6. Maintenance Business

As the container terminal is highly mechanized, problems with cargo equipment have great direct influence on the terminal operation.

Containers themselves as receptacles of cargo often get damaged during the process of transportation.

It is said that about 50% of discharged containers are damaged when they are returned from the consignee as empty containers.

(1) Maintenance of cargo handling equipments

Problems with container cranes or with transtainers stops the flow of container operation and makes the docking time of container ships longer. It completely stops the functioning of the container terminal.

Accordingly, the following measures are necessary.

① Mechanics should always be standing by, ready for trouble, while container operation is carried out.

② To keep the equipment in good condition, maintenance inspection should be done regularly.

③ Maintaining a sufficient supply of all spare parts.

(2) Container maintenance

For the safety of cargo transportation, containers must always be well maintained, and have to be used in good condition. First, the condition of all containers stowed at the terminal area are checked and all damaged ones are repaired completely, then, they are delivered to the next user.

8-3 Container Operation at No. 5 Wharf

This plan has been checked and the operation system presented here is based on ENAPU's current owned equipment list.

8-3-1 Ship's Berth and Container Yard Location

(1) Container Marshalling Yard (see Fig. 8-2)

Location : In front of No. 5 berth "B" 160 m x 56 m = 8,960 m^2

Slots : 396 TEU x 2.5 tiers = 990 TEU (Top lifter operation)

It is located in front of berth No. 5B, and occupies 8,967 square meters used mainly for export container receiving, sorting, and custody.

It is also used for facilitating the quick despatch of container ships by marshalling the containers the day before the ship's arrival, and arranging them according to the ship's loading sequence check list.

In the case where each ship is loading 300 TEU for export and unloading 300 TEU for import, it would be possible to store 3 ship's export containers prior to ship's arrival, as this yard will be able to store 990 TEU containers.

As another way of using, it is possible to store import containers temporarily in part of the

marshalling yard and to assist ship's quick departure.

After the ship leaves imported containers will be shifted to the container storage yard.

A top lifter forklift which has a fast working cycle is suitable for speeding container ship operation.

(2) Container Storage Yard

The container storage yard is used mainly as a storage yard for imported full containers and empty containers.

Location	:	Behind berth's No. 3 & 4 (see Fig. 8-2)			
A area	:	80 m x 200 m = 16,000 m^2	440	TEU	side loader
B area	:	60 m x 200 m = 13,200 m^2	432	"	transtainer
		60 m x 30 m =			
C area	:	3,200 m^2	106	"	top lift forklift
D area	:	5,750 m^2	135	"	side loader
		38,150 m^2	1,113	TEU	

Total container capacity 1,113 TEU x 2.5 tiers = 2,782 TEU

(2) + (1) = 3,722 TEU

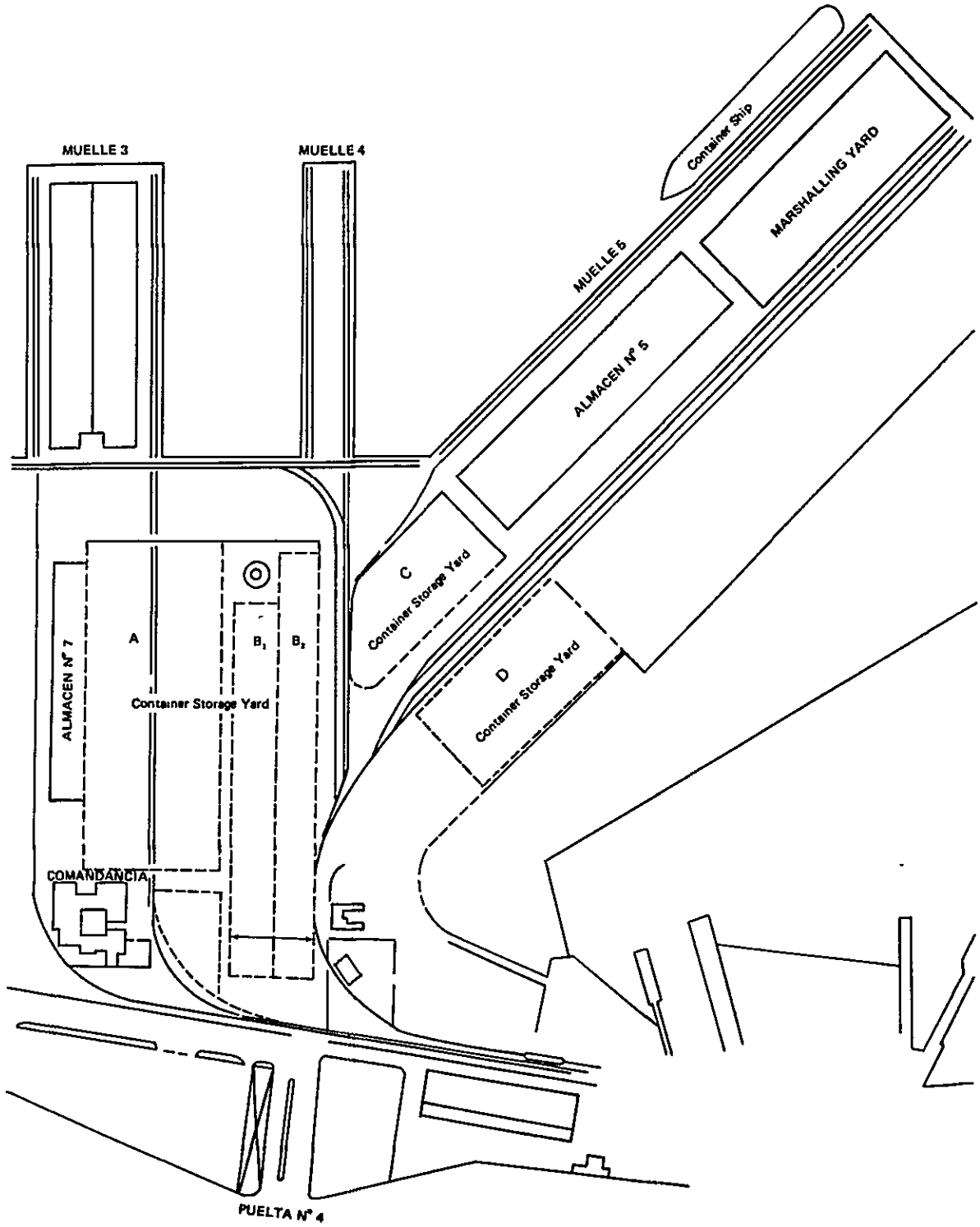


Fig. 8-2 Container Handling Plan at No. 5 Wharf

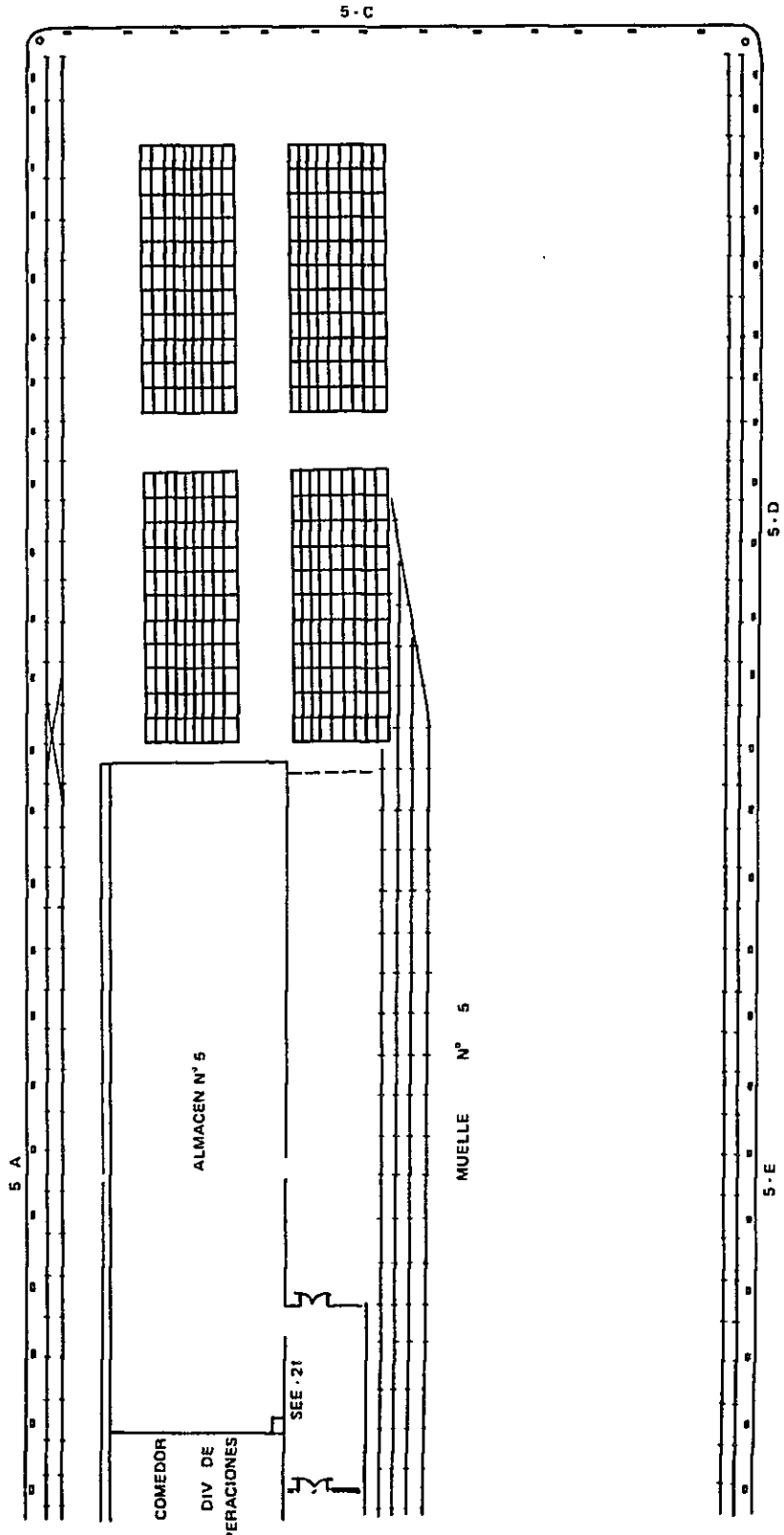


Fig. 8-2 (1) Plan of Stacking Containers

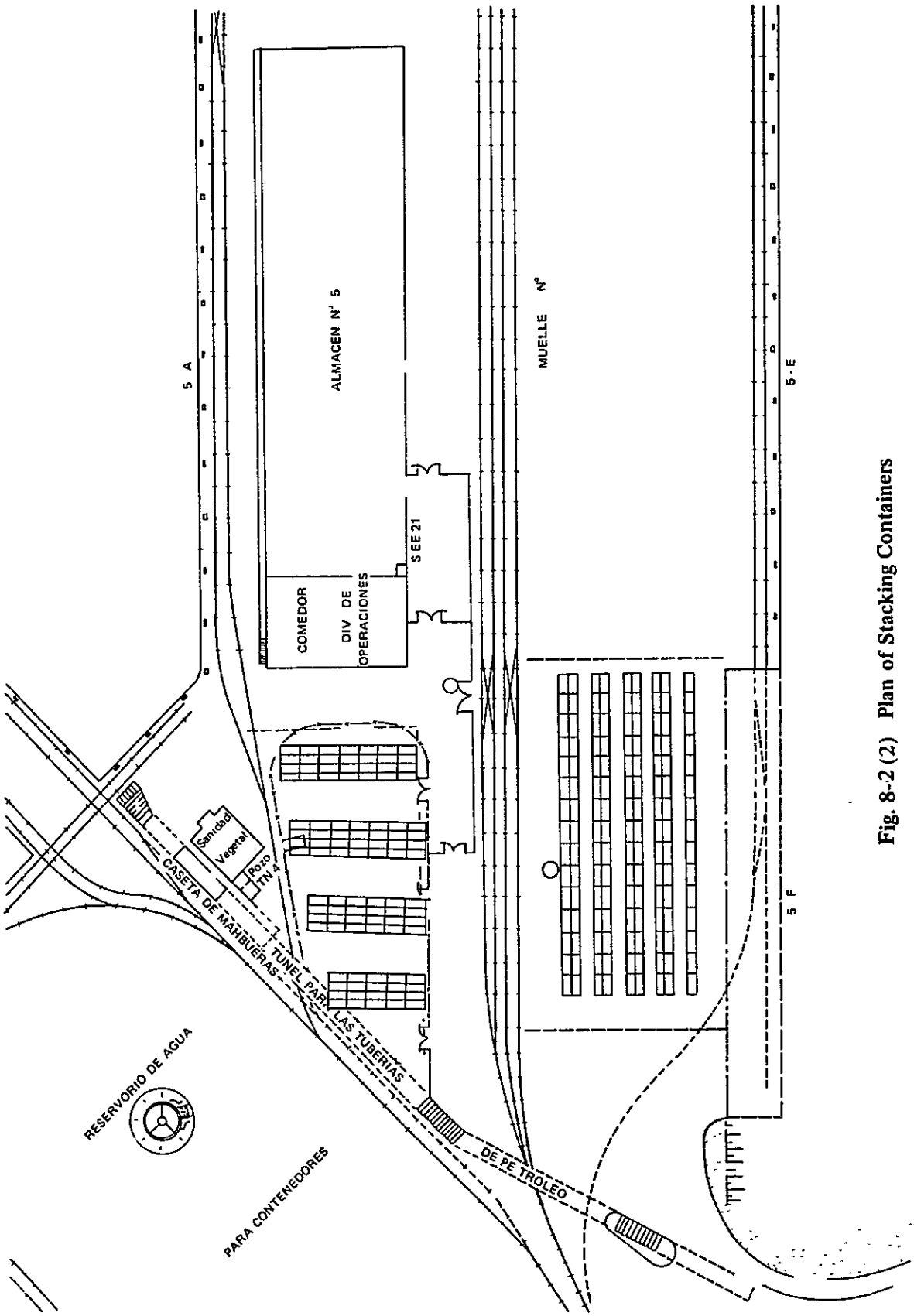


Fig. 8-2 (2) Plan of Stacking Containers

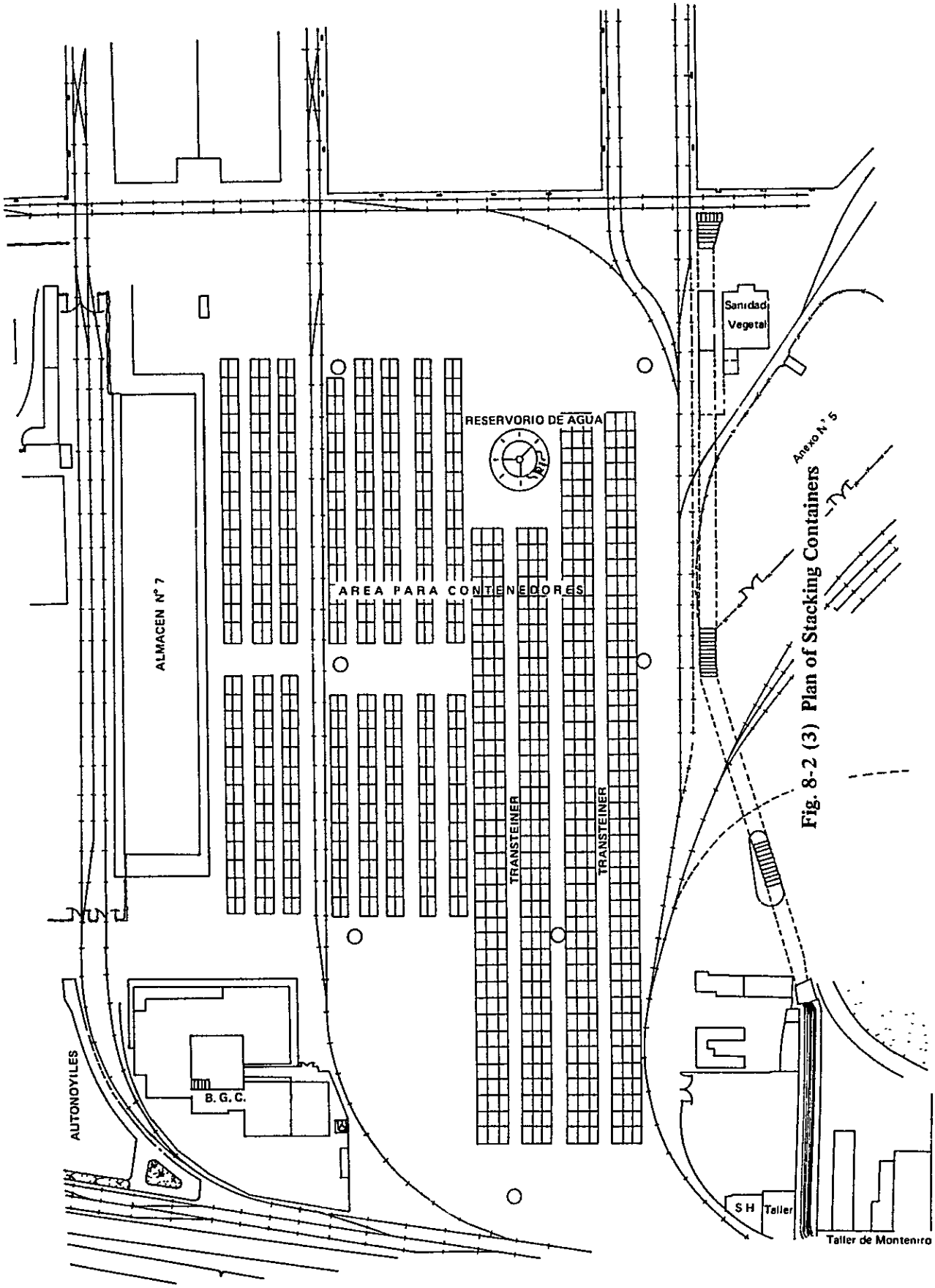


Fig. 8-2 (3) Plan of Stacking Containers

8-3-2 Necessary Equipment and Facilities

(1) Operation Control Center and Planning Office

The third floor of the water tank tower office is suitable for this purpose.

(2) Container Freight Station (C.F.S.) and Office

It is generally said that 15% of all containers handled are LCL containers, and on an average, 17 MT (measurement tons) of cargo are stuffed in one 20' container. The average length of stay of cargo in CFS is 14 days. According to our experience, LCL cargoes of 1.5 MT in CFS require a storage space of 1 square meter, so the annual number of tons stored per square meter will be 39 MT.

(365 days ÷ 14 days = 26 times, 1.5 MT/m^2 x 26 = 39 MT)

Therefore, the necessary CFS space can be calculated as follows:

$$\text{Needed CFS space} = \frac{L \times 0.15 \times 17\ \text{MT}}{39\ \text{MT/m}^2}$$

L: annual maximum number of handled containers (TEU)

Assuming L = 70,000 TEU, needed CFS space will be 4,577 m^2.

According to our investigation of the present devanning ratio in Callao, the LCL percentage is 40%. Therefore, using the following formula

$$\text{Needed CFS space} = \frac{L \times 0.4 \times 17}{39}$$

Assuming L = 70,000 TEU, CFS space = 12,205 m^2

Assuming L = 30,000 TEU, CFS space = 5,231 m^2

There are two warehouses next to this container storage yard. They are warehouses Nos. 6 and 7.

Warehouse No. 6 ..... 55 m x 40 m = 2,200 m^2

Warehouse No. 7 ..... 24 m x 150 m = 3,600 m^2

5,800 m^2

Until total number of containers exceeds 30,000 TEU (maybe 1 ~ 1.5 years after operation starts), Nos. 6 and 7 warehouses will be sufficient for CFS.

In the future more space will be required for CFS.

But, when the overall handling TEU increases, the LCL container ratio might decrease.

In that case, Nos. 6 and 7 warehouses can continue to be used for CFS for a longer time.

(3) Gate office and weight scale (see Fig. 8-3)

The No. 4 entrance of Callao port will be used as the container gate office. At least one weight scale, accurate up to 50 tons, and a checking bridge for container tops should be installed.

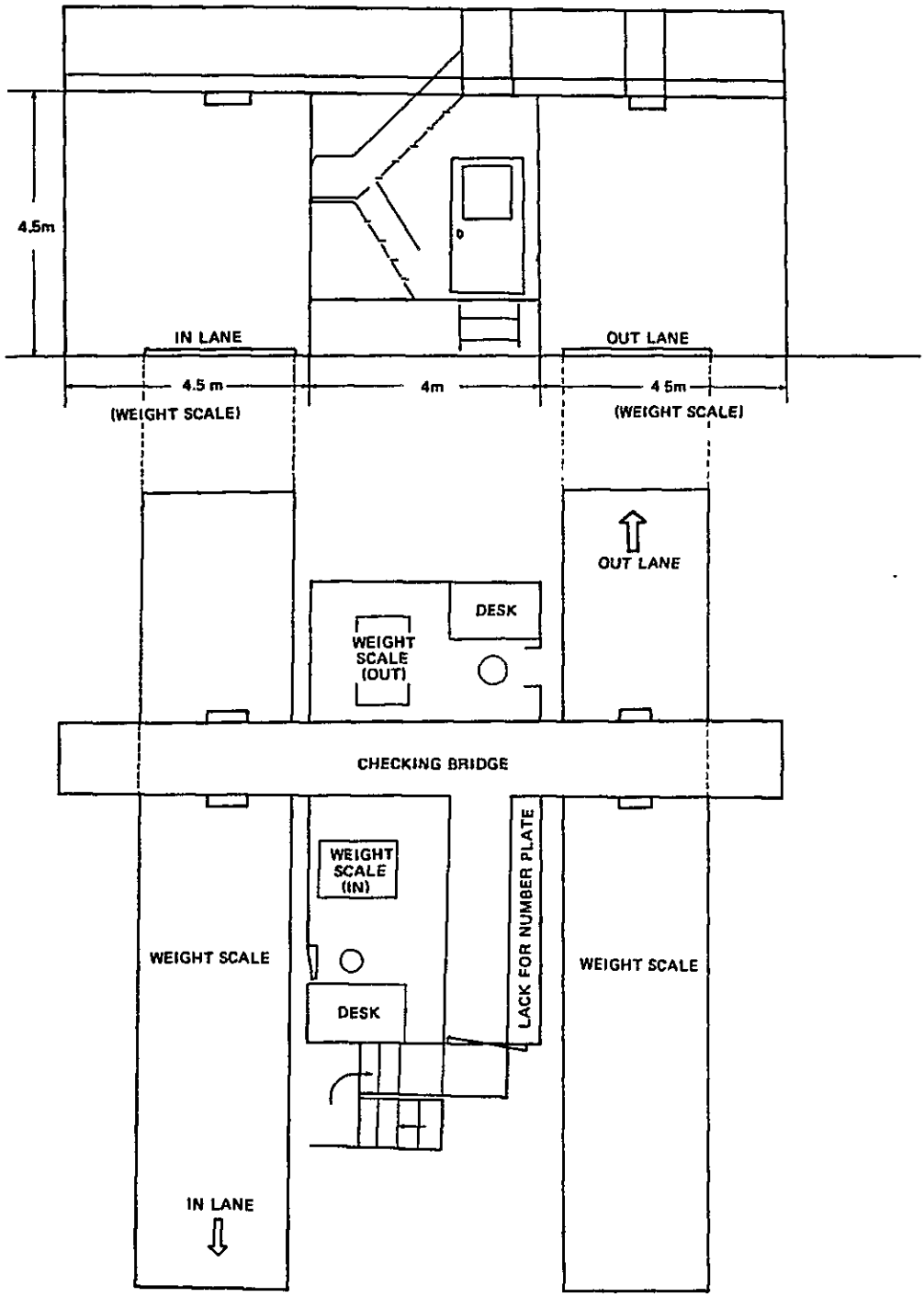


Fig. 8-3 Gate House Office and Container Top Checking Bridge

(4) **Mobile crane with automatic spreader (see Fig. 8-4)**

Mobile crane for lifting containers ..... 2 Units

(5) **Tractor and trailer**

Tractor heads	12 Units	
Container trailers (chassis)	20′	12 units
	40′	4 units

(6) **Transtainers (rated capacity 30.5 tons)** 2 Units

(7) **Side loaders**

For 20′ containers	3 units
For 40′ containers	2 units
	5 units

(8) **Top lift forklifts (20′/40′)**

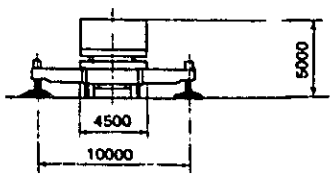
33 ton capacity	3 units
5 ton capacity	1 unit
3 ton capacity	2 units
	6 units

(9) **Wireless phones**

Units for base office	3 units (control room)
Portable units	15 units (equipment use)
	18 units

(10) **Worker's changing room, restroom**

CAPACITIES	
Single cargo handling	25/12/6 t
Motor grab operation	12t
WORKING SPEEDS	
Lifting/lowering, single cargo	33/60/100 m/min
Lifting/lowering, motor grab	60/100 m/min
Slewing	bis 1,6 x/min
Luffing	60 m/min
Travelling 1st gear	bis 3,2 km/h
Travelling 2nd gear	bis 6,4 km/h
DIESEL-ENGINE	
Power output	(540 PS) 397 kW
Engine revolution	1500 U/min
UNDERCARRIAGE	
Driving axles	2
Steering axles	4
Propping base	10.0 m
Width of crane	4.5 m
Inner turning radius	8.3 m
Outer turning radius	16,6 m
Weight of crane	ca 190 t



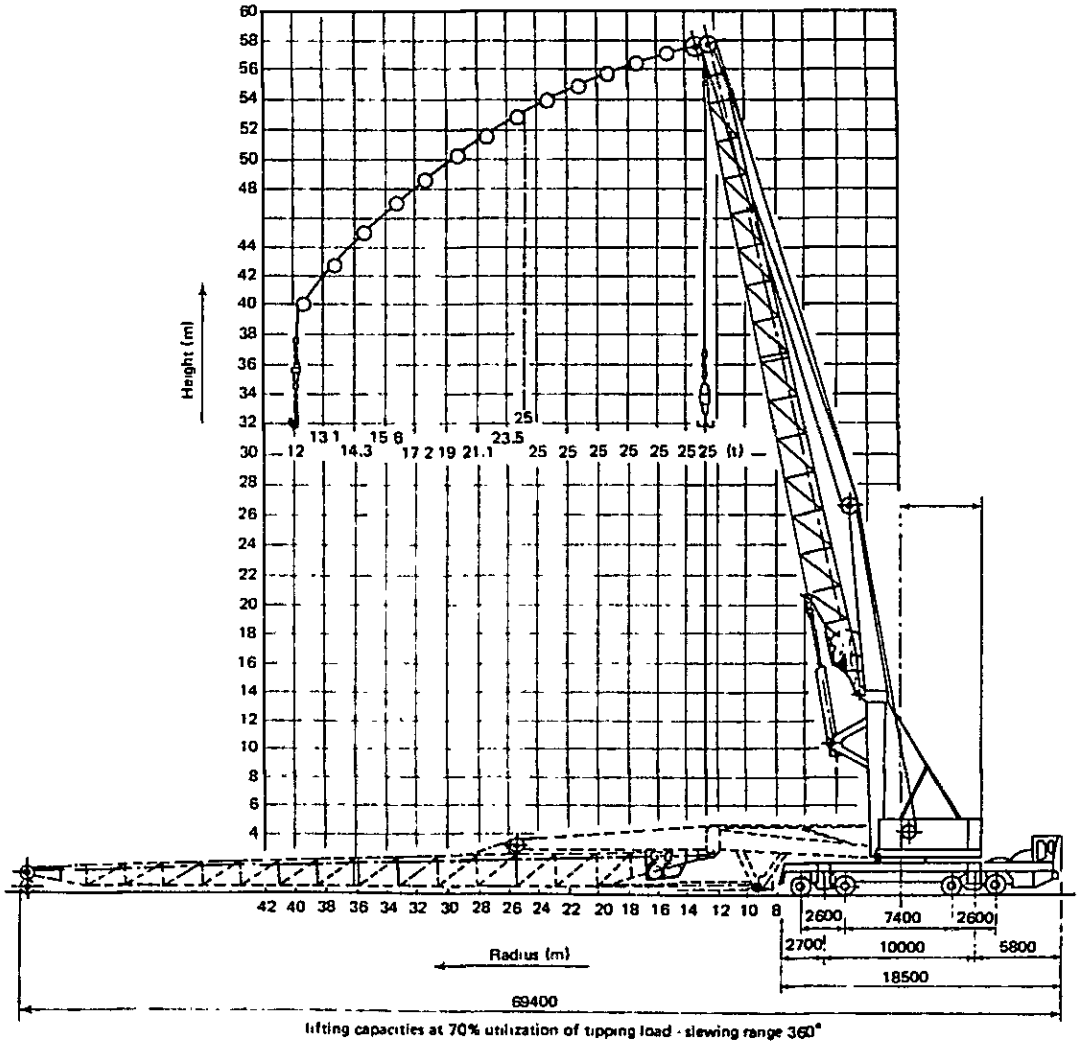


Fig. 8-4 MobileCrane

8-3-3 Operation System

(1) Operation system

The Japanese Study Team recommends tractor trailers with a transtainer system combined with side loaders, for container operation at No. 5 wharf. This selection is based on the following considerations:

① Distance between ship's berth and container storage yard is about 500 meters, and tractor head and trailers are the best transportation means for that distance.

② An operation which is faster and needs less yard space can be done by using straddle carriers rather than side loaders. But training of drivers and maintenance is more difficult in the former case and supplying parts for straddle carriers is not so easy in Peru. Well trained engineers (mechanics) and lots of spare parts would be needed for an operation using them.

③ To make the operation simple and to save space, a rubber tired transtainer system is desirable. However, ENAPU has already ordered 5 side loaders, so the Japanese Study Team recommends a combined system of Transtainers and Side loaders.

(2) Computerized operation

The container handling operation should not be computerized before the number of containers handled reaches 35,000 TEUs annually. Computerization should be introduced after staff members for container operation have become familiar with the operation. Manual container operation should be used at first, and after the operators get enough experience, then the computer system should be introduced.

(3) Container flow (Fig. 8-5)

① All imported containers are unloaded in accordance with the "unloading sequence list" prepared by the planner.

② All imported containers are transferred to the container storage yard and stacked in accordance with the "import yard decking plan", prepared by the planner.

③ Cargoes to be delivered to consignees as break bulk, are unstuffed in the container storage yard. Empty containers unstuffed are stored at the storage yard, or transferred to the shipping companies' private container storage yards by the shipping companies.

④ FCL containers (door to door service containers) are delivered as full containers directly from the container storage yard to consignees through the gate office.

⑤ Containers with consolidated cargoes (LCL cargoes) are moved to the designated shed (CFS). Cargoes are unstuffed from the containers, sorted by consignee, and then delivered.

⑥ If space is available, empty containers are stacked at the storage yard until time of shipment.

⑦ Prior to ship arrival, all export (full and empty) containers are received at the container marshalling yard behind the berth (5B Berth) apron, and the "export yard decking plan" should be made by the planner.

⑧ The planner prepares the "loading sequence list". This is based on the "export yard

decking plan" and the "ship's available space plan". All export (full and empty) containers are loaded onto the ship in accordance with the "loading sequence list" prepared by the planner.

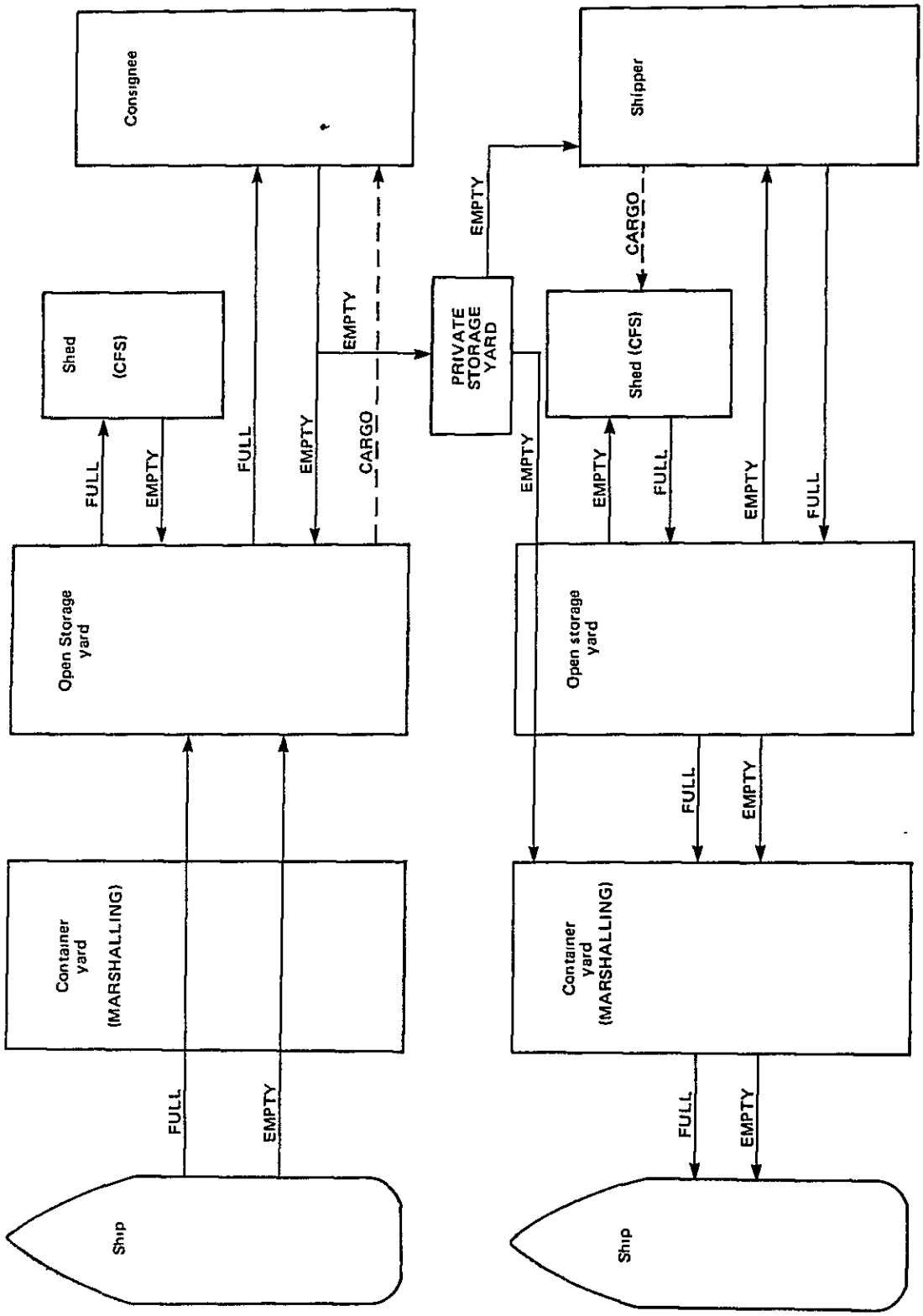


Fig. 8-5 Container Flow

(4) **Import container operation procedure**

① Containers unloaded from ships are loaded directly onto trailers, according to the "unloading sequence list" based on the "ship's discharging stowage plan". Then, they are transferred to the container storage yard. Containers are then unloaded from the trailers by sideloader or transtainer and piled up in columns of three.

LCL containers are transferred to the designated storage area near the CFS (Container Freight Station).

② The containers should be stacked according to the "yard stacking plan" prepared by the planner.

Constant monitoring of the "yard stacking plan" is required to ensure that space is available for each container when it arrives at the yard. Locations of all containers and inventory of all containers must be clear at any time.

③ Consignees or their agents should inform the terminal office of containers which are going to be taken out of the terminal at least one day prior to their drayage.

④ The terminal office should check if all custom documents are clear, and if the consignees have paid all of the terminal charges.

⑤ The yard planner checks the "consignees' taking out order", and the latest "yard stacking plan". Then he prepares "daily working schedule list of delivery" for the next day's yard operation.

⑥ When the consignee's truck arrives at the gate office, the gate clerk checks the "working schedule list of delivery". If he finds containers to be taken out on the list, he gives sequence number plate of working schedule to the truck driver.

⑦ The truck driver proceeds to the appointed yard location under the transtainer of side-loader's transfer point. After receiving the container, he drives the truck back to the gate office.

⑧ The gate clerk checks the container number and the "working schedule list of delivery". He also checks seal condition and seal number. The gate checkers investigate the conditions of the exterior of the containers and if they find any abnormal conditions, they should report those damages to the gate clerk immediately.

⑨ The gate clerk issues the E.I.R. (out) according to the gate checker's investigation, and gives one copy of the E.I.R., which is signed by both the driver and the gate clerk, to the truck driver and lets him go.

(5) **Export container operation procedure**

① The terminal begins receiving of export full containers 7 days prior to the vessel's scheduled arrival. The yard planner appoints the export containers' yard space according to destination, ship's name, weight of container, nature of cargo, and other special requirements (over sized container etc.)

② On the occasion of receiving the containers, the following information is the minimum that should be provided by either the shippers or their agents. They should show the "Gate in Slip" at the gate office when they bring in the container.

Gate in Slip (Fig. 8-6)

(a) container number

SHIP OPERATORS	☐ Japan Line	☐ K Line	☐ MO Line	☐ NYK Line
	☐ Showa Line	☐ YS Line	☐ SK Line	☐ Toyo Line
	☐ AJCL	☐ ANL	☐ Ben Line	☐ CMCR
	☐ FBS	☐ Hapag-Lloyd	☐ Lauro Line	☐ Lloyd Triestino
	☐ Maersk Line	☐ NOL	☐ OCL	☐ OOCL
	☐ Scan Dutch	☐ Other : _____		

SHIP'S NAME	Voy. No.					
CONTAINER NO.		KIND OF CONTAINER	SIZE	20	40	
SEAL NUMBER			TYPE	DRY	REEFER	FLAT RACK / OPEN TOP
				OTHERS		
GROSS WEIGHT		COMMODITY	Ordinary	Reefer	Dangerous	OTHERS
PORT OF DISCHARGE		DANGEROUS CARGO (Classification)				
PORT OF DISCHARGE SERVICE	CY or DOOR / CFS	FROZEN/CHILL TEMPERATURE	(°F)	(°C)		
SHIPPER'S NAME		CUSTOMS	CLEARED	NOT CLEARED		
CUSTOM FOREWARDER TEL· ( )		DATE SIGNATURE				

(REMARKS)	DOCUMENTS RECEIVED/NOT	D/R	CLP	E/D	
	CONTAINER SLOT LOCATION	ROW	BAY	TIER	
	CY				
	MY				
	IN DATE				

Fig. 8-6 Container Cargo Slip (Gate In)

(b) name of shipping company (ship's operator)
(c) name of the ship it is to be loaded on
(d) name of the port where the container will be unloaded
(e) container size and type
(f) weight of the container (gross weight)
(g) name of the commodity in the container
(h) confirmation showing end of custom's procedures
(i) customs agent's name (telephone number and name of the person who is in charge)

③ The gate clerk and checkers check the conditions of container's exterior container number, and seal number/conditions.

④ The contents of the "list of taking in" are passed on to the control center and the control center assigns the adequate location (slot) to the side-loader/transtainer operator by wireless phone. The truck driver is told the location by the gate clerk.

⑤ When the unloading (receiving) operation of the container has been finished, the operator of the side-loader/transtainer should report the container number and it's yard location (slot number) to the control center by wireless phone.

⑥ The yard planner can confirm the container's actual yard location. If necessary, he corrects his "yard decking plan".

⑦ The ship's planner makes ship's available space for container loading clear by contacting with ship's agent, and according to the "yard decking plan", he prepares the "loading sequence list". Then he distributes that list to the concerned people, such as people at the control center, the ship's supervisor, the yard clerk, the operator of equipment and the tractor drivers.

⑧ After berthing of the container ship, according to the "loading sequence list", containers in M.Y. are transferred directly by using a top lift forklift, from their yard location to the wharf apron under the mobile crane. Containers in CY are put onto the trailers using a transtainer or side-loader from their yard location to the wharf apron under the mobile crane.

⑨ The mobile crane operator reports the container number to the control center and picks up container, then puts the container in the allocated space according to the "loading sequence list".

⑩ On board, a supervisor and a tally man confirm that the container has been placed in the right stowage location on the ship.

⑪ The containers which are loaded on deck should be lashed properly by the lashing labourers for ocean going purposes.

⑫ As soon as the ship's loading operation has been finished, a final stowage plan should be completed and given to the chief officer of the ship through the ship's agent. Other cargo documents such as a cargo manifest, and a container loading list which are prepared by a document section, also should be handed over to the ship.

8-3-4 Management

The number and assignments of workers required to perform the above operations efficiently will depend on various factors, such as choice of operation system, labour regulations and

contracts, and work schedules as well as the abilities of the workers employed. The Japanese Study Team's following recommendation is based on the present working conditions at the port of Callao. However, in this study described below, it is assumed that some working conditions can be changed to make container operation smoother.

(1) Working time schedule

While the number of containers handled is not so great the following working schedule will be good enough to manage the operation smoothly.

i) 2 (two) shifts a day

			rest time			
1st shift	from	08:00	(12:00 – 13:00)	to	17:00	8 hours
2nd shift	from	19:00	(24:00 – 01:00)	to	04:00	8 hours
						16 hours working

When the number of ships has increased, it is necessary to increase workers and to take the following working schedule.

ii) 3 (three shifts a day

			rest time			
1st shift	from	08:00	(12:00 – 12:30)	to	15:30	7 hours
2nd shift	from	16:00	(20:00 – 20:30)	to	23:30	7 hours
3rd shift	from	00:00	(04:00 – 04:30)	to	07:30	7 hours
						21 hours working

(2) Allocation of members

i) Operation management department

	(08:00 – 17:00) Day time	(17:00 – 08:00) Night time
Ship's planner	1	1
Wireless phone operator	3	2 (control center)
Yard planner	1	1
Yard clerk	2	– (working day time only)
Gate clerk	2	–
Ship supervisor	1	1
	10 people	5 people

ii) Operation traffic department

Mobile crane operator	2	2
Tally man	2	2
Signal man	2	2
Worker on wharf apron	4	4
People for lashing operation on board	10	10
Tractor driver	12	10
Side-loader operator	5	3

Top lift forklift operator	3	2
Transtainer operator	2	2
Gate checker	3	– (working day time only)
	45 people	37 people

Following workers will be required for each system

2 shifts system: 55 people (day) + 42 people (night) = 97 people

3 shifts system: 55 (1st) + 42 (2nd) + 42 (3rd) = 139 people

(3) Member's duty list

i) Operation management department

Ship's planner	:	Preparation of ship loading/unloading plan, and supervision of entire operation.
Wireless phone operator	:	Making contact with each operator of equipment using wireless phone and keeping operation normally according to the work sequence list.
Ship supervisor	:	Supervision of workers on board and workers on wharf, assistant to the ship's planner.
Yard planner	:	Preparation of container yard plan and supervision of operation in the container yard.
Yard clerk	:	Receiving and delivering of containers at the yard, assistant to the planner.
Gate clerk	:	Receiving and delivering of containers at the gate office, and necessary documentation work.

ii) Operation traffic department

Mobile crane operator	:	Operation of mobile crane to load/unload containers to/from ship.
Tally man	:	Checking each container number and seal condition and exterior conditions of containers.
Signal man	:	Sending signal to mobile crane operator from deck, for keeping safety operation.
Workers on wharf	:	To assist mobile crane operator for the smooth transfer of containers onto/from chassis at wharf apron.
People for lashing	:	Lashing/umlashing of containers stowed on deck and hatch covers.
Tractor operator	:	Transfer of containers between ship side wharf apron and container storage yard.
Side-loader operator/ Top lift forklift operator	:	To load/unload containers to/from chassis at container storage yard or at container marshalling yard.
Transtainer operator	:	To load/unload containers to/from container chassis at container storage yard.

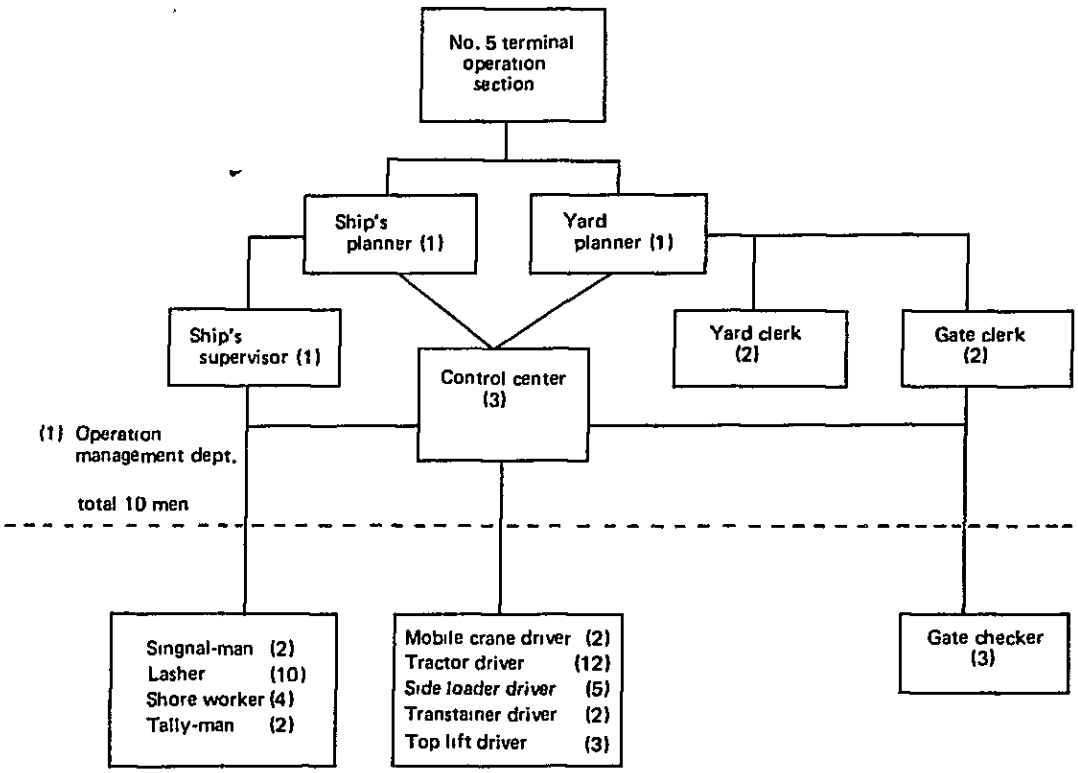


Fig. 8-7 Organization Chart of Terminal Operation Section

CHAPTER 9
Design, Construction and Rough Cost Estimates

CHAPTER 9

Design, Construction and Roads

CHAPTER 9. DESIGN, CONSTRUCTION, AND ROUGH COST ESTIMATES

9-1 Design of Port Facilities

9-1-1 Port Facilities

Port facilities included in the short-term development plan are as follows:

(1) Container wharf
(2) Grain wharf
(3) Container yard temporary revetment
(4) Reclamation work
(5) Pavement
(6) Buildings for offices and C.F.S. etc.
(7) Related facilities (electric power supply, drainage system and water supply)
(8) Silo for grain
(9) Handling equipment

9-1-2 Container Wharf

(1) Outline and Design Conditions

A marginal wharf will be constructed inside the south breakwater, and two container cranes traveling on rails will be installed for the berthing of full container ships.

The structure and the design conditions will be as follows:

Length of the wharf		300 m
Alongside water depth		−12 m (C.D.L.)
Crown height of the wharf		+3.0 m
Seismic intensity	horizontal intensity	0.15
	vertical intensity	0.0
Berthing speed of vessels		10 cm/sec
Surcharge		
uniform load	container yard	
	at normal condition	3.0 t/m^2
	during earthquakes	3.0 t/m^2
	apron	
	at normal conditions	1.0 t/m^2
	during earthquakes	0.5 t/m^2
Container crane load		
	rail span	16 m
	No. of wheels	8 wheels/corner
	self-load	660 t
	load of wheels as follows	

		Vertical	Horizontal
In operation	shore side	36.8 t/wheel	10% of vertical load
(16 m/sec)	land side	28.5 t/wheel	
In earthquake	shore side	25.1 t/wheel	Total seismic force
	land side	35.3 t/wheel	(99 tons)

Table 9-1 shows specifications of container cranes operated in Japan.

Type of Fender

The hull of container vessels are weaker than that of conventional cargo vessels. It is required to select a suitable type of fender so that pressure on the hull will be as small as possible. Rubber fenders which have rubbing board with a large contact surface will meet the requirements.

Table 9-1 Specifications of Container Crane Used in Japan

Berth			No 1		No. 3		No. 4		No. 6		No 8				No 5		No 6		No. 7	
Crane No			OC11		OC31		OC41		OC61		OC81		OC82		HC51		HC61		HC71	
Crane Type			High speed, rope trolley		High speed, rope trolley		Semi-rope trolley		Flexible boom, high speed, semi-rope trolley		Flexible boom, rope trolley		Flexible boom, high speed, semi-rope trolley		High speed, rope trolley		Semi-rope trolley		Semi-rope trolley	
Completion date			Jun 1975		Apr 1975		Feb. 1974		Mar. 1973		Mar 1972		Oct. 1972		May 1974		Jan 1971		May 1970	
Lift load		(t)	45.0		50 0		45.0		50 0		44.0		49 6		43.5		39.5		39.5	
Lift load		(t)	30 5 35 0 (Hatch cover)		30 5 35.6 (Hatch cover)		30.5 35 6 (Hatch cover)		30 5 35.6 (Hatch cover)		30 5 35.5 (Hatch cover)		30.5 35.6 (Hatch cover)		30.5		30.5		30.5	
Crane gauge		(m)	2.5		2.0		2.0		2.0		2.0		2.0		2.0		2 0		2.0	
Rail span		(m)	16 0		16.0		16 0		16 0		16 0		16 -		16 0		16 0		16 0	
Traversing (m)	Trolley overall traversing distance		62.5		67 0		67.0		67 0		67.0		67.0		61.0		57.0		57.0	
	Out reach (from rail on sea side)		35.5		35 0		35.0		35.0		35.0		35.0		35 0		33.5		33 5	
	Back reach (from rail on land side)		11 0		16.0		16 0		16.0		16.0		16.0		10.0		7.5		7.5	
Lift (m)	Overall lift		37 0		37.0		37.0		37.0		37 0		37.0		38.6		33 5		33.5	
	Overall surface		25.0		25 0		25.0		25.0		25.0		25.0		25.0		21.7		21.7	
	Below rail surface		12 0		12.0		12.0		12.0		12 0		12.0		13.6		11.8		11.8	
Effective interval within legs			16 0		16 0		16 0		16.0		16 0		16 0		16 0		14.5		14 5	
Effective height beneath bridge beam		(m)	9 0		9 0		9.0		9.5		9 0		9.5		10 7		9 0		9 0	
Power (cable winding)			A C 3000V 50Hz		A.C 3000V 50Hz		A.C 3000V 50Hz		A C 3000V 50Hz		A.C 3000V 50Hz		A.C 3000V 50Hz		A.C 550V 50Hz		A C 550V 50Hz		A C 550V 50Hz	
Generator drive motor output (KW)			A C 500		3φ Transformer 750 KVA		3φ Transformer 500 KVA		3φ Transformer 750 KVA		A.C 350 (75% ED)		A.C 500 (60% ED)		3φ Transformer 800 KVA		A.C 400 (Continuous)		A C 400 Continuous)	
Generator combination			Winding and traveling	Traversing and elevation	Winding and traveling	Traversing and elevation	Winding and traveling	Traversing and elevation	Winding and traveling	Traversing and elevation	Winding and traveling	Traversing and elevation	Winding and traveling	Traversing and elevation	Winding and traveling	Traversing and elevation	Winding and traveling	Traversing and elevation	Winding and traveling	Traversing and elevation
Generator output		(KW.A)	405	100	SCR500A	SCR300A	-	SCR150A	-	SCR300A	250	100	400	110	-		290	110	290	110
Motor output	Winding	(Rated)	D.C 370 (Continuous)		D.C 370 Continuous)		D.C 220 (Continuous)		D.C 370 (Continuous)		D C 220 (Continuous)		D.C 185 x 2 (Continuous)		D.C 185 x 2 (Continuous)		D.C 125 x 2 (Continuous)		D.C 125 x 2 (Continuous)	
	Traversing	(Rated)	D.C. 80 (Continuous)		D.C 45 x 2 (Continuous)		D C 25 x 2 (Continuous)		D.C 45 x 2 (Continuous)		D.C 50 (60% ED)		D C 100 (40% ED)		D C 75 (Continuous)		D C 25 x 2 (Continuous)		D C 25 x 2) (Continuous)	
	Traversing	(Rated)	D.C 12.5 x 8 (30 mins)		D.C 15 x8 (30 mins)		D C 15 x 8 (30 mins)		D.C 15 x 8 (30 mins)		D.C 12.5 x 8 (30 mins)		D.C 12.5 x 8 . (30 mins)		D.C 30 x 4 (60 mins)		D C 20 x 4 (30 mins)		D C 20 x 4 (30 mins)	
	Elevation	(Rated)	D C 75 (60 mins)		D.C 75 (30 mins)		D C 7.5 (30 mins)		D.C 95 (30 mins)		D.C 90 (30 mins)		D.C 90 (30 mins)		D.C 75 (30 mins)		D.C 67 (30 mins)		D C 67 (30 mins)	
Speed (m/min)	Winding Total load/No load		50/120		50/120		35.5/90		50/120		35.5/90		50/120		50/120		35.5/71		35.5/71	
	Traversing		150		150		125		150		125		150		150		125		125	
	Traveling		45		45		45		45		45		45		45		45		45	
	Elevation (min/cycle)		8		8		8		8		8		8		8		8		8	
Number of wheels		Quay side	8 x 2		8 x 2		8 x 2		8 x 2		8 x 2		8 x 2		8 x 2		6 x 2		6 x2	
		Shore side	8 x 2		8 x 2		8 x 2		8 x 2		8 x 2		8 x 2		8 x 2		6 x 2		6 x 2	
Maximum wheel load (t/wheel)	In operation	Quay side	29 6		37 7		30.1		38 2		33.7		38.1		30 3		37 1		37.4	
		Shore side	27.0		29 6		28 2		28.5		21 8		27 6		32 4		28 9		26 4	
	In storm	Quay side	31 6		30 8		26 4		35 9		31 3		30 4		32 9		30 2		30.5	
		Shore side	41.0		46 0		45 3		43 6		35.7		43.7		45 2		43 8		42.5	
Traveling range		(m)	270		400		400		450		300		300		150		200		200	
Crane weight		(t)	550		615		575		660		583		635		631		521		510	
Traveling rail height Quay side/Shore side		(m)	4 0	4 0	4 02	4 18	4 02	4 18	4.02	4 18	4 02	4 18	4 02	41 8	3 82	3 98	3.82	3.98	3.82	3.98
Operating room mounting system			Trolley suspension		Trolley suspension		Trolly suspension		Trolly suspension		Trolly suspension		Trolly suspension		Trolly suspension		Trolly Suspension		Trolly suspension	
Remarks			With steady rest Telescopic spreader, 2 Spreader truck, 2		With steady rest Telescopic spreader, 1 Spreader truck, 1		20ft Spreader, 1 40ft Spreader, 1		With steady rest 20ft Spreader, 1 40ft Spreader, 1		20ft Spreader 2 40ft Spreader, 2 Spreader truck, 3		With steady Suspension fixture, 1		With steady rest Sea side rocking leg Stacking frame		Spreader 20' x 1 35 x 1 Stacking frame With receptacle		Spreader 20' x 2 40' x 2	

Source: Keihin (Tokyo Bay) Port Development Authority

(2) Type of Structure

Type of structure must be determined considering various conditions of the site, construction period and procurement of construction materials. The conditions to be considered include the following:

Sea conditions	The construction site is calm within the harbour.
Meteorological conditions	Throughout the year, rain is scarce and strong winds do not occur.
Soil conditions	As described under Geological Conditions in Chapter 3, the upper stratum consists of very soft alluvium. Immediately under this stratum (about −21 m) a very hard bearing stratum is found.
Earthquakes	The site is located in the earthquake zone.
Construction period	The construction must be completed by the end of 1987.
Construction site	The site is located in a port with heavy traffic.
Construction base	As vacans space is not available, the existing freight handling yard will be used for the construction base. Therefore a large base will not be desirable. There is no caisson yard.
Procurement of construction materials	Steel pipe piles of large diamters and steel sheet piles will be imported. Types of available shaped steel are limited.

On the basis of the above conditions, the following type of structures will be studied for the container wharf.

1) Concrete caisson quaywall
2) Steel sheet pile cellular cofferdam quaywall
3) Pile type pier
4) Walled Steel Pipe Pile quaywall

Structure of each type is shown in Figs. 9-1 to 9-6.

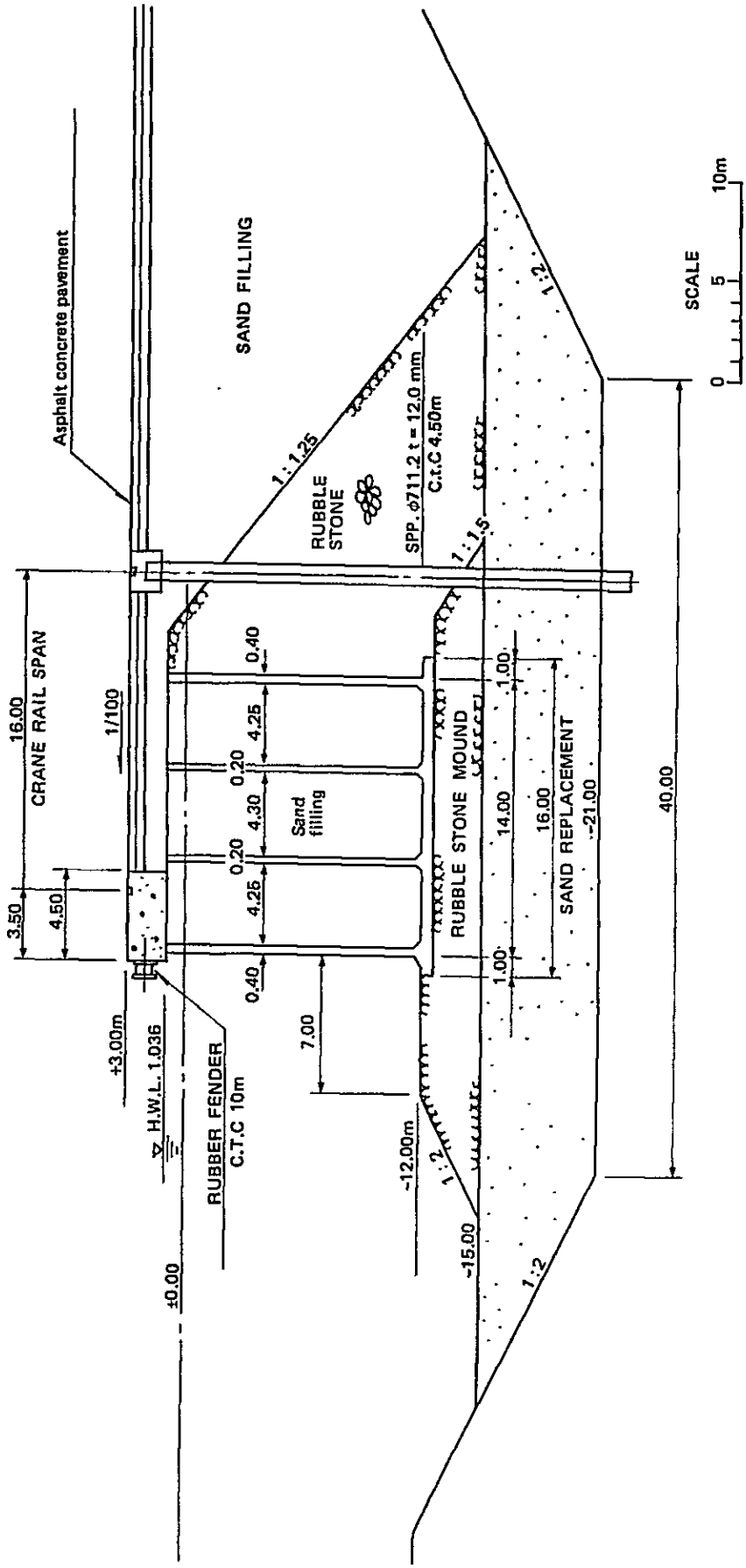


Fig. 9-1 Container Berth Quaywall (Concrete Caisson Type)

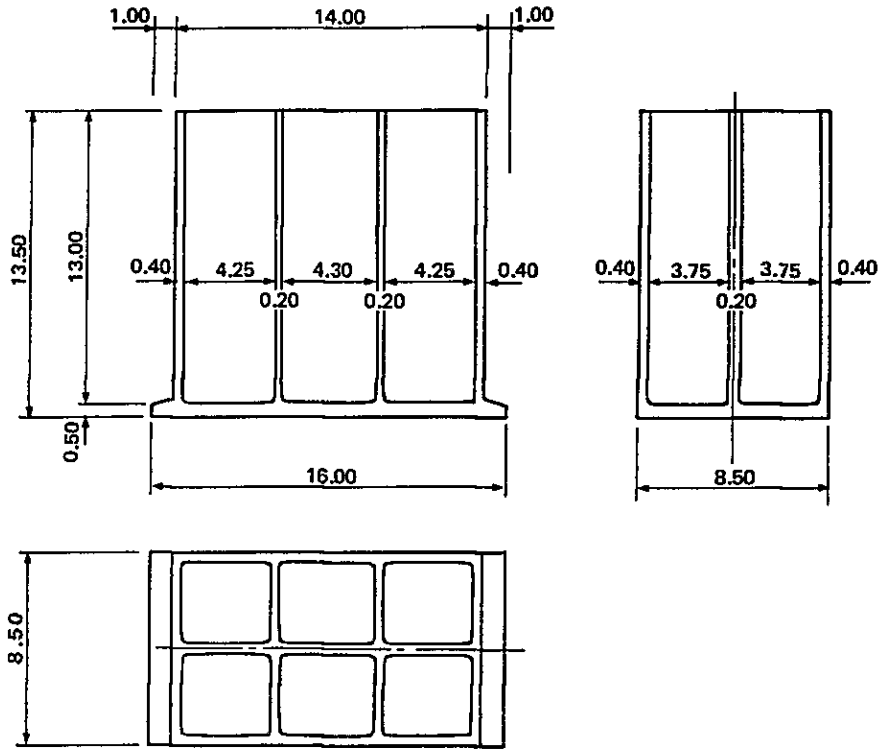


Fig. 9-2 Concrete Caisson Detail

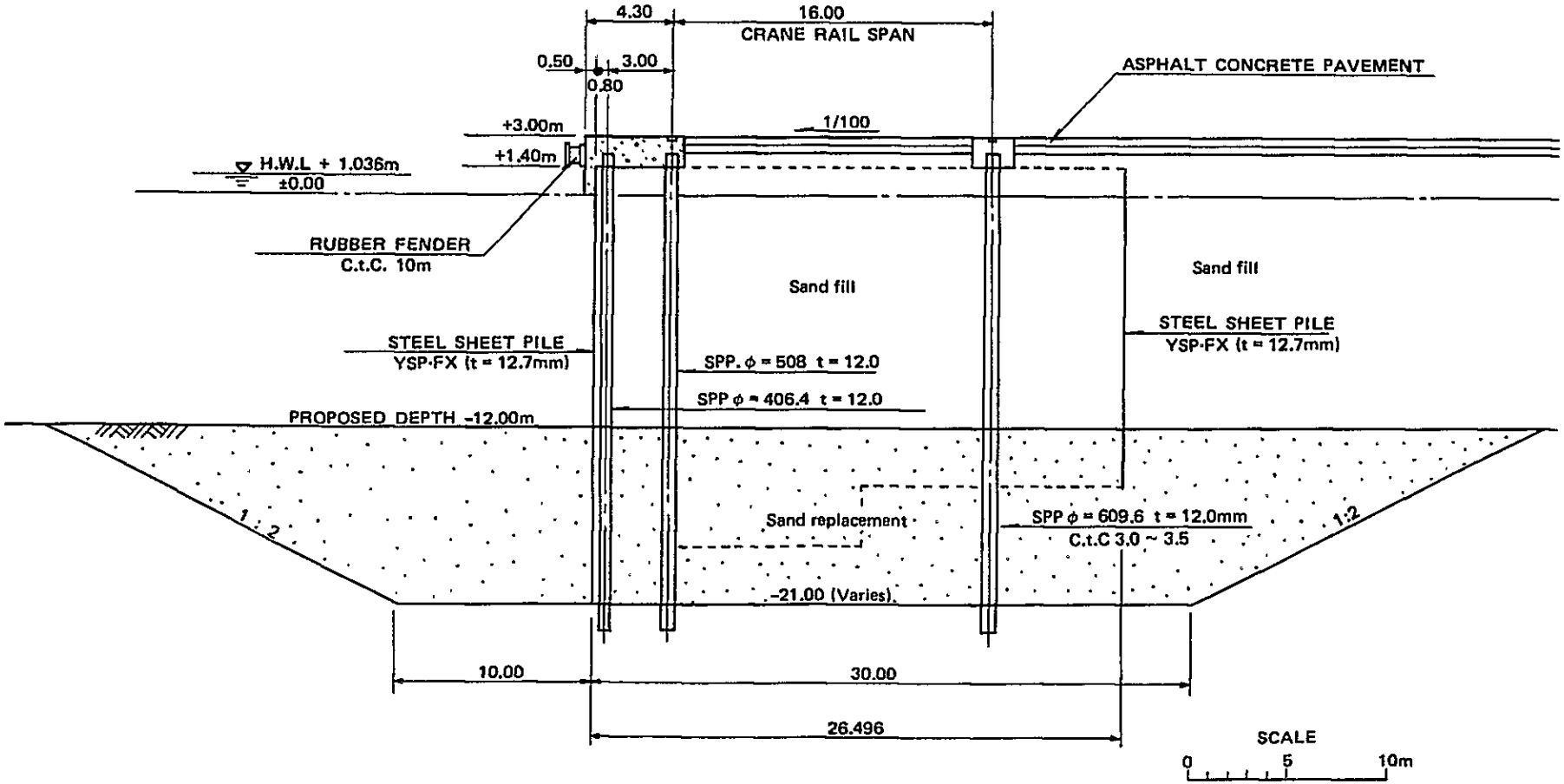


Fig. 9-3 Container Berth Quay Wall (Steel Sheet Pile Cellular Cofferdom Type)

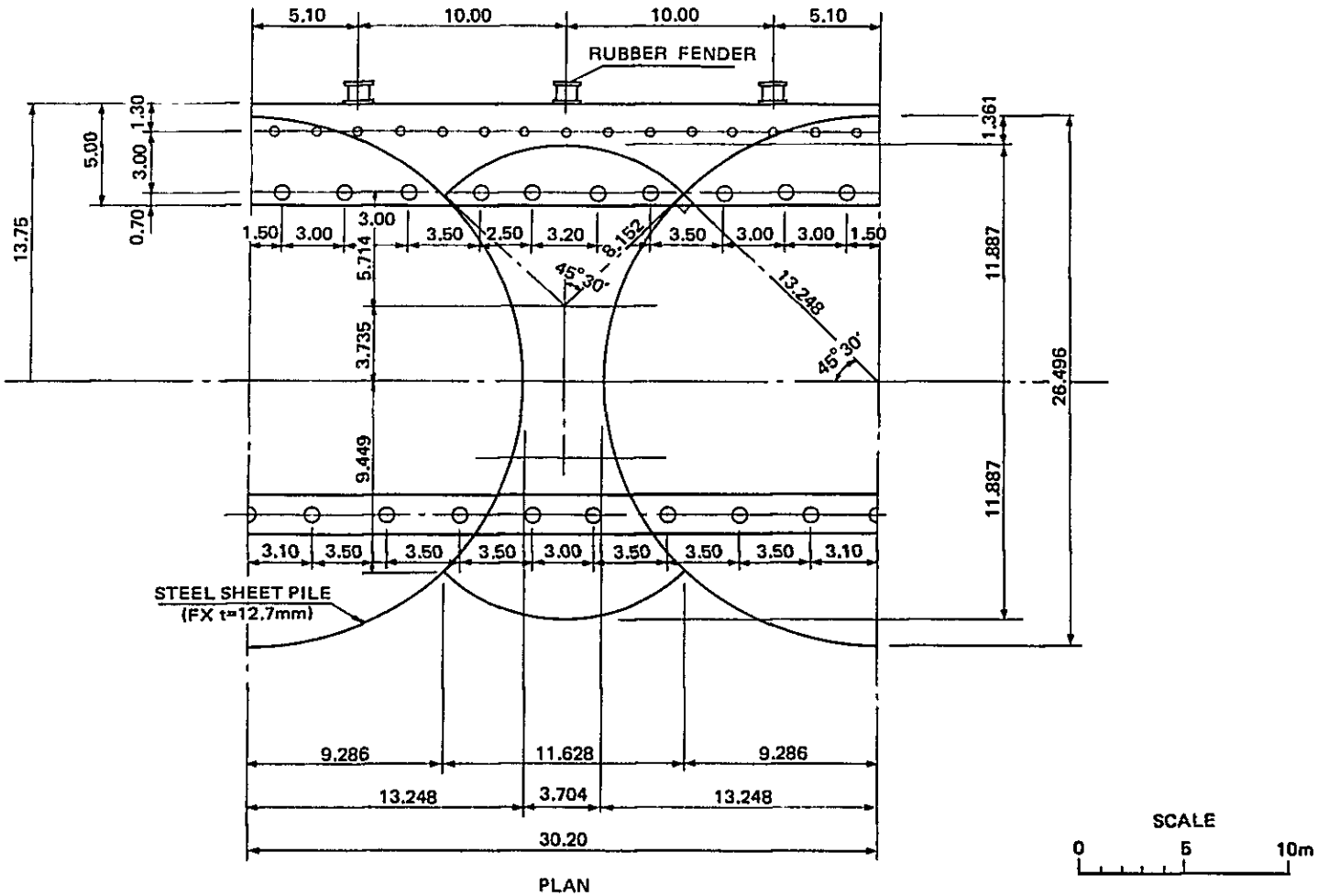


Fig. 9-4 Container Berth Quay Wall (Steel Sheet Pile Cellular Cofferdom Type)

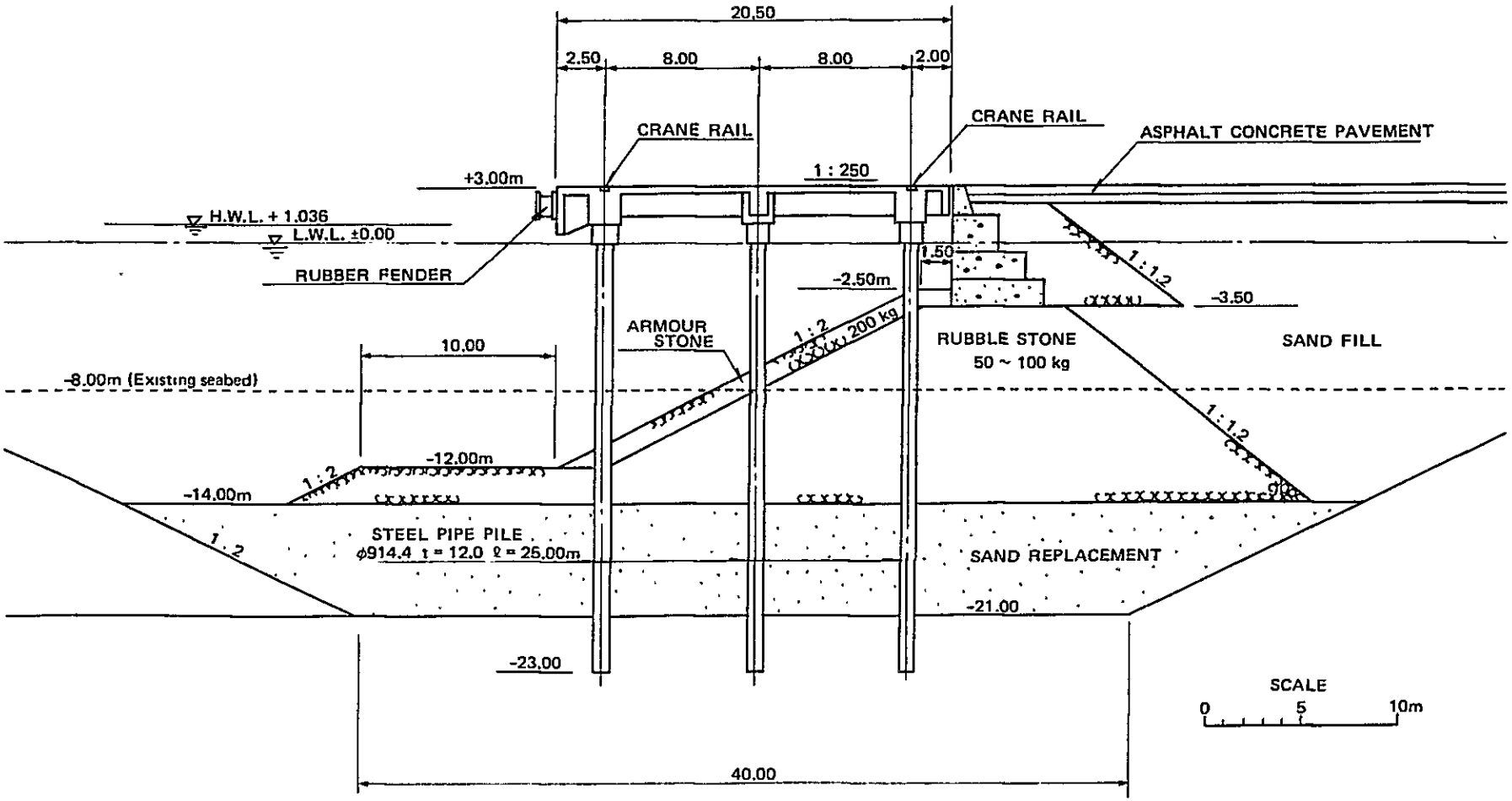


Fig. 9-5 Container Berth Piled Wharf (Steel Pipe Pile Supported Platform)

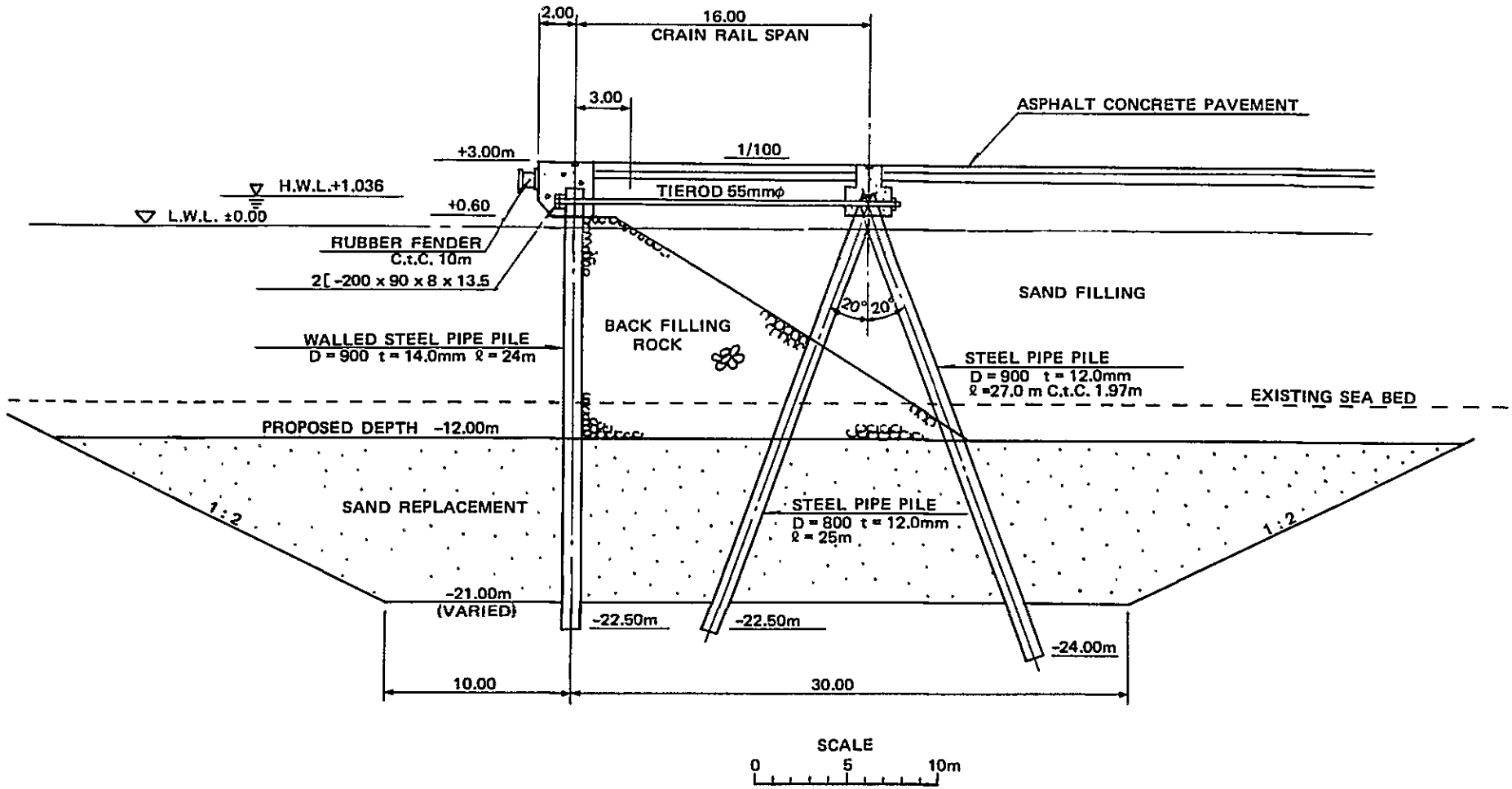


Fig. 9-6 Container Berth Quay Wall (Walled Steel Pipe Pile Type)

1) Concrete caisson quaywall

When construction sites have a favorable foundation and few earthquakes and a yard or dock is available for casting of caissons, this type of structure may be recommended. As the structure is of a precast concrete type, in situ construction works are easily carried out with highly reliable results. Principal construction materials can be procured in Peru.

However, in the case of this project, the concrete caisson quaywall has the following disadvantages.

① It will be difficult to obtain land for the precasting yard or the dock, and cost of providing temporary facilities will be high. This is a disadvantage in the case of a project of the proposed scale.

② Even if a casting yard or a dock can be used, the economic casting speed of the caisson is about 4 caissons per month. Approximately 18 months will be required for the casting and installing of the caissons.

③ In case a floating dock is used, only 2 caissons can be cast in one month. So, 33 months will be required merely to cast caissons.

④ Construction work for the foundation mound will require diving and the construction period will be long. The construction period for the total project will be longer than 4 years.

Due to the above disadvantages, the concrete caisson quaywall does not meet the conditions required and can not be recommended.

2) Steel sheet pile cellular cofferdam quaywall

The steel sheet pile cellular cofferdam quaywall may be constructed in a short period of time. However, the structure has the following disadvantages.

① The volume of steel materials required is more than that required for a pier type structure. The volume is nearly same as the volume required for a walled steel pipe pile structure.

② Construction works are difficult as the structure is not stable during construction.

③ An independent foundation will be required for the container crane.

④ As the thickness of the flat-web sheet piles is limited, maximum 12.7 mm, strict measures must be taken against corrosion of steel materials and attention must be paid to the maintenance of the structure.

⑤ In order to assure the reliability of construction work, the cells may be erected in advance in the sea yard. However, in this case, a large floating crane and a large water space for a temporary sea yard will be required.

Due to the above disadvantages, the steel sheet pile cellular cofferdam quaywall is not recommended.

3) Pile type pier

At the port of Callao, the present wharves are mostly reinforced concrete pile type piers. In many piers, the piles are seriously damaged, but the cause of the damages is not clear.

In this project, considering that the piles are driven into the hard ground, it will be advisable to use steel pipe piles.

In the case of a steel pipe pile pier, the volume of reclamation filling required will be small, the resistance against earthquakes is strong, and the volume of steel materials required

is relatively small. The calmness inside the port will not be greatly affected.

However, a separate retaining wall will be required, so the number of different types of work increases. Work for the coping and covering of the slope will require considerable time.

However, due to the above advantages, the pile type pier will be selected as an alternative type of structure for the project.

4) A walled steel pipe pile quaywall may be constructed rapidly, reducing the construction period. The volume of concrete is small. To prevent corrosion of steel materials, the thickness may be increased or cathodic protection may be provided. Facilities for construction works are comparatively simple, and a small construction base will be sufficient. However, a large volume of steel materials is required. Corrosion of steel materials may be prevented by cathodic protection for 20 years, and by thickness allowance against corrosion for 30 years.

Considering the above mentioned conditions the walled steel pipe pile quaywall may be the most appropriate structure for this project.

(3) Conclusion

Table 9-2 shows comparison of the steel pipe piles type pier structure and the walled steel pipe pile quaywall structure selected out of the 4 types of structures mentioned above.

Therefore the walled steel pipe pile quaywall (Fig. 9-6) is recommended for the structure of the container wharf.

Table 9-2 Comparison of Structures

Items \ Type of Structure		Steel Pipe Pile Type Pier	Walled Steel Pipe Pile Quaywall
Reliability	Displacement	little	very little
	Corrosion of steel materials	protection required	protection required
	Earthquakes effect	slight	slight
Construction Works	Construction base	small scale	small scale
	Construction plant	〃	〃
	Difficulty of construction	rather difficult	easy
	Type of work	separate retaining wall is required	few
Construction materials ·	Concrete	large volume required	small volume
	Steel materials	rather small volume	large volume required
	Stone	rather large volume	small volume
Construction Period		4 years 6 months	3 years 6 months
Construction Cost	per 300 m	thousand $ 8,957	thousand $ 7,884
Overall Evaluation		Good	Very Good

9-1-3 Grain Wharf

(1) Outline and Design Conditions

A marginal wharf will be constructed between the container wharf and wharf No. 10. The structure will be equipped with 2 sets of pneumatic unloaders travelling on rails and a belt conveyor.

Details of the structure and the design conditions are as follows:

Length of quaywall	250 m	
Alongside water depth	−12 m (C.D.L.)	
Crown height of quaywall	+3.0 m	
Earthquake intensity	Horizontal intensity	0.15
	Vertical intensity	0.0

Berthing speed		10 cm/sec	
Surcharge	uniform load	at normal conditions	2.0 t/m^2
(Considering the use for general cargo berth)		during earthquakes	1.0 t/m^2
Pneumatic unloader		Capacity	400 t/h
		Self-weight	250 t
Corrosion of steel materials		Cathodic protection	20 years
		Thickness allowance against corrosion	30 years
			(3.0 mm on one side)

(2) Type of Structure

The structure will be of a walled steel pipe pile quaywall the same as the container wharf, Fig. 9-7 shows a cross of the structure.

The rail span of the pnuematic unloader is 10 m. From the viewpoint of stability, it is not advisable to move the location of the batter pile anchorage further seaward. Therefore, it is necessary to drive in additional piles as foundation for the unloader between the steel pipe pile wall and the anchorage, as foundation for the unloader. As the displacement of this rear foundation and that of the steel pipe pile wall (the front foundation) are not identical, it is advisable to join the two foundations, with reinforced concrete beams, so that they work as a single structure. According to the soil data of ENAPU, the soil in this area consists of clayey soil from the sea bottom to a depth of about −13.5 m. As the soil survey of this area has not been carried out for this project, the characteristics of this clayey soil are not clear. Assuming that the clayey soil is similar to that in the area of the container wharf, this soil will be replaced.

It is advisable to carry out a thorough soil survey to obtain accurate data for the detailed designing of the facilities.

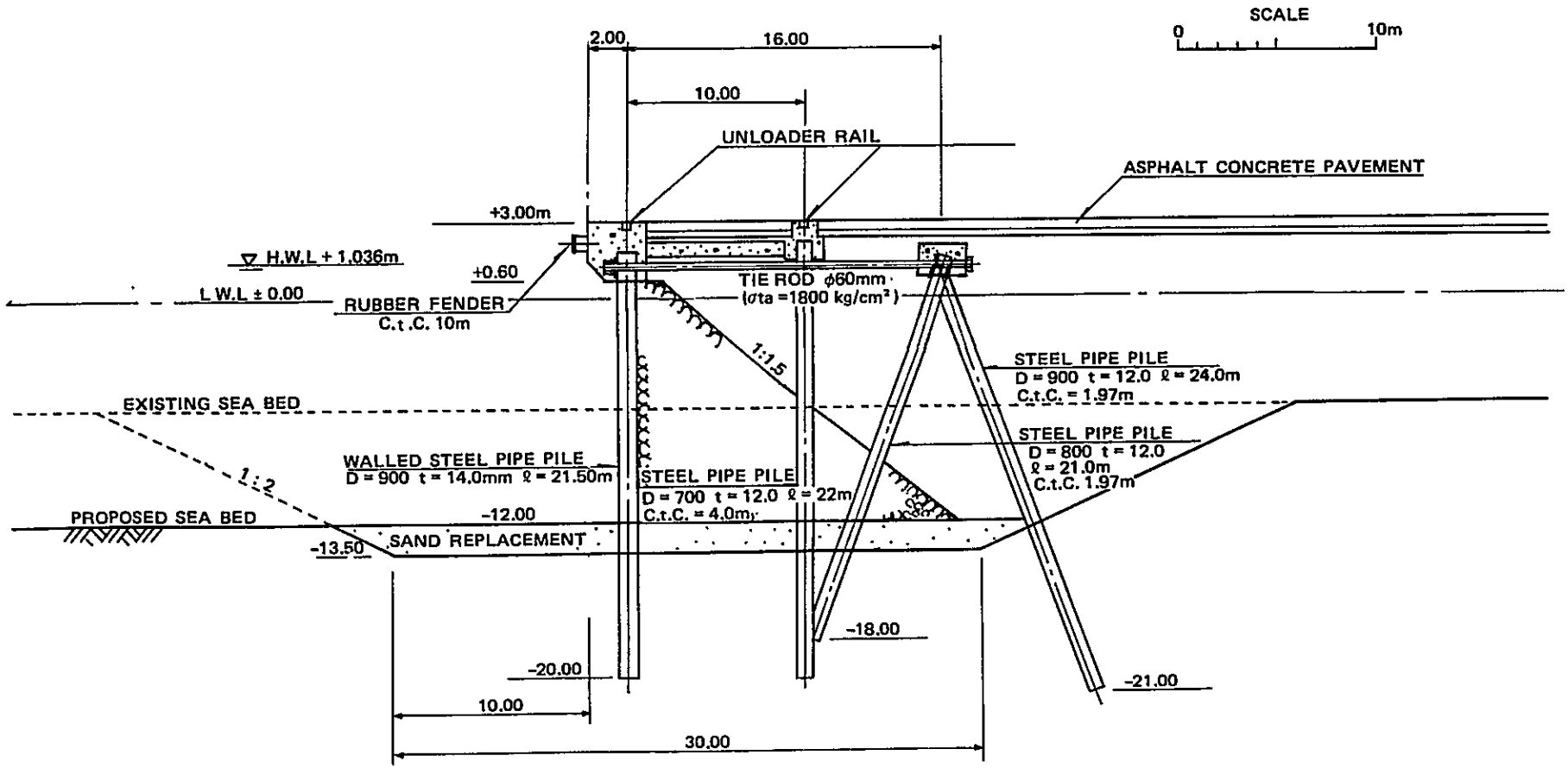


Fig. 9-7 Grain Berth Quay Wall

9-1-4 Container Yard Temporary Revetment

(1) Temporary Revetment

The revetment of the container yard will serve as the retaining wall for the reclamation. When the extension is carried out in the future, the revetment will be removed or buried. However, as the implementation period of the extension has not been decided and heavy mechanical equipment to handle containers will travel in the rear area, the structure must be of sufficient strength to secure the necessary stability until the time of future expansion.

The foundation ground is a soft layer between the sea bottom and the bearing stratum. This layer must be replaced by sand. To meet the requirements of a short construction period, and use of suction dredgers, the bottom width of excavation will be 40 m.

As the site is in a calm water area, the structure will be the rubble mound type because stones can be obtained without difficulties. The cross section is shown in Fig. 9-8.

(2) Revetment backed by the South Breakwater

The construction is done within the port of Callao, therefore it is economical to use the present south breakwater (rubble mound type) as part of a revetment. Fig. 9-9 is a cross section of the revetment.

The reclamation within the port will be filled to +3.0 m for the container yard. However, as the foundation is soft, a circular failure may occur on the slope outside the port. Therefore, it is necessary to provide counterweight fill on the outer side of the breakwater.

Fig. 9-9 shows the cross section of the revetment designed by supposing the increase of the ground strength beneath the breakwater based on the soil survey of this study. At the stage of detailed design, it is necessary to investigate and clarify the following points:

1) It is necessary to investigate soil conditions in the area under and around the breakwater to ascertain the volume of rubble stones sinking into the ground.
2) It is necessary obtain sufficient data about the shape of the breakwater and the condition of the rubble stones.

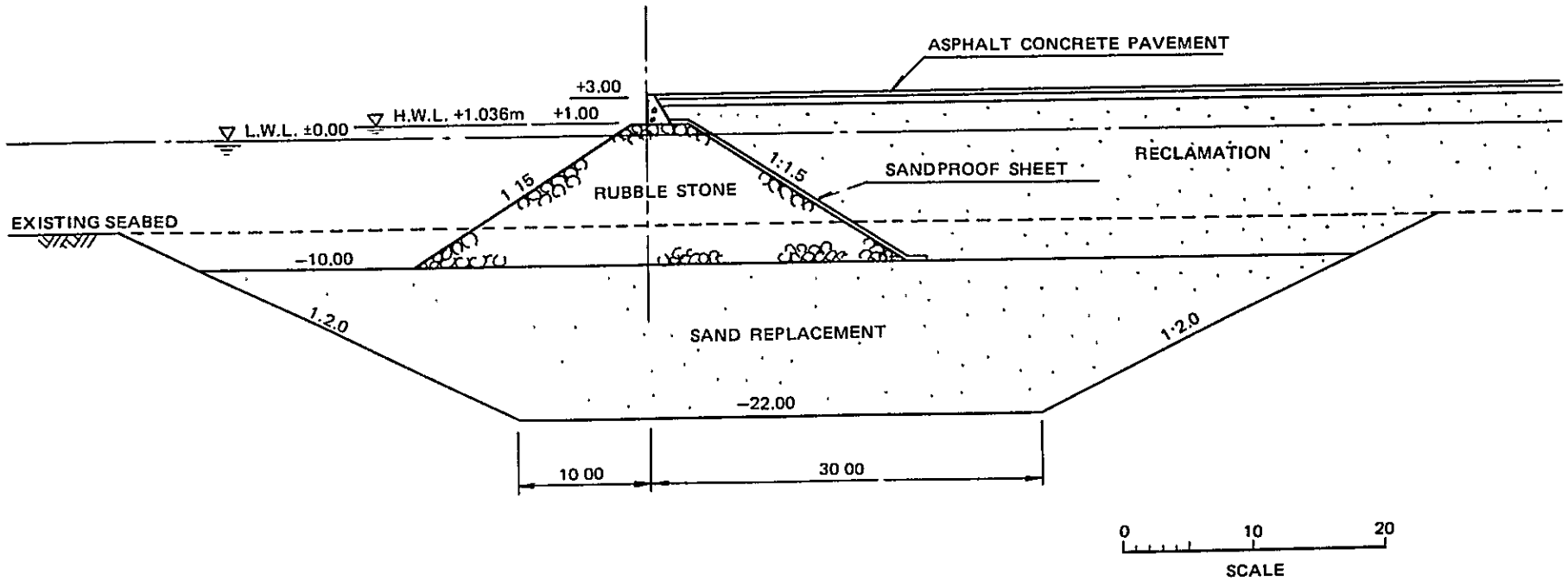


Fig. 9-8 Revetment for Container Yard

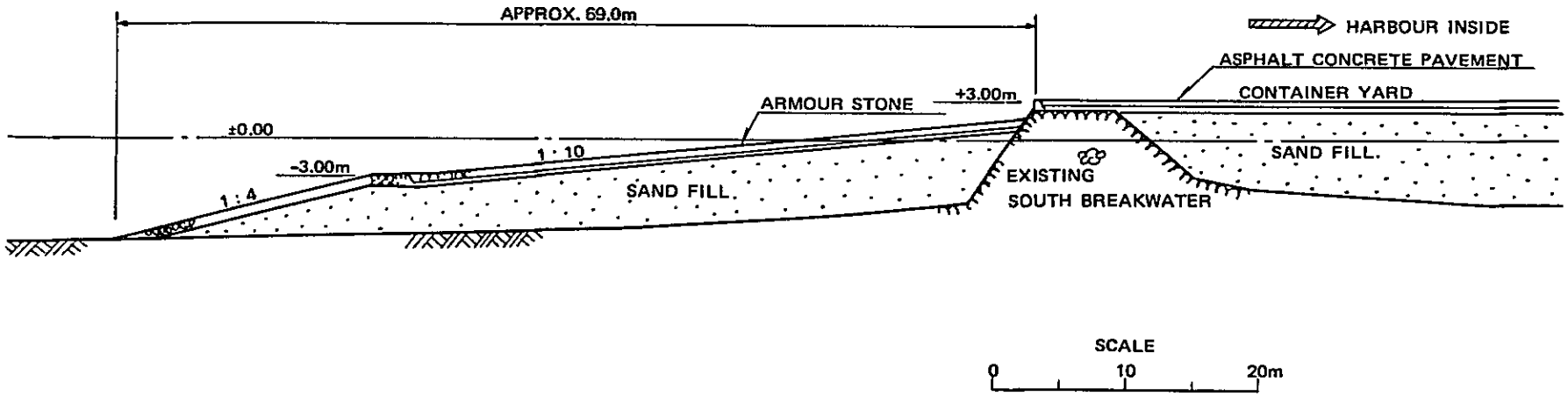


Fig. 9-9 Reventment for Container Yard (Reinforcement of South Breakwater)

9-1-5 Reclamation

Since the ground of the site of reclamation consists of very soft clay soil, ground subsidence may occur after the completion of the container yard.

Figs. 3-33 ~ 3-36 of Chapter 3 show the values of the consolidation coefficient (Cv) and the coefficient of volume compressibility (Mv).

Fig. 9-10 shows the relation between the mean degree of consolidation and the time factor.

Quantity of the settlement and speed of sinking were calculated based on the above data and shown in Fig. 9-11.

Final settlement will be approximately 120 cm in the case of reclamation without any foundation improvement. The settlement will be approximately 40 cm 1 year after the completion and approximately 60 cm in 2 years time.

Many cases of reclamation without improvement of the soft soil layer area found in Japan. However, in the case that this reclaimed land is used for a container yard immediately after completion of reclamation, it is necessary to take ground settlement into consideration as part of routine port operation. Furthermore it is necessary to make arrangements to deal with settlement and pavement repair.

The repairing of pavement decreases the handling capacity of cargoes during the work and represents a maintenance cost. Therefore in the development plan of the Port of Callao, it is desirable that improvement of the soft soil layer be done during the initial construction stage in order to keep settlement to a minimum after the start of facilities operation and to achieve stabilized port operation.

The dotted line of Fig. 9-11 shows the estimated settlement in the case that soft clayey soil is replaced by sand to −13 m deep. In this case, the settlement is estimated to be approximately 13 cm in 1 year time and 18 cm in 2 years time after completion, and the final settlement will be approximately 30 cm.

Extra banking will be sufficient to deal with this settlement.

The thickness of the soft clay layer behind, the grain wharf is comparatively thin, therefore replacement by sand in this area to −11 m may be sufficient. The required cost for these improvements of the soft soil layer will be about US$2,800,000.

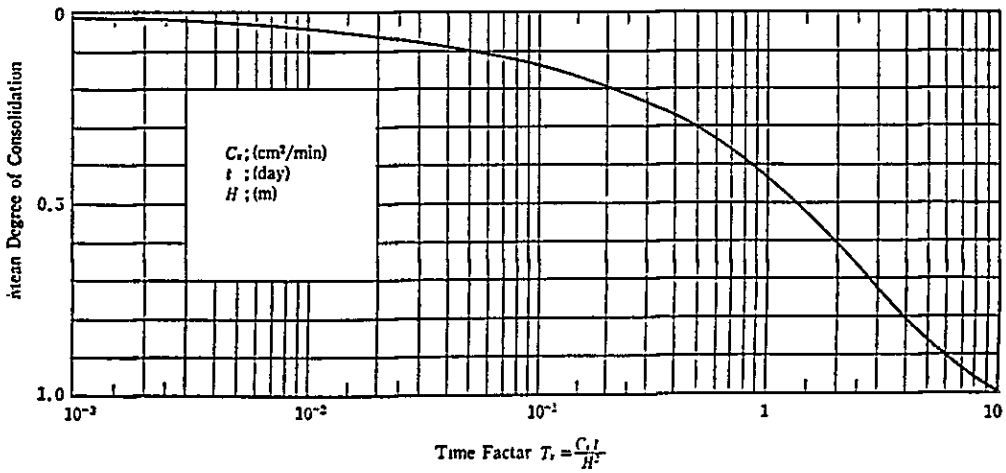


Fig.9-10 The Relation between Mean Degree of Consolidation and Time Factor

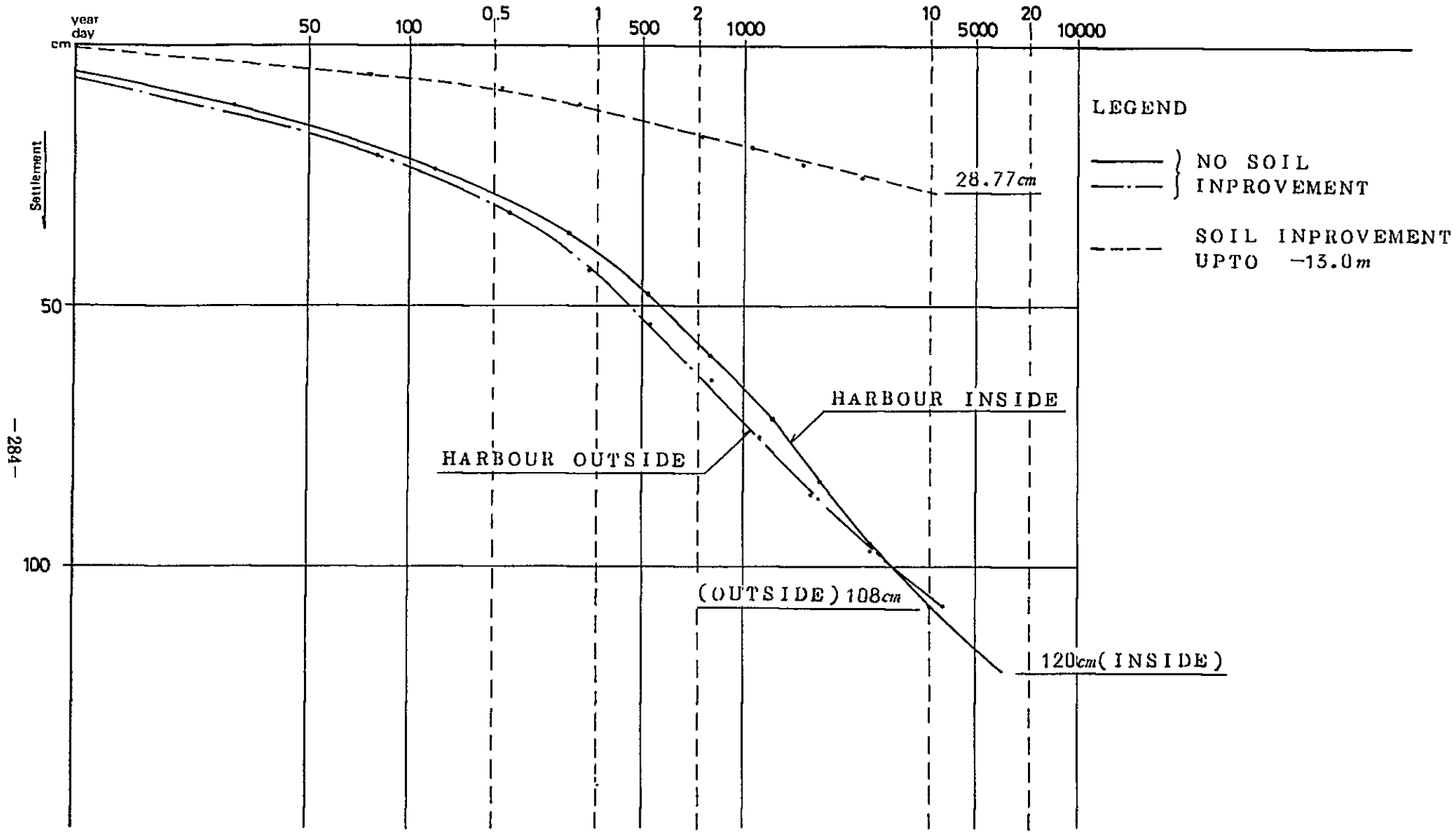


Fig. 9-11 Estimation of Settlement of Reclamation

9-1-6 Pavement

Since the container yard will be constructed on soft ground, maintenance to deal with differential settlement of the ground will be required. Therefore asphalt pavement which is easily maintained is desirable. However, on the course of the rubber-tired transfer crane which has a heavy wheel load, rigid pavement such as PC pavement or concrete pavement will be required. It is advisable to design the pavement so that the paving can be easily repaired in case of differential settlement.

It is advisable to limit the areas where large concentrated loads, such as the outrigger load of truck cranes and other mechanic equipment, will be present. It is necessary to cover these areas with concrete pavement.

In designing the pavement of a container yard, the type of vehicles to travel and the volume of traffic must be estimated for each section of the gate, road, cargo transfer area and storage yard. Then, pavements suitable for these sections are designed.

For this study, the pavement of the Honmoku container yard in the port of Yokohama, Japan has been taken up as reference. As CBR of the reclamation filling is about 1 ~ 2%, it is necessary to use pit sand of good quality to raise the CBR to about 3.0%.

Cross section of the pavement for a container yard using a transfer crane and tracter chassis system are given in Figs. 9-12, 9-13.

9-1-7 Buildings

The main buildings include a port office, a gate, a maintenance shop, and a container freight station.

The port office will be a three-story reinforced concrete building with a pile foundation, as it will be built on reclamation.

The gate, the maintenance shop and the container freight station will be of a steel frame prefabricated structure.

9-1-8 Related Facilities

Related facilities include the drainage system, water supply system and the electric power supply facilities. Electric wires, water pipes and drain pipes will be installed underground. As the terminal is constructed on the relamation of soft ground, it is necessary to consider the effect of ground subsidence on the pipe ducts installed underground. When the pipe ducts are connected to the foundation of buildings and quaywalls of negligible settlement, manholes and flexible pipes may be used to deal with differential settlement.

9-1-9 Silo for Grain

The capacity of the silo will be 33,000 tons.

There are various methods of construction such as precast concrete method, steel plate method, and reinforced concrete method. In this project, from the viewpoint that the construction base is comparatively small and that materials procured in Peru should be used as much as possible, the reinforced concrete structure is recommended. However, for the execution of the project, it is desirable to decide after comparative study of the economic conditions and construction conditions.

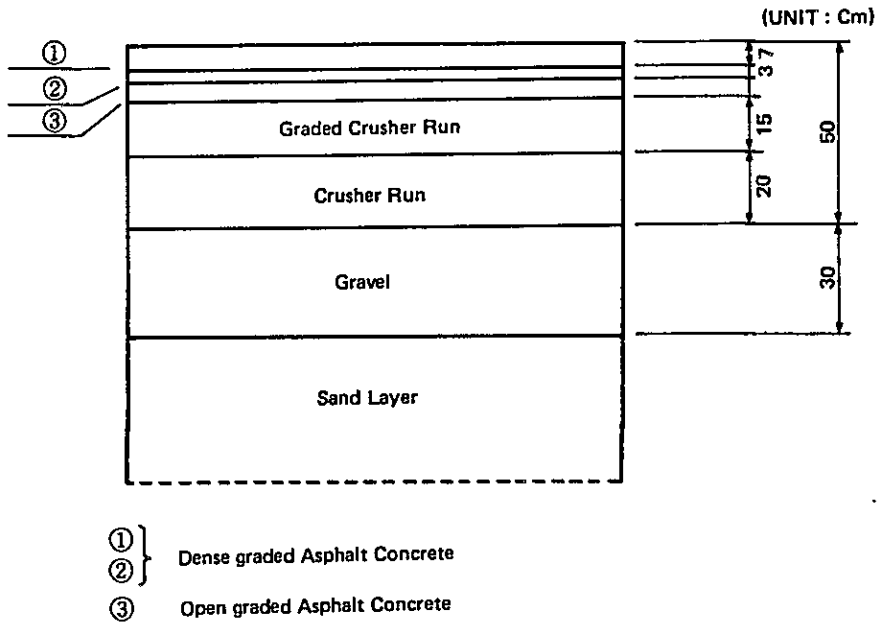


Fig. 9-12 Asphalt Concrete Pavement for Container Yard

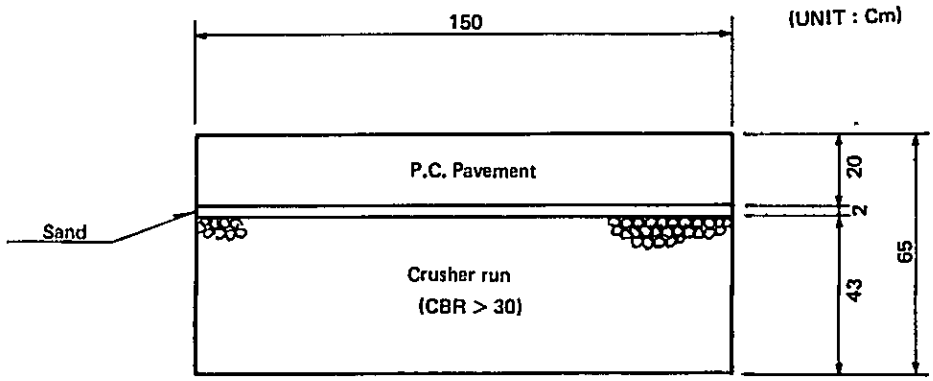


Fig. 9-13 P.C. Pavement for the Course of Transfer Crane

9-2 Method of Construction

9-2-1 Environments of Construction

The climate in the area of Callao Port is mild and almost free from rainfall or strong winds which might obstruct construction work. Thus, winds and waves pose hardly any problem. However, swells with a period of 9 to 19 seconds come all year round and in December to January, when wave height is rather low, $H_{1/3}$ is 1.2 – 1.6 m, while in May and June, when it is high, $H_{1/3}$ sometimes exceeds 3 m. But the effect of swells is considerably assuaged at the construction site since San Lorenzo Island shelters the construction site.

Almost all construction under this project takes place in the relatively small space of the port. Thus, it is important to be careful not to interfere with the navigation of incoming and outgoing ships and the berthing of ships. Also, construction must be planned in consideration of the fact that the area south of the port, which is included in the construction site, is a restricted area.

9-2-2 Construction of Principal Facilities

(1) Temporary works

Space necessary for the work base, including a construction office, a material stock yard and a manufacturing yard will be secured by clearing the freight handling yard at the southern end of the port area because there is no idle space available in the vicinity. This area will be developed later as a CFS yard. Also, a temporary pier for hauling materials for field use will be provided perpendicular to the existing quay. The position of this pier must be selected so as not to interfere with construction or the utilization of berths currently in use.

(2) Dredging

Dredging is comprised of, foundation excavation for quays and revetments, removal of soft foundation for the yard area and channel and anchorage dredging. Channel dredging requires the service of a trailing hopper suction dredger (minimum: 4,000 m^3) so as not to interfere with the navigation of incoming and outgoing ships. For anchorage dredging, a cutter suction dredger (minimum: 4,000 hp) in necessary and a grab dredger will also be used for part of this dredging.

It is desirable for the dredged soil (about 840,000 m^3) from foundation excavation and yard area dredging by cutter suction dredger to be dumpted in deep waters of more than –20 m. Since, however, such waters are at a considerable distance from the construction site, thus affecting work efficiency, it is advisable to provide a dumping pocket at a position to the south outside of the port and not interfering with construction (see Fig. 9-14) by dredging in advance with a trailing hopper suction dredger and dump the dredged soil directly into this pocket. The scale pocket must be the same as that of the volume of soil.

(3) Removal of Wharf No. 9

It is necessary for Wharf No. 9 to be removed for the purpose of construction under the short-term development plan. Structurally, it is an RC pile pier and includes a stone masonry retaining wall. So, mainly a grab dredger will be used to remove it. The work will take a rather long time because only one ship group will be used so as to minimize the cost of transporting

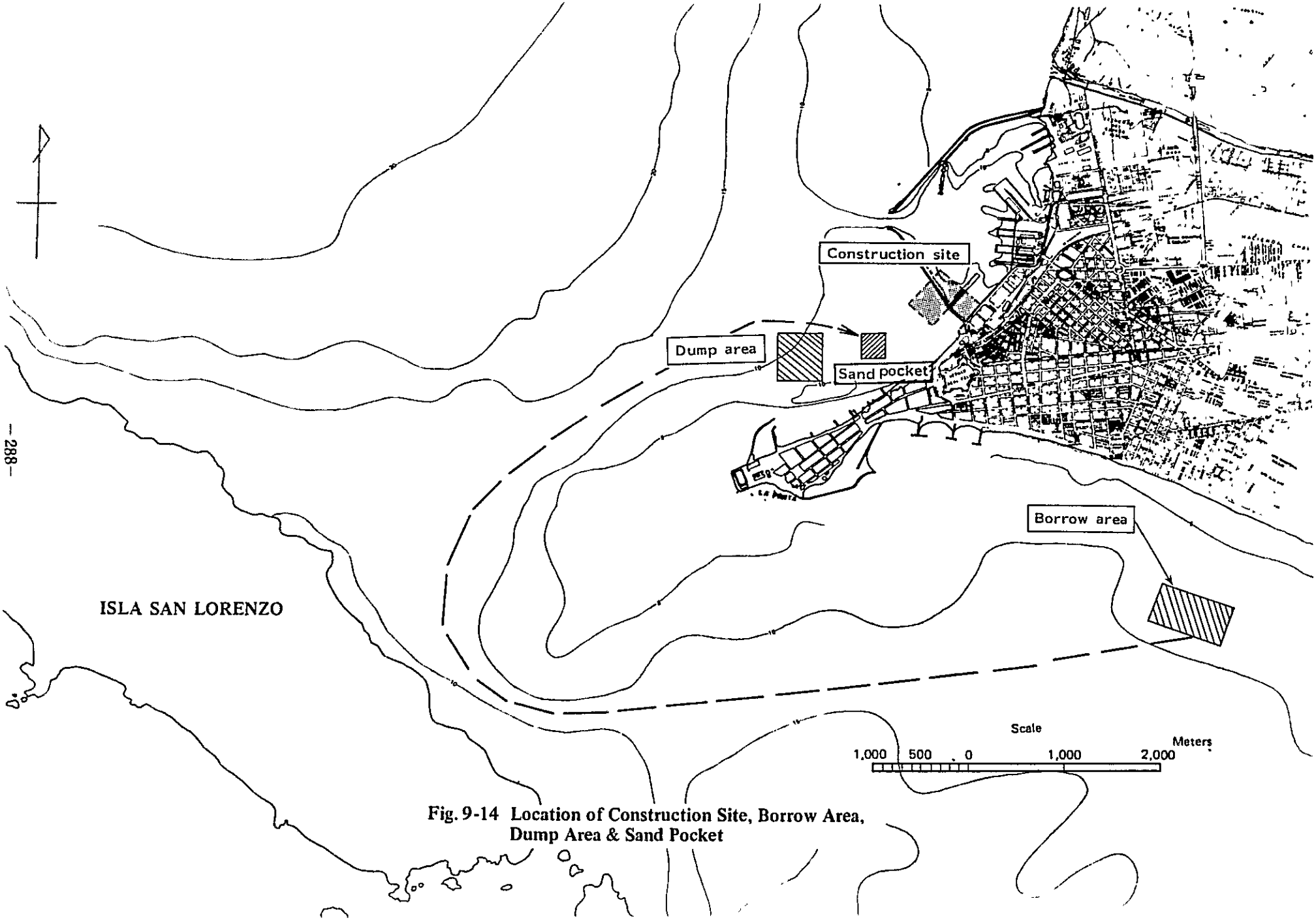


Fig. 9-14 Location of Construction Site, Borrow Area, Dump Area & Sand Pocket

construction equipment and reduce their idling. So, the portion interfering with quay construction will be removed first and the remaining portion will be left for removal during the final stage of construction.

Truck cranes may also be used to speed up construction. Stones and reinforced concrete from the removal may be used as materials for the temporary road to be constructed on the southern breakwater.

(4) Quay construction

Quay construction will be started, beginning with the driving of batter piles anchorage, immediately after foundation excavation and the dumping of replacement sand, using two pile driving barges to shorten construction time.

Special methods including driving combined with drill excavation from the inside of a steel pipe are necessary for the portion of the grain wharf where a sand gravel bearing stratum with an N value of more than 50 appears at a shallow level.

(5) Revetment construction

For the west side revetments, rubble stone dumping from land will be carried out from the rivetment base adjoining the southern breakwater, taking advantage of the temporary road on the breakwater, when foundation excavation and the dumping of replacement sand are completed.

In the case that the southern breakwater is used as a revetment, excavation for soft soil dredging cannot extend closer than 30 m or so from the breakwater in order to assure the stability of the existing breakwater. So, reclamation must be performed while preventing the collapse of the breakwater by filling equally on both side of the breakwater.

Upon completion of reclamation, soft ground improvement by sand drain method must be carried out for a width of 30 m on the inside of the breakwater to prevent ground subsidence.

(6) Reclamation

Reclamation sand for the yard and replacement sand for the foundation of quays and revetments will, in accordance with the results of a bottom sediments survey, be taken from waters on the south side of La Punta, as indicated in Fig. 9-14. These waters are outside of the shelter of San Lorenzo Island and are directly exposed to strong swells coming off the sea. So, a trailing hopper suction dredger useable in swells will be used to take sand there. Sediments collected will, instead of being dumped at the reclamation site directly from the trailing hopper suction dredger, be temporarily deposited in the temporary pocket provided in advance by dredging with the trailing hopper suction dredger, as indicated in Fig. 9-14, and then later dumpted at the reclamation site by a cutter suction dredger.

Reclamation and replacement sand amounts to about 2,200,000 m^3. However, the temporary pocket need not be sufficiently large to hold this total amount; instead, its size can be suitably decided according to the work schedule because replacement sand will be dumped immediately after foundation excavation for quays and revetments but reclamation will not be conducted until after quay and revetment construction is completed. It is recommended that, to ensure satisfactory compaction, pit sand be spread for a thickness of about 30 cm atop the sea sand used for reclamation.

(7) Building

The CFS will be constructed in the area which is used as the work base. So, its construction must be started as soon as possible after clearing the base during the last stage of the construction period.

The silos will be of reinforced concrete and use sliding forms. Their construction will be planned in conjunction with the layout of machines to be installed in their interiors.

For the foundation, RC piles must be driven down to the bearing stratum.

9-2-3 Construction Schedule

The construction schedule is shown in Fig. 9-15.

In this construction schedule, assuming that tha starting time of operating service is the end of 1987, the construction period must necessarily be made as short as possible. On the other hand, we have also considered making use of as small a number of construction machines as possible in order to save construction cost.

So, it was decided to use only one unit of such major machines as cutter suction dredger, trailing hopper suction dredger and grab dredger but that using two pile driving barges was unavoidable due to the construction schedule.

The use of two paving machines has been considered in this schedule but in the execution of this project, the selection of machines and the decision of their number should be actually made after a detailed study of the local conditions.

The construction period will be three years and six months. Twelve months before the start of construction are necessary as the period of consultant technical service excluding supervision of construction assuming that the bidding period is three months.

9-2-4 Problems Involved in Construction

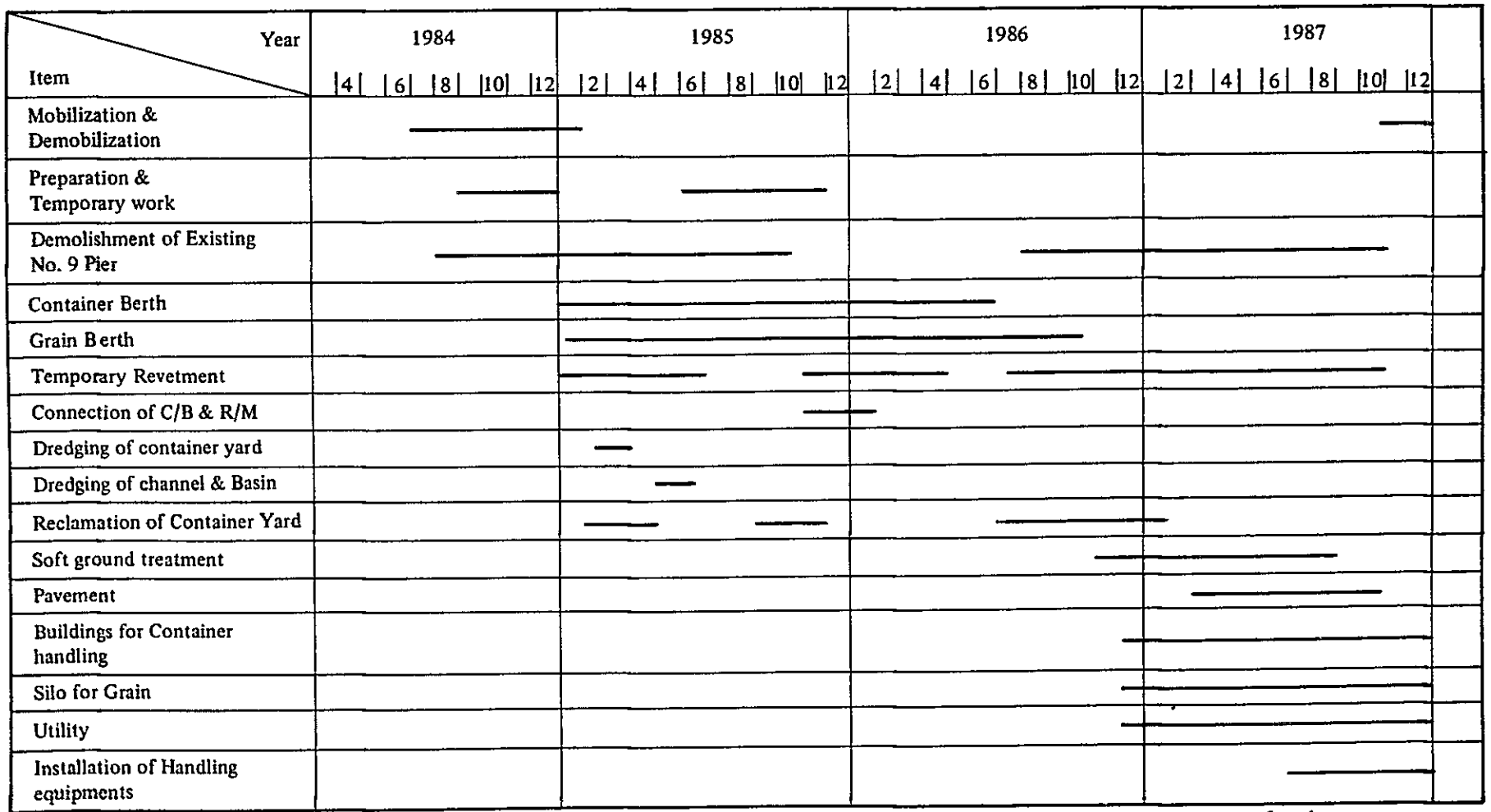
(1) It was decided from the results of a bottom sediments survey to take sand for reclamation from waters on the south side of La Punta. But in executing the project, the local geology must be carefully studied to determine soil properties and the amount of sand that can be taken there. Also, the potential impact of sediment collection on the nearby beaches must be taken into consideration.

The trailing hopper suction dredger to be used for sediment collection will have to pass through the narrow strait between La Punta and San Lorenzo Island and navigate the anchorage of naval craft on the south side of Callao Port. So, utmost care must be exercised about its safety.

(2) The port area of Callao is relatively small and the rate of berth utilization there is high. So, construction work to be performed in the port must be planned with care so as not to obstruct the navigation of incoming and outgoing ships or the berthing of ships.

(3) Wharf No. 9 must be removed prior to foundation excavation for the grain berth. The removal will take considerable time because of the limited number of machines that can be used for this purpose, therefore at first, the section blocking the quay construction (about 50 m) will be removed and then, when the grab dredger becomes available, the rest will be removed at the final stage. Under certain circumstances, using an increased number of machines may be necessary.

Fig. 9-15 Construction Schedule of Short Term Development Plan



NOTE: Assuming that tendering for construction needs 3 months, engineering services for the Project such as detailed design and preparation of tender documents must start at least 12 months before commencement of construction work.

(4) If the southern breakwater is used as a revetment, counterweight fill is necessary on the outside of the breakwater. Since this counterweight fill will be dumped directly on the soft ground, a considerable part of the sand is expected to sink into the existing ground. Also, a rather gentle slope must be formed so as not to cause the slip of the counterweight fill itself. Further, it is difficult to maintain this condition for a long time. It is, therefore, desirable for the follow-up work to be performed as early as possible. If there is no prospect of the follow-up work being performed at an early period, the replacement of soft ground, foot protection with rubble stones and the protection of slopes with armor stones must be carefully executed.

(5) The work base must be fairly large but no idle land is available in the port area or its vicinities. So, there is no choice but to use part of the currently utilized freight handling yard after remodeling it for this purpose. But in such event, port cargo handling may be temporarily affected. Hence, the necessity to plan with careful consideration for the operation of the port. Also, the position of the temporary jetty to be used for construction purposes must be carefully decided because of the shortage of idle waterlines.

(6) It is desirable that the temporary sand pocket is as close to the construction site as possible, however the construction site is adjacent to an area restricted to naval ships, so the location of the pocket may have to be outside of the restricted area as shown in Fig. 9-14.

9-3 Estimation of Construction Cost

9-3-1 Construction Materials

It is assumed that structural steel and other special materials will be procured from Japan.

Cement and petroleum products to be used are Peruvian.

Stones for concrete will be taken from La Molina and the Rimac River while backfill stones, armor stones and paving stones will be taken from La Molina.

Pit sand for reclamation will be brought from La Molina or the hills between Callao and Ventanilla.

9-3-2 Construction Equipment

It is assumed that the principal construction equipment will be procured abroad. The cutter suction dredger will be procured from the west coast of the United States while the trailing hopper suction dredger will be brought from Europe.

The other construction equipment will be procured from the west coast of the United States. This construction equipment includes what can be procured in Peru itself but it is believed that its procurement from abroad is more favorable in terms of cost, even considering transportation cost, than if it was procured in Peru.

9-3-3 Labor Force

Though common construction workers can be procured domestically, special technicians, particularly maritime technicians (including divers and special machine operators), must be procured from abroad. So, it is assumed here that common workers and land work semi-skilled

workers (masons, reinforcing bar workers, electricians, etc.) and junior seamen concerned with maritime work (including seamen of auxiliary carft) will be procured domestically and the rest will be procured from other countries.

9-3-4 Conditions of Construction Cost Estimation

(1) The exchange rate between the Japanese yen, the Peruvian sol and the U.S. dollar used in this estimation is the actual level as of August 1982, which is as follows:

1 U.S.$ = 715.5 soles = 257 yen

(2) Unit prices used in the estimation are as of August 1982.

(3) The transportation cost for major construction equipment is for round trips.

(4) F.O.B. prices are used for materials to be procured from Japan and their transport cost is estimated separately.

(5) C.I.F. prices are used for imported machines.

(6) No taxes are anticipated for materials and equipment imported for this construction and labor wages.

(7) Contingencies are estimated at 15% of the total construction cost from which the mobilization cost and handling equipment cost are excluded, plus 5% of the handling equipment cost.

9-3-5 Construction Cost

The construction cost under the master plan is shown in Table 9-3, the construction cost under the short-term development plan is shown in Table 9-4 and the investment plan by years is shown in Table 9-5.

Table 9-3 Construction Cost of Master Plan

UNIT: 1,000 US$

Item	Unit	Quantity	Construction Cost		
			Foreign	Local	Sub-Total
Mobilization & Demobilization	L.S.	1	13,152	-	13,152
Preparation	L.S.	1	18,719	8,321	27,040
Container Berth Quaywall	m	1,280	26,008	7,172	33,180
Grain Berth Quaywall	m	250	4,504	1,488	5,992
Grain Berth Jetty	m	300	1,947	1,024	2,971
General Cargo Berth Quaywall	m	2,000	32,514	8,965	41,479
Oil Jetty	m	240	2,327	1,108	3,435
Revetment	m	3,180	23,155	22,460	45,615
Temporary Revetment	m	1,530	9,490	10,833	20,323
Breakwater	m	640	6,698	12,945	19,643
Bridge	m		9,339	6,226	15,565
Dredging of yard	m^3	3,951,200	7,680	1,345	9,025
Dredging of Channel & Basin	m^3	1,901,000	3,076	554	3,630
Reclamation	m^3	16,690,200	48,666	12,266	60,932
Soft Ground Treatment	m^2	38,400	784	275	1,059
Demolishment Wharf No.1,2,3,4,9	L.S.		8,279	3,345	11,624
Pavement	m^2	852,650	2,051	26,220	28,271
Buildings	L.S.		-	22,665	22,665
Silo for Grain	set	2	11,842	11,668	23,510
Utility	L.S.		6,031	2,568	8,599
Handling Equipment	L.S.		71,376	-	71,376
(Sub Total)			(307,638)	(161,448)	(469,086)
E/S			15,245	8,209	23,454
Contingency			37,035	24,217	61,252
Total			359,918	193,874	553,792

Table 9-4 Construction Cost of Short Term Development Plan

(Unit. 1,000 US$)

Item	Unit	Short Term Development Plan				UNIT	Alternative (Plan A)			
		Quantity	F/C	L/C	Total		Quantity	F/C	L/C	Total
Mobilization & Demobilization	L.S		7,637	-	7,637	L.S		7,637	-	7,637
Preparation & Temporary work	L.S		2,831	1,711	4,542	L.S		4,680	2,080	6,760
Demolishment of Existing No. 9 Pier	L.S		2,386	964	3,350	L.S		2,386	964	3,350
Container Berth Quaywall	m	300	6,203	1,681	7,884	m	300	6,096	1,681	7,777
Grain Berth Quaywall	m	250	4,526	1,488	6,014	m	250	4,504	1,488	5,992
Revetment	m	-	-	-	-	m	230	1,396	1,624	3,020
Temporary Revetment	m	* 470	1,382	1,547	2,929	m	830	5,037	5,861	10,898
Connection of C/B & R/M	m	20	205	30	235	m	20	205	30	235
Dredging of Container Yard	m^3	441,720	980	150	1,130	m^3	579,260	1,126	197	1,323
Dredging of Channel & Basin	m^3	636,000	1,145	185	1,330	m^3	636,000	1,029	185	1,214
Reclamation of Container Yard	m^3	1,853,973	5,775	1,341	7,116	m^3	3,205,115	9,346	2,356	11,702
Soft Ground Treatment	m^2	9,600	196	69	265	m^2	19,200	392	138	530
Pavement	m^2	157,650	432	5,234	5,666	m^2	202,120	402	5,524	5,926
Buildings for Container Handling	L.S		-	3,589	3,589	L.S		-	3,701	3,701
Silo for Grain	set	1	5,921	5,834	11,755	set	1	5,921	5,834	11,755
Utility	L.S		1,508	642	2,150	L.S		1,508	642	2,150
Handling Equipment	L.S		20,062	-	20,062	L.S		20,062	-	20,062
(Sub Total)			(61,189)	(24,465)	(85,654)			(71,727)	(32,305)	(104,032)
E/S			2,784	1,499	4,283			3,381	1,820	5,201
Contingency			6,027	3,670	9,697			7,607	4,846	12,453
Total			70,000	29,634	99,634			82,715	38,971	121,686

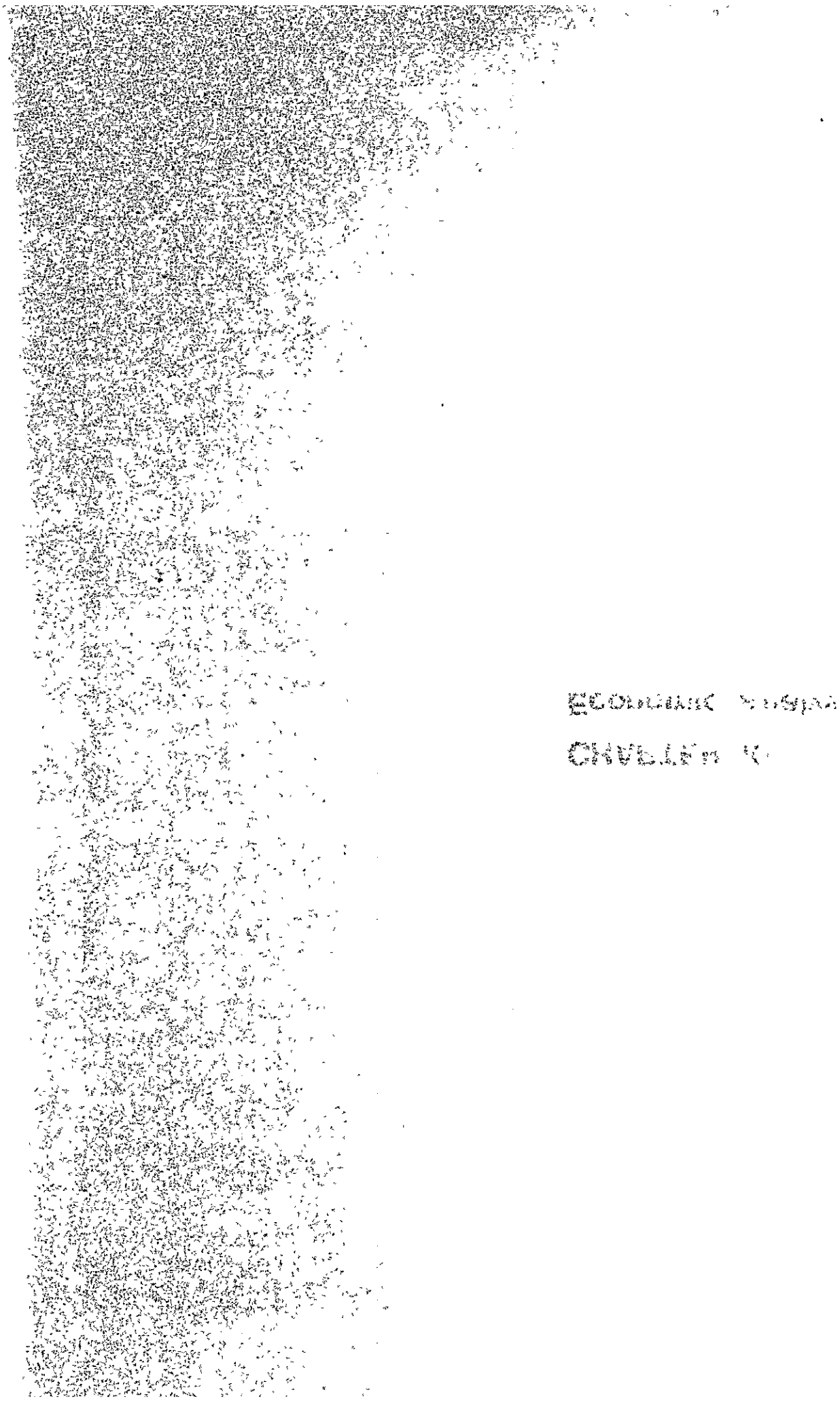
*Including reinforcement of south breakwater

Table 9-5 Yearly Investment of Short Term Development Plan

(Unit: 1,000 US$)

Item \ Year	1983			1984			1985			1986			1987			Total		
	F/C	L/C	Sub Total	F/C	L/C	Sub Total	F/C	L/C	Sub Total	F/C	L/C	Sub Total	F/C	L/C	Sub Total	F/C	L/C	Total
Mobilization & Demobilization				5,091	-	5,091	849	-	849	-	-	-	1,697	-	1,697	7,637	-	7,637
Preparation & Temporary work				1,416	856	2,272	1,415	855	2,270	-	-	-	-	-	-	2,831	1,711	4,542
Demolishment of Existing No.9 Pier				404	163	567	768	310	1,078	404	163	567	810	328	1,138	2,386	964	3,350
Container Berth				-	-	-	4,135	1,121	5,256	2,068	560	2,628	-	-	-	6,203	1,681	7,884
Grain Berth				-	-	-	2,479	815	3,294	2,047	673	2,720	-	-	-	4,526	1,488	6,014
Temporary Revetment				-	-	-	402	450	852	477	534	1,011	503	563	1,066	1,382	1,547	2,929
Connection of C/B & R/H				-	-	-	137	20	157	68	10	78	-	-	-	205	30	235
Dredging of Container yard				-	-	-	980	150	1,130	-	-	-	-	-	-	980	150	1,130
Dredging of Channel & Basin				-	-	-	1,145	185	1,330	-	-	-	-	-	-	1,145	185	1,330
Reclamation of Container Yard				-	-	-	2,665	619	3,284	2,665	619	3,284	445	103	548	5,775	1,341	7,116
Soft ground treatment				-	-	-	-	-	-	39	14	53	157	55	212	196	69	265
Pavement				-	-	-	-	-	-	-	-	-	432	5,234	5,666	432	5,234	5,666
Buildings for Container handling										-	276	276	-	3,313	3,313	-	3,589	3,589
Silo for Grain										455	449	904	5,466	5,385	10,851	5,921	5,834	11,755
Utility										116	49	165	1,392	593	1,985	1,508	642	2,150
Handling equipments										-	-	-	20,062	-	20,062	20,062	-	20,062
(Sub Total)	-	-	-	6,911	1,019	7,930	14,975	4,525	19,500	8,339	3,347	11,686	30,964	15,574	46,538	61,189	24,465	85,654
Engineering study & Supervision	838	452	1,290	313	169	482	544	293	837	544	293	837	544	293	837	2,784	1,499	4,283
Physical Contingency	-	-	-	273	153	426	2,119	679	2,798	1,251	502	1,753	2,384	2,336	4,720	6,027	3,670	9,697
Total	838	452	1,290	7,497	1,341	8,838	17,638	5,497	23,135	10,134	4,142	14,276	33,892	18,203	52,095	70,000	29,634	99,634

CHAPTER 10
Economic Analysis



CHAPTER 10. ECONOMIC ANALYSIS

10-1 Outline of Analysis

This chapter discusses the study of the economic efficiency of the short term plan of the project using internal rate of return (IRR). IRR is a discount rate which makes the cost and benefit of the project equal. The benefits come from the saving in the cargo transportation cost between the "with project" case and the "without" case.

The project includes, in the case of 'with project'. (1) reclamation inside the south breakwater, (2) construction of a container berth, Construction of a grain berth (3) Construction, purchase and operation of land facilities and cargo handling equipments. The case of 'without project' is where the above mentioned project has not been carried out.

Repair of No. 5B Berth and utilizing it as a container berth are included in the both cases of 'with' and 'without'.

The volume of cargo handled in these facilities is cargo transported to and from the hinterland of Callao Port and taken as an exogenous variable.

In both 'with' and 'without' cases, the volume of cargo related to the hinterland of Callao Port is considered the same. Cargo which exceeds the handling capacity of Callao Port is considered to be transported through San Martin Port.

The calculation of the cost and benefit is made using the market prices prevailing at the time when the study was carried out (July – Sept., '82).

The calculation period for economic analysis is 19 years after the completion of the project, i.e. until 2006.

10-2 Benefit

10-2-1 Benefit items

As the benefits brought by the development project of the Port of Callao, the following are considered.

(1) Contribution to the economic development by strengthening the basis for the nation's economic development through modernization of the Port.
(2) Reduction in cargo handling costs by raising cargo handling productivity through mechanization and containerization.
(3) Reduction of damage to cargo through containerization and mechnization.
(4) Reduction in packing costs through containerization.
(5) Reduction in ship costs for berth-waiting and for loading/unloading cargo, through upgrading the port services.
(6) Possible function as a center for an entrepor trade, handling tranship cargo and providing container feeder services to the neighbouring countries.
(7) Reduction of transportation costs on land.
(8) Prompt control of accurate information through introduction of a computer system.
(9) Reduction of insurance cost.
(10) The stable supply of grain to Lima Metropolitan area can be ensured upon the construction of Grain Berth.

Among these, it is considered indispensable for the economic development being sought by this country to increase the cargo handling capacity of the port and, at the same time, to meet the demand for container transportation. To promote, by the investment for the Plan, the function as a center for an entreport trade handling tranship cargo and that of container feeder services leads to the improvement of not only nation's economic situation but also nation's international status.

The rates of damage to cargo and burglary are reported to be high at Callao Port, so it is expected that these rates will be reduced through containerization.

The present comprehensive insurance cost (todo riesgo) is 1 – 1.5% of goods prices (under certain circumstances, goods prices plus freightage) for containers. It goes up to 4 – 5% for wood boxes and 5 – 5.5% for cartons. So, reduction of insurance cost is expected through containerization.

All the benefits which are expected in various fields cannot easily by evaluated in monetary terms and some are themselves immeasurable. The following three benefits are evaluated in monetary terms and considered in the analysis.

(1) Reduction in ships' staying cost
(2) Reduction in cargo handling cost
(3) Reduction in transportation cost on land

10-2-2 Reduction in ships' staying cost

When the staying time of ships is shortened by carrying out the project, the ships' staying cost reduction is a benefit of the project.

(1) Change of ships' staying time

1) Frame of Handled Cargo Volume

In determining the cargo volume, the following considerations are made.

① It is based on the demand forecast of container cargo and general cargo.

② Improvement of 5B berth is assumed to be carried out by ENAPU by the end of 1983.

③ Handling capacity of general cargo at Callao Port after the completion of improvement of 5B berth is assumed to be 2.15 million tons/yr, while that of container cargo is assumed to be 0.65 million tons/yr.

As a result of demolishing the No. 9 wharf, the handling capacity of general cargo will decrease to 1.55 million tons/yr.

The capacity of the new container wharf will be 0.85 million tons/yr.

The capacity of the new Grain Berth, as explained below, will be 2.254 million tons/year.

④ General cargo volume which exceeds the handling capacity of Callao Port is to be transported to and from Lima and Callao Area through San Martin Port.

⑤ In the 'without' case, container cargo exceeding 650 thousand tons cannot be containerized, so it is handled in the style of general cargo.

⑥ In the "without" case, grain volume exceeding the current handling capacity of Callao Port (1,224,000 tons) will be unloaded at San Martin Port and then transported to

Lima Metropolitan area by land.

As explained below, since the prospective entrepot cargo volume through San Martin Port is expected to grow to 1.34 million tons in 2000, it will surpass the current handling capacity of San Martin Port. Therefore, in the case of "without", it is proposed to build a grain berth and a silo at San Martin Port. It will be at about the same time that they would be constructed at Callao Port in the "with" case.

As to the construction cost, it is projected that the overall cost will be the sum of E/S for grain berth construction, silo construction and grain handling equipment cost and contingency cost in the case of Callao Port. In this case, the total cost amounts to US$28,513,000.

These costs are the advantages of the "without" case. Next, to calculate ships' staying costs and the saving of the cargo handling costs in the case of "with", it is necessary to assess the allocation of cargoes between new grain berth and present grain berth of Callao Port, and in the case of "without" it is required to project the allocation of cargoes between present grain berth of Callao Port and new grain berth of San Martin Port. To assess the prospective utilization in the case of "with", it is only natural to suppose that more cargoes will go to new grain berth. The more cargoes are handled by new grain berth of Callao Port, the greater the benefits from its construction.

On the other hand, in the case of "without" the cargo will go to the present berth of Callao Port, because of the additional land freightage required to move the cargo from San Martin Port to Lima Metropolitan area. Whereas the situation above is conceivable, here we assess that in both cases of "with" and "without" the capacity of the existing grain berth of Callao Port would be utilized to its maximum capacity, and only the excess volume would be handled by the new grain berth. When projected as above, it means that the advantage of the new grain berth construction at Callao Port is assessed at a minimum.

Based on the projection as above, in both the cases of "with" and "without", ships' staying costs become equal to the cargo handling costs with respect to Grain Berth. Therefore, as far as the benefits are concerned, it is sufficient to assess only the saving equivalent to the land freightage cost.

Figs. 10-1 ~ 4 show the method of allocation of cargo in the 'with' and 'without' cases.

Table 10-1 ~ 3 show the frame of cargo volume used as subject of economic analysis.

2) Frame of Ships

The frame of ships is established in the following manner and it will not be changed in the future.

In this case, the number of ships (general cargo ships and container ships) will change as shown in Table 10-4 according to the cargo volume given in Table 10-1.

① Frame of General Cargo Ships

According to the port statistics, loading/unloading efficiency of general cargo is 12.2 tons/gang hr. and average loading/unloading time per ship is 54.9 hours and volume of cargo handled per ship (including loading and unloading) is 2,009 tons.

According to the past performance, stevedoring work aboard ship is 20 hours a day with an average of 2.2 gangs. Therefore, average berthing time per ship will be 89.8

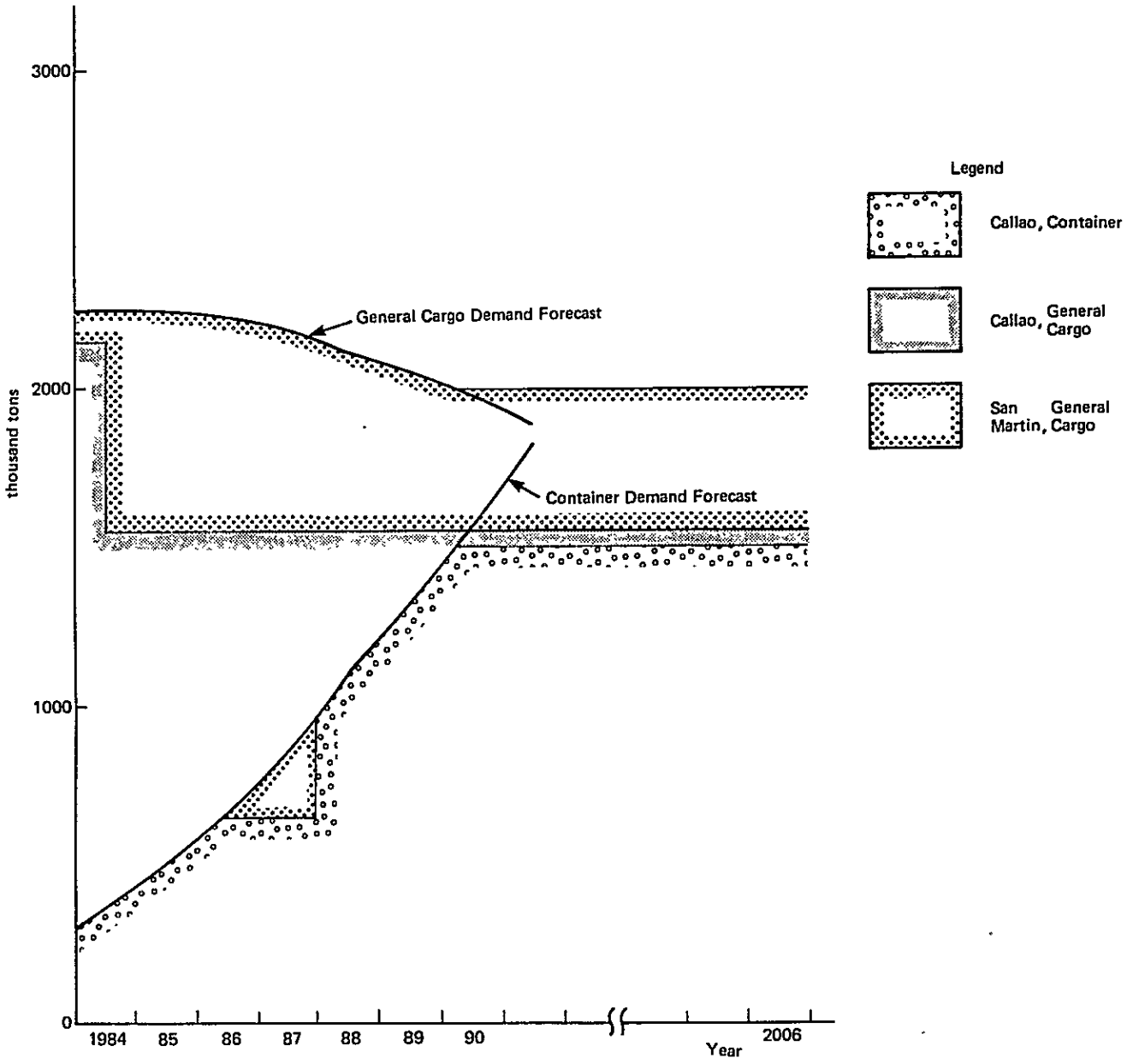


Fig. 10-1 Allocation of Handled Cargo Volume (with)

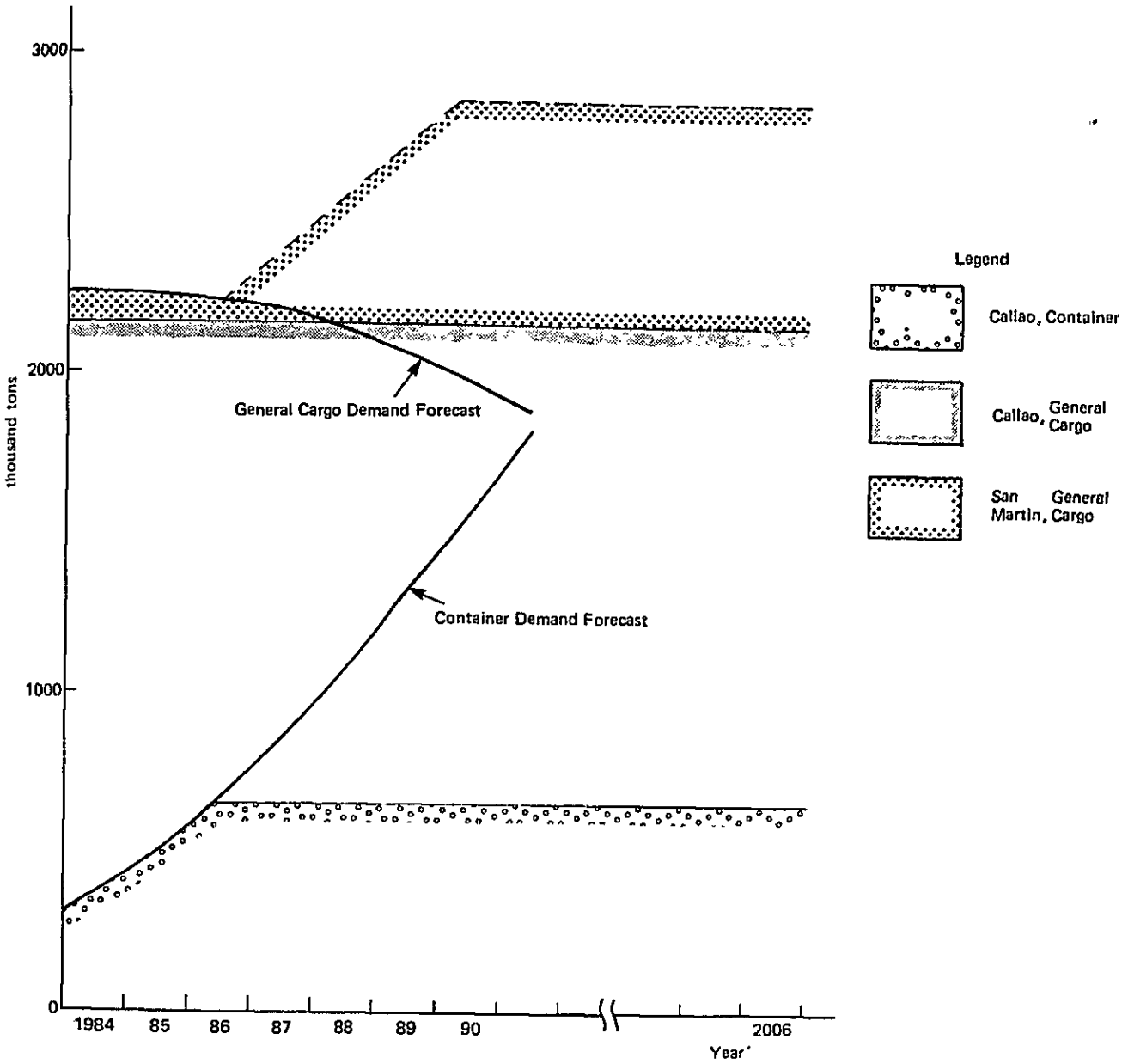


Fig. 10-2 Allocation of Handled Cargo Volume (without)

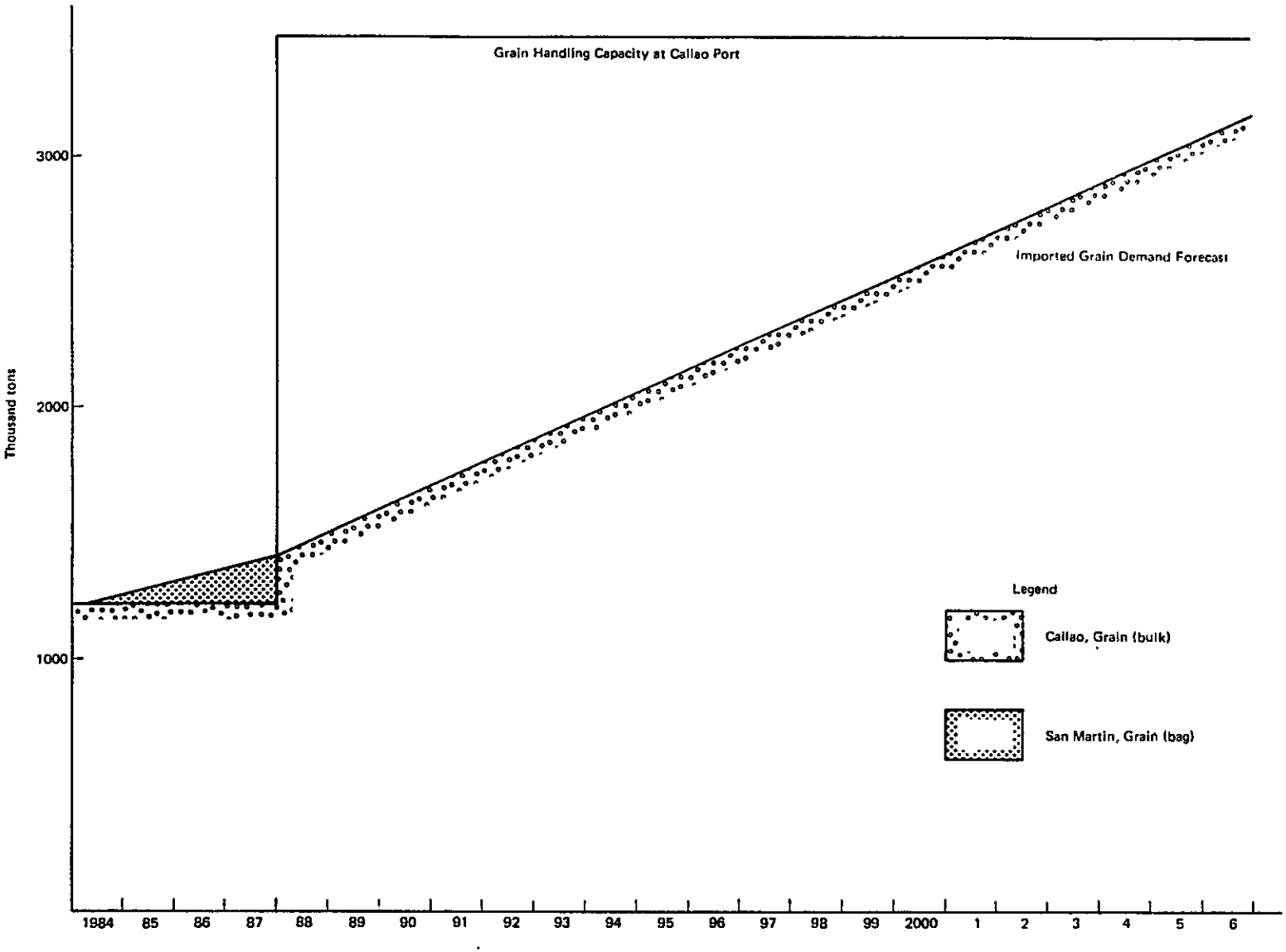


Fig. 10-3 Allocation of Handled Grain Volume (with)

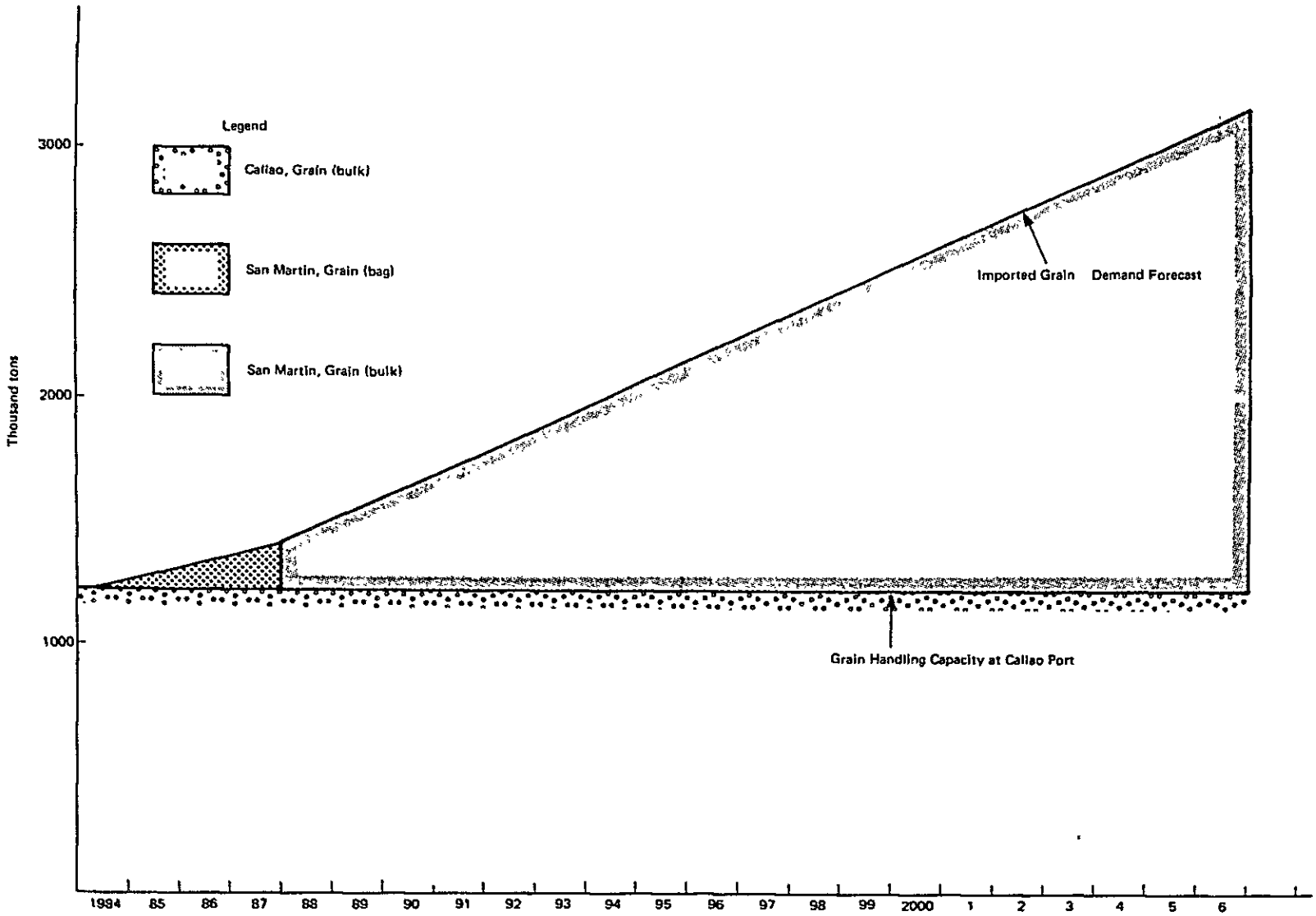


Fig. 10-4 Allocation of Handled Grain Volume (without)

Table 10-1 Frame of Handled Cargo Volume (Container & General Cargo)

1. With

(Unit: Thousand tons)

Cargo / Year	Callao (Container)	Callao (General Cargo)	San Martin (General Cargo)	Total
1984	367	1,850	399	2,616
85	506	1,550	694	2,750
86	650	〃	692	2,892
87	650	〃	841	3,041
88	1,091	〃	558	3,199
89	1,328	〃	487	3,365
90	1,500	〃	450	3,500
〃	〃	〃	〃	〃
〃	〃	〃	〃	〃
〃	〃	〃	〃	〃
2006	1,500	1,550	450	3,500

2. Without

Cargo / Year	Callao (Container)	Callao (General Cargo)	San Martin (General Cargo)	Total
1984	367	2,150	99	2,616
85	506	〃	94	2,750
86	650	〃	92	2,892
87	〃	〃	241	3,041
88	〃	〃	399	3,199
89	〃	〃	565	3,365
90	〃	〃	700	3,500
〃	〃	〃	〃	〃
〃	〃	〃	〃	〃
〃	〃	〃	〃	〃
2006	650	2,150	700	3,500

Table 10-2 Frame of Handled Grain Volume (with)

(Unit: Thousand tons)

Cargo / Year	Callao (Grain, Bulk)		San Martin (Grain, bag)	Total
	No. 11	New Terminal		
1984	1,224	0	11	1,235
85	"	0	55	1,279
86	"	0	100	1,324
87	"	0	144	1,368
88	"	241	0	1,465
89	"	337	"	1,561
90	"	434	"	1,658
91	"	524	"	1,748
92	"	615	"	1,839
93	"	705	"	1,929
94	"	796	"	2,020
95	"	886	"	2,110
96	"	976	"	2,200
97	"	1,067	"	2,291
98	"	1,157	"	2,381
99	"	1,248	"	2,472
2000	"	1,338	"	2,562
1	"	1,436	"	2,660
2	"	1,526	"	2,750
3	"	1,616	"	2,840
4	"	1,706	"	2,930
5	"	1,796	"	3,020
6	1,224	1,896	0	3,120

Table 10-3 Frame of Handled Grain Volume (without)

(Unit: Thousand tons)

Cargo / Year	Callao (Grain, bulk, No. 11 Berth)	San Martin (Grain, bag)	San Martin (Grain, bulk)	Total
1984	1,224	11	0	1,235
85	〃	55	0	1,279
86	〃	100	0	1,324
87	〃	144	0	1,368
88	〃	0	241	1,465
89	〃	〃	337	1,561
90	〃	〃	434	1,658
91	〃	〃	524	1,748
92	〃	〃	615	1,839
93	〃	〃	705	1,929
94	〃	〃	796	2,020
95	〃	〃	886	2,110
96	〃	〃	976	2,200
97	〃	〃	1,067	2,291
98	〃	〃	1,157	2,381
99	〃	〃	1,248	2,472
2000	〃	〃	1,338	2,562
1	〃	〃	1,436	2,660
2	〃	〃	1,526	2,750
3	〃	〃	1,616	2,840
4	〃	〃	1,706	2,930
5	〃	〃	1,796	3,020
6	1,224	0	1,896	3,120

Table 10-4 Frame of Calling Vessels

1. With

Cargo / Year	Callao (Container)	Callao (General Cargo)	San Martin (General Cargo)
1984	113	921	199
85	156	772	345
86	201	772	344
87	201	772	419
88	337	〃	278
89	410	〃	242
90	463	〃	224
〃	〃	〃	〃
〃	〃	〃	〃
〃	〃	〃	〃
2006	463	772	224

2. Without

Cargo / Year	Callao (Container)	Callao (General Cargo)	San Martin (General Cargo)
1984	113	1,070	49
85	156	〃	47
86	201	〃	46
87	〃	〃	120
88	〃	〃	199
89	〃	〃	281
90	〃	〃	348
〃	〃	〃	〃
〃	〃	〃	〃
〃	〃	〃	〃
2006	201	1,070	348

hours.

Fig. 10-5 shows results plotted out by obtaining an average of average cargo volume per ship and DWT of ships for each berth with general cargo ships entering/leaving Callao Port.

According to the figure, the average DWT of a general cargo ship with a cargo handling volume of 2,009 tons is 10,481 DWT.

② Frame of Container Ships

The average type of container ship calling at Callao Port is assumed to be a 28,000 DWT container ship with a loading capacity of 1,500 TEU. Assuming a ship carrying 1,050 TEU (using 70% of its capacity), of which 235 TEU is presumed to be destined for Peru, 470 TEU would be expected to be loaded/unloaded at Callao Port.

Based on the ratio of 17.5% empty containers to loaded containers expected in 1990, 400 TEU will be loaded containers and 70 will be empty containers.

When the container cargo volume at 5B berth is less than 520 thousand tons (or by 1985), berthing time is assumed to be 36 hours.

Loading/unloading time in this case will be 20.9 hours using 2 mobile cranes with loading capacities of 15 TEU/hr per crane and a loading efficiency of 0.75.

When 3 shift operation is carried out at 5B berth after 1986, although the loading time of 20.9 hours remains unchanged, the berthing time will be 24.8 hours.

After the completion of a new container terminal, the average capacity of container handling at 5B berth and the new container terminal, weighted by the volume of cargo handled at each berth is assumed to be 21 TEU/hr.

In this case, loading/unloading time per ship will be 14.9 hours and berthing time will be 18.3 hours.

③ Frame of Grain Carriers

According to ENAPU statistics, the average DWT and the loaded volume/carrier are investigated concerning carriers which load/unload cargoes at No. 11 Berth.

The investigation results show that the average DWT came to 29,808 tons while the average loaded volume/carrier was 21,468 tons.

As to the average berthing time, it was 107 hours according to the actual performance at 11A Berth.

From the above data, we see the maximum number of carriers to be berthed there will be 57 carriers/annum, on the basis of a 70% berth occupancy. In this case, the annual grain handling capacity comes to 1,224,000 tons. On the other hand, the planned grain berth capacity set in the short term Development Plan can be calculated as follows:

Based on a 60% handling efficiency, the unloader capacity is 480 tons/2 units/hour. The average ship model of a grain carrier is about 45,000 DWT and it unloads a cargo volume of 35,000 tons at Callao Port. In this case, the berthing hours, including in-coming and out-going time of 2 hours, come to 75 hours.

Based on a 70% berth occupancy rate, the annual grain handling capacity comes to 2,254,000 tons on the basis of 6,900 working hours per year.

Consequently, the grain handling capacity of Callao Port upon completion of the

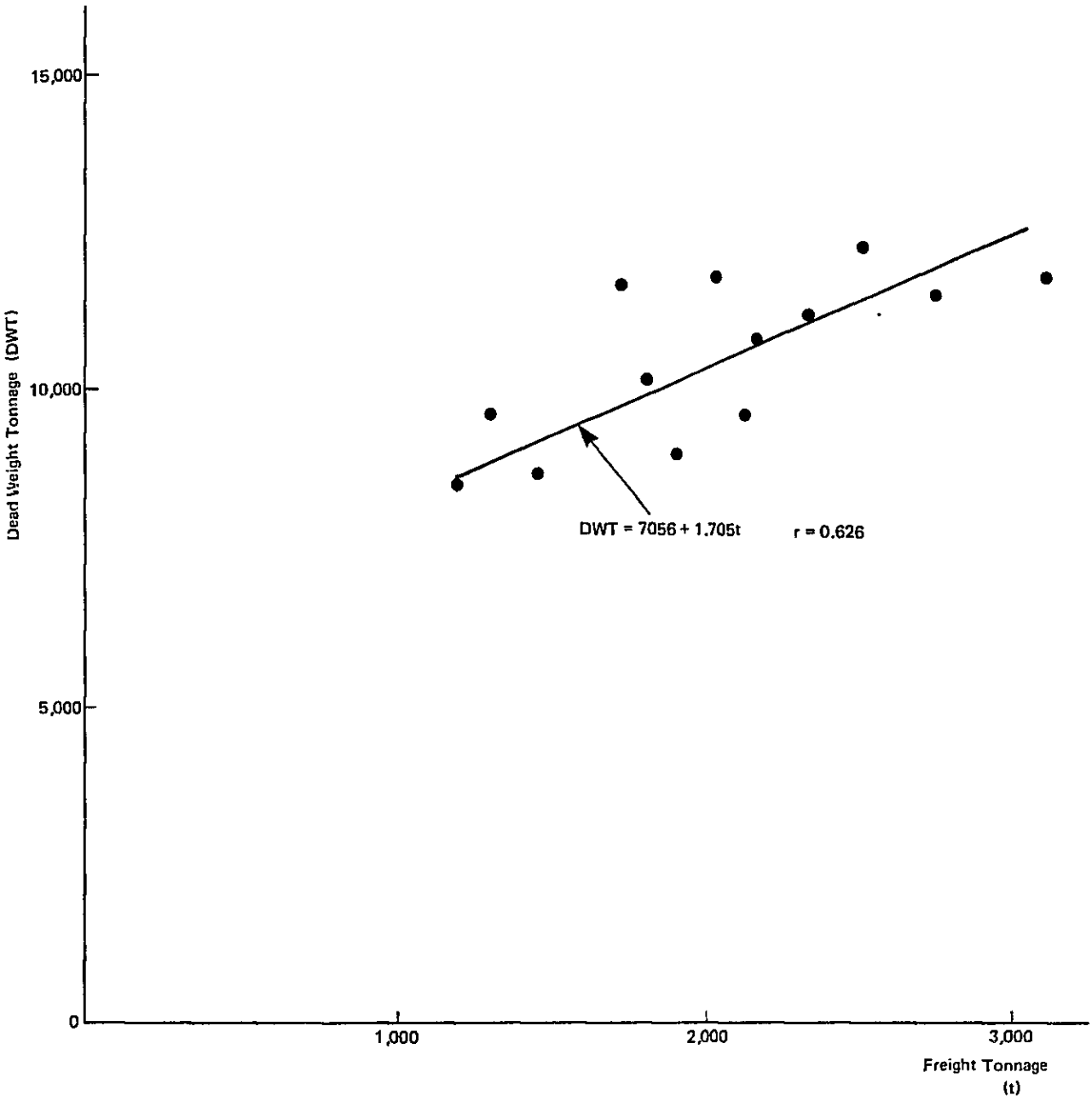


Fig. 10-5 Correlation between Ships' Dead Weight Tonnage and Freight Tonnage

construction planned in the Short-term Development Plan (the end of 1987) will total 3,478,000 tons.

3) Frame of the number of berths

Table 10-5 shows the frame of the number of berths.

The number of general cargo berths at Callao Port in 1984 is listed at 10.5 because there are 12 berths in the first half of 1984 and 9 berths in the second half.

At present there are 4 general cargo berths in San Martin Port. But we assumed that this number would remain unchanged in both cases of "with" and "without".

Table 10-5 Frame of Berths

Berth Type / Year	Callao						San Martin			
	Container		General Cargo		Grain (bulk)		General Cargo		Grain (bulk)	
	with	without	with	without	with	without	with	without	with	without
1984	1	1	10.5	12	1	1	4	4	0	0
85	1	"	9	"	1	"	"	"	"	0
86	1	"	"	"	1	"	"	"	"	0
87	1	"	"	"	1	"	"	"	"	1
88	2	"	"	"	2	"	"	"	"	1
89	2	"	"	"	2	"	"	"	"	"
90	2	"	"	"	"	"	"	"	"	"
"	"	"	"	"	"	"	"	"	"	"
"	"	"	"	"	"	"	"	"	"	"
"	"	"	"	"	"	"	"	"	"	"
2006	2	1	9	12	2	1	4	4	0	1

4) Simulation of ship waiting time

Ship waiting time is calculated using the simulation method discussed in "6-2-2, Master Plan of Callao Port" for the frames of ships and number of berths.

In this calculation, it is assumed that only container ships can berth at the container terminals of Callao Port, that only general cargo ships can berth at the general cargo berths of Callao Port and San Martin Port, and that grain carriers can berth only at grain berths.

In the simulation, with regard to arrival of ships, the distribution of number of ships calling at the port during a certain time is considered to be a Poisson Distribution.

Likewise the intervals between ship arrivals follow a distribution of exponential type.

With regard to the berthing time of ships, since berthing time of general cargo ships at Callao Port is known to match the Erulung distribution of Phase 2 as shown in Fig. 6-4, the calculation is made using this distribution.

For instance, an Erulung distribution of Phase 2 which gives an average value of berthing time of 89.8 hours is used for general cargo ships.

This means that calculation of $M/E_2/S$ of queuing theory is done.

Here, S shows the number of berths.

Also it is assumed that ships are berthed and served in the order of arrival.

Table 10-6 shows calculated average waiting time of all ships calling at Callao Port and San Martin Port.

Table 10-6 Average Ships' Waiting Time

(Unit: hours)

Ship Type / Year	Callao (Container)		Callao (Gneral Cargo)		San Martin (Gneral Cargo)	
	with	without	with	without	with	without
1984	19.8	19.8	142.6	61.8	5.4	0
85	39.2	39.2	42.7	〃	92.5	0
86	20.0	20.0	42.7	〃	90.8	0
87	20.0	〃	〃	〃	360.0	- 0.8
88	1.7	〃	〃	〃	19.9	5.4
89	2.7	〃	〃	〃	11.3	26.5
90	3.7	〃	〃	〃	9.5	97.9
〃	〃	〃	〃	〃	〃	〃
〃	〃	〃	〃	〃	〃	〃
〃	〃	〃	〃	〃	〃	〃
2006	3.7	20.0	42.7	61.8	9.5	97.9

(2) Ship's staying cost

The staying cost of ships is evaluated by charterage. Fig. 10-6 shows the charterage of ships as of July, 1982. Since charterage does not include the cost of diesel oil used for generators, the staying cost of ships can be obtained by adding the price of diesel oil. It is calculated that the staying cost of a general cargo ship of 10,481 DWT is US$3,006/day and that of a container ship of 28,000 DWT is US$3,629/day.

(3) Rate of Return of Staying Cost to Peru

On the saving in staying costs, only the staying cost of Peruvian ships is assumed to return to Peru and can be assumed to be a benefit in the economic analysis. The percentage of Peruvian ships against all ships is assumed to be equal to the loading rate of Peruvian ships. Table 10-7 shows the loading rate (share) of Peruvian ships for 1976 – '80 in monetary value.

Because the rate of loading is prescribed as 50% both for export and import according to the Decree in Peru and the rate of unloading for imports (imports include more general cargo than exports) averages 38.8%, larger than in the case of exports, it is assumed that the loading rate of Peruvian ships in the future will be 50%.

The rate of return of staying cost to Peru is accordingly decided to be 50%.

(4) Amount of saved staying cost

The amount of saved staying cost returned to Peru is obtained by multiplying the waiting time of ships by the charterage by the rate of return, and by the number of ships.

The result is shown in Table 10-8.

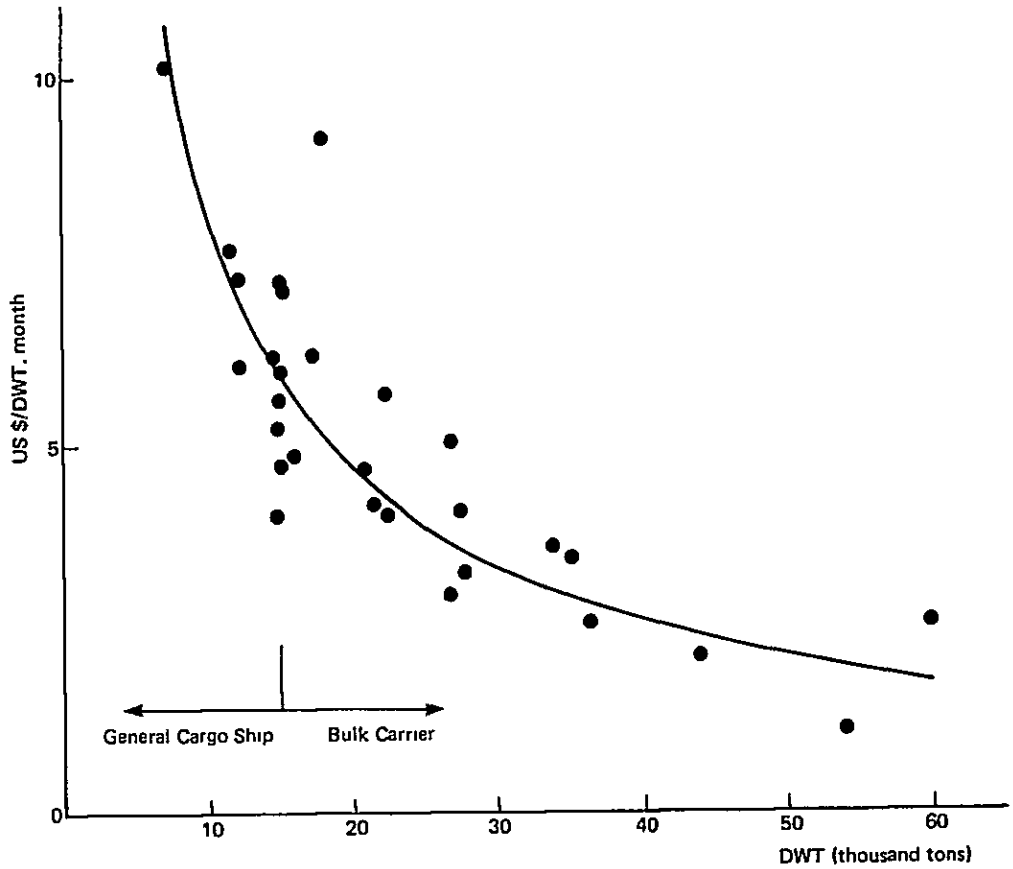


Fig. 10-6 Time charterage of Vessels
After Maritime Research Inc. (as of 1982, July)

Table 10-7 Share of Peruvian Ships in Cargo Traffic

Year	Export (Freight Thousand $)			Import (Freight Thousand $)		
	Total	Peruvian Ships	Percentage	Total	Peruvian Ships	Percentage
1976	106,784	44,980	42	208,218	72,701	35
77	158,733	45,470	28	152,849	68,946	45
78	187,290	62,731	33	126,796	56,446	44
79	245,754	60,012	25	156,811	58,441	37
80	280,182	66,970	24	282,703	91,834	33
Average			30.4%			38.8%

Table 10-8 Ship's Waiting Cost

(Unit: 1,000 US$)

Year	Callao (Container)			Callao (General Cargo)			San Martin (General Cargo)			Total
	with	without	with -without	with	without	with -without	with	without	with -without	with-without (minus means benefit)
1984	169	169	0	8,225	4,141	4,084	67	0	67	4,151
85	462	462	0	2,064	"	-2,077	1,999	0	1,999	-78
86	304	304	0	"	"	"	1,956	0	1,956	-121
87	304	"	0	"	"	"	9,446	6	9,440	7,363
88	43	"	-261	"	"	"	346	67	279	-2,059
89	84	"	-220	"	"	"	171	466	-295	-2,592
90	130	"	-174	"	"	"	133	1,373	-1,240	-3,491
"	"	"	"	"	"	"	"	"	"	"
"	"	"	"	"	"	"	"	"	"	"
"	"	"	"	"	"	"	"	"	"	"
2006	130	304	-174	2,064	4,141	-2,077	133	1,373	-1,240	-3,491

10-2-3 Reduction in cargo handling cost

(1) Outline of analysis

In 10-2-3, the effective change of the operational cost of cargo handling resulting from this project is studied.

In other words, the difference in operational cost between the cases of 'with the project' and 'without the project' is considered as a benefit in the economic analysis. The operational cost does not include the staying cost of ships or the inland transportation cost of cargo but does include the cost borne by the shipping agents for the stevedoring service which is controlled by CCTM.

The operational cost which varies in the cases of 'with the project' and 'without the project' is assumed to be the only direct variable cost as shown in Table 11-12 of Financial Analysis.

The cost is calculated based on prices of 1982 and no cost increase due to inflation is considered. The subject period of operational cost estimation is the construction period from 1984 to 1987 and the service period from 1988 to 2006 for a total of 19 years.

In the analysis, the frames of cargo volume, ships and berths are assumed to be the same as those discussed in the benefit saving of stay costs 10-2-2.

(2) Unit Costs

The unit costs of the direct variable cost-of-operation costs are given in Table 10-9.

Table 10-9 Unit Direct Variable Cost in 1982

(Unit: dollars)

	Shipping Service (per ship)	Storage Service (per ton)	General Cargo Handling Service (per ton)
Labour Cost (ENAPU)	1,120.58	1.96	5.15
Labour Cost (CCTM)			31.22
Material Cost (ENAPU)	100.00		0.12
Outside Job Cost (ENAPU)	41.25	0.04	0.05
Total	1,261.83	2.00	36.54

The direct variable costs of storage services and cargo handling services are assumed to change according to the volume of cargo handled and the unit cost is obtained as cost per ton.

Direct variable costs of shipping services are considered to be in proportion to the number of ships calling at the port and unit cost per ship is thus obtained.

With regard to the storage service cost since the percentage of the total cargo that was indirect cargo through the transit shed (in 1982) was 79% for imports and 61% for exports, the volume of cargo through the transit sheds can be calculated. Then, the cost per ton is obtained. Costs paid by shipping agents for stevedoring services which are controlled by CCTM vary according to the volume of cargo and correspond to the direct variable costs of ENAPU. Table 10-10 and 10-11 show the operation costs aboard ship as obtained by loading, unloading and types of cargo.

Table 10-9 shows the unit direct variable costs including operation costs aboard ship weighted with the volume of exports and imports of general cargo in 1982.

(3) Cost of cargo handling service

1) General cargo

Based on the frame of cargo volume and the unit costs, the direct variable cost of cargo handling service and stevedoring for general cargo are estimated in both 'with' and 'without' cases and shown in Table 10-12.

Calculation is made on the premise that cargo handling cost at Callao Port is same as that at San Martin Port.

2) Container

Containers are handled at berth No. 5B during 1984 – '87 and after 1988 handled at both No. 5B and new container terminal in the case of 'with'.

Table 10-13 shows the allocation of container cargo which was obtained by making the rate of use of two berths equal in the case of 'with'.

Operation costs are studied separately for berth No. 5B and the new container terminal.

① Berth No. 5B

At Berth No. 5B, the container handling personal amount to 92 men for two shifts and 132 men for 3 shifts. These men are only engaged in work aboard ship and at the container yard. They do not include those engaged in maintenance, storage and administration.

For calculating the costs, the following system is assumed.

(a) Maintenance, storage and administration, etc. are carried out within the present operation system of general cargo.

(b) Presently stevedoring work aboard ship is carried out by shipping agents and longshore cargo handling is carried out by ENAPU.

At Berth 5B, both stevedoring on board and longshore cargo handling are assumed to be carried out by ENAPU. Unit cost of the direct variable costs is considered as follows.

Labor Cost (ENAPU) of the direct variable costs shown in Table 10-9 is related to longshore cargo handling. Base of labor cost related to longshore handling is assumed to be 5.15 US$, the same as for general cargo. However, as discussed

Table 10-10 Operation Cost Paid by Shipping Agents (Unloading Cargo)

Commodity	Container	Palletized Cargo	Refrigerated Cargo	General Cargo	Bagged Cargo (wheat)	Iron & Steel	Vehicle
Number of Gangs	1	2	2	2	2	2	2
Handled Cargo Volume (ton) per Gang, Shift	360	150	50	80	120	200	150
For Stevedores (US$)	3,366	1,683	1,212.50	1,496	1,610.40	1,642	1,866
For Tallymen (US$)	240	280	280	280	280	280	280
For Rigging Gang (US$)	337	337	337	337	337	337	337
Others (US$)	162.50	325	325	325	325	325	325
Total (US$)	4,105.50	2,625	2,154.50	2,438	2,552.40	2,584	2,808
Operation Cost per ton (US$)	11.40	17.50	43.09	30.48	21.27	12.92	18.72

Table 10-11 Operation Cost Paid by Shipping Agents (Loading Cargo)

Commodity	Container	Palletized Cargo	Refrigerated Cargo	General Cargo	Bagged Cargo (Coffee, Fish Meal)	Bagged Cargo (Cotton)	Metal	Timber
Number of Gangs	1	2	2	2	2	2	2	2
Handled Cargo Volume (ton) per Gang, Shift	300	200	150	100	200	150	400	200
For Stevedores (US$)	3,561	2,692	3,699	2,313	3,184	3,168	3,736	2,918
For Tallymen (US$)	320	360	360	360	360	360	360	360
For Rigging Gang (US$)	337	337	337	337	337	337	401	337
Others (US$)	132.50	265	265	265	265	265	265	265
Total (US$)	4,350.50	3,654	4,661	3,275	4,146	4,130	4,762	3,880
Operation Cost per ton (US$)	14.50	18.27	31.07	32.75	20,73	27.53	11.91	19.40

Table 10-12 General Cargo Handling Cost

(Unit: 1,000 US$)

Year	Callao (General Cargo)			San Martin (General Cargo)			Total (minus means benefit)
	with	without	with-without	with	without	with-without	with-without
1984	67,588	78,548	-10,960	14,577	3,617	10,960	0
85	56,628	⋮	-21,920	25,354	3,434	21,920	0
86	56,628	⋮	⋮	25,282	3,361	21,920	0
87	⋮	⋮	⋮	30,725	8,805	21,920	0
88	⋮	⋮	⋮	20,386	14,577	5,809	-16,111
89	⋮	⋮	⋮	17,792	20,642	-2,850	-24,770
90	⋮	⋮	⋮	16,440	25,574	-9,134	-31,054
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
2006	56,628	78,548	-21,920	16,440	25,574	-9,134	-31,054

Table 10-13 Allocation of Container Cargo

(Unit: thousand tons)

Year	Without	With	
	(5B Berth)	5B Berth	New Container Terminal
1984	367	367	0
85	506	506	0
86	650	650	0
87	↓	650	0
88	↓	473	618
89	↓	575	753
90	↓	650	850
↓	↓	↓	↓
2006	650	650	850

later, in the case of container handling at Berth 5B, since productivity is 6 times the conventional container handling, unit labor cost is 0.86 US$ as obtained by applying 1/6 to the above figure.

The units of material cost and outside job cost may be considered to be the same as in the case of general cargo.

The stevedoring cost aboard ship is as follows. The labor cost paid by shipping agents includes 15 stevedores (unloading) or 19 (loading), 1 tallyman, 1.5 rigging men (number of rigging men for 1 stevedore gang). In other words, 17.5 men for unloading and 21.5 men for loading are included (the average number of men required is 19.5).

According to the operation plan of Berth 5B, the number of men required for work aboard ship is 10 lashers, 1 talley-man, 1 signalman, for a total of 12. Therefore, assuming the cost per man remains same, cost per ton will be obtained by multiplying by 12/19.5.

The loading/unloading productivity of containers is assumed to be 3.75 TEU/gang-hour (6 TEU/gang-hour x 5/8. Where 5/8 is the work efficiency.) in Tables 10-10 and 10-11.

While for operation of No. 5B berth, loading/unloading productivity of 22.5 TEU/gang hour is assumed. (15 TEU x 2 cranes x 0.75. 0.75 is work efficiency.) Therefore, the loading/unloading productivity will increase by 6 times. Thus container handling cost per ton will decrease by 1/6.

When the unit costs given in Tables 10-10 and 10-11 are weighted with the volume of container cargo in 1982, the unit cost of work aboard ship will be US$1.32 (US$12.84 x 12/19.5 x 1/6 = US$1.32).

Table 10-14 shows the unit costs of the container cargo handling service.

Table 10-18 shows costs of cargo handling service at berth 5B (direct variable costs) obtained based on the above unit costs.

Table 10-14 Unit Container Cargo Handling Cost at 5B Wharf

(Unit: US$/ton)

Labour Cost (at wharf)	0.86
Labour Cost (on board)	1.32
Material Cost	0.12
Outside Job Cost	0.05
Total	2.35

② New Container Terminal

This terminal will start its service from 1988 and be operated with 3 shifts from the first year.

The number of men required for the terminal will be 403

This number includes people for administration, maintenance and CFS as well as people for the direct work of cargo handling.

Personnel cost for these people is comprised of the direct variable cost, the direct fixed cost and the general administration cost.

The total personnel cost will be 6,693 thousand US$ assuming the present personnel cost of ENAPU is applied according to job classifications.

In this case, personnel cost per man/yr will be 16,608 thousand US$.

Material cost will be the total of the costs for electricity, water and fuel (diesel).

The breakdown is given in Table 10-15.

The total cost will be 419.6 thousand US$.

The volume of materials consumed in the above case assumes the volume of container cargo handled is 850 thousand tons.

Since the container cargo volume handled in 1988 and 1989 will not reach 850 thousand tons, only a part of the electricity and fuel costs need be considered, according to the volume of cargo, making the material cost 328 thousand US$ in 1988 and 381 thousand US$ in 1989.

Repair and maintenance costs will be 3% of the purchase cost of equipment and 1% of the civil facilities and buildings. The results are shown in Table 10-16.

Besides the above costs, 20% is added as miscellaneous cost.

In summary the cost of the new container terminal (personnel cost, material costs, repair and maintenance cost and miscellaneous cost) are as given in Table 10-17.

③ The savings of container handling cost

Table 10-18 shows the results of calculation of costs in the case of 'with' and 'without' for the container cargo handling service.

Table 10-15 Fuel, Power & Water Cost at New Container Terminal

		Quantity	Unit Price (dollars)	Cost (1,000 US$)
1. Electricity				
Office	70,000 KWH/Month x 12 =	840,000 KWH		
Refrigerated Container (360 TEU)	176,000 KWH/Month x 12 =	2,112,000 KWH		
Gantry Crane	40,000 KWH/Month x 12 =	480,000 KWH		
Repair Shop	70,000 KWH/Month x 12 =	840,000 KWH		
Sub Total		4,272,000 KWH	0.0449	191.7
2. Water				
Office	1,100 m^3/Month x 12 =	13,200 m^3		
C.Y.	500 m^3/Month x 12 =	6,600 m^3		
Sub Total		19,800 m^3	0.3788	7.5
3. Fuel (Diesel)				
Transtainer	4 x 170 (ℓ/8 hours) x 364 x 0.75 =	185,640 ℓ		
"	2 x 170 (ℓ/8 hours) x $\frac{22}{8}$ x 364 x 0.75=	255,255 ℓ		
Tractor	8 x 14 (ℓ/8 hours) x 364 x 0.75 =	30,576 ℓ		
"	8 x 14 (ℓ/8 hours) x $\frac{22}{8}$ x 364 x 0.75=	84,084 ℓ		
Fork Lift	19 x 28 (ℓ/8 hours) x 364 x 0.75 =	145,236 ℓ		
Sub Total		700,791 ℓ	0.3145	220.4
Total				419.6

Table 10-16 Maintenance Cost

	Purchase Price & Construction Cost (thousand dollars)	Maintenance Cost Ratio (%)	Maintenance Cost (thousand dollars)
Equipments	14,999	3	450
Civil Facilities & Building	48,769	1	488
Total			938

Table 10-17 Cost at New Container Terminal

(Unit: 1,000 US$)

Cost \ Year	1988	1989	1990 – 2000
Labour Cost	6,693	6,693	6,693
Fuel, Power Water	328	381	420
Maintenance Cost	938	938	938
Sub-Total	7,959	8,012	8,051
Others (20% of Sub-Total)	1,592	1,602	1,610
Total	9,551	9,614	9,661

Table 10-18 Container Cargo Handling Cost at Callao Port

(Unit: 1,000 US$)

Year	With			Without (5B Berth)	With-Without (minus means benefit)
	5B Berth	New Container Terminal	Total		
1984	860	0	860	860	0
85	1,185	0	1,185	1,185	0
86	1,523	0	1,523	1,523	0
87	1,523	0	1,523	↓	0
88	1,108	9,551	10,659	↓	9,136
89	1,347	9,614	10,961	↓	9,438
90	1,523	9,661	11,184	↓	9,661
↓	↓	↓	↓	↓	↓
2006	1,523	9,661	11,184	1,523	9,661

(4) Shipping Service Cost

Table 10-19 shows the difference between 'with' and 'without' cases for shipping service cost.

In calculating the cost, it is assumed that shipping service cost per container ship or general cargo ship is same.

Table 10-19 Shipping Service Cost

Year	Unit Cost (dollars)	Ship Amount (Callao) with-without (Container Ship & General Cargo Ship)	Shipping Service Cost (Callao) with-without (thousand US$)	Ship Amount (San Martin) with-without (General Cargo Ship)	Shipping Service Cost (San Martin) with-without (thousand US$)	Total Shipping Service Cost with-without (thousand US$) minus means benefit
1984	1,261.83	-149	-188	150	189	1
85	↓	-298	-376	298	376	0
86	↓	-298	-376	298	376	0
87	↓	-298	-376	299	377	1
88	↓	-162	-204	-79	100	-104
89	↓	-89	-112	-39	-49	-161
90	↓	-36	-45	-124	-156	-201
↓	↓	↓	↓	↓	↓	↓
2006	1,261.83	-36	-45	-124	-156	-201

(5) Storage Service Cost

Storage service cost is calculated separately for general cargo and container cargo.

1) General cargo

The volumes of cargo handled at Callao Port and San Martin Port shown in Table 10-1 are

allocated to exports and imports using the composition rate of exports and imports of general cargo in 1984.

Then the volume of indirect export/import cargo is obtained assuming rate of indirect cargo for export at 61% and that of indirect cargo for import at 79%.

The results are multiplied by the cost per ton of storage service and the differences between 'with' and 'without' are obtained. They are shown in Table 10-20.

2) Container cargo

Since the storage service cost of LCL container cargo handled at the new container terminal and passing through CFS is already given in the above cargo handling service cost, it is not included for this calculation.

Therefore, the storage service cost for cargo handled at berth 5B is only calculated.

It is assumed that LCL cargo is 50% of the total loaded container cargo and that the storage service cost per ton is US$2.00/ton the same as the case of general cargo.

The results of calculation are shown in Table 10-21.

The storage cost does not include the cost of storage for empty containers, since empty containers are taken to the container yard outside the port as much as possible.

Table 10-20 Storage Service Cost (General Cargo)

Year	Callao				San Martin				Total Storage Service Cost (thousand US$) with-without (minus means benefit)
	Indirect Cargo Volume (Thousand tons)			Storage Service Cost (Thousand US$)	Indirect Cargo Volume (Thousand tons)			Storage Service Cost (Thousand US$)	
	with	without	with-without	with-without	with	without	with-without	with-without	
1984	1,354	1,573	-219	-438	292	73	219	438	0
85	1,135		-438	-876	508	69	439	878	2
86					507	67	440	880	4
87					616	177	439	878	2
88					409	292	117	234	-642
89					307	414	-57	-114	-990
90					329	512	-183	-366	-1,242
2006	1,135	1,573	-438	-876	329	512	-183	-366	-1,242

Table 10-21 Storage Service Cost at No. 5B Berth (Container)

Year	LCL Cargo Volume (thousand tons)			Storage Service Cost (Thousand US$) minus means benefit
	with	without	with-without	
1984	183.5	183.5	0	0
85	253	253	0	0
86	325	325	0	0
87	325		0	0
88	236.5		−88.5	−177
89	287.5		−37.5	−75
90	325		0	0
↓	↓	↓	↓	↓
2006	325	325	0	0

10-2-4 Reduction in Transportation on Land

(1) Unit cost of land transportation

With regard to cargo passing through Callao Port and San Martin Port, in the case of exports it is assumed to originate and in the case of imports to be destined from and for the Lima/Callao metropolitan area.

Since the details of the land transportation costs are not known, they are assumed to be same as the land transportation fees set by Orett. In this case local tariff is applied for transportation between Callao Port and Lima/Callao metropolitan area and external tariff is applied for transportation between San Martin Port and Lima/Callao metropolitan area.

Table 10-22 shows the unit cost of land transportation on the foregoing assumptions

Table 10-22 Unit Cost of Land Transportation

(Unit: US$/ton)

Commodity type / Transportation Route	General Cargo	Container	Grain
Callao Port ~ Lima, Callao Area	5.13	10.93	3.65
San Martin Port ~ Lima, Callao Area	11.84	–	11.84

(2) Land transportation cost

Table 10-23 shows the results obtained for the case of 'with' and 'without' for the land transportation cost of general cargo and containers, by multiplying the volume of cargo handled at Callao Port and San Martin Port by the unit cost of the above land transportation. Table 10-24 shows the saving of grain over land freightage as well as the savings for aggregate land transportation cost for general cargo, containers and grain.

Table 10-23 Transportation Cost (General Cargo & Container, with-without)

Year	Callao Port				San Martin Port	
	General Cargo		Container		General Cargo	
	Transportation Volume (Thousand tons)	Transportation Cost (Thousand US$)	Transportation Volume (Thousand tons)	Transportation Cost (Thousand US$)	Transportation Volume (Thousand tons)	Transportation Cost (Thousand US$)
1984	-300	-1,539	0	0	300	3,552
85	-600	-3,078	0	0	600	7,104
86	⋮	⋮	0	0	600	7,104
87	⋮	⋮	0	0	600	7,104
88	⋮	⋮	441	4,820	159	1,883
89	⋮	⋮	678	7,411	-78	-924
90	⋮	⋮	850	9,291	-250	-2,960
⋮	⋮	⋮	⋮	⋮	⋮	⋮
2006	-600	-3,078	850	9,291	-250	-2,960

Table 10-24 Transportation Cost (Grain & Total, with-without)

Year	Callao Port		San Martin Port		Total Transportation Cost (thousand US$) minus means benefit
	Grain		Grain		
	Transportation Volume (thousand tons)	Transportation Cost (thousand US$)	Transportation Volume (thousand tons)	Transportation Cost (thousand US$)	
1984	0	0	0		2,013
85	0	0	0		4,026
86	0	0	0		4,026
87	0	0	0		4,026
88	241	880	241	-2,853	1,652
89	337	1,230	337	-3,990	649
90	434	1,584	434	-5,139	-302
91	524	1,913	524	-6,204	-1,038
92	615	2,245	615	-7,282	-1,784
93	705	2,573	705	-8,347	-2,521
94	796	2,905	796	-9,425	-3,267
95	886	3,234	886	-10,490	-4,003
96	976	3,562	976	-11,556	-4,741
97	1,067	3,895	1,067	-12,633	-5,485
98	1,157	4,223	1,157	-13,699	-6,223
99	1,248	4,555	1,248	-14,776	-6,968
2000	1,338	4,884	1,338	-15,842	-7,705
1	1,436	5,241	1,436	-17,002	-8,508
2	1,526	5,570	1,526	-18,068	-9,245
3	1,616	5,898	1,616	-19,133	-9,982
4	1,706	6,227	1,706	-20,199	-10,719
5	1,796	6,555	1,796	-21,265	-11,457
6	1,896	6,920	1,896	-22,449	-12,276

10-2-5 Summary of benefits

Table 10-25 shows a summary of various benefits described above.

Table 10-25 Total Benefit (Minus means benefit)
(Market Price)

(Unit: thousand US$)

Year	Ship's waiting cost	Land transportation cost	Cargo handling cost		Shipping service cost	Storage service cost		Construction of Grain Berth at San Martin	Total benefit
			General Cargo	Container		General Cargo	Container		
1984	4,151	2,013	0	0	1	0	0	−636	5,529
85	−78	4,026	0	0	0	2	0	−4,394	−444
86	−121	4,026	0	0	0	4	0	−4,402	−493
87	7,363	4,026	0	0	1	2	0	−19,081	−7,689
88	−2,059	1,652	−16,111	9,136	−104	−642	−177	0	−8,305
89	−2,592	649	−24,770	9,438	−161	−990	−75	↓	−18,501
90	−3,491	−302	−31,054	9,661	−201	−1,242	0	↓	−26,629
91	↓	−1,038	↓	↓	↓	↓	↓	↓	−27,365
92	↓	−1,784	↓	↓	↓	↓	↓	↓	−28,111
93	↓	−2,521	↓	↓	↓	↓	↓	↓	−28,848
94	↓	−3,267	↓	↓	↓	↓	↓	↓	−29,594
95	↓	−4,003	↓	↓	↓	↓	↓	↓	−30,330
96	↓	−4,741	↓	↓	↓	↓	↓	↓	−31,068
97	↓	−5,485	↓	↓	↓	↓	↓	↓	−31,812
98	↓	−6,223	↓	↓	↓	↓	↓	↓	−32,550
99	↓	−6,968	↓	↓	↓	↓	↓	↓	−33,295
2000	↓	−7,705	↓	↓	↓	↓	↓	↓	−34,032
01	↓	−8,508	↓	↓	↓	↓	↓	↓	−34,835
02	↓	−9,245	↓	↓	↓	↓	↓	↓	−35,572
03	↓	−9,982	↓	↓	↓	↓	↓	↓	−36,309
04	↓	−10,719	↓	↓	↓	↓	↓	↓	−37,046
05	↓	−11,457	↓	↓	↓	↓	↓	↓	−37,784
06		−12,276							−38,603

10-3 Costs

For costs, construction cost of the new container terminal, the grain berth, and the purchase cost of equipment etc. are considered.

Table 10-26 shows a financial schedule by year.

The cost of maintenance and operation of facilities is considered in 10-2 Benefits', so it is not included here.

The cost shown in Table 10-26 does not include the improvement cost of berth 5B, since it is included in both the cases of 'with' and 'without'.

Table 10-26 Construction Cost and Equipments Purchase Cost

(Unit: thousand US$)

Year	1984	1985	1986	1987
Total Cost	10,128	23,135	14,276	52,095

10-4 Shadow Pricing

10-4-1 Method of estimating shadow prices

In the economic analysis, the economic efficiency of the project is studied by using the shadow prices evaluated based on the world prices (border prices) as well as the market prices.

All benefits and costs calculated above have used the market prices consisting of the world prices and the domestic prices, but in this study all benefits and costs are to be calculated by the world prices. Therefore, the market prices calculated by the domestic prices are revised to the shadow prices.

The method of estimating shadow prices is as follows.

(1) Generally, all benefits and costs are to be divided into labor, traded goods and non-traded goods.

Further, the labor is to be divided into skilled labor and unskilled labor. The cost of skilled labor is obtained by multiplying its market price by a standard conversion factor (SCF) and the cost of unskilled labor is calculated by multiplying its market price by a ratio of a shadow wage rate and SCF.

Traded good are to be expressed by CIF Value for import and by FOB Value for export. Prices for non-traded goods are to be derived by multiplying appropriate conversion factors.

(2) In this analysis, the local portion in the construction costs is to be devided into labor and the other goods.

The shadow price for the labor is calculated by the same method of the above item (1) and that for the the other goods is obtained by multiplying its market price by a SCF.

With regard to the benefits, reduction in ship's waiting cost itself is expressed in terms of the shadow price.

Reduction of land transportation cost and cargo handling cost are not to be divided into labor and the other goods.

The shadow price for these reduction is calculated by multiplying its market price by a SCF.

10-4-2 Standard Conversion Factor (SCF)

A Standard Conversion Factor (SCF) is calculated by the following formula based on the Import & Export and Custom Statistics in 1980 and 1981. Shown in the table 10-27 and SCF is 0.912.

$$SCF = \frac{1 + E}{1 + Di + E - De}$$

I: Total amount of import

E: Total amount of export

Di: Total amount of import duties

De: Total amount of export duties

10-4-3 Shadow wage rate

Unskilled laborers engaged in the construction of the project are supposed to be workers in the agriculture sector in the provinces surrounding Lima.

Method of estimating of a shadow wage rate is based on an average GDP or minimum wage per capita in agriculture sector in the four provinces of Ayacuche, Pasco, Junin and Huancavelica.

In this study, the minimum wage per capita is assumed to be a shadow wage rate. The shadow price of unskilled labor cost is obtained by multiplying the market price by the percentage of the shadow wage rate against the market price.

The minimum wage rate (shadow wage rate) and the its percentage against the market price are shown in the table 10-28 and these are 1,410 soks per day and 6.7% respectively.

10-4-4 Shadow price of construction costs

It is shown in the table 10-29.

10-4-5 Shadow price of benefits

Shadow price of all benefits consting of the reduction of ship's waiting cost, land transportation cost and cargo handling is shown in the table 10-30.

Table 10-27 Import & Export and Custom Statistics and SCF

(Unit: US$ million)

	1980	1981	average (1980/1981)
Import	3,540	4,451	
Import duties	948	1,147	
Export	3,898	3,218	
Export duties	422	199	
SCF	0.934	0.890	0.912

Table 10-28 Minimum wage (Shadow wage rate) and its percentage against market price

Unit: soles

province	minimum wage per day for worker in agriculture sector	Percentage of minimum wage against market price (%)
Ayacucho	1,360	
Pasco	1,366	
Junin	1,439	
Huancavelica	1,474	
Total	5,639	
average	1,410	$6.7\left(\frac{1,410}{21,230}\right)$

Table 10-29 Shadow Price of Construction Costs

(Unit: US$ 1,000)

	1984	1985	1986	1987	Total
Construction Costs					
Foreign Portion	8,335	17,638	10,134	33,893	70,000
Local Portion					
Labor Costs (Skilled Laborer)	489	702	654	3,814	5,659
(Unskilled Laborer)	16	43	35	167	261
Other Costs	899	3,674	2,607	10,285	17,465
Sub-Total	1,404	4,419	3,296	14,266	23,385
Total	9,739	22,057	13,430	48,159	93,385

Table 10-30 Total Benefit (Minus means benefit)

(Shadow Price)

(Unit: thousand US$)

Year	Ships' waiting cost	Land Transportation cost	Cargo handling cost		Shipping Service Cost	Storage service cost		Construction of Grain Berth at San Martin	Total Benefit
			General Cargo	Container		General Cargo	Container		
1984	4,151	1,836	0	0	1	0	0	–612	5,376
85	–78	3,672	0	0	0	2	0	–4,187	–591
86	–121	3,672	0	0	0	4	0	–4,142	–587
87	7,363	3,672	0	0	1	2	0	–17,631	–6,593
88	–2,059	1,507	–14,693	8,332	–95	–586	–161	0	–7,755
89	–2,592	592	–22,590	5,607	–147	–903	–68		–17,101
90	–3,491	–275	–28,321	8,811	–183	–1,133	0		–24,592
91		–947							–25,539
92		–1,627							–26,219
93		–2,299							–26,891
94		–2,980							–27,572
95		–3,651							–28,243
96		–4,324							–28,916
97		–5,002							–29,594
98		–5,675							–30,267
99		–6,355							–30,947
2000		–7,027							–31,619
1		–7,759							–32,351
2		–8,431							–33,023
3		–9,104							–33,696
4		–9,776							–34,368
5		–10,449							–35,041
6	–3,491	–11,196	–28,321	8,811	–183	–1,133	0	0	–35,788

10-5 Economic Profitability

10-5-1 Definition of internal rate of return

Economic profitability is assessed by the internal rate of return.

The internal rate of return is expressed in a discount rate satisfying the following equation.

$$\sum_{t=0}^{T} \frac{B_t - C_t}{(1+r)^t} = 0$$

where, B_t: benefit in the year t

C_t: Cost in the year t

T: Period of economic calculation

r: Discount rate

The difference between 'with' and 'without' is substituted into B_t and C_t, because the case of 'without' is considered as a base for the economic calculation.

10-5-2 Period of economic calculation

The average useful life time of the facilities related to the project is obtained by dividing the total amount of investment by the annual depreciation amount (overall depreciation cost).

According to the calculation,

Total investment amount: 99,634 thousand US$

Annual depreciation cost: 5,228 thousand US$

Therefore, the average useful life time of the facilities will be 19.1 years. So the period of economic calculation (project life) is assumed as 19 years after the completion of the facilities.

10-5-3 Calculation and assessment of the internal rate of return

Table 10-31 and 10-32 show the flow of costs and benefits calculated by shadow prices and market prices, respectively.

The internal rate of return is calculated as r = 19.53% in the case of shadow prices and 19.77% in the case of market prices.

The period of economic calculation is 19 years and the undepreciated amount will remain in the final year. It is assessed as benefit in the final year.

According to Instituto Nacional de Planificacion, The Social Discount Rate in Peru is 15% and in the case of infra-sector, 13% is used as a supplement.

Even if economic calculation was done for only three items which can easily be quantified and the reduction of land transportation cost was taken into consideration only for grain the IRR of the project was 19.53%. Therefore, the project is considered feasible.

Table 10-31 Consts/Benefits and IRR (Shadow Price)

(Unit: 1,000 US$)

No.	Year	Costs	Benefits	Ben. – Cost	Present Value I.R.R. 19.53 (%)
0	1984	9,739	–5,376	–15,115	–15,115
1	1985	22,057	591	–21,466	–17,959
2	1986	13,430	587	–12,843	–8,989
3	1987	48,159	6,593	–41,566	–24,339
4	1988	0	7,755	7,755	3,798
5	1989	0	17,101	17,101	7,008
6	1990	0	24,592	24,592	8,431
7	1991	0	25,539	25,539	7,325
8	1992	0	26,219	26,219	6,291
9	1993	0	26,891	26,891	5,398
10	1994	0	27,572	27,572	4,630
11	1995	0	28,243	28,243	3,968
12	1996	0	28,916	28,916	3,399
13	1997	0	29,594	29,594	2,910
14	1998	0	30,267	30,267	2,490
15	1999	0	30,947	30,947	2,130
16	2000	0	31,619	31,619	1,820
17	2001	0	32,351	32,351	1,558
18	2002	0	33,023	33,023	1,331
19	2003	0	33,696	33,696	1,136
20	2004	0	34,368	34,368	969
21	2005	0	35,041	35,041	826
22	2006	0	49,869	49,869	984
Total		93,385	555,998	462,613	0

• Table 10-32 Consts/Benefits and IRR (Market Price)

(Unit: 1,000 US$)

No.	Year	Costs	Benefits	Ben. – Cost	Present Value I.R.R. 19.77 (%)
0	1984	10,128	–5,529	–15,657	–15,657
1	1985	23,135	444	–22,691	–18,946
2	1986	14,276	493	–13,783	–9,609
3	1987	52,095	7,689	–44,406	–25,846
4	1988	0	8,305	8,305	4,035
5	1989	0	18,501	18,501	7,506
6	1990	0	26,629	26,629	9,021
7	1991	0	27,365	27,365	7,740
8	1992	0	28,111	28,111	6,638
9	1993	0	28,848	28,848	5,688
10	1994	0	29,594	29,594	4,872
11	1995	0	30,330	30,330	4,168
12	1996	0	31,068	31,068	3,565
13	1997	0	31,812	31,812	3,048
14	1998	0	32,550	32,550	2,604
15	1999	0	33,295	33,295	2,224
16	2000	0	34,032	34,032	1,897
17	2001	0	34,835	34,835	1,622
18	2002	0	35,572	35,572	1,382
19	2003	0	36,309	36,309	1,178
20	2004	0	37,046	37,046	1,004
21	2005	0	37,784	37,784	855
22	2006	0	53,553	53,553	1,011
Total		99,634	598,636	499,002	0

CHAPTER 11
Financial Analysis

CHAPTER 11 FINANCIAL ANALYSIS

11. Financial Analysis

11-1 Method of Financial Analysis

In the Economic Analysis of the preceding Chapter, the economic effectiveness of the investment was studied from the point of view of the national economy.

The aim of this Financial Analysis is to study the soundness of the financial affairs for Callao Port, the profitability of the Project itself, and the reasonableness of the project execution from the managerial position of the executing agency, ENAPU-PERU, S.A.

1) Analysis of Financial Statements

In order to find out whether Callao Port can maintain soundness of financial affairs with the execution of the Project, estimated Financial Statements (Revenue and Expenditure, Source and Application of Funds and Balance Sheet) are prepared for the period from the year 1981, established as the initial year of reckoning when the accounts for the Port were settled, to the year 2006 when the project life is to be completed, to analyse revenues and expenditures, conditions of fund raising and financial status.

The following two points are considered in preparing financial statements.

(1) Methods of fund raising

The enormous project investment is a great financial burden for ENAPU. Four cases are considered, two where self-financing accounts for some of the funds, and two where all funds are raised by loans. In both of the self-financed cases the foreign portion is 50% loan and 50% self-financed, while the local portion is 50% self-financed in one and 100% in the other. When 100% of the funds are raised by loans, cases are considered for two different sources of the foreign portion, while in both, loans from domestic banks account for the local portion.

It will be assumed that loans are to be raised by Callao Port.

(2) Operating expenses of Callao Port

Like other ports managed by ENAPU, Callao Port uses a self-supporting accounting system based on the cost method.

The Statement of Account for 1981 for Callao Port is as follows: sales 23,445, cost of sales 15,672, gross profit on sales 8,273, operating profit 5,203, net profit 5,030. The financial ratio shows a sales cost ratio of 66%, an operating profit ratio of 22% and a net profit ratio of 22% indicating the extreme soundness of financial affairs. (Unit: 1 million soles)

However, overall financial status of ENAPU indicates difficulties in revenue and expenditures: Sales 29,591, cost of sales 27,271, gross profit on sales 4,320, operating profit -2,893, net profit -646. Financial ratio discloses 85% and -10% for the sales cost ratio and the operating profit ratio respectively. The above indicates ENAPU's heavy dependence on the profit from Callao Port, in other words, the considerable influence which the management of the Port extends over ENAPU.

In estimating the operating cost for Callao port, the central position this Port occupies in

ENAPU was considered, and two types of operating costs are adopted: Type A – the operating cost based on the present system; Type B – the operating costs are increased by 10% over Type A cost in order to include the interest on loans, from which the ports are presently exempted, and the ENAPU administrative expenses, which might be born by Callao Port.

(*As examples of the operating expenses which Callao Port may bear the ENAPU administrative expenses more than Type B, there are two Types of the operating expenses of C and D of which are increased by 15% and 20% respectively over Type A. The Financial statement of the both cases are studied in the Appendix.)

2. Discount Cash Flow Analysis

The analysis of Financial Statements mentioned above concerned the total business of the executing agency, including the Project. However, this section aims at analyzing the profitability of the Project itself, seeking the so-called financial rate of return (FRR) by using the Discount Cash Flow Method. The FRR is a discount rate which makes the net present value of the cash flow (revenue minus cost) equal to zero.

The project which is analyzed in this chapter includes construction of a container wharf and a grain wharf, construction or purchase of the related facilities on land and of the cargo handling equipment, and the removal of wharf No. 9.

There will be two frame works for the financial analysis. The first framework is that the object of the financial analysis is limited to services rendered by the above new facilities for handling grain cargoes and containers. The second framework includes all services offered by both the new facilities and the existing facilities, handling all the general cargoes, containers and grains. On the process of seeking a reasonable FRR in the former case, tariffs for cargo handling at the new facilities will be examined independently of the present tariffs. But setting multi tariff system for the same service in one port is unrealistic. Therefore, the latter case was adopted as the framework of the financial analysis. According to this framework, there will be a unique tariff for the same service, i.e. tariff for the services at the new facilities will be the same as that at the existing facilities.

The profit used in the FRR analysis is the profit before depreciation and loan interest payment. So the FRR must at least be a rate of profit which can cover payment of the loan interest and the depreciation cost of the raised funds.

11-2 Analysis of Financial Statement

11-2-1 Premises

(1) The year 1981 when the accounts for Callao Port were settled is established as the initial year of rockoning, and the estimated financial statements for the period between 1982 and 2006 when the project life is to complete, are to be prepared.

(2) The port tariff used in the calculation of revenue is the present tariff of 1982.

(3) Costs are based on those of 1982.

(4) Funds for the project investment will be raised by Callao Port and will consist either partly of self-financed funds, or completely of loans, and will be appropriated in the Financial Statement in accordance with the fund raising method for the four cases.

(5) As for the construction costs of the container yard for Berth 5B to be carried out prior to the project execution, 5,000 for 1982 and 6,000 for 1983 (Unit: US$1,000) are appropriated in the Financial Statement.

(6) ENAPU's existing long-term loans related to Callao Port are ignored on twe study.

(7) Existing facilities and the additional facilities mentioned above are regarded as fixed assets. Depreciation is by a straight line method. Revaluation of fixed assets will not be made from 1982 onward.

(8) For the operating expenses, Type A based on the existing system, and Type B which is increased by 10% over Type A, are used.

(9) The rate of income tax is established as 50% of the profit after depreciation.

(10) The above figures are all in US $ 1000.
The exchange rate is, as a rule, US $1 = Soles 715.50.
The summarized financial statements are shown in unit of US $ million.

11-2-2 Long-term Loans

Project fund is shown in Table 11-1.

Table 11-1 Project fund

(Unit: US$1,000)

Year	Total amount	Foreign portion	Local portion
1983	1,290	838	452
1984	8,838	7,497	1,341
1985	23,135	17,638	5,497
1986	14,276	10,134	4,142
1987	52,095	33,893	18,202
Total	99,634	70,000	29,634

Table 11-2 shows the 4 cases assumed for the fund raising.
Table 11-3 shows the repayment plan for the loans in each case.

Table 11-2 Methods of Raising Funds

	Foreign Portion	Local Portion
Case 1	50% Self-finance 50% Long-term loan from Foreign Bank at 4.25%/annum interest Repayment period: 25 yrs incl. 7 yrs grace period	100% Self-finance
Case 2	– ditto –	50% Self-finance 50% Long-term loan from domestic bank at 12% per annum interest Repayment period: 17 yrs incl. 4 yrs grace period
Case 3	100% Long-term loan from Foreign Bank at 12% annum interest Repayment period: 17 yrs incl. 4 yrs grace period	100% Long-term loan from domestic bank at 17%/annum interest Repayment period: 17 yrs incl. 4 yrs grace period
Case 4	100% Long-term loan from Foreign Bank at 4.25%/annum interest Repayment period: 25 yrs incl. 7 yrs grace period	100% Long-term loan from domestic bank at 12%/annum interest Repayment period: 17 yrs incl. 4 yrs grace period

Table 11-3 Long-term Loans (1)

(Unit: US$ 1,000)

Year	Borrowing				Repayment				Balance				Interest			
	Case 1	Case 2	Case 3	Case 4	Case 1	Case 2	Case 3	Case 4	Case 1	Case 2	Case 3	Case 4	Case 1	Case 2	Case 3	Case 4
1983	419	645	1,290	1,290					419	645	1,290	1,290	9	23	88	45
1984	3,749	4,424	8,838	8,838					4,168	5,065	10,128	10,128	89	156	702	312
1985	8,819	11,568	23,135	23,135					12,987	16,633	33,263	33,263	365	638	2,830	989
1986	5,067	7,138	14,276	14,276					18,054	23,771	47,539	47,539	660	1,222	4,697	1,890
1987	16,947	26,048	52,095	52,095		1,140	7,664	2,280	35,001	48,679	91,970	97,354	1,127	2,325	9,599	3,884
1988						1,140	7,664	2,280	35,001	47,539	84,306	95,074	1,488	3,095	12,145	6,189
1989						1,140	7,664	2,280	35,001	46,399	76,642	92,794	1,488	2,958	11,112	5,915
1990					1,944	3,084	7,664	6,168	33,057	43,315	68,978	86,626	1,467	2,801	10,078	5,601
1991					1,944	3,084	7,664	6,168	31,113	40,231	61,314	80,458	1,384	2,581	9,044	5,161
1992					1,944	3,084	7,664	6,168	29,169	37,147	53,650	74,290	1,302	2,362	8,011	4,723
1993					1,944	3,084	7,664	6,168	27,225	34,063	45,986	68,122	1,219	2,142	6,977	4,284
1994					1,944	3,084	7,664	6,168	25,281	30,979	38,322	61,954	1,136	1,922	5,944	3,845
1995					1,944	3,084	7,664	6,168	23,357	27,895	30,658	55,786	1,054	1,704	4,910	3,406
1996					1,944	3,084	7,664	6,168	21,393	24,811	22,994	49,618	971	1,484	3,876	2,967
1997					1,944	3,084	7,664	6,168	19,449	21,727	15,330	43,450	889	1,265	2,843	2,529
1998					1,944	3,084	7,664	6,168	17,505	18,643	7,666	37,282	806	1,045	1,809	2,090
1999					1,944	3,082	7,666	6,162	15,561	15,561	0	31,120	723	825	776	1,651
2000					1,944	1,944		3,888	13,617	13,617		27,232	641	641		1,281
2001					1,944	1,944		3,888	11,673	11,673		23,344	558	558		1,116
2002					1,944	1,944		3,888	9,729	9,729		19,456	475	475		951
2003					1,944	1,944		3,888	7,785	7,785		15,568	393	393		786
2004					1,944	1,944		3,888	5,841	5,841		11,680	310	310		620
2005					1,944	1,944		3,888	3,897	3,897		7,792	228	228		455
2006					1,944	1,944		3,888	1,953	1,953		3,904	145	145		290
2007					1,953	1,953		3,904	0	0		0	62	62		125

The construction fund for the container yard for Berth 5B being carried out prior to the project execution is 5,000 for 1982 and 6,000 for 1983 (unit: US$1,000). Assuming repayment conditions of 7% annual interest rate, and an 18 year repayment period including a 5 year grace period, (estimated from the existing conditions of ENAPU's loans related to Callao Port), a loan repayment schedule is shown in Table 11-4.

Table 11-4 Long-term Loans (2)

(Unit: US$1,000)

Year	Borrowing	Repayment	Balance	Interest
1982	5,000		5,000	175
1983	6,000		11,000	560
1984			11,000	770
1985			11,000	770
1986			11,000	770
1987		846	10,154	755
1988		846	9,308	696
1989		846	8,462	637
1990		846	7,616	578
1991		846	6,770	518
1992		846	5,924	459
1993		846	5,078	400
1994		846	4,232	341
1995		846	3,386	281
1996		846	2,540	222
1997		846	1,694	163
1998		846	848	104
1999		848	0	30

11-2-3 Fixed Assets

Fixed assets related to the existing facilities are based on the details of Fixed Assets for Callao Port for the year 1981 and the additional investment in 1982 and thereafter are regarded as additional fixed assets.

The depreciation rate is set as 6.13% per year for the fixed assets related to this Project and 4.12% for others.

Present depreciation rates are as follows:

Buildings	3%
Wharfs, breakwaters	3%
Ancillary facilities	3%
Cargo handling equipments	15%

The existing fixed assets for the year 1981 are expressed in US dollars at the exchange rate of US$1 = Soles 992.14 as of December 31, 1982 and new facilities are added to the fixed assets. Table 11-5 shows changes in the fixed assets after 1982.

Table 11-5 Changes in Fixed Assets

(Unit: US$1,000)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Fixed Assets at Beginning of Year		38,621	42,147	47,963	54,786	75,906	88,167	138,247	131,004	123,761	116,518	109,275	102,032
(Land)		712	712	712	712	712	712	712	15,081	15,081	15,081	15,081	15,081
(Assets to be depreciated)		35,774	34,300	32,826	43,946	41,931	39,916	37,901	115,923	108,680	101,437	94,194	86,951
(Construction in process A/C)		2,135	7,135	14,425	10,128	33,263	47,539	99,634					
Investment		5,000	7,290	8,838	23,135	14,276	52,095						
(Existing)		(5,000)	(6,000)	(0)	(0)	(0)	(0)						
(New)		(0)	(1,290)	(8,838)	(23,135)	(14,276)	(52 095)						
Depreciation		11,474	1,474	2,015	2,015	2,015	2,015	7,243	7,243	7,243	7,243	7,243	7,243
(Existing 4 12%)		(1,474)	(1,474)	(2,015)	(2,015)	(2,015)	(2,015)	(2,015)	(2,015)	(2,015)	(2,015)	(2,015)	(2,015)
(New 6.13%)		(0)	(0)	(0)	(0)	(0)	(0)	(5,228)	(5,228)	(5,228)	(5,228)	(5,228)	(5,228)
Fixed Assets at End of Year	38,621	42,147	47,963	54,786	75,906	88,167	138,247	131,004	123,761	116,518	109,275	102,032	94,789
(Land)	712	712	712	712	712	712	712	15,081	15,081	15,081	15,081	15,081	15,081
(Assets to be depreciated)	35,774	34,300	32,826	43,946	41,931	39,916	37,901	115,923	108,680	101,437	94,194	86,951	79,708
(Construction in process A/C)	2,135	7,135	14,425	10,128	33,263	47,539	99,634						

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Fixed Assets at Beginning of Year	94,789	87,546	80,303	73,060	65,817	58,574	51,331	44,088	36,845	29,602	22,359	18,727	16,712
(Land)	15,081	15,081	15,081	15,081	15,081	15,081	15,081	15,081	15,081	15,081	15,081	15,081	15,081
(Assets to be depreciated)	79,708	72,465	65,222	57,979	50,736	43,493	36,250	29,007	21,764	14,521	7,278	3,646	1,631
(Construction in process A/C)													
Investment													
(Existing)													
(New)													
Depreciation	7,243	7,243	7,243	7,243	7,243	7,243	7,243	7,243	7,243	7,243	3,632	2,015	1,631
(Existing 4 12%)	(2,015)	(2,015)	(2,015)	(2,015)	(2,015)	(2,015)	(2,015)	(2,015)	(2,015)	(2,015)	(2,015)	(2,015)	(1,631)
(New 6 13%)	(5,228)	(5,228)	(5,228)	(5,228)	(5,228)	(5,228)	(5,228)	(5,228)	(5,228)	(5,228)	(1,617)	(0)	(0)
Fixed Assets at End of Year	87,546	80,303	73,060	65,817	58,574	51,331	44,088	36,845	29,602	22,359	18,727	16,712	15,081
(Land)	15,081	15,081	15,081	15,081	15,081	15,081	15,081	15,081	15,081	15,081	15,081	15,081	15,081
(Assets to be depreciated)	72,465	65,222	57,979	50,736	43,493	36,250	25,007	21,764	14,521	7,278	3,646	1,631	0
(Construction in process A/C)													

11-2-4 Project Life

The project life is calculated as 19.1 years by classifying the investment according to the type of fixed assets, calculating the annual depreciation costs based on the existing depreciation rate, and dividing the sum of the investment by the depreciation costs.

11-2-5 Calculation of Revenue and Expenditure

Revenue and expenditure are calculated by trading activity at Callao Port such as shipping, cargo handling, cargo storage and other special services.

All cargo (general cargoes, containers, grains, minerals and petroleum) handled through Callao Port are subjects for calculation.

1) Revenues

Revenues are calculated in the following manner.

Shipping service:	Total GRT or total GRT Days x port fees
Cargo handling service:	Cargo volume (t or TEU) x port fees
Cargo storage service:	Stored cargo volume (t) x port fees
Special services:	2% of the total sum of the above

Tables 11-6 to 11-10 show respectively the cargo handling volume (it is assumed that all the grains will be handled through the new wharf after it is opened for service (in 1988 or after), container cargo volume, stored cargo volume, number of ships, total GRT and total GRT Days for ships.

Table 11-6 Cargo Forecast for Callao Port Terminal

(Unit: 1,000t)

Cargo / Year	Containers									General Cargoes			Grains			Minerals	Petroleum							Grand total
	Berth No. 5B			New CNTR Berth			Total						Berth No. 11	New Berth	Total	Exp	Import			Export			Total	
	Imp	Exp	Sub-total	Imp	Exp	Sub-total	Imp	Exp	Total	Imp	Exp	Total	Imp	Imp			Foreign	Domestic	Sub-total	Foreign	Domestic	Sub-total		
1982	111	97	208	0	0	0	111	97	208	1,469	712	2,181	1,146	0	1,146	1,405	96	1,456	1,552	238	113	351	1,903	6,843
1983	148	110	258	0	0	0	148	110	258	1,496	754	2,230	1,190	0	1,190	1,452	100	1,514	1,614	238	113	351	1,965	7,095
1984	207	160	367	0	0	0	207	160	367	1,252	598	1,850	1,224	0	1,224	1,499	105	1,590	1,695	238	113	351	2,046	6,986
1985	273	233	506	0	0	0	273	233	506	1,067	483	1,550	1,224	0	1,224	1,546	111	1,670	1,781	238	113	351	2,132	6,958
1986	349	301	650	0	0	0	349	301	650	1,084	466	1,550	1,224	0	1,224	1,593	116	1,753	1,869	238	113	351	2,220	7,237
1987	379	271	650	0	0	0	379	271	650	1,066	484	1,550	1,224	0	1,224	1,641	122	1,841	1,963	238	113	351	2,314	7,379
1988	256	217	473	335	283	618	591	500	1,091	1,118	432	1,550	0	1,465	1,465	1,688	128	1,933	2,061	238	113	351	2,412	8,206
1989	317	258	575	416	337	753	733	595	1,328	1,131	419	1,550	0	1,561	1,561	1,735	134	2,030	2,164	238	113	351	2,515	8,689
1990	369	281	650	482	368	850	851	649	1,500	1,133	417	1,550	0	1,658	1,658	1,782	141	2,131	2,272	238	113	351	2,623	9,113
1991	369	281	650	482	368	850	851	649	1,500	1,133	417	1,550	0	1,748	1,748	1,829	148	2,238	2,386	238	113	351	2,737	9,364
1992	369	281	650	482	368	850	851	649	1,500	1,133	417	1,550	0	1,839	1,839	1,876	156	2,349	2,505	238	113	351	2,856	9,621
1993	369	281	650	482	368	850	851	649	1,500	1,133	417	1,550	0	1,929	1,929	1,923	163	2,467	2,630	238	113	351	2,981	9,883
1994	369	281	650	482	368	850	851	649	1,500	1,133	417	1,550	0	2,020	2,020	1,970	172	2,590	2,762	238	113	351	3,113	10,153
1995	369	281	650	482	368	850	851	649	1,500	1,133	417	1,550	0	2,110	2,110	2,017	180	2,720	2,900	238	113	351	3,251	10,428
1996	369	281	650	482	368	850	851	649	1,500	1,133	417	1,550	0	2,200	2,200	2,064	189	2,856	3,045	238	113	351	3,396	10,710
1997	369	281	650	482	368	850	851	649	1,500	1,133	417	1,550	0	2,254	2,254	2,064	189	2,856	3,045	238	113	351	3,396	10,764
1998	369	281	650	482	368	850	851	649	1,500	1,133	417	1,550	0	2,254	2,254	2,064	189	2,856	3,045	238	113	351	3,396	10,764
1999	369	281	650	482	368	850	851	649	1,500	1,133	417	1,550	0	2,254	2,254	2,064	189	2,856	3,045	238	113	351	3,396	10,764
2000	369	281	650	482	368	850	851	649	1,500	1,133	417	1,550	0	2,254	2,254	2,064	189	2,856	3,045	238	113	351	3,396	10,764
2001	369	281	650	482	368	850	851	649	1,500	1,133	417	1,550	0	2,254	2,254	2,064	189	2,856	3,045	238	113	351	3,396	10,764
2002	369	281	650	482	368	850	851	649	1,500	1,133	417	1,550	0	2,254	2,254	2,064	189	2,856	3,045	238	113	351	3,396	10,764
2003	369	281	650	482	368	850	851	649	1,500	1,133	417	1,550	0	2,254	2,254	2,064	189	2,856	3,045	238	113	351	3,396	10,764
2004	369	281	650	482	368	850	851	649	1,500	1,133	417	1,550	0	2,254	2,254	2,064	189	2,856	3,045	238	113	351	3,396	10,764
2005	369	281	650	482	368	850	851	649	1,500	1,133	417	1,550	0	2,254	2,254	2,064	189	2,856	3,045	238	113	351	3,396	10,764
2006	369	281	650	482	368	850	851	649	1,500	1,133	417	1,550	0	2,254	2,254	2,064	189	2,856	3,045	238	113	351	3,396	10,764

Table 11-7 Tonnage and Number of Containers

Year	Tonnage (1,000t)			Number of Containers (TEU)					
	Import	Export	Total	Import			Export		
				Loaded	Empty	Total	Loaded	Empty	Total
1982	111	97	208	13,704	82	13,786	11,975	1,811	13,786
1983	148	110	258	18,272	110	18,382	13,580	4,802	18,382
1984	207	160	367	25,556	153	25,709	19,753	5,956	25,709
1985	273	233	506	33,704	202	33,906	28,765	5,141	33,906
1986	349	301	650	43,086	259	43,345	37,160	6,185	43,345
1987	379	271	650	46,790	281	47,071	33,457	13,614	47,071
1988	591	500	1,091	72,963	438	73,401	61,728	11,673	73,401
1989	733	595	1,328	90,494	543	91,037	73,457	17,580	91,037
1990	851	649	1,500	105,062	630	105,692	80,123	25,569	105,692
1991	851	649	1,500	105,062	630	105,692	80,123	25,569	105,692
1992	851	649	1,500	105,062	630	105,692	80,123	25,569	105,692
1993	851	649	1,500	105,062	630	105,692	80,123	25,569	105,692
1994	851	649	1,500	105,062	630	105,692	80,123	25,569	105,692
1995	851	649	1,500	105,062	630	105,692	80,123	25,569	105,692
1996	851	649	1,500	105,062	630	105,692	80,123	25,569	105,692
1997	851	649	1,500	105,062	630	105,692	80,123	25,569	105,692
1998	851	649	1,500	105,062	630	105,692	80,123	25,569	105,692
1999	851	649	1,500	105,062	630	105,692	80,123	25,569	105,692
2000	851	649	1,500	105,062	630	105,692	80,123	25,569	105,692
2001	851	649	1,500	105,062	630	105,692	80,123	25,569	105,692
2002	851	649	1,500	105,062	630	105,692	80,123	25,569	105,692
2003	851	649	1,500	105,062	630	105,692	80,123	25,569	105,692
2004	851	649	1,500	105,062	630	105,692	80,123	25,569	105,692
2005	851	649	1,500	105,062	630	105,692	80,123	25,569	105,692
2006	851	649	1,500	105,062	630	105,692	80,123	25,569	105,692

Notes: 1. Number of containers was calculated based on 1 TEU = 8.1t.
2. Number of empty containers wasset at 0.6% of the loaded containers for import; and for export, it was assumed that the total number of import containers including empty containers was equal to that of export containers. So, number of empty containers for export is the difference between the total number of containers and number of export loaded containers.

Table 11-8 (1) Stored Cargo Volume of General Cargo

(Unit. 1,000t)

Year	Total Cargo Volume			Indirect Cargo (Storage)		
	Import	Export	Total	Import 79%	Export 61%	Total
1982	1,469	712	2,181	1,161	434	1,595
1983	1,496	734	2,230	1,182	448	1,630
1984	1,252	598	1,850	989	365	1,354
1985	1,067	483	1,550	843	295	1,138
1986	1,084	466	1,550	856	284	1,140
1987	1,066	484	1,550	842	295	1,137
1988	1,118	432	1,550	883	264	1,147
1989	1,131	419	1,550	893	256	1,149
1990	1,133	417	1,550	895	294	1,149
1991	1,133	417	1,550	895	254	1,149
1992	1,133	417	1,550	895	254	1,149
1993	1,133	417	1,550	895	254	1,149
1994	1,133	417	1,550	895	254	1,149
1995	1,133	417	1,550	895	254	1,149
1996	1,133	417	1,550	895	254	1,149
1997	1,133	417	1,550	895	254	1,149
1998	1,133	417	1,550	895	254	1,149
1999	1,133	417	1,550	895	254	1,149
2000	1,133	417	1,550	895	254	1,149
2001	1,133	417	1,550	895	254	1,149
2002	1,133	417	1,550	895	254	1,149
2003	1,133	417	1,550	895	254	1,149
2004	1,133	417	1,550	895	254	1,149

Table 11-8 (2) LCL Container Cargo Volume at Berth No5B

(Unit: 1,000t)

Year	LCL Container Cargo Volume
1982	104
1983	129
1984	183.5
1985	253
1986	325
1987	325
1988	236. 5
1989	287.5
1990	325
1991	325
1992	325
1993	325
1994	325
1995	325
1996	325
1997	325
1998	325
1999	325
2000	325
2001	325
3002	325
2003	325
2004	325
2005	325
2006	325

Table 11-9 Number of Ships

Numbers of Ships / Year	Total	General Cargo Ships	Container Ships			Grain Ships			Mineral Ships	Petroleum Ships		
			Berth 5B	New Terminal		Berth 11	New Terminal			Foreign	Domestic	
		DWT 10,481 GRT 7,244 Load 2,009t	DWT 28,000 GRT 30,000 Loaded CNTR 400 TEU (3240t) Empty CNTR 70		Total	DWT 29,808 GRT 18,653 Load 21,468	DWT 45,000 GRT 27,974 Load 35,000	Total	DWT 16,300 GRT 10,299 Load 8,185t	DWT 18,122 GRT 11,032 Load 8,947t		Total
1982	1,588	1,086	64	0	64	53	0	53	172	37	176	213
1983	1,642 (1,245)	1,110	80	0	80	55	0	55	177	38	182	220
1984	1,503 (1,091)	921	113	0	113	57	0	57	183	38	191	229
1985	1,412 (985)	772	156	0	156	57	0	57	189	39	199	238
1986	1,473 (1,030)	772	201	0	201	57	0	57	195	40	208	248
1987	1,489 (1,030)	772	201	0	201	57	0	57	200	40	219	259
1988	1,627 (1,151)	772	146	191	337		42	42	206	41	229	270
1989	1,720 (1,227)	772	177	233	410		45	45	212	42	239	281
1990	1,793 (1,282)	772	201	262	463		47	47	218	42	251	293
1991	1,814 (1,285)	772	201	262	463		50	50	223	43	263	306
1992	1,836 (1,288)	772	201	262	463		53	53	229	44	275	319
1993	1,858 (1,290)	772	201	262	463		55	55	235	45	288	333
1994	1,882 (1,293)	772	201	262	463		58	58	241	46	302	348
1995	1,904 (1,295)	772	201	262	463		60	60	246	47	316	363
1996	1,930 (1,298)	772	201	262	463		63	63	252	48	332	380
1997	1,931 (1,299)	772	201	262	463		64	64	252	48	332	380
1998	1,931 (1,299)	772	201	262	463		64	64	252	48	332	380
1999	1,931 (1,299)	772	201	262	463		64	64	252	48	332	380
2000	1,931 (1,299)	772	201	262	463		64	64	252	48	332	380
2001	1,931 (1,299)	772	201	262	463		64	64	252	48	332	380
2002	1,931 (1,299)	772	201	262	463		64	64	252	48	332	380
2003	1,931 (1,299)	772	201	262	463		64	64	252	48	332	380
2004	1,931 (1,299)	772	201	262	463		64	64	252	48	332	380
2005	1,931 (1,299)	772	201	262	463		64	64	252	48	332	380
2006	1,931 (1,299)	772	201	262	463		64	64	252	48	332	380

* Figures in parenthesis indicates total of general cargo ships, CNTR ships and grain ships.

Table 11-10 Gross GRT and Berthing Days for Ships

Year	General Cargo Ships (1)		Container Ships (2)						Grain Ships (3)						Total (1) + (2) + (3)	
	GRT 7,244 Berthing Days 3.7		GRT 30,000 Berthing Days (–1985) 1.5, (1986 & 1987) 1.03 (1988–) 0.76)						GRT (–1987) 18,653 (1988–) 27,974 Berthing Days (–1987) 4.5 (1988–) 3.1							
			Berth 5B		New Terminal		Total		Berth – 11		New Terminal		Total			
	Gross GRT	Berthing days x Gross GRT	Gross GRT	Berthing days x Gross GRT	Gross GRT	Berthing days x Gross GRT	Gross GRT	Berthing days x Gross GRT	Gross GRT	Berthing days x Gross GRT	Gross GRT	Berthing days x Gross GRT	Gross GRT	Berthing days x Gross GRT	Gross GRT	Berthing days x Gross GRT
1982	7,866,984	29,107,841	1,920,000	2,880,000	0	0	1,920,000	2,880,000	988,609	4,448,741	0	0	988,609	4,448,741	10,775,593	36,436,582
1983	8,040,840	29,751,108	2,400,000	3,600,000	0	0	2,400,000	3,600,000	1,025,915	4,616,618	0	0	1,025,915	4,616,618	11,466,755	37,967,726
1984	6,671,724	24,685,379	3,390,000	5,085,000	0	0	3,390,000	5,085,000	1,063,221	4,784,495	0	0	1,063,221	4,784,495	11,124,945	34,554,874
1985	5,592,368	20,691,762	4,680,000	7,020,000	0	0	4,680,000	7,020,000	1,063,221	4,784,495	0	0	1,063,221	4,784,495	11,335,589	32,496,257
1986	5,592,368	20,691,762	6,030,000	6,210,900	0	0	6,030,000	6,210,900	1,063,221	4,784,495	0	0	1,063,221	4,784,495	12,685,589	31,687,157
1987	5,592,368	20,691,762	6,030,000	6,210,900	0	0	6,030,000	6,120,900	1,063,221	4,784,495	0	0	1,063,221	4,784,495	12,685,589	31,687,157
1988	5,592,368	20,691,762	4,380,000	3,328,800	5,730,000	4,354,800	10,110,000	7,683,600	1,063,221	4,784,495	1,174,908	3,642,215	1,174,908	3,642,215	15,819,866	32,017,577
1989	5,592,368	20,691,762	5,310,000	4,035,600	6,990,000	5,312,400	12,300,000	9,348,000	1,063,221	4,784,495	1,258,830	3,902,373	1,258,830	3,902,373	19,151,198	33,942,135
1990	5,592,368	20,691,762	6,030,000	4,582,800	7,860,000	5,973,600	13,890,000	10,556,400	1,063,221	4,784,495	1,314,778	4,075,812	1,314,778	4,075,812	20,797,146	35,323,974
1991	5,592,368	20,691,762	6,030,000	4,582,800	7,860,000	5,973,600	13,890,000	10,556,400	1,063,221	4,784,495	1,398,700	4,335,970	1,398,700	4,335,970	20,881,068	35,584,132
1992	5,592,368	20,691,762	6,030,000	4,582,800	7,860,000	5,973,600	13,890,000	10,556,400	1,063,221	4,784,495	1,482,622	4,596,370	1,482,622	4,596,370	20,964,990	35,844,532
1993	5,592,368	20,691,762	6,030,000	4,582,800	7,860,000	5,973,600	13,890,000	10,556,400	1,063,221	4,784,495	1,538,570	4,769,567	1,538,570	4,769,567	21,020,938	36,017,729
1994	5,592,368	20,691,762	6,030,000	4,582,800	7,860,000	5,973,600	13,890,000	10,556,400	1,063,221	4,784,495	1,622,492	5,029,725	1,622,492	5,029,725	21,104,860	36,277,887
1995	5,592,368	20,691,762	6,030,000	4,582,800	7,860,000	5,973,600	13,890,000	10,556,400	1,063,221	4,784,495	1,678,440	5,203,164	1,678,440	5,203,164	21,160,808	36,451,326
1996	5,592,368	20,691,762	6,030,000	4,582,800	7,860,000	5,973,600	13,890,000	10,556,400	1,063,221	4,784,495	1,762,362	5,463,322	1,762,362	5,463,322	21,244,730	36,711,484
1997	5,592,368	20,691,762	6,030,000	4,582,800	7,860,000	5,973,600	13,890,000	10,556,400	1,063,221	4,784,495	1,790,336	5,550,042	1,790,336	5,550,042	21,272,704	36,798,204
1998	5,592,368	20,691,762	6,030,000	4,582,800	7,860,000	5,973,600	13,890,000	10,556,400	1,063,221	4,784,495	1,790,336	5,550,042	1,790,336	5,550,042	21,272,704	36,798,204
1999	5,592,368	20,691,762	6,030,000	4,582,800	7,860,000	5,973,600	13,890,000	10,556,400	1,063,221	4,784,495	1,790,336	5,550,042	1,790,336	5,550,042	21,272,704	36,798,204
2000	5,592,368	20,691,762	6,030,000	4,582,800	7,860,000	5,973,600	13,890,000	10,556,400	1,063,221	4,784,495	1,790,336	5,550,042	1,790,336	5,550,042	21,272,704	36,798,204
2001	5,592,368	20,691,762	6,030,000	4,582,800	7,860,000	5,973,600	13,890,000	10,556,400	1,063,221	4,784,495	1,790,336	5,550,042	1,790,336	5,550,042	21,272,704	36,798,204
2002	5,592,368	20,691,762	6,030,000	4,582,800	7,860,000	5,973,600	13,890,000	10,556,400	1,063,221	4,784,495	1,790,336	5,550,042	1,790,336	5,550,042	21,272,704	36,798,204
2003	5,592,368	20,691,762	6,030,000	4,582,800	7,860,000	5,973,600	13,890,000	10,556,400	1,063,221	4,784,495	1,790,336	5,550,042	1,790,336	5,550,042	21,272,704	36,798,204
2004	5,592,368	20,691,762	6,030,000	4,582,800	7,860,000	5,973,600	13,890,000	10,556,400	1,063,221	4,784,495	1,790,336	5,550,042	1,790,336	5,550,042	21,272,704	36,798,204
2005	5,592,368	20,691,762	6,030,000	4,582,800	7,860,000	5,973,600	13,890,000	10,556,400	1,063,221	4,784,495	1,790,336	5,550,042	1,790,336	5,550,042	21,272,704	36,798,204
2006	5,592,368	20,691,762	6,030,000	4,582,800	7,860,000	5,973,600	13,890,000	10,556,400	1,063,221	4,784,495	1,790,336	5,550,042	1,790,336	5,550,042	21,272,704	36,798,204

Year	Mineral Ships (4)		Petroleum Ships (5)				Total (4) + (5)			
	GRT 10,299 Berthing days 1.7		GRT 11,032 Berthing days 1.4				Foreign		Domestic	
	Gross GRT	Berthing days x Gross GRT	Gross GRT		Berthing days x Gross GRT		Gross GRT	Berthing days Gross GRT	Gross GRT	Berthing days Gross GRT
			Foreign	Domestic	Foreign	Domestic				
1982	1,771,428	3,011,428	408,184	1,941,632	571,458	2,718,284	2,179,612	3,582,886	1,941,632	2,718,284
1983	1,822,923	3,098,969	419,216	2,007,824	586,902	2,810,954	2,242,139	3,685,871	2,007,824	2,810,954
1984	1,884,717	3,204,019	419,216	2,107,112	586,902	2,949,957	2,303,933	3,790,921	2,107,112	2,949,957
1985	1,946,511	3,309,069	430,248	2,195,368	602,347	3,073,515	2,376,759	3,911,416	2,195,368	3,073,515
1986	2,008,305	3,414,119	441,280	2,294,656	617,792	3,212,518	2,449,585	4,031,911	3,294,656	3,212,518
1987	2,059,800	3,501,660	441,280	2,416,008	617,792	3,382,411	2,501,080	4,119,452	2,416,008	3,382,411
1988	2,121,594	3,606,710	452,312	2,526,328	633,237	3,536,859	2,573,906	4,239,947	2,526,328	3,536,859
1989	2,183,388	3,711,760	463,344	2,636,648	648,682	3,691,307	2,646,732	4,360,442	2,636,648	3,691,307
1990	2,245,182	3,816,809	463,344	2,769,032	648,682	3,876,644	2,708,526	4,465,491	2,769,032	3,876,644
1991	2,296,677	3,904,351	474,376	2,901,416	664,126	4,061,983	2,771,053	4,568,477	2,901,416	4,061,983
1992	2,358,471	4,009,401	485,408	3,033,800	679,571	4,247,320	2,843,879	4,688,972	3,033,800	4,247,320
1993	2,420,265	4,114,451	496,440	3,177,216	659,016	4,448,102	2,916,705	4,773,467	3,177,216	4,448,102
1994	2,482,059	4,219,500	507,472	3,331,664	710,461	4,664,329	2,987,531	4,929,961	3,331,664	4,664,329
1995	2,533,554	4,307,042	518,504	3,486,112	725,906	4,880,556	3,052,058	5,032,948	3,486,112	4,880,556
1996	2,595,348	4,412,092	529,536	3,662,624	741,350	5,127,674	3,488,884	5,153,442	3,662,624	5,127,674
1997	2,595,348	4,412,092	529,536	3,662,624	741,350	5,127,674	3,488,884	5,153,442	3,662,624	5,127,674
1998	2,595,348	4,412,092	529,536	3,662,624	741,350	5,127,674	3,488,884	5,153,442	3,662,624	5,127,674
1999	2,595,348	4,412,092	529,536	3,662,624	741,350	5,127,674	3,488,884	5,153,442	3,662,624	5,127,674
2000	2,595,348	4,412,092	529,536	3,662,624	741,350	5,127,674	3,488,884	5,153,442	3,662,624	5,127,674
2001	2,595,348	4,412,092	529,536	3,662,624	741,350	5,127,674	3,488,884	5,153,442	3,662,624	5,127,674
2002	2,595,348	4,412,092	529,536	3,662,624	741,350	5,127,674	3,488,884	5,153,442	3,662,624	5,127,674
2003	2,595,348	4,412,092	529,536	3,662,624	741,350	5,127,674	3,488,884	5,153,442	3,662,624	5,127,674
2004	2,595,348	4,412,092	529,536	3,662,624	741,350	5,127,674	3,488,884	5,153,442	3,662,624	5,127,674
2005	2,595,348	4,412,092	529,536	3,662,624	741,350	5,127,674	3,488,884	5,153,442	3,662,624	5,127,674
2006	2,595,348	4,412,092	529,536	3,662,624	741,350	5,127,674	3,488,884	5,153,442	3,662,624	5,127,674

Table 11-9 Number of Ships

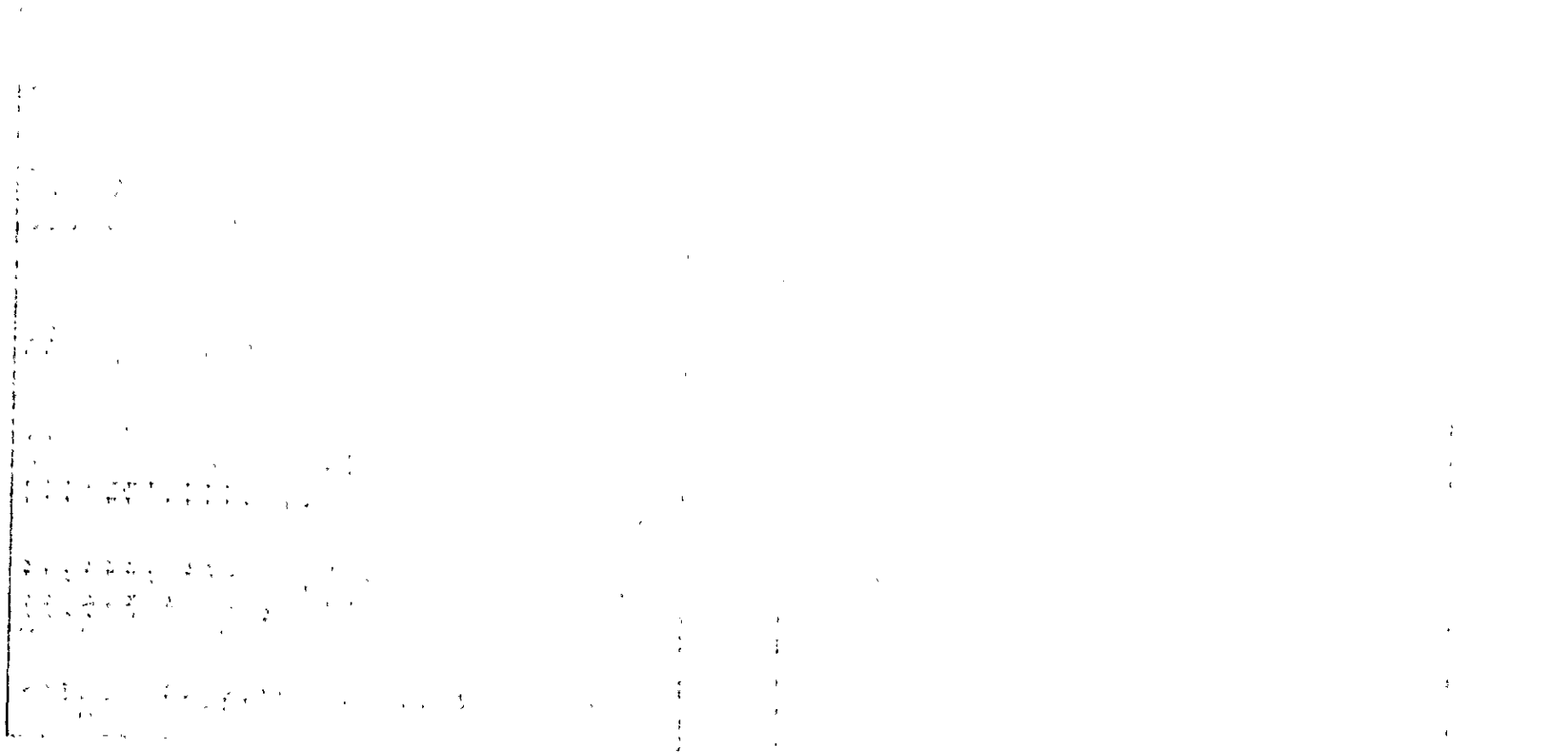


Table 11-11 Port Fees (1982)

1. **Fees related to vessels**

(1)	Port dues	$0.28 per GRT
(2)	Berthing & unberthing fees	$0.22 per GRT, Total: $0.44
(3)	Wharfage	$0.11 per GRT DAYS
(4)	Others	Total of (1) – (3) above x 4.3%

Provided, however, the fees for the domestic vessels will be half of the above.

2. **Fees related to cargo handling**

(1)	General cargoes	$12.68 per ton for import,
		$8.51 per ton for export
(2)	Container	
	(For the ship owner)	$40 per loaded container 20' TEU
		$3.85 for empty container (for import)
		$20 per loaded container 20' TEU
		$3.85 for empty container (for export)
	(For the cargo owner)	$237 per 20' TEU (for import)
		$144 per 20' TEU (for export)
(3)	Grains	$3.92 per ton (for import)
(4)	Minerals	$3.50 per ton (for export)
(5)	Petroleum	
	(In foreign currency)	$4.95 per ton (for import)
		$0.19 per ton (for export)
	(In domestic currency)	$0.02 per ton (for import)
		$0.02 per ton (for export)

3. **Fees related to cargo storage**

(1) General cargoes

			For 30 days
Import	Free for 10 days	10 days	$0.00
	$0.35/t "	0.35 x 10 days	$3.50
	$0.55/t "	0.55 x 10 days	$5.50
	$0.75/t thereafter	Total	$9.00

			For 13 days
Export	Free for 5 days	5 days	$0.00
	$0.09/t 10 days	0.09 x 8 days	$0.72
	$0.18/t thereafter	Total	$0.72/t

(2) Container (20')

Import	Free for 10 days
	$7.00/TEU for days
	$11.00/TEU
	$15.00/TEU thereafter
Export	Free for 5 days
	$2.00/TEU for 10 days
	$4.00/TEU thereafter

2) Operating Expenses

In the event the Project is executed, it is recommended that the operating expenses be estimated corresponding to changes in the services offered by the existing and the new facilities. The operating expenses for Callao Port are classified as follows;

1) in terms of business items; shipping, cargo handling and cargo storage; 2) in terms of expense items; personnel costs, material costs and outside job services costs; and 3) in terms of variable/fixed expenses; direct variable expenses, direct fixed expenses, general administrative expenses (fixed expenses).
The following are assumed as premises in estimating the operation expenses.

(1) The variable expenses are to vary corresponding to decrease/increase of cargo volume and number of ships, while the fixed expenses are to remain constant for every year irrespective of such changes.

(2) In the classification by expense items, the same method for calculating the operation expenses will be employed for both existing and new facilities (container wharf, grain wharf) regarding the shipping services and the cargo storage services (general cargo and containers). For instance, the operating expense for LCL container in regard to container cargo storing services will be assumed by the same method used for general cargo.
For cargo handling services, personnel cost, material cost, maintenance and repairs, etc. are assumed in respect of the new container wharf, and operating expenses are calculated by adding these together. As for container Berth 5B, only the personnel cost will be assumed, and the material costs and outside job/service costs will be calculated by using the same method as that used for general cargo.
Although it is desirable to estimate the operating expenses per item for the new grain terminal, the present analysis will calculate by the same method used for the grains handled by the existing facilities.

(3) The operating expenses for the services of shipping, cargo handling (general cargo including containers, grains, minerals, petroleum) and cargo storage offered by the existing facilities are estimated in terms of expense items, and variable/fixed expenses. They are calculated based on the operating expenses for Callao Port for 1982 shown in Table 11-12.
The operating expenses for 1982 and onward are estimated as follows.

Shipping service:

number of ships x unit cost per ship (direct variable expenses) + direct fixed expenses + general administration expenses

Cargo handling serives:

Expenses are to be assumed for the new container wharf. For the container yard of Berth 5B, the personnel cost alone is estimated, and others are calculated in the same way as was used for general cargo.

For the new grain wharf, the expenses will be calculated by the same method as for the existing grain wharf.

For existing facilities (general cargo, grains, minerals, petroleum), cargo volume (t) x unit cost per t (direct variable expenses) + direct fixed expenses + general administrative expenses

Cargo storage service:

Stored cargo volume (t) x unit cost per t (direct variable expenses) + direct fixed expenses + general administration expenses

The above mentioned operating expenses are based on the existing system and are to be referred to as Type A.

As discussed in the beginning, Type B operating expenses are increased 10% over Type A as port of the administration expense of ENAPU will also be included in the operating expenses of Callao Port.

Table 11-12 Estimated Operating Expenses for 1982

(Unti: US$1,000)

			Shipping Services		Storage Service		Cargo Handling Services										Grand Total
							General Cargoes		Grains		Minerals		Petroleum		Total		
			Ships 1839		1,741,000 t		2,389,000 t		1,146,000 t		1,405,000 t		1,903,000 t		6,843,000 t		
			Cost per ship	Costs	Cost per ton	Costs	Cost per ton	Costs	Cost per ton	Costs	Cost per ton	Costs	Cost per ton	Costs	Cost per ton	Costs	
Personnel Costs	Direct Costs	Variable	1,120.58	2,061	1.96	3,416	5.15	12,300	0.34	392	0.61	850	0.01	22		13,564	19,041
		Fixed		2,829		4,715		7,537		1,582		868		393		10,380	17,924
		Sub-total		4,890		8,131		19,837		1,974		1,718		415		23,944	36,965
	Administration Costs			1,189		1,834		4,557		478		412		99		5,546	8,569
	Total			6,079		9,965		24,394		2,452		2,130		514		29,490	45,534
Material Costs	Direct Costs	Variable	100.00	184	–	–	0.12	277	–	–	0.04	52	–	2		331	515
		Fixed		818		545		192		70		82		61		405	1,768
		Sub-total		1,002		545		469		70		134		63		736	2 283
	Administration Costs			170		87		62		10		18		9		99	356
	Total			1,172		632		531		80		152		72		835	2,639
Outside Service Costs	Direct Costs	Variable	41.25	76	0.04	70	0.05	118	0.01	17	0.02	33	0.01	20		188	334
		Fixed		1,362		1,256		2,126		332		632		293		3,383	6,001
		Sub-total		1,438		1,326		2,244		349		665		313		3,571	6,335
	Administration Costs			174		149		162		25		48		22		257	580
	Total			1,612		1,475		2,406		374		713		335		3,828	6,915
Depreciation Costs	Direct Costs			588		137		811		157		707		343		2,018	2,743
	Administration Costs			101		23		139		27		121		58		345	469
	Total			689		160		950		184		828		401		2,363	3,212
Grand Total	Direct Costs	Variable	1,261.83	2,321	2.00	3,486	5.32	12,695	0.35	409	0.67	935	0.02	44		14,083	19,890
		Fixed		5,597		6,653		10,666		2,141		2,289		1,090		16,186	28,436
		Sub-total		7,918		10,139		23,361		2,550		3,224		1,134		30,269	48,326
	Administration Costs			1,634		2,093		4,920		540		599		188		6,247	9,974
	Grand Total			9,552		12,232		28,281		3,090		3,823		1,322		36,516	58,300

Exchange Rate: US$1 = Soles 715.50

(Ship Size)

Loading volume per ship.

General Cargo Ship	2,009 t
Grain Ship	7,389 t
Ore Carrier	4,986 t

11-2-6 Financial Statements

Based on the calculation of revenues and expenditures, consideration of long term loan conditions and changes in fixed assets, the summarized tables for 1982 – 2006 are shown in TAble 11-13, 11-14 and 11-15. The tables are respectively, estimated Revenue & Expenditure, Source & Application of Funds, and Balance Sheet.

Financial statements are respectively for the following eight cases.

Case – A1, A2, A3 and A4

Case – B1, B2, B3 and B4

(A and B indicate the type of operating expenses, and 1 to 4 the methods of fund raising).

For all eight cases, the picture for revenues and expenditures as well as for financial status presents no problems. The former is particularly excellent: The reasons are assumed to be that the volume of general cargo, which produces high costs will decrease by 600,000 t, while the container cargoes with a higher profitability will increases, once the Project is executed. The 650,000 tons handled by Berth 5B and 850,000 tons by the new container berth will add up to 1,500,000 tons, increasing the profitability. Construction of the grain wharf will increase the grain volume handled to 1,000,000 tons, which is reflected in the excellent results. However, in fund raising, Cases 1 and 2 for both Types A and B will see shortages of funds during construction, between 1985 to 1987, since these cases adopted, in part, the self-financing method. In 1987, this shortage of funds will amount to max. US$29 million Cumulative net current assets (current assets minus current liabilities) will respectively become –25 million (1987) and -14 million (1988) for case A, and -13 million (1987) and -4 million (1988) for Case B (in US$). After 1988 when high earnings are expected from the operation of the container wharf and grain wharf, these red figues are expected to disappear and smoothly move toward the black.

Accordingly, if the funds during the construction period are raised by loans, a healthy financial state will be realized as the revenues and expenditures go smoothly. Thus, execution of the Project at an early date is awaited. In the financial statements for the 8 cases, detailed financial statements for Case-B3 with the severest long term loan conditions are shown in Tables 11-16, 11-17 and 11-18 respectively. The financial ratio for this case is shown in Table 11-19.

(*The Financial statements based on the operating expenses of Type C and D are studied on the Appendix. In this study, Case 3 and 4 are adopted as the conditions of fund raising and 4 cases of Case-C3, C4, D3 and D4 are analyzed.)

Table 11-13 Estimated Revenue and Expenditure (Summary)

(Unit. Million US$)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Revenue																										
Case-A1, A2, A3, A4		63	67	64	63	68	70	86	97	106	106	107	108	108	109	110	110	110	110	110	110	110	110	110	110	110
Case-B1, B2, B3, B4																										
Expentidutre																										
Case-A1		54	55	53	52	52	53	64	64	65	64	65	65	64	64	64	64	64	64	64	64	64	63	63	63	63
-A2		54	55	53	52	53	54	65	65	66	65	66	66	65	65	65	65	64	64	64	64	64	63	63	63	63
-A3		54	56	54	54	56	62	74	74	74	72	71	71	69	68	67	66	65	64	63	63	63	63	62	63	62
-A4		54	56	53	52	53	55	68	68	69	68	68	68	67	67	67	66	65	65	64	64	64	64	63	63	63
-B1		60	61	58	57	57	58	70	70	71	70	71	71	70	71	71	70	70	70	70	70	70	70	69	69	69
-B2		60	61	59	57	58	60	72	72	72	72	72	72	71	71	71	71	71	70	70	70	70	70	69	69	69
-B3		60	61	59	59	61	67	81	80	80	78	77	77	75	75	74	72	71	70	69	69	69	69	69	69	69
-B4		60	61	59	58	59	61	75	75	75	74	74	74	73	73	73	72	72	71	71	71	70	70	69	69	69
Profit before Depreciation																										
Case-A1		9	12	11	11	16	17	22	33	41	42	42	43	44	45	46	46	46	46	46	46	46	47	47	47	47
-A2		9	12	11	11	15	16	21	32	40	41	41	42	43	44	45	45	46	46	46	46	46	47	47	47	47
-A3		9	11	10	9	12	8	12	23	32	34	36	37	39	41	43	44	45	46	47	47	47	47	48	47	48
-A4		9	11	11	11	15	15	18	29	37	38	39	40	41	42	43	44	45	45	46	46	46	46	47	47	47
-B1		3	6	6	6	11	12	16	27	35	36	36	37	38	38	39	40	40	40	40	40	40	40	41	41	41
-B2		3	6	5	6	10	10	14	25	34	34	35	36	37	38	39	39	39	40	40	40	40	40	41	41	41
-B3		3	6	5	4	7	3	5	17	26	28	30	31	33	34	36	38	39	40	41	41	41	41	41	41	41
-B4		3	6	5	5	9	9	11	22	31	32	33	34	35	36	37	38	38	39	39	39	40	40	41	40	41
Less Depreciation		1	1	2	2	2	2	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	4	2	2
Profit after Depreciation																										
Case-A1		8	11	9	9	14	15	15	26	34	35	35	36	37	38	39	39	39	39	39	39	39	40	43	45	45
-A2		8	11	9	9	13	14	14	25	33	34	34	35	36	37	38	38	39	39	39	39	39	40	43	45	45
-A3		8	10	8	7	10	6	5	16	25	27	29	30	32	34	36	37	38	39	40	40	40	40	44	45	46
-A4		8	10	9	9	13	13	11	22	30	31	32	33	34	35	36	37	38	38	39	39	39	39	43	45	45
-B1		2	5	4	4	9	10	9	20	28	29	29	30	31	31	32	33	33	33	33	33	33	33	37	39	39
-B2		2	5	3	4	8	8	7	18	27	27	28	29	30	31	32	32	32	33	33	33	33	33	37	39	39
-B3		2	5	3	2	5	1	2	10	19	21	23	24	26	27	29	31	32	33	34	34	34	34	37	39	39
-B4		2	5	3	3	7	7	4	15	24	25	26	27	28	29	30	31	31	32	32	32	33	33	37	38	39
Income Tax																										
Case-A1		4	5	4	4	7	7	7	13	17	17	17	18	18	19	19	19	19	19	19	19	19	20	21	22	22
-A2		4	5	4	4	6	7	7	12	16	17	17	17	18	18	19	19	19	19	19	19	19	20	21	22	22
-A3		4	5	4	3	5	3	2	8	12	13	14	15	16	17	18	18	19	19	20	20	20	20	22	22	23
-A4		4	5	4	4	6	6	5	11	15	15	16	16	17	17	18	18	19	19	19	19	19	19	21	22	22
-B1		1	2	2	2	4	5	4	10	14	14	14	15	15	15	16	16	16	16	16	16	16	16	18	19	19
B2		1	2	1	2	4	4	3	9	13	13	14	14	15	15	16	16	16	16	16	16	16	16	18	19	19
-B3		1	2	1	1	2	0	0	5	9	10	11	12	13	13	14	15	16	16	17	17	17	17	18	19	19
-B4		1	2	1	1	3	3	2	7	12	12	13	13	14	14	15	15	15	16	16	16	16	16	18	19	19
Profit after Income Tax																										
Case-A1		4	6	5	5	7	8	8	13	17	18	18	18	19	19	20	20	20	20	20	20	20	20	22	23	23
-A2		4	6	5	5	7	7	7	13	17	17	17	18	18	19	19	19	20	20	20	20	20	20	22	23	23
-A3		4	5	4	4	5	3	3	8	13	14	15	15	16	17	18	19	19	20	20	20	20	20	22	23	23
-A4		4	5	5	5	7	7	6	11	15	16	16	17	17	18	18	19	19	19	20	20	20	20	22	23	23
-B1		1	3	2	2	5	5	5	10	14	15	15	15	16	16	16	17	17	17	17	17	17	17	19	20	20
-B2		1	3	2	2	4	4	4	9	14	14	14	15	15	16	16	16	16	17	17	17	17	17	19	20	20
-B3		1	3	2	1	3	1	-2	5	10	11	12	12	13	14	15	16	16	17	17	17	17	17	19	20	20
-B4		1	3	2	2	4	4	2	8	12	13	13	14	14	15	15	16	16	16	16	16	17	17	19	19	20
Accumulated Net Profit from 1981																										
Case-A1	25	29	35	40	45	52	60	68	81	98	116	134	152	171	190	210	230	250	270	290	310	330	350	372	395	418
-A2	25	29	35	40	45	52	59	66	79	96	113	130	148	166	185	204	223	243	263	283	303	323	343	365	388	411
-A3	25	29	34	38	42	47	50	53	61	74	88	103	118	134	151	169	188	207	227	247	267	287	307	329	352	375
-A4	25	29	34	39	44	51	58	64	75	90	106	122	139	156	174	192	211	230	249	269	289	309	329	351	374	397
-B1	25	26	29	31	33	38	43	48	58	72	87	102	117	133	149	165	182	199	216	233	250	267	284	303	323	343
-B2	25	26	29	31	33	37	41	45	54	68	82	96	111	126	142	158	174	190	207	224	241	258	275	294	314	334
-B3	25	26	29	31	32	35	36	34	39	49	60	72	84	97	111	126	142	158	175	192	209	226	243	262	282	302
-B4	25	26	29	31	33	37	41	43	51	63	76	89	103	117	132	147	163	179	195	211	227	244	261	280	299	319

Table 11-14 Estimated Source and Application of Funds (Summary)

(Unit: Million US$)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Source of Funds																										
Profit before Depreciation																										
Case-A1		9	12	11	11	16	17	22	33	41	42	42	43	44	45	46	46	46	46	46	46	46	47	47	47	47
-A2		9	12	11	11	15	16	21	32	40	41	41	42	43	44	45	45	46	46	46	46	46	47	47	47	47
-A3		9	11	10	9	12	8	12	23	32	34	36	37	39	41	43	44	45	46	47	47	47	47	48	47	48
-A4		9	11	11	11	15	15	18	29	37	38	39	40	41	42	43	44	45	45	46	46	46	46	47	47	47
-B1		3	6	6	6	11	12	16	27	35	36	36	37	38	38	39	40	40	40	40	40	40	40	41	41	41
-B2		3	6	5	6	10	10	14	25	34	34	35	36	37	38	39	39	39	40	40	40	40	40	41	41	41
-B3		3	6	5	4	7	3	5	17	26	28	30	31	33	34	36	38	39	40	41	41	41	41	41	41	41
-B4		3	6	5	5	9	9	11	22	31	32	33	34	35	36	37	38	38	39	39	39	40	40	41	40	41
Long-term Loans																										
Case-A1,B1		5	6	4	9	5	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-A2, B2		5	7	4	12	7	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-A3, A4, B3, B4		5	7	9	23	14	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total																										
Case-A1		14	18	15	20	21	34	22	33	41	42	42	43	44	45	46	46	46	46	46	46	46	47	47	47	47
-A2		14	19	15	23	22	42	21	32	40	41	41	42	43	44	45	45	46	46	46	47	47	47	48	47	48
-A3		14	18	19	32	26	60	12	23	32	34	36	37	39	41	43	44	45	46	47	47	47	47	48	47	48
-A4		14	18	20	34	29	67	18	29	37	38	39	40	41	42	43	44	45	45	46	46	46	46	46	47	47
-B1		8	12	10	15	16	29	16	27	35	36	36	37	38	38	39	40	40	40	40	40	40	40	40	41	41
-B2		8	13	9	18	17	36	14	25	34	34	35	36	37	38	39	39	39	40	40	40	40	40	40	41	41
-B3		8	13	14	27	21	55	5	17	26	28	30	31	33	34	36	38	39	40	41	41	41	41	41	41	41
-B4		8	13	14	28	23	61	11	22	31	32	33	34	35	36	37	38	38	39	39	39	40	40	41	40	41
Application of Funds																										
Cost of Fixed Assets Addition		5	7	9	23	14	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Repayment of Long-term Loans																										
Case-A1		0	0	0	0	0	1	1	1	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	1
-A2		0	0	0	0	0	2	2	2	4	4	4	4	4	4	4	4	4	4	2	2	2	2	2	2	2
-A3		0	0	0	0	0	9	9	9	9	9	9	9	9	9	9	9	9	9	2	0	0	0	0	0	0
-A4		0	0	0	0	0	3	3	3	7	7	7	7	7	7	7	7	7	7	4	4	4	4	4	4	4
-B1		0	0	0	0	0	1	1	1	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	1
-B2		0	0	0	0	0	2	2	2	4	4	4	4	4	4	4	4	4	4	2	2	2	2	2	2	2
-B3		0	0	0	0	0	9	9	9	9	9	9	9	9	9	9	9	9	9	2	0	0	0	0	0	0
-B4		0	0	0	0	0	3	3	3	7	7	7	7	7	7	7	7	7	7	4	4	4	4	4	4	4
Income Tax																										
Case-A1		4	5	4	4	7	7	7	13	17	17	17	18	18	19	19	19	19	19	19	19	19	19	20	21	22	22
-A2		4	5	4	4	6	7	7	12	16	17	17	17	18	18	19	19	19	19	19	19	19	19	20	21	22	22
-A3		4	5	4	3	5	3	2	8	12	13	14	15	16	17	18	18	19	19	20	20	20	20	22	22	23
-A4		4	5	4	4	6	6	5	11	15	15	16	16	17	17	18	18	19	19	19	19	19	19	21	22	22
-B1		1	2	2	2	4	5	4	10	14	14	14	15	15	15	16	16	16	16	16	16	16	16	18	19	19
-B2		1	2	1	2	4	4	3	9	13	13	14	14	15	15	16	16	16	16	16	16	16	16	18	19	19
-B3		1	2	1	1	2	0	0	5	9	10	11	12	13	13	14	15	16	16	17	17	17	17	18	19	19
-B4		1	2	1	1	3	3	2	7	12	12	13	13	14	14	15	15	15	16	16	16	16	16	18	19	19
Total																										
Case-A1		9	12	13	27	21	60	8	14	20	20	20	21	21	22	22	22	22	22	21	21	21	22	23	24	23
-A2		9	12	13	27	20	61	9	14	20	21	21	21	22	22	23	23	23	23	21	21	21	22	23	24	24
-A3		9	12	13	26	19	64	11	17	21	22	23	24	25	26	27	27	28	21	20	20	20	20	22	22	23
-A4		9	12	13	27	20	61	8	14	22	22	23	23	24	24	25	25	26	26	23	23	23	23	25	26	26
-B1		6	9	11	25	18	58	5	11	17	17	17	18	18	18	19	19	19	19	18	18	18	18	20	21	20
-B2		6	9	10	25	18	58	5	11	17	17	18	18	19	19	20	20	20	20	18	18	18	18	20	21	21
-B3		6	9	10	24	16	61	9	14	18	19	20	21	22	22	23	24	25	18	17	17	17	17	18	19	19
-B4		6	9	10	24	17	58	5	10	19	19	20	20	21	21	22	22	22	23	20	20	20	20	22	23	23
Increase/Decrease (–) of Net Current Assets																										
Case-A1		5	6	2	-7	0	-26	14	19	21	22	22	22	23	23	24	24	24	24	25	25	25	25	24	23	24
-A2		5	7	2	-4	2	-19	12	18	20	20	20	21	21	22	22	22	23	23	25	25	25	25	24	23	23
-A3		5	6	6	6	7	-4	1	6	11	12	13	13	14	15	16	17	17	25	27	27	27	27	26	25	25
-A4		5	6	7	7	9	6	10	15	15	16	16	17	17	18	18	19	19	19	23	23	23	23	22	21	21
-B1		2	3	-1	-10	-2	-29	11	16	18	19	19	19	20	20	20	21	21	21	22	22	22	22	21	20	21
-B2		2	4	-1	-7	-1	-22	9	14	17	17	17	18	18	18	19	19	19	20	22	22	22	22	21	20	20
-B3		2	4	4	3	5	-6	-4	3	8	9	10	10	11	12	13	14	14	22	24	24	24	24	23	22	22
-B4		2	4	4	4	6	3	6	12	12	13	13	14	14	15	15	16	16	16	19	19	20	20	19	17	18
Net Current Assets at Beginning of Year																										
Case-A1		12	17	23	25	18	18	-8	6	25	46	68	90	112	135	158	182	206	230	254	279	304	329	354	378	401
-A2		12	17	24	26	22	24	5	17	35	55	75	95	116	137	159	181	203	226	249	274	299	324	349	373	396
-A3		12	17	23	29	35	42	38	39	45	56	68	81	94	108	123	139	156	173	198	225	252	279	306	332	357
-A4		12	17	23	30	37	46	52	62	77	92	108	124	141	158	176	194	213	232	251	274	297	320	343	365	386
-B1		12	14	17	16	6	4	-25	-14	2	20	39	58	79	97	117	137	158	179	200	222	244	266	288	309	329
-B2		12	14	18	17	10	9	-13	-4	10	27	44	61	79	97	116	135	154	173	193	215	237	259	281	302	322
-B3		12	14	18	22	25	30	24	20	23	31	40	50	60	71	83	96	110	124	146	170	194	218	242	265	287
-B4		12	14	18	22	26	32	35	41	53	65	78	91	105	119	134	149	165	181	197	216	235	255	275	294	311
Net Current Asses at End of year																										
Case-A1	12	17	23	25	18	18	-8	6	25	46	68	90	112	135	158	182	206	230	254	279	304	329	354	378	401	425
-A2	12	17	24	26	22	24	5	17	35	55	75	95	116	137	159	181	203	226	249	274	299	324	349	373	396	419
-A3	12	17	23	29	35	42	38	39	45	56	68	81	94	108	123	139	156	173	198	225	252	279	306	332	357	382
-A4	12	17	23	30	37	46	52	62	77	92	108	124	141	158	176	194	213	232	251	274	297	320	343	365	386	407
-B1	12	14	17	16	6	4	-25	-14	2	20	39	58	77	97	117	137	158	179	200	222	244	266	288	309	329	350
-B2	12	14	18	17	10	9	-13	-4	10	27	44	61	79	97	116	135	154	173	193	215	237	259	281	302	322	342
-B3	12	14	18	22	25	30	24	20	23	31	40	50	60	71	83	96	110	124	146	170	194	218	242	265	287	309
-B4	12	14	18	22	26	32	35	41	53	65	78	91	105	119	134	149	165	181	197	216	235	255	275	294	311	329

Table 11-15 Estimated Balance Sheet (Summary)

(Unit: Million US$)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Assets																										
Fixed Assets	38	42	48	55	76	88	138	131	124	117	110	103	96	89	82	75	68	61	54	47	40	33	26	22	20	18
Net Current Assets																										
Case-A1	12	17	23	25	18	18	8	6	25	46	68	90	112	135	158	182	206	230	254	279	304	329	354	378	401	425
-A2	12	17	24	26	22	24	5	17	35	55	75	95	116	137	159	181	203	226	249	274	299	324	349	373	396	419
A3	12	17	23	29	35	42	38	39	45	56	68	81	94	108	123	139	156	173	198	225	252	279	306	332	357	382
-A4	12	17	23	30	37	46	52	62	77	92	108	124	141	158	176	194	213	232	251	274	297	320	343	365	386	407
-B1	12	14	17	16	6	4	-25	-14	2	20	39	58	77	97	117	137	158	179	200	222	244	266	288	309	329	356
-B2	12	14	18	17	10	9	-13	- 4	10	27	44	61	79	97	116	135	154	173	193	215	237	259	281	302	322	342
-B3	12	14	18	22	25	30	24	20	23	31	40	50	60	71	83	96	110	124	146	170	194	218	242	265	287	309
-B4	12	14	18	22	26	32	35	41	53	65	78	91	105	119	134	149	165	181	197	216	235	255	275	294	311	329
Total																										
Case-A1	50	59	71	80	94	106	130	137	149	163	178	193	208	224	240	257	274	291	308	326	344	362	380	400	421	443
-A2	50	59	72	81	98	112	143	148	159	172	185	198	212	226	241	256	271	287	303	321	339	357	375	395	416	437
-A3	50	59	71	84	111	130	176	170	169	173	178	184	190	197	205	214	224	234	252	272	292	312	332	354	377	400
-A4	50	59	71	85	113	134	190	193	201	209	218	227	237	247	258	269	281	293	305	321	337	353	369	387	406	425
-B1	50	57	65	71	82	92	113	117	126	137	149	161	173	186	199	212	226	240	254	269	284	299	314	331	349	368
-B2	50	57	66	72	86	97	125	127	134	144	154	164	175	186	198	210	222	234	247	262	277	292	307	324	342	360
-B3	50	52	66	77	101	118	162	151	147	148	150	153	156	160	165	171	178	185	200	217	234	251	268	287	307	327
-B4	50	57	66	77	102	120	173	172	177	182	188	194	201	208	216	224	233	242	251	263	275	288	301	316	331	347
Capital Employed																										
Capital 25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Long-term Loans																										
Case-A1	0	5	11	15	24	29	45	44	43	40	37	34	31	28	25	22	19	16	13	11	9	7	5	3	1	0
-A2	0	5	12	16	28	35	59	57	55	51	47	43	39	35	31	27	23	19	15	13	11	9	7	5	3	1
-A3	0	5	12	21	44	58	101	92	83	74	65	56	47	38	29	20	11	2	0	0	0	0	0	0	0	0
-A4	0	5	12	21	44	58	107	104	101	94	87	80	73	66	59	52	45	38	31	27	23	19	15	11	7	3
-B1	0	5	11	15	24	29	45	44	43	40	37	34	31	28	25	22	19	16	13	11	9	7	5	3	1	0
-B2	0	5	12	16	28	35	59	57	55	51	47	43	39	35	31	27	23	19	15	13	11	9	7	5	3	1
-B3	0	5	12	21	44	58	101	92	83	74	65	56	47	38	29	20	11	2	0	0	0	0	0	0	0	0
-B4	0	5	12	21	44	58	107	104	101	94	87	80	73	66	59	52	45	38	31	27	23	19	15	11	7	3
Other Reserves and Provision																										
Case-A1	25	29	35	40	45	52	60	68	81	98	116	134	152	171	190	210	230	250	270	290	310	330	350	372	395	418
-A2	25	29	35	40	45	52	59	66	79	96	113	130	148	166	185	204	223	243	263	283	303	323	343	365	388	411
-A3	25	29	34	38	42	47	50	53	61	74	88	103	118	134	151	169	188	207	227	247	267	287	307	329	352	375
-A4	25	29	34	39	44	51	58	64	75	90	106	122	139	156	174	192	211	230	249	269	289	309	329	351	374	397
-B1	25	26	29	31	33	38	43	48	58	72	87	102	117	133	149	165	182	199	216	233	250	267	284	303	323	343
-B2	25	26	29	31	33	37	41	45	54	68	82	96	111	126	142	158	174	190	207	224	241	258	275	294	314	334
-B3	25	26	29	31	32	35	36	34	39	49	60	72	84	97	111	126	142	158	175	192	209	226	243	262	282	302
-B4	25	26	29	31	33	37	41	43	51	63	76	89	103	117	132	147	163	179	195	211	227	244	261	280	299	319
Total																										
Case-A1	50	59	71	80	94	106	130	137	149	163	178	193	208	224	240	257	274	291	308	326	344	362	380	400	421	443
-A2	50	59	72	81	98	112	143	148	159	172	185	198	212	226	241	256	271	287	303	321	339	357	375	395	416	437
-A3	50	59	71	84	111	130	176	170	169	173	178	184	190	197	205	214	224	234	252	272	292	312	332	354	377	400
-A4	50	59	71	85	113	134	190	193	201	209	218	227	237	247	258	269	281	293	305	321	337	353	369	387	406	425
-B1	50	59	65	71	82	92	113	117	126	137	149	161	173	186	199	212	226	240	254	269	284	299	314	331	349	368
-B2	50	59	66	72	86	97	125	127	134	144	154	164	175	186	198	210	222	234	247	262	277	292	307	324	342	360
-B3	50	57	66	77	101	118	162	151	147	148	150	153	156	160	165	171	178	185	200	217	234	251	268	287	307	327
-B4	50	57	66	77	102	120	173	172	177	182	188	194	201	208	216	224	233	242	251	263	275	288	301	316	331	347

Table 11-16 Estimated Revenue and Expenditure (Case-B3)

(Unit. 1,000 US$)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Revenue																										
Shipping Services		15205	15989	15448	15475	16512	16615	19123	21966	23484	23691	23912	24105	24339	24532	25046	25078	25078	25078	25078	25078	25078	25078	25078	25078	25078
Cargo Handling Services		36268	38985	38122	38470	42729	44224	57073	65228	71999	72405	72820	73226	73646	74057	74474	74686	74686	74686	74686	74686	74686	74686	74686	74686	74686
Cargo Storage Services		10761	10961	9164	7799	7908	7790	8137	8221	8238	8238	8238	8238	8238	8238	8238	8238	8238	8238	8238	8238	8238	8238	8238	8238	8238
Others		1245	1319	1255	1235	1343	1373	1687	1908	2074	2087	2099	2111	2124	2137	2155	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160
Total		63479	67254	63989	62979	68492	70002	86020	97323	105795	106421	107069	107680	108347	108964	109913	110162	10162	110162	110162	110162	110162	110162	110162	110162	110162
Expenditure																										
Personnel Costs		44553	45139	42869	41267	41825	41868	48287	48780	49161	49245	49330	49416	49504	49589	49679	49698	49698	49698	49698	49698	49698	49698	49698	49698	49698
Material Costs		2626	2645	2600	2574	2599	2603	2926	3001	3058	3062	3067	3071	3075	3079	3084	3084	3084	3084	3084	3084	3084	3084	3084	3084	3084
Outside Job Services		6892	6905	6877	6863	6879	6881	10167	10181	10191	10194	10198	10200	10203	10207	10210	10210	10210	10210	10210	10210	10210	10210	10210	10210	10210
Interest on Loans		175	648	1472	3600	5467	10354	12841	11749	10656	9562	8470	7377	6285	5191	4098	3006	1913	806	0	0	0	0	0	0	0
Others		5407	5469	5235	5070	5130	5135	6138	6196	6241	6250	6260	6269	6278	6288	6297	6299	6299	6299	6299	6299	6299	6299	6299	6299	6299
Total		59653	60806	59053	59374	61900	66841	80359	79907	79307	78313	77325	76333	75345	74354	73368	72297	71204	70097	69291	69291	69291	69291	69291	69291	69291
Profit before Depreciation		3826	6448	4936	3605	6592	3161	5661	17416	26488	28108	29744	31347	33002	34610	36545	37865	38958	40065	40871	40871	40871	40871	40871	40871	40871
Less Depreciation		1474	1474	2015	2015	2015	2015	7243	7243	7243	7243	7243	7243	7243	7243	7243	7243	7243	7243	7243	7243	7243	7243	3632	2015	1631
Profit after Depreciation		2352	4974	2921	1590	4577	1146	-1582	10173	19245	20865	22501	24104	25759	27367	29302	30622	31715	32822	33628	33628	33628	33628	37239	38856	39240
Income Tax		1176	2487	1460	795	2288	573	0	5086	9622	10432	11250	12052	12879	13683	14651	15311	15857	16411	16814	16814	16814	16814	18619	19428	19620
Profit after Income Tax		1176	2487	1461	795	2289	573	-1582	5087	9623	10433	11251	12052	12880	13684	14651	15311	15858	16411	16814	16814	16814	16814	18620	19428	19620
Accumulated Net Profit from 1981	25283	26459	28946	30407	31202	33491	34064	32482	37569	47192	57625	68876	80928	93808	107492	122143	137454	153312	169723	186537	203351	220165	236979	255599	275027	294647

Table 11-17 Estimated Source and Application of Funds (Case-B3)

(Unit: 1,000 US$)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Source of Funds																										
Profit before Depreciation		3826	6448	4936	3605	6592	3161	5661	17416	26488	28108	29744	31347	33002	34610	36545	37865	38958	40065	40871	40871	40871	40871	40871	40871	40871
Long Term Loans		5000	7290	8838	23135	14276	52095	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		8826	13738	13774	26740	20868	55256	5661	17416	26488	28108	29744	31347	33002	34610	36545	37865	38958	40065	40871	40871	40871	40871	40871	40871	40871
Application of Funds																										
Cost of Fixed Assets Addition		5000	7290	8838	23135	14276	52095	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Repayment of Long-term Loans		0	0	0	0	0	8510	8510	8510	8510	8510	8510	8510	8510	8510	8510	8510	8510	8514	0	0	0	0	0	0	0
Income Tax		1176	2487	1460	795	2288	573	0	5086	7622	10432	11250	12052	12879	13683	14651	15311	15857	16411	16814	16814	16814	16814	18619	19428	19620
Total		6176	9777	10298	23930	16564	61178	8510	13596	18132	18942	19760	20562	21389	22193	23161	23821	24367	24925	16814	16814	16814	16814	18619	19428	19620
Increase/Decrease (-) of Net Current Assets		2650	3961	3476	2810	4304	-5922	-2849	3820	8356	9166	9984	10785	11613	12417	13384	14044	14591	15140	24057	24057	24057	24057	22252	21443	21251
Net Current Assets at Biginning of Year		11822	14472	18433	21909	24719	29023	23101	20252	24072	32428	41594	51578	62363	73976	86393	99777	113821	128412	143552	167609	191666	215723	239780	262032	283475
Net Current Assets at End of Year	11822	14472	18433	21909	24719	29023	23101	20252	24072	32428	41594	51578	62363	73976	86393	99777	113821	128412	143552	167609	191666	215723	239780	262032	283475	304726

Table 11-18 Estimated Balance Sheet (Case-B3)

(Unit 1,000 US$)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Assets																										
Fixed Assets	38621	42147	47963	54786	75906	88167	138247	131004	123761	116518	109275	102032	94789	87546	80303	73060	65817	58574	51331	44088	36845	29602	22359	18727	16712	15081
(Land)	712	712	712	712	712	712	712	15081	15081	15081	15081	15081	15081	15081	15081	15081	15081	15081	15081	15081	15081	15081	15081	15081	15081	15081
(Net Fixed Assets to be depreciated)	35774	34300	32826	43946	41931	39916	37901	115923	108680	101437	94194	86951	79708	72465	65222	57979	50736	43493	36250	29007	21764	14521	7278	3646	1631	0
(Construction in process a/c)	2135	7135	14425	10128	33263	47539	99634	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Current Assets	11822	14472	18433	21909	24719	29023	23101	20252	24072	32428	41594	51578	62363	73976	86393	99777	113821	128412	143552	167609	191666	215723	239780	262032	283475	304726
Total	50443	56619	66396	76695	100625	117190	161348	151256	147833	148946	150869	153610	157152	161522	166696	172837	179638	186986	194883	211697	228511	245325	262139	280759	300187	319807
Capital Employed																										
Capital	25160	25160	25160	25160	25160	25160	25160	25160	25160	25160	25160	25160	25160	25160	25160	25160	25160	25160	25160	25160	25160	25160	25160	25160	25160	25160
Long-term Loans	0	5000	12290	21128	44263	58539	102124	93614	85104	76594	68084	59574	51064	42554	34044	25534	17024	8514	0	0	0	0	0	0	0	0
Other Reserves and Provision	25283	26459	28946	30407	31202	33491	34064	32482	37569	47192	57625	68876	80928	93808	107492	122143	137454	153312	169723	186537	203351	220165	236979	255599	275027	294647
Total	50443	56619	66396	76695	100625	117190	161348	151256	147833	148946	150869	153610	157152	161522	166696	172837	179638	18986	194883	211697	228511	245325	262139	280759	300187	319807

Table 11-19 Financial Ratio

Year	Operating Ratio (%)	Return on Net Fixed Assets (%)	Interest Earmed Ratio	Debt/Equity
1982	96	6	14.4	9/91
1983	92	12	8.7	19/81
1984	93	8	3.0	28/72
1983	92	7	1.4	44/56
1986	85	11	1.8	50/50
1987	84	8	1.1	63/37
1988	87	9	0.9	62/38
1989	77	18	1.9	58/42
1990	72	26	2.8	51/49
1991	71	28	3.2	45/55
1992	71	30	3.7	39/61
1993	71	33	4.3	32/68
1994	70	37	5.1	26/74
1995	70	41	6.3	20/80
1996	70	46	8.2	15/85
1997	69	51	11.2	9/91
1998	69	57	17.6	5/95
1999	69	66	41.7	
2000	69	76		
2001	69	91		
2002	69	114		
2003	69	150		
2004	66	199		
2005	65	233		
2006	64	260		

11-3 Discount Cash Flow Analysis

The total of all services which are offered by the new and existing facilities handling all the general cargoes, containers and grains in the event the Project is executed, is examined, and the so-called Financial Rate of Return (FRR) is sought and analyzed by using the Discount Cash Flow method in order to assess if the profits (revenue minus operating expenses) from these services are reasonable when compared to the construction cost for the Project.

1983 when the Project is begun will be the initial year of reckoning.

The term of analysis will be from 1983 when the Project is executed, or the initial year of reckoning, until 2006 when the Project life is to be completed.

The revenues will be those from the shipping, cargo hndling, cago storage and special services concerning general cargo, containers and grains, and the operating expenditures for these services. The profits obtained by subtracting expenditure from revenue are the profits before interest payment and depreciation.

The construction cost for the Project is 99,634 (US$1,000) as shown in Table 11-1. This does not include the import duty nor primage duty for the construction materials. The FRR is sought for the Case of Type B which is under the most severe conditions selected from among the eight cases discussed in the preceding section by the analysis of financial statements. The FRR as shown in Table 11-20 becomes 35.31% for this case. It is desirable that the FRR should reasonably exceed the total of interest paid on loans and depreciations. An FRR of 15-20% is aimed at in this Project. The above mentioned FRR of 35.31% exceeds this aim, indicating that the Project execution is feasible.

The net present value for the Case of Type B when the FRR is 20% is 42,885 (US$1,000).

(*FRR based on the operating expenses of Types C and D are studied on the Appendix.)

The FRR when the container wharf alone is constructed in the Project (Case of Type B) is reviewed in the Appendix.

Table 11-20 F.R.R. (Case-B)

(Unit: 1,000 US$)

No.	Year	Cost	Net Surplus Revenue			Balance		
		Project Cost	Revenue	Expenditure	Net Surplus	Rev. Cost	F.R.R. 35.31 (%)	F.R.R. 20.00 (%)
0	1983	12,290	63,070	55,262	7,808	-4,482	-4,482	-4,482
1	1984	8,838	59,654	52,631	7,023	-1,815	-1,342	-1,513
2	1985	23,135	58,488	50,767	7,721	-15,414	-8,420	-10,705
3	1986	14,276	63,838	51,363	12,475	-1,801	- 728	-1,043
4	1987	52,095	65,193	51,358	13,835	-38,260	-11,415	-18,452
5	1988	0	81,041	62,328	18,713	18,713	4,125	7,520
6	1989	0	92,174	62,911	29,263	29,263	4,768	9,800
7	1990	0	100,466	63,341	37,125	37,125	4,470	10,360
8	1991	0	100,920	63,379	37,541	37,541	3,341	8,730
9	1992	0	101,380	63,416	37,964	37,964	2,497	7,357
10	1993	0	101,802	63,454	38,348	38,348	1,864	6,193
11	1994	0	102,260	63,491	38,769	38,769	1 392	5,217
12	1995	0	102,684	63,527	39,157	39,157	1,039	4,391
13	1996	0	103,137	63,566	39,571	39,571	776	3,698
14	1997	0	103,386	63,587	39,799	39 799	577	3,099
15	1998	0	103,386	63,587	39,799	39,799	426	2,583
16	1999	0	103,386	63,587	39,799	39,799	315	2,152
17	2000	0	103,386	63,587	39,799	39,799	233	1 793
18	2001	0	103,386	63,587	39,799	39,799	172	1,494
19	2002	0	103,386	63,587	39,799	39,799	127	1,245
20	2003	0	103,386	63,587	39,799	39,799	94	1,038
21	2004	0	103,386	63,587	39,799	39,799	69	865
22	2005	0	103,386	63,587	39,799	39,799	51	720
23	2006	0	103,386	63,587	39,799	39,799	37	600
Residual Value			14,950		14,950	14,950	14	225
Total		110,634	2,229,967	1,466,664	778,253	667,619	0	42 885

11-4 Sensitivity Analysis

Table 11-21 shows the result of the sensitivity analysis for fluctuations of the revenues, expenditures and construction costs.

Table 11-21 FRR by Sensitivity Analysis

Case	Project Cost	Revenue	Expenditure	FRR
1	±0%	±0%	±0%	35.31% (Case B)
2	±0%	-10%	±0%	19.48%
3	+10%	±0%	+10%	20.57%
4	+10%	-10%	+10%	11.04%

If there are no changes in the construction costs and expenditures, and the revenue decreases by 10%, or when there are no changes in the revenue, and the construction costs and expenditures increase by 10%, the FRR will become about 20%, indicating the feasibility of the Project. However, if the revenue decreases by 10% and the construction cost and expenditure increase by 10%, it will be difficult to execute the Project.