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No. 18

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

PORT AUTONOME INTERNATIONAL DE DJIBOUTI
MINISTRY OF PORT AND MARITIME AFFAIRS
THE REPUBLIC OF DJIBOUTI

THE STUDY ON THE OIL-BERTHS RECONSTRUCTION OF PORT OF DJIBOUTI IN THE REPUBLIC OF DJIBOUTI

TECHNICAL STUDY REPORT

MARCH 1994

PACIFIC CONSULTANTS INTERNATIONAL (PCI)
TOKO ENGINEERING CONSULTANTS LTD.

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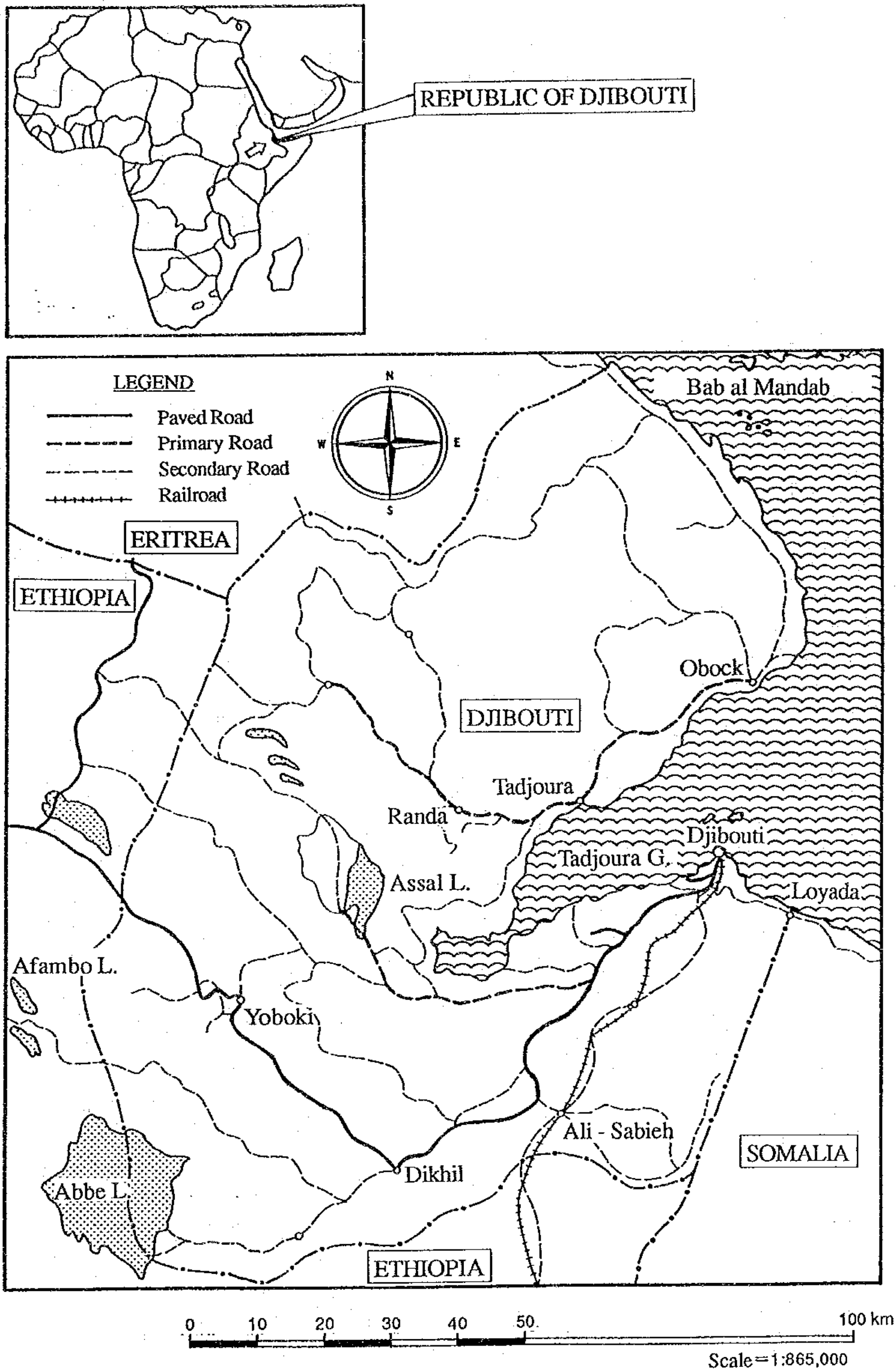
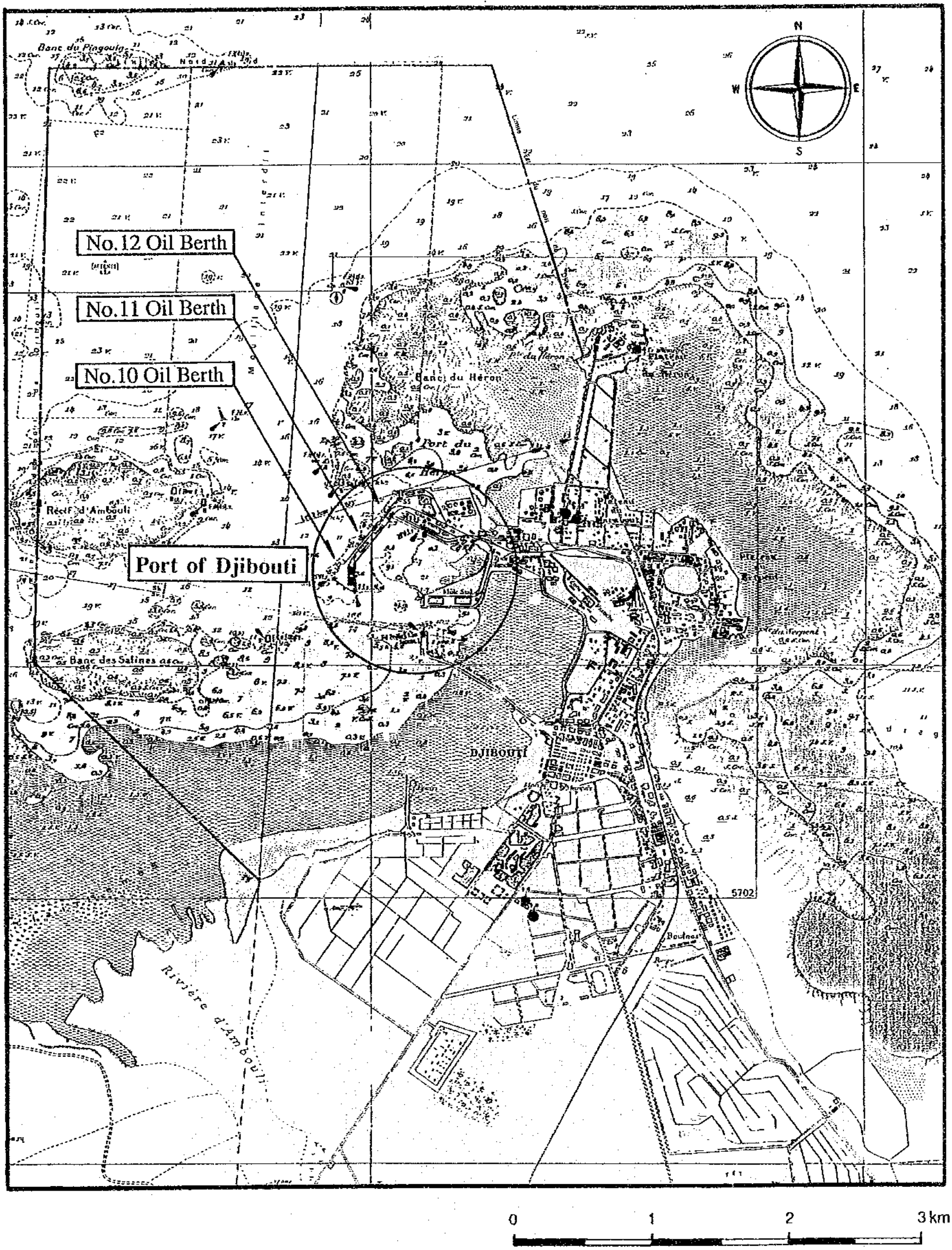
FOREIGN EXCHANGE RATE

1 US Dollar (US $)	=	107.85 Japanese Yen (J ¥)
	=	179.48 Djibouti Francs (FD)
1 FD	=	0.60 J ¥

(average rate from June 1 to November 30, 1993)



LOCATION MAP (I)



LOCATION MAP (II)

THE STUDY ON THE OIL-BERTHS RECONSTRUCTION OF PORT OF DJIBOUTI IN THE REPUBLIC OF DJIBOUTI

TECHNICAL STUDY REPORT

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1 Preliminary Design Conditions

1.1 Design Policy

In design of facilities, their function, importance and lifetime should be taken into consideration.

As for the lifetime of facilities, we propose thirty (30) years as lifetime by examining their function, economic view point, and their social and physical property.

The preliminary design for the Oil-Berth Nos. 11 and 12 will be conducted in consideration of the following points:

(1) Natural conditions at the Site shall be carefully considered so that:

1) The terrain, geology and consideration of weather and oceanographic conditions be reflected in the design;
2) The seismic forces occurring in the area be considered;
3) The environmental protection be considered.

(2) The structures, materials and construction methods should meet the site conditions.

1) The structures should be as simple as possible, and the highest priority will be given to the materials being easily obtainable and facilities easy to maintain and repair;

2) The construction methods and schemes should be planned in considering not only the natural conditions of the site as technical point of view but that of safety;

3) The implementation program should be proposed to minimize the disturbance of port activities during the construction works.

(3) Although the design and construction codes, technical standards and regulations of Djibouti are developed in accordance with those of France, the design of facilities will be based on the Japanese ones as mentioned later unless otherwise specifically needed.

1.2 Design Conditions

Based on the field survey, data collected and results of site surveys, the design conditions for the facilities to be planned are established as follows:

1) Meteorological Conditions

- Winds: Maximum wind velocity = 35 m/sec. for superstructure
  = 20 m/sec. for mooring force

2) Oceanographic Conditions

- Tide: H.W.L. = + 2.90 m
  L.W.L. = + 0.20 m
  L.L.W.L. = 0.00 m = IGN - 1.77 m

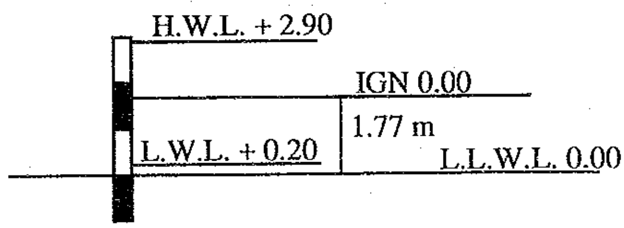


Figure 1-1 Tide Level

- Current: 1 knot

3) Seismic Forces

The design seismic coefficient shall be determined in accordance with the following formula with consideration given to the classification of region where structures are located, that of the subsoil condition and the degree of importance of the structures. For the design seismic coefficient, only the horizontal coefficient "k_h" is considered.

Design seismic coefficient (k_h) = Regional seismic coefficient (α) x Factor for subsoil condition (β) x Coefficient of importance (γ)

For the Oil-Berth Nos. 11 & 12, the seismic coefficient is obtained as follows.

$k_h = \alpha \times \beta \times \gamma = 0.10 \times 1.0 \times 1.2 = 0.12$

where,

Regional seismic coefficient	: $\alpha = 0.10$ as "2nd Region"
Factor for subsoil condition	: $\beta = 1.0$ as "Class 2 subsoil"
Coefficient of importance	: $\gamma = 1.2$ as "Class A"

4) Soil Conditions

- Filling materials for Cellular Cofferdam
  : $\phi 35°$, $\gamma = 1.8$ t/m^3, $\gamma' = 1.0$ t/m^3
- Backfill materials : $\phi 30°$, $\gamma = 1.8$ t/m^3, $\gamma' = 1.0$ t/m^3
- Berth No. 11 area : CPT-5 is applied.
- Berth No. 12 area : CPT-8 is applied.

5) Oil-Berth Use Conditions

Table 1-1 Objective Vessels : 3,000/35,000 DWT Oil Tanker

D.W.T. (ton)	3,000	35,000
Displacement (ton)	4,259	43,940
Overall Length (m)	88	195
Molded Breadth (m)	13.8	29.6
Molded Depth (m)	6.5	15.9
Max. Draft (m)	5.6	11.0
Berthing Velocity (m/sec)	0.20	0.15

- Crown Height +3.50 m same as existing one
- Surcharge
  Ordinary case : $q = 1.0$ tf/m^2
  Seismic case : $q = 0.5$ tf/m^2

6) Materials for Structures

STRUCTURAL STEEL

- Structural Steel : SS 400 (JIS G 3101)
- Steel Pipe Pile : SKK 400 (JIS A 5525)

- Steel Bar for concrete reinforcement : SD 295 A (JIS G 3112) for deformed bar

- Sheet Pile : SY 295 (JIS A 5528)

- Allowable Stresses shall be in accordance with Japanese "Technical Standards for Port Facilities".

- Corrosion Rate of Steel : The corrosion rates of steel for design vary in level and atmosphere from 0.1 mm/year to 0.3 mm/year.

<u>CONCRETE</u>

- Unit Weight

Unit Weight	: Reinforced Concrete	: 2.45 tf/m³ (in air)
		: 1.45 tf/m³ (in water)
	: Plain Concrete	: 2.30 tf/m³ (in air)
		: 1.30 tf/m³ (in water)

- Allowable Strength of Materials

Reinforced Concrete	: 240 kgf/cm² (standard design strength)
	: 90 kgf/cm² (allowable flexural compressive)
	: 9 kgf/cm² (allowable shearing strength)
Plain Concrete	: 180 kgf/cm² (standard design strength)

7) Technical Standards/Codes to be applied in Design

- Japanese Industrial Standard: JIS (Japan Standards Association)

- Technical Standards for Port Facilities (Japan Port & Harbor Association)

- Standard Concrete Specifications (Japan Society of Civil Engineers)

- Technical Standards for Shore Protection Facilities (Japan Association of Coastal Engineering)

* Notes: The following French Technical Regulations are referred: CCBA68, CM66, NV65, PS69 and DTUs concerned.

2 Preliminary Design

2.1 Determination of Structural Type

In order to determine a structural type of the proposed berths, several alternatives are selected by considering the characteristics of the structural types and examining the following factors:

- Natural conditions
- Conditions of use
- Construction period
- Construction cost
- Existing structural types in the Port of Djibouti

Taking into consideration the above, the following structural types are comparatively studied as alternatives (refer to Fig. 2-1):

Solid Structural Type:

Alternative I	Steel Sheet Pile Cellular Cofferdam Type
Alternative II	Cellular Block Type

Flexible Structural Type:

Alternative III	Open-type Pier with Coupled Batter Piles

The results of comparative studies are tabulated in Table 2-1 and the steel sheet pile cellular cofferdam type is selected.

2.2 Preliminary Design Drawings

The preliminary design drawings of the proposed structural type are shown in Figs. 2-2 to 2-4.

Figure 2-1 Structure Comparative Study

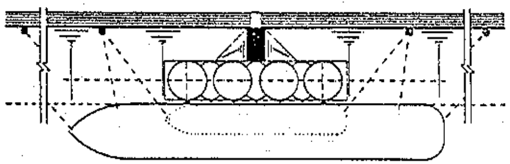
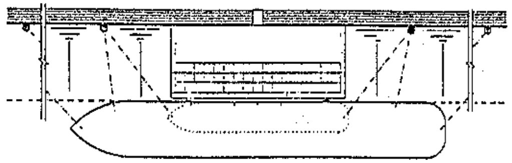
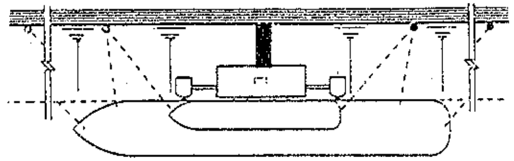
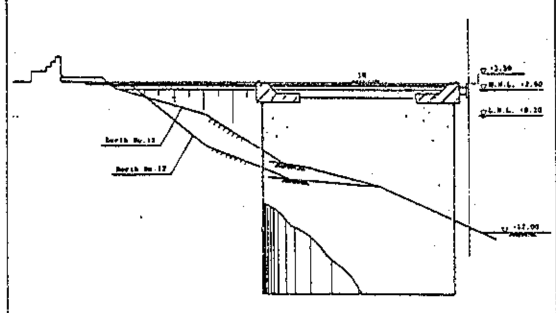
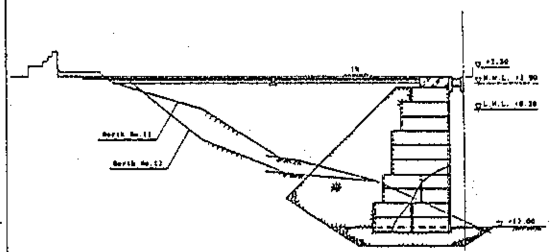
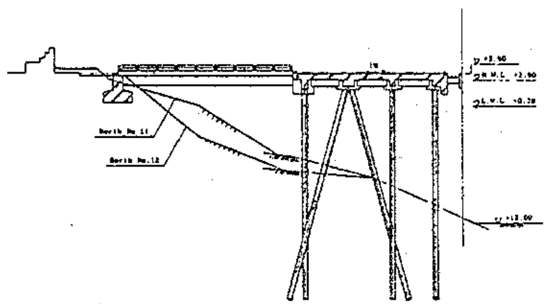
Alternative	I	II	III
Structure Type	Steel Sheet Pile Cellular Cofferdam	Cellular Concrete Block	Open-Type Pier
General Plan			
Cross Section			

Table 2-1 Structure Comparative Study

Alternative	I	II	III
Structural Type	Steel Sheet Pile Cellular Cofferdam	Cellular Concrete Block	Open-Type Pier
Advantages	- As a solid gravity type, it can be more resistant to rough wave forces and even accidental collision of ships with the structure which may happen when it is difficult to maneuver the ship during rough season. - In the Port of Djibouti, there exist many similar structural type quays since long time past. - As for the construction, heavy equipment for marine works such as a pile driving barge is not needed and it can be mostly executed on land. - The demolition of the existing structures can be minimized. - It is easy to obtain filling materials for the cellular cofferdam. - It will be easy to maintain. - It will be easy to expand the berth length.	- As a solid gravity type, it can be more resistant to rough wave forces and a collision of ship with the structure during rough season when it is difficult to maneuver the ship. - It is easy to obtain filling materials for the cellular blocks. - It will be easy to maintain. - It will be easy to expand the berth length.	- Since the critical design force for pile foundation is the berthing and mooring forces, it can be more resistant to seismic force than the other gravity type alternatives for which the critical force is seismic one. - As no reflection wave will occur in front of the berth, there will be less overtopping on the berth than the other alternatives, thus, the equipment installed on the berth will be less affected by sea water. - Pile driving can be done interruptedly even during Khamsin season. - Construction cost is moderate.
Disadvantages	- Since it is vertical wall type, the reflection wave will overtop the berth, thus, the equipment installed on the berth will be affected by sea water. - Since steel sheet piles are standing unstably unless filled with materials inside, the sheet pile driving should be executed during calm sea condition, thus construction method and schedule should be well controlled. In particular, the sheet pile driving can not be done during Khamsin season.	- As same as the Alternative I, the reflection wave will overtop the berth, thus, the equipment installed on the berth will be affected by sea water. - As for the construction, heavy equipment for marine works such as a crane mounted barge is needed. - The existing pile foundations should be completely removed for installation of concrete blocks on the rock mound of which surface should be well leveled and compacted adequately. - Precast concrete blocks should be placed during calm sea conditions, thus construction method and schedule should be well controlled. In particular, the placing of concrete blocks by barge cannot be done during Khamsin season. - It is necessary to provide large temporary yard and a loading quay for precast concrete fabrication, stock and handling. - The transportation and installation of such precast concrete blocks by barge inside port area will disturb port activities. - Construction cost will be very high.	- As same as the existing berths, it will be less resistant to uplift wave forces and a collision of ship with the structure during rough season when it is difficult to maneuver the ship. - As for the construction, heavy equipment for marine works such as a pile driving barge is needed. - Costly anti-corrosive and other maintenance measures should be taken during operation period.
Construction Cost Ratio	1.00	1.17	0.92
Evaluation	1	3	2

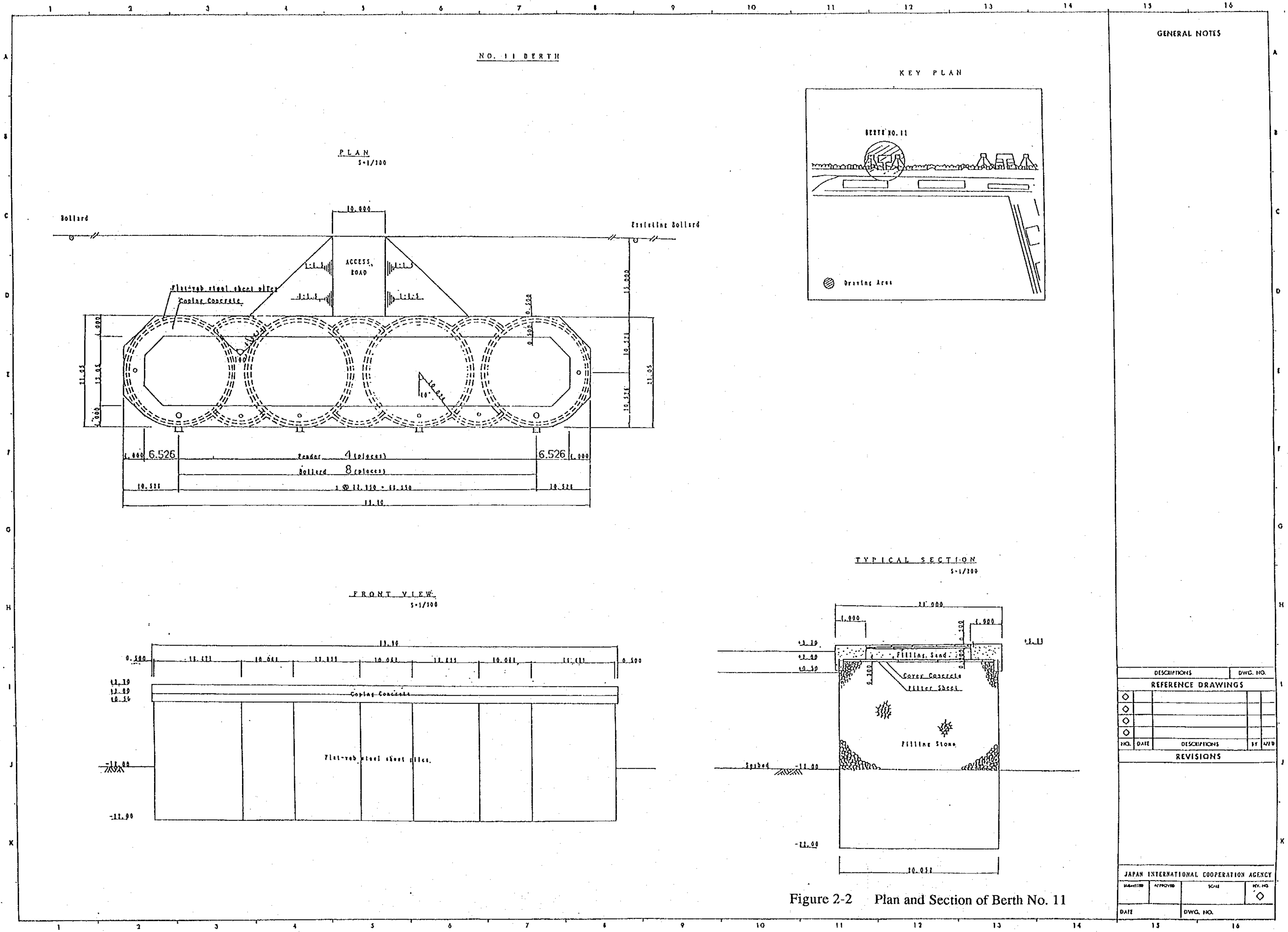


Figure 2-2 Plan and Section of Berth No. 11

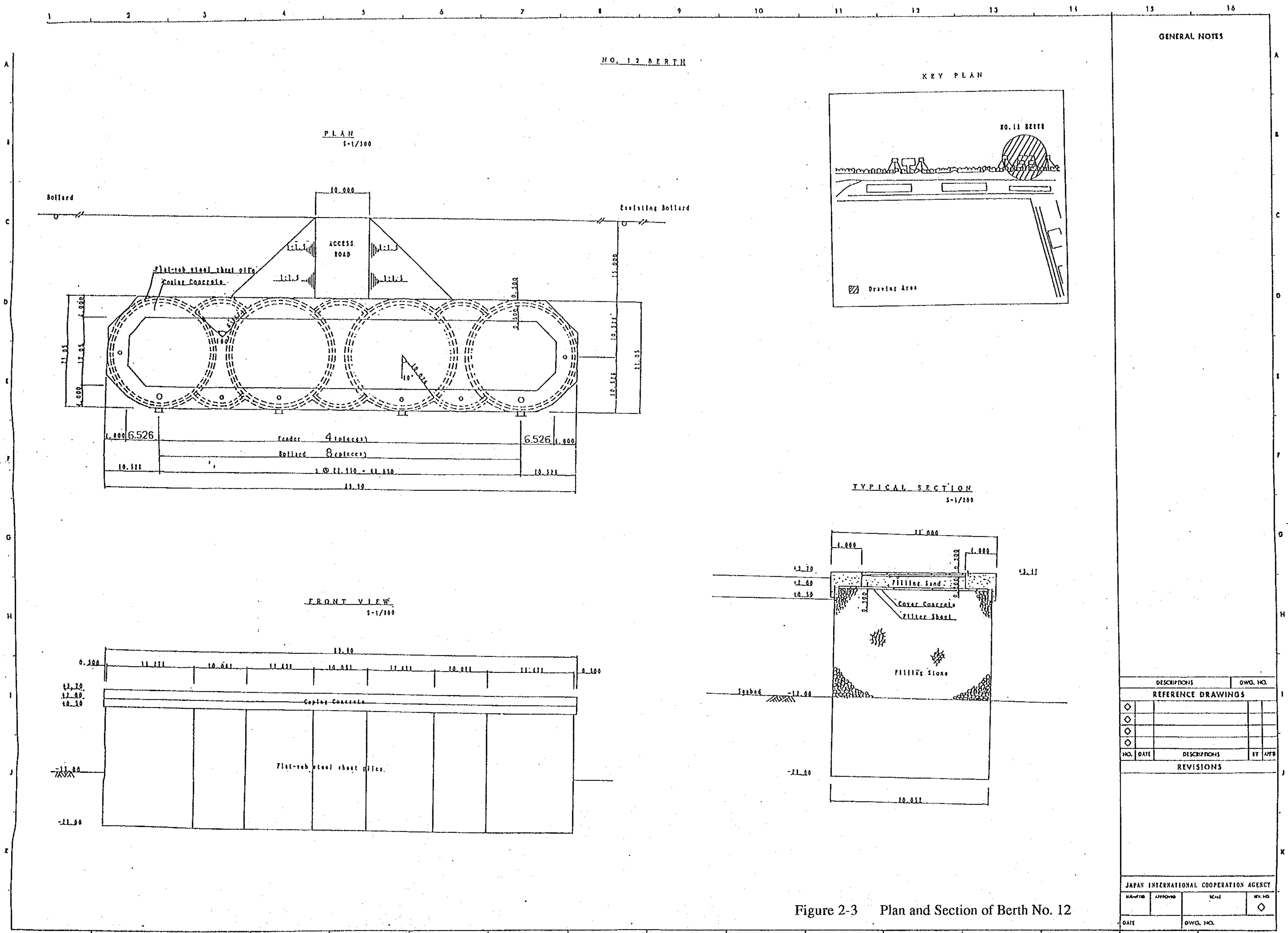
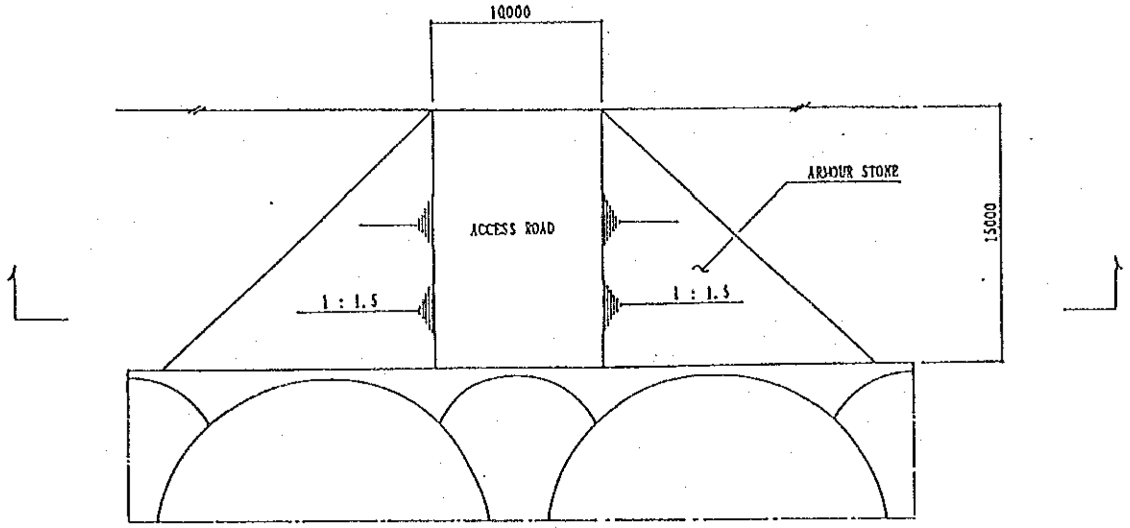
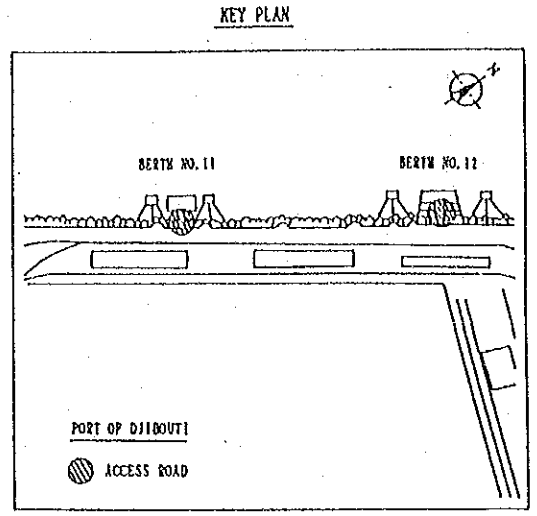
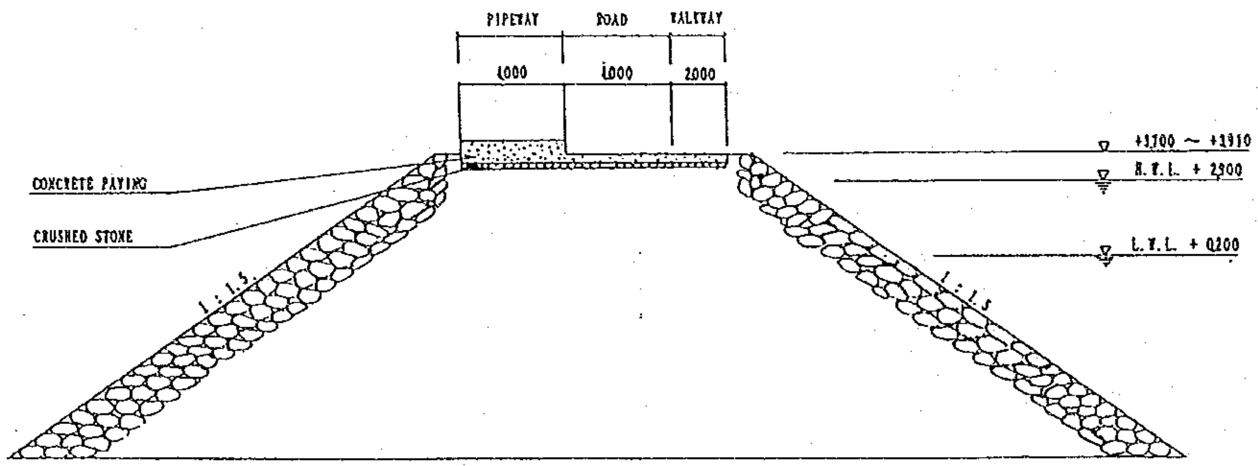


Figure 2-3 Plan and Section of Berth No. 12



ACCESS ROAD PLAN
S = 1:200





SECTION
S = 1:125

GENERAL NOTES

DESCRIPTIONS | DWG. NO.
REFERENCE DRAWINGS
NO. | DATE | DESCRIPTIONS | BY | APPD
REVISIONS

JAPAN INTERNATIONAL COOPERATION AGENCY
DATE | DWG. NO.

Figure 2-4 Access Road

3 Construction Method

3.1 Construction Activities in Djibouti

(1) General

In order to study the construction method, construction schedule and cost estimate, the construction activities in Djibouti have been investigated by collecting data and information from the public sector such as PAID and the Ministry of Pubic Works, Urbanism and Building, and the private construction industries. In Djibouti, there are not only local construction companies but foreign origin general contractors which perform relatively big or difficult construction projects such as internationally financed projects.

(2) Local Availability of Construction Materials/Equipment

The following are locally obtainable with appropriate quality and sufficient quantity: aggregates for concrete, sand, gravel and rocks. However, the other major construction materials are to be imported from several countries as follows:

- Steel products from France, Italy, Belgium, etc.
- Cement from Egypt, France, Belgium, etc.
- Bituminous materials from Dubai, Pakistan, etc.
- Timber from Malaysia.

As for the construction equipment, the following are locally available on lease: crawler cranes (20/40 t); truck cranes (5/25 t); Bulldozer (D7/D9); Graders; Back-hoes; Dump trucks; etc. However, working barges and crane mounted barges are not available in Djibouti.

3.2 Construction Method of Proposed Berths

(1) Site Preparation

Site preparatory works includes the cut-off of the existing parapet wall and replacement of the pipelines to underground in order to facilitate access to the site. Then, temporary access dike will be made of filling materials.

(2) Demolition of the Existing Structures

The existing structure including armor stones on the revetment will be partially demolished.

(3) Construction of Steel Sheet Pile Cellular Cofferdam

The construction method of steel sheet pile cellular cofferdam type quaywall is self-explanatory and schematized in Fig. 3-1. To perform the work, one 100 ton class crawler type crane is indispensable. As for the construction materials, steel sheet piles, cement, reinforcing steel bars, axially cylindrical rubber fenders, bitts are to be imported.

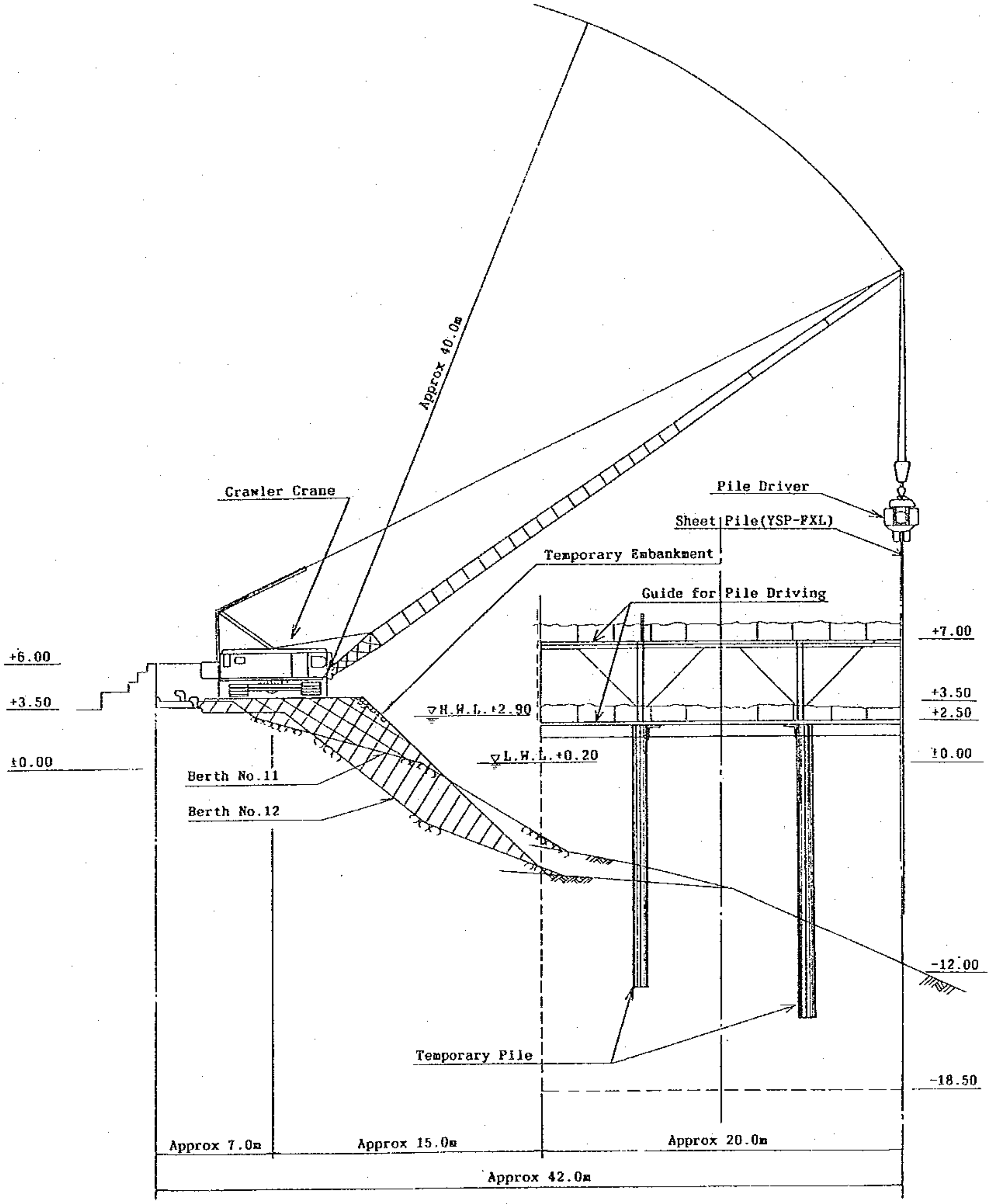


Figure 3-1 Construction Method of Steel Sheet Pile Cellular Cofferdam

4 Cost Estimates

Project cost for the Oil Berths Reconstruction is summarized in Table 4-1. The project cost is estimated by dividing into the following items.

(1)	Direct Construction Cost	:	based on the unit prices as of October 1993, direct construction cost was calculated.
(2)	Indirect Construction Cost	:	Indirect cost is estimated including transportation cost, overhead and company's profit.
(3)	Engineering Services	:	Cost for engineering services is divided into two stages, namely detailed design and construction supervision. The cost for each stage is estimated at 3 % and 7 % of (1) + (2) above respectively.
(4)	Physical Contingency	:	Physical contingency is excluded.
(5)	Price Escalation	:	Price escalation is excluded.

The estimate was based on the following conditions:

(1) Exemption from taxation and duties

(2) Exchange Rate

The exchange rate of cost estimation is computed at an average of daily TTS rate during six months from June 1 to November 30, 1993.

1 US$ = ¥107.85 = 179.48 FD
1 FD = ¥0.60

Table 4-1 Cost Estimate

(Unit: 1,000 Yen)

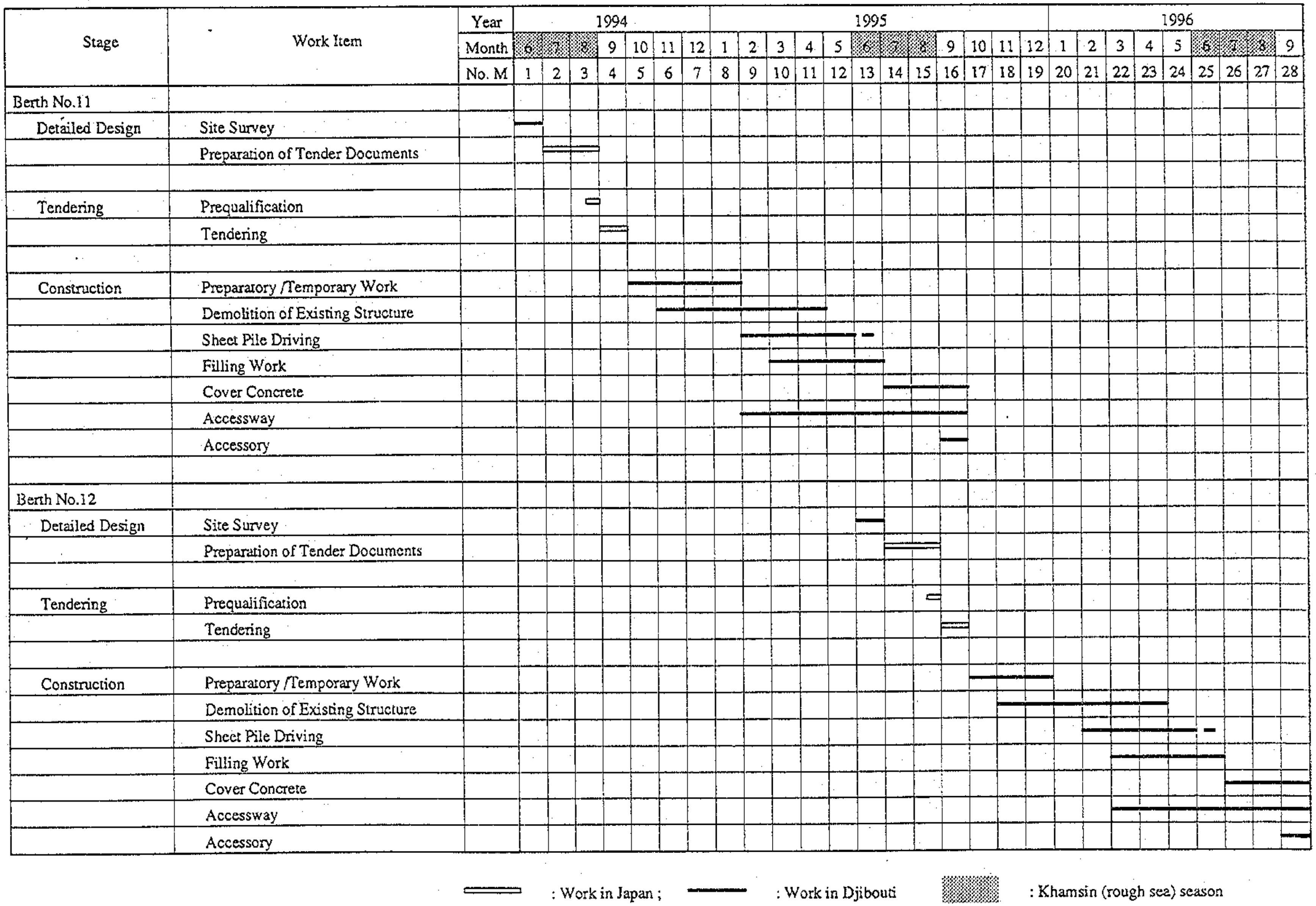
Item	Berth No. 11		Berth No. 12		Total	
	foreign portion	local portion	foreign portion	local portion	foreign portion	local portion
Direct Construction Cost	482,850	329,649	475,281	330,278	958,131	659,927
A. Preparatory Work	57,899	12,550	57,899	12,550	115,798	25,100
B. Demolition of Existing Berth	11,802	8,330	9,598	7,195	21,400	15,525
C. Quay Wall	345,211	282,132	339,670	282,132	684,881	564,264
D. Access Road	2,711	23,385	2,887	25,149	5,598	48,534
E. Other Works	65,227	3,252	65,227	3,252	130,454	6,504
(Improvements of Existing Bitts, Installation of Fire Alarms, Installation of Lighting Poles and Water Supply facilities)						
Indirect Construction Cost	205,736	198,695	169,550	94,955	375,286	293,650
TOTAL CONSTRUCTION COST	688,586	528,344	644,831	425,233	1,333,417	953,577
ENGINEERING SERVICES	86,850	27,269	65,929	20,230	152,779	47,499
TOTAL PROJECT COST	775,436	555,613	710,760	445,463	1,486,196	1,001,076

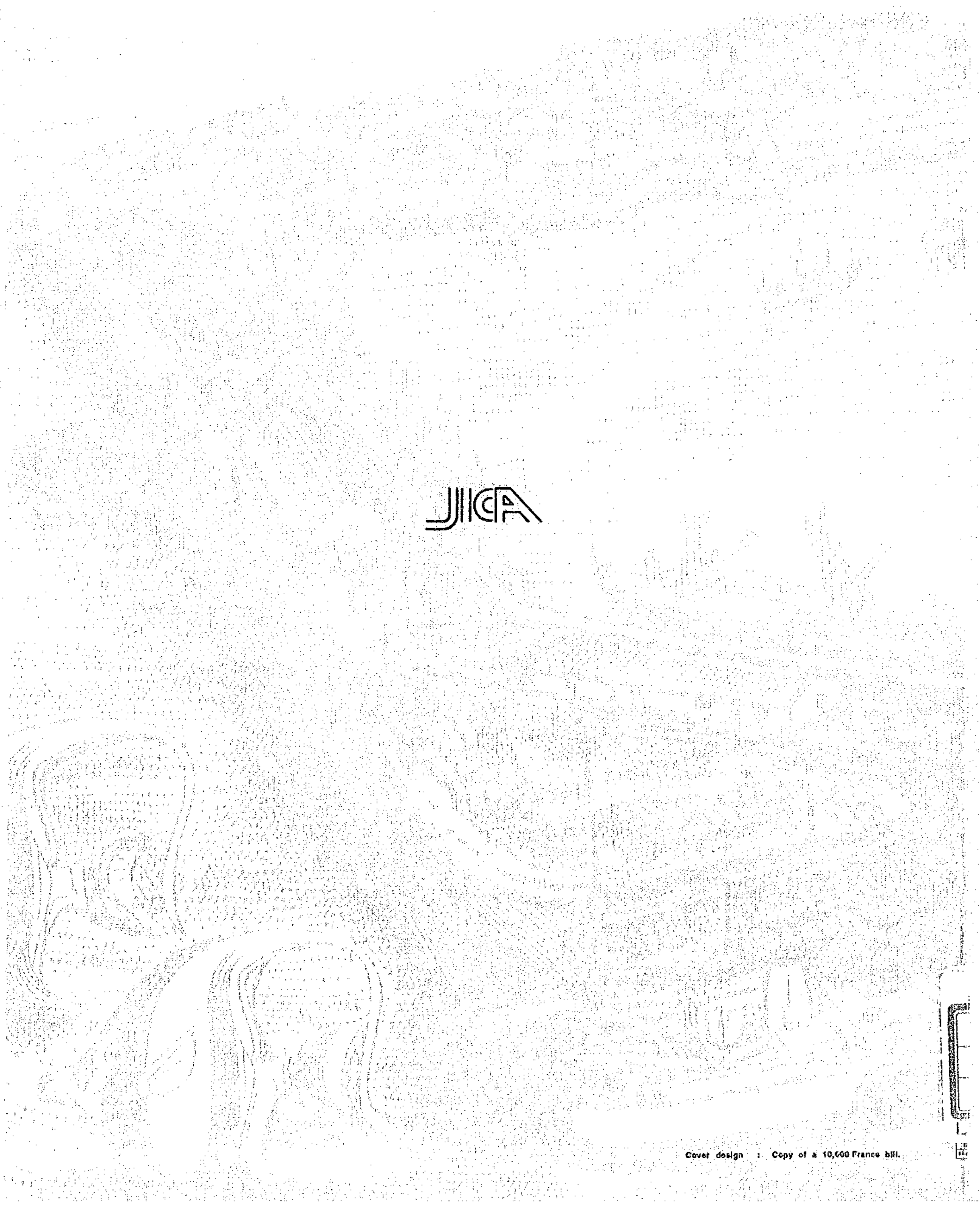
Note: Dredging Work, Diversions of Pipelines and Additional Pipelining are not included in this estimate.

5 Implementation Program

Implementation schedule is proposed as shown in Fig. 5-1 and it will take 28 months from the detailed design to the completion of reconstruction of Berth Nos. 11 and 12. The construction period for one berth is estimated at 12 months. In this schedule, it is emphasized that the steel sheet pile driving could not be done during Khamsin season i.e. from June to August.

Figure 5-1 Implementation Schedule





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Cover design : Copy of a 10,000 Francs bill.