the functional ones, required by the fishing port. This is a conspicuous merit in view of the characteristics of these 3 areas (e.g. Melekeok is expected to become the capital city of the country in the near future; Ngatpang, the ocean fishery base located on the western side of the island and close to Koror and Melekeok is interconnected with these two places by means of roads; and Ngerchelong is a strategic point among the fishing communities of the northern part of Babelthaup Island) besides the roles they play as fisheries bases and the unavailability of flat land in the inland areas of these districts. These areas are reclaimed with a +50 cm ground level at high tide at all harbors, which is the same as the wharf crest. That height is regarded as sufficient because the these districts are normally calm and the probability of the occurrence of waves able to overtop the wharf front (20 m wave height) is only once every 50 years. Under the circumstances there is very little risk of inundation of the land facilities under stormy winds, and furthermore the land structures are constructed with a margin of safety of +30 cm - 50 cm above the ground level according to their importance.

5.5 Civil Design

5.5.1 Design Conditions

The construction and the functions of the basic facilities (breakwater, sand dikes, navigation channel, anchorage, wharf), functional facilities (reclamation revetment, landing yard, access road, lighthouse, multipurpose house, toilet/shower, ice making plant) and ancillary facilities (manual crane, mooring pole, wharf stairway or ladder) of the various sites selected in Section 5-4 are

examined in the following in conformity with the standards and norms mentioned in Section 5.1 and based on the natural conditions summarized in Section 4.1. The natural conditions, loads and permissible stress intensities used for the sake of the design of the main structures of each site are summarized in Table 5-3 and Table 5-4.

In connection with seismic forces, a small intensity earthquake is reported to have occurred in 1967, and furthermore the Palau Islands as a whole are the result of upheavals which occurred in ancient times. Nevertheless, this kind of force is neglected in the design because the area is presumed to be relatively stable from the geological standpoint.

Even in the case of an earthquake with a magnitude of 7 on the Richter Scale, there is no risk of liquefaction of the sand foundation such as in Japan because the foundation soil of the structure at the four project sites consists of a gravel sand stratum containing a large quantity (20% or more) of coral fragments. Under the circumstances, it is presumed that there is no risk of fall of the structures due to liquefaction of the foundation.

In addition, silty sand (SM) containing coral fragments, which can be excavated from the bottom of the sea at the various sites, is a low density material and the larger the content of coral fragments the larger is presumed to become the internal friction angle (ϕ) after compaction, as can be seen from the soil test results summarized in Table 4-2. Thus this material is suited as backfilling earth for the wharf because the earth pressure load working on the wharf becomes proportionally small.

It is important to point out that "coral stone" lags behind volcanic rock in terms of strength and hardness but on the other hand it has a density under 1.7 t/m^3 which is a

Table 5-3 Design Conditions/Civil Structures

		Angaur	Ngerchelong	Ngatpang	Melekeok
Natural conditions	Max. wind speed U (m/sec)	28.3	28.3	25.0	31.3
	Design wave height H 1/3 (m)	(Innermost) 1.0	1.0	1.0	1.0
	Tide range (m)	2.0	2.0	2.0	2.0
Soil	Bedrock depth (m)	2-3	4.5-6.0	10 or more	10 or more
	Bedrock N-value	25 or more	60 or more	(SM) 6	Excluding intermediate gravel stratum (1m) (SM-GM) 7
	Surface stratum soil N-value	(sand mixed with silt SM) 25	SM 10		
	Wet density r' (t/m)				1.7
Fishing boat to be handled	Tonnage	20	10	20	20
	Type of ships	Fishing boats	Fishing boats	Fishing boats	Fishing boats

Table 5-4 Load of the Materials

	Type	Density (t/m3) In the air	Density (t/m3) Immersed in water	Internal friction angle (ø)	Remarks
Load	Rubble-mound (crushed stone)	1.80	1.00	40	After compaction
	Rubble-mound (coral)	1.20	0.50	30 (assumed)	After compaction
	Backfilling stone (crushed stone)	1.80	1.00	40	
	Backfilling stone (coral)	1.60	0.90	35 (assumed)	No screening
Superimposed load	Plain concrete	2.30	-	-	
	Reinforced conc.	2.45	-	-	
	Stone	2.60	-	-	
	Live load	1.00	-	-	Slipway, landing yard

conspicuously low value. If the porosity is 30%, the filling densities in the air and under the water become 1.2 and 0.5, respectively, as shown in Table 5-4, which means smaller horizontal earth pressure working on the wharf. Under the circumstances it is a very advantageous wharf backing material over poor subsoil.

On the other hand, materials of this kind characterized by porosity (water absorption rate approximately 20%) and low density are not suited for such applications as lining and overlay of an inclined breakwater, fill of GABIONS, etc., that require considerable weight. Furthermore, they are not suited as a foundation of gravity wharves because they are easily abraded due to low hardness and insufficient strength.

As mentioned in "DESIGN POLICY", however, the basic line of reasoning adopted in this project is to use as much material as possible that is available at the site in order to cut down the overall construction cost. Thus, it is decided to use this material and to overlook some slight loss in the performance of the structure.

5.5.2 Design Policy of the Harbor Facilities

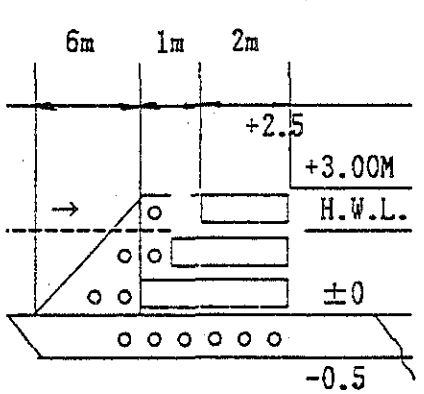
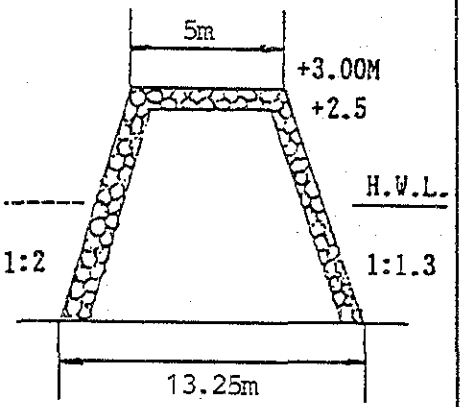
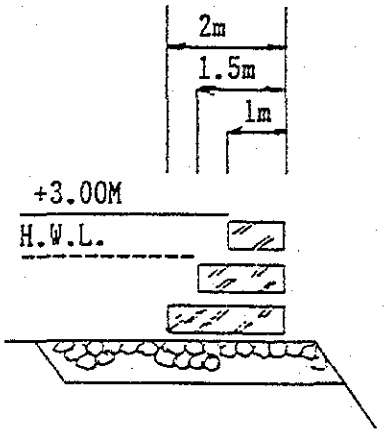
A. NGERCHELONG BREAKWATER (Table 5-5)

The use of stone masonry structure in the breakwater of Ngerchelong Harbor has been decided on in view of the most inexpensive construction cost.

B. WHARVES OF ANGAUR/NGERCHELONG HARBORS

The use of concrete block structure in the wharves of these two harbors has been decided on in view of the abundant record of use and the superior durability, safety and reliability of this system. When the block is

Table 5-5 Comparison of the Breakwater Structure of Ngerchelong

Type		Stone masonry breakwater	Sloped breakwater	Concrete block breakwater
Cross section sketch				
Required materials	Stone	50kg/P - 8 m3/m	50kg/P - 8.6 m3/m	—
	Stone	30kg/P - 4 m3/m	Yuasa sand - 27.4 m3/m	30 kg/P - 4.3 m3/m
	Concrete	—	—	4.5 m3/m
Required machinery	Excavation	Dragline (shared use)	None	Dragline (shared use)
	Hoisting	Crane/barge	None	Crane/barge
	Rubblemound	Grab/barge	Land dump truck	Grab/barge
	Construction cost index	100	70	200
Characteristics	Permeability	Permeable	Impermeable	Impermeable
	Merit	The anchorage side of the breakwater can be used as a wharf.	The jetty for dredging of the anchorage can be left.	The anchorage side of the breakwater can be used as a wharf.

designed with a bottom breadth B=2.40 m, it is possible to satisfy the "standard margin of safety" in terms of sliding resistance, safety against fall and foundation bearing strength as shown in Table 5-6 because the foundation soil has N=25 or more. For further details see Appendix V-17 "Stability Calculation of Concrete Block Wall".

Table 5-6 Angaur/Ngerchelong harbor stability calculation results of gravity type wharf (bottom breadth B=2.40m)

	Margin of safety for the sake of calculation	Approximate S.F. according to the standards	Approved/ Rejected
Sliding resistance	1.5 (-1.6 m)	1.2	Approved
Safety against fall	1.9 (-2.8 m)	1.2	Approved
Bearing strength of the foundation	Qa=68.8 t/m^2	P_1'=17.6 t/m^2	Approved

C. WHARF STRUCTURE OF MELEKEOK/NGATPANG

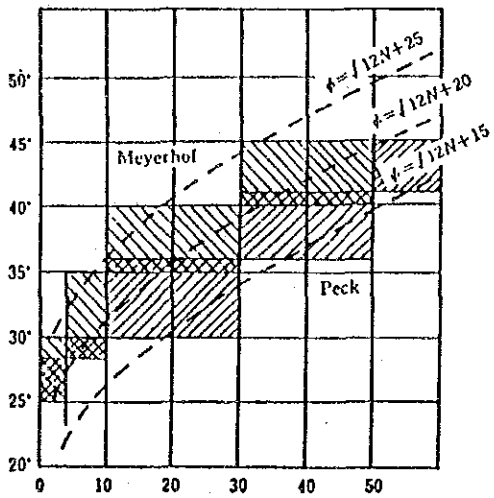
As mentioned in the section referring to the natural conditions and the soil, the strata that will function as the foundation of the wharf bottom at Melekeok/Ngatpang have low N-values (under 10) and the average value down to a depth of 10 meters depth is on the order of 6-7.

The internal friction angle (ϕ) of the sand stratum is estimated from the N-value by using Figure 5-3 of the "STANDARDS". The minimum value of ϕ occurs "when the particles are round and the grading is uniform". Thus, it is presumed that the maximum value corresponding to the "case of square particles with good grading distribution"

is applicable to this site which consists of "gravel sand mixed with silt" (SM-GM) containing coral fragments in large quantities.

In reality the minimum value $\phi=(12N)^{1/2}+15$ and the intermediate value $\phi=N^{1/2}+20$ are examined in this study because the wharf is the most important structure of the fishing port. Assuming N=6, they become $\phi\fallingdotseq20°$ and $\phi\fallingdotseq25°$, respectively.

Figure 5-3 Internal friction angle and N-value



The safety of the wharf against circular slip is examined in Figure 5-4-1 and Figure 5-4-2 for block bottom breadth B = 3.20 m by assuming the aforementioned values as internal friction angles (ϕ) of the foundation stratum and by assuming thicknesses of 0.8 m and 3 m replaced with stone of good quality. According to this study if the internal friction angle of the foundation existing at the site is $\phi=20°$ the safety factor becomes barely 1.02 even when a portion with 3 m thickness at the bottom of the wharf is substituted for with stone of good quality. Therefore the safety factor 1.30 which is required in the "STANDARDS" is not satisfied in this case.

Figure 5-4-1

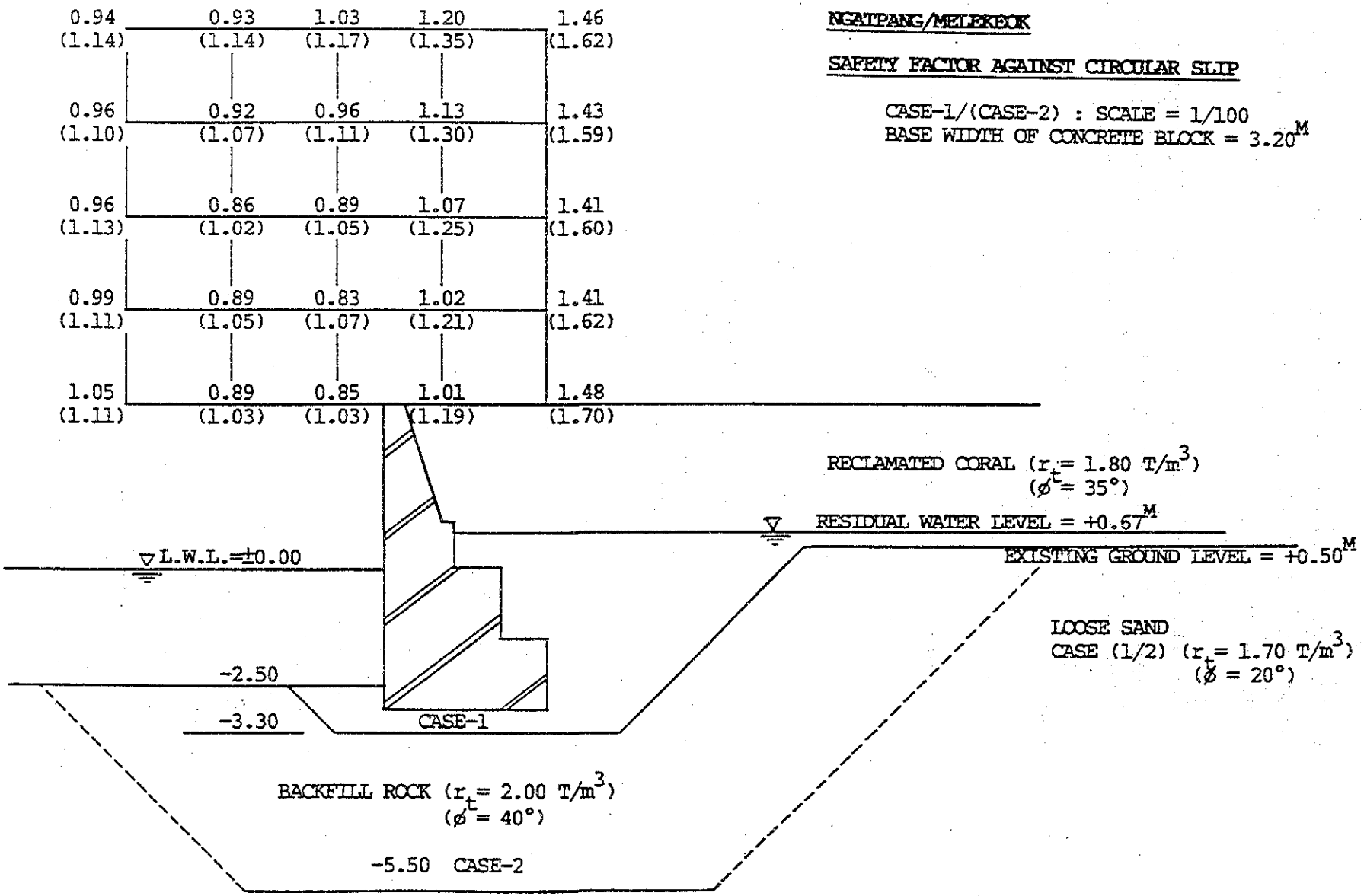
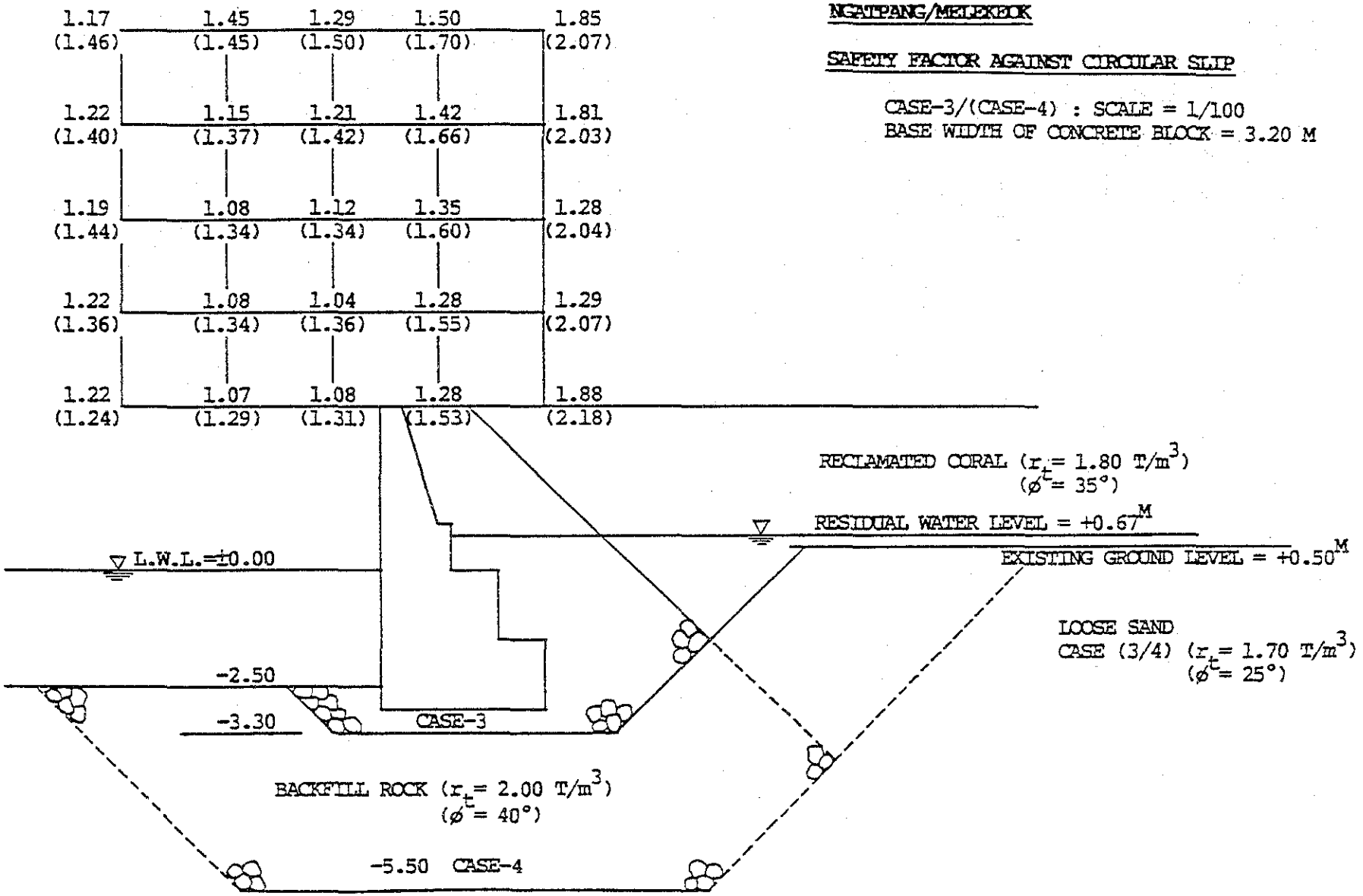

NGATPANG/MELEKEOK
SAFETY FACTOR AGAINST CIRCULAR SLIP
CASE-1/(CASE-2) : SCALE = 1/100
BASE WIDTH OF CONCRETE BLOCK = 3.20M
0.94 (1.14) 0.93 (1.14) 1.03 (1.17) 1.20 (1.35) 1.46 (1.62)
0.96 (1.10) 0.92 (1.07) 0.96 (1.11) 1.13 (1.30) 1.43 (1.59)
0.96 (1.13) 0.86 (1.02) 0.89 (1.05) 1.07 (1.25) 1.41 (1.60)
0.99 (1.11) 0.89 (1.05) 0.83 (1.07) 1.02 (1.21) 1.41 (1.62)
1.05 (1.11) 0.89 (1.03) 0.85 (1.03) 1.01 (1.19) 1.48 (1.70)
RECLAMATED CORAL (r_t= 1.80 T/m^3)
(ϕ= 35°)
RESIDUAL WATER LEVEL = +0.67M
L.W.L.=±0.00
EXISTING GROUND LEVEL = +0.50M
LOOSE SAND
CASE (1/2) (r_t= 1.70 T/m^3)
(ϕ = 20°)
-2.50
-3.30
CASE-1
BACKFILL ROCK (r_t= 2.00 T/m^3)
(ϕ= 40°)
-5.50 CASE-2

Figure 5-4-2

NGATPANG/MELEKEOK

SAFETY FACTOR AGAINST CIRCULAR SLIP

CASE-3/(CASE-4) : SCALE = 1/100
BASE WIDTH OF CONCRETE BLOCK = 3.20 M



In view of the aforementioned problems the practicability of the steel sheet pile type wharf, which is regarded as suited for poor subsoil, was examined for the two sites in question. Figure 5-5 summarized the comparative merits of the block system and the steel sheet pile system at these sites. The construction cost of the steel sheet pile system is cheaper and furthermore the term of work can be halved compared with the concrete block wharf constructed on a foundation stabilized by means of the displacement method. In the case of the steel sheet pile system, however, it is indispensable that a safe, reliable and durable corrosion protection system to secure sufficient durability of the steel sheet piles without repeated coating is selected.

The Type III structure using the material (SY-30) is selected as a result of the structural design carried out in conformity with the "STANDARDS". (The counterfort is a Type II structure.) (Table 5-7, Appendix V-18)

On the other hand, the foundation of Melekeok/Ngatpang, where steel sheet pile will be used, is a stratum with very loose consistency in spite of consisting of sandy material, as mentioned before in this report. Under the circumstances some elastic subsidence, although not so long lasting as in the case of clayey strata, is expected to occur due to the superimposed load caused by the structure.

CORROSION OF THE STEEL SHEET PILE AND SELECTION OF THE CORROSION PROTECTION METHOD

Generally speaking corrosion in the sea progresses as shown in Figure 5-6. The portion above the full tide level exposed to splashes has the highest corrosion rate because it does not have time to dry and suffers the strongest effects of atmospheric oxygen.

Figure 5-5 Comparison of the Various Types of Wharf Structure

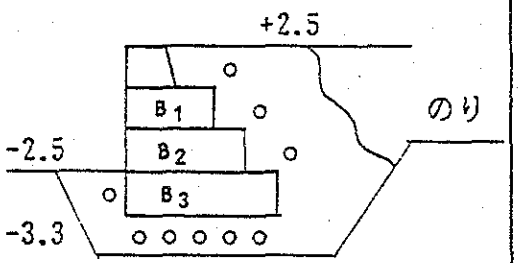
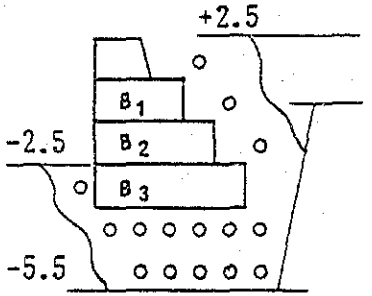
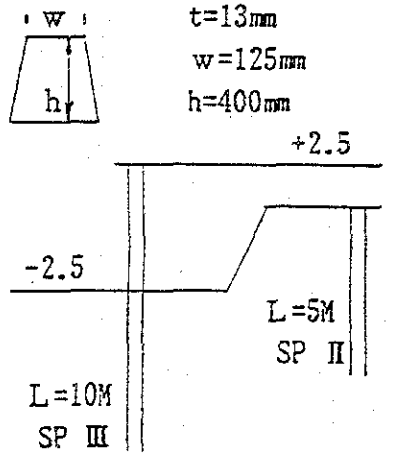
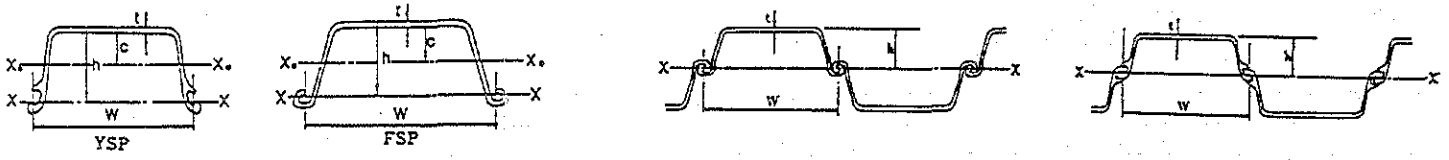
Type		Block Type		Steel Sheet Pipe Type
Outline		(Case 3)  	(Case 4) Replacement method  	
Required materials	Concrete	B0 = (0.4+1.2)/2x1.7m = 1.36m3/m B1 = 1.6x1.2m = 1.92m3/m B2 = 2.4x1.2m = 2.88m3/m B3 = 3.2x1.2m = 3.84m3/m Total 10.00m3/m	10.00m3	Coping + corrosion protection 0.5x1+0.35x4m=1.90m3/m
	Steel	0		150kg/m2 x (10+5) m = 2.25 ton/m + (Tie rod)
	Stone	(Foundation) 30kg/pc. - 4.0m3 (Backfilling) 30kg/pc. - 10.7m3 Total 14.7m3	- 31.80m3 - 11.94m3 Total 43.70m3	} 0
Work index		100	120	100
Characte-ristics	Excavation	Small	Large	None
	Stone cost	Small	Large	None
	Stability	(Unstable)/ Stable with light weight backing	(Stable)	(Stable)
	Durability	50 years or more	50 years or more	40 years or more with concrete corrosion protection lining

Table 5-7 Study of Steel Sheet Pile

U-shaped steel sheet pile:

dimensions and cross-sectional performance



(1): Position of the center of gravity

Type	Dimensions			Weight		Cross-sectional area		Surface area		(1)	Moment of inertia of area		Radium of rotation	Cross-section coefficient	
	W mm	h mm	t mm	kg/m per sheet pile	kg/m² per meter of wall width	cm² per sheet pile	cm²/m per meter of wall width	m²/m per sheet pile	m²/m² per meter of wall width	C cm	cm⁴ per sheet pile	cm⁴/m per meter of wall width	cm per sheet pile	cm³ per sheet pile	cm³/m per meter of wall width
YSP-I	400	75	8.0	36.5	91.2	46.49	116.2	1.15	1.44	2.64	429	3,820	3.04	66.4	509
YSP-U_5	400	80	7.6	35.5	88.8	45.21	113.0	1.17	1.47	2.78	454	4,220	3.17	64.7	527
FSP-IA	400	85	8.0	35.5	88.8	45.21	113.0	1.21	1.51	3.45	598	4,500	3.64	88.0	529
YSP-II	400	100	10.5	48.0	120	61.18	153.0	1.24	1.55	3.62	986	8,690	4.01	121	869
FSP-II	400	100	10.5	48.0	120	61.18	153.0	1.33	1.66	4.04	1,240	8,740	4.50	152	874
YSP-U_9	400	110	9.3	43.2	108	55.01	137.5	1.29	1.61	3.86	1,070	9,680	4.42	120	880
FSP-II	400	120	9.2	43.2	108	55.01	137.5	1.34	1.68	4.72	1,460	10,600	5.15	160	880
YSP-III	400	125	13.0	60.0	150	76.42	191.0	1.33	1.66	4.72	1,920	16,400	5.01	196	1,310
FSP-III	400	125	13.0	60.0	150	76.42	191.0	1.44	1.80	4.90	2,220	16,800	5.39	223	1,340
YSP-U_{15}	400	150	12.2	58.4	146	74.40	186.0	1.43	1.78	5.71	2,700	22,800	5.13	238	1,520
FSP-IIIA	400	150	13.1	58.4	146	74.40	186.0	1.44	1.80	5.84	2,790	22,800	6.12	250	1,520
YSP-VI	400	155	15.5	76.1	190	96.99	242.5	1.47	1.84	5.85	3,690	31,900	6.15	311	2,060
FSP-VI	400	170	15.5	76.1	190	96.99	242.5	1.61	2.01	6.45	4,670	38,600	6.94	362	2,270
YSP-U_{23}	400	175	14.7	74.0	185	94.21	235.5	1.56	1.94	6.51	4,380	39,400	6.81	330	2,250
FSP-VIA	400	185	16.1	74.0	185	94.21	235.5	1.57	1.96	7.45	5,300	41,600	7.50	400	2,250
YSP-V	420	175	22.0	105	250	134.0	319.0	1.59	1.99	6.15	5,950	55,200	6.67	433	3,150
FSP-V	500	200	24.3	105	210	133.8	267.6	1.75	1.75	6.94	7,960	63,000	7.71	520	3,150
FSP-VIL	500	225	27.6	120	240	153.0	306.0	1.83	1.83	8.09	11,400	86,000	8.63	680	3,820

Remarks:
1. The weight per meter of wall width is calculated by rounding the value given {(weight per sheet pile) x 1,000/W (effective width)} in conformity with JIS 8401.
2. The surface per sheet pile is the total of the two sides.
3. The surface per meter of wall width is the value referring to one side after driving the sheet pile.
4. The cross-sectional coefficient per sheet pile refers to the neutral axis X_0-X_0 of each individual steel sheet pile before assembling it.
5. The cross-sectional coefficient per meter of wall width refers to the neutral axis X-X when the sheet piles are assembled.

Figure 5-6 Results of the 5-Year Sea Water Test of Kure Beac (USA)

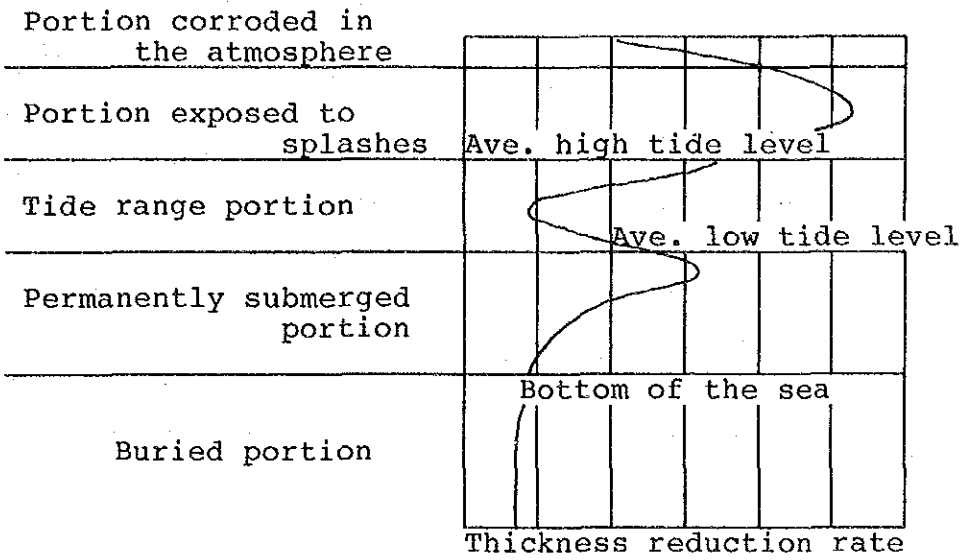


Table 5-8 Methods to Protect Harbor Facilities by Type of Environment

	In the atomos-phere		At the water surface		Sub-merged portion		Buried in the bottom of the sea		Buried on the land	
	A	B	A	B	A	B	A	B	A	B
Coating	***	***	**	*	**	x	**	x	**	x
Lining	***	***	***	***	**	x	**	x	**	x
Concrete lining	***	***	***	**	*	x	*	x	*	x
Corrosion-resistant metal lining	***	***	***	*	**	x	*	x	*	x
Electric corrosion protection	x	x	**	**	***	***	***	***	***	***

*** : Practicable, effective
** : Practicable, moderately effective
* : Practicable, not so effective or not so economical
x : Impracticable, ineffective
A -- New structure B -- Existing structure

The methods mentioned in the following are used to protect steel against corrosion.

1) Corrosion protection by means of elements contained in the steel.
2) Corrosion protection by means of concrete lining.
3) Corrosion protection by means of coating.
4) Electric corrosion protection.
5) Corrosion margin.

The various methods for corrosion protection of harbor facilities used by type of environment are mentioned in Table 5-8.

In the 4 fishing harbors of this project the coating concrete for corrosion protection of the steel sheet pile in the atmosphere and in the splash zone must have a height on the order of 3 meters because the tide range reaches 2 meters, but the concrete lining of the side facing the sea is extended down to the bottom of the sea by taking into consideration the corrosion protection of the submerged portion.

Furthermore, any margin in the cross section of the steel sheet pile designated in the specifications can be used as margin for corrosion. the maximum stress intensity occurs at a point located approximately at 1/2 of the water depth, and that point corresponds to the range where the corrosion rate is small. However, the vicinity of the water surface, where the corrosion rate is large, is the portion with the margin of safety in the cross section. Therefore, steel sheet pile has excellent balance from the standpoint of the life of the material.

According to the "STANDARDS", the corrosion of steel progresses in conformity with the speeds mentioned in the table below. Generally speaking the corrosion speed of

steel sheet piles used for the design is the value occurring at the point with maximum bending moment (0.1 mm/year on the sea side and 0.02 mm/year on the land side according to Table 5-9).

Table 5-9 Corrosion speed of steel

	Corrosion environment	Corrosion speed (mm/year)
Sea side	Above H.W.L.	0.3
	Between H.W.L. and bottom the sea	0.1
	In the sludge stratum at the bottom of the sea	0.03
Land side	In the atmosphere on the land	0.1
	Buried in the earth (above residual water level)	0.03
	Buried in the earth (under residual water level)	0.02

D. NAVIGATION CHANNEL

According to the "STANDARDS", the navigation channel width "Should be determined in accordance with the actual state of things when aimed at fishing boats and vessels sized under 500 t". Therefore, it is designed with a 15 m bottom width by taking into consideration a substantial margin of safety over the width (8 m) of the largest vessels that will use these harbors in the near future.

In connection with the navigation channel depth, the "STANDARDS" stipulate that "Some margin of safety should be added to the anchorage depth by taking into consideration the rolling and pitching of the ship". "The Same Depth as the Anchorage" is adopted in the 3 harbors of Babelthaup Island however, because the rolling and pitching of the ship are negligible as there are no major

waves at the channel mouth. In Angaur Harbor the swell of the outer sea exerts direct influence on the harbor entrance, and the ships accessing the harbor are subject to considerable rolling and pitching, but it must be remembered that ships of larger size use the harbor only very seldom, and the "fully loaded draft" of small- and medium sized fishing boats that use the harbor more frequently is less than 1.0 m meter. Under the circumstances, the "depth of the anchorage" is regarded as sufficiently safe, and this value is adopted here, in the same way as in the other 3 harbors.

E. ANCHORAGE

The anchorages of the 4 harbors are sited at places making it possible to "anchor ships with safety during 90 - 95% or more of the days of the year" as provided for in the "STANDARDS" and by taking into consideration the existing basic facilities (jetty, navigation channel) as well as the location of the wharf and channel. In other words, they are sited at places where the significant wave height (H 1/3) falls under 30 cm (The existing anchorage will be used in Angaur).

On the other hand, the anchorages of the 4 harbors are designed with sizes making it possible to cope with the following needs.

1) To secure the safety of small and medium fishing boats that are the most frequent users.

2) To have sufficient size for smooth maneuvering and cargo loading/unloading of the largest user ships (LST).

According to the "STANDARDS" the "depth of the anchorage" is given by "DL-1.1 x (full load draft of the largest user

ship)" and all of the 4 harbors included in this project are designed with a considerable margin of safety (DL-2.50) compared with the full loaded draft of the LSD (Dd=1.8m).

F. SLIPWAY

The slipways are designed with the characteristics mentioned in the following, in conformity with the "STANDARDS". The slipways of the 3 harbors excluding Angaur will be constructed anew in conformity with the specifications mentioned in the following.

1) The depth of the extremity of the slipway under the water surface is designed approximately to the unloaded draft (50 cm) of the fishing boats using the harbor, in conformity with the "L.W.L.-(draft)" requirement of the "STANDARDS".

2) The water depth at the slipway extremity is (L.W.L.-2.5 m). Therefore, it satisfies the "Full load draft +0.5 m" or more provided for in the "STANDARDS".

3) The crest height of the slipway is approximately the same as that of the wharf.

4) The slope of the slipway is designed with the steepest gradient (1:6) specified in the "STANDARDS" (1:6-1:12).

5) The extremity beam and the side walls of the slipway are gravity type retaining walls, but the same sheet pile structure as the wharf is adopted for the sake of safety on part of the slipway side walls of harbors in which the sheet pile type wharf will be constructed (Melekeok, Ngatpang).

6) The slipway pavement is designed with concrete blocks at the slipway extremity and of the same cast-in-place concrete as the "landing yard" at all other parts including the ship landing yard, by taking into consideration such factors as the ship weight, waves and subsidence of the foundation.

In connection with Angaur Harbor, some minor repair is regarded as sufficient to rehabilitate the existing slipway.

G. LANDING YARD

The landing yard of the 4 harbors is designed with a 10 m width because the "STANDARDS" require a "10 m width when the berth depth is under 4.5 m". Of the various alternatives of cement type pavements (concrete, block, reinforced concrete, continuous plain concrete, prestressed concrete), it is decided to adopt the cast-in-place concrete type which is the system with an extensive record of use in lightweight load applications because this project refers to fishing ports dealing with small and medium fishing boats. Joints in the transversal/longitudinal directions will be provided at intervals not exceeding 5 m to prevent warping of the concrete slabs and cracks due to extension/contraction deformations and furthermore, wire mesh will be inserted under the surface for the sake of reinforcement.

Furthermore, the pavement surface is designed with a proper drainage slope which is sufficient to allow natural drainage of water toward the sea side but is moderate enough not to obstruct the loading/unloading work.

- K-value of the subgrade
  The subbase course is designed with 30 cm thickness, assuming K_{30}>=7-19 kg/cm^3 as the target value

- K-value of the subbase course
  K_{30}>=20 kg/cm^3 is regarded as the target value

- Pavement thickness
  The pavement is designed with 20 cm thickness assuming a lightweight load (CP 1).

- Concrete quality
  Tensile & bending strength of 28 day material cured in 20°C water = 45 kg/cm^2
  (Standard compressive strength = 240 kg/cm^2)

H. MOORING POST

Of the 4 harbors included in this project, 1 ton bits will be used in Angaur and Ngerchelong because they will be utilized mostly by small fishing boats engaged in reef fishing. However, 5 ton bits will be used in Melekeok/Ngatpang because they will presumably be used by medium sized fishing boats and ferry boats as well. The bits are designed with the simplified "iron casting pipe filled with concrete" structure popularly used in Palau and such details as the bit burying depth and anchor concrete weight are designed with care so as to secure a sufficient margin of safety against mooring tension. On the other hand, ladders to be attached to the sheet pipe wharves are designed with robust construction able to cope with mooring tension mounting to 200 kg/unit or more because they are often used for the mooring of small fishing boats.

5.6 Design of the Buildings

(1) DESIGN POLICY

The buildings will be given top priority in regard to their functions. They will be simple constructions with easy maintenance and control. A reinforced concrete structure with high durability will be adopted in this connection because Palau has tropical rainy weather and the sites are adjacent to the sea. Furthermore, a reinforced concrete structure has such advantages as availability of materials in Palau, possibility of employing local workers, etc.

(2) USE AND SCALE OF THE PLANNED BUILDINGS

1) MULTIPURPOSE HOUSE

Each harbor will be provided with a multipurpose house which will be used as a work space for fishermen, rest area and warehouse. The work space will be used for such activities as packing, repair of nets, preparation of fishing gear, etc., and will be an open space with no specific use in particular. the rest area will be freely available for fishermen to rest before and after their work, and will be used as a waiting room by ferryboat passengers as well. The warehouse will be controlled by the fishing associations, and will be used to store such items as fishing gear, ship's fittings, fuel, fish boxes, etc.

2) TOILET/SHOWER

Simplified shower facilities will be provided in each harbor because fishermen of Palau have the custom taking a shower immediately after work. Furthermore, toilets will be installed in each harbor. They will

be housed in the same place because they share the same water system.

3) ICE MAKING PLANT

Fishermen of Ngerchelong State are purchasing ice from Koror in order to maintain the quality of fresh fish. Under these circumstances, fish of that state are more costly compared with other states because such costs as ice purchasing, transportation, etc., are added. The demand for ice in Ngerchelong State amounts to the following quantities.

- Fishery use
  40,000 kg ÷ 200 days = 200 kg
  200 kg x 1.5 (fish conservation) = 300 kg/day
- Consumption by local people
  100 kg/day
- Supply to Kayangeru State
  100 kg/day
- TOTAL : 500 kg/day

Under the circumstances, an ice making machine with a capacity on the order of 1 ton/hour is regarded as necessary by taking into consideration future growth in demand.

(3) BASIC DESIGN

1) DESIGN CONDITIONS

a. As things now stand there is no legislation or standards in Palau applicable to buildings.

b. The buildings will be designed by taking into consideration the climate and the environment

and by making the most of these characteristics for the sake of easy maintenance and control.

c. Lighting and ventilation will be natural types.
Water will be supplied by means of the rain water tank attached to the toilet/shower and by means of water mains.
Waste water will be infiltrated into the ground, with the exception of the toilet which will be provided with a septic tank.
The ice making plant will be provided with a Diesel generator.
The ice making machine will be able to cope with electrical mains because there are plans for the introduction of electricity service (voltage 110 - 120 V, single phase 60 Hz.) in the future.

d. Such phenomena as earthquakes, typhoons and tsunamis have not been taken into consideration as loads and external forces.
Wind velocity of 120 mph (54 m/s) will be adopted for the design, however, in view of consultations held with the Bureau of Public Works.
Reinforcing bars submitted to corrosion protection treatment will be used for construction because the fine aggregates are beach sand.

e. Materials with superior aesthetic and durability characteristics will be used for roofing. It is the intention of the Bureau of Public Works to use roofing tiles in the future in public construction in Palau.

2) OUTLINE OF THE DESIGN

a. MULTIPURPOSE HOUSE

The multipurpose house will be a one story reinforced concrete construction consisting of a work space, warehouse and waiting space. Each space will be an open and well-ventilated shaded area. Only the waiting space will be provided with walls to protect against the wind and the rain.

b. TOILET/SHOWER

Separate toilet/showers will be provided for men and women. Toilets and showers will be installed in the same room for their simultaneous use. A dry area will be provided for natural lighting. They will be provided with an accessory rainwater tank, and will be properly outfitted to use running water as well.

c. ICE MAKING PLANT

The ice making plant will be a two-storied reinforced concrete construction. The surroundings of the ice storage room located on the first story will be an open space with good ventilation to prevent condensation. The periphery of the ice making machine installed on the second story will be provided with a floor which will be used for storing spare parts as well as for maintaining and repairing the equipment. The wall will consist of screen blocks, and ventilation and lighting will be provided.

SPECIFICATIONS OF THE ICE MAKING MACHINE

1) 1 ton plate ice making machine
   Air-cooled type, 7.5 KW
2) Prefabricated ice store
   1.8 m x 1.8 m 2 m
3) Generator: 20 KVA
4) Water supply pump
5) Fuel tank: 1 unit 500 liters
6) Water piping : 1 set
7) Ice making machine stand: 1 set

d. SPECIFICATIONS

The specifications of the ice making plant are mentioned in the following.

EXTERIOR FINISH

- Roof
  Concrete trowel backing, western type tile roofing,waterproof mortar trowel finish
- Outer wall
  Architectural concrete, AEP coating
  Concrete block, AEP coating
- Wainscot wall
  Architectural concrete, AEP coating
- Berm
  Concrete trowel finish
- Roof drain
  Iron casting
- Gutter & water pipe
  Steel pipe 1000 ø, SOP coating

INTERIOR FINISH

- Ceiling: Architectural concrete
- Inner wall:
  Architectural concrete, AEP coating
  Concrete block, AEP coating

- Wainscot wall
  Architectural concrete, AEP coating
- Plinth
  Mortar trowel finish
- Fittings & fixtures
  Wooden, OP coating

STRUCTURAL MATERIALS

- Concrete
  FC = 180 kg/cm^2, slump 5-8
- Reinforcing bars
  Equivalent to SD 30 (fy = 3,000 kg/cm^2)
  Corrosion protection (epoxy resin coating or molten zinc plating)

WASTE WATER DRAINAGE

- Septic tank: Concrete block structure
  Size of each tank: W1.25m x L2.5m x D2.0m, aeration type.
- Infiltration pipe:
  PVC pipe 100 PH/, 9.0m x 3 rows, direct underground discharge

RAINWATER AND MISCELLANEOUS WASTE WATER

Discharged on the surface of the ground or collected in rainwater tanks.

5.7 Design of Other Facilities

1. BEACON

As things now stand fishing boats cannot navigate during the night in Ngerchelong and in Angaur because these harbors are not provided with beacons. Due to this, beacons will be installed in Ngerchelong and in Angaur in order to provide navigation safety during the night.

SPECIFICATIONS

- Power supply : Solar cell 9 Watt
- Switching system: Sunlight switch, automatic operation
- Color: Yellow
- Type: Flickering system
- Light visibility range: Approx. 5.4 km
- Battery: 12V, 24AH
- Post: 5 m (steel post)

INSTALLATION SITES: Ngerchelong and Angaur

The beacons will be installed atop steel poles (approx. 5 m height) at the vicinity of the entrance of each harbor.

2. FREIGHT LANDING CRANE

Angaur Harbor is outfitted with manual cranes for the landing of heavyweight commodities, but the other harbors are provided with no such facilities. Cranes equipped with a manual winch similar to that of Angaur Harbor will be installed in the others within the context of this project for the sake of loading/unloading of fishing gear, ship's fittings, fuel (drums) and the like. The manual crane existing in Angaur harbor will be removed to another place.

SPECIFICATIONS OF THE MANUAL WINCH

- Height: 5.0 m
- Arm length: 3.2 m
- Winch: 300 kg/m
- Rotary type
- Installation places: Ngatpang, Ngerchelong and Melekeok

5.8 Fishing Equipment

Of the equipment for coastal fishing donated by the Government of Japan in 1983, such items as engines for fishing boats, fishing nets and fishing gear cannot be operated nor sold to the fishermen because of a shortage of parts and problems. It was found, as a result of the field survey carried out this time, that the parts listed in the following must be provided within the context of this project.

5.8.1 Parts of Engines for Fishing Boats

1.	Starting motors	10 units
2.	Impellers for cooling-water pumps	30 units
3.	Filter elements	30 units
4.	Selex pump impellers	30 units
5.	Engine tachometer generators	15 units
6.	Wet type mufflers for exhaust pipe	10 units
7.	Crankshaft assembly	2 sets
8.	Drain pumps	2 sets
9.	Cams	30 units
10.	Bilge pumps	20 units
11.	Fuel injection pump assembly	10 sets
12.	Wire cables	30 units
13.	Shutdown solenoid	20 units

5.8.2 Fishing Gear and the Like

PFFA sells fishing gear and the like to the fishermen, and the turnover is pooled as a reserve for renovation of the stock of these commodities. However, fishermen are becoming familiarized with the use of fishing gear and other equipment donated free of charge and the positive effects of the donation are gradually becoming

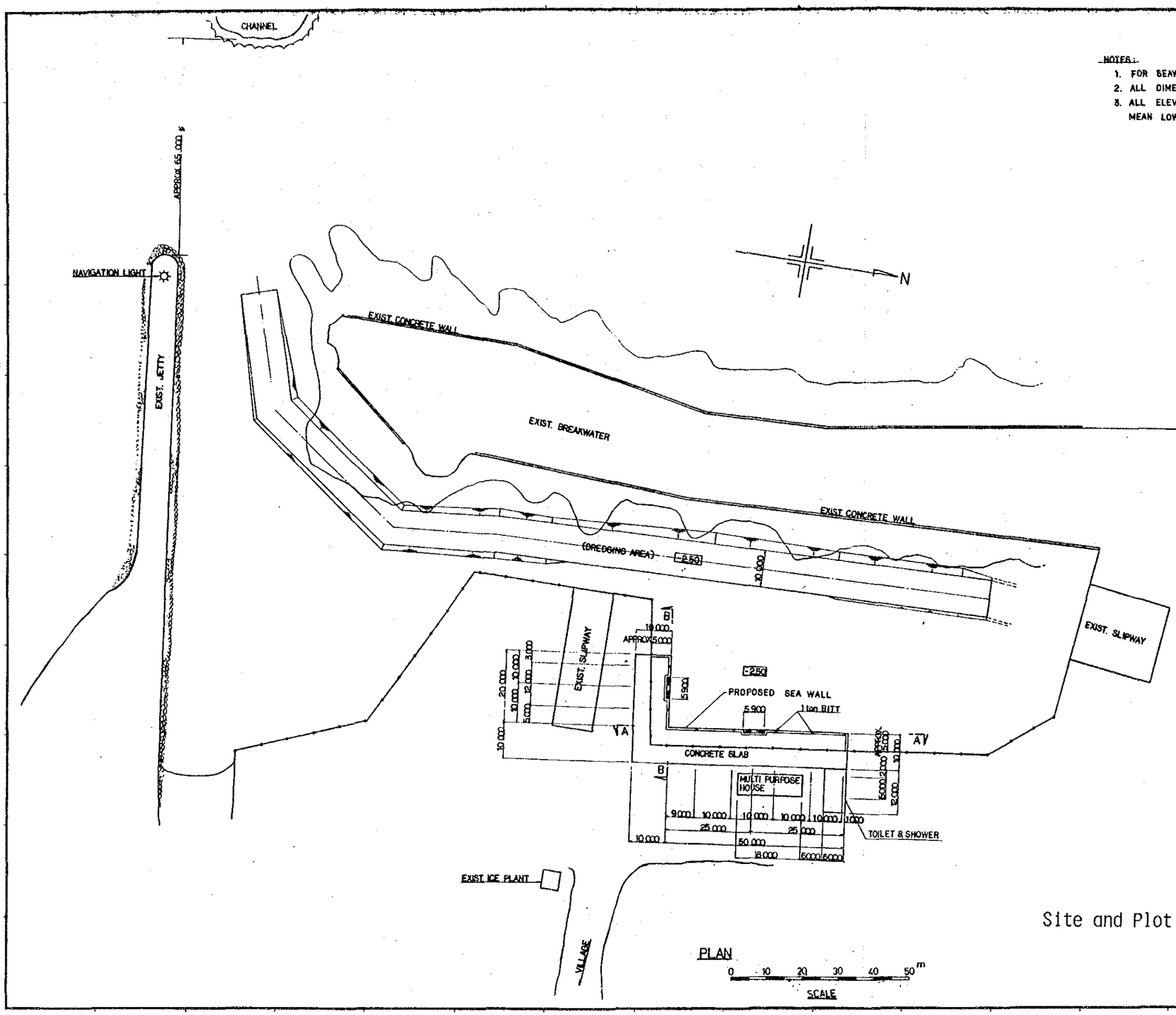
visible. The equipment to be donated this time consists mainly of tug lines and other fishing gear.

- Tug line:	300 rolls
- Artificial bait (squid type):	300 units
- Artificial bait (octopus type):	1,000 units
- Knife:	25 units
- Fishing hook:	1,000 units
- Fish box:	50 units
- Platform balance:	4 units
- Spring balance:	4 units
- Insulated fish bag:	20 bags
- Beak fishing hook:	1 set

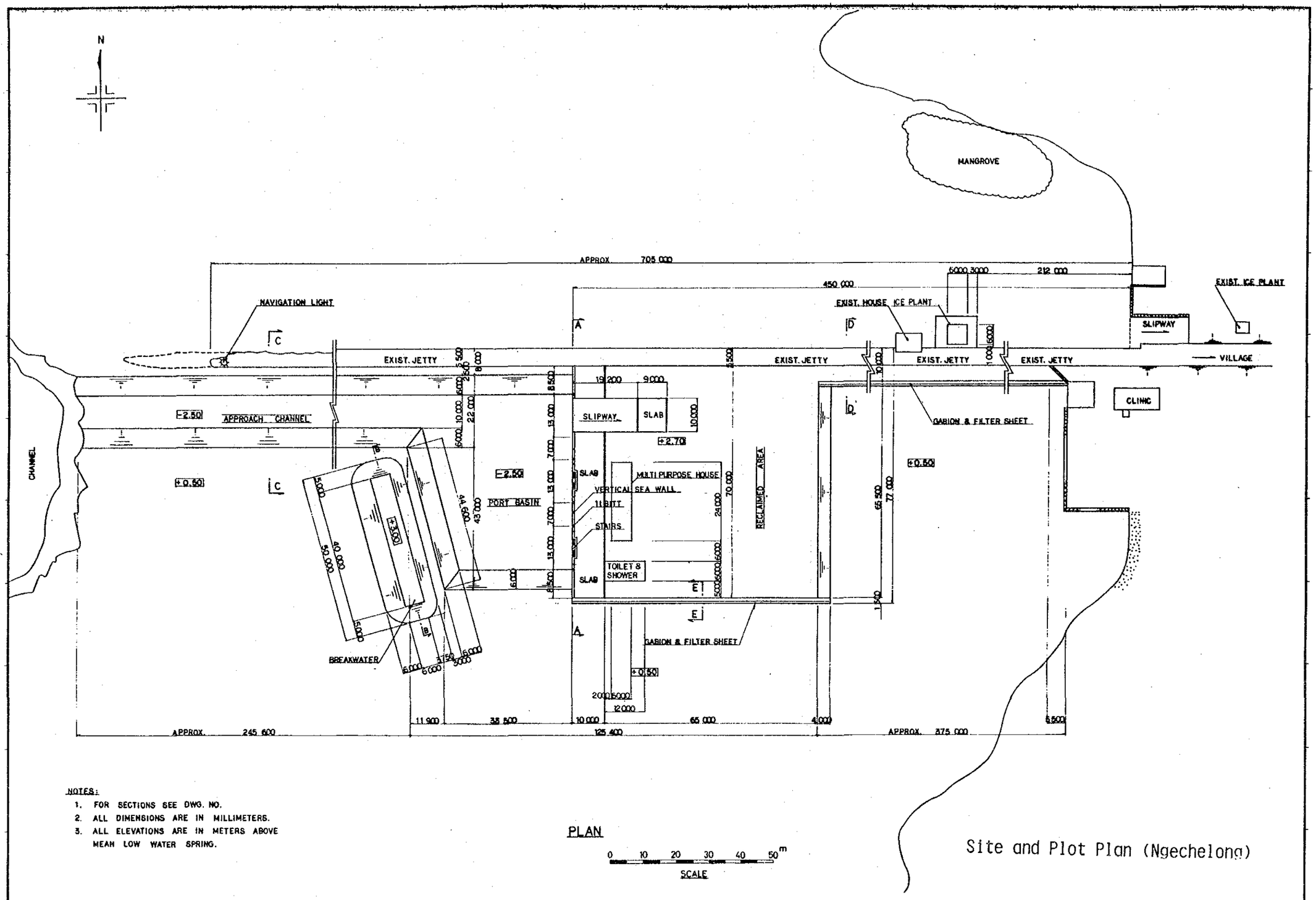
5.9. Basic Design Drawings

1. Site and Plot Plan (Angaur)
2. Site and Plot Plan (Ngerchelong)
3. Site and Plot Plan (Ngatpang)
4. Site and Plot Plan (Melekeok)
5. Multipurpose House (plan)
6. Multipurpose House (elevation)
7. Multipurpose House (section)
8. Toilet/Shower (plan)
9. Toilet/Shower (elevation)
10. Toilet/Shower (section)
11. Ice Making Plant (plan)
12. Ice Making Plant (elevation)

NOTES :
1. FOR SEAWALL STRUCTURES SEE DWG. NO.
2. ALL DIMENSIONS ARE IN MILLIMETERS.
3. ALL ELEVATIONS ARE IN METERS ABOVE MEAN LOW WATER SPRING.



Site and Plot Plan (Angaur)



NOTES:

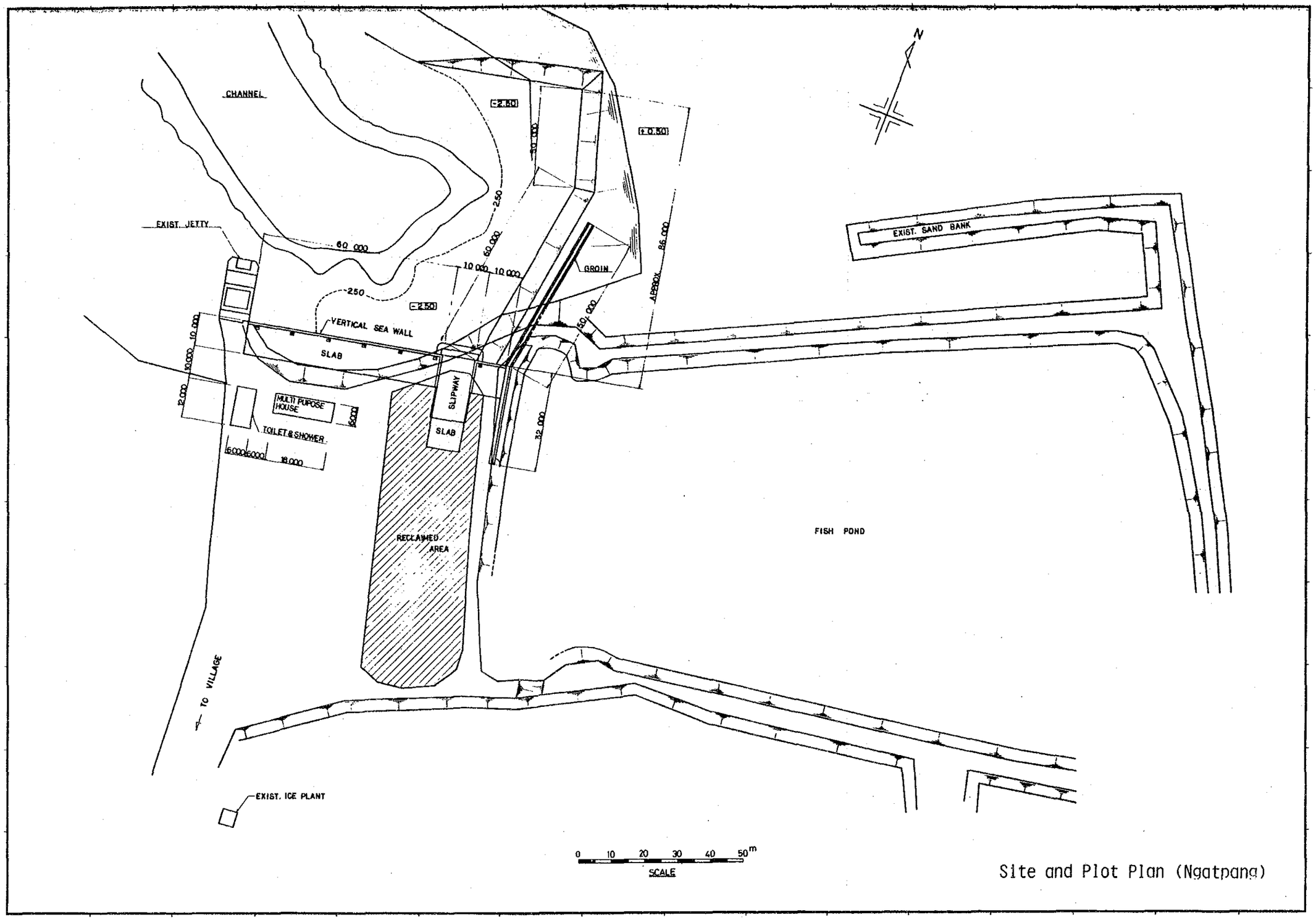
1. FOR SECTIONS SEE DWG. NO.
2. ALL DIMENSIONS ARE IN MILLIMETERS.
3. ALL ELEVATIONS ARE IN METERS ABOVE MEAN LOW WATER SPRING.

PLAN

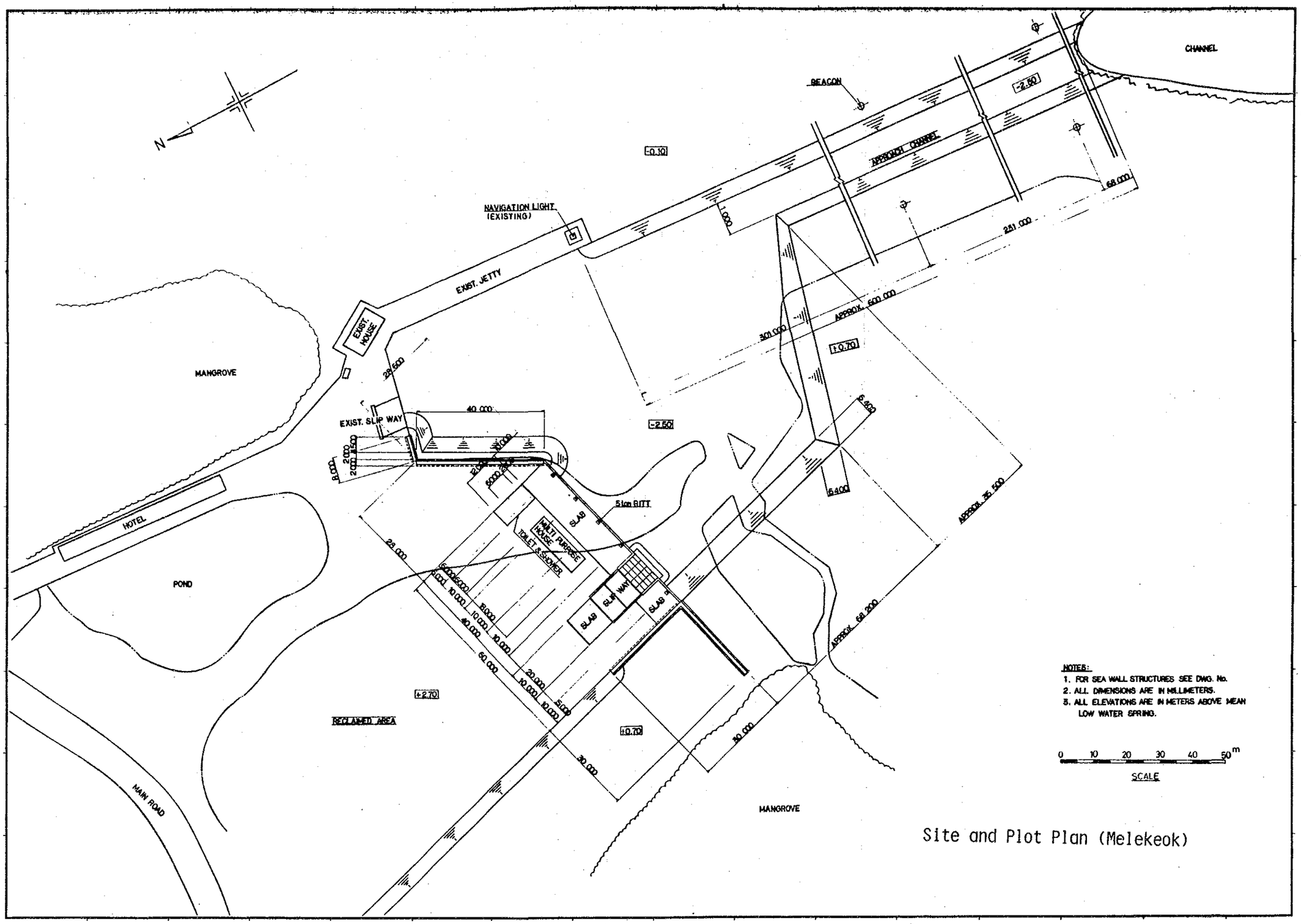
0 10 20 30 40 50 m

SCALE

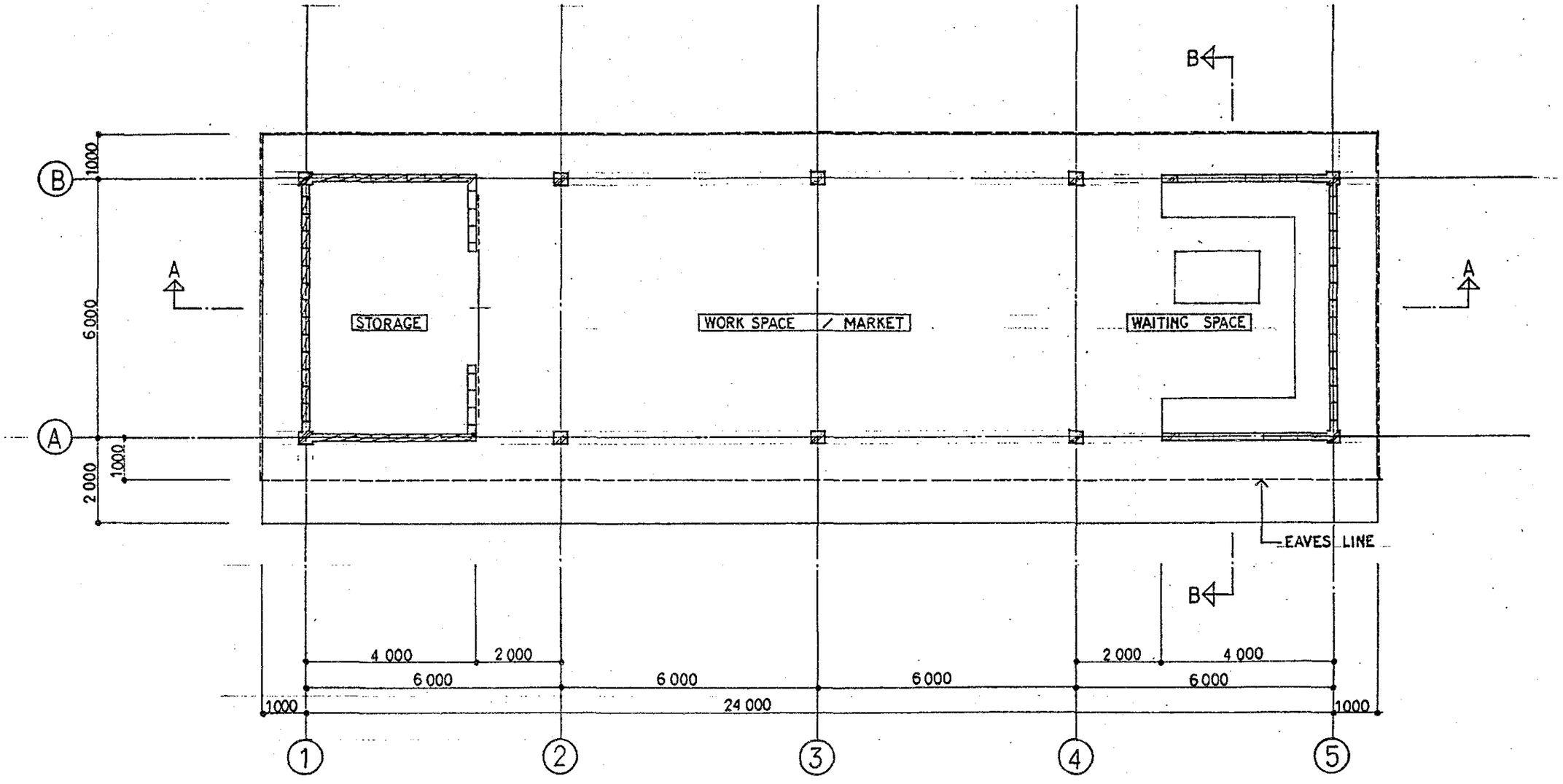
Site and Plot Plan (Ngechelong)



Site and Plot Plan (Ngatpang)



Site and Plot Plan (Melekeok)



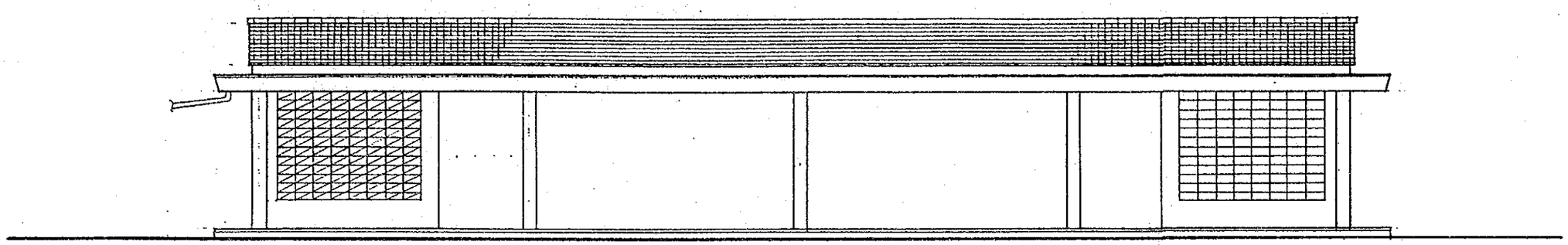
PLAN

LEGEND

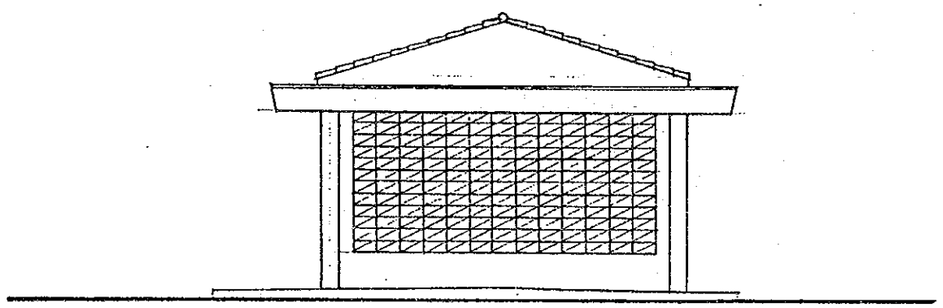
- REINFORCED CONCRETE
- HOLLOW CONCRETE BLOCK
- SCREEN BLOCK

MULTI-PURPOSE HOUSE

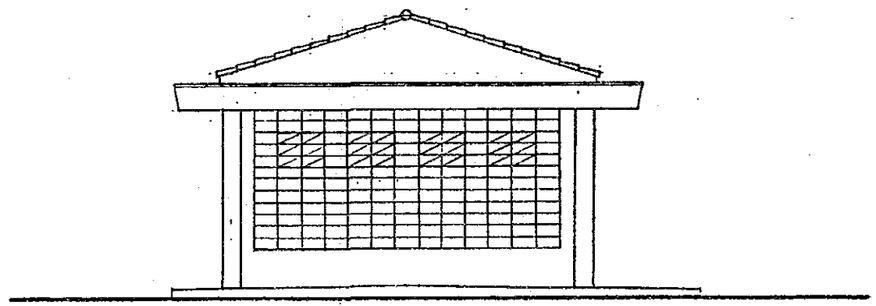
PLAN 1/100



LINE Ⓐ ELEVATION

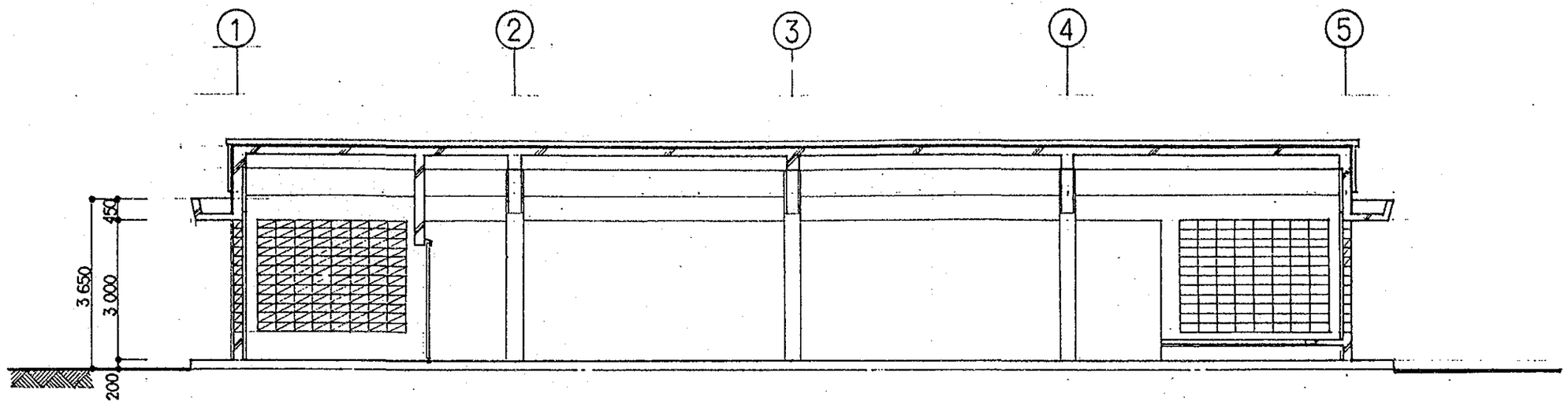


LINE ① ELEVATION

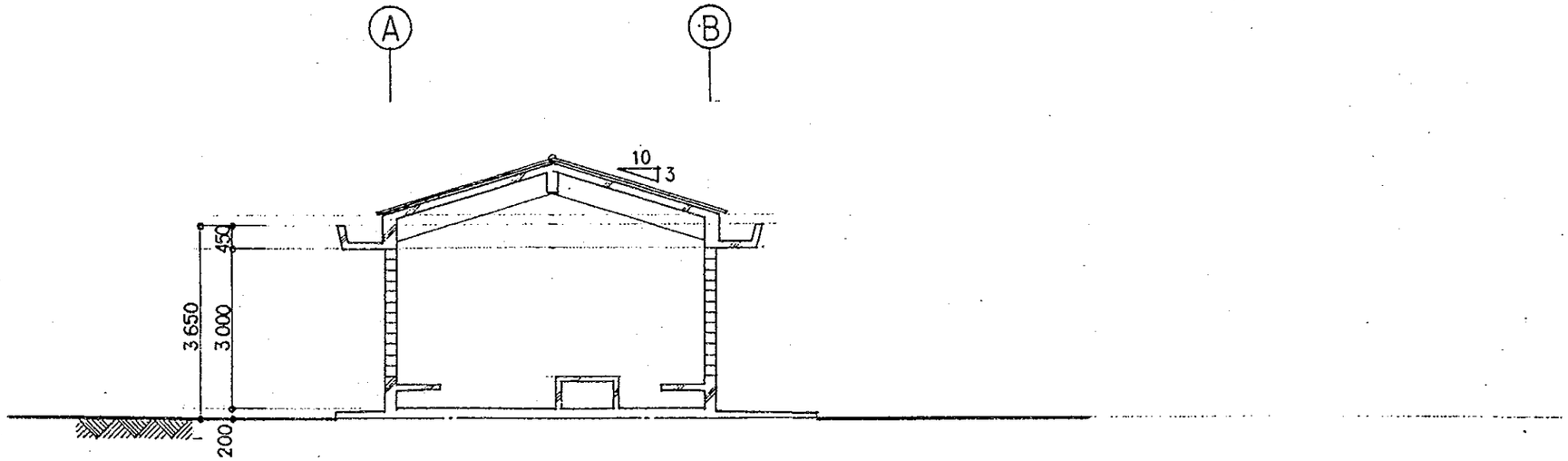


LINE ② ELEVATION

MULTI-PURPOSE SPACE	
ELEVATION	1/100



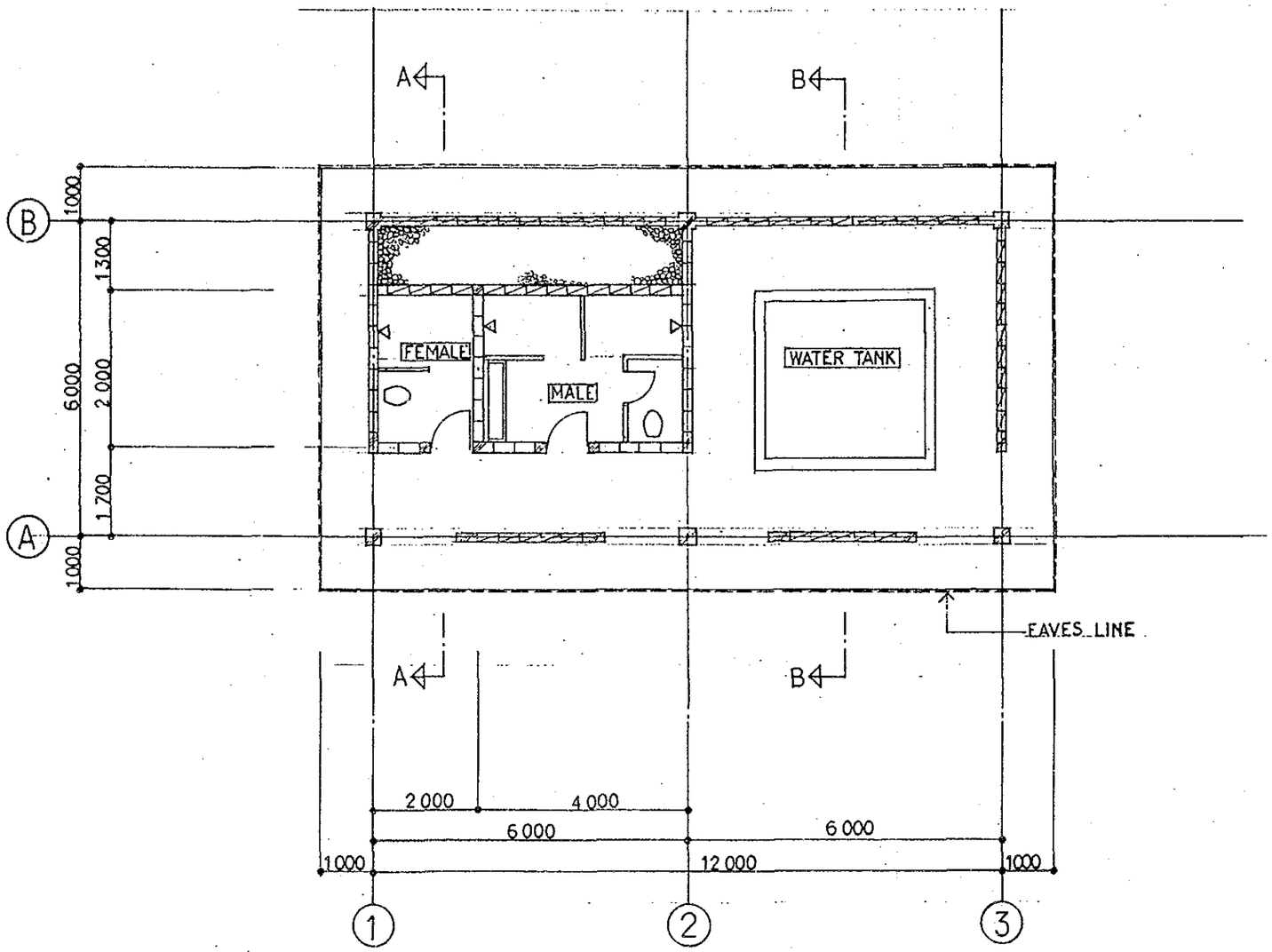
A-A SECTION



B-B SECTION

MULTI-PURPOSE HOUSE

SECTION 1/100



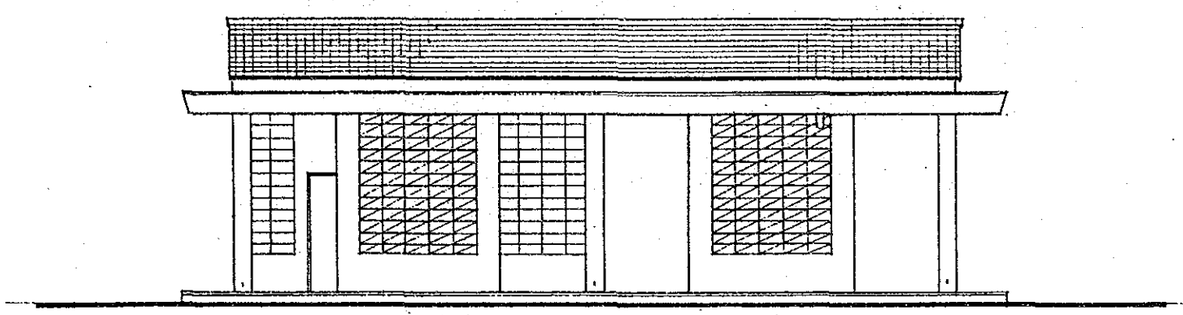
PLAN

LEGEND

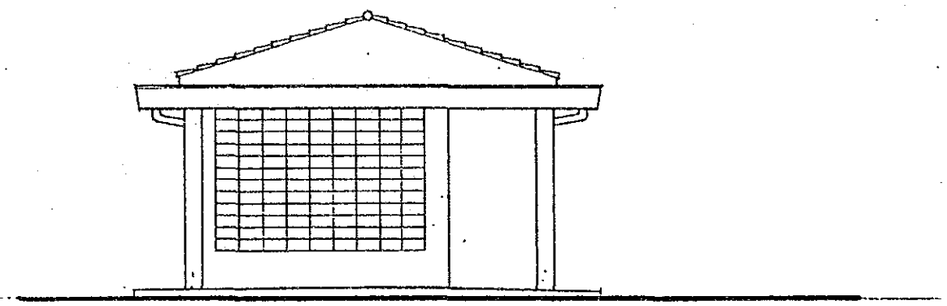
- REINFORCED CONCRETE
- HOLLOW CONCRETE BLOCK
- SCREEN BLOCK

TOILET · SHOWER ROOM · WATER TANK

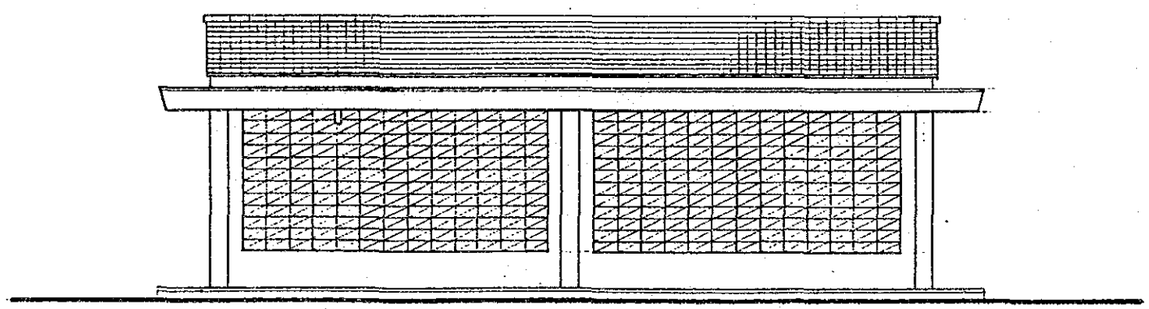
PLAN 1/100



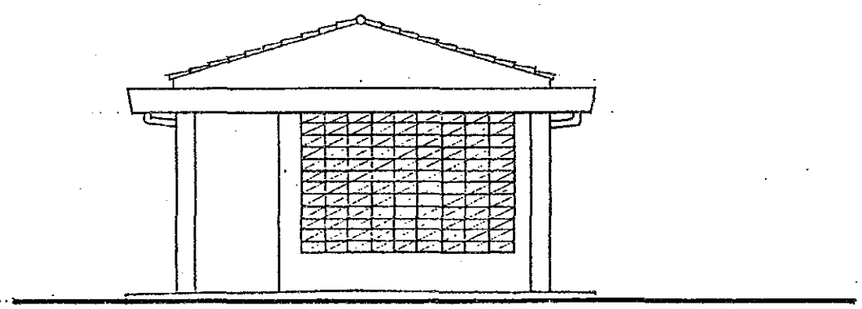
LINE Ⓐ ELEVATION



LINE ① ELEVATION



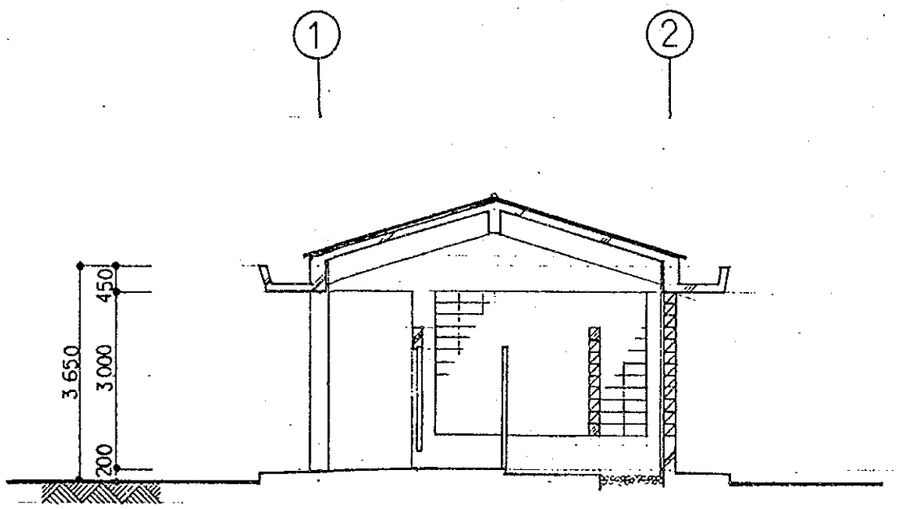
LINE Ⓑ ELEVATION



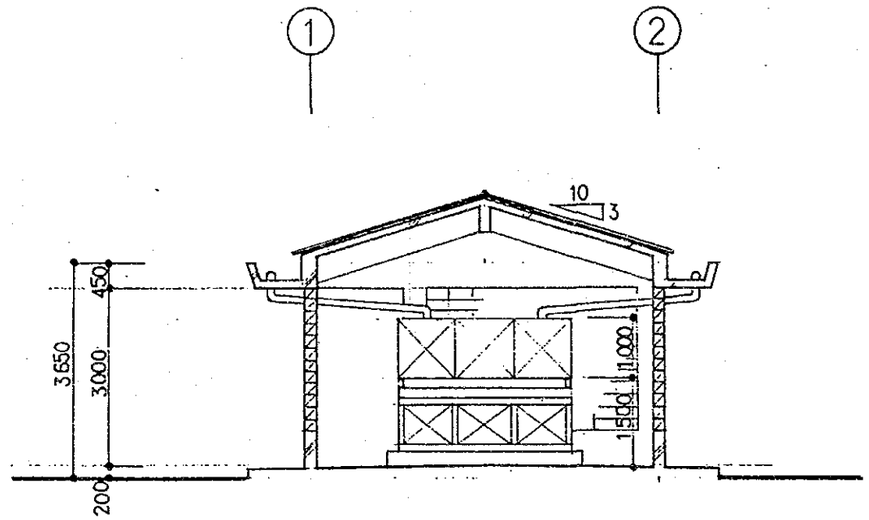
LINE ③ ELEVATION

TOILET · SHOWER ROOM · WATER TANK

ELEVATION 1/100



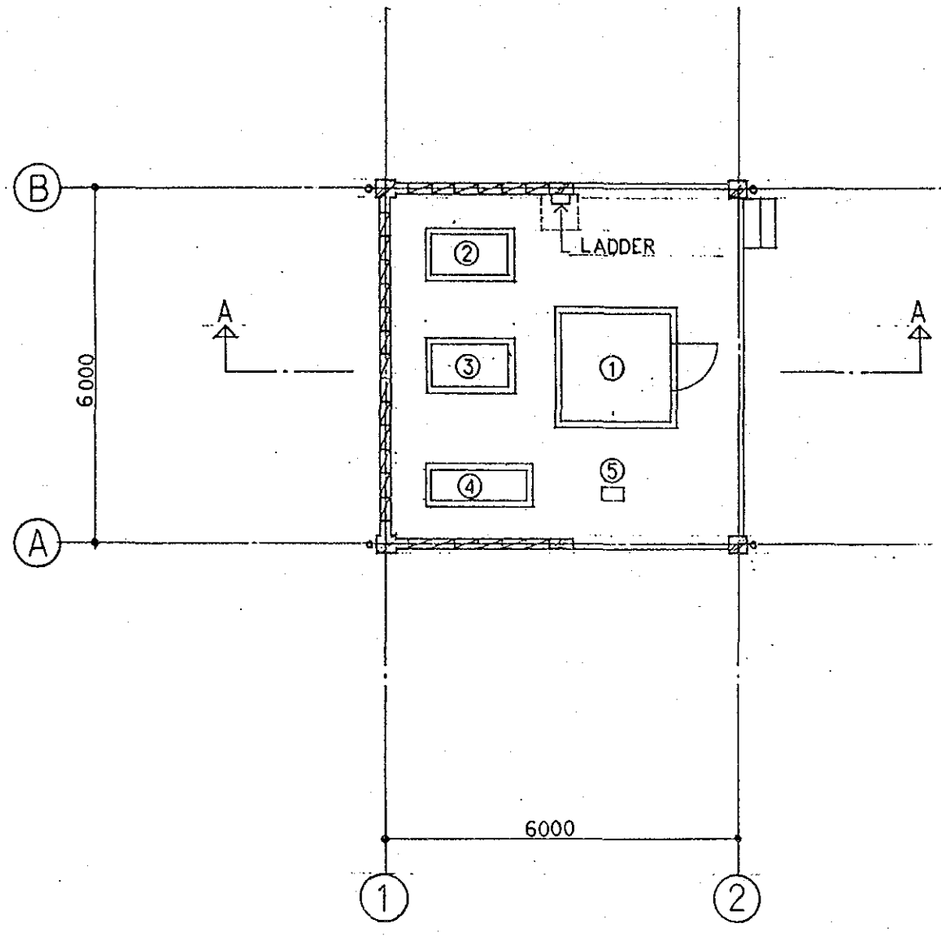
A-A SECTION



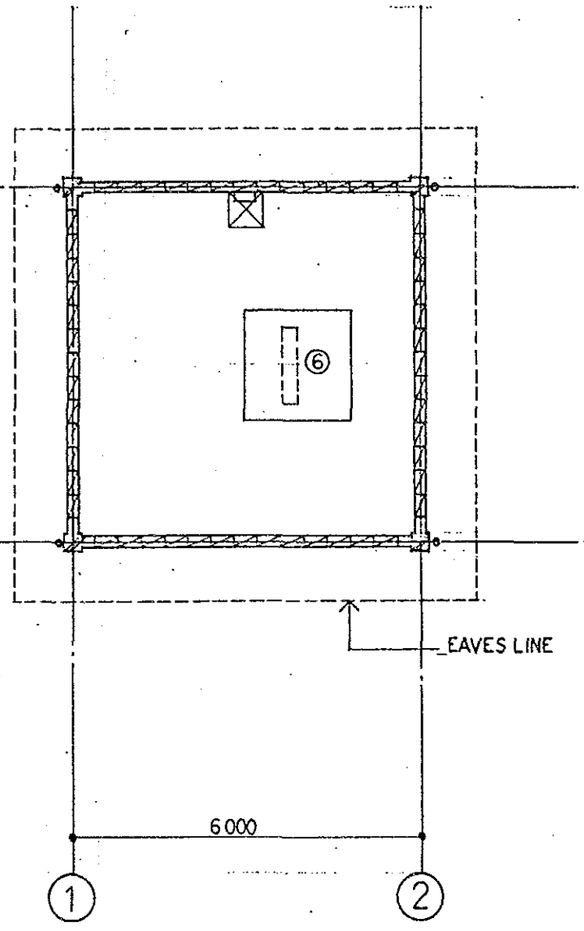
B-B SECTION

TOILET • SHOWER ROOM • WATER TANK

SECTION 1/100



1ST FLOOR PLAN



2ND FLOOR PLAN

LEGEND

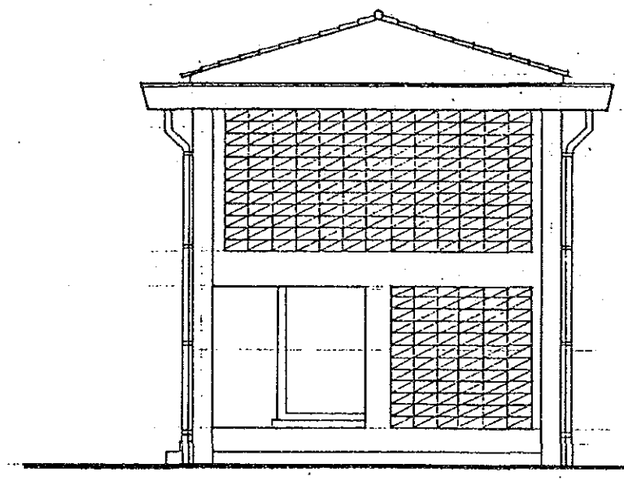
- REINFORCED CONCRETE
- HOLLOW CONCRETE BLOCK
- SCREEN BLOCK

EQUIPMENT

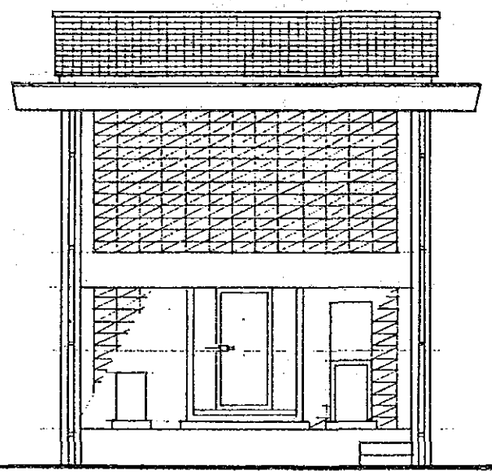
1	ICE STORAGE ROOM
2	FUEL OIL TANK
3	DIESEL ENGINE GENERATOR
4	AIR-COOLED CONDENSER
5	WATER PUMP
6	ICE MAKING MACHINE

ICE PLANT

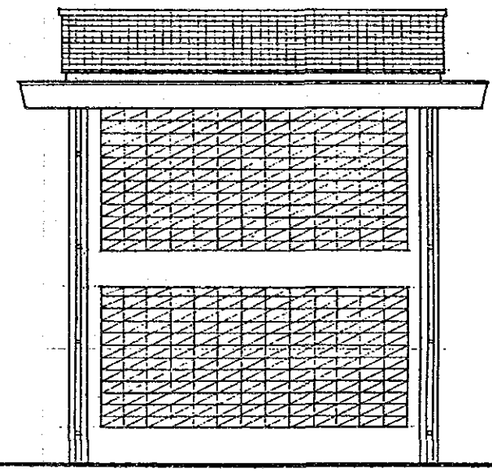
PLAN 1/100



LINE Ⓑ ELEVATION



LINE ② ELEVATION



LINE ① ELEVATION

ICE PLANT	
ELEVATION	1/100

CHAPTER VI

CONSTRUCTION PLAN

CHAPTER VI CONSTRUCTION PLAN

6.1 Construction Situation

6.1.1 Government Office in Charge of the Matter

The Bureau of Public Works of the Ministry of National Resources is the office with jurisdiction over public works of most of the states/villages of the country.

The Bureau of Public of Works possesses some heavy machinery, but its direct involvement in public works is restricted to repair. In spite of this, it possesses three units of Landing Ship Decks [150 ton/6' (draft) x 27' x 100'] for the transportation of heavy machinery, but they are timeworn and 2 of them are broken. One of them can be operated somehow or other, but its navigation reliability is very low.

6.1.2 Status Quo of Public Works

The implementation of many development projects is expected for 1987-1988 concurrently with the enforcement of the Compact of Free Association. Such problems as a shortage of labor, the jump in the prices of materials, the jump in the personnel expenditures, etc., that would result in overall inflation are feared if many projects should be initiated all at once.

The major works that are under way at the present time or are expected to be started in the near future are listed in the following.

1) New international airport construction project

2) Koror/Melekeok road (under construction)
3) Roads in Ngerchelong State (under construction)
4) Roads in Ngeremlengui (under construction)

The aforementioned roads under construction are high standard ones with a more than 20 cm subbase course thickness, 10 cm asphalt pavement, drains at the road shoulders, sidewalks and good road width.

5) Roads/waterworks in Angaur state
Of the roads of Angaur State, those located in the street areas were constructed using coral sand in the subbase course. They are unpaved, but the surface course is in satisfactory condition thanks to the compaction of the calcareous material.
6) General hospital construction project

6.1.3 Categories of Work

The state government sponsors works related to roads, waterworks, electricity and harbors in the various states. In addition to this, the national government sponsors works related to interstate arterial roads, transmission lines, the international airport, transfer of the capital city, etc. It must be borne in mind, however, that as things now stand the cost of most of the works are being borne by the contractors that count on subsidies provided by the United States of America, irrespective of the category of jurisdiction (national government or state government) of the work. The main contractor procures part of the construction machinery, construction materials (sand, gravel) and labor from the local subcontractors.

6.1.4 Construction Machinery

SOCIO Company is the only local contractor equipped with construction machinery. There are 3 Japanese contractors equipped with heavy machinery for road construction. The work sites of these contractors are concentrated on Babelthaup Island, but they are being forced either to rent the LSD possessed by the government or to lease tugboats/barges from the Philippines because those sites cannot be accessed by road from Koror.

6.1.5 Construction Materials

Coral sand (containing fragments) from the sea is being used for the subbase course of the road construction works. The larger the gravel component the easier the compaction, and this kind of material forms a satisfactory subbase course because it is consolidated with the passage of the time. Coral sand is excavated by making use of the peculiar jetty system of this country (earth from the sea is dredged by means of a drag line and the dredged coral is successively embanked to extend the jetty, and more coral is excavated from one or both sides of the jetty).

At the vicinity of Koror the coral is purchased from local suppliers but when the work is carried out at provincial areas the contractor may excavate it directly by obtaining the permission of the state authorities.

In the past, coral has been used as asphalt pavement aggregate, in the same way as in Guam, but in this case the exposed portion has worn out due to the low strength of the calcareous material and the pavement surface becomes slippery as a result. Considering this, the various contractors are using basaltic crushed stone and crushed sand produced in

Malakal, but even that material has low strength and barely satisfies the abrasion resistance requirement of the ASTM test and is frequently rejected through the stability test.

The local contractors are considering the import of aggregate for road paving from the Philippines in spite of the slightly expensive cost when compared with the material of local origin (more than US$14-16/C.Y). Crushed stone produced in Malakal and fine grading beach side are being used as aggregate for cement concrete, but it is necessary to use beach sand with satisfactory grading in conformity with the grading curve standards because the grading of this material is prone to be biased. Crushed stone, crushed sand and beach sand are produced and supplied by a local company (PPC company).

Table 6-1 Unit cost of construction materials (FOB KOROR)

		Unit Cost	Remarks
Stone	50-200 kg/unit	US$11.9/C.Y	Loading included
	0-50/unit	US$11.9/C.Y.	Tug/Barge not incl.
	0-200/unit	US$9.90/C.Y.	

All other construction materials (cement, reinforcing bars, lumber, etc.) excluding crushed stone, beach sand and coral are imported.

- Cement: Taiwan, South Korea
- Reinforcing bar: South Korea, Taiwan
- Water supply/drain, sanitary ware, apparatuses, piping: United States of America, Taiwan
- Electric equipment, wiring: United States of America, Taiwan

- Lumber: Philippines, United States of America, South Korea

Imported materials can be transported with no problem at all to Malakal because regular freighter (5,000 ton class) service is available every other month. It must be borne in mind, however, that as things now stand the transportation of materials and equipment from Malakal to the various sites relies exclusively on ships because of the road situation mentioned in the following. The only means of transportation available in Palau is the LSD possessed by the government, but that craft has low reliability as mentioned before in this report. As a result, the contractor will be forced either to charter a tugboat/barge from overseas or to operate an unloader equipped a barge on its own account.

6.1.6 Labor Situation

Local manpower is available in abundant quantity but the variety is limited and technical personnel of specialized occupations (operators of heavy machinery, carpenters, masons, electricians, mechanics, etc.) are particularly scarce. Under the circumstances there are many foreign workers in Palau. The Government is making an effort to employ as many native people as possible but foreigners are also being recruited in the case of technical occupations that are not available in the country.

The unit cost of skilled workers is approximately US$5.0/hour in the case of South Koreans and approximately US$2.0/hour in the case of Filipinos (including meals and trip expenses). Surveyors, supervisors and foremen are being hired on a monthly salary basis, which is reportedly on the order of US$1,500/month in the case of South Korean personnel. The

official minimum wages for non-skilled workers in Palau is US$ 1.25/hour. There is no official minimum wage for skilled workers, but the average minimum wage rate for skilled workers is US$ 1.50/hour.

6.2 Construction Policy

The construction plan of this project is designed according to the following policies:

1) employ as many native people and use as many local construction materials as possible;
2) increase the working ratio of construction by avoiding work during the rainy season;
3) pay attention to environmental conservation;
4) keep good communication with local people in order to avoid trouble with them; and
5) pay respect to Palauan culture and traditions.

6.3 Scope of Work

This project is aimed at outfitting the fishing ports of four fishing communities of the Republic of Palau; Angaur, Ngerchelong, Ngatpang and Melekeok. The scope of the Project is mentioned in the following.

1) Obtaining of the sites for outfitting of the fishing harbors.
2) Construction of the fishing port facilities.
3) Procurement of the equipment for the fishing port facilities.
4) Supply of the services related to the implementation and supervision of the said work.
5) Obtaining of permission and execution of the procedures for the aforementioned steps.

6.4 Undertakings of the Government of Palau and the Government of Japan

The undertakings of the governments of the two countries related to the implementation of this project are mentioned in the following.

(1) UNDERTAKINGS OF THE GOVERNMENT OF PALAU

1) Obtaining the construction site and removal of any obstacles existing therein, including those in the sea area.

2) Supply of water required for implementation of the Project.

3) Procedures for customs clearance and exemption from import duties and charges on the equipment and machinery to be used for this project.

4) Procedures to exempt Japanese people in Palau from all taxes and charges in connection with the supply of construction materials and equipment as well as services.

5) Provision of all permission and authorizations as well as guaranteeing all rights required by Japanese people concerned for the implementation of the Project.

6) Effective maintenance, control and operation of the facilities constructed through the grant aid.

(2) UNDERTAKINGS OF THE GOVERNMENT OF JAPAN

1) Procurement of all materials, equipment and labor required for the construction work of the Project.

2) Execution of the ocean and inland transportation and sharing of all export and insurance costs of all imported materials and equipment required for the construction.

3) Execution of consulting services related to the detailed design, tendering supervision work, etc.

6.5 Order of Priority of the Works

The Government of the Republic of Palau is attaching top importance to the early outfitting of the infrastructure facilities of isolated islands in its First National Development Plan. Of the four harbors taken into consideration in this project, Angaur is an isolated island and the early start of project implementation there is being given top priority from the standpoints of invigoration of its local economy and outfitting and consolidation of the environment of the local community. Therefore, the outfitting of Angaur port has the first priority and is to be implemented in the first phase.

The next site in order of priority is Ngerchelong, located in the northern part of Babelthaup Island. Reef fishing is very active in this area, but the local fishermen are feeling many inconveniences because the fishing port is not equipped with such basic facilities as a navigation channel, anchorage and wharf. In the first place the construction of the fishing port at this site is expected to exert a strong primary effect on such primary matters as the gathering of fishing boats, increase in the volume of catches, transshipment of the catches to Koror, etc., and that will result in a positive development cycle consisting of the expansion of the economy of the local community beyond the current self-sustenance level, the increasing volume of catches through

the introduction of ships of a larger size and further improvement in the living standards of the local fishermen.

On the other hand, in Ngatpang and in Melekeok the existing harbor facilities are functioning to some extent, and the navigation channel, anchorage, wharf, etc., can be used for fishing purposes. Therefore, the outfitting of these two harbors can be started after the two harbors previously mentioned without problem in connection to the development of fisheries. The efficiency of the work to be executed in these two harbors can be improved, with consequent shortening of the term of works and cutting down of construction costs, by sharing such construction equipment as barges, machinery, etc., because they have the sheet pipe driving work in common. That being so, it is desirable to simultaneously start the works at Ngatpang and Melekeok.

The construction works of this project will be executed in Angaur in the first phase, in Ngerchelong in the second phase, and in and in the third phase.

6.6 Work Execution Plan

The duties to be executed in connection with this project consist of the works related to the basic facilities (dredging and maintenance of the navigation channel and anchorage, construction of new wharves and reinforcement of the existing ones, and construction of the breakwaters, and dikes and reclamation revetments) and functional facilities (land reclamation, broadening of roads, construction of new slipways and repair of the existing ones, construction of landing yards, construction of new multipurpose houses and toilets/showers, construction of new ice making plants, lighthouses and cranes), and supply of fishing gear and spare parts for fishing boats as well as spare parts to repair broken ice making plants.

6.7 Types and Methods of Execution of the Works

The types of works related to the aforementioned project items are mentioned in the following.

A) CONSTRUCTION, ENLARGEMENT AND MAINTENANCE OF NEW AND EXISTING NAVIGATION CHANNELS AND ANCHORAGES

- Dredging
  a. Tugboats, barges, draglines or grab cranes when executing the work on the sea.
  b. Draglines or grab cranes and dump trucks when executing the work on the land.

B) BREAKWATERS, SAND DIKES, RECLAMATION-REVETMENTS/ ROAD-REVETMENTS

- Foundation excavation
- Foundation rubble mound laying
- Levee body construction
  a. Tugboats, barges, grab cranes or cranes when executing the work on the sea.
  b. Grab crane, dump trucks or cranes when executing the work on the land.
  c. Manufacture of the foundation rubble mound and levee body materials and their transportation to the site.

C) CONCRETE BLOCK WHARF

- Foundation excavation
- Foundation rubble mound laying
  a. Tugboats, barges, grab cranes and cranes when executing the work on the sea.
  b. Grab cranes, dump trucks or cranes when executing the work on the land.

c. Manufacture of the foundation rubble mound and levee body materials and their transportation to the site.

- Manufacture/curing of blocks
  Manufacturing yard, batcher plant, form makers, curing sheet, sprinkling facilities, transportation to the cranes.
- Installation of blocks
  Cranes, transportation barges/trucks
- Front foundation stones: Divers
- Installation of bollard/crane foundation:
  Form makers, plumbers, welders
- Concrete placing work of upper part:
  Form makers, plumbers, welders
- Backfilling earthwork: Dump trucks, trucks/barges for transportation of materials & equipment.

D) SHEET PILE WHARF

- Foundation excavation work
- Sheet pile & counter front sheet pile driving work
  a. Tugboats, barges, grab cranes, cranes and pile drivers when executing the work on the sea.
  b. Grabs, trucks, cranes, pile drivers and jacks when executing the work on the land.
- Tie rod tension: Jacks
- Concrete placing work of upper part:
  Same as similar works of C)
- Backfilling earth work:
  Same as similar works of C)

E) LAND RECLAMATION & ROAD CONSTRUCTION

- Revetment work
- Reclamation work: dump trucks, bulldozers, rollers
- Reclamation slope protection work

- Road subbase course work:
  Dump trucks, bulldozers, rollers

F) CONSTRUCTION OF NEW SLIPWAYS AND REPAIR OF EXISTING ONES

- Manufacture of concrete beams and slabs:
  Batcher plant, forms and arrangement of bars
- Excavation work: Same as C)
- Foundation rubble mount laying work: Divers
- Beam & slab laying work: Trucks & cranes
- Paving work & retaining wall work

G) LANDING YARD

- Subbase course work
- Paving work
- Joint work

H) ANCILLARY WORKS

- Lighthouse installation work
- Crane installation work

I) CONSTRUCTION WORK

J) ICE MAKING HOUSE

6.8 Procurement of Materials & Equipment

The construction materials required for the facilities included within the context of this project are stone, earth, concrete, steel (reinforcing bars, shape steel, piles), ancillary equipment (manual crane, bit, beacon) and construction materials (roofing materials, blocks, paint, sanitary ware, piping materials). The construction materials available in Palau are only earth & stone, sand, and gravel (crushed stone). All other materials that can be found in Palau are imported and those are sourced from a wide range of countries (South Korea, Taiwan, United States of America, etc.).

Under the circumstances, when the required construction materials are not produced in Palau it is desirable to use commodities of Japanese origin from the standpoint of guarantee of quality, with the exception of some general-purpose items (hollow blocks for construction, concrete form material, scaffolding materials and other materials for temporary works).

In connection with heavy construction machinery and means for its transportation, there is no other choice but to bring them from Japan because the quantities and models available in Palau are very limited. Local procurement will be used only when absolutely unavoidable.

The plan for procurement and transportation of materials and heavy machinery for construction will be divided into marine transportation from Japan to Koror and local transportation from Koror to the work site, and the relevant details will be examined with utmost care to prevent any omission.

6.9 Work Yard

A large space totalling 1,500 m^2 will be required at each site for storage of the construction materials, as a storage and repair yard for heavy machinery, as well as for the manufacture and temporary storage of concrete blocks, etc. Part of the existing reclaimed areas can be used for the said purposes in Ngatpang and in Melekeok, but in Angaur and in Ngerchelong it will be indispensable to start with the provision of the work yard space (outside the planned site in Angaur and inside the planned site in Ngerchelong) because there is no unused background area at those sites.

6.10 Natural Conditions and Quality

When executing the work on the sea it is indispensable to define in advance the method to shelter the barges in the event of stormy winds. In the three harbors of Babelthaup Island it will be presumably sufficient to suspend work and to anchor the barge by means of an appropriate method in the event of stormy winds because the sites are inside the peripheral reef and there is no risk of significant waves exceeding 1 m. As for Angaur, although it faces directly towards the outer sea, it is possible to secure sufficient safety for the barges taking shelter there because the interior of the harbor is calm even under stormy winds.

The atmospheric temperature and rainfall exert decisive influences on the concrete quality. Therefore care must be taken in connection with the points mentioned in the following for the concrete temperature not to exceed a given temperature (35°C) right after placing it.

(1) Temperature control of the raw materials (cement, sand, gravel and water).

(2) Temperature control when casting concrete (if possible it is desirable to execute the work in the shade).

(3) Temperature control and prevention of drying during the curing (curing with sprinkling).

Measures to prevent the infiltration of rain water are required when casting concrete out of doors in bad weather.

6.11 Construction Supervision Plan

Immediately after the signature of the contract for consulting services with the Government of the Republic of Palau, the consultant carries out the field survey and the final consultations with the local government. After that the consultant should draw up such tender documents as the detailed design drawings, structural calculation report, bill of quantities, construction specifications and the like required for the bid.

Such steps as procedures for approval of the Project, examination of the qualifications for bidding, the execution of the tender and evaluation of the bids should be taken after the completion of the tender documents, and the contractor should be selected through a fair procedure.

After the signature of the construction contract, the consultant should take charge of such duties as a check of the drawings submitted by the contractor in Japan, manufacturing supervision of the materials made at factories, witnessing of the quality tests of the exported products and materials, and inspection of the quantities on the occasion of their shipment. Simultaneously with the start of the work at the site the

contractor should send the supervision engineer to Palau to take charge of such duties as coordination of the acceptance of the contractor, supervision of the work and supervision of the quality tests, witnessing of the inspection of the extent of completion of the works, and preparation of the supervision report.

6.12 Implementation Schedule

Most of the construction materials and equipment will be sourced in Japan because very few items are available in Palau. The periods for procurement and transportation of the construction equipment and materials and the selection of the means of transportation between Koror and the site will be the most important factors for the sake of smooth progress of the work at the site because regular shipping services accessing Palau are available only twice a month.

The bill of quantities corresponding to each category of work mentioned before in this report is calculated for each fishing port, and the implementation schedule is summarized in Table 6-2, 6-3, 6-4, 6-5 by taking into consideration the work efficiency of the selected work method (specification and machinery).

DETAILED DESIGN AND TENDER

The contract for the consulting services of the duties ranging from the detailed design to the tender will be signed each year after the E/N. The approximate terms of these duties are mentioned in the following.

(1) Signature of the contract of the consulting services: 0.5 month

Table 6-2 Angaur Port (Concrete Block Pier)

	Type of Work	Quantity	Work efficiency	Required period
Procurement and preparation	1) Procurement of equipment 2) Transportation (Japan - Palau) 3) Transportation (Korol - Site) 4) Temporary work at site	1 set	-	2 months (4 months for lighthouse)
Dredging and excavation	5) Dredging work of navigation channel and anchorage 5)'Land dredging work 6) Embankment 7) Land reclamation/cleaning	3,800 m3 500 m3	150 m3/day 100 m3/day	1 month
Rubblemound	8) Rubblemound for foundation 9) Backfilling stone	500 m3 350 m3	100 m3/day 100 m3/day	0.5 month
Concrete	10) Block (pier) 11) Site treatment (landing yard) a. Wooden mold treatment b. Reinforced steel bar treatment 11)'Repair work for slipway	770 m3 (232 pcs) 290 m3 410 m3 2.9 ton	20 m3/day (manufacturing) 20 pcs/day (installation)	2 months + 0.5 month within 1 month
Building work	12) Multi-purpose house 13) Toilet/shower	1 set	-	3 months
Other work	14) 1-ton bit 15) Hand crane (500 kg) 16) Lighthouse 17) Water supply piping (ø1")	7 Mobilization 1 1 set	-	0.5 month

Table 6-3 Ngerchelong Port (Concrete Block Pier)

	Type of Work	Quantity	Work efficiency	Required period
Procurement and preparation	1) Procurement of equipment 2) Transportation (Japan - Palau) 3) Transportation (Korol - Site) 4) Temporary work at site	1 set	-	2 months (4 months for ice making, light-house & crane)
Dredging and excavation	5) Dredging work of navigation channel and anchorage	27,000 m3	200 m3/day	5.5 months
	6) Embankment for roads and for reclamation	1,500 m3 (Gabion 372)	20 m3/day	3 months
	7) Land reclamation/road construction	14,400 m3	200 m3/day	3 months +
Rubblemound	8) Rubblemound for foundation	150 m3	100 m3/day	0.5 month
	9) Backfilling stone	800 m3	100 m3/day	
Concrete	10) Block (pier, waterbreak and slipway)	820 m3 (270 pcs)	20 m3/day (manufacturing)	2 months +
	11) Site treatment (landing yard)	310 m3		
	a. Wooden mold treatment	460 m3	20 pcs/day	0.5 month
	b. Reinforced steel bar treatment	4.8 ton	(installation)	
Building work	12) Multipurpose house 13) Icemaking plant 14) Toilet/shower	1 set	-	3 months
Other work	15) 1-ton bit	6		
	16) Hand crane (500 kg)	1	-	0.5 month
	17) Lighthouse	1		
	18) Water supply piping (ø1")	500 m		

Table 6-4 Ngatpang Port (Sheet Piling Pier)

	Type of Work	Quantity	Work efficiency	Required period
Procurement and preparation	1) Procurement of equipment 2) Transportation (Japan - Palau) 3) Transportation (Korol - Site) 4) Temporary work at site	1 set	-	2 months (4 months for sheet pile & crane)
Dredging and excavation	5) Dredging work of navigation channel and anchorage	9,100 m3	200 m3/day	2 months
	6) Sand dike	250 m3 (Gabion 62 pcs)	20 m3/day	0.5 month
	7) Land reclamation	7,500 m3	200 m3/day	1.5 months
Rubblemound	8) Rubblemound for foundation	370 m3	100 m3/day	1 month
	9) Backfilling stone	2,240 m3		
Sheet pile and concrete	10) Sheet pile, etc. (with rudder)	175 ton (VI-207pcs/10m V-170pcs/5m)	10 pcs/day	1.5 months
	10)'Block (slipway)	35 m3 (31 pcs)		
	11) Site treatment (slipway and landing yard)	405 m3	20 pcs/day	1 month
	a. Wooden mold treatment	924 m3		
	b. Reinforced steel bar treatment	14.1 ton		
Building work	12) Multipurpose house 13) Toilet/shower	1 set	-	3 months
Other work	14) 5-ton bit	7	-	1 month
	15) Hand crane	1		
	16) Lighthouse	Not required		
	17) Water supply piping	120 m		

Table 6-5 Melekeok Port (Sheet Piling Pier)

	Type of Work	Quantity	Work efficiency	Required period
Procurement and preparation	1) Procurement of equipment 2) Transportation (Japan - Palau) 3) Transportation (Korol - Site) 4) Temporary work at site	1 set	-	2 months (4 months for sheet pile & crane)
Dredging and excavation	5) Dredging work of navigation channel and anchorage	27,100 m3	200 m3/day	5.5 months
	5)'Land dredging work	2,500 m3	100 m3/day	1 month
	6) Embankment for reclamation/sand dike	350 m3 (Gabion 80)	20 m3/day	1 month
	7) Land reclamation	24,400 m3	200 m3/day	5 months
	7)'Cutting of mangrove trees	1 set		
Rubblemound	8) Rubblemound for foundation	660 m3	100 m3/day	0.5 month
	9) Backfilling stone	90 m3		0.5 month
Sheet pile and concrete	10) Sheet pile, etc. (with rudder)	130 ton (III-157pcs/10m II-114pcs/5m)	10 pcs/day	1 month
	10)'Block (slipway)	35 m3 (31 pcs)	20 m3/day |	1.5 months
	11) Site treatment (slipway and landing yard)	320 m3	20 pcs/day	
	a. Wooden mold treatment	740 m3	100 m3/day	1 month
	b. Reinforced steel bar treatment	10 ton	1 ton/day	
Building work	12) Multipurpose house	1 set		
	13) Toilet/shower	(Existing)	-	3 months
Other work	14) 5-ton bit	5		
	15) Hand crane	Mobilization	-	1 month
	16) Lighthouse	1		
	17) Water supply piping	1 set		

(2) Detailed design (preparation of the detailed design drawings, preparation of the bill of quantities, preparation of the structural calculation report, preparation of the construction specification and preparation of the construction contract and tender documents): 4.0 months

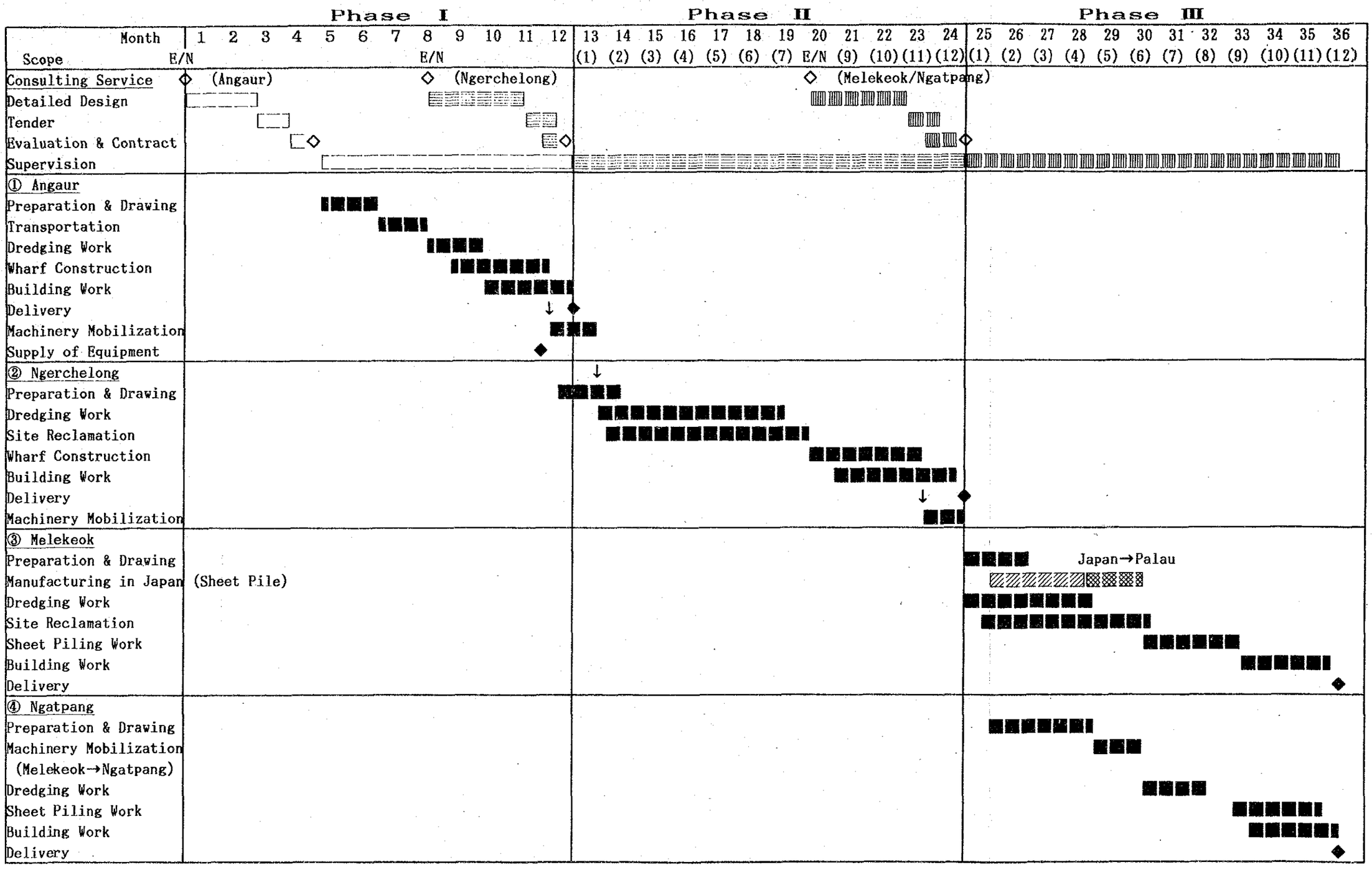
(3) Tender, signature of the construction contract: 1 month

The Project is recommended to be implemented in three phases considerating the order of priority of the project sites and cost reduction. Project phases and their respective sites are as follows.

Phase I	Angaur Harbor
Phase II	Ngerchelong Harbor
Phase III	Ngatpang/Melekeok Harbors

In Phase I, it takes three months after the construction contract for field construction to be conducted due to the transportation of the construction machinery. However, field construction in Phase II and Phase III is conducted immediately after the construction contract using this machinery. The detailed implementation schedule is shown in Figure 6-1.

Figure 6-1 Implementation Schedule



CHAPTER VII

OPERATION PLAN

CHAPTER VII OPERATION PLAN

7.1 Operation Plan

The facilities to be constructed within the context of this project will be handed over from the Ministry of Natural Resources to the various states holding jurisdiction over the harbors. From the standpoint of operation it is desirable that the harbor be operated autonomously by the fishing association of each state. In Ngerchelong and in Angaur, which already have fishing associations, these organizations are taking charge of the operation. Fishing associations will be organized anew in the states of Ngatpang and Melekeok under the guidance of PFFA and each state government to take charge of the operation of the fishing harbor.

There is no need of enforcing anew rules and regulations referring to the use of the harbors and they can be operated as usual because all states are already provided with harbors. It must be remembered, however, that not only local fishing boats and transportation ships but also vessels of other areas will use the various harbors as a consequence of the improvement of their facilities. Hereinafter it is desirable to stipulate the methods of use (mooring method, mooring position, method of use of the ancillary facilities, etc.) for the sake of smooth use of the facilities. Such facilities as wharves, navigation channels and anchorages of the harbors are maintenance free and will require practically no maintenance except in the case of disasters and the like. It must be noted, however, that the multipurpose house, toilet/shower and other ancillary facilities require cleaning and other kinds of routine maintenance and it will be indispensable to designate persons in charge of them to keep them always clean. Furthermore, the presence of a person

stationed in the harbor will guarantee the safety of the moored ships, and as a consequence boats that are being placed by the houses of the villages at the present time will be moored in the harbor.

On the other hand, should such work as the handling, storage, simple processing, etc. of catches be carried out by making use of these facilities, the consumption of water will increase and it will be necessary to determine how the running water charge will be shared.

7.2 Manning Scheme

The chairman of the fishing association of each state will be the person responsible for each harbor, and the routine maintenance and control of the facilities will be taken charge of by the members of the association in turns. On the other hand, the fishing associations will keep close contact with the government of each state so as to carry out repair work and the like by obtaining the cooperation of the people of the villages when collective work is required. Efforts must be made to implant the consciousness that the harbor is an asset to be shared by all people of the village, and the maintenance must be carried out directly by the local people as much as possible.

7.3 Running Cost

The four fishing ports will require no running cost because they are designed to be maintenance free. The fishing associations should take charge of the routine cleaning.

Should the facilities be damaged by such abnormal situations as calamities and the like, it would be desirable to repair them through a joint effort of the fishing association,

which would be in charge, and the residents of the local village. On the other hand, the state authorities should provide financial help to cope with repair materials and the like.

In connection with the ice making facilities to be installed in Ngerchelong Harbor, it will be necessary to determine the retailing price of ice so as to cover the fuel cost, the operator's salary, the parts for maintenance, etc., with the sales of ice.

CALCULATION OF THE RUNNING COST OF THE ICE MAKING PLANT

- Running conditions

  Ice production: 500 kg/day (120 ton/year)
  Daily running time: 6 hours
  Monthly running days: 20 days/month

- Cost

  1. Unit cost

     a) Maintenance
        10%/year of the direct equipment cost
     b) Fuel US$0.33/Lts.
     c) Operator cost US$3/hour
     d) Water for ice Rainwater

  2. Calculation of the ice making cost

     - Fuel cost:
       120t x 12.3Lts. x 0.33 = 487
     - Personnel expenditure:
       US$3 x 6 hours/day
       x 20 day x 12 month 4,320
     - Maintenance 5,185

     TOTAL US$9,992.-

     ICE MAKING COST 8.3 cents/kg of ice

Under the circumstances, the selling price of ice is determined as shown in the following.

- For fishery use : 11 cents/kg
- For household use: 18.5 cents/kg

Therefore, the aforementioned price is perfectly competitive compared with ice for fisheries use sold at 11 cents/kg in the South Pacific area. As all ice produced in the plant can be sold to fishermen, and PFA will give technical advice on the plant operation, the ice making facilities in Ngerchelong can be operated without a financial burden on the fishing association in Ngerchelong.

CHAPTER VIII

EVALUATION OF PROJECT

CHAPTER VIII EVALUATION OF PROJECT

The fishing industry is a very promising means for the Republic of Palau to attain economic independence. It has the potential for development in all states of the country. In fact, the fishing industry is attaining sound development in Palau thanks to the introduction of modern fishing equipment such as outboard engines, FRP fishing boats, fishing nets, ice making machines, and cold stores. Marine products are being exported to neighboring countries and are a precious source of foreign currency. To further expand marine production and to improve the quality of fresh fish in Palau, which is enjoying an excellent reputation in various markets, and thereby promote its exports is an important theme for the economic development of the country. The demand for fish from Palau in Hawaii, Guam, and Saipan is increasing year after year and it grew approximately 100% during the 1984-1986 period. Tourism is expected to grow steadily in the said countries, and accordingly the export of fish from Palau, which will be consumed mainly by tourists, will increase as well.

It must be remembered, however, that the fishing communities of Palau are poorly equipped with social infrastructure facilities; the living standards of the fishing communities are low; young people are emigrating to the urban areas; fishermen are becoming aged; and the villages are becoming badly depopulated. In these circumstances, it is very essential to improve the facilities of the fishing ports in order to improve the fishing communities and their livelihood.

Results of the analysis of the field survey on natural conditions indicate that there are no topographic and marine conditions that could bring about the risk of obstruction of the harbors with littoral drift. The project sites have different foundation conditions, but the construction of wharves with a stable structure in conformity

with the conditions of each site is perfectly practicable.

The broadening of navigation channels through the implementation of this project will secure safe operation of the fishing boats, allowing them to enter and leave the harbor even during low tides. That will allow them to operate freely irrespective of the tide conditions, which will result in a wider range of operation and a greater catch.

The installation of beacons will secure the safety of fishing operations and navigation during the night, making it possible to operate in the early morning and evening periods that are especially suited for fishing, which is expected to bring about more marine production. Furthermore, the outfitting of such facilities as an anchorage, wharf, and slipway will secure the safety of the moored ships even under stormy weather conditions. It will allow better repair and maintenance which will result in operating safety.

The multipurpose house and other ancillary facilities of the harbors will serve for such functions as fish processing, storage, etc., useful for promoting proper distribution of the catch, that will permit a steady supply of fish with excellent freshness to the Koror market. Furthermore, these facilities will function also as a meeting place fishermen, and will play an important role regarding the learning for techniques, exchange of information, etc., that are especially useful for the formation of the fishing community. It is concluded that the outfitting of the four fishing ports is expected to promote the development of local fishing communities. The scale of the fishing port facilities being planned for Angaur, Ngerchelong, Ngatpang and Melekeok is regarded as very appropriate compared with the fishing ports being used in the various states of the Republic of Palau. It is thought that also from the standpoints of the use and operation of the facilities, these fishing ports are properly

designed to match the capacity of the various state governments and fishing associations concerned.

Furthermore, after completion of the works planned within the context of this project, the harbors will play the role of strategic bases for the development of fisheries in the Republic of Palau. Each harbor is expected to play the specific roles mentioned in the following.

1) ANGAUR

- Base for development of the vast southern sea area in Palau.

- Center for technical development of fishing outside the reef (i.e., pelagic fish fishery).

2) NGERCHELONG

- Promotion of fisheries development as base for interreef fishing in the northern reef sea area in Palau.

- Logistic and distribution base for fishing activities in the isolated islands of the northern portion of the archipelago.

- Transit point for physical distribution because of its location at the northern extremity of the Babelthaup Island Road.

3) NGATPANG

- Capability of development of fisheries in the western sea area as a result of the outfitting of this harbor.

- Anchorage base for fishing boats engaged not only in fishing inside the coastal reefs but also in the development of pelagic fish resources outside the reef.

- Capability of industrialization of marine production in this harbor because of provision of such infrastructures as road and electricity.

4) MELEKEOK

- Strategic point of the domestic market for marine products in the future because of its location in the future capital city of the country.

- Base for development of fisheries in the eastern sea area of the country.

Planned construction work in the Project does not destroy the valuable environment in Palau by paying full attention to not polluting the sea with silt and not destroying mangrove and coral resources.

Furthermore, planned outfitting of the facilities is thought to promote local district development in Palau. As development activities which are now concentrated in Koror will be dispersed into local districts by outfitting local fishing harbors, this project is expected to provoke further improvement of local infrastructure.

As seen, this project is expected to play a key role in promoting the economic progress of the country and upgrading the living standards of the people. Therefore, grant aid from the Government of Japan for implementation of this project is very significant.

CHAPTER IX

CONCLUSION AND RECOMMENDATIONS

CHAPTER IX CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion

Through the implementation of this project, the fishing and production infrastructures of local districts of the Republic of Palau will be properly promoted and the production of marine products is expected to increase. Access to the local harbors and Koror will be facilitated, and will result in the transportation of fresh fish to Koror within a short time and proper processing of the catch for export. Furthermore, the development of fisheries in the various harbors will contribute to the invigoration of the provincial districts being plagued by depopulation and will improve the living standards of the local fishermen. Additionally, from the geographic standpoint the four harbors are located at strategic positions to function as bases for development of fishing in the eastern, western, southern and northern sea areas of the Republic of Palau. These will play important roles for regional development.

The facilities of the harbors are basically designed to minimize maintenance, and should the maintenance be taken charge of by the local communities, they would require no additional financial burden. The implementation of this project is regarded as highly recommendable. It should be undertaken as soon as possible within the context of the grant aid cooperation program of Japan.

9.2 Recommendations

The following recommendations are made for the fishing ports to be outfitted by this project to give full play to their functions.

(1) The method of use of each harbor should be decided through consultations between the users from each fishing community for the sake of smooth operation.

(2) Statistics referring to the conditions of use of each harbor, i.e., the number of ships accessing it, the quantity of catch landed, the number of users, etc., should be collected for the sake of effective operation of the harbor, as well as to provide basic information for future harbor development in the Republic of Palau.

(3) Institutions of the Republic of Palau related to fisheries should make efforts to foster young fishermen for the promotion of regional fisheries. Furthermore, measures should be taken to improve the handling and processing techniques of local fishing communities through traveling technical extension programs.

(4) Regular fish transportation services should be established between the various harbors and Koror for the sake of stable collection of the catch at Koror.

(5) Natural resources existing inside the reefs are limited. Therefore, care should be taken to prevent indiscriminate fishing and development should be promoted while paying attention to conservation of the existing natural resources.

APPENDIX

APPENDIX

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Appendix I

Minutes of Discussions

1. Basic Design Study

MINUTES OF DISCUSSIONS ON THE PROJECT FOR FISHING COMMUNITY DEVELOPMENT IN THE REPUBLIC OF PALAU

In response to the request made by the Government of Republic of Palau for the Project for Fishing Community Development (hereinafter refered to as "the Project"), the government of Japan decided to conduct a basic design study on the Project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Palau a study team headed by Mr. Masaru OKAMOTO, Deputy Director, International Cooperation Division, Oceanic Fishery Department, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries from the 18th October to the 11th November 1987.

The team had a series of discussions on the Project with the officials of the Republic of Palau headed by John O. Ngiraked, Minister of State and conducted field survey on Angaur, Melekeok, Ngarchelong and Ngatpang.

As a result of the study, both parties agreed to recommend to their respective governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the project.

Masaru OKAMOTO
Leader, Basic Design
Study Team,
Japan Internationa.
Cooperation Agency (JICA)

John O. Ngiraked
Minister of Sate

ATTACHMENTS

1. TITLE OF THE PROJECT

The title of the Grant Aid Project is "the Fishing Community Development Project".

2. OBJECTIVE OF THE PROJECT

The objective of the Project is to develop coastal fisheries through improvement of facilities of fishing communities.

3. EXECUTING AGENCY

The executing agency of the Project is Bureau of Resources Development, Ministry of National Resources.

4. REQUEST BY THE GOVERNMENT OF PALAU

The Japanese study team will convey to the request of the Government of Palau the Government of Japan that the latter will take necessary measures to ensure cooperation in implementing the Project and provide necessary facilities listed in Annex 1 within the scope of the Japanese Economic Grant Aid programe.

5. SYSTEM OF JAPANESE GRANT AID

The Government of Palau has understood Japanese Grant Aid System as explained by the Team. This system requires that a Japanese consulting firm be used as principal consultant and Japanese firms be used for implementation of the Project.

6. MEASURES TO BE TAKEN BY THE GOVERNMENT OF PALAU

Provided that Grant Aid is extended by the Government of Japan for the Project implementation, the Government of Palau will take the necessary measures listed in Annex 2.

7. FINAL REPORT

Ten final reports in English on the Project will be submitted to the Government of the Republic of Palau by the end of March 1988.

ANNEX 1

The facilities and equipment required by the government of Palau for the Project are listed below.

1. Fishing port facilities for Angaur, Melekeok, Ngerchelong, and Ngatpang.
2. Fishing community facilities such as multipurpose space, toilet with shower, ice making machine, storagehouse and equipment for fish preservation.
3. Spare parts for fishing equipment provided by Japanese grant aid in 1983.

ANNEX 2

The list of necessary measures to be taken by the Government of Palau is the following.

1. To carry out necessary site preparations, including land ownership for the construction work.

2. To arrange the installation of appropriate facilities for the distribution of electricity, water supply, drainge and other incidental facilities before the commencement of the works.

3. To ensure prompt unloading, tax exemption and customs clearance at Koror in Palau and the prompt internal transportation of the equipment provided under the Project.

4. To appoint an appropriate Project manager who will manage and expedite Project activities in the course of Project implementation.

5. To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Palau with respect to the supply of the products and services under the verified contracts.

6. To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry and stay for the performance of their work.

7. To maintain and use properly and effectively the facilities constructed and equipment provided under teh Grant Aid.

2. Draft Report Explanation

MINUTES OF DISCUSSIONS
ON
THE PROJECT OF THE FISHING COMMUNITY DEVELOPMENT
IN
PALAU

In response to the request made by the Government of Palau for a grant aid for the Project of the Fishing Community Development in Palau (hereinafter referred to as "the Project"), the Government of Japan decided to conduct a basic design study on the project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Palau the team headed by Mr. Masaru OKAMOTO, Deputy Director, International Cooperation Division, Oceanic Fishing Department, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries, from 18th October to 11th November, 1987.

As a result of the study, JICA prepared a Draft Report and dispatched a team headed by Mr. Yoshinori UGAJIN, Fishing Port Division, Fishing Port Department, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries to explain and discuss it with the relevant authorities of the Government of Palau from 17th January to 26th January, 1988.

Both parties had a series of discussions on the Report and agreed to recommend to their respective Governments that the major points of undertanding reached between them, attached herewith, should be examined towards the realization of the Project.

25 January 1988

宇賀神 義宣

Mr. Yoshinori UGAJIN
Leader of
The Basic Design Study Team
JICA, Japan

Mr. Wilhelm R. Rengiil
Minister of National Resources
Government of
Republic of Palau

ATTACHMENT

1. The Palau side has principally agreed to the basic design proposed in the draft final report.

2. The Palau side has understood Japan's grant aid system and reconfirmed the necessary measures to be taken by the Palau side for the realization of the Project shown in Annex II as agreed upon the Minutes of Discussion dated October 25, 1987.

3. The Final Report (10 copies in English) will be submitted to the Palau side by the end of March, 1988.

宇賀神

Appendix II

Members of the Study Team

1. Basic Design Study Team

Assigned duties	Name	Position
Team Leader	Mr. Masaru OKAMOTO	Deputy Director, Office for Overseas Fishery Cooperation, Internatioanl Affairs Division, Oceanic Fisheries Department, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries
Fishing Port Planner	Mr. Yoshinori UGAJIN	Inspector, Fishing Port Construction Division, Fishing Port Department, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries
Project Coordinator	Mr. Kenji ISHIWATA	Kanagawa International Fisheries Training Centre, Japan International Cooperation Agency
Fisheries Development Planner	Mr. Yasuo ISHIMOTO	Overseas Agro-Fisheries Consultants, Co., Ltd.
Facilities Designer	Mr. Masato ARAYA	- ditto -
Marine Civil Engineer	Mr. Mamoru NAMIKI	- ditto -
Geological Survey Expert	Mr. Akiyoshi TAKAHASHI	- ditto -

2. Draft Report Explanation Team

Assigned duties	Name	Position
Team Leader	Mr. Yoshinori UGAJIN	Inspector, Fishing Port Construction Division, Fishing Port Department, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries
Project Coordinator	Mr. Ryuji OHNO	Kanagawa International Fisheries Training Centre, Japan International Cooperation Agency
Fisheries Development Planner	Mr. Yasuo ISHIMOTO	Overseas Agro-Fisheries Consultants, Co., Ltd.
Facilities Designer	Mr. Masato ARAYA	- ditto -
Marine Civil Engineer	Mr. Mamoru NAMIKI	- ditto -

Appendix III

Study Schedule

1. Basic Design Study

Date	Location	Survey Contents
10/18 (Sun)	Tokyo - Guam	Departure from Narita (NH001). Arrival in Guam.
10/19 (Mon)	Guam	Courtesy call to the Japanese Consulate General in Guam. Flight to Palau was cancelled because of the typhoon No. 20.
10/20 (Tue)	Guam - Koror	Departure from Guam (CO1819). Arrival in Palau.
10/21 (Wed)	Koror	Meeting with the Minister of State and the State Governors at the Ministry of State (MS).
		Meeting with the Division of Marine Resources (DMR), the Ministry of National Resources.
10/22 (Thu)	Koror-Melekeok -Koror	Site survey and preparation for boring in Melekeok.
10/23 (Fri)	Koror-Ngerchelong-Ngatpang-Koror	Site surveys in Ngerchelong and Ngatpang.
10/24 (Sat)	Koror-Angaur -Koror	Site survey in Angaur.
10/25 (Sun)	Koror	Discussions for the project contents and the draft minutes at MS.
		Aerial survey on the whole Babelthuap Island.
		Signing of the minutes.
10/26 (Mon)	Koror	Survey on fisheries around Rock Island.
10/27 (Tue)	Koror-Ngatpang	Team Leader, Co-Team Leader, and Project Coordinator, depart from Palau.
		Site survey including boring, measuring and sounding in Ngatpang.

Date	Location	Survey Contents
10/28 (Wed)	Ngatpang	- ditto -
10/29 (Thu)	Ngatpang - Ngerchelong	Site survey including boring, measuring and sounding in Ngerchelong.
10/30 (Fri)	Ngerchelong	- ditto -
10/31 (Sat)	Ngerchelong - Melekeok	Site survey including boring, measuring and sounding in Melekeok.
11/1 (Sun)	Melekeok	- ditto -
11/2 (Mon)	Melekeok-Koror	Talks at DMR. Sounding about fisheries.
11/3 (Tue)	Koror	Discussions with the Palau Fishing Authority (PFA). Survey on port facilities in Koror.
11/4 (Wed)	Koror	Investigations of construction firms and materials.
11/5 (Thu)	Koror - Angaur	Site survey including boring, measuring and sounding in Angaur.
11/6 (Fri)	Angaur	- ditto -
11/7 (Sat)	Angaur - Koror	Analysis of survey data and boring test data.
11/8 (Sun)	Koror	- ditto -
11/9 (Mon)	Koror	Final discussions with DMR and PFA.
11/10 (Tue)	Koror - Guam	Departure from Palau. Reporting on the result of the survey to the Japanese Consulate General in Guam.
11/11 (Wed)	Guam - Tokyo	Arrival in Japan (NH012).

2. Draft Report Explanation

Date	Location	Survey Contents
1/17 (Sun)	Tokyo - Guam	Departure from Narita (NH011). Arrival in Guam.
1/18 (Mon)	Guam - Koror	Courtesy call to the Japanese Consulate General in Guam. Departure from Guam (CO958). Arrival in Palau.
1/19 (Tue)	Koror	Explanation of the draft report at MS. Courtesy call to the Minister of National Resources.
1/20 (Wed)	Koror-Angaur -Koror	Site survey in Angaur. Discussions with PFA.
1/21 (Thu)	Koror -Ngerchelong -Ngatpang -Koror	Site survey in Ngerchelong. Discussions with the village people. Site survey in Ngatpang.
1/22 (Fri)	Koror -Melekeok -Koror	Site survey in Melekeok. Discussions with Angaur State.
1/23 (Sat)	Koror	Fishery survey around the Rock Islands.
1/24 (Sun)	Koror	Analysis of survey data.
1/25 (Mon)	Koror - Guam	Investigations of construction situation. Signing of the minutes. Departure from Palau (CO953). Arrival in Guam.
1/26 (Tue)	Guam - Tokyo	Reporting on the result of the discussions to the Japanese Consulate General in Guam. Departure from Guam (NH012). Arrival in Japan (NH012).

Appendix IV

Cooperative Officials in the Study

1. Palauan Officials Concerned

Ministry of State

Mr. John O. Ngiraked	- Minister of State
Mr. Krispin J. Termeteet	- Special Assistant to Minister of State
Mr. Pablo R. Temol	- Special Assistant to Minister of State
Mr. Ray Ulochong	- Palau Representative Office in Japan

Ministry of National Resources

Mr. Wirlhelm Rengiil	- Minister of National Resources
Mr. David K. Idip	- Director, Bureau of Resources and Development
Mr. Toshiro Paulis	- Chief, Division of Marine Resources
Mr. Noah Idechong	- Assistant Fisheries Officer, Division of Marine Resources
Mr. Marcelino Melaire	- Director, Bureau of Public Works

Palau Fishing Authority

Mr. Abby Rdialul	- Chairman
Mrs. Nancy Wong	- Treasurer

Angaur State

Mr. Augustin	- Governor
Mr. Edward Temengil	- Public Works Planning Officer and National Congressman
Mr. Tomei Oscar	- Chief of the Tribe

Ngerchelong State

Mr. Remokt Tarimel	- Governor
Mr. Tadao Ngotel	- Spokesman
Mr. Koichi West	- Treasurer
Mr. Ewatel Ngirchongewikel	- National Congressman
Mr. Shiro Bedul	- Chief in Ollei

Ngatpang State

Mr. Ngiratkel Etpison	- Governor
Mr. Surangel Whipps	- National Congressman
Mr. Techitong Rebluud Ridep	- Chief of the Tribe
Mr. Rebelkuol Ngitong Ngirgibuuch	- Chief of the Tribe
Mr. Hadrainglai Kengichi Madris	- Chief of the Tribe

Melekeok State

Mr. Tellei	- Governor

2. Japanese Officials Concerned in Guam

Japanese Consulate Genaral in Guam

Mr. Katuo Tosa	- Consul General
Mr. Tetsuyuki Yokoyama	- Consul
Mr. Hideo Aihara	- Vice-consul

Appendix V

Reference

V — 1

Resident Population of the Republic of Palau by Sex, 1920, 1925, 1930, 1935 and 1954-1980

YEAR		MALES	FEMALES	TOTAL
1920	Micro	3,143	2,611	5,754
	Other	571	36	607
	Total	3,714	2,647	6,361
1925	Micro	3,315	2,642	5,957
	Other	727	346	1,073
	Total	4,042	2,988	7,030
1930	Micro	3,305	2,704	6,009
	Other	1,279	813	2,092
	Total	4,584	3,517	8,101
1935	Micro	3,390	2,840	6,230
	Other	4,337	2,231	6,568
	Total	7,727	5,071	12,798
1954		3,893	3,833	7,726
1955		3,845	3,811	7,656
1956		4,050	3,949	7,999
1957		4,373	4,190	8,563
1958		4,502	4,382	8,884
1959		4,604	4,468	9,072
1960		4,703	4,617	9,320
1961		4,865	4,809	9,674
1962		5,010	4,955	9,965
1963		5,221	5,059	10,280
1964		5,323	5,305	10,628
1965		5,543	5,289	10,832
1966		5,757	5,468	11,225
1967		5,853	5,512	11,365
1968	r	5,987	5,564	11,551
1969	r	6,132	5,647	11,779
1970	r	6,270	5,745	12,015
1971	r	6,402	5,850	12,252
1972	r	6,518	5,955	12,473
1973		6,618	6,055	12,673
1974	r	6,693	6,138	12,831
1975	r	6,734	6,196	12,930
1976	r	6,740	6,222	12,962
1977		6,703	6,208	12,911
1978	r	6,618	6,144	12,762
1979	r	6,478	6,023	12,501
1980		6,279	5,837	12,116

r=revised

Source: Data for the years 1920 to 1967 from Quarterly Bulletin of Statistics, Vol. III, No. 2; Office of Planning & Statistics, TTPI/Saipan; Data for the years between 1967 and 1980 is interpolated using the 1967, 1973, 1977 and 1980 census results.

V — 2

State Distribution of Population and Population Density, 1958, 1967, 1977 and 1986.

State	1958	1967	1977	1986	Percent Change 1957-1986	Pop. Density (Pop./sq.mi.) 1958	1986
Aimeliik	412	364	295	282	-31.6	20.8	14.2
Airai	442	538	616	1021	131.0	25.3	58.3
Melekeok	310	356	240	255	-17.7	29.0	23.8
Ngaraard	773	770	576	471	-39.1	55.6	33.9
Ngarchelong	558	615	434	272	-51.3	136.1	66.3
Ngardmau	201	227	171	155	-22.9	11.2	8.7
Ngaremlengui	316	436	320	299	-5.4	12.6	12.0
Ngatpang	88	119	267	219	148.9	5.0	12.4
Ngchesar	450	449	302	271	-39.8	27.4	16.5
Ngiwal	366	381	257	218	-40.4	35.5	21.2
Babelthaup Pop.	3916	4255	3478	3463	-11.6	25.6	22.6
Koror	3585	5667	8298	9419	162.7	504.9	1326.6
Peleliu	679	682	637	545	-19.7	144.5	116.0
Angaur	428	429	258	221	-48.4	129.7	67.0
Kayangel	181	199	136	113	-37.6	258.6	161.4
Hatohobei	108	72	66	n.a.	n.a.	180.0	n.a.
Sonsorol	90	61	38	n.a.	n.a.	100.0	n.a.
Rock Islands	-	-	-	11	-	-	-
Total Population	8987	11365	12911	13772	53.2	52.7	80.8

Source: Abstract of Statistics - 1984, Office of Planning and Statistics, Government of Palau.

Note: 1986 population is based on a preliminary count of the census undertaken in March 1986 by the Government's Office of Planning and Statistics, and it excludes Sonsorol and Hatohobei because their population had not been enumerated.

V — 3

Gross Domestic Product, 1983 (In current prices by kind of economic activity/sectoral origin)

Sector	GDP ($'000)	Percentage Share
Agriculture and Fishery	5299	16.8
Agriculture	3080	9.8
Fishery	2219	7.0
Industry	4099	13.0
Manufacturing	117	0.4
Construction	3982	12.6
Infrastructure	1898	6.0
Electricity	594	1.9
Transport	402	1.3
Communications	327	1.0
Ownership of Dwellings	575	1.8
Services	20250	64.1
Trade	5247	16.6
Hotel and Restaurant	539	1.7
Finance & Insurance	549	1.7
Real estate & Business Services	260	0.8
Government Administration	11651	36.9
Other Services	2004	6.4
GDP at factor Cost	31546	99.9
Indirect Taxes	2702	8.6
Less Subsidies	-2668	- 8.5
GDP at Market Prices	31580	100

Population (Mid 1983) (Number) : 13,46
Per capita GDP at current prices: 2345

Source: Abstract of Statistics, 1984; Office of Planning and Statistics, Government of Palau.

V — 4

Value to Non-Market Production, 1983 (in current market prices)

Activity	$'000	Percent
Agriculture	2960	50.9
Fishery	2120	36.5
Construction Labor & Boat Building	157	2.7
Imputed Rental Value of Owner Occupied Dwellings	575	9.9
TOTAL NON-MARKET PRODUCTION:	5818	100

Source: Abstract of Statistics, 1984; Office of Planning and Statistics, Government of Palau.

V — 5

Private Sector Commercial Commodity Exports & Imports (in Current Value), 1979 - 1984 ($'000)

Commodity Exports & Imports	1979 Value	1979 Per Cent	1983 Value	1983 Per Cent	1984 Value	1984 Per Cent
EXPORTS						
Fish (fresh and frozen)	-	-	97.0	31.0	125.0	26.9
Fish (Smoked)	-	-	-	-	22.0	4.7
Copra	-	-	6.0	1.9	-	-
Trochus Shell	-	-	64.5	20.9	173.0	37.3
Scrap Metal	-	-	40.5	13.2	6.0	1.3
Wooden Handicraft	-	-	100.0	32.5	138.5	29.8
TOTAL EXPORTS	-	-	308.0	100	464.0	100
IMPORTS (FOB)						
Food	2947.1	35.2	3382.3	25.0	4280.8	18.6
Beverage & Tobacco	1347.0	16.4	2065.0	15.2	2105.5	9.2
Crude Materials (inedible)	16.6	0.2	402.3	3.0	585.6	2.5
Mineral Fuel, Lubricant	15.7	0.2	2143.0	15.8	2143.0	9.3
Animal & Vegetable Oils, Fats	36.0	0.4	66.1	0.5	97.1	0.4
Chemicals & Related Goods	529.1	6.3	716.1	5.3	762.5	3.3
Manufactured Goods Classified by Materials	1163.3	13.9	1744.3	12.8	6071.0	26.4
Machinery & Transport Equipment	1434.5	17.2	2053.8	15.2	5238.6	22.8
Misc. Manuf. Goods	848.0	10.1	978.6	7.2	1605.9	7.0
Unspecified	-	-	-	-	135.8	0.5
TOTAL IMPORTS(FOB)	8364.2	100	13551.5	100	23025.8	100
TOTAL IMPORTS (CIF)	9219.4		15313.2		26019.2	

Source: Abstract of Statistics, 1984; Office of Planning and Statistics (OPS), Government of Palau, and other detailed import data collected by OPS.

Note: (i) 1984 import data for petroleum, oil & lubricants (POL) are not available, but it is likely that import value in 1984 was not lower than in 1983, hence the 1983 figure may be assumed for 1984 import of POL. (ii) CIF import value for 1983 has been calculated on the basis of 1984 CIF/FOB ratio in which year CIF import value represented 113% of FOB import value.

Quantity and Value of Exports by SITC Item and Destination for 1983 and 1984

SITC Rev. (2)	1983 Description	Destination										Total	
		Guam		Saipan		Japan		U.S.		Other			
		Qty.*	Value ($)	Qty.*	Value ($)	Qty.*	Value ($)	Qty.*	Value ($)	Qty.*	Value ($)	Qty*	Value ($)
034	Fish, Fresh, Chilled or Frozen	32.6	59,000	17.6	32,000	-	-	-	-	3.3	6,000	53.5	97,000
081.37	Copra	-	-	-	-	39.4	6,000	-	-	-	-	39.4	6,000
288.23	Scrap Metal	-	-	-	-	..	40,000	-	-	-	-	..	40,000
291.15	Trochus Shell	-	-	-	-	60.1	65,000	-	-	-	-	60.1	65,000
635.40	Wooden Handicraft	-	-	-	-	..	57,900	..	25,800	..	16,300	..	100,000
	Total (Value)	n/a	59,000	n/a	32,000	n/a	168,900	n/a	25,800	n/a	22,300	n/a	308,000
	1984												
034	Fish, Fresh, Chilled or Frozen	41.5	75,000	24.1	44,000	-	-	-	-	3.0	6,000	68.6	125,000
035.04	Fish, Smoked	-	-	-	-	11.2	22,000	-	-	-	-	11.2	22,000
288.23	Scrap Metal	-	-	-	-	..	6,000	-	-	-	-	..	6,000
291.15	Trochus Shell	-	-	-	-	119.2	173,000	-	-	-	-	119.2	173,000
635.40	Wooden Handicraft	-	-	-	-	..	72,000	..	37,000	..	29,000	..	138,000
	Total (Value)	n/a	75,000	n/a	44,000	n/a	273,000	n/a	37,000	n/a	35,000	n/a	464,000

* Quantity - Short Ton

Source: Outbound Cargo Manifest provided by Airlines & Shipping Line; Palau

Import Quantities of Selected Fresh/Prepared Agricultural Products
1975-1984
(short tons)

Items	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Beef, Frozen	19.5	36.3	16.8	28.9	21.3	37.2	52.9	48.1	62.8	53.1
Pork, Frozen	16.7	21.8	19.9	30.4	34.6	31.2	42.0	38.2	32.0	43.0
Chicken, Frozen	71.4	116.6	80.1	82.4	119.9	119.2	119.4	240.9	241.3	196.1
Fish, Frozen	-	5.4	1.8	0.8	0.4	-	1.0	6.8	3.6	5.0
Eggs (Dozen '000)	27.8	117.6	55.1	29.1	39.8	85.4	117.3	247.0	115.7	116.8
Beef/Pork, Canned	184.3	139.4	73.1	81.9	150.0	115.9	149.5	83.1	151.6	158.0
Fish, Canned	99.4	88.3	152.2	59.3	107.9	128.8	63.9	119.7	76.9	108.3
Chicken, Canned	118.7	32.3	23.6	30.5	18.2	37.7	94.7	80.0	38.9	46.9
Vegetables, Frozen	51.8	138.7	78.5	47.2	57.2	73.0	127.2	107.9	54.4	140.2
Fruits, Frozen	20.2	38.3	63.4	64.2	66.1	80.2	105.3	103.8	44.3	98.2
Vegetable, Canned	11.1	54.0	15.4	1.0	26.6	34.4	34.4	23.8	11.6	23.6
Fruits, Canned	43.7	45.7	36.5	0.3	64.2	30.0	66.9	50.0	25.8	33.4
Rice	838.2	589.3	267.9	513.6	768.0	921.5	879.2	820.0	1,209.9	747.0
Potatoes	7.4	12.2	28.6	10.1	8.2	23.9	15.0	4.5	57.1	11.3
Flour	128.4	143.2	174.6	202.1	158.5	209.2	179.5	215.6	178.9	178.2
Biscuit/Cookies	108.7	85.4	459.5	21.6	33.0	61.5	28.9	46.2	72.6	34.1

Note: Unit is gross weight as indicated on Bill of Lading (B/L)

Source: Division of Agriculture; Palau

V — 8

National Government Merchandise Imports, 1984 ($'000)

Items	FOB Value	FOB Per Cent	CIF Value	CIF Per Cent
Food	0.4	-	0.5	-
Crude Materials (inedible)	35.6	1.2	43.8	1.3
Petroleum Fuel & Lubricant	1896.3	62.6	2142.8	63.5
Animal & Vegetables, Chemicals & Related Products	208.9	6.9	224.5	6.7
Manufactured Goods Classified by Material	249.7	8.2	282.1	8.4
Machinery & Transport Equipment	477.0	15.8	508.7	15.0
Miscellaneous Manufactured Articles	160.8	5.3	172.9	5.1
Total Government Imports	3028.7	100	3375.3	100

Source: Abstract of Statistics, 1984, Office of Planning and Statistics, Government of Palau. Data for fuel import obtained from the Bureau of Public Works, Government of Palau.

Palau Federation of Fishing Associations: Fishing Purchases By Taxonomic Group
1976 - 1981

Species	1976		1977		1978		1979		1980		1981	
	Lbs.	$	Lbs.	$	Lbs.	$	Lbs.	$	Lbs.	$	Lbs.	$
Snapper	43,332	13,813	23,504	7,749	8,002	2,624	56,477	22,057	113,886	55,565	42,138	22,692
Parrot Fish	25,095	8,901	25,667	9,508	12,070	4,628	54,117	22,762	68,620	37,246	46,510	27,926
Rabbit Fish	25,371	8,867	19,062	7,341	26,207	11,094	36,513	17,705	46,261	28,209	17,069	10,914
Unicorn Fish	18,204	6,165	19,260	7,477	16,251	7,167	24,345	12,650	72,223	46,193	31,980	20,616
Grouper	3,397	1,026	20,152	5,069	15,319	3,872	28,335	8,441	27,796	9,155	21,102	8,520
Mullet	7,122	2,648	4,433	1,663	1,757	874	5,833	3,285	6,944	4,605	4,349	3,027
Jack	6,619	1,677	2,815	926	2,146	688	11,166	3,525	9,944	3,982	3,502	1,514
Surgeon Fish	743	247	436	153	1,141	351	7,826	2,845	7,434	4,047	2,413	1,441
Goat Fish	2,225	680	1,631	551	943	330	2,441	1,111	5,109	2,860	2,667	1,571
Wrasse	1,255	414	918	334	957	335	3,836	1,659	3,366	1,834	2,578	1,545
Silver Fish	4,430	1,543	1,935	666	208	73	2,673	870	1,790	701	976	450
Squirrel Fish	40	12	257	90	20	7	584	257	287	164	3,470	2,082
Sweet Lips	-	-	95	14	335	111	973	278	1,511	469	390	150
Other Reef Fish	4,114	1,280	1,906	835	2,373	916	5,914	2,279	11,451	6,003	1,370	779
Assorted Reef Fish*	61,174	20,035	135,498	44,442	47,828	16,740	23,752	8,421	1,133	446	-	-
Pelagic Fish	19,381	4,311	56,059	8,175	159,324	26,232	201,118	38,160	68,985	18,440	28,233	10,489
Invertebrates	3,150	2,818	3,529	3,874	2,324	2,333	9,288	3,395	6,202	5,680	8,695	3,016
Reptiles	-	-	-	-	995	303	1,135	99	5	1	-	-
Total	225,646	74,437	317,157	98,867	298,200	78,678	476,326	149,799	452,947	225,600	217,442	116,669

* Classification by species improved during the period resulting in a declining part of the Assorted reef fish group.

Source: The Palau Reef Fish Production Study; Division of Marine Resources, Palau, November 1983.

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Palau Fishing Authority:
Fish Purchases By Taxonomic Group
April-December 1983 and 1984

Species	1983				1984			
	Quantity		Value		Quantity		Value	
	Pounds	%	Dollar	%	Pounds	%	Dollar	%
Snapper	98,923	22.9	59,583	30.0	100,540	17.5	64,051	23.6
Parrot Fish	47,756	11.1	24,533	12.4	93,206	16.3	44,968	16.5
Surgeon Fish	5,834	1.4	2,612	1.3	4,023	0.7	1,954	0.7
Rabbit Fish	15,896	3.7	9,830	5.0	36,913	6.4	31,895	11.7
Goat Fish	2,444	0.6	1,456	0.7	4,353	0.8	3,523	1.3
Grouper Fish	34,083	7.9	13,742	6.9	42,315	7.4	18,625	6.9
Sweet Lips	1,224	0.3	452	0.2	1,546	0.3	469	0.2
Wrasse	4,645	1.1	2,065	1.0	3,712	0.6	2,323	0.9
Squirrel Fish	1,022	0.2	693	0.4	1,761	0.3	839	0.3
Jacks	10,754	2.5	5,423	2.7	21,106	3.7	10,754	4.0
Mullet	1,331	0.3	797	0.4	1,209	0.2	836	0.3
Silver Fish	325	0.1	176	0.1	639	0.1	390	0.1
Unicorn Fish	47,173	10.9	22,577	11.4	30,432	5.3	15,714	5.8
Other Reef Fish	12,428	2.9	5,581	2.8	7,812	1.4	3,535	1.3
Assorted Reef Fish	2,819	0.7	1,409	0.7	47	-	24	-
Pelagic Fish	139,731	32.4	44,130	22.2	218,025	38.0	63,987	23.5
Invertebrates	3,587	0.8	2,997	1.5	5,977	1.0	7,965	2.9
Reptiles	890	0.2	661	0.3	-	-	-	-
Total	430,865	100.0	198,716	100.0	573,616	100.0	271,852	100.0

Source: Division of Marine Resources

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Fish marketing of PFFA in 1986, 1987

(lbs.)

Month	Fish Purchase	Domestic Sales	Export	Stock
1986				
Jan.	30,822	18,598	5,084	7,140
Feb.	45,915	25,196	11,046	9,673
Mar.	61,811	27,091	18,477	16,243
Apr.	91,716.5	26,092	15,974	49,650.5
May	96,335	29,581	19,465	47,289
Jun.	64,763	30,374	11,916	22,473
Jul.	56,915	35,001	6,317.5	15,596.5
Aug.	32,142.5	37,034	3,793	-8,684.5
Sep.	15,546	25,681	6,024	-16,159
Oct.	49,538	28,305	7,862	13,371
Nov.	52,805	27,101	9,979	15,725
Dec.	51,918	32,881	4,812	14,225
(Subtotal in 1986)	(650,227)	(342,935)	(120,749.5)	(186,542.5)
1987				
Jan	17,587	25,598	7,817	-15,828
Feb.	62,322.5	31,393	16,000	14,929.5
Mar.	62,222.5	35,416	10,020	16,786.5
Apr.	91,062.5	26,017	11,008	54,037.5
May	53,275,5	24,335	3,346	25,594.5
Jun.	47,582	23,785	353	23,444
Jul.	40,345	25,322		

Quantity of domestic sales is estimated by dividing monthly total sales value by average sales price.

Source: PFFA, PFA

Fisherman's Buying Price List
(Cents per lb.)

Fish (Species)	1983				1984			
	Feb	May	Aug	Nov	Feb	May	Aug	Nov
Erangel (Unicorn Fish)	60	60	70	60	50	60	70	80
Um (Unicorn Fish)	55	45	45	30	35	40	60	70
Ersuuch (Dolphin)	30	30	-	-	-	-	-	-
Kelsebuul (Rabbit Fish)	60	60	70	60	75	100	100	100
Meyas (Rabbit Fish)	50	50	60	60	60	60	70	80
Kemedukl (Parrot Fish)	50	30	50	40	60	50	50	60
Mellemau (Parrot Fish)	50	30	30	20	50	20	40	60
Ngyaoch (Parrot Fish)	60	60	70	60	60	50	60	70
Kedesau (Snapper)	50	45	45	35	35	40	40	45
Keremlal (Snapper)	55	60	70	50	50	40	60	70
Mechur (Snapper)	60	60	70	60	60	60	60	70
Melangmud (Snapper)	60	60	70	60	60	60	60	70
Metengui (Snapper)	60	80	150	100	50	60	50	70
Sebus (Snapper)	60	80	150	100	100	125	125	125
Udech (Snapper)	50	50	60	50	50	60	70	80
Temekai (Grouper)	50	45	45	35	35	40	40	50
Tiáu (Grouper)	50	45	60	50	50	50	50	60
Maml (Wrasse)	60	50	60	50	50	60	70	80
Orewidel (Jack)	50	50	60	50	50	50	50	60
Katsuo - Grade I (Pelagic Fish)	35	32	42	25	25	20	20	20
Tekuu (over 7 lbs. - Pelagic Fish)	60	60	70	50	50	40	40	55

Source: Monthly Price-list, Palau Fishing Authority.

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Price groups for purchase and sales of PFFA

	(English name);	(Local name)
Group A	Rabbit Fish;	Meyas, Kelsebuul, Bebael, Beduut
	Parrot Fish;	Mellemau (large), Ngyaoch, Otord, Ngesngis
	Snapper;	Metengui, Sebus Udech
	Dolphins;	Ersuuch
	Jacks,	Orwidel, Wii
	Goat fish;	Bang, Dech
	Mullets	Kelat, Uluu
Group B		
	Unicorn fish;	Erangel, Um, Mesekuuk
	Parrot fish;	Kemedukl, Mellemau (small)
	Snapper;	Kedesau, Keremlal, Mechur, Melangmud
	Grouper;	Temekai, Tiau
	Wrasse;	Maml
	Tuna species;	Tekuu (large)
	Jacks;	Terekrick, Desui
	Barracuda;	Meai, Aii
	Mackerel	Ngelngal, Keskas
Group C	Tuna species;	Tekuu (small)
	Skipjack;	Katsuo
	Frigate mackerel;	Soda

Price in September, 1987 Cents/lbs.

	Purchase	Sales
Group A	70	80
Group B	60	80
Group C	35	50

Note: Some valuable fish such as Etelis species is occasionally sold by more than 80 cents/lbs.

Source: PFFA, PFA

Palau Fishing Authority: Quarterly Fish Exports by Taxonomic Group

Fish	1983		1984									
	2nd-4rd Quarter		1st Quarter		2nd Quarter		3rd Quarter		4rd Quarter		Total	
	Qty. (lbs.)	Value ($)	Qty. (lbs.)	Value ($)	Qty. (lbs.)	Value ($)	Qty. (lbs.)	Value ($)	Qty. (lbs.)	Value ($)	Qty. (lbs.)	Value ($)
Invertebrates	384	651	932	717	564	1,268	484	1,251	146	430	2,126	3,666
Snapper	24,848	25,796	11,138	10,565	14,396	13,019	11,988	10,930	6,708	6,010	44,230	40,524
Parrot Fish	3,779	2,645	5,556	3,760	5,103	3,753	3,867	3,124	2,848	2,404	17,374	13,041
Surgeon Fish	466	317	867	686	1,076	504	1,024	468	181	138	3,148	1,796
Rabbit Fish	3,971	3,423	4,345	4,756	6,915	6,982	5,958	6,404	3,343	3,665	20,561	21,807
Goat Fish	765	589	1,376	1,574	1,621	1,404	1,193	1,022	640	565	4,830	4,565
Grouper	5,169	3,106	2,349	1,442	2,254	1,545	1,854	1,393	1,247	925	7,704	5,305
Wrasse	95	48	23	14	-	-	-	-	-	-	23	14
Squirrel Fish	376	369	228	222	269	125	-	-	-	-	497	347
Jack	841	625	739	547	2,105	1,650	1,928	1,567	837	657	5,609	4,421
Mullet	166	116	341	285	110	94	145	123	145	123	741	629
Silver Fish	285	176	82	57	251	191	166	131	166	131	665	510
Unicorn Fish	6,892	4,363	3,960	2,249	7,818	5,340	5,508	4,135	2,326	1,864	19,612	13,588
Other Reef Fish	3,990	3,195	1,344	1,059	887	713	776	660	678	577	3,685	3,009
Asst. Reef Fish	509	418	791	475	-	-	-	-	-	-	791	475
Pelagic Fish	1,036	904	5,170	2,847	3,497	1,715	3,106	1,608	321	255	12,094	6,425
Prepared Fish	4,312	5,972	5,481	8,550	11,410	15,481	2,169	3,265	801	1,329	19,861	28,625
Total	57,884	52,713	44,722	39,805	58,276	53,784	40,166	36,081	20,387	19,073	163,551	148,743

Source: Palau Fishing Authority

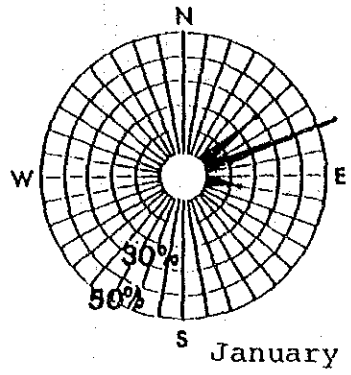
Quantity of Fish Export by Month and Destination
1983 - 1984
(short ton) (1)

Month	1983 Destination					1984 Destination				
	Guam	Saipan	Hawaii	Other	Total	Guam	Saipan	Hawaii	Other	Total
January	2.4	1.5	-	0.2	4.1	3.8	3.2	-	0.2	7.2
February	8.1	2.1	-	0.1	10.3	2.8	3.2	0.1	0.5	6.6
March	6.6	1.0	-	0.1	7.7	10.7	7.4	0.5	1.3	19.9
April	5.8	1.3	-	0.5	7.6	10.9	4.3	0.4	0.1	15.7
May	4.2(2)	2.3(2)	-(2)	0.4(2)	6.9(2)	5.3	2.8	-	-	8.1
June	5.0	3.5	-	-	8.5	2.2	2.6	-	0.6	5.4
July	2.5	3.4	-	-	5.9	2.5	1.4	-	0.4	4.3
August	2.8	1.6	-	-	4.4	4.2	2.3	-	0.1	6.6
September	4.4	4.2	1.2	0.1	9.9	5.8	1.2	-	0.7	7.7
October	4.7	2.8	1.6	0.1	9.2	4.6	1.6	-	-	6.2
November	3.4	2.3	1.0	0.1	6.8	1.6	0.9	-	-	2.5
December	7.2	4.9	0.3	0.1	12.5	4.7	0.9	-	-	5.6
Total	57.1	30.9	4.1	1.7	93.8	59.1	31.8	1.0	3.9	95.8

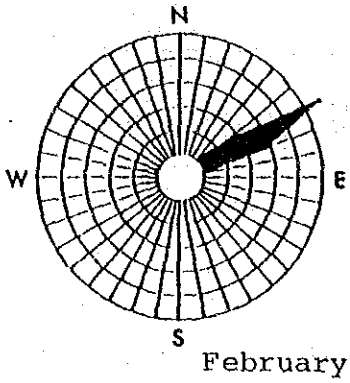
Note: (1) Quantities in gross weight;
(2) Estimates;

Source: Out-bound Cargo Manifest provided by Airlines.

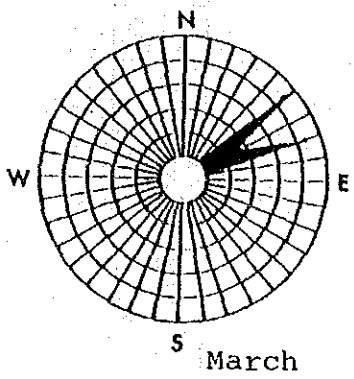
V-15-1 Resultant Wind Direction Frequency Chart (Koror Island)



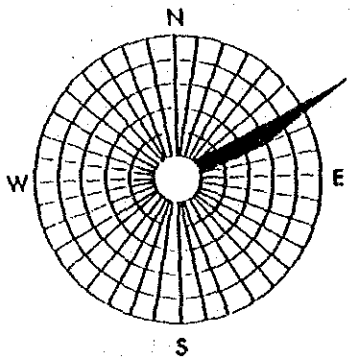
January



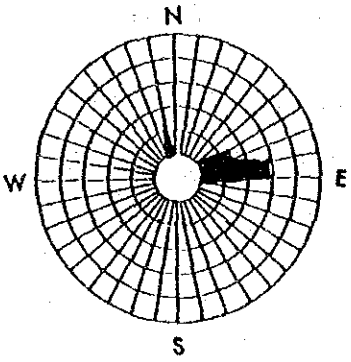
February



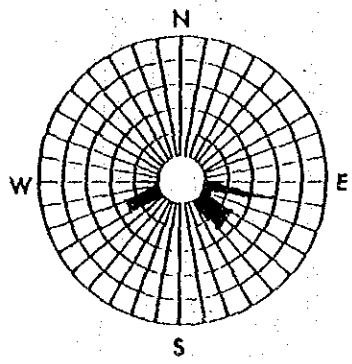
March



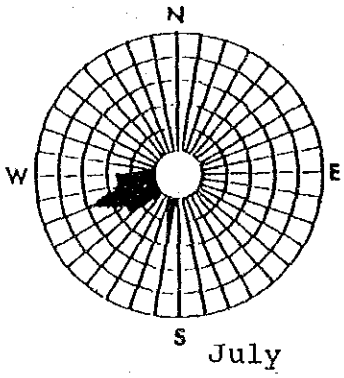
April



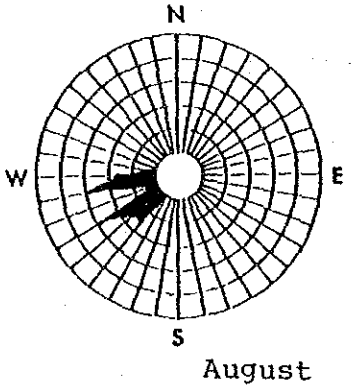
May



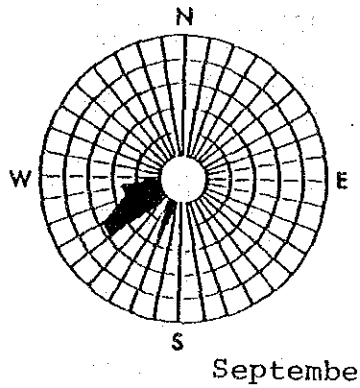
June



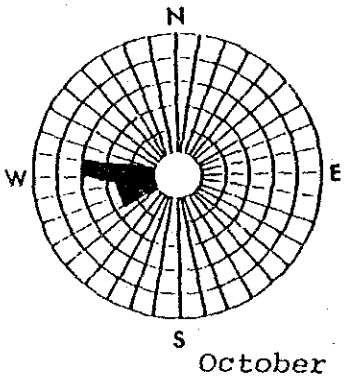
July



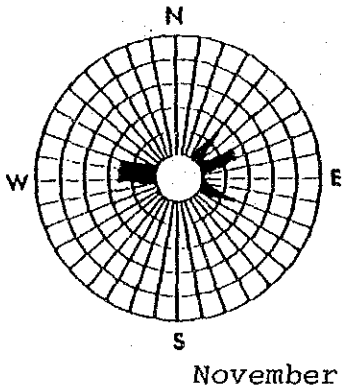
August



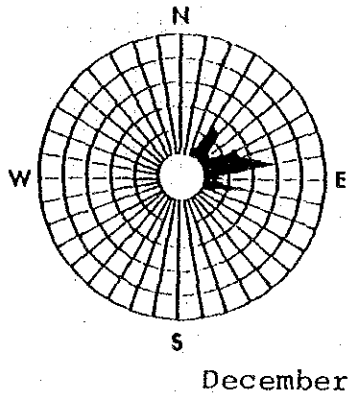
September



October

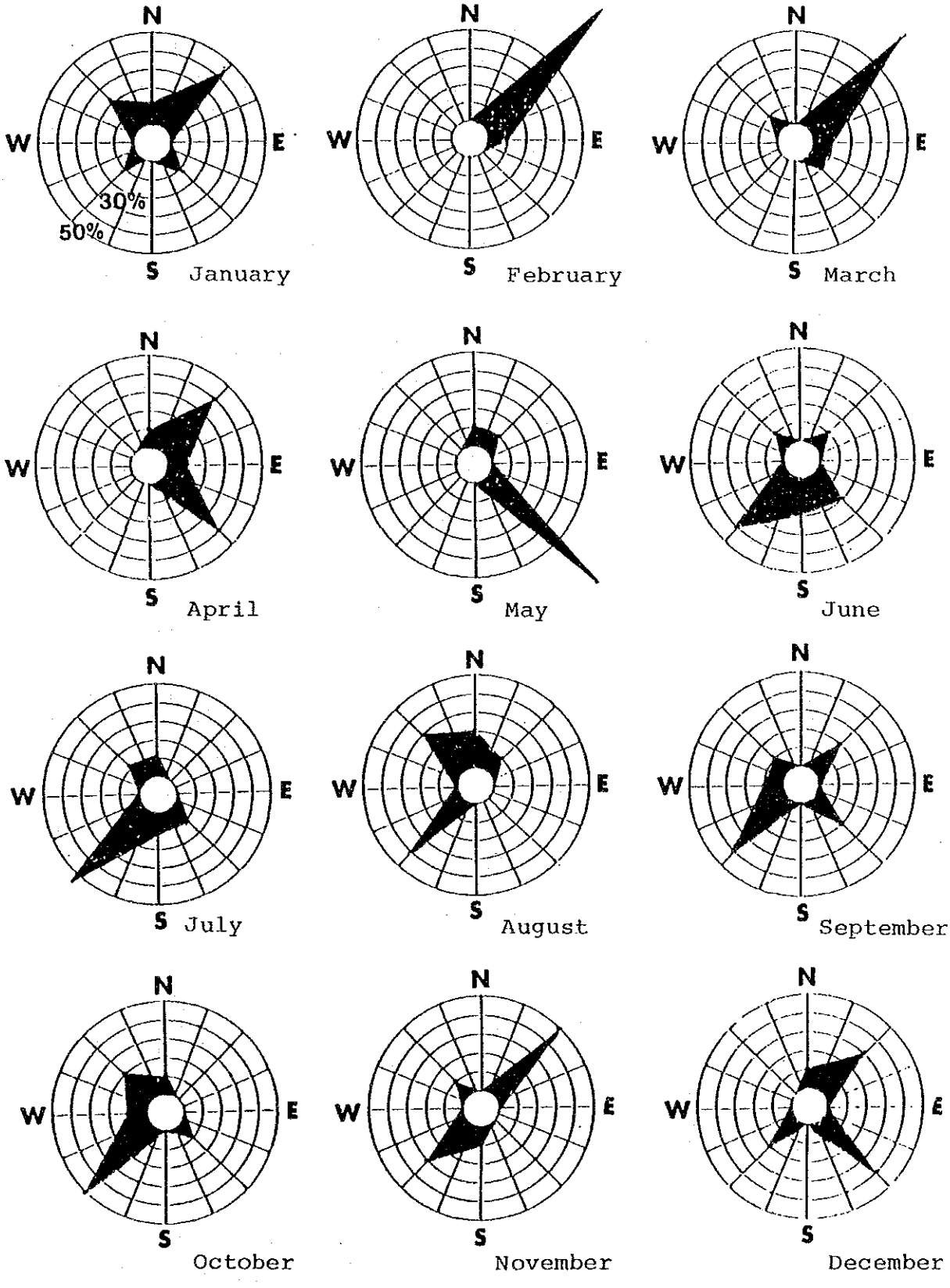


November

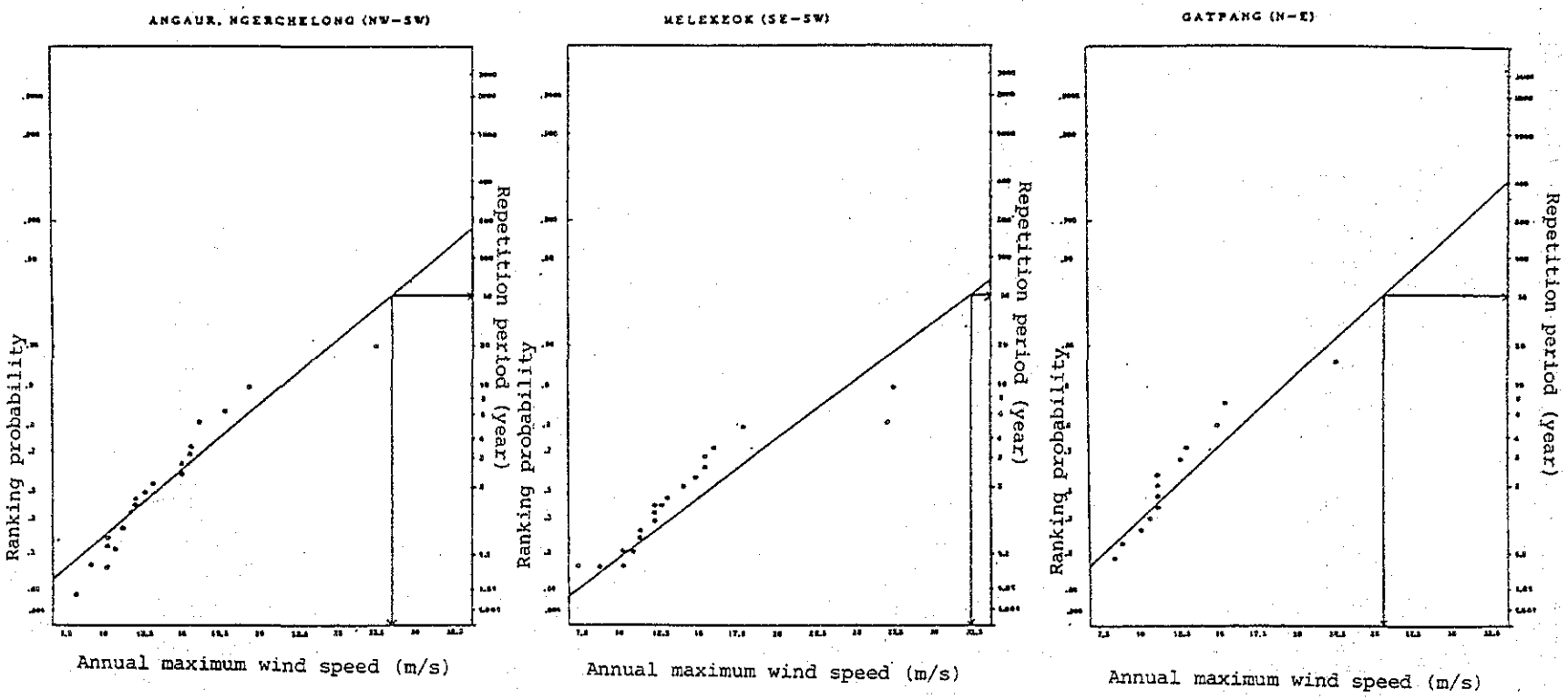


December

V-15-2 Fastest Wind Direction Frequency Chart (Koror Island)

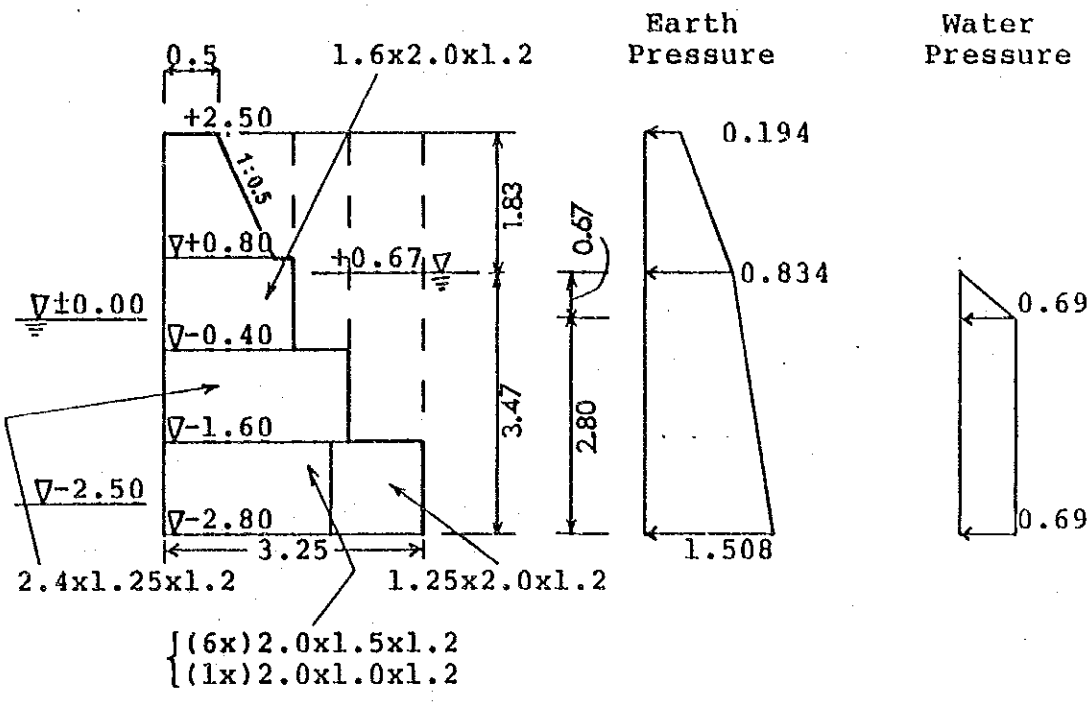


V-16 Expected Value of the Maximum Wind Speed



V-17 STABILITY CALCULATION OF CONCRETE BLOCK WALL

1. Melekeok/Ngatpang Concrete Block Wall



$w=1.0tf/m^2$, $\phi=40°$, $=15°$, $k=0$

$Ka \cdot \cos\delta = 0.194$

$P_{+2.50} = w \cdot Ka \cdot \cos\delta = 0.194\ t/m^2$

$P_{+0.67} = (1.0+1.8x1.83)x0.1942 = 0.834$

$P_{-5.70} = (1.0+1.8x1.83+1.0x3.47)x0.1942 = 1.508$

$Ph_{-0.40} = 1.94\ t/m$

$Ph_{-1.60} = 3.33\ t/m$

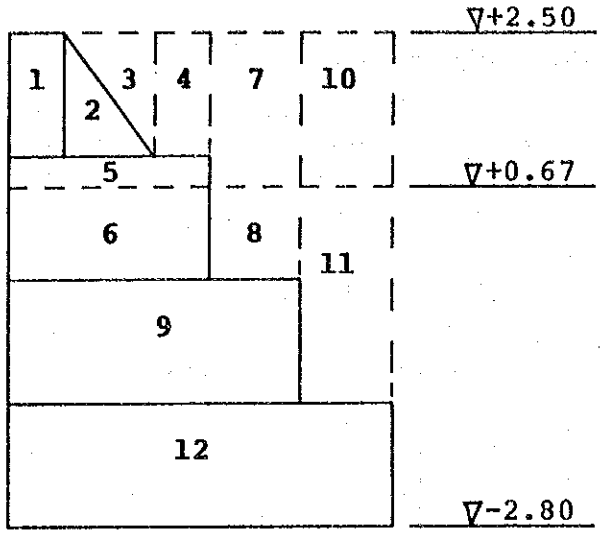
$Ph_{-2.80} = 5.00\ t/m$

$Pv_{-0.40} = 1.94 \tan 15° = 0.52\ t/m$

$Pv_{-1.60} = 3.33 \tan 15° = 0.89\ t/m$

$Pv_{-2.80} = 5.00 \tan 15° = 1.34\ t/m$

Resisting Moment



No.	Weight W (tf)	Gravity Point X (m)	Resisting Moment W X (tf·m)
1	1.96	0.25	0.490
2	1.66	0.78	1.295
3	1.30	1.07	1.391
4	0.77	1.48	1.140
5	0.48	0.80	0.384
6	2.17	0.80	1.736
7	2.64	2.00	5.280
8	0.86	2.00	1.720
9	3.66	1.20	4.392
10	2.80	2.83	7.924
11	1.93	2.83	5.462
12	4.95	1.63	8.069
Total	25.18 tf		39.28 tf·m

Resisting Moment by Earth Pressure

$$M_{RV} = 0.52 \times 1.60 + 0.89 \times 2.40 + 1.34 \times 3.20$$
$$= 7.26 \text{ tf·m}$$

Total resisting moment $M_R = 46.54$ tf·m

Total weight $W = 27.93$ tf

Total overturning moment $Ma = \underset{\text{Earth Pressure}}{10.32} + \underset{\text{Water Pressure}}{3.40} = 13.72$ tf·m

Bearing capacity of foundation

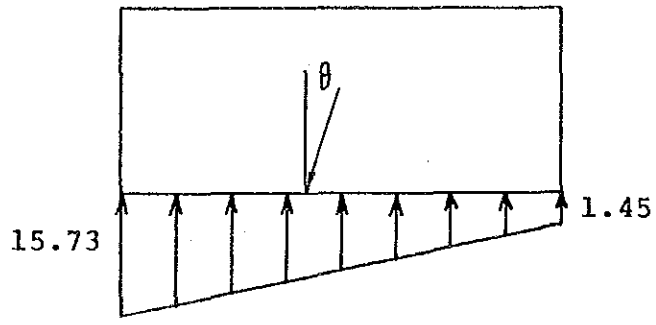
$X = (46.54-13.72)/27.93 = 1.18$ m

$e = B/2 - X = 3.25/2 - 1.18 = 0.45$ m $< B/6$

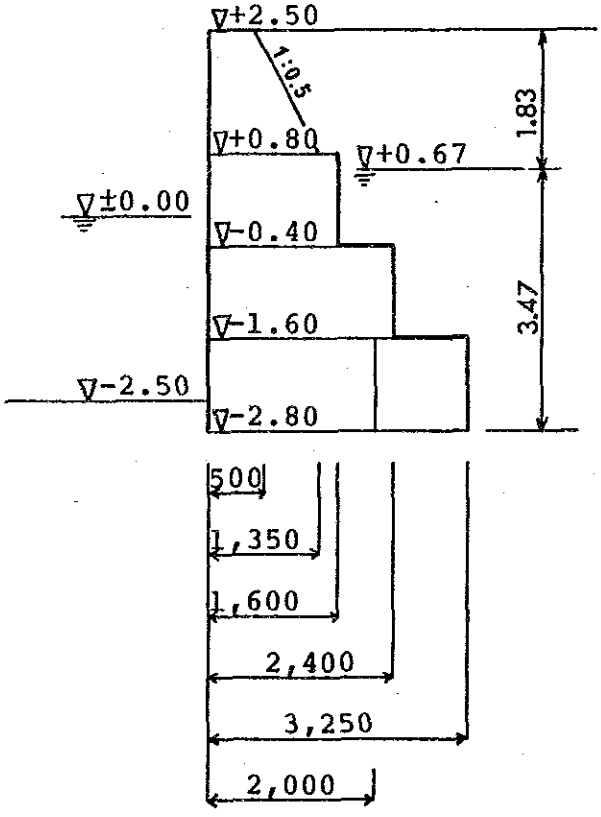
$P_1 = (1 + 6e/B) \times V/A$

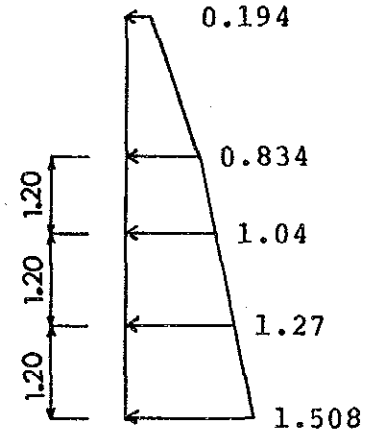
$= (1 + 6 \times 0.45/3.25) \times 27.93/3.25 = 15.73$ tf/m^2

$P_2 = (1 + 6e/B) \times V/A = 1.45$ tf/m^2



$= \tan^{-1} H/V = \tan^{-1} 7.17/27.93 = 14.4°$





$A_1 = 0.941$

$M_1^1 = 3.948$

$A_2^1 = 4.063$

$M_2 = 6.373$

$Mo_1 = 10.32$

$Aw_1 = 0.231$

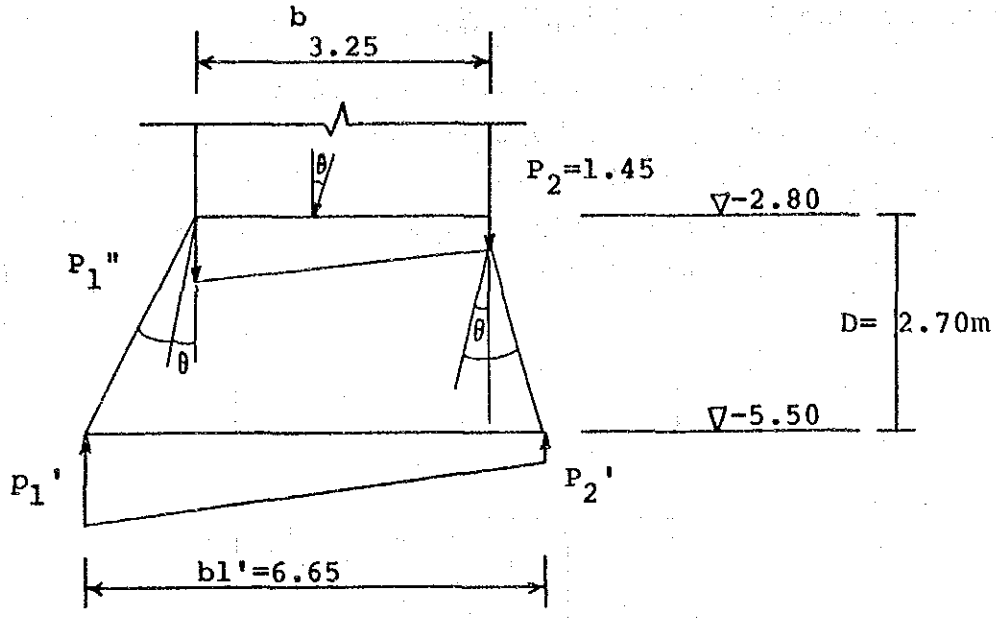
$Mw_1^1 = 0.698$

$Aw_2^1 = 1.932$

$Mw_2 = 2.705$

$Mo_1 = 3.40$

$Mo + Mw = 13.72$



$b_1' = 3.25 + 2.7 \times \{\tan(30+14.4) + \tan(30+14.4)\}$

$= 6.65$ m

$P_1' = P_1 \times b/b_1' + r_2 D$

$= 15.73 \times 3.25/6.65 + 1.0 \times 2.70 = 10.39$ tf/m^2

$P_2 = P_2 \times b/b_1' + r_2 D$

$= 1.45 \times 3.25/6.65 + 2.70 = \quad = 3.41$ tf/m^2

Bottom of foundation

$\phi=25°$, thus, Hr=3.2, Hq=4.7

Therefore,

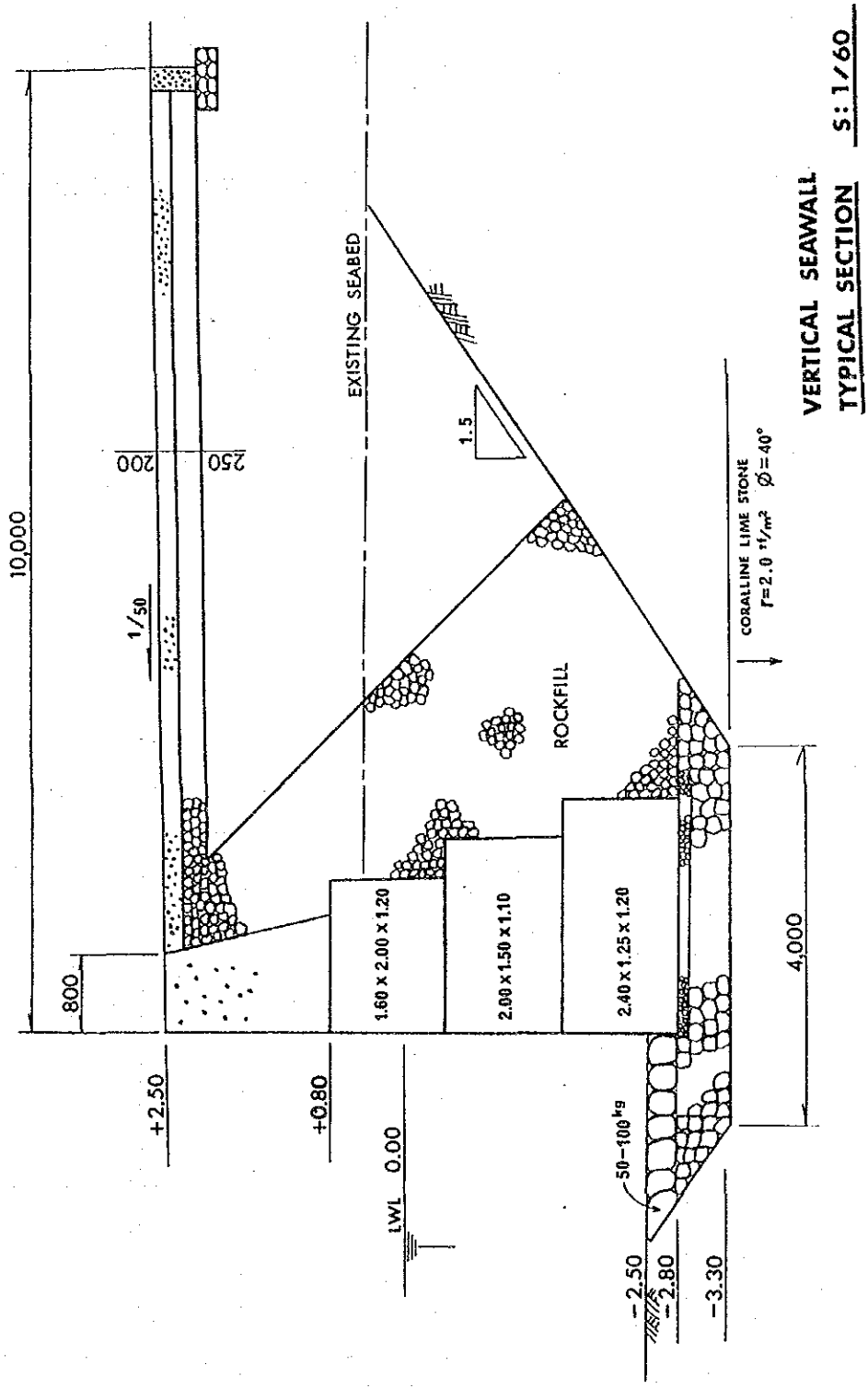
$Qa = 1/F \times (\beta r, BNr + r_2 DNq) + r_2 D$

$= 1/2.5 \times (0.5 \times 1.0 \times 6.65 \times 3.2 + 1.0 \times 2.7 \times 4.7) + 1.0 \times 2.7$

$= 12.0$ tf/m^2 > $P_1' = 10.4$ tf/m^2

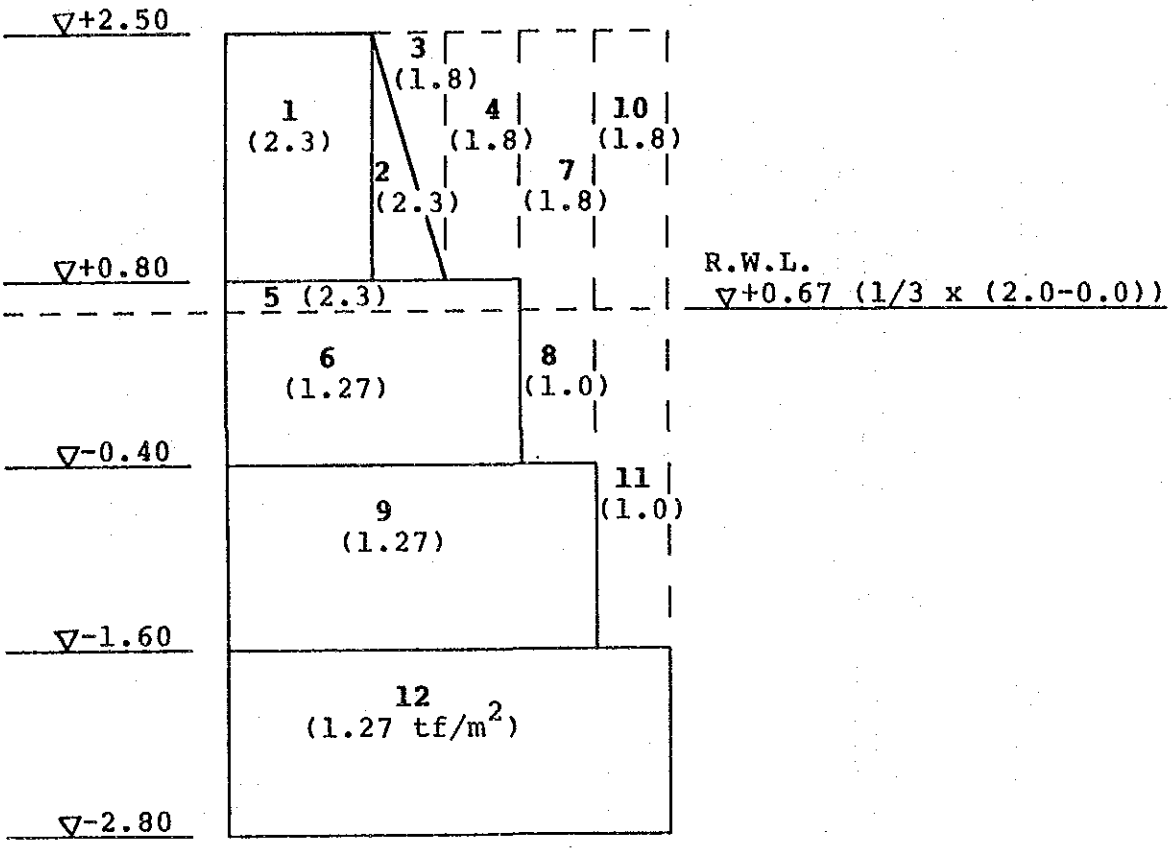
2. Ngerchelong Concrete Block Wall

2-1. Section



2-2. Calculation of Weight and Earth Pressure

(1) Weight



No.	Weight W (tf)		Gravity Point X (m)		Resisting Moment Mr (tf·m)
1	1.70x0.8x2.3	3.13	½x0.8	0.40	1.25
2	½x(1.7x0.4)x2.3	0.78	0.8+1/3x0.4	0.93	0.73
3	½x(1.7x0.4)x1.8	0.61	0.8+2/3x0.4	1.07	0.65
4	1.70x0.4x1.8	1.22	1.2+½x0.4	1.40	1.71
5	0.13x1.6x2.3	0.48	½x1.6	0.80	0.38
6	1.07x1.6x1.27	2.17	½x1.6	0.80	1.74
1-6	(to -0.40m)	8.39			6.46
7	1.83x0.4x1.8	1.32	1.6+½x0.4	1.80	2.38
8	1.07x0.4x1.0	0.43	1.6+½x0.4	1.80	0.77
9	1.20x2.0x1.27	3.05	½x2.0	1.00	3.05
1-9	(to -1.60m)	13.19			12.66
10	1.83x0.4x1.8	1.32	2.0+½x0.4	2.20	2.90
11	2.27x0.4x1.8	1.63	2.0+½x0.4	2.20	3.59
12	1.20x2.4x1.27	3.66	½x2.4	1.20	4.39
1-12	(to -2.80m)	19.80			23.54

(2) Earth Pressure

$Pm = (\Sigma rh + W) \times Kacos\delta$

$W=1.0tf/m^2$, $\phi=40°$, $\delta=15°$, $kh=0$

Therefore, $Kacos\delta = 0.19$

(Calculation point: -0.40m, -1.60m, -2.80m)

$Pa_{+2.50} = 1.0 \times 0.19 = 0.19\ tf/m^2$

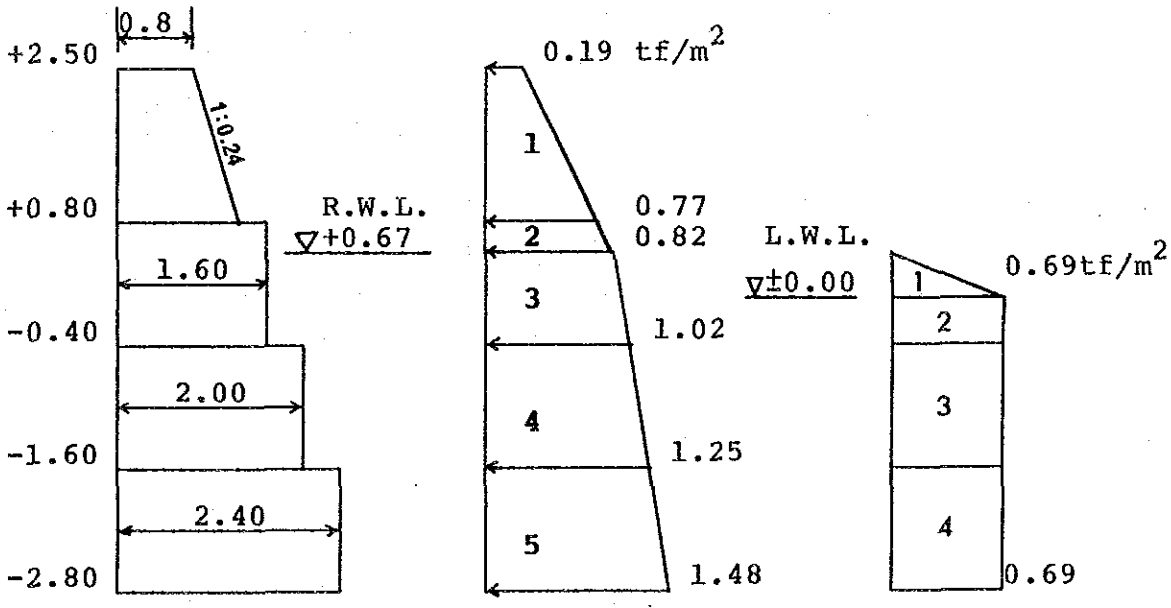
$Pa_{+0.80} = (1.0+1.8x1.7) \times 0.19 = 0.77\ tf/m^2$

$Pa_{+0.67} = (1.0+1.8x1.83) \times 0.19 = 0.82\ tf/m^2$

$Pa_{-0.40} = (1.0+1.8x1.83+1.0x1.07) \times 0.19 = 1.02\ tf/m^2$

$Pa_{-1.60} = (1.0+1.8x1.83+1.0x2.27) \times 0.19 = 1.25\ tf/m^2$

$Pa_{-2.80} = (1.0+1.8x1.83+1.-x3.47) \times 0.19 = 1.48\ tf/m^2$



No.	Ph (tf/m)		Y (m)		Md (PhxY) (tf•m/m)
1	$\frac{(0.19+0.77)}{2}x1.7$	0.82	$3.60+\frac{(2x0.19+0.77)}{(0.19+0.77)}x\frac{1.70}{3}$	4.28	3.51
2	$\frac{(0.77+0.82)}{2}x0.13$	0.10	$3.47+\frac{(2x0.77+0.82)}{(0.77+0.82)}x\frac{0.13}{3}$	3.53	0.35
3	$\frac{(0.82+1.02)}{2}x1.07$	0.82	$2.40+\frac{(2x0.82+1.02)}{(0.82+1.02)}x\frac{1.07}{3}$	2.92	2.86
1-3	(to -0.40m)	1.90			6.72
4	$\frac{(1.02+1.25)}{2}x1.20$	1.36	$1.20+\frac{(2x1.02+1.25)}{(1.02+1.25)}x\frac{1.20}{3}$	1.78	2.42
1-4	(to -1.60m)	3.26			9.14
5	$\frac{(1.25+1.48)}{2}x1.20$	1.64	$\frac{(2x1.25+1.48)}{(1.25+1.48)}x\frac{1.20}{3}$	0.58	0.95
1-5	(to -2.80m)	4.90			10.09

Active moment at -0.40m

$Md_{-0.40}$ = 1.90 x (6.72/1.90 - 2.40) = 2.16 tf·m/m

Active moment at -1.60m

$Md_{-1.60}$ = 3.26 x (9.14/3.26 - 1.20) = 5.23 tf·m/m

(3) Water Pressure

R.W.L. - L.W.L. = 0.67 - 0.00 = 0.67 m

Pw = 0.67 x 1.03 = 0.69 tf/m^2

No.	Pw		Y		Mw
1	0.69x0.67x½	0.23	2.80+2/3x0.67	3.25	0.75
2	0.69x0.40	0.28	2.40+½x0.40	2.60	0.73
1-2	(to -0.40m)	0.51			1.48
3	0.69x1.20	0.83	1.20+½x1.20	1.80	1.49
1-3	(to -1.60m)	1.34			2.97
4	0.69x1.20	0.83	½x1.20	0.60	0.50
1-4	(to -2.80m)	2.17			3.47

Active moment by water pressure at -0.40m

$Mw_{-0.40}$ = 0.51 x (1.48/0.51 - 8.40) = 0.26 tfm/m

Active moment by water pressure at -1.60m

$Mw_{-1.60}$ = 1.34 x (2.97/1,34 - 1.20) = 1.36 tfm/m

(4) Vertical Water Pressure

Pv = Ph·tan δ = 15°

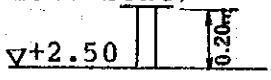
Therefore, tan δ = tan15° = 0.2679

Check point	Vertical Pressure (Pv)		X (m)	Mr=Pv X (tf·m/m)
-0.40m	0.2679x1.90	0.51	1.60	0.82
-1.60m	0.2679x3.26	0.87	2.00	1.74
-2.80m	0.2679x4.90	1.31	2.40	3.14

(5) Anchor Force by boat and this moment

Pk = $1.0^{H} \div \underline{10.0}^{m}$ = 0.1 tf/m (under 10ft boat)

↑ spanot bit



Moment

-0.40 M = 0.1 x (2.5+0.4+0.2) = 0.31 tf m/m

-1.60 M = 0.1 x (2.5+1.6+0.2) = 0.43 "

-2.80 M = 0.1 x (2.5+2.8+0.2) = 0.55 "

(6) Summary of Each Moment

a) Approximate Horizontal Pressure

Check point	Horizontal Pressure (tf/m)				Moment (tf·m/m)			
	E.P.	W.P.	A.P.	Total	E.P.	W.P.	A.P.	Total
-0.40m	1.90	0.51	0.10	2.51	2.16	0.26	0.31	2.73
-1.60m	3.26	1.34	0.10	4.70	5.23	1.36	0.43	7.02
-2.80m	4.90	2.17	0.10	7.17	10.09	3.47	0.55	14.11

E.P.: Earth pressure
W.P.: Water pressure
A.P.: Anchor pressure

b) Approximate Vertical Pressure

Check point	Horizontal Pressure (tf/m)			Moment (tf·m/m)		
	Weight	E.P.	Total	Block W.	E.P.	Total
-0.40m	8.39	0.51	8.90	6.46	0.82	7.28
-1.60m	13.19	0.87	14.06	12.66	1.74	14.40
-2.80m	19.80	1.31	21.11	23.54	3.14	26.68

2-3. Stability Calculation

(1) Sliding of Wall

$F = W\mu/P$

W: Vertical forces acting on the wall
P: Horizontal forces acting on the wall
μ: Coefficient of friction
between conc. and conc. (=0.5)
between conc. and foundation (=0.6)

(2) Overturning of Wall

$F = W \cdot x/P \cdot y$

W·x: Overturing moment
P·y: Resisting moment

Check point	Force type	Force calculation
-0.40	Slide	F = 8.90/2.51x0.5 = 1.8 > 1.2
	Overturn	F = 7.28/2.73 = 2.7 > 1.2
-1.60	Slide	F = 14.06/4.70x0.5 = 1.5 > 1.2
	Overturn	F = 14.40/7.02 = 2.1 > 1.2
-2.80	Slide	F = 21.11/7.17x0.6 = 1.8 > 1.2
	Overturn	F = 26.68/14.11 = 1.9 > 1.2

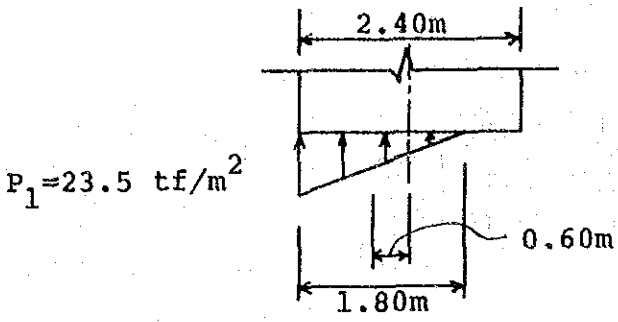
(3) Bearing Capacity of Foundation

$x = (Mr-Mo)/V = (26.68-14.11)/21.11 = 0.60$ m

$e = b/2 - x = 2.4/2 - 0.60 = 0.60$ m $> b/6 = 0.4$ m

$P_1 = 2/3(\frac{1}{2}-e/b) \times V/A = 2/3(\frac{1}{2}-0.6/2.4) \times 21.11/2.4 = 23.5$ tf/m^2

$b' = 3(b/2-e) = 3(2.4/2-0.6) = 1.80$m



$\tan\theta = H/V = 7.17/21.11 = 0.34$

$\varepsilon = 2e/b = 2x0.60/2.40 = 0.50$

$\phi = 40+5 = 45°$

Therefore, N = 14

$Qr = (r'b'N)/2 = (1.0x3.6x14)/2 = 25.2$ tf/m^2

$F = (Qv'B)/V = (25.2x2.4)/21.11 = 2.86 > 1.0$

Bottom of foundation

$\theta = \tan^{-1}(H/V) = \tan^{-1}(7.17/21.11) = 18.8°$

$b_1' = b' + D\{\tan(30+\theta)+\tan(30-\theta)\}$
D: (height of foundation = 0.50m)

Therefore,

$b_1' = 1.80 + 0.5 \times \{\tan(30+18.8)+\tan(30-18.8)\}$
$= 2.47$ m

$P_1' = P_1 \times b'/b_1' + r_2D$
$= 23.5 \times 1.80/2.47 + 1.0 \times 0.50$
$= 17.6$ tf/m^2

$P_2' = r_2D$
$= 1.0 \times 0.5$
$= 0.50$ tf/m^2

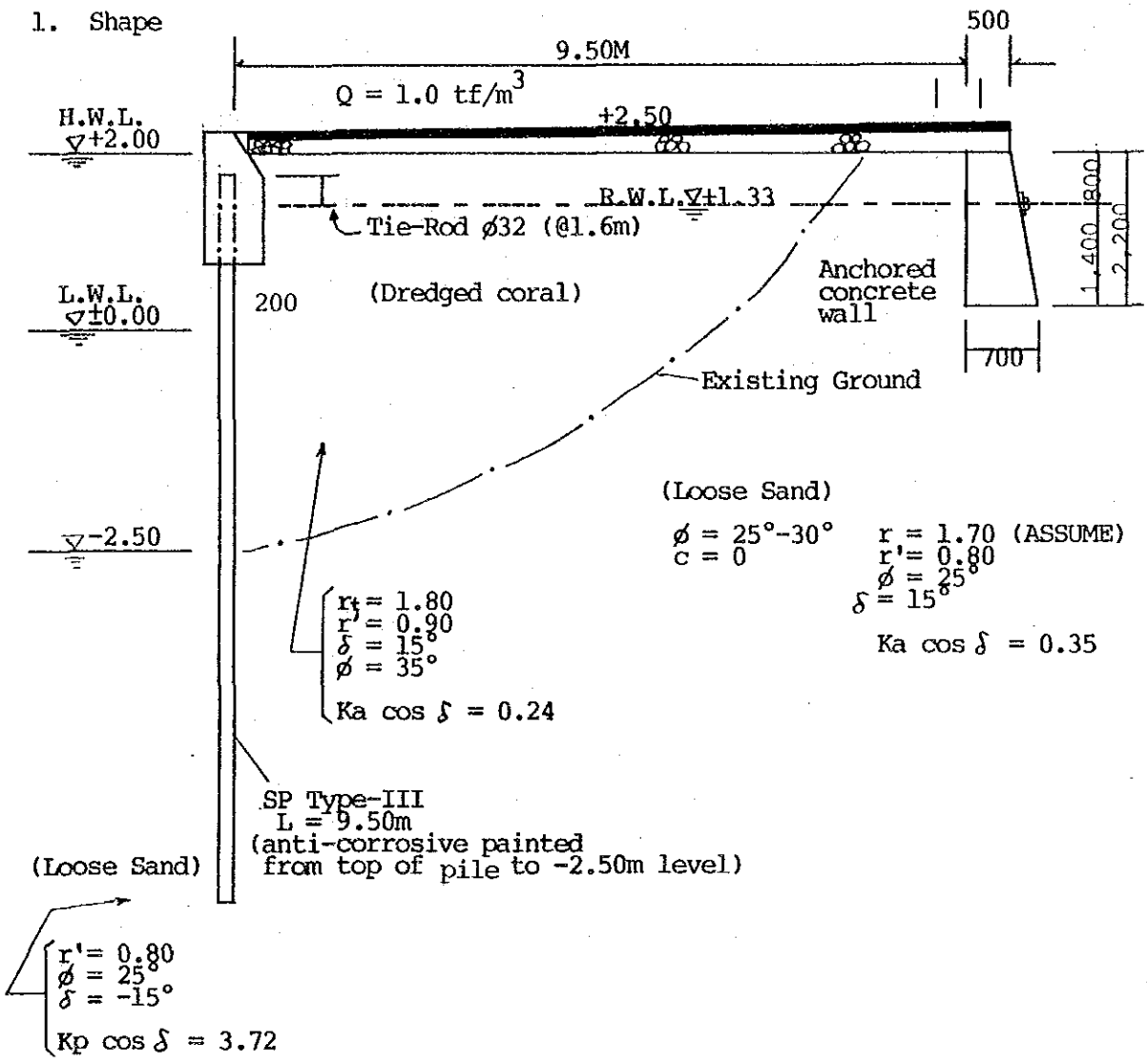
$Qa = 1/F \times (\beta r_1 b_1' Nr + r_2 DNq) + r_2 D'$
$F = 2.5$
$\beta = 0.5$
$r_1 = r_2 = 1.0$ tf/m^3
$D = 0.50$m
$\phi = 40°$ ---- Nr=110, Nq=70

Therefore,

$Qa = 1/2.5 \times (0.5x1.0x2.47x110+1.0x0.5x70) + 1.0 \times 0.5$
$= 68.8$ tf/m^2 > $P_1 = 17.6$ tf/m^2

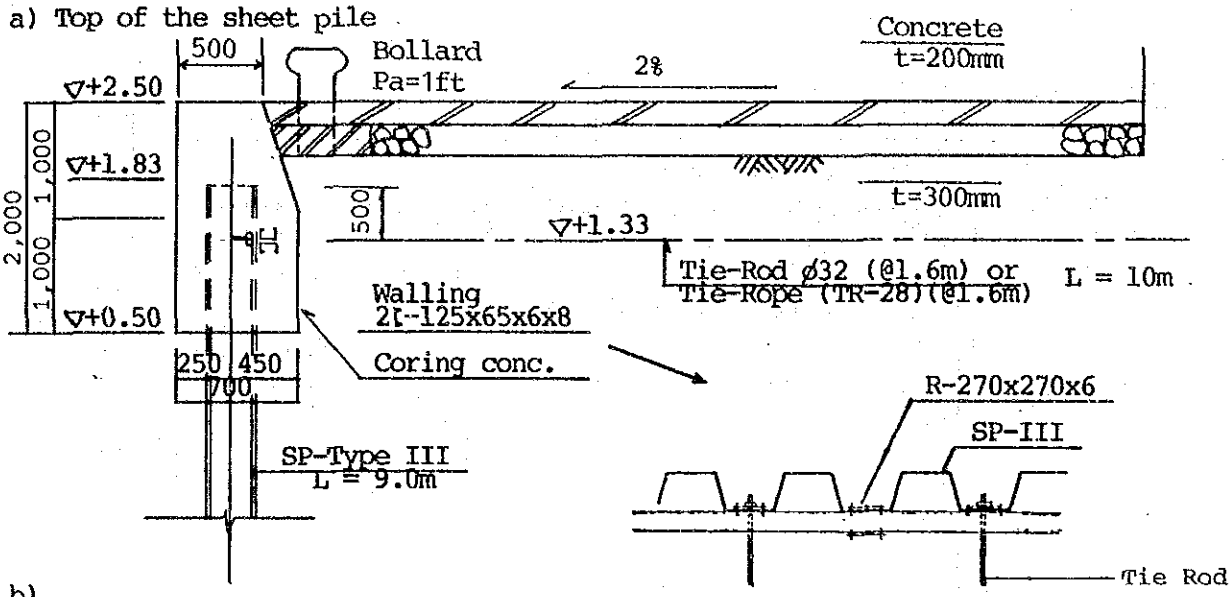
V-18 Stability Calculation of Sheet Pile Wall (Ngatpang)

1. Shape

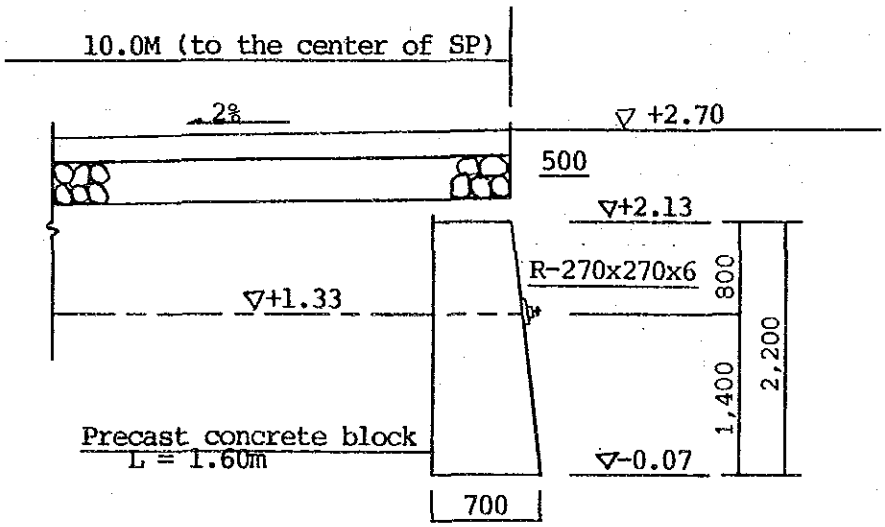


Typical Section Detail

a) Top of the sheet pile

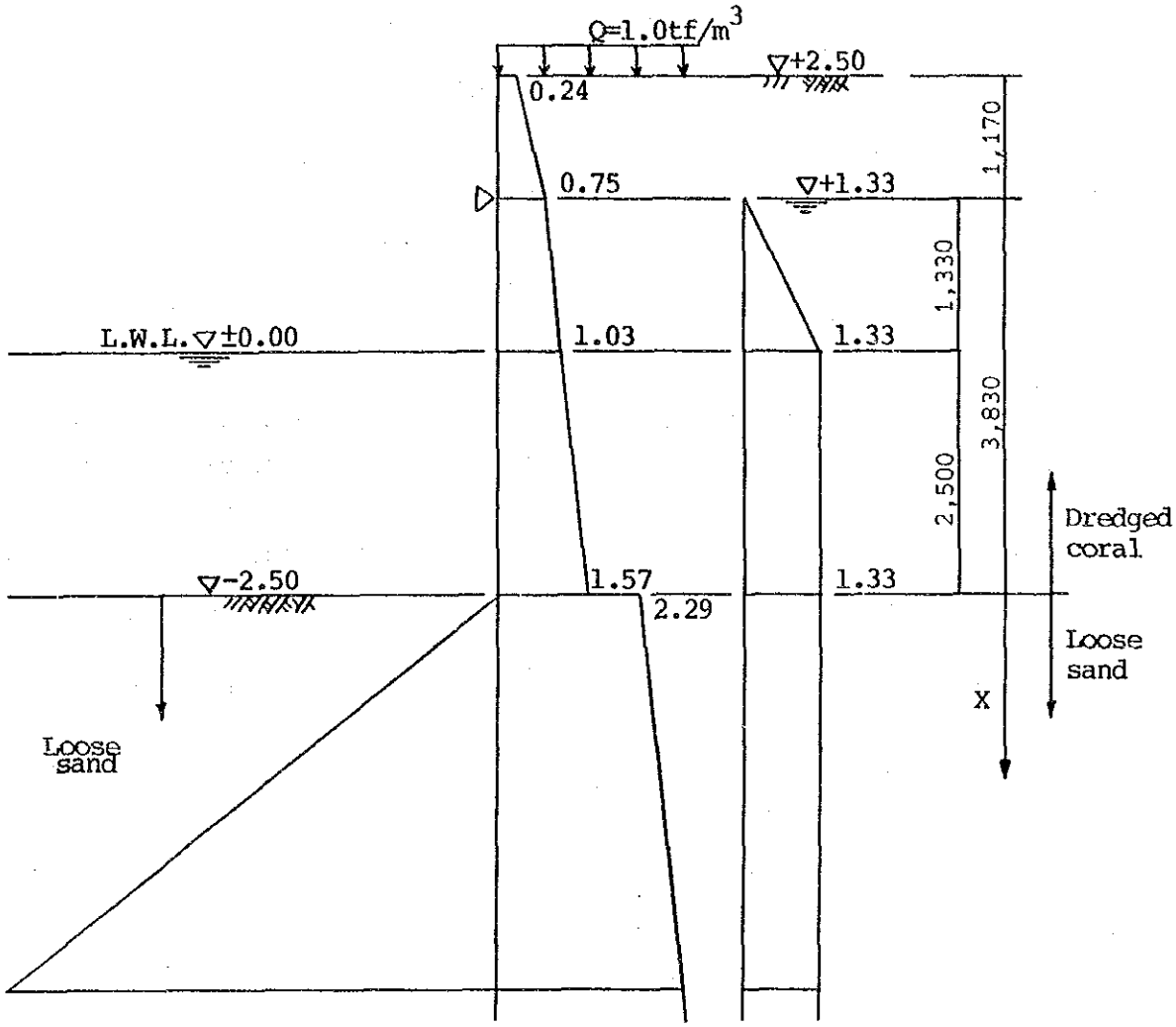


b)



2. Calculation of Sheet Pile

(1) Calculation of length



$Pa_{+2.50}$ = 0.24 x (1.0) = 0.24 (tf/m²)

$Pa_{+1.33}$ = 0.24 x (1.0 + 1.8x1.17) = 0.75 (")

$Pa_{\pm 0.00}$ = 0.24 x (1.0 + 1.8x1.17 + 0.9x1.33) = 1.03 (")

$Pa_{-2.50}$ = 0.24 x (1.0 + 1.8x1.17 + 0.9x3.83) = 1.57 (")

$Pa'_{-2.50}$ = 0.35 x (1.0 + 1.8x1.17 + 0.9x3.83) = 2.29 (")

Pa'_{X} = 0.35 x (1.0 + 1.8x1.17 + 0.9x3.83 + 0.8xX) = 2.29 + 0.28X (")

$Pp_{-2.50} = 0.00\ tf/m^2$

$Pp_X = 3.72 \times (0.8 \times X) = 2.98X$

$Pw_{+1.33} = 0.00\ tf/m^2$

$Pw_{\pm 0.00} = 1.32$

Drive

1) $Md_1 = \frac{1}{2} \times 0.75 \times 3.83 \times 1/3 \times 3.83 = 1.83$ tfm/m
2) $Md_2 = \frac{1}{2} \times 1.57 \times 3.83 \times 2/3 \times 3.83 = 7.68$
3) $Md_3 = 2.29 \times X \times (\frac{1}{2} \times X + 3.83) = 1.15X^2 + 8.77X$
4) $Md_4 = \frac{1}{2} \times 0.28X \times X \times (2/3 \times X + 3.83) = 0.09X^3 + 0.54X^2$
5) $Md_5 = \frac{1}{2} \times 1.33 \times 1.33 \times (2/3 \times 1.33) = 0.78$
6) $Md_6 = 1.33 \times (2.50 + X) \times \{\frac{1}{2} \times (2.50 + X) + 1.33\} = 8.58 + 5.09X + 0.67X^2$

Resistance

1) $Mr_1 = \frac{1}{2} + 2.98X \times X \times (2/3 \times X + 3.83) = 0.99X^3 + 5.71X^2$ tfm/m

Balanced depth of resisting moment againsr acting moment

$$Fs = 1.5 = \frac{Mr}{Md}$$

$Md = 0.09X^3 + 2.36X^2 + 13.9X + 18.9$ tfm/m

$Mr = 0.99X^3 + 5.71X^2$ tfm/m

Therefore,

$Mr - 1.5 \times Md = 0.86X^3 + 2.17X^2 - 20.9X - 28.4 = 0$

Therefore,

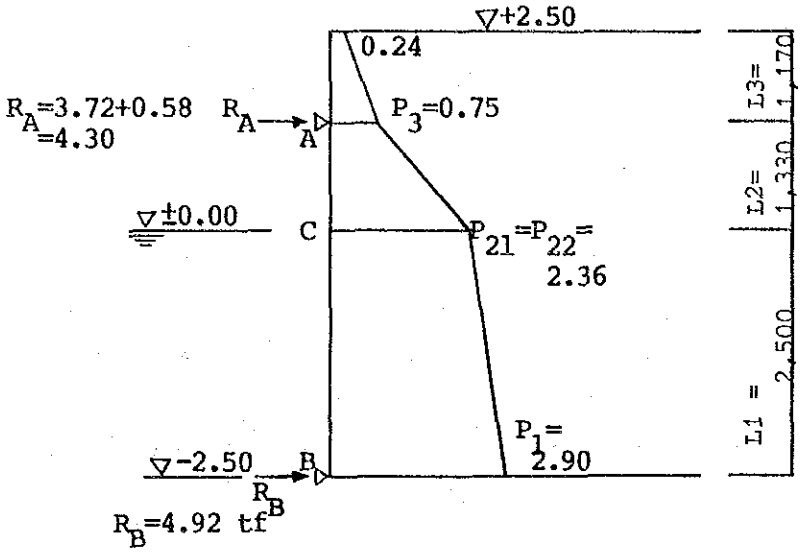
$X = 4.51$ m $(-7.01$ m$)$

The length of sheet pile is,

$L = 2.50 + 7.01 = 9.51$ m ⟶ 10.0 m

$1.83 + 7.01 = 8.84$ ⟶ 9.0 m

(2) Bending Moment for Sheet Pile



$2R_B/P_1+P_{21} = 2x4.92/2.90+2.36 = 1.87 < 2.50 = L_1$

$M_{max} = R_BX - \frac{1}{2}P_1X^2 + 1/6 \times P_1-P_{21}/L_1 \times X^3$

$X = L_1/P_1-P_{21} (P_1 - P_1^2 - 2 \times (P_1-P_{21})/L_1 \times R_B)$

Therefore,

$X = 2.50/2.90-2.36 \times (2.90 - 2.90^2 - 2 \times (2.90-2.36)/2.50 \times 4.92)$

$= 1.82$ m

$M_{max} = 4.92 \times 1.82 - \frac{1}{2} \times 2.90 \times 1.82^2 + 1/6 \times (2.90-2.36)/2.50 \times 1.82^3$

$= 4.37$ tfm/m

Stress calculation

Member : SP Type-III

$Z = 1,310 \times 0.8^* = 1,050$ cm^3/m

* : Reduction due to jointing

(assumed the value of 0.8 because of restraining head)

Therefore,

$= M/Z = 4.37 \times 10^3/1,050 = 420$ kgf/cm^2 < sa = 1,800 kgf/cm^2 (SY30)

3. Design of Tie Rod

(1) Diameter of the rod

$d = 4T/\pi\sigma_a$

$T = R_A \, L \sec\theta$

d : Diameter of tie rod

T : Tensile of tie rod

R_A: Reaction of strut (= 4.30 tf/m)

L : Distance of each tie rod (= 0.4 x 4 = 1.6m)

θ : Angle (= 0°)

σ_a: Allowance stress of tie rod (=960kgf/cm^2, SS41, d=40mm)

Therefore,

$T = 4.30 \times 1.6 \times \sec 0°$

$= 6.88$ tf/No.

$d = (4 \times 6.88 \times 10^3)/(\pi \times 960) = 3.02$cm ------► ø32mm

4. Design of Wale

(1) Bending Moment

$M_{max} = 1/10 \times T \times L$

$= 1/10 \times 6.88 \times 1.6$

$= 1.11$ tfm

(2) Stress Calculation

Member : 2[- 125 x 65 x 6 x 8

$Z = 2 \times 68.0 = 136.0$ cm^3

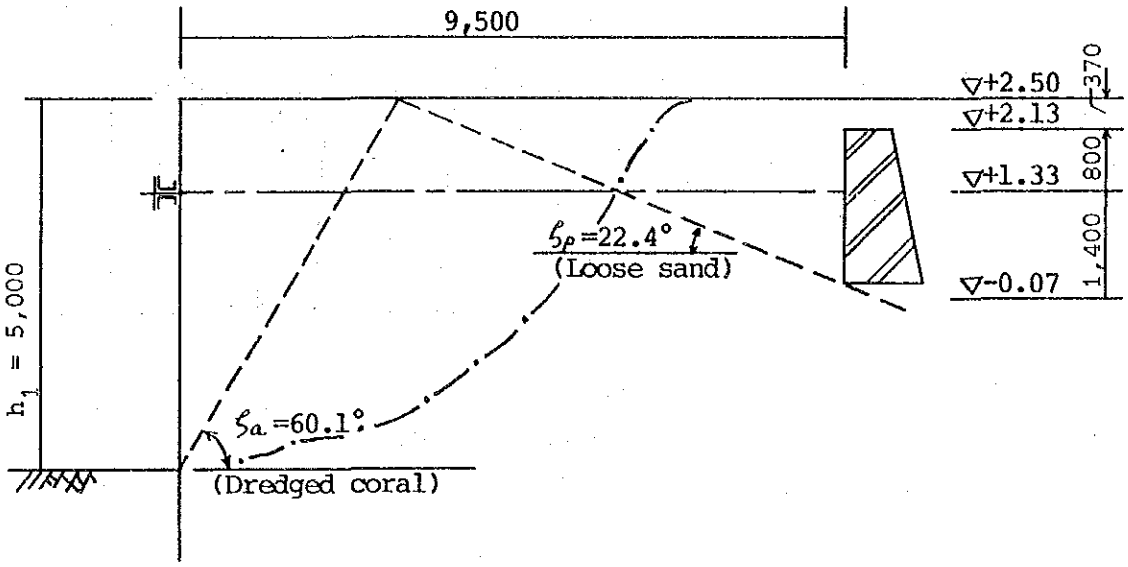
$\sigma = M_{max}/Z$

$= (1.11 \times 10^5)/136$

$= 820$ kgf/cm^2 $< \sigma_{sa} = 1{,}400$ kgf/cm^2 (SS41)

5. Design of Anchor Plate

(1) Location of Installation



$$L = h_1 \cot \zeta_a + h_2 \cot \zeta_p$$
$$= 5.0 \times \cot 60.1° + 2.57 \times \cot 22.4°$$
$$= 9.11 \longrightarrow 9.5 \text{ m}$$

(2) Height of Anchor Plate

$\psi = \beta = 0$, therefore, Ka $\cos\delta$ = 0.35, Kp $\cos\delta$ = 3.72

$Pa_{+2.50}$ = 0.35

$Pa_{+2.13}$ = 0.35 x (1.00 + 1.70 x 0.37) = 0.57 tf/m^2

$Pa_{+1.33}$ = 0.35 x (1.00 + 1.70 x 1.17) = 1.05 tf/m^2

$Pa_{-0.07}$ = 0.35 x (1.00 + 1.70 x 1.17 + 0.80 x 1.40) = 1.44 tf/m^2

$Pp_{+2.13}$ = 3.72 x (1.70 x 0.37) = 2.34 tf/m^2

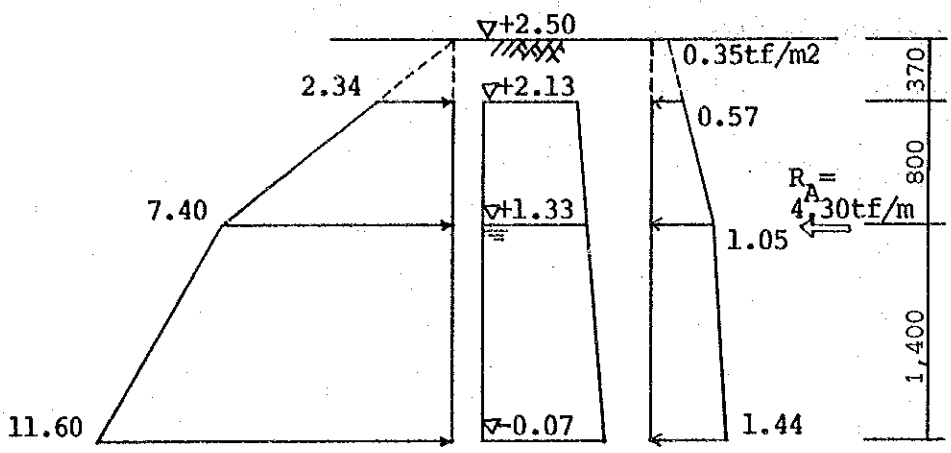
$Pp_{+1.33}$ = 3.72 x (1.70 x 1.17) = 7.40 tf/m^2

$Pp_{-0.07}$ = 3.72 x (1.70 x 1.17 + 0.80 x 1.40) =11.60 tf/m^2

R_A = 4.30 tf/m

E_A = 2.39 tf/m

E_p = 17.2 tf/m



$$F = Ep/(R_A+E_A)$$
$$= 17.2/(4.30+2.39)$$
$$= 2.57 > 2.50$$

(3) Section of Anchor Plate

M_H = TL/12 (Horizontal max. bending moment)

Mr = TD/8L (Vertical max. bending moment per 1 meter of quay wall length)

T = 6.88 tf/m

L = 1.60 m

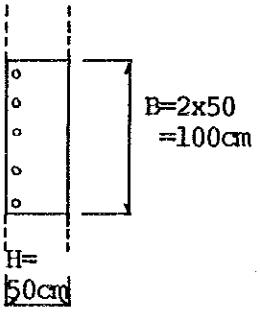
D = 2.20 m

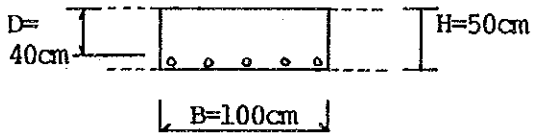
Therefore,

M_H = (6.88x2.20)/12 = 0.92 tfm

Mr = (6.88x2.20)/(8x1.6) = 1.18 tfm/m

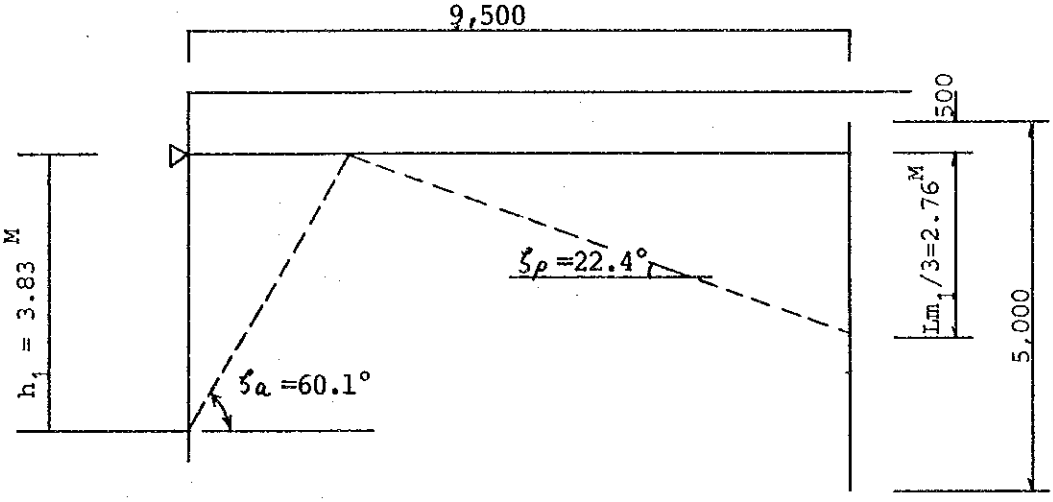
	Horizontal	Vertical	
M	0.92 tfm	1.18 tfm	
B	2 x H = 100 cm	100 cm	
H	50 cm	50 cm	
d	40 cm	40 cm	
As	D10 @300 = 2,375 cm^2/m	D10 @300 = 2.375 cm^2/m	Welded steel net (NK high mesh)





	Horizontal	Vertical
σ_s	1,010 kgf/cm^2	1,300 kgf/cm^2
σ_c	10 kgf/cm^2	12 kgf/cm^2

(In case of the Sheet Pile)



Soil condition of loose sand

r_t = 1.70 tf/m^3

r' = 0.80

ϕ = 25°

$\bar{N}$ = 5 (Assume)

E = 28N = 140 kgf/cm^2

Therefore, k_0 = 1/3 x 0.2 x $\sqrt[3]{140}$ x 100$^{-3/4}$ = 0.30 kgf/cm^3 ⟶ Fig 4-22 (p.98) 0.6 - 1.0

$\beta = \sqrt[4]{k_0 B/4EI}$

B = 100cm

E = 2.1 x 10^6 kgf/cm^2

I = 16,400 cm^4/m (SP Type-III)

Therefore,

$\beta = \sqrt[4]{(0.30 \times 100)/(4 \times 2.1 \times 10^6 \times 16{,}400)} = 0.00384$ cm^{-1} = 0.38m^{-1}

$Lm_1 = \pi/\beta = \pi/0.38 = 8.27$ m

$Lm_1/3 = 2.76$ m

$L_{req} = h_1 \cos \zeta_a + Lm_1/3 \cos \zeta_p$

= 3.83 cos 60.1° + 2.76 cot 22.4°

= 2.02 + 6.70

= 8.72 m < 9.50 m

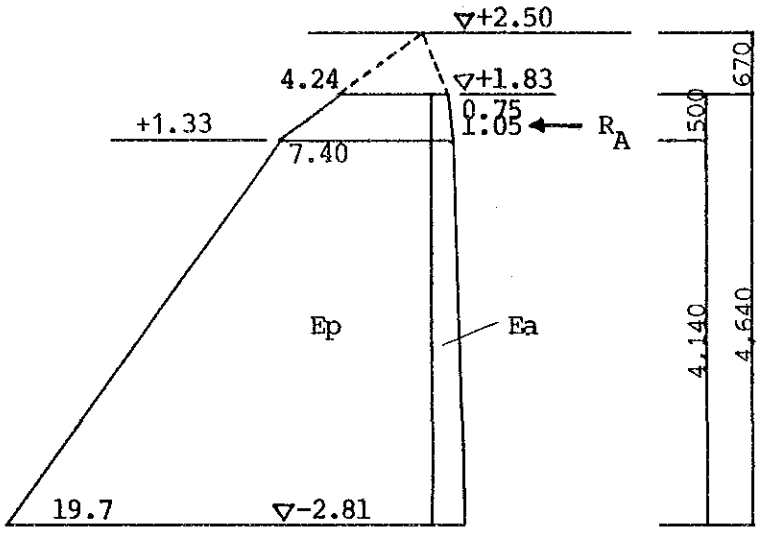
Length of embedding

$L = L_0 - 0.5 = 5.0 - 0.5 = 4.50\ m < Im_1 = 8.27\ m$

Therefore,

Same as for anchor plate because of short pile.

Herein, short pile between anchoring position and the point of $Im_1/2$ = 4.14m shall be neglected.



$Pa_{+2.50} = 0.35\ tf/m^2$

$Pa_{+1.83} = 0.35 \times (1.0 + 1.70 \times 0.67) = 0.75\ tf/m^2$

$Pa_{+1.33} = 0.35 \times (1.0 + 1.70 \times 1.17) = 1.05\ tf/m^2$

$Pa_{-2.81} = 0.35 \times (1.0 + 1.70 \times 1.17 + 0.8 \times 4.14) = 2.21\ tf/m^2$

$Pp_{+2.50} = 0$

$Pp_{+1.83} = 3.72 \times (1.70 \times 0.67) = 4.24\ tf/m^2$

$Pp_{+1.33} = 3.72 \times (1.70 \times 1.17) = 7.40\ tf/m^2$

$Pp_{-2.81} = 3.72 \times (1.70 \times 1.17 + 0.8 \times 4.14) = 19.70\ tf/m^2$

$R_A = 4.30\ tf/m$

$Ea = 7.20\ tf/m$

$Ep = 59.0\ tf/m$

Therefore,

$F = 59.0/(4.30+7.20) = 5.13 > Fs = 2.50$

Against M_H, wale can resist as the front sheet pile.

$Mr = TD/8L = (6.88 \times 4.64)/(8 \times 1.6) = 2.49\ tfm/m$

$= M/Z = (2.49 \times 10^5)/1{,}310 = 190\ kgf/cm^2$