4.3 Basic Design

4.3.1 Establishment of Construction Scale

(1) Requirements

In order to alleviate the harbour congestion which is the main purpose of the rehabilitation project, the following requirements must be fulfilled:

1) The inner fishing harbour is for the exclusive use of the inshore fishing vessels while steel vessels should use the outer fishing harbour or other places.

2) Functional segregation of the wharf in the inner fishing harbour for a better utilization.

3) Rehabilitation of the facilities for an efficient use of the wharf.

(2) Functional Segregation of the Wharf

The wharf is an important place for mooring, fish landing, loading of fishing gear and provisions. To this end, the quay is demarcated into a fish landing wharf, a preparation wharf and a lay-by wharf.

As described in Paragraph 2.4.2, the existing wharf is not clearly demarcated into the various purposes. This demarcation should be settled in order to alleviate the congestion for its efficient use.

If the wharf is allowed to be used in its present condition with the fish landing and preparation combined together, management and congestion problems will arise. Therefore, demarcation of the wharf should be established to alleviate the harbour congestion.

1) Fish Landing Wharf

In order to ease the congestion during the fishing season and to have a highly efficient operation of the vessels, adequate space should be left open for the exclusive use of fish landing operation.

2) Preparation Wharf

After unloading fish, the vessels must have adequate space for its preparation procedures.

3) Lay-by Wharf

One of the reasons for the harbour congestion is the overstaying of idle vessels. These vessels (including steel vessels) are a major contribution to the congestion. Therefore, a lay-by jetty should be planned for the mooring of these vessels.

(3) Location of Each Wharf

For alleviating congestion, enough space should be made available for each wharf. However, in addition to space, the proper location of each wharf should be taken into account.

Strategic locations are as follows:

1) Fish Landing Wharf

Though the fishing vessel may move to the preparation wharf after the fish is unloaded, the next one can not unload the fish if the unloaded fish is left on the wharf an unnecessarily long time.

Therefore, the fish unloading wharf should be situated near the fish handling place for a quick distribution of fish. Since there is a fish market on the east-west wharf, the fish landing wharf must be in its proximity.

2) Preparation Wharf

This wharf is used for the loading of water, ice, fuel and fishing gear. It should be equipped with water and fuel supply facilities and should have an easy access as ice is supplied by a tractor. An advisable positioning for this wharf will be on the south-north wharf.

3) Lay-by wharf

A great number of vessels are laying idle for long periods due to a shortage of spare repair parts. The lay-by wharf should be situated near the boatyard or repair yard and must allocate a part for a net repair yard. The lay-by wharf should be at a location where it does not disturb maneuvering other vessels because it requires ample space to moor many vessels continuously. To satisfy these requirements this wharf should be situated on the south-north wharf and at the corner of the south breakwater.

To further satisfy these requirements, requested 2 new jetties built in the anchoring area will not be adequate since maneuvering will be made difficult. Also, this area is a passageway for the 400 canoes using the canoe basin. The extention of the jetties will interfere with the sea lanes. Hence, they cannot be extended in the anchoring area for safety reasons. Therefore, these lay-by jetties will be limited in size.

(4) Scale of Each Wharf

The standard fish landing condition per one fishing day during the fishing season is normally applied for determination of the scale of wharf in Japan. In order to estimate the standard fish landing condition, three years data is used.

However, as shown in Talbe 2.3.4, the fish landing for inshore fishing in Tema during the last 5 years has been found to be constant. Therefore, the scale of wharf, in this case, was estimated by using one year data of 1985.

1) Standard Fish Landing Condition

From the 1985 data shown in Fig. 4.3.1 for the Tema fishing harbour, the fishing season lies over 3 months from July to September (See Table 4.3.2 and Figs. 4.3.2 to 4.3.5 for the details). The standard fish landing condition is estimated as shown below by applying an average amount of top ten fish landing volume during fishing season (See Table 4.3.1)

Average fish landing amount = 5,548 crates
Number of vessels unloading fish = 45 vessels
Average fish landing amount per vessel
= 124 crates/vessel

Table 4.3.1 Top Ten Fish Landings and Number of Vessels during the Fishing Season

Ranking	Fish Quantity (No. of crates)	Number of Vessels (No.)	Average Fish Amount/ Vessel (Crate/vessel)
1	7,706	47	164
2	7,038	52	135
3	6,561	42	156
4	5,630	47	120
5	5,387	47	115
6	5,227	45	116
7	4,630	40	116
8	4,456	44	101
9	4,437	43	103
10	4,403	38	116
Average	5,548	45	124

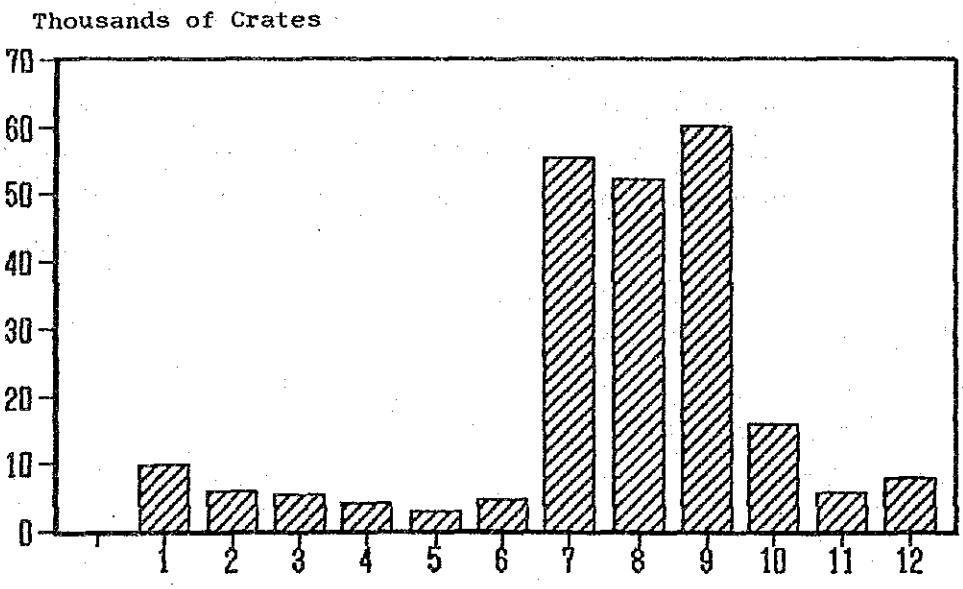


Fig. 4.3.1 Monthly Landing of Inshore Fishing at Tema

Table-4.3.2 : Operating fishing boats and fish loads (1985, July, August , September)

DATE	JULY			AUGUST			SEPTEMBER		
	NUMBER OF VESSELS	AVERAGE FISH UNLOADING VOLUME PER VESSEL	UNLOADING VOLUME	NUMBER OF VESSELS	AVERAGE FISH UNLOADING VOLUME PER VESSEL	UNLOADING VOLUME	NUMBER OF VESSELS	AVERAGE FISH UNLOADING VOLUME PER VESSEL	UNLOADING VOLUME
1	12	55	657	19	58	1101	4	57	227
2	13	20	260	14	1	10	30	40	1217
3	7	20	137	14	14	191	0	0	0
4	5	6	29	7	56	395	36	50	1800
5	11	23	251	31	73	2278	39	36	1423
6	12	12	142	3	102	307	44	67	2948
7	19	30	583	38	116	4403	35	68	2389
8	30	104	3124	33	70	2319	41	102	4182
9	7	45	314	32	51	1632	38	26	1002
10	13	44	574	28	111	3117	2	0	0
11	23	72	1662	35	51	1790	33	80	2624
12	29	49	1423	32	63	2021	29	112	3249
13	29	76	2196	0	0	0	34	78	2644
14	26	30	771	28	102	2848	22	65	1434
15	45	49	2193	24	72	1729	51	7	343
16	3	111	333	28	92	2576	45	26	1151
17	47	115	5387	22	158	3474	0	0	0
18	35	85	2969	31	132	4101	52	135	7038
19	47	120	5630	25	67	1670	43	103	4437
20	38	93	3546	2	214	428	45	116	5227
21	44	88	3870	44	101	4456	40	116	4630
22	47	164	7706	28	48	1358	42	82	3442
23	1	36	36	32	115	3673	42	156	6561
24	38	101	3857	27	104	2806	0	0	0
25	22	55	1216	36	80	2896	17	55	929
26	23	35	816	13	38	499	14	14	196
27	16	93	1487	0	0	0	10	6	57
28	17	50	856	18	4	73	6	41	244
29	12	56	674	2	6	12	16	16	261
30	5	6	28	5	2	12	16	27	436
31	27	100	2699	4	4	18	—	—	—
TOTAL	703	1943	55426	655	2105	52193	826	1681	60091
AVG	23	63	1788	21	68	1684	28	56	2003

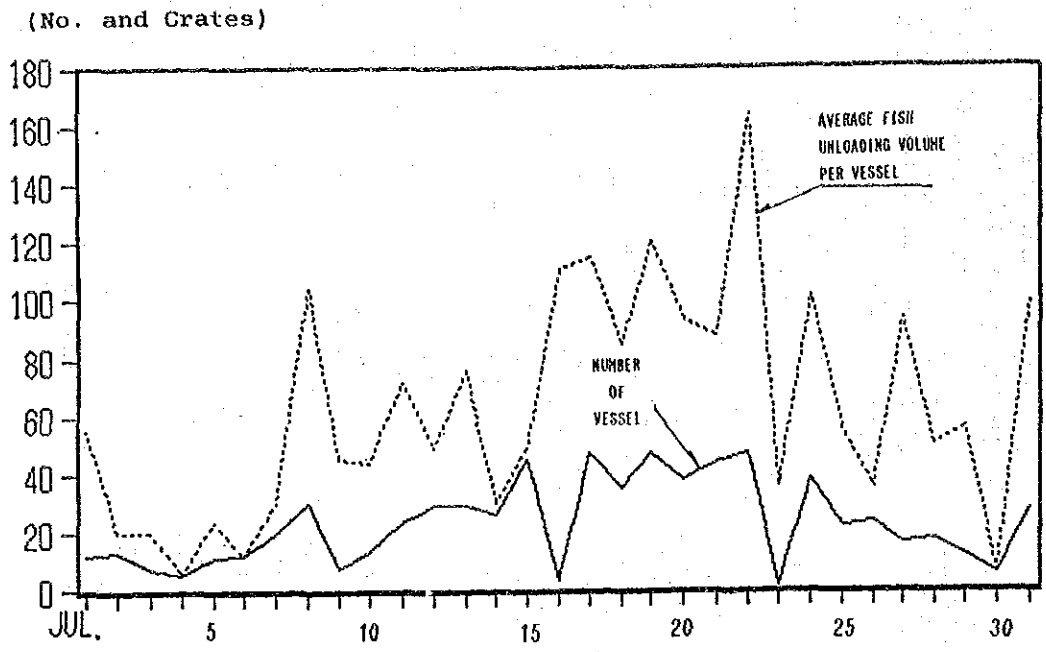


Fig. 4.3.2 Number of Vessels and Fish Landings (July 1985)

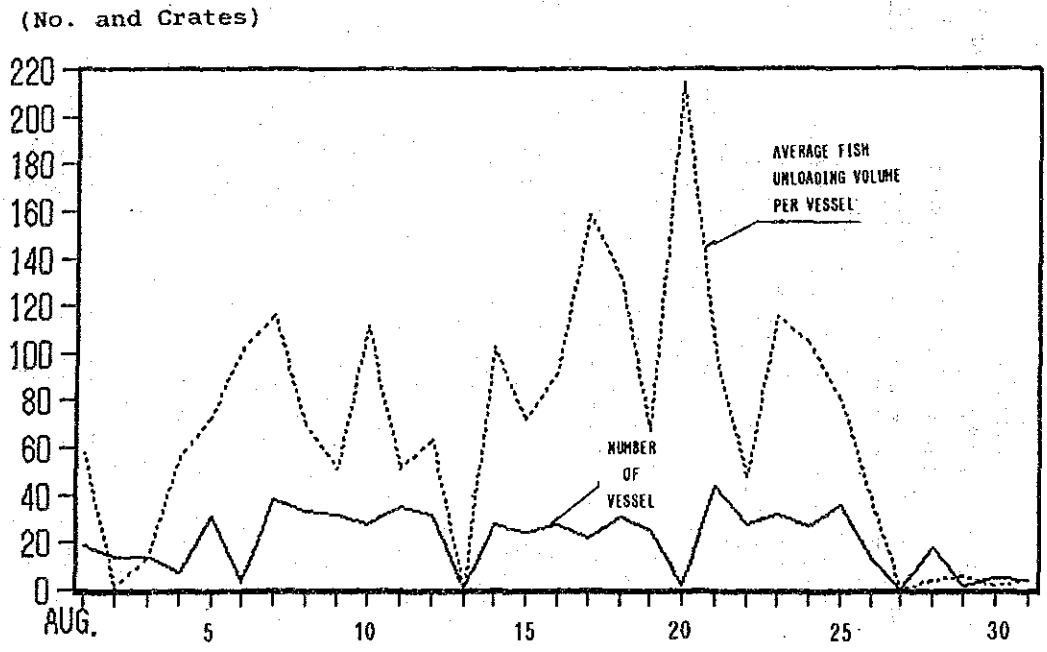


Fig. 4.3.3 Number of Vessels and Fish Landings (August 1985)

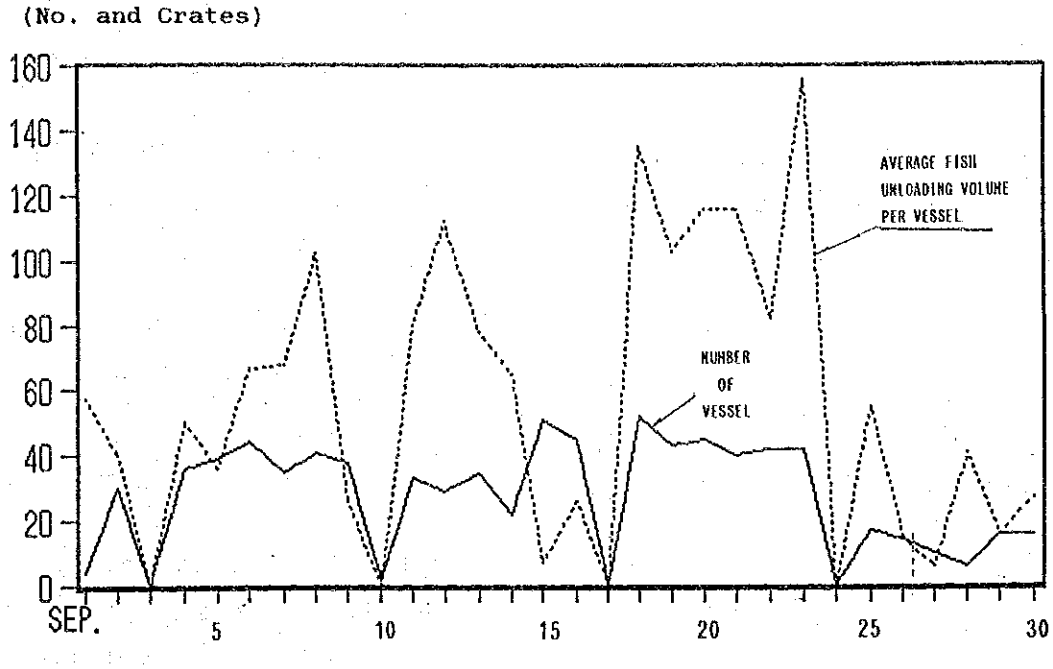


Fig. 4.3.4 Number of Vessels and Fish Landings (September 1985)

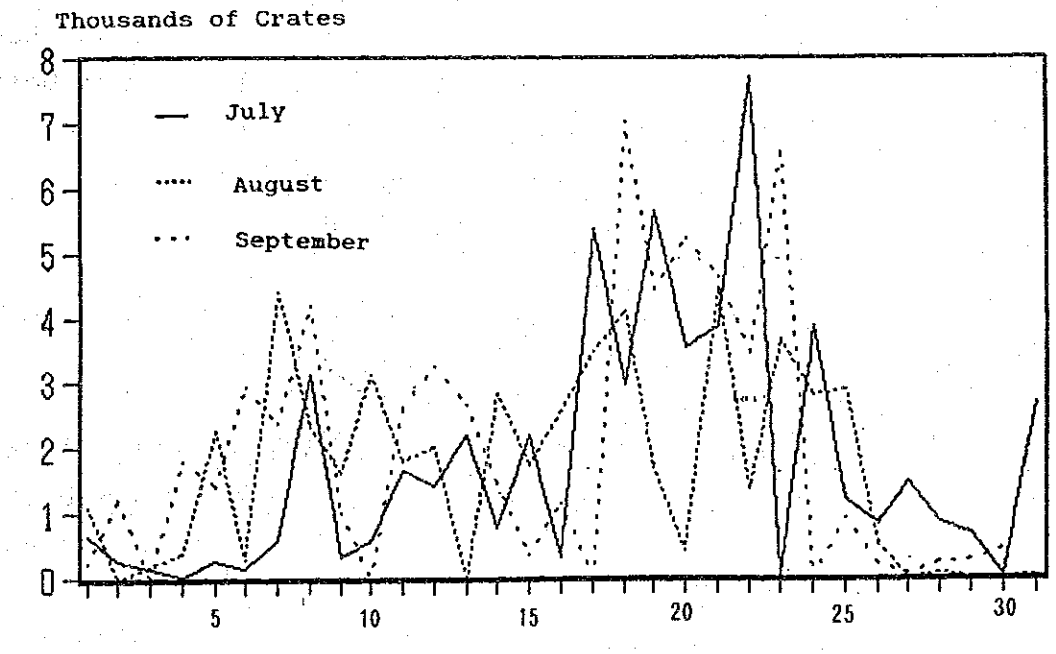


Fig. 4.3.5 Fish Landings during the Fishing Seasons

2) Required Length of Fish Landing Wharf

The required length of the fish unloading wharf is calculated as below:

$$\text{Requested Length} = \sum \frac{N}{r} \cdot L \qquad \text{..... (Formula 4.3.1)}$$

where

L : Berth length = vessel length + allowance

N : Standard number of vessels operating per day

r : Berth rotation = $\frac{\text{Workable hour per day}}{\text{Fish unloading time per vessel}}$

(a) Berth Rotation Number

The fish landing time for 1 vessel is determined by the unloading time and the time of vessel berthing and deberthing the wharf. The fish unloading time for the case of sardines is 1 hour per 75 crates and 10 minutes for the vessel berthing and deberthing. The available time for fish unloading per day is assumed as 10 hours considering the marketing time.

Therefore the berth rotation can be calculated as follows:

Time required for fish unloading:	124/75 =	1.65 hr.
Time required for maneuvering :	10 min.=	0.17 hr.
Total		1.82

Berth rotation = 10/1.82 = 5.49 = 5 rotations

(b) Standard Number of Operating Vessels per Day

From Table 4.3.1, the standard number of operating vessels per day is found to be 45.

(c) Required Length of the Wharf

Table 4.3.3 shows the average length of the inshore fishing vessels and 15% of the vessel length is added as an allowance. Then, the required length of 1 berth will be calculated as follows:

Berth length = 1.5 x 1.15 = 17.25 m

Therefore, the required length of the fish unloading wharf using formula 4.3.1 will be 155.24 m for 9 berths as below.

Required length = 45/5 x 17.25 = 155.25 m = 9 berths

Table 4.3.3 Number of Inshore Fishing Vessels by Size

	1986			1987		
Total length (m)	Operating	Idle	Sub-total	Operating	Idle	Sub-total
Less than 9.9	123	86	209	135	84	219
10.0 - 21.0	104	62	166	92	76	168
21.0 - 30.5	15	13	28	17	14	31

(d) Location of the Fish Unloading Wharf

The east-west wharf facing to the fish market hall and the finger jetty are selected as a fish unloading place (refer to Fig. 4.3.6).

3) Required Length of the Preparation Wharf

The required length of the preparation wharf is calculated as follows:

$$\text{Requested Length} = \frac{N'}{r'} L \qquad \cdots\cdots \text{(Formula 4.3.2)}$$

where

N': Standard number of vessels operating per day

r': Number of Berth rotation =

$$\frac{\text{Workable hour per day}}{\text{Standard time for preparation per vessel}}$$

(a) Preparation Time for 1 Vessel

The main items to be loaded are water, fuel, provisions, and ice where the storage of ice takes most of the time. For the storage of ice on site, each supplier uses a different wagon size between 2.5 and 5.0 tons. The time needed for supplying one vessel with ice is 20 minutes.

If the conditions are similar to the Japanese ones, the ice needed for 1 ton load of fish will be 1 ton. Taking on a ship load of 124 crates (124 x 30 kg = 3.7 tons) the amount of ice needed will be approximately 4 tons.

Therefore 2 wagon loads will be needed for the storage of 4 tons of ice. The time needed for this storage will be 40 minutes but it will depend also on the slope gradient of the chute. In this case, the ship maneuvering will take 10 minutes which is similar to fish unloading and the ship preparation will last for 50 minutes (0.83 hour).

(b) Berth Rotation

Since the wharf utilization time is similar to the fish landing time taken from morning to evening, i.e. 10 hours, the rotation number for the preparation wharf will therefore be 12 times (10/0.83 = 12).

(c) Standard Number of Operating Vessels per Day

Since durng the fishing season, ships are out for a whole day fishing, the standard number of operating vessels per day is the same as the number of fish unloading which is 45.

(d) Required Length of the Wharf

The required length of the wharf is calculated using formula in 4.3.2 and is found to be for 4 berths.

$$45/12 \times 17.25 = 65 \text{ m} = 3.7 \text{ berths} \doteqdot 4 \text{ berths}$$

(e) Location of the Preparation Wharf

Taking into account the fuel and water supply as well as the fact that the ice is supplied by tractor, the preparation wharf shall be situated on south-north wharf. Considering some vessels maneuvering from the lay-by jetty to the preparation wharf, this preparation wharf should be situated in such a way that the passageways are clear.

Since the water area beteween the finger jetty and the south-north wharf is 60 m which is narrow, the preparation wharf shall be located 60 m from the north end of the south-north wharf and taking up 4 berths (refer to Fig. 4.3.6).

4) Required Length of the Lay-by Wharf

Required length of the lay-by wharf is determined based on 3 abreast mooring.

(a) Number of Fishing Vessels

The 1986 data shown below indicates the inshore fleet registered in the Tema fishing harbour which was 101 units.

Inshore fleet based in Tema fishing harbour in 1986

Vessel length	Number
Below 15.2 m	46
15.2-18.2 m	24
Over 18.2 m	31
Total	101

(b) Shortage of the Lay-by Wharf under the Existing Facilities

The total length of existing mooring wharf is 687 m in which available space for lay-by mooring is only for about 33 vessels after deducting the space for before said fish unloading and preparation wharf.

Therefore, 23 berths for lay-by mooring will be short as shown below.

101 - 33 = 68 vessels

68/3 = 23 berths (based on 3 abreast)

(c) Location and Scale of the Lay-by Wharf

In order to ease the congestion and improve the fish unloading and ship preparation during the fishing season, the front area of the fish market as indicated above where fish unloading and preparation wharf should be kept clear.

The anchorage area in the Tema fishing harbour is very narrow and is also used as a passageway. During the non-fishing season when activity is at a minimum, buoys can be set for lay-by mooring. However, this cannot be done during the peak of fishing season due to a lack of anchorage space especially from the entrance to the east breakwater where more than 400 canoes are operating.

Therefore, an extension of the lay-by wharf is necessary in such a way so as not to interfere with normal operating conditions of the harbour during both the fishing and non-fishing seasons. To satisfy these requirements, it will be necessary to build this wharf at the south-north wharf and to the corner of the south breakwater along this breakwater.

In order to accommodate the remaining 68 vessels at the south breakwater, the lay-by wharf has to be extended towards the entrance of the harbour leading then to an obstruction of the waterway. For this reason, the lay-by wharf will only extend up to 100 m which is equivalent to 18 berths. The remaining vessels will be anchored at the newly built jetty east of the fish market. The lay-by jetty east of the fish market, however, cannot be extended too much since this will obstruct the canoe passageway. The maximum extension of the jetty will be about 150 m considering the vessel operation.

If the lay-by wharf is extended to 100 m along the south breakwater, the number of berths will be reduced to 30 taking a space of 0.5 to 1.0L.

The required lay-by jetty for 53 vessels (101-30-18 = 53) will be extended to 155 m from the east side of the fish market hall.

(d) Possibility of a Combined Use of the Wharf

It is possible to combine the fish unloading, preparation and lay-by areas, but this will affect the efficiency of the operations and increase the congestion.

Since the fishing day off in the Tema fishing harbour is usually on Tuesday, most of the 101 Tema registered vessels come back to home port and leave for fishing on Wednesday morning for early fish unloading. This leads to an increased congestion of the fish unloading wharf and is the reason for avoiding the combined use as a fish unloading wharf and a lay-by wharf.

(e) Uses of ⌐ Area for the Lay-by Wharf

The existing usage of ⌐ area is considered as a lay-by wharf. However, this 60 m water area being narrow, affects the fish unloading operations and its use during the fishing season leads to a congestion of the apron near the fish market hall.

This configuration for the lay-by wharf is therefore not advisable. Since this area is near the fish market hall, it should be kept as an alternative fish unloading area after the rehabilitation work so that it will cater for the increasing number of operating vessels. Since the required length of the fish unloading and preparation wharves was calculated under the standard conditions of an average year, the configuration of the existing wharf area should be kept for use during peak periods.

4.3.2 Layout of Wharf

The location and size of each wharf are determined as follows.

(1) Fish Unloading Wharf

As shown in Figure 4.3.6, the 9 berths at the east-west wharf including the finger jetty in front of the fish market hall are used as a fish unloading wharf.

(2) Preparation Wharf

As shown in Figure 4.3.6, the 4 berths 60 m from the north end of the north-south wharf, are used as a preparation wharf.

(3) Lay-by Wharf

The remaining portion of the wharf, after setting aside areas for fish unloading and preparation, is inadequate for accommodation of the 101 inshore fishing vessels required in the Tema fishing harbour.

Therefore;

(a) the 155 m finger jetty projecting from the east end of the east-west wharf

(b) the 100 m wharf at the corner of the south-north wharf and south breakwater should be newly built and used as a lay-by wharf along with a part of the south end of the south-north wharf. The apron of the newly built wharf (b) is to be used as a net repairing yard.

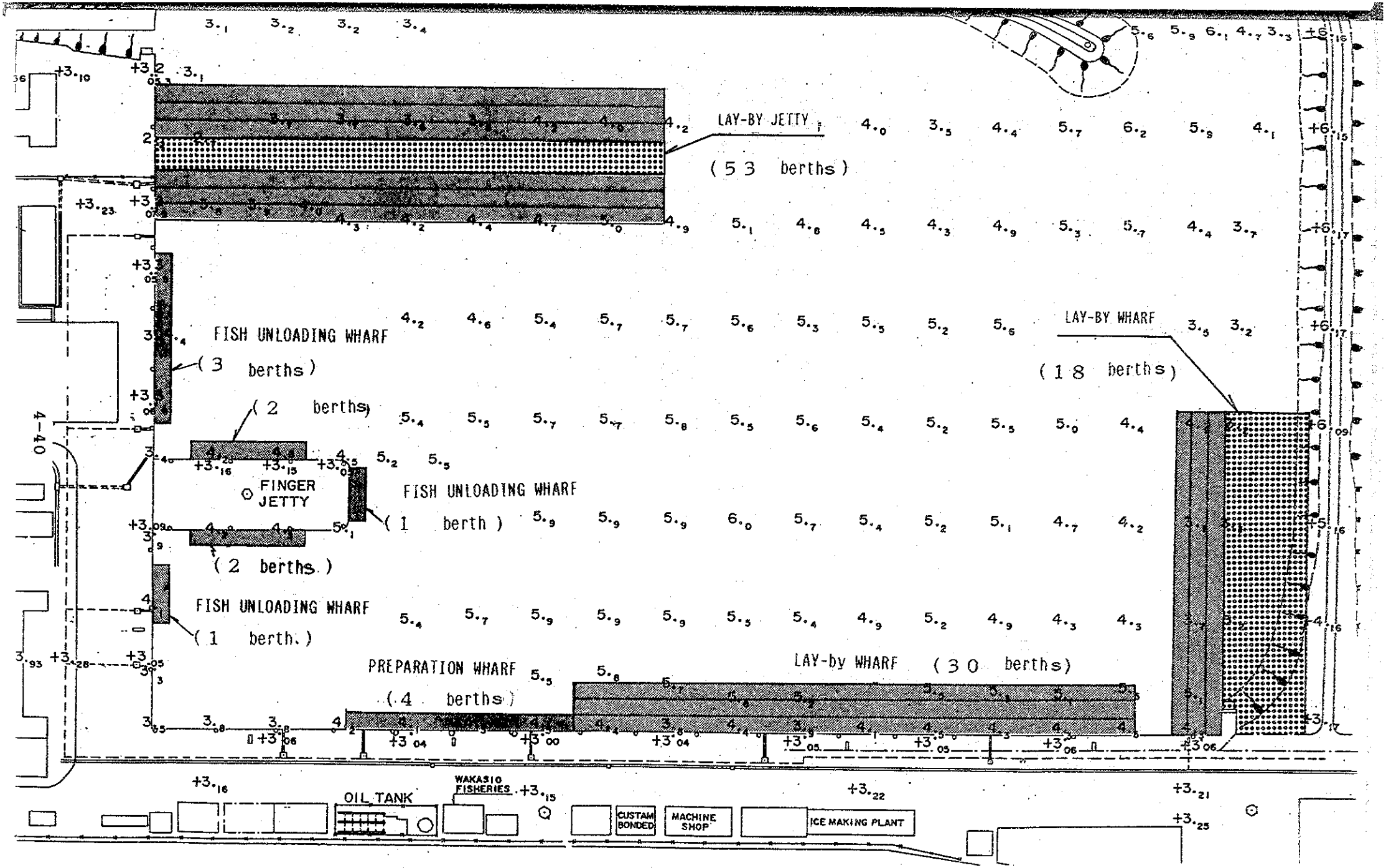


Fig. 4.3.6 Layout of the Wharf

4.3.3 Design Outline

Table 4.3.4 and Fig. 4.3.7 show the summary of the design outline. The following is the design outline of each facility of this project.

(1) Lay-by Wharf and Jetty

1) Design Condition

The details of the design conditions are presented in paragraph 4.2.7.

2) Comparative Design

Since the lay-by jetty and wharf are the main objects of this project, a comparative study has been conducted for choosing the best design. Since there is a hard gravel and rock stratum under the soft sandy strata, it is difficult to drive piles at this site. The structure of the lay-by wharf and jetty will then be a gravity style construction. The construction period and cost will be taken into account for the selection of the design.

Lay-by wharf

(a) Block type
(b) Cellular block type
(c) L shaped retaining wall

Lay-by-jetty

(a) Block pier type
(b) Cellular block pier type
(c) Block type

The comparative results are shown in Tables 4.3.5 and 4.3.6.

Table 4.3.4 Summary of Projected Facilities

Facilities	Dimensions
1. Lay-by wharf	Length 100 m. Water depth -3.5 to -4.0 m. Top elevation = +3.05 m. Apron width 25 m. Cellular block type wharf.
2. Lay-by jetty	Length 155 m. Water depth -3.0 to -4.2 m. Top elevation = +3.05 m. Apron width 10 m. Cellular block type.
3. Lay-by mooring	Steel boat (30 m long) for 20 vessels built in outer fishing harbour.
4. Net storage and repairing yard	Used on 25 m wide apron behind lay-by wharf.
5. Fish market hall repair	Roof repair: 2,300 m^2 approximately. Removal of wooden wall (front and rear entrance repairing only). Stall marking. Ice storage 1 x 3 m^2. Lighting facilities. Water supply facilities.
6. Fish handling shed	Canoe basin: 1,000 m^2. In front of fish market hall: 610 m^2.
7. Fitting-out quay	Length 30 m. Water depth -2.5 m. Top elevation +2.80 m. Apron 10 m.
8. Motor boat jetty	25 m length repair.
9. Sub-station	Repair of switchgear at sub-station Nos. 10, 11, 12
10. Lighting facilities	1 light tower behind lay-by jetty (24 m high). Road light on the canoe base (6 units)
11. Water supply facilities	Lay-by wharf : 2 positions. Lay-by jetty : 4 positions. Fish market : 14 positions. Fish handling shed at canoe basin : 3 positions

Fig. 4.3.7 TEMA REHABILITATION PLAN

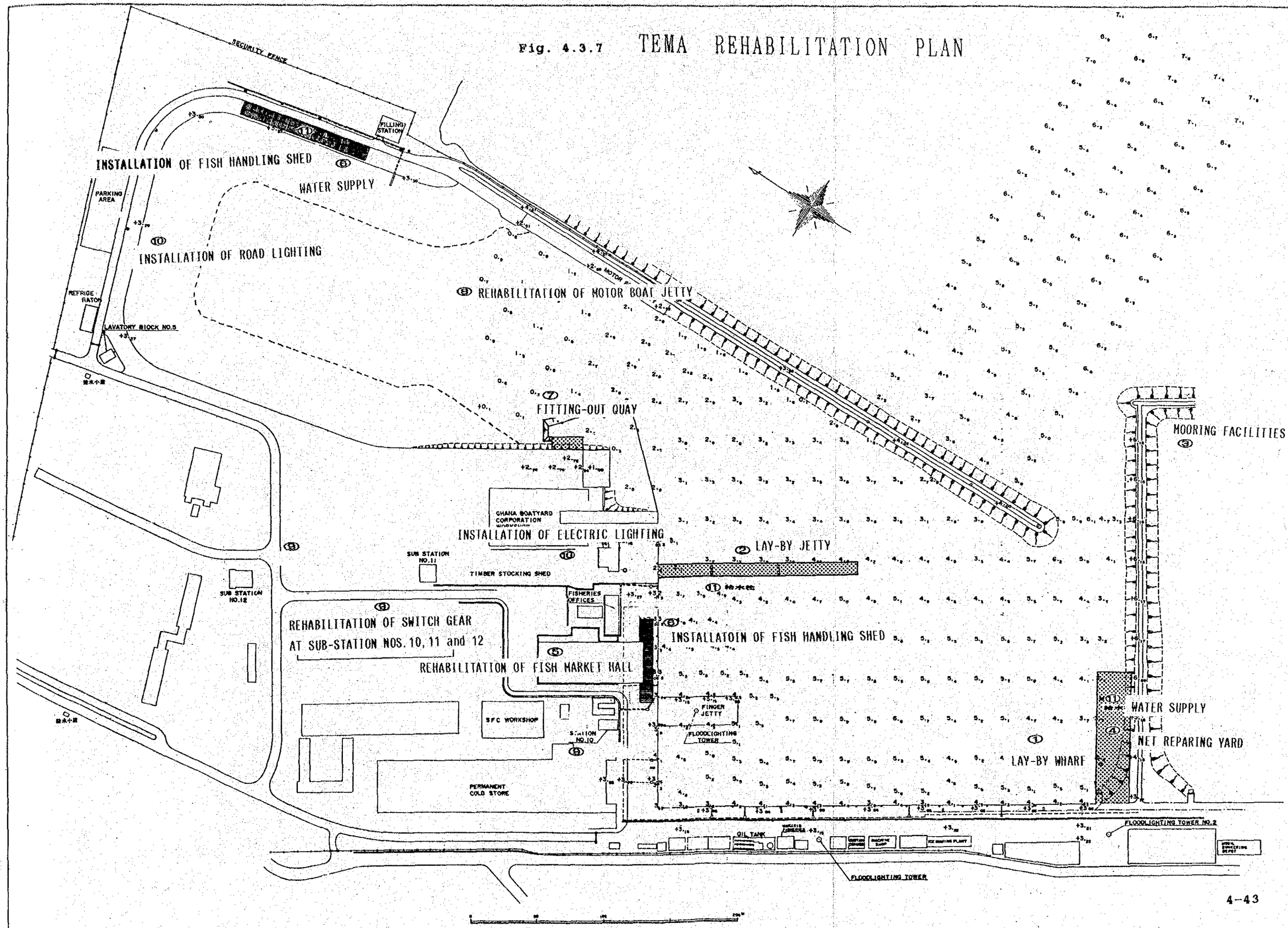


Table 4.3.5 Comparison Table of the Lay-by Wharf Structure

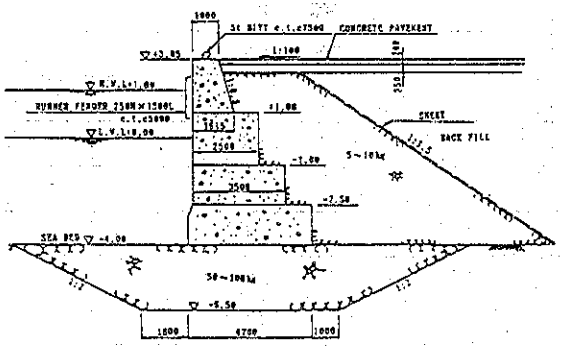
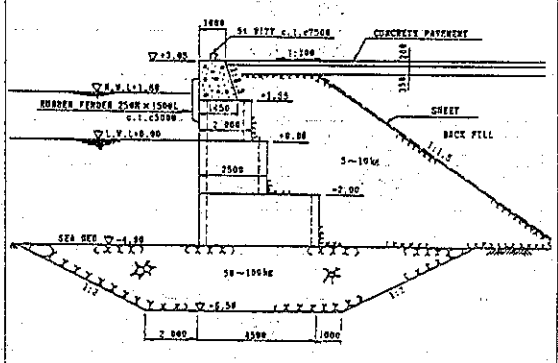
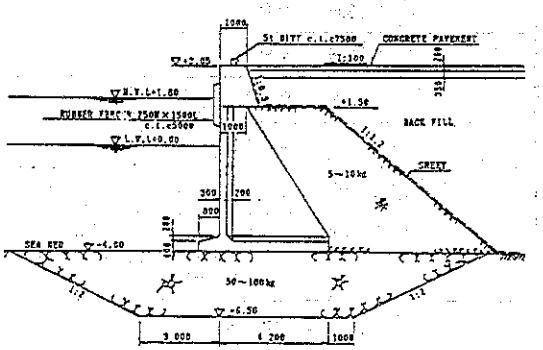
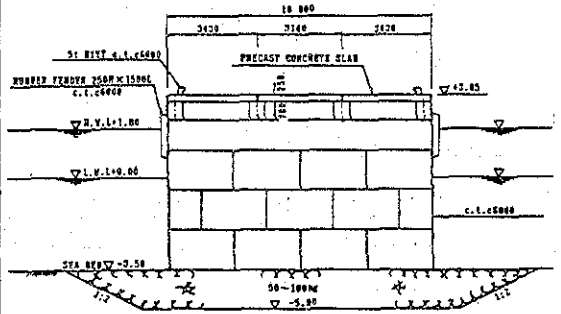
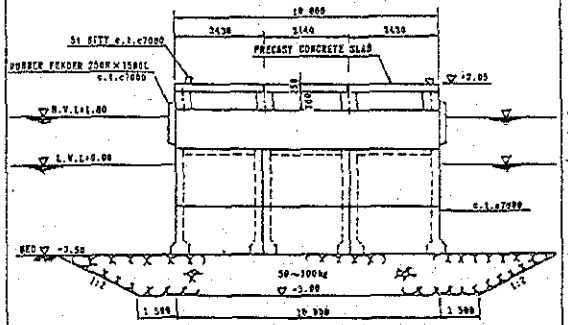
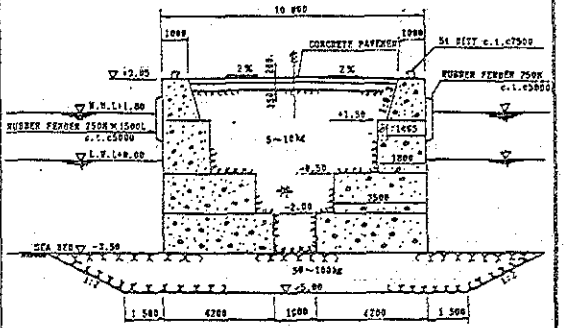
ITEM \ SYSTEM		BLOCK TYPE	CELLULAR BLOCK TYPE	L SHAPED RETAINING WALL TYPE
STRUCTUAL OUTLINE				
CHARACTERISTICS	MERIT	Since the kind of work is rare , the construction is easy.	Number of cellular blocks are not as many as BLOCK TYPE.	Number of precast blocks are not as many as BLOCK TYPE and CELLULAR TYPE.
	DEMERIT	In comparison with the other types of structure there are many blocks to be installed.	The accurate leveling of filling materials in cellular is required. As compared with BLOCK TYPE, it has many kinds of work and needs longer construction period.	Weight of one block is heavier than others, so the lifting equipment with larger capacity must be utilized.
SUBMARY QUANTITIES TYPICALSECTION×LENGTH	SUB & PRECAST CONC (m^3)	1610	670	550
	UPPER & INSITUCONC (m^3)	270	190	190
	TOTAL (m^3)	1880	860	740
	MOUND (m^3)	3100	3100	3300
	BACK FILLING (m^3)	7800 (SAND) / 3800 (5~10kg)	7400 (SAND) / 4300 (5~10kg)	9400 (SAND) / 3500 (5~10kg)
	FILLING (m^3)		1000	
	EXCAVATION	3100 m^3	3100 m^3	3300 m^3
	CONCRETE PAVEMENT	2500 m^3	2500 m^3	2500 m^3
	FENDER	21 NOS.	21 NOS.	21 NOS.
	BITT	14 NOS.	14 NOS.	14 NOS.
CONSTRUCTION COST		×	○	△
PERIOD (MONTH)		8	9	8
EVALUATION		×	○	△

Table 4.3.6 Comparison Table of the Lay-by Jetty Structure

ITEM \ SYSTEM	BLOCK PIER TYPE	CELLULAR BLOCK PIER TYPE	BLOCK TYPE
STRUCTUAL OUTLINE			
MERIT	Since the pier doesn't prevent the circulation flow, the water quality will be kept good.	Since the pier doesn't prevent the circulation flow, the water quality will be kept good.	Since the kind of work is rare, the construction is easy Structural stability is safer than others.
DEMERIT	The accurate finish of upperstructure is required as compared with BLOCK TYPE.	The accurate finish of upperstructure is required as compared with BLOCK TYPE. There is a possibility of differential settlement from the structural point of view as compared with BLOCK PIER TYPE.	Since the wall prevents from the circulation flow, the water quality will be growing worse.
SUB & PRECAST CONC. (m^3)	3050	1760	4700
UPPER & INSITU CONC(m^3)	930	990	590
TOTAL (m^3)	3980	2750	5290
MOUND (m^3)	3500	3700	3700
BACK FILLING (m^3)			
FILLING (m^3)		1300 (5~10kg)	4200 (5~10kg)
EXCAVATION	3500 m^3	3700 m^3	3700 m^3
CONCRETE PAVEMENT			1240 m^2
FENDER	54 NOS.	46 NOS.	64 NOS.
BITT	54 NOS.	46 NOS.	44 NOS.
CONSTRUCTION COST	○	○	×
PERIOD (MONTH)	8	9	12
EVALUATION	△	○	×

3) Selection of Structure

(a) Lay-by Wharf

As shown in Table 4.3.5 the cellular block type is considered as the most advantageous structure and therefore is widely used for wharf structure and construction. The dimension of the lay-by wharf is shown below:

A.	Top elevation	+3.05 m
B.	Planning water depth	-4.00 m
C.	Length	100 m

(b) Lay-by Jetty

As shown in Table 4.3.6 the differences in the durability and cost between the block type and cellular block type structure is not so big. The cellular block pier type is used for this design, since the same construction as the lay-by wharf will apply.

A.	Top elevation	+3.05 m
B.	Planning water depth	-3.05 m
C.	Length	155 m

4) Additional Facilities

The following equipment will be installed on the lay-by wharf and jetty for safe ship maneuvering:

A. Rubber Fender : V-250H x 1500L
B. Mooring Bit : 5 tons
C. Wheel Guard
D. Water supply facilities (Refer to water supply paragraph)

Figures 4.3.8 to 4.3.12 show the details of lay-by wharf and jetty.

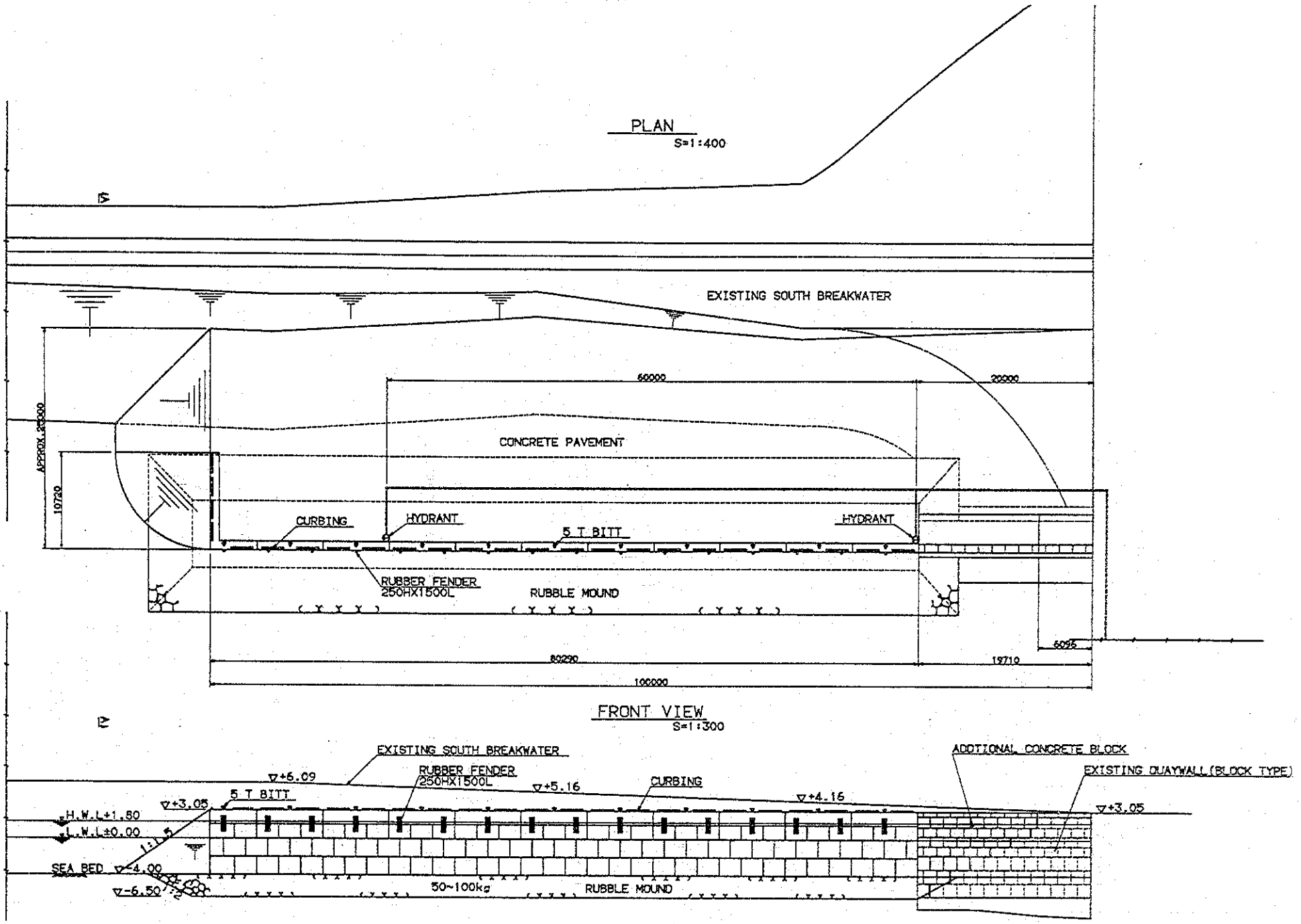


Fig. 4.3.8 Lay-by Wharf (1)

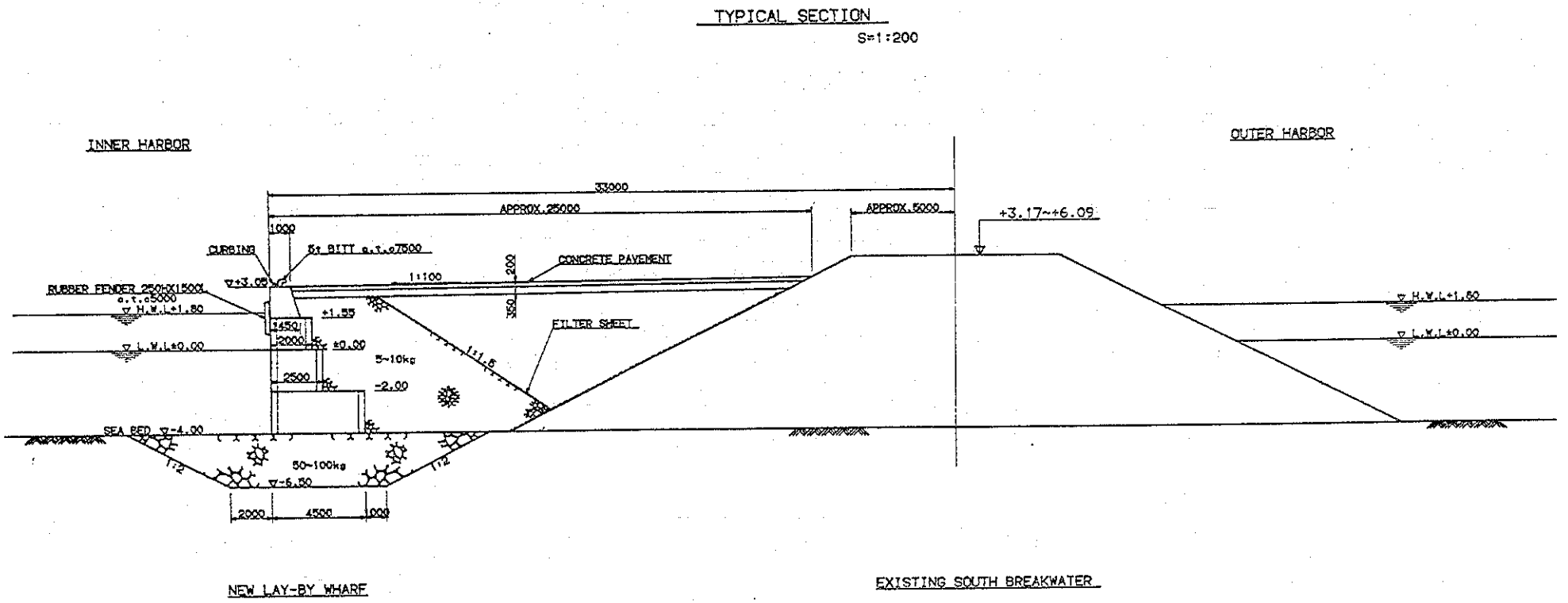


Fig. 4.3.9 Lay-by Wharf (2) Standard Sectional View

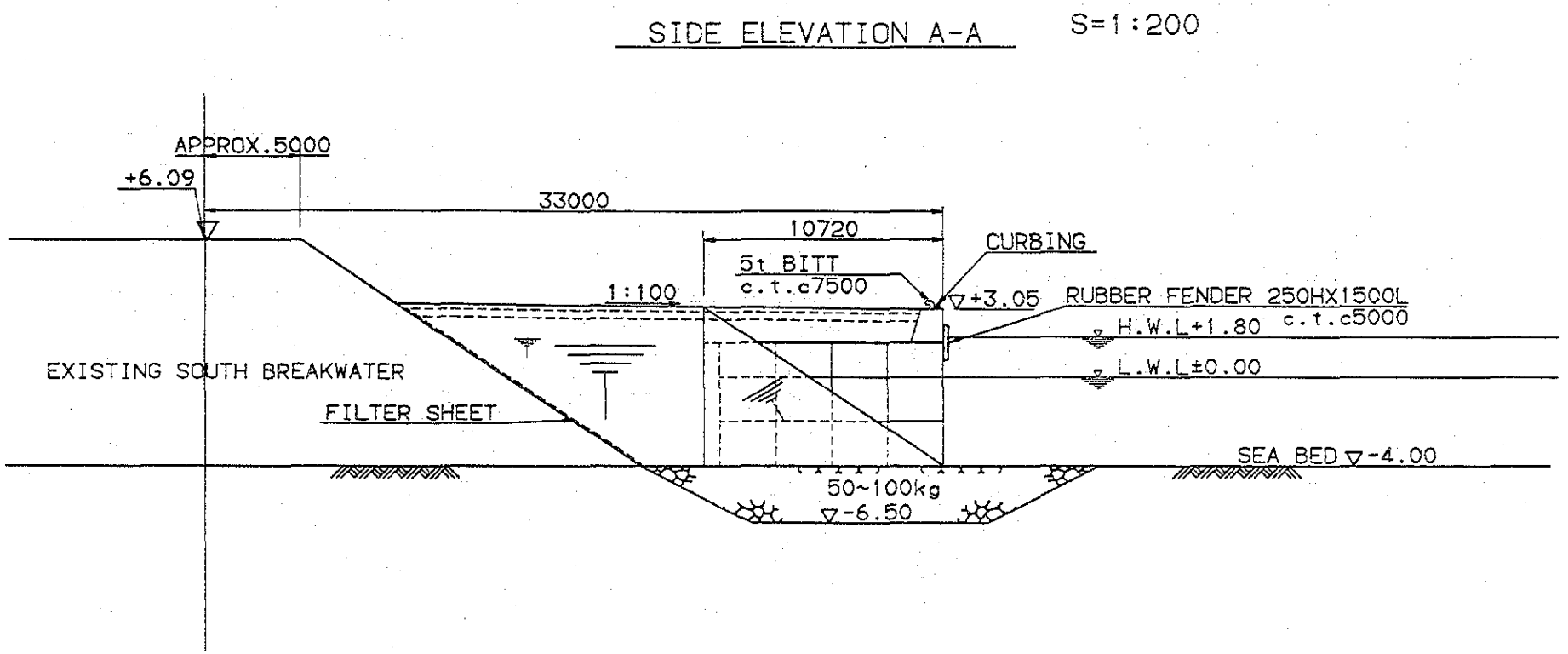


Fig. 4.3.10 Lay-by Wharf (3) A-A Section View

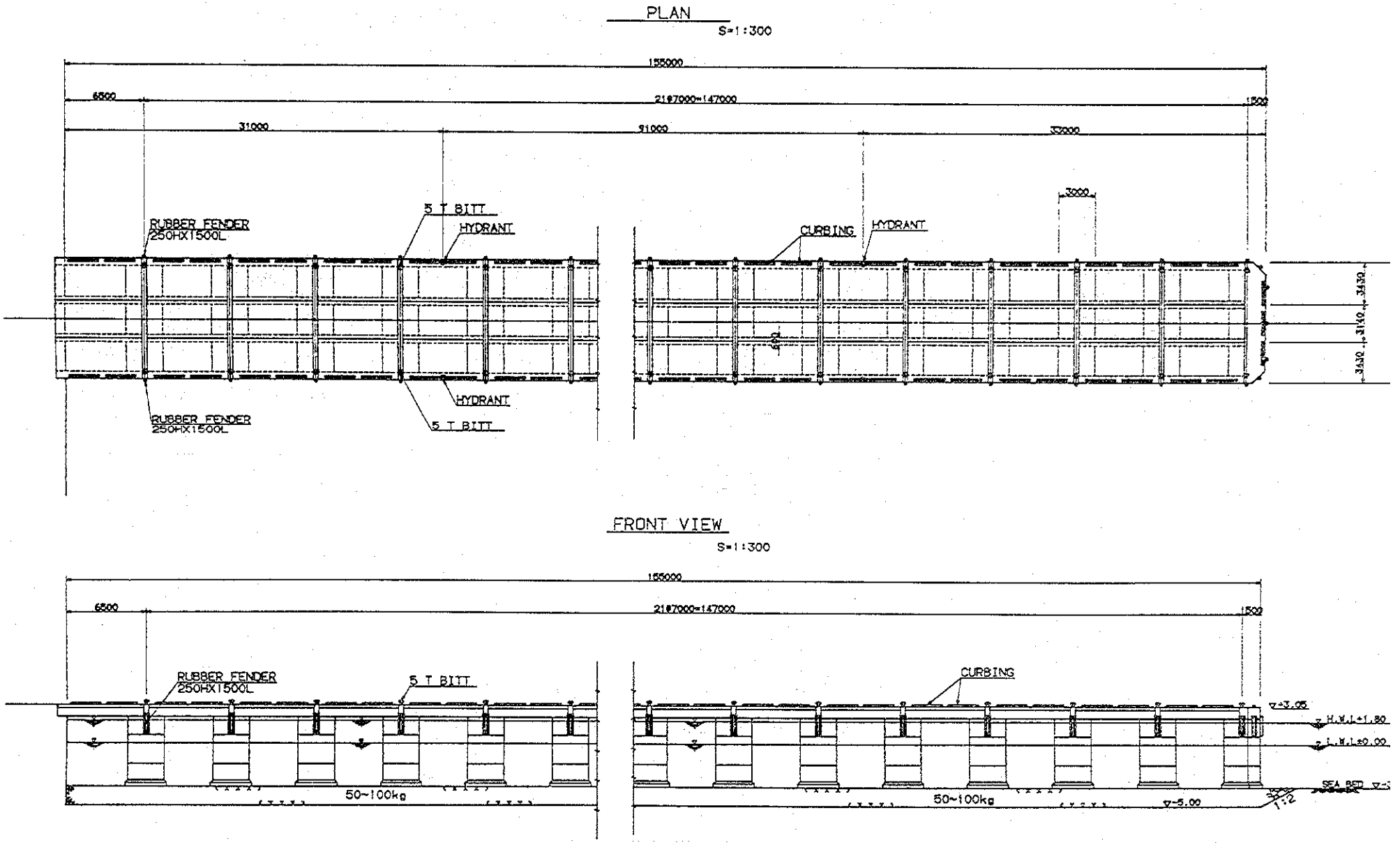


Fig. 4.3.11 Lay-by Jetty (1) Plan & Front View

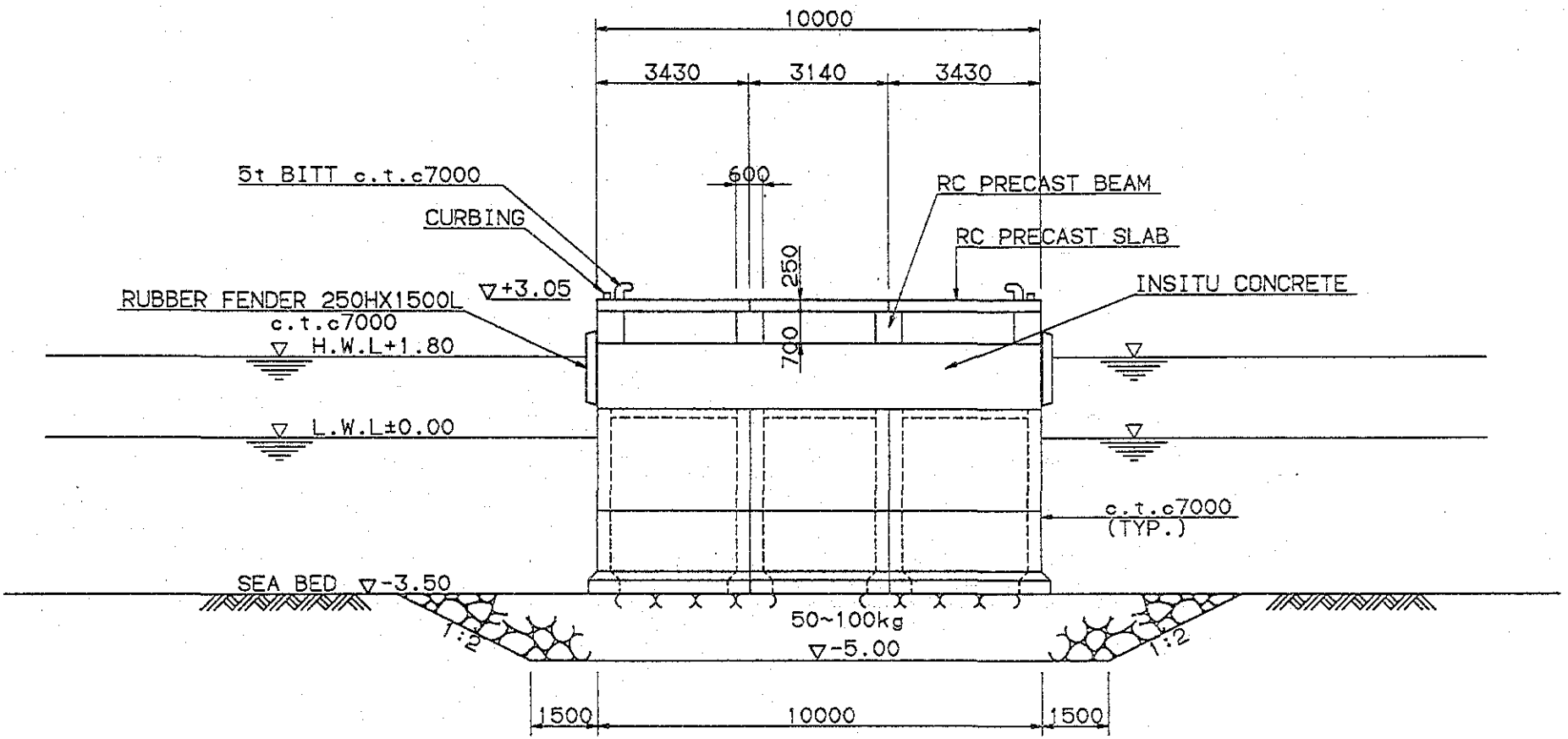


Fig. 4.3.12 Lay-by Jetty (2) Typical Section

(2) Mooring Buoy

To free some space for fish unloading and alleviating the harbour congestion, it is necessary to avoid mooring steel vessels in the inner fishing harbour. They are an important factor in alleviating the harbour congestion.

As shown in Figure 4.3.6, setting buoys in the anchorage area of the inner fishing harbour tends to aggravate the congestion. Therefore, the area behind the existing new east breakwater in outer fishing harbour is considered best for the location of this facility (See Fig. 4.3.13).

1) Design Condition

(a) Objective Vessel

LOA 30M x 86.5M x Df 3.7M (100GT steel vessel)

(b) Number of mooring vessels

Number of mooring vessels = 20 units

(c) Natural Conditions

A. Water depth	:	Average -6.1 m
B. Tide level	:	Refer to design condition.
C. Sea bed condition	:	Silty sand (top strata 2 to 3M)
D. Wind direction and speed	:	Predominant direction SE (throughout the year) Average speed 10 to 14 knots Maximum speed 50 knots

2) Design Outline

(a) Design Outline

The design of the mooring buoy system is for a maximum number of anchored vessels in a limited area. This was investigated for 2 cases:

Case 1 : Mooring bit system
Case 2 : Parallel mooring system

(b) Conclusion

As seen from the comparative table (See Table 4.3.7), the mooring bit system is most acceptable in this instance.

Fig. 4.3.14 shows the general layout of the mooring bit system and typical cross section. Anti-corrosive paint will be applied to the steel members at the platforms.

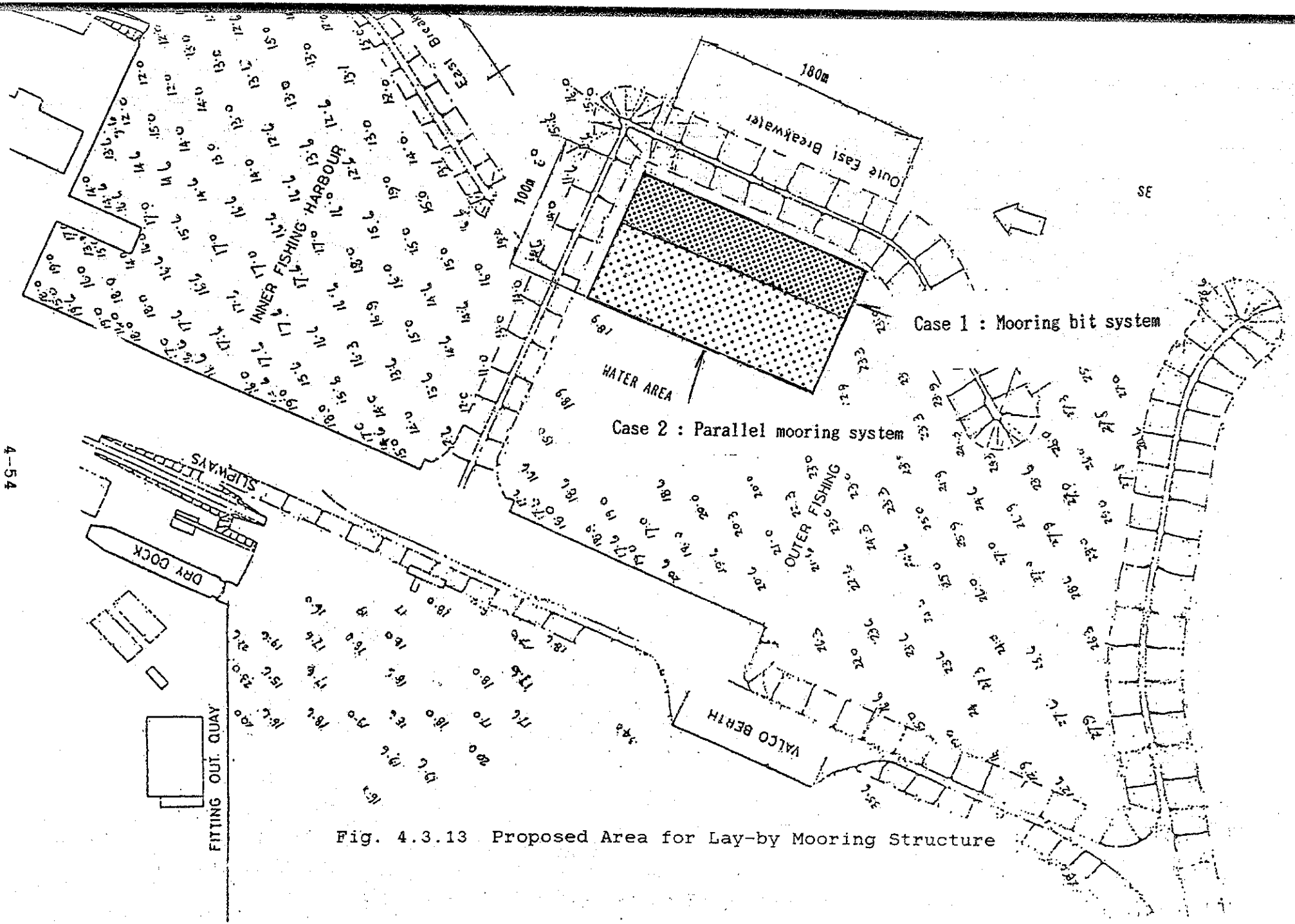
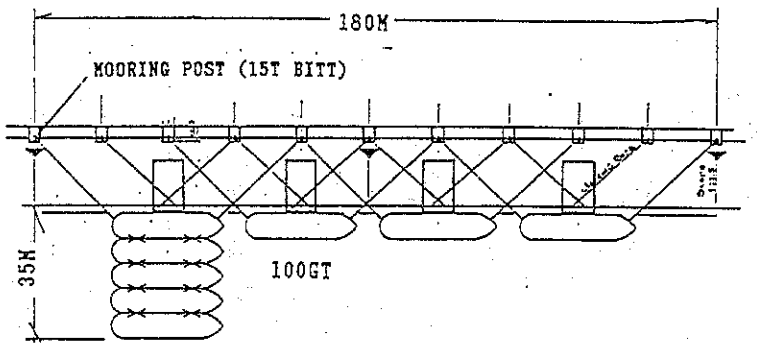
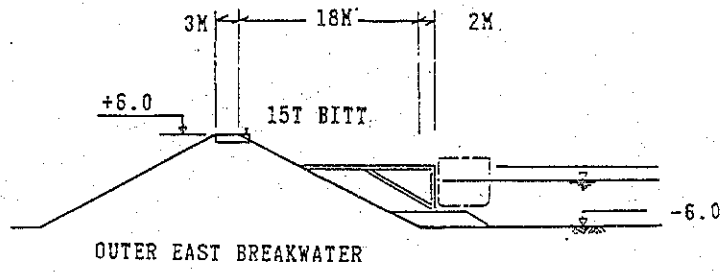
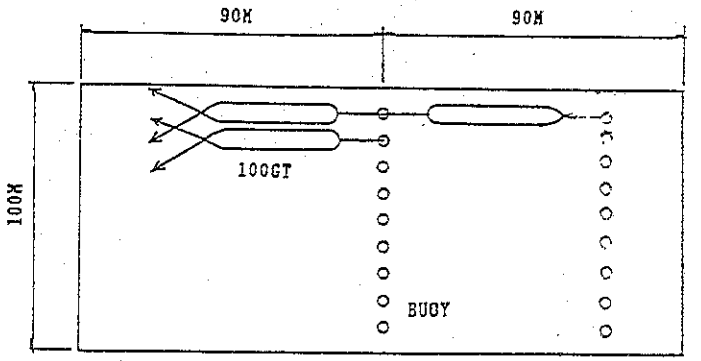
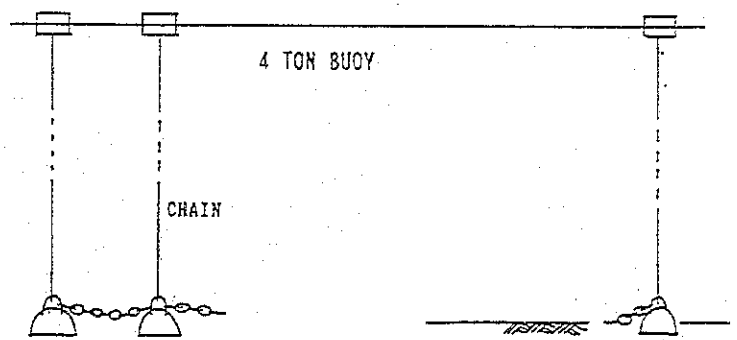


Fig. 4.3.13 Proposed Area for Lay-by Mooring Structure

Table 4.3.7 Comparison Table of the Lay-by Mooring Structure

SYSTEM / ITEM	ONSHORE MOORING POST SYSTEM	PARALLEL MOORING BUOY SYSTEM
STRUCTURAL OUTLINE	 20 VESSELS.  OUTER EAST BREAKWATER	 18 VESSELS  5~6 TON SINKER
CHARACTERISTICS — MERIT	It is possible to moor vessels without their anchors. Restricted water area can be efficiently utilized.	It is possible to replace buoys,if necessary.
CHARACTERISTICS — DEMERIT	From the structural point of view,long construction period is required.	It is not easy to arrange mooring ropes of vessels. Some countermeasures against touches between moored vessels might be necessary.
CONSTRUCTION COST	○	×
EVALUATION	Good	Not good

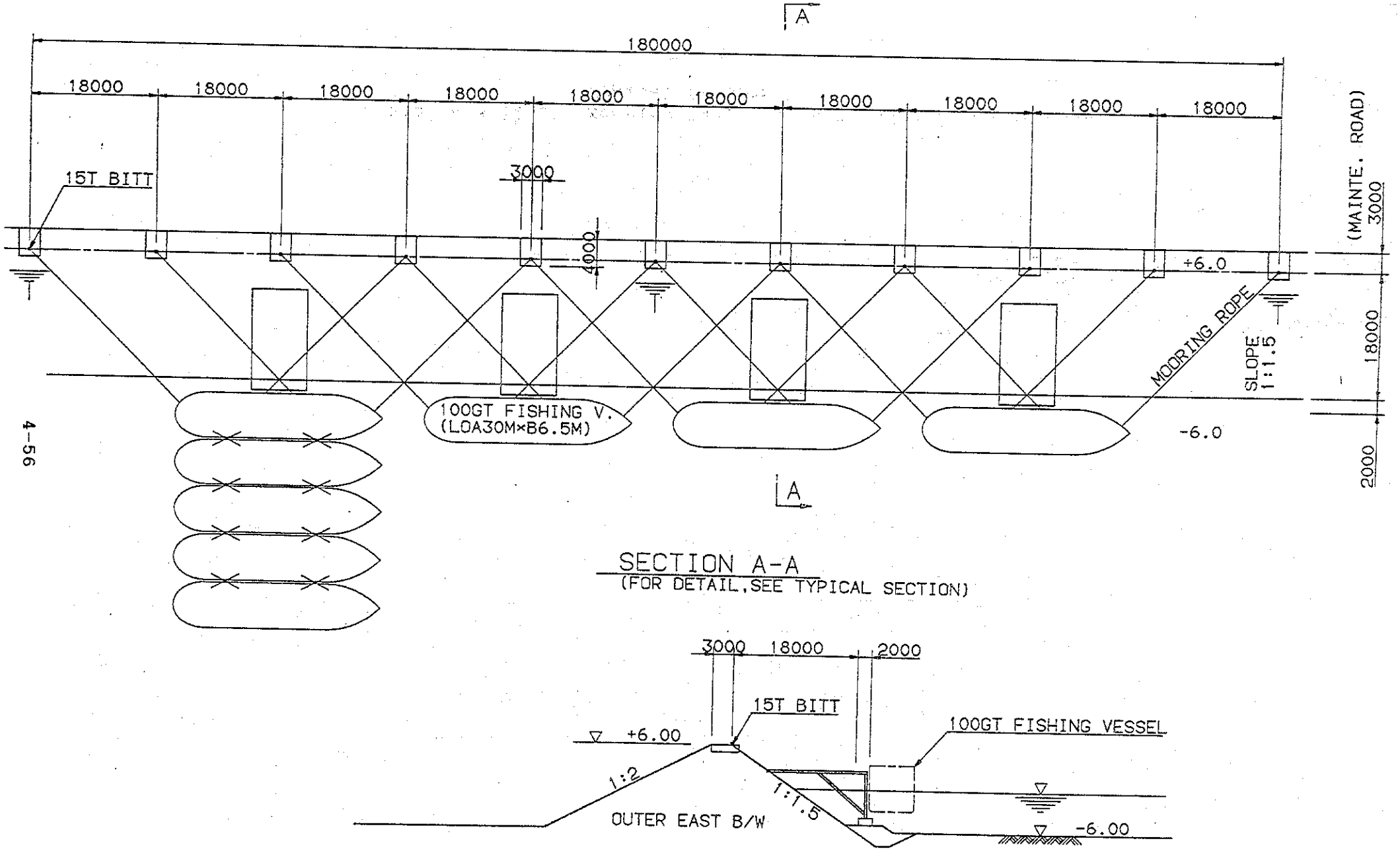


Fig. 4.3.14(1) Mooring Facility in Outer Fishing Harbour Plan

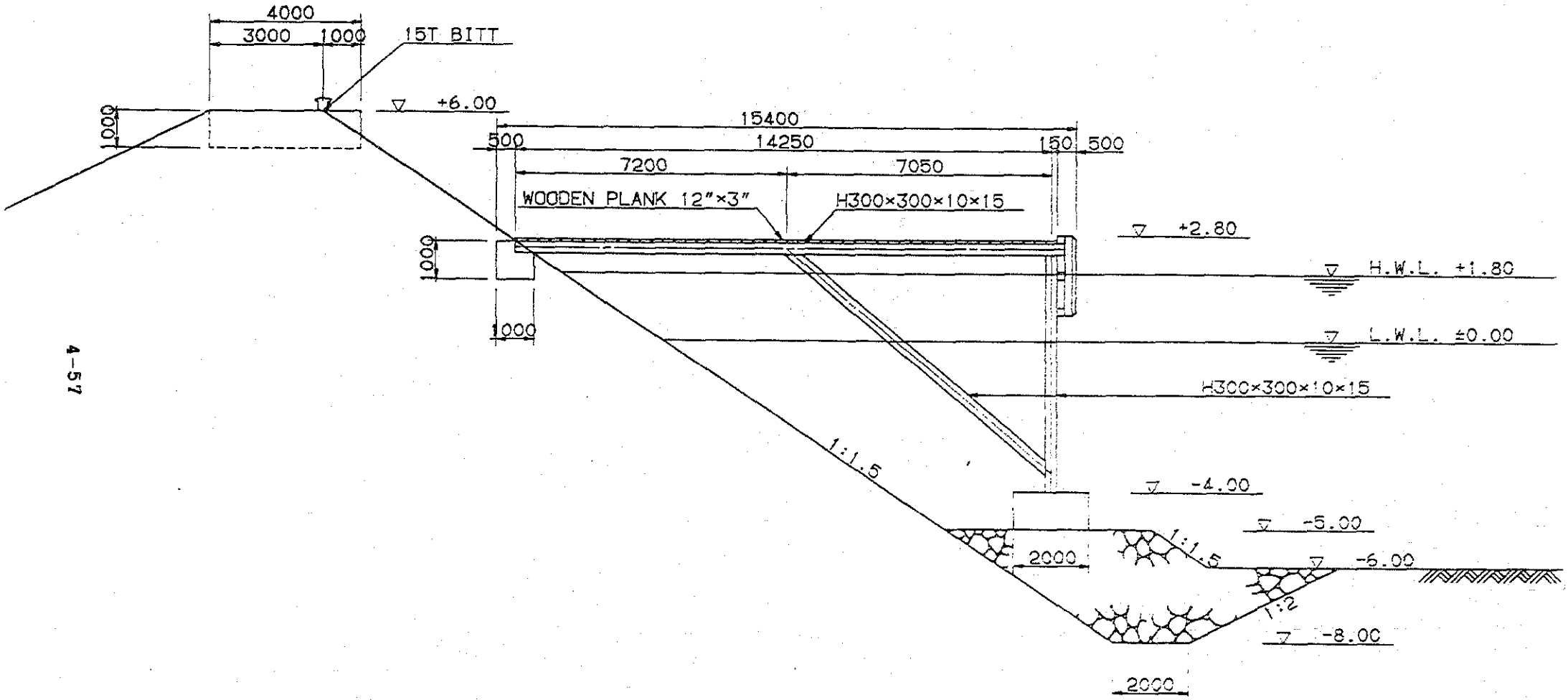


Fig. 4.3.14(2) Mooring Facility in Outer Fishing Harbour
Typical Section

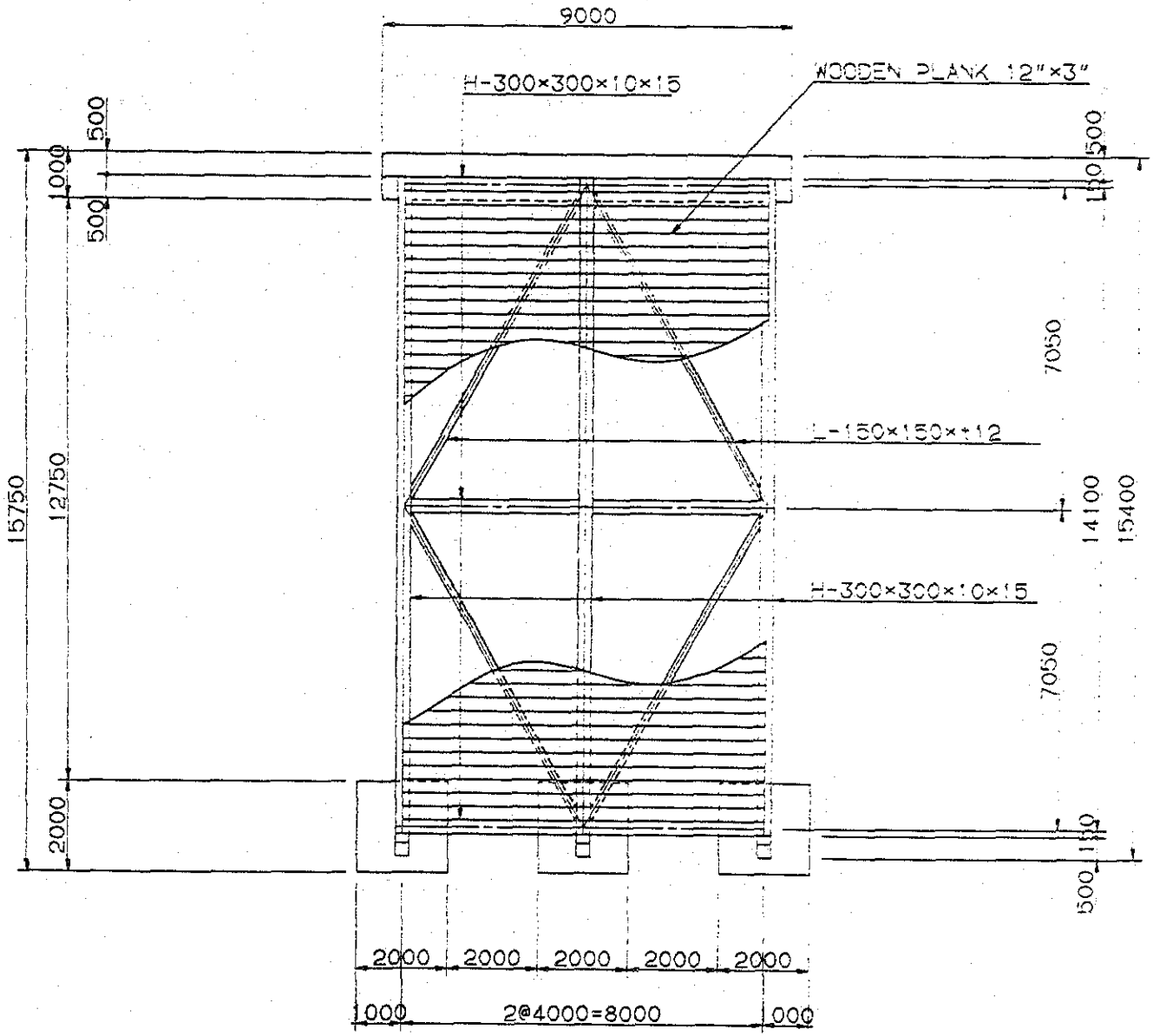


Fig. 4.3.14(3) Mooring Facility in Outer Fishing Harbour, Plan

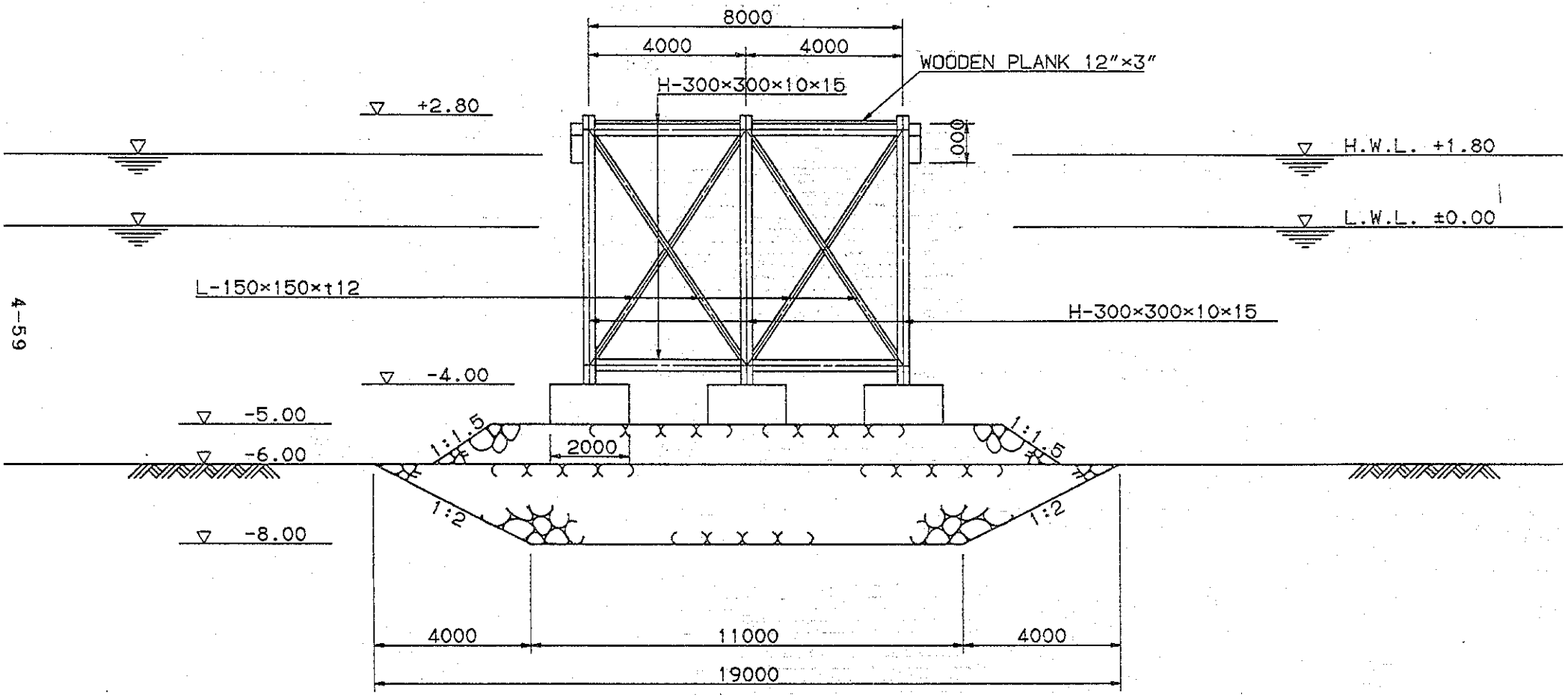


Fig. 4.3.14(4) Mooring Facility in Outer Fishing Harbour, Front View

(3) Net Storage and Repairing Yard

The 2,500 m^2 (25 x 100 m) of reclaimed land located behind the lay-by wharf is to be used for the net storage and repairing yard.

The reclaimed land used for this purpose is surrounded by the existing breakwater and newly built lay-by wharf. In order to prevent sand from being blown into this area, a permeable sheet will be installed.

A typical cross sectional view of the existing breakwater and the new lay-by wharf is shown in Fig. 4.3.15.

Since asphalt materials are difficult to provide, the pavement will be concrete.

The gradient of the surface for rain drainage will be 1/100 and the stairs will be built at three places for access to the existing breakwater.

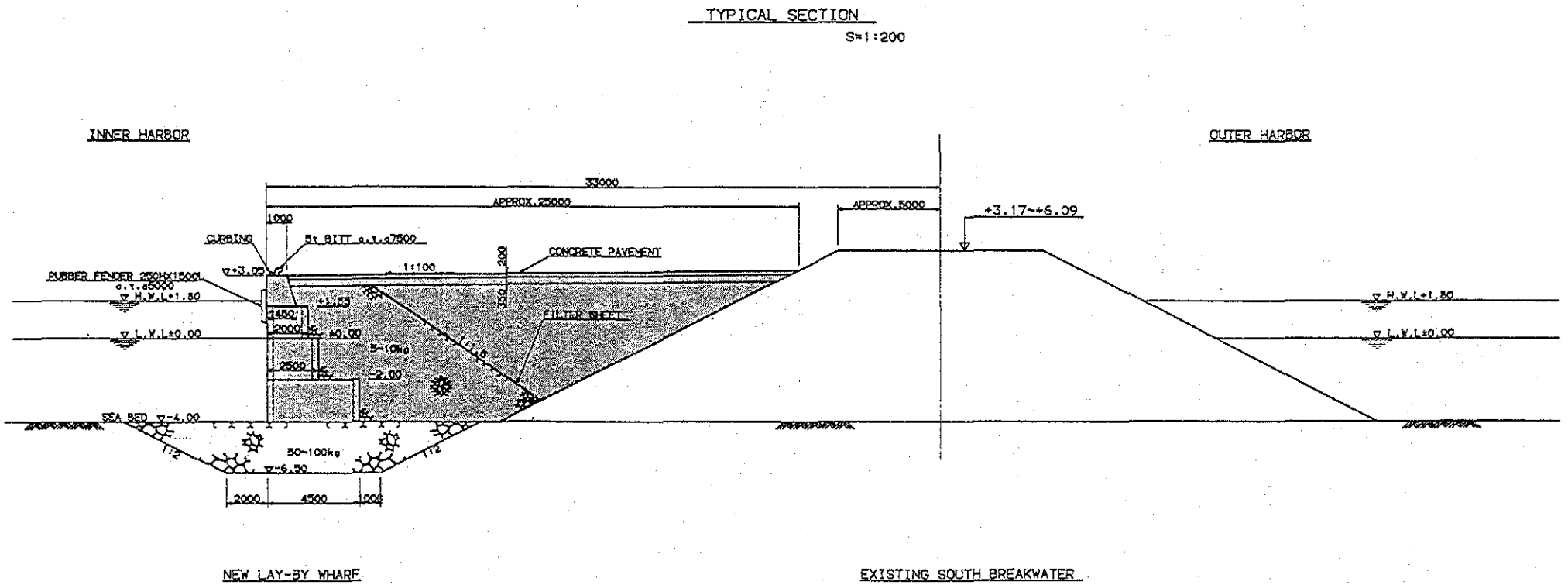


Fig. 4.3.15 Sectioinal View of the Net Repairing Yard

(4) Rehabilitation of Fish Market Hall

a. Function of the Fish Market Hall

Although the functional segregation of the wharf is clearly defined, the frequency of fish unloading will be reduced and congestion of the wharf arise if the unloaded fish is left on the wharf for long time.

It is necessary then to improve the utilization of the fish market by easing the fish landing operation and stepping up fish distribution.

The fish market is an important facility with the following capabilities:

(a) It is a place for the selection, cleaning and weighing of the catch.

(b) It is used as a display and market place.

(c) It is used as a packing and forwarding place.

Since it is a place for dealers, brokers and market related individuals, the fish product must be in a fresh condition.

b. Present Condition of the Fish Market Hall

When the Tema harbour was first built it was meant to be a main marketing place for fish similar to harbours in developed countries where refrigerated vans were used for the distribution of the catch throughout the nation.

c. Outline of the Rehabilitation Work

The fish market hall have the function as indicated above as well as the function of the distribution base for the inland area of the nation. The following is an outline of the rehabilitation works.

1) Scope of Rehabilitation Works

The scope of rehabilitation works is indicated below:

(a) Roof works

The roof shall be replced with aluminum corrugated sheets of 0.8 mm thickness which is domestically produced. The wooden joints shall be replaced and the windows shall be made of transparent plastic sheets.

(b) Installation of the lighting facilities

The interior of the fish market hall should be bright enough to distinguish the freshness of the fish. Therefore, the lighting conditions shall be as follows:

i. Standard illumination: 200 lux
ii. Lighting source : Fluorescent lamps or electric bulbs

(c) Installation of the water supply system

The main pipes will be 50A. The water hydrant will be as follows:

50A (2 1/2") at 8 locations
15A (1/2") at 6 locations

(d) Repair of the existing partition wall

The existing 1.5 m high wooden partition wall, a part of block wall, and wooden walls at the front and back of the building will be removed.

(e) Rehabilitation of stall

On the floor of the fish market hall the sections for stalls are to be marked with paint. One ice storage unit will be installed in front of this building.

2) Design Outline

Fig. 4.3.16 shows rehabilitation of roof works and repair of the existing partition wall. Fig. 4.3.17 indicates installation of the water supply system and stall painting.

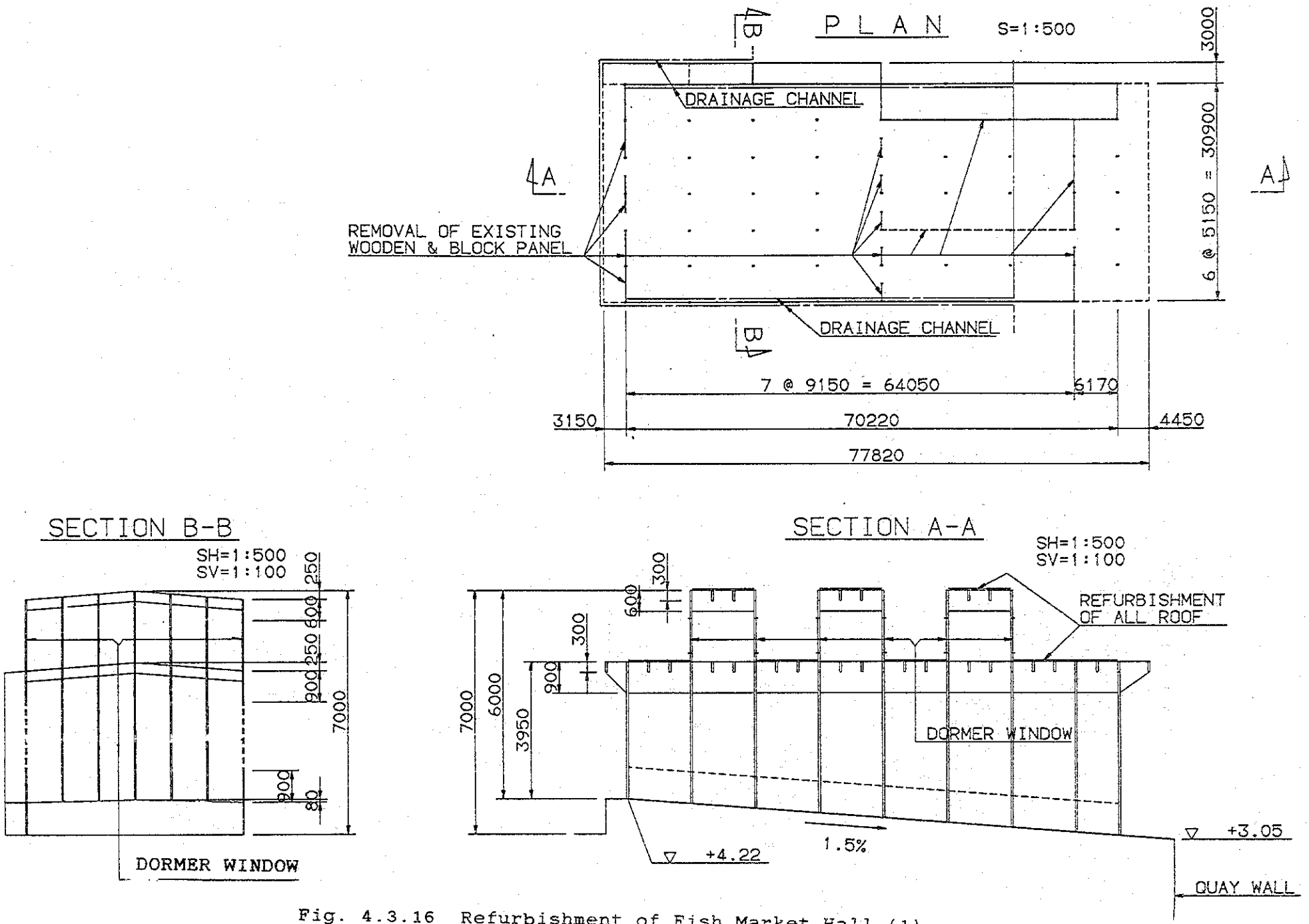


Fig. 4.3.16 Refurbishment of Fish Market Hall (1)

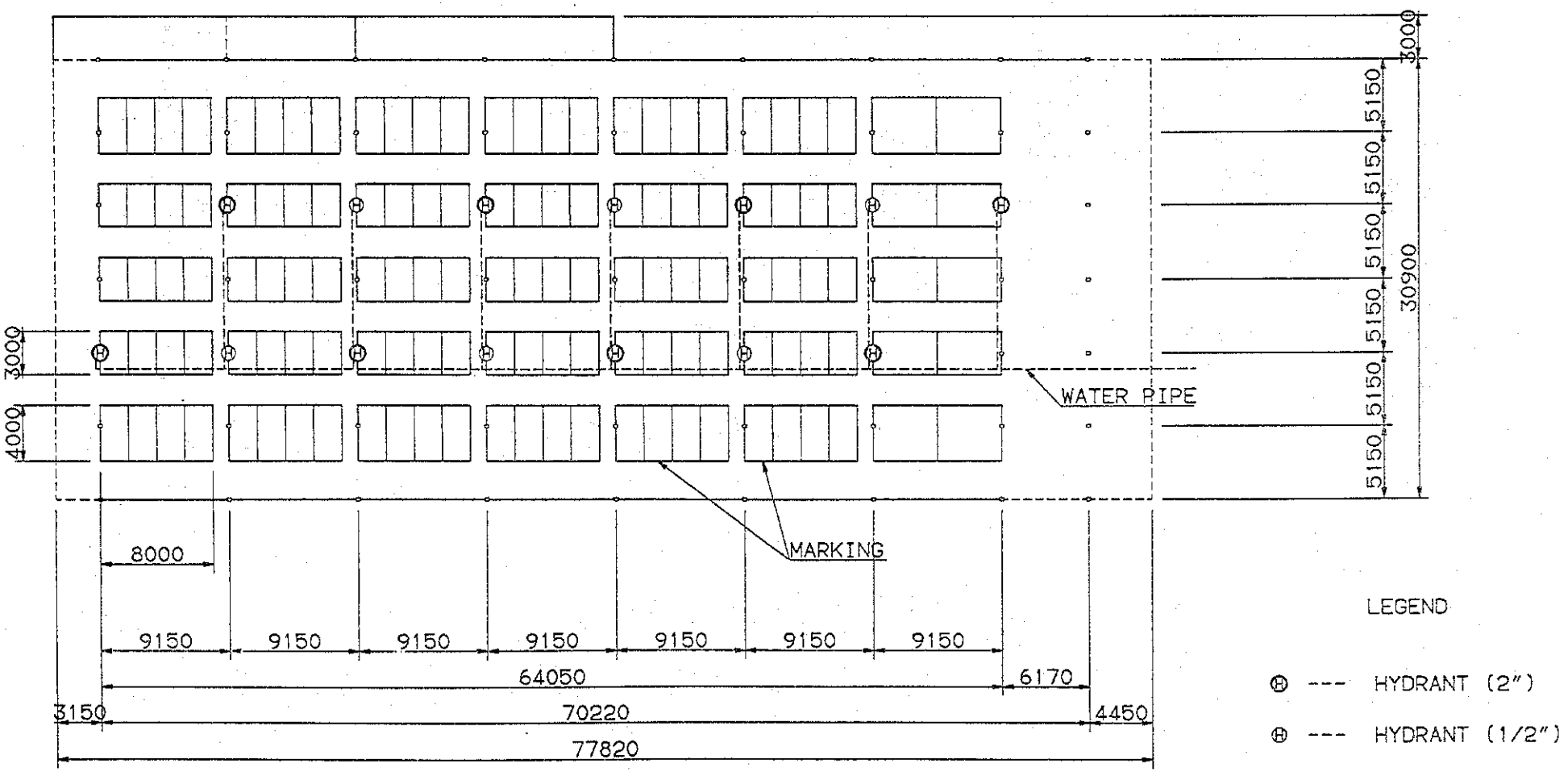


Fig. 4.3.17 Refurbishment of Fish Market Hall (2)

(5) Fish Handling Shed

1) Location and Scale

The fish handling area will occupy a specific floor area for fish unloading and storage in order to avoid fish handling in the open and thus retard fish deterioration.

The fish handling shed shall be built parallel to the wharf face line and its length is calculated so that the period of stay of unloaded catch in the open shall be at a minimum.

The fish market hall in the Tema fishing harbour could be used as a fish handling shed but, since it is facing the wharf only a 30 m length and the apron width is 11 m, the fish handling operation would be difficult.

On the other hand, the fish handling in the canoe basin where the handling operations are carried out is in the open. This leads to fish deterioration.

Therefore, new fish handling sheds are planned in front of the fish market hall and east apron in the canoe basin.

In the case of Japan, the necessary area of fish handling shed is found by the following formula :

$$S = \frac{N}{R \times \alpha \times P}$$

where

S : Area necessary for fish handling shed (m^2)
N : Planned handling volume per day (kg/day)
P : Handling volume per unit area (kg/m^2)
α : Occupation rate (%)

The average handling volume per day in the Tema fishing harbour is shown in Table 4.3.1. According to this table 5,548 crates (= 170 tons) of fish are handled daily. Using the formula indicated above, the size of the fish handling shed in front of the fish market hall is calculated as follows.

$$S = 170{,}000/40 \text{ to } 50 = 4{,}250 \text{ to } 3{,}400 \text{ m}^2/5$$
$$= 850 \text{ to } 680 \text{ m}^2$$

Therefore, an area equivalent to at least 680 m^2 will be needed in front of the fish market hall. Since a passageway must be left between the wharf and the fish handling shed for transport, the area left for the fish handling shed will be 610 m^2, with a passageway of 4 m wide.

For the fishing handling shed in the canoe basin, the area east of the basin on the 12 m wide apron will be considered taking a width of 10 m with an extension of 100 m.

The size of each fish handling shed is indicated below :

(a) Fish handling shed in front of the fish market hall

East side	20 m x 10 m	200 m^2
Front side	30 m x 7 m	210 m^2
West side	20 m x 10 m	200 m^2
Total		610 m^2

(b) Fish handling shed in the canoe basin

10 m x 100 m = 1,000 m^2

The maximum design wind speed is taken as 25 m/sec.

2) Design Outline

The structure is a steel column surrounded by anti-corrosion concrete material to avoid the effects of handling and water. KUSIA and/or steel member are used for structural member. The roof is made of corrugated aluminium sheets.

The basic structure is shown in Fig. 4.3.18.

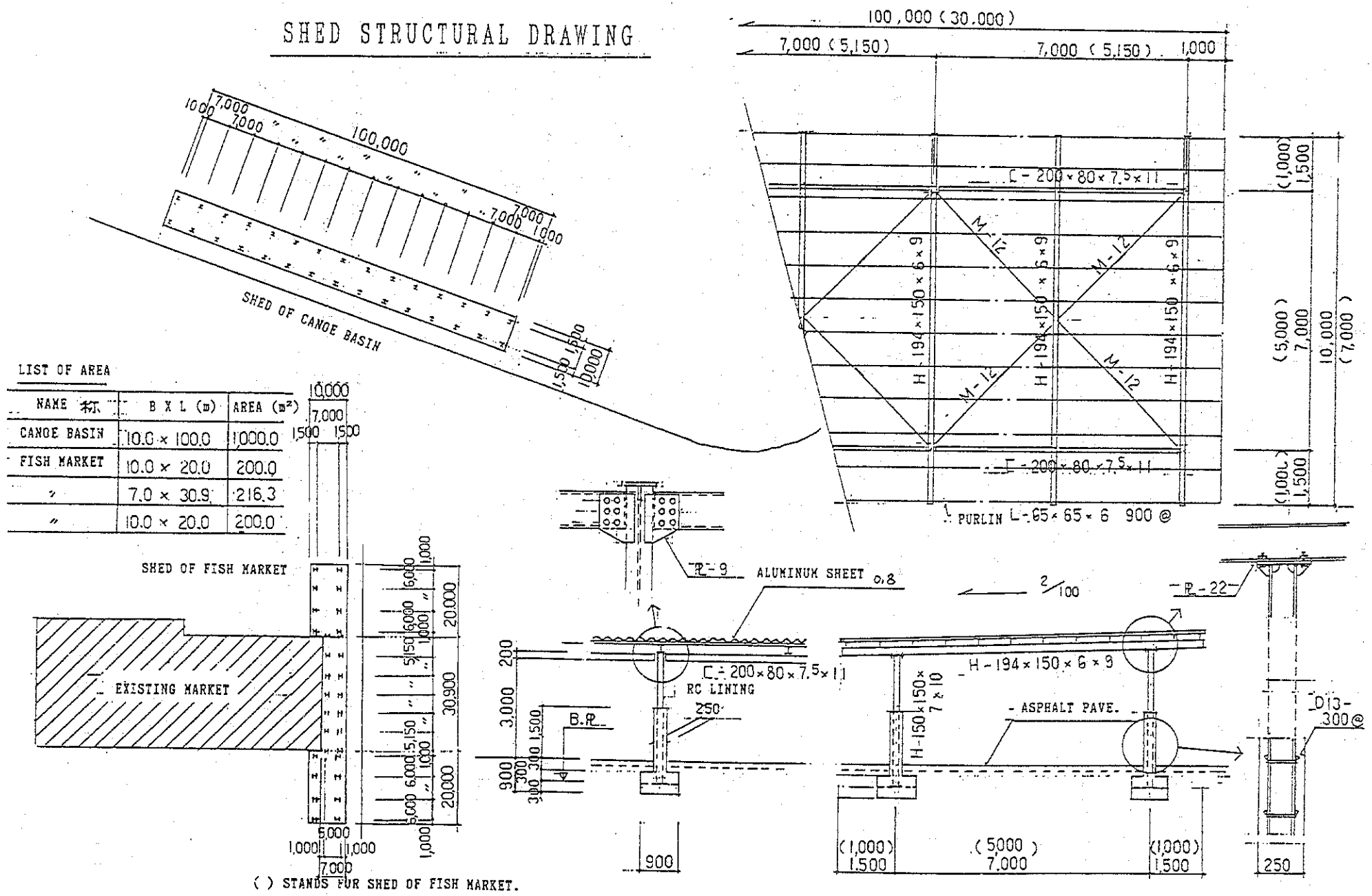


Fig. 4.3.18 Fish Handling Shed

(6) Fitting-Out Quay

1) Plan

To design the fitting-out quay, two cases were considered according to 2 locations (Refer to Fig. 4.3.19).

(a) Case 1: Installation near the existing slipway
(b) Case 2: Installation behind the existing slipway

The advantages and disadvantages of the 2 cases are as follows :

Case 1 presents an advantage because necessary digging is minimal and a disadvantage because part of the existing slipway has to be removed. Therefore, during the construction work, the slipway cannot be used effectively.

Case 2 needs a maximum digging but does not affect the usage of the existing slipway. The location of the fitting-out quay will be as stated in case 2 since it is more advantageous for the continuous operation of the harbour during construction.

2) Selection of Structure

The structure of the fitting-out quay will be a gravity type structure since the underground soil is solid, being composed of gravel and rocks. Cellular blocks are used for the same reasons as in the case of the lay-by wharf.

The structural considerations are as follows :

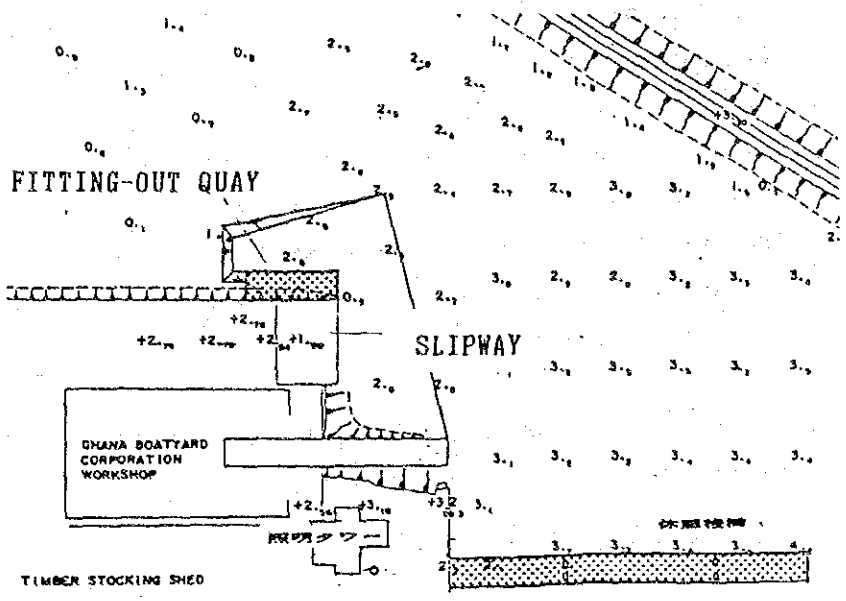
Top elevation	+2.80 m
Planned water depth	-2.50 m
Length	30 m

The same 70 foot long wooden vessel were considered in the design of the lay-by wharf and jetty. Mooring bit and rubber fenders are planned to be installed.

Since the water is shallow at the wharf and considering safe passage of 70 foot long vessels, it is necessary to dredge the proposed area up to -2.5 m. Since the draft of 70 foot long vessels is 1.8 m, a water depth of -2.5 m will be sufficient with a 0.50 m allowance.

The plan and sectional view of the fitting-out quay is shown in Fig. 4.3.20 and 4.2.21.

CASE 1



CASE 2

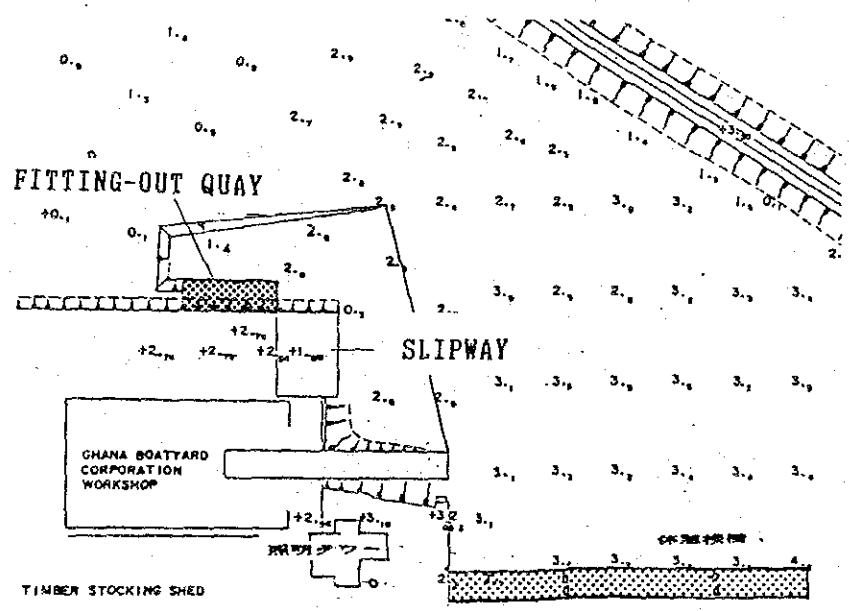


Fig. 4.3.19 Location Plan of Fitting-out Quay

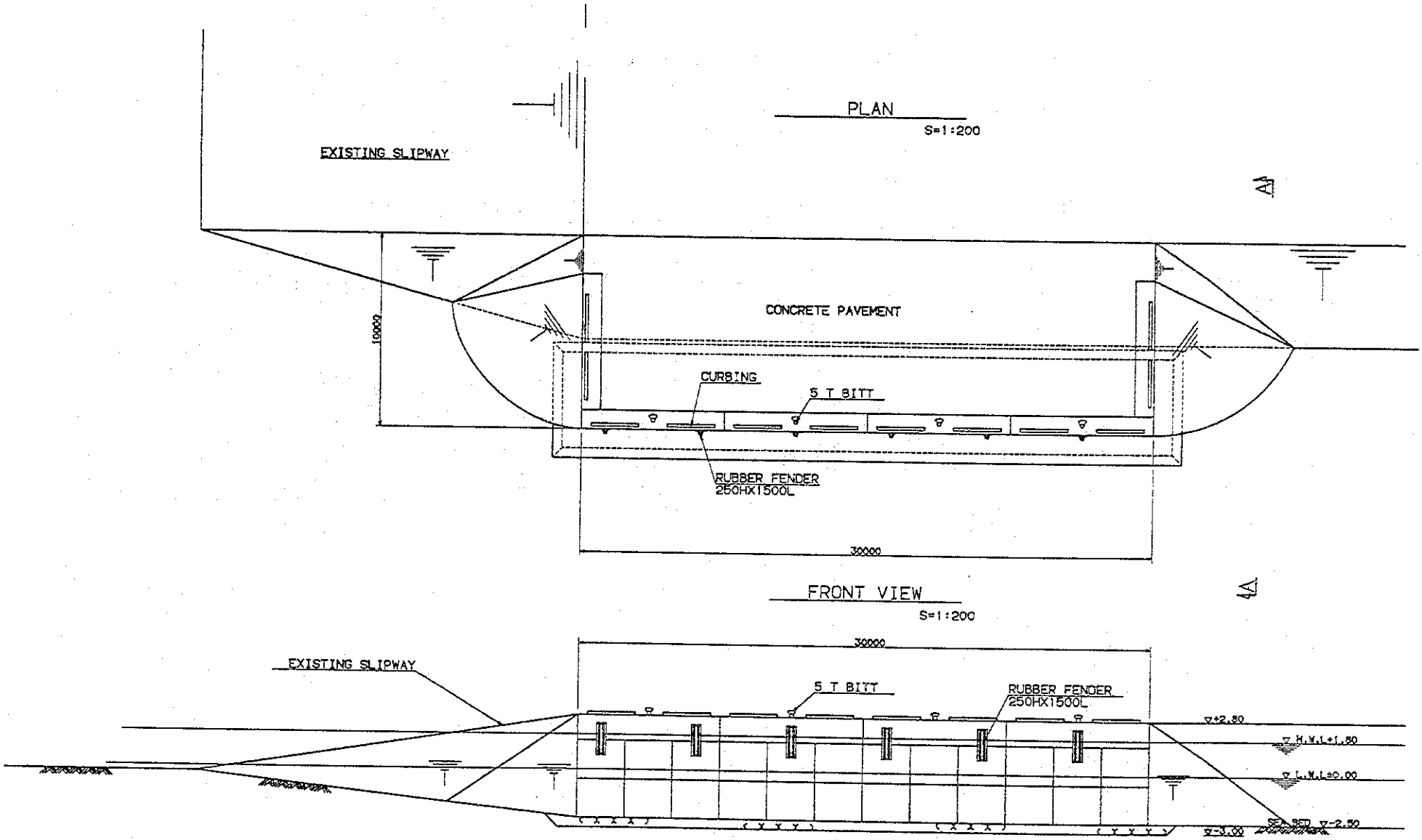


Fig. 4.3.20 Fitting-out Quay (1), Plan & Front View

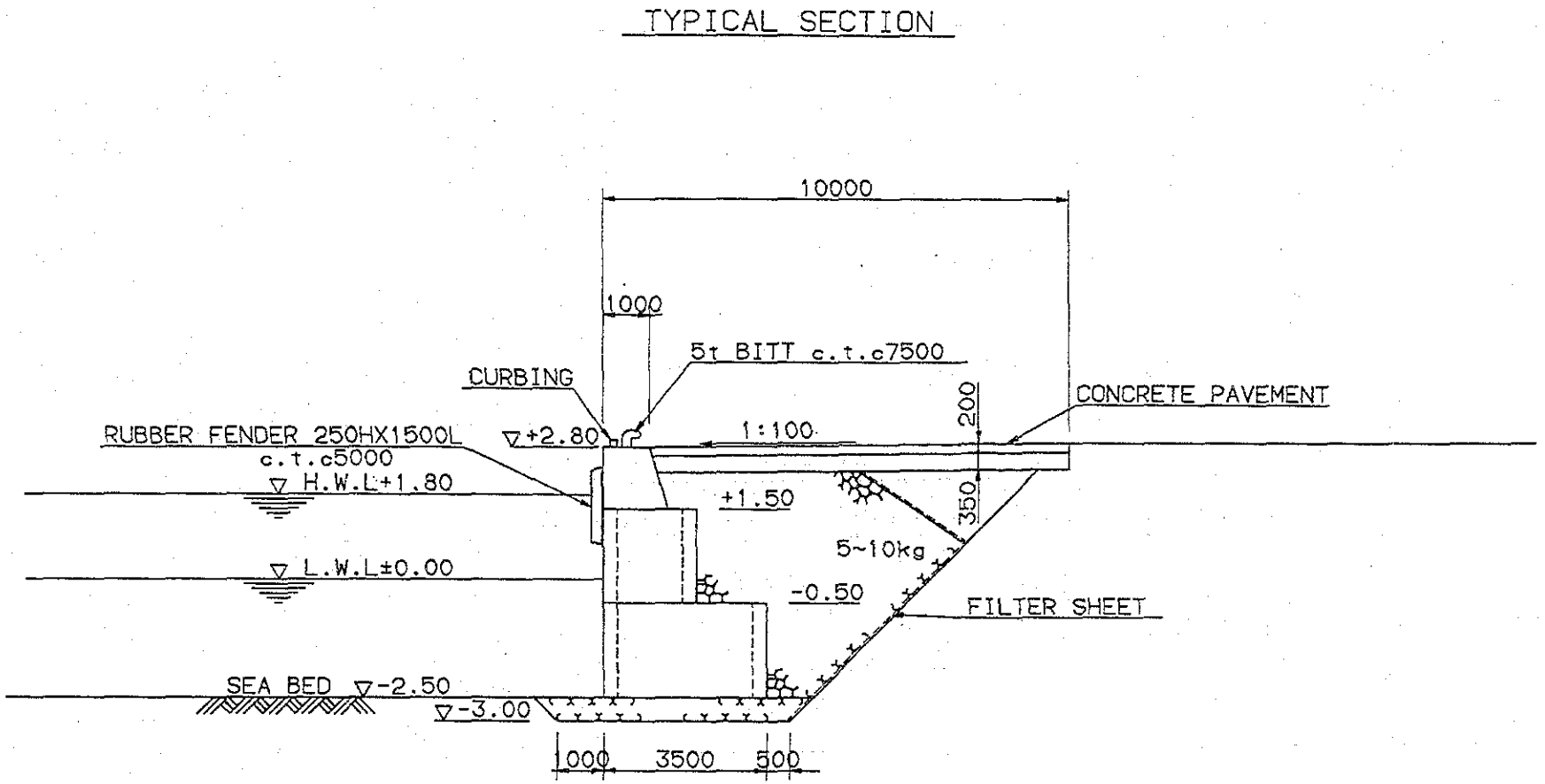


Fig. 4.3.21 Fitting-out Quay (2), Typical Section

(7) Repair of the Motor Boat Jetty

There are mobile fuel supply facilities on the motor boat jetty. The jetty is used for fuel supply, fish landing and net repairing.

In order to have a proper net repairing yard and improve the efficiency of the operations, the motor boat jetty should be set apart.

Two portions (about 25 m long in total) damaged by fire should be repaired.

1) Design Outline

KUSIA materials are to be used for the repair of the existing jetty. This material has the same properties as the materials previously used and are available locally.

Although the entire deck is planned for replacement, the existing columns will be reused where they are structurally sound.

2) Repair Method

The repair method shown in Fig. 4.3.22 is based on the original drawing shown in Appendix 2.5.1.

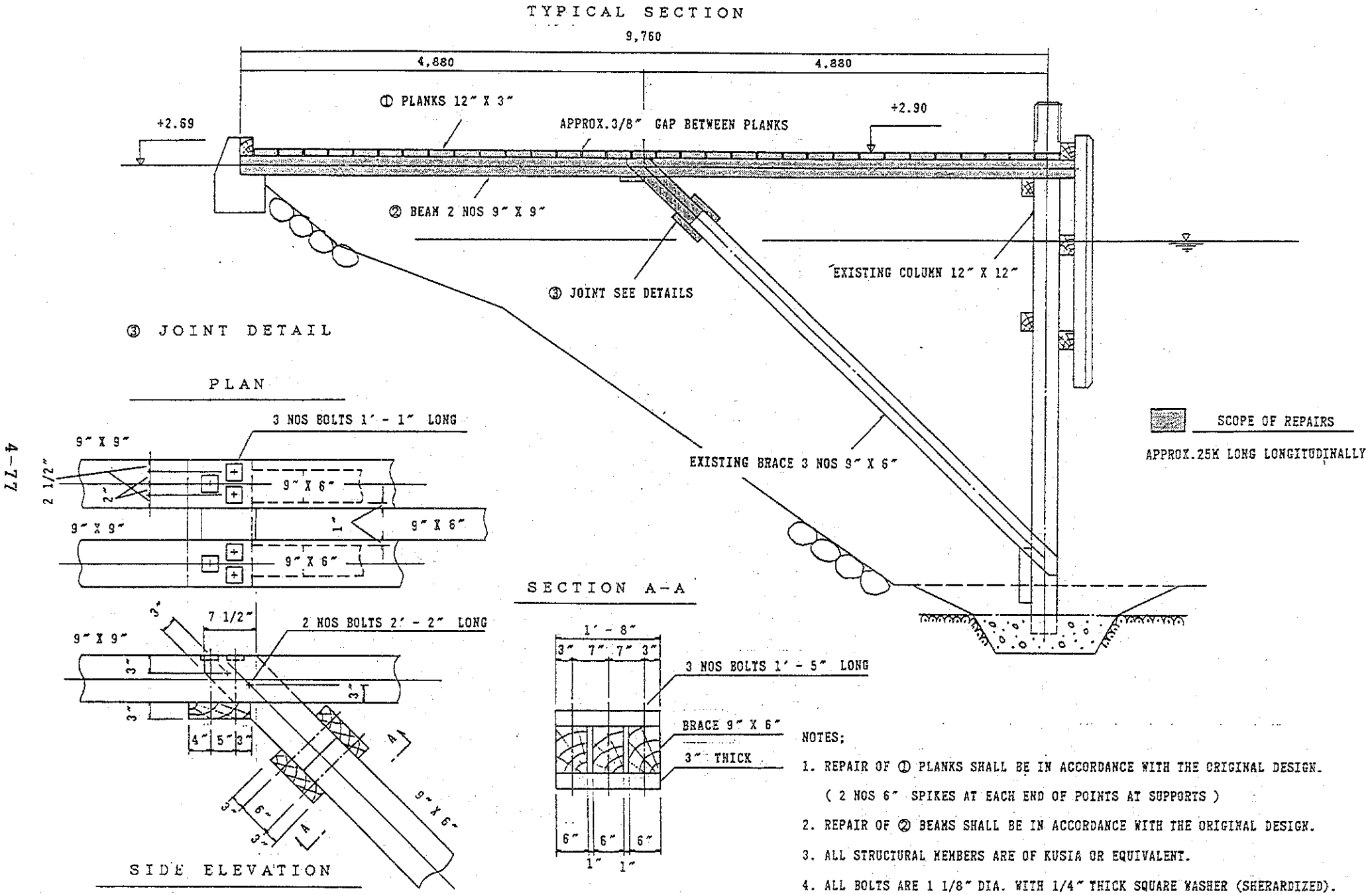


Fig. 4.3.22 Repair of Motor Boat Jetty

(8) Repair of Sub-station

1) Present Condition

(a) Existing electrical power supply

There are 3 sub-stations (Nos. 10, 11, 12) in the fishing harbour and the electric power is supplied from main sub-station in the commercial harbour with 11 kV currency which is transformed at each sub-station into 415V 3 phase currency.

Sub-station	Transformer
S/S No. 10	1,000 KVA x 2, 500 kVA x 1
S/S No. 11	500 kVA x 2
S/S No. 12	500 kVA x 2

(b) Present condition of the equipment

Maintenance and management works have not been carried out routinely, thus decreasing efficiency.

2) Scope and Method of the Repair Works

(a) Scope of the Repair

Switch gears of secondary side, including connecting cables, must be replaced.

(b) Repair Method

If, when replacing the switch gears the power supply cannot be stopped for long time, then the proposed switchboard should be pre-assembled so as to be replaced quickly.

(9) Lighting Facilities

1) Design Conditions

(a) Installation Place

This is limited to the area not equipped with lighting facilities (i.e.: Net storage and repairing yard). The installation of the lighting facilities will be carried out in the following places :

A. Behind the lay-by jetty
B. On the street leading to the canoe basin.

(b) Lighting Capacity

The lighting devices will be installed at the same levels as the existing light towers.

(c) Design Wind Speed

Design wind speed for lighting tower: 30 m/sec

2) Design Outline

(a) Design Outline

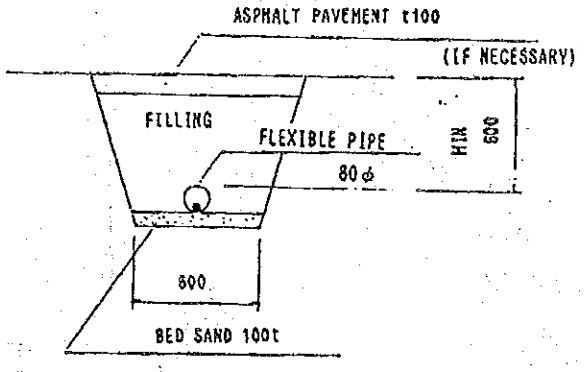
A. Behind the lay-by jetty

One 24 m high steel tower having lighting capacity of 1 kW x 4 will be installed behind the lay-by jetty. The 240V power will be supplied from sub-station No. 10 with underground cable.

B. Six 10 m high lighting posts (400W x 1 bulb) will be installed at 100 m interval which 240V power will be supplied from sub-station No. 12 with underground cable.

(b) Wiring Diagram

The location and equipment necessary for the lighting facilities are shown in Figs. 4.3.23 and 4.3.24 while the sectional view of the underground wiring is shown below.



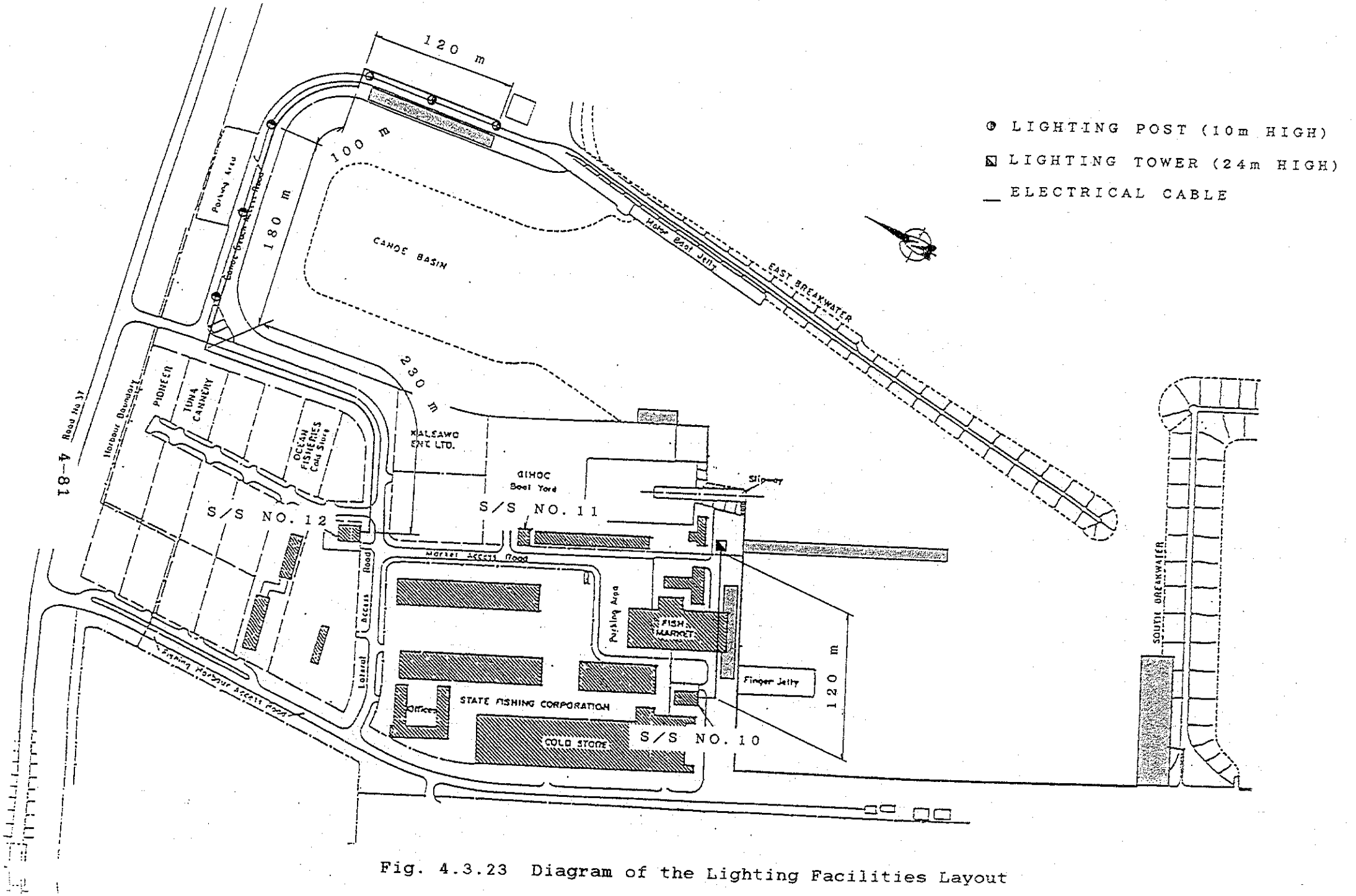


Fig. 4.3.23 Diagram of the Lighting Facilities Layout

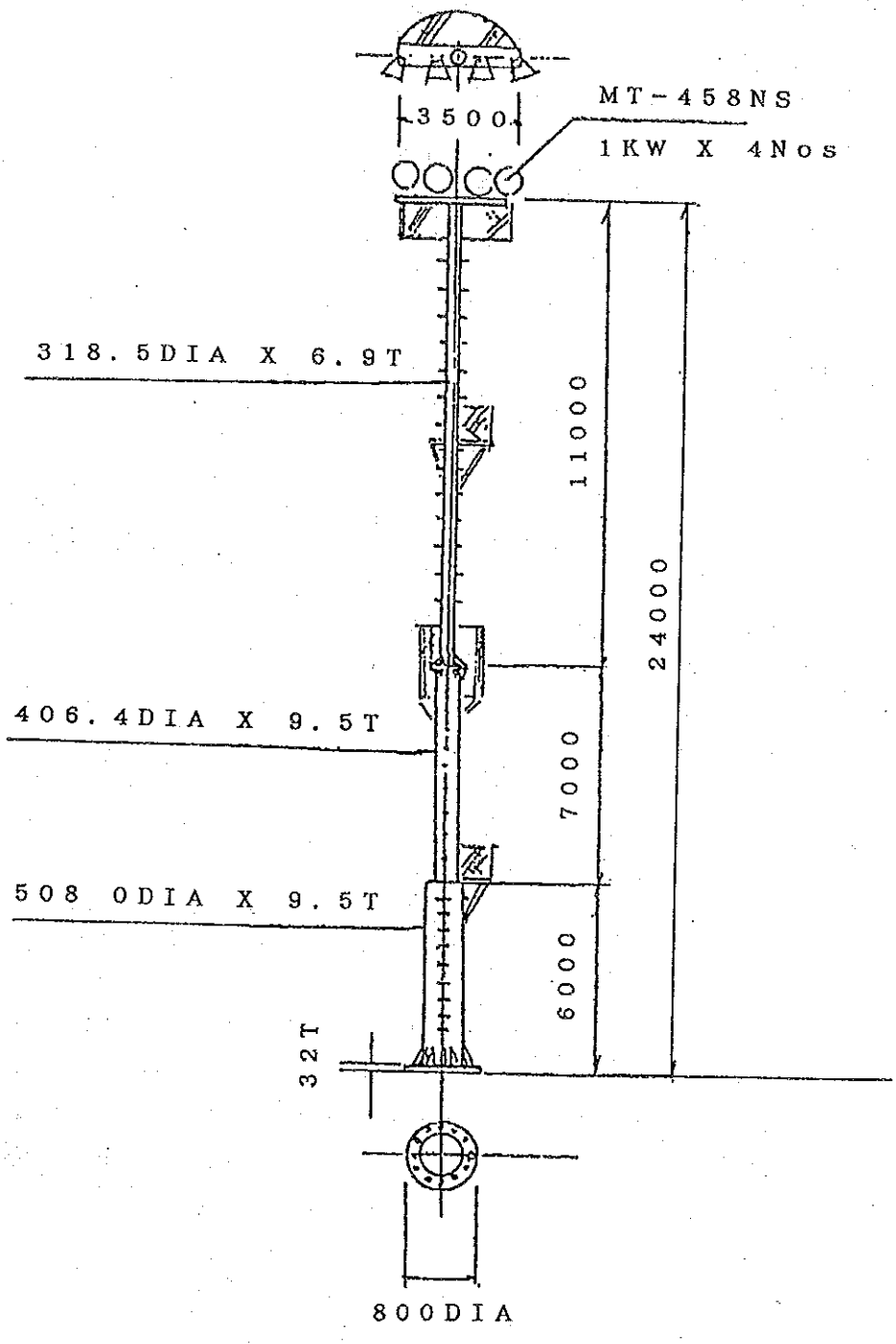


Fig. 4.3.24 Lighting Tower

(10) Water Supply Facilities

1) Design Conditions

(a) Facilities Involved

The water supply equipment for vessel and other facilities are as follows :

	Number of water faucets
A. Lay-by jetty	4
B. Net storage and repairing yard	2
C. Fish handling shed in canoe basin	3
D. Fish market hall	Refer to Fig. 4.3.16

(b) Required Water Quantity to be Supplied

The total amount of water required per day is assumed as 50 m^3.

2) Design Outline

(a) Utilization of the Existing Water Supply Facilities

The proposed faucets will be connected to the nearest existing water supply line which is considered to have sufficient capacity against the requirement of 50 m^3/day. Therefore, no additional water pump will be installed.

(b) Determination of the Pipe Diameter

The new piping diameter is determined as follows.

A. Lay-by wharf and jetty

From the main water pipe (150A) a supply pipe of diameter 80A is used.

B. Fish maraket hall

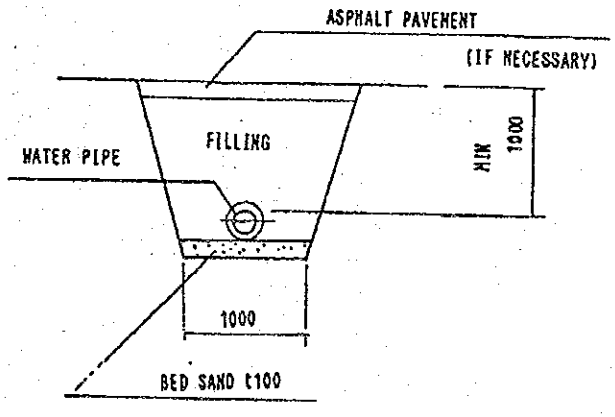
50A pipe line will be branched from the nearest existing water line.

C. Canoe basin facilities

The distribution of water in this area is done by means of pipes of diameter 50A.

(c) Piping Plan

The piping plan is shown in Fig. 4.3.25 while the sectional view of the underground piping is indicated below.



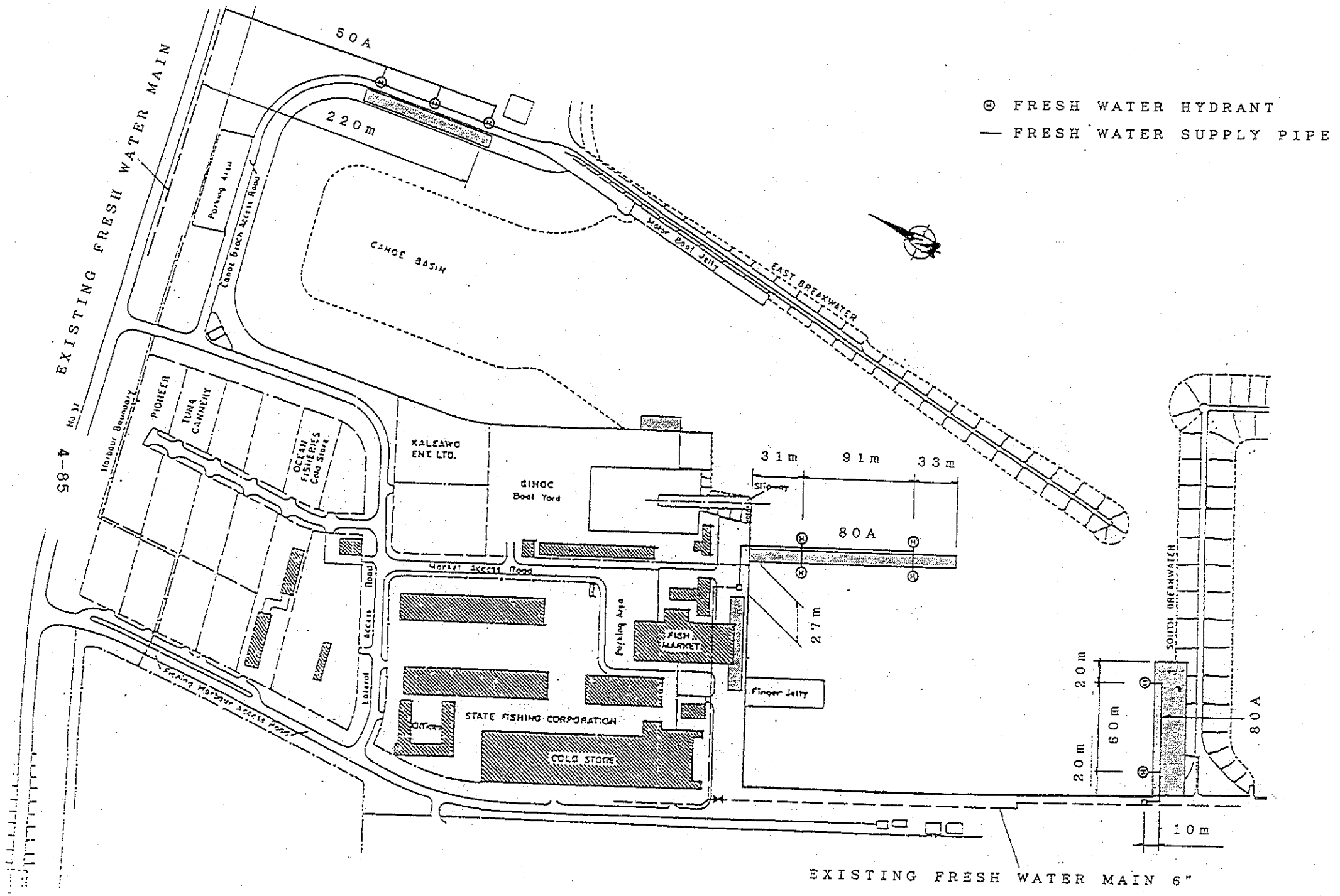


Fig. 4.3.25 Diagram of the Water Supply Piping

4.4 Construction Planning

4.4.1 Construction Circumstances and Implementation Policy

(1) Construction Circumstances

Around large cities such as Accra or Tema, delayed implementation of construction is common. Due to Ghana's low foreign currency reserves, the import of materials and equipment is very slow and difficult. Secondary products manufactured in Ghana are often defective and non-operating due to a shortage of spare parts. Most of the construction materials needed for this project, therefore, have to be imported.

The equipment to be used for the project in progress is mostly imported for the sole purpose of the project. The cranes (80 ton), barges and other equipment and materials which are needed for this project have to be imported since they are nonexistent in Ghana. For the project undertaken by the World Bank for the Tema commercial harbour involving repairs and small construction, only small equipment and a light crane were used.

There are no experienced workers or companies qualified for the particular work to be carried out in the ocean. Therefore, specialist Japanese engineers will be required for this project. There are only 3 companies experienced in dealing with foreign companies and only one has some experience in carrying out this kind of project.

(2) Implementation Policy

Taking into consideration the above situation, all the construction materials apart from sand, stones and wood which will be available locally will be imported and the electrical equipment will be assembled in Japan before being imported. Since construction equipment is difficult

to be found in Ghana, it will be imported from abroad during the project term.

The construction is difficult to carry out during the fishing season between July and September since the harbour is congested. Therefore, it may be difficult to complete this project within a single Japanese fiscal year. Since the project under the Japanese Grant Aid assistance shall be completed within a single year, the project is divided into 2 stages. Fig. 4.4.1 shows the construction stage of this project.

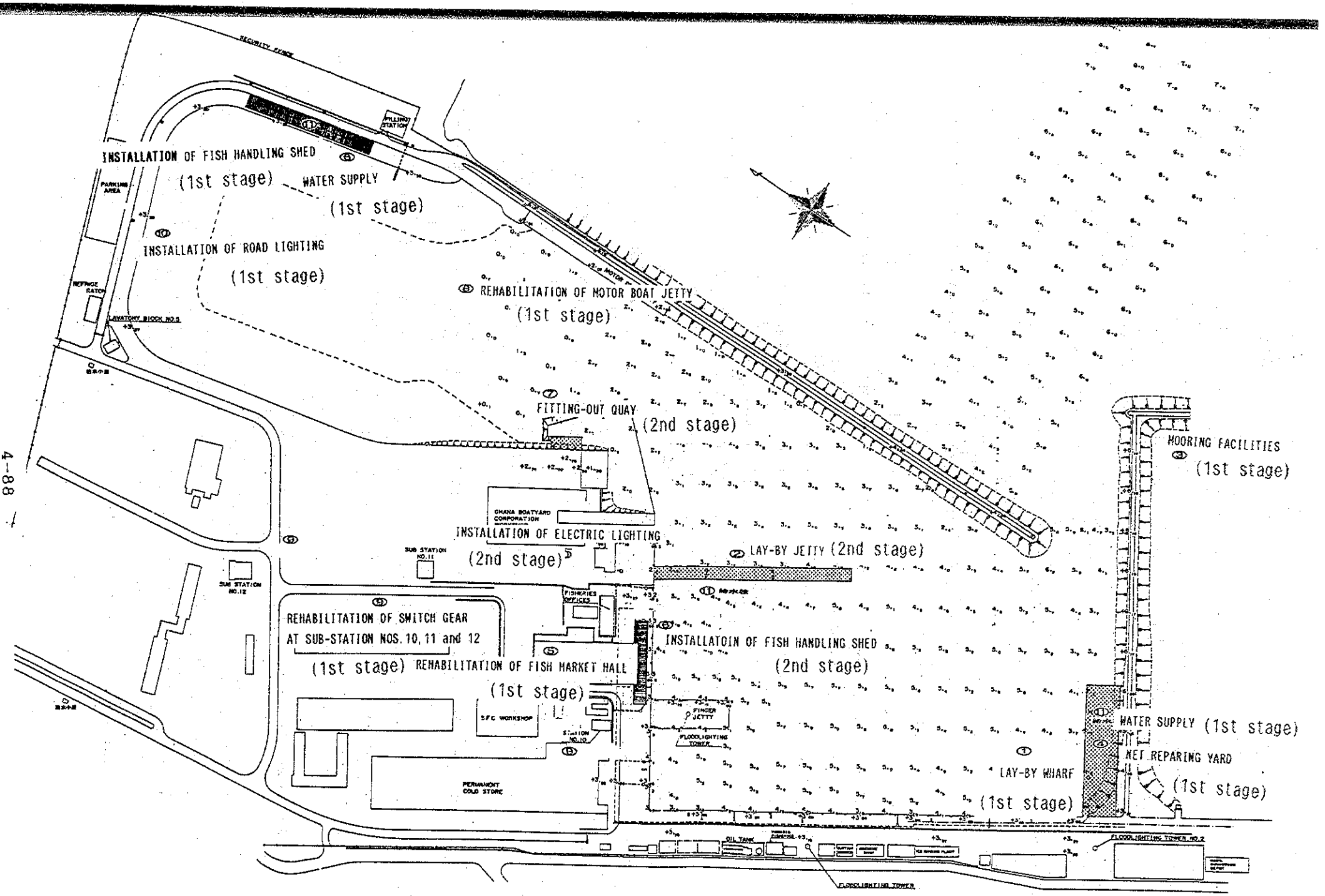


Fig. 4.4.1 Construction Stage of the Project

4.4.2 Work Division

Work division which have to be carried by the both governments are as follows.

(1) Japanese Part of the Construction

1) Construction of 100 m length of lay-by wharf (Net repairing yard and stockyard will be provided behind the wharf).
2) Construction of 155 m length of lay-by jetty.
3) Mooring facilities for 20 steel vessels at outer fishing harbour.
4) Rehabilitation of fish market hall.
   (a) Rehabilitation of roof about 2,300 m^2
   (b) Rehabilitation of wooden wall
       (Front and rear way out)
   (c) Installation of fish stall
   (d) Installation of ice storage
   (e) Installation of water supply and lighting facilities
5) Installation of fish handling shed
   (Canoe basin, 1000 m^2, and 610 m^2 in front of fish market hall).
6) Construction of fitting-out quay 30 m long
7) Rehabilitation of motor boat jetty
8) Rehabilitation of switchgear at sub-stations Nos. 10, 11 and 12.
9) Installation of water supply and lighting facilities.
10) Consultation required for the implementation of the project.

(2) Ghanaian Part of the Construction

1) Construction of access road to the project site and provision of the construction yard.
2) Provision of tax exemption and custom clearance of the imported materials for the project.
3) Administrative services for applications, registrations,

and bear the commissions to the Japanese foreign exchange bank for the banking services based upon B/A.

4) Ghanaian VAT charges for local materials.
5) Tax exemption for all Japanese nationals entering Ghana for the purpose of this project.
6) Provision of necessary facilities for Japanese nationals entering Ghana for the purpose of this project.
7) Bearing all the expenses, other than those to be borne by the Grant, necessary for construction of the facilities.

4.4.3 Construction Plan

While the Tema harbour is operating, no alternative harbour can be used during the construction. The Tema fishing harbour will be operating during the construction works. The work offshore will be kept at a minimum in order not to affect the operation of the vessels especially during the sardine season when there is a lot of vessel movement.

The area of 18,000 m^2 should be reserved for the construction yard. The ground being low, it must be raised by 30 cm and levelled for drainage and transportation, and the use of barbed wire fencing and a guard man at the gate shall be employed.

The area of 40-50 m at the corner of the south-north wharf and the south breakwater will be kept for the transport of the blocks and stones. Since there is some swell outside the harbour, the installation of a provisional jetty is not recommended.

The lay-by wharf will be completed during the 1st stage, while the lay-by jetty and fitting-out quay are installed during the 2nd stage after completing the 1st stage. In order not to affect the fishing vessel operation, the crane barge must be anchored securely (See Fig. 4.4.2).

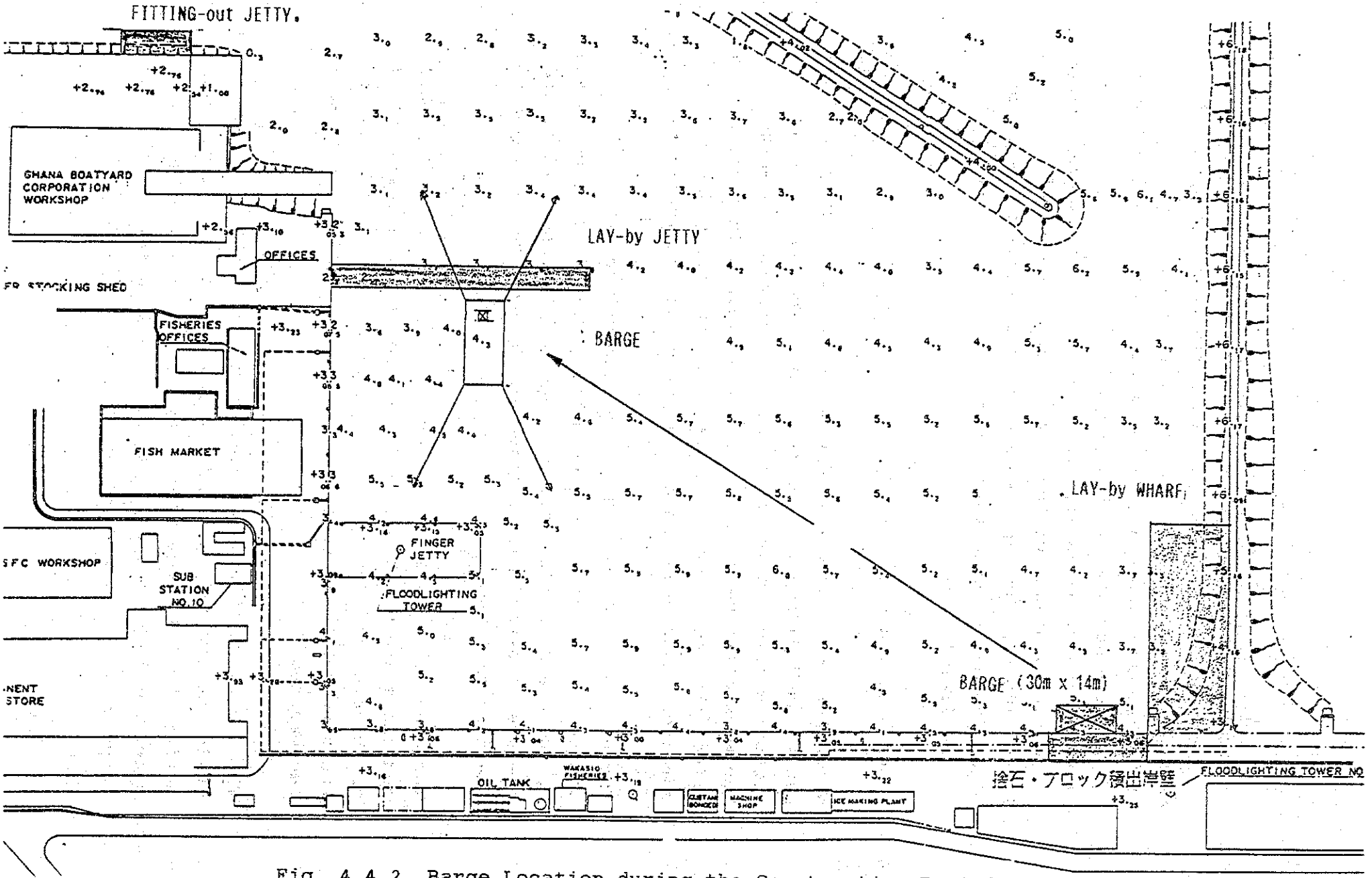


Fig. 4.4.2 Barge Location during the Construction Period

4.4.4 Materials and Equipment Plan

(1) Materials

Materials for this project will be imported except the materials available locally such as sand, stone, wood, etc.

a. Materials Available Locally

1) Sand for concrete
2) Ballast rock
3) Plywood (4' x 8')
4) Form materials for concrete work
5) Wood for repairing materials of motor boat jetty
6) Acetylene, oxygen
7) Cement
8) Reclamation sand
9) Corrugated aluminium sheet for roof
10) Fuel and lubricating oil

b. Materials from Europe

. Reinforcing steel bar

c. Materials from Japan

. Transparent corrugated PVC sheet
. Bollard, rubber fender
. Permeable sheet
. Electrical instrument and materials for water supply
. Materials for temporary work (Steel, form steel, etc.)

(2) Equipment

Since the equipment is not available in Ghana, equipment will have to be imported taking into account the following alternatives.

i) Lease from Europe, use in Ghana and reexport at the end of the project (Not easy to buy second-hand equipment from Europe)

ii) Buying from Singapore second-hand equipment, using in Ghana and dispose in Ghana.

iii) Barges bought from Japan, assembled in Ghana. Other equipment bought from Singapore.

Based on the above case studies, case ii) will be employed for this project considering the mobilization cost and construction period.

4.5 Project Implementation Schedule

The implementation of this project will start after the Exchange of Note (E/N) between the Japanese and the Ghanaian governments.

After the Exchange of Note is made, a consultant contract for detailed design and supervisory services must be signed between the executing agency of Ghana (GPHA) and a Japanese consulting firm . This will be followed by the implementation of the Japanese Grant Aid Program.

The project will be realized in the following work stages:

(1) Detailed Design Stage

The consultant will carry out the detail design of the lay-by wharf, lay-by jetty, fitting-out quay, fish market and fish handling shed. Based on this basic design reports, tender documents such as drawings and specifications will be prepared for the approval of GPHA.

(2) Tendering Stage

GPHA will carry out the tender. The contractor for this project should be selected from a group of Japanese firms. In order to execute the tender, the consultant will assist GPHA with the following items:

1) Tender publication
2) Investigation of tender participants
3) Discussion of tender with bidding participants
4) Tendering
5) Tender evaluation

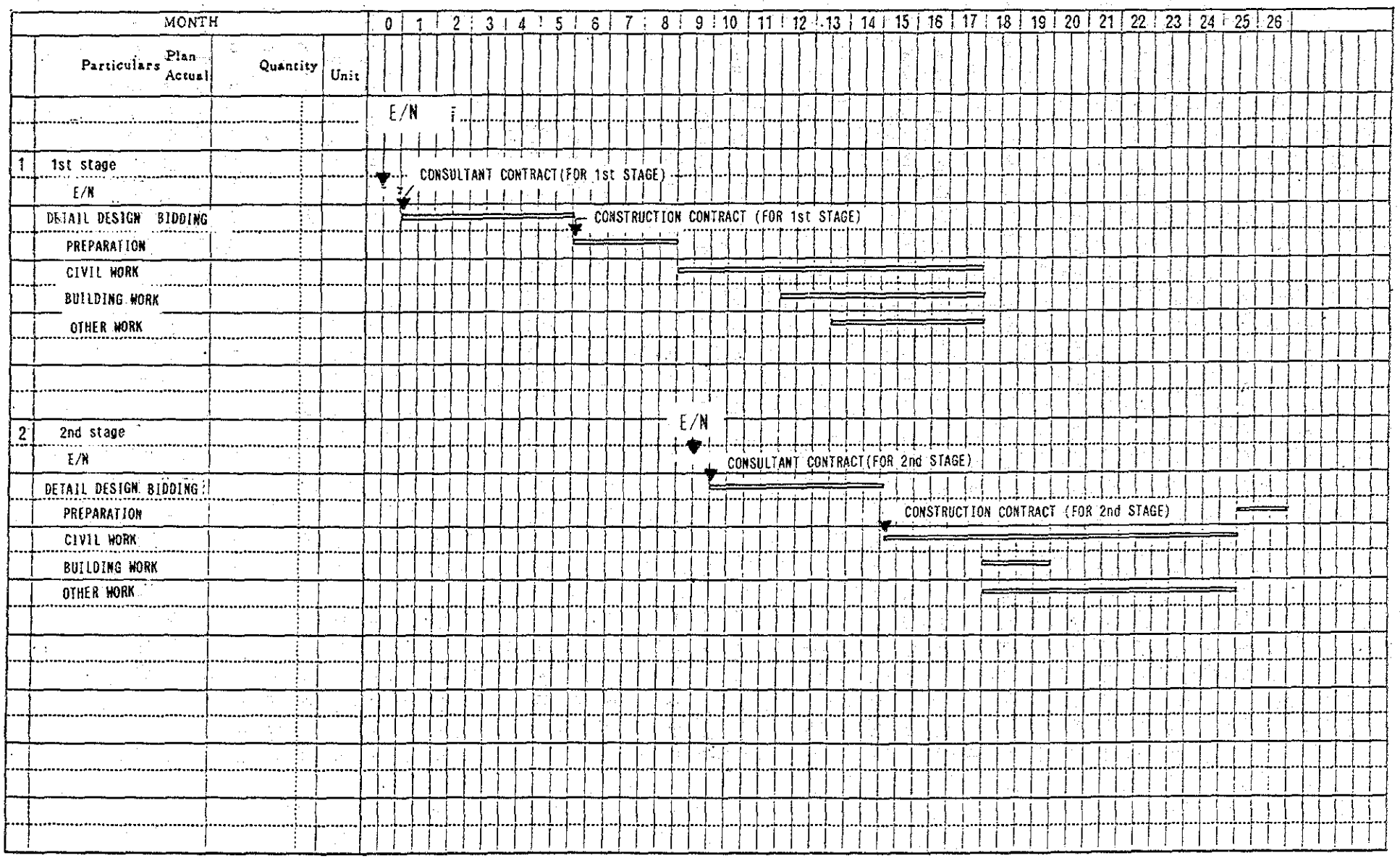
(3) Constrcution Stage

GPHA concludes a contract for implementation of the project with a selected Japanese contractor. After the contract, the Government of Japan will check and verify the contract then proceed with the construction work.

Before the completion of the construction work, the contractor must receive approval from GPHA as well as the consultant. The contractor will have to submit to GPHA through the consultant the construction method, maintenance and management required for this project.

Fig. 4.5.1 shows above implementation schedule.

Fig. 4.5.1 Implementation Schedule



4.6 Maintenance and Management Planning

4.6.1 Maintenance and Management Costs

As described in paragraph 2.4.8, maintenance and management of the Tema fishing harbour are operated by GPHA and a regional office of the Fishery Department of Ghana at the Tema harbour with a staff of 155 persons.

Therefore, an increase in the number of staff for fishing port operations is not planned even after the project is completed. Thus, it is unnecessary to add additional personnel cost; however, additional electric and water charges are expected.

(1) Electrical Supply Charge

Lighting facilities will be installed in the fish market hall, behind lay-by jetty and canoe basin street. The charges per one year will be as follows :

For the fish market hall	:	¢ 454,118
Behind lay-by jetty	:	¢ 75,686
Street lighting in canoe basin	:	¢ 45,411
Total		¢ 575,215

(2) Water Supply Charges

The water supply facilities will be installed as follows : 2 faucets at lay-by wharf, 4 faucets at lay-by jetty, 14 faucets in fish market hall, and 3 faucets in fish handling shed at canoe basin. With this installation, the water supply consumption will be a maximum of 50 m^2 per day. The water supply for fishing vessels will be charged at a rate of 400 Cedis per ton. Therefore, the increased operation cost will be covered by the water tariff to the vessels.

4.6.2 Evaluation of Maintenance and Management Costs

The maintenance and management costs of this project will be included in the GPHA budget. Since the GPHA budget in 1988 is estimated based on 5,483,000,000 Cedis revenue and 3,077,000,000 Cedis expenditure, the financial outlook of this harbour is good. Therefore, the additional maintenance and management costs of this project of 575,215 Cedis will be covered by this port revenue.

4.7 Project Cost Estimate

Project costs to be borne by the Government of Ghana :

Since the Tema harbour is already supplied with water and electric facilities, Ghana will be responsible only for the removal of an existing wall and for providing an access road to the site. The cost of this work is estimated at 1,200,000 Cedis.

CHAPTER 5 PROJECT EVALUATION

CHAPTER 5 PROJECT EVALUATION

5.1 Effect of the Project

Tema fishing harbour is the only fishing harbour in Ghana handling vessels larger than 10 m in length. The implementation of this project will result in the decongestion of the inner fishing harbour and have the following direct and indirect effects.

(1) Direct Effect

(a) The following effects will be anticipated by alleviating the harbour conjestion with the arrangement of lay-by wharf, lay-by jetty and mooring platform for non-operational steel vessels.

- The waiting time for fish unloading is reduced and the fish is kept fresh.
- Preparation and setting out for fishing is eased and the opportunity for fishing is increased.
- A high level of service will be provided by efficient fish unloading and preparation.
- Management of the wharf by segregation of usage will be made possible by the creation of a sufficient lay-by wharf and jetty.
- The maintenance cost of wooden fishing vessels will be reduced by the installation of a mooring platform for non-operational steel vessels which will decrease the congestion of both steel and wooden vessels and prevent damage.
- The introduction of the exclusive wharf will increase the safety of the fishing harbour due to the reduction of congestion, accidents and damage.

(b) The following effects will be expected by the improvement of the fish handling facilities by the rehabilitation of fish market hall and the arrangement of the fish handling shed.

- The freshness of the catch will be maintained.
- The management and control of fish unloading areas will be facilitated.
- Effective organization of the management for fish unloading and marketing will be introduced.
- The operations in the canoe basin will be improved with the installation of the fish handling shed and water supply facilities in the area.

(c) The prevention of fish deterioration which are stored in cold storage facilities, will be anticipated by the rehabilitation of sub-stations.

(2) Indirect Effects

The direct effects will benefit the workers and the fishing industry and should lead to an increase in fish and catch and higher incomes which will lead to the following indirect effects :

(a) Increase in the collection of tax.
(b) Development of fishery related industries.
(c) Increased supply of animal protein to the nation.

5.2 Evaluation from Management, Maintenance and Operational Viewpoints

No management and operation problem is considered since more effective fishing port operation and establishment of reorganization of the management and operation body will be expected.

5.3 Overall Evaluation

Tema fishing harbour is an important fishing port for the development of Ghanaian fishing industry since the Tema fishing harbour is the only fishing harbour in Ghana handling vessels larger than 10 m in length.

The implementation of this project is urged because it will benefit not only the fisheries related industries, but increase the supply of stable animal protein to the nation, thus benefiting Ghanaians in general.

In view of this, it can be judged that early implementation of the project with grant aid cooperation from Japanese Government is appropriate and worthwhile.

CHAPTER 6 CONCLUSION AND RECOMMENDATION

CHAPTER 6 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The Tema fishing harbour which is the object of this project is the only Ghanaian fishing port handling vessels larger than 10 m in length. It is the main port to supply the fish to the capital city Accra and animal protein to the nation as a main distribution center.

However, the fishing harbour's facilities are becoming obsolete, leading to delays in fish landing and handling as well as delays in vessel availability with deterioration and related losses, hence affecting adversely the entire fishing industry.

In veiw of the above situation, the implementation of this project is indispensable not only for alleviating the congestion of the Tema fishing harbour which leads to the improvement of the fish handling method and avoiding the fish deterioration but also to the development of fishing industries and the socio-economic situation in Ghana.

It is therefore recommended that this project be implemented as soon as possible in order to improve this situation with the Japanese grant aid assistance.

6.2 Recommendations

In order to operate this harbour efficiently, the following recommendations are proposed.

(1) Segregated wharf utilization is introduced in this planning for efficient wharf operation of fish unloading and lay-by berth. In order to operate the wharf utilization as planned, regulation or management rules have to be established.

(2) In order to provide adequate space for the fish unloading vessels at the fish unloading wharf, marketing should be prohibited on the apron of the fish unloading wharf and in the fish handling shed, and these operations should be transferred to the fish market hall.

(3) It is necessary to establish a management system for the efficient operation of the renovated fish market hall and fish handling shed as well as a fee management system for proper harbour maintenance.

(4) For efficient management of operations, the establishment of a single governing body for the regulation of combined fishing harbour and dockside activities is highly recommended.

(5) The idle steel vessels will be anchored at the mooring facilities installed in the outer fishing harbour. A fee collection system should be established for better maintenance and management.

(6) It is necessary to develop outer fishing harbour as soon as possible to gain the expected effects of this project in its early stage.

APPENDICES

APPENDICES

Appendix 1.2.1 : Member of the Basic Design Study Team

(1) For the Basic Design Study on the Project

Name	Title	Present Position
1. Mr. Takeshi Kawaguchi	Team Leader	Deputy Director, Planning Division, Fishing Port Department, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF)
2. Mr. Hiroto Taguchi	Fishery Promoter	Overseas Fishery Cooperation Section, International Affairs Division, Fisheries Agency, MAFF
3. Mr. Kazuo Senga	Project Coordinator	Sub-head, Kanagawa International Fisheries Training Center, JICA
4. Mr. Kazunao Sakata	Technical Experts (Fishing Port Planning)	Project Manager, Port and Harbour Division, Pacific Consultants International
5. Mr. Kentaro Yoshida	Technical Experts (Port Civil Engineering)	Assistant Manager, Port and Harbour Division, Pacific Consultants International
6. Mr. Hiroshi Nishimaki	Technical Experts (Fishery/Facility Design)	Port and Harbour Division, Pacific Consultants International
7. Mr. Naozo Saiga	Technical Experts (Natural Condition Survey)	- do -
8. Mr. Masahiro Mizuno	Technical Experts (Economic Analysis/ Cost Estimate)	- do -

(2) For the explanation of the Basic Design Study Report

1. Mr. Yuji Nishi	Team Leader	Deputy Director, Prevention & Coastal Protection Division, Fishing Port Department, Fisheries Agency, MAFF
2. Mr. Yoshio Nozu	Project Coordinator	Kanagawa International Fisheries Training Center, JICA
3. Mr. Kazunao Sakata	Technical Experts (Fishing Port Planning)	Project Manager, Port and Harbour Division, Pacific Consultants International
4. Mr. Kentaro Yoshida	Technical Experts (Port Civil Engineering)	Assistant Manager, Port and Harbour Division, Pacific Consultants International
5. Hiroshi Nishimaki	Technical Experts (Fishery/Facility Design)	Port and Harbour Division, Pacific Consultants International

Appendix 1.2.2 : Schedule of Study Team

Date (1988)	Activities
For basic design study team (from May 22 to June 16, 1988)	
May 22, Sunday	Team members departed Narita for London. Arrived at London.
May 23, Monday	Departed London for Accra. Arrived at Accra.
May 24, Tuesday	Paid a courtesy visit to Ministry of Finance & Economic Planning (MFEP), Ministry of Transport & Communication (MTC), Ministry of Agriculture & Fisheries, Ghana Port and Harbour Authority (GPHA) and Embassy of Japan.
May 25, Wednesday	Inspected the Project Site and a meeting among the Study Team members. Preparation of tide observation.
May 26, Thursday	Held a 1st meeting with the officials of MFEP, GPHA about the purpose of the study team. Preparation of tide observation.
May 27, Friday	Inspected the Project Site for confirming the requested facilities. Held a 2nd meeting with GPHA about the requested project facilities. Started tide observation.
May 28, Saturday	Repair of tide gage.
May 29, Sunday	Repair of tide gage. Held a meeting among the Study Team member about the basic design concept.
May 30, Monday	Minutes of Discussions was signed at MFEP office. Team Leader, Mr. Kawaguchi, fishery promoter, Mr. Taguchi and the project coordinator, Mr. Senga departed Accra for London. Preparation of sounding survey.
May 31, Tuesday	Preparation of sounding survey. Data collection from MFEP, GPHA, Fishery Department and Survey Department.

Date (1988)	Activities
June 1, Wednesday	Mr. Mizuno departed Narita for London. Preparation of sounding survey. Data collection at Fishery Department & CPC.
June 2, Thursday	Mr. Mizuno departed London for Accra. Preparation of sounding survey. Inspected cold storage facilities at Tema. Government officials arrived at Narita.
June 3, Friday	Mr. Mizuno arrived at Accra. Carried out sounding survey. Data collection at Fishery Department.
June 4, Saturday	Carried out sounding survey and current observation. Preparation of jet boring. Inspection at the quarry site. Study of wharf length.
June 5, Sunday	Meeting among the Study Team members. Inspected Elmina Fishing Port.
June 6, Monday	Carried out jet boring. Data collection from MFEP, MTC and Fishery Department. Data collection about construction materials.
June 7, Tuesday	Carried out jet boring. Data collection from GPHA and Fishery Department. Data collection about construction materials.
June 8, Wednesday	Carried out sounding survey. Inspection at sub-stations. Data collection from GPHA, World Bank, etc. Sea bed soil sampling.
June 9, Thursday	Topographic survey. Data collection from MFEP, etc.
June 10, Friday	Discussion about port layout with GPHA. Data collection from MFEP and GPHA. Topographic survey.
June 11, Saturday	Topographic survey. Data collection about construction materials.

Date (1988)	Activities
June 12, Sunday	Meeting among the Study Team members. Inspection inland fishery at Volta. Study of collected data.
June 13, Monday	Data collection at AESC and GPHA. Visited MFEP and Embassy of Japan and explained the progress of the study. Removal of tide gage. The Study Team departed Accra for London.
June 14, Tuesday	Arrived at London.
June 15, Wednesday	Departed London for Narita.
June 16, Thursday	Arrived at Narita.
For the explanation of the draft report (from August 7 to August 18, 1988)	
August 7, Sunday	Team members departed Narita for Paris.
August 8, Monday	Departed Paris for Accra. Arrived at Accra.
August 9, Tuesday	Paid a courtesy visit to JICA, Embassy of Japan and GPHA. Inspected the Project Site.
August 10, Wednesday	Inspected the Project Site. Explained the draft report at GPHA.
August 11, Thursday	Explained the draft report at GPHA.
August 12, Friday	Data collection at Fishery Department. Meeting about Minutes of Discussions at MFEP.
August 13, Saturday	Data collection. Inspection of fishing market at Accra.
August 14, Sunday	Meeting among the members. Inspection Elmina Fishing Port.
August 15, Monday	Minutes of Discussions was signed at MFEP office. Departed Accra for London.
August 16, Tuesday	Arrived at London.
August 17, Wednesday	Departed London for Narita.
August 18, Thursday	Arrived at Narita.

Appendix 1.2.3 : Minutes of Discussions, May 30, 1988

MINUTES OF DISCUSSIONS
FOR
BASIC DESIGN STUDY
ON
TEMA FISHING HARBOUR REHABILITATION PROJECT
IN
REPUBLIC OF GHANA

In response to the request of the Government of Ghana, the Government of Japan had decided to conduct a basic design study on Tema Fishing Harbour Rehabilitation Project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Republic of Ghana the Basic Design Study Team headed by Mr. Takeshi KAWAGUCHI, Deputy Director, Planning Division, Fishing Port Department, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries from May 22 to June 2, 1988.

The Team had a series of discussions on the Project with the officials concerned of the Government of Ghana headed by Miss Quist, Acting Chief Director, International Economic Relations Division and conducted a field survey in Tema Fishing Port.

As a result of the study, both parties agree to recommend to their respective Governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

Accra May 30 , 1988

Mr. Takeshi KAWAGUCHI
Leader, Japanese Basic Design
Study Team
Japan International Cooperation
Agency (JICA)

Miss Eleanor Quist
Acting Chief Director
International Economic Relations
Division

A T T A C H M E N T

1. OBJECTIVE OF THE PROJECT

The objective of the Project is to rehabilitate the present congested and deteriorated facilities at Tema Fishing Horbour in order to contribute the development of Ghanaian marine fisheries and fishing industry.

2. EXECUTING BODY

The responsible and executing body for the Project is Ghana Ports and Harbours Authority, which is under the supervision of the Ministry of Transport and Communications.

3. SITE OF THE PROJECT

The proposed site of the Project is located in Tema Inner fishing Harbour as shown in Annex-1.

4. REQUEST BY THE GOVERNMENT OF GHANA

The Study Team will convey the request of the Government of Ghana to the Government of Japan that the latter will take necessary measures to cooperate in implementing the Project and provide necessary facilities and equipment as listed in Annex-2 within the scope of the Japan's Grant Aid Programme.

5. MEASURES TO BE TAKEN BY THE GOVERNMENT OF GHANA

The Government of Ghana will take the necessary measures listed in Annex-3 on conditions that the Grant Aid by the Government of Japan is extended to the Project.

T. Kawaguchi

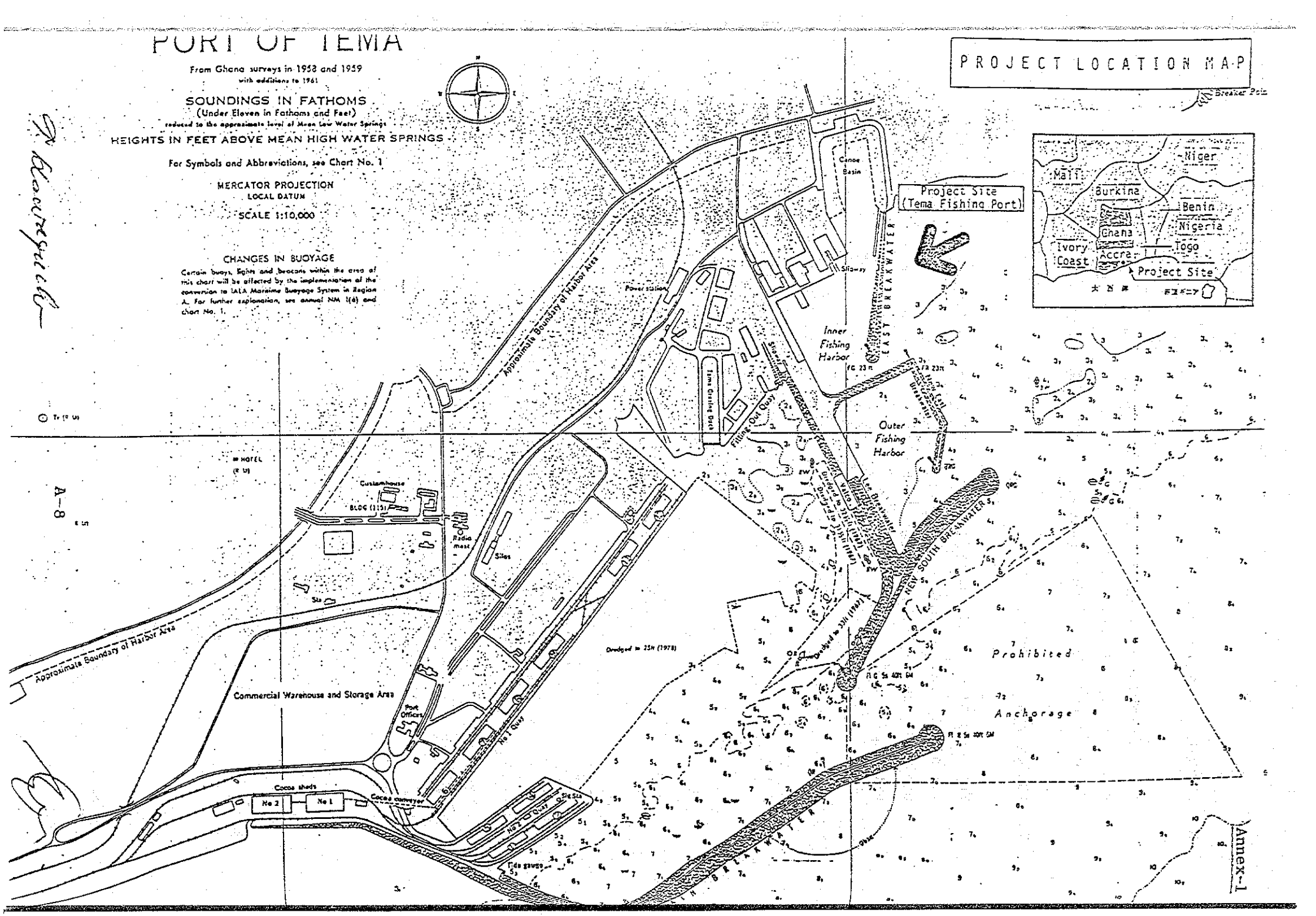
6. SYSTEM OF JAPAN'S GRANT AID

The Government of Ghana has understood the system of Japan's Grant Aid explained by the Team, which includes a principle of the use of the Japanese consultant and Japanese firms for the execution of the Project.

7. BUDGET AND PERSONNEL

The Government of Ghana will assure the necessary budget and personnel for the operation and maintenance of the facilities and equipment provided, on condition that the Grant Aid by the Government of Japan is extended to the Project.

T. Kawaguchi


PORT OF TEMA
From Ghana surveys in 1958 and 1959
with additions to 1961
SOUNDINGS IN FATHOMS
(Under Eleven in Fathoms and Feet)
reduced to the approximate level of Mean Low Water Springs
HEIGHTS IN FEET ABOVE MEAN HIGH WATER SPRINGS
For Symbols and Abbreviations, see Chart No. 1
MERCATOR PROJECTION
LOCAL DATUM
SCALE 1:10,000
CHANGES IN BUOYAGE
Certain buoys, lights and beacons within the area of this chart will be affected by the implementation of the conversion to IALA Maritime Buoyage System in Region A. For further explanation, see annual NM 1(4) and chart No. 1.
PROJECT LOCATION MAP
Project Site
(Tema Fishing Port)
Niger
Mali
Burkina
Benin
Nigeria
Ghana
Ivory Coast
Accra
Togo
Project Site
Canoe Basin
Inner Fishing Harbor
Outer Fishing Harbor
EAST BREAKWATER
Approximate Boundary of Harbor Area
Power station
Tema Grazing Dock
Filling Out Quay
Customhouse
BLDG (115)
Radio mast
Silos
Commercial Warehouse and Storage Area
Port Officers
No 1 Quay
Cocoa sheds
No 2
No 1
Cocoa conveyor
No 2 Oil Quay
Tide gauge
Dredged to 25ft (1978)
Dredged to 33ft (1968)
NEW SOUTH BREAKWATER
Prohibited
Anchorage
BREAKWATER
Breaker Pois
Annex-1
A-8

Major facilities and structures of the Project requested by the Government of Ghana.

1. Lay-by wharf and/or jetties.

2. Lay-by mooring for non-operational vessels about 20 vessels.

3. Repairs to wooden jetty in canoe basin, broken parts only.

4. Fitting-out quay, 30m long at GIHOC boatyard.

5. Net repairing yard, if the place is obtainable behind the new quay wall.

6. Refurbishing of market area (Details are listed in Annex - 4)

7. Repairs to Services (Details are listed in Annex - 5)

T. Kawczynski

Necessary measures to be taken by the Government of Ghana.

1. (*)To secure land necessary for the execution of the Project and provide enough space for such construction as temporary.

2. (*)To ensure that sea area necessary for the construction of the facilities be freely acceptable.

3. (*)To ensure the successful implementation of the project for removal of all wrecks and non-operation vessels from the inner fishing harbours.

4. To provide facilities for distribution of electricity, water supply, drainage and sewage, telephone and other incidental facilities up to the Project site. (These facilities will be completed its distribution line before the completion of the Project.)

5. To ensure prompt unloading, tax, exemption, customs clearance at ports of disembarkation in Ghana and prompt internal transportation therein of the products purchased under the grant.

6. To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Ghana with respect to the supply of the products and services under the verified contracts.

7. To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into Ghana and stay therein for the performance of their work.

Note: Marked with (*) should be completed before start of construction of the facilities.

8. To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid.

9. To bear the following commissions to the Japanese foreign exchange bank for the banking services based upon the B/A.

   a) Advising commission of A/P
   b) Payment commission

Details of Refurbishing of Market Area.

1. Installation of stalls for fish monger inside the existing fish market.

2. Rehabilitation of roof for day lighting.

3. Water supply system inside the fish market.

4. Electrical lighting.

5. Rehabilitation of wall.

6. Ice Storage.

Details of Repairs of Services

1. Rehabilitation of switch gears of substantions No. 10, 11 and 12.

2. Installation of flood lighting tower.

3. Transit shed for handling of fresh fish.

ATTENDANTS LIST

1. Japanese Side

(1) Japanese Study Team:

Mr. Takeshi KAWAGUCHI	-	Team Leader
Mr. Hiroto TAGUCHI	-	Fishery Promoter
Mr. Kazuo SENGA	-	Project Coordinator
Mr. Kazunao SAKATA	-	Technical Expert (Fishing Port Planning)
Mr. Mentaro YOSHIDA	-	Technical Expert (Port Civil Engineering)
Mr. Hiroshi NISHIMAKI	-	Technical Expert (Fishery/Facility Design)

(2) Japan Embassy

Mr. Haruyuki TOGASHI	-	Second Secretary

2. Ghana Side

Miss Eleanor Quist	-	Ag. Chief Director Int. Economic. Relations Min. of Finance & Econ. Plann.
Mr. Samuel Kabo	-	(IERD) M.F.EP.
Mr. John Aidoo	-	Ag. Director-General G. P. H. A.
Mr. T. T. Addy	-	Director of Ports - Tema
Mr. Joe Owusu	-	Engineer in Chief - GPHA
Mr. Bismarck B.K. Okutu	-	Chief Port Engineer - GPHA
Mr. E. A. Kwakye	-	Min. of Transport & Commun.
Mr. V. N. Dowuona	-	Director of Fisheries
Mr. E. O. Prempeh	-	Economic Planning Officer M. F. E. P.
Mr. Kwasi Opoku	-	M. F. E. P.

T. Kawaguchi

Appendix 1.2.4 : Minutes of Discussions, August 15, 1988

MINUTES OF DISCUSSION
ON
THE TEMA FISHING HARBOUR REHABILITATION PROJECT
IN
REPUBLIC OF GHANA

In response to the request of the Government of Republic of Ghana for Grant Assistance for the Tema Fishing Harbour Rehabilitation Project (hereinafter referred to as "the Project"), the Government of Japan decided to conduct a basic design study on the Project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Ghana the team headed by Mr. Takeshi KAWAGUCHI, Deputy Director, Planning Division, Fishing Port Department Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries, form May 22nd to June 16, 1988.

As a result of the study, JICA prepared a draft report and dispatched a team headed by Mr. Yuji NISHI, Deputy Director, Disaster Prevention & Coastal Protection Division, Fishing Port Department, Fisheries Agency to explain and discuss it from August 7, to August 18, 1988.

Both parties had a series of discussions on the Report and agreed to recommend to their respective Governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

Accra, August 15, 1988

Mr. Yuji NISHI
Leader ,Japan Basic Design
Study Team
Japan International Cooperation
Agency (JICA)

Miss Eleanor Quist
Acting Chief Director
International Economic Relations
Division

ATTACHMENT

1. The Ghana side has agreed in principle to the basic design proposed in the Draft Final Report with minor but appropriate alternation as shown in Annex-I mutually agreed upon to be incorporated in the Final Report.

2. The Ghana side has understood Japan's grant aid system and confirmed that the necessary measures will be taken by the Ghana side as shown in Annex-II which are manifested in the Annex 3 of the MINUTES OF DISCUSSIONS on the project signed on May 30, 1988, on condition that the grant aid by the Government of Japan would be extended to the Project.

3. The Ghana side will assure the necessary budget (from Fiscal Year 1990/91) for operation and maintenance of the equipment provided, on condition that the grant aid of the Government of Japan should be extended to the Project.

4. The Final Report (10 copies in English) will be submitted to the Ghana side in the middle of October, 1988.

1. Mooring facilities for 20 non-operational steel vessels.
   Anti corrosive painting will be applied for the steel members at the platforms of mooring facility in outer harbour.

2. Rehabilitation of fish market hall

   Removal work of existing wooden louver of longitudinal sides of wall at the fish market hall shall be deleted.

Necessary measures to be taken by the Government of Ghana.

1. (*)To secure land necessary for the execution of the Project and provide enough space for such construction as temporary.

2. (*)To ensure that sea area necessary for the construction of the facilities be freely acceptable.

3. (*)To ensure the successful implementation of the project for removal of all wrecks and non-operation vessels from the inner fishing harbours.

4. To provide facilities for distribution of electricity, water supply, drainage and sewage, telephone and other incidental facilities up to the Project site. (These facilities will be completed its distribution line before the completion of the Project.)

5. To ensure prompt unloading, tax, exemption, customs clearance at ports of disembarkation in Ghana and prompt internal transportation therein of the products purchased under the grant.

6. To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Ghana with respect to the supply of the products and services under the verified contracts.

7. To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into Ghana and study therein for the performance of their work.

Note: Marked with (*) should be completed before start of construction of the facilities.

8. To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid.

9. To bear the following commissions to the Japanese foreign exchange bank for the banking services based upon the B/A.

   a) Advising commission of A/P
   b) Payment commission

ATTENDANTS LIST

1. Japanese Side

(1) Japanese Study Team:

Mr. Yuji NISHI	Team Leader
Mr. Yoshio NOTSU	Project Coordinator
Mr. Kazunao SAKATA	Technical Expert (Fishing Port Planing)
Mr. Kentaro YOSHIDA	Technical Expert (Port Civil Engineering)
Mr. Hiroshi NISHIMAKI	Technical Expert (Fishery/Facility Design)

(2) Japan Embassy

Mr. Terufusa ARIGA	Counsellor

2. Ghana Side

Miss Eleanor Quist	Ag. Chief Director Int. Economic Relations Min. of Finance & Econ. Plann.
Mr. Samuel Kabo	(IERD) M.F. EP.
Mr. E.O. Prempeh	Economic Planning Officer M.F.E.P.
Mr. V.N. Dowuona	Director of Fisheries

Appendix 1.3.1 : List of Interviewed Personnel

Japanese Side

Japanese Embassy in Ghana :

Mr. Shigemi Ando	Ambassador
Mr. Terufusa Ariga	Counsellor
Mr. Haruyuki Togashi	2nd Consul

JICA office in Ghana :

Mr. Noboru Yamazaki	Office Manager
Mr. Takashi Nagakura	Office Manager

Wakashio Fishery Co., Ltd.

Mr. Tokuo Abe	Office Manager

Ghana Side

Ghana Posts & Harbour Authority :

Mr. John Aidros	Acting Director
Mr. Joseph Owusu	Engineer-in-Chief
Mr. B.B.K. Okutu	Chief Port Engineer
Mr. Klaus Riebensham	Project Co-ordinator
Mr. John N. Wolfe-Barry	Chief Resident Engineer Sir William Halcrow & Partners Ltd.
Mr. Sam Quist	Marine Operation Department (Hydrographic Section at Tema)
Mr. Stephen Ray Afagkedzi	Senior Public Relation Officer

Ministry of Transport & Communication :

Dr. William Adote	Chief Director (Planning)
Mr. E.A. Kwakye	Principal Planning Office Transport Planning Division

Ministry of Finance & Economic Planning

Miss Eleanor Quist	Acting Chief Director International Economic Relations Division
Mr. Samuel K. Kabo	Senior Economic Planning Officer
Mr. Osei Prempeh	Economic Planning Officer

Ministry of Agriculture, Fisheries Department

Mr. Victor N. Dowuona	Director of Fisheries
Mr. M. Arman	Deputy Director of Fisheries

Tema Fishing Port Office

Mr. Adjei Lomo	Fisheries Biologist Regional Fishery Officer
Mr. Joe Akepey	Senior Technical Officer Fisheries Department
Mr. Cherles Auudi	Fishing Harbour Manager Fishing Harbour Manager Office
Mr. Rajendra K. Sharma	Deputy Resident Representative, The World Bank, Resident Mission in Ghana
Mr. Foli Amekor	General Secretary of Construction & Building, Trades Union Congress
Mr. G.K. Owusu-Addo	Director, Structures Div. AESC
Mr. Joseph K. Akpey	Senior Fisheries Extension Officer Fisheries Department
Mr. Godwin Yao Kowu	Fisheries Extension Officer Fisheries Department

Ghana Tuna Fishing Department Co., Ltd.

Mr. Emmanuel Blankson	Joint Operation Manager

GPHA 予算 1988

A basic summary of the GPHA 1988 Budget which highlights the main features is detailed below:

GPHA Budget Summary 1988

REVENUE	(¢000's)
Tema Port	¢3,715,235
Takoradi Port	1,746,326
Headquarters	22,140
TOTAL:	¢5,483,701

Dollar earnings have been converted at the rate of ¢190 per dollar and account for 67% of Tema Port Revenue and 73% in the case of Takoradi.

EXPENDITURE	
Tema Port	¢1,640,473
Takoradi Port	1,258,390
Headquarters	178,945
TOTAL:	¢3,077,808

REVENUE SURPLUS FOR THE YEAR (AFTER DEPRECIATION)	
Tema Port	¢1,773,762
Takoradi Port	339,936
Headquarters	156,805
TOTAL:	¢1,956,893

The forecast operating revenue surplus for 1988 amounts to ¢1,956,893,000 after providing for depreciation but before taxation.

GHANA PORTS AND HARBOURS AUTHORITY

BUDGET PROFIT AND LOSS ACCOUNT FOR THE YEAR TO 31ST DECEMBER 1988

(CEDIS 000'S)

	TEMA	TAKORADI	TOTAL
Revenue (Port Operations)	3,715,235	1,746,326	5,461,561
Less: Expenditure (Port Operations)			
Payroll Costs	994986	718511	1713497
Operating Materials	10000	15820	25820
Maintenance	130000	262703	392703
Fuel, Power & Water	374500	105633	480113
Third Party Services	-	22000	22000
Other Administration Costs	130987	133723	264710
	1640473	1258390	3163573
Operating Profit	2074762	487936	2562698
Less: Depreciation	301000	148000	449000
	1773762	339936	2113698
Less: Headquarters			
Payroll Costs			72761
Other Costs			106184
			178945
Less: Headquarters Income			(22140)
Total Headquarters Costs			156805
Budgeted Net Profit before taxation			1956893
Less: Provisional estimate for taxation			900000
Budgeted Net Profit for the year			¢1056893

Appendix 2.3.1 : Fish Landings by Species Mode (1983-1986)

Unit in MT

Species/Species Group	1983	1984	1985	1986
Sea breams	8,377	11,462	9,787	9,939
Croakers/grunters	9,838	17,425	14,109	20,929
Trigger fish	3,676	4,020	3,595	7,473
Round sardinella	45,130	38,032	60,667	48,395
Flat sardinella	8,265	11,015	23,262	17,882
Anchovy	24,392	47,231	27,590	15,209
Chub mackerel	241	712	164	19,292
Scad mackerel	33	46	170	141
Frigate mackerel	3,570	7,079	3,521	3,256
Cuttlefish	1,412	1,702	1,828	1,136
Yellowfin tuna	2,231	4,230	5,714	5,551
Bigeye tuna	284	119	77	187
Skipjack tuna	22,404	20,252	21,551	25,213
Other	75,332	68,185	62,185	94,253
Annual Total	205,195	231,510	234,220	269,156

Source : Fishery Department