THE
INVESTIGATION REPORT
ON
KRUNG DHEB BRIDGE
AND
KRUNG THON BRIDGE

OVERSEAS TECHNICAL COOPERATION AGENCY

THE INVESTIGATION REPORT ON KRUNG DHEB BRIDGE AND KRUNG THON BRIDGE

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INVESTIGATION REPORT ON

KRUNG DHEB BRIDGE AND KRUNG DHON BRIDGE

1. Preface:-

The Krung Sheb Bridge (Refer Fig-1) and the Krung Shon Bridge (Refer Fig-2) now existing in the metropolitan area of Bangkok were built by Fuji Car Manufacturing Co., Ltd., Japan and were duly delivered in 1959 and 1958 respectively.

Now that ten odd years have passed since the erection of these bridges, the Public and Municipal Works Department of Thailand is now required to investigate just how much safety do these bridges maintain against the increased traffic volume and the automobile load in recent years and is further pressed with the need of establishing the proper and expedient measures against the future traffic volume.

The OTCA (Overseas Technical Cooperation Agency, Japan) complying with the request of the Japanese Ambassador to Thailand (Letter of January 12, 1970), decided to send experts as a line of Colombo Plan for a technical cooperation toward this problem.

This report is an investigation report compiled by the said expert team, the investigation of which made between the period of 1 April and 15 April, 1970. The report covers the problem on concrete floor slab and the problem on electrical and mechanical equipment and recommends the respective countermeasures.

The names of the experts dispatched to Thailand are as follows:-

Tetsuo Kunihiro
Kazuya Yokota
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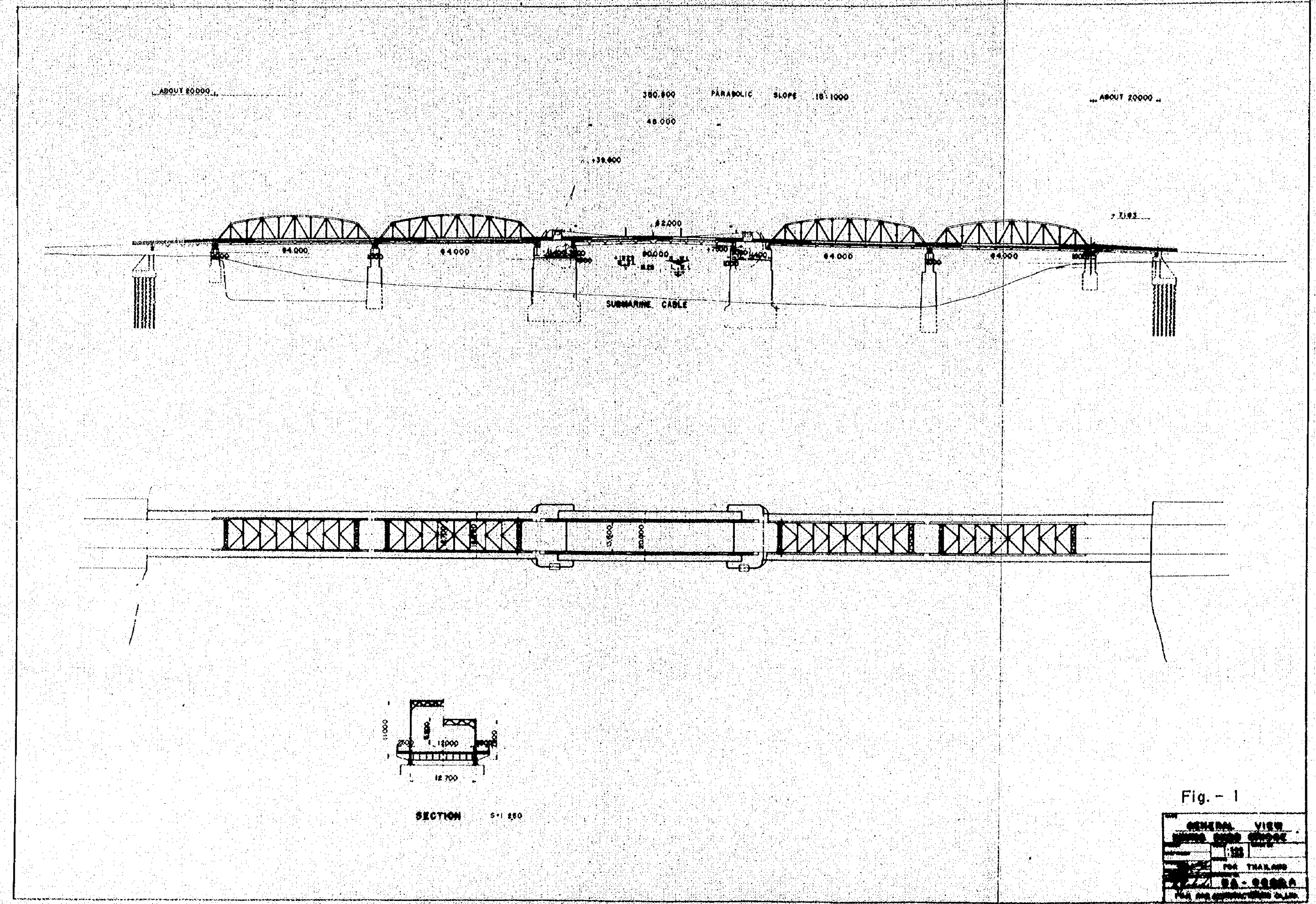

ABOUT 20000
380.800
PARABOLIC
SLOPE
48.000
ABOUT 20000
64.000
64.000
90.000
64.000
64.000
SUBMARINE CABLE
12.700
SECTION
GENERAL VIEW
FOR THAILAND

Fig. - 1

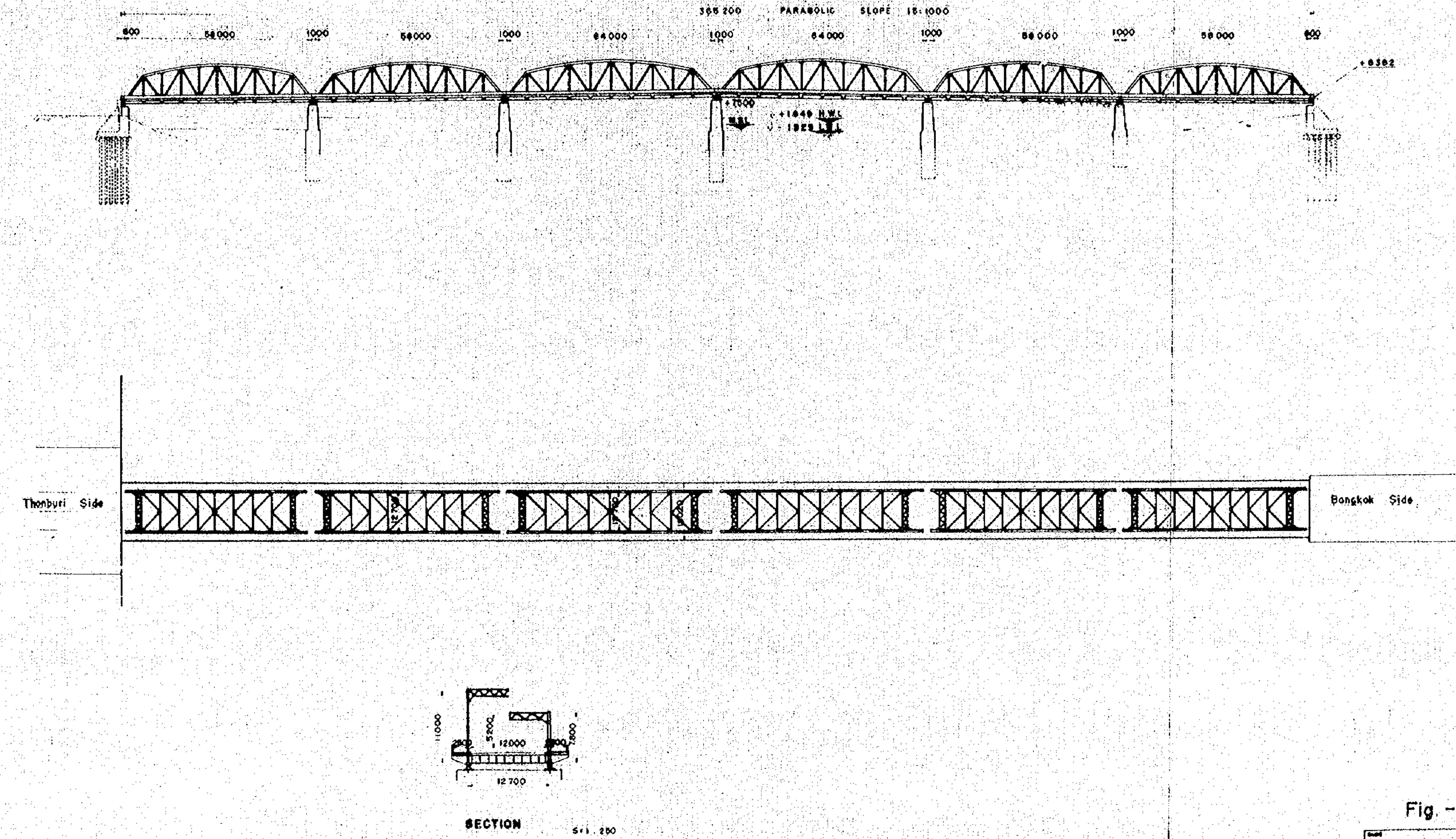


Fig. - 2

GENERAL VIEW
KRUNG DHON BRIDGE
1 : 100
FOR THAILAND

2. Conditions of Design:-

Before entering into investigation and establishment of the countermeasures on the existing bridges, the then design conditions, by which these bridges were built, are given below: The design of these bridges has been made in accordance with the Specifications furnished by the Government of Thailand, but partially with the Standard Specifications for Steel Highway Bridge approved by the Ministry of Construction, Japan in 1939, thereby using the steel complying with the Japanese Industrial Standard (JIS).

2.1 For Truss Span

(1) Length of span: All central spans shall not be less than 60 meters in clearance.

(2) Width of roadway: 12 meters with the footpath 2.5 meters wide on each side.

(3) Construction gauge: Height varies from 5.20 meters at center of the bridge to 4.50 meters at the side.

(4) Live load:

(a) One traffic lane shall be reckoned as 3 meters wide and the number of the traffic lane on these bridges is four.

(b) In one traffic lane of each span, only two 16 ton standard trucks shall be considered in the design (Refer to Fig-3).

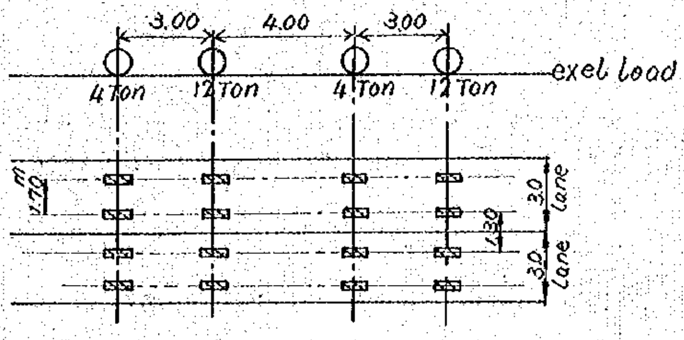


Fig-3 (These figures show axle load)

(c) Only one heavy 29.25 tons tractor truck with semi-trailer shall be considered on each span and the space left on the roadway shall be considered as full of the equivalent.

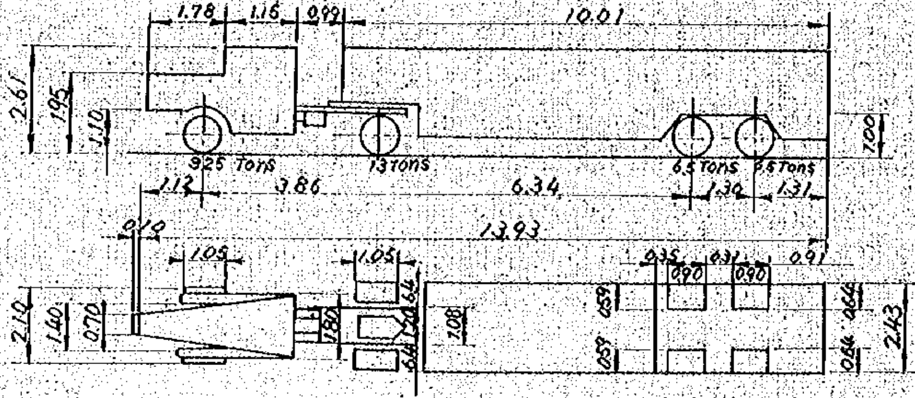


Fig-4 Uniformly distributed load of 400 kg/m^2

(d) Uniformly distributed load of 300 kg/m^2 on the footpaths.

(e) Live load stresses, without said equivalent uniform load, shall be increased by an impact factor as shown hereunder:-

$$i = \frac{20}{L + 60}$$

where: i = impact factor
L = loading length in meters

(5) Wind load: 200 kg/m^2

(6) Temperature range: from 10°C to 65°C.

(7) Water & Electricity mains: Provision shall be made for the future fixing of steel water mains, 50 cms diameter, under the footpath on one side of the bridge, and a trough for holding electric wires on the other.

2.2 For Bascule span

(1) Length of span: There must be a clear width of not less than 48.00 meters at the top of the elevated leaves.

(2) Height of Bridge: The lowest part of girder shall be at the level of +7.50 meters (M.S.L.) for the center of span.

(3) Elevation of Bascule Bridge: The elevation of Bascule span is to be operated by an electric motor with an ordinary internal combustion engine as a stand-by. The time for operation shall not exceed 3 minutes by the electric

motor & 15 minutes by the engine. The structure considered in this design is double leaves trunnion bascule highway bridge as illustrated in Fig-1 (Dwg. No. BA-0009A).

There are two concrete piers, each pier carrying one leaf and its appurtenant machinery.

Each leaf is operated by electric motor geared to pinions which engage racks on the girder ends.

When in the lowered position and open for the land traffic, the two leaves are locked together at the center. Each leaf is supported by live load shoe and trunnion and the end of leaf connected to pier by rear lock.

The bascule bridge under the live loading is the cantilever and the affect of shear lock shall also be considered. When the bridge is raised for the river traffic, the angle of opening makes 72° against a horizontal line, the time for full opening being 100 seconds.

2.3 Allowable Stress

According to the Standard Specification for the Steel highway Bridge, the following allowable stresses are duly adopted in the design.

(a) Allowable stress of structural steel (SS41)

(1) Axial tensile stress (net section)

$$\delta = 1,300 \text{ kg/cm}^2$$

(2) Axial compressive stress (gross section)

$$0 < \frac{l}{r} \leq 110 \qquad \delta = 1200 - 0.05\left(\frac{l}{r}\right)^2 \text{ kg/cm}^2$$

$$\frac{l}{r} > 110 \qquad \delta = 7,200,000\left(\frac{r}{\ell}\right)^2 \text{ kg/cm}^2$$

where: r = Radius of gyration (cm)

l = Length of member (cm)

Axial compressive member in the splice member (gross section)

$$\delta = 1,200 \text{ kg/cm}^2$$

(3) Bending stress

Tensill fiber of floor beam (net section)

$\delta = 1{,}300\ kg/cm^2$

Compressive fiber of floor beam (gross section)

$\delta = 1{,}200 - 0.5\ (\frac{l}{b})^2\ kg/cm^2$

Where l = Distance between fixed points of flange (cm)

b = Width of flange (cm)

When the reinforced concrete slab, etc. is directly fixed to the compressive flange of floor beam.

$\delta = 1{,}200\ kg/cm^2$

Pin $\delta = 1{,}900\ kg/cm^2$

(4) Shearing stress

Web of plate girder (net section);

$\tau = 1{,}000\ kg/cm^2$

Shop rivet and pin;

$\tau = 1{,}000\ kg/cm^2$

Field rivet and finishing bolt;

$\tau = 800\ kg/cm^2$

Anchor bolt;

$\tau = 600\ kg/cm^2$

(5) Bearing stress

Bearing stress of rivet hole;

Shop rivet $\delta = 2{,}200\ kg/cm^2$

Field rivet and finishing bolt $\delta = 1{,}800\ kg/cm^2$

Bearing stress of pin hole;

$\delta = 1{,}600\ kg/cm^2$

Roller;

$\delta = 45\ d\ \ kg/cm^2$

where d = Diameter of roller (cm)

Line bearing;

$\delta = 80\ (\frac{r_1\ r_2}{r_1 - r_2})\ kg/cm$

where r_1 = Radius of concave surface

r_2 = Radius of convex surface

(b) Allowable stress of Cast steel

Same as the structural steel.

(c) Allowable stress of cast iron

(1) Bearing stress calculated by Hertz formula.

$\delta = 4,500$ kg/cm^2

(2) Bending stress

(Tensile fiber $\delta \doteqdot 400$ kg/cm^2
(
(Compressive fiber $\delta = 800$ kg/cm^2

(3) Shearing stress

$\tau = 300$ kg/cm^2

(d) Allowable stress of concrete

Compressive fiber stress due to bending

(Including when accompanied by the axial compressive stress);

$$\delta_a = \frac{\delta 28}{3} \quad \text{however} \quad \delta_a \leqq 70 \text{ kg/cm}^2$$

(e) Allowable stress of weld

(1) Tensile stress $\delta = 1,300$ kg/cm^2

(2) Compressive stress $\delta = 1,200$ kg/cm^2

(3) Shearing stress $\tau = 800$ kg/cm^2

3. Floor slab

3.1 Present condition

Cracks are seen in the concrete floor slab of these bridges as shown in Fig-5 (investigated by the Public and Municipal Works Dept.) and the photographs: Figs. 6, 7 and 8.

The present conditions as seen externally may be summarized as followings:

1) The direction of crack is wholly perpendicular to the bridge axis with the exception of a part (No. 5 span from Bangkok side) of Krung Shon Bridge.

2) It seems that the cracks appeared at the lower surface of floor slab of roadway are minor ones which being about less than 0.2 mm wide.

3) On the upper surface of roadway, cracks are seen on the pavement surface of the cross beam position only.

4) On the footpath, cracks were seen on both the upper surface and lower surface.

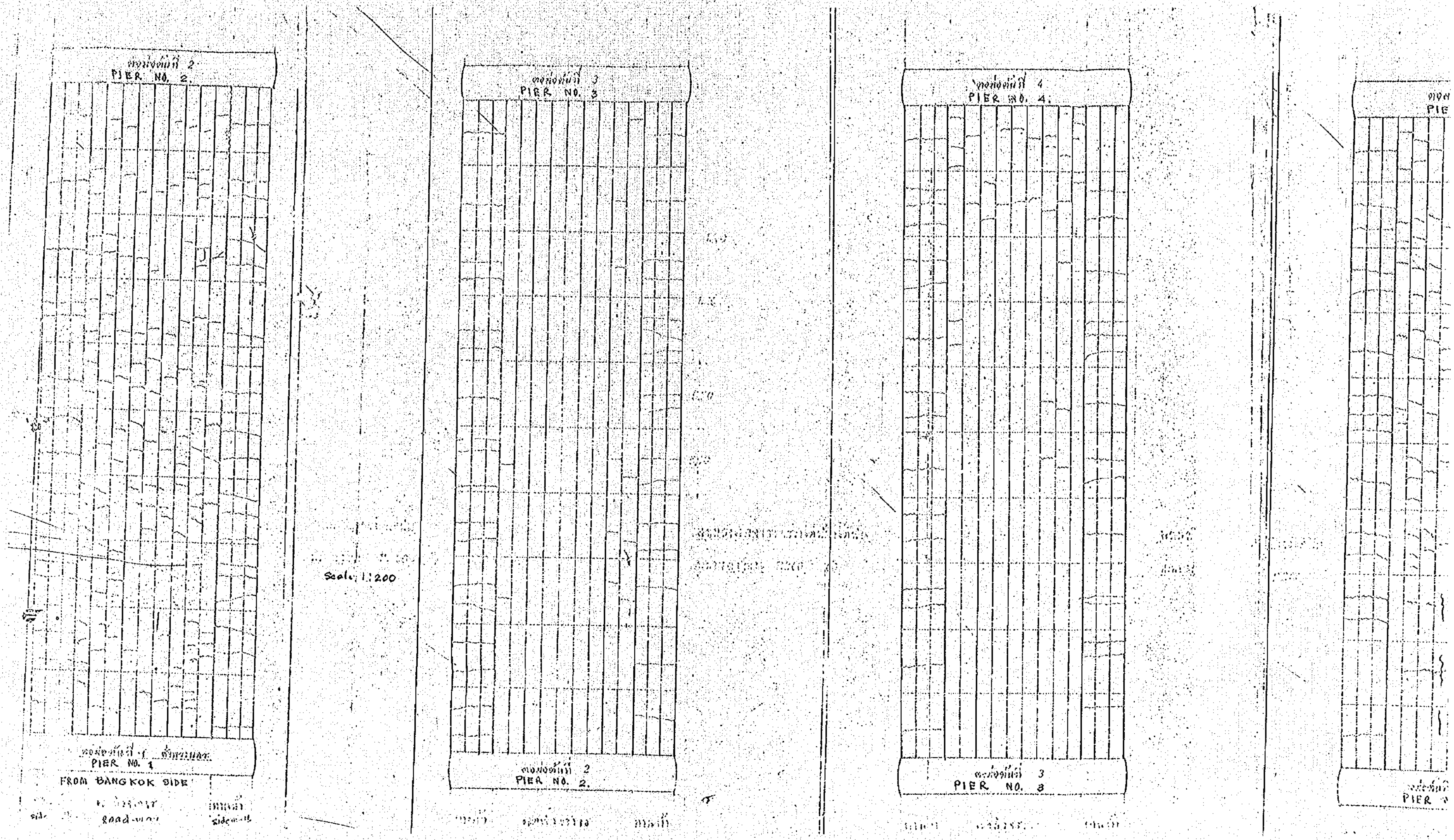
5) In Nondhaburi Bridge which is of the same structure as Krung Sheb Bridge and the Krung Shon Bridge erected by the same builder at the same period of time, the traffic volume was rather low and the cracks almost none.

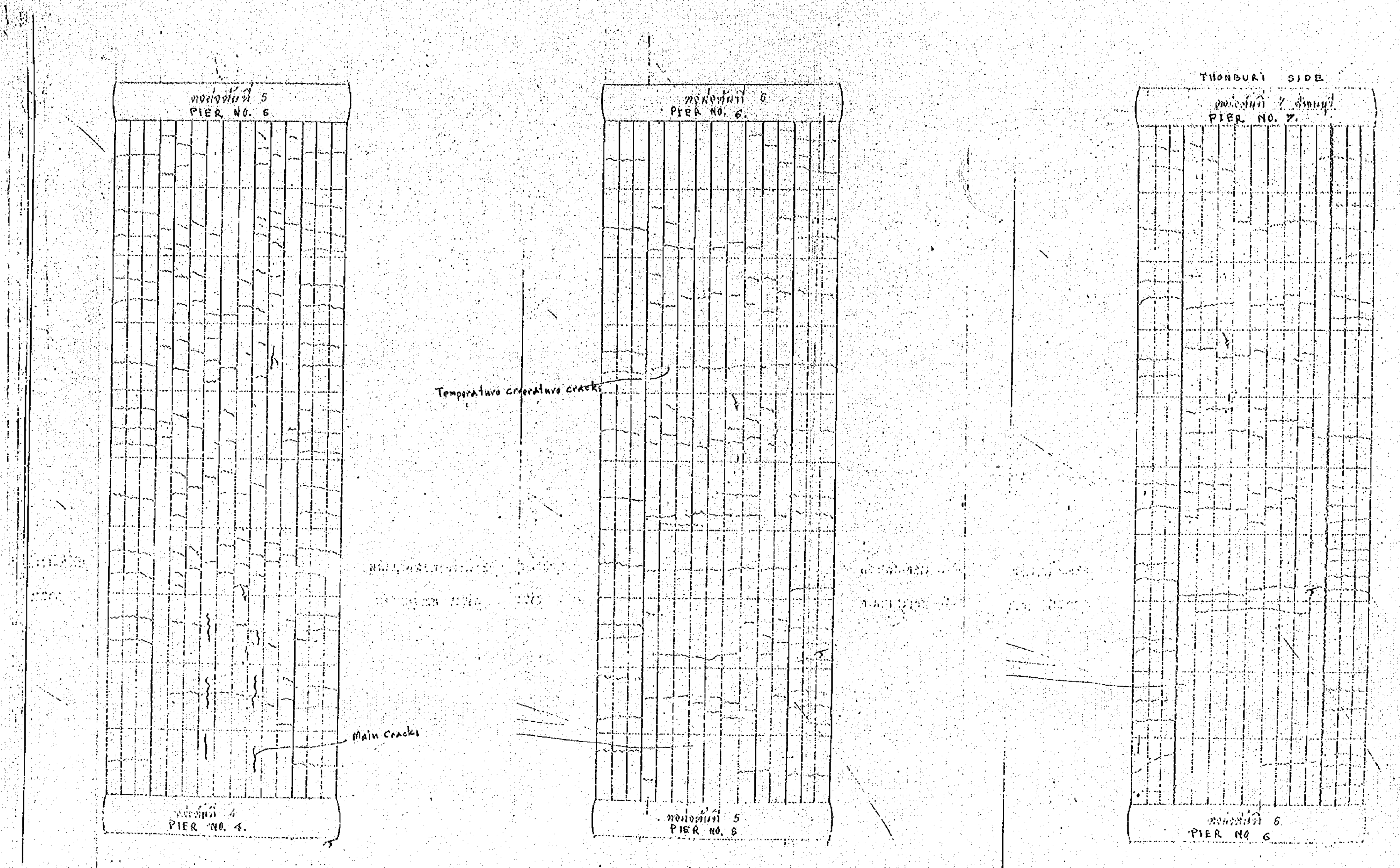
Generally, the tensile resistance of concrete is small, hence small cracks such as shrinkage cracks, etc. cannot be avoided. Further, due to large increase of automobile load in recent years, cracks are often seen in Japan, too.

As for the floor slab, any external changes such as flaking off of concrete, exposure of steel bar and collapse of concrete, etc. except such crack as mentioned above were not found.

Hereinafter, the cause of such cracking shall be investigated and the countermeasures described in due order.

On the top surface of the existing bridge, it may be considered that the pavement work is liable to wear and an automobile slippery accident has occurred. In this respect, it may be necessary that every feasible measure shall be taken for the pavement of the bridge surface in order to secure the traffic safety.


PIER NO. 2
PIER NO. 3
PIER NO. 4
PIER NO. 1
FROM BANGKOK SIDE
Road-way
Scale 1:200
PIER NO. 2
PIER NO. 3



PIER NO. 5
PIER NO. 4.
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PIER NO. 5
THONBURI SIDE
PIER NO. 7.
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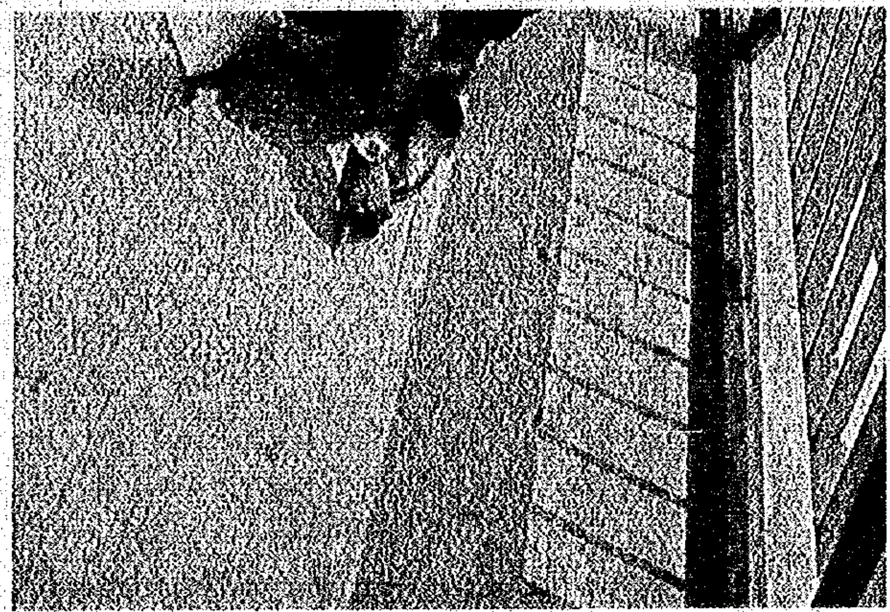
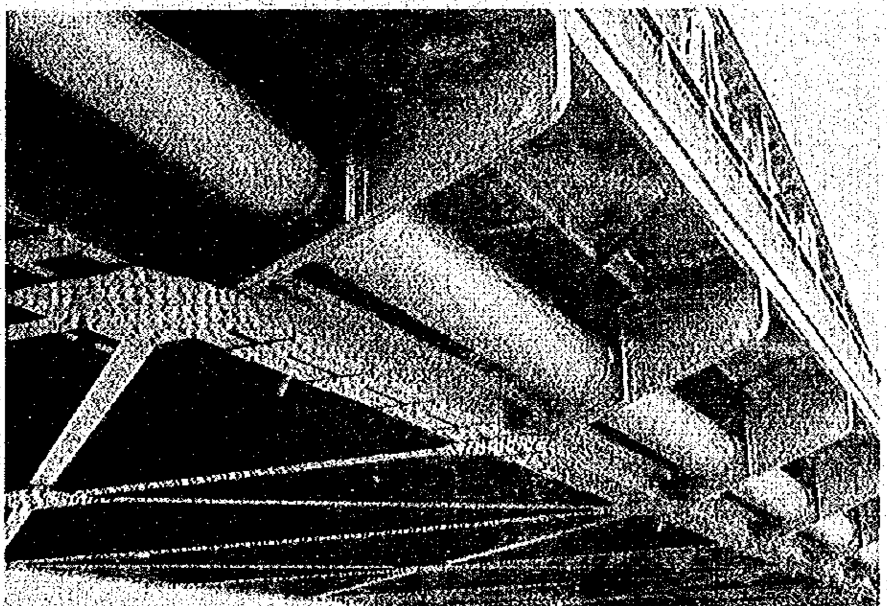
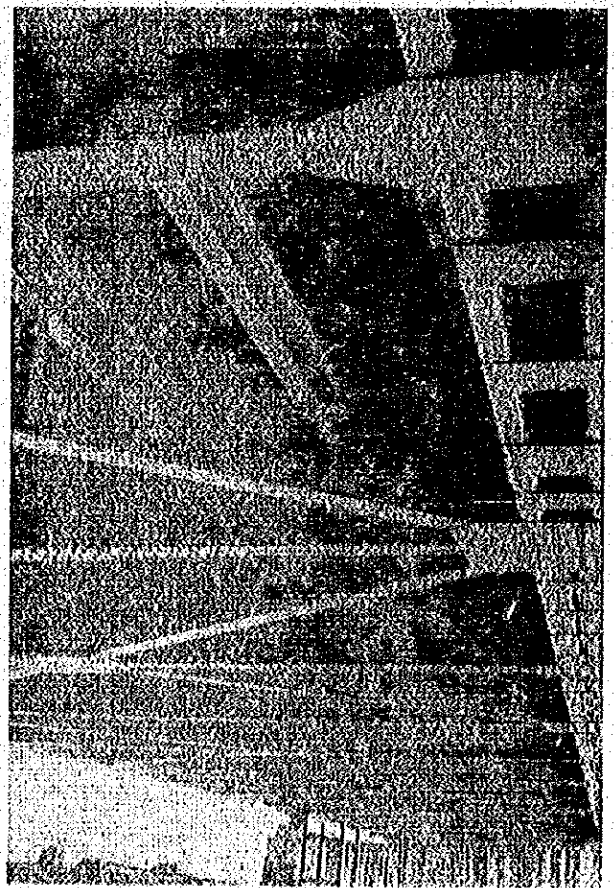
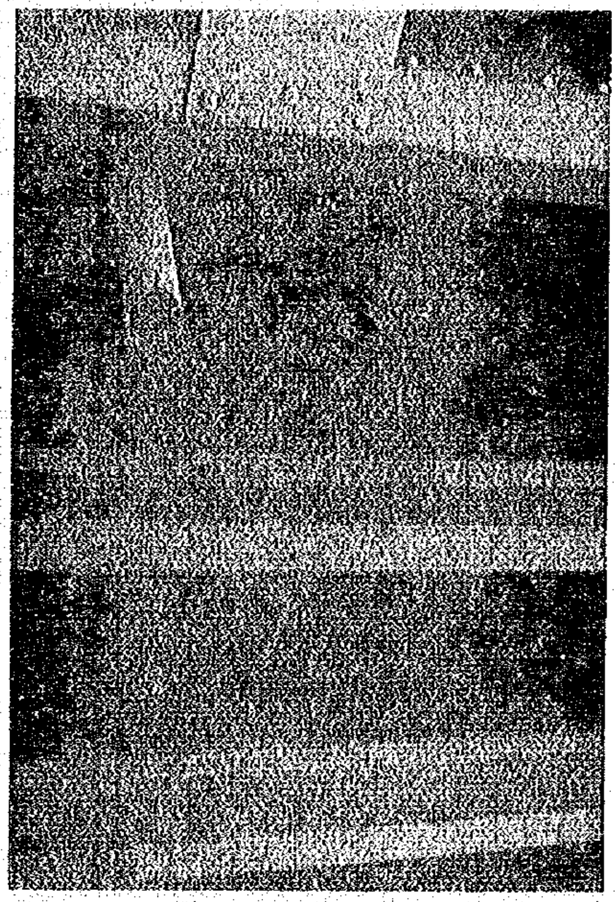
Temperaturo crderaturo cracks
Main cracks





Fig—6





Fig－7

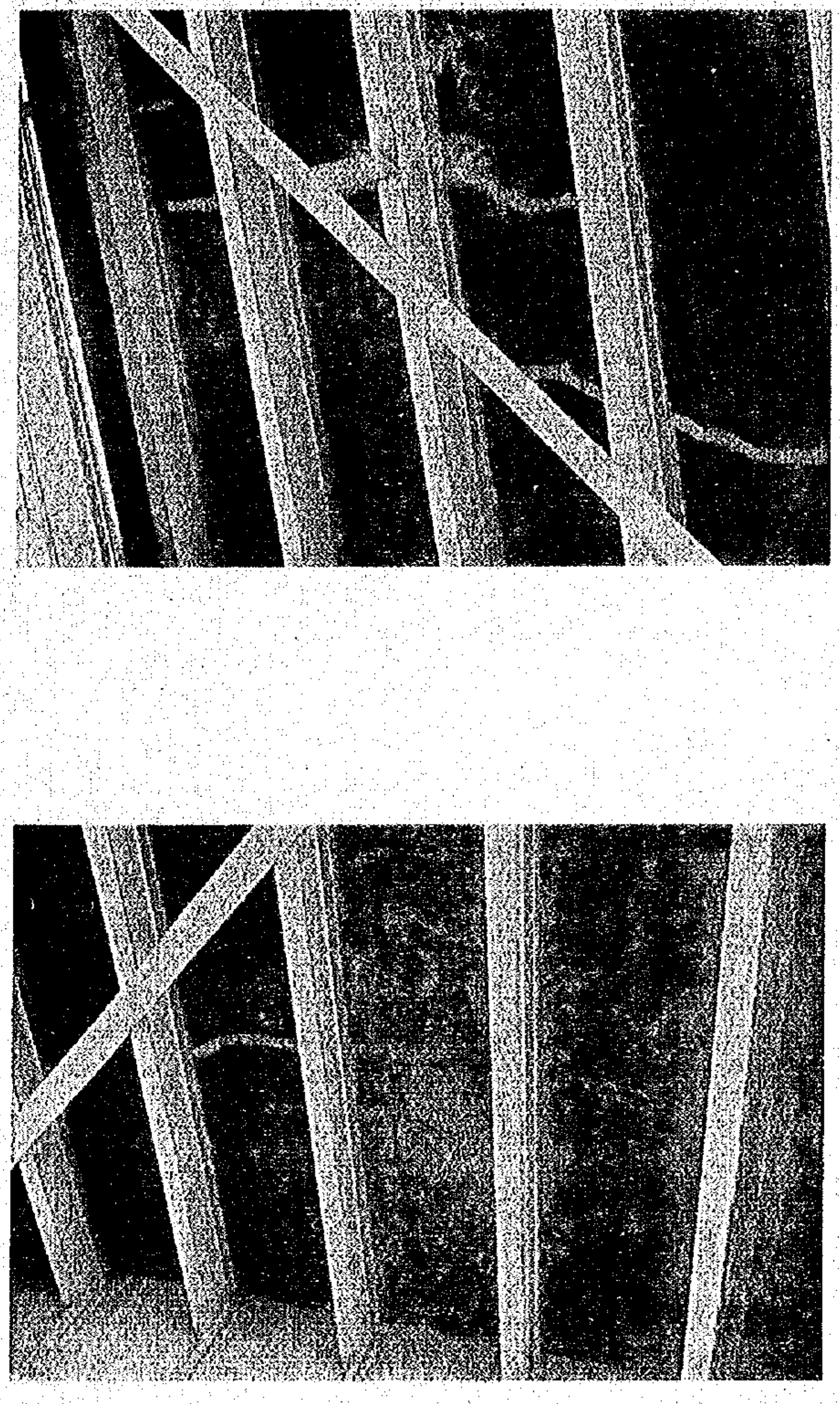


Fig – 8

3.2 Cause of crack

Not only one but also a combination of several factors as given below is considered as the cause of crack.

(1) As one wheel load, vehicles having more than the design load have passed over the bridge.

(2) Due to improvement of automobile tires in quality, the grounding area of tire has been reduced.

(3) The shrinkage stress has occurred in the concrete structure and the complete prevention of the shrinkage crack due to the above stress is very difficult.

(4) The floor slab also receives a portion of tensile stress of the main truss. Because that acts as a part of truss lower chord member.

(5) By the composite action due to adhesion of stringer and floor slab, the tensile stress works on the floor slab on the cross beam.

(6) As has not been generally considered in the then design stage, there is now in need of some more reinforcements.

Steel bars shall be the bridge axis direction stress of the floor slab. According to the Japanese Design Specifications for the Steel Highway Bridge at the time of designing these bridges, it has been so considered that the required amount of the reinforcement steel bars for the bridge axis direction may be approximately 25% of the required amount for that of the perpendicular direction to the bridge axis. However, the Tentative Standard on the design of reinforced concrete floor slab established in 1968 in Japan now stipulates by the revision that the reinforced steel bars to the bridge axis direction be more increased than the previous required amount.

3.3 Countermeasures:-

As the measures toward these cracks, the present measures and the permanent measures shall be given respectively as mentioned below:

(1) The present measures

① Where cracks are found on the surface of the pavement, such measures as to prevent water from entering within from these cracks shall be taken.

② Keep observation on whether the existing cracks grow larger than the present ones (Observe at least once in two months).

We think that, as a temporary means, the above measures shall be carried into effect and when the crack becomes tortoise shell pattern and the extricated lime seeps from there in the future, then some permanent measures may be taken up accordingly.

As for ① above, the following measures as in Fig-9 and Fig-10 are recommended.

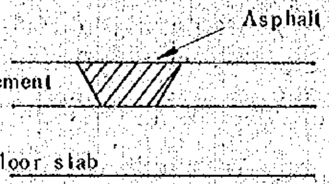


Fig-9

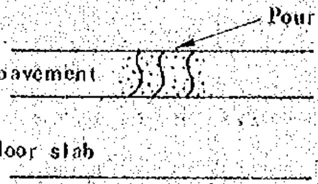


Fig-10

(2) Permanent measures

The following ① Over Lay method which is considered least expensive, and yet very effective one, is recommended. According to the circumstances, however, the ②, ③ and ④ measures are considered also effective.

① Over Lay method

1) Removal of the existing asphalt pavement.

2) Full cleaning of concrete floor slab surfaces.

3) Such measures as making better adhesion between existing concrete floor slab surface and newly casting concrete shall be taken. For instance, apply wire brush over the top surface of existing floor slab, thereby making it rough surface.

4) Cast approximately 6 cm thick concrete of small shrinkage on the existing floor slab.

5) Put steel wire meshes of about 6 mm. dia. into the new concrete.

6) Further, in order to prevent shrinkage crack of new concrete, provide joint of about 10 mm wide at the locations over the cross beam. To this joint, watertight joint agent shall be filled in.

7) For a large crack in width (assumed general limit: 0.3 mm in general location, 0.2 mm in an easily corrodible location and 0.1 mm in especially corrodible location such as immersed in sea water), epoxy resin shall be filled in.

If the above work process has been accomplished properly, the satisfactory results can be expected with the least cost. However, a temporary suspension of traffic even though partially may be necessary.

In order to shorten the period of traffic suspension, it is recommended that the cement of quick hardening quality be used. In Japan, much quicker hardening cement* than the ordinary one has been developed (the subject cement may be bought at about Y11,000/ton in and around Tokyo.)

The effect of this work method depends upon the relative adhesive strength of new and old concrete. In order to confirm the adhesion effect, the static and the fatigue testing, etc. by means of model may be one of the effective means. However, the most desirable is that this work process be put into practice in a portion of the field spot, thereby making good effect to the actual bridge testing under the actual traffic circumstances.

② Method of Additional Provision of Stringers:- (Refer to Fig-11)

As the second method, another stringer shall be provided between the existing two stringers and the gap space between floor slab and upper flange of the new stringer filled by epoxy, thereby assuring complete adhesion between floor slab and upper flange. By this work method, the load carrying capacity of the floor slab may be greatly increased. This work method has an advantage of accomplishing the work without suspending the traffic. The working cost, however, would become considerably higher.

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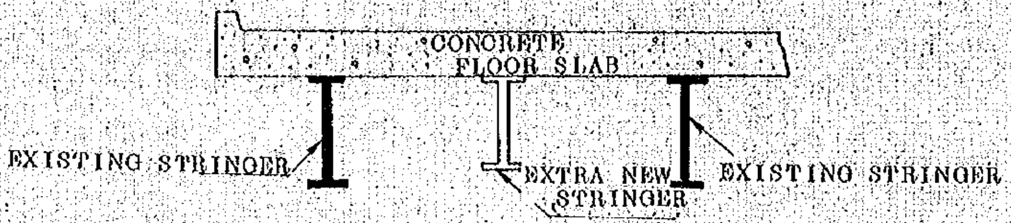
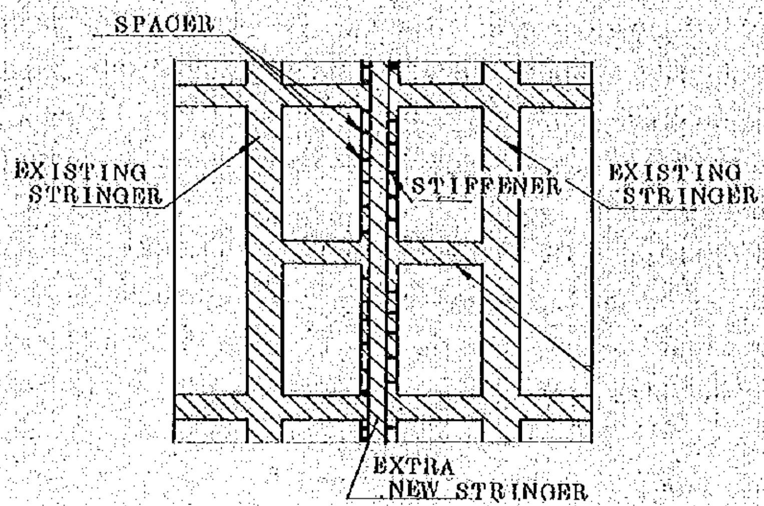
* For instance, ASANO SUPER VELO CEMENT.

ROUGH WORK PLAN OF EXTRA PROVISION

OF STRINGERS





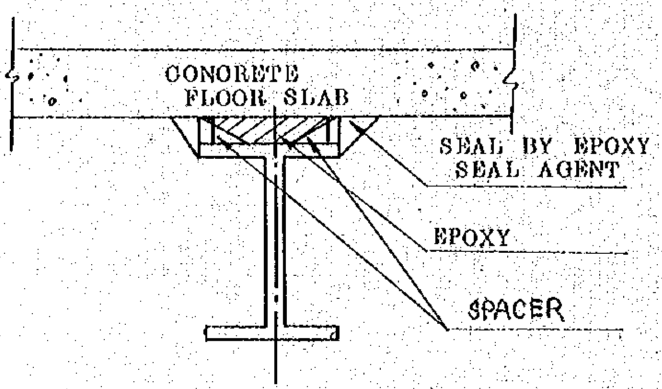


Fig-11

③ Reinforcing Method by means of Steel Plate Bonding (Refer to Figs. 12 & 13)

The steel plate with the load carrying capacity shall be bonded to the tension side surfaces of the cracked floor slab by using of hole-in-anchor and support, thereby reinforcing the floor slab.

There are two kinds, namely:-

a) Fill in method:

Make a gap of about 2 ~ 4 mm between floor slab surface and steel plate, in which epoxy grouting agent filled.

b) Pressure-contact method:

Coat the contact surfaces of floor slab and steel plate with epoxy resin and then both are firmly contacted together by pressure.

This work method has an advantage of accomplishing the work without suspending the traffic. The working cost, however, would become considerably higher.

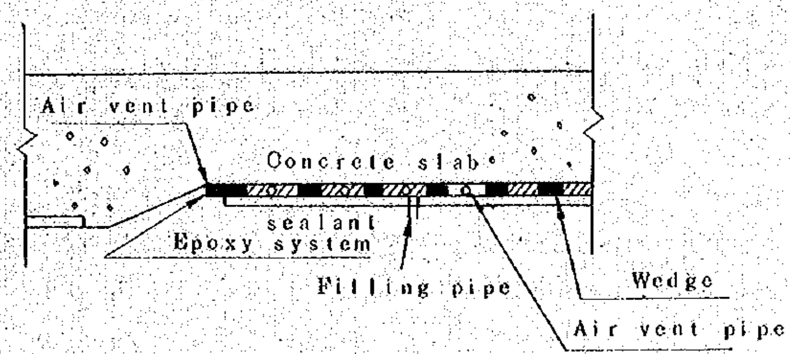


Fig-12 Fill in method

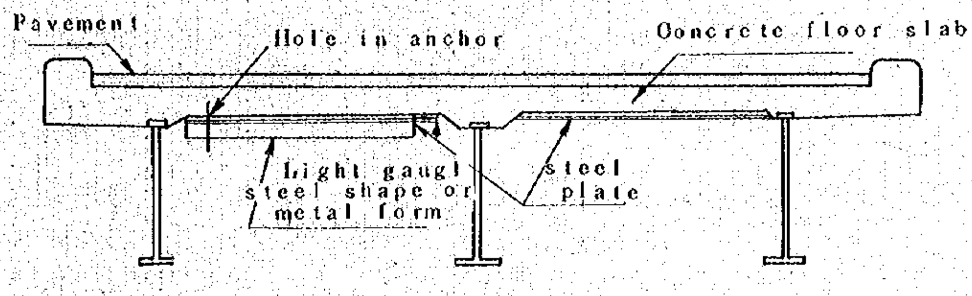


Fig-13 Pressure contact method

④ Floor Slab Renewal Method:-

The existing floor slab shall be removed and the new floor slab installed instead. In order to assure the sufficient reinforcing effect, this method may be most satisfactory.

However, this requires suspension of traffic for a considerably long time. In this case the newly installed floor slab would be two kinds, namely:-

1. Reinforced concrete floor slab
2. Grating floor slab

The grating floor slab is light in weight, which is advantageous in relation to the main structure components. But, the cost of construction would be higher than the reinforced concrete.

(3) Examination of stresses after reinforcement

The load carrying capacity and strength of the bridge after having been reinforced by the above (2)-① method shall be examined herein.

The calculation shall be made on 64 meter span and the detailed calculations attached to the end of this Report as an appendix.

Assumption of calculation:

Sead load: After removal of pavement by 4 cm, provide floor slab concrete by 6 cm instead.

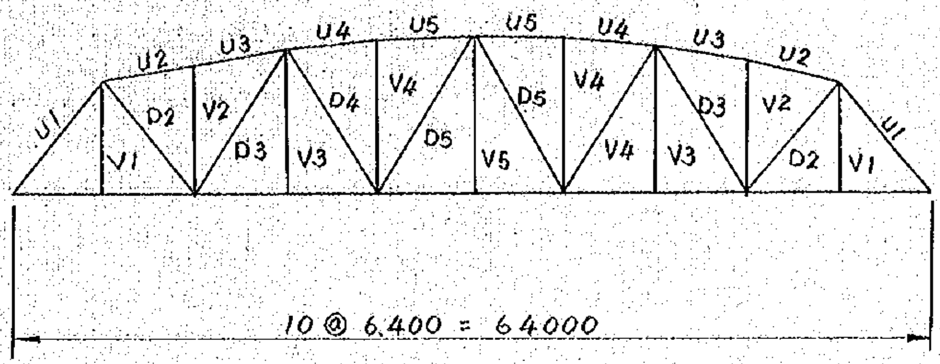
Live load: AASHO H20-S16-44 loading shall be used. However, the clause concerning Reduction against 4 traffic lanes stipulated in AASHO shall be neglected and calculated as 100%.

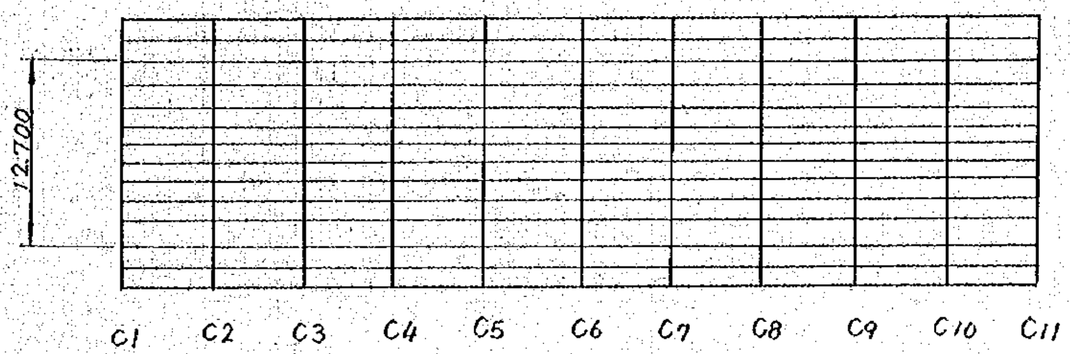
The allowable stress shown in the Standard Specification now adopted in Japan shall be observed.

The calculation result of the stresses after reinforcement shall be as follow:-

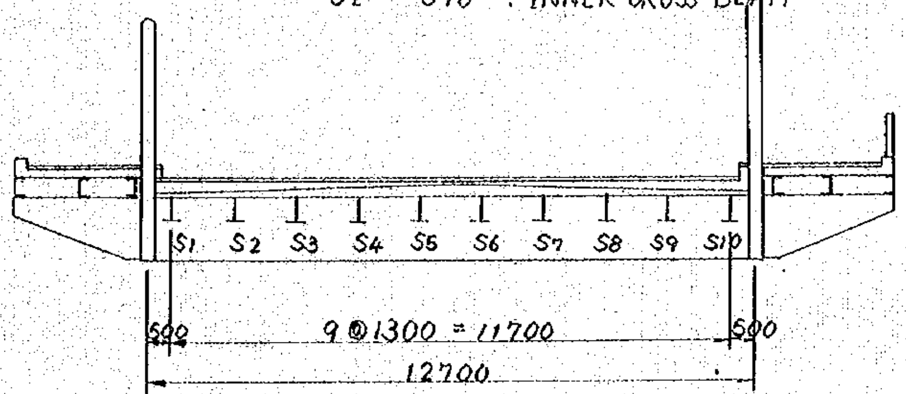
Floor slab

	Concrete	Steel bar
Stress perpendicular to bridge axis		
At Center of span	$\delta_c = 31$ kg/cm^2	$\delta_s = 857$ kg/cm^2
At Support	$\delta_c = 32$ kg/cm^2	$\delta_s = 1{,}155$ kg/cm^2
Stress parallel to bridge axis	$\delta_c = 30$ kg/cm^2	$\delta_s = 2{,}019$ kg/cm^2





C1 , C11, : END CROSS BEAM
C2 ~ C10 : INNER CROSS BEAM



S1. S10 SIDE STRINGER
S2 ~ S9 INNER STRINGER

Fig-14

Unit: kg/cm^2

	Dead load stress	Live load stress	Max. stress	Allow. stress
INNER STRINGER	286	922	1208	1300
SIDE "	286	561	847	1300
INNER CROSS BEAM				
δ_c (Compression)	434	793	1227	1300
δ_t (Tension)	499	912	1411	1400
END CROSS BEAM				
δ_c (Compression)	306	921	1227	1300
δ_t (Tension)	351	1055	1406	1400
MAIN TRUSS				
U_1	661	144	805	1132
U_2	736	266	1002	1240
U_3	731	264	995	1241
U_4	768	277	1045	1232
U_5	766	277	1043	1232
L_1, L_2	751	257	1008	1400
L_3, L_4	926	334	1260	1400
L_5	922	332	1254	1400
D_2	849	367	1216	1400
D_3	524	282	806	959
D_4	440	357	797	1400
D_5	127	277	404	923
V_1, V_3, V_5	593	482	1075	1400
V_2	221	74	295	1400
V_4	262	95	357	1400

From above calculation results, beyond the allowable stress are the steel bars in the bridge axis direction and the tension flange of cross beam. As to the cross beam, however, the excess in stress is very minute and assumed as causing no problem. While, the steel bars in the direction of bridge axis of floor slab exceed by about 40% of their allowable stresses.

In order to keep the stress of the steel bars in the bridge axis direction within the allowable stress of 1,400 kg/cm^2, the thickness of newly casting concrete shall be made considerably bigger. If doing so, the dead load stress in the main structure increases considerably, which would make the application of this work method difficult. The main reason for recommending this 'Over Lay' method is that this work method is very economical. As above mentioned, though the stress of the steel bars of bridge axis direction exceeds its allowable limit, the safety factor of about 1.2 (the steel bars used in this bridge is SR24 class, and the yielding strength of the steel bars assumed more than 2,400 kg/cm^2. Hence, it possesses the safety factor of $\frac{2400}{2019} \fallingdotseq 1.2$) remains against the yield point.

Therefore, we consider it the best plan to adopt the economic feasibility of this work method, even if paying the sacrifice of reducing a little portion of the safety factor and thus recommend this 'Over Lay' method.

4. Mechnical & Electrical Equipment of Bascule Driving Device

4.1 Present situation

In order to assure the good driving operation, an inspection and an investigation were conducted on the state and performance of the driving machinery according to the check sheet. Of which, the main items are depicted as follow:-

(1) Trunnion

① Amperage value at the time of driving:-

There is almost no wide difference in the amperage value of motor required for opening and closing the bascule bridge between Bangkok side and Tonburi side. The amperage was 50 ~ 55 Amp. at the time of driving 35 HP motor. The rated current of the motor is 70 Amp. and for the driving condition of the motor, it is below 25% load. Hence, the value shown is normal compared with the design value.*

② The upper clearance of the bearing was 0.6 ~ 0.75 mm, and the value remained the same as originally made and considered normal. The later-alwise clearance was approximately 0.3 mm.

③ No other particular phenomenon such as jolting motion, etc. was to be seen.

(2) Pin and Shoe

① The vertical movement of leaf front end at Bangkok upstream side when the Shear Lock Pin has been inserted was a few millimeters.

② The pin and the pin hole were examined after the Rear Lock Pin has been removed. There was no traces of steady contact there.

③ The contacting width of live load shoe was as shown below in Bangkok side.

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* The characteristic value of the motor (Certified horsepower ; 35 HP)

Load :	0	25%	50%	75%	100%	125%
Amperes :	54.7	55.6	58.0	63.0	69.0	76.7

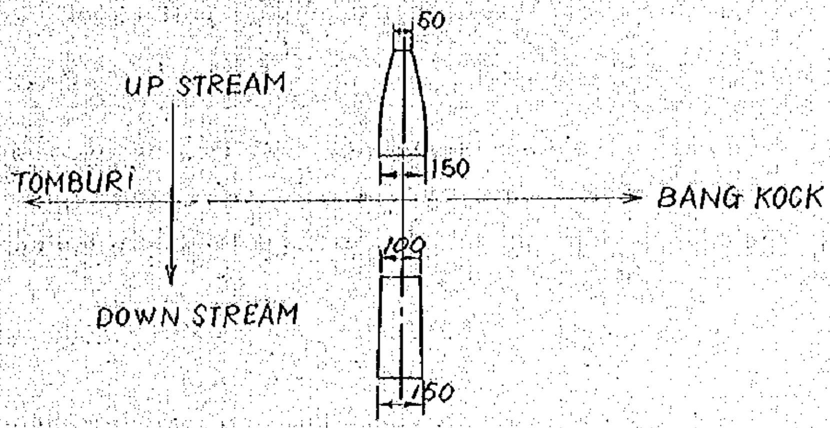

Fig-15

④ The Shear Lock Pin of the downstream side has been modified by the Public and Municipal Works Department of Thailand and is considered satisfactory now.

The height difference of front end of Bangkok side and Thonburi side allowed for insertion of Shear Pin will be 10 ~ 15 mm as the limit. If the limit is exceeded, it needs adjustment. In order to align the height of both bascule leaves, adjust the bolting attached to the side of Live Load Shoe.

The lag of Shear Lock Pin and the Pin hole can be adjusted by means of adjustment wedge of Shear Lock Pin.

(3) Others:-

① Renewed parts:-

1-1 Poor insulated circuits

	Contactor in poor	Symbol circuits
In magnetic control panel:	AX1	No. 2 and 3 from upper right
	RC3	Left end
	UVA	2 nos. of left side
	RC1	1 no. of the center
	RC2	1 no. of the center
	LRC4	Front
	LFC4	Front
	BCR	
Motor:	100 HP (Thonburi side)	Secondary side circuit
	35 HP (Bangkok side)	Secondary side circuit

1-2 For other parts which require renewal such as some parts of flexible coupling, etc., they were explained on the spot.

4.2 Proposed Measures

(1) In order to assure a correct and proper driving of bridge machinery, the "Inspection for the Proper Maintenance of Machinery" (in draft) has been attached herein for the reference in inspecting the condition and performance of the machinery.

(2) For consumable parts, the necessary nos. of Spares should be kept in hand.

(3) A submarine cable system has been adopted in this Bridge. In view of the present technical standard, it is considered as advantageous in various ways that the two power source system without using submarine cables be adopted in lieu of the existing submarine cables in the future.

The approximate designs made on this two power source system are described below.

Change of Electric Wiring System of Krung Dheb Bridge

The electrical wiring system for operation of the bascule leaves of the subject bridge has so far been operated solely from Bangkok side by means of the submarine cables.

Taking into consideration of the poor durability of the submarine cables due to high water velocity, it is hereby recommended that by extending the power sources from both sides (Bangkok and Tomburi), the bascule leaves may be operated from each side operation room respectively.

When following this sytem, all the submarine cables may be eliminated, which relieves the bridge superintendents from tending the maintenance of electric wires for a long period in the future.

In this respect, we sincerely recommend this change of the electric wire system and ask your Excellency's kind consideration for its adoption in the earliest possible opportunity.

The principal changes of the electric system for operating the bascule leaves shall become as follows.

1. The bascule leaf, rear lock and illumination on the Bangkok side shall be operated from the control desk on Bangkok.

2. The bascule leaf, rear lock and illumination on the Tomburi side shall be operated from the control desk on Tomburi side.

3. The shear lock and signal on the bridge shall be operated from the control desk on either side.

4. The electric apparatus and illumination on the Bangkok side shall be powered from the power source on Bangkok side as in the past.

5. The electric apparatus and illumination on the Tomburi side shall be powered from the newly provided high tension lines on the Tomburi side.

6. The interlocking system between both sides shall be operated by the wireless control apparatus.

7. The communication between both sides shall be done by the wireless telephone.

Due to the changes of electric system as indicated above, the following apparatus shall be changed.

1) To be abolished in Bangkok side:-

Magnetic control panel for 100 HP motor	2
" " " 35 HP "	2
" " " auxiliary "	1
" " signal panel	1
Control desk	1

2) To be newly installed in Bangkok side:-

Magnetic control panel for 100 & 35 HP motor	1
" " " auxiliary "	1
Signal control panel	1
Control desk	1
Wireless control apparatus	1 set
Wireless telephone	1

3) To be newly installed in Tomburi side:-

Magnetic control panel for 100 & 35 HP motor	1
" " " auxiliary "	1
Signal control panel	1
Control desk	1
Receiving panel	1
Incoming panel	1
100 KVA 3 phase transformer	1
Transformer panel	1
Storage battery and rectifier	1
50 KVA diesel alternator	1
Wireless control apparatus	1
Wireless telephone	1

General outline

Applied rules:

All electric machineries and tools are as specified in the following standard rules excluding the special instructions.

JIS Japanese Industrial Standard
JEC Japanese Electric Technical Committee Rule
JEM Japanese Electric Manufacturers Association

Power source:
A.C. 3300 V, 50 hz, 3 ϕ
Power circuit:
A.C. 440 V, 50 hz, 1 ϕ
Control circuit:
A.C. 220 V, 50 hz, 1 ϕ
D.C. 110 V

Detail of electric equipment

1) Magnetic control panel for 100 HP & 35 HP motors 2
Steel made cubicle type indoor use

2) Magnetic control panel for auxiliary motor (Bangkok side) 1
For cage motor 2 ~ 5 HP rear lock
2 ~ 5 HP shear lock
1 ~ 2 HP pump
Steel made cubicle type indoor use

3) Magnetic control panel for auxiliary motor (Tomburi side) 1
For cage motor 2 ~ 5 HP rear lock
1 ~ 2 HP pump
Steel made cubicle type indoor use

4) Signal control panel 2
Steel made cubicle type indoor use

5) Control desk 2
incorporated in the desk
1 - Speed meter
1 - Volt meter 600 V
1 - Ammeter 300 A
1 - Ammeter 100 A
8 - push button switch
1 - pilot lamp

6) Incoming panel 1
incorporated in the panel
1 - Disconnecting switch
1 - Hook bar for above
1 - Lightning arrestor
Steel made cubicle type indoor use

7) Receiving panel 1
1 - Oil circuit breaker
1 - Volt meter
1 - Ammeter

1 - Frequency meter
1 - Indicating watt meter
1 - Watt hour meter
1 - Power factor meter
1 - Overcurrent relay
1 - O.C.B. Switch
1 - Manual operated hand lever
Steel made cubicle type indoor use

8) Transformer 1
Type: three phase
Frequency: 50 cycle
Capacity: 100 KVA
Voltage: Primary 3650/3500/3350/3200/3050 V
Secondary 440 V
with oil gage and thermometer

9) Primary panel for transformer 1
incorporated in the panel
1 - Oil circuit breaker
1 - Disconnecting switch
1 - Volt meter
1 - Ammeter
1 - Pilot lamp
Steel made cubicle type indoor use

10) Secondary panel for transformer 1
Incorporated in the panel
2 - No fuse breaker

11) D.C. Source panel
Storage battery 1
110 V, 150 AH
Rectifier with voltage regulator

12) Wireless control apparatus
2 - Transmitter 12 channel
2 - Receiver 12 channel
2 - Antenna
100m - Coaxial cable
20m - Multicore cable
2 - Spare transmitter and receiver

Wave frequency: 40 MHZ
Wave power: According to the Japanese Law

13) 50 KVA diesel alternator 1
1500 r.p.m.
440 volt
50 hz

5. Postscript

As for the problem of crack occurred in the floor slab concrete, Japan suffers from this problem, too. In Japan, the present state of affairs is that various countermeasures according to the traffic volume and economic feasibility have been adopted for remedy. Considering the economic feasibility, the best possible countermeasures based on our investigation has been recommended in this report.

For mechanical and electric equipment of the bascule, the "Inspection for the Proper Maintenance of Machinery" (in draft) has been attached herein. We hope that the periodical inspection be conducted according to this document.

In closing, we would like to express our sincerest gratitude to His Excellency Damrong, General Director of the Public and Municipal Works Department of Thailand, Mr. Pratuang, Chief of Road Superintendence Office, Mr. Tongjul and Mr. Vichit of Planning Section for their supreme cooperation; to Mr. Tamamitsu, the First Secretary of the Japanese Embassy for affording us every facility in investigation; and all the members of the Second Japanese Survey Team for Sattorn Bridge headed by Mr. Mino, the Head of the Team for their giving us effective advices.

APPENDIX

1. The Stress Calculations after the Repair

2. The Inspection for the Proper Maintenance of Machinery