REPORT ON IMPLEMENTATION DESIGN
ON
MOUNTAIN LOGGING PRACTICES
IN
JAVA TECHNICAL COOPERATION PROJECT

1978

Japan International Cooperation Agency

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1. Purpose of the survey and its outline

1-1 Purpose of the survey

This survey is for the implementation design about the facilities, necessary for the cooperation project of mountain logging practices in Java ATA-184, to be commenced for the first three years under the sign of R/D on 3rd, December, 1977.

The purpose of this project is to transfer the logging techniques necessary for the yielding of the Pinus Merkusii in the mountainous area of the State Forestry Corporation of Indonesia. (Perum Perhutani : Purusahaan-Umiem Kehutanan Negara)

For this purpose the office and the training center is prepared in Madiun, East Java, and practise the basic technical training especially of the logging by skyline system, establishing the demonstration forest in the region of Lawu District Forest Office.

After that, the trainee who finished the training course in Madiun go to the model logging operation forest in Pekalongan, Central Java, to practise the actual operations.

About the model logging operation forest in the District Forest Office of Pekalongan, the forest survey, the forest resources survey and the land feature survey to get the yielding plans are already completed.

In the demonstration forest, they practise not only the yarder yarding operation like the setting of skyline, checking, operation of machine, the method of yarding and the removal of it etc., but also the construction of strip road by tractor and the tractor skidding process etc., all these practical trainings.

These fundamental trainings must be achieved to get the sufficient results in a short term of 6 months.

Therefore, in determining the demonstration forest we must scrutinize its location, forest aspects and land condition etc. to select the best fit forest and also must check the actual process and steps, and also check technically the public road, the approaching road and the strip road to execute the trainings. And also the necessary cost must be surveyed beforehand.

The survey team of this time is sent to survey the necessary items to realize the training as described above.

1-2 Team member and schedule of the survey

(1) Members of the team

Chief:	Mr. Hiroshi Shimoyama	Senior officer, Planning Division, Forestry Agency
Member: (Cordinator)	Mr. Masaru Morimoto	Officer, Japan International Cooperation Agency
Member: (Felling & yarding planning)	Mr. Tsutou Tohyama	Consultant, Japan Federation of Logging Association
Member: (Skyline yarding)	Mr. Masao Dobashi	Ditto.
Member: (Forest road and its conceins)	Mr. Yasuhiro Itokawa	Ditto.
Member: (Forest road and its conceins)	Mr. Denji Kinoshita	Ditto.

Counter parts

Mr. BAMBANG WAHJONO SOERJOSOEBAGJO

Mr. MATHEUS MARINUS EZERMAN

(2) Schedule of the survey

Ordinal days	Date	Day of the week	Trip	Surveying content
1	May 7	Sun	Tokyo - Jakarta	
2	8	Mon	Stay in Jakarta	Respecting visit to the Perum Perhutani.
3	9	Tues	Ditto.	Courtesy call to the Japanese Embassy & JICA Office.
4	10	Wed	Ditto.	Courtesy call to, and made arrangements with Perum Perhutani.
5	11	Thurs	Jakarta - Surabaya	
6	12	Fri	Stay in Surabaya	Courtesy call to the Surabaya Regional Forestry Office.(Unit II)
7	13	Sat	Surabaya - Madiun	Consulting with the Regional Forestry Office in the morning.
8	14	Sun	Stay in Madiun	Prearranging about the survey.
9	15	Mon	Ditto.	Discussion with the Training Center and District Forest Office. Survey the field.
10	16	Tues	Ditto.	Discussion with Specialists, concerning members of the Training Center and D.F.O.
11	17	Wed	Ditto.	Survey of the facilities in the Training Center.
12	18	Thurs	Ditto.	Ditto. Mr. Shimoyama & Mr. Morimoto made a trip to Surabaya.
13	19	Fri	Ditto.	Ditto.
14	20	Sat	Ditto.	Ditto.
15	21	Sun	Ditto.	Arranging the surveyed data.
16	22	Mon	Madiun - Ngetel	Report to the Chief of the Training Center about the results of rearranging plan of training center.
17	23	Tues	Stay in Ngetel	Survey.
18	24	Wed	Ditto.	Ditto.

Ordinal days	Date	Day of the week	Trip	Surveying content
19	May 25	Thurs	Ngebel - Madiun	Survey. Discussion with Specialists in the afternoon.
20	26	Fri	Madiun - Ngebel	Survey. Discussion with officials of the Maran Planning Bureau in the morning.
21	27	Sat	Stay in Ngebel	Survey.
22	28	Sun	Ditto.	Ditto.
23	29	Mon	Ditto.	Ditto.
24	30	Tues	Ditto.	Ditto.
25	31	Wed	Ditto.	Ditto.
26	June 1	Thurs	Ngebel - Madiun	Discussion with specialists in the afternoon.
27	2	Fri	Madiun - Sarangan	Arranging the data.
28	3	Sat	Sarangan - Madiun	Ditto.
29	4	Sun	Stay in Madiun	Ditto.
30	5	Mon	Ditto.	Ditto.
31	6	Tues	Ditto.	Ditto.
32	7	Wed	Ditto.	Ditto.
33	8	Thurs	Ditto.	Ditto.
34	9	Fri	Madiun - Surataya	Report to the Training Center, D.F.O. and Maran Planning Bureau.
35	10	Sat	Surataya - Jakarta	Report to the Regional Forestry Office of Unit II.
36	11	Sun	Stay in Jakarta	Arranging the data.
37	12	Mon	Ditto.	Courtesy call to the Embassy and report to JICA Office.
38	13	Tues	Ditto.	Arranging the data.
39	14	Wed	Ditto.	Report to the Perum Perhutani.
40	15	Thurs	Jakarta - Tokyo	Return to Japan.

2. General aspects of the demonstration forest

2-1 Location of the demonstration forest

According to the Record of Discussion signed on 3rd December 1977 (Mountain Logging Practices in Java, ATA-184), the demonstration forest of about 200 ha is to be set in the Lawu District Forest.

The training in the demonstration forest will necessarily include the felling, the selection of the forest will be confined to the stands of final cutting age (35 years) or near the age.

On the other hand, in the domain of Lawu District Forest Office, there are not only many farm lands scattered all over but also many protection forests under prohibition of cutting, that if we select the stand fit for the training, it will be scattered in wide range.

In consideration of these conditions and to meet the begining of training, also the present arrangement of roads, we decided to include partially the stands immature for cutting after confering with the Indonesian authorities.

As a result, the stands selected for the training are planted forest of Pinus Merkusii of the age-class from 5 to 8 and the area of 133.2 ha.

The location is as shown in Fig 2 (1).

2-2 Stand conditions of the demonstration forest

About the demonstration forest of Fig 2 (1), the outline of stand conditions are shown in Table 2 (1), such as the area, age of tree, volume per ha and the land discription of each sub-compartment.

The demonstration forest is mountain forest in the high altitude and it is said that the meteorolgical changes of wet and dry seasons are gentle as compared with that of the plain, but the training period is in the rainy season and the changes in weather are remarkable, peculiar to the mountainous region.

To perform an efficient training under these unstable weather conditions, the contents and arrangements of the facilities must be considered carefully.

2-3 Circumstances in deciding the demonstration forest during the cooperating period.

According to the training plan, decided after the consultation at the R/D meeting, the training for the 12 trainees of the 1st term will be started in october, 1978.

To meet this training plan, the demonstration forest land has to be selected in the place as nearer to the existing road as possible.

In consideration of these conditions and consulting with the Indonesian side, we decided to add the 70 Compartment m Sub-compartment of the planted forest of Pinus Merksii, planted in 1954, which is the nearest stand from the existing road and good for felling, to the sub-compartment "58 d", "58 j", "58 k" & "73 a" located on the extension line as the objects of the survey.

The results of the survey and the checking for these compartments are as follows.

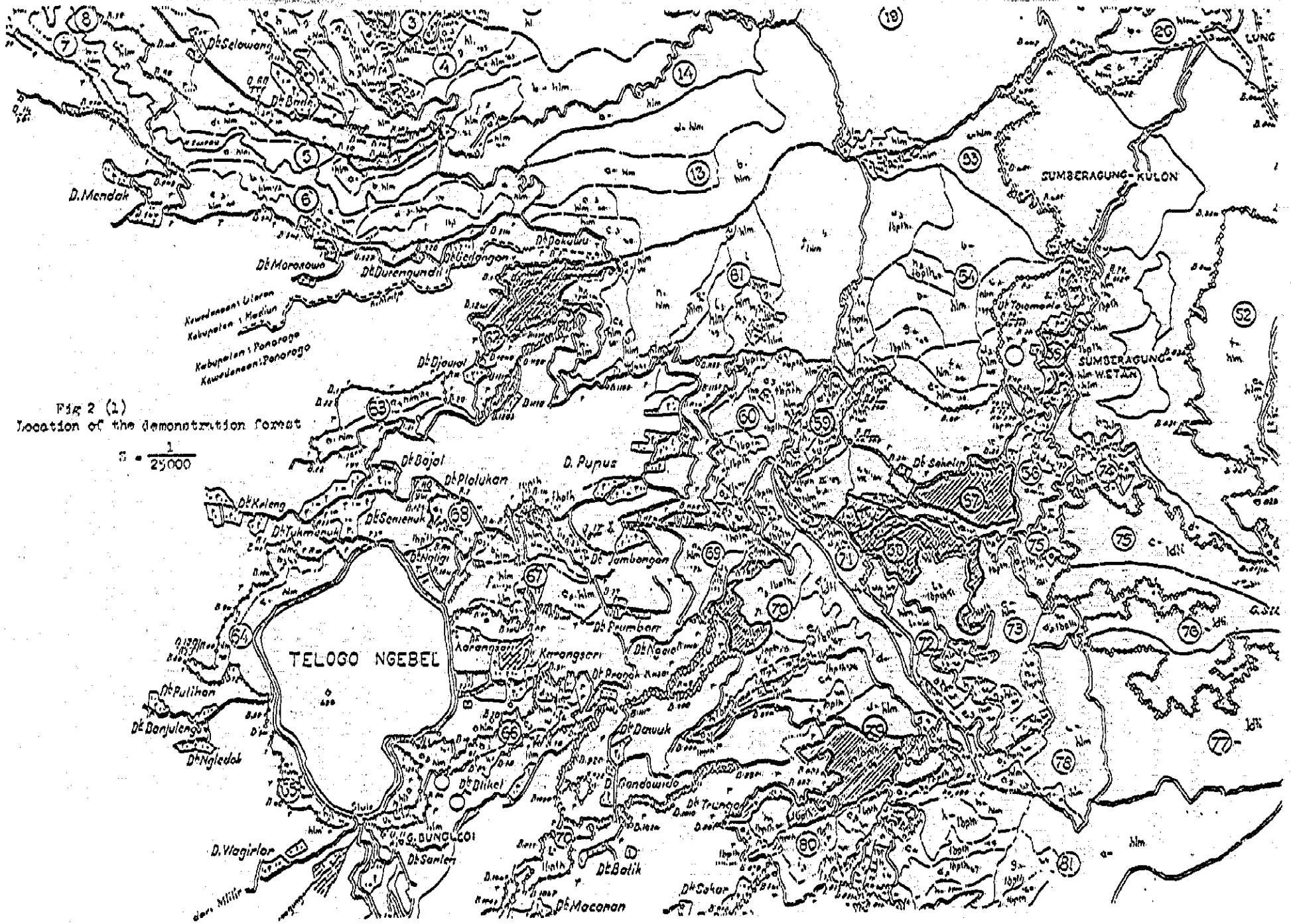


Fig 2 (1)
location of the demonstration format

$S = \frac{1}{25000}$

Table 2 (1) Outline of stand conditions of the demonstration forest

Sub-compartment	Area (ha)	Age-class	Planted year	Volume of a stand per ha (m^3)	Total volume of stand (m^3)	Planned area of felling (ha.)	Planned volume of felling (m^3)	No. of trees per ha	Land descriptions
5 o	6.10	V	1953	243	1482.3	6.10	1482.3	743	Steep mountainous slope
6 e'	5.30	VII	1940	307	1627.1	1.38	424.0	200	Inclination 25.6 % mountainous slope
58 d	4.30	VII	1943	449	1931.0	4.30	1931.0	833	Inclination 36 % steep mountainous slope
k	0.80	VII	1943	773	618.0	0.80	618.0	433	Inclination 25 % mountainous slope
j	8.60	VII	1939	856	7361.6	8.60	7361.6	420	ditto 40 % steep mountainous slope
h	5.40	VIII	1936	341	184.0	5.40	184.0	—	Inclination 45 % ditto
j	1.40	VII	1939	868	1215.0	1.40	1215.0	—	ditto 40 % ditto
55 d	6.50	VIII	1937	327	2125.0	6.50	2125.0	—	ditto 40 % ditto
57 b	21.10	V	1954	488	10297.0	12.00	5856.0	383	ditto 50 % ditto
59 e'	0.70	VIII	1936	278	195.0	0.70	195.0	—	ditto 37.5 % ditto
73 a	8.00	VII	1941	1058	8464.0	8.00	8464.0	480	ditto 31 % mountainous slope
62 a	18.10	VII	1939	419	7584.0	18.10	7584.0	406	ditto 42.4 % steep mountainous slope
70 m	10.60	V	1954	119	1261.0	8.60	1023.0	—	Steep mountainous slope
79 l	28.00	VIII	1938	398	11144.0	28.00	11144.0	—	Inclination 40 % steep mountainous slope
80 b	8.30	VIII	1938	437	3627.0	5.50	2403.0	—	Inclination 45 % ditto
	133.20			443.8	59116.0	115.38	52009.9		

(1) "70 m" is located at the point 850 m from the terminal of the existing road, We describe later about the land descriptions and the stand conditions, but this sub- compartment is well fit for the skyline yarding operations.

As mentioned before, we planned to practise the training for the tractor operation together with the skyline yarding, but this land is in general too steep to fit for this purpose.

If one dare to practise it, it may be confined to the limited small area and more over not only we have to spend a lot of cost in constructing the strip road, but also be anxious about the many problems derived from passing through the farm land

(2) "58 d", as for this sub-compartment, it is located at the point 3150 m from the terminal of existing road.

About the planning of the road, we describe in "4-1", but from the land aspects the road is planned to pass along the south-western border of this sub-compartment which is located at the highest ridge of this sloped forest land.

The slope of this forest land is about 23 degrees by acutual measuring, so it is difficult to operate the skidding by tractor.

On the other hand, planned road passes through the higher part of this land and felled trees are carried upwards to the road by skyline yarding as exceptional means, and this land is not fit for the training.

(3) "58 j" is in the gentle slope of 14 to 15 degrees and is fitted for training of both skyline yarding and skidding by tractor.

In this case, the planned road passes along the highest place of this forest land and so it is necessary to construct a strip road passing through the middle of it.

When the strip road is constructed in the middle, it is good for the skidding by tractor, but the skyline yarding will be confined to a short range in any case, and the various wirings can not be expected.

Therefore, this is not fully proper from the stand point of training.

(4) "58 k" and "73 a" are located at the point about 6 km from the terminal of existing road and are too far as the demonstration forest for the 1st term.

"58 k" is the gentle slope land of about 8 degrees, locating at the skirt of "58 j" and is best fit for the tractor operation.

By these conditions, if the auto-road passing through the north-eastern border of the "58 k" and "58 j" will be opened in 1979 and the training will be performed in these two sub-compartments at a time, it will be best fit area as not only the tractor operations but also the training of the skyline yarding of fundamental types can be performed.

(5) As the summary of checking, we have got the following conclusions.

(i) Training of the 1st term (1979, Jan. - Mar.)

(a) Training on the skyline is to be performed in "70 m".

(b) Training on the tractor is to be performed in "58 j".

In this case, the construction of new road to "58 d" of 3150 m and strip road of 1000 m is necessary.

If the completion of these roads are impossible, the training on the tractor will be restricted only to the pre-skidding of the skyline yarding.

(ii) Training of the 2nd term and after (1980, Jan. and after)

Construct the road to reach the north-eastern border of "58 j"and "58 k", and regard these two sub-compartments as one compartment and perform the trainings both of the skyline and tractor.

The sub-compartments of "58 j" and "58 k" are favored not only with the land conditions but also abandant in its stand volumes, and if we add "73 a" to them, they will be expected as the demonstration forest for a long period.

As for "70 m", we prepare one yarder in it for the 1st term and practice the training on skyline yarding on the 2nd term and after.

3. Annual plan of the training

3-1 The first term training plan (Jan. - Mar. 1979)

3-1-1 Training on skyline yarding operation

(1) General description of the training site

①	Compartment for training	"70 m"
②	Map of felling compartment	Fig 3 (1)
③	Felling area	8.1 ha
④	Species and tree age	Pinus Merkusii 24 years
⑤	Number of standing trees	280/ha
⑥	Diameter breast high	26 cm
⑦	Tree height	20 m
⑧	Volume of a stand per ha	140 m^3
⑨	Total volume of a stand	1134 m^3
⑩	Land descriptions	

As indicated in the map of felling compartment, this sub-compartment is divided into two parts by the stream flowing from north-east to south-west.

The north-west side of the stream is almost the slope facing to the south-east and the steepest part of it is as great as about 30 degrees at the south-east part.

North-east part is the sloped ground facing to the south and it is the gentle slope of 5 to 6 degrees.

South-east side of the stream is almost the sloped ground facing to south-west or south and the inclination is 11 to 18 degrees.

Fig 3 (1) Map of felling sub-compartment "70 m"

Felling area	8.1 ha
Species and tree age	Merkusii pine 24 years
Volume of a stand per ha	140 m³
Total volume of a stand	1134 m³

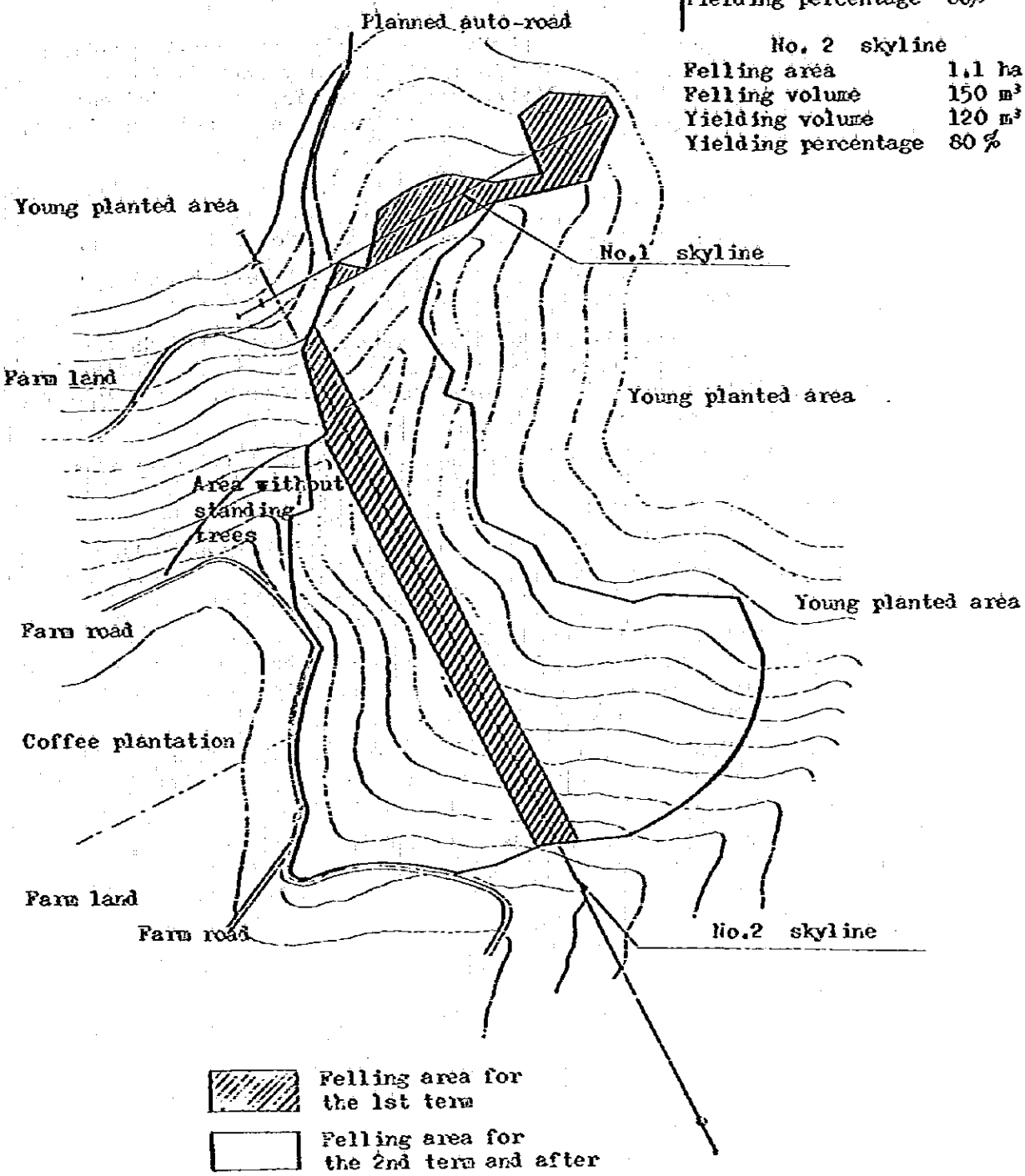
S = 1/4000

No. 1 skyline

Felling area	0.61 ha
Felling volume	90 m³
Yielding volume	72 m³
Yielding percentage	80%

No. 2 skyline

Felling area	1.1 ha
Felling volume	150 m³
Yielding volume	120 m³
Yielding percentage	80 %



(2) Principle of the training

① Location of skyline

Repeated training is necessary to increase the effect of training and considering the term length of the training, we planned to set two skyline, long and short.

That is, No.1 skyline is about 250 m and No. 2 is about 660 m in span.

② Skyline system

Each of these skyline is nearly horizontal yarding from the land conditions, while the yarder is 2 drums type with one endless drum, so we adopted the Endless Tyler System which is most efficient and fundamental one. (Fig 3 (2))

③ Yarding form

As for the yarding, there are 2 forms in general.

That is, ordinary log yarding and full tree-length yarding.

We considered, by the reasons as described in the following items, that the ordinary form is fit for No.1 skyline and full tree-length form is No. 2, and established the operation plan therewith.

i. In full tree-length yarding, we need two platforms in general and one is for the bucking and another is for the loading.

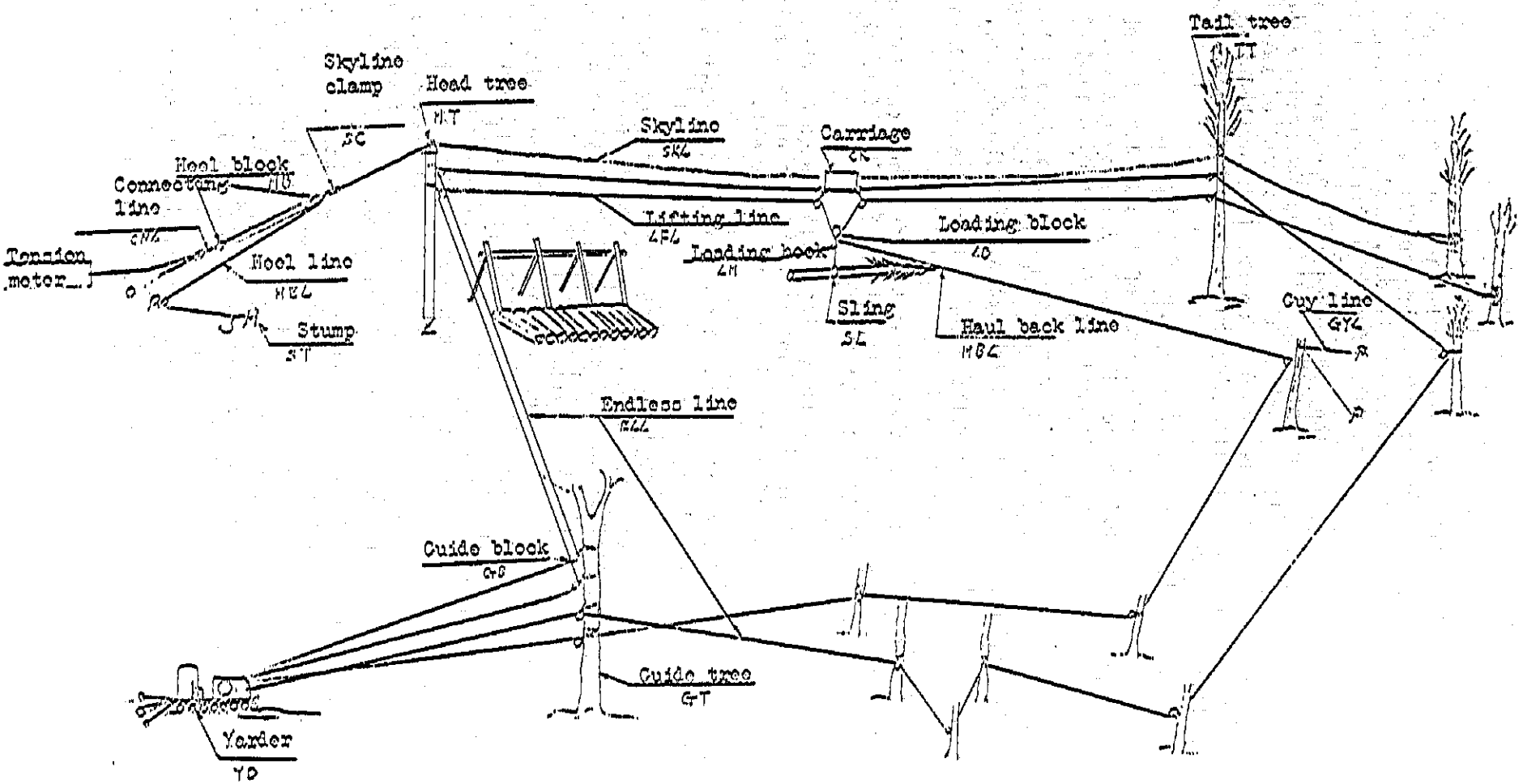
The frontage of platform becomes wider according to the tree length, resulting in the increase of area as compared with the ordinary log yarding.

Onthe other hand, in case of No.1 skyline, logs for constructing the platform will be gained after starting the yarding and it will take many days to construct the platforms.

Therefore, in order to practise the training by using two skylines in the limited term, we should force a considerable hard schedule.

ii. As for No.1 skyline, the planned yarding area, accordingly its yielding volume is small and the utility value of the platform is low compared to the labor amount.

Fig 3(2)Picture of model wiring of the endless



iii. By adopting the full tree-length yarding form for No.2 skyline, the two forms, the ordinary one and the full tree-length one, must be comprehended and this is agreeable from the standpoint of training techniques.

iv. As the platform for No.2 skyline can be previously constructed by utilizing the yarding logs of No.1 skyline prior to its commencement of yarding operation, there would be no forcing in scheduling even if full tree-length yarding is adopted in No.2 skyline.

④ Area and volume of felling

The total area of this felling sub-compartment is 8.1 ha from the boundary survey and the total volume of a stand is estimated to be 1100- - 1200 m^3.

But it is so hard to yield the total volume during the training term, that we limited the range only to deal with obstructive trees under the skyline.

The felling range is indicated with hatched lines in Fig 3 (1).

It is expected that the area and felling volume of No.1 skyline is 0.61 ha, 90 m^3 respectively and No.2 skyline is 1.1 ha, 150 m^3.

The range of the felling area of obstructive trees under the skyline is 15 m wide on each sides of the skyline and 30 m breadth after all.

⑤ Share of operations between the trainee and the worker

The trainee must sufficiently master the full range of skyline yarding operation during the training, and after this, must have the ability of accomplishing the operation by directing the worker.

For this, he must not only comprehend and remember the operation but also must experience the full operation by himself being in a sweat.

Therefore, as a rule, the training must be carried out under the principle of being experienced in full operations, including the one which they might not do by themselves in the future.

But the training must be carried out in the limited schedule, and the items of training would be divided into the important and not so important ones from the standpoint of training, that it is necessary to do the training efficiently by utilizing the labor of workers as possible.

From the standpoint already mentioned we made steps and schedule of the training.

(3) Steps and schedule of the training

Steps of the training on the skyline yarding are shown in Table 3 (1) .

About the sub-column of trainee in the column of personnel setup, ◎ mark indicates the items which should be executed by the trainee alone or mainly by the trainee.

O mark is the one which the trainee should once experience by themselves to get the outline of it, but the actual operations may be carried out mainly by the worker.

About the some operation which should be described in details are written in as reference.

Schedules of the training are shown in Table 3 (2) and Table 3 (3) according to each skyline.

Trainee's are shown by the arrow line and worker's by the dotted arrow line, the number of personnel required are indicated in parentheses.

(4) The labor and the cost

About the labor and the cost of the training are shown in Table 3 (4) for No.1 skyline and Table 3 (5) for No.2 skyline.

(5) Other items in carrying out the training

① In order to set up two skylines and yield the pretty good amount of stand volume in the limited term of the training, the securing of workers(including the selection of them from the standpoint of bringing up to the craftsmen in the future) and the adjustment of machines and materials etc. should be prepared perfectly, and in studying the design of skyline the field investigation and survey should be completed prior to the study and finish the design of skyline as an exercise, then carry out the schedule efficiently.

② In the latter half of the yarding operation of No.1 skyline, we must collect the logs for the platform of No.2 skyline and so at the step of felling, direct the bucking to get the long logs which are used for cross slide of full length trees.

③ The skyline yarding operations are apt to cause a serious accident by the lack of cautions, and especially the new comer has little knowledge about the wire rope and this cause the accidents frequently.

From these, especially in the demonstration forest, the education of safety for all the persons concerned including the worker, should be done strictly, namely the indication of dangerous area and the sheltering place and the well acquaintance of signals.

Table 3 (1) Steps of the training on the skyline yarding

Article	Details	Contents of operation	Personnel setup		Remarks
			Trainee	Worker	
Field investigation	Investigation of the planned forest land for yarding	Investigate the land & forest conditions and fix the timber yard, the spot of yarder. Selection of head tree, tail tree & guide tree, setting the arrangement of operating lines, and wind the tape arround the trees as the mark.	◎	○	Worker: Cut open the pedestrian road.
Survey	Survey the spot of skyline system	Survey for the anchor of head tree and the anchor of tail tree.	◎	○	Worker: Cut open the surveying spot
Design	Design of skyline	By the result of survey, fix the type of system, design and calculation of skyline and operating lines. Also, draw the load locus curve.	◎		Operation in the class room.
Checking and lubricating of instruments	(1) Check & lubricate the yarder and tools. (2) Check & lubricate the accessories. (3) Confirm the number of accessories.	(1) Check & lubricate each operating system, fuel and lubrication system and electric system. Check & lubricate the tools. (2) Check & lubricate the wire ropes, and accessories like blocks & carriage. (3) Confirm the number of accessories by the detailed list of the wiring instrument of the separate table.	◎	○	
Construction of pedestrian road		Construct the road to head tree and tail tree.		◎	Direct, beforhand, the planned route to worker.
Making the caul (wooden protector)	Preparation for caul making.	Make the cauls and rubber bands.	○	◎	Trainee learn the point of making the caul.

Article	Details	Contents of operation	Personnel setup		Remarks
			Trainee	Worker	
Transportation and setting of yarder	(1) Transporting the yarder (2) Construction of machine platform and fixing. (3) Set up the shed.	(1) Use the winding drum of the yarder, but in some case use "Tir-for" to move. (2) About the construction of machine platform, you may refer to the "Setting of yarder" of the separate leaf. (3) Set 4 pillars on four corners and make the simple roof on them. Pay attention not to disturb the sight.	◎	○	Leveling the setting spot, digging for the artificial anchor and setting up shed etc. are done by worker.
Felling operation	(1) Felling of obstructive trees under the skyline. (2) Main felling of the trees in a stand.	(1) Felling of obstructive trees under the skyline will be done within about 30 m width along the skyline. (2) Main felling volume will be the amount possible to yarding during the term of retaining the freshness.		◎	
Setting the telephone system		Setting of the telephone wiring from the yarder to the planned place of yarding.	◎		
Construction of towers.	(1) Construction of head tree. (2) Construction of tail tree.	In case of spar tree, the transportation of machines and instruments, trimming, setting of loading block, caul and rigging rope, setting of saddle block, guide blocks and guy lines, are necessary. In case of artificial tower, the transportation of it, construction of base and anchor is necessary.	◎	○	Worker should transport the tower and dig the anchor holes and leveling.
	(3) Construction of guide tree. (4) Construction of stumps for the operating line.	Trimming, transportation of machines and instruments, setting of caul, rigging rope guide block and guy line. In case of artificial one, do as the case of head and tail tree.	◎	○	Equal to the case of head tree & tail tree.

Article	Details	Contents of operation	Personnel setup		Remarks
			Trainee	Worker	
Wiring operation (Endless Tyler system)	(1) Taking around the haul back line.	(1) Taking around the lead rope. (2) Replacing the lead rope with haul back line.	◎		
	(2) Taking around the skyline and lifting line.	(1) Connect the haul back line to the skyline and take around the skyline. (2) Connect the haul back line to the lifting line and take around the lifting line.			
	(3) Fixing the skyline of tail tree side.	(1) Temporary fixing of skyline and haul back line. (2) Fixing the skyline to the anchor. (3) Connect the haul back line with lifting line and return the connecting part to the platform.			
	(4) Setting the carriage. (including the replacement of HBL & ELL)	(1) Set the carriage on the main cable. (2) Set the guide blocks, loading block and ballast to the carriage. (3) Replace the haul back line with the endless line, that is to remove the HBL from the 1st drum and wind it to the endless drum passing through the guide blocks of guide tree and head tree and set it to the carriage. Then, release the connection of HBL, LFL and fix the HBL to the carriage. (4) LFL is fixed to loading block reserving the sufficient length to fix to the tail tree.			
	(5) Setting the heel line.	(1) Set the skyline clamp to the main cable. (2) Set the skyline clamp to the heel block. (3) Taking around the heel line and its setting to the heel block. (4) Prevention for the twisting of heel line.			
	(6) Streching up the skyline.	(1) Streching up the skyline. (2) Measure the tension of skyline.			

Article	Details	Contents of operation	Personnel setup		Remarks
			Trainee	Worker	
Wiring operation (Endless Tyler system)	(7) Fixing the heel line.		◎		
	(8) Fixing the lifting line.	Shift the carriage to the tail tree side and fix the lifting line from the loading block to the stump of the tail tree side.			
	(9) Taking around of the haul back line.	Draw back the carriage near to the head tree again, fix the lead rope to the loading block or fix the lead rope and HBL together to the loading block, and carry them to the tail tree and take around the haul back line.			
Checking the wiring cable	(1) Check the main cable & operating lines. (2) Check each tower tree. (3) Check the block & carriage. (4) Check the junction. (5) Check each stump.	Check whether the wires are rubbing each other or not, and whether the operating lines are out of sheave and rubbing with the side case of blocks or not. Check the fixing part of the cable.	◎		
Trial running	Checking & adjusting	Test the skyline with no load at first and increase the load gradually to the designed load. Make additional fastening of the clip & so on of the skyline and measure the tension of skyline under the designed load.	◎		
Construction of platform	(1) Leveling the ground. (2) Setting up a scaffold.	Refer to the Fig 3 (4)-(5) and "About the operation platform".	○	◎	

Article	Details	Contents of operation	Personnel setup		Remarks
			Trainee	Worker	
Removal of skyline system	(1) Release the tension of skyline.	(1) Move the carriage near to the platform. (2) Remove the haul back line from the drum and replace it with heel line. (3) Lower the skyline together with the heel line to the ground, releasing the tension of endless line at the same time.	◎	○	Workers assist the transportation of instruments.
	(2) Removal of heel line.	(1) Wind the heel line once to the drum, then remove it from the drum and arrange it. (2) Set the haul back line to the 1st drum.			
	(3) Removal of endless line.	(1) Remove the endless line from the carriage. (2) Arrange the endless line of head tree side. (3) Wind up the endless line of tail tree side, using the endless drum and arrange it.			
	(4) Removal of skyline	(1) Remove the carriage from the skyline. (2) Release the fixing of skyline of the tail tree side. (3) Release the fixing of lifting line. (4) Connect the lifting line to the haul back line. (5) Set the taper vise to the skyline and draw up the skyline by using the lifting line and the haul back line and wind it.			
	(5) Removal of haul back line and lifting line.	(1) Remove the haul back line. (2) Remove the lifting line.			
	(6) Removal of spars.	(1) Removal of head tree. (2) Removal of tail tree. (3) Removal of guide tree. (4) Removal of guide block, etc.			
	(7) Checking and arranging the instruments.	Materials & tools are checked, arranged and stocked according to the steps.			

Table 3(2) Training schedule of No.1 skyline (Yarding the ordinary log)

( ) No. of personnel

Operation by trainee ←——→

Operation by worker ←- - - -→

Articles \ Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Field investigation	(2)																												
Survey		(2)																											
Design																													
Checking & lubricating of instrument																													
Construction of pedestrian road								(2)																					
Making the caul						(5)																							
Transportation & setting of yarder						(4)																							
Felling operation of hindrance trees etc.					3 m³/man/day (4) (Ordinary log bucking 72 m³)																								
Setting the telephone system																													
Construction of head spar							(2)																						
Construction of guide tree								(2)																					
Construction of tail tree																													
Construction of stumps																													
Wiring operation																													
Checking the wiring																													
Trial running																			(Yarding ordinary log 8 m³/day)										
Yarding operation																		(4)					(piling 2)						
Construction of platform																												(4)	
Removing operation																													

Table 3(3) Training schedule of No.2 skyline

Felling area 1.1 ha
Tree-length felling man-day 3.75 m³/man-day
Bucking & piling man-day 3 m³/man-day

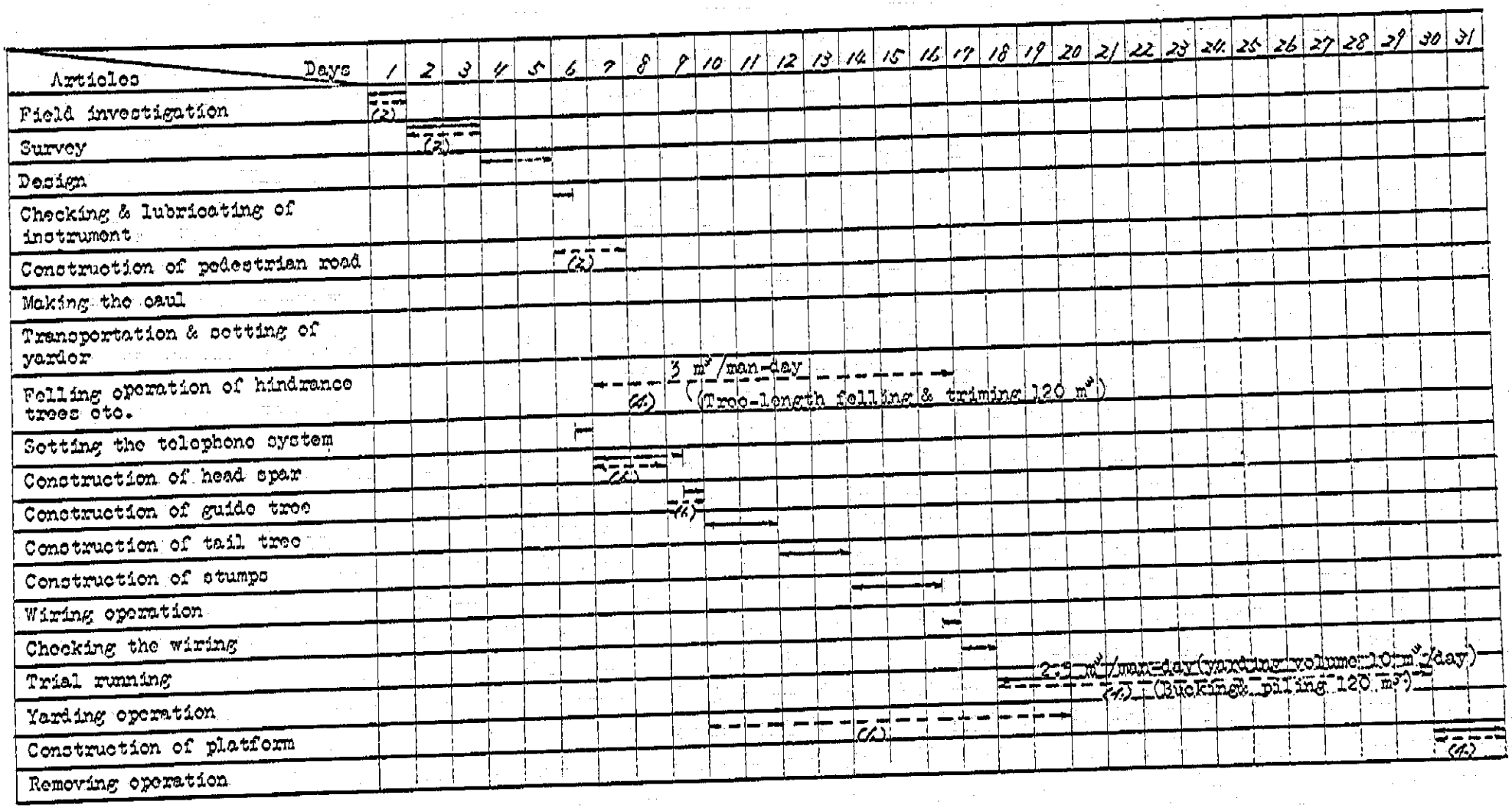


Table 3 (4) Details of the cost for No.1 skyline

Article	Executor		Item	Cost			Remarks
	Trainee	Worker		Quantity	Unit price	Price	
Field investigation.	◎	○	Labor fee	2	300	600	Cut opening of pedestrian road.
Survey.	◎	○	ditto.	2	300	600	ditto.
Construction of pedestrian road.		◎	ditto.	4	300	1,200	4 man x 2 days
Making the caul.	○	◎	ditto.	18	300	5,400	Making the caul & rubber band.
Setting of yarder.	◎	○	ditto.	8	300	2,400	Leveling and base digging of artificial anchor. Making the shed.
Felling and bucking.		◎	ditto.	36	300	10,800	Standing volume 90 m^3 logging volume 72 m^3 (yielding percentage 80 %). 2 m^3/ man-day. 72 m^3 ÷ 2 m^3 = 36 man-day.
Wiring operation.	◎	○	ditto.	20	300	6,000	Base digging of guy line anchors of artificial spar and skyline. Base digging of guy line anchor of guide tree.
Yarding operation.	◎	○	ditto.	18	300	5,400	Unloading & piling. 8 m^3/ man-day. 2 man x 9 days.
Construction of platform.	○	◎	ditto.	20	300	6,000	Leveling and removing the earth of the intended place for platform. 4 man x 5 days.
Removal operation.	◎	○	ditto.	4	300	1,200	Assistant for transporting the instrument.
Materials for constructing the platform.			Clamp.	200	50	10,000	⌀ 12 mm x 240 mm (including for No.2 platform)
			Wire	20 kg	150	3,000	Gauge No. 10 (including for No.2 platform)
Fuel of yarder.			Kerosine	180 ℓ	40	7,200	12 ℓ/ day. setting. yarding. removal. 15 days.
Lubricating oils.			Mobil oil	20 ℓ	300	6,000	Including for No.2 skyline.
			Grease	5 kg	600	3,000	ditto.
			Gear oil	5 ℓ	400	2,000	ditto.
Other materials.						10,000	ditto. Materials for the shed. Tubes for caul. # 16 gauge wire. etc.
Total.						80,800	RP

Table 3 (5). Details of the cost for No.2 skyline

Article	Executor		Items	Cost			Remarks
	Trainee	Worker		Quantity	Unit price	Price	
Investigation & survey	◎	○	Labor fee	6	300	1800	Rp
Construction of pedestian road		◎	ditto	4	300	1200	
Felling & bucking		◎	ditto	40	300	12000	1 man x 1 day = 3 m³, 120 m³ ÷ 3 m³ = 40 man-day.
Construction of platform		◎	ditto	60	300	18000	Digging, earth moving, leveling and setting up of platform.
Wiring operation	◎	○	ditto	18	300	5400	Base digging for artificial anchor etc.
Yarding operation	◎	○	ditto	48	300	14400	Bucking & piling. 1 man x 1 day = 2.53 m³. 4 men(crew) x 1 day = 10 m³, 120 m³ ÷ 10 m³ = 12 days.
Fuel for yarder			Kerosine	200 ℓ	40	8000	12 ℓ x 17 days = 200 ℓ.
Removal operation			Labor fee	8	300	2400	
Total						63200	

Details of main materials for cable yarding system
(Supporting materials)

Name	Standard or part No.	Quantity		Remarks
		#1 cable	#2 cable	
Wire rope	6 x 7 o/L Λ 24 mm	400 m	860 m	Skyline
"	6 x 19 °/o Λ 18 mm	40 m	40 m	Rigging rope of saddle block
"	6 x 19 °/o Λ 14 mm	200 m	200 m	Fixing rope of yarder, guy line rope of tower.
"	6 x 19 °/o Λ 12 mm	800 m	1400 m	#1 cable. LFL 450 m CYL 300 others 50. #2 cable, LFL 900 m CYL 400 others 100.
"	6 x 19 °/o Λ 10 mm	1600 m	3200 m	#1 cable. HBL 580 m ELL 600 MEL 300 others 120. #2 cable. HBL 1350 m ELL 1400 MEL 400 others 50.
Carriage	MCD 34	1	1	
Loading block	BLS 31 B	1	1	
Skyline clamp	BC 28	1	1	
Saddle block	MD 28 Λ	2	2	
Heel block	MH 28	2	2	
Guide block	BS 7 B	6	12	
"	MS9C	6	6	
"	BS 12 FE	2	2	
Artificial tower	K 60	6 m	8 m	

(6) Design for the model skyline

① "70 m" No.1 skyline

From the result of survey for "70 m" No.1 skyline, the design calculation sheet is made as Table 3 (6).

The main articles are as follows,

i. Type of wiring: Endless Tyler system.

ii. Horizontal distance of the span: 248 m.

iii. Height difference(at the saddle block): 4.7 m.

iv. Inclination angle: 1° 5'.

v. Main cable: 6 x 7 C/L, sort A, 24 mm.

vi. Lifting line: 6 x 19 o/o, sort A, 12 mm.

vii. Haul back line & endless line: 6 x 19 o/o, sort A, 10 mm.

viii. Sag-span ratio of original skyline: 0.03

ix. Head spar: 8 m height, artificial spar.

x. Tail tree: 10 m height, standing tree.

xi. Weight of load: Pinus Merkusii, 1.2 m^3, 1440 kg.
(specific weight: 1.2)

xii. Original form, and corrected form of the skyline at designed load: Fig 3 (3).

xiii. Location and type of the platform:
Location of platform is shown in Fig 3 (5).
Type and dimensions, etc. are shown in Fig 3 (4).

② "70 m" No.2 skyline

The design calculation sheet is made as Table 3 (7).

The main articles are as follows,

i. Type of wiring: Endless Tyler system.

ii. Horizontal distance of the span: 661.7 m.

iii. Height difference(at the saddle block): -29.3 m

iv. Inclination angle: - 2° 32'.

v. Wiring cables, used: Same to No.1 skyline.

vi. Sag-span ratio of original skyline: 0.035

vii. Head spar: 8 m height, artificial spar.

viii. Tail tree: 6 m height, standing tree.

ix. Weight of load: Pinus Merkusii, 1 m^3, 1200 kg.

x. Original form, and corrected form of the skyline at designed load: Fig 3 (6).

xi. Location and type of the platform:
Location of platform is shown in Fig 3 (5).
Type and dimensions, etc. are shown in Fig 3 (7).

Table 3 (6) Design Sheet of Skyline for Yarding: " 70 m " No.1 skyline

1. Fundamental terms (Type of wiring system: Endless Tyler System)

Span

(1) Horizontal distance of the span	(2) Inclination angle of the span	(3) Oblique distance	(4) Height difference	(5) Sag-span ratio of original skyline
ℓ_0 = 248 m	α = 1° 5′	ℓ = 248 m	h = 4.7 m	s_0 = 0.03

Wire rope

Uses	Construction of rope	Rope diameter	(6) Guaranteed breaking force	(7) Weight of rope per meter	(8) Weight (7) x (3)
Skyline	6 x 7 C/L, Λ	24 mm	B = 34900 kg	P = 2.14 /	W = 531 kg
Lifting line	6 x 19 %, Λ	12 mm	B_1' = 7920 kg	P_1' = 0.526 /	W_1' = 130 kg
Haul back line Endless line	6 x 19 %, Λ	10 mm	B_2' = 5500 kg	P_2' = 0.364 /	W_2' = 90 kg

Load

(9) Weight of load P	Weight of empty carriage P	Impact load coefficient I	Weight of operating line W + W	(10) Weight of the carriage load (designed) P
(1440 kg + 245 kg) x (1 + 0.2) + 133 kg = 2155 kg				

(11) Displacement of the supporting point $\Delta\ell$ = (0.12) m

(12) Displacement ratio of the supporting point $\Delta d = \Delta\ell/\ell$ = (0.0005)

11. Caluculation of the safety factor of skyline

(13)	Total load	$\overset{(6)}{(}\ W + \overset{(11)}{P}\ )$		= 2686 kg
(14)	Load ratio	n	$= {}^{(m)}P\ /\ W^{(n)}$	= 4.06
(15)	Equivalent coefficient of sag-span ratio	Z_1	$= \dfrac{1+n}{\sqrt{1+3n+3n^2}}$	= 0.6395

(16)	Corrected sag-span ratio	s	$= \overset{(5)}{s_0} \times \overset{(21)}{\varepsilon}$		Corrected value = 0.048
(17)	Equivalent sag-span ratio	s_1	$= \overset{(18)}{Z_1} \times \overset{(5)}{s_0}$ or $\overset{(18)}{Z_1} \times \overset{(16)}{s}$	= 0.0192	" " = 0.0307
(18)	Coefficient of maximum tension	ψ_1	$= \dfrac{\sqrt{1+(4s_1+\tan\alpha)^2}}{8s_1}$	6.54	" " = 4.11
(19)	Maximum tension	T_1	$= \overset{(13)}{(W+P)} \cdot \overset{(18)}{\psi_1}$	= 17556 kg	" " = 11039 kg
(20)	Safety factor	N	$= \overset{(6)}{B} / \overset{(19)}{T_1}$	= 1.98	" " = 3.16≧2.7

(21) Calculation of the correcting coefficient.

This calculation should be done when the value of the safety factor N, which is derived as the result of the calculation (1) - (10) & (13) - (20), come out to be less than 2.7

Wire tension of no load	Coefficient of maximum tension	ψ_0	$= \dfrac{\sqrt{1+(4s_0+\tan\alpha)^2}}{8s_0}$	4.21
	Maximum tension	T_0	$= \overset{(13)}{W} \times \psi_0$	= 2236 kg
Wire tension with load (non corrected)	Equivalent sag-span ratio	s_1	$= \overset{(18)}{Z_1} \times \overset{(5)}{s_0}$	= 0.0192
	Coefficient of maximum tension	ψ_1	Same as (18)	6.54
	Maximum tension	T_1	$= \overset{(13)}{(W+P)} \cdot \psi_1$	= 17556 kg
	Difference of tension	T_d	$= T_1 - T_0$	= 15330 kg
Elastic elongation ratio	For 1 ton of tension	λ	Refer to "Wire rope table"	0.00042/t
	Elastic elongation	Δe	$= \lambda \times T_d$	= 0.00643
Coefficient of correction	For elastic elongation	ε_e	$= \dfrac{1}{2}\left\{1+\sqrt{1+\left(1-\dfrac{s^2}{8s_0^2\cos^2\alpha}\right)\Delta e}\right\}$	1.46
	For displacement of supporting point	ε_d	$= \sqrt{\dfrac{1+\dfrac{s^2}{8s_0^2\cos^2\alpha}\Delta d}{1-\Delta d}}$	1.1
	Over-all	ε	$= \varepsilon_e \times \varepsilon_d$	= (1.60) ⟶ (16)

III. Calculation of the safety factor of operating lines.

(a) Lifting line (Hoisting line, haul back line of Falling Block system)

(22)	Maximum lifting stroke	h_1		30 m
(23)	Load on loading block	P_l	Weight of logs, loading block and ballast.	1546 kg 366 " 1912 kg

* In case the haul back line is fixed to the loading block, the resultant force of above calculated one and the tension of haul back line should be used. In this case, we must calculate the tension of haul back line prior to (a).

(24)	Number of ply of the lifting line	n_o		2
(25)	Maximum tension	T_1'	$= P_l / n_o + P_l' h'$	972 kg
(26)	Safety factor	N	$= B_1' / T_1'$	$8.1 \geqq 6.0$

(b) Haul back line or endless line

(1) Load pulling force: TP

Coefficient of load pulling force: $(\sin\beta)$
(if apply the value of $\sin\alpha$ instead of $\sin\beta$, increase it as (30)'.)

(27)	SB	$= 0.8 \times s$	0.0348
(27)'	SB	$= (1 + 2n) \times s$	

(When the carriage can approach to the upper supporting point within 10-% of span, use (27)'.)

(28)	Coefficient of load pulling force	$\sin\beta$	SB	0.17
(29)	Load	P	(10)	2155 kg
(30)	Load pulling force	TP	$= P \times (\sin\beta)$	= 366 kg
(30)'	Replaced by $\sin\alpha$	TP	$= P \times (\sin\alpha \times 1.4)$	=

(ii) Fundamental tension of endless line: To

(Needless for other system than Endless Tyler System)

(31)	Fundamental sag-span ratio	α'	$= {}^{(11)}\varepsilon \times (1.2 - 1.3)$	= 0.058
(32)	Coefficient of maximum tension	ψ_o'	$= \frac{\sqrt{1 + (4\varepsilon' + \tan\alpha)^2}}{8\varepsilon'}$	2.22
(33)	Fundamental tension	T_o'	$= {}^{(8)}W_2' \times \psi_o'$	= 200 kg

(iii) Maximum tensions.

(34)	Haul back line, Tyler system	T_2'	$= {}^{(30)}TP \times 1.4$	= 512 kg
	Endless line, Endless Tyler system	T_3'	$= {}^{(29)}TP + T_o' {}^{(33)}$	= 566 kg
	Falling Block system	T_3'	$= {}^{(28)}TP + T_1' {}^{(27)}$	=
	Endless system	T_2'	$= {}^{(27)}TP + T_1' {}^{(27)}$	=
(35)	Safety factor	N	$= {}^{(6)}B_2' / T_2'$	Haul back line: 10.7 ≧4.0 Endless line: 9.7
	For the endless line of Endless system			≧6.0

(10) Details of the weight of the carriage load (Designed).

Item		Maker's standard	Quantity	Unit weight	Weight	Remarks
Carriage	PC	BCD - 34	1	113 kg	113 kg	
Guide block	PC	BS 9	2	10	20	
Loading block	PC	BLA 31 B	1	36	36	
Loading hook	PC					
Ballast	PC	MB - 70 S	1	70	70	
Sling & etc.	PC				6	PC: sub-total 245 kg
Lifting line	W_1'	$\frac{1}{2} W_1'$			65	
Haul line	W_2'					
Haul back line	W_2'	$\frac{1}{2} W_2'$			23	
Endless line	W_2'	$\frac{1}{2} W_2'$			45	W_1' & W_2': 133 kg
Loading weight	P_o	Pinus Merkusii	1.2 m^3	1200	1440	
Total: P					1818 kg	

Remarks:

1. In the column " Type of wiring system " of the fundamental terms I, write the name of system like Tyler, Endless Tyler, Falling block, Endless or Snapping etc.

2. In the column " Construction of rope " of wire rope of the fundamental terms I, write like " 6 x 7, C/L. A ".

3. " Impact load coefficient I " in the column of load of the fundamental terms I, need not fill up when calculated without correction, but if calculate with correction, take I = 0.2 ~ 0.3

4. As for the "Displacement ratio of the supporting point Δd (12), if the displacement $\Delta \ell$ at the supporting point is difficult to measure, use the value $\Delta d \leq 1/2000$.

5. Defining the length of the operating lines to calculate their weights, refer to the following standard.

   Tyler system: $W' = \frac{1}{2} W_1' + \frac{1}{2} W_2'$ Endless Tyler system: $W' = \frac{1}{2} W_1' + \frac{1}{2} W_2'$

   Falling block system: $W' = \frac{1}{2} W_1 + \frac{1}{2} W_2'$ Endless system: $W' = \frac{1}{2} W_2'$

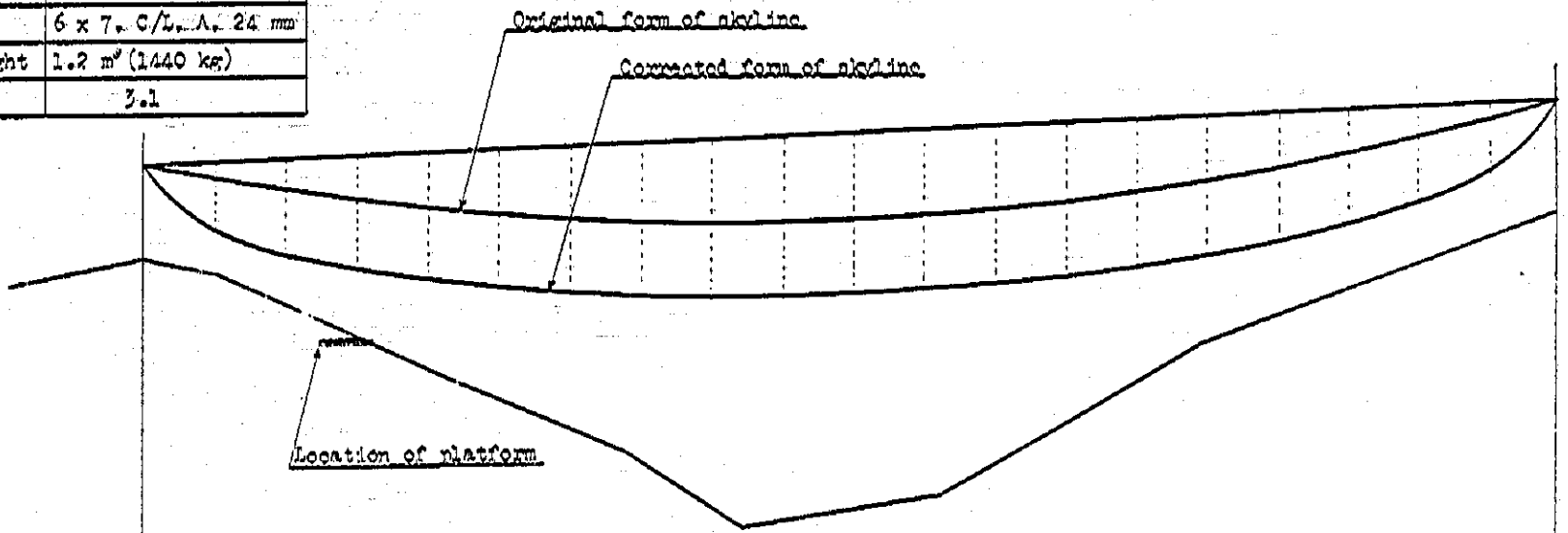
   Snapping system: $W' = \frac{1}{2} W_1'$

6. About the Falling block system & Endless system, when the haul back line is fixed to the loading block, the value (34) T_2' should use the upper line value of (23) P_2.

Fig 3 (3) Original form of skyline and load locus curve of " 70 m " No.1 skyline

Horizontal distance: S = 1/1000
Vertical distance: S = 1/500

Horizontal distance	248 m
Inclination angle	1° 5′
Central sag-span ratio	0.0%
Main cable	6 x 7, C/L, A, 24 mm
Maximum loading weight	1.2 m³ (1440 kg)
Safety factor	3.1



Distance coefficient	k_x	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
Horizontal distance	x	12.4	24.8	37.2	49.6	62.0	74.4	86.8	99.2	111.6	124.0	136.4	148.8	161.2	173.6	186.0	198.4	210.8	223.2	235.6
Form coefficient	η_x	0.19	0.34	0.51	0.64	0.75	0.86	0.91	0.96	0.99	1.0	0.99	0.96	0.91	0.84	0.75	0.66	0.54	0.36	0.19
Original form	f_x	1.61	2.68	3.39	4.24	5.08	6.25	6.77	7.16	7.37	7.47	7.37	7.16	6.77	6.25	5.08	4.24	3.39	2.68	1.61
Sag increase coefficient	γ	2.56	1.89	1.60	1.45	1.33	1.24	1.21	1.18	1.16	1.15	1.16	1.18	1.21	1.26	1.33	1.43	1.60	1.89	2.56
Load locus curve	f_D	3.41	3.07	2.84	2.81	2.62	2.58	2.49	2.43	2.55	2.55	2.55	2.43	2.49	2.58	2.62	2.81	2.84	3.07	3.41
Coefficient of correction	ε	1.66																		
Corrected form	f'_D	5.78	8.11	7.70	12.30	11.87	12.41	12.10	12.49	12.65	12.70	12.65	12.49	12.10	12.41	11.87	10.70	7.70	8.11	5.78
Span	l_0	248 m																		

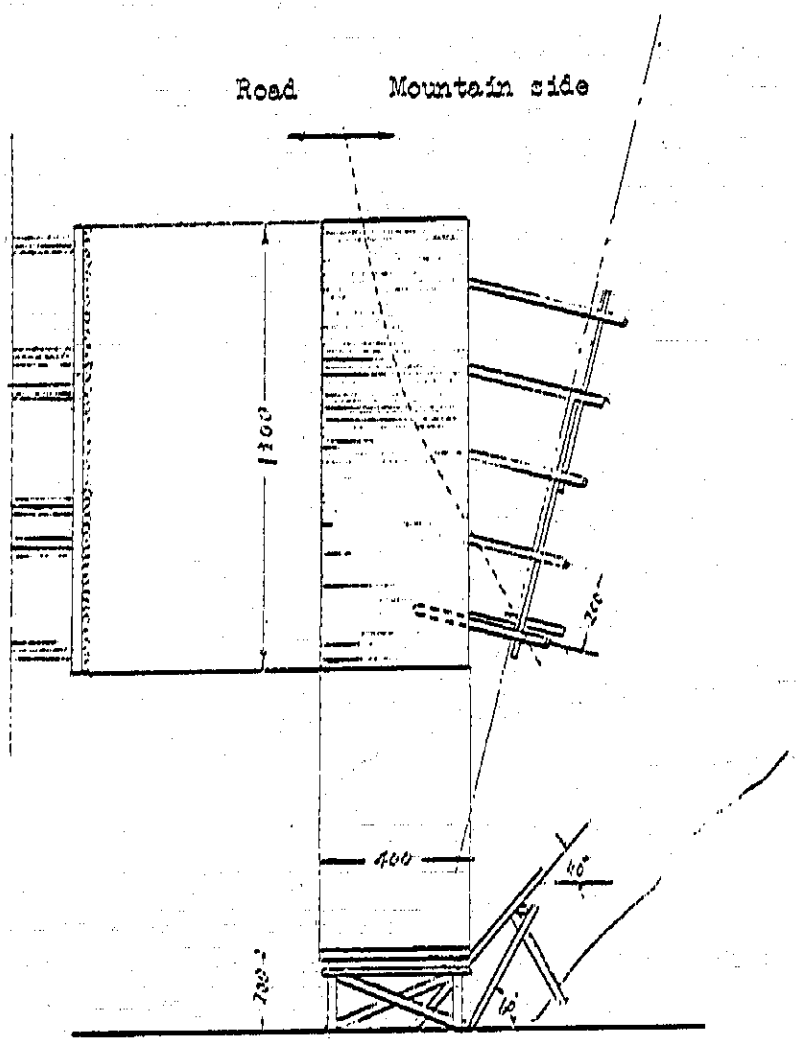


Fig 3 (4) Platform of NO.1 skyline

$S = \frac{1}{200}$

Type: Single step platform with skid.
(Scaffold construction)

Area: 4 m x 12 m = 48 m^2

Logs for use: 15 m^3

Labor amount.(including Trainee): 27 man- day

Fig 3 (5) "70 m" Location of facilities

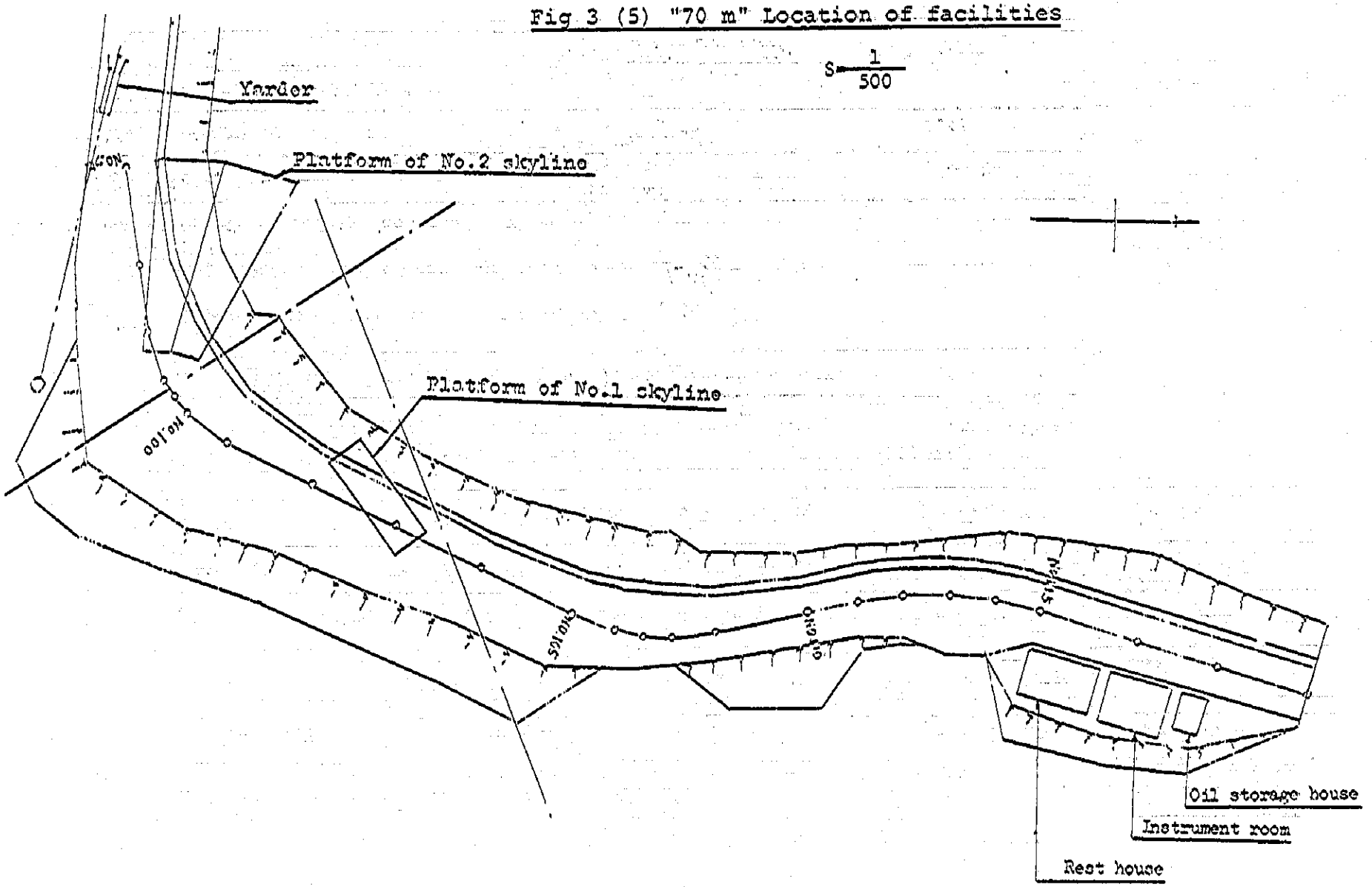


Table 3 (7) Design Sheet of Skyline for Yarding: " 70 m " No.2 skyline

1. Fundamental terms (Type of wiring system: Endless Tyler System)

Span

(1) Horizontal distance of the span	(2) Inclination angle of the span	(3) Oblique distance	(4) Height difference	(5) Sag-span ratio of original skyline
l_0 = 661.7 m	α = - 2° 32′	l = 662.3 m	h = - 29.3 m	s_0 = 0.035

Wire rope

Uses	Construction of rope	Rope diameter	(6) Guaranteed breaking force	(7) Weight of rope per meter	(8) Weight (7) x (3)
Skyline	6 x 7 $^{C}/_{L}$. A	24 mm	B = 34900 kg	P = 2.14 /	W = 1417 kg
Lifting line	6 x 19 $^{O}/_{O}$. A	12 mm	B_1' = 7920 kg	P_1' = 0.526 /	W_1' = 348 kg
Haul back line Endless line	6 x 19 $^{O}/_{O}$, A	10 mm	B_2' = 5500 kg	P_2' = 0.364 /	W_2' = 241 kg

Load

(9) Weight of load P	Weight of empty carriage P	Impact load coefficient I	Weight of operating line W + W	(10) Weight of the carriage load (designed) P
(1200 kg + 245 kg) x (1 + 0.2) + 355 kg = 2089 kg				

(11) Displacement of the supporting point Δl = (0.330) m

(12) Displacement ratio of the supporting point $\Delta d = \Delta l / l$ = (0.0005)

II. Caluculation of the safety factor of skyline

(13)	Total load		$(W + P)^{(8)\ (10)}$	= 3506 kg
(14)	Load ratio	n	$= P^{(10)} / W^{(8)}$	= 1.47
(15)	Equivalent coefficient of sag-span ratio	Z_1	$= \frac{1+n}{\sqrt{1+3n+3n^2}}$	= 0.7162

(16)	Corrected sag-span ratio	s	$= s_0 \times \varepsilon$ (5) (21)		Corrected value = 0.049
(17)	Equivalent sag-span ratio	s_1	$= Z_1 \times s_0$ or $Z_1 \times s$ (15) (5) (15) (16)	= 0.025	" " = 0.035
(18)	Coefficient of maximum tension	ψ_1	$= \frac{\sqrt{1+(4s_1+\tan\alpha)^2}}{8 s_1}$	5.05	" " = 3.63
(19)	Maximum tension	T_1	$= (W+P) \cdot \psi_1$ (13) (18)	= 17705 kg	" " = 12727 kg
(20)	Safety factor	N	$= B / T_1$ (4) (19)	= 1.97	" " = 2.74 ≧ 2.7

(21) Calculation of the correcting coefficient.

This calculation should be done when the value of the safety factor N, which is derived as the result of the calculation (1) - (10) & (13) - (20), come out to be less than 2.7

Wire tension of no load	Coefficient of maximum tension	ψ_0	$= \frac{\sqrt{1+(4s_0+\tan\alpha)^2}}{8 s_0}$	3.63
	Maximum tension	T_0	$= W \times \psi_0$ (5)	= 5144 kg
Wire tension with load (non corrected)	Equivalent sag-span ratio	s_1	$= Z_1 \times s_0$ (15) (5)	= 0.025
	Coefficient of maximum tension	ψ_1	Same as (18)	5.05
	Maximum tension	T_1	$= (W+P) \cdot \psi_1$ (13)	= 17705 kg
	Difference of tension	T_d	$= T_1 - T_0$	= 12561 kg
Elastic elongation ratio	Per 1 ton of tension	λ	Refer to "Wire rope table"	0.00042/ t
	Elastic elongation	Δe	$= \lambda \times T_d$	= 0.00527
Coefficient of correction	For elastic elongation	εe	$= \frac{1}{2}\left\{1+\sqrt{1-(1+\frac{s}{8 s_0 \cdot \cos\alpha})\Delta e}\right\}$	1.31
	For displacement of supporting point	εd	$= \sqrt{\frac{1+\frac{s}{8 s_0 \cdot \cos\alpha}\Delta d}{1-\Delta d}}$	1.07
	Over-all	ε	$= \varepsilon e \times \varepsilon d$	= (1.40) ⟶ (16)

III. Calculation of the safety factor of operating lines.

(a) Lifting line (Hoisting line, haul back line of Falling Block system)

(22)	Maximum lifting stroke	h_1		80 m
(23)	Load on loading block	P_ℓ	Weight of logs, loading block and ballast.	1312 kg 407 〃 1719 kg

* In case the haul back line is fixed to the loading block, the resultant force of above calculated one and the tension of haul back line should be used. In this case, we must calculate the tension of haul back line prior to (a).

(24)	Number of ply of the lifting line	n_o		2
(25)	Maximum tension	T_1'	$= P_\ell / n_o + P_j' h'$	902 kg
(26)	Safety factor	N	$= B_1' / T_1'$	8.7 ≧ 6.0

(b) Haul back line or endless line

(i) Load pulling force: TP

Coefficient of load pulling force: $(\sin\beta)$
(if apply the value of $\sin\alpha$ instead of $\sin\beta$, increase it as (30)'.)

(27)	SB	$= 0.8 \times s$	0.039
(27)'	SB	$= (1 + 2n) \times s$	

(When the carriage can approach to the upper supporting point within 10 % of span, use (27)'.)

(28)	Coefficient of load pulling force	$\sin\beta$	SB	0.195
(29)	Load	P	(10)	2088 kg
(30)	Load pulling force	TP	$= P \times (\sin\beta)$	= 407 kg
(30)'	Replaced by $\sin\alpha$	TP	$= P \times (\sin\alpha \times 1.4)$	=

(ii) Fundamental tension of endless line: To

(Needless for other system than Endless Tyler System)

(31)	Fundamental sag-span ratio	δ'	$= {}^{(11)}s \times (1.2 - 1.3)$	= 0.059
(32)	Coefficient of maximum tension	ψ_o'	$= \frac{\sqrt{1 + (a.s' + \tan\alpha)^2}}{8s'}$	2.2
(33)	Fundamental tension	To	$= {}^{(9)}W_2' \times \psi_o'$	= 530 kg

(iii) Maximum tensions.

(34)	Haul back line, Tyler system	T_1'	$= {}^{(m)}TP \times 1.4$	= 570 kg
	Endless line, Endless Tyler system	T_2'	$= {}^{(m)}TP + To^{(33)}$	= 937 kg
	Falling Block system	T_2'	$= {}^{(m)}TP + T_1'^{(2E)}$	=
	Endless system	T_2'	$= {}^{(m)}TP + T_1'^{(2E)}$	=
(35)	Safety factor	N	$= {}^{(2)}B_2' / T_2'$	Haul back line: 9.6 Endless line: 5.8 $\geqq$ 4.0
	For the endless line of Endless system			$\geqq$ 6.0

(10) Details of the weight of the carriage load (Designed).

Item		Maker's standard	Quantity	Unit weight	Weight	Remarks
Carriage	PC	BCD - 34	1	113 kg	113 kg	
Guide block	PC	BS 9	2	10	20	
Loading block	PC	BLA 31 B	1	36	36	
Loading hook	PC					
Ballast	PC	MB - 70 S	1	70	70	
Sling & etc.	PC				6	PC: sub-total 245 kg
Lifting line	W_1'	$\frac{1}{2} W_1'$			174	
Haul line	W_2'					
Haul back line	W_2'	$\frac{1}{2} W_2'$			60	
Endless line	W_2'	$\frac{1}{2} W_2'$			121	W_1' & W_2': 355 kg
Loading weight	P_o	Pinus Merkusii	1.0 m^3	1200	1200	
Total: P					1799 kg	

Remarks:

1. In the column " Type of wiring system " of the fundamental terms I. write the name of system like Tyler. Endless Tyler. Falling block. Endless or Snapping etc.

2. In the column " Construction of rope " of wire rope of the fundamental terms I. write like " 6 x 7. C/L. A ".

3. " Impact load coefficient I " in the column of load of the fundamental terms I. need not fill up when calculated without correction. but if calculate with correction. take I = 0.2 - 0.3

4. As for the "Displacement ratio of the supporting point Δd (12), if the displacement Δl at the supporting point is difficult to measure. use the value $\Delta d \leq 1/2000$.

5. Defining the length of the operating lines to calculate their weights, refer to the following standard.

   Tyler system: $W' = \frac{1}{2} W_1' + \frac{1}{4} W_2'$ Endless Tylor system: $W' = \frac{1}{2} W_1' + \frac{1}{2} W_2'$

   Falling block system: $W' = \frac{1}{2} W_1' + \frac{1}{2} W_2'$ Endless system: $W' = \frac{1}{2} W_1'$

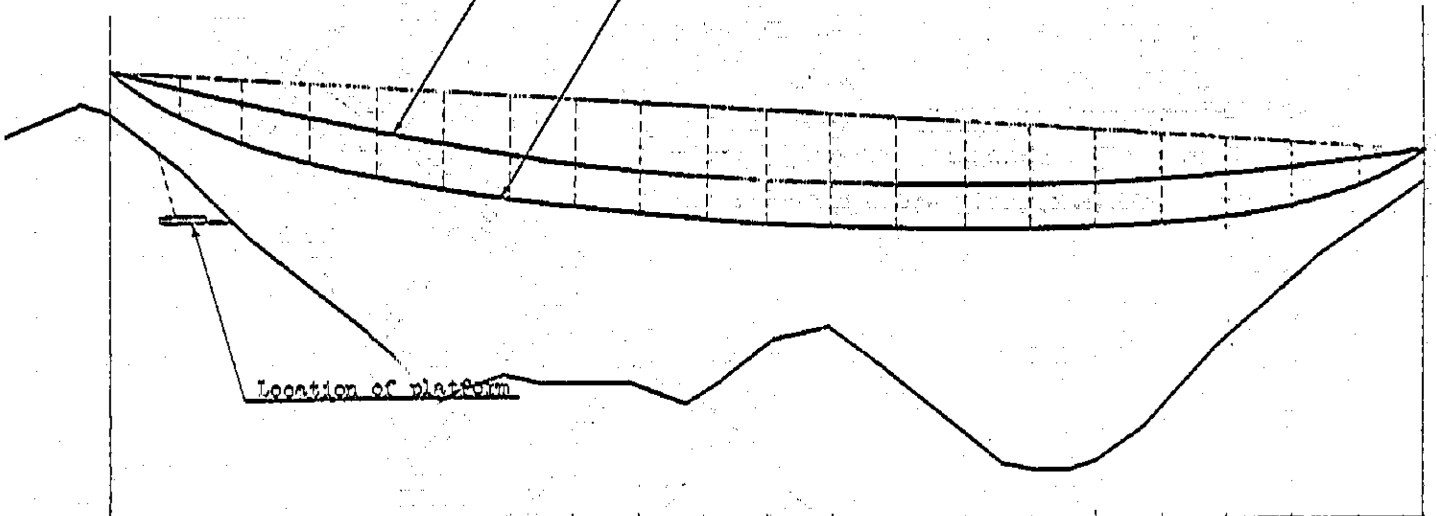
   Snapping system: $W' = \frac{1}{2} W_1'$

6. About the Falling block system & Endless system. when the haul back line is fixed to the loading block. the value (34) T_2' should use the upper line value of (23) P_2.

Fig 3 (6). Original form of skyline and load locus curve of " 70 m " No. 2 skyline

Horizontal distance	661.7 m
Inclination angle	- 2° 32′
Central sag-span ratio	0.035
Main cable	6 x 7, o/Z, A, 24 mm
Maximum loading weight	1 m^3 (1200 kg)
Safety factor	2.74

Horizontal distance: S = 1/3000
Vertical distance: S = 1/2000

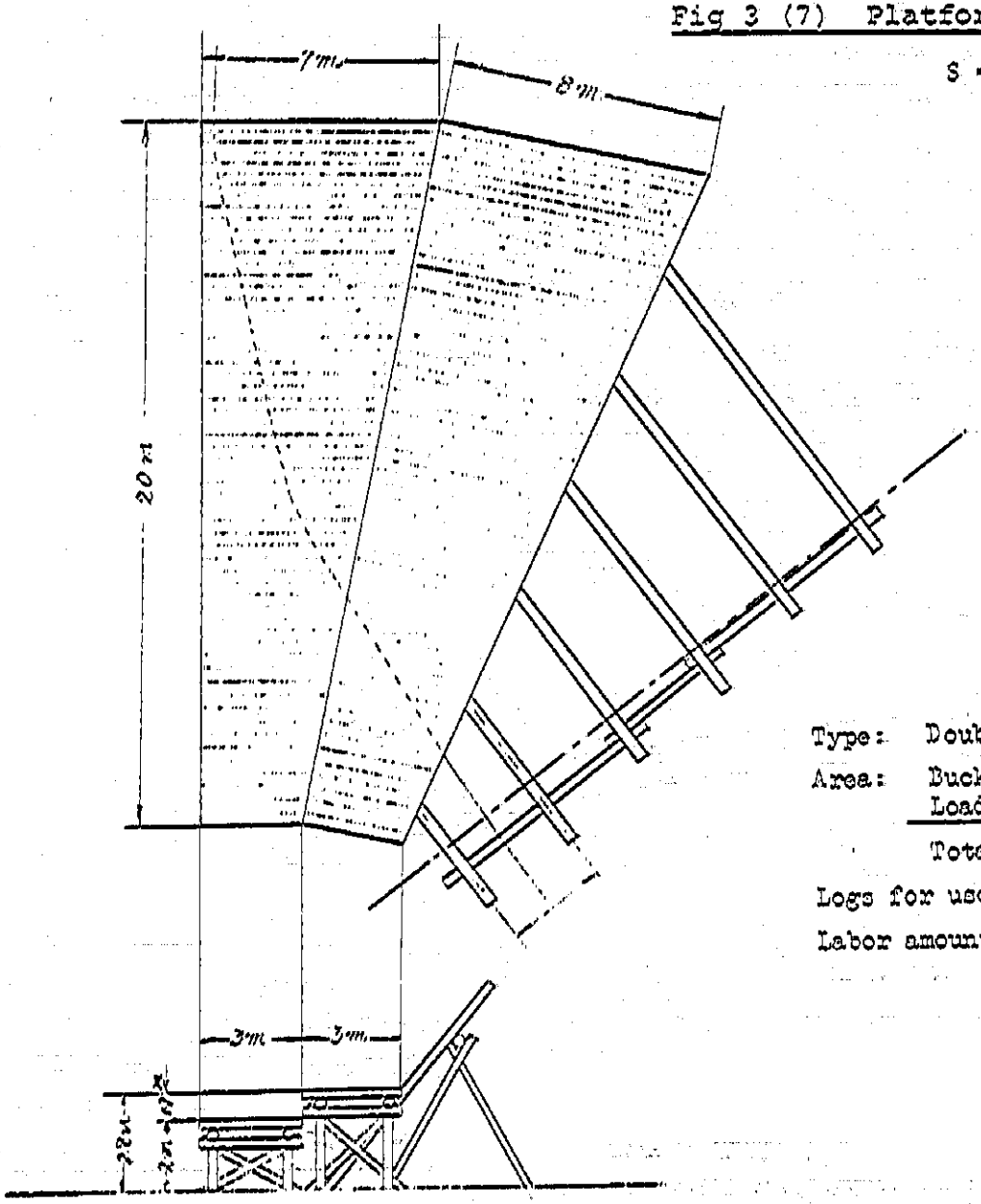


Distance coefficient	k	0.05	0.1	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50
Horizontal distance	x	33.1	66.2	99.3	132.3	165.4	198.5	231.6	264.7	297.8	330.9
Form coefficient	m	0.19	0.36	0.51	0.64	0.75	0.84	0.91	0.96	0.99	1.0
Original form	f_x	4.40	8.36	11.81	14.82	17.37	19.45	21.08	22.23	22.93	23.16
Sag increase coefficient	r	2.25	1.78	1.54	1.40	1.30	1.24	1.17	1.16	1.15	1.14
Load locus curve	f_D	9.90	14.88	18.19	20.75	22.58	24.12	25.09	25.79	26.37	26.40
Coefficient of correction	ε										1.40
Corrected form	f'_D	13.86	20.79	25.47	28.51	31.61	33.77	35.13	36.11	36.92	36.96
Span	l_0										661.7 m

Distance coefficient	k	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
Horizontal distance	x	363.9	397.0	430.1	463.2	496.3	529.4	562.4	595.5	628.6
Form coefficient	m	0.99	0.96	0.91	0.84	0.75	0.64	0.51	0.36	0.19
Original form	f_x	22.93	22.23	21.08	19.45	17.37	14.82	11.81	8.36	4.40
Sag increase coefficient	r	1.15	1.16	1.19	1.24	1.30	1.40	1.54	1.78	2.25
Load locus curve	f_D	26.37	25.79	25.07	24.12	22.58	20.75	18.19	14.85	9.90
Coefficient of correction	ε									
Corrected form	f'_D	36.92	36.11	35.13	33.77	31.61	28.81	25.47	20.79	13.86
Span	l_0									

Fig 3 (7) Platform of No.2 skyline

$S = \frac{1}{200}$



Type:	Double step platform with skid.	
Area:	Bucking platform	112 m²
	Loading platform	100 m²
	Total	212 m²
Logs for use:		51 m³
Labor amount:		60 man-day

(Reference)

About the Operation Platform

In case of yarding by skyline or tractor, operation platform is constructed at the last point of yarding operation. Whether they are full tree length or whole tree, felled trees are bucked to the prescrited length on the operation platform, in general, and they are loaded on the truck from here.

As the material for the platform, we use the log in producing and after the operation is finished they are removed, but the value of logs as the merchandise extremely decrease. Therefore, too ample one is uneconomical but too narrow one lower the efficiency of operation.

As the platform, there are simple single step one, and with the "skip", bucking platform or loading platform ones.

The "skid" is set in order to collide the logs carried by yarder to this, change their directions and then let them fall to the platform beneath them. With this, the danger of platform operation just beneath the skyline is avoided.

The dimension of bucking platform is decided by the length of full tree length to be carried. For instance, in case of 20 m long of full tree length, the width of the bucking platform should be 22 m adding 2 m to the log length, and the depth should be half of the width.

As for the loading platform, the dimensions should be changed according to the size of the truck.

For calculation of the necessary area, it is sufficient when the logs for one truck is placed in one layer within this, and the results are as following table.

In this case, to minimize the side shifting after bucking of the full tree length, the width of platform set wider, but in case of the ordinary logs, unloading spot is almost fixed that the width would be narrower and sufficient.

Area of the loading platform

Style of yarding	Sort of truck(t)	Width(m)	Depth(m)	Area(m^2)
Full tree length	4	22	2.7	60
	6	22	3.2	70
	8	22	4.0	88
Ordinary log	4	14	3.5	49
	6	14	4.7	66
	8	14	5.4	75

To calculate the labor amount for the construction of platform, there is an experimental formula as follows:

Scaffold construction: $z = 0.066x + 2.120y + 10.27$

Well crib construction: $z = 0.030x + 5.902y + 10.24$

Where, x: Area of platform (m^2)

y: Maximum height of platform (m)

z: Total labor amount (man-day)

The scaffold construction is the one, the lower part of it is set up in scaffold with the pillar, beam and stay.

The well crib construction is the one, the logs are set up in lattice.

The labor amount necessary for the removal of platform is 30 % of that of the construction.

The relation between the volume of logs to be used and its small end diameter are as follows:

Scaffolds construction: $y = 0.071 + 0.0064\ x$

Well crib construction: $y = 0.029 + 0.0111\ x$

Where, y: The volume needed for 1 m^2 of the area of platform (m^3)

x: The small end diameter of the logs used (cm)

3-1-2 Training on tractor skidding operation

As explained in 2-3 (5), the training on tractor skidding operation is to be performed in " 58 j" .

In this case, the strip road of 1000 m long from the auto-road which leads to " 58 d " to the middle of "58 j " is necessary.

We describe about the training on tractor skidding operation as follows:

(1) General description of the training site

1	Compartment for training:	"58 j"
2	Map of felling compartment:	As shown in Fig 3 (8)
3	Felling area:	8.6 ha
4	Species and age of tree:	Pinus Merkusii, 39 years old.
5	Number of standing tree:	450/ha
6	Mean diameter breast high:	34 cm
7	Mean tree height:	22 m
8	Volume of a stand per ha:	410 m^3
9	Total volume of a stand:	3526 m^3
10	land descriptions:	

As shown in Fig 3 (8), " 58 j " has a gentle slope which face to the north-east and its mean gradient is 13 degrees having easy undulation.

(Note)

According to the data presented by the Indonesian side, the volume of a stand per ha of "58 j " is 856 m^3 as from the Table 2 (1), but by surveying the forest we assumed the value as described above to be more proper.

(2) Principle of the training

① The form of skidding

As for the form of skidding, we adopted the full tree length skidding from the stand point of efficiency and safety, and planned there by it.

② Felling area & felling volume

From the restriction of the training term, we planned the felling volume as about 200 m^3. Therefore, assuming the yielding percentage as 80 %, the yielding volume will be about 160 m^3.

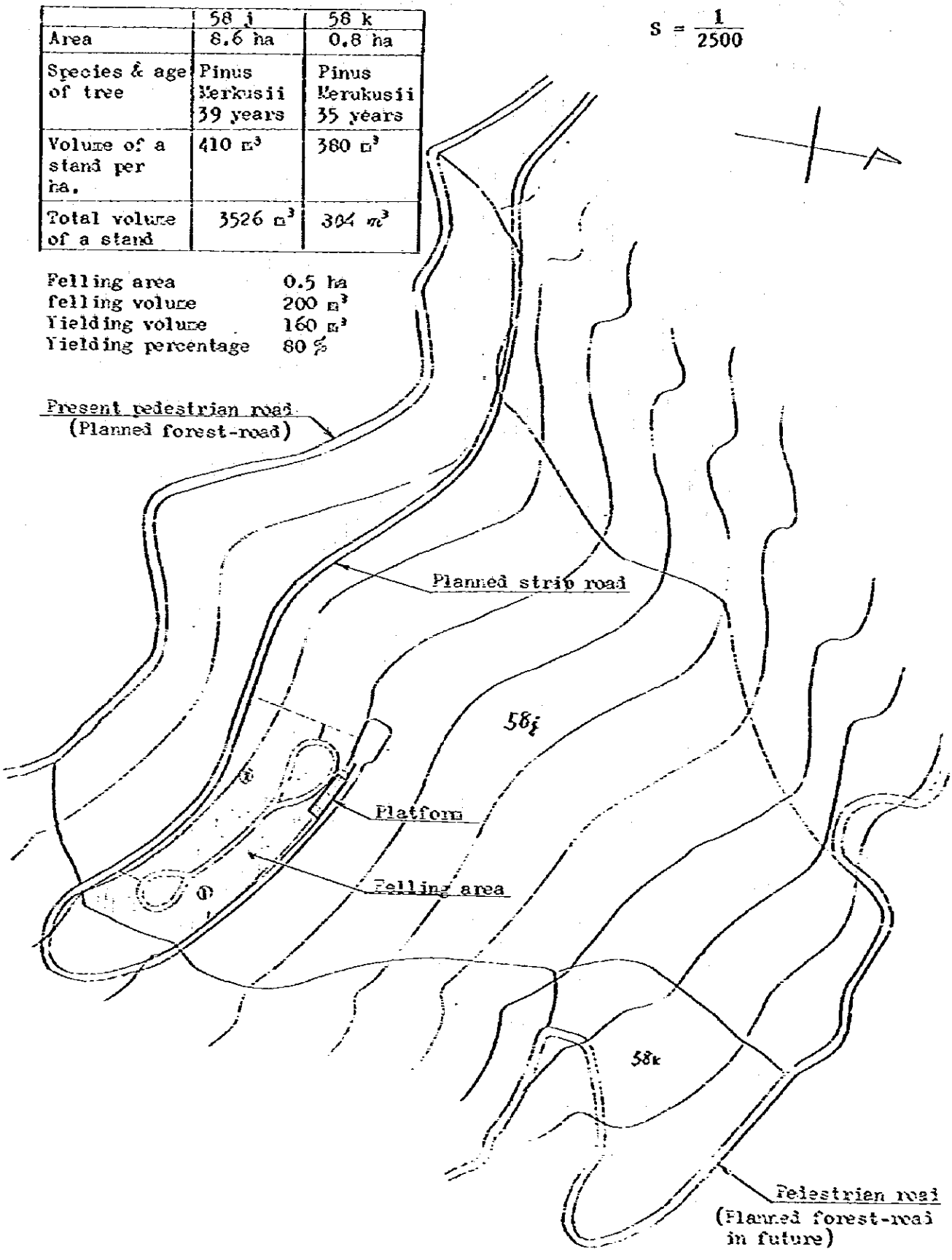
③ Construction of road for tractor skidding

Tractor skidding road should be constructed as the training of bull-dozing operation by the trainee. The width is 2.8 m - 3.0 m and about 200 m long.

Fig 3 (8) Map of the sub-compartment "k" & "j" in the 58 compartment

	58 j	58 k
Area	8.6 ha	0.8 ha
Species & age of tree	Pinus Merkusii 39 years	Pinus Merukusii 35 years
Volume of a stand per ha.	410 m³	380 m³
Total volume of a stand	3526 m³	304 m³

Felling area 0.5 ha
felling volume 200 m³
Yielding volume 160 m³
Yielding percentage 80 %



④ How to carry out the training

Necessary term for the training is about one month from the Table 3 (9). On the other hand, the training on skyline yarding takes two and a half months and therefore it seems impossible to execute the plan in 3 months from Jan. to Mar.

But as for the training on yarder operation during the skyline yarding training, all the members would not necessarily be engaged in the operation at a time and therefore utilizing this term, make the teams of 3 personnels and these teams exercise the construction of tractor skidding road and the yarder yarding operation alternatly, the training plan would possibly be carried out entirely with ease.

⑤ About the facilities

A warehouse and a fuel storage house should be prepared in "70 m".

(3) Steps and schedule of the training

The steps and schedule of the tractor skidding training is shown in Table 3 (8) & 3 (9) respectively.

About the detail, refer to the Reference " Skidding operation by tractor".

(4) The labor and the cost

The labor and the cost necessary for the training of tractor skidding is shown in Table 3 (10).

(5) Other items in carrying out the training

As the training term is in the rainy season, never precede the felling too much to make the residuals, and the tirely felling corresponding to the skidding progress is necessary.

In this case, keep the close contact of felling and skidding operations, and if possible arrange the watchman to prevent the accident without fail.

Table 3 (8) Training steps of the tractor skidding

Article A	Details	Contents of operation	Personnel setup		Remarks
			Trainee	Worker	
Field investigation	Investigation of the forest to be yarded.	(1) Affirm the felling area. (2) Decide the location of timber yard. (3) Decide the tractor skidding road. (Mark the obstructive trees by winding the tape around them.)	◎	○	Workers cut open the pedestrian road.
Felling the obstructive tree.	(1) Felling the obstructive tree on the main road of tractor skidding. (2) Felling the obstructive tree in the timber yard.	(1) For the main road of tractor skidding. the felling width is 6 m. (2) The obstructive trees in the timber yard are going to be used immediately to the construction of platform.		◎	
Construction of the tractor skidding main road		The width of the main road is 2.8 - 3.0 m. In the flat place, do not hurt the vegetation as possible. and skid the log for construction of platform at the same time.	◎		Construct by bull-dozer.
Felling and trimming	Felling the tree. (full tree length operation)	Divide the felling area into two. (1) & (2). After the felling of (1) area is finished, corresponding to the skidding progress, fell the area (2). When felling at the boundary of the skidding road, pay full attention for the safety, certifying whether the tractor is in the vicinity or not and also the signals. About the felling direction. refer to the Reference " Skidding operation by tractor ".		◎	

Article	Details	Contents of operation	Personnel setup		Remarks
			Trainee	Worker	
Skidding operation	Full tree length skidding	Snatching operation, unloading and piling operation must be executed by the trainee to master the point of operation, but if necessary, may change with the worker. Bucking operation is executed by the worker.	◎	○	
Construction of platform	Construction of the bucking and the loading platform.	Determine the height of platform according to the height of the deck of truck. See Fig 3 (9).	○	◎	

Table 3 (9) Training schedule of the tractor skidding

Article \ Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Field investigation	—																								
Felling of the hindrance tree on the skidding road in the timber yard.	3 m³ per man per day ← 4man x 4 days																								
Construction of skidding road					25 m. / day. x 8 days → (Including the skidding of logs for the construction of platform)																				
Construction of platform					4 man x 8 days (Including the bucking of logs for the construction) →																				
Felling & trimming					← 4 man x 5 days → (60 m³) ① area 3 m³ per man per day													← 4 man x 5 days → (56 m³) ② area								
Skidding operation													Skidding volume per day 12 m x 12 days (138 m³) → 4 man x 16 days (skidding and piling volume 3 m³ per man per day)												

Table 3 (10) Details of the cost for tractor skidding

Article	Executor		Items	Cost			Remarks
	Trainee	Worker		Quantity	Unit price	Price	
Felling of obstructive tree			Labor fee	16	300	4800	0.135 ha, stand vol.: 55 m^3 55 m^3 x 0.8 = 44 m^3 (yielding vol.) 2 men one team: 6 m^3, 2 teams: 12 m^3, 44 m^3 ÷ 12 m^3 ≒ 4 days.
Construction of platform			ditto.	32	300	9600	Bucking of logs for platform 22 m^3 is included. Area of platform is 96 m^2.
Felling & trimming			ditto.	40	300	12000	2 men one team: 6 m^3. 116 m^3 ÷ 12 m^3 ≒ 10 days.
Skidding operation			ditto.	48	300	14400	Skidding volume/day/machine is 12 m^3. Total volume: 138 m^3. Bucking & piling: 3 m^3/ man/day. 4 men x 12 days.
Fuel for tractor			Kerosine	500	40	20000	Construction of skidding road: 8 days. Skidding operation: 12 days. 25 ℓ/day x 20 days = 500 ℓ
Lubricating oils			Mobile oil	20	300	6000	
			Other oils			5000	
Other materials						15000	Materials for construction of platform and others.
Total						86800	RP

Note: Construction of skidding road (200 m), alike the skidding of logs for the construction of platform (22 m^3), will be executed by trainee.

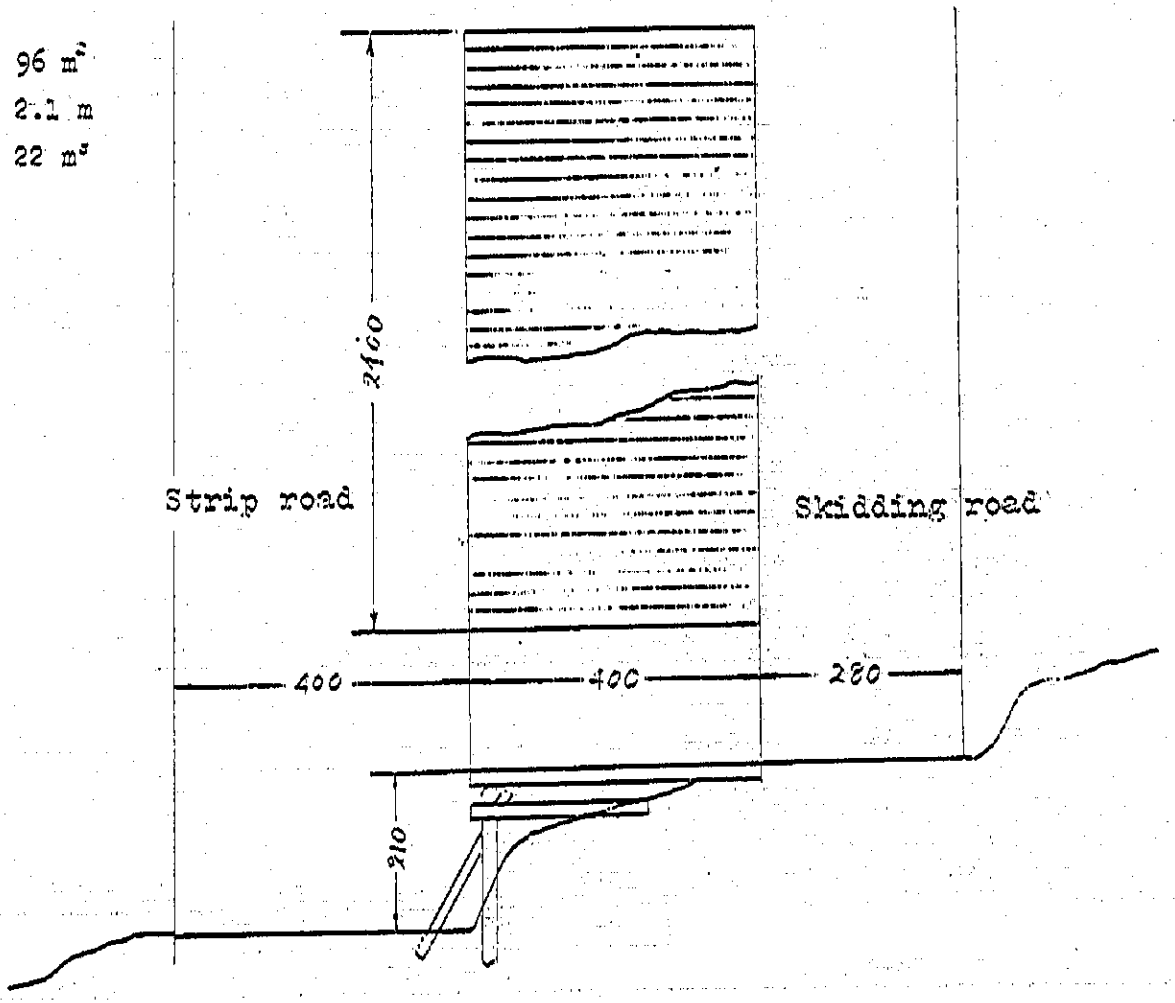
Fig 3 (9) Operation platform for tractor S = $\frac{1}{100}$

Area: 96 m²

Height: 2.1 m

Necessary volume of logs: 22 m³

(In case of using the log which has 24 cm in small end diameter: 22 m³)



(Reference) Skidding operation by tractor

1. Construction of timber yard and skidding road

To carry out the tractor skidding efficiently, we must deliberate on the construction of timber yard and skidding road.

(1) About the unloading timber yard

① To be a convinient place for the following process.

② Has an ample area considering the planned skidding volumes and pilings.

③ Able to construct the timber yard road in it to avoid the jamming of tractors in the yard. (See Fig 3(11).)

④ In case of whole-tree and full tree-length skidding, think about the place to treat the branches, the location of bucking space, and the steps of timber piling.

⑤ The timber yard road is apt to become one side cut, in general, and the entrance to the yard is apt to become steep slope. Therefore, if the road bed is soft, it often becomes muddy and the traveling of tractor becomes difficult in case of rain.

As for the prevention for these conditions, the consideration are necessary to make some ditches to drain the brook water and the rain water, especially in the vicinity of the timber yard. And in some case, we had better to prepare an auxiliary timber yard which is used only when the condition is bad like rainy day.

Further more, if the operation is stopped by rain, cover the road with Vinyl sheets to prevent the permeation of rain water and efficiently carry out the operation without troubles after the rain stopped.

As above mentioned, in the vicinity of timber yard the traveling of tractor is so frequent that the decreasing of efficiency by the muddy road is feared, and therefore the considerations upon the construction and maintenance of timber yard are important.

(2) About the construction of skidding road

The skidding road by tractor is to be considered individually as the trunk road and the branch road.

The trunk road should be decided at the step of designing the skidding plan, by considering where to set it in the felling area.

On the contrary, the branch road is constructed and extended on demand at any time in the execution of skidding operation.

We will describe, as follows, about the construction of the trunk road and the branch road following the above mentioned definitions.

① As the trunk road will do the function of the skyline in skyline yarding, it must be constructed in the place of the highest utilizing effect, considering the range of hauling by winch line.

② The trunk road has the possibility to be used as the strip road (auto road) in the future, and so it is agreeable to set it along the contour line considering the slopes and etc.

③ In case of collecting the logs by using the tractor winch, it is compairatively easy to draw up the log from the lower place as the nose of the log leaves the ground, but to draw it down from the higher place is rather difficult.

And if we set the road in the low land along the valley, it would easily become muddy by the poor drainage.

Considering all these, it is agreeable to construct the road in the dry and good drainage place, even though some of the load should be drawn up.

④ The trunk road must not have the dead end, lest the tractor should change its moving directions. (See Fig 3 (10).)

⑤ The trunk road must be constructed prior to the begining of felling.

If we begin the construction after the felling, the felled tree would disturb not only the efficient construction of it, but also the control of felling direction, resulting in the disturbance of skidding operations thereafter.

⑥ The branch road is not like the one which should be constructed beforehand as the trunk road, but is generated naturaly during the skidding operations.

After the skidding of the area, ranging to the reach of the winch (about 30 m in ordinary case)is finished, the felled trees in the farther depth are to be skidded.

For this, the tractor must necessarily go into the forest land and in this step the road is constructed for the first time.

In this case, if the ground conditions are good after skidding the felled trees, the place would become good enough for the tractor to come in and in most cases the road would be completed without dozzing operations.

The conception of the branch road is the one which allows the tractor with tracting load to go through, as the traveling frequency is not so great as the trunk road.

⑦ The range of the skidding by using the winch is within 30 m, in ideal, and not proper more than 50 m from the efficiency.

When we consider about the road density from these conditions, assuming the reach of the winch is 30 m from both the trunk road and the branch road, it will be calculated as 160 m/ha.

If the length of the felled tree is considered, skidding range will be assumed as 50 m and the density of the skidding road will be about 100 m/ha.

⑧ As a principle in constructing the skidding road, the vegetations on the surface of ground should only be cut and not be dug out roots by the dozer blade etc.

The reason is that the existence of roots of grass will greatly prevent the road surface from becoming muddy.

⑨ The width of the skidding road must be more than 1.2 times of the width of tractor tread, and at the curve it must be increased according to the log length.

⑩ The slope of the tractor skidding road is defined as follows in the "Japanese National Forest's Stanards For the Tractor Skidding Operations".

i. The limiting inclinations of the tractor logging road is 25 degrees for earth road and 15 degrees for snow road.

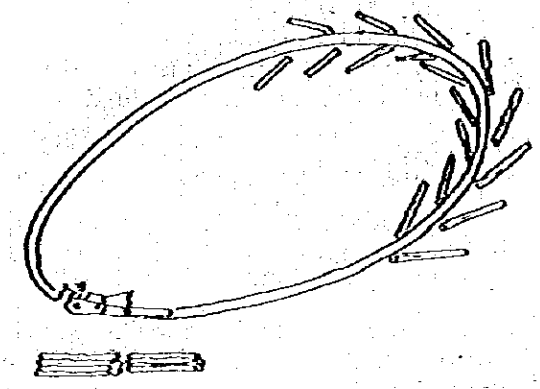
ii. Never construct the logging road which has the slope continuing over 50 m of or near the limiting inclination.

iii. Make the section of the gentle slope before and after the logging road of the inclination almost near the limitation.

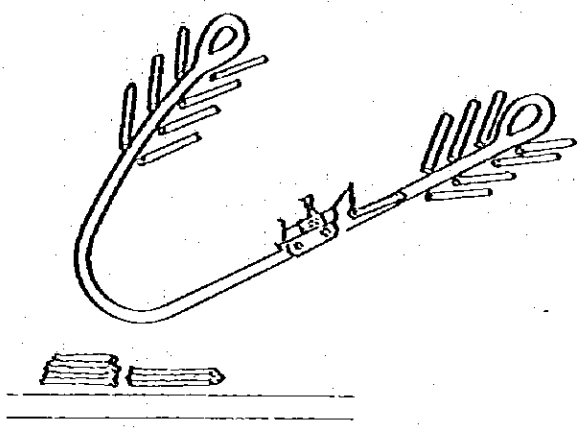
iv. Do not make any small radius curve road in or before or after the section of inclination almost near the limitation.

(11 The inclination of the asscending tractor road is not always the same depending upon the soil conditions, but for the soil road 14 - 15 degrees is the limit, and if it is over this limitation, not only the climing up becomes difficult but also often damages the road in or after the rain.

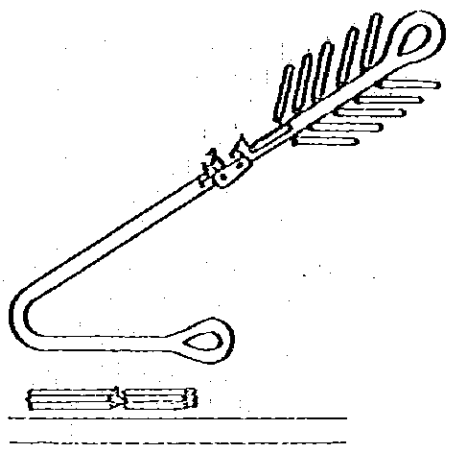
Fig 3(10) Tractor skidding road



(1) Loop road



(2) U - shaped road



(3) L - shaped road

2. Caring points for the felling and bucking operations in tractor skidding.

(1) About the direction of felling

You had better fell the trees in the direction making 30 - 45 degrees of angle to the skidding line as Fig 3(11)-(1).

In general, face the bottom end to the skidding line as a rule, but in some cases they do it very efficiently by felling the trees so as to be arranged as the small end face to the skidding line.

In case of whole-tree skidding, we have to depend on the former process, but in case of full tree-length skidding, the latter process might be more efficient in many cases.

The reasons are as follows,

① Applying the slings to the tree top is easier and faster in operation.

② The hauling distance will be reduced corresponding to the tree height.

③ In hauling by the winch, the top will be lifted up and won't be caught by the obstacles.

In some case, the top would be broken, but this does not effect the quality and the volume of the log so much.

④ Much load can be pulled.

⑤ Less impact to the winch.

⑥ The damage of tractor road is slighter.

⑦ The distribution of load between the sulky and the ground, the sulky bears less.

But there are some demerits on the contrary.

① In felling, the direction is inverse to the mountain side, and this may injure the logs sometimes.

② The sling ropes would slip off, if we do not limit the diameter of small end to some size(about 10 cm).

③ Seldom have to hook the log again by the breakage of small end in tracting.

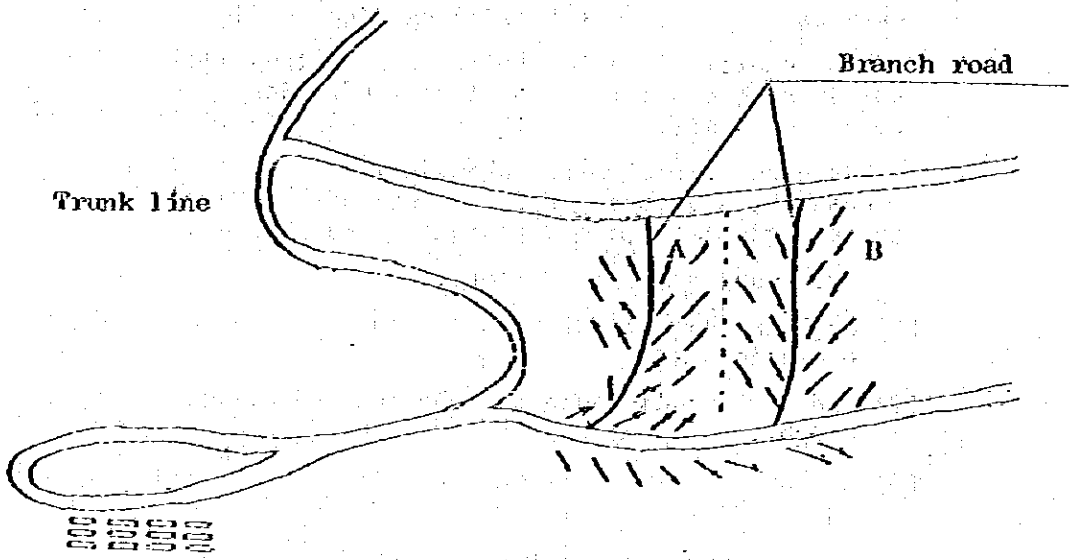
④ The ground skidding resistance becomes greater.

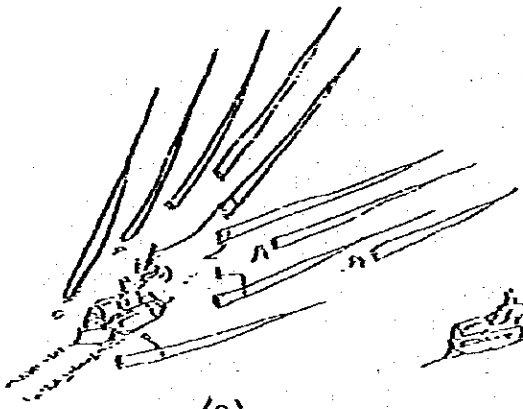
(2) About the stump height

The stump height should be as low as possible to enable the tractor to cross them over.

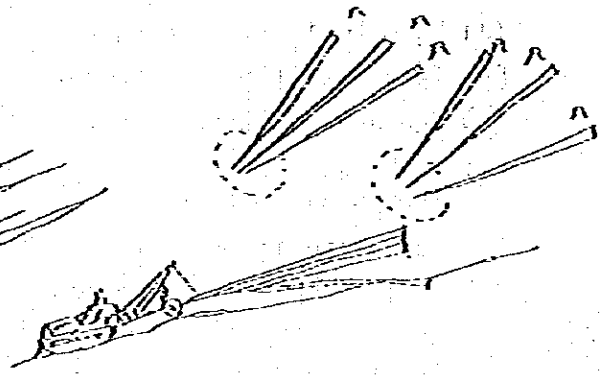
Fig 3(11)

(1) Skidding road and the direction of felling





(2)



(3)

(3) Other items

① It is efficient to skid in the form of full tree-length as possible.

The whole-tree skidding of small diameter is disadvantageous as the number of logs to be tracted is small.

② In case of the ground skidding, rounding the cut edge of the log on its drawn side (to make the round shaped end of log) will diminish the resistance and also the damage.

3. Caring points on skidding operation

(1) Pre-skidding operation

① As the distance of pre-skidding by the winch becomes longer, the angle of nose-up will become smaller and the frequency of catching by the bush and the stump would increase, effecting greatly to the production.

The pre-skidding distance is within 40 m from the winding capacity of the winch and it seems about 20 m for average.

② The tractive force of the winch is fairly strong in general, and makes no remarkable difference in working volume both in case of drawing up and drawing down.

③ In the pre-skidding operation, when the logs to be skidded is located far from the axial line of tractor, the sulky and the tractor itself would be in danger of turning over to a side if you tract them straight by the winch rope.

In this case, use the guide block or the automatic snatch block or as shown in Fig 3(12), besides the ordinary archline hook at the end of the rope, set another hook which can freely travels on the archline, and hook up the logs on both sides of the axial line of the tractor to ballance and pull them at a time, then the direction of the resultant force from the weight of logs and the axial line of the tractor would become nearly the same and can be smoothly skidded.

④ In pre-skidding operation by the winch, logs are often caught by the stumps and difficult to be tracted.

In these case, if you force to wind up further on with all power of winch, the log would stand up and fall in unexpected direction or the rope would be brocken and these might cause a great accident, and so these operation must be strictly forbidden.

In these case, it is important to loosen the rope entirely and make sure that the log is stabilized, then turn to the next actions.

⑤ As the counter plan for the above described case (4), use the blocks as in case (3) or to dodge the stump as shown in Fig 3(13) in some case.

Fig 3(12) The pre-skidding way by dint of the double archline hook, in case the logs to be skidded are not on the axial line of the tractor.

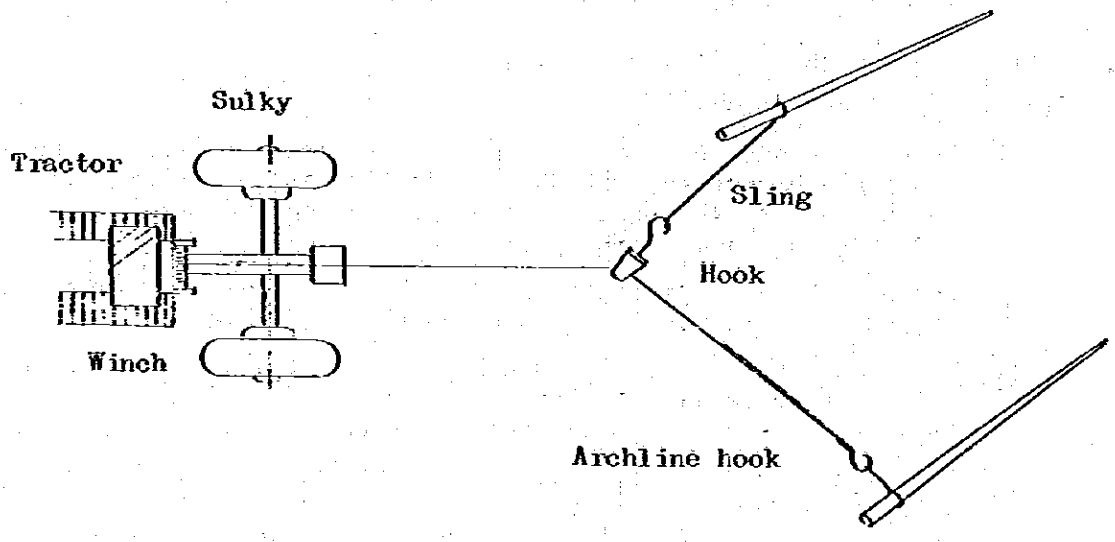
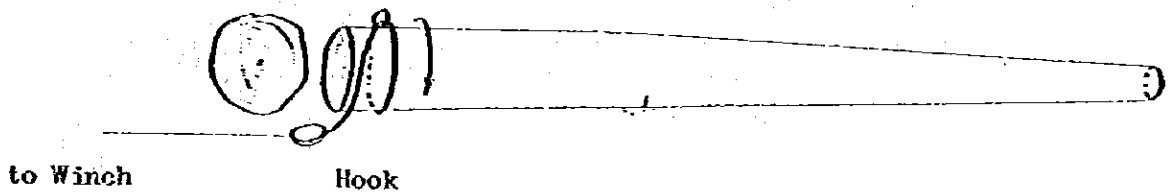


Fig 3(13) The log will turn to left or right by the position of the sling to be fitted.

Place the eye part of the sling to the right and the log will turn to the arrowed direction.



(2) Loading, traveling and unloading operations.

1 In ordinary case, the loading operations by sulky or integral-arch skidding, will be done by one personnel.

The loading man will decide the logs to be skidded for next time and the steps for it, then attach the slings to them, if possible during the time of tractor traveling.

2 To attach the slings to the small end or to the butt end will be decided according to the direction of felling.

3 The skidding volumes per one cycle will vary according to the size of logs, but from the survey reports of the Regional Forest Office in Hokkaido, number of logs to be hooked up for one cycle are 2 or 3 for average, and its volume is 2.5 m^3 - 5 m^3 per cycle, in case of full tree-length skidding by sulky.

4 In the muddy section or the asscending slope of the skidding road, it often happens that the tracting become difficult.

In such a case, let travel the tractor alone to the good spot leaving the load behind and pull up the load again by tractor winch from there.

5 In loading and unloading operations, the operator and the driver must be in close contact, sending signals to each other and after confirming the safety, proceed to the next step.

3-2 Training for the 2nd term and after.

3-2-1 Training on skyline yarding operation.

In the second term, number of trainee will become 24 personnels, and two sets of yarder will be used in the training at Madium Training Center.

That is, trainees are divided into two teams "A" and "B" for each yarder, and "A" team will be trained in "70 m" succeeding to the 1st term, "B" team will be trained in "58 j".

In the 3rd term, one more yarder will be set and "C" team will be organized.

The 3rd term training will be executed for "A" team in "70 m", and for "B" team and "C" team in "58 j".

About the general description of the training forest land, it is already descrited in the 1st term training plan, and so here we describe about the felling order, area, and felling volume in accordance with the map of felling area.

(1) Map of felling area. As shown in Fig 3(14) & Fig 3(15).

(2) Annual felling area and felling volume.

Term	Team	Compart-ment	Skyline No.	Area (ha)	Standing volume (m^3)	Yielding volume (m^3)	Remarks
II	A	70 m	1	0.61	88	70	
		"	2	1.54	213	170	
		Sub-total		2.15	301	240	
	B	58 j	1	0.34	140	110	
		"	2	0.56	230	180	
		Sub-total		0.90	370	290	
III	A	70 m	1	0.38	50	40	
		"	2	1.88	263	210	
		Sub-total		2.26	313	250	
	B	58 j	1	0.34	140	110	
		"	2	0.60	240	190	
		Sub-total		0.94	380	300	
	C	58 j	1	0.39	160	130	
		"	2	0.58	240	190	
		Sub-total		0.97	400	320	

(3) Processes and steps of operations.

Alike the 1st term training on the skyline yarding operations.

(4) The labor and the cost.

The labor amount and the details of cost for each term, as shown in Table 3(11) to Table 3(15).

Fig. 3 (14) The map of felling area of "70 m" compartment for the skyline yarding training

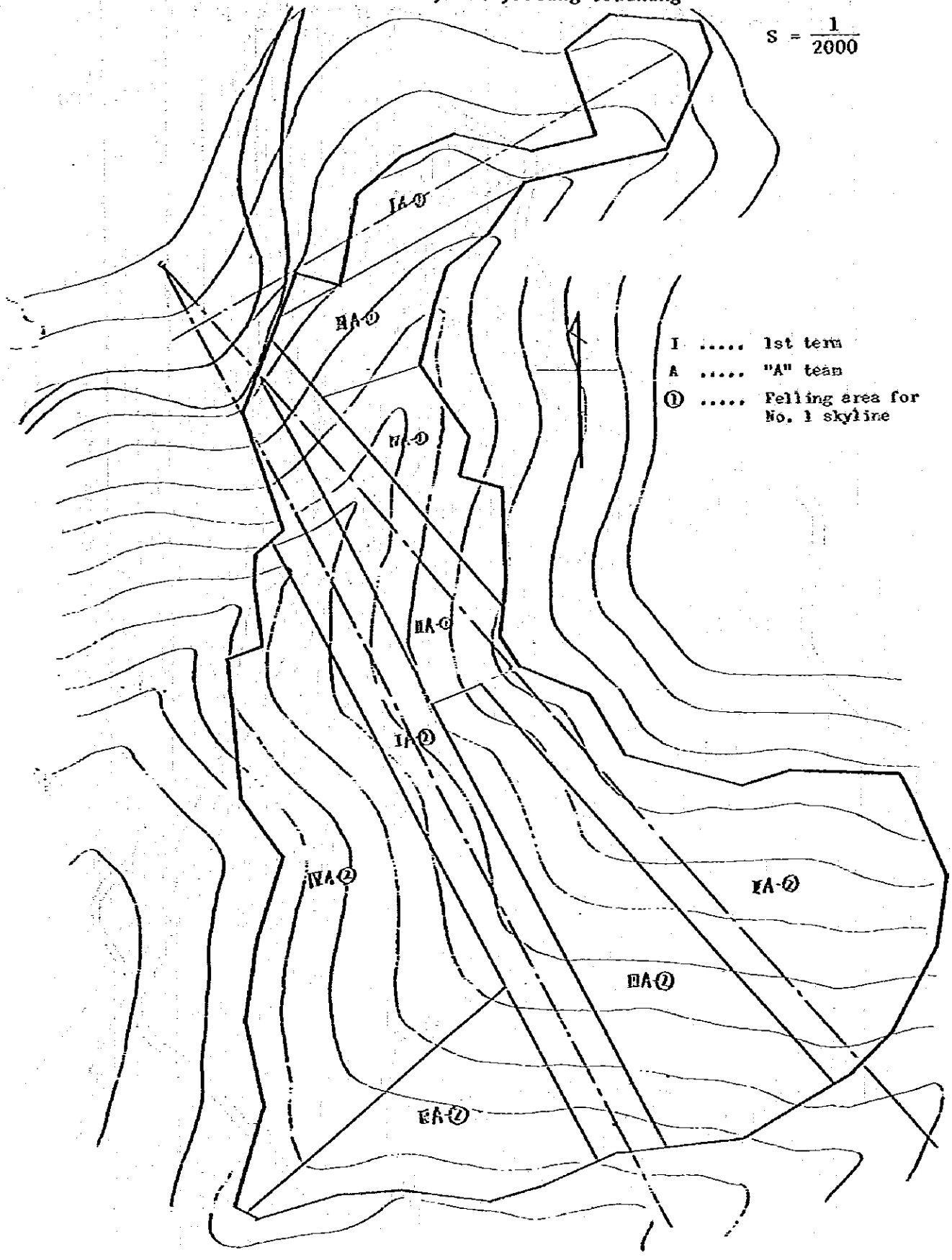
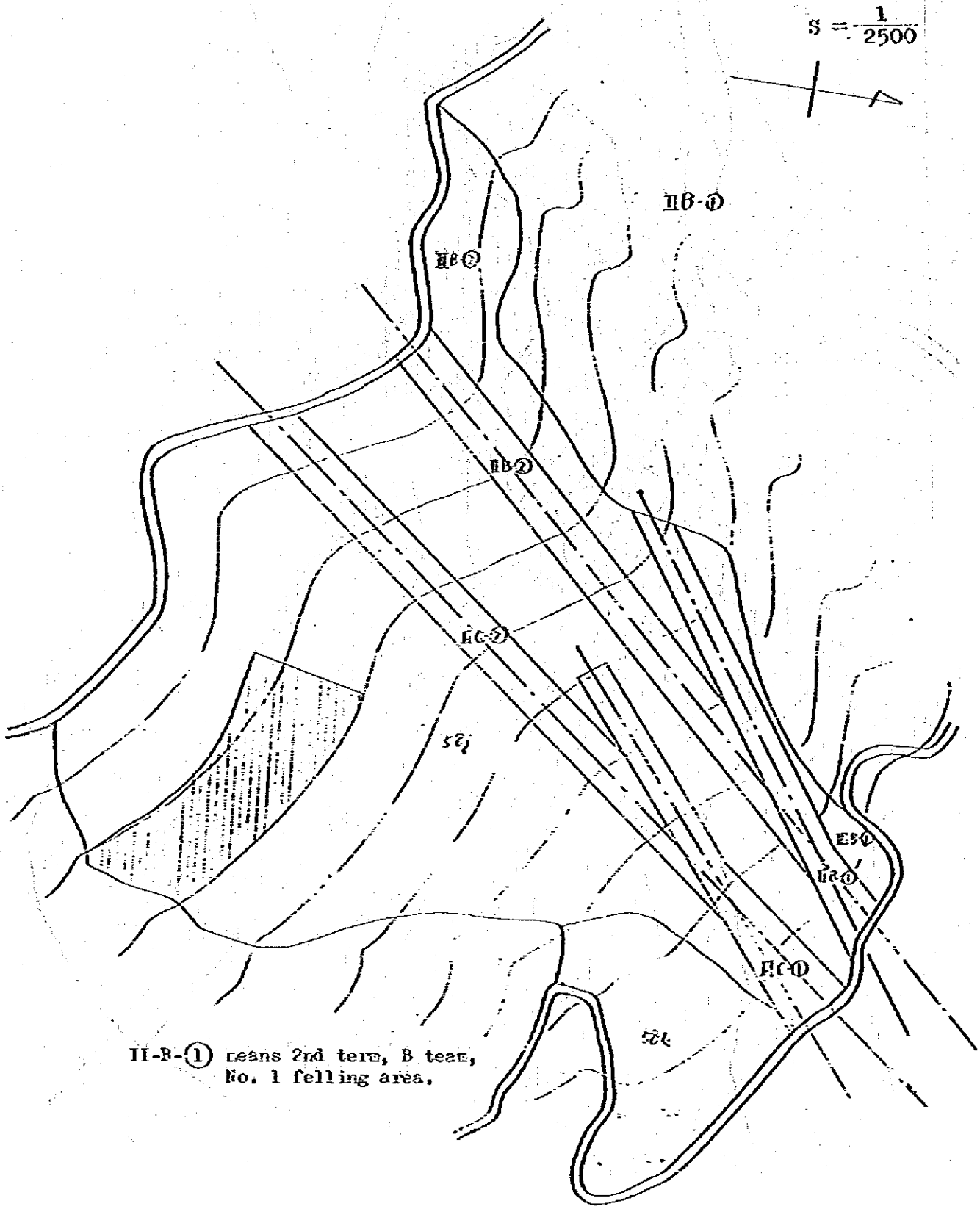


Fig 3 (15) The map of felling area of "58 j" compartment for the training of skyline yarding.



II-B-① means 2nd term, B team, No. 1 felling area.

Table 3(11) Details of the cost of skyline for the 2nd term A team

Article	Executor		Item	Cost			Remarks
	Trainee	Worker		Quantity	Unit price	Price	
Investigation & survey	◎	○	Labor fee	10	300	3000	
Construction of pedestrian road		◎	ditto.	8	300	2400	
Caul making (protector)	○	◎	ditto.	8	300	2400	
Setting of yarder	◎	○	ditto.	8	300	2400	
Felling, trimming and bucking		◎	ditto.	35	300	10500	70 m³ ÷ 2 m³ (per man-day) = 35 men (No.1 skyline)
Felling & trimming		◎	ditto.	57	300	17100	170 m³ ÷ 3 m³ (per man-day) = 57 men (No.2 skyline)
Construction of platform	○	◎	ditto.	80	300	24000	No.1 platform: 20 men No.2 platform: 60 men
Wiring operation	◎	○	ditto.	38	300	11400	
Ordinary yarding operation	◎	○	ditto.	18	300	5400	70 m³ ÷ 4 m³ (per man-day) = 18 men (No.1 skyline)
Full tree-length yarding operation	◎	○	ditto.	68	300	20400	170 m³ ÷ 2.5 m³ (per man-day) = 68 men (NO.2 skyline)
Removal operation	◎	○	ditto.	12	300	3600	
Fuel			Kerosine	430 ℓ	40	17200	No.1: 15 days x 10 ℓ = 150 ℓ No.2: 23 days x 12 ℓ = 280 ℓ
Lubricating oil			Mobile oil	20 ℓ	300	6000	
			Grease	5 Kg	600	3000	
			Gear oil	5 ℓ	400	2000	
Other materials						18000	Materials for the shed, wire, clamp etc.
Total						149100	RP.

Note: No.1 skyline, span 220 m, mean yarding distance 140 m.
No.2 skyline, span 680 m, mean yarding distance 340 m.

Table 3 (12) Details of the cost of skyline for the 2nd term B team

Article	Executor		Item	Cost			Remarks
	Trainee	Worker		Quantity	Unit price	Price	
Investigation & survey	◎	○	Labor fee	6	300	1800	
Construction of pedestrian road		◎	ditto.	8	300	2400	
Caul making (protector)	○	◎	ditto.	16	300	4800	
Setting of yarder	◎	○	ditto.	4	300	1200	
Felling, trimming and bucking		◎	ditto.	55	300	16500	110 m^3 ÷ 2 m^3 (per man-day) = 55 men (No.1 skyline)
Felling & trimming		◎	ditto.	60	300	18000	180 m^3 ÷ 3 m^3 (per man-day) = 60 men (No.2 skyline)
Construction of platform	○	◎	ditto.	60	300	18000	No.1 platform: 20 men No.2 platform: 40 men
Wiring operation	◎	○	ditto.	20	300	6000	No.2 skyline
Ordinary yarding operation	◎	○	ditto.	28	300	8400	110 m^3 ÷ 4 m^3 (per man-day) = 28 men (No.1 skyline)
Full tree-length yarding operation	◎	○	ditto.	72	300	21600	180 m^3 ÷ 2.5 m^3 (per man-day) = 72 men (No.2 skyline)
Removal operation	◎	○	ditto.	6	300	1800	
Fuel			Kerosine	530 ℓ	40	21200	12 ℓ x 44 days = 530 ℓ
Lubricating oil			Mobile oil	20 ℓ	300	6000	
			Crease	5 kg	600	3000	
			Gear oil	5 ℓ	400	2000	
Other materials						23000	
Total						155700	RP.

Note: No.1 skyline, span 280 m, mean yarding distance 130 m.
No.2 skyline, span 500 m, mean yarding distance 250 m.

Table 3 (13) Details of the cost of skyline for the 3rd term A team

Article	Executor		Item	Cost			Remarks
	Trainee	Worker		Quantity	Unit price	Price	
Investigation & survey	◎	○	Labor fee	4	300	1200	
Construction of pedestrian road		◎	ditto.	4	300	1200	
Caul making (protector)	○	◎	ditto.	4	300	1200	
Setting of yarder	◎	○	ditto.	6	300	1800	
Felling, trimming and bucking		◎	ditto.	20	300	6000	40 m^3 ÷ 2 m^3 (per man-day) = 20 men (No.1 skyline)
Felling & trimming		◎	ditto.	70	300	21000	210 m^3 ÷ 3 m^3 (per man-day) = 70 men (No.2 skyline)
Construction of platform	○	◎	ditto.	50	300	15000	
Wiring operation	◎	○	ditto.	30	300	9000	
Ordinary yarding operation	◎	○	ditto.	10	300	3000	40 m^3 ÷ 4 m^3 (per man-day) = 10 men (No.1 skyline)
Full tree-length yarding operation	◎	○	ditto.	84	300	25200	210 m^3 ÷ 2.5 m^3 (per man-day) = 84 men (No.2 skyline)
Removal operation	◎	○	ditto.	12	300	3600	
Fuel			Kerosine	460 ℓ	40	18400	No.1: 11 days No.2: 27 days } 38 days x 12 ℓ = 460 ℓ
Lubricating oil			Mobile oil	20 ℓ	300	6000	
			Grease	5 ㎏	600	3000	
			Gear oil	5 ℓ	400	2000	
Other materials						15000	Wire, clamp & etc.
Total						132600	R.P.

Note: No.1 skyline and No.2 skyline will be set at the places of the No.1 skyline and No.2 skyline of the 1st term.

Table 3 (14) Details of the cost of skyline for the 3rd term B team

Article	Executor		Item	Cost			Remarks
	Trainee	Worker		Quantity	Unit price	Price	
Investigation & survey	◎	○	Labor fee	2	300	600	
Construction of pedestrian road		◎	ditto.	2	300	600	
Caul making (protector)	○	◎	ditto.	4	300	1200	
Setting of yarder	◎	○	ditto.	2	300	600	
Felling, trimming and bucking		◎	ditto.	55	300	16500	110 m^3 ÷ 2 m^3 (per man-day) = 55 men (No.1 skyline)
Felling & trimming		◎	ditto.	64	300	19200	190 m^3 ÷ 3 m^3 (per man-day) = 64 men (No.2 skyline)
Construction of platform	○	◎	ditto.	20	300	6000	No.1 is constructed. No.2 is used that of the 2nd term.
Wiring operation	◎	○	ditto.	20	300	6000	
Ordinary yarding operation	◎	○	ditto.	28	300	8400	110 m^3 ÷ 4 m^3 (per man-day) = 28 men (No.1 skyline)
Full tree-length yarding operation	◎	○	ditto.	76	300	22800	(No.2 skyline) 190 m^3 ÷ 2.5 m^3 (per man-day) = 76 men
Removal operation	◎	○	ditto.	6	300	1800	
Fuel			Kerosine	540 ℓ	40	21600	12 ℓ x 45 days = 540 ℓ
Lubricating oil			Mobilo oil	20 ℓ	300	6000	
			Grease	5 kg	600	3000	
			Gear oil	5 ℓ	400	2000	
Other materials						15000	
Total						131300	RP.

Note: Carry out in the same place of the 2nd term B team.

Table 3 (15) Details of the cost of skyline for the 3rd term C team

Article	Executor		Item	Cost			Remarks
	Trainee	Worker		Quantity	Unit price	Price	
Investigation & survey	◎	○	Labor fee	6	300	1800	
Construction of pedestrian road		◎	ditto.	8	300	2400	
Caul making (protector)	○	◎	ditto.	16	300	4800	
Setting of yarder	◎	○	ditto.	4	300	1200	
Felling, trimming and bucking		◎	ditto.	65	300	19500	130 m^3 ÷ 2 m^3 (per man-day) = 65 men (No.1 skyline)
Felling & trimming		◎	ditto.	64	300	19200	190 m^3 ÷ 3 m^3 (per man-day) = 64 men (No.2 skyline)
Construction of platform	○	◎	ditto.	60	300	18000	No.1 platform: 20 men No.2 platform: 40 men
Wiring operation	◎	○	ditto.	20	300	6000	No.2 skyline
Ordinary yarding operation	◎	○	ditto.	32	300	9600	130 m^3 ÷ 4 m^3 (per man-day) = 32 men (No.1 skyline)
Full tree-length yarding operation	◎	○	ditto.	76	300	22800	190 m^3 ÷ 2.5 m^3 (per man-day) = 76 men (No.2 skyline)
Removal operation	◎	○	ditto.	6	300	1800	
Fuel			Kerosine	560 ℓ	40	22400	12 ℓ x 47 days = 560 ℓ
Lubricating oil			Mobile oil	20 ℓ	300	6000	
			Grease	5 ㎏	600	3000	
			Gear oil	5 ℓ	400	2000	
Other materials						23000	
Total						163500	RP.

Note: No.1 skyline. span 250 m. mean yarding distance 100 m.
No.2 skyline. span 500 m. mean yarding distance 250 m.

3-2-2 Training on tractor skidding operation

As for the numbers of tractor to be used in training are two for the 2nd term and three for the 3rd term.

But in case of tractor skidding operation, differ from the case of skyline yarding, we can introduce the plural numbers of tractor at a time in the same route, same timber yard, and this plan is designed under this consideration.

The training land is fixed to "58 k" sub-compartment for the 2nd term, and "58 j" for the 3rd term.

As the general description of "58 j" sub-compartment is already mentioned, we now describe about the "58 k".

(1) General descriptions of "58 k".

1 Area: 0.8 ha.

2 Species and age of tree: Pinus Merkusii, 35 years old.

3 Number of standing tree: 530/ha

4 Diameter breast high: 30 cm

5 Tree height: 22 m

6 Volume of a stand per ha: 382 m^3

7 Total volume of a stand: 305 m^3

8 Land descriptions:

As indicated in the map of felling area, this land has a gentle slope of about 12 degrees, facing north east.

(2) Map of felling area

As shown in Fig 3(16).

(3) Annual felling area and felling volume

Term	Team	Compartment	Felling area	Standing volume	Yielding volume	Remarks
			ha	m^3	m^3	
II	A & B joint	58 k	0.80	305	240	Construction of tractor road: 240 m long.
III	A,B,C joint	58 j	1.30	530	420	Construction of tractor road: 360 m long.

(4) Operation processes and steps

Corresponding to the 1st term training on tractor skidding.

(5) The labor and the cost

As shown in Table 3(16) and Table 3(17).

Fig 3(16) Map of felling area for the training on tractor skidding

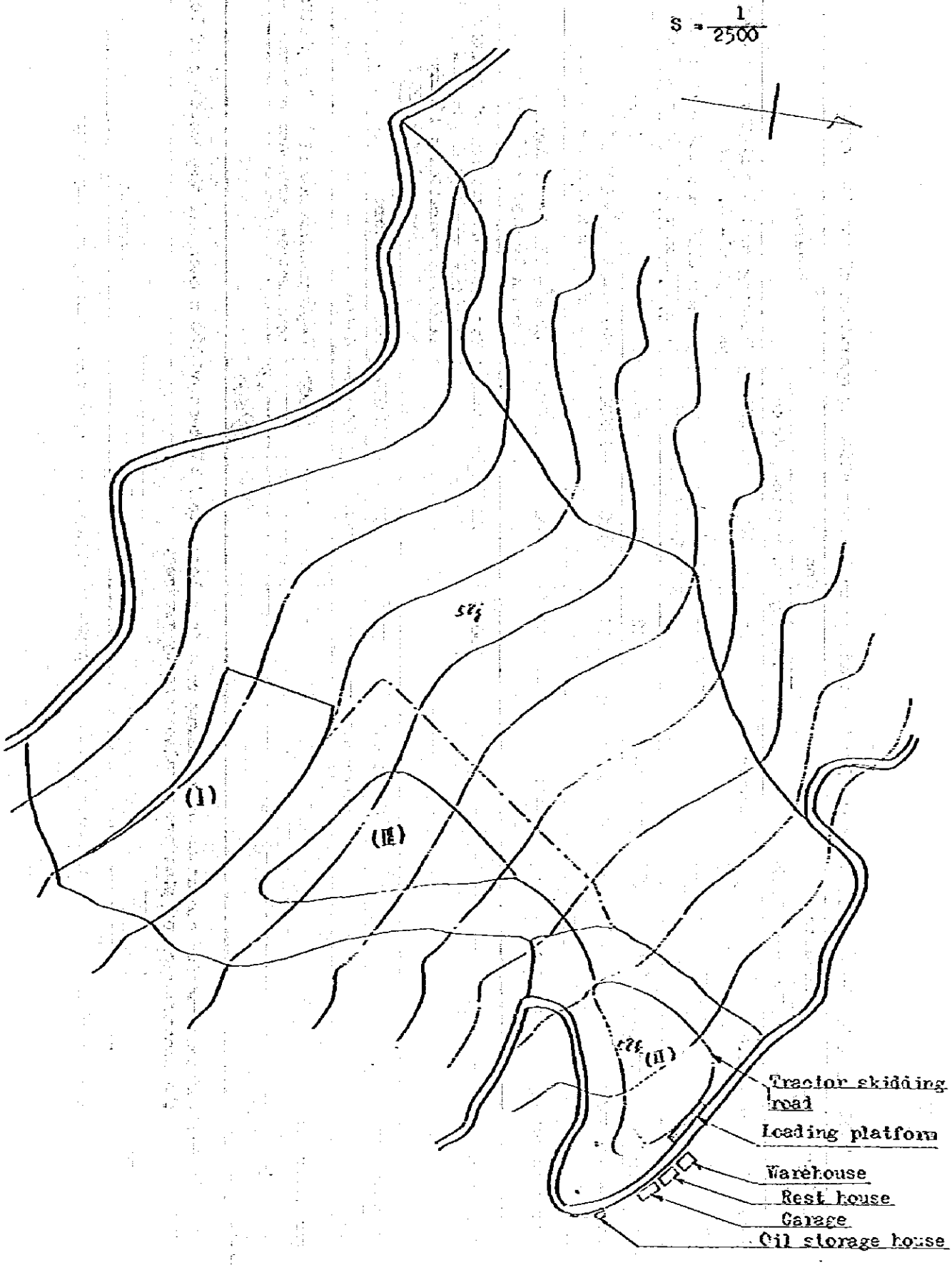


Table 3 (16) Details of the cost for the training on tractor skidding operation of the 2nd term.

Article	Executor		Item	Cost			Remarks
	Trainee	Worker		Quantity	Unit price	Price	
Felling of the obstacle trees		◎	labor fee	16	300	4800	Skidding road 6 m x240 m + timber yard 150 m^2 = 0.16 ha 382 m^3 x 0.16 ha x 0.8 ÷ 48 m^3 2men 1 team : 6 m^3 48 m^3 ÷ 6 m^3 = 8 teams
Construction of platform	○	◎	ditto	32	300	9600	
Felling & trimming		◎	ditto	64	300	19200	240 m^3 - 52 m^3 = 188 m^3 188 m^3 ÷ 6 m^3 x 2 men = 64 men
Skidding operation	◎	○	ditto	64	300	19200	188 m^3 ÷ 12 m^3 = 16 days 4 men x 16 days = 64 men
Tractor fuel				700 ℓ	40	2800	For the construction of tractor skidding road 240 m ÷ 20 m = 12 days skidding operation : 16 days total 28 days x 25 ℓ = 700 ℓ
Lubricating oil			Mobil oil	40 ℓ	300	12000	for 2 tractors
ditto			other oil		5000	10000	ditto
Other materials						36000	Replenishing materials for platform, consumption parts and others.
Total						RP 138800	

Note: The construction operation of skidding road is alloted to A & B team of 120 m each and the skidding of logs for the construction of platform is also done by trainee.

Table 3(17) Details of the cost for the training on tractor skidding operation of the 3rd term.

Article	Executer		Item	Cost			Remarks
	Trainee	Worker		Quantity	Unit price	Price	
Felling of the obstacle trees		◎	labor fee	22	300	6600	0.216 ha x 382 m^3 x 0.8 = 66 m^3 66 m^3 ÷ 6 m^3 x 2 men = 22 men
Felling & trimming		◎	ditto	118	300	35400	420 m^3 - 66 m^3 = 354 m^3 354 m^3 ÷ 6 m^3 x 2 men = 118 men
Skidding	◎	○	ditto	140	300	42000	420 m^3 ÷ 12 m^3 = 35 days 4 men x 35 days = 140 men
Tractor fuel				1325 ℓ	40	53000	for tractor road 360 m ÷ 20 m = 18 days skidding operation 35 days 25 ℓ x 53 days = 1325 ℓ
Lubricating oils			mobil oil	60 ℓ	300	18000	for 3 tractors
ditto			other oil		5000	15000	
Other materials						51000	
Total						221000	RP

Note: (1) As for the platform, we use the one which is constructed on the 2nd term training.

(2) As for the timber yard operations, we calculated under the condition that 4 men carry out the bucking and piling with one tractor, but if 3 tractors operate at a time, the number of personnel for the timber yard need not 12 men and considering the work volume deminish the number of personnel for the timber yard operation or the number of tractor to be used by adopting the shifting system.