3. Annexes:

3-17 Roads: The road leading from Stan. Vac. road should be 6m wide and 798m long. The road running in the center of the nursery will be 7m wide and 523m long.
The spur roads running through the nursery will be 4m wide and 1,408m long. The total length is 2,729m.
Detailed information on the construction of the roads are explained in Chapter 4.

3-18 Drainage: On both sides of the above roads, there will be ditches for drainage. Details on construction are explained in Chapter 4.

3-19 Shelter belts: The trees surrounding the nursery will be kept as shelter belts for the purpose of protecting the nursery from wind and dust coming from the Stan. Bac. road.

3-20 Sample trees: The tall trees growing in the nursery will be reserved as samples of tropical broad-leaved trees. The actual placements of the shelter belts and sample trees will be decided after examinning every tree and setting a standard for trees to be kept.

3-21 Wire fence: To prevent robbery and other disturbances, a wire fence will be set up around the nursery.

3-3-4 Nursery Facilities

The nursery will have germination beds, nursery beds and irrigation facilities and will be divided into 12 blocks by roads. In one of the blocks, a working room and germination beds will be set up and the other blocks will be mainly used for nursery beds. The beds will be laid from south to north. The details on making the blocks will be shown in Fig. 3-1(

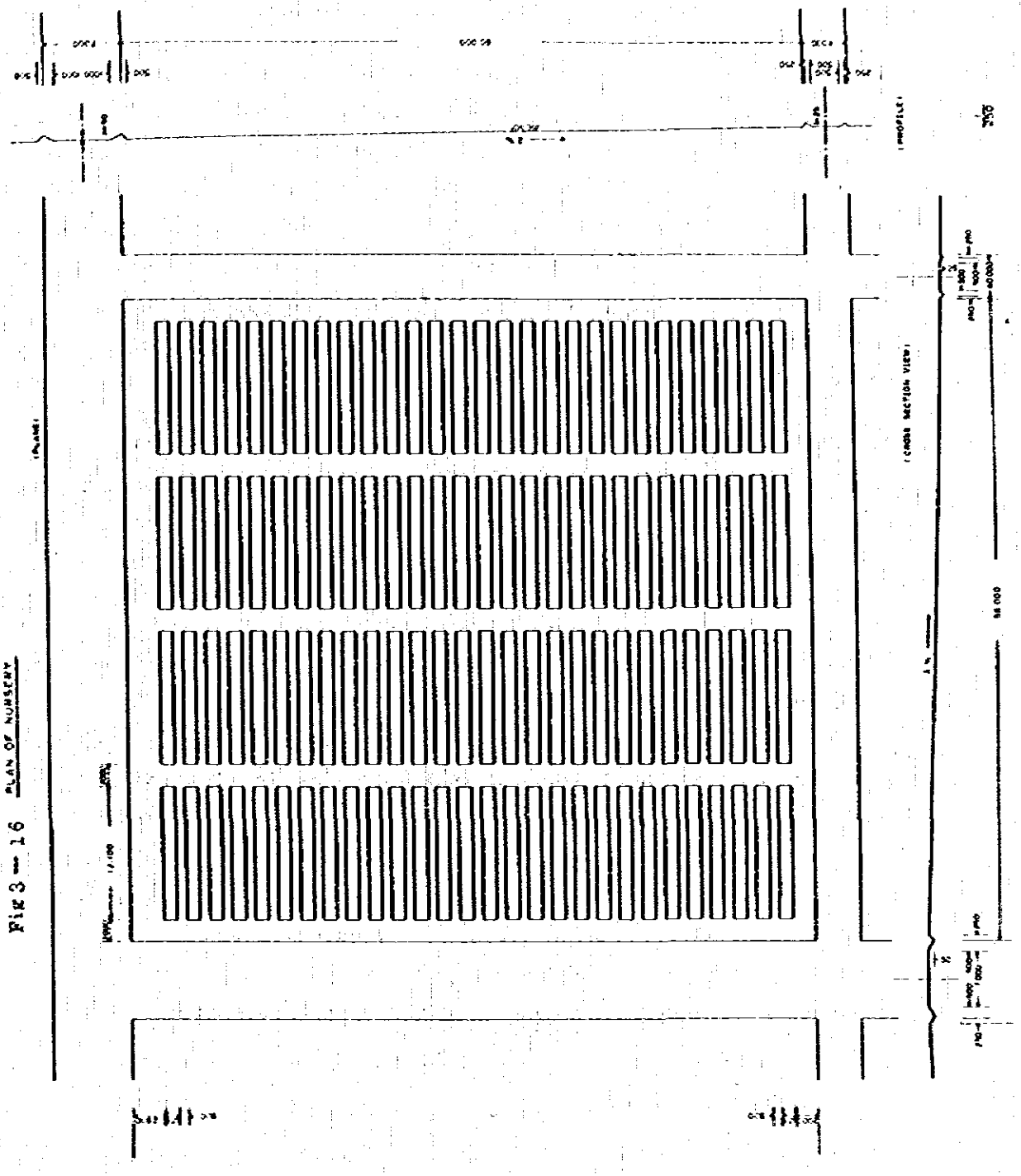


Fig 3 — 16 PLAN OF NURSERY

The following are the details of the facilities:

1. Germination beds: These beds are for species of large seeds such as Mahogani, Gmelina among others. The beds should be 1.2m wide, 12m long and 10cm high. Frame the bed with wood and put soil into it or just pile up the soil without making a frame around it. Put pebbles at the bottom, then soil and fine sand on top so that water can run through. The soil, sand and pebbles have to be heated and sterilized. The germination beds should be equipped with sun shades and sprayers for watering. The number of the germination beds to be made is 60.

2. Stump beds: These beds are for stumps such as and will be used for seeding and nursery practice. The structure of the beds is the same as the germination beds. Three or four blocks of the nursery will be used as stump beds but part of the space may be turned into germination beds or potted seedling beds if necessary.

3. Potted seeding beds: These beds are for potted seedlings such as Merkusii and Deglupta Eucaly, transplanted from germination beds into pots. The size of the beds is 1.2m wide, 12m long and 10cm high, as shown in Fig.3-17, 3-18. The bed will have some inclination to prevent water from stagnating.
Make the bottom ground hard by stamping on it about 30cm deep, place bricks (20cm x 10cm x 5cm) over it and concrete around the bricks so that they will not fall apart. And then cover the bed with a sheet of polypropylene, about 100μ thick.
The reasons making the bed into the above structure are:

1) To prevent the roots to grow through the pot into the ground and a bsorb water.

2) To do away with the necessity of weeding and lower the expenses for weeding.

In order to make the seedlings stand upright in the bed, put the pots close to each other if they are species of small branches like Merkussi. Therefore, wooden flames should be put on nursery beds. In case of species of large branches, such as eucalyptus, the pots should be spaced some distance from each other.

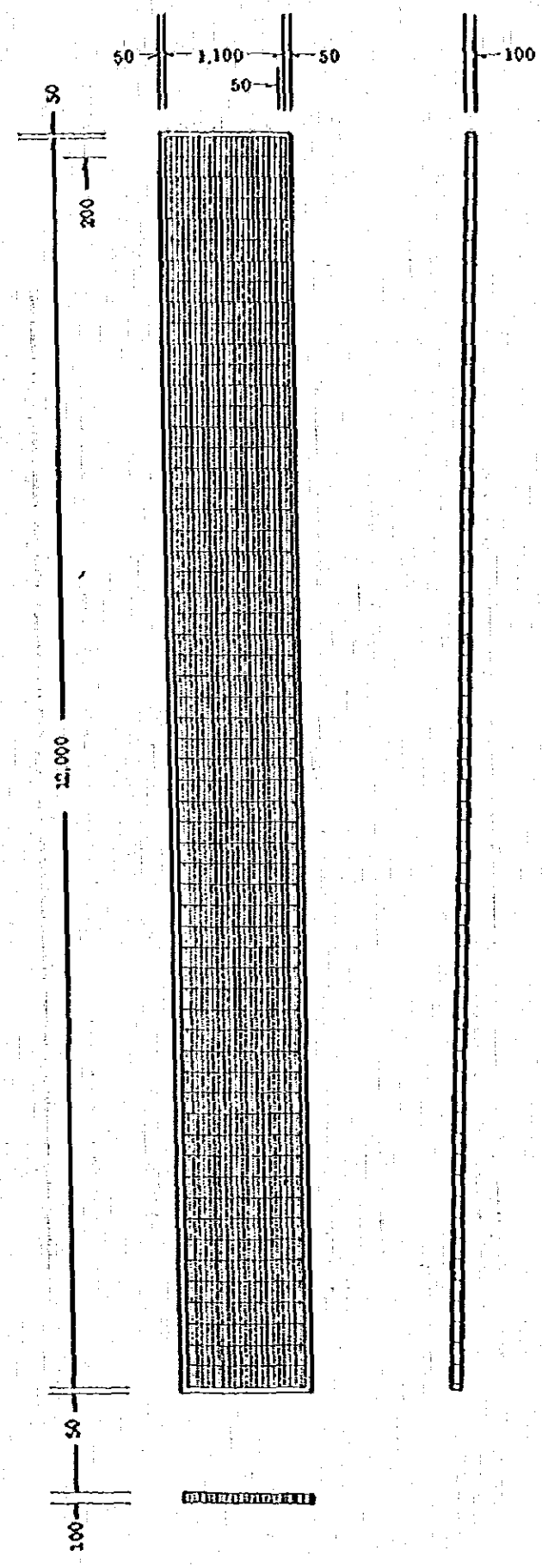
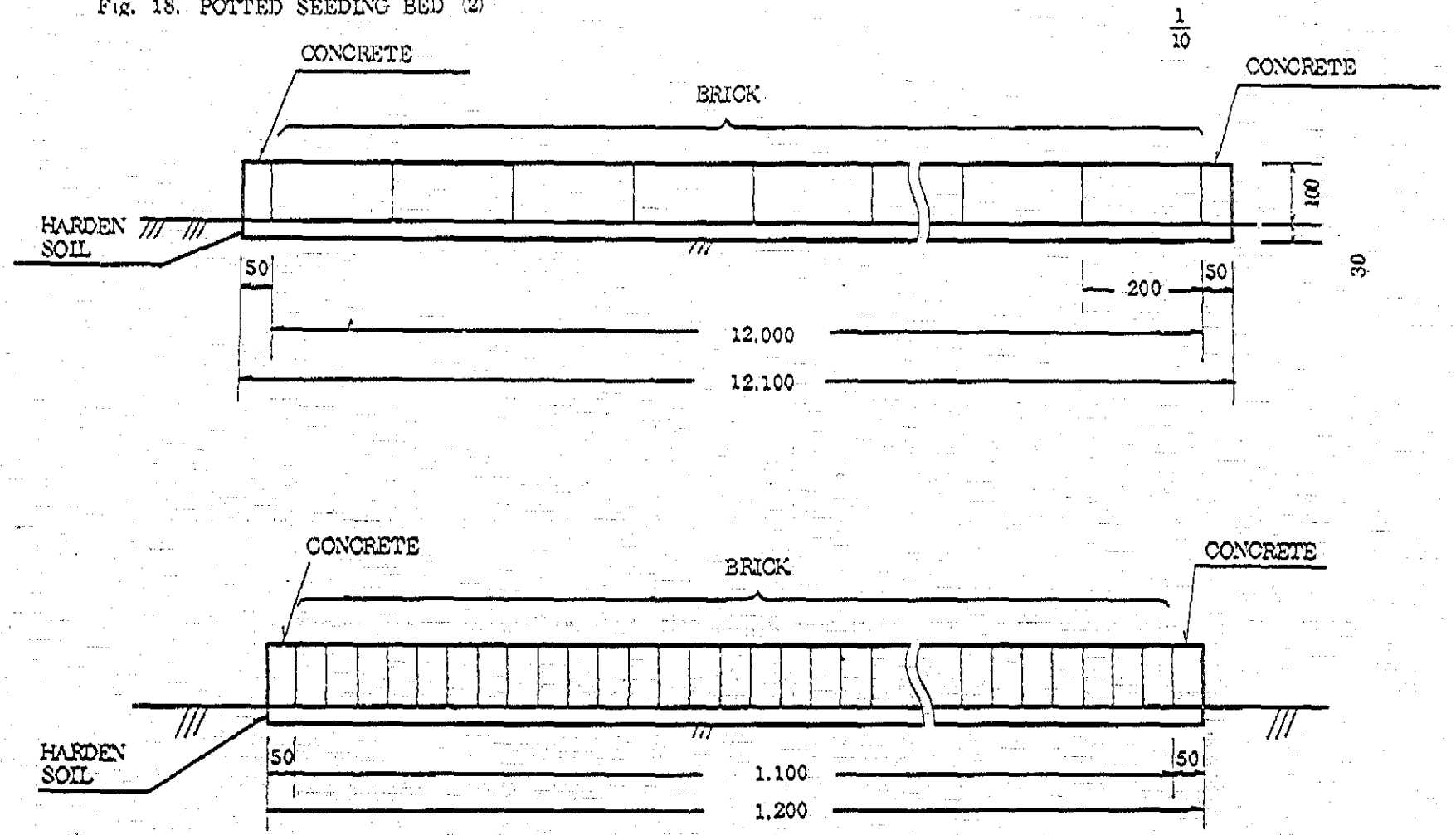
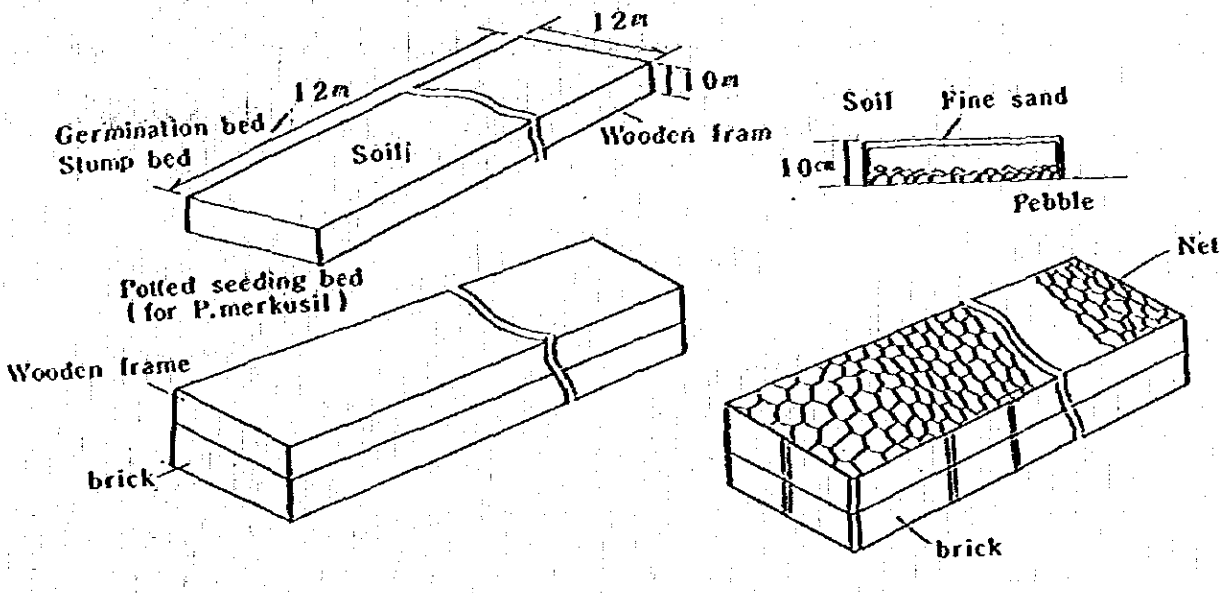


Fig. 17. POTTED SEEDING BED (1)

Fig. 18. POTTED SEEDING BED (2)



In this case, cover the bed with a wire-net and put the pots into each of meshes of the net. Since the pot is 5 to 8cm in diameter, the size of the mesh has to be the same of the pot.
In the nursery beds, sun-shading facilities, and irrgation facilities will be equipped.



The total number of the stump beds and potted seedling beds is 959. (Refer to Table 3-8-2 for the necessary amount of seedlings by year.)

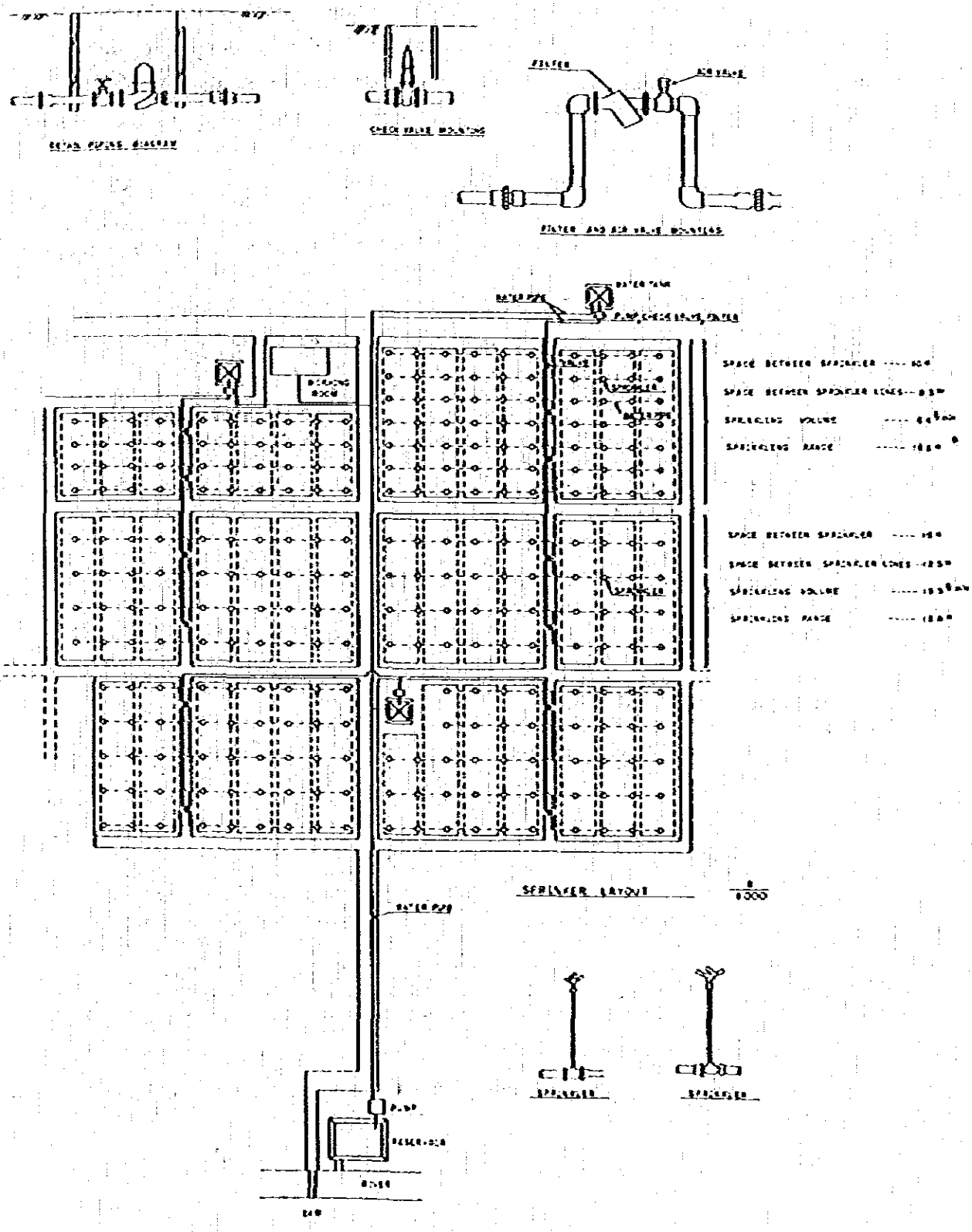
4. Watering facilities: The watering facilities are very important because most of the seedlings are potted and the beds are made so as to prevent the seedlings from absorbing water out of the ground.
The sprinklers will be used as the major watering facility, but, in case these sprinklers do not work, other sprinkling systems connected with the holding tank will also be installed. An example of the placement of the sprinklers is shown in Fig. 3-19.

The system of guiding water is to lead the water from the River Baun into the reservoir first and pump the water out of the reservoir into the tank, from which the water should be sent out to the sprinklers by a pressure pump. Al sprinklers should be fixed on a ground and two different types which can eject 6 - 20 liters of water per minute will be employed.

5. Drainage facilities: For draining water, the waterways will be built on both sides of the spur roads running through the nursery. For details of construction of the waterways, refer to the section of forest roads in Chapter 4.

6. Sun-shading facilities: Since it is necessary to open and close the shades every morning and evening, they should be the type that can be handled easily by hand.

Fig 3 – 19 SPRINKLER SYSTEM



3-3-5 Calendar Schedule for Nursery Construction

The construction of the silviculture is scheduled to start in January 1981, and it is necessary to start seeding in Junary 1980 for such species as Merkussi whose nursery period is around 12 months. Therefore, the seeding beds for Merkussi and other species whose nursery period is 12 months have to prepared by January 1980. Other facilities, however, should be completed by June 1980 when seeding should be done for such species as Deglupta eucoly whose nursery period is six months.

The calendar schedule for the nursery construction plan is as follows:

No.	Item	1979									1980		
		1	2	3	4	5	6	7	8	9	10	11	12
1	Clear the area around the nursery site.	↔											
2	Rough measuring for the sites of facilities.	↔											
3	Investigate the trees to be kept as sample plantation & shelter belts. Make a map of the standing trees.	↔											
4	Cutting and cleaning of bush. Pile up the cut off branches in the area arround nursery.	↔											
5	Decide the definite site of the nursery and stake out the site.		↔										
6	Construction of preliminary roads.	↔											
7	Survey the roads and the sites of facilities.		↔										
8	Land preparation of the nursery.		←	—	—	—	—	—	—	—	→		
9	Construction of nursery bed.		←	—	—	—	—	—	—	—	—	—	→

		1	2	3	4	5	6	7	8	9	10	11	12
10	Construction of roads.		←	-	-	-	-	-	-	-	→		
11	Construction of the working room.		↔										
12	Construction of the warehouse for tools and materials		↔										
13	Construction of the warehouse for machinary.		↔										
14	Construction of the electric generator room.		↔										
15	Construction of the pump room.		↔										
16	Construction of the reservoir.		↔										
17	Construction of the oil storage room.						↔						
18	Construction of the repair shop.										↔		
19	Construction of the warehouse for fertilizer.										↔		
20	Construction of the planting camp.		↔										
21	Construction of the building to accomodate the engineers.		↔										
22	Construction of the forestry laboratory and training rooms.										↔		
23	Construction of the building to accomodate the the guests.										↔		

After preparing the land for the nursery, it will be desirable to pile up the surface soil at one place somewhere in the nursery field since the soil might be used for potting later.

3-3-6 Necessary Materials and Machinary for the Nursery Construction

The following is an example list of necessary materials and machinary for constructing the nursery.

1 Machinary

Name and Type of Machinary	No.	Purpose
1. Angledozer (with a rip saw, 15 tons)	3	Cutting, heaping soil, land preparation of the nursery, construction of roads, preparing land for the facilities sites
2. Motor grader	1	Construction of roads, preparing land for the facilities sites, preparing the nursery
3. Road roller	1	Construction of roads
4. Trencher	1	Digging waterways, ditches for service and drain pipes
5. Dump truck	2	Construction of roads
6. Shovel-dozer	1	Construction of roads
7. Bulldozer (with , 6 tons)	1	Construction of reservoir
8. Truck (4 ton, 4x4, with a crane)	1	Transportation of materials
9. Rammer	1	Construction of nursery beds
10. Concrete mixer	1	Construction of nursery beds, construction of drainage ditches
11. Submerged pump	1	Dam construction
12. Bush cutter	3	Management of sample trees & construction of shelter belts
13. Others		

2 Materials

Materials and Tools	Purpose
1. Sandbags	Dam construction
2. Sprinklers	Irrigation facilities
3. Materials needed for nursery beds (bricks, woodframes, wire-nets, etc.)	Construction of nursery beds
4. Materials for building construction	Warehouses, accomodation buildings
5. Materials for water tanks	Water tanks
6. Materials for drainage ditches	Drainage ditches
7. Monkey hammer	Dam construction
8. Surveying instruments	Serveying
9. Wood working tools	Construction of buildings
10. Engineering machinary	Road construction, preparing land, etc.
11. Stationary Others	Administration

3-3-7 Nursery Construction Expenses

Details of the nursery construction expenses are as follows:

1. Nursery Construction

(1) Earth volume

Unit: M^3

Distance from the No. 5 stake	Filling			Cutting		
	South side	North side	Total	South side	North side	Total
(25)	(0)	(0)		(244.4)	(227.5)	
25 - 50	0	560	560	6,068.8	4,550.0	10,618.8
(50)	(0)	(44.8)		(241.1)	(136.5)	
50 - 75	467.5	2,342.5	2,810	5,151.3	2,966.3	8,117.6
(75)	(37.4)	(142.6)		(171.0)	(100.8)	
75 - 100	2,222.5	2,607.5	4,830	2,688.7	2,382.5	5,071.2
(100)	(140.4)	(66.0)		(44.1)	(89.8)	
100 - 200	14,195.0	7,755.0	21,950	6,375.0	11,520.0	17,895.0
(200)	(143.5)	(89.1)		(83.4)	(140.6)	
200 - 250	10,027.5	6,205.0	16,232.5	2,835.0	5,395.0	8,230.0
(250)	(257.6)	(159.1)		(30.0)	(75.2)	
Total	26,912.5	19,470.0	46,382.5	23,118.0	26,813.8	49,932.6

Note: The figures in parentheses are square measures of cross section at each surveying point.

(2) Bulldozer Operation Hours (15 tons)

Calculation of operation hours

$$Q = \frac{60 \times q \times f \times E}{Cm}$$

Q = Operating amount per operation hour (m^3/h)

q = Graded amount of soil per one shovelling

If the length is 70m (on flat land),

$q = 3.00m^3 \times 0.76 = 2.28m^3$/shovel

f = Conversion coefficient of amount of soil = $\frac{1}{12} = 0.83$

E = Operating efficienty = 0.375

Cm = Cycle time (minute) = $0.037\ell + 0.25$

$= 0.037 \times 70 + 0.25 = 2.84$ minute/shovel

therefore,

$$Q = \frac{60\ (\text{minute/hour}) \times 2.28\ (m^3/\text{times}) \times 0.83 \times 0.375}{2.84\ (\text{minute/times})} = 14.99m^3/h$$

therefore, the operation hours of construction of the nursery are:

$$H = \frac{49,942.6}{14.99} = 3,331 \text{ hours}$$

If three bulldozers are operated for 6 hours per day, number of days necessary = 3331 ÷ 3 ÷ 6 = 185 days

(3) Bulldozer operating expenses

Operating expense per hour (RP)

Item	Quantity	Unit price	Amount	Remarks
Bulldozer	1 hour	26,000	26,000	
Fuels	15ℓ	60	900	
Oil & fat			180	20% of total fuel
Caretakers	0.04	1,875	75	
Assistant construction workers	0.33	1,500	495	2 persons for one machinary 6 operation hours therefore, 2/6 = 0.33 person/h
Toral			27,650	

(4) Therefore, the total operating expense of bulldozer is:

$$S = 27,650^{RP} \times 3.331^{h} = RP92,102.150—$$

2. Grading land for administration buildings

(1) Earth volume (amount of graded soil)

The total space of the site: $1,146.51m^2$

Average depth of soil to be removed: 0.5m

Therefore, the total amount of graded soil: $1,146.51 \times 0.5 = 573.3m^3$

(2) Operation hours and expense of bulldozers

$$Q = \frac{60 \times 2 \times f \times E}{cm}$$

Q = Operating amount per hour (m^3/h)

$q = 3.00 \times 1.0 = 3.00m^3$/shovel (distance: 10m)

$f = 0.83$

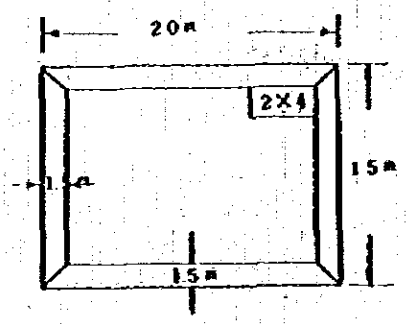
$E = 0.375$

$cm = 0.037\ell + 0.25 = 0.037 \times 10 + 0.25 = 0.62$

Therefore, the graded amount of soil per hour is:

$$Q = \frac{60 \times 3.00 \times 0.83 \times 0.375}{0.62} = 90.4m^3/h$$

(3) Therefore, operation hours and expenses will be as follows, respectively:

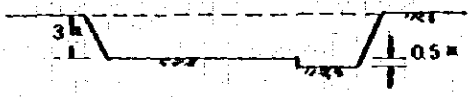


$$H = \frac{573.3}{90.4} = 6.3 \text{ hours}$$

$S = 27,650RP/h \times 6.3 = RP174.195--$

3. Digging of Reservoir

(1) Earth volume



$$\frac{20 \times 15 + 17 \times 12}{2} \times 3 + 2 \times 4 \times 0.5 = 760m^3$$

(2) Bulldozer operating hours (6 ton bulldozer)

Digging amount

$$Q = \frac{60 \times q \times K \times f \times E}{cm}$$

Q = Digged amount of soil per hour m^3/h

q = Bucket capacity = $0.2m^3$

K = Bucket coefficient = 0.8

f = Conversion coefficient of amount of soil = $\frac{1}{1.2} = 0.83$

E = Operating efficiency = 0.25

cm - Cycle time = 20 seconds = 0.33 minute

Therefore,

$$Q = \frac{60 \times 0.2 \times 0.8 \times 0.33 \times 0.25}{0.33} = 6.0m^3/h$$

Therefore, the digging hours are:

$$Hd = \frac{760m^3}{6.0m^3/h} = 126.7 \text{ hours}$$

Shovelling

$$Q = \frac{60 \times q \times f \times E}{cm}$$

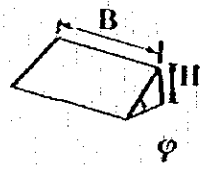
Q = Shovelled amount of soil per hour

q = Average shovelled amount of soil per shovel

f = 0.83

E = 0.25

Cm = Cycle time



$$q = \frac{BH^2}{2 \tan \Phi}$$

B = 2.43m

H = 0.745m

Φ = Angle of ground = 40°

Therefore,

$$q = \frac{2.43 \times (0.745)^2}{2 \times \tan 40} = 0.80$$

$$cm = \frac{\ell}{V_1} + \frac{\ell}{V_2} + t$$

ℓ = Average distance of soil to be removed: 20m

v1 = Proceeding velocity = 2.2km/h = 36.7m/min.

v2 = Receding velocity = 4.3km/h = 71.7m/min.

t = Gear change, time of acceleration = 0.1 minute

Therefore,

$$cm = \frac{20}{36.7} + \frac{20}{71.7} + 0.1 = 0.924$$

Therefore,

$$Q = \frac{60 \times 0.80 \times 0.83 \times 0.25}{0.924} = 10.8m^3/h$$

Therefore, the total shovelling hours are:

$$Hp = \frac{760}{10.8} = 70.4$$

Therefore, the total operating hours are:

$$H = H_d + H_f = 126.7 + 70.4 = 197.1$$

(3) Bulldozer expense

Bulldozer expense per hour

Item	Quantity	Unit price	Amount	Remarks
Bulldozer	1 hour	RP 21,000	RP 21,000	
Fuel	8.4ℓ	60	504	
Oil & fat			101	20% of total fuel
Assistance	0.13	1,500	195	1/8
Assistant construction workers	0.06	1,500	90	$20m^2$/
Total			21,890	

(4) Therefore, the total expense on bulldozer is:

S = 21.890 x 197.1 = RP 4,314,519.--

3. Bluilding Construction Expenses

Unit=1,000 YEN

Item		Space (m^2)	Unit price per m^2	Expense
Operation facilities	Working room	500	40	20.000
	Warehouse for materials and tools	108	40	4,320
	Warehouse for machinary	108	40	4,320
	Warehouse for fertilizer	88	40	3,520
	Oil storage room	25	40	1,000
	Repair shop	224	50	11,000
	Pump room	12	35	420
	Electric generator room	27	35	945
	Sub total	1092		45,725
Administration facilites	Field office	299.85	50	14,992.5
	Laboratory, training room	358.56	50	17,928.0
	Building to accomodate the engineers	257.25	60	15,435.0
	Building to accomodate guests	230.85	60	13,851.0
	Sub total	1,146.51		62,206.5
	Grand total	2,238.51		107,931.5

5. Nursery Construction Expense

(1) Material Expense per Germination Bed

Number	Item	Quantity	Unit price	Amount	Remarks
1	Bricks	1320	RP 30	RP39,600	
2	Concrete	0.132m^3	43,650	5,762	Note (1)
3	Plastic sheet	21.25m^2	500	10,625	
4	Construction workers for making beds	1,016	1,500	1,524	14.52m^{2}x0.07/m^2
5	Bricklayers	0.725	1,500	1,089	14.52m^2 20m^2/
	Total			RP58.600	

(2) The total nursery construction expense:

959 beds x RP58,600 = RP56,197,400

Note: Calculation of expense for concrete

Price of concrete per 1m^3

Item	Quantity	Unit price	Amount
Cement	11.25	RP 2,600	RP 29,250
Sand	0.45m^3	6,000	2,700
Ballast	0.90m^3	8,500	7,650
Construction workers	2.7	1,500	4,050
Total			43,650

3-3-8 Calculations

1. Number of germination beds necessary for each year (Merkussi)

(1) Quantity of seeds required per square meter: 50g

(2) Germination rate: 50%

(3) Number of seeds in 1kg: 50,000 seeds

(4) Actual germination quantity per 1sq. m.: 50g/sq. m. x $\frac{50,000}{1,000}$ seeds x 0.5 = 1,250/sq.m.

(5) Space of one nursery bed: 1.2m x 12 = 14.4sq.m

(6) Number of germination beds necessary each year

Year	Production quantity	Total space	Number of germination bed
1	-	-	-
2	434,400	347.5m^2	25
3	674,200	539.4	38
4	1,167,200	933.8	65
5	1,105,000	884.0	62

Since germination boxes and stump nursery beds are used for some certain species, the total number of germination beds required is 60.

2. Number of Nursery Beds Required Each Year

(The following is an example of the case in which Merkusii and Deylupta Eucaly are used by 50% respectively.)

(1) Size of a pot: 8cm in diameter, 20cm high

(2) Inner size of a nursery bed: 1.2m x 12m

(3) Number of pots necessary for each bed:

Merkusii: $\frac{120}{8} \times \frac{1200}{8} = 2,250$ pots

Deglupta Eucaly: $\frac{120}{8} \div 2 \times \frac{1200}{8} = 1,125$

(4) Number of nursery beds necessary each year

Year	Production quality	Necessary number of nursery beds		
		Merkusii	Deglupta Eucaly	Total
1	-	-	-	-
2	434,400	97	193	290
3	674,200	150	300	450
4	1,167,200	259	519	778
5	1,105,000	246	491	737

3-4 Nursery Practice System

3-4-1 Methods

The methods of nursery practice varies on the species, but they can be categorized as follows as far as the species to be used for this plan are concerned.

Number	Method	Species
1	Direct seeding	Mahogani
2	Direct slip planting	Sunkai
3	Direct seeding in pots	Albizzia, Merkusii
4	Direct slip planting in pots	Gmelina
5	Nursery practice in pots	Deglupta Eucaly
6	Stump nursery practice	Mahogani, Gmelina

For No. 1 and 2 in the above table, nursery beds are not necessary. For No. 3 and 4, germination beds are not necessary.
In the methods of No. 6, in case of Mahogani for example, make a stump cutting the stem at 20cm from the root collar and keeping the root in length of 20 to 40 cm.

It depends on the condition of the land, species and purpose of an examination which method should be adopted.

3-4-2 Nursery Practice

The outline of the method of nursery practice in pots, which is assumed to be the main method, is described as follows:

The following are the schedules of major works:

Merkusii (nursery period: 12 months)

Number	Type of work	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	Purchase of seeds			◇														
2	Seeding				↔													
3	Transplanting into pots					↔												
4	Nursery practice in pots						↔									↔		
5	Out-planting																↔	

Deglupta Eucaly (nursery period: 6 months)

Number	Type of work	Month																
		10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	Purchase of seeds									◇								
2	Seeding										↔							
3	Transplanting											↔						
4	Nursery practice in pots												↔					
5	Out-planting																↔	

Mahogani (nursery period: 12 months, stump)

Number	Type of work	Month																
		10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	Purchase of seeds	↔																
2	Storage of seeds		↔															
3	Seeding				↔													
4	Nursery practice					↔												
5	Preparing stumps																↔	

3-4-3 Details of nursery practice

The details of nursery practice are as follows:

1. Obtaining Seeds (purchase)

The seeds can be either purchased from domestic source or imported from other countries until it is possible to obtain seeds in the area around the nursery or from a seed orchard.

2. Storage of Seeds

It is not necessary to store seeds of the species whose seeds can be obtained at the time of seeding, which can be calculated from the time of out-planting. However, storage of seeds is necessary for other species, such as Mahogani, whose harvesting time and seeding time do not meet. The methods of storage varies depending on the specie, and the following are major methods:

Ways of storage	Species
Refrigeration (drying)	merkusii deglupta Swietenia Spp.
Air-tight drying	falcata Anthocephalus Acacia auriculiformis glauca
Drying, storing in a dark room, refrigerating storing in a ventilated room	Gmelina

For storing seeds, a storage room with a refrigerator will be provided. Germination tests should be conducted before seeding.

For storing seeds, a storage room with a refrigirator will be provided. Germination tests should be conducted before seeding.

3. Transport of Soil

The soil will be used in germination beds and in pots. As it is stated in 3-3-1, there are two possibilities of obtaining soil; one is to collect the surface soil upon construction of the nursery, and the other is to buy chernozem from the Benakat region. In either way, tractor shovels and dump trucks will be used for transportation.

4. Purchase of Sand and Ballast

The area where the nursery will be constructed does not produce sand or ballast. Since they are necessary only in small amounts for the germination beds and aggregate for concrete, they can be purchased in Benakat.

5. Preperation of Compost

Since the soil in this region has clay in it and contains little nourishment, it will be necessary to mix manure in the soil to be used in

the stump beds and pots. There are two types of manure, one is chemical fertilizer and the other is compost,which can be prepared in a storage but to be built in a corner of the nursery.

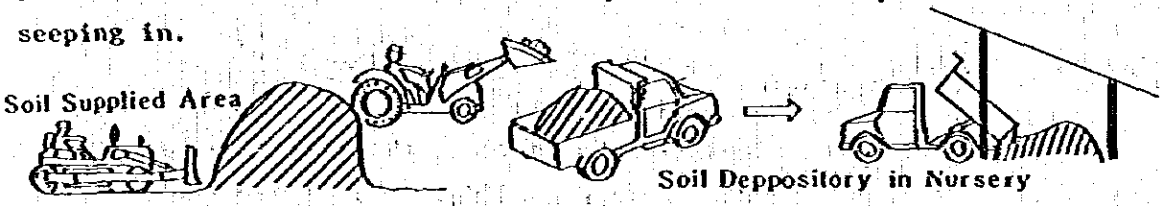
Alang-alang grown in the plantation area and droppings of cows and chickins can be used to make compost, and it should be mixed with lime. As compost has a wide variety of uses in agriculture and fruts-culture, it will be necessary to investigate the detailed processes of making compost actually adopted in agriculture.

6. Mycorrhization

For the pots, it is necessary to mix soil that contains Mycorrhiza, which is necessary for growing certain species such as Merkusii. Mycorrhiza is contained in the soil of Merkusii pine woods, and it can be obtained from the Merkusii pine stand adjacent to the south side of the nursery.

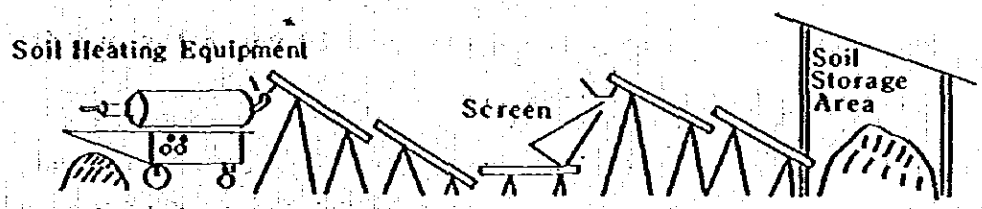
7. Storage of Soil

The soil, sand and ballast transported in trucks has to be dried in the air before being sifted. Therefore, the soil should be stored some-place under a roof or covered with a plastic sheet to prevent rain from seeping in.



8. Sterilization of Soil

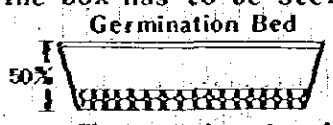
The soil piled up at the storage area will be sifted through a screen with a mesh of 6mm and then will be heated and sterilized in a soil heating equipment. The sand and ballast will be sterilized in the same way.



9. Preperation of Germination Beds

The structure of a germination bed is explained in 3-3-4-1, and these beds are used specifically for species of large seeds.
For other species, such as Deglupto Eucaly whose seeds are very fine, germination boxes should be used instead. The size of the box should be handy to carry around, about 25cm wide, 35cm long and 5 - 15cm deep.

It should be made of either wood or plastic. The bottom should have holes about 6 - 20mm in diameter through which water can run. Also to make drainage better, pebbles, soil, fine sand and silt should be laid from the bottom in that order.
As for the thickness of each layer, about 1mm from the surface is silt, 8mm of fine sand, 10 - 15mm of pebbles, and the rest should be soil.
The "fine sand" means sand sifted through a sift with meshes of about 5mm, and "silt" is sand sifted through a sift with meshes of about 1mm.
The box has to be sterilized before putting soil into it.



The germination boxes will be kept in a germination room to be taken care of. The upper part of the walls of the germination room can be open so wind can come through easily. In order to gain as much sunshine as possible, waveshaped fiberboard should be used as a roof, and a shade should be installed to control the sunshine in the room.
To prevent dampness and the formation of moss, it has to be carefully checked so the room does not get too damp, and watering should be done with a sprayer.

10. Germination Stimulation

Some species require stimulation to increase their germination rate, and this trestment should be done before seeding.
The following are stimulation methods generally used for the species which will be planted during the first year of this plan:

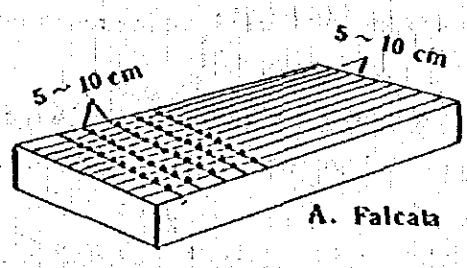
Number		
1	Merkusii	Soak the seeds in cold water for one day before seeding.
2	Albizzia	Since the skin of the seeds are not very permeable, soak the seeds in hot water (80 - 100C) for about 2 minutes. After that, leave them under running water for about 24 hours. The night before seeding, put the seeds in a damp jute sack and leave them overnight.
3	Deglupta Eucaly	No special method

Number		
4	Mahogani	No special method
5	Ipil Ipil	Sock the seeds in hot water for 3 - 4 minutes and leave them under running water for half a day.

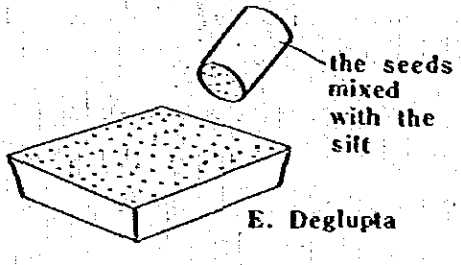
11. Seeding Method

Methods of seeding vary depending on the specie, and the following are the major methods generally used. It is important to water the beds sufficiently before seeding.

Number		
1	Merkusii	Scatter the seeds all over the bed, with about 50g/sq.m.
2	Albizzia	Place each seed with about 5cm x 1cm - 5cm x 10cm space between each other.
3	Deglupta Eucaly	Since the seeds are very small, mix with silt and scatter all over.
4	Mahogani	Place each seed so that wings will be above in the soil, with about 5cm x 5cm - 10cm x 10cm space between each other.
5	Ipil Ipil	Place each seed with about 5cm x 10cm space between each other.



A. Falcata



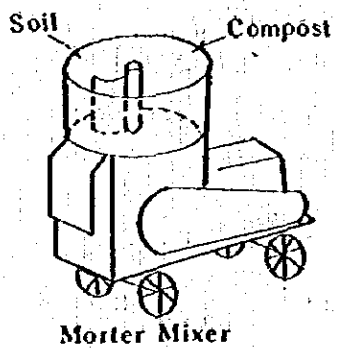
E. Deglupta

12. Fostering Seedlings

The seeds germinate a few days after seeding. After that until transplanting, careful attention is needed concerning watering and sunshine. It is also necessary to scatter disinfectant to prevent pests and disesse.

13. Preparation of Soil for Pots

The sterilized soil, as it is explained in 8, will be mixed with compost in a mortat mixer. The mixing ratio of the soil and compost differs depending on the kind of soil, compost and tree, and it is recommended to try some different ratios first and adopt the most suitable one.



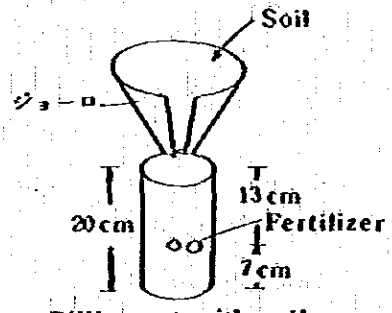
Morter Mixer

14. Putting Soil into Pots

Transport the soil mixed with compost to the working room and put the soil into the plastic pots there. The size of the pot should be 8cm in diameter and 20cm deep. The lower part of the pot has holes of about 5mm. It also may be necessary to experiment using tin or bamboo pots.
A watering pot made of tin should be used for filling pots with soil.

15. Chemical Fertilizers

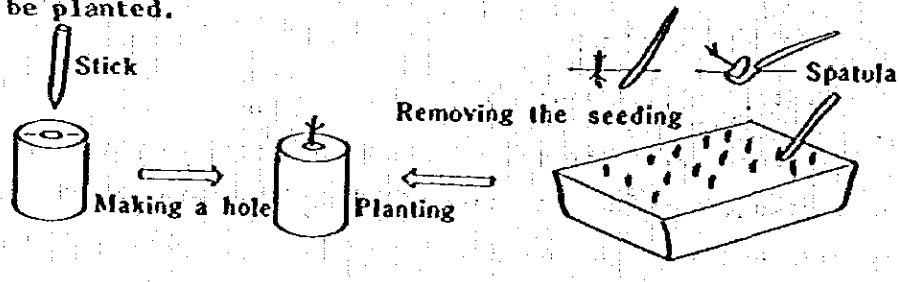
The types of chemical fertilizers to be used are 25-10-15 and 7-8-5-1. Fill one-third of the pot with soil. The work is interrupted at this stage. Then put chemical fertilizers over the soil and fill the pot with soil. Shake the pot while filling so that there will be no spaces in the pot.



Filling pot with soil

16. Transplanting of Seedlings

The germination boxes and the pots filled with soil will be transported in containers to the working room, where the transplanting work is done. The seedlings grown in the outdoor germination beds will be transplanted into pots by the beds outside.
Before transplanting, the soil in the pots should be watered adequately and poked with a stick about the size of a pencile to make a hole in which a seedling should be planted.

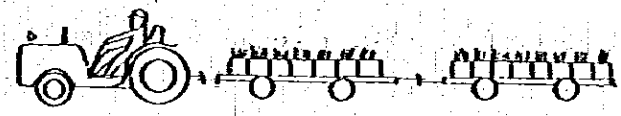


Remove each seedling carefully with a small spatula from the germination beds, put it in the hole and cover with the soil pushing lightly. After transplanting, keep the pots indoor away from wind, and move them to the nursery beds after making sure that the seedlings are rooted. The transplanting time for major species is as follows:

Number	Species	Transplanting time
1	Merkusii	When the seelings are 5cm high. (six weeks after seeding)
2	Albizzia	Soon after seeding (the height of the seedling should be a few centimeters.)
3	Deglupta Eucaly	When the seedlings are 1 to 2 cm and have some leaves.
4	Ipil-Ipil	When the seedlings have grown to a few centimeters high.

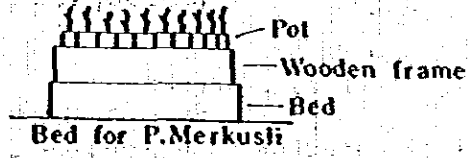
17. Nursery practice of seedlings in the beds

The pots will be transported in a wheelbarrel or trailer to the nursery beds.

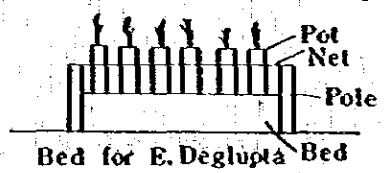


Transporting the Pot

As it has been explained already, the pots of certain species like Merkusii should be placed close to each other in the beds. On the other hand, the pots of other species like Deglupta Eucaly should be placed with certain spaces between each other in each of the meshes of a wire-net put over the bed.



Bed for P.Merkusii



Bed for E. Deglupta

18. Taking Care of the Nursery Beds

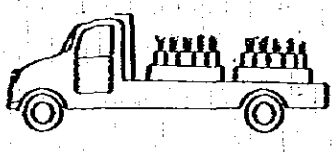
The sunshine control, watering, preventive measures against pests and diseases and weeding should be done according to the characteristics of each specie. The following are the sunshine controls for each specie.

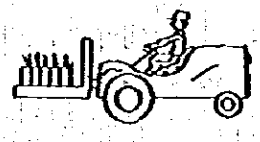
Number	Species	Method
1	Merkusii	A shade is necessary to lessen the sunshine.
2	Albizzia	No shades are necessary.
3	Deglupta Eucaly	The shades could be removed gradually after transplanting and should be removed completely one month before out-planting.
4	Mahogani	Complete covering is required for the seedlings but the shades should be removed gradually within four months.
5	Ipil-Ipil	No shades are necessary.

A shade which can intercept 65 to 75% of the sunshine should be used, and it should be removed during the night. Watering should be done with sprinklers twice a day. For the amount of water, refer to Section 3-4-6-2. Weeding should be done periodically, along with the scattering disinfectants to prevent pests and diseases.

19. Out-planting

The standard size of seedlings to be selected for planting should be 25 to 30 centimeters. However, it may have to be changed depending on the species, planting method and transportation costs, and further consideration is required. When will be put on pallets and carried to the truck using a fork-lift.





3-4-4 Materials and Equipment for Nursery Practice

The following are the lists of materials and equipment necessary for nursery practice:

1, Machinary

No.	Machinary	Purpose
1	Dump truck (4.5 ton) 4x4	Transportation of soil
2	Truck with (4.5 ton, 4x4, with a crane)	Transportation of materials
3	Tractor	
	Attachments	
	Trailor	Transportation of seedlings
	Shovel	Transportation of soil, preparation of manure
	Sprayer	Scattering disinfectant
	Others	
4	Fork-lift	Transportation of seedlings
5	Soil heating equipment	Sterilization of soil
6	Belt conveyer	Same as above
7	Screen	Sifting soil
8	Roller conveyer	Transportation of potted seedlings
9	Sun shades	Sunshine control
10	Sprinklers	Watering
11	Pump	"
12	Holding tank	"
13	Electric generator	
14	Refrigirator	Storage of seeds
15	Moving machine	Sample plantation
16	Chain saw	"
17	Cutter	"
	Others	

2. Tools

No.	Materials	Purpose
18	Screen for sifting sand	Sifting silt and fine sand
19	Germination box	Seeding
20	Can for seeding	"
21	Rubber gloves	"
22	Watering pot	"
23	Hose	"
24	Sprayer	"
25	Container for disinfectant	"
26	Shovel	Nursery beds, heating soil
27	Plow	"
28	Fork	"
29	Rake	"
30	Hammer	"
31	Steel stick	"
32	Saw and other tools	"
33	Wheelbarrel	"
34	Container for seedlings	"
35	Sickle	Nursery beds
36	Screen	
37	Steel board	
38	Gauze or bleached cotton cloth	
39	Plastic bucket	
40	Scale	
41	Plastic string	
42	Transplanting trowel	
43	Fire extinguisher	
44	Strecher	
45	Ambulance car	
46	Others	

3 Materials

No.	Materials	Purpose
1	Plastic pot	8cm in diameter, 15cm deep, 0.02 - 0.04 mm thick
2	Disinfectant	
3	Chemical fertilizer	
4	Materials for manure	
5	Seeds, scions	
6	Parts of machinary	
7	Fuel, Oil	
	Others	

3-4-5 Nursery Stock Production Expenses

The following are the expenses for producting nursery stock of Merkusii and Macrophyla.

1. Pinus Merkusii (12 months, 400,000, POT)

Personnel expense (@RP1,500/person)

Item	Number of workers	Amount
Seeding	200	300,000
Watering, weeding	780	1,170,000
Heating soil	90	135,000
Filling soil in pots	2,000	3,000,000
Transplanting, providing manure, weeding	840	1,260,000
Daily care	390	585,000
Total	6,500	9,750,000

(RP)

Material cost

Item	Quantity	Unit price	Amount
Seeds	25.6kg		960,000
Plastic bag	400,000	RP 2	800,000
Manure	200kg		75,000
Disinfectant			15,000
Total			1,850,000
Total personnel and material expenses			11,600,000
Production cost per seedling			29,00

2. Swietenia Macrophyla (Mahogani) (12 months, 400,000, STUMP)

(RP)

Personnel expense (@RP1,500/person)

Item	Number of workers	Amount
Heating soil, mixing manure	260	390,000
Construction of beds	450	675,000
Seeding (10x10,400,000)	400	600,000
Watering, weeding, sunshine control	2,880	4,320,000
Providing manure, daily care	40	60,000
Administration expense	390	585,000
Total	4,420	6,630,000

(RP)

Material cost

Item	Quantity	Unit price	Amount
Seeds	200kg		225,000
Manure	200kg		75,000
Disinfectant			15,000
Total			315,000
Total personnel and material expenses			6,945,000
Production cost per seeding			17,36

3-4-6 Numerical Calculations

1. Necessary amount of soil (including sand, ballast and manure, for Merkusii)

(1) Soil for pots

Necessary amount of soil per pot: $(\frac{8}{2})^2 \times 15 \times 3.14 = 753.6cm^3$

$= 0,0007536m^3$

(2) Soil for germination beds

Necessary amount of soil per bed: $1.2m \times 12m \times 0.1m = 1.44m^3$

(3) Necessary amount of soil by year

Year	Production number of nursery stocks	Number of germination beds	Necessary amount of soil for germination beds	Necessary amount of soil for pots m^3	Total m^3
1	-	-	-	-	-
2	434,400	25	36,0	327.4	363.4
3	674,200	38	54.7	508.1	562,8
4	1,167,200	65	93.6	879.6	973,2
5	1,105,000	62	89.3	832.7	922,0
Total	3,380,800		273,6	2,547.8	2,821.4

2. Maximum Amount of Water Necessary for Watering

(in case merkusii and deglupta are grown 50% respectively)

The maximum amount of water is calculated as follows so that even during the season with moderate rain there will be the same amount of water as the average amount of rainfall during rainy season.

(1) Monthly Rainfall Volume

Month	1	2	3	4	5	6	7	8	9	10	11	12	Total	Average rainfall volume
Rainfall volume	323	340	331	391	204	129	108	208	221	224	186	352	3017	251.4

(2) Rainy season (December-April) Average (A) 347.4mm/month

(3) Season with moderate rain (June-July) Average (B) 118.5mm/month

(4) Necessary amount of water for watering (C= A-B) 228.9mm/month
= 7.63mm/day

(5) Necessary amount of water for watering per ha. $76.3m^3$ = 76.3ton/ha/day

(6) The space to be watered per a bed =2m x 14m = $28m^2$

(7) Amount of water by year

Year	Number of nursery beds	Space to be watered ha	Amount of water ton/day
1	0	0	0
2	290	0.81	61.8
3	450	1.26	96.1
4	778	2,18	166.3
5	737	2.06	157.2

§ 4. Forest Road Design

4-1 Principles of Forest Road Design

4-1-1 Topography

The experimental planting area is comprised of undulating terrain with 40 to 80 meter elevation. The maximum grade of the mountain in the North-South direction is approximately 9% and approximately 12% in the East-West direction.

A watershed runs through the area in the North-South direction with some swampy streams in its eastern side at right angles with this watershed. While in the western side of it, streams flow dawn almost in parallel with the watershed. The longitudinal gradient of those swampy is so relaxed that the water is similar to swamps where water is usually stangnated.

Furthermore, the water body exhibits a tendency to increase its level during rainfall, and decrease during water subsiding seasons instead of flowing from upstream to downstream of the stream.

Such facts, that water bath is possible in a river where the water level has risen up to 5m due to floods, or that ricecrops completely hidden under water remain intact after its flood subsides, are totally inconceivable for Japanese rivers.

The sectional gradient of the streams is relaxed to an intermediate level, and seemed to be free of landslides and catastrophes which may hinder erosion control.

4-1-2 Soil Property

The soil consists of 0% gravel, under 5% sand, with mostly silt and clay, and is classified as clay in accordance with the triangular diagram 4-1.

Clay under natural conditions is sometimes found near the plasticity limit and is coloured greyish-white to brown or reddish brown. Dry clay exhibits enough consistency to support the track load. This clay shrinks as it desiccates, and approximately 1cm thick hexagonal patterned cracks with 2cm sides occur.

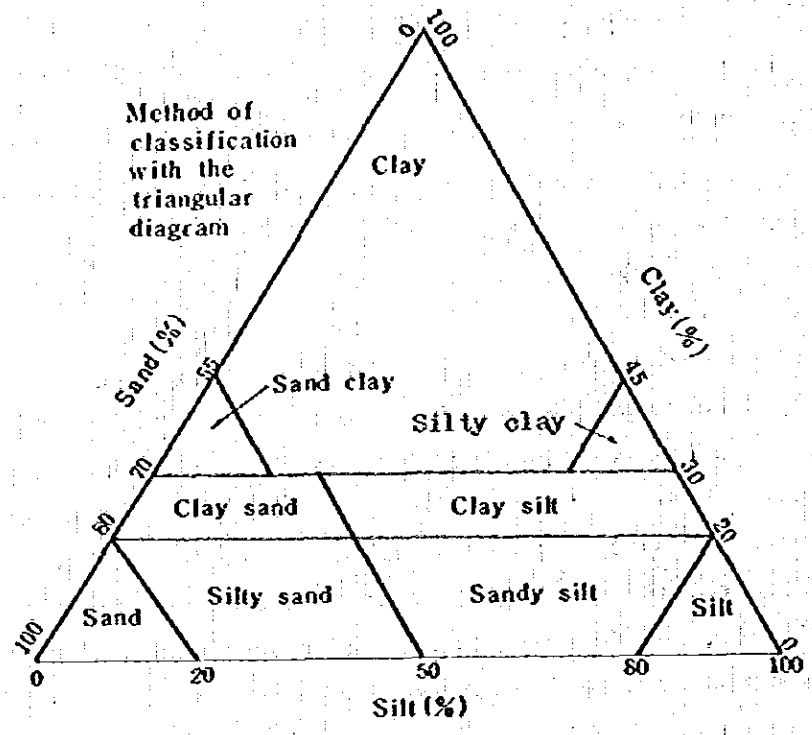


Diagram 4-1

But the load resistance drastically decreases with an increase of the soil's water content and forms a rut after a track passes. The soil then finally becomes muddy and prohibits passage.

Upon examining the existing road, it was believed to be adequate since there were no indications of slope failures between cutaway slope gradients of 1 : 0.8 - 1 : 1 with this soil property as well as the soil was free of surface erosion, and the original road surface was maintained after the road was completed.

Furthermore, surface erosion tends to increase on surfaces with inclines relaxed to 1 : 1. With the top soil removed, erosions are found i the longitudinal and lateral directions and present a problem for forest land conservation. Moreover, it is believed that it would be more benefici to increase the incline of short lengthed slopes instead of relaxing the incline, since minor failures may occur during rainfall by doing this but surface erosion may be prevented.

Also, in areas of dense shrubs, black clay silt of 80 - 20cm thickness containing large amounts of organic substances are partially found.

4-1-3 Design Principles

As mentioned in 4-1-1, since the terrain of the test planting area is undulating, regardless of how the forest road is aligned, forest roads with minimal earth working volume may be produced with the height of cutting or banking under 3m and mean cutting volume under $5m^3$.

As far as structures are concerned, it is believed that the only item to be considered is the drainage pipes. To reduce the work, it is suggested to select the road which needs the shortest drainage pipes length. In other words, the route along the ridge top is suitable for that.

Additionally, the main forest road split from the existing Stan.Vac. road running in the north-south direction, the working forest road (considered also to be used as a fire protection belt) circling the various plantations, as well as the several working roads running in the east-west direction through the plantation are to be considered as a road network.

Additionally, yarding roads are to be provided to the aforementioned road network to reduce the physical transportation distance of potted plants to 200 - 500m with an average distance of 300m.

As aforementioned in 4-1-2, the soil property is extremely weak in water resistance. Therefore, it is necessary to obstruct rainwater running to the road from other sources as much as possible as well as to drainage the rainwater within the road rapidly.

In area on the long water collection slopes, a water obstruction ditch is to be excavated 1m away from the head of the slope in order to preclude water from running in. Additionally, provisions for a temporary drainage ditch is to be considered to drain rainwater, etc. during the execution of the work.

Generally, the work of the road surface is executed employing unscreened gravel with large ballast content. Furthermore, in the event that the soil property tend to soften drastically with moisture content such as clay, it is suggested to employ sand or fine unscreened gravel with large sand content.

It is necessary to employ burial prevention planks as illustrated in diagram 4-2 in order to prevent rut formation when spreading Sand with a truck, because of being slippery or loose on the sand for lack of supportability.

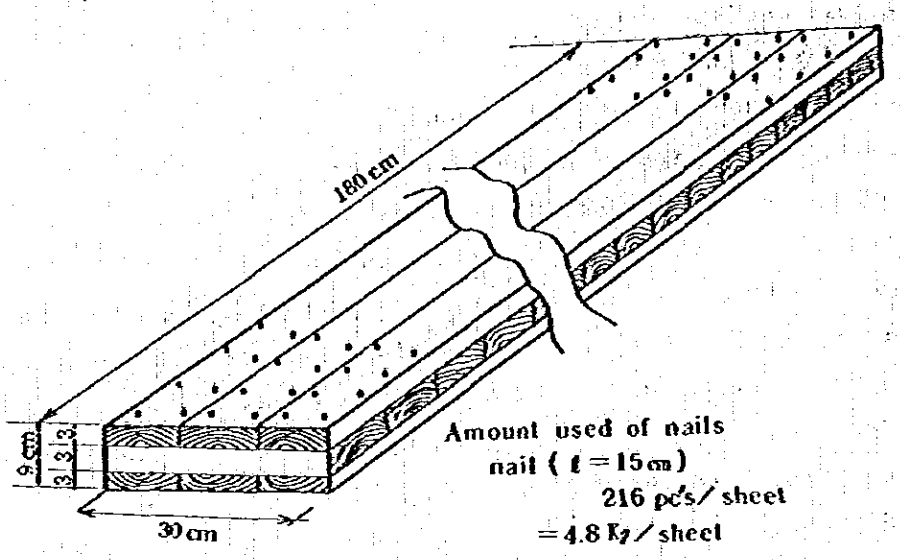


Fig 4-2 Burial Prevention Plank

4-2 Forest Road Route Plan

4-2-1 General Plan

Fig 4-3 as well as Table 4-1 describe the general route plan of the forest road in accordance with the concept aforementioned in 4-1-3.

Table 4-1

Classification / Length	Main Forest Road	Working Forest Road	Feeder Road
km	9.4	33.0	31.0

4-2-2 Annual Plan for Forest Road Construction

It is most desirable to open the forest road a year ahead of the plantation. Table 4-2 describes a plan to open forest roads a year ahead in accordance with the forest plantation plan.

4 – 3 FOREST ROAD PLANNING MAP

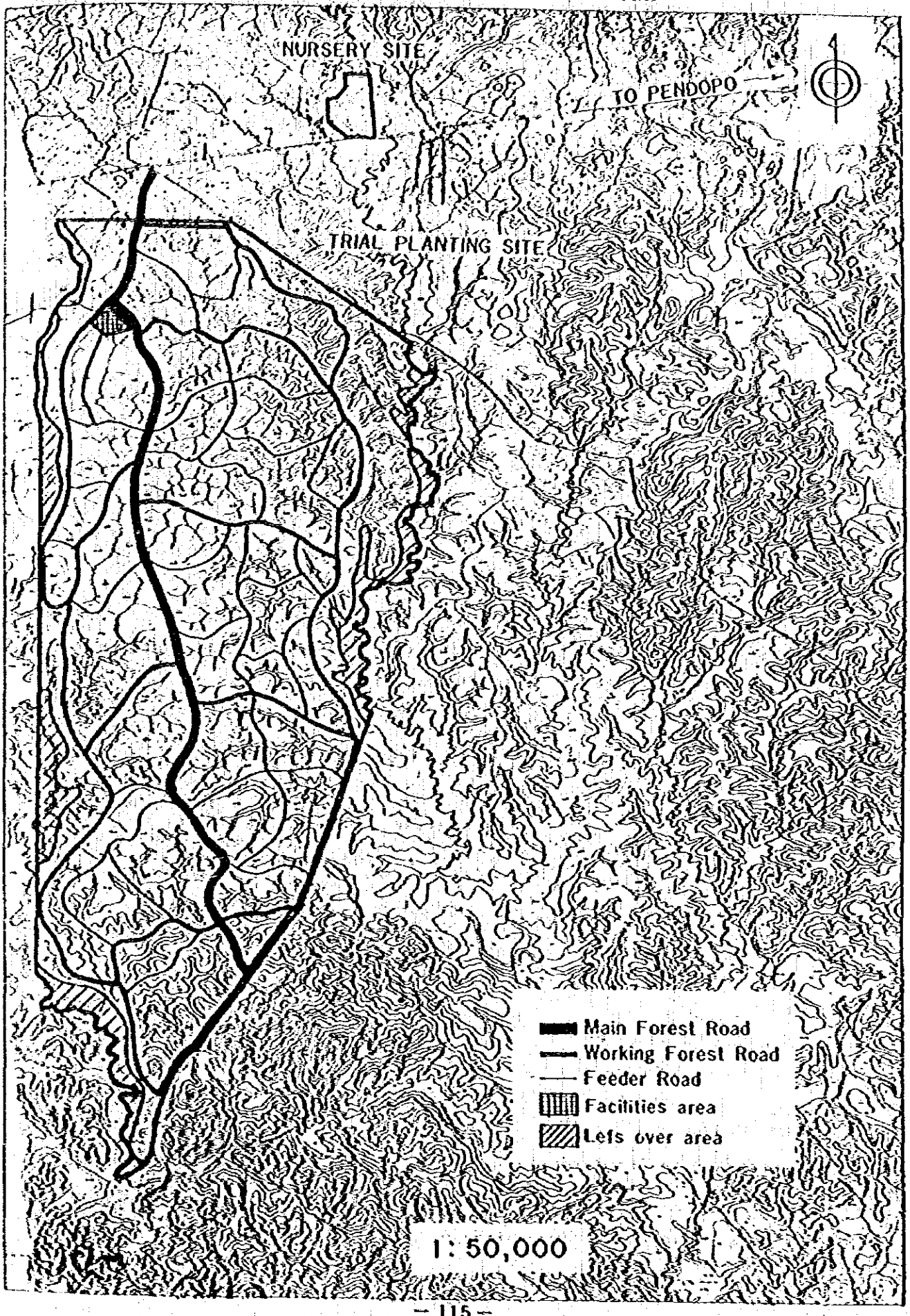


Table 4-2

Unit: km

Classification / Year	Main Forest Road	Working Forest Road	Feeder Road
1 year	0.7		
2 year	2.3	7.8	7.1
3 year	2.6	9.2	11.9
4 year	3.8	16.0	12.0

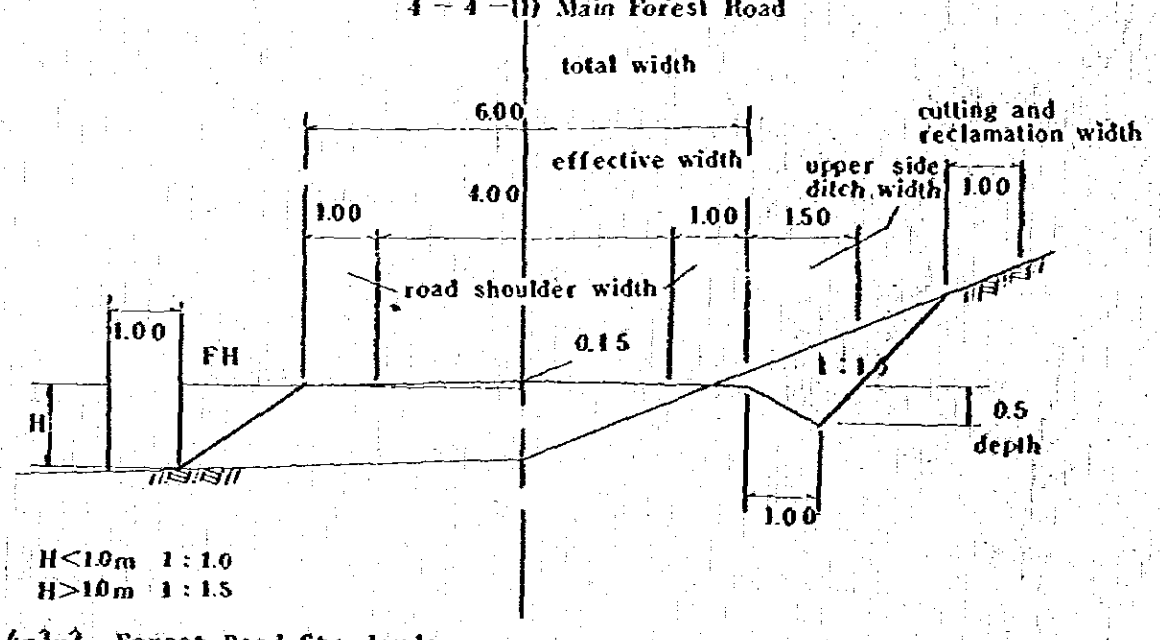
The forest road execution for the initial year is scheduled to be accomplished with model infrastructure. Additionally, execution of feeder roads need not be always adhered to the "year ahead" opening policy.

4-3 Forest Road Structure

4-3-1 Roadway Diagram

Diagram 4-4-(1) thru 4-4-(3) illustrate the forest road width, side ditch form, and slope gradient as roadway diagrams.

4 - 4 -(1) Main Forest Road

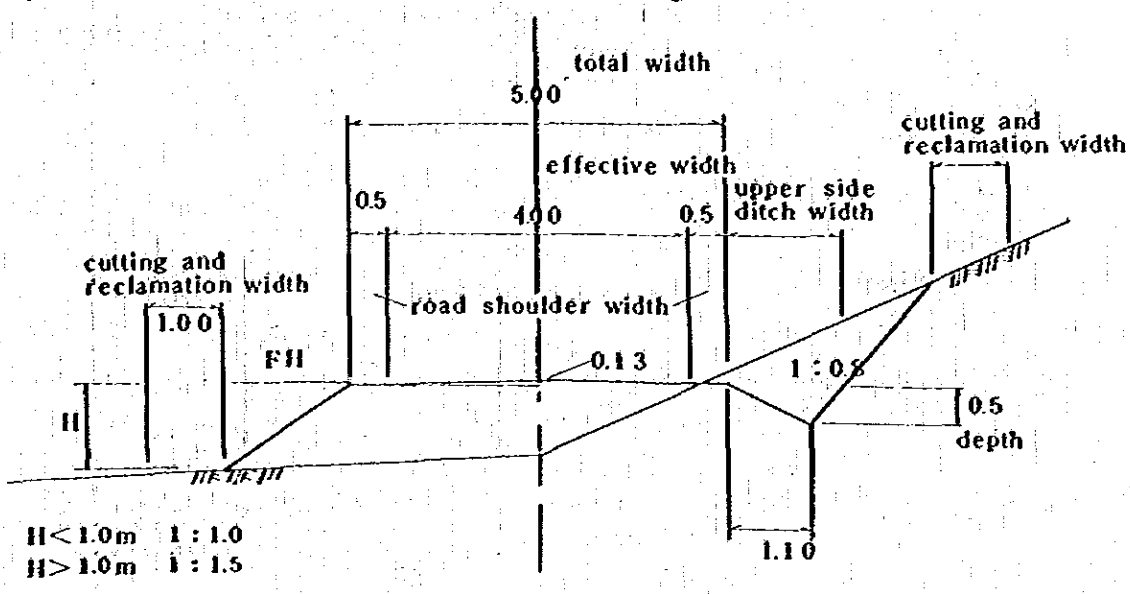


H<1.0m 1 : 1.0
H>1.0m 1 : 1.5

4-3-2 Forest Road Standards

Table 4-3 describes the structural standards for forest roads other than those indicated in the roadway diagram.

4 — 4 —(2) Working Forest Road



4 — 4 —(3) Feeder Road

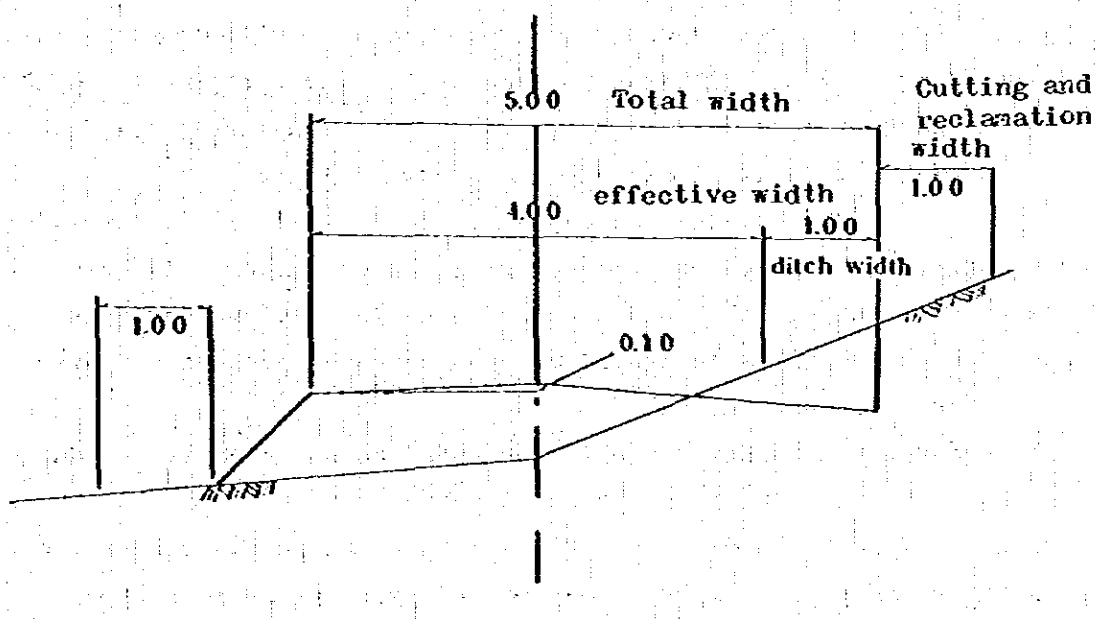


Table 4-3

Classification / Item	Main Forest Road	Working Forest Road	Yarding Road
Designed Speed	20 km/h	10 km/h*	-
Minimum Curve Radius	30m	20m	10m
Safe Sight Distance	40m	20m	20m
Maximum Longitudinal Grade	7%	10%	12%
Particular Place	9%	12%	15%
Bed Height	Sand 30cm	Sand 20cm	Sand 10cm
Banking Slope	Sodding Work	Sodding Work	-
Under drain	Corrugated Pipe	Corrugated Pipe	Wooden Drain

4-4 *Forest Road Construction*

The forest road construction described in the following is segregated into the earth-work and the road surface work. The earth-work volume is minimal 3-4m^3/ha with only closed conduits to be considered for structures, and therefore is believed to be simple at first glance.

The subject soil texture as explained in 4-1-2 is clay. Therefore, although presents no problems which hinder the execution while dry, the consistency to support the load becomes significantly reduced when the moisture content becomes increased or when agitated presenting various problems for construction.

Therefore, the construction is suggested to be accomplished during the dry season.

The transportation distance of the sand which is the material for the surface work is 80 - 100km, and the transportation may become impossible due to the poor road conditions during the rain season. Additionally, attention must be paid closely when laying the sand since the resulting road may become inadequate as a forest road.

The following describes some points for the construction in accordance with the type of work or the work specifications.

4-4-1 Bulldozer Employment

The general precautions for bulldozer employment are described in the following:

(1) Perform the work in staight-lines in order to reduce the soil dosing distance to a minimum.

(2) The forward movement for digging is to be accomplished slowly in order to increase the soil volume to a maximum as well as the reverse movement is to be accomplished repidly.

(3) The bulldozer is to be driven with care taken to minimize the vertical dozer movement in order to even the digging section.

(4) The digging is to be performed on downward grades as much as possible.

(5) Digging should be accomplished gradually where the dozer is filled at the end instead of a full dozer (earth moving plate) from the beginning.

The following are considerable points for execution during the rain season or on well moisture containing clay after a rainfall:

(1) Execute with care not agitating the clay.
(2) Prevent water from running in.
(3) Drain water as fast as possible.

The actual measures for these considerable points are described in the following:

(1) Carry away the dozed clay within the same day, and don't leave the clay in a heap.

(2) Spread out and even the surface of the clay brought into the banking section within the same day.

(3) Operate the bulldozer with care taken to prevent overlapping previously gone over spots while constantly cutting new digging sections.

(4) Pay close attention for the drainage of the banking sections during execution with over 8% cross sectional grades provided.

(5) Clean and tidy up the clay spilled on the transportation route as well as the caly agitated by the bulldozer movement.

(6) Longitudinal and cross sectional grades must be provided enough for drainage to the cutting section where bulldozer works.

(7) Cover the scheduled banking and cutting sections with waterproof sheets before rainning.

(8) Refrain from producing multiple work sites for repeated banking on the identical spot. It is suggested to spread with several days apart between the execution. Muldiple overlay on identical spots within the same day must be prevented.
Furthermore, mud must constantly be cleaned off from the bulldozer to prevent mechanical troubles as well as the decrease of working efficiency.
Particularly, the engine and the caterpillar must be cleaned.

4-4-2 Road Surface Work Execution

Soil reduces its strength with moisture content. However, sand is the only material which increases its strength with moisture content.

By adding sand to liquidiges clay, it transforms from a plastic form to a solid body along with increase in strength.

Additionally, the sand layer exhibits highly beneficial characteristics to uniform and reduce the distribution of the load to the lower layer.

The following describes the points for spreading and levelling the sand:

(1) Spread the sand with minimum track rut. Fill the rut immediately with sand.

(2) Upon spreading the sand, lay burial prevention planks not to make rut. After the aforementioned are done, compact the sand.

Cost reduction should be considered since the cost of the surface work forms over 50% of the forest road construction cost. As one method, the improvement of roadbed by blending a mixture of cement and lime into clay may be considered. For example compact with the soil and the mixture

(approximately 10% of the soil weight) such as cement 1:lime1, cement 1:lime2, and cement 1:lime3, etc.

4-4-3 Drainage Pipe Burial Work Execution

Since the data of the precipitation which is the basis for determining the drainage pipe diameter was inavailable as well as due to the feature of the water movement exhibited as explained in 4-1-2, the 60cm pipes in diameter was selected based on the survey data of the existing road. Twin parallet 60cm pipes are considered for swamps with large rates of flow.

Furthermore, the corrugated pipe was selected for the drainage pipe considering the ease of local procurement.

The following are some points for burying the corrugated pipes:

(1) The bed is to be excavated into an arc form to facilitate the pipe settlement.

(2) Bank with soil primarily when burying into particularly soft spots. Perform bed excavation and bury the pipes after the banking soil is naturally packed.

(3) Parallel burials are to be performed in the stream with over 5m width and water current.

4-4-4 Work Specifications

4-4-4-1 Earth Work

(1)-1 (Design Drawing/Blueprint)

(1) The cutting and reclamation width, total width, and slope incline, etc. are to be in accordance with the road way diagram as much as possible. Particularly, it is important to secure the total width including the side ditch width.

(2) Referencing the longitudinal diagram with the finishing stake applied, it must be finished smoothly where it is free of hindering truck movements even when excessive cutting or inadequate banking occur. Particularly, close attention should be paid constantly to the balance between the cutting and banking in order to remain no soil.

(1)-2 (Cutting & Reclamation)

(1) Cutting and reclamation are to be performed within the area designated on the roadway diagram. Additionally, shrubbery, bamboo, and weed, etc. must be removed out of the cutting and reclamation area.

(2) Furthermore, vegetation such as shrubbery, bamboo, and tree crop, etc. which hinder the traffic and road conservation must be cut and eliminated, even if the vegetation is not in the cutting and reclamation area.

(3) The following works are only to be commenced upon completion of cutting and reclamation.

(1)-3 Leveling

(1) Leveling is a term given to earth works performed in an area with continuous under 50cm cutting and banking. Ground covering objects are dug out and removed at first, and irregularities are then banked and cut with their balance in consideration to attain a smooth, well conformed finish.

(1)-4 Cutting

(1) The cutting work is to be performed with care taken for drainage to prevent rainwater accumulation on the digging section.

(2) In the event that the digging was excessive, finish smoothly in order to prevent sudden change of the incline within a short span.

(3) Pay close attention to the slope incline so that it does not become relaxed,than the figures indicated on the roadwork diagram as well as finish its surface to be free of excessive irregularities and visually adceptable.

(1)-5 Banking

(1) The bed for embankment must be cleaned before banking.

(2) Banking must be accomplished while providing over 8% cross sectional incline to facilitate water drainage since the banking mterial is the cut-out clay.

(3) It is suggested to consider covering the embankment with vinyl sheets, etc. during the rain season or excessive rainfall periods.

(4) Compacting the embankment slope surface is to be accomplished when the moisture content is suitable for such operation.

(1)-6 Sodding

(1) Sod growing near the work-site is to be used for the sodding work.

(2) On the sodding work, sods are layed on packed slope surface at first. Then they are strongly tamped with a tamping plank closely on the surface. After this is done, covering soil is spered on the sod surface uniformly and is once again tamped with a tamping plank. Finally, sods are secured with over four securing piles per sod sheet in order to prevent falling off.

(1)-7 Side Ditch

(1) The side ditch form is to be accordance with the roadwork diagraph. However, side ditches need not be provided for places where extra spacing is needed for vehicle siding/turnout, etc.

(2) Drainage holes are to be considered for the side ditch to prevent the water from flowing over 50m.

(3) The end of the side ditch is to guide the water into the natural ground in order to prevent direct water current on the part the embankment, and the water from stagnation.

4-4-4-2 Road Surface Work

(2)-1

The material for the road surface work is to be sand or unscreened fine gravel with large sand content. Additionally the layer thickness is to be average 30cm for the nursery access road and average 20cm for the main forest road.

(2)-2

Prevent rut formation when laying and spreading the sand, etc. as much as possible as well as spread into the designed base width upon leveling the surface irregularities.

(2)-3

Constantly consider the drainage of the road surface in order to preclude softening by the moisture. It is desirable to lay and spread the surface material during dry periods as much as possible.

(2)-4

The layer thickness described is the thickness before compaction.

(2)-5

Ruts formed on the construction must be immediately filled with sand.

4-4-4-3 Drainage Pipe Burial Work

(3)-1 Execution

(1) Upon confirming and determining the position, direction, and incline in accordance with the blueprint and survey pit, excavate the bed in conformance with the arc of the pipe as much as possible. Additionally closely execute to prevent the pipe from ununiformed sinking down.

(2) Refill the pipes without inpacts and eccentric load. The sides of the pipe must always be refilled to an identical height and the thickness of a single layer is to be about 30cm. Furthermore, these layers must be promptly compacted individually by the layer.

(3) Shrubbery roots and bamboo roots, etc. on the pipe laying position must be removed, and the bed must be escavated evenly.

(3)-2 Corrugated Pipe

(1) Washers must be set for the corrugated pipe securing bolts.

(2) The center of the pipe must be set slightly raised (1/100 of the pipe length is the limit) since the settlement due to consolidation is more evident in the center of banking section than in the edges.

(3) The assembly of the pipe is to be accomplished as designated by thightening the bolts from the inside. Furthermore, the loose bolts must be tightened just before refilling.

4-5 Actual Design

The actual design accomplished is for 1,800m of main forest road, 875m of working forest road, and 820m of nursery branch road (34m of the road is the original point access road).

The following lists the resultant items and are annexed to the end of this papers:

① Main forest road

- Plane
- Profile
- Structures plane
- Roadway diagraph

② Working forest road

- Plane
- Profile
- Structures plane
- Roadway diagraph
- Approach

③ Nursery road

- Plane
- Approach

④ Quantity reckoner

4-5-1 Model Infrastructure

700m of main forest road and 820m of nursery road are to be made in model infrastructure. The items are considered for the model infrastracture integration as follows.

(1) Earth works are generally indicated with the earth volume (m^3). However, due to the earth-work volume being minimal as well as the soil property single type in this case, it has been decided to express with the total length of the road since the earth-work volume is almost constant even with center line or longitudinal grade variation.

(2) Works to finish up the cutting slope surface and the banking are included in the earth work.

(3) The thickness and quantity of the sand on the road cannot be checked, at the completion (final) inspection, and therefore is expressed with the length of the road since the road surface sand is mixed and united with the roadbed soil.

(4) Temporary drain ditch approximately 10m long are needed for every 30m earth work length.

(5) Designation of a soil bank and a burrow pit are believed to be unnecessary since the balance between the cutting and banking work was constantly considered throughout the construction. However, unemployable agitated soil are to be discarded in a soil bank selected as close as possible beyond the road area in a run-off free level ground, etc.

(6) A single corrugated pipe section is 510mm long, with 2cm or 2% difference per meter. However, it is expressed in meters in the design.

4-6 Inspection of Forest Road Works

Although the supervision of forest road works include various inspection, only the final inspection is explained below.

(1) It is necessary to be acquainted with the contents of the contract specifications, principles of design and estimation, as well as the existence and contents of any modifications applied to the work during the execution prior to the inspection.

(2) It is also necessary to confirm whether construction management (progress schedule, initial survey, daily work reports), quality (construction quality) control (completion survey, as built diagrams, quantity calculations) as well as photographic record keeping are being performed.

(3) The center line inspection is to be performed by comparison with the piece plan with the following procedures.

(i) Several positions must be checked for an IP position with a tolerance of ± one degree within the angle of intersection and a clearance between the IP within 1m.

(ii) The distance between the survey points must be checked every 100m and the tolerance must be within ± 10cm.

(iii) Several BC, MC, and EC positions are to be checked for a tolerance of within ± 10cm.

(4) The profile gradient is to be checked by comparison with the piece profile plan at more than one point between every BM. The tolerance for the BM height must be within ± 5cm for every 500m. However, the tolerance for the execution base plane is not specified.

(5) The road width must be visually checked at several points for narrowness between the IPs to confirm whether the designated road width is attained.

(6) The thickness of the road surface is to be inspected by the actual measurement or by the number of trucks which transported the surface material.

(7) The drainage pipe (corrugated pipe) is to be checked at every point for a length and tolerance under -5%. Additionally, confirm whether the total length is attained in accordance with the design.

(8) The slope length and gradient of the cutting and banking is not checked.

(9) The side ditches must be checked for their sitting and drainage abilities. The inlet conditions must be checked for stagnated water.

4-7 Maintenance and Repair of the Forest Road

It is assumed that the slope slide probability is minimal since the slope length of the cutting and banking are usually under 3 meters. Slopes tend to slip out instead of sliding during daily rainfall over 200mm. However, such land slippage is minimal in magnitude and is considered to be free from blocking the passage. Therefore, the fallen soil can be manually removed within a relatively short period of time.

The side ditches are free of erosion by the run-off current due to their clay soil nature. However, mud, dust, etc. which accumulate within the side ditch and obstruct the run-off current must be removed at an early stage in order to maintain its drainage characteristics.

Although the road pavement is composed of packed sand and clay at completion, some doubts exists about its supportability against pavement slide and live load. Therefore, the most important element for maintenance and repair of the forest road is to attain a stable surface condition. The following are required conditions for the repair of the forest road.

(1) Small grain ballast is to be spread on steep inclines and low bearing power areas during the dry season by a dump truck. The volume of this ballast is to be between 0.1 m^3/m to 0.2 m^3/m. Pay close attention to the road surface conditions to prevent from spreading the ballast with a constant thickness.

(2) Fill ruts and mud immediately when they are formed. Refrain from using large grain ballast or boulders when filling the aforementioned.

(3) Plase several ten cubic meters of sand every 300 meters along the main forest road in order to haul and manually spread it with wheel barrows or carts when necessary. This is particularly important for the maintenance and repair during the raining season when the forest road is frequently used.

4-7-1 Forest Road Signs, Etc.

Road signs (speed limits, etc.), as well as safety devices such as curved mirrors and guard ropes, etc. are not necessary as long as the speed limit is restricted and stringently enforced at about 10 km/h over the designed speed, since the majority of the traffic is comprised of smaller vehicles.

An road map signboard indicating the outline of the forest road is to be provided at the start of the forestroad. Additionally, guide signs indicating the destination and the plantations are to be provided at every road junction.

Fig. 4-5-(1) and 4-5-(2) illustrate examples of signboards.

Fig. 4-5-(1). Signboard of the start

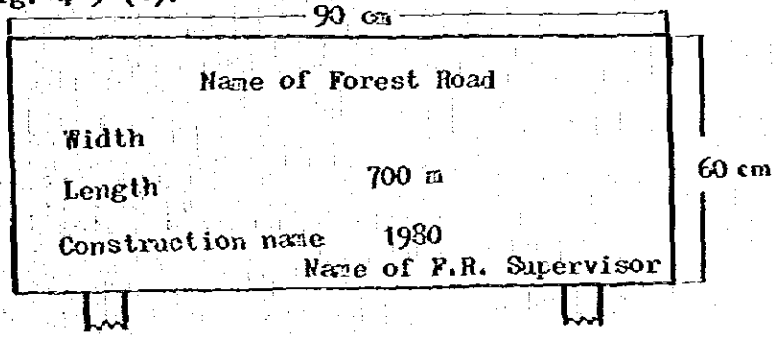
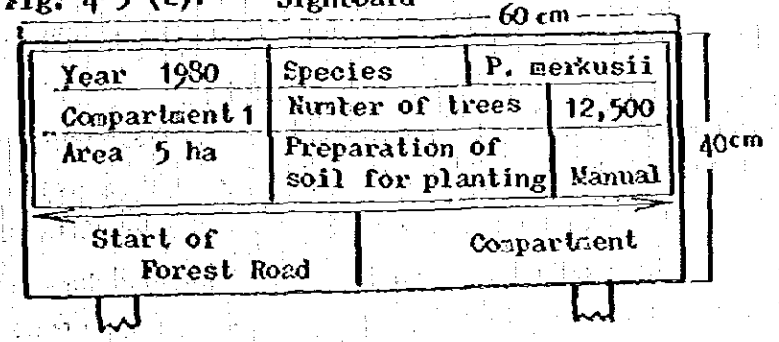


Fig. 4-5-(2). Signboard



§ 5. System of Forest Fire Protection

5-1 Principles

Forest fire protection includers both prevention and extinguishing of forest fires. Forest fires are not generated when the prevention system is fully utilized. Therefore, the following are the possible causes of forest fire that are to be considered for fire prevention of the experimental plantation.

(i) Burning for shifting cultivation
(ii) Burning for grazing
(iii) Burning for hunting

Aside from the above, fire occurance due to (iv) camp fires and (v) cigarettes by workers entering the experimental plantation area during the project is expected. Fire generation from within the experimental plantation area by reasons (i), (ii), and (iii) is highly unlikely since the plantation is located in national forest where burning for such causes is prohibited. However, the chances of the fire spreading to the experimental plantation from beyond the boundary is highly probable. Additionally, the risk of fire generation from within the experimental plantation by the camp fires and cigarettes of personnel entering the perimeter can only be prevented through thorough education.
Therefore, it is necessary to provide fire protection belts around the experimental plantation to prevent the spreading of fire from beyond the perimeter. Additionally, fire protection belts are also to be provided within the experimental plantation to preclude the fire from spreading as well as for normal working paths and evacuation routes in the event of fire.

The ground of the fire protection belt is to be covered with low growing plants such as Digitaria compressus or Pueraria phaseloides which grow into a mat form after removing the flammable Alang-Alang. These plants not only provide fire resistance but also protect the ground from erosion.

Additionally, remove the alang alang from the banks and cover them with cover plants for fire protection belts which comprise rivers and swamps. The existing forests are to be used for the aforementioned types of fire protection belt with trees on the banks.

Furthermore, lookout towers are to be constructed and patrols are to be done either by walking or by driving with particular attention

given to the spreading of fire from beyond the perimeter.

5-2 Layout of the Fire Protection Belt

Fire protection belts are to be provided along the main forest road, working forest road, feeder road, experimental plantation block boundary, and the perimeter of the experimental plantation.

The fire protection belt along the main forest road must be 30 meters wide including the pavement on each side and 20 meters wide including the pavement along the working and feeder forest roads. Additionally, the width at the boundaries of the three experimental plantation blocks as well as around the perimeter of the experimental plantation area must be 20 meters.

The overall experimental plantation area can be covered by providing four lookout towers at the 0.5km, 2.5km, 4.5km, and 7.0km points along the main road, since the general topography of subject terrain is undulating and is free of drastic elevation variations. The lookout towers and fire protection belts are to be provided in the locations indicated in Fig.5-1.

5-3 Other Provisions Relevant for Fire Protection

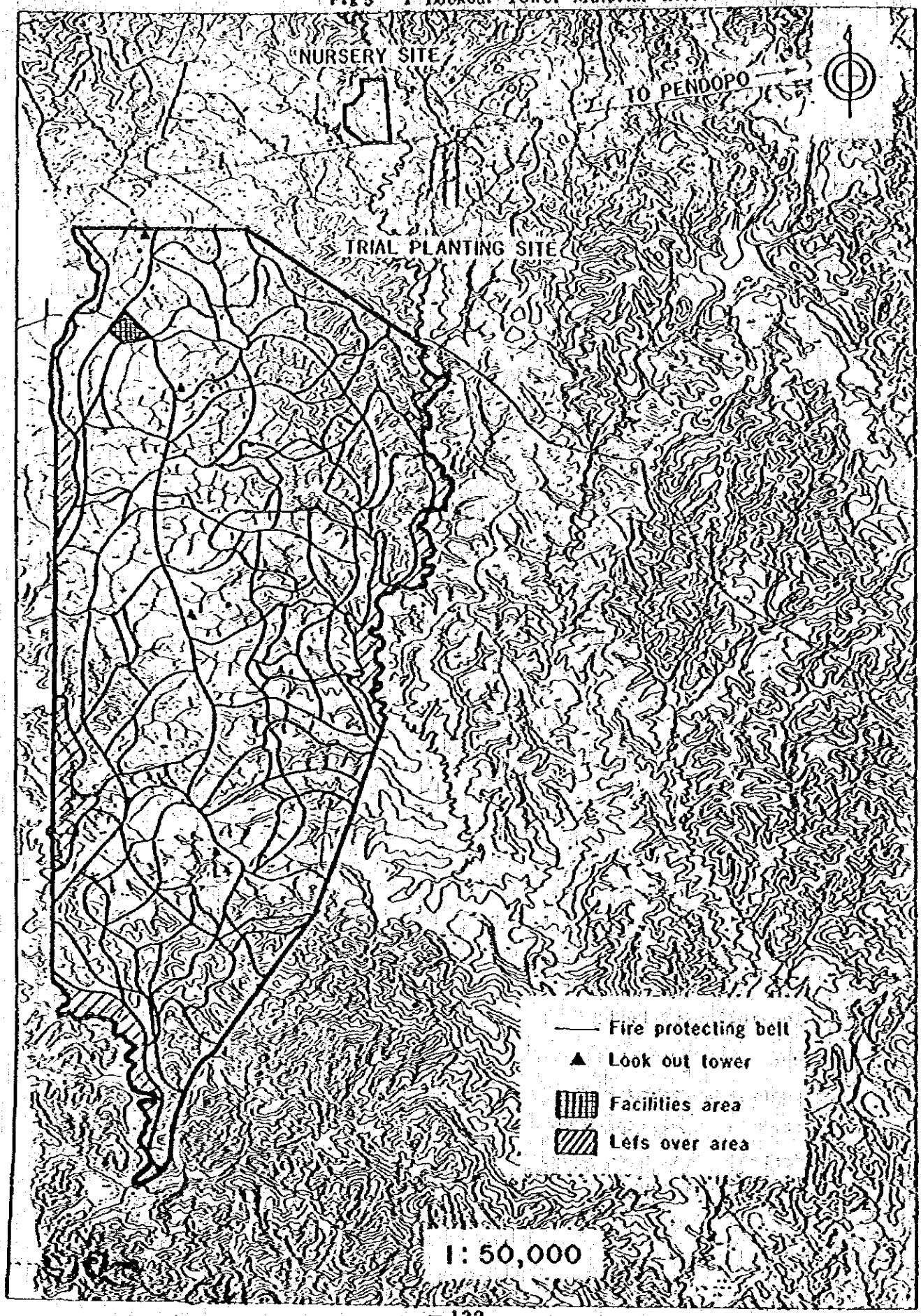
Telephone lines are to be provided between the lookout towers, plantation field office and administration office for rapid communication in the event of fire. Additionally, the patrolmen who are patrolling the plantation are to provided with walkie-talkies for communication.

The actual fire extinguishing is to be accomplished by removing the combustible materials and spreading water as well as fire extinguishing agents on the terrain. Manual pump corts, sand, steel rakes, and fire extinguishing agents are to be maintained in the lookout tower. Furthermore, wats reservoirs for fire extinguishing purposes are to be provided as close as possible to the forest road considering the lean water condition during the dry season.

The following list shows the necessary equipments for fire protection:

Motorcycle (for patrol and communication)
Tapezoidl Shaped Water Tank
Fire Extinguishing Pump
Portable Tank with Manual Pump
Fire Extinguisher

Fig 5 – 1 Lookout Tower Material List



Safety Hats
Fire Protection Set
Special Steel Rake
Cloth Bucket
Walkie-Talkie
Siren
Binoculars
Safety Shoes
Others

5-4 Design of Lookout Towers

The suitable height of the lookout tower is assumed to be 15 meters upon observation of the existing local towers. Design Procedures:

(1) To determine a individual panel heights in accordance with the experiment values as illustrated in Diagram 4-7-(1) after the determination of the total height.

(2) To compute the weight and wind force of the lookout tower.

(i) Lookout Tower Weight

a) Dead weight : 2,832.1kg
b) Ladder, Handrail, etc. : 300kg (Estimate)
c) Personnel Weight : 350kg (70kg/person x 5)

Total 3,482.1kg

(ii) Wind Force

The sail area is 1.3 times of the actual area and the wind force of the lookout tower is 290 kg/m^2 since the wind receiving area is actually larger including the ladders, etc.

Panel 1

The sail area of the top is estimated to be 1/4 of the overall sail area.

$2.5 \times 2.0 \times 1/4 \times 1.3 \times 290 = 472$

Panel 2

$(3.0 \times 0.065 + 0.05 \times 2.9) \times 1.3 \times 290 = 129$

Panel 3

$(2.0 \times 0.065 + 0.05 \times 4.6) \times 1.3 \times 290 = 136$

Panel 4

$(2.5 \times 0.07 + 3.7 \times 0.05 + 1.3 \times 0.06) \times 1.3 \times 290 = 166$

Panel 5

$(2.5 \times 0.07 + 5.3 \times 0.06 + 1.5 \times 0.045) \times 1.3 \times 290 = 212$

Panel 6

$(3.0 \times 0.075 + 6.1 \times 0.06 + 1.7 \times 0.06) \times 1.3 \times 290 = 262$

Panel 7

$(3.0 \times 0.075 + 1.8 \times 0.06 + 3.5 \times 0.05 + 4.3 \times 0.045) = 264$

The wind force described in Fig 4-7-(1) is for one leg and therefore becomes 1/2 of the calculated value.

(3) Compute the wind force stress using of Fig 4-7-(2). Table 4-4 lists the stress calculation table for the steel weight and the steel wind area.

Stress 150 of Fig 4-7-(2) B-1 is listed in column 1 and the G-11 1600 stress is listed in column 9.

(4) Calculate the safety factors of the structural material by the table for the selection of the material.

(5) It is listed in the lookout tower material list (Table 4-5) when the material is calculated from the lookout tower blue-print attached at the end of this manual.

(6) Check the foundation for safety.

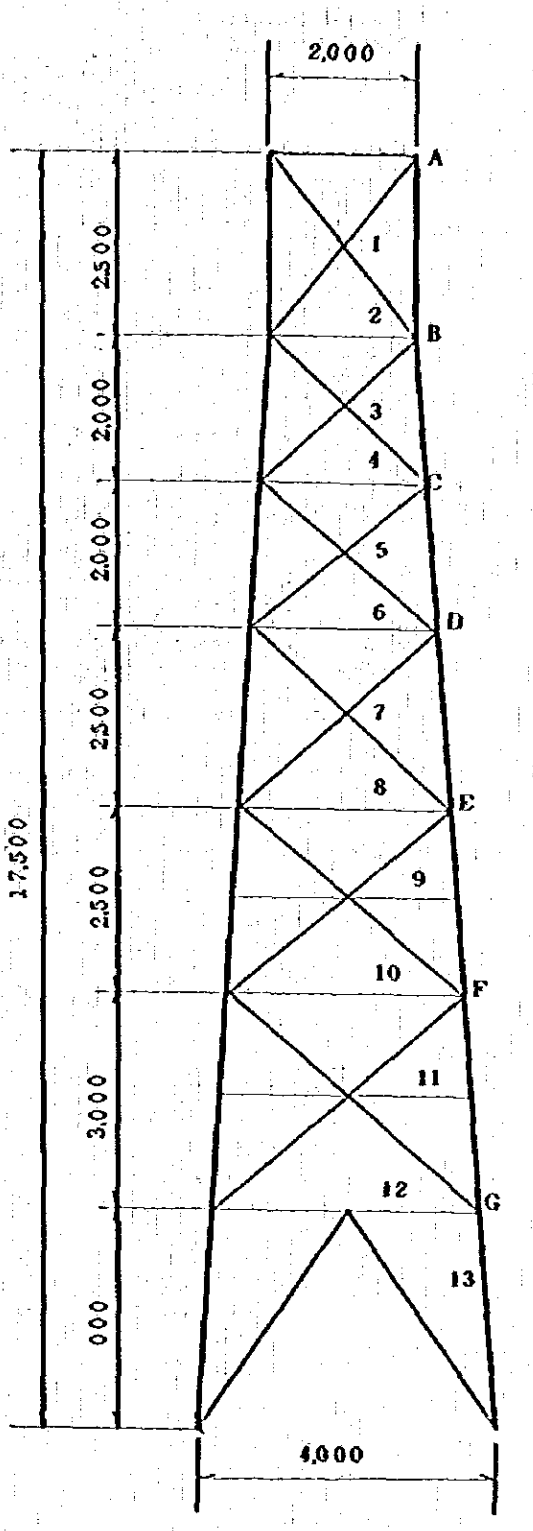
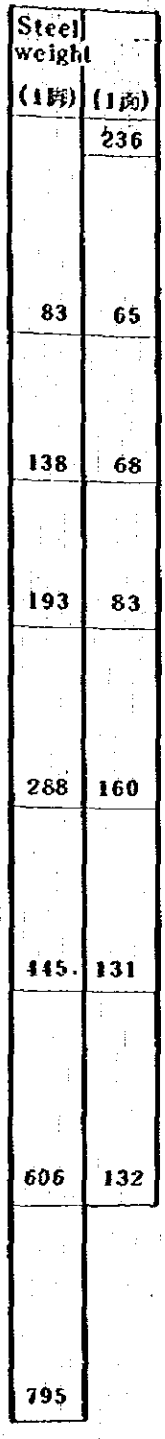


Fig 4 – 7 –(1)



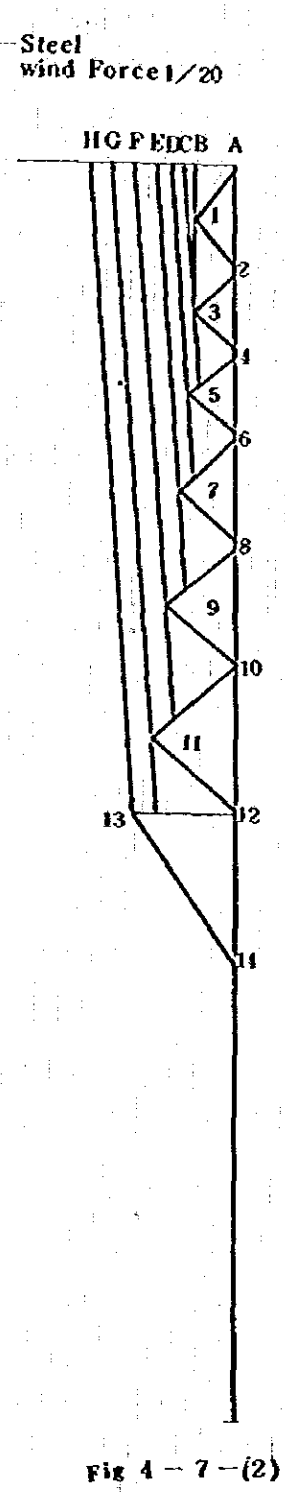


Fig 4 – 7 –(2)

Table 4 – 4 Stress Calculation Table

Sign		Stress		Stress Total	Material Selection				
		Steel Weight	Steel Wind Force		Material Dimensions	L (cm)	L/R	Material Strength	Safety Factor
Main pillar material	1	83	150	233	L 65 × 65 × 6	250	189	1,240	532
	3	138	400	538	L 65 × 65 × 6	200	142	3,540	658
	5	193	630	823	L 65 × 65 × 6	200	142	3,540	430
	7	288	900	1,188	L 70 × 70 × 6	250	164	2,860	241
	9	445	1,220	1,665	L 70 × 70 × 6	125	81	8,980	5.40
	11	606	1,600	2,206	L 75 × 75 × 6	150	92	8,890	403
	13	795	1,820	2,615	L 75 × 75 × 6	150	92	8,890	340
Sub pillar material	1 – 2		190	190	L 50 × 50 × 4	160	148	1,680	884
	3 – 4		170	170	L 50 × 50 × 4	160	148	1,680	988
	5 – 6		190	190	L 50 × 50 × 4	160	148	1,680	884
	7 – 8		230	230	L 50 × 50 × 4	200	184	1,090	474
	9 – 10		260	260	L 60 × 60 × 5	210	161	2,120	215
	11 – 12		320	320	L 60 × 60 × 5	210	182	1,660	519

Table 4-5. Lookout Tower Material List

Dimen-tions / No.	L75×75×6	L70×70×6	L65×65×6	L60×60×5	L50×50×6	L50×50×4	L45×45×4	Total
	68.3Kg/m	63.5Kg/m	59Kg/m	45.5Kg/m	44.3Kg/m	30.6Kg/m	27.4Kg/m	
	2200×4			3600×4	3700×2×4			
1	3300×4				700×2×4	2500×4	4700×2×4	
	500×4				4000×2		900×2	
							1200×4	
	3300×4			3400×4				
2				3200×4		2300×4		
				4500×4×2	4000×2		900×2	
		300×4						
		5300×4		4000×2×4			3000×4	
3		4000×2			3000×2		900×2	
		3700×2		2500×4		3700×2×4		
4		300×4			2500×2		900×2	
			4000×4			2300×4		
5					4300×2	3200×2×4		
			2100×4			2900×2×4		
6						2000×7		
						2000×4×2	2000×4	
7			2500×4			1500×4		
Total	372×685 ×13	390×635 ×13	341×59 ×13	1188×455 ×13	708×413 ×13	1432×306 ×13	660×274 ×13	Kg
	3313	3219	2638	7027	4077	5696	2351	28321

Vari-ation / No.	25m/m Ø	10m/m Ø	32m/m×20m/m mesh	32m/m×9m/m press				
	Pipe	Steel Frame	Net		Corrugated Steel Sheet	Foundation Concrete Volume		
1	700×10×2	800×24						
2	700×10×2	800×24						
3	700×8×2	800×24						
4	700×7×1	800×24						
5	700×9×1							
6								
7	1000×1×4		2000×2000	2000×3	24×24			
Total		768×0617 ×13		6×226 ×13				
	781m	618Kg	40m²	176Kg	576m²	30m³		

(i) Against compression

$$\frac{q'}{F} \geq \frac{C + G + Ws}{A} \quad \text{-------- (1)}$$

Where; q': Compression of the Ground

F : Safety Factor

C : Compression from the Lookout Tower Top

Ws: Weight of the Soil immediately above the Foundation Floor

A : Foundation Base Area

From Equation (1):

$$C = \frac{q'A}{F} - G - Ws \quad \text{-------- (2)}$$

$$A = 1.0^{m} \times 1.0^{m} = 1.0m^{2}$$

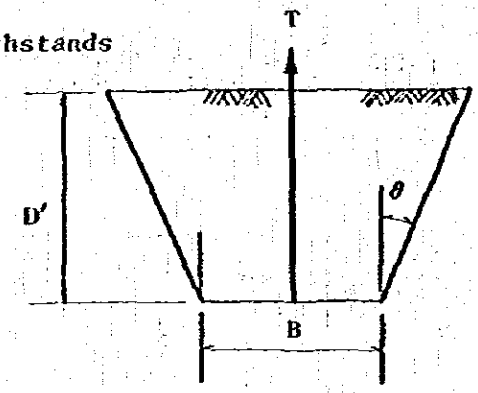
$$G = 0.74 \times 2.4 = 1.78t$$

$$Ws = (1.0 \times 1.0 \times 2.0 - 0.74) \times 1.5 = 1.89t$$

$$C = \frac{4.0 \times 1.0}{2} - 1.78 - 1.89 = 16.33t$$

Therefore, it is satisfactory since it withstands the aforementioned compression.

(ii) Against the Lifting Force



$$\frac{r' (Ve - Vc') + G}{F} \geq T \quad \text{-------- (3)}$$

Hereby: T : Lifting force from the top of the Lookout Tower (t)

r': Constant soil value cubic unit weight ------- $1.5\ t/m^{3}$

Ve: Deleted

$$Ve = D' (B^{2} + 2BD' \tan\theta + \frac{4}{3}D^{12} \tan^{2}\theta) = 6.32$$

θ : Effective Angle of the Soil Resisting the Lifting Force = 20°

Vc' : Cubic Volume of the Subsurface Foundation Body (m^{3})

$$\frac{1.5 (6.32 - 0.74) + 1.78}{2} = \frac{10.15}{2} = 5.07t$$

Therefor, it withstands the aforementioned lifting force.

§ 6. Materials and Machines Required for the Project

One of the purposes of this experimental plantation project is to establish a mechanized plantation system. Mechanization should be planned not only in the planting work but also in the nursing work.

Various machines which will be introduced in the various works of plantation, nursery and forest road construction are shown below.

(1) Materials and machines for plantation

Machines	Use
Wheel tractor (75.PS)	Traction, power source
(Attachment)	
Plow	Cultivating work
Sub soiler (2 claws)	Deep cultivating work
Harrow	Soil crushing work
Rotary slusher	Clearing for land preparation Clearing for weeding
Rotary cutter	"
Hammer knife more	Clearing for land preparation Clearing for weeding
Crawler tractor	Installation of machines, Construction and repair of forest roads
(Attachment)	
Pot planter	Planting of poted seedlings
Auger	Hole making for planting (cultivation)
Holer	Hole making for planting Hole making for fertilizing
Fertilizing machine	Fertilizing
Brush cutter	Clearing for land preparation " for weeding
Chain saw	Clearing for land preparation
Fork-lift	Unloading of containers of seedlings
Trailer	Transportation of seedlings
Truck (4.5 ton, with Winch)	"

(ii) Materials and Machines for Nursery

Machine	Use
Dumped motor car (4.5 ton)	Trasportation of soil
Flat body truck (4.5 ton, with winch)	Transportation of materials
Wheel tractor (Attachment) Trailer	Traction, power source Transportation of seedling
Shovel	Transportation of soil, Production of farmyard mannure
Sprayer	Medical spray
Fork-lift	Transportation of seedling with containers
Soil burning machine	Soil disinfection
Belt conveyor	"
Roller conveyor	Transportation of poted seedling
Watering equipment Set of sprinklers, pump, reservoir, generator etc.	Watering in nursery
Refrigerator	Storage of seeds
Trencher	Excavation of drainage canals, Excavation of canals for water supply and drain pipes
Back ho (Attachment of angle dozer)	Construction of reservoir
Rammer	Fixation of nursery bed
Concrete mixer	Construction of nursery, Construction of drainage canals
Underwater pump	Water pumping

(iii) Materials and Machines for the Construction of Forest Roads

Machine	Use
Angle dozer (15 ton) with ripper	Construction and repair of forest roads, preparation of nursery, preparation of facility site.
Motor grader	Stablization, maintenance and control of road surface, preparation of field
Tire roller	Pressing, maintenance and control of road surface
Shovel dozer	Construction and repair of roads
Dumped motor car (4.5 ton)	Construction and repair of forest roads
Truck (4.5 ton, with crane)	Transportation of materials
Corrugated pipe	Drain facility

(iv) Other Necessary Machines

Machine	Use
Fire Pump	Prevention of forest fire
Fire extinguishing equipment	"
Equipment for metero-logical observation	Survey and investigation
A set of surveying instruments	"
Radio communication equipment (Project head office-project office-plantion field office)	Communication of office work
Wire communication equipment (Project head office-project office-look out tower)	Alarm for forest fire, Emergency communication

Machine	Use
Soil analysis equipment	Survey and investigation
Office machines such as duplicator etc.	Office work and investigation
Generator	"
Tools for the repair of machines	Repair of machines
Machine parts	"