REPORT
ON
THERMAL POWER SITE SURVEY AND PLANNING
IN
THE REPUBLIC OF INDONESIA

VOLUME IV

APPENDICES

DECEMBER 1973

OVERSEAS TECHNICAL COOPERATION AGENCY

GOVERNMENT OF JAPAN

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1. CONCERNING THE THERMAL POWER SITE SURVEY

1-1 Standard Specifications for Geological Survey

Specification attached here is the standard one of the fundamentals for hydro, thermal power and the other sites. Therfore depending upon the features of region and the survey purpose, it may become necessary to add some items by Additional Specification, or eliminate some standard items.

1-1-1 Standard Specifications

GEOLOGICAL SURVEY

(1) General

a. The matters which are not specified herein shall be refered to the supplemental specifications and the design documents.

b. Exploration and survey, which are necessary for the geological survey work herein specified, shall be executed by the expenses of the contractor. The control points of survey shall be indicated by the investor.
The data which are possessed by the investor may be shown to the contractor for reference.

c. The geological judgement shall be made by the expert who has enough knowledge and experience.

(2) Geological Exploration

a. The contractor shall grasp the general geological feature in the survey area by means of the comprehensive judgement. For this purpose, the contractor shall execute the site exploration in and around the expected survey area and also shall collect the reference data such as existing topographical maps, geological maps, records of construction works nearby, records of disasters which happened in the surrounding region, and others.

b. The site exploration shall include following matters.
(a) Exploration of outcrops, taluses and river deposits
(b) Exploration of surface slips of land slope and landslides
(c) Exploration of faults or weak zones
(d) Exploration of ground-water making use of existing wells
(e) Sampling for the tests on rock and soil materials
(f) Observation of vegitation on the ground surface
(g) Others which are necessary

c. The report of the geological survey shall include following matters in principle.

(a) General feature of topography, geology and geological history

(b) Detailed descriptions of geology

(c) Figures and photoes

Topographical plan

Geological plan

Estimated geological section

Distribution of landslide

Photo of the site

Photo of the vegitation

d. Others

(3) Exploration Adit and Shaft

a. At the time of execution of survey work, the contractor shall follow this specifications, the supplemental specifications and design documents.

b. In order to execute the work safely and smoothly, the contractor shall carry out enough ventilating, draining and lightening in the adit or shaft.

c. Excavation

(a) Measurement of excavation in adit and shaft will be limited to the specified sectional dimension (pay-line) which is designated on the drawings.

(b) Timbering shall be set up at the place where the cave-in or fall of rocks are anticipated.

(c) At the time of excavation, outbreak shall be made as little as possible, finished excavation surface shall be smooth, bedrock shall not be loosened and consideration shall be given to make the grasping of geological condition easy.

(d) At the time of blasting, the contractor shall follow the related laws and regulations, shall be careful on the safety preservation and shall make proper protection for the timbering.

(e) The contractor shall constantly observe and record the geology, strata, water spring, the condition of gas and vapour at and around the excavating place. The investor may request the contractor to submit these data as ocassion demands.

(f) After the completion of excavation, the contractor shall measure the cross-section of excavation and submit the result in the form of drawing to the administrative personnel of the investor.

d. Timbering

The contractor shall constantly inspect the timbering and if an unusual condition will be found, reinforcement work shall be carried out without delay.

e. Mucking

Muck of excavation shall be disposed of as it is specified in the supplemental specifications in the case where the spoil-bank will be designated by the investor. In the case where the spoil-bank will not be designated by the investor, the contractor shall dispose of the muck on his responsibility and shall not cause annoyance to the investor.

f. Keeping and handling of explosives

(a) Explosives shall be kept at the assigned place under lock and key. A qualified explosive technician shall be nominated for the responsible person for keeping explosives.

(b) In case of fuse blasting, a qualified fuse blasting technician shall be nominated for the responsible person for the work and all the work shall be executed under his indication. The responsible person shall wear the arm band which will clearly show his post.

(c) - deleted -

(d) Notice board shall be set up at the pathway in the dangerous area and the watchman shall be stationed as ocassion demands.

(e) Before the blasting, the warning shall be sent out. The blasting shall be started after the evacuation of all the person will have been confirmed.

(f) After the blasting, the responsible person shall inspect the misfiring and confirm the safety. After that, the excavation work shall be proceeded again.

(4) Boring

a. The contractor shall report to the administrative personnel of the investor and get his confirmation after all the depth will have been drilled. The administrative personnel of the investor may indicate to make additional drill when it will be recognized necessary.

b. Drilling work shall be carried out by the method which is specified in the supplemental specifications. In the case where the different method will be used, the contractor shall get the permission of the administrative personnel of the investor.

c. In case of the boring aiming mainly to sample the core, the contractor shall endeavour to sample the core along the entire depth. As for the geological strata where the core sampling is too difficult, the contractor shall sample the material which the geology will be judged by.

d. Sampled core shall be arranged and kept in the case with the indication of bored hole number and the depth. Proper treatment shall be made for the keeping of core which is apt to be deteriorated.

e. Sampled core shall be treated carefully and care shall be taken not to change the sampling condition during the transportation.

f. The ground-water level shall be measured everyday before the start of drilling. Colour of silty water from the bored hole and that of the core shall be recorded during the drilling.

(5) Penetration Test

The method of penetration test shall be as follows.

a. Standard penetration test

b. Portable cone penetration test

c. Swedish penetration test

d. Vane test

e. Others

(6) Soil Test

a. Undisturbed sampling

(a) As for the sampler, it shall be standard to use the fixed piston type thin-wall sampler made of steel or brass. In case of using other type of sampler, it shall be necessary for the contractor to get the permission of the administrative personnel of the investor.

(b) The sampling shall be carried out using the fixed piston type thin-wall sampler after the slime at the bottom of bored hole will be removed completely. The tube shall be pushed in by the static force as fast as possible at a stretch. The ratio of core-recovery shall be recorded.

(c) In the case where the core recovery ratio will be exeptionally low, the sampler different from the above-mentioned type may be used according to the indication of the administrative personnel of the investor.

(d) In the case where the sampling is difficult, the sample which is disturbed to some extent (although it is disturbed, its fine particle part is not washed out by the pumped water of boring work) may be takne according to the indication of the administrative personnel of the investor.

(e) The sampled specimen shall be sealed with paraffin without delay not to dismiss the water content and shall be transported to the place of soil test carefully not to be disturbed by the shock, vibration, heating and other effects.

The sample shall be clearly indicated with the date of sampling, sampled place (depth) and the number of bored hole.

b. Testing method

The method of soil test shall be those of standared procedure. As for the tests without standard, some appropriate conventional method may be adopted with the permission of the administrative personnel of the investor.

The kind of soil test shall be as follows.

(a) Unit weight of soil constituents

(b) Water content

(c) Grading analysis

(d) Liquid limit

(e) Plastic limit

(f) Unit weight

(g) Unconfined compression

(h) Direct shear

(i) Triaxial shear

(7) Load Test

a. The method of load test on the ground shall be as follows.

(a) JIS A 1215 (Japanese Industrial Standards)

(b) ASTM D1194-57 (American Society for Testing Materials)

(c) Others

b. The kind of load test for the rock foundation shall be as follows.

(a) Shear test

(b) Compression test

(c) Deformability test

(d) Others

(8) In-situ Measurement of Unit Weight

In-situ measurement of unit weight shall be executed by replacing soil with standard sand at the site and the unit weight shall be measured by the method designated by JIS A 1214 or other conventional method which shall be indicated by the administrative personnel of the investor.

(9) Measurement of Ground-Water Level

(Making use of the bored hole)

Ground water level shall be measured once a day at the assigned time, after more than 24 hours will have elapsed from the completion of drilling.

In the case where the variation of ground-water level with respect to the time shall be measured, the observation shall be executed by setting up the automatic water-level recorder.

(10) In-situ Permeability Test

The method of permeability test shall be as follows.

a. The method to vary the water-level in the bored hole and observe the induced variation of ground-water level around the bored hole.

b. The method to inject water with the constant pressure into the bored hole

(11) Measurement of Pore-Pressure

a. As for the measurement of the pore-pressure, the stage shall be set with respect to every geological stratum and measurement shall be continued until the measured value will have converged to a definite value.
In this case, the contractor shall get the permission of the administrative personnel of the investor as for the selection of the stratum to be measured.

b. Before the measurement of the pore-pressure at each depth, the water level in the hole shall be measured for comparison.

(12) Measurement of Steel Corrosiveness of the Ground

a. The depolarization ratio, specific resistance and stray current in the ground shall be measured in order to estimate the steel corrosiveness of the ground. The steel corrosiveness ratio of the ground shall be judged based on these measured values.

b. The depolarization ratio shall be measured every 3m or every alternation of geological stratum.

c. The specific resistance of the ground shall be measured directly by the electric logging method (with 2 poles). The measurement shall be made every 1m.

d. As for the stray current, the research on the influence of the source to the ground shall be executed by selecting the stray current source which will especially have a strong influence to the site to be surveyed.

e. In the case where the water quality test shall be executed for the estimation of steel corrosiveness of the ground, acidity and alkalinity (PH index) shall be measured by the quantitative analysis.

(13) Seismic Prospecting

a. Course of measurement and measuring

(a) Setting of the course of measurement at the site and the survey shall be executed by the contractor.

(b) The refraction method shall be adopted in principle.

(c) For the measurement, pick-ups with high magnification and the recording apparatus with more than 12 elements shall be used. It shall be standard to set pick-ups at the interval of 5 - 10 m.
Seismic wave shall be measured more than 3 times at each measuring point.

(d) The interval of blasting points, the interval of pick-ups and the measuring apparatus shall be those conformed well to the location and length of the measuring course and the explorable depth. With respect to these matters, the contractor shall consult with the administrative personnel of the investor in advanca.

(e) In case of the survey in the mountainous area or so, the contractor shall execute weeding to the direction of the measuring course with the width of 1 m as a rule, in order to make the apparatus transportation and the survey easy.

(f) Longitudinal levelling along the course of measurement shall be executed by putting up pegs at each measuring point.

(g) At the blasting point, a small hole shall be dug for the explosive charge and the necessary amount of the explosive shall be charged there.

(h) In advance of the measurement, the adjustment of the measuring apparatus, fixing of pick-ups and reconfirmation of blasting signal shall be executed.

(i) During the operation, the recording paper shall be developed and inspected at an appropriate time. If the recording will not be good, the contractor shall execute the measurement again without delay.

(j) The measurement shall be executed at the time with little noise and watchmen shall be stationed not to let persons or vehicles get near to the pick-up points.

(k) The course of measurement shall be a straight line and the end point of the previous measurement and the start point of next measurement shall be overlapped.

(l) The blasting point shall not be located at the place with abrupt change of ground such as the high place, the top of cliff, the top of hill and the neighbourhood of big rock.

b. The use of explosives

With respect to this item, (3) - c - (f) shall be followed.

(14) Electric Prospecting and Electric Logging

a. Electric Prospecting

(a) Setting of the course of measurement at the site and the survey shall be executed by the contractor.

(b) The contractor shall consult with the administrative personnel of the investor in advance with respect to the prospecting method (horizontal or vertical prospecting), distribution of electric poles (2 - 4 pole method or so) and the interval between poles.

(c) In case of the survey in the mountainous area or so, the contractor shall execute weeding to the direction of the measuring course with the width of 1 m as a rule, in order to make the apparatus transportation and the survey easy.

(d) Longitudinal levelling along the course of measurement shall be executed by putting up pegs at each measuring point.

(e) During and after the rainfall, if the rainwater will have an extraordinary influence upon the measured values, the measurement shall not be executed.

(f) In measuring, the insulation resistance test and other tests shall be executed in advance not to bring about the error to the measured value by faulty insulation.

(g) During the operation, the pole position shall be confirmed in order to keep the interval correct.

b. Electric logging

Electric logging shall be executed continuously by 2 - 4 pole method.

(15) Sonic Prospecting

a. Basic survey shall be executed by the contractor.

b. In executing the survey, the datum level shall be set up.
As for the datum level, that of the construction work in the district concerned shall be used in principle.

c. The survey-ship shall follow the course of measurement which will have been set up in advance and execute measurement. The position of measuring point shall be confirmed by using sextant or transit with the connection to the control points on the shore. At the time of measurement, sounding shall also be executed.

d. The velocity of the survey-ship shall be about 2 knot as a rule.

e. The depth shall be analyses in principle up to the bedrock.

f. In the case where the bedrock will be shallow and the undulation will be remarkable, the precise measurement shall be executed by setting up the additional course of measurement and shortening the measuring intervals.

g. The contractor shall analyse the data which will be obtained by the measurement, shall prepare the geological cross-sections and make the geological plan by putting together these cross-sections.

h. Four to five control points shall be set up on the shore and the connection to the triangulation stations on the ground shall be made.

i. During the measurement, tidal level, wave-height, tidal current and wind velocity shall be measured at the same time.

1-1-2 Additional Specifications for Geological Survey

Main points to be described

(1) In case the indication exists for the same item, the indication of the Additional Specification, has the priority.

(2) Purpose of Survey.

(3) Scope of Survey.

(4) Period of Survey.

(5) Number of Report to be made.

(6) Submittance Date of Report.

(7) Survey Item Other Them Written in Standard Specification.

(8) Survey Items not Required, Among Those in Standard Specification.

1-2 Standard Specifications for Marine Condition Survey

Specification attached here is the standard one for the fundamentals of marine survey. Therefore, depending upon the features of region and the survey purpose, it may become necessary to add some items by Additional Specification, or eliminate some standard items.

1-2-1 Standard Specification

MARINE CONDITION SURVEY

(1) For those matters which are not described here, follow the additional special specification for the individual work.

(2) Wave height, direction and period shall be measured at the survey site.
Measured data shall be arranged and analysed.

a. Method of observation
Wave shall be observed by instruments or visuality - visual observation.

b. Installation of Instruments
Preliminary survey should be performed prior to installation of instruments, in order to avoid the least unexpectedness.

c. Maintenance of Instruments

Instruments shall always be kept in good maintenance for the correct functioning.

d. Arrangement and Analysis of Observation Data

Observation Data shall promptly be arranged and analized as in the following.

(a) Wave height, period and direction (dayly and hourly)
(See Table 1·2·1)

(b) Frequency of wave height and period (monthly and yearly)
(See Table 1·2·2)

(c) Frequency of wave direction and height (monthly and yearly)
(See Table 1·2·3)

(d) Wave height distribution by the continuous appearence time
(See Table 1·2·4)

(3) Tide Observation

Tide shall be measured in the sea of survey site. And the measurement data shall be arranged and analyzed, hourly, dayly and yearly.

(4) Sea Observation

Sea shall be measured in the sea of survey site. The sea condition shall be investigated as to the following items.

a. Movement Survey

Movement of the sea shall be surveyed by using bottom mounted current meter, tracer method using measuring disc, and dye dispersion .(See Table 1·2·5)

b. Water Temperature Survey

Sea water temperature shall be observed vertically and horizontally.

c. Water Quality and See bed Survey

Water Quality survey shall be performed according to the water quality check method determined by governental law, principally as to the following items.

(a) P.H.
(b) B.O.D.
(c) C.O.D.
(d) D.O.
(e) Cl (Ion)
(f) Nitrogen Ion
(g) Sulfuric Acid Ion
(h) Sulfuric Acid Deoxidigation Bacteria from Bottom Materials
(i) Turbidity
(j) Particle Analysis

d. Sea Lives Survey

Animal plankton, sea weed and other sea lives shall be observed as to their kinds and life.

e. Littoral Drift Survey

This Survey shall be performed as to the supply source of drift sand, quantity of drift sand movement, direction of movement, and the condition of beach errosion.

Table 1・2・1 Wave Height, Period and Direction

(Example)

(W.H. = Wave Height)
(W.D. = Wave Direction)

Month Day Hour	1/3 W.H.		Maximum W.H.		W.D. From -N	Month Day Hour	1/3 W.H.		Maximum W.H.		W.D.
	Period (Sec)	W.H. (M)	Period (Sec)	W.H. (M)			Period (Sec)	W.H. (M)	Period (Sec)	W.H. (M)	
9.1.0.	10,2	0,86	10.0	1.43		4.2.6.					
2.	9,6	0,87	9,4	1.35		8.					
4.	9,6	0,98	11,2	1,71		10.					
6.	9,9	1,00	10,0	1,45		12.					
8.	9,7	0,99	8,8	1,50	48°	14.					
10.	9,2	0,83	9,4	1,47		16.					
12.	8,9	0,78	8,4	1,74		18.					
14.	9,8	0,79	9,4	1,48		20.					
16.	10,3	0,67	10.0	1,07	50°	22.					
18.	9,8	0,65	9,4	1,47		4.3.0.					
20.	9,0	0,69	11,2	0,91		2.					
22.	10,6	0,61	10,0	1,29		4.					
						6.					
4.2.0.						8.					
2.						10.					
4.						12.					

Table 1·2·2 Frequency of Wave Height and Period

(Example)

(W.H. = Wave Height)
(P = Wave Period)

(4, 1972)

P (Sec) \ W.H (M)	0-0,5	0,5-1	1-1,5	1,5-2	2-2,5	2,5-3	3-3,5	3,5-4	4.0	Total
5										
5-5,9			1 (0,3)							1 (0,3)
6-6,9		10 (3,0)	16 (4,8)	4 (1,2)						30 (8,9)
7-7,9		28 (8,3)	24 (7,1)	3 (0,9)						55 (16,4)
8-8,9		41 (12,2)	42 (12,5)	4 (1,2)						87 (25,9)
9-9,9		24 (7,1)	18 (5,4)	4 (1,2)	6 (1,8)					52 (15,5)
10-10,9		14 (4,2)	11 (3,3)	11 (3,3)						36 (10,7)
11-11,9		10 (3,0)	6 (1,8)	9 (2,7)	5 (1,5)					30 (8,9)
12-12,9		8 (2,4)	5 (1,5)	6 (1,8)	5 (1,5)					24 (7,1)
13-13,9				1 (0,3)	11 (3,3)	6 (1,8)				18 (5,4)
14-14,9					2 (0,6)	1 (0,3)				3 (0,9)
15										
TOTAL		135 (40,2)	123 (36,6)	42 (12,5)	29 (8,6)	7 (2,1)				336 (100)

Rate of Numbers of Measurement actually done against that of expected $= \frac{336}{(12 \times 30)} = 93,3\ \%$

Table 1·2·3　Frequency of Wave Direction and Height
(Example)

(W.H. = Wave Height)
(W.D. = Wave Direction)

W.D.	W.H. \ Month	4.1972	5.	6.	7.	8.	9.	10.
NNE	0-0,49					1		
	0,5-0,99					1		
	1.0-1.99		1		3		1	
	2.0-2.99							
	3.0-3.99							1
	4.0 <							
NE	0-0,49			4	16	3		1
	0.5-0.99		4	8	66	12	8	10
	1.0-1.99	11	5	6	44	9	18	14
	2.0-2.99	1	2	1	6	1	2	1
	3.0-3.99							
	4.0 <			1	1			
ENE	0-0.49	4	1	2	31			
	0.5-0.99	7	7		84			
	1.0-1.99	5	4	4				
	2.0-2.99							

Table 1・2・4 Wave Height Distribution by the Continuous Appearence Time (Example)

Wave Height \ HOUR	2-6	8-12	1 DAY 14-24	2 DAY 26-48	3 DAY 50-72	4 DAY 74-120	7 DAY 122-168	10 DAY 170-240	10 DAY 240
0-0.5	164	30	27	19	6	4	1		
0-1.0	140	39	45	41	19	26	13	5	4
1.0-1.5	357	87	69	32	1	1			
1.0-2.0	267	56	70	53	10	8	3		
1.0-2.5	214	40	57	48	28	11	4	2	
1.0-3.0	184	37	53	45	25	14	8	2	
1.0	161	32	41	39	18	15	9	3	3
2.0-3.0	117	30	21	7	2	1			
2.0-4.0	83	21	17	16	3	3			
2.0	88	19	18	12	3	4			
3.0	35	9	2	1	2				
4.0	9		1						

Explanation of Table 1・2・4

The following points can be known from Table 1・2・4

(1) It is quite rare that the sea condition of wave height below 0.5 m continues more than a week.

(2) It is almost none that the sea condition of wave height over 3 m continues more than five days.

(3) It is quite rare that the sea condition of wave height over 2.0 m continues more than a week.

(4) It is very similar that the frequency of the continuous appearence time of wave height over 1.0 m and below 1.0 m, and for either of them, it happens just once or twice a year that this appearence time continues more than ten days.

(5) It can not be considered, that the sea condition of wave height over 4.0 m continues more than two days.

Table 1·2·5 Recorde Table of Current Speed Observation (Example)

Month Day Hour	Bearing Direc-tion	Wave Direc-tion	Current Speed	Month Day Hour	Bearing Direc-tion	Wave Direc-tion	Current Speed
6.9.0	334°	N N W	10 cm/sec	6.9.17	234	S W	16.6
1.	-	-	-	18	149	S S E	20.0
2.	309	N W	13,3	19	134	S E	23.3
3.	324	"	26,7	20	129	"	20.0
4.	"	"	20.0	21	294	W N W	"
5.	314	"	11.7	22	249	W S W	26.6
6.	309	"	16.7	23	319	N W	26.6
7.	274	"	-"-	6.10.0	-	-	-
8.	224	S W	20.0	1	319	N W	16.6
9.	214	"	21.7	2	304	"	13.3
10.	219	"	20.0	3	-	-	-
11.	224	"	33.3	4	-	-	-
12.	204	S S W	13.3	5	-	-	-
13.	224	S W	10.0	6	-	-	-
14.	-	-	-	7	-	-	-
15.	214	S.W	10.0	8	-	-	-
16.	"	"	16.6	9	-	-	-

1-2-2 Additional Specifications for Marine Condition Survey

Main points to be described

(1) In case the indication exists for the same item, the indication of the Additional Specification has the priority.

(2) Purpose of Survey.

(3) Scope of Survey.

(4) Period of Survey.

(5) Number of Report to be made.

(6) Submittance Date of Report.

(7) Survey Item Other Than Written in Standard Specification.

(8) Survey Items not Required, Among Those in Standard Specification.

1-3 Survey Method of Marine Conditions

1-3-1 Purpose

In order to protect land and facilities of the thermal power station from the energy of the sea and also to make construction work economical and smooth, marine phenomenal survey data are necessary as underneath.

(1) Fundamental data necessary for the planning of cooling water intake and discharge

(2) Fundamental data necessary for the design of coastal structures.

(3) Fundamental data necessary for reclamation and construction of waterway and anchorage.

(4) Fundamental data necessary for construction method and time scheduling of marine structures.

(5) Fundamental data necessary for the planning of anti-pollution measures.

1-3-2 Survey Items

Marine phenomenal survey items necessary for the planning of the thermal power station are different with the features of the power station and the regional characteristics, but also with the storage of existing data and the stages of survey, namely preliminary survey and feasibility survey. Generally in the stage of preliminary survey, there are still some doubts, whether the project can be realized at the site, therefore for the sparing of time and expenses the collection and analysis of existing data are usually the main work, supplemented by some survey works. Survey items explained underneath are the general ones and only necessary, when there is no existing data.

It does not mean that these items are necessary for every case.

Of primary, importance is to judge what items are most necessary and decisive for the development of the power station and to make the survey planning itself.

For instance as the seashore in the Jawa Sea is most of the part shallow and rich in Ooze deposit. It is necessary to put the emphasis upon the survey of the character and behaviour of seabed soil, and of water quality concerning their effects on the construction and operation of the power station.

(1) Wind

Wind is the prime cause of wave and is indispensable as the fundamental data for air pollution problems. Therefore it is necessary to have measurement data of direction and velocity, and to know the characteristics by season, frequency and maximum velocity.

(2) Wave

Wave characteristic is essential to the planning of harbour, design of coastal structures, and determination of method and schedule of construction. Therefore it is necessary to make survey for the seasonal characteristics of height, direction and wave period maximum value and the total characteristics of the sea.

(3) Tide (Tidal level and current)

The factor decisive for the design of ground level for the power station site is the tidal level at the spot. Accurate knowledge of the tidal current or level is essential not only to the design of water intake and discharge, mooring facilities, breakwater and rivetment but also to the determination of method and schedule of marine construction.

The data of tidal current is necessary for the prevension of cooling water recirculation and diffusion.

(4) Littoral Drift

Soil particle at the seabed has the habbit of movement in relation with the size of particle, the depth of the sea, the wave and the tidal current. This is called littoral drift. In case the harbour or the power station is going to be built at the place, rich in littoral drift, characteristics of the littoral drift such as quantity, direction, depth and material of movement, and supply sources must be investigated. Otherwise the blockade may occur unexpectedly at the harbour entrance and the cooling water intake place for condencer.

(5) Sea Water Depth

The first thing to be done in the marine phenomenal sruvey is the investigation of sea water depth around the development site. This is one of the fundamental elements for the planning of reclaiming and dredging, the planning of waterway and anchorage, and the determination of the construction work.

(6) Beach features Shoreline

One of the fundamental survey matters is the knowledge of shoreline features or beach features at the site.

It is necessary to know whether the beach is under aggrading condition or under eroding condition, or is stable, for the sake of land acquisition and land reclamation. A beach can be called "beach under aggrading beach" when the shore line moves toward sea by the accumulation of littoral drift. While "Beach under eroding condition" means, the coastline goes back toward land by beach erosion.

In addition, it is necessary to make investigations (1) whether the site is largely influenced by the dominant wave direction, (2) how much the fetch is, being one of the factors incurring the wave, (3) what the features of the river are, for instance, quantity and quality of the material carried by the river, and the stream velocity, in case if there is a river.

(7) Quality and Temperature of Sea Water

It is necessary to make investigation, for the sea water, where there contain chemical components which spoil the condenser tube, or floating sand.

Temperature distribution of the sea water to the depth direction shell necessarily be investigated, whether low temperature cooling water can be effectively taken from the deeper point.

The lower the cooling water temperature is, the better it is for the condenser vacuum and consequently resulting in the fuel cost saving.

(8) Bottom Soil Materials

It is necessary to make sampling and analysis for grain size and chemical conponents of materials sediments in front of water intake whether the bottom or materials sediments will move or float by wave and tidal current and also for the existance of sulfide which spoils the condenser tube.

1-3-3 Survey Method

(1) Wind

In the phase of preliminary survey, first obtain the data from meteorological observatory or meteorological station nearby and make wind rose. Then judge the maximum and mean velocity value of main wind direction, and seasonel characteristics and also use this for wave calculation.

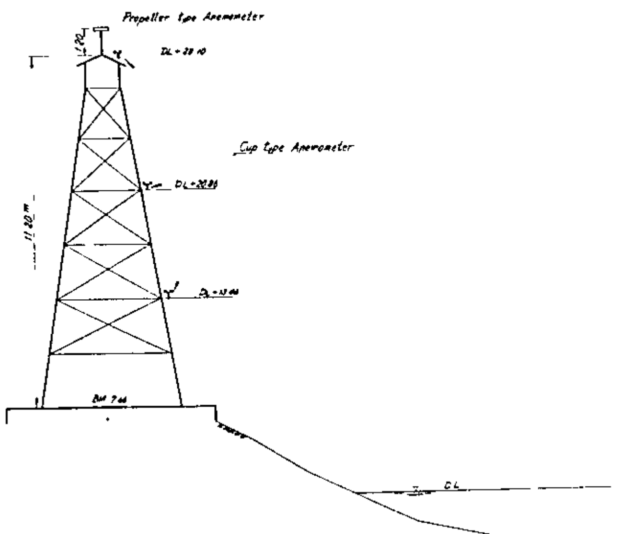
In case there is no existing meteorological observatory or meteorological station nearby, in preliminary survey stage or in the phase of feasibility survey, wind velocity and direction meter shall be installed with own initiative. Measured data shall be put into analysis.

Wind velocity and direction meter shall be installed at the top and every floor of the simple tower which is set up on the flat part or the top of the hill at the site where there is no big shielding structures.

There are two kinds of wind velocity meter, namely propeller type and cup anemometer-type.

An example for installation is shown in Fig. 1·3·1. Automatic recorder shall work in continuous operation, but as the data for analysis, at two precisely must be used for making the monthly, seasonal and yearly Wind Roses.

Fig. 1·3·1 Standard Tower of Anemometers



Wind Rose is made in the following way.

First of all, make the "Wind Velocity and Direction Hourly Recording Sheet" as shown in Table 1·3·1, reading the figures from the automatic recorder sheets. Then, as shown in Table 1·3·2, make the "Monthly Wind Velocity Sheet Classified by Direction".

From this sheet, Wind Rose can be expressed by numbers of appearence or percentage.

Wind Rose must be first made monthly, knowing the seasonal characteristics. Then make the yearly one, knowing the dominant velocity and direction. Further, it is desirable to make the average one by years and months over the total observation period.

An example of making this diagram is shown about Surabaya in Vol. III.

Table 1·3·1 Hourly Wind Velocity and Direction Recording Sheet

(W.D. = Wind Direction)
(W.V. = Wind Velocity)

HOUR \ DAY	1		2		3		4		5	
	W.D.	W.V.	W.D.	W.V.	W.D.	W.V.	W.D.	W.V.	W.D.	W.V.
0	SW	3.0								
1	SW	1.0								
2	WSW	0								
3	W	2.0								
4	"	0								
5	SSW	0								
6	"	0								
7	NNW	0								
8	SW	0								
9	S	2.0								
10	ESE	2.9								
11	SSE	5.0								
12	"	5.0								
13	S	5.0								
14	"	6.0								
15	"	4.0								
16	"	6.8								
17	"	7.3								
18	"	5.5								
19	SSW	4.8								
20	S	3.9								
21	"	3.0								
22	"	3.0								
23	"	4.2								
TOTAL		73.4								
DAYLY MEAN W.S.	3.1 m/s									
MOST DIRECTION	S									
MAXIMUM INSTANTANEOUS	11.8 m/s									
- WIND VELOCITY	S16°- 32									

Table 1・3・2 Monthly Wind Velocity & Direction Sheet

Velocity / Direction										TOTAL
No Wind										
N										
NE										
E										
SE										
S										
SW										
W										
NW										
TOTAL										

If all the measurement exist for one month of 30 days, this column will become 720.

As there are various kinds of classification in this "velocity" column, intensionally omitted.

(2) Wave

If there is existing data concerning the environs of the site, analysis shall be made in connection with height, direction and period of the wave, and maximum and design wave height and seasonal characteristics of the dominant direction shall be judged.

If there exists no data, preparation becomes necessary for the observation.

For the observation of wave height, there are two methods, namely visual observation and the one with wave gauge.

In visual observation, measurement rod is fixed in the measured sea (off the breaker zone to the open sea), and regular observation shall be done from the land by using transit. Usually this will be done twice a day, i.e. 9.00 am and 15.00 pm. For each observation, measurement shall be done 60 times of wave. Period shall be measured at the same time by using stop watch.

There are various kinds of wave gauge, but hydro-pressure type and gradual register type are the typical ones. Both of them have the possibility of continuous and intermittent recording and more over have a self-operating recorder.

When making wave height observation by using wave gauge, the recorder is usually set to operate 10 - 20 minutes contineously every two hours.

The summarizing method of this records is find average wave height at 12 measurement per day and extract the continuous wave height records of the time in which the average wave height proved to be the highest. From the extracted records, find the maximum and one third wave height and period on the day.

The observation of wave direction shall be performed at the point straight to the offing side of the breaker line near the installed place of wave gauge with 10 - 20 succeeding waves and this shall be indicated by the deflection from the base line set up on the coast-line. The deflection is the one, by which holizontal hair and wave crest becoems parallel, turning the transit horizontally. A hydropressure type standard wave height meter and a standard wave staff are shown in Fig. 1·3·2 and Fig. 1·3·3.

In addition, an example of wave height records is shown at the end of "Standard Specifications for Marine Condition Survey".

Fig. 1·3·2 Hydro Pressure Type Standard Wave Height Meter

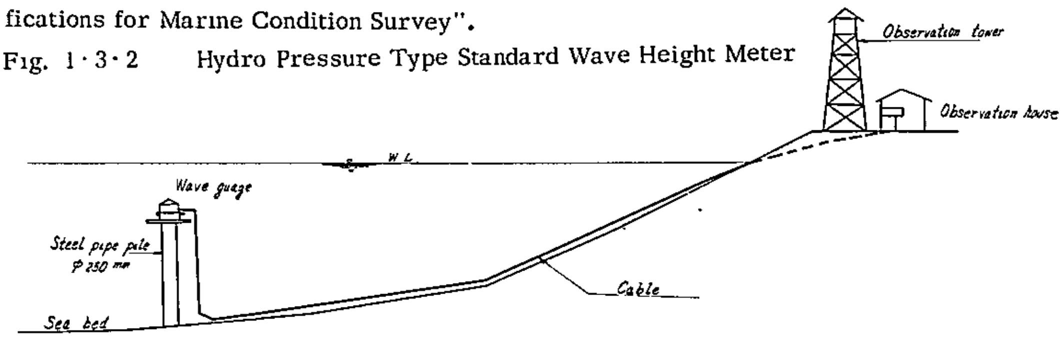
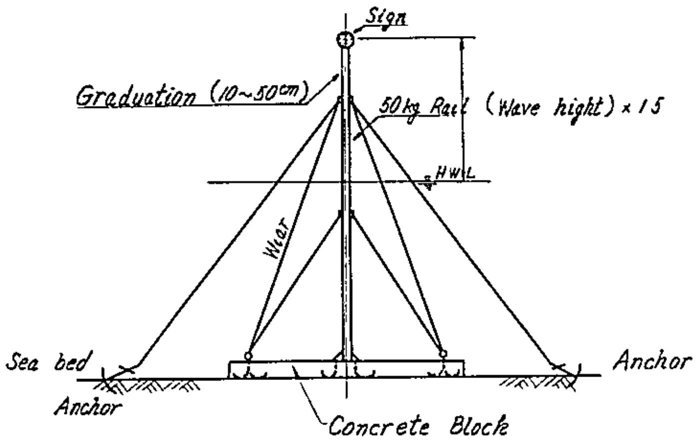


Fig. 1・3・3　　An Example of Wave Staff



(3)　Tide

First, obtain the existing data concerning tidal level from navy or some other survey bodies. Then find the maximum, minimum and average tidal level. This will help to determine the design tidal level.

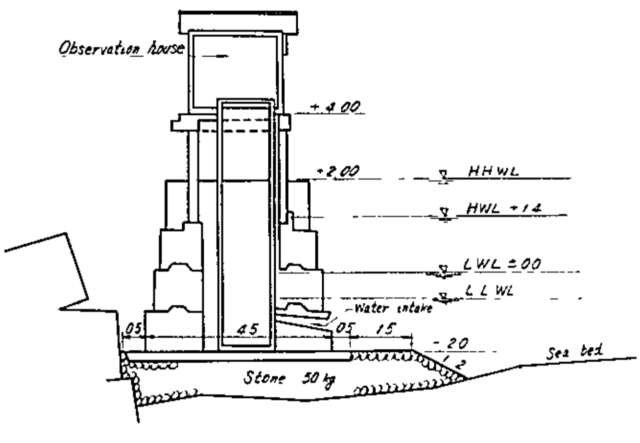
In case there exists no data, judgement shall be done from Tide Tables.

At the place where there is much sea level departure from normal data of long period is desirable. But at the place where meteorological tide is less, tide tables is enough for use.

In the case of self-observation, tide station must be set up. Tide station shall be selectively located at the place where there is less influence of wave and littorol drift. Automatic recorder device is usually equiped with a chart for one month. But, considering the trouble of tide gauge, it is necessary to have tide staff in the station for visual observation. The data shall be arranged for the purpose of determining the mean monthly-highest water level, mean monthly lowest water level, highest high water level, lowest low water level.

The way of calculation is shown at the Volume II-5. A typical tide station is shown in Fig. 1・3・4.

Fig. 1・3・4　　Tide Station



In observing tidal current qualitatively and quantatively, there are two methods, one is the simultaneous observation of tidal current using current meter and of littorale drift, and the other is the observation by current meter for a fixed point in the sea area to be surveyed.

In the former method tidal current can be observed simultaneously using more than two current meter at the different depth.

In the latter method the tidal direction and current velocity can be observed at the inside and outside of surf zone.

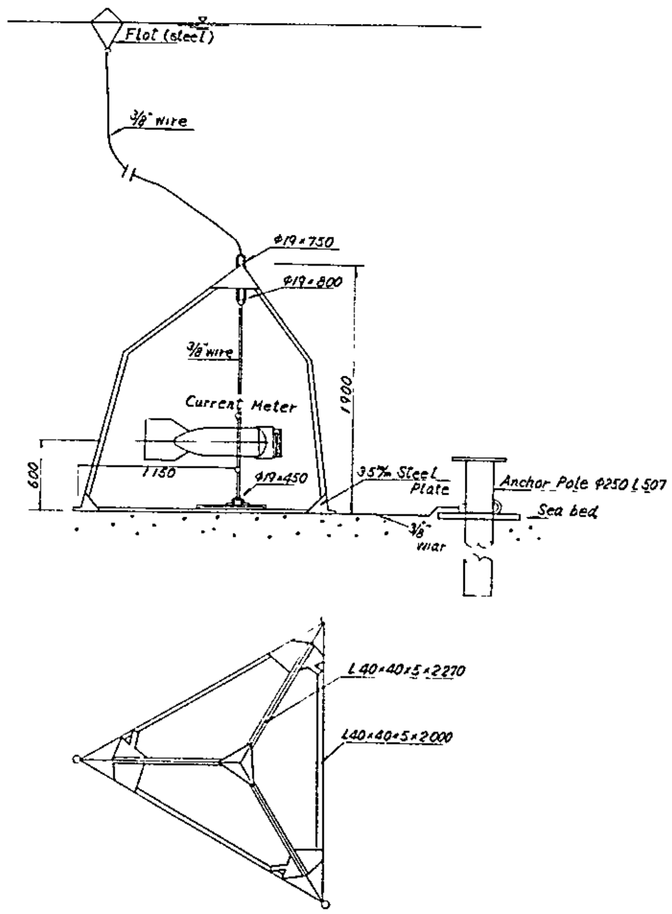
The observation record must include meteorological data, tidal level, wave hight, etc..

In case of observating offing side of breaker zone, there are two tidal current observation methods; namely one is by using current meter and the other is by tracing float.

Two current meters must be installed at one meter above the seabed, avoiding the place where the tidal current is dense, or there is much uneven of seabed.

An example of the current meter anchoring shall be shown in Fig. 1·3·5.

Fig. 1·3·5 Current Meter



Float observation shall be performed, when the sea is serene.
Let there float be drifted at the same time and these locations shall be measured periodically by using two transits on the land. Then the traces of drift shall be plotted on the paper.
Float observation shall be performed not less than twice a year at the time of flood tide, ebb tide, sprniq tide and neap tide.
As float observation in the surf zone is impossible, this shall be measured by anchoring velocity meter.

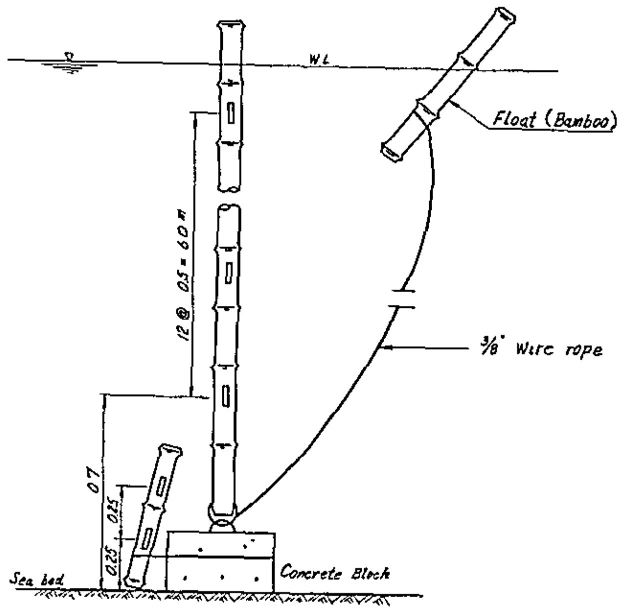
(4) Littoral Drift

Among the survey method for littoral drift, there are radioisotope sand method, fluorescent sand method brick brag ments method sediment pipe sampler method sediment bamboo sampler method, and method by sounding. (deapth measurement)
In radioisotope sand method, glass balls, containing isotope shall first be made, which have the same size and density of seabed sand and mude. This glass balls shall then be spread on the seabed and their movement shall be traced by Geiger counter, from the time they shall be thrown away.
Trace shall be done four times, namely, the moment after thrown away, two to three days later, seven to ten days later, fourteen to twenty days later.
In the case of surf zone, trace shall be done four times, namely, the moment after thrown away, two to three hours later, five to seven hours later, one day later.
As this measurement work handles with radio-active material, usually Co-60, coordiation of qualified experts is necessary.
The position of Geiger counter on the ship can be measured on land, by using two transits and its movement shall be plotted on the paper. In fluorescent sand method, natural sand with fluorescent pigment shall be thrown into survey sea area. As samples, the sand in sand seizing bamboo stick which is installed near the thrown area and 500 cc sand, collected in 10 days later which arrived in seashore shall be gathered.
These samples shall be projected by ultra-violet lamp in a dark room and the fluorescent sands contained shall be measured. Then the movement direction of littoral drift can be known.
There is another method using crushed fragments of brick. In this method, about 10 m^3 of crushed fragments of brick which size lies between three to five centimeter square, shall be laid down at one place, at the water depth of four to eight meter and observe the drift of the crushed fragments of brick toward beach. But this method can not be call a good one, because the movement of the crushed fragments of brick is more like

that of gravel than that of sand. But, as this method does not require ı can be applied, when only outline is needed to know.

Radioisotope sand method, fluorescent sand method and crushed fragm method are the method of mainly investigating the movement of seabed While sand method, can be applied, when investigating the vertical mc sands caused by wave and tidal current. As shown in Fig. 1·3·6, fou

Fig. 1·3·6 Installation of Sand Seizing Bamb



bamboo-sticks of 6 m length and 4 cm diameter are laid down at the s -10, -12 m respectively. After 10 - 20 days. These bamboo-sticks ε to plot the relation on the graphic paper between depth direction and a seized.

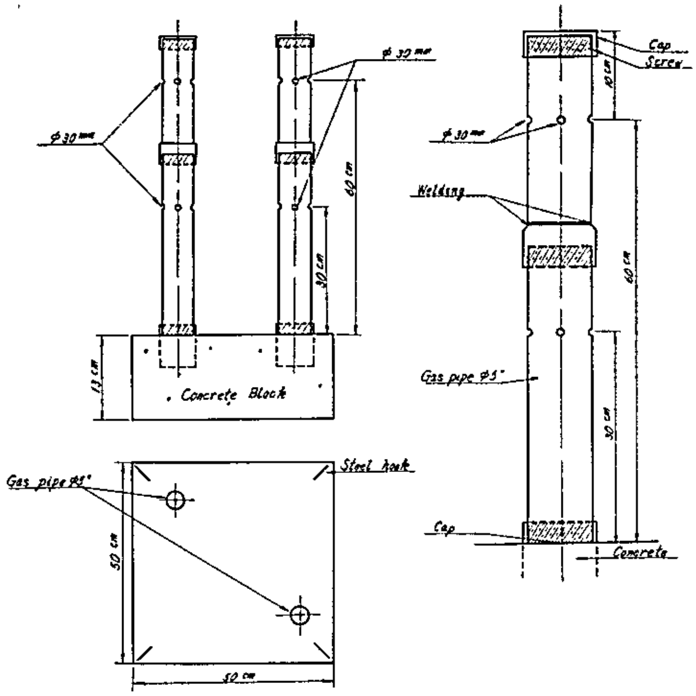
In this method, bamboo-sticks are often removed or inclined, therefo consideration should be made.

In sand seizing tube method as shown in Fig. 1·3·7, two gas pipes of 12.7 cm diameter are laid down at the sea bottom of -4, -5, -6, -8, After 10 - 20 days, these pipes are drawn up to measure the amount o sand diameter. If velocity meter is installed in same time the relati drift and tidal current can also be found.

(5) Sounding

The purpose of sounding is to complement the chart and to know the c and the condition of litoral drift to complement of the hard,

Fig. 1·3·7 Sketch of Sand Seizing Tube



Scope of measurement shall be determined by the purpose of survey.
When the water is deeper than 5 m, echo-sounder is used. When the water is shallower than 5 m, a string with sounding lead is used from the ship. For the very shallow parts, pole is used most of the time for measurement.

(6) Water Quality

Sample water shall be taken at the sea near the site by using water sampler.
Various kinds of tests as shown "Standard Specifications for Marine Condition Survey".

(7) Water Temperature

There is a ultra-violet photo method by air plane for the survey of sea water temperature distribution. In general, a ship way run with thermometer to measure the temperature distribution in vertical as well as horizontal direction.
Ideal is the simultaneous measurement at all places, but it may cost too much practically, so several methods are now being studied in order to shorten the measurement time.
In most elementary method, two transits shall be installed at the both end of the base line made on the land. Then, with communication with ship by tranceiver, observation point can be determined by simultaneously measurement at many points.

And a new measurement method is developed. In this method, a ship runs to the open sea at right angle to the shore line, while micro wave is being sent from the land. By receiving this micro wave, the position of the ship can be determined. A radio controled boat is in the testing stage, but is not completed yet.

(8) Bottom Soil

Sand at the seabed is taken by sampler and various kinds of test shall be performed as shown in the "Marine Survey Standard Specification". It has been explained above, concerning general items and methods of marine phenomenal survey. But in the actual survey, method and items of the survey shall be selected according to the purpose and regional characteristics.

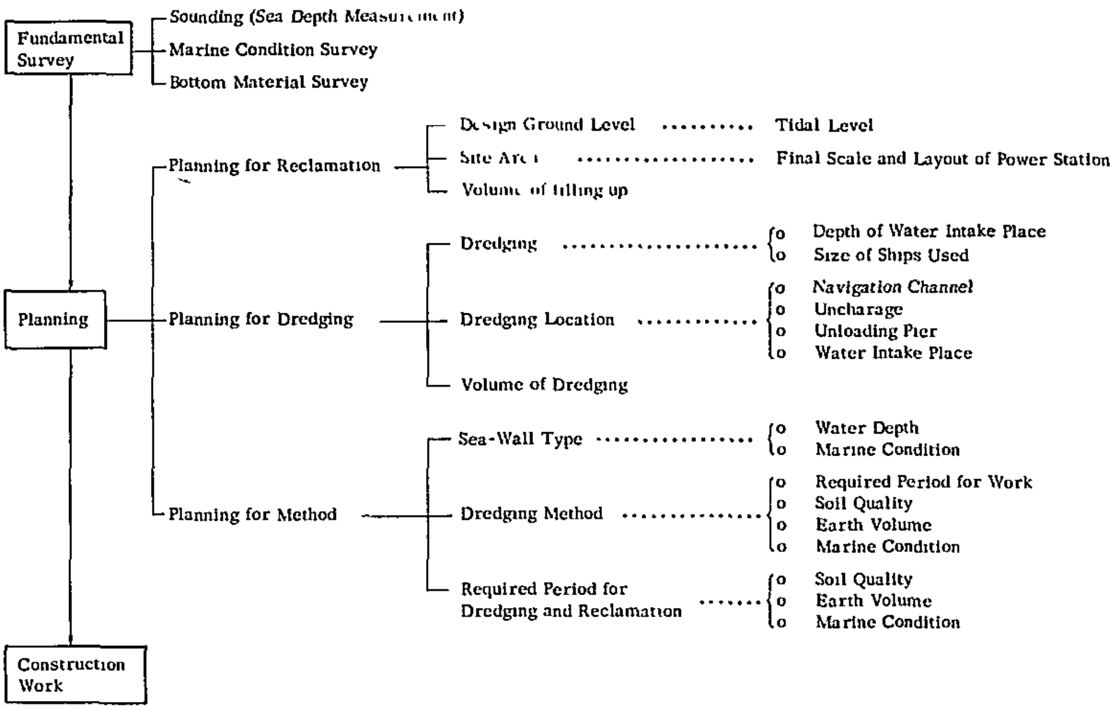
2. CONCERNING THE THERMAL POWER STATION PLANNING

2-1 Outline Planning of Land Reclamation

2-1-1 Planning Procedure for Dredging and Reclamation

This procedure of engeneering can be shown schematically as in the following.

Fig. 2•1•1



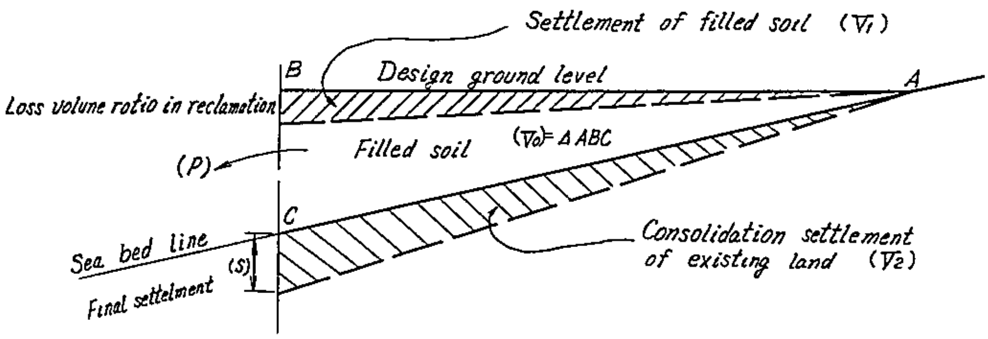
2-1-2 Method of Planning

Concerning the Fundamental Survey, it has been explained in detail in "Standard Specification" and "Method of Marine Survey".

The purpose of reclamation planning is to calculate the volume of filling up and for this sake, area and ground level of the site must be determined first.

Concerning the determination of site area, it has been stated already in Vol. II "Outline Planning". Concerning the determination of the ground level, it has been stated already in Vol. II "Outline Planning" and Vol. IV "Port Facilities"

Fig. 2·1·2



(1) Calculation of Volume of Filling up

The points to be considered in calculating volume of filling up are the following;

- o Consolidation settlement coused by softness of the existing land
- o Settlement of filled soil
- o Loss volume in reclamation

Considering the above-mentioned points, the required volume of filling up shall be calculated by the following formula.

$$V = \frac{V_0}{P} + V_1 + V_2$$

where,

V .... refuired volume of filling up

V_0 .... theoretical volume of filling up

V_1 .... Settlement of filled soil

V_2 .... Consolidation settlement of existing land

P .... Loss volume ratio in reclamation

V_1 is different with the level of reclamation, working method and required period for work. This value shall be determined by an engeneer in charge referring to Table 2・1・1

Table 2・1・1 Settlement of filling-up

Soil quality	Settlementratis of filling up
gravel, coarse sand	1 ~ 3%
sand	3 ~ 5%
fine sand	5 ~ 10%
silt, clay	≑ 15%

Elements influencing the determination of Factor P are size of dredged sand and mud, location and height of spillway, distance from discharge place, scale of dredging area and the relation between tide and ground level.

The calculation of loss volume ratio is very difficult, but the values in Table 2・1・2 can be used approximately.

Table 2・1・2 The loss volume ratio of filling-up

Soil quality	Loss volume ratio
gravel, coarse sand	95 ~ 100%
sand	90 ~ 95%
fine sand	70 ~ 90%
silt, clay	70% below

In order to make rough estimation of consolidation settlement S, the following formula shall be used. But, first of all, consolidation layer for calculation must be divided properly, and the rate of volume change, vertical stress and the thickness of layer should be predetermined.

$S = \Sigma\, m_{vi} \cdot pi \cdot hi \cdot$

S : Final Settlement (cm)

P_i: Vertical stress in center of individual layer (g/cm^2)

h_i: thickness of individual layer (cm)

m_{vi} : equal to almost twice value of volume tric change ratio caused by primary consolidation against the lood of individual layer (cm^2/g)

Vertical stress at the depth of hm in the ground shall be obtained by the following formula, assuming that the load is destributing on the ground at the inclination angle of 30 degree to the vertical line.

linear forme load

$$P = \frac{w}{1 + 1.15 \frac{h}{b}}$$

rectangular forme load

$$P = \frac{w}{(1 + 1.15 \frac{h}{b})(1 + 1.15 \frac{h}{\ell})}$$

disc forme load

$$P = \frac{w}{(1 + 0.57 \frac{h}{r})^2}$$

P: vertical stress at hm depth (t/m^2)

w: load on ground level (t/m^2)

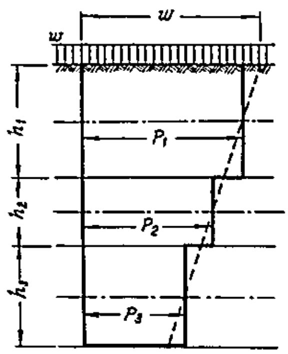
h: depth from ground level (m)

b: width of load (m)

ℓ: length of rectangular form (m)

r: a radius of disc form (m)

Fig. 2·1·3



(2) Determination of Dredging Location

After the volume of filling-up is determined, its supply source must be determined. This is the dredging planning.

In the thermal power station, the unloading space and the basin are necessary.

Of course these places must be dredged, but still more, in case the sea water in shallow, the sea in front of intake place must be dredged carefully, so that this place will not become shallow later, preventing the inability of water intake.

Therefore intake place front navigation channel and anchorage are regarded in general as area for dredging.

Regarding the area and depth of dredging, available ships for the power station must be able to pass through. For this sake the largest tanker used must be predetermined.

On the other hand, as dredging area will sometimes tend to sink for a long period, the margin shall also be taken into account.

Based upon the above-mentioned knowledge, it is most desirable to make planning so that the volume of dredging is equal to required volume of filling-up.

(3) Dredging Ship

After location and area of reclamation, the volume of filling-up navigation channel, anchorage and volume of dredging have been determined, method of dredging and reclamation must then be determined in connection with marine condition and period of work. As dredging ships, there are ziper dredger, backet dredger, grab dredger, rock cutter, pump-dredger. But the type of ship to be used must be determined, considering the volume of dredging, soil quality, period of work, marine condition, meteorological condition and the relationship between soil disposal and reclamation.

However, in the case when large scale of dredging is going to be made in short period, utilization of pump ship is prevalent and most economical. Therefore, it will be mainly described here about pump dreding.

In pump dredging ship there are self-propelling and nonpropelling and classified by kinds of driving power, of diesel type and of electric motor. In the case when the location is in the ocean and dredging area is vast, self-propelling ship is effective. But in the case when the location is in the bay or in the serene sea, and still more, dredging soil is used for reclamation, nonpropelling pump dredger will be used most of the time.

Nonpropelling pump dredger can swing right and left ward, being either of two spud as axis. For swinging two anchors are laid down at the place about 100 - 150 m apart from the ship. And then, by winding the swinging wire through the tip of ladder.

Ship herselt moves forward by alternately using two spud zigzag.

Fig. 2·1·4 Working of Pump Dredger

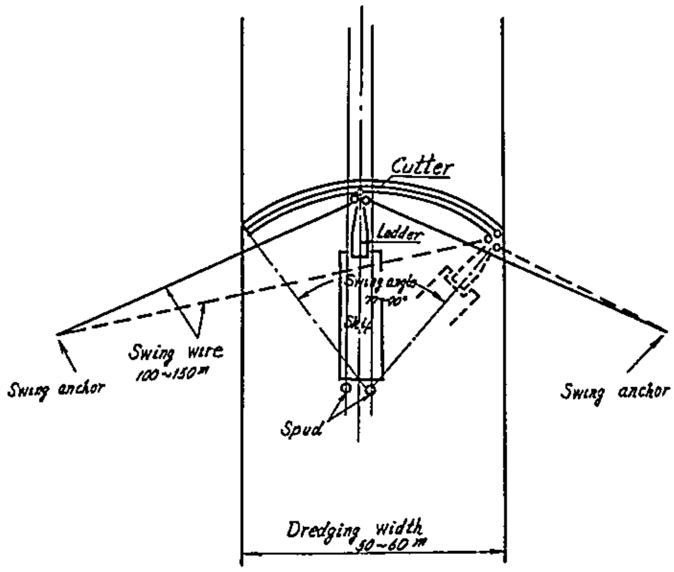


Table 2·1·3 Standard dredging width

Ship Size	Dredging Width
1,200 ~ 3,000HP	60 ~ 80 m
500 ~ 1,200	45 ~ 60
200 ~ 500	20 ~ 45

Note

Working width shall most effectively be determined considering area, depth and thickness of dredging, soil quality and anchor position.

Table 2·1·4 The Main Dimension of Nonpropelling Dredger with Motor Driven Pump

Main pump driving power	displacement tonnage	Size of Ship				Pump delivery pipe diameter	Discharged pipe diameter	Nominal Capacity		
		Length	Width	Depth	Draft			Maximum dredging depth (under water saface)	Nominal discharge length	Nominal capacity
HP	t	m	m	m	m	mm	mm	m	m	m^3/h
250	150	19	6.5	1.9	1.2	350	350	8	600	120
400	250	21	7.25	2.1	1.3	400	400	9	900	160
600	350	25	8.5	2.3	1.4	450	450	10	1,200	200
800	450	31	9.75	2.5	1.5	500	500	11	1,500	250
1,000	500	32	10.0	2.7	1.55	550	550	12	1,750	300
1,250	550	33	10.25	2.9	1.6	600	600	13	2,000	360

Table 2·1·5 Actual Dredging Ship Ability for Various Kinds of Soil Quality

Main pump Capacity	Nominal Capacity	Soil quality				
		Silt	Sand	Solid sand	Gravel	Slightly hard sand-clay mixture
HP	m^3/h	m^3/h	m^3/h	m^3/h	m^3/h	m^3/h
400 below	160 below	250 below	120 below	80 below	70 below	-
400~600	160~200	250~300	120~160	80~150	70~130	120 below
600~800	200~250	300~350	160~200	150~180	130~150	120~140
800~1,000	250~300	350~400	200~250	180~200	150~170	140~160
1,000~1,200	300~360	400~450	250~300	200~220	170~190	160~180

o Main pump is of single stage sand pump type. Discharge length means the length of pipe between suction flange of the suction pipe and the outlet of discharge pipe.

o Nominal discharge length means the discharge length of which the velocity in the discharge pipe becomes 3.5 m/sec under normal operation of the pump. Approximate figure can be calculated by the following formula.

$$L_o = \frac{N}{D}$$

where, L_o : Nominal discharge length (m)

N : Main Motor Rating (HP)

D : Diameter of discharge pipe (m)

o Nominal dredging capacity means 10% of discharge volume in an hour for nominal discharge length. This is expressed in the following formula

$$G_o = 1000\ D^2\ (m^3/h)$$

Required pipe velocity for the sand and mud transportation chnges with the size of sand and mud as shown in the following table.

Table 2·1·6 Discharging Velocity of Soil

Discharging velocity	Soil quality	Modulus of soil (β)
m/sec		
2.5	mud	2
3.0	fine sand	-
3.5	sand	3
4.5	coarse sand, gravel-sand mixture	4
5.5	gravel	5

In short, as dredging capacity of the ship depends upon the pump capacity, hardness a softness of sand and mud, dredging depth, and diameter and length of discharge pipe, suitable dredging ship must be adopted, matching the situation.

(4) Availability Factor

Dredging capacity of the ship depends upon the marine condition of working area, mainly wind and wave. There are two kinds of availability factors, namely the daily one and the yearly one. The daily availability factor can be arbitrarily determined in connection with the time schedule, but for the yearly one depends upon the seasonal marine condition and climate, so that marine survey shall sufficiently be made in advance for the calculation of actual dredging capacity. In no case shall there be any mistake for the required period of work.

As there is typhoon and strong wind in the sea near Japan, availability through out the year becomes 50 - 60% usually, while this figure in Indonesia will be imagined to be 70 = 80%. A real survey should necessarily be made at the required regions from now on.

The working limitation of the pump ship depends upon the size of the ship and characteristics of wave, but in general, the limitation is said to be 10 m/sec for wind velocity and 0.5 m for wave height.

(5) Discharge Pipe

Pumped-up sand and mud is transported to the reclamation site through the float-pipe and the pipe on the land.

When the dredging place is far from the land, the sea pipe can also be used next to the float-pipe instead of the pipe on the land.

The pipe on the land is sometimes installed directly on the ground and sometimes on the support as shown in Fig. 2·1·5. The standard dimension of the discharge pipe is shown in Table 2·1·7.

Table 2·1·7 Standard Dimension of Discharge Pipe

Discharge pipe			Flange Outside diameter	Weight
Inside diamater	Length	Thickness		
mm	mm	mm	mm	kg
350	6,000	6	520	400
400	6,000	6	580	450
450	6,000	6	650	500
500	6,000	6	750	550
550	4,500	9	800	560
600	4,500	9	800	610

Fig. 2·1·5 Piping Method

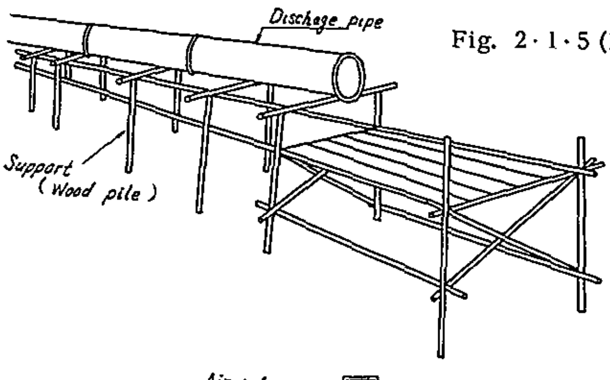


Fig. 2·1·5 (No. 1) Overhead Piping

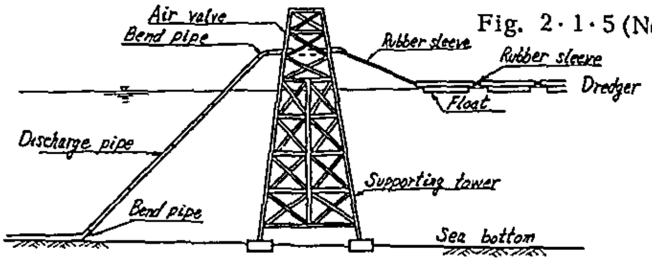


Fig. 2·1·5 (No. 2) Submarine Piping

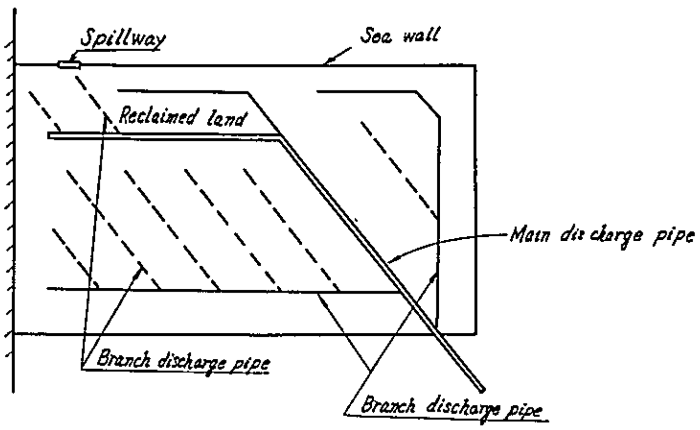
In general, reclamation begines right behind the sea wall and moves toward the spillway.

The distance between sea wall and discharge pipe is different with soil, kind and height of sea wall, but is approximately as in the following.

Pump Driving Power	Distance between sea wall and Discharge Pipe
More than 500 HP	10 - 13 m
Less than 500 HP	5 - 15 m

Layout of branch pipe is different with soil quality, reelaimed land level and discharge pipe height, but design shall be so made that the total length be the minimum as much as possible. This idea is shown in Fig. 2•1•6.

Fig. 2·1·6 An Example of Pipe Location on the Reclamation Site



The standard pipe length is as shown in the following.

Pump Driving Power	Reclamation Area per one Pipe
More than 500	30 - 100 m
Less than 500	20 - 70 m

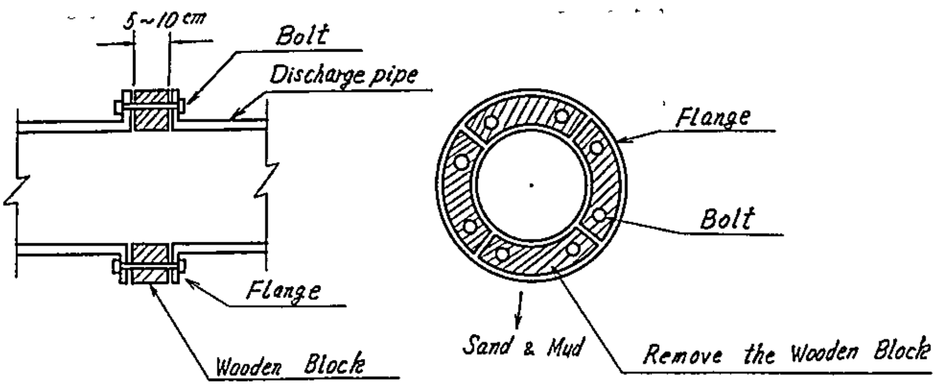
These pipes will not usually be installed from the very beginning, but most of the time, will be added or switched over to other parts.

Sand and mud will be discharged from the tip of the discharge pipe in general.

But, for the reclamation at the back of sea wall, leakage discharge method can be applied. In this method, a gap of about 5 - 10 cm shall be kept at every connection of discharge pipes with the wooden removable packing.

This is illustrated in Fig. 2•1•7.

Fig. 2·1·7 An Illustration of Leakage Discharge Method



(6) Spillway

Muddy discharge water from the pipe separates sand and mud for sedimentation and the water is discharged from the spillway. There are two spillway Method, namely overflow method and reservoir method. In overflow method, water is discharged to outsite area by overflowing. In reservoir method, a reservoir is made in the site, rejecting water to outside area through headrace pipe from the bottom of the reservoir.

Following points should be considered for making spillway:

a. Location of spillway shall be as far as possible from the outlet of discharge pipe.

b. Location of spillway shall be as far as possible from the place where important structures are expected to be built in future.

c. The location of spillway shall be at the place, where the ocean wave does not give direct influence.

d. The crest of overflow shall be generally set higher than the low water level.

e. The discharge place shall be inforced with concreat or stone in order to prevent scour.

f. Cross section area of discharge way of reservoir method shall be 5 - 7times larger than that of discharge pipe.

Standard section width is shown in Table 2·1·8 for overflow method.

Table 2·1·8 Standard Section Width of Spillway

Pump Driving Power	width of spillway
3,000 Hp	6 ～ 8m
1,500 Hp	4 ～ 6m
1,000 Hp Below	4m

(7) Sea Wall for Reclamation

In reclaiming, structure becomes necessary enclosing the site. There are two methods for this, namely temporaly wall and normal sea wall method.

When the water is comparatively shallow (say until - 3 m), the following temporaly wall is adopted as shown in Fig. 2·1·8 and Fig. 2·1·9.

Fig. 2·1·8 Wooden Wall Type Revetment

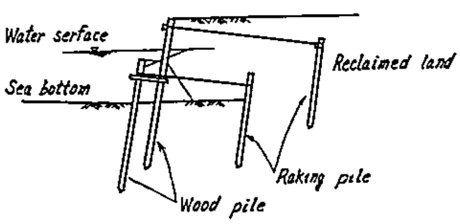
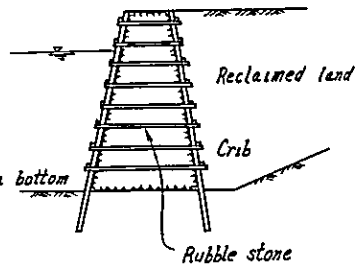


Fig. 2·1·9 Crib Type Revetment



When the depth is more than 3 m, temporaly wall may be broken, so that long durable sea wall is often used. As this method, steel raking pile method, block type, caisson type, rubble mound type and rubble mound block type are used as shown in Fig. 2·1·10.

2-1-3 Construction Cost

(1) Construction Cost

This consists of the following items.

a. Sea wall construction cost

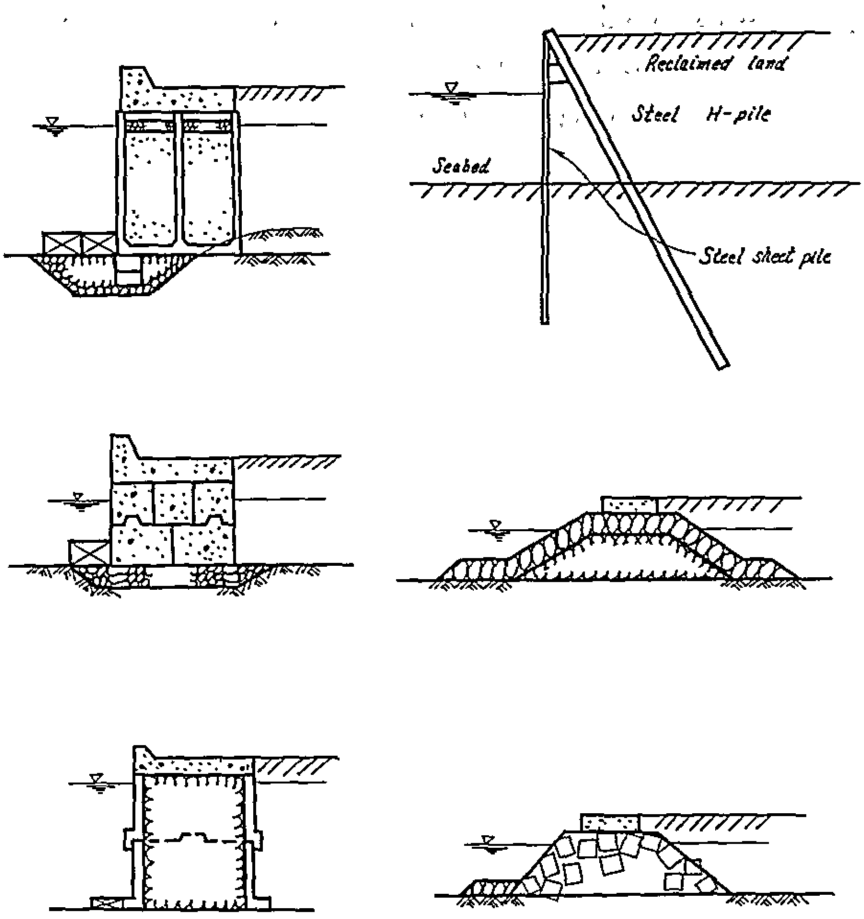
b. Filling-up Cost (refer to Note 1)

c. Construction cost of discharge pipe in the reclamation (refer to Note 2)

d. Cost of internal temporaly wall and water discharge in the reclamation area in case of devided reclamation.

e. Land grading cost in the reclamation area

Fig. 2·1·10 Structure Type of Sea-walls for Reclamation



f. Compensation cost

Note:

(1) Filling-up cost

This consists of the following items

a. Electrical equipment suppling power to the dredger in case of using the ship with motor driving pump.

b. Cost for dredger transportation cost.

c. Operating cost of the dredger.

d. Construction cost of discharge pipe between dredger and reclamation land.

e. Maintenance and repairing cost, depreciation cost.

In operating cost, electric power cost is the largest, 70% of the total.

In addition, the sea bottom shall necessarily be extra dredged as shown in Fig. 2•1•11 for the sake of navigation channel and anchorage because the undulation remains after the dredging this extra dredging soil volume the size of dredging ship and soil, but is approximately 0.3 - 0.5 m.

The slope of seabed deforms to stable settlement after dredging, but this slope in stability changes with soil quality. Therefore, this most be taken into account in calculating the volume of dreding standard slope is shown in Table 2•1•9.

Fig. 2•1•11 An Illustration of Extra Dredging

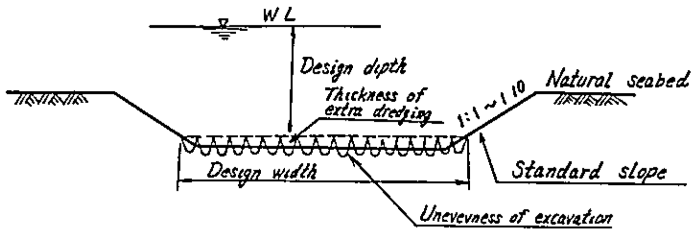


Table 2•1•9 Standard Slope of Stability

gravel solic sand-clay mixture	1:1 ~ 1:1.5
sand sand-clay mixture slightly hard clay	1:1.5~1:2.0
solid fine sand soft sand-clay mixture	1:2.0~1:3.0
soft clay, mud, ooze	1:3.0~1:10.0

Note: (2)

Construction cost of discharge pipe in the reclamation area.

This cost consists of the following items.

a Transportation and construction of discharge pipe

b Piping cost

c Cost of removal

d Maintenance and repairing cost of the pipe Depreciation cost

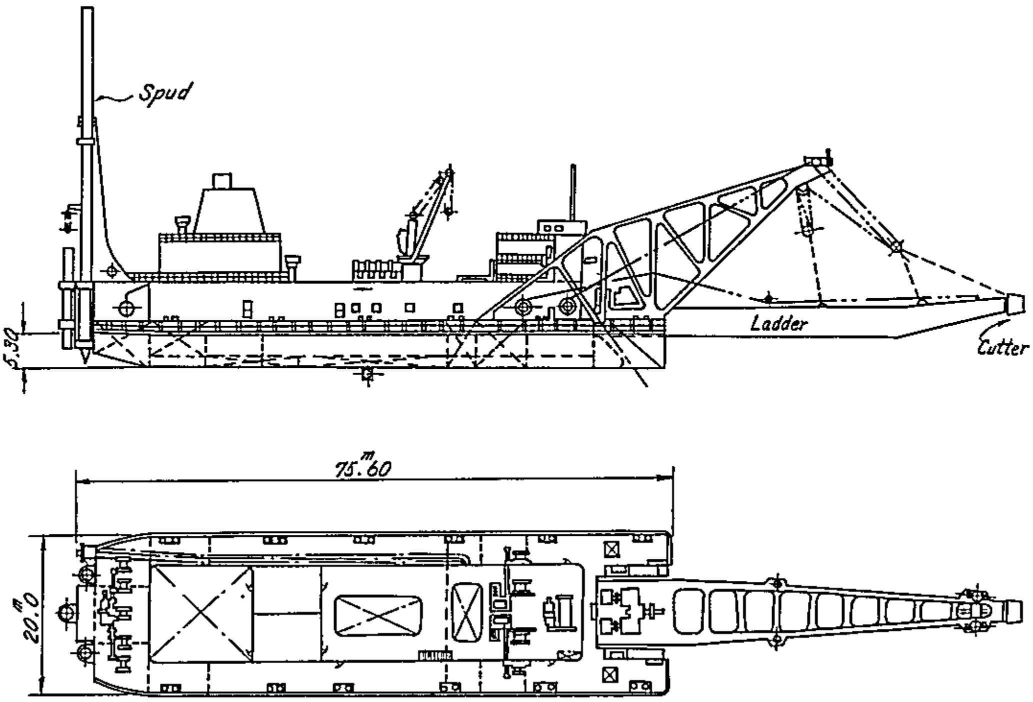
2-1-4 An Example of Dredging Pump Ship

The main dimension of a dredging pump ship will be introduced as below. This is the largest dreding pump ship in Japan, built in September 1972.

Refer to Fig. 2·1·12.

Pump Driving Steam Turbine	9200 HP
Dredgable Depth	6.50 - 35 m
Max. Discharge Length	5,000 m
Dredging Capacity	fine sand 1,350 m^3/h
percentage of soil content 15%	
Inside Dia. of Discharge Pipe	760 mm

Fig. 2·1·12 Dredging Pump Ship



2-2 Port facilities

2-2-1 Waves and tidal level

(1) Datum level for construction work

As the datum level for construction of facilities, the datum plane which is adopted at nearest port shall be used in principle.

(2) Design tidal level

a. How to decide design tidal level

Design tidal level shall be decided considering the astronomical tide, high tide, tsunami and secondary undulation, and besides, referring to the past high and low tidal levels. It is the general rule to take the tidal level at which the structure becomes most dangerous as design tidal level, which are often different according to various types of structure. In the case of facilities such as high tide facilities which are meant for protecting hinterland from high tide and waves, it is necessary to select design tidal level considering wave overtopping as the subject, and when calculating wave force in the design of breakwaters and sea wall, study shall have to be made on tidal levael when haves break just in front of the structure, generating the maximum wave force. Moreover, mooring wharf has the dangerous property of sliding to front at the time of tsunami or other abnormal low water level. Therefore, when designing, case must be taken to ensure that the structure is safe at any tidal level and may exhibit the expected performance by carrying out various comparative studies on the tidal levels within the expected ranges.

b. High water

(a) The design high water level is obtained from the following.
When a reliable record is obtainable of the passing of the past famous typhoons, traversing the point in question or near thereto:
(High water ordinary spring tide + maximum tidal level deviation in the past)
High water ordinary spring tide and maximum tidal level deviation in the past are obtained on the basis of observation record at the nearest tide station.

(b) In lack of the above-mentioned record, when important facility is planned.
(High water ordinary spring tide + tidal level deviation by model typhoon)
The tidal level deviation by model typhoon is obtained by tidal level calculation assuming the typhoons likely to happen.

(c) Other items
(Maximum past tidal levael + margin)

Maximum past tidal level is obtained from past record of observation, while margin height is obtained considering tidal levels at new moon & full moon at the time of observation.

(3) Wave height

Basic principle to decide design wave

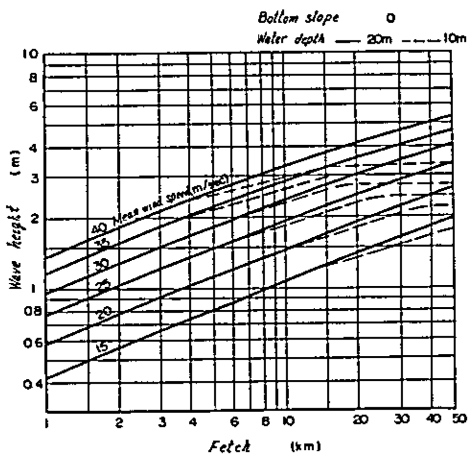
Various dimensions of design wave is decided referring to the past maximum wave (Significant wave) obtained by using either the following a or b as well as the statistical property of waves for a long time (significant wave) (refer to 2-2-8 (8))

a. Actually observed data of waves for considerably long time.

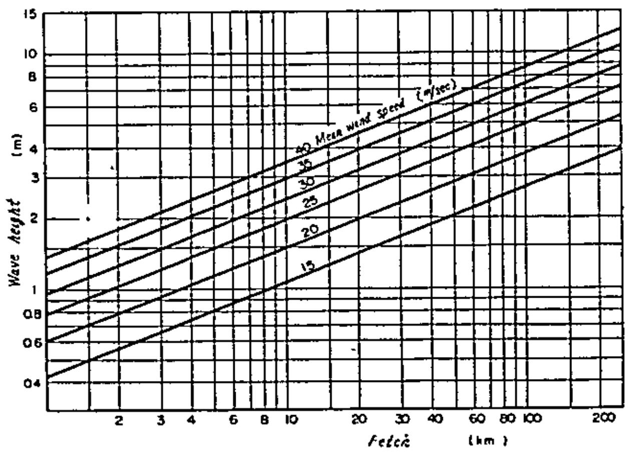
b. The estimated data of waves for considerably long time using meteorological data corrected by reference to actual observation data of waves for a given period.

Fig. 2·2·1 Graph to Obtain Wave Height

(No. 1) Graph to Obtain Wave Height – The Case of Inland Sea (Bullet Schuneider Method)



(No. 2) Graph to Obtain Wave Height – The Case of Open Sea (By S·M·B Method)



(4) Wave force

a. Wave pressure of standing waves

(a) Applicable limit of wave force formula of standing waves

Wave pressure of standing waves applies, as a principle, when the following conditions are satisfied.

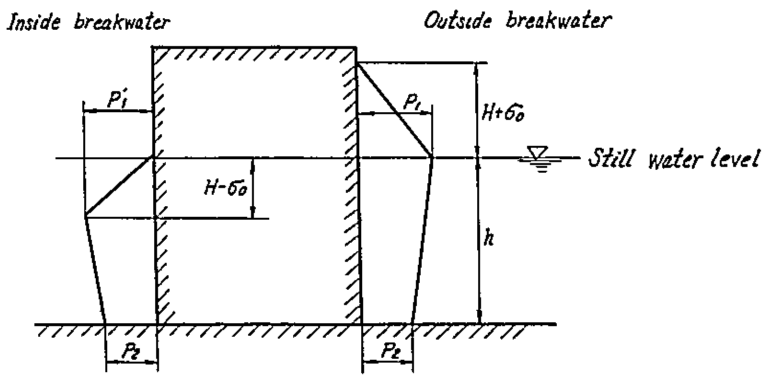
$$h' \geqq 2H \quad \cdots\cdots\cdots\cdots \quad (2\cdot 2\cdot 1)$$

where, h' : Water depth measured from crown of foot protection block (m)

H : Wave height as progressive wave at that place (m)

(b) Calculation has been made assuming that the wave pressure of standing wave makes lineal distribution as shown in Fig. 2·2·2 and takes the following maximum and minimum value

Fig. 2·2·2 Wave Pressure of Standing Wave



i) When there is crest of waves at the wall

$$\left.\begin{aligned} P_1 &= (P_2 + W_0 h)\left(\frac{H + \delta_0}{h + H + \delta_0}\right) \\ P_2 &= \frac{W_0 H}{\cos h \dfrac{2\pi h}{L}} \\ \delta_0 &= \frac{\pi H^2}{L} \cot h \frac{2\pi h}{L} \end{aligned}\right\} \quad \cdots\cdots (2\cdot 2\cdot 2)$$

ii) When there is wave trough at the wall

$$\left.\begin{aligned} P_1' &= W_o (H - \delta_o) \\ P_2' &= P_2 = \frac{W_o H}{\cos h \frac{2\pi h}{L}} \end{aligned}\right\} \cdots\cdots (2\cdot 2\cdot 3)$$

Where: P_1 ; Wave pressure intensity on still water level when there is wave crest at the wall (t/m^2)

P_2, P_2'; Wave pressure intensity at lower end of wall body (t/m^2)

P_1'; Wave pressure intensity at $H - \delta_o$ below still water level when there is wave trough at the wall (t/m^2)

w_o ; Unit capacity weight (t/m^3) 1.03 t/m^3 of sea water

δ_o ; Height on still water level of wave dividing face at the wall (m)

h ; Water depth in front of wall body (m)

H ; Wave height as progressive wave at the location of wall body (m)

L ; Wave length at water depth h (m)

b. Breaking wave pressure

Wave pressure is calculated by Equation 2·2·4 considering that there is possibility of generating breaking wave when water depth is less than twice of wave height

$$Pb = 1.5\, w_o H \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (2\cdot 2\cdot 4)$$

Where: Pb; Wave pressure intensity through breaking wave (t/m^2)

w_o; Unit capacity weight of sea water (t/m^3) 1.03 t/m^3

H ; Wave height as progressive wave at the location of breakwater (m) (wave height at 2-3 wave length more in the offing than breakwater location).

It is assumed that this wave pressure intensity works uniformly on 1.25 H above still water level or breakwater crest, whichever is the lower (Refer to Fig. 2.2.3)

c. Correction of wave force according to wave direction

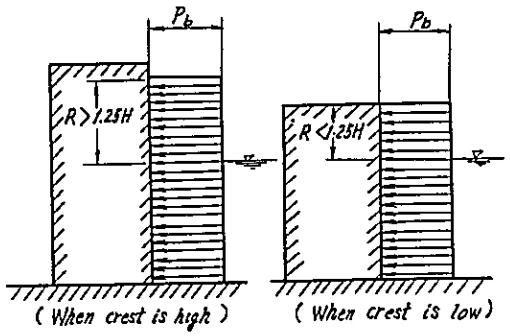
The wave pressure of which wave direction is inclined to the normal line of structure is calculated by Equation 2·2·5.

$$P'b = Pb \cos^2 \beta \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (2\cdot 2\cdot 5)$$

Where; P'b; Pressure intensity of breaker coming into obliquely (t/m^2)

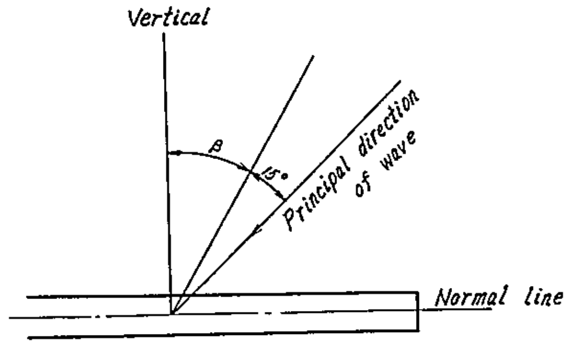
Pb ; Pressure intensity of breaking wave as incident wave at right angle (t/m^2)

Fig. 2・2・3 Wave Pressure of Breakwater



β ; Angle (^{o}) made by the perpendicular of structure normal line and the most dangerous direction within range of $\pm 15^{o}$ from the principal direction of the wave (Refer to Fig. 2・2・4)

Fig. 2・2・4 Illustration of Wave Direction Correction



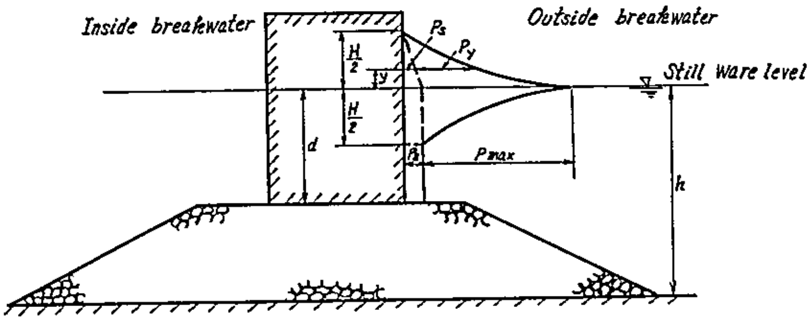
d. Impact breaking wave pressure

When upright standing wall is situated at near the breaker point on steep-sloped sea shore, extremely big impact breaking wave pressure is generated at the moment of breaking.

It is advisable that structures with upright walls have the section which is not worked upon by the impact breaking wave pressure as possible. However, when there is danger of working of strong impact breaking pressure, suitable wave quenching works shall be erected in front thereof.

Note) In addition, when there is any necessity of making intensity calculation or stabilizing the impact breaking wave pressure, it is the general standard to calculate wave pressure by Equation 2・2・6. Refer to Fig.2・2・5

Fig. 2・2・5 Breaking Wave Pressure by Minikin Formula



Dynamic Pressure : $P_y = Pmax\,(1 - \frac{2|y|}{H})^2 \qquad -\frac{H}{2} \leqq y \leqq \frac{H}{2}$

$$Pmax = 100\,W_o d(1 + \frac{d}{h})\,\frac{H}{L}$$ 2・2・6

Static Pressure : $Ps = \begin{cases} 0.5\,W_oH\,(1 - \frac{2y}{H}) & 0 \leqq y \leqq \frac{H}{2} \\ 0.5\,W_oH & y \leqq 0 \end{cases}$

Where

Py; Dynamic pressure working at height of y from still water level (t/m^2)

Pmax; Maximum wave pressure working upon still water level (t/m^2)

Ps; Static pressure (t/m^2)

wo; Unit capacity weight of sea-water (t/m^3) 1.03 t/m^3

y ; Height to supposed point from still water level (upper side positive) (m)

d ; Water depth up composite breakwater (m)

h ; Water depth in front (m)

L ; Wave length corresponding to water depth h (m)

H ; Wave height as progressive wave at the point (m)

The conditions generating impact breaking wave pressure contains at present many unknown points, and no uniform view is so far obtained. But, the result of experiment comparatively known is as follows.

(a) In case the bottom slope is a uniform inclined surface

In case there is pier water depth (hM) mentioned in Equation 2・2・7, impact breaking wave pressure is the most conspicuous.

$$\frac{hM}{Ho} = CM\,(\frac{Ho}{Lo})^{-0.25} \qquad \text{.........................} \quad (2 \cdot 2 \cdot 7)$$

CM: $0.59 - 3.2 \tan\theta$ Ho: deep water wave height (m)

Lo : deep water wave length (m)

$\tan\theta$: slope of uniform inclination

(b) In case of composite breakwater

When $d<0.5h$, if water depth at base of upright portion is 1.5 times or less ($d<1.5H$) of wave height in front, (refer to Figure 2·2·5 for d, h, H) there is possibility of generating impact breaking wave pressure.

Note) In case deformed concrete block is piled up in front of upright standing wall, in order to decrease the wave pressure working thereon, the value of Equation 2-2-8 may be used as mean design wave pressure. However, this applies to the case where the water depth at base is 1.5 times or less of wave height, and the crest of wave-quencher height piled up is 0.5H or more of design high water level.

$$Pb' = 1.0\, W_0 H \quad \text{.............................} \quad (2\cdot 2\cdot 8)$$

Pb': wave pressure after locating wave-quencher level (t/m^2)

wo: unit capacity weight of sea water (t/m^3)

H : wave height as progressive wave at that place

2-2-2 Navigation channel, basin

(1) Navigation channel

a. Width

The width of navigation channel and harbour entrance shall be determined after full deliberation on the type of ships handled, amount of navigation, topography, meteorology, maritime meteorology, whether one way or return and presence of tug-boats or not.

(a) In the navigation channel under Port Regulation Law, though parallel salling and passing sailing is forbidden, return sailing is approved. But, in ports and harbours where traffic is abundant, it is desirable to plan the governing of both way traffic and establishment of secondary navigation channel, etc.

(b) As the width of navigation channel, the following value is normally adopted.

Both way navigation channel: 1-1.5 times of ship's length

One way navigation channel (where it is calm and the tidal current is parallel with navigation channel) : 0.5 times or more of ship's length. However, width may be decreased as the result of topography, use of tug boat or on the opinion of those persons concerned.

b. Water depth

As the depth of water of navigation channel, it is the standard to adopt the berth water depth of the ship to be handled.

However, as to the navigation channel on which ships navigate at normal velocity such as navigation channel outside port, navigation channel where waves, wind and tidal current is especially strong, navigation channel where tidal range is remarkably great, and navigation channels for super-sized ships, it should be fixed separately, considering the marginal water depth for the following various factors:

(1) Oscillation of ship due to waves

(2) Trim of ship

(3) Squatting of ship

(4) Bottom soil

(5) Maneuverability

(a) Ships develop trim, squatting, and sinking of hull while in navigation, but on the navigation channel within ports and harbours, berth water depth may be applicable, since ships navigate at slow velocity.

(b) It is generally understood that for the amount of hull sinking due to waves, 2/3 of wave height for small or medium size ships, and 1/2 for large-size vessels, may be enough as marginal water depth.

(c) The draft difference at stem and stern of ship caused as the result of loading of cargo and navigation is called trim. Under normal cargo loading, stem will sink at a low velocity, and when velocity is accelerated, stern is apt to go down.

(d) Upon shallow water area or water area with small channel section area, water level at ship side lowers and hull sinks. This phenomenon is called squatting. Also in this case, the phenomenon or poor steerage appears.

(2) Anchorage

a. Area

The area of anchorage shall have the following value for a ship as the standard.

(a) Single anchorage: Area including a circle with a radius of (L + 60)m - (L + 90) m

(b) Double anchorage: area including a circle with radius of (L + 45)m

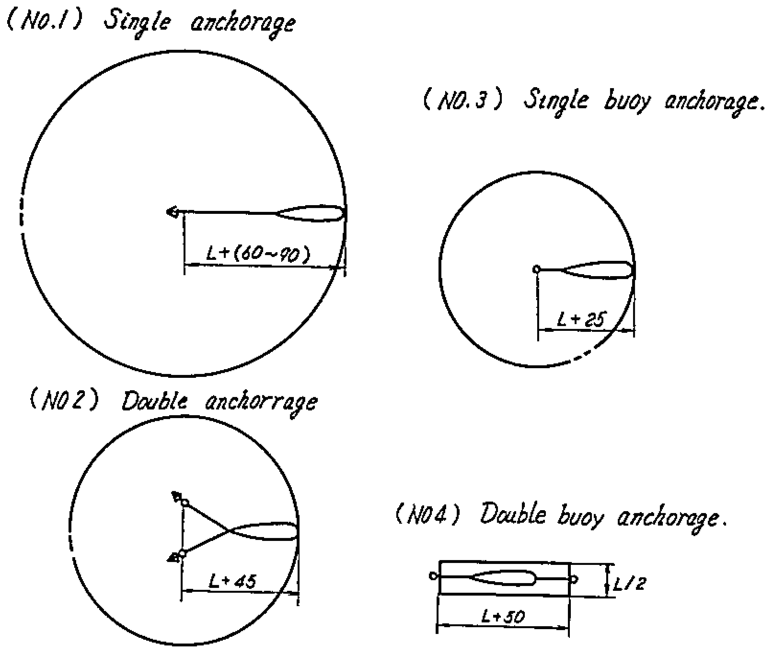
(c) Single buoy anchorage: area including a circle with radius of (L + 25)m

(d) Double buoy anchorage: area including a rectangle with sides of (L + 50)m and L/2 respectively.

where:

L : length of ship (m)

Fig. 2·2·6



b. Depth of water

The depth of water for anchorage will be enough if the berth depth of water is adopted. The berth depth of water shall conform to the paragraph of

2-2-4 Unloading	Table 2·2·2 Dimension of berth
2-2-5 Fuel unloading facilities	Table 2·2·6 Dimension of Berth

c. Calmness

Calmness generally refers to wave height ratio inside and outside of breakwater, and may be obtainable by means of diffraction diagram.

Calmness means in general the smallness of wave height, but the effect on waves in berth and anchorage, etc., does not indicate wave height alone, but takes a complicated form being dependent upon the cycle of wave, wave direction and other various factors, and nothing is available which refers to the limit of wave height.

2-2-3 Ships

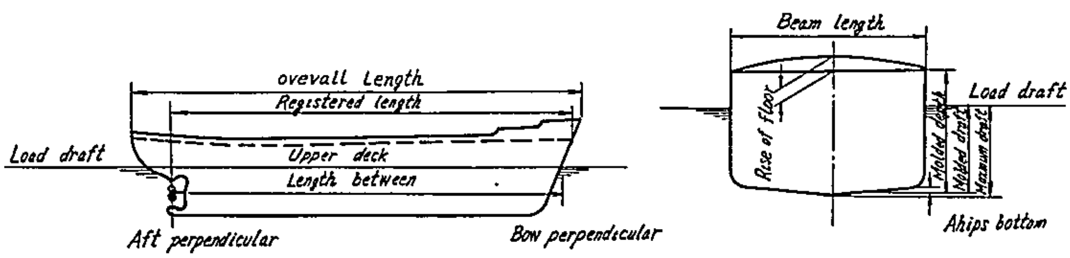
(1) Standard ship type

Table 2·2·1 Standard Ship Type

Kinds	Tonnage	Lenth	Width	Depth	Load draft
	Weight Tonnage	m	m	m	m
Freighter	700	50	8.3	4.2	3.9
	1,000	57	8.7	4.4	4.2
	2,000	75	10.8	5.7	4.9
	3,000	89	12.4	6.7	5.6
	4,000	101	13.7	7.5	6.1
	5,000	111	14.8	8.2	6.6
	6,000	119	15.6	8.8	7.0
	7,000	126	16.4	9.3	7.4
	8,000	132	17.0	9.8	7.7
	9,000	137	17.6	10.2	8.0
	10,000	142	18.1	10.6	8.2
	12,000	150	19.0	11.2	8.6
	15,000	160	20.0	11.9	9.1
	17,000	164	20.5	12.3	9.4
	20,000	170	21.0	12.7	9.8
LNG Ship	30,000	249.5	34.0	21.2	10.0
	50,000	280	40.0	23.0	11.0
	70,000	330	45.0	31.0	12.0

Kinds	Tonnage	Length	Width	Depth	Load draft
	Weight Tonnage	m	m	m	m
Tanker	700	48	8.6	4.2	3.8
	1,000	53	9.1	4.7	4.1
	2,000	68	10.2	5.5	4.8
	3,000	81	11.3	6.3	5.4
	4,000	92	12.3	6.9	5.9
	5,000	102	13.3	7.5	6.3
	6,000	111	14.1	8.1	6.7
	8.000	126	15.7	9.0	7.4
	10,000	140	17.2	9.8	7.9
	12,000	150	18.4	10.4	8.3
	15,000	163	20.0	11.2	8.8
	17,000	170	21.0	11.7	9.1
	20,000	178	22.4	12.3	9.5
	25,000	190	24.2	13.0	10.0
	30,000	200	25.8	13.6	10.3
	35,000	208	27.4	14.2	10.6
	40,000	215	29.0	14.7	11.0
	50,000	230	32.0	16.0	11.8
	60,000	240	34.0	17.6	12.6
	80,000	260	37.6	19.6	14.3
	100,000	285	41.2	20.6	15.0
	150,000	307	47.5	24.0	16.5
	200,000	315	50.3	-	18.3

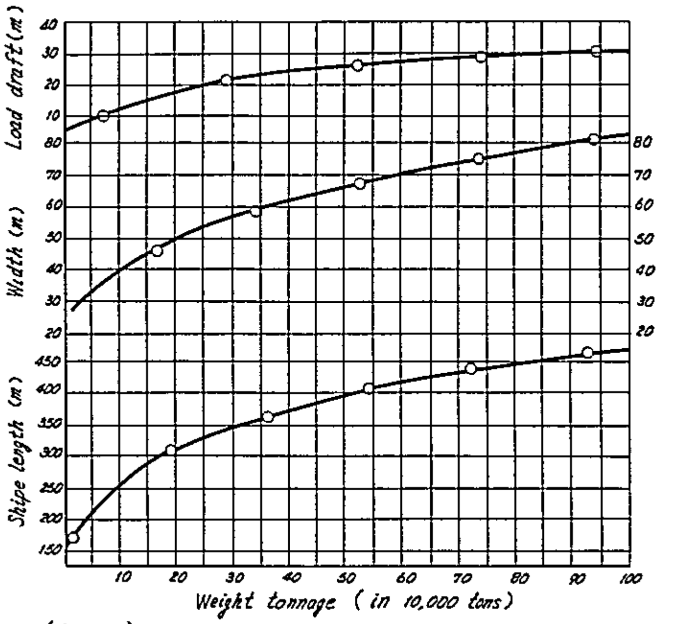
Fig. 2·2·7 Principal Dimension of Ship



o Weight tonnage; (D.W.T.)

this refers to full load displacement minus light weight. Therefore, it denotes the weight (dead weight capacity) of cargo, fuel, water, oil and other loads which may be taken on to the ship. On a freighter, the weight of dead weight capacity except cargo is, in the case of coastwise service, 10% or less of dead weight capacity, and in the case of ocean going service, if equipped with internal combustion engine, 10 - 15%, and with coal burning ships, 15 - 20% or thereabout. The weight tonnage against gross tonnage of 1.0 may be takne approximately a's 1.5 for freighter, 1.7 for tanker and 1.6 for ore carriers, respectivaely:

Fig. 2・2・8 Standard Size of Manmoth Tanker



(Source)
Journal of the WATERWAYS AND HARBORS DIVISION
Proceedings of the American Society of Civil Engineers (May 1970)

2-2-4 Unloading

(1) Purpcse

Unloading wharf shall be designed as the facility for landing the construction materials and heavy machinery used during the construction period.

(2) Scale of berth

Table 2·2·2 Dimension of Berth

Tonnage of freighter	Length of berth	Water depth of berth
Weight tonnage	m	m
700	60	4.5
1,000	70	5.0
2,000	90	5.5
3,000	105	6.0
4,000	120	7.0
5,000	130	7.5
6,000	140	8.0
7,000	145	8.0

In Table 2·2·2, the length of berth is determined considering the ship's length plus the length of mooring rope, etc., between 10m - 20m, and water of depth, considering the load draft plus margin depth of water by ship type of 0.5 - 1.0m.

(3) Load

The surcharge of unloading wharf includes loading capacity of landed cargo, load of motor vehicle and crane with its shed load, and the value thereof is as shown in Table 2·2·3 as the standard.

Provided, in the study of earthquake time, no consideration is required for the live load in Table 2·2·3 as well as the loading capacity of landed cargo.

Table 2·2·3 Surcharge of Unloading Wharf

Name of load	Design Surcharge	Subject area of load	Remark
Construction material	3 t/m^2	Entire unloading wharf area	
Heavy machinery	Maximum weight of load	Whole area of conveyance route	Refer to Table 2.2.4
Motor Vehicle load	T-20 load	Entire unloading wharf area	
Crane load	Weight of located machinery	Where located	Refer to Fig. 2.2.10 2.2.11
Shet	Located weight	"	

Table 2·2·4 Example of Max. Landing Weight at Unloading Wharf

Station	Cargo	Surcharge (t/m^2)	Gross weight when transported	Remark
(A) SITE	600MX, main converter	16.0	380	Except insulation oil, accessory machinery
(B) "	"	15.1	326	"
(C) "	350MW, main converter	11.6	270	"
(D) "	784MW, Besser	20.0	565	

(4) Crown height

The crown height of unloadin wharf shall be decided considering the tidal range, load draft of ship, system of cargo handling and ground level of the premise.

The crown height of general mooring wharf takes, as the standard, the value in Table 2·2·5 above H.W.L., according to "Design standard of port & harbour structures"

Table 2·2·5 Crown Height of Mooring Wharf Above H.W.L.

Kinds	Tidal range of 3.0m or more	Tidal range less than 3.0m
Large-size unloading	0.5m - 1.5m	1.0m - 2.0m
Small size unloading wharf	0.3m - 1.0m	1.0m - 1.5m

Fig. 2·2·9 Design Example of Unloading Wharf

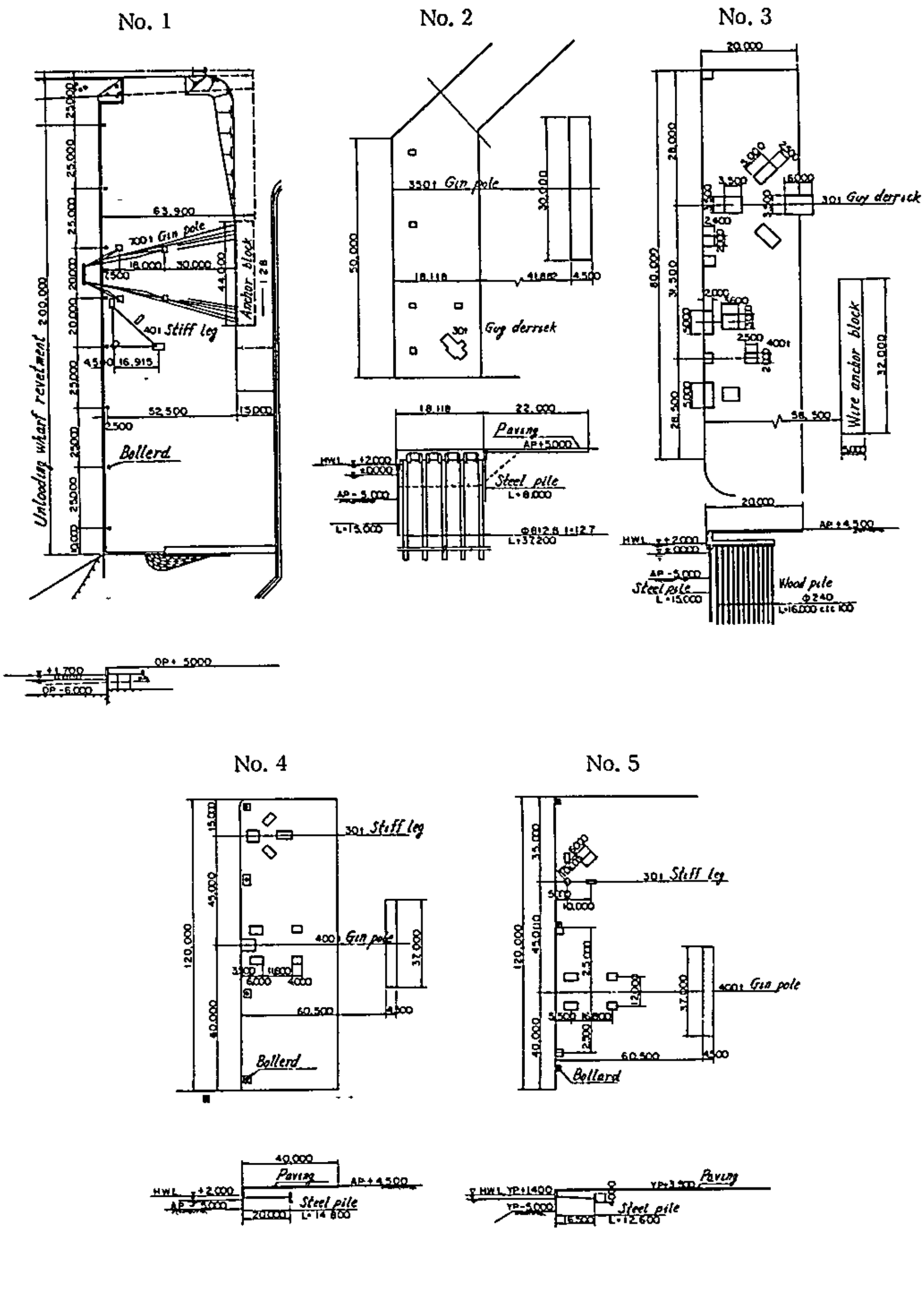


Fig. 2・2・10 Gin Pole Crane (480 ton)

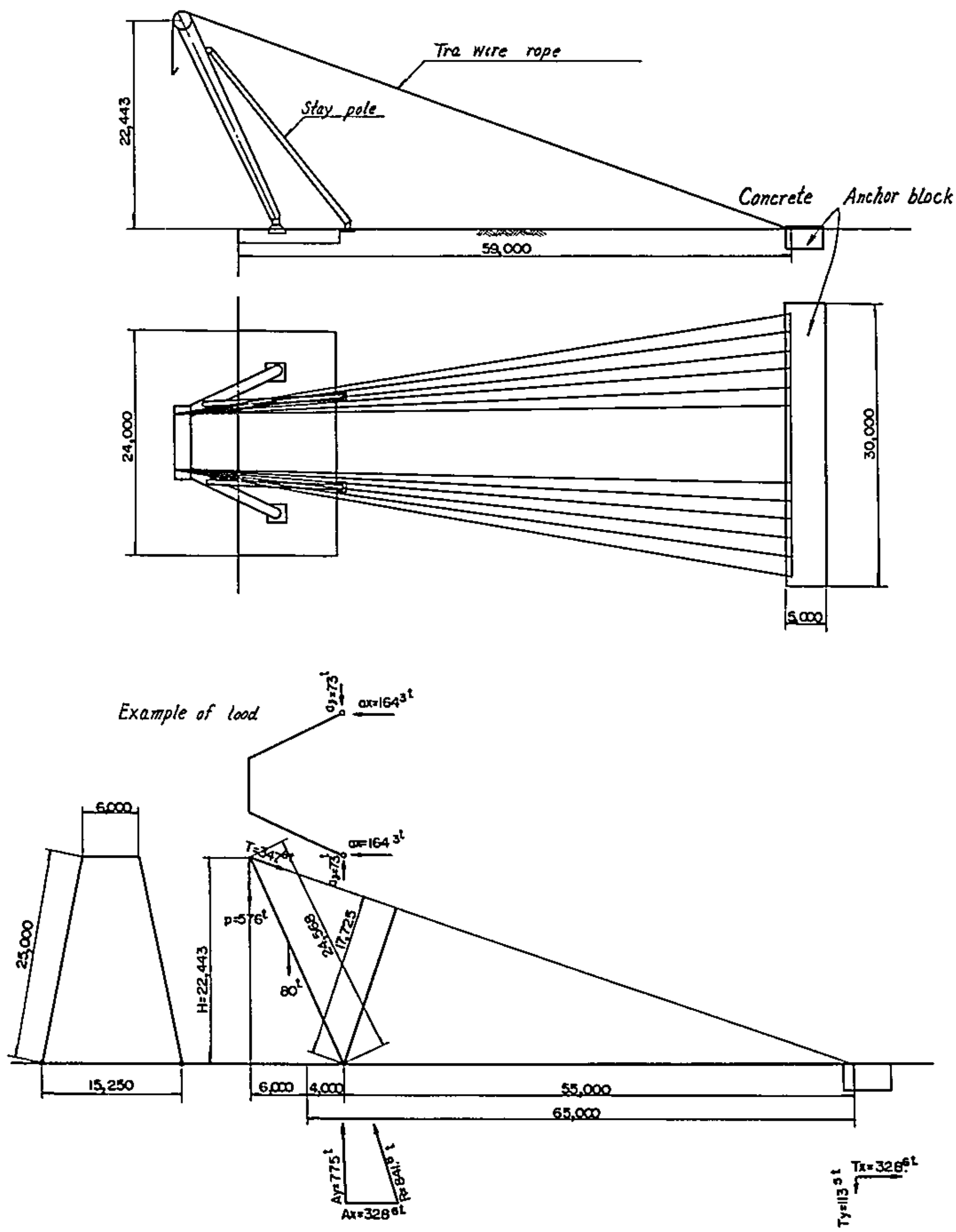
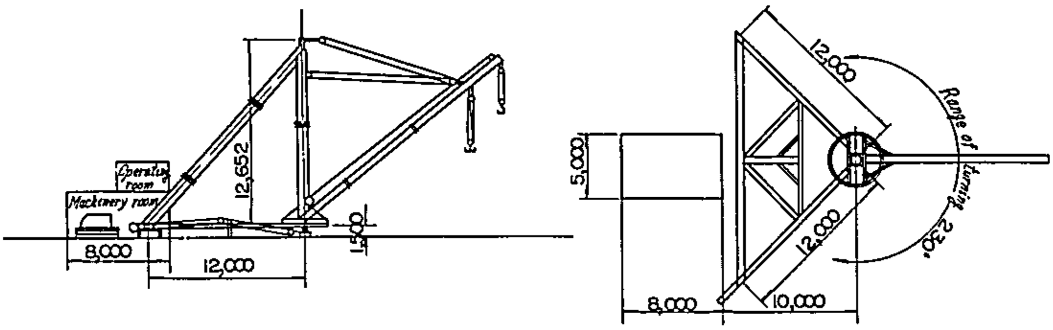
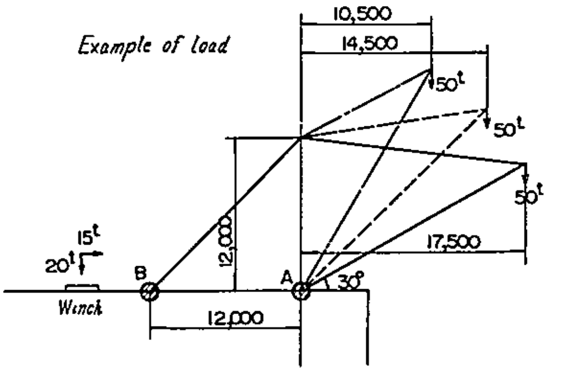


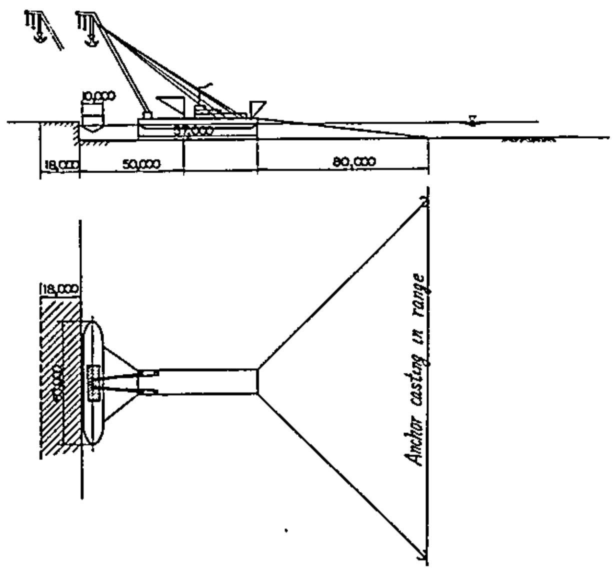
Fig. 2·2·11 Stiff Leg Derrick-crane





Load (ton) \ Boom Angle		30°	45°	60°
A	Vertical (Compressive)	180	163	137
B	Vertical (Tensile)	100	83	57
	Vertical (Compressive)	105	88	62

Fig. 2·2·12 Floating Crane



2-2-5 Fuel unloading facilities

(1) Scale of berth for unloading oil

Table 2·2·6 Dimension of Berth

Kinds	Tonnage	Length of berth	Depth of water of berth
Tanker	D.W.T	m	m
	300	40	3.8
	500	50	4.0
	700	60	4.5
	1,000	70	5.0
	3,000	100	6.0
	5,000	120	7.0
	6,000	130	7.5
	8,000	145	8.0
	10,000	165	9.0
	17,000	195	10.0
	25,000	210	11.0
	40,000	240	12.0
	65,000	280	14.0
	85,000	290	15.0
	100,000	315	16.0
	150,000	340	18.0
	200,000	380	19.0

In the Table 2·2·6, the length of berth is fixed by the ships length plus 15 - 30m, taking into account the length of mooring lines, and, for depth of water, by the load draft plus 0.5m - 1.5m as margin water depth corresponding to the type of ship.

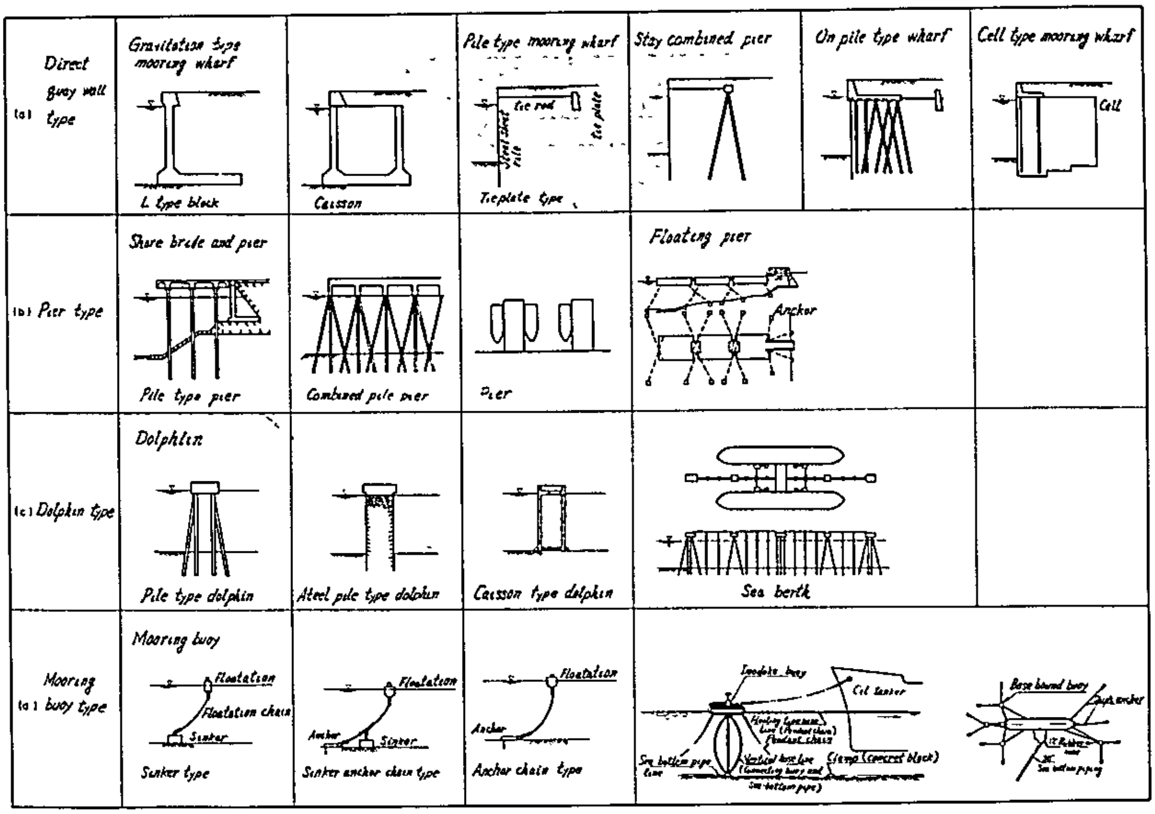
(2) Type of structures

As the system of oil unloading mooring facility, generally there are the following ones:
(a) Direct quay wall type, (b) Pier type (c) Dolphin type (d) Mooring buoy type.
Fig. 2·2·13 shows the main types of structure of above mentioned systems.

a. Arrangement of dolphins

The arrangement of dolphines shall be so made as not to cause obstructions to the anchoring or navigation of other ships, taking into account the various dimensions of ships to be handled, depth of water, wind direction and wave direction as well

Fig. 2·2·13. Type of Structures



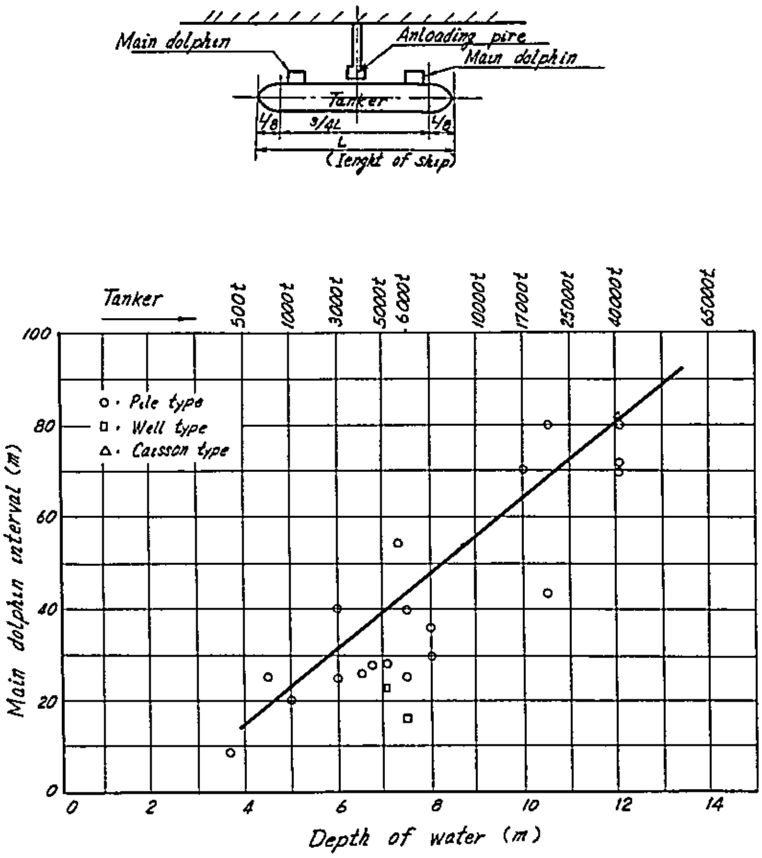
as the tidal current. (Refer to Fig. 2·2·14).

(a) The broadsides of big size ships to be handled at the dolphin has a curve of some 1/8 of ship's length at the stem and stern ordinarily, with 3/4 length of central section being straight. Dolphin should be arranged in such a way that berthing may be made within this straight line section.

(b) The numbers of main dolphin are set to be one unit for fore and behind respectively, but in the case of dolphines handling the super size type ship, the so-called super tanker or mammoth tanker, there are some cases in which the equipment of 2 units to the front and the rear respectively is more advantageous (Refer to Fig. 2·2·14).

(c) In the case of dolphines requiring special cargo handling devices such as oil dolphine, it is desirable to plan to equip, in addition, one unit of dolphin for operation of cargo handling machinery in the center, or to arrange a little to land side from the main dolphin, so that the ship's impact force does not work directly. (Refer to Fig. 2·2·14).

Fig. 2·2·14 Relation of Main Dolphin Interval and Depth of Water



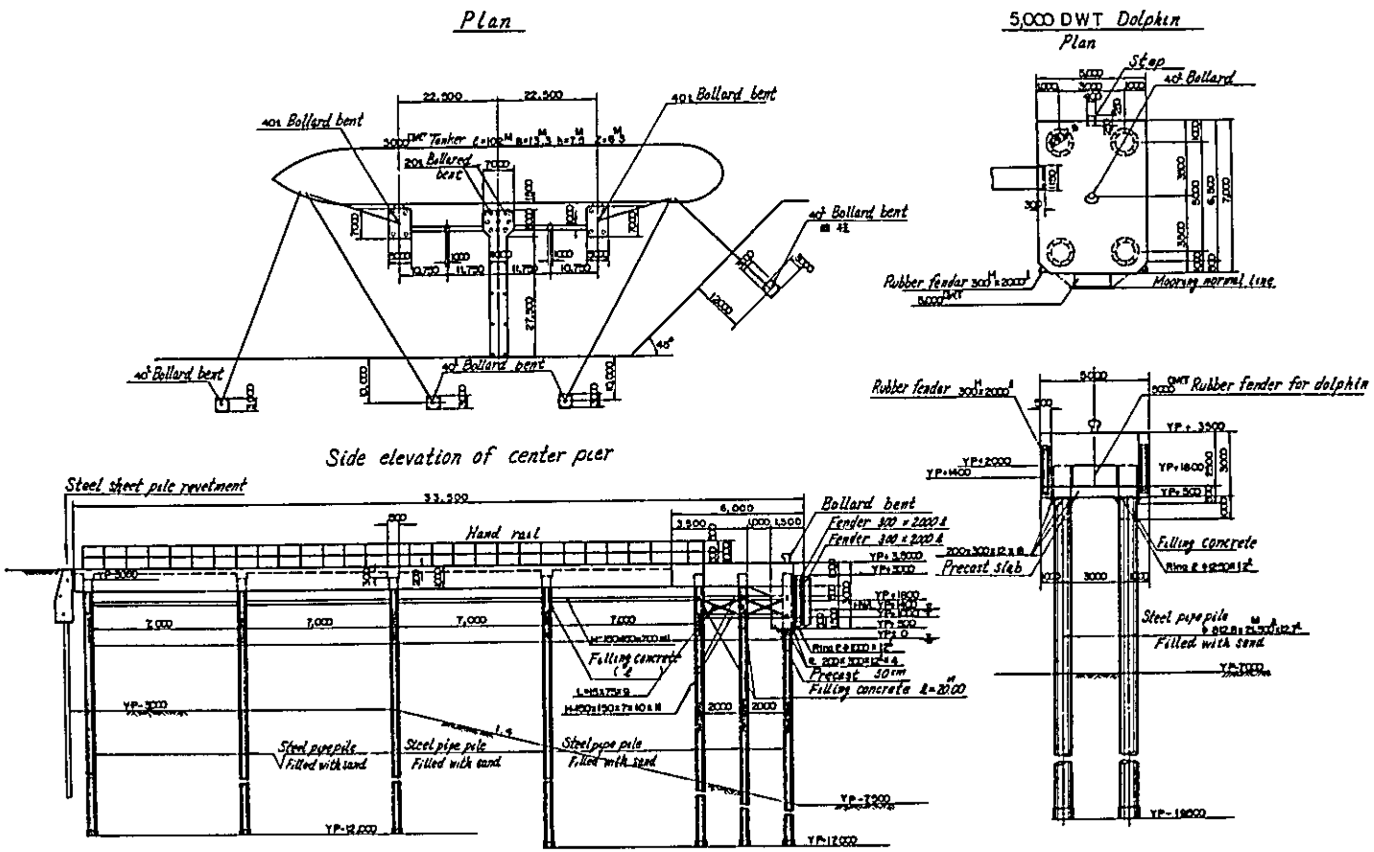
(3) Height of crown

The height of crown of fuel unloading facilities is decided taking the tidal range, oil-landing system, load draft of ship and ground level of premise into consideration. The crown height for average mooring wharf takes the value in Table 2·2·7 above H.W.L., in the "Design standard of port & harbour structures".

Table 2·2·7 Crown Height of Mooring Wharf Above H.W.L.

Kinds	Tidal range of 3.0m or more	Tidal range of less than 3.0m
Large-size mooring wharf	0.5m - 1.5m	1.0m - 2.0m
Small size mooring wharf	0.3m - 1.0m	1.0m - 1.5m

Fig. 2·2·15 Design Example of Unloading Berth



2-2-6 Sea wall

(1) General

In the design of sea wall such conditions shall be taken into consideration as those for nature, utility, construction and economic character.

(2) Type of structure

As the type of sea wall structure, there are generally those which are shown in Fig. 2·2·16.

(3) Crown height

The crown height of sea wall shall be decided considering the design tidal level, settlement of sea wall wave character and utility conditions behind the sea wall, as a rule.

(4) Design

The design of sea wall shall be carried out for the under-mentioned items in conformity with the shape and construction of sea wall.

The following are matters to be especially attended to in the design of sea wall.

a. To cause the load of structure to be distributed uniformly over the entire base ground;

b. Where no wave over topping is allowed, study shall be made on the dumping of wave-quenching blocks and/or establishment of wave repellant works.

c. Where wave over topping is allowed, scouring prevention work at back of sea wall shall be undertaken and drain disposal facilities shall be provided.

d. Measures shall be taken so that no backfilling soil and sand may not be absorbed through the gaps in the joint of mound cobble and blocks, etc.

e. The structure shall be in such form as will make maintenance and repair as easy as possible in conformity with the conditions of the field.

2-2-7 Breakwater

(1) Performances of a breakwater

A breakwater serves to secure necessary calmness for cargo handling, anchoring of ships, taking in or discharging of water for condenser, etc., and at the same time, to protect the hinterland as well as port & harbour facilities from waves, high tide and tsunami, etc.

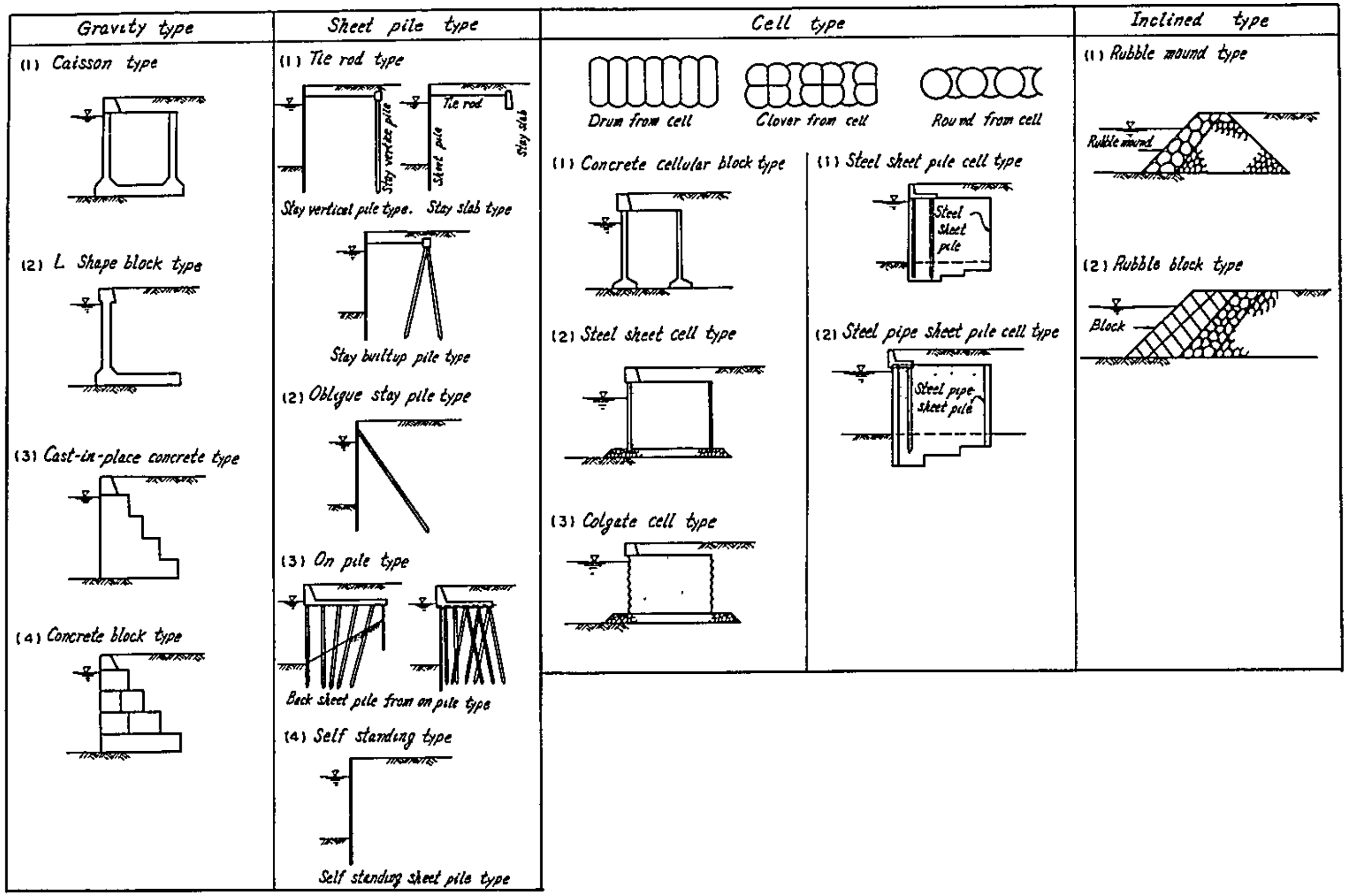
(2) Arrangement of breakwaters

The arrangement of breakwaters shall roughly be determined upon consideration of the

Table 2·2·8

Matters for study	Tidal level	To exterior		
		Normal time	When there are waves	At time of earthquake
Sliding out to seaside Stumbling to seaside sustaining force	Low water level design high water level	Weight of wall body residual water pressure earth pressure surcharge bouyancy	To normal load up light pressure, water pressure to shore in wave trough is added	To normal load seismic force working upon wall body is added, and load in earth- quake is taken as earth pressure
Sliding to land side	design high water level		Weight of wall body buoyancy residual water pressure uplift pressure resistant earth pressure wave pressure	
Circular are sliding	Low water level	Surcharge earth weight ground water pressure		Surcharge earth weight ground water pressure seismic force
Penetration of pile	Low water level	Surcharge earth pressure residual water pres- sure		Surcharge seismic earth pressure residual water pressure

Fig. 2・2・16 General Types or Seawall Construction



following items, and jointly with the estimation of calmness in the port by calculation, shelter experiment shall be made when necessary and ultimate decision shall be made thereon.

a. Calmness in berth necessary for cargo handling

The calmness of berth necessary for cargo handling is generally taken as 0.5m - 1.0m or thereabout of wave height, but since they are different according to the kind of cargo to be handled, the arrangement of breakwaters shall be considered on the basis of necessary availability factor and appearance ratio of wave height.

b. Calmness necessary for taking in and discharging of cooling water for condenser. Since the level fluctuation limiting the operation of pump taking in the water for cooling purpose is ± 10 - 20% or thereabout of pump design lift, where pump chamber is to be located in a position affected by waves, the breakwaters shall be arranged in such a way that calmness may be obtained for undisturbed operation of pump.

c. Harbour Entrance

(a) Harbour entrance shall be located avoiding the wave direction of the most frequent and strongest so that invading wave may be less.

(b) The location of harbour entrance shall have such depth of water as to secure the least flowing littoral drifts. (For this purpose, the bottom fluctuation and suspended load should be less. To be located where deeper than the surf zone which occurs relatively frequently, etc.,)

(c) The tidal velocity near the harbour entrance shall be caused to be less as possible, and be in such a way that no ship shall be subjeacted to strong lateral tidal current (2 knots or so, or more).

(d) The width of harbour entrance shall be the same as the width of navigation channel.

d. Area in the port

A port shall have an area which may secure the facilities for berthing, cargo handling, anchoring, navigation and taking in the condenser cooling water, etc.

The navigation channel length necessary for berthing the ship (distance from harbour entrance to mooring wharf) shall be the distance of 4 times the ship's length plus the ship's length, as the stopping distance (ship s stop distance) or more.

In addition, it is desirable that the curbed part of a navigation channel shall not exceed 30^{o} in its maximum angle of intersection; when exceeding 30^{o}, it is desirable that radius of curvature contacting the center line of navigation channel draws the circular are of 4 times or more of ship's length, and that, to corner cut around this circular are so that necessary width may be secured.

e. Other items

(a) That the normal line of breakwater shall shelter the port effectivaely against the most frequent and strongest waves;

(b) To arrange in such a way that the effect as the result of concentration of reflection waves and attendant waves by the breakwater be made the least towards navigation channel and berth;

(c) To avoid to take the form to cause concentration of waves;

(d) To avoid the location where the ground is especially unfavorable, and select a location enabling easy execution as possible;

(e) To make utmost use of topography which may be utilized, such as promontory and island;

(f) When there is no near available port and harbours, it should be so made as is available for basin, etc., of workships for execution of breakwater;

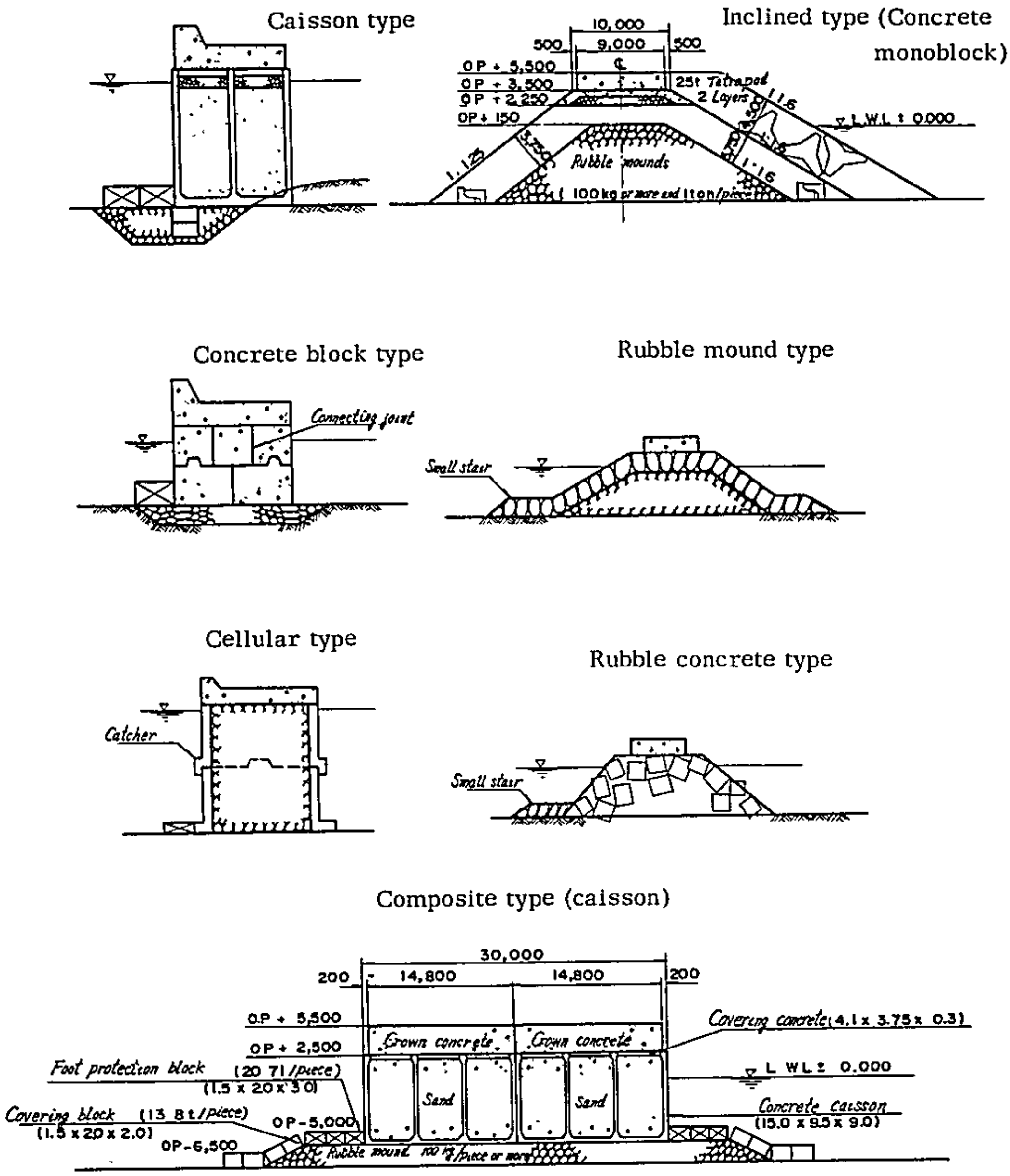
(g) When it is necessary to execute such port facilities as sea wall and unloading wharf before the completion of breakwater, effective sheltering shall be available thereby.

(3) Construction forms of breakwater

Breakwaters are classified generally as follows according to construction forms. (Refer to Fig. 2·2·17).

- Breakwater
  - Upright type
    - Caisson type
    - Block type
    - Cellular block type
    - Concrete monoblock type
  - Inclined type
    - Rubble mound type
    - Rubble concrete type
  - Composite type
    - Caisson type
    - Block type
    - Cellular block type
    - Concrete monoblock type
  - Special breakwater

Fig. 2・2・17 Construction of Breakwater



a. Characteristics of upright breakwater

Upright type is of construction erecting the front vertical wall body on sea bottom, and is chiefly used for reflecting the wave's energy.

It has the following advantages:

(a) Material used is relatively small in quantity;

(b) Requires less maintenance and repair cost;

(c) Dispenses with the widening of harbour entrance to secure effective harbour entrance width;

(d) There is no wave or littoral drift permeating breakwater.

(e) Inside of breakwater may be utilized as mooring facility.

Its disadvantages are as follows:

(a) Bottom reaction force gets greater, and since scouring by waves is likely to occur, unsuitable unless the ground is solid;

(b) The reflective waves are big, and convergence of waves may be caused by the face line of breakwater.

(c) When stormy weather days last long, the erection of breakwater will be restricted, making the construction period longer.

b. Structural characteristics of upright type

(a) Caisson type

Caisson type is a type in which caisson is used as the main body. Generally speaking, it has strong resistance to wave force as the whole breakwater is an integral body, and because the making of main body may be available in dry work, the execution is secure and number of maritime working days may be reduced. Besides, construction expenses may be saved by using less expensive filling materials. It has the advantage of being able to relocate the caisson by using sand as the filling material, in case there is any plan of relocation in future. However, it requires considerable working expenses in facility equipment for caisson production facilities or large type floating crane, and the launching, conveyance and erection, etc., of caisson is controlled by water depth. Besides, where stormy weather days prevail, the days for execution is controlled considerably. It sometimes happens that, unless filling and/or cover concrete is executed in a short period after erection of caisson the caisson may be damaged by waves. In addition, because various work kinds such as cutting and levelling of rock bed, rubble mounds, bagged concrete, erection of body proper, filling and upper work are included, the control of execution of work is complicated.

(b) Block type

In block type, concrete block is piled up to form body proper. On the average, it has the advantage in that the execution is secure and easy, and the execution facilities are simple. However, the union between each block is not sufficient, and lacks integrality as compared with caisson. It has the disadvantages in that the maritime working period is generally longer, requires large space for manufacture when great number of blocks are used. Further, as a questionable point, the distribution of ground reaction force is not known when the downmost stage is not integral.

(c) Cellular block type

In this type, stone or concrete is filled in cellular block to form the body proper. Generally speaking, the bottom friction is great as compared with caisson type, and has big stability against sliding. Besides, though it has the merit of saving work expenses by using less expensive filling materials, it has demerit of lacking integrality. Further, as a debatable point, the calculation method in the case no bottom slab is used, is not established yet.

(d) Concrete monoblock type

In this type, breakwater consists of integral concrete, allowing solid structure. It has the advantage of requiring no horizontal ground necessarily, and may be executed in the field, which dispenses with complicated execution facilities. However, this may not be resorted to except in especially solid ground.
It is important to confirm rock property, of which negligence has often caused a number of disasters.
Further, special attention shall be paid because concrete execution in the water is apt to be other than perfect. It has defects that the materials of breakwater may not be reused when relocation is required in future. These types are not adopted for big breakwater, and is used for those in shallow water or of comparatively small scale.

c. Characteristics of sloped breakwater

Sloped type consists in the pilling up stones and concrete blocks into trapezoid shape, serving chiefly to disperse the wave energy on a slope.
It has the following advantages.

(a) May be executed regardless of unevenness of ground;

(b) May be applicable to weak gound;

(c) Has relative adaptability to scouring due to waves;

(d) Execution facilities are simple, and may be executed without being affected by waves as in the case of upright type; work stage is simple, and execution control is less difficult;

(e) Maintenance and repair is easy;

(f) Because of less reflective waves, does not disturb the near sea surface;

The demerits are as follows:-

(a) When water is deep, great amount of material and labour will be required;

(b) Cost of maintenance and repair is high;

(c) Harbour entrance width will be wider in order to secure effective port mouth width, and the inside of port is apt to be disturbed by waves permeating breakwater.

(d) Burying inside of port is apt to be caused where there is effect of littoral drifts;

(e) The inside of breakwater may not be used for mooring facilities;

(f) Warm drain water will permeate.

As the debatable point, there is the relation of damage ratio of rubble mounds and rubble block, and continuous time of waves, on which future study is required.

d. Structure and property of inclined type

(a) Rubble mound type

Since the size of rubble mound is limited, this type is used where wave energy is weak, and where wave energy is strong, the face of slope has to be covered with block.

(b) Rubble block type

Necessary stability may be obtained through the use of heavy deformed square blocks as blocks. Spacious lot for block manufacture is necessary.

e. Property of composite breakwater

Composite breakwater consists of upright wall erected upon rubble mound portion, and when the rubble mound crown is shallow as compared with wave height, it has the performance of inclined type , and when deep, its performance resembles that of upright type.

It has the following advantages:

(a) It is suitable for location with great depth of water, and also for relatively weak ground;

(b) The ratio of height of rubble mound and of upright portion will be decided by comparing the easy availability and price of stone and concrete materials, and may construct economic section;

The demerits are as follows:

(a) Wave energy is apt to concentrate near the boundary of upright section and rubble mound section, and tends to generate scouring;

(b) The execution system and execution facilities are numerous;

In selecting these breakwaters, decision will be made after comparison and study on the conditions of arrangement, natural conditions, utility conditions execution conditions, work expenses, work term, importance, easy availability of materials as well as difficulty or not of maintenance and repair.

(4) General section

a. Upright type

(a) Crown height shall be of the following value as the standard.

1) In ports & harbours with access of big ships, where the area inside breakwater is spacious, and may allow a certain wave over topping;

a) In ports & harbours where no consideration for high tide is necessary, crown height shall be 0.6H above mean monthly highest water level.

b) In ports & harbours with considerable high tide, decision shall be made in the same way as a), taking the mean monthly highest water level added with proper deviation based on past records as design tidal level.

ii) Where conspicuous wave over topping is desired to be prevented;

Where the area inside breakwater is desired to use as mooring purpose, and where wave over topping is desired to be prevented due to smallness of ships anchoring in the basin inside the breakwater, and the area inside breakwater is narrow, the value of 1.25H above the mean monthly highest water level (in waters where considerable high tide is estimated, tidal level modified with proper deviation shall be taken).

(b) The thickness of upper work shall be 1m or more when wave height is 2m or more. Even when wave height is 2m or less, the minimum thickness shall be 50cm or more.

(c) It is better to have the height of uppermost stair block of block type, upper part of cellular block and caisson, is above water level on the average, and if possible, above H.W.L. at the least, to make the execution of upper work easier.

(d) The crown width shall be temporarily fixed on consideration of execution system and be decided by making stability calculation.

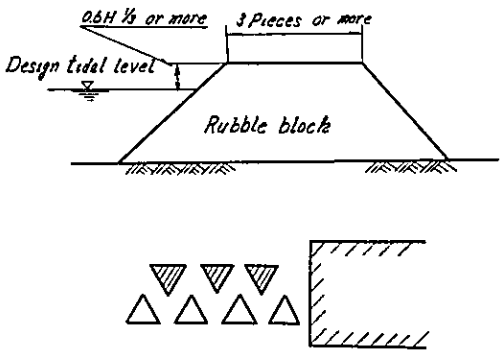
b. Inclined type

(a) The crown height shall be, as the case of upright type, 0.6H 1/3 or more.

(b) The crown width shall be, as shown in Fig. 2·2·18 of 3 pieces of deformed block or more arranged in a row.

Provided, when placing deformed block in front of upright type, crown width shall be 2 deformed blocks or more arranged in a row.

Fig.·2·2·18 Crown Width of Inclined Levee



(c) In addition, decision will be made taking account of the crown width, working of execution machines in case of placement execution of breakwater from land side.

(d) Face of slope is decided considering the stability calculation of breakwater and stability of materials used.

In the examples of rubble mound type, 1:2 or thereabouts on sea side, 1"1.5 or thereabouts on port inner side is more often the case.

C. Composite breakwater

(a) Crown height of upright part is similar to that of upright type, but when sinking is feared due to weak ground, it is advisable that crown height be raised by adding the margin height in advance, or to make such structure as is easy of raising.

(b) It is better to make the crown height of rubble mound part as deep as possible. In addition, the depth must be such that the upright part, if it is a caisson, may allow erection.

(c) The thickness of rubble mound part must be 1.5m or more at the minimum.

(d) The shoulder of rubble mound part shall be of sufficient breadth in conformity with wave height on outside of port. Where waves are rough, it is desirable that the breadth is 5m or more in the minimu. Besides, in the inside of port, 2/3 of outside port value may suffice.

(e) The thickness of upper work and crown height of breakwater except upper work shall be similar to those upright type.

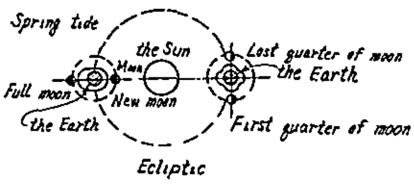
2-2-8 Explanation of terms

(1) Mean monthly-highest waterlevel

Mean monthly-lowest waterlevel

These are the terms customarily used in Japan, the mean monthly-highest waterlevel referring to the mean waterlevel of highest high waterlevel in each month appearing within 5 days of new moon and full moon, and mean monthly-lowest waterlevel, to the mean waterlevel of the lowest low waterlevel in each month appearing within 5 days from the new moon and full moon. As the abbreviation for these, H.W.L. and L.W.L. are respectively used.

Fig. 2·2·19 Relation of Celestial Body and Tides



(2) Spring tide

The tide with the greatest tidal range occurring after 2 or 3 days of new moon or full moon.

(3) Mean higher high water springs

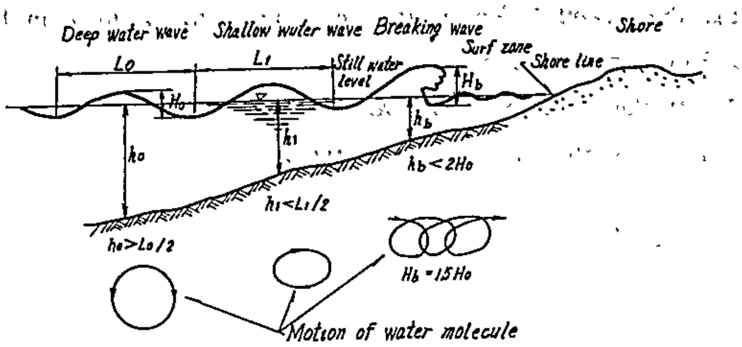
Mean lower low water springs

These refer to the mean level of water of level of all high water (low water) in spring tide for long years, for which the abbreviation of M.H.W.S. (M.L.W.S.) are used.

(4) Deep water wave (off sea waves)

This refers to wave occurring on deep sea level of $h \geqq L/2$ as shown in Figure 2·2·20, with propagation velocity of wave forms being $w = \sqrt{g. L/2\pi}$, and is not concerned with the depth of water shown. Where, g: acceleration of gravity, L: wave length.

Fig. 2·2·20



(5) Shallow water wave

This refers to waves occurring on the surface of shallow water depth of $\frac{Lo}{2} \geqq (1/20 - 1/25)L$ as shown in Fig. 2·2·20, with propagating velocity being represented by $w = \sqrt{(gL/2\pi)\tanh(2\pi h/L)}$, of which w changes through L and h.

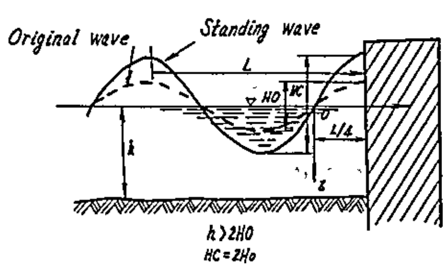
(6) Breaking wave

Deep sea waves, as they approach shallow seashore, are affected by friction with sea bottom, and the track of water molecule takes the form of flat ellipse. The track thereof skids little by little to the shore by each cycle conveying water amount. Simultaneously, the wave height increases, with wave length and wave velocity decreasing. When the velocity of water molecule near the surface of water becomes nearly equal to the velocity of waves, the wave form collapses, and the water near the surface of water jumps to the front. This phenomenon is referred to as breaking wave.

(7) Standing wave

In general cases, when the depth of water in front of upright standing wall attains twice or more of wave height, the waves do not break up, and, as shown in Fig. 2·2·21, the wave form of original wave and the reflected waves from wall surface overlap the wave height reaching 2Ho. This phenomenon is called standing wave.

Fig. 2·2·21 Standing Wave



(8) Significant wave

Significant wave refers to the value when out of about 100 succeeding waves (in many cases, corresponding to continuous waves for 10 - 20 minutes), 1/3 of entire wave units counting from those with greater wave height is selected, and the average (of wave height and cycle) is obtained. For significant wave, the mark of H 1/3 is generally used.

Usually, when mention is made to design wave, it refers to the above-mentioned significant wave.

(9) Gross tonnage

This refers to the gross capacity of inside of a ship represented by the unit of one ton of 1,000/352m^3 (1000 cubic feet)

(10) Net tonnage

This is the gross tonnage from which the section of quarters for direct nevigation of ship such as engineroom, crew's quarter and ballast tank.

(11) Displacement tonnage

This refers to total weight (including loads) of a ship at a certain load draft. The weight in the state of load draft in sea water with specific gravity of 1.03 is referred to as full load displacement.

(12) Dead weight tonnage

This refers to full load displacement from which the light load (sum of hull section weight and engine section weight) is deducted. Therefore, it denotes the weight of cargo, fuel, water, oil and other loads which may be loadable on the ship.

(13) Face line of the wharf

In port & harbour references, the axial line in the extension direction of structures is customarily called the face line of the wharf. In the case of reclaimed sea wall the extension of point where mean monthly highest waterlevel and sea wall, meets is called face line of revetment or reclamation face line.

(14) Gin pole-crane

This is the crane lifting heavy cargo with one stanchion.

This is employed for cargo landing of heavy machinery on lighter's wharf of heat and atomic energy power plants. Refer to Fig. 2·2·10.

(15) Stiff leg derrick crane

This is the crane which is supported with fixed leg, and through suspending oblique member turnable horizontally from the tip of pole, hoists or lowers cargo by means of pulley attached to the tip of oblique member. Refer to Fig. 2·2·11.

(16) Guy derrick crane

This is a kind of derrick. Its vertical pole extends

Fig. 2·2·22 Face Line of the Wharf

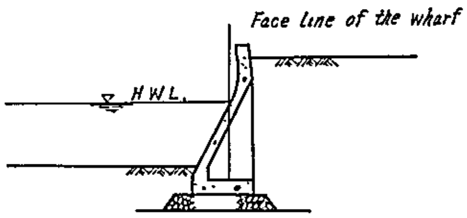
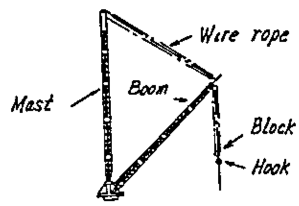


Fig. 2·2·23 Guy Derrick Crane



2-3 Condenser Cooling Water channel

2-3-1 Basic Conditions

(1) Layout

a. Layout of water channel in relation to power plant's main building

The layout of the cooling water channel is usually determined by the location of a power plant's main building and the location of the intake and the outlet which depend on the conditions of the sea basin. Some typical layouts are shown in Fig. 2·3·1 and Fig. 2·3·2.

Fig. 2·3·1 Layouts of Cooling Water channel

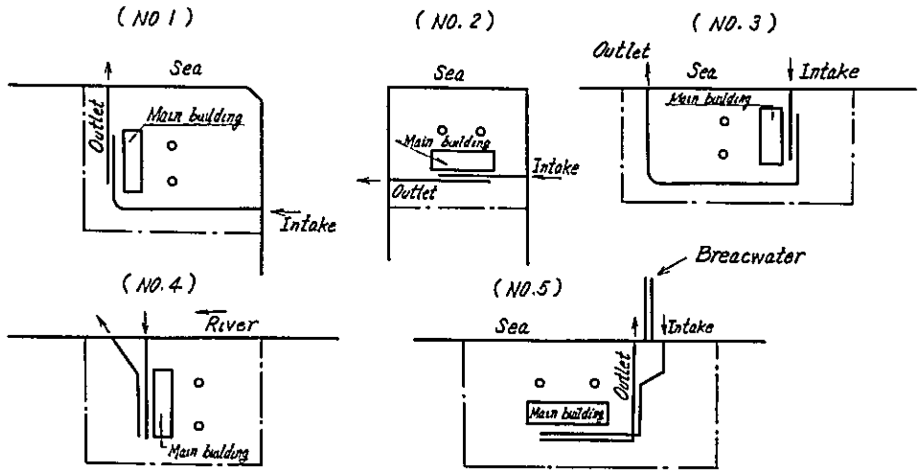
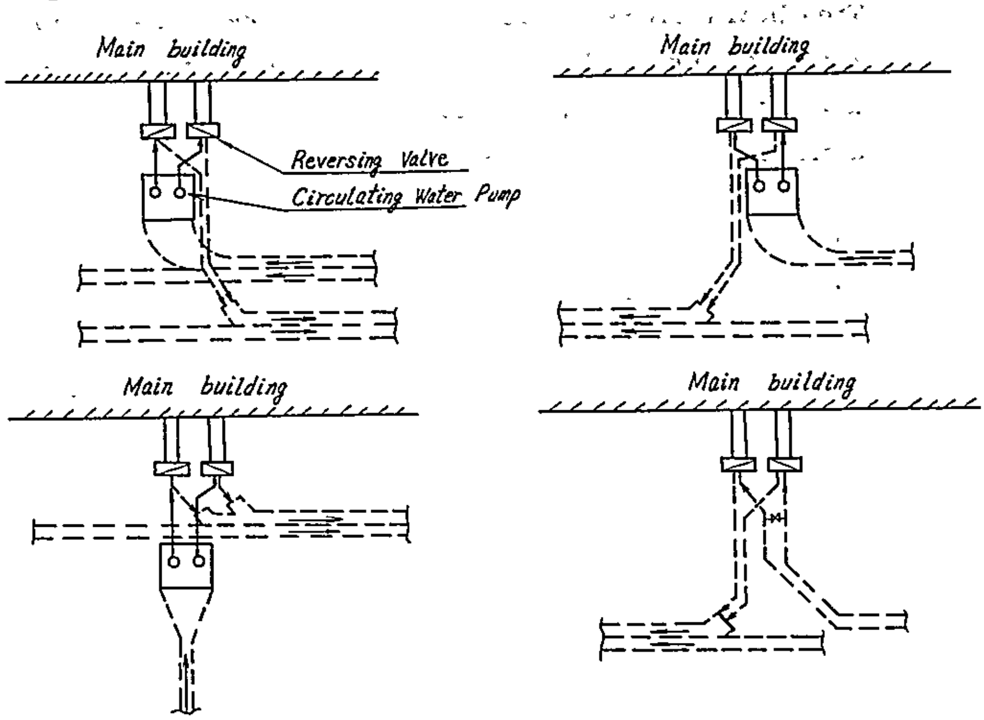


Fig. 2·3·2 Layout of Cooling Water in Front of Main Building



b. Type of cooling water channels

Cooling water channels can be classified into natural flow type and pump pressure feed type. A selection between the two is made on the basis of the relation between the water level of the water source and the level of the turbine room, the distance between them, the site conditions of a power plant as well as economic considerations. Fig. 2·3·3. shows the systematic drawings of these water channels.

Fig. 2·3·3 Type of Cooling Water channels

Natural flow type Water channel

[Intake] → [Screen House] → [Box Culvert] → [Pump] → [Pipeline] → [Condenser] →
→ [Pipeline] → [Box Culvert or Open Channel] → [Outlet]

[Intake] → [Open Channel or Box Culvert] → [Screeen house] → [Box Culvert] →
→ [Pump station] → [pipeline] → [Condenser] → [Pipeline] → [Box Culvert or Open Channel]
→ [Outlet]

Pumping type water channel

[Intake] → [Screen house and pump station] → [pipeline] → [Condenser] → [Pipeline] →
→ [Open Channel or Box Culvert] → [Outlet]

[Intake] → [Box Culvert or Open Channel] → [Screen house and Pump station] →
→ [Pipeline] → [Condenser] → [Open Channel or Box Culvert] → [Outlet]

c. Location of intake and outlet

The following factors must be thoroughly investigated in drawing plans for inlet and outlet facilities. The factors to be studied include waves, tidal flow, coastal flow, littoral drift sand, suspended sand, water quality, water temperature distribution and dispersion of warm discharge water.

The allowable shortest distance on water surface between an intake and an outlet without possible recirculation of intake water and discharged water can be roughly obtained by Equation 2. 3. 1.

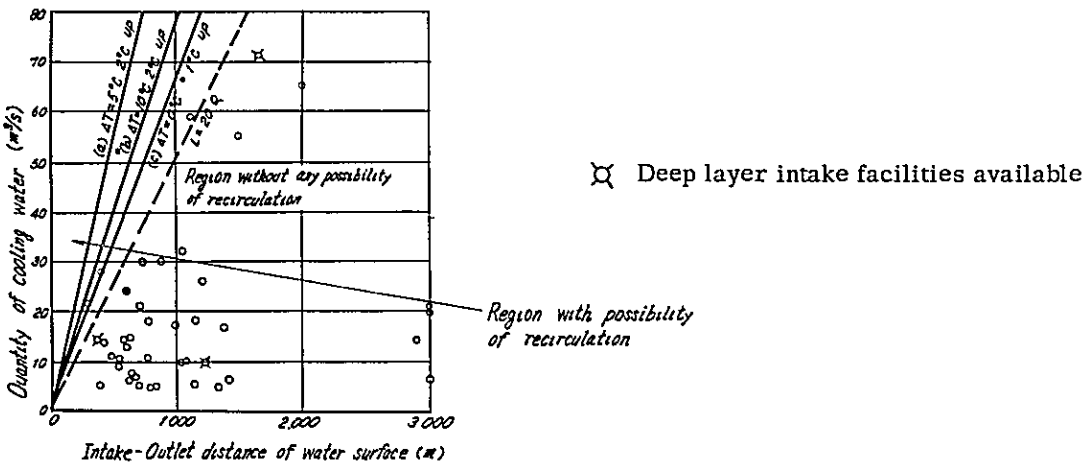
$$L = 20Q \quad \text{---} \quad (2\cdot 3\cdot 1)$$

L : Shortest distance on water surface between intake and outlet (m)

Q : Flow rate of cooling water (m^3/sec)

Fig. 2•3•4 shows the relation between intake-outlet distance on water surface and rate of cooling water at existing thermal power stations in Japan.

Fig. 2・3・4 Relation Between Intake-outlet Distance and Quantity of Cooling Water

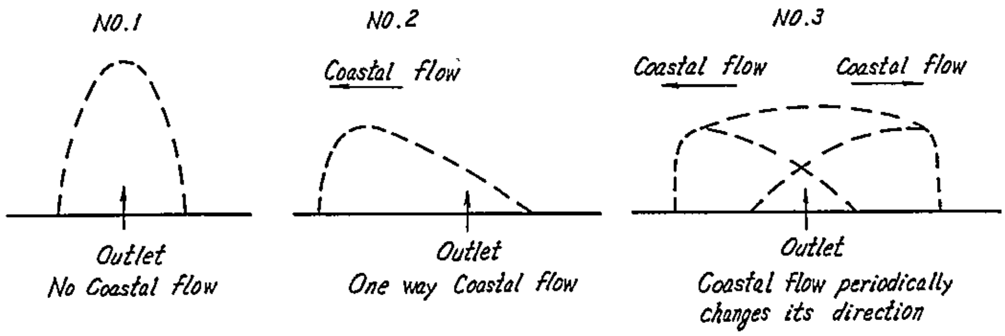


(Remark) Fig. 2•3•4 shows the results of the investigations at 44 thermal power stations conducted by Central Electric Power Research Institute

With Equation 2. 3. 1, the shortest allowable intake-outlet distance on water surface under average maritime meterorological conditions is obtained. The distance can be further shortened if water is to be discharged into open sea or if deep layer intake facilities are to be installed. On the other hand, the distance obtained with the equation is sometimes insufficient under worse marine conditions, especially when worse water basin shapes or unfavorable tidal flows promote recirculation.

Fig. 2·3·5 shows normal dispersion patterns of warm discharged water in relation to coastal flow. (It is assumed that warm water is discharged into open sea)

Fig. 2·3·5 Effect of Coastal Flow on Warm Discharged Water



(2) Quantity of cooling water

The required quantity of cooling water depends on the size of generating equipments, planned steam conditions, and cooling water temperature. Equation (2·3·2) shows the relation between quantity of cooling water and condensation temperature.

$$Q = \frac{W(Xi + t_1 - t2)}{T_2 - T_1} \quad \text{------------------------------} \quad (2\cdot 3\cdot 2)$$

Q : Quantity of cooling water (kg/hour)

W : Turbine exhaust (kg/hour)

i : Latent heat of exhaust in relation to condenser's degree of vacuum (Kcal/kg)

X : Dryness of exhaust

t_1 : Temperature of exhaust (^oC)

t_2 : Temperature of condensate water in relation to condenser's degree of vacuum (^oC)

T_1, T_2 : Temperature of cooling water at condenser inlet and outlet (^oC)

Fig. 2.3.6 and Table 2·3·1 show the data on quantity of cooling water at Tokyo Electric Power Co. 's thermal and atomic power plants.

At thermal and atomic power plants, sea water is used mostly for cooling condenser and cooling water for bearings. The quantity for bearing water cooling is approximately 0.33m^3/sec for 350MW, 0.75 m^3/sec for 600MW, 1.5 m^3/sec for 1.000MW at thermal power plants and 1.05^3/sec for 460MW, 1.91m^3/sec for 78MW at atomic power plants.

Fig. 2・3・6 Data of Quantity of Cooling Water

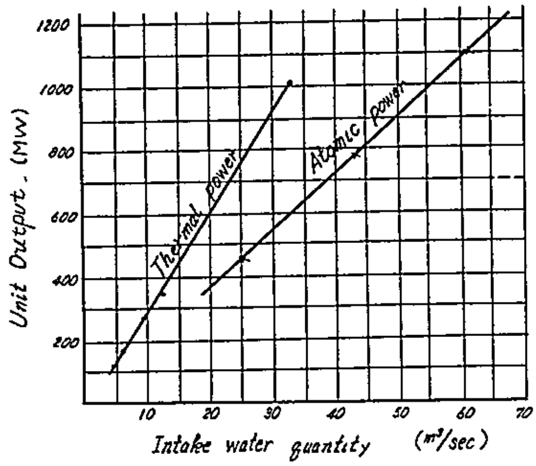


Table 2・3・1 Data Flow Rate of Cooling Water
(Tokyo Power Co.)

Thermal power

Output MW	Intake water quantity m^3/sec
125	4.7
175	6.5
275	9.5
350	12.5
600	19.5
1000	32.5

Atomic power

Output MW	Intake water quantity m^3/sec
460	25.5
784	43.4
1100	61.0

2-3-2 Intake

(1) Structural types

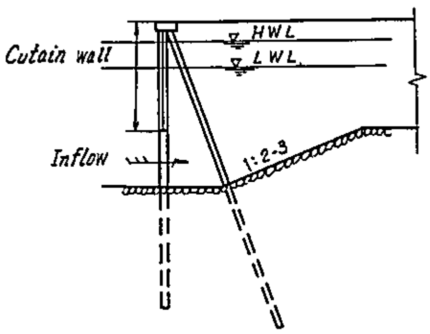
A structure of an intake should be determined by considering waves, littoral drift sand, suspended sand, water temperature, water quality, etc. It is important to draw clean cooling water stably and economically at lowest possible temperature. Fig. 2・3・7 ~2・3・11 show typical structural types of intake Fig. 2・3・12 ~2・3・15 show some designs of intake.

(a) (Curtain wall type)

Applicable conditions

- o The effect of waves is relatively small.
- o Front water depth is sufficiently large.
- o The quantity of intake water is relatively large.
- o Deep intake

Fig. 2·3·7

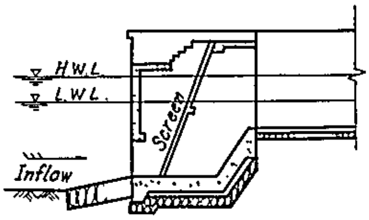


(b) (Curtain wall type)

Applicable conditions

- o The effect of waves is small.
- o Front water depth is relatively small
- o The quantity of intake water is relatively small.

Fig. 2·3·8

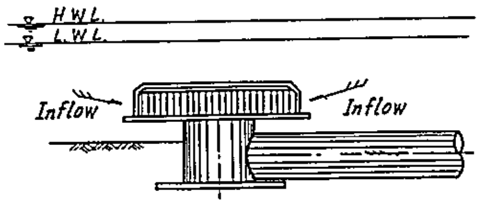


(c) (Submarine intake pipe)

Applicable conditions

- o The effect of waves is relatively large.
- o The sea is shallow.
- o Deep intake
- o The quantity of intake water is relatively small.

Fig. 2·3·9



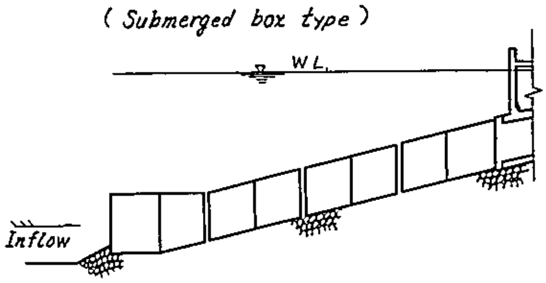
(d) (Sumberged box type)

Applicable conditions

- o The effect of waves is relatively small.
- o Front water depth is relatively small.
- o Deep intake

Fig. 2·3·10

(Submerged box type)



(e) Submarine intake tunnel type)

Applicable conditions

- o The effect of waves is large.
- o The sea is shallow.
- o Deep intake
- o Good geological conditions

Fig. 2·3·11

(Submarine intake tunnel type)

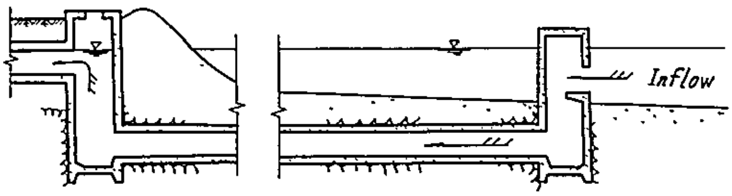


Fig. 2・3・12　Standard Cross Section of Curtain Wall

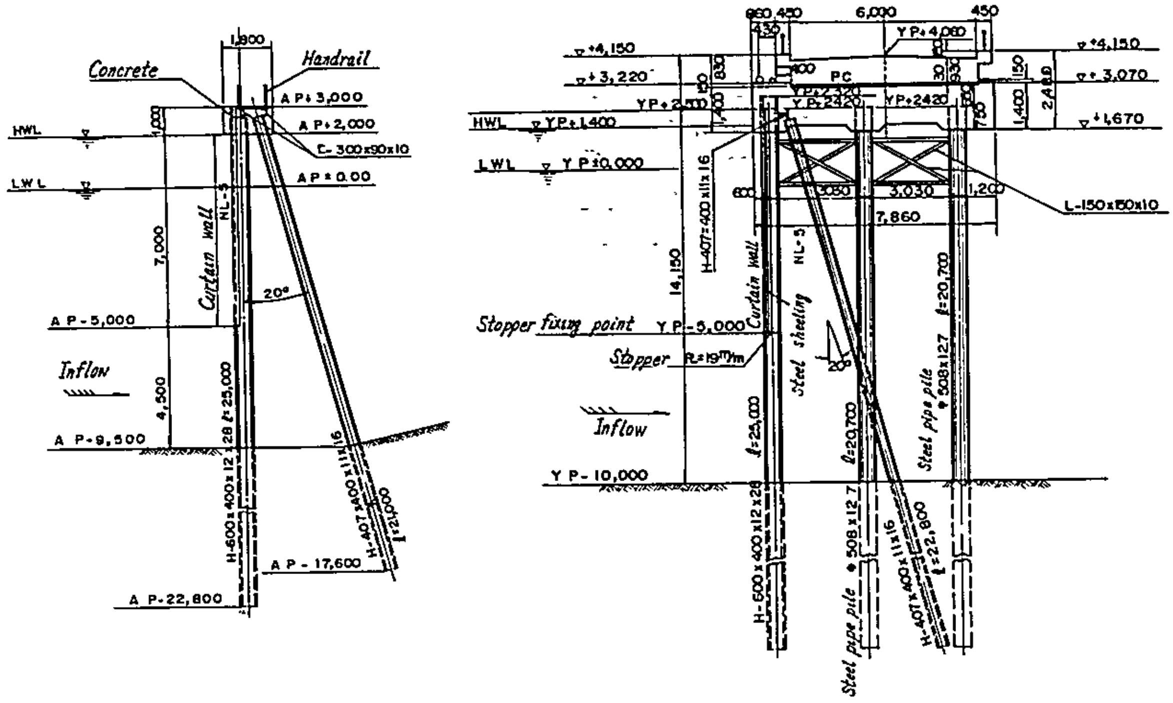


Fig. 2・3・13　Standard Cross Section of Intake

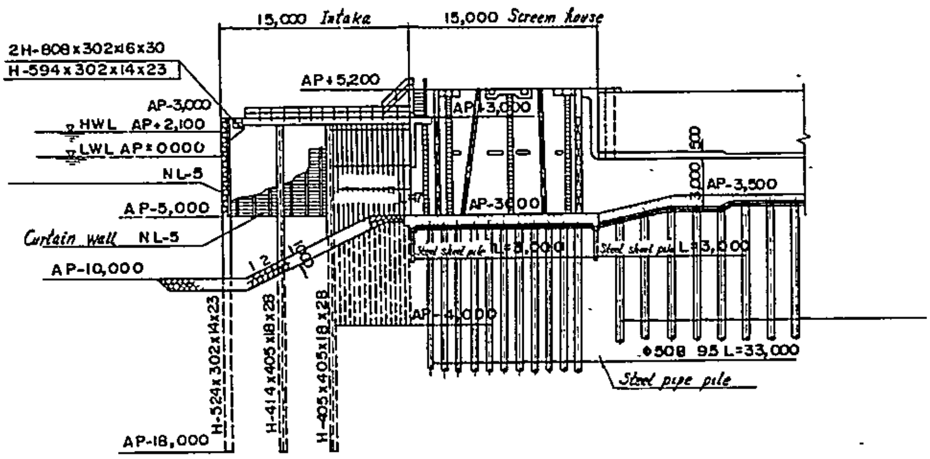


Fig. 2·3·14 Standard Cross Section of Pipe Intake (No. 1)

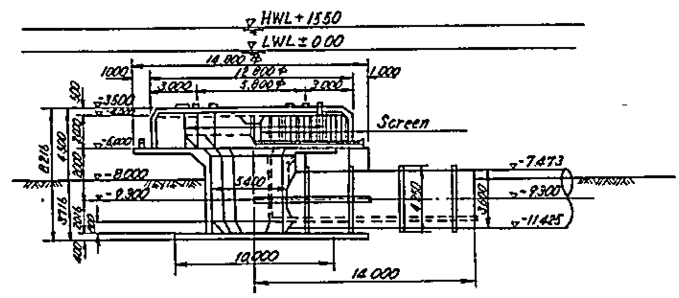
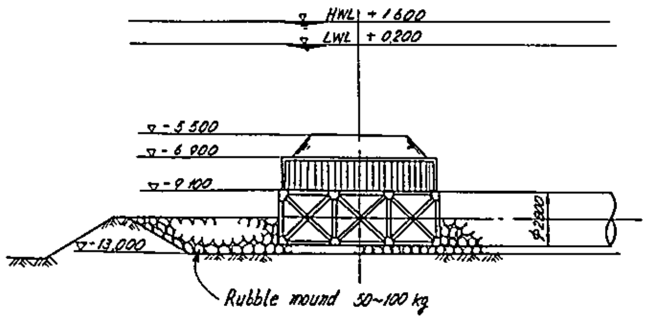


Fig. 2·3·15 Standard Cross Section of Pipe Intake (No. 2)



(2) Design conditions

a. Temperature and flow rate of intake water

The intake for condenser cooling water must be so designed as to draw cool water of which hourly, daily and seasonal temperature variation is small.

Generally, the vertical temperature distribution in sea basin in summer is as shown in Fig. 2·3·16. A boundary layer (discontinuity layer) between the upper layer warm water and lower layer cool water is formed. To draw cooling water economically at low temperature under such conditions, the best intake depth and the best flow rate must be determined to draw as much lower layer cool water as possible and to minimize the mixture of upper layer warm water.

Table 2·3·2 shows the design temperature, the maximum temperature and the minimum temperature of cooling water by region.

Fig. 2·3·16 Example of Vertical Temperature Distribution in Summer

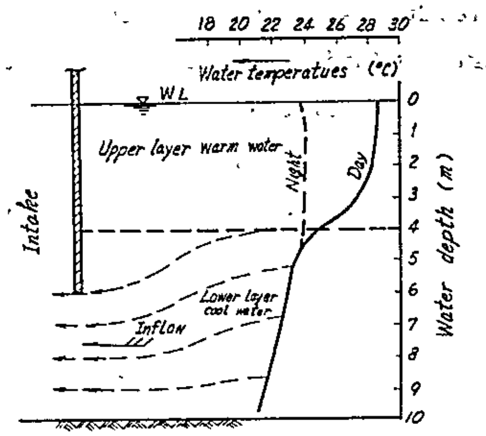


Table 2·3·2 Design Intake Temperature, Maximum Temperature and Minimum Temperature of Condenser Cooling Water

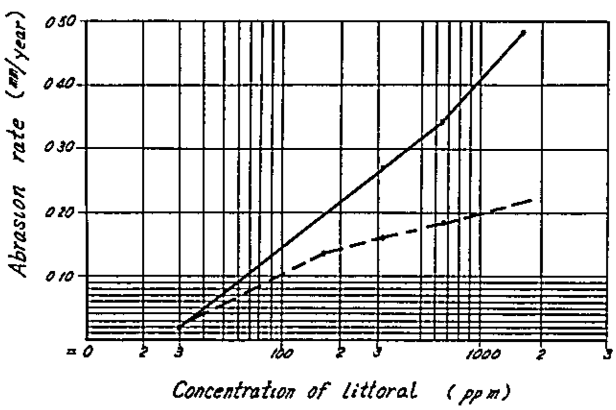
Region	Design intake temperature	Maximum intake temperature	Minimum intake temperature
Hokkaido (rivers)	15°C	24 ～ 28°C	0 ～0.5°C
Tohoku (Japan Sea side)	14°C	27°C	2°C
Tohoku (Pacific Ocean coast)	18°C	25 ～ 27°C	5°C
Kanto (Tokyo Bay), Chubu, Kansai (Pacific Ocean coast)	21°C	27 ～ 29.5°C	7 ～10°C
Kansai (Osaka Bay)	24°C	30°C ～25°C	8 ～ 10°C
Chugoku (Sea of Seto) Shikoku	21°C	28 ～ 30°C	6 ～ 9°C
Kyushu	22 - 24°C	29.5 ～32°C	5 ～8.5°C

b. Littoral drift sand

When an intake is installed at a sandy beach facing open sea especially, the inflow concentration of drift sand at high waves and its grain diameter must be studied to make sure that it gives no effect on the condenser cooling equipments of the power plant.

According to the results of an experiment conducted by Chubu Electric Power Co. and Sumitomo Light Metal Industries, the abrasion rate of a condenser pipe attributable to littoral drift sand containedin cooling water is as shown in Fig. 2·3·17

Fig. 2·3·17 Relation Between Concentration of Littoral Drift Sand Contained in Cooling Water and Abrasion Rate of Condenser Tube



(Remark) Fig. 2·3·17 shows the result of the albrac condenser pipe erosion test conducted jointly by Sumitomo Light Metal Industries and Chubu Electric Power Co.

Experiment June, 1969 - August, 1969

__________ Entrance of condenser pipe

---------- Flat part of condenser pipe

The dimensions of a condenser pipe is usually 16 - 25mm in outer diameter and 1.0 - 1.2mm in thickness.

c. Wave pressure

It is most desirable to investigate the wave pressure required for designing an intake structure by means of fieldwave observation or by simulation experiments. When such data cannot be obtained, a value obtained on the basis of 2-2-1 (Waves and tidal-level) in 2-2 (Port facilities) may be used.

2-3-3 Screen House

(1) Structural types

There are two standard structures for a screen house. One is shown in Fig. 2·3·18 and the other is shown in Fig. 2·3·19. A pump room is installed next to a screen house of the latter type.

Fig. 2・3・18　Structural Type of Screen House (No. 1)

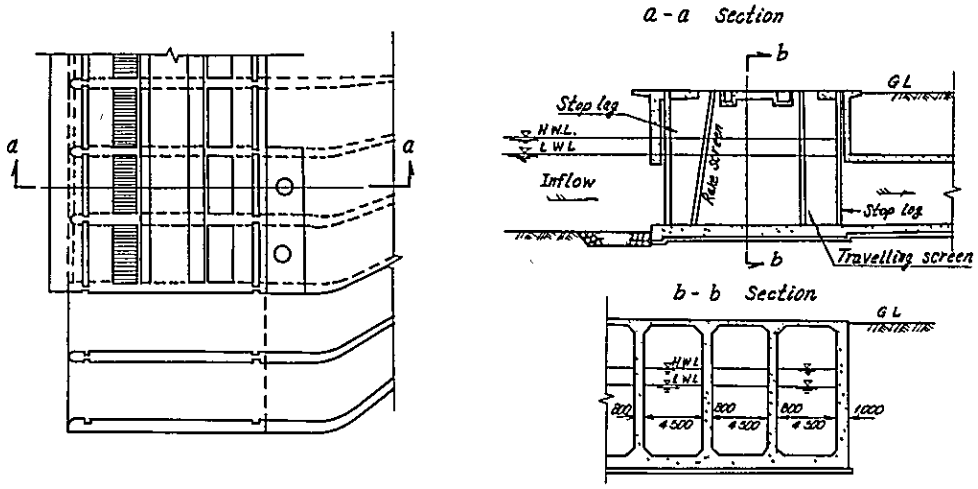


Fig. 2・3・19　Structural Type of Screen House (No. 2)

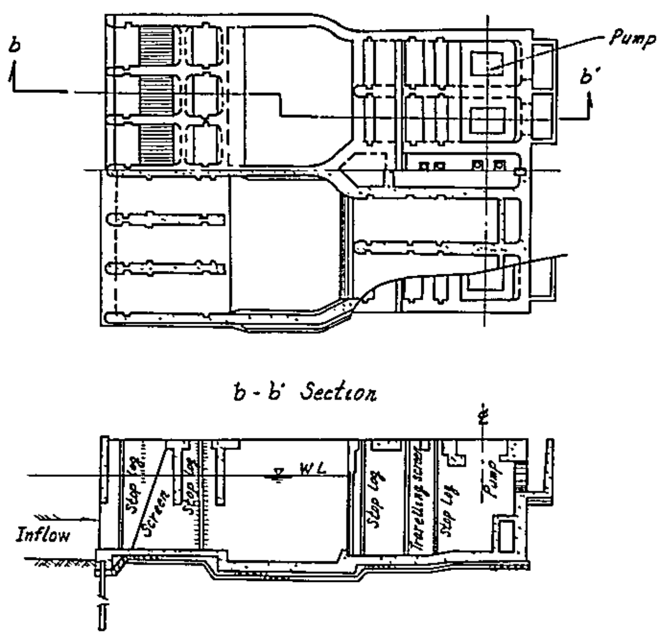
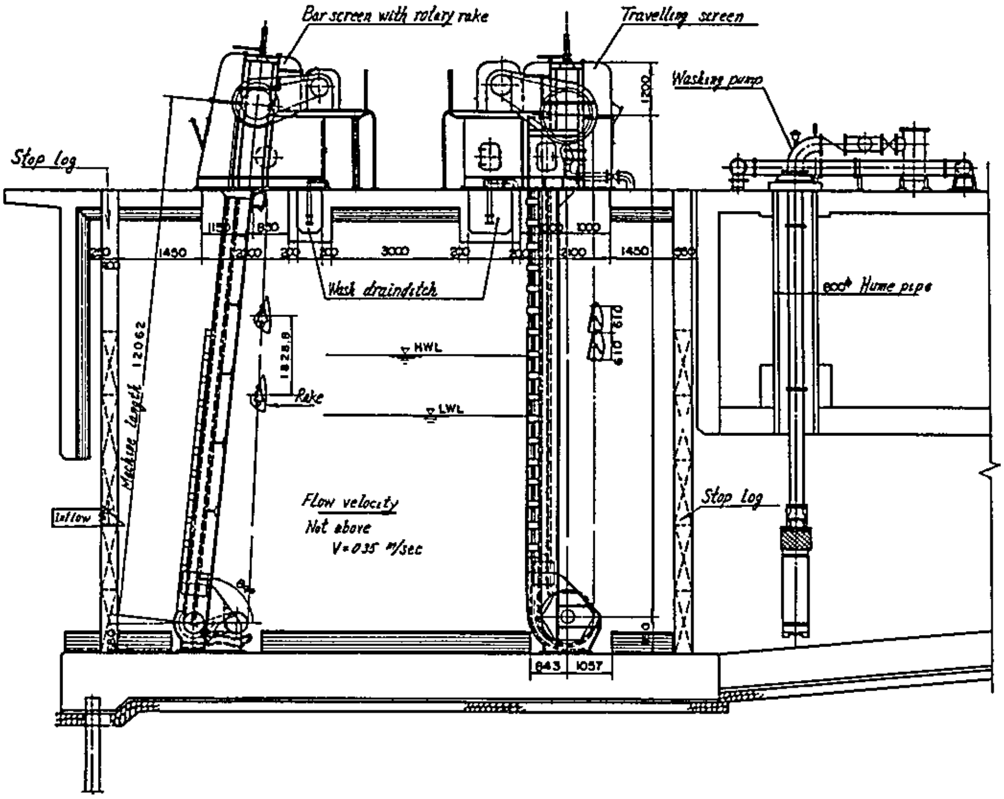


Fig. 2・3・20　Standard Longitudinal Section of Screen



(2)　Design conditions

a.　Sectional shape of screen house

(a) A screen house must have sufficient space for equipments as well as space for operation and maintenance as shown in Fig. 2・3・20.

(b) The standard width of a screen house per port is 4.0 - 4.5m allowing the space for a screen as well as a stop log. It is recommended to adopt a width equal to the adjacent facility to allow interchangeability for the equipments (stop log etc.) (Fig. 2・3・21)

(c) The water passage section of a screen house is determined by allowing a 10cm thick layer of shells and organisms (called as shell allowance) on walls and a 10cm thick layer of deposited refuse, shells, on the bottom.
The thickness of the middle wall is determined in relation to the installation and arrangement of equipments in the screen house. Ordinarily adopted thickness is 80cm～100cm.

(d) The top edge of a screen house is usually at 20cm in height from the surrounding ground.

(e) The height of a screen house floor is determined by considering the pier to pier span the velocity at the screen and construction expense.

b. Velocity at the screen

The Velocity at the screen is determined by considering the ability of screen. Speed of less than 0.35m/sec is usually adopted.

c. Drainage from screw washing

(a) The standard water quantity required for washing a screen per span (4.5 m wide) is as given below.

- o Rake bar screen — $0.8m^3$/min per port
- o Travelling screen — $0.3m^3$/min per port

(b) The flow rate of the drainage ditch is ordinarily not below 0.8m/sec.

d. Design load

(a) The standard loads applied to a screen room's top are as given below.

o Travelling screen machinery	37t/span when one span is 4.5m wide
o Rake bar screen	27t/span when one span is 4.5m wide
o General upper slab	$0.5t/m^2$
o Other installed machineries such as crane.	

(b) The standard load used for the calculation of earth pressure applied to a screen house side walls is $1.0t/m^2$.

(c) A screen house filled-up condition and empty condition must be considered for structural calculation of a screen house.

e. Accessories

A screen house is equipped with the following accessories.

(a) The upper slab must have at least two inspection manholes per one span.

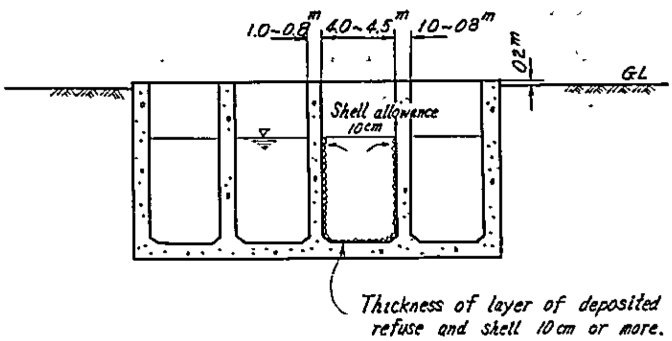
(b) Each manhole has a ladder.

Necessary measures must be taken for corrosion.

(c) At least one drain pit must be made on the bottom for each span.

(d) The screen houses top must have a protective paling (or a hand rail) for preventing a fall.

Fig. 2·3·21 Standard Cross Section of Screen

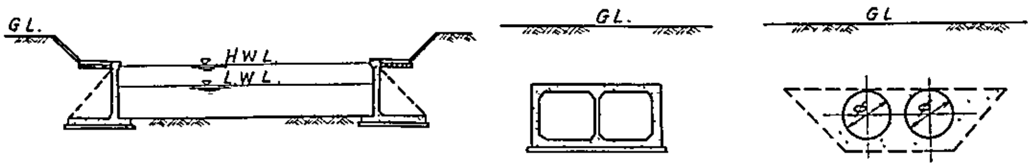


2-3-4 Intake Channel

(1) Structural types

Structural types of an intake channel can be classified into an open channel type, a box culvert type and a pipe type.

Fig. 2·3·22 Structural Types of Intake Channel



(2) Design conditions

a. Shell allowance and deposit allowance

(a) For a natural flow type and a box culvert type, an allowance is to be 10m on the entire inner surface.

(b) For an open channel type, the allowance on the sides should be at least 20cm and the allowance on the bottom should be at least 30cm.

(c) No shell and deposit allowances need be considered for a pump pressure type since its flow speed is relatively high.

b. Position of a box culvert type channel's top edge

It is desirable that the top edge (inner) of a culvert type channel, should be 0.3m below the hydraulic-gradient line to avoid air hammer etc.

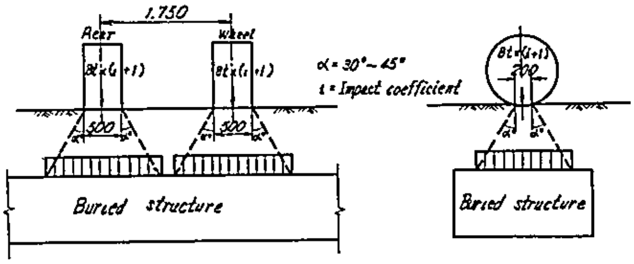
c. Design load

(a) At road crossing

The road load is assumed to be T-20. The impact coefficient is 0.3 when the earth cover is below 3m. No impact coefficient need be considered when the earth cover is 3m or more.

However, the distributed load shown in Fig. 2·3·23 is assumed for an underground structure. When a distributed load is below 1 t/m^2 at aome depth, it is assumed to be $1t/m^2$.

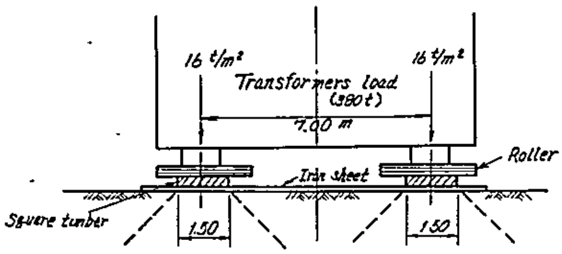
Fig. 2·3·23 Underground Distribution of Load From Road



(b) If specially heavy items, such as a transformer or a turbine equipment, are transported on rollers on a road in transportation is used.

Fig. 2·3·24 shows an example of the load attributable to a transformer being transported on rollers.

Fig. 2·3·24 Load Distribution Attributable to Main Transformer being Transferred



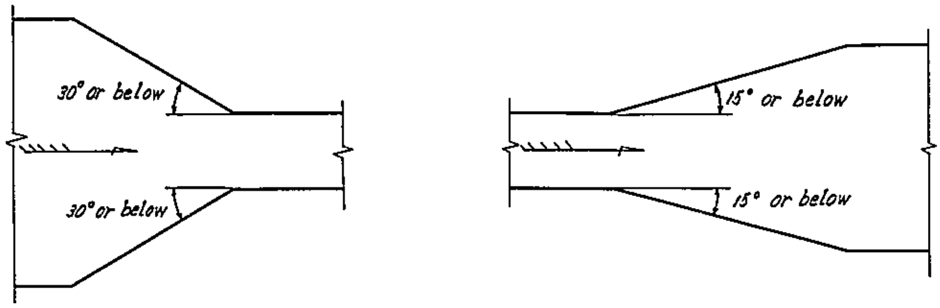
(c) Ordinary part

The design load for ordinary part, above which there is neither structure nor road, is assumed to be $1.0t/m^2$.

d. Channel's plane shape at a gradually expanding part and at a gradually narrowing part.

The shapes shown in Fig. 2•3•25 are considered as standard for a natural flow type water channel without flow distribution device.

Fig. 2・3・25 Water Channel's Plane Shape Gradually Narrowing Part



e. Structural conditions required for inspection and maintenance of water channel

(a) A box culvert type water channel is divided into units in principle to facilitate inspection and maintenance.

(b) A box culvert type water channel has manholes for inspection and cleaning.

(c) Each manhole has a ladder.

(d) It is desirable that a unit water channel should have a connecting hole which allows water to flow into or from an adjacent channel.

(3) Design calculation

a. The cross sectional shape of an intake channel is determined on the basis of the No. of units and their capacity at a power plant as well as their layout by considering construction expense and the pump's power expense as well. It is determined by the following procedure. A cross section is assumed and the construction expense and the pump's power expense due to head loss are calculated. Then the annual expense YA is obtained with Equation 2・3・3. The cross section corresponding to the minimum YA should be selected.

$$YA = [A][r] + [L_E] + [J] \quad \cdots\cdots\cdots\cdots \quad (2\cdot3\cdot3)$$

YA : Annual expense

[A] : Construction expense of water channel & equipment expense of pump

[r] : Ratio of annual expense to construction expense

$[L_E]$: Annual loss of power rates

[J] : Annual repair expense, others

(a) Construction expense of water channel and equipment expense ofpump [A]

The construction expense and the equipment expense of pump can be obtained by the following equation.

[A] = ΣK+P . Kp .... (2·3·4)

ΣK : Construction expense per 1m of water channel (yen/m)

Fig. 2·3·27 shows the construction expense per 1m of a water channel corresponding to cross sectional dimensions of a concrete box culvert water channel obtained for different engineering methods and units.

Fig. 2·3·29 shows the relation between construction expense per 1m of water channel and pipe diameter for a steel pipe water channel.

P : Pump output (Kw/m) per 1m of water channel

It is obtained from Equation 2·3·7.

Kp : Pump (including motor)'s equipment expense corresponding to pump output (KW). It is usually between 20,000 yen/KW and 25,000 yen/KW although it depends on total lift and capacity. (Data obtained at existing thermal power plants :

A. site	(350 MW)	20,150 yen/KW
B. site	(600 MW)	22,900 yen/KW
C. site	(350 MW)	19,150 yen/KW

The total head H of a circulating pump is obtained by the following equation.

$$H = hf + h_{p1} + hc + h_{p2} + h_\alpha$$

The data obtained at Tokyo Electric Power's power plants show that H is between 8m and 12m.

$$H = 8m \sim 12m$$

h_f : Maximum water level difference of intake channel and discharge channel

h_{p1} : Head loss of pipe channel between pump station and condenser

h_c : Head loss of Condenser pipe

h_{p2} : Head loss of pipe channel between condenser and discharge channel

h_α : Margin of head loss

Fig. 2·3·26 Pump's Lift

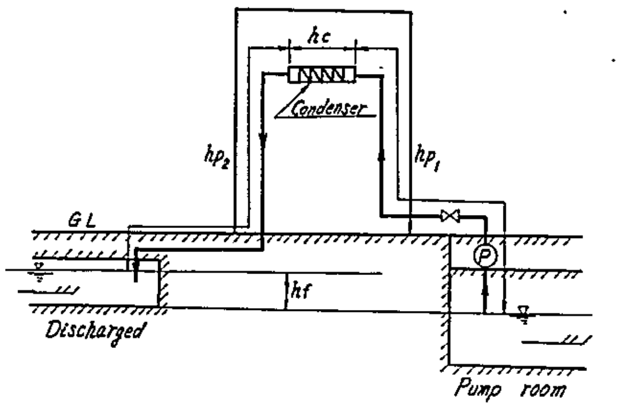
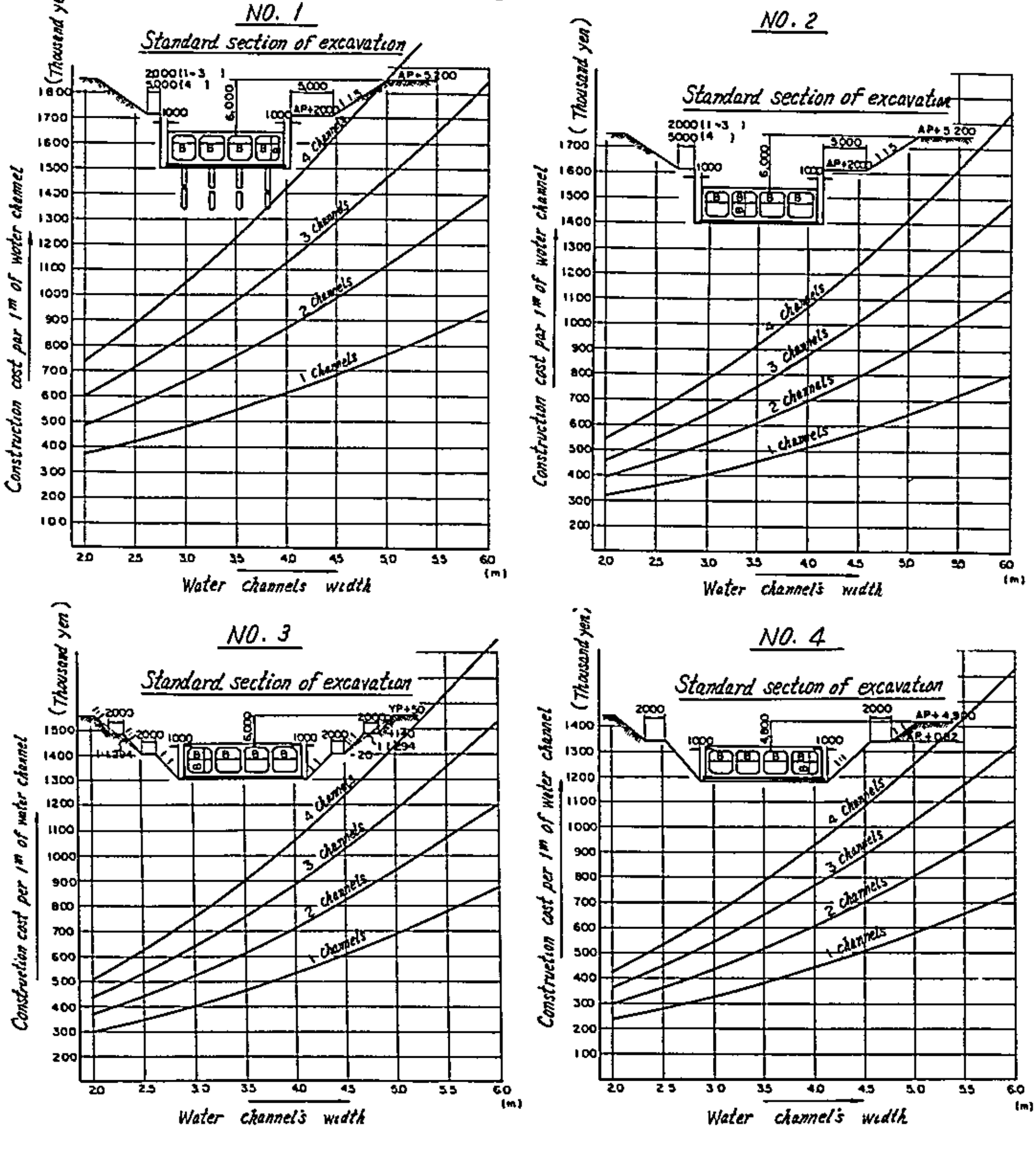


Fig. 2·3·27



No. 5 Standard section of excavation

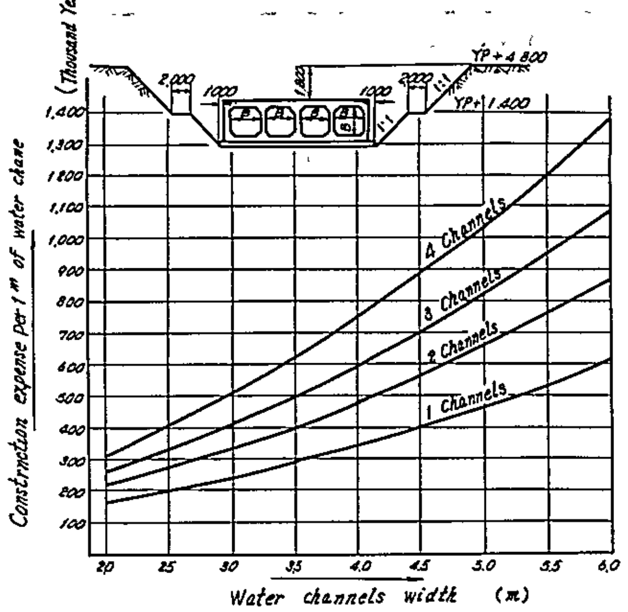


Table 2·3·3

Excavation	322 YEN	Residual soil disposal	230
Concrete	7,400	Refilling expense	520
Frame	1,200	Drainage Cost	35,040
Levelling concrete	6,300	Reinforcement per $1m^3$ of concrete	$0,094^t$
Foundation chest nut stone	3,140		
Reinforcement	45,000	Rate of miscellaneous expense	0,35

The construction expense (per 1m) of water channel shown in Fig. 2·3·27 was obtained from the following equation.

$$A = (e.\ B^2 + f.\ B + g)(1 + \phi) \qquad (2\cdot3\cdot5)$$

e, f, g are obtained as shown below.

$$e = (1.15a_1 + 0.29a_2)\,x + 0.33a_1 + 0.37a_2$$

$$f = \{(H+0.75)a_1 + 0.5a_2 + 3.0a_3 + \tfrac{1}{3}a_5'\}X + \{(0.29H+2.11)a_1 - 0.31a_2 + 2.6a_3 + 0.29a_4 + 0.1a_5' + 2.29a_5''\}$$

$$g = \{(0.35H+0.12)a_1 + 0.02a_2 + 0.3a_4 + 0.12a_5'\}X + \{(1.75H+0.61 + (D_1+D_2)H_2 + ZH_2^2\} - 0.01a_2 + 0.1a_3 - 0.05a_4 + 0.58a_5' \pm (2H - 2H_2 - 0.5)a_5'' + a_6\}.$$

Explanation of symbols

A	:	Construction expense (per/m)
B	:	Water channel width (m)
ϕ	:	Ratio of miscellaneous expenses (to direct construction expense)
a_1	:	Unit price of public engineering work (yen/m^3 excavation) a_1= Unit price of excavation (yen/m^3) + Unit price of remaining earth disposal (yen/m^3) x α + Unit price of back-filling (yen/m^3) x $(1 - \alpha)$ $\alpha = \dfrac{\text{Remaining earth disposal quantity}}{\text{Excavation in quantity}}$ (α : 0.15 ~ 0.35)
a_2	:	Unit price of reinforced concrete (yen/m^3) a_2= Unit price of concrete (yen/m^3) + Unit price of reinforcement (yen/t) x β β : Quantity of reinforcement by 1m^3 of concrete (β : Approximately 0.094)
a_3	:	Unit price of frame loss (yen/m^2)
a_4	:	Unit price of foundation work (yen/m^2) a_4= Unit price of foundation chestnut stone (Yen/m^2) + Unit price of levelling concrete (Yen/m^2) + Unit price of foundation pile (Yen/pile) x r r : No. of foundation piles per/m^2 of foundation work (r : approximately 0.17)
a_5	:	Unit price of temporary coffering work (yen/m^2) $a_5 = a'_5 + a''_5$ a'_5 = Unit price of supporting work (Yen/m^2) a''_5 = Unit price of sheeting work (Yen/m^2)
a_6	:	Unit price of drainage cost (yen/m)

Fig. 2・3・28 Standard Cross Section

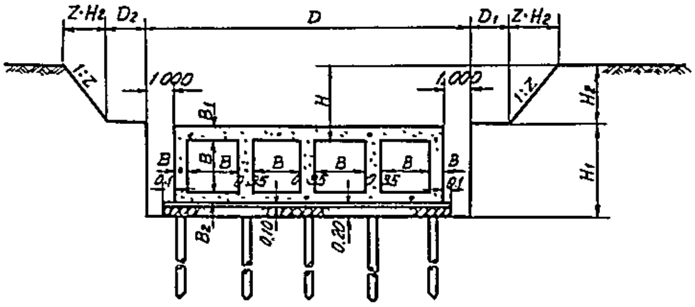
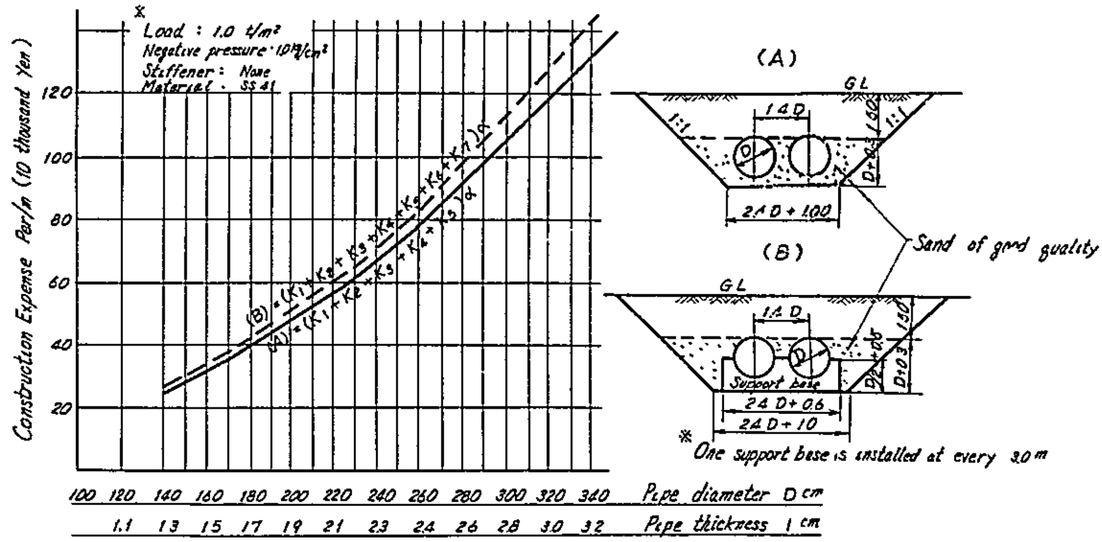


Fig. 2・3・29 Calculation of Construction Cost Per/m of Steel Pipe Water Channel (Two Pipe Line)



(b) Annual loss of electric power [L_E]

The annual loss of electric power [L_E] can be obtained from Equation 2.3.6 and Equation 2.3.7.

$$[\,L_E\,] = P \times S_3 \times 24 \text{ hours} \times 365 \text{ day} \times S_4 \quad \cdots\cdots (2\cdot3\cdot6)$$

$$P = \frac{g \times w \times Q \times h_f}{s_2} \quad \cdots\cdots (2\cdot3\cdot7)$$

P : Pump output (KW)

S_4 : Power charge for station use (yen/KWH)

g : Acceleration of gravity (9.8)

h_f : Loss of water level difference of water channel (m)

S_3 : Availability factor (about 0.7)

S_2 : Pump efficiency (about 0.8)

W : Water weight per unit volume (sea water : 1.03)

Q. : Flow rate (m^3/sec)

Here, a water channel's loss of water level difference (h_f) is considered in terms of friction loss alone. Then the head loss of a channel of square section and a water channel of circulat section h_{fc} and h_{fs} are obtained by Equations 2·3·8and 2·3·9.

$$hfc = \frac{6.35Q^2, n^2}{Bo^{\frac{16}{3}}} . L \text{ (m)} \quad \cdots\cdots\cdots \quad (2\cdot3\cdot8)$$

$$hfs = \frac{101.15Q^2 . n^2}{g \cdot D_o^{\frac{16}{3}}} . L \text{ (m)} \quad \cdots\cdots\cdots \quad (2\cdot3\cdot9)$$

Q : Flow rate (m^3/sec)

n : Coefficient of roughness

L : Total length of water channel (m)

Bo : Length of a side of effective water passage section of a water channel having a square section.

Do : Diameter of effective water passage section of a water channel having a circular section.

f = shell allowance

The following assumption are made for Equations 2·3·6 2·3·9. $S_3 = 0.7$, $S_4 = 3.0$ yen/KWH, $S_2 = 0.8$, $g = 9.8$, $w = 1.03$.

The annual loss of power rates per lm of a water channel having a square cross section and a circular cross section can be expressed by Equation 2·3·10. and Equation 2·3·11.

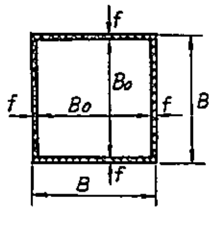
Note that the shell allowance of a water channel having a square cross section is 0.1m and the shell allowance of a water channel having a circular cross section is zero.

$$[L_{EC}] = 1,474 \cdot \frac{Q^3 \cdot n^2}{(B-0.2)^{\frac{16}{3}}} \text{ (thousand yen/year)} \quad \cdots\cdots\cdots \quad (2\cdot3\cdot10)$$

$$[L_{ES}] = 2,396 \frac{Q^3 . n^2}{D^{\frac{16}{3}}} \text{ (thousand yen/year)} \quad \cdots\cdots\cdots \quad (2\cdot3\cdot11)$$

Fig. 2·3·31 and Fig. 2·3·32 show the results obtained with Equation 2·3·10 and Equation 2.3.11.

Fig. 2·3·30



f : Shell allowance

∴ $Bo = (B - 2f)$

$Do = D - 2f$

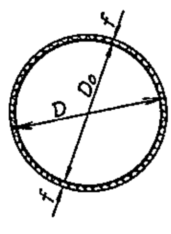


Fig. 2・3・31　Loss of Power Rates of Square Box Culvert Type Water Channel Obtained by Equation 2・3・17

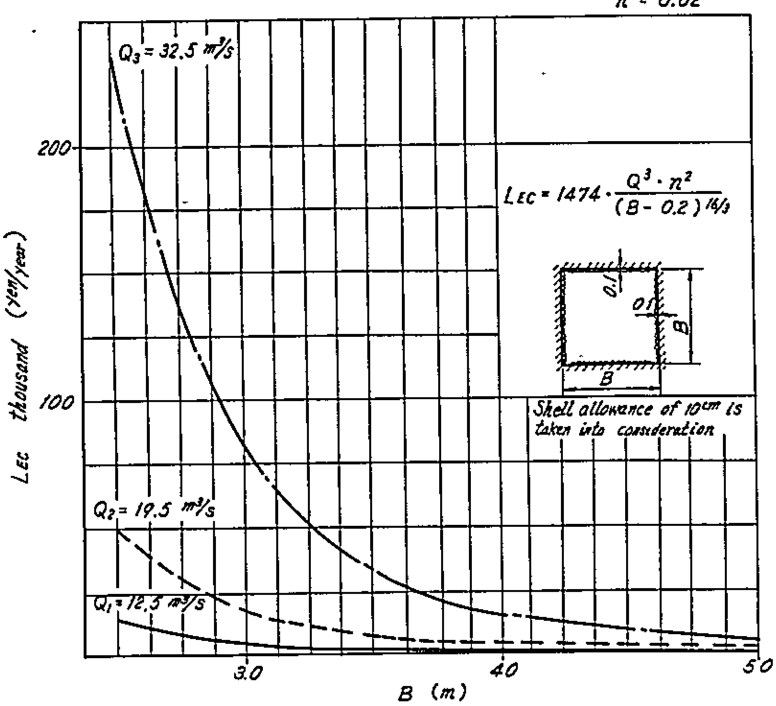
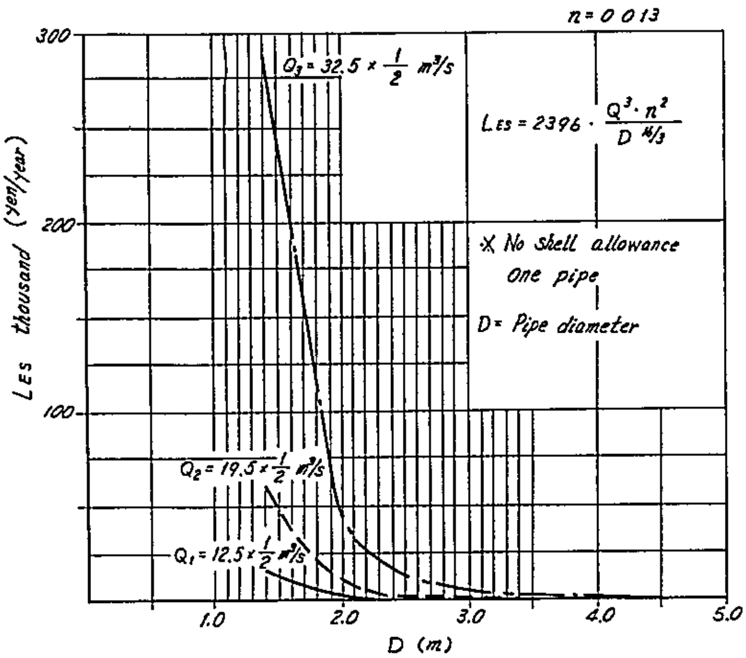


Fig. 2・3・32　Loss of Power Rates of Pipe Water Channel Obtained by Equation 2・3・18



(c) Ratio of annual expenses

Table 2.3.4 shows the ratio of expenses (euqal expenses throughout years of endurance) to the equipment expense of thermal power and atomic power generating equipments.

Table 2・3・4 Ratio of Expenses to Equipment Expense of Thermal Power and Atomic Power Equipment (Equal Expenses Throughout the Year of Endurance)

Item \ Power Plant	Thermal Power	Atomic Power
Interest, depreciation	12.84	12.50
Personnel expense	0.63	0.34
Repairing expense	2.00	1.50
Fixed Property tax	0.33	0.34
Other expenses	0.55	1.27
Part of general management expense	0.16	0.17
Business tax	0.25	0.25
Total	16.76	16.37
Year of endurance	15 year	16 year

Ratio of expenses to equipment expense of thermal power and atomic power equipment (Equal expenses throughout the year of endurance)

The ratio of interest and depreciation was obtained from the following equation on the assumption that the interest on investment is paid and recovered at an equate rate throughout the years of endurance.

$$\text{Ratio of interest and depreciation} = (1 - T) \times \frac{i(1+i)^n}{(1+i)^n - 1} + Txi \quad \cdots\cdots\cdots\cdots \quad (2\cdot 3\cdot 12)$$

T : Ratio of remaining price (10%)

i : Interest rate (10%)

n : Years of endurance

The ratio of annual expense [r] is Equation 2・3・3 is obtained by calculating the repairing expense [J] according to the conditions of a water channel. From Table 2・3・4 the value of [r] in Equation 2・3・3 is 16.76-2.0 = 14.76% in case of thermal power generation, and 16.37-1.50 = 14.87% in case of atomic power generation.

(d) Annual repairing expense and others [J]

The repairing expenses include the expenses for removing shells, and deposit in a water channel, for cleaning and for painting steel plates. The other expenses include the expense for feeding chlorine or sodium hypochlorite. These expenses depend considerably on the type of water channel.

Table 2·3·5 and Table 2·3·6 show the data on the expenses for removing shells, and deposit from an intake water channel and for cleaning it at Yokosuka Thermal Power Plant.

Table 2·3·5

Unit	Total length (m)	Cross section		Area for cleaning (m^2)	expense for cleaning (thousand yen)	cleaning expense (per unit) (yen/m^2)
		width (m)	Height (m)			
1	112	3.1	3.3	1,434	1,418	989
2	165	3.1	3.3	2,112	1,355	642
3	225	3.8	3.3	3,195	1,600	501
4	267	3.8	3.3	4,318	1,995	462
5	222	3.6	3.6	4,100	2,712	588
6	258	3.6	3.6	6,474	3,930	607
Average						632

Expenses for Cleaning concrete open intake channel, Cleaning Once every 4 years

Table 2·3·6

Total length (m)	Cross section		Area for cleaning (m^2)	expense cleaning (thousand yen)	Cleaning expense per unit (yen/m^2)
	width (m)	height (m)			
266	20	4.5	2,394	7,209	3,011

Cleaning expenses per year : 753 yen/m^2

(Average of records between 1961 - 1969)

b. A Design Example of Intake Water channel

- o Calculation will be alone for concrete box culvert.
- o [J] is about 500 1000 Yen from the experience, but can be omitted, because it will not give much influence upon the conclusion of [YA].
- o As cross section, following six cases are chosen and compared.

  $1.7^m \times 1.7^m$
  $2.00^m \times 2.00^m$
  $2.20^m \times 2.20^m$
  $2.50^m \times 2.50^m$
  $2.70^m \times 2.70^m$
  $2.90^m \times 2.90^m$

- o As K, figures of Fig. 2·3·27 No.5 are used.
- o K_p shall be 20,000 Yen/KW.
- o Factors to decide P are shown in (3). a. (b).

Table 2·3·7

Cross section	ΣK (YEN/m)	P/L x Kp (YEN/m)	A (YEN/m)
1.70^2	290,000	20,000	310,000
2.00^2	320,000	14,000	334,000
2.20^2	350,000	4,300	354,300
2.50^2	410,000	2,000	412,000
2.70^2	450,000	1,800	451,800
2.90^2	500,000	800	500,800

Table 2·3·8 L mean = 150 m

Cross section	hf (m)	P (kw)	P/L	P/L x Kp
1.70^2	1.80	146⁻	1.⁻	20,000
2.00^2	1.31	106⁻	0.7	14,000
2.20^2	0.40	32.50	0.216	4,320
2.50^2	0.18	14.6	0.1	2,000
2.70^2	0.12	10.⁻	0.09	1,800
2.90^2	0.08	6.5	0.04	800

Table 2·3·9

N = 0.02 $Q = 6.5^{m^3}/sec$ Shell allowance = 0.2 m

Cross section	(B-0.2)	$(B-0.2)^{16/3}$	$\frac{Q^3 \times n^2}{(B-0.2)16/3}$	LE'	LE
1.70^2	1.50	8,684	0,012	17.7	17,700
2.00^2	1.80	12,299	0,009	13.266	13,266
2.20^2	2.00	40,317	0,0025	3.685	3,685
2.50^2	2.30	84,960	0,0013	1,916	1,916
2.70^2	2.50	132,540	0,0009	1.326	1,326
2.90^2	2.70	199,760	0,00055	0.8107	811

Table 2·3·10

Cross section	A	r	Ar	LE	YA
1.70^2	$310,000^{YEN}$	0.1476	45,756	17,700	63,456
2.00^2	334,000	"	49,298	13,266	62,564
2.20^2	354,300	"	52,295	3,685	55,980
2.50^2	412,000	"	60,811	1,916	62,727
2.70^2	451,800	"	66,685	1,326	68,011
2.90^2	500,800	"	73,918	811	74,729

This result shows that cross section of $2.20^m \times 2.20^m$ is most economical. This calculation also is performed for pipes, in order to know which is more economical box culvert or pipe.

2-3-5 Pump station

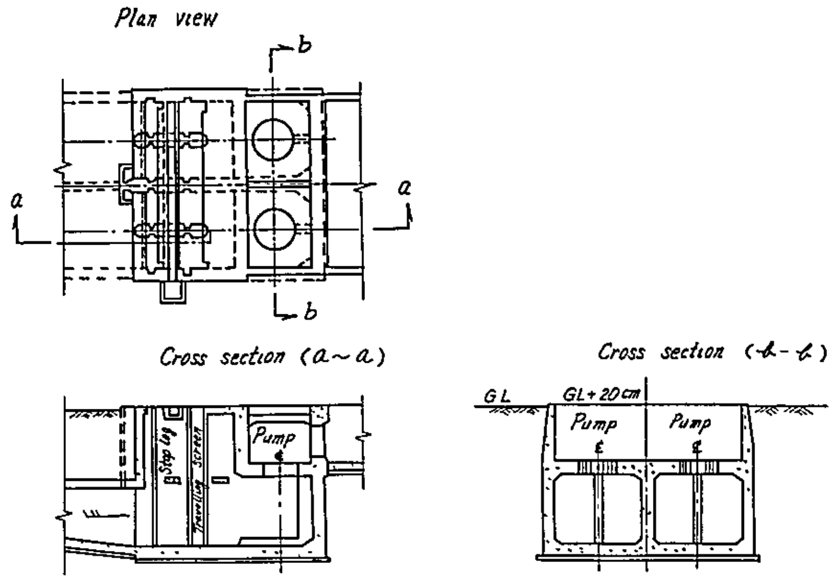
(1) Structure

Generally, a pump station is given enough space not only for a circulating pump but also for a screen and a stop log.

With a natural flow type channel, a pump station is installed at the end of a divided water channel, closest to the main building. With a pump pressure type channel, a pump station is often installed behind a screen house. Fig. 2·3·33 and Fig. 2·3·18

(No. 2) are schematic drawings of a pump station.

Fig. 2·3·33 Schematic Drawing of Pump Station for Natural Flow Type Water Channel



(2) Design conditions

a. Cross sectional shape of pump station

The cross sectional shape of a pump staion is determied on the basis of the pump performances to make sure that the pump draws in no air due to vortex flow.

It is desirable to avoid a sudden change of a cross sectional shape at an upper stream channel.

Table 2·3·11 shows the dimensions of existing pump station of Tokyo Electrical Power Co.

Fig. 2·3·34 Dimensions of Tokyo Electric Power Co. 's Pump Stations

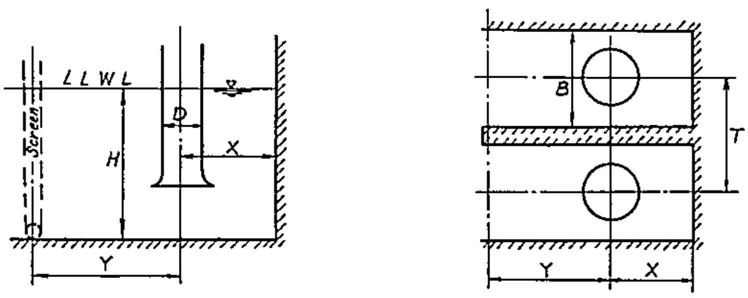


Table 2·3·11

Power station	Capacity	D (mm)	Q (m^3/min)	H (mm)	X (mm)	B (mm)	T (mm)	Y (mm)
A site	175MW	1,350	178	4,000	1,850	2,800	3,660	
B "	125MW	1,067	140	3,400	1,600	3,000	3,658	
C "	265MW	1,350	241	4,700	1,400	2,000	3,600	6,625
D "	265MW	1,500	270	4,800	1,550	2,000	3,600	6,625
E "	350MW	1,800	350	4,370	2,285	4,700	5,400	8,570
F "	350MW	1,800	360	4,200	2,285	4,700	5,300	6,650
G "	350MW	1,800	375	4,200	2,285	4,300	5,400	6,650
H "	350MW	1,800	375	4,320	1,760	4,600	5,400	6,450
I "	600MW	2,135	586.7	5,850	2,600	5,200	6,200	7.750
J "	600MW	2,100	586.7	5,590	2,700	6,450 8,700	7,450	7,750
K "	600MW	3,200 2,500	586.5	5,860	2,600	5,200	6,200	7,900
L "	600MW	2,440	580	4,870	3,00	5,000	5,800	7,900
M "	1,000MW	3,560	975	5,360	3,100	7,500	8,300	7,350
N "	460MW	2,800	1,500	6,000	2,300	6,300	7,300	22,300
O "	784MW	5,000	2,520	6,900	3,680	7,500	8,500	20,820

b. Design load

The loads imposed on a pump station include a pump's weight, a screen's weight, attached equipment's weight.

See 2.3.3 (2) d (Screen housing) for the weight of screen equipments.

The total weight of accessory equipments and uniform load is assumed to belt. m^2.

It is assumed to be distributed uniformly on a pump stations slab.

The structural calculation of pump station must be done both for filled-up and empty times.

c. Allowable water surface flucturation pump station. A pump station water surface fluctuations must be ±10～20% of a pump's design head. Therefore, the allowable water surface fluctuation of a pump is 1～2 m or below when a pump's head is 10 m and when a discharge channel If a pump station's water surface fluctuation is large, a pump's effective suction head (N.P.S.H) will become insufficient. The pump stations bottom must be designed deeper to cover water surface flucturation.

d. Accessories

(a) A pump station's upper slab must have at least one manhole per each port.

(b) Each manhole has a ladder.

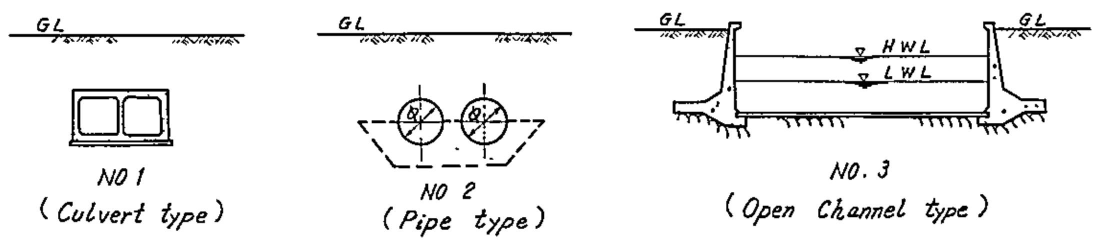
(c) A pump station's bottom has a pit for drawing

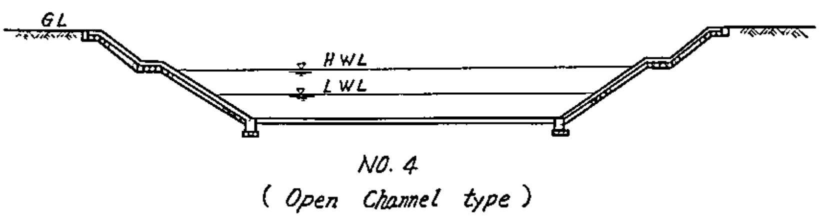
2-3-6 Discharge water channel

(1) Structural types

Structural types of a discharge channel can be classified into an open channel type, a box culvert type and a pipe type.

Fig. 2·3·35 Structural Types of Discharge Channel





(2) Design conditions

a. Design water level

The lowest water level at the discharge channel outlet of a circulating water pipe is so determined as to maintain the circulating water pipe's siphon effect.

The lowest water level can be determined from Equation 2.3.13.

P ≦ -H +△H ....(2・3・13)

P : Siphon effect basis (m)

H : Difference in height between a condenser's center and water level at circulating water dischage channel outlet (m)

△H : Head loss of circulating water pipe between condenser's and outlet of discharge circulating water pipe (m)

o Example of calculation :

Kashima Thermal Plant : No. 1 Two pump's are in operation.

P : -8.0m Height of condenser : YP + 10.385m

Water level at outlet of circulating water pipe with two pumps in operation

YP = 1.780m

Assumption : H = 1.365m

-H+△H=-(10.385-1.780)+1.365=7.24m

Since the following relation stands, it is satisfactory.

-8.0m=P ≦ -7.24m

b. Excess allowance for cross section

No excess allowance need be considered for a cross section since no shell enters a discharge channel.

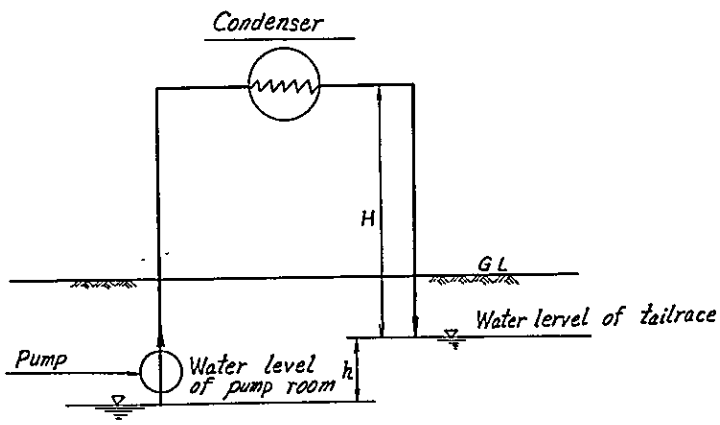
c. Design load

Same as 2-3-4 (2)C (Intake water Channel)

d. Shape of gradually expanding part

See 2-3-4 (2)e (Intake Water Channel) for reference.

Fig. 2・3・36



e. Storage capacity of discharge channel

When a circulating water pump is started, a condenser and the circulating water pipe after the condenser must usually be filled with water. Therefore, a discharge channel has such a structure that allows storage of sufficient water for filling a condenser and the circulating water pipe after the condenser at the starting time of a circulating water pump.

Table 2•3•12 shows the volume of a condenser and a circulating water pipe subsequent to the condenser.

Table 2•3•12. Quantity of Required Water Supply at Starting Time of Circulating Water Pump

Name of plant	Output (MW)	Volume of condenser (m^3)	Volume of circulating water pipe after condenser (m^3)	Required water supply at pump starting (m^3)
A site	350	190	1,310	1,500
B site	600	270	630	900

f. Accessories

When a water channel repeats a cycle of full-empty due to changes of tidal level and discharge flow rate, manholes which also serve as air holes, must be installed.

(3) Design calculation

a. Determination of cross section

The shape of a discharge channel cross section is determined by 2-3-4 (3)a considering the siphone effect of a circulating water pipe.

2-3-7 Outlet

(1) Structural types

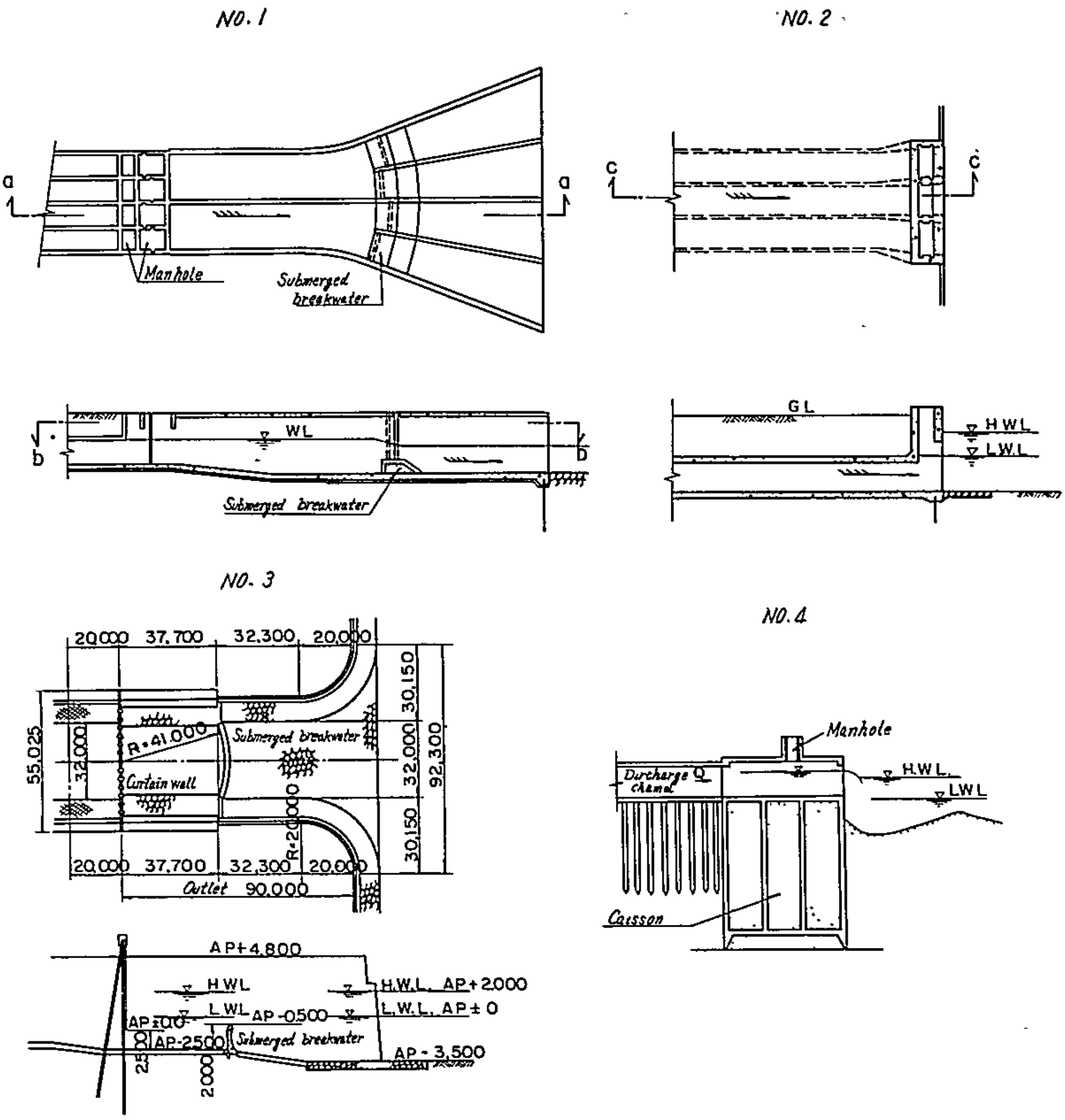
The structural type of an outlet is determined by discharge flow rate as well as sea basin conditions. Fig. 2•3•37 shows major structural types of existing outlets.

(2) Design conditions

a. Discharge flow speed

The following speeds are taken as standard when no restriction is imposed due to the conditions of a sea basin in front of an outlet.

Fig. 2·3·37 Structural Type of Outlet



(a) When neither route nor berth exists in the front sea basin :

V = 1.0 ~2.0m/sec

(b) When a route and a berth exist in the front sea basin :

Inside bay V = 0.30 ~ 0.5m/s
Outside bay V = 0.3 ~1.0m/sec } According to the condition of a route and a berth

(Flow speed after passing of an energy dissipator, when one is installed.)

b. Invading wave

An adequate breakwater structure must be constructed to prevent invading waves from giving undesirable effects on a pump and structures when an outlet is facing open sea with large waves.

The study showed that invading waves gave no serious effect on the circulating water system and the pump as long as the waves in a discharge channel stayed within 1.5m in height and 0.3 ~12 sec. in cycle.

c. Table 2·3·13 and Fig. 2·3·38 show the relation between water quantity and the range of temperature rise. (See "2-3-1"C)

Table 2·3·13 Relation Between Quantity of Cooling Water and the Area of Temperature

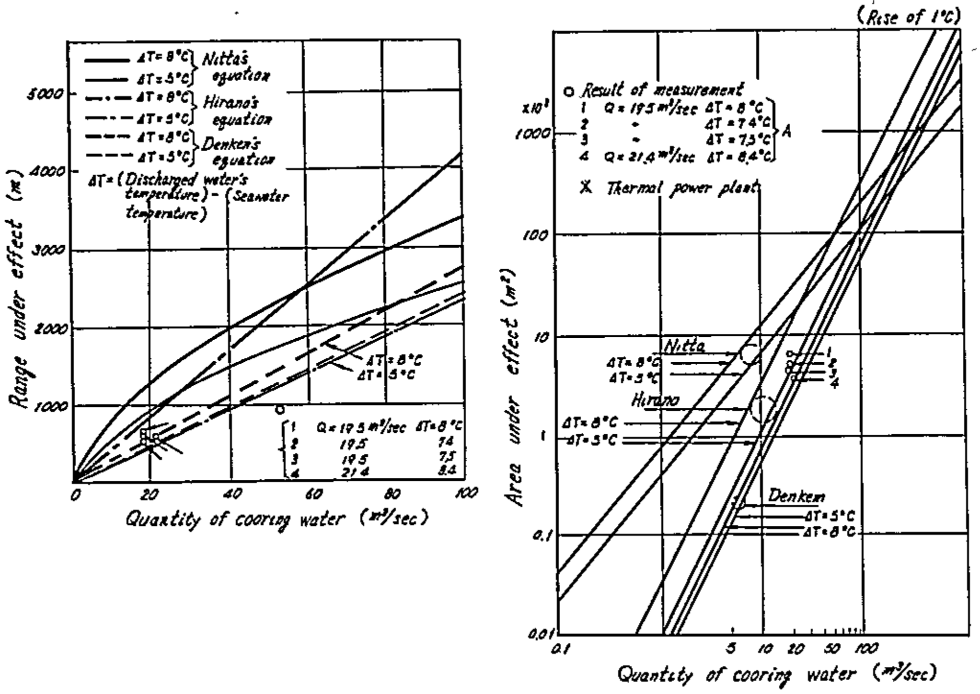
water temperature rise	Quantity of cooring water (m^3/sec)				
	20	40	60	80	100
1°C	17.84X10^4 m^2	71.36X10^4 m^2	160.5X10^4 m^2	285.4X10^4 m^2	446.0X10^4 m^2
2°C	7.96	31.84	71.64	127.36	199.0
3°C	2.52	10.08	22.68	40.32	63.0
4°C	0.22	0.88	1.98	3.52	5.5

According to the Water Standards for Fisheries (The Japanese Association of Water Resources Protection), water temperature should not rise as much as 2°C in an area expecting travelling fish. Water temperature rise attributable to warm discharge water should not exceed 2°C in winter in a sea-weed culture area. A sudden artificial temperature change of water should not exceed 0.5°C/hr.

d. Height of outlet with surface layer discharge system

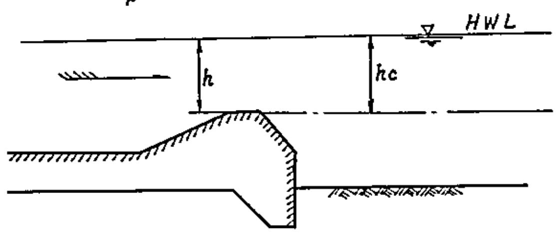
It is recommended that the outlet of a surface layer discharge system is below the critical water depth of the layer of warm discharged water so that no cool

Fig. 2・3・38　Relation Between Quantity of Cooling Water and Range Under Effect of Water Temperature Rise



water of the lower layer may enter the outlet from the open sea.

$$h_C = \sqrt[3]{\frac{Q^2}{B^2 G \frac{\Delta\rho}{\rho}}} \qquad \cdots\cdots\cdots\cdots\cdots\cdots \quad (2\cdot3\cdot14)$$



B　: Water channel's width at outlet (m)

Q　: Flow rate of discharge (m^3/sec)

ρ　: Density of local sea water

$\Delta\rho$　: Density difference due to temperature difference between warm discharged water and local sea water

The water depth at the discharge end is assumed to be h (H.W.L. as standard). Then the height of the discharge end which satisfies the requirement of h<hc is chosen with Equation 2.3.14 and the height that assures the discharge flow velocity to be below the specified level at the time of L.W.L. is determined.

2-4 Conceptual Design of Foundation of the Main Buildings

In designing the foundations, it is necessary to fully understand the soil condition and the load condition. Bearing these two conditions in mind, the following two problems must be considered in order to construct the foundation economically and within a short period of time: that the building load be made lighter, and that the foundation of construction method be the one best suited for the soil condition.

2-4-1 Types of Foundation

In designing the foundation of buildings, not only the main building of the thermal power plant but the foundation of all the various building, there must be soil capablel of supporting the entire weight of these buildings. In other words, first, the bearing stres of the soil must be greater than the load of the building, and secondly, after construction completion, the building load should not cause unequal settlement.
In order to meet these above two conditions, the following methods of engineering techniques of foundation construction are recommended:

(1) Pre-cast Concrete Piles

The following table shows specifications and allowable pile stress which are generally used:

Table 2·4·1

ø	ℓ	Allowable stress of pile
300 mm	15 m	20~25t/m^2
500 mm	"	45~50t/m^2
600 mm	"	80~100t/m^2
800 mm	"	100~120t/m^2

When the length of the pile exceeds 15 meters, two piles should be joined together. However, when joined together, a 20% loss of the allowable stress of pile per each pile joint occurs thus creating a disadvantage. When the allowable stress of pile becomes smaller or the designed load of building becomes greater, the number of piles must be increased. As a result, the piling pitch becomes too short making it unable to drive piles. Also, when there is a sand layer of more than N-value 30 somewhere between the ground surface and the ground base, it becomes difficult to drive piles.
Piles of ø 600 ø 800 in diameter are heavy and sometimes it is impossible to drive

them with a D-22 diesel hammer. In addition, much larger hammers such as those bigger than D-40 are not readily available in most cases.

If the depth of the ground base of the pile under the foundation varies greatly, the length of the pile must vary thus resulting in considerable loss. However, the advantages in regard to these piles are that they are readily available and that the cost of the piles is comparatively cheap.

(2) Cast-in-place Piles

Among cast-in-place concrete piles are Pedestal piles, Benoto piles, and Calweld piles. etc. As the foundation of the main building has a heavy vertical load of column, it is recommended to use piles which have a diameter of at least ϕ 600mm and that each allowable pile stress be more than 100 tons.

In this method, it is considered economical and reliable to have the pile depth less than 30 meters. As this method has combined properties of pier and pile, the allowable stress of ground base of the foundation requires 200 ~ 300 t/m^2.

(3) Steel piles (including H-shaped type piles)

This pile is advantageous in case of a deep groun base. In general, those of ϕ 500 ~ ϕ 600 in diameter with a stress of 100 tons per pile are often used.

This method is used for depths of more than 30 meters as it is economical and shortens the construction period. However, one drawback of this method is corrosion. Recently though, it has become possible to measure the rate of corrosion, and we solve this problem by increasing the thickness of the pile by 2 ~ 3 m/m. In addition, application of an electric anti-corrosion system to 20 meters or deeper in underground is highly difficult in view of setting the electrical elements as well as its treatment. (Note: The base strength of the pile foundation is omitted here as it will be mentioned in the specific examples of General Design, Volumn II).

(4) Pneumatic Caisson Method

This method is regarded superior to others because it is highly reliable and gives assurance of the ground base. The construction cost of this method depends on the volumn of soil to be excavated. Hence, it is necessary to consider ways to reduce the excavated volumn as much as possible. The following table illustrates examples of the foundation area and the total caisson base area. The fact that the caisson base area ranges from 38 ~ 18.8% of the foundation area is due to the difference of the allowable of the ground base.

Table 2·4·2

Output	Foundation Area (m^2) (A)	Caisson area (m^2) (B)	B/A %	Rate stress t/m^2
66 MW (Coal)	2,000	524	26.0	37~60
125 MW (coal)	2,638	908	34.0	34~55
175 MW (coal)	3,020	1,156	38.0	34~55
265MW (coal)	5,066	1,304	26.0	56~140
350 MW (oil)	A 4,559 B 4,359	1,206 818	26.5 18.8	42~98 53~118

Ex 1
- Output 265 MW (Coal)
- Stress of bearing power layer (Soft Rock) 100 t/m^2
- Foundation Area 5,066 m^2
- Total Weight (Bldg) 61,964 t

The required caisson base area becomes 61,964/100 = 620 m^2 as a result of design analysis. However, in order to avoid excessive force which might possibly occur on the Mat foundation, the caisson area should be enlarged to 1,304 m^2.

Ex 2
- Output (Oil)
- Stress of bearing power layer (Soft Rock) 100 t/m^2
- Foundation Area 4,359 m^2
- Total Weight 60,464 t

The required caisson base area 60,464/100 = 604 m^2.

In practice, as the table shows, it is enlarged to 818 m^2. (Note: Along with the necent development of construction methods, the size of caissons have become smaller and now circular caissons 3.0 ~ 2.8 meters in diameter have gradually come into use).

Until now, application of this method has been expensive, but, at present, in cases up to about 30-meter caisson length, these smaller size caissons are competing with other methods in regard to cost and construction period. However, in cases of a 35 meter depth or more, it is generally difficult to apply this method. The following are a few examples of smaller size caissons applied for a -20 meter depth:

2-4-2 Construction Cost

Assuming that there is a 20 meter supporting depth, the following chart is based up upon past results and shows the comparison of the construction cost of the building foundation per ton of the building weight. (Note: It is assumed that the ground base is rock).

Table 2·4·3

Outer diameter	(m)	3.0	2.8	2.6
Wall thickness	(m)	0.6	0.7	0.65
Shaft diameter	(m)	1.2	1.0	1.0
Caisson section area	(m^2)	7.07	6.15	5.30
Total surface area of caisson circumference	(m^2)	182	170	158
Caisson Weight	(t)	225	230	186
Ex. soil Volum	(m^3)	141	123	106
Concrete Volum	(m^3)	90	91.6	67
Filled concrete for caisson bottom	(m^3)	8.5	7	6
Allowable bearing stress	(t)	About 700	600	500

Table 2·4·4

	Pile ϕ (ℓ = 20 m)	Price	Stress	Yen/t	Remarks
Large diameter concrete pile	ϕ — 600	200,000 yen	100t	2,000	meaning big capacity pile drivers are necessary
Concrete pile	ϕ — 350	45,000 yen	20t	2,250	requires a grester number of piles. Hence, it is difficult to arrange piles under the boiler supparting column
Caisson	4m x 5 m V = 400cm^3	@10,000/cm^3 4,000,000 yen	2,000t (sand and gravel)	2,000	meaning construction cost is rater expensive
Small caisson	ϕ — 3.0 m V — 141cm^3	@12,000/cm^3 1,692,000 yen	1,400t	1,200	meaning that it is economical, yet the construction period is rater long
Benoto pile	ϕ — 1.0 m	220,000 yen	160t	1,380	meaning it is difficult to check the slime treatment although it has to be done
Stal pipe pile	ϕ — 503 t = 9_{mm}2.2t	@60,000/t 132,000 yen	100t	1,320	meaning it is difficult to drine piles if these is a gravel/ sand layer between the ground surface and the ground base

(1) Meaning big capacity pile drivers are necessary

(2) requires a greater number of piles. Hence, it is difficult to arrange piles under the boiler supporting column

(3) Meaning construction cost is rather expensive

(4) Meaning that it is ecomomical yet the construction period is rather long

(5) Meaning it is difficult to check the slime treatment although it has to be done

(6) Meaning it is difficult to drive piles if there is a gravel/sand layer between the ground surface and the groun base

The construction cost of the caisson method varies according to the length and the shape of the caisson.

Table 2・4・5 Increasing Rate of Construction Cost per Depth Variance/m^3 (calused by shortening the working time under pressurized conditions in the caisson)

Depth	The rate of increase
-15 m	90%
-20	100%
-25	127%
-30	178%
-35	229%

Table 2・4・6 Increasing Rate of Construction Cost per Caisson Bottom Area/m^3

Caisson bottom area (m^2)	Volume of excarvation (m^3)
20 m^2 above	100%
∅ 4.1 m (circular)	121%
∅ 3.6 (")	130%
∅ 3.0 (") 7 m^2	146%

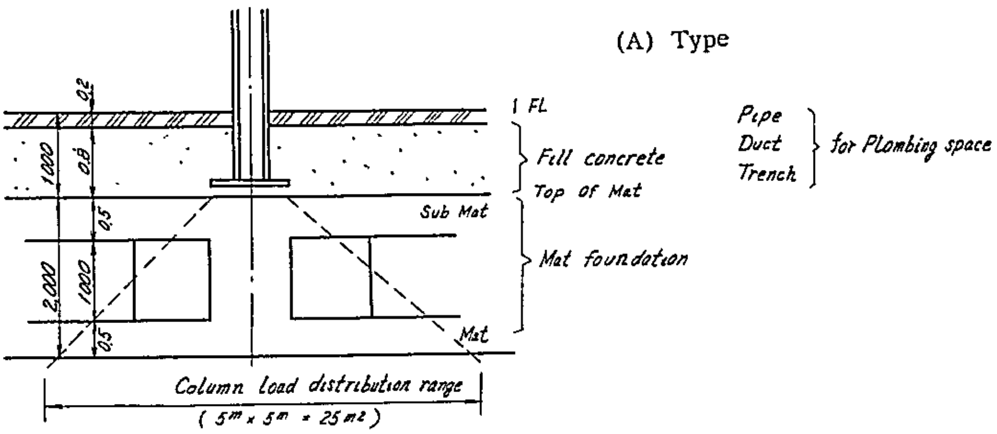
2-4-3 Mat Foundation

The purpose of this is to safely convey the weight of the super-structure and its foundation and the weight of the equipment onto the piles or directly to the ground base. To take a building weight for a unit capacity of 265 MW (coal-burning type) as an example, in regard to the weight of the super-structure and the weight of the equipment, the average reaction of the Mat base is approximately 17 t/m², which is somewhat more than of the average office building. However, special attention in designing is required because the reaction under the turbine pedestal in the turbine room and drum supporting columns in the boiler room are 24 t/m²～60 t/m²

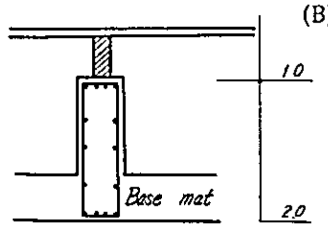
Figure 2·4·1 illustrates a section of a typical and ecomomical type Mat foundation (A-type and B-type).

Fig. 2·4·1

(A) Type



(B) Type



The A-type foundation cost is 2~3% cheaper as compared to the conventional B-type one. In regard to A-type foundations, the thickness of the base Mat and sub-mats are about 0.5 and 0.6 meters respectively. Also, by making an empty space of about one meter in the middle of the Mat foundation, the amount of concrete can be economically reduced without decreasing the strength of the Mat foundation, and by thus doing so, the total weight can be reduced. However, under the turbine bases and columns, the Mat should be rigidly and massively designed by filling it with concrete. The ratio of empty area might be about 10~20% of the total Mat foundation area. Whether the Mat foundation of the main building is integral or divided into boiler and turbine Mat foundation, or only the turbine pedestal mat separated from the others, is determined by the type of foundation, unequal settlement caused by soil conolidation, and the Mat size.

As the Mat foundation is of concrete structure, the expansion caused by temperature heat as well as cracking due to shrinking must be taken into consideration. Therefore, in the case of a large capacity thermal power station, it is generally desirable to provide expansion joints between the turbine and the boiler Mat foundations.

If the Mat foundation of the turbine pedestal be free from unequal settlement, it is desirable to make the Mat and turbine room Mat foundation into one single unit. On the contrary, if there is a fear of unequal settlement, the two should be separate. The weight of the Mat concrete of the turbine pedestal should be more than that of the turbine pedestal and its equipment. The thickness of the Mat is to be determined by the foundation work method and power plant output. When piling reaches the ground base (base rock), there will be no unequal settlement. Therefore, even for foundations of main buildings of large capacity thermal plants, the thickness of the Mat can be about 2.0 meters. However, if there is a fear of unequal settlement, it should be 3.5~6.5 meters. So far, present soil engineering has not been able to sufficiently solve this problem of unequal settlement.

2-4-4 Basic Design Approach

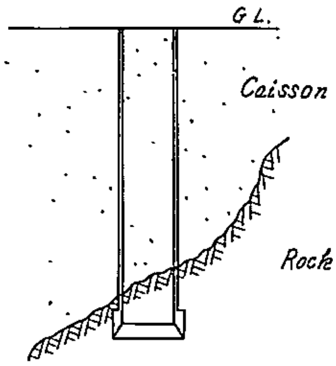
In designing the foundation of the main building, one must always consider settlement of the foundation as well as vibration caused by the equipment operation and its installation. Therefore, one must select the type of foundation which is most economical and best suited for the soil condition. The following are typical methods which suit various types of foundations: (1) when base rock exists 2~5 meters below the ground surface and thick Mat concrete is placed directly onto the ground base, (2) when base rock is 10~30 meters below the ground surface and loose layers exist in between; either concrete piles or small-type caissons used though the latter may be somewhat more economical, (3) when the supporting base layer is not of rock and exists 10 ~30 meters below the ground suface with some

Table 2·4·7 Comparison of Cost of Foundation Construction

Out put (MW)	175			265		350	
Burning type	coal	coal	oil	coal	oil	oil	
Piling type	caisson	steel pipe pile	caisson	mass concrete	steel pipe pile	caisson	
Piling length (m)	28	57	12	4	30.3	20	
foundation area (m^2)	3,020	3,140	2,475	5,066	3,950	4,235	
m^2/mkW	18	18	14.1	19.1	15.0	12.1	
Total Weight of building(t)	39,000	49,000	31,200	89,154	70,000	60,000	
t/m^2	13.0	17.0	14.1	17.6	17.0	14.0	
thickness (Mat) (m)	2.0	3.5	2.0	2.0	6.5	2.0	
cost Yen/m^2	148,000	187,000	41,500	27,200	112,000	68,500	
cost Yen/kW	2,570	3,350	1,220	520	1,510	770	
Construction period (months)	10	7.5	9	7	7	9	mat 4
Caisson	18	-	34	-	-	30	
Piling No	-	ϕ-650 440	-	-	ϕ-650 356	-	
mat concrete vol (m^3)	5,580	8,177	4,570	10,800	17,500	9,103	
mat RE-Bar (t)		653	398	432	903	522	
foundation concrete (m^3)	18,255	-	3,617	15,400	-	7,736	
foundation steel pipe pile (t)	-	4,020	-	-	1,730	-	
foundation RE-Bar (t)	1,090	-	264	-	-	496	

loose layers in between; a comparative study should be made in selecting the diameter of both the concrete piles and steel piles, (4) when the ground base is deeper than 40 meters; in general, steel piles should be considered, (5) when the ground base is 20~30 meters below the ground surface with hard gravel/sand layers in between - as in the case of (4); steel piles should be considered, (6) when the ground base is relatively shallow, that is to say, 10~20 meters below the ground suface but the ground base is inclined; generally concrete piles and/or steel piles are both economical. However, during pile driving, as the bottom of the pile may be caused to slide, small-type caissons may be used.

Fig. 2・4・2



2-4-5 Foundation Design Data

(1) Concrete volume of turbine generator pedestal according to output difference (Fig. 2・4・3)

(2) Building construction cost according to output difference (Fig. 2・4・4)

(3) Frame weight according to output difference (Fig. 2・4・5)

Fig. 2・4・3 Concrete volume of turbine generator pedestal according to output difference

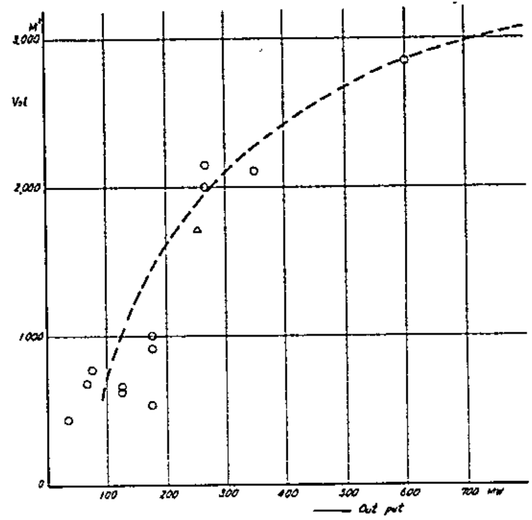


Fig. 2・4・4 Building construction cost according to output difference

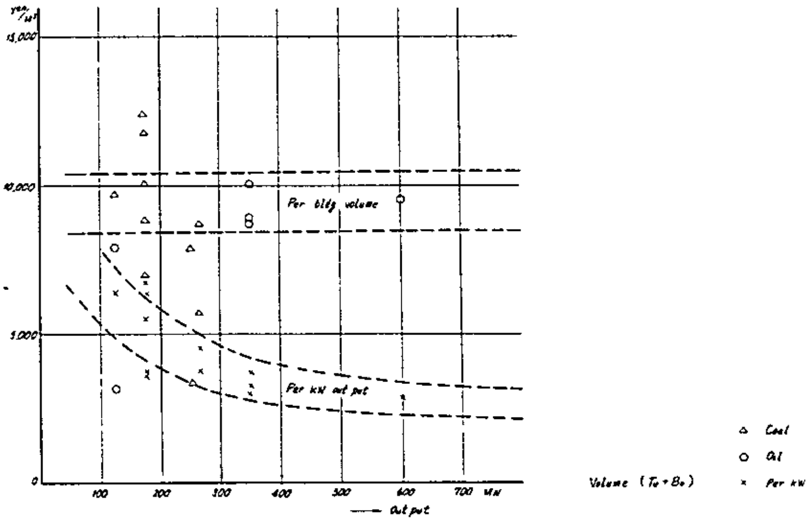
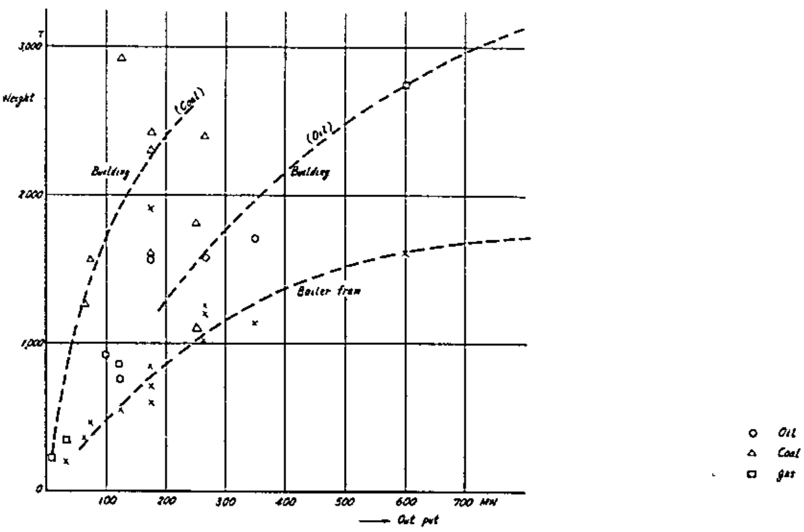


Fig. 2・4・5 Frame weight according to output difference



2-5 Fundamentals for Selection of Thermal Power Unit Size and Type

In Development Planning of Thermal Power, the selection of unit size and type will be determined partly from the requirement of power system, partly from the adoptability of machine available, matching the unit size and characteristics. When the unit is going to be adopted as the first largest one, careful study must be performed.

However, with the historcial development of thermal power, it is a fact that the almost standardized units are now established. In this article, it is aimed to give the vast, yet fundamental knowledge concerning the existing types of machines and their characteristics, supplementing from mechanical engeneering side the selection of the unit in the actual development planning.

2-5-1 Type of Turbine

(1) Tandem Compound and Cross Compound

In the thermal power stations of electric power utility, types of steam turbine can be classified as tandem and cross compound by numbers of axis, as 2, 3, 4, 5, 6 cylindrical by numbers of cylinders and as 2, 3, 4, 6 Flow by numbers of exhaust steam flow of low pressure turbines.

Tandem compound type (Abbreviation : T.C.) is in general simple in equipment and arrangement, and cheap in construction cost. On the otherhand, cross compound type (Abbreviation : C.C.) is in general excellent in thermal efficiency for the same size and same steam condition, having easiness in design and manufacturing so that this type can be usually adopted for the larger turhine. refer to Fig. 2·5·1.

(2) Blade Length of Low Pressure Turbine Last Stage

As turnine size increases, quantity of low pressure turbine exhaust increases. For this purpose, annulous area of the last stage or numbers of exhaust flow must be increased.

The selection of this blade length and numbers of exhaust flow gives much influence upon construction cost and efficiency, which requires much attention.

(3) Maximum Output

For turbines, rating output is regarded as max. continous output in general and also as design point. But some amount of output margin should be taken against the worsening of steam conditions and vacuum. In countries, where sea water temperature is much different in summer and winter, the turbine size is so sepected that even in the worst vacuum condition, the rating output must be secured.

The steam flow in this condition is called maximum guarranteed throttle flow, corresponding turbine capability flow. If this steam flow passes, the turbine under rating vacuum condition, max. output will be obtained.

In the case of Tokyo Electric Power Co. Inc., rating output will be obtained under 1.5 inch Hg abs with sea water temperature of 21°C. But in design it is also considered that even in the worst vacuum of 3.5 inch Hg abs with sea water temperature of about 30°C, rating output must be maintained. Inversely, if this steam flow passes the turbine in the vacuum condition of 1.5 in Hg abs, max. output of about 5% over rating will be obtained.

(4) Indoor type and Outdoor Type

In such countries wher rain fall and snow fall are seldom, outdoor type turnine can be adopted in order to spare construction cost of turbine housing. But in the area where rain fall is heavy, indoor type is selected for the convenience of operation and maintenance.

2-5-2 Type of Boiler

(1) Type of Boiler

In thermal power stations three types of Boiler are used, Their types are natural circulation, forced circulation, and once-through. Natural circulation boiler has its oldest history and can be manufactured from small size to large size. Once-through boiler has a physical feature, that this type can only be used for the higher pressure, but in general it may be said, this type is fitted for the middle and large size. Forced circulation boiler supplements the fault of natural circulation type and is suitable for considerable high pressure and large size. refer to Fig. 2·5·2.

(2) Boiler Capacity

Boiler capacity varies with the variation of margin for the systems of one turbine-one boiler, one turbine-two boilers and one turbine-multi-boilers. But for the one turbine-one boiler system, which is mostly adopted in general, boiler capacity is also selected that it is over 5 - 10% of turbine rating output. This means, boiler capacity comforms with the max. guaranteed throttle flow of turbine or takes some appropriate margin over this steam flow.

This boiler capacity is called Maximum Combustion Rate (Abbreviation MCR) and regarded as boiler rating.

(3) Type of Fuel Combustion

There are following combustion types :

a. Coal Firing

b. Heavy Oil Firing

c. Crude Oil Firing

d. Gas Firing

e. Combination of a - d

Nowadays there is a tendency to adopt dual firing or more, in accordance with the basic principle of fuel diversification. This must be decided, taking into account the following points.

- Fuel situation in long period
- Special regional features and their environment
- Construction cost and maintenance cost
- Operation characteristics

Among these combustion systems, for crude oil fired and gas fired boilers, special considerations are necessary such as anti-leakage measure gainst fuel, anti-explosion measure againts machines and motors, gas detectors and ventilating equipments.

Boiler furance will be smaller in the order of coal, heavy and crude oil, and gas. Size of furnace gives much influence upon the construction cost, along with the combustion equipments.

2-5-3 Selection of Appropriate Unit Type Corresponding to Unit Size.

As described above, there are many kinds of turbine and boiler types. It is important to select the unit type which is most appropriate to unit size.

Standard of unit type, steam conditions and output in Japan in historically as shown in Table 2·5·1. But for the selection of smaller unit, careful study should be carried for the latest technique.

With the increase of unit size, reheat cycle becomes preferable. But the economy study should be made weighing increase of efficiency, increase of construction cost and operation technique. In general, adoption of reheat cycle will be limitted up from around 100 MW.

Beside these, concerning combination of turbine and boiler, there is an idea of unit system (1 turbine - 1 boiler) and 1 turbine - multi boiler system.

Historically speaking, boilers had less reliability and so the 1 turbine - 2 boiler system or superheater outlet common header system has been used. However, recent boiler technique development is remarkable such as manufacturing, control and boiler water treatment technique, therefore unit system is widely adopted except in special cases. 1 turbine - multi boilers system will be adapted in thermal power stations only when there is a special purpose such as considerations against boiler trouble cased

Fig. 2·5·1 Turbine Type

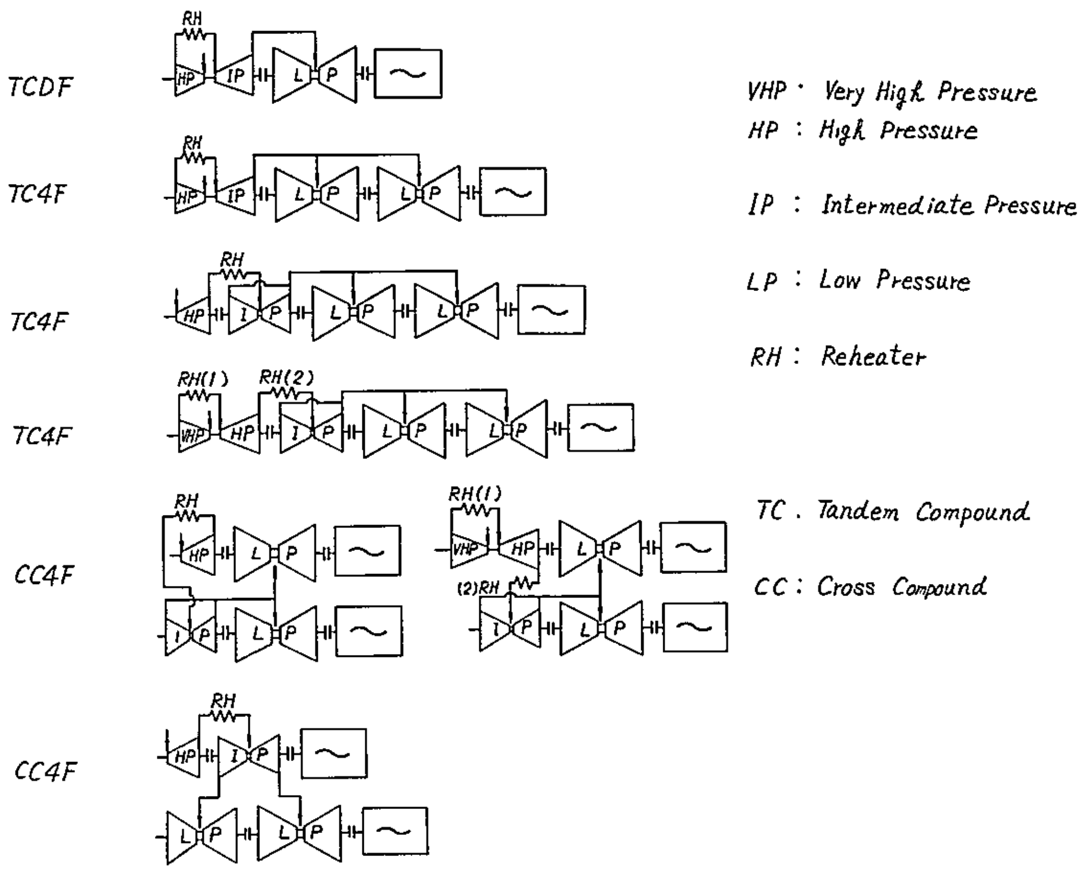


Fig. 2·5·2 Boiler Type

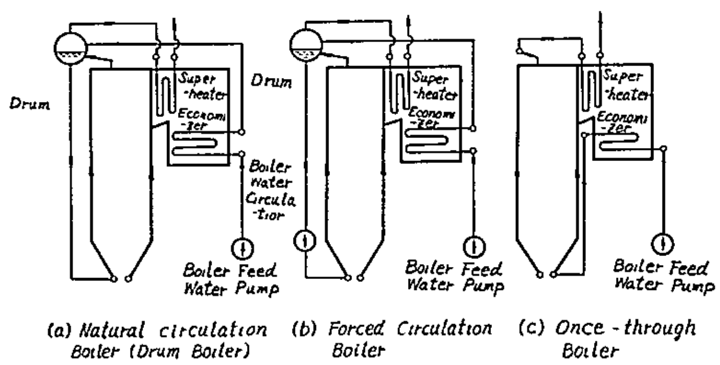


Fig. 2·5·3 Steam Conditions and Heat Rate

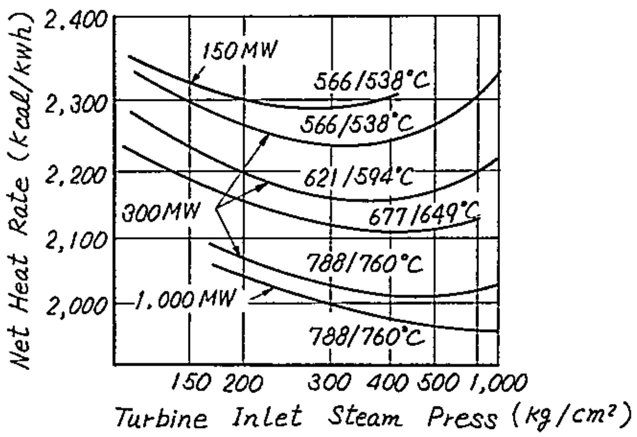
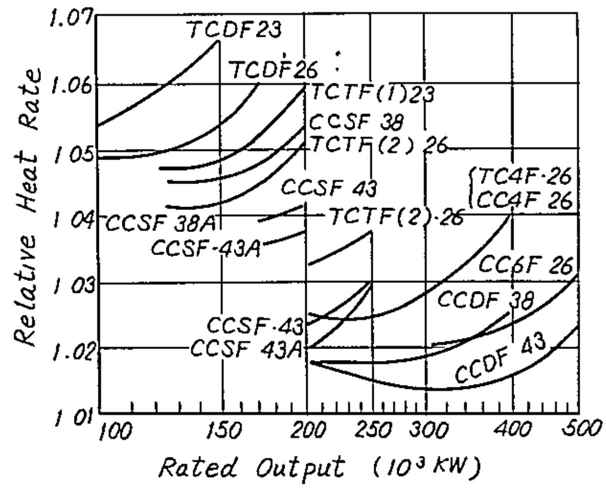


Fig. 2·5·4 Relation Between Unit Type, Unit Size and Thermal Efficiency



Symbols on the curves show turbine types, while figures represent last stage blade length, Symbols behind figures show exhaust types.

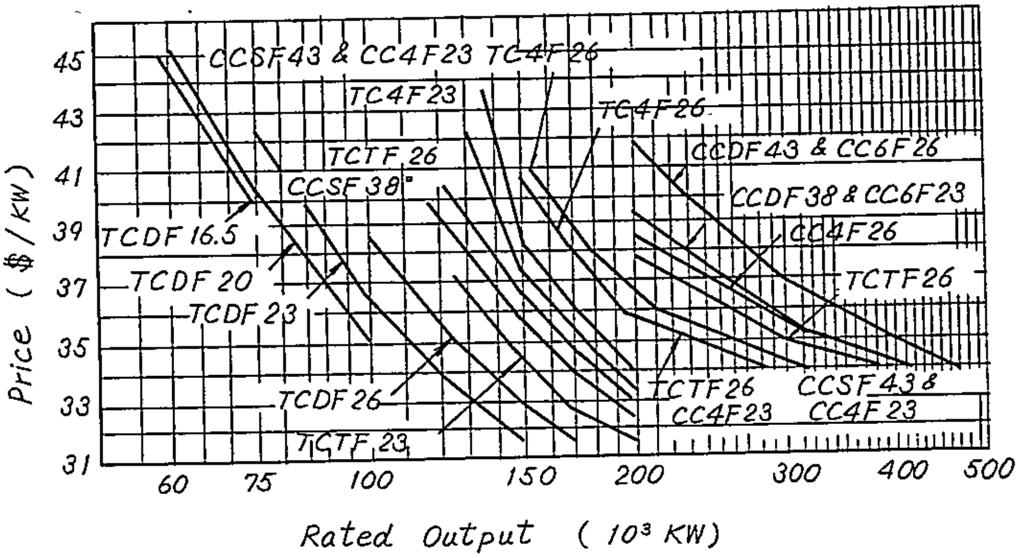
Steam Conditions and Cycle Heat

50,000 ~ 100,000kW
- $102kg/cm^2$, $538^oC/538^oC$
- Eco Inlet Temp 221^oC with
- 3 stages of Feed Water Heater

100,000 ~ 200,000kW
- $127kg/cm^2$, $538^oC/538^oC$
- Eco Inlet Temp 232^oC with
- 6 stages of Feed Water Heater

200,000 ~ 500,000kW
- $169kg/cm^2$, $538^oC/538^oC$
- Eco Inlet Temp 243^oC with
- 6 stages of Feed Water Heater

Fig. 2·5·5 Relation Between Unit Size Unit Type and Construction Cost



Steam Conditions

50～100 × 10^3 kW	102 km/cm²,	538°C/538°C	
100～200	〃	127	〃 538°C/538°C
200～500	〃	169	〃 538°C/538°C

Fig. 2·5·6 Relation Between Steam Conditions and Construction Cost

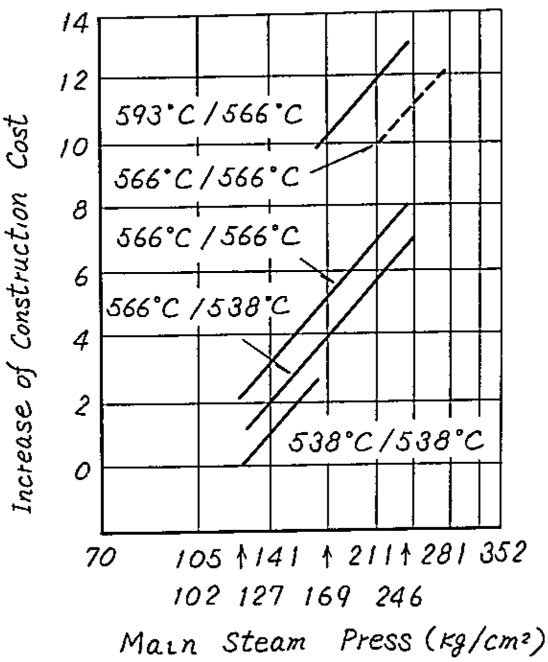


Table 2・5・1 Example of Unit Size and Type

Steam Conditions	Adaptable Output Range	Turbine Type	Boiler Type
Kg/cm^2g °C	MW		
102 x 538/538	60 ~ 125	TCSF, TCDF	Natural Circulation and Once-through
127 x 538/538	75 ~ 150	Same as above	Same as above
169 x 538/538	150 ~ 600	TCDF, TC3F TC4F CC2F, CC4F	Natural Circulation Once-through Forced Circulation
169 x 566/538	150 ~ 600	Same as above	Same as above
169 x 566/566	250 ~ 600	Same as above	Same as above
246 x 538/538	400 ~ 1000	TC4F, CC2F, CC4F CC6F, CC8F	Same as above
246 x 538/566	400 ~ 1000	Same as above	Same as above

by use of low calory coal and measures for low load operation.

In low load, one or more boiler can be stopped.

2-5-4 Relation Betweer Unit Type, Efficiency and Construction Cost

(1) Relation Between Unit Size, Steam Conditions and Thermal Efficiency :

- For the same unit size, higher temperature contribute to the inerease of thermal efficiency.
- Higher pressure will also contribute to the increase of thermal efficiency, but the effect is smaller in comparison with the temperature. If the pressure becomes over a definite value, thermal efficiency will deteriorate because of power for station use, Refer to Fig. 2·5·3.
- For the same steam conditions and the same unit size, the turbine type, having longer last stage blade length, will be of higher efficiency, if the number of exhaust flow is same. And for the same last stage blade length, the turbine type, having larger number of exhaust flow, will be of haigher efficiency, because of the decrease of exhaust loss in the low pressure stage.
- For the same steam conditions and the same turbine type, there is a unit size which has the highest efficiency. Refer to Fig. 2·5·4.

(2) Relation Between Unit Size, Steam Conditions and Construction Cost

- Construction cost per KW decrease with the larger unit size for the same steam conditions, but the ratio of decrease becomes less as the unit size increases.
- For the same steam conditions and the same unit size, construction cost differs with the types of turbine and boiler. Refer to Fig. 2·5·5.
- For the same unit size, construction cost per KW increases with there higher steam condition. Refer to Fig. 2·5·6.

2-6 Problems and Countermeasures of High Sulphur Heavy Oil Combustion in the Thermal Power Station

2-6-1 Meaning of Heavy Oil - fired Boiler

(1) In Japan, for the policy of the exclusive use of heavy oil, strong concerns have been shown.

The greatest reason was that heavy oil surpassed over coal in the economical competition.

In 1957, in the energy consumption area centering around Tokyo district, fuel prices were already equal between heavy oil and coal, and heavey oil has year by year predominated economically.

With on increase of the electric demand and a rise of plant efficiency, the thermal power generation being large sized, high temperature and high pressure, has been developed. Exclusive buring system of heavy oil substituted old dual burning system of heavy oil and coal.

In Tokyo Electric Power Co, Yokohama Thermal Power Station (175 MW, in 1962) and Goi Thermal Power Station (265 MW, in 1963) began the operation, and entered into the exclusive oil firing age.

(2) There exist various reasons why the exclusive burning wystem of heavy oil has been adopted.

They can mainly be summerized in the following reasons.

a. Prospoct of fuel economy in future.

b. Low construction cost.

c. The increase of transportation capacity and the decrease of transportation cost by using large rized tanker.

d. Development of new oil fields.'

e. Requisition to the large rize, high temperature and high pressure power generating unit against the increase of electric demand.

(3) Against the increase of electric demand, development of large rize thermal plant was especially required.

And the following economical merits of the exclusive burning of heavy oil have been evaluated highly.

a. Decreasing of generating cost due to the falling of fuel prise.

b. Decreasing of boiler equipment cost.

c. No need of coal and ash equipments.

d. Decreasing of operating personnels.

2-6-2 Heavy Oil to be used

In order to deside the specification of boiler equipments, property of heavy oil must be studied.

Heavy oil which has been used in Japan, has mainly been imported from the middle East and South East Asia.

As heavy oil involves high sulfur and vanadium contents, special consideration are necessary for design and operation of boilers.

Property and composition of heavy oil is requlated by JIS (Japanese Industrial Standard), however, the heavy oil obtained actually, has been of poor quality. Concerning Sulfur content, the investigated result have that heavy oil has formerly been rather higher in sulfur content.

Recently, requirements of heavy oil compositions become severe, but it is needless to say that the technical investigations is necessary concerning design and operation of boilers.

2-6-3 Problems for the Basic Planning of Heavy Oil Firing Boiler

For the planning of heavy oil firing boiler, main points to be taken into considerstion, are shown below.

a. High temperature corrosion.

b. Plugging of the gas way as in air Preheater and convection tubes.

c. Low temperature corrosion.

d. Air pollution.

2-6-4 High Temperature Corrosion, and its Countermeasure

(1) High temperature corrosion

In a heavy oil firing boiler, slags stick on high temperature heat surfaces such as super - heater tubes, and reheater tubes, and the increase of the induced draft fan power and decrease of the load factor accur. At the some time, the heat surfaces are corroded, and in the extreme case a blast of tube is caused.

The mechanism such - as alage sticked on the high temperature heat surface corrode metals, has been made clear by experiments and actual experiences.

Vanadium (V_2O_5) and sulfate sodium (Na_2SO_4) involved only a little in heavy oil are of principal causes.

The melting point of V_2O_5 is extremely low compared with other chemical compounds. It is about 670° - 680° C and becomes about 600° C when binded with Na.

At the high temperature and pressure boiler, max. metal temperature becomes higher than usual.

In the high temperature gas, these liquid compounds wet the heat surface and melt the oxide film having a protective function.

Further, they corrode metals violently with oxidization and sulfuration Analysis result of slags on the high temperature heat surface is shown below as a example.

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	V_2O_5	Na_2O	SO_3
%	2.8	2.1	4.8	7.8	1.8	8.6	24.3	43.8

(2) Countermeasure

The trial to remove from heavy oil directly V_2O_5, Na_2SO_4, and S which are leading elements for corrosion, has been ivestigated.

But it is not practiced yet except special cases.

At present, the following two methods are considered for the actual boiler.

a. To keep the surface metal temperature (crown metal temperature) below the safety temperature.

b. To treat the corrosive elements chemically, with adding chemicals.

Item a. is a matter of plan and design of boiler.

Also, in order to prevent the high temperature corrosion, the requirements for design and structure must be given to the boiler manufacture.

There are many kinds of adding chemicals and natural compounds including Mg and Ca are used in United States.

Their compositions are mainly about 40% $MgCO_3$, and 60% $CaCO_3$.

Two injection methods are adopted.

One method mixes pulverized dry chemicals into combustion air. Another method atomizes with burners by mixing chemicals into heavy oil.

In Japan, various tests have been tried.

2-6-5 Pluggings of the Gas Way as in Air Preheater and Convection Tubes

By combusion, slage are produced. Alkaline surfies of being low melting point stick and accumlate gradually.

So, for design and operation of boiler, the following points should be considered.

a. To install soot blowers adequately.

b. To change property of slag with chemical injection.

c. To choice appropriate space between tubes each other

d. To the water washing possible for boilers

Especially, it is desirable that air Preheaters can be washed even if they are in operation.

2-6-6 Low Temperature Corrosion and its Countermeasure

(1) Low Temperature Corrosion

In order to raise efficiency of boiler, the temperature of flue gas is choosed low.

At the low temperature part of air preheaters, their metal temperature become lower than dewpoint of the flue gas, and corrosion and plugging will occur.

For the cause of low temperature corrosion, a part of SO_2 in the flue gas changes into SO_3, and further, becomes H_2SO_4 combined with moisture.

This sulfuric acid (H_2SO_4) condenses and corrodes metal. SO_2 (sulfurous acid gas) is produced from S in fuel by combustion and about 3 - 13% of SO_2 gas changes into SO_3.

Of course, the conditions such as S % in fuel, excess air and V_2O_5 acting as catalyzer, will give influences.

(2) Countermeasure

The following methods are generally considered

a. To keep the metal temperature above the safety temperature

b. To inject the chemical additives

c. To use the anti-corrosive materials

d. To operate the boiler in restricting the formation of SO_3

e. To wash out occasionally

Countermeasures such as the installation of washing equipment, the injection of NH_3 (ammonia), low O_2 operation and the periodical washing are used commonly.

2-6-7 Air Pollution and its Countermeasure

By firing the heavy oil, main factors of air pollution consist of sooty dusts, SO_2 gas, and NO, NO_2 (Nitrogen oxide) gas.

Especially, in the suburbs of cities, stationary smoke sources such as those from factories, thermal power stations and large building heatings and movable emission sources of auto-mobils are concentrated excessively. Emission gases cause sometimes serious problems influenced by seasonal weather conditions.

In order to prevent the air pollution, comprehensive countermeasures are necessary for over-all areas.

However, in the case of the thermal power station, the following items are actually executed step by step as countermeasures of equipments and operations.

a. Adoption of the gathering type tall stack

b. Installation of the dust collector

c. To perform the combustion control thoroughly

d. Switching over to the good quality fuel oil in an emergency case

e. Load down is considered even in the worst case

2-7 Problems Concerning Condenser Cooling Water and their Countermeasures

2-7-1 Utilization of Sea Water

For the condenser cooling water, when the sea water is utilized, the sea water has more special character than the river water.

For the condenser cooling, the sea water must possess the following general conditions.

(1) Required quantity be secured all the time

(2) Water quality be good

(3) Water temperature be adequate

(4) Growth of the troublemaking lives (Shells, Seaweeds, Microorganism) be a little.

(5) For the intake place, the influences of the unusual tide or the river flow be a little

(6) Floating dirts and the injurous factory waste be a little

2-7-2 Main Points Requiring Special Attention

(1) The Surroundings around the Intake Place (shapes of land, soil condition of the bottom, water depth, water quality etc.)

As the intake conditions are different with the surroundings, the method of the intake must be studied sufficiently.

a. Not to absorb the floating dusts of the surface

b. Not to move abundantly the sand and mud of the bottom

c. To dredge the rather wider area, if necessary.

(2) The Temperature of the Sea Water

In Japan, in the inland bay about 10m depth, the boundary faces between the warm water layer and cold water layer occur at about 5 m depth.

These are different due to the seasons, winds waves, and tides.

The intake structure is possible to take the water from the cold layer.

If the intake point is deeper than the discharge point, this is preferable for the thermal dispersion of the cooling water and is effective against the recirculation of the warm discharge water.

This principle can be applied when the intake and discharge place is not far enough.

(3) The Troubles by Sea-lives

Lives such as shells and seaweeds which are of settling natures, adhere to pipes and equipments and cause the troubles in their function.

In Japan, overwhelming jelly fishes invade the intakes exceeding the removable capacity.

The following countermeasures are considered agains trouble-making

a. To increase the water velocity in the pipe

a. To install the screen

c. To inject chlorine

At the thermal power station, the injection of chlorine is most useful. The injection time period and the injection concentration are decided by seasonal conditions and surrounding condition.

(4) Corrosive Conditions

Near cities the sea water is contaminated remarkably.

The deposits of shells, seaweeds and planktons are a little however, the corrosion increases there.

Accordingly, after investigating the water quality and the corrosive circumstances, anti-corrosive measures of equipments must be done.

In Japan, corrosion does not progress uniformly during a year and corrosions changes seasonally.

In summer, the action of sulfuric acid deoxidize bacterium is considered to be vigorous.

The forming of slime which brings out the decrease of heat conductivity of the condenser is caused that the microorganisms such as ferrous bacterium stick on the tube wall and settle the inorganic materials and the organic materials in the water.

Furthermore, by the action of sulfuric acid deoxidize bacterium, sulfur compounds are produced and they concern with the partial corrosion.

The following tables show the investigation results concerning the relation between bacterium and ammonium and also the relation between sulfuric acid deoxidize bacterium and bydrogen sulfide (H_2S).

Table 2·7·1 Relation Between Bacterium and Ammonium

Area	NH^+ (p.p.m.)	Bacterium (MPN/ml)
Clean sea	---	$1.0^2 - 10^3$
Tokyo	1.28 - 3.84	$1.7 - 2.3 \times 10^5$
Osaka	0.07 - 3.84	$1.6 - 2.9 \times 10^5$
Tokuyama	0.09 - 0.38	$6.7 - 7.1 \times 10^3$
Tobata	0.12 - 0.26	$5.8 - 6.1 \times 10^4$

Table 2·7·2 Relation Between Bacterium and Hydrogen Sulfide

Area	H_2S (p.p.m.)	Bacterium (MPN/ml)
Clean sea	nil	10
Tokyo	nil - 0.008	$2.2 - 5.4 \times 10^3$
Osaka	nil - 0.18	$0.49 - 16 \times 10^3$
Tokuyama	nil	33 - 72
Tobata	nil	49 - 79

The maximum value of the corrosive component and its time period are very important. Accordingly, in the contaminated sea area, the attention is necessary for the changes of local contaminations.

Trouble preventing measures such as developments of the anti-corrosive tube material, forming of the anti-corrosive film and cathode protection are effective.

A tentative judgement standard about the contaminated sea water is shown for reference in Table - 3.

2-7-3 Adopted Countermeasures in the Thermal Power Station

In order to solve Problems above-mentioned, various efforts are tried in Japan The following measures are performed including the considerations of design and structure, and the method of operation and maintenance.

These must be adequately combined against the surrounding conditions

(1) Double installation of screen

(2) Injection of chlorine

(3) Injection of ferrous sulfate

(4) Installation of the continuing cleaning devices

(5) Installation of the reverse current valves

(6) Choice of the tube materials

(7) Installing the cathode protector

(8) Operation of the one side condenser for cleaning

(9) Periodical cleaning

The corrosion by bilogical and chemical causes can not be solved alone.

After all, there is no countermeasure without the extremely primitive method to remove the corrosive surroundings by using several countermeasures at the same time.

2-8 Density Calculation of Flue Gas Emission into the Air

Sulfur oxides in the flue gas from a stack is dispered into the atmosphere. Their dencity on the ground level can be calculated by utilizing formulas. Various formulas are known. But formulas adopted in regulation of Japan are introduced here.

2-8-1 The Effective Height of a Stack (Bosanquet's Formula).

Even if the height of stacks is equal, emission forces are different due to the velocity and the yemperature of flue gases. The emission force becomes strong as the velocity or

Table 2·7·3 The Tentative Judgement Standard of the Contaminated Sea Water

	Clean Sea	Contaminated	Remarks
1) P H Value	7.6~8.4	6.5~7.5	1) The value tends to go down, when contaminated. 2) Caution is necessary below 7. 3) Carbon steel is rappidly corroded below 4. 4) P H value varies with various causes, judgement can not be done by this value only.
2) Conductivity (V/cm)	45~53 x 10^3	25~50 x 10^3	1) Contamination is not shown by this value only. 2) This value becomes lower when mixed with river water.
3) D O_2 (ppm)	6~10	0~4	1) The value tends to go down when contaminated. 2) 0 means remarkable contaminations by organic matter.
4) K Mn O_2 (ppm)	10~15	> 20	1) Large value shown to include more organic matters. 2) Much organic matters don't relate to the corrosion derectly. 3) This value is important to be connected with D O_2 value.
5) C_1^- (ppm)	18~22 x 10^3	——	1) Contaminated sea shows low values generally. 2) This doesn't always relate to the corrosion. 3) Low values show standards to be mixed with contaminated river water.
6) H_2 S (S^{--}) (ppm)	0	> 0.03	1) To be above 0.1~0.3 is harmful. 2) Especially Cu - alloy and Ni - alloy are attacked.
7) N H_4^+ (ppm)	trace	> 1.0	1) Steel and iron are not corroded by this material only 2) For Cu-alloys worse influences are considered by even a little.
8) N O_2^- (ppm)	0	> 0.1	This value shows to have organic mater contamination

the temperature are higher. So, the effect equal to the emission force of a tall stack appears. This voverted emission force is called an effective height of the shack the effective height consists of an actual stack hight, a rishing height by the momentum of the flue gas and a buoyant height by the temperature.

(1) Calculation of the effective hight

$$He = Ho + k\,(Hm + Ht) \quad \text{------------------------------} \quad (2 \cdot 8 \cdot 1)$$

Here,	He	(m)	: effective height.
	Ho	(m)	: actual stack height.
	Hm	(m)	: rising height by momentum.
	Kt	(m)	: bouyant height by temperature.
	k(0.5-0.75)		: correct coefficient.

(2) Calculation of Hm and Ht.

$$Hm = 4.77 \div (1 + 0.43\, u/V) \times \frac{(QV)^{\frac{1}{2}}}{U} \quad \text{------------------------} \quad (2 \cdot 8 \cdot 2)$$

$$Ht = 6.379 \times Q\,(T - T_1)/(U^3 . T_1) \times (\log e\, J^2 + J/2 - 2) \quad \text{--------------} \quad (2 \cdot 8 \cdot 3)$$

$$J = U^2/(Q.V)^{\frac{1}{2}} \times (0.43\,(T_1/g.G)^{\frac{1}{2}} - 0.28\, V/g \times T_1/(T - T_1) + 1 \quad \text{------------} \quad (2 \cdot 8 \cdot 4)$$

Say	U	(m/s)	: average wind velocity.
	V	(m/s)	: discharge velocity of flue gas.
	T	(^{o} k)	: temperature of flue gas.
	T_1	(^{o} k)	: temperature of atmosphere.
	g	(m. s^2)	: gravity.
	Q	(m^3/s)	: quantity of flue gas at Ti.
	G	(^{o}c/m)	: tempereture gradient of atmosphere.

(3) The increase of the effective height.

In order to increase the effective height of the stack, the following measures are enough.

a. To raise the temperature of flue gas.

b. To increase the discharge velocity.

In this case, mixing of the flue gas with air is quichened and offer the buoyant height decreases.

c. Down Wash Phenomena.

This is phenomena that the smake is rolled up into vortexes which grow on backside of the stack or is made by the near structure.

But this phenomena, the contaminated dencity become occasionally high locally.

d. To increase the discharge quantity

This is effective for the momentum height and the gathering type of the stack is disirable.

(4) The practical formula of the effective height.

The simplified formulas using constants are generally applied, according to the Japanese Law as below.

$H = Ho + 0.65 (Hm + Ht)$ -- (2·8·5)

$Hm = 0.795 (Q. V)^{\frac{1}{2}} / (1 + 2.58/V)$ ------------------------------ (2·8·6)

$Ht = 2.01 \times 10^{-3}.Q (T - 288) \times (2.3 \log J + 1/J - 1)$ ---------------- (2·8·7)

$J = 1/(Q \times V)^{\frac{1}{2}} \times (1460 - 296 \times V/(T - 288) + 1$ -------------------- (2·8·8)

(Example) : Calculation of the effective height.

Say : Ho = 80 m, V = 20m/s, T = 165°C.

T_1 = 15°C, U = 6m/s, G = 0,003°C/m.

d = 1,5m, (Diameter of stack out let).

Solution : Q = 24 m^3/s.

Hm = 15,4 m.

J = 66.

Ht = 23 m.

therefore He = 80 + 0.65 (15.4 + 23) = 105 m.

2-8-2 Dencity on the ground level (Sutton's Formula).

In the regulation, the environmental contaminated dencity is on important controlling condition.

Accordingly, the decity of the smoke on the ground level must be cetimated. For this purpose, the use of the dispersion fromula of the smoke is important. Several theoritical formulas are known supposing the dispersive condition of the atmosphere.

Sutton's Formula at first has been obtained as theoritical formula. However, it is present considered one of the experimental formulase and with adequate coefficients, used for the calculation of the contamination.

(1) Formula of the Dencity of Ground Level

$C\ max = 2/ (e \pi).\ cz/cy\ .\ Q/(uH^2e)$ .... (2·8·9)

$X\ max = (He/cz)^{\frac{2}{(2 - n)}}$ .... (2·8·10).

Say C max (ppm) : max. dencity on ground level

cz : dispersion variable (vertical).

cy : dispersion variable (horizontal).

n : coefficient by weather condition.

Q (Nm^3/s) : quantity fo discharged contamination.

He (m) : effective height.

X max. : distance to the max dencity point

cy, cz and n values are influenced by the weather, condition, stack height, measuring time and so on.

Experimental values are shown.

(2) Calculation of the Dencity an the ground Level.

Formula (2.8.9) can be simplified appling the general constants.

$$q = 5.85 \times 10^{-1} \times He^2 \cdot P\ max. \quad \cdots\cdots \quad (2\cdot8\cdot11)$$

Say q (Nm^3/h) : permissible quantity of discharged contamination.

He (m) : effective height.

P max. (ppm) : max. dencity above ground.

cz = cy = 0.1, n = 0.25.

1 = 0.15 hourly dilution factor if P max. value is designated.

$$q = K_I \times 10^{-1} \times He^2 \quad \cdots\cdots \quad (2\cdot8\cdot12)$$

for instance,

P max. = 0.022 pum = 2.2×10^{-2}.

$$q = K \times 10^{-3} \times He^2 \quad \cdots\cdots \quad (2\cdot8\cdot13)$$

q value of this formula is controlled by the regulation.

Relations between P max. and K value, are shown beforehand and the designation of K is different locally. q is a permissible quantity of the discharged contamination gas.

Table 2·8·1

K - value	5.9	11.7	17.5	23.3	29.2
P max. (ppm)	0.01	0.02	0.03	0.04	0.05

from (2.8.11) . (2.3.13) formulae

X max. the distance from the stack to the max. dencity point is shsown below.

$$X\ max. = (He/cz)^{\frac{2}{(2-n)}} \quad \cdots\cdots \quad (2\cdot8\cdot14)$$

Say X max. (m). : distance.

cz : 0.1

n : 0.25

(3) Example

From the stack, height 50m, diameter 2 m, flue gas including 0.1% SO2 gas is discharged with the temperature 200°C and the velocity 12 m/s.

At the temperature gradient 0.0033°C/m, wind velocity 5m/s, and the atmospheric temperature 15°C, the max dencity on the ground level and, its distance can be calculated.

Suppose n = 0.25, cz = 0.1 cy = 0.46.

solution:

Q = 23 m^3/s.

Hm = 13.5 m from formula (2.8.2).

J = 63.5 from formula (2.8.4).

Ht = 46.9 m from formula (2.8.3).

He = 89.2 m from formula (2.8.1).

q = 0.023 m^3/s.

therefore :

C max. = 0.029 ppm. from formula (2.8.9).

X max. = 2015 m from formula (2.8.14).

Table 2·8·2

No	OUT PUT	STACK HEIGHT	GAS VELOCITY	EFFECTIV HEIGHT	MAX CONTAMINATION	DISTANCE
	(MW)	Ho (m)	Vo (m/s)	He (m)	C max. (p.p.m)	X max (Km)
1.	25	50	5	51.8	0.006	1.9
2.	50	50	5	53.3	0.012	2.0
3.	100 x 2	60	5	71.6	0.023	2.8
4.	"	"	10	73.4	0.022	2.8
5.	"	"	15	75.0	0.021	2.9
6.	"	"	20	76.3	0.020	3.0
7.	"	70	5	81.6	0.017	3.2
8.	"	"	10	83.7	0.017	3.3
9.	"	"	15	85.0	0.016	3.3
10.	"	"	20	86.3	0.015	3.4

Fig. 2·8·1 SO_2 Gas Dencity Calculation (Rough Estimation)

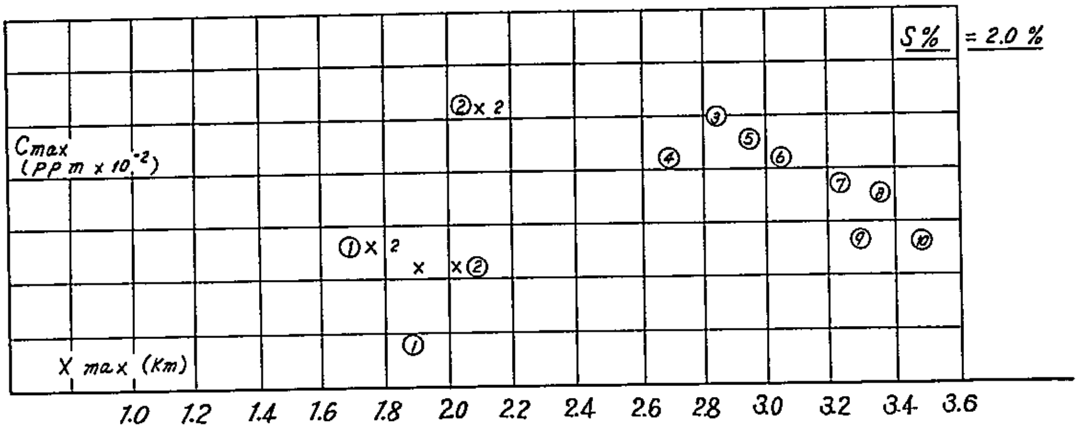
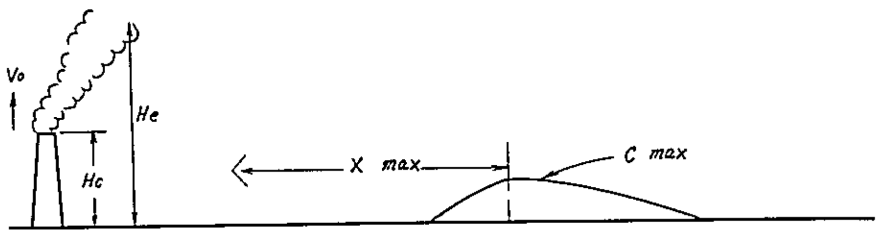


Fig. 2·8·2



2-9 Dilution of Stack Emission is Affected by Climatic Conditions

Stack disharge of coal and oil fired steam electric generating units is considered to disperse in the atmosphere generally according to the formulae given above. However, when stack emissions are not blown high up in the air, the dispersion of stack emissions may some times by affected by the inverse layer or strong wind and may not satisfy requirements for particulate mater. Under these unfavorable climatic conditions, a workable solution of the poor dispersion is a tall stack, or a multiple tube stack system, or a stack fitted with a nozzle or a combination of these advance plans.

2-9-1 Effects to be Produced by the Inverse Layer and Measures for Removal of these Effects

The air temperature on earth normally grows lower in proportion to a higher position in altitudes and grows higher in proportion to a lower position in altitudes. However, when the atmospher is stagnant with not a breath of wind stirring, the temperature situation written above may in some regions be reversed.

Under such climatic conditions, if emissions from power plant stacks or from various industrial processes are not blown up high enough, particulates, sulfur and nitrogen oxides will cease to flow under the inverse layer of atmospheric temperature. This situation is expected to result in a substantial pollution. However, if stack gasses are blown up high enough, stack discharge breaks through the inverse layer, and emissions will be dispersed over a wide area.

Fig. 2·9·1 (No. 1) Effects to be Produced Under Climatic Conditions - 1

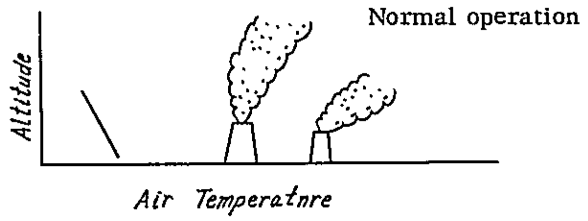
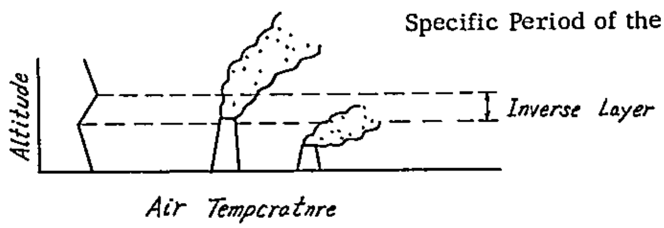


Fig. 2·9·1 (No. 2) Effects to be Produced Under Climatic Conditions - 2

Operation during a Specific Period of the Inverse Layer



2-9-2 Prevention of Ground Level Accumulation of Stack-Emissions.

When a strong wind blows, the stack emissions including particulates, sulfur and nitrogen oxides will sometimes be blown down to the ground level before the dispersion of pollutants will be completed. To remove this nuisance, a variety of plans have been laid out. Among them are an adoption of the tall stack system and an installation of a nozzle on a stack to gain gas emission velocity.

2-9-3 Surmounting the Down Wash

When a strong wind blows, a hollow place (pocket) is created often to the leeward of a stack. Influenced by the reduced atmospheric pressure in this down wash, the stack discharge ascending power is lost. But by increasing the vomiting speed of stack discharge, the loss factor will be alleviated.

Tests indicated that the stack discharge, if its vomiting speed is raised twice as high as the wind velocity, could go up into the atmosphere unaffected by the wind. So the stack system is normally designed to have a vomiting speed of 30m/sec recently.

2-9-4 Overcoming the Down Draft

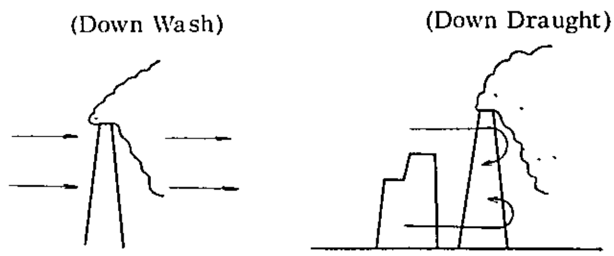
When a down draft arises, depending upon the direction of the draft, a disturbance in the air is produced to the leeward of a power plant building. As the atmospheric pressure is reduced in this area, the dust emissions from the stack are liable to seizure in this low pressure area. Consequently the vomiting speed of stack discharge is greatly reduced.

To avoid this awkward situation, utilities should make plant arrangements taking the wind way into consideration, and furthermore equip their plants with tall stack systems.

In this connection, it has been established that the height of the stack shall be not less than 2.5 times that of the plant building, if utilities desire to be relieved of this awkward situation.

In case of the multiple tube stack system which permits discharge of flue gases from two or more steam electric generating units, the stack system would prove more effective during a high wind period, because the buoyancy of flue gases is larger for the reasons of quantity of flue gases and of slow speed of cooling down.

Fig. 2·9·2 Effects to be Produced on Stack Emissions by a Strong Wind

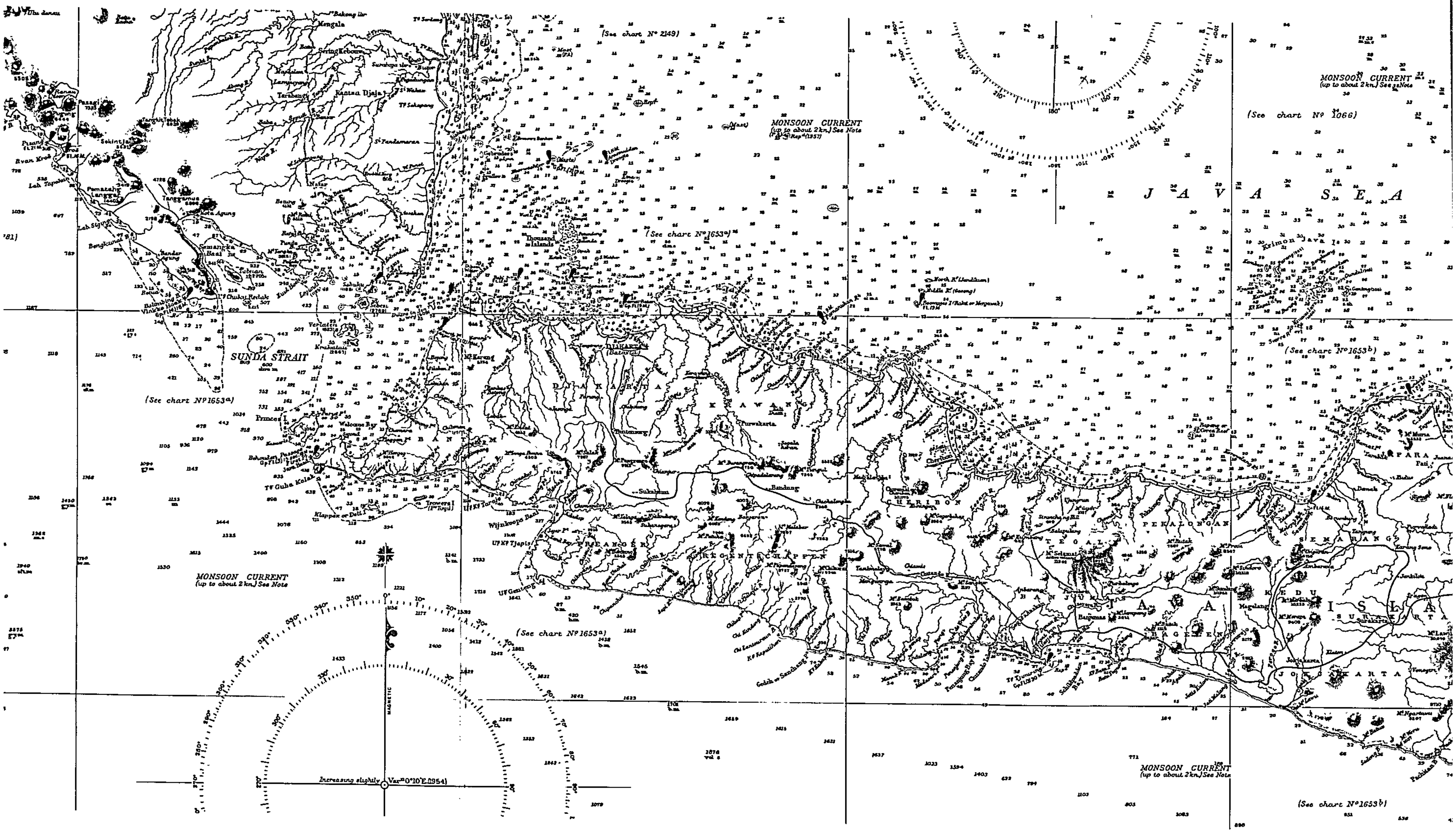


3. CONCERNING THE ENVIRONMENTAL CONDITIONS IN INDONESIA

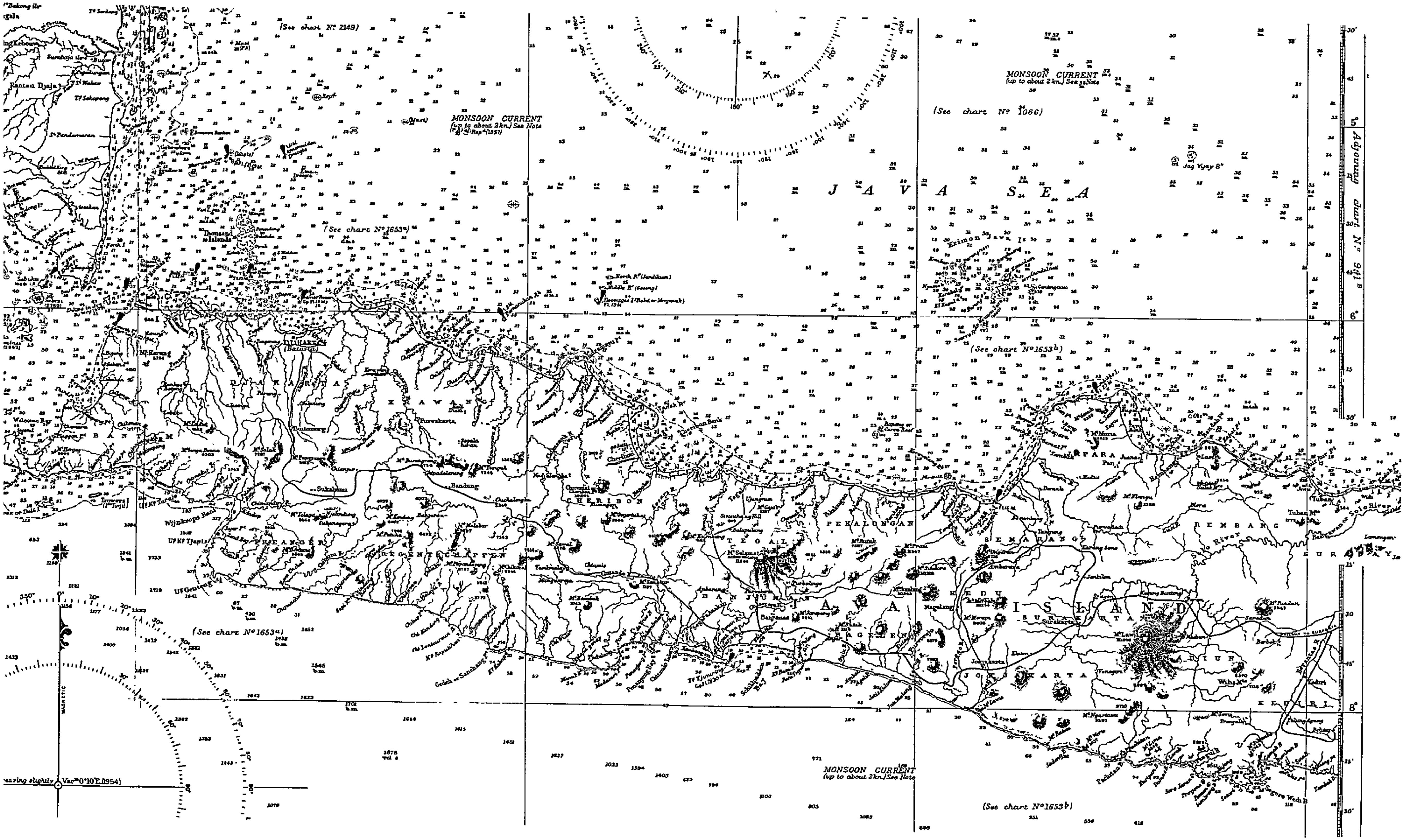
3-1 Sea Chart

1. Around the Jawa Island
2. Around the Jakarta
3. Surabaya
4. Surabaya Channel
5. Cilacap
6. Around the Cilacap
7. Semarang
8. Merak
9. Cirebon
10. Pekalongan'
11. Tegal
12. Around the Probolinggo
13. Belawan
14. Dumai
15. Balikpapan
16. Banten

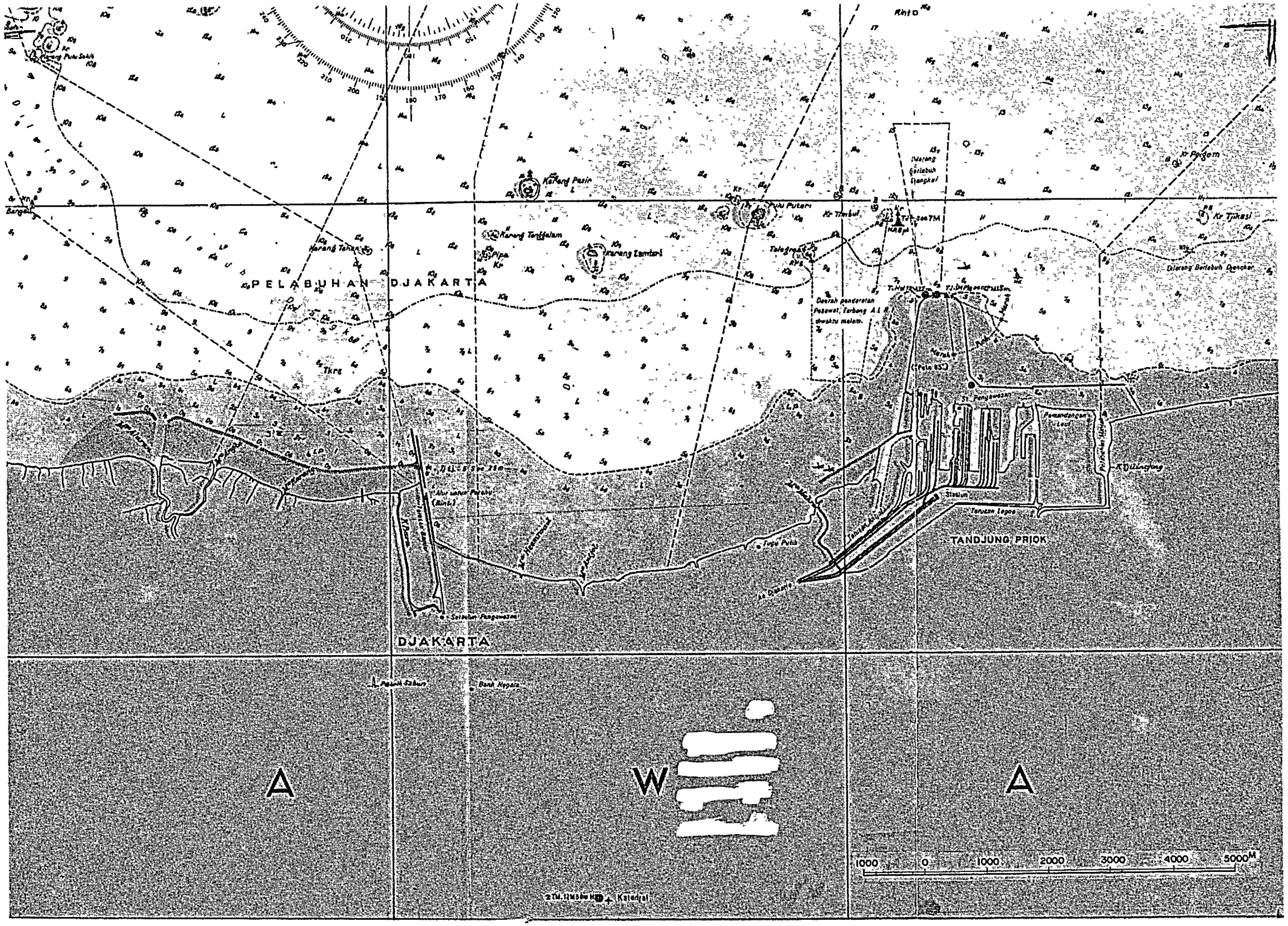
1. AROUND THE JAWA ISLAND



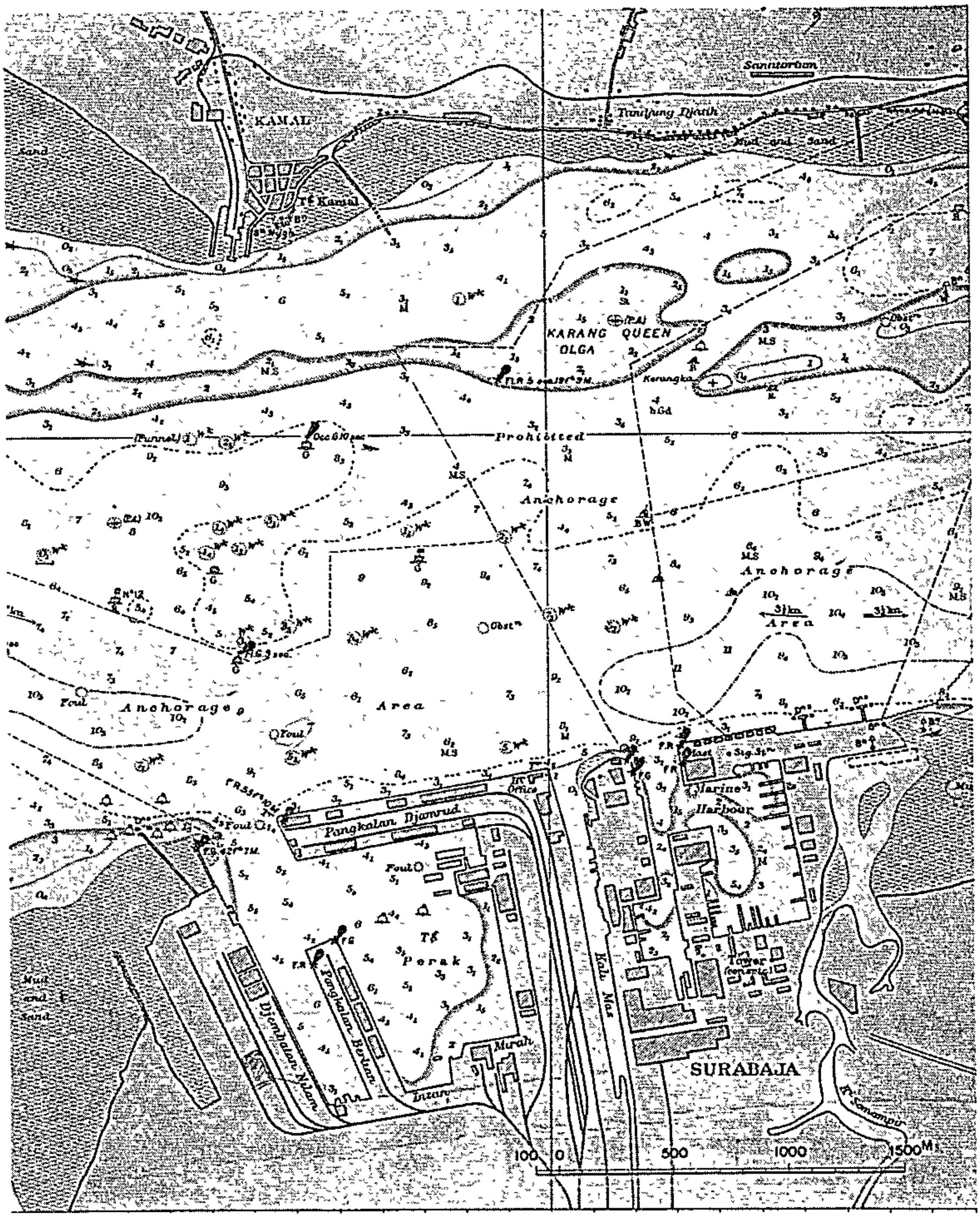
1. AROUND THE JAWA ISLAND



2. AROUND THE JAKARTA



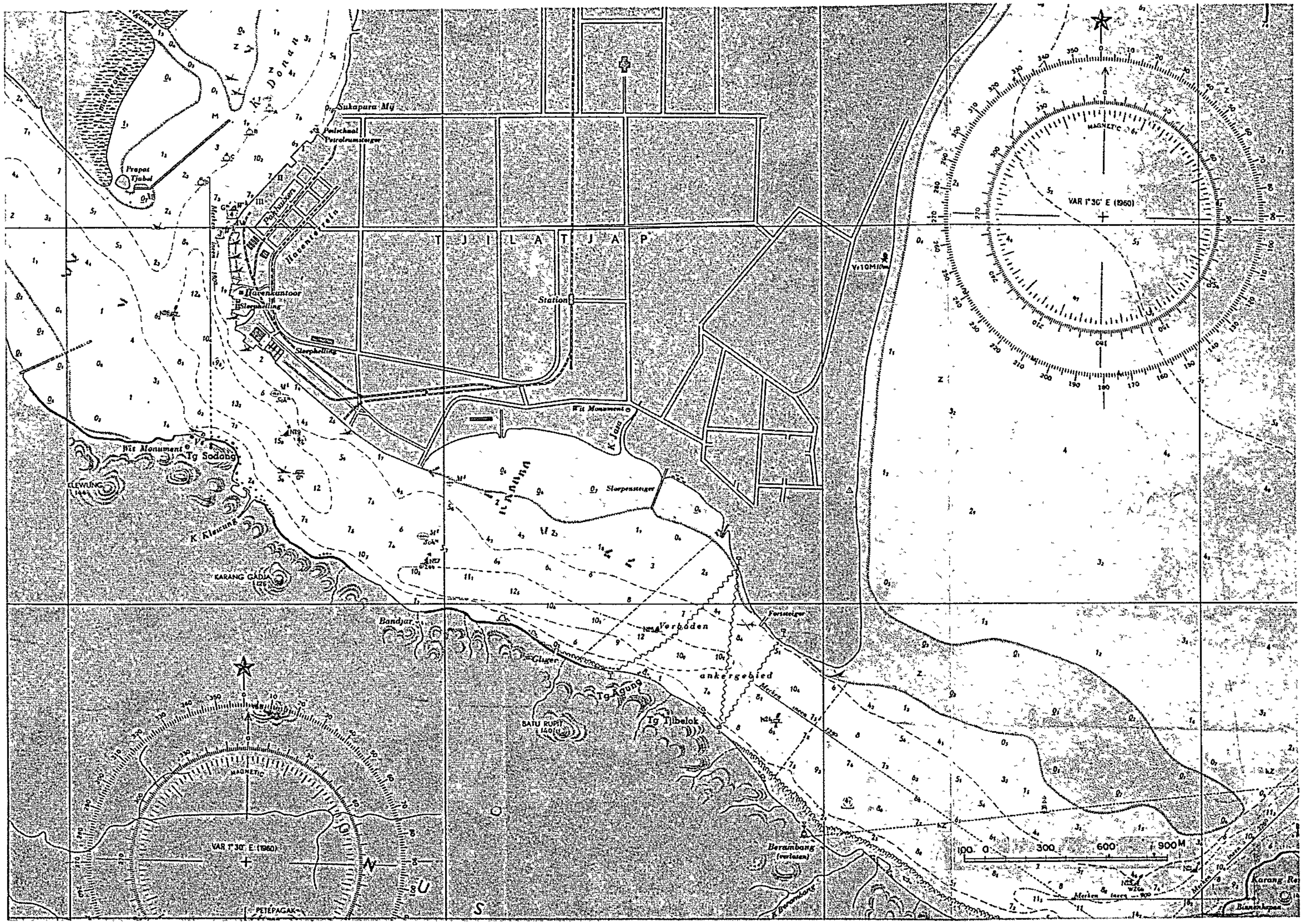
3. SURABAYA



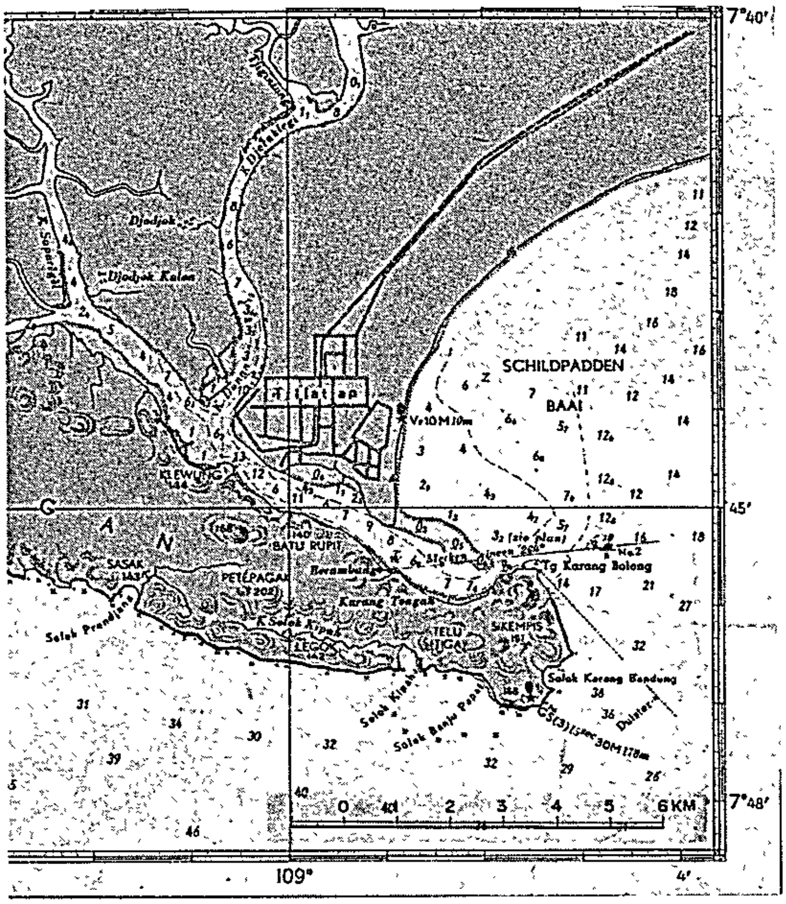
KAMAL
Sanatorium
Mud and Sand
KARANG
OLGA
QUEEN
Prohibited
Anchorage
Area
Pangkalan Djamrud
Marine
Harbour
SURABAJA
100
0
500
1000
1500M

4. SURABAYA CHANNEL

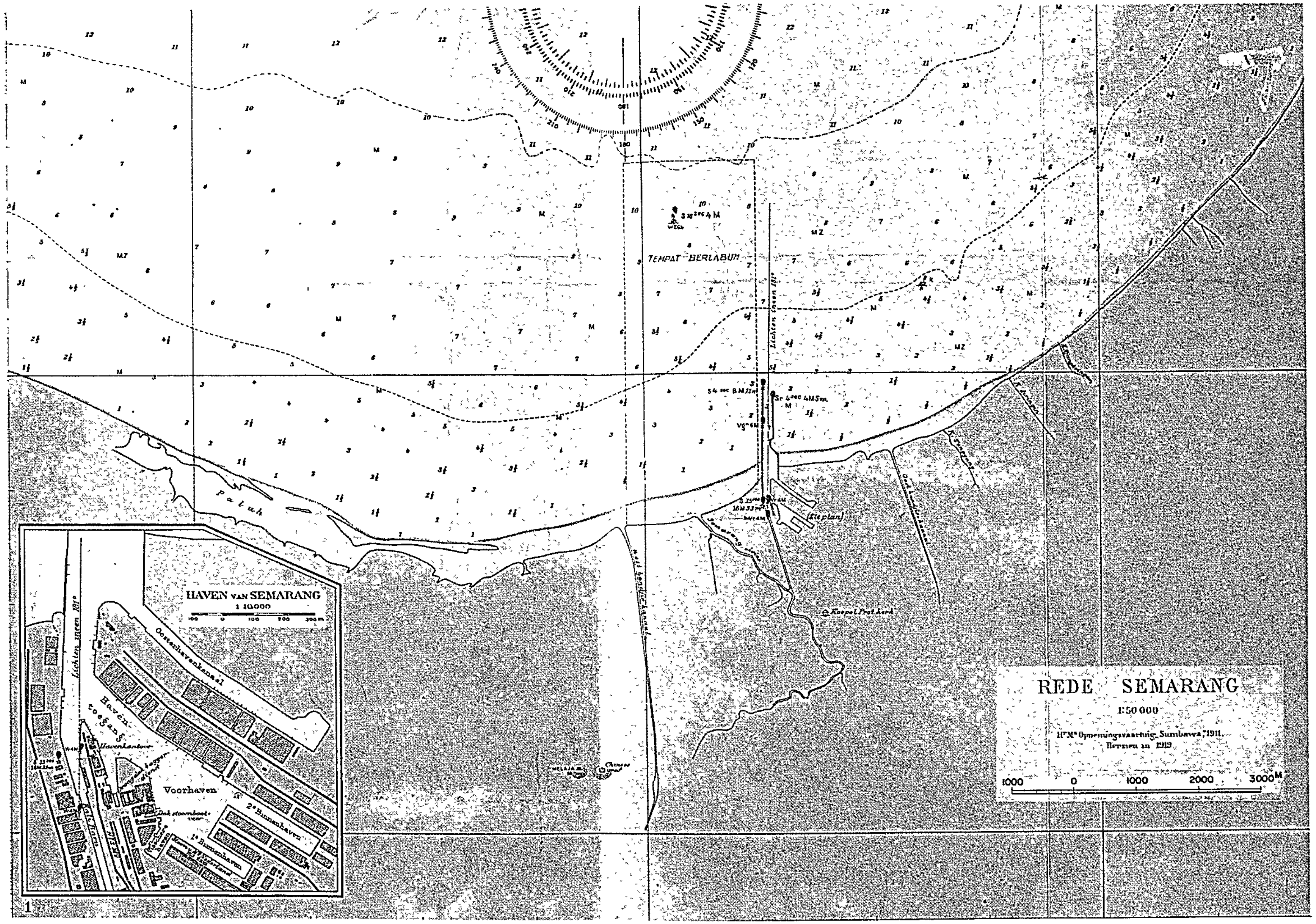
5. CILACAP


TJILATJAP
Sukapura Mij
Havenkantoor
Station
Wit Monument
Tg Sodong
Wit Monument
Sloepensteiger
Verboden
ankergebied
K. Kleciung
KARANG GADJA
Bandjar
Gliger
Tg Agung
Tg Tjibelok
BATU RUPIT
Berambang
Fortsteiger
VAR 1°30' E (1960)
MAGNETIC
100 0 300 600 900M
PETEPAGAK
Karang Re

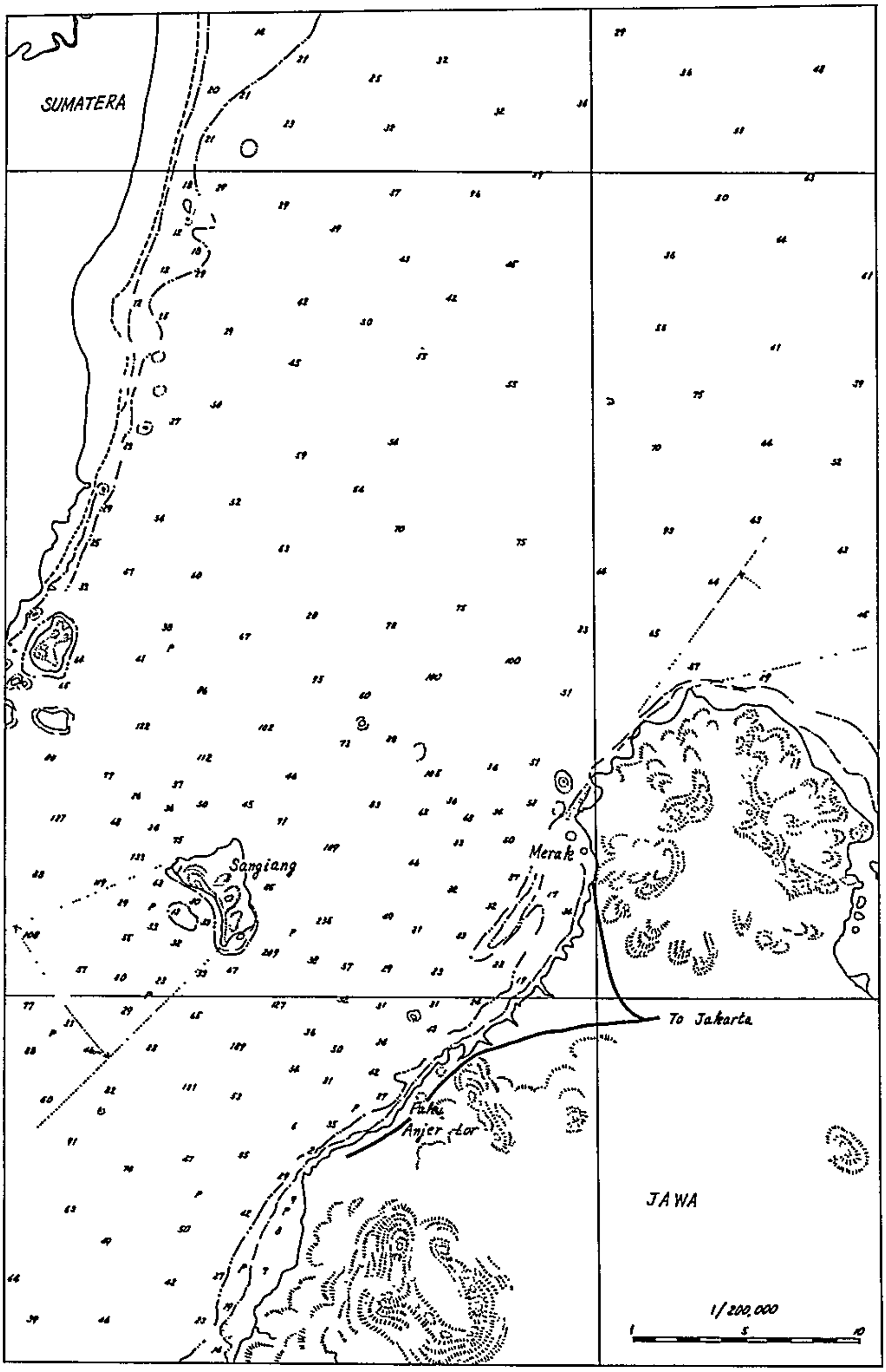
6. AROUND THE CILACAP



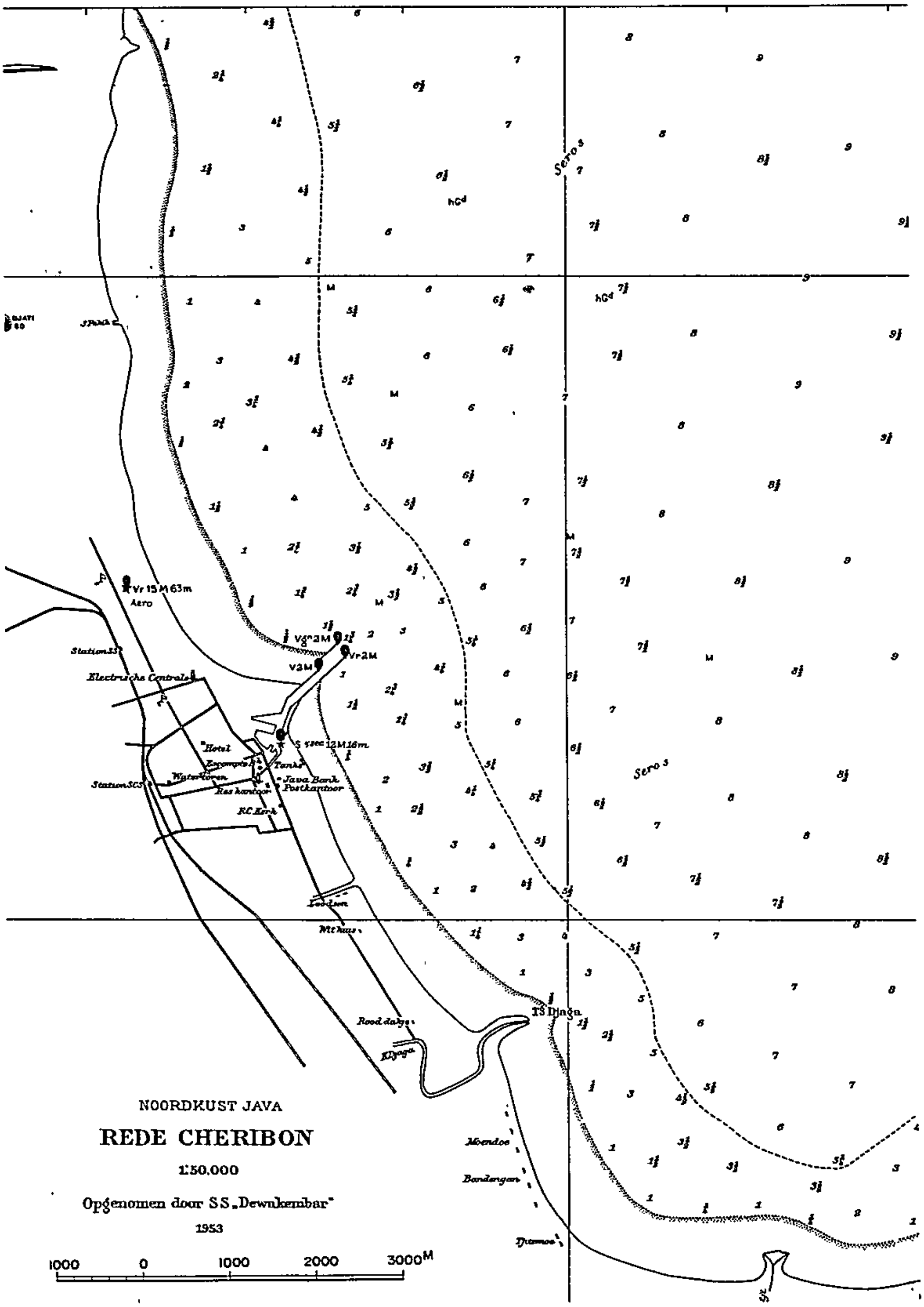
7. SEMARANG


REDE SEMARANG
1:50 000
1000 0 1000 2000 3000M
HAVEN VAN SEMARANG
1:10.000
TEMPAT BERLABUH
Voorhaven
Palah

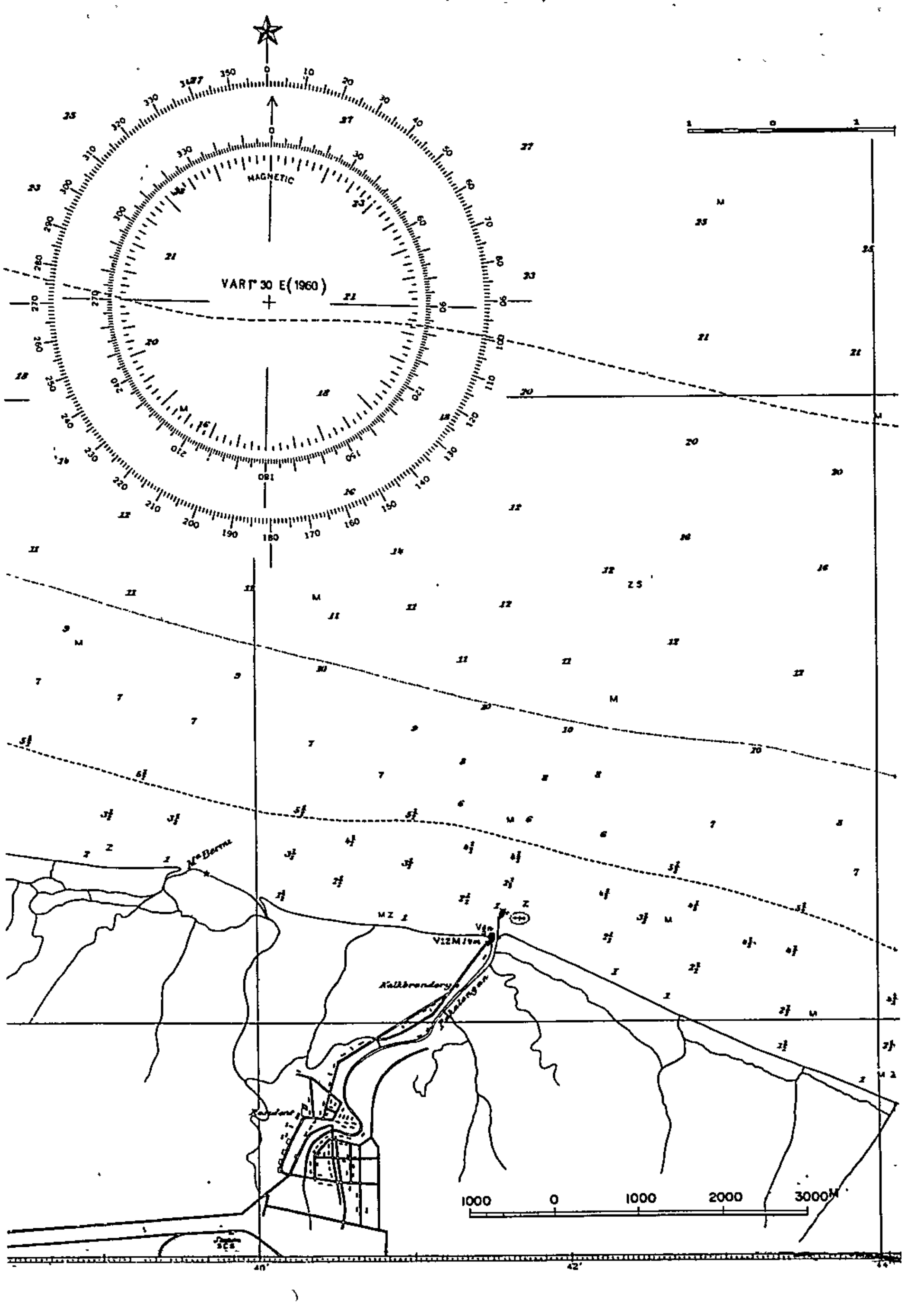
8. MERAK



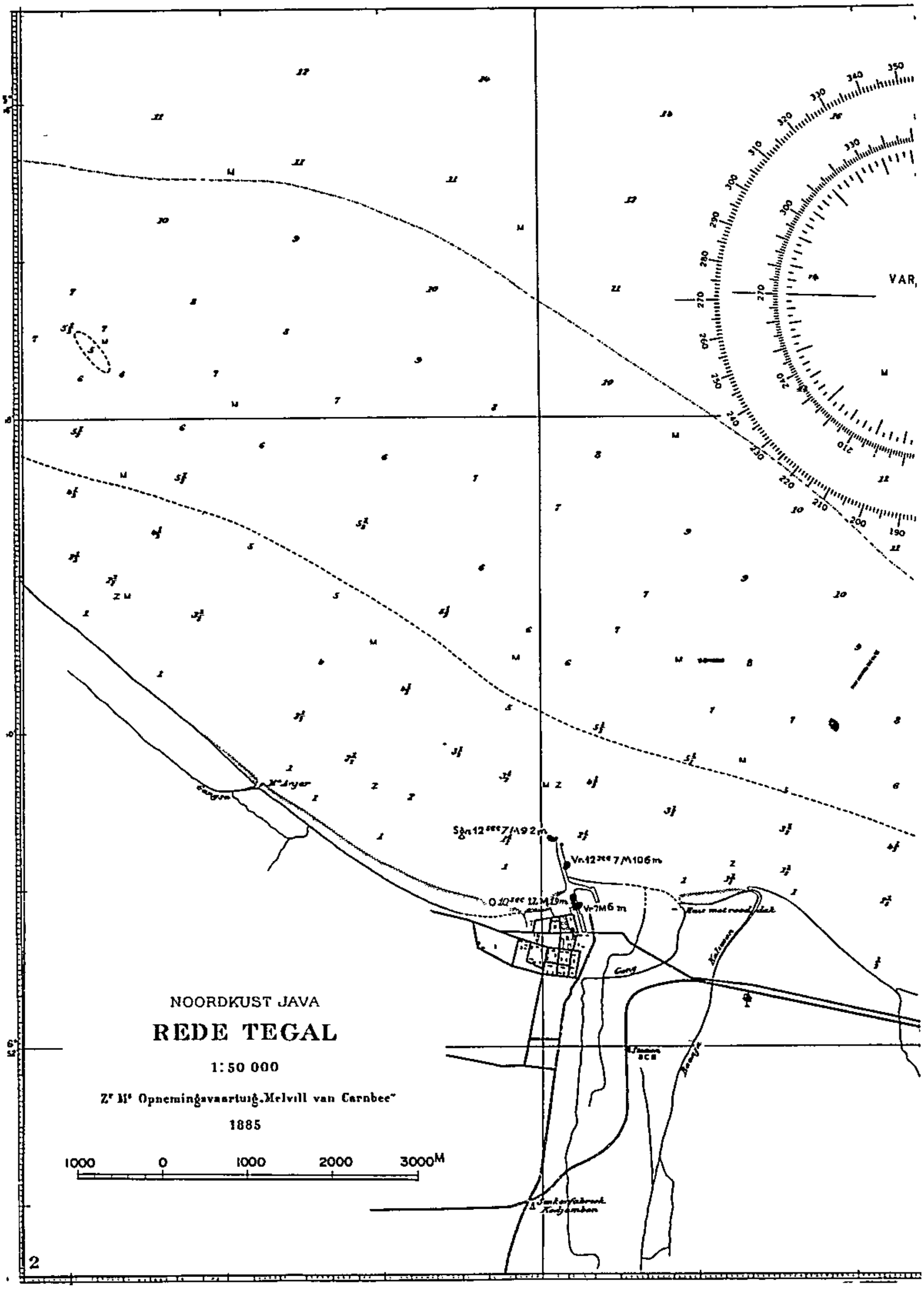
9. CIREBON


Vr 15 M 63m
Aero
V 2 M
Vr 2 M
Electrische Centrale
Hotel
Tanks
Java Bank
Postkantoor
R.C.Kerk
Sero
Moendoe
Bandengan
NOORDKUST JAVA
REDE CHERIBON
1:50.000
Opgenomen door SS „Dewakembar"
1953
1000 0 1000 2000 3000M

10. PEKALONGAN'

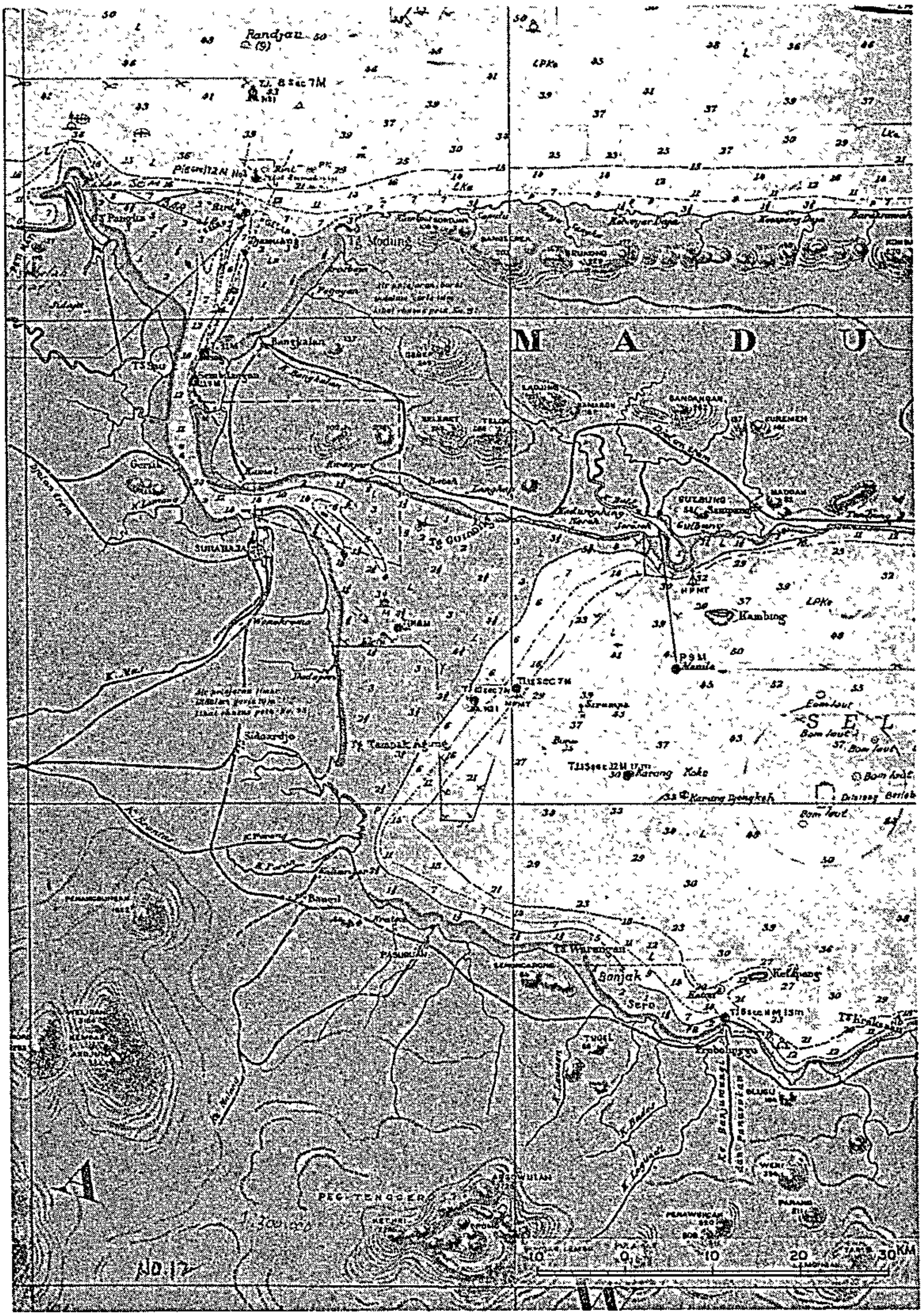


11. TEGAL

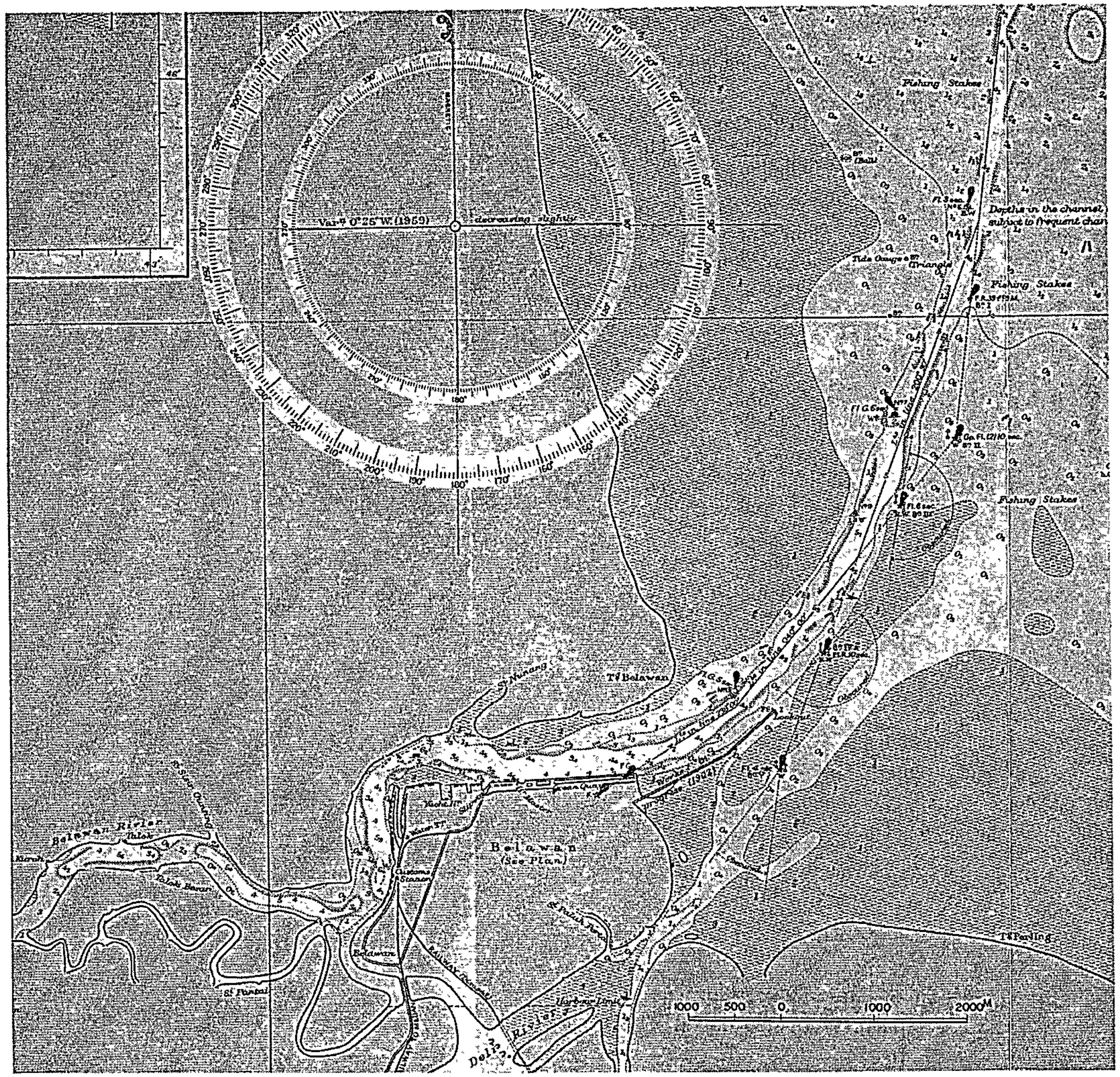


NOORDKUST JAVA
REDE TEGAL
1:50 000
Zr Mt Opnemingsvaartuig „Melvill van Carnbee"
1885
1000 0 1000 2000 3000M
VAR.
2

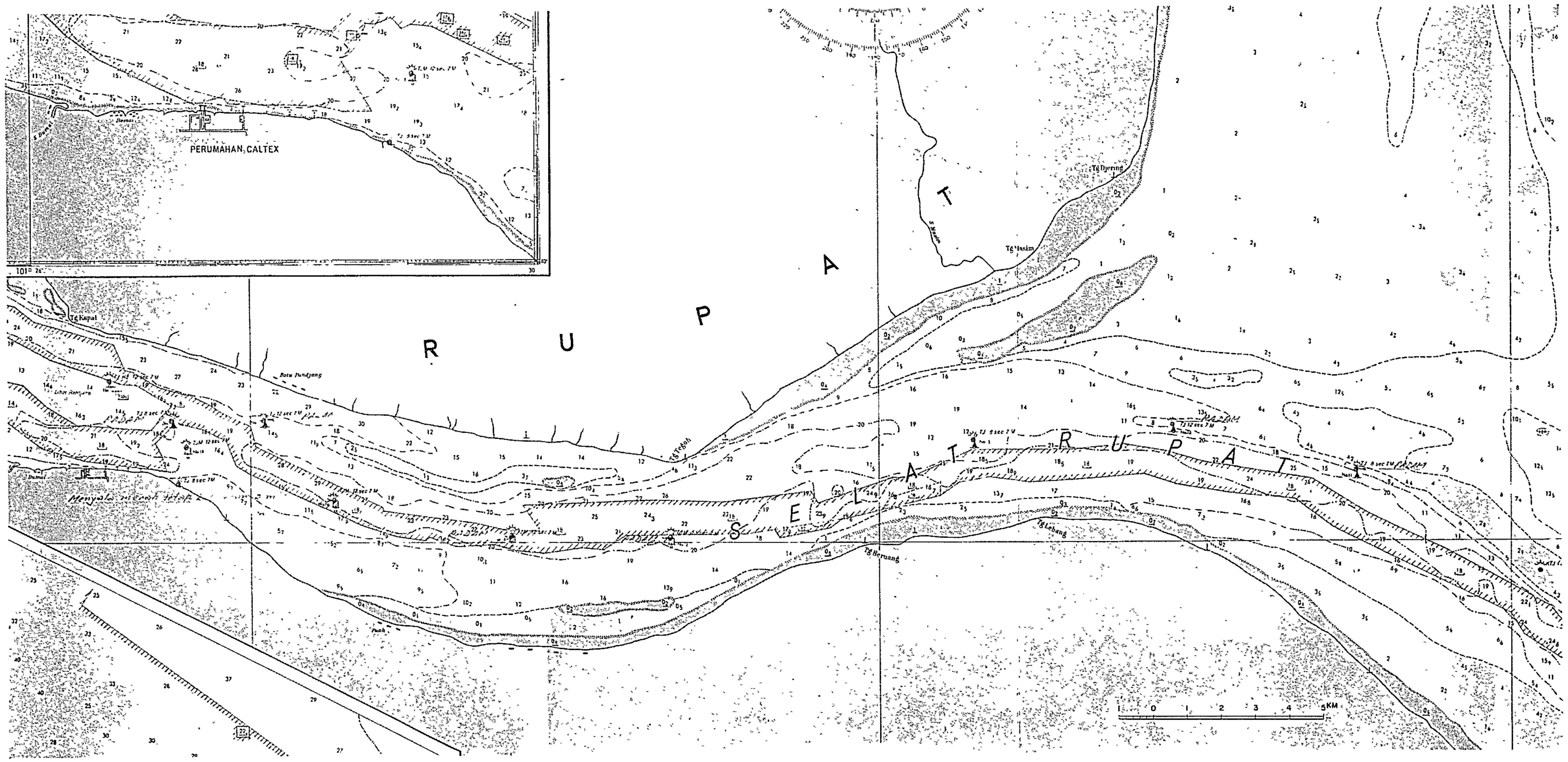
12. AROUND THE PROBOLINGGO



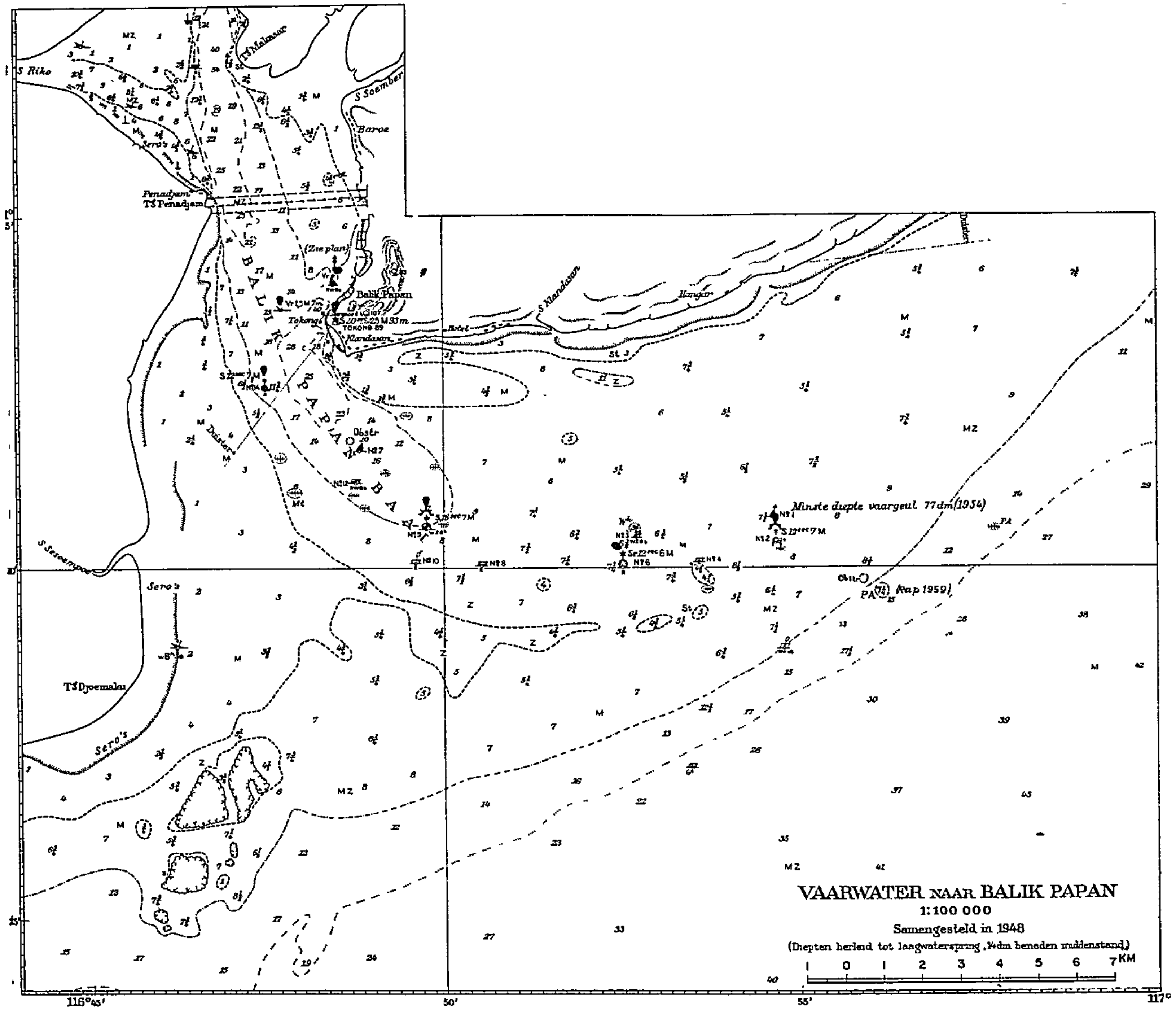
13. BELAWAN

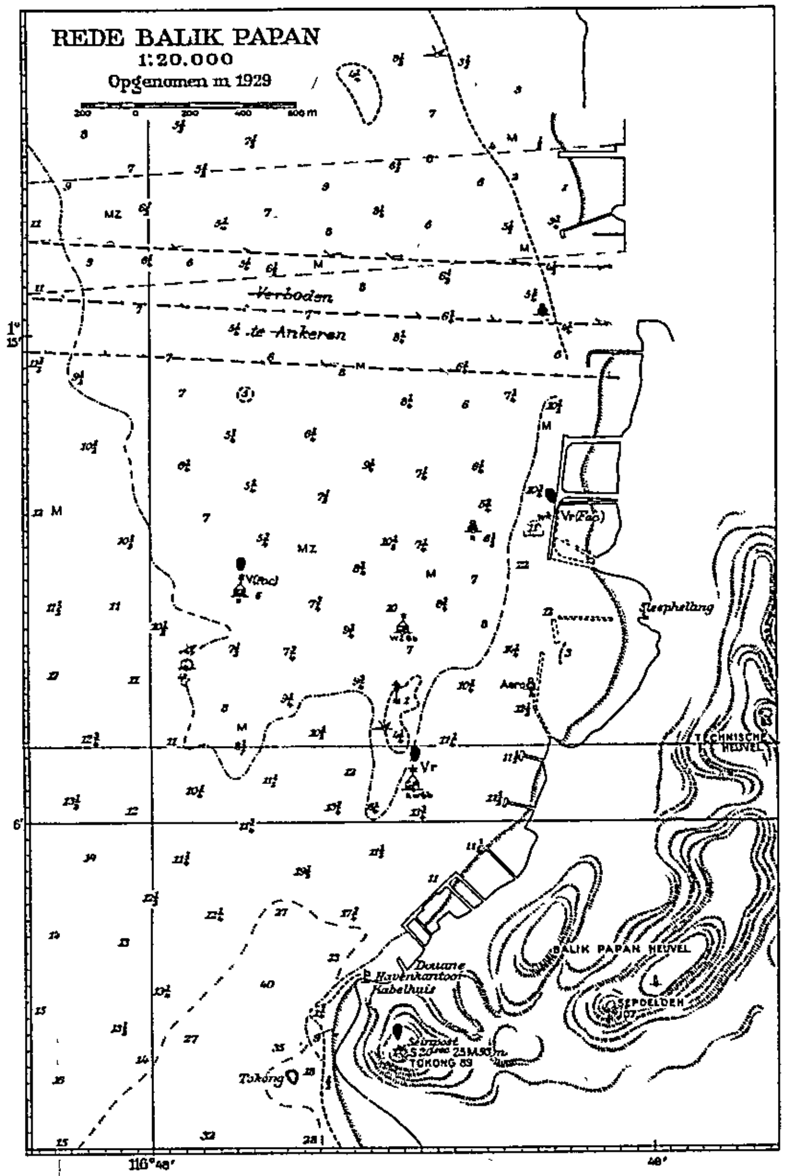

Var. 0°25'W (1959) decreasing slightly
Fishing Stakes
Depths in the channel subject to frequent changes
Fishing Stakes
Fishing Stakes
Tide Gauge
Tg Belawan
Belawan Rivier
Belawan
(See Plan)
Tg Pardling
1000 500 0 1000 2000M

14. DUMAI

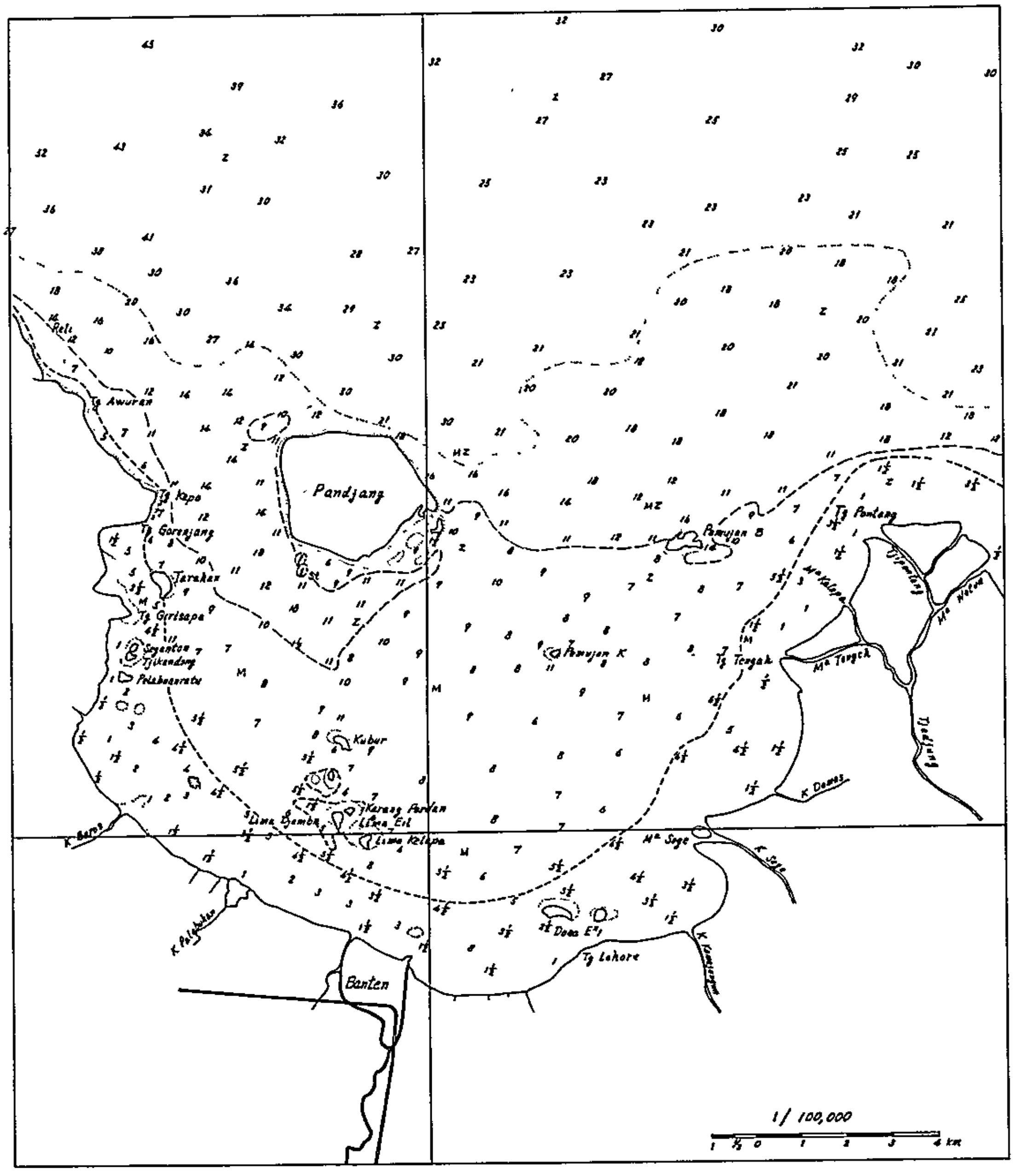


15. BALIKPAPAN





16. BANTEN


Pandjang
Tg Awuran
Tg Kapo
Tg Gorenjang
Terahan
Tg Girisapa
Kubur
Pamujan B
Pamujan K
Tg Pontang
Tg Tengah
K Dowos
K Sage
Tg Lohore
Banten
1/ 100,000

3-2 Wind

Basic Data for Wind Rose of Representative Site in Indonesia

Wind Velocity in 1958

Wind velovity data is shown in following table for each month and each direction

Site	Zone	(m/sec) 0	1～3.0	3.3～8.3	8.6～14	14.1～20.5	Total
(1) Jakarta	West Jawa	(15.6%) 1395	(52.5) 4704	(29.0) 2583	(2.9) 250	(0) 0	(100) 8932
(2) Semarang	Central. J	(21.5) 1098	(40.0) 2020	(38.4) 1936	(0.1) 8	(0) 0	(100) 5062
(3) Bogor	West. Jawa	(40.2) 1167	(42.7) 1237	(16.3) 470	(0.6) 19	(0.2) 3	(100) 2896
(4) Surabaya	East. Jawa	(26.2) 2278	(27.5) 2386	(44.5) 3858	(1.8) 154	(0) 2	(100) 8678
(5) Palembang	Sumatra	(48.0) 2432	(23.2) 1181	(26.8) 1362	(2.0) 93	(0) 7	(100) 5075
(6) Pakan Baru	Sumatra	(35.3) 1546	(31.8) 1399	(31.3) 1369	(1.6) 58	(0) 2	(100) 4374
(7) Medan	Sumatra	(71.5) 6203	(8.0) 704	(17.3) 1504	(3.0) 257	(0.2) 8	(100) 8676
(8) Balikpapan	Kalumantan	(30.6) 1506	(47.0) 2311	(22.4) 1097	(0) 0	(0) 0	(100) 4914
(9) Denpasar	Bali	(22.8) 1248	(26.0) 1429	(51.0) 2795	(0.1) 3	(0.1) 1	(100) 5476

(1) Station JAKARTA
Times of observation: 24 hours

Long : 106° 51'E
Lat 06° 09'S
Height above sea level : 5
Local time = GMT + 7h 30 m

Month JANUARY Year 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	127	–	–	–	–	–	–	–	–	127
N	–	9	27	44	17	2	–	–	–	99
NE	–	8	9	1	–	–	–	–	–	18
E	–	3	8	–	–	–	–	–	–	11
SE	–	22	18	–	–	–	–	–	–	40
S	–	88	61	12	1	–	–	–	–	162
SW	–	34	29	9	5	–	–	–	–	77
W	–	10	35	33	8	1	–	–	–	87
NW	–	7	19	42	51	3	1	–	–	134
Total	127	181	208	139	82	6	1	–	–	744

Month FEBRUART Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	115	–	–	–	–	–	–	–	–	115
N	–	10	13	20	19	–	–	–	–	62
NE	–	6	3	–	–	–	–	–	–	9
E	–	1	2	–	–	–	–	–	–	3
SE	–	7	6	1	–	–	–	–	–	14
S	–	37	35	6	2	–	–	–	–	80
SW	–	28	35	38	23	6	–	–	–	130
W	–	19	28	45	27	6	–	–	–	125
NW	–	2	12	46	64	10	–	–	–	134
Total	115	110	134	156	135	22	–	–	–	672

Month MARCH Year 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	125	–	–	–	–	–	–	–	–	125
N	–	2	17	56	11	4	–	–	–	90
NE	–	5	7	5	–	–	–	–	–	17
E	–	8	10	2	–	–	–	–	–	20
SE	–	25	25	1	1	–	–	–	–	52
S	–	49	37	12	–	1	–	–	–	99
SW	–	37	59	36	4	2	–	–	–	138
W	–	17	36	44	15	1	–	–	–	113
NW	–	5	15	44	21	4	–	–	–	89
Total	125	148	206	200	52	12	–	–	–	743

Month APRIL Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	122	–	–	–	–	–	–	–	–	122
N	–	11	43	65	18	–	–	–	–	137
NE	–	14	28	11	5	–	–	–	–	58
E	–	18	47	37	2	–	–	–	–	104
SE	–	35	28	12	–	–	–	–	–	75
S	–	74	64	6	2	–	–	–	–	146
SW	–	12	15	5	–	–	–	–	–	32
W	–	6	9	1	–	–	–	–	–	16
NW	–	–	8	13	7	–	–	–	–	28
Total	122	170	242	150	34	–	–	–	–	718

Month : MAY Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	126	–	–	–	–	–	–	–	–	126
N	–	11	43	72	8	–	–	–	–	134
NE	–	14	41	11	–	–	–	–	–	66
E	–	25	28	7	1	–	–	–	–	61
SE	–	45	40	5	2	–	–	–	–	92
S	–	80	55	8	–	–	–	–	–	143
SW	–	23	22	12	2	–	–	–	–	59
W	–	6	7	2	1	–	–	–	–	16
NW	–	4	23	15	1	–	–	–	–	43
Total	126	208	259	132	15	–	–	–	–	740

Month : JUNE Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	109	–	–	–	–	–	–	–	–	109
N	–	7	26	57	11	–	–	–	–	101
NE	–	14	39	33	10	–	–	–	–	96
E	–	8	25	16	7	–	–	–	–	56
SE	–	40	49	11	2	–	–	–	–	102
S	–	92	62	9	1	–	–	–	–	164
SW	–	11	22	11	–	–	–	–	–	44
W	–	1	4	3	–	–	–	–	–	8
NW	–	4	12	16	5	–	1	–	–	38
Total	109	177	239	156	36	–	1	–	–	718

Month : JULY　　　Year · 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	150	–	–	–	–	–	–	–	–	150
N	–	1	28	43	15	–	–	–	–	87
NE	–	6	35	26	1	–	–	–	–	68
E	–	16	36	24	7	–	–	–	–	83
SE	–	85	59	12	–	–	–	–	–	156
S	–	65	41	8	–	–	–	–	–	114
SW	–	9	13	6	1	–	1	–	–	30
W	–	6	8	2	3	–	–	–	–	19
NW	–	2	15	17	3	–	–	–	–	37
Total	150	190	235	138	30	–	1	–	–	744

Month · AUGUST　　　Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	113	–	–	–	–	–	–	–	–	113
N	–	6	24	51	24	–	–	–	–	105
NE	–	14	28	30	6	–	–	–	–	78
E	–	22	43	17	8	–	–	–	–	90
SE	–	49	33	10	1	–	–	–	–	93
S	–	95	71	12	1	–	–	–	–	179
SW	–	16	14	9	1	–	–	–	–	40
W	–	2	3	3	–	–	–	–	–	8
NW	–	3	16	17	2	–	–	–	–	38
Total	113	207	232	149	43	–	–	–	–	744

Month : SEPTEMBER　　　Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	93	–	–	–	–	–	–	–	–	93
N	–	6	27	52	34	1	–	–	–	120
NE	–	17	34	29	13	1	–	–	–	94
E	–	20	38	24	5	–	–	–	–	87
SE	–	46	36	6	1	–	–	–	–	89
S	–	96	76	14	1	–	–	–	–	187
SW	–	8	5	1	1	–	–	–	–	15
W	–	3	2	4	–	–	–	–	–	9
NW	–	2	5	13	5	–	–	–	–	25
Total	93	198	223	143	60	2	–	–	–	719

Month . OCTOBER　　　Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	92	–	–	–	–	–	–	–	–	92
N	–	7	27	45	21	–	–	–	–	100
NE	–	5	11	19	5	–	–	–	–	40
E	–	12	22	13	3	–	–	–	–	50
SE	–	32	28	1	–	–	–	–	–	61
S	–	83	65	21	5	–	–	–	–	174
SW	–	35	71	23	4	–	–	–	–	133
W	–	8	5	7	2	–	–	–	–	22
NW	–	3	7	37	24	1	–	–	–	72
Total	92	185	236	166	64	1	–	–	–	744

Month　NOVEMBER　　　Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	112	–	–	–	–	–	–	–	–	112
N	–	3	23	48	17	–	–	–	–	91
NE	–	2	11	6	3	–	–	–	–	22
E	–	10	14	6	2	–	–	–	–	32
SE	–	19	29	2	2	–	–	–	–	52
S	–	82	63	32	4	1	–	–	–	182
SW	–	24	57	32	12	2	–	–	–	127
W	–	7	12	11	8	4	–	–	–	42
NW	–	5	7	25	17	3	–	–	–	57
Total	112	152	216	162	65	10	–	–	–	717

Month : DECEMBER　　　Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	111	–	–	–	–	–	–	–	–	111
N	–	8	8	23	5	–	–	–	–	44
NE	–	4	1	–	–	–	–	–	–	5
E	–	10	5	–	–	–	–	–	–	15
SE	–	26	9	2	–	–	–	–	–	37
S	–	45	52	11	1	1	–	–	–	110
SW	–	38	53	46	12	2	–	–	–	152
W	–	12	34	52	13	2	1	–	–	113
NW	–	12	31	63	47	4	–	–	–	157
Total	111	155	193	197	78	193	1	–	–	744

(2) Stations: SEMARANG KALIBANTENG. Long 110° 23'E
Times of observation: 0000 - 1200 GMT and 2300 GMT. Lat : 06° 59'S
Height above sea level : 3 m
Local time = GMT + 7h · 30 m

Month : JANUARY Year 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	100	–	–	–	–	–	–	–	–	100
N	–	1	5	14	1	–	–	–	–	21
NE	–	5	4	3	–	–	–	–	–	12
E	–	7	9	11	–	–	–	–	–	27
SE	–	4	3	1	–	–	–	–	–	8
S	–	5	8	4	1	–	–	–	–	18
SW	–	5	27	10	1	–	–	–	–	43
W	–	3	16	32	17	–	–	–	–	68
NW	–	6	38	75	18	–	–	–	–	137
Total	100	36	110	150	38	–	–	–	–	434

Month : FEBRUARY Year 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	111	–	–	–	–	–	–	–	–	111
N	–	3	6	5	1	–	–	–	–	15
NE	–	1	2	–	–	–	–	–	–	3
E	–	8	1	1	–	–	–	–	–	10
SE	–	1	5	–	–	–	–	–	–	6
S	–	2	3	2	–	–	–	–	–	7
SW	–	8	23	10	3	–	–	–	–	44
W	–	7	17	32	30	1	1	–	–	88
NW	–	8	26	46	27	1	–	–	–	108
Total	111	38	83	96	61	2	1	–	–	392

Month : MARCH Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	129	–	–	–	–	–	–	–	–	129
N	–	3	9	6	–	–	–	–	–	15
NE	–	3	1	1	–	–	–	–	–	5
E	–	6	8	3	–	–	–	–	–	15
SE	–	6	4	1	–	–	–	–	–	13
S	–	4	13	5	–	–	–	–	–	22
SW	–	8	23	1	2	–	–	–	–	34
W	–	6	16	31	9	–	–	–	–	62
NW	–	10	37	68	20	–	–	–	–	135
Total	129	46	111	116	31	–	–	–	–	433

Month : APRIL Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	98	–	–	–	–	–	–	–	–	98
N	–	2	8	17	1	–	–	–	–	27
NE	–	7	9	13	3	–	–	–	–	30
E	–	8	43	52	–	–	–	–	–	106
SE	–	5	7	4	–	–	–	–	–	16
S	–	6	7	2	–	–	–	–	–	15
SW	–	7	3	1	–	–	–	–	–	11
W	–	3	9	9	–	–	–	–	–	21
NW	–	5	49	39	2	–	–	–	–	95
Total	98	43	135	137	6	–	–	–	–	419

Month : MAY Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	87	–	–	–	–	–	–	–	–	87
N	–	–	6	11	1	–	–	–	–	18
NE	–	4	21	18	–	–	–	–	–	43
E	–	12	60	58	11	–	–	–	–	141
SE	–	4	17	7	1	–	–	–	–	29
S	–	6	2	1	–	–	–	–	–	9
SW	–	8	5	1	–	–	–	–	–	14
W	–	2	13	4	–	–	–	–	–	19
NW	–	4	33	35	2	–	–	–	–	74
Total	87	40	157	135	15	–	–	–	–	434

Month : JUNE Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	59	–	–	–	–	–	–	–	–	59
N	–	4	9	12	1	–	–	–	–	26
NE	–	5	20	20	–	–	–	–	–	45
E	–	14	52	91	9	–	–	–	–	166
SE	–	4	11	1	1	–	–	–	–	17
S	–	3	1	–	–	–	–	–	–	4
SW	–	1	11	–	1	–	–	–	–	13
W	–	3	12	4	–	–	–	–	–	19
NW	–	5	32	25	5	–	–	–	–	67
Total	59	39	148	153	17	–	–	–	–	416

Month · JULY — Year 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	62	–	–	–	–	–	–	–	–	62
N	–	1	11	12	1	–	–	–	–	25
NE	–	3	12	16	1	–	–	–	–	33
E	–	11	57	85	9	–	–	–	–	162
SE	–	9	23	8	–	–	–	–	–	40
S	–	2	4	2	–	–	–	–	–	8
SW	–	3	4	–	1	–	–	–	–	8
W	–	2	11	1	–	–	–	–	–	14
NW	–	5	28	36	5	–	–	–	–	74
Total	62	36	150	160	17	–	–	–	–	425

Month : AUGUST — Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	87	–	–	–	–	–	–	–	–	87
N	–	4	6	11	–	–	–	–	–	21
NE	–	6	16	29	2	–	–	–	–	53
E	–	20	44	91	3	–	–	–	–	158
SE	–	6	13	7	–	–	–	–	–	26
S	–	1	5	1	–	–	–	–	–	7
SW	–	4	9	7	–	–	–	–	–	20
W	–	1	15	8	–	–	–	–	–	24
NW	–	1	2	29	3	–	–	–	–	35
Total	87	43	110	183	8	–	–	–	–	431

Month · SEPTEMBER — Year . 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	77	–	–	–	–	–	–	–	–	77
N	–	4	5	5	4	–	–	–	–	18
NE	–	5	11	11	–	–	–	–	–	27
E	–	13	59	63	7	–	–	–	–	142
SE	–	1	5	4	1	–	–	–	–	11
S	–	1	3	–	–	–	–	–	–	4
SW	–	6	6	2	–	–	–	–	–	14
W	–	4	15	3	2	–	–	–	–	24
NW	–	5	39	45	6	–	–	–	–	95
Total	77	39	143	133	20	–	–	–	–	412

Month : OCTOBER — Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	85	–	–	–	–	–	–	–	–	85
N	–	5	7	11	–	–	–	–	–	23
NE	–	3	14	5	1	–	–	–	–	23
E	–	14	33	29	2	–	–	–	–	78
SE	–	2	4	3	–	–	–	–	–	9
S	–	2	4	3	–	–	–	–	–	9
SW	–	10	8	8	–	–	–	–	–	26
W	–	7	30	18	1	–	–	–	–	56
NW	–	8	37	66	4	–	–	–	–	115
Total	85	51	137	143	8	–	–	–	–	424

Month · NOVEMBER — Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	105	–	–	–	–	–	–	–	–	105
N	–	9	27	12	3	1	–	–	–	52
NE	–	4	5	9	2	–	–	–	–	20
E	–	4	18	16	2	–	–	–	–	40
SE	–	5	5	2	1	–	–	–	–	13
S	–	5	6	2	–	–	–	–	–	13
SW	–	7	5	3	1	–	–	–	–	16
W	–	3	17	13	–	–	–	–	–	33
NW	–	14	38	63	5	–	–	–	–	120
Total	105	56	121	120	14	1	–	–	–	417

Month : DECEMBER — Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	98	–	–	–	–	–	–	–	–	98
N	–	2	10	9	–	–	–	–	–	21
NE	–	5	3	1	–	–	–	–	–	9
E	–	8	7	2	–	–	–	–	–	17
SE	–	6	2	–	–	–	–	–	–	8
S	–	4	15	2	–	1	–	–	–	22
SW	–	9	20	16	2	–	–	–	–	47
W	–	4	24	44	22	3	–	–	–	97
NW	–	6	23	58	19	–	–	–	–	106
Total	98	44	104	132	43	4	–	–	–	425

(3) Station· BOGOR - SEMPLAK.
Times of observation 0000 - 0600
GMT 2300 GMT.

Long = 106° 54'E
Lat = 06° 33'S
Height above sea level = 171 m
Local time = GMT + 7h · 30 m

Month : JANUARY Year . 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	53	–	–	–	–	–	–	–	–	53
N	–	5	17	19	6	1	–	–	–	48
NE	–	5	11	3	2	–	–	–	–	21
E	–	2	10	1	–	–	–	–	–	13
SE	–	6	9	2	–	–	–	–	–	17
S	–	10	7	1	–	–	–	–	–	18
SW	–	2	9	–	–	–	–	–	–	11
W	–	6	12	7	3	1	–	–	–	29
NW	–	4	14	12	7	1	–	–	–	38
Total	53	40	89	45	18	3	–	–	–	248

Month . FEBRUARY Year 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	53	–	–	–	–	–	–	–	–	53
N	–	–	3	4	3	–	–	–	–	10
NE	–	3	5	2	1	–	–	–	–	11
E	–	1	4	1	1	–	–	–	–	7
SE	–	2	6	1	1	–	–	–	–	10
S	–	7	18	1	–	–	–	–	–	26
SW	–	1	6	5	5	1	–	–	–	18
W	–	3	16	4	6	1	–	–	–	39
NW	–	3	21	23	8	3	–	1	–	56
Total	53	20	79	41	25	5	–	1	–	224

Month : MARCH Year · 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	72	–	–	–	–	–	–	–	–	72
N	–	4	9	11	5	1	–	–	–	30
NE	–	5	7	5	2	–	–	–	–	19
E	–	6	5	3	3	1	–	–	–	18
SE	–	6	7	4	–	–	–	–	–	17
S	–	4	10	2	–	–	–	–	–	16
SW	–	2	3	3	–	–	–	–	–	8
W	–	3	9	13	10	1	2	–	–	38
NW	–	–	9	15	5	1	–	–	–	30
Total	72	30	59	56	25	4	2	–	–	248

Month · APRIL Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	93	–	–	–	–	–	–	–	–	93
N	–	4	14	7	4	–	–	–	–	29
NE	–	2	11	5	3	–	–	–	–	21
E	–	4	5	3	2	–	–	–	–	14
SE	–	2	10	3	–	–	–	–	–	15
S	–	2	8	3	–	–	–	–	–	13
SW	–	1	6	7	–	–	–	–	–	14
W	–	5	7	3	1	–	–	–	–	16
NW	–	7	6	9	3	–	–	–	–	25
Total	93	27	67	40	13	–	–	–	–	240

Month · MAY Year . 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	120	–	–	–	–	–	–	–	–	120
N	–	10	16	4	3	–	–	–	–	33
NE	–	2	11	9	1	1	–	–	–	24
E	–	3	2	3	–	–	–	–	–	8
SE	–	11	3	–	–	–	–	–	–	14
S	–	6	3	–	–	–	–	–	–	9
SW	–	5	2	3	–	–	–	–	–	10
W	–	3	4	2	1	–	–	–	–	10
NW	–	–	12	7	–	–	–	–	–	19
Total	120	40	53	28	5	1	–	–	–	247

Month . JUNE Year · 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	92	–	–	–	–	–	–	–	–	92
N	–	10	15	2	1	–	–	–	–	28
NE	–	6	7	–	–	–	–	–	–	13
E	–	4	4	2	3	–	–	–	–	13
SE	–	13	16	1	–	–	–	–	–	30
S	–	11	8	–	–	–	–	–	–	19
SW	–	5	5	2	–	–	–	–	–	12
W	–	6	5	2	–	–	–	–	–	13
NW	–	7	9	4	–	–	–	–	–	20
Total	92	62	69	13	4	–	–	–	–	240

Month · JULY Year . 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	112	–	–	–	–	–	–	–	–	112
N	–	8	18	10	6	–	–	–	–	42
NE	–	9	14	–	5	–	–	–	–	28
E	–	5	9	4	–	–	–	–	–	18
SE	–	3	3	1	–	–	–	–	–	7
S	–	5	2	–	–	–	–	–	–	7
SW	–	4	–	–	–	–	–	–	–	4
W	–	1	4	4	1	–	–	–	–	10
NW	–	7	10	3	–	–	–	–	–	20
Total	112	42	60	22	12	–	–	–	–	248

Month : AUGUST Year . 1958

Calm	153	–	–	–	–	–	–	–	–	153
N	–	6	22	3	–	–	–	–	–	31
NE	–	4	11	1	–	–	–	–	–	16
E	–	5	3	3	–	–	–	–	–	11
SE	–	5	5	–	–	–	–	–	–	10
S	–	1	1	–	–	–	–	–	–	2
SW	–	2	–	–	–	–	–	–	–	2
W	–	1	3	–	–	–	–	–	–	4
NW	–	2	9	4	4	–	–	–	–	19
Total	153	26	54	11	4	–	–	–	–	248

Month : SEPTEMBER Year . 1958

Calm	87	–	–	–	–	–	–	–	–	87
N	–	11	16	8	5	3	–	2	–	45
NE	–	3	8	4	3	1	–	–	–	19
E	–	7	13	1	–	–	–	–	–	21
SE	–	7	5	2	–	–	–	–	–	14
S	–	5	4	1	–	–	–	–	–	10
SW	–	3	2	–	–	–	–	–	–	5
W	–	8	12	2	–	–	–	–	–	22
NW	–	1	6	5	2	–	–	–	–	14
Total	87	45	66	23	10	4	–	2	–	237

Month : OCTOBER Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	125	–	–	–	–	–	–	–	–	125
N	–	11	17	10	–	–	–	–	–	38
NE	–	7	5	2	–	–	–	–	–	14
E	–	7	7	1	–	–	–	–	–	15
SE	–	13	3	–	–	–	–	–	–	16
S	–	11	–	–	–	–	–	–	–	11
SW	–	3	–	–	–	–	–	–	–	3
W	–	6	2	–	–	–	–	–	–	8
NW	–	7	8	3	–	–	–	–	–	18
Total	125	65	42	16	–	–	–	–	–	248

Month · NOVEMBER Year : 1958

Calm	116	–	–	–	–	–	–	–	–	116
N	–	9	17	7	–	–	–	–	–	33
NE	–	5	8	3	–	–	–	–	–	16
E	–	11	6	–	–	–	–	–	–	17
SE	–	3	6	1	–	–	–	–	–	10
S	–	3	3	1	–	–	–	–	–	7
SW	–	3	1	–	–	–	–	–	–	4
W	–	4	4	1	1	–	–	–	–	10
NW	–	6	11	7	3	–	–	–	–	27
Total	116	44	56	20	4	–	–	–	–	240

Month : DECEMBER Year : 1958

Calm	91	–	–	–	–	–	–	–	–	91
N	–	6	6	1	–	–	–	–	–	13
NE	–	4	4	2	–	–	–	–	–	10
E	–	1	1	–	1	–	–	–	–	3
SE	–	10	1	–	–	–	–	–	–	11
S	–	4	–	–	–	–	–	–	–	4
SW	–	12	13	5	4	–	–	–	–	34
W	–	14	22	12	5	–	–	–	–	53
NW	–	8	16	4	1	–	–	–	–	29
Total	91	59	63	24	11	–	–	–	–	248

(4) Station. SURABAJA - PERAK.
Times of observation: 24 hours

Long = 112° 43'E
Lat = 07° 13'S
Height above sea level= 3 m
Local time = GMT + 7.30 m

Month : JANUARY Year . 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	203	–	–	–	–	–	–	–	–	203
N	–	3	18	17	8	1	–	–	–	47
NE	–	3	17	10	1	–	1	–	–	31
E	–	2	5	12	3	–	–	–	–	23
SE	–	2	6	11	2	–	–	–	–	21
S	–	3	16	–	–	2	–	–	–	21
SW	–	10	54	25	2	2	–	–	–	93
W	–	7	43	66	21	5	4	–	–	146
NW	–	1	44	57	35	14	–	–	–	151
Total	203	31	203	198	72	24	5	–	–	736

Month FEBRUARY Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	174	–	–	–	–	–	–	–	–	174
N	–	–	7	12	6	–	–	–	–	25
NE	–	1	1	6	2	–	–	–	–	10
E	–	–	3	1	1	–	–	–	–	5
SE	–	2	1	5	–	–	–	–	–	8
S	–	4	12	4	2	1	–	–	–	23
SW	–	10	39	32	6	–	–	–	–	87
W	–	5	37	96	19	4	–	1	–	162
NW	–	3	33	73	53	13	2	1	–	178
Total	174	25	133	229	89	18	2	2	–	672

Month : MARCH Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	255	–	–	–	–	–	–	–	–	255
N	–	1	11	15	7	–	–	–	–	34
NE	–	1	11	12	2	–	–	–	–	26
E	–	1	6	5	3	–	–	–	–	15
SE	–	3	4	5	3	1	–	–	–	16
S	–	1	16	7	–	–	–	–	–	24
SW	–	3	25	29	5	2	–	–	–	64
W	–	8	51	79	22	1	2	–	–	163
NW	–	2	30	67	32	6	2	–	–	139
Total	255	20	154	219	74	10	4	–	–	736

Month : APRIL Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	246	–	–	–	–	–	–	–	–	246
N	–	1	9	11	6	–	–	–	–	27
NE	–	5	18	26	14	–	–	–	–	63
E	–	9	62	63	18	–	–	–	–	152
SE	–	4	32	30	22	1	–	–	–	89
S	–	5	16	9	3	–	–	–	–	33
SW	–	6	19	9	2	–	–	–	–	36
W	–	–	16	6	–	–	–	–	–	22
NW	–	1	17	14	3	1	–	–	–	36
Total	246	31	189	168	68	2	–	–	–	704

Month : MAY Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	291	–	–	–	–	–	–	–	–	291
N	–	1	6	3	1	–	–	–	–	11
NE	–	3	13	10	3	–	–	–	–	29
E	–	6	23	26	11	–	–	–	–	66
SE	–	13	49	108	46	3	–	–	–	219
S	–	6	16	27	9	–	–	–	–	58
SW	–	10	17	9	1	–	–	–	–	37
W	–	4	14	2	–	–	–	–	–	20
NW	–		12	1	–	–	–	–	–	13
Total	291	43	150	186	71	3	–	–	–	744

Month · JUNE Year · 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	182	–	–	–	–	–	–	–	–	182
N	–	5	9	9	–	–	–	–	–	23
NE	–	3	8	2	3	–	–	–	–	16
E	–	–	16	4	3	–	–	–	–	23
SE	–	9	57	83	53	1	–	–	–	203
S	–	5	33	53	82	5	1	–	–	179
SW	–	3	12	5	2	–	–	–	–	22
W	–	2	17	3	–	–	–	–	–	22
NW	–	13	25	12	–	–	–	–	–	50.
Total	182	40	177	171	143	6	1	–	–	720

Month . JULY Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	170	–	–	–	–	–	–	–	–	170
N	–	2	5	–	–	–	–	–	–	7
NE	–	–	10	9	–	–	–	–	–	19
E	–	12	35	73	27	–	–	–	–	147
SE	–	19	62	126	77	6	–	–	–	290
S	–	3	17	23	16	–	–	–	–	59
SW	–	6	11	6	–	–	–	–	–	23
W	–	1	8	3	–	–	–	–	–	12
NW	–	–	6	8	2	–	–	–	–	16
Total	170	43	154	248	122	6	–	–	–	743

Month · AUGUST Year 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	127	–	–	–	–	–	–	–	–	127
N	–	1	6	1	–	–	–	–	–	8
NE	–	7	20	45	50	6	–	–	–	128
E	–	2	32	80	93	18	3	–	–	228
SE	–	4	22	49	41	7	–	–	–	123
S	–	6	19	26	12	–	–	–	–	63
SW	–	11	15	9	2	–	–	–	–	37
W	–	3	9	5	–	–	–	–	–	17
NW	–	–	4	1	–	–	–	–	–	5
Total	127	34	127	216	198	31	3	–	–	736

Month · SEPTEMBER Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	108	–	–	–	–	–	–	–	–	108
N	–	3	6	11	1	8	–	–	–	21
NE	–	2	40	93	82	7	–	–	–	225
E	–	5	47	80	31	2	–	–	–	170
SE	–	4	27	24	23	–	–	–	–	80
S	–	8	20	7	–	–	–	–	–	35
SW	–	7	19	14	2	–	–	–	–	42
W	–	4	10	6	–	–	–	–	–	20
NW	–	–	4	7	–	–	–	–	–	11
Total	108	33	173	242	139	17	–	–	–	712

Month OCTOBER Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	160	–	–	–	–	–	–	–	–	160
N	–	3	8	19	1	–	–	–	–	31
NE	–	4	34	26	7	–	–	–	–	71
E	–	4	25	75	42	2	–	–	–	148
SE	–	3	25	49	31	–	–	–	–	108
S	–	3	21	9	1	–	–	–	–	34
SW	–	13	38	28	1	–	–	–	–	80
W	–	2	20	31	2	–	–	–	–	55
NW	–	3	22	21	2	–	–	–	–	48
Total	160	35	193	258	87	2	–	–	–	735

Month NOVEMBER Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	216	–	–	–	–	–	–	–	–	216
N	–	–	18	13	9	–	–	–	–	40
NE	–	3	37	32	15	–	–	–	–	87
E	–	5	26	64	14	1	–	–	–	110
SE	–	8	18	15	10	–	–	–	–	51
S	–	–	21	12	1	–	1	–	–	35
SW	–	5	30	11	8	1	–	–	–	55
W	–	–	23	28	4	–	–	–	–	55
NW	–	6	10	21	10	–	–	–	–	47
Total	216	27	183	196	71	2	1	–	–	696

Month . DECEMBER Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	146	–	–	–	–	–	–	–	–	146
N	–	3	13	21	9	–	–	–	–	46
NE	–	1	5	14	4	–	–	–	–	24
E	–	–	3	4	3	–	–	–	–	10
SE	–	–	8	4	1	–	–	–	–	13
S	–	10	10	7	2	1	–	–	–	30
SW	–	10	59	77	10	2	1	–	–	159
W	–	6	32	82	43	8	–	–	–	171
NW	–	2	26	76	36	4	1	–	–	145
Total	146	32	156	285	108	15	2	–	–	744

(5) Station: PALEMBANG - TALANGBETUTU
Times of observation: 00.00 - 12.00 GMT and 23 00 GMT

Long = 104° 42'E
Lat = 02° 54'S
Height above sea level = 10m
Local time = GMT + 7h - m

Month · JANUARY   Year . 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	128	–	–	–	–	–	–	–	–	128
N	–	11	35	30	2	–	–	–	–	78
NE	–	2	3	8	8	1	–	–	–	22
E	–	1	6	2	2	–	–	–	–	11
SE	–	–	1	3	–	–	–	–	–	4
S	–	–	2	1	–	–	–	–	–	3
SW	–	–	2	9	–	–	–	–	–	11
W	–	3	31	33	18	4	–	–	–	89
NW	–	–	22	30	1	33	1	1	–	88
Total	128	17	102	116	31	38	1	1	–	434

Month : FEBRUARY   Year 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	91	–	–	–	–	–	–	–	–	91
N	–	–	19	34	29	2	–	–	–	84
NE	–	–	7	10	6	–	–	1	–	24
E	–	–	1	1	2	–	–	–	–	4
SE	–	–	–	–	–	–	–	–	–	–
S	–	–	1	3	–	–	–	–	–	4
SW	–	–	3	1	1	–	–	–	–	5
W	–	4	24	35	22	2	–	–	–	87
NW	–	2	23	37	30	–	–	–	–	92
Total	91	6	78	121	90	4	–	1	–	391

Month : MARCH   Year 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	208	–	–	–	–	–	–	–	–	208
N	–	–	9	15	12	2	–	1	–	39
NE	–	–	1	5	4	1	–	–	–	11
E	–	–	3	2	1	1	–	–	–	7
SE	–	–	–	4	1	–	–	–	–	5
S	–	–	4	3	1	–	–	–	–	8
SW	–	–	3	7	1	–	–	–	–	11
W	–	–	19	28	16	1	–	–	–	64
NW	–	–	28	45	8	–	–	–	–	81
Total	208	–	67	109	44	5	–	1	–	434

Month APRIL   Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	284	–	–	–	–	–	–	–	–	284
N	–	–	8	9	1	2	–	–	–	20
NE	–	–	4	7	2	–	–	–	–	13
E	–	1	9	13	4	–	–	–	–	27
SE	–	–	–	4	2	–	–	–	–	6
S	–	–	4	4	1	–	–	–	–	9
SW	–	–	3	3	–	–	–	–	–	6
W	–	–	12	8	5	–	–	–	–	25
NW	–	1	11	12	6	–	–	–	–	30
Total	284	2	51	60	21	2	–	–	–	420

Month · MAY   Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	298	–	–	–	–	–	–	–	–	298
N	–	–	2	1	–	–	–	–	–	3
NE	–	–	2	–	–	–	–	–	–	2
E	–	–	7	1	1	1	–	–	1	11
SE	–	–	31	28	6	1	–	–	–	66
S	–	–	16	17	2	2	–	–	–	37
SW	–	–	6	2	–	–	–	–	–	8
W	–	–	2	2	1	–	–	–	–	5
NW	–	–	2	2	–	–	–	–	–	4
Total	298	–	68	53	10	4	–	–	1	434

Month : JUNE   Year . 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	241	–	–	–	–	–	–	–	–	241
N	–	–	4	1	–	–	–	–	–	5
NE	–	–	3	2	–	–	–	–	–	5
E	–	–	11	13	4	–	–	–	–	28
SE	–	3	44	31	6	1	–	–	–	85
S	–	2	1	17	15	1	–	–	–	37
SW	–	–	5	1	1	–	–	–	–	6
W	–	–	3	2	1	–	–	–	–	6
NW	–	–	5	1	1	–	–	–	–	7
Total	241	5	76	68	28	2	–	–	–	420

Month : JULY   Year . 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	206	–	–	–	–	–	–	–	–	206
N	–	–	–	–	–	–	–	–	–	–
NE	–	–	3	4	–	–	–	–	–	7
E	–	–	16	24	4	2	1	–	–	47
SE	–	2	23	55	20	4	–	–	–	104
S	–	1	18	29	5	1	–	–	–	54
SW	–	1	2	4	1	–	–	–	–	8
W	–	–	3	1	1	–	–	–	–	5
NW	–	–	1	–	–	–	–	–	–	1
Total	206	4	66	117	31	7	1	–	–	432

Month : AUGUST   Year 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	222	–	–	–	–	–	–	–	–	222
N	–	–	3	–	–	–	–	–	–	3
NE	–	1	6	11	1	–	–	–	–	19
E	–	4	17	14	7	6	–	–	–	48
SE	–	6	21	42	16	2	–	–	–	87
S	–	1	16	16	2	–	–	–	–	35
SW	–	–	3	4	1	–	–	–	–	8
W	–	–	2	4	1	–	–	–	–	7
NW	–	–	1	1	–	–	–	–	–	2
Total	222	12	69	92	28	8	–	–	–	431

Month : SEPTEMBER   Year . 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	144	–	–	–	–	–	–	–	–	144
N	–	–	1	–	–	–	–	–	–	1
NE	–	–	3	3	–	–	–	–	–	6
E	–	1	19	41	7	8	1	1	–	78
SE	–	–	19	58	27	9	2	1	–	116
S	–	3	25	23	4	1	–	1	–	57
SW	–	–	2	2	–	–	–	–	–	4
W	–	1	2	5	1	–	–	–	–	9
NW	–	–	1	2	–	–	–	–	–	3
Total	144	5	72	134	39	18	3	3	–	418

Month . OCTOBER   Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3 0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	212	–	–	–	–	–	–	–	–	212
N	–	1	12	1	–	–	–	–	–	14
NE	–	5	3	5	–	–	–	–	–	13
E	–	2	10	9	–	–	–	–	–	22
SE	–	11	35	17	2	–	–	–	–	65
S	–	14	33	16	–	–	–	–	–	63
SW	–	1	6	2	–	–	–	–	–	9
W	–	4	22	3	–	–	–	–	–	30
NW	–	–	6	–	–	–	–	–	–	6
Total	212	38	127	53	4	–	–	–	–	434

Month : NOVEMBER   Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	219	–	–	–	–	–	–	–	–	219
N	–	4	13	2	–	–	–	–	–	19
NE	–	1	6	10	–	–	–	–	–	17
E	–	–	15	7	1	–	–	–	–	23
SE	–	2	12	6	–	–	–	–	–	20
S	–	2	19	2	–	–	–	–	–	23
SW	–	2	12	3	–	–	–	–	–	17
W	–	6	42	6	–	–	–	–	–	54
NW	–	2	22	4	1	–	–	–	–	28
Total	219	19	114	40	1	–	–	–	–	420

Month : DECEMBER   Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	179	–	–	–	–	–	–	–	–	179
N	–	5	22	30	3	–	–	–	–	60
NE	–	1	7	4	–	–	–	–	–	12
E	–	–	4	–	1	–	–	–	–	5
SE	–	–	–	–	–	–	–	–	–	–
S	–	–	1	–	–	–	–	–	–	1
SW	–	–	8	2	1	–	–	–	–	11
W	–	9	51	10	–	–	–	–	–	70
NW	–	7	68	20	1	–	–	–	–	96
Total	179	22	161	66	6	–	–	–	–	434

(6) Station: PAKAN BARU
Times og observation· 00.00 - 09 00 GMT

Long = 101° 27'E
Lat = 00° 28'N
Height above sea level = 31 m
Local time = GMT + 6h· 30 m

Month : JANUARY Year 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	60	–	–	–	–	–	–	–	–	60
N	–	4	41	12	–	–	–	–	–	57
NE	–	–	11	30	5	–	–	–	–	46
E	–	2	33	20	2	–	–	–	–	57
SE	–	–	4	6	1	–	–	–	–	11
S	–	1	12	4	–	–	–	–	–	17
SW	–	–	4	1	–	–	–	–	–	5
W	–	2	8	2	–	–	–	–	–	12
NW	–	–	7	7	–	–	–	–	–	14
Total	60	9	120	82	8	–	–	–	–	279

Month · FEBRUARY Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	29	–	–	–	–	–	–	–	–	29
N	–	1	25	10	–	–	–	–	–	36
NE	–	2	20	16	2	–	–	–	–	40
E	–	2	12	8	–	–	–	–	–	22
SE	–	–	–	1	1	–	–	–	–	2
S	–	2	9	9	–	–	–	–	–	20
SW	–	–	4	2	–	–	–	–	–	6
W	–	1	6	4	–	–	–	–	–	11
NW	–	–	8	11	–	–	–	–	–	19
Total	29	8	84	61	3	–	–	–	–	185

Month : MARCH Year · 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	72	–	–	–	–	–	–	–	–	72
N	–	2	7	15	2	–	–	–	–	26
NE	–	–	22	9	1	–	–	–	–	32
E	–	1	6	4	1	–	1	–	–	13
SE	–	–	6	4	–	–	–	–	–	10
S	–	–	9	6	–	–	–	–	–	15
SW	–	2	16	11	1	–	–	–	–	30
W	–	–	11	11	2	–	–	–	–	24
NW	–	1	18	15	3	–	–	–	–	37
Total	72	6	95	75	10	–	1	–	–	259

Month · APRIL Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	121	–	–	–	–	–	–	–	–	121
N	–	3	16	18	5	3	–	–	–	45
NE	–	2	19	34	10	–	3	–	–	68
E	–	3	16	10	9	–	–	–	–	38
SE	–	1	17	22	11	–	–	–	–	51
S	–	3	12	6	4	–	–	–	–	25
SW	–	3	13	10	4	–	–	–	–	30
W	–	2	9	–	2	–	–	–	–	13
NW	–	1	14	11	2	–	–	–	–	28
Total	121	18	116	111	47	3	3	–	–	419

Month . MAY Year · 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	165	–	–	–	–	–	–	–	–	165
N	–	–	8	7	5	–	–	–	–	20
NE	–	–	8	7	4	–	–	–	–	19
E	–	–	7	11	–	–	–	–	–	18
SE	–	–	14	14	3	–	–	–	–	31
S	–	–	15	8	10	2	–	–	–	57
SW	–	–	7	30	7	–	–	–	–	22
W	–	–	11	17	4	1	–	–	–	33
NW	–	–	15	19	14	4	–	1	–	53
Total	165	–	85	113	47	7	–	1	–	418

Month : JUNE Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	174	–	–	–	–	–	–	–	–	174
N	–	–	4	11	1	–	–	–	–	16
NE	–	–	5	4	–	–	–	–	–	9
E	–	–	11	10	1	1	–	–	–	23
SE	–	–	18	23	14	2	–	–	–	57
S	–	–	24	31	29	2	–	–	–	86
SW	–	–	9	11	–	–	–	–	–	20
W	–	–	11	5	3	2	–	–	–	21
NW	–	–	4	9	–	1	–	–	–	14
Total	174	–	86	104	48	8	–	–	–	420

Month : JULY   Year 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	181	–	–	–	–	–	–	–	–	181
N	–	–	8	16	2	–	–	–	–	26
NE	–	–	11	11	3	–	–	–	–	25
E	–	1	13	14	1	–	–	–	–	29
SE	–	–	22	13	5	5	–	–	–	45
S	–	–	28	42	13	1	–	–	–	84
SW	–	–	9	8	2	–	–	–	–	19
W	–	–	7	5	1	–	–	–	–	13
NW	–	–	4	7	–	–	–	–	–	11
Total	181	1	102	116	27	6	–	–	–	433

Month : AUGUST   Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	121	–	–	–	–	–	–	–	–	121
N	–	4	5	3	5	–	1	–	–	18
NE	–	5	4	2	3	1	–	–	–	15
E	–	3	5	9	14	3	–	–	–	34
SE	–	2	19	34	24	1	1	–	–	81
S	–	1	21	16	14	2	–	–	–	54
SW	–	1	5	9	6	–	–	–	–	21
W	–	5	3	10	8	–	1	1	–	28
NW	–	–	6	6	1	–	–	–	–	13
Total	121	21	68	89	75	7	3	1	–	385

Month . SEPTEMBER   Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	113	–	–	–	–	–	–	–	–	113
N	–	–	1	3	1	–	–	–	–	5
NE	–	2	10	2	–	–	–	–	–	14
E	–	3	5	9	–	–	–	–	–	17
SE	–	3	20	22	8	1	–	–	–	54
S	–	6	10	34	9	13	1	–	–	73
SW	–	2	2	5	1	1	–	–	–	11
W	–	3	8	16	–	1	–	–	–	28
NW	–	–	8	5	2	1	–	–	–	16
Total	113	19	64	96	21	17	1	–	–	331

Month . OCTOBER   Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	182	–	–	–	–	–	–	–	–	182
N	–	4	18	6	–	–	–	–	–	28
NE	–	1	4	4	–	–	–	–	–	9
E	–	3	8	5	–	–	–	–	–	16
SE	–	2	7	12	–	–	–	–	–	21
S	–	8	29	10	–	–	–	–	–	47
SW	–	8	9	3	–	–	–	–	–	20
W	–	6	13	7	3	–	–	–	–	29
NW	–	8	15	17	–	–	–	–	–	40
Total	182	40	103	64	3	–	–	–	–	392

Month : NOVEMBER   Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	154	–	–	–	–	–	–	–	–	154
N	–	3	43	25	4	–	–	–	–	75
NE	–	3	23	8	1	1	–	–	–	36
E	–	2	15	3	–	1	–	–	–	21
SE	–	–	8	2	–	–	–	–	–	10
S	–	1	15	1	–	–	–	–	–	17
SW	–	3	6	–	–	–	–	–	–	9
W	–	3	36	6	–	–	–	–	–	45
NW	–	3	28	17	4	–	–	–	–	52
Total	154	18	174	62	9	2	–	–	–	419

Month : DECEMBER   Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	174	–	–	–	–	–	–	–	–	174
N	–	6	34	19	1	–	–	–	–	60
NE	–	8	57	39	7	–	–	–	–	111
E	–	4	13	15	1	–	–	–	–	33
SE	–	–	2	1	–	–	–	–	–	3
S	–	–	4	1	–	–	–	–	–	5
SW	–	1	5	1	1	–	–	–	–	8
W	–	3	4	4	1	–	–	–	–	12
NW	–	3	18	7	–	–	–	–	–	28
Total	174	25	137	87	11	–	–	–	–	434

(7) Station· MEDAN - POLONIA
Times of observation: 24 hours.

Long = 98° 41'E
Lat = 03° 34'N
Height above sea level = 25 m
Local time = GMT + 6h · 30 m

Month : JANUARY Year . 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	479	–	–	–	–	–	–	–	–	479
N	–	1	7	42	34	14	1	1	–	100
NE	–	1	2	6	4	3	1	–	–	17
E	–	–	–	2	2	2	–	–	–	6
SE	–	1	2	2	5	1	–	–	–	11
S	–	–	–	1	–	1	–	–	1	3
SW	–	2	11	15	2	1	–	–	–	31
W	–	1	6	18	14	1	–	–	–	40
NW	–	2	4	21	21	7	2	–	–	57
Total	479	8	32	107	82	30	4	1	1	744

Month : FEBRUARY Year · 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	467	–	–	–	–	–	–	–	–	467
N	–	1	4	28	36	22	4	1	–	96
NE	–	–	3	13	4	2	–	–	–	22
E	–	–	8	–	3	1	–	–	–	12
SE	–	–	–	2	–	–	–	–	–	2
S	–	–	–	9	–	–	–	–	–	9
SW	–	6	6	–	3	–	–	–	–	15
W	–	–	5	9	3	1	–	–	–	18
NW	–	–	4	9	15	3	–	–	–	31
Total	467	7	30	70	64	29	4	1	–	672

Month . MARCH Year · 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	426	–	–	–	–	–	–	–	–	426
N	–	2	5	27	24	35	7	1	1	102
NE	–	–	1	6	2	–	–	–	–	9
E	–	1	1	–	1	–	–	–	–	3
SE	–	–	–	4	1	–	–	–	–	5
S	–	–	1	2	–	–	–	–	–	3
SW	–	1	–	9	4	1	–	–	–	15
W	–	–	4	21	16	2	–	–	–	43
NW	–	–	4	16	9	6	1	–	–	36
Total	426	4	16	85	57	44	8	1	1	642

Month : APRIL Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	512	–	–	–	–	–	–	–	–	512
N	–	–	7	35	26	27	1	1	–	97
NE	–	1	5	20	5	–	–	–	–	31
E	–	–	–	–	–	–	–	–	–	–
SE	–	1	1	12	–	–	–	–	–	14
S	–	–	1	2	2	–	–	1	–	6
SW	–	–	4	7	1	1	–	–	–	13
W	–	–	4	13	5	–	1	–	–	23
NW	–	–	1	6	11	5	1	–	–	24
Total	512	2	23	95	50	33	3	2	–	720

Month : MAY Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	574	–	–	–	–	–	–	–	–	574
N	–	–	8	28	16	4	–	–	–	56
NE	–	–	4	13	4	–	–	–	–	21
E	–	–	–	10	2	–	–	–	–	12
SE	–	–	3	3	9	1	–	–	–	16
S	–	–	2	4	2	3	–	1	–	12
SW	–	–	2	–	11	2	1	–	–	16
W	–	–	5	6	5	2	–	–	–	18
NW	–	1	2	13	1	2	–	–	–	19
Total	574	1	26	77	50	14	1	1	–	744

Month · JUNE Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	554	–	–	–	–	–	–	–	–	554
N	–	1	5	17	23	10	–	–	–	56
NE	–	–	3	23	7	1	–	–	–	34
E	–	–	4	14	4	–	–	–	–	22
SE	–	1	–	5	2	1	–	–	–	9
S	–	–	–	8	1	–	–	–	–	9
SW	–	1	4	5	1	2	–	–	–	13
W	–	–	3	2	5	–	–	–	–	10
NW	–	–	1	7	3	2	–	–	–	13
Total	554	3	20	81	46	16	–	–	–	720

Month : JULY Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	517	–	–	–	–	–	–	–	–	517
N	–	–	3	25	30	12	2	–	–	72
NE	–	3	13	30	14	3	–	–	–	63
E	–	–	6	5	8	–	–	–	–	19
SE	–	–	2	10	2	1	–	–	–	15
S	–	–	1	6	2	–	1	–	–	10
SW	–	–	2	14	4	2	–	–	–	22
W	–	–	4	4	1	1	–	–	–	10
NW	–	–	3	6	3	3	1	–	–	16
Total	517	3	34	100	64	22	4	–	–	744

Month : AUGUST Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	586	–	–	–	–	–	–	–	–	586
N	–	2	5	17	21	6	–	–	–	51
NE	–	–	10	15	7	1	–	–	–	33
E	–	1	2	3	4	–	–	–	–	10
SE	–	1	–	5	–	–	–	–	–	6
S	–	–	–	2	1	–	–	–	–	3
SW	–	–	4	6	3	2	–	–	–	15
W	–	–	2	10	3	4	2	–	–	21
NW	–	1	5	9	2	1	1	–	–	19
Total	586	5	28	67	41	14	3	–	–	744

Month : SEPTEMBER Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	540	–	–	–	–	–	–	–	–	540
N	–	1	5	11	20	15	–	–	–	52
NE	–	–	7	18	8	1	–	–	–	34
E	–	–	3	12	5	–	1	–	–	21
SE	–	–	4	2	–	1	–	–	–	7
S	–	–	3	2	1	1	–	–	–	7
SW	–	1	2	7	1	2	–	–	–	13
W	–	1	2	13	5	1	–	–	–	22
NW	–	1	6	11	2	3	1	–	–	24
Total	540	4	32	76	42	24	2	–	–	720

Month : OCTOBER Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	547	–	–	–	–	–	–	–	–	547
N	–	5	27	30	2	–	–	–	–	64
NE	–	3	21	4	–	–	–	–	–	28
E	–	3	7	–	–	–	–	–	–	10
SE	–	1	1	1	–	–	–	–	–	3
S	–	2	4	1	–	–	–	–	–	7
SW	–	5	8	6	1	–	–	–	–	20
W	–	3	20	13	1	–	–	–	–	37
NW	–	3	11	10	2	2	–	–	–	28
Total	547	25	99	65	6	2	–	–	–	744

Month : NOVEMBER Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	491	–	–	–	–	–	–	–	–	491
N	–	3	25	30	2	–	–	–	–	60
NE	–	–	2	2	–	–	–	–	–	4
E	–	–	1	–	–	–	–	–	–	1
SE	–	3	–	2	–	–	–	–	–	5
S	–	3	8	3	–	–	–	–	–	14
SW	–	7	22	4	–	–	–	–	–	33
W	–	11	31	15	–	–	–	–	–	57
NW	–	4	28	23	–	–	–	–	–	55
Total	491	31	117	79	2	–	–	–	–	720

Month : DECEMBER Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	492	–	–	–	–	–	–	–	–	492
N	–	4	17	33	3	–	–	–	–	57
NE	–	1	8	8	–	–	–	–	–	17
E	–	–	8	3	–	–	–	–	–	11
SE	–	–	3	–	–	–	–	–	–	3
S	–	–	7	1	–	–	–	–	–	8
SW	–	5	19	2	–	–	–	–	–	26
W	–	12	28	22	–	–	–	–	–	62
NW	–	4	38	24	2	–	–	–	–	68
Total	492	26	128	93	5	–	–	–	–	744

(8) Station: BALIKPAPAN - SEPINGGAN.
Times of observation 0000 - 1200 GMT and 2300 GMT.

Long = 116° 54'E
Lat = 01° 16'S
Height above sea level = 3 m
Local time = GMT + 7h · 30 m

Month · JANUARY Year 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	103	–	–	–	–	–	–	–	–	103
N	–	15	19	10	1	–	–	–	–	45
NE	–	11	15	12	2	–	–	–	–	40
E	–	21	34	43	10	–	–	–	–	108
SE	–	10	17	11	1	–	–	–	–	39
S	–	6	15	2	3	–	–	–	–	26
SW	–	4	5	8	–	–	–	–	–	17
W	–	5	3	1	–	–	–	–	–	9
NW	–	9	37	1	–	–	–	–	–	47
Total	103	81	145	88	17	–	–	–	–	434

Month · FEBRUARY Year 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	107	–	–	–	–	–	–	–	–	107
N	–	6	21	13	2	–	–	–	–	42
NE	–	7	25	20	3	–	–	–	–	55
E	–	12	28	59	18	–	–	–	–	117
SE	–	4	11	6	–	–	–	–	–	21
S	–	1	10	2	1	–	–	–	–	14
SW	–	2	3	–	–	–	–	–	–	5
W	–	3	1	5	–	–	–	–	–	9
NW	–	8	12	2	–	–	–	–	–	22
Total	107	43	111	107	24	–	–	–	–	392

Month . MARCH Year · 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	121	–	–	–	–	–	–	–	–	121
N	–	21	10	15	–	–	–	–	–	62
NE	–	13	38	17	3	–	–	–	–	71
E	–	8	32	68	14	–	–	–	–	122
SE	–	3	14	2	–	–	–	–	–	19
S	–	3	6	1	–	–	–	–	–	10
SW	–	1	2	1	–	–	–	–	–	4
W	–	3	4	2	1	–	–	–	–	10
NW	–	7	8	–	–	–	–	–	–	15
Total	121	59	130	106	18	–	–	–	–	343

Month . APRIL Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	103	–	–	–	–	–	–	–	–	103
N	–	5	14	5	–	–	–	–	–	24
NE	–	1	14	9	6	–	–	–	–	30
E	–	9	56	49	8	–	–	–	–	122
SE	–	7	24	5	–	–	–	–	–	36
S	–	1	3	6	1	–	–	–	–	11
SW	–	3	5	–	–	–	–	–	–	8
W	–	2	1	–	–	–	–	–	–	3
NW	–	2	7	2	–	–	–	–	–	11
Total	103	30	124	76	15	–	–	–	–	348

Month : MAY Year · 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	125	–	–	–	–	–	–	–	–	125
N	–	2	4	–	–	–	–	–	–	6
NE	–	2	5	–	–	–	–	–	–	10
E	–	2	11	2	–	–	–	–	–	15
SE	–	–	16	2	–	–	–	–	–	18
S	–	11	14	15	1	–	–	–	–	41
SW	–	11	28	21	1	–	–	–	–	61
W	–	5	15	1	–	–	–	–	–	21
NW	–	4	9	–	–	–	–	–	–	13
Total	125	40	102	41	2	–	–	–	–	310

Month . JUNE Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	155	–	–	–	–	–	–	–	–	155
N	–	–	–	–	–	–	–	–	–	–
NE	–	–	–	–	–	–	–	–	–	–
E	–	–	–	–	–	–	–	–	–	–
SE	–	4	7	5	–	–	–	–	–	16
S	–	27	44	39	9	–	–	–	–	119
SW	–	30	35	29	2	–	–	–	–	96
W	–	8	15	1	–	–	–	–	–	26
NW	–	1	7	–	–	–	–	–	–	8
Total	155	70	108	76	11	–	–	–	–	420

Month : JULY Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	142	–	–	–	–	–	–	–	–	142
N	–	–	–	–	1	–	–	–	–	1
NE	–	–	–	–	–	–	–	–	–	–
E	–	7	4	–	–	–	–	–	–	11
SE	–	12	33	22	–	–	–	–	–	68
S	–	16	79	34	–	–	–	–	–	129
SW	–	13	23	14	–	–	–	–	–	43
W	–	13	19	1	–	–	–	–	–	33
NW	–	4	3	–	1	–	–	–	–	7
Total	142	58	161	71	2	–	–	–	–	434

Month : AUGUST Year 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	162	–	–	–	–	–	–	–	–	162
N	–	1	2	1	–	–	–	–	–	4
NE	–	1	2	–	–	–	–	–	–	3
E	–	–	–	–	–	–	–	–	–	–
SE	–	5	15	5	2	–	–	–	–	27
S	–	14	84	37	2	–	–	–	–	137
SW	–	7	32	17	1	–	–	–	–	57
W	–	6	29	3	–	–	–	–	–	38
NW	–	1	5	–	–	–	–	–	–	6
Total	162	35	169	63	5	–	–	–	–	434

Month · SEPTEMBER Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	94	–	–	–	–	–	–	–	–	94
N	–	–	–	–	–	–	–	–	–	–
NE	–	–	–	–	–	–	–	–	–	–
E	–	2	4	–	–	–	–	–	–	6
SE	–	7	27	7	2	–	–	–	–	43
S	–	17	71	44	15	–	–	–	–	147
SW	–	8	47	28	2	–	–	–	–	85
W	–	10	18	–	–	–	–	–	–	28
NW	–	3	14	–	–	–	–	–	–	17
Total	94	47	181	79	19	–	–	–	–	420

Month : OCTOBER Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	83	–	–	–	–	–	–	–	–	83
N	–	–	–	1	–	–	–	–	–	1
NE	–	–	–	–	–	–	–	–	–	–
E	–	1	8	2	–	–	–	–	–	11
SE	–	2	24	6	–	–	–	–	–	32
S	–	11	64	94	1	–	–	–	–	170
SW	–	–	31	22	–	–	–	–	–	53
W	–	9	33	13	–	–	–	–	–	55
NW	–	3	23	3	–	–	–	–	–	29
Total	83	26	183	141	1	–	–	–	–	434

Month : NOVEMBER Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	127	–	–	–	–	–	–	–	–	127
N	–	4	5	1	–	–	–	–	–	10
NE	–	1	1	4	–	–	–	–	–	6
E	–	3	20	16	–	–	–	–	–	39
SE	–	–	33	16	3	–	–	–	–	52
S	–	3	45	39	–	–	–	–	–	87
SW	–	3	13	4	–	–	–	–	–	20
W	–	6	12	8	–	–	–	–	–	26
NW	–	–	42	1	–	–	–	–	–	53
Total	127	30	171	89	3	–	–	–	–	420

Month : DECEMBER Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	184	–	–	–	–	–	–	–	–	184
N	–	–	8	1	–	–	–	–	–	9
NE	–	–	16	5	–	–	–	–	–	21
E	–	2	34	10	1	–	–	–	–	47
SE	–	2	29	4	–	–	–	–	–	35
S	–	2	27	9	–	–	–	–	–	38
SW	–	2	11	3	–	–	–	–	–	16
W	–	2	18	3	–	–	–	–	–	23
NW	–	10	44	7	–	–	–	–	–	61
Total	184	20	187	42	1	–	–	–	–	434

(9) Station· DENPASAR - TUBAN
Times of observation: 0000 - 1200

Long = 115° 10'E
Lat = 08° 45'S
Height above sea level = 1 m
Local time = GMT + 7h 30 m

Month : JANUARY Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	134	–	–	–	–	–	–	–	–	134
N	–	1	3	–	–	–	–	–	–	4
NE	–	1	–	–	–	–	–	–	–	1
E	–	6	16	7	–	–	–	–	–	29
SE	–	2	12	11	–	–	–	–	–	25
S	–	1	6	2	–	–	–	–	–	9
SW	–	7	23	48	18	–	–	–	–	96
W	–	8	32	94	18	–	–	–	–	152
NW	–	5	1	9	1	–	–	–	–	16
Total	134	31	93	171	37	–	–	–	–	466

Month : FEBRUARY Year · 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	152	–	–	–	–	–	–	–	–	152
N	–	7	3	–	1	–	–	–	–	11
NE	–	1	1	–	–	–	–	–	–	2
E	–	8	15	6	–	–	–	–	–	29
SE	–	6	6	4	–	–	–	–	–	16
S	–	5	4	2	3	–	–	–	–	14
SW	–	5	14	24	3	1	1	–	–	48
W	–	14	29	56	22	–	–	–	–	121
NW	–	4	14	6	3	–	–	–	–	27
Total	152	50	86	98	32	1	1	–	–	420

Month : MARCH Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	166	–	–	–	–	–	–	–	–	166
N	–	2	1	–	–	–	–	–	–	3
NE	–	–	1	–	–	–	–	–	–	1
E	–	13	15	12	–	–	–	–	–	40
SE	–	8	23	8	1	–	–	–	–	40
S	–	1	9	5	–	–	–	–	–	15
SW	–	5	11	11	4	1	–	–	–	32
W	–	9	47	65	13	–	–	–	–	134
NW	–	7	10	13	4	–	–	–	–	34
Total	166	45	117	114	22	1	–	–	–	465

Month : APRIL Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	154	–	–	–	–	–	–	–	–	154
N	–	3	–	–	–	–	–	–	–	3
NE	–	5	1	–	–	–	–	–	–	6
E	–	8	23	71	22	–	–	–	–	124
SE	–	12	28	49	23	–	–	–	–	112
S	–	3	4	–	–	–	–	–	–	7
SW	–	2	6	4	–	–	–	–	–	12
W	–	2	10	16	–	–	–	–	–	28
NW	–	2	2	–	–	–	–	–	–	4
Total	154	37	74	140	45	–	–	–	–	450

Month : MAY Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	108	–	–	–	–	–	–	–	–	108
N	–	–	–	–	–	–	–	–	–	–
NE	–	–	–	–	–	–	–	–	–	–
E	–	16	35	115	11	–	–	–	–	177
SE	–	5	30	107	19	–	–	–	–	161
S	–	1	1	–	–	–	–	–	–	2
SW	–	2	1	2	–	–	–	–	–	5
W	–	4	2	–	–	–	–	–	–	6
NW	–	6	–	–	–	–	–	–	–	6
Total	108	34	69	224	30	–	–	–	–	465

Month . JUNE Year . 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	77	–	–	–	–	–	–	–	–	77
N	–	1	–	–	–	–	–	–	–	1
NE	–	1	1	–	–	–	–	–	–	2
E	–	25	34	100	27	–	–	–	–	184
SE	–	6	26	103	29	–	–	–	–	164
S	–	1	2	–	–	–	–	–	–	3
SW	–	1	–	–	–	–	–	–	–	1
W	–	2	6	5	–	–	–	–	–	13
NW	–	3	–	–	–	–	–	–	–	3
Total	77	40	69	208	56	–	–	–	–	450

Month : JULY Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	95	–	–	–	–	–	–	–	–	95
N	–	1	–	–	–	–	–	–	–	1
NE	–	4	–	–	–	–	–	–	–	4
E	–	11	35	116	15	–	–	–	–	177
SE	–	6	32	108	26	–	–	–	–	172
S	–	3	–	–	–	–	–	–	–	3
SW	–	2	–	2	–	–	–	–	–	4
W	–	1	2	2	–	–	–	–	–	5
NW	–	4	–	–	–	–	–	–	–	4
Total	95	32	69	228	41	–	–	–	–	465

Month : AUGUST Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	34	–	–	–	–	–	–	–	–	34
N	–	–	–	–	–	–	–	–	–	
NE	–	2	1	–	–	–	–	–	–	3
E	–	12	11	74	69	–	–	–	–	166
SE	–	3	9	124	119	1	–	–	–	256
S	–	1	–	–	–	–	–	–	–	1
SW	–	–	–	1	–	–	–	–	–	1
W	–	1	1	1	–	–	–	–	–	3
NW	–	1	–	–	–	–	–	–	–	1
Total	34	20	22	200	188	1	–	–	–	465

Month . SEPTEMBER Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	40	–	–	–	–	–	–	–	–	40
N	–	1	–	–	–	–	–	–	–	1
NE	–	1	–	–	–	–	–	–	–	1
E	–	6	25	77	23	–	–	–	–	131
SE	–	10	33	163	66	–	–	–	–	272
S	–	1	–	3	–	–	–	–	–	4
SW	–	–	–	–	–	–	–	–	–	–
W	–	1	–	–	–	–	–	–	–	1
NW	–	–	–	–	–	–	–	–	–	–
Total	40	20	58	243	89	–	–	–	–	450

Month : OCTOBER Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	88	–	–	–	–	–	–	–	–	88
N	–	–	–	–	–	–	–	–	–	
NE	–	1	9	2	–	–	–	–	–	12
E	–	10	13	44	11	–	–	–	–	78
SE	–	12	37	114	62	–	–	–	–	225
S	–	–	4	8	–	–	–	–	–	12
SW	–	3	3	3	–	–	–	–	–	9
W	–	5	20	14	–	–	–	–	–	39
NW	–	1	1	–	–	–	–	–	–	2
Total	88	32	87	185	73	–	–	–	–	465

Month : NOVEMBER Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	64	–	–	–	–	–	–	–	–	64
N	–	6	3	1	–	–	–	–	–	10
NE	–	4	9	6	–	–	–	–	–	19
E	–	3	21	67	20	–	–	–	–	111
SE	–	5	16	79	30	–	–	–	–	130
S	–	–	–	1	–	–	–	–	–	1
SW	–	1	15	13	1	–	–	–	–	30
W	–	6	34	32	1	–	–	–	–	73
NW	–	4	7	1	–	–	–	–	–	12
Total	64	29	105	200	52	–	–	–	–	450

Month · DECEMBER Year : 1958

m/sec	0	1 ~ 1.66	1.9 ~ 3.0	3.3 ~ 5.2	5.5 ~ 8.3	8.6 ~ 10.8	11.1 ~ 14.0	14.1 ~ 16.9	17.2 ~ 20.5	Total
Calm	136	–	–	–	–	–	–	–	–	136
N	–	10	3	1	–	–	–	–	–	14
NE	–	15	4	5	–	–	–	–	–	24
E	–	13	22	31	–	–	–	–	–	66
SE	–	18	23	26	6	–	–	–	–	73
S	–	2	3	1	1	–	–	–	–	7
SW	–	9	20	14	–	–	–	–	–	43
W	–	21	17	28	–	–	–	–	–	66
NW	–	20	10	6	–	–	–	–	–	36
Total	136	108	102	112	7	–	–	–	–	465

3-3 Tide

The tidal in 1973 shall be summarized at various parts of Indonesia. Generally, the tidal difference is larger at the places along the malacca strait.

Monthly tide table shall be shown in the following, for Medan, Jakarta, and Surabaya.

Site	H.H.W.L.	L.L.W.L.	Tidal difference
Balikpapan	+ 2.80^m	± 0^m	2.80^m
Cirebon	+ 0.90	+ 0.10	0.80
Dumai	+ 3.20	+ 0.40	2.80
Palembang	+ 3.90	+ 0.10	3.80
Jakarta	+ 1.10	+ 0.10	1.00
Surabaya	+ 2.80	± 0	2.80
Padang	+ 1.40	+ 0.10	1.30
Medan	+ 2.60	+ 0.20	2.40
Cilacap	+ 2.10	± 0	2.10
Semarang	+ 1.10	± 0	1.10

JANUARY

(10 cm)

d \ h	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	h / d
1	20	18	16	13	11	09	08	09	10	12	14	16	16	16	14	13	11	11	11	12	14	17	19	21	22	1
2	22	21	18	15	12	09	08	07	08	10	13	15	17	17	16	15	13	11	10	11	13	15	18	20	22	2
3	22	22	20	17	13	10	07	06	07	08	11	14	17	18	18	16	14	12	10	10	11	13	16	19	22	3
4	22	23	22	19	15	11	07	05	05	06	09	12	16	18	19	18	16	13	11	09	09	11	14	18	21	4
5	21	23	23	21	17	13	08	05	04	04	07	10	14	18	20	20	18	15	12	10	09	10	12	16	19	5
6	19	23	24	23	20	15	10	06	03	03	05	08	13	17	20	21	20	17	14	11	09	09	10	13	17	6
7	17	21	23	23	22	18	13	08	04	03	04	06	10	15	19	22	21	20	17	13	10	08	09	11	15	7
8	15	19	22	23	23	20	16	11	06	03	03	04	08	12	17	20	22	21	19	16	12	10	08	10	12	8
9	12	16	20	22	23	21	18	13	09	05	03	04	06	10	15	18	21	22	20	17	14	11	10	09	10	9
10	10	13	17	19	21	21	19	16	12	08	05	04	05	08	12	16	19	21	21	20	17	14	11	10	10	10
11	10	11	14	17	19	20	20	17	15	11	08	06	06	07	10	13	17	19	21	21	19	17	14	11	10	11
12	10	10	12	13	16	18	18	18	16	14	12	09	07	07	08	11	14	17	19	20	20	19	17	14	12	12
13	12	11	10	11	13	15	16	17	17	16	14	12	10	08	08	10	12	14	17	19	20	20	19	18	15	13
14	15	12	11	10	10	11	13	14	15	16	16	15	13	11	10	10	10	12	14	16	18	20	21	20	18	14
15	18	15	13	10	09	09	09	11	13	15	16	17	16	15	13	11	10	10	11	13	16	19	21	22	21	15
16	21	19	15	12	09	07	07	08	09	12	15	17	18	18	16	13	11	10	09	11	13	16	19	22	23	16
17	23	22	19	15	11	07	05	05	06	09	13	17	19	20	19	16	13	10	09	09	10	13	17	21	23	17
18	23	24	22	19	14	09	05	03	04	06	10	14	18	21	21	19	16	13	10	08	08	10	14	18	22	18
19	22	25	24	22	17	12	07	04	02	03	07	11	16	20	22	22	19	15	11	08	07	08	11	16	20	19
20	20	24	25	24	20	15	10	05	02	02	04	08	13	18	22	23	21	18	14	10	08	07	09	13	17	20
21	17	22	24	25	23	18	13	08	04	02	03	05	10	16	20	23	23	20	17	13	09	08	08	10	14	21
22	14	19	22	24	23	20	16	11	06	04	03	04	08	13	18	21	23	22	19	15	11	09	08	09	12	22
23	12	16	20	22	23	21	18	13	09	06	04	04	07	11	15	19	22	22	20	17	14	11	09	09	10	23
24	10	13	17	20	21	21	19	15	11	08	06	05	06	09	13	17	20	21	21	19	16	13	11	10	10	24
25	10	12	15	17	19	19	18	17	13	10	08	07	07	09	11	15	18	19	20	19	18	15	12	11	11	25
26	11	11	13	15	16	17	17	16	14	12	10	09	08	09	11	13	16	18	19	19	18	17	15	13	12	26
27	12	12	12	13	14	15	15	15	13	12	11	10	10	11	13	14	16	18	18	18	18	18	17	16	14	27
28	14	13	12	12	12	13	13	14	14	14	13	13	12	12	12	12	13	15	16	17	18	18	18	17	16	28
29	16	14	13	12	11	11	11	12	12	13	14	15	14	13	13	12	13	13	14	15	15	17	19	19	18	29
30	18	16	14	12	11	10	09	10	11	12	14	15	16	15	14	13	12	12	12	13	15	17	18	19	20	30
31	20	19	16	13	11	09	08	08	09	11	13	16	17	18	17	15	13	12	11	12	13	15	18	20	21	31
h / d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d \ h

BELAWAN (MEDAN)

FEBRUARY

d \ h	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	h / d
1	21	20	18	15	12	09	07	06	07	09	12	15	18	19	18	17	14	12	10	10	11	13	16	19	22	1
2	22	22	20	18	14	10	07	05	05	07	10	14	18	20	20	19	16	13	10	09	09	11	14	18	21	2
3	21	23	23	20	16	11	07	04	03	05	08	12	17	20	22	21	18	15	11	09	08	09	12	16	20	3
4	20	23	24	23	19	14	09	05	03	03	06	10	15	19	22	23	21	17	13	09	07	07	09	13	18	4
5	18	22	24	23	21	16	11	06	03	02	04	08	13	18	22	23	23	20	15	11	08	07	08	11	15	5
6	15	20	23	24	23	19	14	09	05	03	03	05	10	16	20	23	23	22	18	13	10	07	07	08	12	6
7	12	17	20	23	23	21	17	12	07	04	03	04	08	13	18	22	23	23	20	16	12	08	07	07	10	7
8	10	14	18	21	23	22	19	15	10	07	05	05	07	10	15	19	22	23	21	18	15	11	08	07	08	8
9	08	11	15	18	20	21	19	17	13	10	07	06	06	09	13	17	20	22	21	20	17	14	11	09	08	9
10	08	10	12	15	17	18	19	18	15	13	10	08	08	09	11	14	17	19	20	20	19	17	14	11	10	10
11	10	09	10	12	13	15	16	17	16	15	13	11	10	10	10	12	14	16	18	19	19	19	17	15	13	11
12	13	11	10	10	11	12	13	14	16	16	16	14	13	12	11	11	12	13	15	17	18	19	19	18	16	12
13	16	14	11	10	09	09	10	11	13	15	16	17	16	15	13	12	11	11	12	14	16	18	20	20	19	13
14	19	17	14	11	09	07	07	08	10	13	16	18	19	18	16	14	12	10	10	11	13	16	19	21	22	14
15	22	21	18	14	10	07	05	05	07	10	15	18	20	21	19	17	13	10	09	09	10	13	17	20	23	15
16	23	23	21	17	12	08	05	03	04	07	11	16	20	22	22	19	16	12	09	07	08	10	14	19	22	16
17	22	24	23	20	16	10	06	03	03	04	03	13	18	22	23	22	19	14	10	07	06	07	11	16	20	17
18	20	24	24	23	19	14	08	04	02	03	06	10	16	21	23	23	21	17	12	08	06	06	08	13	17	18
19	17	22	24	24	21	17	11	06	03	02	04	08	14	19	23	24	23	19	15	10	07	06	07	10	15	19
20	15	19	22	23	22	19	14	09	05	03	03	07	11	17	21	23	23	21	17	13	09	07	07	08	12	20
21	12	17	20	23	22	20	16	11	07	05	04	06	10	14	19	22	23	23	19	15	11	08	07	08	10	21
22	10	14	18	20	21	20	17	13	10	07	05	06	09	13	17	20	22	22	20	17	13	10	08	08	10	22
23	10	12	16	18	19	19	17	15	12	09	07	07	09	12	15	13	20	21	20	18	15	12	10	09	10	23
24	10	11	14	16	17	18	17	15	13	11	09	09	10	11	14	16	19	19	19	18	17	14	12	11	10	24
25	10	11	12	14	15	16	16	15	14	12	11	11	11	12	13	15	17	18	18	18	17	16	14	13	12	25
26	12	12	12	12	13	14	14	14	14	13	13	13	12	12	14	14	15	16	17	17	17	16	16	15	14	26
27	14	13	12	12	11	12	12	13	13	14	14	14	15	14	14	14	14	14	15	16	16	17	17	17	16	27
28	16	14	13	11	10	10	10	10	12	12	15	16	17	16	15	14	13	13	13	14	15	16	18	18	18	28
29																										29
30																										30
31																										31
h / d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d \ h

BELAWAN (MEDAN)

MARCH

h \ d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d / h
1	18	16	14	12	10	08	08	09	10	12	15	17	19	18	17	15	13	12	11	12	13	15	17	19	20	1
2	20	19	17	13	11	08	07	07	08	11	14	17	20	20	19	17	14	11	10	10	11	13	16	19	21	2
3	21	21	19	16	12	08	06	05	06	08	13	17	20	22	21	19	16	12	09	08	08	10	14	18	21	3
4	21	23	22	18	14	09	06	04	04	06	10	16	20	23	23	21	18	13	09	07	07	08	12	16	20	4
5	20	23	23	21	17	12	07	04	03	04	08	13	18	23	24	23	20	16	11	07	05	06	09	13	18	5
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BELAWAN (MEDAN)

AUGUST

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BELAWAN (MEDAN)

SEPTEMBER

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BELAWAN (MEDAN)

OCTOBER

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BELAWAN (MEDAN)

NOVEMBER

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BELAWAN (MEDAN)

DECEMBER

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BELAWAN (MEDAN)

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SURABAYA (PELABUHAN)

FEBRUARY

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SURABAYA (PELABUHAN)

MARCH

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SURABAYA (PELABUHAN)

APRIL

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OCTOBER

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SURABAYA (PELABUHAN)

NOVEMBER

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SURABAYA (PELABUHAN)

DECEMBER

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SURABAYA (PELABUHAN)

JANUARY

(10 cm)

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h / d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d \ h

TANJUNG PRIOK (JAKARTA)

FEBRUARY

h \ d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d / h
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30																										30
31																										31
h / d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d \ h

TANJUNG PRIOK (JAKARTA)

MARCH

h\d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d/h
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h/d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d\h

TANJUNG PRIOK (JAKARTA)

APRIL

h\d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d/h
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31																										31
h/d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d\h

TANJUNG PRIOK (JAKARTA)

MAY

h \ d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d / h
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28	07	06	05	04	04	03	03	03	03	04	04	04	04	04	04	05	06	07	08	08	08	09	09	09	08	28
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h / d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d \ h

TANJUNG PRIOK (JAKARTA)

JUNE

h \ d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d / h
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31																										31
h / d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d \ h

TANJUNG PRIOK (JAKARTA)

JULY

h \ d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d / h
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5	08	08	07	07	06	05	04	03	03	03	03	03	03	04	04	05	05	06	07	07	07	08	08	08	08	5
6	07	07	06	06	05	05	04	04	03	03	03	03	04	04	05	05	06	07	07	07	07	08	07	07	06	6
7	06	06	06	05	05	04	04	04	04	04	04	04	04	04	05	06	07	07	08	08	08	08	07	07	06	7
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13	08	07	05	03	02	01	01	01	01	02	03	03	04	04	05	05	06	07	08	09	10	10	10	10	09	13
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19	08	07	07	06	05	04	04	03	03	03	03	03	04	04	05	05	05	06	06	07	07	07	08	07	07	19
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21	06	06	05	05	05	04	04	04	04	04	04	04	05	05	05	06	07	07	07	07	07	07	07	06	05	21
22	05	05	05	04	04	04	04	03	04	04	04	05	05	05	05	06	07	08	08	08	08	08	07	06	05	22
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25	06-	04	03	02	02	02	02	02	03	03	04	05	05	05	06	06	07	08	09	09	10	10	09	08	07	25
26	07	05	03	02	01	01	01	02	02	02	03	03	04	05	05	05	07	08	09	10	10	10	10	09	07	26
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31	09	08	07	05	04	03	02	02	03	03	03	03	04	04	04	05	05	05	06	07	08	08	09	09	08	31
h / d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d \ h

TANJUNG PRIOK (JAKARTA)

AUGUST

h \ d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d / h
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2	08	07	06	06	05	04	03	03	03	04	04	04	04	05	05	05	06	06	06	06	07	07	07	07	07	2
3	07	06	06	05	05	04	04	04	04	04	05	05	05	05	06	06	06	06	06	06	07	07	07	06	06	3
4	06	05	05	05	05	04	04	04	04	04	05	05	05	05	06	06	07	07	07	07	07	07	06	05	05	4
5	05	05	04	04	04	04	04	04	04	05	05	05	05	06	06	07	07	07	07	07	07	07	06	05	05	5
6	05	04	04	03	03	03	04	04	04	05	05	05	05	06	06	07	07	08	08	08	08	08	07	06	05	6
7	05	04	03	03	03	03	03	03	04	05	05	05	05	06	06	07	08	08	09	09	09	08	08	06	05	7
8	05	04	03	02	02	02	03	03	04	04	05	05	05	05	06	07	08	08	09	09	09	09	08	07	06	8
9	06	04	03	02	02	02	02	02	03	04	05	05	05	05	06	06	07	08	09	09	10	10	09	08	07	9
10	07	05	03	02	02	02	02	02	03	03	04	05	05	05	05	06	07	08	09	09	10	10	10	09	07	10
11	07	05	04	03	02	02	02	02	03	03	04	04	05	05	05	05	06	07	08	09	10	10	10	09	08	11
12	08	06	05	03	02	02	02	02	03	03	04	05	05	05	05	05	06	07	09	06	09	09	09	09	08	12
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15	08	07	06	05	04	04	03	03	03	04	04	04	05	05	05	05	05	05	06	06	07	07	08	07	07	15
16	07	07	06	05	05	04	04	04	04	05	05	05	05	05	05	05	05	05	05	06	06	07	07	07	06	16
17	06	06	06	05	04	04	04	04	04	04	05	05	05	06	06	06	06	06	06	06	06	06	06	06	05	17
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19	05	04	04	04	04	04	04	04	05	05	05	06	06	06	07	07	07	07	07	07	07	06	05	05	04	19
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21	04	03	02	02	03	03	03	04	04	05	05	06	06	06	07	07	08	08	08	08	08	07	06	05	04	21
22	04	03	02	02	02	02	03	03	04	05	05	05	06	06	07	07	08	09	09	09	09	08	07	06	05	22
23	05	03	02	02	02	02	02	02	04	04	05	05	06	06	06	07	08	08	09	09	09	09	08	07	05	23
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28	07	06	05	04	03	03	03	03	04	04	04	05	05	05	05	05	05	05	06	07	07	08	08	07	07	28
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h / d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d \ h

TANJUNG PRIOK (JAKARTA)

SEPTEMBER

h \ d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d / h
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6	03	02	02	02	02	02	03	04	04	05	06	06	06	06	07	07	08	09	09	09	08	08	07	06	04	6
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13	06	06	05	05	04	04	04	05	05	06	06	06	06	06	06	05	05	05	05	05	05	06	06	06	05	13
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18	03	02	02	02	03	04	04	05	06	06	07	07	08	08	08	08	08	08	07	07	06	05	04	03	02	18
19	02	02	02	02	03	03	04	05	06	06	07	07	07	08	08	08	08	08	08	07	07	06	05	04	03	19
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31																										31
h / d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d \ h

TANJUNG PRIOK (JAKARTA)

OCTOBER

h \ d	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	d / h
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TANJUNG PRIOK (JAKARTA)

NOVEMBER

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TANJUNG PRIOK (JAKARTA)

DECEMBER

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TANJUNG PRIOK (JAKARTA)

Fig. 3・4・1 Map of Epicenters

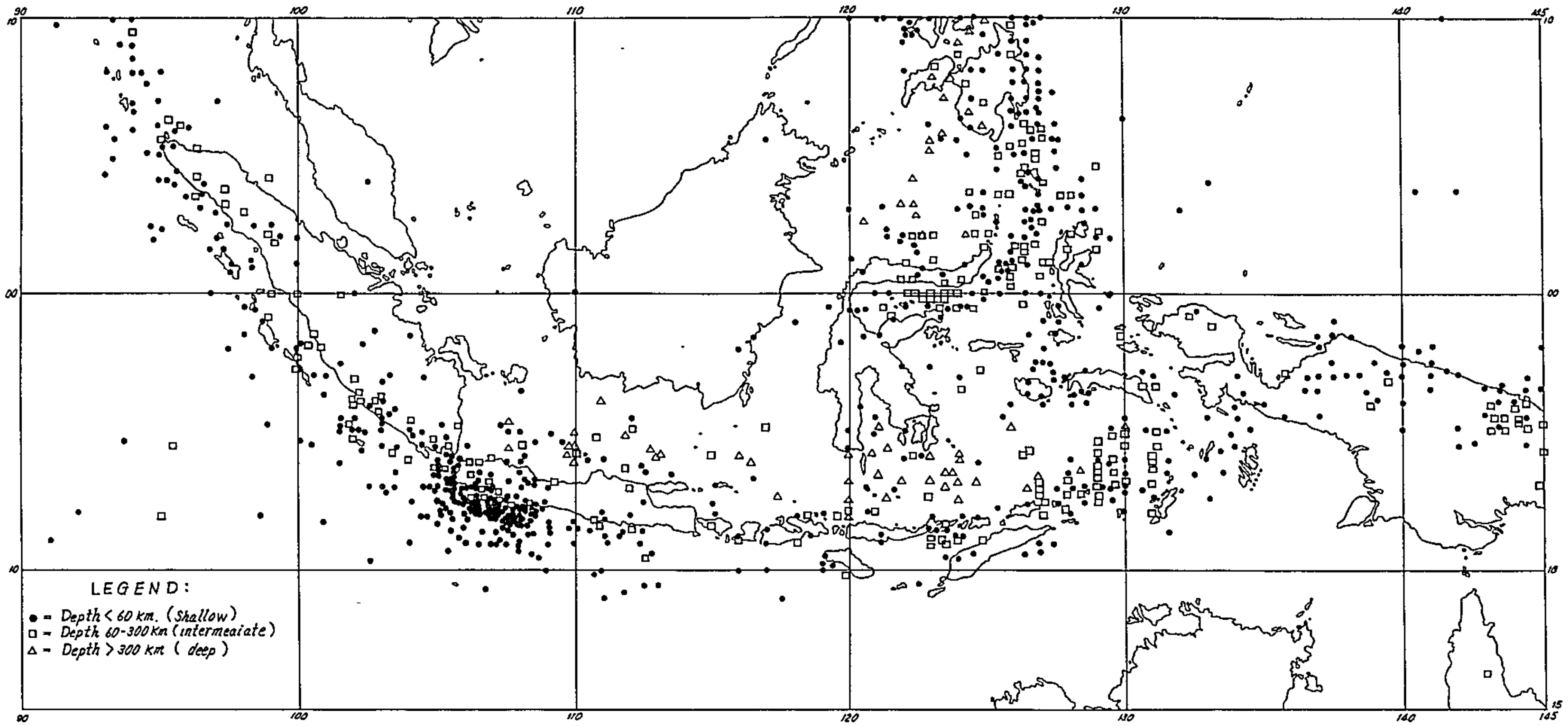


Fig. 3・4・2   Map Showing Generalised Distribution of Intermediate and Deep Earthquake Foci in Indonesia

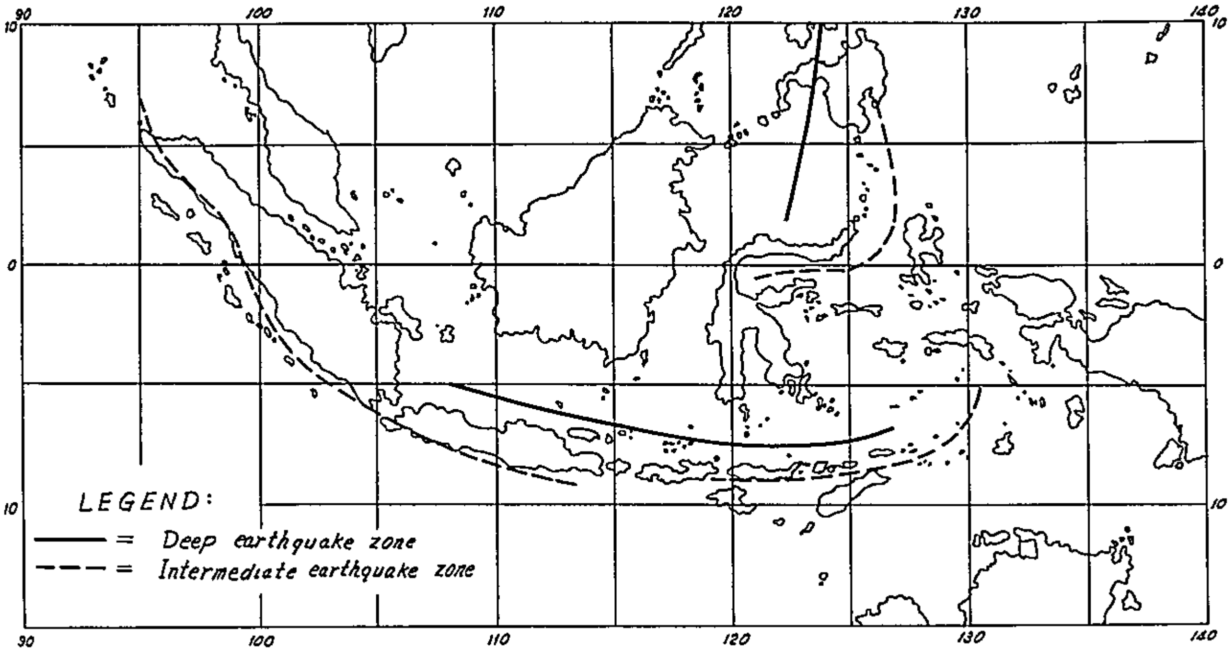
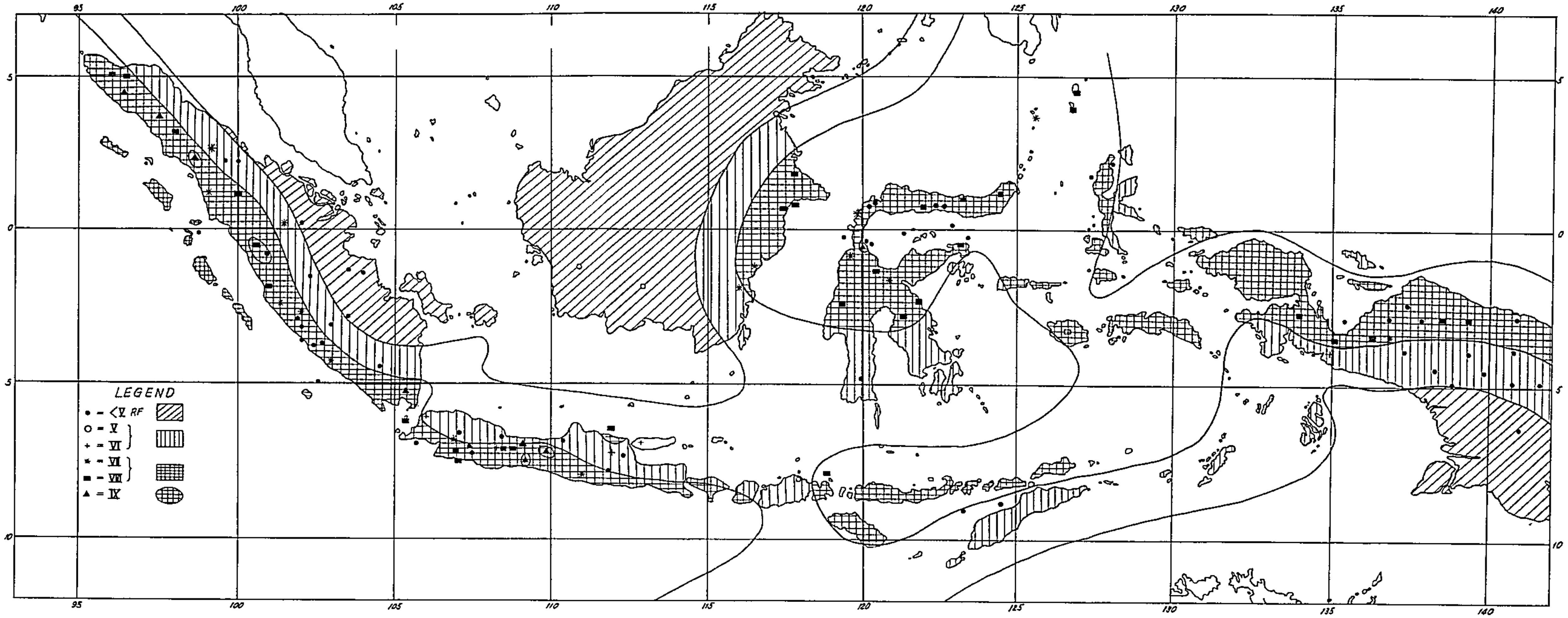


Fig. 3·4·3 Seismic Zones of Indonesia

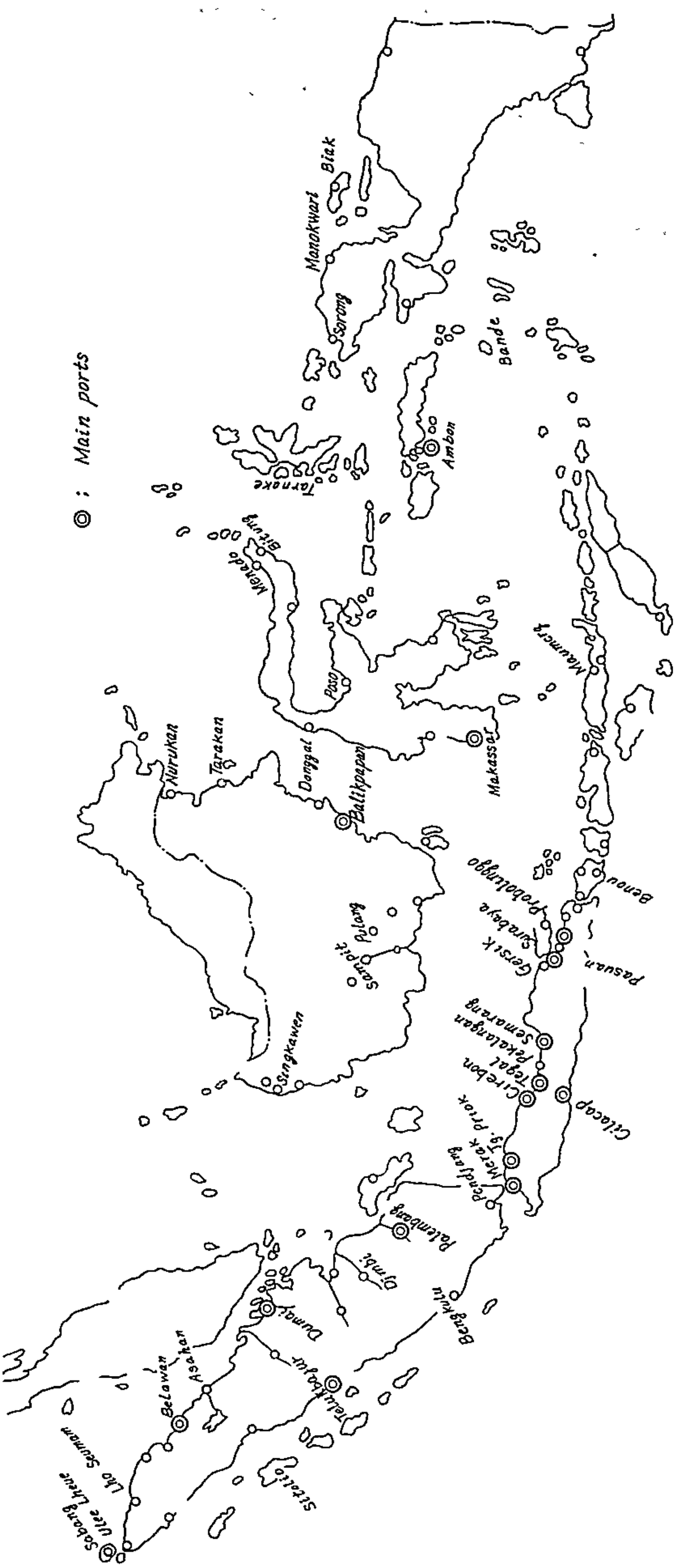


4. CONCERNING THE PORT FACILITIES IN INDONESIA

Main ports in Indonesia (1973. 8.)

(Source : Indonesia ports information)

Ports \ Kinds	Maxmum Tidal difference (m)	Water depth of berth (m)	Total length of berth (m)	The biggest ship ever anchored (D.W.T.)
(1) Tanjung priok (Jakarta)	1.00	-10.0	5,800	17,000
(2) Surabaya	2.80	- 8.0	5,450	7,000
(3) Cirebon	0.90	- 5.0	730	1,300
(4) Semarang	1.10	- 5.5	2,982	2,000
(5) Tegal		- 3.0	615	
(6) Merak	1.40	- 4.0	150	
(7) Cilacap	2.20	-11.00	650	30,000
(8) Probolinggo		- 2.0	600	
(9) Dumai	2.90	-24.0	2,127	150,000
(10) Belawan (Medan)	2.40	- 7.2	2,000	5,000
(11) Palembang	1.80	- 9.0	350	20,000
(12) Telukbajur	1.40	-10.0	435	15,000
(13) Balikpapan	2.80	-15.0		85,000
(14) Ambon	2.30	-12.7	290	50,000
(15) Makassar	1.30	- 7.0	5,000	5,000


◎ : Main ports
Biak
Manokwari
Sorong
Bande
Ambon
Bitung
Menado
Poso
Maumere
Makassar
Nunukan
Tarakan
Donggal
Balikpapan
Probolinggo
Benoa
Surabaya
Gersik
Pasuruan
Semarang
Pekalongan
Tegal
Cirebon
Tg. Priok
Cilacap
Merak
Pandjang
Palembang
Djambi
Bengkulu
Dumai
Belawan
Asahan
Lho Seumawe
Ulee Lheue
Sabang
Sampit
Singkawang

(1) TANJUNG PRIOK
(JAKARTA)

Position

Lat. 6° 6′ S.; Long 106° 52′ E.

Accommodation

The harbour is protected by breakwater and uneffected by tide.
The berthing places are separated in :

Pelabuhan Nusantara

Provided with 676 metres long concrete wharf on one side, with 4 metres depth at wharf face. Expecially for coasters.

First Inner Harbour

Provided with concrete wharf on two sides with a total length of 1830 metres. Average depth 7 metres at wharf face. Appointed for the interinsular shipping routes.

Second Inner Harbour

Provided with concrete wharf on two sides with a total length of 2.200 metres. Average depth 8 metres at wharf face. Appointed for oceangoing vessels.

Third Inner Harbour

Provided with concrete wharf on one side and 1.025 metres long. Average depth 9 metres at wharf face. On the northern part occupied by a passenger-station named "Samudera Pura".
Especially oceangoing vessels take berth.

Gasoline pier

There are two gasoline piers, each 25 metres long with a depth of 10 metres. One situated on the northern east end of Second Inner Harbour and the other one in the new Oil Harbour just in front of the oil installations area.

Ships must always berth heading north, and must turn in the harbour to come alongside quay stern first. Dangerous cargo must be discharge into lighters outside harbour area. There are 50 transit sheds with a total area of 197.000 sq. metres of which 29 sheds of 128.000 sq. metres appointed for foreign trade and the other 21 sheds of 69.000 sq. metres for domestic trade.

Existing cargo handling machines are :
35 quay-cranes ; 107 forklift trucks ; 17 mobile-cranes and 4 floating-cranes with lifting capacity of resp. 30, 50, 100 and 200 tons.
Besides, new in operation 5 tugboats ; 7 lightertug ; 4 mooring boats ; 4 waterbarges and 47 cargo barges.

Working hours :

Monday to Thursday, 08.00 to 12.00 and 13.00 to 16.00 ;

Friday, 08.00 to 11.00 and 13.00 to 16.00 ;

Saturday, 08.00 to 13.00.

Sunday, overtime rates.

Tandjung Priok Radio (call signal PKZ) :

a. on frequency 8754,4 Kc/s at 02.00, 04.00 and 10.00 gmt. ;

b. class of emission A.1.

Development

Extension plan :

a. lengthening gasoline pier in the new Oil Harbour ;

b. building new wharf on the east side of Third Inner Harbour especially for Armed Forces.

Bunkers

Supplied by P.N. Pertamina per lighters as well as per pipelines.

Shiprepairs

a. P.N. Dok Tandjung Priok (cables : Priok dok) ownes three floating dry-docks, two of 6.000 tons cap. and one of 10.000 tons.
   One slipway, 2.000 tons cap. One crane 25 tons cap.

b. P.T. Pelita Bahari ownes one floating drydock of 3.250 tons capacity.

c. Radio, radar and electrical repairs by Radio Indonesia.

Towage

5 Tugboats available.

Pilotage

Harbour pilots available.

Officials

— Port Administrator ;

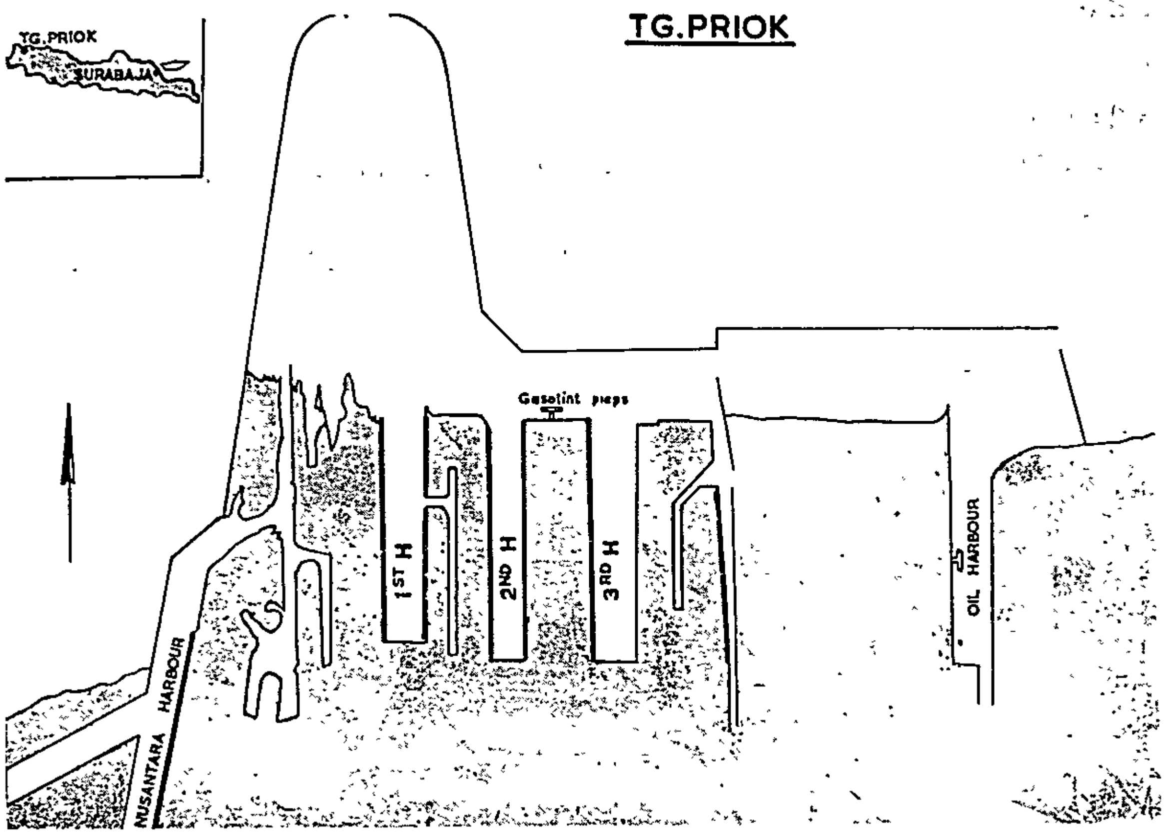
— Custom Officers ;

— Immigration Officers ;

— Port Health & Quarantine Service.

Airport

International airport "Kemayoran", about 14 kilometres via Djakarta By-pass and 12 kilometres via Antjol.



(2) SURABAYA

Position

Lat. 7° 13′ S., Long 112° 44′ E.

Accommodation

The port is called "Tandjung Perak", provided with concrete wharf, total length 5.450 metres. Depth at wharf face varies from 2,50 to 8.00 metres. 44 transit sheds and 32 warehouses available. Cargo handling machines in use : 6 quay-cranes, cap. 3 to 5 tons, 3 mobile-cranes, cap. 3 tons, 3 forklift-truck, resp. 1, 5, 3 and 5 tons cap.
Several lighters and tugs avilable, belonging to shipping companies. Coastal Radio Station, call signal PKD, on frequency 430, 500 and 8730, class of emission A. 1. and A. 2. ; on frequency 8754, 4 Kc/s, class of emission A. 3. The canal Kali Mas, provided with concrete wharf on one edge about 4, 5 kilometres long. Accessible for small craft and sailing vessels only. Water supply about 450 ton per day.

Development

- None.

Bunkers

Shiprepairs

- P.N. Dok Surabaya, owns 3 floating drydocks, lifting capacity 3.000, 4.000 and 20.000 tons.

  Private repair-yards, P.T. Djawimex, P.T. Waisisil, P.T. Tekad and C.V. Aneka Raya.

Towage

- Tugboats available.

Pilotage

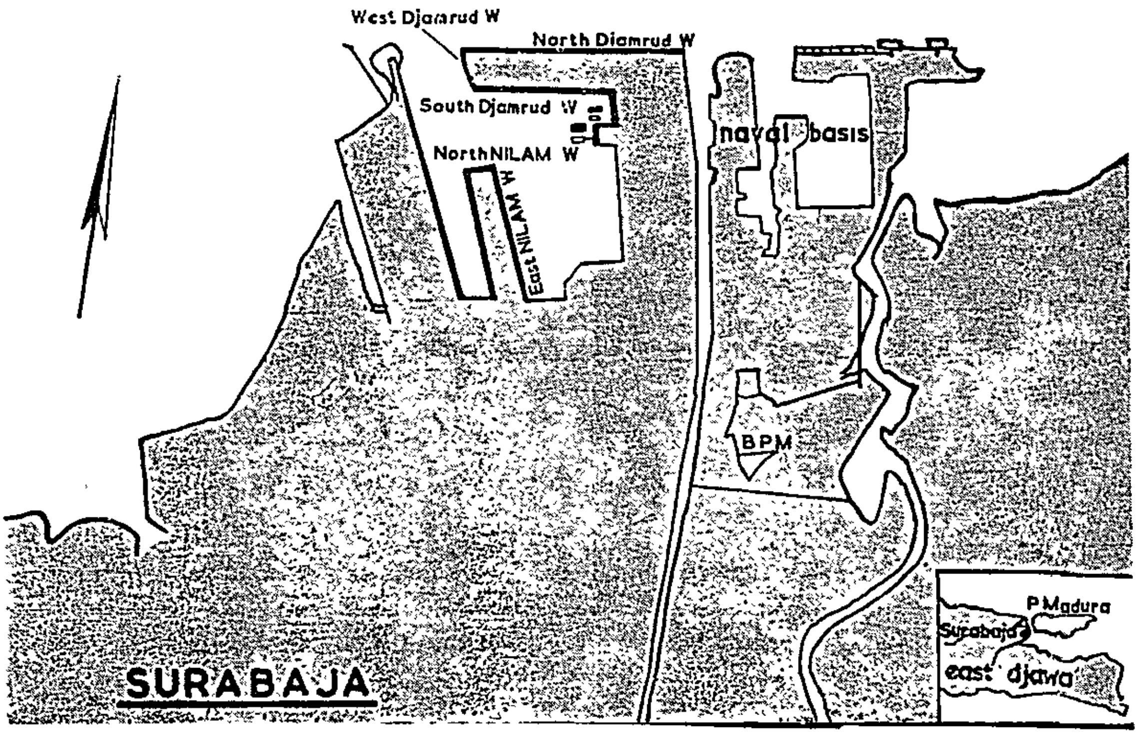
- Harbour and Sea pilots available

Officials

- Port Administrator ;
- Custom Officers ;
- Immigration Officers ;
- Port Health & Quarantine Service.

Airport

International airport "Waru".



(3) C I R E B O N
(West Jawa)

General Remarks

The harbour, which is thrown open for the foreign trade, located on position 6° 41' S, 108° 33' E. The roadstead is properly accessible to ships with 7 m maximum draft. Only ships with 3.5 m maximum draft can enter the inner-harbour and moor alongside wharves. Greatest depth within roadsted limits is 10 m. A mooring buoy is placed on position 6° 04' 40" S., 108° 38' 10" E.
Depths at channel leading to inner-harbour ranging from 2 to 4 m. Enterring inner-harbour is allowed from 06.00 to 18.00 hours local time after permission. Tankers of 300 dwt only are accessible to take berth at special oil-jetty.

Pilotage

No pilot service available.

Port Terminal Facilities

P i e r s .

- Concrete jetty for mooring lighters only, 32 m in length and having a depth of 1.10 m at LWS tide.
- Concrete wharves : "Katjang" having a length of 30 m and a depth of 2.20 m at LWS tide ;
  "Bungkil" having a length of 75 m and a depth of 1.50 m at LWS tide ;
  "Sandang" having a length of 100 m and a depth of 1.50 m at LWS tide ;
  "Parit" having a length of 524 m and a depth of 1.10 m at LWS tide (for mooring lighters only).
- 9 Wooden jetties for particular services. The lenghs ranging from 4 to 10 m and the depths alongside are from 2.00 to 2.50 m at LWS tide
- 3 Privately owned wooden jetties for own use.

S t o r a g e s .

- 8 Waterfront storages totalling 5,567 sq. m. in area.
- One entrepot storage of 1,875 sq. m. in area.
- A large number of private warehouses totalling 38.087 sq. m. in area.

H o i s t i n g   a p p a r a t u s .

- One old caterpillar mobile-crane of 2 tons lifting capacity.
- One forkliftruck of 3 tons lifting capacity.

H a r b o u r   c r a f t s .

- One lightertug of 90 HP. There is no tug service, but in case of need orcers can be directed to agents.

- About 30 privately owned lighters available, either of 80 m^3 loading capacity.

Labour.

- Sufficient dockworkers obtainable.

Coastal Radio Station.

- Cirebon Radio, call signal PKZ2.
- Sending on frequency 6491.5 and 8799.5 Kc/s :
- Watching on frequency 6265 - 6285 Kc/s and 8204 - 8249 Kc/s ;
- Working hours at 00.30 - 01.30 and 06.00 - 07.00 gmt.

Medical

Hospital facilities available. Agents will arrange for medical attention on advance notice.

Pure Water

Maximum water supply is 80 tons per 24-hour day, delivered to ships by barge at day-time only. One delivery is 75 tons and discharged within 6 hours.
For quick delivery two days advance notice to agents required.

Victuals

Plenty of victuals obtainable.

Bunkers

No bunker service available, but in case of emergency agents will arrange.

Shiprepairs

Minor repairs can be carried out by dockyard. A graving dock of 600 dwt capacity available.

Officials

- Port Administrator.
- Customs Officer.
- Immigration Officer.
- Medical Officer in charge with Port Health & Quarantine Service.

Airport

No airport in the vicinity.

Commodities

Important export commodities are: tea, rubber, coffee, cinchona-bark, lumber and cattle-fodder.

(4) SEMARANG

General Remarks

The harbour of Semarang, which is located on position 07° 01' S., 110° 27' E., is the main harbour for Central jawa. Owing to the Shallow depth, the port is accessible only to vessels measuring below 900 tons gross with a maximum draught of 3.5 m.

Advised anchorage is, during east-monsoon in front of harbour entrance as close in as possible at - 5 to-7 m. depth, and during westmonsoon westward of the moles within circle drawn with a radius of three miles around the lighthouse on position 06° 57' S., 110° 25' E. at some-9 m. depth. Outside the roadstead it is possible for vessels to anchor in water deeper than 10 m. in sand.

Bad weather, which normally prevails during the months December to February, prevents another loading or discharging at anchorage.

The average depth in the channel leading to the inner harbour is - 4 m., and in Kalibaru canal, which destined for sailing vessels, is-3 m.

Pilotage

Pilotage is compulsory. There are two harbour pilots available on 24-hour day service, but taking vessels in to inner harbour is customary done at daylight hours.

Terminal Facilities

Berthing.

- Coasters' Wharf is 310 m. long with a depth of 5.5 m. alongside :
- Wharf at inner harbour I is 540 m. long with a depth of 3 m. alongside ;
- Wharf at inner harbour II is 685 m. long with a depth of 3 m. alongside ;
- Eastern wharf of Kalibaru canal is 1,447 m. long with a depth of 2.5 m. alongside ;
- Western wharf of Kalibaru canal is 1,446 m. long with a depth of 2.5 m. alongside.

Storages.

There are 20 waterfront storages available totalling 39, 451 sq. m. in area.

Hoisting apparatus.

The port avails :

- Five quay cranes each of 5 tons lifting capacity ;
- One mobile crane of 5 tons lifting capacity ;
- Three forklifttrucks (at present in disorder).

Besides, there are :

- One 1.5 ton mobile crane, belonging to the ARMY ;
- One 5-ton mobile crane and one 2 tons forkliftruck, belonging to P.N. DJAKARTA LLOYD.

Harbour crafts.

The port provides the fresh water delivery service with :

- Two 100-tons waterbarges, and
- Two powerboat of 150 HP average capacity.

P.N. DJAKARTA LLOYD provides themself with :

- Eleven lightertugs cach of 120 HP average capasity ;
- 54 cargo lighter totalling 3,700 tons loading capacity.

P.T. SAMUDERA INDONESIA provides themself with :

- Four lightertugs each of 120 HP average capacity ;
- 12 cargo lighter totalling 1,750 tons loading capacity.

Labour.

There are 1,518 dockworkers registered at the Labour Pool.
Normal working hours : 07.00 - 11.30 and 12.30 - 15.30 (13.30 on Saturday).
The average working capacity is estimated to 20 tons per gang/hour. Handling vessels at anchorage is a 24 - hour advance notice of detailed specification of discharge cargoes required to arrange number of labourgangs and adequate stevedoring materials needed.

Coastal Radio Station.

SEMARANGRADIO, call sign PKR, working :

at gmt	00.00 - 00.30	on frequency	500 Kc/s
	01.00 - 01.30		8249
	02.30 - 03.00		8354
	04.00 - 04.30		500
	08.00 - 08.30		8249/500
	08.30 - 09.00		8249
	12.00 - 12.30		500

Medical

A clinic under attendance of a physician is available.
Hospitals in town are : Government Public Hospital, Elizabeth Hospital and Telogoredjo Hospital.

Fresh Water

The fresh water supply attains to maximum 100 tons per day, delivered either alongside wharves or by waterbarges. It is suggested to take fresh water in Tandjung Priok or Surabaya.

Victuals

Provisions are in sufficient quantity obtainable.

Bunkers

There is no bunker-station available, but in case of emergency bunker fuel in limited quantity obtainable to order.

Shiprepairs

Minor floating repair can be carried out by local dockyard. The providing slipway is accessible to ships of up to 150 gross tons with a maximum length of 36 m.

Officials

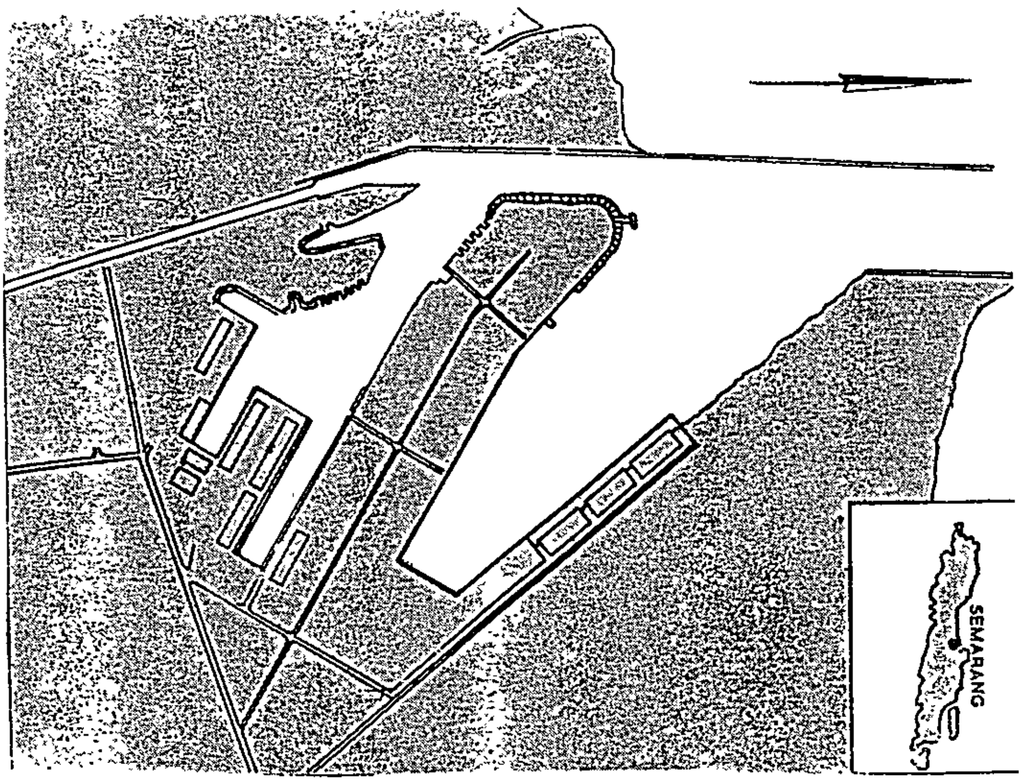
- Port Administrator ; Djalan Sers. KKO Usman Djanatin No. 8 tel. 245 and 726
- Customs Officer.
- Immigration Officer.
- Medical Officer in charge with Port Health & Quarantine Service.

Airport

"AHMAD YANI" airpot located about 5 Km. from the city.

Commodities

Outbound cargoes are agricultural and forest products.



(5) T E G A L

General Remarks

A small harbour located on position 6° 51' S., 109° 08' E. being unfit for deep-diaft vessels. The channel leading to the inner harbour is formed by two breakwaters, extending in a direction of 345° and about 640 m outside the coastline. The port is run in business and is thrown open for the foreign trade. Oceangoing ships have to remain in the roads about 4 miles from the port. The depths in the basin of inner harbour are from 3 to 4.5 m.

Pilotage

There is no pilot service available

Port Terminal Facilities

P i e r s .

- Wharf in inner harbour is 215 m long with a depth alongside of 3 m.
- Westside-wharf in the canal is 150 m long with a depth alongside of 2 m.
- Eastside-wharf in the canal is 250 m long with a depth alongside of 2 m.
- Several lengths of taluds capable of mooring sailing vessels.

S t o r a g e s .

- One waterfront storage of 840 sq. m in area.
- Three warehouses totalling 1,510 sq. m in area.

H o i s t i n g   a p p a r a t u s .

- Two hand cranes of respectively 3 and 18 tons lifting capacity.

H a r b o u r   C r a f t s .

- P.N. Djakarta Lloyd avails ten 70-tons cargolighters and two tugs of respectively 60, 200 and 200 HP capacity.

L a b o u r

- There are 360 dockworkers employed in various shipping and expediting companies.

Medical

The Port Health Service is provided with a clinic under attendance of a physician. For medical treatment referred to the Public Hospital in the city Tegal.

Pure Water

Fresh water supply attains to 10 tons per 24-hour day only.

Bunkers

There is no bunker supply availavble.

Shiprepairs

P.T. MENARA dockyard owns 300-tons slipways.

Fa. M. DJOESDI affords minor floating repairs.

Officials

- Port Administrator.
- Customs Officer.
- Medical Officer in charge with Port Health & Quarantine Service.

Airport

No airport in the vicinity.

(6) M E R A K

General Remarks

The port of Merak, which is located on position 5° 55′ 50″ S., 105° 59′ 50″ E, functioned as a proper ferry - boat terminal. As this ferry - boat service forms a link of the railway-sistem in Java and Sumatra, the State Railways prevails the entire port activities here. With the exception of tankers discharging petroleum, there is no other merchant freighter calling at this port. Neither bunkers nor fresh water obtainable.

Pilotage

There is no pilot service available

Port Terminal Facilities

P i e r . - Concerete wharf 80 m long with a depth alongside of 5.20 m at low-water spring tide.

S t o r a g e . - There is no cargo storage available. The extant waterfront building is used partly for passenger - station and partly for officials work-rooms.

Officials

- Chief of the Port.
- Customs Officer.

(7) C I L A C A P

General Remarks

A small harbour located in the Donan River on the southern coast of Central-Jawa (position 07° 41′ S., 109° 05′ E.). It is run in business and is thrown open to foreign trade. Many wrecks are still laying down in the harbour area. Average dopth in channel leading to the harbour is 7.00 m. at low water tide. Advised anchorage is on position 07° 45′ 25″ S., 109° 03′ 16″ E. in - 6.50 m. depth.

Pilotage

Pilotage is compulsory. There is one harbour-pilot available.

Terminal Facilities

W h a r v e s

- Wharf No. I an iron jetty 120 m. in length with a depth of -4.00 m. alongside ;
- Wharves No. II, III and IV, iron jetties connected one another 418 m. in total length with depths alongside ranging from - 5.00 to - 7.00 m.;
- Wharf in front of Hanger No. 39, a concrete jetty 50 m. in length;
- Oil-wharf, an iron jetty 10 m. in length provided with dolphins and the depth alogside is - 6.00 m.;
- Two wooden landingbridges of respectively 5 and 48 m. long.

S t o r a g e s

Waterfront storages are :

- Godown No. 3 is 2,000 sq. m. in area;
- Godown No. 5 is 1,400 sq. m. in area;
- Godown No. 6/7 is 1,950 sq. m. in area;
- Godown Nos. 9/10 1,950 sq. m. in area.

Warehouses are :

- Four government's warehouses totalling 7,850 sq. m. in area ;
- Several privately owned warehouses.

Hoisting apparatus.

- One pneumatic mobile-crane of 6 tons lifting capacity, belonging to P.N. Pelni ;
- One 2.5 - tons forkliftruck ;
- Four small derricks of respectively 1, 2, 5 and 10 tons lifting capacity.

Other equipments.

One decauville unit, consisting of 200 wagons of 500 Kg loading capacity with removable tracks, available. Railwaytracks run along the cargo-wharves.

Labour.

There are 1,060 dockworkers registered at the Labour Pool.

Coastal Radio Station

CIL ACAPRADIO, call sign PKR3, works on frequencies 500/475Kc/s at

00.00 - 01.00 gmt

02.00 - 02.30 "

04.00 - 05.00 "

07.30 - 08.00 "

08.00 - 08.30 "

Fresh Water

Fresh water supply attains to maximum 200 cu. m. per 24-hour day, delivered alongside cargo-wharves.

Bunkers

There is no b unker-sation available. Fuel can be obtain to order and delivered per tank-wagons alongside cargo-wharves.

Shiprepairs

Shiprepairing is impossible.

Officials

- Port Administrator.
- Customs Officer.
- Immigration Officer.
- Medical Officer in charge with Port Health & Quarantine Service.

Airport

There is no airport in the vicinity, but railways communicate this settlement with major towns.

Commodities

Imports : cotton for textile industry ;

fertilizer.

Exports : mangaan ore.

(8) PROBOLINGGO

General Remarks

A small harbour on the northern coast of East-Jswa, about 44 miles south-eastward Surabaya, on position 07° 43′ S., 113° 13′ E.
The port is run in business and is thrown open to foreign trade. Owing to the shallow depth, sea-going vessels have to remain anchored in the open roadstead at about one mile from the extremety of the moles, which is marked by a light-beacon. The inner-harbour consists of two bassins, and is accessible to lighters and small crafts only. The depth in access channel to the inner-harbour is -0.80 m. and in the bassins is -2.00 m. at low water tide.

Pilotage

There is no pilot service available.

Terminal Facilities

Wharves.

The total length of the providing wharves in both inner-harbours is 600 m.

Storages.

- The Government avails waterfront storages totalling 8,085 sq. m. and a warehouse of 894 sq. m. in area.
- Several private companies have their own warehouses built on waterfront areas.

Equipment.

There is no cargo-handling equipment available. Railwaytracks run along waterfront storages, either at front-and rearside.

Harbour crafts.

P.N. Pelni avails 13 cargobarges and two tugs for effecting loading and discharging.

Labour.

There are about 200 dockworkers registered at the Labour Pool.

Supplies

Neither fresh water nor bunkers are obtainable.

Medical

Medical treatment referred to the Public Hospital in the town.

Officials

- Chief of the Port.
- Customs Officer.

Airport

There is no airport in the vicinity.

Commodities

Important export articles are tobacco, dried cassave-ships and rice.

(9) DUMAI

General Remarks

Dumai is mainly a crude oil shipment harbour in Sumatra, located on position 01° 41' 14" N, 101° 27' 42" E. The crude oil installations are operated by P.T. Calted Pacific Indonesia, which commonly referred to as CPI.

The harbour can be reached by deep draft vessels by proceeding from Malacca Strait into Bengkalis Strait and following a buoyed channel on a southerly course for a distance of 22 miles to the junction of the Rupar Strait. Vessels must make a turn of approximately 180 degrees to enter the Rupat Strait and thence westerly for a distance of 33 miles to Dumai. The Bengkalis and Rupat Strait fairways have been wiredragged clear to a depth of 16 meters LWS.

Bad weather is rare and fog is virtually non-existent in this area. Visibility is normally good except during heavy rain-squalls.

Anchorage

The general anchorage area is North and West of the Oil wharves.

The minimim depth of water in this area is 43 feet (131 dm). A 35 feet (106 dm) shoal spot to the East of the general anchorage should be noticed. Holding ground in these anchorage is considered to be good, the bottom being clay.

Pilotage

The approach channel are marked by lighted radar reflecting beacons and buoys.

As a result, channel pilots are not provided. However, vessels above 225 cu. m, gross are subject to certain pilot fees. Mooringmasters moor, unmoor and supervise the movement of all vessels in the vicinity of the piers.

Berthage

There are four wharves. Three wharves are utilized for loading of crude oil only and referred to as Oil Wharf No. 1, Oil Wharf No. 2 and the T-2 Wharf respectively. The fourth wharf is utilized to handle general cargo. However, this wharf is also equipped to handle crude oil as well as refined products. This wharf is referred to as the Cargo Wharf and is Government operated.

(a) The basic design of the Oil Wharf No. 1 is for 84,000 DWT vessels but it is capable of receiving 100.00 DWT vessels under favourable weather and sea conditions.
In term of vissel's size this would be a LOA of appreximately 940 feet (286.5 meters) and a draft of 48 feet (14.6 meters). The least depth at the face of the wharf is 51 feet (15.5 meters) at MLWS. The overall length of the wharf is 1170 feet (356.6 meters) between dolphins.

(b) The basic design of the Oil Wharf No. 2 is for 150,000 DWT vessels.
In term of vessel's size and design this would be a LOA of appreximately 1008 feet (307.2 meters) and a draft of 54 feet (16.5 meters). The least depth at the face of the wharf is 57 feet (17.4 meters) at MLWS. The overall length of the wharf is 1210 feet (368.8 meters) between dolphins.

(c) The T-2 Wharf is utilized mostly for handling crude oil to interinsular vessels.
The basic design of this wharf is for 16,500 DWT vessels, but it is capable of receiving 28,000 DWT vessels. In term of vessel's size this would be a LOA of appreximately 625 feet (190.5 meters) and a draft of appreximately 34 feet (10.4 meters).
The least depth of the wharf is 36 feet (11 meters) at MLWS.
The overall length of the wharf is 680 feet (207 3 mters) between dolphins.

(d) The basic design of the Cargo Wharf is for 16,500 DWT vessels however, under favourable weather and sea conditions this wharf will be capable of receiving vessels up to 23,000 DWT. In term of vessel's size this would be a LOA of appreximately 600 feet (182.9 meters) and a draft of 33 feet (10.1 meters). The least depth of the wharf is 34 feet (10.4 m.) at MLWS. The overall length of the wharf is 750 feet (228.6 meters) between dolphins.

Storage

The Government avails waterfront storages totalling 12,724 square meters in area, however, only a few part there of functioned as transit sheds.

Hoisting Apparatus

There are only mobile cranes with a maximum lifting capacity of five (5) tons available. As no heavy lift floating crane, or stationary crane is available, heavy lift must be handled by ships' gear.

Tugboat Assistance

Mooring and unmooring assistance is provided by two 1500 HP diesel electric tugs which stationed in the immediate vicinity of the wharves.

These tugboats, which belong to the CPI, are fitted with firepumps and monitors to assist in fighting fires.

Health and Hospital Facilities

At the present time the Port Health Doctor has only limited facilities for medical treatment. If the services of more complete and/or specialized medical assistance are needed or emergency cases arise on board vessels calling at Dumai, the Port Health Doctor might refer such cases to CPI hospital facilities, however, masters of all vessels bound for Dumai are requested, if possible, to call at Singapore for medical assistance.

Radio.

The Government coastal radio station bears the name of DUMAIRADIO, call sign PKP, and operates under the following schedules :

Time (gmt)	Transmits	Listens on
00.00 - 00.30	500 Kc/s	500 Kc/s
04.00 - 05.00	500 "	500 "
08.00 - 09.00	500 "	500 "
12.00 - 13.00	500 "	500 "
13.00 - 14.00	8799.2	8354 - 8374 "
00.30 - 01.30	8799.2 "	8354 - 8374 "
02.30 - 03.30	13101 "	12531 - 12561 "
06.30 - 07.30	17184 "	16708 - 16748 "

A CPI operated VHF station is maintained 24 hours a day, and is available for information concerning vessels' port activities.

Channel 12 is utilized only. Frequencies : 156.6.

Miscellaneous Supplies

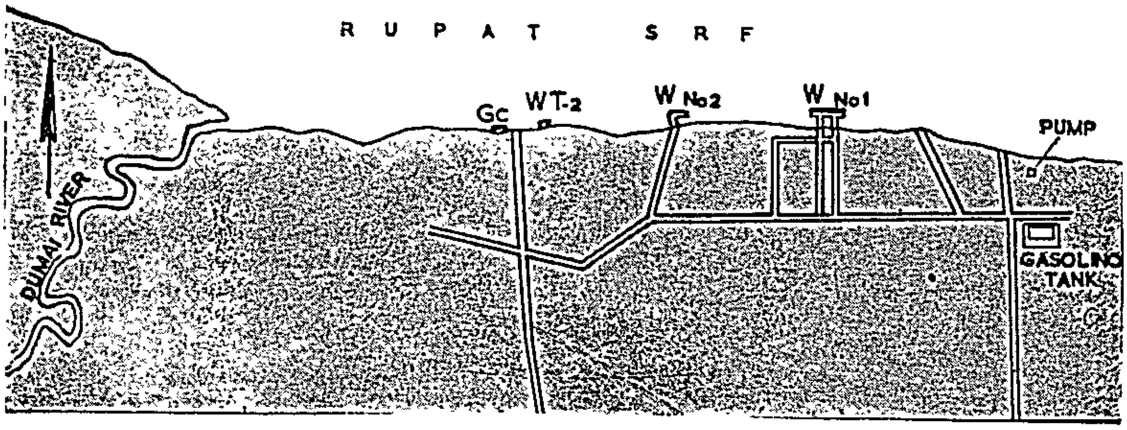
There are limited facilities available to handle ships' laundry, supply ships' provision (fresh vegetables only).

Fresh water is available in limited quantities at all wharves, also no bunker fuels or lubricating oils are available.

Shiprepairs

There are no facilities to make ships' repairs.

DUMAI



(10) B E L A W A N

General Remarks

- The port located on the delta at Sungai Belawan on position 3° 48′ N., 98° 43′ E. Average depth in the channel leading to the port is 7 meters at low-water spring tide.

Many lights along the channel extinguished.

Pilotage

- Pilotage is compulsory. The pilots on service, which are provided with five pilot - boats, usually joint the vessels at the pilot station about two miles from the harbour.

Port Terminal Facilities

M o o r i n g b u o y . - A mooringbuoy available for one berth only.

P i e r s .

- Old mercantile concrete wharf is 1, 183 metres long and in good condition.

- New concrete wharf is 625 metres long.

Average depth alongside these wharves is 7.20 metres at low-water spring tide.

- Several small iron and wooden jetties, used for particulat services.

The depths alongside these piers are from 2 to 6 metres at low-water spring tide.

- Oil jetty ± 200 metres long. Owing to the shallow depth alongside this pier, berthing against it is impossible.

Storages.

- 29 Waterfront storages totalling 82,000 square metres in area.
- 19 Privately owned warehouses totalling 24,000 square metres in area.

Hoisting apparatus.

- One floating crane of 40 tons lifting capacity.
- Three quay cranes (all out of order)
- Seven mobile cranes with capacities from 6 to 10 tons.
- Sufficient amount of forkliftrucks with capacities ranging from 2 to 2.5 tons

Harbour crafts.

- Three tugboats provide the Barbour Tug Service.
- Five mooringboats.

Labour. - Sufficient dockworkers available, supplied by agents.
Shoregang exsist of 20 persons and shipgang exsis 16 persons. Average working capacity ; loading 20 tons per gang/hour and discharging 15 tons per gang/hour.

Medical. - A-clinic under attendance of a medical, officer available for emergency cases only. For medical treatment referred to the hospital in Medan.

Coastal Radio Station. - Medan Radio, call signal PKB.
Working frequencies :

— 8730 Kc/s at :	02.30 - 03.00 gmt
	06.00 - 06.30
	11.00 - 12.00 "
— 13123 Kc/s at :	07.30 - 08.00 "
— 500/474 Kc/s at:	00.00 - 02.00 "
	04.00 - 06.00 "
	08.00 - 10.00 "
	12.00 - 14.00 "

Pure Water

- Water supply about 300 tons per 24-hour day, delivered either alongside all wharves or by water-barge of 200 tons capacity.

Delivery costs : by water - barge Rp. 200.-per m3 ;
alongside wharf Rp. 90.-per m3

Bunkers

- MFO and HSD obtainable, delivered by P.N. PERTAMINA

Shiprepairs

- Minor repairs only can be carried out by workships. Drydocks available for coasters only.

Service

- Simple tank cleaning can be carried out by private companies.

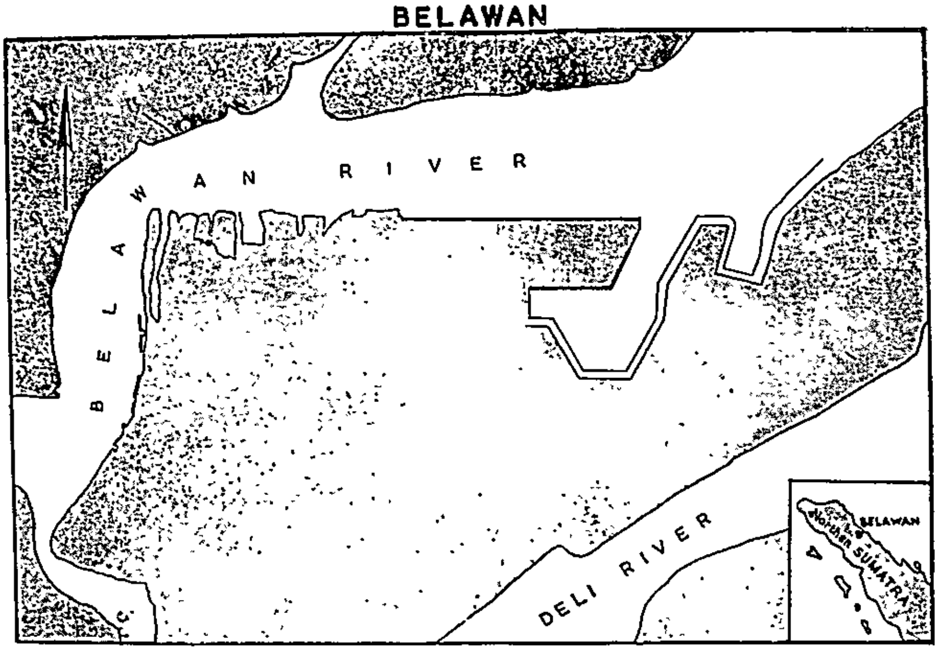
Officials

- Port Administrator.
- Customs Officer.
- Immigration Officer.
- Medical Officer in charge with Port Health & Quarantine Service.

Airport

- "Polonia" airport about 28 Kilometres distance.

BELAWAN



(11) PALEMBANG

General Remarks

A river port located in Sungai Musi on position 2° 59' S., 104° 45' E., distant 54 miles from the outer bar. Depth on outer bar is 14 feet 5 inches at low-water spring tide (maximum draft about 25 feet).

Outward bound vess-ls must cross three bars, viz. Sungai Lais (17 feet 1 inche), Selat Djaran (16 feet 1 inche) and Pulau Pajung (14 feet 9 inches).

Port Terminal Facilities

Piers.

- Iron wharf 250 m long, havily damage. Depth alongside is 6 m.
- Concrete wharf 100 m long and 6 m deep alongside.

Storages.

- Five waterfront storages totalling 7,615 sq. m in area.
- One warehouse of 450 sq. m in area.

Hoisting apparatus.

- One mobile crane of 5 tons lifting capacity (out of order).
- Five forkliftrucks with capacities ranging from 2 to 5 tons.

Harbour crafts.

- Several privately owned lighters available.
  One lightertug of 60 HP capacity.

Services. - The coal wharf at Kertapati is accessible for loading and discharging general cargoes under approval of the authorities.

Fresh Water

Fresh water supply attains maximum 800 tons per 24-hour day, delivered either alongside wharves or by waterbarge of 100 tons capacity.

Bunkers

- Bunker coal obtainable from the Government Mines at Kertapati.
- Oil from refineries obtainable at Pladju and Sungai Gerong.
- Fuel, light diesel and gas oil obtainable at Sungai Gerong.

Shiprepairs

Minor repairs only can be effected by local workshops.

Pilotage

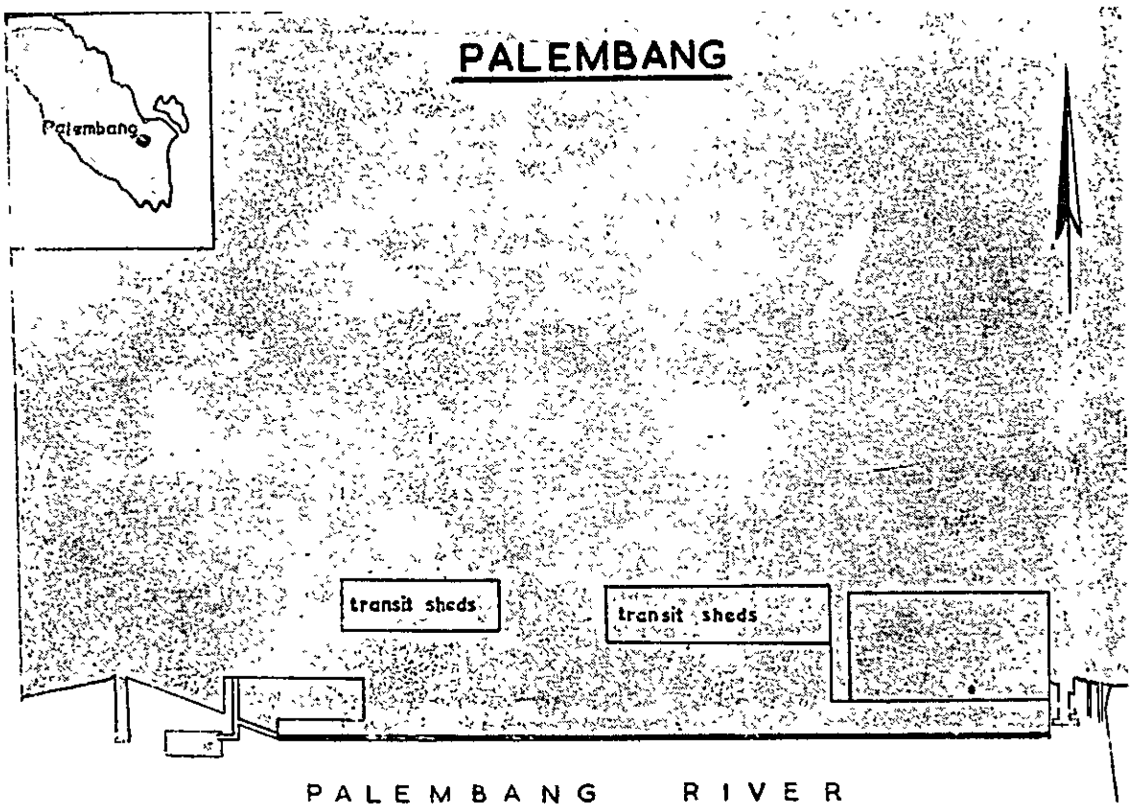
Pilotage is compulsory. Sea pilots at 24-hour day service.

Officials

- Port Administrator.
- Customs Officer.
- Immigration Officer.
- Medical Officer in charge with Port Health & Quarantine Service.

Airport

"Talangbetutu" Airport.



(12) TELUKBAJUR

General Remarks

Telukbajur is the port for Padang, located on position 00° 58′ S, 100° 22′ E. The harbour is protected by breakwater, extending for a distance of about 900 meters in a southeast direction from the western shore, inclosing a space about 836 square meters, with a depth of 7.5 to 8.5 meters. The least depth in the entrance to the port is about 7.5

meters. On Karsik Reef, which occupies the center of the harbour, a breakwater 274 meters in length, built parallel to an distant about 457 meters from the main wharves, shelters the space within, from all winds ; but a portion of the bay eastward of the breakwater is open to southerly winds.

Pilotage

Pilotage is compulsory. Pilot service is provided on request, after prior notice of at least 18 hours.

Berthage

(a) The three main wharves, respectively No. I, II and III, are connected one another, comprising length of about 336 meters with depths alongside from 8 to 10 meters. Eleven mooring buoys are laid parallel to these main wharves.

(b) Wharf No. IV, which is also a cargo wharf, situated at the base of the breakwater and facing northeastward. It has a length of 96 meters and the least depth alongside is 7.5 meters.

(c) The jetties numbered V. VI, VII and VIII (including explosive pier) afford additional berthing spaces within the harbour. Least depths alongside these piers are 5.90, 5.80, 7.30 and 6.30 meters respectively.

Storage

There are nine transit sheds located to the rear of the main wharves, totalling 4, 913 square meters in area.

Wharf No. IV is provided with a transit shed of 1,909 square meters.

Besides, there are warehousing spaces of respectively 313 and 320 square meters and one government-owned entrepot of 1,074 square meters.

Hoisting Apparatus

There's a 5-tons electric crane suitable for cargohandling. It can work 100 meters between wharves No. I and No. II.

Harbour Crafts.

The port avails two tugboats of respectively 185 and 240 HP.

Labour.

Sufficient dockworkers available, employed by shipping companies and forwarding agencies. Their working capacity is approximate 13 tons per gang hour.

Fresh Water

The fresh water supply attains to about 200 tons per 24-hour day, delivered alongside the main wharves and wharf No. IV, at a capacity of 30 tons per hour.

Bunkers

Oil bunkers are stocked in small quantity, delivered alongside jetties by tank-wagon.

Victuals

Provisions of all kinds are plentiful, including reasonable quantity of fresh meat.

Medical

A clinic, under attendance of a physician, is available for emergency cases only. The hospital is situated in Padang.

Shiprepairs

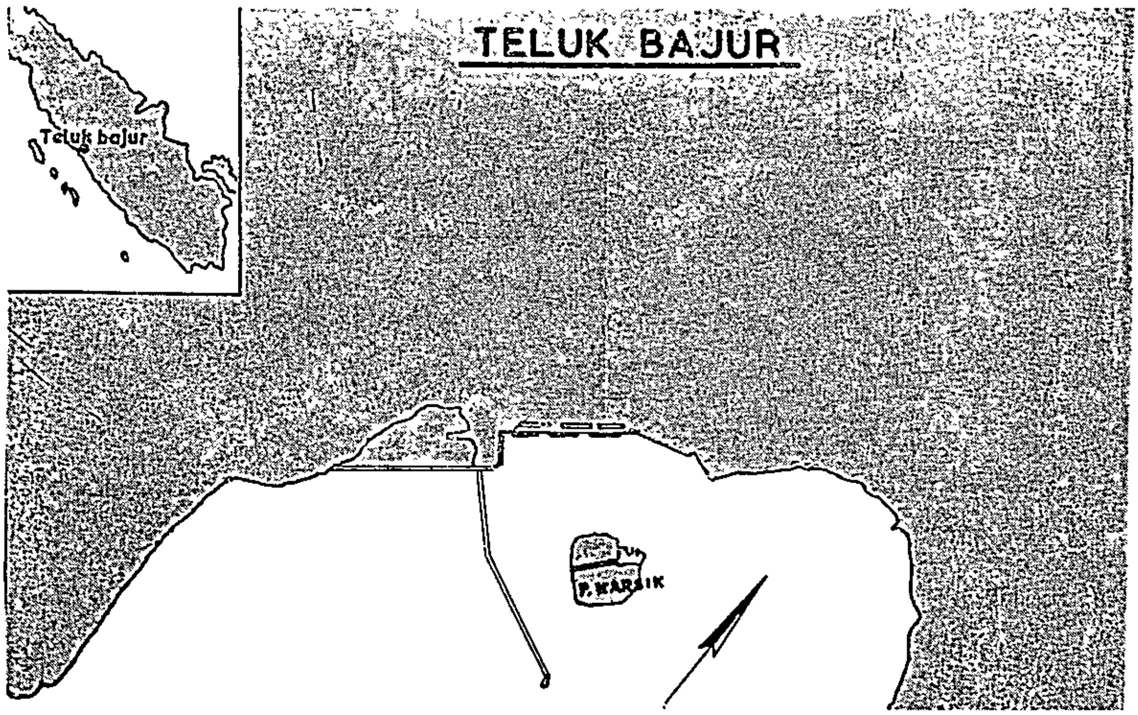
Small floating repair can be carried out by the workshop of the State Railways, and also iron, bronze and copper castings can be supplied. A drydock capable of accommodating vessels of up to 150 tons is available.

Officials

- Port Administrator
- Customs Officer
- Immigration Officer
- Medical Officer in charge with Port Health & Quarantine Service.

Communications

Padang is linked to other major cities of Sumatra by air, road and rail. "TABING" airport is at a distant of about 25 Km from the city.



(13) BALIKPAPAN

Position

Lat. 1° 16′ S., Long 116° 49′ E.

Accommodation

Depth at entrance and/or on bar 24 feet low water level and 33 feet highwater level. Depth in harbour 30 feet low (chart datum on bar is 25 feet 3 inches).

Six piers for bunkering and loading oil least depth 30 feet 8 inches (37 feet 10 inches at No IV jetty). Three piers are suitable for loading or unloading general cargo. These piers belonging to P.T. Pertamina.

Government jetty for one coaster only.

Waterfront storage 1.600 sq. metres. Boiler and drinking water available in limited quantities (max 25 tons per vessel per call).

Fresh and dry provisions in very limited quantities only at high prices.

ETA should be telegraphed 48 hours in advance to Radio PKN, stating deepest draught requirements, etc.

Development

None

Bunkers

All types of marine oil available from P.T. Pertamina at all wharves. No lubricating oil available.

Shiprepairs

For minor repairs can use the assistance of P.T. Pertamina.

Towage.

Various types of tugboats available, belonging to P.T. Pertamina.

Pilotage

Chief of the port, Custom officers.

Airport

"Sepinggan" airport, located about 20 killometres, for Dakota only.

(14) A M B O N

General Remarks

Ambon is the main harbour of the Provice of Maluku, located on position 01° 16′ S, 116° 49′ E. The port, which is accessible to all ships of any draft, is run in business and is thrown open to foreign trade. In the roadstad there's a wreck dangerous to shipping which is marked by two red buoys. It is recently reported that the buoy near the broken jetty of Fort Victoria had drifted apart about 200 m. south-wardly from its original position. Prohibited anchorage is within the circule drawn with a radius of 200 m. around the position 03° 41′ 20″ S, 128° 10′ 00″ E. No mooring buoy is available.

Pilotage

Pilotage is compulsory. A sea pilot is available, functioning also as harbour pilot. Vessels approaching this port are advised to enter the harbour by themselves and anchor as close in as possible.

Flag signal from the tower, warning vessels in manouvre, will mean :

red = inbound current ;

blue = outbound current ;

white = current stands still.

Berthage

There are three berthing facilities, namely :

(a) The main cargo wharf, which bears the name of Jos Soedarso, is of concrete construction. It has a length of 187 meters. The depth alongside the wharf face ranging from -7.50 to -12.70 meters at low water tide.

(b) A wooden jetty on iron poles called Wainitu Jetty has a length of 83 meters. The depths alongside ranging from -6.00 to -9.00 meters at low water tide. It functioned mainly as oil jetty.

(c) The third is a 3 meters board wooden jetty extending seawardly in a length of 17.50 meters. The depth at is extremety is -2.00 meters at low water tide. It accommodates sailcrafts only.

Storages

The Jos Soedarso Wharf is provided with two waterfront storages of respectively 1800 sq. m. in area and 1750 sq. m. in area. and two warehouses of respectively 1000 sq. m. and 600 sq. m. in area. All these are in good condition. At the Wainitu Jetty are two waterfront storages, each of 800 sq. m. in area.

Hoisting Apparatus

There's a stationary crane of 16 tons lifting capacity, but is now unserviceable by reason of the faulty situation, causing the ship's holds lie down beyond reach.
The available two mobile cranes of respectively 1.5 and 3 tons lifting capacity, and four 3-tons forklifttrucks are, at the present time, all lying idle from want of spareparts.

L a b o u r .

There are 470 dockworkers employed by the shipping agencies and another 228 employed by the forwarding agercies. Their working capacity are from 10 to 15 tons per gang hour.
Besides, there are about 125 free labourer acting as luggage porters

Fresh Water

The fresh water supply attains to about 250 tons per 24-hour day, delivered alongside Jos Soedarso Wharf at a capacity of 20 tons per hour.

Bunkers

There's no bunker station available, however, bunker fuel can be obtain to order, namely, HSD from P.N. PERTAMINA and MFO from the Navy. Both type of oil are delivered alongside Wainitu Jetty.

Shiprepairs

Minor repairs only can be effected by the Waiame Dockyard.

Officials

- Port Administrator.
- Customs Officer.
- Immigration Officer.
- Medical Officer in charge with Port Health & Quarantine Service.

Airport

"Patimura" airport located in Laha about 1.5 hours drive.
Air passangers usually shortened their way by crossing the bay in launches served by Garuda Indonesian Airways and the Indonesian Air Force.

Commodities

The important export commodities are copra, nutmegs and mace.

Miscellaneous

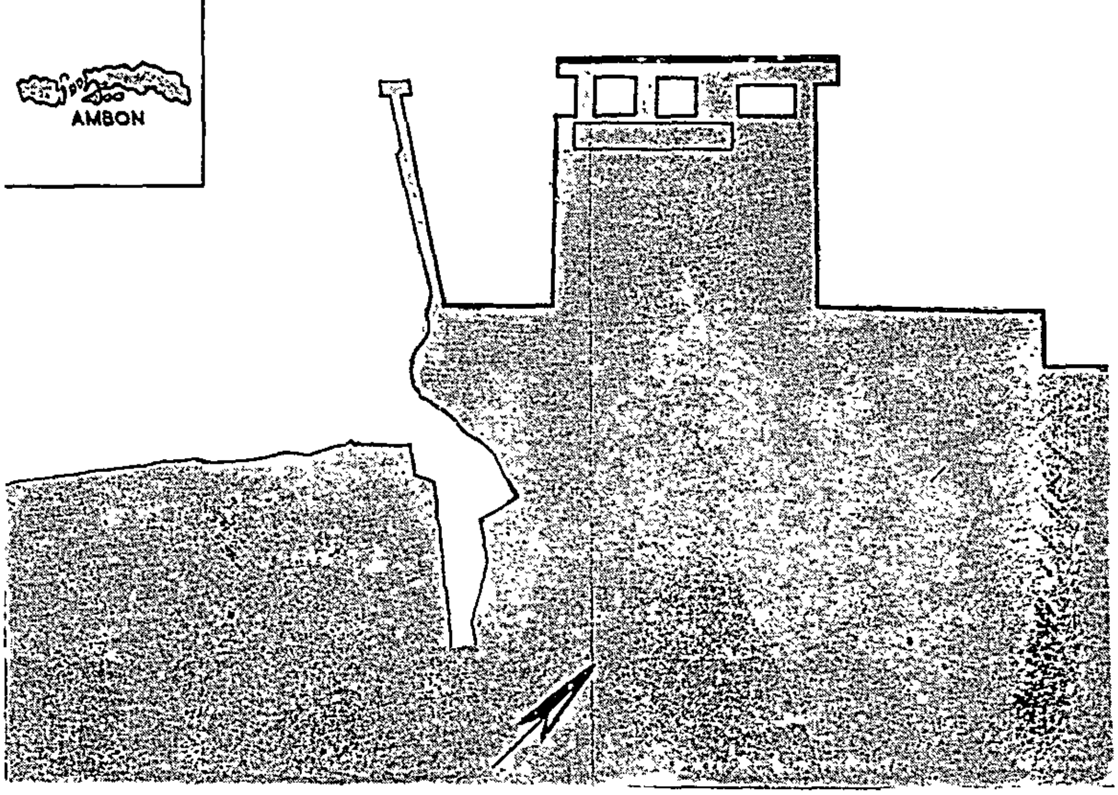
Shipping agencies :

1. P.N. Pelni
2. P.T. Pemal.
3. P.D. Berdikari
4. P.T. Morotai
5. P.T. Wapoga
6 Perwakilan Bhakti

Forwarding agencies.

1. P.N. V.T.P.
2. P.T. Gotong-Rojong.
3. P.T. Mastra.

AMBON



(15) MAKASSAR

General Remarks

The port of Makassar is situated on the western coast of the southern leg of the island of Sulawesi, on position 05° 08′ S, 119° 24′ E. It served as a distribution point for import cargoes and as an accumulation point for exports. In importance, it ranked as one of the major ports of Indonesia.

Approaches

There are four fairways to the port. The northern (leading to Pare-Pare) and the northwestern are of little use to international shipping. Apart from the barrier navigation involved, these two fairways cross still unswept mine fields. The southern fairway passes between Tana Keke and Dajang Dajangan island. Here too mine fields are crossed, but in spite of this, the fairway is quite regularly used. The only officially cleared channel is the western fairway.

In properly marking the western fairway difficulties are encountered with buoys, which often drift. Due to the unreliability of buoys masters often hesitate to approacher or leave Makassar during the dark hours, which results in delay. Hence, the navigational lights ashore are easier to maintain, and are generally more reliable.

Anchorage

There are anchorages both outside and within the two break waters, which protect the harbour from heavy swells during the west monsoon.

The minimum depth at outer anchorage is 21 meters, and at the inner anchorage 16 meters.

Pilotage

Pilotage is compulsory. Vessels entering the swept channel of the western fairway take the pilot aboard just outside the west entrance to the inner road. Here, trade vessels are allowed to anchor, however, embarking or disembarking passenger and loading or disharging cargoes are prohibited.

Berthage

The port of Makassar consists mainly of two marginal quays with related facilities, and a basin for sailing crafts,

(a). Hatta Wharf consisting of concrete slabes on piles, has a length of 550 meters with alongside depths of-7.00 meters.

(b). Sukarno Wharf is a concrete caisson structure of 1360 meters length, with-7.00 meters depths alongside.

(c). Hasannudin Wharf, being the bulkhead of the southern end of Sukarno Wharf, is only 70 meters long and is mostly used for berthing of government - owned vessels.

(d). North of Sukarno Wharf is an old oil jetty, having a length of 70 meters.

(e). 17 mooring buoys have been laid parallel to Sukarno and Hatta Wharves. These buoys are primarily intended to be used when westerly winds prevail causing vessels to bump against the quay. By means of ropes brought out to these buoys, vessels are heaved just clear from the quay fenders. In addition the buoys are used to facilitate unberthing of vessels.

(f). A basin for sailing crafts is located between the two main wharves. Of the 23 fingerpiers in this basin at present only 7 are still usable and even these are in a very poor condition.

(g). A new basin for sailing and fishing crafts is under construction at Paotere in the northern part of the city. There's wooden jetty of 280 meters in length.

Storages

There are 19 transit sheds with a total area of 53,845 sq. m., while there is approximately 18,000 sq. m. of warehousing space in the port, devided over 55 warehouses.

Hoisting Apparatus

The port avails 4 caterpillar mobile cranes, each of 5 tons allowed lifting capacity, however, only two of which are operational. Besides, there are four forklifttrucks whith capacities from 1.5 to 3 tons, but one of which has been lying idle for want of spareparts.

Harbour Crafts

The government-owned harbour crafts are two tugboats of respectively 120 and 300 HP, two mooringboats of 45 HP and one water-barge of 250 tons.

R a d i o

The coastal radio station bears the name of MAKASSARRADIO, call sign PKE, and operates on frequency 465 Kc/s, after announce on 500 Kc/s, at 00.00, 04.00 08.00 11.00 and 14 00 gmt. Class of emission A1.

Fresh Water

Fresh water can be obtained both from pipelines on the quays or from waterbarges. The port-owned waterbarge is, however, very old and out of commission and water is concequently often supplied by the port using barges of outside parties.

Bunkers

Fuel, ligh - diessel and gas-oil are obtainable from P. N. Pertamina. Bunkering can only be done alongside Sukarno Wharf and Oil Jetty.

Shiprepairs

A small slipway, with adjacent workshops, has been taken over by the Navy who often accept work for the private sector.

Officials

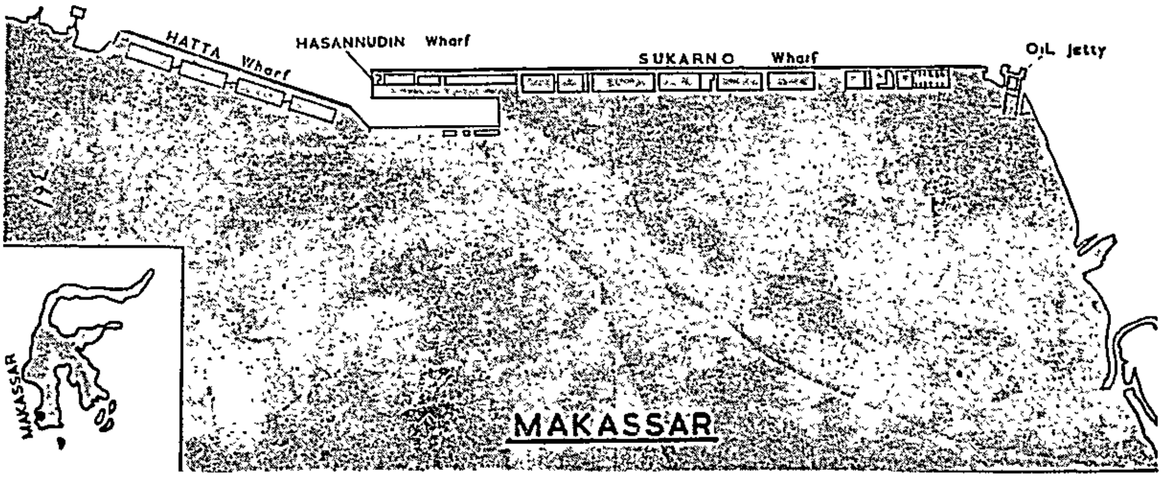
- Port Administrator.
- Customs Officer.
- Immigration Officer.
- Medical Officer in charge with Port Health & Quarantine Service.

Airport

The airport is located in Mandai about 20 Km. distance from the city.

Commodities

The principal export commodities are copra, timber, rottan, seaproducts and beans.



5. CONCERNING THE ORGANIZATION OF THE ELECTRIC POWER COMPANY

Organizational Job Assignment of Tokyo Electric Power Co., Inc.

Item	Department in charge	Brief details
Estimate of Demand	General Planning Dept. Sales Dept.	Integration Branch Office Data
Planning of Demand & Supply and Demand	Power System Operation Dept.	
Development Planning of Power Sources	Engineering Dept.	
Planning of Power System Facilities	Engineering Dept. Operation & Maintenance Dept. Sales Dept.	Main Transmission & Substation Systems Local Transmission & Substation Systems Distribution Systems
Planning of Power System Operation	Power System Operation Dept.	
Construction	Construction Dept. Other Depts. in charge	
System Operation	o Central load-dispatching Control Station o System Load-dispatching Control Station o Load-dispatching Stations	
Operation & Maintenance of Facilities	Dept. in Charge	
Engineering Development	Engineering Research & Development Institute Dept. in Charge	

5-2 Organization Chart of Tokyo Electric Power Co., Inc.

(As of June 1, 1972)

1. Head Office

- President
- Executive Vice Presidents
- Managing Directors
  - Coordinators
  - Secretary Dept.
  - General Planning Dept.
    - General Planning Div.
    - Research Div.
    - Result Analyses & Organization Div.
    - Public & Management Information Div.
    - Affiliated Companies Div.
  - Personnel Dept.
    - Personnel Planning Div.
    - Personnel Div.
  - Management Audit Dept.
  - Invesment Effectiveness & Value Analyses Dept.
  - Administration, Legal & Corporate Affairs Dept.
    - Administration Div.
    - Legal & Corporate Affairs Div.
    - Stock Registration Div.
  - Labour Relations Dept.
    - Labour Affairs Div.
    - Wages & Salaries Div.
    - Employees' Welfare Div.
    - Employees' Housing Div.
    - Health Div.
  - Safety Dept.
    - Personnel Safety Div.
    - Plant & Facilities Safety Div.
  - Accounting & Financing Dept.
    - Budget Div.
    - Accounting Div.
    - Financing Div.
  - Right-of-way & Real Estate Dept.
    - Right-of-way & Land Planning Div.
    - Water Right & Indemnities Div.
    - Real Estate Div.

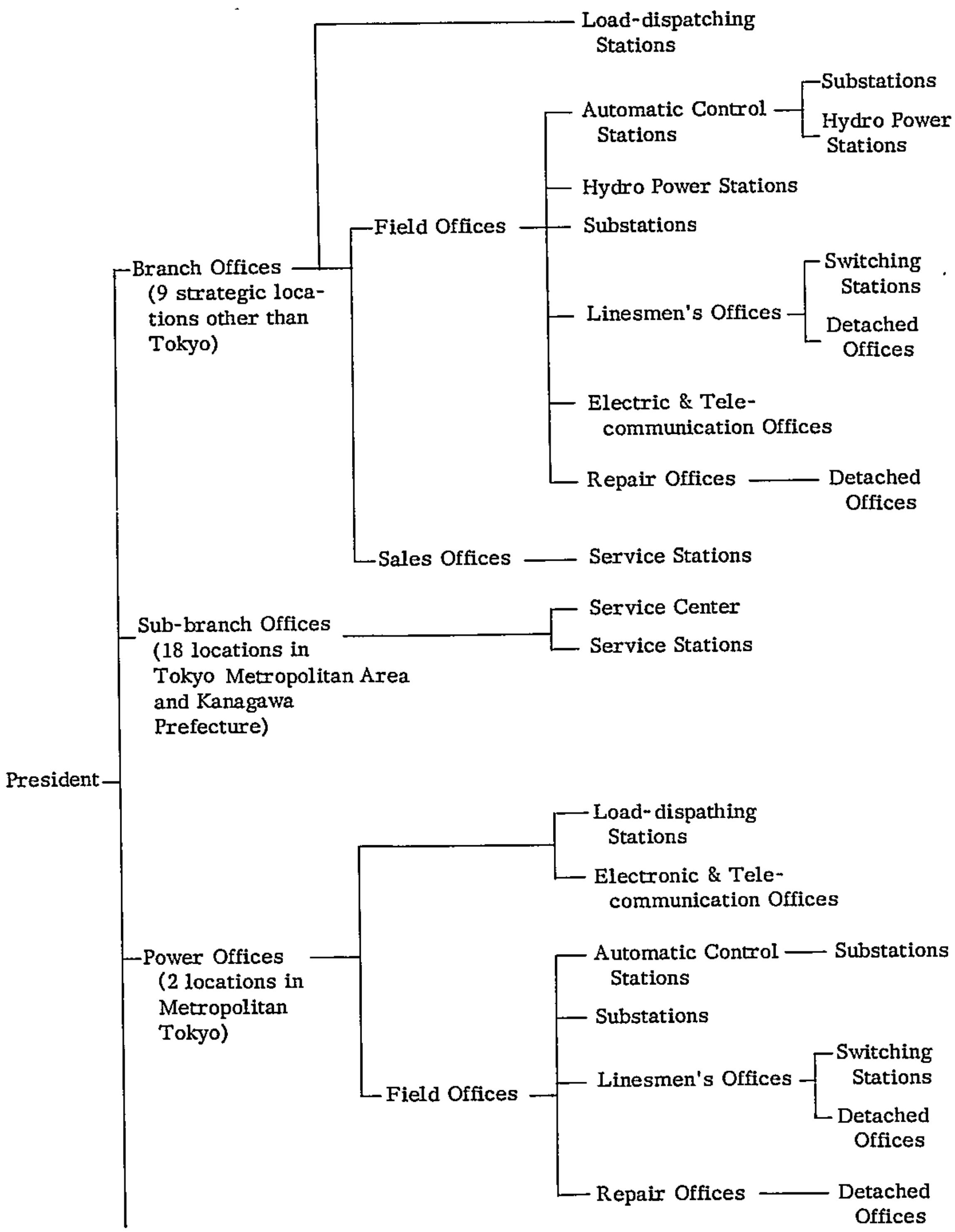
- Materials & Supplies Dept.
  - Materials & Supplies Consultants Div.
  - Materials & Supplies Purchase Div.
  - Machinery Purchase Div.
  - Inventory & Transportation Div.
  - Construction Work Contract Div.
  - Materials & Supplies Distribution Offices
- Fuel Dept.
  - Fuel Planning Div.
  - Fuel Research Div.
  - Fuel Purchase Div.
  - Fuel Control Div.
- Sales Dept.
  - Sales Planning Div.
  - Sales Regulation Div.
  - Area Development Div.
  - Rate-making Div.
  - Public Relations Div.
  - Distribution Planning Dov.
  - Distribution Regulation Div.
  - Underground Distribution Div.
- Engineering Dept.
  - Engineering Administration Div.
  - Power System Palnning Div.
  - Power Development Planning Div.
  - Power Pool Planning Div.
- Power System Operation Dept.
  - Load-dispatching Div.
  - Control Engineering Div.
  - Electronic & Tele-communication Div.
  - Central Load-dispatching Control Station
    - System Load-dispatching Control Station
    - Central Tele-communication Station

- Operation & Maintenance Dept.
  - Operation & Maintenance Coordinations Div.
  - Hydro Power Plant Electrical Facilities Div.
  - Civil Engineering Facilities Div.
  - Overhead Transmission Facilities Div.
  - Underground Transmission Facilities Div.
  - Substation Facilities Div.
  - Underground Transmission Facilities Construction Office
- Thermal Power Dept.
  - Thermal Power Plant Construction Administration Div.
  - Thermal Power Plant Results & Statistics Div.
  - Thermal Power Plant Operation & Maintenance Div. -- Central Analyses Laboratory
  - Thermal Power Plant Construction Div.
  - Thermal Power Plant Construction Design Div.
  - Thermal Power Plant Construction Offices
  - Hirono Thermal Power Plant construction Preparation Office
- Construction Dept.
  - Hydro Power Plant, Transmission & Substation Project Administration Div.
  - Civil Engineering Research Div.
  - Civil Engineering Div.
  - Electrical Engineering Div.
  - Structural & Architectural Engineering Div.
  - Hydro Power Plant Construction Offices
  - Hydro Power Plant Survey Office
  - Transmission & Substation Facilities Construction Office
  - Fukushima Main Transmission Line Construction Office

- (continued)
  - Tokyo Deniyoku Hospital
    - Administration Dept.
      - Administration Div.
      - Accounting Div.
    - Medical Dept.
  - Kashiwazaki and Kariwa Atomic Power Plant Construction Preparation Office
- Overall Capabilities Development Center
  - Human Capabilities Development Div.
  - Information System Planning Div.
  - Electronic Data Processing Div.
- Environmental Affairs Operation
  - Environmental Pollution Prevention Dept.
    - Administration Div.
    - Environmental Pollution Prevention Engineering Div.
  - Plant Siting Dept.
  - Community Affairs Dept.
- Takase River Hydro Power Project Construction Operation
  - Takase River Hydro Power Project General Construction Office
- Large Thermal Power Project Construction Operation
  - Large Thermal Power Project Construction Offices
- Atomic Power Development Operation
  - Atomic Power Dept.
    - Atomic Power Plant Projects Administration Dov.
    - Atomic Power Plant Planning & Personnel Training Div.
    - Atomic Power Plant Operation & Maintenance Div.
    - Electrical & Mechanical Engineering Div.
    - Civil & Structural Engineering Div.
  - Nuclear Fuels Dept.
    - Nuclear Fuels Planning Div.
    - Nuclear Fuels Div.
  - Toden Atomic Power Research & Development Institute
    - Fukushima Atomic Power Plant Construction Office
    - Fukushima Atomic Power Plant Construction Preparation Office at second site

- Training & Education Center
  - Training & Education Planning Div.
  - Toden Educational Institute
    - College
      - Administration Div.
      - Educational Affairs Div.
    - Junior College
      - Educational Affairs Div.
    - Technical Skill Renovation Courses
      - Educational Affairs Div.
    - Senior High School
      - Administistration Div.
      - Educational Affairs Div.
      - Student Relations Div.
  - Toden Training Institute
    - Administration Div.
    - Training Div.
- Engineering Research & Development Institute
  - Development Planning Div.
  - Engineering Research Administration Div.
  - System Engineering Div.
  - Basic Technical Engineering Div.
  - Distribution Engineering Div.
  - Thermal Power Engineering Div.
  - Civil & Structural Engineering Div.

2. Branch Offices



- Power Offices (4 locations in the outside the service area)
  - Load-dispatching Stations
  - Automatic Control Stations
    - Hydro Power Stations
  - Hydro Power Stations
  - Linesmen's Offices
    - Switching Stations
    - Detached Offices
  - Electronic & Tele-communication Offices
  - Repair Office
    - Detached Offices
- Thermal Power Stations
- Fukushima Atomic Power station