# CHAPTER IV

# PROJECT ROAD ENGINEERING STUDY

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# PROJECT ROAD ENGINEERING STUDY

## 4.1 EXISTING ROAD AND BRIDGE CONDITION

### 4.1.1 Section Between Pioneer and Midsalip (4.90 km)

From the town hall of Midsalip, the village road ascends the rolling hills through a distance of 3 km. The south side of the road is covered by 300 - 700 m high mountainous range, while on the north side there lies extensive farm field where the ruins of old air-strip remains wrecked. This 3.50 - 4.00 m wide road is, at places, damaged with slope failures. Most of the curve lengths is less than 15 m, and the gradient ranges from 2% to 8%.

From the end of this village road, a narrow foot path travels though densely vegetated zone upto the Pioneer mine site. Most of the road bed along this section is composed of clayey soil, causing poor drainage and very slippery condition.

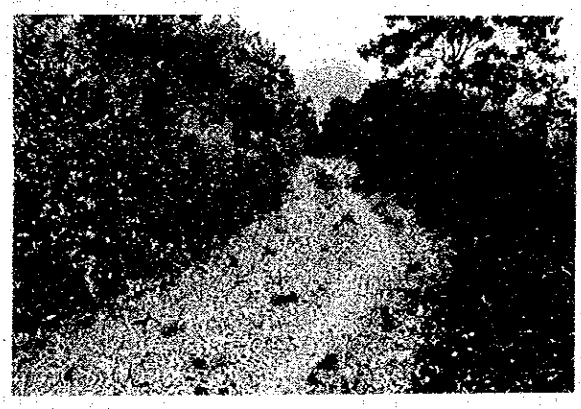


Photo 4.1 Midsalip - Pioneer (Village road)

4.1.2 Section between Midsalip and Switch (32.5 km)

This section passes through the farm land area represented by coconut plantations and corn field. Along this road, there are dotted small villages and towns namely, Magsaysay, Bubungan, Suminot and Midsalip, where farmers earn their living by subsistence farming. The fact that whole section is not provided with the subbase, gives lot of trouble for medium and heavy vehicles to pass over this slippery road. Even light vehicles cannot pass over easily during wet season. This road condition susceptible to wet are accelerated by poor natural drainge system without any drainage facilities like culverts. Except such road conditions, other factors such as vertical/horizontal alignment, gradient and carriage way width are designed and maintained at the provincial road standard level. During this section there are 3 one-lane bridges of truss type which are constructed for temporary use. (see Fig. 4.1)

Photo 4.2 Bonifacio (Gravel, Bad) National road

### 4.1.3 Section between Switch and Tangub City (34.7 km)

This section is a part of the national road connecting Pagadian city and Ozamis city. In short, this section is represented by the frequent rolling in the hilly zone and occasional inundation in the plain zone. The area in the vicinity of Bonifacio is the worst part of this section where the subgrade and subbase remains without maintenance, and it is muddy or dusty throughout the year. Among 21 bridges spanning this section, 6 bridges are of wooden structure with load limit under 3 or 5 tons. In spite of this load limitation at present, most of vehicles pass these bridges with overload condition, occasionally more than 200% of design load. The rest of the bridges consist, of 8 R.C bridges and 7 metal bridges.

Such being road and bridge conditions, the people driving along this road pay special attention during rainy days, and there is less traffic especially in Bonifacio area. Most of the section, though partly asphalt-paved in city area, is gravel-paved with effective carriage way of 6.70 - 8.6 m.

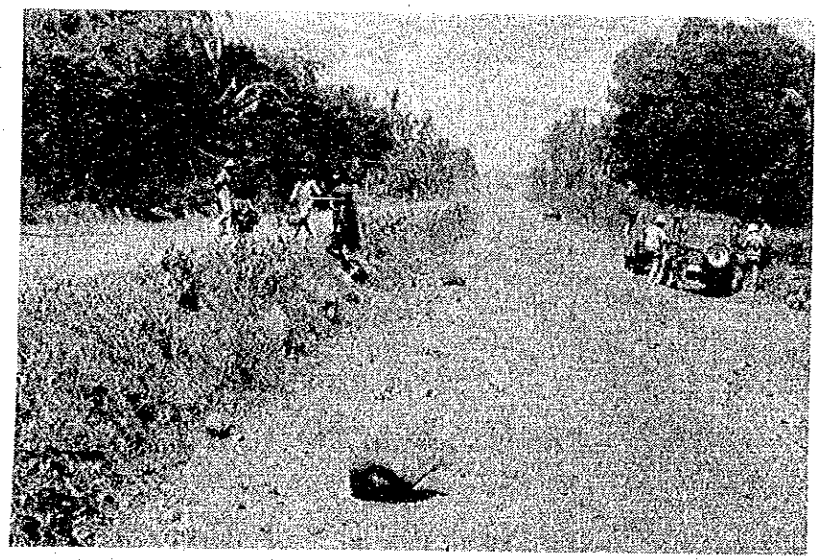


Photo 4.3 Molave (Gravel Fair) National road

### 4.1.4 Section between Tangub City - Tangub Port (4.9 km)

This section is mostly of gravel-paved, provided with constructed drainage of curb with gutter. The surface of gravel pavement is generally in good condition on account of light traffic rather than good maintenance. In this section, there are 2 wooden bridges with the same load limit mentioned above (see Fig. 4.1). At present, the road division of Tangub city is preparing city plan integrated with city road network, so that this city plan will have considerable bearing on the road planning in the project road study.

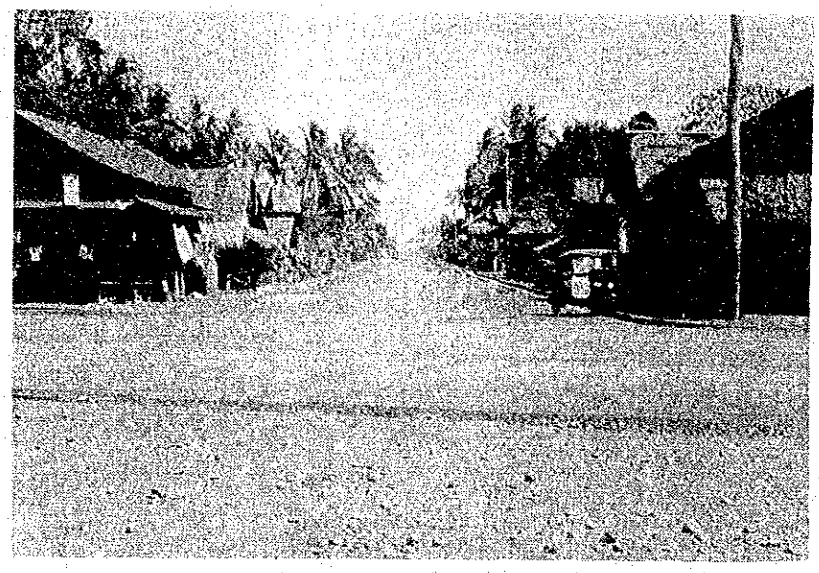


Photo 4.4 Tangub city, Labuyo (Asphalt, Fair)
National road to city road

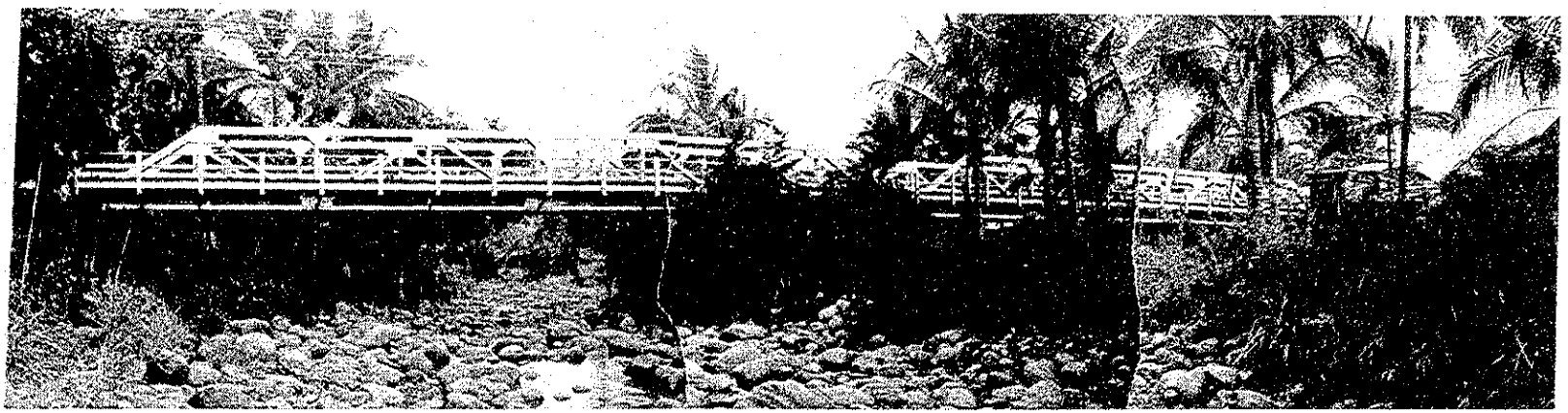


Photo 4.5 Truss bridge (No.14)

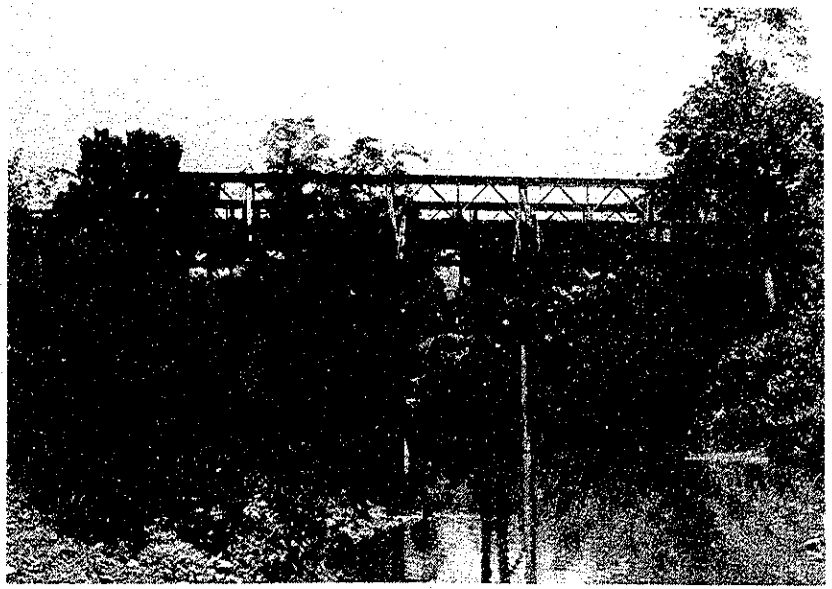
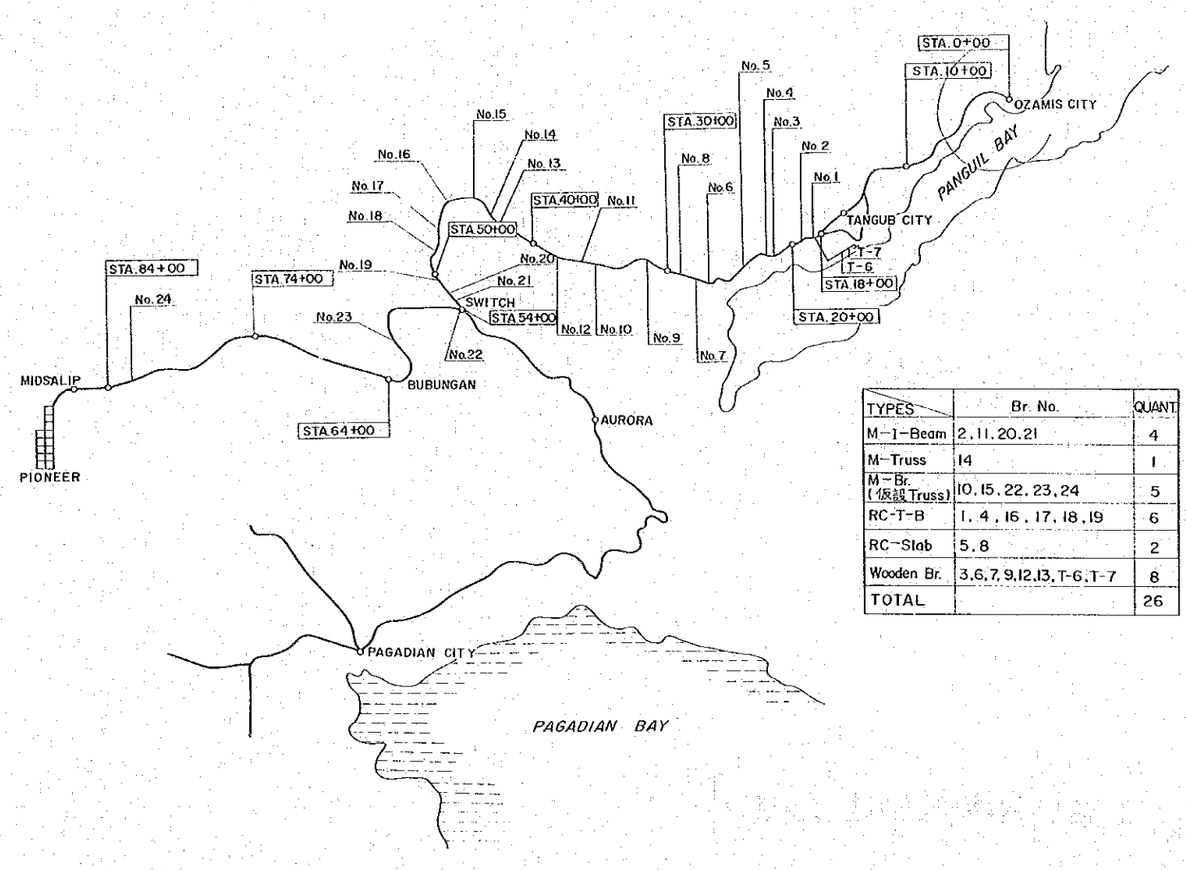


Photo 4.6 Truss bridge for temporary use (No.24)

Fig. 4.1 EXISTING BRIDGES ON THE PROJECT ROAD




| TYPES | Br. No. | QUANT |
|---|---|---|
| M-I-Beam | 2, 11, 20, 21 | 4 |
| M-Truss | 14 | 1 |
| M-Br. (仮設Truss) | 10, 15, 22, 23, 24 | 5 |
| RC-T-B | 1, 4, 16, 17, 18, 19 | 6 |
| RC-Slab | 5, 8 | 2 |
| Wooden Br. | 3, 6, 7, 9, 12, 13, T-6, T-7 | 8 |
| TOTAL | | 26 |

| Bridge Number | SECTION | STATIONING | NAME OF BRIDGE | TYPE OF BRIDGE | LENGTH | WIDTH |
|---|---|---|---|---|---|---|
| No.14 | Tangub-Switch | 42+80 | | Metal-Trused-Beam Br. | 73.800 | 4.900 |
| 15 | " | 43+70 | | Calvert | 6.450 | 8.600 |
| 16 | " | 44+10 | Toluan Br. | RC-T-Beam Br. | 15.000 | 8.600 |
| 17 | " | 48+70 | Gabonon Br. | " | 24.100 | 7.800 |
| 18 | " | 50+90 | Salugdiut Br. | " | 27.200 | 8.300 |
| 19 | " | 52+80 | Dipolo Dacu Br. | " | 53.150 | 8.350 |
| 20 | " | 53+30 | Dipolo Gamay Br. | Metal-I-Beam Br. | 29.000 | 7.700 |
| 21 | " | 53+70 | Mendoza Br. | " | 18.700 | 8.300 |
| 22 | Switch-Midsalip | 61+80 | | " | 18.000 | 8.600 |
| 23 | " | 83+20 | | " | 30.600 | 8.600 |
| 24 | " | 84+20 | | " | 24.000 | 8.600 |
| 25 | " | 86+42 | | " | 18.000 | 8.600 |
| 26 | Midsalip-Pioneer | 87+27 | | " | 18.000 | 8.600 |

| Bridge Number | SECTION | STATIONING | NAME OF BRIDGE | TYPE OF BRIDGE | LENGTH | WIDTH |
|---|---|---|---|---|---|---|
| T-6 | Tangub city | 3+70 | | Metal-I-Beam Br. | 6.400 | 8.600 |
| T-7 | " | 4+60 | | " | 14.000 | 8.600 |
| T-9 | " | 0+26 | | " | 18.000 | 8.600 |
| No.1 | Tangub-Switch | 19+60 | | RC-T-Beam Br. | 24.000 | 8.000 |
| 2 | " | 20+50 | Busikong Br. | Metal-I-Beam Br. | 21.800 | 8.900 |
| 3 | " | 21+60 | Lorenzo Tan Br. | " | 11.500 | 8.600 |
| 4 | " | 22+20 | | RC-T-Beam Br. | 26.900 | 8.100 |
| 5 | " | 24+60 | | RC- Slab Br. | 6.000 | 7.300 |
| 6 | " | 27+20 | | Metal-I-Beam Br. | 18.000 | 8.600 |
| 7 | " | 28+30 | Channel Br. | " | 17.600 | 8.600 |
| 8 | " | 29+40 | Dupol Br. | RC-Slab Br. | 6.000 | 7.200 |
| 9 | " | 31+90 | | Metal-I-Beam | 14.500 | 8.600 |
| 10 | " | 35+20 | Digson Br. | Metal-I-Beam Br. | 18.500 | 8.600 |
| 11 | " | 36+10 | | Metal-I-Beam Br. | 31.400 | 8.800 |
| 12 | " | 38+00 | Tiaman Br. | Calvert | 12.200 | 8.600 |
| 13 | " | 42+10 | Camanse Br. | " | 11.700 | 8.600 |

## 4.2 DESIGN CRITERIA

### 4.2.1 Design Concept

The project road will serve as an iron ore transportation road as well as a public road for normal traffic. As iron ore transportation road, the project road will take care of heavy traffic of dump-truck on 160 ADT level. Since the future normal traffic on the project road is expected to be 430 ADT in 1989 on the national road section, the share of "mine-related-traffic" will exceed one-forth of all traffic. In addition, a total load of dump-truck weighing about 30 tons exceeds the design load condition of the existing bridges, so that all the existing bridge should be replaced or reinforced. In view of traffic intensity, normal traffic shall be considered predominantly, whereas in the structural design, 30 ton load of dump-truck should first be taken into account. In the project economy of the mining company side, it is desirable that the improvement cost for road and bridge be as less costly as possible to satisfy the iron ore transportation requirement. In viewpoint of national road planning, however, more reliable and stable design standards are required which may incur additional costs. Keeping these conflicting matters in mind, the preliminary design criteria will be discussed in the following chapter.

### 4.2.2 Design Criteria of Road

Table 4.1 ROAD DESIGN CRITERIA

| | Private Road | National & Provincial Road | |
|---|---|---|---|
| | | Mountainous | Flat |
| | Midsalip - Mining Site | Switch-Midsalip Bagumbang - Bonifacio | Baga - Bagumbang Bonifacio - Switch |
| Design Speed | 40 km/h | 40 km/h | 60 km/h |
| Road width | 5.50 m | 5.50 m | 6.70 m |
| Shoulder width | 1.50 m | 1.20 m | 2.50 m |
| Base course width | 8.50 m | 7.90 m | 11.70 m |
| Subbase course width | 6.70 m | 5.50 m | 6.70 m |
| Minimum curve radius | 30 m | (50 m) | (120 m) |
| Maximum gradient | 10% | 5% | 5% |
| Maximum Super elevation | 5% | - | - |
| Design load | H-30 | H-30 | H-30 |

Considering the design requirement as well as the results of road/bridge inventory, the design criteria has been established for preliminary design on the project road and bridge as shown on Table 4.1.

i) Design speed

Design speed for the project road has been determined at 40 km/h and 60 km/h for mountainous section and flat section in accordance with the design standard of MPH. A new road (Midsalip - Pioneer),

located in the mountainous area, has been designed with a design speed of 40 km/h.

ii) Road width and shoulder width

On the flat section, the road width has been determined at 6.70 m so as to allow two way traffic to pass with a design speed of 60 km/h, and 2.5 m wide shoulder portion has been spaced to permit car parking. On mountainous section, mainly from economic viewpoint, the road width and shoulder width have been determined at 5.50 m and 1.20 - 1.50 m respectively.

iii) Horizontal alignment

Horizontal alignment can be determined in connection with the design speed established in (i). Minimum curve radius of 50 m or 120 m on mountainous or flat section respectively are desirable. In spite of these design criteria, the section between Midsalip and Pioneer mine site has been designed with a minimum curve radius of 30 m to satisfy the economical requirement of mining company side.

iv) Gradient

Maximum gradient in relation to the design speed of 40 km/h and 60 km/h is 5%. This gradient has been applied to the sections other than new road between Midsalip and Pioneer, where a maximum gradient of 10% has been used for only satisfying ore-carrying dump-truck traffic.

v) Base course and Sub-base course

Reflecting the traffic density in future and the existing C.B.R value of 10, thickness of base course

and subbase have been determined at 15 cm each.

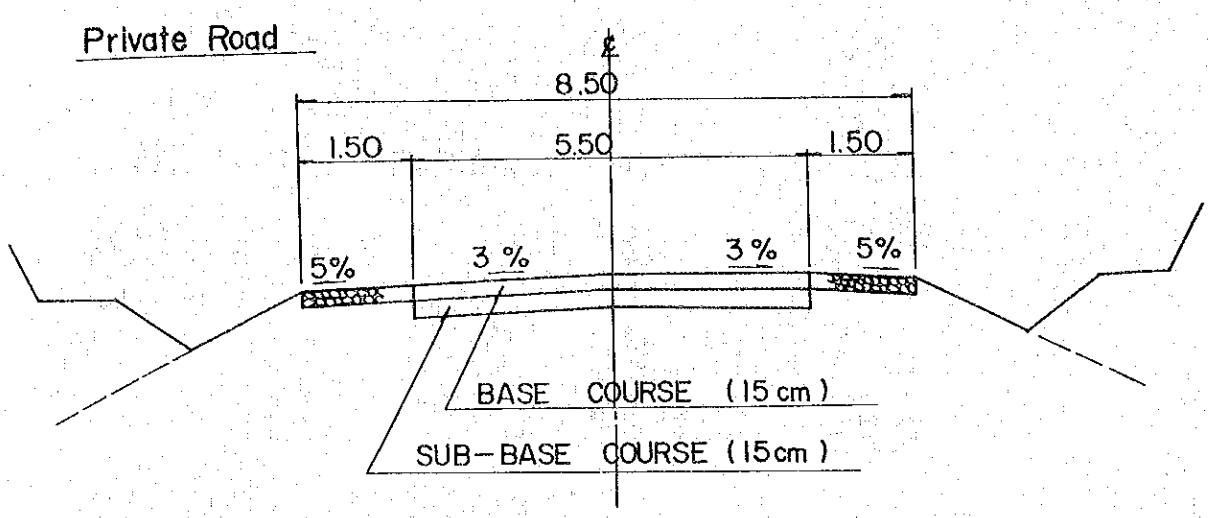
vi) Design load

A maximum design load for bridge has been determined at 30 ton.

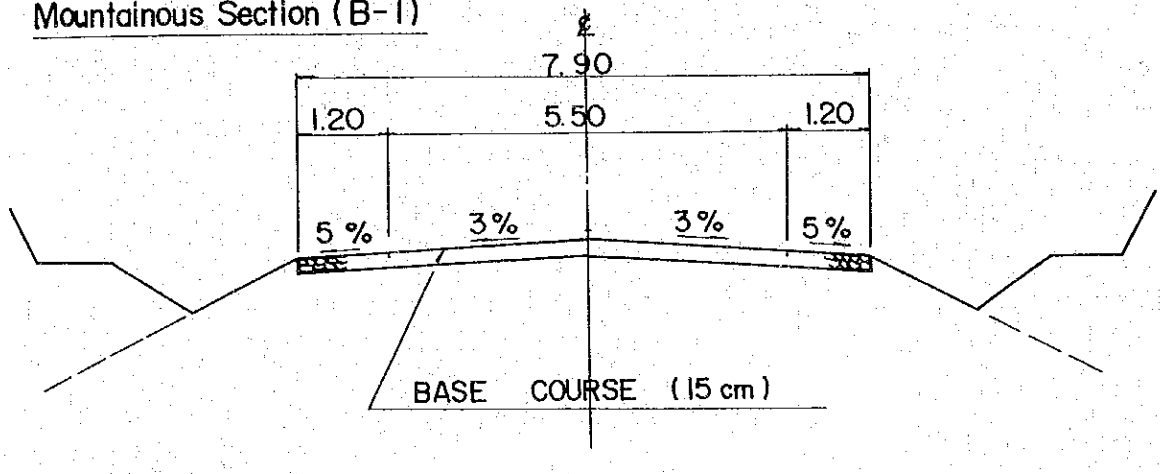
Typical cross sections of the project road are illustrated in Fig. 4.2 in accordance with the above design criteria.

# Fig.4-2(1) TYPICAL CROSS SECTION

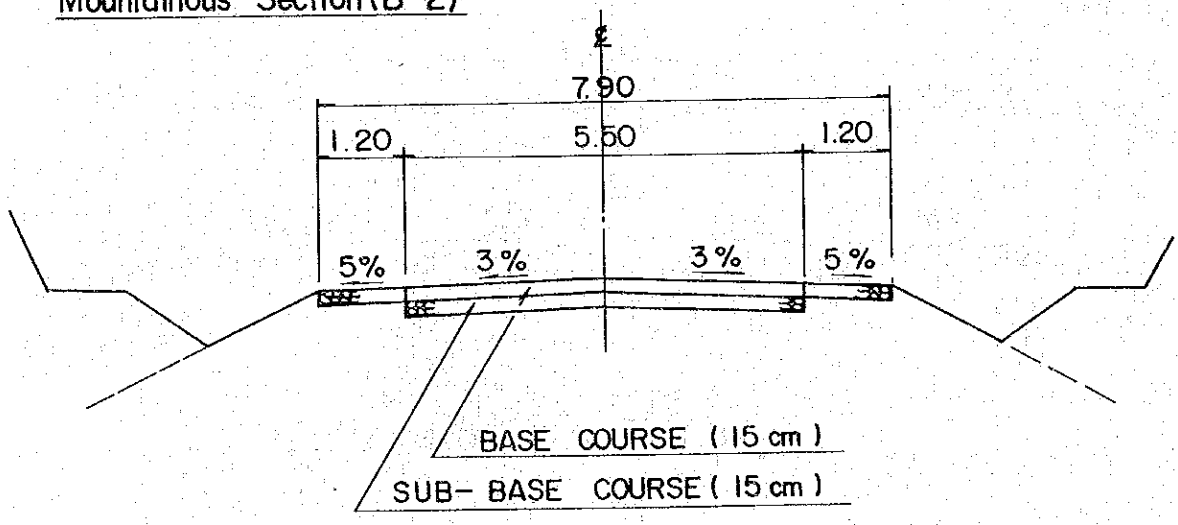
Private Road




Mountainous Section (B-1)



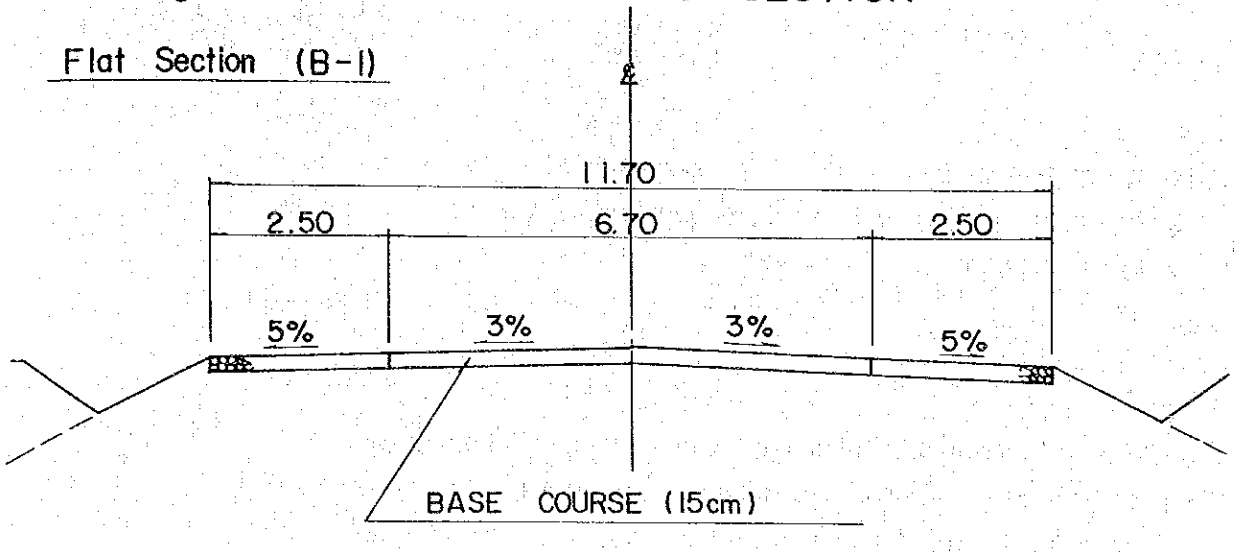

Mountainous Section (B-2)



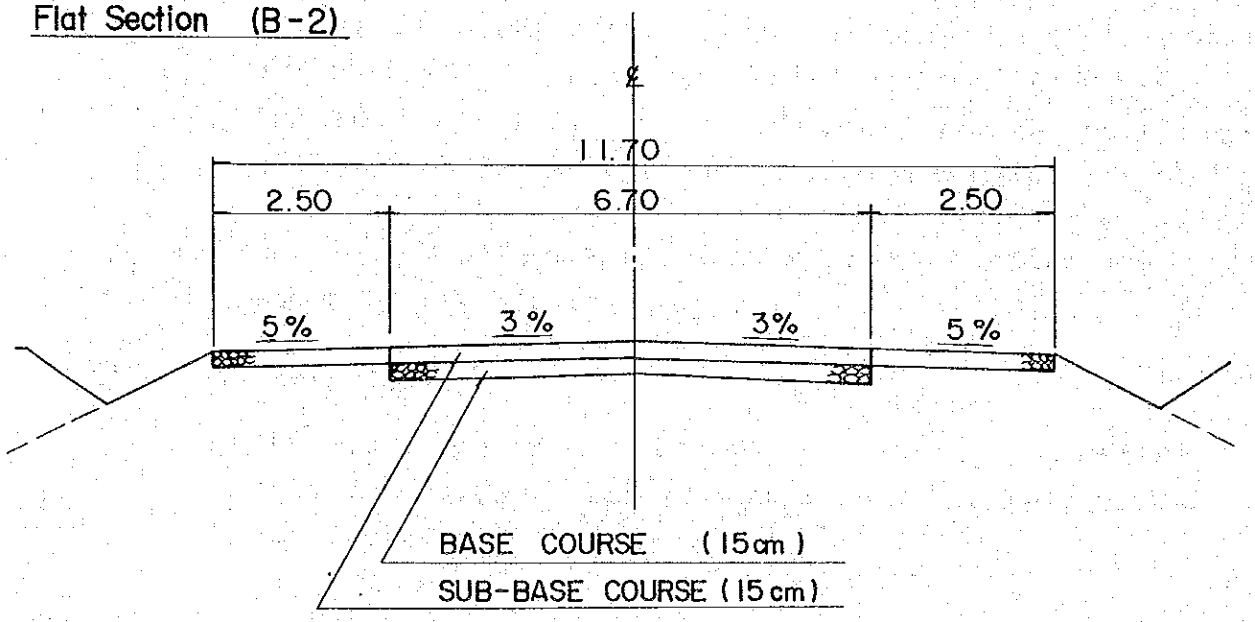

NOTE : B— 1 means base course with a thickness of 15 cm.
B— 2 means base course with a thickness of 15 cm.
plus sub-base course with a thickness of 15 cm.

## Fig.4-2(2) TYPICAL CROSS SECTION

Flat Section (B-1)




Flat Section (B-2)



## 4.3 PRELIMINARY DESIGN OF ROAD AND BRIDGE

### 4.3.1 Road Design

Based upon the design criteria, preliminary design of the project road has been carried out as follows:

i) Alignment

The whole section has no special problem in view of sight distance, vertical and holizontal alignment, etc., so that no improvement of alignment will be made on the project road.

ii) Earthwork

The new road between Midsalip and Pioneer mine site (4.9 km) will require earthwork, where cutting portion shall be used as subgrade and banking portion shall be filled by on-site-born material. Typical slope is 1 : 0.25 - 0.75 in cut and 1 : 2 - 1.5 in embankment.

iii) Base course and subbase course

The sections where the gravel surfacing on the existing road was judged as "Fair" shall be improved to form a 15cm thick subbase course, while the sections of "Bad" shall be improved to form a combination of 15 cm thick base course and 15 cm thick subbase course. The locations of improvement section are shown on Fig. 4.3.

iv) Surfacing

The surfacing of the project road shall be provided only for dust pollution prevention in densely populated city area.

v) Drainage

Especially in cutting portion and mountainous segment, open ditches shall be provided and in other flat area, pipe culverts with a diameter of 0.9 - 1.8 m shall be placed at proper intervals.

### 4.3.2 Bridge Design

When applying 30 ton load to the existing bridges spanned on the project road, the shortage of bearing capacity will come about on such portions of the bridge: slab, floor, girder, pier and abutment. It is expected that even the existing R.C bridges and metal bridges cannot support the 30 ton loads.

To cope with this capacity shortage, the bridges shall be reinforced or replaced. As to reinforcement, the following manners can be employed:

i) Steel plates be welded to the main chords of truss structure.

ii) Steel plates be bonded or bolted on the underside of floor or beam of RC-T-Beam.

iii) Steel plates be welded to I beam.

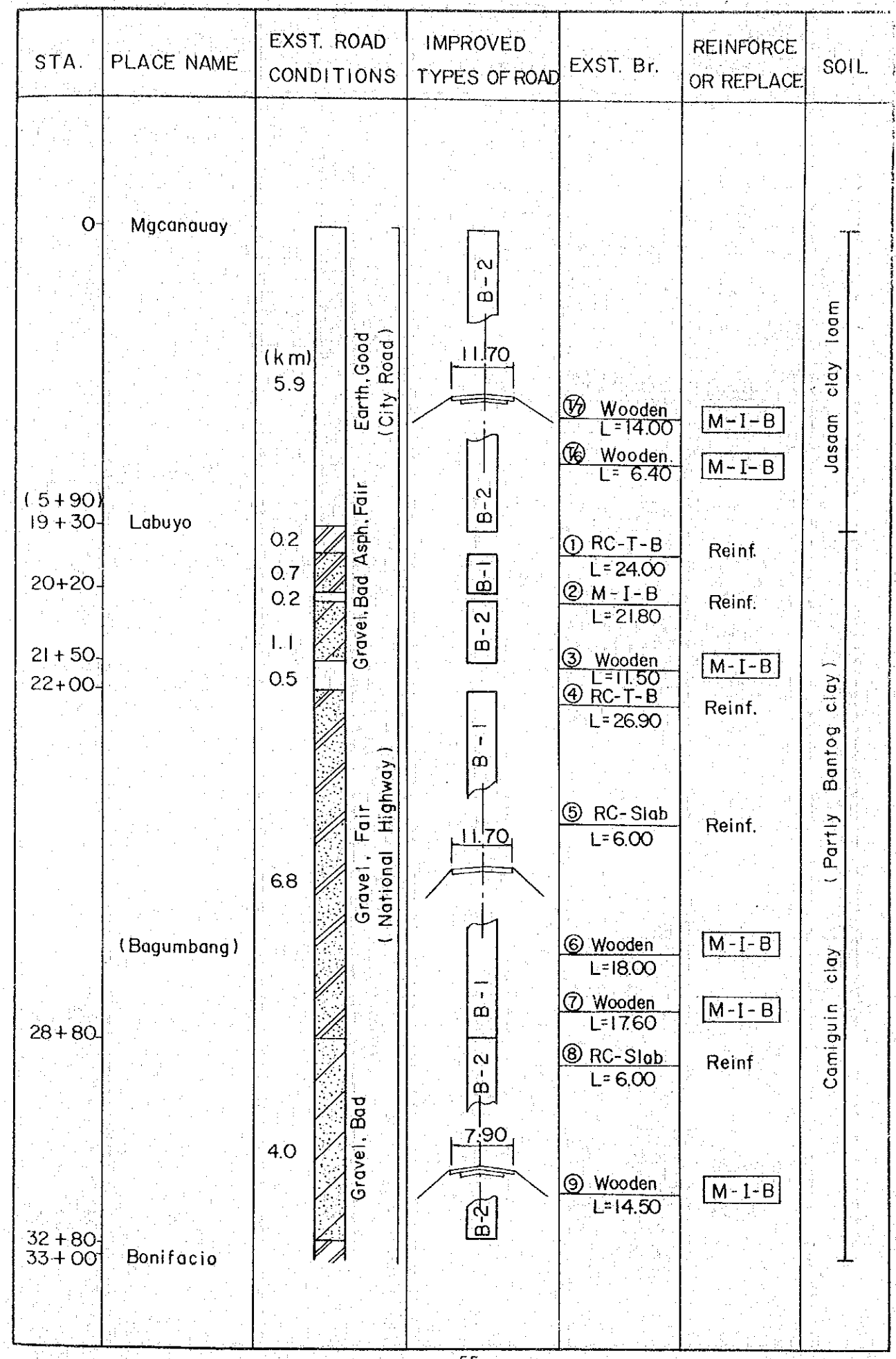
iv) Increase the number of beams.

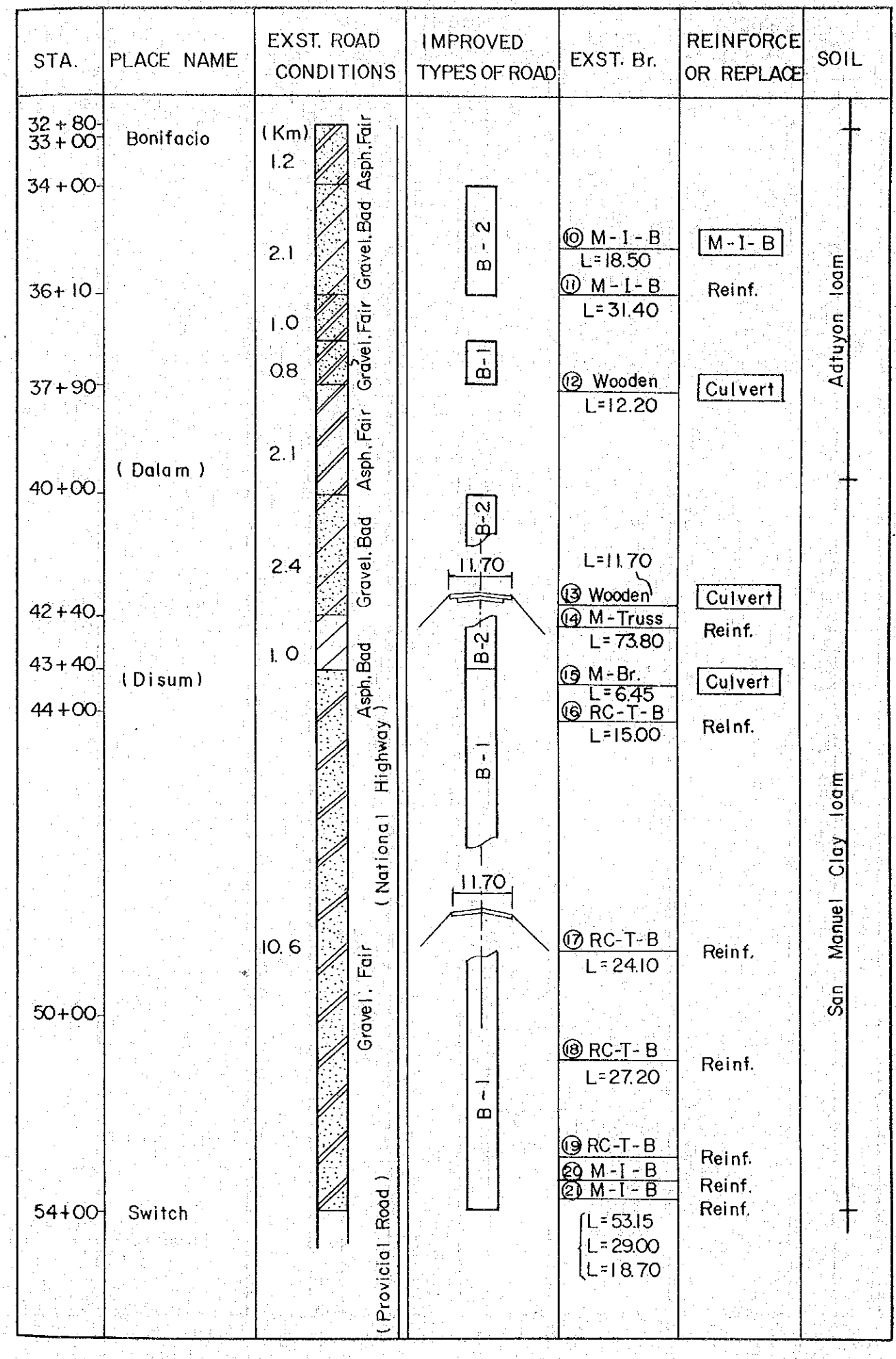
For the replacement of bridges, Metal-I-Beam has been applied for the following reasons:

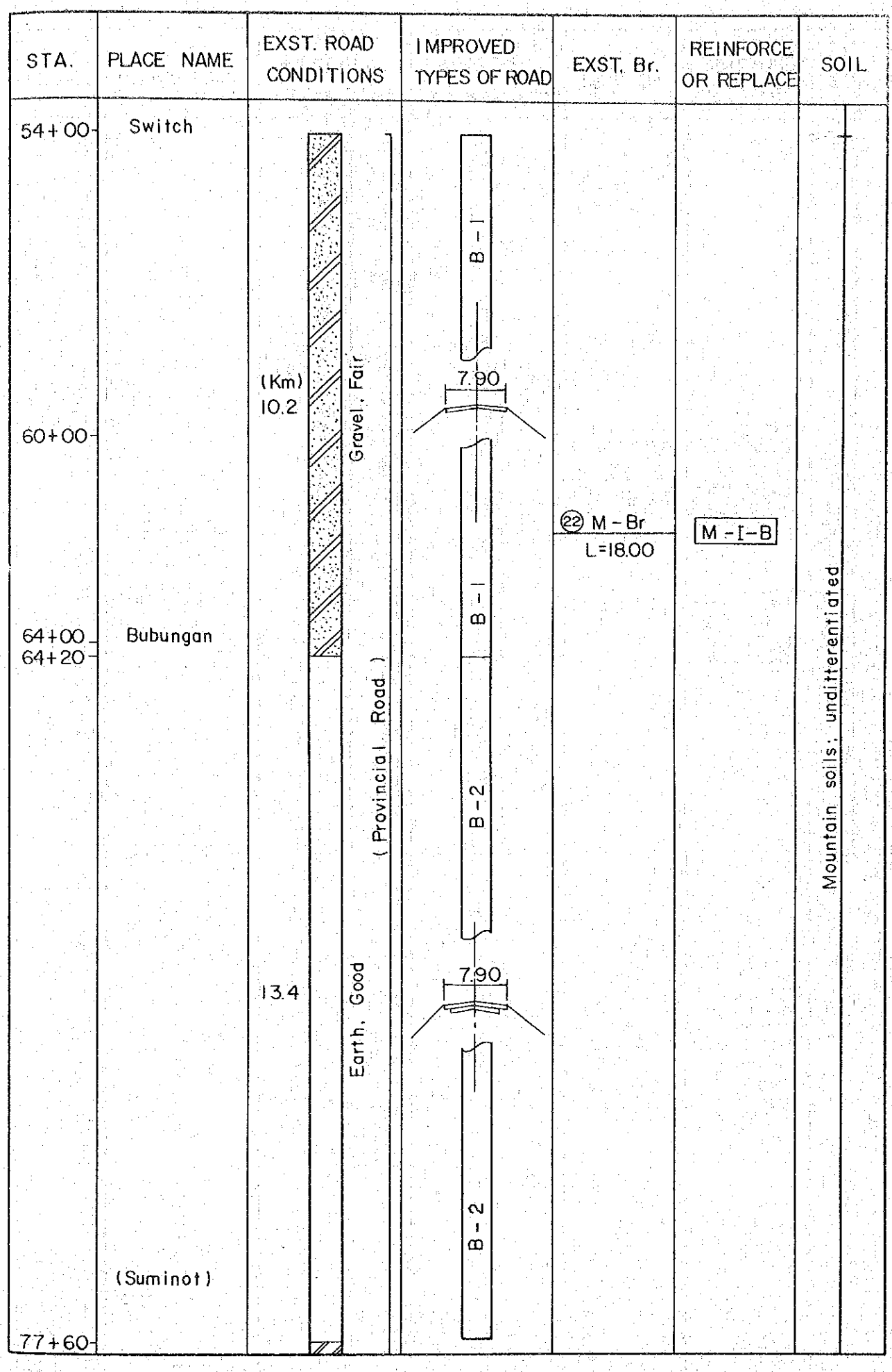
i) Easy mobilization to site for light weight
ii) Speedy erection in the form of prefabricating
iii) No high technics for fabrication
iv) Comparatively low cost

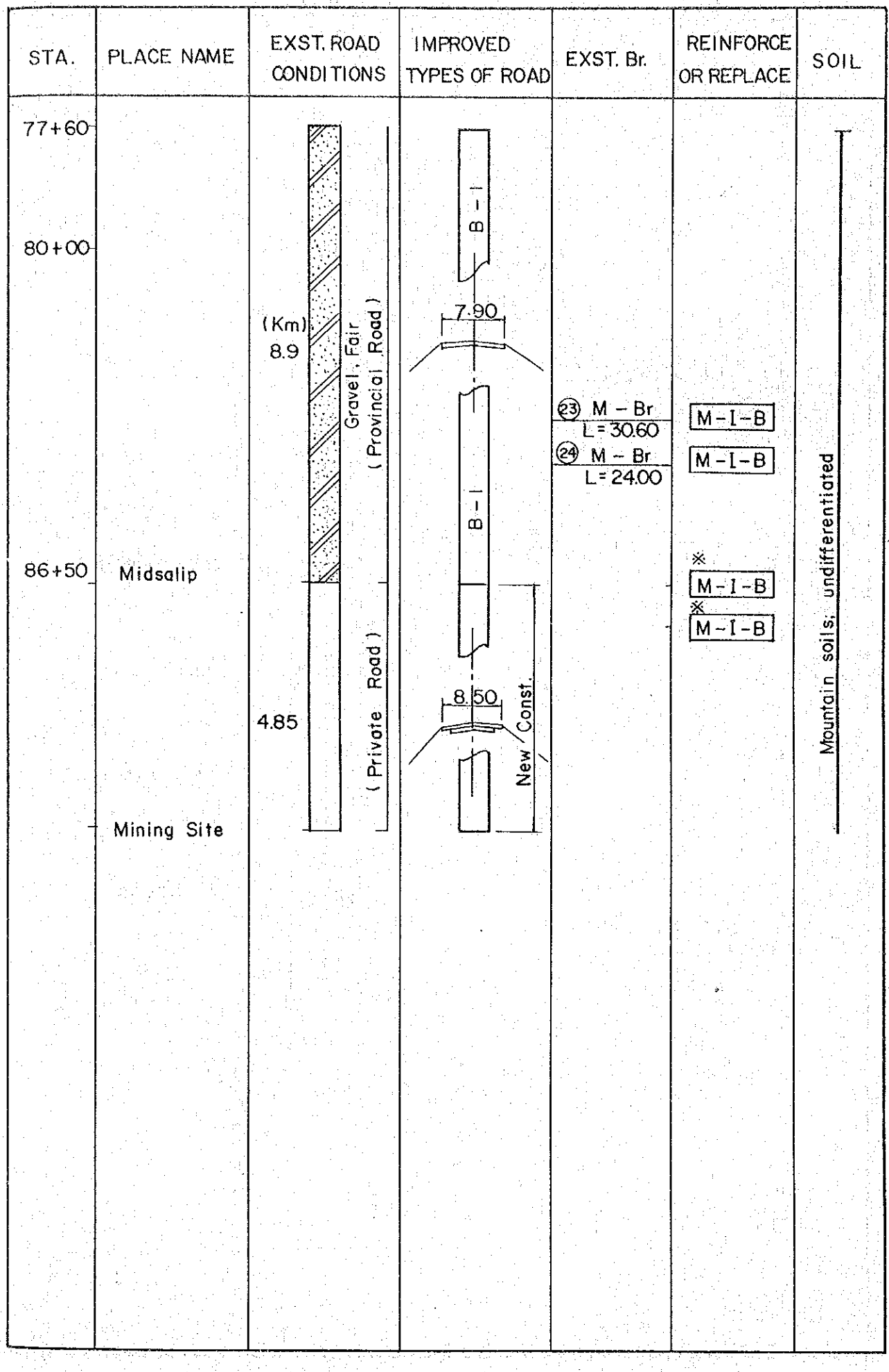
The location of the bridges to be replaced or of new bridges are shown on Fig. 4.3.

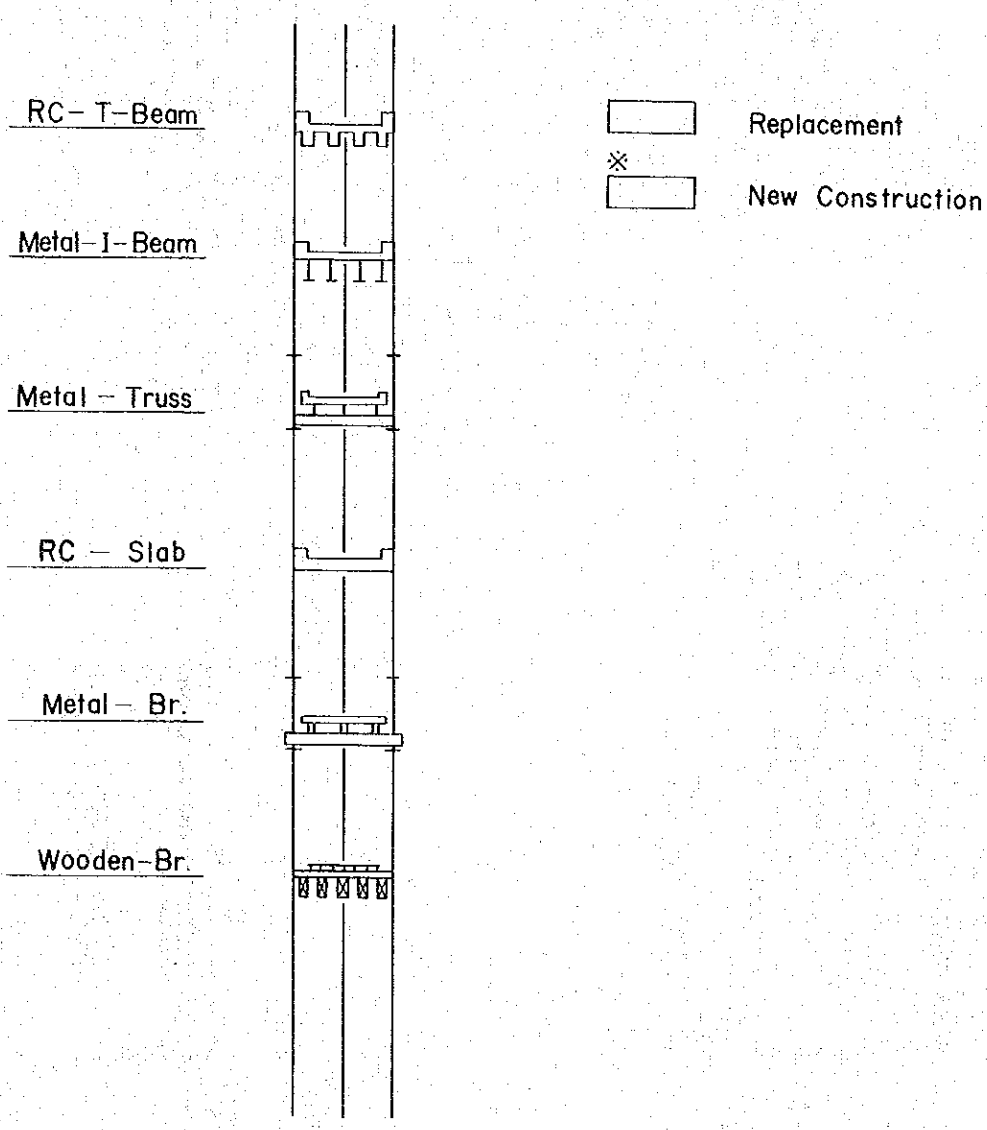
Fig. 4.3 ROAD & BRIDGE IMPROVEMENT

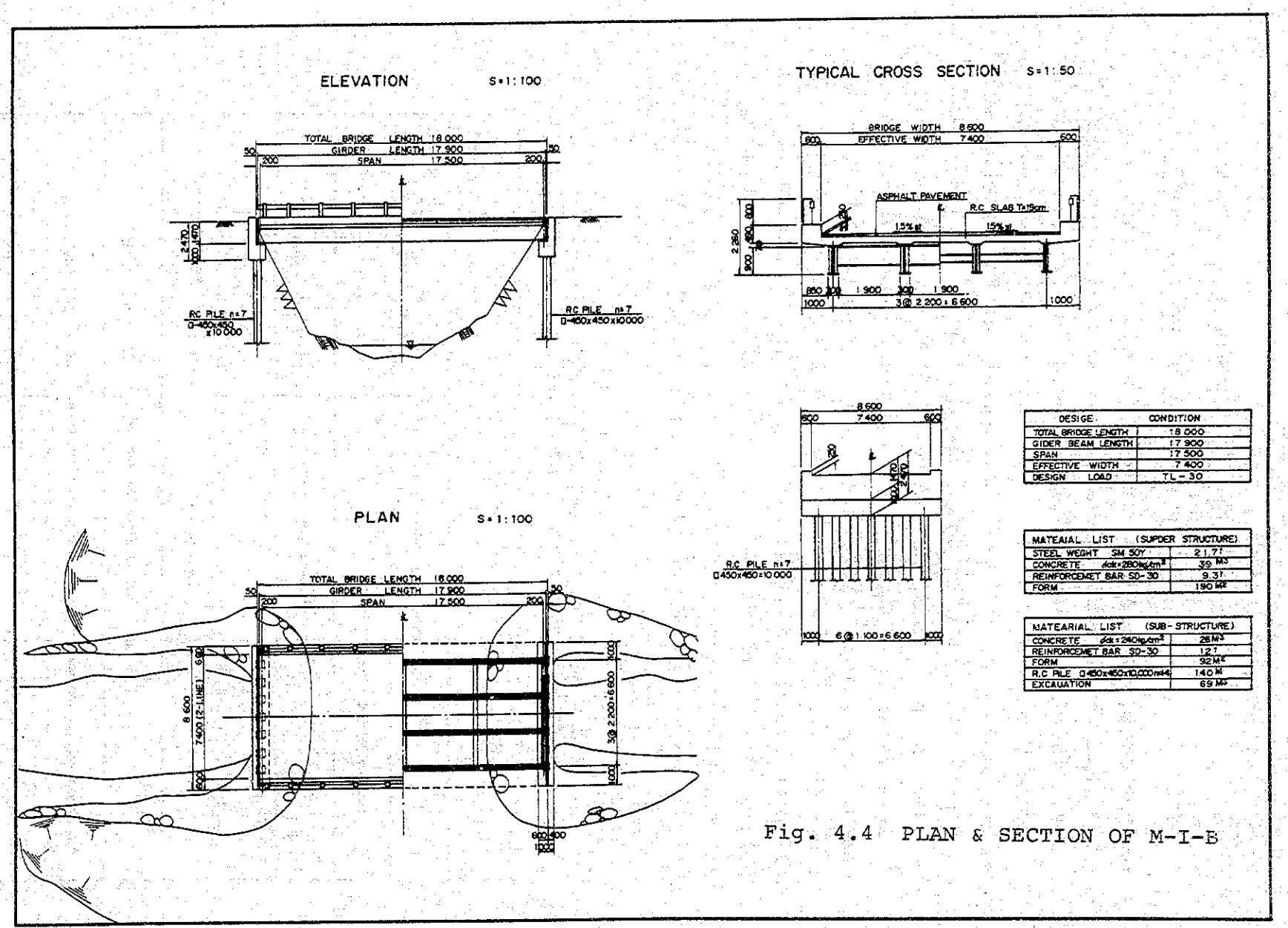



STA.
PLACE NAME
EXST. ROAD CONDITIONS
IMPROVED TYPES OF ROAD
EXST. Br.
REINFORCE OR REPLACE
SOIL
32+80
33+00
Bonifacio
34+00
36+10
37+90
40+00
(Dalam)
42+40
43+40
(Disum)
44+00
50+00
54+00
Switch
(Km)
1.2
2.1
1.0
0.8
2.1
2.4
1.0
10.6
Gravel, Fair
Gravel, Bad
Asph, Fair
Gravel, Fair
Gravel, Bad
Asph, Fair
Gravel, Bad
Asph, Bad
(National Highway)
(Provicial Road)
B-2
B-1
B-2
B-1
B-2
B-1
11.70
11.70
⑩ M-I-B
L=18.50
⑪ M-I-B
L=31.40
⑫ Wooden
L=12.20
L=11.70
⑬ Wooden
⑭ M-Truss
L=73.80
⑮ M-Br.
L=6.45
⑯ RC-T-B
L=15.00
⑰ RC-T-B
L=24.10
⑱ RC-T-B
L=27.20
⑲ RC-T-B
⑳ M-I-B
㉑ M-I-B
L=53.15
L=29.00
L=18.70
M-I-B
Reinf.
Culvert
Culvert
Reinf.
Culvert
Relnf.
Reinf.
Reinf.
Reinf.
Reinf.
Adtuyon loam
San Manuel Clay loam


STA.
PLACE NAME
EXST. ROAD CONDITIONS
IMPROVED TYPES OF ROAD
EXST. Br.
REINFORCE OR REPLACE
SOIL
54+00
Switch
(Km)
10.2
Gravel, Fair
B-1
7.90
60+00
22 M-Br
L=18.00
M-I-B
64+00
64+20
Bubungan
( Provincial Road )
B-1
B-2
7.90
13.4
Earth, Good
B-2
(Suminot)
77+60
Mountain soils; undifferentiated


STA.
PLACE NAME
EXST. ROAD CONDITIONS
IMPROVED TYPES OF ROAD
EXST. Br.
REINFORCE OR REPLACE
SOIL
77+60
80+00
86+50
Midsalip
Mining Site
(Km)
8.9
4.85
Gravel, Fair
(Provincial Road)
(Private Road)
B - I
7.90
8.50
New Const.
㉓ M - Br
L = 30.60
㉔ M - Br
L = 24.00
M-I-B
※
M-I-B
※
M-I-B
Mountain soils; undifferentiated


RC- T-Beam
Metal-I-Beam
Metal - Truss
RC - Slab
Metal - Br.
Wooden-Br.
Replacement
※
New Construction




| DESIGE | CONDITION |
|---|---|
| TOTAL BRIDGE LENGTH | 18.000 |
| GIDER BEAM LENGTH | 17.900 |
| SPAN | 17.500 |
| EFFECTIVE WIDTH | 7.400 |
| DESIGN LOAD | T-L-30 |

| MATEAIAL LIST (SUPDER STRUCTURE) | |
|---|---|
| STEEL WEGHT SM 50Y | 21.7t |
| CONCRETE $\sigma ck = 280 kg/cm^2$ | 39 $M^3$ |
| REINFORCEMET BAR SD-30 | 9.3t |
| FORM | 190 $M^2$ |

| MATEARIAL LIST (SUB-STRUCTURE) | |
|---|---|
| CONCRETE $\sigma ck = 240 kg/cm^2$ | 28 $M^3$ |
| REINFORCEMET BAR SD-30 | 12t |
| FORM | 92 $M^2$ |
| R.C PILE □450x450x10,000 n=4 | 140 M |
| EXCAUATION | 69 $M^3$ |

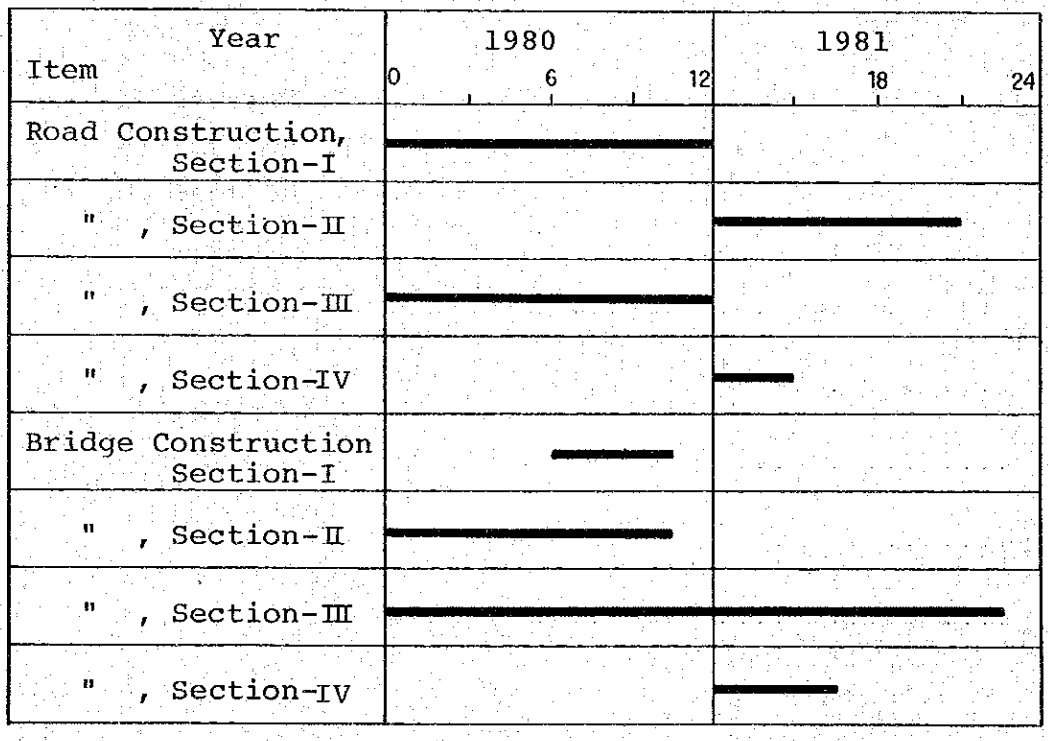
Fig. 4.4 PLAN & SECTION OF M-I-B

## 4.4 CONSTRUCTION SCHEDULE & COST

### 4.4.1 Construction Schedule

Building the operability of construction plant and machines on site into required construction quantities, the practical construction schedule has been tentatively established as shown in Fig. 4.5. It is recommended that the project road is divided into four sections, i.e. new road between Midsalip and Pioneer, which will take the longest construction time shall be initiated first, and the port access improvement (Tangub city - Tangub port site) shall be proceeded in pace with the port development, and remaining two sections shall be improved either on province level or national level under each construction office's guideline. In view of construction procedure, construction head office of provincial road section and national road section is desirable to be located in Bonifacio and Magsaysay respectively.

Fig. 4.5 CONSTRUCTION SCHEDULE OF ROAD AND BRIDGE IMPROVEMENT



### 4.4.2 Construction Cost

Preliminary cost estimate has been made for road and bridge improvement/development. The annual maintenance cost for road and bridge have been assumed to be 3% and 1.5% of road construction cost and superstructure cost of bridge respectively.

Table 4.2 CONSTRUCTION COST OF ROAD & BRIDGE

i) Capital cost (unit: Million peso)

| | Road | Bridge | Total |
|---|---|---|---|
| a) Section I | 9.03 | 0.58 | 9.61 |
| b) Section II | 3.87 | 3.42 | 7.29 |
| c) Section III | 4.49 | 11.06 | 15.55 |
| d) Section IV | 1.02 | 0.45 | 1.47 |
| Total | 18.41 | 15.51 | 33.92 |

ii) Annual maintemance cost (unit: Million peso)

| | Road | Bridge | Total |
|---|---|---|---|
| a) Section I | 0.27 | 0.04 | 0.27 |
| b) Section II | 0.12 | 0.02 | 0.14 |
| c) Section III | 0.14 | 0.09 | 0.23 |
| d) Section IV | 0.03 | 0.01 | 0.04 |
| Total | 0.56 | 0.16 | 0.68 |

# CHAPTER V

# PROJECT PORT ENGINEERING STUDY

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## 5.1 PROPOSED PORT SITES

### 5.1.1 General

As one component of iron ore transportation system, ore loading berth shall be established in connection with the project road improvement. Ozamis port (major port of Misamis Occidental) and Pagadian port (major port of Zamboanga del Sur) were, at first, studied for prospective ports for this purpose. Pagadian port was deleted mainly due to more expensive ocean freight to Cagayan de oro than Tangub and Ozamis port, while Ozamis port was withdrawn, because of poor possibility of vast open space for ore stock yard. In place of these existing ports, Tungub port sites has come to be spotlighted both from engineering and economic viewpoints. Tangub port sites, though located deep inside the Panguil Bay, can be reached from open sea without any dredging, and is well sheltered from open seas and swells. In addition, Tangub city itself is eager to construct a new port, and has already been constructing a new causeway. Therefore the project port planning at Tangub is considerably promising. Under these circumstances, three alternative port sites in and around Tangub city have been selected and preliminarily studies has been made as given hereunder. Three prospective port sites are Migcanauay, Solaton and Talabaan.

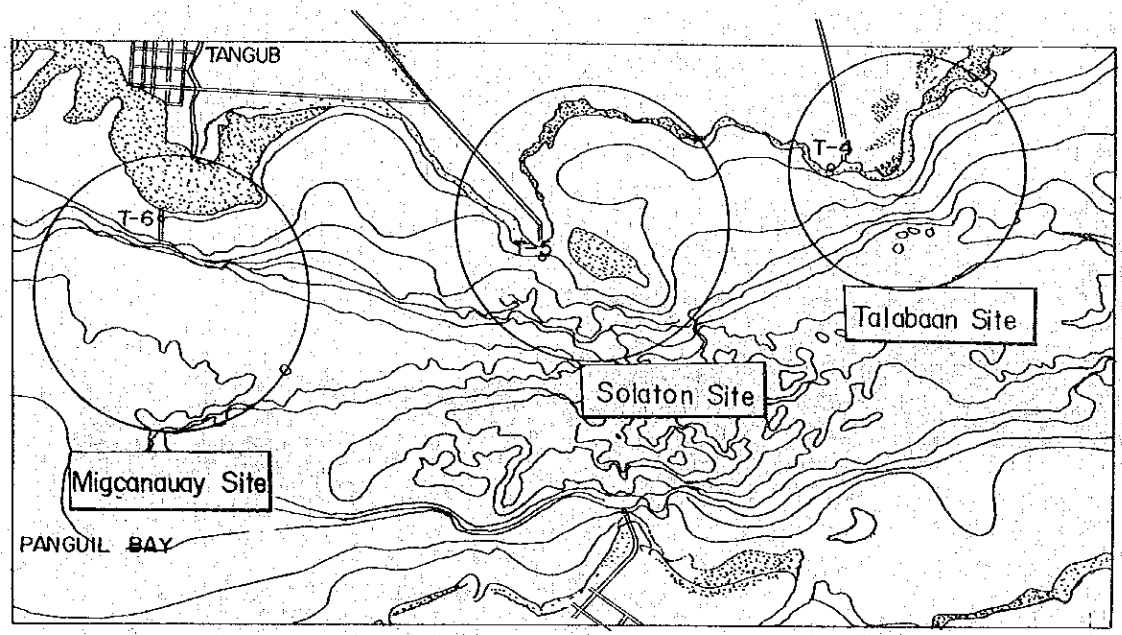



Fig. 5.1 Alternative port sites

### 5.1.2 Solaton Site

This proposed port site is located 5.0 km from Palao of national road. The proposed ore loading pier is to be built 200 m off the Solaton island, so that access bridge shall be constructed between the mainland and this Solaton island, where a stockyard will be provided by minor earthwork. On the shoreside of Silanga peninsula, there is a ferry terminal, whose ferry service is now operating between this Tangub city and Tubod town, opposite across the Panguil Bay. At the proposed berth site, tidal currents exceed 2.2 knots in ebbing and flooding tides, because this area is the narrowest portion in width of the Panguil Bay. This fast currents shall be carefully considered in designing berth orientation and siltation study. On the other hand, the channel between Solaton island and the mainland is not

affected by such high speed currents, so that construction of the access causeway will not be troubled.

Photo 5.1 Ferry wharf at Solaton site

### 5.1.3 Migcanauay Site

This proposed port site is located 5.9 km from Labuyo and 3 km from Palao of national road. The existing causeway stretches about 360 m offshore upto a water depth of 5 m. The shoreline where a reclamation is expected for ore stockyard is covered by coconut trees and mangrove. In the vicinity of causeway, houses, small and large, are densely located, so that the access road between port and national road is to be set outside this populated area. This road will require partly some asphalt pavement for dust prevention. The proposed ore loading pier is to be built at a water depth of 6 m, 120 m offshore from the head

of the existing causeway, requiring 120 m extention of trestle.

Photo 5.2 Existing causeway at Migcanauay

### 5.1.4 Talabaan Site

This proposed port site is located 4 km away from Baga of the national road. The road of this section is earth road with a width of 4 - 6 m. The seabed is sloping with a steep gradient and a water depth of 6 m can be obtained 150 m offshore of the shoreline. This situation gives most economical sea access among three port sites. However, final selection of the proposed port site shall be made inclusive of approach road and stockyard reclamation.

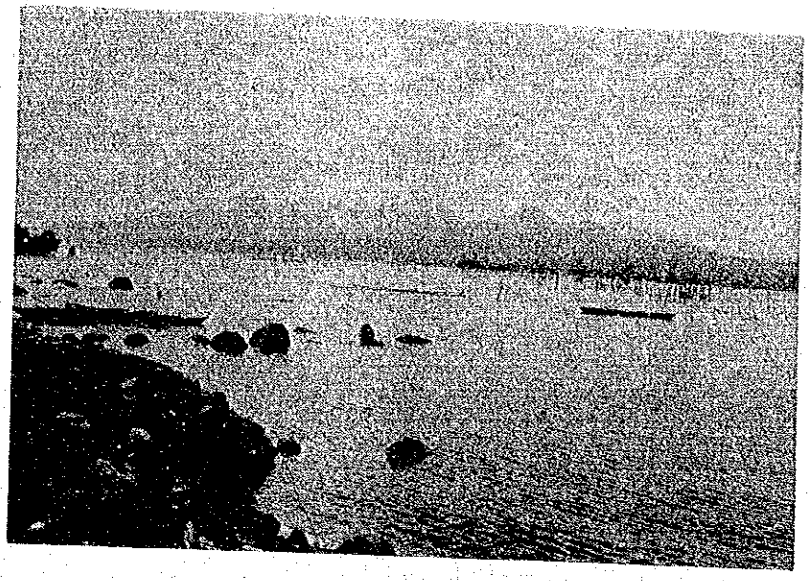
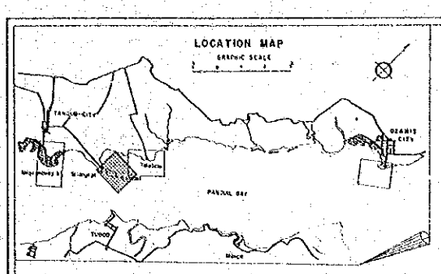


Photo 5.3 Talabaan site

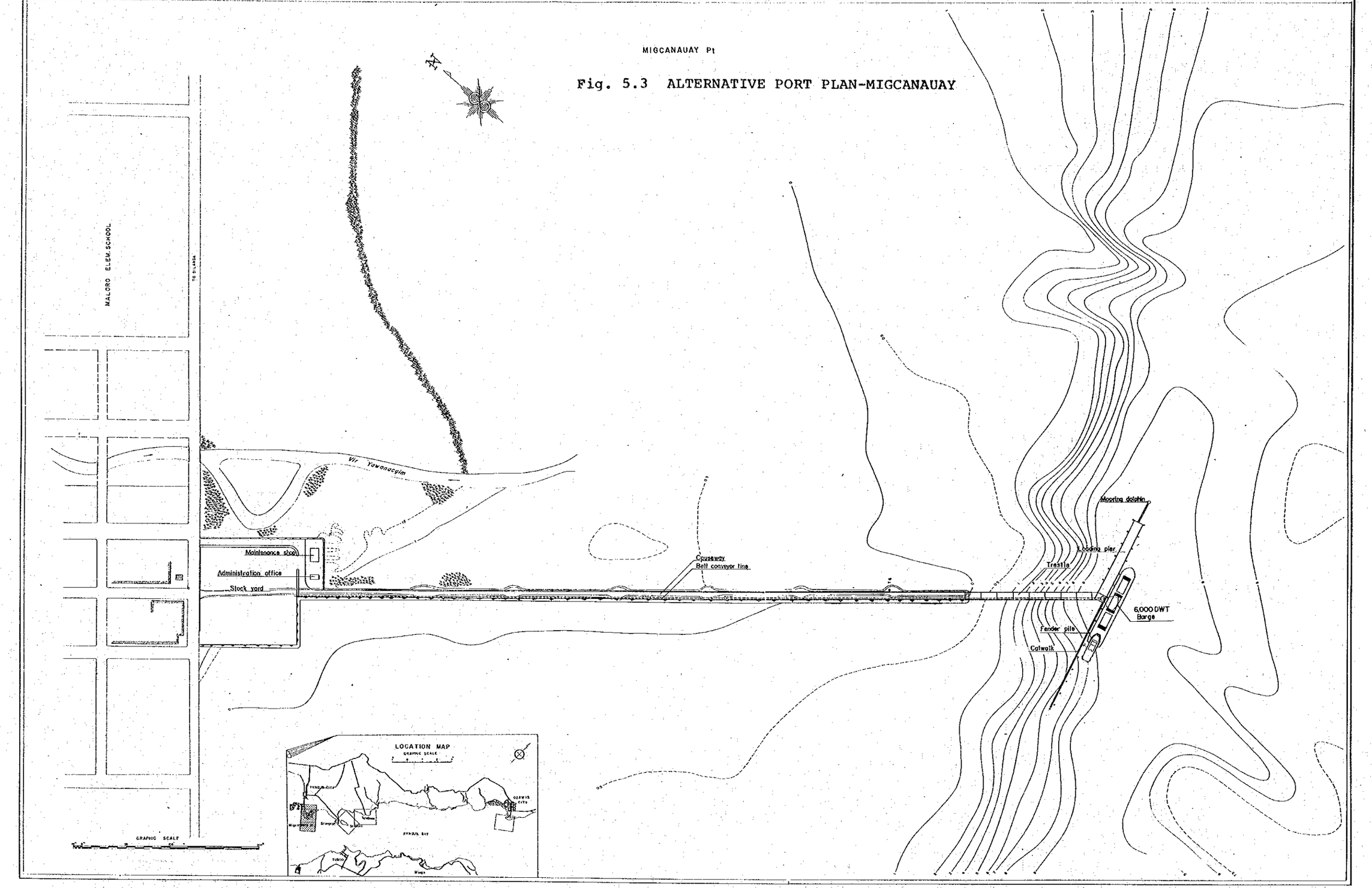



SILANGA PT

Fig. 5.2 ALTERNATIVE PORT PLAN-SOLATON

MIGCANAUAY Pt

Fig. 5.3 ALTERNATIVE PORT PLAN-MIGCANAUAY



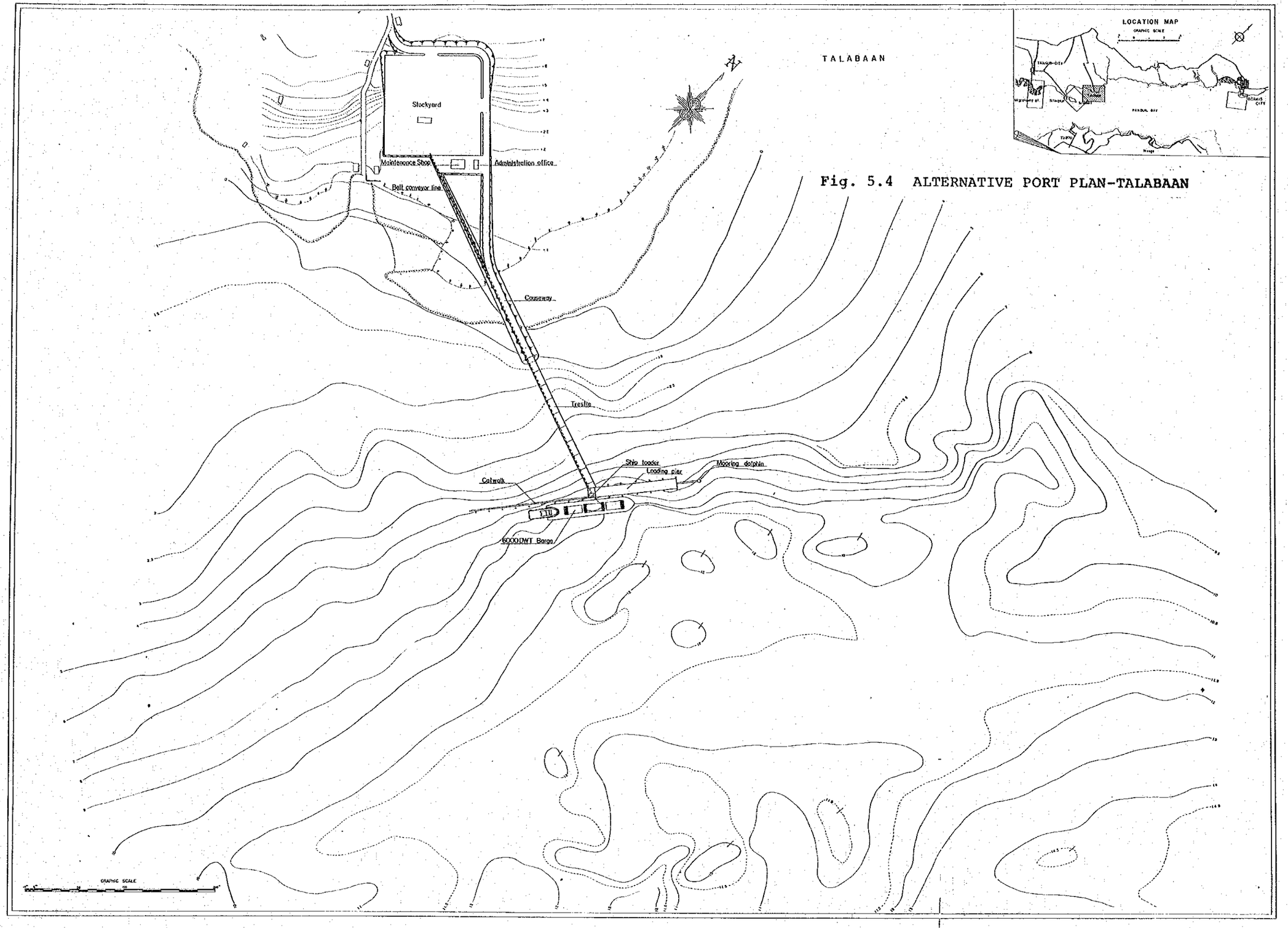



Fig. 5.4 ALTERNATIVE PORT PLAN-TALABAAN

## 5.2 DESIGN CRITERIA OF PORT

### 5.2.1 Design Concept

The project port at Tangub shall serve as an iron ore loading port as well as a public port. The iron ore exploitation is scheduled to complete after 7 years operation, so that in future this Tangub port will function exclusively as a public port of Mindanao. To cater for this requirement, the project port shall be designed to accommodate both ore carring barges and general cargo vessels.

### 5.2.2 Design Criteria

i) Vessel size

The nautical distance between Tangub port and destination (Cagayan de Oro) is about 160 km. To meet this short distance transportation. 2000 - 6000 DWT class barges have been adopted. For public berth, a maximum of 4000 DWT general cargo has been adopted, considering future trend of coastal vessel size (at present 250 - 500 DWT carries are dominating).

ii) Berth number

At the initial stage, one berth each has been planned for ore carrier pier and public pier.

iii) Berth size

The water depth of pier has been determined at 7 m for ore berth and 5 m for cargo berth by adding 10% allowance to a maximum draft to be expected. Berth length has been determined at 200 m for ore berth and 90 m for cargo berth.

iv) Marine condition

The tidal elevation at Tangub port ranges from 0 to 1.67 m. A maximum tidal current is expected to be 2.2 knots near Silanga. But this fast currents are limited in area and in time, so that no fatal affect will come about. Since the proposed berth site is located deep inside the Panguil Bay, no significant waves occur.

v) Soil condition

The subsoil at the berth site is classified as clayey soil.

vi) Turning Basin and approach channel

The diameter of turning basin has determined at 360 m and the width of approach channel has been fixed at 120 m.

## 5.3 ALTERNATIVE PORTS STUDY

Based on the design criteria determined in chapter 5.2, preliminary port design has been made on each proposed berth sites. Fundamentally, the design procedure has proceeded with the principle that domestic construction materials be preferably used and simple construction method be preferably applied.

### MIGCANAUAY SITE (SELECTED)

Port facility consists of stockyard, causeway, trestle and loading pier. A stockyard of 110 m by 110 m is reclaimed adjacent to the existing city road. Its fill material is supplied by land excavations. The existing causeway is widened by 7.50 m and armored by 300 kg stones. Of its total width of 7.50 m, 1.50 m is allocated for installing an belt

conveyor which feeds iron ore to a ship loader and the remaining 6.00 m is allocated for 2-lane service road. Structurally, this causeway is made of rip-rap rock which will be obtained from the nearby river bed. A final approach for the loading of pier has been designed as a trestle structure instead of rock-fill causeway so as not to bring about siltation problem in the berthing area. This trestle is made of concrete piled platform. The loading pier consists of concrete slab platform and wood-piled breasting dolphins. The wood-piled breasting dolphins, though comparatively weak and undurable, has been employed taking into account locality that proper wood material is easily obtained at economic price.

SOLATON SITE

Though the components of port facility in this plan is the same as the Migcanauay plan, the configuration of each component is slightly different. The stockyard is spaced in the Solaton island by landcut and the access to this island from the mainland is provided by approach bridge and causeway. Since this narrow channel is being used by the fishermen living there, the center section of the access has been designed as an navigable structure. The road width in Solaton island is 7.50 m for two way traffic. The loading pier is located 280 m offshore of the Solaton island so as not to involve dredging work. The berthing area is affected by a maximum of 2.2 knots currents, so that changing the seabed by dredging is not desirable in view of siltation problem.

The berth orientation has been set as parallel to dominant directions of tidal currents as possible for easy berthing and stable mooring. Like Migcanauay plan, the trestle with piled foundation has been applied to the approach from Solaton island to the loading pier.

TALABAAN SITE

The stockyard in this plan has been placed on the mainland. The stockyard and the offshore berth is connected by causeway and trestle. The structure type and major dimensions of each component is the same as those of other two plans except for the length required. Among three plans, a total length of causeway and trestle is the shortest.

The major dimensions and construction costs of each component in three alternative plans are summarized as follows:

Table 5.1 MAJOR DIMENSIONS OF ALTERNATIVE PORT PLANS

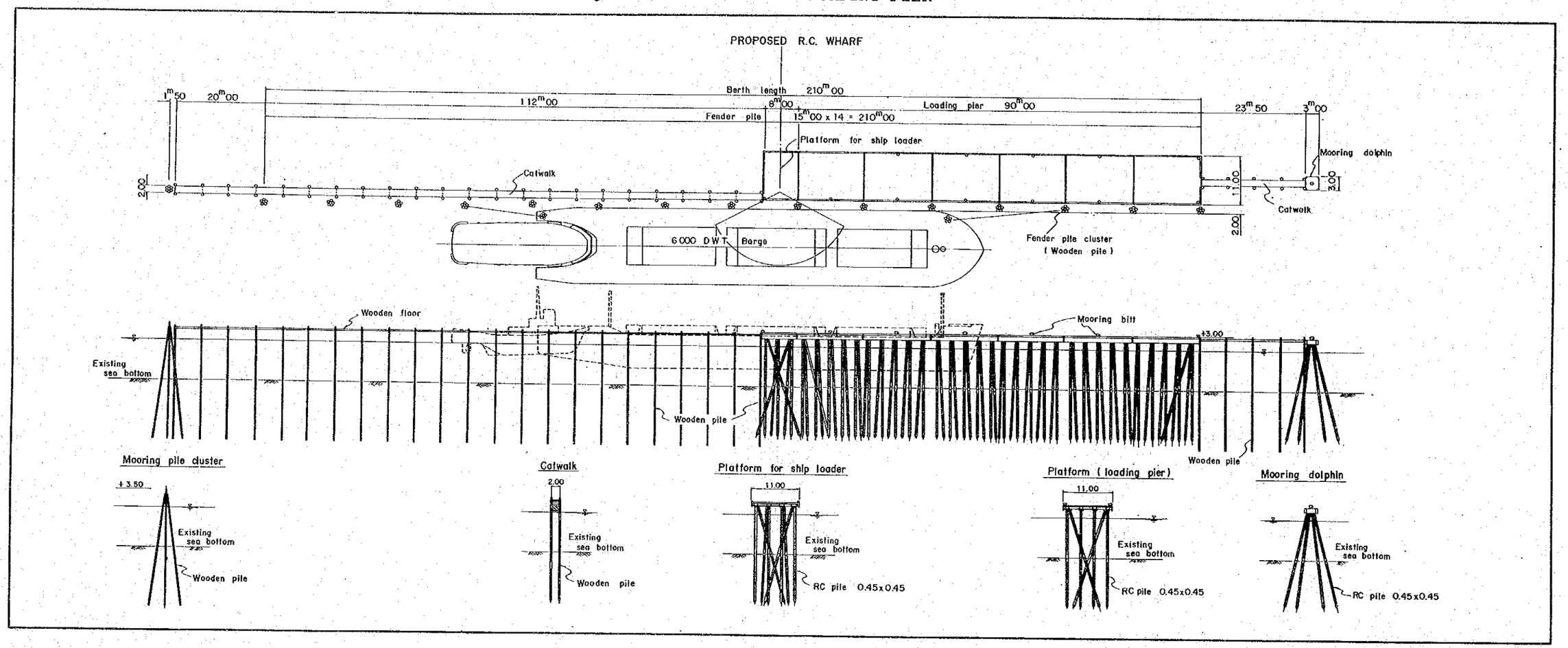
| | Migcanauay | Solaton | Talabaan |
|---|---|---|---|
| i) Stockyard | 12,100 $m^2$ | 12,100 $m^2$ | 12,100 $m^2$ |
| ii) Causeway | 860 m | 100 m + 240 m | 210 m |
| iii) Trestle | 150 m | 280 m | 150 m |
| iv) Pier | 90 m x 11 m | 90 m x 11 m | 90 m x 11 m |

Table 5.2 CONSTRUCTION COST OF ALTERNATIVE PORT PLANS
(unit:million pesos)

| | Migcanauay | Solaton | Talabaan |
|---|---|---|---|
| Port portion | 10.3 | 13.2 | 9.6 |
| Access Road and bridge portion | 1.5 | 2.3 | 3.1 |
| Total | 11.8 | 15.5 | 12.7 |

Solaton site is inferior to other sites in respect to navigation due to fast tidal currents. In terms of construction costs, Talabaan site and Migcanauay site are almost same, cost difference being only 0.9 million pesos. Migcanauay site plan had been already incorporated into Tangub city plan.
Therefore, in view of such situations, Migcanauay plan using the existing causeway has been selected as a final plan.

Fig. 5.5 PROPOSED ORE LOADING PIER



## 5.4 CONSTRUCTION METHOD AND SCHEDULE

Most of the construction material to be used for port development can be obtained in Mindanao. Cement and steel bars are produced in Iligan city, and concrete aggregates are easily obtainable in the nearby river such as Labo river. Rip-rap rock sized between 200 - 300 kg can also be picked up in the vicinity of Tangub city. Lumber and logs of good quality can be purchased from nearby saw mills.

Following the principle of "domestic material first", major port facilities have been designed in R.C. structure rather than steel structure.

The existing 15 m long pier next to the car ferry berth has been considered as a construction pier. Generally the sea condition in the proposed berth site is relatively calm except for a rapid tidal currents. Though, considering the storm condition, the sea inshoreside of Solaton island has been designated as a haven.

Table 5.3 MAJOR CONSTRUCTION QUANTITY OF PROPOSED PORT PLAN (MIGCANAUAY)

| | |
|---|---|
| R. C pile | 264 nos. |
| Wooden pile | 210 nos. |
| Cast in-situ concrete | 750 $m^3$ |
| Rip-rap (300 kg or less) | 4,300 $m^3$ |
| Run-of-quarry | 7,700 $m^3$ |
| Banking | 14,500 $m^3$ |

### i) Piling work

The piling work will be done by diezel hammer of D-22 class. The total construction time will require 4.0 months for R.C pile and 1.0 month for wooden piles.

ii) Concrete work

Butching plant will be installed at Silanga and concrete will be transported by truck or labor up to the site.

iii) Earthwork

11 ton class bulldozer will be capable enough to carry out the earthwork to be expected. To complete a total of 14,500 $m^3$ earthwork within a half year, at least 2 bulldozer will be required.

iv) Rip-rap work

The rip-rap to be picked up at Rv. Labo will be transported to site and cast in pell-mell by bulldozer. This rip-rap work will take about 5 months.

Fig.5-6 PORT CONSTRUCTION SCHEDUCE