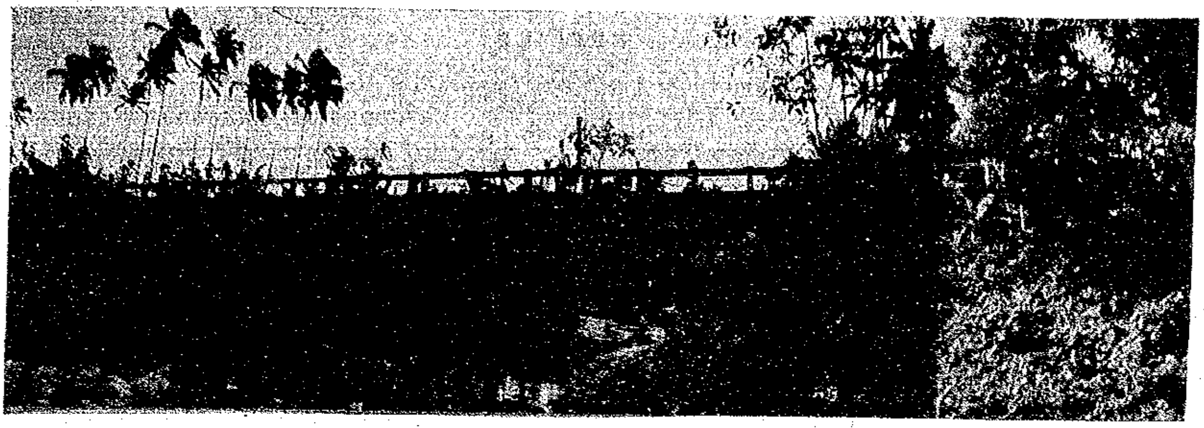
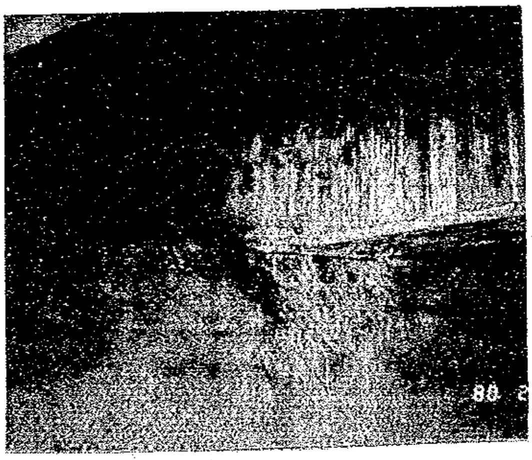
REHABILITATION			METHOD	SHEET NO.	31/49
NO.	(10)	DESCRIPTION	WIDENING PIER CAP/BEARING SHEET		

(EXST. SITUATION)



GENERAL VIEW OF BINAHAAN BRIDGE



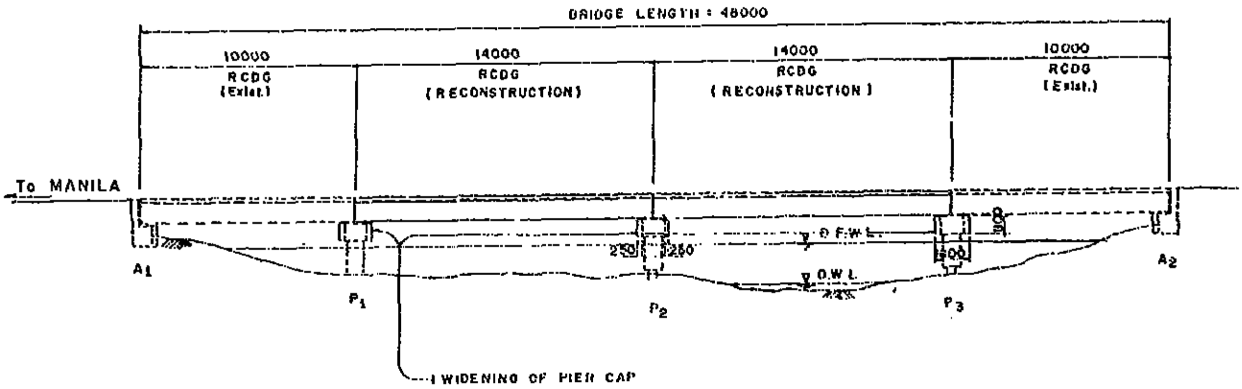
DAMAGE OF PIER COPING

SERIOUS DAMAGE OF ABUTMENT SHEET

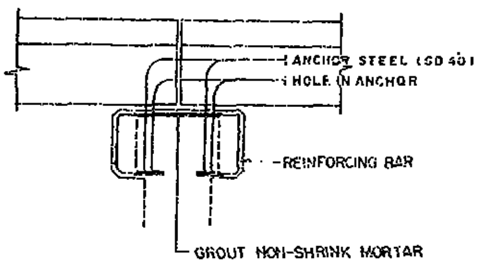
REHABILITATION		METHOD	SHEET NO.	32/49
NO.	(10)	DESCRIPTION	WIDENING PIER CAP/BEARING SHEET	

(REHABILITATION)

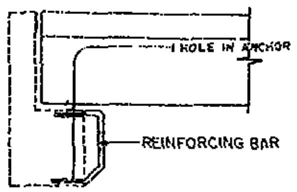
PROFILE



WIDENING OF PIER COPING



WIDENING OF ABUTMENT BEARING BED



REHABILITATION METHOD			SHEET NO.	33/49
NO.	(11)	DESCRIPTION	REINFORCEMENT OF SUBSTRUCTURE (1)	

1. REFERENCE: BR. NO. 54 TAGAMUSING, REGION - II

2. DETERIORATION AND DAMAGES:

- Substructure deterioration and/or damages are too serious to sustain the superstructure.
- Structural size of the substructure is too short to support the newly constructed superstructure.

3. CAUSES:

- Construction defects make quick deterioration.
- Low standard requirement of design criteria allows short size of the substructure.

4. APPLICATION:

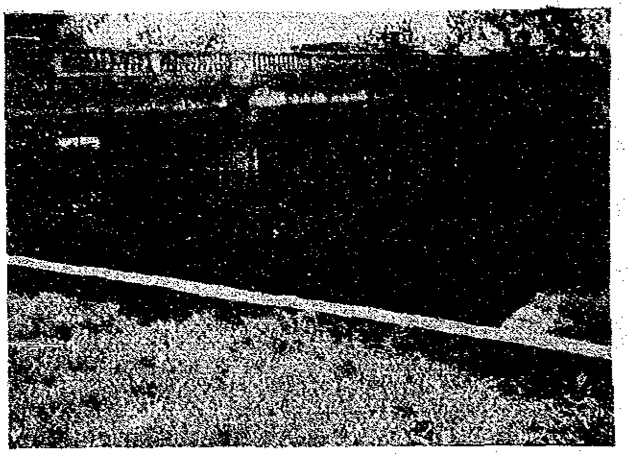
- To enlarge structural size with additional reinforced concrete and to provide additional foundation pile, if necessary.

5. PROCEDURE:

1. Construct a detour bridge for existing traffic.
2. Construct sandbag cofferdam to an elevation above water level and excavate around the pier footing.
3. Drive concrete piles for additional footing.
4. Set-up formworks for additional footing.
5. Place reinforcing steel and pour concrete.
6. Prepare staging for reinforcement of substructure
7. Chip concrete surface of substructure.
8. Place reinforcing steel bars around substructure.
9. Set-up formworks.
10. Pour the concrete.

REHABILITATION			METHOD	SHEET NO.	34/49
NO.	(11)	DESCRIPTION	REINFORCEMENT OF SUBSTRUCTURE (1)		

(EXST. SITUATION)



GENERAL VIEW OF TAGAMUSING BRIDGE

LOW STANDARD REQUIREMENT OF DESIGN CRITERIA OF PIER

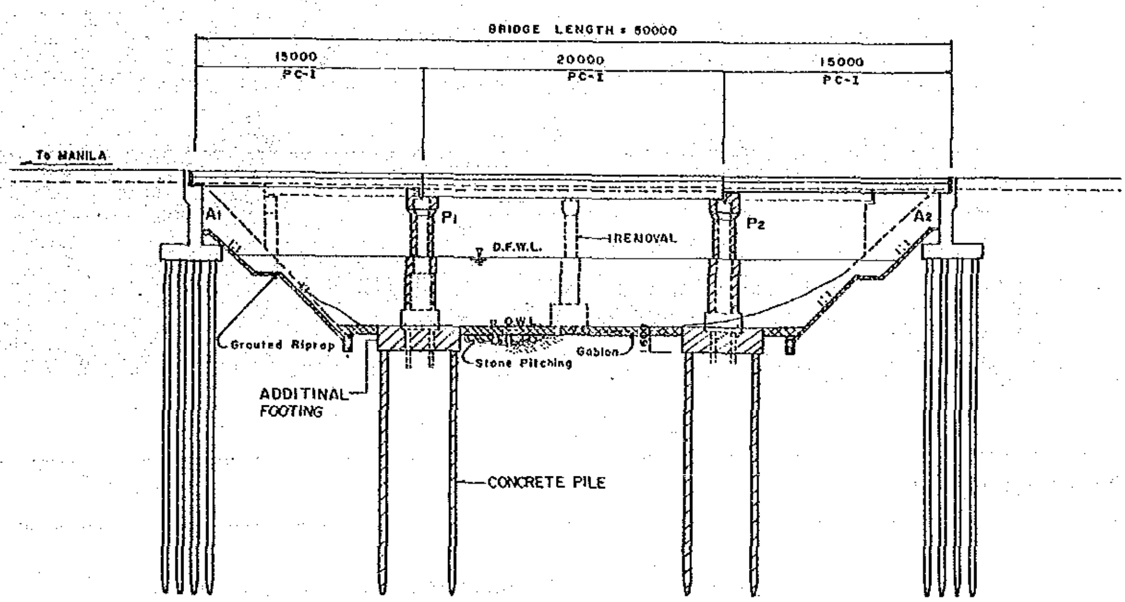
THIN CONCRETE PIER SHAFT AND LOCAL SCOUR AT PIER

THIN CONCRETE PIER SHAFT

REHABILITATION METHOD			SHEET NO.	35/49
NO.	(11)	DESCRIPTION	REINFORCEMENT OF SUBSTRUCTURE (1)	

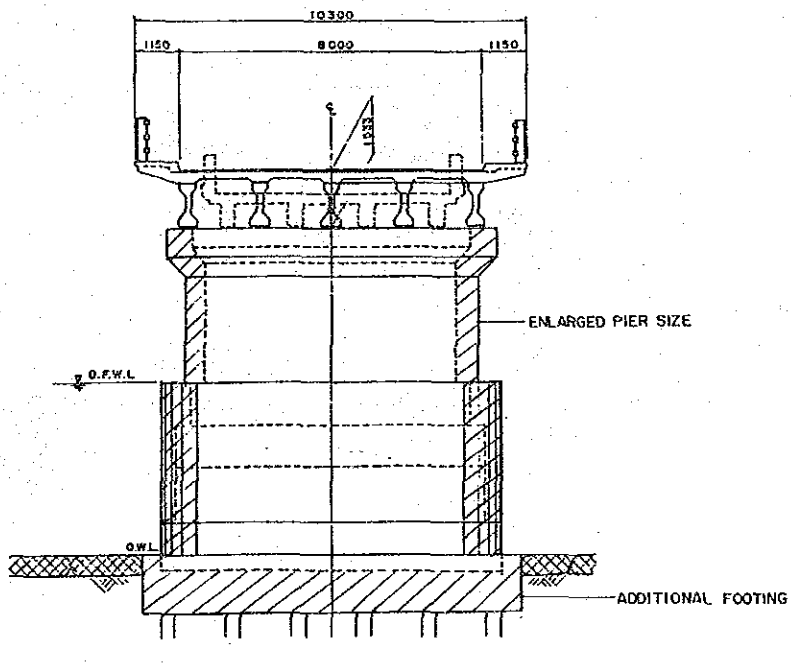
(REHABILITATION)

PROFILE



CROSS SECTION

(NEW CONSTRUCTION OF PC-I)



REHABILITATION METHOD				SHEET NO.	36/49
NO.	(11)	DESCRIPTION	REINFORCEMENT OF SUBSTRUCTURE (2)		

1. REFERENCE: BR. NO. 139 PINACANAUAN, REGION - II

2. DETERIORATION AND DAMAGES:

- Substructures (bent pile piers') are too serious to sustain the superstructure.

3. CAUSES:

- Low standard requirement of design criteria allows small size of substructure.

4. APPLICATION:

- To replace the low standard pier into appropriate standard pier.

5. PROCEDURE:

1. Construct cast-in-pile or open caisson at the desired locations outboard of bridge rails.
2. Cast the reinforced concrete pier shaft and strut up to top of the shaft.
3. After the concrete has reached sufficient strength, place and jack the temporary support beam in order to support the existing beams.
4. Cast the new reinforced concrete cross beam.
5. After the concrete has reached sufficient strength, jack down the existing beams and set on the shoes.

REHABILITATION			METHOD	SHEET NO.	37/49
NO.	(11)	DESCRIPTION	REINFORCEMENT OF SUBSTRUCTURE (2)		

(EXST. SITUATION)

GENERAL VIEW OF PINACANAUAN BRIDGE

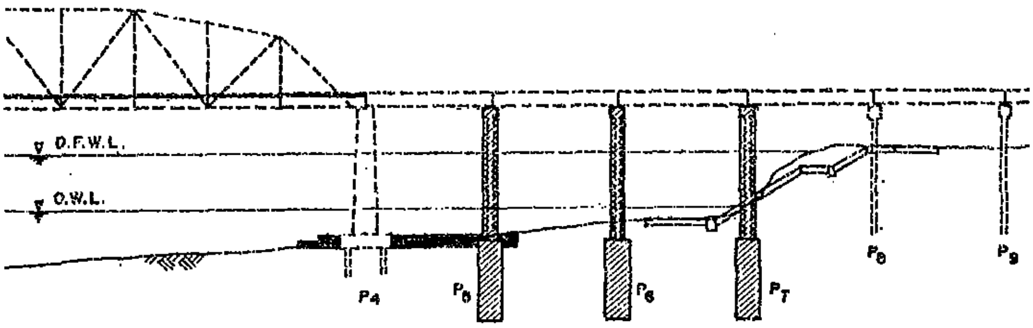
VIEW OF APPROACH BRIDGE

BENT PILE DESIGNED
LOW STANDARD CRITERIA

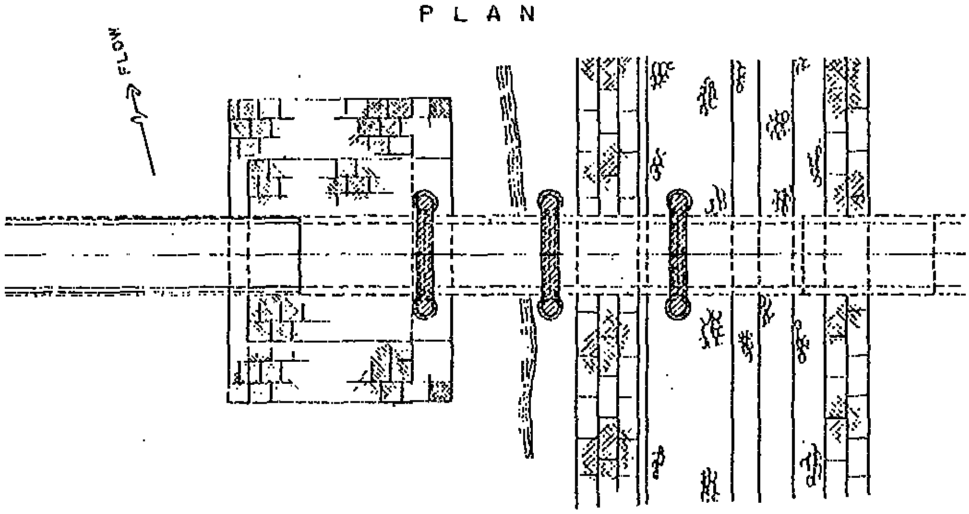
REHABILITATION METHOD			SHEET NO.	38/49
NO.	(11)	DESCRIPTION	REINFORCEMENT OF SUBSTRUCTURE (2)	

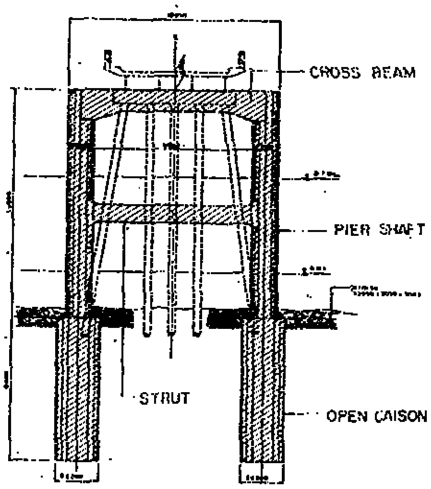
(REHABILITATION)

PROFILE



PLAN





REHABILITATION METHOD			SHEET NO.	39/49
NO.	(12)	DESCRIPTION	PROTECTION OF PIER FOUNDATION	

1. REFERENCE: BR. NO. 71 INDIANA, REGION - II

2. DETERIORATION AND DAMAGES:

- The river bed around the piers is seriously lowered due to local scouring.

3. CAUSES:

- Short footing installation and no protection of foundation allow local scouring and lowering of the river bed.

4. APPLICATION:

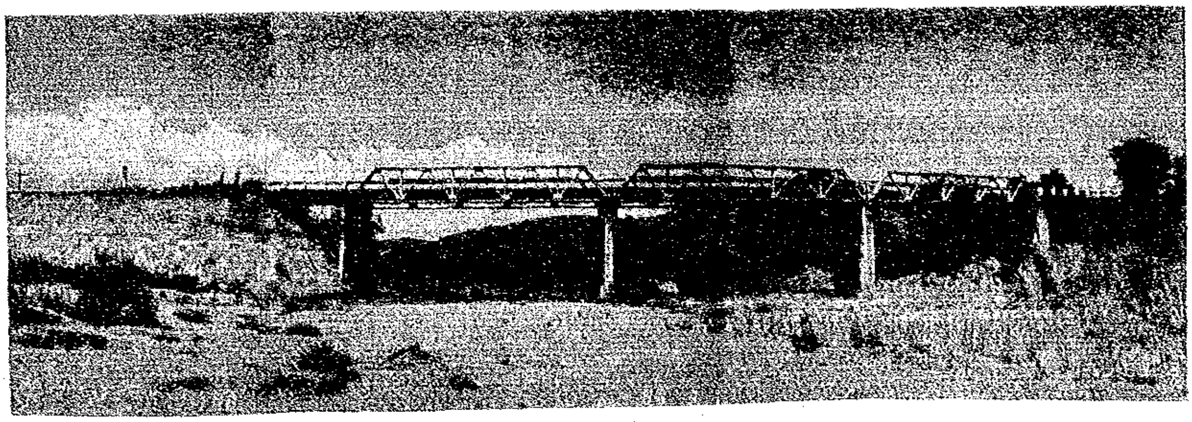
- To provide protection around pier foundation with gabion.

5. PROCEDURE:

1. Construct approach road to the river bed.
2. Construct sandbag cofferdam to an elevation above water level and dewater.
3. Excavate and trim the river bed for gabion foundation.
4. Fabricate the gabions (2000 x 2000 x 500 mm) with annealed wire and install to the river bed.
5. Stuff boulder stone by man power.

REHABILITATION METHOD			SHEET NO.	40/49
NO.	(12)	DESCRIPTION	PROTECTION OF PIER FOUNDATION	

(EXST. SITUATION)



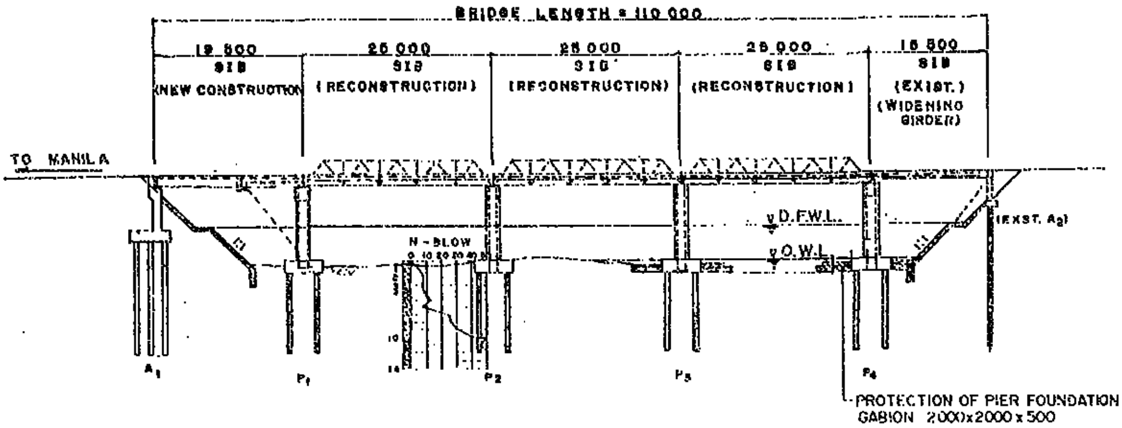
GENERAL VIEW OF INDIANA BRIDGE

LOCAL SCORING AROUND PIER

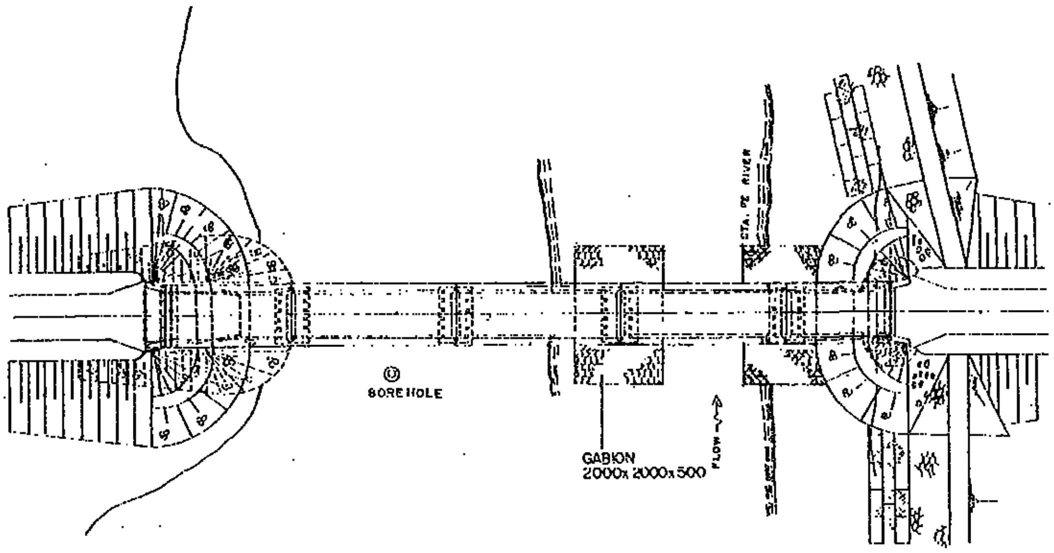
REHABILITATION METHOD		SHEET NO.	41/49
NO.	(12)	DESCRIPTION	PROTECTION OF PIER FOUNDATION

(REHABILITATION)

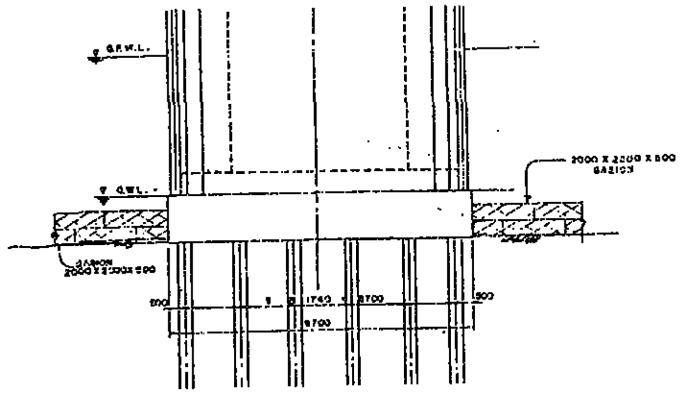
PROFILE



PLAN



CROSS SECTION



REHABILITATION METHOD			SHEET NO.	42/49
NO.	(13)	DESCRIPTION	SLOPE PROTECTION AND RIVER BANK PROTECTION	

1. REFERENCE: BR. NO. 19 SUJE, REGION - V

2. DETERIORATION AND DAMAGES:

- The existing slope protection is eroded, loosened and washed out.
- The river bank is also eroded.

3. CAUSES:

- Depth of foundation of existing slope protection is insufficient.
- No protection on the river bank allows bank erosion by flood.

4. APPLICATION:

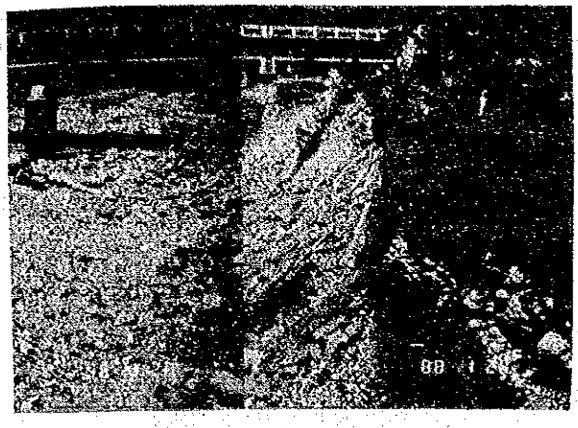
- To protect the slope with suitable method and materials in order to prevent developing erosion.

5. PROCEDURE:

1. Construct sandbag cofferdam for the foot of slope protection.
2. Excavate for footing of slope protection and set-up formwork.
3. Place the stones and grout cement mortar sufficiently.
4. Compact fill material properly in each layer of not more than 20 cm thick.
5. Trim and compact on the slope and make appropriate grade up.
6. Place boulder stones on the slope by hand.
7. Grout mortar into space of boulder.

REHABILITATION METHOD			SHEET NO.	43/49
NO.	(13)	DESCRIPTION	SLOPE PROTECTION & RIVER BANK PROTECTION	

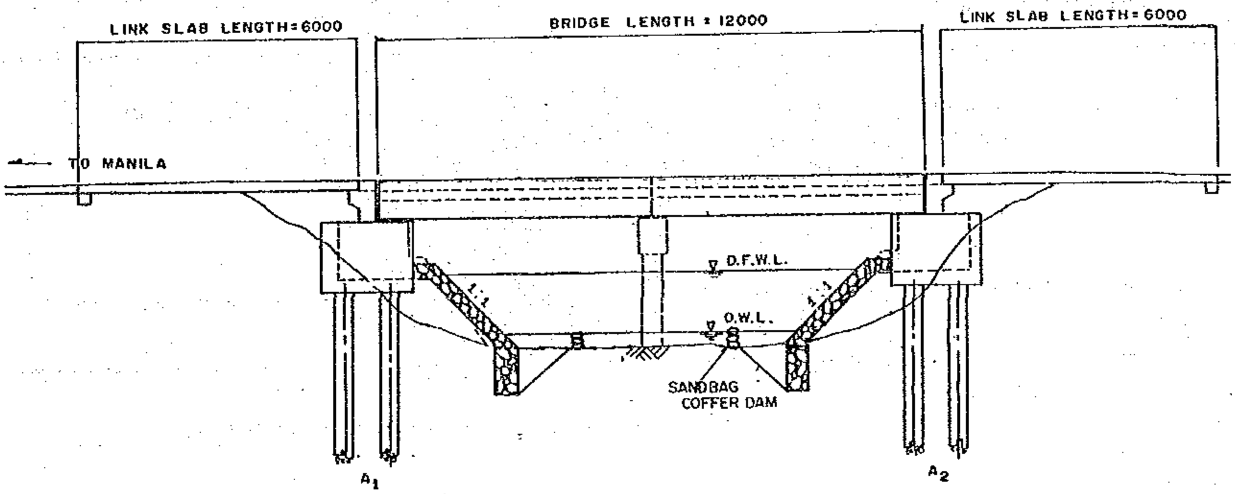
(EXST. SITUATION)

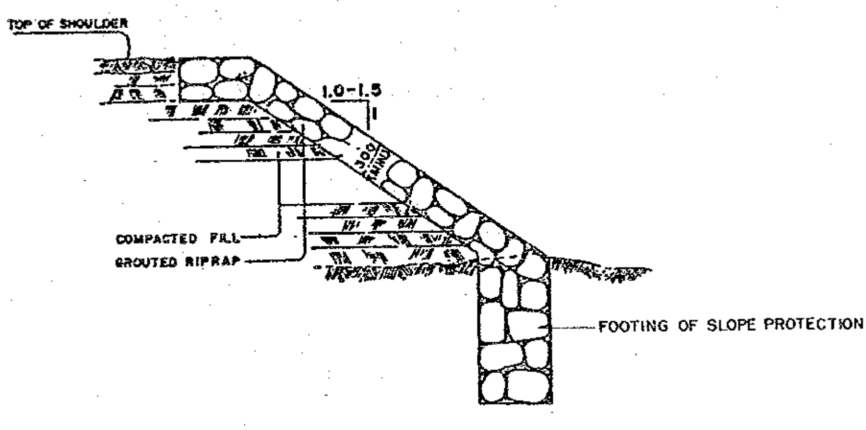


RESULT OF INADEQUATE OF SLOPE PROTECTION

INADEQUATE GROUTED RIPRAP (STEEP GRADE)

(REHABILITATION)





REHABILITATION METHOD				SHEET NO.	44/49
NO.	(14)	DESCRIPTION	FOOT PROTECTION		

1. REFERENCE: BR. NO. 139 PINACANAUAN, REGION - II

2. DETERIORATION AND DAMAGES:

- The foot portion of the slope is seriously eroded.
- Developing erosion may make the existing pier fall down.

3. CAUSES:

- No protection of the slope and its foot portion cause developing erosion due to floods.

4. APPLICATION:

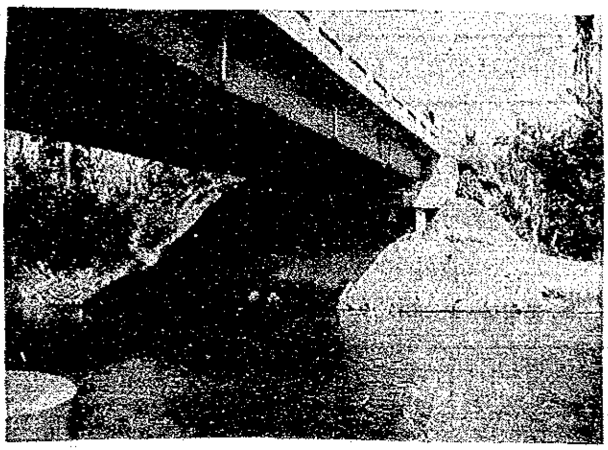
- To provide a gabion on the river bed at the foot portion of the slope to prevent erosion and lowering of river bed.

5. PROCEDURE:

1. Construct sandbag cofferdam to an elevation above water level and dewater.
2. Excavate and trim the river bed for gabion foundation.
3. Fabricate the gabions with annealed wire and connecting wire and install to the river bed.
4. Stuff boulder stone by man power.

REHABILITATION METHOD			SHEET NO.	45/49
NO.	(14)	DESCRIPTION	FOOT PROTECTION	

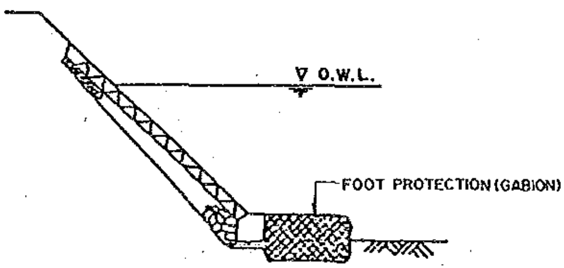
GENERAL VIEW OF GUINOBATAN BRIDGE



RESULT OF LACK OF FOOT PROTECTION

(REHABILITATION)

DETAIL OF FOOT PROTECTION



REHABILITATION METHOD			SHEET NO.	46/49
NO.	(15)	DESCRIPTION	RIVER BED PROTECTION	

1. REFERENCE: BR. NO. 71 INDIANA, REGION - II

2. DETERIORATION AND DAMAGES:

- The river bed is eroded and lowered down specially at main current portion.

3. CAUSES:

- Insufficient span length between pier causes river bed lowering by erosion.

4. APPLICATION:

- To provide river bed protection with a gabion to prevent the developing erosion.

5. PROCEDURE:

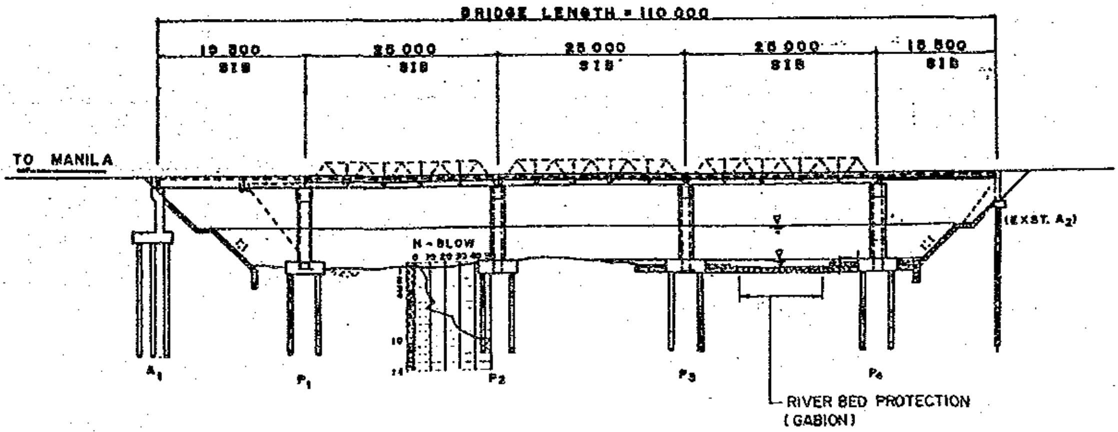
1. Construct approach road to the river bed.
2. Prepare the cofferdam.
3. Trim the bed for gabion.
4. Install the gabion.

REHABILITATION METHOD			SHEET NO.	47/49
NO.	(15)	DESCRIPTION	RIVER BED PROTECTION	

(EXST. SITUATION)

(REHABILITATION)

PROFILE



REHABILITATION METHOD			SHEET NO.	48/49
NO.	(16)	DESCRIPTION	GROYNE	

1. REFERENCE: BR. NO. 73 BATU

2. DETERIORATION AND DAMAGES:

- River current is not coincident with the existing bridge situation.
- Upstream side of abutment is seriously eroded.

3. CAUSES:

- The current is not coincident with the bridge situation due to meandering flow of the river.

4. APPLICATION:

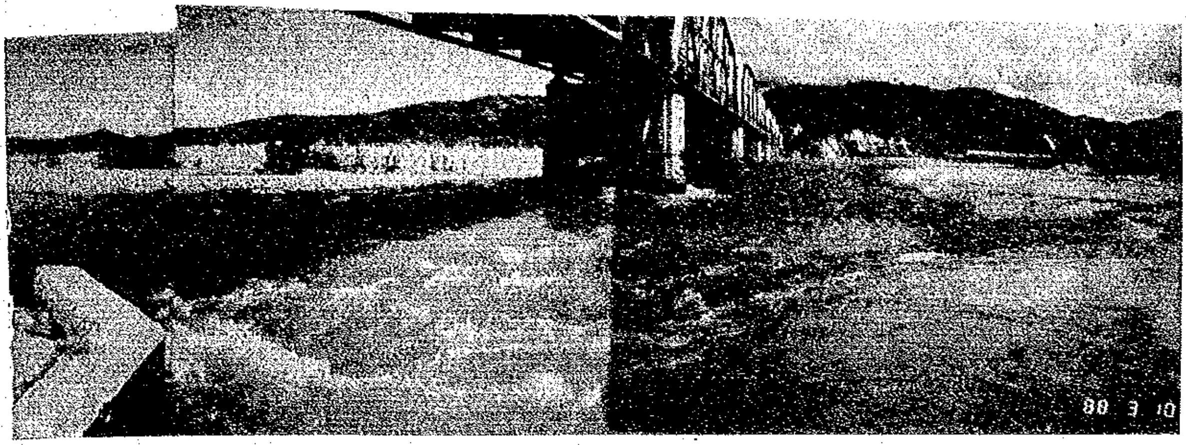
- To provide groynes to rivers where the flow of water shall be controlled from the shore of the river bank to the center of current flow.

5. PROCEDURE:

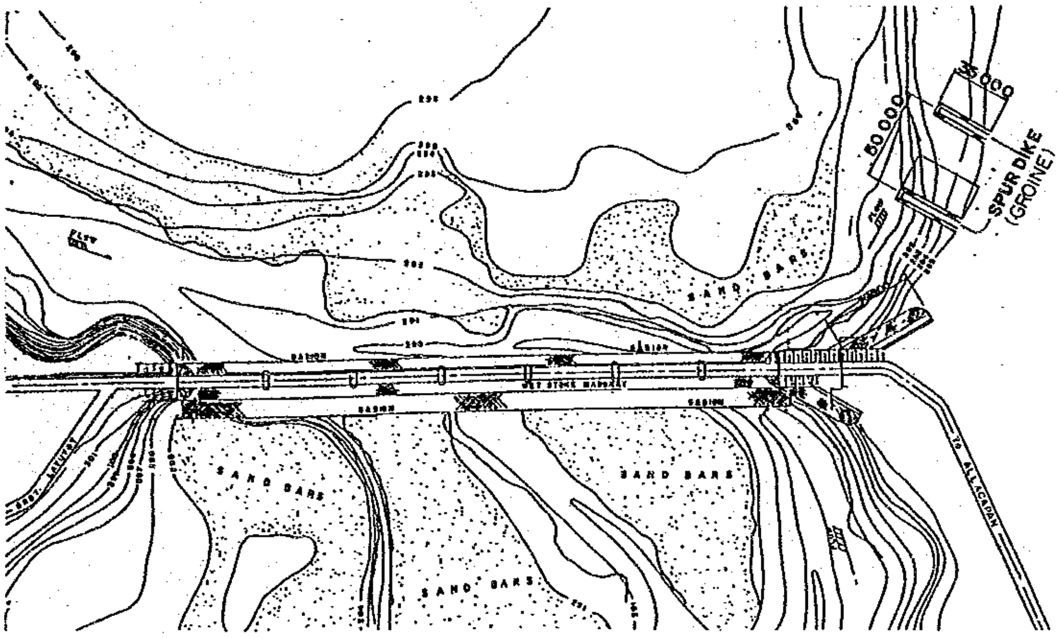
1. Prepaer the cofferdam.
2. Trim the bed for groyne.
3. Excavate for the foundation.
4. Place cable stone on the bed.
5. Construct the grouted riprap.
6. Install the rubble concrete block for foot protection.
7. Construct embankment of groyne.
8. Prepaer the slope.
9. Construct the grouted riprap.

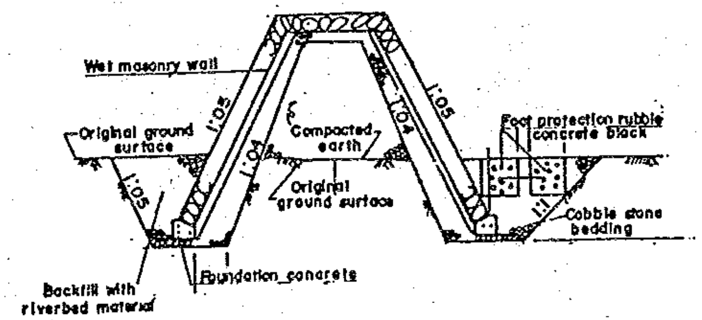
REHABILITATION METHOD				SHEET NO.	49/49
NO.	(16)	DESCRIPTION	GROYNE		

(EXST. SITUATION)

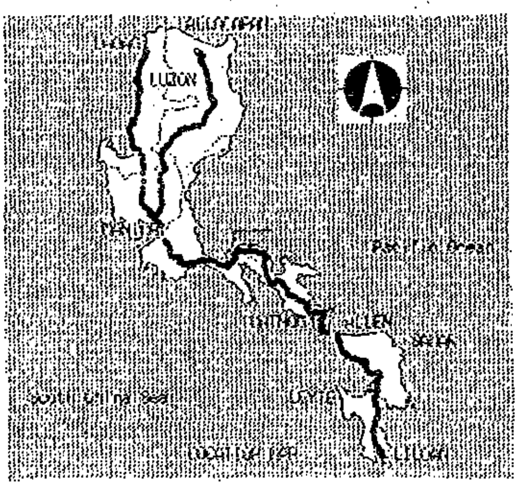


(REHABILITATION)





CHAPTER 4
ORGANIZATION AND TRAINNING



CHAPTER 4 ORGANIZATION AND TRAINING

4.1 Organization of Bridge Inspection and Maintenance

The Department of Public Works and Highways is divided into five Bureaus. The Bureau of Maintenance which is directly under the supervision and control of the Secretary is responsible for the overall inspection and maintenance policy. The Bureau of Maintenance provides direct communication and contact with the regional offices and also provides technical assistance and guidance in the efficient economic implementation of the maintenance functions of the department. Inspection and maintenance of infrastructures such as roads, bridges, portworks, river control, buildings, etc. are a primary function of the Bureau of Maintenance.

The Bureau of Maintenance is composed of the following five Divisions;

1) Planning and Programming Division
2) Inspectorate Division
3) Inventory Division
4) Monitoring and Methods Division
5) Building Services Division

Each division has three sections divided into Area (Regions)

Area I	:	Region I, II, III, IV-A & CAR
Area II	:	Region IV-B, V, VI, VII & NCR
Area III	:	Region VIII, IX, X, XI, XII

Organization Chart is shown in Fig. 4.1.

4.2 Authorities Responsible for Bridge Inspection and Maintenance

(1) Superficial Inspection

Superficial inspection is carried out by the District or City Office which is responsible for bridges under their Area. It has the advantage of having more intimate knowledge of actual bridge conditions. Bridge conditions are than reported to the Regional Office based on the result of the superficial inspection.

(2) Periodical Inspection

Periodical Inspection is carried out by the Regional Office which is responsible for bridges located in the whole region. The periodical inspection can be planned to be simple and efficient based on the guidelines and key points. The results of periodical inspection and the rating of structure damage are reported to the Bureau of Maintenance. If the damages needed more detailed inspection and specialized inspection equipment, the Regional Office then requests the Bureau of Maintenance to dispatch a special inspection team.

(3) Special Inspection

Special Inspection is carried out by the Special Inspection Team belonging to the Inspectorate Division in the Bureau of Maintenance. However, the Special Inspection Team does not, at present, exist as a team. The Special Inspection is conducted to evaluate and assess severe damages discovered in the periodical inspection and in disasters caused after cyclone, flood and earthquake based on the request from the Regional Office or the direct order from the DPWH.

(4) Data Base

Data Base of bridges was developed by the JICA Study Team based on inventory data and then stored in a personal computer belonging to the Inventory and Statistics Division in the Bureau of Maintenance. The data base will be operated and updated under the control of the Inventory Statistics Division. The data are obtained from the periodical and special inspection and checked, reviewed and verified by the Inspectorate Division. The updated bridge data base will be made available for the Regional Offices if they have an equivalent computer and devices with a 5.25 inch FDD.

(5) Ordinary Maintenance

Ordinary maintenance is carried out by the District or City Office based on the result of the superficial inspection or from orders of the Regional Office. When the damage or deterioration is discovered in the periodical inspection and it can still be recovered, ordinary maintenance is carried out. Ordinary maintenance should be done in close coordination with the superficial and periodical inspection teams.

(6) Rehabilitation

Rehabilitation cannot in most cases be performed by personnel in the District Office and Regional Office, because of the magnitude of rehabilitation cost and special equipment is needed for appropriate size and in a variety of types of structures. The rehabilitation operation of the bridge should be carried out by a Contractor with the appropriate equipment under contract basis. The Regional Office makes rehabilitation program based on the periodical and special inspection and the submits it to the Bureau of Maintenance for approval. The Bureau of Maintenance checks and evaluates the program and then prepares the annual budget for maintenance and rehabilitation projects and submits then with a comprehensive appraisal to the DPWH for decision making. The procedure of rehabilitation programs such as data collection, comparative study, detail design, tendering and supervision of construction are mainly carried out by the Regional Office under approval of the DPWH.

The Schematic flow Chart of Bridge Inspection and Maintenance/Decision Making is shown in Fig. 4.2.

4.3 Training of Bridge Inspection and Maintenance Personnel

The DPWH has not formalized the training system of bridge inspection and maintenance but recognized the need for initial training of inspector and maintainer for the identification of actual and potential damages of existing bridges. The training program should be drawn up in consideration with organization of the DPWH, the number of staffs available and needed and level of techniques necessary. The training program is envisaged to be on two levels.

1) It is necessary for the engineers who belong to the Special Inspection Team to get and keep their knowledge up-to-date on the latest testing techniques, materials and maintenance procedures. The following training program are available and valuable to them.

   a) The DPWH invite specialists on inspection and maintenance who will lecture including a practice on-the-job training. The specialists will make the special inspection team an experienced and capable group for Inspection and Maintenance.

   b) The engineers in the Special inspection team should be sent to special lectures or seminars held in Japan or other countries in order to update and improve their knowledge.

2) The inspectors and maintainers, who belong to the Regional, District and City Office, who will make a rating of damage or deterioration will often use equipment and materials which they have little knowledge or experience. Therefore, practical courses which are carried out by the trained engineers in the Special Inspection Team are desirable for all inspection and maintenance teams.

Fig. 4.1 ORGANIZATIONAL CHART OF BUREAU OF MAINTENANCE

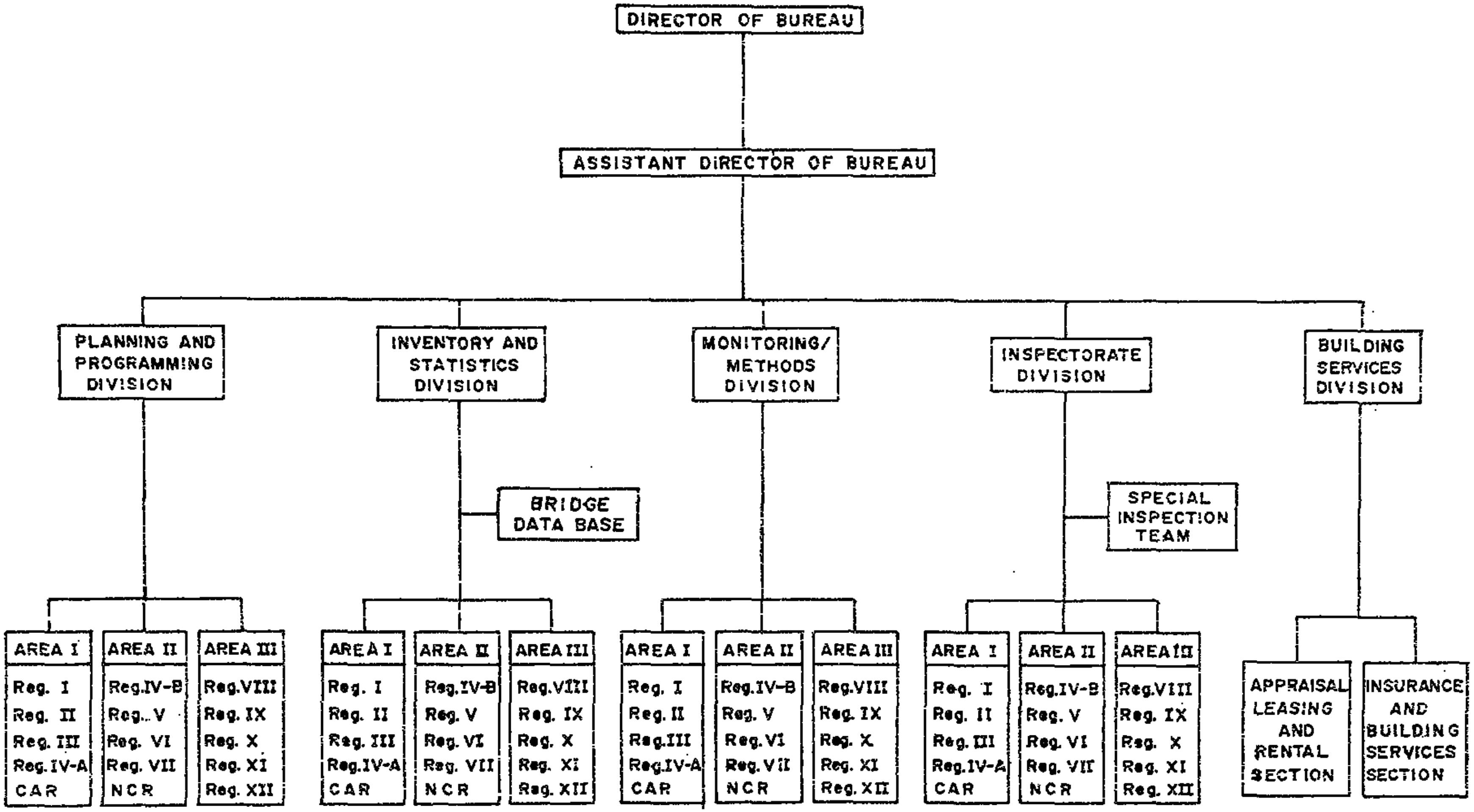
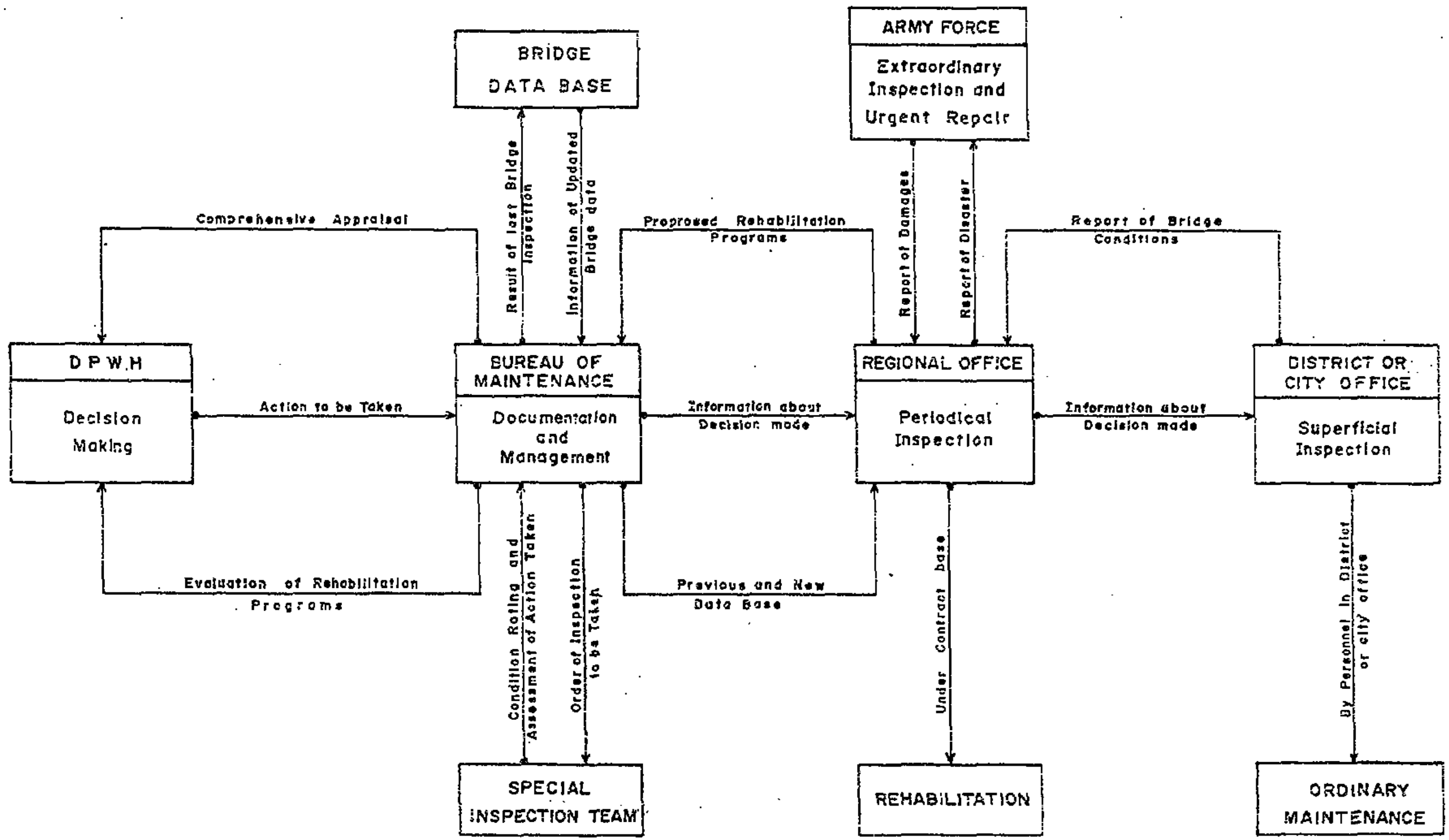


Fig.4.2 SCHEMATIC FLOW CHART OF BRIDGE INSPECTION AND MAINTENANCE/DECISION MAKING.



CHAPTER 5
INSPECTION AND MAINTENANCE FOR MAGAPIT SUSPENTION BRIDGE

CHAPTER 5 INSPECTION AND MAINTENANCE FOR MAGAPIT SUSPENSION BRIDGE

5.1 General

Suspension bridge, which is a structure suspended with a cable, is unique in both material and physical viewpoints. The methods used in the inspection and maintenance of the suspension bridge are different, in many aspects from other type of bridges. It is, therefore, normally required to assign a qualified inspector in order to make an effective inspection of the suspension bridge and to apply a special maintenance as presented in subsequent sections.

5.2 Checkpoints for Inspection

In the inspection of suspension bridge, the qualified inspectors' assignment is required by means of a predescribed reason. The inspection items consist mainly of identifying design condition and present situation as well as finding abnormal displacement and vibration for overall or local part of bridge structures.

5.2.1 Identification between Design Conditions and Present Situation

(1) To identify the structural size and specified materials; That is to check suspension sag, span length and width of bridge and to check structural size and materials such as main cable, hanger rope, anchor and stiffening truss, and then to identify design load.

(2) To check the differences of circumstance between the present situation and designed/constructed conditions of the bridge; That is to check the weathering and deterioration of the tower base and also to check the unstability of foundation due to loosened ground and rising up of underground water and abnormal external force.

5.2.2 Finding Abnormal Displacement and Vibration

To check abnormal displacement and vibration in the normal utilized situation. To check the movement of anchor block and hanger and then to inspect the deformation of stiffening truss.

5.3 Locations to be Inspected

The locations to be inspected and its checkpoints are shown in the following VISUAL INSPECTION AND CHECKPOINTS FOR SUSPENSION BRIDGE.

5.4 Keypoints of Maintenance

(1) The cable anchor is the most noticeable keypoint of the main cable. Corrosion of the cable at this point increasingly developes because of its closeness to the ground. The serious corrosion of the cable causes an impediment to its structural function. Corrosion of the cable anchor itself very much affect the corrosion of wire strand of the cable. Moreover, the part in the concrete block of the cable anchor might be corrosive. This kind of corrosion is normally difficult to find. So special care must be taken during the inspection. Corrosion of the cable directly lowers the function of the suspension bridge. Early rehabilitation action must be taken when unusual circumstances arise.

(2) Bearing Shoes

The bearing shoes is the bottom part of the tower and the stiffening truss. So, the bearing shoes are in the wetted and corrosive condition due to the heaping dust and mud. Thus, short term inspection and maintenance are to be considered.

(3) Tower Top and Bottom

The type and shape of saddle sometimes very much affect the reduction of durability of the cable since they might induce cable deformation. Furthermore, the tower top is the most difficult part to inspect during inspection. On the other hand, the painting work for the tower bottom is very important in order to prevent corrosion on the pin, roller and rocker.

VISUAL INSPECTION AND CHECKPOINTS FOR SUSPENSION BRIDGE

① Anchor Block

- Movement of Anchor Block
- Deterioration of Concrete at Cable Anchor
- Corrosion of Anchor Plate
- Slip Out of Anchor Plate
- Deterioration of Cable

③ Connection Part of Cable

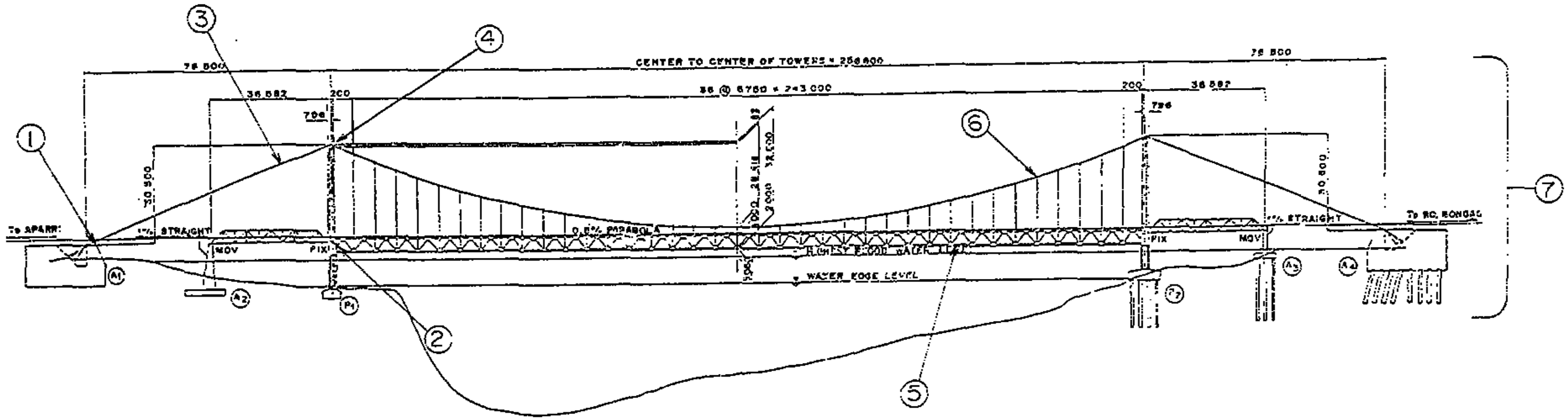
- Corrosion, Deterioration and Crack of Clip
- Deterioration of Cable

④ Saddle at the Tower Top

- Corrosion and Deterioration of Saddle
- Buckling of Bearing Plate of Saddle
- Slide of Roller
- Deterioration of Cable

⑥ Cable Band

- Slip out of Cable Band
- Losened Bolts and Nuts
- Deterioration of Filler Material
- Deflection of Hanger
- Deterioration of Cable



② Bearing Shoes

- Movement of Bearing Shoes
- Deterioration and Corrosion of Bearing Shoes
- Slide of Bearing Shoes
- Deterioration of Bed Concrete

⑤ Stiffening Truss

- Corrosion and Deterioration of Truss Members
- Deformation and Buckling of Lower Chord and Lateral Members

⑦ General Situation of Overall Bridge

- Bridge Span Length
- Sag of Stiffening Truss
- Bridge Surface
- Main Cable and Hanger Rope
- Change of Bridge Site Circumstance
- Change of Loading Condition

(4) Stiffening Truss

The looseness of hanger rope often induces the buckling of the upper chord of the stiffening truss. In this case, the hanger rope must be retensed and the failed and deformed upper chord must be replaced.

(5) Main Cable

Corrosion of the main cable, generally, does not occur at once, it deteriorates gradually as the years go by. However, special care must be taken on the cable anchor, cable at the tower top and the connection of hanger rope because of their corrosion. The maintenance work, thus, must be considered before the cable corrosion becomes serious and also before the maintenance cost becomes very high.

(6) Hanger Rope and Cable Band

The looseness of the hanger rope is the most frequent abnormal case. The major causes of the looseness are insufficient torque to the bolts, slip of the cable band due to unsuitable filler and the reduction of cable area due to creep. Resulting from the above looseness, the buckling of the upper chord might be induced because of the sag down of the stiffening truss. When the slip of the cableband can be found, it must be set back to its original position with assistance from temporary hanger members and simultaneously it must be retightened.

(7) Traffic and Loading Control

Since overloading causes serious damages not only in some sections but to the whole structure as well is therefore necessary to regulate traffics and loading. In the determination of the permissible loading, a total evaluation must be considered such as suspension structure, traffic condition, design documents, results of detailed inspection.

APPENDICES

APPENDIX 2.1 GUIDELINES AND KEY POINTS FOR BRIDGE INSPECTION

APPENDIX 2.2 GUIDELINES FOR BRIDGE INVENTORY SHEET NO.1

APPENDIX 2.3 GUIDELINES FOR BRIDGE INVENTORY SHEET NO.2

APPENDIX 2.4 RESULTS OF ANALYSIS AND COMPARISON OF LOADING TEST

APPENDIX 2.5 SAMPLE OF COMPUTATION OF PERMISSIBLE LOADING CAPACITY

APPENDIX 2.1 GUIDELINES AND KEYPOINTS FOR BRIDGE INSPECTION

(1) Pavement

Pavement condition is to be checked for unevenness, cracking, scaling, waving (roughness) and other evidence of deterioration.

- Examine joints between the approach pavement and the abutment backwall.

- Examine any indication of deterioration or distress on the underside of the slab.

(2) Curve and railing

Concrete curves and railings are to be check for cracks, spalls, scaling and other deterioration of the concrete. Metal railings are to be checked for condition of paint and corrosion.

- Examine the region around the base of the supporting posts where it is usually fairly corroded due to splashing action from road vehicles.

- Check damages due to traffic impacts and signs of inadequacy of strength.

- Examine the vertical and horizontal alignment because settlement in the substructure or deficiencies in the shoes will be shown in the railing.

(3) Expansion Joint

Expansion joints are generally considered as weak points in bridge construction, for this reason rapid deterioration or damages usually occur due to heavy traffic.

- Examine irregularity of vertical profile, they cause additional impact forces under traffic loading.

- Check leakage of water through joints and the adequacy of the drainage system.

- Examine steel type expansion joint for evidence of loose anchorages and cracking which may create a hazard to traffic.

- Examine the underside of the expansion joints. Lack of adequate room for expansion, especially in small area of the joints will concentrate thermal expansion stress causing the concrete to shear and spall.

(4) Deck Slab

Deck slabs are to be checked for cracking, scaling, spalling, pot-holing, exposure of reinforcement and other evidence of deterioration.

- Examine cracking patterns (Fig. AP.1) on the size, distribution and penetration of cracks. Cracking is a reflection on the characteristics of material and workmanship.

- Examine scalling which is gradual and continuous on the surface mortar and aggregate over irregular areas. The depth and size of the area should be recorded to monitor the progression of this defect.

- Check spalling on deck slabs which take the form of circular or oral deprssions.

- Examine corrosion of reinforcement from surface discoloration of concrete and pattern of cracking as shown in Fig. AP.1. In extreme cases, the reinforcement bars are exposed.

- Check drainage on the surface of deck slab. If a water pond on the surface of the deck slab can be observed, it may contribute to deck deterioration.

- Examine excessive deflection or vibration and check whether this is caused due to the damage of support of the deck or of the deck itself.

(5) Concrete Beam

Concrete beams are checked for cracking spalling, exposure of reinforcing bar and any other desintegration (PHOTO 1).

- Check points of bearing where the damage (spalling concrete) may be due to friction from shoes or high edge pressures.

- Examine cracking patterns; collecting information on the size, distribution and penetration of cracks. The crack should be recorded to monitor the progression. Diagonal cracks may indicate a shear failure while vertical cracks may indicate an excessive degree of stressing in flexture. Shear cracking has serious consequence on the structure.

- Check the lower slab in box girders and the outside face of the girders for cracking due to over-stresses.

- Examine the following defects for pre-stressed concrete bridge.

  . Longitudinal cracks in the flanges may indicate insufficient transverse reinforcement bar, while transverse cracks in beams are an indication of serious loss of pre-stress.

  . Cracks around the bearings and at cast-in-place diaphragms are due to creep and humping of the girder.

  . Spalling or cracking of concrete occurs near cable ducts due to inadequate resistance to radial forces.

  . Most defects of prestressed concrete bridges cannot be assessed by visual inspection because the position and condition of the cable, the uniformity and density of grouting of the cable duct, fracture of strands of the cable or other factors are not known. Therefore, serious defects in P.C. bridges should be checked by the special inspection team using radiographic technique.

(6) Steel beam

Steel beams are checked for cracking, corrosion, fracture, excessive vibration and noise, deformation, deflection and loosened bolts.

- Check cracking: Special attention is paid to attachment by the welding. For example, the cracking usually occurs in welded connections and adjacent metals subject to high stress fluctuation and stress concentration or reversals. Attention is also paid to sudden changes in cross section of the member.

- Examine corrosion, assess its magnitude, its location and its pattern. Attention is paid to junctions of steel work with masonry, concrete and structural materials and specially to the numerous pockets created by the framing and connections of the various members in truss bridges. As far as possible, the loss of effective structural section from corrosion is estimated and identified.

- Examine excessive vibration and noise. These factors in itself are not a structural damage, however they are indicators on where problems may be occuring in the structure. Therefore, some research should be made to identify the cause of excessive vibration and noise.

- Check deformation and deflection. Excessive deformation and deflection are one of the best visual indicators of the state of the structure. Since buckling, twisting, warping and waviness are a form of deformation associated with members in compression, a countermeasure is needed to reduce resistance to compressive forces in case where such excessive deformations are observed. Fracture in member caused from impact by vehicles should be defected in size, scale and location of the defect and examined whether the member still ensure the level of safety (PHOTO 2).

- Check loosened bolts if there are some accompanying movements or noises associated on the above item (excessive vibration and noise).

(7) Painting

Steel bridges are checked for condition of paint (PHOTO 3). Strains (discoloration) may indicate severe damage on the structure. Check also for discoloration, noting and exfoliation.

(8) Shoes and shoe bases

Shoes and shoe bases are an important indicator not only of the condition of the shoe itself but of the health of the bridge. They are therefore checked for the following defects.

- Check corrosion and debris that impair movement and cause excessive friction (PHOTO 4).

- Check the tightness of anchor bolt and nuts.

- Check on whether any uplift is present. In extreme cases, a clear space between the shoes and shoe bases is indicated.

- Examine any sign of relative movement between the beams and shoe bases and any sign of cracking on shoe connection of the superstructure and shoe bases on the substructure (PHOTO 5). Such cracking, which is caused by a concentration of loads along edges, may lead to a serious damages.

- Check specially simple sliding shoes used in older bridges which have tended to become more resistant to movement. They may be cracking or spalling of the concrete in the area of the shoe bases.

(9) Abutment and Pier

Abutments and Piers are checked for cracking, exposure of reinforcing bar, settlement, lateral movement, sliding and scouring. The abutments and piers include piles and footings although they are usually unseen.

- Check vertical cracking caused by differential settlement. This crack may be a structural damage of the abutment and pier. Crack monitoring is therefore necessary to detect the differential settlement.

- Check concrete surface deterioration and erosions of piers and abutment under water level due to current. The erosion of concrete should be examined in each low water season. If exposure of reinforcing bar is discovered, the abutments or piers should be urgently repaired (PHOTO 6).

- Check on whether piles are exposed by scour (PHOTO 7). In cases where the piles are exposed, check loss of section through scaling and spalling.

- Check the settlement. Differential settlement can cause serious damage to the abutments and piers. Damage due to differential settlement is often seen as crack between adjoining wing wall or in the abutment stem. Uniform settlement of all the foundations of a bridge may have little effect upon the structures. However, a simply supported stringer bridge and a continuous bridge are more susceptible to these damages even on the uniform settlement.

- Check lateral movement and sliding abutments and piers. The lateral movement will take place when shear failure of soil under the structure and if the vertical loads do not develop sufficient friction forces to resist movement between the base and foundation soil. The sliding will take place when lack of friction between inclined layers of soil strata and water level is quickly lowered but soil behind the abutment is still fully saturated.

(10) Approach Road

Approach road is checked for uneveness, settlement, or roughness. These defects may cause vehicles coming onto the bridge to induce on excessive inpact stresses in the structure.

- Examine joint between the approach pavement and the abutment parapet on whether there is adequate clearance and the joint is adequately sealed to prevent intrusion of non compressible materials.

- Examine a void under cement concrete pavement caused from fill settlement or erosion.

- Check condition of the shoulders, slopes, drainage and approach guard rail such as ancillary facilities of approach road.

(11) *River Condition*

River condition is checked whether the waterway is not obstructed, but that it affords free flow of water.

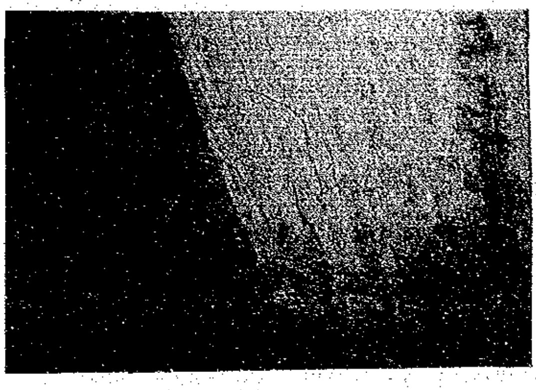
- Check obstruction such as debris or wood in the upstream and downstream which may contribute to scour.

- Check for sand and gravel bars deposited in the waterway (PHOTO 8).

- Provide a channel profile record of the tendency of scour, channel shifting, highwater or debris marks.

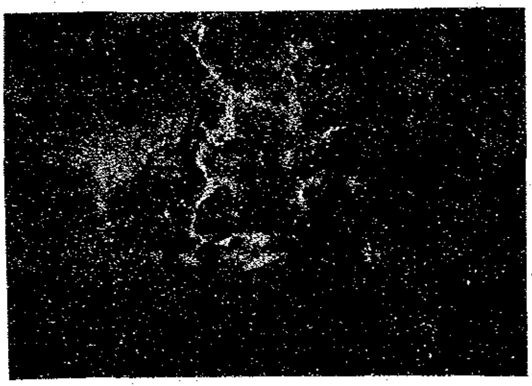
- Check the existing bank, slop protection, or other protective devices whether they are sound and functioning properly or not (PHOTO 9).

Fig. AP.1 PROGRESSIVE CRACKS PATTERN OF DECK SLAB

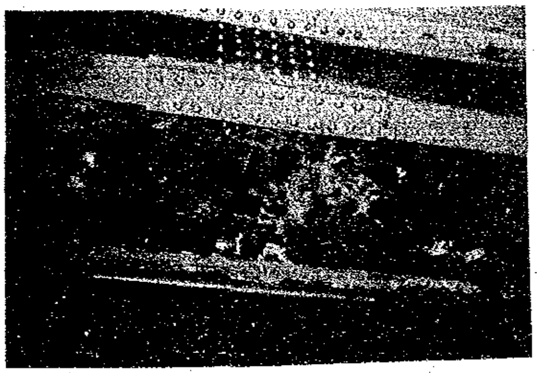


PATTERN 1: Occurrence of cracks in one direction of deck slab

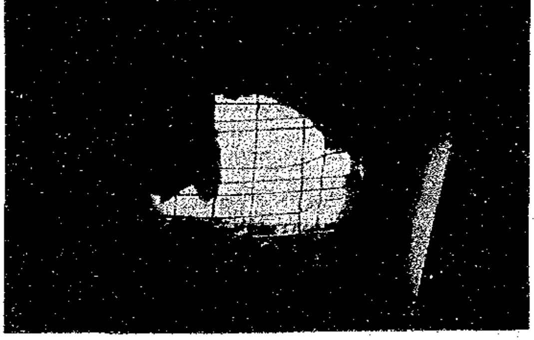
PATTERN 2: Cracks developing into two directions, uneven distribution of loads



PATTERN 3: After repetition of PATTERN 1 and 2, cracks develop in lattice pattern



PATTERN 4: Crack slitting along a lattice pattern line



PATTERN 5: Deck slab spoiling down

Fig. AP.2 PHOTOGRAPH OF DAMAGES (1/3)

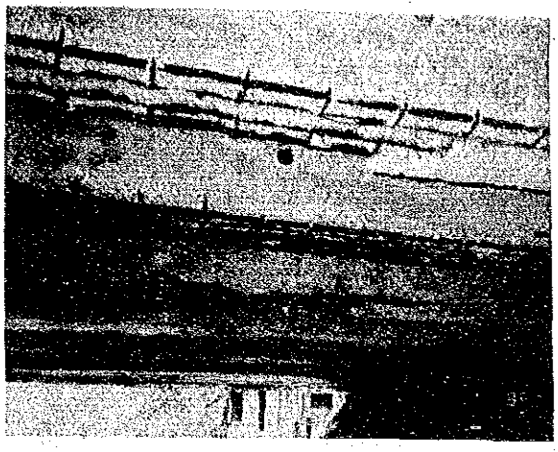


PHOTO 1

CONCRETE BEAM:

Exposed reinforcing bars of the beam (R.C.D.G.)

PHOTO 2

BRIDGE WIDTH:

Damaged by collision of vehicles due to narrow width of the bridge

PHOTO 3

STEEL STRUCTURE:

Serious rust of main beam (S-I-B)

Fig. AP.3 PHOTOGRAPH OF DAMAGES (2/3)

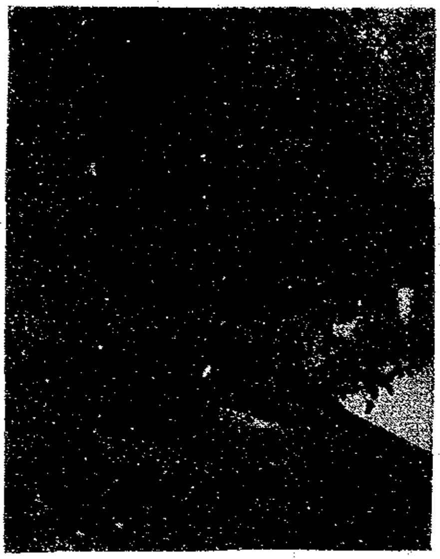


PHOTO 4

SHOE:

Rulled out anchor bolt from concrete bed

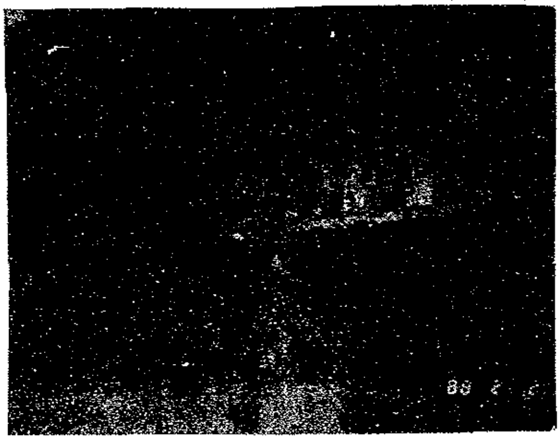


PHOTO 5

SUBSTRUCTURE:

Spalling at pier cap due to the movement of concrete beam

PHOTO 6

ABUTMENT:

Exposed abutment after washing away of slope protection

Fig. AP.4 PHOTOGRAPH OF DAMAGES (3/3)

PHOTO 7

FOUNDATION:

Exposed pile foundation due to local scouring of the river bed

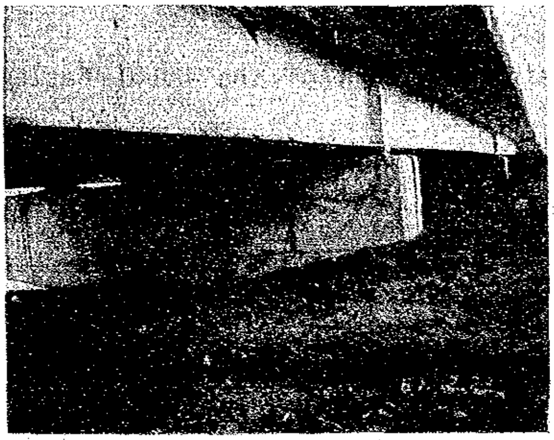


PHOTO 8

RIVER CONDITION:

Hidden columns of piers due to river sedimentation

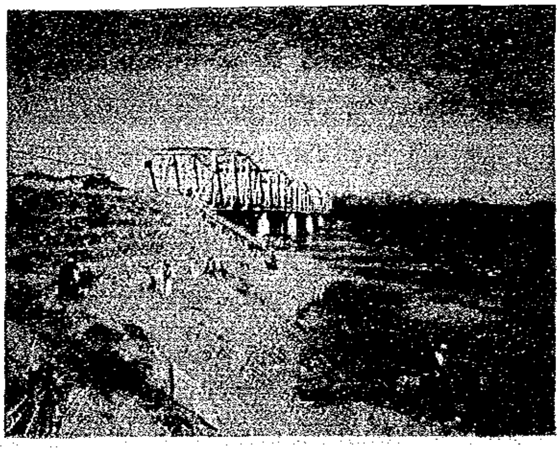


PHOTO 9

RIVER BANK:

Washed-out river bank under construction

APPENDIX 2.2 GUIDELINES FOR BRIDGE INVENTORY SHEET NO. 1

1. Fill-up column according to the order of DPWH stationing.
2. For the station refer to the DPWH official Km.
3. Write the corresponding Name of the Bridge.
4. For the Type of Bridge refer to the note below the sheet. Designate the type of bridge according to their number. For continuous bridge (bridge with 2 or more spans) that uses different type of materials, indicate them separately.
5. Fill-up the No. of Span and Span Length respectively. In cases, wherein there are 2 or more spans with different span length, indicate them separately.
6. For the Bridge Length, multiply the No. of Span and the Span length.
7. Width of Bridge (including the sidewalk).
8. For the Design Load, indicate the Traffic Load/Axle Load (referred to as highway live loads) used in the design.
9. Indicate the year when it was constructed or built.
10. Priority Column-fill it up using the data of the total Rating Evaluation of SHEET NO. 3.
11. For each bridge, under the heading Remark, you will be using a letter code. The meaning of each code is given as follows:
    A. The bridge is an old, narrow and in poor condition; it needs to be reconstructed.
    B. The bridge is old, but in good condition; it might need to be reconstructed or widened because it is too narrow.
    C. The bridge shows important shear cracks in the beams.
    D. The bridge appears in good condition, but is beginning to have some problems of corrosion.
    E. The bridge has a much damaged slab due to poor quality of the concrete and also shows shear cracks in the beams.
    F. The bridge needs urgent repair at the beams damaged by collision and maintenance to avoid corrosion.
    G. The bridge has the central span supported by additional temporary piers to reduce the vertical swaying. Permanent repairs must be made.
    H. The bridge is completely broken at the support, due to a mistake in the design or in the construction.

I. Others (Specify your comments and suggestions).

APPENDIX 2.3 GUIDELINES FOR BRIDGE INVENTORY SHEET NO. 2

1. For Nos. (1) to (8) refer your data to sheet No. 1.
2. Bridge Width (9) is the horizontal distance from face to face of railings or curbs (if pedestrian walkways/sidewalks are not provided). See Typical Section of Fig. AP.5.
3. Carriageway Width (10) horizontal distance between face of curbs. See Typical Section of Figure 1 attached.
4. Crossing Condition (11): Indicate if the bridge crosses a river, railway, roadway, valley, others.
5. Clearance Freeboard (12) is the vertical distance from the bottom of the girder to the water maximum leve. See Elevation of Fig. AP.5.
6. For the Plan of bridge (13), a bridge is considered straight if the abutments are perpendicular (90^oC) to the longitudinal axis of the bridge. If the abutments are not perpendicular to the longitudinal axis of the bridge it is said to be skewed. Please include the skew angle.
7. For the environment (14), specify if there are any indirect route (detour route including distance).
8. Indicate the type of material used (Steel, RC, P.C., others), including the Type of Bridge (15) using the data of sheet No. 1.
9. For the Type of Support (16) simple refers to simply supported beam. Continous refers to beams continous over three or more supports and rigid frame refers to structures where the substructure is monolithically constructed with the superstructures.
10. For the Type of Beam (17) refer to the attached Fig. AP.6 .
11. For the No. of Girder and Pitch (18) refer to the Fig. AP.5 attached.
12. Cross Beam (19) refers to floor beam (transverse beam) in truss bridges or diaphragms in concrete and steel I-beam bridges.
13. Stringers (20) are used in bridges with truss - (longitudinal beams).
14. For the Type of Slab (21) R.C. is used in most Philippine bridges. For the Span of Slab refer to the attached Fig. AP.5. Indicate the thickness of the slab if the data is available.
15. For Expansion Joints (24) indicate the type of material used. In Philippine bridge, there are only two type of material that are

commonly used (Steel and Dummy Joint).

16. For the substructure (25) and Foundation (26), see Fig. AP.7 and 8 attached respectively.

17. Waterway Width (27) is the horizontal distance between the river banks measured when the water level is at its maximum (H.W.L.).

18. Hydrologists will provide information/data for the Flood Velocity (28).

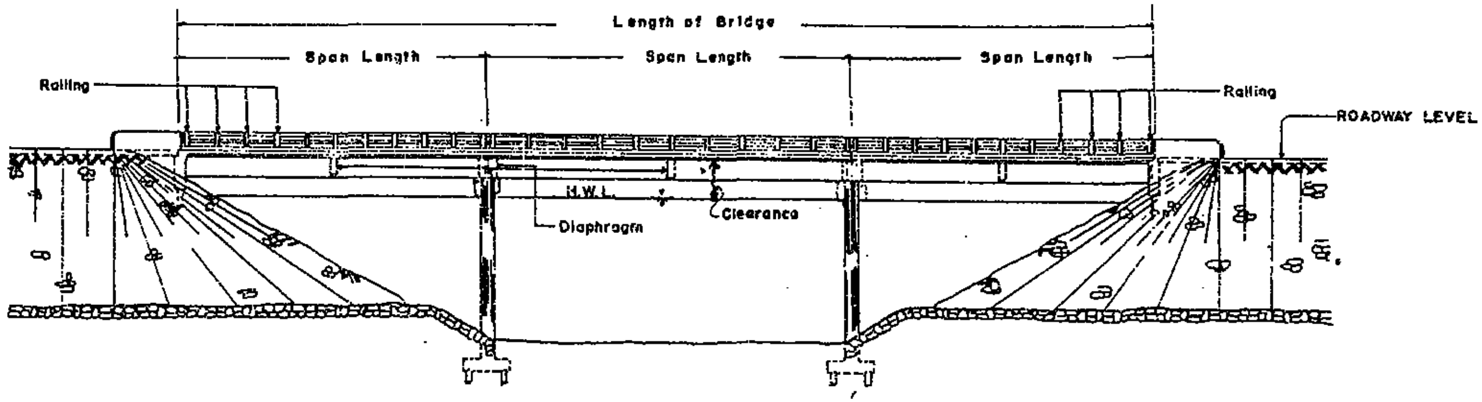
19. Orientation of water-way and Bridge (29): If the flow of water is parallel to the longitudinal axis of the pier it is coincident, otherwise, it is incoincident. Indicate the skew angle.

20. Traffic volume (30) refers to the number and type of vehicles that passed through the bridge.

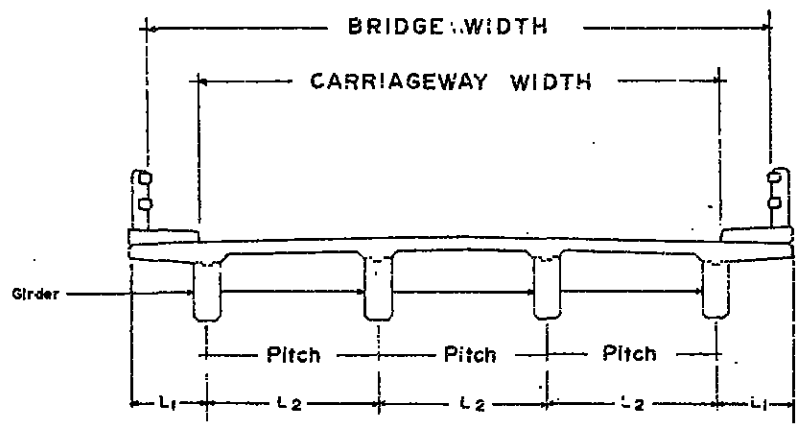
NOTE:

1. Encircle the corresponding type of each item and/or specify if necessary.
2. For the Note (lower portion of the sheet), please try to sketch each bridge (Freehand only) and indicate the type of the bridge for each span.

Fig. AP.5 GENERAL BRIDGE FEATURE



ELEVATION



TYPICAL SECTION

L_1 & L_2 : Span of Slab

Fig. AP.6 TYPES OF BEAM

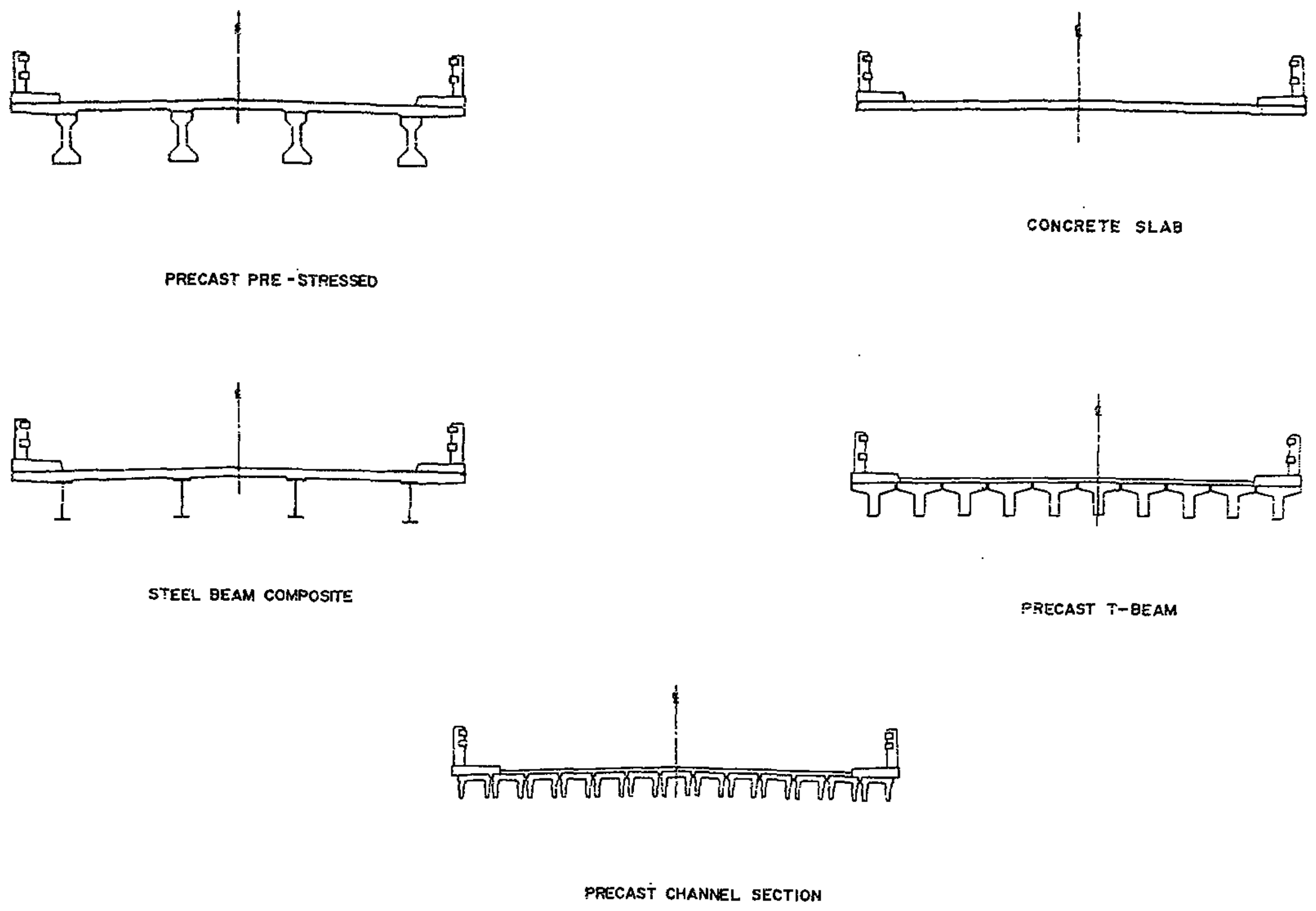


Fig. AP.7 TYPES OF PIER AND FOUNDATION

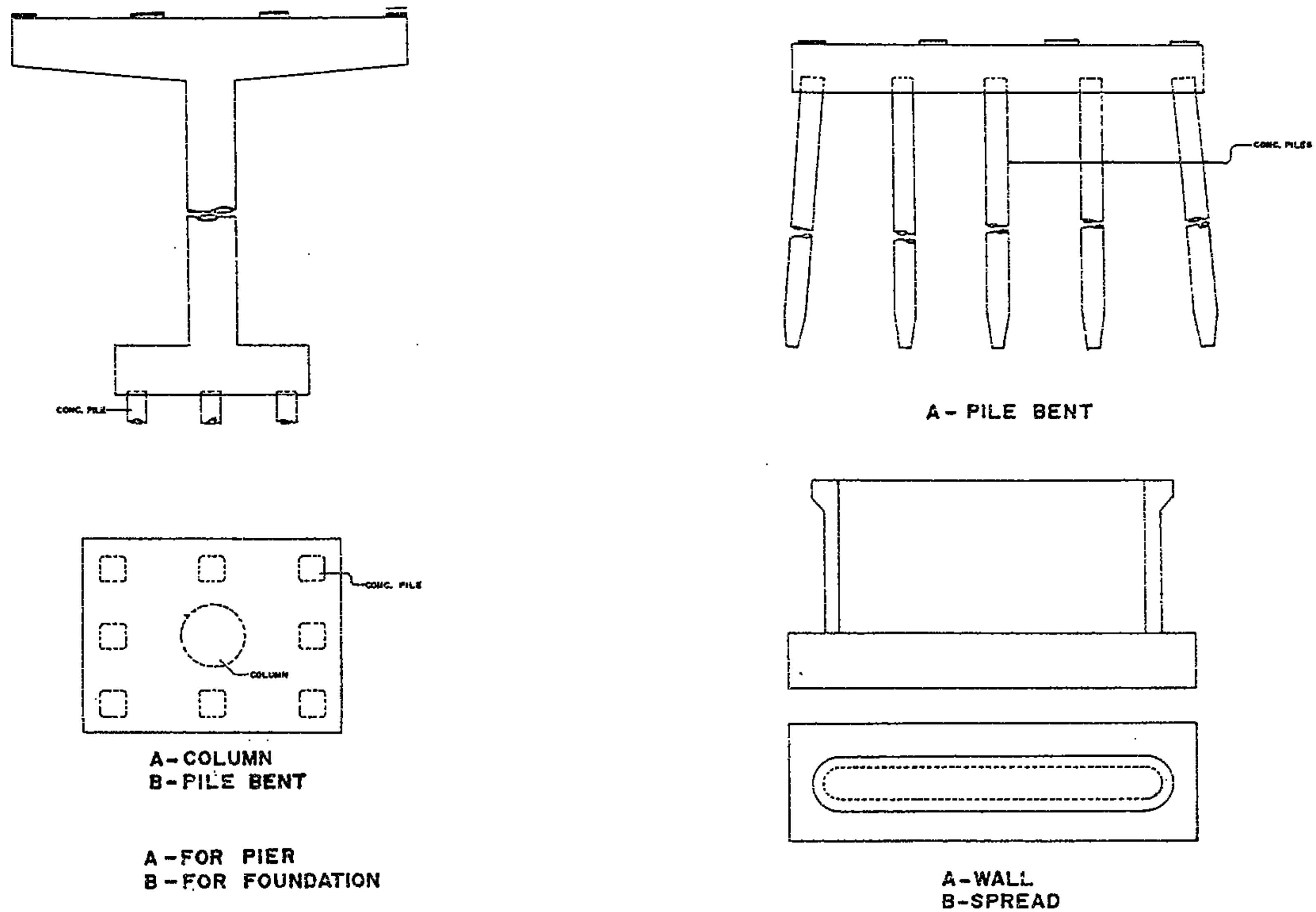
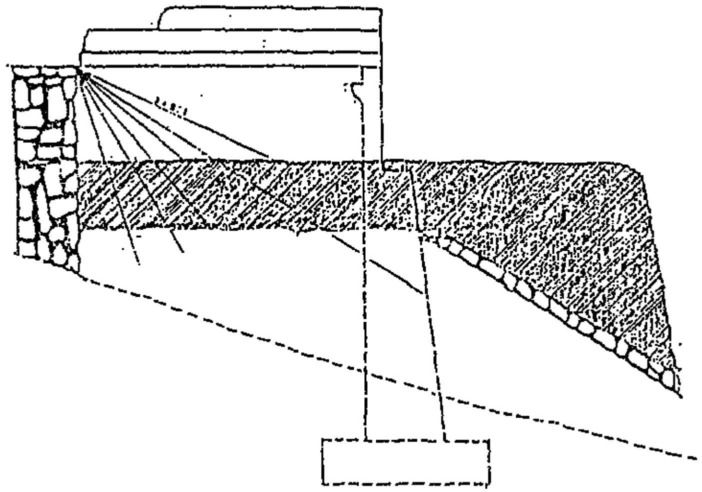
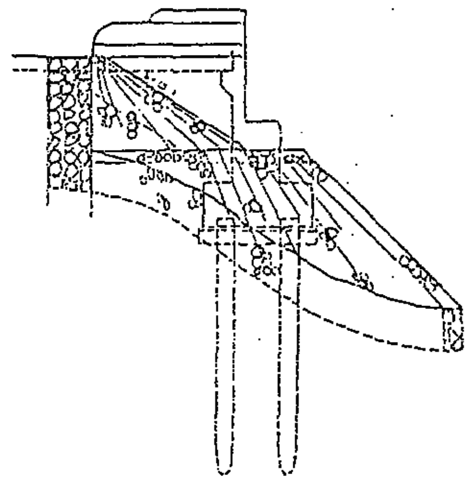


Fig. AP.8 TYPES OF ABUTMENT



OPEN/ORDINARY



PILE-BENT

APPENDIX 2.4 RESULTS OF ANALYSIS AND COMPARISON OF LOADING TEST

The loading test of San Cristobal bridge was carried out on July 1988 in accordance with the manual for loading test. The results of loading test are expressed in contrast with that of theoretical computation and allowable stresses computed through NSCP and also with the use of the Japanese Specification as reference.

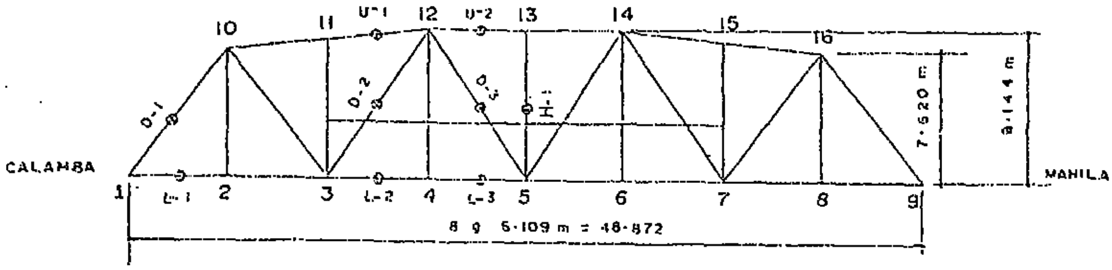
The following cases were considered for both theoretical computation and actual loading test.

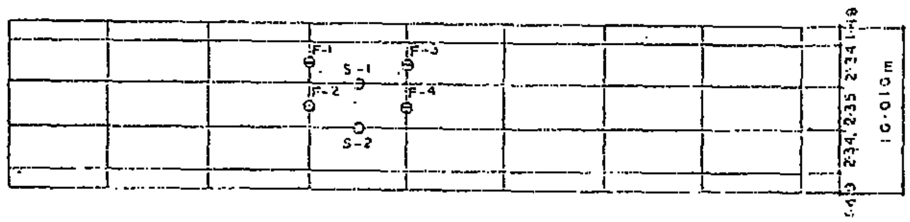
Case - 1 : Dead Load (DL) only
Case - 5 : DL + 2 trucks (2 x 15 = 30 tons)
Case - 6 : DL + 3 trucks (3 x 15 = 45 tons)
Case - 7 : DL + 4 trucks (4 x 15 = 60 tons)

The measured results of strain of major members are shown below and the ratio of strains by loading test and theoretical computation is 1.24 to 1.51, strain by loading test is greater than that by theoretical computation. (Refer to Table AP.1).

Members	Allowable Stress (kg/cm^2)	Axle Force (ton)		Stress (kg/cm^2)		Deflection (mm)	
		Computed	L. Test	Computed	L. Test	Computed	L. Test
U-2	1987	-145	-143	808	797	-	-
D-3	1395	16	19	60	304	-	-
L-3	1395	136	123	844	766	11.6	11.0

As understood from the above results, stress is not so much different between theoretical computation and loading test within elastic range. Deflection is also smaller than its allowable value of 8.3 cm (1/600). It is roughly expected that San Cristobal bridge has more surplus of displacement incurred by the vehicular loading which is greater than the case of loading test.





RESULT OF TEST
(4 Trucks)

MEMBERS			① TEST	② THEORETICAL	③=①/② RATIO
	UPPER CHORD	U-2	-139 ~ -121	-112	1.24
	DIAGONAL CHORD	D-2	-134 ~ -105	-72	1.86
		D-3	-89 ~ 34	59	1.51
STRAIN	VERTICAL CHORD	H-1	-21 ~ 11	0	0
(1×10^{-6})	LOWER CHORD	L-2	84 ~ 74	112	0.75
	CROSS BEAM	F-3	-95 ~ 95	—	—
	STRINGER	S-1	23 ~ 19	—	—
DEFLECTION AT CENTER mm			11	11.6	0.95

Table AP.1 COMPARISON TABLE BETWEEN COMPUTED AND LOADING TEST

			LOWER MEMBER	UPPER MEMBER		VERTICAL MEMBER	DIAGONAL MEMBER			DEFLECTION
			TENSION	COMPRESSION		COMPRESSION	TENSION	COMPRESSION		
			L−3 (4−5)	U−1 (11−12)	U−2 (12−13)	H−1 (5−13)	D−3 (5−12)	D−1 (1−10)	D−2 (3−12)	
AREA, A (CM^2)			161.20	−179.52	−179.52	−85.00	62.00	−179.52	−85.00	—
MOMENT OF INERTIA, I (CM^4)			7 533.79	−28 731.00	−28 731.00	−10 400.00	7 117.60	−38 731.00	−10 400.00	—
RADIUS OF GYRATION, r			6.84	−12.20	−12.20	−11.06	10.71	−12.20	−11.06	—
LENGTH / RADIUS OF GYRATION, L / r			89.37	−50.45	−50.08	−82.67	102.64	−80.03	−99.42	—
ALLOWABLE STRESSES (KG/CM^2)	NSCP		1395.00	−1 100.66	−1 098.12	−928.39	1395.00	−955.50	−806.73	—
	JAPAN STD.		1400.00	−1 144.24	−1 147.49	−873.58	1400.00	−895.75	−732.86	—
CASE 1 (Dead Load)	AXIAL FORCE (Ton)	COMPUTED	98.90	−88.70	−105.60	−1.70	12.00	−88.70	−22.60	—
		LOADING TEST	98.90	−88.70	−105.60	−1.70	12.00	−88.70	−22.60	—
	STRESS (kg/cm^2)	COMPUTED	613.90	−484.60	−588.20	−20.00	190.00	−494.10	−265.90	0.0
		LOADING TEST	613.90	−484.60	−588.20	−20.00	190.00	−494.10	−265.90	0.0
CASE 5 (DL + 2 Trucks)	AXIAL FORCE (Ton)	COMPUTED	121.90	−105.20	−130.00	−1.70	14.90	−104.30	−32.20	—
		LOADING TEST	111.60	−105.02	−129.20	−3.45	20.73	−103.02	−38.30	—
	STRESS (kg/cm^2)	COMPUTED	756.70	−586.00	−725.30	−20.00	236.50	−582.10	−378.80	7.1
		LOADING TEST	(78.80) 692.70	(−100.40) −585.00	(−131.30) −719.80	(−20.60) −40.60	(144.10) 334.40	(−79.80) 573.90	(−185.20) −451.10	8.0
CASE 6 (DL + 3 Trucks)	AXIAL FORCE (Ton)	COMPUTED	130.10	−110.30	−139.30	−1.70	19.00	−108.90	−34.90	—
		LOADING TEST	120.60	−117.46	−137.90	−3.45	17.00	−116.52	−38.30	—
	STRESS (kg/cm^2)	COMPUTED	807.60	−614.40	−776.00	−20.00	301.10	−608.60	−410.60	9.8
		LOADING TEST	(133.90) 747.80	(−169.70) −654.30	(−180.10) −768.30	(−20.60) −40.60	(84.90) 274.90	(−125.00) −649.10	(−185.20) −451.10	9.0
CASE 7 (DL + 4 Trucks)	AXIAL FORCE (Ton)	COMPUTED	135.90	−119.70	−145.10	−1.70	16.40	−120.60	−34.30	—
		LOADING TEST	123.40	−120.24	−145.00	−3.44	16.07	−114.10	−41.60	—
	STRESS (kg/cm^2)	COMPUTED	943.60	−666.80	−808.30	−20.00	260.30	−671.80	−403.90	11.6
		LOADING TEST	(132.30) 766.20	(−185.20) −669.80	(−208.30) −796.30	(−20.50) −40.50	(114.30) 304.20	(−141.30) −635.60	(−223.00) −488.90	11.0

NOTE:

Values enclosed with parenthesis are the stresses due to truck loading only.

APPENDIX 2.5 SAMPLE OF COMPUTATION OF PERMISSIBLE LOADING CAPACITY

COMPUTATION OF PERMISSIBLE LOADING CAPACITY (CASE-1)

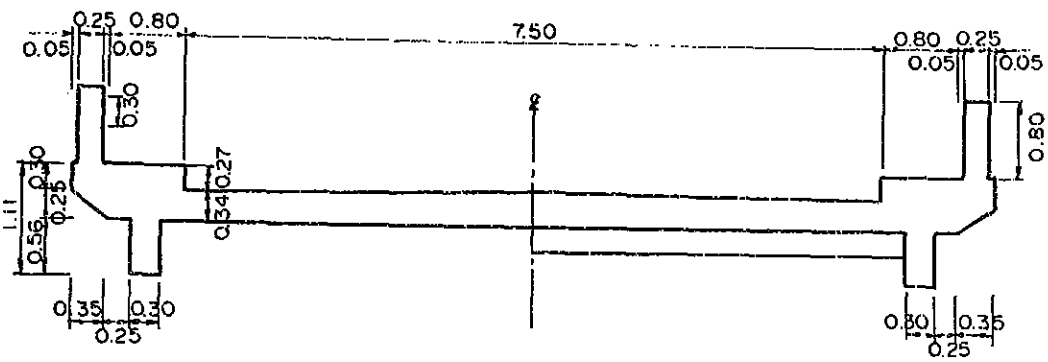
Bridge Number : 78

Bridge Name : San Gabriel

Bridge Type : RC - Slab

Bridge Span Length : 6.50 meters

Cross Section



1. Bending Moment

Dead Load (W_d = 11.067 kn/m^2) .... 58.5 KN-m/m

Live Load (i = 0.30)

Truck + impace .... 74.8 KN-m/m

Uniform + impact .... 57.5 KN-m/m

Total 133.3 KN-m/m

* Assumed Tension Bars

$$A_s = \frac{M}{fa \cdot j \cdot d}$$

$$= \frac{13,330}{13.8 \times 7/8 \times 29}$$

$$= 38.1 \text{ cm}^2$$

$$A_s = 8 - \phi\ 25 - 125 \text{ ctc}$$

$$= 39.27 \text{ cm}^2$$

2. Stress of Tension

$$f = \frac{M}{A_s\ jd}$$ where: K = 0.466, j = 0.845

Md = 58.5 KN-m = 5,850 KN-cm

$$fd = \frac{5,850}{39.27 \times 0.845 \times 29} = 6.08\ KN/cm^2 = 60.8\ MPa$$

M_L = 74.8 KN-m = 7,480 KN-cm

$$F_L + i = \frac{7,480}{39.27 \times 0.845 \times 29} = 7.77\ KN/cm^2 = 77.7\ MPa$$

* PERMISSIBLE LOADING CAPACITY, P

$$P = 135 \times \frac{fa - fd}{F_L + i} \times Ki$$

where: Ki = KS · Kr
= 1.0 x 0.9
= 0.90

$$P = 135 \times \frac{138 - 60.8}{77.7} \times 0.90$$

P = 121 KN < Pa = 135 KN

COMPUTATION OF PERMISSIBLE LOADING CAPACITY (CASE-2)

Bridge No. : 188

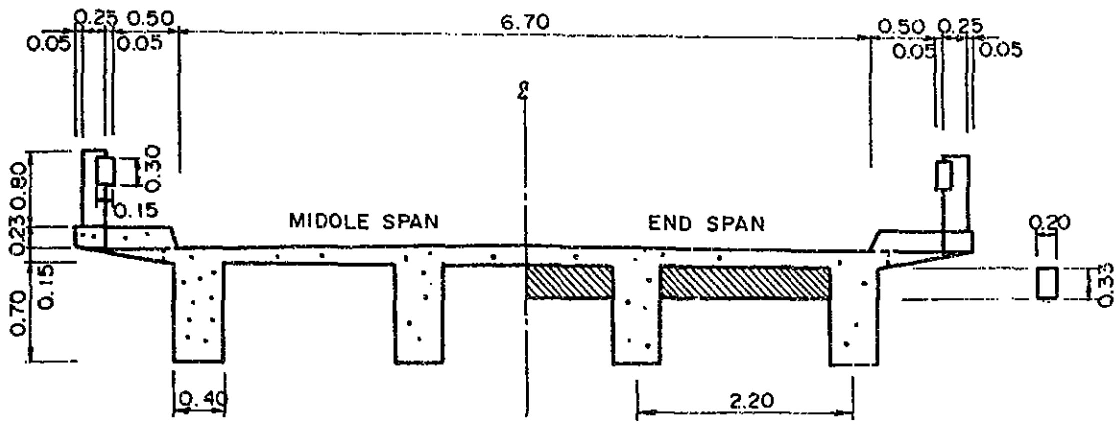
Bridge Name : Binahaan

Bridge Type : RCDG

Bridge Length : 10.0 + 14.0 + 14.0 + 10.0 = 48.0 m

Span Length : 14.0 m

CROSS SECTION



1. Bending Moment & Shear Force

Dead Load = Wd = 41.93 KN/m (two beams)

Md = 1/8 Wd L^2 = 513.64 KN-m/one beam

* Impace = $\frac{15.24}{L + 38}$ = 0.293

a) Truck Loading

$M_{max} = (33.75L + \frac{24.58}{} - 57.6045) \times (1 + i)$

= <u>538.70 KN-m/one lane</u>

b) Lane Loading

$M_{\text{℄}} = (1/8\ W_L \times L^2 + 1/4\ PL) \times (1 + i)$

= 496.447 KN-m

* Consider one lane (3.05)

$M_L = \frac{Mmax}{3.05} = 176 \times 2.20 = \frac{388.50\ KN\text{-}m}{one\ beam}$

* Bending Moment for Interior Beam

For RCDG $\qquad S = 2.20$ m

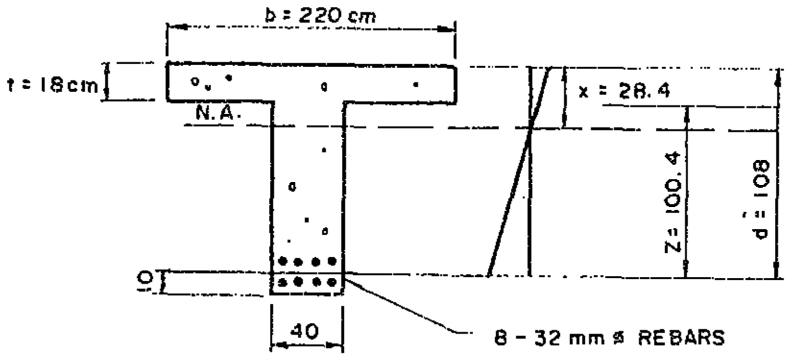
$M_L = M_{max} \times 1/2 \times \frac{S}{1.83} = 323.80$ NK-m

2. Stress

$A_s = \frac{M}{f_s\ (d - t/2)}$

$= 61.30\ cm^2 < A_s = 8 - 32$ mm Ø

$= 64.30\ cm^2$



n = 15

$kd = x = \frac{bt^2 + 2n\ Asd}{2\ (bt + n\ As)} = 28.4$ cm

$Z = jd - d = \frac{t}{2} + \frac{t^2}{6\ (2x - t)}$

Z = 100.4 cm

* $f_s = \frac{M}{As \cdot Z}$

$f_{SL} = \frac{323.80 \times 100 \text{ KN-cm}}{64.30 \times 100.4 \text{ cm}^2 - \text{cm}} = 5.02 \text{ KN/cm}^2$

(Dead Load)

$f_{SD} = \frac{513.64 \times 100 \text{ KN-cm}}{64.30 \times 100.4 \text{ cm}^2 - \text{cm}} = 7.96 \text{ KN/cm}^2$

$P = 135 \times \frac{fa - fd}{f_L}\ kj$

$= 135 \times \frac{13.8 - 7.96}{5.02}\ (0.90)$ $\qquad$ P = 141.3 KN > 135 KN

APPENDIX 2.6 PROCEDURES OF INSPECTION EQUIPMENT

(1) Testing Method of Concrete Strength

(A) Selecting the points to be tested

1) Vertical surfaces of concrete structures which are encased in a form are to be favoured.

2) Form joints, honeycombs and porous areas are to be avoided.

3) With thin structural parts (slabs and walls less than 10 cm thick, columns less than 12.5 cm thick), special care must be exercised as the elasticity of such structural parts may falsify the test hammer indication.

(B) Preparing points to be tested

1) Before testing any plaster work or coating must be removed.

2) Slightly uneven surfaces caused by unplaned wooden forms can be smoothened by hand with carborundum stone supplied with the hammer.

3) The ton surface of the concrete is only suitable for hammer test if the always present cement slurry was previously removed.

(C) Operation instruction for the concrete test hammer

1) By lightly pressing on the head of the impact plunger: The plunger is released and will slide out of the housing by itself.

2) The plunger is pressed against the spot of the concrete surface to be tested. Just before it disappears completely in the housing the hammer is released.

Release must be effected by slowly increasing the pressure on the housing. At the moment of impace the hammer must be held exactly at right angle to the surface. Don't touch the push button.

3) After impact the hammer mass rebounds by a certain amount which is indicated on the scale by the rider. The reading of the rider position gives the rebound value in percent of the forward movement of the hammer mass.

4) Carrying out impact test at 5 or better 10; points of the prepared area.

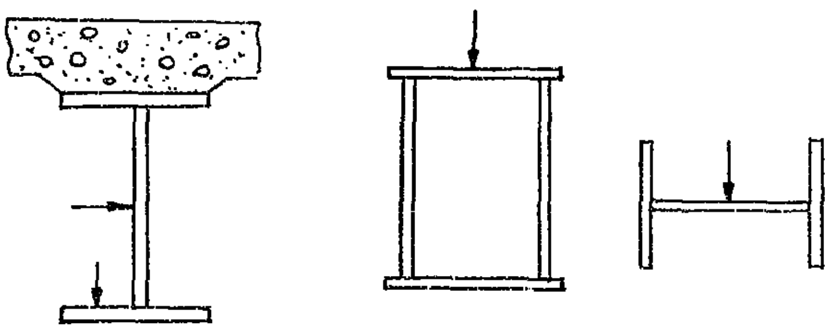
5) Rebound - compressive strength relationship is shown below.

(2) Testing for Hardness of Structural Steel

(A) General Description and Specification

1) Foe every bridge and/or test pit location, the conditions at the site like bridge environment, name of member, place of testing and surface condition of structural steel should be carefully noted and recorded. If necessary a photograph should be taken.

2) Location of test pit



I TYPE BOX TYPE H TYPE

3) Test pit should be thoroughly clean of corrosion and paint before testing.

(B) Test Procedure

1) Tester should be checked and recalibrated before or after testing.

2) A small brush is supplied with the instrument. Use it to ensure that both the base of the instrument and the measured surface are clean.

3) It is always advisable for the operator to stand in an upright position and to operate the instrument from above by pressing slowly and steadily either on the two handle pads or with both hands on the head of the instrument.

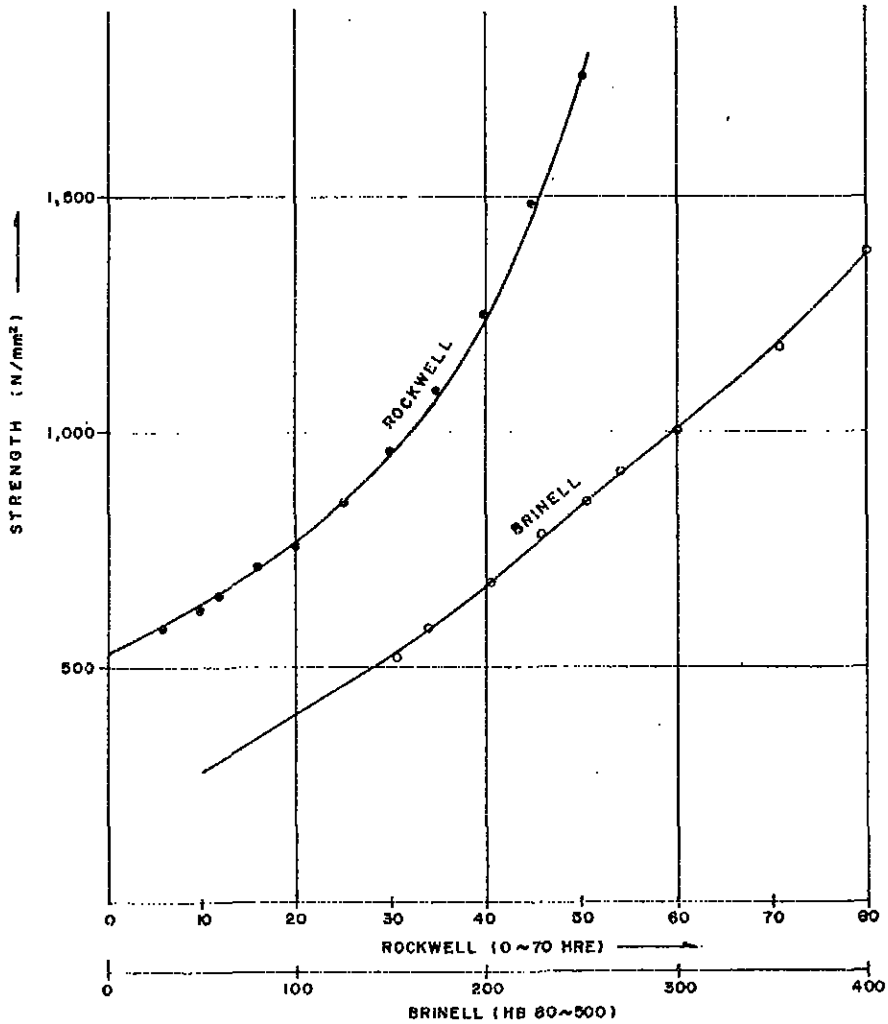
4) In the normal position, pressure is applied downwards by way of the handle pads.

5) When using the instrument near a vertical surface, the handle pads are remove and pressure is applied at the top.

6) The bubble in the center of teh head helps to guide the pressure in the correct direction and avoid tilting.

7) The result is independent of the pressure applied. Read the hardness of the scale where the comparator hand come to rest and releases the pressure.

8) Hardness - strength relationship is shown below.



RELATIONSHIP BETWEEN STRENGTH AND ROCKWELL, BRINELL

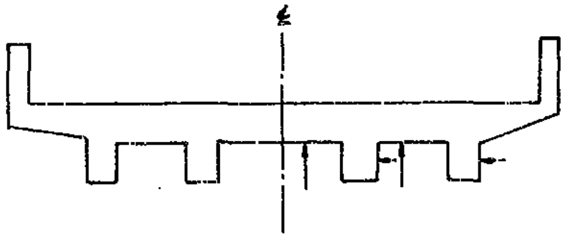
TESTING FOR NEUTRALITY OF CEMENT CONCRETE

(A) General Description and Specification

1) For every bridge and/or test pit location, the conditions at the site like bridge environment, name of member, place of testing and surface condition of cement concrete should be carefully noted and recorded. If necessary, a photograph should be taken.

2) Location of test pits

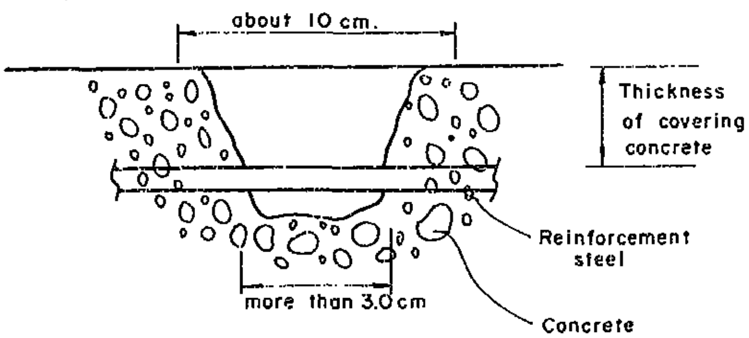
a) RCDG



b) Concrete Slab

c) Pier or Abutment

3) Test pit specification



4) Test pits should be thoroughly clean of debris and concrete powder before testing.

5) Corrosion of reinforcing steel should be carefully noted by visual inspection and recorded according to the degree of corrosion as specified below.

Degree of Corrosion	Condition of Reinforcing Steel
I	Original condition
II	Partially rusty
III	Totally rusty, no section defect
IV	Defects in some sections

6) A detailed sketch of the actual test pit must be drawn, noting the diameter and direction of reinforcing steel bars as well as the thickness of covering concrete. If necessary a photograph should be taken.

(B) Test Procedure

1) Spray the newly crushed face of cement concrete with a reagent consisting of one (1) percent phenolphtalen liquid.

2) Measure the neutrality depth, three (3) to five (5) times, by using Nogis or steel scale. Record each trial in the record sheet. Neutrality depth is defined as the vertical distance from the surface of cement concrete up to the depth where the concrete face has not changed color. It should be noted that a chemical reaction must take place, change of the original color of concrete to red, before neutrality depth can be measured.

3) A photograph must be taken after the measurement of neutrality depth.

4) Neutrality Test should be done more than twice for each structure (slab beam, pier, etc.)

MEASUREMENT OF NEUTRALITY DEPTH OF CEMENT CONCRETE
AND CORROSION OF REINFORCING STEELS

1. BRIDGE NUMBER & NAME :
2. LOCATION OF BRIDGE :
3. BRIDGE TYPE :
4. BRIDGE LENGTH & SPAN :
5. BRIDGE WIDTH & CARRIAGEWAY :
6. YEAR BUILD :
7. DATE OF TEST :
8. WEATHER CONDITIONS :

TESTING PLACE		CEMENT CONCRETE		REINFORCING STEEL		
NAME OF STRUCTURE	DIMENSIONS	NEUTRALITY DEPTH	DESCRIPTION	THICKNESS OF COVERING CONCRETE	DEGREE OF CORROSION	DIAMETER (mm)

REMARKS:

JICA