to the nature of the soil.

Some do not share the views of providing inward slope to a hill road with a ditch on the inside. They consider the best section for a hill cart road to be one that has the entire slope outwards with no inside drain. As a matter of fact outward slope can well suit bridle paths the cost of maintenance of which is trifling. Where the rainfall is excessive and the soil is very bad a hill bridle path with an entirely outward slope and no inside drain is more easily and more economically maintained than with a section of inward slope with inside drain. A side drain may be necessary in places to lead away a spring from a soft part of the road, etc. but these are the only exceptions, which pertain to the general engineering of the road. A slope entirely outwards is especially unsuitable where the sides are liable to slip. The inside drain is also contrary to one of the first principles of hill engineering, which is that if there is a smallest slip of a few buckets full of earth or even the collection of a few leaves which allow the, silt to accumulate will choke the inside drain, when the accumulated water will of course down the road, causing much injury to the surface, and discharge itself over the edge in a strong stream, of course often at a weak place, will cut away the, bank and destroy the retaining wall. So water should not be allowed to accumulate where inside drains are provided. As a matter of fact maintenance gangs, invariably seek shelter during a heavy rain fall and it is during the actual falling of the rain that

the chief damage is done to a road. Ten minutes after the rain has stopped the side drains are practically dry .The best arrangements, therefore, are required to be made, where there are drains, inside, to see that the road is kept properly drained during heavy snowfall. The outside slope is not even inconvenient for cart traffic. Any danger, that may be anticipated from the centrifugal force, at salient angles could not affect a vehicle untill it was on the outside half of the road; and it would be immaterial whether the other (inner half) bad a slope upwards or downwards. As a matter of fact tonga drivers prefer, outward slope as they have only to look out for danger on one side whereas on the section of a road with inward slope they have also to take care to avoid the inside drain. An outside slope of 1 in 20 has been found, to be the most suitable, When a road is made with an outside slope the, following precautions have to be borne in mind for its proper maintenance, etc.

(i) The outlet at 'A' in the Fig. 14.2 below should be low enough to discharge the road drainage freely. This is often blocked by:

(a) The road wearing down in the centre.

(b) When slips are cleared away a lot of the spoil, is left at the outlet and thus a bank is formed at A (shown in dotted line) which obstructs the free flow of the road drainage.

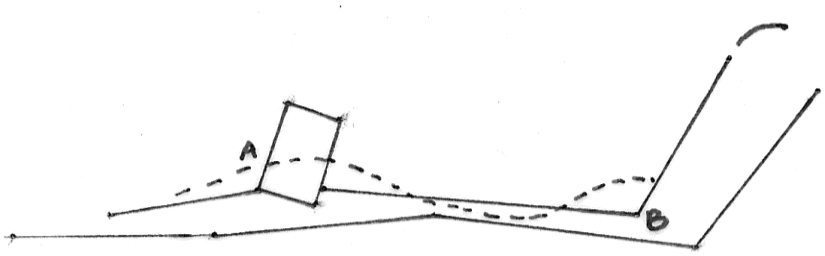



Fig 14-2

The earth from slips should be cleared clean away to the full width of the road, and not left banked up against the side of the hill at B, as the width of the road is thereby reduced.

When these precautions are not observed the road may assume the section shown by dotted line, when the centre of the road would become a water-course and by thereby destroyed. The outlet A mentioned above refer to the one metre intervals left in the parapet walls to pass the surface drainage. The parapet walls are usually built in lengths of 3 metres with one metre intervals. By this arrangement 3/13th of the parapet walling is saved, whilst they equally serve as outside fence, or the parapets may be built in 2.50 metres lengths with 60 cm openings.

Another advantage of the outside slope is that the road is widened by 60 cm required for the inside drain or the width of the cutting may be reduced 60 cm in the first construction. As this is the inside 60 cm where the heaviest digging is required, the saving in the first construction would be great. Should the soil be strong and the rainfall moderate there is no objection, except so far as the great increase of cost is concerned, to making the road with inside drain but with an excessive rainfall or in

bad soil liable to slip or be washed away there is no question but that from an engineering point of view, the outward slope should be adopted.

In view of the above before taking the work in hand, Range Officers should obtain orders from Divisional Forest Officers on this point whether the road or path should be constructed with inward slope and a drain inside or with outward slope and no drain. The Divisional Officer will decide in the following manner:

> Should the soil be strong and the rainfall moderate, there is no objection (except so far as the great increase of cost is concerned) to making the road with inward slope and an inside drain. But with an excessive rainfall or in bad soil liable to slip or to be washed away, the outward slope should be adopted.

**Retaining Walls**

Walls built of stone or brick masonry concrete or of a combination of any, of these for the, purpose of holding up water, are called dams. But when such walls are built to support earth and to prevent it from sliding, they are called retaining or revetment walls. Breast wall is a kind of revetment wall erected to protect the exposed surface of cutting from the deteriorating effects of the weather. Retaining Walls are built with or without mortar.

In the Forest Department they are usually built of dry stones which are most useful (logs and sawn timber can be used when creosoted); they can be built very quickly by men accustomed to the work. In rocky places, or narrow awkward nullahs where the ground is steep their use enable blasting to be avoided, and in Steep portions the road in place of having to be cut in the hill, can be carried outside the hill, surface with a minimum of excavation. Blasting whenever possible must be avoided as it takes a long time, much labour and is expensive. Dry stone retaining walls require great care in their construction as their stability entirely depends on the accuracy, with which the stones are laid and on the correctness of the bond. Unless the workmen are carefully watched they may make a good face while the filling and the backing may be laid carelessly and with unsuitable material. For such reasons it is a good plan to collect all the material required before the work commences, and not to all the earth filling at the back to be put in till every metre of the work has been passed by the Range Officer.

The masonry in a dry stone wall consists of courses of roughly dressed large stones laid as alternate headers and stretchers with filling places as shown in the Fig. 14.3 Headers are marked H, stretchers S, and filling pieces F.

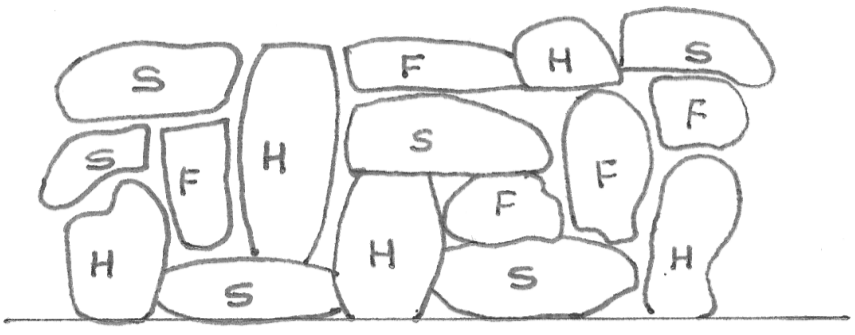



Fig 14-3

Before a retaining wall is built it is of the utmost importance that the foundations are correctly dug. The excavation must be level longitudinally, and in steep ground they must be stepped down horizontally, the foundations must slope inwards at 1 in 6 to I in 4, at right angles to the outer face of the wall. For dry stone walls the top must be 75 cm for walls up to 3 metres height and 120 cm. thick for those over 3 metres high. The foundations must be taken down to solid material, safe from scour, frost, and surface water. Solid rock may be cut level but it is advisable to slope it towards the filling. Foundations must be at least 30 cm plus 1/10th of the height of the wall below ground. In high dry walls a bond of stone in line should be given at intervals varying with the quality of the stone. A normal method is to give 30 cm bed for every 2 meters in walls over 4 meters high.

Great care should be taken to see that there should be plenty of weep holes in the wall and the weepers are built right through the wall. As the weepers interfere with the banding, the mason, if not looked after, will blind weepers about 30 cm deep from the outside and these cannot be rectified later on without pulling down the entire wall. A good precaution, therefore, in building such walls is to see that every weeper has been left in it a stick of the, full thickness of the wall. When the Range Officer inspects the completed work, he pulls out the stick and tests the lengths of the weep holes.

(For details of construction of dry stone masonry walls see technical order on construction and repairs of buildings).

(For Details for blasting see technical orders on explosives).

**Control of expenditure on daily labour.**

It is essential that the work should be completed within the sanctioned estimate which involve the preparation of accurate estimates and careful supervision of the labour employed.

In order to control the expenditure, the officer in-charge of the construction of the road will maintain a record showing the sum sanctioned in the estimates for each section of the read, (which should not exceed 30 meters), and the expenditure incurred each month on each section. As soon as the expenditure on a section has reached the amount sanctioned in the estimates, no further work will be carried out on that section less money is available from savings on other sections or unless additional sanction is obtained from the proper authority for increased expenditure on the road. Boards will be erected on the road at the commencement of each section on which will be shown the number and length of the section to which it relates and the expenditure sanctioned in the estimates and after the construction of the section is completed, the actual expenditure is incurred.

**Estimates**

A sample of the form in which the note book should be kept is attached (Appendix A) Column 3 alone should be written up when the aligning and chaining are being done ; but as soon as a section is finished the remaining information required for the estimate for that section should be collected.

This is done by taking the slope of the hill at right angles to the line of the road, at the beginning of each chain, in the following manner.

The 3 metre rod should be held horizontally, at right angle to the road line, with one of its ends resting against the hill side. From the other end, a plummet line should be dropped to the, ground vertically, and its length should be measured; this length divided by 10, will give the slope of hill side.

The slope is recorded in Column 4 of the note-book.

The nature of the ground is then examined throughout the length of each chain and its average quality is estimated by its appearance on the line, or immediately above or below the line, or by means of small excavations. The quality is then entered in Column 2 of the note book, and the corresponding rate per 100 cum of excavation is shown in Column 1. In Column 5 is then entered the prescribed width of road, modified so far as may be necessary on account of special conditions, e.g. where the gradient is steep or there are snow slides, etc. the width must be increased.

Each day the information recorded in the note book should be carefully transferred to an estimate form (Appendix B). In this, form:

(i) the figures of column C are :- the slope of the hill multiplied by half the width of the road; and

(ii) Those in column E are:- the figures of column C multiplied by the width of the road.

In column C the figures have to be written under each chain concerned and they must be put in a new line unless the width of the road and the rate for excavation are both the same as in some previous chain. The cross sectional areas are written in column E in accordance with the rate for excavation. Totals are made for every 10 chains and are transferred to abstract (Appendix C) for each kilometer.

It will be seen that this system of estimating does not allow for any part of the width of the road being obtained by filling i.e. the full width of the road has to be excavated. When completed, the road will, therefore, be wider than is required, but in small roads and hilly country, the excess soil, where the slope of the hill is steep, will soon disappear and washed away. Cutting the full width of road avoids the expenses of building retaining walls and of frequently repairing them, but when excavation is more expensive then the building of retaining walls, also where there are curves in nullahs, retaining walls must be built, unless another suitable alignment can be selected which shall enable them to be avoided.

**'APPENDIX-A**

Showing an example of a field note-book used in making the alignment of a full section from the 20th to the 29th chain

| Rate per Thousand Cubic Mtr. | Quality of ground | Chain | Slope of hill 2 cm. | Width. road |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| Rs. P | | | | |
| 25.00 | Hard lime-stone rock | 20.00 | 1½ | 1.50 Mtr |
| 20.00 | Hard sand-stone | 21.00 | 1½ | 1.50 Mtr |
| 10.00 | Shale (loose) | 22.00 | 1½ | 1.50 Mtr |
| 7.50 | ¾ earth, ¼ stone | 23.00 | 1½ | 1.50 Mtr |
| 22.50 | Disintegrating lime stone | 24.00 | 1¾ | 1.50 Mtr |
| 17.50 | ½ hard stone, ½ (3/4 stone, ¼ earth) | 25.00 | 1¾ | 1.50 Mtr |
| 12.50 | Nearly ¾ stone, ¼ earth | 26.00 | 2 | 1.50 Mtr |
| 15.00 | ¾ stone, ¼ earth | 27.00 | 2 | 1.50 Mtr |
| 5.00 | Earth | 28.00 | 2½ | 2.50 Mtr |
| 5.00 | Earth | 29.00 | 1¼ | 2.50 Mtr |

Note:- Gradient 1 in 12 except chains 6 and 7 of 1 in 8, snow slides common is chains 8 & 9. Retaining wall 4 Mtr. Long 1.50 Mtr. High in chain 200 Mtr 60 cm. filling 3 Mtr in chain 150 Mtr.

## APPENDIX – B

### FORM OF ESTIMATE PREPARED FROM THE FIELD NOTE BOOK ON ROAD ALIGNMENT

| Chain | Width of road | Half heights according to chain number | | | | | | | | | | Length | Cross areas (b xc) according to rates for excavation Rs. per % | | | | | | | | | Remarks retaining walls cutting filling etc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20th to 29th | - | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | - | 5 | 7.8 | 10 | 12.8 | 15 | 17.8 | 20 | 22.8 | 25 | |
| | 5 | 2 | | | | | | | | | | | | | | | | | | | 10 | |
| | 5 | | 1.7 | | | | | | | | | | | | | | | | 8.5 | | | |
| | 5 | | | 1.7 | | | | | | | | | | | 8.5 | | | | | | | |
| | 6 | | | 2 | | | | | | | | | | 12 | | | | | | | | 60 cm filling |
| | 5 | | | | 1.4 | | | | | | | | | | | | | | | 7 | | 3 Mtr long |
| | 5 | | | | 1.4 | | | | | | | | | | | | | 7 | | | | 60x3x5=2.70 |
| | 8 | | | | | 1.3 | | | | | | | | | 6.5 | | | | | | | Cum. |
| | 5 | | | | | | | | | | | 1.3 | | | | 6.5 | | | | | | Retaining wall 3.60 Mtr long 1.5 Mtr high 1.5 high i.e. 4x 5x 12 |
| | 8 | | | | | | | | | | | | 1.8 | 3.2 | | 40 | | | | | | Extra width on account of snow slide |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| | Total excavation (dxe cft) | | | | | | | | | | | 4000 | 4000 | 1200 | 850 | 650 | 650 | 700 | 850 | 700 | 1000 | Road gradient 1 in 12 except chains 6 & 7 |
| 20th to 29th | | | | | | | | | | | | | | | | | | | | | | |
| | Addl 25 per cent cutting back in Rs. 5, Rs. 10. | | | | | | | | | | | - | 1000 | 300 | 213 | - | - | - | - | - | - | Where it is 1 in 8 |
| | Total Excavation for 10 chains cft. | | | | | | | | | | | - | 5000 | 1500 | 1063 | 650 | 650 | 700 | 850 | 700 | 1000 | |

# CHAPTER XV

## AERIAL ROPEWAYS

**Introduction**

During the Third Five Year Plan mechanised logging was undertaken on a large, scale in Himachal Pradesh both in Kullu and Rohru Forest Divisions by importing equipment from Europe. Powered Baco, Buco, Lesso ropeways, Gravity Conveyers, All Terrain Skyline crane, Long Distance Skyline Cranes, Lesso Winches, Plumet Tractors etc. were used on a large scale together with improved logging tools. The experiment did not succeed on account of following reasons.

(i) No culture for the use of sophisticated machines had yet been built up in the hills

(ii) Spare parts etc. were not available

(iii) The prime movers were assorted makes and any break down created numerous difficulties to procure the services and spares.

(iv) The machines were designed for working on low elevations while conditions in hills were very different and their performance was much low than the rated capacity;

(v) Inspite of having got a large number of persons trained on the operation of different machines the work could not be economically executed:

(vi) Machines could be used where large volumes were to be felled almost touching clear felling. Such fellings are being discouraged in hills on ecological considerations and

(vii) The mechanised equipment has to be utilized in conjunction with availability of good roads in the valleys and tracks. This could note be harmonised. Loading and unloading of the heavy vehicles was a very big impediment in spite of having used heavy log loaders. The Logging Research Institute of Government of India at Dehradun has developed some prototype of these machines indigenously but still they have not become very popular. It appears that we have to wait for sometime more before we can take up use of such machines.

**Improved Logging Tools.**

Large quantity of improved logging tools for different operations in the exploitation of timber were imported from Switzerland and Sweden. Large number of trainers and workers were got trained. The flow of such equipment has now ceased. The Productivity and utilisation of the available forest resources can be highly increased with the use of this equipment. We have serious problem with the labour, which is migratory. The training once imparted to any group of labourers is not available in subsequent years. Under the circumstances it is necessary that whenever labour comes for any work it should be given training in the use of improved logging tools which have been certified for use by the Logging Training Institute Dehradun. The productivity can certainly be increased by use of these tools.

**General Description of Aerial Ropeways**

Aerial Ropeways are used for transport of materials by carriers suspended from one or more ropes which take the place of the track in a railway.

There are two principal forms of ropeways:

(1) Double or Multiple Ropes; consisting of stationary suspension (or track) ropes and moving control (or haulage) ropes. (2) Single Rope; consisting of a single moving rope to which the load is directly attached and so serves to combined purpose of suspension and control or haulage.

In both these types the loads travel continuously in the same direction, the haulage power can, be derived from gravity only when the load has to be carried down hill, where uphill carriage is required, some form of engine, power must be provided to pull the load.

**The Donald Aerial Ropeways**

The Donald Aerial Ropeways is strictly speaking a combination of these two classes. The carriage of the load is on the same principle as the first class but in the running of empty carriers will the moving control rope, the second class is also employed, because the rope which merely serves as a control or haulage rope for the load actually carries the empty carriers uphill again.

These ropeways are being used for timber extraction and exploitation all over the State where portability and low cost of installation are of primary importance and where owing to the precipitous nature of the country the number of scantlings that can economically be delivered to each ropeway system is small; and the distance from the forest to a floatable stream or river being comparatively short. The increased cost of installing the more expensive Double Rope or Single Rope types with through stations would not be compensated for by the total reduced cost of operation. The country being very precipitous with projecting ridges and deep re-entrants long spans of Donald Ropeway between 600 metres and one thousand metres long can be installed to serve nearly every section of the forest. To install ropeway of either double or single type say 2000 metres long of such a type that the load would not have to be disconnected from the control or, haulage rope, it would be necessary for the ropeway to be absolutely straight and to support it at more frequent intervals. In addition, and in particular when angle stations are necessary a large factor of safety is required to obviate the possibility of breaks, since men are or may be working under the ropes at the angle stations. Heavier rope results in increase in capital cost and in cost for carriage too site, construction of terminals, installation, etc., while expert supervision is also necessary.

The ropeways may be either gravity or power operated. In the H.P. all are gravity operated. The simplest Donald Ropeway consists of a single stationary track rope with an endless control rope placed vertically under it.

In the Himalayan forests transport can only be effected through labourers and it is essential that ropes be light and portable. The single track is replaced by three each supporting one third the weight of the single track rope These lighter ropes are more easily tightened than the heavier rope, and at less expense,. With, three track ropes in use, loads are carried at right angles to the direction of the span which is a distinct advantage, in launching and receiving on steep spans.

The three track ropes are placed parallel to one another in the same horizontal plane the distance apart depending on the length of the load. The most convenient distance when handling B.G. Sleepers is 90 cms between ropes. The track ropes are supported at each end by simple wooden tresses. At the top terminal the track ropes are attached to another log sunk 1.5 m. in the ground, or to a tree or to an iron bar fixed in a hole drilled in the solid rock.

Tightening is most conveniently and economically effected from the lower terminal as the tension there is less than at the top, terminal. Simple wooden wind lasses are used, the free or running end of the, rope being attached to another posts.

The endless control rope is placed vertically under the central track rope and 2 m. below it and travels round a grooved wheel or “sheave” at each terminal. The sheaves revolve in metal bearing blocks which are bolted on to horizontal wooden

beams supported at each end by up right posts, the stress being taken by guys tightened by turn buckle to any convenient anchorage.

All the equipment required is now readily available in markets at Batala, Yamunanagar, Phagwara etc. Specifications of most of the items have been given in the above, but may have to be varied to suit local conditions based on past experience. These changes may be brought about by the Conservator of Forests concerned.

The design, erection and maintenance of such ropeways is a speciality of people of Lug Valley of Kullu district, these trained personnel are employed all over. It will be desirable if training is imparted to the locals. It is not a very technical matter as brought out above and building up expertise will be very desirable.

**Detailed description of Ropes and Fittings for erection of terminals and installation**

**Track Rope:** Wire Rope 25 mm circumference, galvanized, flexible of best Crucible steel, acid quality 6 x 7 construction, Lang's Lay, hemp core, breaking strain 3.5 tonnes,

**Control Rope:** Wire rope, 20 mm circumference un-galvanized flexible of best crucible steel, acid quality, 6 x 7 construction. Lang's Lay, hemp core, breaking strain 1.4 tonnes.

The 5 mm circumference rope weighs 220 gm per metre 20 mm circumference rope weighs 150 gm/mt. so the length of rope can easily be ascertained by weighing it and dividing the weight by 220 gm or 150 gm.

**Explanation of above**

**Galvanized:** The track rope is stationary and should be galvanized as a protection against damp, despite the fact that galvanizing weakens it slightly.

**Ungalvanized:** The control rope runs over sheaves and if galvanized the zinc would quickly wear off.

**Flexible:** For our work we require flexible rope (see remarks on breaking strain below) of best Crucible steel. Crucible steel is a trade name for steel produced by the Acid Open Hearth process, and distinguishes this steel from the more expensive "Plough" steel.

**Lang's Lay (Sometimes called Albert Lay).** The strains are twisted in the same direction as the wires which, it is claimed affords a larger area to resist wear. Rope of this Lay is not as flexible as of "Ordinary Lay" where the strands are twisted in the opposite direction to the wires.

**6 x 7 Construction.** This defines the structure of the rope, and means a rope of six strands of which each strand consists of seven wires (six wire twisted round a central one). .

For the same diameter rope, the 6 x7 has wires of about 64 percent, greater diameter thin the 6 x 19 hence it withstands surface wear better. Rope of this construction is not so flexible as the 6 x 19, which was previously used.

**Hemp Core:** The functions of the hemp core are to absorb and hold lubricant, and to act as a yielding cushion for the strands. This is particularly necessary when the rope is bent passing over a pulley or when the rope is stretched by the application of a load. The hemp core does not add to the strength however.

**Breaking Strain:** The quality of the rope cannot be judged entirely by the guaranteed breaking strain as is largely a matter of tempering, since the tensile Strength may be increased in tempering but the wires made brittle and less flexible. We want a happy medium with both strength and flexibility.

**Note B:** Care should be taken that in indenting for track rope Galvanized wire rope is specified, while in ordering control rope ungalvanized wire rope is specified.

**Control grooved wheels and their accessories**

Control grooved wheels are of two kinds (i) with a projecting rim 5 cm wide for the band brake and (ii) without rim. They are of cast iron 5 cm out side diameter, with either a replaceable liner forming the bottom of the groove or a detachable groove screwed on. For the sheave with break rim, this type has six spokes of cruciform cross section and to date no case has occurred of the spokes breaking. The four spoke oval section type has not proved satisfactory for the sheave with brake rim, the design being rather clumsy and a large number of spokes having broken in use probably due to the expansion of the rim by the heat generated by the friction of the brake acting on the rim. The weight of the grooved wheel is 50 Kg. and four labourers are required, for its transport.

The grooved wheel without the projecting brake rim has curved oval section spokes 50 mm + 22 mm section and this seems to be very satisfactory. The spindle or axle diameter has been increased from 40 mm to 50 mm because on long spans the smaller diameter causes excessive axle wear and friction. The liner depth has also been increased from 12 mm to 25 mm as with the smaller depth it cannot be securely fixed.

Axles or spindles are of polished mild steel shafting fixed by key in the, hub of the grooved wheel. In the past 40 mm diameter spindles have been used but in future the diameter must be increased to 50 mm to decrease friction and wear on long spans. The hub is 12.5 cm wide. The length of the axle will depend on the width of the bearing to be used; for 75 mm bearings, 30 cm axle, for 15 cm 45 cm axle. Ends of axles should be levelled to prevent burring. It should be borne in mind that the axle is 1.60 mm less in diameter than the hub, so that the key must be a driving fit to prevent the sheave creeping along the axle when in use, thus exposing the key and permitting it to come in contact with the bearing brass.

Bearings are of phosphor bronze or gun metal bored solid and are held in solid cast iron bearing blocks. Generally the bearing brass is 10 mm thick and 7.5 cm wide, the block being 35 cm. long x 7.5 cm. wide and the base about 25 mm thick. Type previously supplied by other firms have 6 mm thick bushes, width 7.5 cm and 15 cm, block length 20 cm. With the 50 mm diameter axle a standard type heavy service "Plummer block" should prove quite satisfactory and more economical and if this can be obtained, blocks with cast iron bearings, which are also self lubricating and adjusting will be the most efficient and economical.

It should be noted that 12 mm diameter hold down bolts are not satisfactory as they are easily damaged and bent, so that a larger diameter bolt, say 20 mm diameter is most economical in the long run.

**Brake:** The descent of the load is controlled by a semi-circular band brake acting on the rim of the grooved wheel, the brake being operated by a simple hand lever. The brake is for convenience usually placed at the unloading terminal as this ensures that the brakeman brings the load in gently, while he also can give warning if a load starts off before it is connected to the, control rope. For actual breaking effect the upper terminal is better since the tension is greater here and consequently there is more friction between the rope and the groove, the band is of mild steel 3 mm to 41

mm thick by 5 cm wide. The type manufactured by the Roorkee Canal. Foundry is not absolutely satisfactory since the brakeman is behind the sheave and cannot assist in disconnecting the coupling "Y" and in connecting the returning empty carriers, while since he is directly behind the sheaves he may be seriously hurt if the control rope breaks. Diagrams of breake are attached.

**Carriers:** These are simple carriers of the usual type for such work, consisting of hanger, spindle and small grooved wheel, and will readily be under-stood from the attached diagrams.

The grooved wheel is turned from mild steel bar being 125 mm diameter and 4 cm wide at hub. The hanger passes over the top of the grooved wheel and supports the spindle at both ends; it is made from 50 mm X 10 mm or 12 mm mild steel flat bar, the latter thickness being better. Spindles are made from mild steel round iron bar. To start with they are used 20 mm diameter and are replaced by large diameter spindles to take up wear in the hub of the grooved wheel. Patches may be rivetted on the side of the hanger and may be replaced when wear has become great. Weight of complete carrier of 12 mm thick iron with patches is 3 kg.

For a very flat span where the weight of the returning empty carriers is the controlling factor a simpler and lighter type of carrier can be made in which the hanger does not pass over the top of the grooved wheel but is fixed to one end of the spindle. These carriers are more liable to jump off the track and the speed must be very carefully controlled.

**Track Supports:** The track ropes are supported at both ends by simple wooden frames consisting of two posts sunk 1.50 metres in the ground supporting a horizontal pole called a cap or transom. Struts or guys are added to prevent the posts being pushed over or shaken.

**Track Anchorages:** At the top terminal the track ropes are anchored by "U" Bolt Grips to a log sunk 1.5 metres in the ground, or to a substantial tree, or a 50 mm diameter round iron bar securely fixed in a hole drilled in the solid rock.

**Track Tighteners:** Tightening is usually effected from the lower terminal as the tension in the rope is less here, but if holes cannot be dug economically it may be necessary to do the tightening from the top terminal.

Tightening is effected by simple wooden windlasses 1.35 metre girth by 0.65 metre long with the projecting ends 450 mm circumference which act as the axle or spindle. The drums are turned by removable wooden levers of the strongest wood obtain able 225 mm circumference and 1.5 metre long which fit into sockets chiselled into the drums 75 x75 x 125 mm deep. There are four pairs of sockets and four levers are used in turning two in front of the drum and two behind, two men working each lever. The windlasses are supported by inclined posts sunk full 1.5 metre in the ground and hold by wire rope guys further to strengthen them. Care should be taken that the drums are so placed that the rope leaves the track supports in a straight line. One windlass is provided for each track rope and further rope and getting it into position on the grooved wheels. Anchor posts to which the running ends of tracks ropes are attached are placed centrally in the rear of the drums.

**Control sheave supports:** The Control Sheaves are supported by two parallel horizontal wooden plates of 15 cm side of square section sawn true and kept 12.5 cm or 15.0 cm apart by timber logs or wooden blocks and bolts. They are supported by vertical posts sunk tip down in the ground the usual 1.5 metre. The joints are fixed on and morticed, and 22 mm diameter bolts and nuts are used. Care should be taken

that the surface of the two parallel horizontal Wooden plates supporting the bearing blocks are exactly in the same horizontal plane so that the axle of the sheave is truly horizontal.

To take the tension of the control rope of the posts a "Y" shaped wire rope guy, in which is inserted a turn buckle is taken from, hooks on the bearing blocks to the track anchor log, the turn buckle being used to shorten the guy and put it in tension.

**Angles between terminals and lengths of spans:** The longest and steepest span so far used was 1,400 metre long, at a grade of 46 degrees with the horizontal between terminals. This is the limit in length. The lowest angle of grade has been I7 degrees on 800 metres span. One span 1,200 meters long at I8 degrees grade worked but the load had to be pulled by hand into the terminal for the last 60 metre and the factor of safety was only 1½ so that this grade cannot be recommended for this length of span.

The best lengths and grades for speed and economy are 800 to 1100 metro at 22 to 35 degrees between stations.

Below are given grades for different lengths of spans which should be taken as minimum for economical working and reasonable life of rope:

| Length of span horizontal | Minimum angle of line From top terminal to Bottom terminal With the horizontal |
|---|---|
| Meter | Degree |
| 300 | 15 |
| 600 | 17½ |
| 900 | 20 |
| 1200 | 22½ |

**Location of Ropeways and selection of sites for spans:** This has of course to be done after the forest has been marked for felling. A very careful reconnaissance of the ground is necessary, time spent on this being well repaid by increased output and low installation and operating costs. It should be borne in mind that for most economical operations 25 cum. of scantling should be roped daily and that the greater the total number of scantlings roped over a span the lower the installation cost per cubic metre. If spans are so located that only say 8 cum can be extracted daily the cost is very considerably increased. Of course it often happens, that it is not practicable to so arrange the spans or the crews that 25 cm are roped daily, as the increased distance of manual carriage to the ropeway or the precipitous nature of the forest may prevent this.

The following instruments and materials are necessary:

I Abney's level which should be tested to ensure that it is in order.
12 Flags, 6 red (or yellow) and 6 white.
1 Pair Field glasses.
1. Contoured survey sheet including the forest of the largest scale available.
1. Indelible pencil for marking station pegs. Pegs can be cut in forest as required.
1. Hand axe for marking trees (optional).
1. Whistle.

**Survey party:** Two or three men as assistants to carry flags, cut pegs, etc. These should preferably be local men with a thorough knowledge of the forest. The beat guard should accompany this party. An official who has helped in the marking and knows exactly where the greatest number of scantlings will be sawn should accompany the officer making the selections.

A rough reconnaissance should first be made from some place such as the opposite hill side where the whole of the forest to be worked is visible. With the help of the survey sheet alternate positions for spans can very often then be chosen, the location of terminals being decided front the visible density of the forest, the configuration of the ground, and the survey sheet contours, lengths and grades being obtained approximately from the survey sheet. These stations should lightly be marked on the survey sheet with lead pencil. The spans so selected, can then be examined on the ground, working from station to station, the actual grades being measured with the hand level, The sag of the rope at the centre normally be between 5 percent and 10 per cent of the length of the span and this must be remembered in considering whether the span will be sufficiently high above the intervening ground for the load to pass down and the empty carries to pass up, without coming in contact with the ground.

**Erection of Terminals:** This is best done departmentally by a trained construction crew working under trained subordinate. This work of course can but and has been done by the ordinary roping coolies on contract and the first cost is cheaper, but it is not satisfactory. Posts are not sunk to the proper depth, joints do not fit property, bearings are not set on a level bearing nuts are put on bolts riding the thread sheaves which are not perfectly in line with the rope, and the journals of the axles are damaged in handling. All these faults cannot be noticed on inspection and it is not until roping starts and the ropeway is subjected to vibration, etc., that fault make their appearance.

It is, therefore, recommended that the work be done departmentally and the crew required is as follows:

One Deputy Ranger of construction.

One, Skilled Carpenter such as is employed on building construction.

The ordinary village Carpenter is not suitable.

Two trained labourers who are good sawyers and

I expert axemen.

Local labourers according to the amount of unskilled labour necessary which will depend on the nature of the site.

A certain amount of blacksmith work will be necessary but this will not justify the whole time employment of a blacksmith and it can, therefore, be done by the man employed for general maintenance work at a central point, any article for repair being sent to him.

The felling and carriage of the timber required for each terminal can best be done by the local beat guard. Detailed particulars have been given in the schedule of Material and Fittings Nos. 3 and 4 of the timber required. Installation of ropes, can be done by the roping contractor at the time of roping, but under the supervision of a trained sub ordinate.

**Duties of the crew:** The Deputy Ranger will be responsible for the efficiency of erection and generally for supervising the carpenter and labourers.

The carpenter will do all the skilled work such as joints, and setting of sheave bearings. He will also set all posts and see that they are in alignment.

The two trained labourers will assist the carpenter to the best of their ability in all semi-skilled and unskilled works when occasion arises.

**Tools required for erection of terminals:**

Four Shovels.
Four Pick axes.
Four Crowbars.
Four Jumpers.
Four Pharwas.
Two Steel Wedges for splitting rock.
Two Axes (if skilled labourer do not provide their own).
Two Hand Adzes.
Two Full Size metric scales.
One Measuring Tape 15 metres
One Spirit Level, Carpenters.
One Oil Can.
Six Files assorted, found, triangular, and flat.
Two Cold chisels 20 mm wide.
Two Sledge hammers, 5 Kg.
One Handsaw, cutting on the pull and not the push.
Two Mortice chisels, one 12 mm and one of 25 mm.
One Firmer gauge 25 mm.
Two Spanners, one for 12 mm and 15 mm and one for 20 mm and 22 mm bolts and nuts. One Breast Brace, with bits long enough for cutting 20 cm deep.)
Holes of width 25 mm and 50 mm (Augers are not satisfactory).

**Actual Erection:** The attached diagrams show the ideal position for the various members, and Ibis should be adhered too as far as possible. The distance between the control posts, and the track support posts, the track support post and the windlasses or anchor log, is not important, and this can be varied according to the nature of the, ground but the control sheave bearing must be at the proper distance from the supporting posts, the control support caps must be sufficiently high above the ground for the empty carriers to hang clear of the ground, and the track support cap must be at the proper distance above the control support cap. The control support caps must be between 12.5 and 15.0 cms apart, and a plumb line dropped from the centre track should pass midway between the two plates. The, centres of the track windlasses should be exactly 1 metre apart, centrally in line with the position the tracks will occupy, and they should be at right angles to the span. Similarly the control rope windlass if used should be centrally in line with the control rope. The anchor posts should be centrally in rear of each windlass. All posts should be sunk the full 1.5 meter. The control rope guys as shown in the drawing should be taut. All joints should fit correctly.

Installation of Ropes. This, as previously stated, is best done by the roping contractor provided it is done under the supervision of trained subordinate, a subordinate with no training or who is being trained, being of no more use than an untrained man.

The contractor's one subject will be to get the ropes in position for roping in the shortest possible time. He will be indifferent to damage done to the ropes from contact with jagged rocks and by kinks. An uncoiling windlass must be used for passing out the ropes as this is the only way in which kinks can be avoided. Any kinks, which cannot be straightened out, should be cut out and the rope spliced with a 6 metre splice.

All ropes are first carried to the top terminal of the span. An absolutely straight narrow lane is then cleared from the top terminal to the lower by lopping interfering branches and felling trees. This land should not be any wider than is necessary to permit the first track to be raised from the ground and is best done under the supervision of the beat guard as this obviates, the possibility of friction between the subordinate in charge of the construction and the Range Staff. One track rope is then laid between the two terminals with the upper end attached to the, Centre anchor log loop by a thimble and 5 U bolt grips and the lower end given five turns round the Centre track windlass, the rope of course passing over the track supports and not through them. The rope is then raised by the windlass, eight men being employed on the windlass levers, two to each lever and when in position running eight men being employed on the windlass levers, two to each lever and when in position the running end secured at the anchor post by U bolt grips. In tightening all ropes care should be taken to keep the rope between the windlass and the anchor post taut as there is always the possibility of one of the levers breaking which unless this precaution is taken may result in serious injury to the windlass crew. One track rope now being in position the other two in turn are slid down it, being supported at intervals by forked twigs. When the lower end has been passed round the windlass and the strain taken these twigs are knocked off by a small piece of wood being allowed to slide down the first rope. Both these ropes are stretched in the same manner as the first and fixed securely. The control rope will of course be double the length of the span. To get it into position the two ends are sent down the track ropes in the same way that the second, and third track ropes were and the loop thus formed at the top terminal passed round the top control sheave. A, special anchor rope is then attached by a clamp, or U bolt grips, 6 metre from the end so that the clamp, or grips are adjacent to the control sheave. If there is a fourth windlass for the control rope, and this is undoubtedly a convenience, the running end is then, given five turn round this end the rope is raised by the windlass to its proper position, the forked twigs being knocked off as in the case of track rope. If there is no fourth windlass, the Centre track rope must be clamped to an anchor, rope removed from the windlass and the control raised to position by this windlass. A mark is made on the control rope, at the control sheave for cutting for the slice and the whole rope lowered to the ground by reversing the windlass. The anchor clamp on the free end is then released, the rope out at the place marked for cutting and the two ends, bought together and spliced. The, control rope is now endless, is in position on the top sheave and must be stretched and got in position on the bottom sheave as Well. To do this a piece of rope about 6 metre long is taken and each end clamped either by cramps or U bolt grips to the control rope leaving about 3.5 metre of the control rope in between. The end of the control rope still on the windlass is attached by a thimble and U bolt grips to the added piece of rope and the control rope raised. The control sheave is removed from the bearing blocks, the control rope slipped over it and into the groove and the sheave replaced in its bearings. The control rope and the track ropes are now in position and the Centre track rope should be returned to its windlass and the clamps removed. The brake is next placed in position and the loading and unloading platform made of sleepers build up in a track of crib. The span is now ready for roping.

Tools required
For splicing:-

One Cold Chisel for cutting rope 20 mm,
One Hand Hammer.
Two, Hand Vices 90 mm,
Two Pliers 25 cm.
One Marline, Spike 15 mm tapering to a. point.
One knife for cutting hemp core.
One Copper of lead Hammer, 1 kg. for hammering rope ever.,
One Roll of Electrician's Friction Tape. For Removing Control Sheaves:
One Spanner 12 mm and 15 mm.
One Spanner 20 mm and 22 mm.

Splicing. The splice should be at least 6 metre long. Tools required are hammer and sharp Cold chisel, 3 pairs of strong pliers, steel marlin spike, a knife and a pair of I kg. Copper or lead mallets. A bench vice is convenient. To splice, (1) Overlap the rope 6 metre or more, and mark Centre of lap on each end with string or chalk.

(2) Unlay each end to Centre mark, and cut off hemp core,

(3) Interlock the 6 unlaid stands of each end alternately and draw together until Centre marks meet.

(4) Unlay a strand A from one end, and follow it closely with opposite strand 1 of other end laying it into the groove left open by A and proceeding thus until all but 30 cm of strand I are laid in, then cut off A an equal length and tie the strands temporarily in place.

(5) Treat similarly strands 4 and D, and so On far each pair of opposite strands stopping each pair about 1/5 of the length of splice short of the preceding pair.

(6) Bend the rope back and forth until all strands are set in place and have equal tension.

(7) Warp ends of strands with friction tape or strips of sheet lead, and straighten them.

(8) With the vice and pliers, untwist and open the rope at the point where the first Pair of strands meet, cut the hemp core at the Centre, draw it out slowly and follow it up with the strand to be buried in the Centre until the later occupies the Centre. Cut off the core, at the end of this strand. In the same manner tuck in the other strand of the pair, being careful that their ends do not cross over each other.

(9) Twist the pliers back to close up the rope and hammer the strands with the mallet to fix them firmly in place.

(10) Shift the pliers and repeat operation at the other 5 pairs of ends, and the splice is complete

A few hints on the use, handling and care of wire ropes something, which must not be done, the reason what must be done.
(a) Do not uncoil like a manila or hemp rope.

Why: - It causes kinks, which leads to fractures of the small wires, composing the rope. You cannot take kink out of a rope by pulling.

What to do: - Either unroll along the ground, or place the coil upon a real or an uncoiling windlass and uncoil, if you have kink in your rope throw it out by throwing the rope the opposite way to the kink if possible.

(b) Do not place a rope over, or round.
(a) the raw edge of a rock, or
(b) square piece of timber.
Why: - It causes fractures of the small wires
What to do:- (a) If over or round the rock, place a jacket of small pieces of thick wood between the rope and the rock, (b) use round timber not less than 300 mm diameter.

(c) Do not use knots.
Why: -When the knot pulls tight it fractures small wires
What to do: - Give the end of the rope several turns round the anchorage and clump it or bind it with wire to the standing piece.

(d) Do not allow the end of the rope to remain unwrapped.
Why: - The strands of rope will work loose and several yards will quickly become Useless

What to do: - Wrap the ends of all ropes, with thin wire about 5 cm from the end, and finish your wrapping in the middle.

(e) Do not use a tourniquet.
Why: - It fractures all the wires wherever used

What to do: - Tighten your ropes with a drum, or ratchet pully block (a stopper hitch can easily be fastened to a rope to form a connection for a hook) of secramps or U bolt grips which do not harm the rope,

(f) Do not make short splices.
Why: - If in the carrying rope short splice cause the carrier to bump and will perhaps throw t off the rope. If in the control rope, they cause a bump when passing over the Sheave. The strength of the splice depends on the friction between the strands.

What to do: - Always make long splices and carefully thin them out, the overlap of each rope should be at least 3 metre giving a 6 metre splice.

(g) Do not allow the control rope to grind against the flange of the sheave.

Why: - It will cause a raw edge on the flange, which will quickly cut the whole of your control rope and besides the rope is bent.

What to do:- The control rope must run in the centre of the groove and be parallel with the rim.

(h) Do not have a control rope too tight.

Why: - It causes unnecessary strain in the rope, which wears itself out very quickly and also wears out the grooves.

What to do:- Unless there is danger of fouling the ground with loose ropes the sag of the control rope should be considerably more than that of the carrying rope.

A tight control rope can only be justified when it is necessary for the carriers to clear the ground between stations.

(i) Do not tighten your carrying ropes more than is necessary to cause the load to run home. This refers to spans up to 28 degrees

Why: - The tighter your rope the quicker it wears out.

What to do: - On spans up to 28 degrees the difference between angles of the top and bottom stations, and angle taken from the top station along 30 metre of carrying rope, should be not less than 5 degrees.

(j) Do not put up new ropes and at once pull them tight.

Why: - Ropes must be allowed to stretch and all small wires to correct their tension after being coiled up. If you at once strain a new rope, you will stretch some wires and not others.

What to do: - Allow new ropes to remain up 3 or 4 days, before being tightened. This will prolong the life of your rope.

(k) Do not forget to slacken all ropes after a season s work, or when not required for some months.

Why: - It prolongs their life.

What to do: - Slacken all ropes as much as possible. If the ground is dry and not used by traffic allow the ropes to rest upon the ground except in rains or snow season.

(l) Do not forget to oil on grease all ropes when first put up and also before monsoon and snowfall.

Why: - To prevent rust, which quickly eats into steel wire.

What to do: - The control rope can easily be oiled or greased by being pulled round by hand power and the oil rubbed on with a rag. The suspension on track rope can be oiled when it is being put up; as the rope is played out rub the oil on with a rag. When necessary to oil it after erection fix a tin on to the top of carrier the tin having a small hole in the bottom immediately over the centre or the carrier wheel. When the carrier is on the rope with the some oil into the tin, and slowly load attached ready to start, pour lower the load. The oil will fall on to the carrier wheel and as it revolves will be carried on to the rope. Do this to each rope in turn, and be sure the loads go very slowly each time.

(m) Do not work ropes with broken wires, even if the broken wires are cut off and tucked in.

Why: - This strength of your rope is the strength of its weakest part, broken wires quickly become untwisted either by passing over the sheave, or by carriers passing over them. The longer you work a rope with broken wires, the more you will have to cut out when you splice it. If you work it with many broken wires the remaining strands will be pulled out of place and you will damage the elasticity of your rope.

What to do Cut your rope, take out the length with broken wires and replace it.

(n) Do not allow the carrying ropes to override when passing round the drum.

Why 1. It is very difficult to slacken your wires.
2. When a load is passing down the carrying ropes there is a slight endways movement this will cause the overriding ropes to chaf one another and cause damage to the small outside wires.

What to do have no difficulty in preventing the pull of rope. You will then have no difficulty in preventing over riding.

(o) Do not have carrying ropes of unequal tension.

Why The tight ropes will carry an unfair amount of load, and become strained or wear out quickly.

What to do Keep a sharp look out on your ropes, and if necessary tighten or slacken your ropes as required to keep them at equal tension.

(p) Do not use new and old ropes in the same span

Why The old rope has probably finished stretching while the new one has just commenced. It will mean adjusting your tension several times daily and will give unfair treatment to the new rope.

| | |
|---|---|
| What to do | Each span must be composed of ropes of the same age and condition. |

Technical Terms Explained.

| | |
|---|---|
| Kink | Twist in a roap formed by the rope being taken back and forward thus forming a coil which on being pulled distort the rope forming what is called a kink. |
| Standing | Piece of rope. The end of a rope secured to some object, of that part not free. |
| Running end of a rope | The free and of a rope |
| Whipped | One rope lashed or bound to another is said to be whipped. |
| Wrapping | Wire bound round the end of a rope to prevent its untwisting. |
| Tourniquet | A simple lever placed between two adjacent and parallel ropes so that by turning the lever at right angles to the axis of the ropes they are twisted round one another and thus shortened. |
| Over-ride | when a rope is coiled on a drum and one coil crosses over another it is said to “override”. |
| Sheave | A wheel with a grooved rim for a rope to run in, the grooved wheel in a pulley, block being a good example. |
| Flange | A projecting flat rim. |

Loading and unloading Platforms. Platforms are made of scantlings built up as a crib, no nails or spikes being used.

At the loading Terminal two are erected, one on each side of the rope and about 120 cm apart to allow clearance for the arms of the coupling “Y”.

At the unloading Terminal one Platform only is built and this is placed over the control grooved wheel, the span side being open. The advantages of the single platform are that a continuous platform is provided for the unloading labourers to work on, and if the brakeman is in rear of the grooved wheel there is no chance of scantlings or carriers falling on him.

The construction of these loading and unloading platform is most conveniently done by the roping contractor as part of the roping contract.

Dismantling of ropes and Fittings. This is best done by the roping contractor, either at the conclusion of roping or when the ropes are to be transferred to a fresh span. This must, however, be done under the supervision of a trained subordinate, and there should be one such subordinate to each span being dismantled, Particular attention should be given to the coiling of the ropes in order that kinks may be avoided, and a coiling windlass should be used.

**Transport of Ropes and Fittings**

A 1,200 metres track rope will weigh 270 kg., so it is obvious that it cannot be carried on one coil. The rope is, therefore, coiled on the coiling windlass in a number of bundles of coils, leach bundle weighing 20 kg. or which one cooly load, about 3 metre of rope being left between each bundle of coils for convenience in carrying. When the rope is being carried kinks may be formed between the bundle unless supervision is Very strict. When the rope is to be transported a long distance a good way of avoiding kinks is to see sacking round the rope between the bundles.

**Loads**

A good normal load for the 25 mm circumference track rope is to B.G. Sleepers or say 0.20 cum. or 120 kg. but this may be increased to three B.G. sleepers on occasions. A load of three B.G. sleepers was the normal load on a span of 1,200 metre with a grade of I8 degrees as with only two B.G. sleepers The load did not run down to the unloading terminal. A load of two B.G. sleepers can be launched conveniently by the despatching labourers, but with a heavier load the strain on the labourers arms becomes excessive for continuous working. The steeper the slope of the track the greater the proportion of the weight of the load thrown on the labourers arm in launching, and it must be remembered that only one arm is available as the labour has to support himself with the other.

**Capacity**

The most reasonable figure would appear to be 30 cum. or say 300 scantlings per diem. For a ten-hour working day this means a load dispatched every four minutes which is Very reasonable for spans where the grade is such that the load runs into the unloading terminal without external aid. While one load is passing down the ropeway the next is being arranged and when the load comes to rest all that is necessary is for the carriers to be removed from, the old load, placed on the control rope and the new load suspended from the track and coupled to the control rope these operations taking only a few seconds.

By increasing the load to three B.G. Sleepers and by, increasing the number of labourers and the number if working hours daily the output can be increased of course and is done for short periods, but for normal working the figures in the previous, paragraph should be taken.

**Supervision**

Any officer or subordinate with a year's experience on the Donald Aerial, Gravity Ropeways should be in a position to supervise the work efficiently. A tendency for officers and subordinates to regard this work as required technical training should be discouraged as it is not justified, because no great technical knowledge is required but preliminary instruction and training should be carried out under a capable officer with experience of ropeway work. In past the responsibility of ropeway work has been left too much to untrained work charged temporarily employed persons for the purpose, but in practice it makes for more efficient working if the Range Officers are made primarily responsible for supervision, regulation of labour, and supply and replacement of damaged and worn posts.

**Crew required to operate**

Scantlings are stacked near the loading terminal and are carried to the loading platform as required and the crew will depend on the number of scantlings to be roped daily.

The number of men required to carry the scantlings from the stacks to the ropeway platform and from the unloading platform to the new stacks or the next ropeway terminal if the ropeways are in series will depend on the number of scantlings to be roped daily and the distances, the scantling else to be carried by hand. For the actual loading, despatching, receiving and unloading of the scantlings five men are absolutely and the normal crews for the operation of the rope way may be taken as follows, provided the men are working, on contract:-

| | Number scantlings per diam. | | | | |
|---|---|---|---|---|---|
| | 100 | 150 | 200 | 250 | 300 |
| Crew required for the single Span | 6 | 7 | 8 | 9 | 10 |
| Crew required for each additional span if spans are in series | 4 | 5 | 6 | 7 | 8 |

In the above sagement no allowance has been made for cooks, nor for time lost in fetching godown, etc.

Each crew should include at least one expert splicer and at least half of each team should be experienced ropeway men. The balance of each crew can be ordinary, labourers accustomed to carrying scantlings, as they will only be used for this purpose normally.

Assuming 300 scantlings or 30 cum. roped daily over an isolated span.

Manual carriage from stacks of previous span to platform 3 men.

Loading and dispatching 2 men assisted by one of above three.

Unloading terminal,
Unloading, 1 man,
Brakeman 1

Manual carriage from ropeway to stacks, 3 men, Total 10 men.

For each additional span i n a series the crew is reduced by two, because the crew of the upper span deliver the scantlings at the, loading platform of the lower, span thus saving carriage from stacks to the ropeway.

**Rules to be observed regarding loads and loading**

(a) No load should exceed 0.3 cum. because by suddenly throwing the weight of the load as far as possible when sending down mixed sizes.

(b) Launching should be done slowly and gently, because by suddenly throwing the weight of the load on the rope the strain in the ropes is enormously increased.

(c) The load should travel exactly at right angles to the ropes and perfectly horizontal. The two arms of the “Y” coupling should be of equal length and should be passed round the load at equal distances from control rope if the load travels obliquely the carrier also travel obliquely and the sides of the grooves wear the track rope while in addition there is more tendency for them to jump off the track.

(d) All three slings should be of the same length and as short as possible they should grip the load at all four corners of the cross section of load.

(e) Slings should hang vertically under the track ropes.

(f) Slings and coupling “Y” should be made from the thinnest rope available.

(g) The height of the loading platform should be so adjusted that it is necessary to pull the track rope down to attach the slings to the carriers.

**Speed Braking etc.**

(a) The rapidity of descent of the road should not at any time be allowed to exceed 300 metre per minute. The wear of the rope and carriers depends almost entirely on the speed so that provided the capacity of the ropeway is not curtailed this should be kept as low as possible.

(b) When the load is being placed on the ropes the brake should be pull on, as the brakes man can then control the speed, and the full weight of the load (that portion held by the control rope) is not borne by the launching labourers.

(c) The brake should never be completely off while the load is travelling down.

(d) Loads should be kept under proper control throughout the journeys and should be allowed to come into the receiving terminal slowly and gently. If the load is stopped with a jerk, great strain is thrown On the Control rope and its supports, which on long spans result in the breaking of the rope.

(e) The brake blocks and the rim of the control wheel should be free from grease and blocks should be replaced before the screws are exposed as other wise the, rim will be damaged.

**Maintenance and Repairs**

Repairs such as splicing ropes, replacing brake blocks, carriers wheels and spindles, should be done by the contractor working the ropeway as part, of the roping contract under the direction of the forest subordinate trained in ropeway work responsible for the supervision of the roping. All other repairs such as reforming carrier hanger replacing patches on carrier hangers, renewal or replacement of control wheel liners, replacement of worn out bearing and control wheel axles, etc. for which a trained blacksmith fitter is necessary, should be done at a central work shop. A supply of spare parts should be kept in the neighborhood of each ropeway system and when it is necessary to send any part to the central, repair shop for, replacement its place should be, taken by one of the spares in reserve.

Normally one blacksmith fitter with local blacksmith and four or five labourers to help him will be sufficient to maintain the fittings of twenty spans of ropeway.

Twelve carriers are required for the actual operation of roping on each span of ropeway.

Articles to be kept in reserve by the subordinate in charge of each system for the replacement of worn out ones:

**For each Span**

3 Carriers.
12 Spindles varying in size from 20 mm to
30 mm diameter.
20 Washers assorted.
50 split pins.
1 Oil can.

For each system.

1 Brake sheave complete with axle (spindle) key, bearings and blocks, and hold down Bolts and Nuts.

1. Brake complete with necessary fittings. Similar articles to be kept in Reserve for exchange in Divisional Store.

**Roping cost**

The crews required for roping various, numbers of scantlings have been given. Knowing the daily earnings the average Labourer may expect contract work and adding an allowance for the carriage of godown, if any, and cooking, and allowing one man per crew, he brake man, 50 percent, higher wages, the cost per scantling can be calculated without difficulty,

**To estimate the all inclusive cost of roping scantling**

In estimating the cost of extraction by rope ways for comparison with other methods such as manual carriage, wet slide, khad floating, either above or in combination, the total all inclusive cost of extraction must be considered. The all inclusive cost will include all costs such as:

(a) Cost of carriage of ropes and fittings from previous site to now, site.
(b) Erection of stations and installation of ropes.
(c) Maintenance and repair of fittings, and oil.
(d) Dismantling for removal to next site and for an allowance for the depreciation of ropes and fittings:

(Carriage of ropes and fittings from previous site.

One Labourer can carry 90 metres of 25 mm circumference track rope, and 150, metres of 20mm circumference control rope, nine labourers the sheaves and fittings, two labourers the, carriers of one span. Knowing the length of rope required and the distance from the previous site to the new site this can be calculated).

A Large number of units is available in the less handling of such ropes can throw timber extraction works into great confusion. Proper maintenance, storage and carriage of such ropeways is very essential. Periodic oiling of the ropes and other equipment .has to be ensured by the officer in-charge of timber extraction works and gravity ropeways in particular. Any portion of rope, which is damaged, must be removed to avoid accident while the installation is in operation.

A large number of units are available in the country who supply steel wire ropes. The ropes when purchased should conform to ISI specifications and purchase should be made only when the inspection has been done by an Officer not below the rank of Divisional Forest Officer. The physical verification of the stocks of steel wire ropes and other equipment should be done every year before dispatch to the site of work and on arrival on work.

These ropeways are also being used for the transport of fruit, vegetables and other bulk material. The officers making use of such ropeways should think of innovation and improve the efficiency and carrying capacity apart from decreasing the cost per quintal per Km.

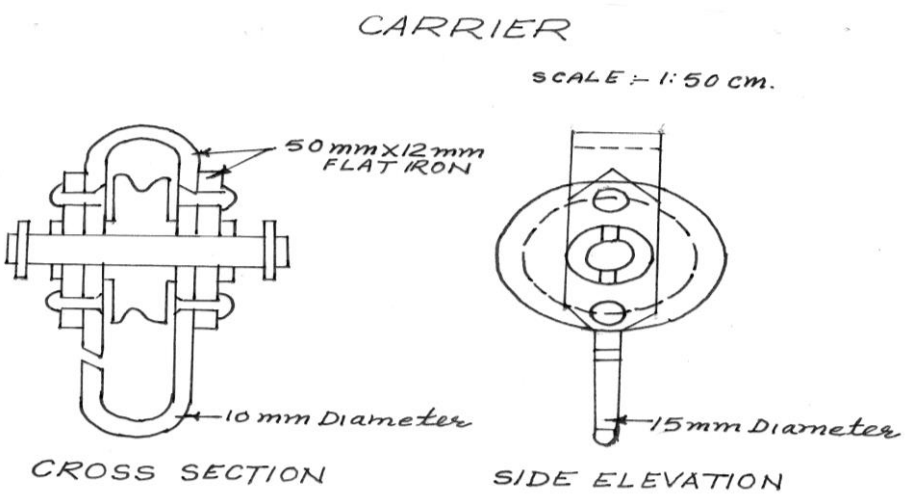
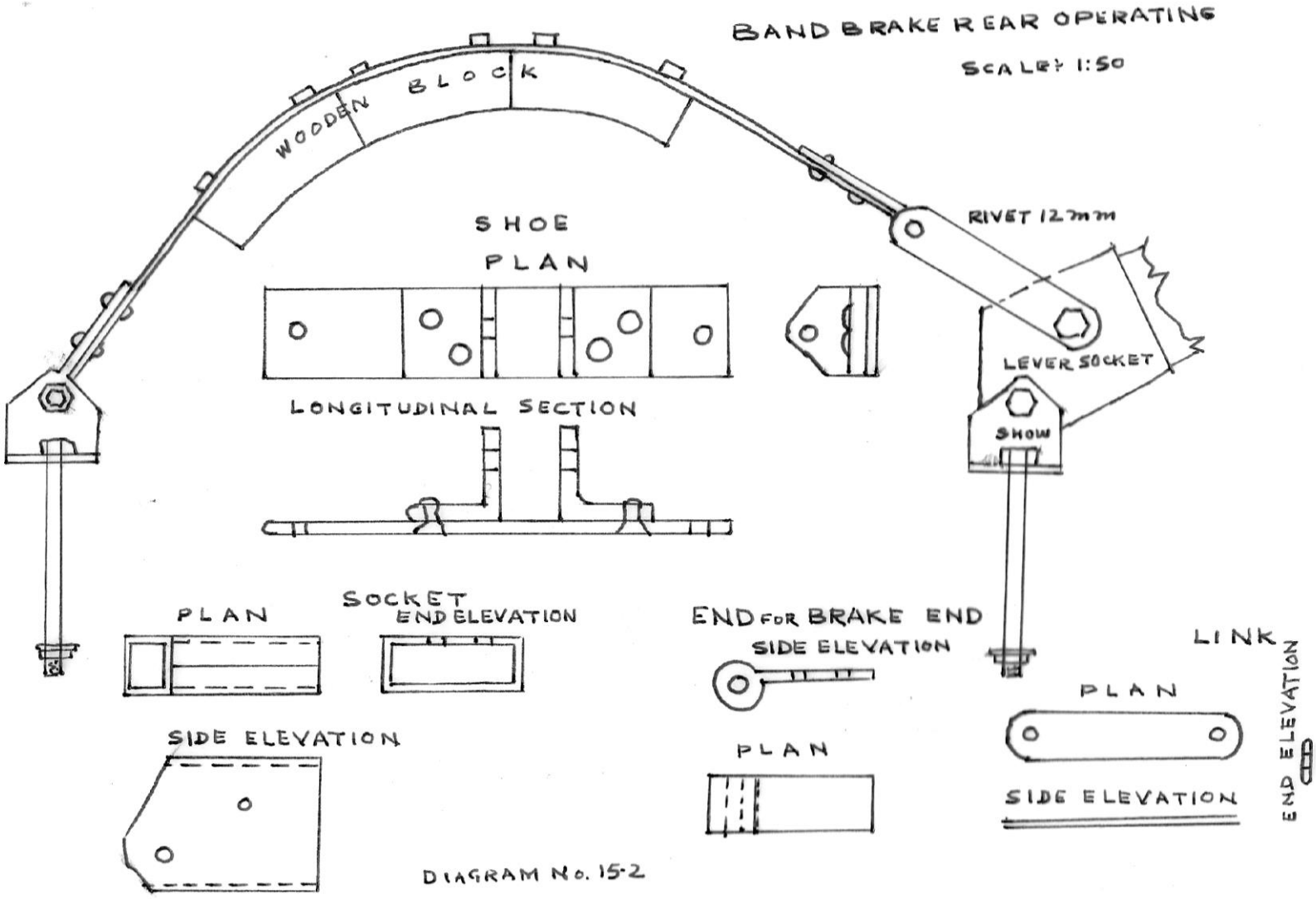



Fig. 15-1


BAND BRAKE REAR OPERATING
SCALE: 1:50
WOODEN BLOCK
SHOE
PLAN
LONGITUDINAL SECTION
RIVET 12.7mm
LEVER SOCKET
SHOW
PLAN
SOCKET
END ELEVATION
SIDE ELEVATION
END FOR BRAKE END
SIDE ELEVATION
PLAN
LINK
PLAN
SIDE ELEVATION
END ELEVATION
DIAGRAM No. 15-2

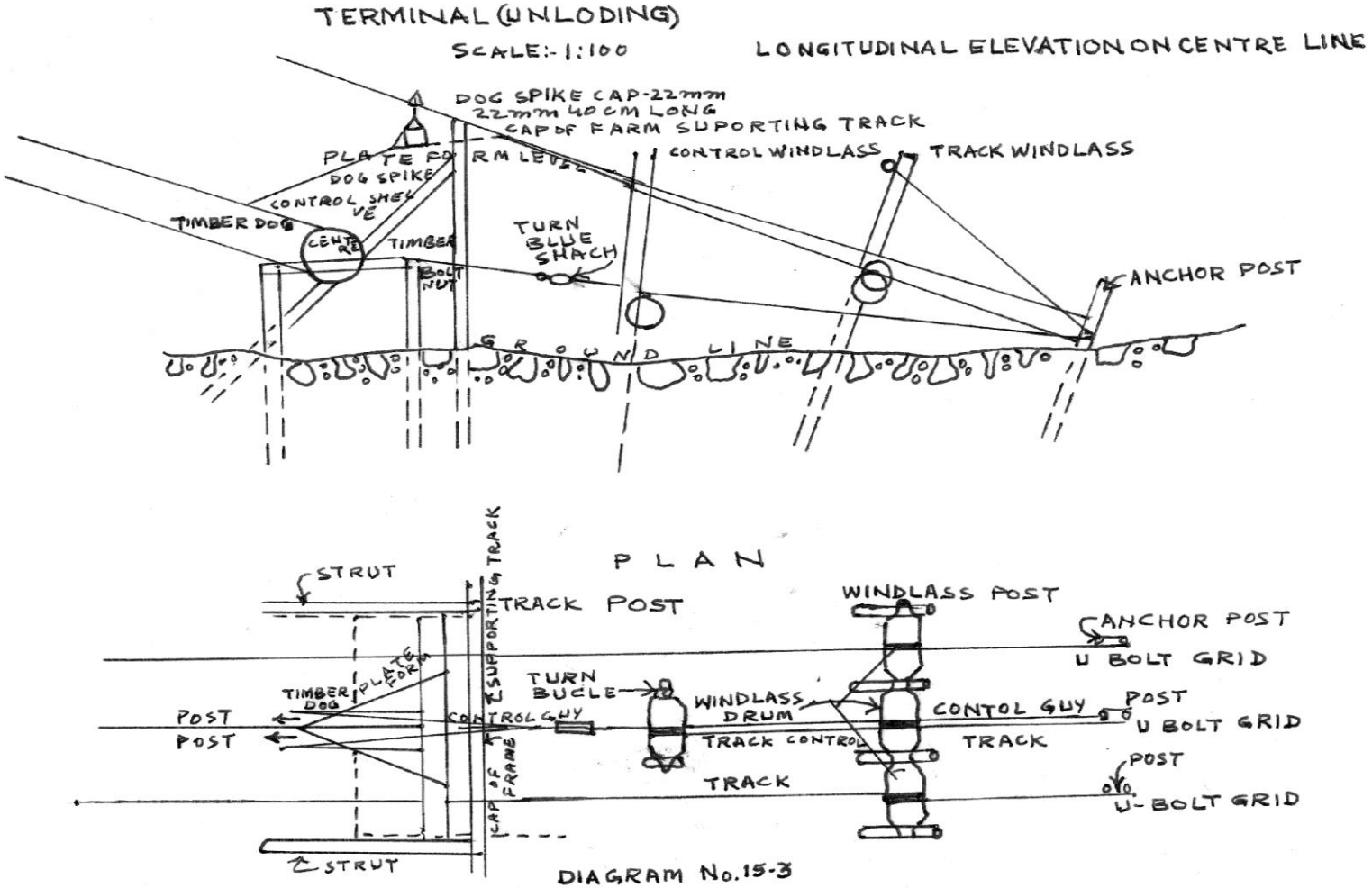
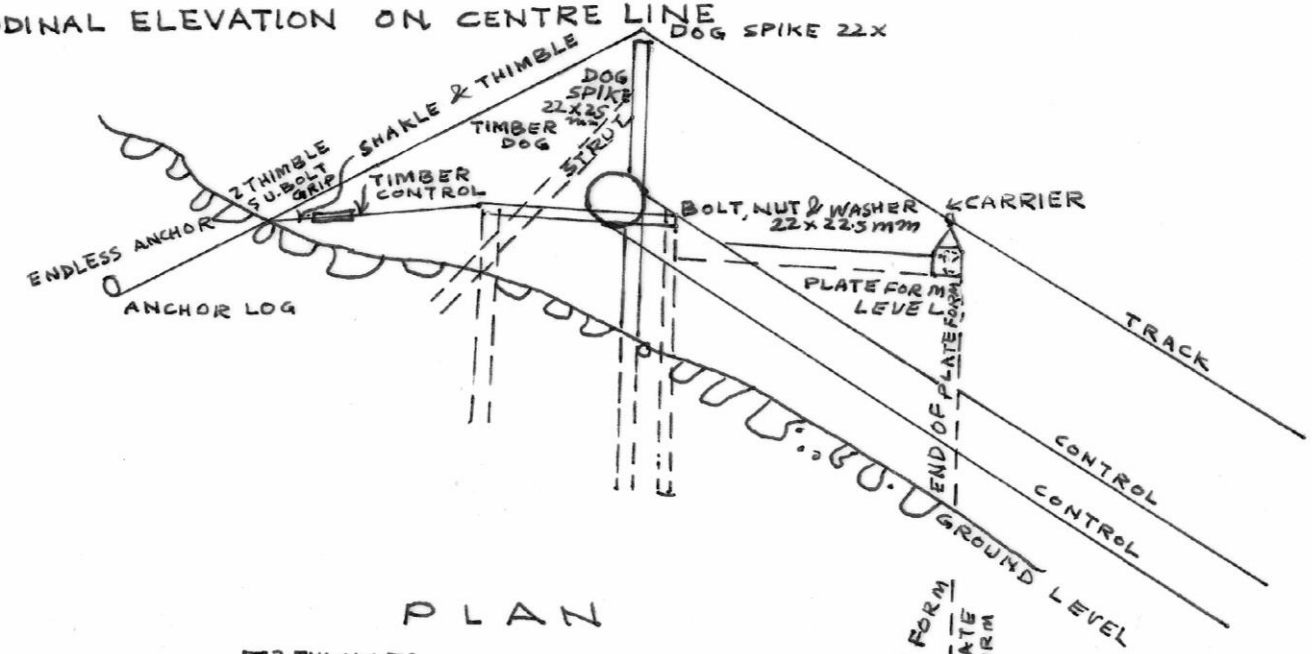



DIAGRAM No.15-3

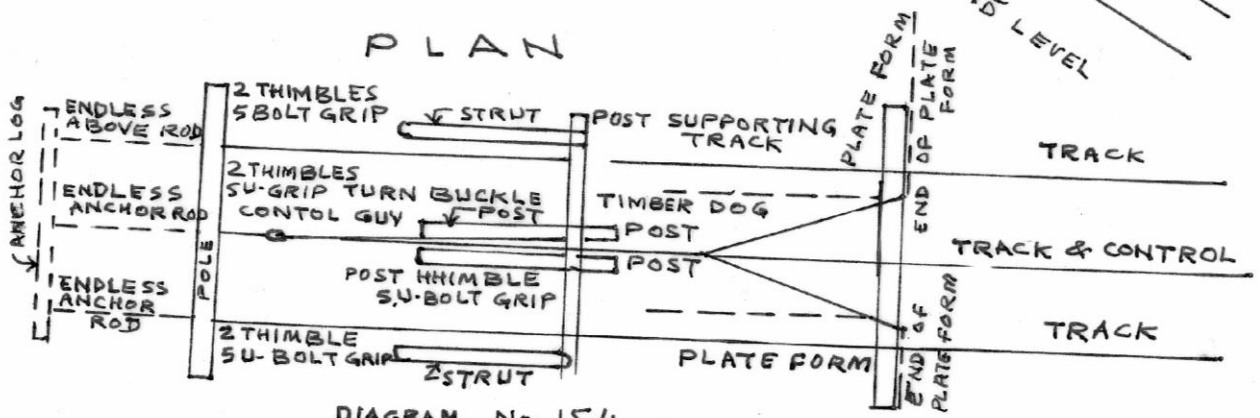
# LOADING TERMINAL

SCALE:1:60 CM

LONGITUDINAL ELEVATION ON CENTRE LINE




PLAN

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# CHAPTER XVI

## BIOSPHERE RESERVES

**Introduction**

The idea of Biosphere Reserves was initiated by UNESCO in 1973- 74 under the Man and the biosphere (MAB) Programme, and is intended to conserve representative ecosystems.

The Indian National Man and Biosphere Committee has been set up for the purpose, There, is a need to set up such biosphere reserves. This programme aims to "develop within the natural and social sciences a basis for the rational use and conservation of the resources of the biosphere and for the improvement of the relationship between man and the environment; to predict the consequences of today's actions on tomorrows world and thereby to increase man's ability to manage efficiently the natural resources of the biosphere".

**Selection of Area**

The biosphere reserves should be situated in a well defined ecosystem. It should have a core area with a buffer zone. The area should be situated in virgin ecosystem or least disturbed ecosystem. It will be desirable, if the history of management of such areas is also known for reference. Under ideal circumstances there should not be any biotic interference in the core and buffer zone. If possible the existing, rights should be extinguished.

A core area of a National, Park or a protected research site could serve the purpose as these protected areas are often the best examples of naturally unaltered landscape. Further the 'core' of a biosphere reserve is chosen so as to represent the ecosystem in a climax state, including natural seral stages leading to the climax. In case the climax community no longer exists the core should contain the sub climax communities in as natural a state as possible which should be allowed to proceed by natural succession towards the climax.

The buffer zone is provided primarily to screen the core area from disturbance from surrounding forms of land use. In the choice of a buffer zone site prime attention should be paid to ensuring that it is harmonious with the core area. Different forms of land use are allowed in the buffer, zone and this allows to assess the effects of use on an area Vis-a- Vis a natural zone. All experiments and manipulative research is undertaken in the 'buffer zone' while the 'core' helps us to compare and chalk out best course of action.

**Functions Expected of a Biosphere Reserve**

The main function expected of the a biosphere reserve is that it provides in situ under natural conditions long term conservation of plants, animals and microorganism to ensure self-perpetuation and unhindered evolution of the living resources. It acts as a gene pool both for fauna and flora and is a rich source of many important and desirable traits. This function helps to preserve genetic diversity, which is of fundamental interest to mankind. Another function expected of a biosphere, reserve is to art as a model of an ecosystem in a climax state. In case climax is not there, sub climax communities are set aside to proceed by natural succession towards the climax. This function helps research in silviculture.

A biosphere reserve allows comparison between areas subjected to use and an area left naturally so. The damage that can be done by unwise land use is depicted and in case rehabilitation is resorted to, it illustrates the extent, of recovery.

An important function played by a biosphere reserve is that it enhances conservation consciousness. Reserve management achieves a two fold objective one to learn from the traditional practice of the people, in the management of natural resources and record people s appreciation of the natural resources that exists. This integrated approach allows the benefits of such management to accrue to people and helps monitor activities for better understanding of environmental change. Environmental education too is made possible.

The functions expected d a biosphere reserve are further outlined by the Indian National Man and Biosphere programme which envisages research on the following major aspects.

(i) Base line data collection - for preparation of an inventory of abiotic and biotic components of biosphere reserve areas, collection. of information on meteorology, land use practices distribution and status of key species as well as endemic, rare and threatended species, socioeconomic survey regarding the local population, their occupations, needs etc.

(ii) Monitoring - This concentrates on climatological measurements, soil, water and air pollution studies, productivity, phenology population dynamics of selected animals and plant species, energy and material flow, demography of human population, patterns of human utilisation of wild plants and animals for food, fodder, drugs, construction of shelter etc.

(iii) Manipulation research - This aims at investigating the effects of various kinds and degrees of human use and interferences.

(iv) Restoration research - is designed to study the ways of rehabilitating degraded ecosystem or restoring climax where this has disappeared.

**Minimum Area**

Normally the buffer zone has an area 3-4 times that of the 'core area', since the availability of a large chunk of least disturbed ecosystem is low, a reasonably big virgin forests, diverse in fauna and, flora could best serve the purpose of a core area. The minimum area chosen for the core should be atleast 100-150 hectares while the adjoining buffer zone could be around 400-500 hectares.

**Operations to be carried out before the establishment of a Reserve and the Periodic Measurement required**

After pinpointing areas/ecosystems that are found least disturbed by biotic interference, a comprehensive floral and faunal analysis is undertaken. Help from the Botanical and Zoological Survey of India could be sought. For the 'core' the exact measures as are undertaken for a National Park are gone through based on the Wild Life (Protection) Act, 1972, in the absence of a separate legislation for biosphere reserves. This course of action would help to provide the necessary protection required for a biosphere reserve. However it must be noted that though in a National Park we do undertake activities beneficial for the faunal and flora population in a biosphere reserve, every action is restricted at least in the core. Biotic interference is eliminated and natural conditions are allowed to prevail. Nature is allowed a free reign to show facts as natural as possible.

In the buffer zone there is no need, for changes in land holding or regulation. Adequate long term legislation, regulatory or institutional protection, must only be provided to the 'core'. In the buffer, manipulative research may be practiced and also

different forms of land use like grazing, timber extraction etc. be allowed. It must be noted that not even salvage fellings are to be allowed in the 'core'. Dead, dying, diseased and moribund trees are to be left as such. The 'core' is only an observational site, no manipulation of any sort is to be allowed. As in a National Park, so in the 'core', of a biosphere reserve costs would have to be incurred on acquisition of rights, & land. It must be noted that a biosphere reserve is complementary to the existing network of National Park and Sanctuaries, thus the Wild Life (Protection) Act, 1972 could be used to help create a biosphere reserve. The declaration could be as follows:

(i) The State Government may, by notification declare its intention to constitute any area as Biosphere Reserve (core) if it considers that such area is of adequate ecological, faunal, floral and geomorphological significance for the purpose of studying and maintaining an ecosystem in its natural state so that comparison is possible vis-a-vis adjoining areas subjected to or other manipulations,

For the Biosphere Reserve (core) provision of sanctions, 19 to 26 of Wild Life (Protection) Act, I972 (both inclusive,) shall as far as may be apply to the investigation and determination of claims and extinguishment of rights, in relation to any land, in such area Is they apply to the said matter in relation to any land in a sanctuary After the core becomes right free total protection along with restrictions on all could be accorded by the notification specifying the limits of the area. The buffer zone could also, be defined through the notification. However, it remains a harmonious landscape fully open, to people, participation from all legal, restrictions.

After the declaration and constitution of Biosphere Reserve is done, the approach must always be to associate local population with the formulation and implementation of research projects. This is important because proper protection is possible only through people's participation especially since establishing and managing protected areas invariably involves restrictions on the changes in the traditional use and rights etc. The local populace has to develop a permanent interest in the reserve chosen, 'Paryavaran Kendras' (Environmental Centres) must be opened. These Kendras would help educate local populace how their participation would, make the, biosphere, reserve management successful and how benefits accruing thereof would reach them. Paryavaran Kendras would also enable researcher teachers, students and even interested amateurs to undertake field work for purposes of research education and training as a so to familiarise them with the problems in a particular reserve. Thus the Paryavaran Kendras help to foster general awareness as, well as to impart and disseminate the knowledge and skills on the relevant subject areas.

After the biosphere reserve is established technical experts are put to carry out scientific and technical programmes. They would concern themselves with monitoring, appropriate supervision, guidance and evaluation.

A detailed work plan for atleast 10 years should be prepared at a time to ensure continuity of management, monitoring and evaluation. The work plan should delineate the original state of affairs and constantly monitor changes, which take place.

# CHAPTER XVII

## SOIL AND WATER CONSERVATION *

**Poverty Alleviation, Inclusive Growth, Equity, Empowerment of Women (Gender Sensitivity), Capacity Building are some of the important objectives of watershed management projects**

Photos : Dr. S.S. Grewal

### INTRODUCTION

This chapter is particularly intended for the forest field functionaries, in the HP Forest Department-a pictorial depiction with basic thumb rules, to ease and facilitate their field application in watershed management and specifically for soil and water conservation works. This would also be beneficial to the other related departments connected with soil and water conservation.

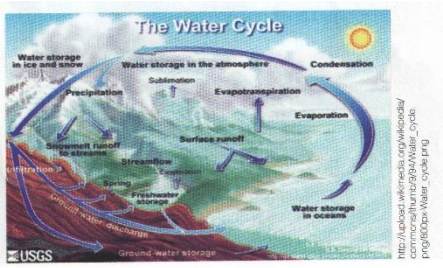
### VARIOUS TERMS AND THEIR DEFINITIONS:

**A. Hydrology:**

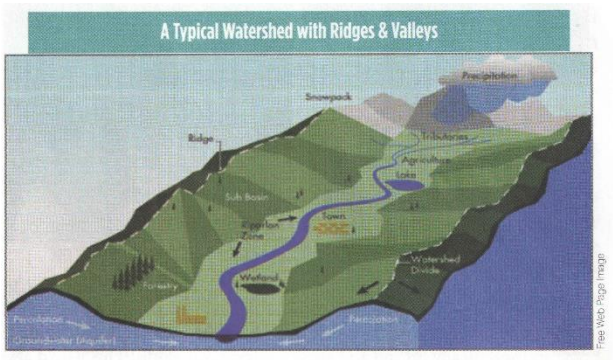
Hydro-water, logos-study: study of the movement and distribution of water (surface, sub-surface)

**B. Hydrological Cycle**

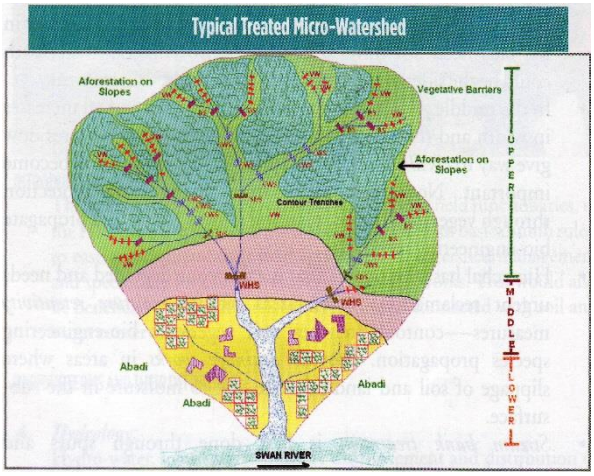
**C. Water Shed**




A hydrological unit of land area covered by ridges having a single drainage system which contributes runoff to a common outlet point. It is also an ideal planning unit (Depending on area/administrative unit, it can be a basin, catchment, sub- catchment, watershed, sub-watershed or a micro-watershed).




**D. Watershed Management:** The process of creating and implementing plans, programs and projects to sustain and enhance watershed functions that affect fauna, flora and local populace within a watershed boundary. The objectives would be reduction of erosion, improved moisture retentivity, rainwater management, increased productivity (drinking water in perpetuity, improved soil conditions, tackling degradation, improved land use) and improved livelihoods for local community.




**CHECK LIST**

- VW' are the vegetative works, 'DS' are the dry-stone check- dams, 'CWS' are crate-wire structures, 'SDS' are the silt- detention structures while 'WHS' are the water-harvesting structures.
- The above diagram has a lot of information-:
- We combine vegetative structures with civil/masonry structures as both the structures are important and are required. The civil/masonry structures are for short term basis, temporary in nature. It is the vegetative measures on them that will give stability/permanence to the structures. Masonry structures are costly while the vegetative measures are reasonably cheap.
- Along a stream, we invariably do work; along the nala--- thinking out of the box, why do we not take up the sides of the nala for reclamation work. Vegetative structures/measures must be attempted through local, native species---grasses, herbs and shrubs. (Think 'Jhar'- Bio-engineering methodology works). Upper areas require smaller structures. Vegetative structures are the best here as slope is high. We need to break the slope, erodibility must be kept least, never break/erode areas for stones/boulders; runoff water momentum is high-we need to break velocity (a check dam enables dividing forward velocity into horizontal and vertical components-the horizontal velocity is made zero, this means the vertical velocity would scour-needs a good foundation). Water in the nala need not travel over your check dam---an easier path could be the sides of the check dam if your side walls are weak.
    - In the middle zone and in the bottom area, the channel increases in width and the slope is lower----the vegetative structures now give way to civil/masonry structures. Silt detention works become important. Nothing stops us from giving extra protection through vegetative means, planting natives (Raise and propagate bio-engineering species).
- Himachal has a lot of area that is calcareous/degraded and needs urgent reclamation. These areas require moisture retentivity measures----contour trenches and vegetative bio-engineering species propagation. Provide drainage works in areas where slippage of soil and landslides are due to moisture in the sub- surface.
- Stream bank treatment is best done through spurs and embankment works.
- Land use planning is extremely important. Potato is grown along the slide rather than along contours.
- Payments for environment services (PES) provides an action incentive for the local community and needs to be explored. Water harvesting structures can be really beneficial in areas where water is less. Rain-fed areas can be made very productive through proper land–use management. Check dams need to be in series- planned with respect to the flow.

## Options for Implementing under an incentive based mechanism framework

| | Activity<br><br>Multi stage Village catchment plan | Steps | Local Biomass Benefit | Local ES Benefit | Down Stream Erosion Control | Local opportunity Cost | Indicative amounts |
|---|---|---|---|---|---|---|---|
| 1 | Spring & reservoir catchment mgt. zone | Identify spring catchment hydro geologically. Support basic interventions. Incentivize long term protection | * | ***** | ** | L if small areas | Rs. 1500-2500/ha/yr for 3 yrs |
| 2 | Stream mgt. plan | Support preparation of plan | | | | as L-M coordination and control required | |
| 2a | Implementation of stream mgt. plan | | | | | | |
| 2b | Stream Protection zone | Closed to extraction. Vegetative barriers added) | * | *** | *** | | Rs.10/ m/yr. depending on length |
| 3a | Forest mgt. plan | Support preparation of plan | ** | ** | ** | | |
| 3b | Closed forest zone | Local | | *** | ** | M-H, as per size | Rs.1000/ha |
| 3c | Managed forest zone | Vegetative filter strips, rotational lopping conservative lopping, grazing control and a controlled timber and fuel-wood extraction | * | * | ** | L-M depending on previous history of protection and extent o control | Rs.1000/ha |
| 3d | Planted forest zone | Free plants at nursery. | ** | * | ** | Grazing areas reduced. M | Rs.1-5 per plant per year (1500-2000/ha) depending on survival rates. For 3 years |
| 4a | Agricultural field mgt plan | Conservation agriculture practices, piggy back with organic farmers | * | ** | ** | | Effort required but low when established |
| 4b | Agricultural bund grass/tree plan | Grasses on bunds-between 1000-3000 running m per ha | ** | * | ** | L | Rs.2/ Running m |
| 5 | Land conversion-shamlat/private | Free seedlings +Rs.2/surviving per year | * | ** | | Low if marginal land | Rs.2/ surviving plant |
| 6a | Ghasni mgt. plan | | | | | | |
| 6b | Ghasni vegetative strips | Cut tufts 6-9 inches above ground in strips to start with Intensify | | * | ** | M as not easy to control grazing | Rs.2-4/m |
| 7 | Alternative energy | Biogas, cookers, human, lpg | * | * | ** | | Soft, flexible loan, and also use as payment for above |

**E. Approaches for watershed management:**

Integrated, participatory, bottom-up, process-based, gender sensitive and inclusive, sustainable natural resource management.

**F. Study on Himachal Pradesh:**

The National Bureau of Soil Survey, titled "Study on Soils of Himachal Pradesh, land capability classification and assessment of soil degradation status" concluded that only 21.4% of the State's area was moderately suitable for agriculture. 53.8% of the State's area was affected by water erosion of different intensity. The tribal districts of Kinnaur and Lahaul-Spiti were not covered by the study

**River Basins of Himachal Pradesh**

- Indus River System
  - Important rivers are Satluj, Beas, Ravi, Chenab and Jhelum. First four, flow through Himachal Pradesh along with their tributaries
- Ganga River System
  - Covers one third of the Western Himalaya and the entire Central Himalayas. Starts from the Shimla Ridge and covers parts of Kinnaur, Shimla, Solan and Sirmaur Districts
- Markanda, Ghaggar and Yamuna River System
  - Covers parts of Sirmour District

**River Basins of Himachal Pradesh**


River Basins of Himachal Pradesh (Source : ADB Document)

| Sr. No. | Name of River | Area (Sq Km) | %age |
|---|---|---|---|
| 1 | Sutlej | 20398 | 36.6 |
| 2 | Beas | 13663 | 24.5 |
| 3 | Chenab | 7850 | 14.2 |
| 4 | Yamuna | 5872 | 10.6 |
| 5 | Ravi | 5528 | 9.90 |
| 6 | Indus | 1450 | 2.60 |
| 7 | Markanda | 360 | 0.60 |
| 8 | Ganga | 290 | 0.50 |
| 9 | Ghaggar | 262 | 0.50 |
| | **Total** | **55673** | **100** |

**Cycle of Natural Resources Degradation in Hilly Ecosystems**

Small holdings, uneven eroded land, crops fail under rain dependent agriculture.

Livestock kept to supplement low farm income. Fodder is however scarce.

Photos : Dr. S.S. Grewal

People resort to open grazing in adjoining forests.

Fuel wood scarcity leads to illicit tree cutting.

Forest fires (natural and human causes) add to deforestation.

Photos : Dr. S.S. Grewal

With removal of protective vegetation cover from sloping lands, intense monsoon rains cause severe soil erosion / gully formation and floods.

Both forest and farm lands suffer stream bank erosion and loss to infrastructure.

The degradation cycle continues with trees being replaced by bushes; rills become gullies; the poor become poorer. Reversal of this trend requires integrated/ participatory watershed management approach involving **Jamin-Jal-Jungle-Janwar-Jiwan**.

Photos : Dr. S.S. Grewal

**G. Baseline information:**

Physiographic—shape, size, slope, drainage etc.
Climate—Rainfall, temperature;
Soil—type of soil, fertility, land capability, erosion susceptibility, silt data etc.
Vegetation survey—type of forest, inventory of species—herbs, shrubs, grasses etc.
Hydrological parameters—water table, peak run-off etc.
Socio-economic survey—traditional modes, livestock, fuel and fodder requirements, social structures, income, infrastructure facilities, institutions—banking, marketing etc.

**H. Methodology:**

Participatory village transact walks, participatory rural appraisal (PRAs), Rapid rural appraisal, structured interviews etc.

**I. Modern Techniques:**

Google maps, topographic sheets, remote sensing, satellite imagery, GIS/MIS, GPS, digital cameras, mobile mapping systems, PDAs etc.

## BIO-ENGINEERING MEASURES

**DEFINITIONS:**

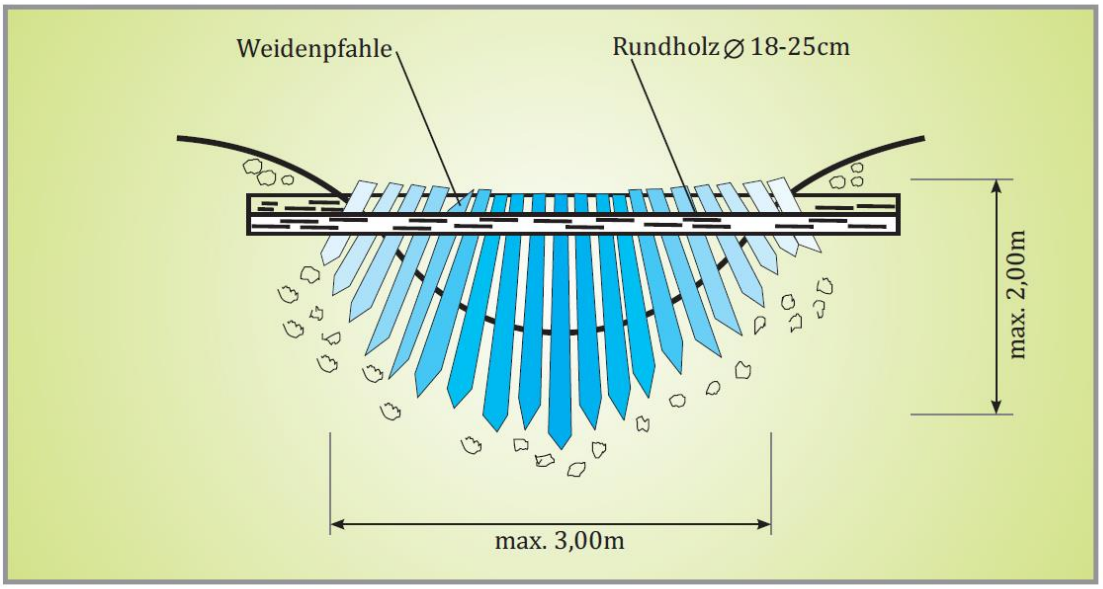
- Bio-engineering refers to the use of live plants and plant parts to reinforce soil, act as erosion prevention barriers, and promote dewatering of water laden soils.
- Bio-engineering is simply part of wise and sustainable asset management. Bio-engineering technique offers the best way of blending slopes into the landscape and limiting damage to surrounding agricultural and forest land. They allow the restoration of something of the original vegetation and ecosystems, particularly of tipping sites and spoil disposal areas. Through both implementation and productivity, they offer social and economic benefits for the poor and rural farmers.

**Bio-engineering techniques:**

The first use of bio-engineering is recorded from the 5th century B.C. in ancient China. Soil-engineering methods were used by the Romans and in the middle Ages. These days some of the old techniques have been modified and applied. These are Palisades, Bamboo Crib wall, Brush layer, Hedge brush layer, Fascines and grass plantation:-

### (a). Palisades

Palisades are used for protection of small but deeper, narrow gullies and shallow V-shaped rails. Immediately after construction they provide mechanical protection by catching debris, armoring and reinforcing gully floors. These effects are increasing after shoot and root development of cuttings



## Vegetated Palisade Wall

## Bamboo Crib Wall

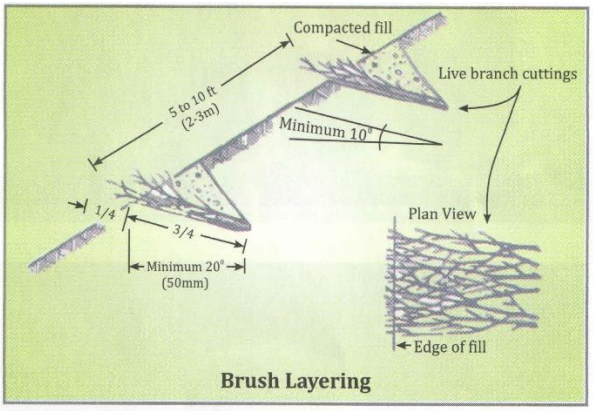
## Bamboo Crib Wall

## Bamboo Crib Wall

## Bamboo Crib Wall Construction

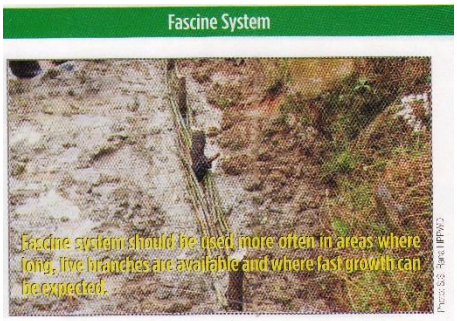
**(b) Brush Layer/ Hedge Brush layer: P**

This is a more effective method for earth reinforcement and mass stability of slope. The construction breaks up the slope length into series of shorter slopes separated by rows of brush layer. It also reinforces the soil with un-rooted branch stems and reinforces the soil as root-develop, adding significant resistance to sliding or shear resistance




Fascines means "a bundle of sticks". Fascines are used for a variety of slope stabilization purposes. Fascines slow run off, catch debris and reinforce the slope due to rooting. Fascines in particular stabilize and drain slopes, and are built into rills or small gullies

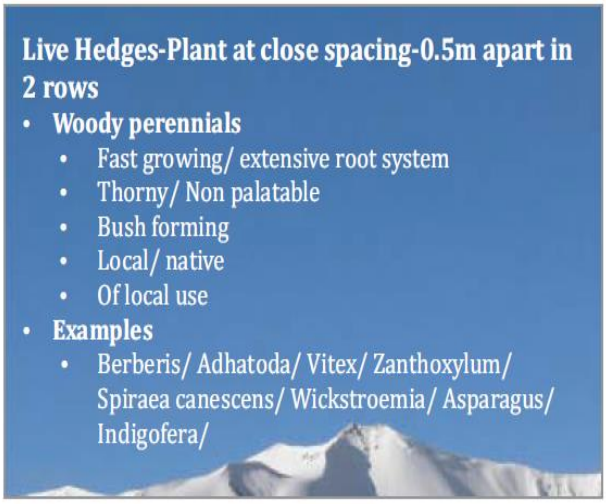
**(c) Fascines:**





**Under Woody Perennials (Trees/ Shrubs) the species suitable for dry open areas are:-**

Boehmeria rugulosa/ Boehmeria platyphylla/ Debregeasia salicifolia/ Berberis sp./ Adhatoda zeylanica/ Vitex negundo/ Zanthoxylum armatum/ Asparagus adscendens/ Indigofera heterantha/ Colebrookia oppositifolia/ Agave sp./ Woodfordia fruticosa/ Jasmine humile/ Murraya koenigii/ Cotinus coggygera/ Spiraea canescens/ Rosa moschata/ Tinospora cordifolia, Ficus semicordata/ Ficus palmata/ Wendlandia exserta/ Ailanthus excelsa/ Punica granatum

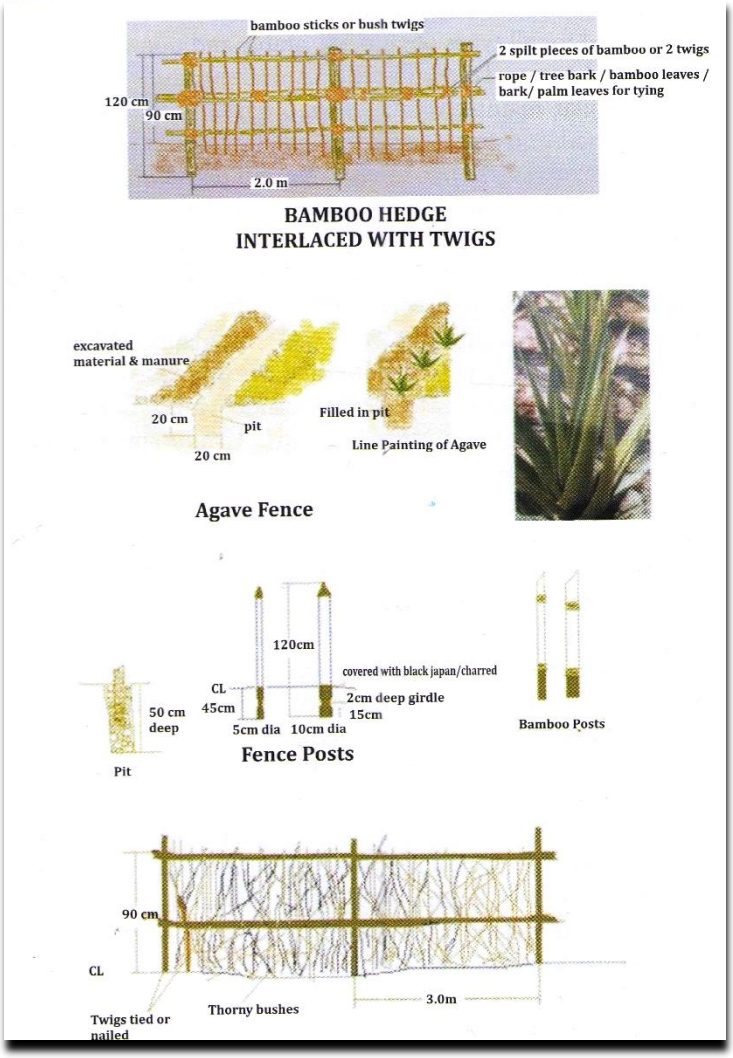



**Under Woody Perennials (Trees/ Shrubs) the species suitable for moist areas are:-**

Arundinaria falcata/ Salix elegens/ Murraya paniculata/Rubus Ellipticus/Alnus nitida/ Populus ciliata/ Salix tetrasperma

**Under Grasses---Perennial/ Creeping, stout root stock, the species are:-**

Arundo donax (Nal)/ Thysanolaena maxima (Broom grass)/ Saccharum munja (Munj)/ Saccharum spontaneum (Kana)/ Eulalipsis binata (Bhabar)/ Cynodon dactylon (Dub)/ Vetiveria lawsonii (Khas)/ Cymbopogon citratus (lemon grass)



**Vegetative Measures for Soil and Water Conservation:**

Soil and water are the two most valuable natural resources. They are essential for sustainable biomass production. The conservation and management of soil and water resources therefore, form an integral part of all watershed development programs. These measures are divided into two main categories i.e. mechanical or engineering measures and biological/vegetative or bio-engineering measures. Both are suitably integrated for all types of land e.g. arable and non-arable such as forest and pasture lands. The mechanical measures are costly and need regular maintenance but are often essential to effectively manage soil and water resources on degraded landscapes. The vegetative measures are cost effective and play an important role in conserving soil and water and are included in any watershed management plan. The bio-engineering measures for soil erosion control are different for arable and non-arable lands. Generally, these are divided into three categories.

- Bioengineering measures for land slope management.
- Bioengineering measures for drainage line treatment.
- Bioengineering measures for landslide stabilization.
- Bioengineering measures for land-fill, mine spoils and other problem areas.

**1. Bio-engineering measures for land slope management:**

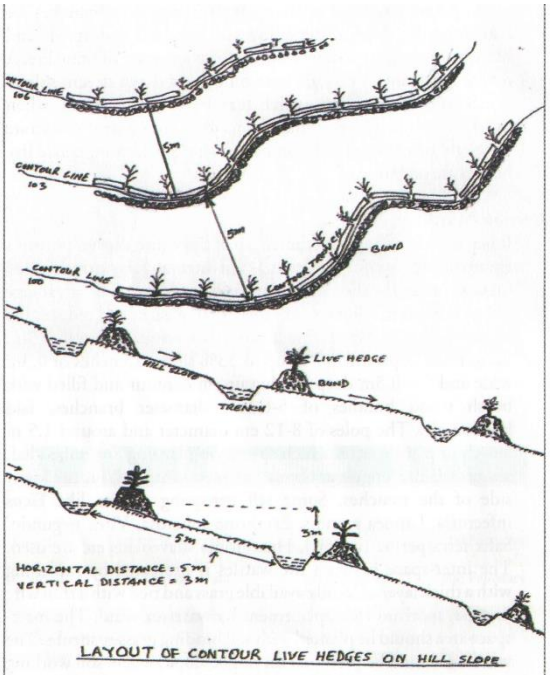
- Barriers of suitable and compatible grasses, shrubs and trees are established, over land slope on contour to intercept soil and water.
- The species vary according to agro-climatic conditions.
- There is considerable variation in soil working, planting techniques and planting material.
- In general, the soil excavated from contour trenches/V- ditches/contour furrows is deposited on the down–slope side, leaving a 15 cm berm to form a parallel contour bund along the contour trench having breaks at regular interval.
- Rooted slips of grasses are planted at a spacing of 10 to 15 cm on bunds and fodder trees are planted in/along the trenches.
- On the lower side of the bunds, a row of bushes is raised so that a complete barrier is formed.
- The vertical interval between the rows varies usually with slope and tree rows spacing, which may vary from 3 to 6 meters.
- The contour trenches are partly filled with eroded soil and store rainwater, which in-turn, provides sufficient moisture to the vegetative strips.
- Once established, the closely growing hedges along with dense roots, reduce soil erosion by---breaking the slope length, reducing velocity of water and increasing infiltration to the soil, inducing deposition of the eroded soil and helping in establishing trees raised on trenches by improving moisture regime. The grass barriers are established during rainy season and when planted during a drizzle establish very quickly. Vetiver grass performs well only on wet/moist areas in non-arable lands but suffers high mortality and then termite attack on drier slopes. Bhabbar grass performs well when planted properly during light showers and particularly in association with trees having light/ thin canopy like Khair (Acacia catechu). Napier grass is most liked by the farmers and provides forage for livestock. These hedges take 2 to 3 years to establish; and over a period of time, eroded soil accumulates, above the hedges and this would tend to form terraces by breaking the slope into a series of terraces. The fact remains that such hedge rows compete with crops, in low rainfall and under moisture stress conditions.

**2. Bio-engineering measures for drainage line treatment:**

**(a) Live check Dams:**

Barriers created with native jhar (Vitex negundo, Arundo donax, Ipomaea cornea (an exotic, should be avoided), Agave sislana etc.; grasses—normally in two rows---Vetiver, Panicum, Napier etc.) across small gullies (small run-off)—check erodibility, fine soil and

moisture. On the down side of grass rows, two rows of shrubs like Vitex, Arundo donax and Ipomaea are planted at close spacing of 30 cm from plant to plant and 50 cm from row to row across the nala bed. This arrangement comes in handy along drainage lines to prolong be life of WHS (Water Harvesting Structure) and in between SDDs (Silt Detention Dams).



LAYOUT OF CONTOUR LIVE HEDGES ON HILL SLOPE

**(b) Brush wood Check Dams:**

If material (locally available brushwood material and poles) available only then construct--Only for small gullies (Depth<1 meter). Two types---single row post brush wood dams and double row post brush wood dams.

Single row post brush wood dams: These are made of wooden stakes to which long branches of trees and shrubs are tied in a zigzag manner across the small gully. The site is first eased to slope of 1:1 and bottom of the gully is excavated by about 25 cm. Then, the wooden stakes of about 10 cms in diameter, is driven about 0.75-0.90 m deep and 0.60-0.90 m apart along the dam axis. Their tops are kept in such a way that a depression is formed in the centre for disposal of excess water. In order to control termite attack, the wooden stakes are treated with coal tar. The height of such brush wood dams may vary from 30 to 60 cm. On the lower side, the brush wood is laid in such a way that cut end side half is placed inside the structure and remaining half extended downward as a mat to act as apron which may protect the base against erosion.

**Double row post brush wood dam:**

When the size of gully increases from 1 to 2-2.5 m deep and 5-6 m wide; then double row post brush wood dam is more appropriate. The construction is the same as that of single row dam, except that the brush wood is laid across the gully, in between two rows of poles spaced about 0.9 m apart. At the base, some branches are laid along the slope of the gully, with cut ends laid upside and branches extending to lower side to form an apron of branches. A row of live hedge is planted both on up and down stream side of brush wood check dam, which may become functional, when brush wood decay, after some time. Because of serious termite problem, brushwood is decomposed very quickly and hence live hedges are preferred.

**Contour Wattling:**

It is a method of breaking the length of slope into shorter portions by providing contour wattles at 3-5 m interval. It is normally used on portions of the slide which are easily accessible. The advantage is that it holds the downward movement of earth and reduces the raindrop impact. Wattles are laid out at a vertical interval of 3m, up to 66% slope and 5-7 m up to 33% slope. Trenches of 0.3m wide and 0.3-0.5m deep are dug up on contour and filled with brush wood bundles of 5-6 cm diameter branches, laid horizontally. The poles of 8-12 cm diameter and around 1.5 m length of plant species which sprout on planting are embedded, about half the length, at about one meter interval, on the lower side of the trenches. Some self-sprouting species like Ficus infectoria, Lannea grandis, Erythrina suberosa, Vitex negundo, Salix tetrasperma (willow), Hamiltonia suaveolens etc. are used. The inter-space between the wattles is protected by mulching with a thick layer of locally available grass and tied with a thin wire or rope, to avoid its displacement by water or wind. The inter- space area should be planted with soil binding grasses/shrubs. The wattling should be preferred on fragile slopes where soil working is difficult and mulching material locally available. The live contour wattles obstruct the movement of debris and allow the run off to pass through.

## Important Trees, Herbs and Shrubs in Himachal Pradesh

| S. No | Scientific Name | Common Name | Altitude | Bio-engineering properties of the species | Habit of species | Propagation method | Uses |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | Abies pindrow | Tosh | 2800 to 3800m | Huge tree, cold tolerant | Evergreen | Seeds | Wood |
| 2 | Acacia catechu | Khair | 1200m | Grows on eroded slopes, coppices well, drought resistant | 9 to 10m height prefer light & browsing | Seeds | Katha, tanning |
| 3 | Acacia nilotica | Babul/ Kiker | 1200m | Tolerent to excessively hot & dry sites | 10 to 15m height prefer light | Seeds | Tans & dye |
| 4 | Adhatoda vasica | Basuti | 1000m | Tolerent dry stony as well as shady places, good coppicer | Gregarious evergreen, 3m height | Stem cuttings | Live hedge medicine |
| 5 | Aegle marmelos | Beal | 1200m | Hardy, medicinal religious plant, deciduous drugs | 18 to 25m ht fruit ripe in one year | Seeds | Juice, jam |
| 6 | Aesculus indica | Khanor | 1800 to 2800m | Huge tree, elegant foliage nuts used in piles | Deciduous 20 to 25m ht. | Seeds | Seeds/wood |
| 7 | Agave amiricana | Ramban | 2000m | Grows well in hot and dry areas | Large cactus height 1.5m | Root suckers | Fibre |
| 8 | Ailanthus excelsa | Heaven tree | 1000 to 2800 | Growing in tough condition coppices well, pollard well | Medium to large tree Deciduous | Wood/ Match boxes | Wood/ fodder |
| 9 | Albiizia lebbek | Siris | Upto 1200m | Drought resistant, Coppices well & grows on poor soil | Deciduous, susceptible to browsing | Seeds | Wood & fodder |
| 10 | Alnus nepalenses | Alnus | 1000 to 2800m | Sowing directly on site,shade loving tree | Medium to large, Deciduous | Seeds | Wood/ fodder |
| 11 | Alnus nitida | Kunish | 1000 to 2800m | Sowing directly on site,shade loving tree | Medium to large, Deciduous | Seeds | Wood/ Fodder |
| 12 | Arundinaria falcata | Nirgal | 800 to 2500m | Holds soil, along moist slopes | Clumps | Seeds/ cutting | Fodder. Culms |
| 13 | Arundinaria spathiflora | Nirgal | 2400 to 3000m | Holds soil, along moist slopes | Clumps | Seeds/ cutting | Fodder. Culms |
| 14 | Arundo donex | Narket | Upto 1500m | Coppices well poor fodder, large stature tropical grass | Hollow stem, Less woody | Cutting | Grass |
| 15 | Bauhinia variegata | Kachnar | Upto 1600m | Drought resistant, coppices well, perform well in degraded sites | Medium size tree, susceptible to browsing | Seeds/ cuttings | Fodder |
| 16 | Berberis spp. | Kashmal | 1200 to 2000 | Grows in dry areas, coppices well thorny shrub | Bears edible fruits, drugs | Seeds | Medicinal bee flora |
| 17 | Boehmeria rugulosa | Seengar | Upto 1600m | Adapts well to dry slopes | Small tree | Seeds | Fodder |
| 18 | Boehmeria platyphylla | | Upto 2000m | For moist slopes, along eroded streams | Shrub | Cutting | Fodder |
| 19 | Bombax ceiba | Cotton tree | Upto 1500m | Coppices well when small, timber used for match factory | Used for stuffing pillows | Seeds | Flowers edible |
| 20 | Buddleia paniculata | Buddleia | 1500 to 2500m | Drought resistant, coppices well flowering pink | Tomentum white/ brown | Seeds | Soil conser-vent |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21 | Butea monosperma | Palash | Upto 1500m | Flame of forest, drought resistant, pollard well | Deciduous Medium tree | Seeds/Root cutting | Dye, edible flower |
| 22 | Carisa carandus | Karonda | Below 1500m | Hardy bush type, thorny, fruit bearing, ornamental shrub | Bush type plant, evergreen | Seeds | Medicinal tree |
| 23 | Cassia fistula | Amaltas | Below 1000m | Hardy flowering, deciduous tree, drought resistant | Medium to large tree | Seeds | Medicinal tree |
| 24 | Cedrus deodara | Deodara | 1600 to 2800m | Shade loving, hardy tree, grows in snow areas well | Evergreen tree | Seeds | Timber |
| 25 | Colebrookia oppositifolia | Binda | Upto 2000m | Adapts well to dry slopes | Evergreen shrubs | Seeds | Medicine |
| 26 | Cotinus coggygera | Tung | Upto 2000m | Adapts well to dry slopes | Shrubs | Seeds | Medicine |
| 27 | Cynodon dactylon | Drub | Upto 1800m | Used only for turfing, medicinal value | Creeping grass | Seeds/ stolons | Fodder |
| 28 | Dalbergia sissoo | Shisham | Upto 1500m | Long tap rooted, producing abundance roots when injure | Deciduous large tree | Root suckers | Wood |
| 29 | Debregeasia salicifolia | Siharu | Upto 1800m | Coppice well pollard well hardy, shade loving | Ever green | Seeds | Fodder |
| 30 | Dendrocalamus hamiltoni | Banse | Upto 1800m | Large clumping, widely cultivated bamboos | Ever green | Suckers | Wood |
| 31 | Dendrocalamus strictus | Bans | 1200 to 2500m | Hardy, grows well in damper site | Evergreen clumps | Seeds | Fodder |
| 32 | Dodonea viscosa | Mehndru | Upto 1000m | Hardy, coppices well, Pollard well | Ever green | Cutting/ seeds | Hedges |
| 33 | Elaeagnus umbellata | Ghain | 1500 to 2000m | Thorney,fruit bearing,hardy plant | Bush type | Seeds | Wood |
| 34 | Emblica officinalis | Aonla | Below 1500m | Coppices well pollard moderately survive in degraded area | Small tree,strong light demanded | Seeds | Pickle |
| 35 | Erythrina indica | Flame of forest | Below 1500m | Hardy, fodder,fast growing plant | Deciduous | Seeds/stumps | Fuel |
| 36 | Eulaliopsis binata | Sebal grass | Upto 1500m | Used in direct seeding and all configuration of planted grass lines | Medium Seized, clumping grass | Cutting/ seeds | Grass |
| 37 | Ficus bengalensis | Bargad | Below 1000m | Frost resistant, strong light demander and hardy plant | Deciduous | Layering | Fodder |
| 38 | Ficus religiosa | Peepal | Below 1200 m | Medicinal frost resistant, strong light demander, hardy | Evergreen | Seeds | Fodder |
| 39 | Ficus palmata | Phegra | Upto 1700m | Hardy, adapts well to dry slopes | Evergreen | Seeds/ cuttings | Fodder |
| 40 | Ficus semicordata | | Upto 1500m | Hardy, adopts well to dry slopes | Evergreen | Seeds, cuttings | Fodder |
| 41 | Grewia optiva | Beul | Upto 2000m | Pollard well, hardy tree | Medium ht. | Seeds | Fodder |
| 42 | Hedychium acuminatum | Van haldi | 1000 to 2800m | Holds soil, along moist slopes | Rhizomatous perennial herbs | Rhizomes | Medicine, leaves |
| 43 | Hippophae rhamnoides | Seabuck thorn | Kinnaur L-Spiti | Deciduous, small bush, moisture loving, soil binder | Tea, drink, & other products | Seeds/ cutting | Fuel, fruit |
| 44 | Hippophae salicifolia | Seabuck thorn | Kinnaur , L-Spiti | Deciduous, large shrub, moisture loving, soil binder | Deciduous shrubs | Seed/ cutting | Fuel, fruit |

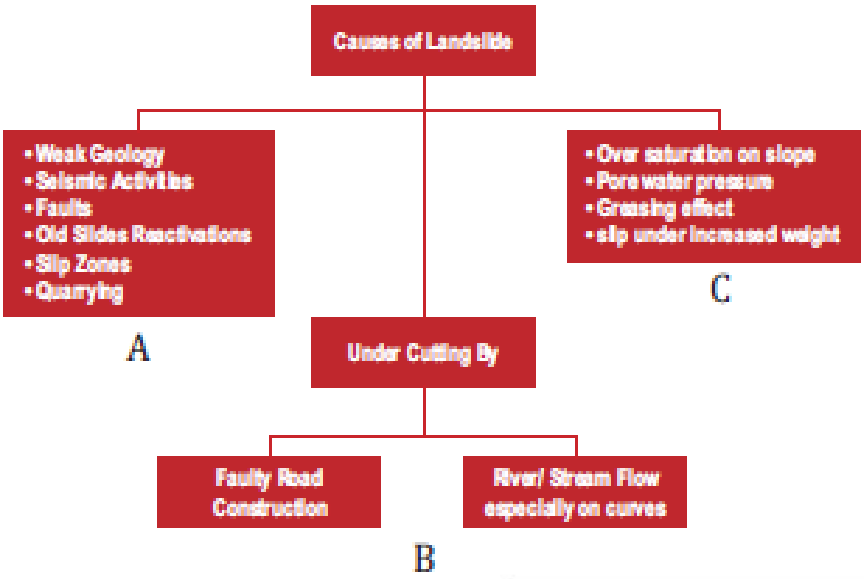
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 45 | Indigofera heterantha | Kathi | Upto 2400m | Coppices well, deciduous, eatable flowers | Flowering bush | Seeds | Fodder |
| 46 | Jasminum humile | Pit malti | Upto 1800m | Coppices well Pollard well, ground covering | Leaves used for sugar treatment | Cuttings | Ornamental |
| 47 | Jugulans regia | Akhrot | Upto 2800m | Moist loving, dye of bark is used in candy and ice cream | Deciduous large tree | Seeds/ grafting | Nuts, furniture |
| 48 | Mallotus Philippinensis | Kamal | Upto 1500m | Oil seed bearing, hardy, woody, soil conserving plant | Medicinal, fodder plant | Seeds | Oil |
| 49 | Mangifera indica | Mango | Below 1500m | Large evergreen fruit bearing plant | Bee flora, timber | Seeds | Fruits |
| 50 | Morus alba | Tut | Up to 1500m | Moisture loving used in silk worm rearing | Deciduous | Seeds/ cutting | Fodder |
| 51 | Murraya Koengaii | KARI Patta | Upto 1300m | Bushy evergreen, soil binder, hardy plant | Used in condiments | Seeds | Hedges |
| 52 | Murraya peniculata | Chameli | Upto 1500m | Large shrubs, hardy | Evergreen shrubs | Seeds | Hedges |
| 53 | Myrica esculenta | Kaphal | Upto 1500m | Drought resistant, pollard well | Evergreen tree | Seeds | Fruits fodder |
| 54 | Opuntia dilenali | Opuntia | Upto 1800m | Comes up well on neglected oil, drought resistant | Evergreen tree | Seeds/ cutting | Fruit |
| 55 | Parthenosissus tricuspidata | Verginea creeper | Upto 1800m | Covering rocks, Massionary works/buildings etc. | Deciduous creeper | Cuttings | Tree/ building cover |
| 56 | Pennisetum purpurium | Napier grass | Upto 1300m | Used in most of the Bio-engg. technique | Large grass | Cutting/ slips | Fodder |
| 57 | Phoenix sylvestris | Khajoor | Upto 1300m | Very hardy, fruit bearing, fodder plant | Bees flora | Seeds | Fruits |
| 58 | Picea smithiana | Rai | Upto 2500m | Shade/snow loving, required deep soil, ever green | Snow tolerant | Seeds | Packing cases |
| 59 | Pinus roxburghii | Chil | 500 to 2100m | Large coniferous tree, turpentine excreting plant | Huge evergreen tree | Seeds | Timber |
| 60 | Pinus wallichiana | Kail | 1500 to 2800m | Large coniferous tree turpentine excreting plant | Huge evergreen tree | Seeds | Timber |
| 61 | Pistacia integerrima | Kakar singi | Upto 1800m | This plant is of medicinal importance, deciduous in nature | Deciduous to small tree | Seeds | Medicine |
| 62 | Pongamia pinnata | Pongam mia | Upto 1000m | Hardy, leaves not relished by cattle etc. | Evergreen | Seeds | Soap ind |
| 63 | Populus ciliata | Pahari peepal | Upto 2500m | Moisture loving, wood used for packing purposes | Deciduous | Cutting/ seeds | Fodder |
| 64 | Prinsepia utilis | Bhekul | Upto 1800m | Hardy, thorny bush plant, bee flora | Evergreen medicinal plant | Seeds | Oil |
| 65 | Prunus cerasoides | Paja | Upto 1800m | Bee flora, hardy, wood used for making agriculture implements | Deciduous | Seeds | Omamental |
| 66 | Punica granatum | Daru | Upto 1500m | Fruits and bark of the plant has medicinal value | Medium to small tree | Seeds | Anardana |
| 67 | Pyrus pashia | Kainth | Upto 2000m | Hardy, fruits bearing, wood used for | Bee flora, root stock | Seeds | Walking sticks |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | agricultural implements | | | |
| 68 | Quercus leucotrichophora | Ban | Upto 2800m | Huge fodder plant & wood used in charcoal making | Ever green, fuel wood plant | Seeds | Fodder |
| 69 | Rosa muschata | Kuja | Upto 2800m | Resistant to grazing scented flower, root stock for roses | Thorny ground cover/ creeper bush | Cutting/ Seeds | Fodder |
| 70 | Rubus ellipticus | Hiunre/ Aankh | Upto 1500m | Fruit bearing hedging plant, (yellow fruit) | Spiny shrub 2 mtr. In ht | Seeds/root cutting | Fruit |
| 71 | Rubus niveus | Hiunre | Upto 2500m | Bee flower bearing hedging plant | Spiny shrub 2 mtr. In ht height | Seeds/root cutting | Fruit |
| 72 | Saccharum spontaneum | Sarkanda | Below 900 m | Very good grass for various bio-engineering activities | Grass up to 3 mtr. In ht. height | Seeds/root cutting | Fruit |
| 73 | Salix alba | Willow | Upto 1800m | Used in various bio-engineering techniques | Deciduous tree | Seeds/ cuttings | Fodder |
| 74 | Salix elegens | Willow | 2200 to 3500m | Moist slopes | Deciduous shrub | Cuttings | Fuel wood |
| 75 | Salix babylonica | Majnu | Upto 1500m | Used in various bio-engineering techniques | Deciduous large tree | Seeds/ Cuttings | Omamental |
| 76 | Salix tetrasperma | Biunse | Upto 1800m | Used in various bio-engineering techniques | Deciduous tree | Seeds/cuttings | Fodder |
| 77 | Sapindus mukorossi | Ritha | Below 1800m | Deciduous tree require deep soil | Medicinal tree | Seeds | Soap ind |
| 78 | Spirea canescens | Chaku | Upto 2500m | Hardy, soil conserving, flowering bush | Deciduous bush | Cuttings | Omamental |
| 79 | Syzygium cumini | Jamun | Below 1000m | Prefer moist places and coppices well | Medium to large size tree | Seeds | Fruits |
| 80 | Terminalia bellirica | Behra | Below 1300m | Hardy require deep soil, deciduous, fodder, adhesive | Medium to large size tree | Seeds | Medicine |
| 81 | Terminalia Chebula | Hared | Below 1300m | Hardy require deep soil patented drugs, fodder, deciduous | Medium to large size tree | Seeds | Medicine |
| 82 | Thysanolaena maxima | Broom grass | Upto 2000m | Used in varuoud bio-engineering techniques | Evergreen | Seeds/ Slips | Grass |
| 83 | Tinospora cordifolia | Galoi | Upto 1800m | Used in lot of Aurvedic medicine | Deciduous long creeper | Cuttings | Fodder |
| 84 | Toona ciliata | Tooni | Below 1500m | Moisture loving, hardy, unscientific pollarding is fatal to plant | Deciduous | Seeds | Timber, fodder, fuel |
| 85 | Wendllandia exserta | | Upto 1500m | Hardy, adapts well to dry slopes | Small tree | Seeds | Fuelwood |
| 86 | Vetivera zizanioides | Khas | Upto 2000m | Grows in almost every condition of soil & climate | Used in hedges, boundary marking | Slips/seeds | Grass |
| 87 | Vitex negundo | Shamalu | Upto 1000m | Prefer moist shady, stoney, hot road cuts | Can be used as hedges | Cuttings | Medicinal plant |
| 88 | Vitis vinifera | Jungli angure | Upto 2000m | Prefer shady spot, spreading on the canopy of tree | Deciduous | Seeds | Tree/ building cover |
| 89 | Woodfordia fruiticosa | Dhai | Below 1400m | Coppice well, pollard well, hardy plant | Grows in rocks | Seeds | Fodder |
| 90 | Zanthoxylum armatum | Timber | Upto 1700 m | Armed shrubs, adapt well to dry slopes | Deciduous hardy shrubs | Seeds | Fruits, datum |
| 91 | Zixyphus spp. | Jungle ber | Upto 1800m | Deciduous strong light demander, coppice/ pollard well | Medium sized tree | Seeds | Fruits/ fodder |

# Measures for Landslide Control


The Himalayan Mountains are vulnerable to landslides. Debris flow and other forms of mass wasting are commonly observed. These are the main geomorphic processes responsible for the transformation of landforms, along the mountain slopes, the valleys, plains and river channels far downstream. Such transformation because of frequent occurrences of landslides and debris flow is very pronounced in the Himalayas due to active tectonics, rugged topography, very high relief and high concentration of monsoon precipitation. Moreover, high human and livestock population and anthropological change in land use and land cover have caused further intensification of the processes of landslide and debris flow. The loss of life and properties from landslide, debris flow and flood has been increasing and the livelihood options of mountain people have been threatened.

## Causes of Landslides/landslips




### Land slide triggered by weak geology.

(Note: suitable grasses for eco-restoration)

- Weak Geology
- Seismic Activities
- Faults
- Old Slides Reactivation
- Slip Zones

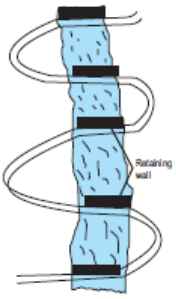
**Solution**

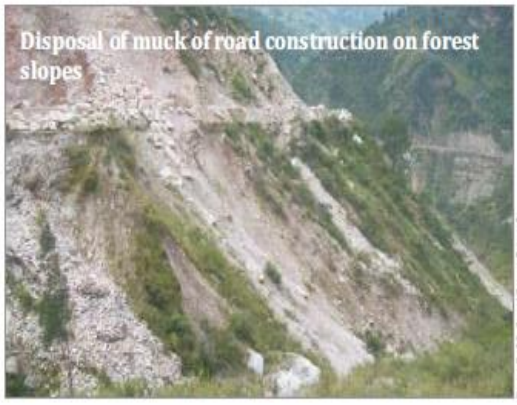
- Close the area with bio fence of Ram Ban
- Retaining wall at the base
- Dry stone walls at strategic location (1 m X 4 to 5 m)
- Geo-jute at pockets (astrial)
- Planting of local plant species
- Robinia, Drake, Leucinia, Alnus nitida (Kunish), Ailanthus Ram Ban, Punica granatum, Dodonaea viscosa, Debregeacia salicifolia (white leaves from below)
- Grass seeding (Good grass sods), Artemisia (broom), a deep rooted species proper.

### Landslide Triggered By Faulty Road Construction

### Solution

- Making slopes according to angle of repose
- Disposal of muck at defined muck sites
- Diversion of water from top to stable nala
- Retaining wall at the base and all sections on road cuts
- Channelizing flow through a waterway
- Planning bushes and grasses all along the waterway
- Cross drainage works along roads



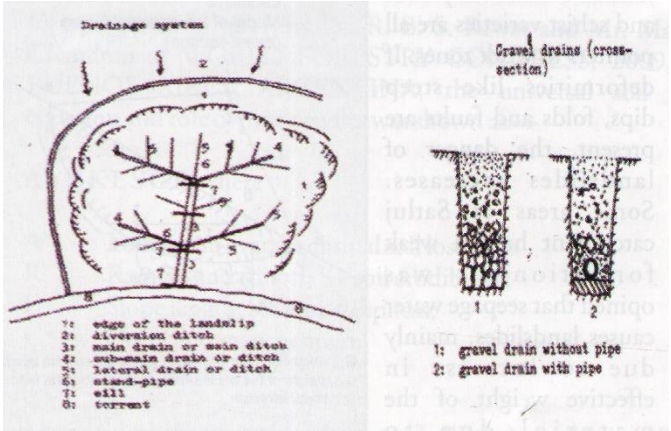
In Himachal Pradesh, several activities like road construction, deforestation, cultivation on steep slopes, excessive moisture (wetness) in pockets, and concentration of settlements contribute to landslides in addition to weak geology, location on faults, heterogeneity of strata and seismic activity. Basically, landslides manifest important soil degradation processes- Over saturation of steeply sloping strata increases its weight and reduces soil strength which slips under its own weight. This hydrological phenomenon often occurs during rainy season. Sometimes leaking irrigation channels also cause over saturation of soil mass. The under cutting of the base of slopes, by stream bank erosion or faulty road construction also leads to landslides. Reduction in forest cover is also responsible for landslides as network of roots, bind the soil together and trees anchor the soil mass and obstructs its downward movement. Increasing weight on slopes, by constructing buildings, also trigger land slips. In addition, blasting for road construction and excavation of tunnels of hydro- electric projects and unscientific quarrying also contribute to land slips and slides. The above said causes may act singularly or in combinations. Most slips occur during rainy season when the chances of combination of causative factors are highest. The emergence of hydro-electricity as a cheap source of energy has brought in its wake construction of long tunnels below the mountains, through blasting. Heavy machinery required in such projects calls for widening of roads. Construction of roads has increased ecological threats. Development and environment are at cross-roads----a huge amount of debris is produced, causing landslides—soil is invariably pushed down the slopes and adds to the silt loads of rivers. Fortunately, some biological production potential of the ecosystem gets to work with several plant species quickly coming up to colonize the site.

The landslide affected areas need to be restored quickly to halt further deterioration of the Himalayan ecosystem. The landslide control measures vary for different types of landslides, their causes of occurrence, extent of damage, location or altitude, type of local vegetation and materials available and urgency of control. A close study of site conditions and locality factors responsible for triggering landslide is necessary.

In one of the study, Agrawal 2006, reported that the prime cause of landslide was the triggering effect of excess rainfall generated, runoff spread over the creeping soil mass at the crown section, coupled with cutting at the toe by high discharge of the stream. The slip was further aggravated by rock bed dipping in the general slope direction. So, the over saturation, under cutting and weak geology joined together to cause the landslide. Sharma and Singh 1991 reported that thin beds of clayey limestone, shale, highly jointed sedimentary beds and schist varieties are all pointers to weak zones. If deformities like steep dips, folds and faults are present, the danger of landslides increases. Some areas of Satluj catchment have a weak formation—it was opined that seepage water causes landslides, mainly due to increase in effective weight of the material due to saturation, lubrication of the sliding planes especially of shale, and weakening of the strata, if it is clayey structure. Panchhot, Gumo (Urni) and Malling landslides/slips in Himachal are examples where hydrological factors played a role in landslides.

**Measures for landslides caused by excessive wetness/over saturation of slip zone:**

- The first and foremost action point is to locate the source of water entering from the upper areas.
  In case water is entering from some leaking irrigation channel, the control of such a leak by suitable technique is necessary. The channel may have to be lined, or water passed through a pipeline in that particular area. In case of runoff water, the



construction of a diversion channel would be necessary, to divert the runoff and dispose it off, at non-erosive velocity to a side drainage way. The diversion channel on gentle gradient may be protected by a stone laid bed and sides supported by vegetation.

- The drainage of excess water in the soil mass would require cross drainage works which may be done by installing perforated pipes, filter drains of stones/rubble (wire bolsters) and/or simple open drains converging to main pipe drain as shown in the figure.

**In the figure given above, the drainage system of a typical landslip site is shown**

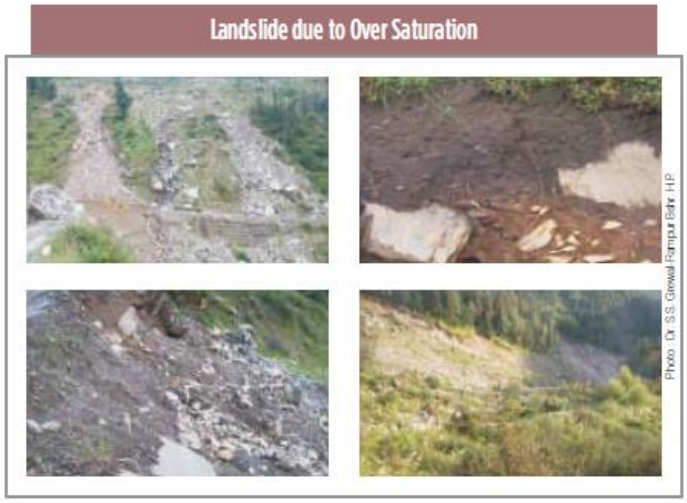
1. The land slide area is shown by outer hatching.
2. A diversion ditch is provided to carry away the water from top, for safe disposal.
3. A main drain of perforated pipes or gravel filter is provided in the centre along the slope.
4. Four sub-drains are provided as laterals to carry seepage/surface water to the main drain.
5. In each sub drain, few lateral drains or ditches are provided to drain water from the wet land.
6. At each junction, vertical stand pipes are provided, in which sub- pipes discharge water.
7. The main pipe at the end is placed over a wall or check dam or retaining wall for support; and water goes over this wall/structure without causing scouring at the base.
8. All the drained water is ultimately drained into the main torrent or drainage system.

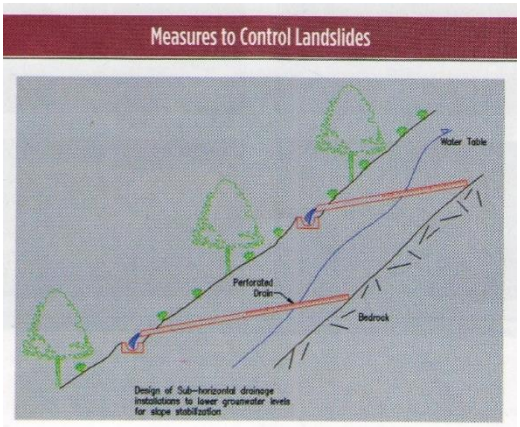
**Construction of Gabion/masonry/dry stone retaining wall:**

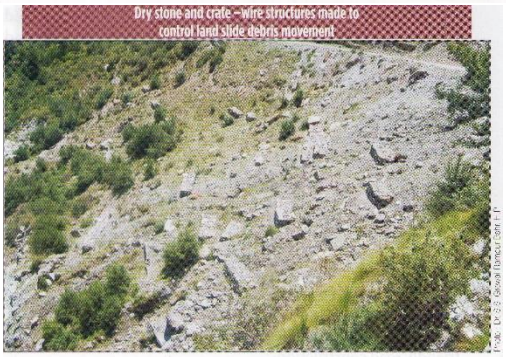
This is the third most important part of the treatment package of landslides. One major retaining wall, at the base of the landslide/slip zone, to hold back the entire soil mass, is necessary. The site should be selected carefully where maximum load can be retained with minimum length. The height of the retaining wall may vary from 1.5 m to 4.0 meters, depending upon the height of the soil mass at site. The base width of 2.0 m and top width of 1.0 m is often suggested. The retaining wall is constructed either straight with steps or slanting at an angle of 75-80 degree from the base. Weep holes of 7.5 cm must be made at regular interval @ 1/ 6 sq. meter. The back of wall is filled with boulders for ensuring quick drainage. A toe drain at the foot of the wall may be required to carry the overflow to the nearby nala.

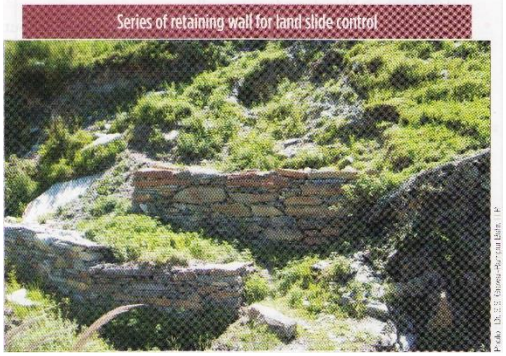
**Construction of a series of staggered retaining walls on the slope:**

In addition to the main retaining wall at the base, series of staggered dry-stone retaining walls are often required over the slipped land mass to retain the debris, in-situ. The local slate type stones are preferred for better stability. The number should not be too large as it would increase the weight of soil mass. More reliance has to be placed on vegetative measures.




**Bio-engineering measures for landslide control:**

The live hedges of selected tree and shrubs are planted almost on contour and soil binding grasses are planted between the rows of hedges. Close growing plant types, forming a mat structure and showing spreading and creeping habit, hold promise. Hardy and xerophytes are ideal for dry areas. Ravat et. al. reported that Woodfordia fruticosa shrub has great potential because of deep root system and Mimosa himalayana, a shrub, is also a good coloniser. Alnus nepalensis (tree), Debregeasia hypoleuca, Populus ciliata are considered as potential soil conserving tree species (Singh et. al. 1986 and Mathur et al 1982). Chaudhry et al recommended Alnus nepalensis, Populus ciliata, Crataegus crenulata shrub, Pennisetum clandestinum grass, on landslides damaged forest sites in the Himalayas.

**Protection of landslide areas triggered by faulty road construction:** The road construction and maintenance practices should be such that minimum disturbance is caused to the ecology of the mountain ecosystem. The following steps are necessary for eco- friendly road construction-:

- The cutting of rocks should not be vertical but slanting at an angle of 60 degree so that slope does not collapse.
- All the debris generated should not be pushed along the slopes but properly dumped at pre-decided dump sites.
- The dumping sites should have proper retaining walls to check the debris from falling into nalas.
- The dumping sites should be planted with suitable trees and bushes.
- The seepage and runoff water should be carried by guide channels and disposed off safely by making culverts and cross drainage works. Vegetation should be established on the slip sites.
- The steep slopes can be vegetated, using geo-jute mats.

**(a) Geo Jute:**

In recent times, natural geo textile products called geo-jute have entered the market and have become popular for eco-restoration of disturbed sites. This is basically a mat made of jute, with mesh size of 2 to 5 mm having an aperture of 10 mm. This being a bio- degradable material is found highly effective when used to stabilize mine-spoil sites, landslide/slip areas and specific slope stabilization essential to maintain road/railway network. The area to be treated is carefully measured and the length and width of sheet required is calculated. The surface to be covered is smoothened. The mat sheet is spread over the area and is secured by driving wooden stakes to a reasonable depth of 50 to 100 cm. The sides of strips can be buried in a 30 cm deep trench. The sheets are then overlapped with the adjoining sheet. The seeds/rooted slips/cuttings of the plants are planted during the wet season, through the openings, at quite close spacing, to have good cover, in a short time. The jute mat does not allow the movement of eroded mass and allows undisturbed germination and establishment of plants. Geo-jute was found successful for initial establishment of vegetation on degraded slopes up-to 60- 70 %. The total cost of jute and planting should be around Rs. 20-25/ Sq M.

**(b) Log Crib Structures:**

The log-wood crib structures are generally constructed, where stone check dams, are not feasible because of steep slope. The log-check dams are constructed as steps by nailing each of the horizontal cross poles of long lasting wood with 3-4 longitudinal poles. These poles are of 3-4 m length and 8-12 cm diameter. These are driven to a depth of 50 to 60 cm depth and erected in two parallel lines, about a meter, apart from pole to pole and one meter, from line to line. The height may be kept about 1.5 meters above the ground. The log-wood crib structures are filled with stones/brush wood which can be used to stabilize slopes, above 40 %. The inter space between paired lines is vegetated with suitable quick growing plant species. These are stable, because horizontal poles can withstand the load of the earth above it and consequently hold the soil more effectively and provide the vegetation an opportunity to establish.

**(c) Gunny Bag Structures:**

The practice of using empty cement gunny bags for temporary protection is quite common in the PWD department (primarily because of easy availability). These bags are filled with inert material like sand and gravel (not soil as it hastens decomposition of gunny bag), and used for bank protection, slope stabilization and temporary diversions. For more stability and durability, the cement and sand are mixed in the ratio of 1: 20. The filled gunny bags are laid in rows, one over the other, to gain the desired height. The back side is filled with earth and compacted.

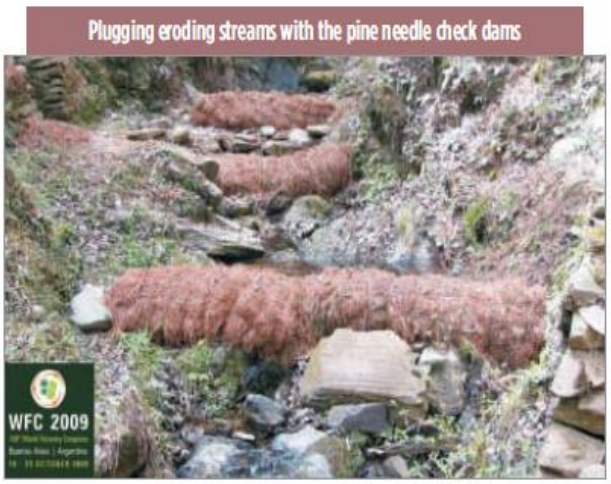
**Pine Needle Check Dams**

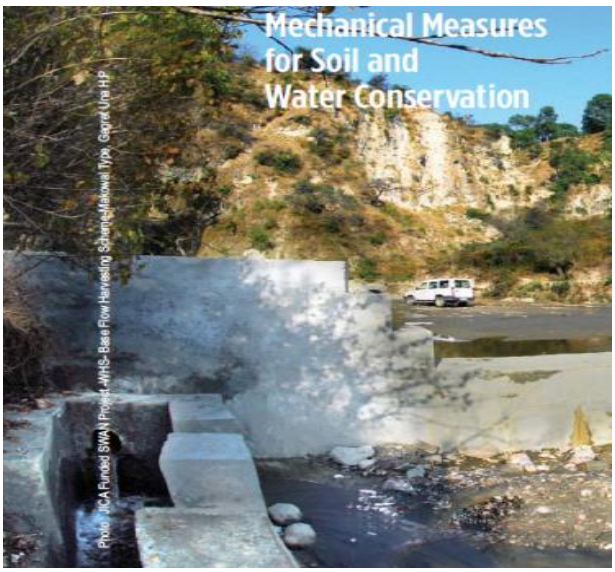
In a presentation given by Dr. R. B. S. Rawat and Mr. Manoj Chandran at WORLD FORESTRY CONGRESS, 2009, in BUENOS AIRES, ARGENTINA, the universal soil loss equation and role of pine needles was shown as =>

**A = R K L S C P**, where

**A** – Long-term average annual soil
**R** – Rainfall and runoff; K - soil
**L** – Slope length; S -slope steepness;
**C** – Cover and management;
**P** – Support practice.

Materials required were coir net 4" (10cm) mesh size; Pine needles and stakes–vegetative cuttings. It was observed that the costs incurred were effective compared to stone check dams or gabion structures.






## Mechanical Measures for Soil & Water Conservation


## Calculation of Peak Discharge at proposed site

$$Q = \frac{C \times I \times A}{360}$$

Estimation for Peak Discharge, where
- Q = Peak Rate of Run-off in cumecs
- C = Runoff Coefficient
- I = Intensity of Rainfall( mm/hour)
- A= Area of catchment (Ha)

| Vegetable Cover and Slope | C-Values in Soil Textural Classes | | |
|---|---|---|---|
| | Sandy Loam | Clay & Silt Loam | Stiff Clays |
| **Cultivated Land** | | | |
| 0-5% | 0.30 | 0.50 | 0.60 |
| 5-10% | 0.40 | 0.60 | 0.70 |
| 10-30% | 0.52 | 0.72 | 0.82 |
| **Pasture Land** | | | |
| 0-5% | 0.10 | 0.30 | 0.40 |
| 5-10% | 0.16 | 0.36 | 0.55 |
| 10-30% | 0.22 | 0.42 | 0.60 |
| **Forest Land** | | | |
| 0-5% | 0.10 | 0.30 | 0.40 |
| 5-10% | 0.25 | 0.35 | 0.50 |
| 10-30% | 0.30 | 0.50 | 0.60 |

## Design of spillway to carry peak discharge

To carry the peak discharge at a recurrence interval of 10 years, equal to the time of concentration, the spillway section is designed where

$$Q = 1.711 \times L \times H^{3/2}$$

$$L = Q / 1.711 \times H^{3/2}$$

- L= Length of spillway
- H = Height of spillway over crest/Head wall
- F = Freeboard

Assume value for H according to cross section and work out Length. Add about 20 % free board to the head of weir.

## Structural Design

H= Height of the structure
δ = Density of material used
h = Head of weir
F = Fall

- Base Width $= \frac{H}{\sqrt{\delta}}$
- Top Width $= 0.552 \sqrt{H}$
- Foundation Depth = H/3
- Apron Length = 2.28 h + 1.18F (1.5f+h)
- Apron Thickness: For an over fall of 2.0 m, the apron thickness, in concrete construction, is 0.30 m. If constructed in gabion, the same may be increased by 1.5 and 2.0 times.
- Wall Thickness: The thickness of different walls of the structure (masonry) are given below:

| Description | Thickness of walls (m) | |
|---|---|---|
| | Top Width | Bottom Width |
| Head Wall | 0.45 | 1.33 |
| Side Wall | 0.30 | 0.45 |
| Wing Wall | 0.30 | 0.50 |

## Dimensions of various parts of drop structures for 3 height classes when constructed in plain cement concrete(Thumb Rules)

| Structure Part | Structure Design Dimension | | Height of drop structure 1m | 2m | 3m | Remarks Based on area, location and purpose |
|---|---|---|---|---|---|---|
| Crest Head Wall | Top Width | 0.2 -0.3f | 0.30 | 0.45 | 0.90 | |
| | Base Width | 0.6 -0.7f | 0.60 | 1.20 | 1.90 | Up to hard strata |
| | Foundation depth | 0.3f | 0.45 | 0.60 | 0.90 | |
| | I-Step | 1:4.8 | 0.15 | 0.20 | 0.30 | Gatka |
| | II-Step | 1:3.6 | 0.30 | 0.40 | 0.60 | |
| Head Wall Extension | Base Width | 0.30 | 0.60 | 0.90 | | Anchor % 0.6 to 0.9m |
| | Top Width | 0.30 | 0.45 | 0.60 | | |
| | Foundation I-Step | 0.10 | 0.20 | 0.30 | | |
| | II-Step | 0.20 | 0.40 | 0.60 | | |
| Sidewalls | Width to be lifted From Apron | | 0.30 | 0.30 | 0.50 | To be raised from apron |
| Apron | Length | 1.5 X F | 2.0 | 3.0 | 5.0 | 2.28(h/f+0.52) |
| | Foundation I-Step | 1:4.8 | 10 | 15 | 20 | |
| | Foundation II-Step | 1:2.4 | 20 | 30 | 40 | |
| Toe wall | Foundation I-Step | 1:4.8 | 0.10 | 0.15 | 0.20 | |
| | Foundation II-Step | 1:3.6 | 0.20 | 0.30 | 0.40 | |

| | Structure Design Dimension | Height of drop structure Up to 2m | Above 2m | Remarks |
|---|---|---|---|---|
| General Formulas | Foundation depth | 1/3F | 1/3F | |
| | Base Width of Crest Wall | 0.6- 0.7F | F/ | Fall % 1.55 |
| | Top Width of Crest Wall | 0.2- 0.3F | 0.552 | |
| | Sidewall width | 0.3m | 0.5m | |
| | Apron Length | 1.5F | 2.28 | |
| | Head wall extension width | 0.3 m | 0.5 -1 m | |

Where
F = Fall /Drop (in meter)
h = Head of weir (in meter)
= Density of material used e.g. 2.4 t/m3
Based on manual of Soil & Water Conservation and practical experience.
Can be modified for specific site requirement.

## TECHNICAL ISSUES

### Technical Issues for Improving the Quality of Construction Work

The quality of construction is very important:-

- Firstly, the specification of the material to be used in the construction should be clearly laid down in the cost estimates.
- Secondly, wherever the use of local material was considered feasible and its quality was found suitable, the sieving and grading of such materials should be done to further improve their quality.
- Thirdly, local carriage to be provided depending upon the distance involved.
- Lastly, a set of guidelines to be provided with each estimate which clearly mention the need of effective supervision, use of proper equipment, need of curing and so on.
- Vegetative measures are equally important and form part of treatment package.
- These measures should precede and not follow the mechanical measures.
- Local conservation flora should be used such as Nara, Bana, Bamboo, Ipomea, Kana, Agave etc.
- Best time for planting is October when moisture is there.
- Regular inspection is necessary.
- Crate wire structures constructed by purchasing stones from outside turns out to be quite expensive.
- The concrete check dams of the same size and capacity as that of the crate wire turns out to be relatively cheaper, provided local material is used.
- Moreover, concrete structures have longer life and more durable and better visibility.
- Crate wire and dry stone structures should be constructed preferably when stones of the desired quality and quantity are available at construction site.

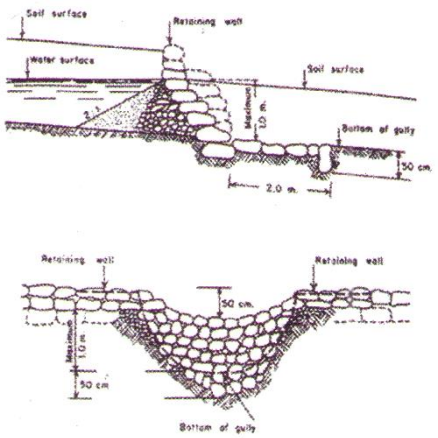
### SOCIAL ISSUES

- Developing a mutually agreed common agenda with Gram Panchayat, based on watershed concept, needs a lot of effort and patience.
- Communities are pressing hard for water resources development where user group formation need attention.
- No rigidity as some works may emerge after micro planning.
- The construction of footpath is largely be managed from NREGA funds and hence may carry low priority for the NRM projects.
- The impact assessment of project intervention would require establishment of base lines.
- The base lines for environmental impact assessment are particularly important.
- A proper methodology and mechanism needs to be worked out for this purpose.
- Socio-economic data collection is necessary for working out changes in social and economic status of communities.
- A welfare state must address problems of the community and take them along.
- Way to forest should be through the village.

## ADMINISTRATIVE ISSUES

- The skill development of the field functionaries is important to handle such technical works.
- Various categories of staff would require different types of trainings for their capacity building.
- Provide topo-sheets, survey equipment, GPS, relevant literature.
- Ensure supervision and guidance.

**Dry Stone Check Dams**




Dry Stone Check dams are porous checks constructed across the nala using loose boulders to check water velocity and to arrest silt. These can be constructed in all areas irrespective of soil and rainfall and are effective for reducing run-off velocity in upper parts of the drainage lines having steep slopes. These are planned in shallow/ first order gullies, having stones of suitable quality and required quantity, locally available in and around the drainage ways. When properly constructed by trained masons and suitable sites selected, such structures help in stabilizing bed gradient and establishment of vegetation, in the silted up portions of the gullies. This is a semi-permanent mechanical measure. Slab type dressed stones are arranged with proper spillway in the center. At least half a metre anchorage to sides and half meter foundations are enough for a one metre high structure.

The normal design specifications are as under:

| | |
|---|---|
| Top width | : 0.5 to 1.0 m |
| Base width | : 1.0 to 2.0 m Height above ground level : 0.6 to 1.2 m Depth |
| of foundation | : 0.3 to 0.6 m |
| Side slopes | : 0.5: 1.0 |
| Anchorage to banks | : 0.45 to 0.75 m |
| Spillway section | : Length should be as per discharge or roughly 1/3 of nala width and head over crest may be as per discharge or 0.3 to 0.5 meter. |
| Apron | : Width 1.0 to 1.5 X Fall |
| Length | : Entire section below spillway and side walls |
| Depth | : Minimum 0.3 m and should be below the immediate ground Level. |

Proper site selection is very important for all types of erosion control structures. These structures are constructed in series, one after the other, usually keeping head and toe relationship minus the permissible stable bed gradient. The following points may be considered in site selection:

- The gully should have a narrower section at the dam axis.
- It should have bowl type wider section above the site for storage of water and silt.
- Preferably, the bed gradient in nala should be as low as possible above the site. This would ensure more storage of water/debris.
- Slab type/flat type stones should be available near the sites. No stones should be excavated from the actual nala bed.
- Construction with stones transported from longer distances be avoided in view of high cost involved.
- In case nala bed is well covered with vegetation and no scouring is visible, then dry stone check dams may not be required.

**Construction**

- A copy of the approved plans and estimates should be obtained by the field staff executing the work.
- First of all, the proposed site is located on the ground.
- The slab type stones are collected at site in advance.
- The site is cleared of all vegetation including uprooting of trees, bushes, grass and removal of all organic matter.
- The foundations are dug to a uniform depth and dimensions as provided in the plans.
- These stones are laid properly by breaking the joints. Anchorage to sides is ensured.
- The stones of larger size are used in the central part and spillway portion because of more pressure of water.
- The slab type stones in each layer are made stable by inserting smaller broken stone pieces.
- The corners of stones are slightly dressed to maintain uniformity in size.
- The gaps are filled with smaller stones or broken pieces such that the holes between the stones are reduced to the minimum size.
- Slight curvature is given, like half-moon to the main wall on the downstream side, so as to provide the strength of an arc to the dam body.
- Each layer of stones is receded by about 5 cm (slightly more from centre and less from sides) so that a cascading effect is generated when water falls from the spillway section over the apron.
- Round stones be avoided as they do not remain stable in construction without mortar.
- Slabs of soft sandstone are not recommended because of their low structural strength.
- The apron should be lowered and embedded in the ground and its top should be 20 to 30 cm below immediate ground level.
- The top level of wing walls/ head wall extensions should be at the same level.
- Vegetative reinforcement above and below the structure is important for its functional success.

**The dry stone structures may fail when**

- Wing walls/ extensions are not anchored sufficiently to the sides or into the banks.
- Less anchorage to the sides, at the base, results in leakage from the sides.
- Toe of the structure erodes if no head-toe relationship is maintained.
- Structure may tilt, sag or breach, if sufficient foundation is not provided.
- Structure constructed at a bend or at a curve in a nala is more liable to fail.

**Gabion Check Dams**

Gabion structures are made with stones/ boulders packed closely in wire mesh cages made with G.I. wire of 10 gauge thickness. Gabion structures are preferred in soil conservation works as they are: (a) Flexible (bend without breaking), (b) Porous (Water can seep through them), (c) Stable, and (d) Economical as compared to cement concrete structures.

Galvanized iron (GI) wire of 8-10 gauge thickness is used in the fabrication of wire nets and the mesh size is generally kept 10-15 cms. Gabion structures have a long life(20-25 years) almost similar to cement masonry permanent structures.

**Suitability:**

The Gabion check dams may be constructed in main gullies/channels for retention of debris and soil accumulation without pondage. The debris carrying capacity within the inter-structure reach, lessens, due to reduction in channel gradient. The check dams encourage good plant cover, not only along the bank, but also in the bed of the stream, due to increased moisture regime. Cross barriers are suitable in the head water reaches, in higher order streams and main drainage channels, receiving relatively large quantities of runoff and debris flow.

**Specifications:**

| | | |
|---|---|---|
| Top width | : | 1 m |
| Depth of foundation | : | 0.3-0.5 m |
| Height above GL | : | 1-3 m |
| Keying into banks | : | 0.3 -0.6 m into stable portion |
| Galvanized iron wire | : | 10 gauge (3.14 mm dia) |
| Mesh size | : | 15 cm x 15 cm to 20 cm x 20 cm |

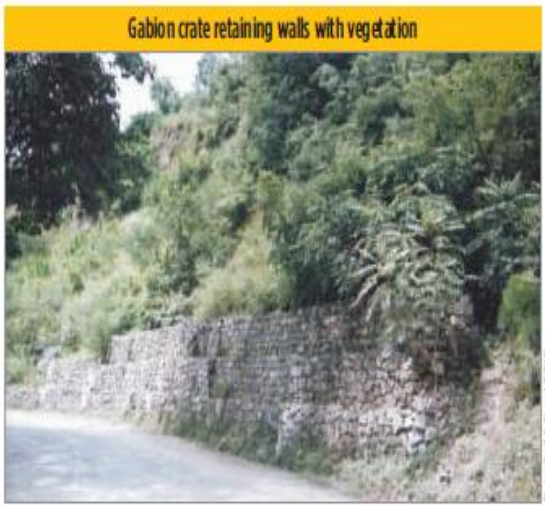
Gabion structures are made with stones/ boulders packed closely in wire mesh cages made with G.I. wire of 10 gauge thickness. Gabion structures are preferred in soil conservation works as they are:

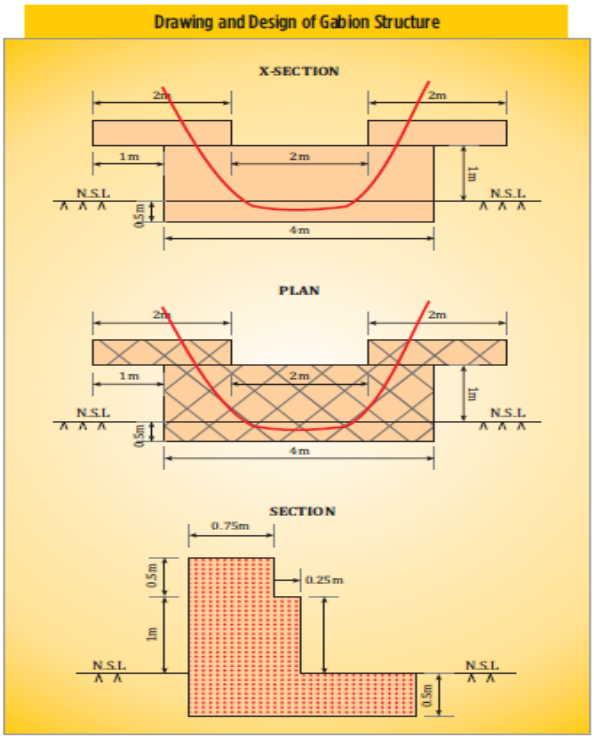
- Flexible (bend without breaking)
- Porous (Water can seep through them)
- Stable, and
- Economical as compared to cement concrete structures.

**Construction**

- The wire mesh is fabricated and boxes are made with a dimension of 2 m x 1 m x 1 m or to another desired dimension with a mesh opening size of 10-20 cm depending on the stone size.
- The site needs clearance.

- Excavate the foundation trench of required width and upto desired depth (normally a foundation depth of 0.3-0.5 m is sufficient). The trench is smoothened and compacted; the sides of gully are also excavated to about 0.3-0.6 m for keying of the structure to prevent undercutting.
- Place the G.I. wire mesh in the trench and start hand packing of stones. Larger size stones (more than 20 cm size) are used at the bottom portion and along the sides. The void space between the stones is filled with small size stones. The construction is carried on till the desired height is obtained.
- The sides of the wire mesh are tied together with the protruding wires. If required next wire mesh cage is laid over/along it and the same procedure is repeated. The adjoining cages are again tied together with the wires.
- Provide the desired weir opening to the structure for safe disposal of peak runoff.
- On downstream side, provide 2 to 2.5 m wide gabion/rubble soling along the full length of the structure. This helps to prevent erosion of the downstream side of the structure.


Gabion crate retaining walls with vegetation




**Gabion structure with Ferrocement Impervious Barrier:-**

A Ferrocement gabion has 2.5 cm thick impervious wall of ferrocement at the centre of the structure which goes below the ground level upto the hard strata. This ferrocement partition supported by gabion is able to retain the water. It effectively retains water as well as withstands the force of runoff water. Use G.I. wire of good quality for wire mesh fabrication to ensure durability and strength to the structure.

**Construction of ferrocement impervious barrier**

- Clean the site first
- Excavate the foundation trench upto the hard strata.
- Lay down the concrete in the proportion 1:3:6 and thickness of 15 cm for the ferrocement of the foundation.
- Construct the ferrocement wall at the centre of the foundation trench upto 7.5 cm below ground level. Fill up the upstream and downstream sides of the ferrocement wall with sand (about 15 cm thick) and the remaining trench with available soil. The sand layers protect the ferrocement from the swelling action of the surrounding soil and also allows the water which is sprinkled on top for curing to go down to the bottom.

- Next, provide a 7.5 cm thick concrete bed of 1:2:4 proportion on the ferrocement wall. Place on it, the G.I. wire mesh of size 15 cm x 15 cm made of GI wires of 10 gauge thickness. Lay the remaining 7.5 cm thick concrete above the earlier layer, so that the chain link gets fully embedded in the concrete. A ferrocement wall upto the full supply level of the structure should then be built above the concrete.
- Construct a stone bund keeping the Ferro cement wall at the centre.
- The whole structure including ferrocement core wall should go upto 0.3 to 0.6 m into the stable portion of the gully side to prevent end-cuttings.
- Raise the end portion of the structure to the level equal to the flood depth plus free board- the aim is to prevent scouring of the nalla banks.
- On the downstream side, provide 2 to 2.5 m wide gabion/rubble soling along the full length of the structure. This helps to prevent erosion of the downstream side of the structure.

**Flexibility:**

In uneven, sinking foundations gabions can bend without breaking. Whenever there is some unequal settlement in the foundation, these structures do not collapse like rigid structures.

**Permeability:**

Gabion structures are highly permeable and act as self-draining units. Seepage or base flow is easily drained off, by them and thus structures are safer against hydraulic pressure.

**Stability:**

A gabion is a heavy gravity unit, able to withstand earth thrust. With time, silt deposits within the voids and vegetation finds a foot hold, with the whole structure becoming a solid mass.

**Economy:**

Gabion structures are comparatively cheaper than masonry or concrete structures. Boulders and stones are used for their construction, often locally available. Construction is simple and can be done by unskilled labour with a little experience.

**Construction procedure:**

Gabion structures are constructed, joining individual stone packed wire mesh cages of suitable sizes. These cages serve as unit blocks for Gabion constructions. These unit blocks may be made in the desired shapes. However, a mesh size of 3 m x 1 m x 1 m size has been found most common and convenient.

Hot dipped galvanized iron (GI) wire (IS: 280-1978) should be used for fabrication of wire mesh. A 10 gauge (3.14 mm dia) thick wire is generally used. However, 8 gauge wire may be used in river training works, if necessary.

**Fabrication of wire mesh:**

Wire mesh can be fabricated at the site by a semi-skilled worker. Mesh size may be kept from 7.5 cm – 20 cm depending upon the size of stones/boulders available (Mesh opening should be less than the size of stones). Two methods of fabrication of wire meshes are generally used. In the former method, the wires are knit moving in the same direction, whereas in the later method wires move laterally. The vertical frame method, is described below for fabrication of a wire mesh of 10 cm x 10 cm mesh opening and for a finished wire cage of 3 m x 1 m x 1 m. However, meshes of other sizes can also be fabricated.

1. A wooden frame is erected with the central 3 m portion is used for the main wire net, whereas 1 m sides on both sides are used for fabricating the flanks. Nails are fixed at 10 cm spacing (or at desired mesh opening).
2. Wire pieces are cut as per following: 18.5 m -1 No. (For peripheral wire, 5.5 m (9 numbers), 4.5 m (39 numbers), 3.25 m (30 numbers) and 1.25 m (20 numbers)). These wires are winded in coils by a simple wire winding machine.
3. First the peripheral wire (18.5 m long) is placed over the nails in the frame such that the wire goes all along the periphery of the wire net. The coils are vertical wires (4.5 m long) are tied up from the nails at the upper horizontal beam. Similarly, the coils of horizontal wire (10 numbers, 3.25 m long) tied up from the second beam, from left. Both the horizontal as well as vertical coils are unwound generally and at every junction given a double twist. After one metre length of net, the 5.5 cm long wire coils are tied up on the nails of the first beam on the left. Additional 1.1 m long wires are tied on the upper horizontal beam on extreme left and right side. These are used for making side flaps of wire cage. After making 1 m length of wire net, the rest 2 m length is made as per procedure described earlier. As the fabrication of wire net proceeds, the finished portion is lifted up and tied by a wire for convenience knitting of the rest portion.

Another method of wire knitting uses a horizontal beam. Two wires are put together along each nail. Two wires are taken each from the adjoining nails and given a double knot. Here wires move laterally instead of horizontally and vertically in the method described earlier.

A foundation of about 0.3 – 0.5 m deep is dug at the site for Gabion construction. The Gabion mesh is placed at the site, keeping the sides, top and flaps in the correct position. The stones/boulders are hand -packed inside the mesh, keeping the big boulders at the bottom and sides which are smaller are filled in the middle. When the stone packing is complete, the sides and flaps are pulled up tightly over the stones and tied up with extra wire, extending from the mesh or by using separate wire pieces. Similarly, other gabion blocks should be tied with each other firmly so that the whole structure is intact.

**Permanent Structures for Gully Stabilization**

Permanent soil conservation structures such as Drop, Drop Inlet and Chute spillways are often used for runoff and sediment control as well as storage of water for irrigation in arable and non- arable lands. These structures can be constructed of cement masonry or Gabion.

**Suitability:**

Their use becomes necessary when the runoff from the catchments is too large to be handled through vegetative measures/temporary structures or where high degree of safety is warranted against the loss of life and property. However, it should be ensured that the benefits from such structures are justifiable to the cost of construction.

Drop spillways are used for gully stabilization or sometimes as water storage structures where the drop is low. Drop inlet structures are used at appropriate locations in the gully for storage of water/sediment. Chute spillways are used at gully heads to convey the water safety to the gully bed.

**Design Criteria:**

The hydraulic structures consist of three major components-the inlet, conduit and outlet. Water enters the structures through the inlet and is conveyed through the conduit and leaves through the outlet which is responsible for the energy dissipation to prevent erosion.

Permanent structures in soil conservation are normally designed for a recurrence interval (RI) or frequency of 10 -50 years which means, they are supposed to discharge the maximum discharge during the designed (RI) safely. The structure should be strong enough to withstand the forces exerted by water/earth. A structure should, therefore, be designed with the following considerations:

i) **Hydrologic design-** It involves computation of the peak discharge at the point of the watershed, where the structure is to be constructed. Generally, Rational Method is employed for the purpose.

ii) **Hydraulic design-** It involves calculation of the dimensions of the spillway which is able to carry the above peak discharge.

iii) **Structural design-** It involves calculation of the dimensions of each component of the structure which ensures its safety against water/earth forces which the structure is to withstand.

**Drop Spillway:**

Drop spillway is a weir structure. Flow passes through the weir opening, drops to an approximately level apron or stilling basin and then passes into the downstream channel. The different components of the drip spillway are (1) head wall and head wall extension, (2) side walls, (3) wing walls, (4) apron, (5) longitudinal sills.

**Functional uses:**

- Gully and ravine stabilization
- Erosion control structures for stabilization of landslides and mined areas.
- Protection of fields, roads and hutments etc. from gullies.
- Grade control for stabilizing channels & waterways.
- Reservoir spillway where the total drop is relatively low
- Control of irrigation water

**Adaptability:**

The drop spillway is an efficient structure for controlling low heads, normally upto 3 metres.

**Site selection:**

- The site should be selected so that the spillway can be located on a reasonably straight section of the channel, with no upstream or downstream curves, within at least 30 m of the structures. Poor alignment may result in reduction of the storage capacity and excessive scour of the embankment and channel banks.
- The site should provide an adequate foundation for the spillway.
- The foundation material must have the required supporting strength, resistance to sliding and piping and be reasonably homogenous, so as to prevent unequal settlement of the structure.

**Design of Drop Spillway:**

a. **Hydrology design:**

The peak rate of runoff expected during the designed recurrence interval (RI) from the watershed can be computed by the Rational Formula given below:

$$Q = \frac{CIA}{360} \quad \text{.....1}$$

Where,

Q = Design peak rate of runoff, m3/s

C= Runoff coefficient

I= Intensity of rainfall, mm/hr for the duration equal to time of concentration (Tc) of watershed and design RI

A= Area of watershed, ha

**b. Hydraulic design**

The discharge through a broad crested rectangular spillway is governed by the following forumula:

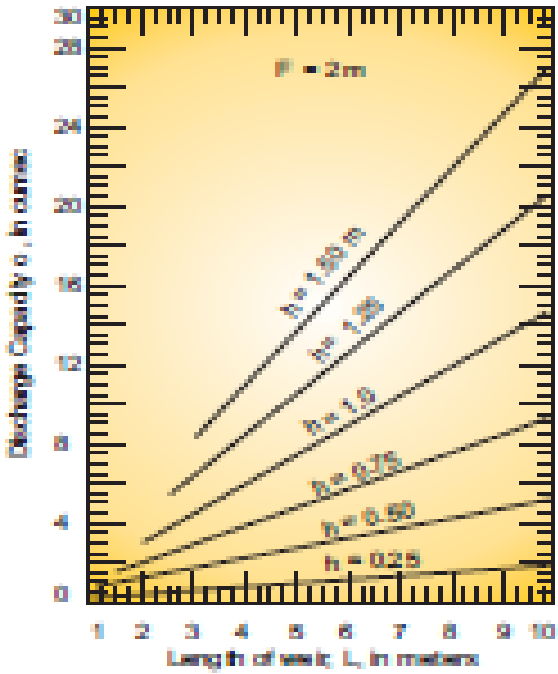
$Q = 1.71\ LH^{3/2}$ .....2

Taking into account the force board (f. b) to be provided for the wave action the above formula is modified as

$$Q = \frac{1.711\ Lh^{3/2}}{(1.1 + 0.01\ F)}$$ .....3

Where
Q= Maximum discharge capacity of weir (including f.b.), m3/sec L= Crest length of weir, mts.
h= Height of weir (including f.b), mts.
f= Net drop from top of transverse fall to crest, mts.

The peak discharge (Q) in Eq. 3 can be taken as the one calculated from Eq. 1. The net fall, F, is known from the survey of the site where the structure is to be located. Still Eq. 3 consists of two known variables L and h, hence the equation cannot be solved as such and requires hit and trial solution. To start with one of the unknown values of L or h can be assumed based on gully cross section and computations done as explained below:




Assume a suitable value of h such that h/F<= 0.5 (as h/F ratio increases the tendency to scour increases, this ratio should in no case exceed 0.75).

1. Put this assumed value of 'h' in Eq. 3 and compute value of 'L'.
2. Check L/h>= 2. If not, assume another lower value of 'h' and compute corresponding value of L as in step 2, till this condition is satisfied.

See that the computed value of 'L' is appropriate with the width of the gully.

**Structural Design**

After L, h and F have been decided by the hydraulic requirements the dimensions of the components of the structure can be computed from the following empirical relations (Eq. 10)

E = Minimum length of head wall extension, m
= (3h+0.6) or (1.5 F) whichever is greater -------- (4) LB = Length of apron, m
= F (2.28 h/F + 0.52) ----- (5)
S = height of end sill, m
= h/3 ----- (6)
J = Height of wing wall and side wall at junction, m ----- (7)
M = 2(F + 1.33 h-J) -------- (8)
K = (LB + 0.01) – M -------- (9)
Sh = Height of longitudinal sill = h/4 -------- (10)
St = Height of transverse sill = h/3 -------- (11)

**Foundation design:**

Cut off and toe wall are constructed below the ground level in foundation (Figure). Cut off wall is constructed below the head wall to prevent seepage below the structure. Whereas, cut off wall is extended below the front of apron to prevent under cutting. Scour formulae are adopted for the design of cut off and toe wall as below:

Normal Scour depth (NSD) = 0.473 (Q/f)1/3 ---- (12)

Where f = silt factor (1-1.2)

Maximum scour depth (MSD) = 1.5 x NSD ---- (13)

The height of the cut off and toe wall may be taken equal to MSD in eq. above.

**Apron thickness:**

Thickness of the apron in plain concrete may be kept from 20 cm to 30 cm for overfall height (F) varying from 0.5 to 3.0 m. For masonry and gabion constructions, the same may be increased by 1.5 and 2 times respectively.

**Wall thickness:**

Top width and minimum base widths of headwall, side wall, wing wall and headwall extension for different wall heights for different constructions can be determined using the formulae presented in the table below:

Table: Formulae for determination of base width of different walls of a drop spill way in different construcitons:-

| Type of construction | Min. Top width (m) | Walls Head wall | Side wall |
|---|---|---|---|
| Plain Concrete | 0.25 | 0.67 (F -0.4) + 0.25 | 0.55 (F- 0.45) + 0.25 |
| Masonry | 0.45 (head wall)<br>0.30 (Other walls) | 0.67 (F- 0.67) + 0.45 | 0.55 (F – 0.55) + 0.30 |
| Gabion | | 0.67 (F- 1.12) + 0.75 | 0.55 (F- 1.40) + 0.75 |

F = height of wall from top of the crest to the bottom of apron.

Based on the above formula for masonry construction, the dimensions of above mentioned walls are given on table below:

Table: Thickness of walls of a drop spillway constructed in stonew or brick masonry:

| Description Minimum top width (m), Wall height (m) | Head wall 0.45 | Side wall 0.30 |
|---|---|---|
| 0.5 | 0.45 | 0.30 |
| 1.0 | 0.67 | 0.55 |
| 2.0 | 1.33 | 1.10 |
| 2.5 | 1.67 | 1.37 |
| 3.0 | 2.00 | 1.65 |

**Masonry Drop Structures:**

Drop spillway is a weir structure. Flow passes through the weir opening, drops to an approximately level apron or stilling basin and then passes into the downstream channel. The different components of the drip spillway are (1) head wall and head wall extension, (2) side walls, (3) wing walls, (4) apron, (5) longitudinal sills.

**Functional uses:**

Gully and ravine stabilization

Erosion control structures for stabilization of landslides and mined areas.

Protection of fields, roads and hutments etc. from gullies.

Grade control for stabilizing channels & waterways.

Reservoir spillway where the total drop is relatively low

Control of irrigation water

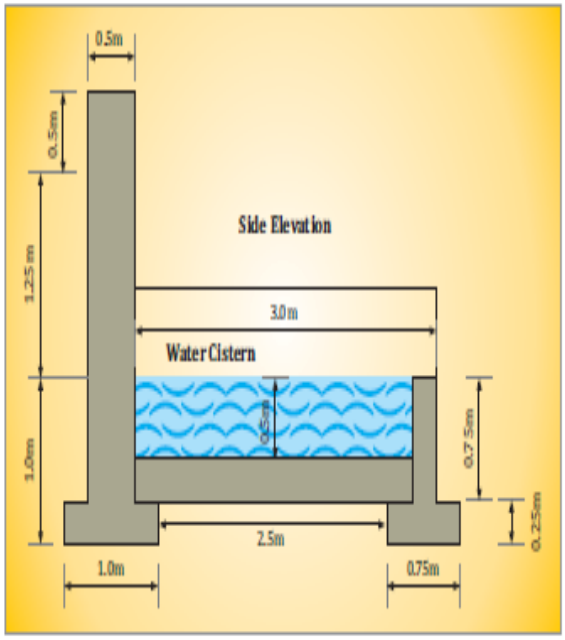
Adaptability

The drop spillway is an efficient structure for controlling low heads,

**Masonry walls with apron:**

**Masonry Drop Structures (1-1.5 m height for Silt Control)**

In some of the forest areas, suitable stones are not available in the drainage lines and hence crate wire check dams cannot be constructed. In case, large size stones are transported from outside, this turns out to be quite expensive. As a substitute to crate wire structures, masonry drop structures constructed with locally available small sized stones and bajri turn out to be cheaper and hence are constructed in series in the drainage lines of such areas. When constructed in series, head-toe relationship is maintained. The scouring of toe wall remains a problem when this relationship is not maintained.




Masonry Drop Structures (1.5-2.0 m height for Silt & Runoff Control)

## Silt Detention Structures

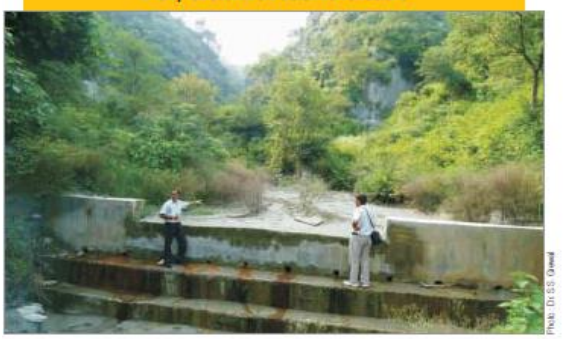
Silt Detention Structures with Local material

Small size Masonry Check dams constructed with local material are cheaper and more stable than crate wirestructures.

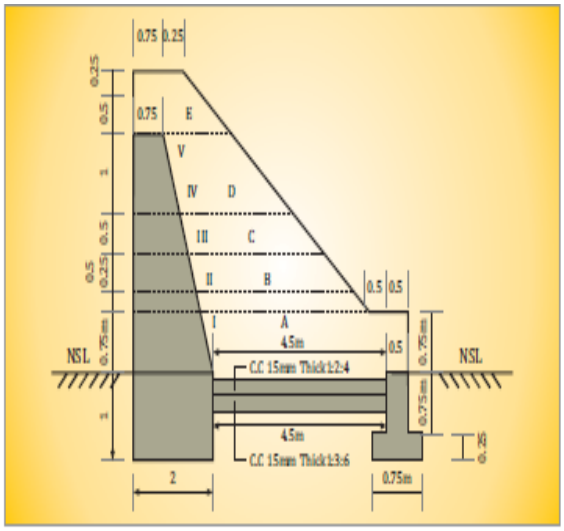
Often, no consideration is given to the number of check dams in a given area. In this case, the lower one would have been sufficient, instead of two, close to each other.

A 5 m high SDS above an Earthen Dam

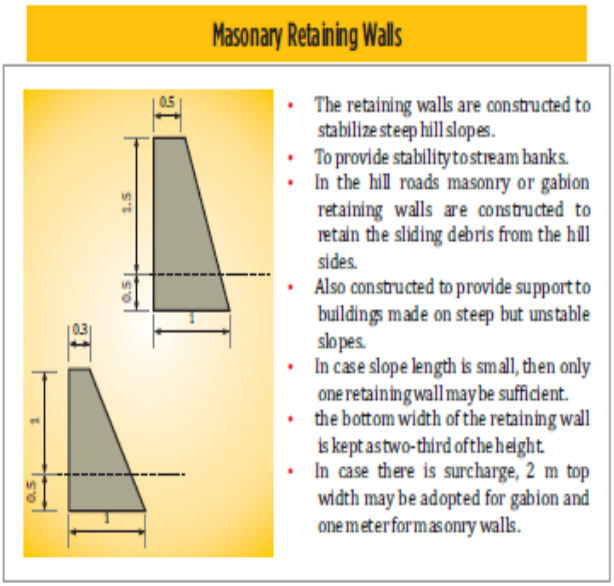
A fully functional silt detention structure



These check dams are constructed in khads to check the flow of silt. A cement concrete wall is constructed across the flow of water. On the downstream side the buttresses can be constructed, if the length of the check dam is more than 3.0 meters. Such types of check dams need proper foundation, as well as sufficient embedment on the sides. A spillway is constructed on the top of the check dam with cistern constructed on the downstream side of the check dam. Apron of proper length is constructed depending on site conditions and drop.




Masonry Retaining Walls:

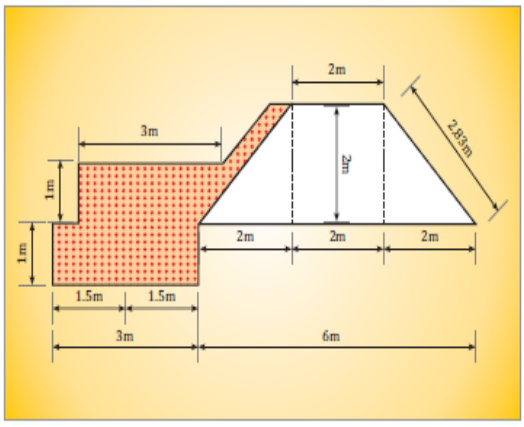



**Crate Wire Retaining Walls:**

In many of the khuds, suitable sizes of stones are available and are used for the construction of gabion retaining walls. The height is decided by the level of flood flow. The size is determined by the size of the khud and flood discharge. One meter foundation is provided.

## Earthen Embankments with Stone Pitching

These are constructed in exceptional cases at strategic locations where threat to land infrastructure is serious.




Why do some civil structures fail? Common faulty designs are depicted below:-

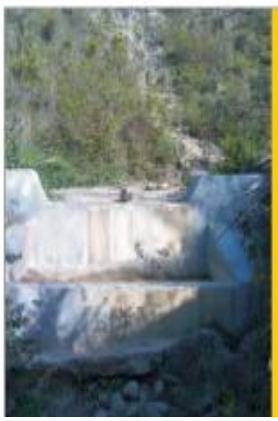
Broken, Leaking, Failed and Non Functional Structures

A Crate Wire Structure Breached From Side

Toe wall has been exposed, H is too small for given length

Constructed at a curve, more height, anchored against a hard rock

Carelessness. A live tree was fixed in the wall of a structure

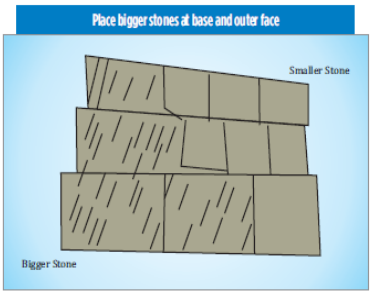


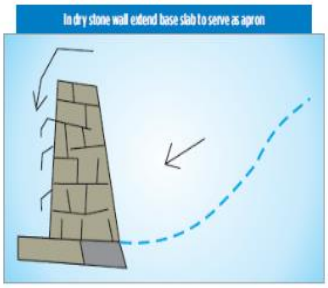
Small size masonry check dams fail when sufficient foundation of toe wall is not provided and spillway is kept much above the ground level. This mistake is again repeated in the next newly constructed structure.

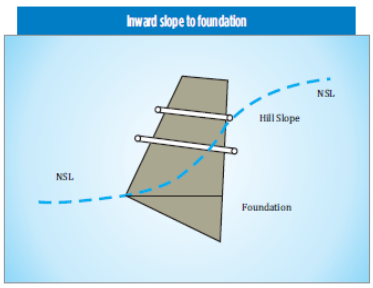
Defective Foundation Work

Defective Foundation Work

# STREAM BANK EROSION CONTROL


## Bank Erosion Control

## Mechanical Spurs for Torrent Control

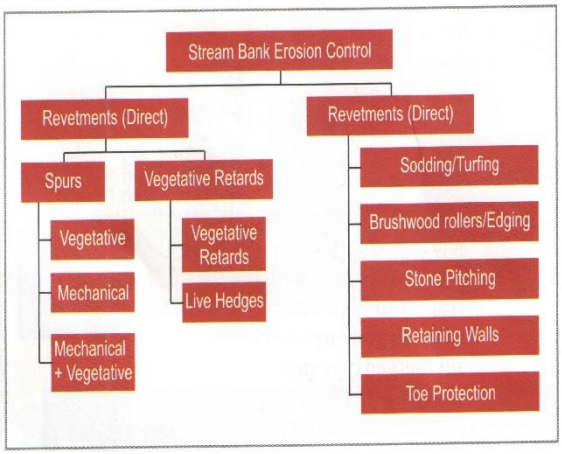
**Land Slide Due to under cutting by River/Stream Flow**

**Solutions**

- Diversion of flow by diversion channel
- Spurs of Vegetation for small flows
- Mechanical spurs for large flow supported by vegetation
- Revetment in specific cases when spurs are not advisable.

**Stream Bank Erosion Control**

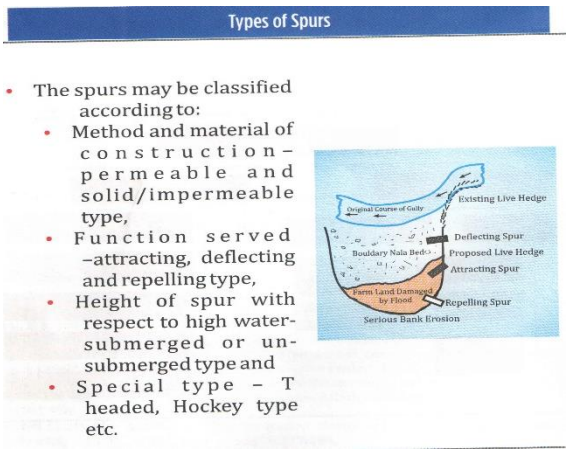
- Hill torrents (locally known as 'Rao' or 'Cho') cause extensive damage to life and property as a result of the frequent changes in their course and associated flash flows with heavy debris loads.
- When torrents reach the flat valley, their debris carrying capacity diminishes, due to reduction in flow velocity and the debris is deposited in the water courses as gravel and sandbars.
- As a result, the flow tends to braid and migrate laterally, overtopping and undermining the low erodible banks and affecting the adjoining forest/agriculture lands and utility services such as roads and bridge.
- Spurs, retards and retaining walls are used at such downstream reaches for training the torrent flow along desired courses and prevent damage to natural resources, life and property.

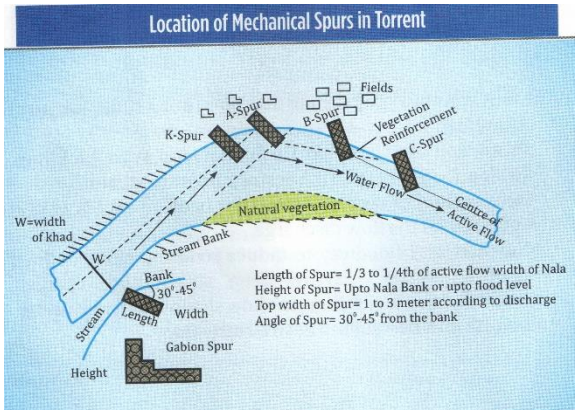



**Function of Spurs**

The functions of a spur system may be one or a combination of following:

- Protection of river banks (including land, road, buildings, bridge abutments and other structures along them)
- Reclamation of land along torrent beds, in excess of that required for the flow discharge.
- Narrowing of floodway to induce scouring along defined lines to create a narrow, deep, straightened channel, instead of one which is more wide, shallow and wandering
- Diversion of current in a desired direction



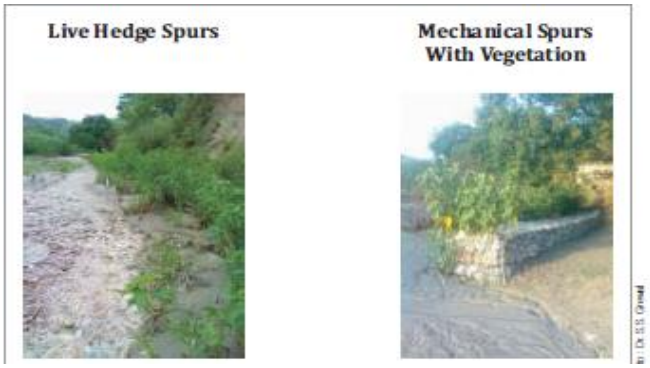



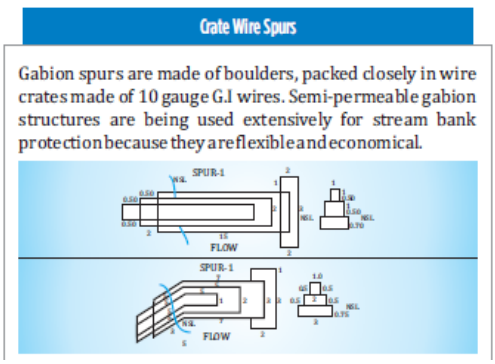

**Design Specifications of Spurs**

- Some of the important factors that determine the use and design parameters of spurs are:
- Nature and extent of the problem: River damage is severe and poses a threat to the adjoining life property.
- River characteristics: River geometry (width, flow depth, bank heights), flow velocity, flow pattern, bed slope, sediment–Debris-boulder movement, river meandering and curvature etc.
- Super geometry: The length of spur, its alignment to flow, shape and permeability are important design considerations.
- Super length: The 'blockage ratio' b/B, where b is projected length of spur and B is the river width, the projected length of the spur should not exceed 1/3rd of the width of river.
- Alignment of Spur: The spur alignment is defined by the angle the spur make with the flow direction, as measured from the downstream. As the angle of the inclination of the spur along the flow direction increases, its sedimentation capacity increases but stability decreases due to greater scour

**Design Specifications of Spurs**

- **Shape of spur:** Stream lined shapes create less disturbance and hence produce less scour than blunt shapes.
- **Permeability of spur:** Permeable spurs are less expensive and can be made by locally available material. Their stability is better than the solid ones due to lesser scour around them.
- **Spacing of Spur:** The recommended optimum spacing of spurs is 3-4 times the projected spur length. A larger spacing can be adopted for convex bank and a smaller one for concave bank i.e. 2 to 2.5 times the length of spurs.
- **Sediment:** The differential mobility in a mixture of particles of different diameter is responsible for armouring or paving of the channel bed. Armour layer formation in nonuniform sediments lead to reduce scour depths.



## INTEGRATED PLANNING ESTIMATION AND COSTING FOR SOIL CONSERVATION WORKS


**Water Shed Planning**

**Selection of micro-watershed:-** Admissibility under law - Law must not prohibit; social acceptability - demand driven – no dispute about site; economic feasibility - flow of benefit (BC ratio, IRR); technical Criteria - Silt load, seepage, trees falling in the project, submergence; design requirement- must be satisfied.

**Watershed delineation and measurement of area:-** Preliminary survey-Understanding bio-physical setting; location of dam site; use of topo-sheets; measurement of catchment

**Watershed characteristics:-** Catchment area, forest cover, soil type, overland slope, land slide problem, drainage density, land use, grazing pressure, rainfall, present status (Govt., Private, Community), previous treatment/ plantation work.

**Technical criteria for selection of dam site:** Objective should be very clear (Silt detention, Water harvesting); Dam site can be good, medium and poor depending upon site condition. All conditions are seldom available-some level of compromise is always needed.

**Dam Characteristics**

**A good dam site should to a large extent satisfy the following conditions:-**

A narrow converging gorge; sufficient large bowl above the dam site (Storage reservoir); side slopes and floor of the valley permit formation of a large deep basin-no shallow spread; site conditions--homogeneous heavy soil on slope, no boulders and gravels, no hard rock – different for bondage, no vertical cliff, no curve in drainage line, reasonable good soil for core-wall and dam body, good saddle nearby for spillway, stabilized drainage lines (low silt load), some perennial flow is better, in case of failure – no risk of habitation damage, when developed as water resource--farm land as near as possible, irrigation with gravity be preferred, responsive community, organization and participation, exert social pressure against grazing, committed for resource sharing and maintenance, prepared for contribution to cess fund.

**Major Issues and Concerns**

- Lack of supervision and quality control
- Grazing remains uncontrolled
- Pre-mature siltation
- Silt exclusion not possible
- Inlets are choked
- Spillways develop cracks
- Spillway toe exposed
- Management disputes
    - Non-payment of water rent
    - Poor accounts maintenance
    - Failure of rotation system in society to handle distribution
- Lack of withdrawal strategy
    - Incomplete works are handed over
    - Maturity of institution not evaluated
- Problem with schedule of rates

## FIELD WORK ASSOCIATED WITH AN INTEGRATED SOIL AND WATER CONSERVATION DESIGN:

**STEP 1:**

VISIT THE AREA—area description (location, altitude, slope, climate, aspect, topography, soil, drainage), COLLECT SITE SPECIFIC DATA—Fauna/ flora (natives/exotics), past history of management (treatment—afforestation, structures etc.) and the impact assessment/outcomes. Topo-sheets, geo-referenced point information and digital photos are most important.

**STEP 2:**

IDENTIFY THE PROBLEMATIC AREAS

**STEP 3:**

MAKE A MAP OF THE WATERSHED AREA

**STEP 4:**

RECOMMEND VARIOUS TREATMENT ACTIVITIES IN THE AREA (DESIGN OF STRUCTURES, ACTIVITIES (prime: silt measurement) AND COST ESTIMATION). Discharge calculations are to be done and also structural calculations--important. Future strategy and monitoring mechanism be spelt out.

**STEP 5:**

DOCUMENTATION OF PRE-AND POST-TREATMENT CONDITIONS OF THE AREA.

### PAST HISTORY OF WATERSHED MANAGEMENT

Base data—fauna, flora, socio-economic, livelihoods, land-use Inputs—civil structures, vegetative measures, afforestation
Outcomes—silt reduction, water quality, landslides, moisture retentivity, improved livelihoods, faunal and floral status
Learning---monitoring, mentoring

### Site Specific Planning

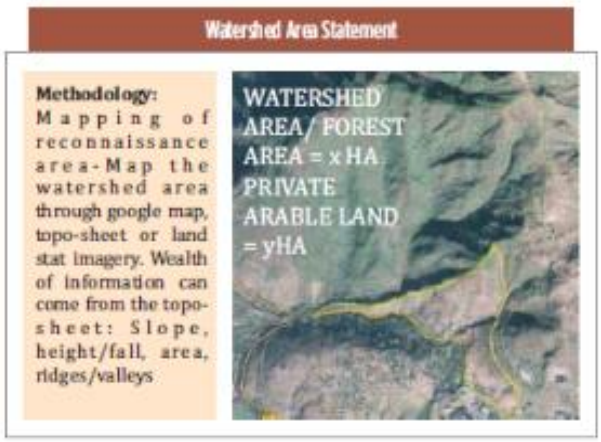
Reconnaissance for field work---survey of prominent nalas on foot----occular survey-----surveyor/draftsman/JEE
Terrain conditions----slope, aspect, drainage, biotic pressures Digital photos, Mapping
Geo-referencing/positioning
Objectives---moisture retentivity, landslide control, stream bank stabilization, land-use---grassland/plantation
Holistic planning, funding, time management

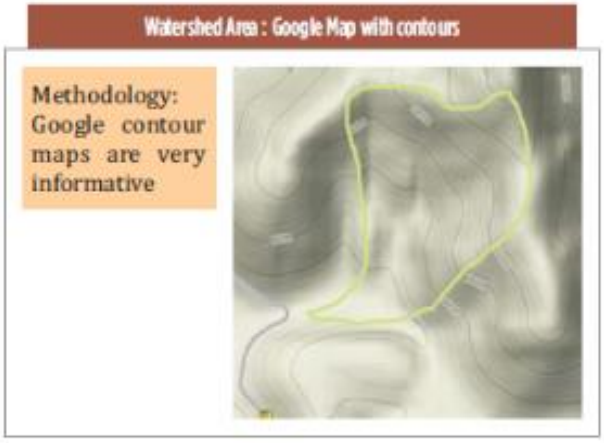
### Future Strategy

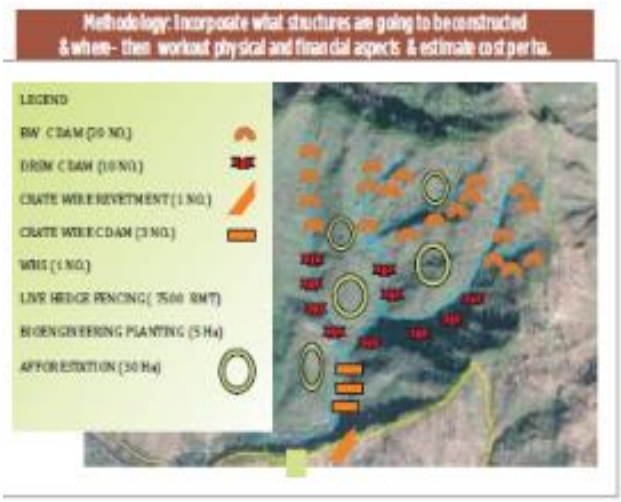
Holistic river basin work rather than CAT plan work in limited nalas
Native species versus exotics—grasses, jhar, herbs/shrubs Bio-engineering methodology rather than civil structures Regulations, monitoring
Increasing infiltration/percolation-----contour trenches Fencing---live hedges versus B-wire
User groups—women self-help groups—improved participation

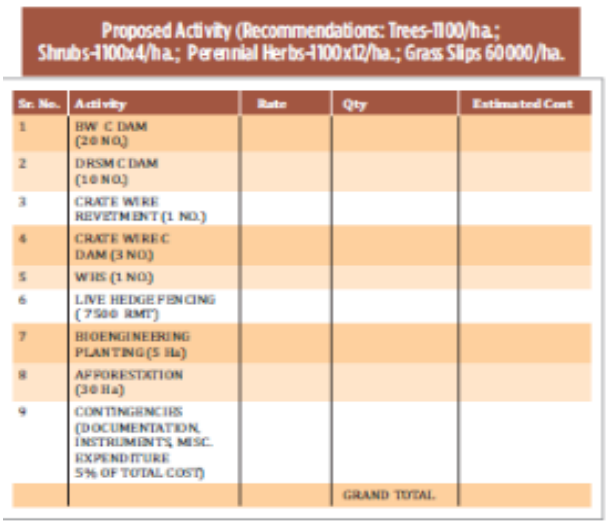
**Methodology**

- Field work Mapping
- Site specific estimates—drawings, designs
- Documentation
- Arrangement of funds, labour
- Work execution
- Monitoring
- Maintenance
- Mentoring
- Withdrawal strategy, usufruct sharing




| Sr. No. | Activity | Rate | Qty | Estimated Cost |
|---|---|---|---|---|
| 1 | BW C DAM (20 NO.) | | | |
| 2 | DRSM C DAM (10 NO.) | | | |
| 3 | CRATE WIRE REVETMENT (1 NO.) | | | |
| 4 | CRATE WIRE C DAM (3 NO.) | | | |
| 5 | WHS (1 NO.) | | | |
| 6 | LIVE HEDGE FENCING ( 7500 RMT) | | | |
| 7 | BIOENGINEERING PLANTING (5 Ha) | | | |
| 8 | AFFORESTATION (30 Ha) | | | |
| 9 | CONTINGENCIES (DOCUMENTATION, INSTRUMENTS, MISC. EXPENDITURE 5% OF TOTAL COST) | | | |
| | | | GRAND TOTAL | |

**Cost Estimates of Soil Conservation Structures:**

At the prevalent schedule of rates the cost estimates of some of the civil structures are worked out (Table).

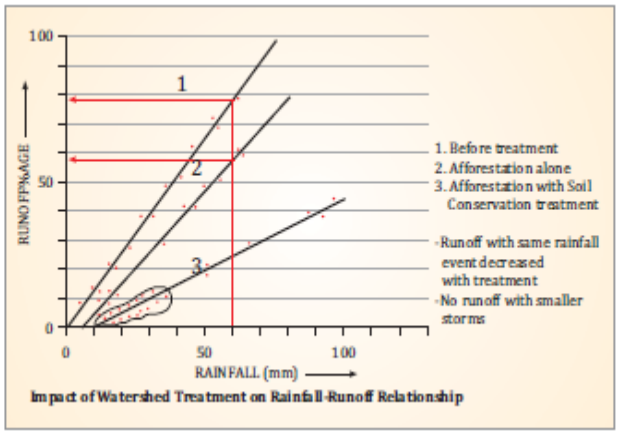
**See Table below: Cost Estimates of different types of Soil & Water Conservation Structures, through rates, based on PWD schedule of rates**

| Name of structure | Length | Height | Cubic Content | Cost (Rs) | Cost/m3 (Rs) | Average Cost Rs/m3 |
|---|---|---|---|---|---|---|
| a) Dry stone check dam | 3<br>3<br>4.5 | 1.20<br>1.35<br>1.35 | 7.60<br>7.84<br>9.87 | 8100<br>8300<br>10600 | 1065<br>1059<br>1074 | 1068.00 |
| b) Dry stone protection wall | 10 | 1.50 | 15.08 | 16200 | 1074 | |
| a) Gabion check dams | 5<br>8<br>10<br>15<br>15<br>20 | 1.50<br>1.50<br>1.50<br>1.50<br>2.00<br>2.50 | 16.51<br>24.50<br>41.00<br>59.50<br>94.00<br>192.40 | 25200<br>37300<br>56900<br>82200<br>116000<br>222600 | 1526<br>1522<br>1389<br>1382<br>1234<br>1157 | 1368.00 |
| b) Gabion retaining walls | 3<br>8<br>10<br>15<br>20 | 1.20<br>1.50<br>1.50<br>2.00<br>2.50 | 4.50<br>18.00<br>22.50<br>51.60<br>105.00 | 5800<br>23000<br>28400<br>59600<br>116600 | 1289<br>1278<br>1262<br>1156<br>1110 | 1219.00 |
| a. Spur with CW | 8 | 1.50 | 56.09 | 67003 | 1195 | 1195.00 |
| 1. Silt Detention Dam CC | 10<br>15<br>15 | 1.50<br>2.00<br>3.00 | 41.28<br>68.53<br>112.10 | 126600<br>207900<br>335900 | 3033<br>3034<br>3026 | 3031.00 |
| 2. Protection wall CC | 10<br>10 | 6.00<br>4.00 | 126.60<br>81.00 | 260600<br>149200 | 2058<br>1842 | 1950.00 |

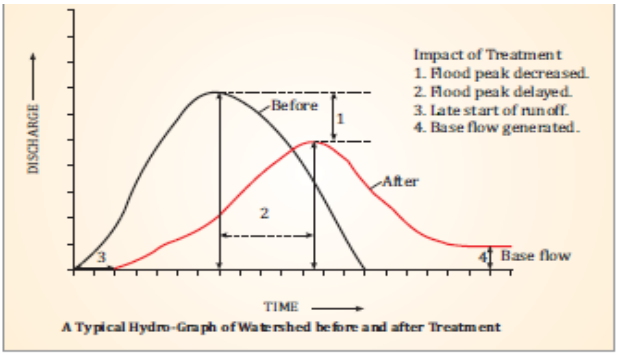
It may be noted that the average cost of dry stone check dams comes to Rs. 1068/- per cum. The cost of Gabion Check Dams/retaining walls and spurs vary from Rs. 1195/- to Rs. 1368/- per cum. The cost of cement concrete protection wall comes to Rs. 1950/- per cum and the cost of Silt Detention Structures of cement concrete comes to Rs. 3031/- per cum.

For line '3' infiltration is high and runoff starts only when rainfall reaches a certain level. Line '3' shows low run-off, low scouring, gentler movement of water--for a 60 mm rainfall, the run-off has reduced significantly.

With treatment, discharge has reduced significantly--reduction in peak is observed over time. Flood has decreased and is delayed. Discharge too starts after some time. Small storms do not affect and infiltration is sharp. Base flow starts which is rejuvenation of water springs---i.e. a nala which has gone dry now has water in perpetuity--in dry season too.



Impact of Watershed Treatment on Rainfall-Runoff Relationship



A Typical Hydro-Graph of Watershed before and after Treatment

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* *Source:* ***"Manual on Soil and Water Conservation with Focus on Watershed Management" published by H.P. Forest Deptt.*** *in the year 2012 under the guidance of* ***Sh. J.S. Walia, IFS, APCCF.***

# CHAPTER XVIII

## GENERAL GUIDELINES FOR ESTABLISHMENT OF DEPOTS

**Depots classified and defined**

Government depots are of two kinds:-

1. Transit depots;
2. Sale depots.

"Transit depots" are used for catching, collecting examining and rafting timber in the case of river borne timber or for the collection, checking and examination of land borne timber. They are more or less permanently located but can be changed from time to time with the approval of the conservator of Forests concerned.

"Sale depots" are appointed for sorting, sale and issue of timbre and are notified by the Chief Conservator of Forests. Temporary sale depots are notified by the Conservator.

**Demarcation depot sites**

All sale depot sites must be demarcated. The Government orders title deeds, or other authority for the occupation of the land must, in each case be forthcoming in the division office. The demarcation fencing, etc., will be permanent or temporary in character, according as the depot is established permanently or otherwise.

## II. MANAGEMENT OF TRANSIT DEPOT

*(a) River borne timber*

**Standing orders for contractors**

The Divisional Forest Officer in charge of the river may issue standing orders to contractors and sub-ordinates regarding the clearance of standard logs or scantlings, and the management of timber in transit and at catching depots.

**Treatment of timber arriving in transit depots**

When timber is landed at transit depot it is at once to be booked. Logs should be marked with a running number preceded by the initial letter of the name of the transit depot at which they are caught. Below the number should be noted the year of receipt.

*Illustration:-* Logs caught at Dalli in 1962 will be marked D1/32, D2/32, D3/32, D4/32 and so forth.

Scantlings will be entered by number under each size and kind. Records of arrivals at transit depots will be kept up in Timber form 5, dispatches of timber are covered by rafting permits and the necessary entries are made in the remarks column of form 5. At catching depots from 5 and 6 are not maintained. Rafting permits show full details of timber dispatched.

**Weekly statement of arrivals and dispatches**

A weekly statement of timber brought into each depot relaunched and suit standard shall be sent by the depot officer to the Divisional Forest Officer, the same to be countersigned by the contractor or his authorised agent.

**Rafting challan**

Every raft of timber shall be accompanied by a chalan (or invoice a duplicate of the same shall be dispatched immediately by post to sale depot officer who should keep and file these invoices.

*(b) Land borne timber*

**Land borne timber**

5.79. The record of arrivals and dispatches will be kept in timber form 5 and 6 other procedure will be according to local standing orders.

## III. MANAGEMENT OF SALE DEPOTS

Every sale depot is to be laid out into separate spaces for each kind of timber or firewood, the com- pertinent being prepared by clear passages to facilitate inspection. Logs must be neatly arranged in lines according to section and class as far as circumstances admit. If owing to lack of space, they have to be piled, care should be taken that only logs of the same classification are put together. Full details of measurements should in such cases be given on the ends of each log.

It is of the utmost importance not to expose scantlings to the sun for larger periods than can be helped, they must be stacked in cribs of 100 or other convenient number each different species and class being stacked separately, and not more than two scantlings in each sanctioning being in direct contact with the ground. There should be an interval of two feet between stacks in order to afford protection to the ends of scantlings from the sun. Sleepers intended for presentation to the railway will be stacked in accordance with the terms of the contract.

**Timber to be measured and marked before stacking and its booking**

All logs and scantlings on reaching a sale depot will be measured, marked and classified according to standing orders Logs and scantling will be entered daily in the register of receipts as they are taken charge of the former by measurements singly and the latter by number under each separate size and kind. Logs shall, be measured to the nearest 3 in length (and marks made showing the points of measurement) and to the next lowest inch in girth; volumes shall be calculated by the (c) 2x length method

**Sale mark**

All logs and scantlings, when sold, will be marked with the sale hammer mark, No officer under the rank of Forest Ranger may be entrusted with the custody of the sale hammer mark without the special permission of the Conservator.

**Safety of money**

The depot Office may to receive cash in excess of one hundred rupees in each case, save as earnest money received at auctions, but must invite payees to deposit the same in a Scheduled Bank. Cash chests in the depots should contain as little money as possible. All moneys received must be remitted forthwith to a Government treasury.

**Bill and receipt books**

Bill and receipt books in the prescribed forms will be used for every sale of timber and every receipt of cash, one copy being handed to the purchaser. At auctions small printed receipts are issued to each purchaser directly the bid is accepted and the deposit paid.

**Taking stock in sale depots**

The stock at each sale depot must be counted once every three months by the depot officer, the depot officer, the depot books being balanced at the time of report of each taking of stock must be submitted to the Division at Officer, Officers taking over charge of depots will be held personally responsible for the correctness of the stock taken over. The whole stock must be; counted by the Divisional Forest Officer personally at least once it each financial year and a stock taking report sent to Conservator.

The Department Manual and other orders governing all accounts, returns, stock accounts and forms, etc., must be complied with.

**Departmental manual to be compiled with**

The depot registers containing information about purchasers timber will be open for inspection at the depot officer during business hours.

## IV. CLASSIFICATION OF TIMBER AT SALE DEPOTS ROUND TIMBER

**Definitions**

Logs-All round timber of minimum length 6' and minimum mid-girth 43".

*Scraps-All* round timber of less than 6' in length and of minimum and mid-girth 42".

*Poles-All* round timber of minimum length 8' and of mid-girth 33" to 41 ".

*Ballas-All* round timber of minimum length 8' and of mid-girth 21" to 23".

*Ballis*- All round timber of minimum length 8' and mid-girth under 21'.

Pole pieces, ball pieces and Balli pieces are length less than 8' in their respective girth classes.

**Classification**

Deodar and kail Logs will be arranged in three girth classes:-

(1) girth 42" to 59"

(2) girth 60" to 95"

(3) girth 96" and upwards (ghallos)

In each division the logs will be arranged in separate length classes for each fool of length; thus a 12" log will be of length 12' to 12' and 13' log of length 13' to 13'-11" etc.

Each length class will be classified as follows:-

(i) Special-Cylindrical logs free form knots and all defects.

(ii) Special-Cylindrical logs free from knots and knots such as no to depreciate the value of scantlings or planks cut from these logs.

(iii) II Class-Sound logs with knots but capable of yielding good scantlings or planks.

(iv) III Class-Sound but very knotty logs or logs of very considerable taper.

(v) Refuse-Unsound logs, i.e. rotten and hollow.

**SCRAPS**

I Class - Sound timber, capable of yielding good but short planks or scantlings.

II Class - Inferior.

Poles - I Class- length 12' and upwards.

*Ballas* – II Class - -8' to 11'-11".

*Ballis* - Samudha within each length class.

*Pieces* - -Samudha.

**CHIR AND FIR**

*Logs-To* be classified into samudha and Refuse under each length and girth class-

| | |
|---|---|
| Poles | |
| Ballis | As for Deodar |
| Ballas | |
| Pieces | |

**SCANTLINGS**

**Definitions**

*(1) Beams-of* minimum length 12' and of minimum cross section 12" x 6".

*(2) Gattus - of* length 4' to 11' and minimum cross section 12"

*(3) Sleepers-14"* sleepers-14' in length and cross section 10" x 5".

*12 Sleepers-12' in* length and cross section 10" x *5".*

*B. G. Sileepers-9' to* 10' in length and cross section 10" x 5".

*8 Sleepers- 8'* in length and cross section 10" x 5" in length and cross.

*6 Sleepers---6' in* length and cross section 10"x *5".*

*M. G. Sleepes-6'* in length -and cross section 8"x 4½" to 9' x 5".

*(4) Karries- of* lengths 9' and up and of rectangular or square section.

(5) Pieces-Broken scantlings.

*(6) Slabs-Outside* planks.

**DEODAR B. G. SLEEPERS**

**Classification**

Special 10' in length of straight grain, full cross section and without knots or blemishes.

Its class railway sleepers = According to specification of current railway contracts.

R. Class-Sleepers returned by the Railway authorities as not 1st class specification.

4 Class-Undersized sleepers without cracks, and sound sleepers not upto railway specifications.

B Classy-Sleepers with damaged ends and cracks extending slightly beyond rail seat.

C Class-With longitudinal or transverse cracks very appreciably lowering the value of the sleepers.

Kail, Chir and fir B. G. Sleepers - As for deodar except that A and B classics are combined and that 'specials' are not ordinarily distinguished.

Other sleepers and scantlings- To be classified as Samudha and 'Rajected' according to foot length and cross sections, broken pieces to be classified separately.

**Sleeper Pieces-**

**To** be classified in under 4' lengths; 4' to 6' lengths; Over 6' lengths.

NOTE-The classifications is raised from time to time under the orders of the Conservator.

## V. SALE OF TIMBER

**Where to be held**

Timber will be sold add issued only at sale depots appointed under Rule No. 1. No sale or delivery of timber on the river or at any catching depot or other places can be permitted except with the special sanction in writing of the Conservator.

**Sale of unregistered material prohibited**

No timber or waste wood that has been received or collected at a sale depot may be sold or issued there from unless previously entered in be depot books as already provided therein.

**Sale of timber**

The sale of all classes of timber shall be made by auction by the Conservator of Forests or by the Divisional Forest Officer or other gazetted Forest Officer acting under the orders of the Conservator.

*Buildings*

**Repair and maintenance**

All buildings will be maintained in thorough repairs and in a clean condition. Annual repairs will ordinarily be carried out in the hills during April- May and in the plains as soon as the rains are over in September-October.

**Responsibility of tenants of Government buildings**

The tenants of Government buildings are personally responsible for the proper treatment of the fabric of the building and any interior fittings and furniture, reasonable fair wear and tear expected. Expenditure necessary to repair damage due to mis-use or neglect will be recovered from the person concerned.

# CHAPTER XIX

## GENERAL GUIDELINES IN RESPECT OF DEALING WITH FOREST OFFENCE CASES

The following instructions are issued for the guidance of the Forest officers:-

***1. Scope for Section 68 of Indian Forest Act-***

(i) All forest offences except those specified in sections 62 and 63 of Indian Forest Act, XVI, 1927, all forest offences under section 4, 5 of the H.P. Land Preservation Act, 1978 are compoundable under section 68 of Indian Forest Act.

(ii) The mere fact that the cattle involved in a forest offence have been impounded under Cattle Trespass Act, 1871 is no bar of the levy of compensation under Section 68 of Indian Forest Act.

(iii) Offences falling under Sections 62 and 63 of Indian Forest Act are not compoundable and should, therefore, be taken to court. Similarly, offences committed by lessees or contractors in the forest area should be dealt with udder terms of the lease or the contract as the case may be.

***2. Powers to compound offences***-All officers of the Forest Department of a rank of Divisional Forest Officer are vested with powers to compound forest offences under section 68 of the Indian Forest Act, 1927. However, as per the latest Notification No. No. FFE-B_A(3)-3/2010 dated 05/05/2010, Govt. has empowered all the Range Officers-in-charge of the ranges to compound forest offences and to accept compensation and / or release the seized property with certain conditions***.( In order to see the contents of the above notification, may refer to the Manual –I (Acts and Rules).***

(ii) All Forest officers of a rank not inferior to that of Extra Assistant Conservator of Forests serving in the H. P., are authorised to exercise the powers mentioned in sub-section (1) of Section, 68 of the Indian Forest Act, 1927 in respect of offences under the Himachal Pradesh Land Preservation (Chos) Act, 1978.

(iii) Forest Rangers in charge of ranges unless specially authorised have no powers to compound forest offences and as such they should submit all compensation cases to D.F.O. for sanction.

***3. Assessment of Compensation***

(i) It is also necessary to remember that the composition to be paid is by way of compensation for a forest offence and not by wav of a fine, although the sum of money to be demanded by way of compensation is not limited to the amount of the damage done to the forest.

(ii) Keeping these principles in view, Divisions Forest Officers shall prepare a Schedule of compensation, rates in the following form for each kind of offence and price of forest produce and implements, seized for his division. The price of forest produce seized will be fixed by Conservator of Forests from time to time which will not be less than full market rates.

| Nature of offence | Compensation | Price of forest produce, and implements seized | Remarks |
|---|---|---|---|

*A. Illicit grazing:-*

(1) Buffaloes
(2) Cow and bullocks
(3) Horses, donkeys and ponies
(4) Camels
(5) Goats
(6) Sheep

*Note:-* Young ones of the above animals with mothers will be charged at the above rates.

*B. Grass Cutting*

(1). Per head load
(2) Per donkey, pony or bull load
(3) Per camel load
(4) Per cart load
(5) Per boat load

*C. Lopping of trees and brush wood-*

(1) Per head load
(2) Per donkey, pony or bull load
(3) Per camel load
(4) Per cart load
(5) Per boat load

D. Cutting of trees-

| | Species | Compensation | | Price of Trees | |
|---|---|---|---|---|---|
| | | Trees upto 1 metre girth | Trees above 1 metre girth | Trees upto 1 metre girth | Trees above 1 metre girth |
| 1. | Deodar | | | | |
| 2. | Kail | | | | |
| 3. | Fir | | | | |
| 4. | Chil | | | | |
| 5. | Shisham | | | | |
| 6. | Khair | | | | |
| 7. | Tun and Walnut | | | | |
| 8. | Kikar and Jand | | | | |
| 9. | Other miscellaneous trees | | | | |

E. Timber seized-

| | | PRICE OF TIMBER PER CUM | | |
|---|---|---|---|---|
| | | Compensation | Species | Rate per cum |
| 1. | Carried on shoulders of man | Per man | Deodar | |
| 2. | Carried on donkey pony and bull | Per animal | Kail, Fir | |
| 3. | Carried on camel | Per animal | Chil | |
| 4. | Carried on cart | Per cart | Shisham | |
| 5. | Carried on trucks | Per truck | Khair | |
| 6. | Carried on boats | Per boat load | Tun, Walnut, Kikkar, Jand and other miscellaneous trees | |

PRICE OF FOREST PRODUCE

| | | Compensation | |
|---|---|---|---|
| 1. | Per head load | Oak, Shisham, Kikar, Jand and Siris | Other species |
| 2. | Per donkey, pony or bull load | | |
| 3. | Per camel load | | |
| 4. | Per cart load | | |
| 5. | Per truck load | | |
| 6. | Per boat load | | |

*G. Charcoal-*

Compensation twice and price four times as for firewood

*H. Tools and implements seized-*

(1) Axe.
(2) Drat.
(3) Khurpa.
(4) Sickle
(5) Dhanga.
(6) Rope
(7) Gunny bag.
(8) Camel equipment.
(9) Equipment of donkeys and other animals.
(10) Carts.
(11) Truck
(12) Small handsaw
(13) Big handsaw.
(14) Frame or cross cut saw.
(15) Taranger.
(16) Boats.

**Note-** Double rates will be charged for (i) second and subsequent offence in the same year, and (ii) offences committed before sunrise and after sunset.

D.F.O. shall then arrange to supply its copies total Range Officers, Tehsilars and Gram Panchayats within his jurisdiction.

(iii) When Divisional Forest Officer considers that the sanctioned schedule rates should be raised to meet certain contingencies, e.g. in the case a notorious villages or otherwise of he must get the concurrence of than Conservator and the Deputy Commissioner of his district to the enhanced rates.

(iv) Compensation in all cases will be assessed according to this schedule. The Divisional Forest Officer may at his discretion reduce or enhance compensation in a particular case.

(v) Section 68 of Indian Forest Act provides that compensation in a single case should not exceed Rs. 50 but no limit is fixed for the assessment of the value of the property seized, which is liable to confiscation or release in a forest offence. All forest produce in respect of which a forest offence has been committed together with all tools, boats, carts and cattle used in committing any forest offence are liable to seizure and classification as provided in section 52 of Indian Forest Act, 1927. In assessing compensation the value of the property to be released has also to be estimated.

(vi) The practice of splitting up what is really one case into two or more and reporting on them separately in order that the arresting officer may obtain additional credit for

having detected a large number of cases is strictly forbidden and officials responsible for the same will be dealt with severely when detected.

***4. Realization of compensation****- (i).* Foresters, Deputy Rangers and Forest Rangers are authorised to realize compensation according to the sanctioned schedule of compensation rates, in anticipation of Divisional Forest Officer's sanction,

(ii) Forest Guards are forbidden to realise compensation under any circumstances.

(iii) Any offence not covered by the, a proved schedules of compensation rates should be reported to D.F.O. separately for assessment of compensation along with the, Range Officer's estimate of the damage.

(iv) Forest officials are strictly forbidden to keep the, money in their own custody. All suits realized be immediately remitted Into Government treasury as soon as, the official concerned arrives at a place with a treasury or hands over such money to the Range, Officer whichever is earlier and the Range Officer is bound to remit the amount into the treasury immediately he reaches a place, with a treasury.

***5. Procedure****- (i) When* a forest offence is committed it is the duty of the nearest Forest Officer to do his utmost to trace and arrest the, offender. When an offender is caught in the act of committing an offence he must be arrested and forest produce together with all tools, boats, and cattle used in committing the offence should be seized. The offender should at once be taken before the Lambardar/Gram Panchayat/Cho Reclamation/Soil Conservation/Forest Managing Committee Member or in their absence before some other respectable person of the nearest village in whose presence the arresting officer will issue a Damage Report in quadruplicate is the copying pencil and carbon papers, of the offence committed and in whose custody he will place any implements or the forest produce captured. He shall hand over the quadruplicate copy of the damage report to the accused under receipt. In which should be taken on the original copy of the damage report by the forest officer. The triplicate copy will be sent straight to the Division Office where it will be entered in a register and will be checked with the complete, cases when received in Divisional Office. A written receipt should be obtained from the person in whose custody the property seized is entrusted and lie should be required to sign the Damage Report made by the arresting officer as also any statement the accused may make seized produce should under no circumstances be kept in the Superdari of offenders. In cases where no other person for Superdari is available the produce should be carried to the nearest Forest Chowki and kept in the Supardghi of Forest Officials.

(ii) When the offender is not known or has escaped arrest on spot, an immediate report will be made to the nearest Lambardar/Gram Panchayat Sarpanch, his signature will be taken on the Damage Report and implements of forest produce seized will be dealt with, as above.

(iii) When cattle are caught in the act of committing a forest offence and the offender is unknown the cattle should be impounded in the nearest cattle pound and the particulars of offenders filled in the Damage Report after ascertaining from the Pound Keeper, the name and address of person who gets the cattle released.

(iv) If the offender has been recognised while making has escape, that Lambardar or the member of the Gram Panchayat will be called upon to produce him, his statement should be taken and signed both by the Lambardar/Member of the Gram Panchayat and the arresting officer. Should the Lambardar and members of the Gram Panchayat happen to be absent or not available, the report should be made in the presence of two reliable and respectable persons of the village and their signatures or seal taken on the report.

(v) When arrest is made the accuse must in the presence of Lambardar, Gram Panchayat members or two reliable witnesses be offered the choice of com- pounding the offence with the sanction, of D.F.O. or standing his trial. When the, offender desires to pay compensation a written statement to this elect-must be drawn up and signed by the accused, and the arresting officer in the presence of the Lambardar/Gram Panchayat Member/two reliable witnesses who will also sign it.

(vi) All details in the printed Damage Report and compensation form must be filled carefully.

(vii) When the arresting officer is a Forest Guard he must complete the Damage Report as per instructions above and forward it with the statement of the accused and witnesses and the application to pay compensation, if made to his range officer through the Block Officer and where there is no Block Officer to the Range officer direct.

(viii) The Range Officer or the Block Officer will hold an enquiry on the spot, inspect the damage done and assess the amount of compensation and payment for property seized according to the sanctioned schedule of compensation rates.

(ix) If the offender is willing to pay compensation the Block Officer or any other official authorized on this behalf will realize 'the amount, issue a printed receipt with copying, pencil and carbora papers for it .to the accused, presence of the witnesses, deposit the amount into a Government treasury as Revenue Deposit or hand it over to the Range Officer as provided heretofore, issue a compensation form and submit the complete case with the Revenue Deposit Receipt and other connected paper to the Range Officer for obtaining D.F.O.'s sanction.

(x) The Range Officer must obtain Divisional Forest Officer's prior sanction if departure from the sanctioned scheduled rates of compensation is considered necessary in any particular case.

(xi) The Range Officer will submit the cases to the D.F.O. for sanction after a thorough scrutiny and making himself sure that the compensation has been assessed and realized according to the scheduled rates and the amount has been correctly remitted into treasury as Revenue Deposit. On sanction by the D.F.O. he will arrange to convert the Revenue Deposit to revenue under 115-Forest and book the sanctioned cases in his cash accounts.

(xii) In all cases where the offenders do not agree to pay the compensation their statement to this effect should be obtained, if possible, and a detailed report made to the D.F.O. recommending prosecution. After the D.F.O. has sanctioned prosecution, a chalan should be prepared in duplicate or proper form giving summary of facts on which prosecution is based and should be submitted, to the D.F.O. without delay. The challan should be accompanied by the Damage Report and other documentary evidence in support of the offence. The D.F.O. will forward one copy of the challan to the District Magistrate and return the second copy along with original documents to the Range Office for conduct of the case. Under all circumstances prosecution should be finalized within two months of the issue of the Damage Report where it is not possible to Compound the offence. A proper register should be maintained both in the Divisional Office and the Range Office for record of the prosecution cases.

(xiii) If an offender applies to be allowed to compound the offence after the prosecution has been launched the Range Officer will allow him to do so without further reference to the D.F.O. provided the offender pays the assessed compensation plus a court penalty at 25 percent of the compensation for any offence assessed at less than Rs. 20 and that of Rs. 5 for an offence of Rs. 20 or above. This may be done with the approval of the trying Magistrate.

***6. Receipt and distribution of Damage Report Books,, Compensation Form Books and Compensation Receipt Book****- (i)* Immediately in receipt of such books from the Press they will be entered in the Divisional Stationery Register on which separate pages will be allotted for each kind of book. Each book will be entered serially in the Register giving its printed number and the serial number of the forms in the book. Where no printed number is available on any book or its form, the numbering will be done in the Divisional Office under initial of the D.F.O. The books will be issued under proper receipt and an appropriate reference given in the Stationery Register. The Range Officers will maintain a similar stationery register for books issued to them.

(ii) The surplus stock of such blank books will be kept in the office of D.F.O. and Range Officers not in the office of Conservator or Chief Conservator.

(i) When such books are issued by the, D.F.O. to any official, the cover of each book will specify the number of pages the book contains under the initials of the D.F.O.

(iv) A list showing the (i) names of persons to whom various books have been issued, (ii) serial number of the book and the forms it contains, (iii) date of issue will always be available in the Divisional Office and the Range Office.

(v) When a book is finished, it shall be returned to the Divisional Office for record. A note will be made in the Stationery Register at item (i) and the list at item (ii) above.

(vi) All books will be carefully preserved against damage by white ants or otherwise.

***7. Damage Report and 'Compensation Register***-A Damage Report Register will be maintained bitwise in each range in the following form:-

| Serial No. | Damage Report Book Form No. | Date of issue of Damage Report | Date of receipt of the Range Office | Date of submission to D.F.O. | Date of return of papers from D.F.O. | Name of reporting officers | Name and particulars of offender | Name of forest | Details of damage | Disposal |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| | | | | | | | | | | |

In the disposal column, a reference to compensation case number will be given if the case has been compounded. If prosecuted, reference to prosecution register case number will be given and if the Damage Report is written off, reference to Divisional Forest Officer's order in this respect will be given.

(ii) Each Damage Report, when received in the Range. Office will be entered in this register. The Range Officers are responsible to see that the Damage Reports are accurately entered and that no report is passed on without its having been entered in the register. They must check the register frequently with the Damage Report books in use to ensure that all Damage Reports have been entered in the register.

(iii) The undisposed Damage Reports will be brought forward in the next year in red ink. Range Officers are responsible to see that the Damage Reports shown as not disposed of in the Damage Report Register, actually, exist and have not been lost. For any loss of Damage Reports, Range Officer concerned will be personally responsible. At the time of taking over charge every Range Officer will satisfy himself that all pending Damage Reports actually exist and if not in the office, receipts for them are forthcoming. No excuse, whatever for this lapse will be accepted.

*(iv)* *Compensation Register*-A compensation register will be maintained in each range in the following form:-

| Sl.No. | Divisional office case No. | Name and description of offender | Name of forest | Particulars of offence & damage and date of offence | Details of property seized | Damage Report Book / Form No. | Compensation Book / form No. | Compensation Receipt Book/ Form No. | Compensation paid on account of damage caused by offence | Compensation paid on account of value of property seized and realized | Date of realization compensation | Date of remittance into treasury | Signature of compounding officer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | | | | | | | | | | | | | |

A similar register will be maintained in the Divisional Office by Ranges except that in column 2 of the Range case number will be entered.

(v) Link registers will be maintained as explained in para 8 below both in the Divisional and Range Offices for linking the Damage Reports, Compensation Application Forms and Cash Receipt Books.

***8. Linking of Damage Reports, Compensation Application Forms Books, Compensation Receipt Books and Cash Books.****-(i)* On each Damage Report, reference will be given (i) to the compensation books form on which the offence was compounded, or (ii) to the orders of D.F.O. under which it was filed and no compensation charged or (iii) to the serial number of the Prosecution Register if the offender was prosecuted. The counterfoils of the Damage Reports with the Beat Guard will be imported in this respect by the Range Officer once a month or earlier furnishing the following certificate:-

"It is certified that all damage reports (numbers) leave been accounted for' and disposed of under proper authority.

Range Officer."

(ii) On each form of the Compensation Application book, a cross reference will be given to (i) Damage Report Book/Form No. (ii) compensation case number, (iii) the Compensation Receipt Book/ Form No. with which the compensation was received and (iv) Dr. item No. of the cash-book.

(iii) One each form of the Compensation Receipt Book cross reference will be given to (i) Damage Report Book/Form No. (ii) Compensation Case No. (iii) compensation Application Book/Form No. and (iv) Dr. item No. of the cash-book.

| Range Damage Report No. | Compensation case No. Divisional Compensation Register No. | Damage Report Book No. with its Form No. | Compensation Application Book No. with its Form No. | Compensation Receipt Book No. with its Form No. | Amount of compensation | Details of offence with property seized or released | Price of tools and forest produce | Date of realization of amount | Date of remittance of amount *Vide* Cr. Item No. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

**9.** ***Check of Compensation cases***-(i) On receipt from Range Officers, Camp Clerk to D.F.O. or any other clerk entrusted with this duty will check the cases, verify if the compensation has been assessed according to schedule of compensation rates, and if, damage report, compensation application form and compensation receipt are correctly filled in and linked by cross references. After doing so, he will enter the cases in the Divisional Register to be maintained by Ranges and put up to D.F.O. for sanction.

(ii) D.F.O. will initial and date entries in this register at the time of sanction.

***10. Remittance of money into Government treasuries*** **-** (i) Any sum of money realised under section 68 of the Indian Forest Act 1927, with or in anticipation of D.F.O.'s sanction shall be remitted into Government treasury as Revenue Deposit as per instructions contained in paragraph 5 (ix) and 5 (xi). Compensation Receipt Book must invariably indicate the date of remittance. The Range Officer must check every month the compensation receipt books to ensure that all remittances have talent place within the shortest possible time.

***11. Payment of rewards***-Payment of rewards to persons who have contributed to the discovery of offenders in particular offences is governed by Sl. No. 56 of rule 19.6 of the Delegation of Financial Powers delegated to Forest officers in H.P. The Range Officers may recommend grant of rewards in particular cases in order to encourage cooperation from villagers in tracing out forest offences. But such recommendations should be made in rare or exceptional cases and should not form a routine.

***12. General****- (i)* It is the responsibility of the Range Officer to see that the books are Kept up-to- date and of D.F.O. to check the books on all occasions when he is in a range to see that they are so kept.

(ii) When a book is finished it is the responsibility of Range Officer to again check the book to see that it has been posted completely and correctly. When such a used book is submitted (and this will be done when all its forms have been accounted for) to D.F.O. it will again be checked in the Divisional Office and if correctly posted will be filed after D.F.O. has recorded a certificate on the cover and also in the Stationery Register that the entries in the books have been check and are in accordance with these orders.

(iii) The Damage Report, Compensation application Forms and Compensation, Receipt Books will be maintained in triplicate, the copies to be prepared with copying pencil and carbon papers.

(iv) Each compensation case submitted to D.F.O. for sanction will be accompanied by:-

a) Damage report,
b) Compensation application form,
c) Compensation receipt form,
d) Reference to treasury chalan,
e) Statement of accused,
f) Statement of witnesses.
g) Cattle pond receipt in case of illicit grazing where obtained.

NOTE- Nos. (a) to (c) will be cross linked as provided under paragraph 8.

(v) At the time of transfer of charge of any official a special mention will be made in the charge report of the damage report books, compensation application form books and compensation receipt books banded over with account of used and, unused forms

in each book. It will be the duty of the relieving officer to report discrepancies if any to the D.F.O.

(vi) The damage reports must be forwarded by the Beat Guards to the Range Officer within 3 days of their issue. The Block Officer should complete his enquiry and forward his report to the Range Officer within a week. Compensation, in all cases will be finalized within two months of the date of issue of the damage report. In order to ensure check or the disposal of compensation cases the Block Officer and Range Officers must give in their diaries, in the following table, the progress in the disposal of the compensation cases:-

| Name of Block | Name of beat | Balance of last fortnight | Receipt during the fortnight | Disposal during the last fortnight | BALANCE | |
|---|---|---|---|---|---|---|
| | | | | | Under two months | Over two months |

(vii) Receipt for the amount of compensation should be issued in the presence of a literate person, preferably a Lambardar or Sarpanch and handed over by the Block Officer or the Range Officer to the accused after obtaining his signature or thumb impression on its counterfoil. It should never be sent through a Forest Guard so that people should know that the Forest Guards are not authorised to deal with compensation money.

(viii) On no account is a damage report to be issued on suspicion against a person. Forest Guards should be warned that if they ask false reports they can be prosecuted under the Indian Peal, Code as well as under Section 43 of the Indian Forest Act,

(ix) On pay day or any other suitable occasion Forest Guards and Block Officers will present their Damage Report, Compensation Application Form and Compensation Receipt Books to the Range Officer who will check them initialing each page and record a certificate to this effect on the back of the last used farm in each book. The result of check will also be mentioned by the Range Officer in his fortnightly diaries to D.F.O.

(x) Use of blank paper for issue of damage reports, compensation forms and compensation receipts is forbidden except with special permission of D.F.O.

(xi) Conservator of Forests and D.F.O. will check thoroughly the registers of Damage, Reports,, Compensation Application Forms and Compensation Receipt Books, with the counterfoils of as many used or current books as may be readily available initial the counterfoils of books so checked and record their observations in their Annual Inspection Reports.

(xii) No damage report will be written off without a regular office order.

(xii) D.F.O.s and Range officers, while on tour, will verify when an opportunity occurs, the amount shown on counterfoils of the compensation receipts with that of the receipts given to any offender to ensure that the amount revised is the same for which receipt had been given.

(xiv) It will be the duty of the officer issuing the Computerization Receipt to inform the Panchayat concerned the name of the offender the offence committed and the amount of compensation realised as soon as he issues the receipt.

**General orders on forest offences and their prosecution**

1. Forest Offences should ordinarily be compounded under section 68 of the Indian Forest Act. Prosecution should be resorted to only when the offenders refuse to compound the offences after resistance or where it is deemed necessary to create a deterrent effect to prevent repetition of offences.

2. Enquiries into Forest Offences and the subsequent complaint to a Magistrate will ordinarily be made by a forest official. The police should be asked to take up enquiries in the following cases only:-

(a) Assault.

(b) Forcible rescue.

(c) In other cases, where it appears to the Range officer that the police, rather than the Range officer should enquire into the matter such cases may be referred to the police as per the latest Govt. instructions issued from time to time. In such cases Divisional Forest Officer's previous sanction should be obtained if time lag is not likely to spoil the case.

(d) All cases relating to areas where the Indian Forest Act does not apply or there are no special rules under which prosecution is possible e.g. P.W.D. and Canal Road side Plantation.

3. Forest Offences can be challaned as under:-

(a) Offences in the Reserve Forests under Section 26 of the lndian Forest Act, 1927.

(b) Offences in the Protected Forests, under Section 33 of the Indian Forest Act, 1927.

(c) Offences in section 38 areas under the rules promulgated by Government in the notification issued for the particular areas.

(d) Miscellaneous offences of breach of rules for which no special penalty is provided in the Indian Forest Act are covered by Section 77 of the Indian Forest Act and other offend on the part of right holders, e.g., withholding information, refusing assistance in preventing the commission of forest offences in particular areas, etc. by section 79 of the Indian Forest Act.

(e) Cases relating to P.W.D. and Canal Road side plantations may be challaned under the departmental rules and regulations where any exist. Otherwise such cases should be handed over to the Police; for prosecution under the Indian Penal Code. Minor offences of grazing could be dealt with under the Cattle Trespass Act.

4. Prosecutions will invariably be conducted by the Range Officers personally and not entrusted to subordinates unless under exceptional circumstances

*5.* No criminal prosecution may be taken up with- out the written sanction of the Divisional Forest Officer. The challaning of infants should be avoided. Where a prosecution is intended the Range Officer must shift the reports of his subordinates and satisfy that no weak or false case is taken to the court. False cases lower the prestige of the department and the Range subordinates should be, made to understand that they will be severely dealt with if the public is unnecessarily harassed through false reports. The challan submitted for prosecution must be carefully prepared giving relevant details in each column of the challan form.

6. The Range Officers should give a brief account of the cast along with the challan and attach the enquiry report and all documentary evidence pertaining to the case for

sanction of prosecution by the Divisional Forest Officer. On approval of prosecution the challan along with original damage report and copy of other documents will be forwarded by the Divisional Forest Office to the District Magistrate and all other papers returned to the Range Officer for conduct of the case. All criminal cases must be considered as urgent and papers regarding enquiries must be submitted for orders as speedily as possible. The Divisional Forest Officer will not sanction prosecution where unreasonable delay has taken place.

7. In dealing with forest offences the Range Officer must be fully conversant with chapter IX of the Indian Forest Act, 1927, relating to penalties and procedure. Their particular attention is invited to sections, 52 and 53 dealing with seizure of forest produce, etc., and sections 64 and 65 relating to arrest of offenders without a warrant. Provisions of section 62 should also be impressed on all Forest subordinates so as to prevent unnecessary vexation of the public.

8. When a serious offence is reported while the D.F.O. is on tour in the neighborhood, the Range Officers should produce the accused and witnesses and if prosecution is decided, the evidence should be recorded in the presence of the accused for submission to a Magistrate.

9. Search warrants when required cap be obtained on application to the Magistrate. No premises may be search without a warrant and search must be conducted during day light in the presence of the occupant and at least two respectable inhabitants. In a search statement of the accused should be taken to make him disclose any objection to the method of search. Under Section 72(c) of the I.F.A. 1927 Conservators have powers to issue search warrants *vide* H.P. Govt. notification No. Ft. 29-256/48 dated 12-7-1949, provided that no search warrant shall be issued for searching houses for timber suspected of having been stolen for which the order of a Magistrate is necessary. In emergent cases where Conservator happens to be touring in the Range a search warrant could be obtained from him if the circumstances so require.

10. Conduct of cases in the Court.-In conducting,, cases the Range Officers must attend the Court fully equipped with all references. The following books should invariably be taken for ready reference:-

a. The Indian Forest Act, 1927 and the Cattle Trespass Act.
b. H.P. Forest Rules.
c. Settlement File of the forest concerned.
d. Notification pertaining to the case.

All cases must be, carefully worked out beforehand.

The prosecutor will open the proceedings by stating clearly when, where, and by whom the offence has been committed, what particular rule has been broken, and the nature of the evidence to be produced. He should invariably be taken for ready reference:-

*(a) Motive of accused-* This should never be neglected, the question being what profit, real or imaginary the accused would have got by the Act committed or abstention from action.

*(b) The fact complained of-*It should be clearly stated and proved by oral evidence supported by documentary evidence recorded at the time of the offence. Oral evidence should be tested previous to hearing in the Court. If the, Prosecution is ready to deal with objection of the accused to each witness doubts in the mind of the Court are readily disposed of. Half the work of prosecution is the intelligent anticipation of arguments of

the defense. Diaries should be produced in proving the whereabouts of subordinate concerned in any case where required.

*(c) To disprove the defense evidence*-This is not easy as no prosecution evidence can be produced after the defense has been heard. Much can be done by insisting on seeing the list of witnesses, called by the accused ad enquiry in to their connections before they are heard. If no such list has been submitted the prosecutor should urge the Court that such evidence should not be considered as no opportunity for enquiry has been allowed.

*(d) Examination of witnesses*-The Prosecution should call his own witnesses to bring out any point he washes to emphasize. He is also entitled to cross examine the defense witnesses, in order to bring out any discrepancies or to criticize the value of their statements.

*(e) Summing up of the case*-The Prosecutor should sum up the evidence calling attention to the seriousness of the offence, naming the maximum penalty incurred on conviction and asking for a substantial penalty. Juvenile offenders can be punished with whipping for any infringement punishable by imprisonment. This is suitable in cases due to gross carelessness or mischief of boys, and as such Government of India Notification No 938-C, dated 10th February, 1941 should be brought to the notice of the Court.

*(f) Fires*-It is necessary to show that the accused (a) set fire to the forest or (b) lit a fire from where it might spread and injure any reserve trees on closed area. Carelessness in lighting a fire in one's own field may lead to an offence being committed under these sections. In all cases instituted under section 79 it is absolutely necessary to prove that the offenders either (a) had rights in the forest in which the fire occurred or (b) in some neighboring forest, and in the latter cases that there was a possibility of the fire spreading to a forest area in which the accused had rights. In prosecuting for refusing to obey a lawful order to attend a fire, it is only necessary to prove that the accused know that the forest in which he held rights was on fire, or that there was a likelihood of the fire spreading, to the forest in which had rights. In such prosecutions for failing to assist at a fire each accused should be given an opportunity of giving his explanation, and only those, persons should be challaned of whom it is certain that they were actually present in the neighborhood and had deliberately neglected to assist if action against Government servant is, called for section 79 of the Indian Forest Act, 1927, the Range Officer must report full particulars to the Divisional Forest Officer before filling in the prosecution challan.

*(g) Grazing*-It is customary with the villagers to -let loose their cattle in the forest without any herd men or to put small boys in charge of the herds so as to escape responsibility and punishment for the trespass. In this collection judgment of the Chief Court of the Punjab in case No. 168 of 1909 and reproduced on page 167 of the Punjab Forest Manual, Vol. I (4th edition) may be carefully studied and brought to the notice of the Court.

*11. Police cases- (a)* Whenever a case is made over to the notice the Range Officer must send a report to D.F.O. and in cases filling under Para 2(c) above he should justify his action in handing over the case to the police without D.F.O.'s previous sanction.

*(b)* When assaulted by a person committing a Forest offence under the, India Forest Act or when cattle caught grazing illicitly are forcibly rescued by their owners the Forest officials

concerned should attempt to arrest the offenders under section 54 of the Indian Forest Act. Should the offender resist arrest or any other person assist the offender in resisting arrest, the Forest Official should at once go to the nearest Police Officer, who should be asked to enquire into the case and arrest the offenders under sections 224, 225 and 3 332 of the In than Penal Code,. The forest official concerned should then report the matter in full to the Range officer who will forward it to D.F.O. as soon as his own investigations are complete.

*(c)* Whenever a forest case is reported to the police a copy of the record made by the police should be obtained at the same time by the Forest Official who makes the report, and he should satisfy himself at the time that the record is complete. If the Police at any time refuse to give such a copy the matter should be reported to the Divisional Forest Officer at once.

*(d)* In all forest cases challaned by the Police, Forest subordinates will appear in the Court either as complainants or witnesses for the prosecution on the dates notified by the Police and they will be punished for noncompliance. Bail need not, be given by any forest subordinate for attendance but if asked to sign a bonded provision attendance such bond may be signed.

12. A strict adherence to the above instructions will facilitate the disposal of cases, command the confidence of Magistrates, and ensure conviction in Court. When an appeal has to be filed in a particular case against the decision of the Court the Range Officer must make a full report of the case and loudly state Pounds on which appeal should be preferred. A copy of the judgment in the case will be obtained for ready reference.

13. The prescribed register for prosecution cases must be maintained in the form appended up to date and put up to the D.F.O. at the time of office; inspection. In order to watch the progress of prosecution cases a special report should be made to the D.F.O. on all cases pending over 6 months.

Form of Prosecution Register

| | |
|---|---|
| Column No.1 | Serial No. |
| Column No. 2 | No. of damage report and damage report book |
| Column No. 3 | Name, parentage, residence etc. of accused |
| Column No. 4 | Number of accused |
| Column No. 5 | Place and nature of offence |
| Column No. 6 | Institution of prosecution<br>(i) Date<br>(ii) Court<br>(iii) Section of Forest Act or of Indian Penal Code |
| Column No. 7 | Decision<br>i. Date<br>ii. Convicted<br>iii. Acquitted<br>iv. Total |
| Column No. 8 | Remarks |

# CHAPTER XX

## ANNUAL ADMINISTRATION REPORT

**Divisional annual reports and returns**

A brief Annual Report, or statement of progress in each division for the financial year extending from. 1st April to 31st March, will be submitted to the Conservators by Divisional Forest Officers on the dates and in a form hereafter prescribed. The report will be accompanied by the annual returns in forms detailed in paragraph 5.43, and by such other returns as the Principal Chief Conservator may direct Divisional reports will be written on one side of the page only. Each section of the report and each form is to be headed with the name of the division concerned. Any corrections made by the Accountant General after the closing of March, final accounts will be made in the next year's report. Paisa will be omitted from all annual reports.

Conservators should compile and submit complete annual reports along with consolidated forms of their circles to the Principal Chief Conservator. Divisional Forest Officer's reports need not be sent. The Provincial report will be compiled in Principal Chief Conservator's office from the Circle reports.

**Date of submission of the report**

The Divisional Offices and Conservators will submit the various Chapters of the report to their Conservators and Principal Chief Conservator of Forests

respectively on the following dates:-

| | **Chapter** | **Section** | **Date of Submission by Divisional Forest Officer** | **Date of submission by Conservator** |
|---|---|---|---|---|
| | **1** | **2** | **3** | **4** |
| I | Constitution of State Forest | I. Alteration in area<br>II. Forest Settlement<br>III. Demarcation<br>IV. Forest Surveys | 1st May | 15th May |
| II. | Management of State Forest | I. Regulation of management<br>II. Communications and buildings<br>III. Protection of Forest Introductory-<br>a) General Protection<br>b) Protection from fire<br>c) Protection from cattle<br>d) Protection against injuries from natural causes<br>e) Protection against erosion | 15th May | 1st June |
| III | Silviculture | All Sections | Ditto | Ditto |
| IV | Exploitation | Ditto | 1st May | 15th May |
| V | Financial results | Ditto | 15th May | 1st June |
| VI | Research & Experiments | Ditto | 15th May | 1st June |

| | | | | |
|---|---|---|---|---|
| VII | Administration | All Section | 15th May | 1st June |
| VIII | Development Progress of Plan Scheme | Ditto | Ditto | Ditto |
| IX | General | Ditto | Ditto | Ditto |

The Annual Report is in the first instance sent to Government in the Administrative Department concerned and has then to go to the Press for printing only when the approval of the former has been obtained and the report is ready for final printing. Further, the report when sent to the Press, has invariably to be accompanied by a spare copy of the 'Review' thereon.

The Annual Report is submitted by Principal Chief Conservator to Government for approval and review by 15th October.

**The arrangements of Chapters**

The subjects treated off will be arranged as follows in all the reports, whether Divisional, Circle or Provincial.

**General instructions regarding the compilation of Annual Report**

5.41. In compiling the Provincial report the following principles should be strictly followed

1. All reports should contain only the explanation of really important or suggestive variations in the statistics and the statement of really noteworthy facts in the history of the year's administration.
2. No mere paraphrasing and reproduction of the statistics should be allowed in the report.
3. All attempts to offer explanation of variations in the figures, which are not important or unusual, should be excluded unless the fact alleged in explanation is in itself important enough to demand mention.
4. The idea that it is necessary to say something should be discharged and it should be recognized that the briefer a report is the better, provided that it says all that is needed for an intelligent comprehension of the meaning of the facts and figures and of the salient features of the year's works.
5. The introduction into the text of large numbers of tables of statistics (usually a reproduction in an abridged form of the statistics in the appendices) detracts from the value and interest of a report while it greatly increases the cost of printing it. The body of the report should be almost entirely in narrative form. It will occasionally be necessary to introduce tables of comparative statistics into the narrative but such tables should be brief and simple and their number rigidly restricted.
6. The number of maps or diagrams should be restricted; they should be placed at the beginning or end of the volume.
7. Tables of statistics should not be printed sideways on a page unless distinct economy of space thereby results.
8. Pages of tabular matter should not be printed with the columns left entirely or almost entirely blank.
9. It is a seldom necessary to give in full detail and in separate columns in tables of statistics the corresponding figures for the preceding year. In most cases it will be found sufficient to give corresponding figures for the totals only, by means of marginal entries on the paragraphs and, if possible, also on the tables themselves.
10. Cross reference between the statistical tables and the paragraphs discussing them should be given by means of marginal entries on the paragraphs and, if possible, also on the tables themselves.

The following additional instructions are issued for the guidance of Divisional Officers:-

(1) It is not infrequently found that Divisional Officers are content to leave the compilation not only of statistics but also of the comments upon and explanations of the features of the year's work to their office. Reports as compiled are, very badly worded and frequently contain comments and "explanations" which are entirely inadequate or even incorrect emphasis is often laid on points of little important features of the year's work are omitted or quite inadequately dealt with.

(2) When it is stated that inadequate "explanations" such as the following are by no means are in annual report received in the past few years, the necessity for improvement will be evident.

i. The increase in the area burnt is due to a greater number of fires.
ii. The larger outturn remove is due to more timber number of fires.
iii. The increased revenue is due to increased sales.

(3) A far higher standard in divisional annual report can be obtained with very little additional work, and it is desired that the Divisional Officers will write their own reports bearing in mind that their clerks should only be required, in the first instance, to put up the forms and statistics upon which the Divisional Officer will comment. It is for the Divisional Officer to call for any cases or papers he wants when he finds himself unable to furnish an adequate explanation of the statistics from his own knowledge of the work in his division. They are themselves responsible for the accuracy of forms and statistics and must satisfy themselves of that accuracy to the best of their ability before submitting their reports to Conservator.

(4) While the annual report is not to be used for the purpose of discussing theories of propounding views not relevant to the actual results of the year's work it can undoubtedly be made an interesting and informative document. Divisional Officers must treat it as a valuable record of progress (or otherwise) in forest conservancy and management during the year.

(5) conservators have often had to compile the Provincial Report from meager, bald and often inaccurate and misleading reports sent in by Divisional Officers, and to reply solely on their own knowledge of the position and to reject the comments and "explanations" contained in divisional reports entirely. In such circumstances it becomes more and more difficult to produce an interesting and informative report for the perusal of Government and the public, and a record of any value to the Forest Department of the year's operations.

**Detailed instructions regarding the writing of various chapter**

The following instructions are laid down for the writing of various chapters, their sections and sub-sections.

## CHAPTER I

## CONSTITUTION OF STATE FOREST

### 1. Alternation in Area

This section should give concisely the areas added or excluded during the year, together with the reasons for additions and exclusions. The following important classes of forests should be dealt with (if existing in the circle):-

**(i) Reserved, (ii) Protected, (iii) Unclassed or Private Forest Land, and (iv) Leased Forests.**

In writing this section divisional officers should classify their areas working circle by working circle in accordance with the form given below:-

| Division | Working Circle | CONIFERS | | BROAD-LEAVE-FOREST | | Scrub | Irrigated plantation | Waste/Blanks Culturable & unculturable | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | Merchantable | Unprofitable or inaccessible | Merchantable | Unprofitable or inaccessible | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | | | | | | | | |

The Pr. Chief Conservator will address the Heads of other Departments for information each year as to what areas of Forest Lands under their control were brought under the various enactments during the year and classed in the four classifications given above. This information will also be shown in appendix I(Chapter X of Annual Administration Report)

## 2. Forest Settlements

The progress made in Forest Settlements will be recorded, the area finally settled during the year that under settlement and the cost and agency employed. An estimate of the area still to be settled should be added together with suggestions for the future.

## 3. Demarcation

The length of boundary demarcated and repaired during the year should be noted, differentiating between external and internal boundaries. The methods employed and its cost per km should be stated and an estimate made of the work still to be done.

## 4. Forest Surveys

A short report by the Survey of India, should where necessary be entered here, followed by a brief notice of local surveys if undertaken. The section should close with an estimate of the amount of survey work still outstanding.

The chapter should end with a statement of the total expenditure under the head, “Constitution of State Forest".

# CHAPTER II

# MANAGEMENT OF STATE FORESTS

## 1. Regulation of Management

### *(a)* ***Preparation and control of regular working plans***

Under "Preparation" should be mentioned the area for which new working plans were sanctioned during the year and the area for which working plans were in compilation. In each case the system of working prescribed or proposed should be recorded; and, in the case of completed plans, the cost per square km. Under "Control" it should be mentioned whether the prescriptions of existing plans were carried out and important deviations should be explained and the authority therefore stated.

Revisions of Working Plan should next be noted and the sub-section should close with an estimate of the area for which Working Plans are still required and a list of Plans which will lapse within the next three years.

### *(b)* ***Preliminary Working Plan Reports***

A brief notice of the reports submitted or under compilation should here be entered.

## 2. Communication and Buildings

The sub-section includes tramways, slides and all other forms of export lines.

The information should be subdivided under the heads of "permanent" and "temporary" works. If the works were of some magnitude details of interest may be given regarding their nature.

### *(b) Buildings*

Here again the information given should differentiate between "permanent" and "temporary" works, nut no details are required save for permanent buildings of importance.

The cost of permanent and temporary roads and bridges and buildings should only be given in totals.

## 3. Protection of Forests

*Introductory*

Here give the number of cases reported during the year and comment on their increase or decrease. Short paragraphs regarding any other executive measures taken for the protection of forests land or produce should be added under this head.

### *(a) General protection*

This sub-section is of importance, and the total number of forest offices which come under observation during the year should be compared with the average of those which occurred during the past three years. In the same way the offences of the year under the head (i) "Injury by fire", (ii) "Unauthorized felling or Removal of Produce", (iii) "Unauthorized Grazing", and (iv) "Other Offences" which includes unauthorized lopping should be compared, the reasons for any marked increase or decrease being given. In another paragraph the number of cases compounded and brought to court should be considered, together with percentage of convictions obtained. The sub-section should close with remarks as to undetected cases and the nature of the punishments inflicted by the magistracy in important forest cases.

### *(b) Protection from fire*

The sub-section should open with a statement of the different method employed, i.e. fire lines, patrols, departmental burning, etc., and the work done under different methods, and be followed by information as to the area under regular protection, the percentage of success attained, and its cost per square km. The origin of fires should be considered under the following heads:-

(i) Those originating in departmental fire conservancy operations.

(ii) Those crossing outer fire traces.

(iii) Those due to carelessness or accident by outsiders, or to unknown causes.

(iv) Those originating from intention or malice.

### *(c) Protection from Cattle*

The percentage of forests upon to (i) grazing, and (ii) browsing, to the whole area may be mentioned. The number of cattle impounded, as compared with the average number of the last three years, should be noted and reasons given for any marked change in these numbers. The injury done by cattle, the means taken to prevent such injury and their results should be recorded.

### *(d) Protection against injuries from natural causes.*

This sub-section should be of interest. Any special danger threatening the forests, such as insects parasites climbers, snow, etc., should be mentioned together with the measures taken to avert these dangers.

## CHAPTER III

## SILVICULTURE

1. **System of Management**

Give general remarks regarding the various systems adopted in the division or circle.

2. G**eneral Progress of Regeneration and Afforestation**

*(a)* ***Mainly natural***

*(i)* ***Concentrated***- Refer to Appendix III (At the end of para 5.44) and comment on the progress of regeneration and give general remarks. Add short paragraphs regarding the progress of regeneration under different systems of management commenting on the various factors which conducted to the progress (or otherwise) of natural regeneration and explaining glaring failures of regeneration. It is for Divisional Officers to say when an area has been completely regenerated. This stage maybe reached when one or more secondary feelings have been made and is always so when a final felling has been completed. A detailed list of all areas allotted for natural regeneration by seed under concentrated systems of regeneration should be kept in divisional offices and examined annually before writing the report with a view to striking off areas in. which regeneration is complete.

***(ii) Not concentrated*** –Here give short paragraphs commenting on the progress of natural regeneration of forests under the selection systems and of protection forests.

*(b)* ***Mainly artificial***

This should be treated under the heads of (i) Regular plantains, (ii) Taungya plantations and (iii) any other form of artificial reproduction. Nursery work and the costs per ha. of sowing and planting is to be dealt with as well as the total expenditure and the total extent of the work carried out.

*(c)* ***Afforestation***

Under this head are included the (i) Irrigated Plantations in the canal colonies, and (ii) Patty Afforestation work (or of future work of a similar nature).

Give a statement showing the progress made with the formation of new irrigated plantation during the year, and comment on the success or otherwise of the operations and any modifications in technique introduced. Costs per ha. on the formation of irrigated plantations are to be dealt with in detail. Give in a separate paragraph a statement showing the restocking of areas planted in the previous years, which for some reason or other had failed, together with costs. The availability (or otherwise) of water in sufficient quantity from the Irrigation Department should be commented on in separate paragraphs. In the end two paragraphs, one dealing with the temporary cultivation leases, and the other with the revenue realised from these leases, as also expenditure incurred on formation or irrigated plantations should be added.

**3. Tending of the Growing Stock in Areas not under Concentrated Regeneration**

Give a short note on the various operations, viz., improvement fellings, stubbing out of kana grass, weeding, burning of debris, etc., in such areas in short separate sub-paragraphs. Areas over which such operations are carried out and their costs per ha. should also be given.

**4. General**

Here give the total expenditure incurred on regeneration afforestation and tending, etc., works during the year and compare it with the previous year.

# CHAPTER IV
# EXPLOITATION

## 1. System of Management

*(a) Major Forest produce*

The system of management in force will be classified working Circle under the different systems stated below:-

*1. High Forest*

i. Clear felling system.
ii. Shelter wood system.
iii. Selection system.

***II. Coppice.***

i. *Simple* coppice system.
ii. Coppice with standards system.
iii. Coppice selection system

For further details regarding, the above systems see Appendix I of Indian Forest Records, Volume XV, Part II, "A glossary of technical terms for use in Indian Forestry". The areas given in the above statement must respond with Annual Report Form No. 7.

*(b)* ***Minor Forest Produce***

The system of disposal of minor forest produce should be explained. Grazing permitted for the purpose of producing revenue should be mentioned here. Efforts made with a view to increase the utilization of minor forest products may be touched on.

## 2. Agency of Exploitation

*(a)* ***Departmental Agency***

The reasons for employing departmental agency should be given and the percentage of total outturn extracted by this method. The more important departmental works may be briefly described, including transport by land or water and depot arrangements. The percentage of loss in converting trees into scantlings the cost per $m^3$ of the different operations of fellings, sawing, carriage and floating and the total cost of delivering in depot per $m^3$ from stump to depot will be stated in this place and the royalty received per $m^3$ of standing timber will be calculated and explained. Firewood will be similarly dealt with; the costs of extraction and royalty realised per $m^3$ stacked being commented on.

A section will be devoted to resin and will deal with quantities and costs per qtl. also with yields per 100 channels.

(b) ***Purchasers***

Sales of timber and firewood standing to purchasers will be dealt, in this section and, prices per $m^3$ standing, volume or $m^3$ stacked of firewood will be stated and commented on and tendency of market prices noted.

(c) ***Rights, Privileges and free grants***

The sub-section, should deal with the utilization by right and privilege holder of the produce placed at their disposal, and explain any increase or decline in the demand, as well as the means taken to permit the proper exercise of rights and privileges without damage to the forests. The estimated value of removals should be stated.

Any large grants made during the year to individuals or communities may be mentioned and the reasons for the grant explained. The estimated total value of the grants should be given.

### 3. Outturn and Sources of Forest Produce

This sub-section will summarize by volume, quantity or value, all outturn by whatever agency extracted and should do so by classes of forests (Chapter I-1.) and classes of produce (Major and Minor). Remarks should be added giving any interesting information that may be available regarding the outturn of valuable timbers and of the more important minor products; also as to the number of cattle for which grazing has been provided. This Chapter should end with a statement of the total expenditure incurred under Management of State Forests as compared to the previous year and to the average of the past three years.

## CHAPTER V

## FINANCIAL RESULTS

A comparison should be made of the income and expenditure of the present and the past year and the average of the five preceding years. An analysis should then be made of the income as derived from major and minor produce, of the expenditure (B) incurred on extension, constitution, improvement and exploitation of the forest property and of that incurred (C) for administrative, executive and protective charges giving percentages of the whole in each case and at the end the percentage of net income. The extent of outstanding and increase or deficit in stock should be taken into consideration.

The Profit and Loss Account will be prepared in the following form, (Figures fictitious)

For the year

| | **Dr.** | **Rs. (Lakh)** | **Cr.** | **Rs. (Lakh)** |
|---|---|---|---|---|
| 1. | Stocks of timber and other produce in forests and at launching depots on 31st March, 1985, as per footnote to form No. 22 for 1984-85. | 3.25 | Stock of timber and other produce in forests and at launching depots on 31st March, 1986 as per form No. 22 for 1985-86. | 3.92 |
| 2. | Timber in transit in river on 31st March, 1985, as per footnote to form No. 22 for 1984-85.<br>Less depreciation at 10 percent | 0.46<br>0.05<br>-0.41 | Timber in transit in rivers on 31st March 1986 as per footnote to form No. 22 for 1985-86<br>Less depreciation at 10 percent | 0.48<br>0.05<br>-0.43 |
| 3. | Stocks of timber, etc., in sale depots on 31st March, 1985 as per form No. 22 for 1984-85. | 0.62 | Stocks of timber, etc., in sale depots on 31st March 1986 as per form No. 22 for 1985-86 | 0.82 |
| 4. | Revenue expenditure for 1985-86. | 25.67 | Net scale for the year | 28.98 |
| 5. | Interest on Capital expenditure. | 3.78 | Net deficit | 0.13 |
| 6. | Depreciation on stores, tools and plants, as per form No. 23 for 1985-86 | 0.57 | | |
| 7. | Pensionary, charges | 0.98 | | |
| | **Total** | **35.28** | **Total** | **35.28** |

For further instructions please see forms No. 22 and 23 in paragraph 5.44.

## CHAPTER VI

## RESEARCH AND EXPERIMENTS

This Chapter should be devoted to a record of research and of experiments made in the introduction of new, species or in the utilization of indigenous growth. A brief but interesting record should here be maintained which may be of great use in extending the scope of economic forestry. The Silvicultural Research Division will prepare a report for the whole province which after approval by the Pr. Chief Conservator of Forests will be sent to the President, Forest Research Institute, Dehra Dun. A summary of the Provincial report on research will appear in this place in the Annual Report

## CHAPTER VII

## ADMINISTRATION

This chapter should deal with establishments, services and conduct of officers, casualties, and relations between Revenue and Forest officials. The inspection of offices should be briefly reported on. No detail need be given of the charges held by various officers during the year nor of the number of days occupied on tour.

## CHAPTER VIII

## GENERAL

This chapter should deal with any special matter of interest which does not fall under any of the previous heads such as game preservation.

**Returns to accompany the Provincial and Divisional Annual Reports**

The following returns should accompany the Circle and Divisional Annual Reports:-

Form No. 7. (i) Area of Reserved Forests.

Form No. 7. (ii) Area of Protected Forests.

Form No. 7. (iii) Area of Unclassed Forests.

FormNo. 7. (iv) Area of Leased Forests.

Form No. 7. (v) Area under section 38 of the Indian Forest Act, etc. etc.

Form No. 8. Progress made in, and expenditure incurred on forest settlements.

Form No. 9. Demarcation and maintenance of boundaries.

Form No. 10. Forest area surveyed and under survey.

Form No. 11. Progress made in working plans.

Form No. 12. Communications and buildings.

Form No. 13. Prosecution for breaches of forest rules.

Form No. 14. Area of forest tracts protected from fire.

Form. *No. 15.* Causes of forest fires.

Form No. 16. Areas open and closed to grazing.

Form No. 17. Return of grazing in State forests.

Form No. 18. General Progress of regeneration and afforestation.

.Form No. 19. Outturn of timber and fuel and agency of exploitation.

Form No. 20. Outturn of minor forest produce.

Form No. 21. Account of timber and other produce collected by Government agency and brought to depots, sold locally, or otherwise disposed of.

Form No. 22. Abstract showing the value of timber and other produce at sale depots.

Form No. 23. Abstract showing the value of live and dead stock.

Form No. 24. Summary of revenue and expenditure for the province, Circle or Division as the case may be.

Form No. 26. Revenue received and out standings on account of revenue.

Form No. 27. Outstanding and liabilities on account of contractors and disbursers.

No additional return giving in a different form the information contained in the above statements shall be submitted. Any other appendices that may be inserted should be strictly limited to the illustration of important material points mentioned in the annual report.

The following, three appendices are prescribed-

Appendix I-Statement showing types of forests in the H.P. to be prepared working circle by working circle. The totals of divisions must agree with Form 7.

Appendix II-Statement showing imports of timber, firewood and bamboos.

Appendix VI-Statement showing progress of concentrated regeneration (mainly natural).

(i) All the forms will be prepared for the financial year.

(ii) Except in Form No. 27, fractions of rupees, square km. ha. cubic meter, if exceeding one-half, will be taken as a full rupees square km. ha. or cubic meter as the case may be; if one-half of less they will be omitted.

**Detailed instructions regarding preparation of forms and appendices**

Form No.7 (Area of Reserved, Protected, Unclassed and Leased Forests.)-Divisional Forest Officers will prepare this form by Ranges and the figures must agree, with the total column of Appendix 1**.**

As this form is often referred to for the purpose of ascertaining the area of a particular forest, it will be prepared in detail every fifth year. All forest statements or forms which are required in detail every fifth year should be so prepared for the years 1952-53, 1957-58 and so on. During intervening years only totals by Ranges are required. Where any alternations in area of any particular forest have occurred, Divisional Forest Officers will give a foot-note to this effect.

Form No. 8. (Progress made in, and expenditure incurred on, Forest Settlement)-Totals for divisions should be given.

Form No. 9 (Record of demarcation and maintenance of boundaries)-As indicated by the heading of column (1) the information give in this, form should be confined to totals for each division, with a grand total for the circle. The entries in column (5) should equal the total of those in columns (2), (3) and (4); while the eighth column should be the total of columns (5), (6) and (7), Column (6) is not intended to include any boundaries, which do not require demarcation, as they will be shown in column (7). Where surveys have not been, completed, the entries in columns (6) and (7) must be estimated.

Form No. 1-0. (Forest area surveyed and under survey)-This form should be restricted to a record of surveys made by the Survey of India. The totals of columns 2, 3, 4, 5, 8, 9, 10 and 11 should show the work done up to date (column 1-4) and this total added to column 15 should equal the total forest area shown in column 16. Boundary surveys should not be taken into account in calculating the figures to be entered in column 15. When a tract which has already been shown as surveyed is resurveyed in a more elaborate manner, the area entered for the year under the head of the superior survey should be deducted from the area for previous years shown under the head of the inferior surveys, the alteration being explained in the column of remarks.

Form No. 11. (Progress made in Working Plans)- This form is required in divisional abstracts only for each class of forests separately.

Form No. 12. (Communications and, buildings) - Only totals by divisions should be given. No further details of expenditure are necessary except that an abstract should be made out at the end giving the totals of the various items. These totals should tally with the figures given in Form No. 24.

Form No. 13. (Register of breaches of Forest Rules)-Only totals by divisions should be given.

Form No. 14 (Area of forests protected from fire)- Information should be given for each range only; with totals for divisions and circles. Only areas actually protected from fire, e.g., all chill, deodar and kail and irrigated plantations should be entered in column 8.

Form No. 15 (Causes of forest fires)-A divisional abstract is all that is required.

Form No. 16. (Area closed and open to grazing)-This form should be filled in by divisions only for each class of forests separately.

Form No. 17. (Return of grazing in State Forests)- Information should be shown separately for each class of forests.

Form No. 18. (General progress of regeneration and afforestation).-This form has now been simplified considerably. The information is required in divisional and circle totals with a grand total 'for the Pradesh. The column cost of regeneration. etc., will comprise the total expenditure on such operation incurred under Non-Plan and Plan Schemes.

Form No. 19. (Outturn of timber and fuel and agency of exploitation)-Only divisional totals are to be given for each class of forests separately. It is not necessary to show separate figures for the several methods of exploitation but if desired, the outturn of the different classes of timber may be given.

Form No. 20. (Outturn of minor forest produce)- An abstract for the whole circle, showing the outturn from each class of forests separately but without details for divisions will suffice. The different kinds of produce to be shown separately may be left to Conservator, who will, apart from receipts on account of grazing and fodder grass and of bamboos, which should invariably be shown separately, confine themselves to items of revenue which, are important in their circles and show the rest in one entry under the head "Miscellaneous".

Form No. 21. (Abstract of timber and other produce cut or collected by Government agency and brought to depots, sold locally, or otherwise disposed of)-For all purposes, of superior control and statistics it will suffice if the opening balances the receipts and disposals during one year (taking into account all the various sources) and the closing balances are given in lump sums for each diversion under the main heads of timber, firewood and minor forest produce only. If any one kind of wood possess any a special value, its transactions may be shown separately from those in woods of other descriptions.

| **Receipt** | **Disposal** |
|---|---|
| *Received from the forest in depots and sold locally | Removed by purchasers from depots. |
| Received by conversion in depots. | Sold locally Converted in depots. |
| Received by transfer from sale depots. | Lost or written off as useless. Used by the department. Transferred to other sale depots. |

Form No. 22. (Abstract showing the value of timber and other procedure at sale depots)-In the preparation of this form, no credit for the value of free grants of forest produce is to be taken. The value of all forest procedure to be entered in form No. 22 will be the cost price, except in case when its market value is definitely known to be less than cost price in which case, it will be put at market value.

The information regarding the quantity of timber in transit in rivers should be, shown separately in order to calculate depreciation on it. This information is to be incorporated in the Profit and Loss Account in Chapter VI.

Form No. 23. (Abstract showing the value of live and dead stock)-In preparing this form the depreciation on store, tools and plants should be taken into account. A foot-note should always be given showing the rate and amount of depreciation calculated and deducted.

The following schedule shows the percentage of depreciation fixed for various types of dead stock

| | **Percent** |
|---|---|
| 1. Buildings Kacha-paca | 2½ |
| 2. Buildings, Kacha | 5 |
| 3. Furniture | 5 |
| 4. Iron safes | 1 |
| 5. Tent, etc., (plain) | 7½ |
| 6. Tents, etc., (hills) | 10 |
| 7. Tools and survey chains | 15 |
| 8. Tapes | 15 |
| 9. Mathematical instruments and steel tapes | 5 |
| 10. Tramways and machinery | 5 |
| 11. Plain leather goods | 10 |
| 12. Ropes, steel | 10 |
| 13. Ropes, Manila | 20 |
| 14. Fencing wire | 5 |
| 15. Miscellaneous | 15 |
| 16. Motor Vehicles and Trucks | 10 |

Owing to the importance of the above forms in the preparation of the, provincial Profit and Loss Account, the greatest care should be taken by the Divisional Officers in seeing that the figures entered are correct.

Form No. 24. (Summary of receipts and expenditure for the Province)-This should contain a summary of receipts and expenditure both Revenue and Capital under the fixed budget sub-heads.

Form No. 26. (Revenue received and outstandings on account of revenue)-This should be given in abstract for each circle, the Chief Conservators office being considered as a circle for the purpose of this form.

Form No. 27. (Out standings and liabilities on account of Contractors and disbursers)-

## APPENDICES

***Appendix I***-Statement showing types of forests in the Himachal Pradesh-This appendix will be prepared by working circles in the following form:-

| Division | Working Circle | Conifers | | BROAD-LEAVE FOREST | | Scrub | Irrigated plantation | Waste | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | Merchant-able | Un-profitable or in-accessible | Merchant-able | Un-profitable or in-accessible | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | | | | | | | | |

***Appendix II***- Statement showing import of timber, firewood and bamboos-This will be prepared in the following form:-

| Rivers | DEODAR LOGS | | PINE LOGS | | OTHER LOGS | | DEODAR SLEEPERS | | OTHER SLEEPERS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Cum. | No. | Cum. | No. | Cum. | No. | Cum. | No. | Cum. |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| | | | | | | | | | | |

***APPENDIX II*** *–Contd.*

| Rivers | DEODAR (SCANTLING) | | OTHER SCANTLINGS | | MISCELLANEOUS | | TOTAL TIMBER | | BAMBOOS | FIREWOOD |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Cum. | No. | Cum. | No. | Cum. | No. | Cum. | | |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| | | | | | | | | | | |

The Statement is to be prepared for each river and totaled up for the whole State. The figure for the three previous years then be given and the average struck. The comparison and comments etc., are to be made in the body of the report.

***Appendix III***-Statement showing the progress of concentrated regeneration (mainly natural)- This statement will be prepared in the following form:-

| Name of Working Circle | Principal species | Regeneration period | Total areas to be regenerated during the period | 'Normal progress of regeneration by 31st March, 20---- | AREA OF FULLY ESTABLISHED REGENERATION BY 31ST MARCH, 19 | | | Percentage of the "Normal" established by 31st March, 20---- | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Previous year | During the year | Total | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | | | | | | | | |

**Timber Costing Statement**

To ensure uniformity in the preparation of costing statements for departmental timber works, such statements will be prepared by all Divisional Officers in the manner detailed below.

Two separate statements are to be submitted. Statement I will show the detailed cost per cubic foot of all sawn timber, including axed balas and round ballies from the forest to the sale depot. Statement II will similarly show the details of costs of delivery per cubic foot of logs from forest to sale depot.

A pillar diagram will be prepared according to Statement I. The vertical scale of this diagram will be one anna ½ inch, and the width of the pillar will be one inch. The colours of the different sections of the diagram representing different operations will be as shown on the specimen. Specimen statements are attached herewith.

No pillar diagram need be prepared according to Statement II.

The statements will be prepared in duplicate annually by the Divisional Forest Officers in charge of the concerned Divisions, and both copies will be sent to the Divisional Forest Officer in charge of the Depot Division concerned. These statements will show all costs incurred on items 1 of 11 of statement I (vide: "Method of Preparation" below, and statement II will similarly show all costs incurred on items 1 to 9 of that statement. At the same time the Divisional Forest Officers will intimate to the Depot Divisions the costs incurred under items 14 (a) and 12 (b), respectively of Statements I and II.

The Divisional Forest Officer, Depot Division, will then complete the statements and will forward them to the territorial Conservator who will forward one complete copy to Divisional Forest Officers of concerned Divisions and one complete copy to Chief Conservator of Forests. The pillar diagrams will be prepared in Chief Conservator of Forest's office and copies thereof will be sent to the Conservator concerned and Divisional Forest Officer.

**Method of preparation of Timber Costing Statements**

The headings used in Form 14 should be so arranged that the total expenditure incurred throughout the year on each operation can be readily ascertained with when the time comes to prepare the statements.

**Statement I**

**Calculation of cost per cubic foot of each operation.**

**(Vide specimen statement I attached).**

| | Item | |
|---|---|---|
| 1. | Marking and felling including commission and godown commission. | Form 14 expenditure marking and felling is divided by the total number of cubic feet sawn |
| 2. | Sawing, including snipping and commission | Form 14 expenditure on sawing and snipping including commission is divided by the number of cubic feet sawn |
| 3. | Godown on sawing | Divide cost of godown or godown commission on sawing shown in Form 14 by volume cubic feet sawn |
| 4. | Godwon on carriage | Divide cost of godown or godown commission on carriage shown in Form 14 by volume cubic feet carried |
| 5. | Coolie carriage including commission | Divide cost shown in Form 14 by volume cubic feet carried by coolies |
| 6. | Roping including erection, commission and godown | Divide costs incurred under these heads as shown in Form 14 by volume cubic feet roped down |
| 7. | Ropeway depreciation | To save labour in calculation depreciation will be taken to be as follows:- |
| | Span 1-2,000 | 0.5 pies per cubic feet roped |
| | 2,001-3,000 | 1.0 pies per cubic feet roped |
| | 3,001-4,000 | 1.5 pies per cubic feet roped |
| | 4,001-5,000 | 2.0 pies per cubic feet roped |
| 8. | Floating | Total cost of floating-vide Form 14 is divided by total Volume of logs delivered at the boom |
| 9. | Loss in Transit | Multiply total volume lost between launching depot and boom by the total cost incurred from stump to launching depot, viz., item 1-7 above, and 10 and 11 below. Divide the amount of this product by the total volume delivered at the boom and you get the cost of loss per cubic foot floated |
| 10. | Miscellaneous | Divide cost taken from Form 14 x ½ (volume sawn + volume carried) |

| | | |
|---|---|---|
| 11. | Temporary establishment including traveling expenses (actual) | Divide cost taken from Form 14 x ½ (volume sawn + volume carried) |
| 12. | Miscellaneous Depot Division | To be supplied by the Divisional Forest Officer, Depot Division. Divide amount charged by volume received at the boom |
| 13. | Rafting | To be supplied by the Divisional Forest Officer, Depot Division. Divide amount charged by volume received at the boom |
| 14. | Distributive- | |
| | (a) Forest Division | (a) Pay and traveling allowance of Divisional Forest Officer, pay and traveling allowance of Range Officers, Exploitation Officers, etc., fraction of pay and traveling allowance of each to be charged to be decided annually by the Divisional Forest Officer himself. The total amount charged to be divided by the average of the volumes sawn, carried and floated |
| | (b) Depot Division | (b) To be supplied by the Divisional Forest Officer, Depot Division |

**Pillar Diagrams**

The different operations will be represented by the following colors in ascending order

| | | |
|---|---|---|
| 1. | Marking and felling | Yellow |
| 2. | Sawing including commission | Brown |
| 3. | Godown on sawing | Brown colour with black hatches |
| 4. | Godown on carriage | Red with black hatches |
| 5. | Coolie Carriage including commission | Red |
| 6. | Roping, including ropeway erection commission and godown | Green |
| 7. | Ropeway depreciation | Green with black dots |
| 8. | Floating | Blue |
| 9. | Loss in transit | Crimson |
| 10. | Miscellaneous | Yellow with dots in black |
| 11. | Temporary Establishment | Yellow with black hatches |
| 12. | Miscellaneous Depot Division | Leave uncoloured |
| 13. | Ratting | Blue with black hatches |
| 14. | Distribute- | |
| | (a) Forest Division | Light green |
| | (b) Depot Division | |

**STATEMENT II**

Method of calculating cost of delivery of logs per cubic foot at boom:-

(vide specimen statement II attached)

| | | |
|---|---|---|
| 1. | Marking and felling, including commission and godown commission. | To be taken from statement I. This may be taken to be the same as for sawn timber. |
| 2. | Logging including commission. | Divide cost,- *vide* From 14 by the total volume logged. |
| 3. | Godwon on logging. | Divide cost,- *vide* From 14 by the total volume logged. |
| 4. | Godwon on rolling. | Divide cost,- *vide* From 14 by the total volume logs rolled. |
| 5. | Rolling, including cost of construction of rolling roads and commission. | Cost,- *vide* From 14 is divided by total of logs rolled. |
| 6. | Floating. | Total cost of floating-*vide* Form 14 is divided by total volume of logs delivered at the boom. |
| 7. | Loss in transit. | Multiply total volume lost between launching depot and boom by the total cost incurred from stump to launching depot (viz., item 1 to 5 above and 8 and 9 below). Divide the amount of this product by the total volume delivered at the boom and you get the cost of loss per cubic foot floated. |
| 8. | Miscellaneous. | Divide cost taken from Form 14 by ½ (volume sawn *plus* volume carried). |
| 9. | Temporary establishment including traveling expenses (actual). | Divide cost taken from Form 17 by ½ (volume sawn *plus* volume carried). |
| 10. | Miscellaneous Depot Division. | To be supplied by Divisional Forest Officer, Depot Division-Divide amount charged by volume received at boom. |
| 11. | Rafting. | To be supplied by Divisional Forest Officer, Depot Division-Divide amount charged by volume received at boom. |
| 12. | Distributive:-<br>(a) Forest Division<br>(b) Depot Division | (a) fraction of pay and traveling allowance of Divisional Forest Officer, pay and traveling allowance of Range Officer, Exploitation Officers, etc., etc., to be charged the amount to be decided annually by the Divisional Forest Officer himself. The total divided by the average of the volumes.<br>(b) To be supplied by Depot Division-divide the amount charged by the total volume of logs received at the boom. |

**(SPECIMEN ONLY)**

**FOREST DIVISION**

**STATEMENT I**

Statement showing cost of delivery of sawn timber

Year_____

| Item No. | Operation | Cost incurred Rs | Volume used for calculation cft | Cost per cubic foot (annas) | Total |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | Marking and felling including commission & godown commission | 3,032 | 213,966 | 0.226 | |
| 2. | Sawing, including snipping and commission | 32,379 | 213,966 | 2.241 | |
| 3. | Godown on sawing | 4,508 | 213,966 | 0.337 | |
| 4. | Godown on carriage | 2,152 | 223,952 | 0.154 | |
| 5. | Cooli carriage including commission | 21,327 | 223,952 | 1.524 | |
| 6. | Roping, including erecting commission and godown | 3509 | 103,396 | 0.543 | |
| 7. | Ropeway Depreciation | -- | 103,396 | 0.078 | |
| 8. | Floating (including timber slide) | 26886 | 238,176 | 1.806 | |
| 9. | Loss in transit | -- | 17,830 | 0.421 | |
| 10. | Miscellaneous | 2210 | 218,959 | 0.161 | |
| 11. | Temporary Establishment including Traveling expenses (actual) | 2419 | 218,959 | 0.177 | |
| 12. | Miscellaneous Depot Division | -- | -- | -- | |
| 13. | Rafting | -- | -- | -- | |
| 14. | Distributive:- | | | | |
| | (a) Forest Division | 28799 | 255,046 | 1.806 | |
| | (b) Depot Division | -- | -- | -- | |
| | TOTAL | | | | |

**(SPECIMEN ONLY)**

**FOREST DIVISION**

**STATEMENT II**

Statement showing cost of delivery of sawn timber

Year_____

| Item No. | Operation | Cost incurred | Volume used for calculation cft | Cost per cubic foot (annas) | Total |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | Marking and felling including commission & godown commission | Taken from statement I | -- | 0.226 | |
| 2. | Logging, including commission | 403 | 22139 | 0.292 | |
| 3. | Godown on Logging | 231 | 22139 | 0.167 | |
| 4. | Godown on Rolling | 411 | 19730 | 0.334 | |
| 5. | Rolling, including cost of construction of rolling roads | 1621 | 19730 | 1.316 | |
| 6. | Floating | 2073 | 23165 | 1.431 | |
| 7. | Loss in transit | -- | 1961 | 0.211 | |
| 8. | Miscellaneous | 107 | 20934 | 0.82 | |
| 9. | Temporary Establishment including Traveling expenses (actuals) | 98 | 20934 | 0.75 | |
| 10. | Miscellaneous Depot Division | -- | -- | -- | |
| 11. | Rafting | -- | -- | -- | |
| 12. | Distributive:- | | | | |
| | (a) Forest Division | 1900 | 21678 | 1.402 | |
| | (b) Depot Division | -- | -- | -- | |
| | TOTAL | | | | |

**Timber Sale Statements**

Statements of chief sizes of average sale rates per cft. of sawn and round timber of each specie separately will be prepared by the Depot Division, at present Division Forest Officer, Kinnaur. The statement will show the following sizes of timber specie wise and will be prepared in the manner noted against.

The heading used in Form 8 should be so arranged that the total sale throughout the year on each size of each specie separately can be readily ascertained when the time comes to prepare the statement.

**STATEMENT**

Calculation of average sale rate per cft., of each size of each specie separately.

**Item:**

**Form 8**

| | | | |
|---|---|---|---|
| 1 | Beams:- | | Total quantity (cft) of sale during the whole year of this size (each specie separately) is divided by the total sale price during the whole year of this size. |
| | (i) | 6'x12"x6" | |
| | (ii) | 14'x12"x6" | Ditto |
| | (iii) | 6'x12"x6" | Ditto |
| 2 | Gattus:- | | |
| | (i) | 8'x12"x6" | Ditto |
| | (ii) | 6'x12"x6" | Ditto |
| 3 | Large Sleepers:- | | |
| | (i) | 14'x10"x5" | |
| | (ii) | 12'x10"x5" | |
| 4 | B.G. Sleepers: | | |
| | (i) 10'x10"x5" | | Ditto |
| | (ii) 9'X10"X5" | | Ditto |
| 5 | Railway Passings:- | | |
| | (i) 9'x10"x5" | | Ditto |
| 6 | Small Sleepers:- | | |
| | (i) | 8'x10"x5" | Ditto |
| | (ii) | 6'x10"x5" | Ditto |
| 7 | M.G. Sleepers:- | | |
| | (i) 6'x8"x5" | | Ditto |
| 8 | Karries:- | | |
| | (i) | Length 12' and over cross section 6"x6" and over | Ditto |
| | (ii) | Length 12' and over cross section under 6"x6" | Ditto |
| | (iii) | Length under 12' and cross section 6"x6" and over | Ditto |
| | (iv) | Length under 12' and cross section under 6"x6" | Ditto |

| | | |
|---|---|---|
| 9 | Scants:-<br>(i) 14'x8"x5"<br>(ii) 12'x8"x5"<br>(iii) 10'x8"x5"<br>(iv) 8'x8"x5"<br>Ballies:- | <br>Ditto<br>Ditto<br>Ditto<br>Ditto |
| 14 | (i) Length 12' and girth 22" and under<br>(ii) Length 8' and under 12' and girth 22" and under | Total quantity (cft) of sale during the whole year of this size (each specie separately) is divided by the total sale price during the whole year of this size.<br>Ditto |
| 15 | Average sale rate per cft. of round timber | Total quantity (cft) of sale of round timber (each specie separately) of above sizes (column 12) during the whole year is divided by the total sale price of round timber during the whole year. |

The Divisional Forest Officer, Kinnaur Forest Division, after completing the above statement will forward it to the territorial Conservator of Forest who will check and forward the same to the Chief Conservator of Forest, so as to reach him on 1st June, each year.

A pillar diagram will be prepared in the office of the Pr. Chief Conservator of Forest and copies thereof will be forwarded to the Conservator of Forest, Shimla & Kullu Circle and Divisional Forest Officer, Kinnaur, Kullu and Seraj Forest Divisions. The vertical scale will be ½" = /4/- (annas four) and the width of the pillar will be ½ inch. The colours of different species as shown in the specimen will be as under:-

| | | |
|---|---|---|
| 1. | Deodar | Green |
| 2. | Kail | Blue |
| 3. | Fir | Red |
| 4. | Chill | Yellow |

**Resin Costing Statement**

In order to organize resin work properly to enable a permanent record of operations and their cost to be maintained the following forms will be maintained in the Forest Divisions in which resin is being extracted departmentally.

**Resin Form A:-**

It will be kept in the following form and will give the result of enumeration of compartments or sub-compartments where such exist and will be permanent record of work actually done.

Division _____

Range_____

Block_____

Compartment_____

Or sub-compartment_____

Year of commencement of tapping_____

| Girth class | LIGHT TAPPING | | HEAVY TAPING | | TOTAL | |
|---|---|---|---|---|---|---|
| | **No. of trees** | **No. of blazes** | **No. of trees** | **No. of blazes** | **No. of trees** | **No. of blazes** |
| 3' to 3'-11"<br>4'-6'<br>over 6' | Nil | Nil | | | | |
| Total | | | | | | |

**Resin Form B:-**

The Form to be kept in the following form will show the monthly account of resin operations range by range, each block or group of forest concerning one resin depot being entered separately for purposes of statistical record and check of costs.

Resin form B

Monthly account of Crude Resin (Net) for 20---

| Name of Range | Locality and year of tapping | No. and Class of trees (Acres tapped) | | Channels | Yield in maunds per month (Net) | | Cost | Export to actual weight at rail head (Net) | Balance in Forest at the end of month (Net) | Additional rates to be filled at the end the year |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Class | No. | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| | | I<br>II<br>III<br><br><br>IV | | | Months<br>March<br>April<br>May<br>June<br>July<br>August<br>September<br>October<br>November | Md.<br>s.c. | Rs.<br>A.P. | Md. S.C. | | Average yield per 100 trees 1,000 channels Rate paid for carriage to rail head per mound Rs. (Net) |

**Resin Form C:-**

It will show the receipt and issue of produce in depot during the month and will be kept in the following form.

Resin Form C

Forest Department, H.P. _____ Division.

Receipt and issues of produce in depot during the month of _____ 20 ____

| Name of Depot | Description of produce | On hand e.g. (Net) | Received during the month of (Net) | | Total | Disposed during the month | | Balance (Net) |
|---|---|---|---|---|---|---|---|---|
| | | | When received | Quantity (Net) | | How disposed of | Quantity (Net) | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | | | | | | | | |

Station _____

Dated _____

NOTE:-This form can also be used for receipt and issue of resin materials on which a very careful check has to be kept.

Officer-in-charge

_____Dept.

**Resin Form D:-**

It will be prepared by the Divisional Forest Officer concerned and will show the following details:-

Resin Form D

1. Year.
2. Division.
3. Ha. tapped.
4. No. of trees tapped.
5. Total blazes.
6. Average per tree.
7. Total resin obtained.
8. Average per tree.
9. Average per 1,000 blazes.
10. Cost of labourer's wages per quintal net resin collected.
11. Cost of bonus to labour per quintal net resin collected.
12. Cost of carriage of resin per quintal net, forest to rail head.
13. Cost of carriage of resin per quintal by rail to depot.
14. Total cost, colour 10 to 13.
15. Total charges of setting up new crops in the year inclusive of pots.
16. Total charges for raising lips inclusive of Pots.
17. Total cost of packing crude resin, i.e., carriage & cost of tins, soldering, solder, etc.
18. Total cost of tools, stores and plant supplied not included in columns 15-17.
19. Total cost of permanent & temporary establishment on resin works and charges.

19. (a) Cost of establishment per 1,000 blazes.

20. Rent and other 13 charges not entered in column 19.
21. Average per quintal net of resin collected of costs given in columns 15-20.
22. General remarks on climate and nature of season labour supply, etc., and information which may be of use for striking to fair average, vide column 21.
23. Grand total average cost, cost of delivery of a quintal net of resin at depot.

The Divisional Forest Officer concerned after completing the above statement will forward it to the territorial Conservator of Forests who will check it and forward the same to the Pr. Chief Conservator of Forests so as to reach him on the 15th May each year.

A pillar diagram will be prepared according to the above statement in the office of the Pr. Chief Conservator of Forests and copies thereof will be forwarded to Conservator of Forest and Divisional Forest Officers concerned. The vertical scale of the pillar diagram will be ½ inch 25 paisa and the width of the pillar will be ½ inch. The colours of the different sections of this diagram representing the different operations will be as shown in the specimen. Specimen statements for the preparation of the diagram and a specimen diagram are attached herewith.

**Method of preparation of Resin diagram**

5.49. The heading used in Form 14 should be so arranged that the total expenditure incurred throughout the year on each operation can be readily ascertained of Resin Form D.

***Calculation of cost of resin per quintal. F.O.R. depot for the preparation of a diagram***

| | | |
|---|---|---|
| 1. | Setting up new crop | Column 15 of Resin Form "D" i.e., total charges for setting up new crops is divided by column 7of Resin Form D i.e. total resin obtained. |
| 2. | Raising up lips | Column 16 of Resin Form "D", i.e., total cost of raising lips is divided by column 7 of Resin Form D. i.e., total resin obtained. |
| 3. | Collection | Column 10 of Resin Form "D", i.e., cost of Labour wage per quintal. |
| 4. | Bonus | Column 11 of Resin Form "D", i.e., cost of bonus to labour per quintal. |
| 5. | Carriage Forest to Rail head | Column 12 of Resin Form "D" i.e., cost of Carriage of resin per quintal from forest to rail head. |
| 6. | Carriage Rail head to Depot | Column 13 of Resin Form "D", *i.e.,* cost of carriage of resin per quintal from Rail head to depot. |
| 7. | Tin Packing | Column 17 of Resin Form "D" *i.e.,* total charges of tin packing etc. is divided by column 7 of Resin Form D, i.*e.,* total resin obtained. |
| 8. | Tools and Plants | Column 18 of Resin Form i.*e.,* total cost of to plants etc., is divided by column 7 of Resin Form D*, .i.e.,* total resin obtained. |
| 9. | Rents | Column 20 of Resin Form "D i.e., total cost on rents etc., divided by column 7 of Resin Form, D, i.e., total resin obtained |
| 10. | Loss in transit | If there is any loss in transit a separate column in Resin Form D showing loss per quintal in transit. |
| 11. | Establishment | Column 19 of Resin Form, "D", i.e., total cost of permanent and temporary establishment is divided by column 7 of Resin Form, D, *i.e.,* total resin obtained |

Note:- Column 23 of Resin Form "D", i.e., grand total average, cost of delivery of. a Qt. net of resin at Depot must tally with the total average to be calculated in the Pr. Chief Conservator of Forests' office.

The different operations will be represented by the following colours in ascending order:-

| | |
|---|---|
| 1. Setting crop | Brown |
| 2. Raising up lips | Green cross hatched |
| 3. Collection | Blue |
| 4. Bonus | Blue, hatched |
| 5. Carriage Forest to Rail head | Green |
| 6. Carriage Rail and head to depot | Red |
| 7. Tin-packing | Yellow |
| 8. Tools and plants | Leave uncoloured |
| 9. Rents | Black |
| 10. Loss in transit | Brown, cross hatched |
| 11. Establishment | Red hatches |

**Resin Statement**

At the end of each year statement of sale of resin will be prepared by the Divisional Forest officers of the Forest Divisions in which resin, is collected ill the following form.

| Name of Depot | Date of auction or month of auction | Total quantity of resin sold | Total sale price | Sale price per qtls. | Average sale price per Qt. for the whole year | Remarks |
|---|---|---|---|---|---|---|
| | | Qtls. | Rs. | Rs. | Rs. | |
| Una | December 1974 | 700 | 3,50,000 | 500 | -- | |
| | August, 74<br>1974-75 | 150 | 75,000 | -- | 500 | |
| | Total for 1974-75 | 850 | 4,25,000 | -- | 500 | |

**Method of preparation**

The heading used in Form 8 should be so arranged that the total sale at each depot on each auction during the year can be readily ascertained when with the time comes to prepare the above form.

**Statement**

Calculation of sale price per quintal of each auction and for the whole year of columns 5 and 6 of the above form.

**Column 5**:-

| | |
|---|---|
| Sale Price per quintal of each auction at each depot. | Total quantity of resin sold in the auction at each depot is divided by total sale price of that auction at each depot. |

**Column 6:-**

| | |
|---|---|
| Average sale price per quintal for the whole year. | Total quantity of resin sold in one depot in the Forest Division is divided by the total price of all auction in all depot in the Forest Division. Forest Division is divided by the total price of all auction in all depot in the Forest Division. |

After completing the statement in the prescribed form the Divisional Forest Officer will forward the statement to his territorial Conservator who will after checking it forward to the Pr .Chief Conservator of Forests.

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