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FEASIBILITY REPORT ON THE PRAIA MOLE PORT CONSTRUCTION PROJECT VOL. II NOVEMBER, 19

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JAPAN INTERNATIONAL COOPERATION AGENCY

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CONTENTS

Page

CHAPTER 6. BASIC DESIGN OF FACILITIES

6. Basic design of facilities

6-1 Breakwaters

6-1-1 Design criteria

(1) Tide level

H.H.W.L.	+1.80m (Yearly highest level)
L.W.L.	±0.00m

(2) Wave height and period

For the design significant wave height, the following values have been adopted in consideration of the direction of the breakwaters, water depth of the site and the importance of the breakwaters as described in Chapter 2-3-4 Oceanology (Fig. 2.3.18):

① South breakwater

Shallower than -5m	$H_{1/3}$ = 4.0m	T = 12 sec
-5 to -10m deep	$H_{1/3}$ = 4.5m	T = 12 sec
Deeper than -10m	$H_{1/3}$ = 5.0m	T = 12 sec

② North breakwater

Shallower than -4m	$H_{1/3}$ = 4.0m	T = 12 sec
-4 to -6m deep	$H_{1/3}$ = 4.5m	T = 12 sec
Deeper than -6m	$H_{1/3}$ = 5.0m	T = 12 sec

6-1-2 Selection of type of structure

The two planned types of structure, a rubble mound breakwater (Figs. 6.1.1 and 6.1.2) and a concrete caisson type breakwater (Fig. 6.1.3), were studied and compared with construction cost and construction period, etc. and in consideration of the experience and execution capacity on the Brazilizn side, and it has been decided to adopt the rubble mound breakwaters as proposed in the Brazilian original plan.

The construction of the rubble mound breakwaters has been experienced in Imbituba Port, Portocel Port and Tubarão Terminal of CVRD. Seeing that, in addition, quarries are available near this Praia Mole Port, the rubble mound breakwaters are considered to be the most suitable type of structure.

6-1-3 Sectional form

The determined section of the breakwaters is based on the results of the model test carried out by INPH (Portobrás-Hydraulics Labs.) and additional hydraulic model tests made by INPH while the Japanese Study Team was in Brazil. In determining the section of the breakwaters, both the Japanese study team and PORTOBRÁS responsible personnel thoroughly studied and discussed the test results, execution methods, land use plans inside the breakwaters to reach a mutual agreement.

(1) Crown height

① As a rule, the crown height of the south breakwater shall have a height not permitting the overtopping of waves. +9.5m is the height determined from the test results and other factors. For shallow portions, however, the crown height may be in a range between +5.8m and +9.5m depending on the design significant wave height.

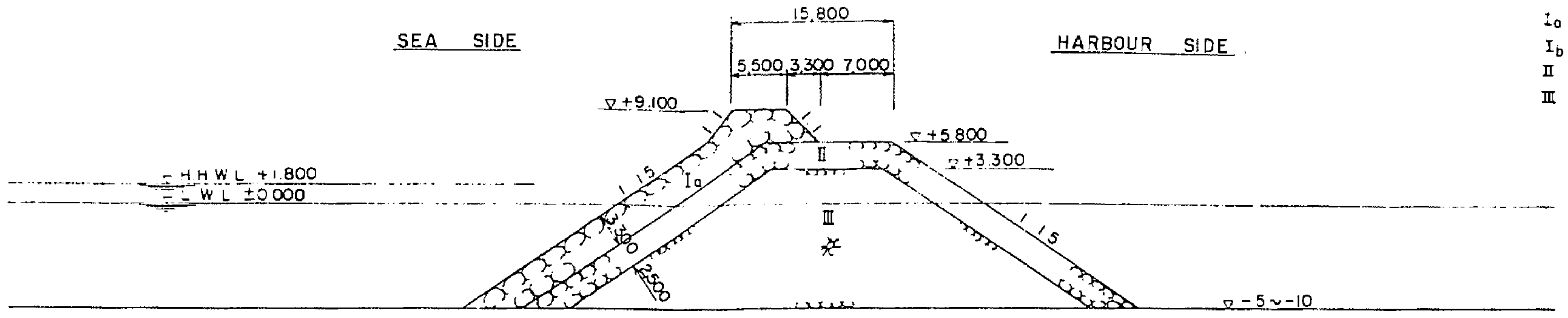
② The crown height of the north breakwater may permit waves to cross over it to a certain degree. Considering waves and tide level during construction, the rubble mound height shall be +3.3m, over which armor stones shall be laid in two layers, and the final crown height including the armor stones shall be +7.3m. For shallow portions, however, the crown height is adjustable within a range from +5.8m to +7.3m depending on the thickness of the armor stones corresponding to the design significant wave height at the shallow portions.

(2) Crown width

① The crown width of the south breakwater shall be 7m, covering a 6m-wide passage and a 50cm-wide shoulder on either side of the passage.

SOUTH BREAKWATER

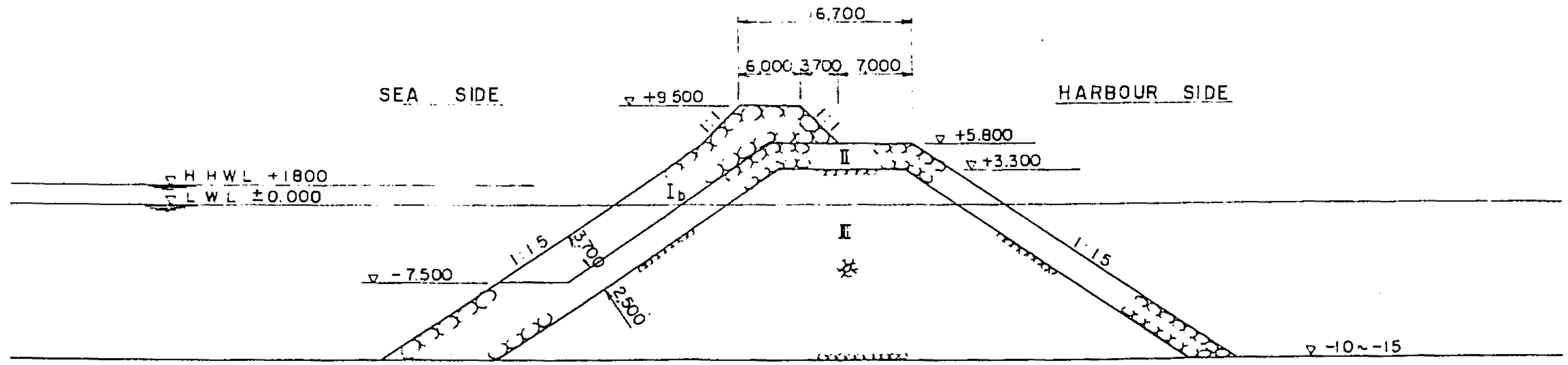
S_2 SECTION S = 1 : 500



THE WEIGHT OF AN ARMOR STONE

I_a : 7 ~ 9 ton
I_b : 9 ~ 12 ton
II : 2 ~ 5 ton
III : 20 ~ 2 000 Kg

S_3 and S_5 SECTION S=1:500



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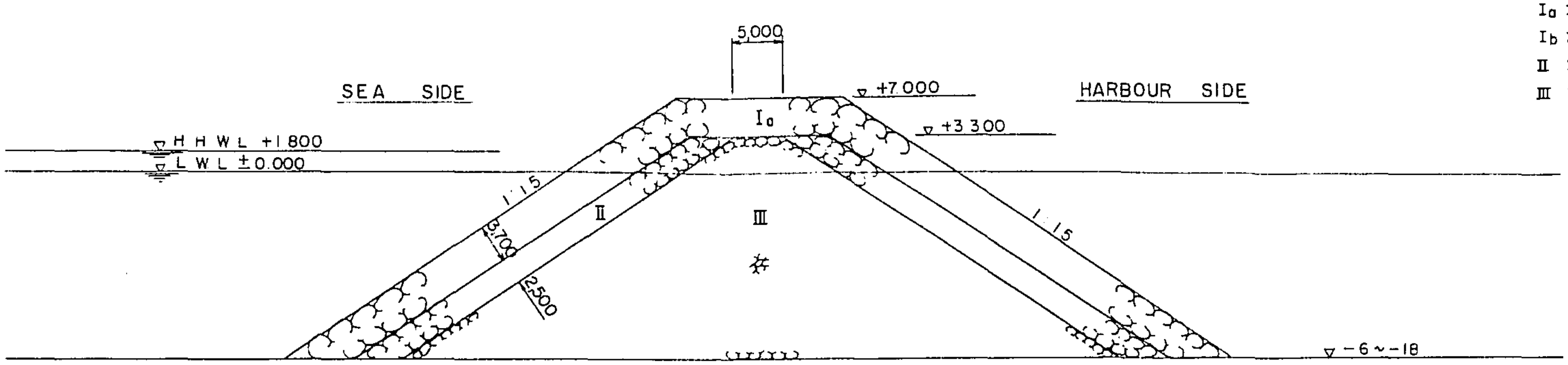
NORTH BREAKWATER

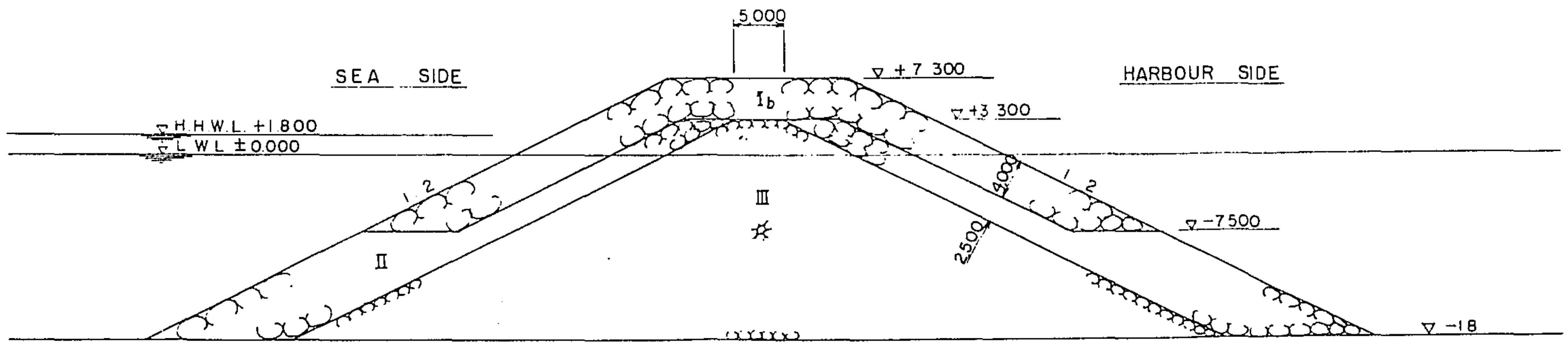
THE WEIGHT OF AN ARMOR STONE

- Ia : 9 ~ 12 ton
- Ib : Over 12 ton
- II : 2 ~ 5 ton
- III : 20 ~ 2,000 Kg

N3 SECTION S = 1 : 500



NH SECTION S = 1 : 500



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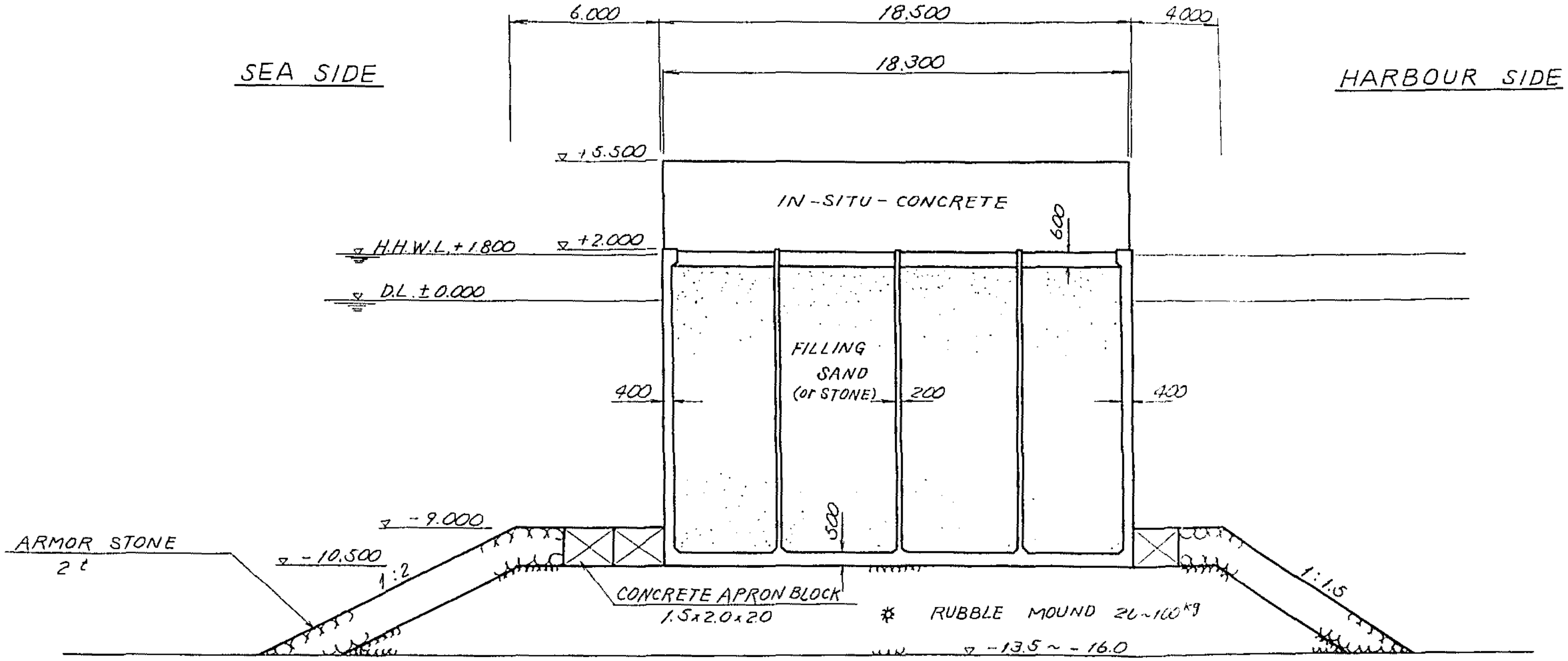
NORTHEAST BREAKWATER

TYPICAL SECTION S=1:200



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② The crown width of the north breakwater shall consist of the basic width 5m required for the execution of the rubble mound, plus an additional width required by armor stones.

(3) Weight of the armor stones

The weight of the armor stones of the breakwaters is designed to keep the damage ratio to less than 1% as tested by experimental regular waves with the design height. It is taken into account that the damage ratio will naturally increase under the attack of actual irregular waves and a minor damage will be allowed.

① The weight of the armor stones at the main part of the breakwater against the design significant wave height ($H_{1/3}$ = 5.0m) shall be 9 to 12 tons.

② The weight of the armor stones at the end of the breakwaters and at the lending point of the south breakwater shall be not less than 12 tons, seeing that external forces working to these places are not fully known.

③ The weight of the armor stones on the harbour side of the south breakwater shall be 2 to 5 tons, considering that the crown height must not permit the overtopping of waves as a rule and also considering the results of the model tests.

④ The weight of the armor stones on both the harbour side and the sea side of the north breakwater shall be same, considering that the waves will strongly act also upon the harbour side of the breakwater and that the crown height of the breakwater is lower.

However, for the portions shallower than -6m, where the design significant wave height is low, and where the functions of mere a temporary road for construction is needed, the weight of the armor stones will be graduated from (2 to 5 tons) to (7 to 9 tons) and connected to the main part of the breakwater with (9 to 12 tons).

(4) Slope gradient

① The slope gradient of the main part of the breakwaters on either side shall be 1:1.5.

② The slope gradient of the end of the breakwater shall be 1:2, determined with same consideration as in the determination of the weight of the armor stones.

③ The slope gradient at the curve of the south breakwater shall be 1:2 by the same reason as ② above.

6-1-4 Structural drawings of breakwaters

The plane views and the structures of the south and the north breakwaters are as shown in Appendix 4. Structural drawings of civil facilities (Figs. PM-C601 to PM-C608).

6-2 Mooring facilities

6-2-1 Design criteria

(1) Tide level

H.H.W.L.	+1.80m	(Yearly highest level)
H.W.L.	+1.50m	
L.W.L.	±0.00m	

(2) Earthquake

It has been assumed that no earthquakers are expected in Brazil.

(3) Soil conditions

According to the up-to-date results of borings presented from Portobras, the stratification along the slab berth substantially consists of the three strata of sandy soil ($N = 5 \sim 25$), cohesive soil ($N = 10 \sim 30$) and sandy soil ($N = 15 \sim 40$) in this order from the sea bottom toward depth.

Also, according to the up-to-date results of borings, it appears that such a Canga (hard rock) as may reject piling does not exist.

The pile bearing stratum shall be a sandy bed having an N-value of not less than 30. Consequently, the average penetration of the slab berth foundation piles should be to a level of approximately -32.5m.

For the coal pier and oil berth foundation piles, sufficient data are not yet available so far but, presumably, penetration down to approx. -30m may be suitable.

For the soil profile, see Chapter 2-3-2 Environmental Conditions.

(4) Crown Height

The crown height of the structures shall be +4.0m, determined in consideration of the tide level, ship's size, etc.

(5) Ship's size and berth dimensions

See 5.3 Mooring facilities.

(6) Berthing speed of vessels

V = 12 cm/s

(7) Uniform live load

Table 6.2.1 Uniform live load

Berth	Quay floor (tons/m^2)	Approach trestle (tons/m^2)
Slab	3.0	-
Coal	2.0	1.0
Oil	1.0	0.5

(8) Load conditions of cargo handling facilities

1) Coal pier

(a) 2,000 t/h, 1,000 t/h unloaders

The wheel spaces and the wheel base of the unloaders are as shown in Figs. 6.3.11 and 6.3.12.

The wheel loads are as shown in Table 6.2.2.

Table 6.2.2 Wheel loads (unloaders)

Load condition		Vertical load (t)	Horizontal load (t)	Duration of load
2,000 t/h unloader	Working	50	5.0	Long time
	Gales	50	8.0	Short time
1,000 t/h unloader	Working	45	4.5	Long time
	Gales	50	8.0	Short time

(b) 2,500 t/h, 1,200 t/h belt conveyors

The load positions of the belt conveyors are as shown in Figs. 6.3.7 and 6.3.8.

Supports : 12m span

Vertical force : 6 tons per support

2) Slab berth

(a) Slab loader

The wheel space and the wheel base of the slab loader are as specified in Fig. 6.3.24.

The wheel load is as shown in Table 6.2.3.

Table 6.2.3 Wheel load (slab loader)

Load condition	Vertical force (t)	Horizontal force (t)	Duration of load
Working	45	4.5	Long time
Gales	50	5.0	Short time

3) Oil berth

(a) Loading arms

The load positions of loading arms are as shown in Fig. 6.2.1.

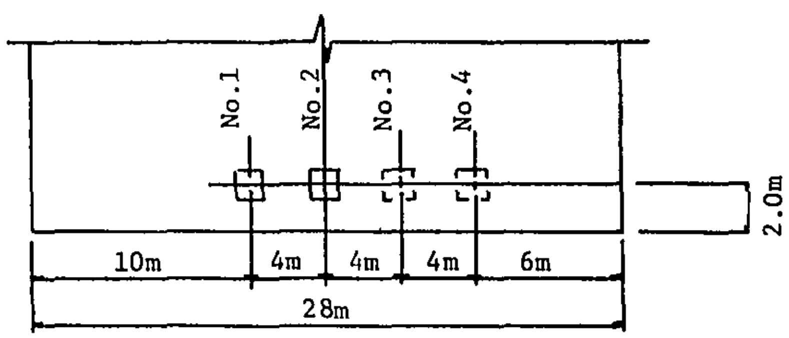


Fig. 6.2.1 Load positions

The loads of loading arms are shown below.

No.1, No.4 = 10 t.

No.2, No.3 = 6 t.

(b) Weight of oil pipelines

22' dia. : 400 kg/m

26' dia. : 470 kg/m

4) Tractor and Trailer

Dead weight Tractor : 30 t.

Trailer : 26.7 t.

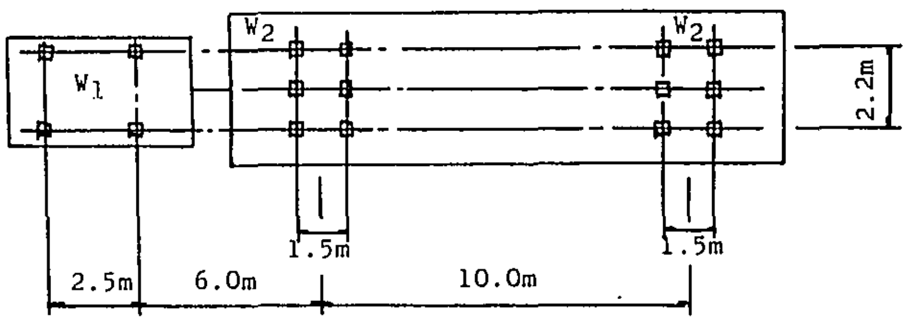


Fig. 6.2.2 Wheel layout of tractor and trailer

Table 6.2.4 Wheel loads (tractor & trailer)

Berth	W_1 (t)	W_2 (t)
Slab	7.5	10.55
Coal	7.5	3.88

5) T-20 truck

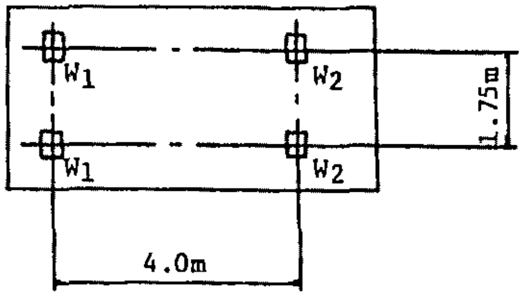


Fig. 6.2.3 Wheel layout of T-20 truck

W_1 = 2 t (front wheels)

W_2 = 8 t (rear wheels)

(9) Allowable stress

1) Steel materials

		(Quality)		(Allowable Stress)	(Standard)
①	Steel pipe pile	(STK-41)	:	σsa = 1,400 kg/cm^2	JIS A 5525
②	Steel sheet pile	(SY-30)	:	σsa = 1,800 kg/cm^2	JIS A 5508
③	Reinforcement	(SD-30)	:	σsa = 1,800 kg/cm^2	JIS G 3112
④	Tie-rod	(SS-50)	:	σsa = 1,800 kg/cm^2	JIS G 3191
⑤	PC steel bar	(Class C No.1)	:	0.6σpu or 0.75σpy (σpu : tensile strength) (σpy : yield point stress)	JIS G 3109
⑥	General structural steel	(SS-41)	:	σsa = 1,400 kg/cm^2	JIS G 3192

2) Concrete

			(Allowable stress)	(Design standard strength)
①	Cast-in-situ concrete	:	σca = 80 kg/cm^2	(σck = 240 kg/cm^2)
②	Prestressed concrete	:	σca = 275 kg/cm^2	(σck = 500 kg/cm^2)
③	Cast-in-situ pile concrete	:	σca = 80 kg/cm^2	(σck = 300 kg/cm^2)
④	Mass concrete	:	σca = 60 kg/cm^2	(σck = 180 kg/cm^2)

(10) Increase of allowable stresses

The allowable stresses shall be increased by 50% for short term loads.

6-2-2 Selection of type of structures

(1) Main types of structures

The main types of structures and their characteristics are briefly described as follows.

1) Gravity-type quaywall

The general characteristics of a gravity-type quaywall are described as follows.

① The wall made of concrete is comparatively strong and durable.

② The term of works can be shortened by the use of precast members.

③ Generally, the horizontal external forces including earth pressure and residual water pressure will increase accordingly as the design water depth increases, and a greater weight is required for the quaywall to withstand such increased external forces. For this reason, the construction of this type of structure will be less advantageous in economy and more difficult in execution than other types of structures, except where a bearing capacity of the foundation can be secured.

④ Large-scale fabricating facilities including concrete caisson yard and concrete block yard are required, and a fleet of floating cranes, tugboats, etc. is also required.

⑤ The marine conditions when launching precast members, towing them and placing them need to be calm. The operations often require a greater number of days and the execution control will become more diffcult, especially when the construction is executed in unprotected waters.

2) Steel sheet pile quaywall

The general characteristics of the steel sheet pile quaywall are described as follows.

① Comparatively simple facilities will suffice to execute the construction.

② A rapid construction is possible, since no underwater works are required for the foundation.

③ The wall being very light and elastic, its differential settlement is permitted to a certain extent.

④ Steel sheet piles as driven and not reinforced with back-filling soil and anchoring are weak against the attacks of waves.

⑤ Corrosion preventive measures are required for the steel materials.

⑥ In a place where the design water depth is very great, the construction of this type of quaywall may be difficult because the section modulus of the steel sheet pile may be insufficient.

As a variation of the steel sheet pile type quaywall, a continuous pipe pile quaywall has been developed in Japan which is constructed by continuously driving hooked pipe piles.

3) Steel sheet pile quaywall with relieving platform

The quaywall of this type, which is similar to 2) steel sheet pile quaywall, consists of steel sheet piles and a relieving platform supported on top of them and is designed to reduce the earth pressure acting upon sheathing sheet piles.

The general characteristics of the steel sheet pile quaywall with relieving platform are described as follows.

① The section of a sheet pile is smaller than that of 2).

② It may be built on a foundation weak enough to sustain a quaywall of type 2).

③ A basic structure to support the relieving platform is required.

④ It requires additional kinds of works and longer periods of construction compared with 2).

4) Open-type wharf and piled pier

The open-type wharf and the piled pier can be built on a deep underwater foundation using long, large-diameter steel pipe piles.

(a) Open-type wharf

A revetment is constructed at the back of the open-type wharf. The horizontal external forces such as the earth pressure and the residual water pressure are curbed by the revetment, while the wheel loads of cranes, uniform live loads and others are sustained by the superstructure which is supported by pipe piles.

The general characteristics of the open-type wharf are described as follows.

① The whole structure, being relatively light-weight, may be built even on a soft foundation where the structures of other types are not permissible.

② Even if the depth of water at the site should need to be increased in future after construction, the structure is relatively economically adaptable for such modification.

③ If the waves crashing upon the slope are likely to uplift the wharf's floor, measures against the uplift need to be provided.

(b) Piled pier

The piled pier is a platform extending over the sea perpendicularly from the shore revetment and supported like a bridge on piles, to provide a berth for ships.

The general characteristics of the piled pier are described as follows.

① The structure, being light-weight like the open-type wharf, can be constructed on a soft foundation where the construction of other types of quaywall might be difficult.

② It scarcely obstructs the flow of the water and hardly disturbs the existing natural conditions.

③ Reclamation soil is not required.

④ For constructing a wide-platform pier, the construction will cost high.

(2) Selection of type of structures

The type of structures to be employed should be selected, considering not only the general characteristics described above, but also the following conditions and requirements:

① Environmental conditions

Mechanical properties of soil, waves, tide level, tidal current, etc.

② Usage

Types of ships accepted, types and volumes of cargoes, types of cargo handling operations, etc.

③ Execution conditions

Execution methods, construction machineries, etc.

④ Construction period and cost

The viewpoint of "a better, faster and safer construction at less cost".

For the slab berth taken as an example, the four types of the structures were studied and compared. It should be noted here that in the claculations of the comparative design the penetration depth of piles was set as -30 m according to the first stage results of soil borings, and that continuous pipe pile quaywall was used for the steel sheet pile type quaywall because the conventional type of steel sheet piles does not have a sufficient section modulus.

① Open-type wharf and piled pier (steel pipe pile type) (Fig. 6.2.4)

② Steel sheet pile quaywall (continuous pipe pile quaywall type) (Fig. 6.2.5)

③ Gravity-type quaywall (caisson type) (Fig. 6.2.6)

④ Continuous pipe pile quaywall with relieving platform (Fig. 6.2.7)

As a result of the study, the open-type wharf and piled pier are considered most advantageous and have been selected. The results of the studies and comparisons are shown in Table 6.2.5.

For the oil berth, the dolphin type structure has been most suitable in view of the conditions of the usage. A concrete block type quaywall has been selected for the small craft berth.

The fundamental considerations given in the process of the above comparative studies are as follows.

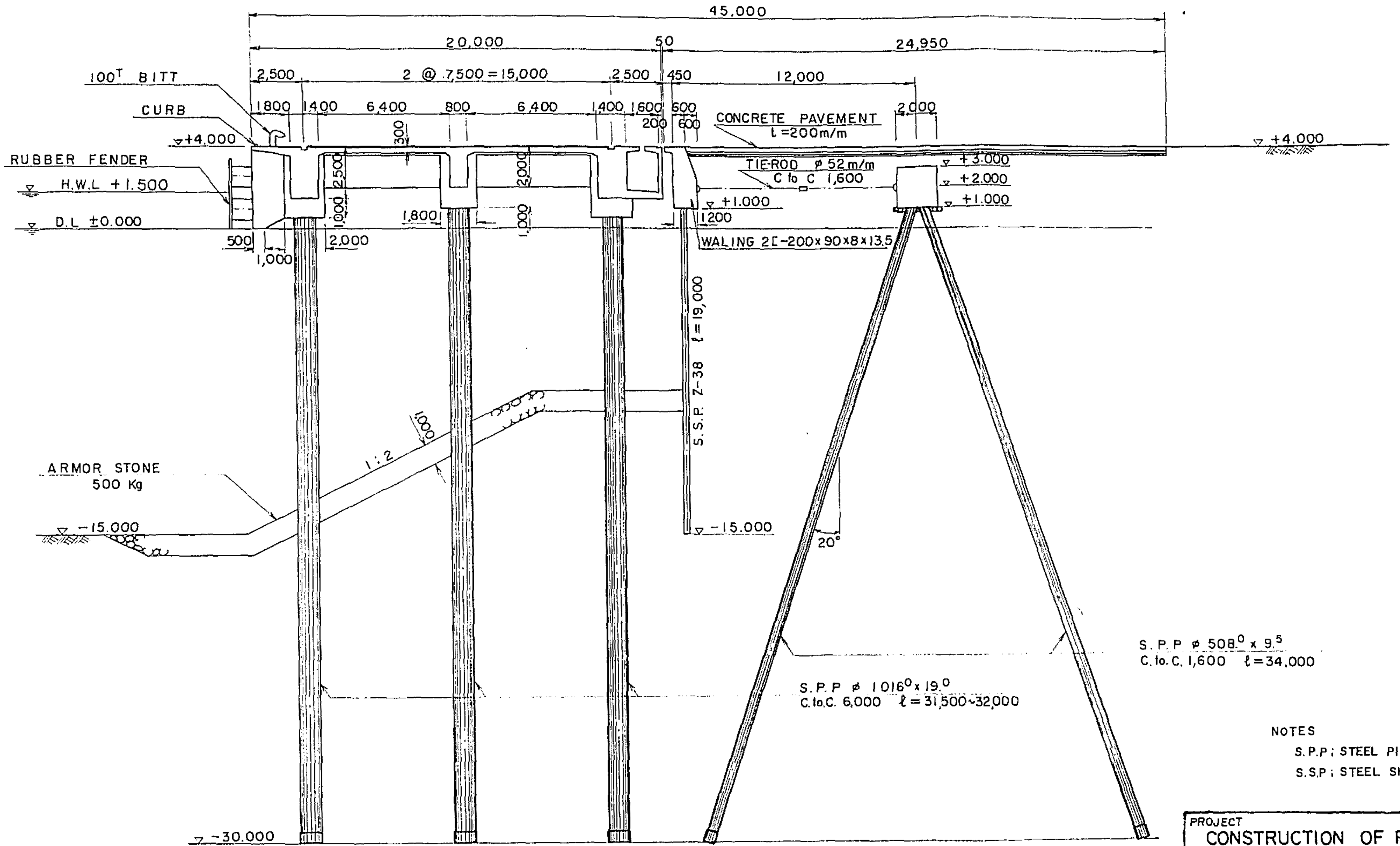
1) Open-type wharf and piled pier

(a) Basic considerations for designing

① The superstructure shall be of cast-in-situ reinforced concrete structure.

-15M SLAB BERTH S= 1:200

STEEL PIPE PILE TYPE



NOTES

S.P.P ; STEEL PIPE PILE

S.S.P ; STEEL SHEET PILE

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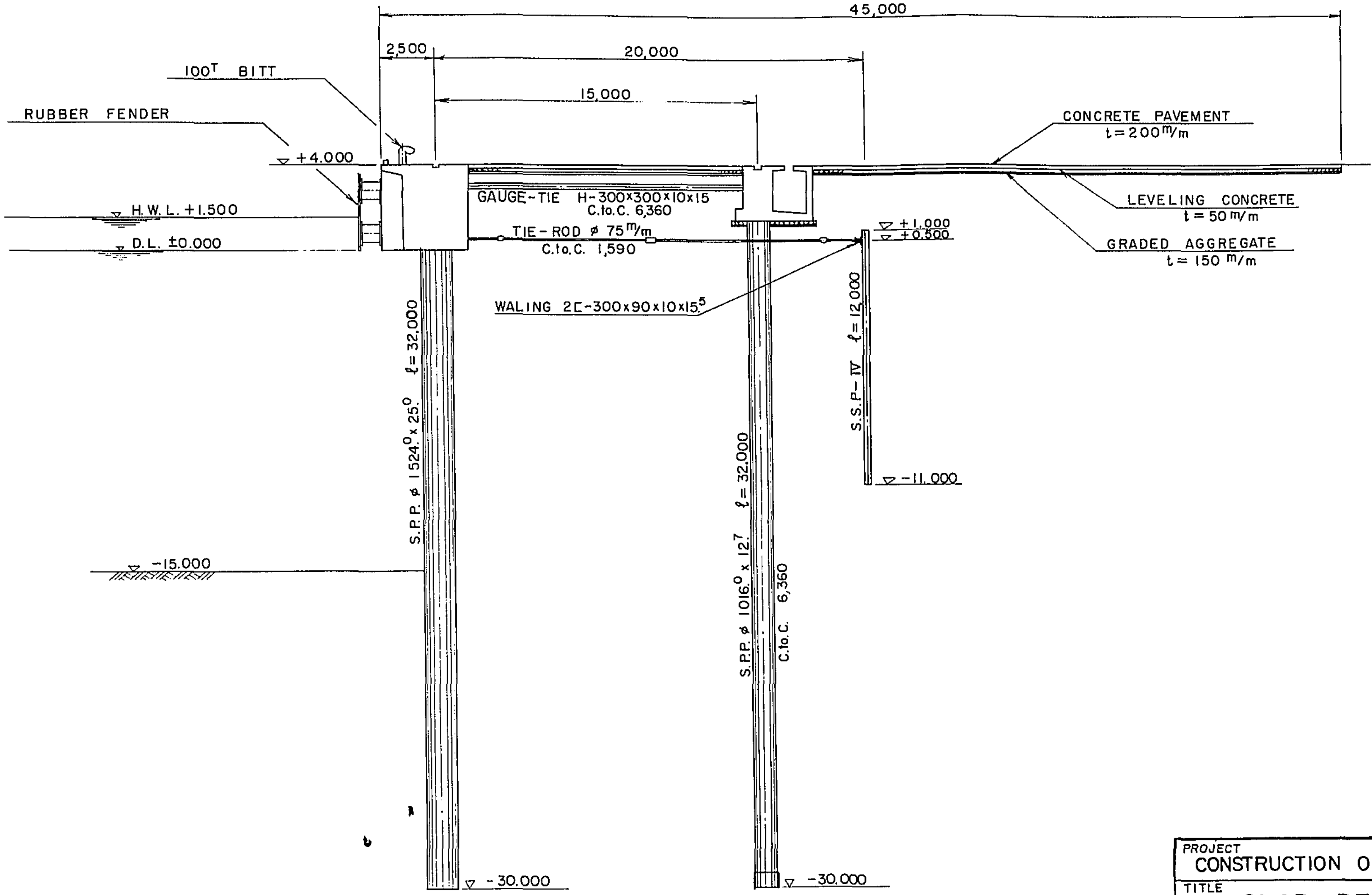
-15^{M} SLAB BERTH S=1:200

CONTINUOUS PIPE PILE TYPE



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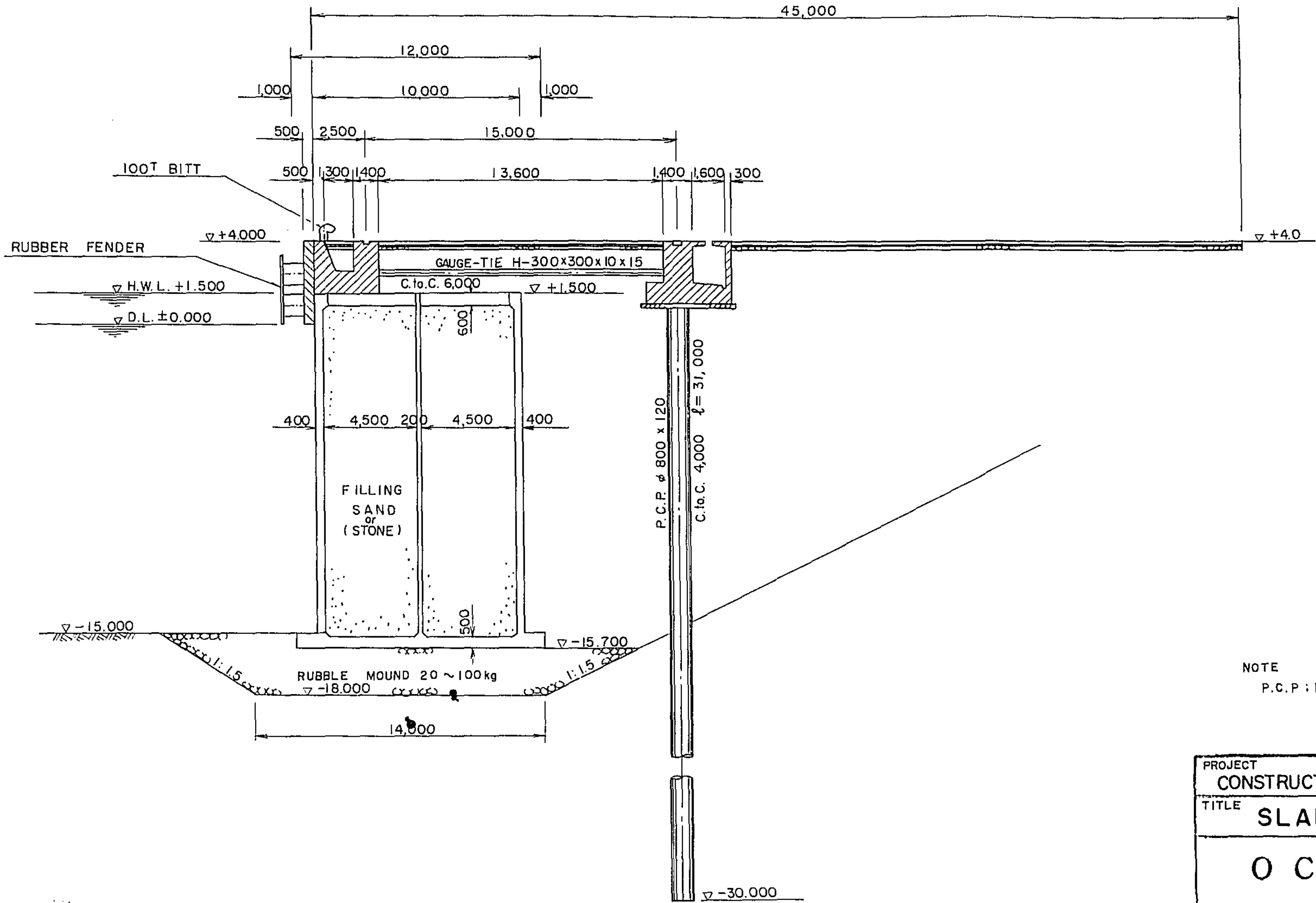
−15M SLAB BERTH

CAISSON TYPE



NOTE
P.C.P : PRESTRESSED CONCRETE PILE

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−15M SLAB BERTH S = 1 : 200

CONTINUOUS PIPE PILE QUAYWALL WITH RELIEVING PLATFORM

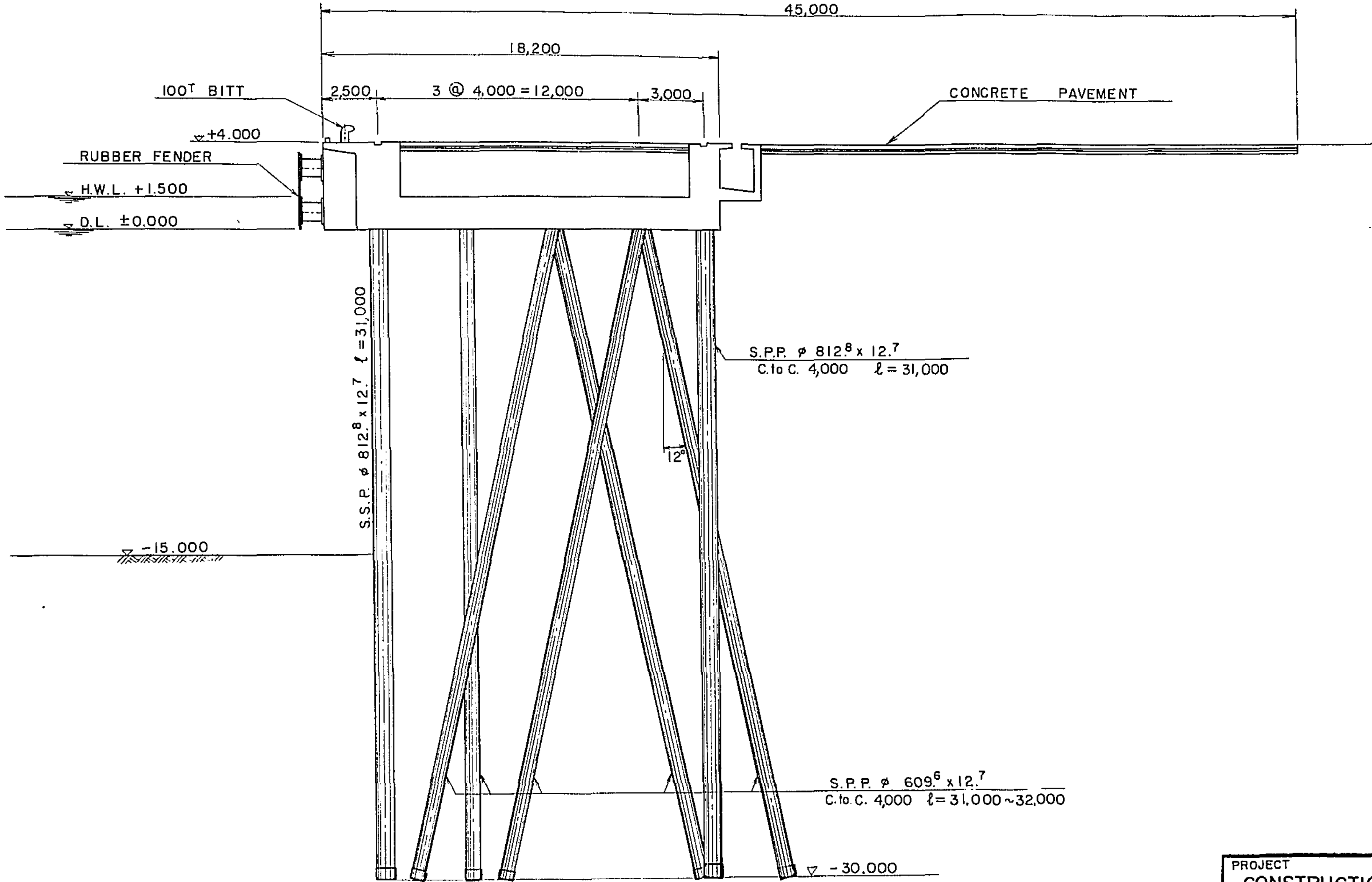

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Table 6.2.5 Comparison table (types of structure)

Item \ Type	Open-type wharf	Continuous pipe pile quaywall	Caisson type quaywall	Continuous pipe pile quaywall with relieving platform
Feasibility of construction from the viewpoint of soil conditions, etc.	Possible	Possible	Possible	Possible
Limitations on use	Nil	Nil	Nil	Nil
Work volume	Medium	Few	Many	Medium
Problems on execution control	Waves during pile driving	Waves during pile driving: care for pile edges	Waves during towing and installation	Waves during pile driving
Construction cost ratio (Open-type wharf = 1.0)	1.0	1.6	1.2	1.9
Durability	Corrosion of pipe piles	Corrosion of steel pipe piles	No particular problems	Corrosion of steel pipe piles

② The impact of a berthing vessel shall be absorbed by rubber fenders, and the reaction force shall be transmitted through the superstructure and the foundation piles into the earth.

③ The slab loader shall not be affected for any harmful displacement by berthing impacts, pulling force of vessels and other horizontal external forces produced when ships come alongside the pier.

④ The steel materials shall be given means to prevent corrosion.

⑤ The piled pier and the revetment shall be structurally independent such that they can have a flexibility to meet differential settlement.

⑥ When the construction of the revetment is executed before the construction of the breakwater is completed, the revetment under construction will be subject to the attacks of waves. For this reason, the coupled pile anchorage shall be used to ensure safety.

⑦ When wind velocity is greater than 16 m/sec, vessels shall take refuge outside the harbour.

(b) Calculation methods

① The beams to support the slab loader shall be taken as a continuous beam, considering the elastic deformation of the piles. That is to say, it is assumed with respect to the continuous beam that "so long as the reaction force at the supporting points does not exceed the allowable bearing capacity of the foundation, the elastic deformation at the supporting points is proportional to the reaction force", and the reciprocal number of the proportional constant is used as the modulus of elastic deformation at the supporting point, W (t/m), in the computation of the section forces.

② The bending moment due to the horizontal forces acting on the foundation piles is calculated by a virtual fixed bearing method based on the Y.L. Chang's formula. In the calculations, it is also assumed that all the horizontal forces are received by the battered piles without causing to the latter any displacement.

③ All the foundation piles shall be regarded as bearing piles.

Where the piles having a diameter of not less than 600 mm, their blocking effect shall be taken into account.

④ The penetration length of the foundation piles shall be a length that satisfies its required bearing capacity and shall not be less than π/β,

where, β: characteristic length (m^{-1}) by Y.L. Chang.

⑤ The Meyerhof's modified formula shall be used for the calculation of the bearing capacity.

2) Steel sheet pile quaywall (continuous pipe pile quaywall)

(a) Basic considerations for designing

① The berthing impacts shall be absorbed by the passive earth pressure.

② The sea-side foundation of the slab loader shall be the sheathing sheet pile structure, while its land-side foundation shall be a pile foundation.

③ Quality soil shall be used for the backfilling. Other basic considerations are same as those described in 1).

(b) Calculations methods

① In the calculations of the maximum bending moment acting upon the sheet piles, a sheet pile shall be regarded as supported at its sea bottom and at points where tie-rods are attached to it, and also shall be regarded as a simple beam upon which the earth pressure and the residual water pressure above the sea bottom act as the loads.

Coulomb's earth-pressure theory shall be used for the calculation of the earth pressure.

② The penetration length of the sheet piles shall be determined from the balance of the moments at the tie-rod attached points due to the earth pressure and the residual water pressure.

③ The anchoring shall be coupled piles anchorage and located behind the plane of active earth pressure acting on the sheet piles formed from the sea bottom level of the sheet piles. For the purpose of calculation, the coupled piles anchorage shall be calculated as the coupled piles upon which the tension of the tie-rods acts as an external force.

3) Caisson type quaywall

(a) Basic considerations for designing

① The berthing impacts by ships shall be absorbed by the weight of the caisson and the passive earth pressure.

② The sea-side foundation of the slab loader shall be the caisson structure, while its land-side one shall be pile foundation.

③ The approximately 3-meter thickness of the caisson bottom ground shall be replaced with cobble stones.

④ The sand (or cobble) of good quality shall be used for filling in or back filling the caisson.

⑤ Other basic considerations are same as 1) above.

(b) Calculation methods

① The Coulomb's earth-pressure theory shall be used for the calculation of the earth pressure.

② For the stability of the caisson as a wall calculations shall be made on the sliding, overturning of the wall and the bearing capacity of the foundation ground, by and against the active earth pressure, residual water pressure, the wheel loads of the slab loader and other external forces.

③ Terzaghi's formula shall be used for the calculation of the allowable bearing capacity of the foundation ground.

4) Continuous pipe pile quaywall with relieving platform

(a) Basic considerations for designing

① The berthing impacts by ships shall be absorbed by the foundation piles of the relieving platform.

② The sea-side foundation of the slab loader shall consist of the sheathing sheet piles, and its land-side one shall be the foundation piles for the relieving platform.

③ Other considerations are same as those for 2) steel sheet pile quaywall.

(b) Calculation methods

The calculations described in 2) steel sheet pile quaywall shall apply to the sheathing sheet piles, and those described in 1) Open-type wharf and piled pier shall apply to the foundation piles with the relieving platform.

6-2-3 Selection of foundation structure

As stated in the paragraph 6-2-2(2), the open-type wharf and piled pier have been adoped as the type of the structure. There are three choices conceivable as the type of their foundation structure:

① Steel pipe pile structure (S.P.P) (Figs. 6.2.8, 6.2.11, 6.2.23 and 6.2.24)

② Prestressed concrete pile structure (P.C.P) (Figs. 6.2.9, 6.2.12, 6.2.14 and 6.2.16)

③ Cast-in-situ pile structure (C.I.P) (Figs. 6.2.10, 6.2.13, 6.2.15 and 6.2.19)

For these three choices, studies are hereunder made on a comparative basis as to such major criteria as follows.

(1) Execution methods

1) Simplity of offshore works

If construction of berths is to be started before the completion of the breakwaters, it becomes necessary to ascertain whether or not such construction methods or equipment as will minimize the adverse effects of waves on the overall construction efficiency can be selected.

2) Simplity of execution control

Execution controls are essentially aimed at better, speedier, less expensive and safer construction. It is, therefore, desired that the construction work comprises relatively simple work procedures which do not necessitate skilled labor, unless some particular situation requires otherwise.

3) Amount of works

Obviously, the amount of works influences the construction speed and cost.

4) Construction speed

Since the early opening of the port is a prerequisite, the execution methods must be of a type highly reliable and providing speedier completion.

5) Adaptability to varied depths of bearing stratum

The present plan assumes that foundation piles will be supported on sandy soil with an N-value not less than 30. Analysis of the boring data, however, indicates that there may be a wide variation in the depth of the bearing stratum and, so, it is reasonably expected that the foundation piles will have to be driven to varied depths. From this viewpoint, therefore, a study as to whether the proposed execution method can cope effectively with this seems essential.

6) Adaptability to soil conditions of intermediate strata

If a hard layer, like the Canga (hard rock) exists in the intermediate strata overlaying the bearing stratum, it must be carefully studied whether or not the pile driving through the hard stratum will be permissible.

7) Readiness of local procurement of materials

Studies in this regard should be made in close reference to local conditions prevailing.

The present plan assumes that steel pipe piles shall be fabricated locally from imported steel plates for economic considerations. Therefore, the estimate of construction cost hereinafter given also assumes this.

(2) Economy (construction cost)

(3) Durability

Prior studies should be made on corrosion problems - corrosion of steel pipe piles and corrosion of steel reinforcement for prestressed concrete due to cracking in concrete.

The result of comparative analysis of the three alternate plans with reference to the above criteria is summarized in Table 6.2.6.

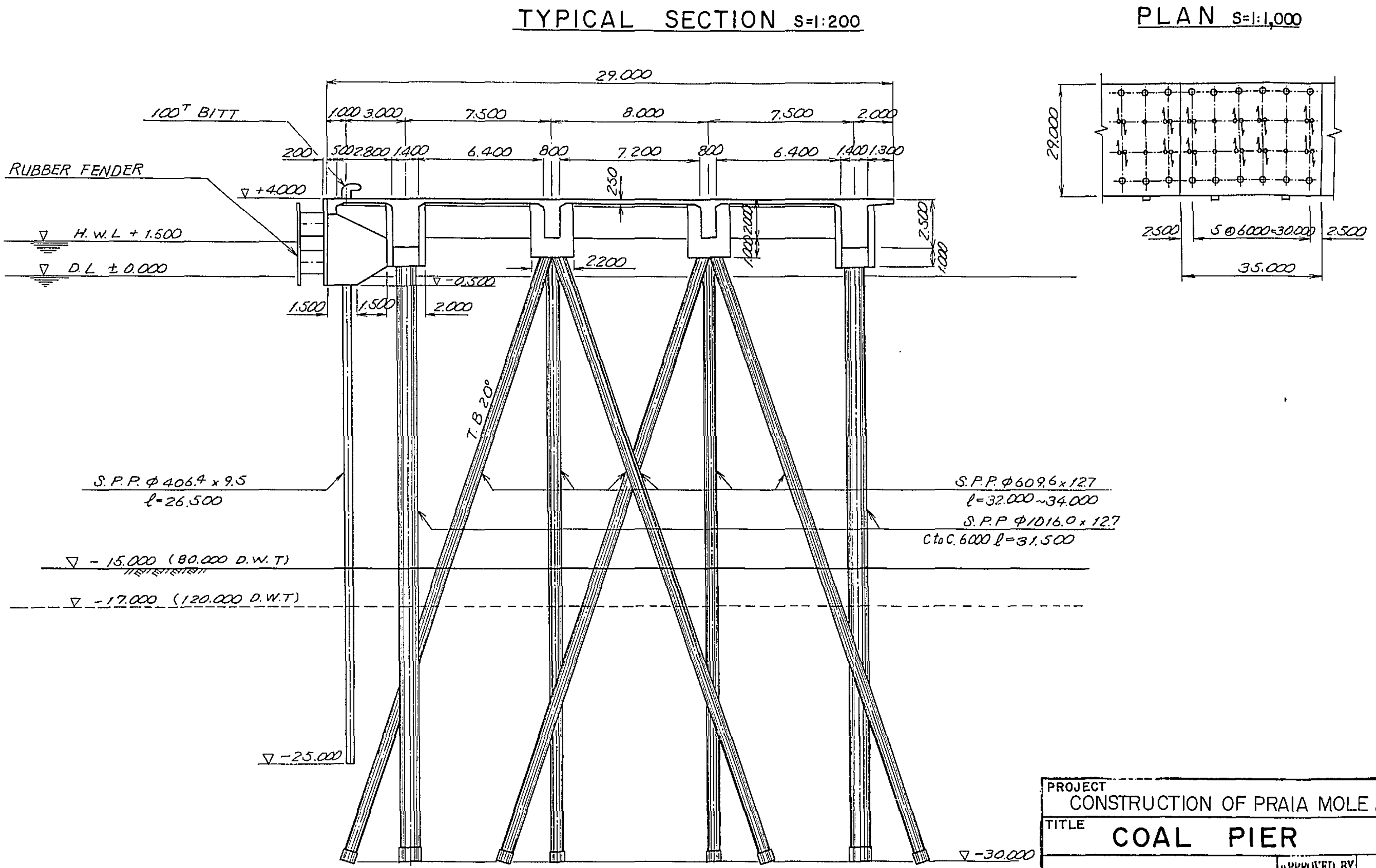
Table 6.2.6 Comparison table (foundation structures)

Item \ Type		Steel pipe pile type	P.C. pile type	Cast-in-situ pile type
Execution	Simplity of offshore works	o	Δ	Δ
	Simplity of execution control	o	o	Δ
	Amount of works	•	o	Δ
	Construction speed	•	o	Δ
	Adaptability to varied depths of bearing stratum	•	Δ	o
	Adaptability to soil conditions of intermediate strata	o	Δ	o
	Execution of battered piles	•	o	Δ
	Readiness of local procurement of materials	Δ	o	•
Ecomony Construction cost ratio (steel pipe pile type = 1.0)		1.0	1.1	1.3
Durability		Δ	o	•

Note : • excels o, o excels Δ.

Thus, as indicated in the table, the steel pipe pile structure seems to offer the best route and has been adopted hereby as the foundation of the open-type wharf and piled pier.

-15 (-17) M COAL BERTH



PROJECT	CONSTRUCTION OF PRAIA MOLE PORT
TITLE	COAL PIER

OCDI THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN	APPROVED BY	
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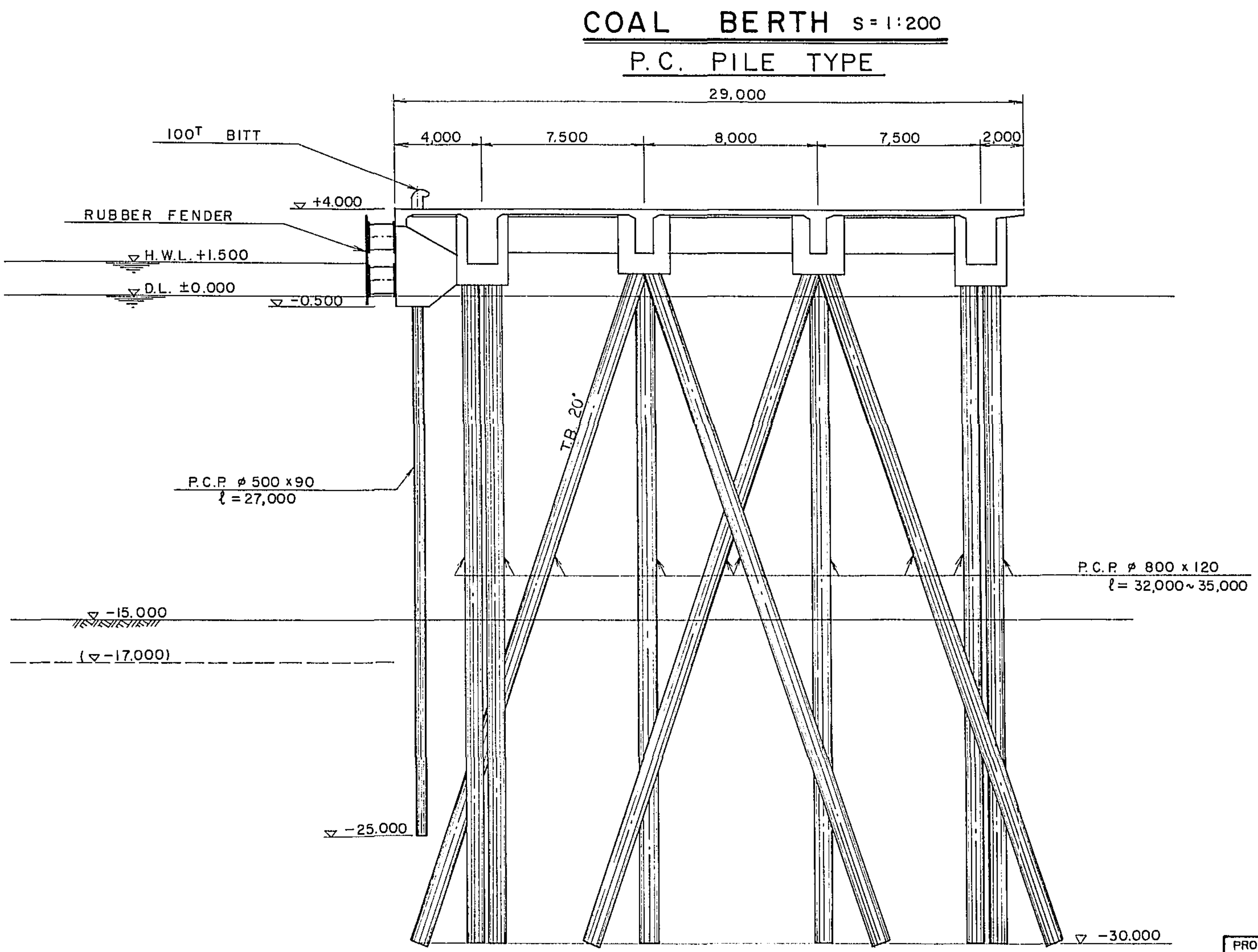
	DWG No. 6.2.8	
	DATE	SCALE as shown



PROJECT CONSTRUCTION OF PRAIA MOLE PORT	
TITLE COAL PIER	
O C D I THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN	APPROVED BY
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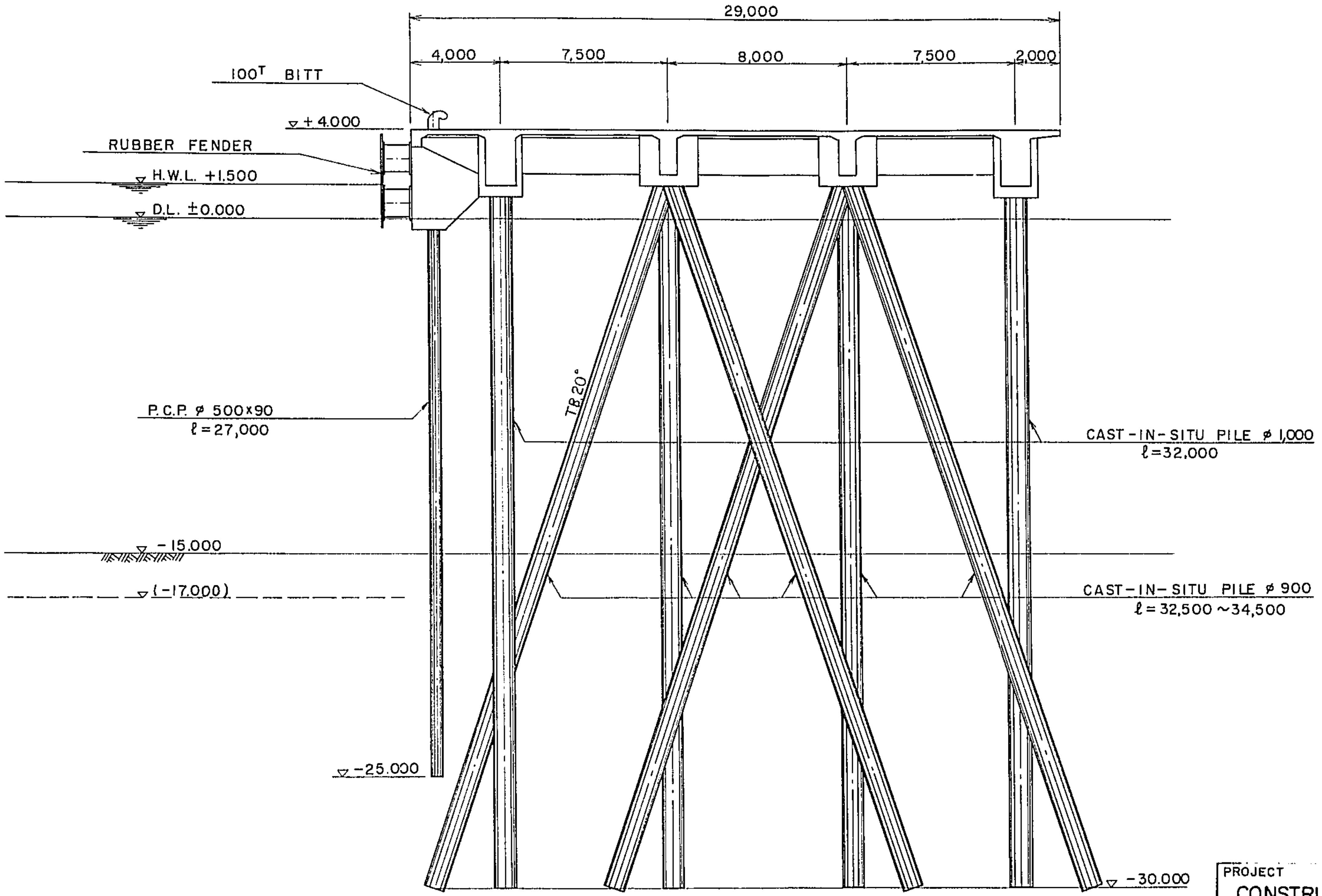
	DWG No. 6.2.9
	DATE / SCALE 1:200

COAL BERTH S= 1:200

CAST-IN-SITU PILE TYPE



PROJECT
CONSTRUCTION OF PRAIA MOLE PORT

TITLE
COAL PIER

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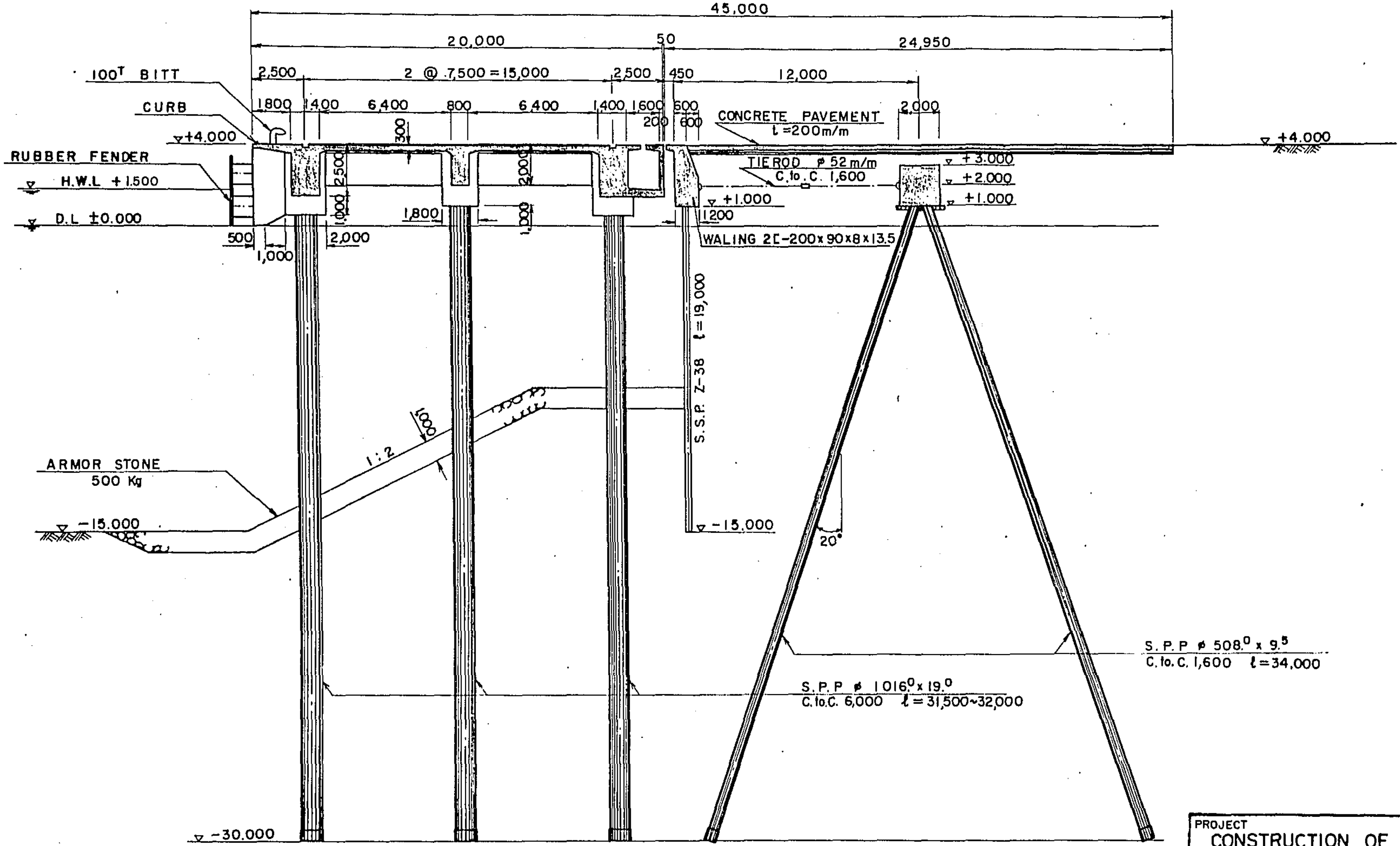
DWG No.	6.2.10
DATE	SCALE 1:200

−15M SLAB BERTH S= 1:200

STEEL PIPE PILE TYPE



PROJECT CONSTRUCTION OF PRAIA MOLE PORT	
TITLE SLAB BERTH	
O C D I	APPROVED BY
	CHECKED BY
	DRAWN BY
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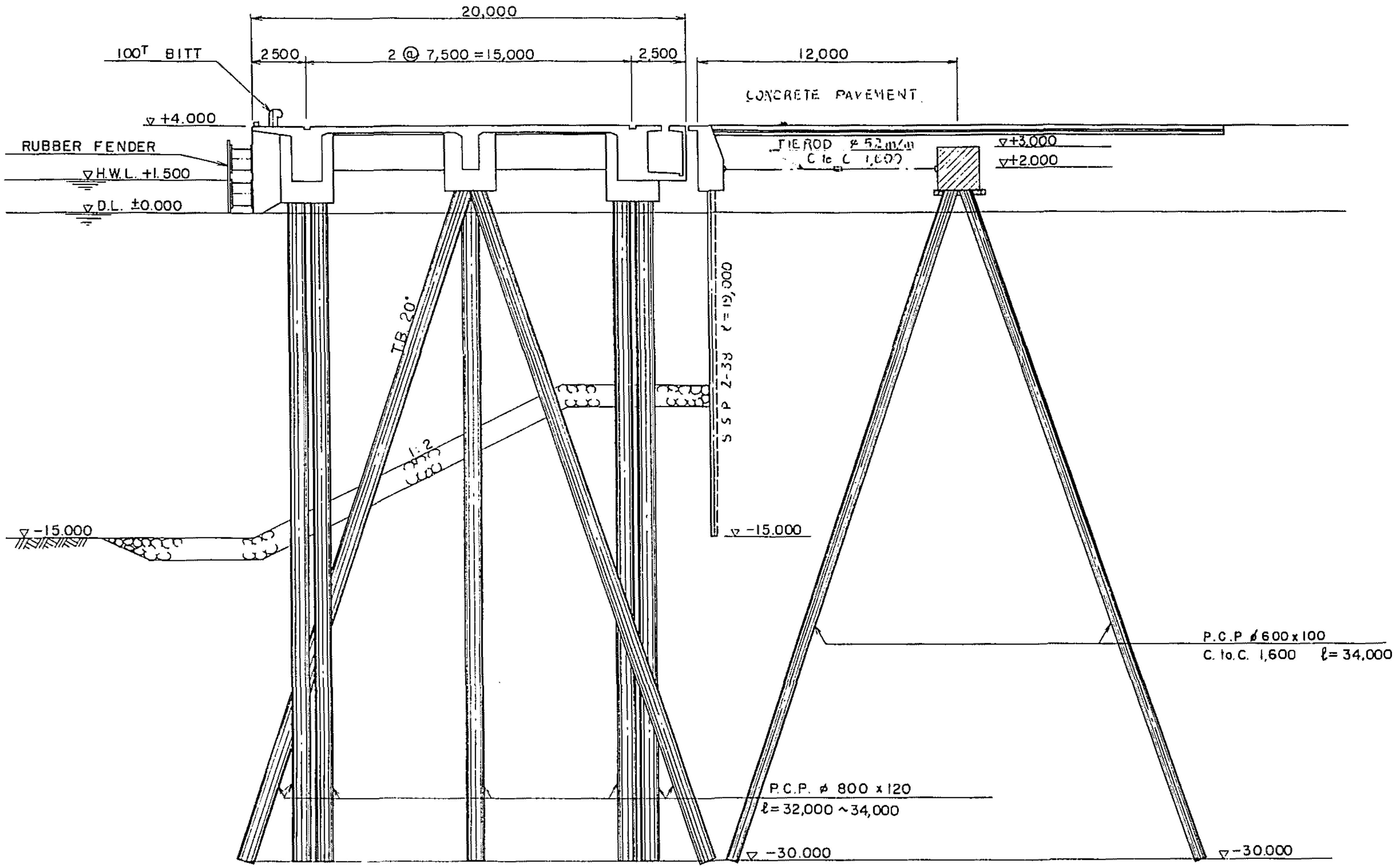
	DATE / SCALE 1:200

−15ᴹ SLAB BERTH S= 1:200

P.C. PILE TYPE



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CONSTRUCTION OF PRAIA MOLE PORT	
TITLE SLAB BERTH	
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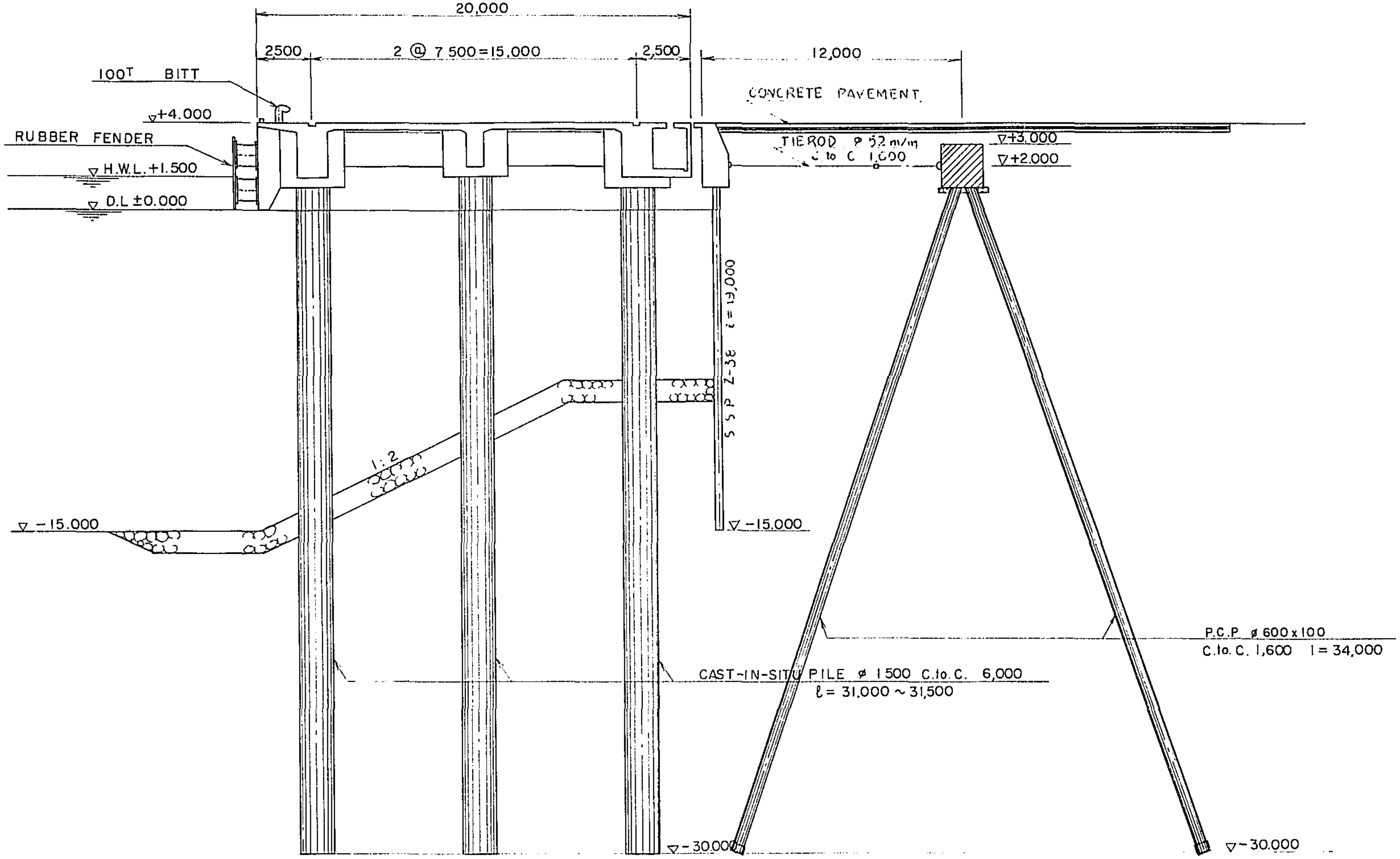
	DATE SCALE 1:200

−15^M SLAB BERTH S=1:200

CAST-IN-SITU PILE TYPE



PROJECT CONSTRUCTION OF PRAIA MOLE PORT	
TITLE SLAB BERTH	
OCDI	APPROVED BY
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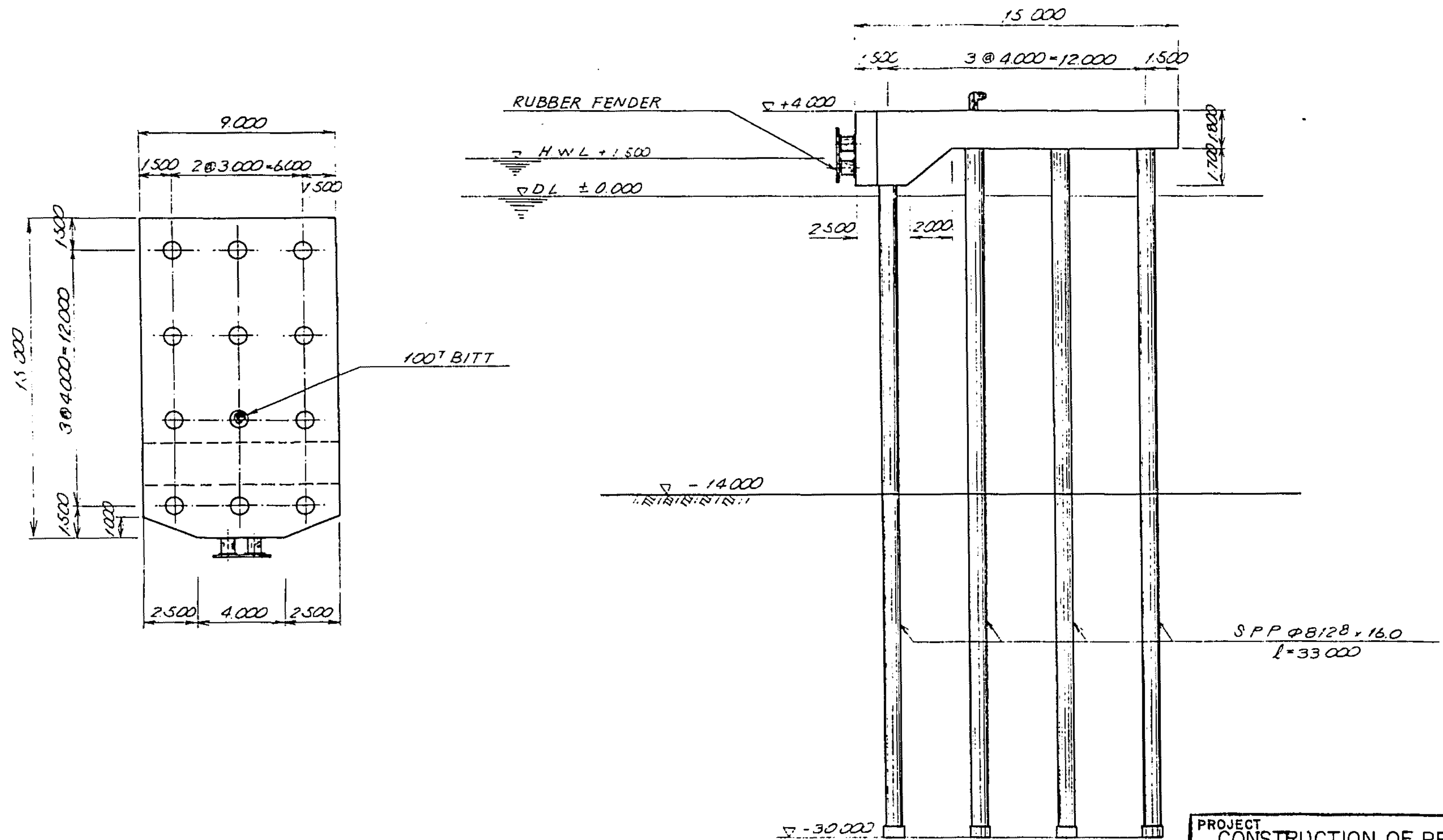
	SCALE 1:200

BREASTING DOLPHIN S=1:200



PROJECT	CONSTRUCTION OF PRAIA MOLE PORT
TITLE	OIL BERTH
OCDI	APPROVED BY
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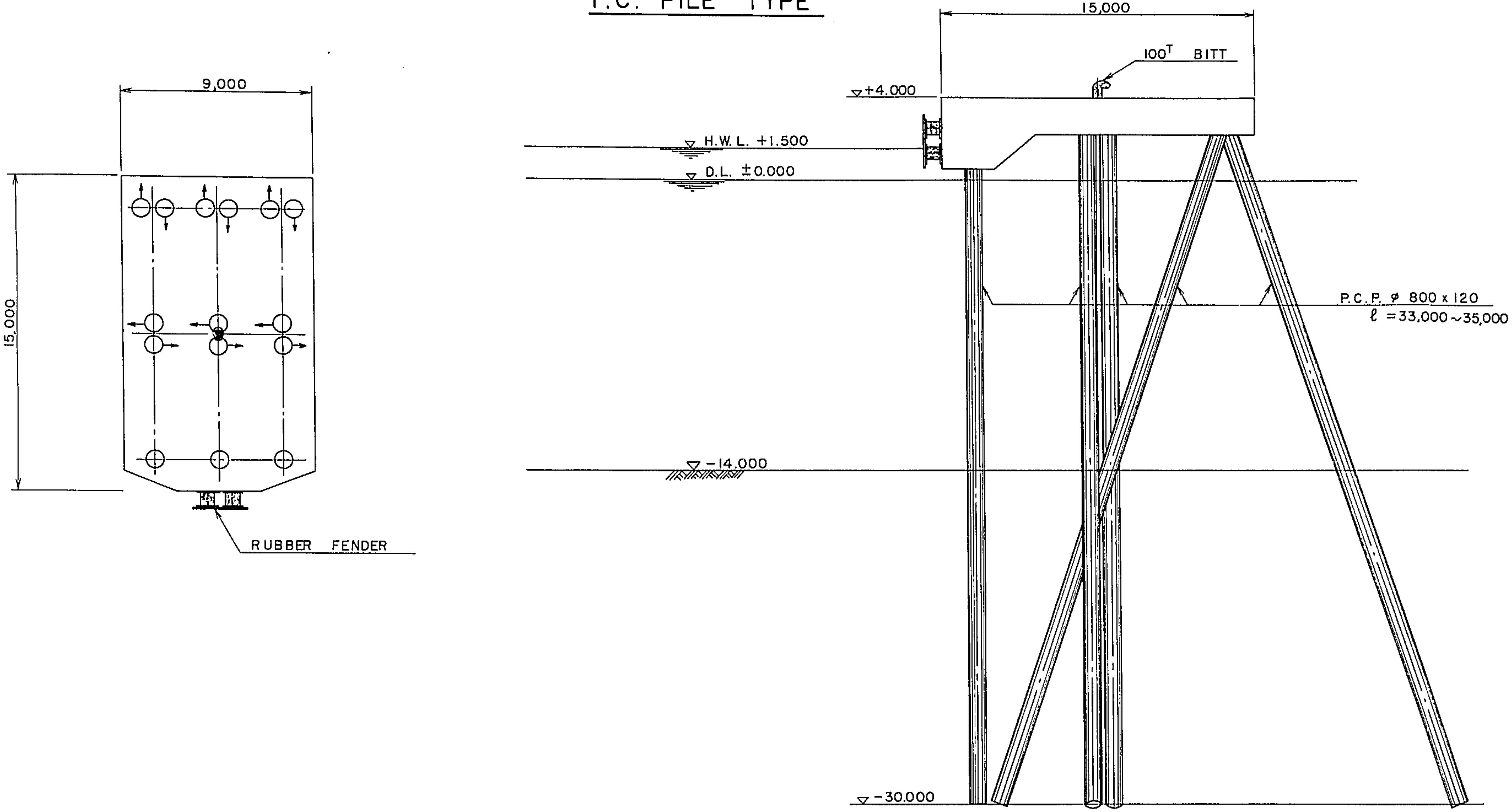
	DATE / SCALE 1:200

BREASTING DOLPHIN S=1:200

P.C. PILE TYPE



PROJECT	CONSTRUCTION OF PRAIA MOLE PORT
TITLE	OIL BERTH

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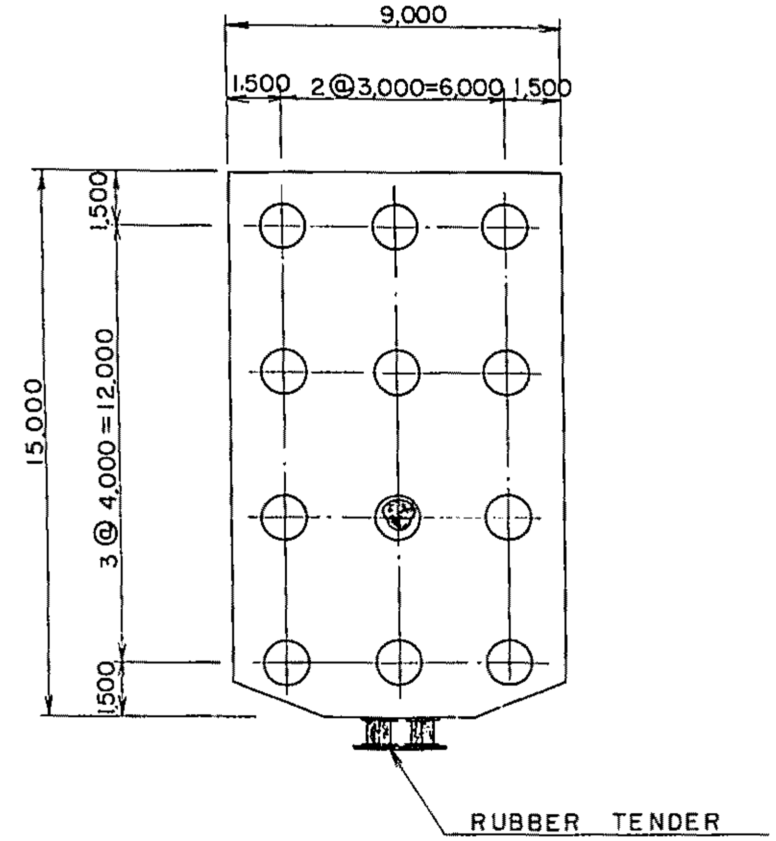
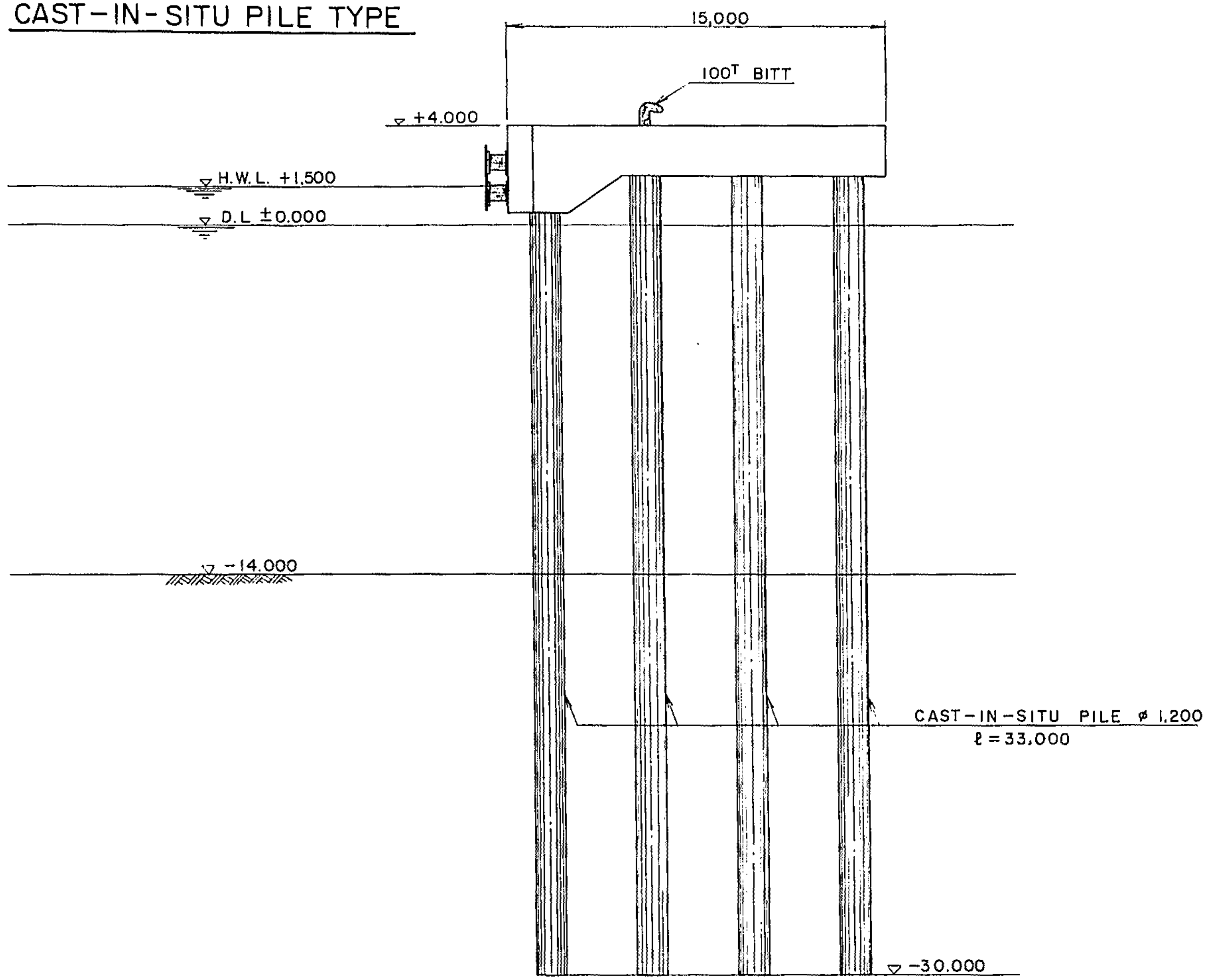
DEVELOPMENT INSTITUTE OF JAPAN	DATE	1:200

BREASTING DOLPHIN S= 1:200

CAST-IN-SITU PILE TYPE





PROJECT
CONSTRUCTION OF PRAIA MOLE PORT

TITLE
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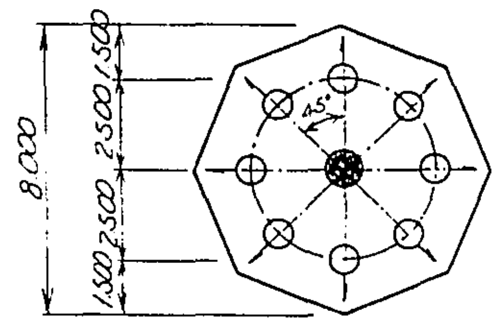
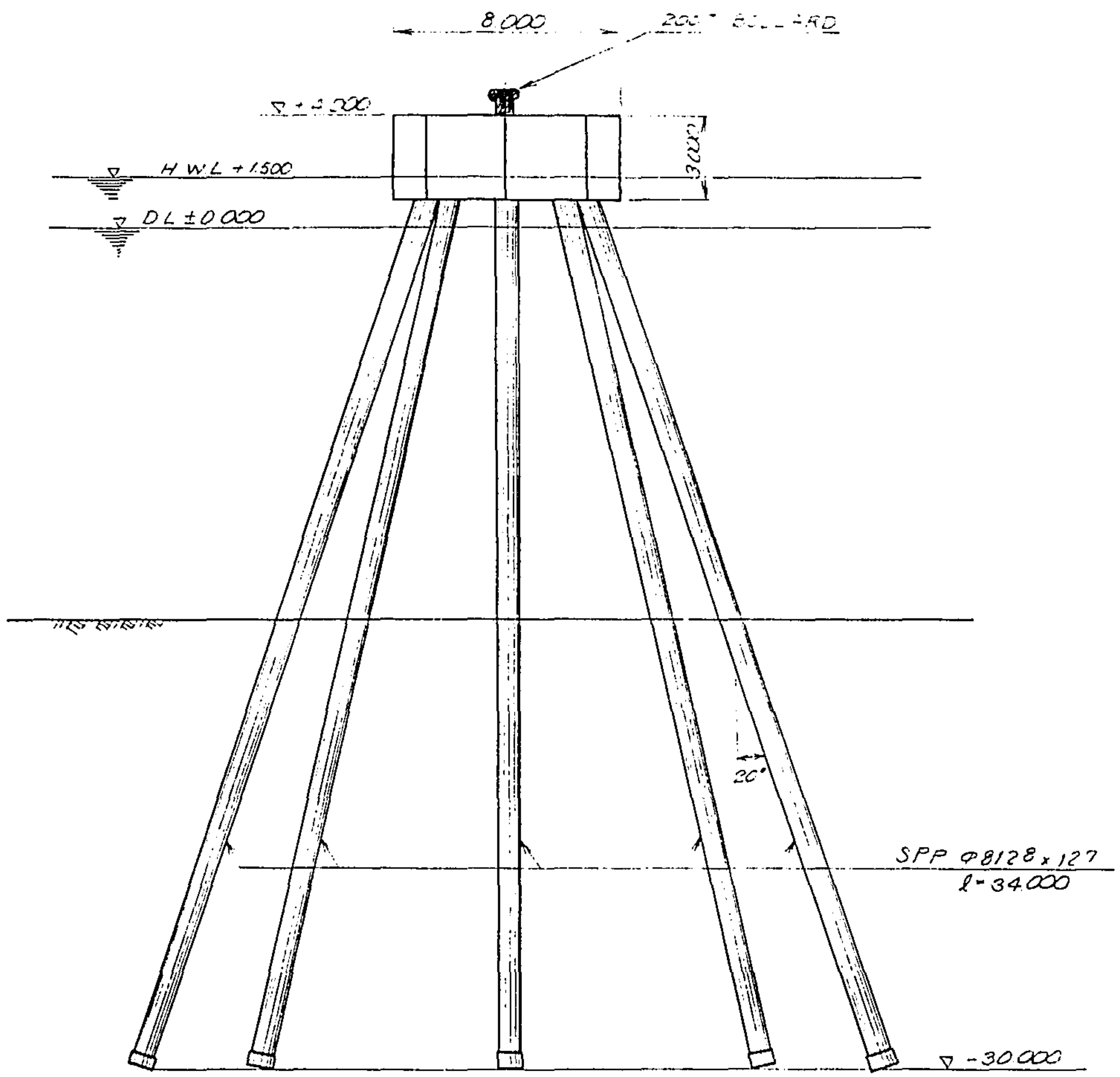
DATE	SCALE 1:200

MOORING DOLPHIN S=1:200

PLAN



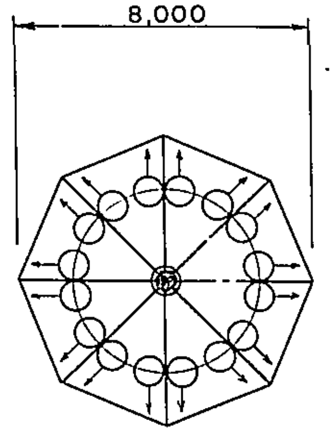
SIDE VIEW

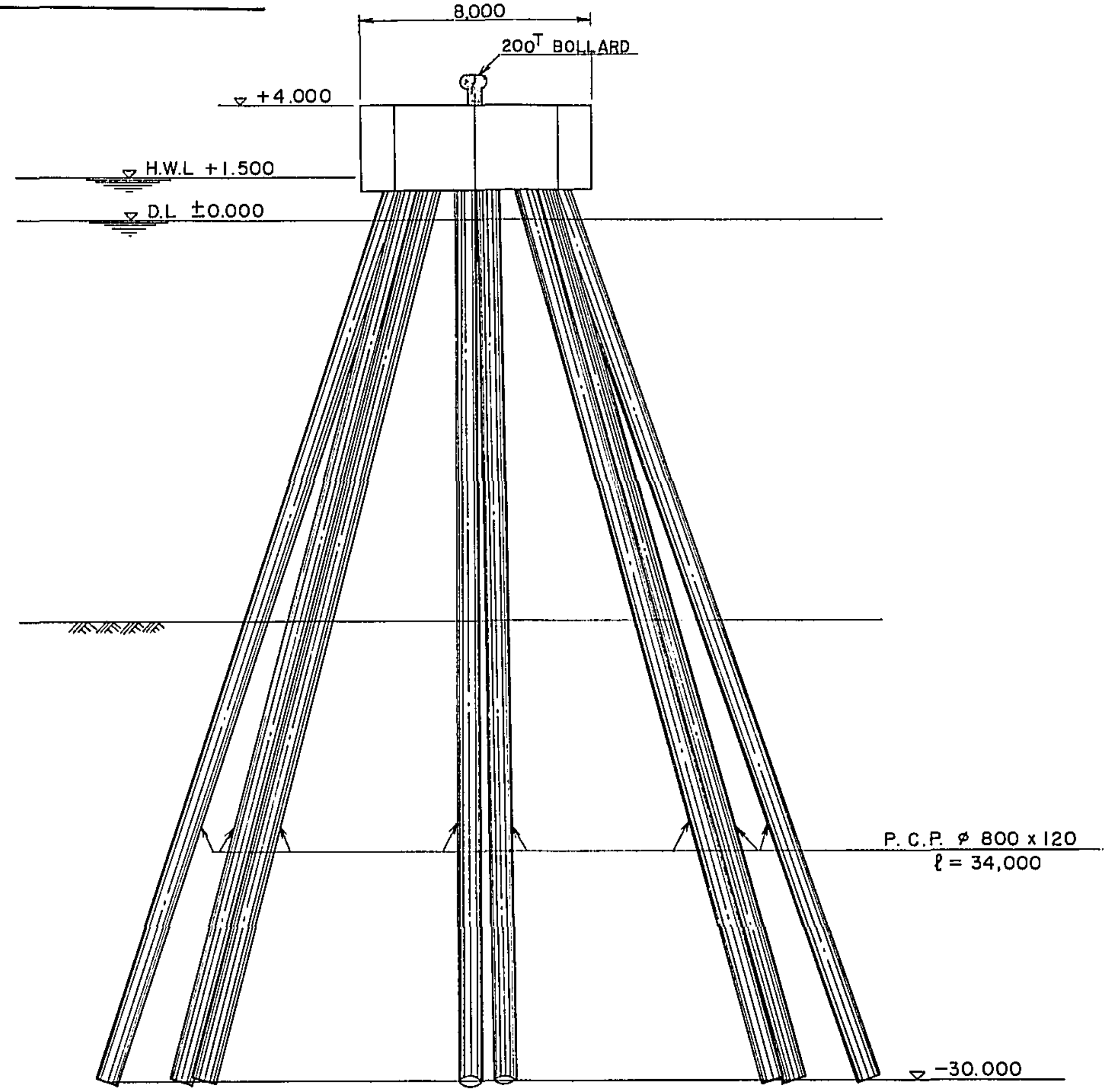


PROJECT	CONSTRUCTION OF PRAIA MOLE PORT
TITLE	OIL BERTH
OCDI THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN	APPROVED BY CHECKED BY DRAWN BY DWG No. 6.2.17 DATE SCALE

MOORING DOLPHIN S = 1:200

P. C. PILE TYPE





PROJECT CONSTRUCTION OF PRAIA MOLE PORT

TITLE OIL BERTH

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THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN

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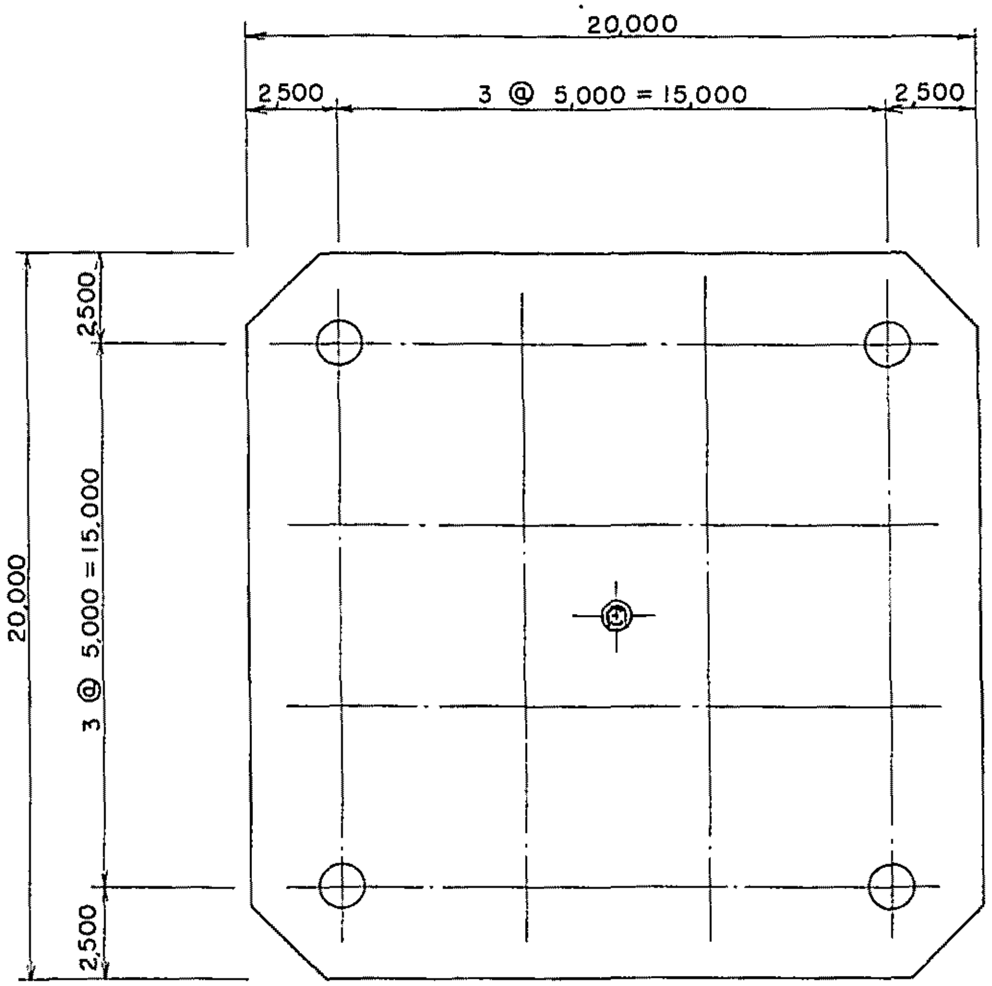
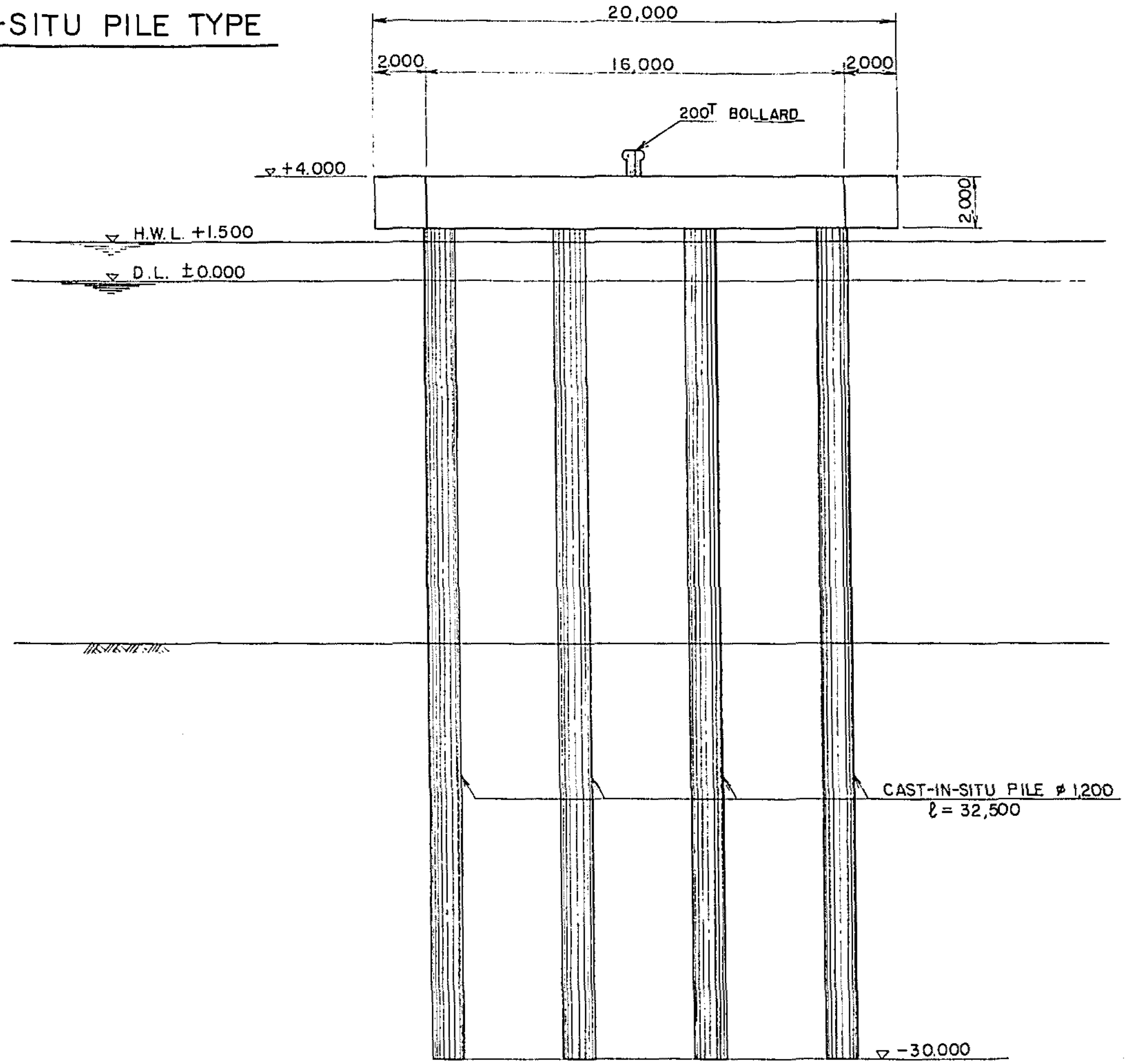
DWG No.	6.2.18
DATE	SCALE 1:200

MOORING DOLPHIN S = 1:200

CAST-IN-SITU PILE TYPE





PROJECT: CONSTRUCTION OF PRAIA MOLE PORT	
TITLE: OIL BERTH	
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6-2-4 Comparison of PLANAVE and OCDI proposals for coal pier

For two proposals for the foundation structure of the planned coal pier - the PLANAVE's proposal shown in Fig. 6.2.20 and OCDI's final proposal shown in Fig. 6.2.21, comparative studies are hereunder made.

The PLANAVE's proposal is characterized by three reinforced points provided in the berth as illustrated in Fig. 6.2.20 to absorb horizontal external force. The structure of this kind is considered to offer the following advantages and disadvantages:

(Advantages)

① Requires reduced number of battered piles.

② Provides higher rigidity against horizontal external force such as berthing impact or tractive force of ships because one unit of the pier large concrete blocks is large.

(Disadvantages)

① The size of one block of the pier should desirably be determined by the concrete placing capacity available. With the PLANAVE's system wherein a very large amount of concrete is required for the one block of the pier, the concrete placing has to be divided into several stages.

② Sensitive to differential settelment.

③ Construction joints of concrete must be reinforced to transmit shearing forces and bending moments.

④ There are problems associated with drying shrinkage and temperature change of concrete.

⑤ Piles tend to undergo a large torsional moment.

⑥ Floor slab must have flexural rigidity in the traverse direction, thus necessitating larger slab thickness.

⑦ Increases the dead weight of pier itself.

Under the PLANAVE's proposal, a rough design was made and dimensions of main members of the pier were determined for comparison with the OCDI's proposal.

The result was that the PLANAVE's proposal required less battered piles but larger dimensions and greater number of vertical piles than the OCDI's proposal, thus as a whole requiring piles more both in number and weight.

Similarly, a larger quantity of concrete was required because the floor slab was designed thick enough to exhibit adequate flexural rigidity in the traverse direction.

The construction cost for the PLANAVE's proposal is estimated to be about 1.5 times as high as the OCDI's proposal.

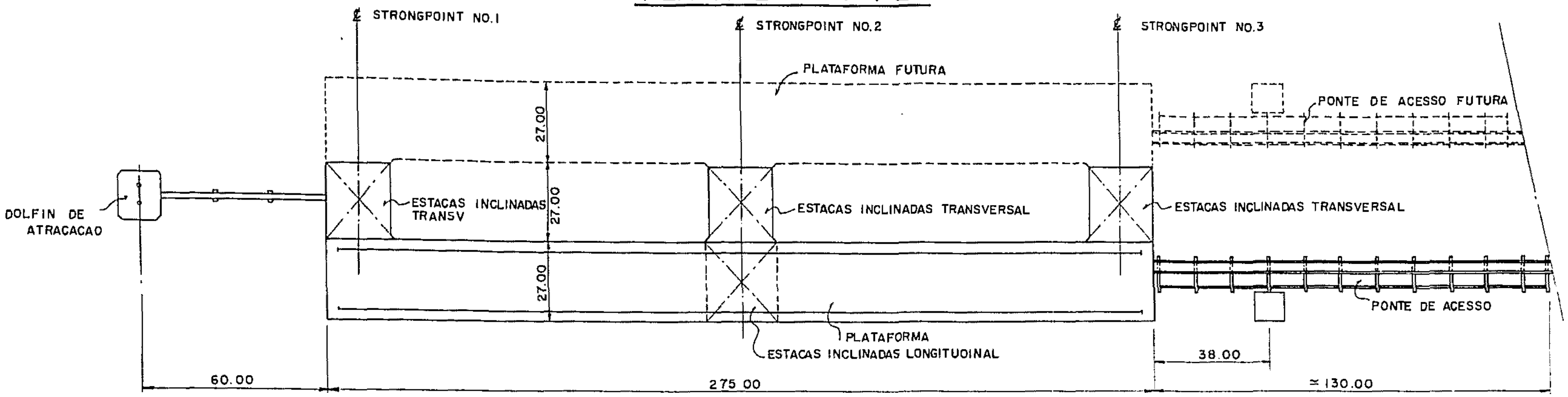
The overall results of these comparative analysis underlies our judgement in favor of the OCDI's proposal.

6-2-5 Basic design and structural drawings

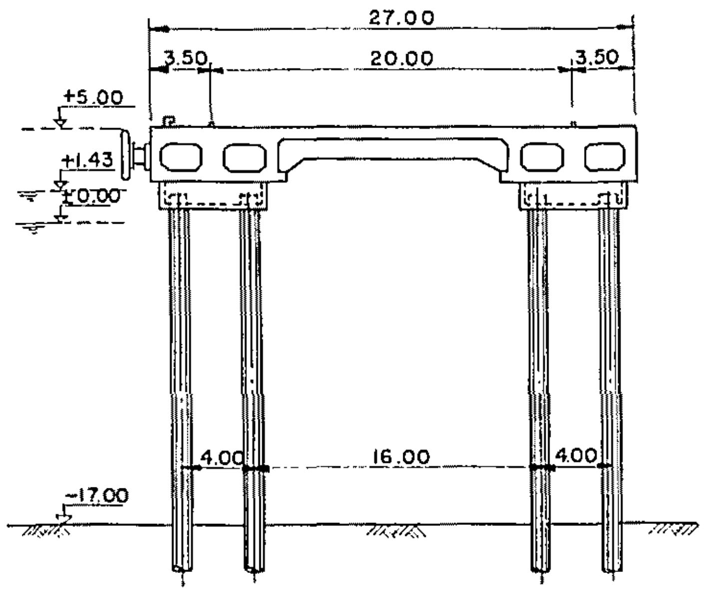
The calculation results for the basic design of each berth are provided in Table 6.2.7. Standard sections of structures are shown in Appendix 4. structural drawings of civil facilities (Figs. PM-C609 to PM-C618).

−17M COAL BERTH

PLANAVE TYPE



PLATAFORMA



CORTE TRANSVERSAL

ESC 1:200

PROJECT	CONSTRUCTION OF PRAIA MOLE PORT
TITLE	COAL PIER
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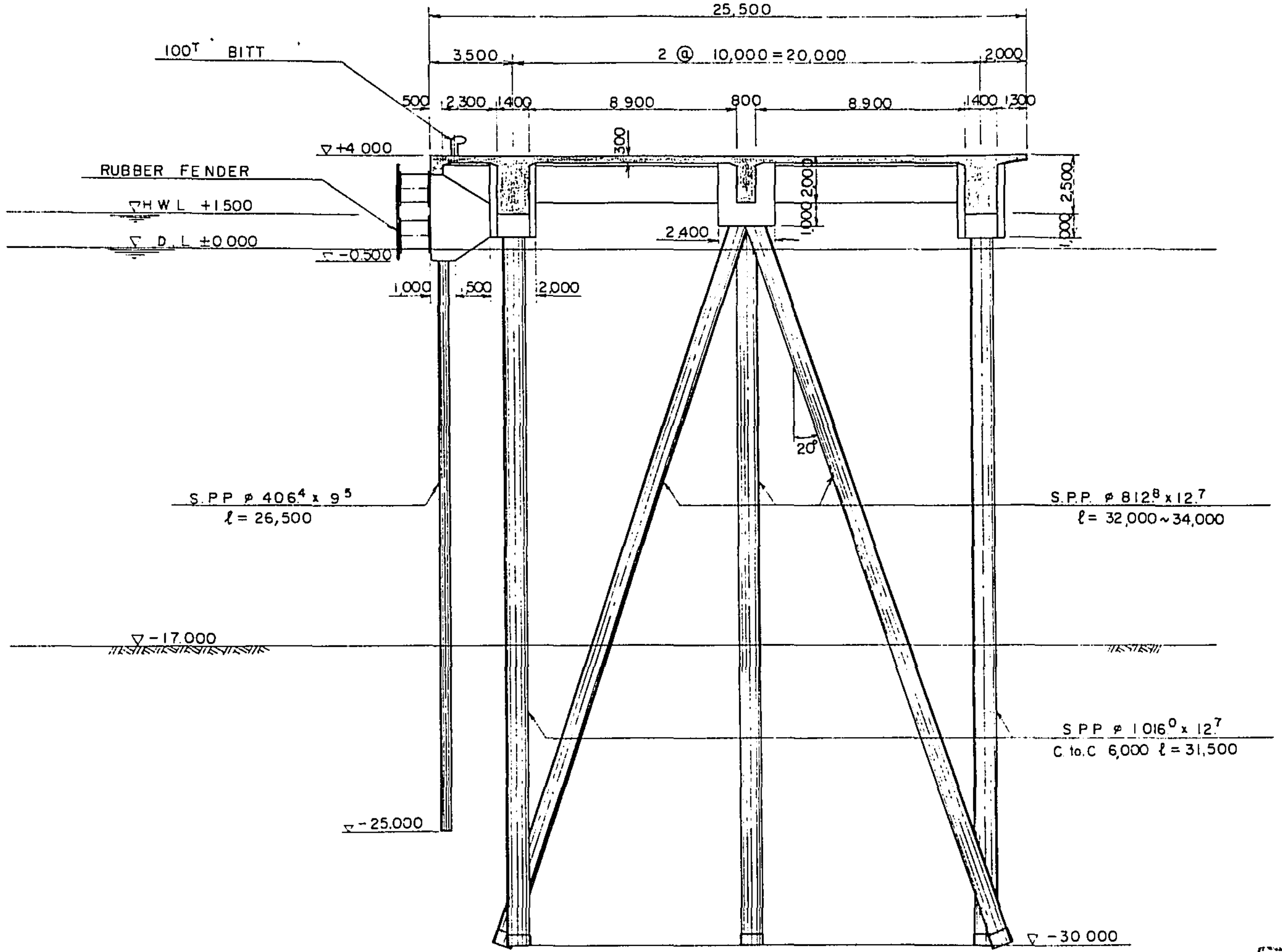
-17M COAL BERTH

TYPICAL SECTION S=1:200



NOTE
S.P.P ; STEEL PIPE PILE

PROJECT CONSTRUCTION OF PRAIA MOLE PORT	
TITLE COAL PIER	
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Table 6.2.7 Summary of calculations

<table>
<tr><th rowspan="2">Type / Item</th><th colspan="3" rowspan="2">Coal pier</th><th rowspan="2">Slab berth</th><th colspan="3">Oil berth</th></tr>
<tr><th>Breasting dolphin</th><th colspan="2">Mooring dolphin</th></tr>
<tr><td>Pier dead load</td><td colspan="3">61.99 t/m</td><td>56.74 t/m</td><td>682.8 t</td><td colspan="2">320 t</td></tr>
<tr><td>Berthing impact</td><td colspan="3">184.6 t</td><td>115.8 t</td><td>112.0 t</td><td colspan="2">-</td></tr>
<tr><td>Tractive force</td><td colspan="3">100 t</td><td>100 t</td><td>100 t</td><td colspan="2">200 t</td></tr>
<tr><td rowspan="2">Pile size</td><td colspan="2">Unloader pile</td><td>S.P.P.ø1016×12.7</td><td rowspan="2">S.P.P.ø1016.0×19.0</td><td rowspan="2">S.P.P.ø812.8×16.0</td><td colspan="2" rowspan="2">S.P.P.ø812.8×12.7</td></tr>
<tr><td colspan="2">Battered piles</td><td>S.P.P.ø812.8×12.7</td></tr>
<tr><td rowspan="2">Stress of piles</td><td colspan="2">Unloader pile</td><td>σ_s = 1053 kg/cm^2</td><td rowspan="2">σ_s = 1366 kg/cm^2</td><td rowspan="2">σ_s = 1437 kg/cm^2</td><td colspan="2" rowspan="2">σ_s = 1336 kg/cm^2</td></tr>
<tr><td colspan="2">Battered piles</td><td>σ_s = 86.9 kg/cm^2</td></tr>
<tr><td rowspan="3">Safety factor for ultimate bearing capacity</td><td colspan="2">Unloader pile</td><td>F_s = 2.55 > 2.5</td><td rowspan="3">F_s = 3.40 > 1.5</td><td rowspan="3">F_s = 6.13 > 1.5</td><td>Indentation</td><td>F_s = 3.55 > 1.5</td></tr>
<tr><td rowspan="2">Battered piles</td><td>Indentation</td><td>F_s = 2.70 > 1.5</td><td>Extracting</td><td>F_s = 2.52 > 2.5</td></tr>
<tr><td>Extracting</td><td>F_s = 3.15 > 2.5</td><td colspan="2"></td></tr>
</table>

Note : The load to be imposed at the time of the berthing impact or when the tractive force is in action is considered to develop for a short time load.

6-3 Cargo handling facilities

As far as the design of main cargo handling facilities is concerned, general agreement was reached between the Japanese study team and the PORTOBRÁS as the result of discussions made during our stay in Brazil.

6-3-1 Design conditions

The main design conditions for each cargo handling equipment are as provided in Table 6.3.1.

6-3-2 Coal handling equipment

(1) Unloaders

1) Basic considerations in planning

Among various types of cranes seemingly applicable to unloaders, such as a bridge crane and a double-link crane, a rope-trolley type bridge crane has been picked up for the planned application mainly for economic and operational considerations since the present plan envisages a large capacity of unloader as high as 1000 to 2000 t/hr.

In planning the unloader for this project, particular considerations were given to the following:

① In the first stage of the project, two 2000 t/hr unloaders will be used as coal unloaders for coal carriers of various capacities ranging from domestic-coal carriers of a 10,000 D.W.T. class to imported-coal carriers of a 120,000 D.W.T. class. This means that two types of grab buckets, one small-capacity and the other large-capacity, will have to be used selectively.

② Both in the first and the second stages, each berth will be equipped with 2 unloaders and 2 belt conveyors to handle various kinds of coal. Because of this, the unloading facilities must be so designed that coal leaving the unloaders can be directed to either of the belt conveyors on the same berth.

Table 6.3.1 Design criteria

	Coal	Slab
Applied vessels	East berth : Max. 120,000 DWT Min. 10,000 DWT West berth : Max. 80,000 DWT Min. 10,000 DWT	Max : 120,000 DWT Min. : 10,000 DWT
Cargo handled	Bulk density : 0.8 t/m^3 Lump size : 1 ∿ 63.5 mm (Mean size : 10 ∿ 15 mm) Moisture content : 8 ∿ 9 % Angle of repose : 37° (7° on belt conveyor)	Weight : Max. 35 t Width : 800 ∿ 2,200 mm Length : 5,000 ∿ 12,500 mm Thickness : 120 ∿ 305 mm
Wind velocity	During operation : Max. 16 m/sec. At rest : Max. 35 m/sec.	
Weather	Ambient temperature : Max. 40°C Min. 5°C Rainfall : Max. 200 mm/day	
Applied standard	JIS (Japanese Industrial Standard) JEC (Japanese Electro-technical Committee) JEM (Japan Electrical Machine Industry Association)	

③ Unloaders should be able to travel without any interference with the ship's bridge on the emptied vessel.

2) Structural considerations

The construction of the unloader thus selected is as shown in Figs. 6.3.1 and 6.3.2.

From the structural point of view, particular considerations were given to the following:

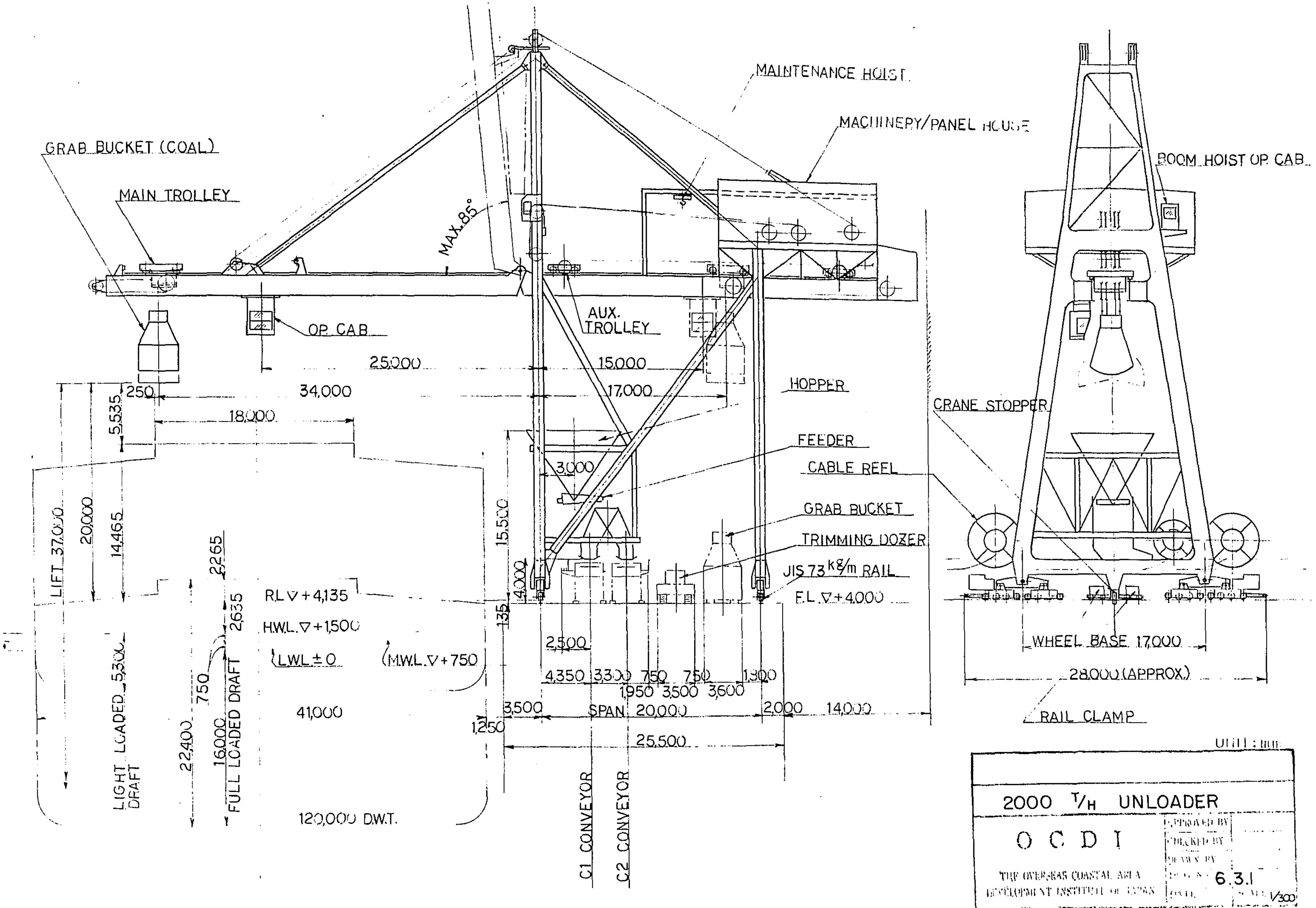
① The outreach at the front leg side of each unloader must be so designed that the grab bucket can easily reach the hatch end of the largest coal carrier it must handle (80,000 D.W.T. for the 1,000 t/hr. unloader and 120,000 D.W.T. for the 2,000 t/hr. unloader).

② The rail gauge of each coal unloader must be wide enough to permit easy traffic of bulldozers for on-board cargo handling and truck cranes or trailers for maintenance service when two lanes of belt conveyors and a spare grab bucket are placed on the pier. (Refer to Figs. 6.3.7 and 6.3.8)

③ Each unloader shall have a back reach enough to allow the grab bucket to land on the floor area close to the rear leg within the span.

④ It is desirable that the wheel base is so designed that two unloaders on a berth can handle coal taken out from both holds of a vessel adjacent to each other.

⑤ The lift shall be sufficient to permit the grab bucket to hang up the bulldozer for on-board cargo handling from the hold of the largest vessel after being emptied and to bring it down on the pier, passing over the hopper of the unloader.


GRAB BUCKET (COAL)
MAIN TROLLEY
MAX. 85°
MAINTENANCE HOIST
MACHINERY/PANEL HOUSE
BOOM HOIST OP. CAB.
OP. CAB
AUX. TROLLEY
HOPPER
CRANE STOPPER
FEEDER
CABLE REEL
GRAB BUCKET
TRIMMING DOZER
JIS 73 kg/m RAIL
F.L. ▽+4,000
RL ▽+4,135
H.W.L. ▽+1,500
L.W.L. ±0
M.W.L. ▽+750
25,000
15,000
34,000
17,000
250
18,000
5,535
3,000
15,500
4,000
135
LIFT 37,000
20,000
14,465
2,265
2,635
750
LIGHT LOADED 5,300
LIGHT DRAFT
22,400
16,000
FULL LOADED DRAFT
41,000
120,000 D.W.T.
2,500
4,350
3,300
750
750
1,800
1,950
3,500
3,600
3,500
SPAN 20,000
2,000
14,000
1,250
25,500
C1 CONVEYOR
C2 CONVEYOR
WHEEL BASE 17,000
28,000 (APPROX.)
RAIL CLAMP
UNIT : mm
2000 T/H UNLOADER
OCDI
THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN
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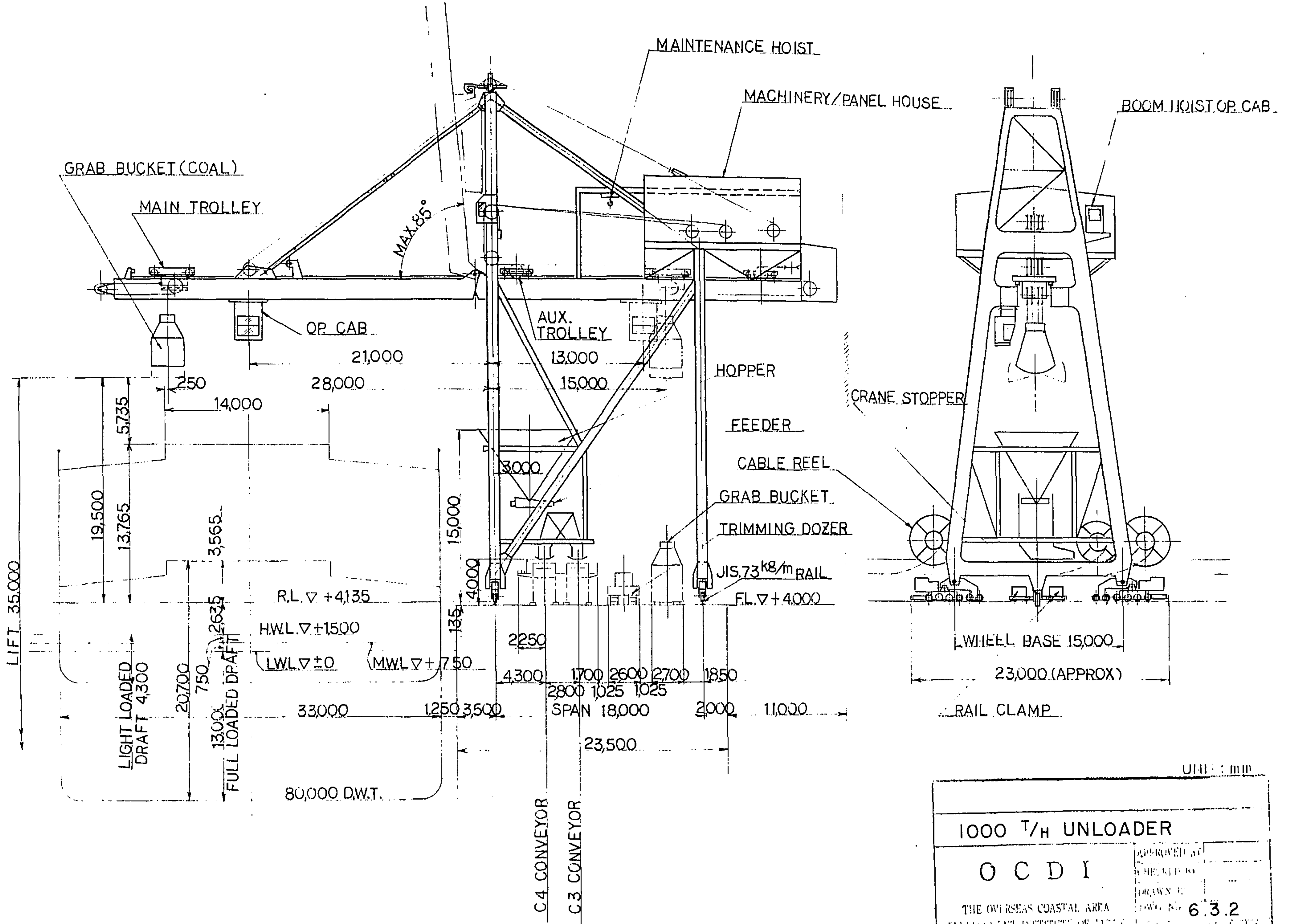
SCALE 1/300



UNIT : mm

1000 T/H UNLOADER

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DATE	SCALE 1/300

Fig. 6.3.7

SECTIONAL VIEW OF COAL PIER 2,000 T/H COAL U.L
(unit : mm)

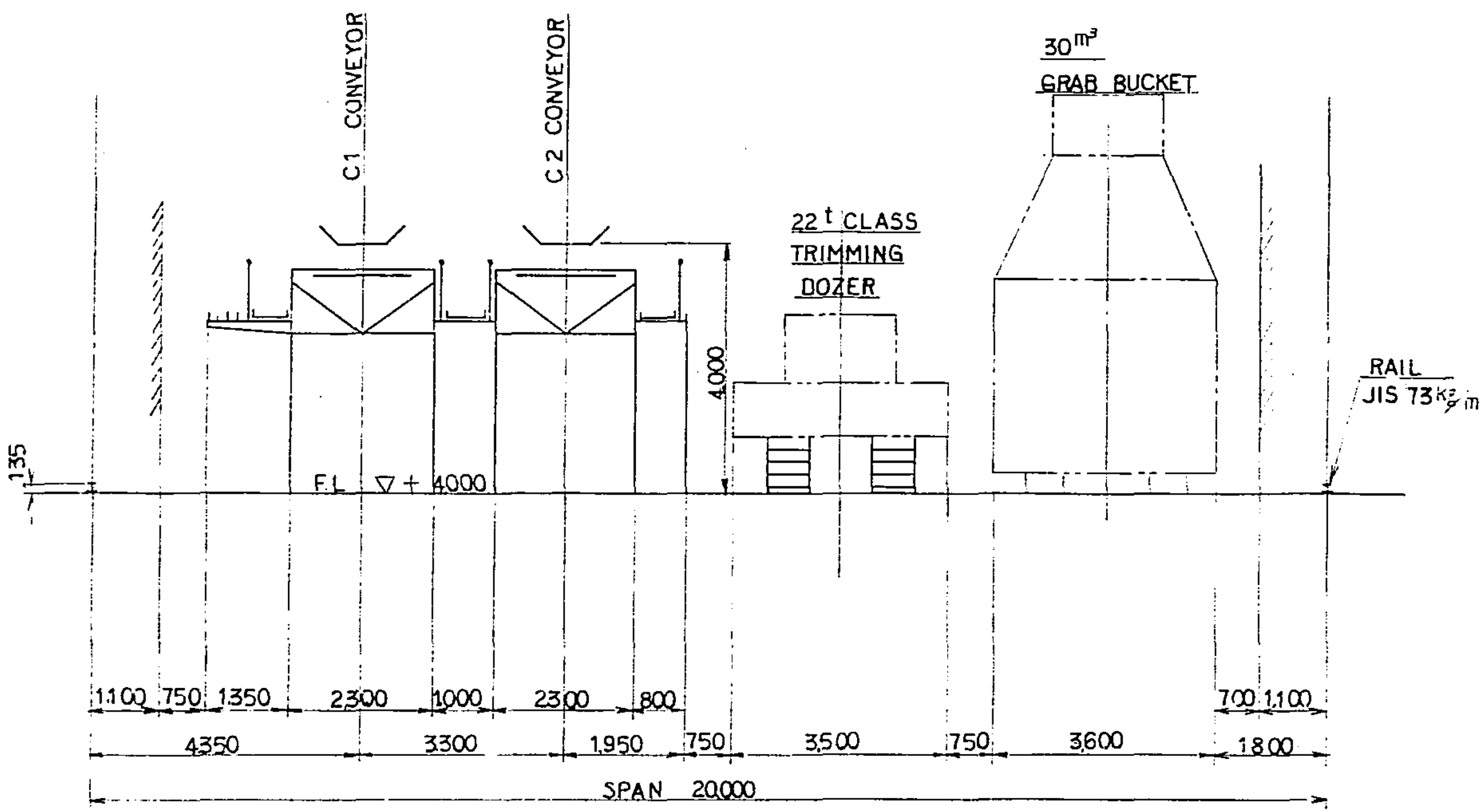
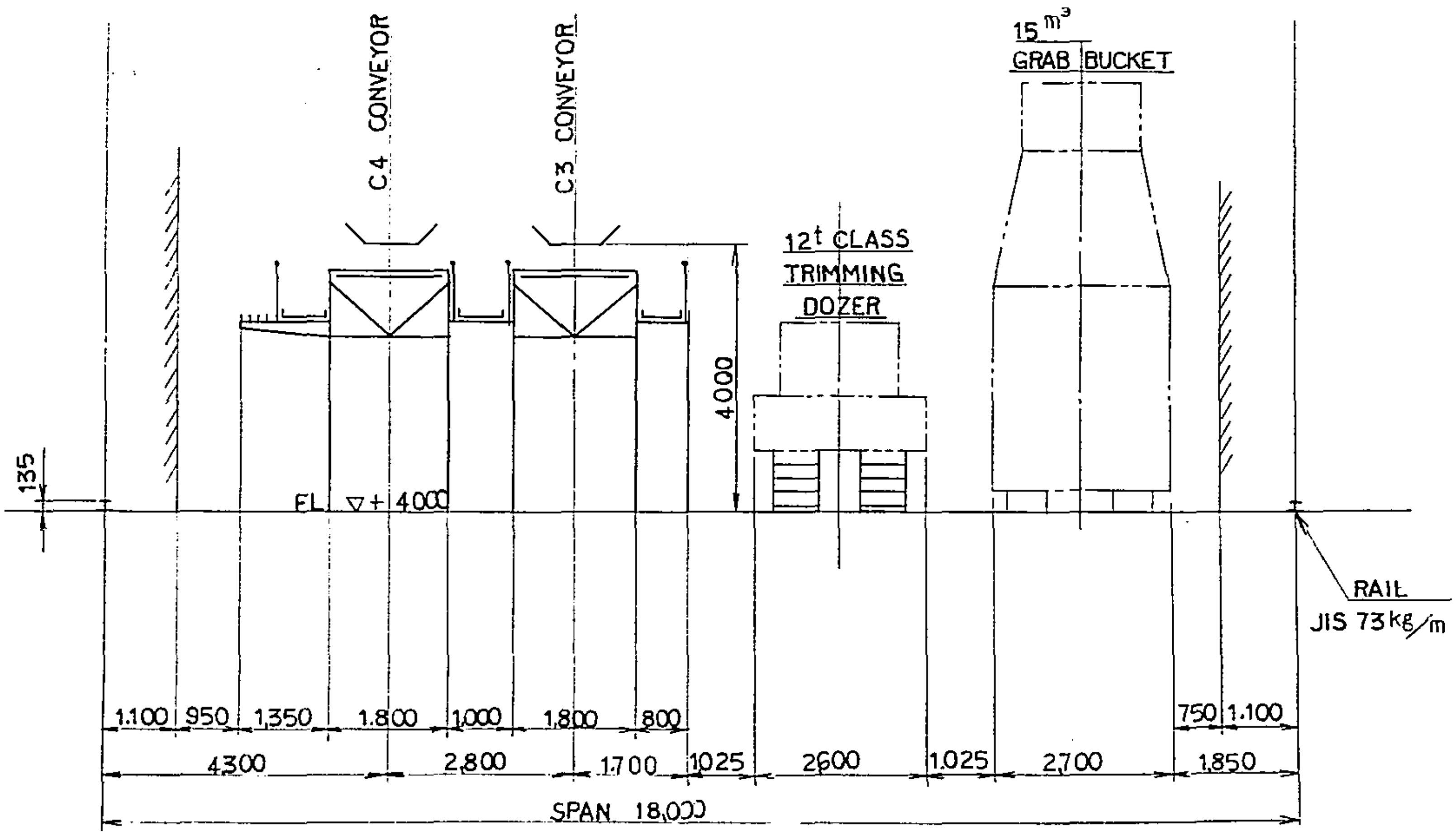


Fig. 6.3.8

SECTIONAL VIEW OF COAL PIER (unit : mm)

1000 T/H COAL U.L



⑥ The suspending meibod of a grab bucket shall be of a dual-rope type for a better operational stability, and the diameter of the pulley and the wire rope system shall be so designed that they can prolong the service life of the rope.

⑦ The upper opening of the hopper shall have a width at least of the width of the bucket opening plus 2 meters (or 1 meter for both sides) for the travelling direction and at least 2.5 times as wide as the bucket width for the travelling direction and at least 2.5 times as wide as the bucket width for the traversing direction.

The hopper shall have an angle of ridgetine not less than 50 deg. so that a smooth flow of various kinds of coal may be assured. In consideration of the function of the electrical feeder employed, the hopper shall have a capacity at least 3 times that of the grab bucket under normal operating conditions and not less than 5 times in emergency.

⑧ The main motions of the unloader shall be operated with DC motors to provide smooth and positive control, and the AC-DC converter provided in the unloader shall be of Motor-Generator type which is easy to maintain and stable in operation.

⑨ The cable reel systems shall be used for both power and signal transmission.

3) Unloading capacity

Since the capacity of an unloader should vary depending upon the size and shape of the vessel for which it is used, the kind of coal to be unloaded, the capacity of the bulldozer used for on-board cargo handling and the level of skill of the operator who operates the unloader, the following theoretical capacity was adopted.

① The cycle pass of the grab bucket from vessel to unloader shall draw a locus starting at a mean water level at the center in the traverse direction of the vessel and terminating at the point 1 meter above the center of the unloader's hopper assuming that the vessel is loaded to full capacity at a mean water level (+0.75 meters) and the average tonnage of vessel 40,000 D.W.T. for the 1,000 t/hr. unloader and 80,000 D.W.T for the 2,000 t/hr. unloader. (Refer to Figs. 6.3.3 and 6.3.5.)

② The cycle time of an unloader represents the total time required for the completion of a both ways of the above cycle pass, from grabbing coal in the hold with the grab bucket to emptying the bucket over the hopper. (Refer to Figs. 6.3.4 and 6.3.6)

The equation for calculating the capacity shall be as follows:

$$Q = \frac{3600}{T} \times V \times \gamma \times \eta$$

where, Q: theoretically calculated capacity (t/hr.)

T: cycle time (sec.)

V: capacity of grab bucket per grabbing (m^3)

γ: bulk density of coal (t/m^3)

η: grabbing efficiency of grab bucket (Though generally cited is 0.8 to 0.9, in this equation η = 1.0 is adopted because the grabbing efficiency is included in the overall efficiency of the unloader 0.5, determined in the stage of equipment planning in the subsection 5-4-2 of this report. (Refer to Table 5.4.4.)

③ In computing the cycle time, the following figures were selected as speeds of motions of the unloader:

	2000 t/hr	1000 t/hr
Hoisting (up/down)	130 m/min	120 m/min
Grabbing (close/open)	130 m/min	120 m/min
Trolley transversing	210 m/min	160 m/min

④ The capacity and cycle time theoretically calculated using the above equation are provided in Figs. 6.3.4 and 6.3.6.

Fig. 6.3.3 CYCLE PASS (unit : mm)

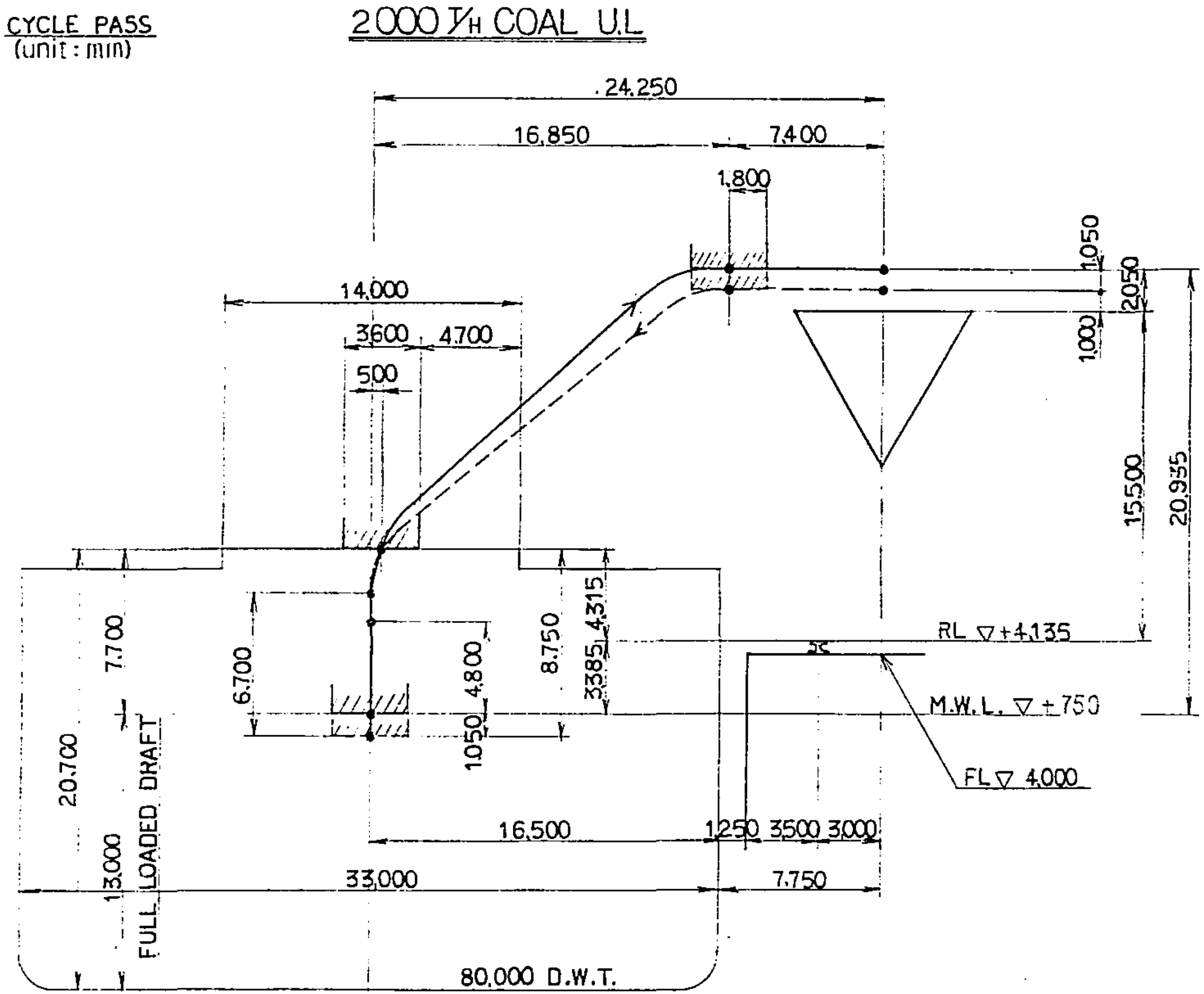


Fig. 6.3.5 CYCLE PASS (unit: mm)

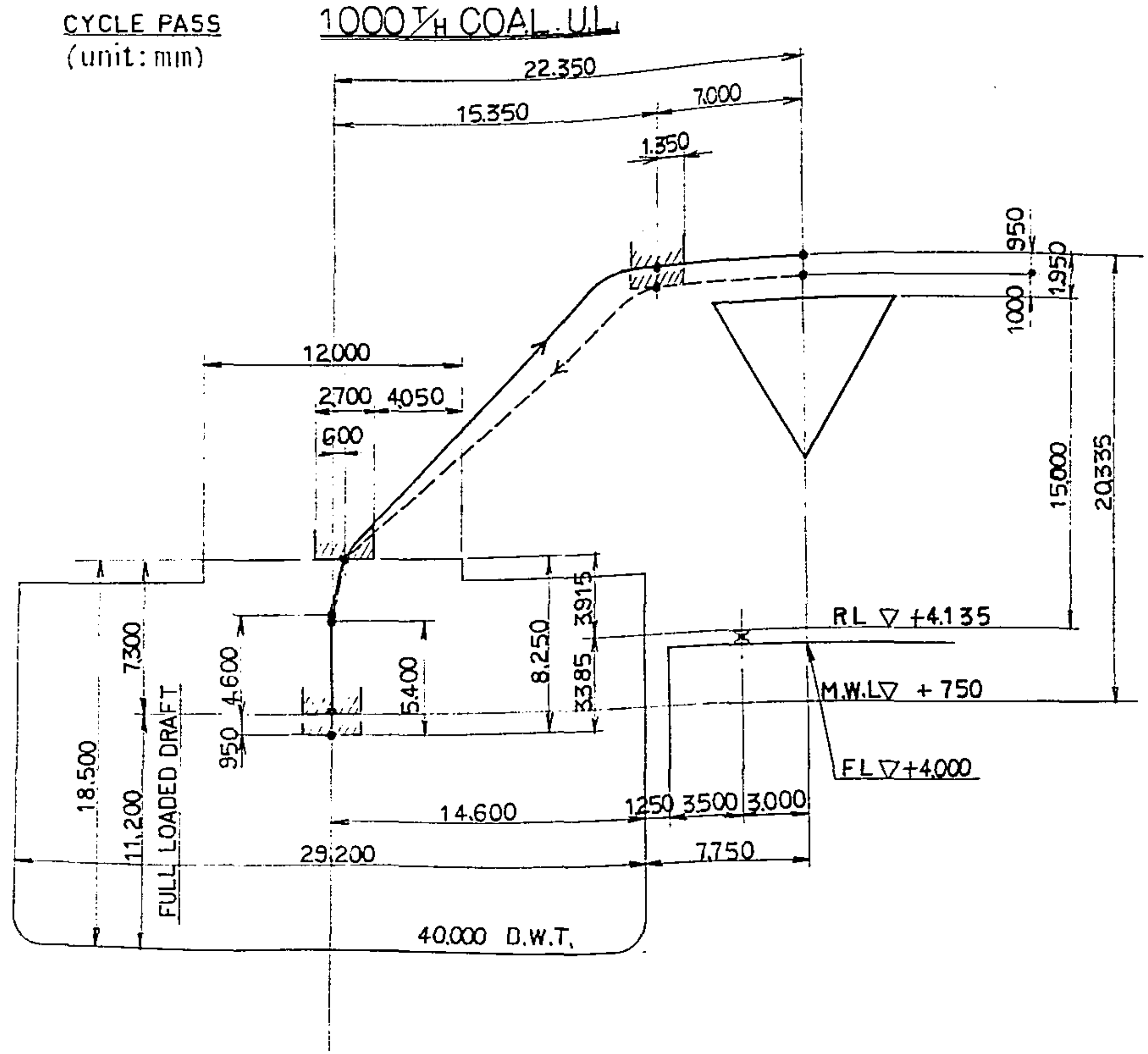
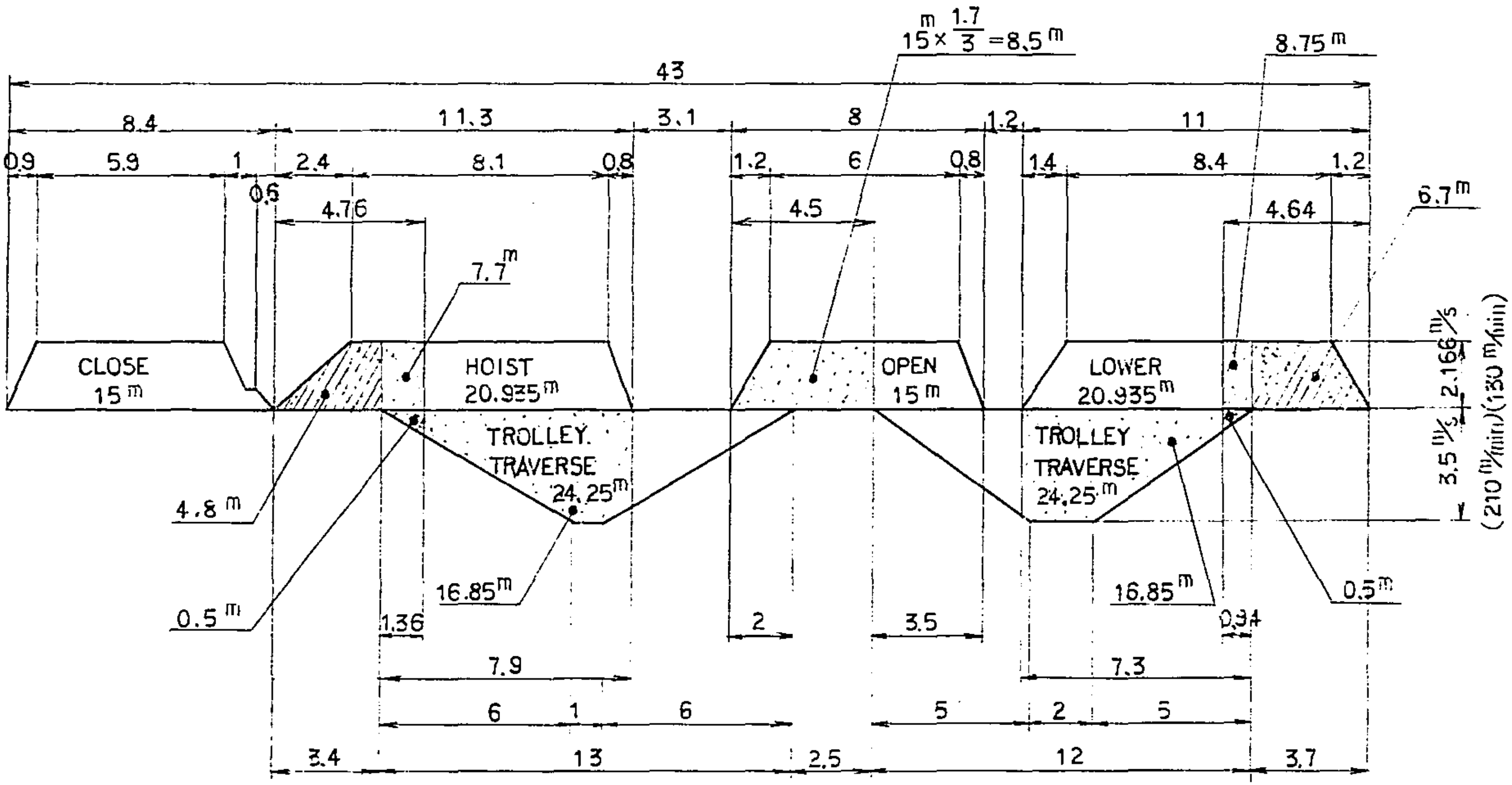


Fig. 6.3.4 CYCLE DIAGRAM (unit: sec)

2000 T/H COAL U.L



MEAN THEORETICAL CALCULATED

UNLOADING CAPACITY (COAL) $24^t \times \frac{3600^s}{43^s} \times 1$ (efficiency) $= 2{,}009$ t/h

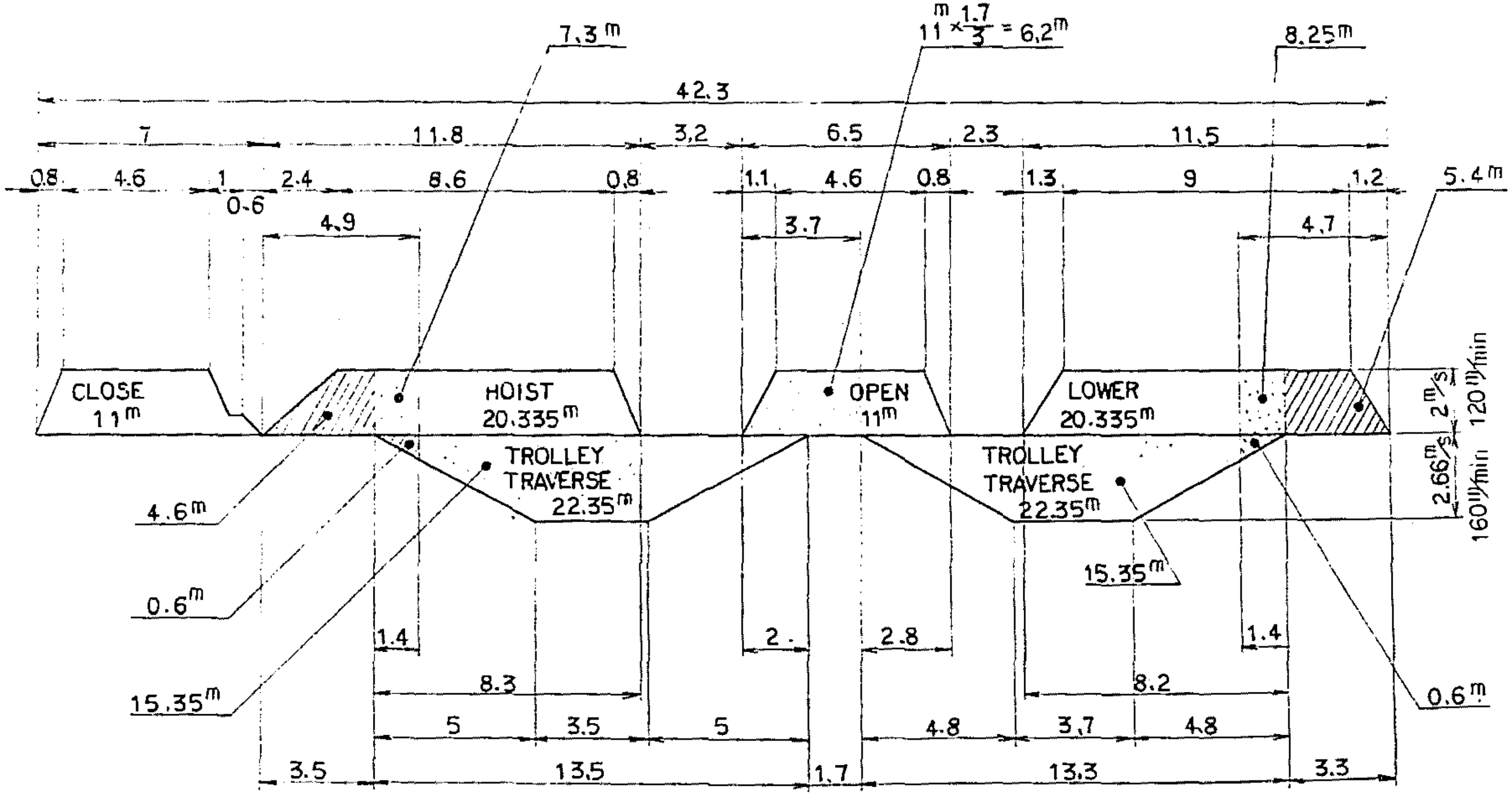
GRAB BUCKET OWN WEIGHT 21^t

GRAB BUCKET VOLUME $24^t / 0.8 = 30^{m^3}$

HOISTING LOAD $24 + 21 = 45^t$

Fig. 6.3.6 CYCLE DIAGRAM
(unit: m)

$1000\ ^{T}/_{H}$ COAL U.L



MEAN THEORETICAL CALCULATED

UNLOADING CAPACITY (COAL) $12^{t} \times \frac{3600^{s}}{42.3^{s}} \times 1$ (efficiency) $= 1021\ ^{t}/_{h}$

GRAB BUCKET VOLUME $12^{t}/0.8 = 15^{m^3}$

GRAB BUCKET OWN WEIGHT 13.5^{t}

HOISTING LOAD $12 + 13.5 = 25.5^{t}$

4) Travelling range

Each unloader shall have a travelling range which allows it to unload coal from all the holds throughout the vessel of the largest class. Similarly, each unloader shall be able to be removed to the berth end in the event of failure to assure an uninterrupted operation of the rest installed on the same berth. (Refer to Figs. 6.3.9 and 6.3.10)

5) Wheel load

The wheel load on the travelling rails on the berth is provided in Figs. 6.3.11 and 6.3.12.

(2) Stackers

1) Basic considerations in planning

There are various types of stackers including a rope-derricking type and a twin-boom type one. In this plan, however, a hydraulic elevation design has been selected from considerations:

① The stacker shall be a light one with a light wheel load so that warping due to ground subsidence may be minimized since the stacker is to be used immediately after the completion of land reclamation of the coal yard.

② The stacker shall be so constructed that it will have no problems in operation and maintenance considering that it will be used in dusty environments.

2) Structural considerations

The stacker thus selected is illustrated in Fig. 6.3.13.

In designing the structure, particular attention was paid to the followings:

Fig. 6.3.9 TRAVELING RANGE ARRAGEMENT

2 000 t/h UNLOADER (unit: mm)

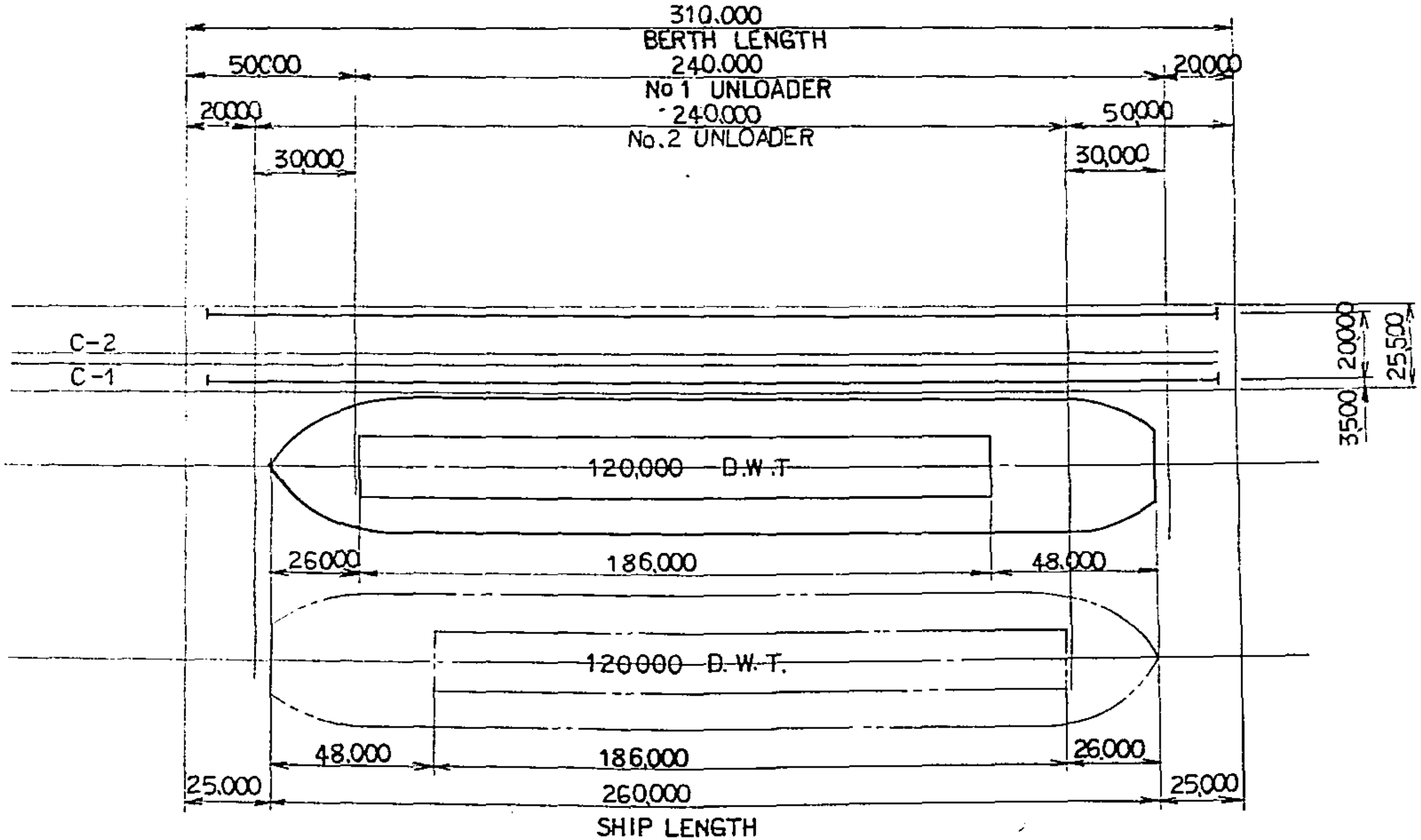


Fig. 6.3.10 TRAVELING RANGE ARRANGEMENT

1000 t/h UNLOADER (unit:mm)

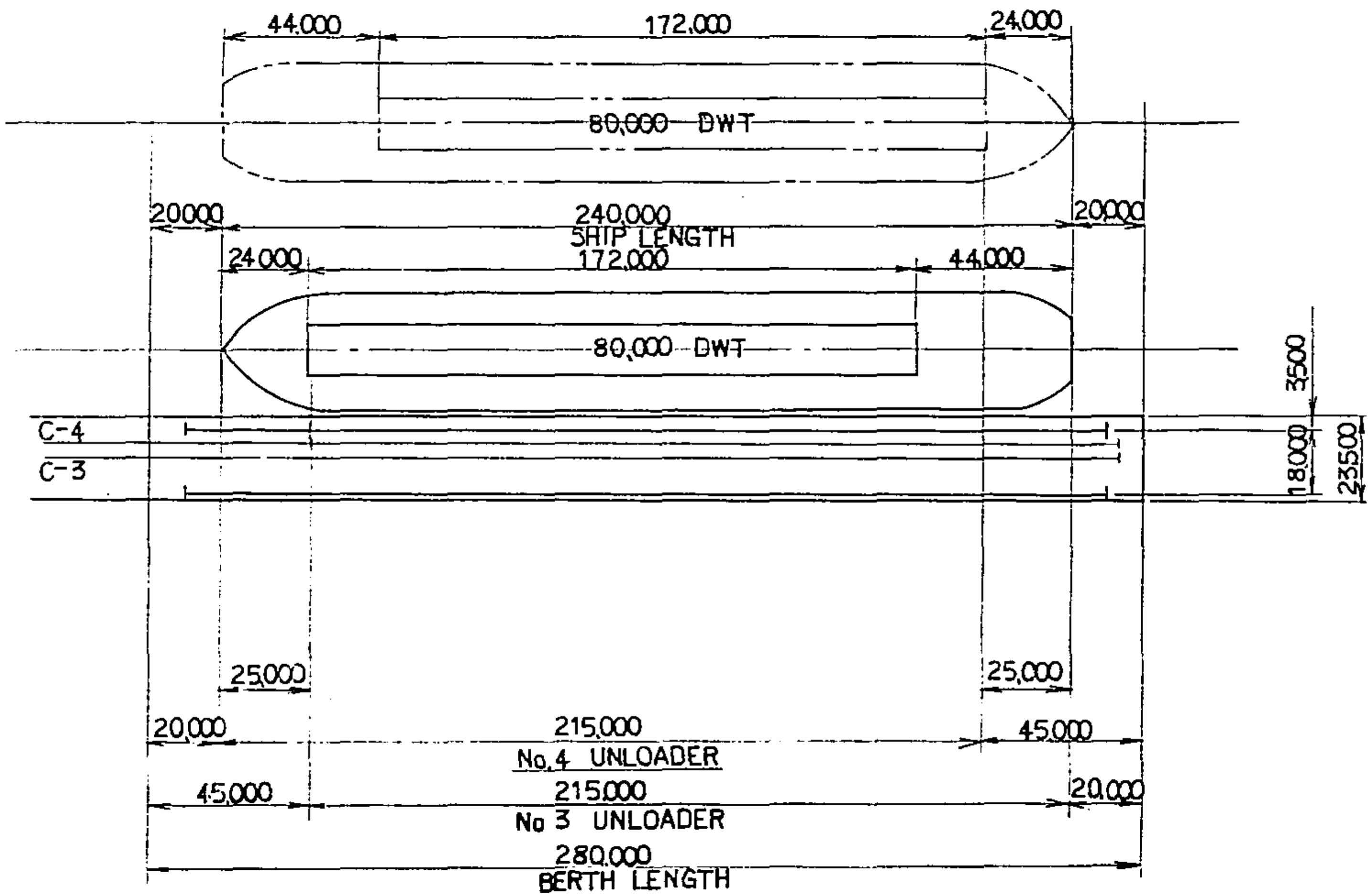
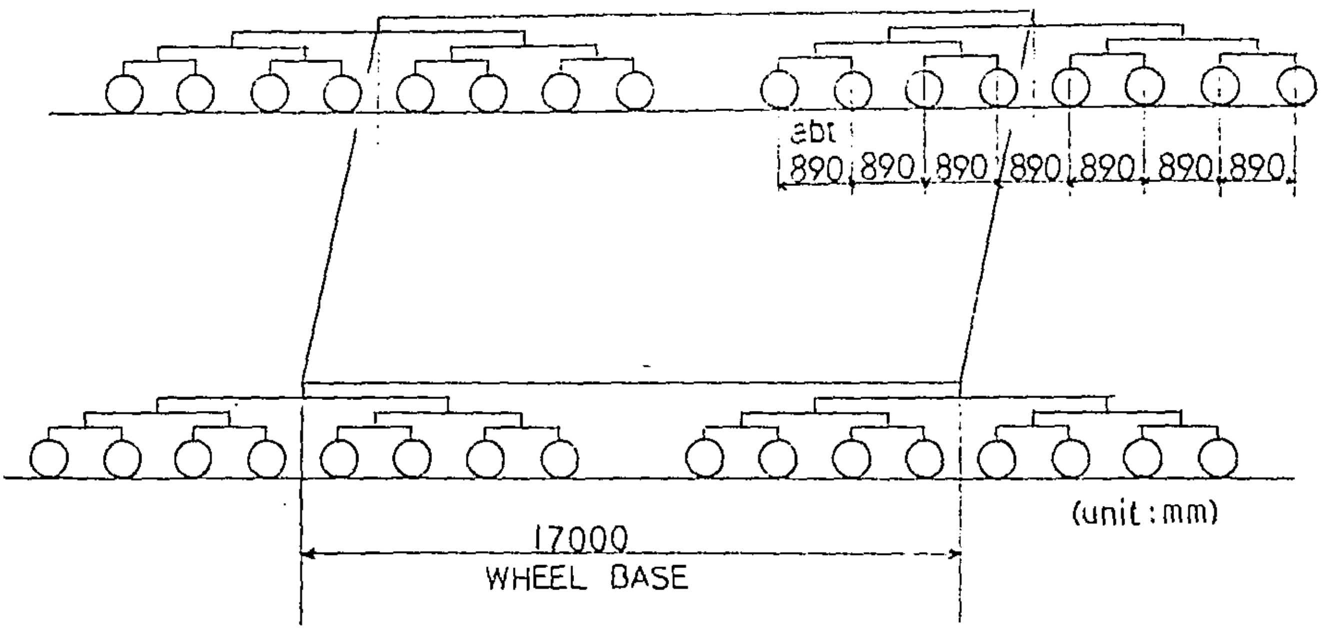


Fig. 6.3.11

TRAVELING WHEEL ARRANGEMENT AND WHEEL LOAD



RAIL SIZE ; JIS 73 kg/m

MAX. WHEEL LOAD (TON/ONE)			
	OPERATING	RESTING	WHEEL/CORNER
LAND SIDE	50	50	8
SEA SIDE	50	50	8

NOTE ; OPERATING CONDITION — WIND VELOCITY 16 m/sec.

HOPPER LOAD ---- 72 ton

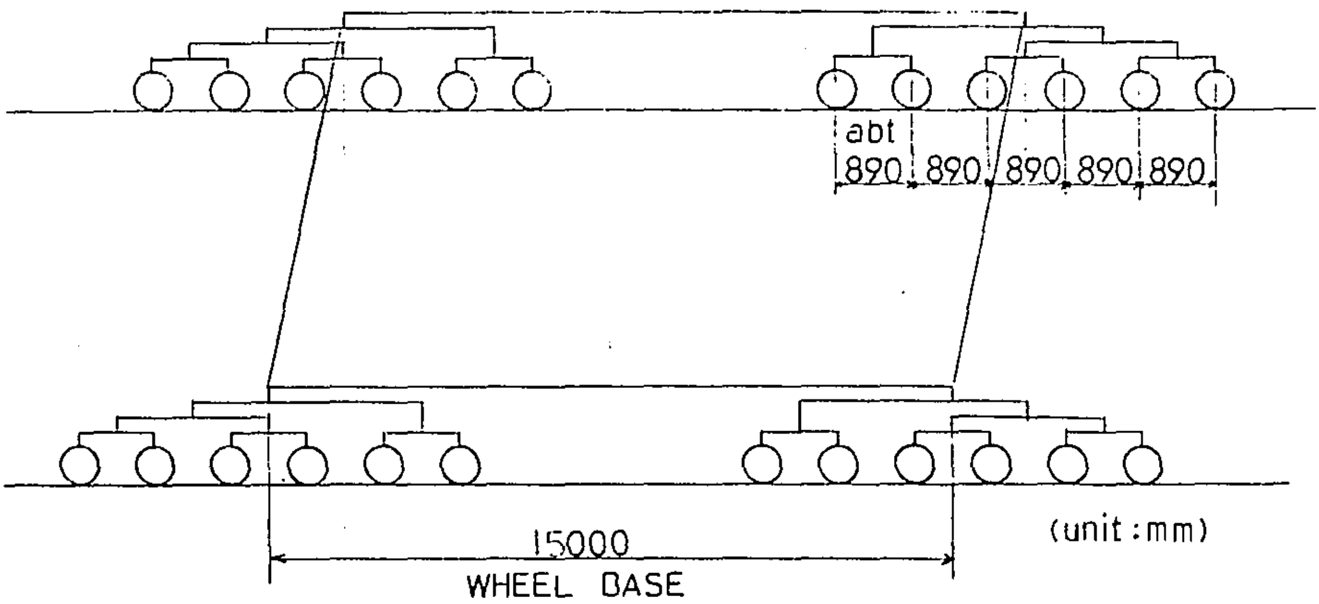
RESTING CONDITION — WIND VELOCITY 35 m/sec.

HOPPER LOAD --- 0 ton

BOOM ---- DERRICK UP

Fig. 6.3.12

TRAVELING WHEEL ARRANGEMENT AND WHEEL LOAD

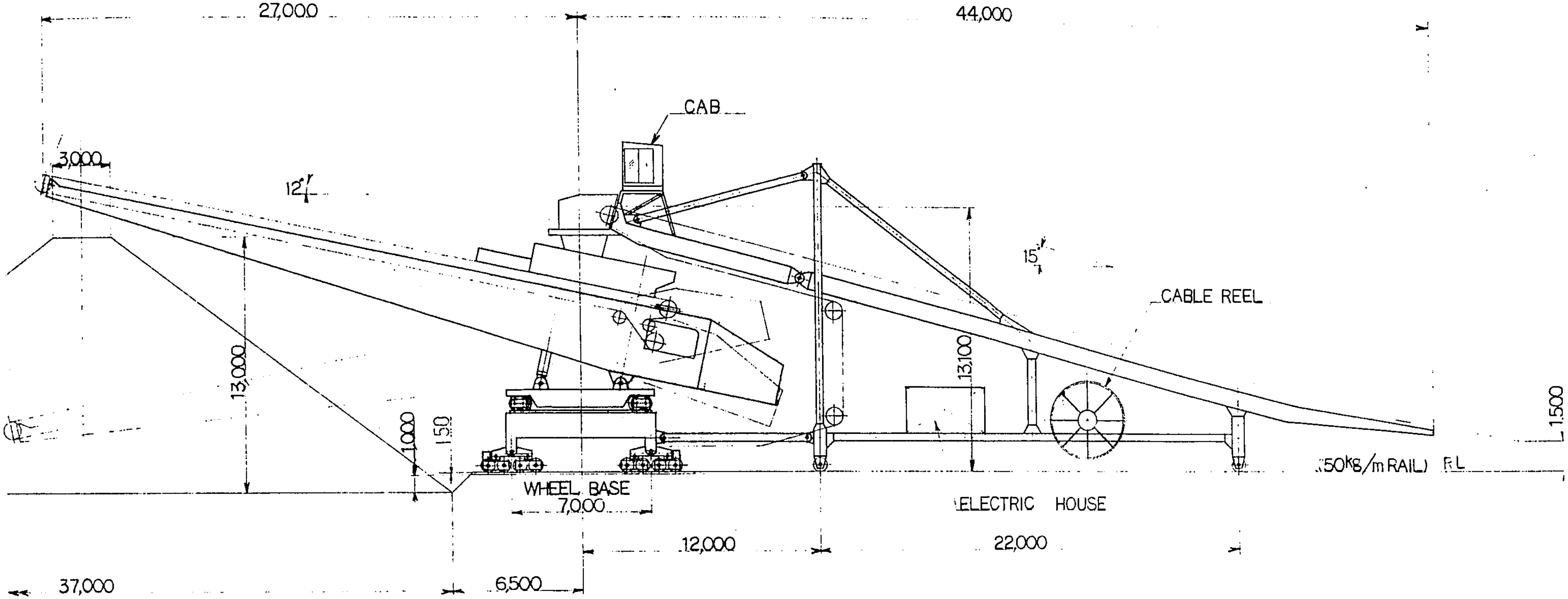


RAIL SIZE ; JIS 73Kg/m

MAX. WHEEL LOAD (TON/ONE)			
	OPERATING	RESTING	WHEELS/CORNER
LAND SIDE	45	50	6
SEA SIDE	45	50	6

NOTE ; OPERATING CONDITION
- WIND VELOCITY 16 m/sec.
- HOPPER LOAD 36 ton

RESTING CONDITION
- WIND VELOCITY 35 m/sec.
- HOPPER LOAD 0 ton
- BOOM --- DERRICK UP



UNIT: mm

2500T/H STACKER	
OCDI	APPROVED BY
	CHECKED BY
THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN	DRAWN BY
	DWG. No. 6.3.13
	DATE / SCALE

① Coal stacking shall be accomplished by making use of the angle of repose of coal and, therefore, the boom shall turn in a radius not to excess. And the slewing range of the boom shall be one enough to stack coal on the yard at both sides of the stacker.

② Coal shall be piled up to 13 meters high on the coal yard, a suitable height determined after giving due considerations to the possible natural ignition of coal and the bearing capacity of the yard, and the boom shall therefore be enough to stack coal up to the height.

③ The travelling device shall be of a 4-corner-drive type and able to travel even when subsidence of ground causes some warp of the travelling rails.

④ The reduction gears of the travelling device, etc. shall all be encased in oil boxes immune to coal dust.

⑤ The tripper conveyor shall be inclined not more than 15 deg. and the boom conveyor not more than 12 deg. so that they can transport coal without any drop-outs.

⑥ The cable reel systems shall be used for both power and signal transmission.

3) Stacking capacity

Basically, the stacking capacity of a stacker is determined by the unloading capacity of an unloader from which the stacker receives coal. Since the unloading capacity varies with the shape and size of the vessel, the grabbing efficiency of the grab bucket, etc. as already stated, it sometimes happens that the unloading capacity exceeds the theoretically calculated capacity of the unloader. With this in mind, the stacking capacity of the stacker has been determined as follows:

① The conveyor which connects the unloader to the stacker shall have a transportation capacity of 2,500 t/hr., a figure approximately 20% larger than the unloading capacity of the unloader (2,000 t/hr.) to be installed in the first stage. The capacity of a stacker must be identical with that of the conveyor.

② Since the tripper's belt of the stacker is a continuous one to the yard stacking conveyor's belt, the stacker capacity, when it stacks coal on the yard while travelling toward the upstream of the yard stacking conveyor, can be computed by the following equation:

$$Q_{max} = Q \left(1 + \frac{Tv}{T}\right)$$

where Qmax : max. stacking capacity in t/hr.
Q : nominal stacking capacity in t/hr.
T : yard stacking conveyor belt speed in m/min
Tv : travelling speed of stacker in m/min

③ The present plan assumes the speed of each motion of the stacker as follows:

Slewing	:	0.2 rpm
Elevation	:	5 m/min (at boom tip)
Travelling	:	30 m/min

④ Using the above equation, the maximum stacking capacity of the proposed stacker can be determined as follows:

$$Q_{max} = 2,500 \left(1 + \frac{30}{160}\right) = 2,969 \text{ t/hr.}$$

4) Travelling range

The stacker shall have a travelling range enough to stack coal to the full length of the coal yard and, at the same time, to enable the stacker to be repaired outside the stacked coal.

5) Wheel load

The travelling wheel arrangement and wheel load on the rails are shown in Fig. 6.3.14.

(3) Reclaimers

1) Basic considerations in planning

A slewing type one with bucket wheels is adopted in this plan with particular considerations to the following:

① The reclaimer shall be, like the stacker, a light one with a light wheel load on the rail so that warping due to subsidence of ground may be minimized.

② The reclaimer shall be so constructed that it will have no problems in operation and maintenance considering that it will be used in dusty environments.

2) Structural considerations

The reclaimer thus selected is indicated in Fig. 6.3.15.

In the structural design, particular considerations were given to the following:

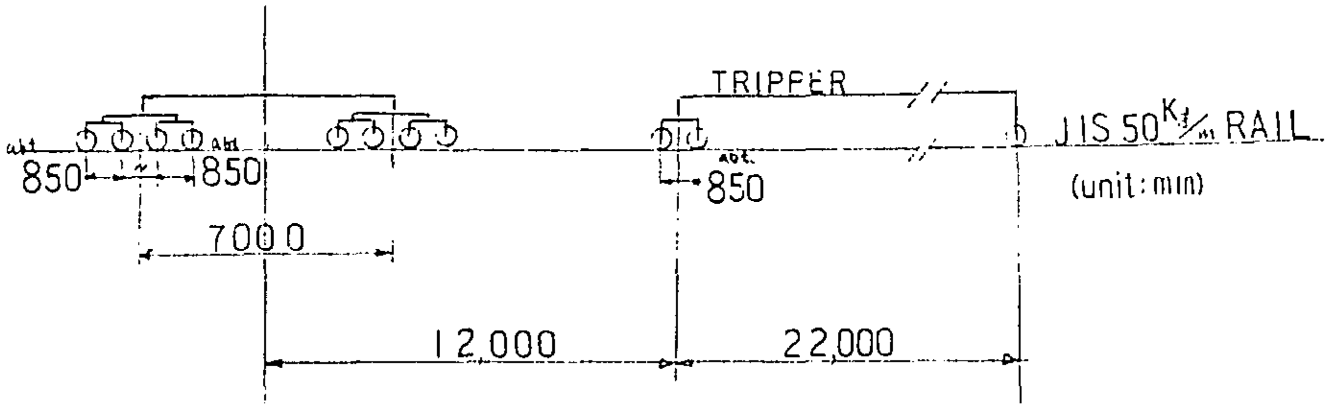
① The boom shall have a slewing radius enough to allow the wheel bucket to take up stacked coal efficiently. At the foot of the pile, a bulldozer or the like shall be used to correct the shape of the coal pile. In addition, the boom shall have a slewing range enough to take up coal from the yard on both sides.

② The boom shall have a height of elevation sufficient to take up coal from the maximum height of the coal pile.

③ The travelling device shall be of a 4-corner-drive type and able to travel even when subsidence of ground causes some warp of the travelling rail.

Fig. 6.3.14

TRAVELING WHEEL ARRANGEMENT AND WHEEL LOAD

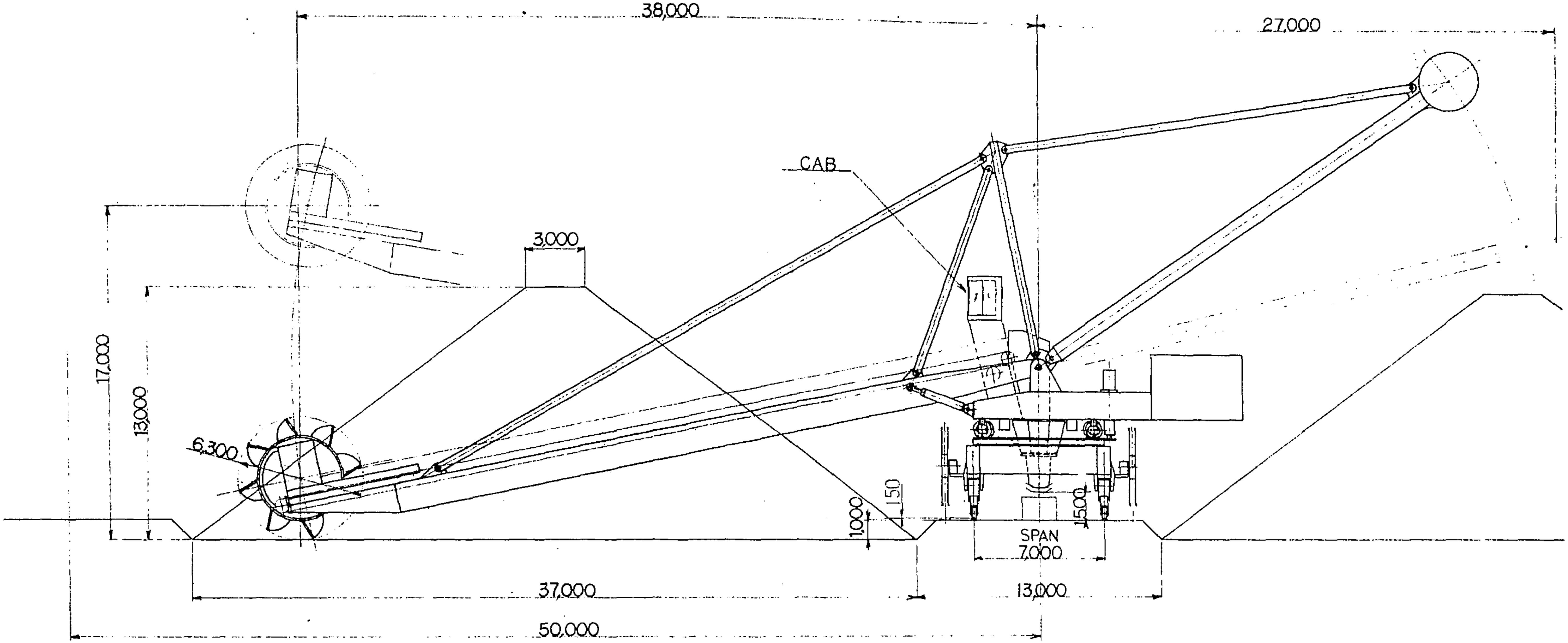


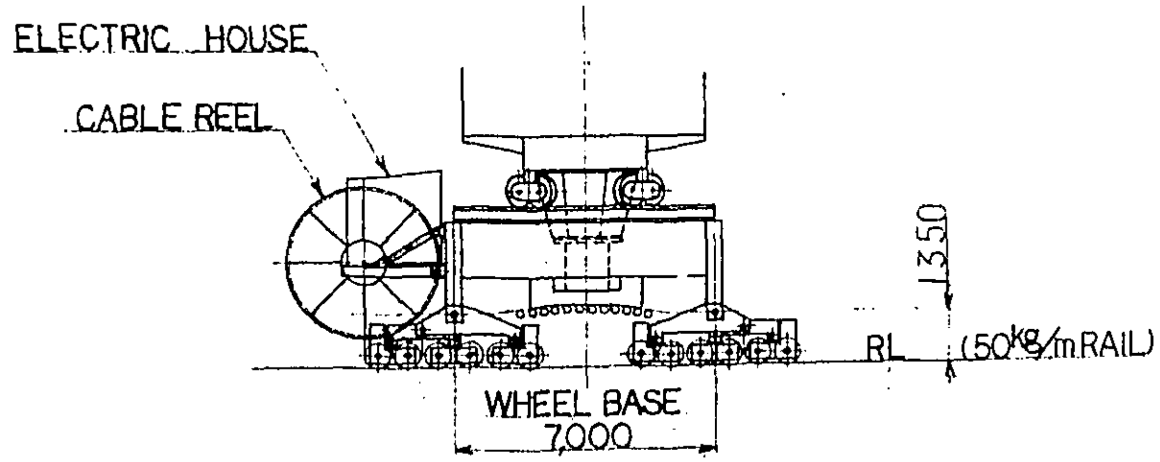
MAX. WHEEL LOAD (TON/ONE)			
	OPERATING	RESTING	WHEELS/CORNER
STACKER'S LEG	25	25	4
TRIPPER'S FRONT LEG	15	15	2
TRIPPER'S REAR LEG	15	15	1

NOTE: WIND VELOCITY

OPERATING CONDITION 16 M/SEC

RESTING CONDITION 35 M/SEC





UNIT: mm

2000T/H RECLAIMER	
OCDI THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN	APPROVED BY CHECKED BY DRAWN BY DWG No. 6.3.15 DATE / SCALE

④ The reduction gears, etc. of the travelling device shall all be encased in oil boxes immune to coal dust.

⑤ The cable reel systems shall be used for both power feed and signal transmission.

3) Reclaiming capacity

The reclaiming capacity should essentially be in compliance with the capacity of the wagon loading silo which will be discussed later. In due consideration of the expected condition of the coal pile, the sort of coal, the level of operator's skill, etc., however, the capacity of the reclaimer has been determined at 2,000 t/hr.

① The theoretical capacity of the reclaimer can be determined using the equation:

$$Q = 60 \times n \times N \times V \times \gamma$$

where, Q: theoretically calculated capacity (t/hr)
n: revolution speed of bucket wheel (rpm)
N: number of buckets attached to a bucket wheel
V: capacity of a bucket (m^3)
γ: bulk density of coal (t/m^3)

② This plan assumes the speed of each motion of the reclaimer as follows:

Slewing : up to 0.2 rpm

Elevation : 5 m/min (at center of bucket wheel)

Travelling : 5/30 m/min (2 variable speeds)

Bucket wheel revolution speed: 7 rpm

③ Using the above equation, the theoretical capacity of the reclaimer can be determined as follows:

$$Q = 60^{min/hr} \times 7^{rpm} \times 8^{pcs} \times 0.75^{m^3/pc} \times 0.8^{t/m^3} = 2{,}016 \text{ t/hr}$$

4) Travelling range

The reclaimer shall have a travelling range enough to reclaim coal over the full length of the coal yard and be able to be repaired outside the stacked coal.

5) Wheel load

The travelling wheel arrangement and wheel load on the travelling rails are shown in Fig. 6.3.16.

(4) Berth conveyors (C-1 ∿ 4)

(Refer to Figs. 6.3.17 and 6.3.19)

1) Basic considerations in planning

The conveyor capacity has been determined at about 20% more than the nominal capacity of the unloader considering the fact that the unloader capacity will vary depending on various factors.

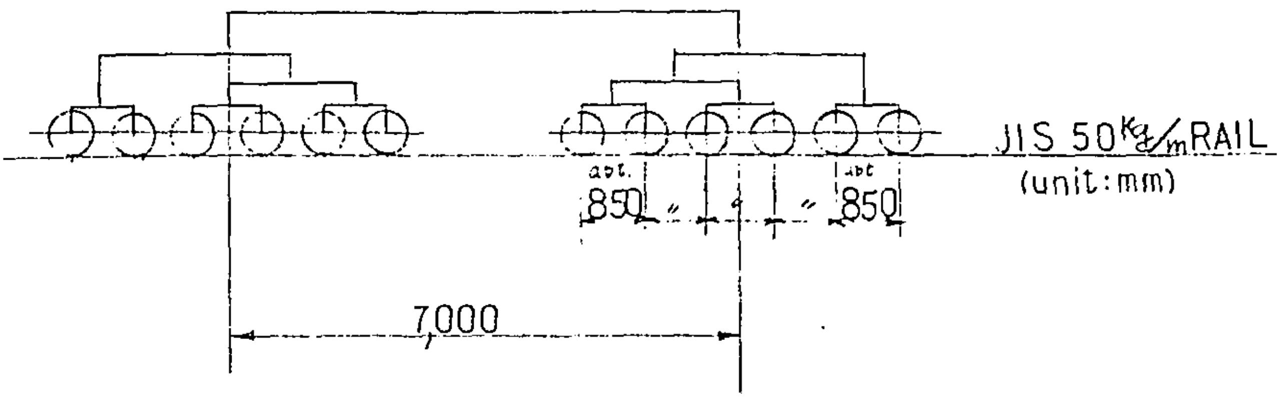
In planning the conveyors, particular considerations were given to the following:

① Unloaded coal will be transferred onto each conveyor at various locations on the same berth according to the travelling position of the unloader. The coal transferring point of each conveyor must therefore be stiff enough to withstand the impact of dropping coal. To this effect, either providing the unloader with some special devices or decreasing the interval at which idlers will be arranged on the conveyor becomes necessary. The latter approach has been adopted in this plan from considerations for easier maintenance and lower capital cost.

② The conveyor shall be installed at a height which will permit easy clean-out of coal spills on the pier.

Fig. 6.3.16

TRAVELLING WHEEL ARRANGEMENT AND WHEEL LOAD

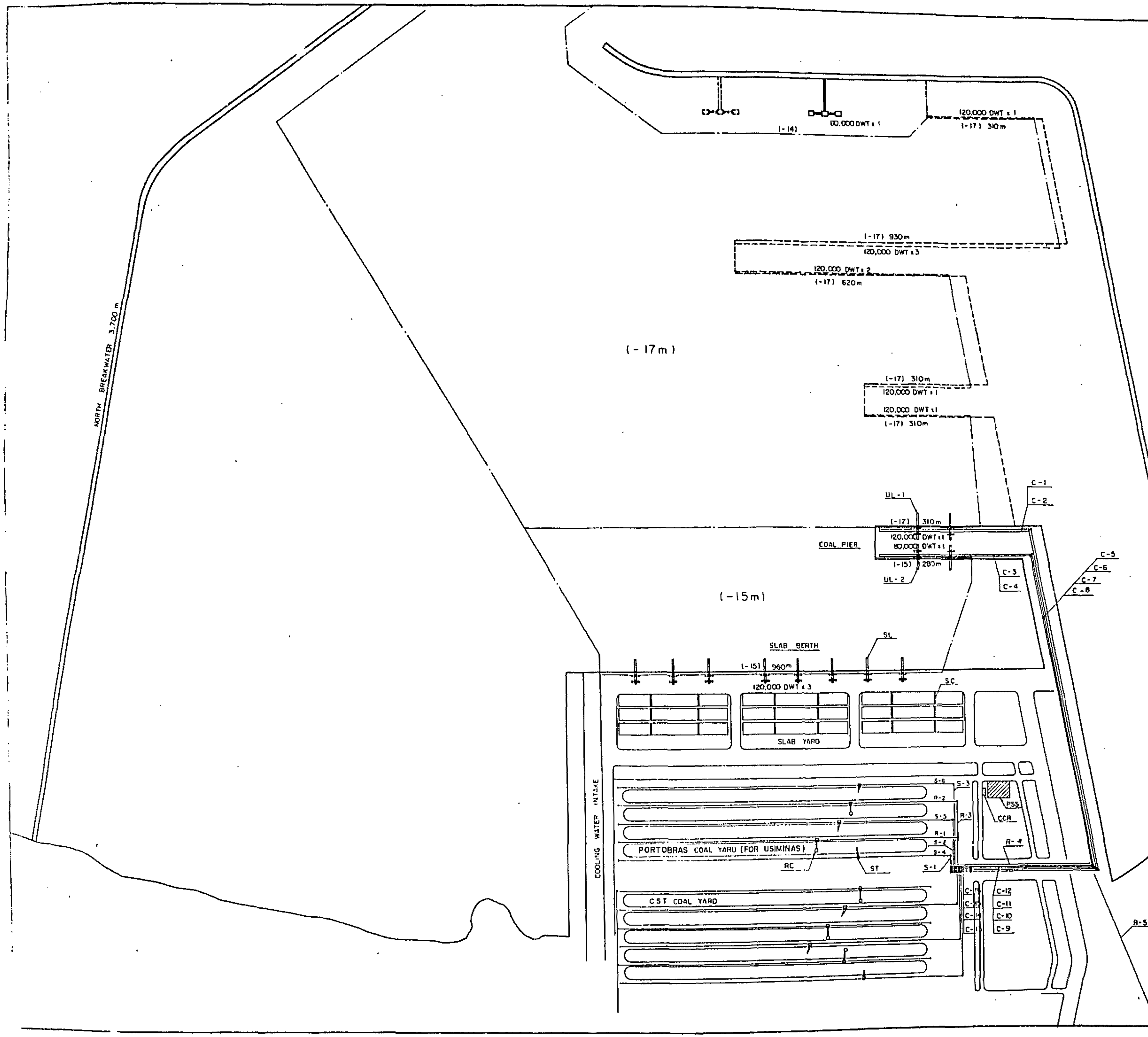


MAX. WHEEL LOAD (TON/ONE)			
	OPERATING	RESTING	WHEELS/CORNER
EACH CORNER	25	25	6

NOTE;WIND VELOCITY

OPERATING CONDITION : 16 M/SEC

RESTING CONDITION ; 35 M/SEC



MARK	PARTICULARS	CONSTRUCTION TIME	Q'TY	REMARKS
UL-1	2,000T/H Unloader	1st Stage	2	
-2	1,000T/H Unloader	2nd Stage	2	
C-1	2,500T/H Berth Conveyor	1st Stage	1	
2	do	do	1	
3	1,200T/H Berth Conveyor	2nd Stage	1	
4	do.	do	1	
5	2,500T/H Ground Conveyor	1st Stage	1	
6	do	do	1	
7	1,200T/H Ground Conveyor	2nd Stage	1	
8	do.	do	1	
9	2,500T/H Ground Conveyor	1st Stage	1	
10	do	do	1	
11	1,200T/H Ground Conveyor	2nd Stage	1	
12	do	do	1	
13	2,500T/H Shifting Conveyor	1st Stage	1	
14	do	do	1	
15	1,200T/H Shifting Conveyor	2nd Stage	1	
16	do	do	1	
ST	2,500T/H Stacker	1st & 2nd Stage	3	1st : 2 sets 2nd : 1 set
S-1	2,500T/H Stacking Conveyor	1st Stage	1	
2	do	do	1	
3	do	2nd Stage	1	
4	do	1st Stage	1	
5	do	do	1	
6	do	2nd Stage	1	
RC	2,000T/H Reclaimer	1st & 2nd Stage	2	1st : 1 set 2nd : 1 set
R-1	2,000T/H Reclaiming Conveyor	1st Stage	1	
2	do	2nd Stage	1	
3	2,000T/H Car Loading Conveyor	1st Stage	1	
4	do	do	1	
5	do.	do.	1	
CLS	Car Loading Silo	do.	1	
SL	35T Slab Loader	1st & 2nd Stage	8	1st : 5 sets 2nd : 3 sets
SC	35T Slab Crane	do	18	1st : 10 sets 2nd : 8 sets
PSS	Power Sub Station	1st Stage	1	
CCR	Center Control Room	do.	1	

THE FIRST AND SECOND STAGES

FUTURE EXPANSION

PROJECT

CONSTRUCTION OF PRAIA MOLE PORT

TITLE

LAYOUT OF CARGO HANDLING FACILITIES

APPROVED BY
APPROVED BY
CHECKED BY
DESIGNED BY
DRAWN BY

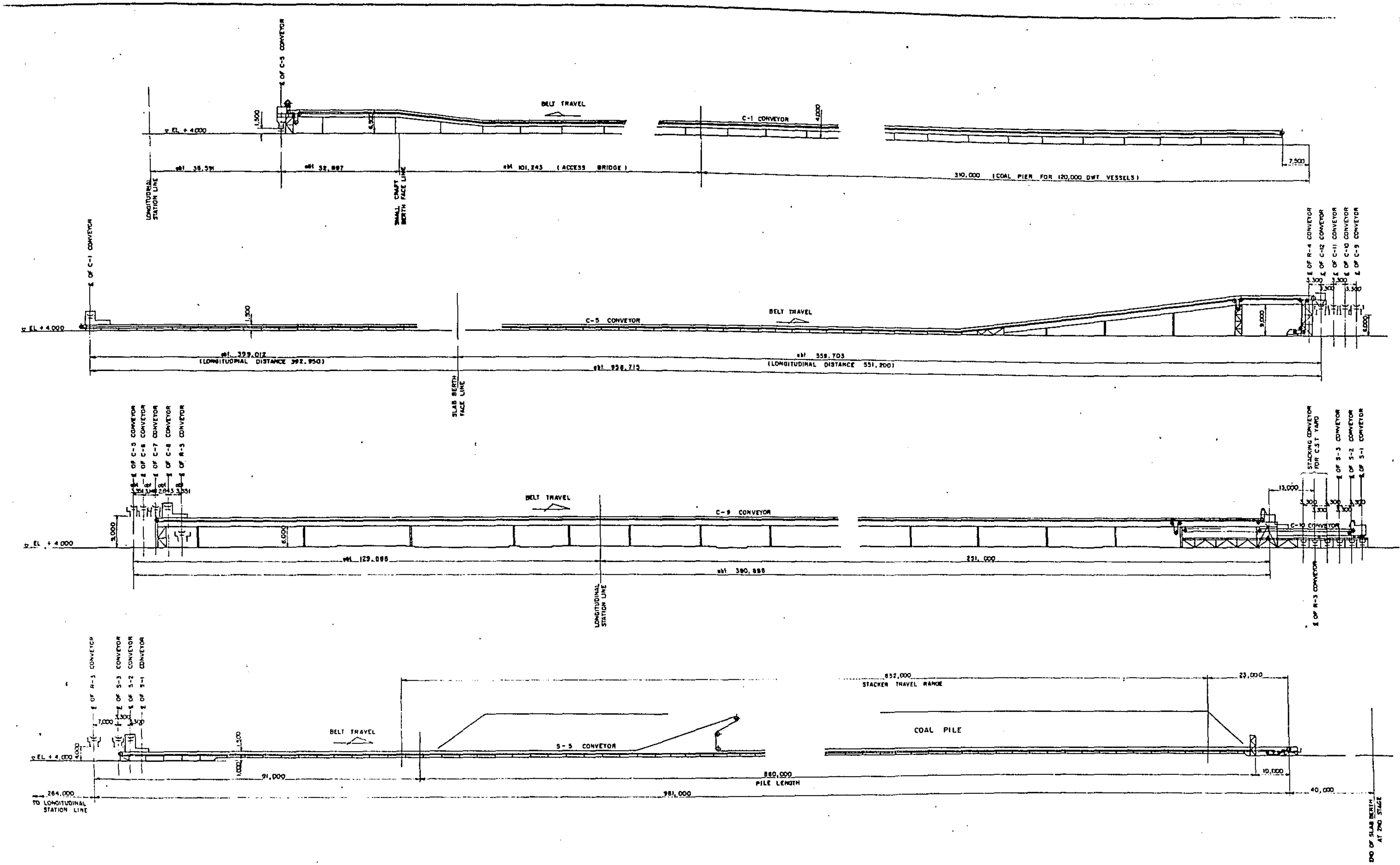
O C D I

THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN

DRAWING NO. 6.3.17

DATE

SCALE 1 : 5,000



UNIT: mm

REFERENCE DRAWING

LAYOUT OF CARGO HANDLING FACILITIES PM-M001-R1

PROJECT	CONSTRUCTION OF PRAIR MOLE PORT
TITLE	BELT CONVEYORS
APPROVED BY / APPROVED BY / CHECKED BY / DESIGNED BY / DRAWN BY	O C D I — THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN
DRAWING NO	6.3.19
DATE	
SCALE	1:500

③ Near the root of the coal pier, a iron detector shall be installed to separate metallic contaminants from coal, together with an instantaneous amount counter to weight unloaded coal.

④ The height of installation of belt conveyors shall be raised near the root of the coal pier so that truck cranes or tractors can make easy access to and from coal berths which will be built on the eastern side of the pier in the future.

⑤ Cable trays shall be provided to the unloaders for both power supply and signal transmission.

⑥ Belts, idlers, motors, fluid couplings and other components of the belt conveyors shall desirably be made to specifications similar to those for the corresponding parts of the other belt conveyors for easier maintenance.

2) Conveyor specifications

Specifications for conveyor belts and belt speeds are provided in Table 6.3.2. The belt speeds were carefully designed because and excess in the speed would result in scattering of coal.

(5) Ground conveyors (C-5 ∿ 16)

(Refer to Figs. 6.3.17 and 6.3.19.)

1) Basic considerations in planning

Ground conveyors are divided into two groups. One is the conveyors for transporting coal from the coal pier to the yard entrance, and the other is the switching conveyors installed at the yard entrance for transferring coal either to the yard for USIMINAS coal or the yard for CST.

In planning, a special attention was paid to the following points.

① Although it would be more favorable, in terms of equipment cost and maintenance, to install conveyors at the lowest possible height

Table 6.3.2 Conveyor specifications

ITEM	MARK	MATERIAL TO BE HANDLED	QUANTITY (T/H)	BELT WIDTH (MM)	BELT SPEED (M/MIN.)	STEEL CORD BELT	
						CALCULATION	ADJUSTMENT
1	C- 1	Coal	2,500	1,800	160	ST- 500	
2	2	do.	2,500	1,800	160	do.	
3	3	do.	1,200	1,400	130	do.	ST- 500
4	4	do.	1,200	1,400	130	do.	
5	5	do.	2,500	1,800	160	ST-1200	
6	6	do.	2,500	1,800	160	do.	ST-1200
7	7	do.	1,200	1,400	130	ST-1000	
8	8	do.	1,200	1,400	130	do.	
9	9	do.	2,500	1,800	160	ST- 400	
10	10	do.	2,500	1,800	160	do.	
11	11	do.	1,200	1,400	130	do.	
12	12	do.	1,200	1,400	130	do.	
13	13	do.	2,500	1,800	160	-	
14	14	do.	2,500	1,800	160	-	ST- 500
15	15	do.	1,200	1,400	130	-	
16	16	do.	1,200	1,400	130	-	
17	S- 1	do.	2,500	1,800	160	-	
18	2	do.	2,500	1,800	160	ST- 300	
19	3	do.	2,500	1,800	160	ST- 400	
20	4	do.	2,500	1,800	160	ST-1200	
21	5	do.	2,500	1,800	160	do.	
22	6	do.	2,500	1,800	160	do.	ST-1200
23	R- 1	do.	2,000	1,800	130	do.	
24	2	do.	2,000	1,800	130	do.	
25	3	do.	2,000	1,800	130	ST- 300	ST- 500
26	4	do.	2,000	1,800	130	ST- 500	
27	5	do.	2,000	1,800	130	ST-1400	ST-1400

above the ground level, clearance for traffic flow underneath should be taken into consideration for those crossing roads in the port (C-9 ∿ 12). Of the alternatives of the underground system and the elevated system, the elevated system was selected in this plan for those conveyors crossing roads from structural and price considerations. Accordingly, the height of C-5 ∿ 8 conveyors will have to be increased at the shore-side end to connect them with C-9 ∿ 12 conveyors.

② Taking into account ground subsidence in the reclaimed site, conveyor girders shall be of pin joint construction, instead of continuous beam construction, to allow beams to be jointed at each span.

③ In view of the fact that these conveyors are installed on a reclaimed land projecting into the sea and at a certain elevation, they shall be equipped with windbreak covers to prevent coal on the belt from being scattered in the wind.

④ The switching conveyors at the coal yard entrance shall be of such a construction that can positively operate and properly transfer coal.

⑤ Consideration shall be given so that specifications of the belt, idlers, motors, fluid couplings, etc. of a conveyor are in common with those of other conveyors in the interest of easy maintenance.

2) Specifications

Specifications of conveyor belts and belt speeds, etc. are as shown in Table 6.3.2.

(6) Yard stacking conveyors (S-1 ∿ 6)

(Refer to Figs. 6.3.17 and 6.3.19.)

1) Basic considerations in planning

Yard stacking conveyors consists of two parts. One is S-4 ∿ 6 conveyors installed in parallel with the yard and connected with the stacker's tripper, and the other is S-1 ∿ 3 conveyors installed at right angles to the yard for transporting coal to the former conveyors.

In planning, a special attention was paid to the following points.

① Among S-1 ∿ 3 conveyors which are installed at right angles to the yard, S-2 and S-3 shall be installed at a higher level for easy access of mobile cranes to the yard in repair and other occasions. Conveyor girders at the elevated sections shall be of pin joint construction, taking into consideration ground subsidence.

② S-4 ∿ 6 conveyors installed in parallel with the yard shall be set up on a foundation 1 meter higher than the yard in parallel with the stacker rails. By raising the foundation level by 1 meter, coal stacked on the yard can be prevented from falling down.

③ S-4 ∿ 6 conveyors shall have a sufficient length to allow the stacker tripper to travel without hindrance to the repair site provided on the upstream of the conveyor when the stacker needs repairs.

④ S-4 ∿ 6 conveyor belts are also used as stacker's tripper belts.

⑤ Consideration shall be given so that specifications of the belt, idlers, motors, fluid couplings, etc. of a conveyor are in common with those of other conveyors.

2) Specifications

Specifications of conveyor belts and belt speeds, etc. are as shown in Table 6.3.2.

(7) Yard reclaiming conveyors (R-1, R-2)

(Refer to Figs. 6.3.17 and 6.3.18)

1) Basic considerations in planning

Yard reclaiming conveyors installed in parallle with the yard are used for transferring coal collected with the reclaimer to the R-3 conveyor connected with the wagon loading silo.

In planning these conveyors, a special attention was paid to the following points.

① Since these conveyors are for transferring coal to the R-3 conveyor installed at right angles to the yard, they have to cross over S-2 and S-3 conveyors at right angles. It is necessary, therefore, to install these conveyors at a high level to pass over the S-2 and S-3 conveyors at the downstream portions of the R-1 and R-2 conveyors.

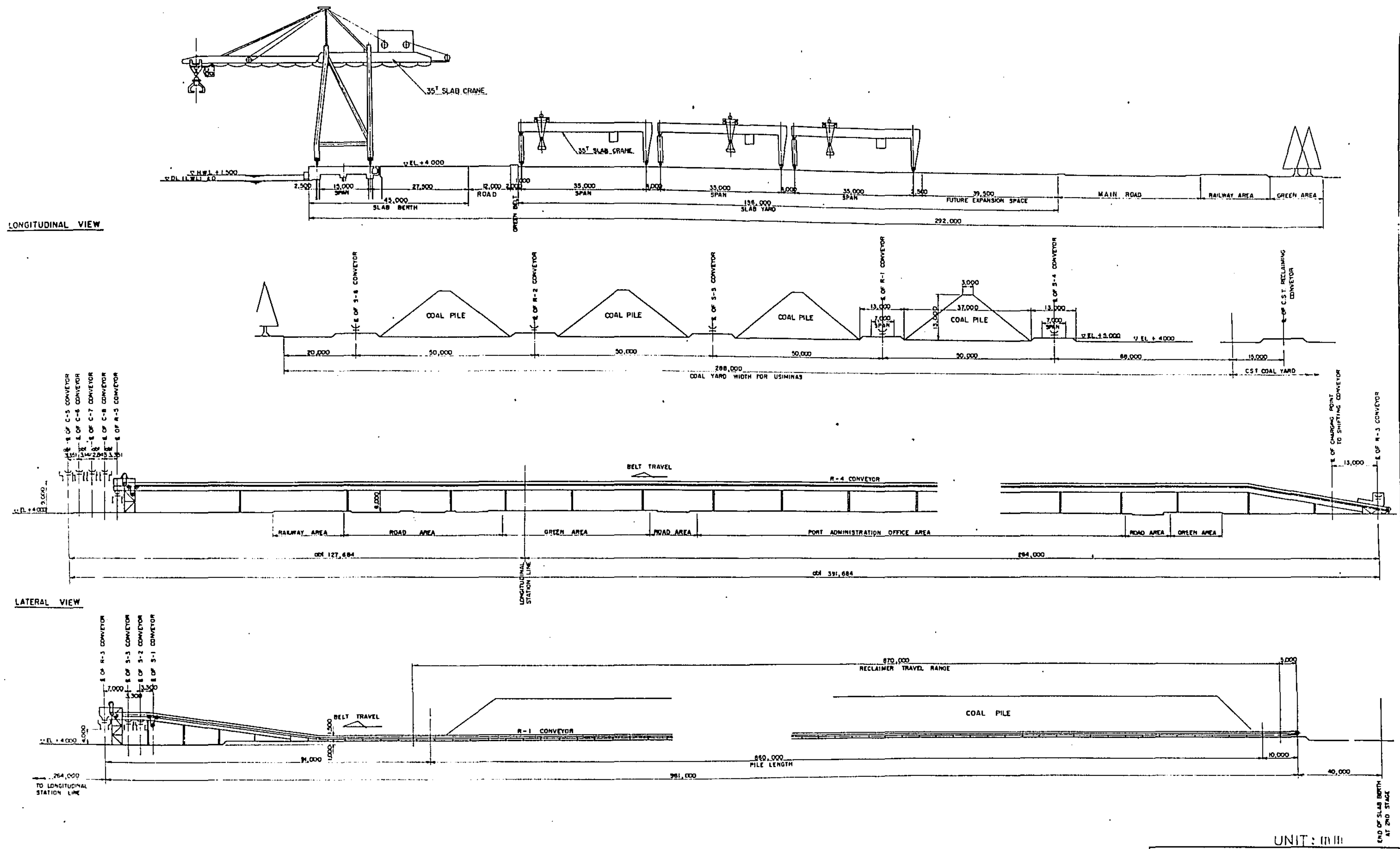
② The height and slope of R-1 and R-2 conveyors at their downstream portions shall be designed so that the reclaimer can travel without any hindrance to the repair site provided on the downstream side of R-1 and R-2 conveyors for repairs.

③ Girders of elevated conveyors shall be of pin joint construction, taking into consideration ground subsidence.

④ Consideration shall be given so that specifications of the belt, idlers, motors, fluid couplings, etc. are in common with those of other conveyors in the interest of easy maintenance.

2) Specifications

Specifications of conveyor belts and belt speeds are as shown in Table 6.3.2.



REFERENCE DRAWING

LAYOUT OF CARGO HANDLING FACILITIES PM-MODI-RI

PROJECT	CONSTRUCTION OF PRAIR MOLE PORT
TITLE	SECTIONAL VIEW OF PORT AREA
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DRAWING NO	6.3.18
DATE	
SCALE	1 : 500

(8) Conveyors connected to the wagon loading silo (R-3 $\sim$ 5)

(Refer to Figs. 6.3.17 and 6.3.18)

1) Basic considerations in planning

These conveyors are composed of two portions; the R-3 conveyor installed at right angles to the yard for receiving coal from the R-1 and R-2 conveyors, and the R-4 and R-5 conveyors for transporting coal received from R-3 conveyor to the wagon loading silo installed in the CVRD site.

In planning these conveyors, a special attention was paid to the following points.

① R-3 conveyor installed at right angles to the yard shall be set up at a sufficient height for easy access of mobile cranes to the yard in repairs.

② R-4 conveyor shall be elevated above roads in the port area so that the roads are left free for traffic.

③ R-5 conveyor is for connecting to the wagon loading silo installed in the CVRD site. Because there ia s considerable height difference between the ground level of the port area and the CVRD site, consideration shall be given so that the slope of the conveyor is less than 15 degrees.

④ An instantaneous amount counter is installed on R-4 conveyor for weighing the coal delivered from the yard.

⑤ Being installed at a high level, R-4 and R-5 conveyors shall be equipped with windbreak covers to prevent the coal on the belt from being scattered in the wind.

⑥ Girders of elevated conveyors shall be of pin joint construction, taking into consideration ground subsidence.

⑦ Consideration shall be given so that specifications of the belt, idlers, motors, fluid couplings, etc. are in common with those of other conveyors in the interest of easy maintenance.

2) Specifications

Specifications of conveyor belts and belt speeds are as shown in Table 6.3.2.

(9) Car loading silo

This silo is used for loading coal on wagons when the coal is transported by rail to USIMINAS, and consists of scale hoppers, coal storage bins, conveyors, etc. (Refer to Fig. 6.3.20.) As five wagons are simultaneously moved to the underside of the silo, coal is discharged on to wagons from two hopper chutes for each wagon.

In planning, a special attention was paid to the following points.

① Coal shall be quickly loaded in equal amounts and in a balanced state on to each of the coupled wagons.

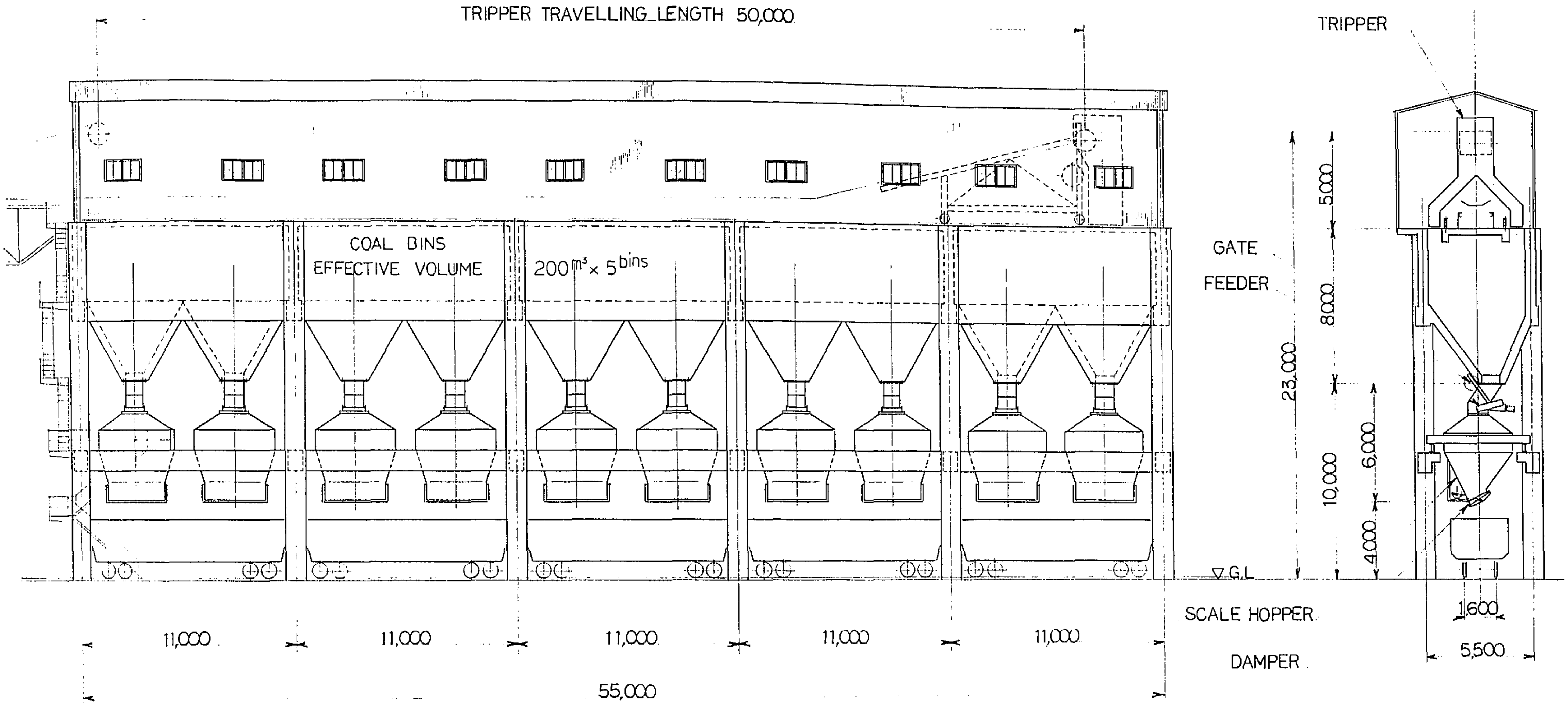
② The coal storage bins shall have a sufficient capacity so as to continuously load coal on to wagons, taking into consideration the function of the electrical feeders.

(10) Other equipment

In order to prevent coal dust from being scattered in the wind, it is desirable to install the following pollution control equipment.

1) Water sprinkler equipment for unloader

When coal is discharged to the unloader's hopper with a grab bucket, coal dust is scattered in the air. As one of measures to prevent this, a water sprinkler is installed around the unloader's hopper.



UNIT: mm

WAGON LOADING SILO	
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2) Water sprinkler equipment for coal yard

Coal stacked in the yard is also scattered in the wind. To prevent this, a water piping is laid along the overall length of the yard with sprinklers installed at appropriate intervals. This water piping is also used for fire fighting.

6-3-3 Slab handling equipment

(1) Slab loaders

1) Basic considerations in planning

Among various types of cranes for loading slabs on a ship, such as a bridge type crane and a double link crane, a semi-rope trolley type bridge crane was selected from the viewpoints of economy and operation.

In planning, a special attention was paid to the following points.

① Slab handling methods shall be designed with due regard to working efficiency and safety.

② The sway of lifted slabs during transportation to a ship by means of the trolley shall be minimized.

③ Consideration shall be given to the trim of the ship during loading, and the parallelism of slabs with respect to the travelling direction of slab loader when the trailer arrives under the slab loader.

④ The slab loader shall be capable of easily handling various shapes of slabs.

⑤ When a ship is berthed with its light draught, the slab loader shall be capable of travelling without interference with the bridge of the ship.

2) Structural considerations

The slab loader selected is as shown in Fig. 6.3.21.

A special attention was paid to the following structural considerations.

① The outreach on the front leg side shall be such that the slab lifting device can easily reach the hatch end even when loading slabs on a 120,000 DWT class ship.

② The span of the crane rails shall be designed with due regard to the stability of slab loader, the wheel load on rails and the economy of slab berth.

③ The land-side reach shall be up to the position where two trailers can be parked side by side behind the land-side leg of the slab loader.

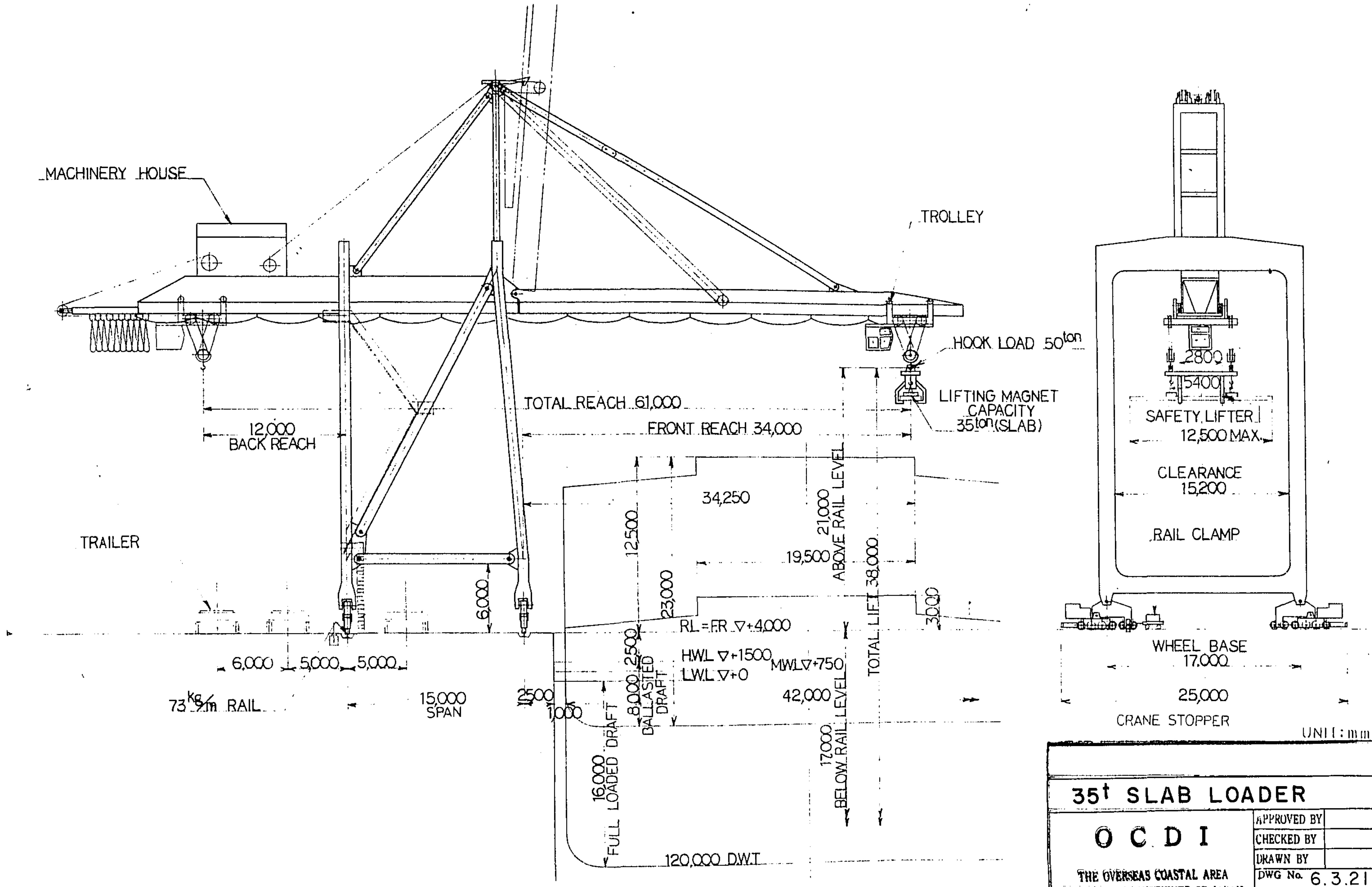
④ The hweel base shall be such that slabs up to 12.5 m long can easily pass between the legs of the slab loader.

⑤ The lift shall be capable of placing on-board handling equipment into ship's hold even when a ship of largest size is berthed with its light water draught.

⑥ The slab lifting device shall be of lifting magnet type with a special grab.

⑦ A stop position setting switch shall be provided so that the trolley can easily stop at the fixed points on land side during its traversing operations. In addition, white lines is desirable to be marked on the ground so that a tractor/trailer can stop in parallel with the travelling direction of the slab loader.)

⑧ Electrical control for major motions of the slab loader shall be of DC power type to ensure smooth and positive operation. The AC/DC converter to be equipped in the slab loader shall be of Motor-Generator type because of easy maintenance and stable operation.



UNIT : mm

35t SLAB LOADER	
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	DATE / SCALE

3) Loading capacity

Although the rated lifting capacity of the slab loader is 35 t, the loading capacity of 400 t/hr has been designed under the following conditions.

① The slab loading capacity varies with the size and shape of ships, the type of slabs, on-board stacking operations, the skill of slab loader operators, etc., while the cycle pass of the slab loader shall be of such a locus that starts at the upper surface of the trailer which stops at the point 5 m behind the land-side leg of the slab loader and ends with the mean water level along the centerline across an average-sized ship of 80,000 DWT which is berthed with its mean draft when the tide is at mean level +0.75 m. (Refer to Fig. 6.3.22.)

② The cycle time is the total time required for a series of operations ranging from going and returning on the cycle pass to lifting and loading 20 ton slabs with the slab lifting device from the trailer on land to the ship. (Refer to Fig. 6.3.23.)

The capacity can be calculated from the following equation.

$$Q = \frac{3600}{T} \times W$$

where Q: Theoretical calculated capacity (t/hr)

T: Cycle time (sec.)

W: Average weight of a slab (ton) = 20

③ Each motion speed of the slab loader selected in calculating the cycle time is as follows.

Lifting/lowering:	35 m/min. (With load)
	80 m/min. (Without load)
Trolley traversing:	100 m/min.

Fig. 6.3.22 CYCLE PASS (unit:mm) 35T SLAB LOADER

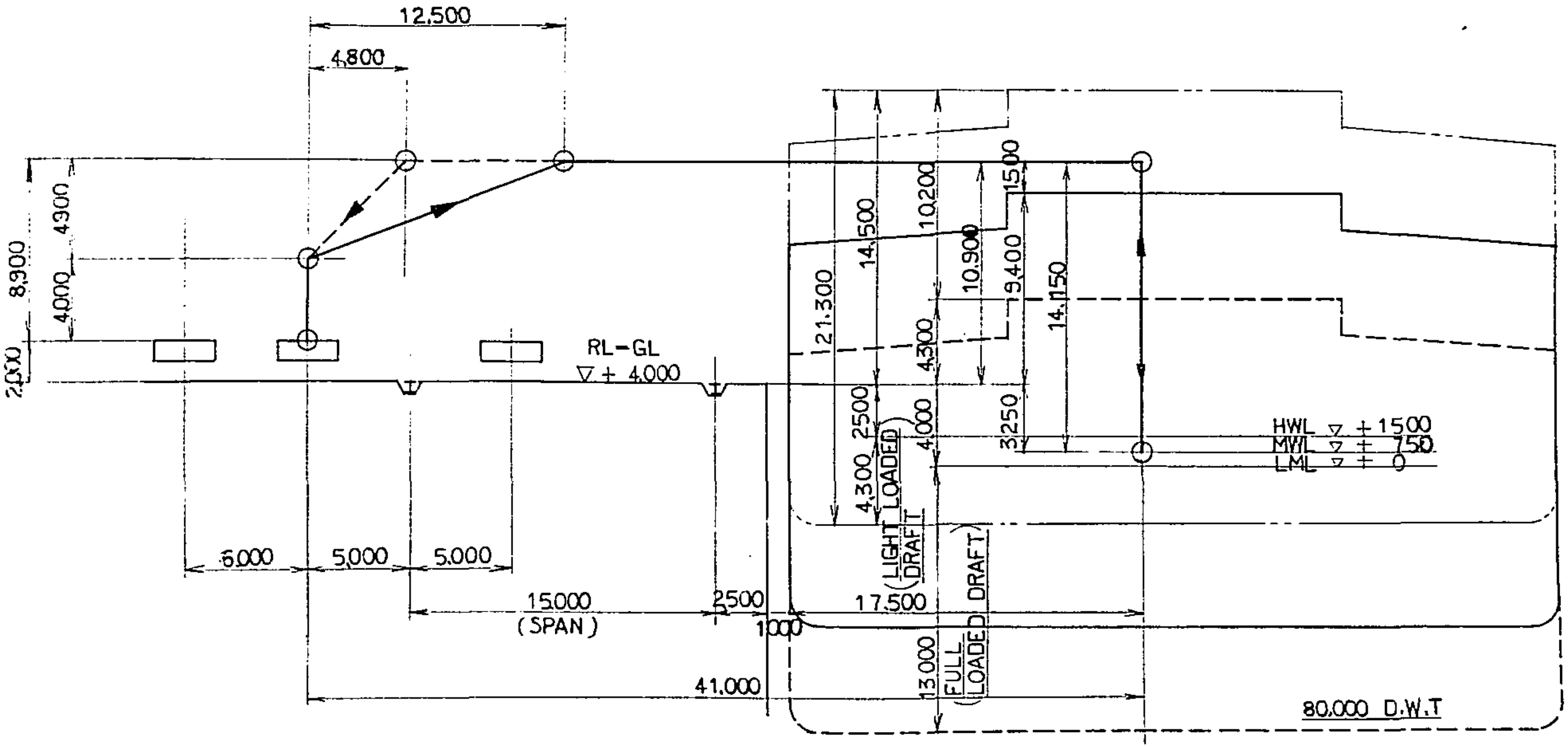
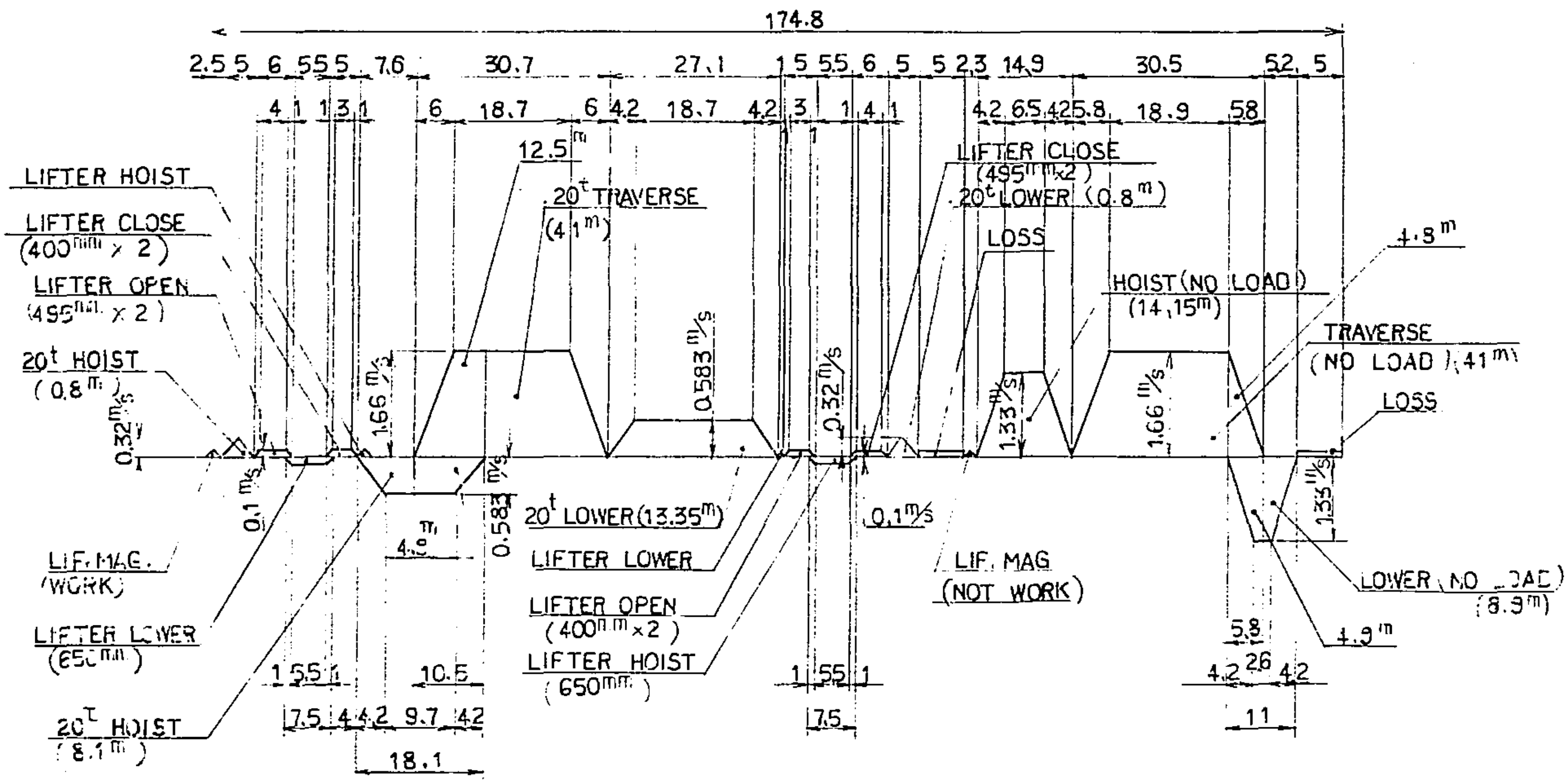


Fig. 6.3.23 CYCLE DIAGRAM (unit: sec)

35^T SLAB LOADER



MEAN THEORETICAL CALCULATED CAPACITY

MEAN SLAB LOAD → $20^t \times \frac{3600}{174.8} \doteqdot 410\ t/h$

④ The theoretical capacity of the slab loader as calculated from the above mentioned equation is shown in Fig. 6.3.20.

4) Travelling range

The travelling range of the slab loader shall be such that three units of slab loaders can simultaneously perform handling operations at a berth. In this plan, a travelling conductor/collector system was employed for the power supply system from the ground to the slab loader so that each loader is not limited to its travelling range.

5) Wheel load

The wheel load of the slab loader on rails is shown in Fig. 6.3.24.

(2) Slab cranes

1) Basic considerations in planning

A gantry crane was selected for slab handling at the slab yard since it can make effective use of the yard space and can be operated easily. This gantry crane, standing astride of the slab yard 35 m wide, handles slabs within its span. A special attention was paid to the following points.

① Taking into consideration that the crane is installed on a newly reclaimed land, the crane shall be of such a type that can be operated without troubles even in case travelling rails are dislocated due to ground subsidence.

② The slab crane shall be capable of easily handling various shapes of slabs with due regard to working efficiency and safety.

2) Structural considerations

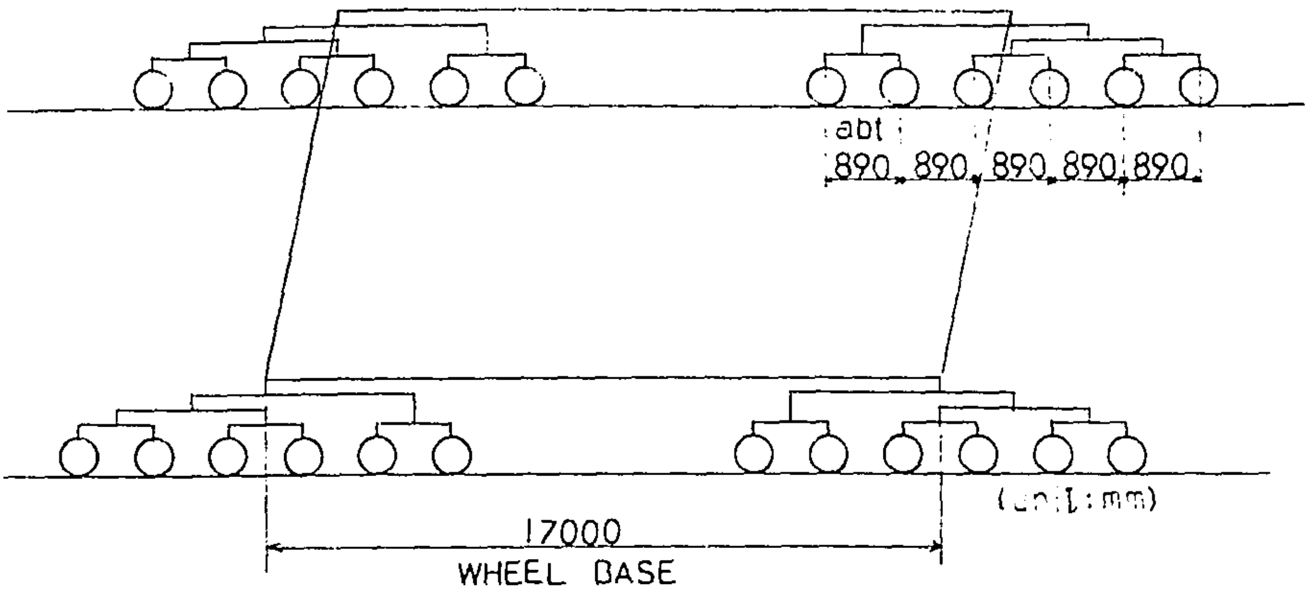
The slab crane selected is as shown in Fig. 6.3.25.

A special attention was paid to the following structural considerations.

Fig. 6.3.24

TRAVELLING WHEEL ARRANGEMENT

AND WHEEL LOAD



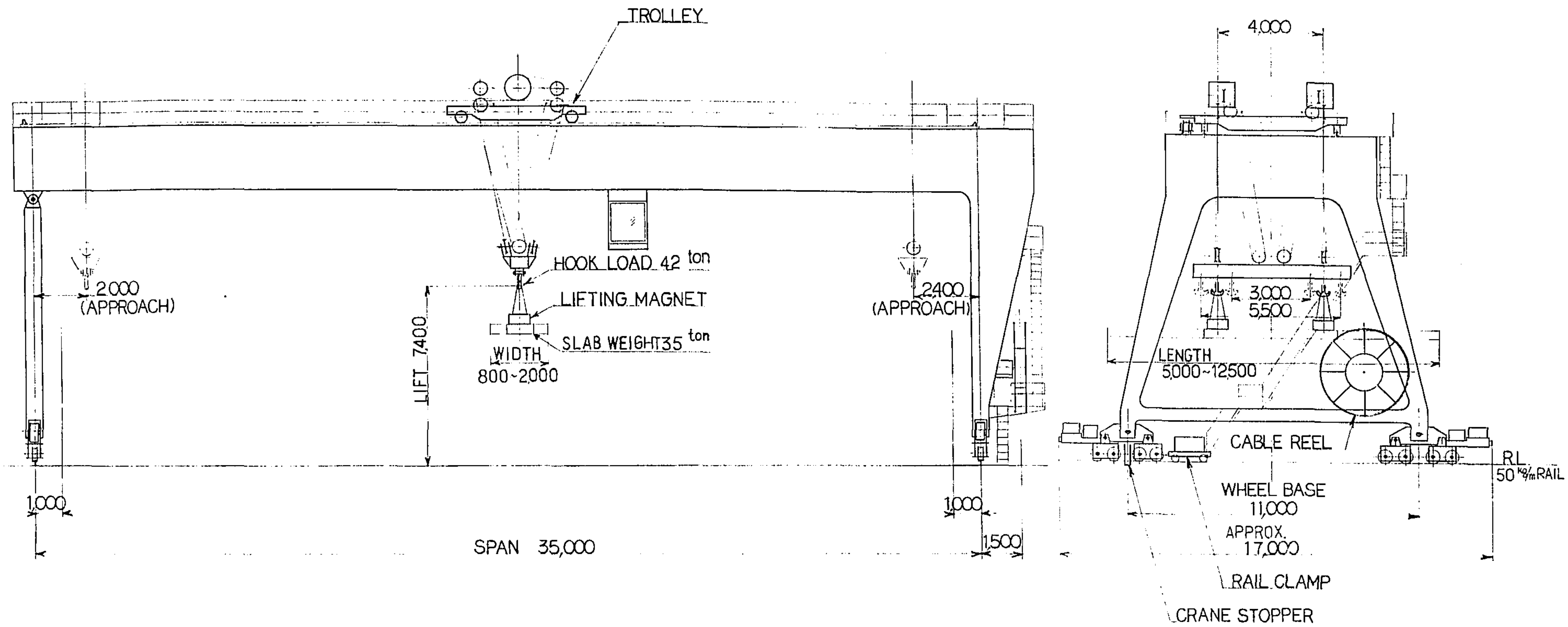
RAIL SIZE ; JIS 73kg/m

MAX. WHEEL LOAD (TON/ONE)			
	OPERATING	RESTING	WHEELS/CORNER
LAND SIDE	45	50	6
SEA SIDE	45	50	6

NOTE ; OPERATING CONDITION WIND VELOCITY 16 m/sec.

RESTING CONDITION WIND VELOCITY 35 m/sec.

BOOM --- DERRICK UP



35t SLAB CRANE

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① In order to make full use of the space within the crane span, the crane shall be free of any projections inside the span.

② Legs on one side shall be of pin joint construction so that the crane can be operated without troubles even in the case of a certain degree of irregularity in rail gauge and level.

③ The lift shall be capable of putting slabs on the trailer up to the height of max. 2 m.

④ The trolley shall be of self-traveled type that can be easily positioned.

⑤ The operator cab shall be of fixed type and installed at a position with good visibility.

⑥ The lifting device shall be of magnet type without a special grab.

3) Speed

Each motion speed of the slab crane has been set as follows to keep pace with the cycle time of the slab loader, taking into consideration the time required for trailer/tractor to move back and forth between the yard and the berth.

Lifting/lowering	15 m/min.
Traversing	40 m/min.
Travelling	50 m/min.

4) Travelling range

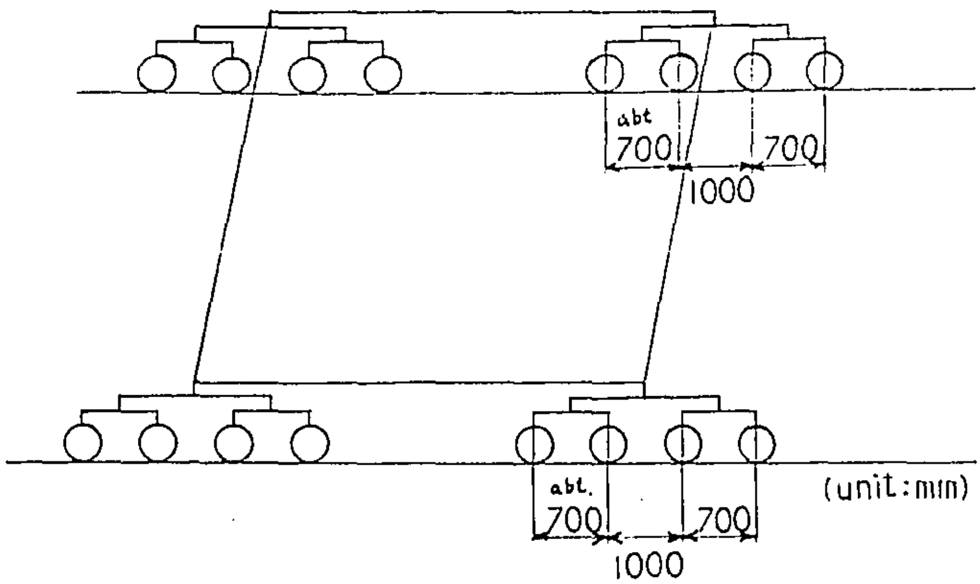
The travelling range shall be 300 m in each slab yard.

5) Wheel load

The wheel load on travelling rails is as shown in Fig. 6.3.26.

Fig. 6.3.26

TRAVELING WHEEL ARRANGEMENT AND WHEEL LOAD



RAIL SIZE ; JIS 50 Kg/m

MAX. WHEEL LOAD (TON/ONE)			
	OPERATING	RESTING	WHEELS/CORNER
RIGID LEG SIDE	25	25	4
PIN LEG SIDE	25	25	4

NOTE ; WIND VELOCITY

OPERATING CONDITION 16 m/sec

RESTING CONDITION 35 m/sec.

(3) Tractors/trailers

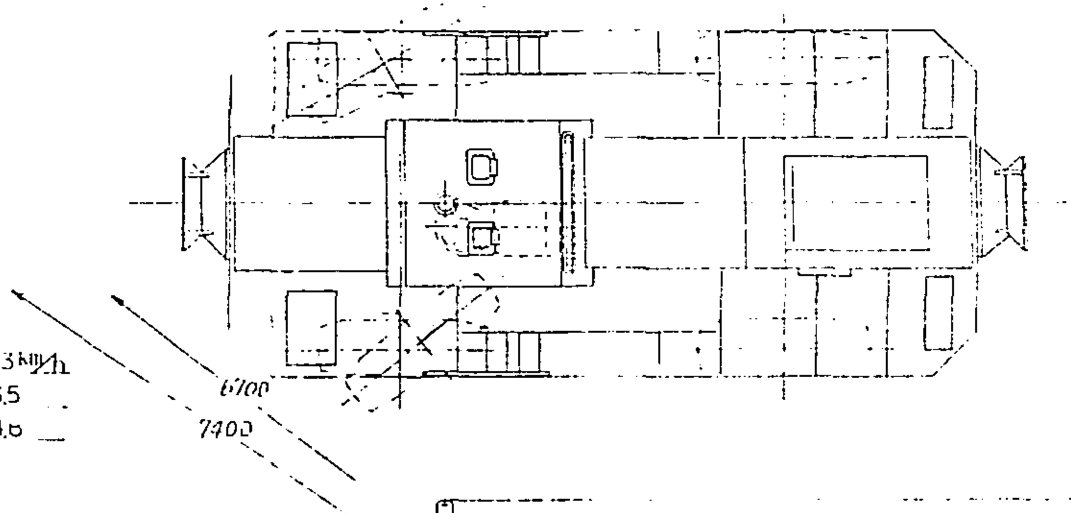
As a method to transport slabs from the slab yard to the slab berth, a tractor/trailer system was selected in this plan. For one unit of slab loader, a group of a tractor and three trailers is allocated, as a rule. Trailers are usually separated from the tractor at the yard and the berth. Therefore, the tractor/trailer system shall be of such a type that trailers can be easily separated from the tractor, and trailers shall have such a structure that they can be free-standing with front and the rear. The structure and specifications of the tractor and the trailer are as shown in Figs. 6.3.27 and 6.3.28.

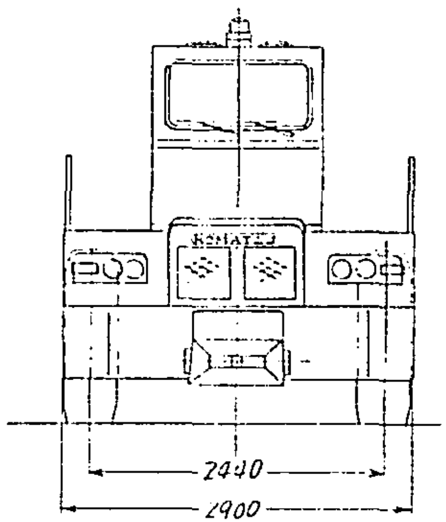
(4) Other ancillary equipment

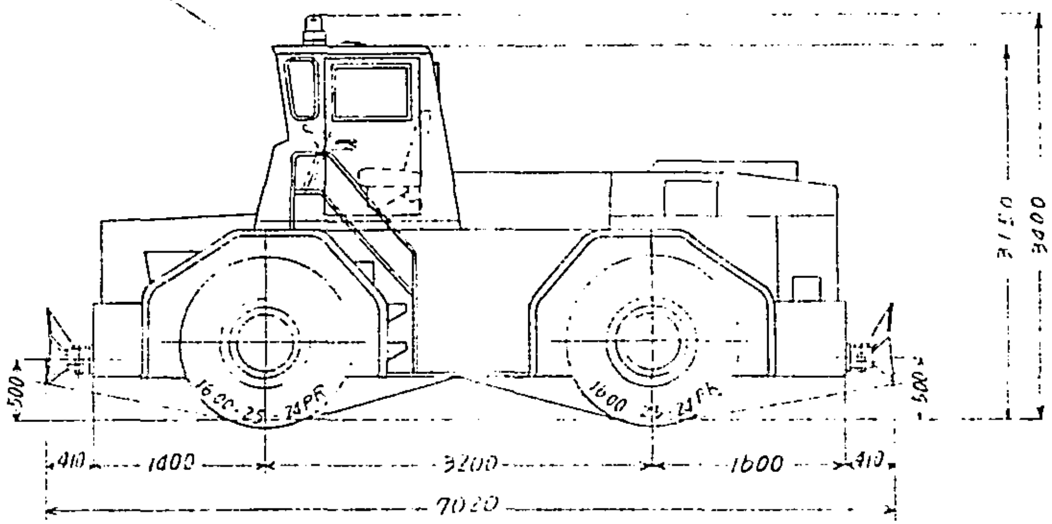
When loading slabs on ships, ship board cargo handling equipment such as fork lift trucks or mobile cranes are required for cargo loading operations on ships. Installation of lifting magnets on these machines eliminates dunnages for cargo hooking work and increases cargo handling efficiency.

Since these shipboard cargo handling equipment are brought in ships by means of the slab loader, their dead weight shall be less than the lifting capacity of the slab loader. However, if they cannot be brought into the ship as an assembled unit because of their dead weight, they can be of such a structure that can be assembled aboard in a short time. Due consideration shall be given to deterioration of environment in holds (air pollution, noise, etc.) caused by these shipboard equipment. The structure and specifications of these machines are shown in Figs. 6.3.29 and 6.3.30.

MODEL : WT 300 2
OPERATING WEIGHT: 30000kg
ENGINE
MODEL: NTA 855
HORSE POWER: 320 HP/2300 rpm
PISTON DISPLACEMENT: 14010 cc
TRAVEL SPEED
FORWARD F1: 0-5.9 km/h REVERSE R1: 0-7.3 km/h
F2: 0-11.0 R2: 0-13.5
F2: 0-20.1 R3: 0-24.6







UNIT: mm

30t TOWING TRACTOR

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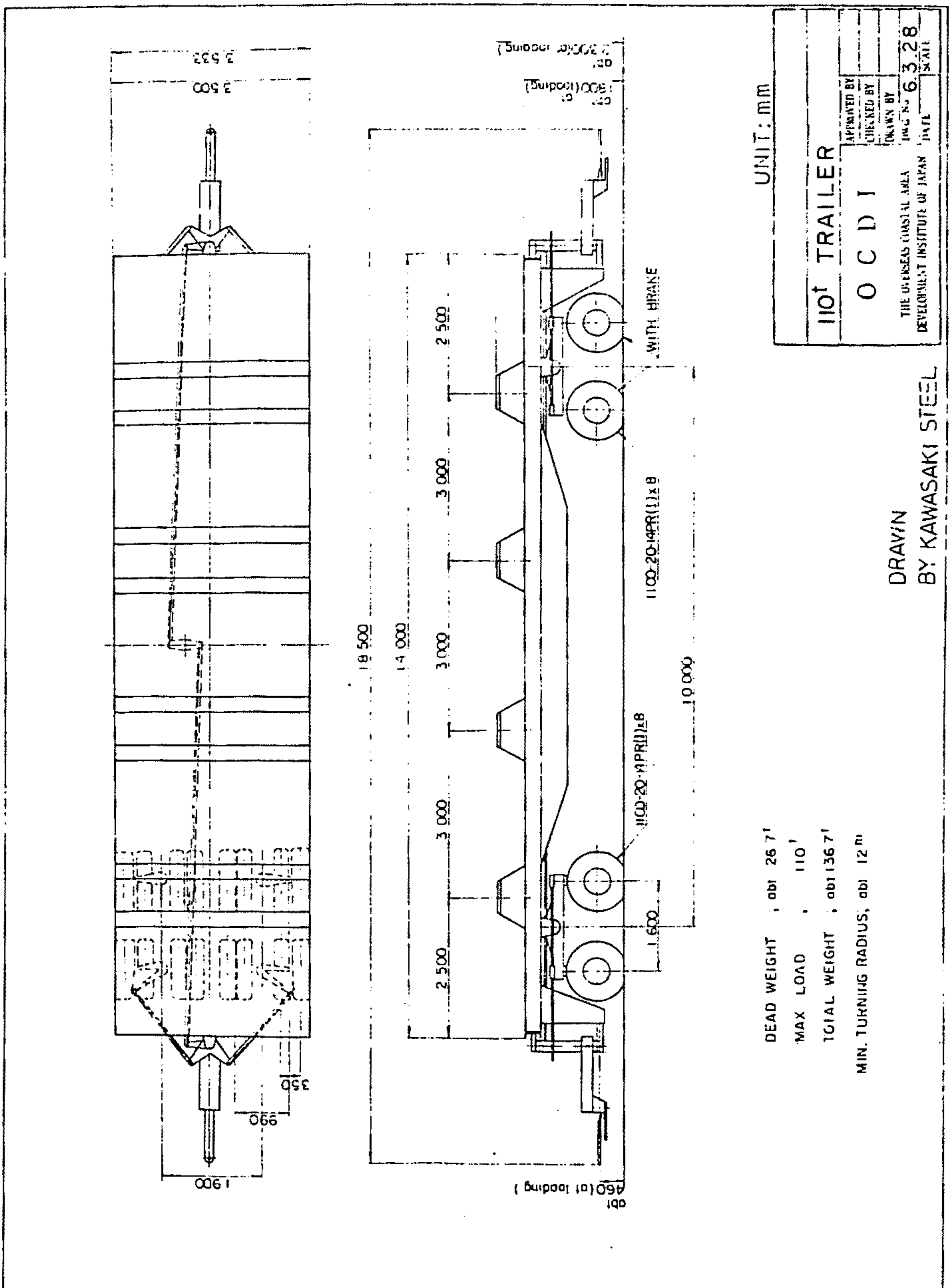
MANUFACTURED BY KOMATSU


110t TRAILER
UNIT: mm
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THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN
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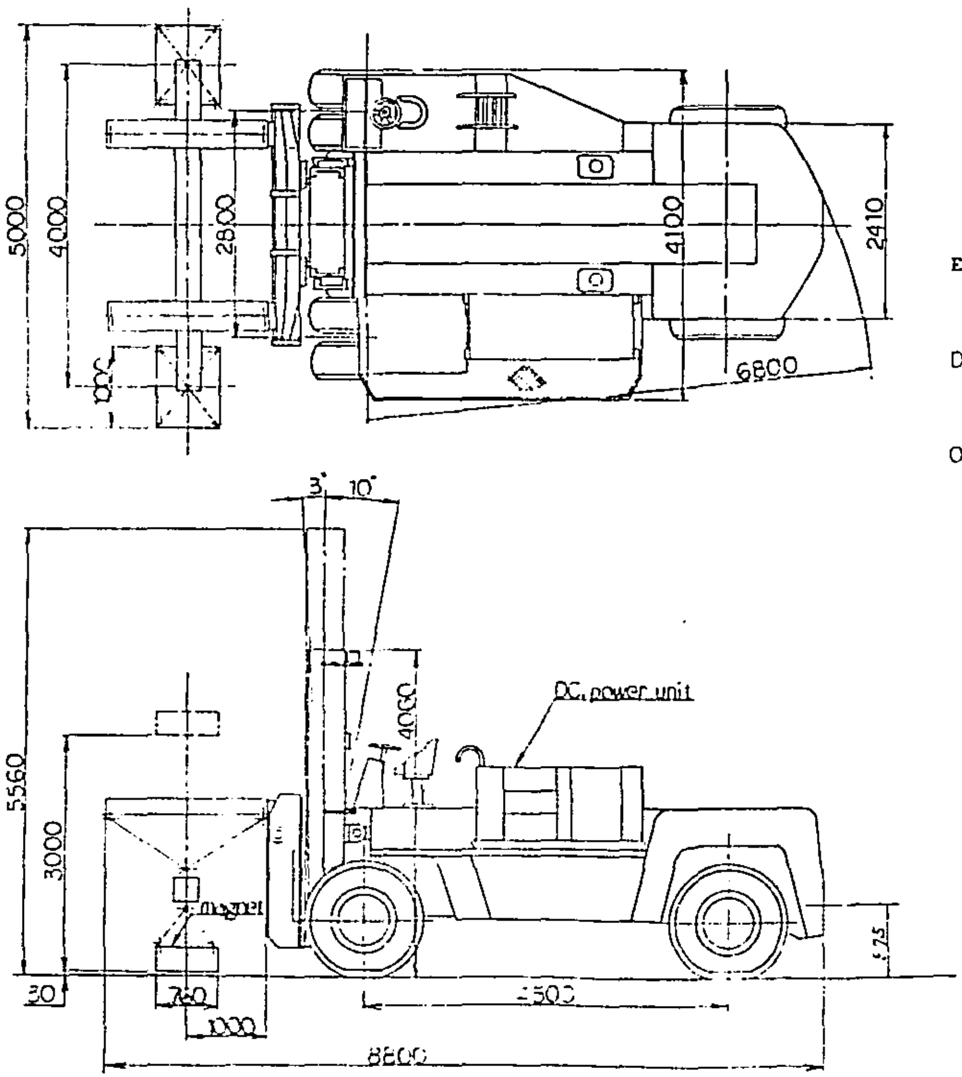
DWG No. 6.3.28
DATE
SCALE
DRAWN BY KAWASAKI STEEL
DEAD WEIGHT , abt 26.7t
MAX LOAD , 110t
TOTAL WEIGHT , abt 136.7t
MIN. TURNING RADIUS, abt 12m
WITH BRAKE
11.00-20-14PR(1) x 8
18 500
14 000
10 000
2 500
3 000
1 600
3 533
3 500
1 900
990
350
abt 460 (at loading)

20TON CAPACITY FORK LIFT TRUCK GENERAL ASS'Y DRAWING



PERFORMANCE		
Max. load		20000kg
Slab size	(length x width x thick)	12500 x 1000~1500 x 120~160mm
Lifting speed	loaded	150mm/s
	empty	160mm/s
Max. traveling speed	loaded	15km/h
	empty	24km/h
No. of speed, forward & reverse		each 4
ENGINE		
Type		4cycle, water cooled diesel engine
Rated output		[illegible]ps/1950rpm
DC. POWER unit		
output		DC 220V [illegible]
weight		approx. [illegible]kg
OTHERS		
Torque converter		NICO [illegible]
Transmission		power shift constant mesh
Front wheel		4 - 16.00 - 25 - 28 PR(I)
Rear wheel		2 - 16.00 - 25 - 28 PR(I)
Brake system		air & hydraulic type with air power booster
Steering System		rear wheel steer
Total weight (inc. device)		approx. 44000kg
Axle load (loaded)	front	approx. 56000kg
	rear	approx. 8000kg

UNIT : mm

MANUFACTURED BY TCM

20t FORK LIFT	
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THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN	DWG No.
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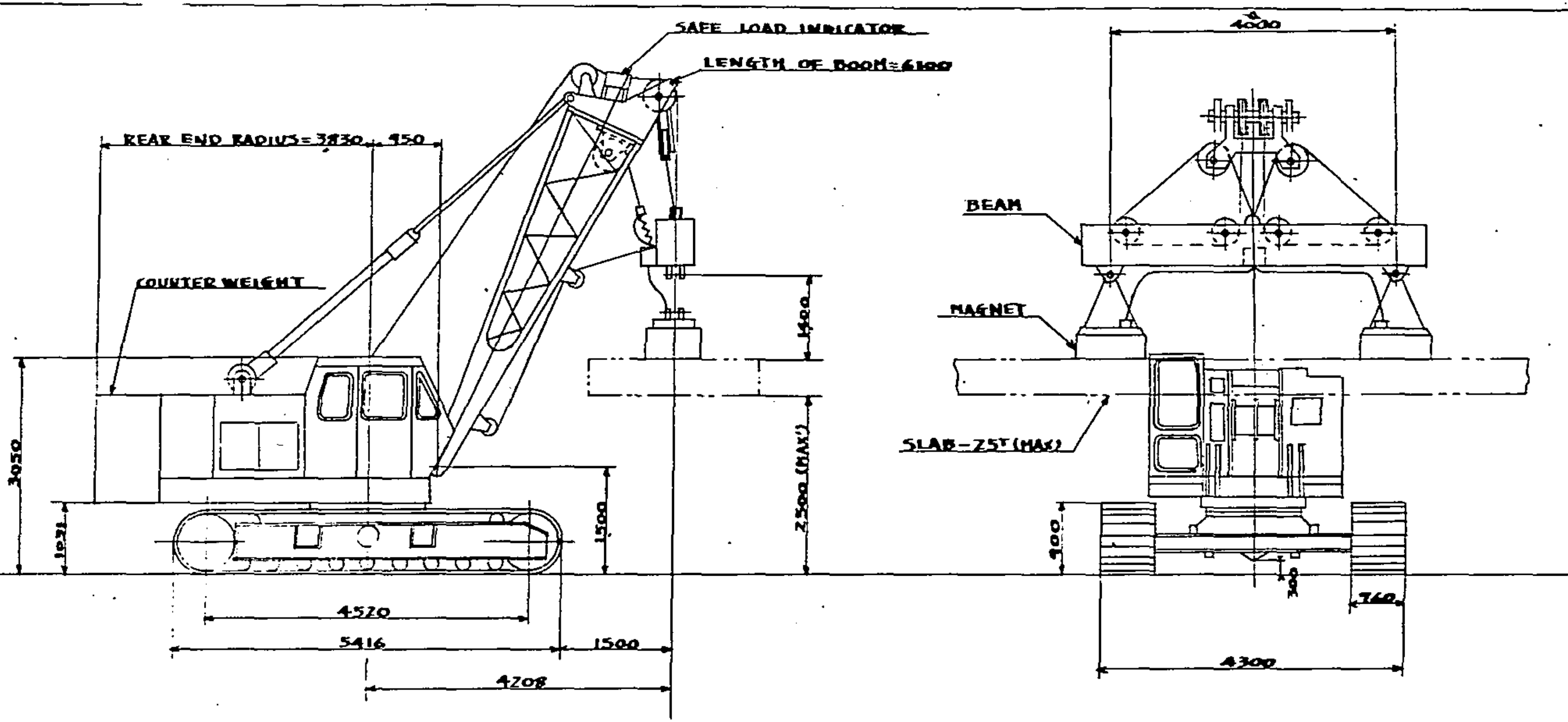
	SCALE



SPEED	
HOIST	11.5 m/min
LOWERING (PLL)	70
BOOM HOIST	4.42
BOOM LOWERING (PBL)	2.21
SWING	4.3 R.P.M
TRACTION	1.4 km/h
PLL=POWER LOAD LOWERING	
PBL=POWER BOOM LOWERING	

LIFTING MAGNET	
TYPE	OBLONG TYPE
SIZE	W 760 x L 1200 x H 450
WEIGHT	$2.65^T \times 2 = 5.3^T$
GENERATOR	DC220V 18KW

WEIGHT (TONS)	
BASE MACHINE	25.7
ATTACHMENT	3.1
BEAM	1.3
COUNTER WEIGHT	11.0
LIFTING MAGNET	5.3
TOTAL	46.4

UNIT: mm

DRAWN
BY KAWASAKI STEEL

25ᵗ MOBILE CRANE

OCDI

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6-4 Other facilities

6-4-1 Electrical facilities

(1) Required power

Average electric power required for cargo handling facilities, lighting of yards and berths, offices, facilities for repair, etc. is given in Table 6.4.1:

Electric power per unit of various machines mentioned above is calculated by totaling outputs of the motions simultaneously taking place out of the motions of hoisting, traversing, etc. in consideration of average load factor, motor efficiency and power factor. An example of calculation of 2000 t/hr unloader is given below:

Hoisting:	560 kW (DC motor)
Graffing:	560 kW (do)
Traversing:	220 kW (do)
Derricking:	74 kW (do)
Travelling:	120 kW (AC motor)
Others:	150 kW (Other auxiliary machines, control, lighting, etc.)

The motions which take place simultaneously out of the above-mentioned motions are 3 motions, hoisting, grabbing and traversing and others. Average load factor (R.M.S. load), motor efficiency and power factor of them are as follows:

	Average load factor	DC motor efficiency	DC generator efficiency	Generator driving motor efficiency	Power factor
Hoisting	90 %	0.95			
Grabbing	90 %	0.95	0.95	0.93	0.9
Traversing	65 %	0.95			

Table 6.4.1 Average power required

	Equipment		kVA/unit	1st stage		2nd stage		Master plan	
	Name	Capacity		Q'ty	kVA	Q'ty	kVA	Q'ty	kVA
1	Unloader	2,000 T/H	1,750	2	3,500	0	-	2	3,500
2	"	1,000 T/H	900	0	-	2	1,800	2	1,800
3	Stacker	2,500 T/H	250	2	500	1	250	3	750
4	Reclaimer	2,000 T/H	350	1	350	1	350	2	700
5	Pier conveyor	2,500 T/H	300	2	600	0	-	2	600
6	"	1,200 T/H	150	0	-	2	300	2	300
7	Ground conveyor	2,500 T/H	900	2	1,800	0	-	2	1,800
8	"	1,200 T/H	500	0	-	2	1,000	2	1,000
9	Yard stacking conveyor	2,500 T/H	800	2	1,600	1	800	3	2,400
10	Yard reclaim-ing conveyor	2,000 T/H	450	1	450	1	450	2	900
11	Car loading silo relaying conveyor	2,000 T/H	850	1	850	0	-	1	850
12	Car loading silo	1,500 T/H	350	1	350	0	-	1	350
13	Slab loader	35 T	400	5	2,000	3	1,200	8	3,200
14	Slab crane	35 T	250	10	2,500	8	2,000	18	4,500
15	Lighting	-	-	1 set	350	1 set	140	1 set	490
16	Other facilities	-	-	1 set	1,000	0	-	1 set	1,000
	Total				15,850		8,290		24,140

(Provided that the above-mentioned values are based on AC-DC conversion through Motor-Generator system.)

In reference to others it is assumed that average efficiency is 90 % and average power factor 75 %.

When electric power (KVA) per unit of 2000 t/hr unloader is calculated on the basis of above-mentioned figures,

P = Hoisting power: $560 \times 0.9 / (0.95 \times 0.95 \times 0.93 \times 0.9)$

+ Grabbing power : $560 \times 0.9 / (0.95 \times 0.95 \times 0.93 \times 0.9)$

+ Traversing power: $220 \times 0.65 / (0.95 \times 0.95 \times 0.93 \times 0.9)$

+ other power : $150 / (0.9 \times 0.75)$

$\fallingdotseq$ 1750 kVA

These powers are supplied through transformers in the substation established in port area. The capacity of the transformers becomes as follows taking into consideration the rate of electric power which the facilities require as a whole simultaneously, that is, the working ratio 75%:

1st stage: $15{,}850 \times 0.75 \fallingdotseq 11{,}890$ kVA

2nd stage increment portion: $8{,}290 \times 0.75 \fallingdotseq 6{,}218$ kVA

As a result the number of transformers to be installed becomes:

1st stage: 7,500 kVA × 2 units

2nd stage increment: 7,500 kVA × 1 unit

Total: 7,500 kVA x 3 units

(2) Power supply system

The system of power supply to respective facilities in this plan depends upon the attached single line diagram Fig. 6.4.1. 2-line power source of 138 kV, 3-phase, 60 Hz received from outside the port area, is stepped down to 3.3 kV, 3-phase, 60 Hz through the transformers of the substation in the port area and supplied to respective cargo handling facilites and buildings.

Three units of transformers are independent each other and their secondary circuits are interconnected by way of two bus tie circuit breakers within the substation. Usually, these two bus tie circuit breakers are left open and power consumption at the secondary circuits of transformers is balanced among three units of transformers.

As against this system, the system proposed by PORTOBRÁS is given in Fig. 6.4.2. The Brazilian system has no difference in respect to the primary circuit compared with the above system but employs a loop system with the secondary circuits of these transformers set at 13.8 kV, 3-phase, 60 Hz which are mutually connected through wiring to the vicinity of respective facilities. Supply of power to each facility is made in the way of the loop and the power is stepped down to 3.3 kV, 3-phase, 60 Hz by 2nd transformers installed near the respective facility. When comparison is made between these two systems, the system shown in Fig. 6.4.1 may have advanatages in the following way:

① Since secondary circuit sides are interconnected in the substation, the reduction of volumes of wires and related works is made possible.

② The number of 2nd transformers is so few that capital costs and maintenance expenses are small.

③ The difference of characteristics of each transformers can be negligible because each transformer is used independently.

The facilities connected to secondary circuit sides of three transformers in Fig. 6.4.1 under this plan are classified into following groups to maintain balance of power consumption at the secondary circuit sides. At the same time, even if one line becomes inoperative due to breakage of a transformer, it is possible to minimize troubles for cargo handling work in the port through switching of the bus tie circuit breaker.

A line: 2000 t/hr unloader × 2 units
2500 t/hr conveyers (installed on the berth, ground and yards)
2500 t/hr stacker × 2 units
Apart of lighting and others

B line: 35 t slab loader × 5 units
35 t slab crane × 10 units
2000 t/hr reclaimer × 1 unit
2000 t/hr conveyers (reclaiming and wagon loading)
Wagon loading silo
Apart of lighting and others

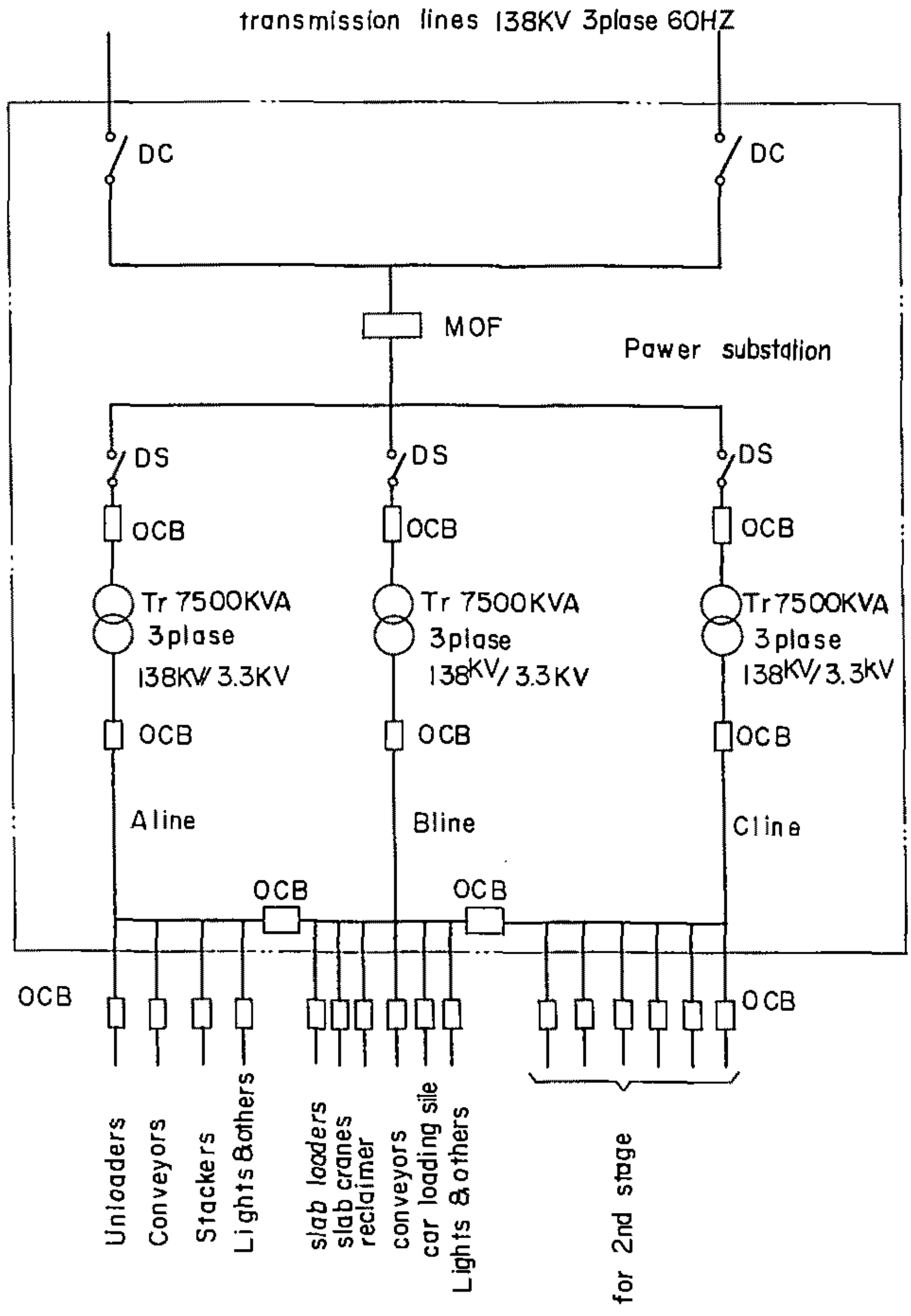
C line (for 2nd stage):
1000 t/hr unloader × 2 units
1200 t/hr conveyors (installed on the berth and ground)
2500 t/hr stacker × 1 unit
2000 t/hr reclaimer × 1 unit
2500 t/hr conveyor (for stacking) × 1 lane
2000 t/hr conveyor (for reclaining) × 1 lane
35 t slab loader × 3 units
35 t slab crane × 8 units
Part of lighting

(3) Power feed system to cargo handling facilities

Power source and feed system of cargo handling facilities are given in Table 6.4.2:

Power sources for lighting and auxiliary machineries inside the unloader, stackers, reclaimers and slab loaders are supplied from built-in transformers so as to give 110 V or 220 V for lighting and 220 V or 440 V for auxiliary machineries.

Slab cranes have to be supplied with 440 V through the transformers inside 2nd substation installed in the slabyard. The total capacity of the transformers has to be 1500 kVA × 3 units composed of 1st stage 1500 kVA × 2 units with increased 2nd stage 1500 kVA × 1 unit.



NOTES
OCB : Oil Circuit breaker
D S : disconnecting switch
MOF : metering outfit
Tr : transformer

Fig. 6.4.1 Power supply system (No. 1)

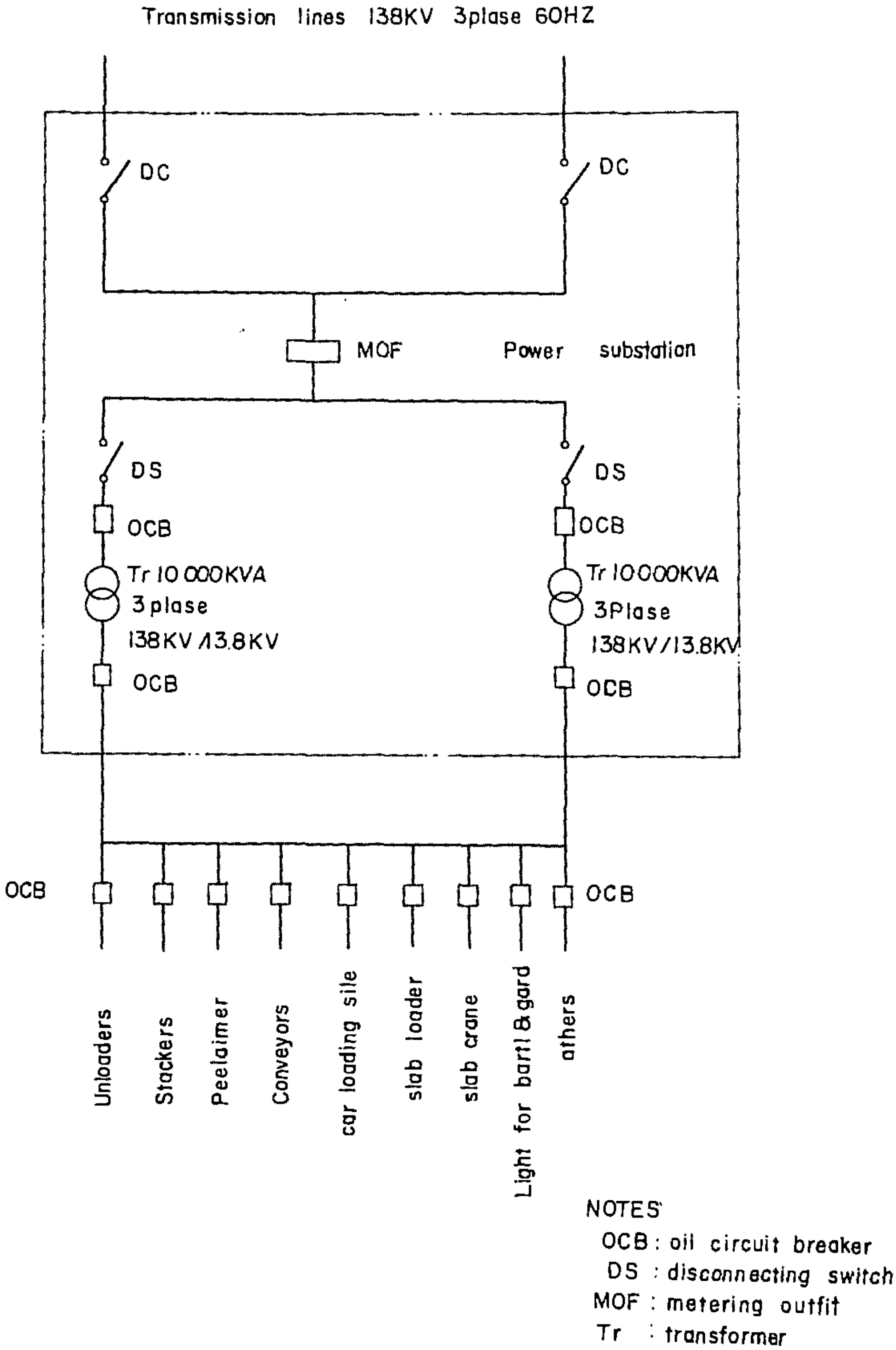


Fig. 6.4.2 Power supply system (No. 2)

Table 6.4.2 Power source and feed system

Equipment	Unloader (2000 t/h & 1000 t/h)	Stacker (2,500 t/h)	Reclaimer (2,000 t/h)	Slab loader (35 t)	Slab crane (35 t)	Belt conveyor
Power supply	A.C. 3,300 V 3-phase, 60 Hz	A.C 3,300 V 3-phase, 60 Hz	A.S. 3,300 V 3-phase, 60 Hz	A.C. 3,300 V 3-phase, 60 Hz	A.C. 4,400 V 3-phase, 60 Hz	A.C. 3,300 V 3-phase, 60 Hz
Feed system	Feed system	Feed system	Feed system	Travelling conductor/ collector	Feed system	

In reference to belt conveyors, small motors of 150 kW or less are driven with 440 V and the larger motor with 3300 V. Transformers for 440 V have to be mounted near the site.

(4) Lighting facilities/others

Since the voltage drop of power for lighting is big for longer distance, it is required to establish several transformers at appropriate locations for the purpose of stepping down the voltage of 3,300 V into 110 V or 220 V. Main lighting facilities are shown in Table 6.4.3.

Power source for miscellaneous purposes for repairing facilities and repairs at respective berths and yards should be provided with 2nd transformers near the site so as to step down the voltage of 3300 V to 440 V or 220 V.

3300 V power source should be supplied directly from the substation in respect to the motor for drainage.

6-4-2 Drainage facilities

(1) Precipiration

The observation results of precipitation in Vitória during the period 1931 ∿ 1970 are given in Table 2.3.6.

Because observation results of precipitation per hour are not avilable, the drainage plan has been established on the assumption that it stands at 50 mm/hr.

(2) Sewage quantity

It is assumed that sewage quantity planned per hour is 12.5 m^3/hr.

(Quantity = 0.2 (m^3/day) × 500 person/8 (hour))

Table 6.4.3 Principal lighting facilities

Location	Type of luminaire	Number of luminaires per pole	Pole height & pitch	Remarks
Belt conveyor	Mercury vapor lamp	250 W × 2 units	h = 6.0 m Pitch 20 m	Pier conveyor, ground conveyors, 15 lux. min.
Berth	Do	400 W × 2 units	h = 5.5 m Pitch 40 m	20 lux. min.
Yard	Do	1,000 W × 10 units	h = 20.0 m Pitch 100 m	20 lux. min.
Oil berth	Do	400 W × 2 units	h = 5.5 m (4 poles in all)	20 lux. min.
Road and parking area	Do	400 W × 1 unit	h = 12.0 m Pitch 40 m	15 lux. min.
Others	Do	50 W × 1 unit	h = 5 5 m	15 lux. min.

(3) Layout of drainage networks (Fig. 6.4.3)

The rainwater at places other than coal yard has to be collected through the side-ditches of roads and centrifugal reinforced concrete tubes and delivered to pump station so that it is drained through pumps into drainage ditches.

Rainwater in the coal yard has to be collected into sedimentation ponds and delivered to the pump station after sedimentation.

Sewage will be sent to the pump station after being processed through centrifugal reinforced concrete tubes.

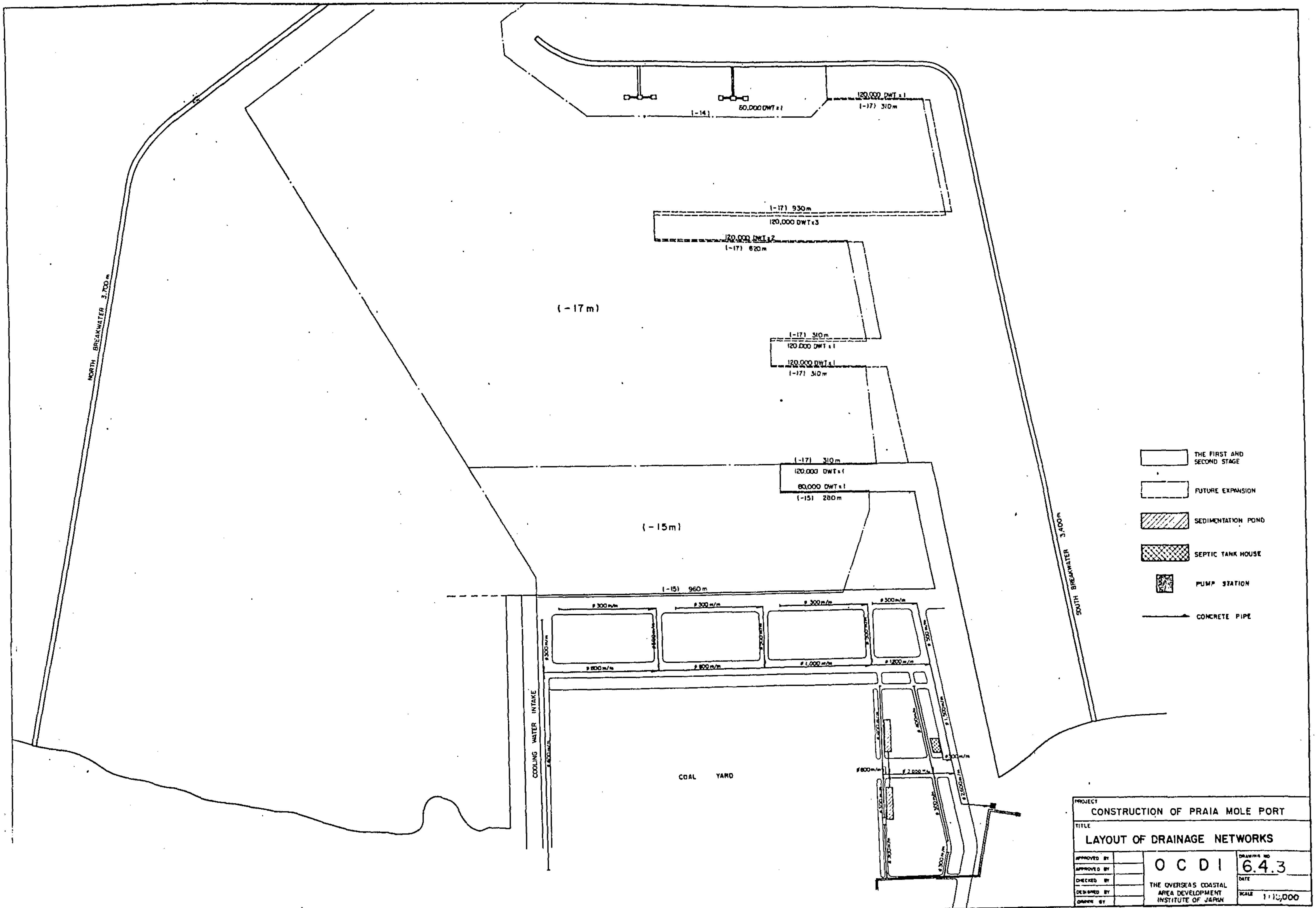
Incidentally, 3 units of axial flow pumps having capacity of 12,500 t/hr each should be established in the pump station. One of them is for reserve. The capacity of the pump is as follows:

① Pump power : 290 kW

② Head : 6.2 m

③ Revolution : 440 rpm

The layout of drainage networks is shown in Fig. 6.4.3.



PROJECT
CONSTRUCTION OF PRAIA MOLE PORT

TITLE
LAYOUT OF DRAINAGE NETWORKS

APPROVED BY		OCDI	DRAWING NO 6.4.3
APPROVED BY		THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN	DATE
CHECKED BY			SCALE 1:10,000
DESIGNED BY			
DRAWN BY			

CHAPTER 7. DREDGING AND RECLAMATION

7. Dredging and reclamation

7-1 General description

It seems that good quality material enough for the reclamation can be obtained only by collecting a small volume of soil from the other source to meet the deficiency even in consideration of the bad quality material, the loss to be washed away during the dredging and reclamation works, the subsidence of the reclaimed land, etc. concerning the below-mentioned volume of soil to be dredged, though the data on the nature of soil available are, at present, still insufficient.

7-1-1 Dredging

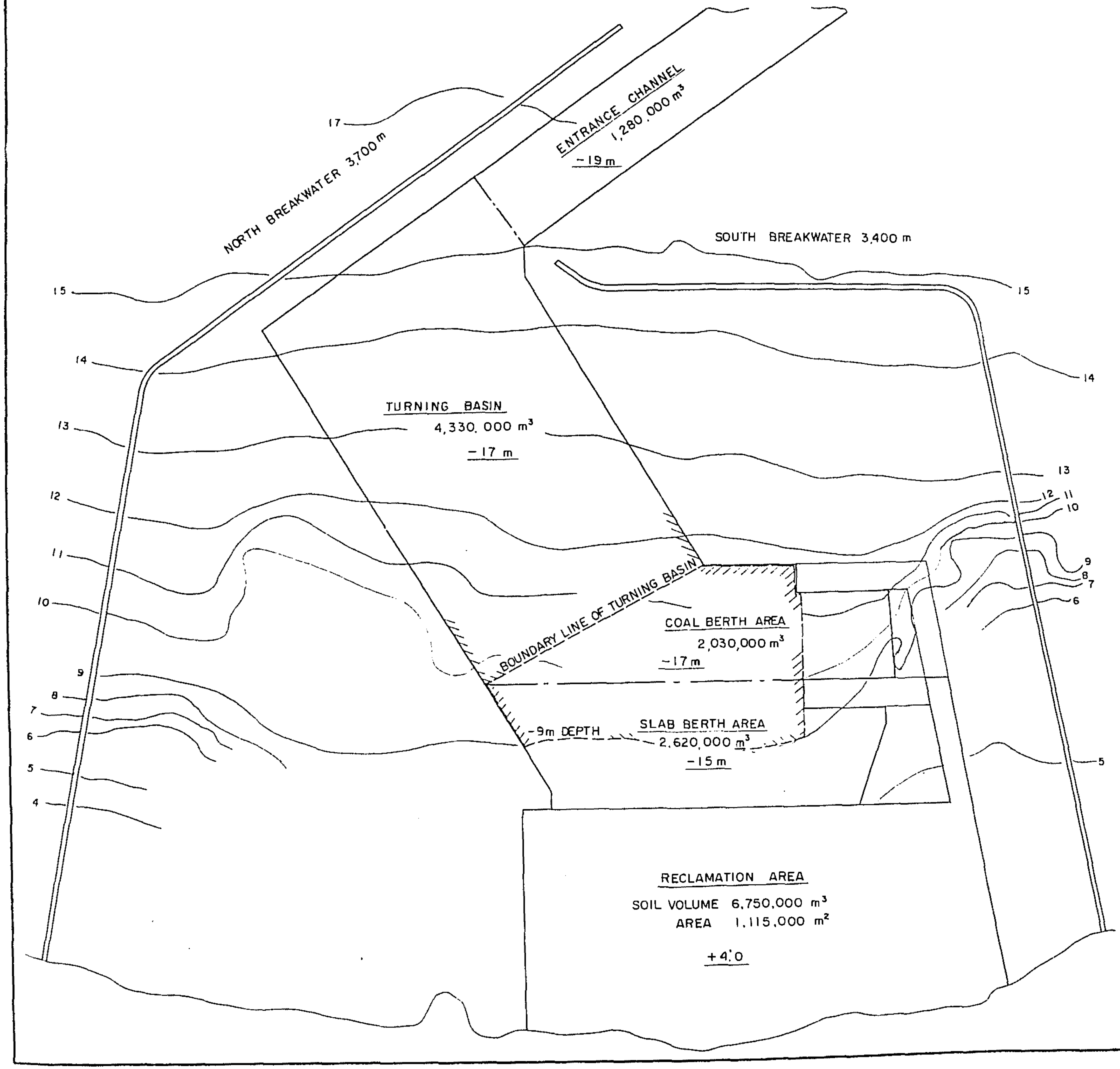
The reclamation area and depth are as shown in Fig. 7.1.1 (Dredging and reclamation area). The volume of soil to be dredged in each dredging area excluding extra dredging to secure the planned depth and the dredging at the side-slope areas is estimated as in Table 7.1.1.

Table 7.1.1 The volume of soil to be dredged per area

Dredging area	Depth, m	Area, m^2	Dredging volume, m^3
Channel	-19	620,000	1,280,000
Turning basin	-17	1,030,000	4,330,000
Slab berth	-15	410,000	2,620,000
Coal pier	-17	340,000	2,030,000
Total :		2,400,000	10,260,000

7-1-2 Reclamation

Supposing that the total reclamation area approximately of 1,115,000 m^2 is to be reclaimed up to +4 m, the net volume of soil required for the reclamation is estimated approximately at 6,750,000 m^3.



NOTE

THE ENCLOSED AREA WITH BROKEN LINES SHOWS THE EXTENDED WORKING AREA OF A HOPPER SUCTION DREDGER (DREDGING UP TO -9M CONTOUR LINE)

Fig. 7.1.1 DREDGING AND RECLAMATION AREA

7-2 The nature and the volume of soil within the dredging area

The soil given in Table 7.1.1 are classified as per Table 7.2.1 according to the present data on the nature of soil.

Table 7.2.1 The nature and volume of soil to be dredged

(Volume in 1,000 m^3)

Dredging area	Mean dredging thickness, m	Depth of soil from sea bed level, m			
		0 ∿ 3		3 ∿ 6.5	
Channel	2.0	Sand N < 10	1,280		
Turning basin	4.5	Sand N < 10 Clayey soil 10 < N < 20	2,330 200	Sand 10 < N < 20	1,800
Slab berth	6.5	Sand N < 10 Clayey soil 10 < N < 20	650 500	Clayey soil 10 < N < 20 Clayey soil 20 < N < 30	500 970
Coal pier	6.0	Sand N < 10 Sand 10 < N < 20	500 730	Sand 10 < N < 20 Clayey soil 10 < N < 20	500 300
Total:			6,190		4,070

7-3 Selection of the type of dredgers and their capacity

7-3-1 Selection of the type of dredger

The selection of the type of dredgers is made on the assumption that the following dredging and reclamation method is to be adopted.

① The material above -9 m level and clayey soil are to be dredged by a cutter suction dredger of 8,000 HP class, while as large area as possible is to be dredged by a seaworthy hopper dredger of 4,000 m^3 ∿ 5,000 m^3 class. The clayey soil dredged is to be delivered to the area scheduled to be reclaimed in the future.

② The material dredged by the hopper dredger is to be stocked temporarily in the vicinity of the reclamation area and to be delivered to the reclamation area by further dredging by a cutter suction dredger of 3,000 HP class. (Secondary pumping)

③ The reclamation soil to fill up the deficiency of the dredged material is to be dredged from outside the harbour by the hopper dredger, and to be delivered to the reclamation area by the cutter suction dredger after stocking it in the temporary depot.

7-3-2 Estimation of the capacity of dredgers

① The average number of workdays per month of a hopper dredger and a cutter suction dredger is estimated at 25 and 20 respectively.

② The volume of soil dredged monthly by each type of dredgers is estimated as follows.

Table 7.3.1 Dredging volume per month by a hopper dredger of 4,000 m^3 class

(Volume in m^3)

Soil	N < 10	10 < N < 20	20 < N < 30	Double dredging 1)	Supplementary dredging 2)
Sand	500,000	400,000	300,000		300,000
Clayey soil	150,000	100,000		200,000	

Notes: 1) Double dredging refers to dumping off the breakwaters the clayey soil dredged by a cutter suction dredger.

2) Supplementary dredging refers to dredging sand outside the breakwaters and bringing it to the temporary depository for reclamation by a hopper dredger

Table 7.3.2 Dredging volume per month by a cutter suction dredger (with main pump of 3,000 HP class)

(Volume in m^3)

Normal dredging	Secondary delivery
75,000	180,000

Table 7.3.3 Dredging volume per month by a cutter suction dredger (with main pump of 8,000 HP class)

(Volume in m^3)

Soil	N < 10	10 < N < 20	20 < N < 30
Sand	330,000	250,000	200,000
Clayey soil	220,000	180,000	130,000

7-4 The term and the cost of the dredging and reclamation works

7-4-1 Condition of the comparative study

The cost of construction is studied comparatively on several engineering methods including the offshore dumping method not to use the dredged clayey soil for the reclamation as proposed by the Brazilian side.

① In case the dredged clayey soil is to be delivered to the area scheduled to be reclaimed in the future (between each of the break-waters and the reclaimed land belonging to the first stage of the work).

② In case the dredged clayey soil is to be dumped offshore.

③ In case the area to be dredged by a hopper dredger is to be from the offshore to the -9 m depth.

④ In case the area to be dredged by a hopper dredger is to be from the offshore to the turning basin.

Table 7.4.1 shows the volume to be dredged by a hopper dredger and cutter suction dredgers by nature of soil in each combination of the above cases.

7-4-2 The Number of dredgers by type and the term of works

Tables 7.4.2 to 7.4.4 show the number of dredgers and their workmonths by type based on the volume of soil in Table 7.4.1 and Tables 7.3.1 to 7.3.3.

7-4-3 The cost of dredging

(1) Monthly cost and mobilization cost

The monthly cost and the mobilization cost for bringing and returning a hopper dredger of 4,000 m^3 class and a cutter suction dredger of 8,000 HP class are estimated under the assumption that they are chartered in Japan.

Table 7.4.1 The volume of soil to be dredged by each dredger

(Volume in 1,000 m^3)

Soil \ Cases		a. Dumping clayey soil into the future reclaimed land				b. Dumping clayey soil into the sea outside the harbour			
		c. up to -9m by hopper dredger		d. up to the turning basin by hopper dredger		c. up to -9m by hopper dredger		d. up to turning basin by a hopper dredger	
dredger		Hopper	Cutter	Hopper	Cutter	Hopper	Cutter	Hopper	Cutter
Clayey soil	10 < N < 20		1,500		1,500	200	1,300	200	1,300
	20 < N < 30		970		970		970		970
Sand	N < 10	4,260		3,610	650	4,260		3,610	650
	10 < N < 20	2,980	550	1,800	1,730	2,980	550	1,800	1,730
Secondary delivery			(8,025)		(6,195)		(8,025)		(6,195)
Double dredging						2,290		2,290	
Supplementary dredging		785		785		785		785	
Total:		8,025	3,020 (8,025)	6,195	4,850 (6,195)	10,515	2,820 (8,025)	8,685	4,650 (6,195)

Notes: 1) The values in parentheses refer to the secondary delivery by a small cutter suction dredger.

2) The supplementary dredging refers to the makeup for reclamation with the loss of secondary delivery and normal dredging set at 0.22 and 0.19, respectively.

Table 7.4.2 Working period of a hopper dredger

(Volume in 1,000 m^3)

Type of work \ Case			a. Dumping the clayey soil into the future reclaimed land				b. Dumping the clayey soil into the sea outside the harbour			
			c. up to -9m by a hopper dredger		d. up to the turning basin by a hopper dredger		c. up to -9m by a hopper dredger		d. up to the turning basin by a hopper dredger	
			Volume	Number of months	Volume	Number of months	Volume	Number of months	Volume	Number of months
Dredging	Clayey sand	10 < N < 20					200	2.0	200	2.0
	Sand	N < 10	4,260	8.5	3,610	7.2	4,260	8.5	3,610	7.2
		10 < N < 20	2,980	7.5	1,800	4.5	2,980	7.5	1,800	4.5
Secondary delivery							2,290	11.4	2,290	11.4
Supplementary dredging			785	2.6	785	2.6	785	2.6	785	2.6
Finishing 1)				5.6		5.0		5.6		5.0
Dredging months, total				24.2		19.3		37.6		32.7
Dredging months per vessel				24.2		19.3		18.8		16.4
Maintenance months				3.8		2.7		2.7		2.6
Months in commission per a vessel				28.0		22.0		21.5		19.0

Notes: 1) The finishing refers to an extra dredging to secure the planed depth and the dredging at the side-slope areas. The same applies to Tables 7.4.3 and 7.4.4

2) When dumping the clayey soil into the sea outside the harbour, 2 dredgers are required in order to shorten the working period.

Table 7.4.3 Wroking period of a cutter suction dredger (with main pump of 3,000 HP class)

(Volume in 1,000 m^3)

Case / Type of work	Either a or b			
	c. up to -9m by a hopper dredger		d. up to the turning basin by a hopper dredger	
	Volume	Number of months	Volume	Number of months
Secondary delivery	(8,025÷3) =2,675	18.6	(6,195÷3) =2,065	14.3
Maintenance months		2.4		1.7
Months in commission		21.0		16.0
Aggregate number of months in commission		63.0		48.0

Note: All the secondary delivery work is to be undertaken by the cutter suction dredger of this class.
As stated in the above table, three cutter suction dredgers are required per one hopper suction bredger.
Except for the finishing, the number of dredging months is just the same.

Table 7.4.4 Working period of a cutter suction dredger (with main pump of 8,000 HP class)

(Volume in 1,000 m^3)

Type of work \ Case			a. Dumping the clayey soil into the future reclaimed land				b. Dumping the clayey soil into the sea outside the harbour			
			c. up to -9m by a hopper dredger		d. up to the turning basin by a hopper dredger		c. up to -9m by a hopper dredger		d. up to the turning basin by a hopper dredger	
			Volume	Number of months	Volume	Number of months	Volume	Number of months	Volume	Number of months
Dredging	Clayey soil	10 < N < 20	1,500	8.3	1,500	8.3	1,300	7.2	1,300	7.2
		20 < N < 30	970	7.5	970	7.5	970	7.5	970	7.5
	Sand	N < 10			650	2.0			650	2.0
		10 < N < 20	550	2.2	1,730	6.9	550	2.2	1,730	6.9
Finishing				3.0		3.3		3.0		3.3
Maintenance months				2.0		2.0		2.0		2.0
Number of months in commission per vessel				23.0		30.0		21.9		28.9

The monthly cost of a hopper dredger of 5,000 m^3 class and a cutter suction dredger of 3,000 HP class, which are Brazilian dredgers, is calculated based on the data submitted by the Brazilian side. The mobilization cost for bringing and returning them is estimated at respective monthly cost. The total cost per dredger is given in Table 7.4.5.

Table 7.4.5 The cost for operation of dredgers

(in US$)

Dredger \ Case	Monthly cost per vessel	Round trip cost per vessel
Hopper dredger		
Domestic (5,000 m^3)	638,047	638,047
Foreign (4,000 m)	602,219	2,320,764
Cutter dredger		
Domestic (3,000 HP)	304,766	304,766
Foreign (8,000 HP)	900,388	4,168,345

(2) Comparison of the costs by combination of cases

Table 7.4.6 shows the costs per combination estimated by the term of works shown in Tables 7.4.2 to 7.4.4 and the cost shown in Table 7.4.6.

7-4-4 Result of the comparative study

As to the disposition of clayey soil, the Brazilian side considers it improper to deliver clayey soil to the reclamation land including the area scheduled to be reclaimed in the future as well as in any area of the harbour which may be adversely affected by such a delivery.

We are, however, of the opinion that case a must be adopted and that the clayey soil can be delivered to the area scheduled to be reclaimed in the future as a result of the comparative study with case b for offshore dumping which requires an additional cost of dredging more than 20% with

Table 7.4.6 Comparison of the costs by combination of cases

(in US$)

Case / Dredger	a. Dumping clayey soil into the future reclaimed land		b. Dumping clayey soil into the sea outside the harbour	
	c. up to -9m by a hopper dredger	d. up to the turning basin by a hopper dredger	c. up to -9m by a hopper dredger	d. up to the turning basin by a hopper dredger
Hopper dredger (4,000 m^3)				
In commission	28 months x 602,914	22 months x 602,914	24.5 months x 602,914	22 months x 602,914
On round trip	2,320,764	2,320,764	2,320,764	2,320.764
Hopper dredger (5,000 m^3)				
In commission			24.5 months x 638,047	22 months x 638,047
On round trip			638,047	638,047
Cutter dredger (3,000 HP)				
In commission	63 months x 304,766	48 months x 304,766	63 months x 304,766	48 months x 304,766
On round trip	3 x 304,766	3 x 304,766	3 x 304,766	3 x 304.766
Cutter dredger (8,000 HP)				
In commission	23 months x 900,388	30 months x 900,388	21.9 months x 900,388	28.9 months x 900,388
On round trip	4,168,345	4,168,345	4,168,345	4,168,345
Total :	64,194,181	62,307,923	77,363,753	77,992,577

Note: In case b, the time of double dredging is uncertain, and it is hard to map out the work schedule for the hopper suction dredger. For this reason, the number of months in service is increased 3 months from the level given in Table 7.4.2. (up 50% of the number of months required for double dredging) the increase in work volume. We do not think that this method constitutes a serious hindrance to the future utilization of the reclaimed land because the volume of clayey soil forms only a small part of the total volume of soil to be reclaimed.

As a result of the comparative study of cases c and d, it has been decided to adopt plan d in consideration of the fact that enlargement of the range of works covered by a hopper dredger involves secondary pumping for reclamation and therefore requires higher cost than that by a cutter suction dredgers and that limitation of works covered by a hopper dredger to as narrow a range as possible is essential for reduction of the cost of dredging though a hopper dredger ensures effective execution of the work for its excellent seaworthiness. From this point of view, it is recommended to adopt the combination of a and d as the optimum method for the dredging and reclamation plan. Mentioned below are the numbers of the dredgers and the term of works required for this plan.

Type of Dredger	Number	Term of Works (in month)
Hopper dredger (4,000 m^3)	1	22
Cutter suction dredger (3,000 HP)	3	16
Cutter suction dredger (8,000 HP)	1	30

As to this allocation schedule of the dredgers, it will be advisable to charter a large-sized cutter suction dredger of 8,000 HP class also applicable to the hard material from abroad since cutter suction dredgers available in Brazil seems insufficient in working ability.

The hopper dredger will have to be chartered also from abroad, since the two newest large-sized hopper dredgers (5,000 m^3) are scheduled to be used for the other projects at the other harbours. Our cost estimate is made on this assumption.

CHAPTER 8. METHOD AND SCHEME OF EXECUTION OF WORKS

8. Method and scheme of execution of works

8-1 Preliminary works and supply schedule of construction plants, materials, etc.

The construction site of the port is situated about 15 km north of Vitória, Espirito Santo State, and on the seashore 5.5 km from the national road BR-101. About 3 km to the south, there lies the Tubarão terminal of CVRD. Between the national road and the port area, CST is going to build an iron works concurrently with this project.

As to the supply route of the construction materials, the domestic materials are to be carried into the construction site mainly by truck, while the imported materials are to be forwarded from the port of Vitória by truck or by marine transportation. The stone materials are to be supplied from a quarry on the west side of the national road BR-101 about 10 km northwest of the construction site. The concrete materials are to be produced in a plant scheduled to be built in a yard near the site. The construction plants, all of which except some of the dredgers are domestically available, are to be carried into the site by overland or marine transportation respectively.

The preliminary works for this project are planned as follows.

8-1-1 Temporary roads for construction works

A road for the construction works which passes under the national road near the quarry and runs parallel with the proposed port road as far as the construction site, is to be built between the quarry and the site to carry the stone materials. This road is also used for general work purposes. Another transport road is to be constructed along the coastline as far as the north breakwater.

8-1-2 Construction materials loading facilities

In the early stage of the works, a temporary pier is built in the port of Vitória to load the stone and other materials. In the following stages of the works, the revetment behind the root of the coal pier is to be used as a landing place for the construction materials. (Fig. 8.2.1.) The length of this landing place is to be of 200 m, and the water depth of -4 m. A temporary rubble mound breakwater of 150 m in length is to be constructed from the east end of it toward the south breakwater.

8-1-3 Development of the quarry

The neighboring land to a quarry, which is now being operated in a small scale, is to be so developed as to supply enough stone materials necessary for this project. A management office, a weigh-house, a magazine and a vehicle repair shop, are to be built for the development of a quarry.

8-1-4 Management office and working yards

At the foot of the south breakwater, an area of 80,000 m^2 is to be secured as a yard for the concrete plant, the fabrication work of precasting members, and the welding shop of steel pipe piles, etc. At the foot of the north breakwater, on the other hand, an area of 50,000 m^2 is to be secured as a space for the management office, the storehouses, and the other facilities.

8-2 Scheme of execution

8-2-1 Breakwaters

Stone for the rubble mound breakwater is to be extracted by blasting. The collected stone is to be carried by 22 ton dump trucks and directly dumped into the water. At the extreme point of the rubble mound thus extruding offshore, a tractor excavator is to be stationed for the settling of stone and the shaping of the breakwater section. The armor stone is to be dropped from a 100 ton crane on the berakwater within the accessible range of the crane, while stone to cover the lower part of the slopes beyond the above range is to be carried by a stone barge and unloaded by a 30 ton crane barge. This work is to be carried out on the instructions of a diver, and no special leveling is to be applied to the slope shaping.

8-2-2 Dredging and reclamation

As stated in Chapter 7, the soil dredged are used for the reclamation. The entrance channel and turning basin area are to be dredged by a hopper dredger of 4,000 m^3 class, while the area in front of the slab berth and around the coal pier is to be dredged by a large-sized cutter suction dredger of 8,000 HP class. The soil dredged by the hopper dredger is to be stocked in a temporary depot of 200 m x 400 m in area, and delivered to the area to be reclaimed by cutter suction dredgers of 3,000 HP class. The reclamation is to be carried out directly from the coastline, and promoted concurrently with the construction of the revetment as shown in Fig. 8.2.2. The north and south sides of the reclaimed land are not to be protected by revetment, and the slab berth slope and the temporary depot for the soil dredged by a hopper dredger are to be dredged a little ahead of time in schedule of respective works.

It is necessary to consult with CVRD in advance on the sheltering of the dredgers and the other work ships to Tubarão Terminal, the nearest harbour, to avoid rough waves.

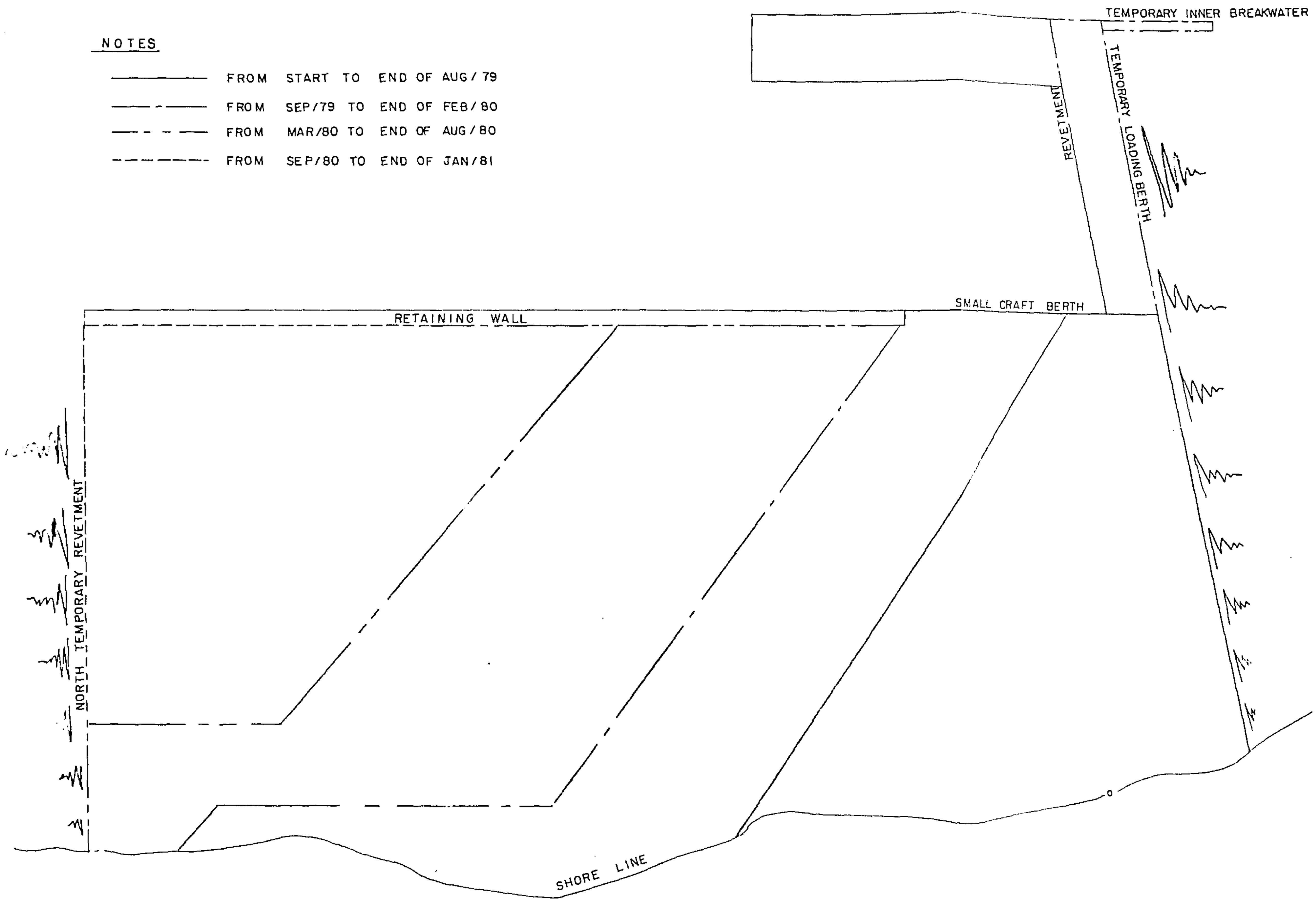


Fig. 8.2.1 PROGRESS OF RECLAMATION WORK

8-2-3 Slab berth (including the revetment)

The piling work is to be carried out by moving the piling rig on the temporaty scaffold. The piles are to be made of imported steel plates in a factory. These steel piles are to be welded into piles with required length in the working yard previously mentioned, and loaded onto a barge from the material loading pier. The piles are to be lifted by the crane of a pile driver and then driven into the aimed positions.

The steel sheet piles for the revetment are jointed with one another previously in the working yard. These steel sheet piles and the steel pipe piles for anchoring are to be carried to the respective spots in the same manner as mentioned above and driven by a piling barge into the aimed positions.

The anchoring piles, are to be driven prior to the steel sheet piles so as to joint the head of the anchoring piles with the revetment to keep it standstill against waves.

Until the enough sheltering effect of the breakwaters is secured, an appropriate measure should be taken to reduce the uplift pressure which may applied to the upper structure of the berth especially when the covering of the anchorage by the breakwaters is insufficient.

Attachement of the tie-rods to the revetment is to be carried out by a crane barge. Stone to protect the slope beneath the pier is placed on the slope by a crane before the upper concrete is set, and roughly arranged by a diver.

The upper structure is to be cast-in-place by a concrete pump after placing the support frames and forms on the main piles. In this case, special attention should be paid to damage of the forms and the fresh concrete by the uplift pressure.

8-2-4 Coal pier

The piling work and the construction of the upper structure of the coal pier are to be basically the same as of the slab berth.

8-2-5 Oil berth

The piling work for the oil berth is to be carried out by a piling barge, since this work is scheduled to start near the completion of the breakwater. Those piles, however, which come in the slope of the breakwater must be driven before the breakwater is built.

8-2-6 Small craft berth and revetment

As for the rubble mound works, stone loaded on a barge is to be scooped up by the grab bucket suspended from a 30 ton crane, and cast into a required shape. The casting work is to be carried out under instructions from a diver while the levelling work is performed by a diver.

The precast concrete blocks are to be carried to the spot by barge, and placed one after another on the rubble mound by a 100 ton crane barge under instructions of a diver. As soon as piled up to the height of +2.5 m, they are to be back-filled so as to facilitate the supply of materials to the slab berth and the coal pier.

8-3 Construction schedule

8-3-1 Outline

The general schedule of works is shown in Fig. 8.3.1. The preliminary construction work is to start in August, 1977, and the construction of the north and south breakwaters is to start simultaneously in February, 1978.

As stated in Chapter 8.3.4, the dates imply the starts of work in the site, and do not include the period necessary for pre-arrangement and post-arrangement.

The first stage of the work for the coal pier and the slab berth is to be completed respectively at the end of January and April, 1981. At this stage, the north breakwater is to be completed leaving approximately 600 m still under construction.

The first stage of the work is to be completed at the end of March, 1982, when the north breakwater is scheduled to be completed.

8-2-2 North and south breakwaters

As for the two breakwaters, the basic portion up to the height of +3.3 m including the core structure is to be constructed sequentially from the shore to the extreme end first, and then added the remaining part up to the finally designed sectional dementions backward from the extreme end after finishing the termination work there.

The progress schedule of construction up to +3.3 m level of both breakwaters is shown in Fig. 8.3.2. The number of workdays per month for breakwater construction estimated is 20, and the number of workhours per day also 20. The number of workhours per day of the crane to be operated on the breakwaters is set at 20, while the working hours of the crane barge is set at 8 hours a day and 15 days a month.

The increase of the marine work ratio is an effective measure to shorten the term of works, but it has been decided to confine the marine work to the minimum required range in consideration of the rise in cost and the

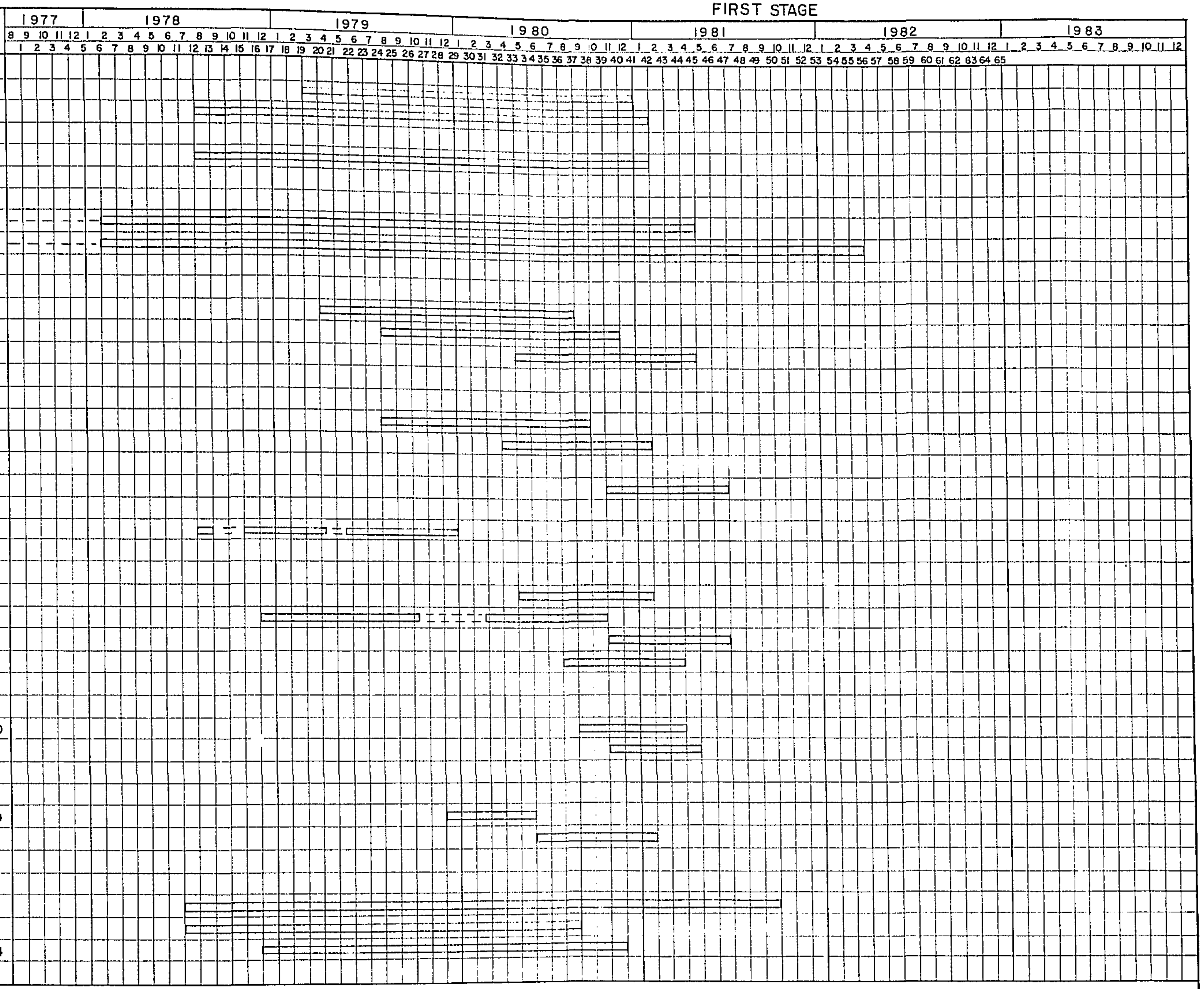
PROJECT

CONSTRUCTION OF PRAIA MOLE PORT

Fig. 8.3.1 PROGRAMME OF WORKS (ORIGINAL)

FIRST STAGE

ITEM	PARTICULARS	UNIT	QUANTITY
1	Dredging		
	dredging by hopper suction dredger	M^3	6,195,000
	dredging by cutter suction dredger	M^3	11,045,000
2	Reclamation	M^2	1,115,000
3	Breakwater		
	south breakwater	M	3,400
	north breakwater	M	3,700
4	Slab berth		
	quaywall	M	640
	retaining wall	M	640
	equipment	SUM	
5	Coal pier		
	pier	M	310
	equipment	SUM	
6	Oil berth	BERTH	1
7	Small craft berth	M	350
8	Revetment		
	retaining wall (A)	M	320
	revetment (B)	M	590
	temporary revetment (C)	M	610
	revetment (D)	M	180
9	Slab yard		
	foundation	M	3,000
	equipment	SUM	
10	Coal yard		
	foundation	M	5,480
	equipment	SUM	
11	Other facilities		
	road	SUM	
	electricity	SUM	
	tug boat	NO	4



NOTE : BROKEN LINES OF BREAKWATER WORKS SHOW THE PRELIMINARY WORKS (MAINLY CONSTRUCTION OF TEMPORARY ROAD, A JETTY AND CLEARANCE OF QUARRY SITE)

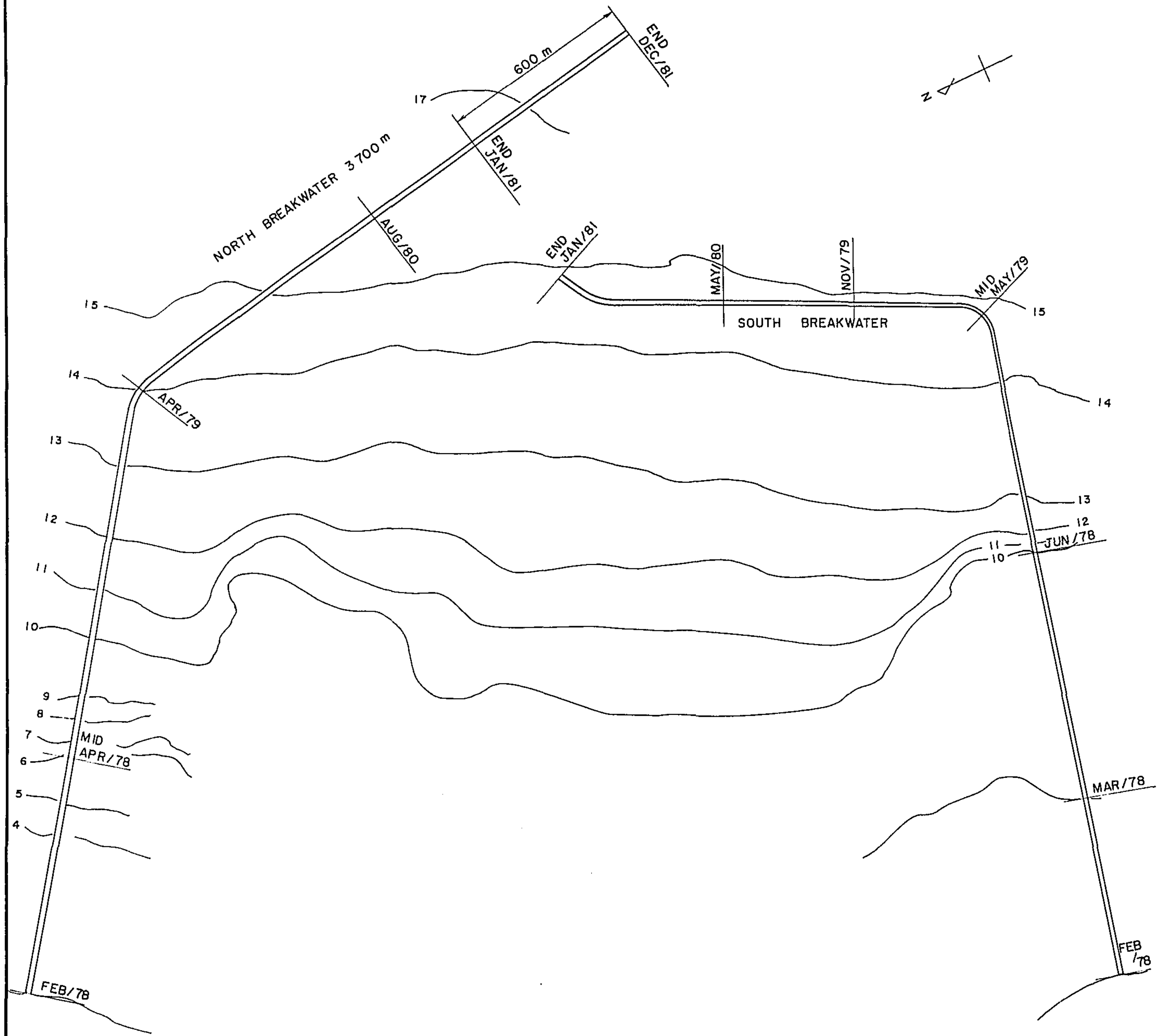


Fig. 8.3.2 PROGRESS OF BREAKWATER WORK

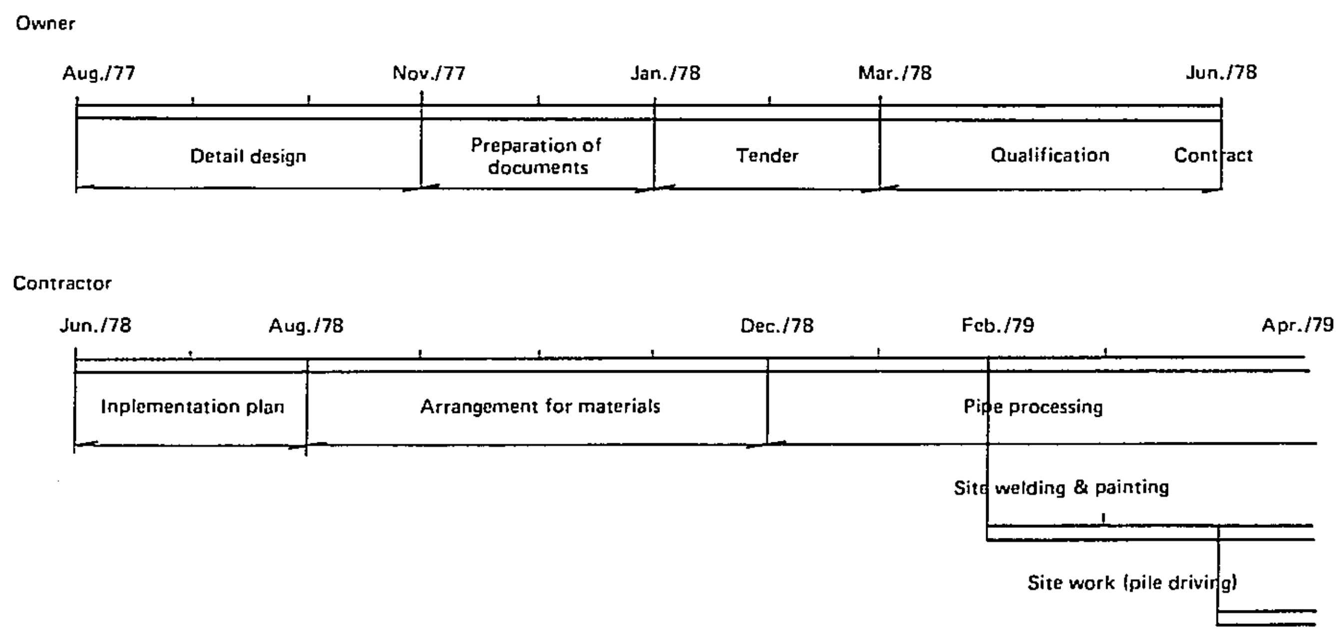


Fig. 8.3.3 Preliminary work schedule

CHAPTER 9. ROUGH ESTIMATE OF THE CONSTRUCTION COST

9. Rough estimate of the construction cost

9-1 Condition of the estimate

The cost of construction is roughly estimated upon the following conditions.

① This estimate is based upon the current cost as of Feburary, 1977, and the result of the final survey made in March.

② The exchange rate used in this estimate is as follows.

Cr$12.8 = US$1 (US$1 = ¥300)

③ The following taxes are to be exempted.

ⓐ Import tax and carrying-in tax (IPI, ICM)

ⓑ Service tax (ISS)

④ The following facilities are to be excluded from this estimate.

ⓐ Loading and unloading facilities (stacker, reclaimer, conveyer, etc.) for the CST coal yard within the port area.

ⓑ Sprinklers installed in coal unloaders and at the coal yard for Usiminas.

ⓒ Oil handling facilities (loading arm, oil pipelines, road on the south breakwater, oil tanks, etc.)

ⓓ Navigational aids (nautical marks, beacons, etc.)

⑤ The other items counted up as foreign goods than those previously mentioned are as per the Record of Discussions.

⑥ The physical contingency reserve for the civil engineering works (including the building of the tugboat, the electrical work, etc.) is to be 10% of the cost of construction.

⑦ From the present situation in Brazil, it seems reasonable to estimate the physical contingency of cargo handling facilities to be approximately 35% of the minimum import rate of foreign goods. In such a case, no physical contingency is to be taken into account to the total construction cost of the cargo handling facilities, since the whole cost of the construction goes down corresponding to any increase of the import rate.

9-2 Result of the estimate

The results of the estimate are as shown in Tables 9.2.1 to 9.2.8.

9-3 In case the import rate of the cargo handling facilities is raised

If the import rate of the cargo handling facilities is raised approximately to 55% (originally estimated at 23%), the total cost of construction is expected to be $349 million (foreign currency portion to be $91 million), though the present import control policy of the Brazilian Government must be duly taken into consideration. If this increase in the import rate is possible, the cost of construction belonging to the first stage work will be $294 million (foreign currency portion to be $68 million).

Table 9.2.1 Estimates of construction cost

Particulars		Unit	Quantity	Construction cost (Amount in US$ 1,000)			Remarks
				Total amount	First stage	Second stage	
1.	BREAKWATERS	M	7,100	(83,075)	(83,075)	-	
1.1	South breakwater	M	3,400	36,683	36,683	-	
1.2	North breakwater	M	3,700	46,392	46,392	-	
2.	DREDGING	M^3	(17,240,000)	(62,618)	(62,618)	-	
2.1	Dredging by a hopper dredger	M^3	6,195,000	15,585	15,585	-	
2.2	Dredging by cutter dredgers	M^3	11,045,000	47,033	47,033	-	
3.	MOORING FACILITIES			(43,059)	(30,138)	(12,921)	
3.1	Slab berths	M	960	26,166	20,031	6,135	
3.2	Coal pier	M	590	13,571	6,785	6,786	
3.3	Oil berth	BERTH	1	1,578	1,578	-	
3.4	Small craft berth	M	350	1,744	1,744	-	
4.	RECLAMATION			(9,686)	(9.686)	-	
5.	OTHER FACILITIES			(39,750)	(33,250)	(6,500)	
5.1	Roads			7,364	7,364	-	
5.2	Power supply			12,111	8,507	3,604	
5.3	Tug boats	NO	5	10,664	8,531	2,133	
5.4	Others			9,611	8,848	763	
	SUB TOTAL :			238,188	218,767	19,421	
6.	PHYSICAL CONTINGENCY			23,819	21,877	1,942	
	TOTAL :			262,007	240,644	21,363	
7.	CARGO HANDLING EQUIPMENT			(112,289)	(69,240)	(43,049)	
7.1	Slab berths			25,492	16,000	9,492	slab loader; 8 sets
7.2	Slab yard			21,659	12,313	9,346	slab crane ;18 sets
7.3	Coal pier			22,782	13,156	9,626	unloader; 4 sets, conveyor; 4 lanes
7.4	Coal yard			42,356	27,771	14,585	stacker; 3 sets, reclaimer; 2 sets (including conveyors)
	GRAND TOTAL :			374,296	309,884	64,412	

Table 9.2.2 Foreign currency allocations

No.	Particulars	Unit	Quantity	Construction cost (Amount in US$ 1,000) Total amount	First stage	Second stage	Remarks
1.	BREAKWATERS	M	(7,100)	(83,075)	(83,075)	-	
1.1	South breakwater	M	3,400	36,683	36,683	-	
1.2	North breakwater	M	3,700	46,392	46,392	-	
2.	DREDGING	M^3	(17,240,000)	(62,618)	(41,618)	(21,000)	
2.1	Dredging by a hopper dredger	M^3	6,195,000	15,585	7,933	7,652	
2.2	Dredging by cutter dredgers	M^3	11,045,000	47,033	33,685	13,348	
3.	MOORING FACILITIES			(43,059)	(31,214)	(11,845)	
3.1	Slab berths	M	960	26,166	17,535	8,631	
3.2	Coal pier	M	590	13,571	10,692	2,879	
3.3	Oil berth	BERTH	1	1,578	1,270	308	
3.4	Small craft berth	M	350	1,744	1,717	27	
4.	RECLAMATION			(9,686)	(7,420)	(2,266)	
5.	OTHER FACILITIES			(39,750)	(35,435)	(4,315)	
5.1	Roads			7,364	7,364	-	
5.2	Power supply			12,111	10,822	1,289	
5.3	Tug boats	NO	5	10,664	8,838	1,826	
5.4	Others			9,611	8,411	1,200	
	SUB TOTAL :			238,188	198,762	39,426	
6.	PHYSICAL CONTINGENCY	SUM		23,819	19,876	3,943	
	TOTAL :			262,007	218,638	43,369	
7.	CARGO HANDLING EQUIPMENT			(112,289)	(93,084)	(25,927)	
7.1	Slab berths			(25,492)	(17,824)	(7.668)	
7.1.1	Slab loarders	NO	8	23,872	17,824	6,048	
7.1.2	Forklifts	NO	6	1,620	-	1,620	
7.2	Slab yard			(21,659)	(18,437)	(3,222)	
7.2.1	Slab cranes	NO	18	13,739	10,517	3,222	
7.2.2	Tractors	NO	10	3,600	3,600	-	
7.2.3	Trailers	NO	24	4,320	4,320	-	
7.3	Coal pier			(22,782)	(18,674)	(4,108)	
7.3.1	Unloarders	NO	4	17,664	13,790	3,874	
7.3.2	Conveyors	NO	4	4,498	4,264	234	
7.3.3	Bulldozers	NO	8	620	620	-	
7.4	Coal yard			(42,356)	(38,149)	(4,207)	
7.4.1	Stackers	NO	3	6,465	5,178	1,287	
7.4.2	Reclaimers	NO	2	4,658	3,594	1,064	
7.4.3	Car loading silo	NO	1	2,462	2,269	193	
7.4.4	Conveyors			28,381	26,718	1,663	
7.4.5	Bulldozers/tractor shovels	NO	4	390	390	-	
7.5	Physical contingency			-	-	(6,722)	
	GRAND TOTAL :			374,296	311,722	69,296	

The sum of the local and foreign currency portions does not become the 374,296 thousand US dollars because the physical contingency for the cargo handling equipment has been allocated to the foreign currency portion only.

Table 9.2.3 Local currency and foreign currency portions (first stage)

	Particulars	Unit	Quantity	Construction cost (Amount in US$ 1,000)			Remarks
				Total amount	First stage	Second stage	
1.	BREAKWATERS	M	(7,100)	(83,075)	(83,075)	-	
1.1	South breakwater	M	3,400	36,583	36,683	-	
1.2	North breakwater	M	3,700	46,392	46,392	-	
2.	DREDGING	M^3	(17,240,000)	(62,618)	(41,618)	(21,000)	
2.1	Dredging by hopper dredger	M^3	6,195,000	15,585	7,933	7,652	
2.2	Dredging by cutter dredger	M^3	11,045,000	47,033	33,685	13,348	
3.	MOORING FACILITIES			(30,138)	(21,539)	(8,599)	
3.1	Slab berth	M	640	20,031	13,237	6,794	
3.2	Coal pier	M	310	6,785	5,315	1,470	
3.3	Oil berth	BERTH	1	1,578	1,270	308	
3.4	Small craft berth	M	350	1,744	1,717	27	
4.	RECLAMATION			(9,626)	(7,420)	(2,266)	
5.	OTHER FACILITIES			(33,250)	(30,074)	(3,176)	
5.1	Road			7,364	7,364	-	
5.2	Power supply			8,507	7,560	947	
5.3	Tug boat	NO	4	8,531	7,071	1,460	
5.4	Others			8,848	8,079	769	
	SUB TOTAL :			218,767	183,726	35,041	
6.	PHYSICAL CONTINGENCY			21,877	18,373	3,504	
	TOTAL :			240,644	202,099	38,545	
7.	CARGO HANDLING EQUIPMENT			(69,240)	(57,522)	(15,820)	
7.1	Slab berth			(16,000	(11,140)	(4,860)	
7.1.1	Slab loarder	NO	5	14,920	11,140	3,780	
7.1.2	Forklift	NO	4	1,080	-	1,080	
7.2	Slab yard			(12,313)	(10,523)	(1,790)	
7.2.1	Slab crane	NO	10	7,633	5,843	1,790	
7.2.2	Tractor	NO	6	2,160	2,160	-	
7.2.3	Trailer	NO	14	2,520	2,520	-	
7.3	Coal pier			(13,156)	(10,760)	(2,396)	
7.3.1	Unloader	NO	2	10,391	8,112	2,279	
7.3.2	Conveyer	NO	2	2,455	2,338	117	
7.3.3	Bulldozer	NO	4	310	310	-	
7.4	Coal yard			(27,771)	(25,099)	(2,672)	
7.4.1	Stacker	NO	2	4,310	3,452	858	
7.4.2	Reclaimer	NO	1	2,329	1,797	532	
7.4.3	Car loading silo	NO	1	2,462	2,269	193	
7.4.4	Conveyor			18,475	17,386	1,089	
7.4.5	Bulldozer/tractor shovel	NO	2	195	195	-	
7.5	Physical contingency			-	-	(4,102)	
	GRAND TOTAL :			309,884	259,621	54,365	

Table 9.2.4 Local currency and foreign currency portions (second stage)

No.	Particulars	Unit	Quantity	Construction cost (Amount in US$ 1,000) Total amount	First stage	Second stage	Remarks
1.	BREAKWATERS	M	-	-	-	-	
1.1	South breakwater	M	-	-	-	-	
1.2	North breakwater	M	-	-	-	-	
2.	DREDGING	M^3	-	-	-	-	
2.1	Dredging by hopper dredger	M^3	-	-	-	-	
2.2	Dredging by cutter dredger	M^3	-	-	-	-	
3.	MOORING FACILITIES			(12,921)	(9,675)	(3,246)	
3.1	Slab berth	M	320	6,135	4,298	1,837	
3.2	Coal pier	M	280	6,786	5,377	1,409	
3.3	Oil berth	BERTH	-	-	-	-	
3.4	Small craft berth	M	-	-	-	-	
4.	RECLAMATION		-	-	-	-	
5.	OTHER FACILITIES			(6,500)	(5,361)	(1,139)	
5.1	Road		-	-	-	-	
5.2	Power supply			3,604	3,262	342	
5.3	Tug boat	NO	1	2,133	1,767	366	
5.4	Others			763	332	431	
	SUB TOTAL :			19,421	15,036	4,385	
6.	PHYSICAL CONTINGENCY	SUM		1,942	1,504	438	
	TOTAL :			21,363	16,540	4,823	
7.	CARGO HANDLING EQUIPMENT			(43,049)	(35,562)	(10,107)	
7.1	Slab berth	SUM		(9,492)	(6,684)	(2,808)	
7.1.1	Slab loarder	NO	3	8,952	6,684	2,268	
7.1.2	Forklift	NO	2	540	-	540	
7.2	Slab yard	SUM		(9,346)	(7,914)	(1,432)	
7.2.1	Slab crane	NO	8	6,106	4,674	1,432	
7.2.2	Tractor	NO	4	1,440	1,440	-	
7.2.3	Trailer	NO	10	1,800	1,800	-	
7.3	Coal pier	SUM		(9.626)	(7,914)	(1,712)	
7.3.1	Unloader	NO	2	7,273	5,678	1,595	
7.3.2	Conveyor	NO	2	2,043	1,926	117	
7.3.3	Bulldozer	NO	4	310	310	-	
7.4	Coal yard	SUM		(14,585)	(13,050)	(1,535)	
7.4.1	Stacker	NO	1	2,155	1,726	429	
7.4.2	Reclaimer	NO	1	2,329	1,797	532	
7.4.3	Car loading silo	NO	-	-	-	-	
7.4.4	Conveyor	SUM		9,906	9,332	574	
7.4.5	Bulldozer/tractor shovel	NO	2	195	195	-	
7.5	Physical contingency			-	-	(2,620)	
	GRAND TOTAL :			64,412	52,102	14,930	

Table 9.2.5 Annual investment (first stage)

(UNIT IN US$1,000,000)

PARTICULARS	TOTAL INVESTMENT			'77			'78			'79			'80			'81			'82		
	L	F	TOTAL	L	F	TOTAL	L	F	TOTAL	L	F	TOTAL	L	F	TOTAL	L	F	TOTAL	L	F	TOTAL
1. BREAKWATERS	(83.1)	-	(83.1)	(3.1)	-	(3.1)	(19.8)	-	(19.8)	(21.6)	-	(21.6)	(21.6)	-	(21.6)	(14.3)	-	(14.3)	(2.7)	-	(2.7)
1.1 south breakwater	36.7	-	36.7	1.3	-	1.3	10.0	-	10.0	10.9		10.9	10.9		10.9	3.6		3.6			-
1.2 north breakwater	46.4	-	46.4	1.8	-	1.8	9.8	-	9.8	10.7	-	10.7	10.7	-	10.7	10.7	-	10.7	2.7		2.7
2. DREDGING	(41.6)	(21.0)	(62.6)				(5.5)	(3.6)	(9.1)	(17.1)	(7.3)	(24.4)	(17.8)	(6.7)	(24.5)	(1.2)	(3.4)	(4.6)			
2.1 dredging by a hopper dredger	7.9	7.7	15.6				-	-	-	3.6	3.6	7.2	4.3	3.0	7.3	-	1.1	1.1			
2.2 dredging by cutter dredgers	33.7	13.3	47.0				5.5	3.6	9.1	13.5	3.7	17.2	13.5	3.7	17.2	1.2	2.3	3.5			
3. MOORING FACILITIES	(21.5)	(8.6)	(30.1)							(9.8)	(3.5)	(13.3)	(10.4)	(5.1)	(15.5)	(1.3)	-	(1.3)			
3.1 slab berth	13.2	6.8	20.0							6.3	3.0	9.3	6.9	3.8	10.7						
3.2 coal pier	5.3	1.5	6.8							1.8	0.5	2.3	3.5	1.0	4.5						
3.3 oil berth	1.3	0.3	1.6							-	-	-	-	0.3	0.3	1.3	-	1.3			
3.4 small craft berth	1.7	-	1.7							1.7	-	1.7									
4. RECLAMATION	(7.4)	(2.3)	(9.7)							(3.1)	(0.1)	(3.2)	(3.3)	(1.5)	(4.8)	(1.0)	(0.7)	(1.7)			
5. OTHER FACILITIES	(30.1)	(3.2)	(33.3)				(1.2)	-	(1.2)	(13.0)	(1.4)	(14.4)	(13.9)	(1.8)	(15.7)	(2.0)	-	(2.0)			
TOTAL	183.7	35.1	218.8	3.1	-	3.1	26.5	3.6	30.1	64.6	12.3	76.9	67.0	15.1	82.1	19.8	4.1	23.9	2.7	-	2.7
6. CARGO HANDLING EQUIPMENT	(57.5)	(11.7)	(69.2)										(26.2)	(4.7)	(30.9)	(31.3)	(7.0)	(38.3)			
6.1 slab berth	11.2	4.8	16.0										4.5	1.5	6.0	6.7	3.3	10.0			
6.2 slab yard	10.5	1.8	12.3										11.1	0.4	1.5	9.4	1.4	10.8			
6.3 coal pier	10.7	2.4	13.1										4.1	1.1	5.2	6.6	1.3	7.9			
6.4 coal yard	25.1	2.7	27.8										16.5	1.7	18.2	8.6	1.0	9.6			
GRAND TOTAL	241.2	46.8	288.0	3.1	-	3.1	26.5	3.6	30.1	64.6	12.3	76.9	93.2	19.8	113.0	51.1	11.1	62.2	2.7	-	2.7

NOTE: 1) The physical contigencies for the civil work and the cargo handling equipment are excluded in this table.

2) L and F are local and foreign currency respectively.

Table 9.2.6 Annual investment (second stage)

(UNIT IN US$1,000,000)

PARTICULARS	TOTAL INVESTMENT			'82			'83			
	L	F	TOTAL	L	F	TOTAL	L	F	TOTAL	
1. MOORING FACILITIES	(9.7)	(3.2)	(12.9)	(9.7)	(3.2)	(12.9)				
1.1 slab berth	4.3	1.8	6.1	4.3	1.8	6.1				
1.2 coal pier	5.4	1.4	6.8	5.4	1.4	6.8				
2. OTHER FACILITIES	(5.4)	(1.1)	(6.5)	(5.4)	(1.1)	(6.5)				
TOTAL	15.1	4.3	19.4	15.1	4.3	19.4				
3. CARGO HANDLING EQUIPMENT	(35.6)	(7.4)	(43.0)				(35.6)	(7.4)	(43.0)	
3.1 slab berth	6.7	2.8	9.5				6.7	2.8	9.5	
3.2 slab yard	7.9	1.4	9.3				7.9	1.4	9.3	
3.3 coal pier	7.9	1.7	9.6				7.9	1.7	9.6	
3.4 coal yard	13.1	1.5	14.6				13.1	1.5	14.6	
GRAND TOTAL	50.7	11.7	62.4	15.1	4.3	19.4	35.6	7.4	43.0	

NOTE: 1) The physical contigencies for the civil work and the cargo equipment are excluded in this table.

2) L and F are local and foreign currency respectively.

Table 9.2.7 The list of imported materials (first stage)

(UNIT IN US$1,000)

PARTICULARS		FOREIGN CURRENCY ALLOCATIONS	IMPORTED ITEMS
1.	BREAKWATERS		
1.1	south breakwater	-	
1.2	north breakwater	-	
2.	DREDGING	(21,000)	
2.1	dredging by a hopper dredger	7,652	(chartering a hoppr suction dredger)
2.2	dredging by a cutter dredger	13,348	(chartering a cutter suction dreger)
3.	MOORING FACILITIES	(8.599)	
3.1	slab berth	6,794	steel sheets for steel pipe piles, steel sheets piles, bollards, fendors, crane rails, tie-rods
3.2	coal pier	1,470	steel sheets for steel pipe piles, bollards, fenders, crane rails,
3.3	oil berth	308	steel sheets for the pipe piles, bollards, fenders
3.4	small craft berth	27	protection sheets
4.	RECLAMATION	(2,266)	steel sheets for steel pipe piles, steel sheets piles, protection sheets, tie-rods
5.	OTHER FACILITIES	(3,176)	
5.1	road	-	
5.2	power supply	947	transformers
5.3	tug boat	1,460	engines
5.4	others	769	crane rails, VHF equipment
	TOTAL	35,041	
6.	CARGO HANDLING EQUIPMENT	(11,718)	as shown in the record of discussions
6.1	slab berth	(4,860)	
6.1.1	slab loader	3,780	
6.1.2	fork lift	1,080	
6.2	slab yard	(1,790)	
6.2.1	slab crane	1,790	
6.2.2	tractor	-	
6.2.3	trailer	-	
6.3	coal pier	(2,396)	
6.3.1	unloader	2,279	
6.3.2	conveyor	117	
6.4	coal yard	(2,672)	
6.4.1	stocker	858	
6.4.2	reclaimer	532	
6.4.3	car loading sile	193	
6.4.4	conveyor	1,089	
6.4.5	bulldozer/tractor shovel	-	
	GRAND TOTAL	46,759	

NOTE: CONTINGENCY IS EXCLUDED

Table 9.2.8 The list of imported materials (second stage)

(UNIT IN US$1,000)

PATICULARS		FOREIGN CURRENCY ALLOCATIONS	IMPORTED ITEMS
1.	BREAKWATERS	-	
1.1	south breakwater	-	
1.2	north breakwater	-	
2.	DREDGING	-	
2.1	dredging by a hopper dredger		
2.2	dredging by a cutter dredger	-	
3.	MOORING FACILITIES	(3,246)	
3.1	slab berth	1,837	steel sheets for steel pipe piles, bollards, fenders, crane rails
3.2	coal pier	1,409	steel sheets for steel pipe piles, bollards, fenders, crane rails
3.3	oil berth	-	
3.4	small craft berth	-	
4.	RECLAMATION	-	
5.	OTHER FACILITIES	(1,139)	
5.1	road	-	
5.2	power supply	342	transformers
5.3	tug boat	366	engines
5.4	others	431	crane rails
	TOTAL	4,385	
6.	CARGO HANDLING EQUIPMENT	(7,487)	as shown in the record of discussions
6.1	slab berth	(2,808)	
6.1.1	slab loader	2,268	
6.1.2	fork lift	540	
6.2	slab crane	1,432	
6.2.1	slab crane	1,432	
6.2.2	tractor	-	
6.2.3	trailer	-	
6.3	coal pier	(1,712)	
6.3.1	unloader	1,595	
6.3.2	conveyor	117	
6.3.3	bulldozer	-	
6.4	coal yard	(1,535)	
6.4.1	stocker	429	
6.4.2	reclaimer	532	
6.4.3	car loading sile	-	
6.4.4	conveyor	574	
6.4.5	bulldozer/tractor shovel	-	
	GRAND TOTAL	11,872	

NOTE: CONTINGENCY IS EXCLUDED

CHAPTER 10. AN ALTERNATIVE PLAN OF THE EXECUTION AND SCHEDULE OF WORK

10. An alternative plan of the execution and schedule of work

10-1 Necessity of an alternative plan

10-1-1 Outline

The construction schedule discussed in Chapter 8 is a soonest possible schedule so drafted as to complete the construction work of Praia Mole Port in time for the inauguration of CST operation. Under this schedule, the dredging work, construction of the mooring facilities, etc. must be promoted without enough covering of the breakwaters. This type of execution method, however, is not advisable especially for the construction work in the open sea like Praia Mole Port, since it often requires longer term of work and higher cost of construction due to possible accidents of dredgers and damage of the structure under construction during unforeseen stormy weather. If any human lives are list, the problem becomes more serious.

In such a case as Praia Mole Port, it is normal to establish the breakwaters first and to start the dredging work, construction of the mooring facilities, etc. after the covering of the anchorage by the breakwaters is almost completed.

In this chapter, the execution schedule of the whole work and the cost of construction for a normal method are discussed as a counter-plan.

10-1-2 Merits and demerits of the alternative plan

In this alternative plan, the dredging work is to start in February, 1981, the construction work of the mooring and other facilities is to be delayed accordingly, while the breakwaters alone are to be constructed as per the original schedule. The total construction schedule is shown in Fig. 10.2.1. Specified below are merits and demerits of this counter-plan compared with the original plan.

① Dredging work

ⓐ With the expansion of the work range covered by cutter suction dredgers, the dredging and reclamation work is expected to be promoted more effectively.

ⓑ The working ratio of dredgers is expected to be improved, and the term of dredging work to be shortened.

ⓒ No large-sized cutter suction dredger of 8,000 HP class is to be necessary, since less seaworthiness is required of dredgers.

ⓓ The arrangement plan of the dredgers can be reexamined together with the availability of Brazilian dredgers, because there is sufficient time more than 3 years before the dredging work is scheduled to start.

② Mooring facilities

ⓐ The piling work can be carried out by a piling barge.

ⓑ No extra reinforcement of the revetment by anchoring piles is required, since it is exposed to less wave force.

ⓒ The wave force applied to the upper structure of the pier under construction is expected to be reduced.

③ Temporary construction

ⓐ Temporary construction of the inner breakwater becomes unnecessary.

④ The construction work in general involves less danger, and the effective execution of work can be secured.

⑤ The construction work of the roads, the electrical facilities, etc. can be carried out with a sufficient time margin.

⑥ The total cost of construction can be reduced.

With all these merits, the only demerit conceibable is that the total term of work is prolonged and the inauguration of the port service is retarded.

As is clear from the general construction schedule shown in Fig. 10.1.1 the operation start of the coal pier standing in the most pressing need is expected to be in September, 1982, nineteen months behind the inauguration date scheduled for February, 1980, in the original plan. If the recent information from the Brazilian side that CST has revealed their intention of using the coal pier from December 1st, 1980, is true, the delay comes to 21 months.

A 35 ton dump truck can be introduced for the construction work of the breakwaters, as proposed from the Brazilian side to our third mission to Brazil. According to our rough estimate, the use of 35 ton dump truck for this work will shorten the term of work for the north breakwater by about four months, though the cost of construction is a little increased. As to this matter, further detailed investigation is required at the actual stage of execution.

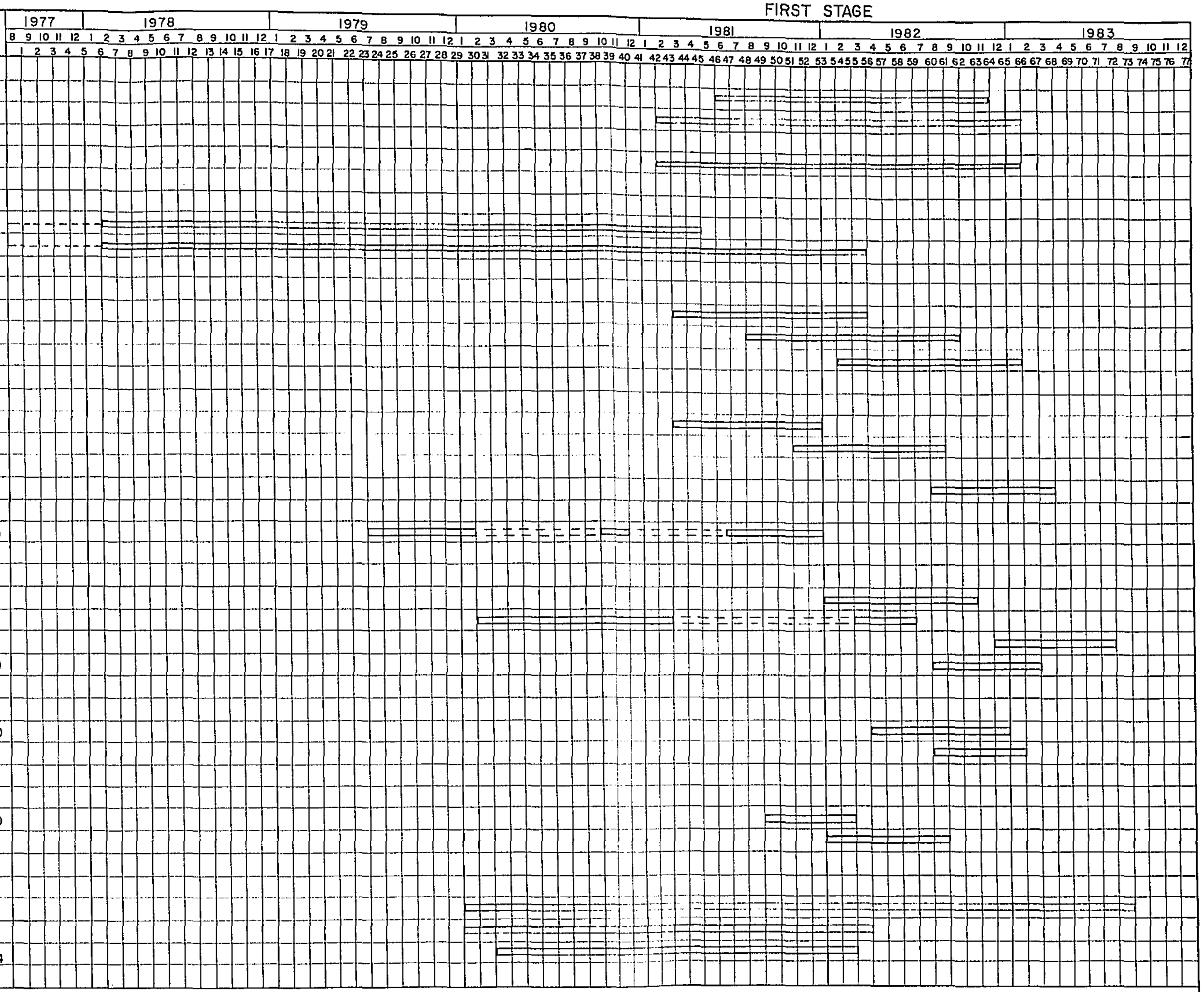
PROJECT

CONSTRUCTION OF PRAIA MOLE PORT

Fig. 10.2.1 PROGRAMME OF WORKS (ALTERNATIVE)

FIRST STAGE

ITEM	PARTICULARS	UNIT	QUANTITY
1	Dredging		
	dredging by hopper suction dredger	M^3	2,280,000
	dredging by cutter suction dredger	M^3	8,520,000
2	Reclamation	M^2	1,115,000
3	Breakwaters		
	south breakwater	M	3,400
	north breakwater	M	3,700
4	Slab berth		
	quaywall	M	640
	retaining wall	M	640
	equipment	SUM	
5	Coal pier		
	pier	M	310
	equipment	SUM	
6	Oil berth	BERTH	1
7	Small craft berth	M	350
8	Revetment		
	retaining wall (A)	M	320
	revetment (B)	M	590
	north tempory revetment (C)	M	610
	temporary revetment (D)	M	180
9	Slab yard		
	foundation	M	3,000
	equipment	SUM	
10	Coal yard		
	foundation	M	5,480
	equipment	SUM	
11	Other facilities		
	road	SUM	
	electricity	SUM	
	tug boat	NO	4



NOTE : BROKEN LINES OF BREAKWATER WORKS SHOW THE PRELIMINARY WORKS (MAINLY CONSTRUCTION OF TEMPORARY ROAD, A JETTY AND CLEARANCE OF QUARRY SITE)

10-2 Dredging and reclamation work

10-2-1 Conditions of the selection of dredger types

① A hopper dredger is to cover the entrance channel and part of the turning basin beyond the range of normal pumping distance covered by a cutter suction dredger.

② A cutter suction dredger is to cover as wide range of the dredging work as possible.

③ As many domestic dredgers as possible are to be used for the work under the more favourable condition of execution compared with the original plan.

④ A hopper suction dredger is to deliver the dredged soil to the area to be reclaimed by its own pump so as to carry out the dredging work by as few work ships as possible. For this purpose, a temporary dolphin is to be constructed.

10-2-2 Capacity of dredgers (monthly dredging volume by nature of soil)

① The average number of workdays per month of both hopper dredgers and cutter suction dredgers is to be 25.

② Table 10.2.1 shows the monthly dredging volume by a hopper dredger. (In case the dredged soil are carried to the area to be reclaimed by itself).

Table 10.2.1 Monthly dredging volume by a hopper dredger

(Volume in m^3)

Soil	N<10	10<N<20	Supplementary dredging and 20 N 30
Sand	250,000	200,000	150,000

③ Table 10.2.2 shows the monthly dredging volume by a cutter suction dredger (main pump is of 3,000 HP class).

Table 10.2.2 Monthly dredging volume by a cutter suction dredger

(Volume in m^3)

Soil	N<10	10<N<20	20<N<30
Sand and clayey soil	180,000	140,000	90,000

10-2-3 Dredging area and dredging volume

Table 10.2.3 shows the dredging volume of a hopper dredger and a cutter suction dredger by N-value.

Table 10.2.3 Dredging volume by each dredger

(Volume in 1,000 m^3)

Item	Hopper suction		Cutter suction	
	N-value	Volume	N-value	Volume
Channel	N<10	1,280 (1,280)		
Turning basin	10<N<20	460 (460)	N<10 10 N<20	2,300 1,540 (3,670)
Slab berth			N<10 10 N<20 20 N<30	650 1,000 970 (650)
Coal pier			10<N<20	2,030 (1,730)
Subtotal		1,740 (1,740)		8,520 (6,050)
Supplementary dredging		540 (540)		
Total		2,280 (2,280)		8,520 (6,050)

Note: 1) That part within the turning basin which is to be dredged by the hopper suction dredger shall be the extension of the channel; it measures 1,850m by 270m in area and 2m in mean thickness, or 460,000m^3 in volume.

2) The values in parentheses refer to the sand volume.

3) The supplementary dredging volume is calculated with the loss of realaiming material dredged by each dredger set at 0.19.

10-2-4 The term of each work

Table 10.2.4 shows the term of work allocated to each dredger.

Table 10.2.4 Working period of each dredger

Dredger / Type of work			hopper suction		cutter suction	
			Volume, m^3	Work period, months	Volume m^3	Work period, months
Dredging month	N-value	N<10	1,280,000	5.1	2,980,000	16.5
		10<N<20	460,000	2.3	4,570,000	32.6
		20<N<30	540,000	3.6	970,000	10.8
Finishing month				4.3		6.1
Total				15.3		66.0
Work period per vessel, months				15.3		22.0
Maintenance period, months				2.7		2.0
Months in commission per vessel				18.0		24.0

10-2-5 The cost of dredging work

Brazilian dredgers are employed for the work.

Hopper dredger	18 month × 638,047 \$/month = 11,484,846 \$
Cutter suction dredger	24 month × 3 NO × 304,766 \$/month = 21,943,152 \$
Cost of building and removal of a dolphin	800,000 \$
Mobilization cost	638,047 \$ + 3 NO × 304,766 \$ = 1,552,345 \$

Total : 35,780,343 US\$

10-2-6 Conclusion

Compared with the original plan, the term of work is expected to be shorten by six months and the cost of construction to be reduced by about 40% (approximately $27 million) by this counter-plan. This reduction in the cost is attributed mainly to the availability of domestic dredgers in Brazil. In a calm water area protected by breakwaters, even the cutter suction dredgers in Brazil will be competent to the work, though they are not necessarily strong enough. There is also enough time to buy, if necessary, a large-sized cutter suction dredger from Japan, since the dredging work in this counter-plan is scheduled to start in 1981.

The most decisive character of this alternative plan is that the dredging work can be promoted without any fear of accidents.

10-3 Mooring facilities and revetment

10-3-1 Construction plant of each work and comparison of their efficiency

The piling work for the main structure of the slab and the coal berths is to be covered by a piling barge because the use of a piling barge is considered to be more effective in a stage that enough sheltering effect is secured by breakwaters, though the work is scheduled to be carried out with a piling rig supported on a staging (temporary scaffold) in the original plan. This method is also to be applied to the piling work of sheet piles.

Table 10.3.1 shows a comparison of the efficiency of piling works for the berth and the revetment.

Table 10.3.1 Comparison of piling work efficiency

Plan / Type of work	Original		Alternative	
	Applied equipment	Efficiency	Applied equipment	Efficiency
Steel pipe pile				
Slab berth	Land piling rig	34.4 piles/month	Piling barge	50 piles/month
Raking pile for revetment	Piling barge	100	Do	150 Do
Coal pier	Land piling rig	34.4	Do	50 Do
Oil berth	Piling barge driver	30	Do	30 Do
Steel sheet pile				
Revetment (1st stage slab)	Land piling rig	240 sets/month	Piling barge	200 sets/month
Revetment (2nd stage slab)	Piling barge driver	120 Do	Do	200 Do
Revetment (temporary revetment)	Do	102 Do	Do	200 Do

Notes: (1) Slab berth and temporary revetment

(2) The revetment for the second stage slab berth is to be constructed in the first stage in consideration of the reclamation.

In this alternative plan, the temporary breakwater to be built at the base of the coal pier also becomes unnecessary.

10-3-2 Comparison with the original plan

In this alternative plan, the term of construction work for the coal pier and the slab berth, for instance, is shortened by four months, from 14 to 10 and from 17 to 13 respectively. As stated later, the cost of construction is reduced approximately by $3.5 million including the reclamation and revetment. The most decisive merit of this counter-plan is that the construction work can be promoted safely and securely, though it makes no great difference in cost.

10-4 The cost of construction

10-4-1 Result of the estimate

According to the above comparative study, the cost of the dredging work, the mooring facility construction, and the revetment is reestimated as per the attached sheet. Comparison of the total cost, including that of the cargo handling facilities, estimated respectively in the original plan and the counter-plan is shown in Table 10.4.1.

Table 10.4.1 Comparison in construction cost between the original and the alternative plan

(in US$ 1,000)

Plan \ Construction cost	Total construction cost	Domestic currency	Foreign currency
Original	374,296	311,722	69,296
Alternative	340,945	301,471	46,196
Difference	33,351	10,251	23,100

The condition of the cost estimate for the alternative plan is the same as for the original plan.

10-4-2 In case the import rate of the cargo handling facilities is increased

As previously mentioned, if the import rate of the cargo handling facilities is raised approximately to 55%, the total cost of construction is estimated at about $316 million (the foreign currency portion to be $68 million). As to the first stage of work, the cost of construction is estimated at about $262 million (the foreign currency portion to be about $45 million).

Table 10.4.2 Estimates of construction cost

PARTICULARS		UNIT	QUANTITY	CONSTRUCTION COST (AMOUNT IN US$1,000)			REMARKS
				TOTAL AMOUNT	FIRST STAGE	SECOND STAGE	
1.	BREAKWATERS	M	(7,100)	(83,075)	(83,075)	-	
1.1	south breakwater	M	3,400	36,683	36,683	-	
1.2	north breakwater	M	3,700	46,392	46,392	-	
2.	DREDGING	M^3	(10,800,000)	(35,781)	(35,781)	-	
2.1	dredging by hopper dreger	M^3	2,280,000	12,923	12,923	-	
2.2	dreging by cutter dreger	M^3	8,520,000	22,858	22,858	-	
3.	MOORING FACILITIES			(40,252)	(28,449)	(11,803)	
3.1	slab berth	M	960	24,689	18,954	5,735	
3.2	coal pier	M	590	12,241	6,173	6,068	
3.3	oil berth	BERTH	1	1,578	1,578	-	
3.4	small craft berth	M	350	1,744	1,744	-	
4.	RECLAMATION			(9,011)	(9,011)	-	
5.	OTHER FACILITIES			(39,750)	(33,250)	(6,500)	
5.1	road			7,364	7,364	-	
5.2	power supply			12,111	8,507	3,604	
5.3	tug boat	NO	5	10,664	8,531	2,133	
5.4	others			9,611	8,848	763	
	SUB TOTAL			207,869	189,566	18,303	
6.	PHYSICAL CONTINGENCY			20,787	18,957	1,830	
	TOTAL			228,656	208,523	20,133	
7.	CARGO HANDLING EQUIPMENT			(112,289)	(69,240)	(43,049)	
7.1	slab berth			25,492	16,000	9,492	slab loader; 8 sets
7.2	slab yard			21,659	12,313	9,346	slab crane; 18 sets
7.3	coal pier			22,782	13,516	9,626	unloader; 4 sets, conveyor; 4 largs
7.4	coal yard			42,356	27,771	14,585	stocker; 3 sets, reclaimer; 2 sets
7.5	physical contingency			-	-	-	(including conveyors)
	GRAND TOTAL			340,945	277,763	63,182	

Table 10.4.3 Foreign currency allocations

	PARTICULARS	UNIT	QUANTITY	CONSTRUCTION COST (AMOUNT IN US$1,000) TOTAL AMOUNT	LOCAL CURRENCY	FOREIGN CURRENCY	REMARKS
1.	BREAKWATERS	M	(7,100)	(83,075)	(83,075)	-	
1.1	south breakwater	M	3,400	36,683	36,683	-	
1.2	north breakwater	M	3,700	46,392	46,392	-	
2.	DREDGING	M^3	(10,800,000)	(35,781)	(35,781)	-	
2.1	dredging by hopper dredger	M^3	2,280,000	12,923	12,923	-	
2.2	dredging by cutter dredger	M^3	8,520,000	22,858	22,858	-	
3.	MOORING FACILITIES			(40,252)	(28,407)	(11,845)	
3.1	slab berth	M	960	24,689	16,058	8,631	
3.2	coal pier	M	590	12,241	9,362	2,879	
3.3	oil berth	BERTH	1	1,578	1,270	308	
3.4	small craft berth	M	350	1,744	1,717	27	
4.	RECLAMATION			(9,011)	(6,745)	(2,266)	
5.	OTHER FACILITIES			(39,750)	(35,435)	(4,315)	
5.1	road			7,364	7,364	-	
5.2	power supply			12,111	10,822	1,289	
5.3	tug boat	NO	5	10,664	8,838	1,826	
5.4	others			9,611	8,411	1,200	
	SUB TOTAL			207,869	189,443	18,426	
6.	PHYSICAL CONTIGENCY	SUM		20,787	18,944	1,843	
	TOTAL			228,656	208,387	20,269	
7.	CARGO HANDLING EQUIP.			(112,289)	(93,084)	(25,927)	
7.1	slab berth			(25,492)	(17,824)	(7,668)	
7.1.1	slab loarder	NO	8	23,872	17,824	6,048	
7.1.2	forklift	NO	6	1,620	-	1,620	
7.2	slab yard			(21,659)	(18,437)	(3,222)	
7.2.1	slab crane	NO	18	13,739	10,517	3,222	
7.2.2	tractor	NO	10	3,600	3,600	-	
7.2.3	trailer	NO	24	4,320	4,320	-	
7.3	coal pier			(22,782)	(18,674)	(4,108)	
7.3.1	unloader	NO	4	4,498	4,264	234	
7.3.2	conveyor	NO	4	17,664	13,790	3,874	
7.3.3	bulldozer	NO	8	620	620	-	
7.4	coal yard			(42,356)	(38,149)	(4,207)	
7.4.1	stacker	NO	3	6,465	5,178	1,287	
7.4.2	reclaimer	NO	2	4,658	3,594	1,064	
7.4.3	car loading silo	NO	1	2,462	2,269	193	
7.4.4	conveyor			28,381	26,718	1,663	
7.4.5	bulldozer/tractor shovel	NO	4	390	390	-	
7.5	physical contingency			-	-	(6,722)	
	GRAND TOTAL			340,945	301,471	46,196	

The sum of the local and foreign currency portions does not become the 340,945 thousand US dollars because the physical contigency for the cargo handling equipment has been allocated to the foreign currency portion only.

Table 10.4.4 Foreign currency allocations (first stage)

PARTICULARS		UNIT	QUANTITY	CONSTRUCTION COST (AMOUNT IN US$1,000) TOTAL AMOUNT	LOCAL CURRENCY	FOREIGN CURRENCY	REMARKS
1.	BREAKWATERS	M	(7,100)	(83,075)	(83,075)	-	
1.1	south breakwater	M	3,400	36,683	36,683	-	
1.2	north breakwater	M	3,700	46,392	46,392	-	
2.	DREDGING	M^3	(10,800,000)	(35,781)	(35,781)	-	
2.1	dredging by hopper dredger	M^3	2,280,000	12,923	12,923	-	
2.2	dredging by cutter dredger	M^3	8,520,000	22,858	22,858	-	
3.	MOORING FACILITIES			(28,449)	(19,850)	(8,599)	
3.1	slab berth	M	640	18,954	12,160	6,794	
3.2	coal pier	M	310	6,173	4,703	1,470	
3.3	oil berth	BERTH	1	1,578	1,270	308	
3.4	small craft berth	M	350	1,744	1,717	27	
4.	RECLAMATION			(9,011)	(6,745)	(2,266)	
5.	OTHER FACILITIES			(33,250)	(30,074)	(3,176)	
5.1	road			7,364	7,364	-	
5.2	power supply			8,507	7,560	947	
5.3	tug boat	NO	4	8,531	7,071	1,460	
5.4	others			8,848	8,079	769	
	SUB TOTAL			189,566	175,525	14,041	
6.	PHYSICAL CONTINGENCY			18,956	17,552	1,404	
	TOTAL			208,522	193,077	15,445	
7.	CARGO HANDLING EQUIP.			(69,240)	(57,522)	(15,820)	
7.1	slab berth			(16,000)	(11,140)	(4,860)	
7.1.1	slab loarder	NO	5	14,920	11,140	3,780	
7.1.2	forklift	NO	4	1,080	-	1,080	
7.2	slab yard			(12,313)	(10,523)	(1,790)	
7.2.1	slab crane	NO	10	7,633	5,843	1,790	
7.2.2	tractor	NO	6	2,160	2,160	-	
7.2.3	trailer	NO	14	2,520	2,520	-	
7.3	coal pier			(13,156)	(10,760)	(2,396)	
7.3.1	unloader	NO	2	10,391	8,112	2,279	
7,3.2	conveyor	NO	2	2,455	2,338	117	
7.3.3	bulldozer	NO	4	310	310	-	
7.4	coal yard			(27,771)	(25,099)	(2,672)	
7.4.1	stacker	NO	2	4,310	3,452	858	
7.4.2	reclaimer	NO	1	2,329	1,797	532	
7.4.3	car loading sile	NO	1	2,462	2,269	193	
7.4.4	conveyor			18,475	17,386	1,089	
7.4.5	bulldozer/tractor shovel	NO	2	195	195	-	
7.5	physical contingency			-	-	(4,102)	
	GRAND TOTAL			277,762	250,599	31,265	

Table 10.4.5 Foreign currency allocations (second stage)

	PARTICULARS	UNIT	QUANTITY	CONSTRUCTION COST (AMOUNT IN US$1,000) TOTAL AMOUNT	LOCAL CURRENCY	FOREIGN CURRENCY	REMARKS
1.	BREAKWATERS	-	-	-	-	-	
1.1	south breakwater	-	-	-	-	-	
1.2	north breakwater	-	-	-	-	-	
2.	DREDGING	-	-	-	-	-	
2.1	dredging by hopper dredger	-	-	-	-	-	
2.2	dredging by cutter dredger	-	-	-	-	-	
3.	MOORING FACILITIES	-	-	(11,803)	(8,557)	(3,246)	
3.1	slab berth	M	320	5,735	3,898	1,837	
3.2	coal pier	M	280	6,068	4,659	1,409	
3.3	oil berth	-	-	-	-	-	
3.4	small craft berth	-	-	-	-	-	
4.	RECLAMATION	-	-	-	-	-	
5.	OTHER FACILITIES	-	-	(6,500)	(5,361)	(1,139)	
5.1	road	-	-	-	-	-	
5.2	power supply	-	-	3,604	3,262	342	
5.3	tug boat	NO	1	2,133	1,767	366	
5.4	others	-	-	763	332	431	
	SUB TOTAL			18,303	13,918	4,385	
6.	PHYSICAL CONTINGENCY			1,830	1,392	439	
	TOTAL			20,134	15,310	4,824	
7.	CARGO HANDLING EQUIP.			(43,049)	(35,562)	(10,107)	
7.1	slab berth			9,492	(6,684)	(2,808)	
7.1.1	slab loarder	NO	3	8,952	6,684	2,268	
7.1.2	forklift	NO	2	540	-	540	
7.2	slab yard	-	-	(9,346)	(7,914)	(1,432)	
7.2.1	slab crane	NO	8	6,106	4,674	1,432	
7.2.2	tractor	NO	4	1,440	1,440	-	
7.2.3	trailer	NO	10	1,800	1,800	-	
7.3	coal pier			(9,626)	(7,914)	(1,712)	
7.3.1	unloader	NO	2	7,273	5,678	1,595	
7.3.2	conveyor	NO	2	2,043	1,926	117	
7.3.3	bulldozer	NO	4	310	310	-	
7.4	coal yard			(14,585)	(13,050)	(1,535)	
7.4.1	stacker	NO	1	2,155	1,726	429	
7.4.2	reclaimer	NO	1	2,329	1,797	532	
7.4.3	car loading silo	NO	-	-	-	-	
7.4.4	conveyor	-	-	9,906	9,332	574	
7.4.5	bulldozer/tractor shovel	NO	2	195	195	-	
7.5	physical contingency			-	-	(2,620)	
	GRAND TOTAL			63,183	50,872	14,931	

Table 10.4.6 Annual investment (first stage)

(IN US$ MILLION)

	PARTICULARS	TOTAL INVESTMENT			'77 AND '78			'79			'80			'81			'82			'83		
		L	F	TOTAL	L	F	TOTAL	L	F	TOTAL	L	F	TOTAL	L	F	TOTAL	L	F	TOTAL	L	F	TOTAL
1.	BREAKWATERS	(83.1)		(83.1)	(22.9)		(22.9)	(21.6)		(21.6)	(21.6)		(21.6)	(14.3)		(14.3)	(2.7)		(2.7)			
1.1	south breakwater	36.7		36.7	11.3		11.3	10.9		10.9	10.9		10.9	3.6		3.6						
1.2	north breakwater	46.4		46.4	11.6		11.6	10.7		10.7	10.7		10.7	10.7		10.7	2.7		2.7			
2.	DREDGING	(35.8)		(35.8)										(15.6)		(15.6)	(19.3)		(19.3)	(0.9)		(0.9)
2.1	dredging by a hopper suction dredger	12.9		12.9										5.1		5.1	7.8		7.8			
2.2	dredging by a cutter suction dredger	22.9		22.9										10.5		10.5	11.5		11.5	0.9		0.9
3.	MOORING FACILITIES	(19.8)	(8.6)	(28.4)				(0.7)		(0.7)	(0.3)		(0.3)	(13.6)	(5.7)	(19.3)	(4.7)	(2.8)	(7.5)	(0.5)	(0.1)	(0.6)
3.1	slab berth	12.1	6.8	18.9										8.2	4.2	12.4	3.9	2.6	6.5			
3.2	coal pier	4.7	1.5	6.2										4.7	1.5	6.2						
3.3	oil berth	1.3	0.3	1.6													0.8	0.2	1.0	0.5	0.1	0.6
3.4	small craft berth	1.7	-	1.7				0.7		0.7	0.3		0.3	0.7		0.7						
4.	RECLAMATION	(6.7)	(2.3)	(9.0)							(2.0)		(2.0)	(0.8)		(0.8)	(3.5)	(2.0)	(5.5)	(0.4)	(0.3)	(0.7)
5.	OTHER FACILITIES	(30.1)	(3.2)	(33.3)							(7.9)	(1.1)	(9.0)	(13.3)	(1.7)	(15.0)	(7.8)	(0.4)	(8.2)	(1.1)		(1.1)
	TOTAL	175.5	14.1	189.6	22.9		22.9	22.3		22.3	31.8	1.1	32.9	57.6	7.4	6.5	38.0	5.2	43.2	2.9	0.4	3.3
6.	CARGO HANDLING EQUIPMENT	(57.5)	(11.7)	(69.2)													(49.4)	(9.5)	(58.9)	(8.1)	(2.2)	(10.3)
6.1	slab berth	11.2	4.8	16.0													8.9	3.0	11.9	2.3	1.8	4.1
6.2	slab yard	10.5	1.8	12.3													4.7	1.4	6.1	5.8	0.4	6.2
6.3	coal pier	10.7	2.4	13.1													10.7	2.4	13.1			
6.4	coal yard	25.1	2.7	27.8													25.1	2.7				
	GRAND TOTAL	233.0	25.8	258.8	22.9		22.9	22.3		22.3	31.8	1.1	32.9	57.6	7.4	6.5	87.4	14.7	102.1	11.0	2.6	13.6

NOTE: 1) The physical contigencies for the civil work and the cargo handling equipment are excluded in this table.

2) L and F are local and foreign currency respectively.

Table 10.4.7 Annual investment (second stage)

(IN US$ MILLION)

	PARTICULARS	TOTAL INVESTMENT			'84			'85		
		L	F	TOTAL	L	F	TOTAL	L	F	TOTAL
1.	BREAKWATERS									
1.1	south breakwater									
1.2	north breakwater									
2.	DREDGING									
2.1	dredging by a hopper suction dredger									
2.2	dredging by a cutter suction dredger									
3.	MOORING FACILITIES	(8.6)	(3.2)	(11.8)	(8.6)	(3.2)	(11.8)			
3.1	slab berth	3.9	1.8	5.7	3.9	1.8	5.7			
3.2	coal pier	4.7	1.4	6.1	4.7	1.4	6.1			
3.3	oil berth									
3.4	small craft berth									
4.	RECLAMATION									
5.	OTHER FACILITIES	(5.4)	(1.1)	(6.5)	(5.4)	(1.1)	(6.5)			
	TOTAL	14.0	4.3	18.3	14.0	4.3	18.3			
6.	CARGO HANDLING EQUIPMENT	(35.6)	(7.4)	(43.0)				(35.6)	(7.4)	(43.0)
6.1	slab berth	6.7	2.8	9.5				6.7	2.8	9.5
6.2	slab yard	7.9	1.4	9.3				7.9	1.4	9.3
6.3	coal pier	7.9	1.7	9.6				7.9	1.7	9.6
6.4	coal yard	13.1	1.5	14.6				13.1	1.5	14.6
	GRAND TOTAL	49.6	11.7	61.3	14.0	4.3	18.3	35.6	7.4	43.0

NOTE: 1) The physical contigencies for the civil work and the cargo handling equipment are excluded in this table.

2) L and F are local and foreign currency respectively

Table 10.4.8 The list of imported materials (first stage)

(IN US$ 1,000)

PARTICULARS		FOREIGN CURRENCY ALLOCATIONS	IMPORTED ITEMS
1.	BREAKWATERS	-	
1.1	south breakwater	-	
1.2	north breakwater	-	
2.	DREDGING	-	
2.1	dredging by a hopper dredger		
2.2	dredging by a cutter dredger	-	
3.	MOORING FACILITIES	(8,599)	
3.1	slab berth	6,794	steel sheets for steel pipe piles, fenders, crane rails, tie-rods
3.2	coal pier	1,470	steel sheets for steel pipe piles, bollards, fenders, crane rials
3.3	oil berth	308	steel sheets for steel pipe piles, bollards, fenders
3.4	small craft berth	27	protection sheets
4.	RECLAMATION	(2,266)	steel sheets for steel pipe piles, steel sheets piles, protection sheets, tie-rods
5.	OTHER FACILITIES	(3,176)	
5.1	road	-	
5.2	power supply	947	transformers
5.3	tug boat	1,460	engines
5.4	others	769	crane rails, VHF equipment
	TOTAL	14,041	
6.	CARGO HANDLING EQUIPMENT	(11,718)	as shown in the record discussions
6.1	slab berth	(4,860)	
6.1.1	slab loader	3,780	
6.1.2	fork lift	1,080	
6.2	slab yard	(1,790)	
6.2.1	slab crane	1,790	
6.2.2	tractor	-	
6.2.3	trailer	-	
6.3	coal pier	(2,396)	
6.3.1	unloader	2,279	
6.3.2	conveyor	117	
6.3.3	bulldozer	-	
6.4	coal yard	(2,672)	
6.4.1	stacker	858	
6.4.2	reclaimer	532	
6.4.3	car loading silo	193	
6.4.4	conveyor	1,089	
6.4.5	bulldozer/tractor shovel	-	
	GRAND TOTAL	25,759	

NOTE: Contingency is excluded

Table 10.4.9 The list of imported materials (second stage)

(IN US$ 1,000)

PARTICULARS		FOREIGN CURRENCY ALLOCATIONS	IMPORTED ITEMS
1.	BREAKWATERS	-	
1.1	south breakwater	-	
1.2	north breakwater	-	
2.	DREDGING	-	
2.1	dredging by a hopper dredger	-	
2.2	dredging by a cutter dredger	-	
3.	MOORING FACILITIES	(3,246)	
3.1	slab berth	1,837	steel sheets for steel pipe piles, steel sheets piles, bollards, fenders, crane rails, tie-rods
3.2	coal pier	1,409	steel sheets for steel pipe piles, bollards, fenders, crane rails
3.3	oil berth	-	
3.4	small craft berth	-	
4.	RECLAMATION	-	
5.	OTHER FACILITIES	(1,139)	
5.1	road	-	
5.2	power supply	342	transformers
5.3	tug boat	366	engines
5.4	others	431	crane rails, VHF equipment
	TOTAL	4,385	
6.	CARGO HANDLING EQUIPMENT	(7,487)	as shown in the record of discussions
6.1	slab berth	(2,808)	
6.1.1	slab loader	2,268	
6.1.2	fork lift	540	
6.2	slab yard	(1,432)	
6.2.1	slab crane	1,432	
6.2.2	tractor	-	
6.2.3	trailer	-	
6.3	coal pier	(1,712)	
6.3.1	unloader	1,595	
6.3.2	conveyor	117	
6.3.3	bulldozer	-	
6.4	coal yard	(1,535)	
6.4.1	stacker	429	
6.4.2	reclaimer	532	
6.4.3	car loading silo	-	
6.4.4	conveyor	574	
6.4.5	bulldozer/tractor shovel	-	
	GRAND TOTAL	11,872	

NOTE: Contingency is excluded

10-5 Conclusion comparison with the original plan

As is clear from the comparative study made so far, the total cost of construction can be reduced approximately by $33 million by adopting this alternative plan, though the term of work is naturally prolonged beyond that in the original plan.

The foreign currency portion is reduced by $23 million from $69 million to $46 million because all the dredging work is to be carried out by domestic dredgers in Brazil in the alternative plan. There is enough time as well as a financial margin to purchase, if necessary, a large-sized cutter suction dredger from Japan, since the dredging work is scheduled to start in 1981.

The cost of construction excluding its contingency is expected to be reduced by $29 million for the first stage of work from $288 million to $259 million. This reduction in cost amounts to 10% of the cost of construction in the original plan.

It can be said that the provision of funds becomes easier by the one year of prolongation in the term of work because the annual investment increases less sharply than in the original plan as shown in Fig. 10.5.1, though the operation start of the coal pier which stands in the most urgent need will have to be delayed by 19 months.

The greatest merit of this counter-plan is that the dredging and reclamation work, construction of the mooring facilities, etc. can be promoted safely and securely. From a viewpoint of the construction work, the daily wave condition at the coast of Praia Mole is not necessarily optimistic even in consideration of the fact that Fig. 2.3.19 in Chapter 2-3-4, which is based upon the maximum significant wave height of the day, indicates the most severe condition. In case of the alternative plan, the wave condition at the Praia Mole can be grasped more precisely through further observation because there is enough time before the dredging work is scheduled to start.

An accident, if occurred in harbour construction work, often causes unexpected delay in the term of work and increase in the cost of construction. We are of the opinion that, therefore, the construction of Praia Mole Port should be promoted in accordance with this alternative plan even in consideration of the possible delay in CST construction.

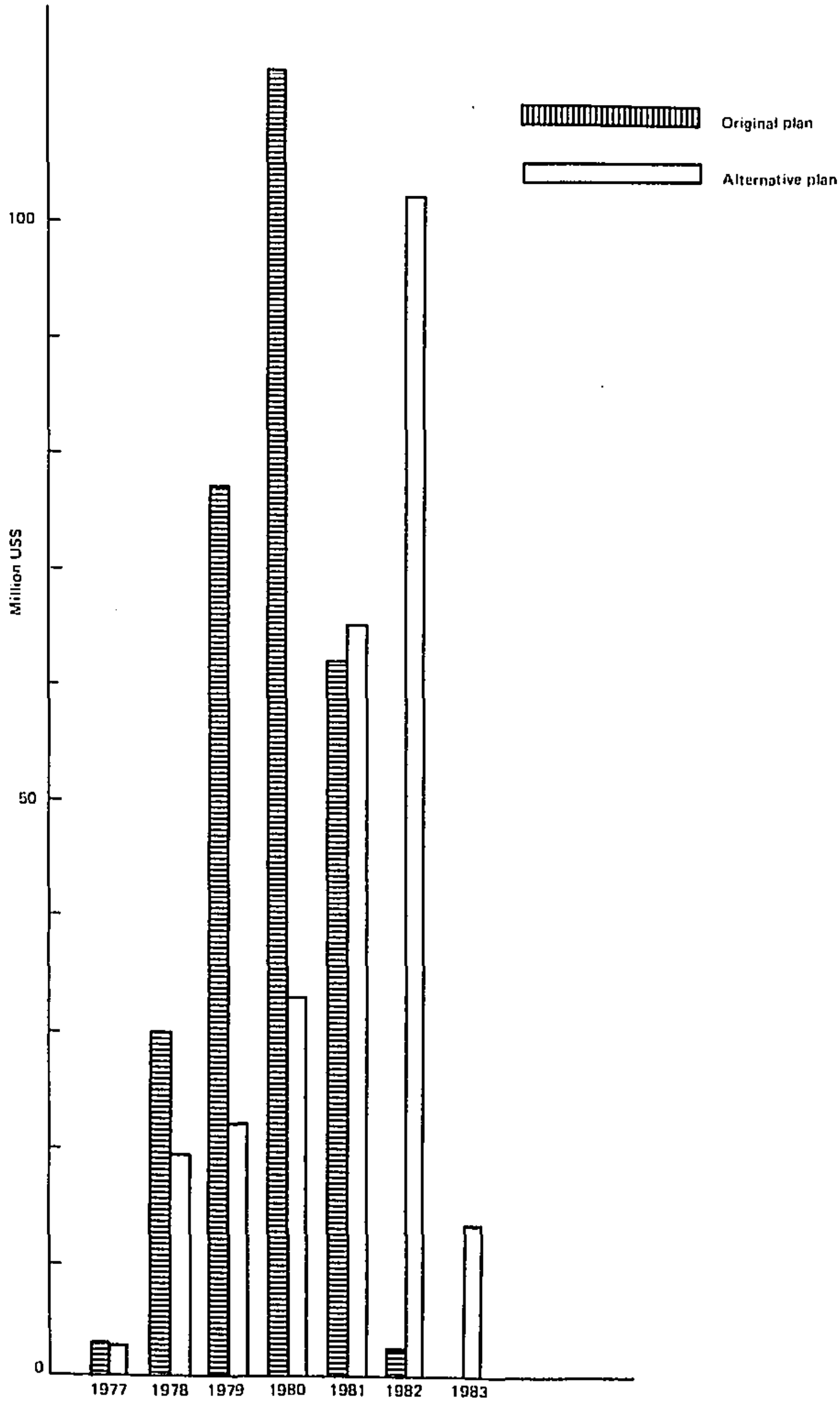


Fig. 10.5.1 Annual investment (first stage)

CHAPTER 11. ADMINISTRATION AND OPERATION SYSTEM OF PORTS AND HARBOURS

11. Administration and operation system of ports and harbours

11-1 Port and harbour administration system in Brazil and execution system of this project

11-1-1 Port administration system in Brazil

Ports and harbours in Brazil are under the control of the Ministry of Transport and managed by PORTOBRÁS (Empresa de Portos do Brasil S.A.), a public corporation under the supervision of the Minister of Transport in the central government (a national enterprise ... 100% financed by the central government).

PORTOBRÁS was established as recently as in January 1976, based upon Law No. 6222 in place of DNPVN which had been an organization of the Ministry of Transport. According to the explanation of PORTOBRÁS, this switch over to a public corporation was aimed at introducing flexibility as well as enterprising character into the port administration policy.

PORTOBRÁS takes in charge of business concerning the construction, administration, and operation of ports and harbours, and inland waterways together with their planning, coordination, supervision, guidance, and finance. The business concerning inland waterways is being administered only provisionally, and is scheduled to be handed over to a corporation fit for the purpose as soon as such an organization is established. Mentioned below are the contents of business PORTOBRÁS takes in charge of.

① Planning and execution of the national policy of ports and harbours

② Planning and investigation relating to the construction, improvement, and operation of ports and harbours, and their promotion, approval, and technical aid to meet the purpose

③ Execution and promotion of the construction and improvement business concerning ports and harbours

④ Management and operation of ports and harbours

⑤ Supervision over the management and operation of the administration, and operation, and of port and dock companies approved or to which business is trusted by PORTOBRÁS, and auditing of the companies.

⑥ Promotion of the utilization of inland waterways and execution of their construction work

However, PORTOBRÁS does not directly manage and operate individual ports and harbours as a rule.

The authorized capital of PORTOBRÁS is Cr$2,500 million and the capital paid by the end of 1976 is Cr$1,500 million.

As shown in Fig. 11.1.1, the organization of PORTOBRÁS is divided into an administration department and a business department respectively supervised by the president.

The decision concerning the management and execution is made by the board of directors, though the supreme decision organ of PORTOBRÁS is the general shareholders meeting. The president is appointed by the president of Brazil according to the recommendation of the Minister of Transport.

The number of officials legally secured is approximately, 3,000, though the present number of staffs of PORTOBRÁS is about 700 (including approximately 200 staffs engaged in business concerning waterways).

11-1-2 Management system of each port

The management system of ports in Brazil is rather complicated, and at present classified into the following four types.

Type A : Mixed economy company port

Type B : State "Concession" port

Type C : Private "Concession" port

Type D : PORTOBRÁS operating port

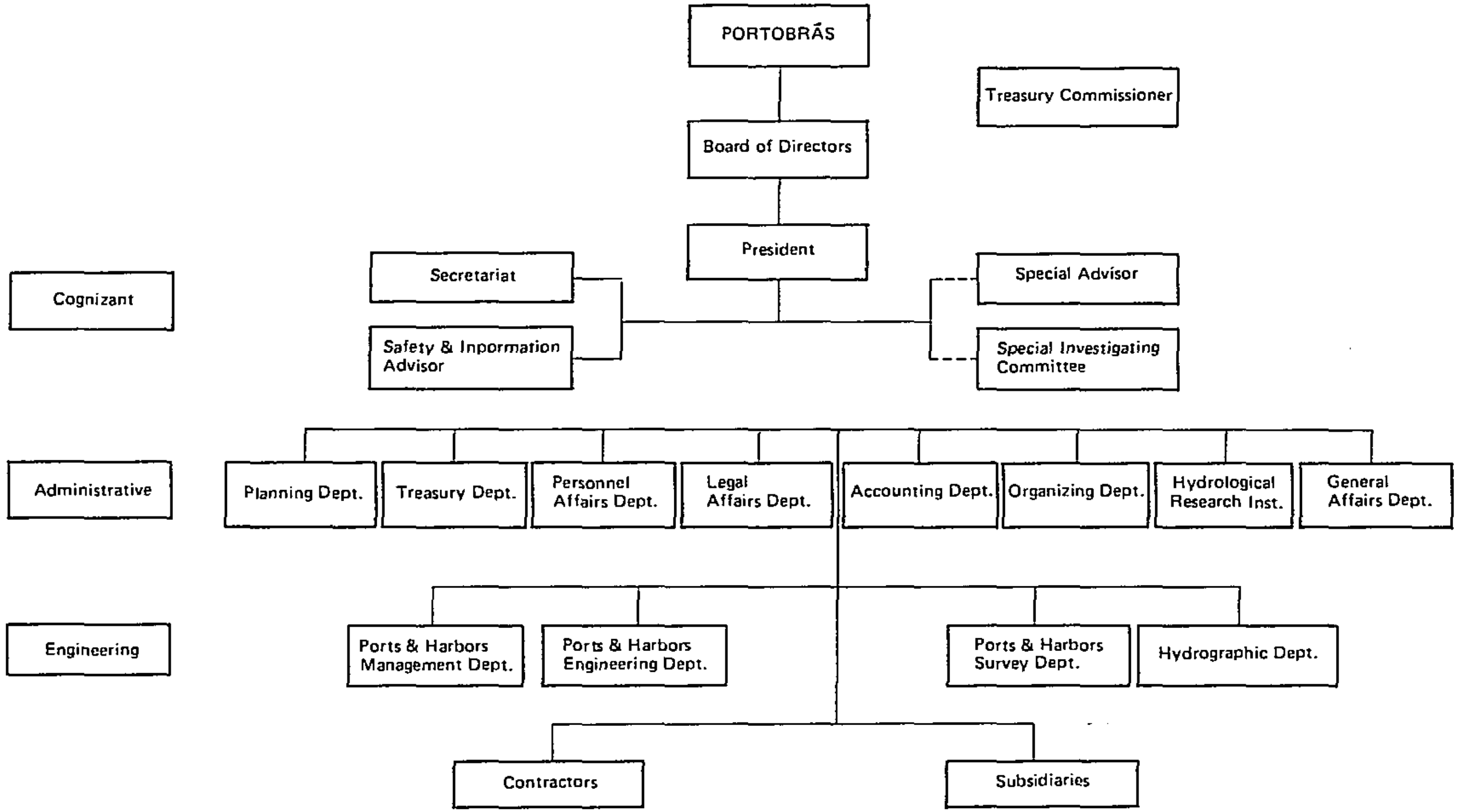


Fig. 11.1.1 Organization chart of PORTOBRÁS

The 22 major ports in Brazil belong to any of the above four types, and there are small number of minor ports which still remain unorganized. Specified below is detailed description of each type.

(1) Type A (Mixed economy company port)

This type is a management system by a semi-governmental corporation which is popular in Brazil.

The corporation is a joint-stock company to execute the management, operation, and construction of ports and harbours under its control, and more than 51% of the capital is always to be possessed by PORTOBRÁS. The following ports have adopted this type of management.

Itaqui	Rio de Janeiro
Belém	Fortaleza
Areia Branca	Salvador

PORTOBRÁS is planning to establish a port managing corporation in each state to centralize the management and operation of ports and harbours within the respective state, and the changeover to type A is being promoted in line with this policy. It is only in Feburary, 1977, that the Bahia State Port and Dock Company was established at Salvador to bring all the ports and harbours in the state of Bahia situated in Mid-Brazil under its centralized managing control.

In this type of port, most of the cost of construction is covered by the money invested by PORTOBRÁS, while the management, maintenance, and operating expenses are covered by port charges.

(2) Type B (State "concession" port)

This type of port is managed by each state government to which the Federal Government granted a concession for the port management on contract for 100 years at the time of construction. The following ports belong to this type.

Vitória	Cabedelo
Recife	Antonina
Rio Grande	Pelotas
Paranaguá	Porto Alegre
São Francisco do Sul	

As stated above, this type of management system will be changed over to type A before long.

In this type of ports and harbours, almost all the construction work is executed by PORTOBRÁS, and the management, maintenance, and operating expenses are covered by port charges as in the case of type A.

(3) Type C (Private "concession" port)

This type of port is managed by a private organization to which the Federal Government granted the same concession as in the case of type B. The ports belonging to this type are Santos and Imbituba.

(4) Type D (PORTOBRÁS operating port)

This type of port does not belong to A $\sim$ C, and is directly managed by PORTOBRÁS. The following ports belong to this type, and their profitability is relatively low.

Manaus	Ilhéus
Itajai	Forno
Bahia	Niterói
Natal	Angra dos Reis
Maceio	Laguna
Aracaju	

11-1-3 System of port and harbour Improvement

(1) Organazation in charge of improvement work

Port and harbour improvement work is executed either directly by PORTOBRÁS or by the respective port management body. In case the scale of improvement work is relatively large or the port management body concerned is regarded as technically incompetent for the work, the project is directly promoted by PORTOBRÁS. In all the other cases, each port management body takes in charge of the improvement work under the funds of PORTOBRÁS. When PORTOBRÁS directly carris out the imporovement work of a mixed economy company port, the facilities are invested in kind to the respective relative port and dock company as its assets upon completion. Even when the improvement work is financed by a loan, the borrowed money is reimbursed by PORTOBRÁS laying no responsibility for the repayment on the company to which PORTOBRÁS invested the facilities.

The fund of PORTOBRÁS used by a port and dock company for the improvement work of a mixed economy company port is treated as an investment to the company, and substantially, reaches the same result as of the work executed directly by PORTOBRÁS. In this case too, it is PORTOBRÁS which bears the responsibility for the refundment.

Where there is no existing port management body to carry out such improvement work, it is probable to establish a new company by a joint-contribution with the corporations and organizations concerned to entrust the project.

Portocel, a loading port of chips constructed by a company established by joint-investment of PORTOBRÁS and SENIBRA, and Ubu, a loading port of pellets built by a company established by joint-investment of PORTOBRÁS and Rio Dose are examples of the projects promoted by such joint-contribution.

(2) Fund for improvement work

The port and harbour improvement work is carried out under the fund of PORTOBRÁS or of the port management body concerned. Most of the fund of the port management bodies is now a depreciation fund levied with a 1% premium overlaid on the tariff, though there seems the other type of investment by special funds to have existed until recently. Use of this depreciation fund requires the approval of PORTOBRÁS, and is limited to a narrow range of port improvement work concerning the renewal of cargo handling equipment, transportation equipment, etc. Therefore, it will be financially difficult to use this fund for construction of a large-scale pier.

Table 11.1.1 shows the total budget (including the expenditures for waterway improvement) of PORTOBRÁS for the fiscal year 1977. As it is clear from this table, the revenue source of the fund for improvement work relies mostly on the object tax called National Port Fund (NPF).
The revenue from this National Port Fund amounts to about 40% in the total budget, and covers approximately 50% of the budget for port and harbour improvement. This fund is financed by the tax assessed on import goods (CIF price) at the rate of 3% and levied directly from the consignee by PORTOBRÁS (practically, transferred to the account of PORTOBRÁS at the Bank of Brazil by the consignee). The rate of taxation had been 2% until 1976, and was scheduled to be raised to 3% from the year 1977. But this plan was interrupted by the investment reduction policy of the Federal Government which curtailed the investment budget of PORTOBRÁS.

The National Port Fund, which is used for the repayment of the loan (including its interest) and for the purchase of the stocks of affiliated companies as well as the direct investment in port and harbour improvement work, plays a quite important role in the formation of port capital in Brazil.

Table 11.1.1 The budget of PORTOBRÁS for the fiscal year 1977

(Cr $ Mil.)

	Total amount	Financial funds		Direct revenues	Loans		Contract funds	Other
		General	Consolidated financial source (N.P.F)		Domestic	Foreign		
I. Social security expenses	26.9	25.0		1.9				
II. General operating expenses	5,303.4	432.5	2100.0	599.8	453.7	501.1	156.0	1,060.0
1. Repayments	640.0	245.5					6.0	2.5
2. General administrative expenses	703.2	142.0		530.5				30.7
3. Channel works	480.0	45.0		69.4				365.6
4. Port and harbour works	(100.0) 2,789.6		(47.7) 1,331.0		(8.9) 247.3	(18.0) 501.4	(5.4) 150.0	(20.1) 559.8
5. Acquisition of shares	272.0		85.0		180.0			7.0
6. Export corridor works	418.0		298.0		26.3			93.7
(1) Vitória Port	163.0		163.0					
(2) Santos Port	20.0		20.0					
(3) Paranagua Port	235.0		115.0		26.3			93.7
Total	5,330.3 (100.0)	457.5 (8.6)	2,100.0 (39.4)	601.7 (11.3)	453.7 (8.5)	501.1 (9.4)	156.0 (2.9)	1,060.0 (19.9)

Notes: 1. Prepared from the '77 comprehensive budget statement for PORTOBRÁS.

2. The rounded values are given, and are not always congruous with respective totals.

(Note) The National Port Fund, which is applicable also to the repayment of the loan (including its interest), substantially forms about 75% of the total fund usable for port and harbour improvement work.

Mentioned below are the other types of fund usable for port and harbour improvement work than the National Port Fund.

① Dredging fund

This fund is financed from 50% overlaid on the harbour of each port, and pooled into a nation-wide fund for dredging work. Approximately Cr$100 million is expected to be levied for this fund in the year 1977. (It is included in "the other source of revenue" in Table 11.1.1.)

② Loan

A little less than 20% of the total budget of PORTOBRÁS is expected to be borrowed from the International Bank for Reconstruction and Development, the Development Bank of Japan, and the Development Bank of Brazil for the year 1977.

③ Agreed fund

This fund is levied from the joint-contributors.

④ The Others

The revenue from general accounts, which falls short of 10% of the total budget, is used for the following purposes as a subsidy.

① Payment of the interest and commission for borrowed money

② Management expenses of PORTOBRÁS, social security contributions, and special expenses of the improvement of ports and waterways in the developing areas.

11-2 Execution system of this project

① According to the explanation of PORTOBRÁS, construction of Praia Mole Port is to be taken in charge of by PORTOBRÁS. The examination of the contractors' qualification and the evaluation of tenders are also to be made by PORTOBRÁS, though the consulting service to PORTOBRÁS is to be given by PLANAVE, a consultant in Brazil. (Of course, there are various other tasks the owner itself has to do.)

② At the stage of principal survey, there was no concrete plan of reinforcement of the organization of PORTOBRÁS, supplementation of the technical and other staffs, establishment of the field office to manage this project, etc.

③ From the principal survey made this time, the following conclusions have been reached as to the execution system of this project.

ⓐ PLANAVE is reliable as a consultant for this project.

ⓑ The technical staffs of PORTOBRÁS, on the other hand, are relatively poor, and require technical cooperation from Japan.

④ We were told that the planning department of PORTOBRÁS, for instance, which takes in charge of all the plannings and budgets for ports and harbours in Brazil, has only three senior engineers except Mr. Carlos Theophilo de Souza e Mello, the head of the department, though half of the 60 staffs are economists and engineers with a college degree. It has been that this is also the case with the port engineering department to take in charge of construction of ports and harbours. A material in hand says that the port engineering department has only 5 senior engineers, though the material itself is rather old. During the principal survey made this time, we found only few staffs except the respective heads of the departments mentioned above who could discuss various matters on equal terms with our survey team, and this was also the case with the preliminary survey made in November 1975.

⑤ We are of the opinion that the technical cooperation to PORTOBRÁS should be given on a governmental base in consideration of the acceptability on the side of Brazil. As to the cooperation staff, it is recommended to send to Brazil such a civil engineer as is familiar with dredging work and also able to play a part as the project manager instead of a dredging engineer required by the Brazilian side. This project, in addition, requires an expert in cargo-handling because various types of large-sized cargo handling equipment unfamiliar to people in Brazil are included in this project. (For details, please refer to the Record of Discussions.)

⑥ As previously stated, the establishment of the execution system of PORTOBRÁS for this project is an important subject awaiting urgent solution, though PORTOBRÁS seems to be planning to reinforce the organization by employing able engineers.

We are of the opnion that PORTOBRÁS must establish a site office with enough engineering staffs for smooth promotion of this project at Vitória, in due consideration of the importance, the scale, and the term of work of the project. In this case, it is desirable that PORTOBRÁS headquarters gives a substantial authority concerning the technical matters to the site manager in the site office.

11-3 Management System after completion of the port of Praia Mole

The following two systems of the port management are conceivable, though nothing in particular had been decided as to this matter at the time of the principal survey.

① Establishment of such a mixed economy company as previously mentioned to centralize the management of all the ports and harbours in the state of Espirito Santo (Even in such a case, the ore terminal of CVRD will be excluded.)

② Establishment of an organization to manage only Praia Mole Port

Establishment of one company requires less expenses than that of two companies, and naturally contributes to the reduction of overhead expenses of the headquarters. It is recommended to adopt the case ① in respect not only of the maintenance and managing efficiency but also of the interchangeability of skilled workers, foremen, staffs, and especially engineers of the technical department hard to employ. It must be noted, however, that the character of Vitória Port is different from that of Praia Mole Port. The former has relatinely a character of an ordinary commercial port, and this character will be further intensified by the completion of the latter.

Praia Mole Port, on the other hand, is rather an industrial port, and the major beneficiaries are confined to a small number of particular users like CST, CVRD, etc. though it is officially a public port. It will, therefore, be better to establish separate organizations for coordination between the port management body and users, and the others relative to the respective port management. There is no reason to establish two companies even in respect of the port dues and charges provided that an allocation system of the operating expenses including those for the relative sections in the head office to both ports is established. The system of deciding the port charges is as shown in the next Chapter.

From a genral viewpoint of the factors mentioned above, it seems advisable that Praia Mole Port is placed under the control of Companhia Docas de Espirito Santo (provisionally so called) which is scheduled to be established before long.

CHAPTER 12. PORT DUES AND CHARGES AND THEIR DETERMINATION PRINCIPLES

12. Port dues and charges and their determination principles

12-1 Kinds of the port charges

The port dues and charges are roughly classified as follows.

① Charterage of a service boat for berthing and unberthing, etc. (such as tugboats)

② Charge for the port facilities (entrance dues, quay dues, cargo handling equipment charge, etc.)

③ Stevedoring charge

④ Longshore handling charge

⑤ The others

Of these port dues and charges, ②, ④, and ⑤ come into the revenue of the port management bodies in Brazil. The tugboats are operated and managed by private corporations under the control of SUNAMAN, and the charterage is paid to the relative corporation by the respective shipping company. The stevedoring under Item ③ is managed also by private persons enlisted in the association under the control of SUNAMAN, and separated from the longshoring hardling charge which is carried out by the port management body. When the facilities or equipments owned by the port management body are used as to ① and ③, the charge fixed by the port management body must be paid, but this is an exceptional case.

The present report of the feasibility study made this time does not refer to Items ① and ③, since the profitability of the project is concerned only with the level of dues and charges which come into the revenue of the port management body.

12-2 Principle of fixing the port dues and charges

Financially speaking, all the ports and harbours in Brazil are, as a rule, managed by a cost principle. The port dues and charges of each port, therefore, are so fixed as to cover the following costs.

① Management, operation, and maintenance expenses

② Depreciation

③ Capital remuneration (See the note below.)

Supposing that the revenue is R and the total amount of the above expenses ① ∿ ③ is E, the port dues and charges are always so fixed as to meet $R = E$. In case of $R > E$, the surplus $(R - E)$ is used for the following purposes.

① In the case of concessionary ports, this surplus is saved up as a compensation fund per port. This fund is usable for various purposes with the approval of PORTOBRÁS.

② In the case of mixed economy company ports, this surplus is levied by the Federal Government except the legal reserve. In 1976, for instance, the surplus from the port of Rio de Janeiro was distributed to PORTOBRÁS, though the right of decision as to how the money is to be spent lies with the Finance Ministry.

(Note) PORTOBRÁS has authorized each port to take 10% of the invested amount in advance as a capital remuneration which is considered to be a kind of devidend. This money is paid to each invester as remuneration.

The balance between R and E is checked every month for the tariff control. In the case of $R < E$, the tariff is raised to eliminate the deficit. If failed into the red in spite of the tariff control, the deficit is covered by the subsidy from PORTOBRÁS so long as the red balance is small enough. Some ports in the northern districts of Brazil suffer a heavy deficit, and such a deficit is made up by the subsidy from the Federal Government.

As a revenue to cover the depreciation amount, 1% of the tariff is levied for the depreciation fund. This fund constituting a part of the tariff is saved at each port, and used for the improvement or renewal of various facilities. (It seems that this fund is being used for the replacement of equipment, etc. since it is practically insufficient to cover the depreciation of the total assets.)

There is no fixed method of depreciation, and the details are decided between PORTOBRÁS and each port management body. In this case, the channels and the breakwaters are excluded from the object of depreciation. The reason why the breakwaters are excluded from the object of depreciation is that they are considered to be permanent facilities, not included in the category of profitable facilities.

12-3 Tariff system of Vitória Port

The tariff of each port in Brazil is petitioned per port and approved by PORTOBRÁS. As stated in the previous clause, the tariff varies with each port in accordance with the principle of tariff control. But the tariff structure itself is much the same all over the country. Introduced here is the tariff structure of the port of Vitória neibouring to the port of Praia Mole.

The newest tariff of the port of Vitória was fixed on November 18, 1976, with the approval of PORTOBRÁS. Thereafter, this tariff has been raised by 20% through Resolução 194/76.

The tariff is divided into 11 tables according to the type of service to be rendered. The wharfage, for instance, is classified under Table "A", and levied on the cargoes loaded, unloaded, or transshipped in the port given below are outlines of each table.

① Table "A" - Wharfage -

The wharfage is charged (by the tonnage) on the cargoes loaded, unloaded, or transshipped within the port, and paid by each shipping company concerned.

② Table "B" - Quay dues -

The quay dues are charged on the pier space (per 1m) occupied by the moored ship on a per diem basis, and is paid by each shipping company concerned.

③ Table "C" - Longshore handling charges -

The longshore handling charges include all the charges of cargo handling and transportation service within the port, from the completion of stevedoring to the carrying out of the port area or vice versa except the charge of equipment used and the rail transportation fare. These charges are paid by the respective owner of cargoes.

④ Table "D" - Bonded storage -

The bonded storage is charged on the import cargoes carried into the port area by ship and stored in the bonded area at the rate of 3% to the import tax, and paid by the respective consignee.

⑤ Table "E" - Domestic cargo storage -

The domestic cargo storage is charged (by the tonnage) on the cargoes stored in the storage facilities within the port area, and paid by the respective owner of cargoes according to the term of storing.

⑥ Table "G" - Spacial storage -

The special storage is charged on dangerous cargoes (like explosives) or cargoes requiring special types of storing facilities, and paid by the respective owner of cargoes.

⑦ Table "H" - Railway transfer charge -

The railway transfer charge is levied on the cargoes loaded, unloaded, or transferred in the course of transportation into or out of the port area, and paid by the respective owner of cargoes.

⑧ Table "J" - Charge of cargo handling equipment -

The charge of cargo handling equipment is charged on the cargoes requiring the use of special cranes, etc. on the pier, and paid by the respective owner of cargoes.

⑨ Table "L" - Water supply charge -

The water supply charge is levied on the water (per 1 m^3) supplied to the moored ships through pipes, and paid by the respective clients.

⑩ Table "M" - Collateral service charge -

The collateral service charge is levied on the cargoes requiring weighing, measurement, inspection, bagging, marking, etc. in the course of storing, transferring, etc. of them as incidental work expenses, and paid by the respective clients.

⑪ Table "N" - Extra charge of exclusive berth -

The extra charge of exclusive berth is levied (by the tonnage) on the cargoes handled on the exclusive berth within the managing area of the port of Vitória, and paid by the respective clients.

Specified above are the basic tariffs applied to the port of Vitória. Beside these charges, 1% each of the respective tariffs is additionally levied per table for the depreciation fund. Moreover, the dredging surtax is additionally levied on the cargoes itemized under Table "A" at the rate of 50% to the tariff, but this income is not paid to each port management body but pooled at PORTOBRÁS. The respective tariffs are attached with a special charge tariff per table besides the ordinary charge tariff, so as to apply the extra charges to specific cargoes or usages.

CHAPTER 13. ECONOMIC ANALYSIS

13. Economic analysis

13-1 General description

This project has originally been laid out in line with the project of CST, and, therefore, the combined evaluation of the two projects should be carried out from a standpoint of national economy. It is, however unpractical to discuss the propriety of the locational conditions of CST as to the problems of land, water supply, etc. when the location of the site has been decided and the preparation work has already started. The present evaluation, therefore, is confined to an economic contribution of Praia Mole Port, which can accommodate large-sized vessels, to the improvement of transport conditions.

The other conceivable economic effects than that to the improvement of transport conditions are limited to the qualitative mentioning since their weighing is difficult. The effects are following.

13-1-1 Effects on the regional development

Vitória Port, which has been playing a very important role as the window of Espirito Santo State and its hinterland, leaves no room of expansion, and is not a suitable port for large-sized bulk carriers in consideration of the natural conditions. Therefore, of the cargoes expected to increase with future development of the hinterland, those requiring large-sized bulk carriers are planned to be handled in Praia Mole Port. In other words, the master plan of Praia Mole Port has been formulated taking account of a sufficient room for expansion so that it can be used as an import and export port for agricultural products, mineral resources, etc. which will be more and more increased in the future, though it is planned to handle the cargoes of CST, the coal destined for USIMINA, and oil until the second stage development of the project.

Judging from the fact that Vitória Port leaves little room of expansion and there is no suitable place for a port along the neibouring coastlines, Praia Mole Port planned in line with the project of CST will play a very important role in the regional development not only as an industrial port for CST but also as a public port.

13-1-2 Improvement of port and harbour construction technology

Most of the ports in Brazil are natural good harbours taking advantage of the geographical features, and it is the first experience to construct such a deep water port facing the open sea as Praia Mole Port. Therefore, the harbour construction technology to be cultivated in various fields of the principal work will make a great contribution to the future construction of ports and harbours in Brazil.

The large-sized cargo handling facilities to be installed in the port of Praia Mole will also make a great contribution to the future development of the machine industry in Brazil.

13-1-3 Increase of employment opportunities

Execution of this project requires a large number of workers skilled and unskilled, and after inauguration of the port service, approximately 800 workers are expected to be employed as the management and operation staffs (such as operators of the cargo handling equipment, etc.) of the port.

13-2 Basic principle of the analysis

The analytic evaluation of this project mainly aims at estimation of the effect on saving of the transport cost by large-sized vessels previously mentioned from a viewpoint of the national economy.

The index of the evaluation used here is the internal rate of return which is decided by the benefit and the cost. The internal rate of return "i" is to satisfy the following formula.

$$\sum_{t=1}^{n} \frac{Bt - Ct}{(1 + i)^{t}} = 0$$

Bt : Benefit in the "t"th year

Ct : Cost in the "t"th year

i : Internal rate of return

In economic analysis, the profitability of the project in question is investigated in comparison with that of alternative cases. Generally, the benefit of the case in which the relevant project is to be executed is compared with that of an assumptive case in which the project is not to be executed. The assumptive benefit to be compared here is to be that of Vitõria Port, because the cargoes will have to be loaded or unloaded in the neibouring port of Vitõria if the port of Praia Mole is not to be constructed. In this analysis, a comparison is made on the benefit on the assumption that Vitõria Port is newly equipped with the same cargo handling facilities as are scheduled to be installed in Praia Mole Port, since the present port of Vitõria leaves no capacity to receive the cargoes of CST.

13-3 Setting of the alternative facilities in the port of Vitória

Assumed here is construction of the enough facilities to cover the cargoes scheduled to be handled in Praia Mole Port. The basic principle of the assumptive facility plan is as follows.

① The assumptive facilities are to be constructed in the most suitable places from an economic viewpoint of the managing efficiency after completion as well as the effect on the usability of the existing facilities.

② The entrance channel of the present port of Vitória is too narrow for large-sized vessels. The maximum size of the vessels to enter Vitória Port is assumed to be of 40,000 DWT passing the channel with the water depth of -13 m.

③ If the occupancy rate of berth becomes more than 60%, the rate is to be secured under 60% by increasing the number of berths.

The number of berths required to meet the above principle happens to be the same as of those scheduled to be built in the port of Praia Mole. The facility plan adopted in this assumption is shown in Fig. 13.3.1. The scope of the assumptive facilities and the cost of their construction are given in Table 13.3.1. The cost of construction is estimated approximately 50% of that of the port of Praia Mole. Table 13.3.2 shows the working conditions of the assumptive facilities compared with that of the port of Praia Mole.

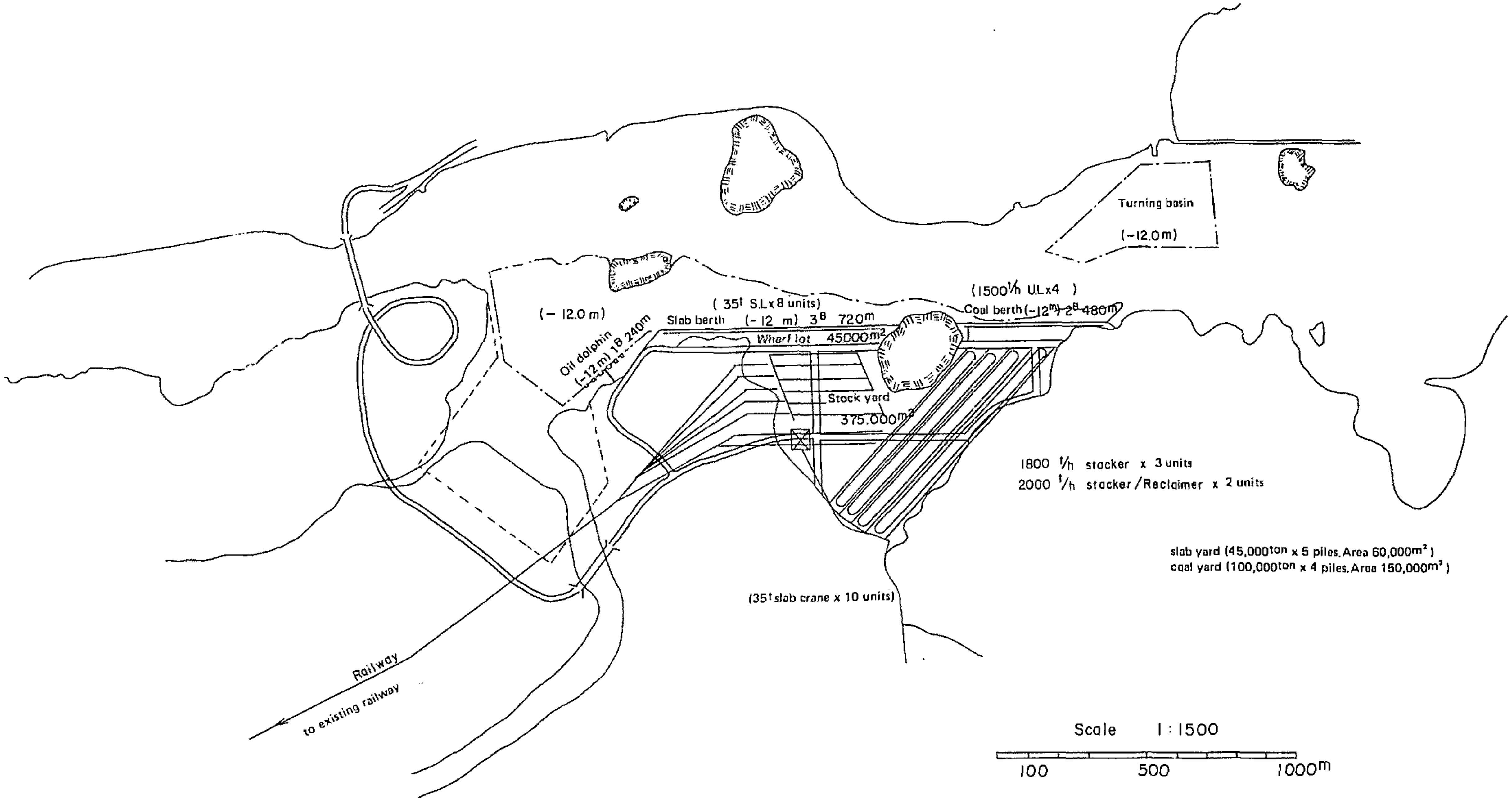


Fig. 13.3.1 Facility plan of the port of Vitória (Alternative)

Table 13.3.1 The scope and the cost of construction of the assumptive facilities of the port of Vitória

(in US$ million)

Item	Quantity	Construction cost			Remarks
		Foreign currency	Domestic currenty	Total	
Dredging & reclamation		(5.2)	(5.5)	(10.7)	
Dredging	$4.58^{4}m^{3}$	5.2	52.	10.4	
Reclamation	1 set	-	0.3	0.3	
Mooring facilities		(4.9)	(11.8)	(16.7)	
Slab berth	(-12m)720m	3.4	6.5	9.9	
Coal berth	(-12m)480m	1.2	4.2	5.4	
Oil berth	(-12m)240m	0.3	1.1	1.4	
Revetment		(2.0)	(3.1)	(5.1)	
Slab berth revetment	1 set	1.2	1.9	3.1	
Coal berth revetment	1 set	0.8	1.2	2.0	
Other civil facilities		(6.9)	(56.1)	(63.0)	
Railway (incl. 2 bridges)	16 km	3.4	30.4	33.8	
Road	4 km	-	1.2	1.2	
Other facilities	1 set	3.5	24.5	28.0	
Pysical contingency for civil work		(2.0)	(7.6)	(9.6)	
Cargo handling facilities		(16.7)	(71.3)	(88.)	
Slab berth cargo handling equipment	1 set	7.7	17.8	25.5	Slab loader; 8 units
Slab yard facilities	1 set	1.8	13.8	15.6	Slab crane; 10 units
Coal berth cargo handling equipment	1 set	4.0	17.8	21.8	Unloader; 4 units, conveyor; 4 lanes
Coal yard facilities	1 set	3.2	21.9	25.1	Stacker; 3 units, stacker/reclaimer; 2 units, conveyor; 5 lanes
Pysical Contingency for cargo handling facilities		(5.8)	-	-	
Total		43.5	155.4	193.1	

Table 13.3.2 Comparison of the working conditions of the facilities in both ports

	Praia Mole Port						Vitoria Pórt					
	Coal		Slab		Petroleum		Coal		Slab		Petroleum	
	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage
Anual cargo volume handled (t)	4,400,000	8,000,000	2,500,000	5,000,000	2,800,000	3,460,000	4,400,000	8,000,000	2,500,000	5,000,000	2,800,000	3,460,000
Average ship size (DWT)	55,000	62,000	105,000 17,000	105,000 17,000	20,000	40,000	30,000	30,000	250,000	250,000	20,0000	20,000
Number of calling ships	88	143	63	126	155	96	163	296	109		155	192
Ship mooring time(day/number)	1.6	2.42	5.01	4.7	0.88	1.61	0.97	1.25	2.95	2.77	0.88	0.88
Ship mooring time(day/year)	140	346	316	592	136	154	158	370	322	601	136	169
Ship waiting time(day/number)	0.70	0.39	0.60	0.47	0.27	0.42	0.40	0.26	0.35	0.33	0.27	0.42
Ship waiting time(day/year)	62	56	38	59	43	40	66	76	38	72	43	81
Total ship stay duration (day/number)	2.30	2.8	5.60	5.17	1.15	2.03	1.37	1.51	3.30	3.10	1.15	1.30
Total ship stay duration (day/year)	202	402	354	651	179	194	224	446	360	673	179	250
BALANCE												
Ship mooring time(day/year)							+18	+24	+ 6	+ 9	0	+15
Ship waiting time(day/year)							+ 4	+20	0	+13	0	+41
Ship stay duration (day/year)							+22	+44	+ 6	+22	0	+56
Number of berths	1	2	2	3	1	1	1	2	2	3	1	1
Berth utilization coefficient	0.38	0.47	0.43	0.54	0.37	0.42	0.43	0.51	0.44	0.55	0.37	0.46

13-4 Calculation of the cost and the benefit

13-4-1 Cost

The cost is to be the total amount of expenses for facility construction, the maintenance and repair, electric power and fuel, and management expenses including the labor cost. The internal rate of return is to be calculated from the difference between the cost required for the port of Praia Mole and that for the port of Vitōria (alternative plan). The maintenance and repair expenses, the cost of electric power and fuel, and the management cost of the port of Vitōria (altanative plan) are to be estimated on the same principle as of the port of Praia Mole. Table 13.4.1 shows the cost of Praia Mole Port and of Vitōria Port.

The calculation of the maintenance and repair expenses, the cost of electric power and fuel, and the cost are shown in the reference materials at the end of this chapter.

13-4-2 Benefit

As previously stated, the benefit is to be evaluated by the expected savings in transport cost due to the utilization of Praia Mole Port in comparison with that of Vitōria Port (alternative plan). In other words, the expected cost savings are estimated by the transport expences varing with the difference in size of vessels to enter both ports as well as the secondary expenses of inland transportation from Vitōria Port to CST.

(1) The cost savings by the difference in size of the ships

The cost savings are to be estimated by the difference in transport costs of the 120,000 DWT carriers (for slabs and coal) and the 60,000 DWT tankers (for oil) which can enter Praia Mole Port and of the 40,000 DWT carriers (for every type of cargoes) which can enter Vitōria Port. However, the import cargoes and the domestic cargo (oil) which are considered to make a direct contribution to the economy in Brazil are to be the object of the present evaluation. The expected savings in transport cost of the export cargoes, which are also considered to make a certain

Table 13.4.1 (1) The cost of the port of Praia Mole

(in Cr$ million)

Year	Construction cost			Other expenses				Total
	Domestic currency	Foreign currency	Subtotal	Maintenance and repair	Manage-ment	Electric power and fuel	Subtotal	
1977	39.7		(39.7) 39.7					(39.7)
78	339.2	(52.9) 46.0	(392.1) 385.2					(392.1) 385.2
79	826.8	(181.0) 157.4	(1,007.8) 984.2					(1,007.8) 984.2
80	1,193.0	(291.4) 253.4	(1,484.4) 1,446.4					(1,484.4) 1,446.4
81	654.0	(163.4) 142.1	(817.4) 796.1	71.3	67.1	15.1	153.5	(970.9) 949.6
82	227.9	(63.0) 55.0	(290.9) 282.9	71.3	67.1	115.1	153.5	(444.7) 436.4
83	455.7	(108.9) 94.7	(564.6) 550.4	71.3	67.1	15.1	153.5	(718.1) 703.9
84				103.4	95.7	30.8	229.9	(229.9) 229.9
85				↓	↓	↓	↓	↓

Notes: 1) Construction cost is per Chapter 9.

2) The values parenthesized are estimated by the shadow price concept.

Table 13.4.1 (2) The cost of the port of Vitória

(in Cr$ million)

Year	Construction costs			Other expenses				Total
	Domestic currency	Foreign currency	Subtotal	Maintenance and repair	Management	Electric power and fuel	Subtotal	
1977	19.8		(19.8) 19.8					(19.8) 19.8
78	182.0	(35.2) 30.6	(217.2) 212.6					(217.2) 212.6
79	454.8	(130.6) 113.6	(585.5) 568.5					(585.5) 568.5
80	628.9	(211.9) 184.3	(840.8) 813.2					(840.8) 813.2
81	309.1	(130.6) 113.6	(439.7) 422.7	65.2	52.6	11.9	129.7	(569.4) 552.4
82	120.9	(42.9) 37.3	(163.8) 158.2	65.2	52.6	11.9	129.7	(293.5) 287.9
83	199.3	(89.0) 77.4	(288.3) 276.7	65.2	52.6	11.9	129.7	(418.0) 406.3
84				87.5 ↓	75.1 ↓	24.1 ↓	186.7 ↓	(186.7) 186.7 ↓
85 ↓								

Note: 1) The values parenthesized are estimated by the shadow price concept.

2) The costs for management, electric power and fuel are determined from the expenses of Praia Mole Port on the basis of proportion of cargo handling facilities construction cost of Praia Mole Port and Vitória Port.

contribution to the domestic economy in some way or other, are to be excluded from this evaluation because the benefit does not seem so direct for the final consumers and the extent they contribute to the domestic economy is not clear.

The object of the benefit evaluation here is to be the import coal and oil, and coal is supposed to be imported in a fifty-fifty percentage from Australia and the United States of America, while oil to be transferred from the port of Santos. All the cargoes are supposed to be carried by vessels of an average size, since it is impossible that all of them is carried by vessels of the maximum size acceptable to the port. The daily ship operation cost and fuel cost per type of bulk carriers are estimated by referring to the data obtained from various Japanese shipping companies, which are given in Fig. 13.4.1 and Fig. 13.4.2. Table 13.4.2 shows the cost saving in the transport per ton of coal to be imported and oil calculated on the condition mentioned above.

The transport expenses of coal and oil classified per port of origin are shown in the reference materials at the end of this chapter.

Table 13.4.2 Cost savings in transport per ton of coal and oil

(in Cr$)

Item	Origin	Praia Mole Port		Vitória Port		Difference	
		1st stage	master plan	1st stage	master plan	1st stage	master plan
Coal	Australia	14.4	13.9	18.9	18.9	4.5	5.0
	Baltimore, U.S.A.	8.52	8.19	11.19	11.22	2.67	3.03
Oil	Santos	1.8	1.6	1.8	1.9	-	0.3

(2) Secondary expenses of transportation from the port of Vitória to CST

The port of Praia Mole is situated so close to CST that the required transportation between CST and the wharf can be ignored as only a part of the inter-plant transportation. The port of Vitória (alternative plan), on the other hand, is approximately 16 km apart from CST, and it is quite

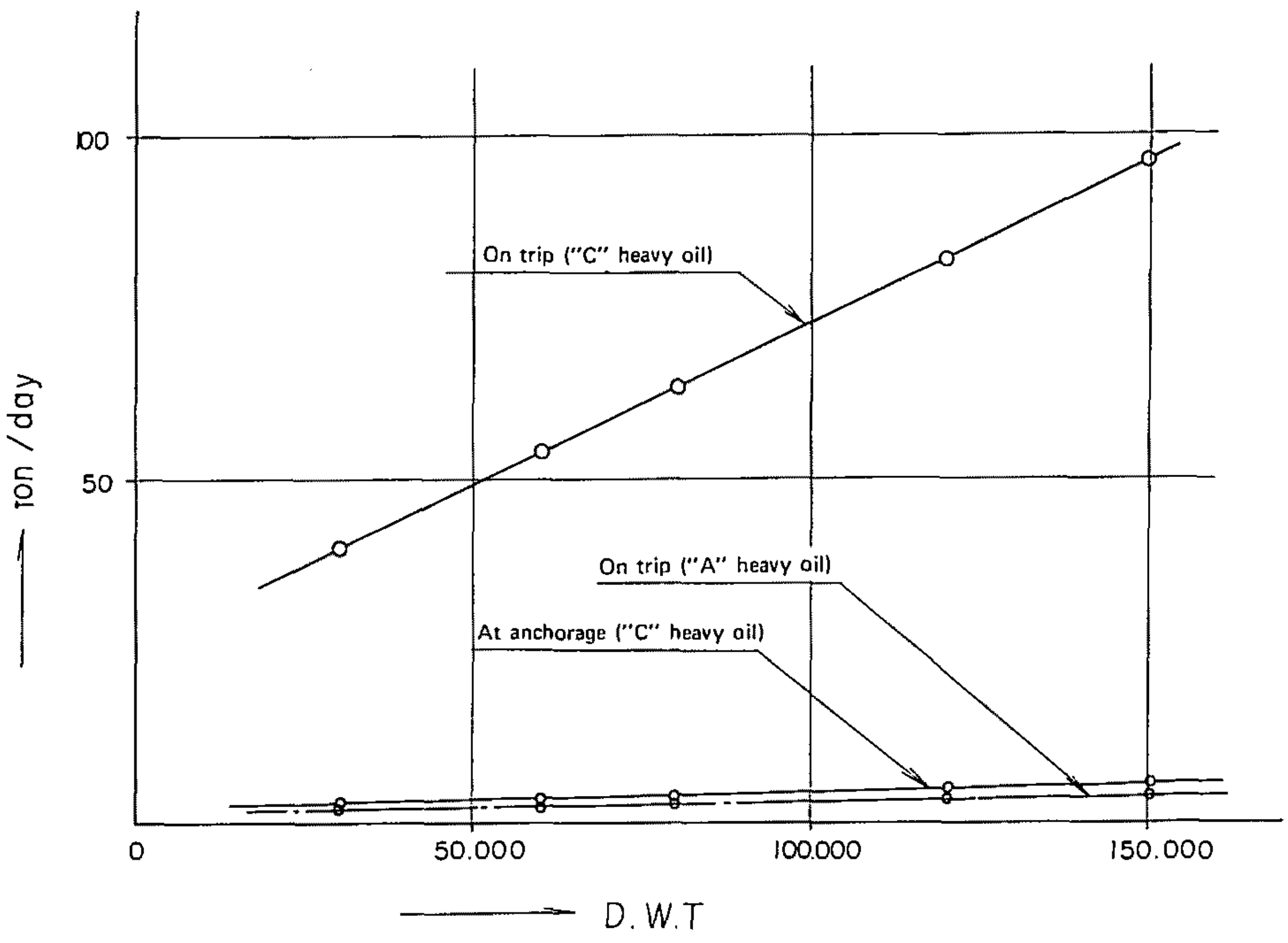


Fig. 13.4.1 Fuel consumption by type of vessels

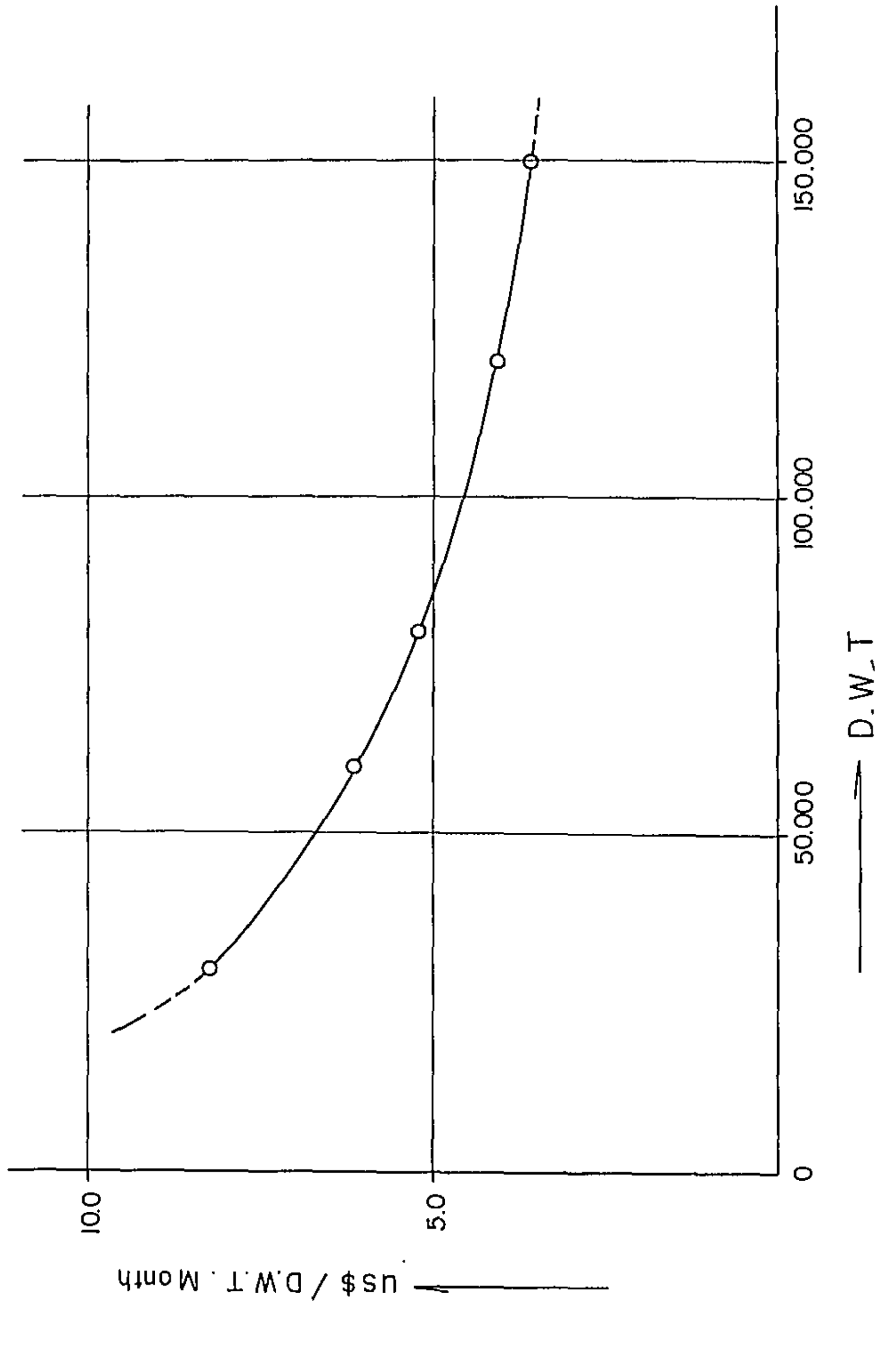


Fig. 13.4.2 The charterage and running costs of bulk carriers

clear that the secondary transportation between them requires higher expenses than that of Praia Mole Port. The additional expenses required of Vitória Port (alternative plan), therefore, is considered to be one of the benefits provided by the construction of Praia Mole Port.

The object of the benefit evaluation here is the relevant portion of coal and slabs that is to be transferred to or from CST by way of the port. This portion of the cargoes is supposed to be transported by the Rio Doce Railways which are extended to the back yard of the port facilities (alternative plan). The transportation by trucks seems impossible unless a large-scale exclusive road is newly constructed, because the total volume of the cargoes to be transported exceeds 10 million tons. The transport cost, therefore, is to be estimated by the freight rates per tonnage used by Rio Doce as of February, 1977. As shown in Table 13.4.3, the freight of coal and slabs per tonnage is Cr$10.54 and Cr$13.89 respectively.

(3) Benefit calculation

Table 13.4.4 shows the annual benefit of this project calculated based on the expected cost savings specified above and the total amount of port cargoes estimated in Chapter 4-3-2.

Table 13.4.3 Rio Doce railway tariff

(in Cr$)

KM	= RAZÕES QUILOMETRICAS EM C:6 P/TONELADA =				
	M - 1	M - 2	M - 3	M - 4	M - 5
001/020	15.70	13.89	12.23	10.54	13.89
021/040	18.23	16.14	14.21	12.37	15.14
041/060	20.75	16.33	16.18	14.19	18.38
051/090	23.28	20.63	18.16	16.02	20.63
031/100	25.80	22.83	20.14	17.34	22.86
101/120	26.32	25.13	22.12	19.66	25.13
121/140	30.85	27.33	24.10	21.49	27.38
141/160	33.37	29.62	26.07	23.31	29.62
161/150	35.90	31.87	28.05	25.14	31.87
181/200	39.42	34.12	30.03	25.95	34.12
201/220	40.94	36.37	32.01	28.78	35.37
221/240	43.47	33.62	33.99	30.61	36.62
241/260	45.99	40.86	35.96	32.43	40.86
251/280	48.52	43.11	37.94	34.25	43.11
281/300	51.04	45.36	39.92	36.08	45.36
301/320	50.56	47.61	41.90	37.90	47.61
321/340	53.09	49.86	43.58	39.73	49.06
341/360	58.61	52.10	45.85	41.55	52.10
351/360	61.14	54.35	47.83	43.38	54.35
331/400	63.65	56.60	49.81	45.20	56.60
401/420	65.13	58.85	51.79	47.02	58.35
421/440	63.71	61.10	53.77	48.85	61.10
441/460	71.23	63.34	55.74	50.67	63.34
461/480	73.76	65.59	57.72	52.50	65.59
481/500	76.28	67.54	59.70	54.32	67.84
501/520	78.60	70.00	61.68	56.14	70.09
521/540	81.33	72.34	63.66	57.97	72.34
541/550	83.85	74.58	65.63	59.79	74.58
561/530	83.38	76.83	67.61	61.62	76.83
581/600	88.90	79.08	69.59	63.44	79.09
601/620	91.42	81.33	71.57	65.26	81.33
621/640	98.95	83.58	73.55	67.09	83.58
641/660	96.47	85.82	75.52	68.91	85.82
651/680	93.00	88.07	77.50	70.74	88.07
631/700	101.52	90.32	79.48	72.55	90.32
701/720	104.04	92.57	81.46	74.33	92.57

Note: Effective as from Feb. 15, 1977

Table 13.4.4 Annual benefit

(in Cr$ million)

Year	Coal			Petroleum (due to difference in type of ship)	Slab (secondary transportation expense)	Total
	Due to difference in type of ship	Secondary transportation expense	Subtotal			
1981	(184.7) 160.6	23.5	(208.2) 184.1	12.3	34.7	(255.2) 231.1
82	(184.7) 160.6	23.5	(208.2) 184.1	13.1	34.7	(256.0) 231.9
83	(184.7) 160.6	23.5	(208.2) 184.1	14.0	34.7	(256.9) 232.8
84	(380.5) 330.9	40.3	(420.8) 371.2	15.0	69.5	(505.3) 455.7
				15.9		(506.2) 456.6
86				17.1		(507.4) 457.8
87				18.2		(508.5) 458.9
88				19.7		(510.0) 460.4

Note: Values parenthesized refer to compensation according to shadow price efficient rate.

13-5 The internal rate of return

In calculation of the internal rate of return, the life time of this project is to be estimated at 25 years from the time when the first profit is yielded.

As for the foreign currency portion included in the cost and benefit evaluation, the case in which the shadow foreign rate coefficient of 1.15 is applied has been also studies, because there exsists a little difference between the official exchange rate of cruzeiro (Cr$), the standard currency in Brazil, and the actual rate.

The result of calculation is summarized in Table 13.5.1. The calculation sheet of the internal rate of return is also included in the reference materials at the end of this chapter.

Table 13.5.1 The internal rate of return

	Where shadow price concept is not incorporated	Where shadow price concept is incorporated	Remarks
Internal rate of return (IRR)	16.6	18.3	

13-6 Evaluation

If the internal rate of return (IRR) calculated here is larger than the opportunity cost of the capital, the project is considered to be feasible from a viewpoint of the national economy. The scocial opportunity cost of capital, however, is quite difficult to estimate, and there is no fixed practice in Brazil to be relied on either. The internal rates of return of similar projects financed by the International Bank for Reconstruction and Development read as follows.

The second railway project (December, 1974) 19%

The third railway project (September, 1975) 21.4%

In the PLANAVE report , the social opportunity cost has been estimated at 10%.

Judging from the reference materials mentioned above, the construction of Praia Mole Port is considered to be quite feasible for the national economy of Brazil, so long as this project premises the construction of CST.

Table 13-1 Details of the maintenance and repair expenses required of Praia Mole Port

Facilities	Maintenance expense rate, %	1st stage			Master plan			Remarks
		Construcution cost	Maintenance and repair expenses		Construcution cost	Maintenance and repair expenses		
		US$ million	US$ thousand	Cr$ million	US$ million	US$ thousand	Cr$ million	
Breakwaters	0.1	91.4	0.091	1.16	91.4	0.091	1.16	
Dredging	1.0	48.4	0.484	6.20	48.4	0.484	6.20	
Reclamation	-	20.5	-	-	20.5	-	-	
Mooring facilities	1.0	33.2	0.332	4.25	47.3	0.473	6.05	
Revetment	1.0	10.6	0.106	1.36	10.6	0.106	1.36	
Other facilities	3.0	36.6	1.098	14.05	43.8	1.314	16.82	
Cargo handling facilities	5.0	69.2	3.460	44.29	112.2	5,610	71.81	
Total		309.9	5.571	71.31	374.2	8.078	103.40	

Table 13-2 Details of the expenses of electric power and fuel of Praia Mole Port

Type of energy	Unit	1st stage	Master plan	Remarks
Electricpower				
Consumption	Million kWh	26.69	51.71	Electric rate:
Electric charge	1,000 Cr$	10,670	20,680	Cr$0.4/kWh
Fuel				Diesel oil:
Diesel oil consumption	1,000 ℓ	1,649.0	5,975.7	Cr$2.7/ℓ
Fuel expense	1,000 Cr$	4,460	10,100	
Total	1,000 Cr$	15,130	30,780	

Table 13-3 Details of the management expenses including the labor cost required of Praia Mole Port

Type of occupation	1st stage		Master plan		Remarks
	Number of labors	Labor costs (1,000 Cr$)	Number of labors	Labor costs (1,000 Cr$)	
Cargo handling operator	324	16,200	521	26,050	
Maintenance and repair worker	84	4,200	104	5,200	
Management staff	100	5,000	130	6,500	
Others	163	8,150	202	10,100	
Total	671	33,550	957	47,850	

Notes: 1) Calculation based on an annual average per capital wage of Cr$50,000.

2) The total is estimated to be twice as much as the management expenses including the labor cost.

Table 13-4 Details of the maintenance and repair expenses required of the Vitória Port (alternative)

(in Cr$ million)

Facilities	Maintenance expense rate, %	1st stage Maintenance and repair expenses	Master plan Maintenance and repair expenses	Remarks
Dredging	1.0	1.5	1.5	
Mooring	1.0	1.5	2.4	
Revetment	1.0	0.7	0.7	
Other facilities	3.0	26.6	26.6	
Cargo handling facilities	5.0	34.9	56.3	
Total		65.2	87.5	

Note: The expenses for the 1st stage are estimated by proration from the ratio of the first stage expenses to the master plan expenses in Praia Mole Port.

13-5 (1) Details of transportation cost per ton of coal (from Australia) classified by type of carriers

	Praia Mole Port		Vitória Port		Remarks
	1st stage	Master plan	1st stage	Master plan	
Shipping schedule					
Round trip day	46.6	46.6	46.6	46.6	Haulage distance 8,379 nautical miles
Mooring day	1.60	2.43	0.97	1.25	
Waiting day	0.7	0.39	0.40	0.26	Running speed: 15 knots
Channel passing day	0.02	0.02	0.02	0.02	
Subtotal (day)	48.92	49.43	47.99	48.13	
Average size ship					
	DWT	DWT	DWT	DWT	
Deadweight tonnage	55,000	62,000	30,000	30,000	
	tons	tons	tons	tons	
Net cargo weight	49,500	55,800	27,000	27,000	
Fuel consumption					
C heavy oil	tons	tons	tons	tons	
on trip	2,376.6	2,563.0	1,748.0	1,748.0	C heavy oil: US$60/ton
at anchorage	7.6	9.3	3.4	3.8	A heavy oil: US$120/ton
A heavy oil	2,384.2	2,572.3	1,751.4	1,751.8	
Transportation cost per ton of coal					
	US$	US$	US$	US$	
Fuel cost	11.32	10.89	14.67	14.70	
Charterage and running costs	3.2	3.0	4.2	4.2	
Total (US$)	14.52	13.09	18.87	18.90	

13-5 (2) Details of transportation cost per ton of coal (from the United States of America) classified by type of carriers (Baltimore, ULS.A. - Vitória)

	Praia Mole Port		Vitória Port		Remarks
	1st stage	Master plan	1st stage	Master plan	
Shipping schedule					
Round trip day	26.7	26.7	26.7	26.7	Haulage distance 4,800 nautical miles
Mooring day	1.6	2.42	0.97	1.25	Running speed: 15 knots
Waiting day	0.70	0.39	0.40	0.26	
Channel passing day	0.02	0.02	0.02	0.02	
Subtotal (day)	29.02	29.53	28.04	28.23	
Average ship size					
Deadweight tonnage	DWT 55,000	DWT 62,000	DWT 30,000	DWT 30,000	
Net cargo weight	tons 49,500	tons 55,800	tons 27,000	tons 27,000	
Fuel consumption					
C heavy oil on trip	tons 1,369.3	tons 1,477.8	tons 1,004.7	tons 1,045.1	C heavy oil : US$120/ton
on trip	1,361.7	1,468.5	1,041.3	1,041.3	A heavy oil : US$60/ton
at anchorage	7.6	9.3	3.4	3.8	
A heavy oil	61.7	61.7	61.7	61.7	
Transportation cost per ton of coal					
Fuel cost	US$ 1.81	US$ 1.69	US$ 2.60	US$ 2.60	
Charterage and running costs	6.71	6.50	8.59	8.62	
Total (US$)	8.52	8.19	11.19	11.22	

Table 13-6 Details of transportation cost per ton of oil classified by type of carriers (Santos - Vitória)

	Praia Mole Port		Vitória Port		Remarks
	1st stage	Master plan	1st stage	Master plan	
Shipping schedule					
Round trip day	25.0	25.0	25.0	25.0	Haulage distance 445 nautical miles
Mooring day	0.88	1.61	0.88	0.88	
Waiting day	0.27	0.42	0.27	0.42	Running speed: 15 knots
Channel passing day	0.02	0.02	0.02	0.02	
Subtotal (day)	28.67	29.55	28.67	28.82	
Average ship size					
Deadweight tonnage	DWT 20,000	DWT 40,000	DWT 20,000	DWT 20,000	
Net cargo weight	tons 18,000	tons 36,000	tons 18,000	tons 18,000	
Fuel consumption					
C heavy oil	tons	tons	tons	tons	C heavy oil: US$120/ton
on trip	91.0	110.9	88.2	88.2	
at anchorage	2.8	4.9	2.8	3.1	A heavy oil: US$60/ton
A heavy oil	3.6	7.4	3.6	3.6	
Transportation costs per ton of cargo	US$	US$	US$	US$	
Fuel cost	0.3	0.2	0.3	0.3	
Charterage and running costs	1.5	1.4	1.5	1.6	
Total (US$)	1.8	1.6	1.8	1.9	

Table 13-7 Calculation sheet of internal rate of return (without shadow price concept)

(in Cr$ million)

Sequence	Year	Cost			④	⑤	Internal rate of return	
		① Praia Mole	② Vitória (alternative)	③ Difference ① - ②	Benefit	(④ - ③)	16 %	17%
	1977	39.7	19.8	29.9		Δ 29.9	Δ 29.9	29.9
	1978	385.2	212.6	172.6		Δ 172.6	Δ148.8	147.5
	1979	984.2	568.5	415.7		Δ 415.7	Δ308.9	303.7
	1980	1,446.4	813.2	633.2		Δ 633.2	Δ405.7	395.4
1	1981	949.6	552.4	397.2	231.1	Δ 166.1	Δ 91.7	88.6
2	1982	436.4	287.9	148.5	231.9	83.4	39.7	38.0
3	1983	703.9	406.3	297.6	232.8	Δ 64.8	Δ 26.6	25.3
4	1984	229.9	186.7	43.2	455.7	412.5	145.9	137.4
5	1985				456.6	413.4	126.1	117.7
6	1986				457.8	414.6	109.0	100.9
7	1987				458.9	415.7	94.2	86.5
8	1988				460.4	417.2	81.5	74.2
9	1989						70.3	63.4
10	1990						60.6	54.2
11	1991						52.2	46.3
12	1992						45.0	39.6
13	1993						38.8	33.8
14	1994						33.5	28.9
15	1995						28.8	24.7
16	1996						24.9	21.1
17	1997						21.4	18.1
18	1998						18.5	15.4
19	1999						15.9	13.2
20	2000						13.7	11.3
21	2001						11.8	9.6
22	2002						10.2	8.2
23	2003						8.8	7.1
24	2004						7.6	6.0
5	2005						6.6	4.4
							53.4	Δ30.0

$$17\% - 1\% \times \frac{30}{53.4 + 30} = 17\% - 0.36 = 16.64\%$$

Table 13-8 Calculation sheet of internal rate of return (with shadow price concept)

(in Cr$ million)

Sequence	Year	Cost			④ Benefit	⑤ (④ - ③)	Internal rate of return	
		① Praia Mole	② Vitoria (alternative)	③ Difference ① - ②			16%	17%
	1977	39.	19.8	19.9		Δ119.9	Δ19.9	19.9
	1978	392.1	217.2	174.9		Δ174.9	Δ148.2	147.0
	979	1,007.8	585.5	422.3		Δ422.3	Δ303.3	298.2
	1980	1,484.4	840.8	643.6		Δ643.6	Δ391.7	381.9
1	1981	970.9	569.4	401.5	255.2	Δ146.3	Δ75.5	73.0
2	1982	444.7	293.5	151.2	256.0	104.8	45.8	43.9
3	1983	718.1	418.0	300.1	256.9	Δ45.2	Δ16.7	15.9
4	1984	229.9	186.7	43.2	505.3	462.1	145.1	136.7
5	1985				506.2	463.0	123.2	115.1
6	1986				507.4	464.2	104.7	97.0
7	1987				508.5	465.3	88.9	81.7
8	1988				510.0	466.8	75.6	68.9
9	1989					64.0	64.0	57.9
10	1990						54.3	48.6
11	1991						46.0	40.9
12	1992						39.0	34.4
13	1993						33.0	28.8
14	1994						28.0	24.3
15	1995						23.7	20.4
16	1996						20.1	17.1
17	1997						17.0	14.4
18	1998						14.4	12.1
19	1999						12.2	10.2
20	2000						10.4	8.5
21	2001						8.8	7.2
22	2002						7.5	6.0
23	2003						6.3	5.1
24	2004						5.4	4.2
25	2005						4.5	3.6
				Difference			22.6	Δ48.9

$$19\% - 1\% \times \frac{48.9}{48.9 + 22.6} = 19\% - 0.68 = 18.32$$

CHAPTER 14. FINANCIAL ANALYSIS

14. Financial analysis

14-1 General description

The financial analysis to investigate the health of financial situation of the organization to take charge of the project execution, while the economic analysis aims at evaluation of the effect of the project on the national economy.

As for this project, one of the affiliated companies to PORTOBRÁS seems to become the execution organization and aim at port management on a commercial basis. There are some cases in general, however, in port management as far as the financial practice is concerned. Some of the ports have received partial or full financial aid of the central government, while the others have generally adopted a self-supporting account system. The financial aid of the government takes various forms such as subsidy, loan, investment, grant for paying a fixed rate of interest, free lending of fixed assets, etc.

In any case, the object of the financial analysis is to analyze the effect of the expenditure and revenue derived from the project execution on the financial condition of the relevant organization, and to investigate the health of finance, or to present a tariff system to assure sound financial management.

The health of finance, therefore, is to be investigated here through the following three types of analysis on a commercial basis while referring to the current port tariffs adopted by the neighboring Vitõria Port to decide the tariff system of the port of Praia Mole which forms the basis of benefit.

① Investigation of the cost per ton of cargo

② Analysis by DCF (Discounted Cash Flow) method

③ Investigation of the cash flow based upon the income and expense estimation.

14-2 Port cost to be borne by a ton of cargoes handled in Vitória Port

In the analysis mentioned above, the port cost to be borne per tonnage by the cargoes is to be calculated in accordance with the current tariff of Vitória Port in order to set up a comparable standard of return. In calculation, the tariff approved by PORTOBRÁS in February, 1977, is used as a basis.

Such cargo handling condition as is shown in Table 14.2.1 is to be set per stage of the construction work (the first stage and the master plan - until the second stage -) since the port cost to be borne per tonnage by the cargoes varies with the size of each carrier and the volume of cargoes concerned. The port cost to be borne per tonnage by each type of cargoes calculated on this set condition is given in Table 14.2.2.

The port cost to be borne by slabs and coal thus calculated is 43.18 ∿ 45.76 Cr$/ton and 32.95 ∿ 38.28 Cr$/ton respectively. The port cost to be borne by oil, on the other hand, is estimated at 7.68 Cr$/ton, of which no charge of the cargo handling equipment is expected because all the other port facilities for oil than the civil enginerring structures are supposed to be built by the users.

Table 14.2.1 Cargo handling conditions

	Slab (1st & 2nd stage)		Coal				Petralum		Pellet (1st & 2nd)
			1st stage		2nd stage		1st stage		
	Foreign Export	Domestic Export	Foreign Import	Domestic Import	Foreign Import	Domestic Import	Domestic Import	Domestic Import	Foreign Export
1. Average ship size	DWT 105,000	DWT 17,000	DWT 65,000	DWT 20,000	DWT 70,000	DWT 30,000	DWT 20,000	DWT 40,000	DWT 50,000
			($55,000^{DWT}$)		($62,000^{DWT}$)				
2. Net registered tonnage	49,000	8,000	30,000	9,000	12,000	14,000	9,000	19,000	NRT 19,000
			(26,000)		(29,000)				
3. Ship length	280m	150m	240m	164m	248m	187m	164m	206m	230m
			(230m)		(235m)				
4. Cargo volume handled	$56,500^{t}$	$15,300^{t}$	$58,500^{t}$	$18,000^{t}$	$63,000^{t}$	$27,000^{t}$	$18,000^{t}$	$36,000^{t}$	$45,000^{t}$
	($40,000^{t}$)		($50,000^{t}$)		($56,000^{t}$)				
5. Ship stay duration	6.6	1.8	1.9	0.6	2.7	1.2	0.88	1.61	0.5
	(4.7)		(1.6)		(2.42)				
6. Storage duration — 1st stage	1.08 month (Stock capacity: 225,000 tons)		1.5 month (Stock capacity: 279,000 tons)		1.75 month (Stock capacity: 558,000 tons)		-	-	-
6. Storage duration — 2nd stage	0.97 month (Stock capacity: 405,000 tons)								
7. Land transportation to/from the port	Tractors & Trailers		Belt Conveyor		Belt Conveyor		Pipe line		Belt Conveyor
8. Water volume supplied	500^{t}	250^{t}	500^{t}	250^{t}	500^{t}	250^{t}	250^{t}	250^{t}	500^{t}
9. Handling equipment inside the ship	2 Fork Lifts (20 ton capacity each) necessary while loading		4 Bulldozers (22 ton capacity each) necessary while unloading		ditto		-	-	-
10. Unit cargo volume	Max 35T	Max 35T	—	—	—	—	—	—	—

Table 14.2.2 The port cost to be borne per tonnage by each type of cargoes to be handled in Vitória Port

(in Cr$ million)

Traffic Item	Slab		Coal		Oil
	Foreign Export	Domestic Export	Foreign Import	Domestic Import	Domestic Import
Wharfage - Table "A" (a)	3.20	1.60	3.20	1.60	3.20
R-194/76 20% of (a), (b)	0.64	0.32	0.64	0.32	0.64
Depreciation Fund 1% of (a + b)	0.04	0.02	0.04	0.02	0.04
Dredging Surtax 50% of (a + b)	1.92	0.96	1.92	0.96	1.92
Total	5.80	2.90	5.80	2.90	5.80
Docking Charge - Table "B" (a)	0.09	0.02	0.02	0.01	0.03
R-194/76 20% of (a), (b)	0.02	-	-	-	0.01
Depreciation Fund 1% of (a + b)	-	-	-	-	-
Total	0.11	0.02	0.02	0.01	0.04
Cargo Handling Charge - Table "C" (a)	16.40	21.00	14.00	12.00	
R-194/76 20% of (a) (b)	3.28	4.20	2.80	2.40	
Depreciation Fund 1% of (a + b)	0.20	0.25	0.17	0.14	
Total	19.88	25.45	16.97	14.54	
Storage Charge - Table "E" (a)	3.10	3.10	6.40	6.40	
R-194/76 20% of (a) (b)	0.62	0.62	1.28	1.28	
Depreciation Fund 1% of (a + b)	0.04	0.04	0.08	0.08	
Total	3.66	3.66	7.76	7.76	
Equipment Charge - Table "J" (a)	13.58	13.58	7.64	7.64	
R-194/76 20% of (a) (b)	-	-	-	-	
Depreciation Fund 1% of (a + b)	0.14	0.14	0.08	0.08	
Total	13.72	13.72	7.72	7.72	
Water Supply Charge - Table "L" (a)	0.01	0.01	0.01	0.02	0.02
R-194/76 0% of (a) (b)	-	-	-	-	-
Depreciation Fund 1% of (a + b)	-	-	-	-	-
Total	0.01	0.01	0.01	0.02	0.02
Cargo Handling Charge - Table "N" (a)					1.80
Depreciation Fund 1% of (a)					1.82
Grand Total	43.18	45.76	38.28	32.95	7.68

Notes:
1. The table above is prepared according to the current tariff of Vitória Port.
2. R-194/76 is the abbreviation for Resolucao 194/76, in which 20% surcharge requirements are provided for with respect to the tables of Vitória Port.
3. As regards the large-sized cargo handling equipments not specified in the tariff of Vitória Port, the charges are calculated according to cost analysis (incl. running costs) while consulting the examples of other ports. (See attached Table 14-1)

14-3 Investigation of the cost per ton of cargo

14-3-1 Cost constitution

The cost per ton of cargo comprises annual depreciation cost, interest of the loan, maintenance and repair cost, cost of electric power and fuel, and management and operation cost including the labor cost. In case there are any facilities to be regarded as non-depreciation assets, the cost equivalent to the rent is included in the above cost per ton of cargo as part of the component elements.

The cost per ton of cargo is calculated in accordance with the flow chart shown in Fig. 14.3.1.

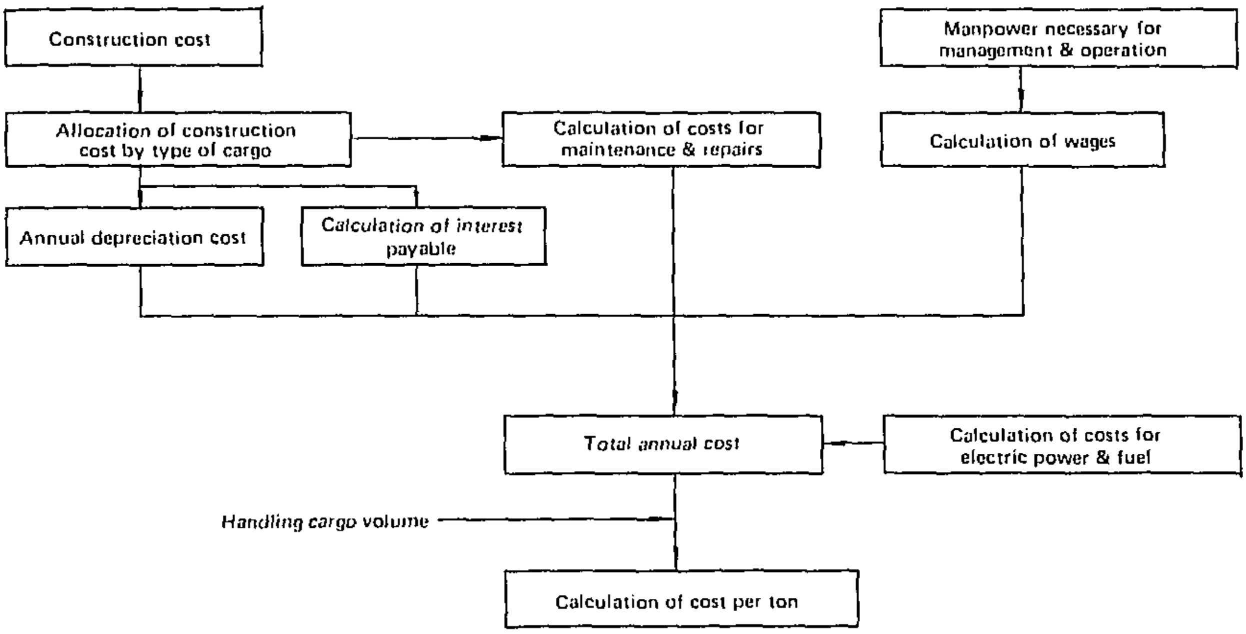


Fig. 14.3.1 Flow chart for cost calculation

This cost is calculated per each of the first stage work and the master plan of the project.

14-3-2 Calculation of the total annual cost

(1) Depreciation cost

In calculating the depreciation cost per type of cargoes, the cost of construction is to be allocated to each type of them. As to such facilities as mooring facilities and cargo handling equipment whose relation to the cargoes is clear the construction cost is naturally allocated to each type of cargoes. The construction cost of such facilities as breakwaters and fairways, on the other hand, is allocated in accordance with the ratio of the number of vessels to carry the relevant cargoes.

Table 14.3.1 shows the result of allocation.

Table 14.3.1 Allocation of the construction cost by type of cargoes

(in US$ million)

Classification	Total	Slab	Coal	Oil	Remarks
1. 1st stage					
1) Breakwaters	9.14	29.8	26.3	26.3	
2) Dredging	48.4	25.9	18.9	3.6	
3) Reclamation	20.5	9.3	11.0	0.2	
4) Mooring facil!ties	33.2	22.6	8.3	2.3	
5) Revetment	10.6	4.8	4.8	1.0	
6) Other facilities	36.6	19.3	13.5	3.8	
7) Cargo handling facilities	69.2	28.3	40.9	-	
Total	309.9	140.0	132.7	37.2	
2. Master plan					
1) Breakwaters	91.4	37.0	32.1	22.3	
2) Dredging	48.4	27.0	18.4	3.0	
3) Reclamation	20.5	9.3	11.0	0.2	
4) Mooring facilities	47.3	29.5	15.6	2.2	
5) Revetment	10.6	5.1	4.7	0.8	
6) Other facilities	43.8	24.3	15.4	4.1	
7) Cargo handling facilities	112.2	47.1	65.1	-	
Total	374.2	179.3	162.3	32.6	

For the breakdown, refer to table 14-1

The depreciation cost is to be calculated according to the life time set per each facility, and by a straight line method making the residual cost zero. The breakwaters, the channels and anchorage basins, and the reclaimed land are, as a rule, to be excluded from the object of depreciation.

The life of the respetive facilities is so set as in Table 14.3.2 by referring to the relative examples in Japan.

Table 14.3.2 The life (in years) of the respective facilities

Facility	Life time in year	Remarks
Mooring facilities	30	
Revetment	30	
Cargo handling facilities	12	
Others facilities	15	

Note: In principle, the breakwaters, dredging and reclamation shall be regarded as non-depreciable assets. For rough estimate, however, their life time may be set at 50 years.

Table 14.3.3 shows the depreciation cost of the respective facilities calculated per type of cargoes on the condition mentioned above.

The equivalent cost to the rent is to be estimated at the amount equivalent to the interest of money borrowed to obtain the non-depreciation assets. Calculated here is the amount equivalent to 6% of the cost for the dredging and reclamation work and the construction of the breakwaters. Table 14.3.4 shows the cost equivalent to the rent of the respective facilities.

Table 14.3.3 Allocation of the depreciation cost

(Unit: in Cr$ 1,000)

Item	Life time years	1st stage			Master plan		
		Slab	Coal	Oil	Slab	Coal	Oil
Breakwaters	(50)	7,630	9,040	6,730	9,470	8,220	5,710
Dredging (channel and basin)	(50)	6,630	4,840	920	6,910	4,710	770
Reclamation(land)	(50)	2,380	2,820	50	2,380	2,820	50
Subtotal							
Mooring facilities	30	9,640	3,540	980	12,590	6,660	940
Revetment	30	2,050	2,050	430	2,180	2,010	340
Others	15	16,470	11,520	3,240	20,740	13,140	3,500
Cargo handling facilities	12	30,190	43,630	-	50,240	69,440	-
Subtotal		58,350	60,740	4,650	85,750	91,250	4,780
Total		74,990	77,440	12,350	104,510	107,000	11,310

Note: As regards the breakwater, dredging and reclamation, the life time is set at 50 years for the sake of convenience.

Table 14.3.4 The cost equivalent to the rent of the respective facilities

(Unit: in Cr$ 1,000)

Facilities	1st stage			Master plan		
	Slab	Coal	Oil	Slab	Coal	Oil
Breakwaters	22,886.4	20,198.4	20,198.4	28,416	24,652.8	17,126.4
Dredging	19,891.2	14,515.2	2,764.8	20,736	14,131.2	2,304
Subtotal	42,777.6	34,713.6	22,963.2	49,152	38,784	19,430.4
Reclamation	7,142.4	8,448	153.6	7,142.4	47,232	19,584
Total	49,920.0	43,161.6	23,116.8	56,294.4	47,232	19,584

(2) Payment of interests

The interest to be paid is to be so calculated as fixed that the sum of the money borrowed to obtain the respective facilities and its interest is evenly repaid every year within their estimated life time. The amount of borrowed money here is supposed to include all the expenses required for the construction of facilities, and the rate of interest is estimated at 6%. Table 14.3.5 shows the result of calculation.

Table 14.3.5 Allocation of the interest payable

(Unit: in Cr$ 1,000)

Facilities	1st stage			Master plan		
	Slab	Coal	Oil	Slab	Coal	Oil
Breakwaters Dredging Reclamation						
Subtotal	35,780	31,670	3,430	50,360	47,320	3,410
Mooring facilities Revetment Other facilities Cargo handling facilities						
Subtotal						
Total	71,920	17,920	20,170	91,130	81,510	17,590

(3) Maintenance and repair cost

The maintenance and repair cost is calculated by multiplying the acquisition cost (the invested amount) by a fixed rate. This fixed constant is decided by the structure of each facility and the past data in Japan. The result of calculation is shown in Table 14.3.6.

Table 14.3.6 Maintenance and repair costs

(Unit: in Cr$ 1,000)

Item	Maintenance cost rate, %	1st stage			Master plan			Remarks
		Slab	Coal	Oils	Slab	Coal	Oil	
Breakwaters	0.1	380	450	340	470	410	290	
Dredging (channel and basin)	1.0	3,320	2,420	460	3,460	2,360	380	
Reclamation	-	-	-	-	-	-	-	
Mooring facilities	1.0	2,890	7,060	290	3,780	2,000	280	
Revetment	1.0	610	610	130	650	600	100	
Other facilities	3.0	7,410	5,810	1,460	9,340	5,910	1,570	
Cargo handling facilities	5.0	18,110	26,180	-	30,140	41,660	-	
Total		32,720	35,900	2,680	47,840	52,940	2,620	

Note: The maintenance cost rate is the percentage of maintenance cost to the construction cost.

(4) Management cost including personnel cost

The management expenses consist of the personnel expenses and overheads. The personnel expenses are calculated based on the manpowers required for the handling of respective cargoes, while the overheads are to be equivalent to 100% of the personnel expenses. Table 14.3.7 shows the personnel cost calculated by the average annual wages per employee which are estimated at Cr$50,000.

(5) The cost of electric power and fuel

The cost of electric power and fuel are to comprise the cost of electricity necessary for the cargo handling facilities, the port management, and the lighting apparatus in general, and of fuel consumed by tugboats and other port vehicles. Table 14.3.8 shows the cost of electric power and fuel calculated per type of cargoes.

14-3-3 Calculation of the cost per ton

The cost per ton of cargo is to be the quotient of the total cost calculated in Chapter 14-3-2 divided by the volume of cargoes to be handled per each stage of the project. The cost calculation covers the following assumptive cases set per stage.

Case A: The cost includes the depreciation cost of all the facilities as well as the other cost.

Case B: The breakwaters, the dredged area (basins and fairways) and the reclaimed land are considered to be non-depreciation assets.

Case C: Construction of the breakwaters and the dredging work are kept in a separate account.

Case D: The interest to be paid and the depreciation cost for construction of the breakwaters and the dredging and reclamation work are excluded from the cost calculation, and 10% of the total amount invested is included instead.

Table 14.3.7 Allocation of personnel cost

(Unit: in Cr$ 1,000)

Classification	1st stage		Master plan		Remarks
	Number of persons	Amount	Number of persons	Amount	
1. Slab					
Cargo handling equipment operation	219		355		
Maintenance and repair	49		61		
Other services	81		101		
Management	50		65		
Subtotal	399	19,950	582	29,100	
2. Coal					
Cargo handling equipment operation	105		166		
Maintenance and repair	32		39		
Other services	66		81		
Administration	40		52		
Subtotal	243	12,150	338	16,900	
3. Oil					
Cargo handling machine operation	-				
Maintenance and repair	3		4		
Other service	16		20		
Administration	10		13		
Subtotal	29	1,450	37	1,850	
Total	671	33,550	957	47,850	

Note: Annual average wage per person is set at Cr$50,000.

Table 14.3.8 Cost of electric power and fuel

(Amount in Cr$ 1,000)

Item	Unit	Unit cost (Cr$)	1st stage		Master plan		Remarks
			Quantity	Amount	Quantity	Amount	
Slab							
Electricity	kWH	0.4	10.92×10^6	4,360	21.52×10^6	8.610	
Diesel oil	ℓ	2.7	538,000	1,450	1,513,000	4,090	
Subtotal				5,820		12,700	
Coal							
Electricity	kWH	0.4	15.42×10^6	6,170	29.76×10^6	11,900	
Diesel oil	ℓ	2.7	637,4000	1,720	1,315,600	3,550	
Subtotal				7,890		15,450	
Oil							
Electricity	kWH	0.4	0.35×10^6	140	0.43×10^6	170	
Diesel oil	ℓ	2.7	473,600	1,280	912,700	2,460	
Subtotal				1,420		2,630	
Total				15,130		30,780	

In case A, the breakwaters, the dredging and the reclaimed land are regarded as depreciation assets. All the expenses required for construction including the depreciation are considered to be the project cost. In case B, on the other hand, the breakwaters, the dredging and the reclaimed land are regarded as non-depreciation assets from their character, and the equivalent amount to the rent is included in the cost instead. In case C, the breakwaters and the dredging whose character clearly differs from that of the other lucrative port facilities such as piers and cargo handling facilities are regarded as non-profitable facilities, and these facilities are to be constructed by the other organizations, for instance the central government, at their own expense. Case D, on the other hand, is a case speially added to the analysis in consideration of the fact that PORTOBRÁS has admitted mixed economy company ports to appropriate 10% of the invested amount in the annual cost, although the cost concept itself is rather vague.

The cost per ton of cargo calculated by case mentioned above is summarized in Table 14.3.9.

14-3-4 Result of the analysis and evaluation

The above cost calculation (Table 14.3.9) proffers the following conclusion.

① If Praia Mole Port is to be operated by the system (Case D) common in Brazil with the volume of cargoes expected in the first stage of the project, the tariff of Praia Mole Port must be set much higher than current tariff of Vitória Port. If the investment in the breakwaters, the basins and the fairways is to be covered within the port revenue (Cases A and B), the tariff must be set also on a higher level, though the situation is not so severe as in Case D.

② It goes without saying that the port management becomes easier after the completion of the second stage of work when the volume of cargoes is to increase as expected than in the first stage stated above. However, if the current system (Case D) of PORTOBRÁS is to be applied also to this stage, the tariff must be set at I.5 to 2 times of the

Table 14.3.9 Cost per ton of cargo

(Unit: in Cr$)

Item	1st stage			Master plan			Remarks
	Slab	Coal	Oil	Slab	Coal	Oil	
(1.) Management cost including labor cost	15.96	5.54	0.89	11.64	4.23	0.94	
(2.) Maintenance and repair costs	13.09	10.26	0.83	9.57	6.62	0.66	
(3.) Electric power and fuel costs	2.33	1.80	0.44	2.54	1.93	0.67	
(4.) Depreciation cost(1)	30.00	17.66	3.81	20.90	13.38	2.87	
(5.) Depreciation cost(2)	23.34	13.85	1.43	17.15	11.41	1.21	
(6.) Subtotal (1) ⑥=① + ② + ③ + ④	61.38	35.26	5.97	44.65	26.16	5.14	Depreciation of all facilities
(7.) Subtotal (2) ⑦=① + ② + ③ + ⑤	54.72	31.45	3.59	40.90	24.19	3.48	Depreciation excl. breakwaters, dredging, and reclamation
(8.) Interest payable (1)	28.78	15.49	6.22	18.22	10.19	4.46	Interest payable for total investment
(9.) Interest payable (2)	14.31	7.22	1.06	10.07	5.91	0.87	Interest payable for the investment excl. the construction costs of breakwaters, dredging and reclamation
(10.) Cost equivalent to the rent (1)	19.96	11.42	7.13	11.25	5.90	4.87	6% of the construction costs of breakwaters, dredging and reclamation
(11.) Cost equivalent to the rent (2)	2.86	7.22	0.05	1.43	1.06	0.04	6% of the construction cost of reclamation
(12.) 10% worth of investment	71.68	38.74	14.69	45.90	25.97	10.59	
Total of cost per ton							
Case A (⑥ + ⑧)	90.16	50.75	12.19	62.87	36.35	9.60	Depreciation of all facilities
Case B (⑦ + ⑨ + ⑩)	88.99	48.52	11.78	62.22	36.00	9.32	Cost equivalent to the rent of breakwaters, dredging and reclamation
Case C (⑦ + ⑨ + ⑪)	71.89	40.60	4.70	52.40	31.60	4.39	Excl. construction costs of breakwaters and dredging
Case D (⑦ + ⑫)	126.30	70.19	18.23	86.80	50.16	14.07	10% of total investment included into the cost
Reference							
Target cargo volume	2,500	4,384	3,241	5,000	8,002	3,942	
Current port cost of Virōtia Port	44.47	35.61	7.68	44.47	35.61	7.68	According to the current tariff of Vitōria Port

current tariff of Vitõria Port. In even cases of A and B, the prime cost cannot yet be redeemed if the tariff is set on the equivalent level to the current tariff of Vitõria Port. The project becomes feasible on a commercial basis only by keeping the investment in the breakwaters, the basins and the fairways in a separate account from the port management budget (Case C). Even in this case, a suitable amount of profit should be added to the cost to ensure continuous healthy management as an enterprise. Judging from the fact that the port of Praia Mole has high efficiency modern facilities for large-sized vessels, this extent of difference in tariff between Praia Mole Port and Vitõria Port will never be so irrational to the port users.

14-4 Analysis by DCF (Discounted Cash Flow) method

14-4-1 Principle of the analysis

The object of this analysis is to grasp the income and the expenses as flow on an annual basis in the term of the project, and to judge the profitability of the project from the discount rate which equalizes the income and the expenses during the term of the project. The discount rate finally fixed is called FRR=fr (Financial Rate of Return) FRR denotes the discount rate (fr) to satisfy the following formula.

$$\sum_{t=1}^{n} \frac{Rt - Ct}{(1 + fr)^t} = 0$$

Rt : Income in the "t"th year

Ct : Expenses in the "t"th year

n : Life time of the project

The condition set for the calculation is as follows.

Income = Port dues and charges + (Government disbursement or subsidy)

Expenses = Initial investment + Management cost + (Tax)

(Note) The management cost denotes the total of the maintenance and repair cost, the cost of electric power and fuel, and the operating cost such as personnel cost.

The construction cost of the breakwaters, basins and channel covered by the national treasury disbursement or subsidy is regarded as income. The tax, on the other hand, is excluded from this FRR calculation on the ground that the tax amount cannot be decided without a detailed statement of income and expenses and that the managing body, while standing on a commercial basis, is characteristically similar to a public corporation, though the company affiliated to PORTOBRÁS expected to take charge of the management is obliged to pay tax according to its benefit as the other ordinary enterprises and such tax is in most cases included in the cost or expenses.

The FRR calculation here is tried in several different cases with various income levels based on the current tariff of Vitória Port, classified into two groups with or without the 100% governmental subsidy for construction of the breakwaters, basins, and channel.

14-4-2 Calculation of income and expenses

Table 14.4.1 shows the annual expenses calculated from the initial investment shown in Chapter 9-2 and the management expenses specified in Chapter 14-3.

The income is to be estimated on the present tariff of Vitória Port, and the subsidy is to be appropriated in the income of the year of investment in the respective facilities concerned. Table 14.4.2 shows an example of the annual income including the subsidy from the central government.

14-4-3 Result of FRR calculation and evaluation

The FRR calculation is divided into two groups, one for the first stage work and the other for the master plan, on the assumption that the term of the project is 25 years.

The FRR calculation entends a total of 12 cases classified into two categories with or without the subsidy and on different income bases applying the current tariff of Vitória Port, +20% of the present tariff, and +50% of the present tariff. The cases in which the subsidy is appropriated represent case C in the cost calculation per ton, and those without the subsidy represent cases A and B. Table 14.4.3 shows the result of FRR calculation.

It is very difficule to determine the acceptable value of FRR, but the open market rate of the country concerned will provide a criterion. In Brazil, the open market rate is considered to be 10 ∿ 12%, and the cases estimated here do not show such a high FRR without the subsidy from the central government. In order to obtain a high FRR, there seems to be no alternative but to raise the tariff far above the current tariff of Vitória Port.

Table 14.4.1 Annual expenses

(Unit: in Cr$ million)

Year	Construction cost		Operating expenses		Total		Remarks
	1st stage	Master plan	1st stage	Master plan	1st stage	Master plan	
1977	43.6	43.6			43.6	4.36	
1978	423.8	423.8			423.8	423.8	
1979	1,082.7	1,082.7			1,082.7	1,082.7	
1980	1,551.4	1,551.4			1,551.4	1,551.4	
1981	826.8	826.8	153.5	153.5	980.3	980.3	
1982	38.0	311.1	↓	153.5	191.5	464.6	
1983	↓	550.4	↓	153.5	153.5	703.9	
1984	↓	↓	↓	229.9	↓	229.9	
1985	↓	↓	↓	↓	↓	↓	

Table 14.4.2 An example of annual income (according to Vitória Port Tariff)

(Unit: in Cr$ 1,000)

Year	Slab			Coal			Oil	Total	
	Foreign trade	Domestic trade	Subtotal	Foreign trade	Domestic trade	Subtotal		1st stage	Master plan
1981	64,770	45,760	110,530	133,940	29,160	163,100	24,890	298,520	298,520
1982	64,770	45,760	110,530	133,940	29,160	163,100	26,570	300,200	300,200
1983	64,770	45,760	110,530	133,940	29,160	163,100	28,360	301,990	301,990
1984	129,540	91,520	221,060	246,410	51,570	297,980	30,270	303,900	549,310
1985	↓	↓	↓	↓	↓	↓	32,310	305,940	551,350
1986	↓	↓	↓	↓	↓	↓	34,490	308,120	553,530
1987	↓	↓	↓	↓	↓	↓	36,840	310,470	555,880
1988	↓	↓	↓	↓	↓	↓	39,340	312,970	558,380
1989	↓	↓	↓	↓	↓	↓	↓	↓	↓
1990	↓	↓	↓	↓	↓	↓	↓	↓	↓

Table 14.4.3 Result of FRR calculation

(Unit: %)

Tariff level	1st stage		Master plan		Remarks
	w/o subsidy	w/ subsidy	w/o subsidy	w/ subsidy	
Current level	minus	6.0	3.7	9.4	
Up 20%	2.6	9.7	6.5	13.2	
Up 50%	5.8	14.5	9.7	18.2	

Although Praia Mole Port is expected to be managed by a company on a commercial basis, the project itself has a strong character of a public enterprise. The feasibility of this project should not, therefore, be denied simply because of the low FRR. So far as this project is concerned, it will be possible to take the interest of the loan (approximately 6%) as a criterion. If the current tariff of Vitória Port is applied to the port of Praia Mole, the case meeting this condition is the master plan estimation with the subsidy. Without the subsidy, the management may be difficult even if the present tariff of Vitória Port is raised by 20%.

If the estimation is confined to the first stage work alone, it is impossible to manage the project without the subsidy even by raising the current tariff of Vitória Port by 20%, and difficult even by raising it as much as 50%.

This will be summarized as follows.

① If the project is to be confined to the first stage work, financially healthy management is impossible even with the subsidy for the construction of breakwaters, basins, and channel, unless the current tariff of Vitória Port is drastically raised. In other words, this project should not be confined to the first stage work.

② Even if the project is to extend to the second stage work, the management on an income basis of the current trariff of Vitória Port requires the subsidy for the construction of breakwaters, basins and channel, and without the subsidy the present tariff of Vitória Port must be raised at least by 20%.

14-5 Investigation of the cash flow based on income and expenses

14-5-1 General description

Financial condition of the project is to be analyzed here through the statement of income and expenses, and the cash flow statement respectively drafted per year, though the financially feasible condition of the project has been made clear to some extent through the calculation and evaluation as shown in the preceding chapters.

The managing body is to be an enterprise possessing a fixed capital (self-capital), following the example of existing port management companies in Brazil. Some of these port managing companies in Brazil have adopted a special accounting system as specified below. In this system;

① As the remuneration, 10% of the invested capital is annually marked up to the expenses. Each port managing company does not repay the long-term loan, but receive the facilities constructed by the long-term loan from PORTOBRÁS in the form of investment.

② If the financial management falls into the red, the tariff is so controlled as to make it into the black.

③ If the financial management still remains in the red in spite of the tariff control mentioned in ②, the deficit is covered by PORTOBRÁS or the central government.

Analyzed here is the cash flow statement based upon an ordinary accounting principle and the idea stated in ①, and the ideas in ② and ③, which defy the significance itself of the adoption of an acounting system on a commercial basis and of the financial evaluation, are excluded from the analysis.

14-5-2 Cases investigated

Investigated here is the master plan, because the project confined to the first stage alone has been estimated to be financially infeasible as a result of the comparative study of the cost per ton of cargo and the analysis by FRR. The six cases given in Table 14.5.1, in which relatively healthy financial management is expected to be secured, are put to analysis, referring to the cases investigated in the preceding chapters.

The case a, in which no subsidy is expected from the central government, roughly corresponds to Case B of the cost analysis in 14-3. The case b and case c include the subsidy, and the case c partially adopts the idea of the accounting system peculiar to PORTOBRÁS. The former corresponds to Case C in the cost analysis, and the latter to Case D, though the remuneration here is estimated at 10% of the invested amount subtracted by the subsidy for the construction of breakwaters, basins and channel which have been included in the total invested amount in the cost analysis.

If the remuneration is estimated at 10% of the total invested amount, it is obvious that the significance of this system is completely lost because it results in accumulation of deficits.

14-5-3 Fund planning

The fund planning made clear so far is only Cr$1,280 million (US$100 million) of a credit in yen and the capital which are borne by PORTOBRÁS and SIDERBRÁS at the ratio of 51:49. The source of the funds except the yen credit and the terms and conditions of loan facilitation still remain unclear. Therefore, the fund planning here is to be investigated on the assumption as shown in Table 14.5.2 classified into two cases with or without the subsidy.

In case there is no subsidy, the capital is to be estimated at 1/2 of the total invested amount subtracted by the yen credit amount, the remaining half is to be covered by domestic long-term loans. In case there is the subsidy, on the other hand, the capital is to be estimated at the total invested amount subtracted by the yen credit amount and the subsidy. In any case, the capital is estimated at 30 ∿ 35% of the total invested amount.

Table 14.5.1 Cases investigated

Item	Tariff level	Subsidy to construction of breakwaters, dredging and reclmation	Other
Case a -①	Current tariff at Vitória Port	Nil	w/dividend
②	Up 20% from current tariff at Vitória Port		
Case b -①	Current tariff at Vitória Port	Esse	w/dividend
②	Up 20% from current tariff at Vitória Port		w/dividend
Case c -①	Current tariff at Vitória Port	Esse	w/o dividends. 100% of the total investment excluding subsidy taken as annual cost.
②	Up 20% from current tariff at Vitória Port		

Table 14.5.2 Fund planning

(Unit: in Cr$ million)

Item	Where subsidy are not available (case-ⓐ)	Where subsidy are available (case-ⓑ,ⓒ)	Financing terms
CAPITAL	1,754.9	1,458.4	
Portbrás	895.0	743.6	Owned capital
Siderbrás	859.9	714.8	
LONG-TERM LOANS			
Yen loan	1,280.0	1,280.0	Interest rate: 5.75% Term of redemption: 17 years (including 5 years of deferment)
Domestic loan	1,754.9	0	Interest rate: 6.0% Term of redemption: 12 years (including 2 years of deferment)
SUBSIDY	0	2,051.4	Corresponding to construction costs of breakwaters, dredging and reclamation.
TOTAL	4,789.3	4,789.3	

14-5-4 Premise of the calculation

The statement of income and expenses, and the cash flow statement are made on the following assumptions.

① The depreciation is to be evenly repaid each year so as to bring the residual price of the respective facilities to zero within their estimated lives. The breakwaters, basins and channel, and the reclaimed land are to be excluded from the object of depreciation.

② The average annual rate of interest of the short-term loans is to be estimated at 12%, and the average deposit rate to be at 6%. In both cases, the interests of the respective year are to be paid or received at the term end.

③ The corporation tax is to be estimated at 30% of the profit before deduction of tax when the accumulated deficits are cleared off, and the legal reserve to be at 5% of the profit after deduction of tax (the upper limit to be 20% of the capital in conformity with the Company Law in Brazil).

④ The dividend is to be paid only for the terms when the net profit after deduction of the corporation tax and the legal reserve exceeds the required amount of dividend to be paid. As a rule, the dividend is to be at 15% of the capital, and if the net income falls short of the required amount of dividend (15%), the rate of dividend to be paid is reduced to 10%. In Case C, however, no dividend is to be paid since 10% of the invested amount after deduction of the subsidy per term is appropriated in the expenses as the remuneration.

⑤ No consideration is to be taken to the correction of the port dues and charges according to the price escalation.

14-5-5 Result of calculation and evaluation

The statement of income and expenses, and the cash flow statement are to be drawn per case for 30 years on the condition stated above. Examples of this trial calculation are shown in the tables attached in the end of this chapter. Table 14.5.3 below shows the result of calculation classified per item.

As a result of this calculation, each case is evaluated as follows.

Case a : If the present tariff of Vitória Port is applied to the port of Praia Mole cannot eliminate the accumulated deficits even 25 years after the inauguration of service, and cannot expect healthy management either. Even if the tariff is raised by 20%, it takes eight years after the inauguration of port service to clear off the accumulated deficits, and it is 13 years after the initial service that payment of dividend becomes possible. In this case, therefore, it is necessary to set up a much higher tariff than the present tariff of Vitória Port or to reduce the proportion of the long-term loans.

Case b : The depreciation of the assets is expected to finish in about 13 years after the inauguration of service and the maximum accumulated deficits, which amount to 12.4% of the capital, are relatively small. The dividend to the investers is payable from the 13th year even on the same tariff condition as of Vitória Port, and if the tariff is raised by 20%, the dividend became payable from the 6th year. In any case, the port management is feasible. It will be, however, desirable to set the tariff by at least 20% higher than the present tariff of Vitória Port so as to pay a reasonable rate of dividend to the investers (Case b-②).

Case c : Judging from the condition of accumulated deficits clearing and the recovery of the invested amount, the management is quite severe, because the case presupposes payment of remuneration at the rate of 10% from the initial year of service. A tariff of the equivalent rate to that of Vitória Port cannot clear off the accumulated deficits. If the tariff is raised by 20%, the cash flow will become more smooth, though the profitability is not so high. The project, therefore, will be feasible by adopting a management policy with a strong public character.

Table 14.5.3 Statement of income and cash flow statement

Item	w/o subsidy (Case a)		w/subsidy (Case b)		w/subsidy (Case c)	
	a - ①	a - ②	b - ①	b - ②	c - ①	c - ②
Turn of year from deficit	16th year	4th year	4th year	1st year	No black figures in 25 years	8th year
Turn of year from accumulated deficits to profit	Deficit is not cleared off in 25 years	8th year	6th year	4th year	Deficit is not cleared off in 25 years	16th year
First year of dividend to be paid	No divident in 25 years	13th year	13th year	6th year	—	—
Max. amount of accumulated deficits						
Time	15th year	3rd year	3rd year	A year before commissioning	On the rise	7th year
Amount	Cr$1,415.4 million	Cr$348.9 million	Cr$193.3 million	Cr$67.0 million	—	Cr$711.1 million
Max. amount of short-term loans						
Time	15th year	3rd year	A year before commissioning	A year before commissioning	7th year	3rd year
Amount	Cr$1,966.0 million	Cr$264.7 million	Cr$67.2 million	Cr$77.2 million	Cr$444.0 million	Cr$227.0 million
Financial state 25 years after commissioning						
Recurring profit rate	0.33	0.67	0.88	0.97	Deficit	0.62
Retained profits	0	Cr$874.1 million	Cr$1,711.2 million	Cr$2,512.4 million	0	Cr$2,239.4 million
Cash deposit	Cr$-783.8 million	Cr$646.9 million	Cr$3,258.7 million	Cr$4,119.5 million	Cr$10.1 million	Cr$4,952.7 million
Year of recovery of initial investment(depreciable assets)	Unrecoverable	14th year	12th year	13th year	Unrecoverable	18th year

Notes: 1) Years given are as counted from the year commissioned.

2) The recurring profit rate refers to the rate of profit before tax to the revenue.

3) The subsidy means the 100% government subsidy for the breakwater and dredging work.

14-6 General evaluation

The result of the above three types of analysis is generalized into the following conclusion. For actual execution of this project, however, further concrete investigation will be necessary.

① Even if the project is to be executed as far as the second stage in one unit, it is impossible to expect a healthy port management from a tariff on the same level as of the present tariff of Vitória Port. Financially, the healthy management requires a drastic raise of the tariff as much as 40 ∿ 50%, but it is not advisable to set a tariff extremely higher than that of the neighbouring port. The healthy management of this project on a basis of a reasonable tariff requires subsidies from other organizations (for instance, the central government) to cover part of the cost of construction, or investments premising no payment of dividend.

As to the idea of subsidy for the cost of construction, there are not a few examples in Europe and America in which the unprofitable facilities such as breakwaters, basins and channels are constructed at the expense of the government (tax). In consideration of the fact that equal allocation of the burden (cost of construction) to the early users and the later users is characteristically difficult and that Praia Mole Port is an important port expected to contribute to the development of basic industries in Brazil and to the expansion of export trade, it is considered to be a quite reasonable policy that the central government should subsidized the construction of basic port facilities such as breakwaters, basins and channel.

② Even if the construction cost of the breakwaters, basins and channel is 100% subsidized by the central government, it will be a little difficult to secure the healthy management of Praia Mole Port on the same income level as of the present tariff of Vitória Port. It is desirable to set a tariff at least 20% higher than the present tariff of Vitória Port.

③ Most of ports in Brazil have adopted an acounting system in which 10% of the invested amount of capital is appropriated in the cost. So long as this system is employed, the management of Praia Mole Port on the same income level as of the present tariff of Vitória Port is impossible irrespective of the subsidy for the construction of breakwaters, basins and channel, and necessitates a drastic raise of the tariff.

④ From these facts, the project is considered to be financially feasible on the condition that the execution scale extends to the second stage work and that the cost of construction for breakwaters, basins and channel is 100% subsidized by the central government. It is desirable to set the tariff about 20% higher than the current tariff of Vitória Port in order to secure a healthy port management. This extent of difference in tariff will be convincible to the users of the port of Praia Mole provided with high efficiency facilities for large-sized vessels.

Table 14-1

Breakdown of calculation in Table "J"
(Equipment Charge)

(1) Slab (annual cargo volume: 5,000 thousand tons)

Investment	:	US$25,500,000 (Cr$326,400,000)
Annual depreciation cost	:	Cr$44,350,000
Annual depreciation cost per ton	:	Cr$8.87/ton
Annual personal cost per ton	:	Cr$0.86/ton
Annual maintenance cost per ton	:	326,400,000 x 0.05 x 1/5,000,000 = Cr$3.26/ton
Annual electric charge per ton	:	0.4 x 7,400,000 kWh/year x 1/5,000,000 = Cr$0.59/ton
Total	:	Cr$13.58/ton

(2) Coal (annual cargo volume: 8,000 thousand tons)

Investment	:	US$22,700,000 (Cr$290,560,000)
Annual depreciation cost	:	Cr$39,478,000
Annual depreciation cost per ton	:	Cr$4.93
Annual personal cost per ton	:	(24 + 172/6) persons x Cr$50,000 x 1/8,000,000 = Cr$0.33
Annual maintenance cost per ton	:	Cr$290,560,000 x 0.05 x 1/8,000,000 = Cr$1.82
Annual electric charge per ton	:	0.4 x 11,100,000 kWh x 1/8,000,000 = Cr$0.56
Total	:	Cr$7.64

Table 14-2 An example of FRR calculation sheet (1) * * *

(Master plan, w/o subsidy, up 20% from current tariff level)

(1,000 CRUZEIROS)

YEAR	① EXPENSES			② INCOME					BALANCE	F.R.R.
	INVESTMENT	OPERATION	TOTAL	SLAB	COAL	PETROLEUM	SUBSIDIES	TOTAL	② - ①	6.471 (%)
1977	43600.0	0.0	43600.0	0.0	0.0	0.0	0.0	0.0	-43600.0	-43600.0
1978	423800.0	0.0	423800.0	0.0	0.0	0.0	0.0	0.0	-423800.0	-398042.0
1979	1082699.9	0.0	1082699.9	0.0	0.0	0.0	0.0	0.0	-1082699.9	-955092.5
1980	155140010	0.0	1551400.0	0.0	0.0	0.0	0.0	0.0	-151400.0	-1285374.7
1981	826800.0	153500.0	980300.0	132636.0	195720.0	29868.0	0.0	358224.0	-622076.0	-484081.0
1982	311100.0	153500.0	464600.0	132636.0	195720.0	31884.0	0.0	360240.0	-104360.0	-76274.1
1983	550400.0	153500.0	703900.0	132636.0	195720.0	34032.0	0.0	362388.0	-341512.0	-234432.5
1984	0.0	229900.0	229900.0	265275.0	357576.0	36324.0	0.0	659172.0	429272.0	276766.2
1985	0.0	229900.0	229900.0	265272.0	357676.0	38772.0	0.0	661620.0	431720.0	261427.6
1986	0.0	229900.0	229900.0	265272.0	357576.0	41388.0	0.0	664236.0	434336.0	247026.6
1987	0.0	229900.0	229900.0	265272.0	357576.0	44203.0	0.0	667056.0	437156.0	233519.4
1988	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440156.0	220831.9
1989	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440.56.0	207410.4
1990	0.0	229900.0	229900.0	265272.0	357576.0	47207.0	0.0	670056.0	440156.0	194804.6
1991	0.0	229900.0	229900.0	265272.0	357576.0	47207.0	0.0	670056.0	440156.0	182964.9
1992	0.0	229900.0	229900.0	265272.0	357576.0	47207.0	0.0	670056.0	440156.0	171844.8
1993	0.0	229900.0	229900.0	265272.0	357576.0	47207.0	0.0	670056.0	440156.0	161400.6
1994	0.0	229900.0	229900.0	265272.0	357576.0	47207.0	0.0	670056.0	440156.0	151591.1
1995	0.0	229900.0	229900.0	265272.0	357576.0	47207.0	0.0	670056.0	440156.0	142377.8
1996	0.0	229900.0	229900.0	265272.0	357576.0	47207.0	0.0	670056.0	440156.0	133724.5
1997	0.0	229900.0	229900.0	265272.0	357576.0	47207.0	0.0	670056.0	440156.0	125597.1
1998	0.0	229900.0	229900.0	265272.0	357576.0	47207.0	0.0	670056.0	440156.0	117963.7
1999	0.0	229900.0	229900.0	265272.0	367576.0	47207.0	0.0	670056.0	440156.0	110794.2
2000	0.0	229900.0	229900.0	265272.0	367576.0	47207.0	0.0	670056.0	440156.0	104060.4
2001	0.0	229900.0	229900.0	265272.0	367576.0	47207.0	0.0	670056.0	440156.0	97735.9
2002	0.0	229900.0	229900.0	265272.0	367576.0	47207.0	0.0	670056.0	440156.0	91795.8
2003	0.0	299900.0	229900.0	265272.0	367576.0	47207.0	0.0	670056.0	440156.0	86216.7
2004	0.0	229900.0	229900.0	265282.0	367576.0	47207.0	0.0	670056.0	440156.0	80976.7
2005	0.0	229900.0	229900.0	265272.0	367576.0	47207.0	0.0	670056.0	440156.0	76055.2
TOTAL										-10.3

Table 14-3 An example of FRR calculation sheet (2)

(Master plan, w/o subsidy, up 20% from current tariff level)

(1,000 CRUZEIROS)

YEAR	① EXPENSES			② INCOME					BALANCE	F.R.R.
	INVESTMENT	OPERATION	TOTAL	SLAB	COAL	PETROLEUM	SUBSIDIEX	TOTAL	② - ①	13.188(%)
1977	43600.0	0.0	43600.0	0.0	0.0	0.0	43600.0	43600.0	0.0	0.0
1978	423000.0	0.0	423000.0	0.0	0.0	0.0	200000.0	200000.0	-223800.0	-197724.1
1979	1052699.9	0.0	1052699.9	0.0	0.0	0.0	600000.0	600000.0	-462700.0	-376770.1
1980	1551400.0	0.0	1551400.0	0.0	0.0	0.0	700000.0	700000.0	-351400.0	-527127.5
1981	826500.0	153500.0	980300.0	132636.0	195720.0	29868.0	470200.0	828424.0	-151876.0	-92531.0
1982	550400.0	153500.0	703900.0	132636.0	195720.0	31884.0	0.0	360240.0	-104360.0	-56173.5
1983	550400.0	153500.0	703900.0	132636.0	192720.0	34032.0	0.0	362383.0	-341512.0	-162406.5
1984	0.0	229900.0	229900.0	265272.0	357576.0	36324.0	0.0	659172.0	429272.0	180355.6
1985	0.0	229900.0	229900.0	265272.0	357576.0	38722.0	0.0	661620.0	431720.0	163250.3
1986	0.0	229900.0	229900.0	265272.0	357576.0	41386.6	0.0	664236.0	434336.0	142463.0
1987	0.0	229900.0	229900.0	265272.0	357576.0	44208.0	0.0	667056.0	437156.0	126657.9
1988	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440156.0	112668.4
1989	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440156.0	99540.9
1990	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440156.0	87943.0
1991	0.0	229900.0	229900.0	265272.0	357676.0	47207.9	0.0	670056.0	440156.0	77696.4
1992	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440156.0	68643.7
1993	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440156.0	60645.7
1994	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440156.0	53579.6
1995	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440156.0	47336.8
1996	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440156.0	41321.4
1997	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440156.0	36948.6
1998	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440156.0	32643.6
1999	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440156.0	28840.1
20000	0.0	229900.0	229900.0	265272.0	357376.0	47207.9	0.0	670056.0	440156.0	25479.8
2001	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440156.0	22511.1
2002	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440156.0	18238.9
2003	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440156.0	17570.9
2004	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440156.0	15523.7
2005	0.0	229900.0	229900.0	265272.0	357576.0	47207.9	0.0	670056.0	440156.0	13714.9
TOTAL										-34.5

Table 14-4 Repayment plan of long-term loans

(Unit in Cr$ million)

ITEM		YEAR	1 (-4)	2 (-3)	3 (-2)	4 (-1)	5 (1)	6 (2)	7 (3)	8 (4)	9 (5)	10 (6)	11 (7)	12 (8)	13 (9)	14 (10)	15 (11)	16 (12)	17 (13)	18 (14)	19 (15)	20 (16)	21 (17)	22 (18)	23 (19)
No subsidy to construction of breakwaters, dredging and reclamation (Case a)	CAPITAL																								
	1. Capital	Capital	43.6	223.8	466.5	455.4	319.0	78.9	167.7																
		Accumulated		267.4	733.9	1189.3	1508.3	1587.2	1754.9																
	DEBTS																								
	2. Yen loan	Debt		200.0	250.0	450.0	200.0	80.0	100.0																
		Balance at year end		200.0	450.0	900.0	1100.0	1180.0	1263.3	1225.8	1150.8	1059.1	960.8	854.1	747.4	640.7	534.0	427.3	320.6	213.9	123.9	54.7	23.0	8.0	
	Deferment, 5 years; redemption in 17 years; interest rate, 5.75%	Repayment							16.7	37.5	75.0	91.7	98.3	106.7	106.7	106.7	106.7	106.7	106.7	106.7	90.0	69.2	31.7	15.0	8.0
		Interest expense		5.8	18.7	38.8	57.5	65.6	70.7	72.6	70.5	66.2	60.9	55.2	49.1	43.0	36.8	30.7	24.6	18.4	12.3	7.1	3.1	1.3	0.5
	3. Domestic loan	Debts			366.2	646.0	307.8	152.2	282.7																
		Balance at year end			366.2	1012.2	1283.4	1334.4	1485.1	1337.9	1162.4	986.9	811.4	635.9	460.4	284.9	146.0	71.7	28.2						
	Deferment, 2 years; redemption in 12 years; interest rate, 6.00%	Repayment					36.6	101.2	132.0	147.2	175.5	175.5	175.5	175.5	175.5	175.5	138.9	74.3	43.5	28.2					
		Interest expense			11.0	41.4	70.0	81.6	88.5	89.1	80.3	69.7	59.2	48.7	38.2	27.6	17.1	8.8	4.3	1.7					
	Total : 2 + 3	Debt		200.0	616.2	1096.0	507.8	232.2	382.7																
		Balance at year end		200.0	816.2	1912.2	2383.4	2514.4	2748.4	2563.7	2313.2	2046.0	1772.2	1490.0	1207.8	925.6	680.0	499.0	348.8	213.9	123.9	54.7	23.0	8.0	
		Repayment					36.6	101.2	148.7	184.7	250.5	266.8	271.8	282.2	287.2	282.2	245.6	181.0	150.2	134.9	90.0	69.2	31.7	15.0	8.0
		Interest expense		5.8	29.7	80.2	127.5	147.2	159.2	161.7	150.8	135.9	120.0	103.9	87.3	70.6	53.9	39.5	28.9	20.1	12.3	7.1	3.1	1.3	0.5
	TOTAL: 1 + 2 + 3		43.6	423.8	1082.7	1551.4	826.8	311.1	550.4																
Subsidy to construction (Case b&c)	1. Subsidy	Subsidy	43.6	200.0	600.0	700.0	470.2	37.6																	
		Accumulated	43.6	243.6	843.6	1543.6	2013.8	2051.4																	
	2. Capital	Capital		23.8	232.7	401.4	156.6	193.5	450.4																
		Accumulated		23.8	256.5	657.9	814.5	1008.6	1458.4																
	3. Yen loan	Debt		200.0	250.0	450.0	200.0	80.0	100.0																
		Balance at year end		200.0	450.0	900.0	1100.0	1180.0	1263.3	1225.8	1150.8	1059.1	960.8	854.1	747.4	640.7	534.0	427.3	320.6	213.9	123.9	54.7	23.0	8.0	
	Deferment, 5 years; redemption in 17 years; interest rate, 5.75%	Repayment							16.7	37.5	75.0	91.7	98.3	106.7	106.7	106.7	106.7	106.7	106.7	106.7	90.0	69.2	31.7	15.0	8.0
		Interest expense		5.8	18.7	38.8	57.5	65.6	70.7	72.6	70.5	66.2	60.9	55.2	49.1	43.0	36.8	30.7	24.6	18.4	12.3	7.1	3.1	1.3	0.5

Table 14-5 Depreciation plan (Master plan)

(Unit: in Cr$ million)

	Mooring Facilities	Revetment	Other Facilities	Cargo Handling Equipment	Total	Remarks
Life Time	30	30	15	12		
Amount (Mil Cr$)	605.4	136.6	560.4	1,436.2		
1981	14.2	4.5	31.2	73.8	123.7	Average service life: 17.5 years
1982	14.2	4.5	31.2	73.8	123.7	
1983	14.2	4.5	31.2	73.8	123.7	Depreciable assets, total: Cr$2,738.4 m million
1984	20.2	4.5	37.4	119.7	181.8	
1985	20.2	4.5	37.4	119.7	181.8	
1986	20.2	4.5	37.4	119.7	181.8	
1987	20.2	4.5	37.4	119.7	181.8	
1988	20.2	4.5	37.4	119.7	181.8	
1989	20.2	4.5	37.4	119.7	181.8	
1990	20.2	4.5	37.4	119.7	181.8	
1991	20.2	4.5	37.4	119.7	181.8	
1992	20.2	4.5	37.4	119.7	181.8	
1993	20.2	4.5	37.4	45.9	108.0	
1994	20.2	4.5	37.4	45.9	108.0	
1995	20.2	4.5	37.4	45.9	108.0	
1996	20.2	4.5	6.2		30.9	
1997	20.2	4.5	6.2		30.9	
1998	20.2	4.5	6.2		30.9	
1999	.	.			24.7	
.	.	.			.	
.	.	.			.	
.	.	.			.	
.	.	.			.	
2010	20.2	4.5			24.7	
2011	6.0				6.0	
2012	6.0				6.0	
2013	6.0				6.0	

Table 14-6 (1) * * * STATEMENT OF INCOME AND EXPENSES * * * (Example 1)

(Case b-②)

(MILLION CRUZEIROS)

	1 1977	2 1978	3 1979	4 1980	5 1981	6 1982	7 1983	8 1984	9 1985	10 1986	11 1987	12 1988	13 1989
OPERATING REVENUES	0.0	0.0	0.0	0.0	353.2	360.2	362.4	659.1	661.6	664.2	667.0	670.0	670.0
OPERATING EXPENDITURES	0.0	0.0	0.0	0.0	153.5	153.5	153.5	229.9	229.9	229.9	229.9	229.9	229.9
OPERATING REVENUES BEFORE DEPRECIATION	0.0	0.0	0.0	0.0	204.7	206.7	208.9	429.2	431.7	434.3	437.1	440.1	440.1
DEPRECIATION	0.0	0.0	0.0	0.0	123.7	123.7	123.7	181.8	181.8	181.8	181.8	181.8	181.8
NET OPERATING REVENUES	0.0	0.0	0.0	0.0	81.0	83.0	85.2	247.4	249.9	252.5	255.3	258.3	258.3
INTEREST EARNED	0.0	0.0	0.0	0.0	0.0	4.3	13.0	21.1	38.0	53.6	60.3	67.2	74.4
INTEREST EXPENSE	0.0	5.8	19.3	41.6	65.5	65.6	70.7	72.6	70.5	66.2	60.9	55.2	49.1
INCOME BEFORE REPAYMENT AND TAX	0.0	-5.8	-19.3	-41.6	15.4	21.7	27.5	195.9	217.5	239.9	254.8	270.4	283.6
REPAYMENT TO PORTOBRAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TAX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58.1	65.2	71.9	76.4	81.1	85.1
NET INCOME	0.0	-5.8	-19.3	-41.6	15.4	21.7	27.5	137.8	152.2	167.9	178.3	189.3	198.5
LEGAL RESERVE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	7.6	8.3	8.9	9.4	9.9
DIVIDEND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	145.8	145.8	145.8	145.8
SURPLUS	0.0	-5.8	-19.3	-41.6	15.4	21.7	27.5	131.0	144.6	13.6	23.6	34.0	42.8
ACCUMULATED SURPLUS	0.0	-5.8	-25.1	-67.0	-51.5	-29.7	-2.2	128.8	273.5	287.2	31.08	344.8	387.6
ACCUMULATED DEPRECIATION	0.0	0.0	0.0	0.0	123.7	247.4	371.1	552.9	734.7	916.4	1098.2	1280.0	1461.8
TOTAL	0.0	-5.8	-25.1	-67.0	72.1	217.6	368.8	681.7	1008.2	1203.7	1409.1	1624.9	1849.5

Table 14-6 (2) * * * STATEMENT OF INCOME AND EXPENSES * * * (Example 1)

(Case b-②)

(cont'd)

(MILLION CRUZEIROS)

	14 1990	15 1991	16 1992	17 1993	18 1994	19 1995	20 996	21 1997	22 1998	23 1999	24 2000	25 2001	26 2002
OPERATING REVENUES	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0
OPERATING EXPENDITURES	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9
OPERATING REVENUES BEFORE DEPRECIATION	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1
DEPRECIATION	181.8	181.8	181.8	108.0	108.0	108.0	30.9	30.9	30.9	24.7	24.7	24.7	24.7
NET OPERATING REVENUES	258.3	258.3	258.3	332.1	332.1	332.1	409.2	409.2	409.2	415.4	415.4	415.4	415.4
INTEREST EARNED	82.0	90.3	99.1	103.6	113.1	117.9	124.3	131.0	140.4	151.2	162.9	175.5	188.7
INTEREST EXPENSE	43.0	36.8	30.7	24.6	18.4	12.3	7.1	3.1	1.3	0.5	0.0	0.0	0.0
INCOME BEFORE REPAYMENT AND TAX	297.4	311.9	326.8	416.2	426.8	437.8	526.5	537.2	548.3	566.2	578.4	591.0	604.2
REPAYMENT TO PORTOBRAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TAX	89.2	93.5	98.0	124.8	128.0	131.3	157.9	161.1	164.5	169.8	173.5	177.3	181.2
NET INCOME	208.2	218.3	288.8	291.3	298.8	306.5	368.5	376.0	383.8	396.3	404.8	413.7	422.9
LEGAL RESERVE	10.4	10.9	11.4	14.5	14.9	15.3	18.4	18.8	19.1	19.8	20.2	20.6	21.1
DIVIDEND	145.8	145.8	145.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8
SURPLUS	51.9	61.5	71.5	58.0	65.1	72.4	131.3	138.4	145.9	157.7	165.8	174.2	183.0
ACCUMULATED SURPLUS	439.6	501.2	572.7	630.7	695.9	763.3	899.7	1038.1	1134.1	1341.9	1507.7	1682.0	1865.1
ACCUMULATED DEPRECIATION	1643.6	1825.4	2007.2	2115.2	2223.2	2331.2	2362.1	2393.0	2423.9	2448.6	2473.3	2498.0	2522.7
TOTAL	2083.3	2326.7	2580.0	2746.0	2919.2	3099.6	3261.9	3431.2	3608.1	3790.1	3981.1	4180.1	4387.9

Table 14-6 (3) * * * STATEMENT OF INCOME AND EXPENSES * * * (Example 1)

(Case b-②)

(MILLION CRUZEIROS)

(cont'd)

	27 2003	28 2004	29 2005	30 2006	31 2007	32 2008	33 2009	34 2010	35 2011	36 2012	37 2013	38 2014	39 2015
OPERATING REVENUES	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0
OPERATING EXPENDITURES	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9
OPERATING REVENUES BEFORE DEPRECIATION	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1
DEPRECIATION	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	6.0	6.0	6.0	0.0	0.0
NET OPERATING REVENUES	415.4	415.4	415.4	415.4	415.4	415.4	415.4	415.4	434.1	434.1	434.1	440.1	440.1
INTEREST EARNED	202.4	216.8	231.7	247.2	263.4	280.3	297.9	316.2	335.3	354.8	375.2	396.4	413.4
INTEREST EXPENSE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INCOME BEFORE REPAYMENT AND TAX	617.9	632.2	647.2	662.7	678.9	695.8	713.3	731.7	769.4	789.0	809.4	836.6	858.6
REPAYMENT TO PORTOBRAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TAX	185.3	189.6	194.1	198.8	203.6	208.7	214.0	219.5	230.8	236.7	242.8	250.9	257.5
NET INCOME	432.5	442.6	453.0	468.9	475.2	487.0	499.3	412.1	538.6	552.3	566.5	585.6	601.0
LEGAL RESERVE	21.6	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIVIDEND	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8
SURPLUS	192.1	220.8	234.2	245.1	256.4	268.3	280.6	293.4	319.8	333.5	347.8	366.8	382.3
ACCUMULATED SURPLUS	2057.3	2278.1	2512.4	2757.6	3014.1	3282.4	3563.0	3756.4	4176.3	4509.0	4857.7	5224.6	5606.9
ACCUMULATED DEPRECIATION	2547.4	2572.1	2596.3	2621.5	2646.2	2670.9	2695.6	2720.3	2726.3	2732.3	2738.3	2738.3	2738.3
TOTAL	4604.8	4850.3	5109.8	5372.2	5660.4	5953.4	6253.7	6576.8	6902.7	7242.3	7569.1	7963.0	8345.3

Table 14-7 (1) * * * CASH FLOW STATEMENT * * * (Example 1)

(Case b-②)

(MILLION CRUZEIROS)

	1 1977	2 1978	3 1979	4 1980	5 1981	6 1982	7 1983	8 1984	9 1985	10 1986	11 1987	12 1988	13 1989
SOURCES OF FUNDS													
OPERATING REVENUES BEFORE DEPRECIATION	0.0	0.0	0.0	0.0	204.7	206.7	208.9	429.2	431.7	434.3	437.1	440.1	440.1
CAPITAL RECEIPTS	0.0	23.8	232.7	401.3	156.6	193.5	450.4	0.0	0.0	0.0	0.0	0.0	0.0
SUBSIDIES	43.6	200.0	600.0	700.0	470.2	37.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LONG-TERM DEBT	0.0	200.0	250.0	450.0	200.0	80.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST EARNED	0.0	0.0	0.0	0.0	0.0	4.3	13.0	21.1	38.0	53.6	60.3	67.2	74.4
TOTAL	43.6	423.8	1082.6	1551.4	1031.5	522.1	772.3	450.3	469.8	487.9	497.5	507.4	514.5
APPLICATION OF FUNDS													
CAPITAL EXPENDITURES	43.6	423.8	1082.6	1551.4	826.8	311.1	550.4	0.0	0.0	0.0	0.0	0.0	0.0
REPAYMENT TO PORTOBRAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAYMENT OF LONG-TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	16.7	37.5	75.0	91.7	98.3	106.7	106.7
INTEREST EXPENSE	0.0	5.8	19.3	41.8	65.5	65.6	70.7	72.6	70.5	66.2	60.9	55.2	49.1
TAX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58.1	65.2	71.9	76.4	81.1	85.1
DIVIDENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	145.8	145.8	145.8	145.8
TOTAL	43.6	429.6	1102.1	1593.2	892.3	376.7	637.8	168.2	210.8	375.7	381.5	388.9	386.7
CASH AVAILABLE FOR WORKING FUNDS	-0.0	-5.8	-19.4	-41.8	139.1	145.4	134.5	282.1	259.0	112.1	115.9	118.5	127.7
NET ACCUMULATED CASH	-0.0	-5.8	-25.3	-67.2	71.8	217.3	351.8	633.9	892.9	1005.0	1121.0	1239.6	1367.4

Table 14-7 (2) * * * CASH FLOW STATEMENT * * * (Example 1)

(Case b-②)

(cont'd)

(MILLION CRUZEIROS)

	14 1990	15 1991	16 1992	17 1993	18 1994	19 1995	20 1996	21 1997	22 1998	23 1999	24 2000	25 2001	26 2002
SOURCES OF FUNDS													
OPERATING REVENUES BEFORE DEPRECIATION	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1
CAPITAL RECEIPTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUBSIDIES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LONG-TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST EARNED	82.0	90.3	99.1	105.6	113.1	117.9	124.3	131.0	140.4	151.2	162.9	175.5	188.7
TOTAL	522.2	530.5	539.3	548.8	553.2	558.1	564.5	571.2	580.5	591.4	603.1	615.7	628.9
APPLICATION OF FUNDS													
CAPITAL EXPENDITURES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
REPAYMENT TO PORTOBRAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAYMENT OF LONG-TERM DEBT	106.7	106.7	106.7	106.7	106.7	90.0	69.2	31.7	15.0	8.0	0.0	0.0	0.0
INTEREST EXPENSE	43.0	36.8	30.7	24.6	18.4	12.3	7.1	3.1	1.3	0.5	0.0	0.0	0.0
TAX	89.2	93.5	98.0	124.8	128.0	131.3	157.9	161.1	164.5	169.8	173.5	177.3	181.2
DIVIDENT	145.8	145.8	145.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8
TOTAL	384.8	382.9	381.3	474.9	471.9	452.4	453.0	414.7	399.6	397.1	392.3	396.1	400.0
CASH AVAILABLE FOR WORKING FUNDS	137.4	147.5	158.0	73.8	81.3	105.6	111.4	156.4	180.9	194.2	210.7	219.6	228.8
NET ACCUMULATED CASH	1504.8	1652.4	1810.4	1884.2	1965.5	2071.2	2182.7	2339.1	2520.1	2714.4	2925.1	3144.8	3373.6

Table 14-7 (3) * * * CASH FLOW STATEMENT * * * (Example 1)

(Case b-②)

(MILLION CRUZEIROS)

(cont'd)

	27 2003	28 2004	29 2005	30 2006	31 2007	32 2008	33 2009	34 2010	35 2011	36 2012	37 2013	38 2014	39 2015
SOURCES OF FUNDS													
OPERATING REVENUES BEFORE DEPRECIATION	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1
CAPITAL RECEIPTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUBSIDIES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LONG-TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST EARNED	202.4	216.8	231.7	247.2	263.4	280.3	297.9	316.2	335.3	354.8	375.2	396.4	418.4
TOTAL	642.6	656.9	671.9	687.4	703.6	720.5	738.0	756.4	775.4	795.0	815.4	836.6	858.6
APPLICATION OF FUNDS													
CAPITAL EXPENDITURES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
REPAYMENT TO PORTOBRAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAYMENT OF LONG-TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST EXPENSE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TAX	185.3	189.6	194.1	198.8	203.6	208.7	214.0	219.5	230.8	236.7	242.8	250.9	257.5
DIVIDEND	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8	218.8
TOTAL	404.2	408.4	412.9	417.6	422.4	427.5	432.8	438.3	449.6	455.5	461.6	469.8	476.4
CASH AVAILABLE FOR WORKING FUNDS	238.4	248.4	258.9	269.8	281.1	292.9	305.2	318.0	325.8	339.5	353.7	366.8	382.2
NET ACCUMULATED CASH	3612.1	3860.6	4119.5	4389.4	4670.5	4963.5	5263.7	5586.8	5912.6	6252.2	6605.9	6972.8	7355.0

Table 14-8 (1) * * * STATEMENT OF INCOME AND EXPENSES * * * (Example 2)

(Case c-②)

(MILLION CRUZEIROS)

	1 1977	2 1978	3 1979	4 1980	5 1981	6 1982	7 1983	8 1984	9 1985	10 1986	11 1987	12 1988	13 1989
OPERATING REVENUES	0.0	0.0	0.0	0.0	358.2	360.2	362.4	659.1	661.6	664.2	667.0	670.0	670.0
OPERATING EXPENDITURES	0.0	0.0	0.0	0.0	153.5	153.5	153.5	229.9	229.9	229.9	229.9	229.9	229.9
OPERATING REVENUES BEFORE DEPRECIATION	0.0	0.0	0.0	0.0	204.7	206.7	208.9	429.2	431.7	434.3	437.1	440.1	440.1
DEPRECIATION	0.0	0.0	0.0	0.0	123.7	123.7	123.7	181.8	181.8	181.8	181.8	181.8	181.8
NET OPERATING REVENUES	0.0	0.0	0.0	0.0	81.0	83.0	85.2	247.4	249.9	252.5	255.3	258.3	258.3
INTEREST EARNED	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	12.6	23.2	34.6
INTEREST EXPENSE	0.0	0.0	0.0	0.0	0.0	8.2	17.3	27.2	11.8	0.0	0.0	0.0	0.0
INCOME BEFORE REPAYMENT AND TAX	0.0	0.0	0.0	0.0	81.0	74.7	67.8	220.2	238.1	255.3	268.0	281.6	292.9
REPAYMENT TO PORTOBRAS	0.0	0.0	0.0	0.0	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8
TAX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NET INCOME	0.0	0.0	0.0	0.0	-192.7	-199.0	-205.9	-53.5	-35.6	018.4	-5.7	7.8	19.1
LEGAL RESERVE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIVIDEND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SURPLUS	0.0	0.0	0.0	0.0	-192.7	-199.0	-205.9	-53.5	-35.6	-13.4	-5.7	7.8	18.1
ACCUMULATED SURPLUS	0.0	0.0	0.0	0.0	-192.7	-391.8	-597.7	-651.3	-686.9	-705.3	-711.1	-708.3	-694.1
ACCUMULATED DEPRECIATION	0.0	0.0	0.0	0.0	123.7	247.4	371.1	552.9	734.7	916.4	1098.2	1200.0	1461.8
TOTAL	0.0	0.0	0.0	0.0	-69.0	-144.4	-226.6	-98.4	47.7	211.1	387.1	576.7	777.7

Table 14-8 (2) * * * STATEMENT OF INCOME AND EXPENSES * * * (Example 2)

(Case c-②)

(cont'd)

(MILLION CRUZEIROS)

	14 1990	15 1991	16 1992	17 1993	18 1994	19 1995	20 1996	21 1997	22 1998	23 1999	24 2000	25 2001	26 2002
OPERATING REVENUES	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0
OPERATING EXPENDITURES	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9
OPERATING REVENUES BEFORE DEPRECIATION	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1
DEPRECIATION	181.8	181.8	181.8	108.0	108.0	108.0	30.9	30.9	30.9	24.7	24.7	24.7	24.7
NET OPERATING REVENUES	258.3	258.3	258.3	332.1	332.1	332.1	409.2	409.2	409.2	415.4	415.4	415.4	415.4
INTEREST EARNED	46.6	59.4	72.9	87.3	102.5	118.7	135.8	150.2	164.1	178.5	193.5	209.0	225.2
INTEREST EXPENSE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INCOME BEFORE REPAYMENT AND TAX	305.0	317.8	331.3	419.5	434.7	450.9	545.1	559.5	573.4	594.0	608.9	624.5	640.7
REPAYMENT TO PORTOBRAS	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8
TAX	0.0	0.0	0.0	0.0	0.0	0.0	61.1	85.7	89.8	96.0	100.5	105.2	110.0
NET INCOME	31.2	44.0	57.5	145.7	160.9	177.1	210.1	200.0	209.7	224.1	234.6	245.5	256.8
LEGAL RESERVE	0.0	0.0	0.0	0.0	0.0	0.0	7.1	10.0	10.4	11.2	11.7	12.2	12.3
DIVIDEND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SURPLUS	31.2	44.0	57.5	145.7	160.9	177.1	203.0	190.0	199.2	212.9	222.9	233.2	244.0
ACCUMULATED SURPLUS	-652.9	-608.8	-551.3	-405.5	-244.6	-67.4	135.5	325.5	524.8	737.8	960.7	1193.9	1438.0
ACCUMULATED DEPRECIATION	1643.6	1825.4	2007.2	2115.2	2233.2	2331.2	2362.1	2393.0	2423.9	2448.6	2473.3	2498.0	2522.7
TOTAL	990.7	1216.6	1455.9	1709.7	1970.6	2263.8	2497.7	2718.6	2948.8	3186.5	3434.1	3692.0	3960.8

Table 14-8 (3) * * * STATEMENT OF INCOME AND EXPENSES * * * (Example 2)

(Case c-②)

(cont'd)

(MILLION CRUZEIROS)

	27 2003	28 2004	29 2005	30 2006	31 2007	32 2008	33 2009	34 2010	35 2011	36 20	37 2013	38 2014	39 2015
OPERATING REVENUES	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0	670.0
OPERATING EXPENDITURES	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9	229.9
OPERATING REVENUES BEFORE DEPRECIATION	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1
DEPRECIATION	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	6.0	6.0	6.0	6.0	6.0
NET OPERATING REVENUES	415.4	415.4	415.4	415.4	415.4	415.4	415.4	415.4	434.1	434.1	434.1	434.1	434.1
INTEREST EARNED	242.1	259.7	276.1	297.2	317.1	337.9	359.5	382.0	405.5	429.6	454.8	481.0	508.2
INTEREST EXPENSE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INCOME BEFORE REPAYMENT AND TAX	657.6	675.2	693.6	712.7	732.6	753.4	775.0	797.5	839.7	863.3	889.0	921.2	949.4
REPAYMENT TO PORTOBRAS	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8
TAX	115.1	120.4	125.9	131.6	137.6	143.8	150.3	157.1	169.7	177.0	184.5	194.2	202.3
NET INCOME	268.7	231.0	293.3	367.2	321.1	335.7	350.8	366.6	396.1	413.0	430.6	453.1	472.2
LEGAL RESERVE	13.4	14.0	14.6	15.3	16.0	16.7	17.5	18.3	19.8	20.6	21.5	22.6	5.0
DIVIDEND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SURPLUS	255.2	266.9	279.1	291.8	305.1	318.9	333.3	348.3	376.3	392.3	409.1	430.5	467.1
ACCUMULATED SURPLUS	1693.2	1960.2	2239.4	2531.3	2836.4	3155.3	3488.7	3837.0	4213.3	4605.7	5014.8	5445.4	5912.5
ACCUMULATED DEPRECIATION	2547.4	2572.1	2596.2	2621.5	2646.2	2670.9	2695.6	2720.3	2726.3	2732.3	2738.3	2738.3	2738.3
TOTAL	4240.7	4532.4	4886.3	5152.2	5432.7	5326.3	6184.4	6557.4	6939.7	7338.1	7753.2	8183.3	8650.9

Table 14-9 (1) * * * CASH FLOW STATEMENT * * * (Example 2)

(Case c-②)

(MILLION CRUZEIROS)

	1 1977	2 1978	3 1979	4 1980	5 1981	6 1982	7 1983	8 1984	9 1985	10 1986	11 1987	12 1988	13 1989
SOURCES OF FUNDS													
OPERATING REVENUES BEFORE DEPRECIATION	0.0	0.0	0.0	0.0	204.7	206.7	208.9	429.2	431.7	434.3	437.1	440.1	440.1
CAPITAL RECEIPTS	0.0	23.8	232.7	401.3	156.6	193.5	450.4	0.0	0.0	0.0	0.0	0.0	0.0
SUBSIDIES	43.6	200.0	600.0	700.0	470.2	37.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LONG-TERM DEBT	0.0	200.0	250.0	450.0	200.0	80.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST EARNED	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	12.6	23.2	34.6
TOTAL	43.6	423.8	1082.6	1551.4	1031.5	517.8	759.3	429.2	431.7	437.1	449.8	463.4	474.7
APPLICATION OF FUNDS													
CAPITAL EXPENDITURES	43.6	423.8	1082.6	1551.4	826.8	311.1	550.4	0.0	0.0	0.0	0.0	0.0	0.0
REPAYMENT TO PORTOBRAS	0.0	0.0	0.0	0.0	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8
PAYMENT OF LONG-TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST EXPENSE	0.0	0.0	0.0	0.0	0.0	8.2	17.3	27.2	11.8	0.0	0.0	0.0	0.0
TAX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIVIDEND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	43.6	423.8	1082.7	1551.4	1100.6	593.2	841.5	301.0	285.6	273.8	273.8	273.8	273.8
CASH AVAILABLE FOR WORKING FUNDS	-0.0	-0.0	-0.0	-0.0	-69.1	-75.4	-82.2	128.2	146.1	163.3	175.9	189.5	200.9
NET ACCUMULATED CASH	-0.0	-0.0	-0.1	-0.1	-69.3	-144.7	-227.0	-98.8	47.2	210.6	386.6	576.1	777.0

Table 14-9 (2) * * * CASH FLOW STATEMENT * * * (Example 2)

(Case c-②)

(cont'd)

(MILLION CRUZEIROS)

	14 1990	15 1991	16 1992	17 1993	18 1994	19 1995	20 1996	21 1997	22 1998	23 1999	24 2000	25 2001	26 2002
SOURCES OF FUNDS													
OPERATING REVENUES BEFORE DEPRECIATION	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1
CAPITAL RECEIPTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUBSIDIES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LONG-TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST EARNED	46.6	59.4	73.9	87.3	102.5	118.7	135.8	150.2	164.1	178.5	193.5	209.0	225.2
TOTAL	486.8	499.6	513.1	527.5	542.7	558.9	576.0	590.4	604.3	618.7	633.6	649.2	665.4
APPLICATION OF FUNDS													
CAPITAL EXPENDITURES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
REPAYMENT TO PORTOBRAS	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8
PAYMENT OF LONG-TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST EXPENSE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TAX	0.0	0.0	0.0	0.0	0.0	0.0	61.1	85.7	89.8	96.0	100.5	105.2	110.0
DIVIDEND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	273.8	273.8	273.8	273.8	273.8	273.8	334.9	359.5	363.7	369.9	374.4	379.0	388.9
CASH AVAILABLE FOR WORKING FUNDS	212.9	225.7	239.3	253.6	268.9	285.0	241.0	230.8	240.5	248.8	259.2	270.1	281.5
NET ACCUMULATED CASH	990.0	1215.8	1455.1	1706.6	1977.7	2262.8	2503.8	2734.7	2975.3	3224.1	3483.4	3753.6	4035.1

Table 14-9 (3) * * * CASH FLOW STATEMENT * * * (Example 2)

(Case c-②)

(cont'd)

(MILLION CRUZEIROS)

	27 2003	28 2004	29 2005	30 2006	31 2007	32 2008	33 2009	34 2010	35 2011	36 2012	37 2013	38 2014	39 2015
SOURCES OF FUNDS													
OPERATING REVENUES BEFORE DEPRECIATION	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1	440.1
CAPITAL RECEIPTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUBSIDIES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LONG-TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST EARNED	242.1	259.7	273.1	297.2	317.1	337.9	359.5	382.0	405.5	429.6	454.8	481.0	502.2
TOTAL	682.3	699.9	718.3	737.4	757.3	778.1	799.7	822.2	845.7	869.8	895.0	921.2	948.4
APPLICATION OF FUNDS													
CAPITAL EXPENDITURES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
REPAYMENT TO PORTOBRAS	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8	273.8
PAYMENT OF LONG-TERM DEBT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST EXPENSE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TAX	115.1	120.4	125.9	131.6	137.6	143.8	150.3	157.1	169.7	177.0	184.5	194.2	202.3
DIVIDEND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	389.0	394.2	399.7	405.5	411.5	417.7	424.2	430.9	443.6	450.8	458.4	468.0	476.2
CASH AVAILABLE FOR WORKING FUNDS	293.3	305.6	318.5	331.9	345.8	360.3	375.5	391.2	402.1	418.9	436.5	453.1	472.1
NET ACCUMULATED CASH	4328.5	4634.2	4952.7	5234.6	5630.4	5990.8	6366.3	6757.6	7159.7	7578.7	8015.3	8468.5	8940.6

CHAPTER 15. PORT CONSTRUCTION AND ENVIRONMENTAL PROTECTION

15. Port construction and environmental protection

15-1 Influence of the construction of breakwaters on the neighboring seacoasts

If artificial structures such as breakwaters are constructed on the shore, the balance of nature is lost and the coastline begins to change to acquire a suitable balance for the new condition. Generally, the beachline advances by accretion on the upper side of a littoral drift, and retreats by erosion on the lower side. One of the typical examples of such phenomenon in Brazil is observed at Mucripe, Fortalesa.

In the case of Praia Mole, the littoral drift is considered to be not so prevailing as at Mucripe. It will, however, be necessary to pay attention to the local change of the neighboring beachline with variations in near shore currents after construction of the breakwaters.

A LIST OF TABLES

A LIST OF FIGURES

Chapter	Fig. No.	Title
(FIGURES IN APPENDIX)		

APPENDIX

CONTENTS

Appendix 1. Scope of work (January, 1977)

1. Introduction

In response to the request of the Government of the Federative Republic of Brazil, the Government of Japan has decided to conduct a feasibility study on "the construction project of Praia Mole Port" in accordance with laws and regulations in force in Japan and the Japan International Co-operation Agency (JICA), the official agency responsible for the implementation of the Technical Cooperation Programmes of the Government of Japan, will carry out the study in close cooperation with the Government of the Federative Republic of Brazil and the authorities concerned.

2. Objectives of the Study

The objectives of the study on the construction project of Praia Mole Port are

(1) to review from technical viewpoints the Master Plan prepared by the Brazilian side,

(2) to appraise economic and financial feasibility of the Master Plan, and

(3) to prepare an alternative plan for the construction of the port.

3. Outline of the Study

The outline of the study are as follows;

(1) Review of the Master Plan prepared by the Brazilian side.

(i) Layout of port facilities

(ii) Design conditions of port structures

(iii) Rough design of port structures

(iv) Dredging and reclamation

(v) Cargo handling equipment and tugboat

(vi) Construction schedule and rough cost estimation

(2) Preparation of an alternative plan

A precise study will be made on the items mentioned above in (1) and an alternative plan will be prepared if necessary.

(3) Economic and Financial analysis

(4) Review of the organizational setup for the port administration and operation

(5) Study of environment impact brought by the port construction

(6) Preparation of recommendations

4. Reports

The feasibility study team will prepare, if possible, the draft report which is to be discussed and agreed with the Government of Brazil and the authorities concerned. The team will prepare the final report after its return to Japan.

The JICA will submit to the Government of Brazil seventy copies of final report (in English).

5. Undertaking of the Government of Brazil

(1) The Government of Brazil and the authorities concerned will provide the team with necessary information and data for the study;

(2) The Government will make arrangements for visiting the authorities concerned;

(3) The Government will assign counterparts to cooperate with the survey team;

(4) The Government will provide the team with an office appropriately equipped;

(5) The Government will provide the team with transportation facilities such as jeeps and boats for the field survey, and, when required, suitable accommodation facilities in the vicinity of the survey areas.

(6) The Government will exempt the team from taxes and duties for equipment and material to be brought into Brazil by the study team.

6. Experts of Study Team

The study team consist of the experts of nine fields as listed below;

(1) Port planning

(2) Transportation economy

(3) Economic and financial analysis

(4) Hydraulics

(5) Geotechnique

(6) Structural design

(7) Cargo handling equipment

(8) Working craft and execution

(9) Cost estimation

7. Schedule of study

Items \ month	1	2	3	4	5	6	7	8
Preparation for study	—							
Field survey		—	—					
Home work			—	—	—	—		
Preparation of report						—	—	
Submission of report								—

MEMORANDUM

We, the President of the Empresa de Portos do Brasil (hereinafter referred to as the PORTOBRÁS) and the Head of the Japanese feasibility study team for the construction project of Praia Mole port of the Federative Republic of Brazil (hereinafter referred to as the Japanese team), herewith agree that the Japanese team will carry out the feasibility study for the construction project of Praia Mole port based on the Scope of Work attached herewith.

February 7, 1977

Arno Oscar Markus,
President of the PORTOBRAS

Susumu Maeda,
Head of the Japanese Team

Appendix 2. The record of discussions

Introduction:

1. The Japanese feasibility study team for the construction project of Praia Mole port of the Federative Republic of Brazil (hereinafter referred to as the Japanese team) started its study works on February 7, 1977 and completed its studies in Brazil on March 9, 1977, under the wholehearted cooperations of the Empresa de Portos do Brasil S.A. (hereinafter referred to as the PORTOBRÁS), various Brazilian authorities concerned, and related companies.

2. Although the Japanese team made its efforts to prepare the draft report which was to be agreed with the PORTOBRÁS it was not possible, by the time of departure for Japan of the Japanese team, to make such a report in a complete form due to various reasons.

3. For the reasons stated in the above, we, the Japanese team and the PORTOBRÁS herewith agree to put on record our main issues of discussions carried out during the stay in Brazil of the Japanese team in order to facilitate and expedite the further study works of the Japanese team and the PORTOBRÁS.

Main Issues of Discussions:

1. Master plan of the port

(1) The plan should be made so that a future expansion of the port is easily possible, regardless of the participation of the CVRD in the port. For this reason the port should not be enclosed to a small scale with a limited possibility of the future expansion.

(2) Even if an initial investment will increase by a certain amount it is desirable to prepare a space for berths required in future to handle pellets and other dry bulk cargoes in the harbour basin protected by the south breakwater.

(3) Although nothing has been decided on the third stage expansion of the steel mill, the future requirement of the CST to the port of Praia Mole will be met by utilizing a northern part of the harbour basin.

(4) The outline of the master plan that was agreed for the first and second stages is herewith attached.

(5) The possibility of future expansion of the port shall be studied considering a partial removal of the north breakwater.

(6) The first stage may consist of the construction of the two breakwaters, north and south, two slab berths, a berth for coal unloading and a pier for oil derivatives, with a complete set of related facilities.

(7) The second stage may consist of the construction of a slab berth, a coal berth and related facilities.

2. Breakwaters

(1) After various discussions between Mr. K. Tanimoto of the Japanese team and the specialists of the INPH it was agreed that the significant wave height to be adopted for the design of main breakwaters should be 5.00 meters. It was, however, agreed that the design wave height could be reduced to 4.00 and 4.50 meters at certain parts of the breakwaters, taking account of the location and importance of breakwaters, in addition to wave characteristics.

(2) A rubble mound type was selected for the breakwaters of the port of Praia Mole as the result of various comparative studies.

(3) It was agreed that the structural design of the breakwaters was to be performed, taking account of the result of hydraulic model experiments, and an agreement was reached on the major design conditions as shown below:

a) Crown height

. South breakwater + 5.80 m ∿ + 9.50 m

. North breakwater + 5.80 m ∿ + 7.30 m

b) Side slope

- 1:1.5 for an ordinary part
- 1:2.0 for a breakwater head and at a sharp bent

c) Weight of an armor stone

- It was assumed that a certain degree of damage to the breakwaters due to actions of waves with a design height could be allowed.
- 9 ∿ 12 tons for the design wave height of 5.00 meters.
- Over 12 tons for a breakwater head.
- The both sides of the north breakwater must be the same in the weight of an armor stone. However, the weight of an armor stone located at the water depth less than 8 meters can be reduced based on the results of hydraulic model studies.

3. Dredging works

(1) It appeared to us that a fleet of cutter suction dredgers owned by the CBD is rather insufficient in its dredging ability, particularly in the unprotected waters and at certain places where the bottom soil is relatively hard, while the CBD has added since December 1976 to its fleet of hopper suction dredgers a most modern one to be followed in March 1977 by another with the same characteristics. These two hopper suction dredgers have a sufficient ability to perform the dredging of the entrance channel and a part of the harbour basin of the port, if the soil condition is suitable for such type of dredgers.

(2) As these two dredgers should be allocated to another important job to be executed at the same period of time, the PORTOBRÁS indicated the possibility of using a foreign large hopper dredger through chartering or buying.

(3) For the hard soil material impossible to be dredged by a hopper dredger, a large cutter suction dredger, capable of works at high seas and at the hard bottom, must be chartered from abroad.

4. Mooring facilities

(1) It was assumed that the pellet pier and related cargo handling facilities would be built by the CVRD.

(2) The first coal berth must be built at the eastern side of the pier to save the dredging cost of the basin.

(3) The PORTOBRÁS has not yet reached any conclusions on structural types to be adopted for the mooring facilities, and cost comparisons have not been made. There are, however, two basic alternatives for infra-structure. One is a concrete pile structure which is common in Brazil, while another is a steel pipe pile structure.
It appeared to us that the economy of costs depends upon the cost of Brazilian steel which is higher than the imported steel.
On the other hand, since most of construction materials and equipment can be obtained in the local market the port construction at Praia Mole does not need much amount of foreign currencies, while the reduction of the construction cost is of a vital importance to users of the port.

For these reasons, the Japanese team made a recommendation that it would be better to manufacture steel pipe piles by utilizing imported steel plates.

5. Cargo handling equipment and conveyance system in the port

(1) Taking into consideration a relatively larger number of small-sized coal carriers in the coastal shipping in Brazil, it was decided that a coal berth should attend the operations of such small vessels unloading at the rate of 2.000 t/h.

(2) It was agreed that the port railways were not installed during the first stage period.

(3) Wagon loading facilities of coal at the CVRD's area and a conveyor system to them must be included in the port project.

6. Cost estimates and foreign currency portions

(1) Construction cost estimates were made by the Japanese team based on the newly settled master plan, although a certain part of the estimates needs a further review due to lack of information.

(2) In calculating the cost an exchange rate of
US$ 1 = Cr$ 12.8 was adopted.

(3) Classification of foreign currency items was also made by the Japanese team as attached herewith and it was agreed. The PORTOBRÁS admitted alternatively the possibility to study the importation of some complete sets of cargo handling equipment.

(4) It was also agreed that 10% of physical contingencies must be added to the cost of civil works and that about 35% be added to the foreign currencies allocated to the cargo handling equipment and conveyance system as physical contingencies.

(5) The price escalation of the foreign currency portion must be considered in the cost estimates.

7. Organizational set-up for the port construction

In order to perform the big project of Praia Mole within a limited span of time, the Japanese team strongly felt that the technical staff of the PORTOBRÁS must be strenghtened and a site office with a sufficient authority should be set up in Vitória.

8. Technical cooperations at the construction stage

(1) In view of a limited span of time for the port construction with difficulties of works in the open sea and particularly with insufficient information on bottom soil conditions, in addition to the scale of construction and the importance of the port of Praia Mole the Japanese team felt the convenience of providing the PORTOBRÁS with at least two experts (a dredging engineer and a mechanical engineer) with advisory capacities to work together with the PORTOBRÁS during the first stage of the construction period of the port based on a technical cooperation programme of the Japanese Government.

The PORTOBRÁS accepted the technical cooperations suggested by the Japanese team and expressed its view that it would be good if the Japanese team could promote to implement such cooperations in consultation with the Government of Japan after it returned to Japan.

The PORTOBRÁS stated, however, that a further study must be made in details on the financing conditions of the expert group.

9. Port dues and charges

(1) It was expressed by the Japanese team that although a financial analysis has not been made the port dues and charges of the Praia Mole port should not always be decided on a cost basis.

(2) The port of Praia Mole is a rather expensive port because it needs long breakwaters to protect its harbour basin due to its geographical conditions.

(3) On the other hand the port has been primarily aimed at serving an important export industry of Brazil. If the port dues and charges are very high the competitive power of such an industry will be reduced.

(4) For the reasons mentioned in the above, the Japanese team showed its keen interests to the determination mechanism and the level of port dues and charges of the port of Praia Mole.

(5) The PORTOBRÁS stated that in any case the port dues and charges should be determined in order to permit a competitive level of prices in the international market, but, in principle, determined on a cost basis.

THE LIST OF FIGURES AND TABLES

THE LIST OF IMPORTED ITEMS

1. Civil Works

Particulars	Imported Items
Dredging	a hopper suction dredger with a high capacity and/or a heavy class cutter suction dredger (chartering) with main crew and auxiliary appliances.
Mooring facilities	crane rails, rubber fenders, steel plates for pipe piles, steel sheet piles, tie-rods.
Other facilities	crane rails, engines for tug boats.

2. Cargo Handling Equipment

Particulars	Imported Items
Unloader	traveling gears, bucket hoisting gear, bucket grapping gear, traversing gears, derricking gear, M.G. set, D.C. motors including D.C. control panels, other D.C. equipment, H.V. panels, trailing cables and spare parts.
Stacker	traveling gears, conveyor driving gear, slewing gear, derricking gear, belt, fluid coupling, H.V. motor, H.V. panels, trailing cables and spare parts.
Reclaimer	traveling gears, conveyor driving gear, slewing gear, derricking gear, bucket driving gear, belt, fluid coupling, H.V. panels, trailing cable and spare parts.

Particulars	Imported Items
Slab Loader	traveling gears, hoisting gear, traversing gears, derricking gear, M.G. set, D.C. equipment, H.V. panels, lifting device and spare parts.
Slab Crane	traveling gears, hoisting gear, traversing gears, hoisting motor, H.V. panels, trailing cable, lifting magnet and spare parts.
Car Loading Silo	Car shifting system, hopper scales and feeder
Conveyor	steel cord belt, fluid couplings, motors and spare parts.
Bulldozer Tractor and Trailer Forklift	the types which cannot be produced by Brazilian industries.

Conclusions

1. Mr. M. Maeda, Head of the Japanese team expressed at the final meeting with the PORTOBRÁS on March 9, 1977, his sincere gratitude to Mr. Arno Oscar Markus, the President of the PORTOBRÁS for the wholehearted cooperations extended to the Japanese team by many officials and peoples of the PORTOBRÁS, various authorities and companies, particularly by engineers Paulo A.D. Da Rin, Carlos Theophilo de Souza e Mello and José Antonio dos Santos. His thanks also went to all the people who had worked for his team behind the scene.

2. It was confirmed that the project of Praia Mole port must be implemented as soon as possible with the fullest efforts of the PORTOBRÁS in view of the importance of the port in the industrial development of Brazil.

3. The Japanese team made a feasibility study in order to identify whether or not the construction of Praia Mole port could be properly carried out. Although there was a certain degree of disparities in the opinions and thinking between the two parties the Japanese team reached a preliminary conclusion that the port construction would generally be performed without much difficulties in the technical field.

4. It was hoped, however, by the Japanese team that the technical cooperations of Japan as extended this time must be continued even in the construction stage in order to complete the port construction at Praia Mole within the shortest possible time.

5. The PORTOBRÁS expressed its special thanks to all the members of the Japanese team, specially to the Head of the team, engineer Susumu Maeda for the efficient and important collaboration that is being dedicated to the port of Praia Mole Project.

March 9, 1977.

Arno Oscar Markus,
President of the PORTOBRÁS

Susumu Maeda,
Head of the Japanese team

Appendix 3. Outline of hydraulic model tests for determination of breakwater section

1. Antecedents

In Brazil, it is generally practised to carry out model tests in determining the cross section of a rubble mound type breakwater. As to Praia Mole Port, the various tests were made, and the following reports have been presented.

① INPH, PORTOBRÁS: Terminal de Praia Mole - Estudo de estabilidade dos cabeços dos molhes de proteção, Abril 1976

② CTH, Universidade de São Paulo: Estudo em modelo reduzido do Porto de Praia Mole modelo bidimensional - Relatório parcial No. 1 - Estudo da estabilidade do quebra-mar trecho Ce B, Outubro 1976

③ CTH, Universidade de São Paulo: Estudo em modelo reduzido do Porto de Praia Mole modelo bidimensional - Relatório parcial No. 2 - Estudo da estabilidade do quebra-mar trecho B - Ensaios complementares, Dezembro 1976

④ CTH, Universidade de São Paulo: Estudo em modelo reduzido de Porto de Praia Mole modelo bidimensional - Relatório parcial No. 3 - Estudo da estabilidade do quebra-mar trecho A, Janeiro 1977

⑤ INPH, PORTOBRÁS: Praia Mole Terminal - Stability experiments final report, March 1977

The report ① prepared by the Instituto de Pesquisad Hidroviárias (INPH) of PORTOBRÁS deals with the experiments concerning the stability of breakwater head. The reports ②, ③ and ④ issued by the Centro Tecnologico de Hidraulica of São Paulo University deal with the stability, crest height and scour, etc. at the trunks of breakwater. The report ⑤ deals with a model test conducted at the INPH of PORTOBRÁS for final determination of the cross section of breakwater during stay of the Japanese Study Team in Brazil.

2. Outline of final hydraulic model test

The test was conducted based on the various preceding test results with a view to finding out the stable cross section of breakwater with the design significant wave height set at 5 m. Since the waves used in the test were regular ones, it was decided that the stability was required to be less than 1% in terms of damage ratio when the test wave height was 5 m equal to the design significant wave height. It is surmised that this damage ratio will be tantamount to a damage ratio of not exceeding 5% by irregular waves which are expected actually. Namely, some allowances should be made for damage.

The channel used for the test was a lengthy one of 1 m wide prepared to a scale of 1 to 40 available at the INPH of PORTOBRÁS.

As illustrated in Attached Fig. 3.1, the cross section of a model breakwater having a seaside slope of 1 on 1.5 and a crown height of +9.5 m was put to tests with respect to the following three values of armor stone weight.

① W = 6 to 9 tons

② W = 8 to 11 tons

③ W = 9 to 12 tons

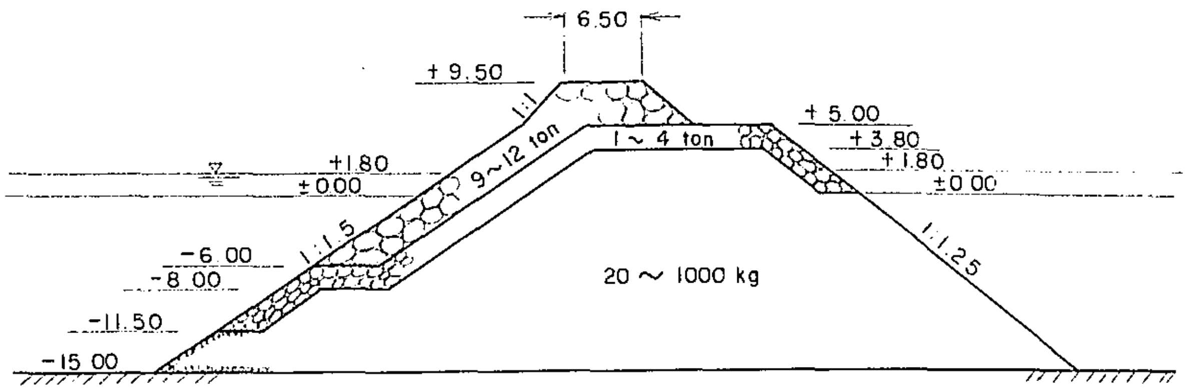
The footing depth of the armor stone was -3.5 m for W = 6 to 9 tons, and -6 m for W = 8 to 11 tons and 9 to 12 tons. The hydraulic test conditions were set as follows.

Water depth : -15 m

Water level : +1.8

Wave period : 10 sec.

The test wave height started with about 3 m and was increased little by little up to about 8 m max. The test continued for more than 2 hrs. in the prototype for each step of wave height, and longer hours were consumed for some specific wave height conditions.

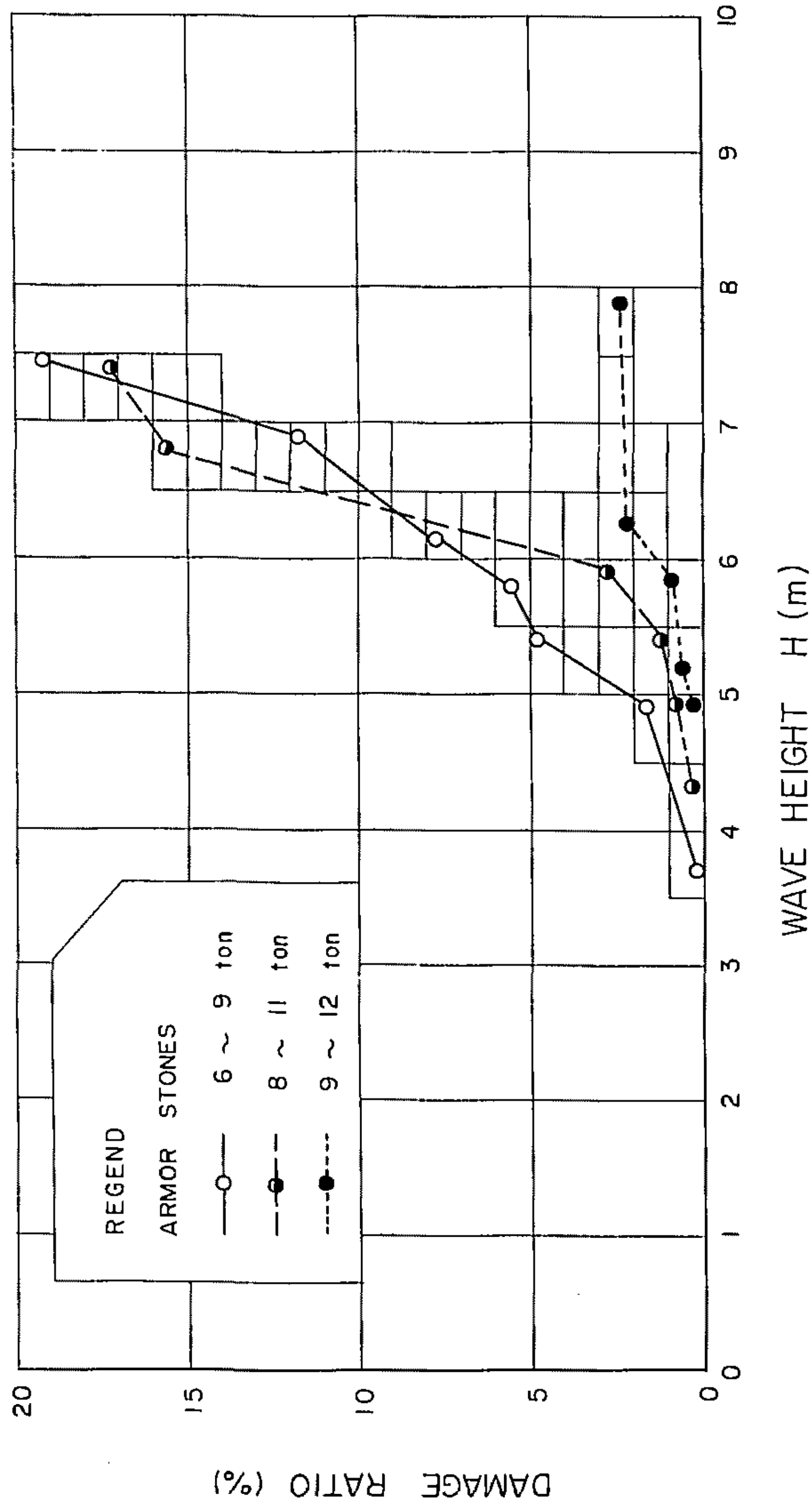


Attached Fig. 3.1 Section of hydraulic model test of breakwater

3. Results

Attached Fig. 3.2 shows the change in damage ratio with gradual increase in wave height. The damage ratio was defined as the rate of the number of stones moved away to the total number of armor stones. The number of moved-away stones was accumulated as the wave height was increased. The total number of armor stones was 481 for W = 6 to 9 tons, 482 for W = 8 to 11 tons and 474 for W = 9 to 12 tons. The total number of 6 to 9 ton armor stones was comparatively small because the footing depth was shallower than others. For 6 to 9 ton armor stones, the test was also conducted with respect to periods of 8 sec. and 12 sec. and at a water level of 0.0 m. Attached Fig. 3.2 shows the results of a test at a water level of +1.8 m and a period of 10 sec., the most severest of all conditions. The damage ratio at a wave height of 5 m was 2% for W = 6 to 9 tons, 0.9% for W = 9 to 11 tons and 0.3% for W = 9 to 12 tons. Although the tests could not be repeated to the full because of time limitations, it is judged from the general tendency that the trunk of breakwater preferably be armoured with 9 to 12 ton stones.

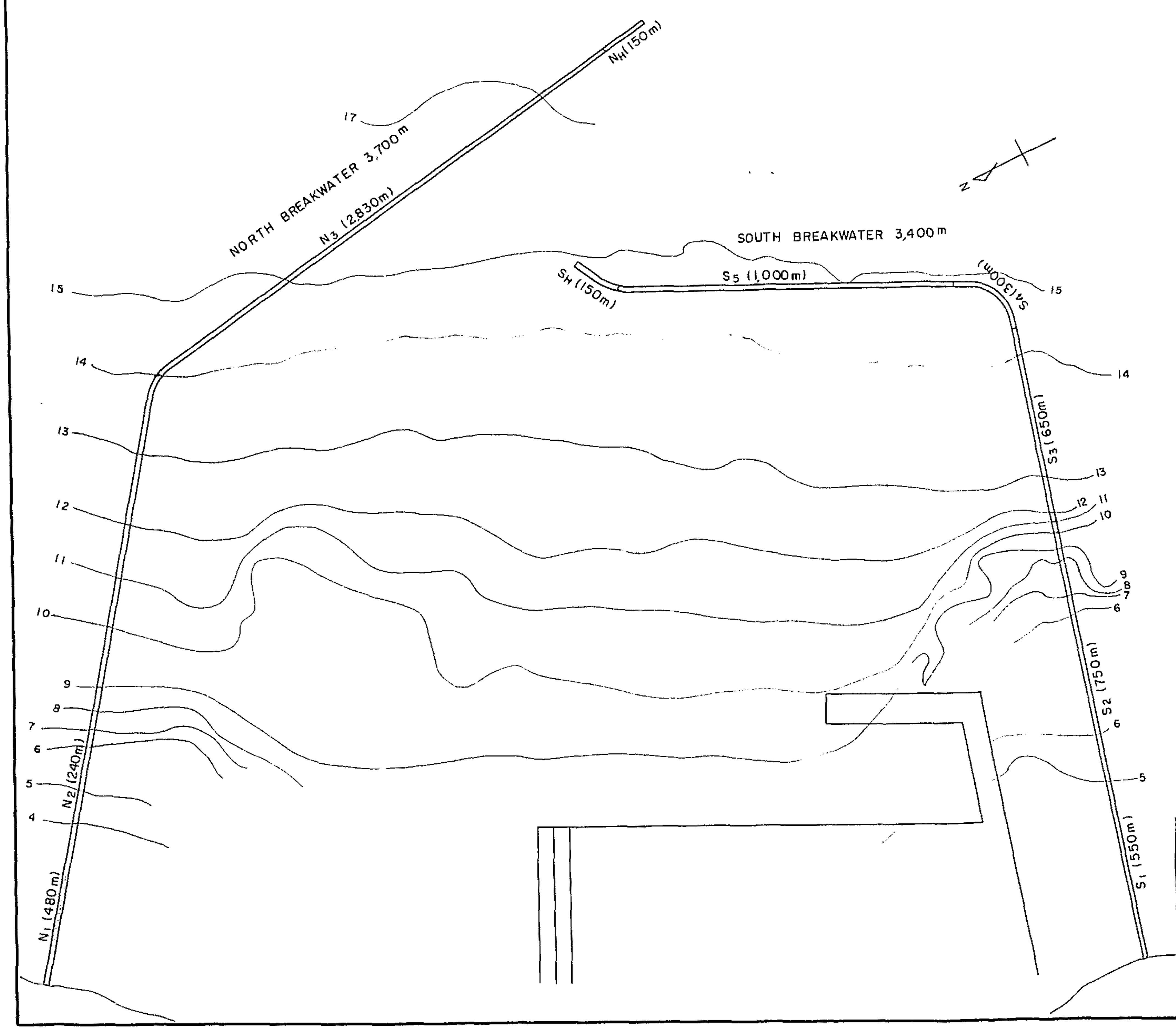
The head and sharp bend of breakwaters should be armoured with more larger stones. On the other hand, the sizes of armor stones may be made smaller the smaller will become the wave height or the nearer the location is to the shore.



Attached Fig. 3.2 Damage ratio of armor stones

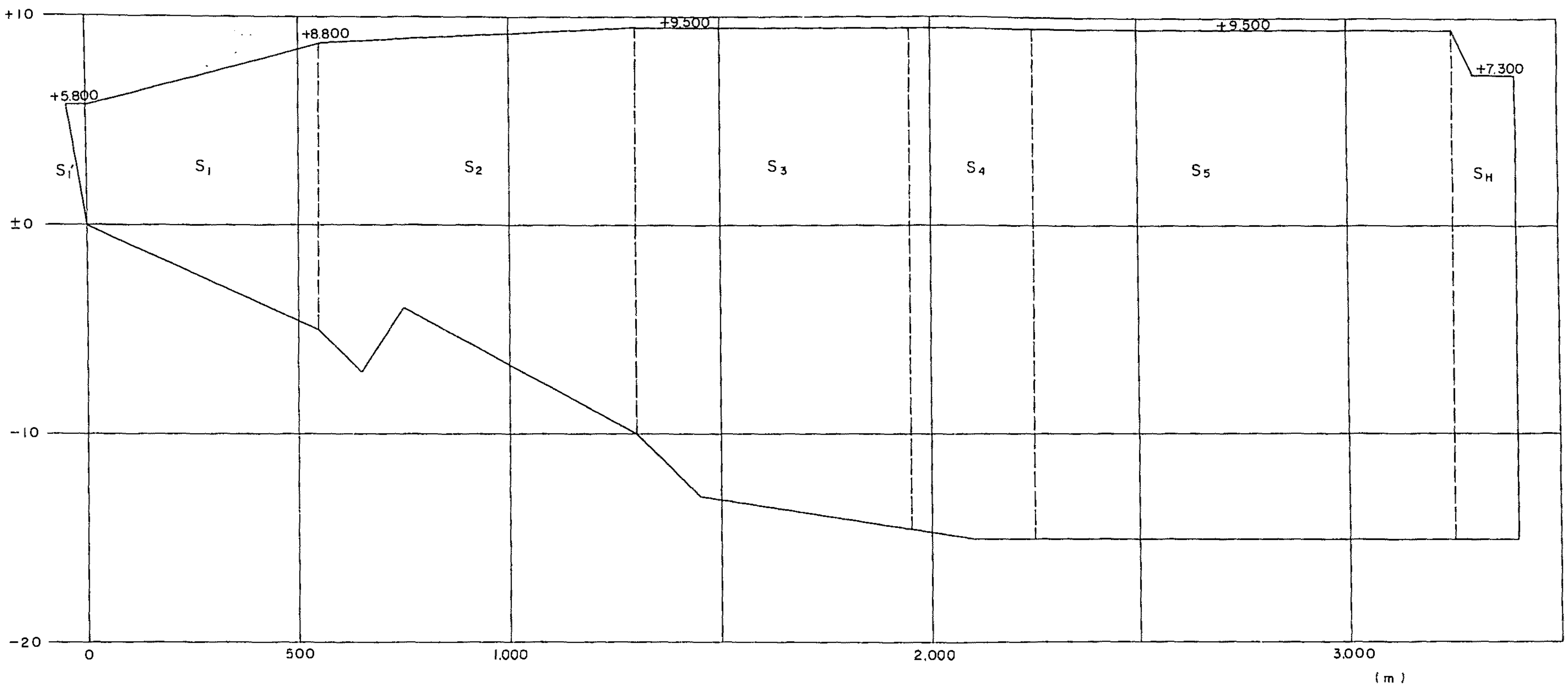
Appendix 4. Structural drawings of civil facilities

PLAN



PROJECT	CONSTRUCTION OF PRAIA MOLE PORT
TITLE	BREAKWATER (I)
OCDI THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN	APPROVED BY CHECKED BY DRAWN BY DWG. No. PM-C601

SOUTH BREAKWATER LONGITUDINAL PROFILE



CONSTRUCTION OF PRAIA MOLE PORT

BREAKWATER (2)

OCDI

THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN

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DWG No.	PM-C602
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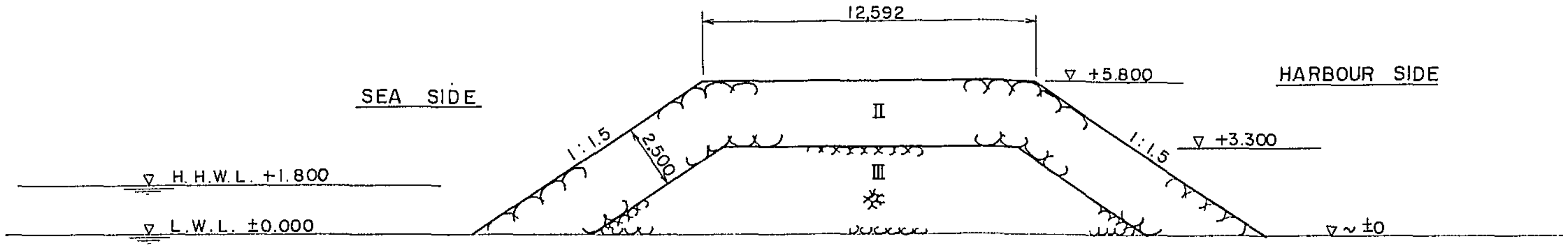
SOUTH BREAKWATER

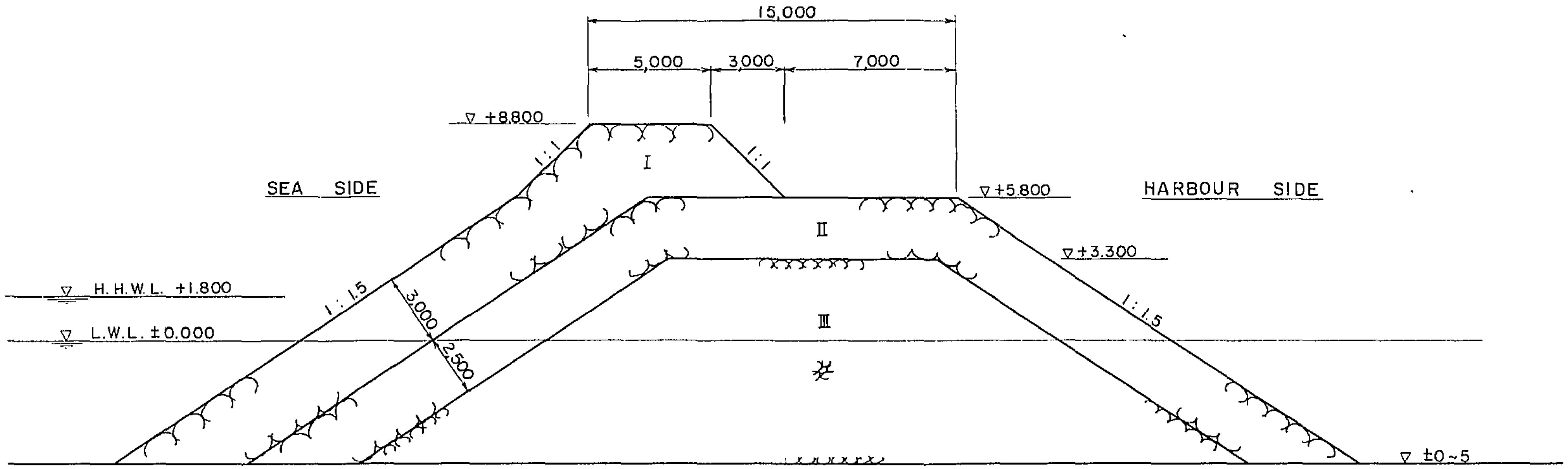
S_1' SECTION S = 1 : 200



THE WEIGHT OF AN ARMOR STONE

I : 5 ~ 7 ton
II : 2 ~ 5 ton
III : 20 ~ 2 000 Kg

S_1 SECTION S = 1 : 200



PROJECT	CONSTRUCTION OF PRAIA MOLE PORT
TITLE	BREAKWATER (3)
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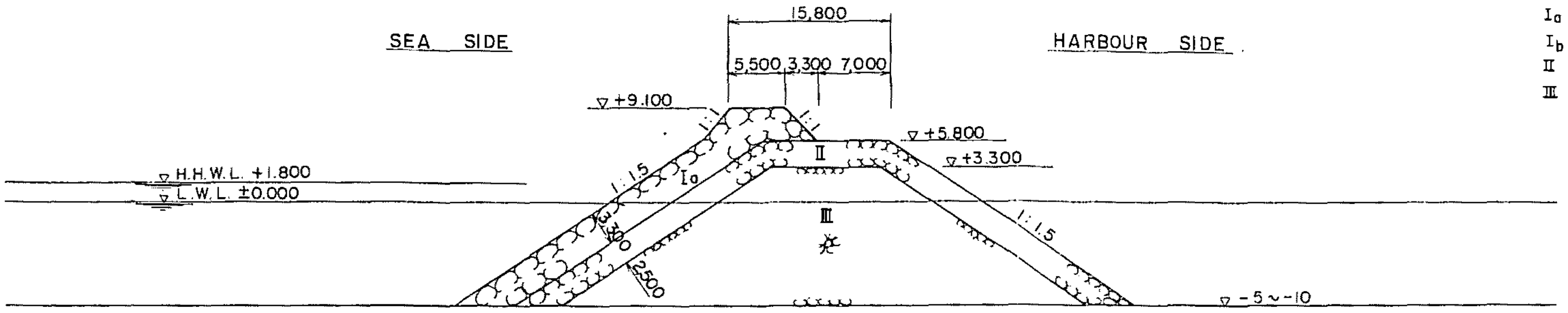
SOUTH BREAKWATER

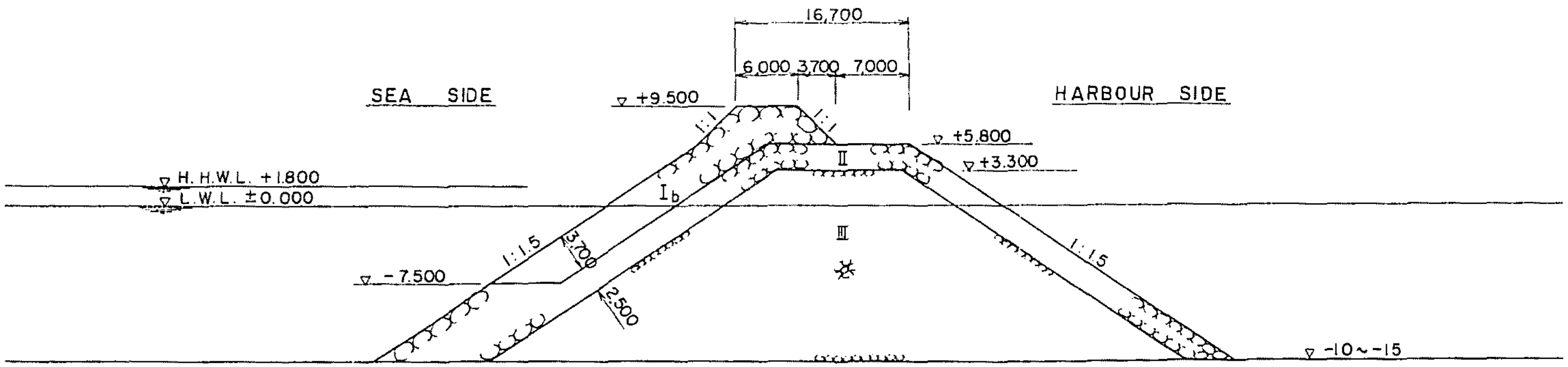
THE WEIGHT OF AN ARMOR STONE

I_a :	7 ~ 9 ton
I_b :	9 ~ 12 ton
II :	2 ~ 5 ton
III :	20 ~ 2,000 Kg

S_2 SECTION S = 1 : 500



S_3 and S_5 SECTION S = 1:500



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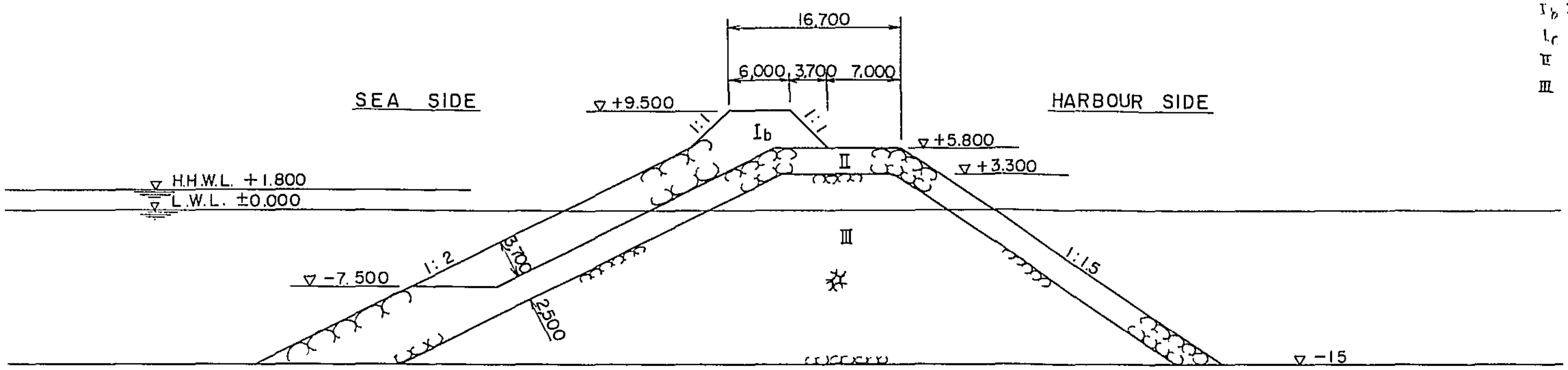
	DATE	SCALE 1:500

SOUTH BREAKWATER

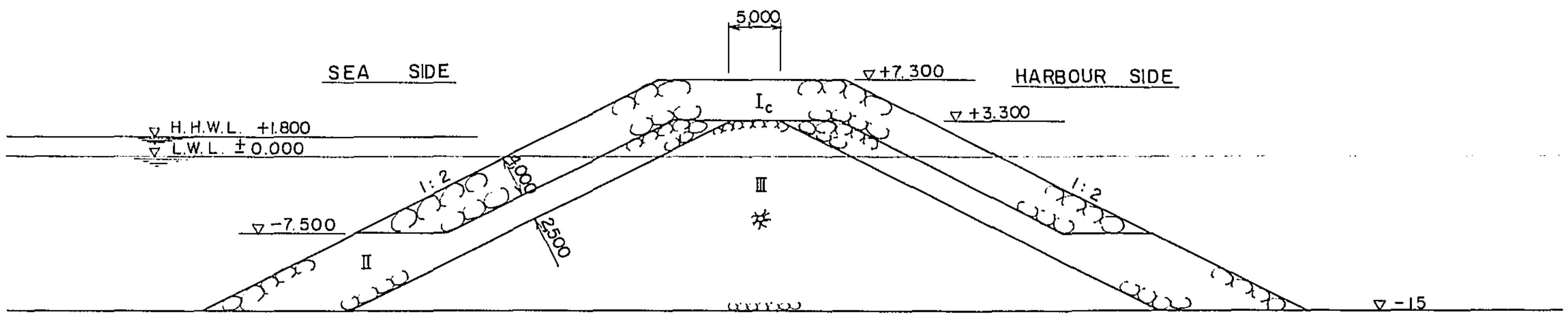
S4 SECTION S = 1 : 500

THE WEIGHT OF AN
ARHOR STONE

Ib : 9 ~ 12 ton
Ic : OVER 12 ton
II : 2 ~ 5 ton
III : 20 ~ 2 000 Kg



SH SECTION S = 1 : 500



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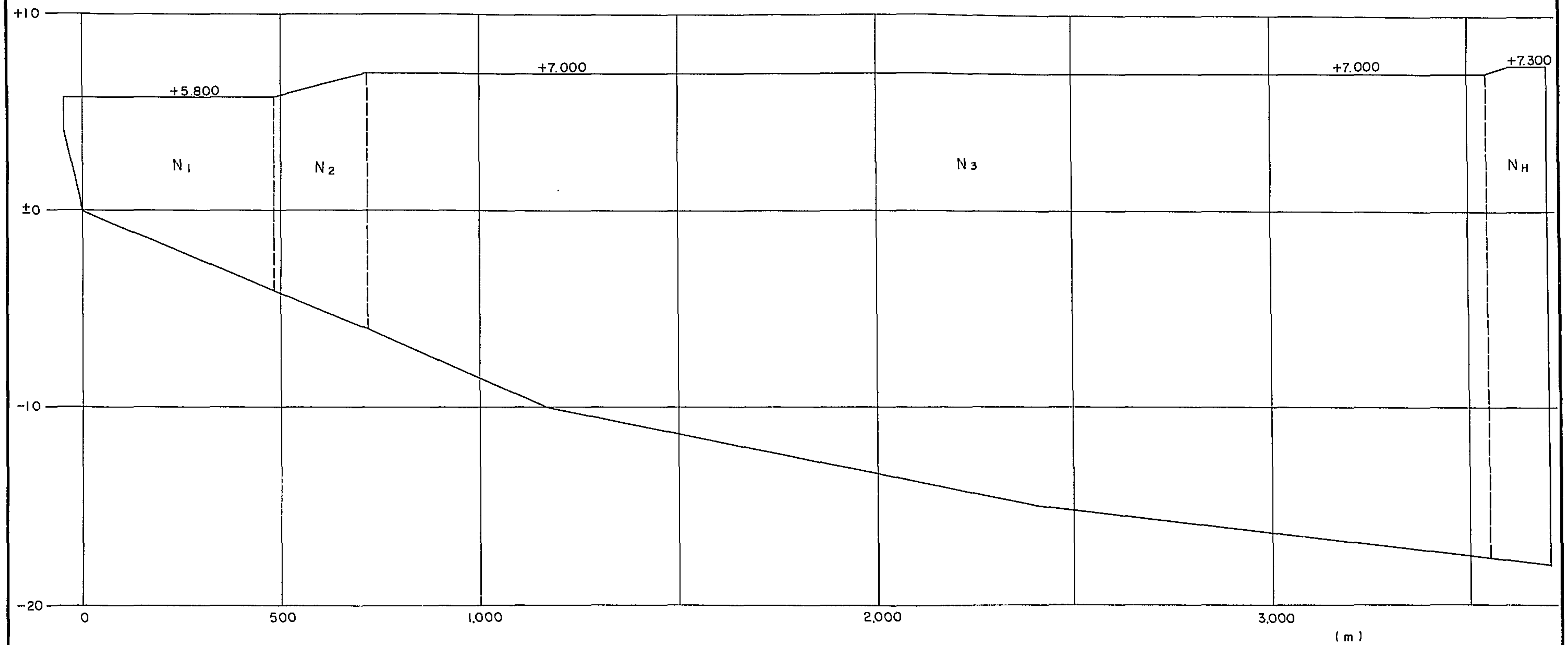
	DWG No. PM-C605
	DATE SCALE 1:500

NORTH BREAKWATER LONGITUDINAL PROFILE



PROJECT
CONSTRUCTION OF PRAIA MOLE PORT
TITLE
BREAKWATER (6)

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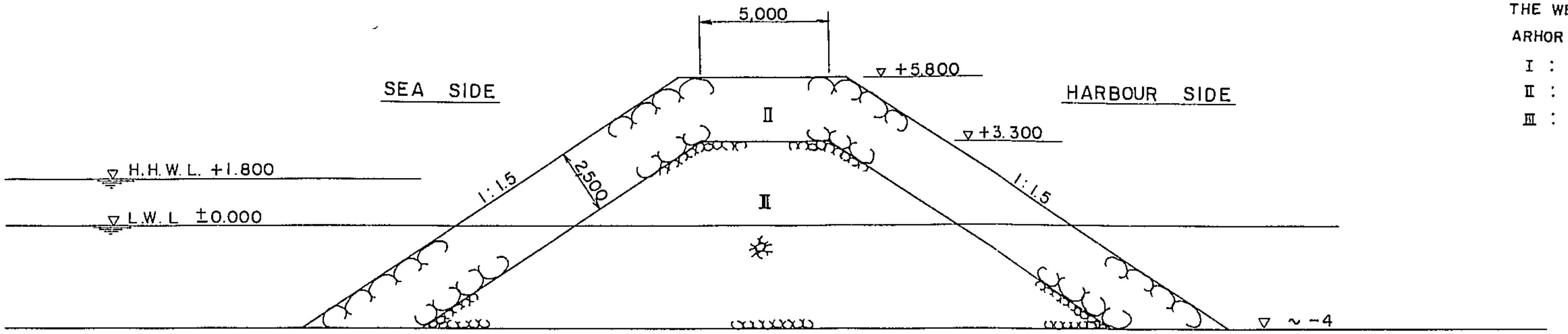
DATE
SCALE as shown

NORTH BREAKWATER

THE WEIGHT OF AN ARHOR STONE

Ⅰ : 7 ~ 9 ton
Ⅱ : 2 ~ 5 ton
Ⅲ : 20 ~ 2 000 Kg

N1 SECTION S = 1:200



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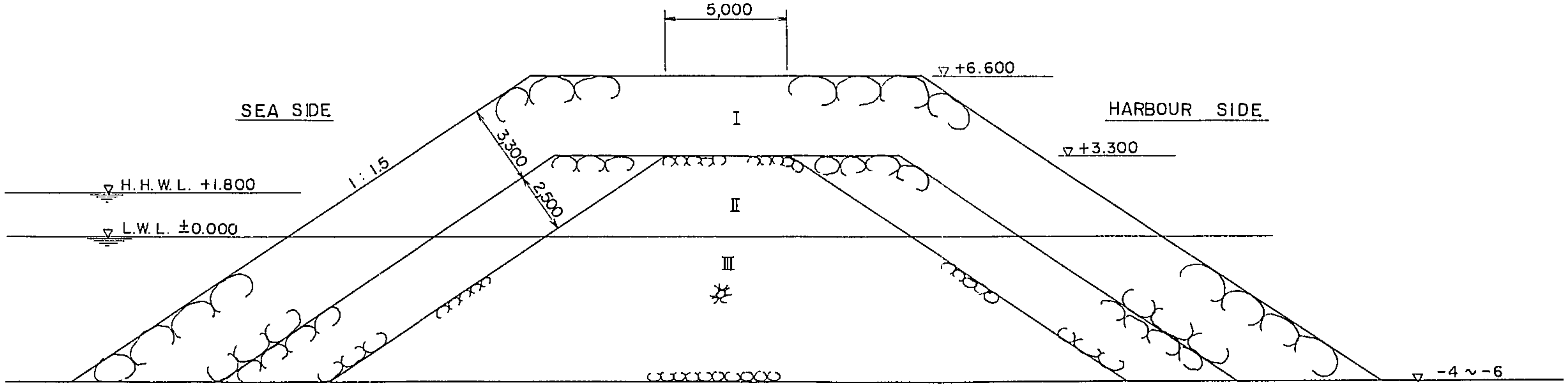

PROJECT
CONSTRUCTION OF PRAIA MOLE PORT

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BREAKWATER (7)

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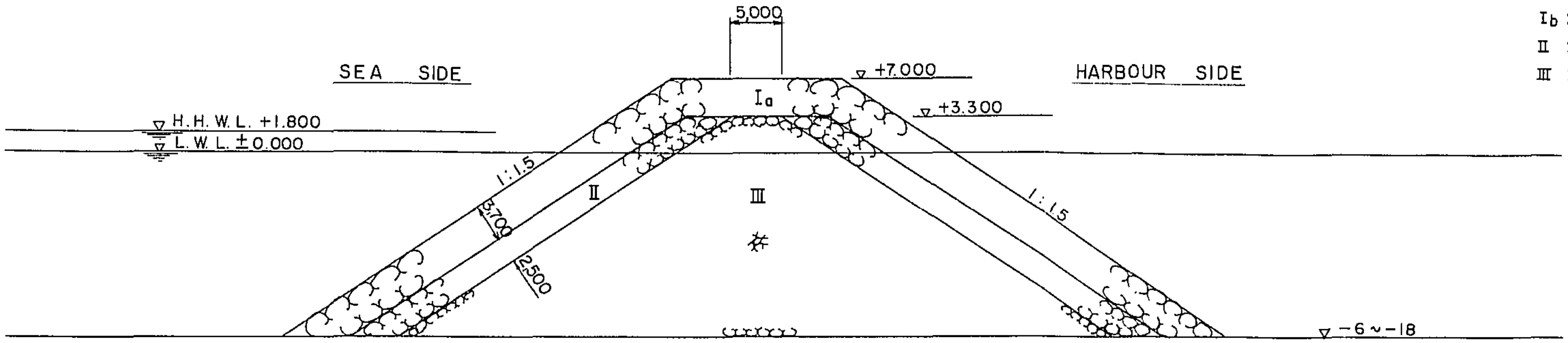
DATE	SCALE 1:200

NORTH BREAKWATER

N3 SECTION S= 1: 500

THE WEIGHT OF AN ARHOR STONE

Ia : 9 ~ 12 ton
Ib : Over 12 ton
II : 2~ 5 ton
III : 20 ~ 2,000 Kg



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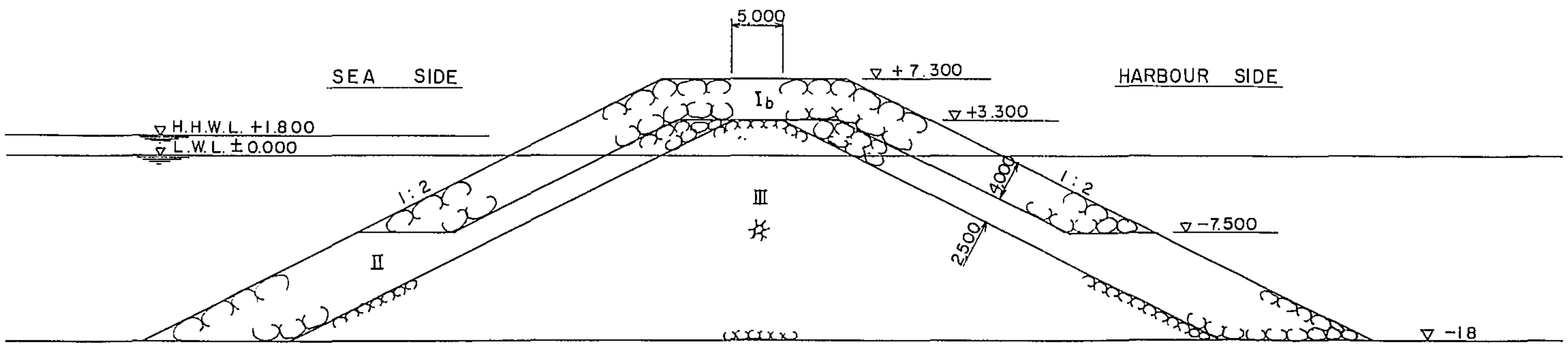

PROJECT
CONSTRUCTION OF PRAIA MOLE PORT

TITLE
BREAKWATER (8)

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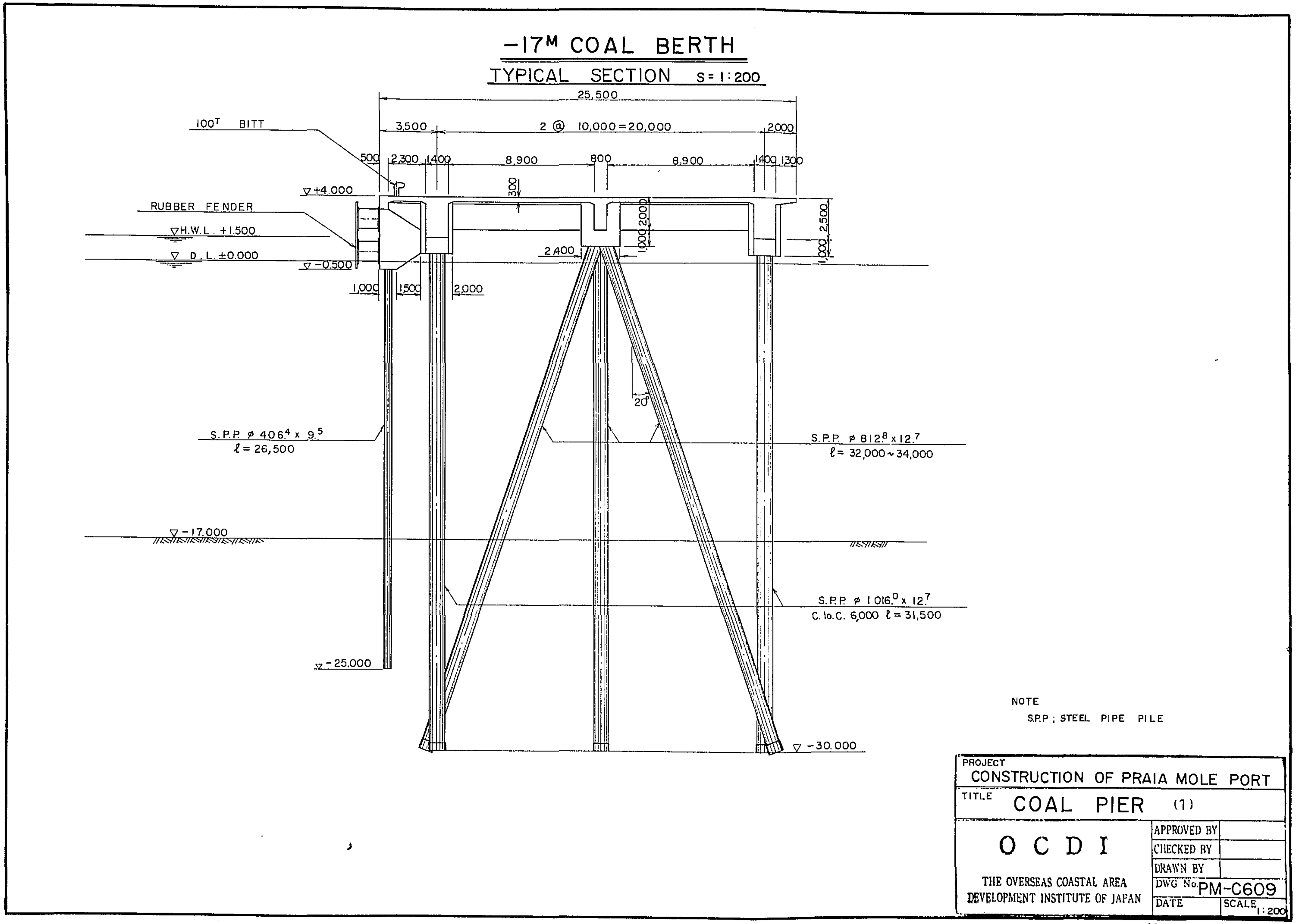
-17M COAL BERTH
TYPICAL SECTION S=1:200
25,500
3,500
2 @ 10,000=20,000
2,000
100T BITT
500 2,300 1,400
8,900
800
8,900
1,400 1,300
▽+4.000
300
RUBBER FENDER
▽H.W.L. +1.500
▽ D.L. ±0.000
▽ -0.500
2,000
1,000
2,500
1,000
2,400
1,000 1,500 2,000
20°
S.P.P ø 406.4 x 9.5
ℓ = 26,500
S.P.P ø 812.8 x 12.7
ℓ = 32,000～34,000
▽-17.000
S.P.P ø 1016.0 x 12.7
C. to C. 6,000 ℓ = 31,500
▽-25.000
▽-30.000
NOTE
S.P.P ; STEEL PIPE PILE
PROJECT
CONSTRUCTION OF PRAIA MOLE PORT
TITLE
COAL PIER (1)
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THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN
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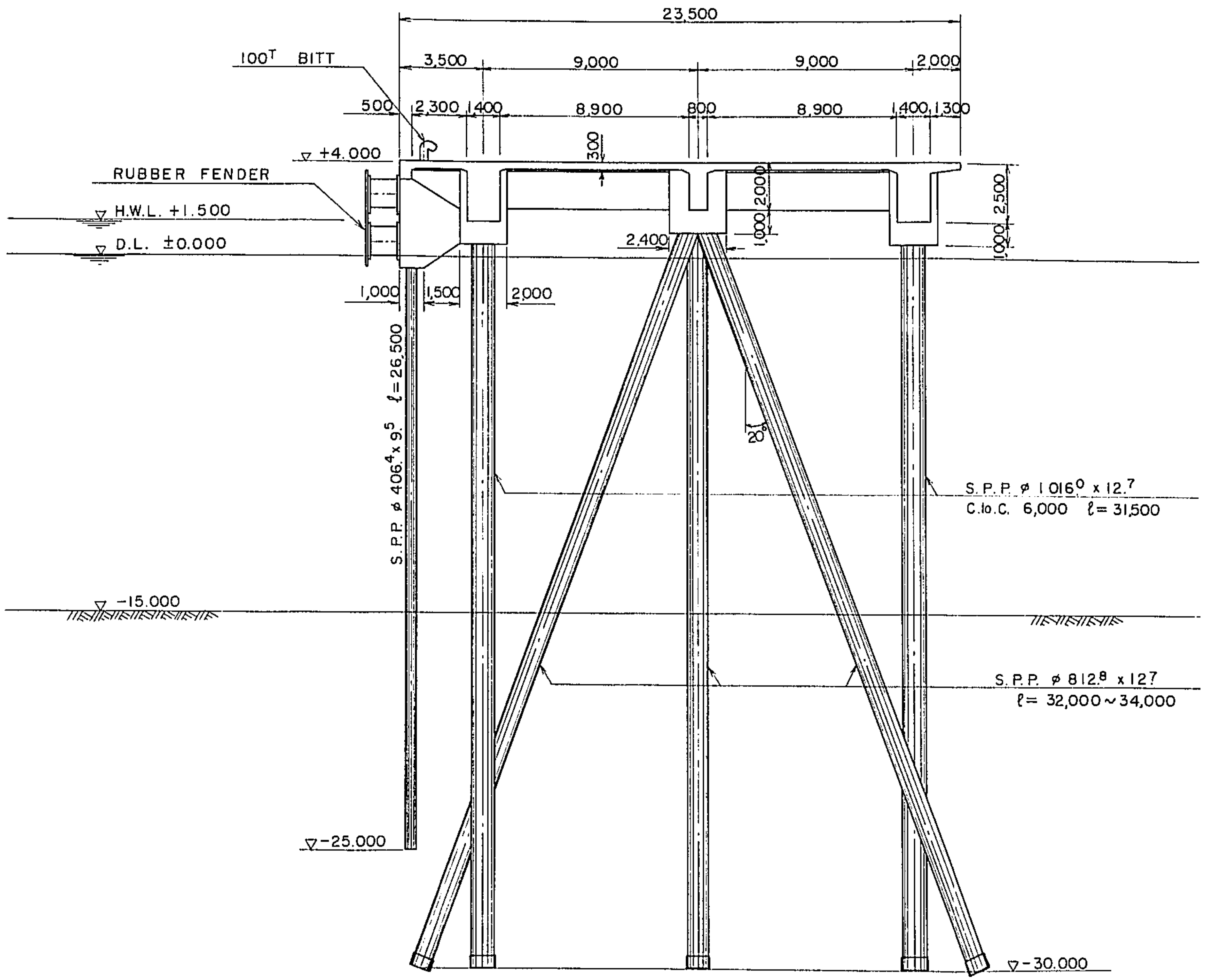
−15M COAL BERTH

TYPICAL SECTION S= 1:200



PROJECT
CONSTRUCTION OF PRAIA MOLE PORT

TITLE
COAL PIER (2)

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DEVELOPMENT INSTITUTE OF JAPAN

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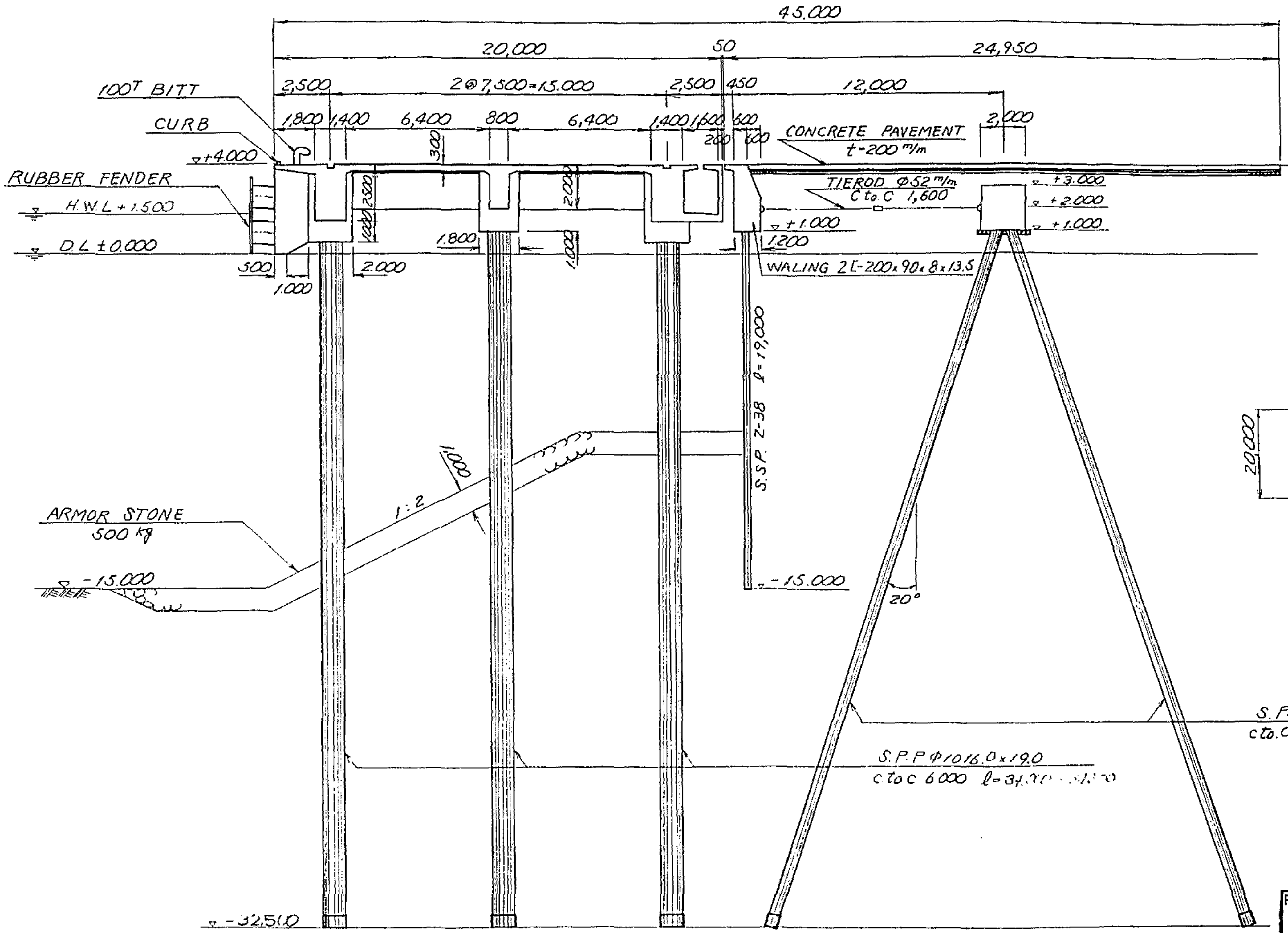
-15 M SLAB BERTH

TYPICAL SECTION S=1:200



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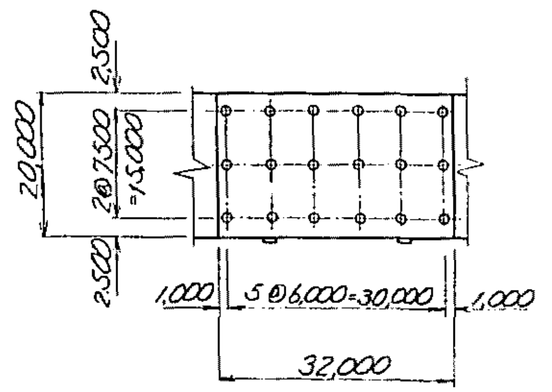

NOTE
S.S.P ; STEEL SHEET PILE

PROJECT	CONSTRUCTION OF PRAIA MOLE PORT	
TITLE	SLAB BERTH	
O C D I THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN	APPROVED BY	
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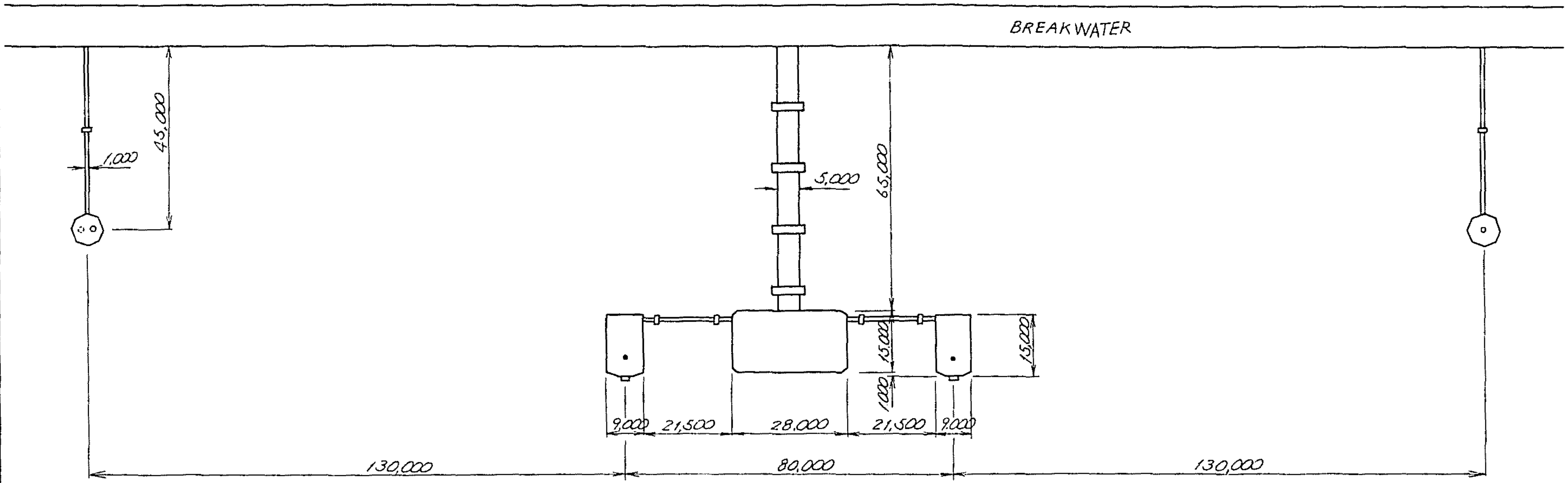
	DWG No. PM-C611	
	DATE	SCALE as shown

ARRANGEMENT OF OIL BERTH S=1:1,000



PROJECT CONSTRUCTION OF PRAIA MOLE PORT		
TITLE OIL BERTH (1)		
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THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN	DWG No. PM-C612	
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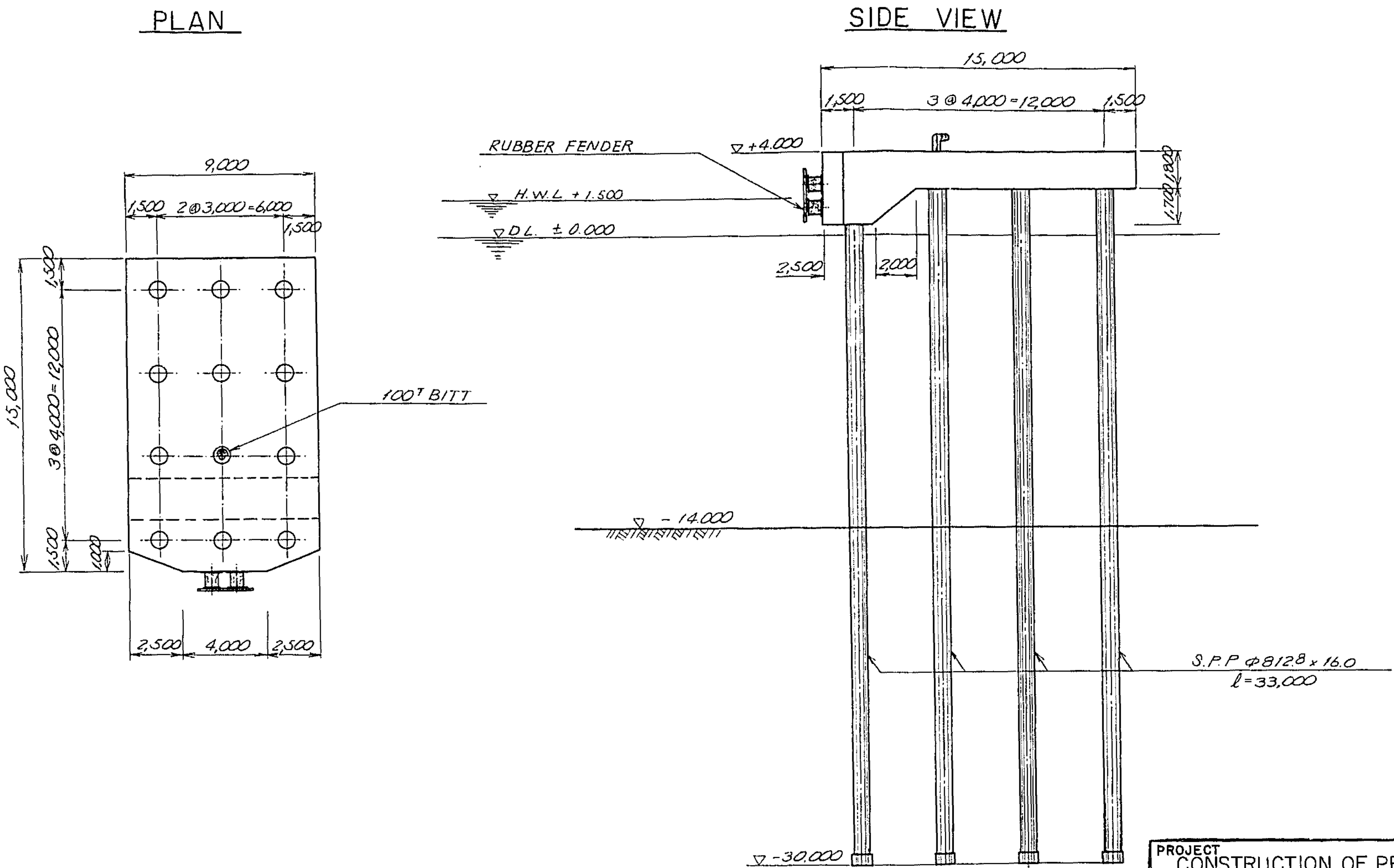
BREASTING DOLPHIN S=1:200



PROJECT CONSTRUCTION OF PRAIA MOLE PORT

TITLE OIL BERTH (2)

O C D I

THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN

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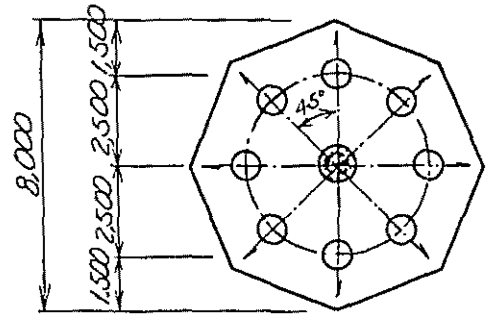
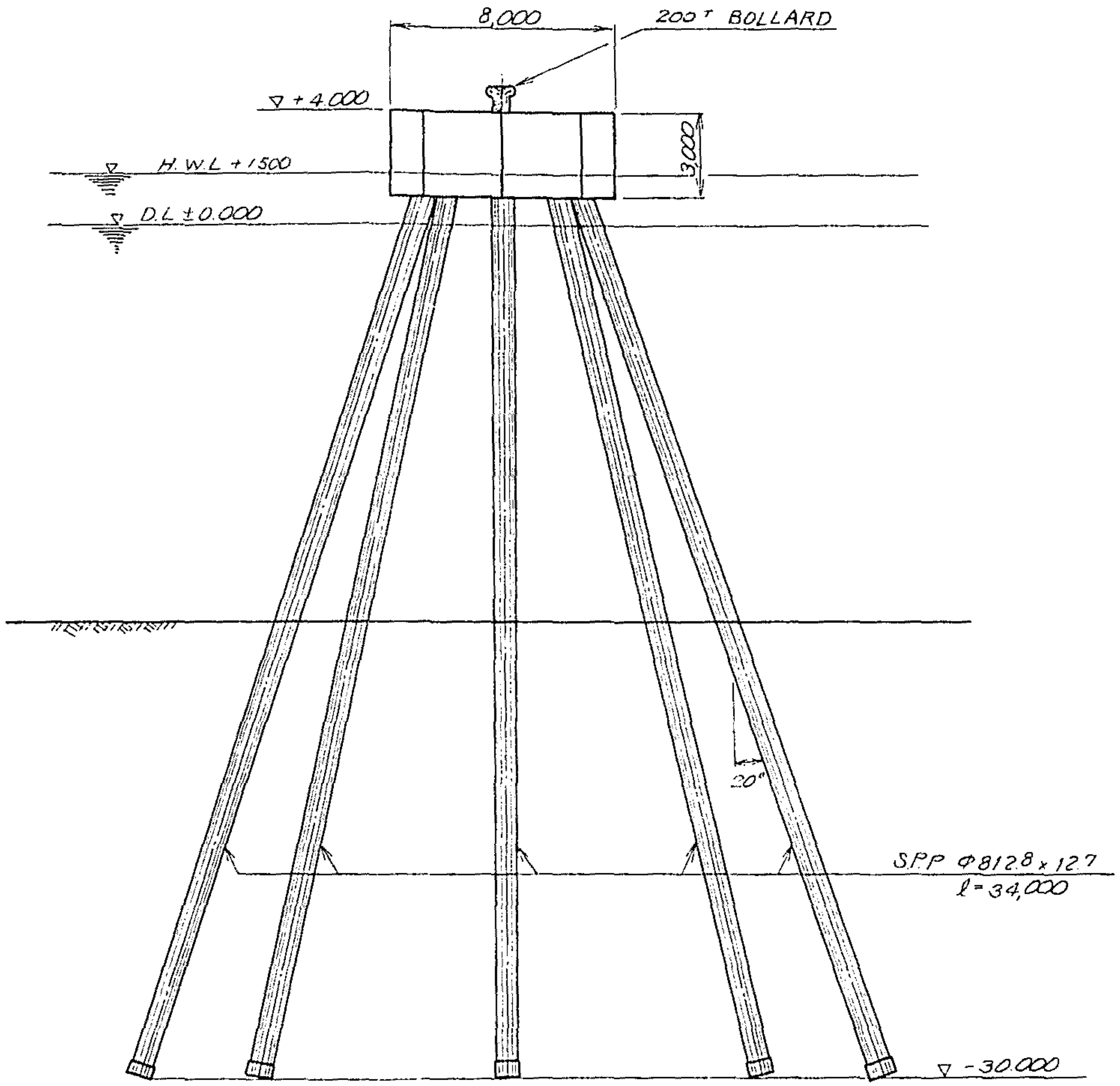
SCALE 1:200

MOORING DOLPHIN S=1:200

PLAN



SIDE VIEW



PROJECT	CONSTRUCTION OF PRAIA MOLE PORT
TITLE	OIL BERTH (3)

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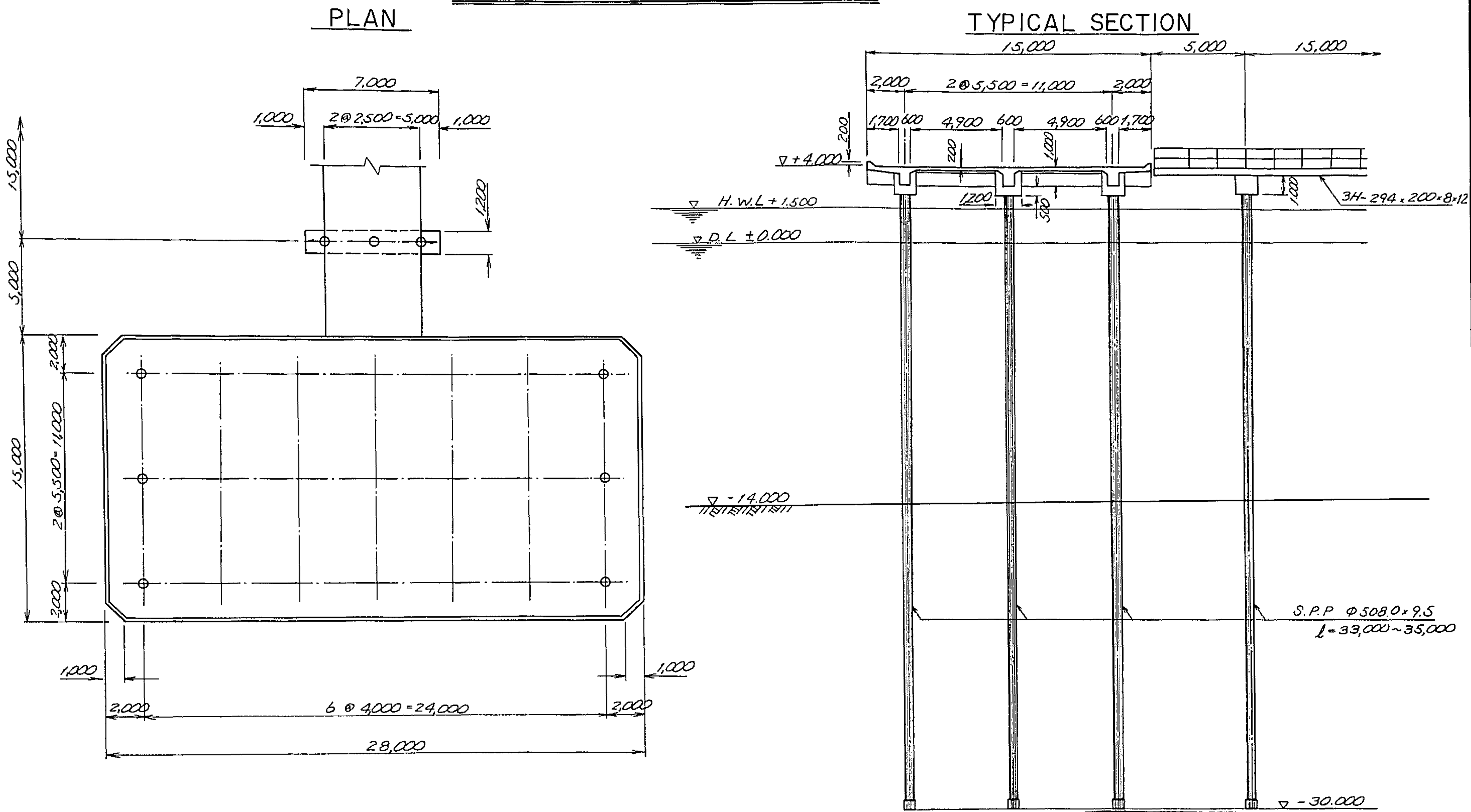
	DATE	SCALE 1:200

LOADING PLATFORM S=1:200



PROJECT	CONSTRUCTION OF PRAIA MOLE PORT
TITLE	OIL BERTH (4)

O C D I	APPROVED BY	
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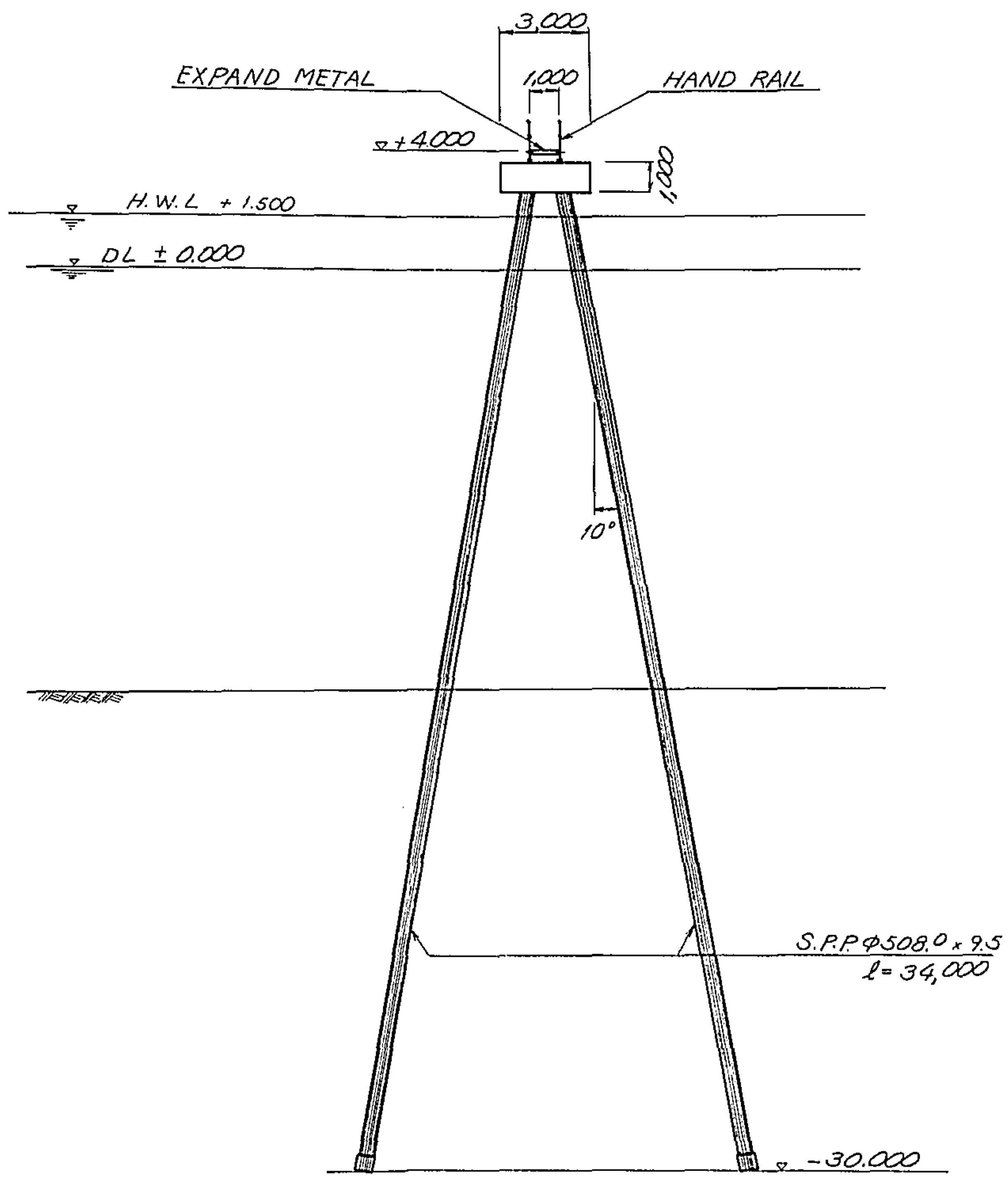
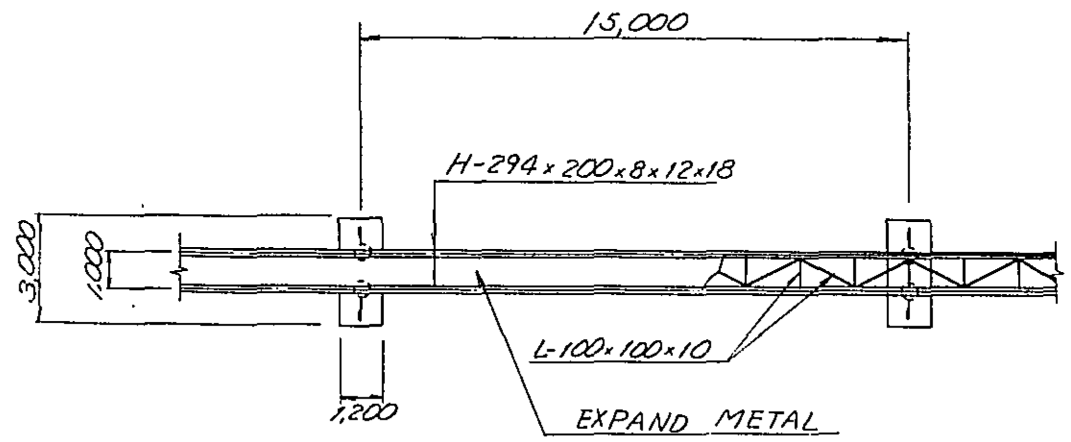
THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN	DRAWN BY	
	DWG No.	PM-C615
	DATE	SCALE 1:200

WALK WAY S=1:200

TYPICAL SECTION



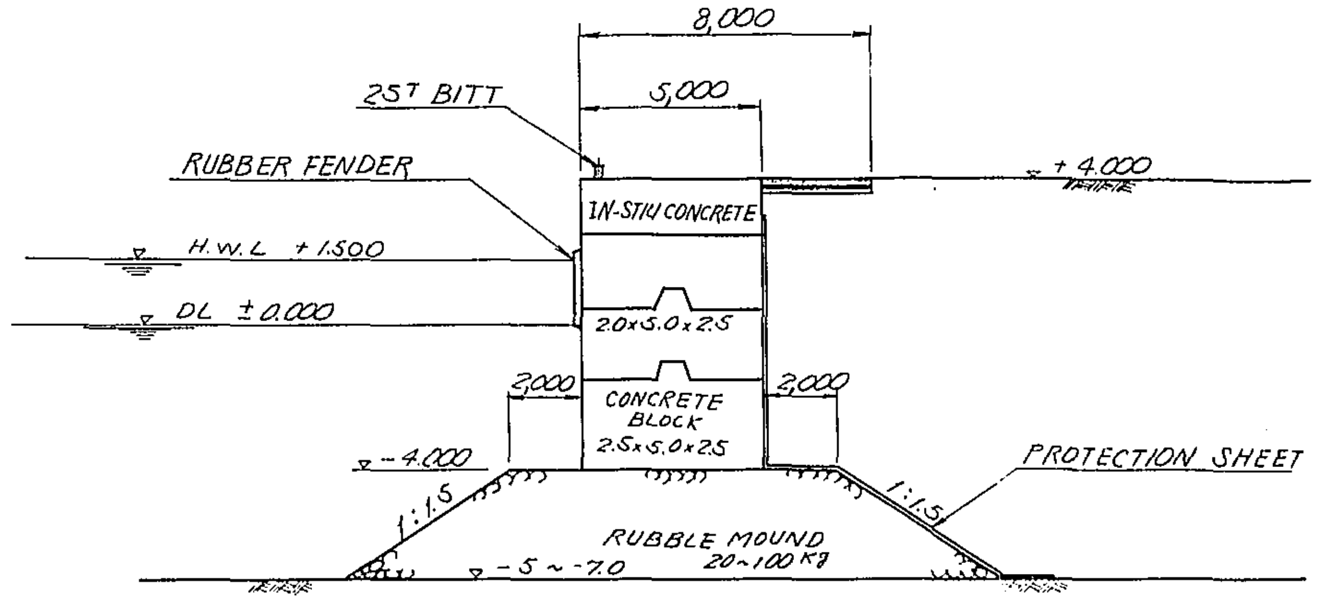
PLAN



PROJECT	CONSTRUCTION OF PRAIA MOLE PORT
TITLE	OIL BERTH (5)
OCDI THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN	APPROVED BY CHECKED BY DRAWN BY DWG No. PM-C616 DATE / SCALE 1:200

SMALL CRAFT BERTH AND SEA WALL

TYPICAL SECTION S=1:200



PROJECT CONSTRUCTION OF PRAIA MOLE PORT		
TITLE OTHER FACILITIES (I)		
O C D I	APPROVED BY	
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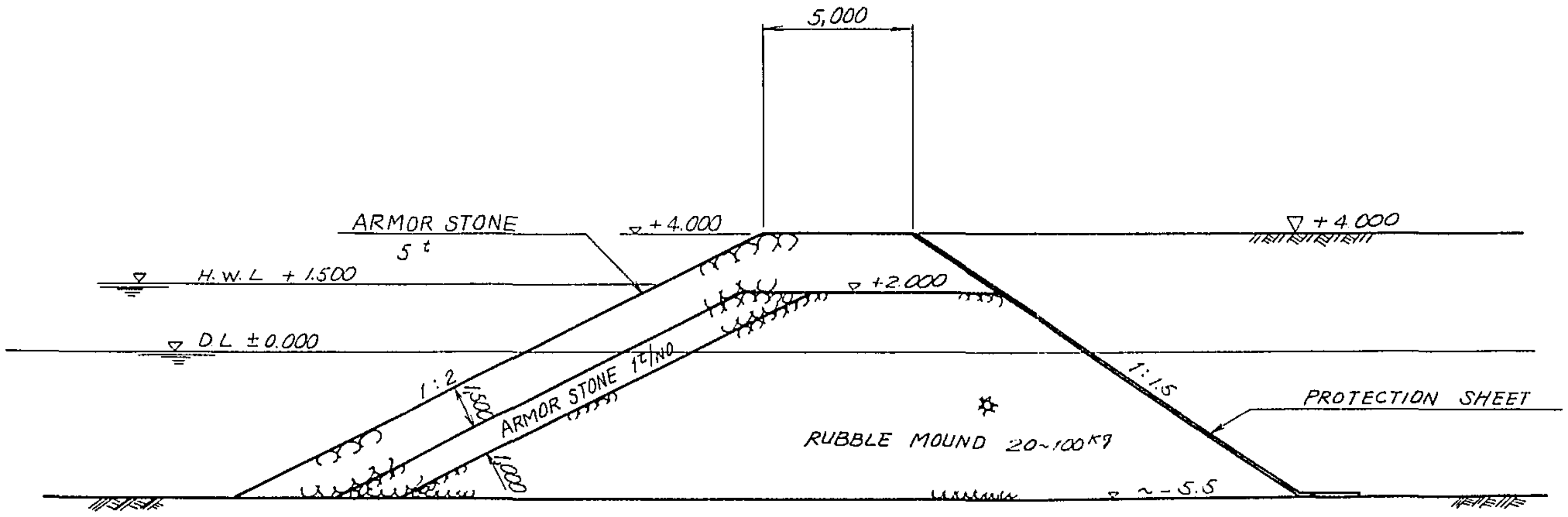
	DATE	SCALE 1 : 200

TEMPORARY REVETMENT

TYPICAL SECTION S=1:200



PROJECT CONSTRUCTION OF PRAIA MOLE PORT		
TITLE OTHER FACILITIES (2)		
OCDI	APPROVED BY	
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	DWG No. PM-C618	
	DATE	SCALE 1:200

ERRATA

Feasibility Report on the Praia Mole Port Construction Project

(Note: * Shows the line from below)

Page	Line	For	Read
(Conclusions and recommendations)			
i	15	Atalantic	Atlantic
v	6	whereever	wherever
	1*	ateel	steel
vi	7*	spec	spect
viii	Note	means	meant
xii	2*	sucy	such
(Summary)			
3	1	and schedule	and construction schedule
(2)	7*	state	State
(5)	10*	coal for	coal and petroleum products for
	10∿9*	and petroleum products for	(to be deleted)
(8)	Table 2	DET	DWT
(10)	5	isset	is set
(14)	4*	crowan	crown
(18)	8*	brabbing	grabbing
(19)	2	onth	on the
(22)	1	method	methods
	11	It	If
	11	is started	work is started
	8*	at (10 -----)	at 20 (10 -----)
(25)	5	wmount	amount
(26)	15	methods	methods,
	13*	Port, and	Port and
(27)	9*	lenger	longer
(29)	3	harbour	harbours
(30)	9*	Found	Fund
		found	fund
	3*	task	tasks
(31)	8	beause	because
(33)	12*	renumeration	remuneration
(33)	11*	renumeration	remuneration
(35)	4*	returns	return
(36)	11*	Clab	Slab
(38)	5	In	If
(39)	6*	income	income and
(40)	Table 8	w/o dividend of 100% -----)	w/o dividend, 10% of the total investment excluding subsidy is taken as an annual cost
	10*	an	and
	5*	divided	dividend
	1*	as shown	are as shown

Page	Line	For	Read
(41)	Table 9, b-②	77.2	67.2
(43)	11	onoy	only
	11*	rately	rarely
	3*	abut	about
(44)	1*	to to	to do
(Contents)			
iii	10∿5	Conclusion	Conclusion -
(Chapter 1)			
1	9	SIDERUGICA	SIDERURGICA
	10	pushed,	pushed
	17*	National	Nacional
3	5	USIMINAS,	USIMINAS'
5	9	Counsellar	Counsellor
6	2	jointed	joined
7	12*	Paid a transport	Paid a
15	9*	Derecto	Director
	8*	Minister	Ministry
(Chapter 2)			
20	10	reet	reef
	12	Portocellying	Portocel lying
21	Fig. 2.3.1	Baixo de	Baixo do
23	13	called are	called canga are
	14	canga	(to be deleted)
	15	it self	itself
25	Fig 2.3.2	Baixo de	Baixo do
48	Table 2.3.6,5*	79.3	73.9
62	2*	waves	wave
63	9*	Directions	direction of
83	3	higher	highest
	4	164	159
84	5	live-stock	livestock
86	Table 2.4.1		(to be replaced with the one attached herewith)
87	8*	live-stock	livestock
92	Title	Manufactured	manufactured
95	10	Gross	Grosso
97		Noua	Nova
		VFCO	VFCB
98	Table 2.4.7	RFFA	RFFSA
107	Table 2.5.1		
	Facilities,2	yard,	yard
	4	unloader yard,	unloader, yard
	5 and 6	shiploader storage,	shiploader, storage
	9	yard,	yard
	10	Silo,	Silo
	1*	2,500 T/H	16,000 T/H
109	3*	∿10,000	∿100,000
110	4	enterance	entrance
112	1*	Ground	Grand
(Chapter 3)			
114	7	mills	mills are
	Table 3.1.3		
	Crude steel, 6	0.04	0.03
	7	0.05	0.04
(Chapter 4)			
161	3	habour	harbour
(Chapter 5)			
196	3	coal	ore

Page	Line	For	Read
	5*	coal	ore
197	6	domestic	domestic trade
199	10	domestic	domestic trade
202	5*	dischange	discharge
204	Table 5.4.1	Piper	Pier
		Car	Wagon
205	Table 5.4.2		
	Remarks	per a berth	per berth
		two berth	two berths
206	11	Table 5.4.6 (1st stage)	Table 5.4.5 (1st stage)
208	Table 5.4.5,1*	1,841	1.841
		1,744	1.744
		1,711	1.711
209	Table 5.4.6,1*	1,764	1.764
		1,740	1.740
		1,738	1.738
		1,738	1.739
226	Table 5.5.5,1	Rainforced	Reinforced
(Chapter 6)			
227	11	Fig. 2.3.18	Fig. 2.3.19
235	16*	lending	bending
237	4*	2-3-2	2-3
260	5	6.2.23	6.2.14
	6	6.2.24	6.2.17
	8	6.2.14	6.2.15
		6.2.16	6.2.18
	9	6.2.15	6.2.16
287	13	large concrete	(to be deleted)
303	1	meihod	method
	8~9	for the travelling direction and at least 2.5 times as wide as the bucket width	(to be deleted)
331	1	a	an
	12*	and	any
340	7	Car	Wagon
344	16*	hweel	wheel
	12*	water	(to be deleted)
	7*	is	are
350	2	6.3.20	6.3.23
362	13	Graffing	Grabbing
365	8*	transformers	transformer
366	4 and 10	Apart	A part
367	Fig. 6.4.1	plase	phase
		car	wagon
		sile	silo
368	Fig. 6.4.2	plase	phase
		Reelaimer	Reclaimer
		car	wagon
		sile	silo
		barth & gard	berth and yard
		athers	others
369	Fig. 6.4.2 Columns:2,3,4 and 6	Feed system	Cable reel
(Chapter 7)			
388	9	2,320.764	2,320,764
389	5*	seems	seem

Page	Line	For	Read
(Chapter 8)			
397	13*	may applied	may be applied
400	5~4*	reclamated	reclaimed
(Chapter 9)			
411, 413 and 415	3	First stage	Local currency
		Second stage	Foreign currencv
	8*	Car	Wagon
413	RECLAMATION	(9,626)	(9,686)
415	12*	(9.626)	(9,626)
419	3*	cargo	cargo handling
421	3.	(8.599)	(8,599)
421	3.1 and 4.	sheets piles	sheet piles
	3.1	fendors	fenders
	6.4.1	stocker	stacker
421 and 423	6.4.3	car	wagon
		sile	silo
423	6.2	1,432	(1,432)
(Chapter 10)			
425	13	list	lost
427	5	10.1.1	10.2.1
431	2	20 N 30	20 < N < 30
432	Table 10.2.3		
	Turnning basin	2,300	2,330
	2*	realaiming	reclaiming
434	3	shorten	shortened
435	Table 10.3.1	revetment	revetment (1)
		Revetment (2nd stage slab)	Revetment (2nd stage slab) (2)
439	4*	largs	lanes
	3*	stocker	stacker
441		car	wagon
443		car	wagon
		sile	silo
445		car	wagon
	7.1	9.492	(9,492)
447	TOTAL and GRAND TOTAL	6.5	65.0
	TOTAL of coal yard in '82		27.2
451	4.	sheets piles	sheet piles
	6.3	record discussions	record of discussions
	6.4.3	car	wagon
455	1	Conclusion	Conclusion -
(Chapter 11)			
461	Fig. 11.1.1	Inpormation	Information
464	7	Improvement	improvement
	15	carris	carries
		imporovement	improvement
	17	relative	(to be deleted)
466	Table 11.1.1	Other	Others
	Column: Foreign	501.1	501.4
	Total	501.1	501.4
467	8	harbour	harbour dues
468	9*	been that	been said that
	1*	1975	1976
469	13*	relatinely	relatively

Page	Line	For	Read
(Chapter 12)			
473	8*	longshoring	longshore
476	13	port	port.
	14	given	Given
(Chapter 13)			
485	Table 13.3.1		
	Dredging	4.58 $^{\text{km}^3}$	4,580 $\times^{1000\text{m}^3}$
		52	5.2
485	Physical	Pysical	Physical
	Physical	Pysical	Physical
487	Table 13.3.2,1	Anual	Annual
489	13	the cost	the operating cost
	12*	expences	expenses
490	Table 13.4.1 (1)		
	82	115.1	15.1
493	19	Cr$	US$
497	3	TOMELADA	TONELADA
498	1*	efficient	coefficient
499	7	studies	studied
501	Table 13-1		
	Columns: 3 and 6	Construcution	Construction
	4 and 7	thousand	million
	2*	5,610	5.610
502	Note 2)	(to be corrected entirely)	The management expenses in Tables 13.4.1 (1) and (2) are estimated to be twice as much as the total of this table.
504	1	13-5	Table 13-5
	Table 13-5 (1)	2,384.2	107.6
	17	2,572.3	107.6
		1,751.4	70.0
		1,751.8	70.0
505	1	13-5	Table 13-5
	Table 13-5,3	U.S.A.	USA
	Column: Remarks	120	60
		60	120
506	Table 13-6		
	Column: Remarks	120	60
		60	120
507	3*	5	25
509	Table 13-8,1	39.	39.7
509	3	979	1979
	Column: ⑤	64.0	(to be deleted)
(Chapter 14)			
513	Columns:	Petralum	Petroleum
	Petralum	1st stage	1st stage | 2nd stage
518	1*		(to be deleted)
518	Table 14.3.1, 2	9.14	91.4
520	Table 14.3.4,2*	47,232	8,448
		19,584	153.6
521	Table 14.3.5		(to be replaced with the one attached herewith)
522	Table 14.3.6	Oils	Oil
524	11* and 4*	Administration	Management
	8*	machine	equipment
525	Table 14.3.8	8.610	8,610
526	12	speially	specially
527	Table 14.3.9,⑩	4.87	4.97

Page	Line	For	Read
530	7	Return)	Return).
531	14*	entends	extends
	7*	difficule	difficult
537	Table 14.5.2, 2	Portbrás	Portobrás
	Column:		
	Financing terms	Owned capital	Owned capital - do -
	(two places)	deferment	grace period
539	6	cannot	Praia Mole Port cannot
	15*	became	becomes
541	Column: b-②	77.2	67.2
543	8*	subsidized	subsidize
547	1980	155140010 -151400.0	1551400.0 -1551400.0
549	2	W/O SUBSIDIEX	W/ SUBSIDIES
551	(Three places)	deferment	grace period
553		Cr$2,738.4m	Cr$2,738.4
561	5*	DIVIDENT	DIVIDEND
563	5*	DIVIDENT	DIVIDEND
567	7*	018.4	-18.4
571	5	20	2012
	Columns: 38 and 39	6.0	0.0
582	9	Vetória	Vitória
	16	mills	mill
589	8	dort	chart
	12*	waves	wave
	8*	of waves	by direction
	7*	ocean	Ocean
	1*	Recurrence	recurrence
590	6*	of	the
(Appendix)			
608	2	M	S
612		REGNED	LEGEND
623, 627 and 629		ARHOR	ARMOR

Table 2.4.1 Population distribution by regions

	1960		1970		1977		Population density		Average growth rate during the ten-years period from 1960 to 1970 (%)
	Actual, thousand persons	Ratio (%)	Actual, thousand persons	Ratio (%)	Actual, thousand persons	Ratio (%)	Area (km^2)	Population density (persons/km^2)	
North	2,601.5	3.67	3,650.8	3.86	3,863	3.86	3,578	1.08	3.9
Northeast	22,428.9	31.59	28,675.0	30.34	30,362	30.34	1,546	19.64	2.7
Southeast	31,063.0	43.76	40,332.0	42.68	42,710	42.63	925	46.17	2.9
Minas Gerais & Espirito Santo	(10,987)		(13,097)		(13,329) (1,711)		(587) (46)	(21.00) (37.20)	
Rio de Janeiro & Guanabara	(7,101)		(9,274)		(5,084) (4,573)		(43) (1)	219.43	
São Paulo	(12,975)		(17,959)		(19,013)		(248)	(76.09)	
South	11,892.1	16.75	16,683.6	17.65	17,662	17.65	578	30.56	3.9
Center-West	3,006.9	4.23	5,167.2	5.47	5,473	5.47	1,879	2.91	6.2
Total	70,992.4	100.0	94,508.7	100.0	100,070	100.0	8,506	11.76	3.3

North : Rondonia, Acre, Amazonas, Roraima, Pará, Amapá

Northeast: Maranhão, Piãui, Geara, Rio Grande do Norte, Paraiba, Pernambuco Alagoas, Fernando de Noronha, Sergipe, Bahia

Southeast: Minas Gerais, Espirito Santo, Rio de Janeiro, Guanabara, São Paulo

South : Parana, Santa Catarina, Rio Grande do Sul

Center-west : Mato Grosso, Goias, Distrito Federal

Table 14.3.5 Allocation of the interest payable

(Unit: in Cr$ 1,000)

Facilities	1st stage			Master plan		
	Slab	Coal	Oil	Slab	Coal	Oil
Breakwaters	16,570	19,630	14,630	20,580	17,850	12,400
Dredging	14,400	10,510	2,000	15,020	10,230	1,670
Reclamation	5,170	6,110	110	5,170	6,110	110
Subtotal	36,140	36,250	16,740	40,770	34,190	14,180
Mooring facilities	11,380	4,180	1,160	14,840	7,850	1,110
Revetment	2,410	2,410	500	2,560	2,360	400
Other facilities	8,970	6,270	1,770	11,290	7,160	1,900
Cargo handling facilities	13,020	18,810	—	21,670	29,950	—
Subtotal	35,780	31,670	3,430	50,360	47,320	3,410
Total	71,920	67,920	20,170	91,130	81,510	17,590