5 BASIC IDEA OF IMPROVEMENT

5 BASIC IDEA OF IMPROVEMENT

5-1 SHIP REPAIR

5-1-1 Planning Conditions

(1) Current Ship Repair Capacity

In order to study the future improvement plan, it is indispensable to understand the current ship repair capacity of CDD by analyzing the past docking performances.

1) Seagoing vessels

Based on the "Docking-Undocking Record" of CDD, docking vessels by customers during 1984/85 - 87/88 is summarized as shown in Table 5-1-1.

Table 5-1-1 Past Docking Record of Seagoing Vessel

Year / Customer	1984/85	1985/86	1986/87	1987/88	Total
BSC					
Docked vessels	9	6	5	11	31
Days spent	171	122	59	196	548
Private/Foreign					
Docked vessels	0	4	4	6	14
Days spent	0	36	45	47	128
Total					
Docked vessels	9	10	9	17	45
Days spent	171	158	104	243	676

Source: CDD, Docking-Undocking Record

Using the above record, the average number of docking vessels per year can be estimated as follows:

Average docking days per vessel = 676/45
= 15.0 days

When the annual working days of CDD are 303 days, with the exception of national holidays and weekly holidays, the average number of vessels per year = 303/15.0
= 20 vessels

Accordingly, the ship repair capacity in the dry dock in 1987 is set at 20 vessels per year.

2) Small vessels

The past docking record of small vessels during 1984/85 - 87/88 is shown in Table 5-1-2.

Table 5-1-2 Past Docking Record of Small Vessel

Item \ Year	1984/85	1985/86	1986/87	1987/88	Total
Docked vessels					
Trawlers	3	11	19	20	53
Coasters	3	10	22	6	41
Total	6	21	41	26	94
Days spent *1	66	117	225	91	499
No. of dockings	4	13	20	11	48

Source: CDD, Docking Undocking Record

*1 This figure does not show the total days spent by each vessel, but the total days of dock used.

Since the plural vessels were docked at the same time, current docking capacity is estimated as follows:

Average days spent per one docking = 499/48
= 10.4 days

Average number of dockings per year = 303/10.4
= 29 times

Meanwhile, the average number of vessels per one docking at the same time can be calculated as follows:

Number of vessels = total No. of vessels/No. of dockings
= 94/48
= 2 vessels

Accordingly, the ship repair capacity in the dry dock in 1987 is set at 29 times per year and 2 vessels at a time.

3) Current repair price per vessel

Current average repair price per vessel is estimated as shown in Table 5-1-3, based on the past performances showing as follows:

(Lac. taka)

Year / Customer	1985/86	1986/87	1987/88	1988/89	Average
BSC	22.8	18.0	21.5	19.7	20.5
Private	15.0	15.7	11.8	16.9	14.8
Foreign flag	10.7		7.5		9.1
Small vessel	10.5	5.7	5.3	8.6	7.5

Source: CDD

The unit price for seagoing vessels is calculated using the unit price by customers and the ratio of the number of docked vessel.

As for small vessels, the past average repair price in the same table, 7.5 lac. taka per vessel is adopted.

Table 5-1-3 Current Repair Price per Vessel

(Lac. taka)

Seagoing vessels	BSC	Private	Foreign
Repair price per vessel by customer	20.5	14.8	9.1
Docked vessel (%) (1985/86 - 1988/89)	62	28	10
Current unit price, Seagoing vessel	17.8 (20.5 x 62 + 14.8 x 28 + 9.1 x 10)/100		
Current unit price, Small vessel	7.5		

Above prices are set as the repair price per vessel in 1987.

(2) Estimated Future Docking Capacity and Repair Price (Without Project - this means a case in which any improvement projects are not considered.)

1) Estimated future growth rate (Without Project)

The docking capacity and the repair work items of CDD are expected to increase gradually in proportion to the productivity and technology increased by self improvement.

The future growth rate of productivity and work volume is set as given in Table 5-1-4.

Table 5-1-4 Estimated Growth Rate (Without Project)

Year	Productivity	Work Volume
1987/88	1.00	1.00
1989/90	1.06	1.04
1992/93	1.16	1.10
1993/94	1.19	1.13
1997/98	1.29	1.22
2002/03	1.37	1.35
2007/08	1.41	1.44
2012/13	1.41	1.44

The growth rate of the productivity by self-improvement is estimated as 3% per year from 1987 to 1993, 2% from 1994 to 1998 and 1% after 1999 based on the current capability, future growth rate of industrial production.

The growth rate of work volume is set at 2% annually considering an increase of repair work items as shown in Table 5-1-19.

2) Estimated docking capacity (Without Project)

Based on the current capacity and future growth prediction of productivity as shown in Table 5-1-4, future docking capacity (Without Project) can be estimated as shown in Table 5-1-5.

The average docking days per vessel in the year 2007 - 2012 is assumed at about 11 days which is 60% of an advanced country's docking days(5 - 6 days).

Table 5-1-5 Estimated Docking Capacity (Without Project)

Year	Seagoing Vessels		Small Vessels	
	Number	Days/docking	Number	Days/docking
1987/88	20	15.2	29	10.4
1989/90	21	14.4	30	10.1
1992/93	23	13.2	33	9.2
1997/98	25	11.7	37	8.2
2002/03	27	11.2	39	7.8
2007/08	28	10.8	40	7.6
2012/13	28	10.8	40	7.6

3) Estimated repair price in the future (Without Project)

Estimated average repair price per vessel can be estimated as shown in Table 5-1-6, based on the current average repair price as given in Table 5-1-3 and the prospective growth of work volume as given in Table 5-1-4.

Table 5-1-6 Estimated Repair Price per Vessel

(Lac. taka)

Year	Seagoing Vessels	Small Vessels
1987	17.8	7.5
1989	18.5	7.8
1992	19.7	8.3
1997	21.7	9.4
2002	24.0	10.1
2007	25.7	10.8
2012	25.7	10.8

5-1-2 Expected Future Work

(1) Seagoing Vessels

Future docking demand of seagoing vessels is estimated as shown in Table 5-1-7, based on the required number of vessels forecast in Chapter 4, Table 4-2-15 and 4-2-16.

The expected future work of ship repair is estimated for two cases, the lifting share of Bangladesh flag vessels is 30% and 40%.

The detailed docking demand of BSC, private, and foreign flag vessels is given in Table 5-1-8 to 5-1-10.

Table 5-1-7 Expected Docking Demand of Seagoing Vessels

1. Lifting Share 30%

Year	BSC Own	Private	Foreign	Total
1989/90	8	2	3	13
1992/93	12	3	4	19
1993/94	13	3	4	20
1997/98	15	6	7	28
2002/03	17	9	10	36
2007/08	17	10	11	38
2012/13	17	10	11	38

2. Lifting Share 40%

Year	BSC Own	Private	Foreign	Total
1989/90	8	2	3	13
1992/93	13	3	4	20
1993/94	13	4	4	21
1997/98	17	7	7	31
2002/03	20	12	9	41
2007/08	20	14	9	43
2012/13	20	14	9	43

Table 5-1-8 Expected Docking Demand of BSC Owned Vessels

1. Lifitng Share 30%

Year	Number of Vessels	Share of CDD	Docking Frequency	Docking Demand
1989/90	22	1	0.4	8
1992/93	25	1	0.5	12
1997/98	30	1	0.5	15
2002/03	35	1	0.5	17
2007/08	35	1	0.5	17
2012/13	35	1	0.5	17

2. Lifting Share 40%

Year	Number of Vessels	Share of CDD	Docking Frequency	Docking Demand
1989/90	22	1	0.4	8
1992/93	26	1	0.5	13
1997/98	34	1	0.5	17
2002/03	40	1	0.5	20
2007/08	40	1	0.5	20
2012/13	40	1	0.5	20

- Docking frequency of BSC vessels is estimated based on the past docking record as stated in Chapter 3, Table 3-4-5, with the expectation of increasing up to 0.5 in 1992, every two years, in accordance with the regulations.
- Docking share of CDD to BSC wned vessels is estimated as 100%, considering the governmental policy.

Table 5-1-9 Expected Docking Demand of Private Vessels

1. Lifting Share 30%

Year	Number of Vessels	Share of CDD	Docking Frequency	Docking Demand
1989/90	25	0.4	0.24	2
1992/93	28	0.4	0.3	3
1997/98	33	0.5	0.4	6
2002/03	39	0.5	0.5	9
2007/08	41	0.5	0.5	10
2012/13	41	0.5	0.5	10

2. Lifting Share 40%

Year	Number of Vessels	Share of CDD	Docking Frequency	Docking Demand
1989/90	25	0.4	0.24	2
1992/93	31	0.4	0.3	3
1997/98	36	0.5	0.4	7
2002/03	49	0.5	0.5	12
2007/08	59	0.5	0.5	14
2012/13	59	0.5	0.5	14

- Future docking shares of CDD is estimated at 0.5 from 1997/98, considering the future improvement of CDD and the past parformance stated in Chapter 3, Table 3-4-7.
- Docking frequency is also estimated to be 0.5(every two years) in 2002/03, in accordance with the regulations.

Table 5-1-10 Expected Docking Demand of Foreign Vessels

1. Lifting Share 30%

Year	Number of Vessels	Share of CDD	Docking Demand
1989/90	195	0.02	3
1992/93	217	0.02	4
1997/98	261	0.03	7
2002/03	343	0.03	10
2007/08	366	0.03	11
2012/13	366	0.03	11

2. Lifting Share 40%

Year	Number of Vessels	Share of CDD	Docking Demand
1989/90	195	0.02	3
1992/93	212	0.02	4
1997/98	248	0.03	7
2002/03	303	0.03	9
2007/08	313	0.03	9
2012/13	313	0.03	9

- The future docking demand of foreign flag vessels is forecast on the assumption that 2% of the vessels calling at the port of Chittagong and Mongla from 1989 to 1992 and 3% of them after 1993 are expected to dock at CDD.

(2) Small Vessels

1) Trawlers

As regards the docking demand of fish trawlers, the estimation is made based on the required number of fishing trawlers being forecast in Chapter 4, Table 4-2-15.
The past docking record mentioned in Chapter 3, table 3-4-7, shows that the share of CDD is 0.41 and the docking frequency is 0.41. Since the data is obtained under the condition that docking priority is given to seagoing vessels, future docking frequency and shares of CDD is considered to be higher than the past.

Therefore, the shares of CDD and the docking frequency of trawlers is set at 0.6 and 1.0 respectively.

The expected docking demand of trawlers is shown in Table 5-1-11.

Table 5-1-11 Expected Docking Demand of Trawlers

Year	Number of Vessels	Share of CDD	Docking Frequency	Docking Demand
1989/90	39	0.6	1.0	23
1992/93	44	0.6	1.0	26
1997/98	51	0.6	1.0	30
2002/03	58	0.6	1.0	34
2007/08	60	0.6	1.0	36
2012/13	60	0.6	1.0	36

2) Coasters

The docking demand of coasters and other small vessels is set at 1.05 times that of trawlers according to the understanding of shipowners and CDD, and the past performances.

3) Total docking demand of small vessels

The total docking demand of small vessels is summarized in Table 5-1-12.

The number of vessels to be docked at the same time is set at 3 vessels after 1989. The number of dockings is calculated for the purpose of corresponding to the number of dockings of seagoing vessels.

Table 5-1-12 Total Docking Demand of Small Vessels

Year	Trawlers	Coasters and Others	Total	Number of Dockings
1989/90	23	24	47	15
1992/93	26	27	53	17
1993/94			54	18
1997/98	30	31	61	20
2002/03	34	35	69	23
2007/08	36	37	73	24
2012/13	36	37	73	24

5-1-3 Future Plan for Improvement

The future docking demand to the docking capacity of CDD without Project is shown in Table 5-1-13 and Fig. 5-1-1, where docking demand of small vessels is shown in the figure of the number of dockings.

Table 5-1-13 Supply and Demand Forecast of Docking

1. Lifting Share 30%

Year	Docking Capacity (C)	Docking Demand (D) Seagoing	Small	(D)/(C)
1989/90	21	13	15	1.33
1992/93	23	19	17	1.56
1997/98	25	28	20	1.92
2002/03	27	36	23	2.18
2007/08	28	38	24	2.21
2012/13	28	38	24	2.21

2. Lifting Share 40%

Year	Docking Capacity (C)	Docking Demand (D) Seagoing	Small	(D)/(C)
1989/90	21	13	15	1.33
1992/93	23	20	17	1.60
1997/98	25	31	20	2.04
2002/03	27	41	23	2.37
2007/08	28	43	24	2.39
2012/13	28	43	24	2.39

Table 5-1-3 shows that the number of vessels in demand exceeds the docking capacity of CDD in this case.

Then the following improvement plans (Plan "A" and Plan "B") are considered to meet the docking demand and increase work volume of CDD. In planning, the reduction of the docking period per repair vessels and diversification of repair work is considered. To achieve this objective, the improvement of engineering technic, worker's skill and provision of proper additional facility is indispensable.

(1) Plan "A"

1) Basic concept

Ship repair business both for seagoing vessels and for other small vessels shall be carried out at the existing dry dock with technical assistance from technically advanced country and provision of additional facility.

2) Training programme

a) Training at overseas shipyard

Engineers, economist and/or staff of CDD shall be dispatched to technically advanced country. (48 man-months)

b) Technical assistance from technically advanced country

Engineers/experts shall be dispatched to CDD.
(54 man-months)

3) Additional facility

In addition to the existing facility, such machinery, equipment and attachments as given in Table 5-1-14 are planned.

4) Estimated future growth rate

At present, due to the insufficiency of overall ship repair technology, know-how and proper machinery, shipowners have a tendency to hesitate placing repairing orders with CDD for complicated work.
This situation makes it difficult for CDD to obtain enough work volume resulting in less sales compared with the scale of its facility.

With the execution of Plan "A", it is expected that CDD can get more repair work such as overhauling of main engine, auxiliary machinery, various steel work, etc.
The prospective repair work is shown in Table 5-1-19.

Table 5-1-14 List of Additional Facility and Its Necessity

Item	Unit	Purpose/Necessity	Expected Effect
Dry dock and workshop			
Air compressor and piping around dock and workshop	1	Increase use of air tools for ship repair and other steel work	Shortening work period & improvement in quality
Oxygen and accetylene manifold and piping	1	Easy preparation for work & reduction of bottle handling job	Shortening work period & easy bottle control
Drinking water piping	1	Supply of satisfying quality & quantity to docked vessels	Increase service item to customers
Workshop			
Static balancing machine for propeller max. 4.5m dia.	1	Adjustment after repair of propeller for seagoing vessels	Increase job opportunity Improvement in quality
Electrical equipment maintenance equipment	1	General overhaul & repair jobs for docked vessels and workshop facility	Increase job opportunity Shortening work period & improvement in quality
Testing equipment for heavy cargo gear	1	Testing after repair for inspection	Increase job opportunity
Lathe machine Center distance 9m Supporting capacity 15 ton	1	Repair of heavy work such as tail shaft, rollers etc.	Increase job opportunity both for repair of vessels and allied work
Lathe machine Center distance 2.5m	2	To fill gap of existing machining	Equalizing of work load Increase job opportunity
Planer stroke 4m, 1.4m W	1	Repair/machining of repair parts such as machine bed, liner, etc.	Increase job opportunity both for ship repair & allied work
Surface grinder stroke 1m, 0.6m W	1	Repair/machining of repair parts such as machine bed, liner, etc.	Increase job opportunity both for ship repair & allied work
Attachment for boring & milling machine	1	Increase capability for various work	Increase job opportunity both for ship repair & allied work

Item	Unit	Purpose/Necessity	Expected Effect
Dynamic balancing machine		Testing of rotor of turbo-charger and basket for centrifugal machine	Increase job oppotunity both for repair vessel & allied work
Wood turning lathe	1	Various wood work such as pattern of casting, etc.	Shortening work period & improvement in quality
Wood planer	1	Various wood work such as pattern of casting, etc.	Shortening work period & improvement in quality
Steam cleaner	2	Cleaning of over-hauled engine parts	Shortening work period & improvement in quality
Paint shop			
Sand blasting equipment	6	Surface prepararion of ship's hull and allied work	Shortening work period & improvement in quality
High pressure water pump	2	Cleaning of ship's hull	Shortening work period & improvement in quality
Foundry			
Casting equipment for ferrous and non-ferrous metals	1	Casting of various parts such as cooler cover, bush, etc.	Increase job opportunity both for repair vessel & allied work
Remetaling equipment	1	Repair of bearings for vessels, etc.	Increase job opportunity
Tools	1	To apply proper tools and safety protectors for various work	Shortening work period & improvement in quality To keep safety work
Hand tools Mechanic Electrician Fitter Carpenter Plumber			
Cutting tool Measuring tools Lifting tools Pneumatic tools Electrical tools Gas cutting tools Welding tools Protectors Scaffoldings			

It is also expected that the technical assistance and additional facility improve CDD's docking capacity year by year till average docking days becomes about one week which is 80% of a advanced country's docking days (5 - 6 days) and considered to be maximum in Bangladesh.

The estimated future growth rate of productivity and work volume are shown in Table 5-1-15. The rate of productivity is estimated at 3% per year from 1987 to 1992, 6% in 1993 and 12% in 1994, and afterwards, the rate is estimated to decrease gradually. Likewise, the rate of increase rate of work volume is estimated at 2% per year from 1987 to 1992, 3% in 1993, 4% in 1994, 5% in 1995 and 6% up to 2002, and afterwards, the rate is estimated to decrease by 1% year by year.

Table 5-1-15 Future Growth Rate of Plan "A"

Year	Productivity	Work Volume
1987/88	1.00	1.00
1989/90	1.06	1.04
1992/93	1.16	1.10
1993/94	1.23	1.14
1997/98	1.67	1.40
2002/03	1.95	1.87
2007/08	2.05	2.16
2012/13	2.05	2.16

5) Estimated docking capacity

Based on the current capacity and future growth prediction of productivity, the future docking capacity can be estimated as shown in Table 5-1-16

Table 5-1-16 Estimated Docking Capacity of Plan "A"

Year	Seagoing Vessels		Small Vessels	
	Number	Days/docking	Number	Days/docking
1987/88	20	15.2	29	10.4
1989/90	21	14.4	30	10.1
1992/93	23	13.2	33	9.2
1993/94	24	12.6	35	8.7
1997/98	33	9.2	48	6.3
2002/03	39	7.8	56	5.4
2007/08	41	7.4	59	5.1
2012/13	41	7.4	59	5.1

Consequently, the future docking capacity of CDD to docking demand is summarized in Table 5-1-17, and Fig 5-1-1.

Table 5-1-17 Supply and Demand Forecast of Docking

1. Lifting Share 30%

Year	Docking Demand Seagoing	Small		Total (D)	Docking Capacity (C)	D/C
1989/90	13	15	(47)	28	21	1.33
1992/93	19	17	(53)	36	23	1.56
1993/94	20	18	(54)	38	24	1.58
1997/98	28	20	(61)	48	33	1.45
2002/03	36	23	(69)	59	39	1.51
2007/08	38	24	(73)	62	41	1.51
2012/13	38	24	(73)	62	41	1.51

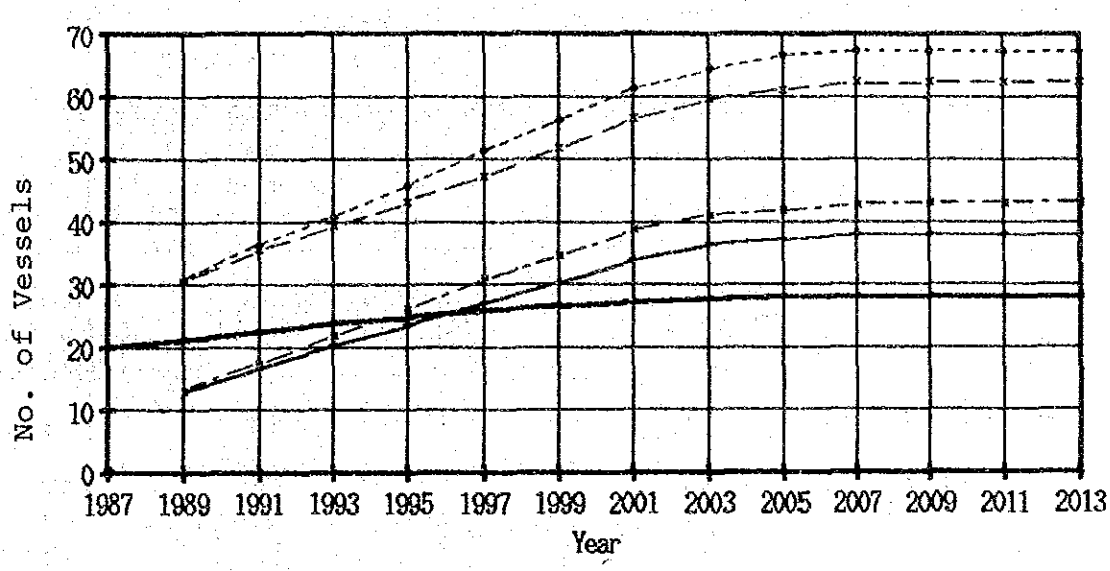
2. Lifting Share 40%

Year	Docking Demand Seagoing	Small		Total (D)	Docking Capacity (C)	D/C
1989/90	13	15	(47)	28	21	1.33
1992/93	20	17	(53)	37	23	1.60
1993/94	21	18	(54)	39	24	1.62
1997/98	31	20	(61)	51	33	1.54
2002/03	41	23	(69)	64	39	1.64
2007/08	43	24	(73)	67	41	1.63
2012/13	43	24	(73)	67	41	1.63

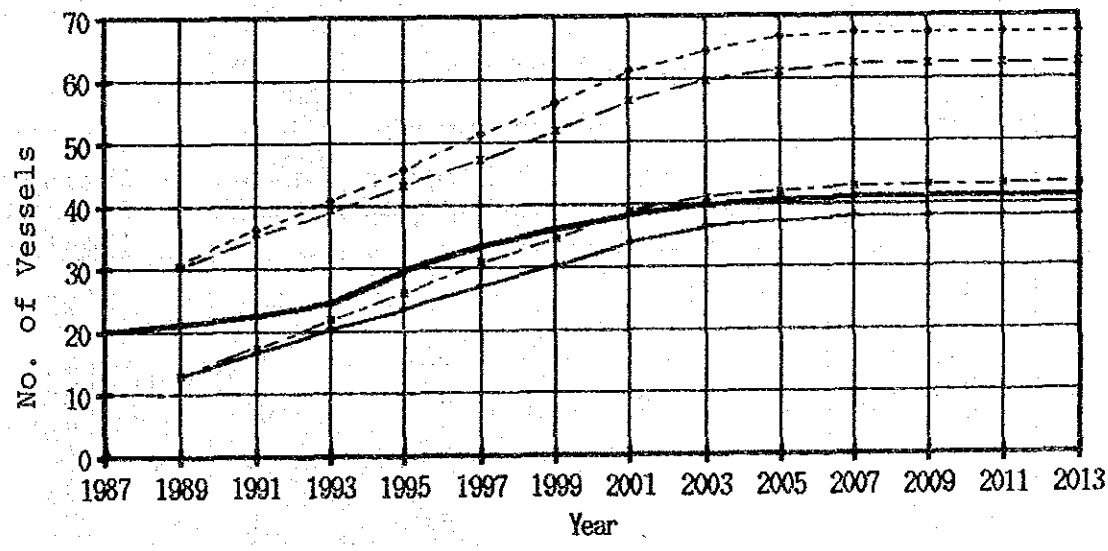
In the above table, docking demand of small vessels is given in the figure of number of dockings.

Figures in bracket show the number of vessels.

1. Without Project



2. Plan "A"



——— Docking capacity of CDD
——— Docking demand (Seagoing vessels, L.S. 30%)
– – – – Docking demand (Seagoing vessels, L.S. 40%)
– – – Docking demand (Seagoing & small vessels, L.S. 30%)
----- Docking demand (Seagoing & small vessels, L.S. 40%)

Fig. 5-1-1 Docking Demand and Supply Capacity

6) Prospective number of docked vessels

According to the aforementioned docking capacity to docking demand, the expected number of docked vessels is summarized as shown in Table 5-1-18.

Table 5-1-18 Prospective Number of Docked Vessels

1. Lifting Share 30%

Year	Docking Capacity	Vessels Docked Seagoing	Small	Demand Surplus (Small)
1989/90	21	13	24	23
1992/93	23	19	12	41
1993/94	24	20	12	42
1997/98	33	28	15	46
2002/03	39	36	9	60
2007/08	41	38	9	64
2012/13	41	38	9	64

2. Lifting Share 40%

Year	Docking Capacity	Vessels Docked Seagoing	Small	Demand Surplus (Small)
1989/90	21	13	24	23
1992/93	23	20	9	44
1993/94	24	21	9	45
1997/98	33	31	6	55
2002/03	39	39	0	69
2007/08	41	41	0	73
2012/13	41	41	0	73

In the above table, small vessels are given in the figure of number of vessels.

Table 5-1-19 Prospective Repair Work Items

1) Current Situation
Hull cleaning and painting Tank cleaning Plate renewal Tail shaft survey and minor repair Valve work Rudder survey and repair Anchor cable survey Lignum-vitae renewal Propeller survey and minor repair Other minor repair
2) Increase by self-improvement
In addition to the current work capability, - Steel repair work such as; Pipings and valves Deck fittings Hatch covers Superstructures - Overhaul and minor repair of; Pumps Deck machinery Cargo gears Electric motors Electric fittings - Other minor repair job
3) Plan "A"
Plan "A" In addition to the increase by self-improvement, - Overhaul and repair of; Main engines Turbochargers Generator engines Aux. machinery Coolers and heaters Aux. boilers Generators - Electrical equipment - Anchoring & mooring apparatus - Steering gears - Navigation equipment - Complicated repairing of shafting, rudders and propellers - Heavy plate renewal - Other repair and inspection work

7) Estimated repair price in future

Prospective average repair price per vessel is estimated as shown in Table 5-1-20, based on the current average repair price as given in Table 5-1-3 and the prospective growth rate of work volume as given in Table 5-1-15.

Table 5-1-20 Estimated Repair Price per Vessel

(Lac. taka)

Year	Seagoing Vessel	Small Vessel
1987	17.8	7.5
1989	18.5	7.8
1992	19.6	8.3
1997	24.9	10.5
2002	33.3	14.0
2007	38.4	16.2
2012	38.4	16.2

(2) Plan "B"

1) Basic concept

This plan is to construct a new docking facility for small sized ship repair, in addition to the implementation of Plan "A".

2) Training programme

a) Training at overseas shipyard
Same as Plan "A".

b) Technical assistance from technically advanced country
Same as Plan "A".

3) Additional facilities

In addition to the machinery and equipment stated in Plan "A", a docking facility for small vessels of maximum ship length 50m is provided.
In order to determine the optimum size and type of the docking facility, the following study is conducted.

Capacity of docking facility

The necessary docking capacity is studied with comparison between a docking demand and a docking capacity in two cases.

Case A : Provision of a docking facility of one vessel.
Case B : Provision of a docking facility of two vessels at the same time
In this case, the docking capacity is set at 70% of double capacity of Case A, considering waiting loss time, etc.

The comparison between supply and demand is shown in Table 5-1-21.

Table 5-1-21 Supply and Demand Forecast of Docking

Year	Docking Capacity Case A	Case B	Docking Demand *1 L.S. 30%	L.S. 40%
1989/90	-	-	23	23
1992/93	-	-	41	44
1993/94	17 *2	23	42	45
1997/98	48	65	46	55
2002/03	56	77	60	69
2007/08	59	81	64	73
2012/13	59	81	64	73

*1 Surplus demand of the dry dock in Table 5-1-18
*2 The new facility is assumed to be constructed in the middle of 1993/94.

Besides the docking demand, a tendency for docking of small vessels has to be taken into consideration in planning the docking capacity.

Since the fishing trawlers operated in the Bay of Bengal are usually in pairs with their sister ships during fishing, shipowners often dock their trawlers at a time.

Under these circumstances, it is recommendable that a new docking facility for small sized vessels should have the capacity of two vessels docking at the same time.

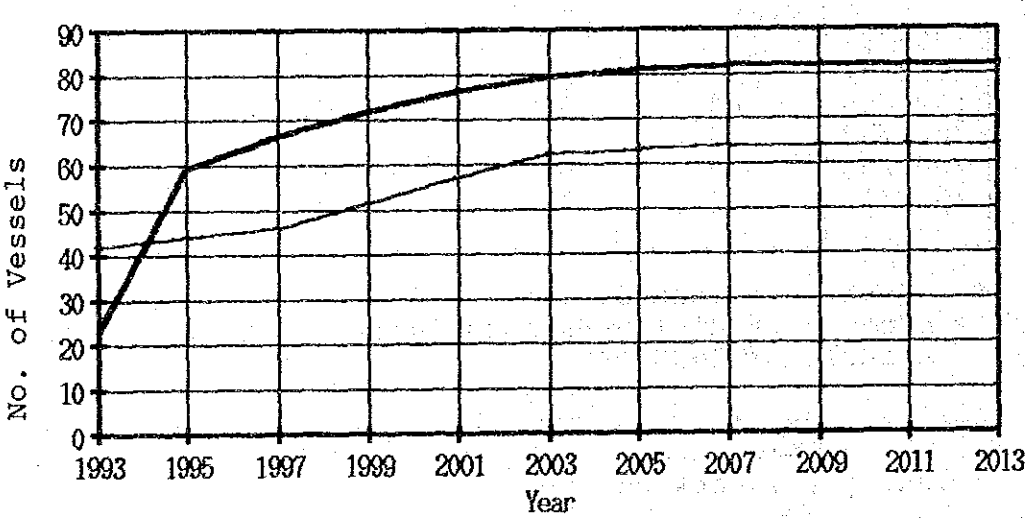
4) Prospective number of docked vessels on a new facility

When a new docking facility is provided, the expected number of docked vessels on it is estimated as shown in Table 5-1-22, and correlation between docking demand and supply capacity is shown in Fig. 5-1-2.

The expected number of docked vessels in the dry dock and the docking capacity are the same as Plan "A", given in Table 5-1-18.

Table 5-1-22 Prospective Docking Vessels in Future on a New Docking Facility

Year	Lifting Share 30%	Lifting Share 40%
1989/90	-	-
1992/93	-	-
1993/94	23	23
1997/98	46	55
2002/03	60	69
2007/08	64	73
2012/13	64	73



Docking Capacity of New Docking Facility

Docking Demand (Remainder of the dry dock, L.S. 30%)

Fig. 5-1-2 Docking Demand and Supply, Plan "B" (On a New Docking Facility)

5) Estimated repair price in future

Estimated average repair price per vessel is the same as Plan "A", given in Table 5-1-20.

5-2 STEEL STRUCTURAL ENGINEERING

5-2-1 Planning Condition

The present condition of Steel Structural Engineering at CDD is as follows:

(1) Outline of Existing Facilities

1) Area of shop

Fabrication shop :	60 m x 18 m x 2 shops	2,160 m2
Fabrication area : (outdoor)	35 m x 40 m	1,400 m2
Steel stockyard :	40 m x 40 m	1,600 m2
Total :		5,160 m2

2) Main facilities

Access door :	3 m B x 3.5 m H	4 doors
Electric power box :		7 boxes

Distribution unit and pipes for compressed air, acetylene gas and oxygen gas are not installed.

3) Operational equipment

O.T.C. :	3.2 tons	2 sets
O.T.C. :	3.2 tons	1 set
O.T.C. :	12.5 tons	1 set
Plate bending roller :	t= 20 mm, w = 3,050 mm	1 set
Hydraulic press :	500 tons	1 set
Hydraulic press :	400 tons	1 set
Horizontal band saw :	Max. dia. 250 mm	1 set
Frame bender :	250tons(Horizontal press)	1 set
Shearing machine :	t=10 mm, w= 2,600 mm	1 set
Pipe bending machine :	Max. 50 A	1 set

Small scale auto gas cutting machines, arc welders, etc.

4) Number of staff & workers and Working hours

Supervisor (Staff) :	5 persons
Workers(Plater, Welder) :	52 persons
Total :	57 persons

Estimated working hours per capita(Based on actual results of 1987 & 1988): about 2,480 hours/year

(Attendance ratio: 90%, Working day: 303 days/year, overtime: about 2 hours/day)

Estimated total working hours per year: 129,000 hours
(52 x 2,480)

(2) Record of Production

Ship repair has been the main sale of this yard and steel structures such as bridges, cranes, heat exchangers, chassis, etc. have also been fabricated since the yard started operating in May, 1981.

The production record of main steel structures on a commercial basis from July, 1985 to April, 1989 is shown in Table 5-2-1.

Table 5-2-1 Production Record of Main Steel Structures (From July, 1985 to April, 1989)

Description	Q'ty	Weight (ton)	Sales amount (Tk)	Price (Tk/ton)	Labour (Hr/ton)
Fabrication of portable bridge	9	195.12	92,12,519	47,215	453
Fabrication of pontoon, platform & tank	5	205.71	102,93,208	50,037	312
Fabrication of lighting & rappel tower	3	55.04	42,47,018	77,162	494
Fabrication of rack & ladder	3	193.08	48,24,239	34,687	243
Fabrication of pipe	2	104.00	18,16,282	17,464	185
Fabrication of zinc pot, casing, roller, etc.	10	24.79	40,64,369	163,952	1,073
Total/Average	32	777.74	343,34,824	44,174	351

Source: CDD

(3) Trend of Sales Record

The sales amount of steel structures has been moderately increasing since the start of the operation.
Especially in 1986 and 1987, the sales of steel structures remarkably increased.
It became 80% of Allied product sales and about 20% of the total sales of CDD.
The past 5 year sales of steel structures and its proportion to total sales of CDD is shown in Table 5-2-2.

Table 5-2-2 Sales Record for 5 Years (80 % of Allied Product Sales)

(Unit: Lac. taka)

Year	1983/84	1984/85	1985/86	1986/87	1987/88
Sales(A)	1.4	25.3	43.1	127.9	127.8
(A)/ Total Sales	4 %	6 %	9 %	22 %	18 %

Source: CDD

(4) Analysis of Present Condition

1) Production and sales

- Average annual sales for latest 2 years;

(127.9 + 127.8) / 2 = 127.85 Lac. taka

- Average annual production for latest 2 years;

127,85,000 Tk/44,174 Tk/ton = 290 tons

2) Rough estimation of production capacity

Average annual production for latest 2 years is about 290 tons.
Accordingly, fabrication capacity per square meter in present fabrication shop (2,160 m2) can be estimated as follows:

290 tons/2,160 m2 = 0.13 tons/m2

(5) Estimation of Working Hours for Manufacturing

The total annual working hours for 52 workers of the steel structure fabrication shop is estimated to be 129,000 hours as mentioned above.

Assuming that the average share of working hours for ship repair work is 25%, the total working hours for steel structure is estimated to be 96,750 hours(129,000 x 0.75).
Accordingly, the average working hours per ton for steel structure is estimated as follows:

96,750 hours/290 tons = 333 hours/ton

5-2-2 Expected Future Work

In planning for improvement of CDD's steel structural engineering, the kind and the volume of CDD's expected work are considered as follows:

(1) Increase of Present Products

The present products are diverse products such as pontoons, tanks, towers, racks & ladders, etc.
They are ordered as peripheral equipment or parts of their facilities for maintenance or repairing by municipal corporations and private companies located in the Chittagong area.
And so, the order used to be inconstant and small in number.
However, as these demand will be stable and augmented, every effort has to be made to meet these demands.

(2) Products for Various Project of National Development

Based on the study results as mentioned in Chapter 4, Section 3 "Steel Structure", the following are expected for CDD as future demands of steel structural projects.

1) Electricity transmission tower and telescopic pole

During the period of Fourth Five Year Plan(1990-1995), the following scale of products are planned by BPDB.

Total procurement volume:	44,000 tons
Average annual demand foecast:	8,800 tons

Large sized towers have been manufactured by overseas makers, on the other hand, rather small sized towers and poles have been manufactured by several domestic makers.
As mentioned above, there will be a strong demand for these products which CDD can participate in manufacturing as a main contractor or as a subcontractor, whichever it may be.

2) Bridge

According to the national development plan of Bangladesh, bridges of a total length of 2,000 m for national roads and of 3,000 m for regional roads are to be constructed.

The total weight of these bridges is estimated to be about 4,400 tons.

National roads	2,000 m x 1.0 ton/m =	2,000 tons
Regional roads	3,000 m x 0.8 ton/m =	2,400 tons
	Total	4,400 tons

The steps for CDD to participate in the bridge market as a promising maker are considered as follows:

i) As bridges for national roads are large and heavy, overseas makers shall get an order as a main contractor.

CDD should make efforts to upgrade technical potential and to receive orders of steel structures from overseas contractors as a local leading subcontractor to increase production volume.

ii) On the other hand, the size of bridges for regional roads are rather small, even domestic makers can manufacture most of them.
In this case, CDD shall become one of the strong makers as a main contractor.

CDD can get top shares in the market of manufacuturing bridges, because CDD has no strong competitor in Bangladesh.

3) Chemical plant

The demand of steel structures for chemical plants is estimated to be 1,200 tons per year.
These component parts of chemical plants consist of such heavy steel structures as steel buildings, crane girders, etc.

CDD is the best equipped manufacturer of steel structures in Bangladesh.

CDD stands in a promising position to become a local leading subcontractor of manufacturing steel structures for overseas contractor.

(3) Other Products

Other products which CDD can manufacture are expected to be as follows:

1) Baskets for centrifugal machines

As CDD has no balancing machine, they can not manufacture the basket of a sugar mill plant.
Upon CDD's investigation, future demand of the product is estimated as follows:

4-5 baskets/year for 1 mill x 15-16 mills = 60 pcs/year

Price per basket is estimated at about 1.5-2.0 Lac. taka.

2) Well pipes for irrigation

CDD can manufacture pipes for pumping up irrigation water by using small bending roller machine.

3) Chassis for automobile

CDD has been manufacturing them, and they shall receive an order together with DEW of BSEC as before.

(4) Suggestion to Manufacture Railway Wagons and Marine Cargo Containers

According to the information got in the Study, the suggestion for production of railway wagons and marine cargo containers is made as follows:

1) Manufacture of railway wagons

The feasibility study, called "Establishment of Railway Carriage and Wagon Manufacturing Plant", was carried out by JICA in 1985, in accordance with the request of the Government of Bangladesh.

According to the report, the project is planned as follows:

- Project site : Near Parbatipur
- Project : Construction of railway carriage and wagon manufacturing plant complex

- Production capacity: 120 Nos. of passenger wagons per year
  900 Nos. of good wagons per year

Considering the project is under planning by the Bangladesh Railway, manufacturing of railway wagon in CDD should be planned carefully, watching the progress of the said project.

2) Manufacturing of marine cargo containers

The growth of Bangladesh container traffic is remarkable as seen in Chapter 4, Table 4-1-11.
Accordingly, the demand of marine cargo containers is expected. At present, there is no manufacturer of marine cargo containers in Bangladesh.

In considering these circumstances, it appears that there is a chance of manufacturing marine cargo containers for CDD.

When the introduction of the manufacturing of this product is planned, however, it should be done very carefully.
Because, in the process of production, dimensional accuracy, structural strength, durability, etc. of the product, very severe conformity with international standards, for example International Organization for Standardization(ISO), are required.

Therefore, those manufacturers who are engaging in this field are required to be equipped with suitable facilities for manufacturing, such as prevention jigs using compressed air cylinders against distortion, welding machines for thin plates, surface treatment and painting, as well as production technique and skill.

As for raw materials, some kinds of steel materials for roof sheets, side sheets, corner posts, etc. are available locally, while door fittings and wooden floor plates have to be imported.

Manufacturers of containers in Japan usually have their specialized production line in their workshops, and a mass production system is introduced for their economical production.

Considering the above, when CDD would try to embark in this field, it should be noted that:

- it costs a considerable investment amount to establish container production lines which enable CDD to keep required product accuracy and to realize competitive production, and

- it is necessary for CDD to establish a material procurement system, so as to obtain parts and fittings of good quality, for a cheaper price and on time.

5-2-3 Future Plan for Improvement

The purpose of this improvement plan is to review the existing facilities and equipment of CDD, and then, to expand the production volume of steel structure based on Chapter 5, Section 5-2-2 "Expected Future Work".

To optimize capacity utilization and to improve the performance of CDD, it is important to recognize future targets and goals.

The future plan shall enable CDD to upgrade productivity and to expand production capacity.

To materialize these purposes, the investigation of CDD's present condition i.e. existing facilities and equipment of steel structural shops was carried out, and the result of the investigation was analyzed. Then the alternative improvement plans i.e. plan "a", plan "b" and plan "c" regarding facilities, equipment, production and management are proposed as shown in Fig 5-2-1.

Considering the basic concept and facility plans, the improvement of productivity and its final goal of each plan are estimated to be as shown in Fig. 5-2-2. Productivity(tons/m2) of plan "b" and "c" is aiming at 0.4 tons/m2 in 2012/13 which is about a half of a highly advanced country's productivity.

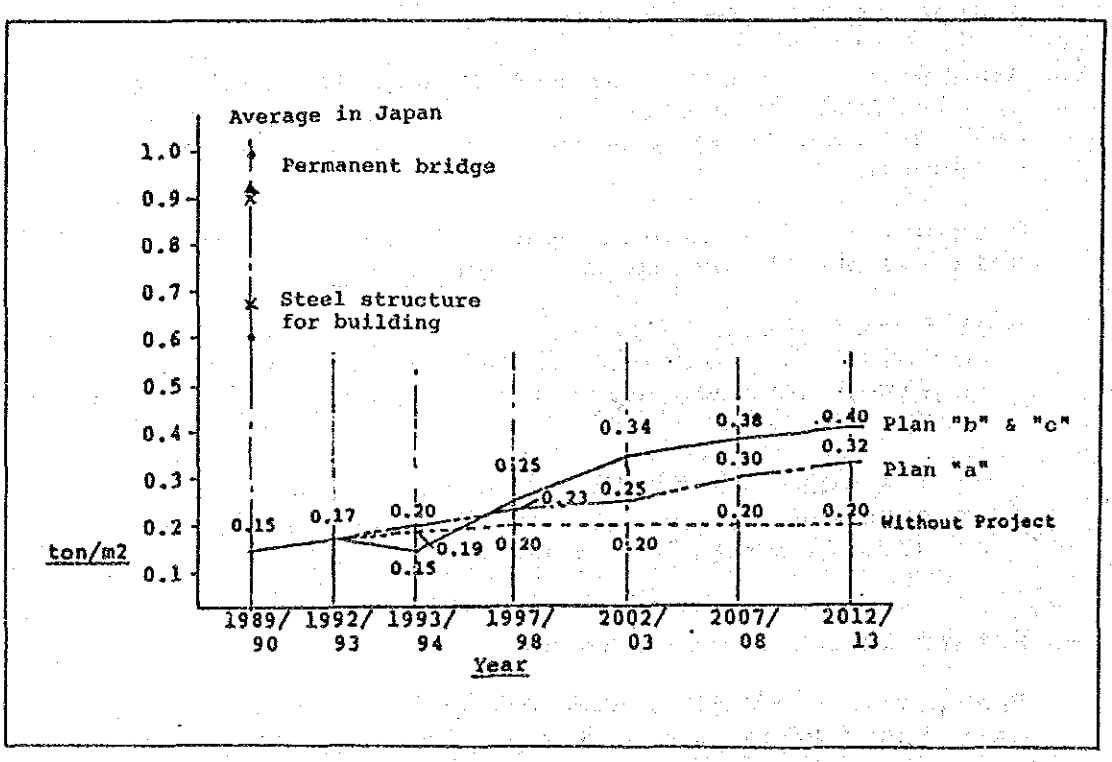


Fig. 5-2-2 Expected Improvement of Productivity

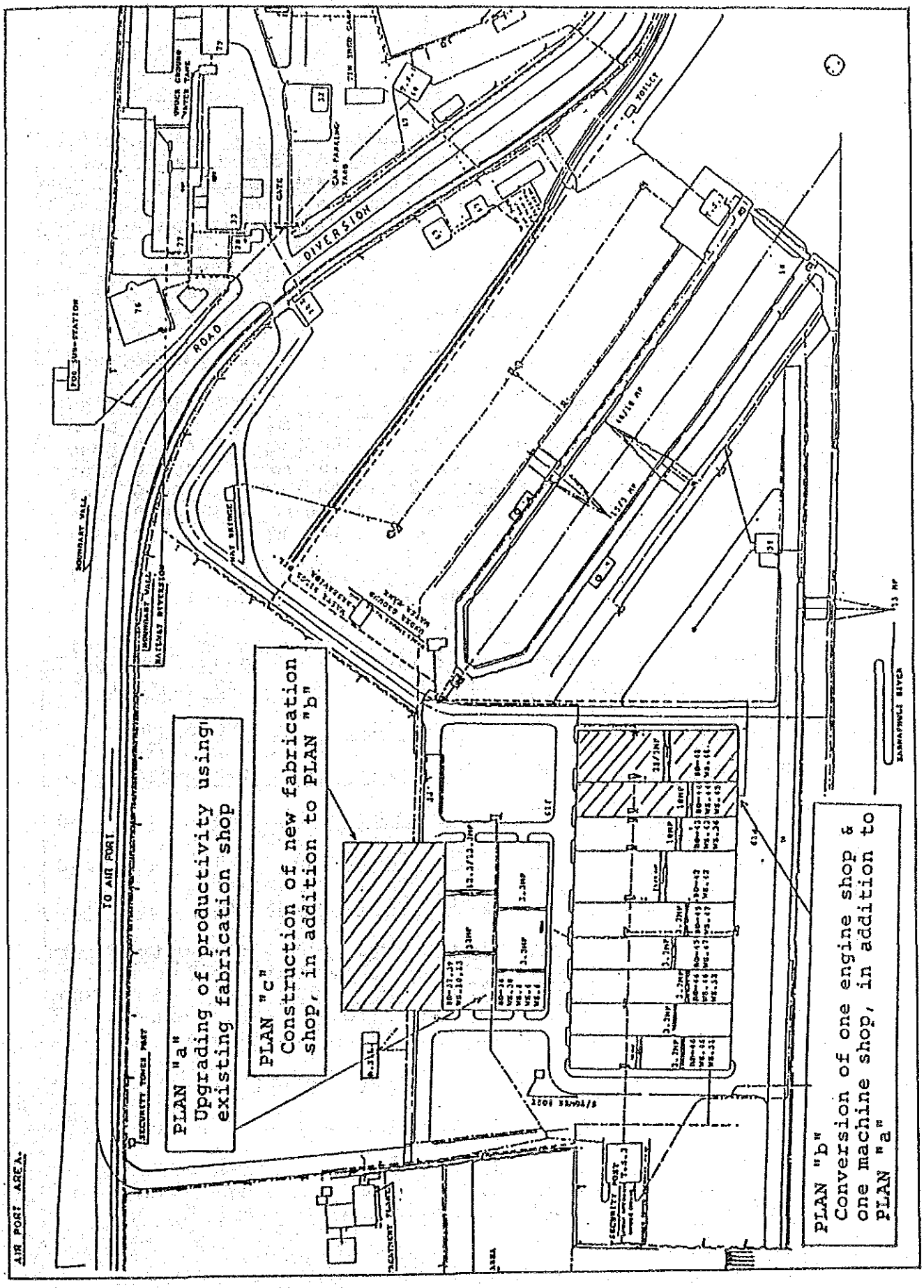


Fig. 5-2-1 Proposed Idea Plan on Steel Structure Fabrication Shop

(1) Plan "a"

1) Basic concept

Plan "a" is the proposition that increase of production volume and productivity shall be performed by effective utilization of the existing fabrication shop and facilities with minimum investment and by receiving engineers despatched from a technically advanced country.

2) Production volume

- Improvement of productivity

Year	Target	Production volume
1989:	0.15 ton/m2	0.15 t/m2 x 2,160 m2 = 324.0 tons
1992:	0.17 ton/m2	0.17 t/m2 x 2,160 m2 = 367.2 tons
1993:	0.20 ton/m2	0.20 t/m2 x 2,160 m2 = 432.0 tons
1997:	0.23 ton/m2	0.23 t/m2 x 2,160 m2 = 496.8 tons
2002:	0.25 ton/m2	0.25 t/m2 x 2,160 m2 = 540.0 tons
2007:	0.30 ton/m2	0.30 t/m2 x 2,160 m2 = 648.0 tons
2012:	0.32 ton/m2	0.32 t/m2 x 2,160 m2 = 691.2 tons

Table 5-2-3 Production Volume of Steel Products, Plan "a"

(Ton)

Year / Products	1989/ 90	1992/ 93	1993/ 94	1997/ 98	2002/ 03	2007/ 08	2012/ 13
Electricity transmission towers	0	0	0	0	0	0	0
Portable bridges	60	50	110	150	170	220	250
Chemical plants	0	0	0	0	20	40	50
Steel Racks and Ladders	80	100	100	110	120	140	150
Pontoons, Platforms and Tanks	100	120	120	140	140	150	150
Other	80	100	100	100	100	100	100
Total	320	370	430	500	550	650	700

3) Sales

Table 5-2-4 Sales of Steel Products, Plan "a"

(Lac. taka)

Year / Products & Price	1989/ 90	1992/ 93	1993/ 94	1997/ 98	2002/ 03	2007/ 08	2012/ 13
Portable Bridges(@47,000 Tk)	28.2	23.5	51.7	70.5	79.9	103.4	117.5
Chemical plants(@40,000 Tk)	0	0	0	0	8.0	16.0	20.0
Steel Racks and Ladders(@35,000 Tk)	28.0	35.0	35.0	38.5	42.0	49.0	52.5
Pontoons & platforms (@50,000 Tk)	50.0	60.0	65.0	70.0	75.0	75.0	75.0
Other (@43,000 Tk)	34.4	43.0	43.0	43.0	43.0	43.0	43.0
Total	140.6	161.5	189.7	222.0	242.9	286.4	308.0

(The price of each product is based on the price shown in Table 5-2-1.)

4) Facilty plan "a"

Above all, products such as pipe piles for marine civil engineering, pen stocks for power plants, tanks, crane girders, etc. shall be manufactured by effecitve utilization of press machines and bending rollers.

Additional new machines and tools necessary for manufacturing the products mentioned above are as follows:

- Punching, shearing & angle cutting machine..... 1 set
  for fabrication of parts of bridge, tower, etc.
- Bending roller(6 t x 200 ¢ x 1.8 m) ..... 1 set
  for bending thin plates into pipes
- Semiautomatic gas cutting machines ..... 2 sets
  for rationalization of gas cutting
- Automatic welding machines ..... 2 sets
  for rationalization of welding
- Air tools, journal jacks, etc.

5) Technical training programme "a"

An engineer despatched from a technically advanced country shall carry out on the job training for upgrading the fabrication technique of steel structures for one year.

(2) Plan "b"

1) Basic concept

The future demand of steel structures shall be much greater than the present production capacity of CDD. Increase of their production capacity by expansion of the fabrication shop enables CDD to extend their share in the market.

Plan "b" is the proposition that as a result of the study of CDD's layout and effective utilization of the facilities, the conversion of one engine shop and one machine shop to two fabrication shops(total: 1,620 m2) enables CDD to expand the existing fabication area of steel structures into 3,780 m2 without disturbance of ship repair work.

The main target of Plan "b" is to receive the order of new products such as electricity transmission towers and portable bridges in addition to present products, in other words, which shall bring stable operation of fabrication shops and effective utilization of the existing facilities.

Supplement of necessary facilities for effective production of new products, measures for zinc plating jobs, technical training programmes for fostering of design technology are considered in Plan "b", in addition to the implementation of Plan "a".

2) Production volume

- Improvement of productivity

Year	Target		Production volume
1989:	0.15 ton/m2	0.15 t/m2 x 2,160 m2 =	324.0 tons
1992:	0.17 ton/m2	0.17 t/m2 x 2,160 m2 =	367.2 tons
1993:	0.15 ton/m2	0.15 t/m2 x 3,780 m2 =	567.0 tons
1997:	0.25 ton/m2	0.25 t/m2 x 3,780 m2 =	945.0 tons
2002:	0.34 ton/m2	0.34 t/m2 x 3,780 m2 =	1,300.0 tons
2007:	0.38 ton/m2	0.38 t/m2 x 3,780 m2 =	1,436.0 tons
2012:	0.40 ton/m2	0.40 t/m2 x 3,780 m2 =	1,520.0 tons

Table 5-2-5 Production Volume of Steel Products, Plan "b"

(Ton)

Year / Products	1989/ 90	1992/ 93	1993/ 94	1997/ 98	2002/ 03	2007/ 08	2012/ 13
Electricity transmission towers	0	0	80	250	400	470	500
Portable bridges	60	50	100	200	350	400	420
Chemical plants	0	0	30	80	100	140	150
Steel Racks and Ladders	80	100	110	130	150	150	150
Pontoons, Platforms and Tanks	100	120	130	140	150	150	150
Other	80	100	110	130	150	150	150
Total	320	370	560	930	1,300	1,460	1,520

3) Sales

Table 5-2-6 Sales of Steel Products, Plan "b"

(Lac. taka)

Year / Products & Price	1989/ 90	1992/ 93	1993/ 94	1997/ 98	2002/ 03	2007/ 08	2012/ 13
Electricity Towers(@80,000 Tk)	0	0	64.0	200.0	320.0	376.0	400.0
Portable Bridges(@47,000 Tk)	28.2	23.5	47.0	94.0	164.5	188.0	197.4
Chemical plants(@40,000 Tk)	0	0	12.0	32.0	40.0	56.0	60.0
Steel Racks and Ladders(@35,000 Tk)	28.0	35.0	38.5	45.5	52.5	52.5	52.5
Pontoons & platforms (@50,000 Tk)	50.0	60.0	65.0	70.0	75.0	75.0	75.0
Other(@43,000 Tk)	34.4	43.0	47.3	55.9	64.5	64.5	64.5
Total	140.6	161.5	273.8	497.4	716.5	812.0	849.4

(The unit price of electricity tower is estimated on the basis of the production cost.)

4) Facility plan "b"

To minimize additional investment for the conversion, only minimum modification shall be carried out. Faciltiy for increase of production volume and for manufacturing electricity transmission towers and bridges shall be introduced.

- Partition wall (4m H x 50 m L)
  for separating the converted shop and machine shop
- Electric distribution boxes and pipings
- Bending roller ... 1 set
- Punching, shearing & angle cutting machine ... 1 set
  for fabricating parts of electricity
  transmission towers and bridges
- Turning rollers ... 2 sets
  for automatic longitudinal and circular
  welding of pipe piles, penstocks, etc.
- Semiautomatic welding machines ... 2 sets
- Semiautomatic gas cutting machines ... 5 sets
- Semiautomatic parallel gas cutting machine ... 1 set
- Traversers ... 2 sets
- Radial hoist cranes ... 3 sets
- Air tools, journal jacks, measuring tools, etc.
- Mold lofting floor (about 300 m2) in the main store

5) Technical training programme "b"

Training at overseas yard	Year Trainee	1992 (Man-Month)	1993
Designing bridges, etc.		12	-
Designing steel towers, etc.		12	-
Drawing		12	-
Mold lofting		12	-
Marking, cutting, drilling, etc.		12	-
Assembling, welding		12	-
Quality Control		12	-
Technical assistance to CDD from overseas yards		1992 Trainer(Man-Month)	1993
Galvanizing engineer		-	6
Designing engineer		-	12
	Total	84	18

(3) Plan "c"

1) Basic concept

Considering the future great domestic demand for steel structures, the fabrication area in Plan "c" is not enough.
Plan "c" is the proposition that new fabrication shops shall be constructed next to and as large as the existing fabrication shop, in addition to the implementation of Plan "b".(Fabrication area becomes 5,940 m2 in total.)

2) Production volume of plan "c"

- Improvement of productivity

Year	Target	Production volume
1989:	0.15 ton/m2	0.15 t/m2 x 2,160 m2 = 324.0 tons
1992:	0.17 ton/m2	0.17 t/m2 x 2,160 m2 = 370.0 tons
1993:	0.15 ton/m2	0.15 t/m2 x 5,940 m2 = 891.0 tons
1997:	0.25 ton/m2	0.25 t/m2 x 5,940 m2 = 1,485.0 tons
2002:	0.34 ton/m2	0.34 t/m2 x 5,940 m2 = 2,019.6 tons
2007:	0.38 ton/m2	0.38 t/m2 x 5,940 m2 = 2,257.2 tons
2012:	0.40 ton/m2	0.40 t/m2 x 5,940 m2 = 2,376.0 tons

Table 5-2-7 Production Volume of Steel Structure, Plan "c"

(Ton)

Year / Products	1989/ 90	1992/ 93	1993/ 94	1997/ 98	2002/ 03	2007/ 08	2012/ 13
Electricity trans-mission towers	0	0	150	450	650	750	800
Portable bridges	60	50	290	400	600	650	700
Chemical plants	0	0	50	100	150	200	300
Steel Racks and Ladders	80	100	150	200	200	200	200
Pontoons, Platforms and Tanks	100	120	150	200	200	200	200
Other	80	100	110	150	200	200	200
Total	320	370	900	1,500	2,000	2,200	2,400

3) Sales

Table 5-2-8 Sales of Steel Products, Plan "c"

(Lac. taka)

Year Products & Price	1989/ 90	1992/ 93	1993/ 94	1997/ 98	2002/ 03	2007/ 08	2012/ 13
Electricity Towers(@80,000 Tk)	0	0	120.0	360.0	520.0	600.0	640.0
Portable Bridges(@47,000 Tk)	28.2	23.5	136.3	188.0	282.0	305.5	329.0
Chemical plants(@40,000 Tk)	0	0	20.0	40.0	60.0	80.0	120.0
Steel Rack and Ladders(@35,000 Tk)	28.0	35.0	52.5	70.0	70.0	70.0	70.0
Pontoons & platforms (@50,000 Tk)	50.0	60.0	75.0	100.0	100.0	100.0	100.0
Other(@43,000 Tk)	34.4	43.0	47.3	64.5	86.0	86.0	86.0
Total	140.6	161.5	451.1	822.5	1,118	1,242	1,345

4) Facility plan "c"

New facilities for new shops mainly consisting of material handling equipment, and present fabricating machines in addition to the facility mentioned in facility plan "b" are used in production.

- Construction of new shops (18 m x 60 m) ... 2 buildings
- O.T.C. (10 tons) ... 2 sets
- Piping for distribution of compressed air, acetylene gas and oxygen
- Electric power distribution box for welding machines ... 10 boxes

5) Technical training programme "c"

Technical training shall be carried out according to the same schedule as Plan "b".

(4) Without Project

"Without Project" means that any modifications and reinforcements are not carried out in CDD's facility and under their management.
The following data was prepared as basic data for camparison of feasibility to the above three plans.

1) Production volume

- Improvement of productivity

Year	Target		Production volume
1989:	0.15 ton/m2	0.15 t/m2 x 2,160 m2 =	324.0 tons
1992:	0.17 ton/m2	0.17 t/m2 x 2,160 m2 =	367.2 tons
1993:	0.19 ton/m2	0.19 t/m2 x 2,160 m2 =	410.4 tons
1997:	0.20 ton/m2	0.20 t/m2 x 2,160 m2 =	432.0 tons
2002:	0.20 ton/m2	0.20 t/m2 x 2,160 m2 =	432.0 tons
2007:	0.20 ton/m2	0.20 t/m2 x 2,160 m2 =	432.0 tons
2012:	0.20 ton/m2	0.20 t/m2 x 2,160 m2 =	432.0 tons

Table 5-2-9 Production Volume of Steel Products (Without Project)

(Ton)

Year / Products	1989/ 90	1992/ 93	1993/ 94	1997/ 98	2002/ 03	2007/ 08	2012/ 13
Electricity transmission towers	0	0	0	0	0	0	0
Bridges	60	100	120	150	150	150	150
Chemical plants	0	0	0	0	0	0	0
Steel racks and ladders	80	110	120	120	120	120	120
Pontoons, platforms and tanks	100	110	110	110	110	110	110
Other	80	50	50	50	50	50	50
Total	320	370	400	430	430	430	430

2) Sales

Table 5-2-10 Sales of Steel Products (Without Project)

(Lac. taka)

Year / Products & Price	1989/ 90	1992/ 93	1993/ 94	1997/ 98	2002/ 03	2007/ 08	2012/ 13
Portable bridges(@47,000 Tk)	28.2	47.0	56.4	70.5	70.5	70.5	70.5
Steel racks and ladders(@35,000 Tk)	28.0	38.5	42.0	42.0	42.0	42.0	42.0
Pontoons & platforms (@50,000 Tk)	50.0	55.0	55.0	55.0	55.0	55.0	55.0
Other(@43,000 Tk)	34.4	21.5	21.5	21.5	21.5	21.5	21.5
Total	140.6	162.0	174.9	189.0	189.0	189.0	189.0

6 SELECTION OF OPTIMUM PLAN

6 SELECTION OF OPTIMUM PLAN

6-1 OUTLINE OF OPTIMUM PLAN

6-1-1 Combination of Each Plan

The outline of the future plan proposed in Chapter 5 is summarized as follows: The estimated investment amount necessary for the implementation of each plan is shown on the following conditions: (1 Taka = 4.35 Yen, at 1989 price)

Plan	Outline	Investment Amount (Lac. taka)	
Ship repair Plan "A"	Effective utilization of existing dry dock by way of technical training and additional machinery and equipment	T/A Facility Total	391.2 925.2 1,316.4
Ship repair Plan "B"	Construction of new docking facility for small sized vessel repair (50 m class x 2 berths), in addition to the implementation of Plan "A"	T/A Facility Total	391.2 1,670.6 2,061.8
Steel Structure Plan "a"	Upgrading of productivity using existing fabrication shop by way of technical training and additional facility (Fab. shop area: 2,160 m2)	T/A Facility Total	64.4 68.8 133.2
Steel Structure Plan "b"	Conversion of one engine shop and one machine shop into a fabrication shop, in addition to the implementation of Plan "a" (Fab. shop area: 3,780 m2)	T/A Facility Total	235.4 159.1 394.5
Steel Structure Plan "c"	Construction of a new fabrication shop, in addition to the implementation of Plan "b" (Fab. shop area: 5,940 m2)	T/A Facility Total	235.4 594.1 829.5

In order to sound preliminary feasibility of each plan and to find an optimum plan for improving CDD, the following four cases are selected by combining each plan.

Steel Struct. / Ship Repair	Plan "a"	Plan "b"	Plan "c"
Plan "A"	Case "1"	Case "2"	
Plan "B"		Case "3"	Case "4"

6-1-2 Selection of an Optimum Plan

(1) Pre-checking of Feasibility

Several improvement plans should be examined as to their worthiness for implementation by financial analysis, so called pre-checking of feasibility.

The pre-checking of feasibility should be examined in accordance with the process as shown in Fig. 6-1-1.

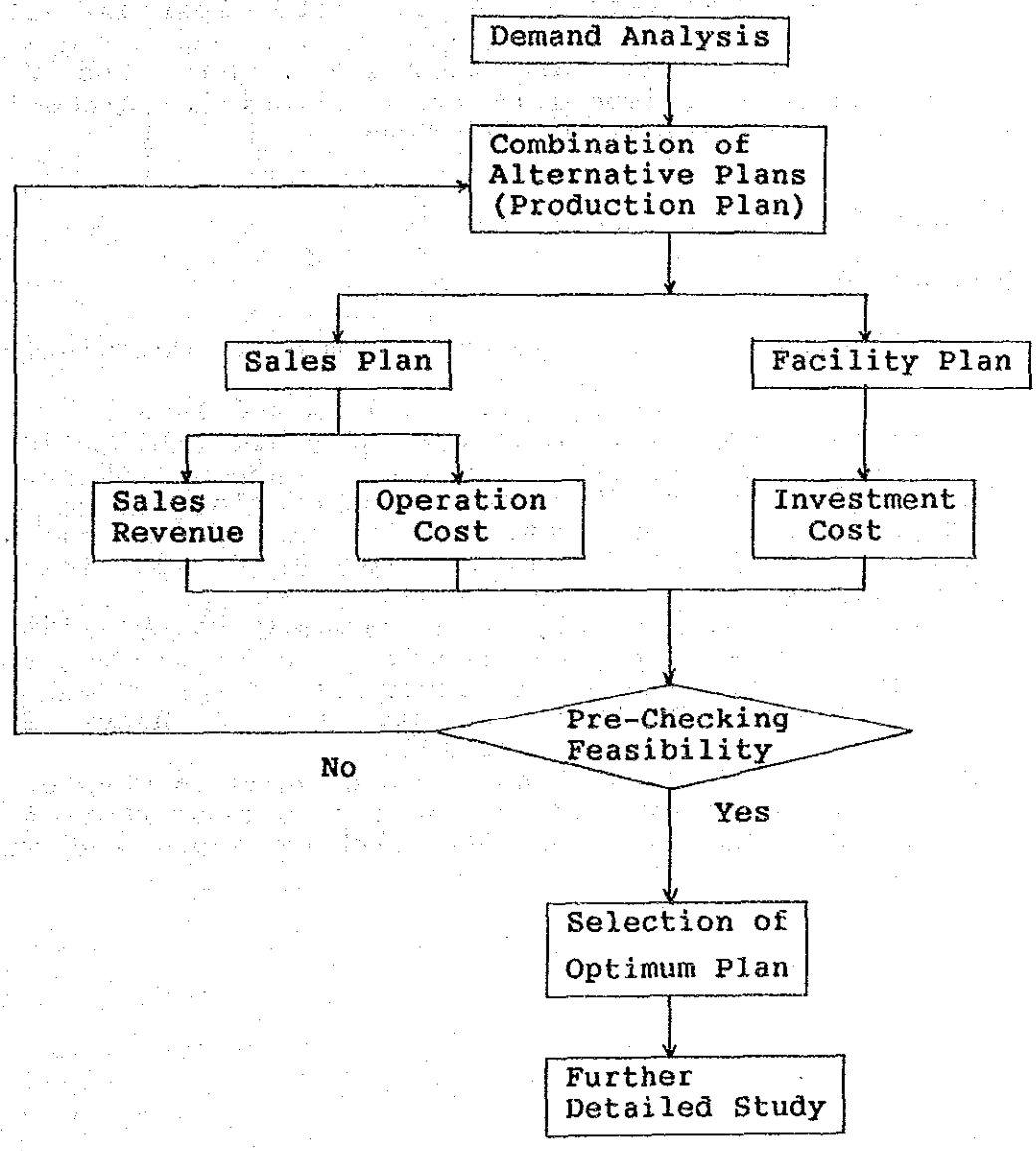


Fig. 6-1-1 Pre-Checking of Feasibility

Since the purpose of pre-checking is to select an optimum plan for further study in detail, the data applied for calculation is estimated at the preliminary level. This section will present the following indexes as the evaluation criteria.

- Financial internal rate of return (FIRR).

FIRR is compared with the interest rate of lending fund from banks and the government. Bangladesh industries procured their fund from banks by around 14% of nominal interest rate per year as on 1985 (BBS, Yearbook 1987). The 4% of real interest rate can be obtained by drawing 10% of the inflation rate from 14%. Thus, the 4% is considered as a minimum rate of profitability since this is the procurement cost of the fund.

(2) Financial Internal Rate of Return

1) Preconditions

The following preconditions are assumed for calculation.

- Period of construction ..... 1992 and 1993
- Operation period ..... 20 years (1993 - 2012)
- Currency exchange rate ..... One taka = 4.35 yen
- No residual value after completion of plan.
- Project revenue and cost to be considered are only expanded portions increased from Base Case (without Project) by implementing the plans.
- Gross operating profit are assumed to be 15% of operation cost for ship repairing and 10% for steel structure, following the study report of "BSEC, Revised Project Proforma on Dry Dock & Heavy Steel Structural Works, September 1982"
- Production and sales plans are presented in Chapter 5.
- Sales and cost by plan are presented from Table 6-1-2 to 6 for demand case of 30% lifting share and Table 6-1-7 to 11 for 40%.

2) Results

Financial profitability of each plan is calculated as follows in terms of FIRR.

Table 6-1-1 FIRR of Each Plan

(%)

		Lifting Share	Repairing	Steel	Total
Case	"1"	30	1.4	0.02	1.3
		40	0.9	0.02	0.8
	"2"	30	1.4	6.8	2.8
		40	0.9	6.8	2.4
	"3"	30	4.4	6.8	4.8
		40	5.1	6.8	5.4
	"4"	30	4.4	5.5	4.7
		40	4.1	5.5	5.2

Source: Study Plan

FIRR for both case "3" and "4" exceed the currently prevailing market interest rate of 4%, and case "3" is found to be obtained the highest FIRR.

Case "3" with 30% case of lifting share shall be selected to study further since it obtained the highest FIRR and the difference in FIRR between 30% and 40% could not appreciate much. Cash flow statements for each case are presented from Table 6-1-2 to 11.

Table 6-1-2 Base Case (Without Project,30%)

(1,000 Taka)

Year	Investment Cost		Production			Sales		Cost	
	Repairing	Steel	Large	Small	Steel	Repairing	Steel	Repairing	Steel
			(1000 DWT)	(1000 DWT)	(1000 TON)				
1990									
1991									
1992									
1993			20.0	9.0	400	47,693	17,490	41,472	15,900
1994			23.0	4.0	407	50,473	17,832	43,890	16,211
1995			24.0	2.0	415	51,811	18,181	45,053	16,528
1996			25.0	1.0	422	54,078	18,537	47,024	16,852
1997			25.0	0.0	430	54,245	18,900	47,170	17,182
1998			26.0	0.0	430	57,543	18,900	50,037	17,182
1999			26.0	0.0	430	58,694	18,900	51,038	17,182
2000			26.0	0.0	430	59,868	18,900	52,059	17,182
2001			27.0	0.0	430	63,414	18,900	55,143	17,182
2002			27.0	0.0	430	64,682	18,900	56,245	17,182
2003			27.0	0.0	430	65,976	18,900	57,370	17,182
2004			27.0	0.0	430	67,296	18,900	58,518	17,182
2005			28.0	0.0	430	70,486	18,900	61,292	17,182
2006			28.0	0.0	430	71,191	18,900	61,905	17,182
2007			28.0	0.0	430	71,903	18,900	62,524	17,182
2008			28.0	0.0	430	71,903	18,900	62,524	17,182
2009			28.0	0.0	430	71,903	18,900	62,524	17,182
2010			28.0	0.0	430	71,903	18,900	62,524	17,182
2011			28.0	0.0	430	71,903	18,900	62,524	17,182
2012			28.0	0.0	430	71,903	18,900	62,524	17,182
Total	0	0	527.0	16.0	8524	1,268,868	374,441	1,103,383	340,401

Source:Study Team

	Total	Repairing	Steel
FIRR =	1.5%	1.4%	0.02%

Table 6-1-3 Case 1 30%

(1,000 Taka)

Year	Investment Cost		Production			Sales		Cost	
	Repairing	Steel	Large	Small	Steel	Repairing	Steel	Repairing	Steel
			(1000 DWT)	(1000 DWT)	(1000 TON)				
1990									
1991									
1992	102,620	6,880							
1993	29,020	6,446	20.0	13.0	430	51,179	18,970	44,503	17,245
1994			21.0	19.0	447	68,212	19,731	59,315	17,937
1995			23.0	20.0	464	68,015	20,522	59,143	18,656
1996			25.0	19.0	481	75,124	21,344	65,325	19,404
1997			27.0	20.0	500	85,458	22,209	74,311	20,182
1998			28.0	20.0	510	93,119	22,603	80,973	20,548
1999			30.0	18.0	519	101,725	23,014	88,457	20,921
2000			32.0	16.0	529	109,782	23,431	95,463	21,301
2001			34.0	13.0	540	119,761	23,857	104,140	21,688
2002			36.0	9.0	550	127,742	24,290	111,080	22,082
2003			36.0	11.0	569	138,221	25,104	120,192	22,821
2004			36.0	12.0	588	146,500	25,945	127,391	23,586
2005			37.0	11.0	608	154,303	26,814	134,177	24,376
2006			37.0	11.0	629	158,759	27,712	138,051	25,192
2007			38.0	9.0	650	162,401	28,640	141,218	26,036
2008			38.0	9.0	660	162,401	29,060	141,218	26,418
2009			38.0	9.0	670	162,401	29,485	141,218	26,805
2010			38.0	9.0	680	162,401	29,917	141,218	27,197
2011			38.0	9.0	690	162,401	30,355	141,218	27,596
2012			38.0	9.0	700	162,401	30,800	141,218	28,000
Total	131,640	13,326	650.0	265.0	11412	2,472,306	503,792	2,149,831	457,993

Source:Study Team

Table 6-1-4 Case 2 30%

	Total	Repairing	Steel
FIRR =	2.8%	1.4%	6.8%

(1,000 Taka)

Year	Investment Cost		Production			Sales		Cost	
	Repairing	Steel	Large	Small	Steel	Repairing	Steel	Repairing	Steel
			(1000 DWT)	(1000 DWT)	(1000 TON)				
1990									
1991									
1992	102,620	33,010							
1993	29,020	6,440	20.0	13.0	560	51,179	27,380	44,503	24,891
1994			21.0	19.0	636	68,212	31,787	59,315	28,897
1995			23.0	20.0	722	68,015	36,904	59,143	33,549
1996			25.0	19.0	819	75,124	42,844	65,325	38,949
1997			27.0	20.0	930	85,458	49,740	74,311	45,218
1998			28.0	20.0	994	93,119	53,507	80,973	48,642
1999			30.0	18.0	1063	101,725	57,559	88,457	52,326
2000			32.0	15.0	1137	109,782	61,917	95,463	56,288
2001			34.0	13.0	1216	119,761	66,606	104,140	60,551
2002			36.0	9.0	1300	127,742	71,650	111,080	65,136
2003			36.0	11.0	1331	138,221	73,466	120,192	66,787
2004			36.0	12.0	1362	146,500	75,327	127,391	68,479
2005			37.0	11.0	1394	154,303	77,236	134,177	70,215
2006			37.0	11.0	1426	158,759	79,193	138,051	71,994
2007			38.0	9.0	1460	162,401	81,200	141,218	73,818
2008			38.0	9.0	1472	162,401	81,935	141,218	74,486
2009			38.0	9.0	1484	162,401	82,676	141,218	75,160
2010			38.0	9.0	1496	162,401	83,424	141,218	75,840
2011			38.0	9.0	1508	162,401	84,178	141,218	76,526
2012			38.0	9.0	1520	162,401	84,940	141,218	77,218
Total	131,640	39,450	650.0	265.0	23829	2,472,306	1,303,468	2,149,831	1,184,971

Source:Study Team

Table 6-1-5 Case 3 30%

	Total	Repairing	Steel
FIRR =	4.8%	4.4%	6.8%

(1,000 Taka)

Year	Investment Cost		Production			Sales		Cost	
	Repairing	Steel	Large	Small	Steel	Repairing	Steel	Repairing	Steel
			(1000 DWT)	(1000 DWT)	(1000 TON)				
1990									
1991									
1992	138,580	33,010							
1993	67,600	6,440	20.0	34.0	560	71,645	27,380	62,300	24,891
1994			21.0	56.0	636	93,032	31,787	80,897	28,897
1995			23.0	57.0	722	102,476	36,904	89,110	33,549
1996			25.0	59.0	819	114,614	42,844	99,664	38,949
1997			27.0	61.0	930	128,364	49,740	111,621	45,218
1998			28.0	62.0	994	139,708	53,507	121,485	48,642
1999			30.0	64.0	1063	155,813	57,559	135,490	52,326
2000			32.0	65.0	1137	172,001	61,917	149,566	56,288
2001			34.0	67.0	1216	191,104	66,606	166,177	60,551
2002			36.0	69.0	1300	211,768	71,650	184,146	65,136
2003			36.0	69.0	1331	223,508	73,466	194,355	66,787
2004			36.0	70.0	1362	235,198	75,327	204,520	68,479
2005			37.0	71.0	1394	248,812	77,236	216,358	70,215
2006			37.0	72.0	1426	256,765	79,193	223,274	71,994
2007			38.0	73.0	1460	266,256	81,200	231,527	73,818
2008			38.0	73.0	1472	266,256	81,935	231,527	74,486
2009			38.0	73.0	1484	266,256	82,676	231,527	75,160
2010			38.0	73.0	1496	266,256	83,424	231,527	75,840
2011			38.0	73.0	1508	266,256	84,178	231,527	76,526
2012			38.0	73.0	1520	266,256	84,940	231,527	77,218
Total	206,180	39,450	650.0	1314.0	23829	3,942,344	1,303,468	3,428,125	1,184,971

Source:Study Team

Table 6-1-6 Case 4 30%

	Total	Repairing	Steel
FIRR =	4.7%	4.4%	5.5%

(1,000 Taka)

Year	Investment Cost		Production			Sales		Cost	
	Repairing	Steel	Large	Small	Steel	Repairing	Steel	Repairing	Steel
			(1000 DWT)	(1000 DWT)	(1000 TON)				
1990									
1991									
1992	138,580	76,510							
1993	67,600	6,440	20.0	34.0	900	71,645	45,110	62,300	41,009
1994			21.0	56.0	1023	93,032	52,419	80,897	47,654
1995			23.0	57.0	1162	102,476	60,912	89,110	55,376
1996			25.0	59.0	1320	114,614	70,782	99,664	64,347
1997			27.0	61.0	1500	128,364	82,250	111,621	74,773
1998			28.0	62.0	1589	139,708	87,458	121,485	79,507
1999			30.0	64.0	1683	155,813	92,995	135,490	84,541
2000			32.0	65.0	1783	172,001	98,883	149,566	89,893
2001			34.0	67.0	1888	191,104	105,143	166,177	95,585
2002			36.0	69.0	2000	211,768	111,800	184,146	101,636
2003			36.0	69.0	2038	223,508	114,168	194,355	103,789
2004			36.0	70.0	2078	235,198	116,585	204,520	105,987
2005			37.0	71.0	2118	248,812	119,054	216,358	108,231
2006			37.0	72.0	2158	256,765	121,575	223,274	110,523
2007			38.0	73.0	2200	266,256	124,150	231,527	112,864
2008			38.0	73.0	2239	266,256	126,154	231,527	114,686
2009			38.0	73.0	2278	266,256	128,191	231,527	116,537
2010			38.0	73.0	2318	266,256	130,260	231,527	118,418
2011			38.0	73.0	2359	266,256	132,363	231,527	120,330
2012			38.0	73.0	2400	266,256	134,500	231,527	122,273
Total	206,180	82,950	650.0	1314.0	37033	3,942,344	2,054,752	3,428,125	1,867,956

Source:Study Team

Table 6-1-7 Base Case (Without Project,40%)

(1,000 Taka)

Year	Investment Cost		Production			Sales		Cost	
	Repairing	Steel	Large	Small	Steel	Repairing	Steel	Repairing	Steel
			(1000 DWT)	(1000 DWT)	(1000 TON)				
1990									
1991									
1992									
1993			21.0	8.0	400	48,853	17,490	42,481	15,900
1994			23.0	4.0	407	50,479	17,832	43,895	16,211
1995			24.0	0.0	415	52,159	18,181	45,356	16,528
1996			25.0	0.0	422	53,895	18,537	46,866	16,852
1997			25.0	0.0	430	54,245	18,900	47,170	17,182
1998			26.0	0.0	430	57,543	18,900	50,037	17,182
1999			26.0	0.0	430	58,694	18,900	51,038	17,182
2000			26.0	0.0	430	59,868	18,900	52,059	17,182
2001			27.0	0.0	430	63,414	18,900	55,143	17,182
2002			27.0	0.0	430	64,682	18,900	56,245	17,182
2003			27.0	0.0	430	65,976	18,900	57,370	17,182
2004			27.0	0.0	430	67,296	18,900	58,518	17,182
2005			28.0	0.0	430	68,464	18,900	59,534	17,182
2006			28.0	0.0	430	70,486	18,900	61,292	17,182
2007			28.0	0.0	430	71,903	18,900	62,524	17,182
2008			28.0	0.0	430	71,903	18,900	62,524	17,182
2009			28.0	0.0	430	71,903	18,900	62,524	17,182
2010			28.0	0.0	430	71,903	18,900	62,524	17,182
2011			28.0	0.0	430	71,903	18,900	62,524	17,182
2012			28.0	0.0	430	71,903	18,900	62,524	17,182
Total	0	0	528.0	12.0	8524	1,267,473	374,441	1,102,150	340,401

Source:Study Team

	Total	Repairing	Steel
FIRR =	0.8%	0.9%	0.02%

Table 6-1-8 Case 1 40%

(1,000 Taka)

Year	Investment Cost		Production			Sales		Cost	
	Repairing	Steel	Large	Small	Steel	Repairing	Steel	Repairing	Steel
			(1000 DWT)	(1000 DWT)	(1000 TON)				
1990									
1991									
1992	102,620	6,880							
1993	29,020	6,446	21.0	10.0	430	50,625	18,970	44,022	17,245
1994			23.0	13.0	447	59,019	19,731	51,321	17,937
1995			26.0	11.0	464	66,075	20,522	57,457	18,656
1996			28.0	10.0	481	73,003	21,344	63,481	19,404
1997			31.0	7.0	500	81,414	22,200	70,795	20,182
1998			32.0	8.0	510	89,941	22,603	78,210	20,548
1999			34.0	6.0	519	98,356	23,014	85,527	20,921
2000			36.0	3.0	529	106,212	23,431	92,358	21,301
2001			38.0	1.0	540	115,976	23,857	100,849	21,688
2002			39.0	0.0	550	124,733	24,290	108,463	22,082
2003			39.0	0.0	569	132,217	25,104	114,971	22,821
2004			40.0	0.0	588	142,387	25,945	123,815	23,586
2005			40.0	0.0	608	148,083	26,814	128,768	24,376
2006			40.0	0.0	629	152,525	27,712	132,630	25,192
2007			41.0	0.0	650	159,465	28,640	138,665	26,036
2008			41.0	0.0	660	159,465	29,060	138,665	26,418
2009			41.0	0.0	670	159,465	29,485	138,665	26,805
2010			41.0	0.0	680	159,465	29,917	138,665	27,197
2011			41.0	0.0	690	159,465	30,355	138,665	27,596
2012			41.0	0.0	700	159,465	30,800	138,665	28,000
Total	131,640	13,326	713.0	69.0	11412	2,397,356	503,792	2,084,657	457,993

Source:Study Team

Table 6-1-9 Case 2 40%

	Total	Repairing	Steel
FIRR =	2.4%	0.9%	6.8%

(1,000 Taka)

Year	Investment Cost		Production			Sales		Cost	
	Repairing	Steel	Large	Small	Steel	Repairing	Steel	Repairing	Steel
			(1000 DWT)	(1000 DWT)	(1000 TON)				
1990									
1991									
1992	102,620	33,010							
1993	29,020	6,440	21.0	10.0	560	50,625	27,380	44,022	24,891
1994			23.0	13.0	636	59,019	31,787	51,321	28,897
1995			26.0	11.0	722	66,075	36,904	57,457	33,549
1996			28.0	10.0	819	73,003	42,844	63,481	38,949
1997			31.0	7.0	930	81,414	49,740	70,795	45,218
1998			32.0	8.0	994	89,941	53,507	78,210	48,642
1999			34.0	6.0	1063	98,356	57,559	85,527	52,326
2000			36.0	3.0	1137	106,212	61,917	92,358	56,288
2001			38.0	1.0	1216	115,976	66,606	100,849	60,551
2002			39.0	0.0	1300	124,733	71,650	108,463	65,136
2003			39.0	0.0	1331	132,217	73,466	114,971	66,787
2004			40.0	0.0	1362	142,387	75,327	123,815	68,479
2005			40.0	0.0	1394	148,063	77,236	128,768	70,215
2006			40.0	0.0	1426	152,625	79,193	132,630	71,994
2007			41.0	0.0	1460	159,465	81,200	138,665	73,818
2008			41.0	0.0	1472	159,465	81,935	138,665	74,486
2009			41.0	0.0	1484	159,465	82,676	138,665	75,160
2010			41.0	0.0	1496	159,465	83,424	138,665	75,840
2011			41.0	0.0	1508	159,465	84,178	138,665	76,526
2012			41.0	0.0	1520	159,465	84,940	138,665	77,218
Total	131,640	39,450	713.0	69.0	23829	2,397,356	1,303,468	2,084,657	1,184,971

Source:Study Team

Table 6-1-10 Case 3 40%

	Total	Repairing	Steel
FIRR =	5.4%	5.1%	6.8%

(1,000 Taka)

Year	Investment Cost		Production			Sales		Cost	
	Repairing	Steel	Large	Small	Steel	Repairing	Steel	Repairing	Steel
			(1000 DWT)	(1000 DWT)	(1000 TON)				
1990									
1991									
1992	138,580	33,010							
1993	67,600	6,440	21.0	34.0	560	71,095	27,380	61,822	24,891
1994			23.0	56.0	636	97,161	31,787	84,488	28,897
1995			26.0	57.0	722	108,918	36,904	94,711	33,549
1996			28.0	59.0	819	121,378	42,844	105,546	38,949
1997			31.0	61.0	930	137,924	49,740	119,934	45,218
1998			32.0	62.0	994	149,842	53,507	130,297	48,642
1999			34.0	64.0	1063	166,555	57,559	144,830	52,326
2000			36.0	65.0	1137	183,487	61,917	159,554	56,288
2001			38.0	67.0	1216	203,173	66,606	176,672	60,551
2002			39.0	69.0	1300	221,363	71,650	192,490	65,136
2003			39.0	69.0	1331	233,678	73,466	203,198	66,787
2004			40.0	70.0	1362	249,437	75,327	216,902	68,479
2005			40.0	71.0	1394	259,919	77,236	226,017	70,215
2006			40.0	72.0	1426	268,205	79,193	233,222	71,994
2007			41.0	73.0	1460	277,924	81,200	241,673	73,818
2008			41.0	73.0	1472	277,924	81,935	241,673	74,486
2009			41.0	73.0	1484	277,924	82,676	241,673	75,160
2010			41.0	73.0	1496	277,924	83,424	241,673	75,840
2011			41.0	73.0	1508	277,924	84,178	241,673	76,526
2012			41.0	73.0	1520	277,924	84,940	241,673	77,218
Total	206,180	39,450	713.0	1314.0	23829	4,139,679	1,303,468	3,599,721	1,184,971

Source:Study Team

Table 6-1-11 Case 4 40%

	Total	Repairing	Steel
FIRR =	5.2%	5.1%	5.5%

(1,000 Taka)

Year	Investment Cost		Production			Sales		Cost	
	Repairing	Steel	Large	Small	Steel	Repairing	Steel	Repairing	Steel
			(1000 DWT)	(1000 DWT)	(1000 TON)				
1990									
1991									
1992	138,580	76,510							
1993	67,600	6,440	21.0	34.0	900	71,196	45,110	61,910	41,009
1994			23.0	56.0	1023	96,856	52,419	84,223	47,654
1995			26.0	57.0	1162	108,089	60,912	93,990	55,375
1996			28.0	59.0	1320	119,928	70,782	104,285	64,347
1997			31.0	61.0	1500	136,334	82,250	118,551	74,773
1998			32.0	62.0	1589	148,129	87,458	128,808	79,507
1999			34.0	64.0	1683	164,680	92,995	143,200	84,541
2000			36.0	65.0	1783	181,470	98,883	157,800	89,893
2001			38.0	67.0	1888	200,969	105,143	174,756	95,585
2002			39.0	69.0	2000	218,956	111,800	190,397	101,636
2003			39.0	69.0	2038	232,094	114,168	201,821	103,789
2004			40.0	70.0	2078	248,778	116,585	216,329	105,987
2005			40.0	71.0	2118	260,310	119,054	226,357	108,231
2006			40.0	72.0	2158	269,747	121,575	234,563	110,523
2007			41.0	73.0	2200	280,692	124,150	244,080	112,864
2008			41.0	73.0	2239	280,692	126,154	244,080	114,686
2009			41.0	73.0	2278	280,692	128,191	244,080	116,537
2010			41.0	73.0	2318	280,692	130,260	244,080	118,418
2011			41.0	73.0	2359	280,692	132,363	244,080	120,330
2012			41.0	73.0	2400	280,692	134,500	244,080	122,273
Total	206,180	82,950	713.0	1314.0	37033	4,141,688	2,054,752	3,601,468	1,867,956

Source:Study Team

6-2 Management and Operation of Optimum Plan

6-2-1 Production Plan

(1) Ship Repair

The quantity of production in ship repair is estimated in Chapter 5, Table 5-1-18 and 22. In order to carry out detail study on the Optimum Plan, dead weight tonnage is considered as the basic value of the quantity of production instead of number of vessels.

The annual production plan of ship repair is shown in Table 6-2-1. This calculation was made under the following conditions:

1) Average dead weight tonnage per vessel

The future vessel size mentioned in Chapter 4, Table 4-2-5 is adopted for the average dead weight tonnage of seagoing vessels to be docked in the future as shown in Table 6-2-1.

The average dead weight tonnage of small vessels in the future is set at 760 DWT per vessel on the basis of the past docking performance.

2) Prospective number of docked vessels

The prospective number of docked vessels estimated in Chapter 5 is adopted. The number of vessels by customers is shown in Table 6-2-1

Table 6-2-1 Average Dead Weight Tonnage and Prospective Number of Docked Vessels

	BSC	Private	Foreign	Total	Small Vessels
Average DWT by customers	12,935	8,403	7,442	-	760
Number of Vessels					
1989/90	8	2	3	13	24
1992/93	12	3	4	19	12
1993/94	13	3	4	20	35
1997/98	15	6	7	28	61
2002/03	17	9	10	36	69
2007/08	17	10	11	38	73
2012/13	17	10	11	38	73

Table 6-2-2 Annual Production Plan of Ship Repair

(1,000 DWT)

Year	BSC	Private	Foreign	Total	Small Vessel
1989/90	103.48	16.81	22.33	142.61	18.24
1992/93	155.22	25.21	29.77	210.20	9.12
1993/94	168.15	25.21	29.77	223.13	26.60
1997/98	194.03	50.42	52.09	296.54	46.36
2002/03	219.90	75.63	74.42	369.94	52.44
2007/08	219.90	84.03	81.86	385.79	55.48
2012/13	219.90	84.03	81.86	385.79	55.48

(2) Steel Structure

Upgrading productivity in planned fabrication shops is a key factor for CDD to keep competitiveness in the market and to meet the demand stated in Chapter 5, Section 5-2-1 "Planning Condition" and the improvement of productivity as shown in Fig. 5-2-2.

Year	Target	Production volume
1989:	0.15 ton/m2	0.15 t/m2 x 2,160 m2 = 324.0 tons
1992:	0.17 ton/m2	0.17 t/m2 x 2,160 m2 = 367.2 tons
1993:	0.15 ton/m2	0.15 t/m2 x 3,780 m2 = 567.0 tons
1997:	0.25 ton/m2	0.25 t/m2 x 3,780 m2 = 945.0 tons
2002:	0.34 ton/m2	0.34 t/m2 x 3,780 m2 = 1,300.0 tons
2007:	0.38 ton/m2	0.38 t/m2 x 3,780 m2 = 1,436.0 tons
2012:	0.40 ton/m2	0.40 t/m2 x 3,780 m2 = 1,520.0 tons

Increase of production volume is shown in Table 6-2-3.

Table 6-2-3 Production Volume of Steel Products

(Ton)

Year / Products	1989/90	1992/93	1993/94	1997/98	2002/03	2007/08	2012/13
Electricity transmission towers	0	0	80	250	400	470	500
Portable bridges	60	50	100	200	350	400	420
Chemical plants	0	0	30	80	100	140	150
Steel racks and ladders	80	100	110	130	150	150	150
Pontoons, platforms and tanks	100	120	130	140	150	150	150
Other	80	100	110	130	150	150	150
Total	320	370	560	930	1,300	1,460	1,520

(3) Production Plan of Galvanizing Shop

Such products as steel structural products, pipes for ship repair and shipbuilding, and some products ordered from other outside companies are galvanized.
As to the products ordered from other companies, considerable amounts of electric products and water supply equipment concerned with development projects are expected.
Accordingly, in addition to the planned steel structural products, galvanizing volume is estimated as shown in Table 6-2-4.

Table 6-2-4 Galvanizing Volume Forecast

(Ton)

Year / Products	1989/90	1992/93	1993/94	1997/98	2003/04	2007/08	2012/13
Towers and bridges	0	0	180	450	750	870	920
Pipes for ship repair & shipbuilding	0	0	50	50	50	50	50
Other products	-	-	30	80	130	180	230
Total	-	-	260	580	930	1,100	1,200

Note: i) Galvanizing capacity :
1 ton/hr x 8 hrs x 303 days x 0.5 (Operation rate)
= 1,200 tons/year,
1 ton/hr x 10 hrs x 303 days x 0.5 = 1,500 tons/year
ii) Galvanizing volume is shown in weight tons of steel products.

6-2-2 Manpower and Training Plan

(1) Ship Repair

1) Manpower plan

The necessary manpower is estimated as shown in Table 6-2-6, based on the annual working hour as shown in Table 6-2-5, calculated with the aforementioned production plan on the following conditions:

a) Annual working hours per capita

Annual working days	:	303 days
Average working hours per day	:	7.1 hours
Average overtime per day	:	2 hours
Attendance ratio	:	90 %
Estimated annual working hours per capita	:	2,480 hours

b) Working hours per dead weight tonnage

Based on the past performance of CDD, current working hours per dead weight tonnage of seagoing vessels is calculated at 1.7 hours/DWT. For small vessels, current working hours per dead weight tonnage is set at 5.1, three times that of seagoing vessels.

These average working hours are low due to the insufficient work volume per vessel. Taking into account the future work volume, the average working hour per DWT is assumed to be increased in proportion to the increase of repair items.

c) Improvement of productivity

As a result of technical assistance, it is expected that the productivity of ship repair in CDD is improved as mentioned in Chapter 5, Plan A and B.

d) Subcontracted work

In this study, a subcontracted work system is applied. The percentage of subcontracted work is assumed as follows:

1989/90	0%
1992/93	0%
1993/94	10%
1997/98	20%
2002/03	30%
2007/08	30%
2012/13	30%

Table 6-2-5 Estimated Annual Working Hours

Year	Productivity	Growth rate	Seagoing vessels Hr/DWT	Seagoing vessels Working hours	Small Vessel Hr/DWT	Small Vessel Working hours
1987/88	1.00	1.00	1.7	-	5.1	-
1989/90	1.06	1.04	1.8	237,866	5.3	91,269
1992/93	1.16	1.10	1.9	338,852	5.6	36,755
1993/94	1.23	1.14	1.9	351,569	5.8	125,734
1997/98	1.67	1.40	2.4	422,610	7.1	198,210
2002/03	1.95	1.87	3.2	603,100	9.5	256,472
2007/08	2.05	2.16	3.7	691,029	11.0	298,131
2012/13	2.05	2.16	3.7	691,029	11.0	298,131

Remark: Working hours = DWT x Hr/DWT / Productivity

Table 6-2-6 Manpower Plan of Direct Workers

Year	Total Working Hours	Skilled Workers		Unskilled Workers		Total	
1989/90	329,135	53	(0)	80	(0)	133	(0)
1992/93	375,607	61	(0)	91	(0)	152	(0)
1993/94	477,303	70	(8)	104	(11)	174	(19)
1997/98	620,819	80	(20)	120	(30)	200	(50)
2002/03	859,572	97	(42)	146	(62)	243	(104)
2007/08	989,160	112	(48)	167	(72)	279	(120)
2012/13	989,160	112	(48)	167	(72)	279	(120)

Figures in brackets show the number of subcontracted workers.

2) Training plan

Although techniques and experience have accumulated at CDD for docking repairs in the 8 years since its inauguration, adequate education and training programmes for other ship repair work has to be implemented for engineers and workers in order to increase their proficiency and improve CDD's productivity.

These activities consist of:

- dispatch of CDD's engineers to an advanced shipbuilding country
- engagement of experts from an advanced shipbuilding country

The training plan is shown in Table 6-2-7.

Table 6-2-7 Training Plan for Ship Repair

1. Training in Overseas Shipyards			
Technical Fields	Number of Trainees	Period (Month)	Man-Months
Engineers			
Management(Costing, Scheduling, Financing)	1	6	6
Hull	1	6	6
Machinery	2	6	12
Electric	1	6	6
Casting	1	6	6
Quality Control	1	6	6
Total	7		48

2. Technical Assistance from Overseas Shipyard			
Technical Fields	Number of Experts	Period (Month)	Man-Months
Engineers			
Hull	1	12	12
Machinery	1	12	12
Electric	1	12	12
Mechanical	1	12	12
Welding	1	6	6
Total	5		54

(2) Steel Structure

1) Estimation of working hours

Production efficiency is shown in average working hours per ton.
CDD's production efficiency(Hr/ton)is shown in Table 5-2-1.
After execution of this project, improved production efficiency and annual working hours per year is estimated as shown in Table 6-2-8.

Table 6-2-8 Estimation of Annual Working Hours

(1,000 hours)

Year		1987/ 88	1992/ 93	1993/ 94	1997/ 98	2002/ 03	2007/ 08	2012/ 13
Efficiency factor		1.00	1.21	1.30	1.80	2.21	2.42	2.52
Products	Hr/ton							
Electricity towers	450	0	0	27.7	62.5	81.5	87.4	88.6
Portable bridges	400	16.0	16.5	30.8	44.5	63.3	66.1	66.1
Chemical plants	400	0	0	9.2	17.8	18.1	23.1	23.6
Steel racks and ladders	220	15.4	18.2	18.6	15.9	14.9	13.6	13.0
Pontoons & platforms	270	27.0	27.0	27.0	21.0	18.3	16.7	15.9
Other steel structures	500	40.0	41.3	42.3	36.1	33.9	31.0	29.5
Other	-	30.6	34.3	51.9	65.9	76.7	79.3	78.9
Total	-	129.0	137.3	207.5	263.7	306.7	317.2	315.6

Note: Annual working hours = (Production weight tons x Hr/ton) / Efficiency factor

2) Manpower plan

a) Manpower of steel structure shop

The number of workers is calculated using the following formula:

Annual total working hours/2,480 hours per man = Number of workers

Table 6-2-9 shows the manpower plan for steel structure work.

Table 6-2-9 Manpower Programme

Year	1987/ 88	1992/ 93	1993/ 94	1997/ 98	2002/ 03	2007/ 08	2012/ 13
Employee increase							
Skilled workers	-	0	7	5	4	0	0
Unskilled workers	-	0	3	2	2	0	0
Subtotal	-	0	10	7	6	0	0
Subcon. increase							
Skilled workers	-	2	13	10	8	3	0
Unskilled workers	-	1	6	5	4	1	0
Subtotal	-	3	19	15	12	4	0
No. of workers by skill							
Skilled workers	37	39	59	74	86	89	89
Unskilled workers	15	16	25	32	38	39	39
Grand total	52	55	84	106	124	128	128

b) Manpower of galvanizing shop

In the estimation of manpower, the efficiency factor is assumed to be a half of the Japanese standard galvanizing shop. Number of workers is shown in Table 6-2-10.

Table 6-2-10 Manpower Plan of Galvanizing Shop

Stage & Manpower \ Year	1993/ 94	1997/ 98	2002/ 03	2007/ 08	2012/ 13
Pretreatment stage					
Skilled workers	2	3	4	4	5
Unskilled workers	3	4	4	5	5
Galvanizing stage					
Skilled workers	2	3	4	5	5
Unskilled workers	3	4	5	5	5
Engineers	1	1	1	1	1
Total	11	15	18	20	21

3) Training plan

To increase the capacity of production, such measures as reinforcement of sales promotion, development of new clients and expansion of product items, is necessary for CDD to get more orders.

As a short-term goal, CDD is expected to play its part in various construction projects as a subcontractor and conduct stable operation of fabrication shops in order to accumulate technical expertise, and then, CDD aims at obtaining a good reputation and position as a main contractor in the future.

Fostering design technology is imperative for CDD to achieve this goal.
To begin with, the training of assigned designers for the purpose of the design of electricty transmission towers and bridges shall be carried out in the overseas steel fabrication yard according to the schedule as shown in Table 6-2-11.

Table 6-2-11 Technical Training Programme

Training at overseas yard	Year Trainee	1992 (Man-Month)	1993
Designing bridges, etc.		12	-
Designing steel towers, etc.		12	-
Drawing		12	-
Mold lofting		12	-
Marking, cutting, drilling, etc.		12	-
Assembling, welding		12	-
Quality Control		12	-
Technical assistance to CDD from overseas yard		1992 Trainer(Man-Month)	1993
Galvanizing engineer		-	6
Designing engineer		-	12
	Total	84	18

(3) Overall Yearly Manpower Plan

The overall yearly manpower plan is made as shown in Table 6-2-12.

Table 6-2-12 Manpower Planning

Year	Officers & Staff	Indirect Workers	Direct Workers: Ship Repair	Direct Workers: Machine Shop	Direct Workers: Steel Structure	Direct Workers: Galv. Shop	Total
1989	301	55	133 (0)	17	52 (0)	0 (0)	558 (0)
1992	306	55	152 (0)	18	52 (3)	0 (0)	583 (3)
1993	313	57	174 (19)	20	62 (22)	5 (5)	631 (46)
1997	320	58	200 (50)	21	69 (37)	7 (7)	675 (94)
2002	330	60	243 (104)	23	75 (49)	9 (8)	739 (161)
2007	335	61	279 (120)	25	75 (53)	10 (9)	785 (183)
2012	335	61	279 (120)	25	75 (53)	10 (10)	785 (183)

Figures in brackets show the subcontracted workers.

6-2-3 Material Procurement

Regarding material procurement, it is considered that, in principle, all materials available locally are used. The procurement of materials necessary for the implementation of production plan is planned as follows:

(1) Ship Repair Work

1) Imported materials
- Steel materials of special quality
- Marine paint
- Mechanical and electric parts

2) Local materials
- Steel materials necessary for general repair work
- Zinc anode
- Consumables (Sand for blasting, welding rod etc.)
- Other

(2) Steel Structure Work

1) Imported materials
- Zinc plated bolts and nuts for electricity transmission towers
- Checkered plates for portable bridges
- Raw zinc material for galvanizing

2) Local materials
- Steel materials from Chittagong Steel Mills Ltd. and National Tubes Ltd.
- Welding consumables
- Paint
- Chemicals for galvanizing
- Other.

It is one of the most important factor for shipyard management to procure these materials on time, for a cheaper price and of good quality.

CDD has established their own material procurement system. With the implementation of the plan, the procurement of materials increase both in quality and variety. Therefore, the following countermeasures should be considered:
- Review of proper kinds and quality of fast moving materials
- Review of present material procurement procedures and prompt action of it
- Planning of suitable procurement and stock in accordance with production plan
- Preparation, in advance, of such imported materials that will take a long time for delivery (for example, it is useful to prepare materials for ship repair prior to their docking by getting information in advance)

6-2-4 Organization

The current organization of CDD seems to be relatively reasonable. But it still is necessary for CDD to reorganize so that every departments can display their function more efficiently, in accordance with the future production plan.

The organization chart shown in Fig. 6-2-1 is recommended. This organization is drafted in consideration of the following points:

1) This organization shall cover the present facilities and the newly planned facilities.

2) The Administration Department shall have a minimum number of members and the Common Service Section covers all office work relating to the production department.

3) The Sales Promotion section shall be newly organized and operated under the control of the Managing Director.

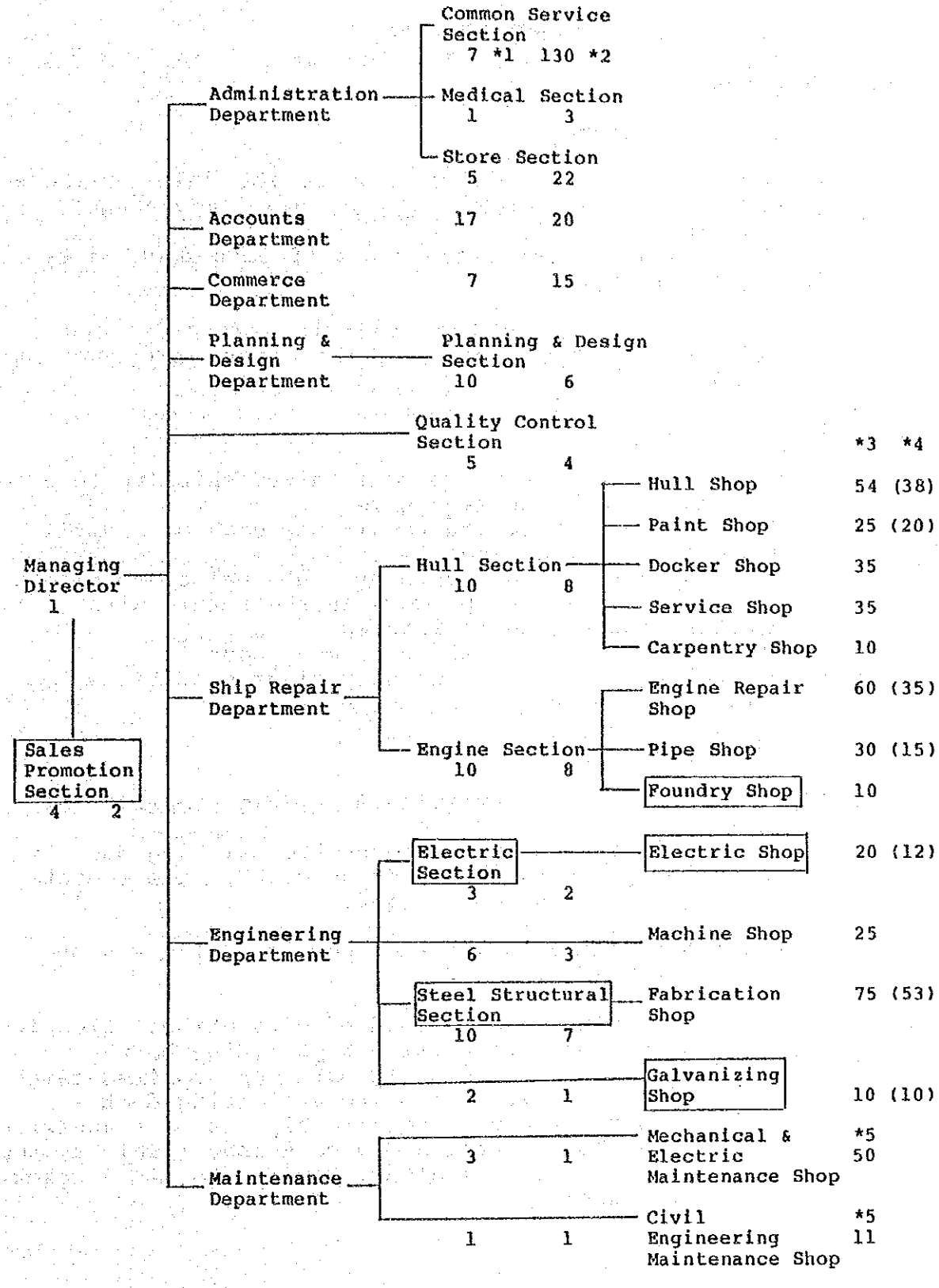
4) A newly planned Foundry Shop shall be put under the control of the Engine Section.

5) The Electric Section shall be newly organized.

6) The Steel Structure Section shall be newly established. The existing fabrication shop shall be operated under this section.

7) A newly built galvanizing shop shall be organized in the Engineering Department.

8) The technical officers group consists of engineers, assistant engineers, sub assistant engineers and foremen.



Remark: *1 Officer
*2 Staff
*3 Direct Worker
*4 Subcontracted Worker
*5 Indirect Worker

* The figures show the number of personnels in 2012/13.
* The newly established sections and shops are shown in rectangulars.

Fig. 6-2-1 Recommended Organization Chart

6-3 NEW FACILITIES OF OPTIMUM PLAN

6-3-1 Ship Repair

(1) Drydocking System

There are several kinds of systems for ship repair and shipbuilding in which there are advantages and disadvantages.
Table 6-3-1 is a comparison table of each docking system in a general way.

In this study, taking the following preconditions into consideration, four plans have been proposed and analyzed.

1) Preconditions

a) To be able to repair two small sized ships(up to 50 m in length) , at the same time
b) To be able to build and repair one each of a small sized ship at the same time
c) To be able to build a ship of 3,000 DWT class coastal cargo vessel(Max. 4,000 DWT) in the future with little modification of the facilities
d) To minimize the initial investment cost
e) Natural conditions, especially river conditions
f) Future expansion or conversion

2) Proposed plans

Plan A : Expansion of existing dock (Fig. 6-3-1)

This is a plan to expand the existing dock by 100 m towards the dock head. The intermediate gate is also considered.

Plan B : A floating dock system combined with a shore berth (Fig. 6-3-2)

This plan is comprised of conventional floating docks and ship repair/shipbuilding berths.
The launching of newly built or repaired ships in a berth is done using a floating dock.
When necessary, a repair ship can be transfered to a shore berth, and vice versa. (This system was adopted in Italthai Marine Ltd. in Bangkok, Thailand)

Table 6-3-1 Comparison of Drydocking System (General)

Item	Slipway System	Graving Dock	Floating Dock	Shiplift
1. Operational possibilities	In general for shiprepair and shipbuilding. In principle, for small and medium-sized vessel.	Depending on design used for shiprepair and shipbuilding.	Normally, for repair only.	For shipbuilding and repair.
2. Productivity and flexibility	The number of vessels to be repaired or built at the same time depends on the number of berths. Accessibility is good.	Depending on the size of dock, one or two vessels can be docked. Accessibility is not good, because of the difference in height between dock bottom and ground level.	Only one ship can be repaired. Accessibility is restricted due to the high side walls.	In principle, same as slipway system.
3. Future extention	Can be extended in longitudinal and transverse direction, within a limit of bearing force.	Normally, no extention possible.	In principle, possible to extend in longitudinal.	Can be extended in longitudinal without problems by adding hoists and platform sections.
4. Docking time	Approx. 1 hour.	Time spent depends on pump capacity. Standard: 5-6 hours.	Medium docking time usually required, depending on pump capacity	Approx. 1 hour.
5. Operation	Experienced and skilled dockers required.	Simple operation	Required skill of personnel.	Required skill of personnel.
6. Maintenance	Cradle-Periodically sandblasted and painted. Groundway-Required periodic replacement.	Gate-Periodic drydocking required.	Dock structure-Protection of steel structure against corrosion required.	Platform-Occasionally blasted and painted. Machinery-Occasional overhaul required. Wire rope-Sample testing and replacement on a recommended schedule.
7. Maintenance cost per year	2 - 3 % of initial cost	1 % of initial cost	4-5 % of initial cost	2 - 3 % of initial cost
8. Siltation	Care be taken to underwater of slipway.	Problems be occured at dock entrance.	Care be paid to clearlance between dock bottom and sea bed.	Care be paid to clearlance between platform and sea bed.
9. Service life	15 - 20 years	30 years	15 - 20 years	20 - 25 years
10. Initial cost	Low	High	Relatively high	Relatively high

Plan C : Shiplift system (Fig. 6-3-3)

A typical mechanical shiplift system is considered. The major components of this system are:
- Liftdock (Docking recess, platform, lifting hoist, etc.)
- Ship transfer (Side transfer pit, transfer carriages, etc.)
- Shipbuilding and/or repair berth

Plan D : Slipway (Fig. 6-3-4)

This system is almost the same as the one normally used in the Bangladeshi shipyards.

Table 6-3-2 shows a comparison of the features of each proposed plan. From this table, it can be found that there are advantages and disadvantages in each plan. In the case when numerous repair vessels are expected, Plan "B" and Plan "C" are effective. However, the demand for CDD is not greatly expected , consequently, Plan "D" (Slipway system) is recommendable from the view of minimum investment, simple operation, easy expansion, etc. as shown in Table 6-3-2.

3) Slipway system

a) Scale of slipway

The scale of the slipway is decided so that whichever bigger of the two ships up to 50 m in length for ship repair or 3,000DWT class coastal cargo vessel(Max. 4,000DWT) for shipbuilding in the future can be accommodated.
The dimension of these types of vessels is as follows:

350GT Fishing trawler		3,000DWT Cargo boat(4,000DWT)	
Loa =	50.0 m	Loa = 82.5 m	(100.0 m)
Lpp =	45.0 m	Lpp = 75.0 m	(90.0 m)
B =	8.0 m	B = 13.2 m	(14.3 m)
D =	5.9 m	D = 6.6 m	(7.7 m)
In light weight condition		In launching condition	
Displacement =	600 T	Displacement =	1,000-1,250 T
df =	1.2 m	df =	0.5-0.6 m
da =	4.2 m	da =	2.5-2.6 m
dm =	2.7 m	dm =	1.5-1.6 m
(Incl. keel depth)			

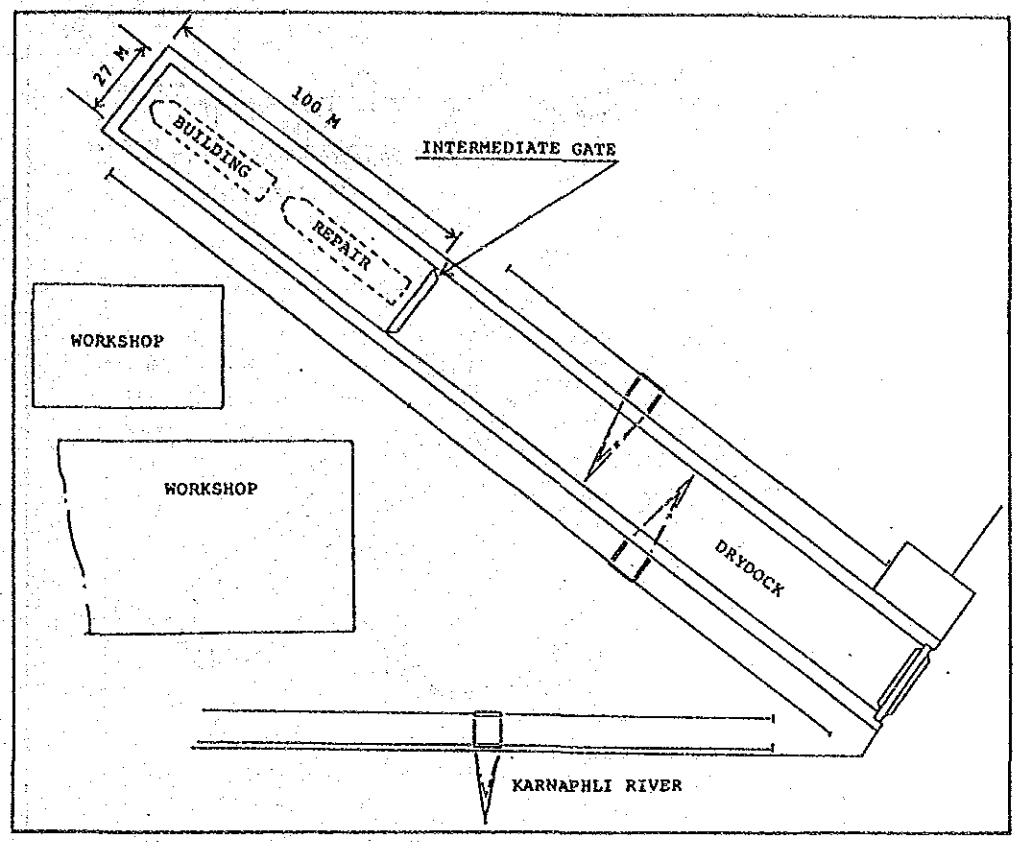


Fig. 6-3-1 Expantion of Existing Dock (PLAN "A")

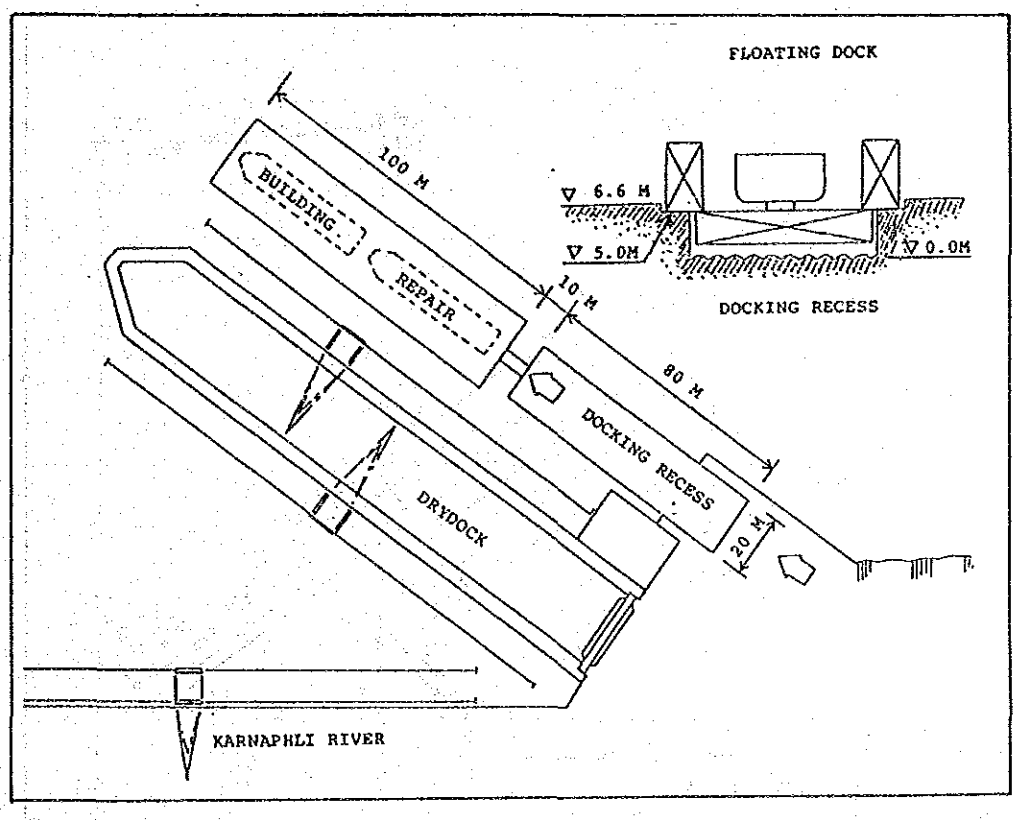


Fig. 6-3-2 Floating Dock System (PLAN "B")

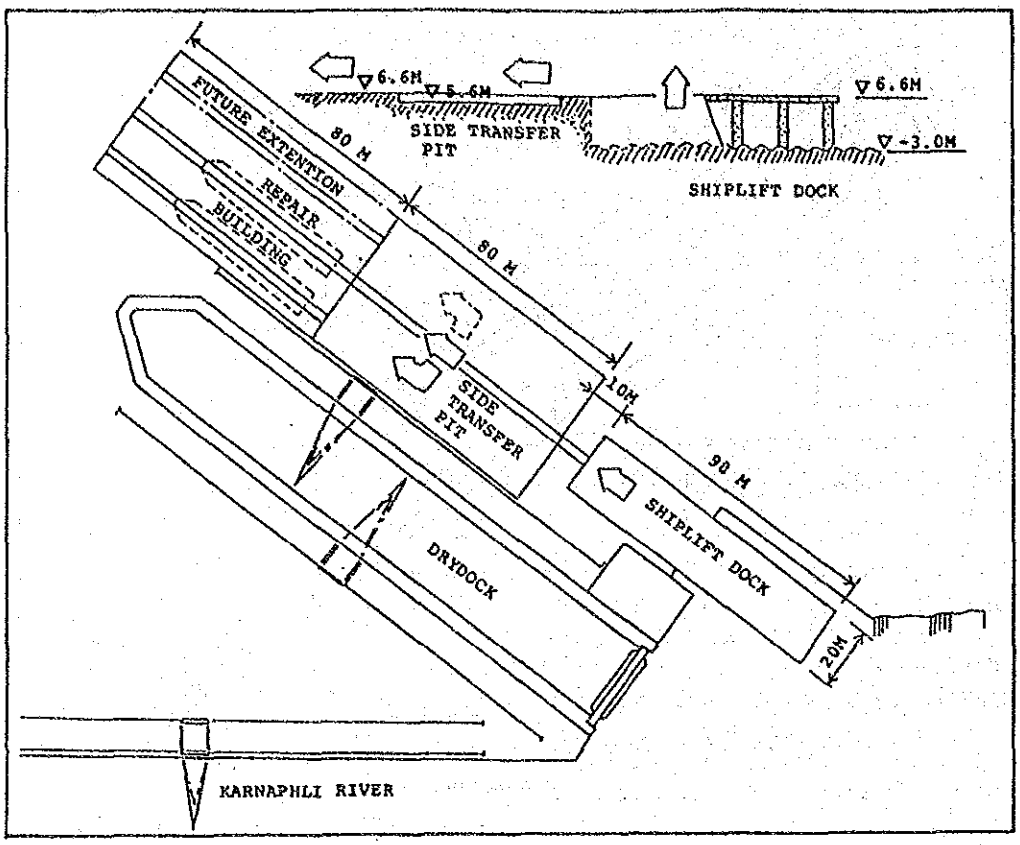


Fig. 6-3-3 Shiplift System (PLAN "C")

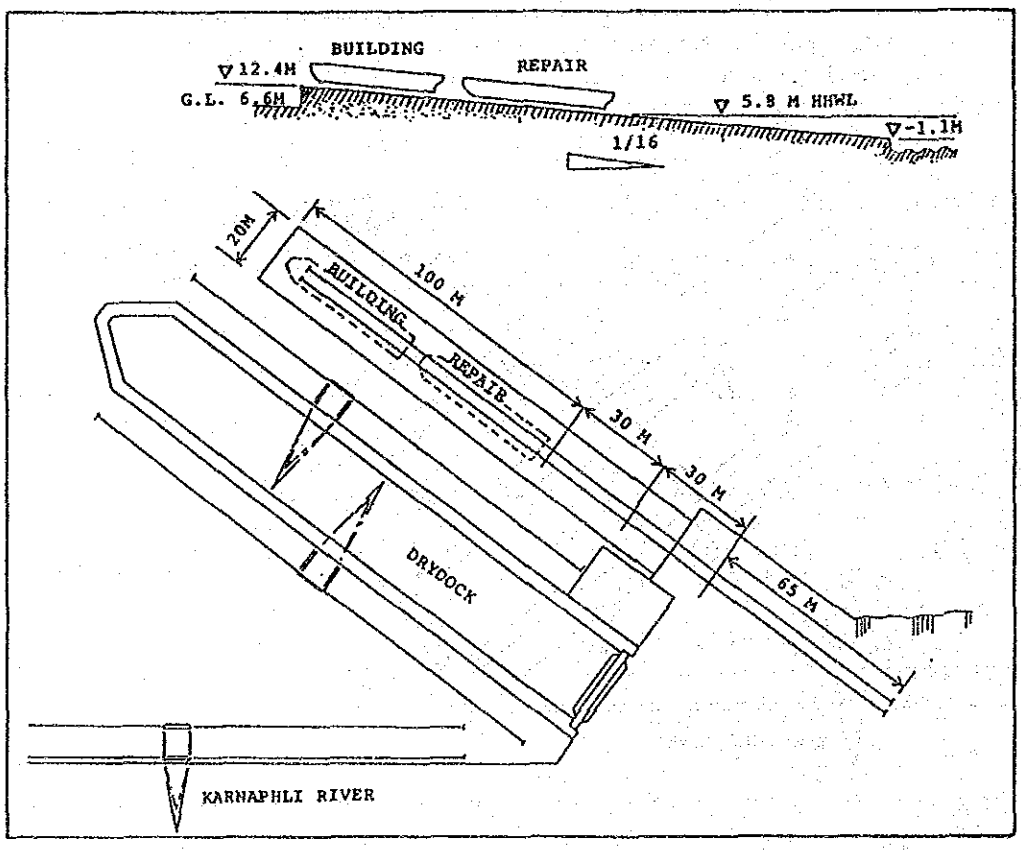


Fig. 6-3-4 Slipway System (PLAN "D")

Table 6-3-2 Comparison of Proposed Docking System

ITEM	PLAN "A" (Expansion of Drydock)	PLAN "B" (Floating Dock)	PLAN "C" (Shiplift)	PLAN "D" (Slipway)
1. Layout	No specific obstruction. Can be kept space for No. 2 Drydock in future. Portside dock crane(40T) available by extending crane rails. ○	Space for No.2 Drydock is allotted. Difficult to find mooring space for Floating dock. Starboard dockside crane(15T) available. △	Space for No.2 Drydock is utilized. Starboard dockside crane available by some extention of crane rails. ○	Space for No.2 Drydock is allotted. Starboard crane available. ○
2. Future Expansion	Difficult △	Difficult X	Difficult X	Not so Difficult ○
3. Flexibility	Both build and repair of small sized vessels can be done at the same time. In case of building up to 4,000 DWT class vessel, repair for small sized vessels can not be done. △	Both build and repair up to class "2" vessels can be done at the same time. ○	Same as PLAN "B" ○	Same as PLAN "A" △
4. Operation	Simple ○	Difficult X	Rather difficult △	Simple ○
5. Maintenance	Minor maintenance ○	Maintenance of dock structure done using existing drydock. △	Required proper maintenance of mechanical/ electrical parts. △	Minor maintenance ○
6. Siltation	Little influence. ○	A little influence for docking recess. △	Much influence, because enough clearance needed between platform and river bed. X	Little influence ○
7. Initial Investment	Large X	Medium △	Relatively large X	Small ○
General Judgement	△	X	X	○

Based on the above figures, the necessary dimension of the slipway becomes as follows:

Railway length = 100m (50m x 2)

Width of ship repair berth = 13m (9m + 2m x 2)

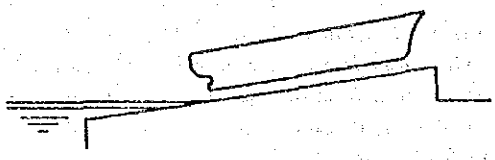
Width of shipbuilding berth = 18.3m (14.3m + 2m x 2)

As for the width of the berth, 13 m is enough for the two 50 m long class ships to be repaired. However, considering the difficulty of widening the berth in the future, 18.3 m in width should be taken so as to afford the docking of shallow draft-wide breadth type of ships and coastal cargo vessels.

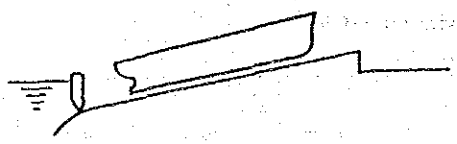
b) Type of slipway

There are two types of slipways : ordinary type and semi-dock type as shown below.

Ordinary type



Semi-dock type



Considering the present site conditions, there exists the following problems in adopting the ordinary type. (See Fig. 6-3-4)

- Longer slipways will be reqired due to big tide differences.
- Working floor level will be considerably higher than ground level.
- Existing underwater concrete floor makes it difficult to stretch slipway into river.
- Maintenance of underwater slipway is difficult, especiallythe siltation problem is unavoidable.
- Wide range of cofferdam is required while under construction, and this may disturb the current docking operation.
- In case of launching, complicated launching preparation will be required.

On the other hand, by adopting the semi-dock type, these problems can be avoided.

c) Location of slipway

Fig. 6-3-5 shows the location of the semi-dock type of slipway. The slipway is being placed within the reach of existing starboard dockside crane(15 tons of lifting capacity).

d) Docking and undocking plan

Fig.6-3-6 shows the arrangement of docking on slipway for 350GT fishing trawlers.

After the keel is touching the top of the hauling cradles, the water inside the slipway is pumped out by using the existing dry dock dewatering pumps. When undocking, filling the water into the slipway is done through the valves installed on the dock gate.

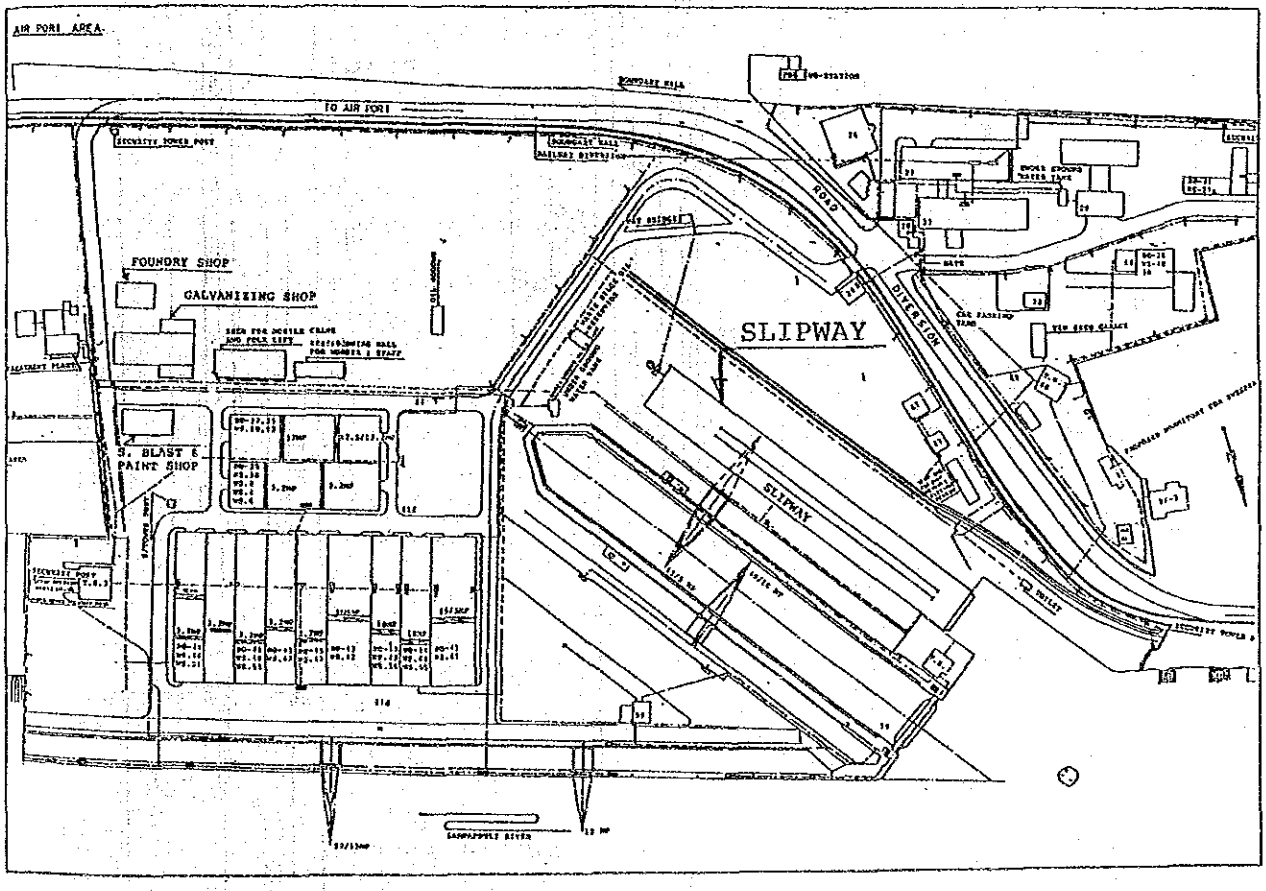


Fig. 6-3-5 Location of Slipway

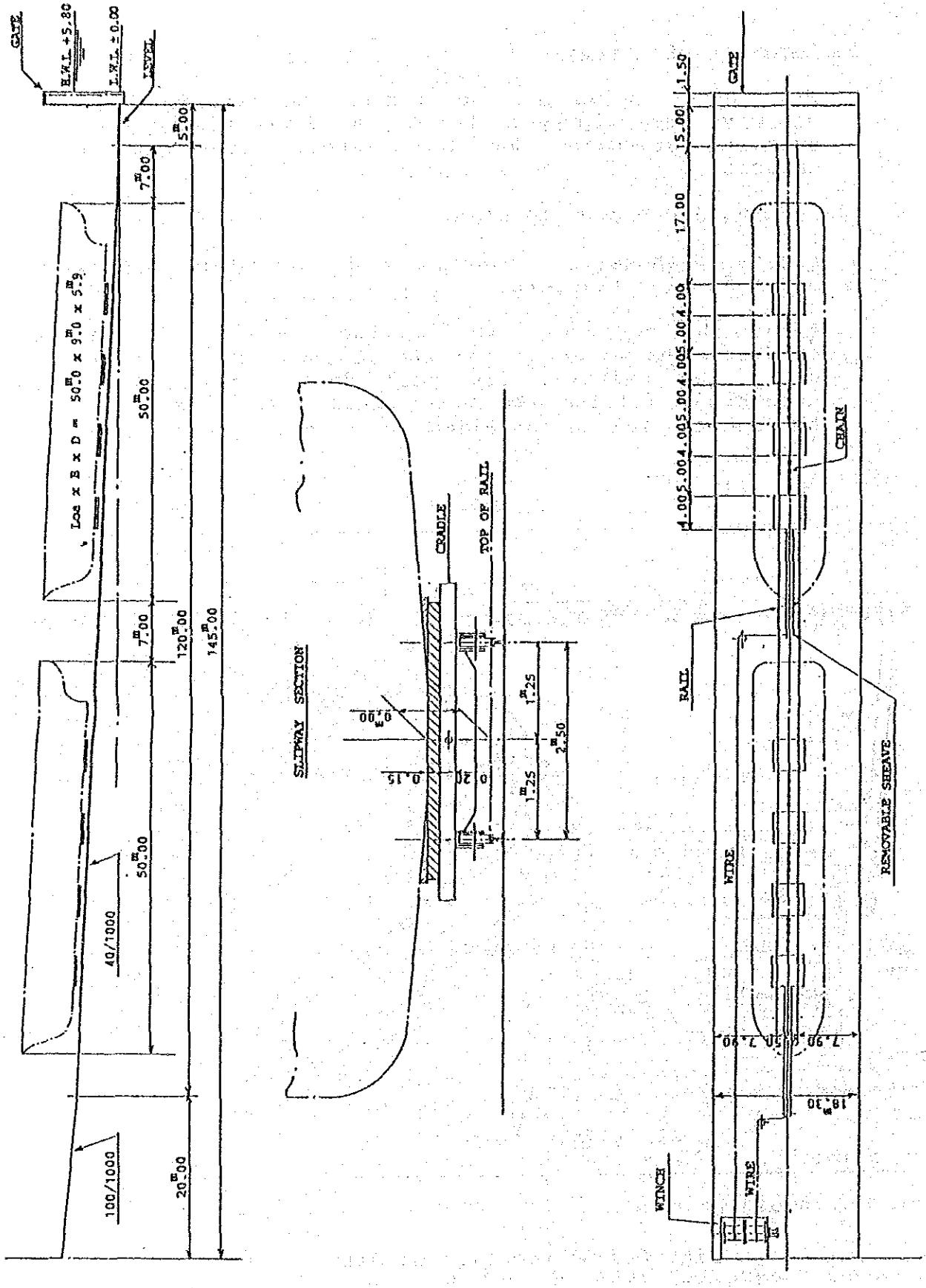


Fig. 6-3-6 Arrangement of Docking on Slipway

(2) Machinery and Equipment

Taking into account the future work volume and prospective ship repair work, additional machinery and eqipment is indispensable.

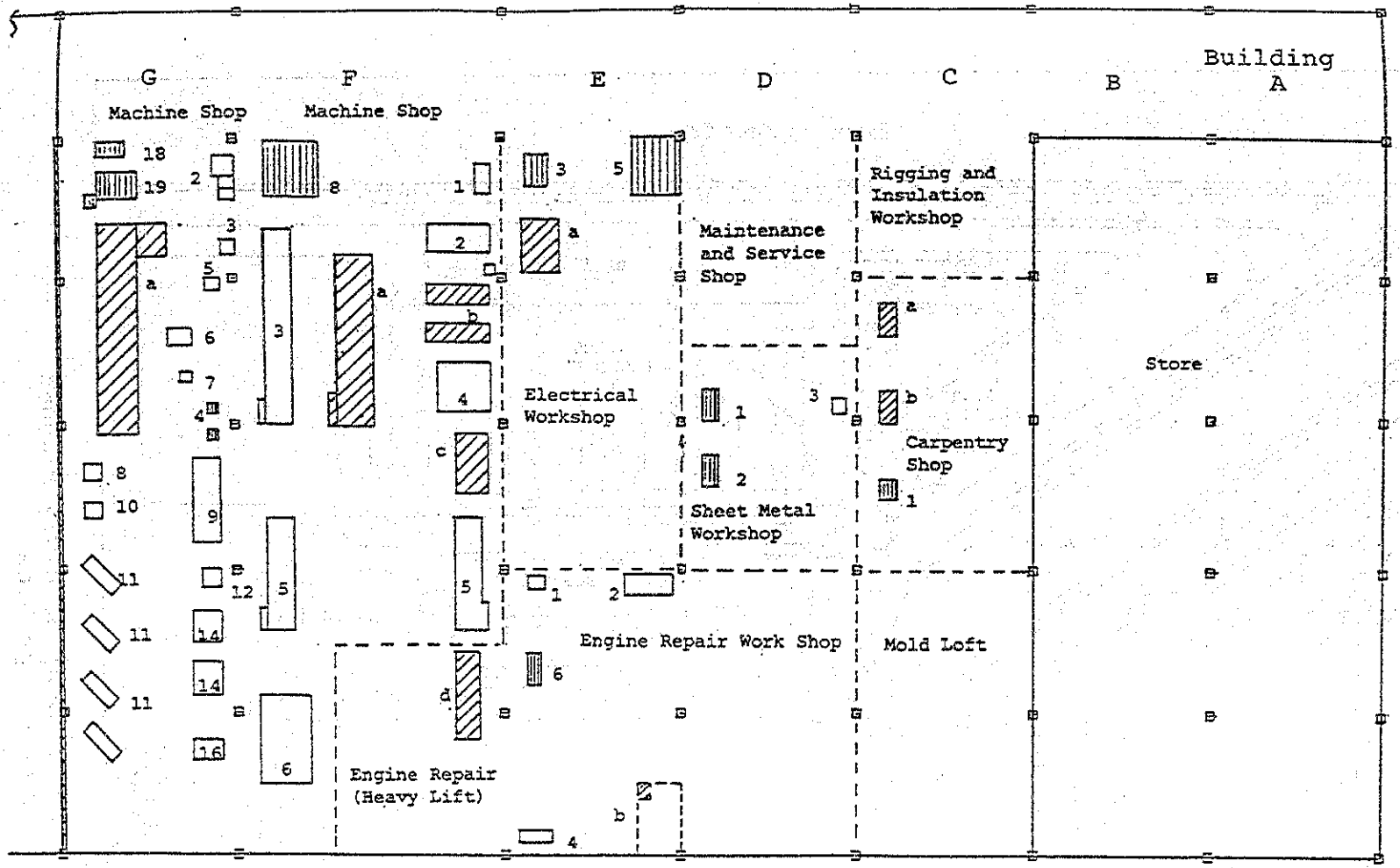
The outline of additional facilities is shown in Table 6-3-3.

The layout of workshop machinery and the arrangement of newly planned utility pipe line is shown in Fig. 6-3-7 and 6-3-8.

Table 6-3-3 Outline of Additional Facilities

No.	Item	Unit	Main Particulars
1	Utility		
	(1) Air compressor and piping	1	30 m3 x 7 kg/cm^2 2 sets
	(2) Compressor house	1	
	(3) Oxygen and acetylene manifold	1	Fixed x 2 sets Portable x 10 sets
	(4) Drinking water piping	1	From WASA line
2.	Workshop		
	(1) Static balancing for propeller	1	Max. dia 5.5 m
	(2) Lathe machine	1	Center distance 9 m Supporting capacity 15 tons
	(3) Lathe machine	2	Center distance 2.5m Swing over bed 1.4 m
	(4) Planer	1	Cutting length 4 m Cutting width 1.4 m
	(5) Surface grinder	1	Table length 1.2 m Table width 0.6 m
	(6) Attachment for boring & milling	1	Boring bar, milling head, etc.
	(7) Dynamic balancing machine	1	Max. diameter 1.6 m Center distance 3 m

No.	Item	Unit	Main Particulars
3.	Ship repair workshop		
	(1) Electrical apparatus testing equipment	1	Testing and measuring equipment
	(2) Testing equipment for heavy cargo gear	1	Weighing scale and weight
	(3) Steam cleaner	2	Capacity 300 L/min.
4.	Paint shop		
	(1) Sand blasting equipment	6	Capacity sand 400kg
	(2) High pressure water pump	2	300 kg/cm^2 100 L/min.
5.	Carpenter's workshop		
	(1) Wood turning lathe	1	Center distance 1 m Swing over bed 0.7 m
	(2) Wood planer	1	Cutting width 0.3 m
6.	Foundry		
	(1) Building	1	16 m x 10 m
	(2) Casting equipment	1	Tilt crucible with furnace
	(3) Remetaling equipment	1	Ladle, soldering bath, crucible, etc.
4.	Tools		
	(1) Hand tools	1	Mechanic Electrician Fitter Carpenter Plumber
	(2) Cutting tool (3) Measuring tool (4) Lifting tool (5) Pneumatic tool (6) Electrical tool (7) Gas cutting tool (8) Welding tool (9) Protectors (10) Scaffoldings		



Machinery shifted from former Engine Repair Shop

Additional Machinery and Equipment

E. Engine & Electrical Shop

1. Column Drill Machine
2. Radial Drilling Machine
3. Twin Disc Lapping Machine
4. Horizontal Band Saw
5. Injector Test Bench
6. Propller Balancing Machine
a. Dynamic Balancing Machine
b. Steam Cleaner

D. Maintenance/Sheet Metal Shop

1. Angle Bendine Machine
2. Bending Roller
3. Column Drill Machine

C. Carpentry Shop

1. Circuler Saw
a. Wood Turning Lathe
b. Wood Planer

G. Machine Shop

1. Hyd. Press 15 ton
2. Twin Chamber Oven
3. Drill Bit Sharpner
4. Band Saw for Non Ferrous Metal
5. Universal Tool Sharpner
6. Shaping Machine
7. Column Drill Machine
8. Vertical Milling Machine
9. Grinding Machine
10. Universal Milling Machine
11. Lath (Small)
12. Universal Milling Machine
13. Double Grinder
14. Vertical Milling Machine
15. Slotter Machine
16. Shaping Machine
17. Column Drill
18. Horning Machine
19. Horning Machine
a. Planer

F. Machine Shop

1. Horizontal Band Saw
2. Radial Drilling Machine
3. Universal Lathe
4. Vertical Turret Lathe
5. Universal Lathe
6. Hor. Boring Machine
7. Thred Cutter
8. Paint Drying Oven
a. Heavy Duty Lathe
b. Universasl Lathe
c. Surface Grinder
d. Propeller Balancing Machine

Fig. 6-3-7 Layout of Workshop Machinery

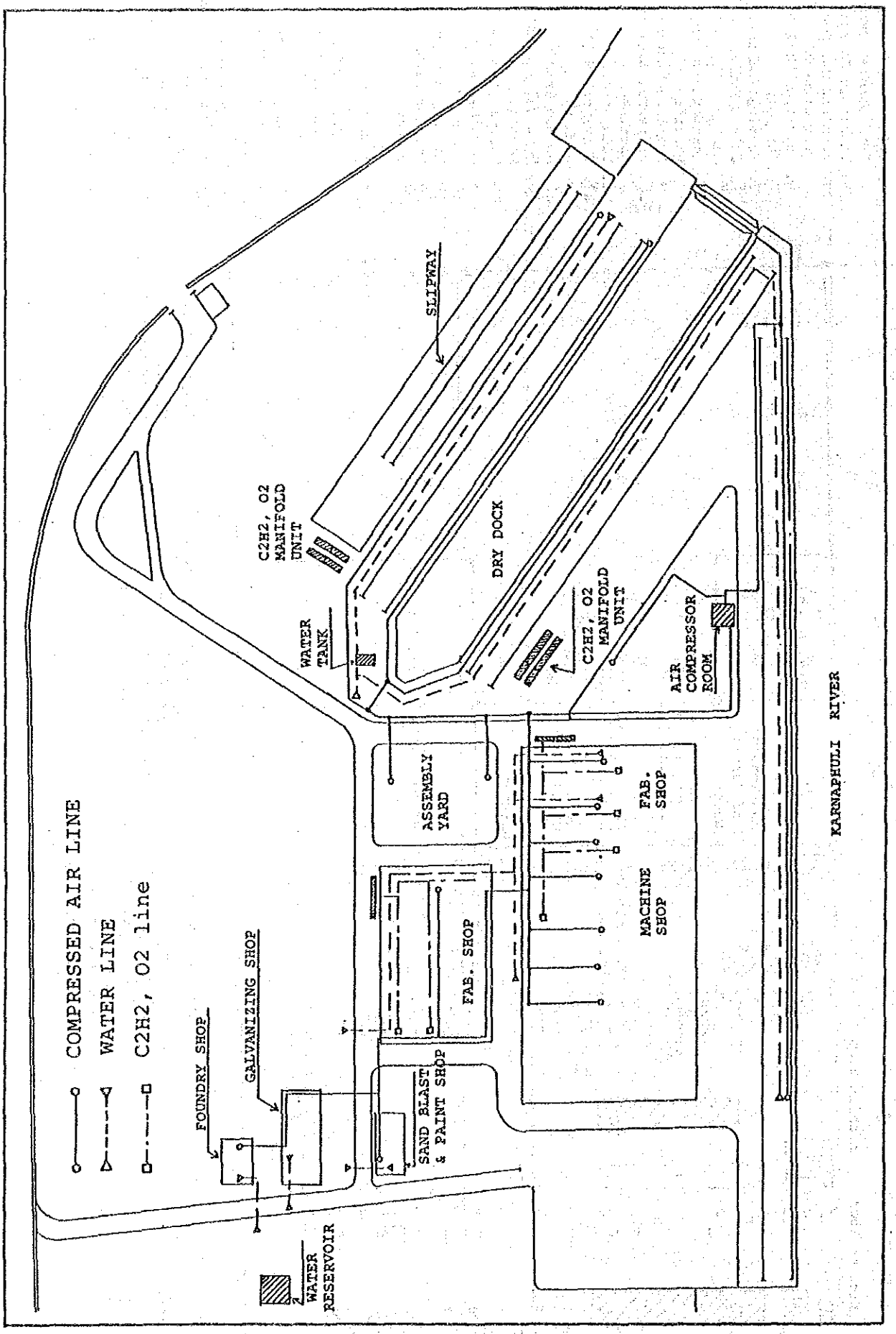


Fig. 6-3-8 Arrangement of Newly Planned Utility Pipe Line