REPUBLIC OF INDONESIA

FEASIBILITY STUDY REPORT ON THE DEVELOPMENT PLAN OF THE PORT OF SEMARANG

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PREFACE

At the request of the Government of the Republic of Indonesia, the Government of Japan decided to conduct a survey on the development of Semarang Port, by the Japan International Cooperation Agency (JICA).

The Agency dispatched in August 1977 a survey team headed by Mr. Kazuhiro Koshiro, Director of the Overseas Coastal Area Development Institute of Japan and conducted a field survey, including the soil study, with the cooperation of the Government and organizations concerned of Indonesia.

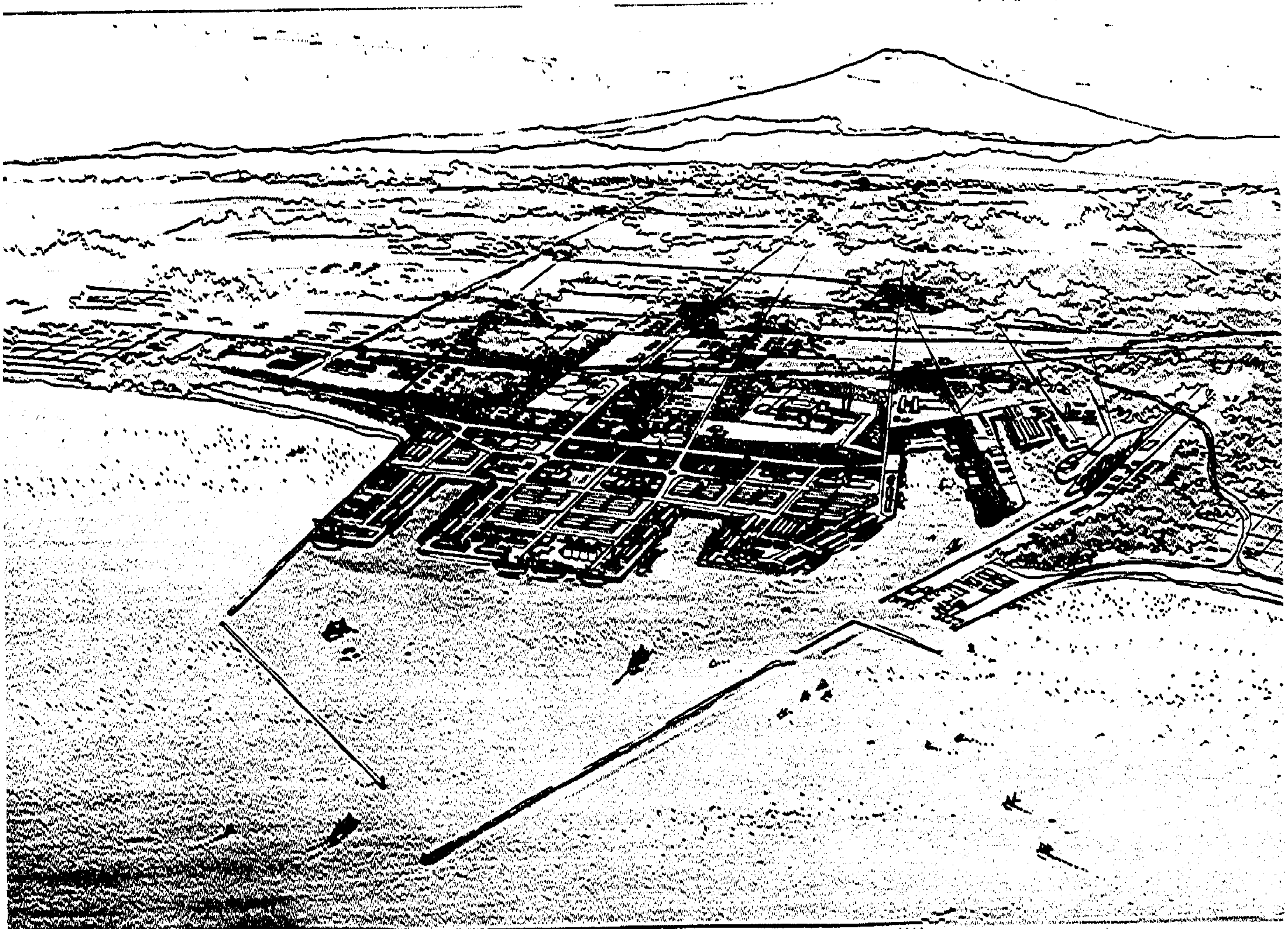
After completion of a field survey, the survey team analysed and evaluated the findings and data obtained, discussed matters including construction cost with concerned Indonesian officials and have completed the present report for submission to the Indonesian Government.

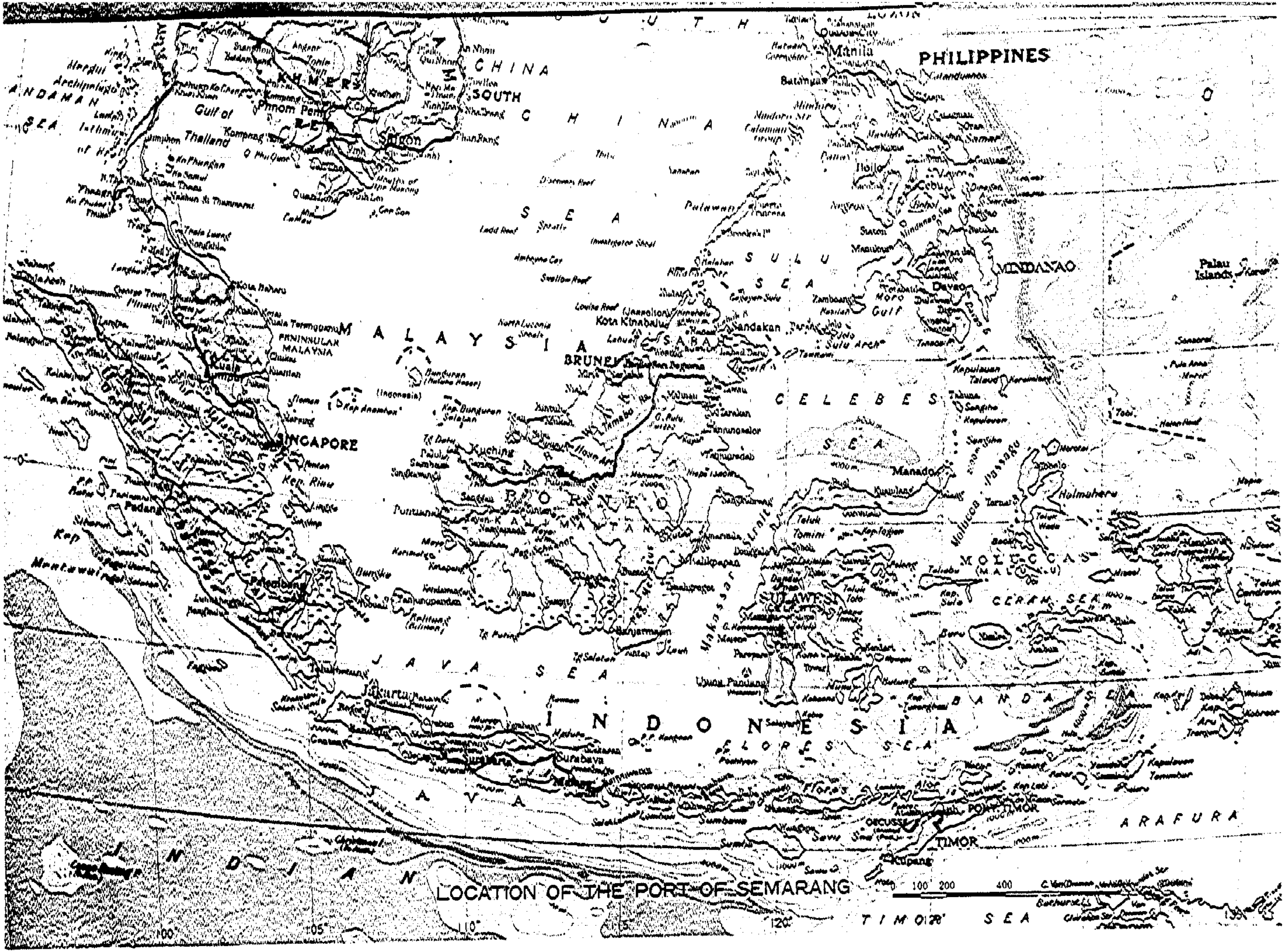
I hope that the present report will contribute through the development of the Semarang Port Development Project and promote in Indonesia's economic development and to the closer friendly relations between Indonesia and Japan.

I would like to express my heartfelt appreciation to the Government and the people concerned of Indonesia for their cooperation extended to the survey team.

June , 1978

Shinsaku Hogen
President
Japan International Cooperation Agency
Tokyo, Japan





LOCATION OF THE PORT OF SEMARANG

STUDY ORGANIZATION

The Japan International Cooperation Agency (JICA), official agency responsible for implementation of the technical cooperation programs of the Government of Japan, organized a Semarang Port Feasibility Study Team of the following membership in order to arrange a Master Plan of Port Development and has sent this team for on-site studies in September, 1977.

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SUMMARY

I. Introduction

The port of Semarang is situated nearly at the center of the Java Sea coast of the Java Island and is one of the typical ports in the Province of Central Java. The port has the largest city in Central Java or the city of Semarang in the background and is linked closely to the other Java Sea coastal cities as well as inland cities by way of road and railway networks. Thus, it is developing its status and function steadily, marking the cargo handling as high as 570,000 tons for foreign trade and 240,000 tons for domestic trade or total 810,000 tons except the oils of PERTAMINA in 1976.

The port has a wharf of 5.5m water depth presently, but the access channel is of a water depth of only 4m or less because of the littoral drift carried on the longshore current. As the result, medium and greater size vessels are unable to enter the port directly and are thus bound to rely on the offshore cargo loading and unloading, this presenting a big problem to be resolved urgently for the port.

II. Basic Conception of Semarang Port Development

1. Characteristics of Port to be Developed

The port to be developed at this time in Central Java should have port characteristics necessary to a base for citizen's economic activities, in the process of selecting optimum policy for its improvement, since a port equipped with foundation for transportation and production combined is indispensable for the regional development of the area being considered.

2. Location of Port to be Developed

As a result of assessment in view of natural conditions, social-economic conditions and the pattern of foreign trade, the following conclusion will be derived.

(1) For promoting economic development in Central Java and for assuring harmonized progress of whole Indonesia, a foreign trade port with proper scale and functions must be provided for improvement in an earliest possible time in Central Java.

(2) The foreign trade port to be developed now, should be located along the coast of the Java Sea and it is considered that necessity to provide another port than existing port of Cilacap on the coast of the Indian Ocean is almost none.

(3) As the result of assessment in view of natural condition, inland transport networks and accumulation of port functions and port properties in Central Java, the site to be proposed for the port development in Central Java along the coast of the Java Sea is the port of Semarang.

This development should be made in an area adjacent to the existing port in order to utilize existing port facilities as much as possible.

III. Natural Condition of the Port of Semarang

1. Meteorological and Oceanographical Conditions

(1) The port of Semarang is situated on the alluvial lowland fostered by the Semarang River, and West and East Banjir Canals.

The East Canal is supposed to be the main source of sediment supply down to the coast.

(2) The beaches on both sides of the port are inclined at a gentle gradient of one to four hundreds.

The coastal sediment mainly comprises clay and sand as thick as 50m or more.

(3) The northwest monsoon prevails in rainy season, and the southeast monsoon in dry season.

The wind direction near the coast is predominantly affected by diurnal change of the wind direction caused by sea and land breezes rather than seasonal change caused by monsoon.

(4) Wind velocity and wave height generally reach their maximum value in the afternoon.

(5) The tide in and around the port ranges within 80cm, usually diurnally or semi-diurnally with tidal inequality.

(6) In the Java Sea, the ocean current flows in the same direction as in the wind direction of monsoon. However, a counter current may occur along the coast.

(7) The significant wave height is estimated at 2m with the probability of occurence of once in five years.

2. Soil Conditions

According to the soil investigations conducted by the Gadjah Mada University, P.L.T.U. and the Japanese Team, it is revealed that the soils in the port area consist of soft clayey silt or silty clay lying between the ground level and the depth of about 25m below L.W.L. and that this layer is underlain by medium to stiff clay continuing down to the depth of about 39m below L.W.L.

The unconfined compressive strength qu of the cohesive soil between the surface and the depth of about 25m is shown below:

(1) Offshore area

$qu = (0.8 + 0.24\ Z)\ t/m^2$ Z: depth below L.W.L. -4.0m

(2) Onshore area

$qu = (1.2 + 0.28\ Z)\ t/m^2$ Z. depth below L.W.L. ±0.0m

IV. Predictions of Population, GDP and Port Traffic

1. Port Service Area

Establishment of the service area of the port of Semarang is made through analysis upon port arrangement and road and railway networks in the island of Java, and by analysis of the potentials of the ports in Central Java.

The port service area covers the area of Central Java excluding Kabupaten of Brebes, Tegal, Cilacap, Banyumas, Purbalingga, Banjarnegara and Kebumen and whole area of D.I. Yogyakarta.

2. Population

(Unit: million persons)

Region	1973	1976	1985	2000
Indonesia	126.1	135.0	165.7	220.0
Central Java	22.60	23.59	27.61	35.89
Yogyakarta	2.55	2.65	3.02	3.81
Service Area	18.62	19.36	22.30	28.15

3. GDP

(Constant 1973 price)

	1973	1976	1985		2000	
			H.P.	L.P.	H.P.	L.P.
Central Java						
1) GDP (Billion Rp.)	706.9	813.7	1,744	1,474	6,887	4,066
2) Per Capita GDP (Rp.)	31,280	34,490	63,170	53,390	191,900	113,290
(U.S.$)	(75.4)	(83.1)	(152)	(129)	(462)	(273)
Yogyakarta						
1) GDP (Billion Rp.)	99.1	126.7	236	201.5	902	482.4
2) Per Capita GDP (Rp.)	38,860	47,810	78,150	66,710	236,750	126,610
(U.S.$)	(93.6)	(115)	(188)	(161)	(570)	(305)
Service Area						
1) GDP (Billion Rp.)	624.3	731.3	1,532	1,297	6,019	3,503
2) Per Capita GDP (Rp.)	33,530	37,770	68,700	58,160	213,820	124,440
(U.S.$)	(80.8)	(91.0)	(166)	(140)	(515)	(300)
Indonesia						
1) GDP (Billion Rp.)	6,753	8,246	15,302		42,218	
2) Per Capita GDP (Rp.)	53,550	61,080	92,350		191,900	
(U.S.$)	(129)	(147)	(223)		(462)	

Note: L.P. (Low Projection) is a case where the GDP of Central Java in and after 1979 would show an equal rate of growth to the national mean at 7.0%.

H.P. (High Projection) is a case where Central Java would realize a higher rate of growth than the national mean (7.0%) so that the per capita GDP would overtake the national mean in 2000.

4. Port Traffic

(Unit: 1,000 tons)

	1976	1980		1985		2000	
		L.P.	H.P.	L.P.	H.P.	L.P.	H.P.
Foreign Trade	569.6	650	690	780	870	1,960	3,000
Export	77.8	100	100	130	130	280	330
Import	491.8	550	590	650	740	1,680	2,670
Domestic Trade	238.5	380	420	740	860	1,980	3,360
Outbound	102.3	140	150	200	230	710	1,180
Inbound	136.2	240	270	540	630	1,270	2,180
Total	808.1	1,030	1,110	1,520	1,730	3,940	6,360

V. Long Term Development Program

1. Layout Plan

(1) The most recommendable plan selected from the three alternatives "A", "B" and "C" in the Interim Report will be Master Plan "A", which is considered to assure well-coordinated functional operations of the port.

(2) Expected changes in port operation and shipping technologies such as containerization are considered into the scheme.

2. Wharf Plan

Deep sea general cargo wharf and regional harbour facilities are planned as follows.

Description	Unit	Year of 2,000 High Projection	Year of 2,000 Low Projection	Remarks
Deep sea general cargo wharf				Import/Export
Cargo volume	1,000t	3,000	1,960	
Number of wharves	Berth	17	11	-10^m in depth
Regional harbour				Domestic Trade
Cargo volume	1,000t	3,360	1,980	
Length of wharves	m	820	Not required	for Interinsular Vessels

3. Construction costs and investment schedule

Construction costs and investment schedule are estimated as follows.

(Unit: U.S.$1,000)

Description	1978-1980 (Urgent)			1981-1985 (Short Term)			1986-2000 (Long Term)			Grand Total 1978-2000
	Local Currency	Foreign Currency	Total	Local Currency	Foreign Currency	Total	Local Currency	Foreign Currency	Total	
PLAN A-1 at High Projection	24,220	60,740	84,960	30,440	58,690	89,130	41,330	65,920	107,250	281,340
PLAN A-1 at Low Projection	24,220	60,740	84,960	22,550	50,870	73,420	27,520	49,070	76,590	234,970
PLAN A-2 at High Projection	18,030	41,430	59,460	37,940	82,220	120,160	41,330	65,920	107,250	286,870
PLAN A-2 at Low Projection	18,030	41,430	59,460	30,000	74,450	104,450	27,520	49,070	76,590	240,500

Note. 1) The wharf s scale at high and low projection for the Urgent Improvement Program are the same, thus, the investment costs are equal.

2) The Urgent and Short Term Development Program at high and low projection have been classified as PLAN A-1 and A-2. The Long Term Development Program has been classified as PLAN A only.

3) PLAN A-1 includes the construction of West Breakwater up to a water depth of -6m, North Breakwater and East groin in the Urgent Improvement Program.

4) PLAN A-2 includes the construction of the West Breakwater up to a water depth of -5m in the Urgent Improvement Program, the remaining portion of the West Breakwater, North Breakwater and East groin will be installed during the Short Term Development Program.

5) An annual rate of 7 percent was estimated for elevation of the commodity prices. Thus, the extra rate due to price elevation is 15 percent in the Urgent Program or 40 percent in the Short Term Program, but no extra rate is considered in the Long Term Program.

VI. Short Term Development Program

1. Wharf Plan

Deep sea general cargo wharf and regional harbour facilities are planned as follows.

Description	Unit	1980 Urgent	Year of 1985 High Projection	Year of 1985 Low Projection	Remarks
Deep sea general cargo wharf					Import/Export
Cargo volume	1,000t	690	870	780	
Number of wharf	Berth	3	6	5	-10^{m} in depth
Regional harbour					Domestic Trade
Cargo volume	1,000t	420	860	740	
Length of new wharf	m	–	–	–	
Required existing wharf length	m	670	1,550	1,330	

2. Structural Types of Breakwaters and Wharf

(1) West Breakwater

The design wave characteristics for the proposed West Breakwater are as follows:

Significant wave height $H_{1/3} = 2.0^{m}$

Wave period $T_{1/3} = 6.0^{sec}$

Three alternative structural types have been proposed for this breakwater taking into consideration the soft soils prevailing at the site, the necessity of preventing the inflow of littoral drift, and other pertinent factors.

The alternatives are listed below.

a) Steel sheet pipe pile type
b) Rubble mound sloping type and
c) Combination of coupled steel piles and steel sheet piles.

The structural type in item c) above, considered the most economical, has been selected taking account of the comments made by the competent Indonesian authorities on the Interim Report as well as various considerations, such as the ease of maintenance and repair after the completion of the structure, availability of major construction materials and plant, and the ease of execution.

For the proposed North Breakwater, the same structural type as for the West Breakwater has been chosen because the design conditions are the same for both structures.

(2) East Groin

The design wave characteristics for the head and main sections of this structure are as follows:

For head section

Significant wave height $H_{1/3} = 1.0^{m}$

Wave period $T_{1/3} = 4.0^{sec}$

For base section

Significant wave height $H_{1/3} = 0.3^{m}$

Wave period $T_{1/3} = 3.0^{sec}$

For the head section, a L-block type of structure is proposed which will consist essentially of a rubble mound with bamboo mattresses spread underneath, so that this section may be easily removed and reused for other purposes in case of future expansion of the port facilities.

A simple reinforced concrete pile type (consisting of the piles driven in a single row) is proposed for the base section of the groin to cope with possible accumulation of sand drift up to the level of +1.0m along the seaward face of the groin, besides meeting the design wave characteristics mentioned above.

(3) Wharf

For the - 10m wharf, a relieving platform type pier is considered the most appropriate structural type in the light of the extremely soft soils encountered at the site, and the necessity of insuring a high degree of reliability in the construction operations.

Comparative analysis has been made of steel pipe piles and prestressed concrete piles as the foundation for the proposed relieving platform type pier. In consequence, the steel pipe pile has been selected because of its definite advantages over the prestressed concrete pile, such as the ease of handling and driving.

3. Main Facilities

Main facilities in the scheme are shown below.

Description	Unit	1976 Existing	1980 Urgent	1985 Short Term	Remarks
Breakwater	m	1,830			
PLAN A-1	m		4,550		Total 4,550m
PLAN A-2	m		1,250	3,300	Total 4,550m Include 2,640m for sailing vessel
Wharf	m	4,610			
At High Projection	m		545	555	Total 6 berths
At Low Projection	m		545	370	Total 5 berths
Dredging	m^3		5,020,000	9,170,000	Total 14,190,000
Maintenance dredging	m^3/year	400,000			
at PLAN A-1	m^3/year		870,000	870,000	
at PALN A-2	m^3/year		1,140,000	870,000	

4. Construction Schedule

Construction schedule is shown below.

Year	1	2	3	4	5	6	7
Urgent Improvement Program							
Engineering study	—						
Construction work		—	—				
Short Term Development Program							
Engineering study			—				
Construction work				—	—	—	—

5. Construction Costs

Construction costs for Urgent Improvement and Short Term Development Program are shown in the paragraph V-3 of the Summary.

6. Maintenance Dredging

(1) After the completion of extended West Breakwater (PLAN A-2, in the Urgent Improvement Program), the amount of annual dredging required is estimated as 1,140,000 m^3.

(2) After the completion of North Breakwater and East Groin (PLAN A-1, in the Urgent Improvement Program), the amount of annual dredging required is estimated as 870,000 m^3

VII. Economic Analysis

1. Cost Benefit Analysis

The way of computing costs and benefits is as follows.

(1) Costs
- Construction costs
- Maintenance dredging costs
- Operation costs and repair and maintenance costs

(2) Benefits
- Benefit accruing from change of offshore to quayside cargo handling
- Benefit of handling the cargos via the ports of Tg. Priok and Surabaya directly at the ports of Semarang

(3) In computation of costs, shadow wage rate is applied and the total amount of sales tax is deleted from the costs.

(4) Costs and benefit are computed over 30 years of lifetime and benefits after that are covered by the residual value of investment.

2. Internal Rate of Return (I.R.R.)

Improvement/Development Program	Low Projection PLAN A-1	Low Projection PLAN A-2	High Projection PLAN A-1	High Projection PLAN A-2
Urgent	10.6%	15.0%	10.7%	15.2%
Short Term	10.5%	–	11.9%	12.6%
Long Term	–	–	12.8%	–

VIII. Financial Analysis

1. Assumption of the Analysis

(1) The port of Semarang will be operated on a self-paying accounting system.

(2) The investment funds for the port are covered by the development fund (free of interest) of the Indonesian Government for 30%, and loans from foreign countries for the remaining 70%.

(3) The maintenance dredging cost in future is assumed to be covered by the revenue of the Indonesian Government.

(4) Computation of port revenue is based upon the assumption that unit port charges in 1985 are raised by 2.0 times average over those in 1976.

As a result, revenue and expenditure and financial position of the port of Semarang will undergo transitions as follows: (High projection, PLAN A-1, Case II)

(Unit: million Rp.)

	1976	1985	2000
Port revenue	869	3,690	5,860
Profit after depreciation & interest	67	-190	980
Total assets	3,243	64,123	64,063
Net current assets	1,066	4,856	4,796
Fixed assets	2,177	59,267	59,267
Long-term loans		39,960	15,960
Government development fund	1,632	19,362	19,362
Operating ratio (%)	92	74	75
Return on net fixed assets (%)	5	2	4

Table of D.C.F. rate of return restricted to revenue and expenditure of the port is as follows.

	High Projection	Low Porjection
PALN A-1	3.3%	2.9%
PLAN A-2	3.4%	3.0%

CONCLUSION AND RECOMMENDATION

I. Conclusion

This project is intended to construct a foreign trade 3 berth wharf of a water depth of 10m, an access channel of a tentative water depth of 9m and breakwaters in the Urgent Improvement Program which is the first phase of the development and thus resolve the off-shore loading and unloading which is an urgent problem for the port and, at the same time, initiate the development of a real foreign trade commercial port, which is to contribute to the regional development of the service area, according to the second phase Short Term Development Program.

As discussed in details in the present report, this port is located at the most idealistic point in the relationship with its foreland and service area and also from the natural conditions and is considered to be one of the priority projects indispensable for promoting the regional development of Central Java Province.

With this project completed, distribution of the commodities to the service area will be rationalized, and the transport cost be reduced. Then, the people will have the general consumption goods supplied at cheaper price and be able to enjoy better living. For the industries, its effect is very great. Particularly for the manufacturing industries, the competitive force will increase as the transport cost of materials and products are reduced so that new industrial locations will be accelerated.

For the port itself, it is expectable that its development will have great effects on the city of Semamag in its background. That is, accompanying the commercial port, there will be promoted the distribution and processing industries, information industry, sales trade, etc. to improve the city functions and consequently the central management function of the city of Semarang for the productive, political and cultural activities in the whole service area, thus enabling further development of the city of Semarang.

Evaluating the project from the result of economic analysis, there was obtained an internal rate of return of 11 to 13 percent for the Urgent and Short Term Programs, although it would vary more or less depending on the increasing rate of cargos and the construction schedule of breakwaters. Further, for the Long Term Development Program, an internal rate of return of 13 percent or more is obtainable so that it may be said that the present project is a fairly well feasible project.

Further, according to the result of financial analysis, it is unavoidable to raise the port dues during the investment period to cope with the increasing expenditure, but the D.C.F. internal rate of return is more than about 3 percent for the Urgent Improvement Program and Short Term Development Program. Moreover, when the operation ratio and return on net fixed assets are taken, they turn favorable from the year of 1986 when the depreciation begins to decrease. Thus, in any case, financial viability is observed.

II. Recommendation

1. Inducement and Location of Coastal Industries

In this report, the development of the port of Semarang has been examined along the direction toward a commercial port contributing mainly to the regional development of the service area. But, as pointed out reiteratedly in this report, it is considered to be desireable for insuring the effect of the project and accelerating the economic development of the service area to induce and locate the coastal industries around the port.

Now that the existing industrial development areas or the vicinities of both cities of Jakarta and Surabaya have already been overcrowded recently, the peripheral area of the city of Semarang blessed with land, labour force and market will be an attractive new world for the enterprises. Construction of an industrial estate is already included in PELITA II, and it is a precisely pertinent conception, and it is urgently desired to carry out the industrial estate project positively and concurrently with the port development. In such case, there may be considered, as the industries adapted for coastal location, the weight industries of which a costdown is expectable by marine transportation and trade dependent industries relying on the overseas for acquisition of materials and sales of products. However, for determination of specific kinds and scales of such industries, it is required to add a more detailed examination.

2. Recomendations of Improving the System

(1) There are some points requiring immediate study in the assignment of personnel, distribution of the work and share of the responsibility, and there should be an adequate personnel plan conforming to the work load.

The Divisions of ADPEL to be given the priority for expansion and reinforcement are Technical Division, Maintenance Dredging Division and Service Division.

(2) It is important to have an opportunity where it is enable to hear candid opinions of and to discuss with the responsible persons of the Local Government and Regional Planning Agency.

As specific measure for such purpose, it will be adequate to provide a permanent committee and also a development liaison conference with participation of the responsible officers of the organizations concerned with the development and have such conference periodically.

(3) To avoid the confusion due to change of the port cargo handling method is also very important subject, introduction of the cargo handling machines should not be made in haste but stepwise with ample time allowed to cope with the qualitative improvement and progress in job conversion of the labourers.

Chapter-1
Overview

CHAPTER 1
OVERVIEW

1-1 Introduction

In response to the request of the Government of the Republic of Indonesia, the Government of Japan made a decision to provide a master plan for Semarang port Development Project and to perform feasibility study for the project in conformity with laws and regulations of Japan as part of its technical cooperation programs.

The Japan International Cooperation Agency (JICA), an official agency responsible for implementation of the technical cooperation programs of the Japanese Government, decided to carry out this study in close cooperation with the Government of Indonesia and sent the Study Team for performing and completing this study.

1-2 Purposes of Survey

The purposes of making the master plan for Semarang Port Improvement Project and the feasibility study for the project are defined in the Scope of Works for the study as having been agreed upon by both Government of Indonesia and Government of Japan, as indicated below.

(1) The port of Semarang now owns the wharf with the depth of 5.5 m but the depth of the access channel is less than 4 meter by the reason of siltation which is occurred by littoral drift, so that vessels larger than middle size class are unable to enter this port directly, for the time being. Therefore, calling ocean going vessels are presently relying upon offshore loading-unloading without choice. Urgent Improvement Program required to improve this conditions and to solve the problems must be prepared.

(2) As a part of improvement on infrastructure in relation with Central Java overall development project, the expansion and improvement plan for the port of Semarang must be made on the basis of long-range outlook for the future.

1-3 Objects and Methods of Study

Items to be taken into consideration in making this plan were clearly indicated in the Scope of Works as also indicated below.

The study was conducted in the following manners:

(1) Collecting and reviewing existing study reports, and hearing and analyzing information

and opinions within Japan.

(2) Collecting and analyzing data and materials and collecting and analyzing engineering data through the field survey and investigation within Indonesia.

The survey within Indonesia was conducted in the following manner:

(1) Data and information were collected mainly from central governmental departments and related organizations where we directly visited mostly within the city of Jakarta, and our studies were conducted. Visited authorities and organizations were:

- BAPPENAS
- Department of Communications and Tourism
- Department of Agriculture
- Department of Mining and Industry
- Department of Public Works
- Department of Commerce
- Central Bureau of Statistics
- Directorate General of Water Resources Development
- Directorate General of Irrigation
- Directorate General of Sea Communications

(2) Data and information were collected for our studies mainly from local governmental bodies and related organizations by directly visiting them within the city of Semarang. Visited departments and related organizations were:

- Semarang Port Administration (ADPEL Semarang)
- Directorate General of District Sea Communications (KANWIL HUBLA)
- Regional Development Planning Agency (BAPPEDA)
- Semarang City Office
- Local Government of Central Java
- Statistics Office
- Meteorological Station
- Representative Department of Communications of Central Java
- Highway Office
- Railway Office

(3) Selected ports related to the development of the port of Semarang were visited, data required to study were collected and information was gathered by hearing mainly. Great cooperation for this study was served by the Port Administration of each port. Ports visited were: -

Ports visited were:

- Port of Surabaya
- Port of Tg. Priok
- Port of Sunda Kelapa
- Port of Cilacap
- Port of Cirebon
- Port of Tegal
- Port of Pekalongan

(4) For the purposes of collecting engineering data of soil investigation implemented in and around the port of Semarang and of hearing of engineering information, we visited Faculty of Engineering of Gadjah Mada University in Yogyakarta.

(5) Soil investigation in the port of Semarang
In the site proposed for extension of the port of Semarang, soil test and investigation were conducted up to −30 to −40 meters in depth at two points on the sea sites and one point on the land using rotary type boring machine and thin wall sampler for collecting basic information for designing of port facilities, and technology transfer in this field to the counterparts of Indonesia was also conducted by the Study Team in access.

(6) Investigation of siltation at the port of Semarang
Bottom materials and water properties which were considered to be related to siltation at the Access Channel, Basin and Anchorage were investigated at the site, and data required for analysis were collected and technology transfer in this field to the counterparts of Indonesia were implemented completely.
Subjects of study and methods of investigation employed are indicated below,

1) Observation Point-A (3 km offshore from end of West Breakwater, depth of −8m)
- Observation of current velocity and its direction;
  Observed at one-hour intervals for a duration of 25 hours at −1m, −4m and −7m below sea level
  Type CM-II current meter was used.
- Observation of water temperature and specific gravity;
  Observed at one-hour intervals for a duration of 25 hours at −1m, −4m and −7m below sea level
  Water sampler was used for sampling
- Measurement of suspended materials;
  Measured at one-hour intervals for a duration of 25 hours at −1m, −4m and −7m below sea level.
  Water sampler was used for sampling

2) Observation Point B_1, B_2 and B_3 (front end of West Breakwater, estuary of East Canal and West Canal)

- Observation of current speed and direction;

  Observed at thirty minutes intervals for a duration of 5 hours at −1m and −2m below sea level.

  Type CM-II current meter was used.
- Observation of water temperature and specific gravity;

  Observed at thirty minutes intervals for a duration of 5 hours at −1m and −2m below sea level.

  Water sampler was used for water sampling
- Measurement of suspended materials;

  Observed at thirty minutes intervals for a duration of 5 hours at −1m and −2m below sea level.

  Water sampler was used for water sampling

3) Observation Point C-1, 2, 3, 4, 5 and 6 (along a line drawn offshore from the estuary of East Canal)

   Observation Point D-1, 2, 3, 4, 5 and 6 (along a line drawn offshore from the estuary of Semarang River)

   Observation Point E-1, 2, 3, 4, 5 and 6 (along a line drawn offshore from the estuary of West Canal)

   - Sampling survey of sea bottom materials

     Sea bottom materials were sampled by sampler at each observation point.

(7) Hinterland survey

For examining hinterland of the port of Semarang, Central Java including the service area of the port of Semarang was visited by using automobiles for on-site survey. The survey was conducted by two groups for following three courses:

- Semarang ... Bawen ... Surakarta ... Yogyakarta ... Kebumen ... Cilacap ... Purwokerto ... Tegal ... Cirebon
- Semarang ... Kendal ... Pekalongan ... Tegal ... Cirebon
- Semarang ... Demak ... Kudus ... Jepara and returned to Semarang

Chapter-2

Basic Conception of Semarang Port Development

CHAPTER 2

BASIC CONCEPTION OF SEMARANG PORT DEVELOPMENT

2-1 General

The commercial ports in Central Java are the ports of Semarang and Tegal located along the coast of the Java Sea, but they are rather shortcoming in the wharves, access channels and other port facilities and are unable to exhibit their port functions respectively.

Consequently, almost all import commodities including the foodstuff which the people of Central Java require have to be supplied via the port of Tg. Priok in West Java or the port of Surabaya in East Java and through land transportation, and this is not only inducing elevation of the commodity prices but impeding greatly the economic development of Central Java.

In this Chapter will be discussed how the port development is required for economic development of Central Java, what should be the character of the port to be developed and where the port development is to be determined generally without limiting the subjects to the port of Semarang alone.

2-2 Necessity of Port

Central Java is nearly equal to one-third of the Java Island in area and population, and presently as well as historically, the economic activities in this region may be regarded to be substantially independent. When the geographical features are taken into consideration, it will be self-evident that the economic region such as Central Java should have a commercial port participating extensively in the foreign trade.

Now, taking the sea distances from the port of Semarang to the foreign trade ports in East and West Java, they are 480 km to the port of Tg. Priok and 340 km to Surabaya. It is of no reason that a port is not required along the coast extending over 820 km in the sea distance. Conversely, a great problem is involved in that the import goods cannot be received directly but via the port of Tg. Priok or Surabaya and through land transportation in use of road or railway, and what really matters is that such situation induces elevation of the commodity prices and directly impede the economic development of the region.

By receiving the import goods directly at a port in the region of Central Java and distributing them to the service area, it is no longer required to add secondary transport expenses accruing from land transportation of the import goods on one hand, and it is enabled to insure systematic and stable circulation of the commodities on the other. Further, in the domestic transport, the secondary transport is eliminated, providing an effect to suppress the elevation of the commodity prices, while it is enabled to receive the commodities that have been obtainable only from the island of Java, from the other areas stably and at cheap prices.

The economy of Central Java is deflected toward the primary industries related mainly to agriculture, and the productivity is as low as before, with the production limited to species of low price. It is undeniable that the retarded industrial development of this region has had an adverse effect upon the lagging regional economy.

Seeing the present condition, the port of Semarang is not functioning properly in the domestic import of imported goods and other goods as well as domestic export of agricultural and other products. The import cargos coming through the port of Tg. Priok or Surabaya are carried into the region by the national highway and railway running along the coast of the Java Sea. But, the national highway is only of two lanes and the railway is of single track so that they are limited in the transport capacity for themselves.

The import commodities needed by Central Java should be received directly at a port in Central Java, and the export products of Central Java should also be loaded out of a port in Central Java, and thus the uneconomical secondary transport should be reduced as much as practicable. Otherwise, the economy has but to go to confusion, and the commodity prices to rise. For Central Java, the port is indispensable as a transport infrastructure, and for promotion of the regional economy, it is required to use the port as an industrial infrastructure. In improving the infrastructures of Central Java, what is to be chosen first is the port, and without improvement of the port in the region, not only the development of regional economy is scarcely expectable, but it can be said this much that the development of national economy will be impeded greatly.

2-3 Characteristics of Port to be Developed

Port has many functions and it is deeply related not only to the area of cargo flows but also to the social living particularly socio-economic activities in most cases.

Port generally rather owns a number of functions combined, and functions of port which give the social and economic influences can be separated into two basic functions, "distribution function" and "productive function". However, distribution itself is frequently considered as productive conduct which yields an added values, and productive function of a port is also frequently achieved through its distributing function. Thus, in the port activities, both productive function and distribution function are rather equal to both sides of one thing. Thus, they can be considered one function acting as two.

On the other hand, three objectives imposed on the transportation are "safe and sureness", "speed" and "low cost" and these are also the purposes of construction and improvement of the port. And these objectives must be fully achieved not only in the port but also in the overall transportation system.

Presently in Central Java, there is no foreign trade port equipped with proper functions and scale at least on the coast of the Java Sea so that demand of transportation imposed is not met resulting in great dependency upon land transportation through West and East Java and also resulting in obstruction for the economic development in the area being considered.

The port to be developed at this time in Central Java should have port characteristics necessary to a base for citizen's economic activities, in the process of selecting optimum policy for its improvement, since a port equipped with foundation for transportation and production combined is indispensable for the regional development of the area being considered.

2-4 Location of Port to be Developed

Central Java is located at the center of the island of Java and is directly tied with East Java and West Java. The north side of Central Java is facing the Java Sea and south side is facing the Indian Ocean. Therefore, it is very important to adequately determine whether the entrance port is to be located on the coast of the Java Sea or facing the Indian Ocean and how the relation with existing ports should be maintained.

(1) Assessment in view of natural conditions

In regard to natural conditions, it is very obvious that the coast line along the Java Sea is completely different from that along the Indian Ocean.

That is, the ocast line along the Java Sea is flat with little variation and wide plain is located behind the coast line. The front sea area has very shallow shoal and sea area with depth of −10m is extended about 4 to 6 km from the sea-shore, and bottom materials are consisting of mud which is uniformly distributed. Sea condition is very mild and waves of only 1m to 2m height will occur during predominant west monsoon. On the other hand, in the coast along the Indian Ocean, there is sand beach with widely varied shoreline, and waves coming to the shore are very high and beach is generally eroded. Also, the land behind the coast is narrow and mountains and hills are located closely to the beach and these are some of examples which indicate great difference from the coast of the Java Sea.

Advantages and disadvantages in the construction of a port on the south coast and the north coast of Central Java are listed in view of natural conditions in Table 2-1. As far as natural conditions are concerned, it is obvious that coast along the Java Sea is more advantageous to construct port terminal than the coast along the Indian Ocean.

Table 2-1 Merits and Demerits of Port Construction in View of *Natural Conditions*

	Coast along Java Sea:	Coast along Indian Ocean:
Merits of Port Construction:	- Shoreline is flat with less variations which is not considered to be disadvantageous in selecting proper land for port. - Waves are small so that size of breakwater can be smaller. - Scale of tidal current is small. - Mud beach with relatively small variations in shoreline and beach is stable. - Gradually shoaling beach can be easily turned to port terminal and industrial site by reclamation. - Both waves and current are small in scales so that setting of port entrance is not greatly limited by them.	- Slope of sea bottom is steep so that access channel is able to establish with small scale dredging work. - Almost all beaches are consisted of sand which is suitable for foundation of port structure.
Demerits of Port Construction:	- Access channel will become very long due to the gradually shoaling beach requiring large-scale dredging. - Soil is soft and poor, and construction of structures is limited by soil conditions.	- Mountains and hills are very close to beach so that proper land for port construction is locally limited. - Waves are high so that large-scale breakwater is needed. - Scale of tidal current is large. - Sand beach with very active littoral drift so that shoreline changes drastically. - Construction of port by reclamation is very difficult. - Waves and current are very severe so that determination of port entrance is greatly limited. - Large scale breakwater should be established to protect port terminal.

Table 2-2 Comparison of Java Sea and Indian Ocean Side in Central Java.

Location	Name of City and Province	Population (1975)	Area	Population Density
		x1,000 Persons	Km²	Persons/Km²
Java Sea Side	City of Semarang	736	99.40	7,404
	City of Pekalongan	113	17.77	6,359
	City of Tegal	109	12.67	8,603
	Coastal Provinces	7,997	12,208.19	655
	Sub Total	8,955 (34.8%)	12,338.03 (32.7%)	726
Indian Ocean Side	Coastal Provinces of Central Java	3,995	6,124.69	652
	Coastal Provinces of D.I. Yogyakarta	1,616	2,579.19	627
	Sub Total	5,611 (21.8%)	8,703.88 (23.1%)	627
Inland of Central Java	Inland Province of Central Java	10,238	16,039.88	638
	Inland of D.I. Yogyakarta	964	607.43	1,587
	Sub Total	11,202 (43.5%)	16,647.31 (44.2%)	673
All Central Java	Central Java	23,188	34,502.60	672
	D.I. Yogyakarta	2,580	3,186.62	810
	Total	25,768 (100%)	37,689.22 (100%)	684

Source: Hasil Registrasi Penduduk 1976, Kantor Sensus & Statistik Propinsi.

Note:

1. Coastal districts of Java sea side are; Brebes, Tegal (excluding city of Tegal), Pemalang, Pekalongan (excluding city of Pekalongan), Batang, Kendal, Semarang (excluding city of Semarang), Demak, Jepara, Pati, and Rembang.
2. Coastal districts of Indian Sea Side are; Cilacap, Kebumen, Purworejo, Kulan Progo, Bantul, G.N. Kindul, and Wonogiri.

(2) Assessment in View of Social Conditions

In Table 2-2, cities and districts in Central Java including D.I. Yogyakarta are classified depending upon whether coastal line is involved and whether facing the Java Sea or the Indian Ocean for comparing populations and land areas between the areas.

While about 35% of population of Central Java is living in north side area facing the Java Sea, only about 25% of population is living in Indian Ocean side where mountains and hills are located very closely to the coast line.

In actuality, about 3.3 million more people are living along the coast of Java Sea Side compared with Indian Ocean side. This fact cannot be neglected in the selection of the core of future development.

Many cities functioning as centers of economic and social activities are located along the Java Sea and inland area but no large cities is located along the coast of the Indian Ocean.

(3) Assessment in View of Foreign Trade

The scale of foreign trade in Indonesia in 1975 is 74.28 million tons (US$7,100 millions) for export and 10.71 million tons (US$4,770 millions) for import and more than 70% of them is for trades within Asia.

Generally, slight increase in sailing distance due to a change in distance to a port of call for ocean going vessels will not directly raise the freight rate. However, in the international shipping where effective vessel operation is the basis of management, there is a tendency to select a route where the vessels may be able to call easily accessible ports as many as possible. This tendency is very outstanding particularly for liners.

Majority of Indonesian trade is with Asian countries in which origins and destinations are located in north hemisphere in the Pacific Ocean area and, if the American line is added to this, 97% of export and 75% of import in 1975 are included in this area (see Table 2-3).

On the other hand, the most highly populated area in the island of Java is west side of the island and foreign trade port in this area is the port of Tg. Priok, and foreign trade port in East Java is the port of Surabaya. And many liners starting from these ports have been already established.

Also, the Strait of Malacca connected to the west side of the Java Sea is used as main

Table 2-3 Import and Export of Indonesia by Country of Destination/Origin

(%)

Country of Origin/Destination	1971		1972		1973		1974		1975	
	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import
Asia	84.5	72.0	76.9	74.5	79.2	72.0	72.1	71.5	64.1	65.1
America	10.7	8.9	15.8	9.8	15.6	16.6	25.3	12.3	33.0	10.2
Sub Total	95.2	80.9	92.7	84.3	94.8	88.6	97.4	83.8	97.1	75.3
Australia & Oceania	1.8	3.6	2.2	4.0	1.9	3.0	0.1	4.1	0	6.8
Africa	0.2	0.3	0.3	0.4	0.2	0.5	0.3	0.5	0	6.3
Europe	2.8	15.2	4.8	11.3	3.1	7.9	2.2	11.6	2.9	11.6
Total	100	100	100	100	100	100	100	100	100	100

Source: Statistical Pocketbook Indonesia, 1976
Biro Pusat Statistik Jakarta

seaway connected between Asia and Europe, and the Middle and Near East while the Lombok Strait connected to the East of Java Sea is used only for sailing of huge vessels such as super tankers which are subject to legal control for navigation.

Total amount of cargos handled in ports in the Java Island in 1974 is about 18.4 million tons and 57% of this, which is 10.5 million tons, is the amount of foreign trades including both export and import.

As indicated in Table 2-4, approximately 92% of total amount of port cargos is handled in ports located on the coast of the Java Sea and only 7% of cargos are handled through the ports located on the coast of the Indian Ocean.

Table 2-4 Traffic through Ports in Java Island (1974)

x1,000 tons

Location	Name of Port	Traffic Amount through Port in 1974				
		Foreign Trade		Domestic Trade		Total
		Export	Import	Outward	Inward	
Java Sea	Surabaya	851	1,492	937	461	3,741
	Semarang	110	444	90	100	744
	Pekalongan	–	–	–	3	3
	Tegal	36	15	1	3	55
	Cirebon	1,812	201	17	340	2,370
	Tg. Priok	155	4,477	440	3,374	8,446
	Others (6 Ports)	98	301	277	884	1,560
	Sut Total	3,062	6,930	1,762	5,165	16,919
		(87.6%)	(98.6%)	(95.6%)	(85.6%)	(91.9%)
Indian Ocean	Cilacap	416	98	–	827	1,341
		(11.9%)	(1.4%)	(–)	(13.7%)	(7.3%)
Others	Merak	–	–	46	22	68
	Others (4 Ports)	19	1	36	17	73
	Sub Total	19	1	82	39	141
		(0.5%)	(0.0%)	(4.4%)	(0.7%)	(0.8%)
	All Java Island	3,497	7,029	1,844	6,031	18,401
		(100%)	(100%)	(100%)	(100%)	(100%)
		(19.0%)	(38.2%)	(10.0%)	(32.8%)	(100%)

If activities of ports facing the Java Sea are examined for a reference, they can be outlined by Table 2-5. That is, ports of Java facing the Java Sea are handling about 14 to 15% of total cargos handled in whole Indonesian ports but, as far as import is concerned, about 79% of total national import is being performed through these ports of Java located on the coast of the Java Sea. This indicates that these ports are functioning as very important ports in the Indonesian economy.

Table 2-5 Share of Traffic through the Ports Facing the Java Sea

(Unit in %)

	Kind of Trade	1970	1971	1972	1973	1974
Ports of Java, facing the Java Sea	Foreign Trade	12.9	12.4	9.6	11.5	14.6
	Export	3.6	3.7	2.3	2.9	5.2
	Import	78.9	75.7	77.6	76.1	78.9
	Domestic Trade	17.8	17.7	21.1	20.3	24.0
	Outward	8.7	8.7	10.1	11.3	10.9
	Inward	29.6	30.1	35.6	29.6	40.9
	Total	14.7	14.2	12.8	14.1	17.4
All Ports of Indonesia		100	100	100	100	100

Source: Statistical data, Directorate General of Sea Communications

Most of foreign countries trading with Indonesia are located in north hemisphere in Asia and majority of foreign trades are with these countries, most of seaways for ocean going liners are located in both east and west straits connected to the Java Sea, and many seaways for ocean going liners are also located within the Java Sea and marine transportation is very actively being maintained. When considering these facts described above, more effectiveness will be expected if a foreign trade port for Central Java is located on the coast of the Java Sea and this plan will be also more natural in view of movement in the marine transport.

As a result of assessment in view of natural conditions, assessment in view of social economic conditions and assessment in view of foreign trade, the following conclusions will be derived:

(1) For promoting economic development in Central Java and for assuring harmonized progress of Indonesia, a foreign trade port with proper scale and functions must be provided for improvement in an earliest possible time in Central Java.

(2) The foreign trade port to be developed now should be located on the coast of the Java Sea and it is considered that necessity to provide another port other than existing port of Cilacap on the coast of the Indian Ocean is almost none.

Now, proper site for port development on the coast of the Java Sea in Central Java will be discussed for a selection.

(1) Topography and coastal line

Central Java is located almost in the center of the Java Island which lies along the equator. In marcroscopic view point, the coastal line along the Indian Ocean is gradually curved with less variations but coastal line along the Java Sea has two wide U-shape patterns. That is, the coastal line along Central Java at Java Sea side is placed between Cape Tg. Indramaju in West Java and Cape Tg. Diati in eastern side of Central Java, and coastal line between these capes show wide U-shape pattern. And at the feet of these capes, port of Cirebon in west and port of Semarang in east are respectively located. And on the almost straight coastal line between the capes, there are ports of Tegal and Pekalongan at almost equal spacing between.

Due to this topography, a cape is sticking out at the east side of the port of Semarang and waves caused by east monsoon are considerably shielded by this cape but both ports of Tegal and Pekalongan are directly receiving waves caused by east and west monsoon in each season.

Plain behind the port of Semarang is widely open and this is larger than those behind any other ports. The Java Sea is very close to equator so that typhoon or hurricane never occur and is called the calmest sea in the world.

The winds related to the generation of the waves are west wind and east wind passing through the Java Sea and they blow constantly over a certain period of time, but velocities of these winds are low and cause only small waves. Though they are small, it will be better if they are avoided so that a site will be ideal for port development if either one of winds can be avoided there. When examining coast line along the Java Sea with this view point in mind, a coast line from the port of Semarang to Jepara seems to have a superiority to establish a foreign trade port.

(2) Sea bottom condition

The Java Sea along the coast of the island of Java is generally very shallow for a long distance from shore and its bottom slope is from 1/300 to 1/500. Differing from the beach where littoral drift is predominant, sudden changes in water depth rarely occur, contour lines are almost parallel to the coast line and pitches of contour lines are almost equal in macroscopic view point.

Sea bottom shallower than 10m in depth slightly varies depending upon the degree of curve of coast line but sudden change in water depth is none while gentle bottom slope is being maintained.

The bottom materials are silty clay consisting of fine particles, and soil at the depth of 20 to 30m below the sea bottom is very soft with uniform silty clay though thin layers of sandy silt is sandwiched in certain area. The bottom materials have small changes in vertical direction and change in horizontal direction offshore from the coast line is almost none.

Sea bottom topography and its materials have only little variation in the area between western port of Tegal and eastern Fishery Port of Jepara in Central Java along the coast of the Java Sea. But this fact has no relation with requirements of the site selection for port development. And superiority of certain area cannot be pointed out on the basis of this fact.

(3) Present conditions of inland transport network

There are two main trunk highways in Central Java; one highway is running from east to west along the coast of the Java Sea, and other is running almost in parallel with coast line of the Indian Ocean at a constant distance of about 10 km inland from the coast. And several highways running north-south direction are connected with these two trunk lines. The trunk highways related to regional transportation are national highway running along the coast of the Java Sea from Jakarta to Surabaya through Cirebon, Tegal, Pekalongan and Semarang, national highway running from Semarang after branched there to Yogyakarta through Bawen and Magelang, and national highway running from Semarang to Surabaya through Bawen, Surakarta and Sragen where the road enters East Java.

On the other hand, in Indian Ocean side, only one Class-3 national highway is running between Yogyakarta and Cilacap so that network connecting both East and West Java has not been developed in this side and apparently the coast along the Java Sea is much stressed for the transportation of goods.

Network of railroad is very similar to highway network. That is, one railway is running from Jakarta to Surabaya through Cirebon, Tegal, Pekalongan and Semarang as east-west line along northern coast; and another line is running from Bandung to East Java through Cilacap, Yogyakarta and Surakarta as east-west line along southern coast. Two branch lines are connected between these two major lines, running in south-north direction. However, these railroads are almost single line and mainly used for passengers presently, and they are also used for freight transport but only for special goods such as bulk freight and liquid freight including oil and molasses. The above tendency is more dominant in east-west line along the northern coast. A strategic point in the railway network is Semarang where east-west trunk line is branched to two lines both connected to Yogyakarta.

One of important functions of the port is the function as junction point between marine and land transport. If a port is planned by ignoring or not fully utilizing functions and accumulation of land transport facilities, important functions of port cannot be fully utilized and primary objectives of planning cannot be fully achieved.

As outlined before, land transport facilities such as highways and railroads are more densely accumulated in and around the city of Semarang than any other places in Central Java. This means that project site should be the city of Semarang or its vicinity when planning port development for the future economic development in view of existing conditions of the land transportation networks.

(4) Accumulation of port function and port properties

Characters of functions of each existing port in Central Java are classified and indicated below:

- Port of Semarang; Character of commercial port being prominent in foreign trade is outstanding where majority of cargo is for foreign import and domestic import of foods, subsistence commodities, etc.
- Port of Pekalongan; Domestic trade by sailing vessels is occasionally made but its main function is a base for fishing boats and this port should be considered as fishery port.
- Port of Tegal; Import of rice, fertilizers, etc. and export of agricultural products such as coffee, rubber, etc. by offshore handling using lighters. But amount of such trades is small so that its character is rather a local commercial port mainly for domestic trade.
- Port of Cilacap; Most of foreign trades are import of construction materials, production machinery, etc. and export of iron sand as industrial materials.
  In domestic trade, a large amount of petroleum is domestically imported to this port of Cilacap so that it has a character of an industrial port rather than commercial port, and this tendency will be also stressed in future.

Accumulation of port facilities for four major ports in Central Java is illustrated in Table 2-6. The port facility accumulation in the port of Semarang is larger than any other ports. Port of Cilacap is handling more cargo than other ports but its cargo handling excluding petroleum is very small and its facilities are heavily accumulated only for petroleum wharf.

Most of facilities in the port of Semarang can be utilized as they are or with slight upgrading or renovation, and this should be evaluated when appraising superiority of the port of Semarang.

Table 2-6 Existing Facilities of Main Ports in Central Java

Facility	Semarang	Tegal	Pekalongan	Cilacap
Breakwater	1,830 m	775 m	200 m	-
Quay Wall	1,970 m	415 m	-	738 m
Sailing Vessel Wharf	2,645 m	200 m	200 m	-
Transit Shed	35,185 m^2	850 m	-	1,400 m^2
Warehouse	10,515 m^2	1,600 m^2	(300 m^2)	3,500 m^2
Oil Jetty	700 D.W.T x 1 unit 500 D.W.T x 1 unit	-	-	35,000 D.W.T x 3
Sea Berth	15,000 D.W.T x 1 unit	-	-	-

(5) Conclusion of site selection for the port development

By summarizing results of assessment for each area analyzed and described above, the site to be proposed, in conclusion, for the port development in Central Java on the coast of the Java Sea is the port of Semarang. This development should be made in an area adjacent to this existing port of Semarang in order to utilize existing facilities as much as possible.

The reasons for this conclusion are:

(1) Specific site for development cannot be determined from topography or coastal conditions.

(2) Specific site cannot be determined from the sea bottom condition since it is almost uniform throughout the coast of the Java Sea.

(3) It is apparent that port development should be made in the city of Semarang or an area adjacent to the city, in view of conditions of existing arrangement of land transport foundation such as highways and railroads, the location of important center of gravity of cargo traffic, and conditions of present activities and outlook in future.

(4) The character of port to be developed should not be merely a distributing port but it should have also the functions of industrial port in addition to functions of foreign trade port equipped with character of production base. In view of current accumulation of port properties and current conditions of activities, the port of Semarang should be selected as site for the port development project concerned with regional development.

2-5 Necessity of Industrial Development

For improvement of a port, a large amount of investment is required normally. In this respect, the port should not be used merely as a point of junction of sea and land transportations in the flow of commodities. It should be noted that the port functions effectively as an industrial infrastructure in industrial development, and multifarious aspects of the port function should be utilized effectively.

The Gross Domestic Product (GDP) of Central Java is, if that of 1969 is taken as 100, given as 117 for 1973. The figure shows a trend of growth but in a slight degree. The growth of industrial production during the same period is given as 115 for 1973 against 100 for 1969, its proportional share in the whole GDP being only 13 percent and this proportion remaining unchanged during the past several years. It is not deniable that such stagnancy in the industrial activities retard the economic activity in Central Java and hinders its development greatly.

Now, seeing the mining industry of Central Java which constitutes a share of only 1 percent in GDP, it is, in fact, giving some mineral products but is hardly expectable that it will grow into a key industry serving as a motive force for development of the region. Then, what is expectable hereafter is the industry using the mineral products as raw materials for which development of the mineral products is a prerequisite.

The agriculture, which occupies about one-half of the GDP and is absorbing about 61 percent of the labor population of Central Java, will continue to hold the position of main industry of the region for a considerable time to come. However, against the total area of 3,400,000 hectares of Central Java, the cultivated area is 2,400,000 hectares, giving a cultivation ratio as high as about 71 percent to indicate how difficult it is to seek the development of agriculture simply through expansion of arable land.

In Central Java where the high land is developed with mountains including many volcanos from the central to southern parts, it is very difficult, in reality, to create arable land newly through reclamation, and for enhancing the productivity of agriculture, there will be no other way but to realize conversion to species of higher price through expansion of the area of irrigation, employ species of higher productivity and pursue a breakthrough to agriculture of fertilization mainly with chemical fertilizers.

The forest area of Central Java is 650,000 hectares or about 20 percent of the total area, and its 53 percent or 350,000 hectares is the teak forest maintaining annual production of 250,000 m^3 of log. Java is proud of the largest production of teak, but the share of teak in the export is small at 10 percent, and nearly all of the product is consumed within the district. Since the area of forest land is limited, the timber material is limited to teak which is of long years of growth, and although the other trees have scarcely been used, their accumulation is not so much, it is difficult to increase the productivity of forestry sharply. Rather, in these years, the production is showing a decreasing trend.

Anyway, in Central Java, it is difficult to seek the economic development of the region through promotion of the agriculture, forestry and fishery or the so-called primary industries only without support of secondary industry.

The industrial development to be carried out simultaneously with the development of the port of Semarang should, therefore, be most realistically directed toward the industries capable of utilizing the functions of the port to be developed to the fullest extent, that is, the seashore industries and the so-called urban type industries following up the urban development of the city of Semarang.

Chapter-3

Present Situation of the Port of Semarang

CHAPTER 3
PRESENT SITUATION OF THE PORT OF SEMARANG

3-1 General

The port of Semarang, a foreign trade port on the north coast of Central Java, faces directly the Java Sea. As the adjacent foreign trade ports, it has the port of Cirebon in West Java and the port of Surabaya in East Java, the former located at a distance of about 230 km and the latter about 390 km from Semarang.

The shallow water area peculier to the Java Sea extends far out from the shore of the port of Semarang. The port basin is connected to the open sea by an access channel maintained at a depth of 4 m by dredging. Large ocean going vessels and interinsular vessels of large drafts stay at anchor in the anchorage about 4 to 6 km in the offing, and the cargo handling is made offshore by use of lighters.

To the service area, the port is connected via railway and road passing through the built-up area of the city of Semarang.

The major facilities of the port area formed by the Old Harbour constructed during 1914 to 1936 and the New Harbour, or Coaster Harbour as is generally called, constructed in 1967. The Old Harbour comprises two basins, Dalam-I and Dalam-II. Lighter cargo handling is made at the wharves and piers of the Old and New Harbours, and the local boats use the Old Harbour, while the interinsular vessels use the New Harbour, mainly.

The Kali Baru Canal in the west of these basins is used mainly for cargo handling and mooring of the sailing boats, but the shallow-draft lighters and local boats also use the Canal. The Old Harbour is connected to the service area by dock roads and railways, but the New Harbour by a two-lane road only.

At the head of the Old Harbour or the so-called Entrance Harbour, there is an oil jetty owned by state enterprise, PERTAMINA, and a floating jetty exclusively for oil. However, majority of oil handling in the port of Semarang is carried out through a sea berth at about 4.5 km in the offing.

As the protective facilities to prevent the waves and swells from entering the port and to protect the access channel from siltation, West Breakwater with the extension of 1,380 m and East Breakwater of 550 m are constructed.

3-2 Present Condition of Port Facilities

(1) Mooring facilities

The mooring facilities of the port of Semarang are divided largely into the Coaster Harbour, Inner Harbour, Naval Harbour and Kali Baru. The wharf having the largest water depth presently is the −5.3m wharf of the Coaster Harbour, and it has an extension of 320m. The wharf and transit sheds are in good conditions and are used for handling cargos of the smaller ocean going vessels, interinsular vessels and lighters.

The Inner Harbour is divided into Dalam-I and Dalam-II. The depth alongside is −3.4m ~ −2.0m in Dalam-II and −1.7m in Dalam-I, and the wharf length is about 870m in Dalam-II and 510m in Dalam-I. Both Dalam-II and Dalam-I are generally in good condition and are used mainly for cargo handling and mooring of the lighters and local boats.

Facing the Entrance Harbour in the port, there is the Naval Harbour used for mooring of the naval vessels and military ships. The extension of the mooring facility is 241m, and the water depth is −2.0m ~ −4.0m.

As the wharf for sailing vessels, the banks of the Kali Baru Canal in the west of the port are used. The east bank has an extension of 1,085m and water depth of −2m, while the west bank has an extension of 1,560m and a water depth of −2.0m. Both banks are used not only by the sailing vessels but also by the local boats and lighters.

For handling of oils at the port of Semarang, a jetty having a water depth of −3m is provided at a place facing the Entrance Harbour.

As an auxiliary facility, a floating pier is used.

(2) Port Terminal Area

The port terminal area of the port of Semarang including the wharves is 325 hectares, while the area of basins and other harbour facilities is 4,710 hectares. The land used by the Port Administration accounts for only about 4.8%, and that used as open storage and truck terminal is merely 2.6%. About 42% of the land is leased to the shipping companies and cargo handling companies. The remainder 51% or so is left unused at present.

(3) Protective facilities

As the protective facilities of the port of Semarang, West Breakwater is constructed over the length of 1,380m for the purpose of preventing intrusion of waves into the port at the west monsoon or siltation of the access channel due to littoral drift, and East Breakwater for an extension of 550m for prevention of siltation at the east monsoon.

Both breakwaters are of the rubble mound type using bamboo mattresses.

Concrete coping is raised and additional rubbles are deposited for the West Breakwater as repair works against its settlement.

About a half length of the East Breakwater is heavily settled down and submerged underwater at mean sea level.

Spacing between the East and West Breakwaters is about 200m.

(4) Access channel and basins

The 2,200m long access channel between the offshore anchorage and the port basin is maintained to a depth of −5m for a width of 50m ~ 60m.

The mooring basins are divided largely into the Coaster Harbour, Entrance Harbour, Front Harbour, Inner Harbour and Kali Baru, and the total area amounts to about 51 hectares. The depth is −4.2m at the Coaster Harbour and about −3m at other basins.

According to the records of the past five years annual requirement for the maintenance dredging of the port is approximately 300,000m³ ~ 400,000m³ at the access channel and basins.

3-3 Ship Calling at the Port of Semarang

In Table 3-1 is shown the annual total of the ship calling at the port of Semarang.

According to the past record in the years from 1969 to 1976, the annual growth rate of ship calling was about 8% per year as a whole.

In view of type of vessels, the growth rate the ship calling of the interinsular vessels was the highest with about 30%/year, and of the ship calling of the ocean going vessels (foreign vessels) was about 12%/year, it was second next to the interinsular vessels. The growth rate of the ship calling of the tanker extremely decreased to −17%/year, and of ship calling of the ocean going vessels (Indonesian vessels) was about −5%/year, and it was second next to the tanker. However, the ship calling of the ocean going vessels as a whole (foreign and Indonesian vessels) were shown a tendency to increase.

In Table 3-2 is shown the use of the wharves and mooring facilities by kind of vessel in 1976.

Table 3-1 Number of Ship Calling at the Port of Semarang by Kind of Vessel (1969 ~ 1976)

(Unit: number of vessels, %)

	1969	1970	1971	1972	1973	1974	1975	1976	Growth Ratio (1969-1970) %
Ocean going Vessel (Foreign)	159	209	238	272	270	309	347	367	12 %
Ocean going vessel (National)	172	149	166	153	119	112	104	118	- 5
Interinsular vessel	158	272	327	452	499	775	1,052	1,008	30
Sailing vessel	679	936	1,046	1,412	1,612	1,329	1,045	916	4
Tanker	217	195	161	72	82	94	106	73	-17
Total	1,355	1,761	1,938	2,391	2,582	2,619	2,654	2,482	8

Source: ADPEL of Semarang

Table 3-2 Utilization of Port Facilities in the Port of Semarang by Kind of Vessel in 1976

(Unit: number of vessels, %)

Kind of Vessel	Wharf	Small Quay	Offshore Anchorage	Oil Seaberth	Total
Ocean going vessel (Foreign)	123		244		367
Ocean going vessel (National)	962		164		118
Interinsular vessel					1,008
Sailing vessel		916			916
Tanker				73	73
Total	1,085	916	408	73	2,482
Share (%)	44	37	16	3	100

Source: ADPEL of Semarang

3-4 Present Situation of the Port Activities

3-4-1 Outline

The statistics taken from years 1970 to 1975 indicate that the share of cargos handled (in tonnage) in the ports in Java Island to the total cargos handled in whole Indonesia, as shown in Table 3-3, increased by 4.2% from 15.7% to 19.9% in these years (see Fig. 3-1).

The cargos handled in Java Island in 1975 were 17,707-thousand tons and its share was second next to Sumatra Island (see Table 3-4).

Table 3-3 Trend of Cargo Flow by Region in Indonesia (1970 ~ 1975)

(Unit: thousand tons, %)

Region	Item	1970		1971		1972		1973		1974		1975	
		Vol. of Cargo	Share	Vol. of Cargo	Share	Vol. of Cargo	Share	Vol. of Cargo	Share	Vol. of Cargo	Share	Vol. of Cargo	Share
Sumatra	Foreign Trade	31,745	85.8	34,556	78.5	50,557	83.5	56,476	77.6	52,526	76.7	49,053	78.7
	Domestic Trade	15,954	76.4	16,903	75.5	16,740	70.0	20,789	69.1	19,450	67.3	14,337	54.0
	Total	47,699	82.4	51,459	77.5	67,297	79.6	77,265	75.1	71,976	73.9	63,390	71.3
Java	Foreign Trade	4,879	13.2	5,838	13.3	6,203	10.2	8,755	12.0	10,525	15.4	9,069	14.5
	Domestic Trade	4,230	20.3	4,560	20.3	5,611	23.5	6,750	22.5	7,874	27.2	8,638	32.6
	Total	9,109	15.7	10,398	15.6	11,814	14.0	15,505	15.1	18,399	18.9	17,707	19.9
Kalimantan	Foreign Trade	-		2,315	3.3	2,300	3.8	4,571	6.3	4,722	6.9	4,038	6.5
	Domestic Trade	-		81	0.4	119	0.5	280	0.9	201	0.7	1,950	7.4
	Total	-		2,396	3.6	2,419	2.9	4,851	4.7	4,923	5.1	5,988	6.7
Sulawesi	Foreign Trade	336	0.9	1,298	2.9	903	1.5	1,618	2.2	623	0.9	200	0.3
	Domestic Trade	461	2.2	611	2.7	955	4.0	1,467	4.9	735	2.5	991	3.7
	Total	797	1.4	1,909	2.9	1,858	2.2	3,085	3.0	1,358	1.4	1,191	1.4
Others	Foreign Trade	36	0.1	13	0.0	615	1.0	1,364	1.9	70	0.1	15	0.0
	Domestic Trade	229	1.1	240	1.1	488	2.0	776	2.6	668	2.3	606	2.3
	Total	265	0.5	253	0.4	1,103	1.3	2,140	2.1	738	0.7	621	0.7
Total	Foreign Trade	36,996	100.0	44,019	100.0	60,578	100.0	72,784	100.0	68,466	100.0	62,375	100.0
	Domestic Trade	20,874	100.0	22,396	100.0	23,913	100.0	30,062	100.0	28,928	100.0	26,522	100.0
	Total	57,870	100.0	66,415	100.0	84,491	100.0	102,846	100.0	97,394	100.0	88,897	100.0

Source: "Cargo loading and unloading at ports in Indonesia"
Central Bureau of Statistics

Table 3-4 Cargo Flow and Its Share by Region in Indonesia in 1975

(Unit: thousand tons)

Region	Cargo Flow			Share (%)		
	Foreign Trade	Domestic Trade	Total	Foreign Trade	Domestic Trade	Total
Sumatra	49,053	14,337	63,390	78.7	54.0	71.3
Java	9,069	8,638	17,707	14.5	32.6	19.9
Kalimantan	4,038	1,950	5,988	6.5	7.4	6.7
Selawesi	200	991	1,191	0.3	3.7	1.4
Others	15	606	621	0.0	2.3	0.7
Total	62,375	26,522	88,897	100.0	100.0	100.0

Source: "Cargo loading and unloading at ports in Indonesia"
Central Bureau of Statistics

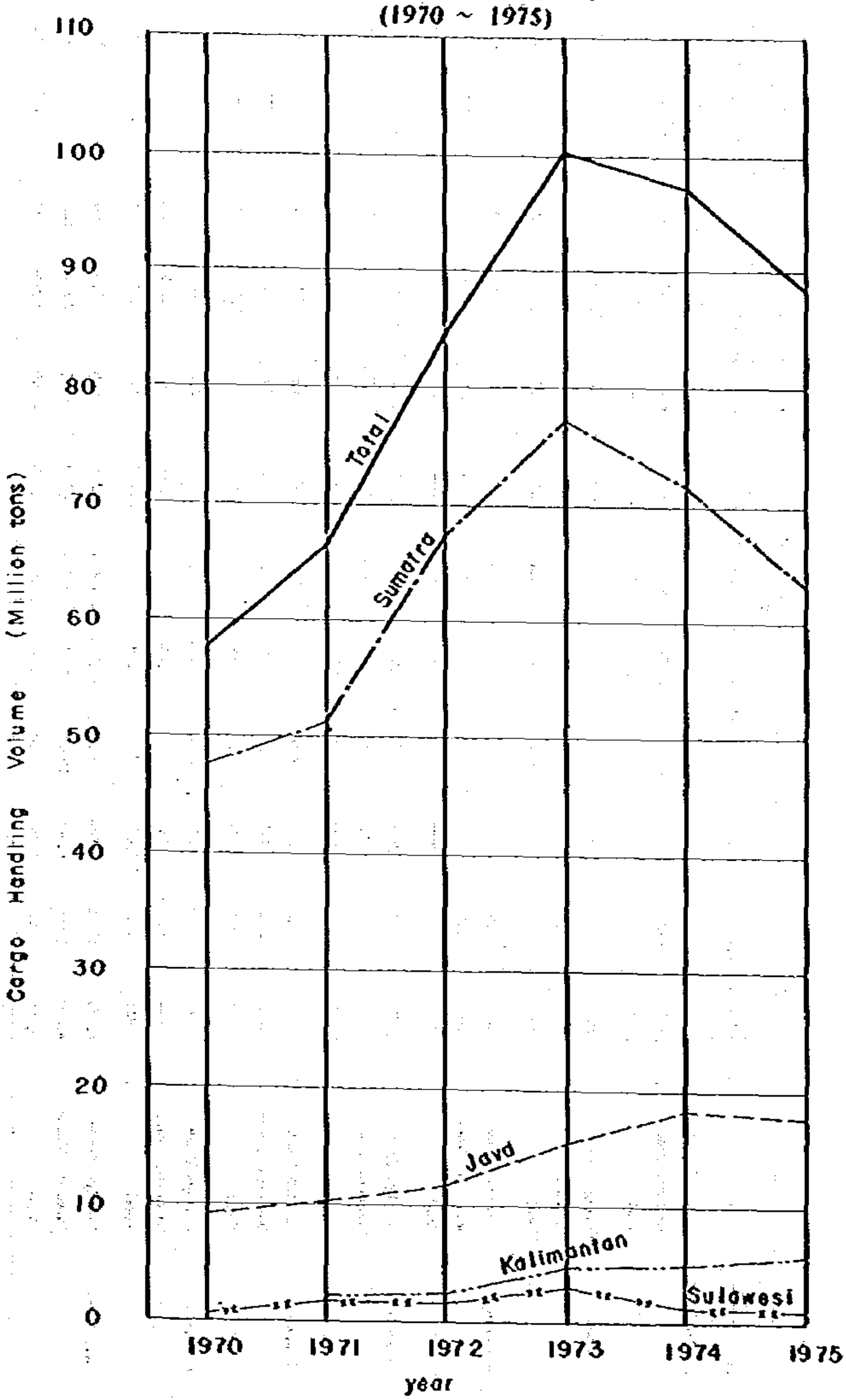
The share of cargos handled in the port of Semarang from the year 1970 to 1975 to the whole Java Island was 4% to 5% as shown in Table 3-5 and this was remaining on the same level in last several years (see Fig. 3-2).

The average growth rate of the cargos handled between 1970 and 1976 as shown in Table 3-6, was 7.6% for foreign trade, 15.5% for domestic trade and 9.6% for whole trades which exceeded GDP's growth rate of 7.5% established for PELITA II. When analyzing these figures further in detail, the export was reduced by 6.9% but import was considerably increased with 12.2%. The growth rate of domestic trade was high for both inbound and outbound cargos and especially the growth rate of inbound cargos was extremely high with 21.1%. Import in 1976 decreased but this was due to a stoppage of fertilizer import.

The share of cargos handled in the port of Semarang in the years from 1970 to 1976 as shown in Table 3-7, decreased by 8% from 78.5% to 70.5% for foreign trade, however, increased from 21.5% to 29.5% for domestic trade.

If outbound to inbound ratios of all cargos handled in this port are compared as shown in Table 3-8, the ratio of 1:1.6 in 1970 has changed to 1:3.5 in 1976 indicating considerable amount of increase of the inbound cargos.

Fig. 3-1 Trend of Cargo Handling Volume by Region in Indonesia (1970 ~ 1975)



Source : ADPEL of Semarang

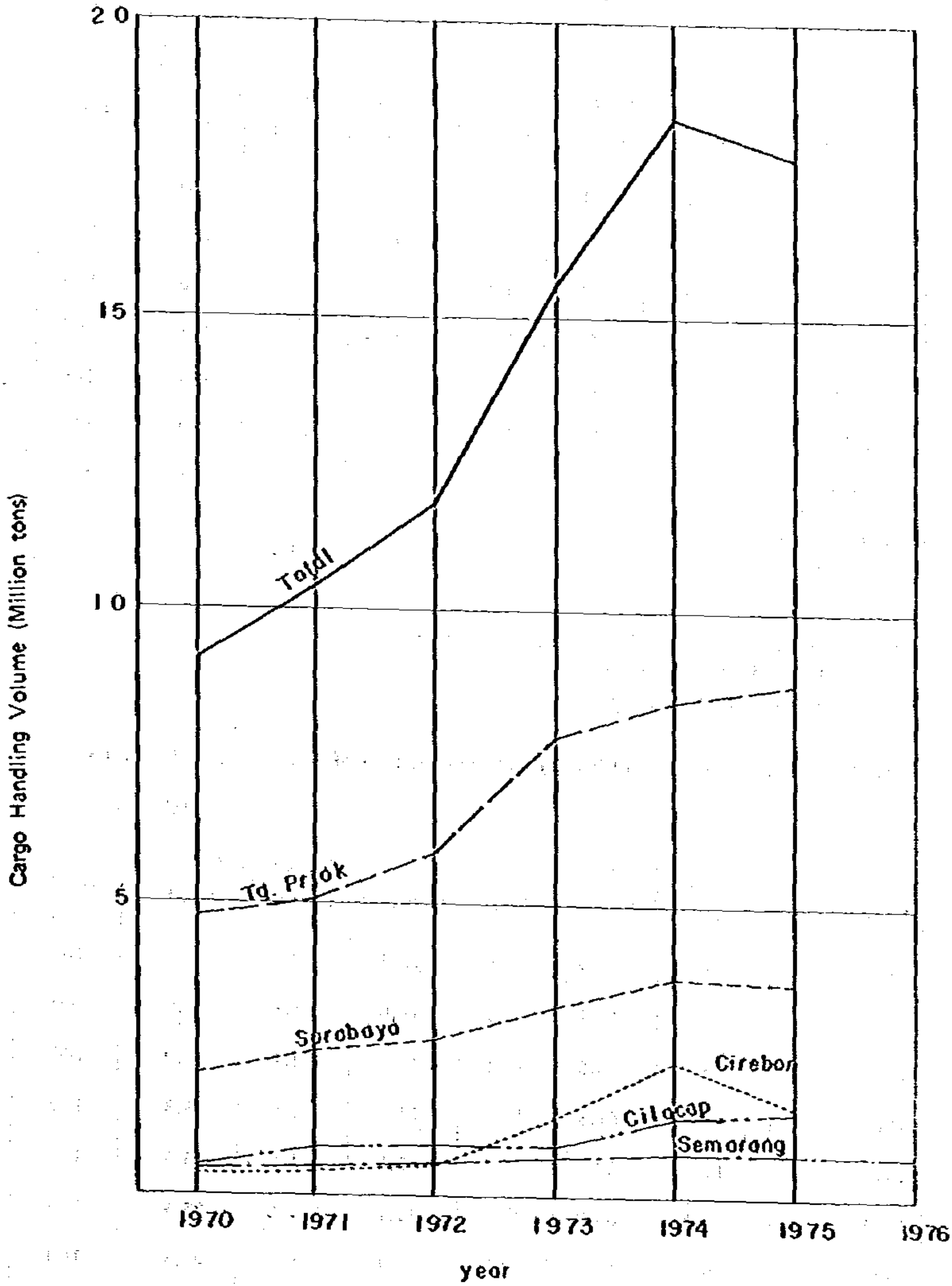
Table 3-5 Trend of Cargo Flow by Major Port in Java Island (1970 ~ 1975)

(Unit: thousand tons, %)

Name of Port	Item	1970		1971		1972		1973		1974		1975	
		Vol. of Cargo	Share	Vol. of Cargo	Share	Vol. of Cargo	Share	Vol. of Cargo	Share	Vol. of Cargo	Share	Vol. of Cargo	Share
Tg. Priok	Foreign Trade	2,890	59.2	3,116	53.4	3,316	53.4	4,611	52.7	4,633	44.0	4,406	48.6
	Domestic Trade	1,905	45.0	1,930	42.3	2,562	45.7	3,223	47.8	3,815	48.5	4,342	50.3
	Total	4,795	52.6	5,046	48.5	5,878	49.8	7,834	50.5	8,447	45.9	8,748	49.4
Cirebon	Foreign Trade	201	4.1	219	3.7	292	4.7	1,066	12.2	2,013	19.1	1,045	11.5
	Domestic Trade	152	3.6	240	5.3	228	4.1	280	4.1	357	4.5	499	5.8
	Total	353	3.9	459	4.4	520	4.4	1,346	8.7	2,370	12.9	1,544	8.7
Semarang	Foreign Trade	366	7.5	393	6.7	440	7.1	511	5.8	554	5.3	580	6.4
	Domestic Trade	100	2.4	116	2.5	146	2.6	173	2.0	189	2.4	199	2.3
	Total	466	5.1	509	4.9	586	4.9	684	4.4	743	4.0	779	4.4
Surabaya	Foreign Trade	1,273	26.1	1,538	26.3	1,594	25.7	1,976	22.6	2,343	22.3	2,211	24.4
	Domestic Trade	799	18.9	952	20.9	1,097	19.5	1,265	18.7	1,398	17.8	1,435	16.6
	Total	2,072	22.8	2,490	24.0	2,691	22.8	3,241	20.9	3,741	20.3	3,646	20.6
Cilacap	Foreign Trade	59	1.2	349	6.0	378	6.1	408	4.6	514	4.9	572	6.3
	Domestic Trade	440	10.4	475	10.4	465	8.3	472	7.0	827	10.5	892	10.3
	Total	499	5.5	824	7.9	843	7.1	880	5.7	1,341	7.3	1,464	8.3
Others	Foreign Trade	90	1.9	223	3.9	181	3.0	183	2.1	468	4.4	255	2.8
	Domestic Trade	834	19.7	847	18.6	1,113	19.8	1,337	19.8	1,288	16.3	1,271	14.7
	Total	924	10.1	1,070	10.3	1,296	11.0	1,520	9.8	1,757	9.6	1,526	8.6
Java Total	Foreign Trade	4,879	100.0	5,838	100.0	6,203	100.0	8,755	100.0	10,525	100.0	9,069	100.0
	Domestic Trade	4,230	100.0	4,560	100.0	5,611	100.0	6,750	100.0	7,874	100.0	8,638	100.0
	Total	9,109	100.0	10,398	100.0	11,814	100.0	15,505	100.0	18,399	100.0	17,707	100.0

Source: "Cargo loading and unloading at Ports in Indonesia"
Central Bureau of Statistics

Fig. 3-2 Trend of Cargo Handling Volume by Major Port In Java Island



Source: ADPEL of Semarang

Table 3-6 Trend of Cargo Flow by Trade in the Port of Semarang

(Unit: thousand tons)

Year	Foreign Trade			Domestic Trade			Total
	Export	Import	Total	Outward	Inward	Total	
1970	120	246	366	57	43	100	466
1971	140	253	393	71	45	116	509
1972	114	326	440	75	71	146	586
1973	89	422	511	80	93	173	684
1974	110	444	554	80	100	189	743
1975	69	511	580	87	112	199	779
1976 1)	78	492	570	102	136	238	808
Average growth rate (%)	-6.9	12.2	7.6	10.2	21.1	15.5	9.6

Source: "Cargo loading and unloading at ports in Indonesia"
Central Bureau of Statistics

1) ADPEL of Semarang

Table 3-7 Share of Cargo Flow by Trade in the Port of Semarang (1970~1976)

(Unit: %)

Year	Foreign Trade			Domestic Trade			Total
	Export	Import	Total	Outward	Inward	Total	
1970	25.6	52.9	78.5	12.3	9.2	21.5	100
1971	27.5	49.7	77.2	14.0	8.8	22.8	100
1972	19.5	55.6	75.1	12.7	12.2	24.9	100
1973	12.9	61.8	74.7	11.7	13.6	25.3	100
1974	14.8	59.7	74.5	12.1	13.4	25.5	100
1975	8.8	65.7	74.5	11.1	14.4	25.5	100
1976	9.6	60.9	70.5	12.7	16.8	29.5	100

Source: ADPEL of Semarang

Table 3-8 Ratio of Cargo Flow by Trade in the Port of Semarang (1970-1976)

Year	Cargo Flow: Ratio by Inbound/Outbound — Outbound	Inbound
1970	1	1.6
1971	1	1.4
1972	1	2.1
1973	1	3.0
1974	1	2.7
1975	1	4.0
1976	1	3.5

Source: ADPEL of Semarang

3-4-2 Ocean Going Vessels

When ocean going vessels called at the port of Semarang in 1976 are classified by D.W.T and percentages of each class are calculated as shown in Table 3-9, the vessels of 5,001 to 10,000 D.W.T class are the most with figure of about 41% as far as number of vessels called is concerned, in view of shares in D.W.T, the share of vessels of 10,001 to 15,000 D.W.T class is the largest with figure of about 46%. Comparing loaded and unloaded cargos by D.W.T class, the vessels of 5,001 to 10,000 D.W.T class have handled about 40% of total cargos which is highest in share.

Table 3-9 Activities of Ocean Going Vessels by D.W.T Class in 1976

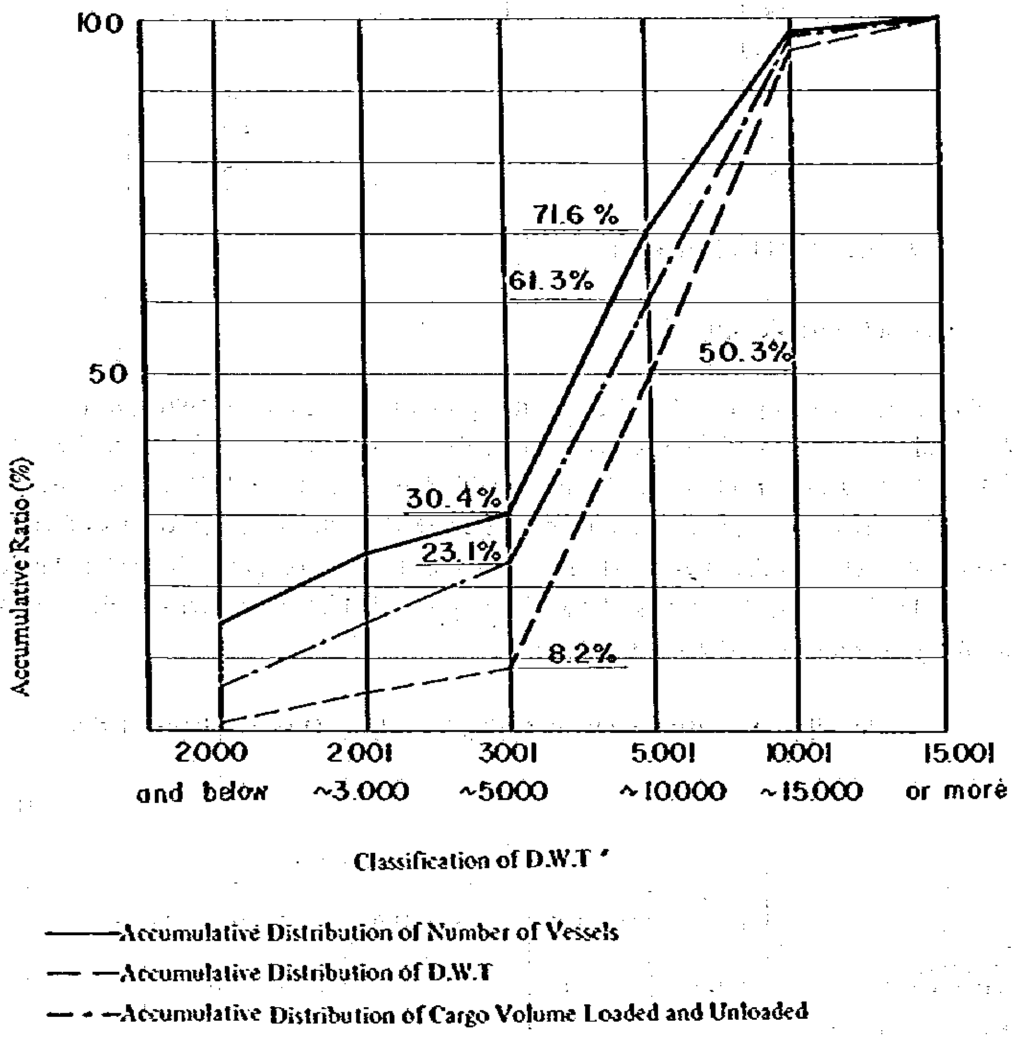
(Unit: %)

	Classification of D.W.T: 2,000 and below	2,001-3,000	3,001-5,000	5,001-10,000	10,001-15,000	15,001 or more	Total
Share in number of calling vessels	14.6	10.1	5.7	41.2	26.9	1.5	100
Accumulative ratio in number of calling vessels	(14.6)	(24.7)	(30.4)	(71.6)	(98.5)	(100)	
Share in D.W.T	1.7	3.3	3.2	42.1	45.8	3.9	100
Accumulative ratio in D.W.T	(1.7)	(5.0)	(8.2)	(50.3)	(96.1)	(100)	
Share in cargo handling volume	6.3	8.8	8.0	40.2	31.9	4.8	100
Accumulative ratio in cargo handling volume	(6.3)	(15.1)	(23.1)	(61.3)	(95.2)	(100)	

Source: ADPEL of Semarang

According to the accumulative distribution curves by tonnage class of ocean going vessels as shown in Fig. 3-3, the vessels smaller than 10,000 D.W.T are about 72% in number of vessels, 50% in D.W.T and about 61% in tonnage of loaded and unloaded cargos.

Fig. 3-3 Accmulative Distributions of Ocean Going Vessels by D.W.T Class



Source: ADPEL of Semarang

In Table 3-10, the average D.W.T for all vessels called at the port of Semarang in 1976 is 7,000 D.W.T. Average days of stay in the port was three days for large vessel and five days for small vessel, indicating that small vessel stays more in the port than large one. Average loaded and unloaded tonnage per vessel was 1,100 tons.

Table 3-10 Average D.W.T and Days of Stay of Ocean Going Vessels in the Port of Semarang by D.W.T Class in 1976

Item	Classification of D.W.T						
	2,000 and below	2,001-3,000	3,001-5,000	5,001-10,000	10,001-15,000	15,001 or more	Average
Average D.W.T (tons)	800	2,300	3,900	7,200	12,000	17,900	7,000
Average Days of Stay (days)	4	5	6	3	3	3	3
Cargo handling volume per vessel (tons)	480	950	1,530	1,080	1,430	1,260	1,100

Source: ADPEL of Semarang

Average days of stay per vessel calling at the port of Semarang were 3.4 days as shown in Table 3-11 and Fig. 3-4. According to Table 3-11, vessel stayed longer during January to March compared to other months. For finding amount of cargos handled during January to March which might be affected by longer days of stay in these months, the average cargos handled per days of stay in the port were examined and it was found out as shown in Fig. 3-5 that the amount of cargos handled in January and February was smaller than those in other months as expected. Cause of this would be mainly due to rough sea area between port and offshore anchorage without being sheltered by the breakwater during west monsoon in winter by which lighters were unable to service and vessels were forced to stay.

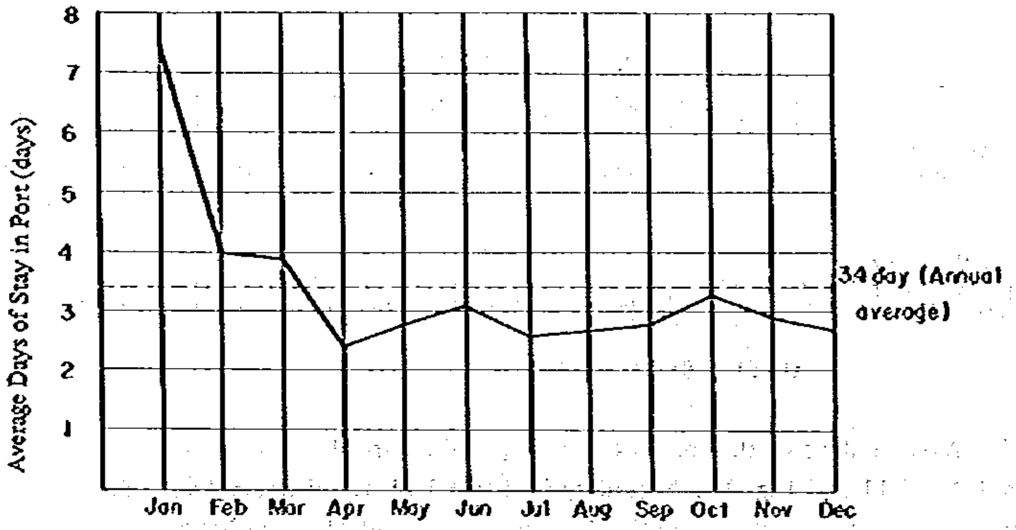
Table 3-11 Average Days of Stay per Vessel by Month and Average Cargo Handling Volume per One-day's Stay by Month in 1976

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Average days of Stay per Vessel (days)	7.5	4.0	3.9	2.4	2.8	3.1	2.6	2.7	2.8	3.3	2.9	2.7	3.4
Average Cargo handling volume per one day's stay (tons)	117	224	349	321	369	302	340	314	425	555	451	359	322

Source: ADPEL of Semarang

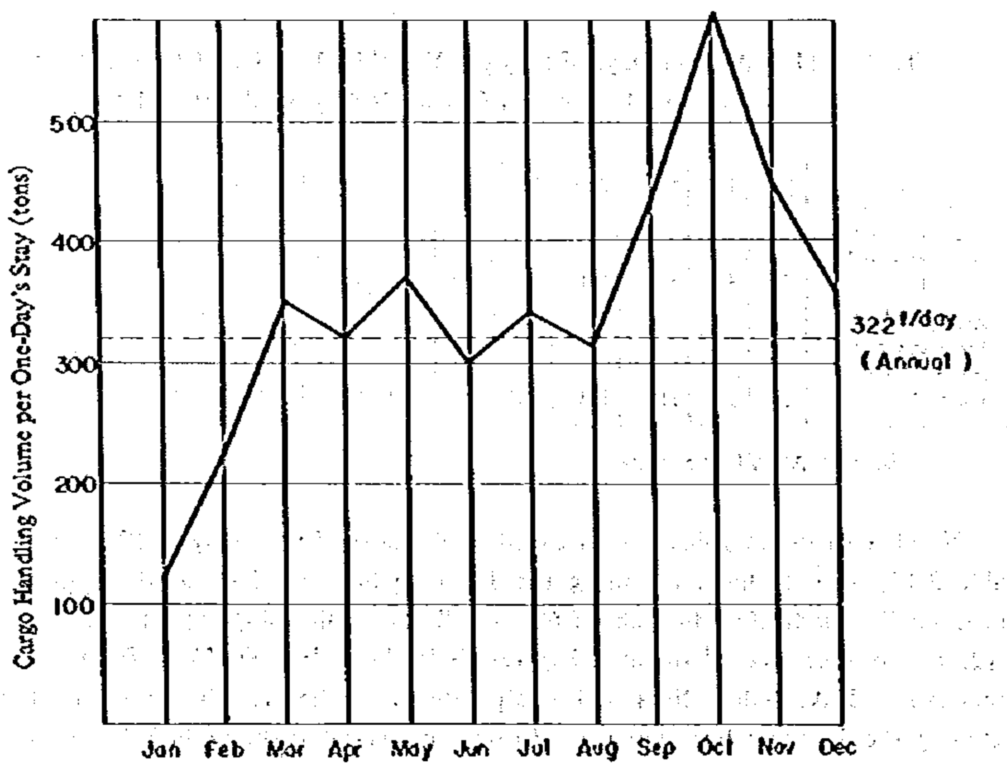
Number of ocean going vessels called at the port of Semarang in 1976 are shown in Table 3-12, 41% of them are using the Japanese line and 20% of them are using the European line, indicating that about 60% of all vessels are using these two lines. In Table 3-12, the average size of ocean going vessels is about 10,000 D.W.T for the European, American and Australian lines and comparatively smaller vessels are using other lines including the Japanese line. Tonnage of cargos per vessel as shown in Table 3-13 is about

Fig. 3-4 Average Days of Stay by Month in the Port of Semarang in 1976



Source: ADPEL of Semarang

Fig. 3-5 Cargo Handling Volume per One-day's Stay per Vessel by Month in the Port of Semarang in 1976



Source: ADPEL of Semarang

Table 3-12 Activities of Ocean Going Vessels by Line in the Port of Semarang in 1976

Item	Line							
	Singapore	Hongkong	Japan	Others in Asia	Europe	America	Australia	Total/Average
Share in number of calling vessel (%)	11.0	10.6	40.5	10.1	20.0	6.2	1.6	100
Share in D.W.T (%)	2.1	5.5	37.7	8.5	33.2	11.0	2.0	100
Average D.W.T (tons)	1,300	3,700	6,500	5,900	11,700	12,500	9,200	7,000
Average Days of Stay (days)	6	5	3	6	2	3	2	3

Source: ADPEL of Semarang

Table 3-13 Share of Cargo Handling Volume of Foreign Trade and Average Cargo Handling Volume per Vessel by Line in 1976

Name of Line	Cargo Handling Volume	
	Share (%)	Average per Vessel (tons)
Shingapore	7.3	730
Hongkong	12.3	1,280
Japan	35.8	970
Others in Asia	23.8	2,580
Europe	9.1	500
America	10.9	1,940
Australia	0.8	590
Total/Average	100.0	1,100

Source: ADPEL of Semarang

2,600 tons for "Other in Asia" as the highest tonnage and the lowest is the European line with a value of 500 tons.

The amounts of cargos handled for foreign trade and their shares by group of commodities and by line in 1975 and 1976 are shown in Tables 3-14 and 3-15. The majority of export cargos were estate crops, food crops and forest products, and the majority of import cargos were fertilizer and manufactured products in 1975, but majority of import cargos in 1976 has been changed to manufactured products and construction materials due to a stoppage of fertilizer import.

Table 3-14 Cargo Flow by Commodity Group and by Line in 1975

(Unit: thousand tons)

Item	Singapore	Hongkong	Japan	Others in Asia	Europe	America	Australia	Total
Total	104.59	26.15	161.42	86.42	152.11	43.94	5.68	580.31
Export	5.97	3.86	11.43	0.03	46.29	0.74	0.60	68.92
Food Crops	1.14	0.28	1.63	-	23.75	0.01	-	26.81
Estate Crops	3.65	0.08	2.92	-	13.86	0.55	0.51	21.57
Manufactured Products	0.55	0.08	1.60	0.03	0.98	0.17	0.01	3.42
Marine Products & Livestock Products	-	0.34	4.33	-	1.73	0.01	0.01	6.42
Forest Products	0.63	3.08	0.95	-	5.97	-	0.07	10.70
Import	98.62	22.29	149.99	86.39	105.82	43.20	5.08	511.39
Industrial Materials & Equipments	24.34	2.58	19.56	5.24	5.74	4.62	0.84	62.92
Food Crops	-	-	-	7.40	-	-	-	7.40
Food Stuffs	1.89	0.23	0.87	11.85	0.13	0.22	0.20	15.39
Manufactured Products	19.59	18.41	64.12	10.79	6.08	2.26	0.89	122.14
Construction Materials	13.55	0.49	16.01	2.93	2.53	-	3.10	38.61
Fertilizer	39.25	0.58	49.43	40.92	91.34	35.75	-	257.27
Others	-	-	-	7.26	-	0.35	0.05	9.66

Source: ADPEL of Semarang

Table 3-15 Cargo Flow by Commodity Group and by Line in 1976

(Unit: thousand tons)

Item	Singapore	Hongkong	Japan	Others in Asia	Europe	America	Australia	Total
Total	95.51	68.84	144.25	140.65	57.08	59.99	3.27	569.59
Export	8.05	15.13	16.85	-	37.10	0.58	0.09	77.80
Food Crops	0.55	4.00	1.30	-	11.63	-	-	17.48
Estate Crops	4.85	0.08	6.87	-	12.42	0.44	-	24.66
Manufactured Products	1.29	0.13	1.65	-	1.28	0.08	0.01	4.44
Marine Products & Livestock Products	-	0.43	5.11	-	2.86	0.01	-	8.41
Forest Products	1.36	10.49	1.92	-	8.91	0.05	0.08	22.81
Import	87.46	53.71	127.40	140.65	19.98	59.41	3.18	491.79
Industrial Materials & Equipments	28.34	8.83	19.96	8.33	9.28	23.72	1.27	99.73
Food Crops	-	-	-	32.81	-	28.89	-	61.70
Food Stuffs	2.55	0.27	0.01	33.77	0.01	0.98	-	37.59
Manufactured Products	20.29	29.35	66.62	19.74	9.77	4.96	1.68	152.41
Construction Materials	36.28	4.76	40.81	28.68	0.92	0.86	0.23	112.54
Others	-	10.5	-	17.32	-	-	-	27.82

Source: ADPEL of Semarang

3-4-3 Interinsular Vessels

The interinsular vessels smaller than 1,000 D.W.T called at the port of Semarang in 1976 were about 77% in number of vessel, 52% in D.W.T and 59% in tonnage of loaded and unloaded cargos, of all vessels as shown in Table 3-16. The average size of interinsular vessels was about 700 D.W.T average days of stay were five days and average loaded and unloaded cargos were 540 tons as shown in Table 3-17.

Table 3-16 Activities of Interinsular Vessels (RLS+RLS.DEVIASI+NON.RLS) by D.W.T Class in the Port of Semarang in 1976

Item	Classification of D.W.T					
	500 and below	501-700	701-1,000	1,001-3,000	3,001 or more	Total
Share in number of calling vessels (%)	42.2	22.7	12.4	22.3	0.4	100
Accumulated ratio in number of calling vessels (%)	(42.2)	(64.9)	(77.3)	(99.6)	(100)	
Share in D.W.T (%)	16.7	19.2	15.8	46.2	2.1	100
Accumulated ratio in D.W.T (%)	(16.7)	(35.9)	(51.7)	(97.9)	(100)	
Share in cargo handling volume (%)	22.5	24.5	11.7	39.8	1.5	100
Accumulated ratio in cargo handling volume (%)	(22.5)	(47.0)	(58.7)	(98.5)	(100)	

Source: ADPEL of Semarang

Table 3-17 Average D.W.T Days of Stay and Cargo Handling Volume of Interinsular Vessels by D.W.T, Class in the Port of Semarang in 1976

Item	Classification of D.W.T					
	500 and below	501-700	701-1,000	1,001-3,000	3,001 or more	Total
Average D.W.T (tons)	260	600	900	1,470	3,400	710
Average days of stay (days)	6	4	4	5	9	5
Average cargo handling volume (tons)	290	550	510	960	1,800	540

Source: ADPEL of Semarang

3-4-4 Local Boats

The transportation of commodities between the port of Semarang and various small ports in West and Central Kalimantan, Banka Island and Riau Islands is being performed by small local boats for coastal services. The major transport cargos are rice and cane sugar. The local boats smaller than 200 D.W.T called at the port of Semarang in 1976 were about 81% in number of vessels, 65% in D.W.T and 69% in tonnage of loaded and unloaded cargos, of all vessels as shown in Table 3-18. The average size of the local boats was 150 D.W.T, average days of stay were six days and average loaded and unloaded cargos were 190 tons as shown in Table 3-19.

Table 3-18 Activities of Local Boats by D.W.T Class in the Port of Semarang in 1976

Item	Classification of D.W.T					
	100 and below	101-200	201-300	301-500	501 or more	Total
Share in number of calling vessels (%)	55.1	25.6	16.8	2.1	0.4	100
Accumulated ratio in number of calling vessels (%)	(55.1)	(80.8)	(97.4)	(99.6)	(100)	
Share in D.W.T (%)	34.8	29.9	28.5	5.1	1.7	100
Accumulated ratio in D.W.T (%)	(34.8)	(64.7)	(93.2)	(98.3)	(100)	
Share in cargo handling volume (%)	38.2	31.1	23.5	4.9	2.3	100
Accumulated ratio in cargo handling volume (%)	(38.2)	(69.3)	(92.8)	(97.7)	(100)	

Source: ADPEL of Semarang

Table 3-19 Average D.W.T, Days of Stay and Cargo Handling Volume of Local Boats by D.W.T Class in the Port of Semarang in 1976

Item	Classification of D.W.T					
	100 and below	101-200	201-300	301-500	501 or more	Total
Average D.W.T (tons)	100	160	260	370	600	150
Average days of stay (days)	6	7	4	6	7	6
Average cargo handling volume (tons)	130	240	270	410	1,060	190

Source: ADPEL of Semarang

3-4-5 Sailing Vessels

The sailing vessels which call at the port of Semarang mainly come from Madura, Sulawesi (Bugis) and Kalimantan. Sailing of these vessels is apt to be influenced by weather and their sailing cannot be made as planned, but a great number of sailing vessels are in service and total cargos transported by these vessels are relatively large in quantity, making of these vessels not negligible in the interinsular transport. These sailing vessels are mainly engaged in transportation of subsistence commodities such as boards and rice between the port of Semarang and local ports in Central, East and West Kalimantan, Sulawesi, and East Sumatra. Comparing year of 1976 to year of 1975, both number of calls and cargos flow are increasing. This increase is considered to be caused mainly due to active transport of foods and various materials from Semarang to inland of Kalimantan and of lumber from Kalimantan to Semarang in recent years. The sailing vessels smaller than 100 D.W.T called at the port of Semarang in 1976 were about 78% in number of vessels, 45% in D.W.T and 51 % in tonnage of loaded and unloaded cargoes, of all vessels as shown in Table 3-20. The average size of the sailing vessels was about 80 D.W.T, average days of stay were six days and average loaded and unloaded cargos were 50 tons as shown in Table 3-21.

Table 3-20 Activities of Sailing Vessels by D.W.T Class in the Port of Semarang in 1976

Item	Classification of D.W.T				
	100 and below	101-200	201-300	301 or more	Total
Share in number of calling vessels (%)	78.1	13.8	6.2	1.9	100
Accumulated ratio in number of calling vessels (%)	(78.1)	(91.9)	(98.2)	(100)	
Share in D.W.T (%)	44.7	24.7	21.6	9.0	100
Accumulated ratio in D.W.T (%)	(44.7)	(69.4)	(91.0)	(100)	
Share in cargo handling volume (%)	51.4	27.7	15.7	5.2	100
Accumulated ratio in cargo handling volume (%)	(51.4)	(79.1)	(94.8)	(100)	

Source: ADPEL of Semarang

Table 3-21 Average D.W.T, Days of Stay and Cargo Handling Volume of Sailing Vessels by D.W.T Class in the Port of Semarang in 1976

Item	Classification of D.W.T				
	100 and below	101-200	201-300	301 or more	Total
Average D.W.T (tons)	50	140	280	370	80
Average days of stay (days)	6	7	10	8	6
Average cargo handling volume (tons)	30	90	120	130	50

Source: ADPEL of Semarang

3-4-6 Offshore Cargo Handling and Lighter System

The port of Semarang has shallow water depth and vessels with draught greater than 4.5 meters are unable to enter the water area of the port. Therefore, by the regulations established by Port Administration of Semarang, the vessels larger than 3,000 D.W.T must anchor at offshore anchorage and their cargo handling must be made by the lighters in order to maintain the safety on the sea.

One tugboat is capable to tow four lighters at one time, each being loaded with about 100 tons, and transport time of cargos by lighters is about two hours and it takes about 1 hour to get there when barge is vacant. However, towing becomes very difficult during west monsoon season between January and February and it will take more than 2 hours.

Six companies are now engaging in offshore cargo-handling work, and five of these companies are managed by shipping companies and only remaining one is specilizing in the offshore cargo-handling business as shown in Table 3-22.

Table 3-22 Cargo Handling Volume at Offshore Anchorage by Company in the Port of Semarang in 1976/1977

Name of Company	Unloading x1,000 tons	Loading x1,000 tons	Total x1,000 tons
P.T. Jakarta Lloyd	85	34	119
P.T. Samudera Indonesia	110	10	120
P.N. Pelni	47	2	49
P.T. Trikora Lloyd	55	7	62
P.T. Gesury Lloyd	42	7	49
P.T. Berkah Bintang Samudura	69	1	70
Total	408	61	469

Source: ADPEL of Semarang

Situation of utilization for anchorage and pier facilities from April, 1976 to March, 1977 is indicated Table 3-23. It shows that approximately 57% of total cargos were handled in offshore anchorage by lighters and 43% of them were handled at wharf.

Table 3-23 Cargo Handling Volume and Its Share by Facility in the Port of Semarang in 1976/1977

Facility	Cargo Handling Volume x1,000 tons	Share (%)
Offshore Anchorage	469	57
Wharf	349	43
Total	818	100

Source: ADPEL of Semarang

3-4-7 Present Situation of Cargo Handling

Unloading capacity of vessel with draught smaller than 4.5 m at quaywall is shown below.

General cargo (including storing work): 280 tons/day/vessel
Major commodities (rice, sugar, fertilizer): 400 tons/day/vessel

Handling of general cargos is performed by mechanical handling using machines such as forklifts but major commodities are handled by manpower alone.

Cargo-handling capacity by lighter at the offshore anchorage is shown below.

General cargos (including storing work): 500 tons/day/vessel
Major commodities: 1,000 tons/day/vessel

The efficiency will be lower than the above values during west monsoon season.

Cargo-handling capacity (loading and unloading) of the port of Semarang expressed by average value of both quaywall handling and offshore handling is 15 tons/hour for general cargo, 20 tons/hour for bagged cargo such as rice and sugar, and 15 tons/hour for bulk cargo, and they can be also expressed by 600 to 900 tons/day for general cargo and 800 to 1,100 tons/days for bulk cargo.

In year 1976, total of 315 thousands workers handled about 808-thousands tons of cargos.

Table 3-24 Trend of Number of Longshoremen in the Port of Semarang (1970-1976)

(Unit: thousand persons)

Year	No. of Longshoremen	Average No. of Longshoremen per month	Average No. of Longshoremen per day
1970	305	25	0.8
1971	311	26	0.9
1972	317	26	0.9
1973	358	30	1.0
1974	418	35	1.2
1975	364	30	1.0
1976	315	26	0.9

Source: ADPEL of Semarang

Fertilizer which needed many labour forces were handled in 1974 and 1975 but import of fertilizer was discontinued in 1976 and general cargos were packed in boxes starting from 1976. Thus, forklifts are mainly used after this year and number of workers employed has been reduced after 1976 as shown in Table 3-24.

Number of workers engaged in cargo-handling in the port of Semarang from April, 1976 to March, 1977 was approximately 800 per day, their work capacity was about 2,000 tons per day and work capacity per person per day was about 2 tons as shown in Table 3-25.

Table 3-25 Number of Longshoremen and Cargo Handling Capacity in the Port of Semarang in 1976/1977

		Monthly No. of Longshoremen (persons)	Monthly Vol. of Cargo Handling (tons)	Average No. of Longshoremen per Day (persons)	Average Capacity of Cargo Handling per Day (tons/day)	Average Capacity of Cargo Handling per Person per Day (tons/person/day)
1976	Apr	24,910	67,329	830	2,244	2.7
	May	24,933	62,510	804	2,016	2.5
	June	19,035	50,025	635	1,668	2.6
	July	25,716	60,263	830	1,944	2.3
	Aug	19,379	46,604	625	1,503	2.4
	Sep	20,025	45,808	668	1,627	2.4
	Oct	35,867	74,378	1,157	2,399	2.1
	Nov	29,182	62,128	973	2,071	2.1
	Dec	25,222	58,845	814	1,898	2.3
1977	Jan	23,696	46,648	764	1,505	2.0
	Feb	28,453	57,983	981	1,999	2.0
	Mar	32,628	84,332	1,053	2,720	2.6
	Total	309,045	719,654	844	1,967	2.3

Source: ADPEL of Semarang

3-4-8 Utilization Trend of Transit Sheds and Warehouses

These facilities are all efficiently being used, and storing and cleaning of cargos are also being performed very effectively.

The utilization rate of the transit sheds rose between 1975 and 1976 and utilization rate of open storage also rose during the same period. However, utilization rate of warehouse for dangerous cargos is reduced during the same period but this is mainly due to discontinuing of use of the old warehouse in 1975 and starting of use of newly built warehouse in 1976.

A cargo-handling system by which cargos are transported directly through consumer's warehouses or warehouses within pier area instead of carrying them to transit shed is being employed in handling particular items such as rice, fertilizer, tapioca, lumber, asphalt, etc.. Records for period from April, 1976 to March 1977 showed that the amount of cargos which did not go through the transit shed was about 68% of total cargos handled as shown in Tables 3-26 and 3-27.

Table 3-26 Cargo Flow without through Transit Sheds by Kind of Vessel in the Port of Semarang (1976/1977)

(Unit: thousand tons)

Kind of Vessel	Cargo Flow
Ocean going vessel	342
Interinsular vessel	98
Local boat	57
Sailing vessel	56
Total	553

Source: ADPEL of Semarang

Table 3-27 Share of Cargo Flow by via/without via Transit Sheds in the Port of Semarang (1976/1977)

(Unit: thousand tons, %)

Classification	Cargo Flow	Share
Without via transit sheds	553	68%
Via transit sheds	365	32%
Total	818	100%

Source: ADPEL of Semarang

3-5 Problems under Present Situation

3-5-1 Offshore Cargo Handling

The anchorage in the port of Semarang currently has an approximate water depth of only −4.5 m so that vessels with draught greater than 5.0 m are unable to enter the water area of the port. The vessels larger than 2,000 D.W.T presently anchor at offshore anchorage which is about 4 km to 5 km away from the harbour and are relying upon the lighter for offshore cargo handling. And such vessels amount to almost 85% of all ocean going vessels. Transport of cargos between the anchorage and wharf is presently performed by 2 to 4 lighters with average capacity of 100 tons which are towed by a tugboat, and time required for this towing is about 2 hours during full load and 1 hour during vacant load. And offshore cargo handling capacity is about 15 tons per hour while it is 20 tons per hour at the wharf. Thus, time required for handling cargos of 100 tons is given by 100 tons/15 tons/hr + 100 tons/20 tons/hr = 12 hours. If time required for a round trip is added to this 12 hours, total of 15 hours will be needed at present time.

The cost for handling cargos by lighters at the offshore anchorage is said to be about 1,500 to 1,600 Rupiahs per one ton of cargos and this cost is borne by shippers.

Also, if a wind of about nine meters per second velocity is forecasted during winter between January and March, Port Administration of Semarang will secure the safety of the port by prohibiting cargo-handling at the offshore anchorage and anchorage in the port which, in the result, will inevitably increase the days of stay of vessels at the port. Thus, increases in cost and cargo-handling time compared to other ports such as the port of Tg. Priok are resulted in the port of Semarang which are considered to be one of main reasons for difficulties in making calls at the port of Semarang for most of the vessels.

According to the example of year 1976, 440-thousand tons of annual incoming and outgoing cargos which was about 55% of total annual inbound and outbound cargos of 808-thousand tons, were relying upon the cargo-handling by lighters and it was said that total of about 700 millions Rupiahs were paid for the cargo-handling by shippers.

Thus, some users prefer to land the cargos on other ports such as Surabaya and Tg. Priok and to use on-land transport means from there in order to save shipping costs rather than landing them on the port of Semarang. However, in such cases, costs for road transport will be naturally required.

Some of demerits of offshore handling are delays in sailing schedule due to loading and unloading of cargos and losses due to damages to the cargos for shippers and losses due to additional costs for fuel of vessels and additional costs for crews for shipping companies. Loss due to delay in schedule of vessel is said to be about 200,000 Rp./day for vessel smaller than 500 D.W.T, 1,000,000 Rp./day for vessel of 3,000 D.W.T class, and 2,000,000 Rp./day for 8,000 D.W.T class respectively. When a berth for large vessels is constructed in future, offshore cargo-handling in the anchorage will be drastically reduced and various losses will be accordingly reduced or eliminated.

There are the main reasons for the great need for the Deep Sea Berth in the port of Semarang.

3-5-2 Siltation and Maintenance Dredging

Coaster Harbour is a fine berthing facilities with -5.3 m design water depth but has been affected by sediment flowing from south and west canals of the city of Semarang and by littoral drift in Inner or Outer Harbour so that its depth has been shallowed and only about -4 m water depth can be now expected. The maintenance dredging for navigation channel and anchorage is now being performed under the direction of the Port Administration of Semarang and total of about 360-thousand cubic-meters of sediment was dredged in fiscal year 1976.

In order to realize the callings by large vessels, actual situation in the port of Semarang must be investigated, measures for solving siltation must be planned through the scientific analyses and widening and deepening of navigation channel and anchorage must be enforced. If widening and deepening of the navigation channel and anchorage are performed, they will naturally increase the amount of sediment of the siltation.

An appropriate limit for stopping the invasion and sedimentation of the inflow sediment by breakwater or groin must be determined but also a limit of maintenance dredging to be expected must be established, and balancing between these two limits is one of the most important factors in making the plan for the port of Semarang.

3-5-3 Handling of Petroleum Products

Presently, the petroleum products are being handled through Oil Jetty in Entrance Harbour and Sea Berth located approximately 4 km offshore in the port of Semarang, and most of these products are the unloading of domestic trade and will be supplied to its service area.

When industries further develop and economic activities become more active within the service area of the port of Semara g including the city of Semarang in the years to come, demand for petroleum products will be naturally increased and therefore amount of petroleum products passing through the port of Semarang will be increased accordingly.

Existing Sea Berth is being used for supplying the petroleum to a petroleum distribution base for the city of Semarang and its role of fuel supply to thermal power station presently being constructed will become very important after starting operation of this power plant. This Sea Berth is located outside the port and no any problem of its utilization is anticipated in future, but Oil Jetty will offer a serious safety problem of the port since it is located at an entrance to the domestic trade wharf and at branching point of channel where many local vessels pass by. Not only for navigation but also in view of utilization of the domestic trade wharf, it is desired to move this Oil Jetty to other place in an earliest time.

As foreign trade wharf is extended and improved from now, the number of calling vessels will sharply increase and demand for fuel supply to vessels will also increase accordingly, and it will become necessary to properly locate the fuel-receiving facilities which also supply the fuel to the vessels by considering overall aspect of the port whem moving existing Oil Jetty to a new location.

3-5-4 Fishing Boats and Fishery

Promoting fishery as a stable supply of protein in this area is indispensable for its development. However, when examining mooring of fishing boats in the present port of Semarang, they are all moored together at the root of West Breakwater of the Entrance Harbour but it is inefficient and has several problems in actual use since it was not planned as a fishing port.

First problem is that presently about 200 fishing boats are registered in the port of Semarang and most of them are moored closely to the navigation channel at the present port entrance so that they sail through the general navigation channel when going to fishing in the morning and evening.

Secondly, a nallow area at the root of the West Breakwater is now being used as a base for fishing preparation for the boats and as a market for fishes in a planless manner so that the connection with the city of Semarang is made only by a single road passing through fishing boats' wharf of Kali Baru and thus it is completely unable to meet the future development of the fishery.

In making a master plan for the port of Semarang, it is required to make a very basic fishing port improvement plan for the development of fishery in future and to realize its construction in parallel with the improvement of the port of Semarang.

Chapter-4

Natural Conditon of the Port of Semarang

CHAPTER 4
NATURAL CONDITION OF THE PORT OF SEMARANG

4-1 General

The port of Semarang is located on the northern coast in Central Java facing to the Java Sea.

The climate in the district is of tropical rain forest type and is divided into rainy season and dry season. In the rainy season the northwestern monsoon is predominant while the southeastern monsoon becomes predominant in the dry season.

The wind has very outstanding daily changes which can be characterized by sea breeze during the day and land breeze at night.

The waves are developed during northwestern monsoon with their sizes maximum in the afternoon.

The rivers flowing into the Java Sea from highlands running in east-west direction of the island of Java in the hinterland of the port, are Semarang River in the vicinity of this port and East and West Canals, all being relatively small in sizes.

The bottom of the sea is gradually shoaling at the beach and the bottom mainly consists of silt.

4-2. Geographical Conditions

The port of Semarang is located at 110° 25' of east longitude and 6° 57' of south latitude on the northern coast in the central area of island of Java, is connected to Pekalongan and Tegal in the west and to Jepara in the northeast and shielded by a cape (50 km wide X 30 km long) having Mt. Muraya.

The port of Semarang is within the alluvial lowland cultured by a small river of Semarang River running through the city of Semarang and by West and East Banjir Canals both being separated approximately by 2 km in east and west.

The areas of basin of the East and West Canals are about 132 km^2 and 190 km^2 respectively. The East Canal has arid zone extended in the upper reach and supply of sediment to the beach is considered to be active.

The West Canal is connected to a dam and sand deposited there is utilized as aggregate for construction work so that sediment supply to the beach is limited to a certain extent.

The bottom of beach is extremely gradually shoaling and area of 10m water depth is more than 4 km away from the coast.

The distance to the highland in Central Java is about 30 km from the beach, and it partially includes hilly topography but mostly is plain occupied by cultivated farm land comprising rice fields and farms.

To the west and east of the present port facilities on the coast, fishponds and trace of abandoned salt farms are continuing.

4-3. Geological Conditions

Fig. 4-1 indicates geological condition of an area including the port of Semarang. Main stratums in the area will be described in Appendix.

The bottom materials in front of the port of Semarang comprise sandy silt of extremely fine grain size or silty sand.

4-4. Meteorological Conditions

The atmospheric pressure on the sea remains relatively constant throughout the year. Since the isobaric lines are linear on the Java Sea, wind velocity should probably be calculated considering the balance between surface friction and atmospheric pressure gradient rather than the deflective force due to earth's rotation.

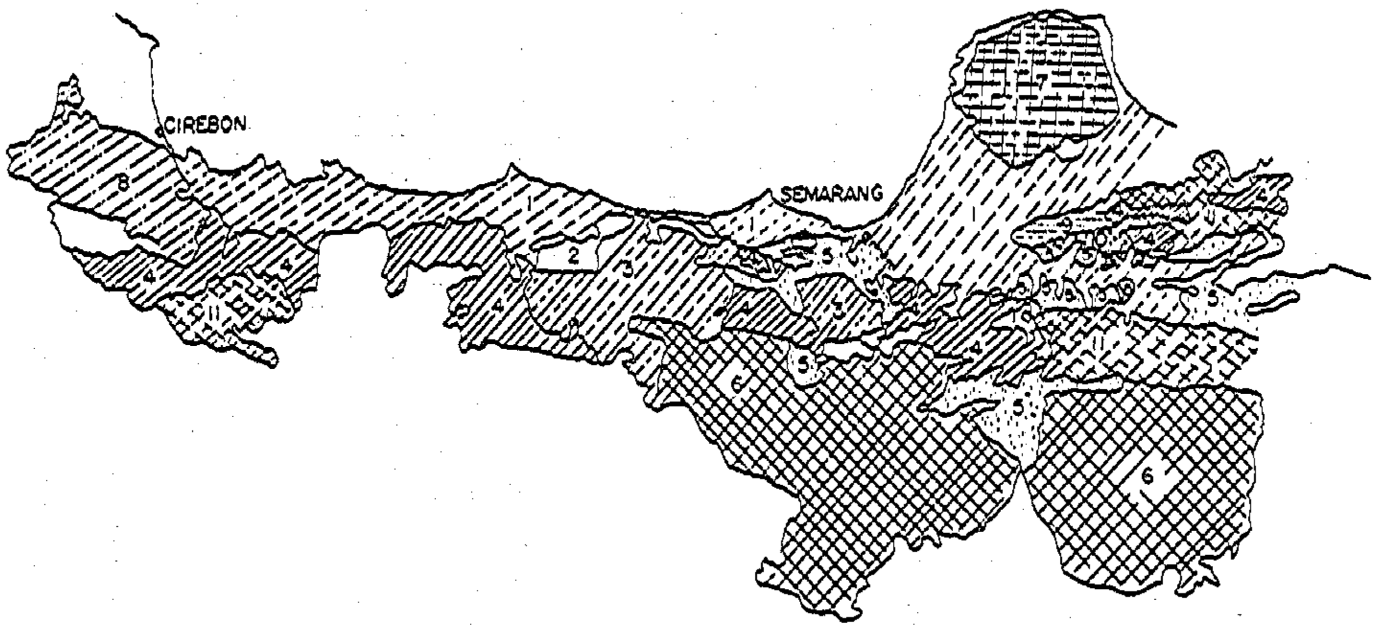
Total wind velocity and velocity exceeding 10m/sec respectively measured in the port of Semarang are shown in figures listed in Appendix.

It indicates that the frequency of appearing of strong W - NW wind is high during northwest monsoon season (rainy season). But east wind as well as north sea wind which is affected by sea and land breezes will appear during southeast monsoon season (dry season).

The time of occurrence of daily maximum wind velocity is shown in Appendix. Daily maximum velocity occurs during the day in the southeast monsoon season between June and September, and during afternoon in the transitional period between October and December.

During northwest monsoon season between January and May and during subsequent transitional period, maximum velocity occurs even in the night due to predominant

Fig. 4-1
Geological Map of Java & Madura 1 : 2,000,000
Prepared by the Geological Survey of Indonesia
printed by the Geological Survey of Japan 1977



1. Alluvium Holocene
2. Alluvium volcanic facies Holocene
3. Old quaternary volcanic products
4. Miocene
5. Pleistocene
6. Young quaternary volcanic products
7. Leucite bearing rocks
8. Undifferentiated volcanic products
9. Pliocene limestone facies
10. Pliocene sedimentary facies
11. Pliocene volcanic facies

monsoon but in majority the maximum velocity occurs in the afternoon being strongly affected by sea and land breezes (sea breeze during day, land breeze at night).

The rainfall by month in Semarang is indicated in Appendix. Rainy season and dry season are clearly distinguished and each season will coincide with north west and southeast monsoon seasons. The average yearly rainfall in the years from 1967 to 1970 is approximately, 2,000mm but it also exceeds 3,000mm in certain particular years and monthly rainfall is also widely varying.

Yearly mean atmospheric temperature in Semarang is approximately 27°C.

4-5. Oceanographical Conditions

4-5-1 Outlook

Deriving of meaningful factors such as wave height, period and wave direction required for design of port structures from the measured data is difficult since long-term waves observation by wave recorder has not been performed around the Javs Sea.

The results of Tg. Priok Port where records of visual observation by use of water gauge are relatively well kept, are indicated in Appendix for reference. According to this table, it is obvious that the high waves appear only in the northwest monsoon season.

Under current Indonesian regulations, all vessels passing particular predetermined points are obligated to report wind and wave conditions to Meteorological Bureau by radios, and outline of oceanographical conditions of the Java Sea can be generally understood using these data.

Wave appearing conditions by month in area at 106° to 114° of east longitude and 4° to 7° of south latitude in the vicinity of the port of Semarang in the Java Sea are shown in Appendix. The waves in northwest monsoon season have the wave direction W – WNW. High waves arriving from direction of SE – E during southeast monsoon are indicated, but they were recorded mainly in northern half of the Java Sea and it is considered that they will be rather concentrated to the direction of E in offshore of the port of Semarang and wave height will be considerably lower.

Ocean current in the Java Sea is a current moved by wind caused mainly by monsoon. Main current direction during southeast monsoon between May and September is rather west. It is mainly east in direction during northwest monsoon season between November and March. October and April are transitional months. Average maximum current is about 0.5 kt for the both east and west currents, and maximum velocity ever observed on the outer sea is about 2 kt for both monsoon seasons.

The tide level in the port of Semarang is automatically being observed in tide station located in front of eastern wharf of the port. Main tide levels and harmonic constants of tide obtained by harmonic analysis are indicated in Table 4-1 and Fig. 4-2. Semidiurnal tide precisely appears during neap tide but generally diurnal tide or semidiurnal tide with frequent diural inequality will occur.

Fig. 4-2 Tide Level in Semarang

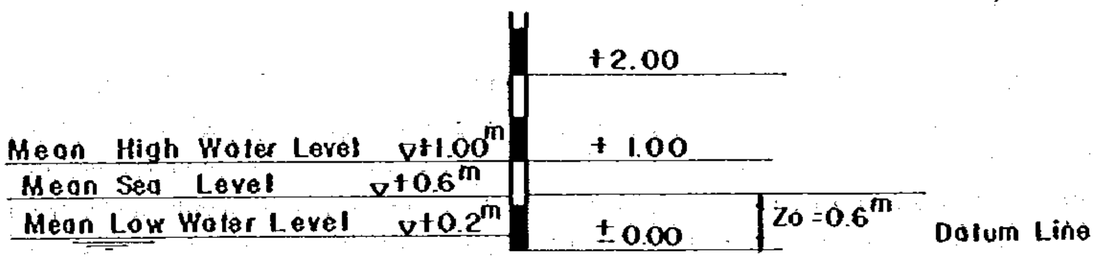


Table 4-1 Tidal Constants at Semarang

Constant	M_2	S_2	N_2	K_2	K_1	O_1	P_1	M_4	MS_4	Z_0
Amplitude (cm)	10	8	5	5	22	8	7	-	-	60
Lag of tide (°)	102	203	139	160	7	128	2	-	-	

The current near the coast is mainly governed by ocean current in offshore area and even the possibility of countercurrent in reverse of general current will exist where concave coastal line is existing as in the case of the port of Semarang. Current in shallow water area with water depth less than several meters is governed by the tidal current, and east current will occur during ebb tide and west current during rising tide.

4-5-2 Previous Studies

Meteoroligical and oceanographical observation in the port of Semarang was conducted by Gadjah Mada University in the northwest monsoon season between 1974 and 1975. According to this report, wave observation was conducted in an area where water depth is 6m and its distance from pier was 2 km offshore. The wave period was measured by stop watch and wave velocity was measured by measuring time required to pass two poles separated 50 meters between.

Wind in February was strong, its velocity was 5 to 10 m/sec and its direction was W – WNW. Wind in November was weaker and its direction varied between N and W. As indicated in the figure listed in Appendix wave height in the port of Semarang has close relationship with wind velocity clearly indicating character of wind waves. Wave height in relation with identical wind velocity is affected by wind direction and time of duration, and it is higher in February than November. Maximum significant wave height observed was 1.5 m. The wave height increased as period increased indicating the character peculiar to the wind waves. (See Appendix.) by location and they were considered to be soft clayey silt containing shells up to 6 to 8 m below the surface layer.

4-5-3 Assumption of Design Wave

Observation of the waves by instruments is more desirable, though visual observation is useful for finding seasonal variation and other tendencies but not relaible quantitatively. Regrettably, continuous observation by instruments such as wave recorder has not been performed in the port of Semarang and only the records of visual observation are existing. Therefore, the waves which are the basis of design of port structures and analyses of the shoaling mechanism will be assumed here under certain assumption.

Table 4-2 indicates fetch by direction. The maximum value of the fetch is 600 km in NW direction. But wind records in the port of Semarang indicates that daily changes of wind are very clear even during northwest monsoon season and most of the time of duration of a same wind direction is about 5 to 10 hours. Thus, the scale of wind waves is limited by duration and effective fetch length will be much smaller than those shown in Table 4-2.

Table 4-2 Directional Distribution of Fetch

Direction	NNE	N	NNW	NW	WNW
Fetch (km)	400	440	∞	600	550

Wind is not blowing uniformly throughout the Java Sea, but sea breeze and land breeze are blowing once a day alternately within the range of certain fetch length from the coast, and monsoon blowing through the Java Sea is adding to or decreasing from the wind velocity near the coast.

Thus, data with large wind velocity and longer duration were selected from the wind data of Semarang, and wind assumption was made. Results of the assumption are shown in Table 4-3.

The maximum significant wave as deepwater wave will have wave height of 2.3 m and 7.4 sec period for NW wave direction, 2.7 m wave height and 7.3 sec period for W wave direction, and 1.0 m wave height and 4.4 sec period for NW wave direction.

Fig. 4-3 Refraction Diagram (1)

Wave direction WNW

T=6.0 sec

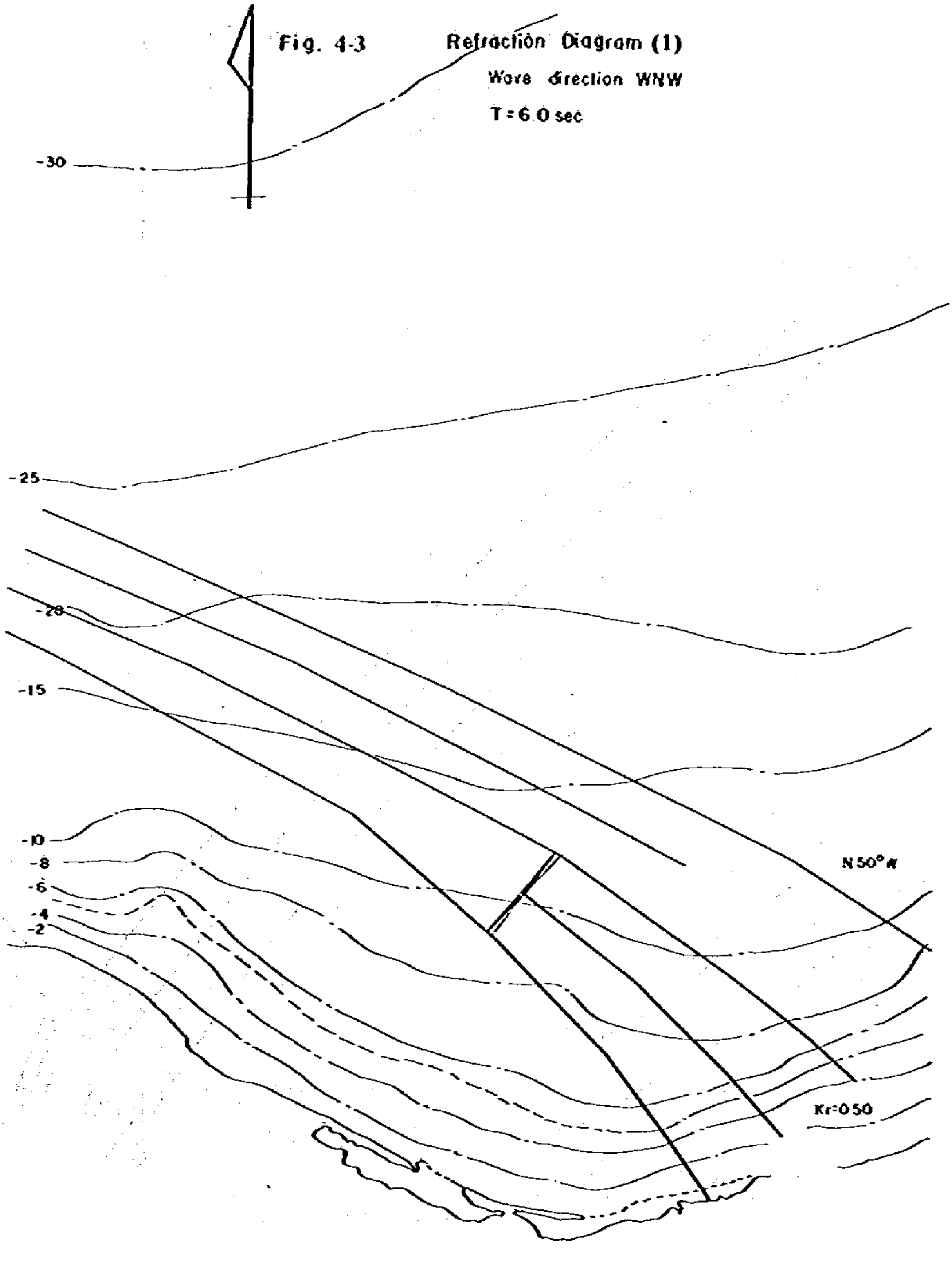
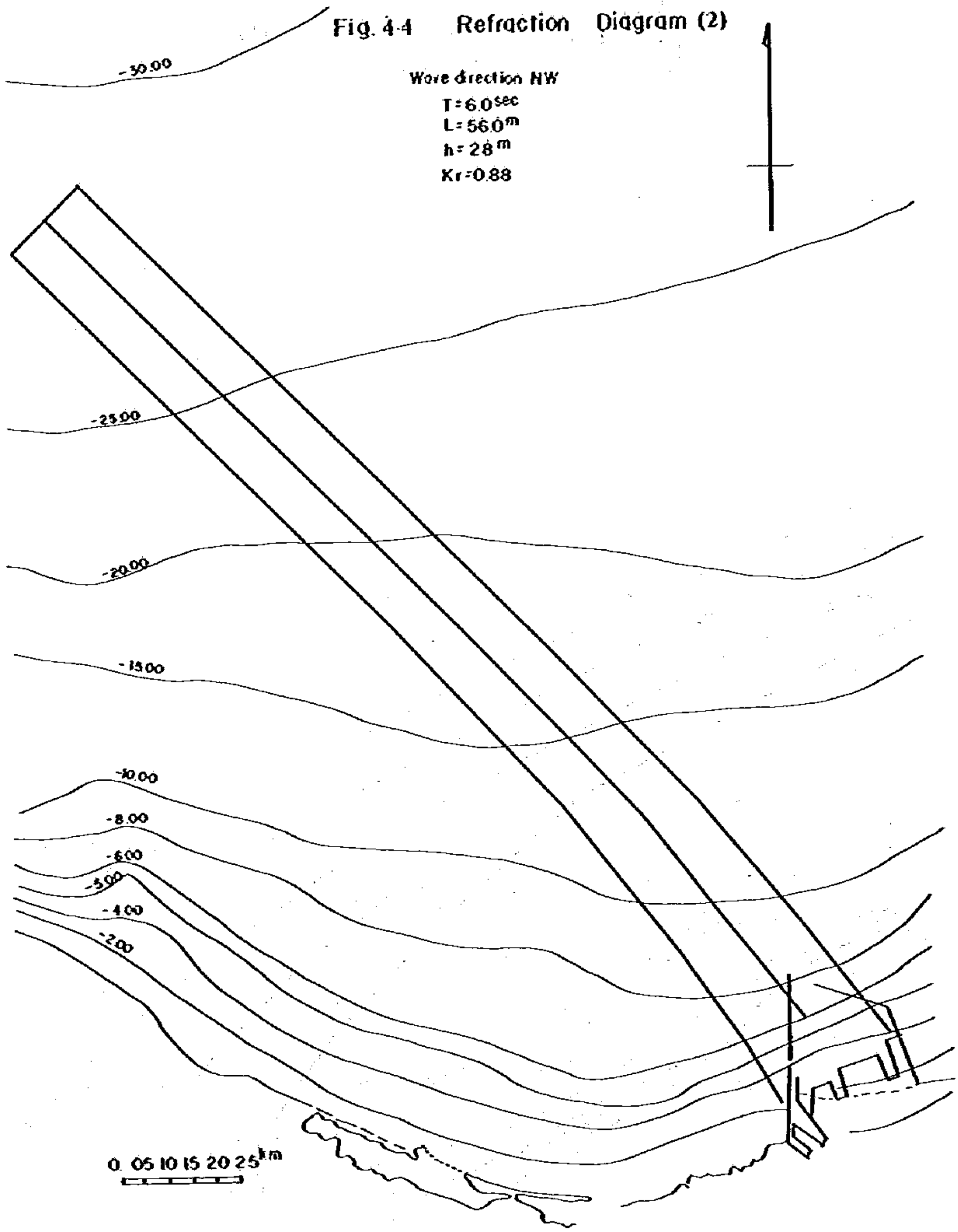


Fig. 4-4 Refraction Diagram (2)



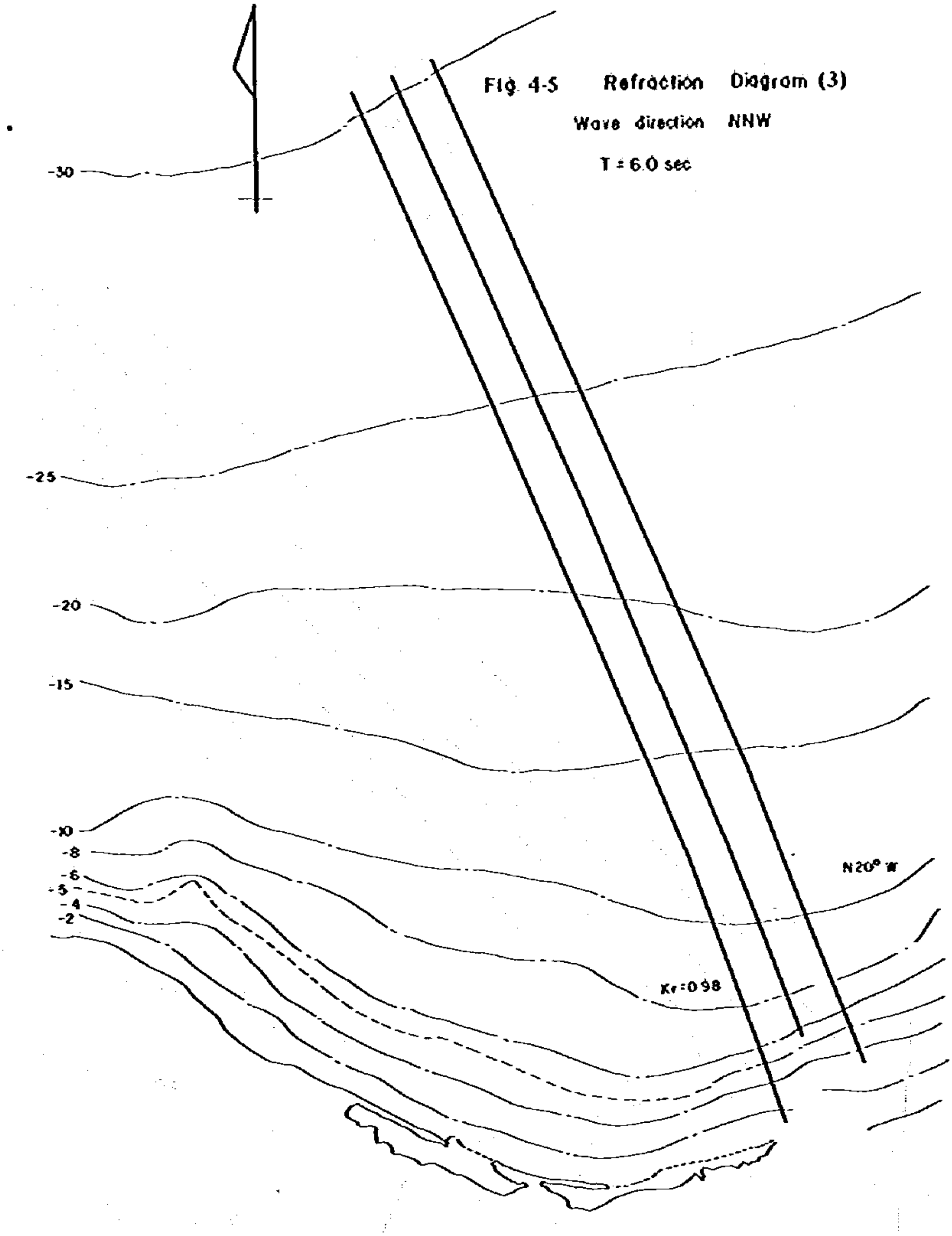
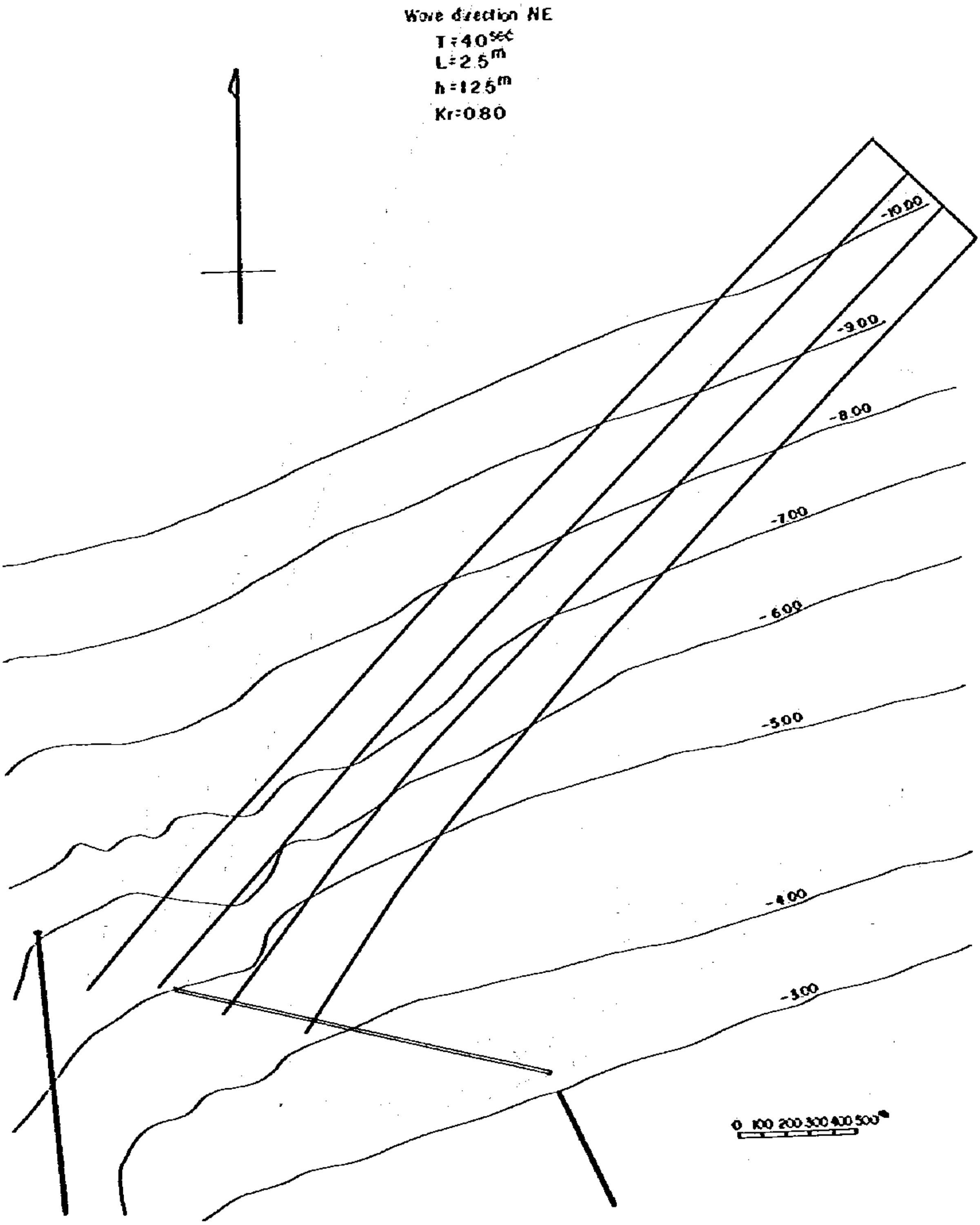


Fig. 4-5 Refraction Diagram (3)
Wave direction NNW
T = 6.0 sec
-30
-25
-20
-15
-10
-8
-6
-5
-4
-2
N20° W
Kr=0.98

Fig. 4-6 Refraction Diagram (4)



However, in this assumption, the wind observed in Semarang was assumed to be uniformly blowing throughout the Java Sea. But it can't be said that both wind velocity and direction of Semarang are coinciding with those of the ocean. Therefore, it is considered to be the best method to collect observed atmospheric pressure at each area around the Java Sea, to compute wind velocity from balance between gradient of atmospheric pressure and friction on sea surface, and to correct the values in reference to observed value for the wind.

The wave computed by assumption of SMB method is so-called deepwater wave, and it will become shallow water wave when it reaches to a sea with depth less than half of its wave length, then wave direction and wave height will be altered (period is assumed to remain unchanged) by the influences of refraction, shallowness, bottom friction, etc. Refraction is illustrated in Figs. 4-3 to 4-6. Several lines shown almost in parallel in the figures are indicating the directions of waves.

Table 4-3 Wave Estimation

(By S.M.B. Method)

Wind Direction	Date	Case	Wind V(m/s)	Wind Duration hour(h)	Deep Sea Wave Wave Height (m)	Shallow Water Wave Kr	Shallow Water Wave $H_{1/3}$(m)	Shallow Water Wave $T_{1/3}$(sec)	Fetch Length (Km)	Continuous Hour
NW	1977. 2.17	1	10.8	13	Ho= 2.3	0.88	2.0	7.4	200	10^h - 22^h
–	2.15	2	11.3	10	2.1	–	1.8	6.9	150	11 - 22
–	2.18	3	11.8	7	2.0	–	1.8	6.6	100	10 - 16
–	3. 1	4	11.3	8	1.8	–	1.6	6.4	110	12 - 19
–	2.20	5	11.3	8	1.8	–	1.6	6.3	110	10 - 17
–	2.22	6	13.9	4	1.8	–	1.6	6.0	52	8 - 11
–	3. 4	7	12.3	4	1.7	–	1.5	5.7	50	3 - 6
W	3. 4	8	11.3	16	WNW 2.2 (2.7)	0.53	1.1	7.3	250	7 - 22
–	2.23	9	12.9	10	WNW 2.4 (2.7	–	1.2	7.3	170	9 - 18
–	2.15	10	11.3	10	WNW 1.8 (2.1)	–	0.9	6.5	150	21 - 04
–	2.15	11	11.3	6	WNW 1.7 (1.9)	–	0.9	6.2	85	5 - 10
–	2.19	12	11.3	10	WNW 1.8 (2.1)	–	0.9	6.4	150	9 - 13
–	2.22	13	11.8	5	WNW 1.4 (1.7)	–	0.7	5.4	62	12 - 16
N	1976 9. 5	14	5.4	9	0.8	1.0	0.8	4.6	55	10 - 15
NE	9. 6	15	9.3	4	1.0	0.80	0.8	4.4	40	11 - 14
–	9.13	16	9.3	4	1.0	–	0.8	4.4	40	11 - 14
–	5. 7	17	7.2	6	0.8	–	0.6	4.2	35	12 - 17
–	5. 3	18	7.2	4	0.7	–	0.6	3.8	32	13 - 16
–	6.30	19	6.2	5	0.6	–	0.5	3.7	40	15 - 19
–	5. 6	20	6.2	4	0.5	–	0.4	3.3	29	13 - 16

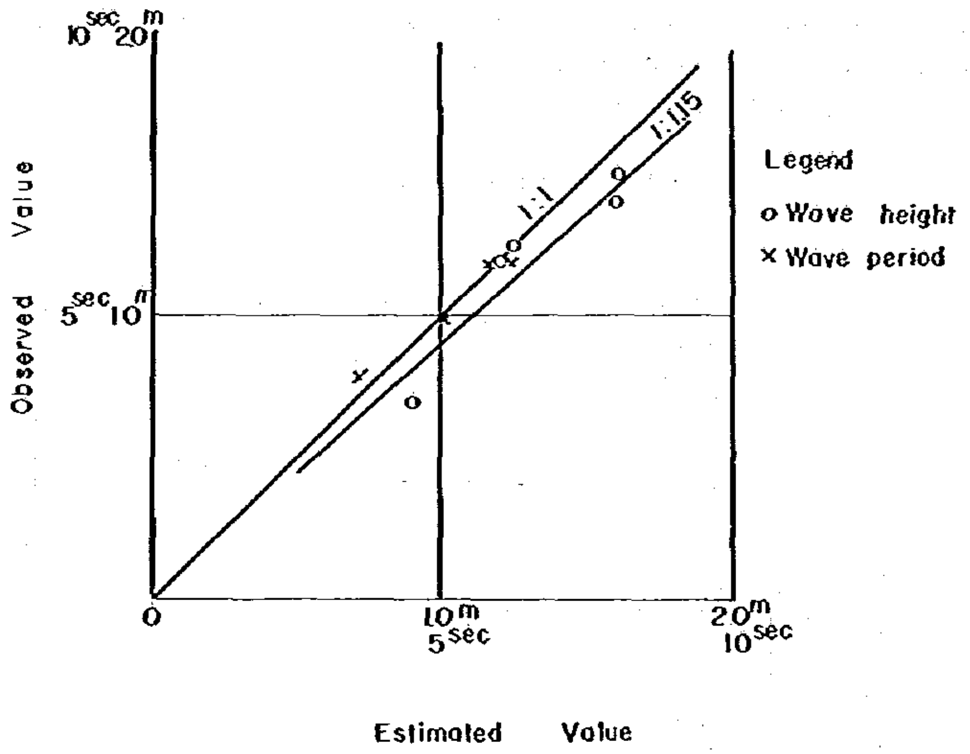
Kr: Refraction Coefficient

As clearly understandable from Table 4-3, the wave arriving at future west breakwater will be deformed to shallow water waves, and deep-water waves with directions of NW, W and NE will become smaller waves with wave height of 2.0 *m*, 1.2 *m* and 0.8 *m* respectively. Since the beach is gradually shoaling, attenuation of wave height by bottom friction can be expected but this effect is not clear for the bottom material of silt.

According to Bretschneider's method, the attenuation factor by the bottom friction for waves with 6 sec period and 2.0 m wave height passing through a shallow water with 6 m mean water depth for a distance of 2 km, has been calculated with a result of 0.85.

Gadjah Mada University conducted a few observations using wave height gauge on 6th to 9th of November, 1974 and on 16th to 18th, February, 1975 and some measured values were obtained. Wind observation was also conducted during this wave observation. Thus, wind velocities and durations in the observation records were taken out and used for calculating the wave by the SMB method. The wave is compared with measured values and indicated in Fig. 4-7.

Fig. 4-7 Correlation between Observed Wave and Estimated Wave



From this figure, the following items have been made clear:

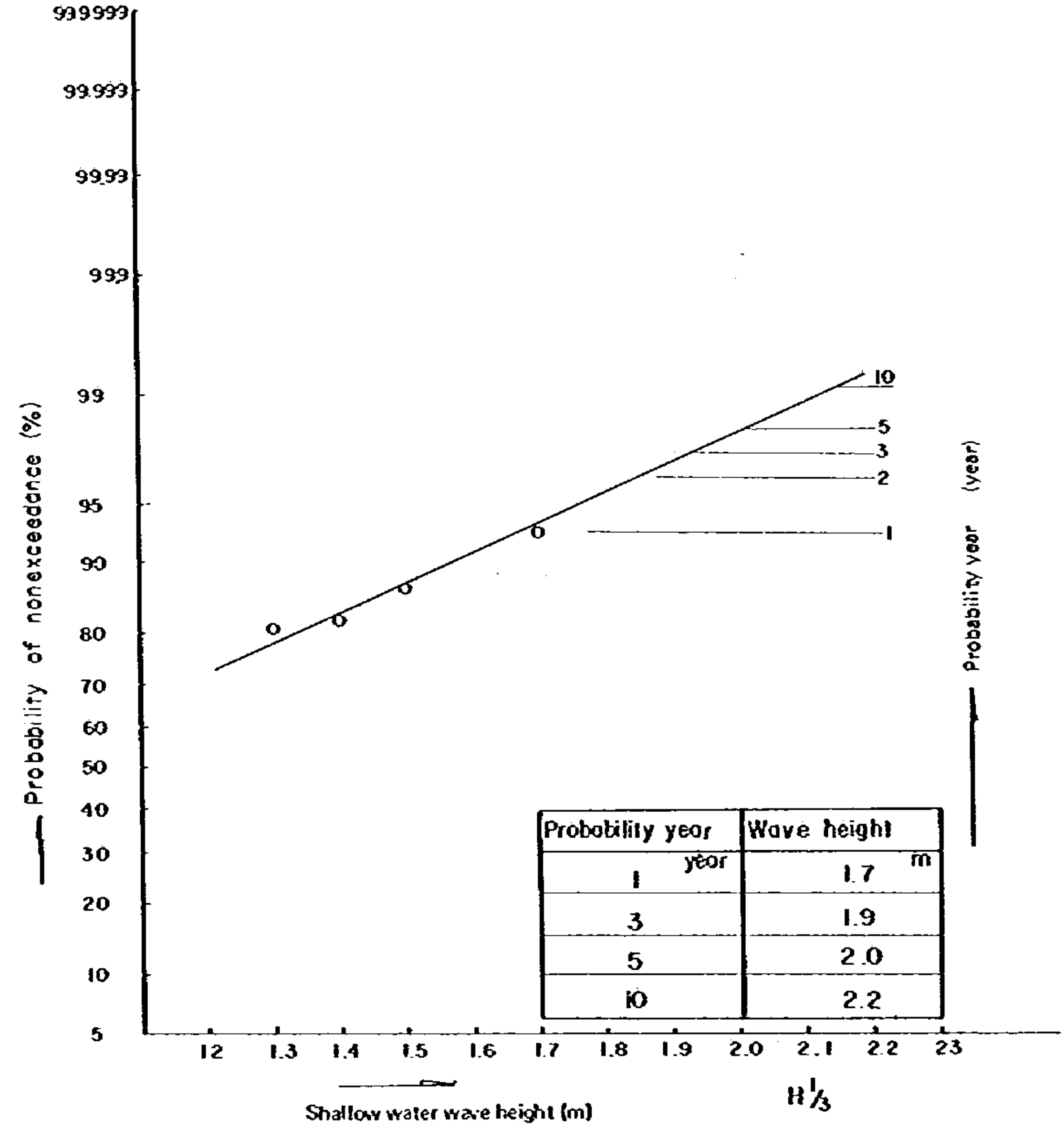
Measured period coincides with calculated value with assumption. Measured wave height is about 85% of calculated value. Generally, scale of wave (wave height, period) is also related to wind velocity, duration and fetch length.

The difference between measured value and calculated value by assumption is considered to be mainly due to the wave development limited by fetch length or due to considerable attenuation of wave height by the bottom friction.

The fetch length shown in Table 4-3 is a minimum fetch length required to generate the calculated wave. Therefore, the range where sea and land breezes are affected, is considered to be slightly shorter than these values, or attenuation of wave height by the bottom friction is considered to be very outstanding. In either cases, however, calculations by assumption were corrected particularly for high waves and it was decided to use only 85% of the wave height.

The frequency of appearance of wave height was then calculated and shown in Fig. 4-8. This indicates that the deepwater waves with direction of NW in the port of Semarang have appearance frequency for 2.0 m significant wave height with 5-year probability year.

Fig. 4-8 Cumulative Frequency Distribution of Wave Height by Thomas Plot



Probability year	Wave height
1 year	1.7 m
3	1.9
5	2.0
10	2.2

4-6 Soil Conditions

4-6-1 Past Surveys

(1) General

The soil in and around the port of Semarang is clayey silt or silty clay with no regional difference observed and is nearly homogeneous to about 30 m below the ground level.

Surveys of the soil of the port of Semarang were carried out by the Gadjah Mada University of Yogyakarta at about 50 points in the vicinity of the port in 1973 to 1975 and by the national electric power corporation P.L.T.U. at 19 points about the site for construction of a thermal power plant.

(2) Soil survey by Gadjah Mada University

The soil survey of the Gadjah Mada University was conducted by the Dutch method cone penetrometer test, and use of the sampler (20 mmϕ) attached to the cone penetrometer, with a pontoon used for survey on the sea.

According to the test result, the soil had a density changing more or less with increasing depth but was generally homogeneous.

The items of survey were the unconfined compression test (qu), bulk density (γ_t), specific gravity (Gs), water content (w), grain size distribution (Ma), Atterberg limits (W_L, W_P and I_P), shearing strength (τ) and coefficient of consolidation obtainable from conversion of the result of the cone penetration test.

The result is briefly described below.

a) The soil from the surface layer to about 23 m is dark grayish clayey silt containing shell fragments and is very soft with almost no penetration resistance according to the sounding test. But, the soil of qc = 2 ~ 5 kg/cm² is observed from place to place.

b) The layer beyond the surface layer to a depth of 23 m is dark grayish silty clay with higher density, that is, qc = 25 ~ 30 kg/cm²

c) The samples obtained by borings were taken to the soil test laboratory of the university to obtain the bulk density, specific gravity, water content, shearing strength, consistency and coefficient of consolidation (See Table 4-4 and Fig.s 4-11 and 4-12).

(3) Soil survey at site for construction of thermal power plant

The Soil survey at the site for construction of the thermal power plant was conducted by the Dutch cone penetration test and according to the core tube system employing a rotary drilling rig U_{D-5} (hereinafter referred to as PLTU survey).

For collection of undisturbed samples, a soil sampler type U developed by D. Moore Corporation was used, and for collection of disturbed samples, a spilit spoon sampler as in the standard penetration test was used.

The items of survey were:
Unconfined compression strength (qu), bulk density (γ_t), water content (w), consistency (W_L, W_P and I_P), specific gravity of soil (Gs) and grain size distribution (Ma).

According to the reported result of survey, the soil from the surface layer to about - 27 m is soft or medium stiff clay of medium to high plasticity, but it is intermingled with organic clay. The foregoing clay layer is underlain by sand or medium to coarse sand present in a thickness of about 2 meters down to about - 29 m. Further beneath there is a greenish gray solid clay layer which adjoins a layer of sand with gravel at a depth of about 39 m. The results of the soil tests are shown in Table 4-4 and Fig. 4-12.

(4) Comparison of the past survey results
Upon comparison of the survey result of Gadjah Mada University with that of PLTU, the following may be said, but when the objectives and the degree of accuracy of the respective surveys and the survey points that are substantially apart from each other are taken into consideration, it may not be proper to discuss the results of the two different surveys by more comparison.

a) In the PLTU survey, the unconfined compressive strength of the cohesive clay generally had a greater value than that obtained by the Gadjah Mada University. This is probably due to the fact that the PLTU survey was carried out onshore, while the Gadjah Mada University Survey was performed in an offshore area.

b) As stated above, results of both survays cannot be simply compared, qu value from the PLTU survey are about twice as great as that from the Gadjah Mada University survey.

c) In both surveys, the number of undisturbed samples derived per borehole was too small to define the increment of the unconfined compressive strength as function of the depth.

d) The depth of the stiff clay layer in an offshore was found to be about - 30 m from the result of survey by cone penetrometer test by the Gadjha Mada University.

e) The PLTU cone penetrometer test showed the depth of the onshore stiff clay layer is about - 20 m, or smaller than that in the sea.

Summary of the item-wise survey results is given in Table 4-4.

Table 4-4 Comparison of Past Survey

Item tested	Report from Gadjah Mada University	Report from PLTU Survey
Cohesion (Cu)	0.072Z (t/m^2)	0.6 + 0.14Z (t/m^2)
Bulk density (γt) t/m^3	1.48 - 1.64	1.49 - 1.81
Dry density (γd) t/m^3	0.8 - 1.08	0.8 - 1.28
Water Content (W) %	60 - 80	42 - 87
Liquid limit (W_L) %	50 - 92	56 - 120
Plastic limit (W_p)	29 - 41	30 - 48
Plastic index (I_p)	19 - 55	24 - 84
Specific Gravity of Soil (Gs)	2.33 -2.67	-

4-6-2 Check boring

From the results of the past soil surveys conducted in and around the port of Semarang, it was concluded that the values for the soil characteristics were too irregular to serve as basic data for designing port structures, and that there was a very thickn layer of soft cohesive soil in the areas surveyed. Thus, it was considered necessary to obtain more detailed soil data.

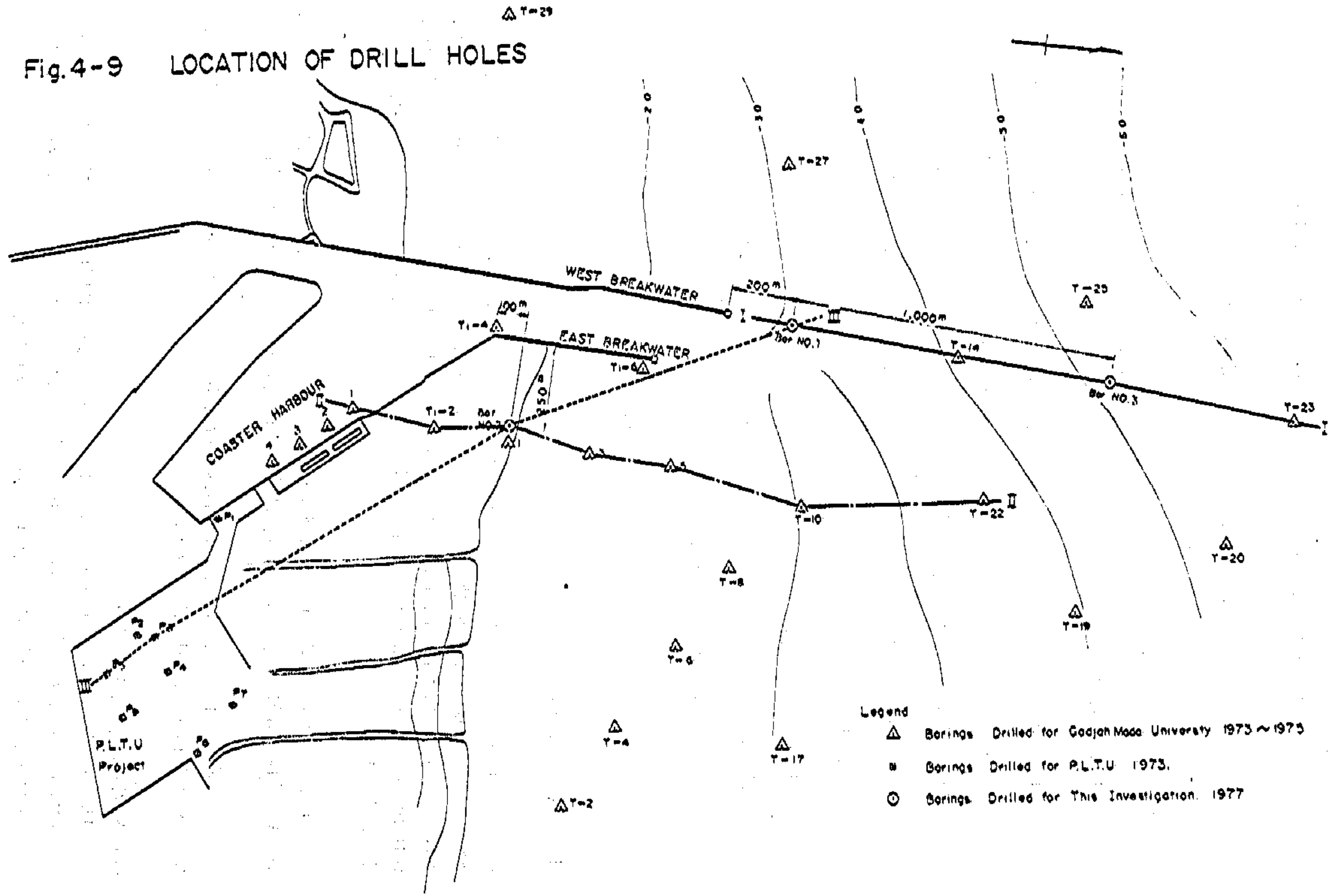
For this reason, the Japanese Study Team conducted check borings at one onshore point and two offshore points in project site of the port of Semarang (See Fig. 4-9).

Transfer of technology on soil survey to the Indonesian counterparts was achieved by the survey team during the check borings.

(1) Method of check boring

The check borings were carried out by a drilling pipe (O.D. 97mmφ) method using a rotary drilling rig. For collection of undisturbed samples, a stationary piston type thin wall sampler and a hydraulic piston type thin wall sampler were used.

Fig. 4-9 LOCATION OF DRILL HOLES



For the sand and solid clay layers, the standard penetration test was carried out primarily with sampling made partially.

For the two offshore survey points, a check boring was performed using a simple boring stage built by fabricating steel pipes on the sea.
Major considerations in the surveys were as follows:

a) To cllect as many samples as possible per borehole, and

b) To try to determine the bearing layer which would serve as the foundations for the structures.

The collected samples were analyzed at the field laboratory provided in the Port Administration of Semarang with respect to the following items:

a) Unconfined compressive strength (qu),

b) Unit weight (γ_t),

c) Water content (w),

d) Liquid limit (only No.2 borehole) (W_L), and

e) Plastic limit (only No.2 borehole) (W_P).

Consolidation tests and classification index tests as shown below were carried out at the laboratory of the Port and Harbour Research Institute, Ministry of Transport, Japan.

a) Consolidation test (Cv, mv, k and Cc).
b) Liquid limit test (W_L).
c) Plastic limit test (W_P).
d) Specific gravity test (Gs).
e) Grain size distribution test (Ma).

(2) Results of surveys
The survey results are summarized below.

a) Data from boreholes Nos. 1 and 3 indicate that stratification in the offshore area comprises very soft dark greenish gray clay or silty clay down to about -25.5 m ~ 27.5 m as shown in Fig. 4-10.

with the qu value at the bottom or qo = kg/cm² and the propensity to increase in strength with depth or k = 0.024Z, this layer consists of very soft cohesive soil. Below this layer, there lies stiff or medium gray clay with an N value of about 10 from -39.5m to -43.0 m. Below the depth of 43.0 m are encountered a brownish fine sand layer and gravel sand layer. These layers showed an N value ranging from 35 to 38.

b) Data from the borehole No.2 show that the stratification in the onshore area is not widely different from that in the offshore area, as shown in Fig. 4-10. However, the medium stiff and stiff layers are more or less shallower than in the offshore area, occurring at -22 m. These layers consist of very soft soils with q_0 = 0.12 kg/cm² and k = 0.028Z. Down to -35m, there was found no sand layer that would serve as a foundation layer.

c) Comparison of the qu values for the offshore area and those for the onshore area shows that the latter generally has a greater value.

d) The value of unconfined strain (ϵ) corresponding to the qu value in unconfined compression test is about 3%.

e) The soils of the area surveyed are characterized by the general presence of fine particles including a large amount of colloidal particles of a size less than 2μ.

f) Silty sand lies about 50 cm thick on the seabed.

g) Stiff clay shows an N value of about 10 when it is confined in the ground but tends to be very brittle when taken out of the ground for sampling and thus unconfined. This is a characteristic of the stiff clay.

h) The consolidated layer is thick, and the coefficient of consolidation Cv representing the consolidation characteristic is smaller than that of clay in general.

i) The investigation results are arranged by item in Table 4-5. Further, the curves of e~log p, long Mv~log $\bar{p}$ and log Cv~long $\hat{p}$ are shown in Figs. 4-13 through 4-15.

Table 4-5 Soil Condition of New Investigation

Item tested	Investigation by Japanese Team		Remarks
Gs		2.72 - 2.81	
γ_t t/m3		1.48 - 1.72	Concentrated somewhere about 1.53 t/m3
W %		58 - 110	
WL %		71 - 116	
Wp %		29 - 39	
Ip		48 - 82	
Ma (%)	Clay	51 - 78	Near the center of the layer (-18.8m)
	Silt	14 - 49	C: 68%
	Sand	0.5 - 14.6	M: 31.5%
			S: 0.5%
Void ratio e from seabed down to 22^m, 1.6 - 2.49			Below -22m 1.41 - 1.57
Compression index Cc from seabed down to 22^m, 0.89 - 1.52			Below -22^m, 0.41
Cv		$3 \times 10^1 cm^2/day$	

3) Relationship between check borings and past surveys

With respect to the relationship between the past survey results and those of the check borings, the following may be said.

a) With respect to the soil conditions in the onshore area, the PLTU survey results and the check boring (No.2) results are comparable with each other. Such comparison indicates that the qu values from both surveys show a nearly identical tendency as shown in Fig. 4-12. Their average linear equation is given by $qu = 0.12+0.028Z$ (kg/cm^2), and for a design value of the soil strength, $Cu = 0.06 + 0.014Z$ (kg/cm^2) may be employed.

b) For the soil conditions in the offshore area, the result of the check borings is comparable with that of the survey conducted by the Gadjah Mada University. As shown in Fig. 4-11, a difference is noted in the distribution of qu values with depth, but this difference is considered to be due to a difference in the objective between the surveys. The survey of the Gadjah Mada University was carried out mainly by means of the cone penetrometer, and the sampling was intended not for measurement of the soil strength but for observation of the soil conditions. The measurements are understood to have been made in an attempt to obtain a general yardstick for the soil strength using the collected samples. A comparison of these values and those obtained from the check borings showed that the latter were twice as great. The average linear equation of these qu values is qu = 0.08 +0.024Z (kg/cm^2). Thus, for the soil strength in the offshore area, the value Cu = 0.04 + 0.012Z (kg/cm^2) derived from the check borings would be adequate as a design value.

Boring Logs of on shore

Fig. 4-10 Boring Logs of Offshore and on Shore

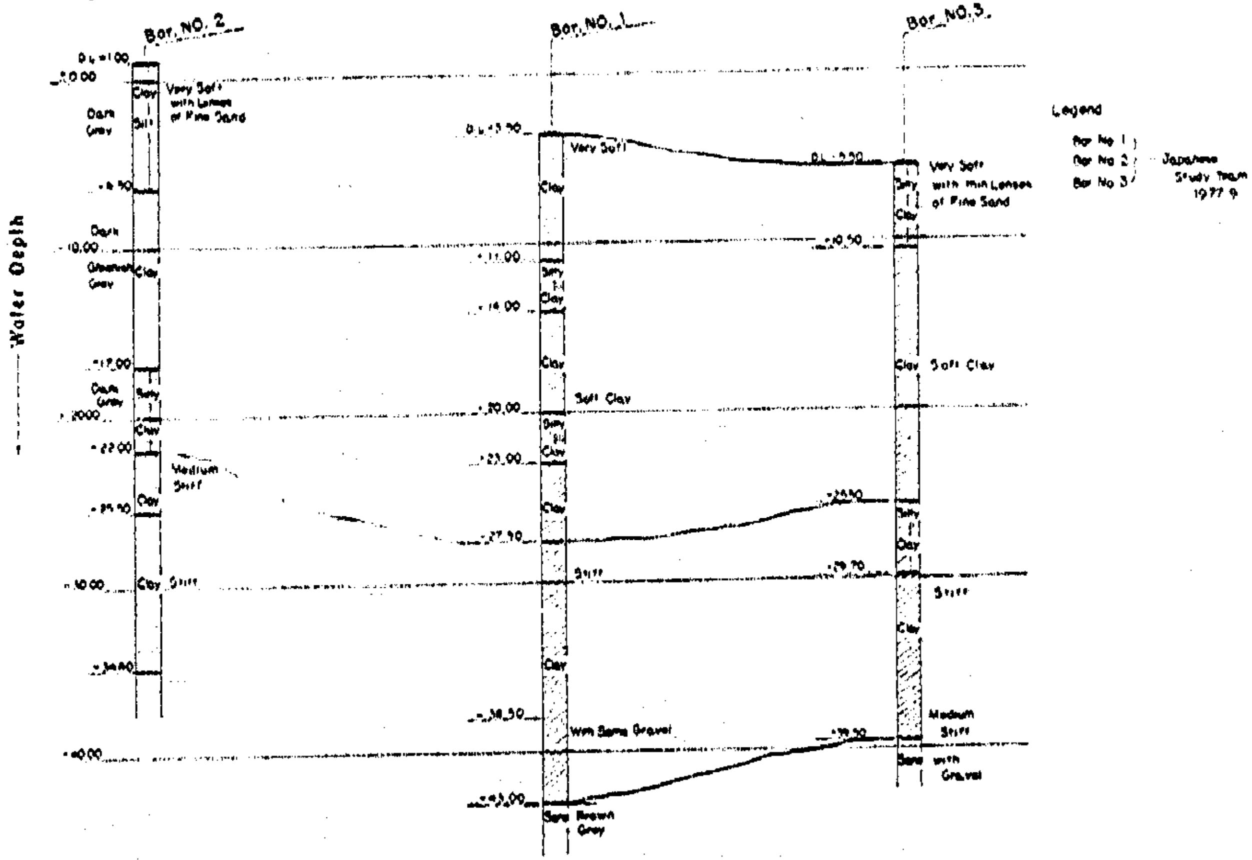


Fig.4-11 qu ~ Depth Relation (off shore)

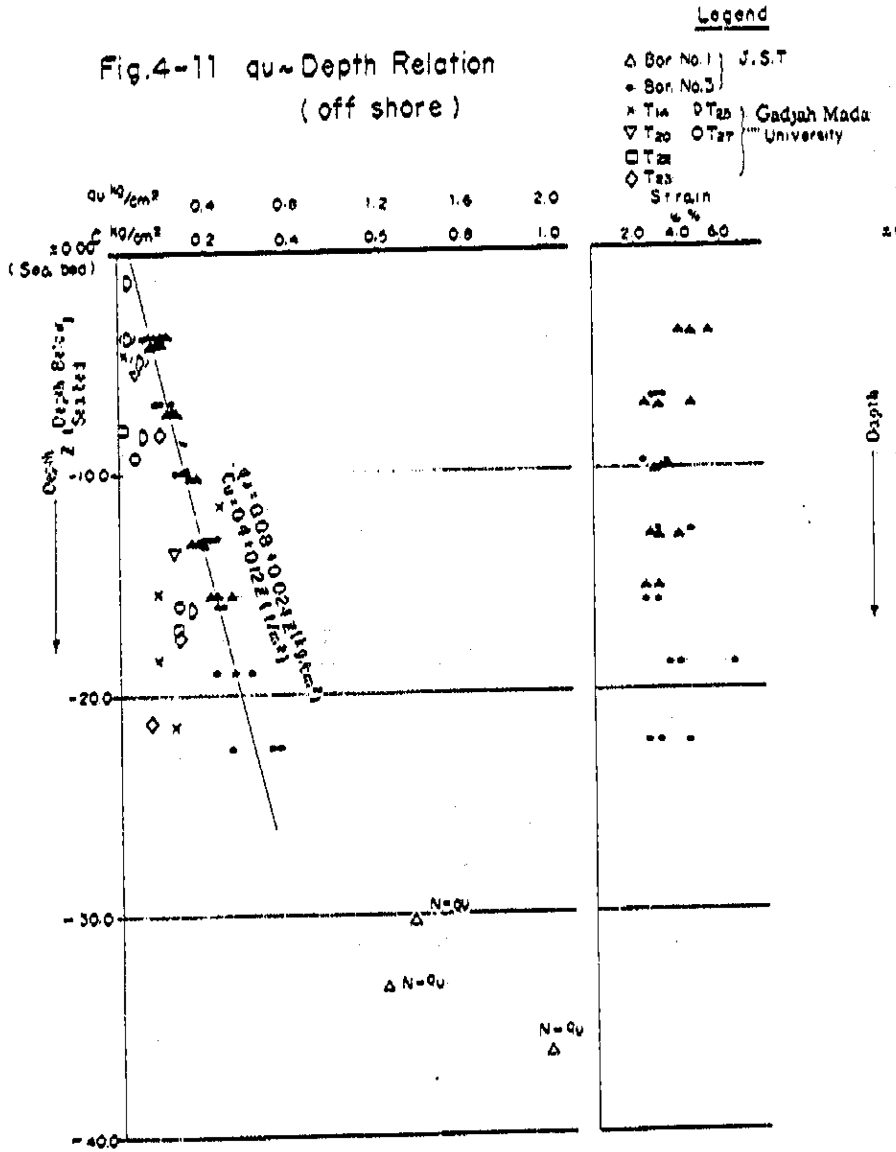


Fig.4-12 qu ~ Depth (on land)

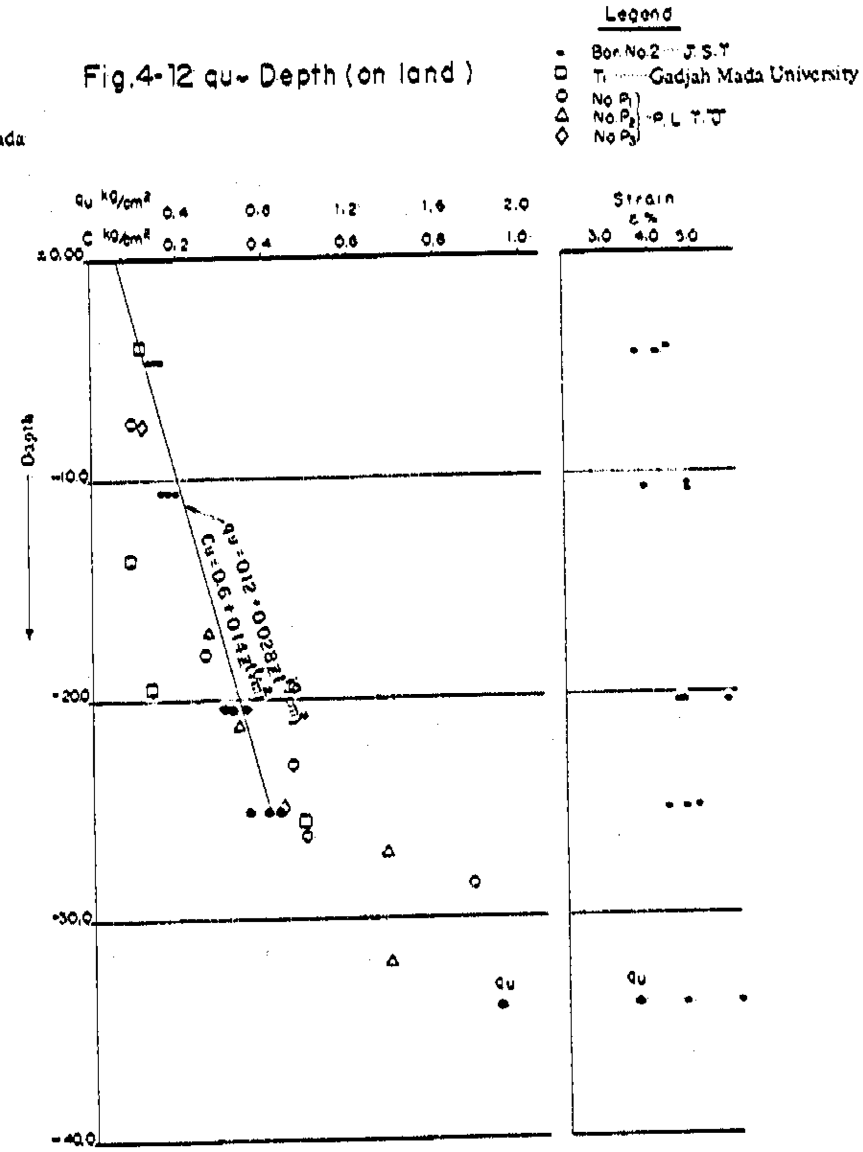
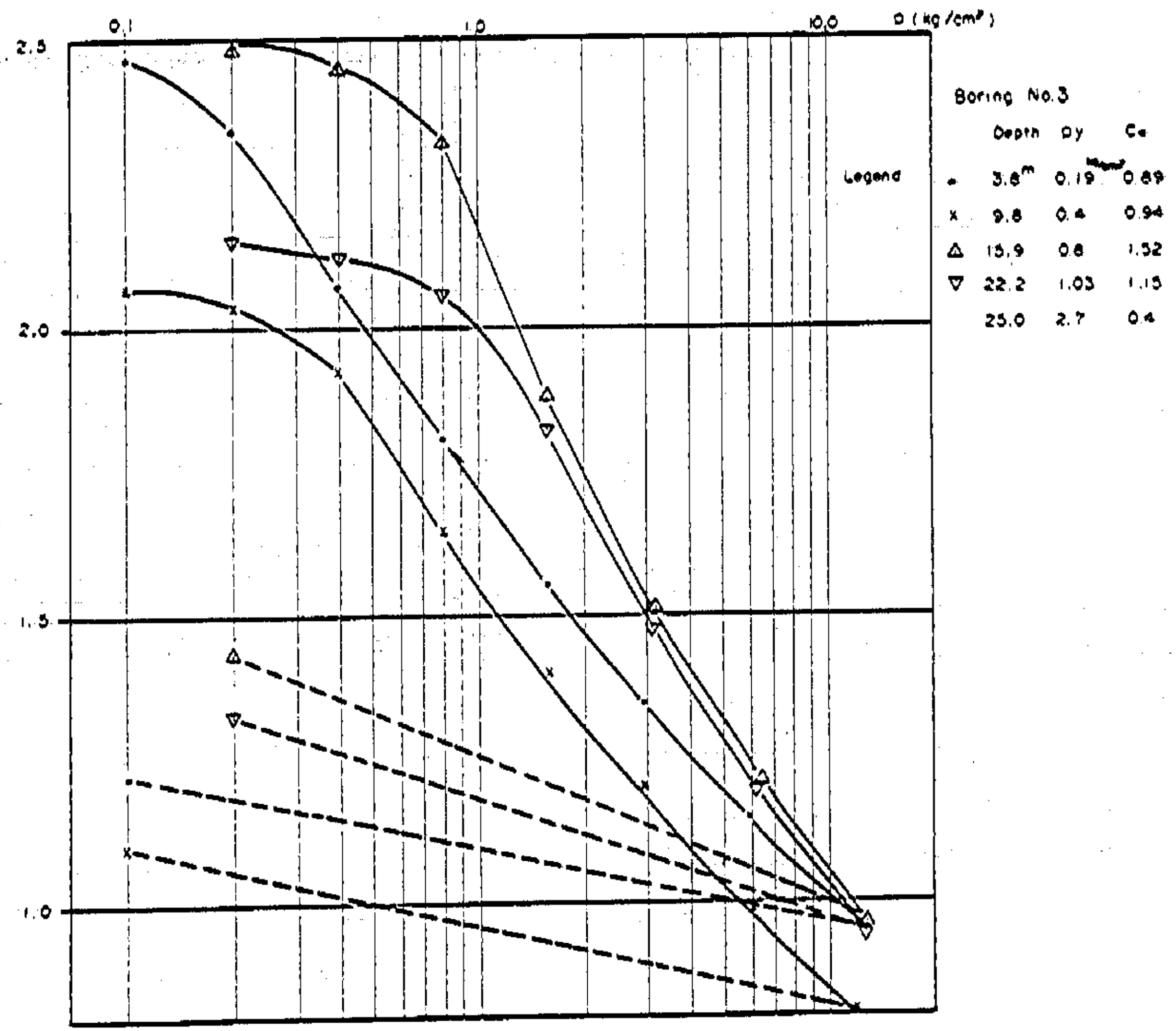


Fig. 4-13 e – long p Curve



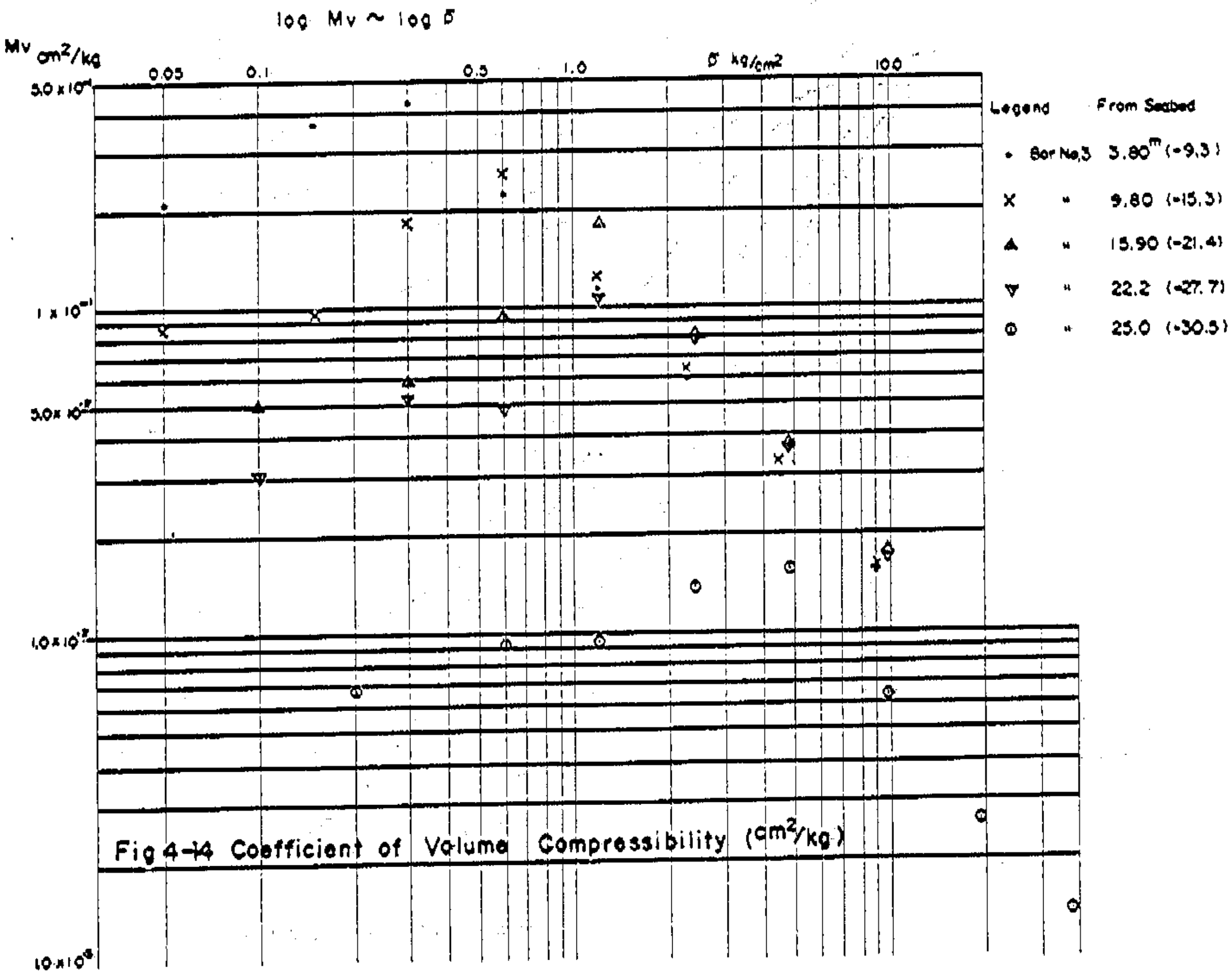
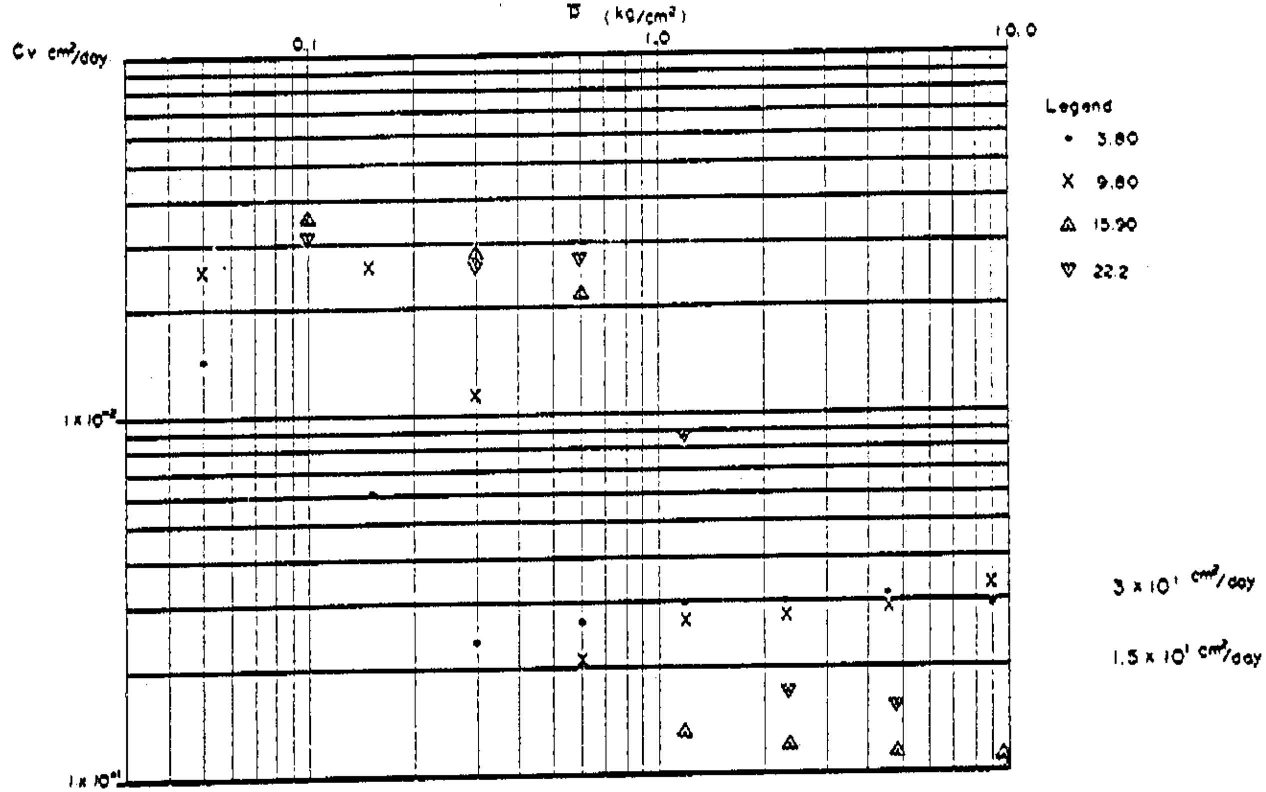


Fig 4-14 Coefficient of Volume Compressibility (cm²/kg)

Fig 4-15 Coefficient of Consolidation (cm^2/day)

log Cv ~ log $\bar{p}$ (Bor No.3)



Chapter-5

Present Situations in the Hinterland of the Port of Semarang

CHAPTER 5
PRESENT SITUATIONS IN THE HINTERLAND OF THE PORT OF SEMARANG

5-1 General

Central Java is a province located in the center of the island of Java, it extends approximately 450 km in east-west direction and 220 km in north-south direction, its area is 34,206 km^2 and its share to total area of the island is 26%. Also, D.I. Yogyakarta is located in southeast district of Central Java, its area is 3,169 km^2 and its share to total area of the island is 2.4% (see Fig. A-5-1).

In the central part of Central Java, many volcanos ranging from an altitude of 2,000 m to 3,000 m are continuing, and many rivers such as the Solo River originated from the highland are flowing into the sea.

Fertile plains spread along the north coast facing the Java Sea as well as the south coast facing the Indian Ocean and in the valley between the two moutains of Merabu and Lawu. These plains are utilized for agriculture as paddy fields up to a height of about 100 m and upland fields at higher elevation, and the cultivation rate is as high as 76% (see Fig. A-5-2).

In the so-called northern plain along the coast of the Java Sea, there are developed such major cities as Semarang, Pekalongan and Tegal.

In the central part of Central Java, the city of Surakarta is the largest, and D.I. Yogyakarta includes the educational city, Yogyakarta. But, along the south coast, there are no cities to be noted specifically (see Fig. A-5-3).

In inland plain, cities such as Surakarta, Magelang, etc. are developed, and an axis connecting Semarang with Yogyakarta through these cities is the most developed area in Central Java.

When analyzing Central Java topographically, this area can be classified into volcanic cone, volcanic fan, coastal plain and tertiary highland. The upper volcanic fan is a place where river water can be utilized in quantities offering high productivity such as double-cropping of rice, while in lower volcanic fan, second crops of maize, cassava, etc. and upland rice are being cultivated.

In the coastal plain, rice is mainly cultivated but there are problems of flood in rainy season and inundation of seawater in dry season in this area.