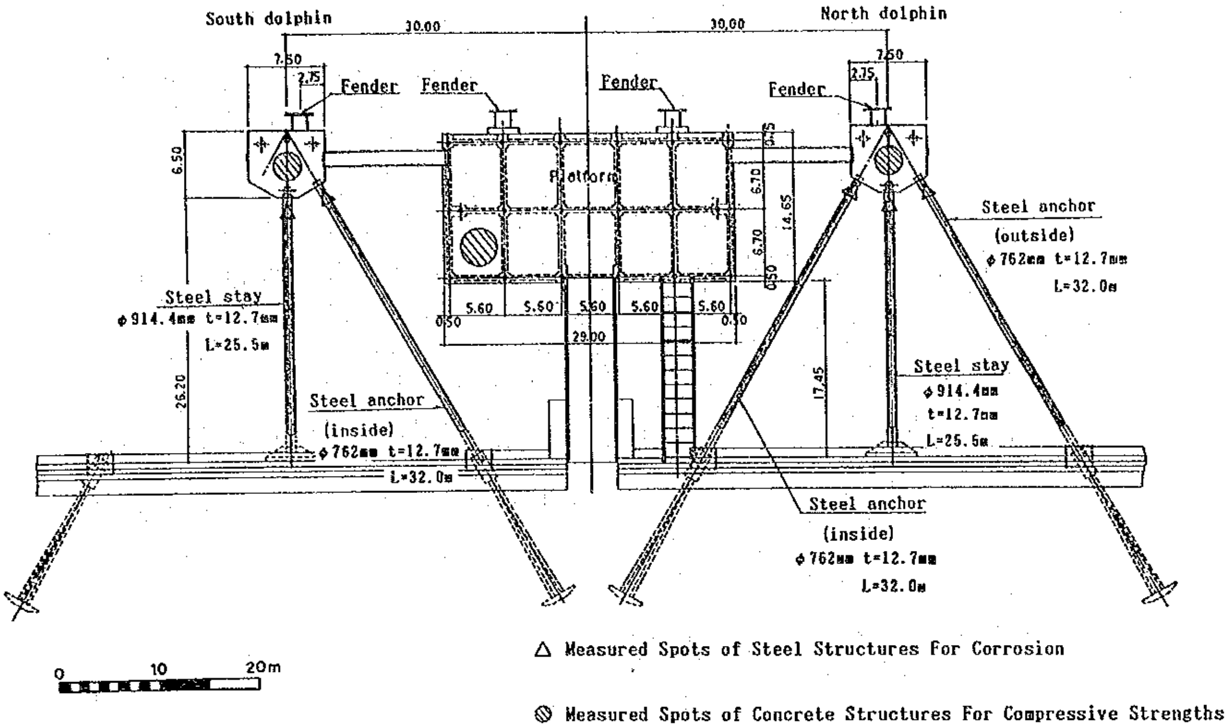



Figure 2-21 Location of Investigation at Berth No. 11

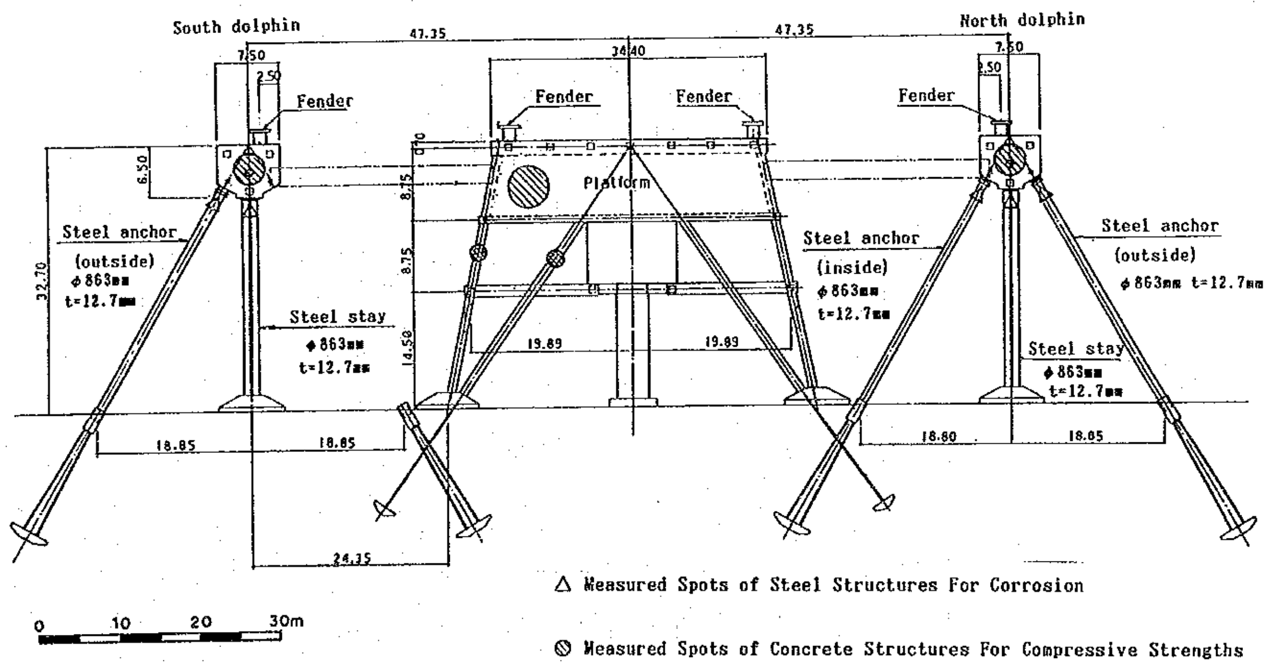



Figure 2-22 Location of Investigation at Berth No. 12

Table 2-4 Scope and Location of Field Investigation

| Item | Location for Inspection |
|---|---|
| Corrosion of steel structures | Steel pipes for dolphin stays and anchors. |
| Damage of reinforced concrete structures | Superstructures of dolphins, slabs and beams of platforms. |
| Measurement of concrete strengths | Superstructures of dolphins, slabs and of platforms. |
| Damage of fenders | Fenders for dolphins and platforms. |
| Visual inspection of structures | Superstructures of dolphins and platforms, piles and steel anchors, stays, armored stones. |

2) Methods of Investigation

a) Corrosion of Steel Structures

Rust and paint of steel pipe anchors and stays are first removed with hammers and wire brushes to expose the steel substrate. Then, the thicknesses of the steel structures are measured at the selected points by means of an ultrasonic thickness gauge.

For each of the steel structures, the thicknesses are measured at 3 different points as shown in Fig. 2-23, then, the average thickness is calculated for each of the steel members measured.

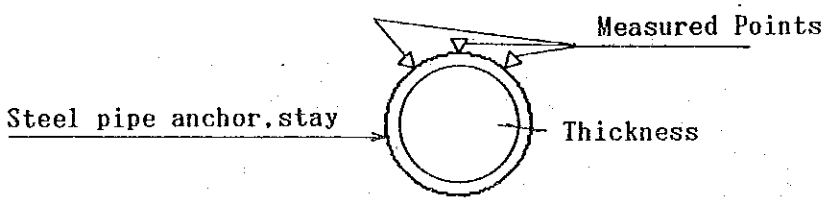



Fig. 2-23 Measured Points of Steel Structures for Corrosion

b) Deterioration of Concrete Members

The extent of the corrosion of reinforcing steel bars, and cracks, separations and peeling-offs of the concrete structures have been visually inspected. The degree of deterioration of each concrete structures, evaluated in the light of the criteria, are presented in Table 2-5.

Table 2-5 Conditions of Structural Corrosion

| Degree of corrosion | Dolphin Superstructures and Platform Slabs | | | Beams | | |
|---|---|---|---|---|---|---|
| | Steel bars | Cracks | Separation and peeling off | Steel bars | Cracks | Separation and peeling off |
| 0 | None | None | None | None | None | None |
| 1 | Rust in spots observed on concrete surface. | Impart, cracks are observed; or either zonal or linear shape gelled projections are observed at 2 or 3 points. | None | Same as those for dolphins/slabs. | Cracks smaller than 1 mm are observed at 2 or 3 points. | None |
| 2 | Rust transudations partly observed. | Cracks or gelled projections either in meshy or linear shape are observed at several points. | Swellings are partly observed. | Same as those for dolphins/slabs. | Cracks exist to some extent. Cracks are only in vertical to the beam axis. | Swellings are partly observed. |
| 3 | Much rust transudation observed. Corrosion of steelbars are widely observed. | Many cracks are observed, including meshy cracks, or cracks with rust transudation. | Peeling offs are partly observed. | Same as those for dolphins/slabs. | Many cracks are 3 mm or wider, including those continuously parallel to the beam axis. | Many swellings exist. |
| 4 | Free rust observed. Rust is widely observed at most of steel bar surface or circumference. | Many meshy cracks are observed all over the structure. | Many swellings and peeling offs are observed in 40 % or less portion of the inspected area. | Same as those for dolphins/slabs. | Many continuous cracks in parallel to the axis appear all over the beam. | Many swellings exist. Separations and peeling offs are observed in about 40 % of inspected area. |
| 5 | Free rust widely observed. Reduction of steel bar cross sectional areas is observed throughout the structure. | - | Swellings, separations and peeling offs are observed in 40 % or more portion of the inspected area. | Same as those for dolphins/slabs. | - | Many separations and peeling offs are observed at approx. 40 % or more of the inspected area. |

c) Concrete Compressive Strengths

Compressive strengths of the concrete structures are measured with a Schmidt Rebound Hammer. For the measurements, spots of the concrete structures, having neither separations nor peeling-offs, are selected. The surface of each selected spot is thoroughly cleaned, and the compressive strengths are measured totally at 20 points. Then, the average compressive strength at each spot is obtained.

b) Fenders

The present conditions of the Kleber Company's axially cylindrical fenders, front pads, shock absorbers, anchor bolts, and chains have been checked by visual inspection. The result of the inspection is then examined based on the criteria as shown in Table 2-6 to justify whether these can be further used or require improvements.

Table 2-6 Criteria for Evaluation of Fenders

| Item | | | Criteria for Evaluation |
|---|---|---|---|
| Structural evaluation | O | : | Normal |
| | Δ | : | Though deficiencies are found, further use is possible. |
| | X | : | Deficiencies are found, which need improvement measures. |
| Steel members | A | : | No rust observed. |
| | B | : | Rust partly appears. |
| | C | : | Rust appears over the entire area. |
| Overall evaluation | 1 | : | No portion requires improvement measures. |
| | 2 | : | Although continuous use is possible, there exist some portions which require improvement measures. |
| | 3 | : | There exist portions which require urgent counter measures to improve deficiencies. |

e) Visual Inspection of Structures

The present conditions of the steel anchors, stays, dolphins, and platform piles are visually inspected. The submerged portions of the structures are inspected by diving experts.

(4) Results of Investigations

1) Corrosion of Steel Members

The results of the investigation are shown in Table 2-7.

Table 2-7 Corrosion of Steel Members

| Berth | Location | Original thickness t1 (mm) | Measured thickness t2 (mm) | Corroded thickness t1-t2 (mm) | Age (year) | Speed of corrosion (mm/yr) |
|---|---|---|---|---|---|---|
| No. 11 | South dolphin stay | 12.7 | 7.23 | 5.47 | 30 | 0.182 |
| | South dolphin anchor (inside) | 12.7 | 7.77 | 4.93 | 30 | 0.164 |
| | North dolphin anchor (inside) | 12.7 | 8.95 | 3.75 | 30 | 0.125 |
| | North dolphin stay | 12.7 | 8.89 | 3.81 | 30 | 0.127 |
| | North dolphin anchor (outside) | 12.7 | 9.19 | 3.51 | 30 | 0.117 |
| No. 12 | South dolphin anchor (outside) | 12.7 | 11.21 | 1.49 | 9 | 0.165 |
| | South dolphin stay | 12.7 | 11.40 | 1.30 | 9 | 0.144 |
| | North dolphin anchor (inside) | 12.7 | 11.30 | 1.67 | 9 | 0.185 |
| | North dolphin stay | 12.7 | 11.50 | 1.20 | 9 | 0.133 |
| | North dolphin anchor (outside) | 12.7 | 11.60 | 1.10 | 9 | 0.122 |

As can be seen from the above table, the stay of the south dolphin at Berth No. 11 is most severely damaged, having corroded as deep as 5.47 mm or 43 percent of the original thickness. The average erosion rates of the steel members at Berth No. 11 are 5.20 mm in the south dolphin and 3.69 mm in the north dolphin, while those in the south and north dolphins of Berth No. 12 are 1.40 mm and 1.32 mm respectively. The average rates of corrosion of the steel members at Berth Nos. 11 and 12 are within the range of 0.18 to 0.12 mm/year indicating small differences.

2) Reinforced Concrete Structures

The results of the investigation on the reinforced concrete structures are as shown in the following table:

Table 2-8 Degrees of Concrete Deterioration

| Berth | Location | Degree of Degradation | | |
|---|---|---|---|---|
| | | Corrosion of steel bars | Cracks | Flaking |
| No. 11 | South dolphin | 4 | 2 | 4 |
| | North dolphin | 4 | 2 | 4 |
| | Platform (upper side) | 3 | 2 | 4 |
| | Platform (bottom side) | 5 | - | 5 |
| | Platform (beam) | 3 | 3 | 3 |
| No. 12 | South dolphin | 4 | 2 | 4 |
| | North dolphin | 3 | 3 | 4 |
| | Platform (upper side) | 4 | 3 | 4 |
| | Platform (bottom side) | 5 | - | 5 |
| | Platform (beam) | 4 | 4 | 5 |

At some locations of the upper portion of the dolphins in Berth Nos. 11 and 12, the concrete was flaked, and as a result, the reinforcing bars were exposed to the air and significantly corroded. The bottom of platform slabs in Berth Nos. 11 and 12 have also been severely deteriorated, and most of the bottom concrete surface was flaked and the reinforcing bars exposed. Consequently, the corrosion has further progressed and the sections of the steel bars noticeably reduced. At Berth No. 11, the corroded steel bars hung down at many locations.

3) Compressive Strengths of Concrete

The compressive strengths of concrete members have been measured with a Schmidt Rebound Hammer. The measured strengths are adjusted according to the tapping angle of the Hammer and age of concrete material to obtain the actual strengths, as shown in Table 2-9.

Table 2-9 Concrete Compressive Strengths

| Berth | Measured Location | | Compressive Strengths ($kg/cm^2$) |
|---|---|---|---|
| No. 11 | South dolphin | (upper side) | 238 |
| | North dolphin | (upper side) | 229 |
| | Platform slab | | 172 |
| No. 12 | South dolphin | (upper side) | 231 |
| | North dolphin | (upper side) | 186 |
| | Platform slab | | 209 |
| | Platform beam | (outside) | 224 |
| | Platform beam | (inside) | 226 |

The results of the measurement indicate that the compressive strengths range from 172 $kg/cm^2$ to 238 $kg/cm^2$ with an average strength of 214 $kg/cm^2$. From the results, it is confirmed that the existing concrete is no longer sound to some extent as compared with the normal concrete compressive strength of 240 $kg/cm^2$.

4) Fenders

The degree of deterioration of the fenders at Berth Nos. 11 and 12, evaluated on the basis of the criteria, are shown in Table 2-10. Although some flaws and small cracks are observed on the fender bodies, these deficiencies are not of such a degree that the fenders cannot safely bear the berthing energy of ships. Frontal pads are missing at some locations, at 3 spots of which flat pads are deformed. Rust is also observed all over the anchor bolts and chain surface, and at 2 locations chains are out of place.

The field inspection has revealed that the fender bodies themselves could be further used, however, where the frontal pads have been deformed, the pads are quite likely to be further deformed by the berthing forces directly placed on them.

On account of these observations, immediate rehabilitation of the frontal pads, by repairing the deformed flat pads, appears to be necessary.

The detached chains should also be urgently repaired, since the fender bodies themselves may possibly become detached, if these detached chains are left without rehabilitation, and not allow equal contact of the frontal pads with berthing ships.

Table 2-10 Present Conditions of Fenders

| No. 11 Berth | | | | |
|---|---|---|---|---|
| Item | South dolphin | Platform (South side) | Platform (North side) | North dolphin |
| Fender body | O | Partial flaw<br>Δ | minute cracks<br>Δ | Δ |
| Frontal pad | O | Upper side<br>1.0 m x 2.4 m<br>broken off<br>X | Upper side<br>1.0 m x 2.4 m<br>broken off<br>X | Upper side<br>1.0 m x 2.4 m<br>broken off<br>X |
| Frontal frame | O | Dents are found<br>X | Dents are found<br>X | Dents are found<br>X |
| Anchor bolt | Δ, C | Δ, C | Δ, C | Δ, C |
| Chain | Upper and lower chains disconnected<br>X, C | Δ, C | Δ, C | Δ, C |
| Synthetic evaluation | Chains<br>3 | Frontal pad<br>Frontal frame<br>3 | Frontal pad<br>Frontal frame<br>3 | Frontal pad<br>Frontal frame<br>3 |
| No. 12 Berth | | | | |
| Item | South dolphin | Platform (South side) | Platform (North side) | North dolphin |
| Fender body | O | Δ | O | Partially damaged<br>Δ |
| Frontal pad | O | Δ | Upper side<br>1.0 m x 2.4 m<br>broken off<br>X | O |
| Frontal frame | O | O | O | O |
| Anchor bolt | Δ, C | Δ, C | Δ, C | Δ, C |
| Chain | Chains are off<br>X, C | Δ, C | Δ, C | Anchors of chain are deformed<br>Δ, C |
| Synthetic evaluation | Chains<br>3 | 2 | Frontal pad<br>3 | 2 |

5) Visual Inspection of Structures

The result of the visual inspection of the structures are summarized in Table 2-11 and 2-12, and the locations of deformed portions are shown in Fig. 2-24 and 2-27.

The visual inspection of structures has revealed the following facts:

- Since the steel anchors of dolphins at Berth Nos. 11 and 12 are disconnected, the mooring forces of ships are borne by the remaining one steel anchor. Also, bolts connecting the dolphins to the steel anchors are either corroded or damaged.
- There exist some openings between the upper portion of the piles and platform slab at Berth No. 11. Consequently, the raking piles do not support the horizontal forces but are supported by the vertical piles.
- Of the 5 supporting piles of the north dolphin at Berth No. 12, one pile is broken at a point about 7 m above the seabed. Thus, all the loads of upper structures are supported by the remaining 4 piles.
- Of the 7 front piles of the platform at Berth No. 12, 2 piles are disconnected and another is broken at a point about 2 m above the seabed. Hence, all the loads of the upper structures and the berthing forces are supported with the remaining 4 piles.

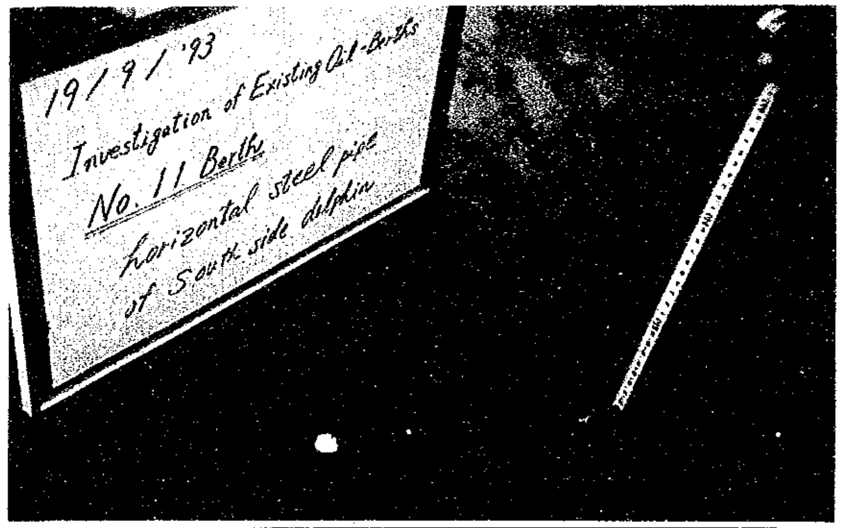
The general plans of Berth Nos. 11 and 12 are shown in Fig. 2-28 and 2-29 respectively. The riprap at the toe of slope is found to be relatively undisturbed. Also, various types of piles are used for the foundation of Berth No. 12.

Table 2-11 Visual Inspection of Structues

| Berth | Location | (*) Ref.No. | Existing Condition |
|---|---|---|---|
| No.11 | South dolphin | ① | Steel anchor (outside) disconnected. |
| | | ② | Anchor bolts corroded. |
| | | ③ | A hole exists near the center of steel anchor. |
| | | ④ | a space exists between anchor concrete foundation and steel pile. |
| | North dolphin | ⑤ | Anchor bolts corroded. |
| | | ⑥ | A space exists between anchor concrete foundation and steel pile. |
| | | ⑦ | Reinforcing steel bars of foundation at land side exposed. |
| | Platform | ⑧ | Pipe racks are lost. |
| | | ⑨ | Concrete head of pile is lost. |
| | | ⑩ | Supporting pile deformed. |

Note: (*) Refers to the location numbers shown in Fig.2-21.

| Photo -Ⓐ Berth No.11 south dolphin (9/9/'93) |
|---|
| Steel anchor disconnected. |




| Photo -Ⓑ Berth No.11 south dolphin (19/9/'93) |
|---|
| Measurement of rust thickness of corroded steel stay. |

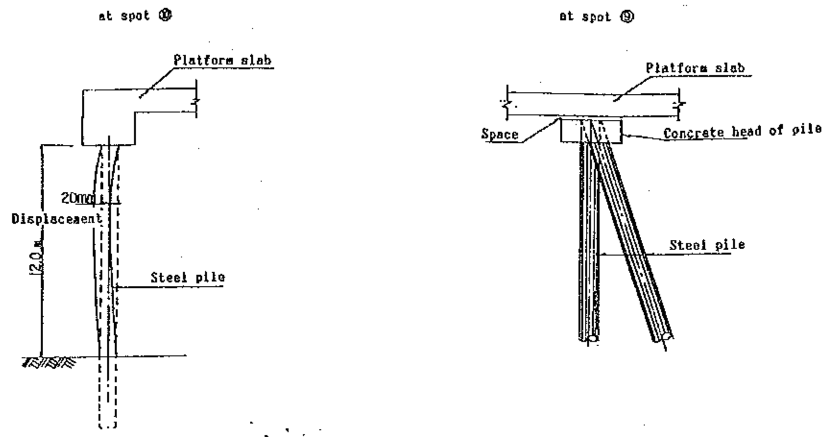



Figure 2-25 Detail of Deformed Spots at Berth No. 11

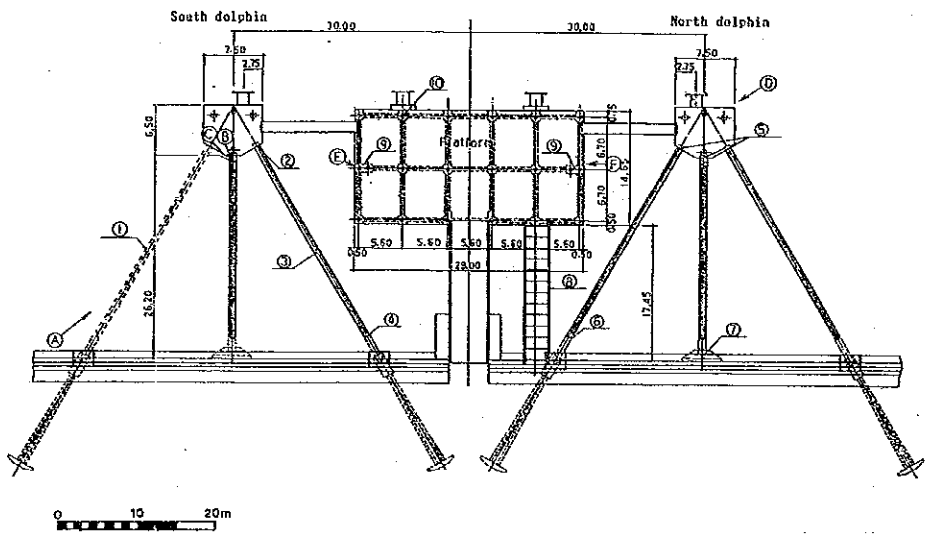
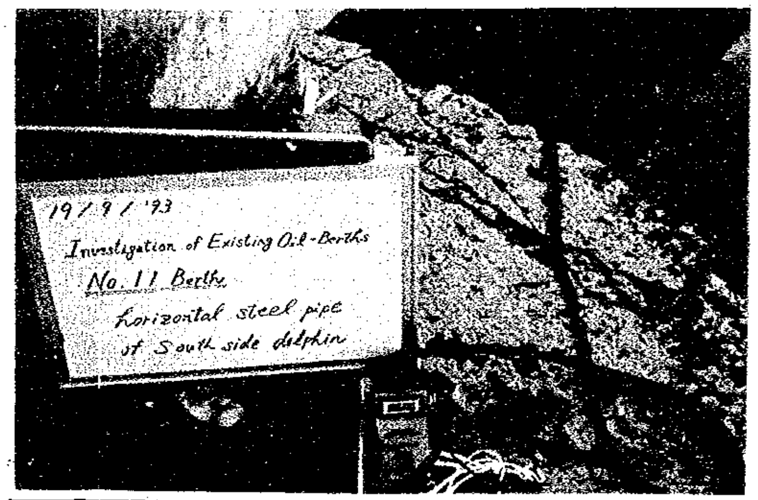
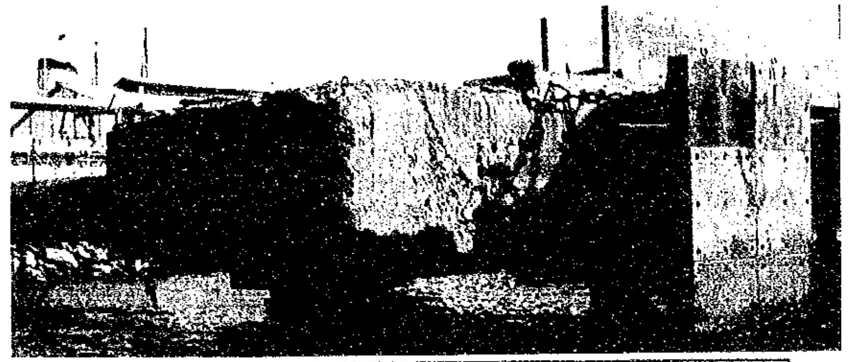


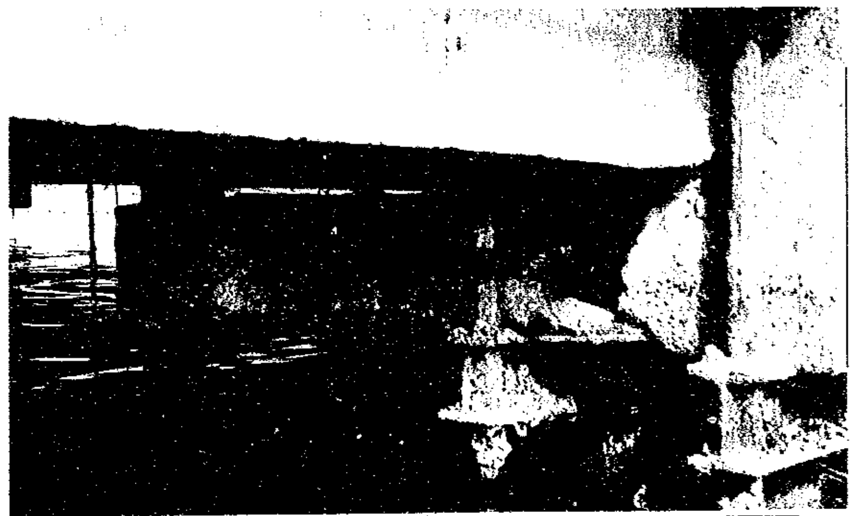

Figure 2-24 Visual Inspection Spots at Berth No. 11



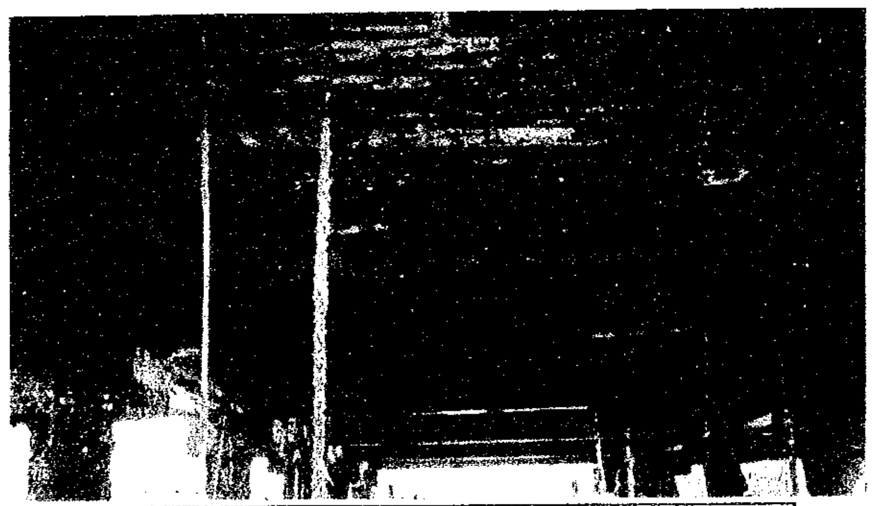

| Photo -Ⓒ Berth No.11 south dolphin (19/9/'93) |
|---|
| Measurement of corroded steel stay. |



| Photo -Ⓓ Berth No.11 North dolphin (19/9/'93) |
|---|
| Deteriorated superstructure concrete and exposed steel bars. |



| Photo -Ⓔ Berth No.11 Platform (22/9/'93) |
|---|
| Batter pile disconnected. |



| Photo -Ⓕ Berth No.11 (19/9/'93) |
|---|
| Exposed bottom steel bars. |

Table 2-12 Visual Inspection of Structues

| Berth | Location | (*) Ref.No. | Existing Condition |
|---|---|---|---|
| No.12 | South dolphin | ① | Anchor bolts corroded. |
| | | ② | Steel anchor (inside) disconnected. |
| | North dolphin | ③ | Anchor bolts lost. |
| | | ④ | Supporting pile damaged. |
| | Platform | ⑤ | Supporting pile damaged. |
| | | ⑥ | Supporting pile lost. |
| | | ⑦ | Catwalk damaged. |

Note: (*) Refers to the location numbers shown in Fig.2-23.

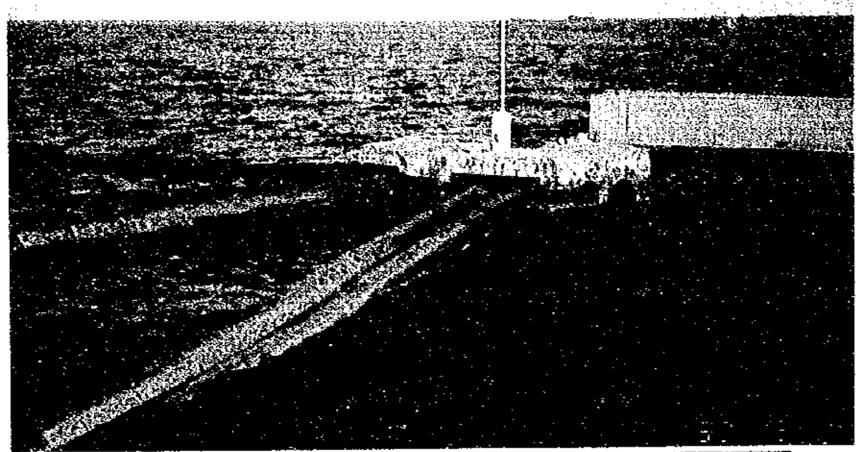


Photo -Ⓐ Berth No.12 south dolphin (9/9/'93)
Steel anchor disconnected.

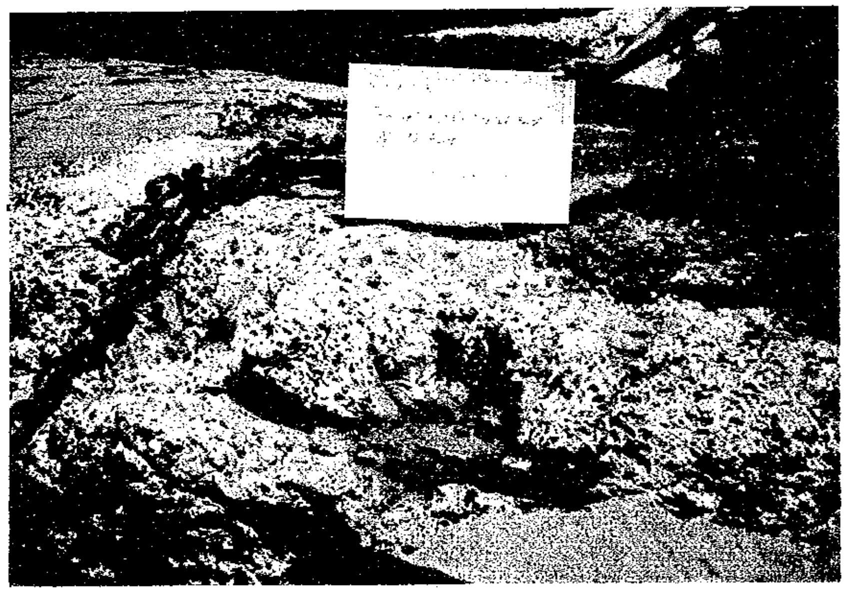


Photo -Ⓑ Berth No.12 south dolphin(18/9/'93)
Deteriorated superstructure concrete and exposed steel bars.

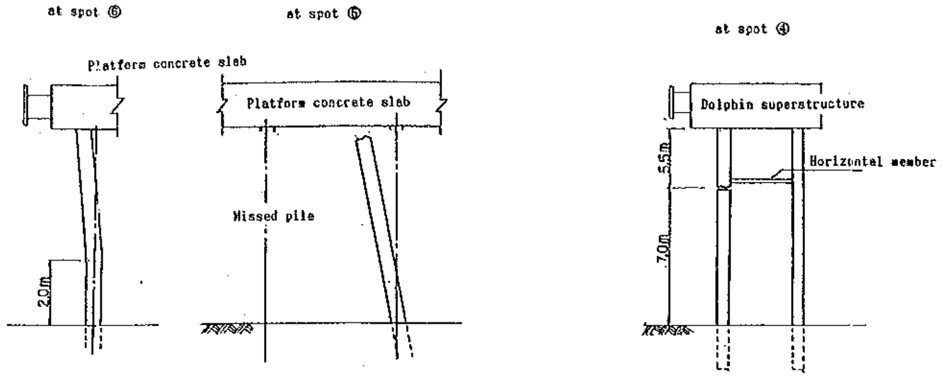



Figure 2-27 Detail of Deformed Spots at Berth No. 12

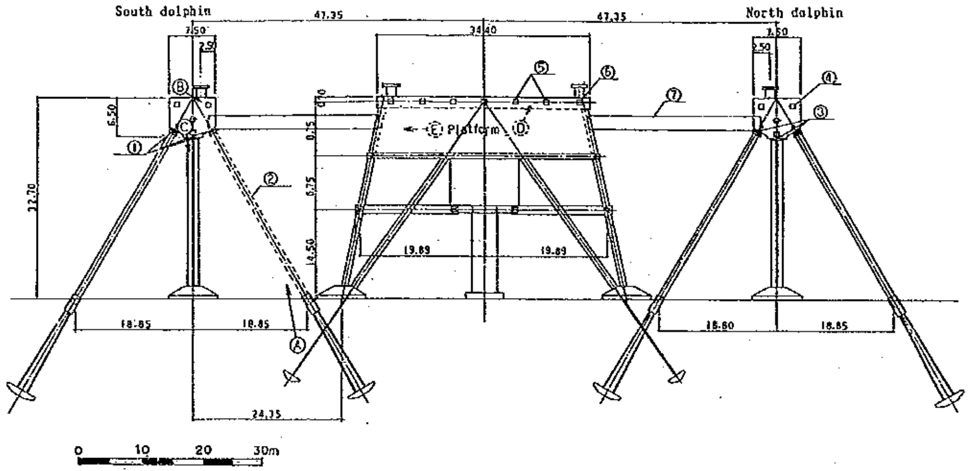



Figure 2-26 Visual Inspection Spots at Berth No. 12

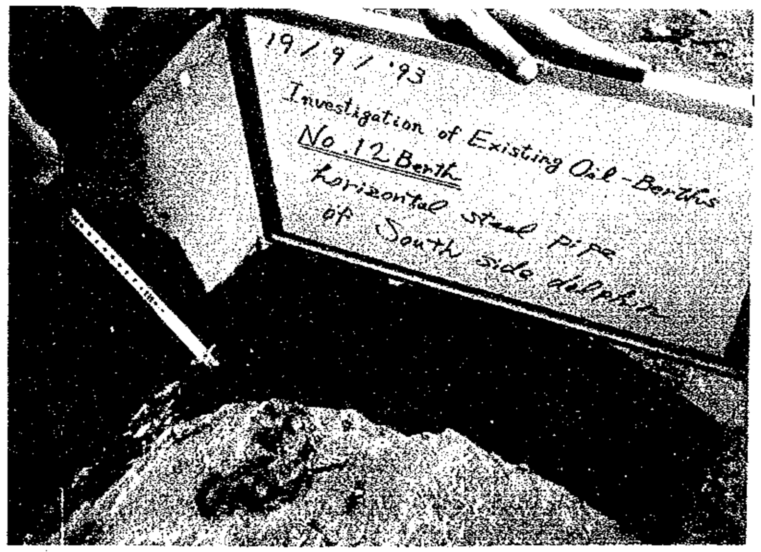



Photo -Ⓒ Berth No.12 south dolphin(19/9/'93)
Measurement of rust thickness of corroded steel stay.

Photo -Ⓓ Berth No.12 Platform (19/9/'93)
Missed 2 piles of frontal row.

Photo -Ⓔ Berth No.12 Platform (19/9/'93)
Exposed bottom steel bars.

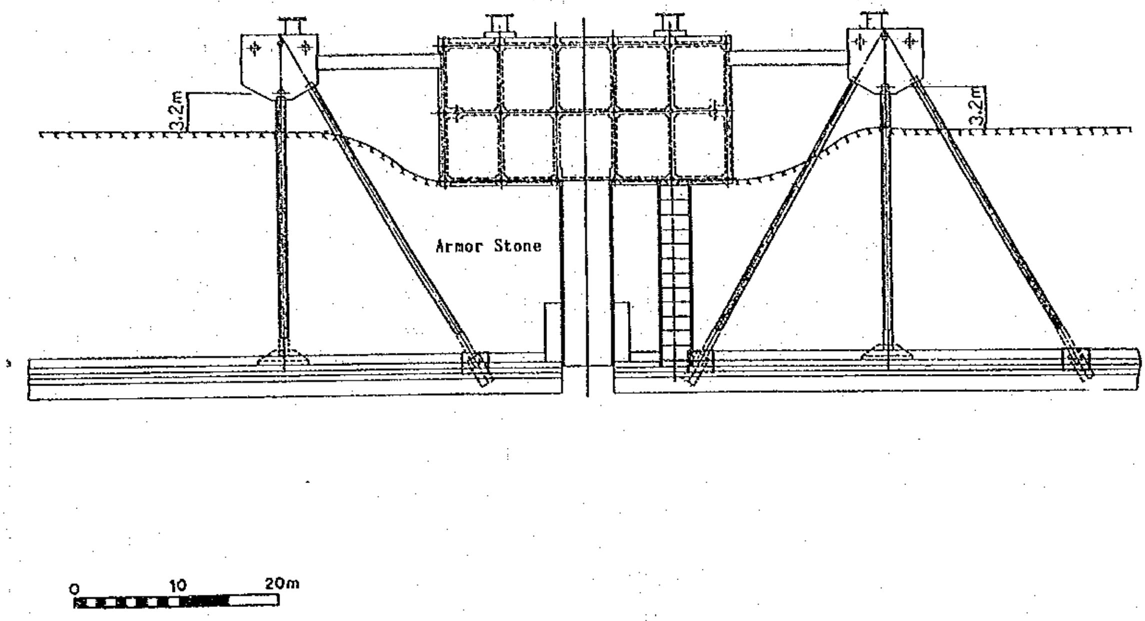
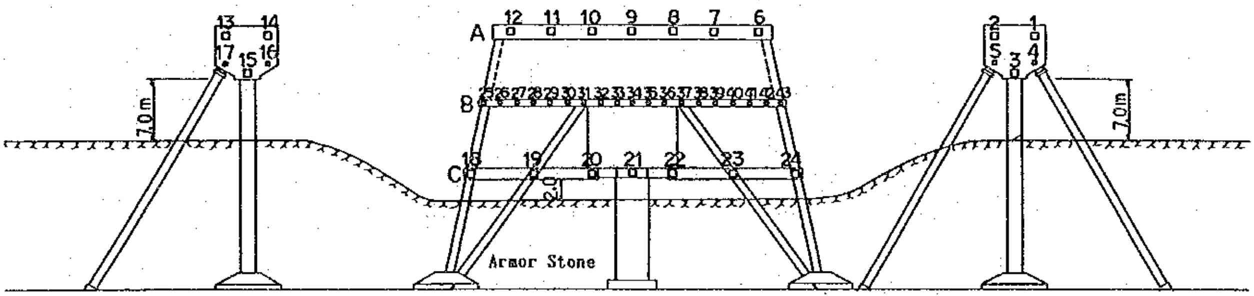



Figure 2-28 Armor Stone at Berth No. 11




Note : Figures show pile number

| Pile No. | Shape of Pile |
|---|---|
| 1, 2, 3 | : 4 steel sheet piles, diameter 0.8m |
| 4 | : 4 flat steel sheet piles |
| 5 | : 2 steel sheet piles, diameter 0.6m |
| 6 ～ 12 | : 4 steel sheet piles, diameter 0.8m |
| 13 ～ 15 | : 4 steel sheet piles, diameter 0.8m |
| 16 , 17 | : 2 steel sheet piles, diameter 0.6m |
| 18 , 24 | : 2 steel sheet piles and H-steel pile(width 0.4m) |
| 19,21,23 | : Steel pipe piles, diameter 0.6m |
| 20 , 22 | : 4 steel sheet piles, diameter 0.6m |
| 25 ～ 43 | : 4 steel sheet piles, diameter 0.6m |

Note : Pile Nos.7 and 8 are missed

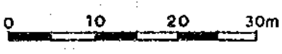



Figure 2-29 Armor Stone and Piles at Berth No. 12

### 2.3.2 Ancillary Facilities

The ancillary facilities attached to Berth Nos. 11 and 12 are enumerated in Table 2-13. Location of the ancillary facilities of Berth Nos. 11 and 12 are shown in Fig. 2-30 and 2-31 respectively.

Table 2-13 Ancillary Facilities of Berth Nos. 11 and 12

| Berth | Location | Item | Standard | No. |
|---|---|---|---|---|
| No. 11 | North dolphin | Fender | Cell type (kleber) 1,500 H | 1 |
| | | Bitt | 80 ton type | 1 |
| | | Water supply pipe | Ø8.5" | 1 |
| | | Water supply tap | 47 x 34 x 13 | 1 |
| | South dolphin | Fender | Cell type (kleber) | 1 |
| | | Bitt | 80 ton type | 1 |
| | | Lighting pole | 200 W | 1 |
| | | Water supply pipe | Ø8.5" | 1 |
| | | Water supply tap | 47 x 34 x 13 | 1 |
| | Platform | Fender | Cell type (kleber) 1,500 H | 2 |
| | | Bitt | | 2 |
| | | Lighting pole | 200 W | 4 |
| | | Oil pipe | Ø8.5", flange size 15" | 1 |
| | | Oil pipe | Ø12.5", flange size 15" | 1 |
| No. 12 | North dolphin | Fender | Cell type (kleber) 1,500 H | 1 |
| | | Bitt | | 1 |
| | | Lighting pole | 200 W | 1 |
| | South dolphin | Fender | Cell type (kleber) 1,500 H | 1 |
| | | Bitt | 80 ton type | 1 |
| | | Lighting pole | 200 W | 1 |
| | Platform | Fender | Cell type (kleber) 1,500 H | 2 |
| | | Bitt | | 2 |
| | | Lighting pole | 200 W | 3 |
| | | Water supply pipe | Ø9" | 1 |
| | | Water supply pipe | Ø10" | 1 |
| | | Water supply tap | 47 x 34 x 13 | 1 |
| | | Oil pipe | Ø12" | 4 |
| | | Oil pipe | Ø10" | 1 |
| | | Oil pipe | Ø9" | 1 |
| | | Recovering pipe of residual oil | Ø2" | 1 |
| | | Oil pan | 1.3 m x 2.6 m | 3 |

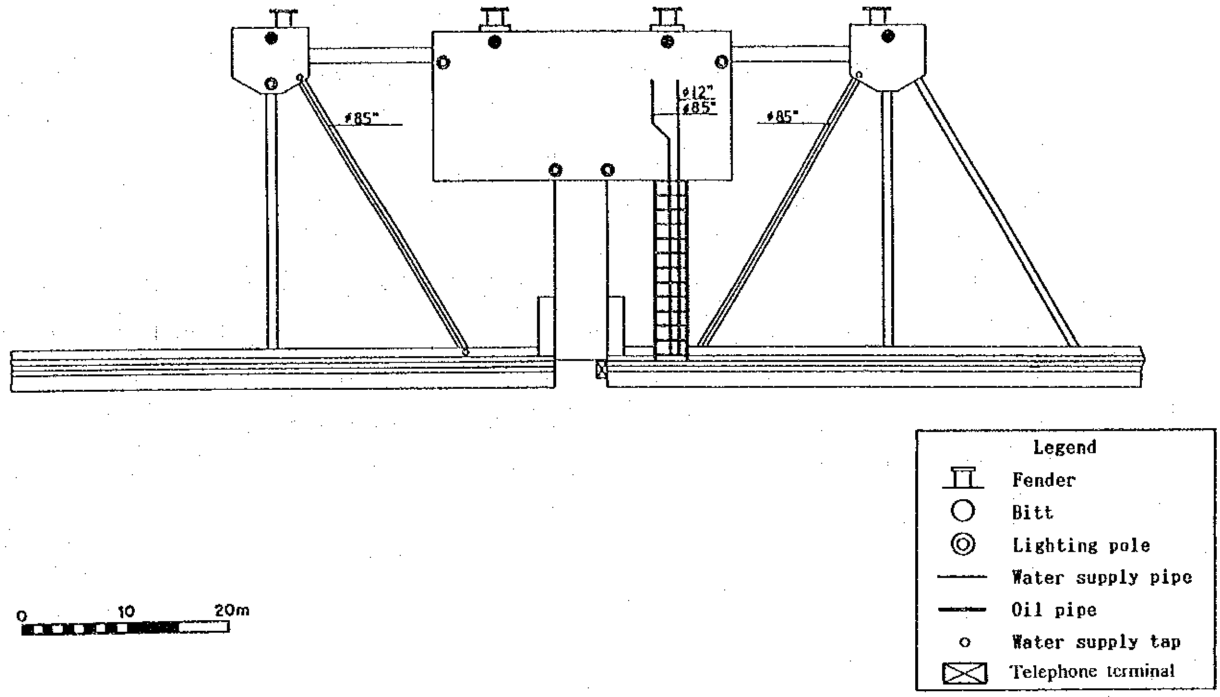



Figure 2-30 Ancillary Facilities at Berth No. 11

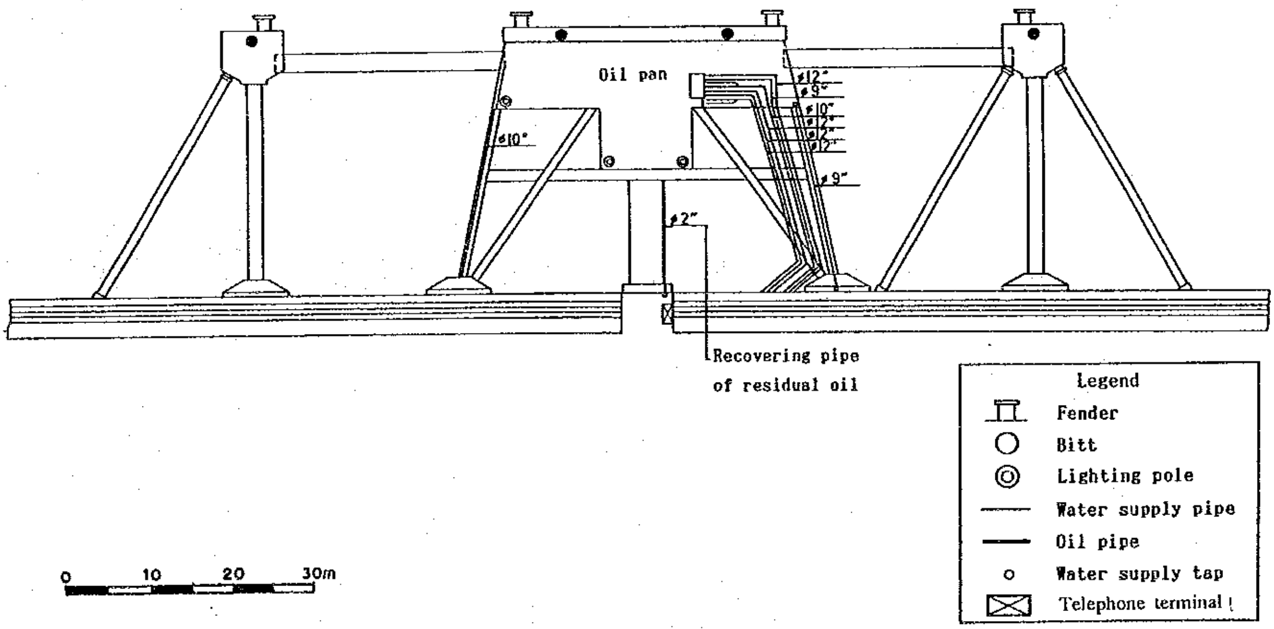



Figure 2-31 Ancillary Facilities at Berth No. 12

### 2.3.3 Present Condition of Revetments

The revetment behind the berths is of a concrete retaining wall type. According to the available design drawings of the wall, the original elevation of the crest was +6.00 m. However, the surveyed elevations of the existing crest range between +5.7 m and +5.9 m, which has apparently settled about 0.1 to 0.3 m from the original level.

The present conditions of the armor stones have been inspected by two divers over the length of 500 m, from the mid-point between Berth Nos. 10 and 11 to the Harbor Master's Office. The inspection has revealed that the armor stones generally maintain their designed shape, and no appreciable collapse or break is found. The typical revetment sections measured by the inspection are shown in Fig. 2-32 through 2-34.

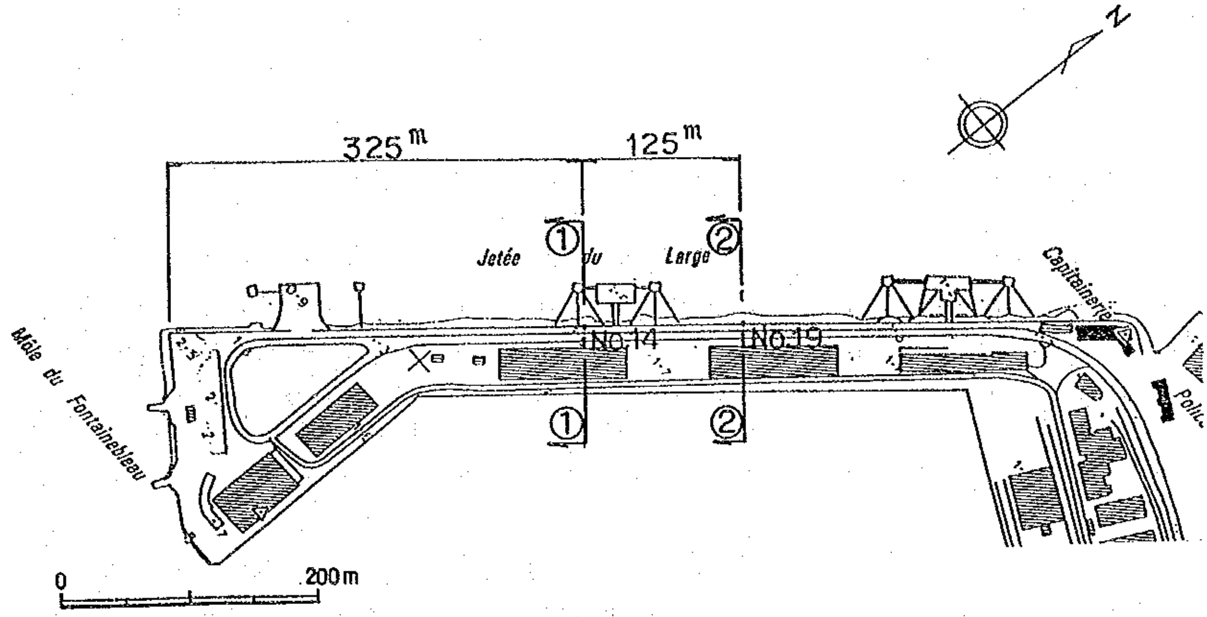



Figure 2-32 Location of Typical Cross Sections of Revetment

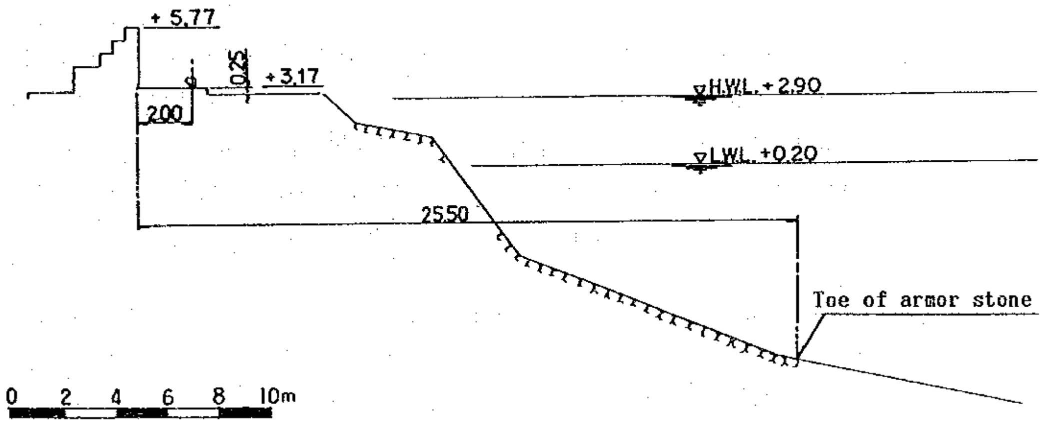



Figure 2-33 Cross Section of Revetment ① - ①

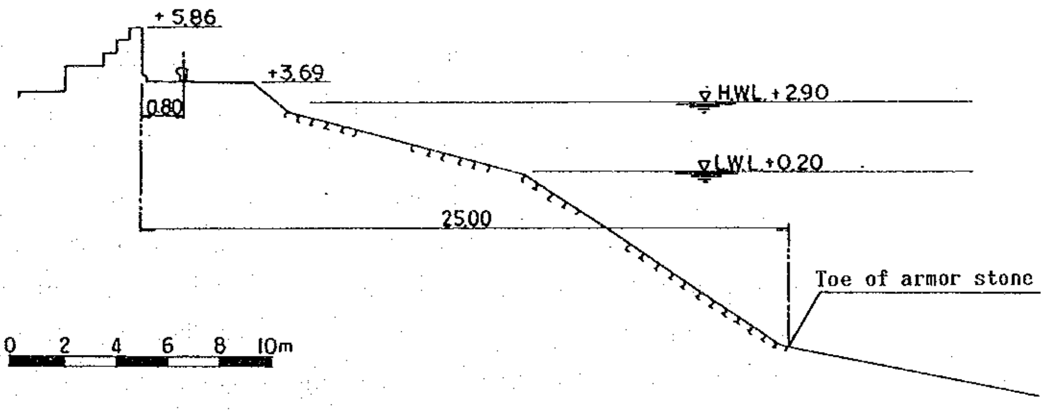



Figure 2-34 Cross Section of Revetment ② - ②

### 2.3.4 Evaluation of Existing Oil-Berth Facilities

The results of the field investigation and the evaluation made on the existing facilities of Berth Nos. 11 and 12 have led to the conclusion that to construct the new berths is more advantageous than to continue using the existing facilities by rehabilitating them.

a) According to the available design drawings for the berths, the original fenders were made of wood material, but were replaced in 1986 by the present larger fenders to cope with the increased berthing forces by larger vessels. To fend off the expected berthing forces, the fenders of this size seem to be necessary; however, no consideration has so far been given to reinforcing of the dolphin and platform structures. As a result, pile bodies and heads have been damaged due to the increased horizontal berthing forces.

b) The dolphins of Berth No. 11 and dolphins and platform of Berth No. 12 are no longer capable by themselves of bearing the horizontal forces of berthing and earthquake. All of these forces are supported by the horizontal anchors or stays which connect these superstructures to the revetment. The structure using these horizontal connecting members involves the following problems:

    i) Because the dolphin at Berth No. 11 is supported by a single stay of steel pipe, the internal stress in the actual steel pipe stay of which the thickness is eroded by more than 5 mm exceeds the allowable stress of the stay when the allowable maximum reaction of the fender is imposed, even though the original section of the stay remains. Thus, the steel pipe stay is estimated to not be capable of bearing the fender's reaction at all.

    ii) The horizontal connecting members of the dolphins at Berth No. 12 were replaced in 1984 by the new horizontal stay composing of a pair of steel pipes. Since the connecting members are located at the tidal zone, one of the horizontal anchors was already disconnected due to the severe erosion and the wave actions. When a ship moors at a certain horizontal angle to the face line of berth, a force will act on the dolphin in the direction of the line, and the existing horizontal connecting members are not capable of bearing such force. There exist many cracks in the concrete beam horizontal member, connecting the platform to the revetment, and at some points, severe shear failures occurred.

iii) In addition, the type of existing structures, using the horizontal connecting members, may create different movements between the revetments and berths once earthquake occurs, thus, resulting in undesirable effects on the structures.

c) Only the platform at Berth No. 11 is of the self-standing type by its own batter piles, unlike other parts of Berth Nos. 11 and 12. However, the upper parts of both of the two pairs of the batter piles have been damaged due to the berthing forces of the large vessels far exceeding the originally designed bearing forces of the piles. Because of this, the piles have been under the condition that they can no longer sustain the horizontal forces, and could easily collapse even by a slight force due to the movement of vessels or earthquake.

Even if it is assumed that the piles have the originally designed strength, the piles have only 1/32 of the required bearing capacity against the expected berthing forces.

d) If no measures are taken to improve the existing conditions of the berths, the degradations of concrete and reinforcing steel bars will continuously proceed, and may cause further reduction of their strength. Since the dolphins and platforms have been under unstable conditions, it is quite possible that a severe accident will occur unless the present system is renewed immediately.

e) If the existing berths are to be continuously used after rehabilitation, there will be many structural problems as mentioned above, and as such, the concept to rehabilitate the existing facilities appears to not be appropriate. For the rehabilitation of the facilities, much more costs must be expended and the economic life of the rehabilitated facilities could be shorter than that of the renewed facilities.

f) From the overall justification on the results of field investigations and analyses, it is concluded that the construction of new berths is more appropriate than to continuously use the existing berths by rehabilitation.

## 2.4 Oil Distribution/Storage Facilities

### 2.4.1 Oil Distribution Pipelines

The oil storage tanks of three international oil companies, namely Shell, Mobil and Total, are connected to the berths of the Port through the oil distribution pipelines as shown in Fig. 2-35.

The pipelines between Berth No. 12 and Point B are jointly used by the three oil companies. Diameters of the pipelines for fuel oil, gas oil and white products are 12, 12 and 10 inches respectively. The pipelines of 12 inches in diameter, between Berths No. 9 and No. 11, are partly two parallel pipelines, each being used for transporting fuel oil and white products. The pipelines between Points B and C, with the same diameters as other pipelines, are used as common pipes of the three oil companies.

The owner of the pipelines between Points A and C is Mobil, whereas those between Points C and D are owned by Total. The pipelines from Point D to the Mobil's oil storage tanks are provided for Mobil's exclusive use.

The pipelines between Point D and Berth No. 2, with a diameter of 10 inches for both fuel oil and gas oil pipes, are owned by Mobil and Total. The pipelines from Point A to Point C, from Point C to Point D, and from Point D to Berth No. 2 were replaced recently by new ones. The pipelines laid two years ago between the Point B and Point C, are jointly used by the three Companies.

A coordinating company has been selected every year among the three companies, and Mobil is the coordinating company for 1993. The maintenance costs of the common pipelines are shared among the three companies.

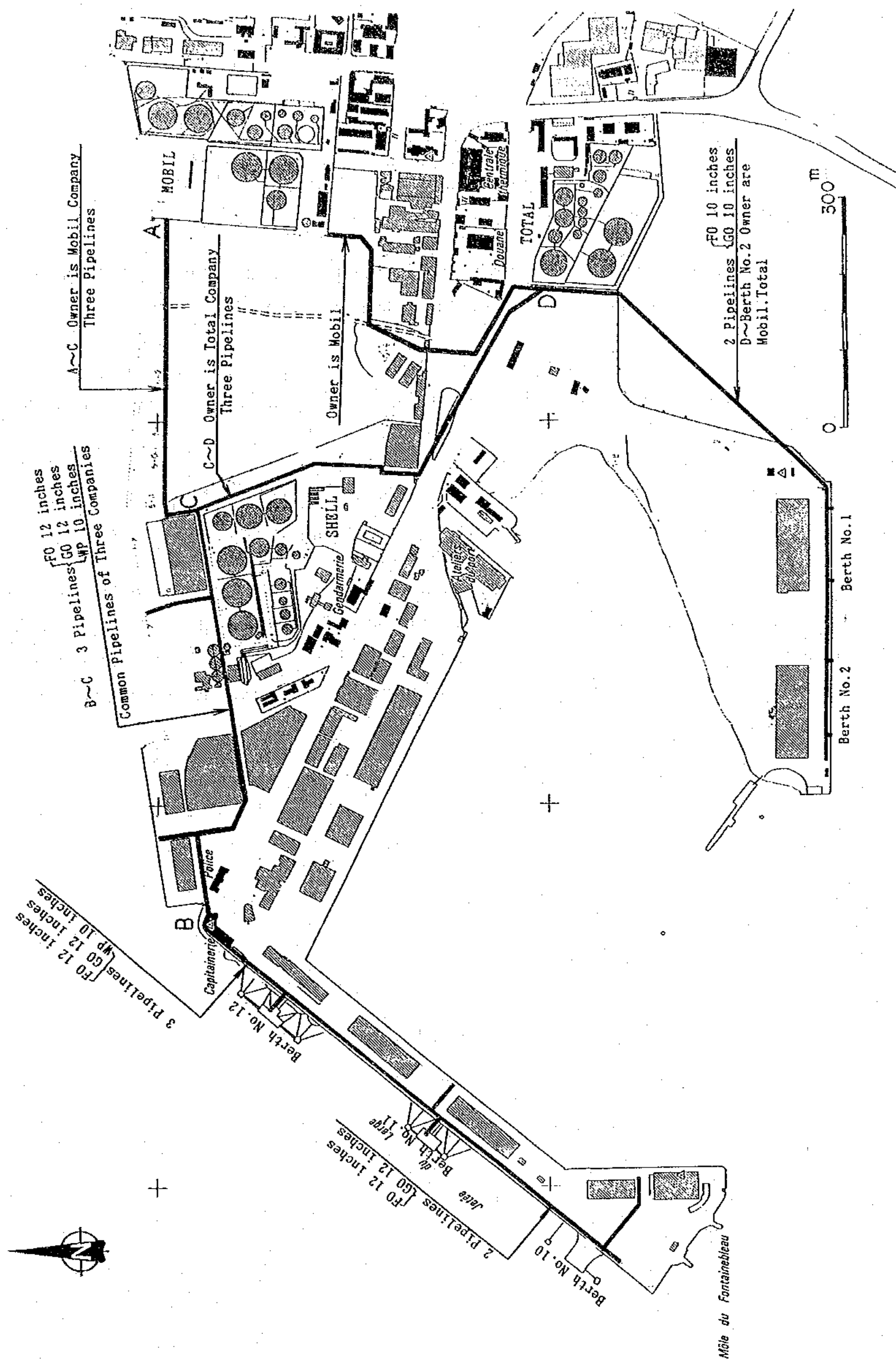



Figure 2-35 Plan of Oil Distribution Pipelines

### 2.4.2 Oil Storage Facilities

Each terminal of the three companies has several oil storage tanks, and the total oil storage capacity of the three companies is approximately 200,000 $m^3$.

As shown in Fig. 2-36, Shell has a total of 13 storage tanks, however, at present 2 tanks have been out of use, with the total available oil storage capacity of 60,890 $m^3$.

Totally 13 tanks are provided in Mobil's storage complex, as illustrated in Fig. 2-37, out of which 12 tanks are used for oil storage. The total oil storage capacity of these tanks is 81,896 $m^3$.

Total has 15 tanks in its complex, as shown in Fig. 2-38, of which 12 tanks are used for oil storage. The total storage capacity of the oil tanks is 56,724 $m^3$.

The oil from tankers is distributed to each of the oil terminals by means of pumps equipped on board. Oil bunkering from the oil terminals to ships is provided with pumps in the oil terminals. For bunkering of less than 10 kl of oil, the oil companies use a tank lorry to supply the oil. For inland oil transportation, the oil companies use oil wagons or tank lorries owned by themselves.

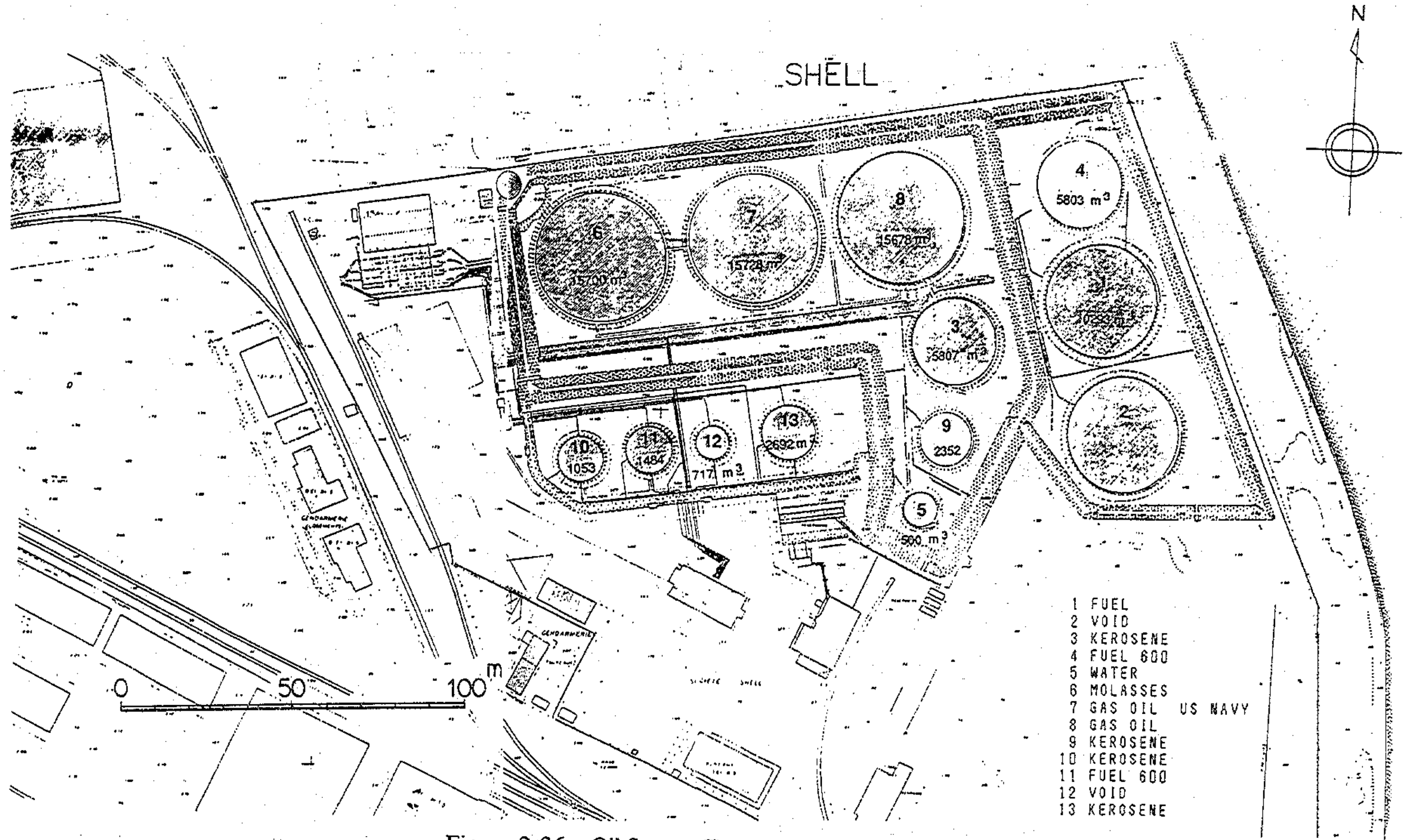



Figure 2-36 Oil Storage Terminal Plan (Shell)

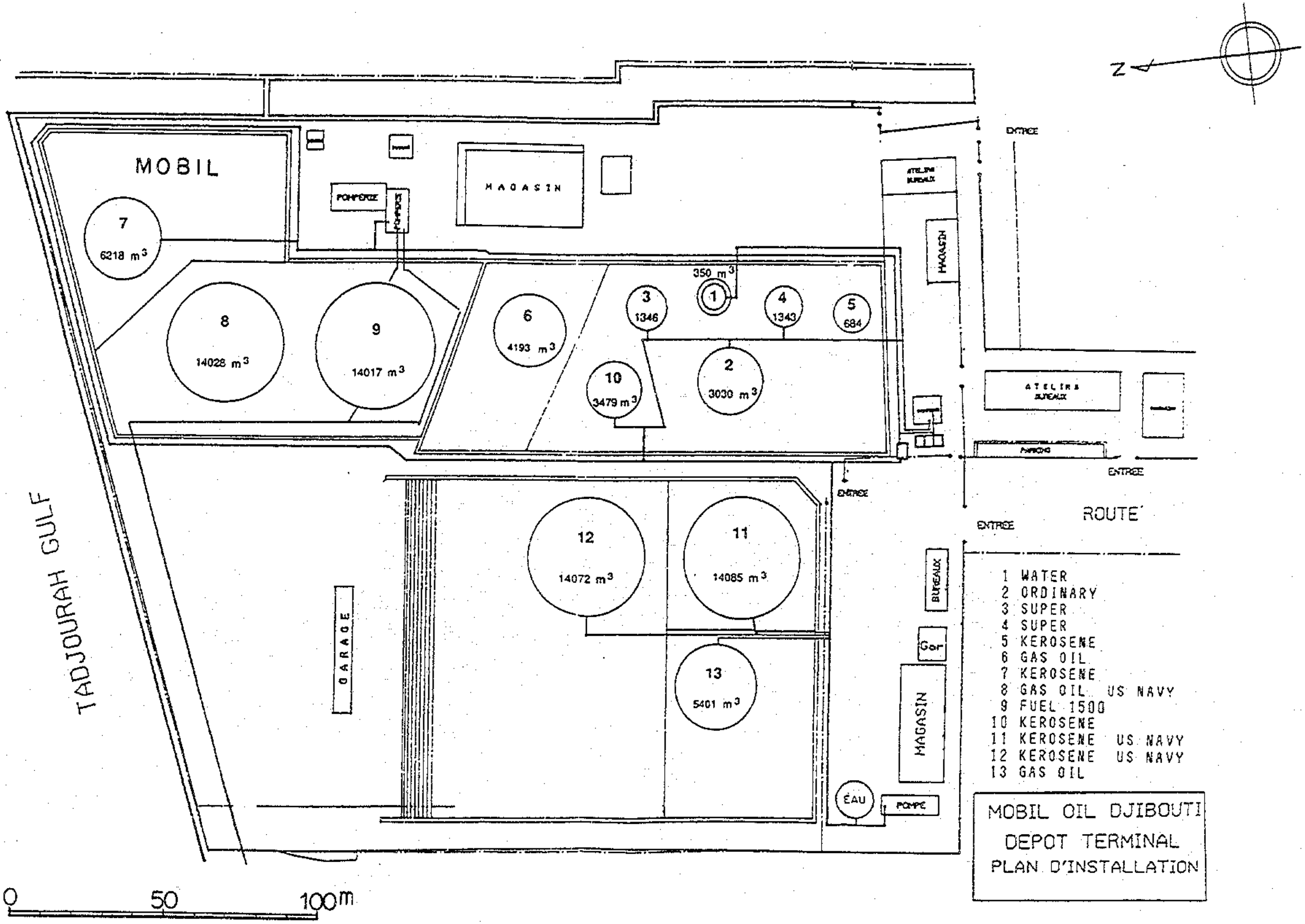



Figure 2-37 Oil Storage Terminal Plan (Mobil)

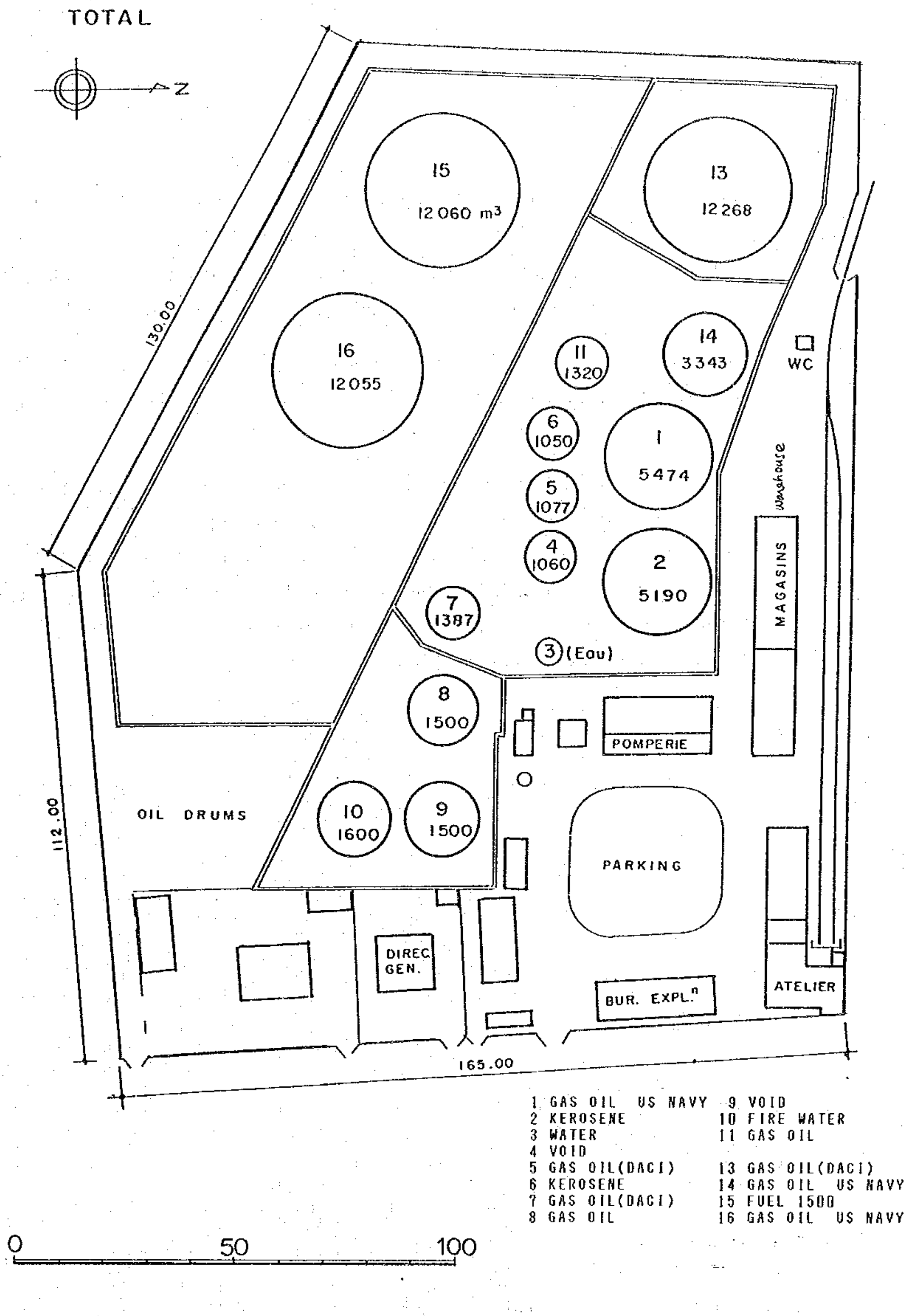



Figure 2-38 Oil Storage Terminal Plan (Total)

## 2.5 Railways

### (1) General

The construction of the Djibouti-Ethiopian Railways (C.D.E.) was started in 1896 and completed in 1917, presently serving a total of 782 km, of which a portion of about 100 km belongs to Djibouti. The operating route and 35 stations existing between Djibouti and Addis Abeba are shown in Fig. 2-39.

This railway system starts from the Port of Djibouti and ends at Addis Ababa, and has a maximum inclination of 27 ‰. The spurs to the oil terminals are owned by the oil companies.

The C.D.E. has a firm function as the relay base traffic network for neighboring countries. According to the five-year plan, the total import traffic volume is expected to increase up to 246,000 tons by 1995/1996, a little less than 150 percent of the volume in 1990. The amount of export also increases up to 198,000 tons, a little less than 160 percent compared with the 1990 volume. These are shown in the following table:

Table 2-14 Planned Railway Cargo Volume (1991/92 to 1995/96)

| | Major Commodities | 1990-91 (tons) | 1991/92 (tons) | 1992/93 (tons) | 1993/94 (tons) | 1994/95 (tons) | 1995/96 (tons) |
|---|---|---|---|---|---|---|---|
| 1. | Djibouti → Ethiopia | | | | | | |
| | Steel | 25,000 | 25,000 | 35,000 | 35,000 | 40,000 | 40,000 |
| | Cereals | 30,000 | 30,000 | 30,000 | 20,000 | 20,000 | 20,000 |
| | Oil products | 50,000 | 50,000 | 60,000 | 60,000 | 65,000 | 65,000 |
| | Fertilizer | 15,000 | 20,000 | 30,000 | 40,000 | 40,000 | 45,000 |
| | Chemical product | 5,000 | 5,000 | 5,000 | 9,000 | 9,000 | 9,000 |
| | Vehicles | 2,000 | 2,000 | 3,000 | 4,000 | 4,000 | 4,000 |
| | Others | 40,000 | 40,000 | 53,000 | 58,000 | 58,000 | 63,000 |
| | Sub Total | 167,000 | 172,000 | 216,000 | 226,000 | 236,000 | 246,000 |
| 2. | Ethiopia → Djibouti | | | | | | |
| | Molasses | 45,000 | 45,000 | 53,000 | 54,000 | 54,000 | 60,000 |
| | Sugar | 48,000 | 48,000 | 72,000 | 80,000 | 83,000 | 83,000 |
| | Dry vegetables, etc. | 2,000 | 5,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| | Cattle | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 7,000 |
| | Vegetable and fruits | 20,000 | 20,000 | 25,000 | 25,000 | 28,000 | 28,000 |
| | Others | 5,000 | 8,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| | Sub Total | 125,000 | 131,000 | 175,000 | 184,000 | 190,000 | 198,000 |
| 3. | Domestic | | | | | | |
| | Cereals | 15,000 | 20,000 | 30,000 | 30,000 | 30,000 | 35,000 |
| | Sugar | 6,000 | 9,000 | 12,000 | 15,000 | 20,000 | 22,000 |
| | Cattle | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 9,000 |
| | Manufacturing articles | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 12,000 |
| | Vegetable and fruits | 6,000 | 6,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| | Cement | 6,000 | 6,000 | 17,000 | 20,000 | 25,000 | 25,000 |
| | Others | 15,000 | 15,000 | 15,000 | 20,000 | 20,000 | 20,000 |
| | Sub Total | 66,000 | 74,000 | 102,000 | 113,000 | 123,000 | 133,000 |
| | Grand Total | 358,000 | 377,000 | 493,000 | 523,000 | 549,000 | 577,000 |

Source: C.D.E

Djibouti - Addis Ababa = 782 km
Dire Dawa - Addis Ababa = 450 km
Djibouti - To border = 100 km

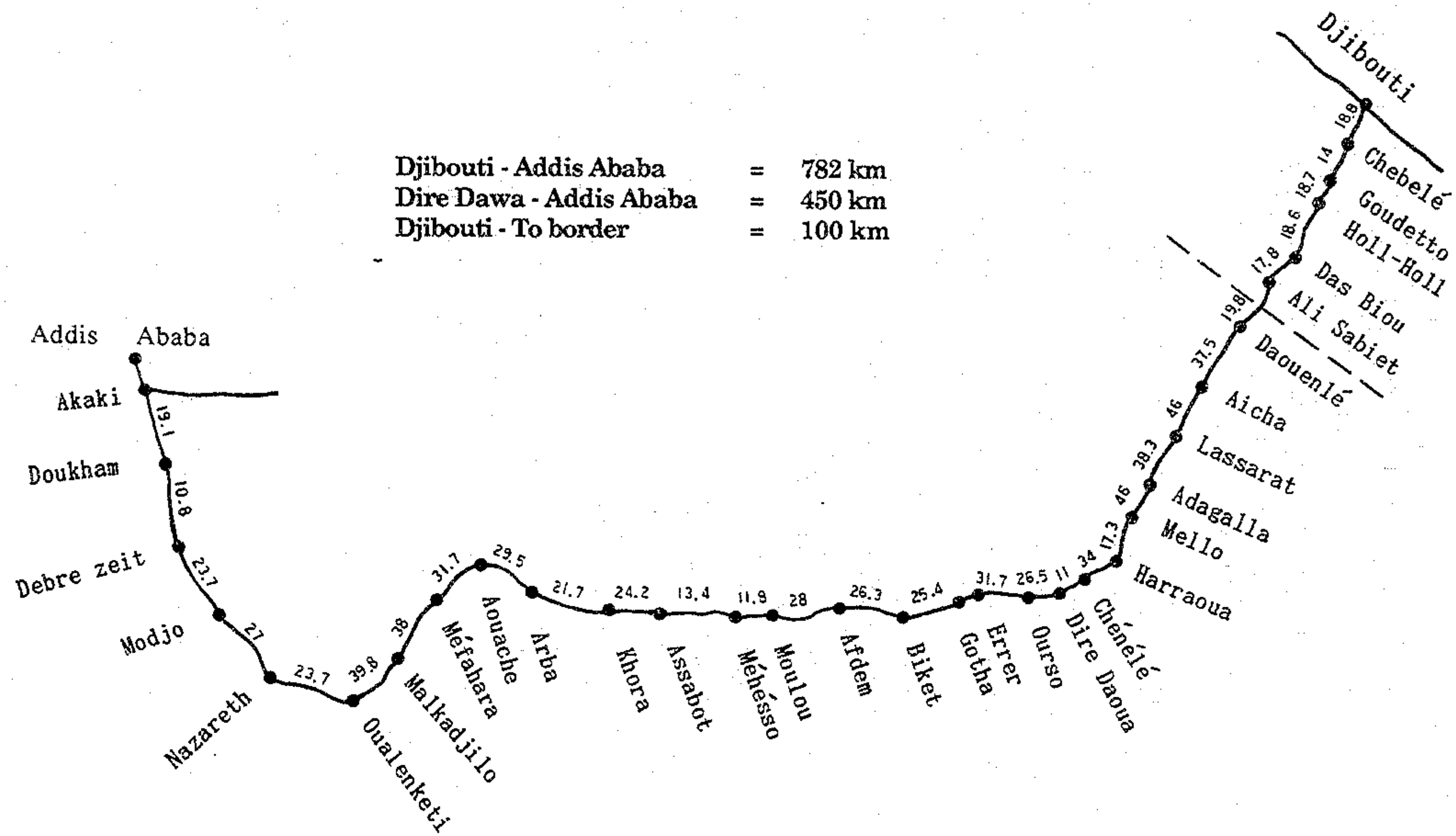



Figure 2-39 Working Route of C.D.E

(2) Organization

The headquarters of CDE is located in Addis Ababa. CDE is administered by an administrative committee. This administrative committee is composed of twelve (12) members, six each national assigned for a four year term.

CDE is managed by a staff as follows:

| | | |
|---|---|---|
| (1) | General Director | stationed at Addis Ababa |
| (1) | Assistant General Director | stationed at Addis Ababa |
| (1) | Technical Director | stationed at Djibouti |
| (1) | Commercial Director | stationed at Djibouti |
| (1) | Administrative/Financial Director | stationed at Addis Ababa |
| (1) | Personnel Director | stationed at Addis Ababa |

As a whole, CDE employs 2,570 workers of which 382 are working in Djibouti.

(3) Transportation Capacity of C.D.E.

C.D.E. has a total of 107 railway tank wagons with a capacity of 30 kl or 24 kl. In addition, 541 freight wagons, excluding the tank wagons, and 55 passenger cars belong to C.D.E. C.D.E. operates six passenger trains, and five or six freight trains a week (See Table 2-15).

Table 2-15 Rolling Stock owned by C.D.E.

| Type of Cars | Number of Cars | Remarks |
|---|---|---|
| Tank wagons | 107 | - |
| Freight wagons | 541 | - |
| Passenger cars | 55 | - |
| Locomotives | 6 | for main line use |
| Locomotives | 13 | for switching |

Source: C.D.E.

(4) Railway Fares

Passenger fares and freight charges of C.D.E. are as follows:

Table 2-16 Railway Passenger Fares

| Class | Fares (DF) | Section |
|---|---|---|
| First | 4,000 | Djibouti - Dire Dawa |
| Second | 3,000 | Djibouti - Dire Dawa |
| Third | 2,000 | Djibouti - Dire Dawa |

Source: C.D.E.

Table 2-17 Railway Freight Charges

| Products | Rate (DF/ton) | Section |
|---|---|---|
| White oil | 8,345 | Djibouti - Dire Dawa |
| White oil | 13,247 | Djibouti - Addis Ababa |
| Heavy oil | 6,720 | Djibouti - Dire Dawa |
| Heavy oil | 13,247 | Djibouti - Addis Ababa |

Source: C.D.E.

(5) Reconstruction Funds to C.D.E.

The European Union has contributed a fund of 450 million French Francs to C.D.E., and a further 35 million ECUs was already committed to finance C.D.E. Besides, Italy, France and Japan have provided financial assistance to C.D.E. for procurement of spare parts for the telecommunication system.

# Chapter 3 Demand Forecast

# CHAPTER 3 DEMAND FORECAST

The purpose of this Chapter is to estimate domestic demand, transshipment, and bunker supply of petroleum products in Djibouti in the year of 2010, in order to allocate oil berths in Djibouti port to tanker vessels loading and unloading these petroleum products.

## 3.1 Socio-Economic Background

### 3.1.1 Economic Indicators

As shown in Table 3-1, according to the Government statistics, the population of Djibouti was 519,900 at the middle of 1991 including the population of refugees which was said to be around 100,000. Gross domestic products of Djibouti in 1988 was 40,125 million Djibouti francs, that made GDP per capita in Djibouti 89,166 FD in 1988 (502 US dollars). This GDP per capita was considerably higher than those of the neighboring countries, such as Ethiopia (118 US dollars) and Somalia (156 US dollars).

Consumer prices were relatively stable and the exchange rate of Djibouti francs to US dollars has been fixed at 177.72 FD since 1974 as shown in Table 3-1.

### 3.1.2 Finance

Table 3-2 shows the budgetary balance of the Government from 1981 to 1991. Budgetary balance had been in the surplus until 1987, but had been in most years at break-even level since 1988. In the 1991 Budget, total revenue was 26,387 million FD, of which tax revenue was 19,023 million FD and most of the other revenues came from drawings from various foreign aid funds.

The amount of official development assistance from bilateral and multilateral sources amounted to 116.9 million US dollars in 1991, and France contributed most in bilateral assistance in the amount of 48.9 million US dollars as shown in Table 3-3. Djibouti's external debt at the end of 1991 was 197 million US dollars.

Table 3-1 Economic Indicators in Djibouti

| | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|
| Population(1000) | 180 | 195 | 212 | 230 | 250 | 300 | 330 | 345 | 355 | 366 |
| GDP at current price (million FD) | | | | | | | 19,839 | | | |
| GDP per Capita (FD) | | | | | | | 60,119 | | | |
| GDP per Capita (US$) | | | | | | | 338 | | | |
| Consumer Price Index (January 1984=100) | | | | | | | | | | |
| Exchange rate FD:$ | 197.47 | 179.94 | 177.72 | 177.72 | 177.72 | 177.72 | 177.72 | 177.72 | 177.72 | 177.72 |

| | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| Population(1000) | 372 | 383 | 405 | 430 | 456 | 483 | 500 | 510 | | 520 |
| GDP at current price (million FD) | | 27,959 | 30,844 | 33,562 | 35,111 | 37,580 | 40,125 | | | |
| GDP per Capita(FD) | | 75,566 | 80,115 | 83,906 | 84,403 | 87,396 | 89,166 | | | |
| GDP per Capita(US$) | | 425 | 451 | 472 | 475 | 492 | 502 | | | |
| Consumer Price Index (January 1984=100) | | | 100.7 | 102.0 | 120.4 | 125.4 | 133.4 | 137.5 | 148.1 | 158.1 |
| Exchange rate FD:$ | 177.72 | 177.72 | 177.72 | 177.72 | 177.72 | 177.72 | 177.72 | 177.72 | 177.72 | 177.72 |

Source: DINAS

Table 3-2: The Government Budget

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|
| Revenues | 27,473 | 33,716 | 30,040 | 25,915 | 25,782 | 24,494 |
| : of which | | | | | | |
| Tax Revenues | 15,469 | 16,450 | 16,372 | 16,900 | 17,744 | 17,041 |
| Expenditures | 18,046 | 25,399 | 25,470 | 22,776 | 23,452 | 23,133 |
| Balance | 9,427 | 8,317 | 4,570 | 3,140 | 2,330 | 1,361 |

| | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|
| Revenues | 24,315 | 23,516 | 24,853 | 25,876 | 26,387 |
| : of which | | | | | |
| Tax Revenues | 17,045 | 17,936 | 18,885 | 18,864 | 19,023 |
| Expenditures | 22,973 | 23,516 | 24,853 | 25,803 | 26,013 |
| Balance | 1,342 | 0 | 0 | 74 | 374 |

Source: DINAS

Table 3-3: Gross Official Development Assistance and External Debt (million $)

| | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|
| Bilateral | 79.2 | 68.6 | 182.9 | 90.1 |
| of which: | | | | |
| France | 41.6 | 40.5 | 58.4 | 48.9 |
| Italy | 17.3 | 13.0 | 18.3 | 22.1 |
| Arab countries | 7.6 | 3.7 | 91.9 | 5.3 |
| Multilateral | 22.2 | 13.7 | 20.4 | 26.8 |
| of which: | | | | |
| ADF | 4.7 | 1.4 | 6.0 | 6.5 |
| EC | 2.5 | 4.5 | 3.8 | 5.2 |
| WFP | 2.1 | 1.0 | 0.6 | 4.2 |
| IDA | 5.0 | 2.0 | 3.0 | 3.0 |
| Total | 101.4 | 82.3 | 203.3 | 116.9 |
| of which: | | | | |
| grants | 78.9 | 65.9 | 175.4 | 94.2 |

Source: OECD, Geographical Distribution of Financial Flows to Developing Countries

| | | | | |
|---|---|---|---|---|
| External Debt (Million US$) | 185 | 180 | 210 | 197 |

Source: IMF, International Financial Statistics

### 3.1.3 Foreign Trade

External trade and transshipment are the main commercial activities in Djibouti. As shown in Table 3-4, the volume of cargoes handled at the Djibouti port was around one million metric tons during 1984 and 1988. The Gulf war and international aid commodities to Ethiopia suffering famine and political conflicts helped boost the activities of Djibouti Port in addition to the completion of the container yard.

Petroleum trade has been decreased, as shown in Table 3-4, from 1,104 thousand tons in 1983 to 467 thousand tons in 1991 due to improvements in the services and facilities at the competing neighboring ports, such as Jidda and Aden, political difficulties in Ethiopia and Somalia, and out-dated facilities of Djibouti port. For reference, the major ports around the Red Sea area with their characteristics are listed in Table 3-5. The rate of petroleum import amount also decreased to 7.1 percent in 1990 from 9.4 percent in 1983, but rebounded to 9.2 percent in 1991 on account of active transshipment to Ethiopia.

### 3.1.4 Domestic Energy Consumption

Djibouti is required to import all its energy needs since it produces no energy resources. Only fuelwood can be counted as an indigenous energy resource, but its contribution to the national energy supply has been limited. In the final energy consumption, only petroleum products and electricity are used, but all electricity has been produced through expensive diesel generators fueled by gas oil and fuel oil which account for almost half of the total domestic petroleum consumption. Djibouti should be viewed as a "single-energy economy."

As indicated in Table 3-6, Djibouti's total energy consumption was 98,524 million Kcal and 189 thousand Kcal per capita in 1991 compared with 287 thousand Kcal in 1981. The decrease was considered due to the rapid increase of population resulting from refugees flowing in from the neighboring countries. The energy consumed to produce million Djibouti francs of gross domestic products(energy intensity) was 2.66 million Kcal in 1988 compared with 3.75 million Kcal in 1983.

## Table 3-4: Foreign Trade

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Trade** | | | | | | | | | | | | |
| 1000MT | 1,256 | 1,189 | 1,249 | 1,513 | 1,346 | 1,067 | 990 | 1,185 | 1,026 | 800 | 1,456 | |
| Million FD | | 41,419 | 42,429 | 41,226 | 41,787 | 38,158 | 36,359 | 41,463 | 39,887 | 39,343 | 42,596 | |
| **Import** | | | | | | | | | | | | |
| 1000MT | 795 | 778 | 806 | 924 | 867 | 778 | 748 | 805 | 768 | 613 | 905 | 1,339 |
| million FD | | 39,865 | 40,197 | 39,307 | 39,425 | 35,670 | 32,731 | 36,487 | 35,771 | 34,920 | 38,174 | 38,103 |
| **Export** | | | | | | | | | | | | |
| 1000MT | 461 | 411 | 443 | 584 | 479 | 289 | 242 | 380 | 258 | 187 | 551 | |
| Million FD | 2,221 | 1,554 | 2,232 | 1,919 | 2,362 | 2,488 | 3,628 | 4,976 | 4,116 | 4,423 | 4,422 | 3,083 |
| **Petroleum Trade** | | | | | | | | | | | | |
| 1000MT | 861 | 729 | 853 | 1,104 | 817 | 458 | 373 | 464 | 411 | | 707 | 467 |
| **Import** | | | | | | | | | | | | |
| 1000MT | 514 | 470 | 507 | 635 | 486 | 308 | 286 | 328 | 324 | 292 | 439 | 369 |
| Million FD | | | | 3,708 | 3,423 | 3,507 | 2,336 | 2,606 | 2,543 | 2,339 | 2,716 | 3,524 |
| **Export** | | | | | | | | | | | | |
| 1000MT | 347 | 259 | 346 | 469 | 331 | 150 | 87 | 136 | 87 | | 268 | 98 |
| Million FD | Not Available | | | | | | | | | | | |
| **Total vs. Petroleum** | | | | | | | | | | | | |
| Quantity % | | | | | | | | | | | | |
| Total trade | 68.6 | 61.3 | 68.3 | 73.0 | 60.7 | 42.9 | 37.7 | 39.2 | 40.1 | | | |
| Import | 64.7 | 60.4 | 62.9 | 68.7 | 56.1 | 39.6 | 38.2 | 40.7 | 42.2 | 47.6 | 48.5 | 27.6 |
| Export | 75.3 | 63.0 | 78.1 | 80.3 | 69.1 | 51.9 | 36.0 | 35.8 | 33.7 | | | |
| Amount % | | | | | | | | | | | | |
| Import | | | | 9.4 | 8.7 | 9.8 | 7.1 | 7.1 | 7.1 | 6.7 | 7.1 | 9.2 |

Source: DINAS, PAID

## Table 3-5 Bunkering at Major Ports around the Red Sea

| Name of Port | Nation | Price of Bunker Oil [1)] | Bunkering Information [2)] |
|---|---|---|---|
| Aden | Yemen | D/O $260<br>F/O $110 to 120 (180CST) | F/W: Available<br>F/O: 3500, 2500, 1000, 600, 200 SEC OK |
| Berbera | Somalia | N/A (Not available) | F/W: Alongside OK (15T/H)<br>F/O: N/A |
| Bosaso | Somalia | - No information | - No information |
| Assab | Eritrea | N/A | F/W: OK, F/O: All grade available (Required advance notice) |
| Massawa | Eritrea | N/A | F/W: Alongside only<br>D/O: Supply by tank truck<br>F/O: Alongside only |
| Port Sudan | Sudan | N/A | F/O: 1000 SEC only<br>(Required advance notice available) |
| Hodeidah | Yemen | N/A | F/W: Available<br>Only small quantity of D/O available |
| Mogadicio | Somalia | N/A | F/W: Alongside<br>F/O: May available, inquire agent |
| Jidda | Saudi Arabia | D/O $240<br>F/O $ 81(180CST) Barge delivery | F/W: Available<br>F/O: All type bunker available |

Notes 1. Source 1) Japanese Shipping Company
2) "Guide to port entry, 1993"
2. D/O : Diesel oil (Gas oil)
F/O : Fuel oil
F/W : Fuel/Water
3. CST : Centi Stokes (Classification of oil)
SEC : Red Wood (Classification of oil)
3500 SEC Å‡380CST, 2500 SEC Å‡280 CST, 1500 SEC Å‡180 CST.
Larger figure shows higher viscosity and lower quality.
Ocean going vessels, domestic ferry, fishing boats are using 380 CST, 180 CST and D/O respectively.

Table 3.6: Oil Consumption and Electricity Generation

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Petroleum Products(Kl) | | | | | | | | | | | | |
| Gasoline | 14,250 | 14,345 | 13,932 | 13,560 | 13,034 | 13,122 | 13,112 | 13,740 | 12,529 | 12,320 | 12,303 | 11,949 |
| Kerosene | 8,390 | 9,465 | 9,893 | 10,777 | 11,888 | 12,257 | 12,651 | 13,154 | 13,651 | 13,965 | 14,625 | 15,229 |
| Gas Oil | 24,539 | 21,102 | 28,496 | 26,466 | 29,328 | 32,907 | 36,194 | 36,651 | 31,476 | 32,352 | 37,523 | 31,871 |
| Fuel Oil | 27,825 | 32,981 | 38,505 | 38,408 | 37,990 | 39,522 | 41,120 | 44,885 | 41,015 | 50,466 | 48,877 | 50,025 |
| Total | 75,004 | 77,893 | 90,826 | 89,211 | 92,240 | 97,808 | 103,077 | 108,430 | 98,671 | 109,103 | 113,328 | 109,074 |
| Imported Oil(Kl) | 76,578 | 79,884 | 92,825 | 91,002 | 93,954 | 99,771 | 104,989 | 110,087 | 100,260 | 110,756 | 115,055 | |
| Total Energy Consumption (million kcal) | 105,267 | 106,511 | 104,792 | 102,810 | 100,410 | 101,639 | 102,197 | 106,912 | 98,644 | 97,659 | 98,524 | 96,124 |
| Per Capita (1000 Kcal/head) | 287 | 286 | 274 | 254 | 234 | 223 | 211 | 214 | 193 | | 189 | |
| Energy Intensity (Kcal/FD) | | | 3.75 | 3.33 | 2.99 | 2.89 | 2.72 | 2.66 | | | | |
| Electricity generated(MWh) | 119,505 | 126,563 | 142,188 | 140,863 | 158,827 | 164,020 | 173,408 | 185,949 | 180,106 | 193,139 | 197,583 | 206,044 |
| Per Capita (KWh/head) | 327 | 340 | 371 | 348 | 369 | 360 | 359 | 372 | 353 | | 380 | |

Source: DINAS

## 3.2 Trends in Ocean Traffic

In 1991, the total number of vessels calling at Djibouti Port, as shown in Table 3-7, reached 1,208 with combined 5,824 thousand tons net, of which oil tankers were 98.

Table 3-7: Evolution of Number of Vessels calling at Port of Djibouti

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of Vessels | 1,109 | 1,067 | 1,029 | 937 | 898 | 955 | 1,130 | 1,213 | 950 | 1,067 | 1,208 |
| Net Tonnage(1000) | 5,547 | 6,376 | 5,253 | 4,273 | 4,198 | 4,626 | 4,190 | 4,276 | 3,874 | 4,960 | 5,824 |
| Of which: | | | | | | | | | | | |
| Oil Tankers | | | | 108 | 81 | 69 | | 89 | 86 | 108 | 98 |
| Net Tonnage(1000) | | | | | | | | | | | |
| Number % | | | | 11.5 | 9.0 | 7.2 | | 7.3 | 9.1 | 10.1 | 8.1 |
| Net Tonnage % | | | | | | | | | | | |

Source: PAID

## 3.3 Trends in Oil Traffic

Table 3-8 shows the size of typical oil takers calling at Djibouti Port in 1991. Ship lengths of the petroleum product tankers varied from 95 meters to 342 meters, but most of them centered around 175 meters. Drafts of the tankers were less than 11 meters. Gross tonnage was mostly between 16,000 and 19,000 with a few exceptions.

Table 3-8: Main Tanker Size (1991)

| Tanker Name | Length (m) | Draft (m) | Gross tonnage | Net Ton |
|---|---|---|---|---|
| Cielo di Roma | 172 | 8 | 18,161 | 10,845 |
| General Pliev | 179 | 8 | 18,495 | 9,128 |
| Romiro | 321 | 9 | 98,905 | 80,974 |
| Chlham Castle | 171 | 11 | 16,595 | 11,053 |
| Shiphone | 122 | 7 | 4,296 | 1,359 |
| Cielo di Napoli | 171 | 8 | 18,598 | 13,782 |
| Sand Gate | 171 | 11 | 16,585 | 11,063 |
| Overseas Valdez | 198 | 10 | 20,879 | 16,471 |
| Flamina | 229 | 9 | 38,629 | 18,271 |
| Athenien Olympic | 178 | 11 | 18,509 | 8,883 |
| Ranger | 181 | 10 | 21,512 | 16,498 |
| Conastoga | 174 | 11 | 17,506 | 10,589 |
| World Protector | 171 | 10 | 18,204 | 12,312 |
| Captain Kyriakou | 179 | 10 | 18,509 | 10,203 |
| Irkut | 130 | 7 | 11,100 | 8,894 |
| Pride | 175 | 7 | 23,290 | 10,185 |
| Awash | 95 | 5 | 2,492 | 1,127 |
| Overseas Orions | 202 | 8 | 20,879 | 16,471 |
| Myrtea | 171 | 9 | 19,173 | 18,732 |
| Brooklyn | 342 | 9 | 103,904 | 90,852 |
| Padia | 174 | 9 | 16,948 | 11,458 |
| Mobil Produce | 172 | 9 | 19,258 | 11,536 |
| Louise | 192 | 10 | 19,925 | 8,178 |
| Iz | 176 | | 22,601 | 13,114 |

Source: PAID

In 1990, the average anchoring time of tankers in Djibouti port was 41 hours and 15 minutes, of which the average berthing time was 39 hours and 15 minutes. In 1992, they were shortened to 39 hours 26 minutes and 30 hours 23 minutes respectively.

## 3.4 Trends in Oil Demand

In Djibouti, petroleum demand is divided into 3 categories; they are domestic demand, bunker supply, and transshipment. The evolution of the demand for each sector is shown in Table 3-9.

### 3.4.1 Domestic Consumption

There are three international major oil companies operating in Djibouti. They are Mobil, Shell and Total. They all have their own oil terminals at the port of Djibouti and are handling all petroleum products. Mobil has the largest share with almost 50 percent, and the other two companies have around 25 percent each.

Domestic consumption for petroleum in Djibouti, consists of six main products, namely premium gasoline, regular gasoline, kerosene, jet fuel, gas oil, and heavy fuel oil. Gasoline is used for motor vehicles exclusively and sold at about 20 service stations under the brand names of Mobil, Shell, and Total. Only Mobil is importing gasoline and the other two oil companies purchase gasoline from Mobil.

Kerosene is used for cooking in the residential sector, and jet fuel for aviation. Use of gas oil varies from motor vehicles, electricity generation, railways, agriculture to industry. The transportation sector consumes most of it.

Fuel oil is solely used for electricity generation in the domestic market. Electric de Djibouti (EDD) makes a bid for the purchase of fuel oil every three years, and Shell is the supplier at present. EDD notifies the volume requirements for fuel oil to an oil company who must have a stock-holding equals to 3 months' supply, the cost of which is borne by EDD.

### 3.4.2 Transshipment

Djibouti Port has prospered as the gateway to Ethiopia and is the starting point of the railway to transship commodities to the capital of Ethiopia, Addis Abbeba. Though statistical data concerning transshipment of petroleum products has not been well-prepared in Djibouti, according to the data prepared by Etablissement Public des Hydrocarbures, the transshipment volume in 1992 was 141,741 kilo liters consisting of about 35% of the total volume of shipment. Gas oil was the largest product in volume in the transshipment.

Fuel oil transshipment had been made from Assab refinery to the Ethiopian market through Djibouti Port and Djibouti-Ethiopia railway.

Ethiopia once possessed a refinery in Assab, which had a capacity of 18,000 BD, but the refinery was taken over by Eritrea in accordance with the agreement of their independence. Since Eritrea has a small demand in oil and the refined products from the refinery is not suitable for the domestic products consuming pattern, considerable amount of fuel oil is transshipped to Ethiopia from Assab through the port of Djibouti. Somalia also has a small 10,000 BD refinery in Mogadishu, which is not in operation at present due to the political conflict in this area. Most of the petroleum products in Somalia are now supplied by U.S.A.

### 3.4.3 Bunker Supply

According to the statistics of Port Autonome International de Djibouti, bunker supply of petroleum products to vessels calling at Djibouti Port has decreased year by year from 337,168 tons and 725 vessels in 1980 to 59,367 tons and 295 vessels in 1991 as shown in Table 3-10.

This is because the competing ports, such as Jidda and Aden located in oil producing countries with refining facilities have been well-equipped for bunkering services as previously noted.

## Table 3.9: Evolution of Oil Demand

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Domestic Consumption | | | | | | | | | | | | |
| Premium Gasoline | 9,007 | 9,271 | 9,218 | 9,025 | 8,654 | 8,634 | 8,761 | 9,224 | 8,370 | 8,358 | 8,606 | 8,337 |
| Regular Gasoline | 5,243 | 5,074 | 4,714 | 4,535 | 4,380 | 4,488 | 4,351 | 4,516 | 4,159 | 3,962 | 3,697 | 9,293 |
| Kerosene/Jet Fuel | 8,390 | 9,465 | 9,893 | 10,777 | 11,888 | 12,257 | 12,651 | 13,154 | 13,651 | 13,965 | 14,625 | 15,229 |
| Gas Oil | 24,539 | 21,102 | 28,496 | 26,466 | 29,328 | 32,907 | 36,194 | 36,651 | 31,476 | 32,352 | 37,523 | 31,871 |
| Fuel Oil | 27,825 | 32,981 | 38,505 | 38,408 | 37,990 | 39,522 | 41,120 | 44,885 | 41,015 | 50,466 | 48,877 | 50,025 |
| Total | 75,004 | 77,893 | 90,826 | 89,211 | 92,240 | 97,808 | 103,077 | 108,430 | 98,603 | 109,103 | 113,328 | 114,825 |
| Bunker Supply | | | | | | | | | | | | |
| Aviation Gasoline | 202 | 986 | 398 | | 155 | 157 | 173 | 184 | 101 | 141 | 175 | 412 |
| Kerosene/Jet Fuel | 71,792 | 78,548 | 78,710 | 78,269 | 77,254 | 72,792 | 70,083 | 82,468 | 92,905 | 117,020 | 113,813 | 82,238 |
| Gas Oil | 31,608 | 46,185 | 40,383 | 42,713 | 49,356 | 48,352 | 49,003 | 69,775 | 53,071 | 70,784 | 45,557 | 49,108 |
| Fuel Oil | 230,693 | 211,904 | 109,768 | 77,100 | 67,846 | 46,028 | 71,380 | 59,338 | 26,447 | 37,445 | 24,286 | 17,665 |
| Total | 334,295 | 337,623 | 229,259 | 198,082 | 194,611 | 167,329 | 190,639 | 211,765 | 172,524 | 225,390 | 183,831 | 149,428 |
| Transshipment | | | | | | | | | | | | |
| Premium Gasoline | | | | | | | | | | | | |
| Regular Gasoline | | | | | | | | | | | | 3,126 |
| Kerosene/Jet Fuel | | | | | | | | | | | | 33,315 |
| Gas Oil | | | | | | | | | | | | 86,498 |
| Fuel Oil | | | | | | | | | | | | 18,802 |
| Total | | | | | | | | | 119,815 | 286,628 | 189,875 | 141,741 |
| Grand Total | | | | | | | | | 390,942 | 621,121 | 487,034 | 405,989 |

Source: PAID, EPH

## Table 3.10 . Marine Bunkering at Port of Djibouti

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Supplied Quantity(MT) | 337,168 | | | | 108,652 | 101,239 | | 84,824 | 128,858 | 65,134 | 81,670 | 59,367 |
| Vessels supplied | 725 | | | | 348 | 315 | | 309 | 292 | 278 | 315 | 295 |

Source: PAID

## 3.5 Demand Forecast

Demand forecast was made for petroleum products shipped to Djibouti domestic market, bunker supply, and transshipment by the type of oil in 2010 based on the assumptions described below:

### 3.5.1 Basic Assumptions

In this forecast, Djibouti's social and economic framework is set up as in Table 3-11.

Table 3-11 Forecast of Economic Indicators

| Year | 1988 | 1995 | 2000 | 2010 |
|---|---|---|---|---|
| Population(1,000) | 500 | 615 | 713 | 958 |
| GDP(million FD) | 40,125 | 60,333 | 80,739 | 144,931 |
| GDP per Capita(FD) | 80,250 | 98,102 | 113,238 | 150,931 |
| GDP per Capita(US$) | 452 | 500 | 637 | 849 |

Population of Djibouti, which is said to include about 100,000 refugees from the neighboring countries, will be estimated to increase 3 percent annually from 500,000 in 1988 to just under 1 million in 2010 considering an annual increase rate of 3 % in East Africa, 1.74 % in Ethiopia, 3.76 % in Somalia and 3.09 % in Djibouti during 1985 and 1990. While GDP is estimated to increase around 6.0 percent per year on the average to 151 billion FD in 2010, thus GDP per capita would increase to 849 US dollars in 2010 from 452 US dollars in 1988. GDP for Djibouti has grown nominally at the rate of 7.2 % from 1972 to 1988, while that of Ethiopia 5.1 % from 1984 to 1989 and that of Somalia at the rate of 4.3 % from 1985 to 1987 on a real term basis.

In the National Energy Plan, which was compiled in 1987 by ISERST in cooperation with USAID and UNDP, GDP per capita was estimated at 1,052 US dollars in the Growth scenario and 911 US dollars in the Reference scenario in 2000. This is considered to be optimistic.

Djibouti's first petroleum refinery with a capacity of 120,000BD, to be built at Dorale west of Djibouti city with the help of an Saudi Arabian private investor, was planned to operate in 1994. But peace and order conditions in some parts of Djibouti have delayed considerably the start of this project. Somalia also is said to have a similar refinery project with the help of Saudi Arabian investment with a capacity of 200,000BD. These kinds of export-oriented refinery projects usually take considerable time to materialize and also have many financial and technical problems as well as political problems. We consider the export refinery project in Djibouti will be extremely difficult to be operable before 2010.

### 3.5.2 Oil Demand Forecast

The demand of petroleum products in 2010 is estimated by dividing the demand into three categories, viz. Djibouti's domestic demand, bunker supply, and transshipment. In 2000, total demand of oil is estimated at 495,280 tons and that in 2010 at 741,300 tons. The detail of the forecast is compiled in Table 3-12.

Table 3-12 Oil Demand Forecast (2010)

(in kilo liter)

| | 1992 | 2000 | 2010 |
|---|---|---|---|
| Domestic Consumption | | | |
| Gasoline | 17,630 | 21,730 | 31,850 |
| Kerosene/Jet Fuel | 15,299 | 23,680 | 40,890 |
| Gas Oil | 31,871 | 65,300 | 85,090 |
| Fuel Oil | 50,025 | 85,950 | 146,800 |
| Total | 114,825 | 196,660 | 304,630 |
| Bunker Supply | | | |
| Gasoline | 412 | 500 | 700 |
| Kerosene/Jet Fuel | 82,238 | 96,350 | 117,460 |
| Gas Oil | 49,108 | 62,210 | 83,600 |
| Fuel Oil | 17,665 | 22,380 | 30,070 |
| Total | 149,423 | 181,440 | 231,830 |
| Transshipment | | | |
| Gasoline | 3,126 | 4,620 | 7,520 |
| Kerosene/Jet Fuel | 33,315 | 49,220 | 80,180 |
| Gas Oil | 86,498 | 127,800 | 208,170 |
| Fuel Oil | 18,802 | 27,780 | 45,250 |
| Total | 141,741 | 209,420 | 341,120 |
| Grand Total | 405,989 | 587,520 | 877,580 |
| Equivalent to ton | 341,140 | 495,280 | 741,300 |

Note: 1 kl = 0.737 metric ton for gasoline
1 kl = 0.814 metric ton for kerosene/jet fuel
1 kl = 0.843 metric ton for gas oil
1 kl = 0.9 metric ton for fuel oil
(according to IEA Conversion)

In the domestic demand forecast, gasoline and gas oil for motor vehicles are estimated by multiplying the average annual fuel consumption per car between 1984 and 1991 (1,222 liters and 1,469 liters respectively) with the number of cars expected to be registered in 2010 respectively. Gasoline is assumed to be solely used for motor vehicles, and gas oil is assumed to be used for motor vehicles at the rates of 80 percent in 2000 and 90 percent in 2010 respectively. The estimate of the number of motor vehicles and the fuel efficiency are shown in Table 3-13. The number of motor vehicles increased 3.7 % annually from 1984 to 1991.

Table 3-13 Number of Vehicles & Motor Fuel Consumption

| | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|
| Motor Vehicle Numbers (At Year-end) | 29,769 | 31,493 | 32,457 | 33,735 | 34,846 | 35,800 | 37,160 | 38,442 |
| Transportation Fuels | | | | | | | | |
| Gasoline | 13,560 | 13,034 | 13,122 | 13,111 | 13,740 | 12,529 | 12,320 | 15,659 |
| Gas Oil* | 16,673 | 18,476 | 21,060 | 23,526 | 24,190 | 21,089 | 22,000 | 37,648 |
| Fuel Consumption Liter/car/year | | | | | | | | |
| Gasoline cars | 1,409 | 1,276 | 1,231 | 1,188 | 1,202 | 1,064 | 1,012 | 960 |
| Diesel cars | 1,375 | 1,436 | 1,543 | 1,640 | 1,603 | 1,337 | 1,330 | 1,010 |

*Based on an assumption that diesel engine driven cars account for two-thirds of the total cars.
Source: DINAS

Kerosene and Jet fuel for domestic consumption are estimated from the trends in the past (1981 ~ 1992: refer to Table 3-9) with the annual rate of increase of about 5.6 percent.

Base case estimation for electricity generation by EDD is adopted to forecast the consumption of fuel oil in 2000 and 2010 as shown in Table 3-14. Fuel oil is assumed to be used exclusively for electricity generation.

Table 3-14 Electricity Generation Forecast (forecast by EDD)

(Low=4%, Base=5.5%, High=7%)

| | | 1992 (Actual) | 1995 | 2000 | 2005 | 2010 |
|---|---|---|---|---|---|---|
| Electricity Generation (Gwh) | | | | | | |
| | Low Case | 206.0 | 227.7 | 277.1 | 337.1 | 410.1 |
| | Base Case | 206.0 | 259.1 | 338.6 | 442.5 | 578.3 |
| | High Case | 206.0 | 294.2 | 412.6 | 573.6 | 811.6 |
| Fuel Consumption (MT) | | | | | | |
| Gas Oil | Low Case | | 689 | 838 | 1,019 | 1,240 |
| | Base Case | 623 | 784 | 1,024 | 1,338 | 1,749 |
| | High Case | | 890 | 1,248 | 1,735 | 2,454 |
| Fuel Oil | Low Case | | 52,022 | 63,308 | 77,016 | 93,693 |
| | Base Case | 47,064 | 59,196 | 77,359 | 101,096 | 132,122 |
| | High Case | | 67,215 | 94,265 | 131,048 | 185,423 |
| Local Consumption (MT) | | | | | | |
| Gas Oil* | | 1,791 | 2,252 | 2,944 | 3,847 | 5,028 |

* Estimated by Base Case
Source: EDD

As for bunker supply for aviation and marine use, demand for gasoline is set at 500 kl and 700 kl in 2000 and 2010 respectively, and that for jet fuel is assumed to increase 2 percent annually from the past trends, and both gas oil and fuel oil for marine bunker are estimated to stop decreasing and recover at the average annual rate of 3 percent from 1992 taking results of consultations with the oil companies and other institutions into consideration.

Since there is no reliable statistical data regarding transshipment of fuel oils to Ethiopia, Somalia, and other countries including France and U.S.A., we estimate growth rate of the volume of transshipments at 5 percent based on the potential economic growth rate in Ethiopia which is supposed to be the biggest importer of the transshipment from Djibouti and has a customs clearance office of their own within Djibouti Port. Macro economic indicators in both Ethiopia(including Eritrea) and Somalia in the past several years are shown in Table 3-15.

Table 3-15 Economic Indicators of Neighboring Countries

| Ethiopia(Incl. Eritrea) | | 84/85 | 85/86 | 86/87 | 87/88 | 88/89 | 89/90 |
|---|---|---|---|---|---|---|---|
| GDP at current price (million Birr) | | 8,929 | 9,817 | 10,227 | 10,572 | 11,129 | 11,436 |
| GDP at constant price(80/81) | | 7,704 | 8,239 | 9,024 | 9,193 | 9,342 | 9,301 |
| Real Change % | | -5.9 | 6.9 | 9.6 | 1.9 | 1.6 | -0.4 |
| Per Capita (Birr) | Current | 206 | 219 | 221 | 221 | 225 | 224 |
| | Constant(80/81) | 178 | 183 | 195 | 192 | 189 | 182 |
| Real change % | | -8.7 | 2.9 | 6.6 | -1.5 | -1.6 | -3.7 |
| | | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
| Official Exchange Rates (Birr/US Dollar) | | 2.07 | 2.07 | 2.07 | 2.07 | 2.07 | 2.07 |
| Population (Mid-year estimate, 1000) | | 45,740 | 47,190 | 48,590 | 50,170 | 51,690 | 53,380 |
| Consumer Price Index(1985=100) | | 90.2 | 88.0 | 94.2 | 101.6 | 106.8 | 145.0 |
| Change % | | -9.8 | -2.4 | 7.0 | 7.9 | 5.1 | 35.8 |
| Somalia | | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
| GDP at current price (million shillings) | | 87,361 | 120,558 | 168,085 | 238,898 | 559,480 | 738,770 |
| GDP at constant price(87) | | 154,569 | 159,999 | 168,085 | 166,945 | 166,700 | 164,103 |
| Real Change % | | 8.1 | 3.5 | 5.1 | -0.7 | -0.1 | -1.6 |
| Per Capita (Shilling) | Current | 13,714 | 18,294 | 24,646 | 33,838 | 26,746 | 23,836 |
| | Constant (80/81) | 24,265 | 24,279 | 24,646 | 23,647 | 22,867 | 21,880 |
| Real change % | | 4.5 | 0.1 | 1.5 | -4.1 | -3.3 | -4.3 |
| Official Exchange Rates (Shilling US Dollar) | | 39.49 | 72.00 | 105.2 | 170.5 | 490.7 | 1,055.9 |
| Population (Mid-year estimate, 1000) | | 6,370 | 6,590 | 6,820 | 7,060 | 7,290 | 7,500 |

Source: UN International Financial Statistics Yearbook

Since the independence of Eritrea, Ethiopia has been keeping the balance between Djibouti and Eritrea, where Assab Refinery is located, in the supply of petroleum products to Addis Ababa and other main consuming areas.

### 3.5.3 Comparison of Forecasts

This oil demand forecast is compared with that of National Energy Plan (NEP) prepared by ISERST in cooperation with Volunteers in Technical Assistance of USA in July 1987 and also that to the Port Master Plan prepared by BCEOM, France, in February 1993. The result is as follows:

Table 3-16 Comparison of Oil Demand Forecasts

Unit: Metric Ton

| | JICA Study Team | NEP | | BCEOM | |
|---|---|---|---|---|---|
| | | Reference Case | Growth Case | Low Case | High Case |
| 2000 | | | | | |
| Domestic Demand | 167,693 | 140,957 | 178,335 | 136,486 | 139,150 |
| Bunker Supply | 151,382 | - | - | 207,766 | 234,202 |
| Transshipment | 176,207 | - | - | 131,973 | 131,973 |
| Total | 495,282 | - | - | 424,721 | 505,324 |
| 2010 | | | | | |
| Domestic Demand | 260,609 | - | - | 179,896 | 187,005 |
| Bunker Supply | 193,666 | - | - | 256,183 | 290,880 |
| Transshipment | 287,021 | - | - | 90,948 | 145,101 |
| Total | 741,296 | - | - | 527,027 | 622,986 |

The difference between our oil demand forecast and that of the New Energy Plan is very small, and our forecast falls between Reference case and High Growth case of the NEP in 2000. However, this oil demand forecast exceeds even that of the High case in BCEOM's Port Master Plan. BCEOM's oil demand forecast was made before February 1993 when the actual demand for petroleum products in 1992 was not known. Moreover, accuracy of the statistical data for the petroleum products movements in Djibouti has been much improved due to the efforts made by the departments concerned after April, 1993, and more reliable data for petroleum products demand have become available for 1992. At any rate, BCEOM's oil demand forecast is considered to be too low except for bunker supply taking the recent development of the oil demand in Djibouti.

# Chapter 4 Reconstruction Plan of the Oil-Berths

# CHAPTER 4 RECONSTRUCTION PLAN OF THE OIL-BERTHS

## 4.1 Present Trends in Oil-Berths Utilization

To determine the existing port activities such as existing oil cargo handling, oil tankers call, and bunkering at Berth Nos. 11 and 12, the following data were examined:

(1) "Fiche de renseignements concernant le sejour" (Port time information sheet) (1990-1992) by PAID
(2) "Fiche d'arrivée" (Ship's arrival notice) (1992) by Maritime Agencies
(3) "Statistiques Portuaires" (Port Statistics ) (1985 - 1992)by PAID
(4) "Statement of facts/Time sheet" (1992) by oil tankers (Total Mory)
(5) "Ship's Manifest" (1992) by shipping companies.

The past port activities at Berth No. 10 which was under construction during this study period were also taken into consideration simultaneously so that the allocation of oil tankers and oil cargo among all Oil Berth Nos. 10, 11, and 12 could be well coordinated.

### 4.1.1 Oil Tankers

(1) Number of Calls of Oil Tankers

The number of ship calls of oil tanker per annum at Port of Djibouti, relevant total tonnage, average tonnage are summarized in the following Table 4-1.

Table 4-1 Number of Calls of Oil Tanker, Total Tonnage & Average Tonnage

| Year | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|
| Total tonnage (1,000 G.T./annum) | 1,775 | 1,702 | 2,586 | 2,186 | 1,302 |
| Number of Calls | 89 | 86 | 428 | 98 | 78 |
| Average Ship size (G.T./Vessel) | 19,944 | 19,791 | 23,944 | 22,306 | 16,692 |

Source : "Statistiques Portuaires" PAID

Further detail review was made hereunder over the data of the year 1992 as a specimen. The number of ship calls by the size of oil tanker is summarized as shown in Table 4-2 below:

Table 4-2 Size of Oil Tanker and Number of Calls at Berth Nos. 10, 11 and 12

| Size of Oil Tanker | | | | Number of Calls (1992) |
|---|---|---|---|---|
| Below | | 5,000 | DWT | 12 |
| 5,000 | to | 10,000 | DWT | 1 |
| 10,000 | to | 15,000 | DWT | 1 |
| 15,000 | to | 20,000 | DWT | 2 |
| 20,000 | to | 25,000 | DWT | 3 |
| 25,000 | to | 30,000 | DWT | 3 |
| 30,000 | to | 35,000 | DWT | 32 |
| 35,000 | to | 40,000 | DWT | 2 |
| 40,000 | to | 45,000 | DWT | 11 |
| 45,000 | to | 60,000 | DWT | 0 |
| 60,000 | to | 65,000 | DWT | 1 |
| 65,000 | to | 80,000 | DWT | 0 |
| 80,000 | to | 85,000 | DWT | 2 |
| 85,000 | to | 95,000 | DWT | 0 |
| 95,000 | to | 100,000 | DWT | 1 |
| Total | | | | 71 |

NOTE: 1) Source :"Fiche de renseignements concernant"
2) Number of calls for only those ships of which tonnage are known.

The sizes of dominant ships are known from the above table at below 5,000 DWT, 30,000 to 35,000 DWT, and 40,000 to 45,000 DWT.

The small size tankers below 5,000 DWT are usually fully loaded at either Assab, Aden, Jedda and sometimes Yanbu and discharge all oil cargoes at Port of Djibouti. They return to the original port in ballast condition.

The latter two classes of oil tankers are usually loaded at Saudi Arabian original port and some part of their oil cargo is discharged at Port of Djibouti and proceeding to south bound African Region or other destinations.

(2) Oil Cargo Handling

The average quantity of oil cargo per each oil tanker handled at Port of Djibouti and the related berthing time per call are given below :

Table 4-3 Average Handling Volume and Berthing Time per Call

| Year | Average handled volume per ship | Average time per call |
|---|---|---|
| | (MT) | (hr min.) |
| 1990 | NA | 39 h 15 m (83) |
| 1991 | 5,496 (65) | NA |
| 1992 | 6,839 (48) | 30 h 23 m (48) |
| Average | 6,050 (113) | 36 h 23 m (131) |

NOTES 1) Source : i) "Fiche de renseignements concernant"
ii) "Manifest"
2) Figures in parentheses show the number of specimens

The efficiency of handled volume: 168 MT./hr equivalent to approx. 200 cu.m/hr of berthing time obtained from the above results is much lower than ordinary standard figure of 300 or sometimes can reach up to 800 cu. m/hr. This is presumed to be caused by (1) relatively small size of oil tankers, (2) many kinds of oil products loaded in one ship, and (3) oil cargoes of two or three oil companies as consignees being frequently carried in one tanker, caused longer handling time thus less efficiency.

The efficiency of oil discharging, however, is still better than that of loading. Particularly the efficiency of bunkering is much worse than those aforementioned oil cargo handling due to the small size receiving facilities of the objective ships and less capacity of pumps at storage tank yards.

For small quantity bunkering, tank trucks are being used instead of cargo pipe lines.

(3) Particulars of Oil Tankers calling at Port of Djibouti.

The principal particulars of oil tankers calling at Port of Djibouti in 1992 are summarized in Table 4-4.

Except for some tankers almost all tankers are old, i.e., 3/4 of the tankers shown in Table 4-4 are older than 10 years. 20% of the tankers are even older than 20 years.

## Table 4-4 Particulars of Oil Tankers Called at Port of Djibouti (1992)

| No. | Name of Vessel | Tonnage (Ton) | | | Length (m) | | | Draft (m) | | Depth | Speed | Number of | Built in | Flag | Owner |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DWT | GT | NT | LOA | LBP | B | Full | Actual at the Port | (m) | (knot) | Call in 1992 | | | |
| 1 | Athenian Fidelity | 29,940 | 18,350 | 10,589 | 178.87 | 165.00 | 25.33 | 11.00 | | 15.02 | 15.00 | 1 | 1984 | Cyprus | Blue Macedonia |
| 2 | Athenian Theodore | 29,940 | 18,509 | 10,203 | 178.87 | 165.00 | 25.33 | 11.12 | 9.00 | 15.02 | 15.00 | 1 | 1982 | Cyprus | Artemission Shipping |
| 3 | Athenian Victory | 29,940 | 18,509 | 8,883 | 178.87 | 165.00 | 25.33 | 11.12 | | 15.02 | 15.00 | 1 | 1981 | Cyprus | Blu Saronic |
| 4 | Awash | 3,618 | 2,492 | 1,127 | 94.50 | 87.36 | 14.60 | 5.41 | 5.00 | 6.80 | | 10 | 1989 | Ethiopia | Ethiopia Shipping |
| 5 | Castor | 31,068 | 19,459 | 14,482 | 183.52 | 172.27 | 26.01 | 10.97 | 6.00 | 14.36 | 15.50 | 2 | 1977 | Cyprus | Kingserv Trading |
| 6 | Captain Helen | 40,406 | 25,060 | 11,125 | 176.00 | 168.00 | 32.20 | 10.87 | 7.00 | 17.00 | 14.00 | 7 | 1991 | France | Services at Transp. |
| 7 | Cielo di Napoli | 32,737 | 18,764 | 11,134 | 170.67 | 163.07 | 25.94 | 11.37 | 9.00 | 15.30 | 15.50 | 3 | 1970 | Italy | D"Amico Societa |
| 8 | Clear Venture L. | 30,996 | 17,872 | 12,434 | 170.69 | 162.03 | 26.04 | 11.02 | 11.00 | 14.46 | 15.50 | 1 | 1973 | Greece | Elcoral Inc. |
| 9 | Conastga | 29,967 | 17,505 | 10,588 | 171.61 | 161.55 | 25.96 | 10.94 | 11.00 | 14.48 | 16.00 | 2 | 1972 | Liberia | Mobil Shipping |
| 10 | Corsicana | 29,960 | 17,505 | 10,588 | 171.61 | 161.63 | 25.96 | 10.93 | | 14.48 | 16.00 | 2 | 1973 | Liberia | Mobil Shipping |
| 11 | Courier | 35,663 | 21,572 | 16,498 | 216.80 | 208.67 | 25.66 | 10.50 | | 13.87 | 15.75 | 2 | 1977 | U.S.A | Omi Courier |
| 12 | Crest Venture L. | 31,275 | 17,872 | 12,434 | 170.69 | 162.03 | 26.04 | 11.02 | 11.00 | 14.46 | | 1 | 1974 | Greece | Elcrown Inc. |
| 13 | Grigoriy Achkanov | 22,630 | 15,090 | 8,154 | 186.01 | 174.02 | 23.45 | 9.81 | 8.00 | 12.55 | 17.25 | 1 | 1965 | Russia | Novoshp |
| 14 | Ionian Glory | 5,734 | 2,918 | 1,656 | 103.00 | | | | | | | 1 | 1981 | Panama | |
| 15 | IZ | 40,455 | 22,651 | 13,114 | 175.93 | 168.89 | 32.16 | 11.22 | | 15.12 | 14.75 | 4 | 1984 | Yougoslavia | Ro JugoTanker |
| 16 | Kobe "J" | | | | | | | | | | | 1 | | | |
| 17 | Koyo Spirit | 96,779 | 51,200 | 36,870 | 258.17 | 248.42 | 38.99 | 14.50 | | 21.04 | 12.00 | 1 | 1976 | Liberia | VSSI Marine |
| 18 | Kyoto | 1,180 | 496 | 335 | 59.00 | | | | 5.00 | | | 1 | 1978 | Panama | |
| 19 | Lawrensc H.Gianclla | 32,965 | 18,490 | 13,600 | 187.46 | 179.08 | 27.49 | 11.13 | 8.10 | 16.36 | 16.00 | 1 | 1986 | U.S.A. | Wilmington Trust |
| 20 | Louise | 29,900 | 19,925 | 8,178 | 174.90 | 165.00 | 26.61 | 10.15 | 10.00 | 16.51 | | 1 | 1988 | Liberia | Prima Alfa |
| 21 | Marisea Excel | 16,801 | 9,838 | 6,794 | | | | | 6.00 | | | 2 | 1973 | Panama | |
| 22 | Nestor | 62,278 | 30,479 | 21,691 | 218.50 | 210.01 | 32.24 | 12.82 | | 18.80 | | 1 | 1983 | Greece | Apache Tanker |
| 23 | New Star | 33,650 | 20,036 | 13,964 | 171.00 | | | | | | | 1 | 1976 | Malta | |
| 24 | Oshima Spirit | 81,279 | 44,989 | 35,976 | 241.49 | 230.00 | 40.04 | 13.12 | 8.00 | 18.80 | 15.50 | 1 | 1976 | Liberia | VSSI Pacific |
| 25 | Oppama Spirit | 81,248 | 51,811 | 25,900 | 233.00 | | | | 8.00 | | | 1 | 1980 | Bahamas | |
| 26 | Padea | 29,912 | 16,949 | 11,458 | 174.00 | | | | 9.00 | | | 3 | 1982 | Bahamas | |
| 27 | Paul Buck | 29,500 | 19,037 | 13,660 | 187.43 | 179.08 | 27.46 | 10.38 | 10.00 | 16.36 | 16.00 | 1 | 1985 | U.S.A | Wilmington Trust |
| 28 | Satuket | 30,397 | 16,861 | 11,260 | 171.61 | 161.55 | 25.96 | 10.93 | 11.00 | 14.48 | 15.50 | 3 | 1971 | Liberia | Mobil Shipping |
| 29 | Seaheron | 10,884 | 5,072 | 3,599 | 123.00 | | | | | | | 1 | 1982 | Norway | |
| 30 | Sea Horse | 24,277 | 14,519 | 7,667 | | | | | 5.00 | | | 1 | 1969 | Malta | |
| 31 | Shabonnee | 31,102 | 18,258 | 11,536 | 171.00 | | | | | | | 5 | 1974 | Liberia | |
| 32 | SS King | | 20,346 | 12,616 | 195.00 | | | | | | | 1 | | | |
| 33 | Stainless Fighter | 21,718 | 12,098 | 8,551 | 167.00 | | | | 9.00 | | | 1 | 1970 | Panama | |
| 34 | Yorksand | | 2,206 | 1,322 | | | | | | | | 1 | | | |
| 35 | Zina | | 18,094 | 11,636 | 175.00 | | | | 11.00 | | | 1 | | | |

Notes 1. DWT: Dead Weight Ton
Gt: Gross Ton
Mt: Net Ton
LOA: Length Overall
LBP: Length between Perpendicular
B: Breadth

2. Source - PAID
- Lloyd's Register of ships 1990 - 91
- Lloyd's Shipping Index. Oct. 1992

### 4.1.2 Bunkering and "Non-Commercial" Operation Ships at Berth Nos. 10, 11 and 12

The activities of bunkering for ships at Port of Djibouti for the last few years are summarized in Table 4-5.

Table 4-5 Activities of Bunkering at Port of Djibouti by Oil Companies

| Name of Oil Companies | 1990 | | 1991 | | 1992 | |
|---|---|---|---|---|---|---|
| | Volume (MT) | Number of ships | Volume (MT) | Number of ships | Volume (MT) | Number of ships |
| Mobil Oil | 50,627 | 127 | 26,686 | 102 | 30,267 | 66 |
| Total Mory | 25,103 | 130 | 22,939 | 123 (76) | 32,592 | 145 (96) |
| Shell B.P. | 5,940 | 58 | 9,742 | 70 | 12,172 | 106 |
| Total | 81,670 | 315 | 59,367 | 295 | 75,031 | 317 |

NOTE : 1) Source : " Statistiques Portuaires " 1991/1992 , PAID.
2) ( ) Shows the number of ships bunkering at Berth Nos. 10, 11 and 12.

Berth Nos. 10, 11 and 12 are being used not only for the handling of oil cargo but utilized for bunkering with large supply volume especially for those ships calling Port of Djibouti for bunkering purpose only. Taking the year 1992 as specimen, the type and number of ships which called at Port of Djibouti and berthed at Berth Nos. 10, 11 and 12, for the purpose of bunkering and "Non-Commercial" operation such as 1) Repair/maintenance, 2) Change of crew, 3) Supply of spare parts, 4) Supply of food/water and so on, are summarized in Table 4-6.

Table 4-6 Bunkering and "Non-Commercial" Operation at Berth Nos. 10, 11 and 12 (1992)

| Berth No. | Description | Conventional | Container | Ro/Ro | Fishing Boat | Others | Total |
|---|---|---|---|---|---|---|---|
| 11&12 | No. of Calls | 58 | 5 | 5 | 20 | 59 | 147 |
| | Average Berth Time/Call | 27h 23' | 43h 11' | 12h 20' | 84h 51' | 31h 08' | 36h 43' |
| | Average G.T. | 7,770 | 17,054 | 3,526 | 1,103 | 4,559 | 5,746 |
| 10 | No. of Calls | 5 | 0 | 1 | 9 | 21 | 36 |
| | Average Berth Time/Call | 82h 19' | 0 | 2h 45' | 138h 42' | 76h 14' | 90h 39' |
| | Average G.T. | 1,498 | 0 | 2,510 | 920 | 5,141 | 3,507 |
| Total (11,12 &10) | No. of Calls | 63 | 5 | 6 | 29 | 80 | 183 |
| | Average Berth Time/Call | 31h 44' | 43h 11' | 10h 44' | 101h 33' | 42h 58' | 47h 20' |
| | Average G.T. | 7,272 | 17,054 | 3,357 | 1,046 | 4,712 | 5,305 |

Source : "Fiche de renseignements concernant le sejour ". (PAID).

The average berthing time of all ships for bunkering and "Non-Commercial" operation at Berth Nos. 10, 11 and 12 in 1992 was 47 hr. 20 min. per vessel.

### 4.1.3 Activities of Oil Companies

(1) Operation of Oil Companies

At Port of Djibouti, three (3) Oil Companies, namely Mobil Oil, Total Mory and Shell B.P. are operating. The share among the three Oil Companies is summarized in Table 4-7.

The storage facilities of each oil company and relevant oil products stored therein are summarized in Table 4-8.

The three Oil Companies are well coordinated with each other on oil cargo handling operation and making effort to realize better efficiency and safer operation.

Table 4-7 Share of Oil Products Handled by Oil Companies

(in Thousand MT)

| Oil Products | Year | Mobil Oil | | Total Mory | | Shell B.P. | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Import | Export | Import | Export | Import | Export | Import | Export | Total |
| Gasoline | 1989 | 10.3 | - | 1.7 | - | 3.0 | - | 15.0 | - | 15.0 |
| | 1990 | 66.4 | 62.9 | 0.2 | - | 0.8 | - | 67.4 | 62.9 | 130.3 |
| | 1992 | 14.6 | - | 0.2 | - | 0.6 | - | 15.5 | - | 15.5 |
| Kerosene/ Jet Fuel | 1989 | 39.6 | - | 28.1 | - | 20.4 | - | 88.0 | - | 88.0 |
| | 1990 | 40.7 | - | 38.7 | - | 25.6 | - | 105.0 | - | 105.0 |
| | 1992 | 45.5 | 1.2 | 22.9 | - | 19.9 | - | 88.3 | 1.2 | 89.5 |
| Gas Oil | 1989 | 53.1 | - | 20.0 | 14.0 | 21.7 | 7.5 | 94.8 | 21.5 | 116.4 |
| | 1990 | 77.7 | 35.5 | 87.3 | 76.0 | 26.4 | - | 191.7 | 111.5 | 303.2 |
| | 1992 | 41.8 | 12.8 | 56.0 | 20.0 | 26.9 | - | 124.7 | 32.8 | 157.5 |
| Fuel Oil | 1989 | 29.8 | - | 22.8 | - | 40.5 | - | 93.1 | - | 93.1 |
| | 1990 | 16.1 | 20.2 | 19.1 | - | 40.4 | - | 75.6 | 20.2 | 95.8 |
| | 1992 | 13.1 | - | 40.5 | 4.1 | 16.4 | - | 70.0 | 4.1 | 74.1 |
| Total | 1989 | 132.7 | - | 72.7 | 14.0 | 86.2 | 7.5 | 291.6 | 21.5 | 313.1 |
| | 1990 | 200.8 | 48.6 | 145.3 | 76.0 | 93.2 | - | 439.3 | 194.6 | 633.9 |
| | 1992 | 115.1 | 14.0 | 119.6 | 24.2 | 63.8 | - | 298.5 | 38.1 | 336.6 |

Source: "Statistiques Portuaires" , PAID

Table 4-8 Oil Storage Facilities at Port of Djibouti

| Tank | Mobil Oil | | Total Mory | | Shell B.P. | | Total |
|---|---|---|---|---|---|---|---|
| No | Products | cu. m | Products | cu. m | Products | cu. m | |
| 1 | Water | (350) | Gas Oil | 5,474 | Fuel Oil | 10,293 | – |
| 2 | M.Gas Regular | 3,030 | Kerosene | 5,190 | Empty | – | – |
| 3 | M.Gas Super | 1,346 | Water | – | Kerosene | 5,807 | – |
| 4 | " | 1,343 | Empty | (1,060) | Fuel Oil | 5,803 | – |
| 5 | " | 687 | Gas Oil | 1,077 | Water | (500) | – |
| 6 | Gas Oil | 4,193 | Kerosene | 1,050 | Molasses | (15,700) | – |
| 7 | Jet A-1 | 6,218 | Gas Oil | 1,387 | Gas Oil | 15,728 | – |
| 8 | Gas Oil | 14,028 | " | 1,500 | " | 15,678 | – |
| 9 | " | 14,017 | Empty | (1,500) | Jet A-1 | 2,352 | – |
| 10 | Jet A-1 | 3,479 | Water | (1,600) | " | 1,053 | – |
| 11 | " | 14,085 | Gas Oil | 1,320 | Fuel Oil | 1,484 | – |
| 12 | " | 14,072 | – | – | Empty | – | – |
| 13 | Fuel Oil | 5,401 | Gas Oil | 12,268 | Kerosene | 2,692 | – |
| 14 | – | – | " | 3,343 | – | – | – |
| 15 | – | – | Fuel Oil | 12,060 | – | – | – |
| 16 | – | – | Gas Oil | 12,055 | – | – | – |
| Gasoline Super | | 3,373 | | – | | – | 3,373 |
| Gasoline Regular | | 3,030 | | – | | – | 3,030 |
| Kerosene/Jet A-1 | | 37,854 | | 6,240 | | 11,904 | 55,998 |
| Gas Oil | | 32,238 | | 38,424 | | 31,406 | 102,068 |
| Fuel Oil | | 5,401 | | 12,060 | | 17,580 | 35,041 |
| TOTAL | | 81,896 | | 56,724 | | 60,890 | 199,510 |
| Total Yard Area (sq. m) | | 35,000 | | 68,500 | | 53,000 | 156,500 |
| Gasoline is handled only by Mobil | | | | | LPG is handled only by Shell | | |

(2) Desires and Future Plan of Oil Companies

Through interviews made to individual three (3) Oil Companies, their opinions as users on the re-construction of Berth Nos. 11 and 12 and their future working plan were obtained and enumerated below.

1) Three Oil Companies will continue their operations to maintain the activities of oil reservation, in line with the marketing strategy made by their individual head offices to increase their handling volume.

2) Three Oil Companies have similar prospect on future demands of oil products, that the volume of bunkering may be stable and the drastic increase of domestic oil consumption may not be expected. As for the transshipment, the Ethiopian market will be hopeful. The rehabilitation of railways (CDE) going to Dire Dawa and Addis Ababa, which is scheduled

to be implemented sometime in 1993 by EU finance, will give an impact on Ethiopian demand, since the role of Assab in Eritrea is still not strong enough.

3) Although oil tankers are given priority of berthing at berth Nos. 10, 11 and 12, the Oil Companies still have strong wishes to be allocated at least one or two oil berths for exclusive use of oil tankers, considering the present utilization of Berth Nos. 10, 11 and 12 which are being used by ships for "Non-Commercial" operation frequently.

4) Size of oil tanker and Berth water depth :

Considering the scale of oil cargo volume handled by individual Oil Companies, they prefer suitable size of oil tankers to be 30,000 to 45,000 DWT, thus, 30,000 DWT class tanker is their most desirable capacity. The water depth of the Berth is to be -12.0 m.

The Oil Companies also reminded the useful and convenient usage of small size oil tanker of 3,000 to 5,000 DWT class which are plying between Aden, Assab and sometimes Jedda or Yanbu.

5) Oil discharging/loading equipment

According to the Oil Companies, they don't consider the necessity of the oil discharging/loading equipment such as oil loading arm(s) because of (1) relatively small quantity of oil cargoes and (2) scattered oil discharging berths, in fact, allocated at Berth Nos. 10, 11 and 12, and Quay Nos. 13 and 14. But , in other words, once oil cargo handling operations were concentrated at either Berth Nos. 10, 11 and 12, upon completion of the re-construction works, they might consider the adoption of the loading arm(s) or loading tower(s) on the working platform of the Berths.

6) All Oil Companies emphasized that there is no question on the necessity of the re-construction of the Berth Nos. 11 and 12 of which structural conditions are much below of international standards and might collapse at anytime.

7) Sequence of the re-construction of Berth Nos. 11 and 12:

To avoid or minimize the stoppage and disturbance on the Oil Companies' daily operations, the re-construction works are preferable to be started after completion of Berth No. 10 and to commence the works one berth after the other's completion. Most probably, Berth No. 11 should be the first and Berth No. 12 will follow.

## 4.2 Allocation of Oil -Berths

### 4.2.1 Present Situation of Oil Berths Utilization

The existing Oil Berths including Berth No. 10 are utilized under the situations as enumerated below :

(1) The dangerous cargo handling including oil cargo and LPG (Liquefied Petroleum Gas) are scattered at Berths Nos. 10, 11 and 12, and Quay No. 13 and 14, due to unsatisfactory conditions of original Oil Berth Nos. 10, 11 and 12.

(2) Among the above Berths, No. 10 is now under rehabilitation. i.e. the reconstruction of breasting dolphins consisting of two (2) steel sheet pile type cells (gabion). The rehabilitation of working platform consists of the steel sheet pile wall connecting two breasting dolphins, giving a character of multi-purpose to Berth No. 10, and the dredging of the frontal basin to be -13.0 m as 2nd phase are, however, not included in the scope of the on-going rehabilitation project. The schedule of finance and construction work for the 2nd Phase are not finalized to date.

(3) Berth Nos. 10, 11 and 12 are also utilized for bunkering with large quantity supply, and other "Non-Commercial" operations such as water supply, repair, food and spare parts supply, change of crew and so on.

### 4.2.2 Allocation of Oil Berths

Based on aforementioned situation, to perform more efficient and safer operations at Oil Berths, following basic policy on the berthing allocation is presumed for oil tankers, bunkering ships and other "Non-Commercial" operation ships at Berth Nos. 11 and 12 including Berth No. 10.

(1) The larger size oil tankers above 35,000 DWT with max. draft of 12 m will berth at Berth No. 10.

(2) The small size oil tankers below 35,000 DWT with max. draft of 11 m will berth at Berth Nos. 11 and 12.

(3) Bunkering activities for large quantity supply will be accepted at Berths Nos. 10, 11 and 12 unless they can not be supplied at designated individual berths.

(4) The "Non-Commercial" operation will be allowed only for larger size vessels which cannot enter the inner harbor basin and be utilized within the limit as long as the oil cargo handling and bunkering operations will not be disturbed.

The above berthing allocation is summarized below:

| Description | Berth Nos. 11 & 12 | Berth No. 10 | Total |
|---|---|---|---|
| Oil cargo handling operation of Oil Tanker | 80 % (below 35,000 DWT or max. draft 11.0 m) | 20 % (above 35,000 DWT or max. draft 12 m) | 100 % |
| Bunkering Service for supply of large volumes | 67 % | 33 % | 100 % |
| "Non-Commercial" operation ships (large size) | 67 % | 33 % | 100 % |

## 4.3 Determination of Number and Size of Proposed Oil Berths

### 4.3.1 Required Number of Proposed Oil Berths

(1) Oil Tankers for Oil Cargo Handling

The relation between ship size (DWT) and oil cargo volume handled by individual oil tankers in 1992 are shown in Fig. 4-1. This Figure reveals almost all oil tankers, except for 3,000 DWT class, discharged much less volume than their own capacity, and it means that there is no significant relation between ship size and oil cargo volume discharged at the Port of Djibouti.

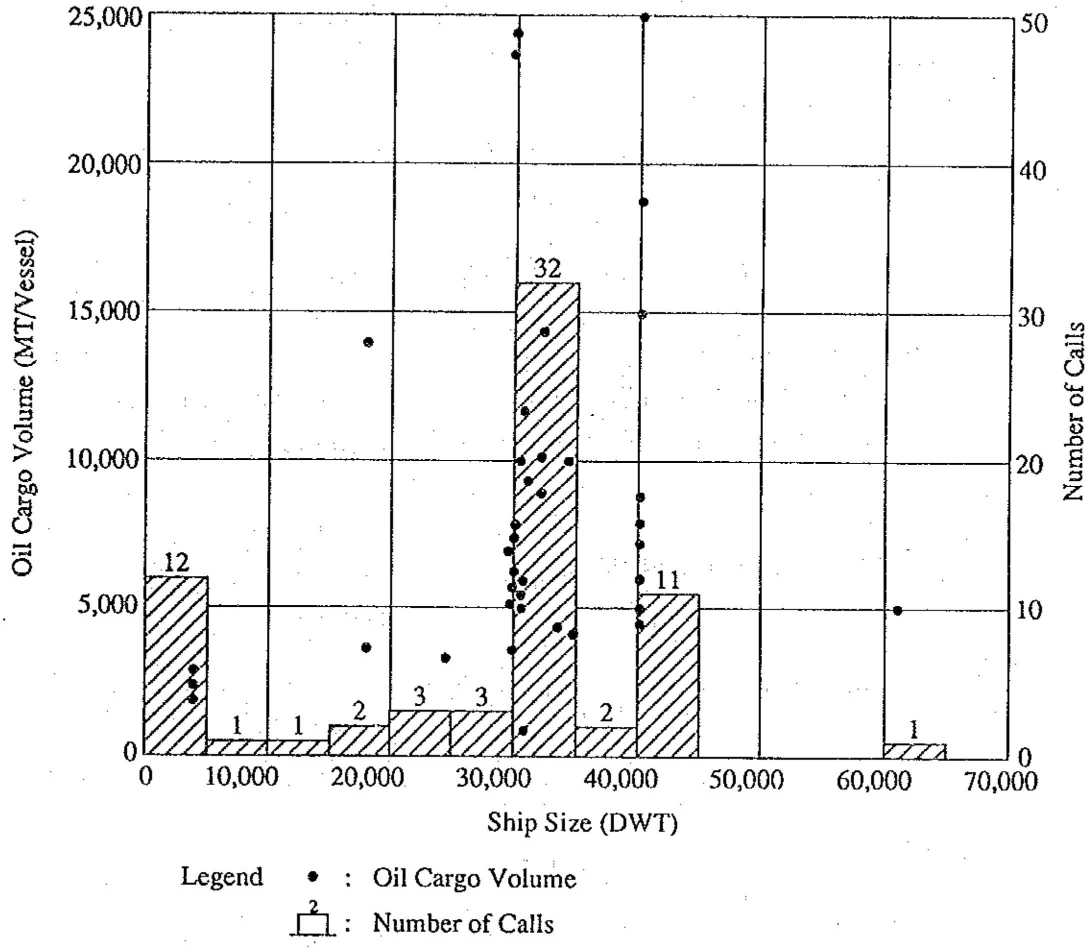



Figure 4-1 Ship Size, Oil Cargo Volume and Number of Calls

It is assumed that in target year 2010, the average oil cargo handling volume per vessel will be 6,050 tons unchanged to the present condition as described in Section 4.1.1 (2).

Consequently, the projected number of annual ships calls "n" will be obtained as follows:

$$n = \frac{\text{Total Forecast Oil Cargo Volume}^{(1)}}{\text{Average Oil Cargo Handling Volume per Vessel}^{(2)}}$$

$$= \frac{741300}{6050}$$

$$= 123 \text{ calls/annum}$$

Notes: 1) See Section 3.5.2.
2) See Section 4.1.1.

Applying the present average berthing time : 36 hr. 00 min./oil tanker (see Section 4.1.1 (2) ), the total annual berthing time "T" of oil tankers will be as follows:

"T" = ("n") x (Average berthing time)
= (123) x (36 hr. 00 min.) = 184.5 days/annum.

(2) Bunkering and "Non-Commercial" Operation Ships:

Based on the present figures in 1992 (See Section 4.1.2) and the berth allocation as described in pervious Section 4.2.2, the total annual berth occupancy days at Berths Nos. 10, 11 and 12 are prospected as follows:

| | | |
|---|---|---|
| Bunkering | : | 209 days/annum |
| "Non-Commercial" Operation | : | 152 days/annum |
| Total | : | 361 days/annum |

Taking the berth occupancy rate of the entire Port of Djibouti as described in the following Sub-Section (3) into consideration, this "Non-Commercial" operation ships cannot be shortened out of Berth Nos. 10, 11 and 12.

(3) Berth Occupancy rate

According to "Preliminary Design Report, Quay No 14, Berth No. 10 & Ancillary Facilities" Jan. 1986 by BCEOM, the present berth occupancy rate of Port of Djibouti is as shown below:

| Quay/Berth No. | | Berth Occupancy Rate |
|---|---|---|
| Quay | 1 | 9.7 % |
| | 2 | 61.7 % |
| | 5 | 31.0 % |
| | 6 | 65.8 % |
| | 7 | 40.1 % |
| | 8 | 58.3 % |
| Berth | 10 | 31.0 % |
| | 11 | 44.3 % |
| | 12 | 22.4 % |
| Quay | 13 | 68.1 % |
| Total Average Rate | | 43.2 % |

Considering the above present berth occupancy rate and based on "queuing theory" to minimize tanker's waiting time, the berth occupancy rate of the proposed oil berth is set up at 50 %.

(4) Number of Effective Working Days:

The past 8 year's port activities records (as summarized in Table 4-9) show the number of port closing days in which the port operation was stopped mainly due to bad weather caused by seasonal wind "Khamsin".

Considering the location of Oil Berths, which are directly facing windward against Khamsin, the annual effective working days is presumed accordingly to be 330 days.

Table 4-9 Record of Port Closing/Operation stoppage

| Year | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | | | 2[2] | | | | 2 | | | | | | 4 |
| 1982 | | | | | | | | 2 | | | | | 2 |
| 1983 | | 1 | 1 | 1 | | | 2 | 2 | | | | | 7 |
| 1987 | | | 1 | | 2 | | 1 | 7 | | | | | 11 |
| 1988 | | | | | | 2 | 2 | 5 | 1 | | | | 10 |
| 1991 | | | | | | 1 | 4 | 1 | | | | | 6 |
| 1992 | 1 | | 1 | | | | 3 | 9 | | | | | 14 |
| 1993 | 1[1] | | | | | | 1 | 1 | 1 | | | | 4 |
| Total | 2 | 1 | 5 | 1 | 2 | 3 | 15 | 27 | 2 | 0 | 0 | 0 | 58 |
| Average | 0.25 | 0.13 | 0.63 | 0.13 | 0.25 | 0.38 | 1.88 | 3.38 | 0.25 | 0 | 0 | 0 | 7.25 |

Notes 1) 1993: until September 24, 1993

2) Unit: Number of port closing days

3) All port closing days were mainly due to bad weather of which [ ] shows the number of operation stoppage days caused by other reasons such as "earthquake" in March 1973, "No lighting" in Jan. 1993.

4) Source: "Registre" Pilot Office, PAID

(5) Required Number of Oil Berths

Using aforementioned figures, the required number of Oil Berths for the forecast oil cargo handling and bunkering activities in the year 2010 (See Chapter 3) is obtained as shown hereunder:

Table 4-10 Forecasted Berth Occupancy Time in Year 2010

| Category of activities | | Berth Occupancy Time (days/annum) | | |
|---|---|---|---|---|
| | | Berth Nos. 11 & 12 | Berth No. 10 | Total |
| 1) Oil tankers/oil cargo handling | By tankers > 35,000 DWT | - | 37 days | 37 days |
| | By tankers < 35,000 DWT | 148 days | - | 148 days |
| 2) Bunkering and "Non-Commercial" operation | Bunkering | 139 days | 70 days | 209 days |
| | "Non-Commercial" operation | 70 days | 82 days | 152 days |
| Total | | 357 days | 189 days | 546 days |

The required number of Berths : "N" is obtained as follows:

$$N = \frac{\text{(Annual berth occupancy days)}}{\text{(Annual effective working days)}} \times \frac{1}{\text{(Berth occupancy rate)}}$$

$$= \frac{546}{330} \times \frac{1}{0.50} = 3.31 \text{ Berths}$$

The existing three (3) oil-berths, namely Berth Nos. 10, 11 and 12 will therefore, be utilized accordingly.

As for the surplus demand portion calculated as "0.31" (=3.31-3) berth, the "Non-Commercial" ships should berth at the quays other than the above oil-berths.

### 4.3.2 Size of Oil Berths

Following aspects are considered to determine the size of Oil Berths:

(1) As revealed in previous Section of this report, almost all oil tankers are calling at Port of Djibouti in semi-loaded condition except for small size tankers around 3,000 DWT.

(2) At the same time as described in Section 4.2.2 the oil tankers larger than 35,000 DWT should be allocated to Berth No. 10.

(3) The age of oil tankers calling at Port of Djibouti in 1992 are old as described in Section 4.1.1. In other words, in the year 2005 or 2010, those built in 1990 or 1995 will be the dominant age of oil tankers calling at Port of Djibouti.

Table 4-11 shows the trends of tanker size built in 1980s'.

Table 4-11 Trends of Oil Tankers Size Built in 1980s'

| Name of Oil Tanker | Built in year | DWT (tons) | LOA (m) | B (m) | d. (m) | Speed (knot) |
|---|---|---|---|---|---|---|
| Alden W. Clausen | 1981 | 35,587 | 179.23 | 30.41 | 10,911 | 15 |
| Berganger | 1980 | 34,450 | 173.67 | 32.03 | 10,496 | 15.5 |
| Borburata | 1981 | 30,500 | 190.00 | 25.84 | 10,302 | 16.0 |
| Canopus | 1981 | 31,000 | 170.69 | 26.04 | 11,259 | 15 |
| Carla A. Hills | 1981 | 35,597 | 179.23 | 30.41 | 10,980 | 15 |
| Clipperventurel | 1981 | 31,745 | 169.55 | 27.23 | 11,208 | 12 |
| Ebalina | 1980 | 31,374 | 170.01 | 26.01 | 11,042 | 14.5 |
| Formosa One | 1981 | 31,378 | 176.79 | 27.84 | 10,519 | 15.5 |
| Fort Windsor | 1981 | 33,420 | 170.69 | 25.94 | 11,591 | - |
| George H. Weyarhaeuser | 1981 | 35,597 | 179.23 | 30.41 | 10,978 | 15 |
| Jo Clipper | 1981 | 33,695 | 182.71 | 29.51 | 10,002 | 15 |
| Jo Lind | 1982 | 33,532 | 182.71 | 29.51 | 10,056 | 15.5 |
| Kenneth T. Derr | 1982 | 35,587 | 179.23 | 30.43 | 11,051 | 15 |
| Kinokawa | 1981 | 35,709 | 174.91 | 30.01 | 11,019 | 15 |
| Mauranger | 1981 | 33,695 | 182.79 | 29.55 | 10,065 | 16 |
| Mobil Endeavour | 1982 | 33,187 | 171.00 | 30.03 | 10,831 | - |
| Napo | 1981 | 31,543 | 176.71 | 28.05 | 10,402 | 16.5 |
| New York Sun | 1980 | 31,382 | 186.54 | 27.49 | 11,218 | 15.5 |
| Osco Stream | 1982 | 33,886 | 182.61 | 29.93 | 10,618 | 15 |
| Chevron Pacific | 1983 | 34,950 | 179.23 | 30.43 | 10,978 | 15 |
| Falcon Champion | 1984 | 33,869 | 202.95 | 25.63 | 9,602 | 16 |
| Kalcon Leader | 1983 | 33,869 | 203.84 | 25.63 | 10,997 | 16 |
| Goodhope | 1985 | 36,998 | 182.00 | 30.05 | 10,535 | 14.5 |
| Jo Brevik | 1986 | 33,490 | 182.71 | 29.55 | 10,051 | 15.5 |
| Lawrence H. Gianella | 1986 | 32,965 | 187.46 | 27.49 | 11,126 | 16 |
| Mascarin | 1986 | 31,990 | 178.19 | 27.54 | 11,381 | 14 |
| Al Badiyah | 1989 | 35,643 | 182.94 | 32.20 | 9,766 | 13.5 |
| Australa Sky | 1989 | 33,239 | 180.50 | 26.82 | 10,674 | 14.75 |

Note; 1) Source : "Lloyd's Register of Ships 1990 - 91"
2) DWT : Dead Weight Tonnage
LOA : Length Overall
B : Breadth

Based on the above mentioned studies, the dimensions of proposed Oil Berth Nos. 11 and 12 are to be finalized under the following conditions:

| | | | | |
|---|---|---|---|---|
| (1) | Objective ships | : | Minimum Oil Tanker | 3,000 DWT |
| | | | Maximum Oil Tanker | 35,000 DWT |
| (2) | Maximum Draft | : | -11 m | |
| (3) | Water depth of frontal basin | : | -12 m | |
| (4) | Length of Berth | : | 250 m | |

## 4.4 Alternative Layout Plans of Proposed Oil Berths

### 4.4.1 Problem of Existing Oil Berths Structures:

In order to accommodate aforementioned objective ships the following major points should be improved:

(1) Existing structure of Berth Nos. 11 and 12;

As described in Chapter 2, the existing structure is no longer usable due to insufficient structural strength and severe deterioration.

(2) The location of present breasting dolphins of Berth No. 11 is too close to each other which does not meet an oil tanker of 20,000 DWT class or above to berth while that of Berth No.12 is too far.

(3) The wooden access bridges and catwalks are not strong enough nor durable;

(4) The crown height (elevation +3.50 m above MLLW as 0.) of the working platform and mooring/breasting dolphins are relatively low against the tidal range and for oil cargo handling works for larger size oil tankers.

(5) Face line of the Berth Nos. 10, 11 and 12 are staggered, i.e.;

1) The face line of Berth No. 11 is 4.0 m on the land-side of Berth No. 10.
2) The face line of Berth No. 12 is 0.6 m on the land-side of Berth No. 10.

### 4.4.2 Layout Plan of Proposed Oil-Berths

The major policies on the re-construction of the Oil-Berth Nos. 11 and 12 are tentatively summarized as shown below :

(1) Oil Berths Nos. 11 and 12 will be re-constructed in similar layout plan, and scale under the conditions described hereinbefore.

(2) The layout of working platforms, mooring/breasting facilities will be so arranged that all sizes of objective ships can be accommodated smoothly and safely.

(3) The size and strength of the access will be determined to meet the size of vehicles and oil pipelines to be accommodated thereon.

(4) To decide the crown height of the working platform and mooring/breasting facilities, the following points will be considered:

1) Height of existing port road level
2) Design height of on-going rehabilitation of Berth No. 10
3) Freeboard of oil tankers for oil cargo handling activities

(5) As for oil cargo handling it is presumed that depending upon the future increase of oil cargo volume, the oil unloader such as loading arms, oil handling tower and/or derrick will be installed on the working platform in the future stage.

(6) The face lines of proposed Oil Berth Nos. 11 and 12 will be in the same alignment with that of new Berth No. 10 which will be approx. 4 m seaward of existing Berth No. 10.

Consequently, two alternative general layout plans as shown in Figs. 4-2 and 4-3 are examined as compared in Table 4-12 and it is concluded that Alternative "1" is recommendable.

General arrangement of mooring points and fenders are also determined in Fig. 4-4, considering the position of oil tankers' manifold as at the center of berth and the size and shape of the various objective ships.

Table 4-12 Comparison of General Lay-out of Berth Nos. 11 and 12

| | Alternative 1 (Fig 4-2) | Alternative 2 (Fig 4-3) |
|---|---|---|
| Layout Plan | 1. The actual location of access bridge is adopted as it is.<br>2. The new faceline is set at same alignment with that of new Berth No. 10. | 1. In order to provide room to maneuver for 55,000 DWT tanker at No. 10, the center of Berth Nos. 11 & 12 are to be shifted northward by 20 m and 15 m respectively.<br>2. same as "Alternative 1" |
| Advantage | 1. Demolition/relocation of the existing concrete parapet wall and pipelines will be minimal.<br>2. The re-utilization of existing mooring points along the concrete parapet wall will be maximized, hence berthing works will be easier than "Alternative 2". | 1. Appropriate bow space for Berth No. 10 will be secured (although according to the Japanese Design Standard requires 226 m length (LOA) of 55,000 DWT oil tanker, the planned one is 190 m which is even shorter than that of 35,000 DWT). |
| Disadvantage | 1. The angle of stern line of max. size tanker (35,000 DWT) at Berth No. 4 will be larger than 45° against the face line. Careful berthing operation will be required. | 1. The bow space of Berth No. 12 will be minimized by the navigation approach to Quay No. 13.<br>2. The location of the existing mooring points along the concrete parapet wall will be eccentric against the berthing position of ships, hence less applicable to the existing mooring points. This will increase the required number of new mooring points. |

Note: For both Alternatives, the existing overhead pipelines with a head space of 3.2 m and 4.0 m for Berth Nos. 11 and 12 respectively, will require relocation prior to the construction works, to allow the access of heavy construction equipment to the seaside.

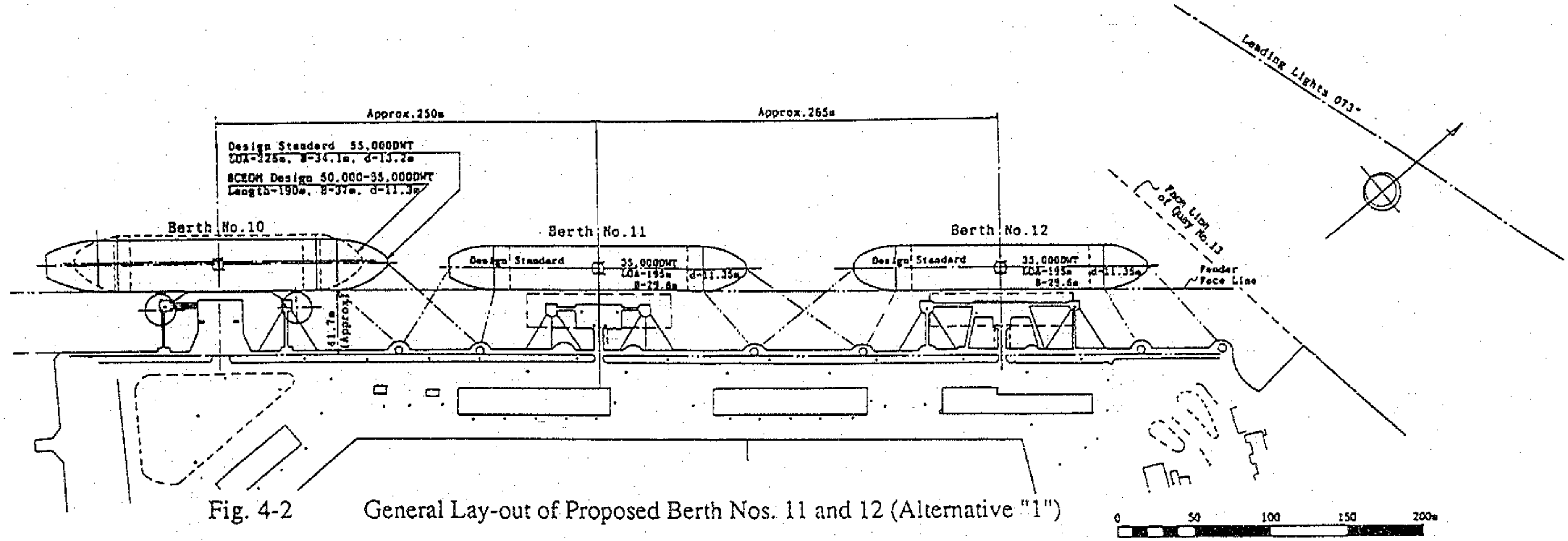



Fig. 4-2 General Lay-out of Proposed Berth Nos. 11 and 12 (Alternative "1")

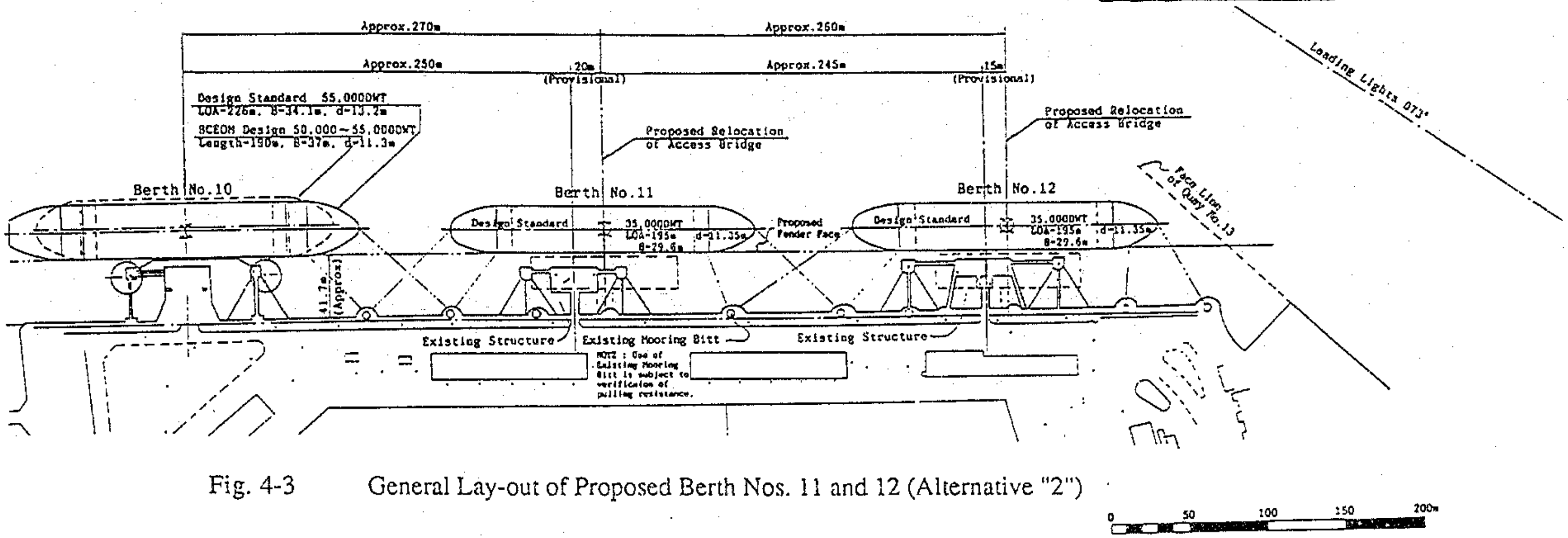
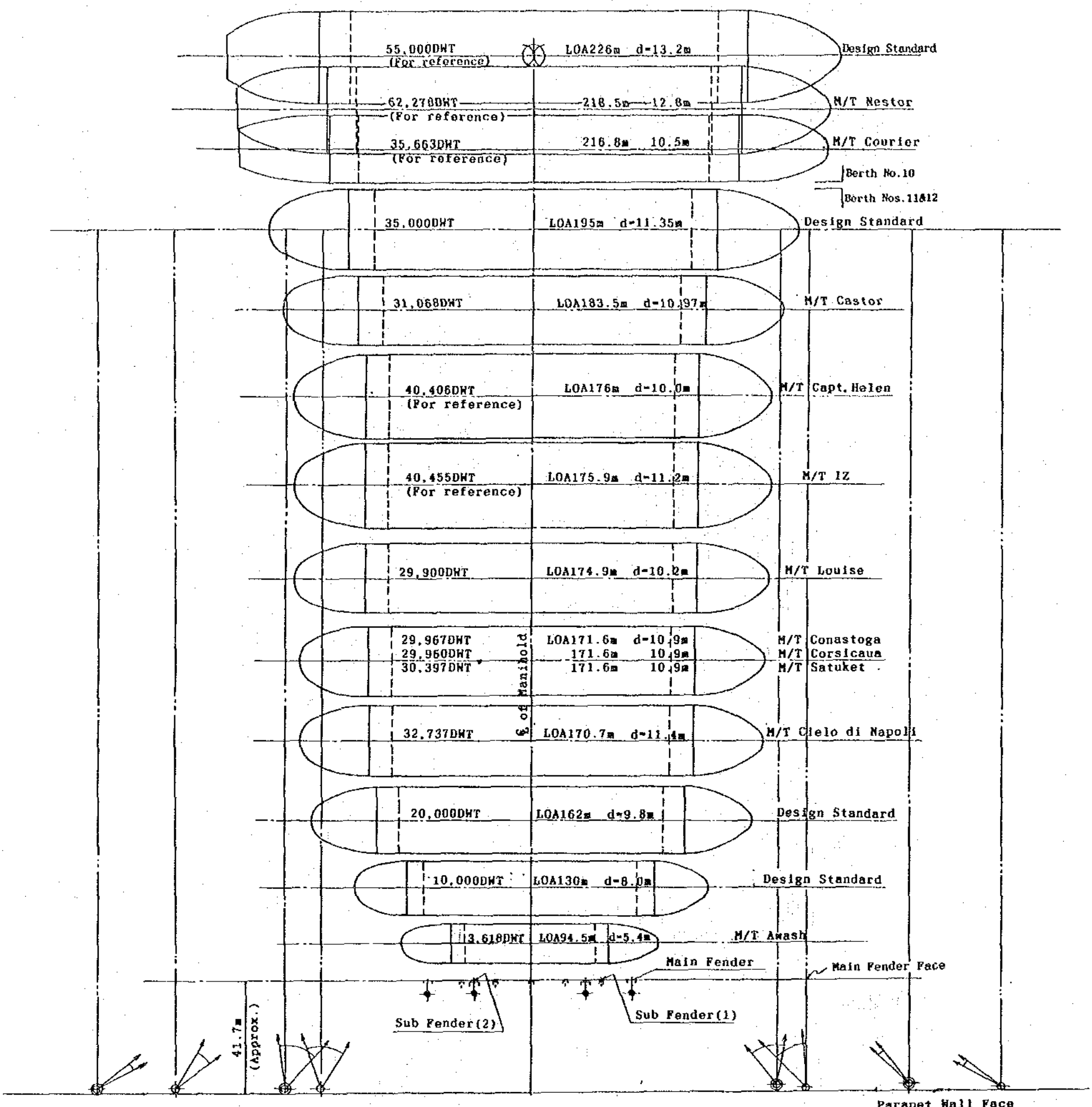



Fig. 4-3 General Lay-out of Proposed Berth Nos. 11 and 12 (Alternative "2")




LEGEND : Proposed Mooring Point (Bitt) on the Berth Structure

Existing Mooring Point (Berth No.11)

Existing Mooring Point (Berth No.12)

Notes : 1. Sub Fender(1) for vertical wall type structure
2. Sub Fender(2) for pile type structure
3. Arrows on the existing mooring poins show the range of mooring lines when tankers are alongside of berth

Fig. 4-4 Various Ship Sizes and Arrangement of Berth Facilities

## 4.5 Location and Back-up Facilities of Oil-Berths

Upon completion of berthing facilities, the on-land back-up facilities should have sufficient capability to meet the forecasted oil cargo volume and also satisfy the safety and environmental aspects.

From these points of view, the following determinations were made and as a consequence, there were no major hindrance found against the reconstruction of the oil-berths.

### (1) Location of Oil-Berths

The existing oil-berths are located at the extreme outer edge of the Port of Djibouti which gives the deepest water of frontal basins and easy accessibility from the outer sea to the berths, thus allowing for safe maneuvering of tankers.

The hydrographic survey conducted by the Study Team (see Section 2.2.3) verified that the water depth of frontal basin is well maintained except for some marginal areas.

Although the proposed berths are facing the outer sea where seasonal wind engenders during Khamsin season, other alternative locations are not recommendable due to the congestion of the inner harbor and the unsafe operation. The location of tank yards which is a little remote from the existing oil-berths and connected by pipelines is not ideal from the safety view point but underground pipelines instead of the existing on-ground pipelines will minimize the hazards. According to PAID, the existing pipelines are planned to be placed underground.

### (2) Storage Tank Yards

The total capacity of the existing oil storage tanks owned by the three oil companies is approximately 200,000 cubic meters equivalent to 170,000 metric tons. (see Table 4-8)

Based on the oil storage planning practice in Japan, the required capacity of oil tanks is determined as follows:

| | | | |
|---|---|---|---|
| i) | For oil storage: | One sixth of annual oil volume to be handled | |
| | | 740,000 MT/year x 1/6 = | 123,000 MT |
| ii) | For oil receiving: | Volume of one maximum oil tanker | |
| | | | 35,000 MT |
| | Total capacity required | | 158,000 MT |

This figure indicates that the existing oil storage has a 10 % more capacity than the required one.

The pipelines and relevant facilities are owned, operated and maintained by the oil companies. As described in Section 2.4, some pipeline have been renewed recently.

Therefore, it can be said that the PAID and the oil companies have sufficient experience, capacity and capability for operation and maintenance since the forecast volume to be handled in the target year 2010 is 740,000 MT still very low compared with the capacity of almost two million metric tons per year in the 1960's.

(3) Inland Transportation

Among the major inland transport modes, the railways (CDE) are predominant for the transshipment of cargo to Ethiopia.

As described in Section 2.4, the CDE owns more than 100 oil tank wagons, 19 locomotives and other rolling stock which will meet future transportation demands of oil.

The rehabilitation of the railways facilities including rolling stock and railway tracks was scheduled to be started by the end of year 1993. The inland transportation systems therefore are deemed not to become bottleneck for oil cargo distribution.

# Chapter 5 Preliminary Design

# CHAPTER 5 PRELIMINARY DESIGN

## 5.1 Preliminary Design Conditions

### 5.1.1 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.

### 5.1.2 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 |

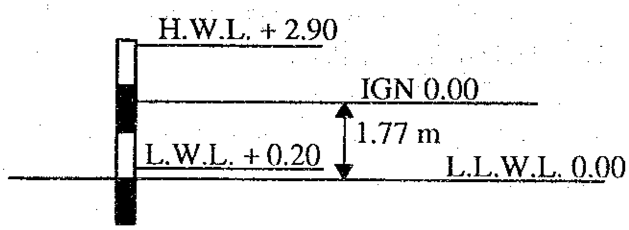



Figure 5-1 Tide Level

- 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 ($\alpha$) x Factor for subsoil condition ($\beta$) x Coefficient of importance ($\gamma$)

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 5-1 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.

CONCRETE

- Unit Weight : Reinforced Concrete : 2.45 tf/m$^3$ (in air)
  : 1.45 tf/m$^3$ (in water)
  : Plain Concrete : 2.30 tf/m$^3$ (in air)
  : 1.30 tf/m$^3$ (in water)

- Allowable Strength of Materials

  Reinforced Concrete : 240 kgf/cm$^2$ (standard design strength)
  : 90 kgf/cm$^2$ (allowable flexural compressive)
  : 9 kgf/cm$^2$ (allowable shearing strength)
  Plain Concrete : 180 kgf/cm$^2$ (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.

## 5.2 Preliminary Design

### 5.2.1 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. 5-2):

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 5-2 and the steel sheet pile cellular cofferdam type is selected.

### 5.2.2 Preliminary Design Drawings

The preliminary design drawings of the proposed structural type are shown in Figs. 5-3 to 5-5.

Figure 5-2 Structure Comparative Study

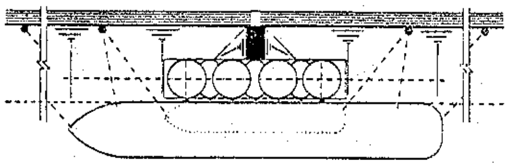
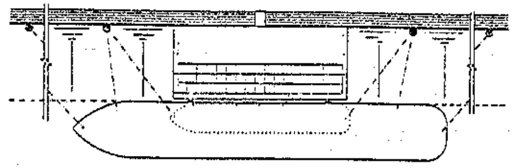
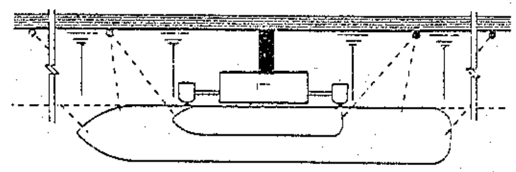
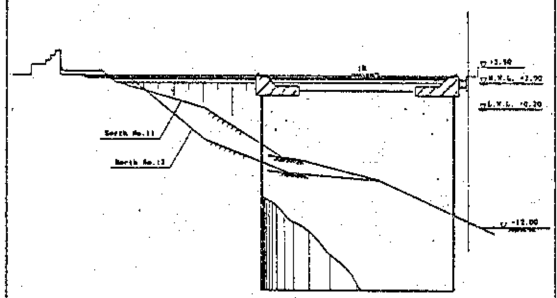
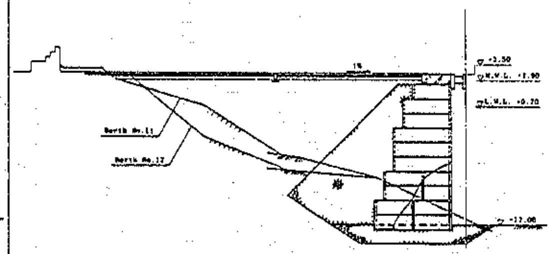
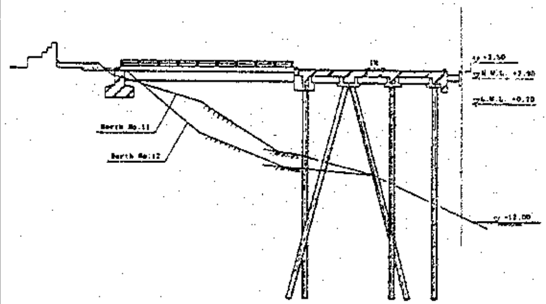
| Alternative | I | II | III |
|---|---|---|---|
| Structure Type | Steel Sheet Pile Cellular Cofferdam | Cellular Concrete Block | Open-Type Pier |
| General Plan |  |  |  |
| Cross Section |  |  |  |

Table 5-2 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.<br>- In the Port of Djibouti, there exist many similar structural type quays since long time past.<br>- 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.<br>- The demolition of the existing structures can be minimized.<br>- It is easy to obtain filling materials for the cellular cofferdam.<br>- It will be easy to maintain.<br>- 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.<br>- It is easy to obtain filling materials for the cellular blocks.<br>- It will be easy to maintain.<br>- 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.<br>- 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.<br>- Pile driving can be done interruptedly even during Khamsin season.<br>- 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.<br>- 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.<br>- As for the construction, heavy equipment for marine works such as a crane mounted barge is needed.<br>- 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.<br>- 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.<br>- It is necessary to provide large temporary yard and a loading quay for precast concrete fabrication, stock and handling.<br>- The transportation and installation of such precast concrete blocks by barge inside port area will disturb port activities.<br>- 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.<br>- As for the construction, heavy equipment for marine works such as a pile driving barge is needed.<br>- 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 |

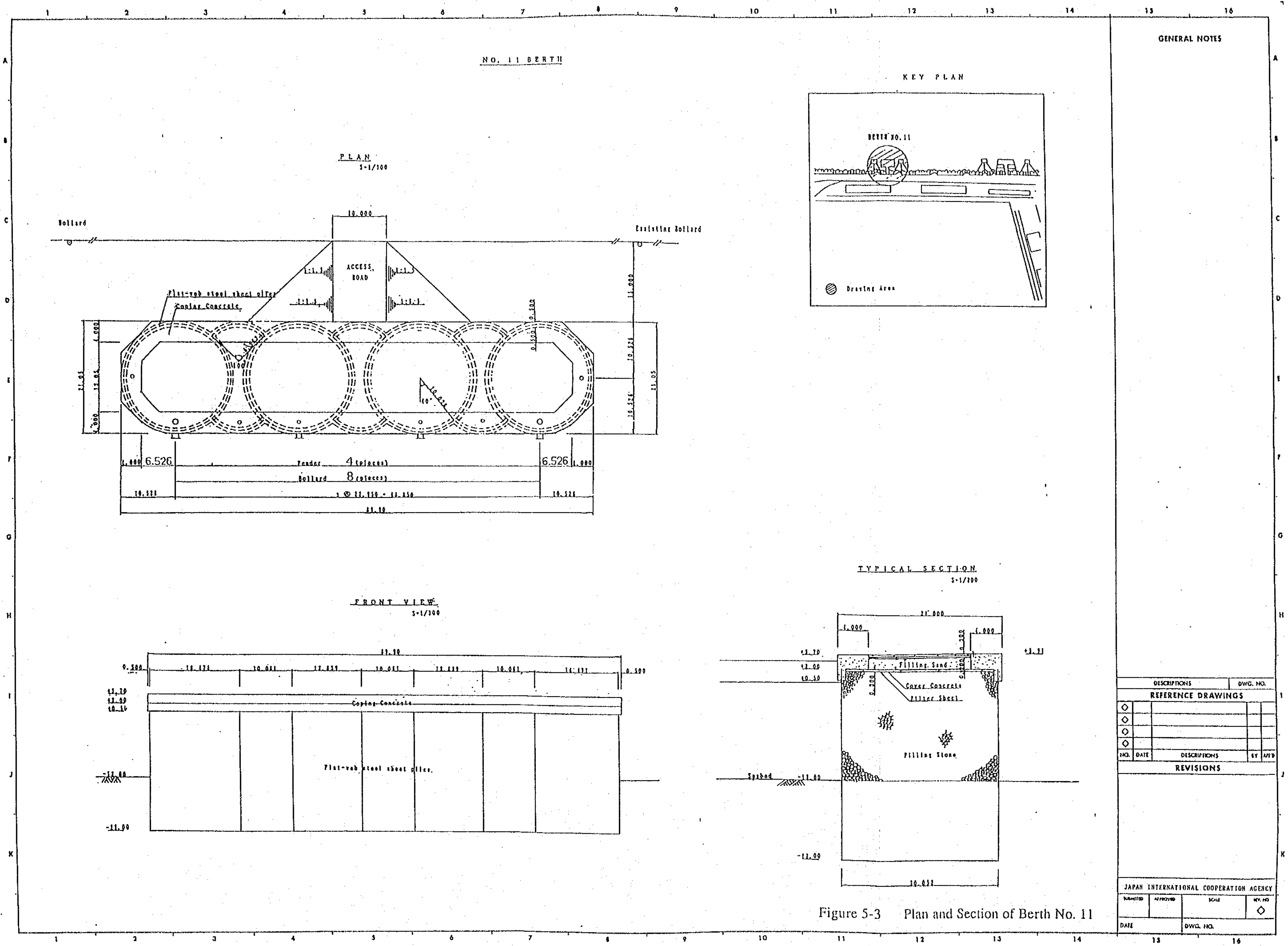



Figure 5-3 Plan and Section of Berth No. 11

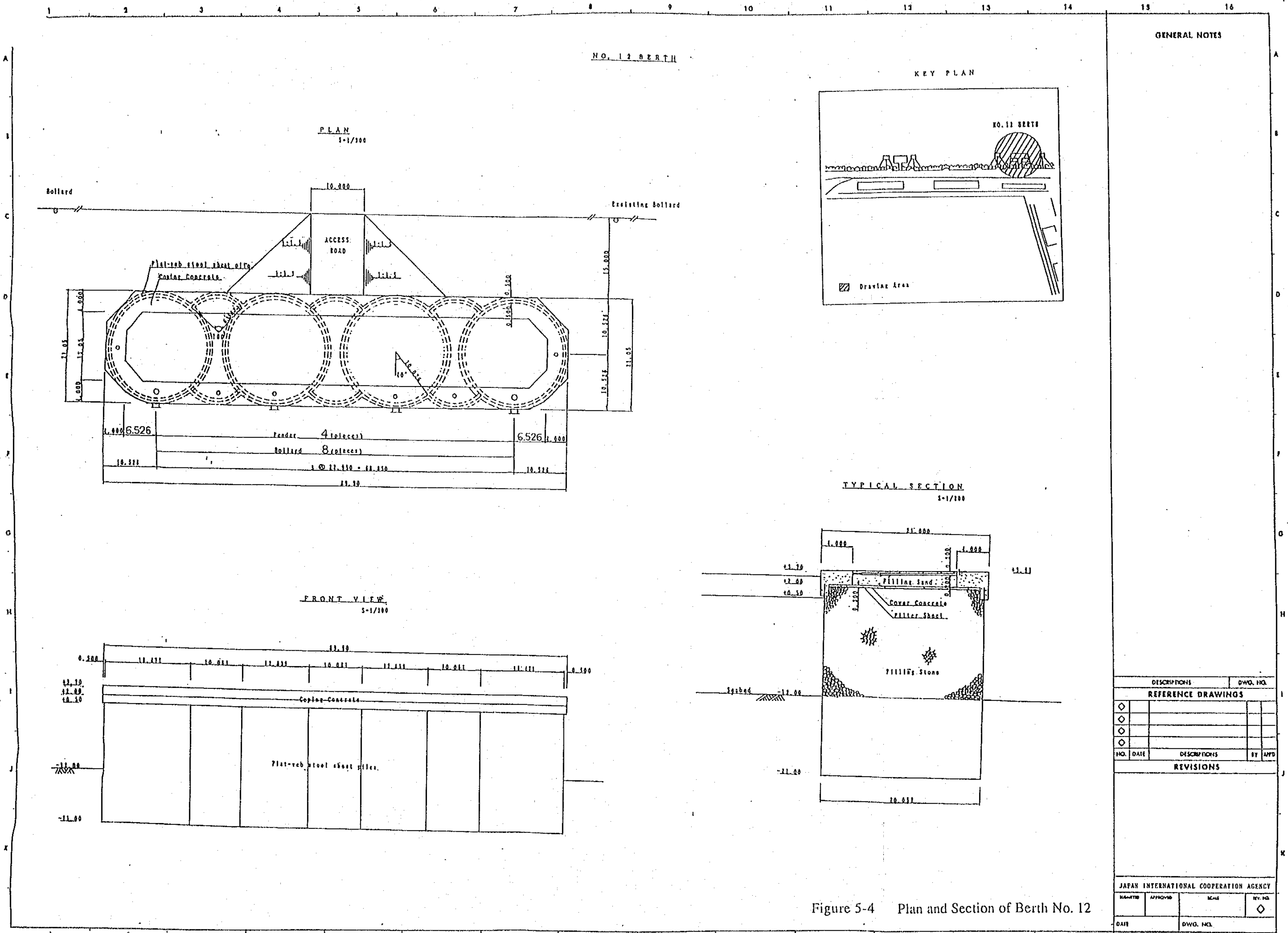
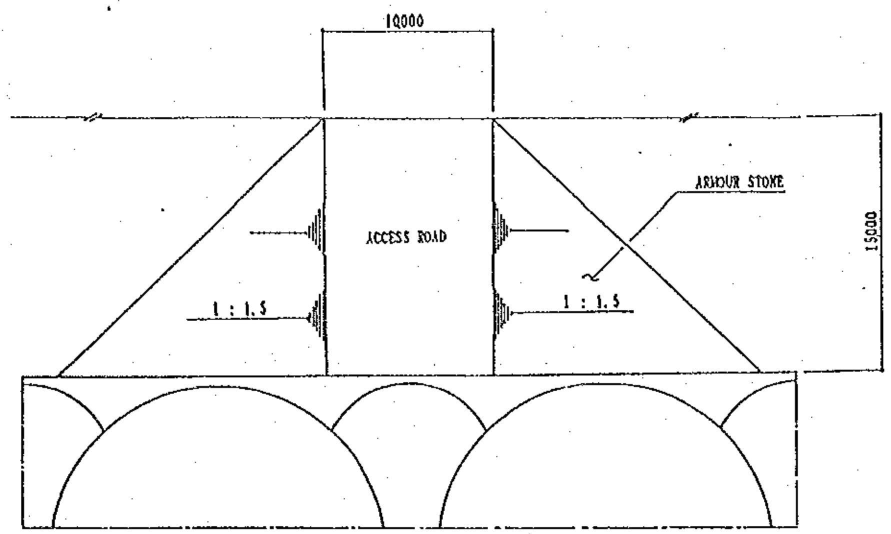
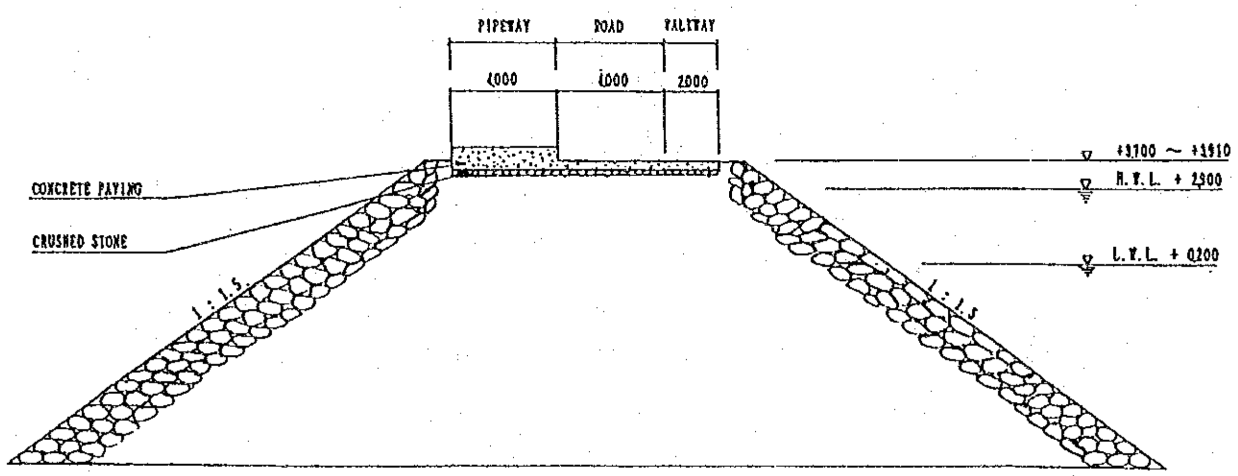



Figure 5-4 Plan and Section of Berth No. 12

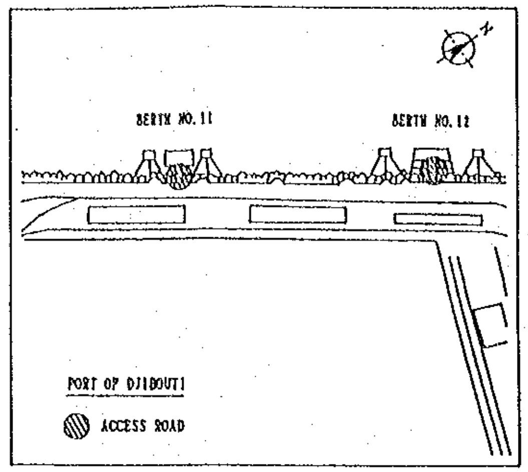



ACCESS ROAD PLAN
S = 1:200




SECTION
S = 1:125

KEY PLAN




GENERAL NOTES

DESCRIPTIONS | DWG. NO.

REFERENCE DRAWINGS

NO. | DATE | DESCRIPTIONS | BY | APPD

REVISIONS

JAPAN INTERNATIONAL COOPERATION AGENCY

SUBMITTED | APPROVED | SCALE | REV. NO.

DATE | DWG. NO.

Figure 5-5 Access Road

## 5.3 Construction Method

### 5.3.1 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.

### 5.3.2 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. 5-6. 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.

## 5.4 Cost Estimates

Project cost for the Oil Berths Reconstruction is summarized in Table 5-3. 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

## 5.5 Implementation Program

Implementation schedule is proposed as shown in Fig. 5-7 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.

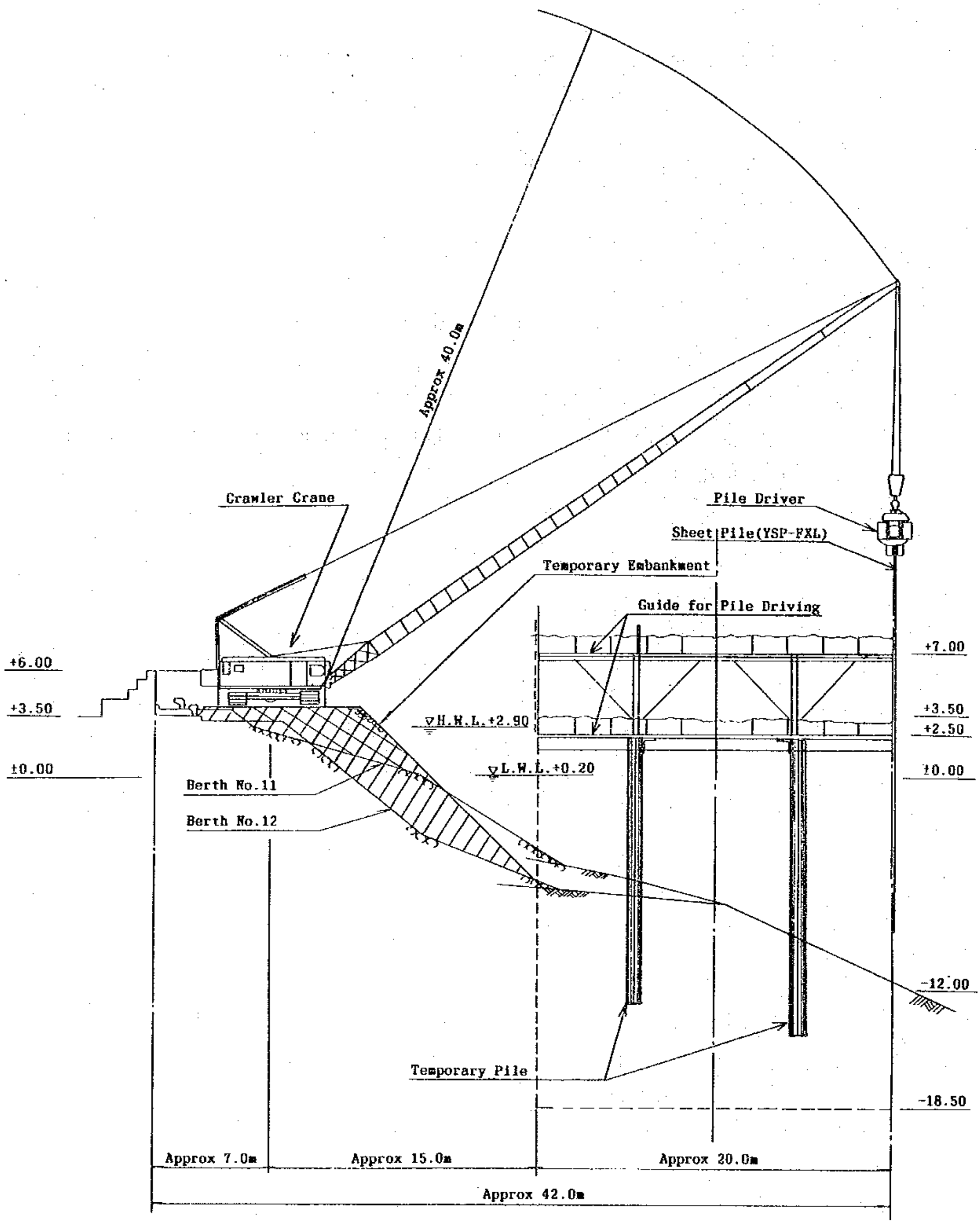



Figure 5-6 Construction Method of Steel Sheet Pile Cellular Cofferdam

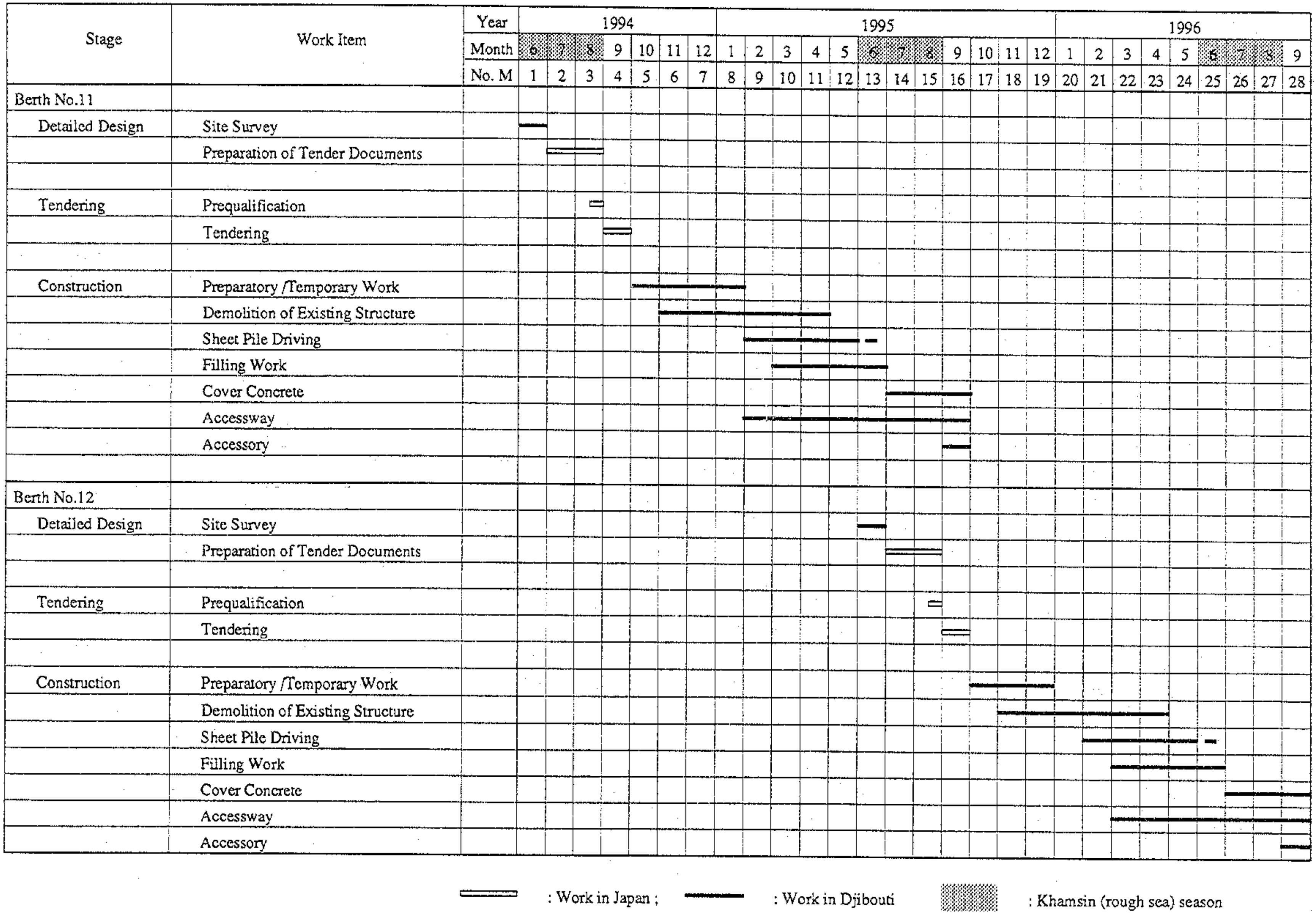
Table 5-3 Cost Estimate

(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.

## Figure 5-7 Implementation Schedule



# Chapter 6 Environmental Impact Study

# CHAPTER 6 ENVIRONMENTAL IMPACT STUDY

## 6.1 General

The proposed Oil-Berth project principally consists of re-construction works of similar berthing facilities which will give positive environmental impacts by improving the existing facilities and oil cargo handling systems but additional significant adverse effects are, therefore, not anticipated except for some small negative impacts which will be mainly caused by construction works of the project.

The project sites, including temporary construction yard, are located in the existing port area and surrounded by artificial structures such as dredged port basin, armour rock revetment, and port yards hence negligibly minimal effects on the local habitants, fishery activities, aquatic creatures, ecosystem and other environmental elements,.

The forecasted future oil cargo volume in the year 2010 is approximately 740 thousand metric tons which is more than double that of 1992.

Above forecasted volume is, however, much below the past maximum oil cargo handling volume in 1960's which was almost 2 million metric tons per annum. Those onland existing oil facilities such as oil storage tanks, pipelines, pumps, rolling-stock (CDE), were built to meet the past oil demand, and have enough capability for handling the future demand volume.

The major considerations in this environmental impact study are therefore, on the mitigating counter measures to be made on the existing environmental conditions, particularly to minimize seawater pollution caused by oil handling activities.

## 6.2 Sources of Environmental Impact

Sources of environmental impact of the Oil-Berth Re-construction Project are described in two stages viz: (1) during construction works and (2) after completion.

### 6.2.1 During Construction Works

Sources of environmental impact which could be caused by the proposed plans can be divided into five components as follows:

- Demolition of existing structures
- Dredging/excavation
- Operation of heavy equipment

- Construction of structures
- Transportation of construction materials.

### 6.2.2 After Completion

As for "after completion of the Oil Berths", the sources of environmental impact can be divided into four components as follows.

- By existence of Oil-Berths
- By operation of Oil-Berths
- By oil tankers calling at Oil-Berths
- By tank yards (oil companies):(Note : this component is described for reference purpose).

### 6.2.3 Identification of Environmental Impact

A project impact matrix that covers the possible impacts on environmental elements during construction and after completion is shown in Table 6-1.

## 6.3 Forecast and Evaluation of Environmental Impact of Proposed Plan

Environmental impacts which may be caused by the proposed Oil-Berths re-construction plan are given in Table 6-1 of the preceding section. These impacts are examined in detail as summarized in Table 6-2 and 6-3 for "during construction works" and "after completion," respectively.

## 6.4 Conclusion

"During the construction works", impacts which will be caused by the proposed project will not be serious for the environment and be within the manageable limits of the construction contractors.

Results of the environmental study on "after completion" shows that depending on the proposed facilities, oil handling system and proper discipline of the end users, the negative environmental impact will be moderated within the tolerable limit.