2) Underground mining equipment

The new investment such as self-advancing support, cutter and side dump loader will be covered in the equipment investment, while the maintenance investment of equipment already owned is considered to be included in the general expenses.

The major rock drift, which may be considered as a part of equipment investment, will not be covered in the current operating area. Table 1-42 shows the investment plan by year.

9.2.5 The number of workers for the cost estimate

The number of workers in the current operating area is shown in Table 1-33.

9.2.6 Operating cost

1) Labor cost

The labor cost is worked out by the number of workers and an average annual income. An average annual income of 1,020 US$ is applied, which was obtained before. Also, the surface workers both in the planning and the current operating area are included in the calculation.

Table 1-43 Labor cost by year

(10^3US$)

Year	1980	1981	1982	1983	1984	1985-2005
Open pit	155	155	155	155	155	155
Underground	576	576	576	527	437	408
Surface	818	818	818	769	716	716
Total	1,549	1,549	1,549	1,451	1,308	1,279

2) Maintenance cost

(1) Open-cut mining

(1)-1 Spare parts

Spare parts for the equipments will be divided in two categories of tyre and the others. (Table 1-44)

The life of tyre and the operating hours of the equipment per year are taken from "Review report".

As for the other spare parts, theoretical calculation was made on the basis of "Caterpillar formula".

The prices of spare parts listed in "Review report" are those as of 1978, so their 1980 prices are estimated 21% higher than those.

(1)-2 Explosives and detonators for blasting

The quantity to be used for blasting the overburden of one cubic meter is as follows, and the total amount of overburden is estimated on the basis of stripping ratio of 1:7.

ANFO	1 kg/overburden 12.4 BCM
Gelignite	ANFO x 4%
Detonator	Gelignite x 1/2

As the prices listed in the data of P.N. Tambang Batubara are those as of 1979, they are boosted 10% each for the 1980 prices.

ANFO	617 Rp/kg x 1.1 = 679 Rp/kg = 1.10 US$/kg
Gelignite	1,605 Rp/kg x 1.1 = 1,766 Rp/kg = 2.85 US$/kg
Detonator	512 Rp/kg x 1.1 = 563 Rp/kg = 0.91 US$/piece

Since 1 US$ = 620 Rp,

Table 1-44 ANNUAL SPARE PARTS COST (Open cut)

		Number of unit	Tyre					Others		Total	Import duty	Grand total
			Cost/unit	Total	Hour life	Formulation	Cost/year	Formulation	Cost/year			
		Unit	US$	US$	Hours		10^3US$		10^3US$	10^3US$	10^3US$	10^3US$
Overburden removal	35 sht dump truck	7	10,890	76,230	3,000	$\frac{76,230}{3,000} \times 2,310$	59	$\frac{0.08(1,417,472-76,230)}{1,000} \times 2,310+6\%$	263	322	97	419
	Bulldozer(300HP)	5	—	—	—	—	—	$\frac{0.09 \times 1,076,430}{1,000} \times 2,940+6\%$	302	302	91	393
	Wheel scraper(15M³)	3	9,680	29,040	25,000	$\frac{29,040}{25,000} \times 2,860$	3	$\frac{0.09(659,409-29,040)}{1,000} \times 2,860+6\%$	172	175	53	228
	Hydraulic shovel(2.5M³)	1	—	—	—	—	—	$\frac{0.9 \times 312,439}{25,000} \times 2,970+6\%$	35	35	11	46
	F.E. wheel loader	1	16,940	16,940	2,500	$\frac{16,940}{2,500} \times 2,970$	20	$\frac{0.07(196,886-16,940)}{1,000} \times 2,970+6\%$	40	60	18	78
	Blast hole rig	1	—	—	—	—	—	7,260/year	7	7	2	9
Coal handling	F.E. crawler loader	1	—	—	—	—	—	$\frac{0.09 \times 114,837}{1,000} \times 2,300+6\%$	25	25	8	33
	Bulldozer(62HP)	1	—	—	—	—	—	$\frac{0.09 \times 33,630}{1,000} \times 1,200+6\%$	4	4	1	5
	Coal truck(8t)	4	2,251	9,004	3,000	$\frac{9,004}{3,000} \times 2,563$	8	$\frac{0.08(248,232-9,004)}{1,000} \times 2,563+6\%$	52	60	18	78
General	Plat form truck(7t)	1	1,350	1,350	4,000	$\frac{1,350}{4,000} \times 1,500$	1	$\frac{0.08(47,878-1,350)}{1,000} \times 1,500+6\%$	6	7	2	9
	Personnel carrier	1	1,220	1,220	2,500	$\frac{1,220}{2,500} \times 1,500$	1	$\frac{0.08(46,377-1,220)}{1,000} \times 1,500+6\%$	6	7	2	9
	Tipper truck	1	1,220	1,220	2,500	$\frac{1,220}{2,500} \times 1,500$	1	$\frac{0.08(47,878-1,220)}{1,000} \times 1,500+6\%$	6	7	2	9
	Land rovers	4	254	1,016	1,500	$\frac{1,016}{1,500} \times 1,500$	1	—	—	1	0	1
	10t mobile crane	1	5,306	5,306	4,000	$\frac{5,306}{4,000} \times 500$	1	$\frac{0.05(127,596-5,306)}{1,000} \times 500+6\%$	3	4	1	5
	Lubricantion truck	1	1,350	1,350	4,000	$\frac{1,350}{4,000} \times 1,500$	1	$\frac{0.08(71,126-1,350)}{1,000} \times 1,500+6\%$	9	10	3	13
	Water sprinkler truck	1	1,350	1,350	4,000	$\frac{1,350}{4,000} \times 1,500$	1	$\frac{0.08(51,810-1,350)}{1,000} \times 1,500+6\%$	6	7	2	9
	Fuel truck	1	1,350	1,350	4,000	$\frac{1,350}{4,000} \times 1,500$	1	$\frac{0.08(55,166-1,350)}{1,000} \times 1,500+6\%$	7	8	2	10
	Road grader	1	13,264	13,264	2,500	$\frac{13,264}{2,500} \times 2,915$	15	$\frac{0.09(120,152-13,264)}{1,000} \times 2,915+6\%$	30	45	14	59
	Maintenance work shop	1						48,400/year	48	48	14	62
Total							113		1,021	1,134	341	1,475

(Note) An import duty is regarded as 30% of the total spare parts cost.
Actual working time is referred to Table 1-41.

Table 1-45 Expenditure for explosives and detonators in the open cut

		1980	1981	1982	1983	1984-2005
Coal output(raw coal)(10^3t)		78	102	155	155	206
Overburden (10^3m^3)		546	714	1,085	1,085	1,442
ANFO	Quantity (kg)	44,032	57,581	87,500	87,500	116,290
	Value (10^3US$)	48	63	96	96	128
Gelig-nite	Quantity (kg)	1,761	2,303	3,500	3,500	4,652
	Value (10^3US$)	5	7	10	10	13
Deto-nator	Quantity (piece)	881	1,152	1,750	1,750	2,326
	Value (10^3US$)	1	1	2	2	2
Total (10^3US$)		54	71	108	108	143

(1)-3 Oil (Fuel oil, Lubricating oil)

The amount and the unit price of oil to be consumed are given according to "Review report". (Table 1-46)

The amount of consumption per year is obtained by total operating hours of a year.

All the unit prices presented in the report were those as of 1978. In view of the increase in the oil price since then, doubled 1978 prices are deemed proper for the 1980 prices.

Table 1-46 ANNUAL CONSUMPTION OF DIESEL, LUBRICANT, ETC. (Open cut)

		Number of unit	Operating hours		Diesel fuel			Lubricant			Grease			Filter			Premium			Total
			Per unit	Total	Per hr.	Price	Cost	Per hr.	Price	Cost	Per hr.	Price	Cost	Per hr.	Price	Cost	Per hr.	Price	Cost	
		Unit	Hours	Hours	ℓ/h	US$	10^3US$	ℓ/h	US$	10^3US$	ℓ/h	US$	10^3US$	ℓ/h	US$	10^3US$	ℓ/h	US$	10^3US$	10^3US$
Overburden removal	35 sht dump truck	7	2,310	16,170	37	0.1	60	0.7	0.80	9	0.05	2.00	2	0.85	0.5	7				78
	Bulldozer(300HP)	5	2,940	14,700	42	0.1	62	0.7	0.80	8	0.05	2.00	1	0.85	0.5	6				77
	Wheel scraper(15M³)	3	2,860	8,580	45	0.1	39	0.9	0.80	6	0.05	2.00	1	0.85	0.5	4				50
	Hydraulic shovel(2.5M³)	1	2,970	2,970	—	—	—	—	—		—	—	—	—	—	—				—
	F.E. wheel loader	1	2,970	2,970	52	0.1	15	0.7	0.80	2	0.05	2.00	0	—	—	—				17
	Blast hole rig	1			—			—	—		—	—	—	—	—	—				—
Coal handling	F.E. crawler loader	1	2,300	2,300	31	0.1	7	0.7	0.80	1	0.05	2.00	0	1.20	0.5	1				9
	Bulldozer(62HP)	1	1,200	1,200	8	0.1	1	0.7	0.80	1	0.05	2.00	0	0.85	0.5	1				3
	Coal truck(8t)	4	2,563	10,252	25	0.1	26	0.7	0.80	6	0.05	2.00	1	0.85	0.5	4				37
General	Plat form truck(7t)	1	1,500	1,500	25	0.1	4	0.7	0.80	1	0.05	2.00	0	0.85	0.5	1				6
	Personnel carrier	1	1,500	1,500	25	0.1	4	0.7	0.80	1	0.05	2.00	0	0.85	0.5	1				6
	Tipper truck	1	1,500	1,500	25	0.1	4	0.7	0.80	1	0.05	2.00	0	0.85	0.5	1				6
	Land rovers	4	1,500	6,000	—	—	—	0.4	0.80	2	0.02	2.00	0	—	—	—	7	0.22	9	11
	10t mobile crane	1	500	500	—	—	—	0.7	0.80	0	0.05	2.00	0	0.85	0.5	0	25	0.22	3	3
	Lubrication truck	1	1,500	1,500	25	0.1	4	0.7	0.80	1	0.05	2.00	0	0.85	0.5	1				6
	Water sprinkler truck	1	1,500	1,500	25	0.1	4	0.7	0.80	1	0.05	2.00	0	0.85	0.5	1				6
	Fuel truck	1	1,500	1,500	25	0.1	4	0.7	0.80	1	0.05	2.00	0	0.85	0.5	1				6
	Road grader	1	2,915	2,915	25	0.1	7	0.7	0.80	2	0.02	2.00	0	0.85	0.5	1				10
	Maintenance work shop	1																		
	Total						241			43			5			30			12	331

(2) Underground

(2)-1 Coal getting

With the mechanization of coal getting, very few materials will be required. Thus, here, the material cost is regarded as zero, except during the period from 1980 to 1982 when the conventional mining by single wooden prop requires the consumption of materials. The calculation method is the same with that in the planning area, and the result of calculation is shown in Table 1-47.

Table 1-47 Material expenses for coal getting

	Year	1980	1981	1882
Coal output (raw coal)(10^3t)		99	133	198
Material expenses (10^3US$)	Explosives	6	8	11
	Timber	36	48	72
	Others	8	11	17
	Total	50	67	100

(2)-2 Road excavation

Annual amount of excavation is calculated on the basis of length excavated per thousand tons of raw coal in the planning area, which is as follows.

4.2 m arch rock drift

620 m ÷ 706,000 tons = 0.88 m/1,000 t

4.2 m arch seam road

4,040 m ÷ 706,000 tons = 5.72 m/1,000 t

2.4 m x 2.4 m seam road

4,200 m ÷ 706,000 tons = 5.98 m/1,000 t

Table 1-48 Performance of excavation in the current operating area

Year		1980	1981	1982	1983	1984-2005
Coal output (raw coal) (10^3t)		99	133	198	198	265
Performance (m)	4.2m arch rock drift	87	117	174	174	233
	4.2m arch seam road	566	761	1,133	1,133	1,516
	2.4m×2.4m seam road	592	795	1,184	1,184	1,585
	Total	1,245	1,673	2,491	2,491	3,334

An unit consumption of materials and unit price are employed the same as those in the planning area. (Refer to Table 1-49)

(2)-3 Others

The total expenses in the underground in 1979 excluding the labor cost were recorded at 136,517,486 Rp. Of these, the other expenses except for mining and excavating were 52,917,276 Rp. Converting it into US$, it corresponds 85,000 US$. During the period of increase in production from 1980 to 1984, these expenses shall increase at an annual rate of 10%.

Table 1-49 MATERIAL COST FOR ROAD EXCAVATION

				Unit consumption	Unit price	1980	1981	1982	1983	1984~2005
4.2m arch rock drift	Performance		m			87	117	174	174	233
	Material cost	Explosive	US$ 10^3	14.41	2.86	4	5	7	7	10
		Detonator	〃	48	0.91	4	5	8	8	10
		Steel frame	〃	241.1	0.58	12	16	24	24	33
		Timber	〃	0.32	12.90	0	0	1	1	1
		Rail	〃	4.0	13.97	5	7	10	10	13
		Pipe 4 inch	〃	1	7.12	1	1	1	1	2
		Pipe 2 inch	〃	2	3.49	1	1	1	1	2
		Sleeper	〃	4	1.41	0	1	1	1	1
		Others	〃	(17%)		5	6	9	9	12
		Total	〃			32	42	62	62	84
4.2m arch seam road	Performance		m			566	761	1,133	1,133	1,516
	Material cost	Explosive	US$ 10^3	3.53	2.86	6	8	11	11	15
		Detonator	〃	18	0.91	9	12	19	19	25
		Steel frame	〃	241.1	0.58	79	106	158	158	212
		Timber	〃	0.53	12.90	4	5	8	8	10
		Rail	〃	2.0	13.97	16	21	32	32	42
		Pipe 2 inch	〃	1	3.49	2	3	4	4	5
		Pipe 1 inch	〃	2	2.16	2	3	5	5	7
		Sleeper	〃	2	1.41	2	2	3	3	4
		Others	〃	(17%)		20	27	41	41	54
		Total	〃			140	187	281	281	374
2.4mx2.4m seam road	Performance		m			592	795	1,184	1,184	1,585
	Material cost	Explosive	US$ 10^3	2.28	2.86	4	5	8	8	10
		Detonator	〃	12	0.91	6	9	13	13	17
		Steel frame	〃	—	—					
		Timber	〃	1.02	12.90	8	10	16	16	21
		Rail	〃	—	—					
		Pipe 2 inch	〃	1	3.49	2	3	4	4	6
		Pipe 1 inch	〃	2	2.16	3	3	5	5	7
		Sleeper	〃	—	—					
		Others	〃	(17%)		4	5	8	8	10
		Total	〃			27	35	54	54	71
Grand total			〃			199	264	397	397	529

Table 1-50 Other expenses

(10³US$)

Year	1980	1981	1982	1983	1984-2005
Other expenses	85	94	103	103	113

The cost of spare parts will be calculated in the same way with that in the planning area. The disbursement shall take place only from 1983 when the equipments are put to full operation.

Table 1-51 Estimation of annual spare parts cost (10³US$)

	Repair factor (%)	Amount of investment	Spare parts	Import duty	Total
Drum shearer	12	750	90	27	117
Shield support	10	5,340	534	160	694
Power pack	10	160	16	5	21
Face chain conveyor	5	590	30	9	39
Stage loader	5	120	6	2	8
Gate chain conveyor	5	60	3	1	4
Side dump loader	10	300	30	9	39
Section belt conveyor	3	1,150	35	10	45
Total			744	223	967

Electricity used in Ombilin Coal Mines is all generated by home coal of Ombilin. Such coal for generating electricity will be earmarked for the cost in recognition that it is for domestic consumption. It will be further discussed later.

(3) Expenses for the surface operations - general expenses

General expenses cover all the costs (excluding the labor cost) other than 1) and 2), including those arising in the surface of the planning area.

The figure for 1979 was estimated at 422,349,000 Rp according to the data of Ombilin Coal Mine. It corresponds to 681,000 US$.

During the period from 1980 to 1989 when all the Ombilin Coal Mine increase output, these expenses shall increase at an annual rate of 2%.

Table 1-52 Annual general expenses

(10^3US$)

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989-2005
General expenses	681	695	709	723	737	752	767	782	798	814

(4) Coal for own consumption

As mentioned before, all the electricity in Ombilin Coal Mine is independently generated by Ombilin Coal. Such coal will, thus, be assessed and earmarked for the cost. About 15,000 tons of coal are consumed a year mainly for power generation at present in the Ombilin Coal Mine.

Considering the electric consumption both in the planning and the current operating area, calorific value of coal and power generating efficiency, the annual required amount of coal for own consumption is calculated and it is shown in Table 1-53. This amount is available from 1,000,000 tons of annual output.

Table 1-53 Annual required amount of coal for own consumption

(10^3t)

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988 ~ 2005
Current operating area	15	15	15	15	15	15	15	15	15
" (additional)				5	5	5	5	5	5
Planning area							20	20	40
Total	15	15	15	20	20	20	40	40	60

An assessed amount of 22 US$ per ton of coal is applied based on the domestic market price

9.2.7 Depreciation

Open-cut and underground minig equipment described in 9.2.5 are the objects of depreciation.

Calculation of depreciation is made in the same way with that of the planning area, although that of the open-cut equipment was made in conformity with "Review report". According to the report, the same amount of depreciation will be earmarked every year since the equipment is renewed on the same cycle as the duration. Table 1-54 and Table 1-55 show the depreciation amounts of open-cut and underground equipment respectively.

Table 1-54 Annual depreciation cost of open-cut equipment

		Capital cost (10^3US$)	Durable year (year)	Depreciation (10^3US$)
Overburden removal	35 T dump truck	2,088	9	232
	Bulldozer (300HP)	1,507	5	301
	Wheel scraper	975	7	139
	Hydraulic shovel	453	8	57
	F.E. wheel loader	269	5	54
	Blast hole rig	216	10	22
Coal handling	F.E. crawler loader	172	7	24
	Bulldozer (62HP)	45	13	3
	Coal truck (8t)	344	8	43
General	Plat form truck (7t)	48	11	4
	Personnel carrier	46	10	5
	Tipper truck	48	10	5
	Land rovers	62	8	8
	10t mobile crane	128	15	9
	Lubrication truck	71	11	6
	Water sprinkler truck	52	8	6
	Fuel truck	55	11	5
	Road grader	163	5	33
	Maintenance work shop	481	40	12
Total				968

Table 1-55 DEPRECIATION COST OF CURRENT OPERATING AREA (Underground)

		Durable year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Underground	Drum shearer	10		75	75	75	75	75	75	75	75	75	75	75	75	75	75
	Shield support	8		668	668	668	668	667	667	667	667	668	668	668	668	667	667
	Power pack	7		23	23	23	23	23	23	22	23	23	23	23	23	23	22
	Face chain conveyor	7		84	84	84	84	84	85	85	84	84	84	84	84	85	85
	Stage loader	6		20	20	20	20	20	20	20	20	20	20	20	20	20	20
	Gate chain conveyor	7		9	9	9	9	8	8	8	9	9	9	9	8	8	8
	Side dump loader	8	38	38	38	38	37	37	37	37	38	38	38	38	37	37	37
	Section belt conveyor	9		128	128	128	128	128	128	128	127	127	13	26	39	39	39
Total			38	1,045	1,045	1,045	1,044	1,042	1,043	1,042	1,043	1,044	930	943	954	954	953

(10³US$)

1997	1998	1999	2000	2001	2002	2003	2004	2005	Total
75	75	75	75	75	75	75	75	75	1,725
667	667	668	668	668	668	667	667	667	15,353
23	23	23	23	23	23	22	23	23	526
84	84	84	84	84	85	85	84	84	1,938
20	20	20	20	20	20	20	20	20	460
9	9	9	9	8	8	8	9	9	198
37	38	38	38	38	37	37	37	37	900
39	39	38	37	37	38	39	39	39	1,651
954	955	955	954	953	954	953	954	954	22,751

9.3 Collective Table of the Cost of Production

All the items of the cost of production are summarized in Table 1-56 by year. The prices are based on those as of 1980, given no consideration to the price escalation.

Table 1-56 SUMMARY OF COAL PRODUCTION COST AT MINE

Item	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Clean coal production (10^3 t) – Current operating area – Open cut	66	87	132	132	175	175	175	175	175	175	175	175	175
Clean coal production – Current operating area – Underground	84	113	168	168	225	225	225	225	225	225	225	225	225
Clean coal production – Current operating area – Sub total	150	200	300	300	400	400	400	400	400	400	400	400	400
Clean coal production – Planning area (U/G)							150	300	450	600	600	600	600
Clean coal production – Total	150	200	300	300	400	400	550	700	850	1,000	1,000	1,000	1,000
Operating cost* (10^3 $) – Labor cost – Current operating area – Open cut	155	155	155	155	155	155	155	155	155	155	155	155	155
Labor cost – Current operating area – Underground	576	576	576	527	437	408	408	408	408	408	408	408	408
Labor cost – Current operating area – Sub total	731	731	731	682	592	563	563	563	563	563	563	563	563
Labor cost – Planning area							443	582	607	650	650	650	650
Labor cost – Surface and others	818	818	878	769	716	716	716	716	716	716	716	716	716
Labor cost – Total	1,549	1,549	1,549	1,451	1,308	1,279	1,722	1,861	1,886	1,929	1,929	1,929	1,929
Maintenance cost – Current operating area – Open cut – Spare parts	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475
Maintenance cost – Open cut – Explosive	54	71	108	108	143	143	143	143	143	143	143	143	143
Maintenance cost – Open cut – Fuel and lubricant	331	331	331	331	331	331	331	331	331	331	331	331	331
Maintenance cost – Open cut – Sub total	1,860	1,877	1,914	1,914	1,949	1,949	1,949	1,949	1,949	1,949	1,949	1,949	1,949
Maintenance cost – Underground – Coal getting	50	67	100										
Maintenance cost – Underground – Development	199	264	397	397	529	529	529	529	529	529	529	529	529
Maintenance cost – Underground – Spare parts				967	967	967	967	967	967	967	967	967	967
Maintenance cost – Underground – Others	85	94	103	103	113	113	113	113	113	113	113	113	113
Maintenance cost – Underground – Sub total	334	425	600	1,467	1,609	1,609	1,609	1,609	1,609	1,609	1,609	1,609	1,609
Maintenance cost – Current operating area – Total	2,194	2,002	2,514	3,381	3,558	3,558	3,558	3,558	3,558	3,558	3,558	3,558	3,558
Maintenance cost – Planning area – Coal getting							79	160	79	79	79	79	79
Maintenance cost – Planning area – Development							1,412	1,412	1,412	1,412	1,412	1,412	1,412
Maintenance cost – Planning area – Spare parts							2,011	2,011	2,011	2,011	2,011	2,011	2,011
Maintenance cost – Planning area – Others							229	252	277	305	305	305	305
Maintenance cost – Planning area – Total							3,731	3,835	3,779	3,807	3,807	3,807	3,807
Maintenance cost – Common expenses	681	695	709	723	737	752	767	782	798	814	814	814	814
Maintenance cost – Own use coal	330	330	330	440	440	440	880	880	1,320	1,320	1,320	1,320	1,320
Maintenance cost – Grand total	3,205	3,327	3,553	4,544	4,735	4,750	8,936	9,055	9,455	9,499	9,499	9,499	9,499
Depreciation – Current operating area – Open cut	968	968	968	968	968	968	968	968	968	968	968	968	968
Depreciation – Current operating area – Underground			38	1,045	1,045	1,045	1,044	1,042	1,043	1,042	1,043	1,044	930
Depreciation – Current operating area – Sub total	968	968	1,006	2,013	2,013	2,013	2,012	2,010	2,011	2,010	2,011	2,012	1,898
Depreciation – Planning area							2,556	2,910	3,688	3,723	3,762	3,070	3,208
Depreciation – Total	968	968	1,006	2,013	2,013	2,013	4,568	4,920	5,699	5,733	5,773	5,082	5,106
Operating cost	5,722	5,844	6,108	8,008	8,056	8,042	15,226	15,836	17,040	17,161	17,201	16,510	16,534
($/t)	38.15	29.22	20.36	26.69	20.14	20.11	27.68	22.62	20.05	17.16	17.20	16.51	16.53

Item	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Clean coal production (10^3 t) – Current operating area – Open cut	175	175	175	175	175	175	175	175	175	175	175	175	175
Clean coal production – Current operating area – Underground	225	225	225	225	225	225	225	225	225	225	225	225	225
Clean coal production – Current operating area – Sub total	400	400	400	400	400	400	400	400	400	400	400	400	400
Clean coal production – Planning area (U/G)	600	600	600	600	600	600	600	600	600	600	600	600	600
Clean coal production – Total	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Operating cost* (10^3 $) – Labor cost – Current operating area – Open cut	155	155	155	155	155	155	155	155	155	155	155	155	155
Labor cost – Current operating area – Underground	408	408	408	408	408	408	408	408	408	408	408	408	408
Labor cost – Current operating area – Sub total	563	563	563	563	563	563	563	563	563	563	563	563	563
Labor cost – Planning area	650	650	650	640	640	640	640	640	640	640	640	640	640
Labor cost – Surface and others	716	716	716	716	716	716	716	716	716	716	716	716	716
Labor cost – Total	1,929	1,929	1,929	1,919	1,919	1,919	1,919	1,919	1,919	1,919	1,919	1,919	1,919
Maintenance cost – Current operating area – Open cut – Spare parts	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475	1,475
Maintenance cost – Open cut – Explosive	143	143	143	143	143	143	143	143	143	143	143	143	143
Maintenance cost – Open cut – Fuel and lubricant	331	331	331	331	331	331	331	331	331	331	331	331	331
Maintenance cost – Open cut – Sub total	1,949	1,949	1,949	1,949	1,949	1,949	1,949	1,949	1,949	1,949	1,949	1,949	1,949
Maintenance cost – Underground – Coal getting													
Maintenance cost – Underground – Development	529	529	529	529	529	529	529	529	529	529	529	529	529
Maintenance cost – Underground – Spare parts	967	967	967	967	967	967	967	967	967	967	967	967	967
Maintenance cost – Underground – Others	113	113	113	113	113	113	113	113	113	113	113	113	113
Maintenance cost – Underground – Sub total	1,609	1,609	1,609	1,609	1,609	1,609	1,609	1,609	1,609	1,609	1,609	1,609	1,609
Maintenance cost – Current operating area – Total	3,558	3,558	3,558	3,558	3,558	3,558	3,558	3,558	3,558	3,558	3,558	3,558	3,558
Maintenance cost – Planning area – Coal getting	79	79	79	79	79	79	79	79	79	79	79	79	79
Maintenance cost – Planning area – Development	1,412	1,412	1,412	1,412	1,412	1,412	1,412	1,412	1,412	1,412	1,412	1,412	1,412
Maintenance cost – Planning area – Spare parts	2,011	2,011	2,011	2,011	2,011	2,011	2,011	2,011	2,011	2,011	2,011	2,011	2,011
Maintenance cost – Planning area – Others	305	305	305	305	305	305	305	305	305	305	305	305	305
Maintenance cost – Planning area – Total	3,807	3,807	3,807	3,807	3,807	3,807	3,807	3,807	3,807	3,807	3,807	3,807	3,807
Maintenance cost – Common expenses	814	814	814	814	814	814	814	814	814	814	814	814	814
Maintenance cost – Own use coal	1,320	1,320	1,320	1,320	1,320	1,320	1,320	1,320	1,320	1,320	1,320	1,320	1,320
Maintenance cost – Grand total	9,499	9,499	9,499	9,499	9,499	9,499	9,499	9,499	9,499	9,499	9,499	9,499	9,499
Depreciation – Current operating area – Open cut	968	968	968	968	968	968	968	968	968	968	968	968	968
Depreciation – Current operating area – Underground	943	954	954	953	954	955	955	954	953	954	953	954	954
Depreciation – Current operating area – Sub total	1,911	1,922	1,922	1,921	1,922	1,923	1,923	1,922	1,921	1,922	1,921	1,922	1,922
Depreciation – Planning area	3,154	3,063	3,097	3,001	3,064	3,158	3,186	3,194	3,255	3,275	3,294	2,661	2,690
Depreciation – Total	5,065	4,985	5,019	4,922	4,986	5,081	5,109	5,116	5,176	5,197	5,215	4,583	4,612
Operating cost	16,493	16,413	16,447	16,340	16,404	16,499	16,527	16,534	16,594	16,615	16,633	16,001	16,030
($/t)	16.49	16.41	16.45	16.34	16.40	16.00	16.53	16.53	16.59	16.62	16.63	16.00	16.03

CHAPTER II

COAL STORAGE AND SHIPLOADING

CHAPTER 2. STORING AND SHIPLOADING FACILITIES FOR COAL

1. INTRODUCTION

This planning is for the storing and shiploading facilities of coal at port area which form a part of coal development plan through the rehabilitation of Sawahlunto (Ombilin) mine in West-Sumatra State, Indonesia. These facilities are to be built up from a view point of long-range plan at Teluk Bayur port area in Padang district, a principal district with important ports in West-Sumatra state.

Coal produced at Ombilin mine is transported by the existing rail-road to Padang and Teluk Bayur via Padang Panjang. The facilities mentioned herein comprise of wagon discharging facility, stacking facility, storage yard, reclaiming facility and dockside facilities including shiploader for the handling of coal transported by rail-road. Part of the coal is separated at Bukit Putus station, 1.8 km this side of Teluk Buyur station and transported to the cement factory in Indarung district by rail-road, and thus the remaining part of coal is loaded onto ship at Teluk Buyur port. Therefore, planning for these facilities must be made taking account of expansion of cement factory at Indarung as well as development in coal mine. In the planning explained hereinafter, handling cost to be added to the cost of coal will be minimized with the minimum amount of investment by utilizing as many existing facilities as possible.

2. EXISTING FACILITIES

2.1 Wagon Discharging and Coal Storage Facilities

In the port area of Teluk Bayur there remain some old facilities of P.N. TAMBANG BATUBARA. These facilities were built up about seventy years ago to shipload the coal, but now they are not operated. These facilities are such that wagons transporting coals are carried onto the top of silo, and that coal is discharged from wagon directly into the silo and stored there. There exist two silos (Photograph 2-1). Coal is reclaimed from the silos, loaded on wagons, transported to the jetty of the port and then discharged into ship through the chute of a shiploader. Fig. 2-1 and Fig. 2-2 illustrate the layout of the facilities.

One of the two silos has thirty-eight rooms and has the total storing capacity of 8,550T, each room having capacity of 225T.

This silo is repaired by partial reinforcement, nevertheless further inspection and/or repair will be required for the actual use.

The other silo has thirty-two rooms and has total storing capacity of 5,600T, each room having capacity of 175T. However, it seems that this silo cannot be used any more due to its heavy damage because no maintenance has been made since this silo ceased to be operated.

Repair of hinge of a loading chute will be required for the operation of the chute which is installed at the side wall of the silo to discharge coal from silo onto wagons. Although there remain some old rail-road tracks inside the silo area, replacement of those rails will also be required.

There is a mountain in the vicinity of silo area. After the rail-road tracks which ran along this mountain had been removed, a new road of 3 m width is now under construction. There is a railway bridge from the end of this new road to the jetty. However, rails and sleepers have been removed and maintenance work such as repainting is not carried out.

On the other hand, there are some wooden jetties and concrete jetties in the port, however, no ocean-going vessel can be berthed at these wooden jetties.

Beside the aforesaid existing facilities, it is noted that the area for petroleum terminal (Photograph 2-2) will be available if necessary for coal storage yard, because the petroleum terminal is planned to be shifted to another location during the year of 1981 - 1982. The rental cost of this area is RP 350/m^2 (1980 basis). If the petroleum terminal is removed, the mooring bouy for tunkers which exists in the offing of the petroleum terminal will become unnecessary and therefore, construction of new shiploading wharf will be feasible around this port area.

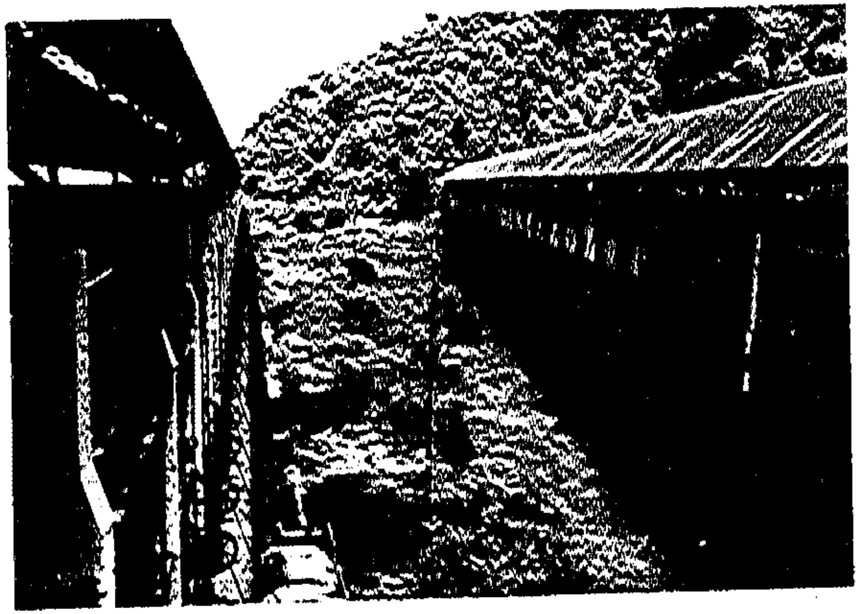


Photo2-1

Photo2-2

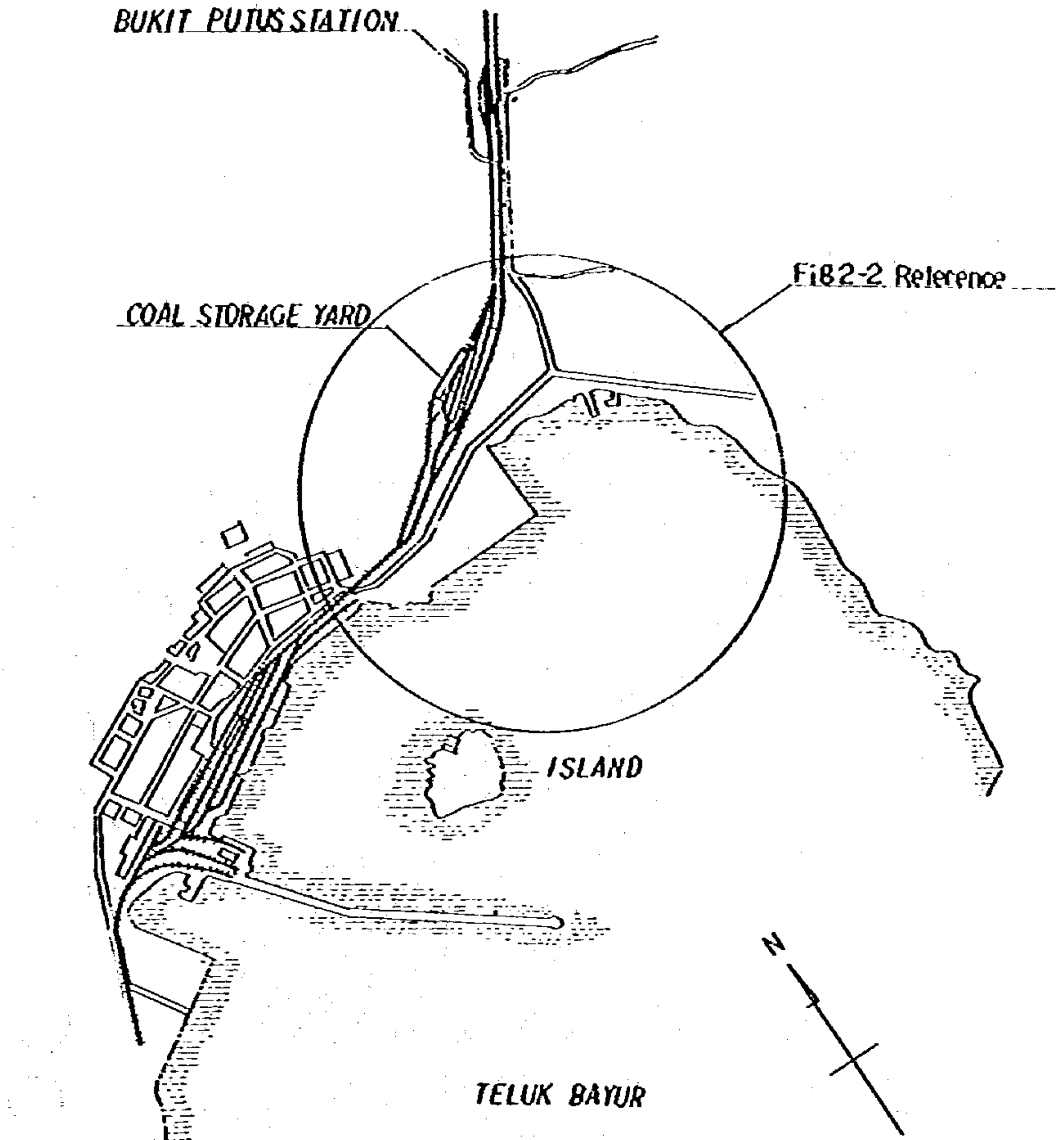


Fig 2-1 ARRANGEMENT OF THE FACILITIES

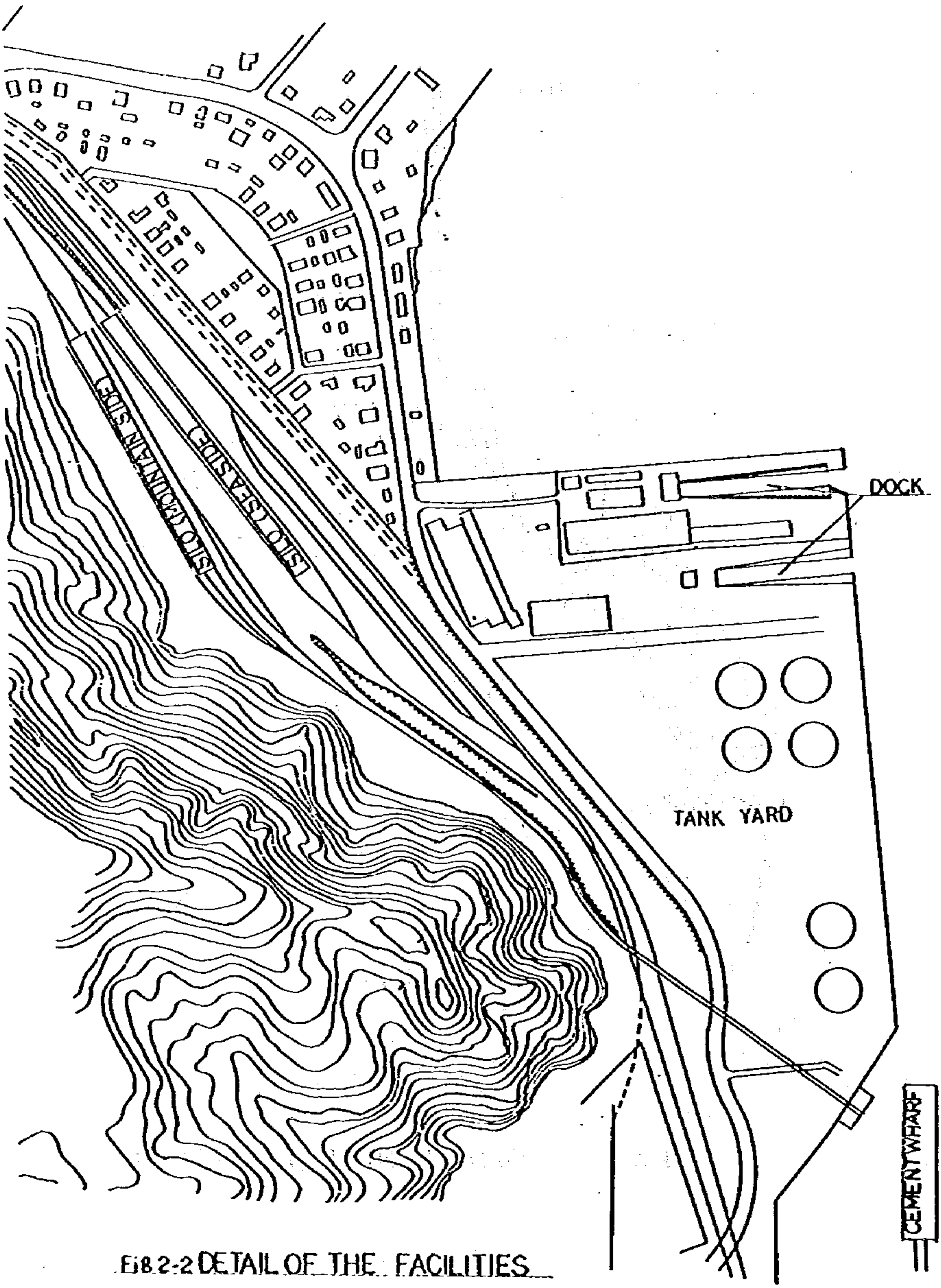


Fig.2-2 DETAIL OF THE FACILITIES

2.2 Port Facilities

2.2.1 Mooring facilities

1) Exclusive cement berth:

Type	Steel pipe pile type
Length	100 m
Width	18 m
Water depth	7 ∿ 9 m

2) Exclusive oil dolphine:

For white oil; 2.7 m 10 m, Water depth 7 ∿ 8 m

For black oil; 6 m, Water depth 7 ∿ 8 m

3) General cargo berth:

	(length)	(water depth)
Concrete berth	150 m	7 ∿ 9 m
Wooden berth I	120 m	7 ∿ 9 m
Wooden berth II	108 m	7 ∿ 9 m
Wooden berth III	108 m	7 ∿ 9 m
Wooden berth IV	96 m	7 ∿ 9 m

2.2.2 Land facilities

1)	Transit shed 101A	1,180 m^2
	Transit shed 101B	976 m^2
	Transit shed 102	2,000 m^2
	Transit shed 103	2,000 m^2
	Transit shed 104	1,954 m^2
2)	Warehouse 201	1,074 m^2
	Warehouse 202	320 m^2
	Warehouse (dangerous article)	320 m^2
3)	Open storage yard 101	1,348 m^2
	Open storage yard 102	987 m^2
	Open storage yard 103	858 m^2
	Open storage yard 104	1,000 m^2
	Open storage yard (dermage beton)	1,588 m^2
	Open storage yard 201	880 m^2

2.2.3 Material handling machines

1)	Fork lift 2.5 t	3 sets
	Fork lift 5 t	4 sets
	Fork lift 7 t	2 sets
	Fork lift 10 t	1 set
2)	Mobile crane 15 t	1 set
3)	Portable crane 6 t	1 set

2.2.4 Others

1)	Tugboat 235 HP	1 vessel
	Tugboat 235 HP	1 vessel
	Tugboat 1700 HP	1 vessel
2)	Pilot boat 180 HP	1 vessel
3)	Mooring boat 82 HP	1 vessel
4)	Dry dock 200 t	
	Slipway dock 20 t and 200 t	
5)	Electrical facilities TR I	100 KWA
	Electrical facilities TR II	100 KWA
	Electrical facilities TR III	250 KWA
	Electrical facilities TR IV	50 KWA
	Electrical facilities TR V	50 KWA

3. CONDITIONS FOR PLANNING

3.1 Materials to be Handled

3.1.1 Kind of materials	Ombilin Coal
3.1.2 Bulk density	0.8 t/m^3
3.1.3 Moisture content	8 %
3.1.4 Lump size	- 40 mm

3.2 Annual Production of Coal

(Million ton)

Year	Production Plan	Consumption at the Mine	Transportation by Rail-road	Consumption at the the Cement Factory	Quantity Shiploaded
1980	15	1.5	13.5	12.5	1.0
1981	20	"	18.5	14.0	4.5
1982	30	"	28.5	23.5	5.0
1983	30	2.0	28.0	23.5	4.5
1984	40	"	38.0	33.0	5.0
1985	40	"	38.0	33.0	5.0
1986	55	4.0	51.0	33.0	18.0
1987	70	"	66.0	33.0	33.0
1988	85	6.0	79.0	33.0	46.0
1989	100	"	94.0	33.0	61.0
1990	100	"	94.0	33.0	61.0
1991	100	"	94.0	33.0	61.0

3.3 Climatic Conditions

3.3.1 Wind conditions at Teluk Bayur Port
(Actual record during the past 9 years)

1)	Average wind velocity	2.3 m/sec.
2)	Most frequent wind direction at average velocity (to the north counterclockwise)	260° ~ 270°
3)	Average velocity of a gust	11.7 m/sec.
4)	Most frequent wind direction of a gust (to the north counterclockwise)	270° ~ 330°

5) Maximum wind velocity — 20.6 m/sec.

6) Most frequent wind direction at the maximum wind velocity (to the north counterclockwise) — 210° ~ 340°

3.3.2 Rainfall (Record of 1979)

1) Annual rainfall — 4,076 mm

2) Annual rainy days — 177 days

3) Maximum rainfall per day — 230 mm

3.3.3 Tide level

1) Designed high water level — +1.93 m

2) Designed low water level — ± 0 m

3.4 Other conditions

3.4.1

1) Max. D.W.T. of coal carrier: Dmax 15,000 D.W.T.

2) Average D.W.T. of coal carrier: Dmean 8,000 D.W.T.

3) Min. D.W.T. of coal carrier: Dmin 5,000 D.W.T.

4) Dimensions of coal carrier
Dimensions of maximum, average and minimum size of coal carriers are presumed as follows.

Table 2-2

D.W.T.	Length L (m)	Breadth B (m)	Depth D (m)	Full Draft d_F (m)	Empty Draft d_L (m)	Hatch Width b (m)	Nos. of Hatch
15,000	145	22.0	12.2	8.5	2.2	9.8	4
8,000	117	16.0	8.9	6.8	2.0	7.0	3
5,000	100	14.5	7.6	6.4	1.8	7.0	2

* Minimum draft at the time of shiploading will be 1/3 dF.

3.4.2 Working conditions

1)	Annual working days :	W_H		350 days
2)	Working hours per day :	H_W	24 hours (3 shift)	20 hours (Actual working hrs.)
3)	Hours for arrival in and departure from port (working hours of pilot)			24 hours

3.4.3 Rail-road wagons

1)	Gauge	1,067 mm
2)	Height	3,200 mm
3)	Total length (buffer to buffer)	10,650 mm
4)	Wheel spacing	1,600 mm
5)	Bogie spacing	5,700 mm
6)	Loading capacity	25 t (23 t: in case of coal)

3.4.4 Soil conditions (port area)

- 9.00 ～ - 35.00	clay N = 3	(estimated)
- 35.00 ～	rock N > 50	

3.4.5 Seismic coefficient

Horizontal seismic coefficient (Kh)	0.1
Vertical seismic coefficient (Kv)	0.0

4. OUTLINE OF THE FACILITIES

4.1 General

The facilities explained in this section are the complex of coal handling facilities consisting of the following machineries and equipment.

- Wagon discharging facility to unload coal from rail-road wagon and stock coal in the storage yard
- Reclaiming facility to reclaim the coal in the storage yard and transport the coal to shiploading facility at the wharf
- Shiploading facility to load the coal onto the ship berthed along the jetty side.

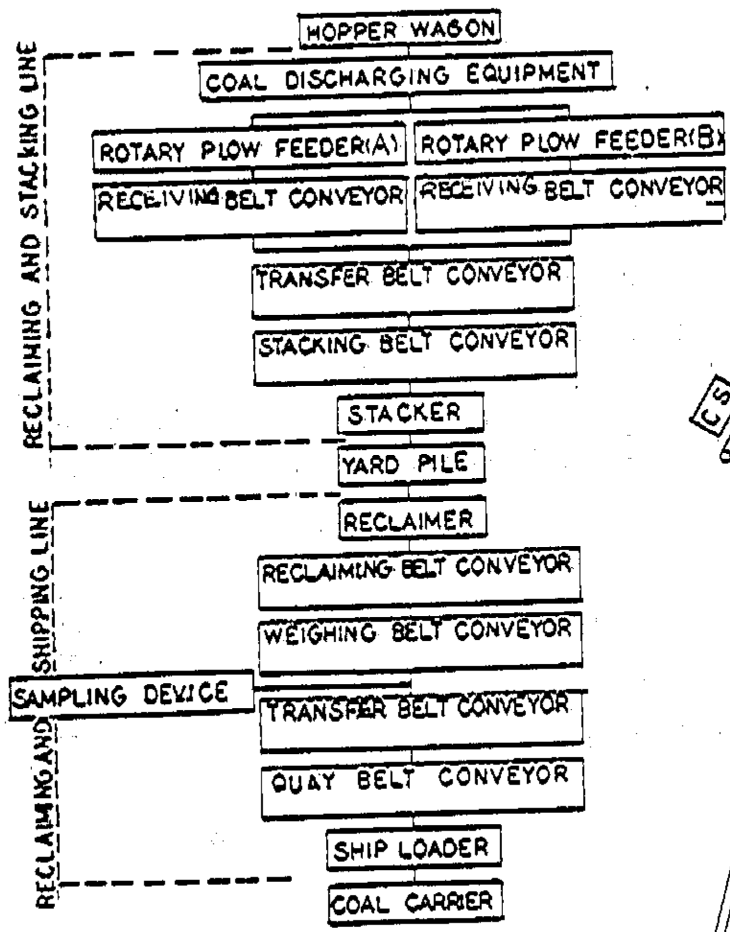
Fig. 2-3 shows the flow of coal and the general layout of the facilities will be illustrated in Fig. 2-11.

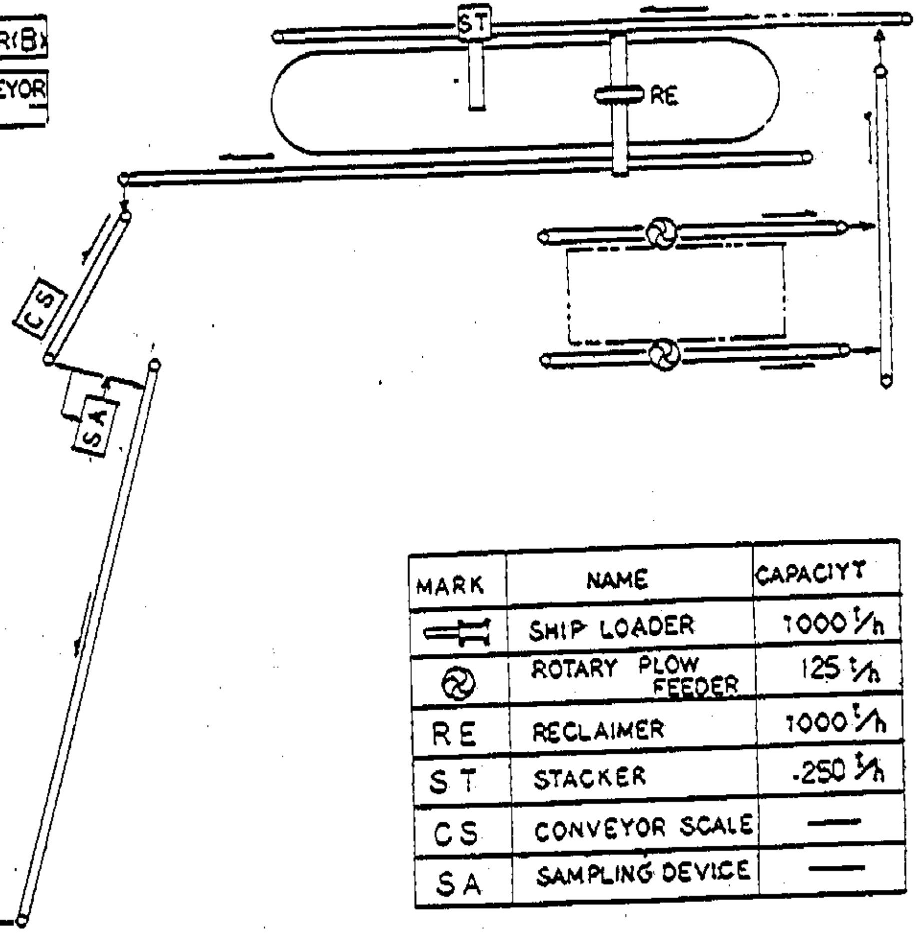
The coal transported by hopper wagon is discharged into silo by openning hopper gate by manual operation and stored temporarily. The outlet of silo will be constructed so that the coal will be prevented from spilling by the effect of its repose angle.

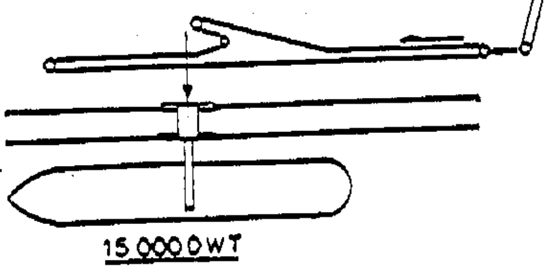
Coal is reclaimed by rotary plow feeders which are remote-controlled from the supervisory control room, transported by belt conveyors and then stored in the storage yard by stacker. The stacker can also be operated through remote control from the supervisory control room, once initial stacking position of the stacker is fixed by manual operation.

For the belt conveyor from silo to stacker, a weighing scale will be provided to control the quantity of coal to be stacked in the storage yard.

When a coal carrier comes to the port, coal stacked in the storage yard is reclaimed by reclaimer, transported by belt conveyors and loaded onto the carrier by shiploader. For the belt conveyor from reclaimer to shiploader a sampling equipment and a weighing scale will be provided to check the quantity of coal discharged in the vessel, and also to take the increment of coal during shiploading operation in order to analyze and control the quality of coal at the existing laboratory.







MARK	NAME	CAPACIYT
(ship loader symbol)	SHIP LOADER	1000 t/h
(rotary plow feeder symbol)	ROTARY PLOW FEEDER	125 t/h
RE	RECLAIMER	1000 t/h
ST	STACKER	250 t/h
CS	CONVEYOR SCALE	—
SA	SAMPLING DEVICE	—

Fig 2-3 FLOW SHEET

4.2 Coal Discharging Equipment

The existing coal discharging equipment can be utilized by repairing some part of the silo.

1)	Storing capacity (For one day):	approx. 2,000 t
2)	No. of wagons to be discharged at the same time:	2 wagons/line
3)	No. of lines to be discharged :	2 lines

4.3 Coal Reclaiming Equipment — 2 Nos.

1)	Type	Rotary plow feeder
2)	Capacity	65 t/h ∿ 125 t/h

4.4 Coal Storing Facility

4.4.1 Coal storage yard — 1 bed

1)	Type of coal storage	Outdoor bedding
2)	Dimension of pile	
	Width :	23 m
	Length :	Approx. 233 m
	Height :	Approx. 12.7 m
3)	Capacity	Approx. 30,000 t

4.4.2 Stacker — 1 Unit

1)	Capacity	250 t/h
2)	Type	Single wing type
3)	Span	4.5 m

4.4.3 Belt conveyor — 1 set

1)	Stacking conveyor	1 Unit
	Capacity :	250 t/h
	Belt width :	750 mm
	Length :	250 m

2) Relay conveyor (with weighing scale) — 1 Unit

Capacity	:	250 t/h
Belt width	:	750 mm
Length	:	53 m

3) Reclaiming conveyor — 2 Units

Capacity	:	125 t/h
Belt width	:	600 mm
Length	:	60 m

4.5 Reclaiming and Shiploading Facility

4.5.1 Reclaimer — 1 Unit

1) Capacity — 1,000 t/h

2) Type — Bridge type, reversible bucket-wheel type reclaimer with harrow

4.5.2 Belt conveyor — 1 set

1) Reclaiming conveyor — 1 Unit

Capacity	:	1,000 t/h
Belt width	:	1,200 mm
Length	:	268 m

2) Weighing conveyor (with weighing scale and sampler) — 1 Unit

Capacity	:	1,000 t/h
Belt width	:	1,200 mm
Length	:	25 m

3) Transfer conveyor — 1 Unit

Capacity	:	1,000 t/h
Belt width	:	1,200 mm
Length	:	318 m

4) Jetty conveyor (for shiploading) — 1 Unit

Capacity	:	1,000 t/h
Belt width	:	1,200 mm
Length	:	184 m

4.5.3 Shiploader — 1 Unit

1)	Type	Travelling and slewing boom derricking type (with telescopic chute)
2)	Capacity	1,000 t/h
3)	Outreach (from berthing line)	16 m

4.6 Electrical Facilities — 1 set

1)	Electric substation	1 set
	Incoming 3 kV 50 Hz	kVA
2)	Supervisory control equipment	1 set
3)	Electrical equipment for each machinery and equipment	1 set
4)	Communication system	1 set
5)	Lighting system	1 set
6)	Emergency power supply system	1 set

4.7 Approaching Facilities

4.7.1 Mooring wharf

A mooring wharf should be constructed in parallel with the existing oil base berth.

1)	Berth type	Batter piled mooring wharf
2)	Berth length	200 m
3)	Berth width	20 m
4)	Cope level	+2.5 m
5)	Superstructure	Reinforced concrete
6)	Sub-structure	Steel pipe pile, 500 ∅

4.7.2 Transfer bridge

1)	Bridge type	P.C. girder bridge
2)	No. of bridges	2
3)	Dimensions (L x W)	24 m x 10 m, 12 m x 10 m

4)	Superstructure	Post-tension girder
5)	Sub-structure	Steelpipe pile

4.7.3 Accessory facilities

1)	Rubber dock fender	1,500 L x 500 H x 40 pcs.
2)	Bollard	350 ∅ x 50 t x 10 pcs.
3)	Concrete curb	505 m x 150 mmH
4)	Lighting	16 points
5)	Protective coating	216 m, for steelpipe piles
6)	Others including handrails, stairs, painting, etc.	Lump sum

4.8 Control Building

A reinforced-concrete building of three stories should be constructed for the control and maintenance of the coal storage yard and facilities.

1)	First floor	Electric substation,	150 m^2
2)	Second floor	Office room,	150 m^2
3)	Third floor	Control room,	150 m^2

5. PRELIMINARY DESIGN

5.1 Coal Mooring Wharf

The existing port is congested, so this port shall be improved for further development of the region.

Accordingly, an exclusive mooring wharf for coal should be planned in full consideration of necessary extension of the port in near future.

5.1.1 Scale of activity of the port

1) Yearly amount of cargo:

Data on yearly amount of cargo handled in the port in 1979 are as following.

a)	Loading	254,789 tons
		62,677 persons
		301,160 log/m^3
b)	Unloading	331,163 tons
		65,412 persons

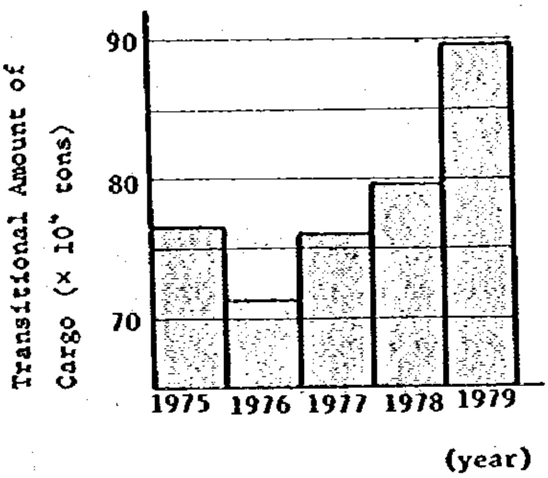
2) Yearly entrance of vessels:

Data of yearly entrance of vessels recorded in the port in 1978 are as following.

a)	Ocean ship	No. of vessels	201 (1,605,574 DWT)
		Unloading	92,994 tons
		Loading	418,375 tons
b)	Interinsular ship	No. of vessels	358 (350,400 DWT)
		Unloading	159,858 tons
		Loading	122,293 tons
c)	Domestic passenger ship	No. of vessels	74 (120,600 DWT)
		No. of passengers	40,171 ashore
			27,999 on board
d)	Tanker	No. of vessels	113 (454,708 DWT)
			265,772 tons
e)	Local ship	No. of vessels	1,834
		Unloading	17,323 tons
		Loading	43,836 tons

3) Handling amount of cargo:

Yearly handling amount of cargo in the port is shown below in graph for the past five years. The growth in yearly amount has reached 16% in 1979 as based on 1975, or 24% as based on 1976. There can be seen an average growth of 7.5%.



Yearly amount of cargo, 1975 to 1979

4) Summary:

Yearly amount of unloaded cargo is substantially balanced with that of loaded cargo, while the former is somewhat prevailing over the latter. With respect to yearly entrance of vessels, the ocean ship as averaged in tonnage is about 8,000 DWT and by far leading other types of vessel, which are small ships of sizes under 4,000 tons in average. Also in yearly amount of cargo, the ocean ship is highest, thus characterizing the port to be a trade port of medium-sized ocean-going vessels. Moreover, the yearly amount of cargo is rising at an average rate of 7.5%, thus assuring an increasing importance of the port as a base of marine transportation.

5.1.2 Future plan of berth

1) General cargo berth:

Yearly amount of cargo handled in the port is growing at a rapid rate as described in Sec. 5.1.1. With such a rapid growth, the length of berth will run short.

When assuming standard yearly amount of cargo for berth length to be 800 tons/m/year, in the case of 1979 where in the cargo amounted to 887,114 tons,

necessary berth length $L_1 = \frac{887,114}{800} \fallingdotseq 1,100$ m,

existing berth length $L_2 =$ 582 m, and

want of berth length $L_0 = 1,100 - 582 \fallingdotseq 500$ m.

As shown above, even the present berth is about 500 m short in total length. Hence, without construction of new general cargo berth, there will be resulted impossibility of control.

2) Cement berth:

The planned amount of coal for use in cement production permits a cement production plan to be estimated as shown in the table below.

Cement Production Plan

	Indarung I	II	III	IV	Total
1980	330,000	600,000	-	-	930,000
1981	330,000	720,000	-	-	1,050,000
1982	330,000	720,000	720,000	-	1,770,000
1983	330,000	720,000	720,000	-	1,770,000
1984	330,000	720,000	720,000	720,000	2,490,000
1985	330,000	720,000	720,000	720,000	2,490,000

On the assumption that whole amount of production at Indarung I is consumed in West Sumatra and those at Indarung II - IV is exported, the exportation of cement will amount to 216 x 10^4 tons/year in 1984. When further assuming the existing 100 m cement berth for exclusive use to have an average loading capacity of 180 tons/hour, it's working time to be 20 hours/day under three-shift systems, and its allowable occupation ratio of the berth to be 0.55, then the necessary berth length in 1984 can be calculated as follows.

$$\frac{2.16 \times 10^6 \text{ tons/hour}}{20 \text{ hours/day} \times 180 \text{ tons/hour} \times 350 \text{ days/year} \times 0.55} \times 100 \fallingdotseq 300 \text{ m}$$

Hence, the berth length will be 200 m short in 1984.

3) Coal berth:

According to the coal mining plan, yearly coal outturn will reach 100 x 10^4 tons/year in 1989, thus giving rise to the shipment of coal from the port to 61.0 x 10^4 tons/year.

When coal carries to enter the port are supposed to have an average tonnage of 8,000 DWT, the necessary yearly frequency of entrance for the coal carrier as a whole is predictable as following.

$$\frac{\text{Yearly amount of coal}}{\text{Average dead weight tonnage}} = \frac{61.0 \times 10^4}{8,000} = 77 \text{ vessels/year}$$

Moreover, the coal carrier will be a large-sized vessel of 5,000 DWT as minimum to 15,000 DWT as maximum, thus requiring additional loading machines for exclusive use. Therefore, judging from the amount of cargo and frequency of entrance, there will become necessary an exclusive berth for coal carrier.

4) Summary:

In near future, there will become necessary the following numbers of berths.

For general cargo, 5 berths, each 100 m long.

For cement only, 2 berths, each 100 m long.

For coal only, 1 berth.

The port is planned to be extended along the east coast thereof. As shown in Fig. 2-5, the east coast will be reclaimed and, on account of the shallow water depth and poor subsurface condition, a rubble-mound method will be suitable for revetting the reclaimed coast. To obtain a necessary berth water depth of 9.0 - 10.0 m, the mooring wharf will be of a piled type.

When considering the wind direction, the present length of breakwater seems insufficient for protecting the east berths and cargo handling thereon from being adversely affected by waves. Therefore, construction of new breakwaters will be necessary on both east and west sides as shown in the attached drawings, while the east breakwater will not be required until the use of reclaimed land II starts.

Planned arrangement of berths is shown in Fig. 2-6 for near future. As the best use, the existing coal stock yard will be utilized as a coal storage yard in plan and the mooring wharf for loading coal will be suitably located at the nearest revetment portion of the oil storage yard.

General Drawing of Future Berth Planing

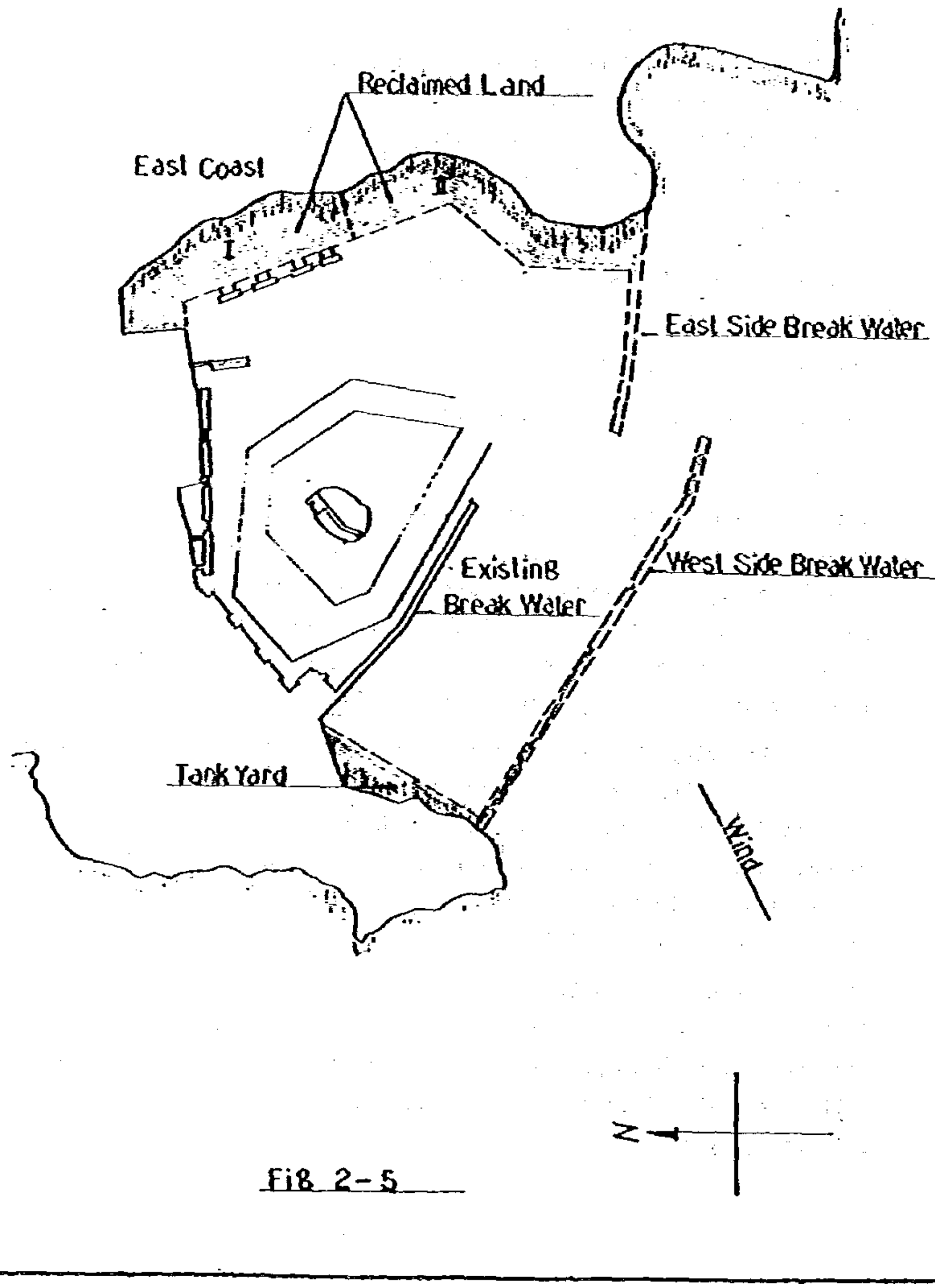


Fig 2-5

General Drawing of Future Berth Planning

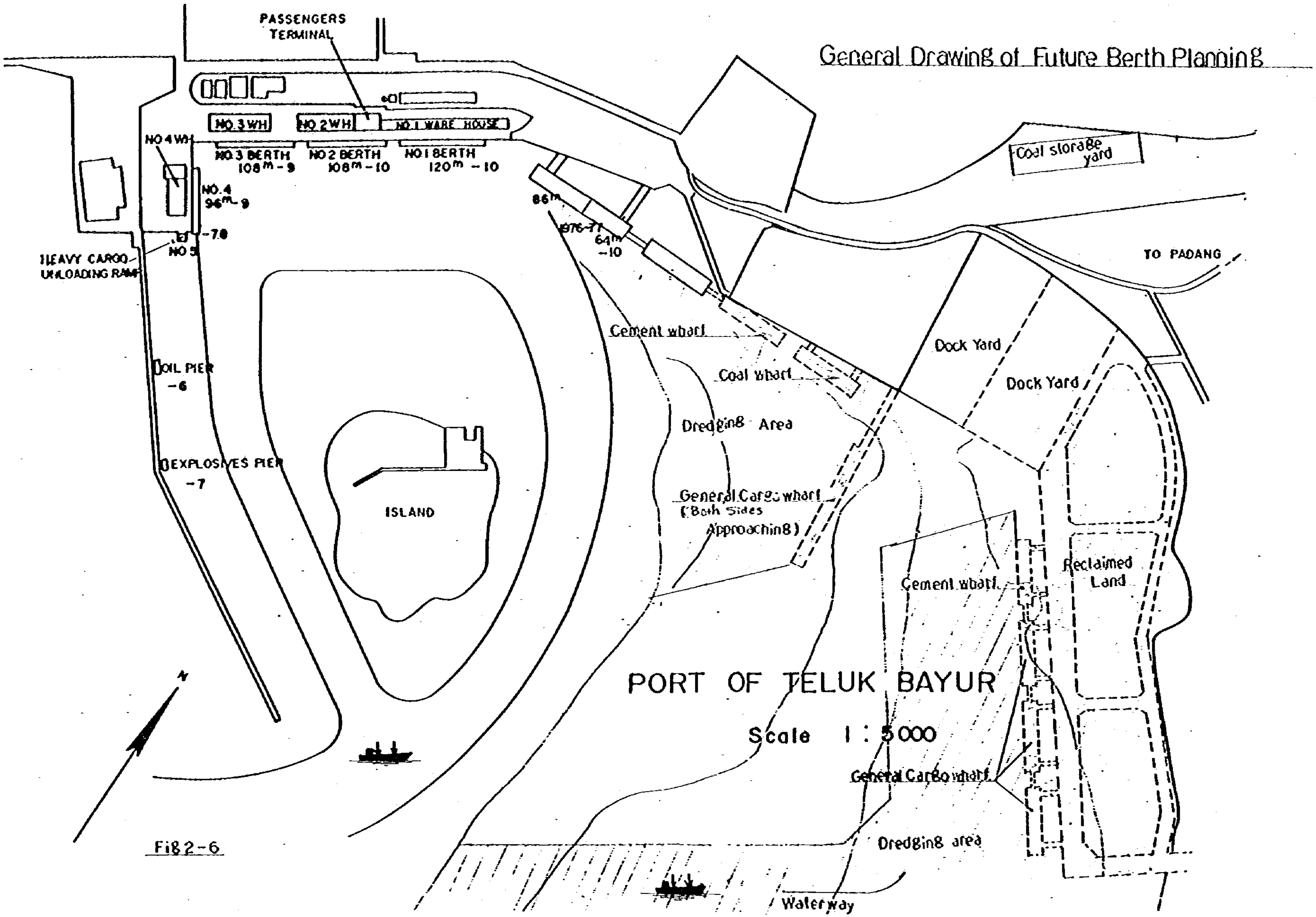


Fig 2-6

5.1.3 Planning mooring wharf

1) Style of mooring wharf:

The style of mooring wharf should be carefully selected in consideration of climatic condition, marine condition, geographical and geological features, hinterland, type of cargo, size of vessels to be moored, etc. Of the data thereof at hand, insufficient are those on climatic and marine conditions and geological features, especially of wind and barometric conditions as for climatic data and of waves as for marine data. The wind and barometric pressure are responsible for occurance of high tide and their data are necessary to determine the wind pressure to act on port facilities and moored vessels and the efficiency of works in the port including cargo handling. With respect to geological features, a soil test will become necessary to have soil properties data covering both bedrock and surface deposit.

Mooring wharfs fall into some types in style: jetty type, wharf type, dock type, etc.

Jetty type: A mooring wharf projecting from the shore into water thus permitting vessels to be moored to both sides. In comparison with the land wharf which is restricted in length, larger number of vessels can be moored.

Wharf type: A mooring wharf for mooring vessels in parallel with the shore, Possible wide wharf floor allows smooth communication with inland transportation.

Dock type: A berth in a dock which is recessed in the land and provided with a gate. Advantageous if tide variation is large or when calm water surface is required.

In this port, the dock type mooring wharf is unsuitable because of the geographical features. Therefore, the jetty type or wharf type will be employed in the plan.

2) Direction of mooring wharf:

The direction of mooring wharf should be desirably determined in consideration of the approaching direction of vessel and in accordance with constant wind. According to observations at Tabing, the wind direction ranges from N240° ∿ 60°. On the other hand, the site of planned mooring wharf, where oil tanks once stood, has its revetment aligned for N270°. Thus, preferably, the approaching direction of vessel will be in substantial accordance with wind direction, if the wharf type is employed. In the case of jetty type, the vessel will be subjected to lateral winds when approaching to and departing from the mooring wharf. However, as blowing from the side of mountains around the port, the wind should be slower than that as observed at Tabing. If the wind is blocked by the mountains around the port, its effect on moored vessels should be small. This plan assumes that the jetty type mooring wharf will be applicable, while actual observation should be performed at the port Teluk Bayur for necessary check of the wind velocity.

3) Structure of mooring wharf:

The following two factors are considered to select the structure of mooring wharf.

a) Subsurface condition:

Subsurface of the port is a poor subsoil about 40 m thick.

b) Requirements for service:

Exclusive cargo handling machines for coal are to be installed, such as on-rail mobile loader or stationary loader.

Types of wharf structure are listed in the table below.

Type of structure	Applicability of the subsoil	Cargo handling machine	
		Mobile	Stationary
Gravity type	×	o	o
Sheetpile type	×	o	o
Celler type	×	o	o
Piled wharf	o	o	×
Dolphin	o	×	o

As easily known from the above, an piled wharf or dolphin is suitable for the subsurface condition of the port. The cargo handling machine should be mobile for the piled wharf, or stationary for the dolphin type.

4) Berth length:

a) Piled wharf:

Required minimum is a combination of the total length of vessel and a 15 - 30 m allowance determined in consideration of the length of mooring chain. Thus, in the case of a 15,000 DWT-er as largest in the vessels to be considered, a berth length over 185 m is necessary. Here, the occupation ratio of the coal vessel to the wharf is not so large, other types of vessel are considered including a 15,000 DWT-er as maximum. Then, the piled wharf is to have such length as calculated below.

Wharf length = (Required minimum berth length) + (Space for siding cargo handling machine)

= 185 m + 15 m

= 200 m

b) Dolphin:

Because of stationary cargo handling machine, the vessel is required to move during loading work.

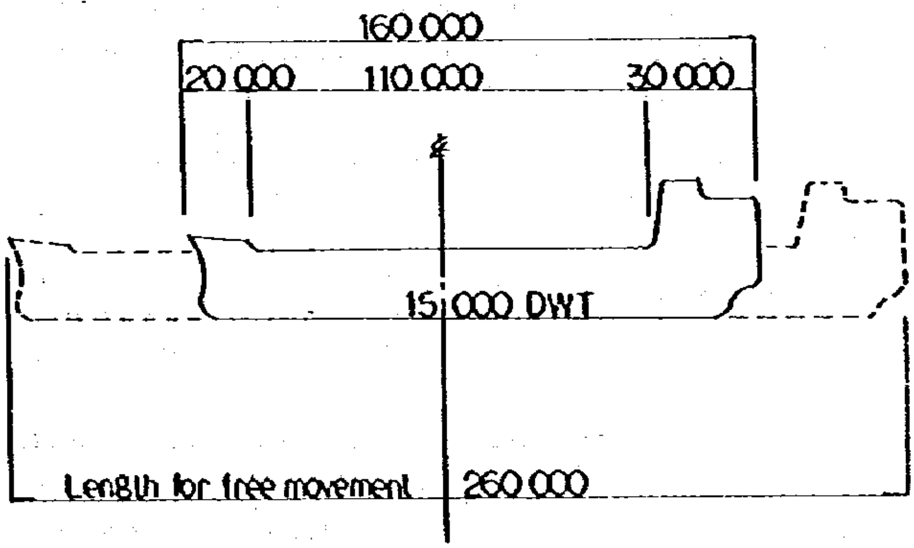


Fig. 2 - 7

Therefore, necessary berth length of dolphin is larger than other cases, as shown below.

Berth length = (Length for free movement) + 30 m
= 260 m + 30 m
= 290 m

As easily understood from the necessary berth length 290 m, it is impossible to construct such a long dolphin in parallel with the alignment of revetment of the oil tank yard as planned site. Then, the dolphin is to be constructed perpendicular thereto.

5) Cope level of mooring wharf:

The cope level of mooring wharf is desired to be low as possible in view of construction cost. However, it should be determined in full consideration of the size of vessels to be moored, tide range and waves so as not to adversely affect the handling of cargo nor cause damages on facilities. Standard cope level of mooring wharf is H.W.L. plus 1.0 m to 2.0 m. However, the cope level as planned is made equal to that of the existing mooring wharf on account of insufficient data on waves.

6) Calmness at berth:

It is difficult to know calmness at the berth without detail observations of the wind and waves in the port. As for the calmness of of vessel, which depends on the function of cargo handling machine, loading method, and cargo's type, style, weight, etc., the following values are recommendable as standard.

Moored vessel	Significant wave hight
300 ∿ 1,000 gross tonnage	0.3 m
1,000 ∿ 5,000 gross tonnage	0.5 m
over 5,000 gross tonnage	0.7 m

Now, a clamness at the planned berth site subject to the existing breakwater will be estimated.
Disturbance factors affecting the calmness in the port are invading waves from the entrance of the port, overtopping waves from the breakwater, waves occurring in the port, and reflected waves due to the preceding waves.

Examination will be made of the invading wave which is most affecting. In general, waves are not completely blocked by breakwater, but subjected to diffraction thus producing more or less waves. Diffraction of water waves at the existing breakwater is shown in Fig. 2-8 ∿ 2-10, which has been prepared based on Sormefeld's diffraction theory of light as expanded for water waves, assuming for calculation that waves are completely reflected at the breakwater. In the diffraction diagram, the diffraction coefficient Kd is calculated as following.

For a N215° wind, $Kd = \frac{\text{Diffraction wave height}}{\text{Incident wave height}} = 0.6$

For a N260° wind, Kd = 0.3

For a N290° wind, Kd = 0.1

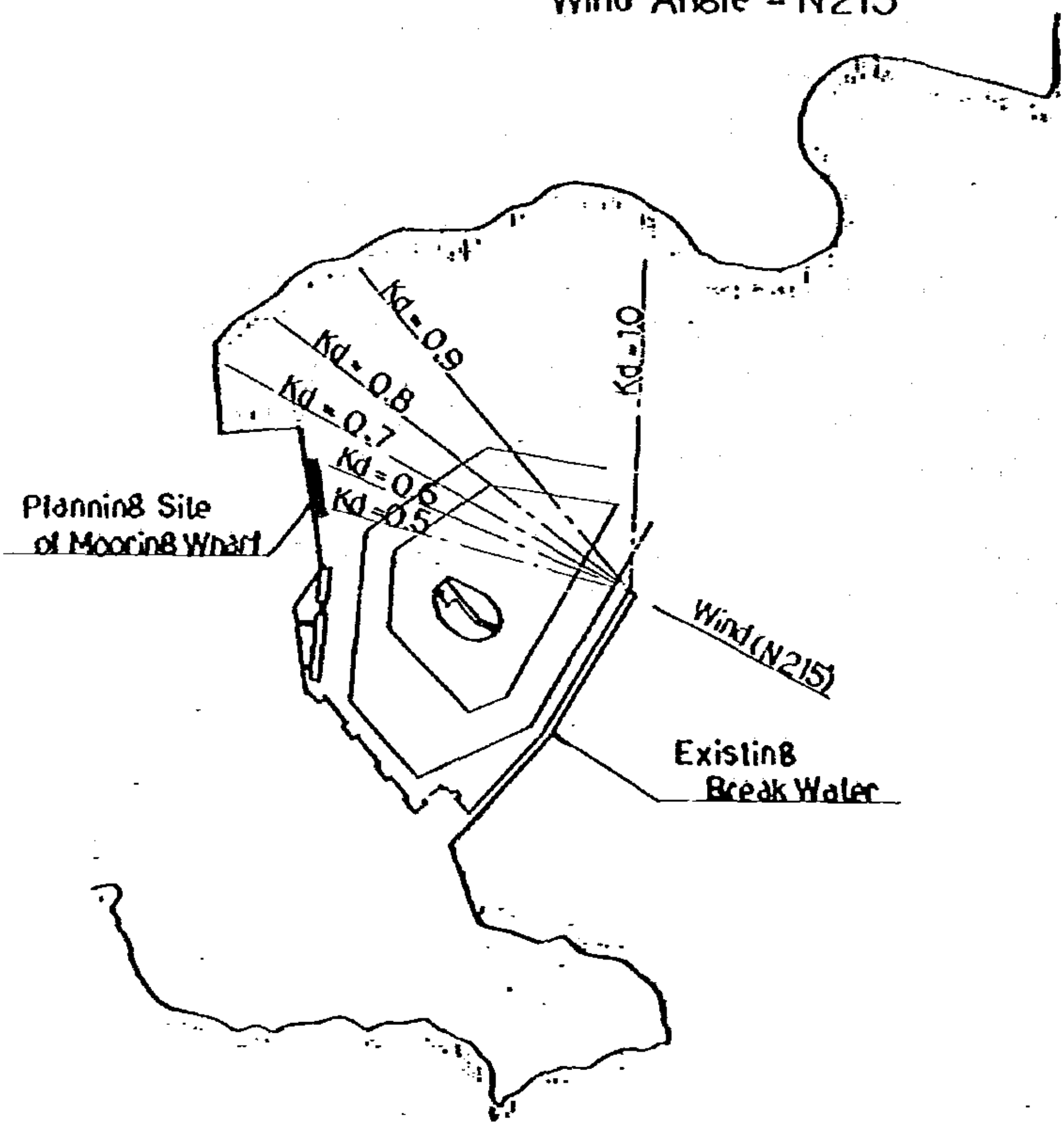
Since the wind direction in the port lies between N240° to N260°, corresponding diffraction coefficient Kd is about 0.5. By supposing the wave height (incident wave height) to be 2.0 m at the outer side of breakwater, there can be reduced a wave height H (diffraction wave height) near the planned berth as below.

H = 0.5 x 2.0 m = 1.0 m

Thus, vessels at the planned mooring wharf are to be somewhat affected by waves.

Diffraction Diagram

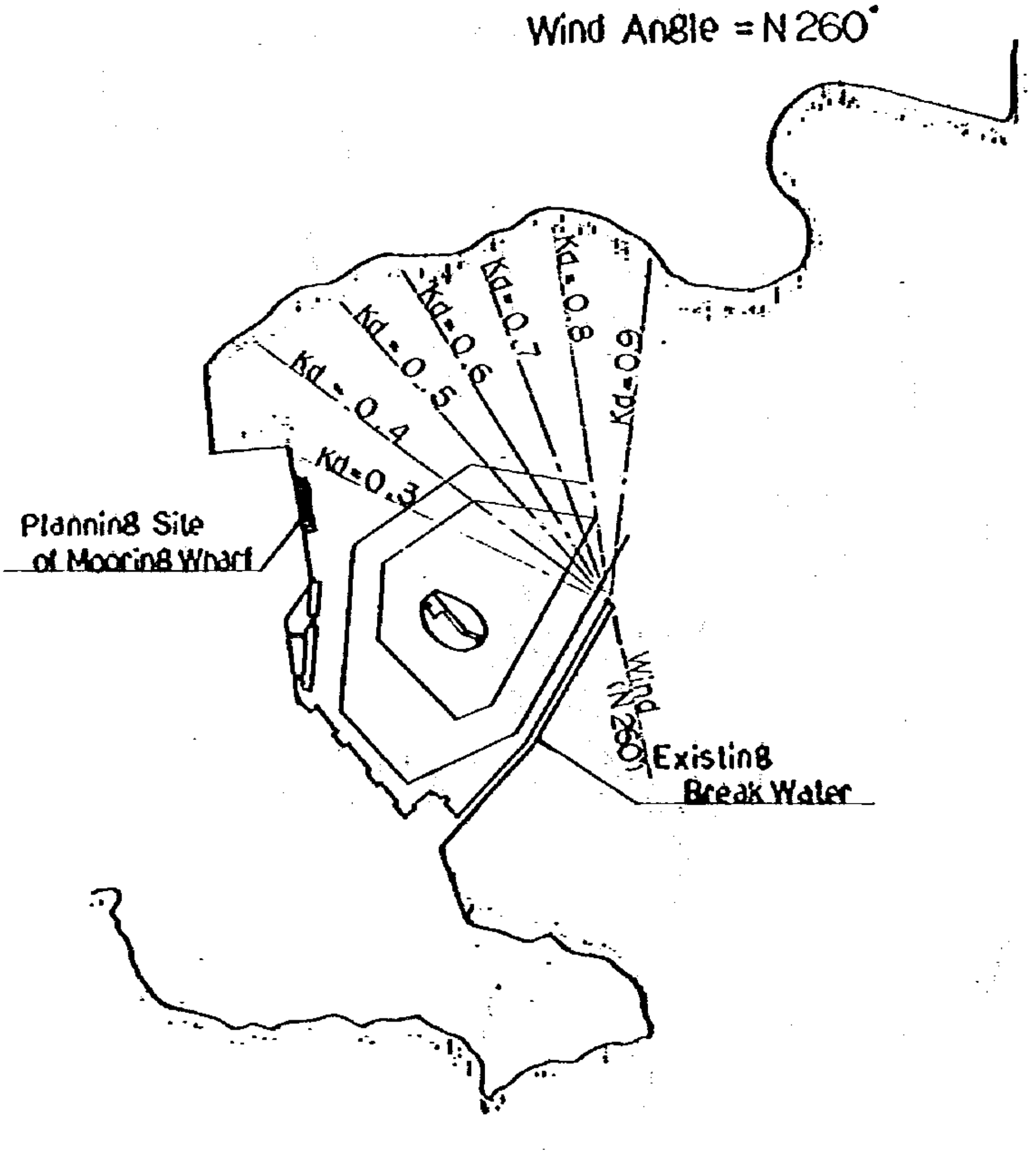
Wind Angle = N215°



$$Kd = \frac{\text{Diffraction Height of Wave}}{\text{Incident Height of Wave}}$$

Fig. 2-8

Diffraction Diagram

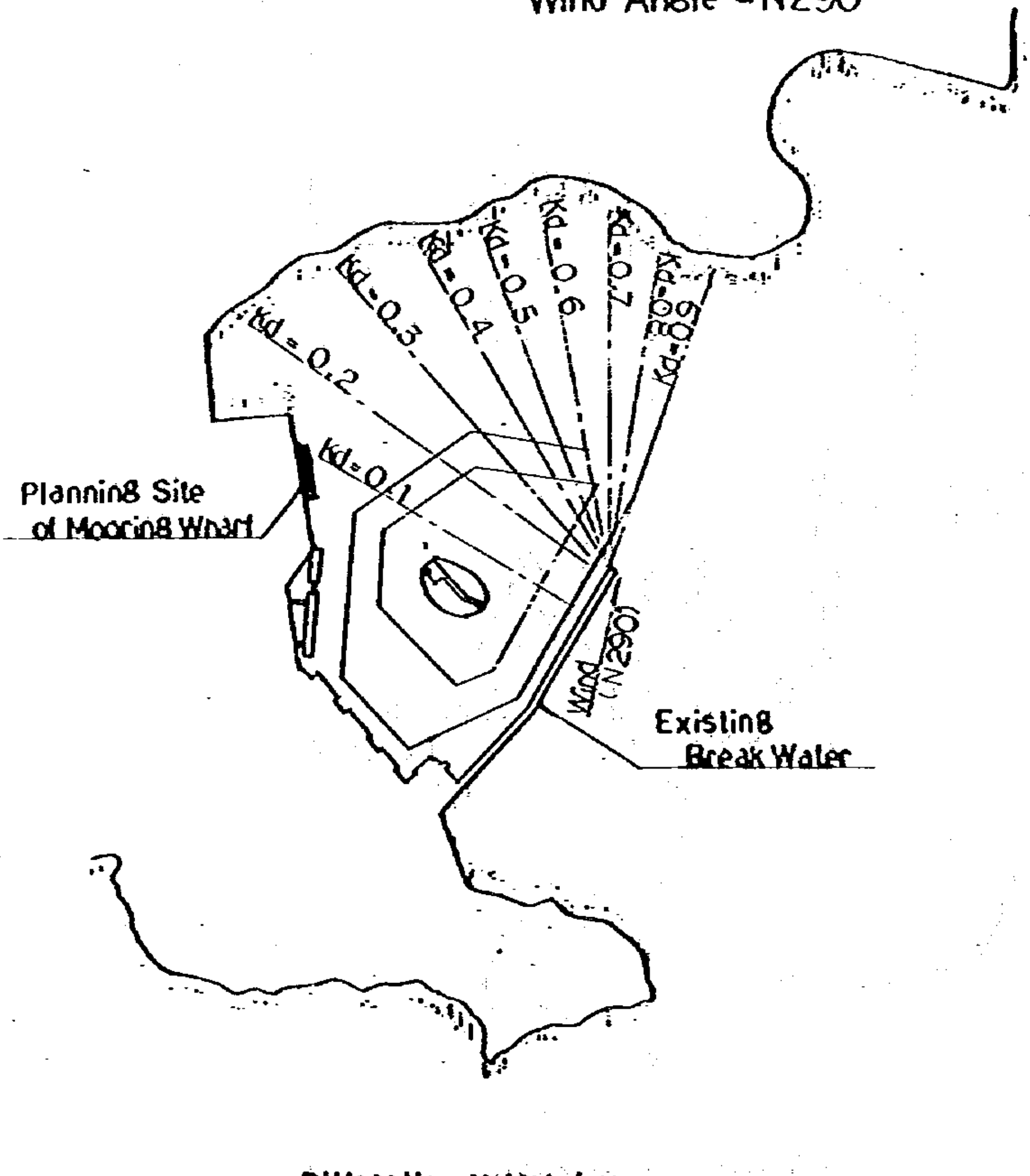


$$Kd = \frac{\text{Diffraction Height of Wave}}{\text{Incident Height of Wave}}$$

Fig 2-9

Diffraction Diagram

Wind Angle = N290°



$$Kd = \frac{\text{Diffraction Height of Wave}}{\text{Incident Height of Wave}}$$

Fig 2-10

7) Determining structure of mooring wharf:

Here will be determined the structure of mooring wharf by comparing the piled wharf and dolphin both of which are considered to be suitable. Compared factors are listed below.

Items	Piled wharf	Dolphin
Berth length	200 m	290 m
Style	Marginal type or pier type	Pier type
Cargo handling machine	Mobile	Stationary
Loading time	Short	Long
Handling of general cargo	Possible	Impossible
Difficulty of loading	Not difficult	Difficult
Construction cost	Slightly high (1.2)	Low (1.0)

As compared above, the construction cost of dolphin is lower than that of piled wharf by about 20%. However, when considering the dolphin to carry the difficulty in loading, the long loading time, the impossibility of handling general cargos other than coal, etc., it can be judged that the piled wharf is superior as a whole. Therefore, the mooring wharf should be a piled wharf.

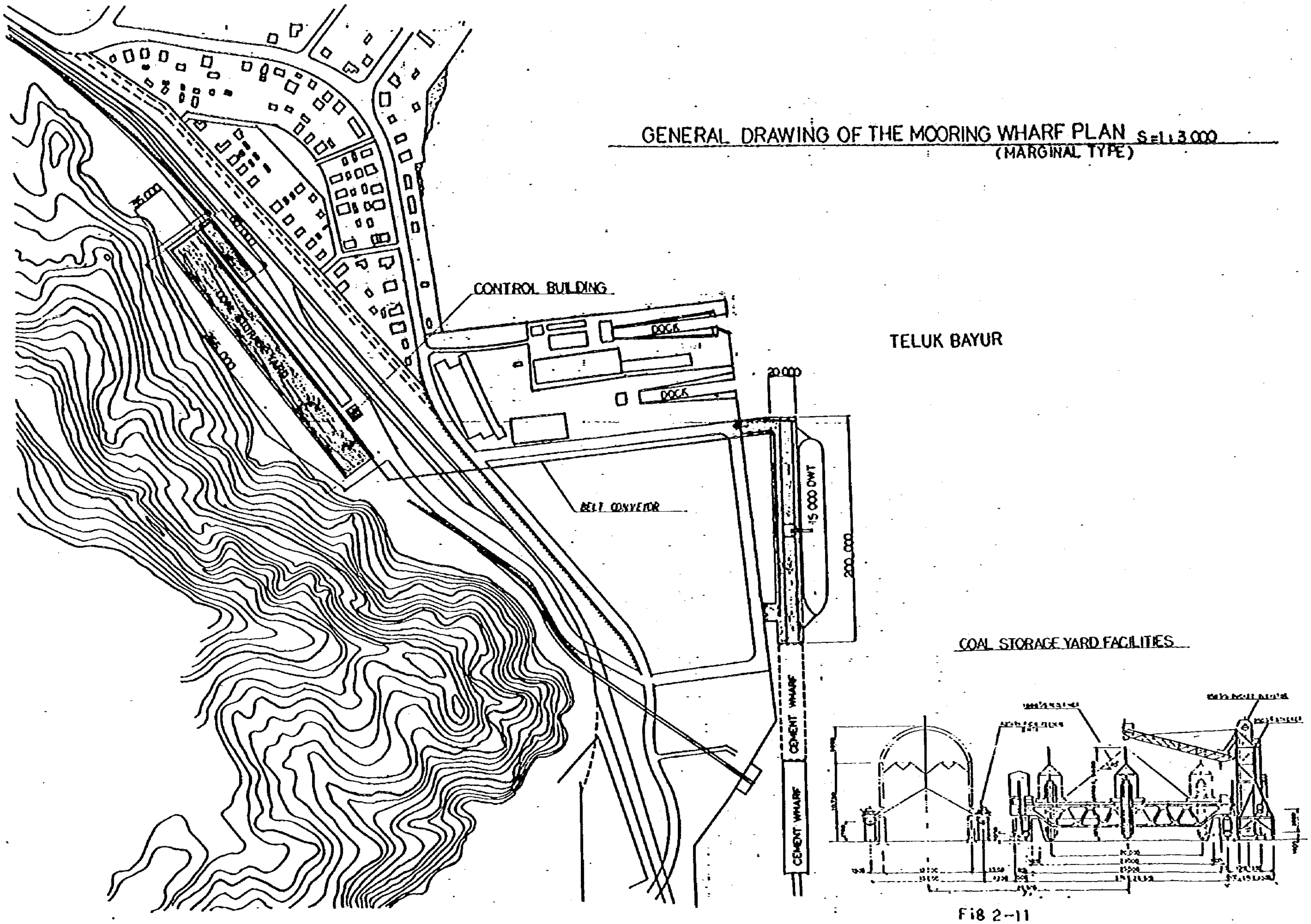
The piled pier is more expensive than the marginal wharf, because of the approach bridge of the former is longer than the one of the latter. So the marginal wharf is planned from the view point of engineering and economical aspect.

8) Water depth at berth:

The water at berth should have a suitable depth larger than the full load draft of vessels considered, in the light of swing and the lied of the vessels due to the wind, waves, tidal current, etc. Recommendable is a water depth determined by addin 0.5 m to the full load draft as under the normal water surface level.

When assuming the 15,000 DWT vessel, which is the biggest in those considered, to have a full load draft of 8.5 m, the water depth at the berth under plan should be 9.0 m. Hence, the area of planned berth, as having a shallow water depth of 8.0 m, is required to be dreadged. The thickness of outbreak depends on the water depth of the place to be dreadged. For water depths larger than 9.0 m, an outbreak of 0.5 m will be suitable.

Planned water depths and areas for dredging are shown in Fig. 2-15.


GENERAL DRAWING OF THE MOORING WHARF PLAN S=1:3.000
(MARGINAL TYPE)
TELUK BAYUR
CONTROL BUILDING
DOCK
DOCK
BELT CONVEYOR
COAL STORAGE YARD
15 000 DWT
20.000
200.000
CEMENT WHARF
CEMENT WHARF
COAL STORAGE YARD FACILITIES

Fi8 2-11

GENERAL DRAWING OF THE MOORING WHARF PLAN S=1:3000 (PIER TYPE)

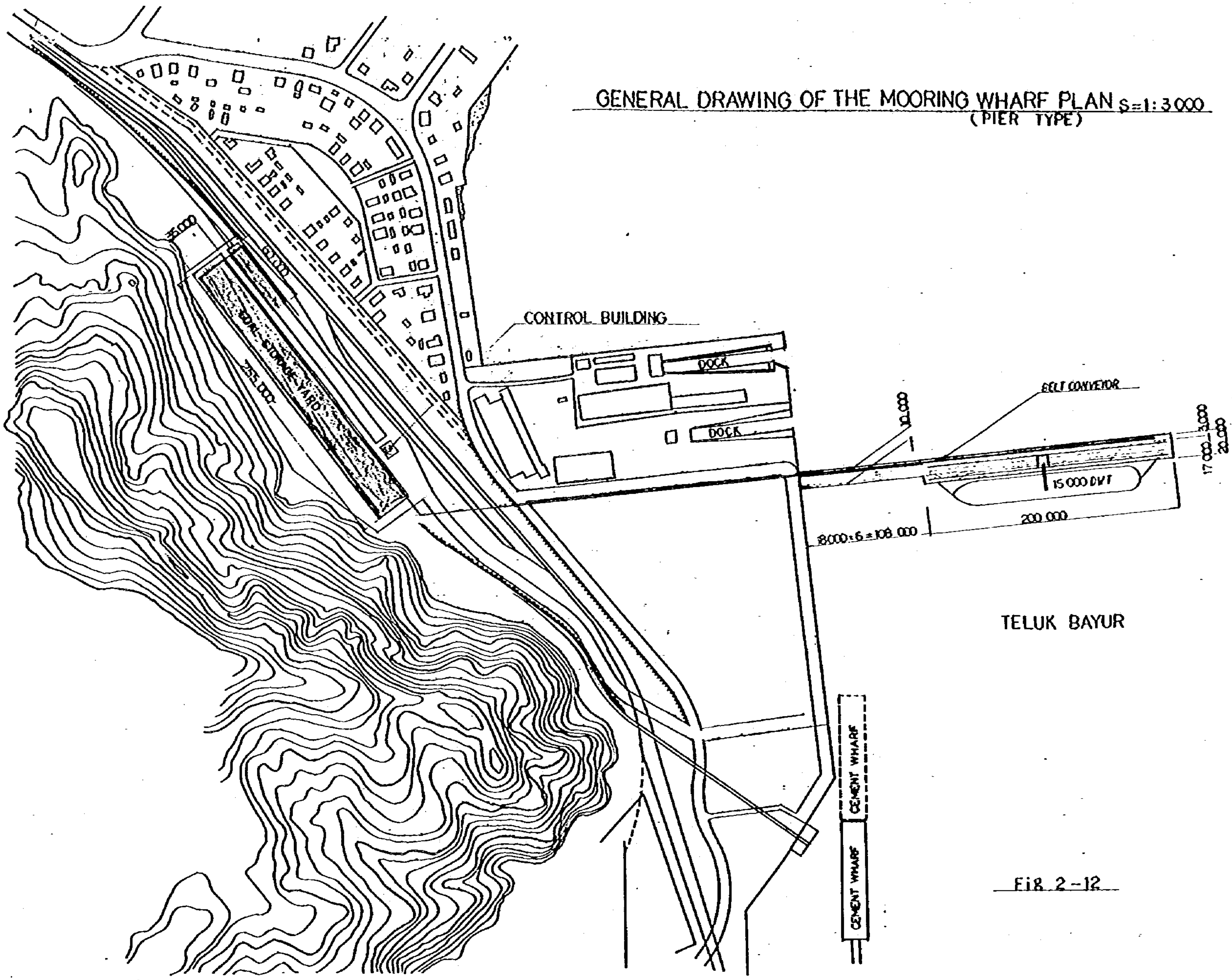


Fig. 2-12

GENERAL DRAWING OF THE MOORING WHARF PLAN S=1 : 3.000
(DOLPHIN TYPE)

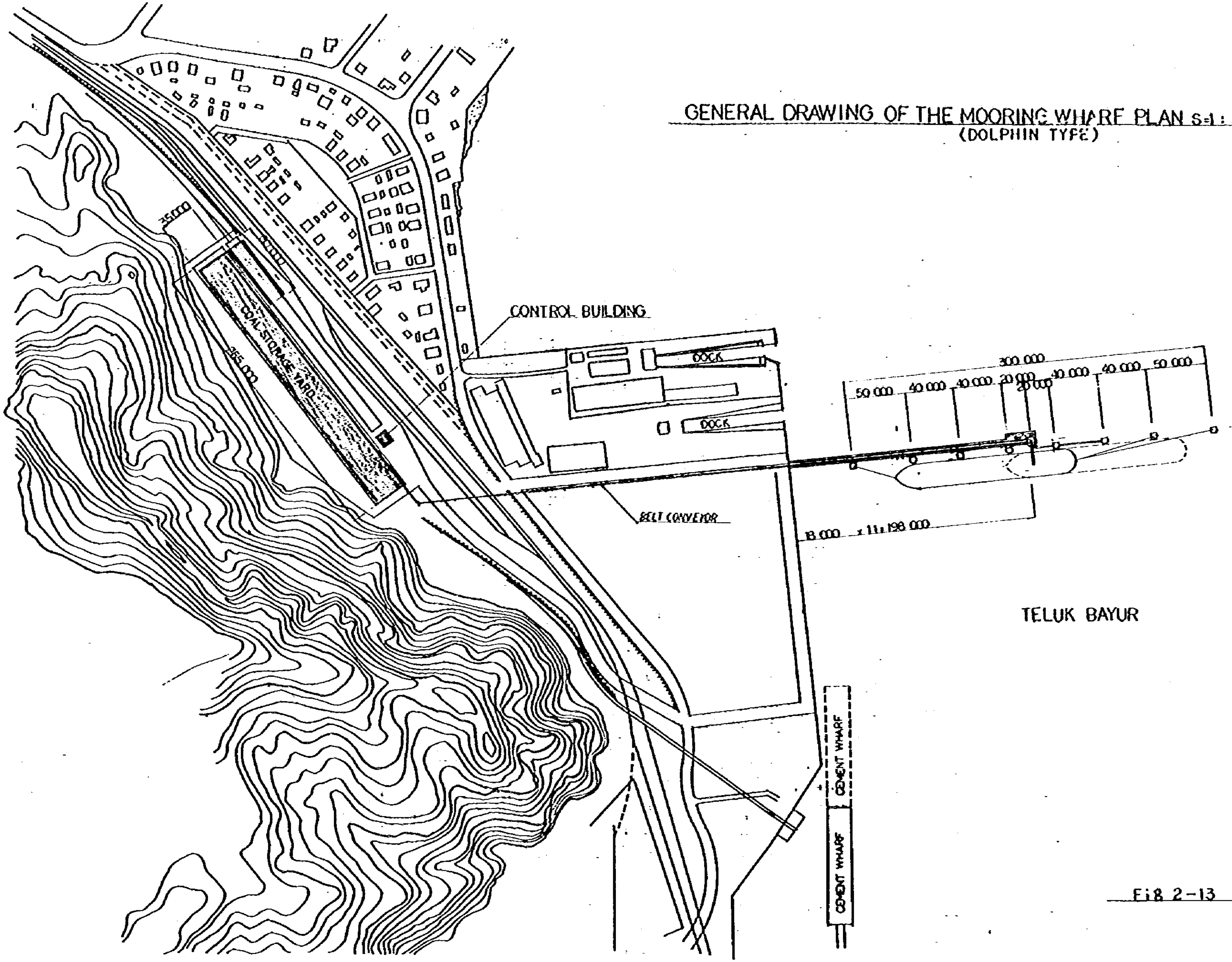
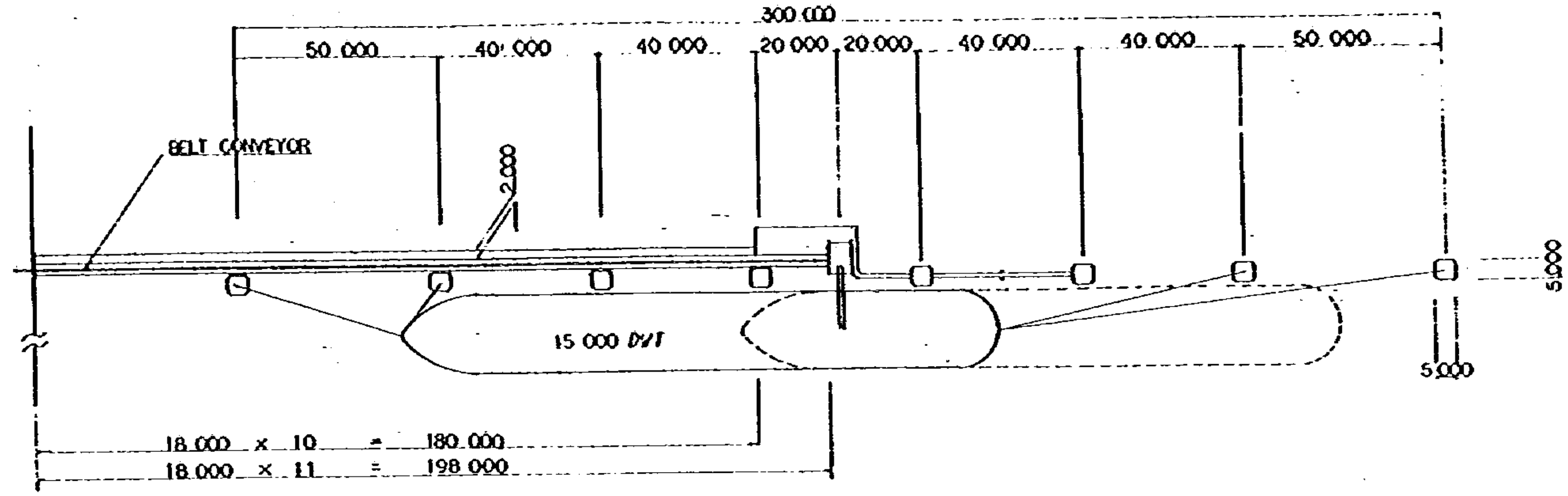


Fig 2-13

GENERAL DRAWING OF DOLPHINS S=1:1000



CROSS SECTION S=1:1000

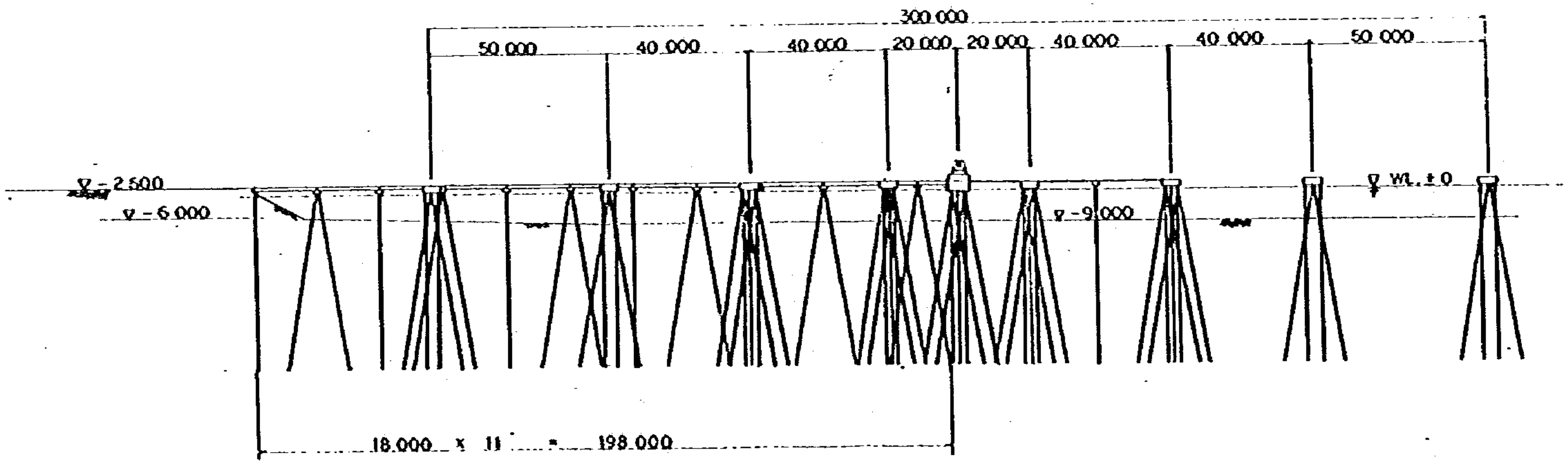


Fig 2-14

GENERAL DRAWING OF THE DREDGEING PLAN

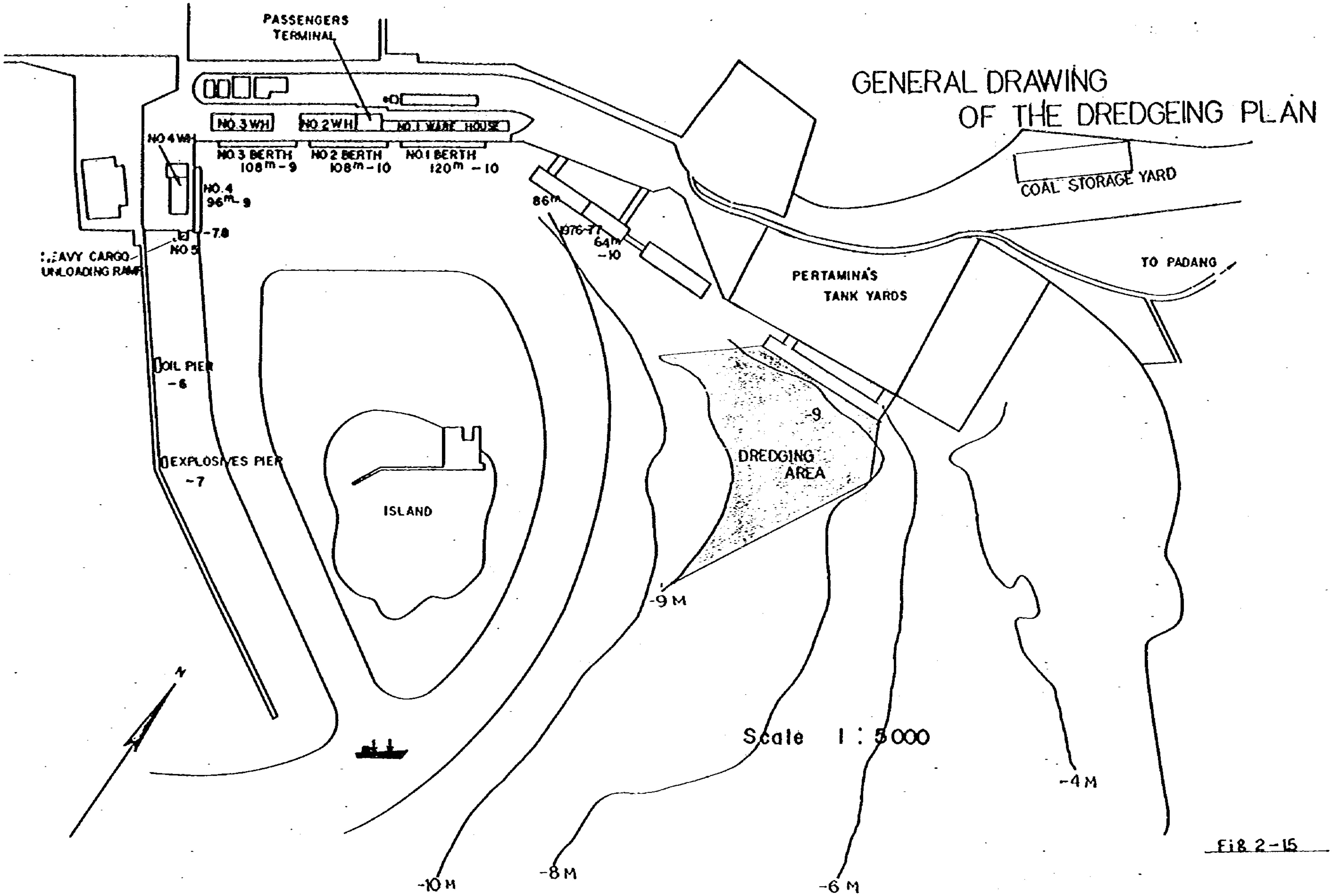


Fig 2-15

5.2 Coal Discharging Facility

5.2.1 Decision of the storing capacity for coal discharging facility

1) Average handling capacity per day of coal discharging equipment: Q_1

$$Q_1 = \frac{\text{Annual handling quantity}}{\text{Annual working days}} = \frac{610,000}{350}$$

$= 1,743$ t/day

2) Average incoming quantity per day: Q_2

$$Q_2 = \frac{\text{Annual handling quantity}}{\text{Annual working days of railroad}} = \frac{610,000}{360}$$

$= 1,695$ t/day

The average reclaimed quantity per day (Q_1) does not coincide the average incoming quantity per day (Q_2). This is due to the fact that annual working days are different between rail-road operation (incoming) and receiving facility operation (reclaiming). Therefore, the coal discharging facility must have a capacity of storing the incoming coal to be sent for more than one day, becuase the coal might be sent while reclaiming operation is stopped. In this planning the storing capacity of coal discharging facility is decided to be approximately 2,000 t, taking account of the quantity of coal to be remained in the coal discharging facility.

5.2.2 Decision of reclaiming capacity from silo

Coal stored in the silo is reclaimed by two sets of rotary plow feeders. Suppose the reclaiming operation is not carried out one day, the quantity to be reclaimed on the next day must be twice the quantity to be reclaimed for a single day. As the operation of railroad is 2-shift (actual operation: 14 hrs., total operation: 16 hrs.), reclaiming operation is assumed to be also 2 shift.

1) Max. reclaiming capacity

$$\frac{\text{Average input per day x Two days}}{\text{Actual operation hours}} = \frac{1,695 \times 2}{14}$$

$= 242 \Rightarrow 250$ t/h

There are two sets of rotary plow feeders on both sides of the silo and the reclaiming capacity per one unit machine is 125 t/h.

2) Average reclaiming capacity

As the input and the output of coal are usually balanced, the reclaiming capacity in usual case (average reclaiming capacity) can be half the maximum capacity.

Therefore, total average reclaiming capacity is 130 t/h and the average reclaiming capacity per one unit machine is 65 t/h.

3) The capacity of rotary plow feeder

As is evident from 1) and 2) above, the capacity of a rotary plow feeder is required to vary from 65 t/h to 125 t/h.

5.2.3 The capacity of wagon hopper

1) Number of wagons unloaded per one day

$$\frac{\text{Average input per day}}{\text{Quantity per one wagon}} = \frac{1,695}{23} = 73.7$$

$\Rightarrow$ 74 wagons/day

2) Required cycle time for wagon unloading

Suppose two sets of wagons are fed to the wagon discharging facilities at the same time, the cycle time will be;

$$\frac{\text{Actual working hours per day} \times 60}{\text{Average number of wagons discharged}} = \frac{14 \times 60}{74 \times 1/2}$$

$= 22.7$ min/cycle

This value can be less than the shunting time rail-road as explained in Chapter III, even if working efficiency is taken into consideration.

5.3 Coal Storing Facility

5.3.1 Decision on the quantity of coal to be stored

1) On the deviation of ships' intervals of arrival

In case coal is shiploaded at the port, received quantity and shiploaded quantity are well balanced in the long run, e.g. for one year, while it is usual that they are not balanced in the short run. Therefore, it is necessary to store the difference between the received quantity and the shiploaded quantity. This is due to the fact that coal is constantly received at the port by railway wagons arranged regularly, while there is deviation of intervals when ships come to the port for shiploading.

Now, the deviation of ships' intervals of arrival will be analysed probabilistically. If ships are coming to the port at random, it is already proved that the intervals of arrival time to the port will be subject to exponential distribution, and summation of 'n' number of random variable to the exponential distribution (random variable of a ship group with 'n' number of ships) will be subject to n-th order Erlang distribution. If there is deviation of ships' interval of arrival, although these ships are arranged so as to arrive at the port with constant intervals, the actual intervals of ships' arrival to the port will be subject to n-th order Erlang distribution.
As the Erlang distribution will be regarded as normal distribution, if the order number is more than 10, the number of n, i.e. the number of ships of the ship group coming to the port will be fixed so as to make the distribution of ships' interval to be 10th order Erlang distribution. In this case, thrice the standard deviation of n-th order Erlang distribution which is regarded as normal distribution will be enough for the maximum and the minimum intervals at which the ship group with 'n' number of ships come to the port. If the ship interval of arrival per each ship is subject to k-th order Erlang distribution, the maximum and the minimum intervals of arrival at which the ship group with 'n' number of ships come to the port are as follows;

$$\frac{n}{\lambda} \pm 3\frac{\sqrt{n}}{\sqrt{k\lambda}} \quad \text{(where } n \cdot K \geq 10)$$

λ means the average number of ships coming to the port.

2) On the number of ships (n) of a ship group coming to the port

Generally, the standard deviation (σ) of the k-th order Erland distribution is;

$$\sigma = \frac{1}{\sqrt{k}\,\lambda}$$

when the mean value is $1/\lambda$. Suppose the number of ships per annum is n_a and the arrival intervals per one ship is subject to k-th Erlang distribution with the mean value of $1/\lambda$, the standard deviation and the mean value of arrival intervals for the total number (n_a) of ships are as follows;

$$\sigma_a = \frac{\sqrt{n_a}}{\sqrt{k}\,\lambda}$$

$$m_a = \frac{n_a}{\lambda}$$

m_a is 365 days if considered for one year. Therefore,

$$\frac{\sigma_a}{m_a} = \frac{1}{\sqrt{k.n_a}} \quad , \quad k = \left(\frac{365}{\sigma_a}\right)^2 / n_a$$

The value (k) can be determined, if the tolerance is fixed for the standard deviation (σ_a) of intervals of ships' arrival to the port per annum.

Here, the following assumptions will be made for this project.

$$n_a = \frac{\text{Total quantity to be handled per annum}}{\text{Average D.W.T.}}$$

$$= \frac{610{,}000}{8{,}000} \doteqdot 77 \text{ ships/year}$$

$$m_a = 365 \text{ days}$$

If σ_a equals to 15 ($3\sigma = 45$ days), this assumption means that all the ships which are scheduled to come to the port for one year will arrive at the port within the following period.

$$365 \pm 45 = 320 \sim 410 \text{ days}$$

Therefore,

$$k = \left(\frac{365}{15}\right)^2 / 77 = 7.7$$

The value of 'n' which meets the condition of $n \cdot k \geqq 10$ can be now solved.

$$n \geqq 10/k = 1.30$$

Therefore, it is enough to consider the ship group with 1.30 number of ships.

3) Required storage quantity

The maximum and the minimum intervals for the ship group with 'n' number of ships will be considered now. The average arrival intervals per one ship ($1/\lambda$) is

$$\frac{1}{\lambda} = \frac{365}{n_a} = \frac{365}{77} = 4.74 \text{ days/ship}$$

(1) Maximum interval of ship group with n (=1.30) number of ships ; Tmax

$$T_{max} = \frac{n}{\lambda} + 3\sqrt{\frac{n}{k}} \cdot \frac{1}{\lambda}$$
$$= 1.30 \times 4.74 + 3\sqrt{\frac{1.30}{7.7}} \times 4.74$$
$$= 12.0 \text{ days}$$

(2) Minimum interval of ship group with n (=1.30) number of ships ; Tmin

$$T_{min} = \frac{n}{\lambda} - 3\sqrt{\frac{n}{k}} \cdot \frac{1}{\lambda}$$
$$= 1.30 \times 4.74 - 3\sqrt{\frac{1.30}{7.7}} \times 4.74$$
$$= 0.32 = 0 \text{ days}$$

This means that the ship group with n (=1.30) number of ships will arrive at the port almost at the same time continuously.

(3) Allow for unworkable days

The total number of unworkable days per annum (U) can be calculated as 15 days, as the total working days are 350 days. The following case will be considered in which unworkable days follow the longest period of arrival interval of a ship group. If the number of unworkable days (U=15) are distributed regularly for a year, the probability that an arrived ship is incapable of operation is as follows,

$$P = \frac{U}{365} = \frac{15}{365} = 0.041$$

In case the operation is impossible for the continuous j-days, the probability that the operation will become possible on the (j+1)th day is $P^j(1 - P)$, and the mean value of unworkable days (E) is,

$$E = \sum_{n=0}^{\infty} nP^j(1 - P) = \frac{P}{1-P} = \frac{0.041}{1 - 0.041} = 0.043$$

The variance (V) is

$$V = \sum_{n=0}^{\infty} n^2P^j(1 - P) = \frac{P(1+P)}{(1-P)^2} = \frac{0.0427}{0.92} = 0.0465$$

Therefore, the maximum value (H_{max}) of the continuation of unworkable days is

$$H_{max} = E + 3\sqrt{V - E^2} = 0.043 + 3\sqrt{0.0465 + 0.043^2}$$
$$= 0.68 \text{ days}$$

and it is enough to allow for only one day.

(4) Maximum quantity of coal to be stored in case of delay in ships' arrival ; S_1

This is the sum of the following items,

- Maximum value of delay in ships' arrival as explained in above (1)
- Maximum value of the continuation of unworkable days as explained in above (3)

that is,

$$S_1 = (T_{max} + H_{max})Q_2$$
$$= (12 + 1) \times 1,695 = 22,035 \text{ t}$$

(5) Required storage quantity in case ships' intervals are minimized ; S_1

As explained in the above (2), the number of ships arriving at the port continuously is two ship groups, and the number of ships per one ship group (n) is 1.30 ships.

Therefore,

$$S_2 = (2 \times n)D_{mean} = 2 \times 1.30 \times 8,000 = 20,800 \text{ t}$$

where D_{mean} is average D.W.T.

(6) Conclusion

The larger value either S_1 or S_2, that is, the value of more than S_1 = 22,000 t will be required for the storage capacity.

5.3.2 The capacity of stacker and belt conveyors

Stacker, transfer conveyor, and stacking conveyor receive the coal reclaimed by two sets of rotary plow feeders which are installed on both sides of silo. Therefore, the capacity of stacker, transfer conveyor and stacking conveyor must be twice the capacity of one rotary plow feeder.

$$125 \times 2 = 250 \text{ t/h}$$

The capacity of belt conveyors which are connected to each rotary feeder to receive reclaimed coal is equal to the capacity of a rotary plow feeder (125 t/h).

5.4 Reclaiming and Shiploading Facility

5.4.1 Decision of shiploading capacity

1) Required capacity from the view point of berth occupancy

The case in which berth is occupied exclusively by coal shiploading operation will be considered. The allowable berthing occupancy is assumed to be $\rho = 0.55$.

(1) The number of ships coming to the port per annum ; n_a

$$n_a = 77 \text{ ships/year } [5.2.1 \quad 1)]$$

(2) Allowable berth occupancy time per annum ; T_a

$$T_a = \rho \times K_H = 0.55 \times 350 = 192.5 \text{ days/year}$$

(K_H : refer to 3.4.2)

(3) Allowable berth occupancy time per ship

$$T_b = \frac{T_a}{n_a} = \frac{192.5}{77} = 2.50 \text{ days/ship}$$

(4) Required actual capacity : Q and
design capacity : Q_t

T_b can be shown from its definition as follows,

$$T_b = H_L + \frac{D_{mean}}{Q \cdot H_w}$$

H_L means the time loss when a ship comes to and depart from the berth. The meaning of H_w and D_{mean} is as explained in 3.4.
Suppose H_L = 4 hours/ship = 0.17 days/ship,
then

$$Q = \frac{D_{mean}}{(T_b - H_L)H_w} = \frac{8{,}000}{(2.50 - 0.17) \times 20} = 172 \text{ t/h}$$

If handling efficiency is $\eta_w = 0.8$, design capacity is,

$$Q_t = \frac{Q}{\eta_w} = \frac{172}{0.8} = 215 \text{ t/h} \Rightarrow 250 \text{ t/h}$$

2) Required capacity in case berth occupancy time per one ship are restricted.

In case berth occupancy hours per one ship is T_b = 1 day/ship, then from the above 4),

$$Q = \frac{D}{(T_b - H_L)H_w}$$

D means the D.W.T. of a coal carrier.

(1) Required capacity for the average D.W.T.

($D = D_{mean}$ = 8,000 D.W.T.)

$$Q_8 = \frac{8{,}000}{(1 - 0.17) \times 20} = 482 \text{ t/h}$$

Design capacity is,

$$Q_{t8} = \frac{482}{0.8} = 602.5 \text{ t/h} \Rightarrow 600 \text{ t/h}$$

(2) Required capacity for the maxium D.W.T.

($D = D_{max}$ = 15,000 D.W.T.)

$$Q_{15} = \frac{15{,}000}{(1 - 0.17) \times 20} = 903.6 \text{ t/h}$$

Design capacity is,

$$Q_{t15} = \frac{903.6}{0.8} = 1{,}130 \text{ t/h}$$

3) Conclusion

Generally, the demurrage of US$ 4,000 per day is required for 8,000 D.W.T. vessel class and for 15,000 D.W.T. vessel class the demurrage of US$ 7,000 per day will be required, when a vessel is anchored for operation.

Under the condition of above 1), the berth occupancy in case of discharging coal onto 15,000 D.W.T. vessel is,

$$T_{b15} = \frac{15{,}000}{172 \times 20} + 0.17 = 4.5 \text{ days/ship}$$

Under the assumption that all the coal to be handled for one year is transported by vessels of 15,000 D.W.T. class, the number of vessels required for one year is,

$$\frac{610{,}000}{15{,}000} = 41 \text{ ships/year}$$

Now, the cases of above 1) and 2) will be compared. The difference in anchoring days between case 1) and 2) is,

$$(4.5 - 1) \times 41 = 144 \text{ days/year}$$

The demurrage required for case 1) is, compared with case 2),

$$144 \times 7{,}000 = \text{US\$ } 1{,}008{,}000\text{/year}$$

In case of 8,000 D.W.T. vessel class, the difference in anchoring days is, $(2.50 - 1) \times 77 = 116$ days/year

As the number of days for shiploading operation will be counted as one anchoring day if it is less than one.

The demurrage required for case 1) in comparison with case 2) is,

$$116 \times 4{,}000 = \text{US\$ } 464{,}000/\text{year}$$

Therefore, the cost difference of shiploaders between case 1) and 2) will be offset within 1 - 3 years by the demurrage, and here case 2) will be adopted. However, as the vessel of 15,000 D.W.T. class will seldom come to the port, the design capacity of 1,000 t/h will be adopted by rounding off fraction.

5.4.2 Decision of the capacity of reclaimer and reclaiming belt conveyors

The capacity of reclaimer must be the same as that of shiploader, as the former is connected to the latter by means of belt conveyors. Therefore, the capacity of reclaimer as well as belt conveyors is 1,000 t/h.

If working efficiency of shiploader is 0.9 and working efficiency of reclaimer is 0.9 in case of automatic control operation of reclaimer, then total working efficiency of shiploading operation (η_W) is

$$\eta_W = 0.9 \times 0.9 = 0.81 \doteqdot 0.8$$

6. PRINCIPAL FACILITIES AND EQUIPMENT

6.1 General

The facilities and equipment explained herein-after are for the coal shiploading facilities which are to be constructed at Teluk Bayur Port in West Sumatra State of Indonesia. Therefore, the facilities must meet the requirement for handling the coal produced in Sawahlunto (Ombilin) mine, and must have the economical advantage as well.

To each facility or equipment which is decided and selected taking account of above requirements the following standards will be applied.

1) Japanese Industrial Standard (JIS)

2) Standards of the Japanese Electrotechnical Committee (JEC)

3) Standards of the Japan Electrical Manufacturer's Association (JEM)

4) Technical Standard of Electrical Equipment issued by Japan Ministry of International Trade and Industry (MITI)

Other standards which are regarded as similar to these standards above can also be applied if necessary. Numerical system will be metric system. Bolts and nuts are to ISO standard.

Each equipment and part to be selected should have interchangeability. Also, equipment and parts to be used for the facilities should have enough durability for the climatic conditions as stated in above 3.3.

6.2 Wagon Discharging Facility

6.2.1 Receiving silo

A existing silo will be utilized for receiving silo. As the required capacity for receiving silo is about 2,000 t as calculated in 5.2.1, 9 rooms (each having capacity of 225t) will be utilized and these rooms will be reinforced and/or repaired as necessary.
The storing capacity is,

225 x 9 = 2,025 t

A room at the end of the silo on which wagons enter cannot be utilized for storing coal, because a belt conveyor is installed to go through the bottom of the room. Therefore, total 10 rooms will be used actually. The other part of silo is to be removed or kept remained. Roof of the silo must be installed to cover the space completely from the 1st room to the 10th room, including the uncovered central part of the silo. Damaged part must be duly repaired. A partition must be provided between the 1st room and the 2nd room, and a sealing cover must be provided over the 1st room.

6.2.2 Coal reclaiming facility

1) General

Rotary plow feeders will be provided to reclaim coal which is discharged from wagons and stored in the silo and to feed the coal to reclaiming belt conveyors (Fig. 2-16). These rotary plow feeders are capable of fully automatic operation through remote control from the supervisory control room. The reclaiming range is divided into 9 sections for 9 rooms of silo and reclaiming operation is carried out for the pre-determined continuous sections, so, reclaiming range can be fixed.

In order to vary reclaiming capacity, revolution of plow can be remote-controlled from the supervisory control room.

2) Main particulars

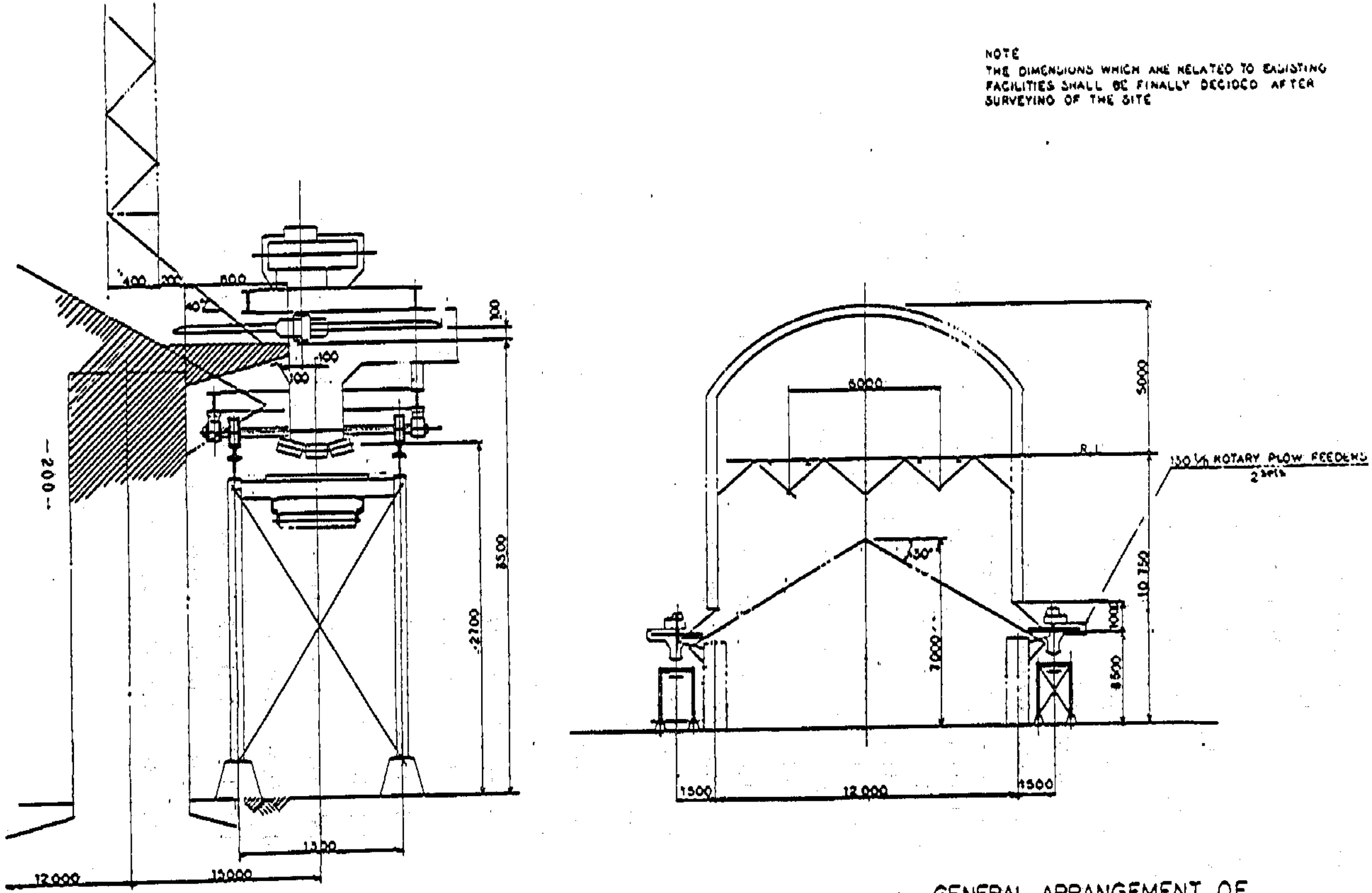
(1) Capacity	65 t/h ~ 130 t/h variable
(2) Type	Rotary plow feeder type
(3) Travelling distance	Approx. 60 m
(4) Reclaiming outlet	As shown in Fig. 2-16
(5) Diameter of rotary plow	Approx. 2.1 m
(6) Travelling rails	22 kg
(7) Rail span	Approx. 1.3 m
(8) System of power supply	Spring type cable reeling

3) Major requirement

(1) Each single plow of rotary plow feeder is removable for the purpose of easy maintenance.

(2) Adjustment of reclaiming rate is capable through the variable

NOTE
THE DIMENSIONS WHICH ARE RELATED TO EXISTING FACILITIES SHALL BE FINALLY DECIDED AFTER SURVEYING OF THE SITE



GENERAL ARRANGEMENT OF ROTARY PLOW FEEDER

Fig.2-16

control of plow revolution.

(3) All the wheels are driven for travelling motion.

(4) Location of rotary plow feeder is indicated in the supervisory control room. Location detecting equipment will be provided for fixing the reclaiming range.

6.3 Coal Storage Facility, Reclaiming Facility and Shiploading Facility

6.3.1 Stacker

1) General

Stacker discharges the coal in the storage yard which is reclaimed from silo of the wagon discharging facilities (Fig. 2-18).

In stacking operation initial positioning of the stacker is carried out manually at the operator's cabin of the stacker. Once the initial stacking position is fixed manually, the stacking operation can be remote-controlled from the supervisory control room and can be operated automatically according to the designated programme.

2) Main particulars

(1) Capacity	250 t/h
(2) Type	Travelling single wing type
(3) Travelling distance	Approx. 210 m
(4) Rail span	4.5 m
(5) Wheel base	5.0 m
(6) Outreach (from the rail center of pile side)	14.8 m
(7) Travelling rails	37 kg
(8) Width of boom conveyor belt	750 mm
(9) System of power supply	Torque motor type cable reeling

3) Major requirement

(1) In order to change location and to shift during operation the travelling speed will have 2 steps of high speed and low speed.

As the operation to change location is carried out at the operator's cab, travelling speed can be changed at the operator's cab of the stacker.

(2) As the tripper length of stacker is restricted by the spacing of storage yard, a vertical conveyor such as bucket elevator will be applied for transferring coal from tripper to boom.

(3) Bolt jointing method will be applied to site assembly work.

(4) Width of inspection walk way is more than 600 mm and hight of handrail is more than 1,000 mm. Inclination of ladder is less than 55 degree to horizontal level.

6.3.2 Reclaimer

1) General

The reclaimer diggs and shovels the coal in storage yard and feeds it to belt conveyors (Fig. 2-18). In reclaiming operation, initial positioning of reclaimer to the right location of pile is handled manually at the operator's cab of reclaimer. Once initial position is fixed manually reclaiming operation like the operation of stacker can be remote-controlled from the supervisory control room and can be automatically controlled according to the designated programme. After a pile has been reclaimed, another new pile will be stacked on the reclaimed area of the yard.

Therefore, once the reclaimer has finished reclaiming one pile, the reclaimer will reverse its travelling direction and reclaim another new pile.

2) Main particulars

(1) Capacity	1,000 t/h
(2) Type	Single bucket-wheel type with harrow
(3) Dimension of pile	Width; Approx. 23 m Height; Approx. 12.6 m
(4) Angle of harrow	32 ~ 45 degree (variable)
(5) Rail span	26 m

(6) Travelling distance	Approx. 240 m
(7) Travelling rail	37 kg
(8) System of power supply	Torque motor cable reeling

3) Major requirement

(1) In order to change location and to shift during operation travelling speed will have 2 steps of high speed and low speed. As the operation to change location is carried out manually at operator's cab, travelling speed can be changed at the operator's cab of reclaimer.

(2) Bolt jointing method will be applied to site assembly work.

(3) Reclaimer is provided with harrows on both front side and rear side of it. Revolution of bucket wheel will be reversible so that direction of reclaiming operation can be also reversible. Easy operation will be required to reverse each bucket.

(4) As for the inspection walkways and ladders same requirements as those of 6.3.1 3) (4) will be applied.

6.3.3 Shiploader

1) General

Shiploader discharges the coal onto ship berthed along the wharf which is reclaimed by reclaimer from coal pile in storage yard and transported through belt conveyors (Fig. 2-17). Operation of shiploader is carried out manually at the operator's cab of shiploader, and the situation operation is indicated in the supervisory control room. A pendant control switch hanging from the top of the boom will enable the shiploading operation on the ships deck.

Moreover, a telescopic chute will be provided so as to lessen the dust during shiploading operation.

2) Main particulars

(1) Capacity	1,000 t/h
(2) Type	Travelling, slewing, and boom derricking type

(3)	Travelling distance	Approx. 150 m
(4)	Rail span	10 m
(5)	Wheel base	10 m
(6)	Outreach (from berthing line)	16 m
(7)	Travelling rail	50 kgN
(8)	Width of boom conveyor belt	1,200 mm
(9)	Angle of boom derricking (during operation ±15 degree, at rest +30 degree)	- 15 ~ + 30 degree
(10)	Angle of slewing (to the vertical line of berthing line)	± 90 degree
(11)	Method of power supply	Torque motor type cable reeling

3) Major requirement

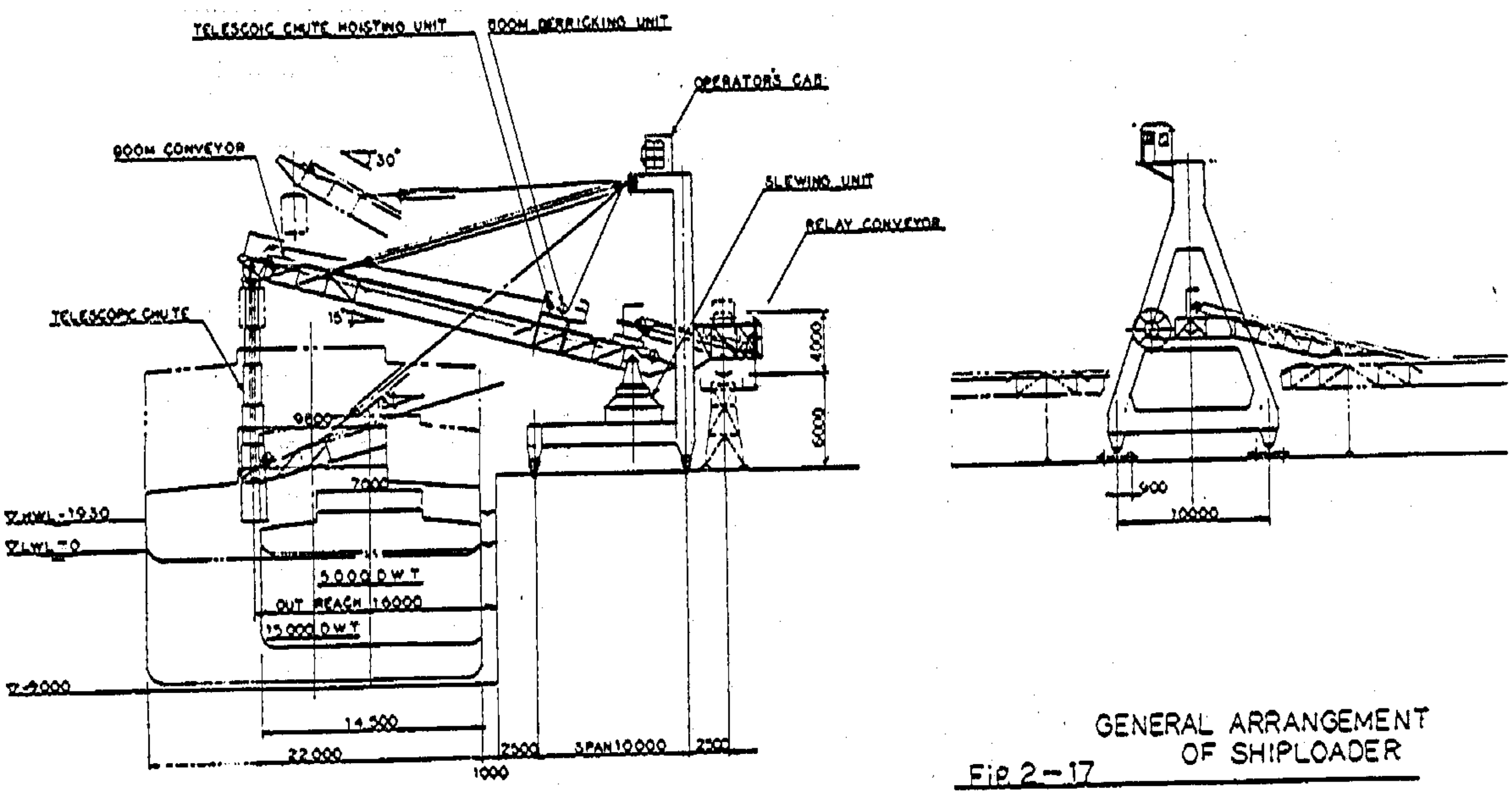
(1) Shiploader can be operated both at the operator's cab and with the pendant control switch provided on the top of the boom. Selection whether operation at operator's cab or with pendant control switch will be made at the operator's cab.

(2) In order to avoid the intereference with ship while ship is leaving from or berthing at the wharf, boom can slew by 90 degree and can be positioned parallel to berthing line.

(3) When a ship is berthed at the wharf for handling materials other than coal, shiploader can be anchored at the end of the wharf not to interefer the operation of the ship.

(4) Bolt jointing method will be applied to site assembly work.

(5) As for inspection walkways and ladders same requirements as those of 6.3.1 3) (4) will be applied.



GENERAL ARRANGEMENT OF SHIPLOADER

Fig. 2—17

6.3.4 Belt conveyors

1) General

Belt conveyors transfer the coal between unit machines such as stacker, reclaimer and shiploader. Arrangement of belt conveyors is shown in Fig. 2-3 and elevation in Fig. 2-19 and 2-20.

The operation route of belt conveyors is made up by connecting each conveyor to another conveyor taking account of each purpose of transporting the coals.

Belt conveyors are started and stopped sequentially and automatically controlled at the supervisory control room. Also, each conveyor can be operated individually at machine site. Belt conveyor system mentioned herein consists of the following two lines.

(1) Receiving and stacking line

(2) Reclaiming and shiploading line

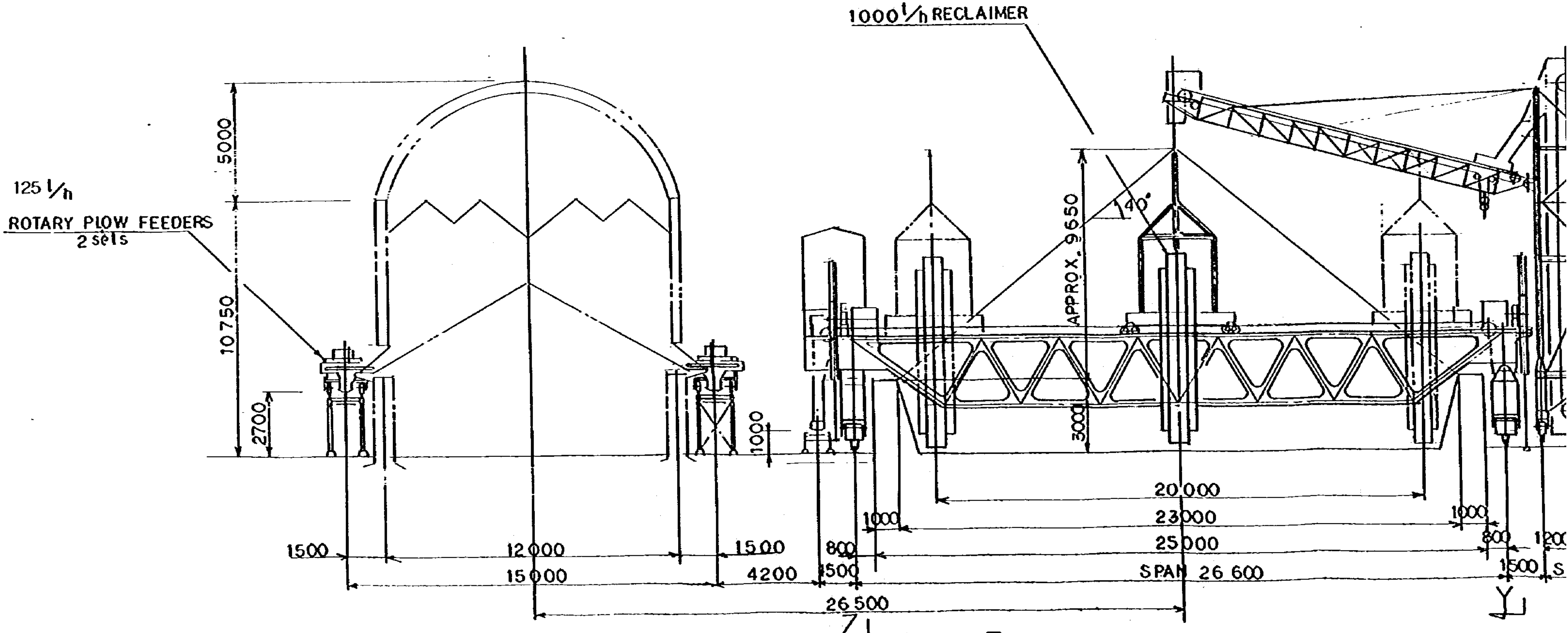
These two lines of belt conveyor system can be operated independently.

2) Main particulars

Main particulars of belt conveyors applied to the coal handling facilities are as follows.

Table 2-6

Conveyor No.	Capacity (t/h)	Belt width (mm)	Trough angle (°)	Speed (m/min)	Length (m)
RA-1A	125	600	20	130	@ 60
RA-1B	125	600	20	130	@ 60
RA-2	250	750	20	160	@ 53
RA-3	250	750	20	160	@ 250
SA-1	1,000	1,200	35	180	@ 268
SA-2	1,000	1,200	35	180	@ 25
SA-3	1,000	1,200	35	180	@ 318
SA-4	1,000	1,200	35	180	@ 184



1000 t/h RECLAIMER
125 t/h
ROTARY PLOW FEEDERS
2 sets
5000
10750
2700
1000
APPROX. 9650
3000
40°
1500
12000
1500
800
15000
4200
1500
20000
1000
23000
1000
25000
800
1200
SPAN 26 600
1500
26 500
Z
Y

E ~ E

NOTE
THE DIMENSIONS WHICH ARE RELATED TO EXSISTING FACILITIES SHALL BE FINALLY DECIDED AFTER SURVEYING OF THE SITE

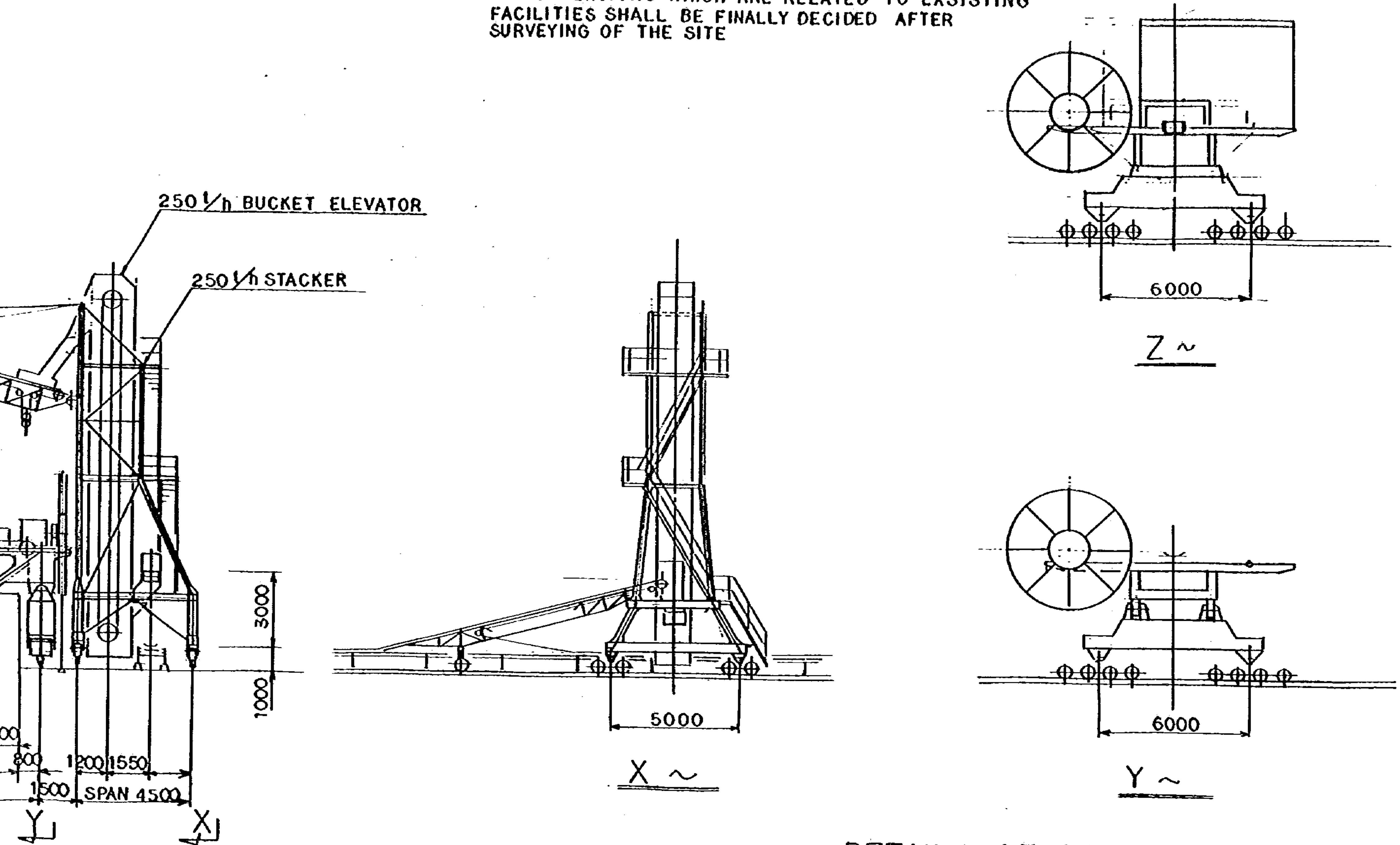
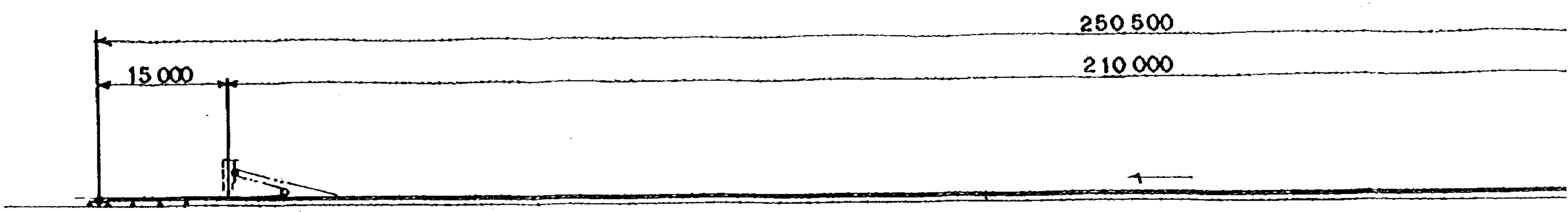
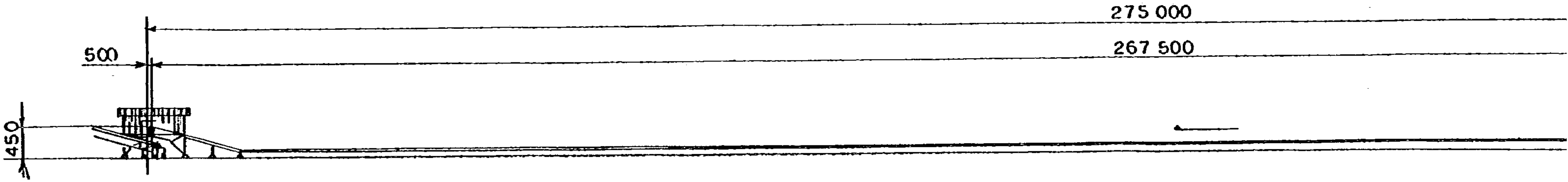


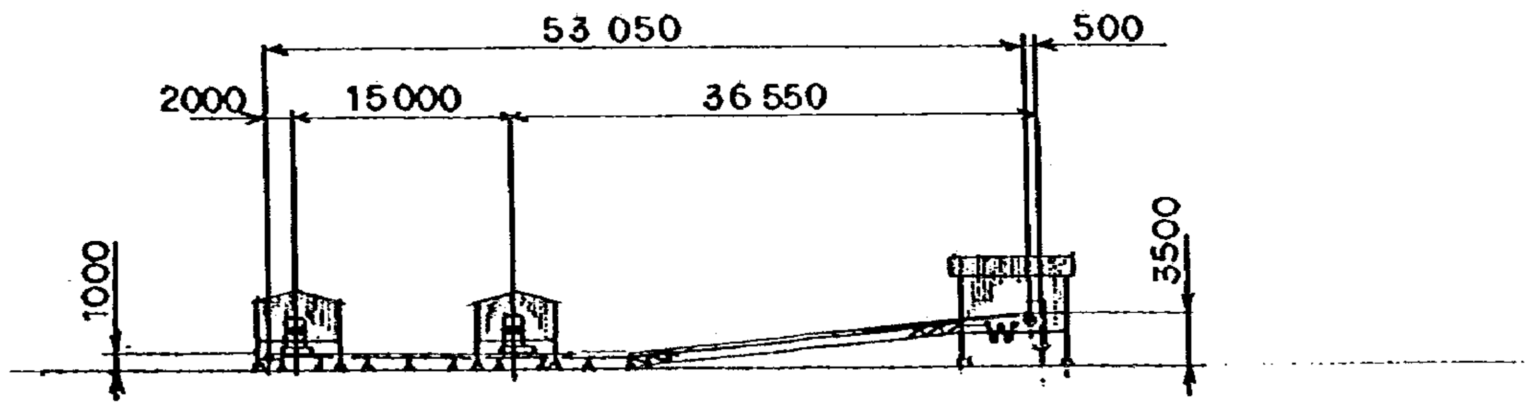
Fig 2-18 DETAILS OF COAL STORAGE YARD FACILITIES


250 500
15 000
210 000

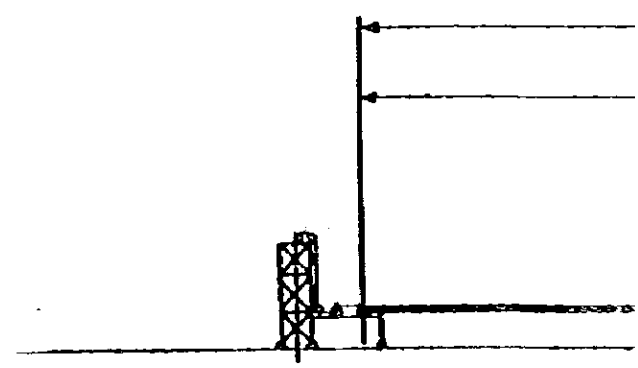
A ~ A

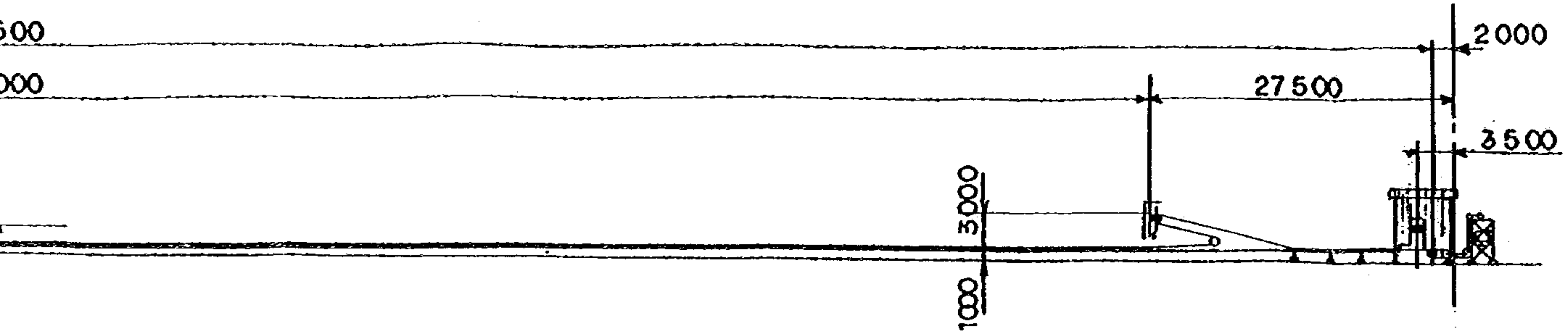

275 000
500
267 500
450

B ~ B

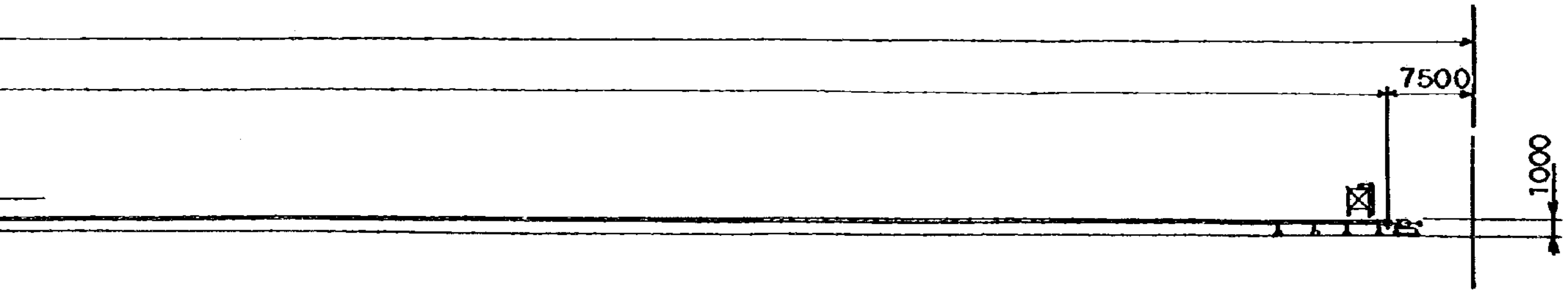

53 050
500
2000
15 000
36 550
1000
3500

D ~ D

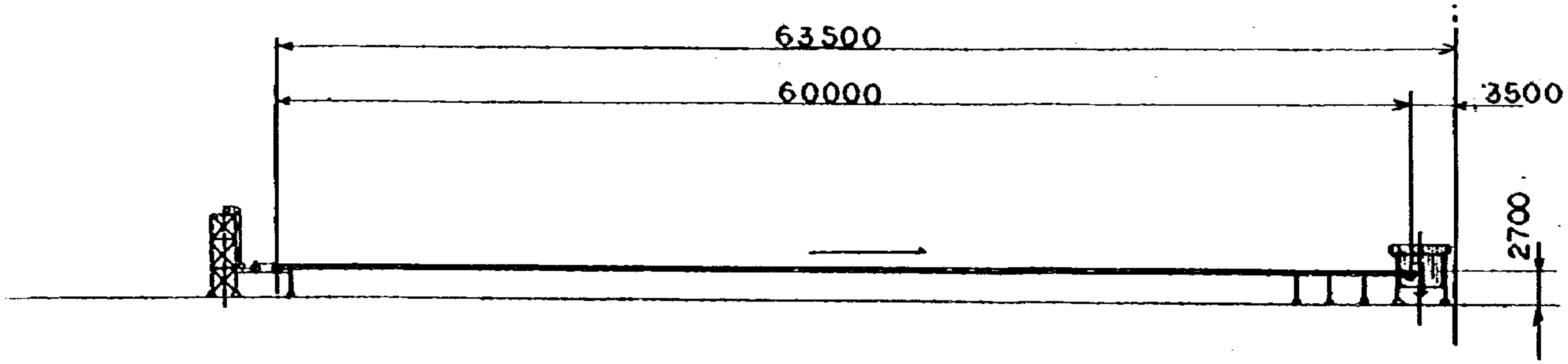




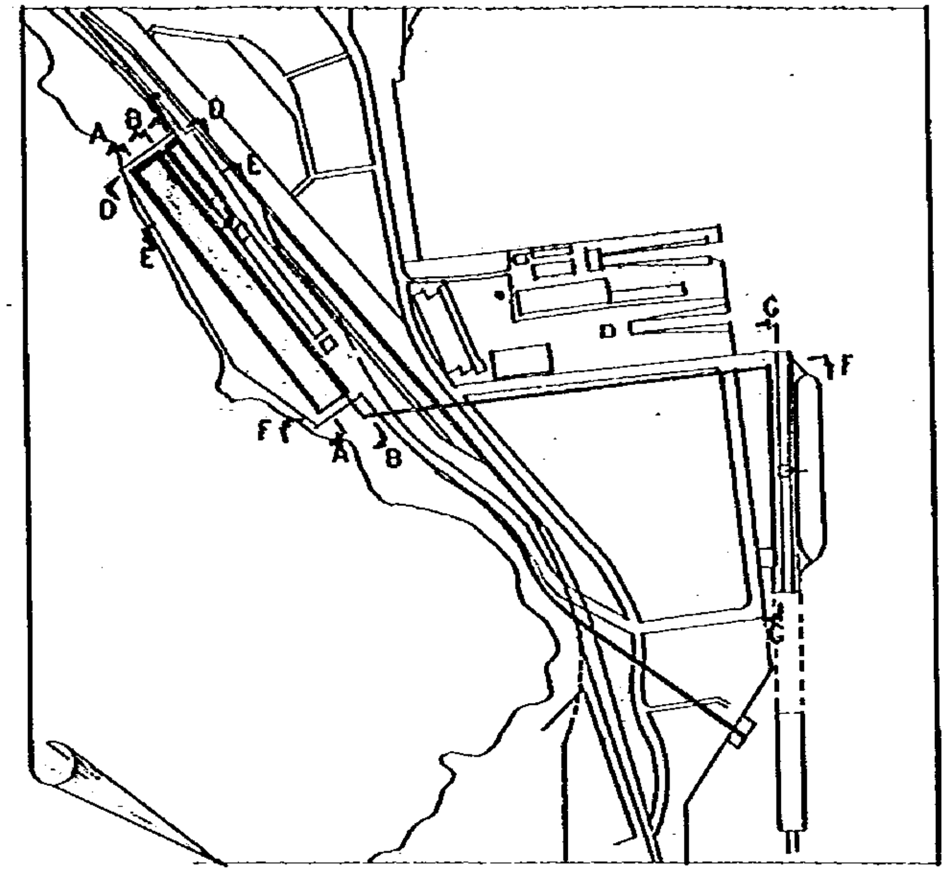
~ A



~ B



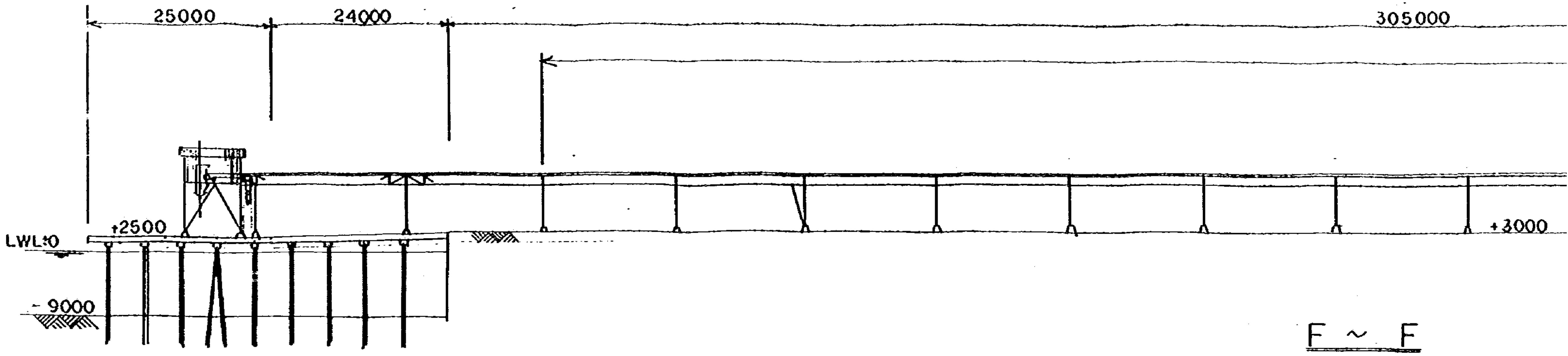
C ~ C

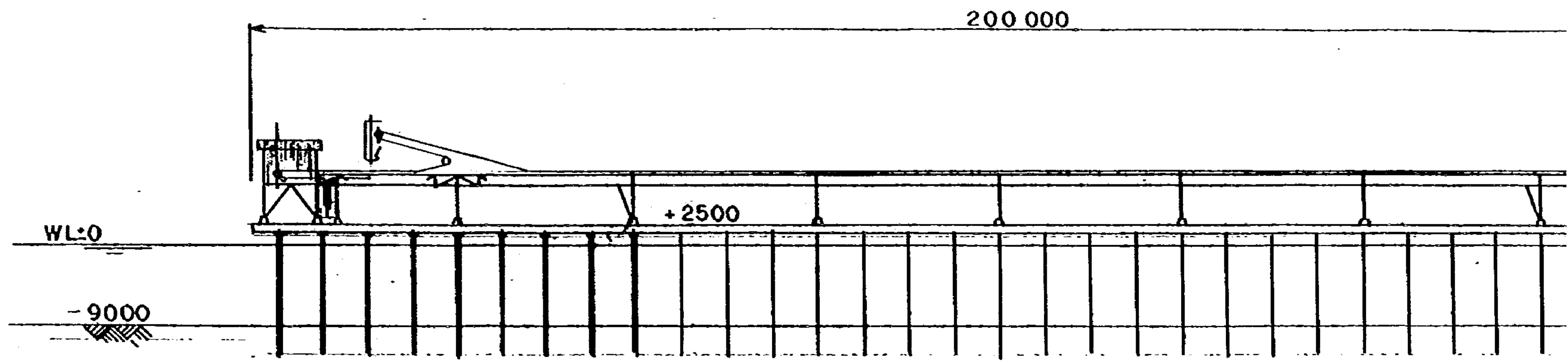


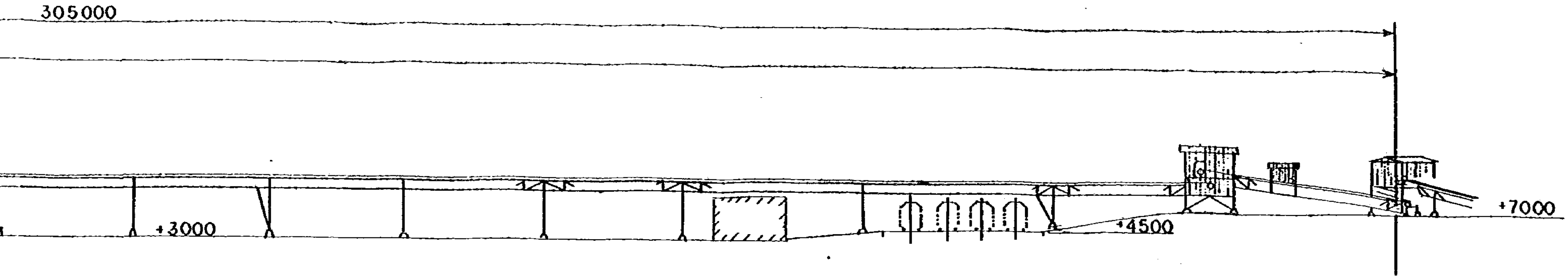
KEYPLAN

NOTE
THE DIMENSIONS WHICH ARE RELATED TO EXSISTING FACILITIES SHALL BE FINALLY DECIDED AFTER SURVEYING OF THE SITE

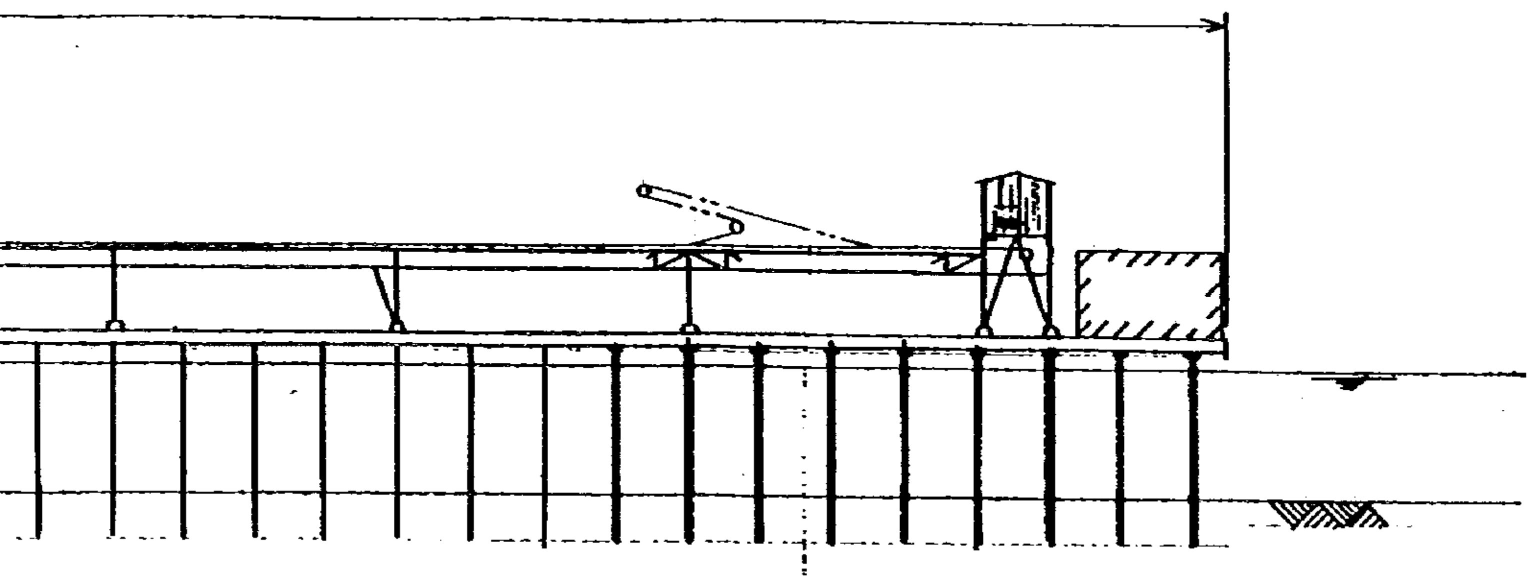
Fig 2-19 ELEVATION OF YARD BELT CONVEYOR


25000
24000
305000
+2500
LWL±0
-9000
+3000
F ~ F


200 000
+2500
WL±0
-9000



~ F



NOTE
THE DIMENSIONS WHICH ARE RELATED TO LXSISTING FACILITIES SHALL BE FINALLY DECIDED AFTER SURVEYING OF THE SITE

Fig.2-20 ELEVATION OF TRANSFER AND QUAY BELT CONVEYOR

3) Major requirement

(1) In case driving power is less than 55 kW, motor and reducer as well as reducer and driving pulley are connected with flexible coupling. Driving device of geared motor type can be also applied.

(2) In case driving power is more than 75 kW, motor and reducer are connected with fluid coupling, and reducer and driving pulley are connected with flexible coupling.

(3) A control device will be provided for the belt conveyors which might reverse its rotation at the interruption of electric power or for the belt conveyors with large inertia force.

(4) The junction part of belt conveyors will be housed in a small shed.

(5) Each belt conveyor will be covered with a round hood as far as practicable. The part of belt conveyor which cannot be covered with hood due to the existence of tripper, etc. will be provided with side-cover.

(6) Belt conveyors with the length of more than 50 m will be provided with pull-cord-switch for emergency stop.

(7) Standard spacing of troughed idlers and returnidlers will be as follows.

Belt width (mm)	Troughed idler spacing (mm)	Return idler spacing (mm)
600	1,200	3,000
750	1,100	2,500
1,200	1,000	2,500

(8) Driving pulley will be provided with rubber rugging, the surface of which will be cut like diamond shape.

(9) For the belt conveyors with the length of more than 20 m and with weighing scale, take-up device of gravity type will be provided.

(10) Walkways are made of expand metal with the thickness of more than 6 mm. The same requirements as those of 6.3.1 3) (4)

will be applied unless otherwise stated.

6.4 Auxiliary Equipment

6.4.1 Weighing equipment

1) General

Each one set of weighing equipment will be provided at the receiving side and reclaiming side of storage yard to weigh the incoming quantity and the outgoing (reclaiming) quantity of coal. Weighing equipment is to produce the data for administrating the coal handling facilities and not to produce the data for commercial use. Weighing for commercial purpose will be made by checking ship's draft.

2) Main particulars

Table 2 - 8

Conveyor No.	Weighing range		Minimum scale (kg)	Accuracy
	Max. (t/h)	Min. (t/h)		
RA-2	340	68	50	1/200
SA-2	1,300	260	50	

(Note) Accuracy will be checked by test-chain.

3) Major requirement

(1) Integrated quantity of coal and instantaneous flow rate of coal will be indicated at the supervisory control room as well as at machine site.

(2) For the weighing equipment installed at the reclaiming side of storage yard a device which sends pulse-signal to sampling equipment will be provided.

(3) Two kinds of test-chains will be provided, namely 30% and 60% of whole scale. Reeling and accommodating device of test chain will be provided at machine site.

6.4.2 Sampling equipment

1) General

Sampling equipment will be provided at the down stream of weighing equipment. By the signal from weighing equipment the sampling equipment will take the increment of coal from belt conveyor which is transferring the same quantity of coal with constant weight interval. Whenever a predetermined quantity of coal transfer through sampling equipment, sampling equipment will take the increment of coal by the signals from weighing equipment. Increment to be taken will be two kinds, namely increment for analysing contents and for measuring moisture content. The size and quantity of increment will conform to JIS M8811.

2) Main particulars

(1)	Capacity of main belt conveyor	1,000 t/h
(2)	Type	belt sampler
(3)	Size of rod	5,000 t ∿ 15,000 t (variable)

3) Major requirement

(1) Dividing and preparation of increment will not be carried out at sampling equipment. Increment of each sub-rod will be put into each container automatically.

(2) If the primary increment is more than suitable size, then the increment will be subject to secondary sampling. This procedure will be continued until the increment will become the suitable size.

(3) The increment for measuring moisture content will be taken from the primary increment. It will be put into auto-packer and sealed soon after taken.

6.5 Electric Facilities

6.5.1 Electric substation

1) General

Electric substations must have capacity enough to operate all the relevant facilities, machineries and equipment of coal shiploading facilities at Teluk Bayur port. They are installed at the ground floor of the buildings such as office and supervisory control room which are to be built at the part of the yard. Electric substations mentioned herein consist of main substation which receives the H.V. power of 3,000 V from power station and substations to distribute the suitable power to each machineries and equipment.

2) Main particulars

(1)	Primary voltage	AC 3 ϕ, 3 W, 3,000 V
(2)	Frequency	50 Hz
(3)	Primary power	Approx. kVA
(4)	Allowable fluctuation of voltage	
	Voltage; (under the rated frequency)	less than ± 10%
	Frequency; (under the rated voltage)	less than ± 5%

In case both voltage and frequency fluctuate, the summation of absolute values of both fluctuation must be less than 10%.

3) Main voltage

(1)	H.V. motors (not less than 110 kW)	AC 3 ϕ, 3 kV, 50 Hz
(2)	L.V. motors (less than 110 kW)	AC 3 ϕ, 380 V, 50 Hz
(3)	Lighting circuit	AC 1 ϕ, 220 V, 50 Hz

4) Major requirement

Power factor of H.V. will be 0.9, and power factor of L.V. will be more than 0.8.

6.5.2 Control system of belt conveyors

1) The operation of belt conveyors is controlled through the control panel at the supervisory control room which is built on the second floor of the office building. A mimic board will be provided at the vertical part of the control panel so that operation condition can be checked for belt conveyors, rotary plow feeders, stacker, reclaimer and shiploader. On the desk of control panel operation switches will

be provided to operate the machines such as belt conveyors and rotary plow feeders.

2) Operation system of belt conveyors

(1) Remote and sequential control system of belt conveyors

Sequential starting, sequential stopping and emergency stopping will be controlled through the control panel of supervisory control room. Interlock system will be provided between belt conveyors, between conveyors and stacker and between reclaimer and shiploader. Before driving belt conveyors alarm will be given with the bells installed at the side of belt conveyor. The following control will be feasible as remote and sequential control of belt conveyors.

i. Sequential starting

Operation of conveyor will start from down-stream conveyor to upper-stream conveyor.

ii. Sequential stopping

Upper-stream belt conveyor will stop first and down-stream conveyor will stop next sequentially so that coal will not pile at the junction part of belt conveyors.

iii. Stopping of reclaiming operation

Reclaiming conveyor lines must be stopped so as to keep the coal unremained on conveyor belt.

iv. Stopping by interlock system

In case following safety devices are actuated, the belt conveyor which is located on the upper-stream of the belt conveyor equipped with those safety devices will stop immediately.

- Chute plugging switch
- Belt slip detector
- Motor overload detector
- Detecting switch of belt misalignment

v. Emergency stop

When the emergency stop switch on the control panel of supervisory control room is switched on, or when the pull-cord-switch installed along the walkway of belt conveyor is pulled, all the relevant conveyors of the same line will be stopped.

(2) Individual operation at machine site

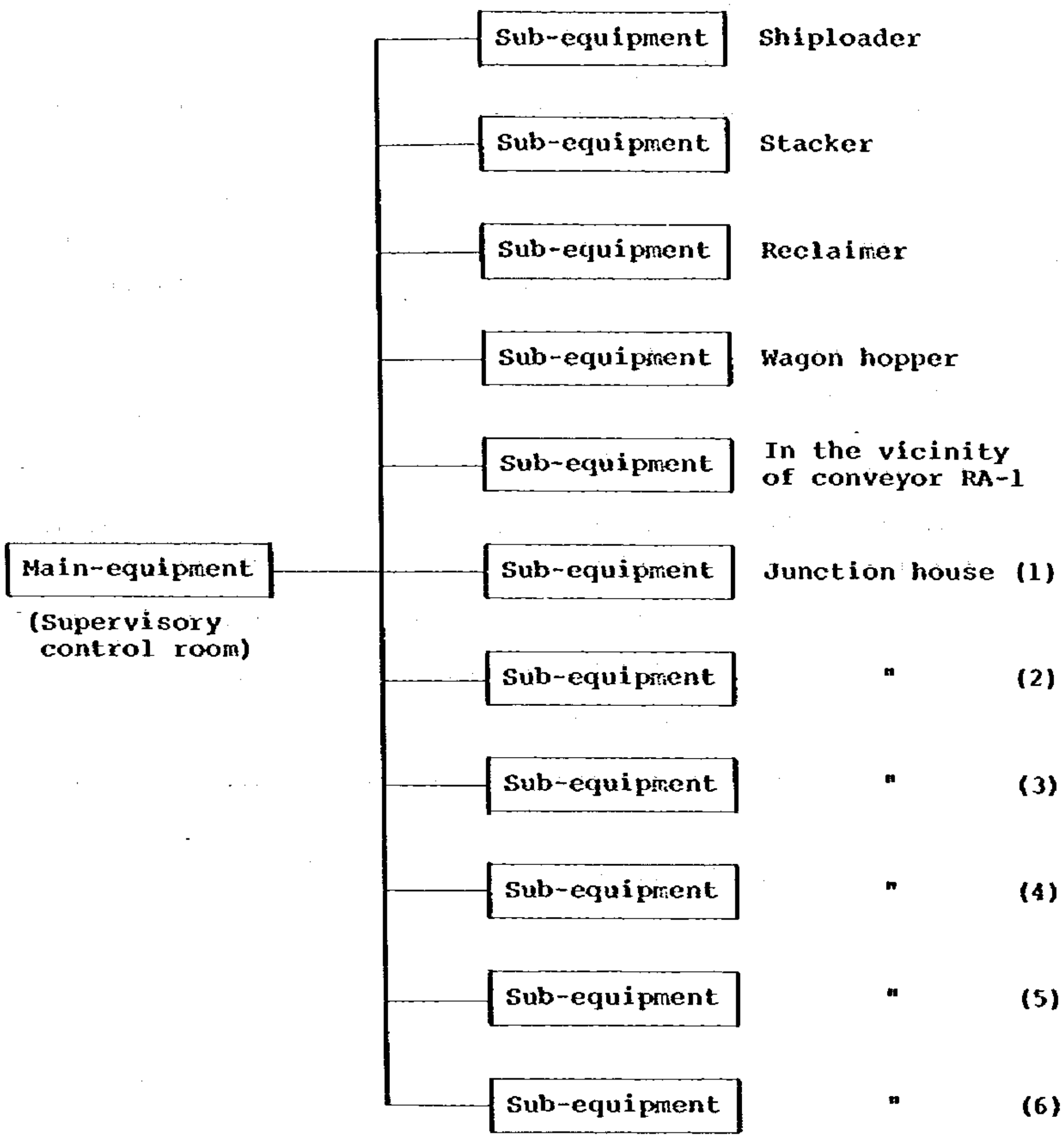
Individual operation of belt conveyor at machine site will be carried out mainly for the purpose of maintenance or trial run for adjustment work. Each conveyor can be operated individually by push-button switch installed in the vicinity of driving device. When a belt conveyor is individually operated, all interlock system will be released except the cases of electric troubles and pull-cord switches.

3) Indication of troubles

The causes of stop by interlock system and the belt conveyor to which interlock has been actuated will be indicated in the supervisory control room. Major troubles such as trip of power source will also be indicated in the supervisory control room.

6.5.3 Communication system

The communication between the relating facilities will be feasible by the communication system to be provided. Paging will be made by loud-speaker and the person called will call back by hand-set at the neighboring communication station. Communication network by these hand-sets will be as follows.


Main-equipment
(Supervisory control room)
Sub-equipment
Shiploader
Sub-equipment
Stacker
Sub-equipment
Reclaimer
Sub-equipment
Wagon hopper
Sub-equipment
In the vicinity of conveyor RA-1
Sub-equipment
Junction house (1)
Sub-equipment
" (2)
Sub-equipment
" (3)
Sub-equipment
" (4)
Sub-equipment
" (5)
Sub-equipment
" (6)

6.5.4 Lighting system

1) Lightings for nightwork

In consideration of nightwork the following lightings will be provided.

Location	Lighting Material	Illumination
Conveyor Walkway	Fluorescent Lamp	Ave. 20 LX
Junction House	Fluorescent Lamp	Ave. 200 LX
Vicinity of Junction House	Mercury Lamp	Ave. 20 LX
Storage Yard	Mercury Injector Lamp	Min. 2 LX

2) Emergency lightings

Incandescent lamps of battery incorporating type will be provided at the following position so that worker can escape to the ground.

(1) Walkway from operator's cab of movable machines to the ground

(2) Walkway from the building of wagon hopper to the ground

(3) Stairs at the junction house

(4) Walkway from the supervisory control room or office building to the ground

(5) Inside the substations

6.6 Design of Berthing Facilities

6.6.1 Design of piled wharf

1) Design condition

a) Dimensions of mooring wharf

Water depth	-9.00 m
Cope level	+2.50 m
Berth length	200 m
Apron width	20 m

b) Requirements for service

Vessels considered	Min. 5,000 DWT
	Max. 15,000 DWT
Approaching velocity	0.1 m/sec.
Type of cargo	Coal
Loads to be born,	
Normal	2.0 tf/m^2
In earthquake	1.0 t/m^2
Cargo loader weight	230 t, normal
	250 t, in service
Conveyor weight	0.7 t
Track weight	20 t, T-20

c) Natural conditions

Soil condition (estimated) (Fig. 2-22)	-9.0 m ∿ -35.0 m cohesive soil N=3		
	under -35.0 m bedrock		N > 50
Seismic coefficient	Horizontal	Ka = 0.1	
	Vertical	Kv = 0	
Marine condition	Tide level	H.W.L. = +1.93 m	
		L.W.L. = ±0.00 m	

Cross Section of Mooring Wharf S=1:100

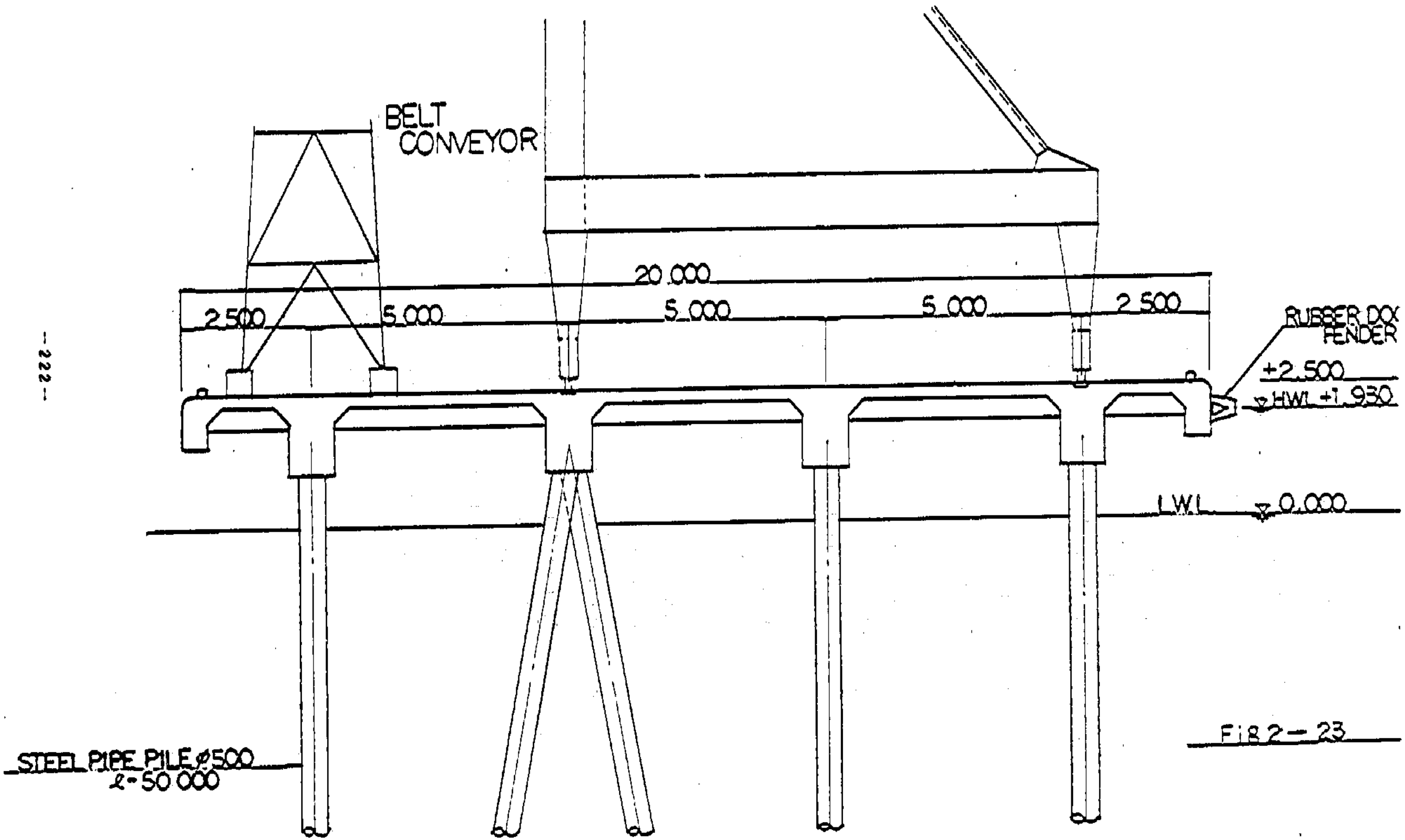


Fig 2—23

DATA OF BORING LOG

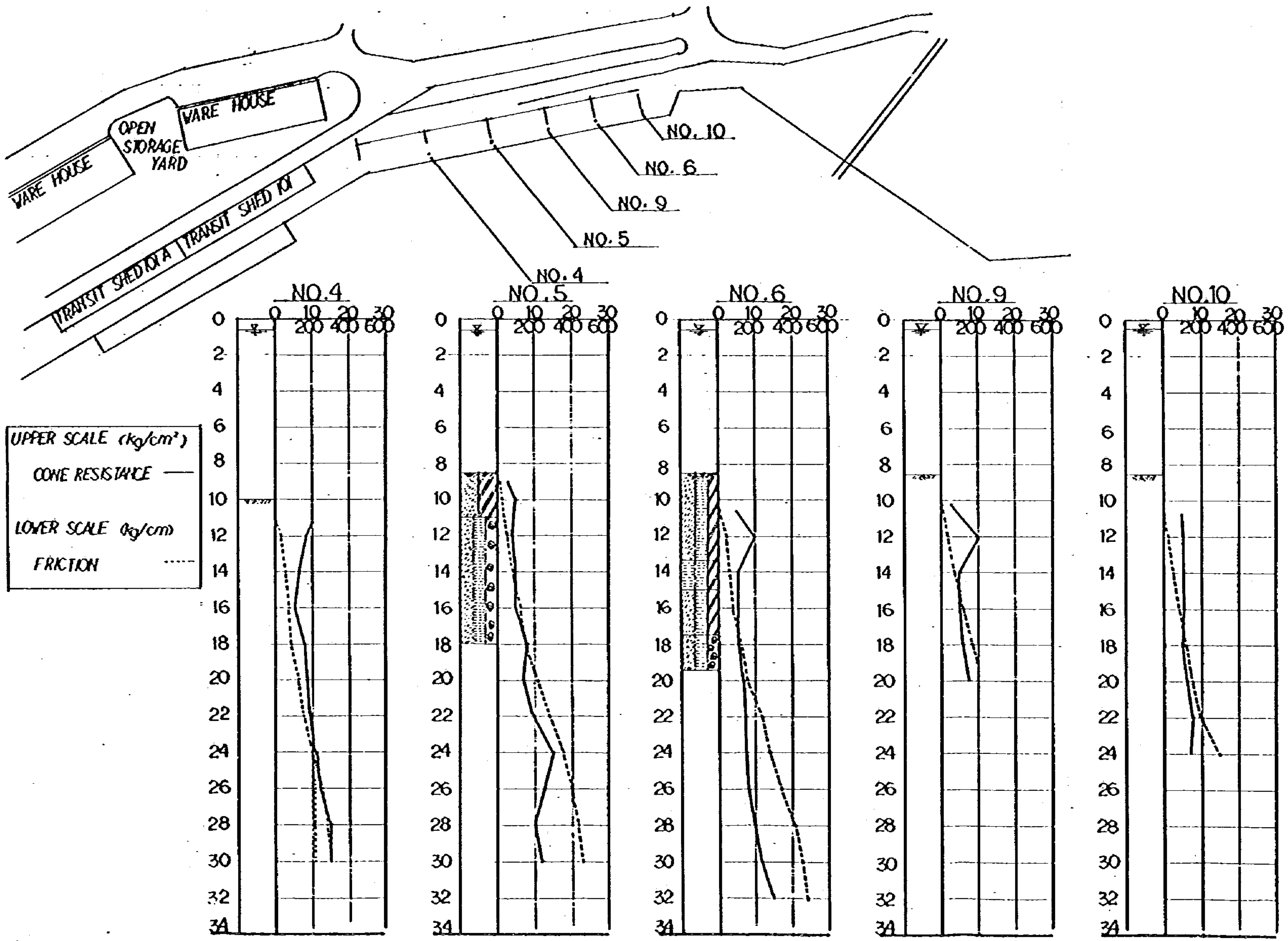


Fig 2-22

GENERAL DRAWING OF THE MOORING WHARF

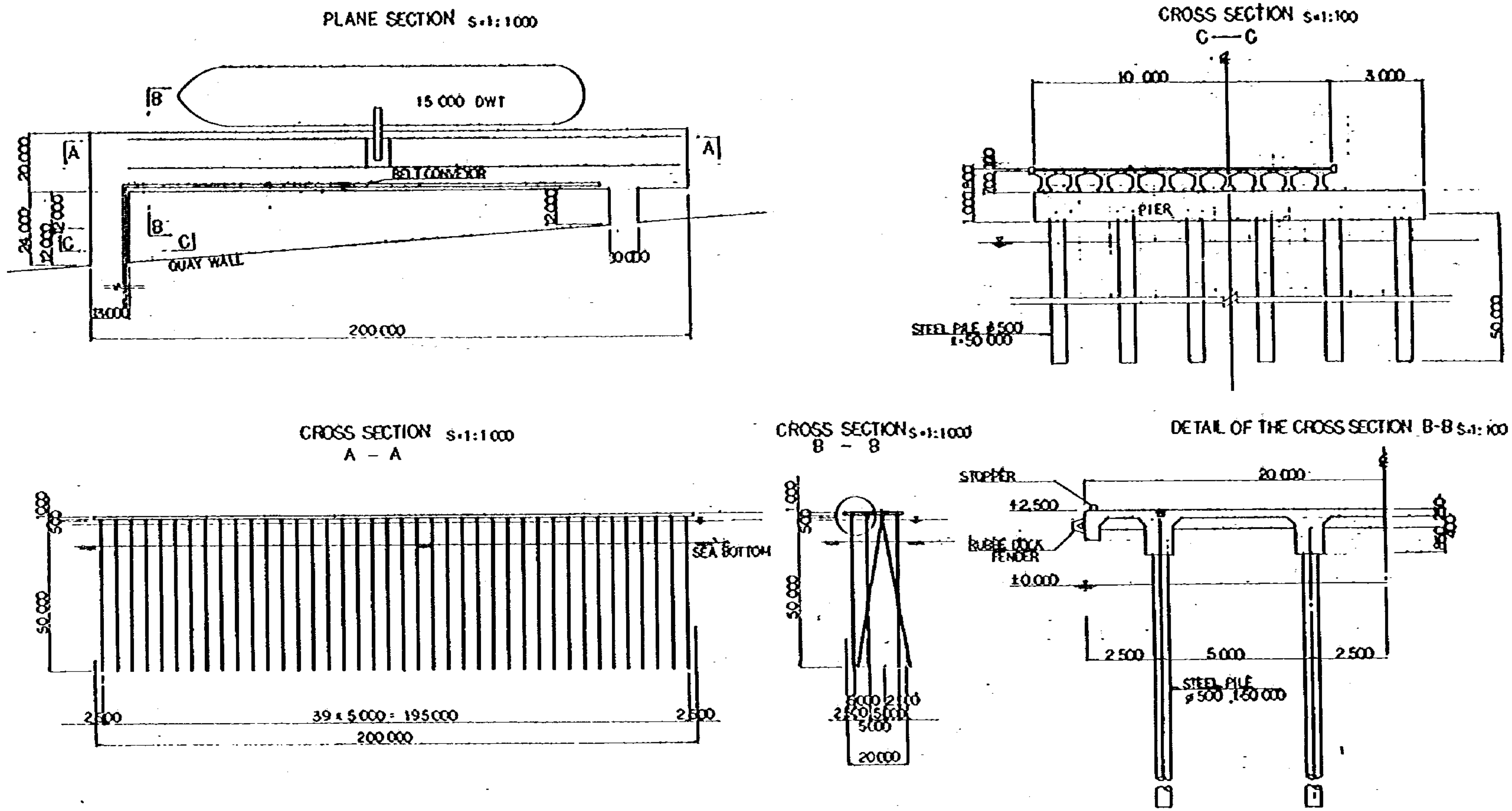


Fig 2 – 24

2) Structure of piled wharf:

The piled wharf will be composed of a foundation comprising steelpipe piles including battered piles and a superstructure comprising a slab deck of reinforced concrete, the slab deck being paved with asphalt to a thickness of 8 cm. Then, two PC concrete girder bridges of 10 m width will be provided for connection between the piled wharf and land.

Total wharf length	200 m
Wharf width	20 m
Transfer bridge	2
Foundation pile	Steelpipe 500 ∅ x 50 mL

6.6.2 Accessory facilities

1) Rubber fender:

When a vessel is approaching a berth, it first enters into contact with the latter at its portion near the bow or stem. As the shipside for berthing is formed in a curvature, if rubber fenders are spaced apart too wide, the above said portion of the vessel directly hits such portion of the berth as protected with no fender, before the fenders sufficiently absorb energy of the approaching vessel.
To avoid this problem, the rubber fenders are generally spaced by 5 m.

Type of fender	V-shaped rubber fender
Effective length	150 cm
Total length	175 cm
Height	50 cm

Calculation sheet and dimensions of rubber fender are filed as Fig. 2-25 and in Fig. 2-26, respectively.

The rubber fenders are to be provided laterally and spaced apart with a 5.0 m pitch.

DOCK FENDER TECH. DESIGN

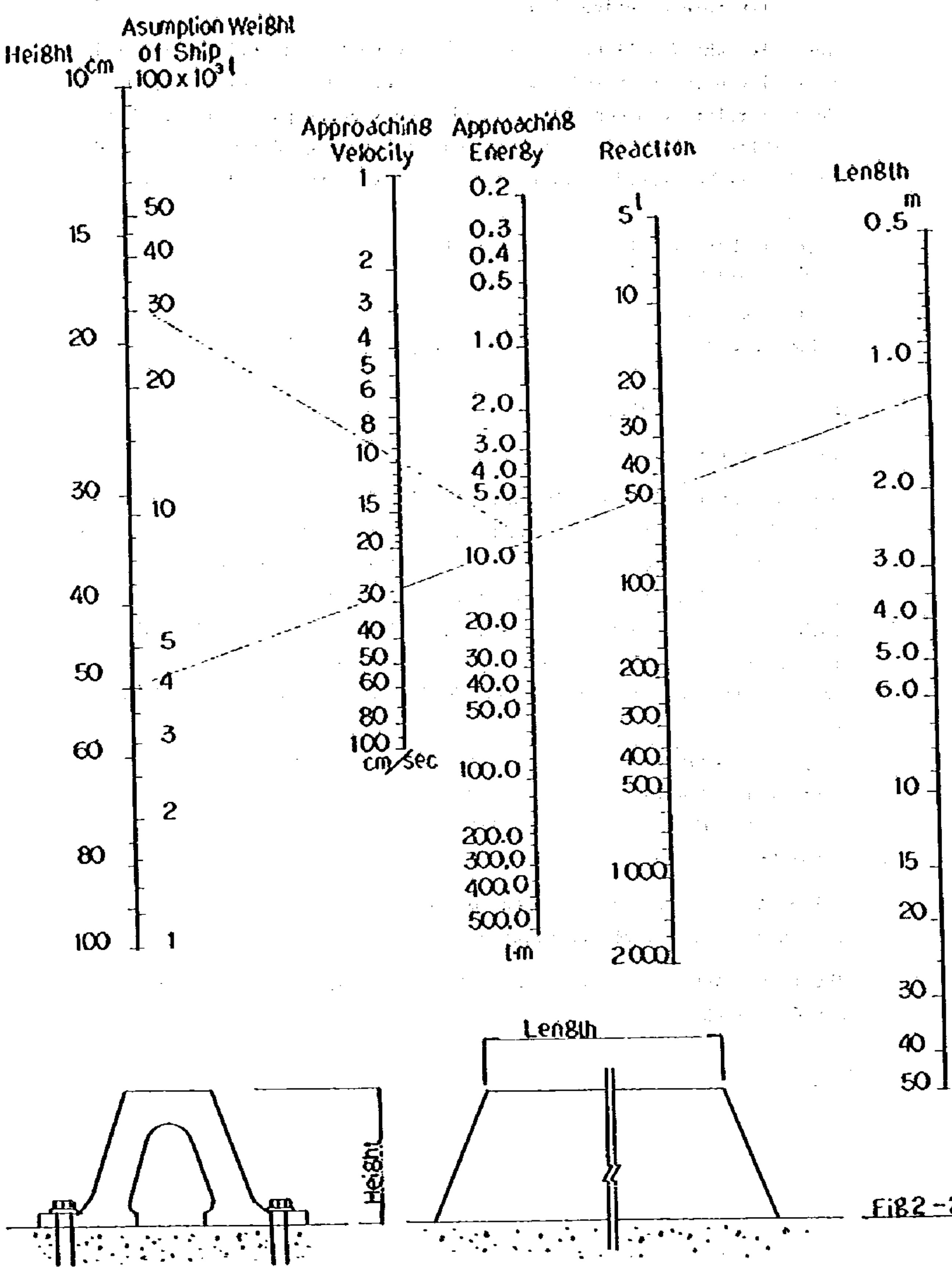
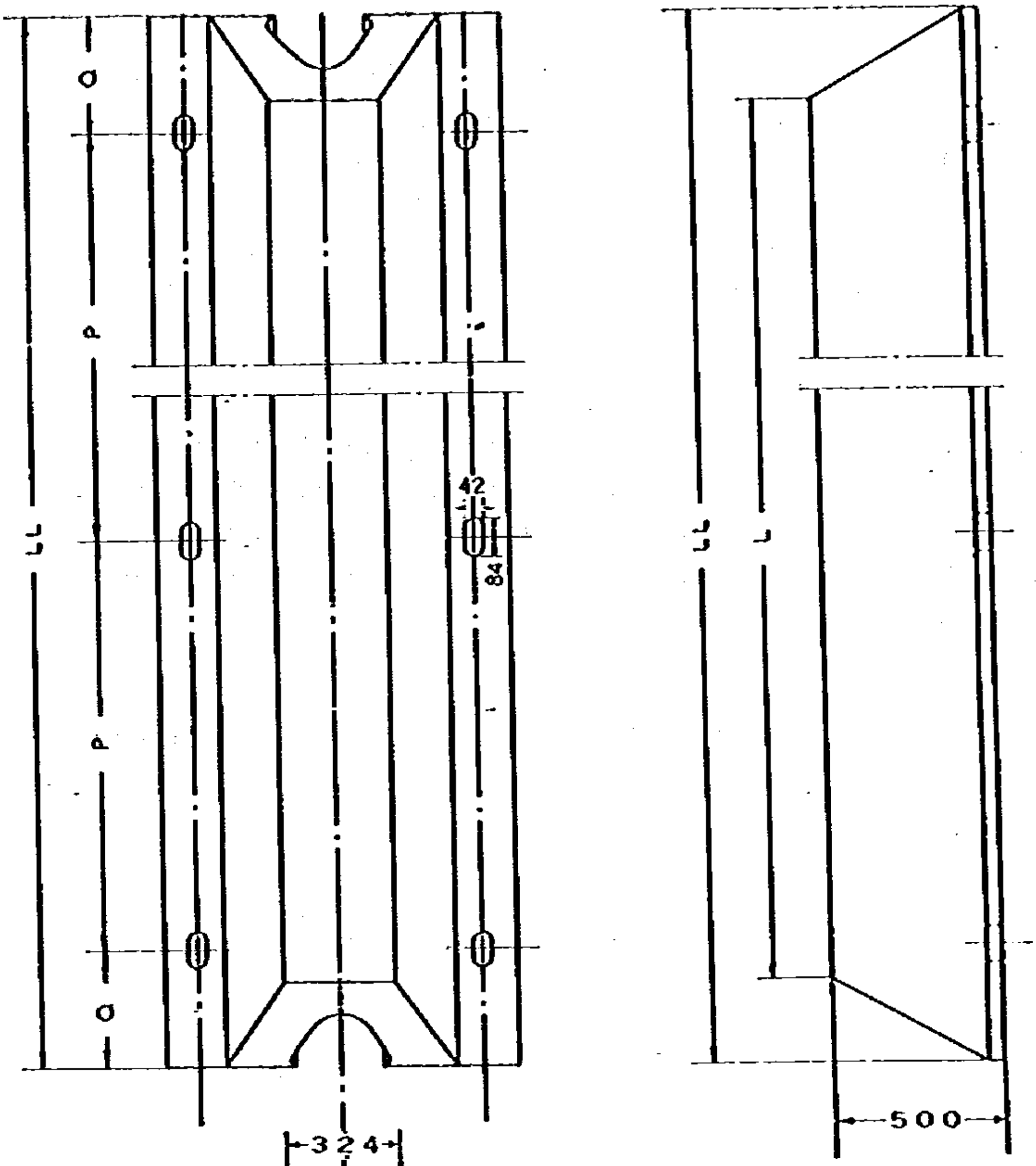
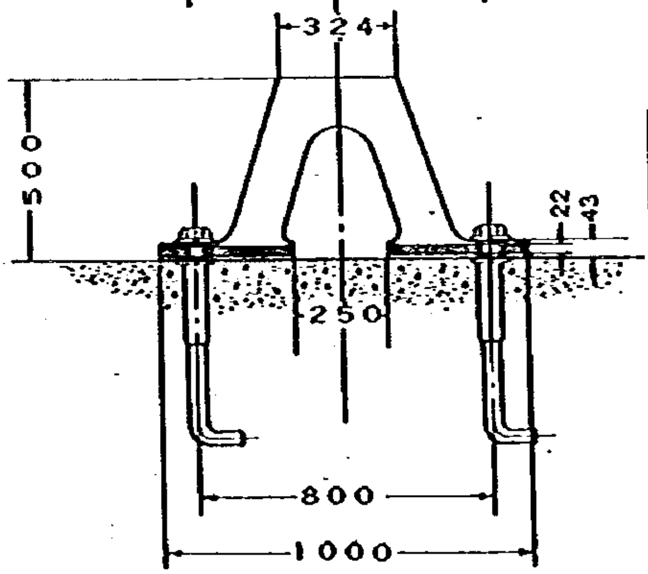


Fig 2-25

Detail Drawing of Rubber Dock Fender





L (m)	LL (mm)	P (mm)	O (mm)	Anchor Bolt 1½"X(nos)
1.0	1,250	900	175	4
1.5	1,750	700	175	6
2.0	2,250	630	180	8
2.5	2,750	800	175	8
3.0	3,250	725	175	10

Fig 2-26

2) Mooring bollard:

For normal use in mooring vessels and to have them approach to or leave from the berth, a plurality of bollards will be arranged on berth at intervals of 20 m. In consideration of the use for 15,000 DWT vessels, each bollard is designed to bear a 50-ton traction force and to have a 350 mm diameter, as shown in Fig. 2-27. The bollard shall not be used for mooring in storms. No mooring post will be employed.

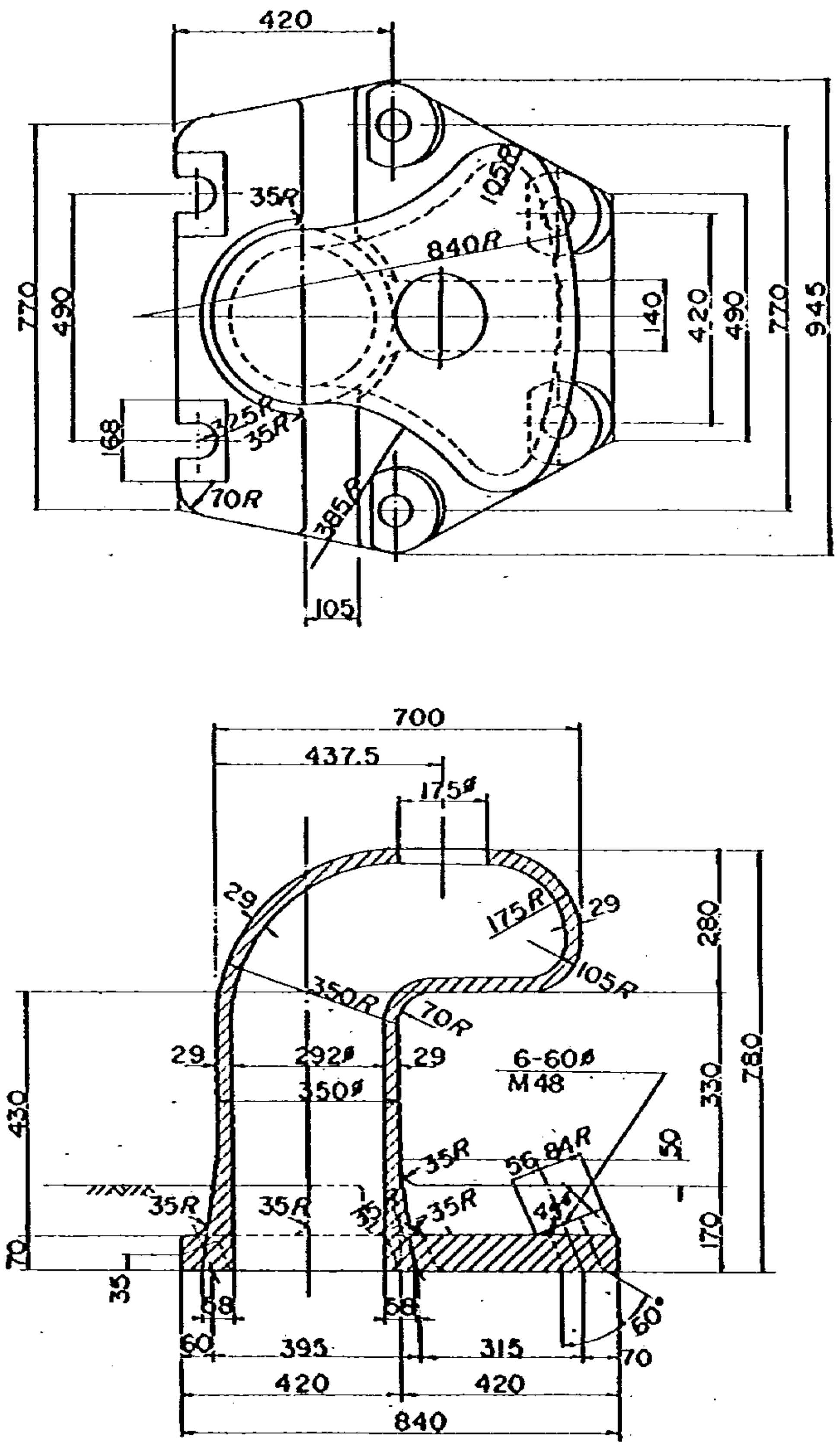
3) Lighting facilities:

Lighting facilities are necessary for night works such as cargo handling and the approaching or leaving of vessel to or from the berth. The devices to be used should be of water-proof construction. Poles of a 7 m length will be employed. Standard illumination is 20 lux at the apron.

4) Others:

As other accessory facilities, there will be provided water-supplies, stairs, ladders, etc.

DETAIL DRAWING OF THE BITT



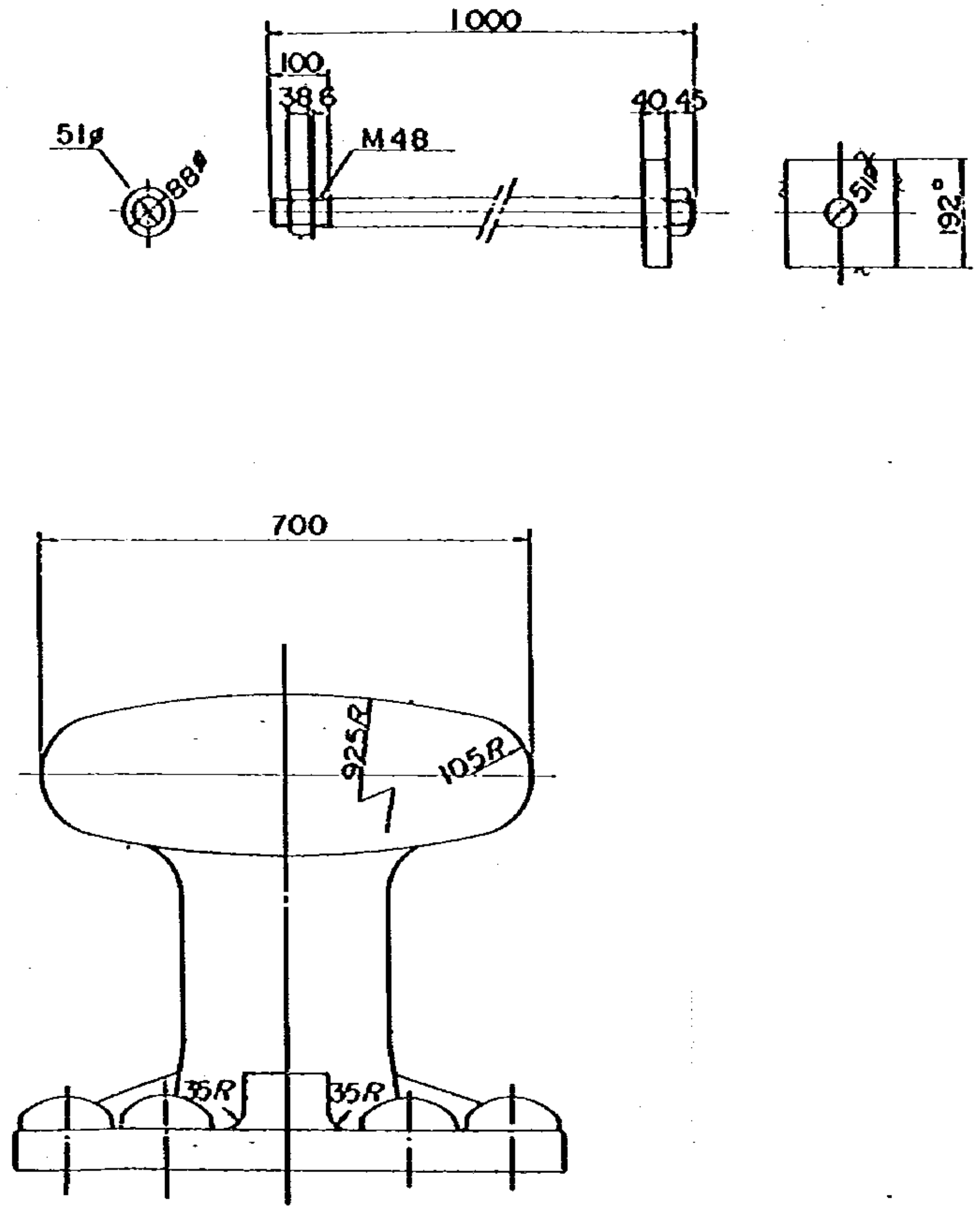


Fig 2 – 27

6.6.3 Foundation of coal storage yard

Dimensions of the foundation are determined based on the equipment plan. The existing coal stock hopper on the mountain side of the port will be removed, then there will be constructed a new coal storage yard.

Design conditions of foundation:

Allowable load on the ground	30 t/m^2
Operational loads, belt conveyor	0.7 t/m^2
reclaimer	100 t/leg
stacker	50 t/leg
Weight of coal per unit volume	1.0 t/m^3
Internal friction coefficient of coal	30°
Repose angle of coal	40°

All foundation will be of site-casted reinforced concrete. Foundations of stacker and coal surefooting wall are integrally casted. Reclaimers have a span of 26.6 m and their foundations thus separated. If these foundations are shifted horizontally, the stacker may be derailed or damaged. To prevent such accidents, there will be provided underground beams.

The subgrade of coal storage yard will comprise a gravel layer of 50 cm thickness and a sand layer of same thickness thereby to drain rainwater. Around the lot of coal storage yard, there will be installed a ditch of 1.0 m x 1.0 m section terminating at a 5.0 m x 4.0 m x 2.0 m sedimentation basin.

The foundation of stacker is to overlap a mountain side on the north side of the port, thus requiring some to be excavated. The excavated slope of the mountain will be protected with a stone retaining wall.

The hopper to receive coal from wagon, installed in the silo on the sea side of the port, should have its rail supporting girders, coal outlet, roof, etc. repaired.

The rail supporting girders (H-280 x 280 x 19 x 10) are still sufficient to bear the wheel load of locomotive B-300, however, their painting has been deteriorated so as to cause corrosion and should be recoated.
As for the coal outlet, the existing chute will be removed to thus provide an open as a new coal outlet using the whole of the silo with

the columns left. Further, a blind plate will be provided to prevent releasing coal from the wagon when the hopper is empty. Still more, there will be provided steel racks on the outside of silo for receiving coal from the coal outlet.

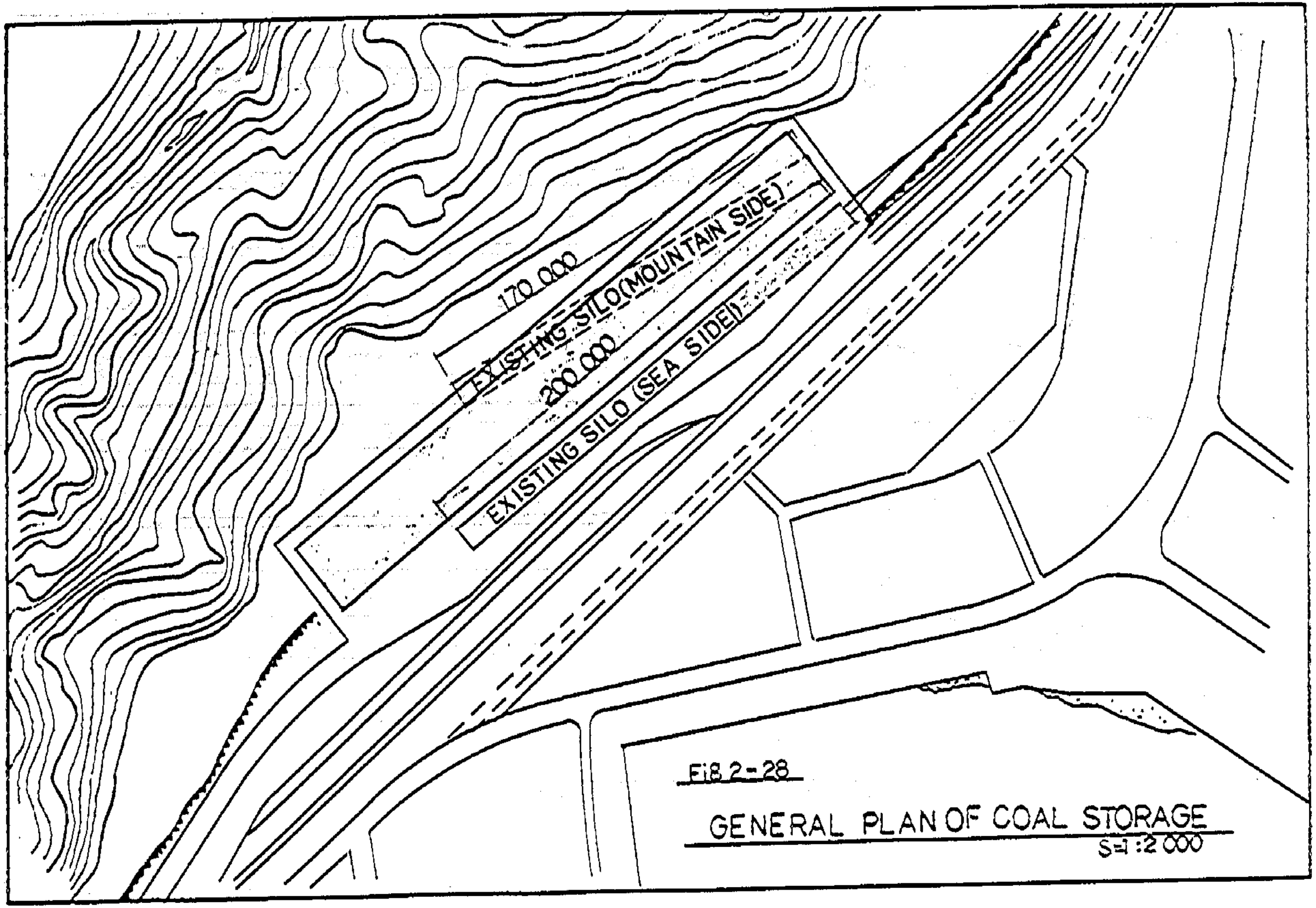


Fig 2-28

GENERAL PLAN OF COAL STORAGE

S=1:2 000

COAL HOPPER S=1:200

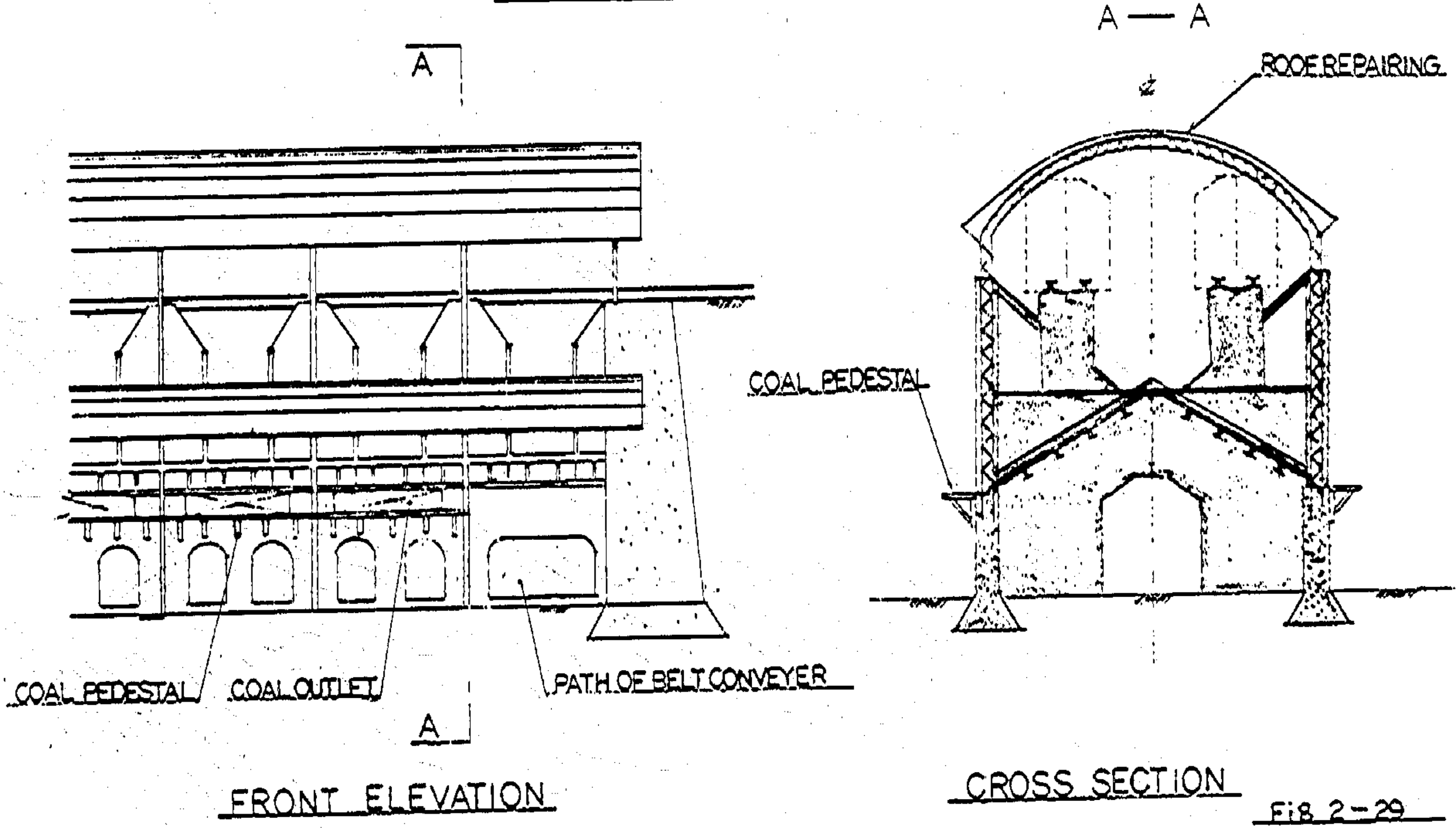


Fig 2-29

GENERAL DRAWING OF THE COAL STORAGE BASE S=1:750

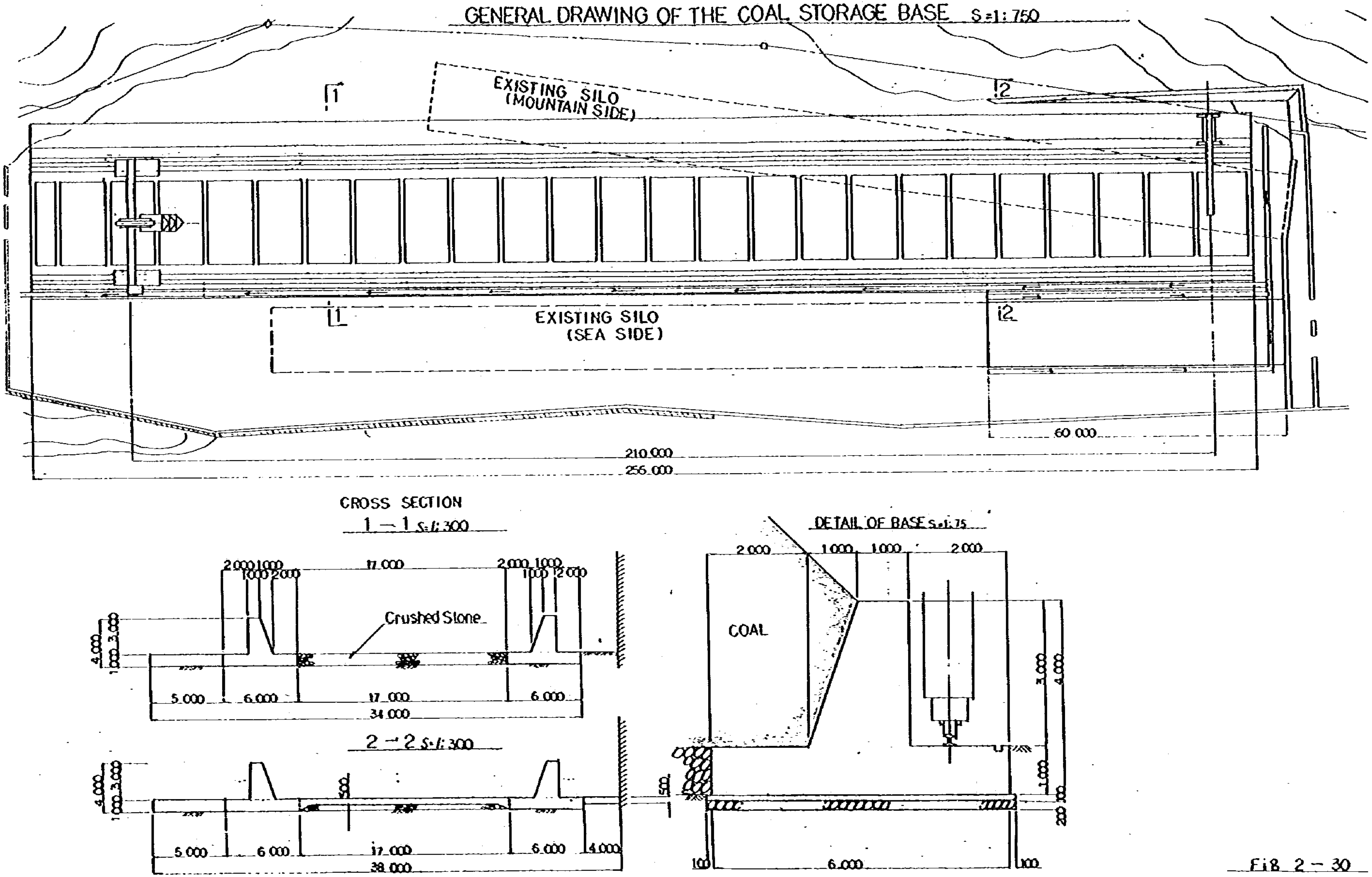


Fig 2 — 30

6.6.4 Control building (Fig. 2-31)

The control building is a control center for controlling coal storage yard, belt conveyors, shipping facilities and the like.

First floor	Distribution room
Second floor	Office room
Third floor	Control room

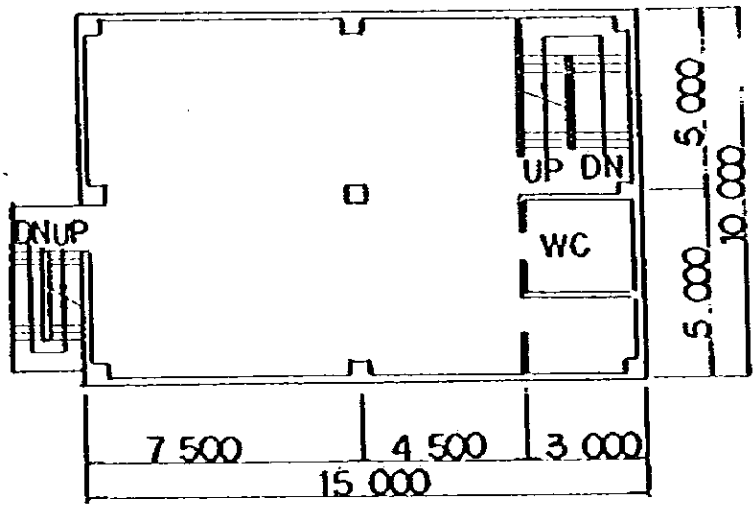


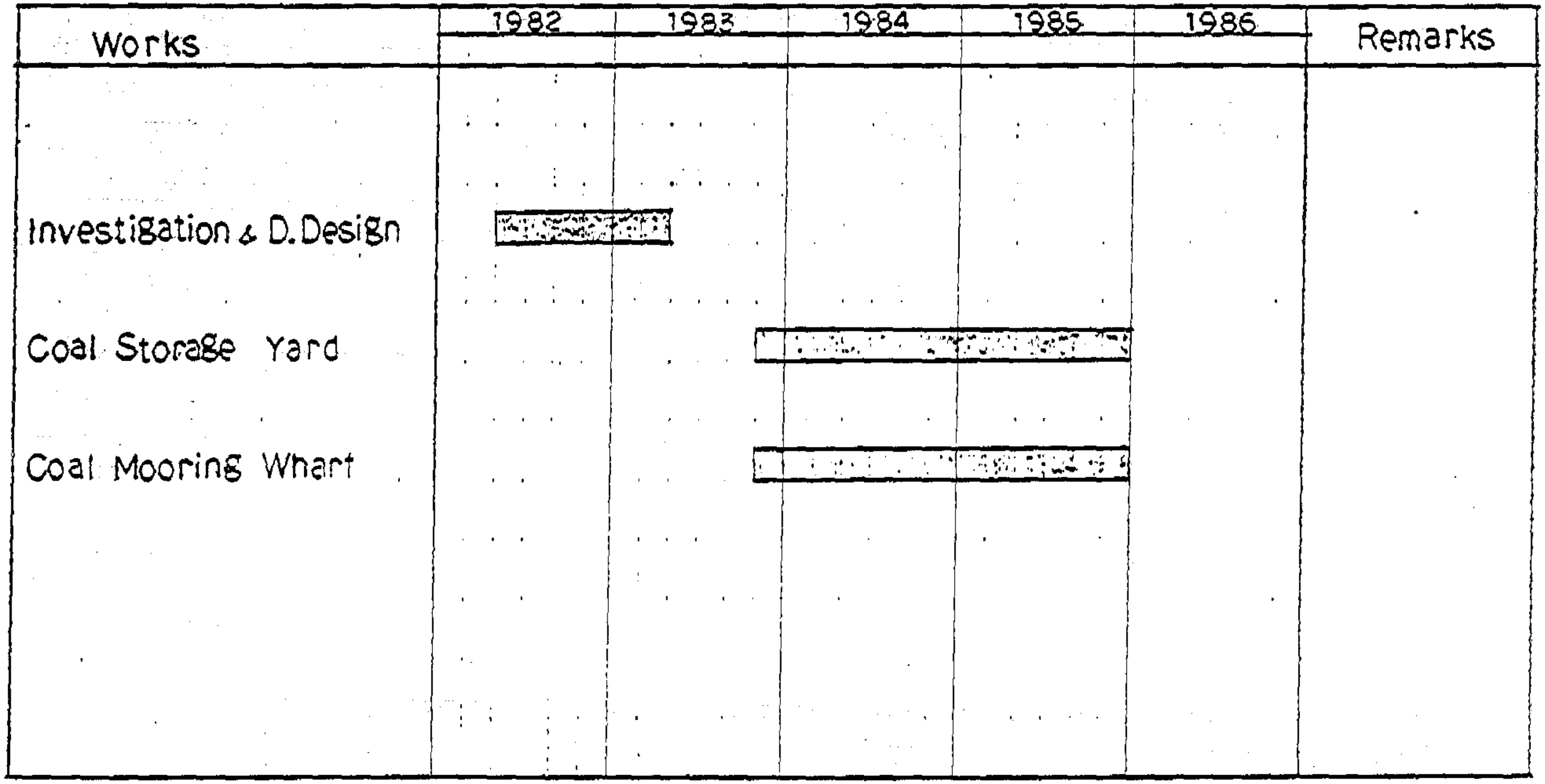
Fig. 2 - 31

7. CONSTRUCTION SCHEDULE

Yearly construction schedule and detail of construction schedule are shown in Fig. 2-32 and Fig. 2-33 respectively.

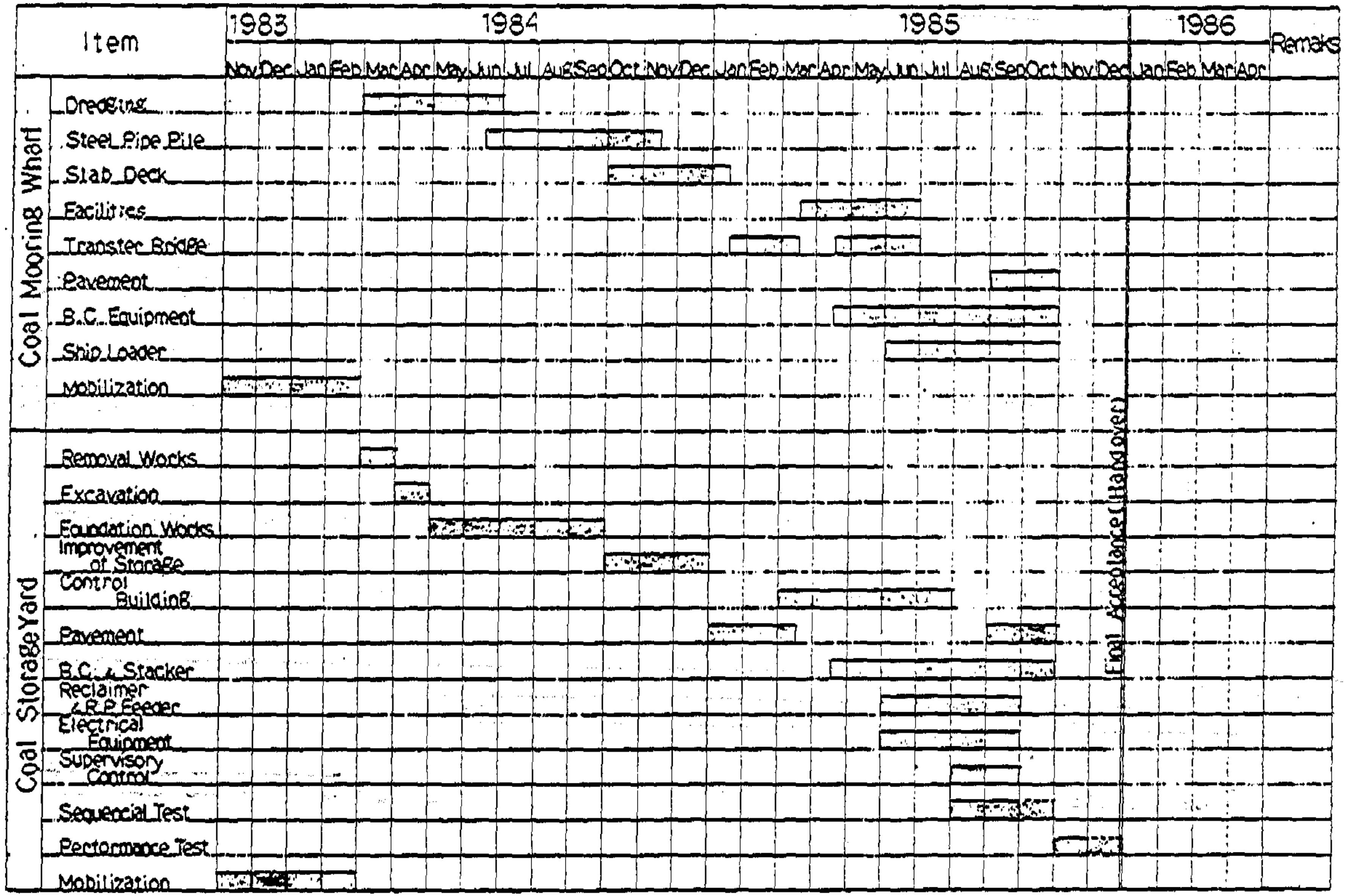
CONSTRUCTION SCHEDULE

Fig 2 - 32



TIME SCHEDULE OF WORKS

Fig. 2-33



8. PRESUMPTION OF CONSTRUCTION COST

Yearly construction cost [Coal mooring wharf, Coal storage yard] and coal handling facilities are shown in Fig. 2-34 and in Fig. 2-35 respectively. Total of construction cost is shown in Fig. 2-36.

CONSTRUCTION COST 1/3

Fig. 2-34

US $

	Item	Quantity	Local Cost	Foreign Cost	Total Cost	1981	1982	1983	1984	1985	Remarks
Coal Mooring Wharf	Dredging	56,000 m³	81 000	323 000	404 000				404 000		
	Steel Pipe Pile	1 691 t	2,838 000	1 528 000	4,366 000				4 366 000		
	Slab Deck	2,732 m³	394 000	205 000	599 000				342 000	257 000	
	Facilities	Lump Sum	168 000	656 000	824 000					824 000	
	Transfer Bridge	283 m³	48 000	25 000	73 000					73 000	
	Pavement	4 055 m²	72 000	39 000	111 000					111 000	
	Contingency	Lump Sum	360 000	278 000	638 000				511 000	127 000	
	Engineering	Lump Sum		864 000	864 000		364 000		353 000	147 000	
	Sub Total		3,961 000	3,918 000	7,879 000		364 000		5,976 000	1,539 000	
Coal Storage Yard	Removal Works	2 700 m²	101 000	54 000	155 000				155 000		
	Excavation	13 244 m³	91 000	49 000	140 000				140 000		
	Foundation Works	2 700 m²	940 000	506 000	1,446 000				1,446 000		
	Improvement of Storage	Lump Sum	84 000	75 000	159 000				159 000		
	Control Building	Lump Sum	281 000	151 000	432 000					432 000	
	Pavement	2,000 m²	30 000	16 000	46 000					46 000	
	Contingency	Lump Sum	153 000	85 000	238 000				190 000	48 000	
	Engineering	Lump Sum		477 000	477 000		114 000		274 000	89 000	
	Sub Total		1,680 000	1,413 000	3,093 000		114 000		2,364 000	615 000	
	Total		5,641 000	5,331 000	10,972 000		478 000		8,340 000	2,154 000	

2/3

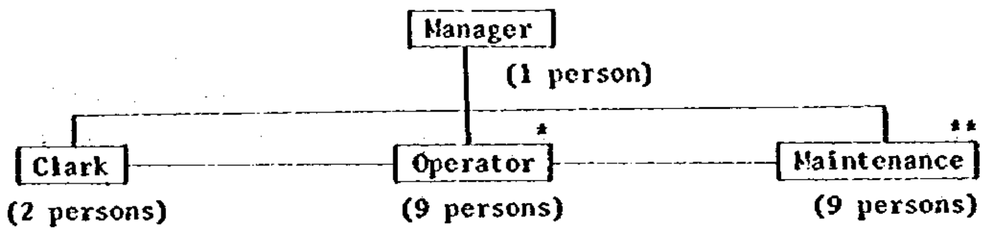
Fig 2-35

	Item	Quantity	Local Cost	Foreign Cost	Total Cost	1984	1985	1986	1987	1988	Remarks
Coal Handling Facilities	Belt Conveyor	1 Set		1,890,000	1,890,000	1,890,000					
	Shiploader	1 Unit		980,000	980,000	980,000					
	Reclaimer	1 Unit		1,210,000	1,210,000	1,210,000					
	Stacker	1 Unit		570,000	570,000	570,000					
	Rotary Plow Feeder	2 Units		200,000	200,000	200,000					
	Sampling Equipment	1 Set		620,000	620,000	620,000					
	Control Equipment	1 Set		1,410,000	1,410,000	1,410,000					
	Power Substation	1 Set		380,000	380,000	380,000					
	Erection	1 Set	600,000	1,880,000	2,480,000		2,480,000				
	Supervision	1 Set		350,000	350,000		350,000				
	Training	1 Set		270,000	270,000			270,000			
	Maintenance Parts	Lump Sum		220,000 / Year	220,000 / Year			220,000	220,000	220,000	Notice: Maintenance Cost is continueing every year.
	Sub Total		600,000	†9,760,000	†10,360,000	7,260,000	2,830,000	490,000	220,000	220,000	† Sub Total of Foreign and Local Cost means without Maintenance Cost.

TOTAL CONSTRUCTION COST 3/3

Item	Quantity	1981	1982	1983	1984	1985	1986	1987	1988	Remarks
Coal Mooring Wharf	Lump Sum		364,000		5,976,000	1,539,000				
Coal Storage Yard	Lump Sum		114,000		2,364,000	615,000				
Coal Handling Facilities	Lump Sum				7,260,000	2,830,000	490,000	220,000	220,000	
										Notice: Maintenance Cost is continuing $220,000 every year.
Total Cost		—	478,000	—	15,600,000	2,154,000	490,000	220,000	220,000	

9. ORGANIZATION OF COAL STORAGE AND SHIPLOADING OPERATION



Note

* Detail of Operator

3 persons for yard machines operation
(Shiploader, Reclaimer, Stacker and Plow Feeders)

2 perosns for supervisory control
(Including the belt conveyor operation)

4 persons for coal discharging operation

** Detail of Maintenance Persons

Mechanical Engineer .... 1 person
Electrical Engineer .... 1 person
Technician .... 2 persons
Helper .... 5 persons
(Unskilled)

10. PORT HANDLING CHARGE

Since the coal shipping amount will increase correspondingly to the production increase at the Ombilin Coal Mine, construction of the coal wharf, coal storage yard, and coal shipment facilities are studied in this Cahpter. Various expenses are derived from management of these facilities.

10.1 Labor Cost

Required personnel will be employed and arranged by P.N. Tambang Batubara so that their employment conditions should be the same as those for personnel in service at the Ombilin Coal Mine.

Therefore, the labor cost are obtained from the average annual income of 1,020 US$/year/person on the basis of the before-mentioned personnel allocating.

21 persons x 1,020 US$ = 21,000 US$/year

10.2 Maintenance Parts

During the object period of this study no renewal of the facilities is executed, but 220,000 US$ is to be appropriated for the expense for maintenance parts every year from 1986 in order to maintain the facility capacities.

10.3 Power Expense

The power expense will be incurred from 1986 when the new facilities are brought in operation.

The power consumption for coal handling is estimated hare as 0.8 KHW/ton. 100,000 KHW per year is assumed as the other general power consumption.

Table 2-10 Power consumption by year

	1986	1987	1988	1989~2005
Coal handling amount (1,000 ton)	180	330	460	610
Power consumption (KWH)				
For coal handling	144,000	264,000	368,000	488,000
Others	100,000	100,000	100,000	100,000
Total	244,000	364,000	468,000	588,000

Note: The coal handling amount stated here is including coal for domestic use.

According to the data of P.N. Tambang Batubara, the average power charge per KHW in 1980 amounts to 44.63 RP (0.07 US$). Consequently the power charge burdened by P.N. Tambang Batubara is shown in the following table.

Table 2-11 Power charge by year

	1986	1987	1988	1989~2005
Power consumption (KWH)	244,000	364,000	468,000	588,000
Power expense (1,000US$)	17	25	33	41

10.4 Miscellaneous Income (amount deducted)

When the coal wharf constructed and owned by P.N. Tambang Batubara is made to use for general cargo only for a period of executing on coal shipment, the wharf charge will be received from the port authorities. As mentioned above, the coal price for domestic sale in requiring shipment is to be invoiced on the basis of F.O.R. at the colliery. Accordingly a part of the expenses under the items of 10.1 - 10.3 and depreciation mentioned later will be burdened by consumers and be assumed as an income to P.N. Tambang Batubara.

(In this study the coal price for all of domestic consumption is assumed to be invoiced on the basis of F.O.R. at Sawah Lunto.)

This miscellaneous income is considered here as an amount deducted for the port handling and wharf charge.

Since the charges for coal wharf should be agreed between the P.N. Tambang Batubara and the port authorities, it is difficult to estimate it in this study. It is considered that the period of executing no coal shipment amounts to about 1/3 of a year so that the amount equal to 1/3 of annual depreciation of the coal wharf facilities is assumed as the income.

Assuming;

Construction cost of the coal wharf

6,375,000 US$ (except for the contingency and engineering expenses)

Durable period 50 years

6,375,000 US$ ÷ 50 years x 1/3 ≒ 43,000 US$/year

Besides, a part of port handling charge including depreciation, which shall be burdened by domestic consumers, obtained through the ratio of total handling amount and that of domestic consumption is assumed as the income.

Table 2-12 Part of port handling charge burdened by domestic consumers

	1986	1987	1988	1989	1990	1991~2005
Port handling charge						
Labor cost	21	21	21	21	21	21
Maintenance parts	220	220	220	220	220	220
Power expense	17	25	33	41	41	41
Depreciation	1,075	1,075	1,075	1,075	1,074	709
Total (A)	1,333	1,341	1,349	1,357	1,356	991
Shipping amount						
For domestic consumption (B)	150	150	150	150	150	150
Total shipment amount (C)	180	330	460	610	610	610
(B)/(C) (D)	83%	45%	33%	25%	25%	25%
Income (1,000US$) (A) x (D)	1,106	603	445	339	339	248

Note: The depreciation here means that from which the charge for coal wharf of 43,000US$ is deducted.

10.5 Depreciation

It is assumed that the facilities mentioned above will be depreciated in the same manner as in case of those at the coal mine. The beginning fiscal year of depreciation is 1986 when the facilities are brought in operation. The durable period is assumed as 50 years for the coal mooring wharf, and 20 years for coal storage yard and coal handling facilities.

The engineering and training expenses are to be considered as initial costs and depreciated equally for 5 years from 1986. On the other hand, the contingency cost will be excluded from the object of depreciation in the same manner as in case of it at the coal mine.

Table 2-13 Depreciation of port facilities

	Durable period (year)	Investment amount (1,000 US$)	Depreciation by year (1,000US$)					
			1986	1987	1988	1989	1990	1991~2005
Coal mooring wharf	50	6,375	128	128	128	128	128	128
Coal storage yard	20	2,379	119	119	119	119	119	119
Coal handling facilities	20	10,090	505	505	505	505	505	505
Sub-total	—	18,844	752	752	752	752	752	752
Engineering and training	5	1,829	366	366	366	366	365	—
Total	—	20,673	1,118	1,118	1,118	1,118	1,117	752

Table 2-14 Summary table of port handling charge (×US$1,000)

	1986	1987	1988	1989	1990	1991~2005
Maintenance cost						
Labor cost	21	21	21	21	21	21
Maintenance parts	220	220	220	220	220	220
Power expense	17	25	33	41	41	41
Charge for general cargo wharf						
Amount deducted	Δ1,149	Δ646	Δ488	Δ382	Δ382	Δ291
Sub-total	Δ891	Δ380	Δ214	Δ100	Δ100	Δ9
Depreciation	1,118	1,118	1,118	1,118	1,117	752
Total	227	738	904	1,018	1,017	743

Note: The mark·Δ means the value of minus.

CHAPTER Ⅲ

RAILWAY TRANSPORTATION

CHAPTER III RAILWAY TRANSPORTATION

1. THE AIM AND SCOPE OF STUDY

The aim of the present study consists in the following:

To transport by rail the almost entire quantity of coal produced at Ombilin coal mine, from Sawahlunto Station to Bukitputus Station, and at this point, excluding the portion to be assigned to cement factory at Indarung, to carry again by rail the whole remaining portion as far as the Silo or coal yard located near Telukbayur port.

As far as the railway is concerned , utmost use of existing facilities will be carried out by providing necessary restoration as well as improvement so that the object of transport will be attained. Accordingly, as regards the railway routes, consideration will be paid only to existing routes, without paying attention to providing of new routes. Thus, as to branch line from intermediate stations, they are excluded from the object of the present study.

Further, we make it clear here that the present study will exclusively carried out in regard to coal transport, since, as regards non-coal goods, it is inferred that their quantity thereof is small, and moreover, the transport therefore remains on low standard also in future.

2. OUTLINE OF THE PRESENT SITUATION OF THE RAILWAY

2.1 Summary Description of the Route

Bukitputus Station, the terminal of train transport, is located directly to south of Padang, near west coast of Sumatra, and the route length as far as Sawahlunto located near Ombilin coal mine, is about 155 km. This distance is approximately 55 km when measured as the crow flies. However, the route distance is triple because the route makes a detour averting the mountain range extending northward in parallel with the west coast and again running southward through the northern col (Fig. 3-1).

When the route is roughly divided into three portions, the section between Bukitputus and Kayutanam in the western part, extending for 58 km, as well as the route from Batutabal to Sawahlunto in the Eastern part, which is 62 km long, are on the whole level line. From Kayutanam in the central section to Batutabal by way of Padanpanjang located at the highest level point, which extends for 34 km, forms a steep grade section including a gradient of 70 to 1000.

This steep gradient section is provided with rack-rail system, over the entire route, the rack railway system is provided intermittently. There are many steep curves also because the route is located along the ravine.

The above-mentioned section constitutes a big neck for transportation owing to such causes as the reduced tractive force of locomotives through steep gradient, and moreover, the fact that the train speed is restricted to 20 km/h on rack-rail sections.

2.2 Outline of Track Structure

The outline of track structure at present is as stated hereunder:

Classes of Track: The class of track is divided as follows according to the maximum velocity of train


Fig 3-1
76
62

Class of Track	Maximum Velocity of Train V(km/h)
Ia	$90 < V$
Ib	$59 \sim 90$
IIa	$45 \sim 59$
IIb	$30 \sim 45$
IIc	$V < 30$

At present, track is classified into IIb kinds in accordance with the above-mentioned classification. However, the said classification is now being changed into a new system based on the passing tonnage as follows:

New Track Classification	Passing Tonnage Tf(ton/day)
5	$28,000 \geq Tf > 14,000$
6	$14,000 \geq Tf > 7,000$
7	$7,000 \geq Tf > 3,500$
8	$3,500 \geq Tf > 1,500$
9	$1,500 \geq Tf$
9 (No passenger car coupled)	$1,500 \geq Tf$

The new classification has no direct relation with the existing classification, since their bases are different. Although the regulation provides for principal track structure according to the classes of existing track, no regulations are yet set as for new track classifications.

On the basis of new track classifications, the present track belongs to 8 classification grade, but as is mentioned hereafter, the tracks will be raised to 6 classification grade in future.

Track : Single Track

Gauge : 1,067 mm

Track Clearance: As shown in Fig. 3-2

BANGUNAN RUANG BEBAS LIN KLS II.

(NORMAL PROFIEL VAN VRYERUIMTE)

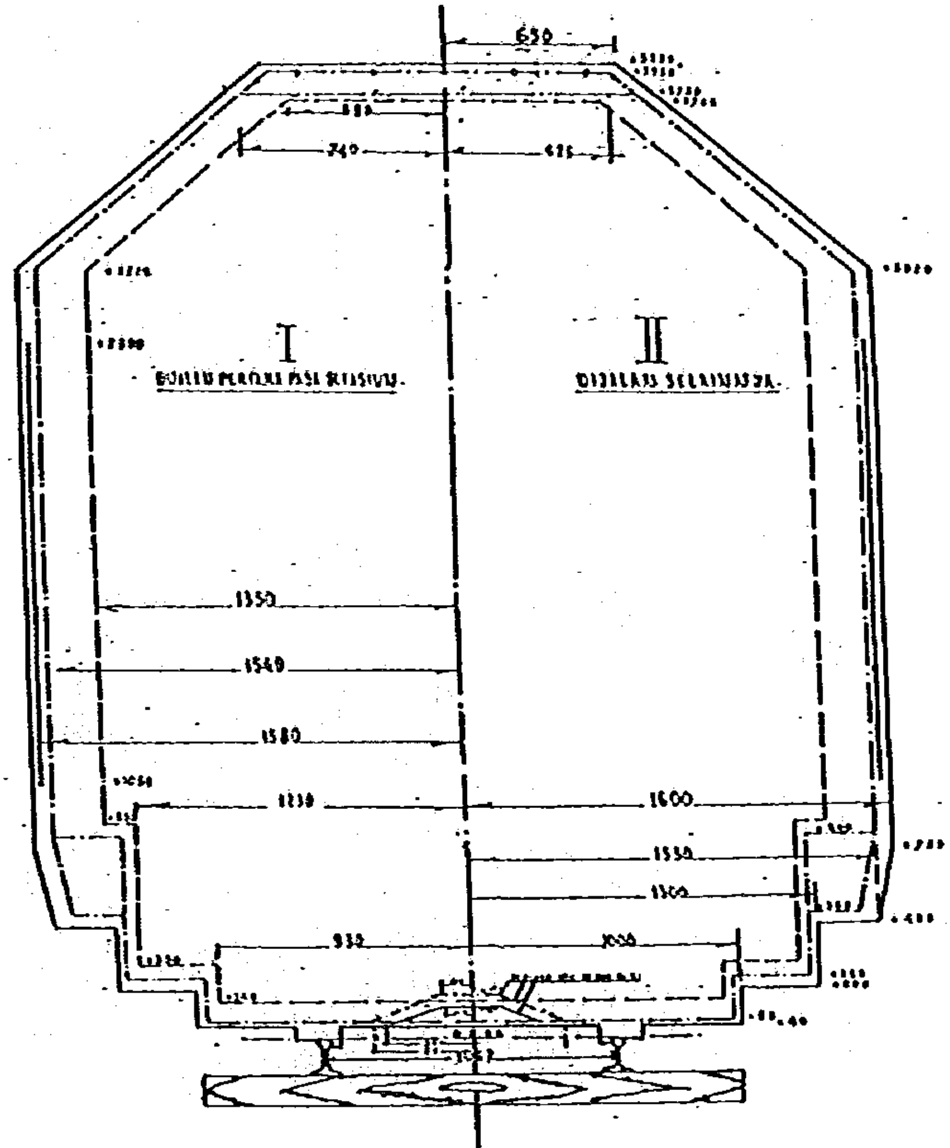


FIGURE 4

KETERANGAN

—— BATAS BIASA DARI RUANG BEBAS

—·— BATAS BIASA DARI RUANG GERAK

—— BATAS BIASA DARI RUANG GERAK [illegible]

+–+ BATAS BIASA DARI RUANG GERAK MELALUI "VONKENRUIMTE"

- - - BATAS BIASA DARI RUANG [illegible]

Fig 3-2

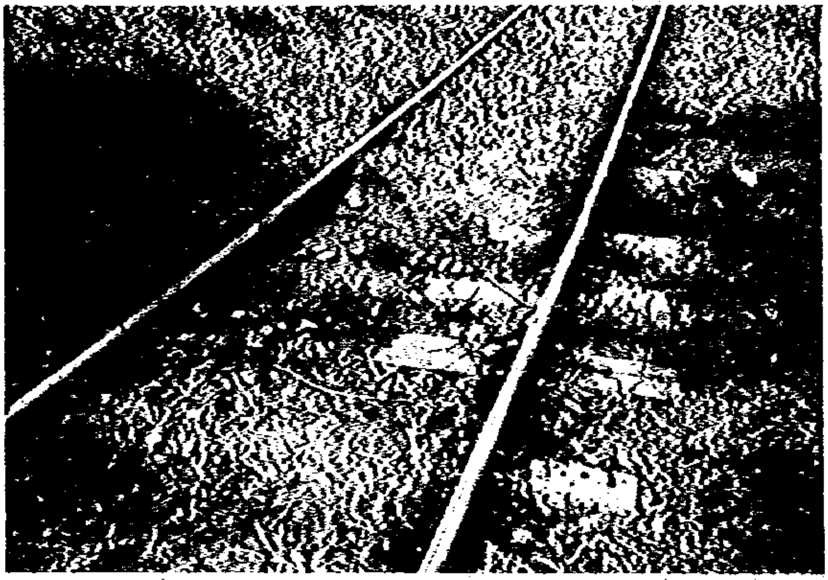


PHOTO3－1

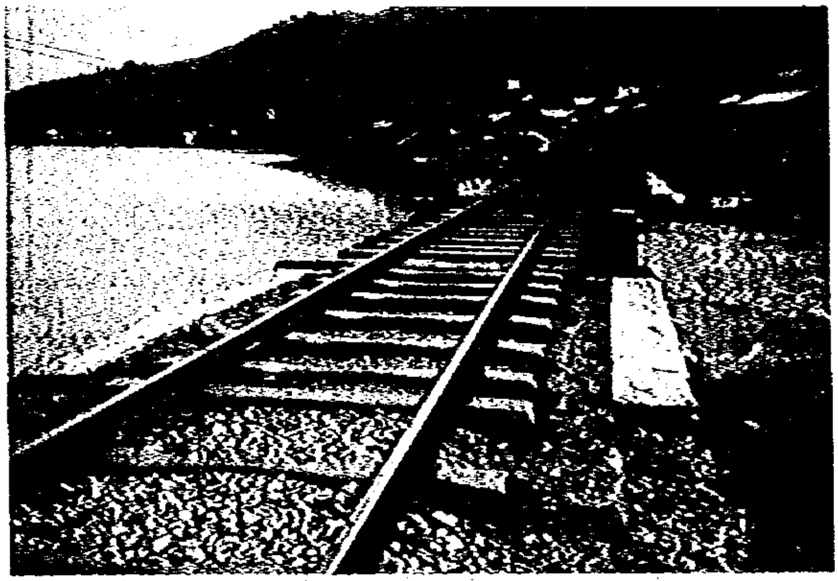


PHOTO3－2

Rails	:	Those rails conforming to the regulations: R2 (25.75 kg/m rail) At present, the rails on rack-rail sections has been converted to R3 (33.40 kg/m) rails; the rails on other sections are all R2 rails.
Sleepers	:	Wooden sleepers and iron sleepers are used commingled. On the rack-rail section, iron sleepers are principally used.
Spacing of Sleepers	:	As stipulated by regulation: 720 mm Under the present state, the west half section from Bukitputus to Padangpanjang is improved into 680 mm, but the east half section from Pandangpanjang to Sawahlunto remains at the spacing of 810 mm.
Ballast	:	Depth of ballast according to regulations: 150 mm Crushed stone is used as ballast. At present, ballast is extremely insufficient over almost entire sections, and there are found many points where only roadbed earth is present, with scarcely any ballast observed.
Rack-rail	:	On the steep gradient sections, rack and pinion system railway is employed. The rack-railway is of Riggenbach system. Namely, two L type steel bars of the length of 4.81 m are placed at the interval of 130 mm, between which steel bars are secured at the spacing of 109.375 mm, which are so arranged that these gear into the pinion of the locomotive.

2.3 Current Mode of Rolling Stock and Service

2.3.1 Current mode of rolling stock

(1) Locomotive

At present, the West Sumatra Region has its locomotive depots at Solok, Padang Panjang, and Padang responsible for lines between Sawahlunto and Batutabal, Batutabal and Kayutanan, and Kayutanan and Teluk Bayur, respectively.

In the Padang Panjang depot responsible for the line between Batutabal and Kayutanam which is a rack rail section of steep gradient, there are distributed Model-E10 steam locomotives for rack rail section.

In the Solok and Pandang depots responsible for relatively flat rail sections, there are provided two each of steam locomotives for shunting and eight Model-BB303 diesel locomotives for main-line, three at Solok and five at Pandang.

In the Padang depot, there are further provided three Model-BB300 diesel locomotives for shunting.

Of those locomotives, remarkably timeworn are Model-C30, -C33, and -F10 steam locomotives for shunting and steam locomotives for rack rail section not younger than No. E1018, which locomotives had been manufactured before 1930 and have served over 50 years.

In the locomotives for rack rail section, those not older than No. E1052 excluding the locomotives not younger than No. E1018 had been manufactured between 1964 to 1966 and are relatively new as steam locomotives. However, as having served 14 to 16 years, they have already started being time-worn so that for their hauling capacities an upper limit is two hopper wagons loaded with coal. They are insufficient to answer the needs for transportation in future. Therefore, it is necessary to substitute new diesel locomotives in near future for both the existing steam locomotives for flat line and those for rack rail section. Indonesia National Railway (PJKA) also has a plan to purchase from 1981 to 1982 six racking/adhesion diesel locomotives for use in rack rail section.

The existing and planned diesel locomotives have their specifications listed next page.

Table 3-1

Type of locomotive	Diesel hydraulic locomotive		Diesel electric locomotive for rack rail section
Model No.	BB300	BB303	-
Year of manufacture	1958	1978 ~1980	Under plan
Engine output	680 HP	1010 HP	1230 HP
Axle load	9 t	10.7 t	10.7 t
Normal weight	36 t	42.8 t	55 t
Adhesive weight	36 t	42.8 t	42.8 t
Max. speed	75 km/h	85 km/h	Adhesive 60 km/h Racking 20 km/h
Overall length	11,890 mm	12,320 mm	13,500 mm
Overall width	2,720 mm	2,800 mm	2,800 mm
Overall height	3,700 mm	3,690 mm	3,700 mm

Wheel arrangement of Diesel locomotives

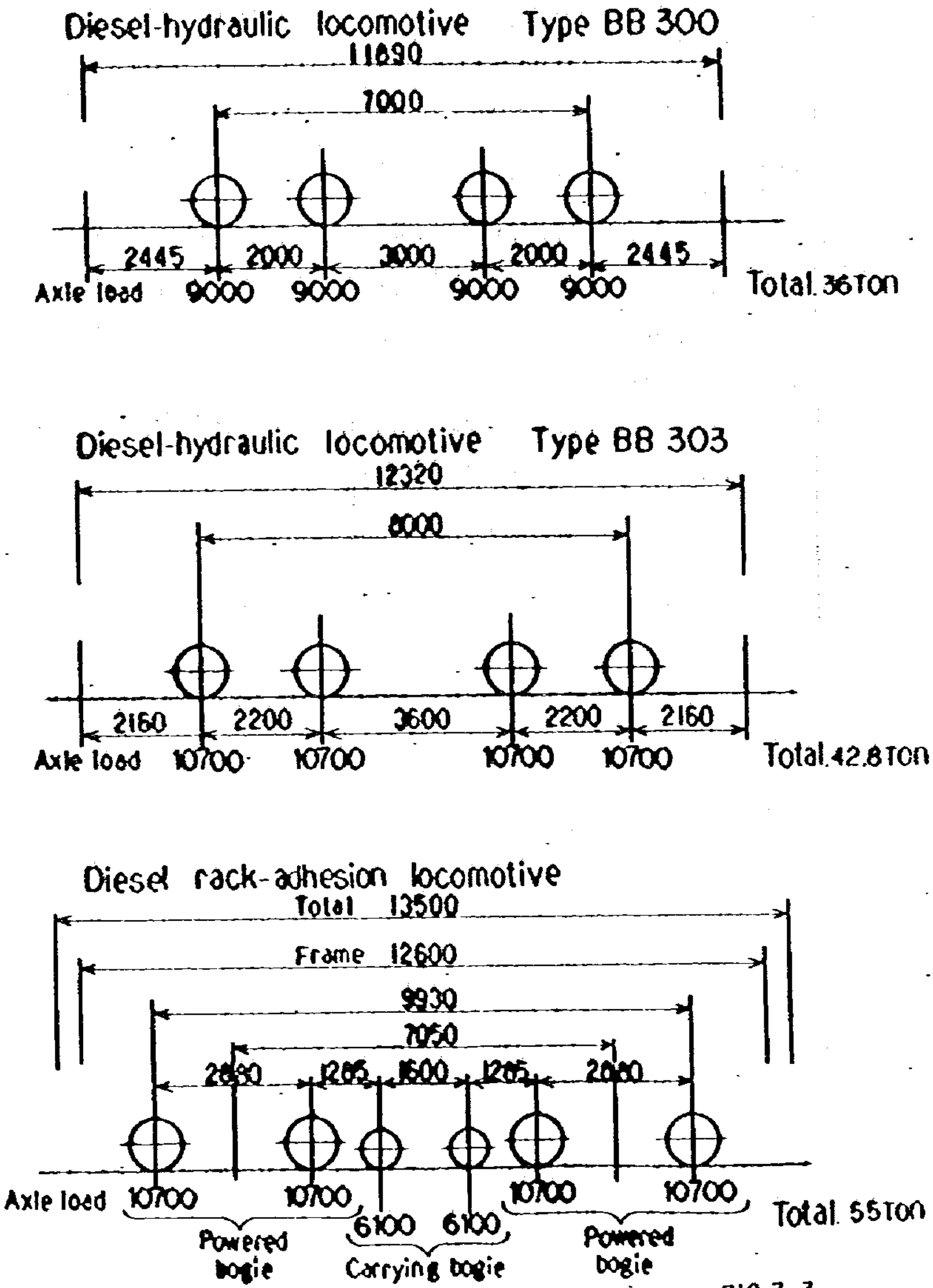


Fig 3-3