REPORT ON
PAN-PHILIPPINE HIGHWAY FERRY SERVICE PLAN
IN
THE REPUBLIC OF PHILIPPINES

May, 1976

JAPAN INTERNATIONAL COOPERATION AGENCY

REPORT ON
PAN-PHILIPPINE HIGHWAY FERRY SERVICE PLAN
IN
THE REPUBLIC OF PHILIPPINES

May, 1976

JAPAN INTERNATIONAL COOPERATION AGENCY

No. 14501
118
71
SD

Preface

In compliance with the request of the Government of the Republic of Philippines, the Government of Japan decided to make a feasibility study of the Pan-Philippine-Highway Ferry-Service Project as a part of Japan's overseas technical cooperation programmes, and this study was conducted by the Japan International Cooperation Agency (JICA).

JICA organized and dispatched a survey team consisting of Six (6) experts, headed by Mr. K. Fukagawa, Special Assistant, Administration Division, Ship Bureau, Ministry of Transport, to the Philippines from January 19th to February 17th 1976 to carry out the field survey for its technical and feasibility. The results of the survey has been carefully reviewed, and them complied into the report herewith.

It is my great pleasure if the report would make a contribution to the improvement of the maritime transport in the Philippines, and further if the friendly relations between our two countries which are happily existing so far would be promoted through technical cooperation.

On this occasion I wish to express my sincere gratitude to the authorities of the Government of the Republic of Philippines, and other authorities concerned, for the kind cooperation extended to the team.

May, 1976

Shinsaku Hogen
President
Japan International Cooperation Agency
Tokyo, Japan

INTRODUCTION

1) The Government of the Republic of Philippines decided to start regular car-ferry services at the San Bernardino straits between Sorsogon Province (south end of Luzon) and North Samar Province (Samer Island) and at the Surigao Straits between South Leyte and Surigao (Mindanao Island) as a part of the Pan-Philippine Highway Project. They requested the Government of Japan to make a feasibility study.

Accordingly, the Government of Japan dispatched a survey team for studying and evaluating the technical and economic feasibility of this project on the basis of the Philippine plan.

JICA dispatched a survey team consisting of 7 experts, headed by Mr. K. Nishimura, Head, Design Standard Division, Port and Harbour Research Institute, Ministry of Transport, to the Philippines from January 27th to February 19th, 1976 to carry out the field survey for its technical and economical feasibility.

The Mission conducted the ocular inspection on the following points based on the Pre-feasibility study submitted by the Government of the Republic of the Philippines to this Mission :

1. Traffic survey.
   Estimation of future traffic demand.
2. Preparation of preliminary design of ferry boats.
   a) Types of ferry boats.
   b) The equipment.
3. Studies of the ability of shipbuilding in the Philippines.
4. Preparation of preliminary design, construction cost and construction plan of port facilities (including the study of port location).
5. Preparation of operation plans.
6. Studies of management plans.
7. Studies of financing plans.
   a) Financing plans.
   b) Revenue-expenditure plan.
8. Economic evaluation.
   a) Estimation of benefits.
   b) Cost-benefit analysis.

c) Calculation of internal rate of return.

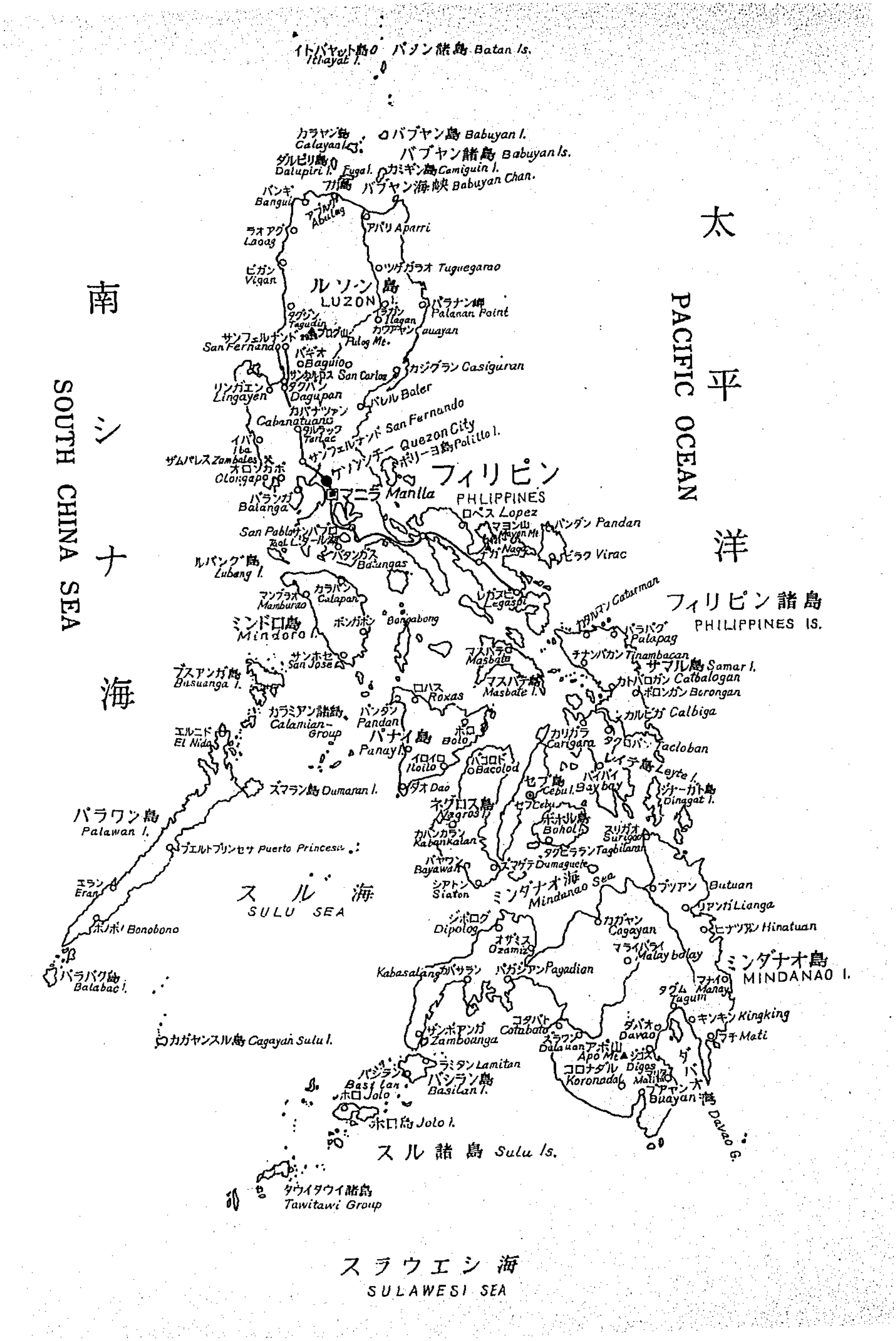
9. Construction schedule.

2) The survey team consisted of the following members.

Leader	Mr. Kazuo Nishimura (General & Port Engineering)	Head of Design Standard Division, Port and Harbour Research Institute, Ministry of Transport
Member	Mr. Yoshiro Iwai (Basic Planning)	Ship Bureau, Ministry of Transport
"	Mr. Takashi Okuyama (Ship Equipments)	Overseas Shipbuilding Cooperation Centre, The Shipbuilding Research Centre of Japan
"	Mr. Yasuharu Yabe (Port Planning)	Third District Port Construction Bureau, Ministry of Transport
"	Mr. Hirotoshi Niwa (Management)	Bureau of Shipping, Ministry of Transport
"	Mr. Yasuhiro Hisamatsu (Economic Study)	Passenger Boat Division, Maritime Credit Corporation
"	Mr. Tokukiyo Hirai (Coordination)	Social Development Cooperation Department, Japan International Cooperation Agency

3) Survey period

January 27 ~ February 25, 1976 30 days



イトバヤット島 Ithayat I.
バタン諸島 Batan Is.
カラヤン島 Calayan I.
バブヤン島 Babuyan I.
バブヤン諸島 Babuyan Is.
ダルピリ島 Dalupiri I.
フガ島 Fuga I.
カミギン島 Camiguin I.
バブヤン海峡 Babuyan Chan.
バンギ Bangui
アブルグ Abulog
アパリ Aparri
ラオアグ Laoag
ツゲガラオ Tuguegarao
ビガン Vigan
ルソン島 LUZON
パラナン岬 Palanan Point
タグジン Tagudin
イラガン Ilagan
カウアヤン Cauayan
サンフェルナンド San Fernando
プログ山 Pulog Mt.
バギオ Baguio
カシグラン Casiguran
サンカルロス San Carlos
リンガエン Lingayen
ダグパン Dagupan
バレル Baler
カバナツアン Cabanatuan
タルラック Tarlac
サンフェルナンド San Fernando
イバ Iba
ケソンシチー Quezon City
ポリーヨ島 Polillo I.
ザムバレス Zambales
オロンガポ Olongapo
マニラ Manila
フィリピン PHILIPPINES
バランガ Balanga
ロペス Lopez
パンダン Pandan
マヨン山 Mayon Mt.
サンパブロ San Pablo
ナガ Naga
ビラク Virac
ルバング島 Lubang I.
バタンガス Batangas
カラパン Calapan
マンブラオ Mamburao
レガスピ Legaspi
カタルマン Catarman
フィリピン諸島 PHILIPPINES IS.
ミンドロ島 Mindoro I.
ボンガボン Bongabong
パラパグ Palapag
マスバテ Masbate
チナンバカン Tinambacan
サンホセ San Jose
ブスアンガ島 Busuanga I.
マスバテ島 Masbate I.
サマル島 Samar I.
カトバロガン Catbalogan
ロハス Roxas
ボロンガン Borongan
カラミアン諸島 Calamian-Group
パンダン Pandan
カルビガ Calbiga
エルニド El Nido
パナイ島 Panay I.
カリガラ Carigara
タクロバン Tacloban
イロイロ Iloilo
バコロド Bacolod
レイテ島 Leyte I.
セブ島 Cebu I.
バイバイ Baybay
ズマラン島 Dumaran I.
ダオ Dao
ジナーガト島 Dinagat I.
ネグロス島 Negros I.
セブ Cebu
パラワン島 Palawan I.
ボホル島 Bohol I.
カバンカラン Kabankalan
スリガオ Surigao
タグビララン Tagbilaran
プエルトプリンセサ Puerto Princesa
バヤワン Bayawan
ズマゲテ Dumaguete
エラン Eran
スル海 SULU SEA
シアトン Siaton
ミンダナオ海 Mindanao Sea
ブツアン Butuan
リアンガ Lianga
ボノボ Bonobono
ジポログ Dipolog
カガヤン Cagayan
ヒナツアン Hinatuan
オザミス Ozamiz
マライバライ Malaybalay
ミンダナオ島 MINDANAO I.
バラバク島 Balabac I.
カバサラン Kabasalan
パガジアン Pagadian
マナイ Manay
タグム Tagum
キンキン Kingking
ザンボアンガ Zamboanga
コタバト Cotabato
ダバオ Davao
マチ Mati
カガヤンスル島 Cagayan Sulu I.
ダルアン Dulauan
アポ山 Apo Mt.
ジゴス Digos
ラミタン Lamitan
バシラン Basilan
バシラン島 Basilan I.
コロナダル Koronadal
ダバオ湾 Davao G.
ホロ Jolo
ブアヤン Buayan
ホロ島 Jolo I.
スル諸島 Sulu Is.
タウイタウイ諸島 Tawitawi Group
南シナ海 SOUTH CHINA SEA
太平洋 PACIFIC OCEAN
スラウエシ海 SULAWESI SEA

CONTENTS

Chapter 1. Summary and Recommendation

1 - 1. Estimate of Traffic Demand

The future traffic demand at the San Bernardino Straits and Surigao Straits is estimated to be as given below.

1) San Bernardino Straits Crossing (weekly two-way traffic volume)

Year	Number of passengers	Cargo in tons	Number of passenger cars	Number of trucks
1974	1, 900	30	30	9
1980	3, 800	293	90	70
1985	6, 900	330	260	80
1990	12, 400	390	760	100
1995	22, 300	484	2, 200	120

2) Surigao Straits Crossing

Year	Number of passengers	Cargo in tons	Number of passenger cars	Number of trucks
1974	1, 100	190	20	50
1980	2, 200	330	50	80
1985	4, 000	530	150	130
1990	7, 200	860	440	210
1995	12, 900	1, 380	1, 280	340

1 - 2. Preliminary Design of Car Ferry

1) Determination of Car Ferry's Capacity

The capacity of a ferry was decided on the basis of the estimated traffic demand in 1985 under the condition of 70% utilization of actual ferry capacity.

2) Study of Two Types

A 59 m type (a round trip) and a 50 m type (two round trips) were studied. The latter has half the transportation capacity of the former.

	59 m type	50 m type
Length overall	about 65. 50 m	about 56. 00 m
Length design waterline	61. 60	52. 70
Length between PP	59. 00	50. 00
Breadth (molded)	12. 50	11. 50

Depth (molded)	4.60	4.00
Draft (full load)	about 3.25	about 2.70
Displacement (full load)	about 1,350	about 930
Gross Tonnage	about 1,000	about 500
Main Engine (max BHP 2 shafts)	3,200 PS	2,400 PS
Sailing Speed	14.5 Knots	13 Knots
Accommodation		
Complement	22 P	18 P
Passenger	400 P	200 P
Car Capacity (converted into equivalent of 8 ton truck)	14 units	8 units

	59 m type	50 m type
Ship Class	NK(NS* MNS*)	NK(NS* MNS*)
Total Ship Price	1,200,000,000 yen	960,000,000 yen
	4,000,000 dollars	3,200,000 dollars

The survey team recommends the 59 m type in consideration of weather conditions, operational reasons and high economic efficiency.

3) Building of the Car Ferry

Various difficulties are expected to arise if boats are built in the Republic of the Philippines due to some delicate structural characteristics of car ferries. Therefore, it is the best to build them abroard.

To build car ferries in the Philippines, an extensive range of techniques must be introduced from foreign countries because of the lack of experience in this field. It has not been possible to estimate building cost and term in this project because of the excessive uncertainly connected with the scope and extent of technological introduction. If car ferries are to be built in the Philippines, it is necessary to conduct the survey on this subject.

1 - 3. Selection and Design of Terminals

1) Selection of Terminal Site

As for the San Bernardino Straits, Matnog and San Isidro are the best. Padang Point, which was proposed by the Philippines, is not appropriate because of poor weather conditions, and possible damages by typhoons. Additionally, the slope of sea bottom is steep (about 1/6), and a structure must be constructed at large depth (-10 m ~ 20 m), which will require tremendous construction cost. For these reasons, Padang Point is not suitable for a terminal.

As for the Surigao Straits, the survey team agrees that Liloan and Lepata

West are the best, as proposed by the Philippines.

2) Arrangement of Facilities

The following facilities will be required from the initial stage.

Wharf, terminal building, parking area, water supplying facilities for ferry boats, access road, and revetment (breakwater).

3) Approximate Construction Cost

(unit : 1, 000 Pesos)

Matnog	12, 750	
San Isidro	8, 130	
Liloan	8, 720	
Lepata West	14, 100	
Total	43, 700	$5, 900
Padang Point	55, 080	

The required Foreign currency (for purchasing steel sheet piles and steel pipes, as well as designing, execution and management) is 4, 343, 000 pesos for the 59 m type and 3, 198, 000 pesos for the 50 m type.

1 - 4. Operation Plan

1) Travel Time (59 m type, one-way, sailing speed of 14. 5 knots, passenger boarding and unboarding time included)

San Bernardino Straits	3 hours
Surigao Straits	4 hours

2) Number of Daily Trips

One round trip per day will be sufficient until 1980. Two round trips per day will be required at the both straits to meet the estimated demand in 1985. Therefore, one ferry boat for each service route will be sufficient.

3) Employees

Eight officers and twelve crewmen (20 men in total) will be enough for each ship. Additionally, some standby crew (about 20 % of regular crew) will be necessary.

As to land-based employees, one of the terminals of each route should be selected as the main base. A purser, a port captain and an operation manager are to be stationed at each main base. Purser Department and Operation Department of each port are to be organized under them. Eight employees will be sufficient at each main base.

4) Management of operation

Establishment of safe and secure transportation system

5) Training and Advisor Team

Crew and land-based employees must receive practical training on board and on land.

1 - 5. Required Expenses (Prices as in January, 1976)

1) Sum Total

		59 m type
Construction cost (if built in Japan)	US$	8, 000, 000
Shipowner's supervision		200, 000
Expense for bringing ferries to RP		47, 000
Terminal construction cost		5, 950, 000
Total		14, 197, 000

2) Required Foreign Currency

Construction cost	US$	8, 000, 000
Shipowner's supervision		200, 000
Expense for bringing ferries to RP		47, 000
Terminal construction cost		600, 000
Total		8, 847, 000

1 - 6. Economic Evaluation

In order to make an economic evaluation of car ferry introduction, a cost-benefit analysis was made from the viewpoint of national economy of the Philippines. We obtained the internal rate of return by discounting the costs and benefits of the present project by various discount rates. The following results were obtained.

San Bernardino Straits

One	59 m type ferry	10%
Two	50 m type ferries	5%

Surigao Strait

One	59 m type ferry	9%
One	50 m type ferry	5%

Consequently, this project will be feasible from the view point of national economy, if one 59 m type ferry is adopted for each route.

Chapter 2. Estimate of Future Traffic Demand

2 - 1. Estimating Method

In order to determine the best scale for roll-on and roll-off car ferries and terminals, the future traffic demand for crossing the San Bernardino and Surigao Straits is estimated here.

The following items were taken into consideration for the estimate.

a) The traffic volume of passenger cars and trucks is determined on the basis of the estimated traffic volume of passengers and cargo.

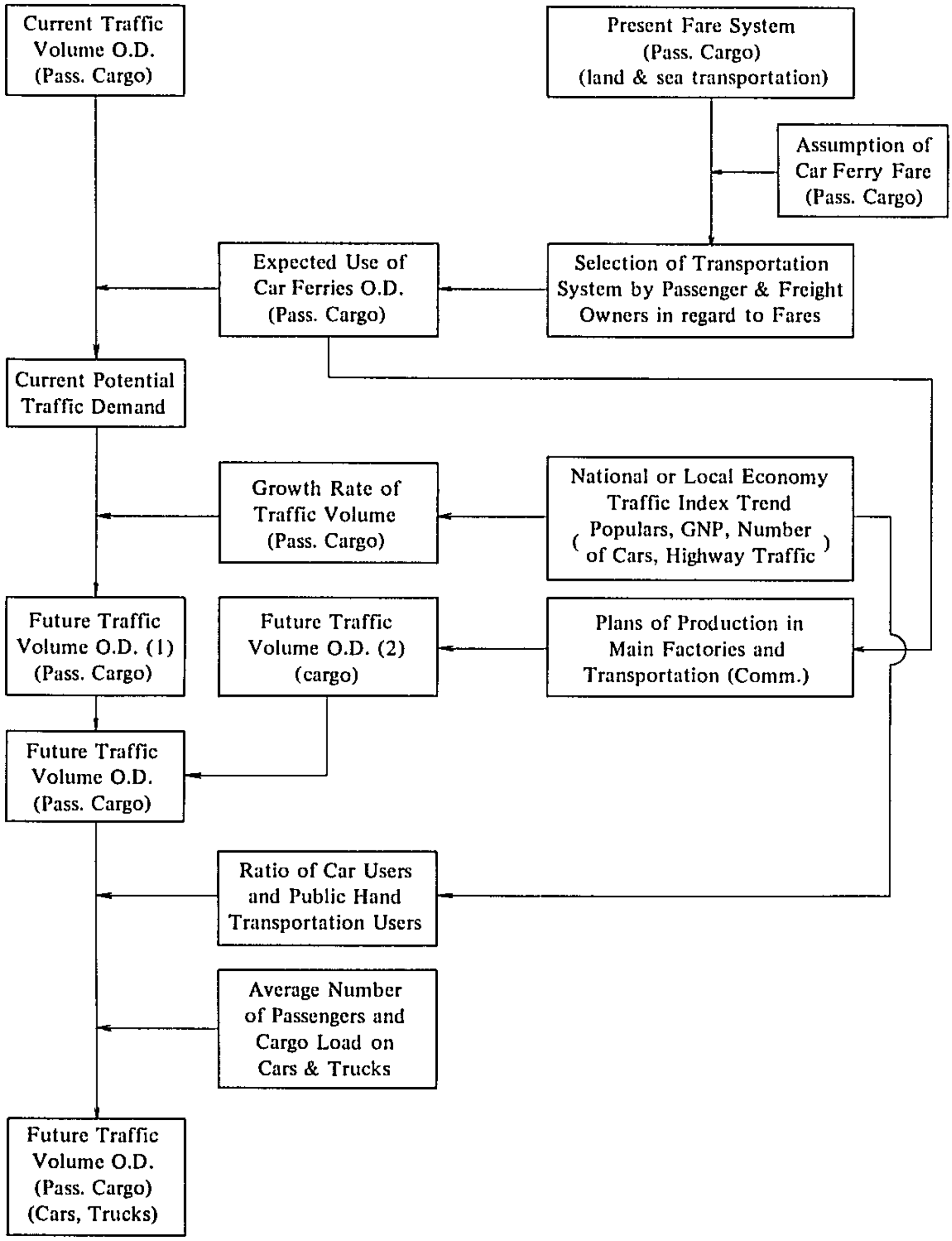
b) Passengers and cargo shippers are assumed to select car ferries among various means of transportation by comparing transportation fares.

c) Modestly estimated traffic volumes are used to avoid excessive investment.

d) The unit of metric tons is to be used for cargo traffic volume.

Fig. 2-1 shows the flow chart for estimating future traffic demand under the above assumptions.

Fig. 2-1. Flow Chart for Estimating Future Traffic Demand



2 - 2. Result of Estimate

2 - 2 - 1. Feasibility of Utilizing Car Ferry Services

Assuming that passengers and shippers select means of transportation by comparing fares, we compared the combined transportation using both car ferry and Pan-Philippine Highway with the conventional marine route. The result of this study revealed that car ferry services of both the San Bernardino Straits and Surigao Strait will be used by almost all passengers and shippers of cargo origined from and destined to the two provinces facing the straits (Sorsogon and Northern Sawar for the San Bernardino Straits, and Southern Leyte and Surigao del Norte for the Surigao Straits).

The following factors were considered in comparing fares :

a) Passengers

Ferry-highway combined transportation

* Land-transportation fare from origin to terminal.
* Car ferry fare
* Land-transportation fare from terminal to destination

Conventional marine transportation

* Land-transportation fare from origin to nearest port
* Marine transportation fare
* Land-transportation fare from nearest port to destination

b) Cargo

Ferry-highway combined transportation

* Land-transportation fare from origin to terminal
* Car ferry fare
* Land-transportation fare from terminal to destination

Conventional marine transportation

* Land-transportation fare from origin to nearest port
* Cargo handling and storage charges at a departing port
* Marine transportation fare
* Cargo handling and storage charges at an arriving port
* Land-transportation fare from nearest port to destination

The following figures were used for these fares and expenses.

(1)	Land-transportation fare	(Passenger)	0. 04 p/person· km	
		(Cargo)	0. 30 p/ton· km	Based on the materials of Bureau of Transportation

(2) Marine transportation far	(Passenger)	0. 10 p/person· km	
	(Cargo)	0. 06 p/ton·km	Same as above
(3) Cargo-handling and storage charges at port		42. 50 p/ton	Based on hearing from cargo-handling companies and materials of Bureau of Customs
(4) Car ferry fare	(Passenger)	8~10 p/person	
	(Cargo)	6. 3~8. 8 p/ton	Based on UNESCAP report and hearing

2 - 2 - 2. Current Traffic Volume

Based on the findings of the Department of Public Highway's origin-destination survey conducted in September 1974 at both straits, as well as the feasibility study of car ferry utilization by passengers and cargo, we estimated the traffic volume of ferry service users, on the assumption that it had been started in September 1974.

a) San Bernardino Straits

Passengers	about 1, 900 persons
Cargo	about 34 tons

b) Surigao Straits

Passengers	about 1, 100 persons
Cargo	about 186 tons

(Note : Weekly round-trip traffic volume)

2 - 2 - 3. Future Traffic

We assumed that the traffic volume of passengers and cargo grows annually at the rate of 12. 5% and 10. 0%, respectively on the basis of the estimated current traffic volume, the trend of population, GNP, and car and truck holdings in the Philippines as well as the trend of land transportation (passengers and cargo) in Sorsogon and Surigao del Norte.

According to a copra processing factory in Legaspi, 1, 000 tons of copra will be transported from the northern part of Samar (or 230 tons per week). This must be added to the estimate after 1980. Table 2-2 shows the future traffic volume estimated with these considerations and the current traffic volume.

Table 2-2. Future Traffic Volume

San Bernardino Straits Crossing				
Year	Number of passengers	Cargo in tons	Number of passenger cars	Number of trucks
1974	1, 900	30	30	9
1980	3, 800	293	90	70
1985	6, 900	330	260	80
1990	12, 400	390	760	100
1995	22, 300	484	2, 200	120

Note : Weekly round trip traffic volume

Surigao Straits Crossing

Weekly traffic in both ways

Year	Number of passengers	Cargo in tons	Number of passenger cars	Number of trucks
1974	1, 100	190	20	50
1980	2, 200	330	50	80
1985	4, 000	530	150	130
1990	7, 200	860	440	210
1995	12, 900	1, 380	1, 280	340

Note : Weekly round trip traffic volume

Chapter 3. Preliminary Design of Car Ferry

3 - 1. Determination of Capacity

3 - 1 - 1. Year for Plan

The expected traffic volume in 1985 was used as the basis for determining transportation capacity. If capacity is determined to meet the demand in the first year of services, the occupation efficiency will be high during the initial years. However, it will not be enough to meet growing demand in the future, though a car ferry has about twenty durable years. In such a case, a new ferry must be built. If traffic demand in remote future is used, the occupation efficiency will be low during early years and error in the estimate will be large. Therefore, the demand in 1985 was used as the basis for this study.

3 - 1 - 2. Utilization Rate

The lower a ship's occupation rate is, the more flexibly it can meet changing demand. However, this is not desirable for a shipowner's economy. The higher a ship's occupation rate is , the better for its owner's economy. However, some passengers and cargo may be left out of services. Considering the above, 70% was taken as utilization rate.

3 - 1 - 3. Type of Ship

New ships of the same size are to be used for both the San Bernardino Straits and the Surigao Straits. They are capable of carrying 400 passengers and 14 trucks. (This ship type is called as 59 m type, hereafter) They are to make one round trip during the initial years and two round trips after 1985. It is possible to employ a ship with a half the capacity of the 59 m type (to be called as 50 m type hereafter) and make two round trips from the beginning. This method is convenient for passengers since it reduces their waiting time. However, the cost of a ship cannot be cut down sharply by reducing size. Since the sailing time for two round trips exceeds normal working hours, two groups of crew must be employed. This will require additional fund for lodging facilities etc. Since ships' durable years are reduced, new ships must be built by 1990. For these reasons, this method cannot be recommended.

The following tables show the daily traffic volume and the required transportation capacity obtained on the basis of the estimated future traffic volume.

1) San Bernardino Straits

Year	Daily traffic volume		Required transportation capacity		Number of round trip
	Number of passengers	Number of vehicles	Number of passengers	Number of vehicles	
1978	431	7	310	5	1
1980	545	17	390	13	1
1985	982	31	710	23	2
1990	1, 768	69	1, 270	50	4

Note : (1) Round trip traffic volume

(2) Required transportation capacity required

$$= \frac{\text{Daily round trip traffic volume}}{2} \times 0.7$$

2) Surigao Straits

Year	Daily traffic		Required transportation capacity		Number of round trip
	Number of passengers	Number of vehicles	Number of passengers	Number of vehicles	
1978	249	13	180	10	1
1980	316	16	230	12	1
1985	569	30	410	22	2
1990	1, 025	62	740	45	4

In principle, it is desirable to choose such a ship type that may meet the demand of a route. Since no large difference exists between the demands for the two routes, it is preferable to employ ships of the same design from the view point of parts control and maintenance.

It is possible to employ used vessels. Used ships will be less expensive, even if remodelled. However, it is doubtful whether ships suitable for the routes should be available in the market. Additionally, the agents concerned will not feel the satisfaction of "putting new vessels into service."

3 - 2. Two Types of Ferry Boat

3 - 2 - 1.

1) 59 m type

This ferry boat has the Lpp of 59 meters and can transport 14 trucks and

400 passengers. This type was studied in details as a ship for car ferry service at the two straits.

2) 50 m type

This ferry boat has the Lpp of 50 meters and can transport 8 trucks and 200 passengers. This type was studied in details a ship for car ferry service at the two straits.

The principal dimensions of this type are almost identical with those proposed by the Philippine Government.

3 - 2 - 2. Principal Dimensions of Proposed Roll-On-Off Car Ferry Boat

- 59 m type -

Length overall	about 65. 50 m
Length design waterline	61. 60 m
Length between perpendiculars	59. 00 m
Breadth (molded)	12. 50 m
Depth (molded)	4. 60 m
Draught (full load)	about 3. 35 m
Displacement (full load)	about 1, 350 tons
Gross tonnage	about 1, 000 tons
Main engine (max. BHP 2 shafts)	3, 200 PS
Sailing speed	14. 5 knots
Accommodation	
Complement	22 persons
Passenger	400 persons
Car capacity (converted into equivalent of 8 ton trucks)	14 units
Ship's class	NK (NS*. MNS*)

3 - 2 - 3. Estimated Price of a 59 m Type Car Ferry (Delivery at the end of 1977)

Hull materials	$400, 000
Fittings materials	$710, 000
Machineries	$483, 500
Main engines	$400, 000
Electric equipments	$193, 500
Labor cost	$866, 500
Direct expense	$450, 000
Administrative expense	$350, 000
Total prime cost	$3, 853, 500
Margin 3. 8%	$146, 500
Total price of a ship	$4, 000, 000

3 - 2 - 4. Principal Dimensions of Proposed Roll-On-Off Car Ferry

- 50 m type -

Length overall		56. 00 m
Length design waterline		52. 70
Length between perpendiculars		50. 00
Breadth (molded)		11. 50
Depth (molded)		4. 00
Draught (full load)	about	2. 70
Displacement (full load)	about	930 tons
Gross tonnage	about	500 tons
Main engine (max. BHP 2 shafts)		2, 400 PS
Sailing speed		13. 0 knots
Accommodation		
Complement		18 persons
Passenger		200 persons
Car capacity (converted into equivalent of 8 ton trucks)		8 units
Ship's class		NK (NS*, MNS*)

Estimated Price of a 50 m Type Car Ferry
(Delivery at the end of 1977)

Hull materials	$320, 000
Fitting materials	$567, 000
Machineries	$386, 500
Main engines	$300, 000
Electric equipments	$170, 000
Labor cost	$693, 500
Direct expense	$360, 000
Administrative expense	$280, 000
Total prime cost	$3, 077, 000
Margin 4%	$123, 000
Total price of a ship	$3, 200, 000

These dimensions were obtained as a result of seeking for sufficient loading capacity for the estimated traffic demand, seaworthiness, stability, payability for operations and building cost.

A 50 m type ferry boat is not suitable for safe ferry services throughout a year under the oceanographic and meteorological conditions at the both straits. The survey team recommends the 59 m type as the minimum-sized ship for offering car ferry services at the two straits.

3 - 3. Principles of Car Ferry Designing

3 - 3 - 1. General

Compared with a general merchant ship, a roll-on-off-type car ferry requires more careful and extensive considerations as well as techniques not only at the stage of construction but also at the stage of basic designing. A car ferry is like an aircraft carrier in that it must meet a variety of requirements in both its structure and fittings. In another respect, a car ferry offers chances to adopt various ideas of designers. Each car ferry can be unique. It can be a work of art at sea and resembles various buildings on land in this respect.

Characteristics of Car Ferry

The requirements and characteristics of a car ferry are listed below.

USERS' NEEDS

* Safeness
* Cheaper fare
* No damage on cars and cargo
* Quick, safe and easy boarding and unboarding
* High speed
* Enjoyable facilities
* Less rolling & pitching
* Less noise & vibration
* Good appearance
* Better payability
* Less trouble
* Easier maintenance
* Fewer crew
* Easy berthing
* Easy lashing

SURROUNDING CONDITIONS

* Strong winds and waves in open seas
* Large influence by current
* Many confined narrow channels in routes
* Adaptability to land facilities
* Change in pier height due to tidal level changes
* Large variety of passengers aboard
* Gasoline loaded
* Dangerous articles loaded
* Center of cargo gravity positioned high
* Danger of overturning of trucks due to inclination
* Exhaust gas generated
* Large wind resistance area
* Shallow draft
* Passenger rooms positioned high

PERFORMANCES REQUIRED

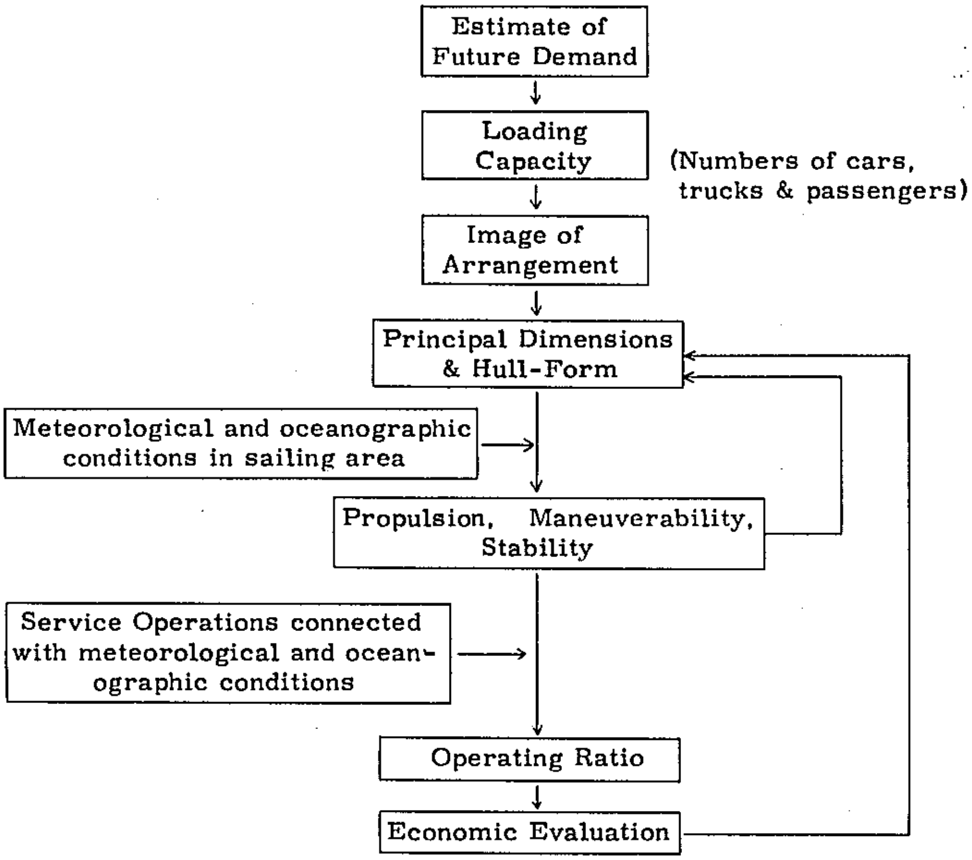
* Safety similar to passenger ships
* Maneuverability similar to tugs
* Punctuality similar to JNR
* Comfort similar to hotels
* Cargo handling capability similar to Ro/Ro boats
* Reliability similar to aircraft

CHARACTERISTICS

* 2 divisions floodable
* Stability equal to greater coasting vessels
* Stability when damaged
* Fire retarding structure
* Fire fighting and detection apparatus
* Escaping devices
* Life-saving equipment
* Unobstructed view angle
* Ventilation
* High HP & high speed
* 2 shafts, CPP
* Anti-rolling devices
* Nonskid fittings
* Lashing devices
* Type of ship with good performances in high sea
* Less L/B, larger B/d
* Bow height
* Narrow engine casing
* Emergency power source
* Explosion proof devices
* Side thruster
* Bow visor
* Stern ramp door
* Void space under deck

3 - 3 - 2. Flow Chart for Designing Car Ferry System

A flow chart for designing a car ferry with such a large variety of elements is illustrated below.



3 - 4. Major Factors of Car Ferry Design

Basically, a ship is designed by following the flow chart. The loading capacity of general cargo ships is expressed by dead weight (DW) and that of passenger ships by gross tonnage (GT). Their principal dimensions are decided by their requirements. In the case of car ferries, however, DW and GT are not the basis, but the result of designing. Generally, the loading capacity a car ferry is determined on the basis of the numbers of cars and trucks, their dimensions and weight, and the number of passengers in each class etc. Cars and trucks vary in kinds, makers, models, and therefore, in dimensions and weight. In deciding dimensions of a car ferry, the numbers of vehicles is generally converted into the number of trucks, because the transportation of trucks is the most payable business. Normally, and 8 ton truck (2. 5 m wide and 8. 5 m long) is used as a standard for designing. This method was applied to this ferry boat. Two cars can be converted to equivalent of one truck.

It is absolutely essential for a ferry boat to leave sufficient spaces among vehicles because a contact between vehicles can cause various dangers and other accidents. It is desired to leave at least 0.4 m space between two vehicles (the fore-and-aft direction) and a 1 m wide transverse passage amidship, and 0.6 m space between two rows of vehicles. Since no inter-vehicle spacing is considered in the Philippine plan, it might not be possible to load all the vehicles planned.

Some unique considerations must be made in designing a car ferry. They include service routes, piers, prevention of vehicles from turnover during an adverse weather, fire prevention measures, adjustment of rolling-on-off angles and inboard work, in addition to sea worthiness, safety, and economical efficiency, which are considered for general cargo ships. Accordingly, the principal particulars of a ferry boat are not plotted on a continuous curve like general ships. The design points of a car ferry change in steps according loading capacity, namely, the number of vehicles and rows. The optimum ship for each set of conditions is one point on one step. Then information on meteorological and oceanographic conditions of a service area is fed to various design points on the stepped line, and propulsion, maneuverability and stability as output are checked. By means of this so-called "feed-back cycle", the optimum principal dimensions and hull form which ensure maximum safety and satisfy a shipowner's needs are determined.

The survey team determined the proposed car ferry dimensions by this method. The proposed car ferry design was prepared by making the following considerations related to structure and fittings.

1) Principal Dimensions

a) Length

The most ideal length was obtained as a result of careful studies on the following conditions.

The length of a car ferry must be adequate for offering effective and safe ferry services under the weather and complicated oceanographic conditions at the both straits and for allowing enough sailing speed to give adequate sea margin and schedule margin. The length of a car ferry must be adequate for economical arrangement of vehicles and within the allowable range of L/B, L/D and L/F (F : Freeboard) which are required for ensuring stability and structural strength. Building cost and operation cost must also be considered in length study.

b) Breadth B (max)

It was assumed that the vehicle deck should carry trucks in three rows, leaving 0.6 m among them. A 1.3 m wide space for engine casing was added on each side. As a result, the team arrived at the breadth of 12.5 m. The watertight engine casings, extending for the entire broadsides, will give additional buoyancy and stability.

c) Draft (d)

The team arrived at d = 3.35 m by considering the following conditions.

* Securing the displacement required.
* Keeping B/d within the range required by stability.
* Obtaining a sufficient freeboard in regard to subdivision flooding calculation.

d) Depth (D)

The depth (D) was selected by adding the draft (d) to the freeboard obtained by flooding calculation and by considering the space to accommodate the main engines under the vehicle deck. This is unique to a car ferry. The result was D = 4.6 m.

2) Speed and Main Engine Output

Considering possible speed-down due to strong tidal current and rough sea at the both straits, the sailing speed of 14.5 knots was adopted to keep the time for one round trip within eight hours at the Surigao Straits, which is longer in distance. Each car ferry should be equipped with two 1,600 PS (3,200 PS in total) engines with twin screws to permit 85% MCR (Max. Contineous Rating) at the full load draft and 14.5 knots at 15% sea margin.

3) Structure

a) Partition Under Bulkhead Deck

Since the ferry boats run at the straits with busy traffics of vessels, there exists a higher probability of collision, compared with general cargo ships. The bulkhead arrangement was determined by allowing two floodable subdivisions at the bow and stern and another floodable subdivision and by confirming the safety over the entire subdivision length. Each car ferry is to be equipped not only with necessary tanks, but also with a bow thruster room at the bow and water ballast tanks for vehicles' rolling-on-off afore, amidship and abaft to allow trim, heel and draft adjustments. Furthermore, an anti-rolling tank is to be installed at the front part of the engine room.

b) The vehicle deck should be strong enough to withstand the weight of vehicles. Wave shocks against a ferry boat are likely to be great because of her flared bow (for loading load vehicles) as well as her high speed. Therefore, the bow stiffening construction must be designed carefully.

4) Hull Fittings

a) Vehicle Loading Equipments

Both the bow and the stern are to have an opening. The bow is to have a lifting type bow-visor and a ramp way with flaps, while the stern is to have a ramp door with flaps. They are to be large to enough to adjust height difference between the deck and a pier, which is attributable to by tide and loading conditions, and to enable a ferry boat to berth directly. This adjustment should be made together with the sheer at the bow and the stern and water ballast tanks.

b) Vehicle Binding Devices

It is necessary to bind cars, trucks and trailers securely lest to prevent skidding and turnover. They are bound usually by driving wooden wedges in front of and behind vehicles' wheels and by binding eyes, rings and clover-leaf-plates fixed on the deck with the rings on vehicles by means of a device having a rachet-type small wire-drum. The wire cable for this device is 14 mm in diameter for trucks and 8 mm for cars. The strengths of the above items are designed under the following conditions :

Rolling angle of hull	25 deg.
Rolling period of hull	Period of the ship
Pitching angle of hull	5 deg.
Pitching period of hull	5 sec.

The strength of binding metals is determined by calculating the horizontal and vertical forces acting on a vehicle and obtaining the turnover moment.

However, some of the vehicles in the Philippines are not equipped with chassis rings for binding. Under the meteorological and oceanographic conditions at these straits, it is required to take another measure to prevent vehicles' turnover. For example, vehicles may be fixed securely with vinyl ropes fixed to the ceiling, walls and pillars. The vehicle deck should be skid-proofed by using synthetic rubber composition.

c) Ventilation

The gas concentration in each subdivision should be kept uniform by discharging exhaust gas mechanically (10 times per hour) and by eliminating short-circuit formation between downward openings and uptake openings.

The engine room should be ventilated by mechanical air suction. It should be ventilated frequently enough to keep higher pressure than the vehicle loading space and to supply sufficient fresh air since high horsepower engines are installed in the small engine room.

Enclosed living quarters and passenger rooms shall be air-conditioned.

Attention should be paid to the places. The air suction ports of the engine room and the air-conditioning ports and suction ports of the living quarter and passenger rooms, and the exhaust ports of the vehicle deck should be arranged carefully to prevent each other.

d) Fire Proof

Non-combustible insulated materials should be used for the bulkheads, ceilings and floors facing the engine room, galley and the vehicle space, thus enabling passengers to escape safely during a fire and retarding fire spreading. Non-combustible or flame-retarding materials generating less smoke and poisonous gas should be used for the interior work, curtains, furniture etc. in the living quarters and passenger rooms.

e) Fire Extinguishing Equipments

Sprinkler system, capable of sprinkling water at the rate of at least 5 liters/min per 1 square meter floor of the vehicle deck, is to be installed. Water pressure should high enough for the simultaneous operation of the sprinkler heads of the adjacent two sprinkling units. They can be started remotely by switching the control valves at the wheelhouse, together with a fire alarm system.

Fixed fire extinguishing appliances of carbon dioxide gas shall be installed in the engine room. And fire hydrants and hoses must be arranged to permit water spraying from two angles at any spot.

f) Life-saving Equipments

Two lifeboats with motor and liferafts shall be equipped. Their total capacity exceeds 115% of the maximum persons aboard. Each ferry should be equipped with as many life jackets (including those for children) as the maximum persons aboard.

g) Escape Installations

One shooter for boarding liferafts and one rope ladder are provided on each side. More than two escape openings shall be provided in the engine room and the other service area under the vehicle deck. Heat-proofed and enclosed passage together with a steel ladder shall lead dinectly to the vehicle deck. All the doors leading to the vehicle deck shall be of self-closing type.

h) Maneuverability

Considering the need for steering in narrow and confined ports sailing across the both straits where 4 to 8 knot tidal current exists, twin-screw, CPP, and twin rudder type shall be employed. The bow is equipped with a bow thruster having 3 ton thrust to obtain a bow turning force capable of withstanding the wind pressure of 10 m/sec.

5) Engines and Electric Fittings

a) Main Engines

Normally, a car ferry has a larger Froude number and a finer hull form than a general cargo ship. It requires a high powered main engine in spite of relatively small breadth and depth.

The height of the vehicle deck should be as low as possible in order to lower the center of gravity for obtaining larger stability. This restricts the height of the engine room. If excessive height is required for disassembling an engine, a disassembling hatch must be installed on the vehicle deck. This will be disadvantageous for cost and maintenance.

The sum of engine length and reduction gear length is in inverse proportion to disassembling height. The lower the disassembling height is, the longer it becomes because a larger number of cylinders are used. Since the length of an engine room is determined by making flood calculation, the length of a main engine should be studied carefully at the stage of its selection.

Considering all these points, each car ferry shall be powered by two diesel engines of 4-cycle, single acting trunk piston type, medium speed with reduction gears, and twin screws.

b) Shaft and Propellers

There are two shaft systems for a car ferry — CPP and FPP. A selection should be made from the viewpoint of economical efficiency, safety and actual service route conditions. The two systems have been employed for ferry boats, but the CPP is more widely used for medium - and large-sized ferries. In some cases, the FPP system is adopted because of lower building cost and fuel cost at a service line where a draft remains almost unchanged and oceanographic conditions remain relatively unchanged in both ways. But the safety and maneuverability are important factors in the case of ferry boats.

In many cases, a ferry boat is required to make a crush astern or a similar action to prevent collision with fishing boats, fishing nets and other small crafts. The CPP can make a stop at a shorter distance or ward off a collision more easily than the FPP.

The CPP has another merit. It allows optimum balance between the main engine speed and torque in spite of changes in draft, resistance by pollution and load by oceanographic conditions.

Since a car ferry has a large wind resistance area and is powered by big engines, it is relatively hard to sail at a slow speed, for instance, for berthing at a port or for maneuvering through a narrow and confined water channel.

The CPP, however, does not require to start and stop the engine for delicate steering.

In the case of a twin-screw ship, the inter-propeller distance must be large to give sufficient tip clearance for eliminating propeller-caused hull vibrations. The outboard propeller shafts tend to be longer because of her fine hull form. Therefore, attention should be paid to the problems connected with shaft fabrication and increase in resistance by shaft attachements.

c) Generator

The capacity of a generator is determined by the main engines and auxiliary machines. This vessel shall be equipped with two sets of generators having the same capacity. Only one generator is to be used during normal navigation and both of them are to be operated simultaneously when large-load auxiliaries, e. g. a bow thruster, are used.

d) Auxiliaries

The engine room of a car ferry is usually enclosed and it is almost impossible to make an opening. Therefore, the capacity and wind pressure of the ventilators for the engine room should be large enough. To maintain high engine performances, duct arrangement must be determined carefully so as to supply fresh air to a supercharger of the main engine especially if a high supercharger, which is sensitive to air supply temperature and pressure, is used.

An enclosed room must be ventilated sufficiently from the best position to keep room temperature uniform and to maintain the performances of the generators and other machineries.

e) Engine Control

The main engines are usually controlled at the bridge by controlling the propellers. The control room is to be equipped with engine, propeller and clutch controllers.

The main engine is to be equipped with an automatic stop device to avoid decrease in oil pressures, increase in water temperatures and an excessive speed.

Instruments and monitoring devices required for the operations of major auxiliaries are also installed at the control room. They decrease the burden of crew in charge of watching multiple engines. The auxiliaries are controlled in groups. They can be operated either locally or remotely at the engine control room.

f) Electric Equipments

Two sets of generators of AC 445 V, 3ϕ, and 60 Hz will be provided. They will be equipped with an automatic synchronous starter, an automatic load distributor and an automatic starter.

Storage batteries having sufficient capacity of floating charge type shall be provided as emergency power source. A switchboard capable of feeding 445 V and 115 V shall be installed at the control room.

Lighting installations on the vehicle deck should be of anti-explosion type. A dual power feeding system is necessary for engine room and passages for the passenger rooms to prevent black out.

g) Miscellaneous Equipments

Two funnels shall be installed on the both sides to discharge exhaust gas. They facilitate the arrangement of exhaust pipes, gratings and ventilating trunks.

The engine room should be designed carefully by considering the relative positions of main engine opening devices, ventilating trunks, ladders etc.

6) Instruments

a) Inboard Communication and Alarm System

Smooth inboard communication and alarm system shall be secured by installing a fire alarm system, general alarm, inboard telephones and 50 W public addressors.

b) Illumination and Navigation Lights

Navigation lights, Morse lamps, 2 KW search lights, projectors, lights for lifeboat launching etc., shall be provided.

c) Navigation Instruments

The ferry boats to sail through the straits characterized by complex topographical and oceanographic conditions shall be equipped with the following instruments :

i) One set of Marine Radar with 40 mile, 10 KW, 10 inch, and PPI solid state high performance.
ii) Navigational Echo Sounder
iii) Electro Magnetic Log
iv) Aerovane
v) Automatic Direction Finder

d) Radio

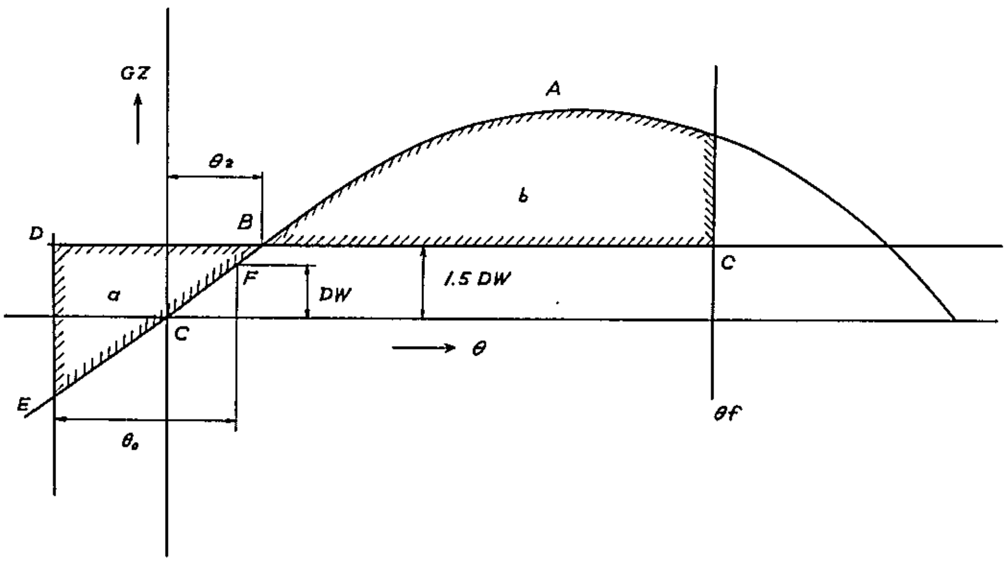
One set of 10 W SSB radio telephone and 25 W VHF/FM radio telephone shall be provided, but land-based communication facilities for both straits must be established.

3 - 5. Types of Ferry in Relation to Meteorological and Oceanographic Conditions

As shown in the flow-chart of 3 - 3 - 2, meteorological and oceanographic conditions are among the restrictives factors for ferry type determination. The stability of the two types was studied in relation to these conditions. Compared with a general cargo ship, a car ferry has a wider breadth and a shallower draft because she is required to carry fully loaded trucks, and her center of gravity is higher because of her loaded weight must be above the waterline. These factors increase rolling angles and transverse list by winds, and decrease stability. This results in less comfort for passengers, vehicle damages and turnover accidents.

In Japan, general cargo ships are categorized into three ranks - limited coasting, coasting and greater coasting service area, which are used to evaluate the stability. It is a common practice that the stability is decided based on a service area, one rank ahead of an actual service area, because the stability is of paramount importance for ferry boats.

Statical Stability Curve



where DW : Inclining moment lever by steady wind in the service area.

1. 5 W : Inclining moment lever by gust DW x 1. 5

θ_0 : Maximum synchronized rolling angle at encountering waves corresponding to steady wind at rolling period Ts.

θ_f : Angle of initial sea water invasion due to list.

θ_2 : List angle by wind at 1.5 DW.

Area BDE (a) Lost stability of ship at encountering with gust at the maximum synchronized rolling angle.

Area BAD (b) Residual stability of ship under the above condition

c Safety factor

$$c = b/a > 1$$

1) Rolling angles should not exceed 24 deg.

Note : A limit angle of vehicles' turnover is about 25 deg.

2) When a rolling angle is in excess of 20 deg., an effective device to decrease rolling (fin stabilizer or anti-rolling tanks) should be used, thus the angle being below 20 deg.

The proposed two types (59 m & 50 m type) were examined in regard to "Greater Coasting" and "Coasting".

Table of Stability

59 m type	Rolling period	1.5 DW rake angle	Rolling angle	C Coefficient
Full load sailing Greater coasting	10.12		24.15	1.69
Full load sailing Coasting	10.12		19.72	3.47
Full load entry Greater coasting	10.51		24.65	1.14
Full load entry Coasting	10.51		19.73	2.86

50 m type	Rolling period	1.5 DW rake angle	Rolling angle	C Coefficient
Full load sailing Greater coasting	7.22		27.95	1.57
Full load sailing Coasting	7.22		25.29	2.09
Full load entry Greater coasting	7.51		29.29	0.91
Full load entry Coasting	7.51		26.27	1.29

The meteorological and oceanographic conditions at the San Bernardino and Surigao Straits are very severe as shown in IV. Meteorological and Maritime Basic Data on p. 19 of ESCAP Report and Papers of Ship Research Institute Statistical Diagrams on the Wind and Waves. (Refer to Fig. 15.) To offer safe services under such severe conditions, ferries must meet "Greater Coasting Area" standards, though the two straits belong to "Coasting Area".

The 59 m type satisfies all the requirements in Table of Stability except the rolling angle being a little over at greater coasting. Concerning the 50 m type, the rolling angle is to large for coasting service, and particularly C of full load entry is too small for greater coasting. The larger type of a ferry is naturally the better for a regular service at these straits. However, we would like to recommend the 59 m type, which is the minimum size ferry capable of securing regular services in regard to operation payability except an excessively adverse weather.

It is possible only for the 59 m type to secure anti-rolling tanks with effective sectional area and capacity. As for the 50 m type, space for the tanks is limited.

As stated previously, the 59 m type is the minimum ferry in regard to safety. Therefore, careful efforts should be made to lower the center of gravity. Otherwise, the stability requirement will not be satisfied.

3 - 5. Considerations related to Building in Philippines

We understand there is a strong desire to build ferry boats in the Republic. There is no doubt that it would greatly stimulate the Philippine shipbuilding industry and contribute to the promotion of local employment and keeping foreign currency. Various difficulties are expected, however, if the Philippines suddenly begin to build ferry boats from the beginning at a dockyard in the Republic. The Philippine authorities believe that a car ferry is simpler to design and easier to build than cargo liners. Their belief is based on a hull form consisting of simpler curves and the absence of compartmentation. There is a difference in recognition of the ferry boat between the Philippine Government authorities and the Survey Team.

A car ferry should have outstanding performances and safety as "Bridge over the Sea" which is an extension of land transportation particularly in an island country. For this reason, we propose car ferries with standard specifications to establish a foundation for the future. To deepen the understanding of the Philippine authorities, the reasons why higher technology and greater experiences are required for building a car ferry are listed below.

3 - 5 - 1. The values of L/B, and B/D differ greatly from those of cargo liners. Ferry's hull form below waterline consists of a complicated three-dimensional curve with small CB. Particularly, the stern shape is complex mainly due to twin screws and twin rudders equipped.

3 - 5 - 2. Since a ferry is planned to satisfy a variety of mutually related requirements simultaneously, it should be built as accurately as planned. Accordingly, many organically connected drawings are prepared and each of them should be applied to actual building work.

3 - 5 - 3. High-level technology is required for installing and adjusting many kinds of sophisticated instruments, machineries and materials. The acquisition and management of materials are not easy. Unique technology of related industries is required.

3 - 5 - 4. It is not easy to make a hull form as precisely as planned because comparatively thin plates are used. Deformation and strain are likely to develop.

3 - 5 - 5. A vehicle deck is a big plain void, and complicated rocking vibrations tend to develop due to the high powered engines. Therefore, its structure must be designed carefully.

3 - 5 - 6. The installation of large CPP and 2 sets of rudder in spite of shallow draft and complicated stern form should be required specially careful hull work and engine mount installation. Any mistake may result in accidents, such as broken crank shafts, broken propeller shafts and burnt bearings.

Taking these points into consideration, extensive technological introduction is required for building car ferries in the Republic. In such a case, the completion of car ferry building will be delayed considerably.

The Survey Team could not estimate the extent, scope and cost of technological introduction which will be required for building ferry boats in the Philippines because of no actual construction data available. If a decision is made to start the above project, the following items should be made clear :

1) Machines and equipments available at a shipyard concerned, and technical level of engineers and employees.
2) Scope of technical introduction (fields, number of engineers and period) and expenses required.
3) Construction materials and outfittings to be imported and to be purchased in the Republic.
4) Work schedule and building cost.

If a decision is made to build car ferries in the Republic, another survey team must be dispatched to study the scope of technical introduction.

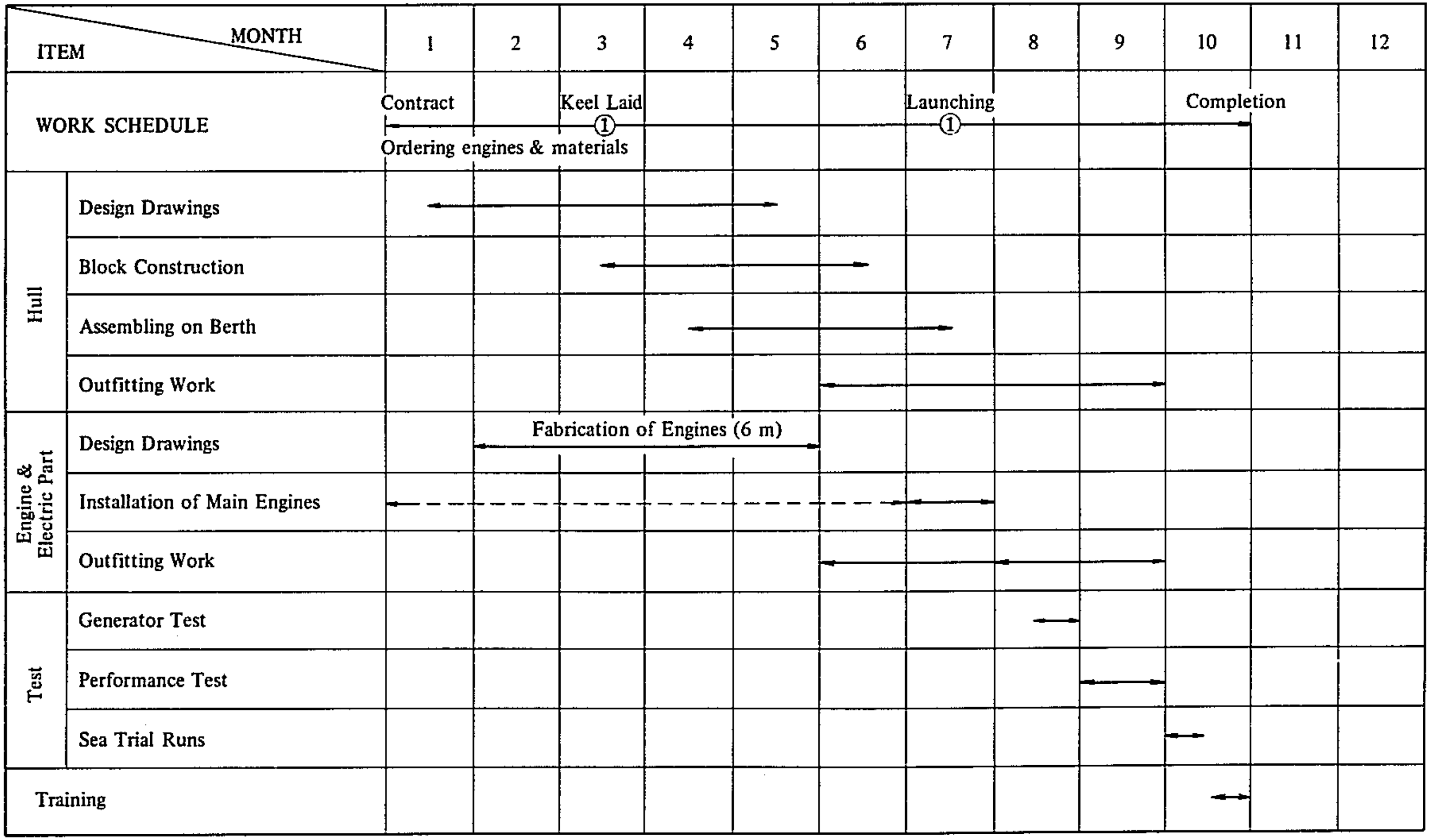
One of the ideas is to build the first car ferry in a foreign country and to send Philippine engineers to this country during its construction for giving chances for practical training and education.

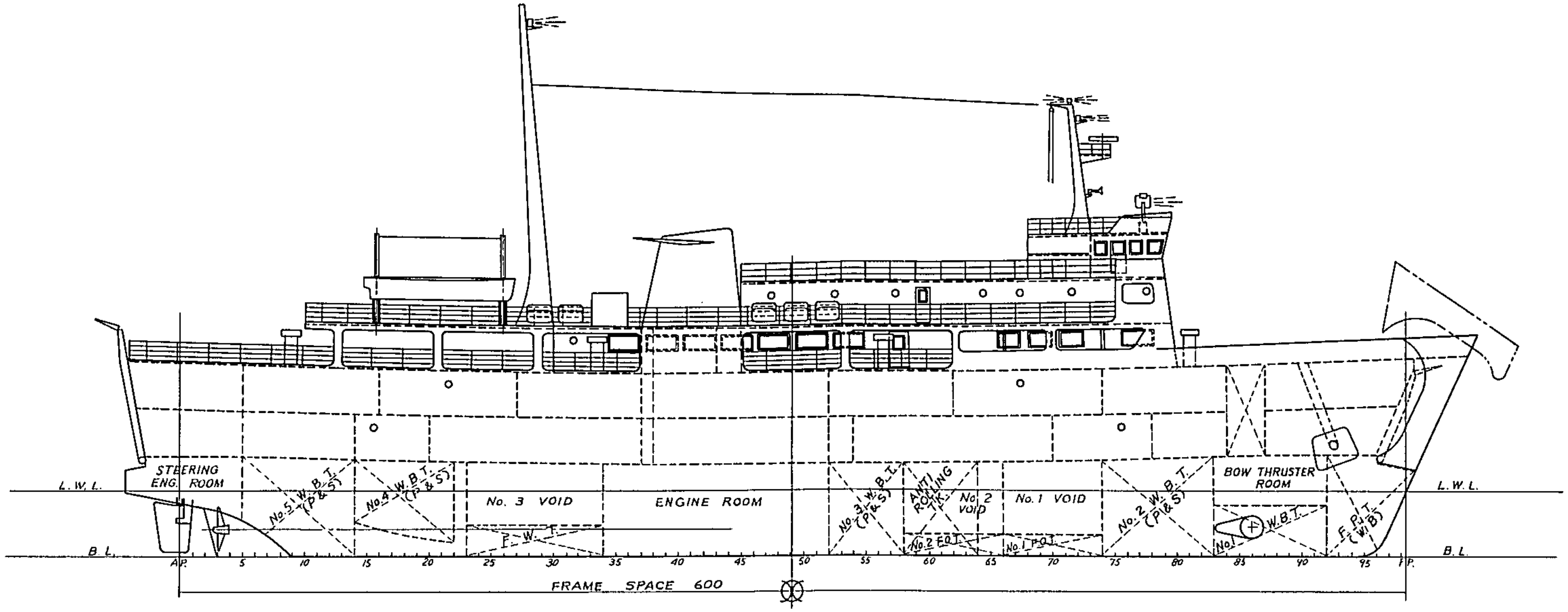
Then they can build the second ship in the Philippines with their own experiences. Although technological introduction is still necessary for the second ship, the unknown factors listed above will become clear to certain extent.

3 - 6. Work Schedule

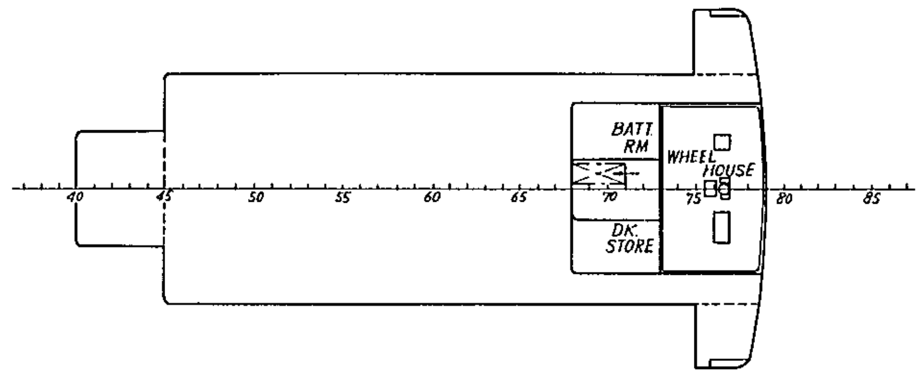
If ferry boats are to be built in Japan, it will take 10 months from contract to delivery. A work schedule is attached for reference. It is possible to deliver two ships at the same time in ten months.

WORK SCHEDULE (Building in Japan)





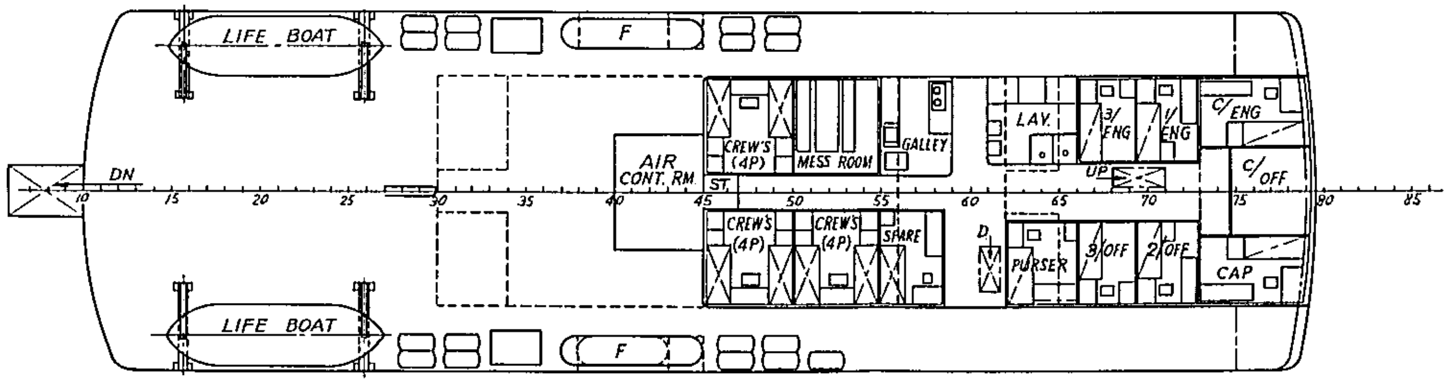
NAV. BRI. DECK



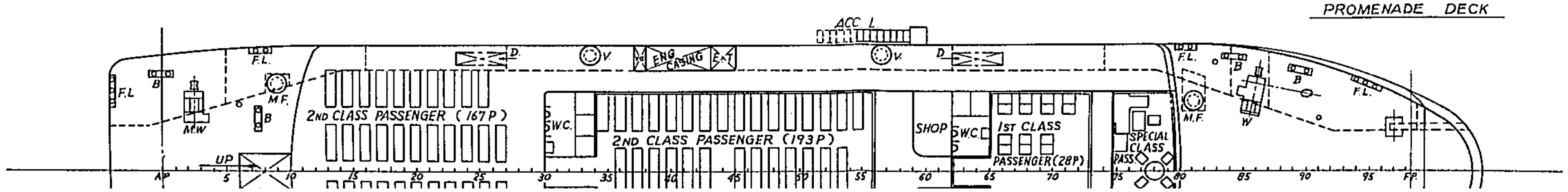
PRINCIPAL PARTICULARS

LENGTH	(O.A)	(ABOUT)	$65^{m}50$
LENGTH	(L.W.L)		$61^{m}60$
LENGTH	(P.P.)		$59^{m}00$
BREADTH	(MLD.)		$12^{m}50$
DEPTH	(MLD.)		$4^{m}60$
DRAFT	(MLD.)	(ABOUT)	$3^{m}35$
GROSS TONNAGE		(ABOUT)	900^{GT}
FULL LOAD DISPLACEMENT			1350^{T}
COMPLEMENT			22P
PASSENGER			
SPECIAL CLASS			12P
1 ST CLASS			28P
2 ND CLASS			360P
TOTAL			400P
TRUCK	($8^{m}50$ x $2^{m}50$)		14
MAIN ENGINE			1600^{PS} x 2
SPEED (SERVICE)		ABOUT	14.5^{KT}

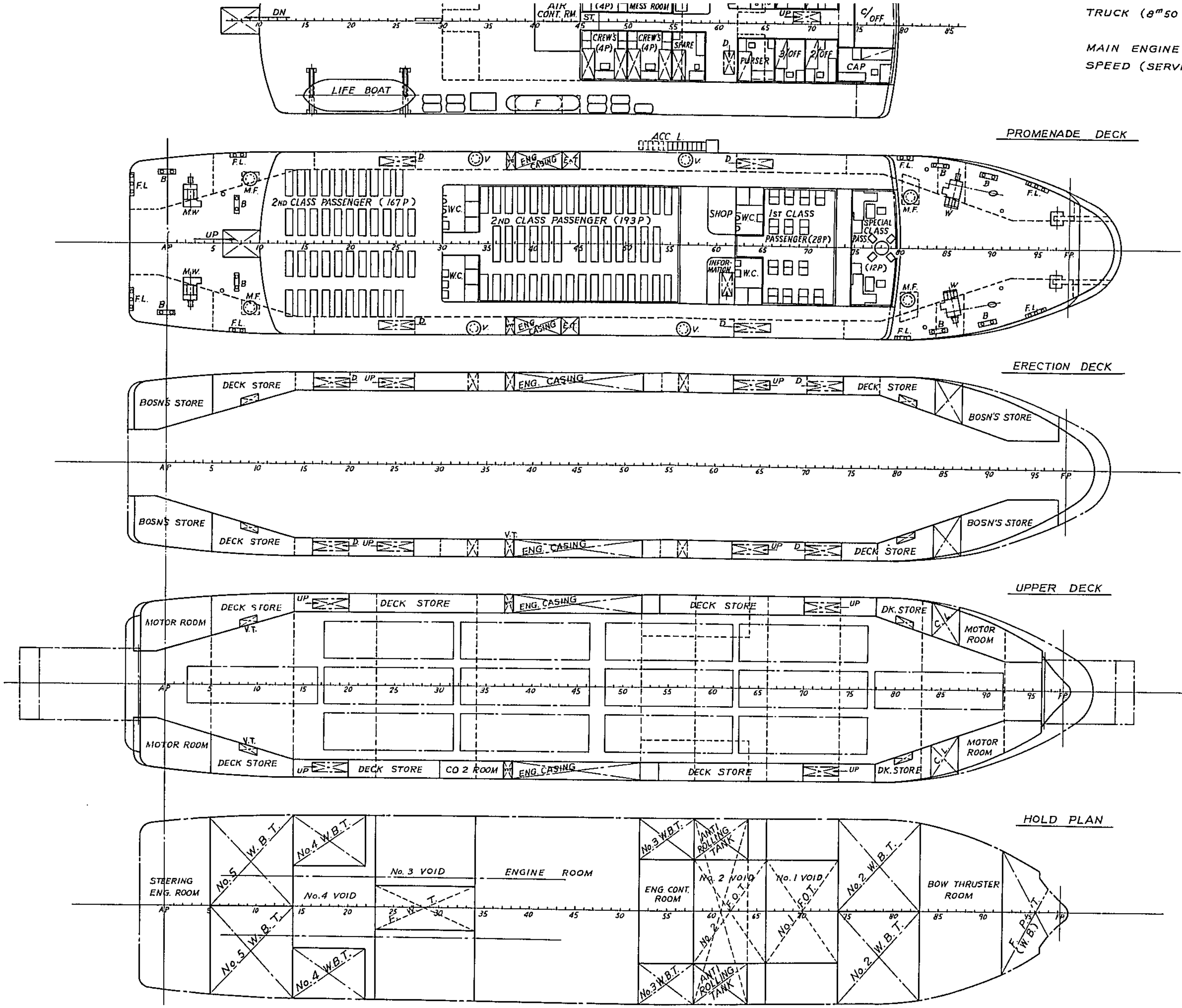
BRIDGE DECK



PROMENADE DECK

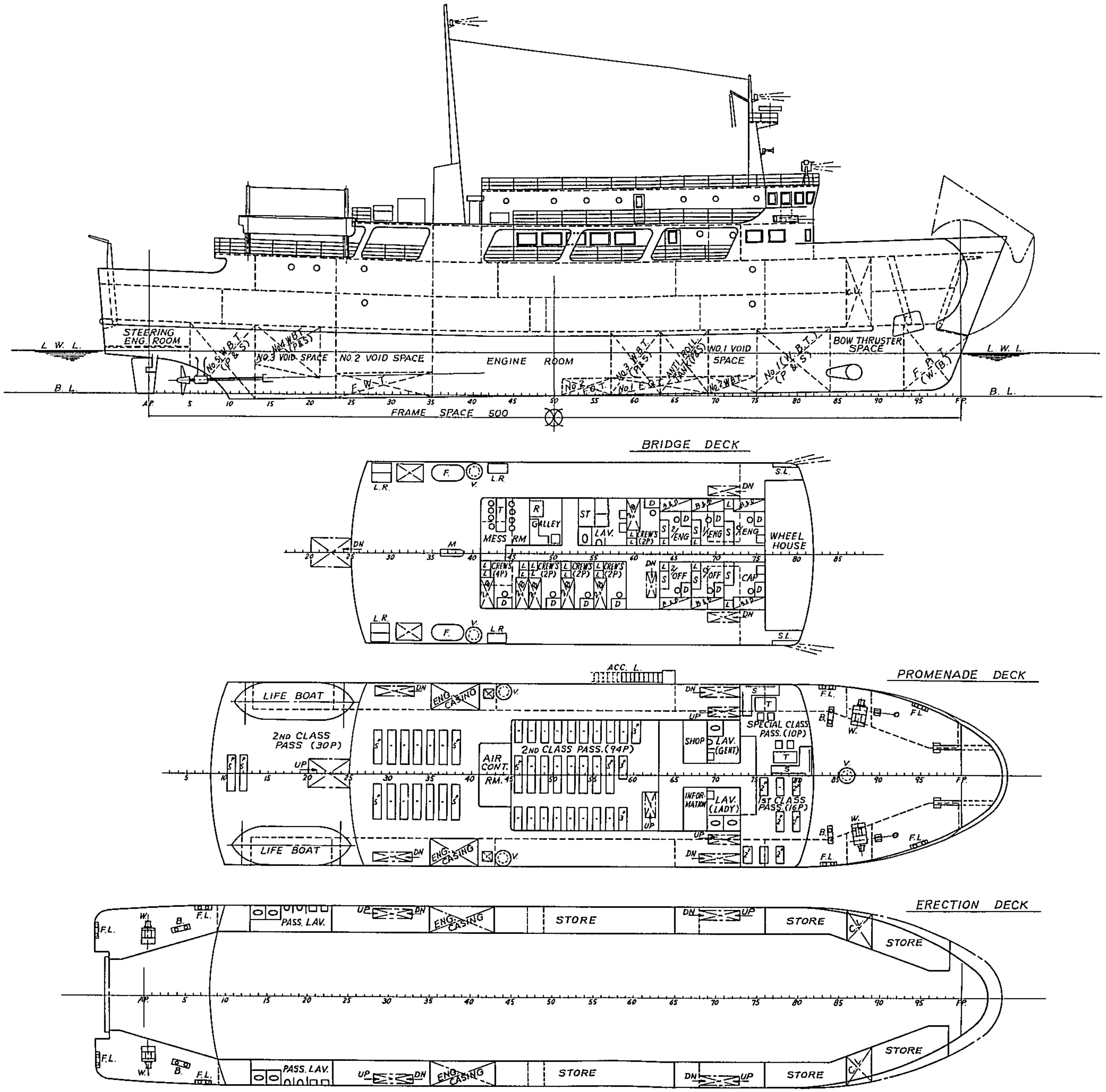


TRUCK ($8^{m}50 \times 2^{m}50$)		14
MAIN ENGINE		$1600^{PS} \times 2$
SPEED (SERVICE)		ABOUT 14.5^{KT}



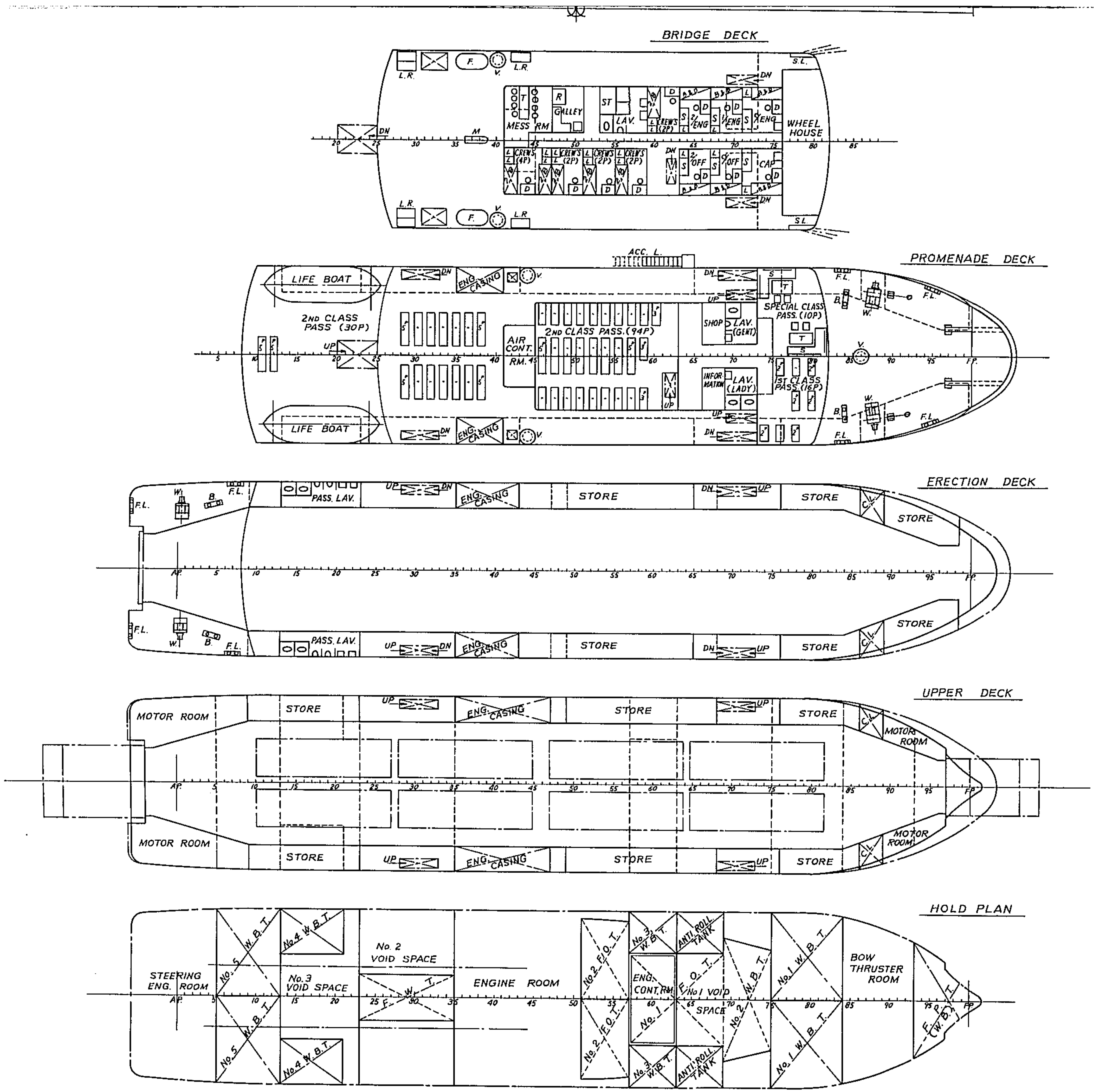
59 m TYPE CAR FERRY

GENERAL ARRANGEMENT



PRINCIPAL PARTICULARS

LENGTH	(O.A.)	ABOUT	56m00
LENGTH	(L.W.L.)		52m70
LENGTH	(P.P.)		50m00
BREADTH	(MLD.)		11m50
DEPTH	(MLD.)		4m00
DRAFT	(MLD.)		2m70
GROSS TONNAGE		ABOUT	500T
FULL LOAD DISPLACEMENT			900T
COMPLEMENT			18P
PASSENGER			
SPECIAL CLASS			10P
1 ST CLASS			16P
2 ND CLASS			174P
TOTAL			200P
TRUCK ($8^m50 \times 2^m50$)			8
MAIN ENGINE			$1200^{PS} \times 2$
SPEED (SERVICE)		ABOUT	13.0^{KT}



SPECIAL CLASS		10P
1 ST CLASS		16P
2 ND CLASS		174P
TOTAL		200P
TRUCK ($8^m50 \times 2^m50$)		8
MAIN ENGINE		$1200^{PS} \times 2$
SPEED (SERVICE)		ABOUT 13.0^{KT}

50 m TYPE CAR FERRY

GENERAL ARRANGEMENT

3 - 7. Loading & Unloading of Vehicles through Ramp Bridge and Pontoon

No ramp bridge is to be used for car ferries in this plan, because it was planned to enable vehicles to roll-on and roll-off without a ramp bridge. Upon a request of the Philippine Government to study the feasibility of changing a ramp bridge to a floating bridge system, a brief explanation is given here.

The contact angle θ (See Fig. 1) formed between a ferry's ramp and a pier's crown becomes the largest in a full load sailing condition as well as at high tide. If this angle exceeds a certain limit, the rear part or bottom of cars will be damaged (See Fig. 2).

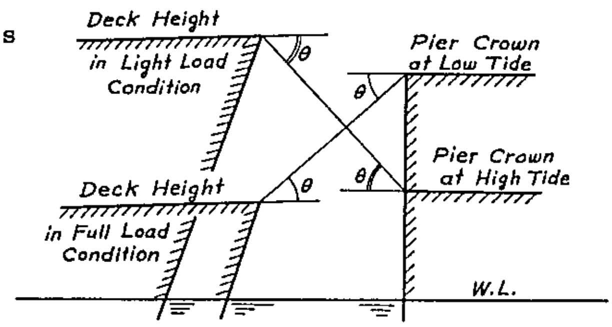


Fig. 1

Nearly 70% of the accidents that have occurred during vehicle transportation on a ferry are attributable to this contact during rolling-on-off. In the case of ordinary trucks and passenger cars, the contact angle θ should be below 6 deg. In the case of special vehicles such as high class sedans and trailers, θ should be below 4 deg.

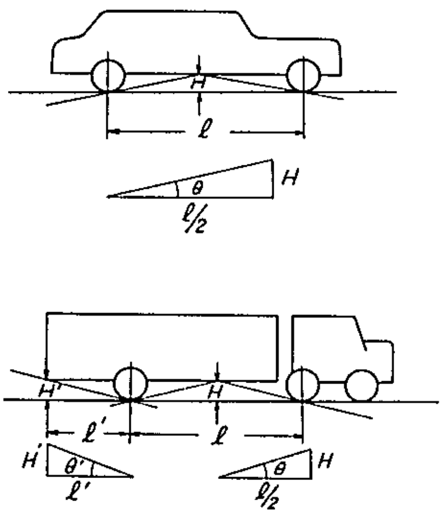


Fig. 2

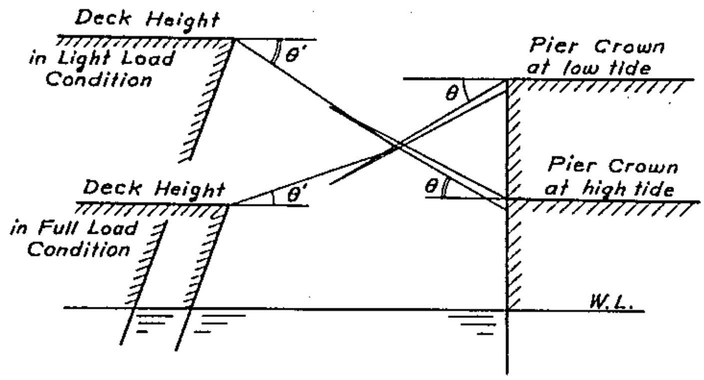


Fig. 3

A land-based ramp bridge is used together with a ship's ramp to make two contact points, thus decreasing the contact angle (See Fig. 3). A floating pontoon rises and falls with tidal devel like a car ferry. The contact angle becomes the largest when a car ferry is in a light load condition and at low tide (See Fig. 4).

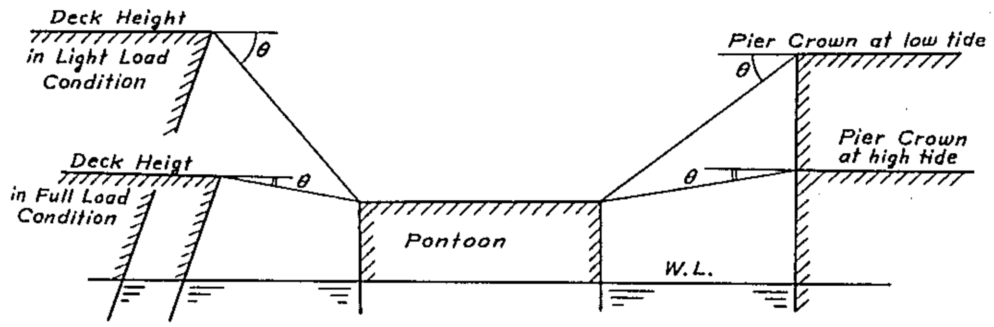


Fig. 4

A long bridge is required between a pier and a pontoon to make the angle θ less than 4 deg. at low tide. In this case, 16.2 m (including 2.5 m flaps) is required. On the other hand, a pontoon is oscillated by the passage of trucks etc. We studied pontoon dimensions for suppressing oscillations sufficiently for the safe passage of trucks. The minimum pontoon dimensions for allowing one 8 ton truck to pass alone are 22.0 m x 10.0 m x 1.5 m. The minimum pontoon dimensions for allowing 8 ton trucks to pass continuously or a trailer alone are 35.0 m x 10.0 m x 1.5 m. To facilitate calculation, width and depth were left unchanged. Stability and trim were studied by changing length alone. The total length including the distance from a pier plus a pontoon will be about 52 m, and a 140 m long pier is also required.

Conclusion

In conclusion, a ramp bridge is more desirable than a pontoon, because the pontoon system requires a pontoon itself, anchoring cables, sinkers, a long bridge between a pier and a pontoon and all pier work concerned. A pontoon may be necessary for the type of a pier proposed by the Philippine Government since it does not allow close-by berthing.

In this plan, it is possible for vehicles to roll-on and roll-off directly from a ferry to a pier. In order to realize the above, the arrangement of ballast tanks, the sheer form at the bow and stern and the length of a ferry's ramp have been carefully studied.

Chapter 4. Selection of Terminals and Their Preliminary Design

4 - 1. Site Selection

4 - 1 - 1. San Bernardino Straits (See Fig. 1)

The Strait is located between the southern end of Luzon Island and the northern end of Samar Island. The shortest distance is about 18 km. Like the northern Luzon, this strait is known for the most frequent attacks by typhoons. The maximum tidal current is as large as 8 kt. Therefore, these natural conditions should be taken into consideration in planning ferry service.

Matnog, which is currently used as a port, is the first to come to our mind as terminal site in the southern Luzon. Matnog is the end of the Pan-Philippine Highway. It will require only a short approach road from the Highway. Since its northeast is open to the Pacific, frequent hitting by billows is expected during not only a typhoon season but the NE monsoon season. Matnog is deep in the Matnog Bay and is sheltered well from waves.

The Philippine Government, however, selected Padang Point for the following reasons.

1) The proposed terminal is so close to Matnog that vehicles using ferry boats will disturb traffic in the village.

2) There is not extra space for future expansion as business center (10 ha required).

Padang Point is completely unprotected from waves. Ferry service will be suspended during typhoon. Since 2. 3~2. 5 m high waves are expected during the NE monsoon season, a breakwater must be constructed for safe docking and undocking of a car ferry. The sea bottom has steep slope (about 1/6), and a breakwater must be constructed in deep water, say -10 m to -20 m deep. This will require large construction cost as discussed in 3-5, and typhoon disasters are also be expected. For the these reasons, Padang Point is not suitable at all.

Basically, a ferry terminal is only a point through which cars and passengers pass. We do not think that Matnog will be developed into a business center simply by constructing a terminal, because Matnog seems to have neither economical nor cultural potentials and merits for a business center.

If Matnog is undesirable because of the existence of a village, another site should be looked for between Matnog and Padang Point.

A terminal site in the Island of Samar can be selected at Allen, which is now

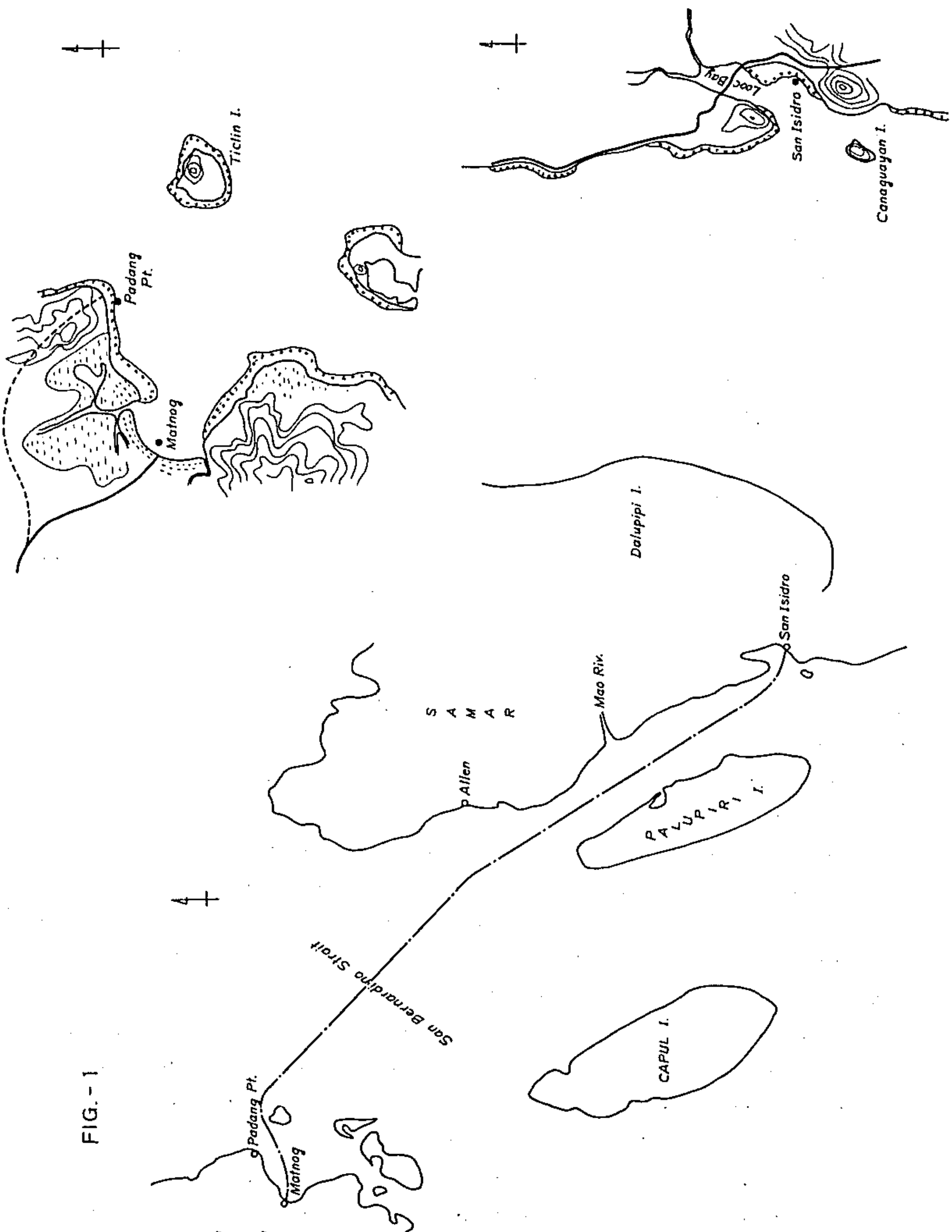

Ticlin I.
Padang Pt.
Matnog
Looc Bay
San Isidro
Canaguayan I.
Dalupipi I.
San Isidro
Mao Riv.
SAMAR
Allen
DALUPIRI I.
San Bernardino Strait
CAPUL I.
Padang Pt.
Matnog
LUZON

FIG. - 1

used as a port like Matnog. Allen is an important traffic point, located at the northern end of Samar and facing west. It is not hit directly by the Pacific waves. It is sheltered by some islands in the west. The maximum distance to the opposite coast is 55 km. But the coastline is rather monotonous and disasters were caused by the Pacific waves from the north during a typhoon season. In order to avoid such disasters, a further southern site should be chosen. Although the shore line is monotonous, it is sheltered by Dalupiri Island, located across the 4 km wide Dalupiri Strait. There are many well-protected sites which are adequate as a terminal. San Isidro, selected by the Philippine Government, is on the opposite side of the southern end of Dalupiri Island. It is located at Looc Bay, 60 m deep in the bay. It is protected well except the W direction (distance to the opposite shore is 70 km), and is sufficiently deep. In addition, the Pan-Philippine Highway passes near the site. Considering these factors, San Isidro is most suitable as a terminal port. The only demerit is 9 miles longer navigational distance than Allen.

4 - 1 - 2. Surigao Strait (See Fig. 2)

The shortest distance between Panaon Island, located at the southern end of Leyte, and the northern end of Mindanao Island is about 18 km. Several sites in the south of Panaon Island were selected as a prospective terminal. However, these sites are hit by the Pacific waves through the Surigao Straits in the east side and by the East China Sea waves through Bohol Sea and Sulu Sea in the west side. Therefore, it became clear that these sites would not be appropriate. Instead, Liloan in the northern extremity of Panaon Island was chosen. In spite that a navigating distance becomes longer by about 20 miles (1. 4 hours), Liloan is really the best natural harbor of the four terminals. An appropriate depth can be obtained at a short distance from the shore. Liloan is completely sheltered except only the NW direction which is no more than 20 km to Leyte. Probably the waves exceeding 50 cm in height are rarely generated. In addition, the terminal site is so close to the town that various conveniences can be available.

Surigao Port may be one of the most promising terminal sites in Mindanao. The port, located at the center of the city, is a gate of the northern Mindanao. The present port is located so closely to the city center that the traffic confusion may be caused by the beginning of ferry service, considering the heavy traffic condition at present. And there is little room left for new berthing facilities in Surigao Port.

The other side (west) of Surigao has poor meteorological conditions due to the same reason as the southern Panaon Island.

Finally, Lipata was selected. It requires the construction of a new 3. 2 km long road. The shore around Lipata is open in the SE - NW directions, and is

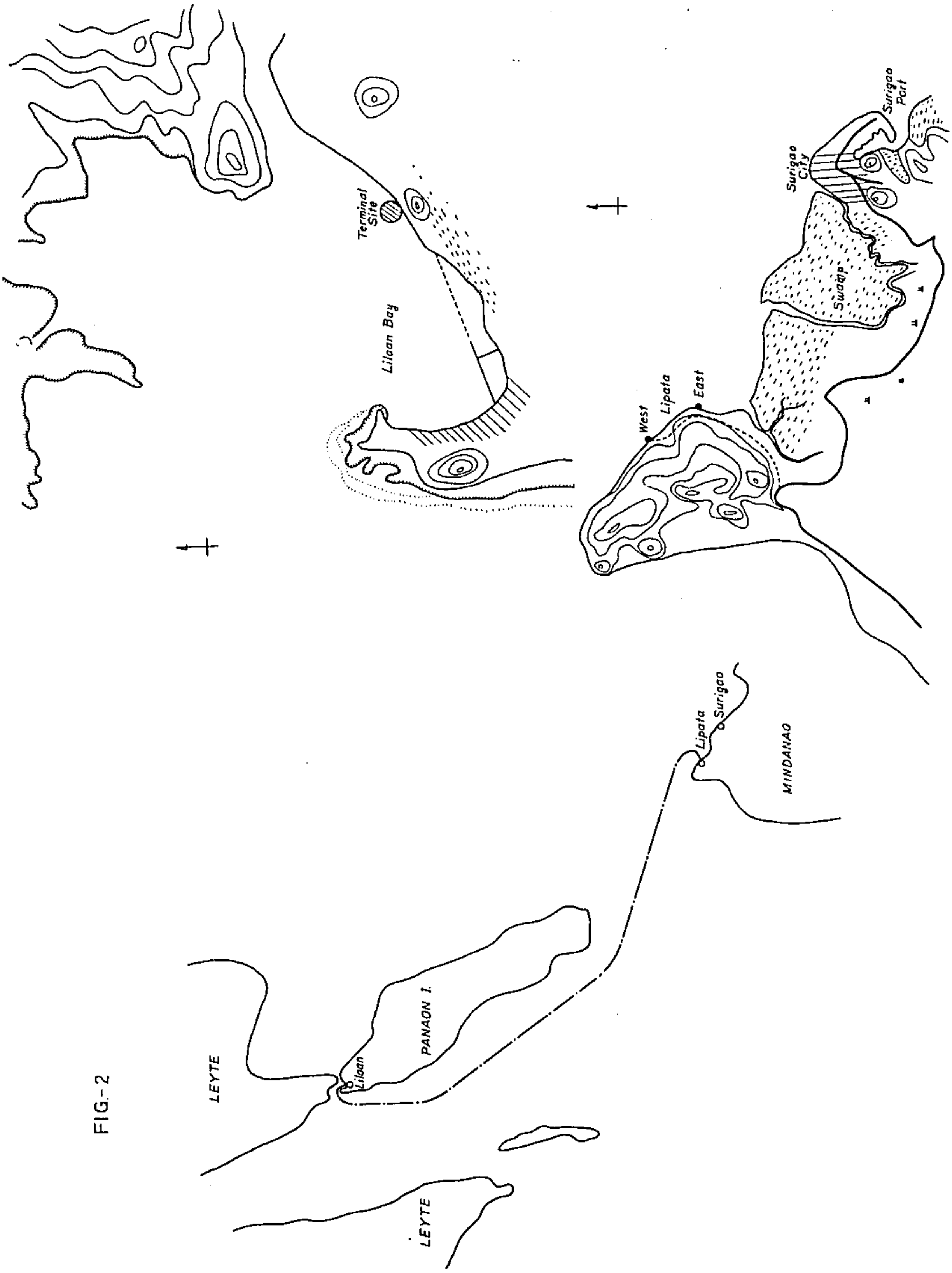

Terminal Site
Liloan Bay
West
Lipata
East
Surigao City
Surigao Port
Swamp
LEYTE
Liloan
PANAON I.
Lipata
Surigao
MINDANAO
LEYTE

FIG.-2

sheltered by many islands in SE to N. The opposite shore of Lipata is about 10 km away, and normal waves may be less than 50 cm high. On the other hand, N - NW is open toward Leyte Bay (150 km away from the opposite side), and normal waves of about 1 m can be expected from the this direction.

There are two prospective sites in the east and west of Lipata respectively. The site in the east is advantageous from the view point of waves from NE, but requires an approach road with a steep slope (6%) near the terminal. The site in the west has the opposite conditions. It is expected to have less frequent waves from NE. We agree to the Philippine selection of the west terminal.

- 2. Arrangement of Facilities

The following facilities are required from the initial stage.

- Wharf
- Water Supply Facilities for Ferry boat
- Terminal Building
- Approach Road
- Parking Area
- Revetment (Breakwater)

These arrangements are illustrated in Fig. 3, 4, 5 and 6. Wharfs are arranged where water depth is large enough to eliminate dredging, with the exception of Padang Point. One of the examples is shown in these layouts. The dimensions of facilities are discussed in 4 - 3.

4 - 3. Planning of Facilities

4 - 3 - 1. Wharf

* Crown Height : + 2. 5 m was selected on the basis of MHHW (Mean Higher High Water) near each terminal. (+ 2. 0 m where vehicles roll-on-off)
* Water Depth : It was obtained by adding rolling allowance, trim to,
  -4. 5 m for 59 m type
  -4. 0 m for 50 m type
* Length : It was obtained by adding 9 m to the overall length of a ferry,
  75 m for 59 m type
  65 m for 50 m type.
* Structure : Sheet pile type was selected because of a good sand seabed, a short construction period and an easy construction. Standard sections and design conditions are shown in Fig. 6' and 7.

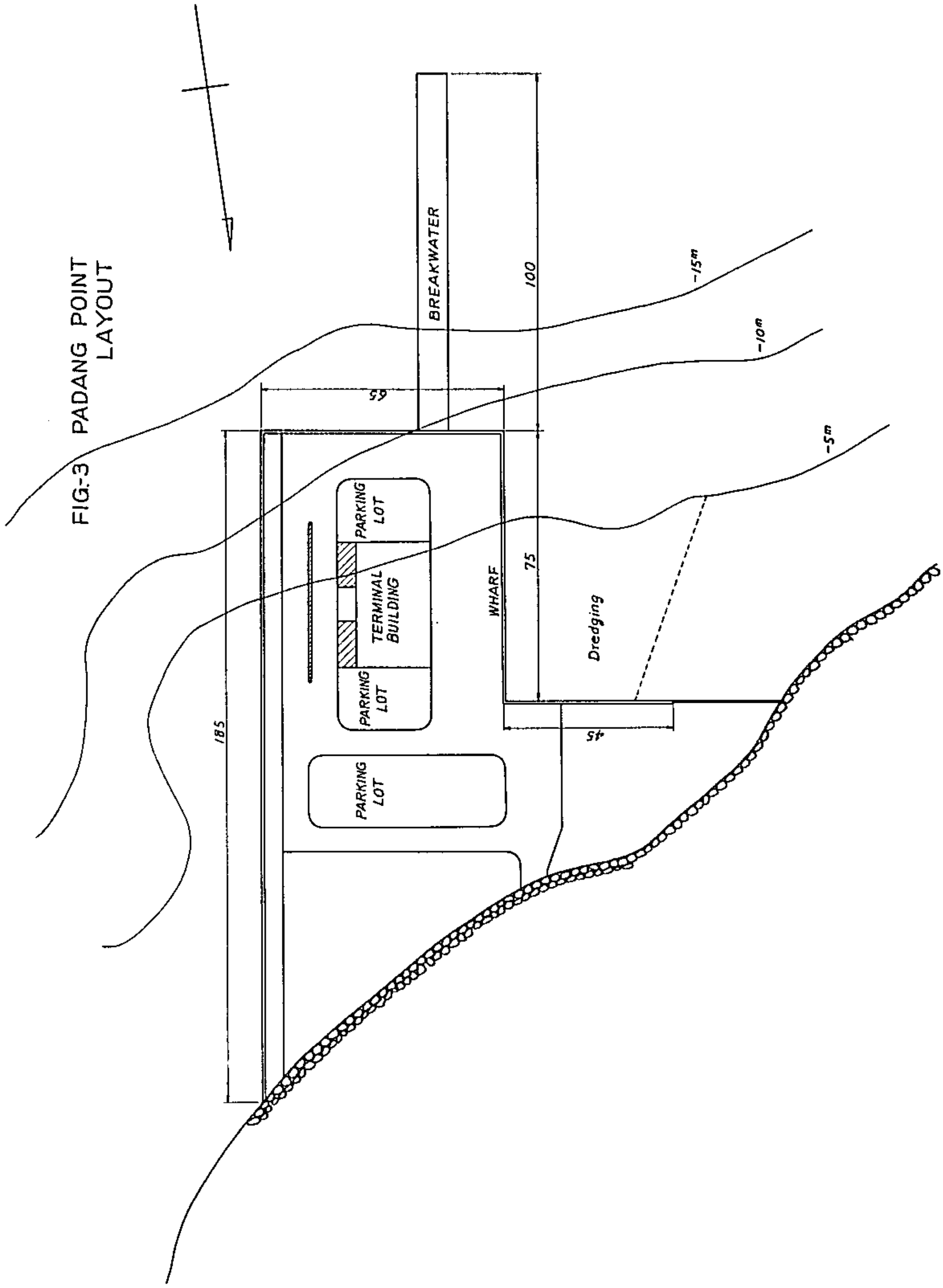


FIG-3 PADANG POINT LAYOUT

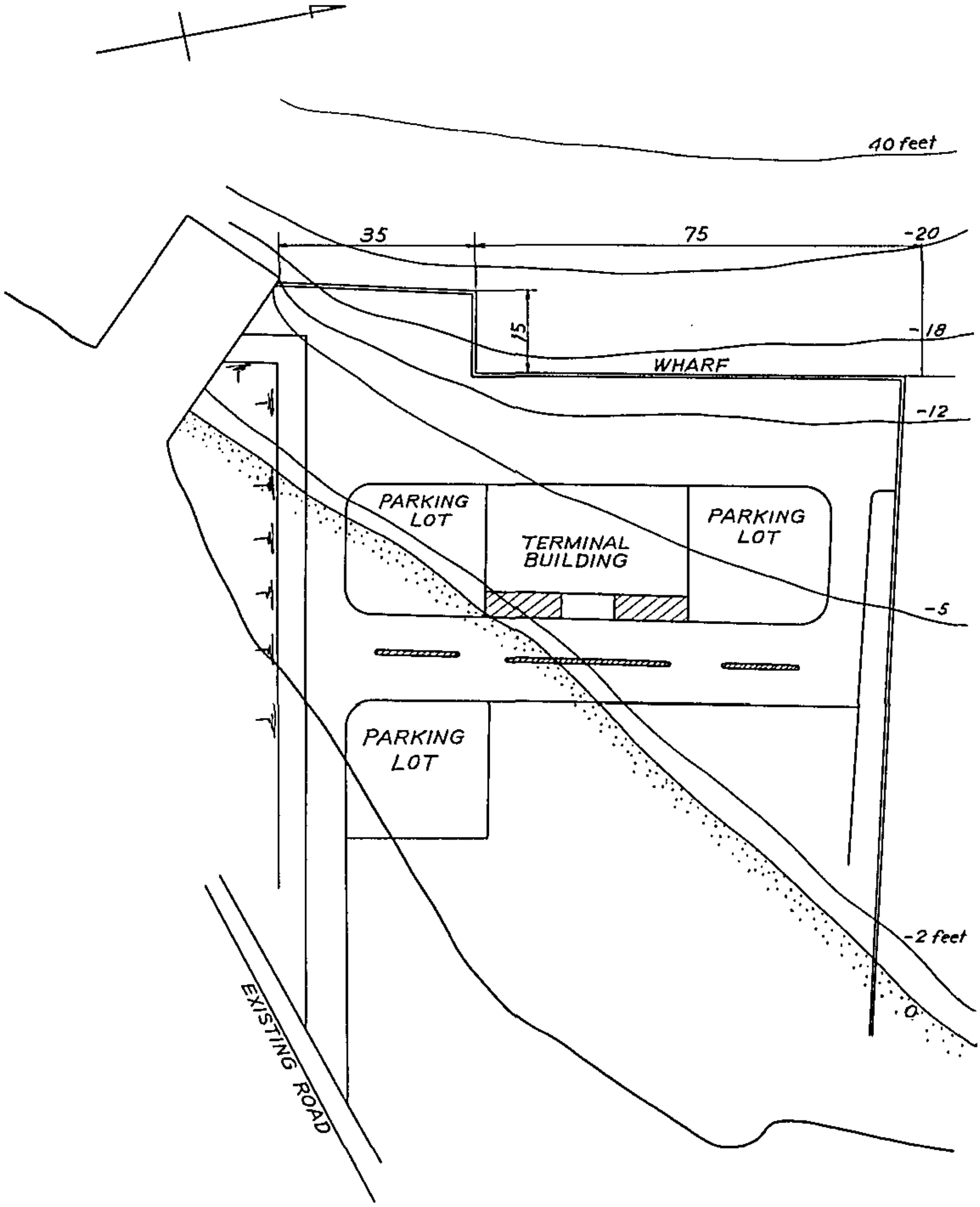


FIG.-4 SAN ISIDRO LAYOUT

FIG.-5 LILOAN LAYOUT

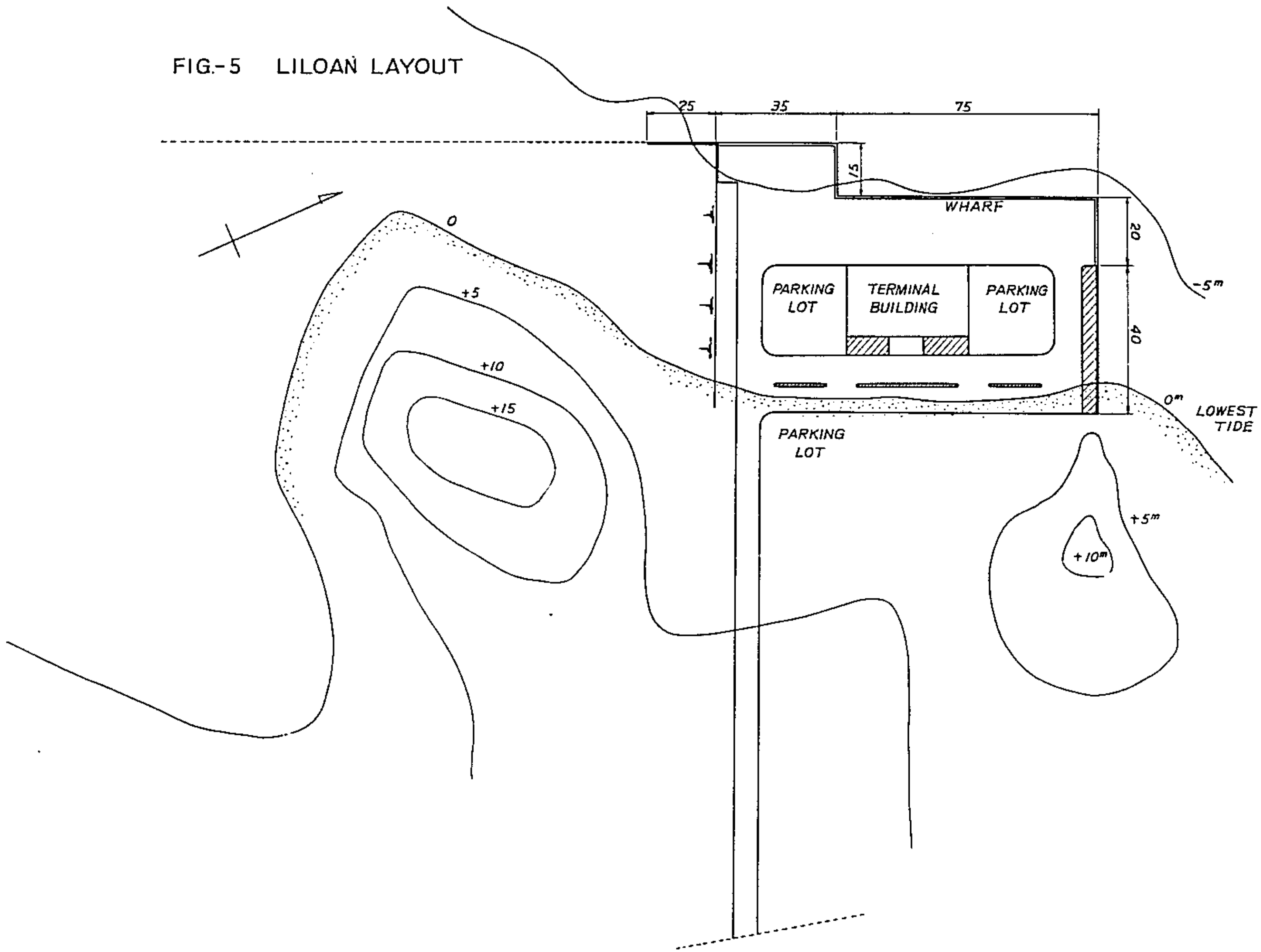


FIG.- 6 LIPATA (WEST) LAYOUT

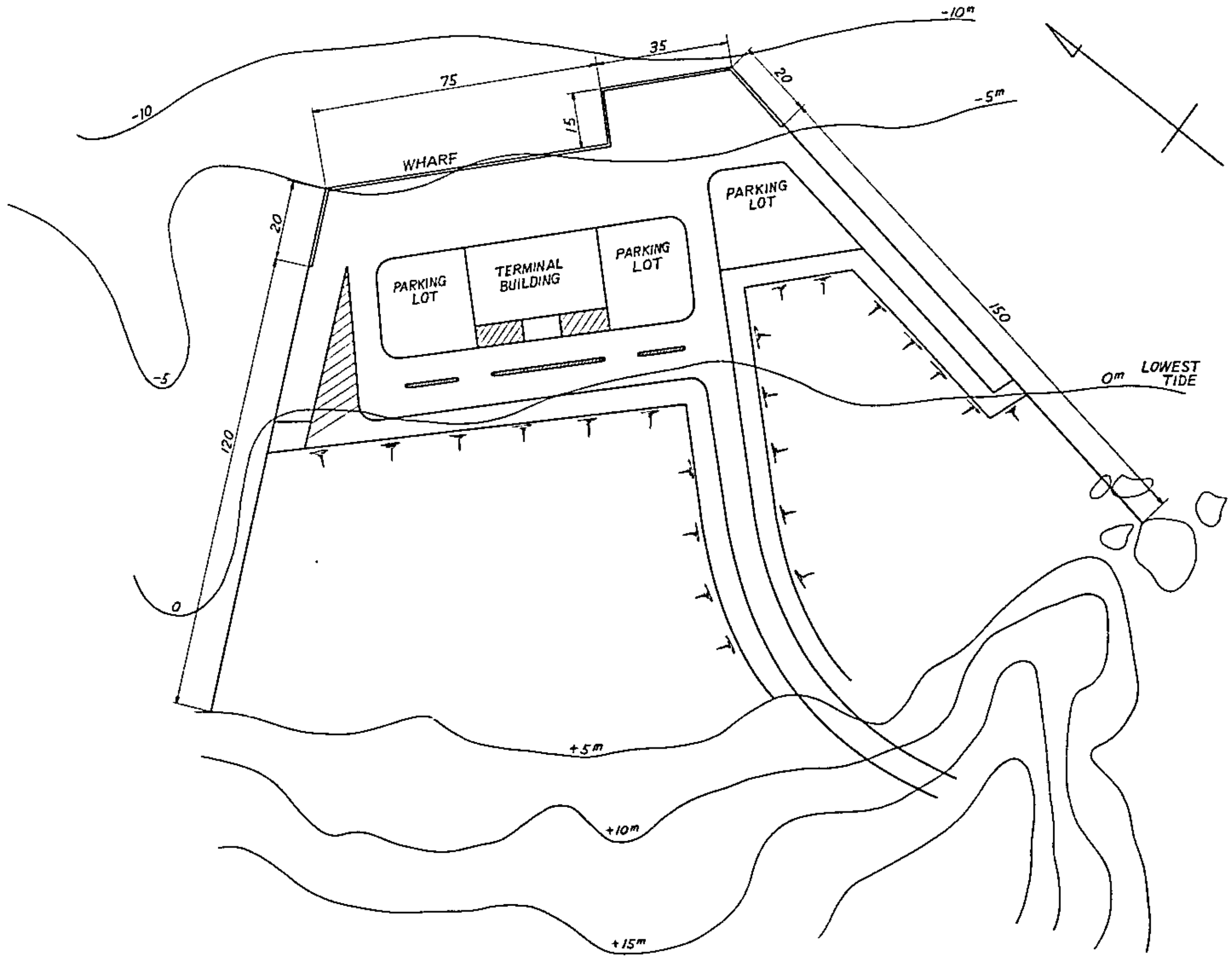


FIG-6' -4.5m BERTH STANDARD SECTION

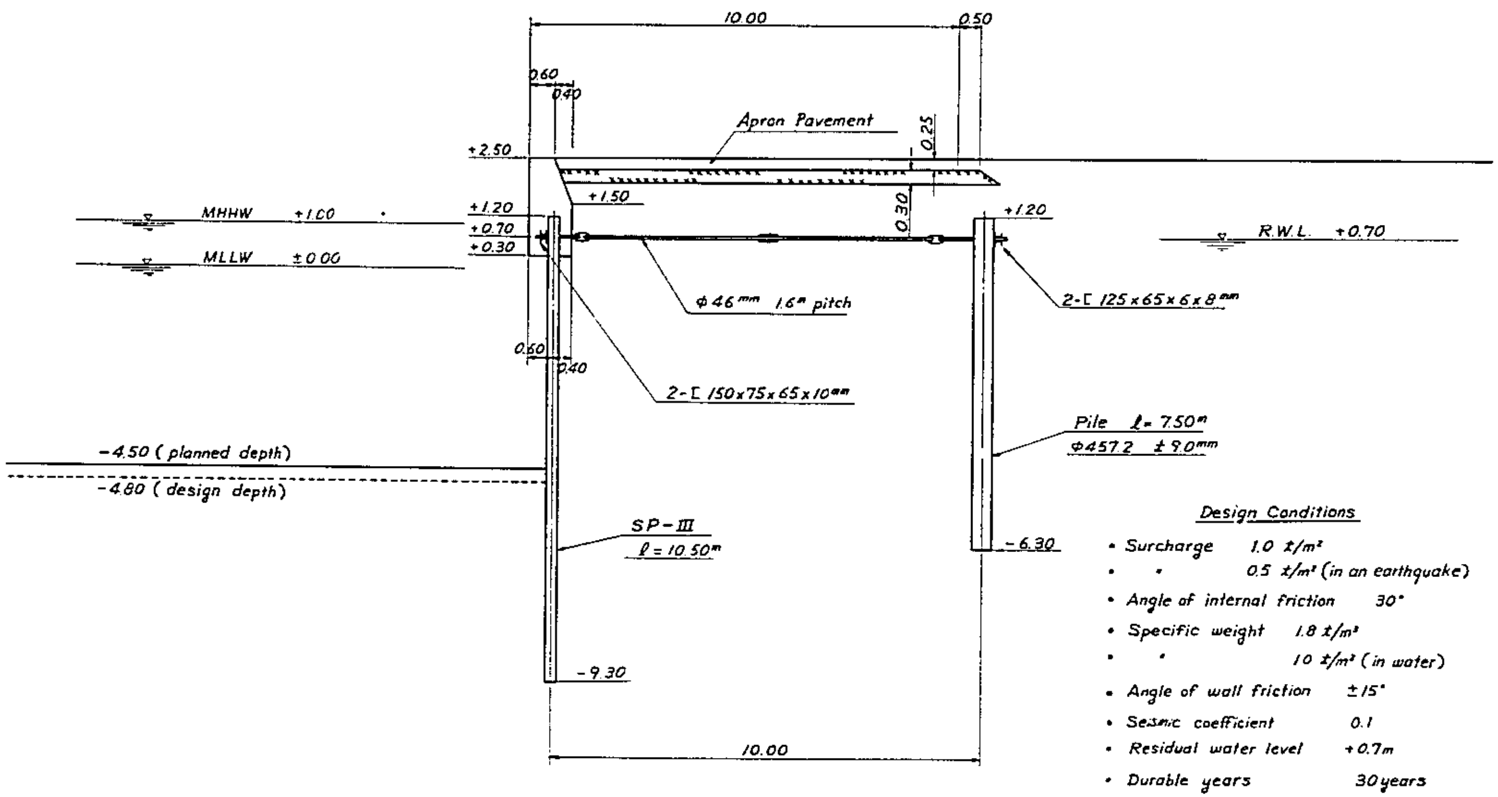
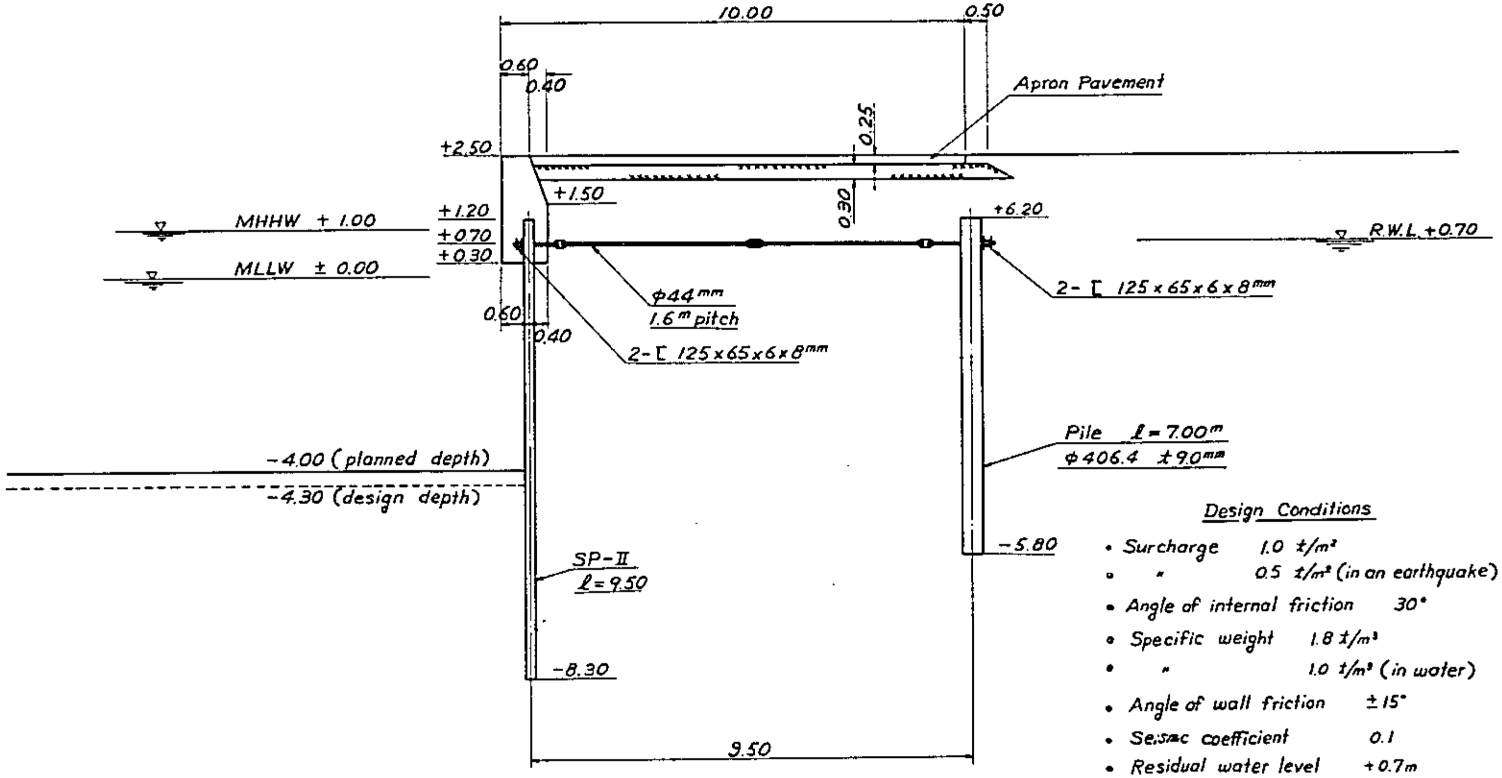


FIG-7 -4.0m BERTH STANDARD SECTION



Design Conditions

- Surcharge 1.0 t/m²
- " 0.5 t/m² (in an earthquake)
- Angle of internal friction 30°
- Specific weight 1.8 t/m³
- " 1.0 t/m³ (in water)
- Angle of wall friction ± 15°
- Seismic coefficient 0.1
- Residual water level +0.7m
- Durable years 30 years

4 - 3 - 2. Terminal Building

* Area : Area of passengers' waiting room

= Ferry's passenger capacity x 1.2 m^2/person

Area of Administrative Department etc.

= 1.5 ~ 2.0 (Area obtained from the above equation)

1,200 m for 59 m type

700 m for 50 m type

* Structure : Reinforced concrete and two stories for 59 m type.

Reinforced concrete and one story for 50 m type

4 - 3 - 3. Road :

6.7 m wide, the same as the Pan-Philippine Highway.

9 inch thick concrete pavement.

4 - 3 - 4. Parking Area

* Area : 1) For vehicles waiting for rolling-on

Ferry's vehicle capacity (converted to 8 ton truck)

x 60 m^2/vehicle

2) For passengers leaving a ferry

Ferry's passenger capacity x 0.9 x 0.5 ÷ 30 p/veh.

x 60 m^2/veh. (Bus)

Ferry's passenger capacity x 0.9 x 0.5 ÷ 9p/veh.

x 30 m^2/veh (Jeepney)

It is assumed that 90% of passengers leaving a ferry use Bus and Jeepney. (50% each)

Summing up 1) and 2) :

1,800 m^2 for 59 m type

1,000 m^2 for 50 m type

* Pavement : 9 inch thick concrete

4 - 3 - 5. Revetment

* Crown Height : It was obtained by adding MHHW to design wave height multiplied by 1.5. (or 1.0 when wave dissipating block is used.)

For Padang Point seawall :

+ 6.0 m (Design wave height 5 m)

For other places :

+ 3.0 m (adding 2.5 m ground height to 0.5 m for traffic safety)

* Structure : Rubble mount breakwater.
Their standard sections are illustrated in Fig. 8 and 9.

4 - 3 - 6. Breakwater

* Length : Assuming that wave height during the monsoon season is 2. 3 m excepting the typhoon season, the length of 100 m was selected so that the wave height in front of the wharf may be less than 50 cm.
* Crown Height : Height not to permit overtopping against normal waves may be + 4. 0 m. However, + 5. 0 m was taken from the viewpoint of construction work.
* Structure : Rubble mound breakwater was selected because no construction facilities is available at sites and the extension is short.

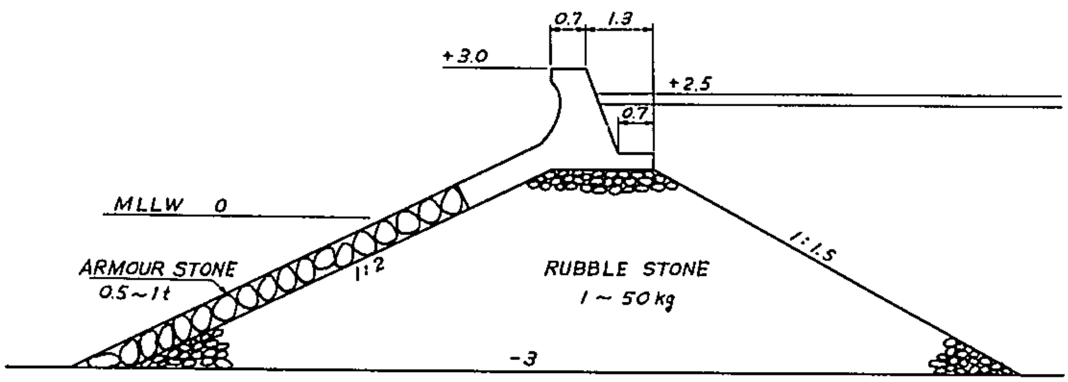


Fig. 8 Rivetement Standard Section

A standard section is illustrated in Fig. 10'.

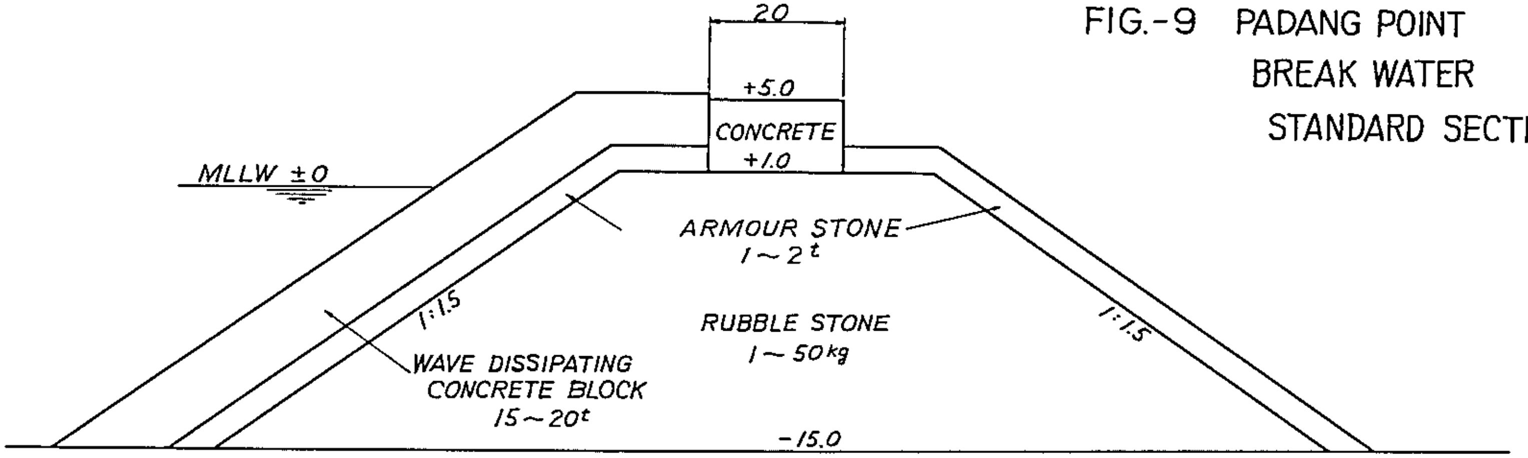


FIG.-9 PADANG POINT
BREAK WATER
STANDARD SECTION

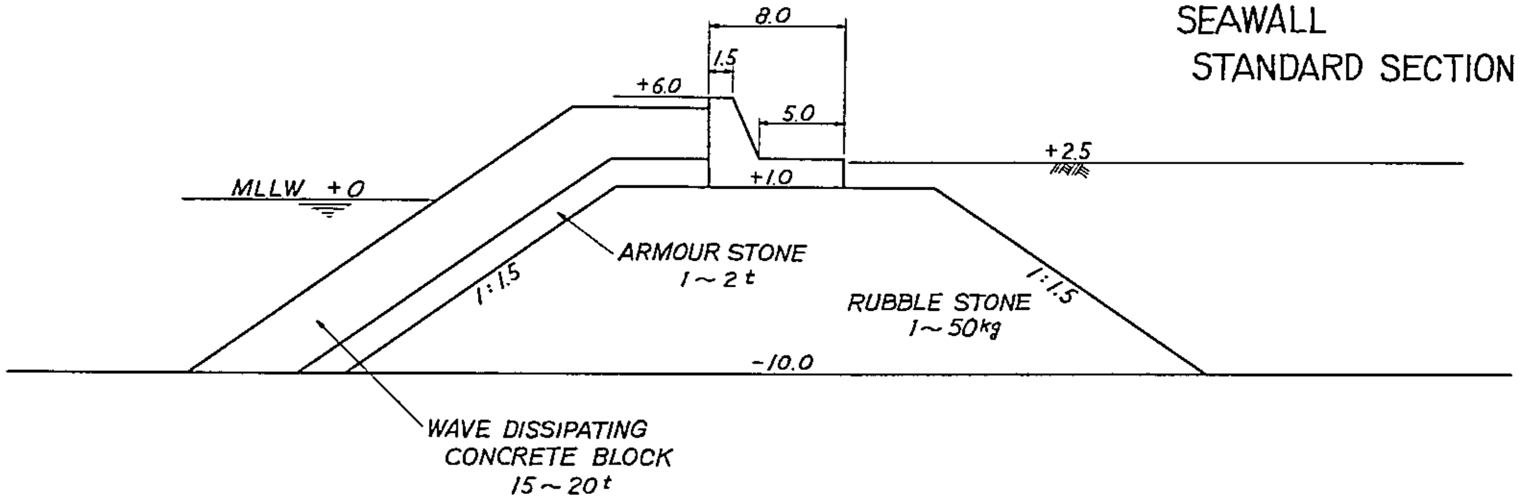


FIG.-10 PADANG POINT
SEAWALL
STANDARD SECTION

4 - 4. Construction of Facilities

4 - 4 - 1. Constructors

This project can surely completed by the following domestic constructors as well as foreign constructors presently operating in the Philippines :

CDCP (Construction & Development Corporation of the Philippines)

Vinnel-Belvoir Philippines Inc.

Mulmac Industrial Construction & Development, Corporation

C & A Construction

CTC Construction Corporation

Soil exploring companies are listed below.

Industrial Inspection Inc.

Development & Technology Consultant

Technotest Inc.

University of Philippines

Jeotechnics Inc.

Since some of them have sufficient capability, domestic organizations will surely be sufficient.

4 - 4 - 2. Material Procurement

* Stone : Possible to procure because many stony mountains exist.

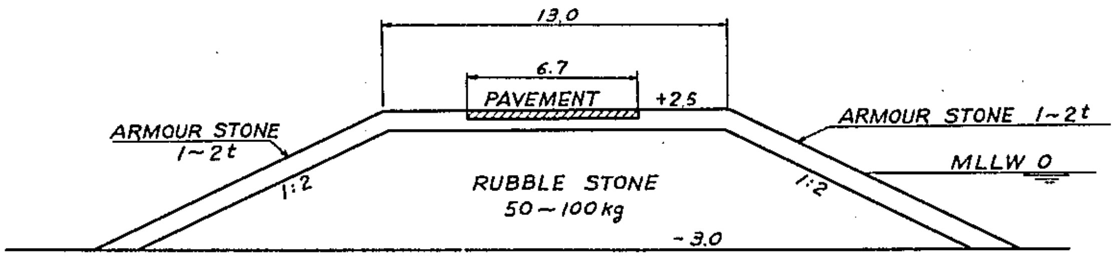


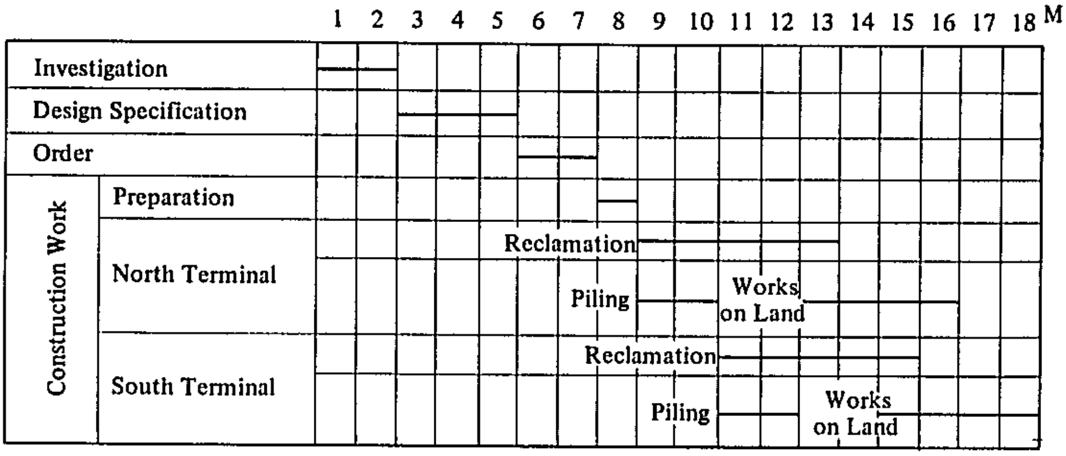
Fig. 10' Matnog access road standard section

Cement : Possible to supply sufficiently because many lime-stone mountains and more than 10 cement factories exist.

Reinforcing bars : Possible to supply bars (less than 32 mm in diameter) sufficiently because there are many makers who make bars from scrap.

Materials listed in 4 - 5 shall be imported.

4 - 4 - 3. Construction Period



* Working system is 1 party for each strait.

* Transporting a large quantity of stone (150, 000 m^3) will delay work in the case of Padang Point. It will be hard to complete within this work schedule.

4 - 5. Approximate Construction Cost

Unit: ₱1,000

	Matnog	San Isidro	Liloan	Lipata W.	Padang Pf.	Remarks
Boring	20	20	25	25	20	Assuming Sand Ground
Expense for Bringing Ships	110	110	175	175	300	Pile Driving Barge, Pontoon, Floating Crane from Manila
Wharf	4,125 (3,410)	3,625 (2,970)	3,625 (2,970)	4,125 (3,410)	3,000	Including Approach
Revetment	1,350	450	450	1,448	18,090	
Terminal Building	2,400 (1,400)	2,400 (1,400)	2,400 (1,400)	2,400 (1,400)	2,400	
Parking Area	324 (180)	324 (180)	324 (180)	324 (180)	324	
Pavement in Facilities	529	529	529	709	612	
Approach Road	2,440	265	175	3,700	4,700	
Reclaimed Soil & Sand	423	470	420	270	424	Excavating pir Sand
Breakwater	–	–	–	–	22,600	
Temporary Works	1,159 (964)	802 (621)	797 (626)	924 (743)	2,610	5 ~ 10 % of Total Cost
Total	12,750 (10,700)	8,130 (6,150)	8,720 (6,750)	14,100 (12,060)	55,080	
	43,700 (35,460)					

The 50 m type is shown in (parentheses).

* Besides, consultant fee of ₱ 300, 000 is required. (Consult for design of wharfs)
* About 3, 000 m^3 dredging and construction of a conrete block yard are required at Padang Point.
* In comparison with others, the estimate of construction cost at Matnog is less accurate because of no depth chart available.

For Foreign Currency (Arrival at Manila)

(C. I. F. Price)

Unit ₱ 1, 000

Sheet Pile	type III. 10. 5 m	979. 6 t	2, 488
	type II. 9. 5 m	(661. 2 t	1, 679)
Steel Pile	457. 2 mmϕ x 7. 5 m	288. 9 t	933
	406. 4 mmϕ x 7 m	(223. 9 t	731)
Shape Steel		43. 4 t	105
		(34. 8 t	85)
Tie Rod		388 pieces	817
		(363	703)
Execution Control (wharf only)			300
Total	for 59 m type	....	4, 643
	for 50 m type	....	3, 498

Chapter 5. Operation Plan and Financial Plan

5 - 1. Cruising Time

As for cruising time in the San Bernardino Straits, it takes 2 hours to make a one-way trip (21 miles) at the sailing speed of 14. 5 knots. It takes 30 minutes to load and unload passengers, vehicles and cargoes at each terminal. Therefore, the total time required for a one-way trip is expected to be 3 hours.

In the Surigao Strait, it takes 2 hours and 50 minutes to make a one-way trip (34 miles) at the sailing speed of 14. 5 knots. If the anchoring time required at each terminal is added to it, the total time required will be about 4 hours.

5 - 2. Number of Daily Trips and Number of Ships

According to the expected traffic demand in 1985, both of the lines will require two round-trips a day, and one round-trip will be sufficient up to 1980. Therefore, one ferry boat should be sufficient for each line.

The plan of acquiring three ferry boats has the advantage of continuing ferry service even during periodical inspection of ships. However, it will be uneconomical to own an extra ferry boat only for the inspection of other two ferry boats, which takes about three weeks every year.

Additionally, extra crew will be required for an extra ferry, which bring about a considerable economical loss.

It is advised to suspend ferry service for regular inspection during a season when passenger and cargo traffic is relatively light. A substitute ship can be employed during this period to carry passengers and cargo.

Needless to say, it is necessary to choose the same season every year for suspension, as far as possible, and to announce it well in advance.

Table 5 - 1 Calculation of Merit and Demerit for Possession of Three Ferry Boats

1980 (unit : peso)

Merit		Demerit	
Item	Amount	Item	Amount
Benefit	321, 202	Cost for crew Insurance Repayment of loans	500, 400 1, 540, 000 2, 003, 000
Total	321, 202	Total	4, 043, 400

1985 (unit : peso)

Merit		Demerit	
Item	Amount	Item	Amount
Benefit	482, 629	Cost for crew Insurance Repayment of loans	500, 400 1, 540, 000 2, 003, 000
Total	482, 629	Total	4, 043, 400

Let's study the idea of using three smaller ferry boats and making two round voyages a day from the initial stage. The merit is the convenience of users. The more frequently a round trip is made, the more convenient the service will be for users. They can make a trip with only a little waiting time whenever they go to a terminal. However, it has the following demerits.

1) The problem of seaworthiness arises if smaller ferry boats are employed.

2) The boarding efficiency becomes low. If the number of trips is doubled to meet fixed demand, the size of a ferry must be one half to obtain the same efficiency. It is undesirable to use a ferry of one half in size from the view point of safety.

3) The price of ferry boats never falls in proportion to the decrease in size.

4) If two round trips are made daily, the total cruising time will exceed regular working hours. Accordingly, your country must keep two teams of crew.

5) Additional fund will be needed for constructing lodging facilities at terminals. If three ferries are employed for making two round trips in the both lines, one ferry must make two round trips in one of the lines. Let's suppose that two ferries are

operated for Surigao Strait service. It takes 12 hours to make two round trips a day with two ferries. If a ferry departs early in the morning, lodging facilities must be constructed around the terminals, because passengers, drivers and the fellow passengers must stay there on the day before their departure. If a ferry departs late at night, they must lodge at a port of arrival.

Let's suppose that two of the three ferry boats are used in San Bernardino Strait Service. It takes 16 hours to make two round trips. This will require not only lodging facilities, but also complete lighting facilities. This means that your country must amend the legistration of maritime traffic.

6) When the present location of industry and cargo are considered, there is no reason to make a trip within one day.

7) Ferries will have to enter or leave a port at night even before crew get accustomed to the operation yet.

For these reasons, we cannot agree to your plan of using three ferry boats and starting with two round voyages a day in the both lines.

If one ferry boat is used in each line, some temporary measures can be taken during busy seasons. When the number of passengers alone is large, a ferry can take more passengers than its capacity. When the number of vehicles is large, the number of trips can be increased. Such arrangements should be publicly announced in advance.

After starting the car ferry service, it will be necessary to investigate the state of uses (including OD survey), and to try to improve the service, e. g. the number of daily trips.

5 - 3. Crew and Land-Based Employees

Twenty crew consisting of eight officers and twelve crew per ship should be enough. Considering their paid vacation and sick-leave, additional stand-by crew at a certain rate (about 20%) will be required.

The above statement is based on the number of crew of your country's ship and an inboard patrol system by crew on duty during navigation.

As for land employees, one of the terminals of each ferry service should be established as main base. Head Official, Chief of Operation and Administrative Officer (responsible for the administration of operation) should be assigned at this base. Chief of Operation may hold the post of Administrative Officer.

Under them, the Administrative Department and Operation Department of each port should be placed. Total number of employees for the Department of each port will be around eight. The main businesses of the Administrative Department are the sale of tickets, and receipts and disbursements of money. Likewise, those of the Operation Department are the collection of meteorological and oceanographic data, maintenance of vehicles at parking places, guiding for loading and unloading passengers and vehicles, lashing and unlashing.

We do not consider the employees in the Administrative Department, since at the present stage no management body has been identified.

In addition, the Administrative Department of Ships may be also necessary.

5 - 4. Management of Operation

5 - 4 - 1. Significance of Management of Operation

Since safety is important for passenger transportation, a system of managing operation should be established. In case of car ferries, safety must be taken into special consideration, since they carry passengers and vehicles loaded with fuels at the same time. It is a captain who has the right of duties concerning safety of his ship. This, however, comes into effect only after an enterpriser entrusts him with the operation of ship. Accordingly, for the purpose of insuring safety, the standard operational procedure covering following points must be prepared :

1) Manual for planning operation, planning ship arrangement, and planning crew arrangement.

2) Checking system on the maintenance of ships and other facilities.

3) Checking system on loading and unloading passengers and vehicles before departure and after arrival.

4) System of collecting meteorological and oceanographic data, their analysis and criteria for suspending operation.

5) System of communication including messages and advices to the captain and orders to ships at the time of occurrence of accident.

6) Checking system on rescue.

5 - 4 - 2. Operation Management Regulations

1) Suspension of Operation

Suspension of operation is the most important duty among those of operation management. A captain must suspend departure or standard cruise (sailing standard route at standard speed) or entry when meteorological and oceanographic conditions reach or are feared to reach certain levels. If it is difficult for a captain to make a judgement of suspension by himself immediately, he should confer with operation managers. If their opinions differ from each other, departure should be suspended.

Operation managers must be able to order the suspension of departure to a captain when they admit that meteorological and oceanographic conditions have reached or are feared to reach certain level.

2) Diagram of Standard Operation

A diagram of standard operation is prepared not only for the benefits of operators, but also for safe cruise. It contains the graphs and tables covering the following points and is used to make sure that all the operators use the same standard.

a) Service route, regular travel time and service speed.

b) Location of hindrances, such as shallows, shore reeves, traffic-congested areas and so on along the route of cruise.

c) Other points which are necessary for insuring safety of navigation (e. g. where severe patrol should be carried out, where the preparation of engine or casting anchor should be made, where contact with operation managers should be established and so on.

3) Information on Conditions

It is essential for an enterpriser to grasp the conditions of a ship in operation constantly. If arrival is delayed, it is required that passengers waiting for the ship and others involved be informed of the delay, and adequate measures must be taken for unloading passengers after arrival. Especially if arrival is delayed for a long time due to rough sea and so forth, measures for rescue must be considered. For this reason when a ship passes a certain point on a standard route of navigation, her captain is required to inform operation managers of the following mattars : passing point, the time of passing, weather, the direction and force of the wind, the condition of waves and so on.

4) Evacuation of Passengers from Vehicular Deck

Passengers are evacuated from the vehicle deck for the complete safety administration on the vehicle deck with a large number of vehicles fully loaded with fuel. This facilitate the escape of passengers in case of an accident. It should be necessary to prohibit drivers and passengers from remaining on the vehicle deck once their cars are loaded.

5) Inboard Patrol

The inboard patrol system is established not only for fire prevention, but also for the safety of facilities, passengers and cargoes. There must be a set of rules and procedures for patrolling, and a responsible person must be informed of the result of patrol each time.

Especially in case of your country, attention must be paid to the patrol of ship, since many cars which are relatively old and poorly equipped are found. Moreover, it will be also necessary to check cars before loading.

6) System for Emergency

An emergency communication table must be prepared so that actions of rescue and medical attendance would be adequately and promptly taken in case of emergency. Moreover, a system must be established to regulate actions at the time of an accident.

7) Assignment under Emergency and Training

A table of crew assignment under emergency must be prepared to ensure the maximum safety of human lives and cargo. They must be assigned to posts of fire prevention, water prevention and rescue boat. In order to inform crew of their duty in case of emergency completely, the notice must be put up at an adequate place and the training for an emergency must be given.

5 - 5. Actual Training and Advisory Team

Since no car ferry has been operated before in the Philippines, some crew and land-based employees must receive some actual training. For this purpose, it is necessary to dispatch several officers (of the both lines, if possible) and a few land-based employees (prospective operation managers) to some foreign shipping companies with similar services for actual training for certain period. And the crew need to have instructors on ferry boats for guidance for certain period of time at the beginning of the car ferry operations. This O. J. T. should also be applied to the land-based employees.

It is also required that after completion of construction prior to assuming the service, turn-around training according to the time schedule should be carried out for about three round trips in order that crew and land-based employees would become proficient in the job. Crew should also receive berthing and unberthing training.

Several prospective operation managers should be dispatched to a foreign shipping company to study the details of operation management regulations both before and after the beginning of service. The expense for training is not included in the total expenses required.

5 - 6. Calculation of Incomes and Expenditure

5 - 6 - 1. Estimate of Expenses

Since no ferry service has been operated in the Philippines, it is difficult to estimate the cost of operation, but the construction cost. The following is, however, a trial estimate. We made the estimate as moderately as we could and disregarded any taxes and profit.

(1) Construction cost 12 billion yen 29, 600, 000 pesos
(if constructed at a Japanese shipyard)

(2) Operation cost

		annually
Cost of crew (20 + 4 persons)		166, 800 pesos
Cost of fuel and lubricant		
3, 200 h. p.		
unit price	755 pesos per ton	683, 600 pesos
* In Surigao Strait Service the fuel cost will be 1, 042, 600 pesos because the cruising distance is longer.		
Maintenance cost of hulls and engines		70, 000 pesos
Others (including hull insurance)		1, 666, 600 pesos
Total		2, 587, 000 pesos
	(in Surigao Strait	3, 023, 400 pesos)

(3) Expenses required at ports 97, 300 pesos

(4) Wages for land-based employees and general administration expenses 229, 500 pesos

(5) Repayment of loans (the first year) 2, 003, 000 pesos
repayment period 20 years
interest rate 4. 2 %

Total cost ((2) + (3) + (4) + (5)) 4, 916, 800 pesos
(in Surigao Strait Service 5, 451, 000 pesos

5 - 6 - 2. Way to Decide Fare and Freight Rates

How are fare and freight rates determined ? The lowest will be the cost spent for transporting passenger or cargo, that is, shipping expense (including profit). The highest will be the upper limit users' capacity, that is, how much they can pay for transportation.

But actual fare and freight rates are between these two limits. This indicates that they are decided in consideration of national economic policy and social policy.

As both of San Bernardino Strait and Surigao Strait Services constitute a part of Pan-Philippine Highway and act as a substitute for bridges, some may say that the ferry services should be free of charge.

The relation between expenses (= incomes) and fare and freight rates is shown below.

Relation between Expense and Rates

San Bernadino Strait	(Yearly, one trip per day)	Transport volume		Rounded
All the expenses are covered by fares	4, 916, 800 pesos	245, 000	Per passenger	12
		5, 490	Per vehicle	348
(2) + (3) + (4) alone are covered by fares	2, 913, 800 pesos	"		7
		"		214
Surigao Strait				
All the expenses are covered by fares	5, 451, 000 pesos	184, 000	Per passenger	18
		9, 500	Per vehicle	237
(2) + (3) + (4) alone are covered by fares	3, 448, 000 pesos	"		11
		"		145

The Government is free to make any decision on fare and freight rates. If your country charges nothing for ferry services because they are a part of highway your country must bear all the operation cost. We do recommend it since it is financially undesirable.

If all the expenses are covered by fare and freight rates, they become very expensive and your country will be criticized for being unfair in comparison with free public roads.

But fare and freight rates must cover as much expenses as possible in consideration of the national policies. If ferry equipments, services and cruising distance are considered, the minimum fare must be 8 pesos per person for the second class and 9 pesos for the first class, which is the current fare (February, 1976) for Matnog ~ Allen.

Chapter 6. Economic Evaluation

6 - 1. Method of Economic Evaluation

To evaluate the introduction of roll-on roll-off car ferries from the economic view point, a cost-benefit analysis must be made from the view point of the nation-wide economy of the Philippines.

The present project, as discussed later, is considered to have not only direct effects on economy by the improvement of transport system, but also effects on various fields. However, most of these effects are to be realized not only by the present project, but more efficiently by the cooperation with other various projects related to the car ferry service.

Accordingly, the results produced directly by the completion of the present project will be regarded as benefits to evaluate. They are compared with expenses for obtaining the internal rate of return. This method has the merits disregarding depreciation methods way and differences in interest rates. This method is today applied widely to examine the feasibility of various projects. It will be adequate to make the analysis of the 2 years preceding the roll-on roll-off car ferry service and 25 years after that for the following reasons. In the Philippines, the durable years of ships are said to be 25 years and those of harbor facilities are generally between 20 and 30 years. To measure benefits, the state with the ferry service and the state without the ferry service were compared and the difference was considered as the benefits.

6 - 2. Expense of Project

With regard to the expenses of the present project, capital cost including the construction (or purchase) cost of roll-on roll-off car ferries and that of terminal facilities, and cost of operating the roll-on roll-off car ferry service should be calculated. Each of the these costs was given in 2 - 3 - 4.

In making the economic evaluation, preliminary cost must be added to capital cost. It is considered that the construction cost of roll-on roll-off car ferries includes preliminary cost. With regard to the cost of the construction of terminal facilities, 10% and 5% of capital cost was added preliminary cost.

Yearly expenses are given in Table 6 - 1.

Table 6-1 Yearly Expenses

(a) San Bernardino Strait Crossing

Case-1 Case-II (unit : 1000 P)

Year	Case-1 (1)	(2)	(3)	Total	Case-II (1)	(2)	(3)	Total
1976	14,880	11,280		26,160	23,870	9,120		32,990
1977	14,880	11,280		26,160	23,870	9,120		32,990
1978			1,105	1,105			1,756	1,756
~			~	~			~	~
1981			2,089	2,089			2,802	2,802
~			~	~			~	~
1984							3,362	3,362
~							~	~
1987			2,636	2,636			3,922	3,922
~			~	~			~	~
1989							4,949	4,949
1990			3,756	3,756			5,509	5,509
~			~	~			~	~
2002								

Notes : 1) (1) Construction (or purchase) cost of car ferries
(2) Construction cost of terminal facilities
(3) Operation cost
2) Case-I : use of one 59 m type ferry
Case-II : use of two 50 m type ferries
3) The exchange rates used here are ¥300 = U. S. $1. 00, and U. S. $1. 00 = P7. 4.

(b) Surigao Strait Crossing

Case-I Case-II

Year	Case-I (1)	(2)	(3)	Total	Case-II (1)	(2)	(3)	Total
1976	14,880	11,980		26,860	11,940	9,870		21,810
1977	14,880	11,980		26,860	11,940	9,870		21,810
1978			1,479	1,479			2,315	2,315
~			~	~			~	~
1985			2,822	2,822				
~			~	~				
1987			4,165	4,165				
~			~	~				
2002								

Note : 1) Case-I : use of one 59 m type ferry
Case-II : use of one 50 m type ferry

6 - 3. Benefits of the Project

6 - 3 - 1. Expected Benefits

The following economic effects are expected from the realization of the present project.

1) Improvement of Passenger and Cargo Transportation System

a) Transportation cost of the existing marine transport can be saved.

b) Transportation time can be shortened.

c) Loss of cargo, which occurs occasionally during existing marine transport, can be prevented.

2) Promotion of Industry and Regional Development

a) It is expected that various service functions, accompanied by the roll-on roll-off car service, will be formed around terminals.

b) It is expected that industries and areas along the Pan-Philippines Highway will be developed and especially that the nothern Mindanao, Samar Island and Leyte Island, which are less developed as compared with Luzon Island will be well developed.

c) It is expected that sightseeing tour near terminals and the nationwide sightseeing tour will be promoted.

The benefits written above can be realized when the present project and Pan-Philippine Highway start to work together as the main artery in the Philippines. Especially with regard to 2), it may be said that promotion of industries and regional development is depends largely on the Pan-Philippine Highway Project and development projects in other fields. Since the present project and Pan-Philippine Highway constitute the most important project of the Philippines, it should not be forgotten that important benefits besides economic effects can be expected.

6 - 3 - 2. Benefits to be Calculated

As for benefits of the present project, economic effects attributable to the improvement of passenger and cargo transport system, mentioned in 5 - 3 - 1, must be considered. These economic effects are listed below.

- Saving of Transportation Cost of the Existing Marine Transport
  - Saving of Marine Transportation Cost
    - Passengers
    - Cargoes
  - Saving of Equipment Cost of Other Harbor Facilities
- Shortening of Transportation Time of the Existing Main Transport
  - Passengers
  - Cargoes
- Prevention Against the Loss of Cargo

1) Saving of Transportation Cost of the Existing Marine Transport

a) Saving of Marine Transportation Cost

When roll-on roll-off car ferry service starts, the passenger and cargo transportation cost of the existing marine transport will become completely unnecessary. As to passengers and cargoes crossing the San Bernardino Straits, the benefits produced by saving transportation cost are supposed to be 11 pesos per passenger and 89 pesos per ton on the average. Likewise, as to passengers and cargoes crossing the Surigao Strait, 13 pesos per passenger and 93 pesos per ton will be saved.

b) Saving of Equipment Cost of Other Harbor Facilities

Judging from the conditions of harbors of the Philippines, no cost will be required for improving harbor facilities. Saving of equipment cost of harbor facilities is regarded to be equal to 76, 000 pesos on the condition that the growth rate of passenger traffic is 1, 000 persons a year. Here, the evaluation is based on the assumption that harbor facilities mean only moorings and that their durable years are 25 years.

2) Shortening of Transportation Time of the Existing Marine Transport

The composite transportation of roll-on roll-off car ferries and the Pan-Philippine Highway shortens transportation time sharply in comparison with the existing marine transport. The benefits produced by shortening transportation time is regarded to be equal to 0. 8 peso per passenger and 5 pesos per ton at the San Bernardino Straits. Likewise, 0. 7 peso per passenger and 5 pesos per ton will be saved at the Surigao Straits.

3) Prevention of the Loss of Freights

About 2% of the cargo carried by the existing marine transport is said to be lost during transportation, including loading and unloading. The benefits produced by this prevention are assumed to be equal to 20 pesos per ton.

Annual benefits produced by traffic growth are shown in Table 6-2.

Table 6-2 Benefit Earned Each Year

1) San Bernardino Straits

Case-I (unit : 1, 000, 000 P)

year	1)-a) passengers	1)-a) cargoes	1)-b)	2) passengers	2) cargoes	3)	Total
1978	1. 6	0. 2	1. 5	0. 1	0. 0	0. 1	3. 5
79	1. 8	0. 2	1. 5	0. 1	0. 0	0. 1	3. 7
80	2. 1	0. 2	1. 7	0. 1	0. 1	0. 3	5. 6
81	2. 3	1. 3	1. 7	0. 2	0. 1	0. 3	5. 9
82	2. 6	1. 4	1. 9	0. 2	0. 1	0. 3	6. 4
83	2. 9	1. 4	2. 1	0. 2	0. 1	0. 3	7. 0
84	3. 3	1. 4	2. 3	0. 2	0. 1	0. 3	7. 7
85	3. 7	1. 5	2. 2	0. 3	0. 1	0. 3	8. 1
86	4. 2	1. 5	2. 6	0. 3	0. 1	0. 3	9. 0
87	4. 7	1. 6	2. 7	0. 3	0. 1	0. 4	9. 7
88	5. 3	1. 6	2. 7	0. 4	0. 1	0. 4	10. 5
89	5. 9	1. 7	3. 0	0. 4	0. 1	0. 4	11. 5
90	6. 7	1. 7	3. 0	0. 5	0. 1	0. 4	12. 4
91	7. 5	1. 8	3. 3	0. 5	0. 1	0. 4	13. 6
92	8. 5	1. 9	3. 2	0. 6	0. 1	0. 4	14. 5
93	9. 5	~	3. 3	0. 7	~	~	15. 9
94	10. 7	~	3. 4	0. 8	~	~	17. 3
95	12. 0	~	3. 4	0. 9	~	~	18. 7
96 ~ 2002	~	~	0	~	~	~	15. 3

Case-II

year	1)-a) passengers	1)-a) cargoes	1)-b)	2) passengers	2) cargoes	3)	Total
1978							
79							
80							
81							
82							
83							
84							
85			Same as the above				
86							
87							
88							
89							
90							
91							
92							
93	9. 5	1. 9	3. 3	0. 7	0. 1	0. 4	15. 9
94	9. 5	1. 9	0	0. 7	0. 1	0. 4	12. 6
95 ~ 2002	~	~	~	~	~	~	~

2) Surigao Straits

Case-I

year	1)-a) passen-gers	1)-a) cargoes	1)-b)	2) passen-gers	2) cargoes	3)	Total
1978	1. 0	1. 3	1. 1	0. 1	0. 1	0. 3	3. 9
79	1. 3	1. 4	0. 7	0. 1	0. 1	0. 3	3. 8
80	1. 4	1. 5	1. 0	0. 1	0. 1	0. 3	4. 5
81	1. 6	1. 7	1. 0	0. 1	0. 1	0. 4	4. 8
82	1. 8	1. 9	1. 0	0. 1	0. 1	0. 4	5. 2
83	1. 9	2. 1	1. 2	0. 1	0. 1	0. 4	5. 9
84	2. 2	2. 3	1. 4	0. 1	0. 1	0. 5	6. 6
85	2. 5	2. 5	1. 4	0. 1	0. 1	0. 5	7. 2
86	2. 8	2. 7	1. 3	0. 2	0. 1	0. 6	7. 7
87	3. 1	3. 0	1. 5	0. 2	0. 2	0. 6	8. 6
88	3. 5	3. 3	1. 8	0. 2	0. 2	0. 7	9. 7
89	4. 0	3. 6	1. 7	0. 2	0. 2	0. 8	10. 5
90	4. 5	4. 0	1. 7	0. 3	0. 2	0. 9	11. 6
91	5. 1	4. 4	1. 8	0. 3	0. 2	0. 9	12. 7
92	5. 7		1. 8	0. 3			13. 4
93	6. 4		2. 0	0. 4			14. 3
94	7. 2		1. 9	0. 4			15. 1
95	8. 1		1. 9	0. 5			16. 0
96	9. 1		2. 0	0. 5			17. 2
97	10. 3		1. 8	0. 6			18. 2
98			0				16. 4
2002							

Case-II

year	1)-a) passen-gers	1)-a) cargoes	1)-b)	2) passen-gers	2) cargoes	3)	Total
1978							
79							
80							
81							
82			Same as the above				
83							
84							
85	2. 5	2. 5	1. 4	0. 1	0. 1	0. 5	7. 2
86	2. 8	2. 5	1. 3	0. 2	0. 1	0. 5	7. 4
87	3. 1	2. 5	1. 5	0. 2	0. 1	0. 5	7. 9
88	3. 1	2. 5	0	0. 2	0. 1	0. 5	6. 5
89							
2002							

6 - 4. Comparison of Cost and Benefits

On the basis of these assumptions, we obtained the internal rate of return by reducing the cost and benefits of the present project at various discount rates.

We came to the following conclusions :

1) San Bernardino Strait Crossing

Case-I	10%
Case-II	5%

2) Surigao Strait Crossing

Case-I	9%
Case-II	5%

Accordingly, the project of Case-1 will be feasible from the view point of the national economy of the Philippines.

If we consider the fact that we reservedly calculated the benefits of the project for the economic evaluation and that other important benefits may be produced, the investment in the present project is said to be more and more adequate.

And these benefits are calculated by the following method.

1) Saving of Transportation Cost

(Passenger) (Fare by land from origin to the nearest port + Shipping fare + Fare by land from the nearest port to destination) - (Fare by land from origin to a terminal + Fare by land from a terminal to destination)

(Cargo) (Freight rates from origin to the nearest port + Cost for loading and unloading and storage fee at a port + Freight rates by land from the nearest port to destination) - (Freight rates by land from origin to a terminal + Freight rates from a terminal to destination)

2) Saving of Equipment Cost of Other Harbor Facilities

Construction cost per one meter of mooring equipment ÷ Cargo handling capacity per one meter of mooring equipment x i/25

Note) i is a number of year during which the equipment is used.

3) Shortening of Transportation Time of the Existing Marine Transport

(Passengers) [(Time by land transport from origin to the nearest port + Time by land transport from the nearest port to destination + Time by maritime transport) - (Time by land transport from origin to a terminal + Time by care ferry + Time by land transport from a terminal to destination)] × (GNP per capital × $\frac{1}{24}$ × $\frac{1}{365}$)

(Cargoes) [(Time by land transport from origin to the nearest port + Time for loading, unloading and custody at a port + Time by land transport from the nearest port to destination) - (Time by land transport from origin to a terminal + Transportation time by car ferry + Time by land transport from a terminal to destination)] x (Cost of freights x The rate of interest x $\frac{1}{24}$ x $\frac{1}{365}$)

4) Prevention Against the Loss of Freights

Cost of freights x 0.02