(10)River bank

Except for a few overpasses and viaducts, most bridges in Malaysia span over waterways or rivers. In this condition, these bridges are susceptible to various damages caused by the river flow.

Many rivers in Malaysia are naturally scour-prone and alluvial channels, in particular, have a tendency to shift their location. The scour-prone will undermine bridge foundations and shifting alignments will result in advance erosion of the river bank and bridge foundation. Moreover, under conditions where water-borne debris is abundant, channel blockage frequently results and causes serious damage to the superstructure as well as the foundation.

Although other types of structural damage are more apparent and spectacular, maintenance operation concerning river banks and river beds is equally important.

Problem	***Correction***
(a)<u>Local bank erosion</u>: This defect is defined as localized removal of river bank material by streams and tidal currents. It may occur naturally as the result of channel constriction or changes in the flow pattern. The local erosion indicates the possibility of serious erosion which could occur during floods. (Refer to Photo-19).	This problem can be solved by the provision of wiremesh gabions, dumped stones or piled walls depending on the soil condition, scale of the erosion and the river.
	 Photo - 19 Bank erosion
(b)<u>Slope protection failure</u>: It is a result of the scouring or erosion against the footings of the slope protection, mostly made by grouted riprap. Most of the cases at present are likely to be caused by inadequate footing depth and/or poor mortar in the riprap. It is important to repair the defect within the earliest time, otherwise the failure becomes critical and eventually effects the stability of the abutment. (Refer to Photo-20).	It is essential to install a solid footing with at least 1.0m of depth from the slope end. The other damaged portion should be repaired by grouted riprap and the mortar mix ratio of cement and sand should be 1 to 3.
	 Photo - 20 Slope protection failure

(c) Dense vegetation: Dense vegetation on the waterway slope could lead to clogging of the bridge opening or waterway clogging by plant accumulation. In addition to this, dense vegetation beneath the bridge causes poor accessibility for bridge inspections.

Grass and plants growing in the area within the river width and at least 10m up and down stream from the bridge shall be cut periodically to provide smooth flow and easy access for inspections.

(d) Illegal waste disposal: It has been observed that rubbish, debris or other solid waste materials have been dumped on bank slopes adjacent to the bridge. (Refer to Photo-21). Excessive accumulation of these materials on the bank could cause closure of the bridge opening, water pollution and insanitary conditions for the public.

Rubbish, debris and other foreign material must be removed. It is recommended to provide prohibition signposts on the river bank after cleaning work is completed.

Photo - 21 Illegal waste disposal

(e) Shack or pen under bridge: Illegal occupancy under the bridge, shacks or pens cause blocking of the water way. (Refer to Photo-22).

Any illegal facilities under the bridge must be taken away, and prohibition signboard shall be installed.

Photo - 22 Shack under bridge

4.4 Management and Implementation

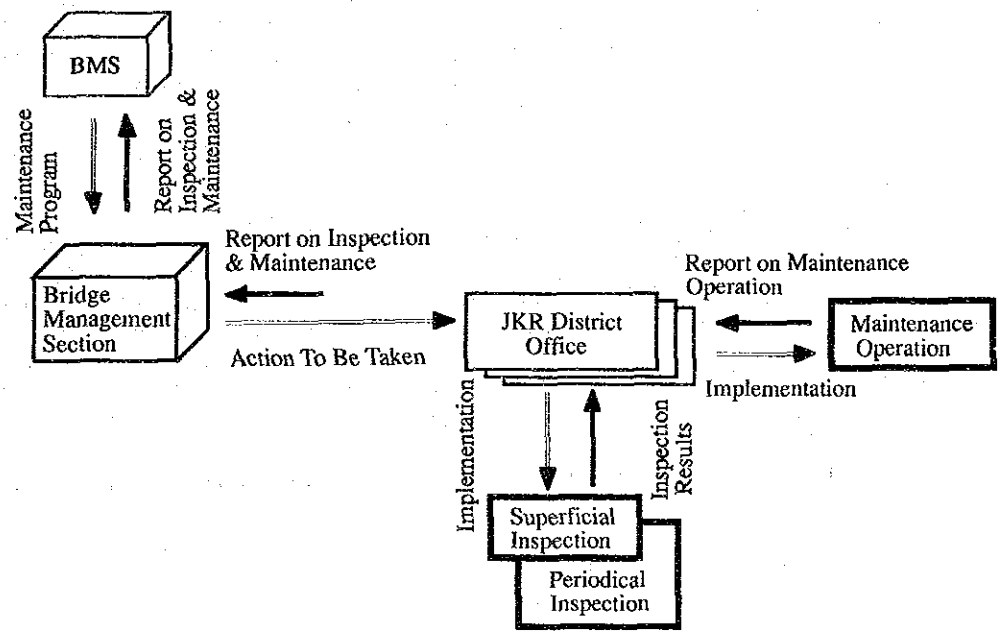
In bridge maintenance, it is essential to effectively manage the bridge maintenance activity and to correctly implement the bridge maintenance work at the job site. However, a successful management and implementation of bridge maintenance rely on the organization and method as well as the staffing and their capability.

Therefore, this section presents the overall organization, linking Federal and District levels, implementation method of the bridge maintenance work and the maintenance team's organization and staffing.

(1) Schematic Flow of Bridge Maintenance

In principal, the maintenance program shall be formulated by the Bridge Unit based on the results of inspections carried out by the District Offices. The maintenance operation shall be standardized from technical and economic view points at Federal level. For these purposes, schematic flow of the bridge maintenance, which is part of the overall schematic flow of the bridge management drawn in Figure 2-8, is depicted in Figure 4-5. It highlights the close relationships between: bridge maintenance programs and inspections, maintenance operation and maintenance records, maintenance records and maintenance standardization.

Figure 4-5 Schematic Flow of Bridge Maintenance



The concepts of above the schematic flow are as follows;

The various types of information and data on the inspections shall be sent to the Bridge Management Section of the Bridge Unit in JKR HQs, for updating data in the BMS and, in particular, for decisions on the maintenance program, type of operation to be carried out and financing.

The Bridge Management Section shall assess the data and information using BMS and reach appropriate decisions to implement the maintenance operation effectively and timely.

The decision as to the maintenance program and operation with the financial arrangement will be forwarded to respective District Offices for implementation. This centralized arrangement indubitably demonstrates the importance of a common language for implementation of rational and uniform maintenance policy.

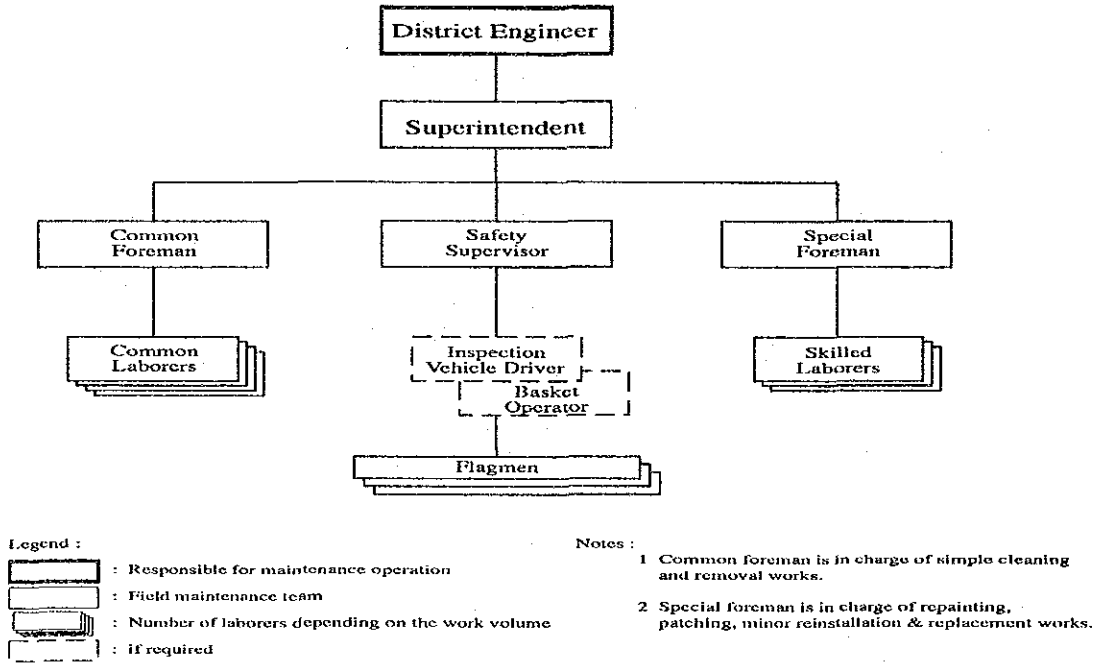
Furthermore, the maintenance record must also be forwarded to the Bridge Unit that will process this data in BMS in which it will be used as a basis for future rationalization of maintenance programs and operations with regards to the technical and economic aspects.

(2) Maintenance Operation

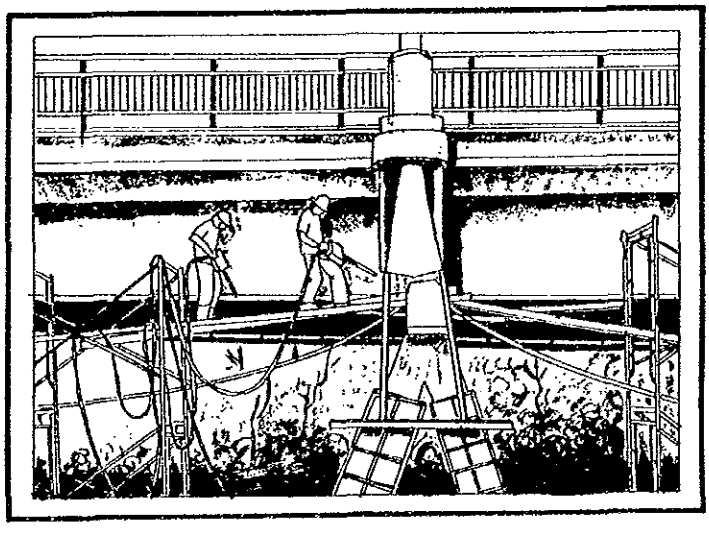
The maintenance operation is under the responsibility of respective JKR District Offices representing the District Engineers. The operation shall be carried out on a force account basis, i.e.the work is implemented by staff belonging to the JKR District Office. Therefore, the District Offices are required to increase their resources and technical capacity related to bridge maintenance.

To this end, the maintenance team depicted in Figure 4-6 shall be organized in each District Office to carry out bridge maintenance. In the maintenance team, at least the superintendent and technicians should have some knowledge of the structures and techniques as well as multi-discipline of the maintenance works, because the quality of the work depends on the skill and techniques of the staff.

Figure 4-6 Proposed Organization of the Maintenance Team



CHAPTER 5 : BRIDGE REHABILITATION



CHAPTER 5 BRIDGE REHABILITATION

5.1 General

At present in Malaysia, there are about 4500 bridges. The aging of these bridges is one of the most potential problems. While the rapid growth of total traffic volume and an increase in the traffic loads require widening of the bridge carriageways and an increase in the bridge load-carrying capacity, respectively. Furthermore, river water and air pollution could generate bridge materials deterioration due to chemical attack, chloride attack and carbonation.

Consequently, with the accumulating number of bridges, increasing traffic, both in terms of volume and load, and aggravating environmental conditions lead to serious problems such as loss of traffic safety, reduction of structural safety and an increase in the government expenditure for bridge replacement.

In order to prevent those problems, rehabilitation and strengthening of the bridges are required. These are only part of a broad panoply of the measures including inspection and maintenance.

In this context the objectives of rehabilitation and strengthening are as follows;

-Preserving, serviceability and loading capacity for as long as possible;
-Achieving economy as regards present and future costs;
-Assuring the safety of road users;
-Minimizing interference with traffic;
-Providing adequate rideability and travel comfort.

Taking into account the above background and objectives, rehabilitation and strengthening are generally the technical aspect of repair which is remedial in nature while maintenance can be considered as the technical aspect to upkeep the bridges which is preventive in nature.

In this manual, "Rehabilitation" is defined as restoring the bridge to the service level it once had and "Strengthening" is defined as endowing the bridge with a service level higher than that initially planned. From the manner of the implementation, those works can be classified as a work which will be carried out by specialized contractors.

It should be emphasized that during the normal life cycle of a bridge, frequent maintenance operations are requisite so that rehabilitation works that are relatively costly could be minimized. These two types of activity are complementary to ensure long life spans. Furthermore, they are interactive in so far as

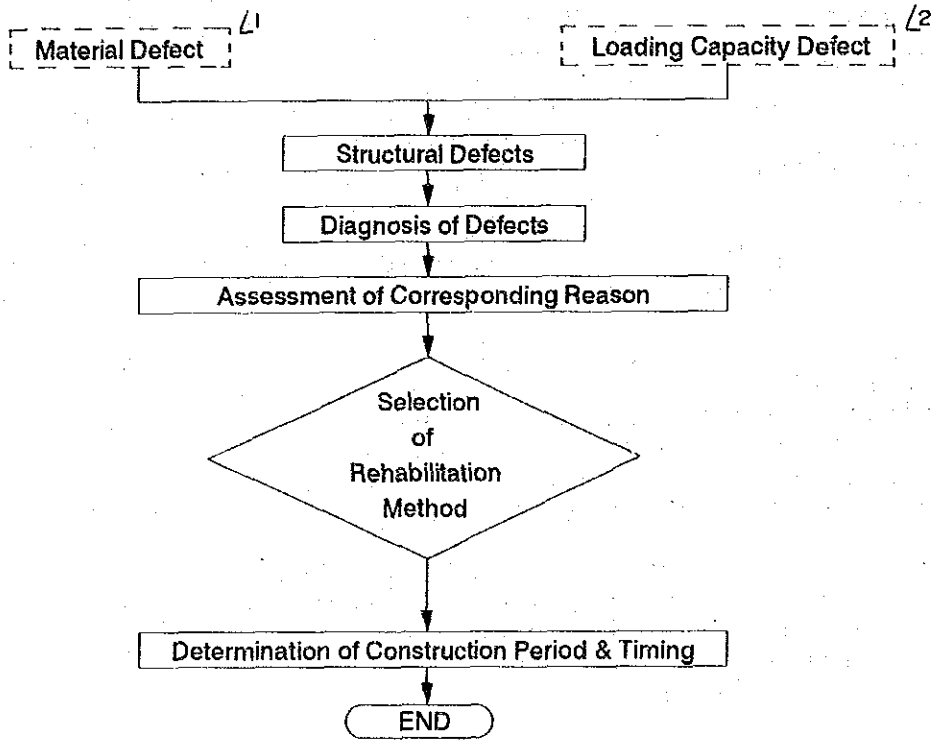
inadequate maintenance accelerates the frequency of the rehabilitation work.

5.2 General Rehabilitation Planning

In rehabilitation planning, it is essential to diagnose all the defects from structural, functional and hydraulic view points, which should be detected during the detailed inspection. The corresponding reasons for the defects should also be assessed so that a suitable rehabilitation method could be selected to effectively rectify them.

General flow of structural rehabilitation planning is depicted below :

Figure 5-1 General Flow of Structural Rehabilitation Planning



Note /1 is detected in the detailed inspection.
/2 is identified in the analytic assessment.

5.2.1 General Selection of Rehabilitation Method

In the selection of a rehabilitation method, several possible rehabilitation alternatives shall be evaluated from the following aspects and the most suitable method and material to be applied shall be selected accordingly.

- Structural Aspect :
  - Type, degree and extent of a defect and its corresponding reason.
  - Location of defective member.
  - Environmental condition of bridge site.
  - Effect of adjacent construction.
- Working Aspect :
  - Working space.
  - Accessibility of construction materials and equipment required.
  - Means of traffic control.
  - Environmental effect (Noise, Vibration and water pollution)
  - Safety measures.
- Aesthetic Aspect :
  - Suitability to existing structure.
  - Fitness of surrounding area.
- Economic Aspect :
  - Cost minimum.

In general, the defects and the corresponding rehabilitation method for concrete structures are more complicated than those of steel structure. Therefore, a relationship diagram between concrete defect together with several reasons and the possible rehabilitation methods is shown in Table 5-1 as a guide.

5.2.2 General Repair Material

In bridge maintenance and rehabilitation work, many chemical products are frequently used in addition to general bridge materials such as concrete, structural steel, P.C cables and reinforcement bar. Therefore, this subsection presents general characteristics of the repair materials applicable in the rehabilitation work, while requirements for the general bridge materials can be refered to in the "Standard Specification for Road Work" (JKR/SPJ/1988).

The repair materials are broadly divided into resin based material and cement based material. The Resin Based is subdivided into four groups consisting of epoxy, polyester, polyurethane and rubber/asphalt group. The general characteristics and effectiveness of each group material are tabulated in Table 5-2.

Table 5-2 General Characteristics and Effectiveness of Each Resin Based Repair Material

Item	Epoxy Group	Polyester Group	Polyurethane Group	Rubber/ Asphalt Group
Adhesivebility	◎	○	○	△
Flexibility	△	△	◎	○
Durability	◎	○	○	×
Workability	○	○	○	◎
Waterproofing	◎	○	○	△
Alkali-Resisting	◎	×	○	△
Shrinkage	None	Large	Small	Large
Economy	△	○	○	◎

Legend : ◎ Very Good, ○ Good, △ Fair, × Bad

Table 5–1 General Relationship Between Rehabilitation Methods For Concrete Structures and Defect

Defects \ General Rehabilitation Methods / Reasons		Injection	Patching	Gunitting	Surface Coating	Jacketing	Lining	Steel Plate Bonding	Additional Prestressing
Crack	– Effect of Excessive Load /1	o	o			o	o	o	
	– Design Deficiencies /2	o	o			o	o	o	o
	– Improper Construction /3	o	o	o	o	o	o	o	o
	– Environmental Effect /4		o	o	o				
	– Disaster /5	o	o	o	o	o	o		
	– Aggravation of Foundation /6	o				o	o	o	o
Spalling & Section Loss	– Effect of Excessive Load /1		o	o		o	o	o	
	– Design Deficiencies /2	o	o	o		o	o	o	
	– Improper Construction /3		o	o	o				
	– Environmental Effect /4		o		o	o	o		
	– Disaster /5		o	o		o	o		
Rebar or PC cables exposed, Corrosion of Rebar or PC Cables	– Design Deficiencies /2			o		o	o	o	o
	– Improper Construction /3		o	o	o	o	o		
	– Environmental Effect /4		o	o		o	o		
	– Disaster /5		o	o		o	o		
Deterioration	– Improper Construction /3	o		o		o	o		
	– Environmental Effect /4			o	o	o	o		
	– Disaster /5				o	o	o		

Notes :
- o Generally applicable.
- /1 Increase of dead and live loads.
- /2 Inadequate amount of rebars or PC force, inadequate concrete cover, wrong structural analysis or incorrect structural model.
- /3 Poor concrete quality, inadequate concrete cover, honey comb, poor cold joint, improper supporting or form work, inadequate P.C. force, improper grouting, improper compaction or vibration work.
- /4 Carbonation, chloride attack, acid attack, sulphate attack, alkali–aggregate reaction, shrinkage.
- /5 Fire, collision.
- /6 Local scouring, reduced bearing capacity, adjacent construction effect.

Out of the four groups above, epoxy resin is normally applied in the bridge rehabilitation work. Furthermore, a more flexible epoxy resin has been recently developed but it is not suitable for use in strengthening work.

In applying resin based material, the wet ground material reduces the adhesion and causes exfoliation. Thus the ground material should be thoroughly dry before applying the resin material. In the case of wet ground material, cement based material shall be applied.

The cement based material is subdivided into polymer cement slurry, polymer cement paste, polymer cement mortar, cement filler and expansive cement grout. Most of the cement based materials have relatively strong adhesive to the wet ground material but in the case of dry ground material, frequently it causes exfoliation due to shrinkage. At present, the cement based materials are inferior to resin based materials especially from workability and shrinkage view points.

It is essential to select a material, which is best suited to the rehabilitation method, with the following general characteristices :

- Good workability
- Advantegous quality meeting rehabilitation purpose
- Strong adhesion to existing concrete surface
- Early hardening and minimal shrinkage
- Adequate alkali-resistance and durability

Table 5-3 General Relationship Diagram Between Applicable Repair Material and Rehabilitation Method

Type of Repair Material		Injection	Patching	Protective Coating
Resin Based Material	Resin Mortar		o	
	Epoxy Resin	o	o	
	Flexible Epoxy Resin	o	o	
	Elastic Sealing Compound		o	o
	Coating Elastic Membrance			o
Cement Based Material	Polymer Cement Slurry	o		
	Polymer Cement Paste			o
	Polymer Cement Mortar		o	
	Cement Filler Expansive Cement Grout	o		o

o : Means applicable

General application of the above mentioned materials to the corresponding concrete rehabilitation method is tabulated in Table 5-3.

5.3 Rehabilitation Techniques

The rehabilitation techniques covered in this Manual are broadly divided into three categories comprising of structural rehabilitation, functional rehabilitation and hydraulic rehabilitation. The structural rehabilitation is to rectify a deteriorated / damaged bridge member or to strengthen or replace a bridge member which is seriously damaged or has inadequate load carrying capacity. While functional rehabilitation is to improve the bridge function by widening carriageways to increase traffic capacity, adding sidewalks in terms of pedestrian flow capacity, raising bridge grade or extension of bridge length from bridge opening capacity view point. Hydraulic rehabilitation is mainly to protect river banks or river beds in the vicinity of abutments and river piers.

The following subsection presents appropriate rehabilitation techniques divided into the above three categories.

5.3.1 Structural Rehabilitation Techniques

The structural rehabilitation techniques are broadly subdivided into three categories comprising of protection, strengthening and replacement. Each category has various rehabilitation methods depending on the type of defect, its extent and degree as well as the cause of the defect. The followings are general criteria to distinguish the rehabilitation methods against the corresponding type of structural defects consisting mainly material deterioration defect and load carrying capacity defects.

(A) Protection technique is applicable to a bridge member which has adequate load carrying capacity but which has minor material deterioration defects including inactive cracks due to shrinkage, creep or temperature or some construction deficiencies such as honeycomb, flaking, water stain etc.

In the protection works, application of a specific rehabilitation technique depends on the type of defect, its extent and degree as well as the cause of the defect. Each type of rehabilitation technique together with the corresponding application criteria is tabulated in Table 5-4. The drawing, work sequence and indicative specification of each rehabilitation technique is tabulated in the succeeding pages.

Table 5-4 Protection Technique and Corresponding Application Criteria

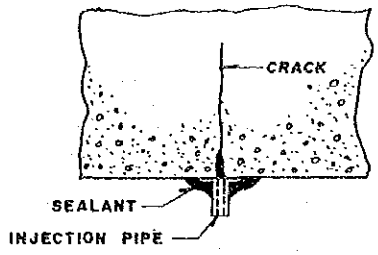
Rehabilitation Plan	Method	Application Criteria
o Protection work to concrete member	Injection	o Cracks are not active and its surface width is more than 0.2 mm, but less than 3.0 mm. o Reason of the crack appearance is due to shrinkage, creep of concrete, etc. o No water leak and no liquid rust. o No carbonation and no chloride attack. (1) : If surface crack width is more than 3.0mm, apply cement paste injection (2) : If crack surface is wet due to water leak, apply expansive cement grout.
	Patching	o Defects such as honeycomb, flaking, cavity etc. are not active. o Reason for these defects are mainly due to inferior concrete or poor workmanship, or due to traffic collision. o Minimal carbonation, no chloride attack and no water leak. o Adequate concrete cover. o Defective area is scattered. o In case that the cavity due to scaling, etc. is relatively small and shallow, apply epoxy resin based material as a repair material, but if the cavity is extensive and and large, use polymer cement mortar from an economic view point.
	Guniting	o Cracks of which surface width is less than 0.20mm are not active. o Concrete is slightly carbonated. o Minimum concrete cover is inadequate. o No water leak (or water leak prevention work has been completed). o Defective area is extensive.
	Protective Coating	o Cracks are not active and surface width is less than 0.2mm. o No water leaks, no scaling, no flaking. o Minimal carbonation and no choloride attack. o Adequate concrete cover.
	Waterproofing	o Water stain, free lime and other associated defects are observed at slab soffit. o Defects that are not active. o Water is penetrating from top of slab through defective concrete or inferior joints between precast members.
	Concrete Lining	o Minimum concrete cover is inadequate. o Wide longitudinal cracks due to chloride attack or rebar corrosion. o Abrasion of concrete surface or loss of concrete matrix due to inferior concrete or chemical attack. o Concrete is carbonated.
o Protection work to steel member	Repainting Superstructure	o Adequate load carrying capacity. o Non-active corrosion. o Paint deterioration.
	Adding cover plate	o Adequate load carrying capacity. o Cracking of steel member due to fatigue damage or stress concentration. o Stress due to total load including additional load is still within allowable stress.
	Repainting steel pile	o Steel surface is slightly corroded but load carrying capacity is still adequate. o Bridge is located at non-severe environmental condition. o No chloride attack.
	Concrete lining steel member	o Steel surface is considerably corroded but load carrying capacity is still adequate. o Bridge is located at severe environmental condition. o Chloride attack is considerable.
o Protection work to incidental facility	Extension of Drainage Pipe	o The drainage pipe is too short or missing. o The water through the pipe which is improperly installed splash the structural members.
	Installation of Drip Check	o Water stain at soffit of cantilever slab and external face of beam web.

REHABILITATION PLAN : PROTECTION WORK TO CONCRETE
METHOD : INJECTION

DRAWING :

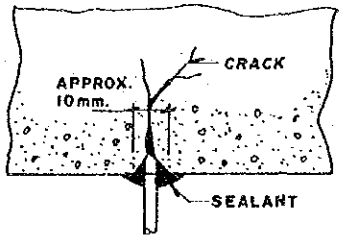
TYPE 'A'

(APPLICATION : CRACK WIDTH IS MORE THAN 0.2mm. BUT LESS THAN 0.8mm.)



TYPE 'B'

(APPLICATION : CRACK WIDTH IS MORE THAN 0.8mm. BUT LESS THAN 3.0mm.)



CRACK WIDTH (mm.)	INJECTION PIPE INTERVAL (mm.)
< 0.3	50 ~ 100
0.3 ~ 0.5	100 ~ 200
0.5 ~ 1.0	150 ~ 250
1.0 <	200 ~ 300

APPLICATION CRITERIA :

- Cracks are not active and its surface width is more than 0.2 mm, but less than 3.0mm.(1)
- Reason of the crack appearance is due to shrinkage or creep of concrete.
- No water leak(2) and no liquid rust.
- No carbonation and no chloride attack.

(1) : If surface crack width is more than 3.0mm, apply cement paste injection.
(2) : If crack surface is wet due to water leak, apply expansive cement grout.

WORK SEQUENCE :

1) Remove any loose weak material on the surface and thoroughly clean and dry (1) the cracks with oil-free compressed air.
2) Sealed the crack surface and marked the injection points. The spacinge tween injection points shall be as shown in the table above.
3) Fix the injection pipes into position by sealing its surrounding area.
4) Commence injection of epoxy resin from either the lowest injection point in a vertical crack or from either extreme end of a horizontal crack.
5) Remove the injection pipes and seal the holes as work proceeds.
6) Remove the sealing strip when the resin has cured and carry out final surface treatment if required.

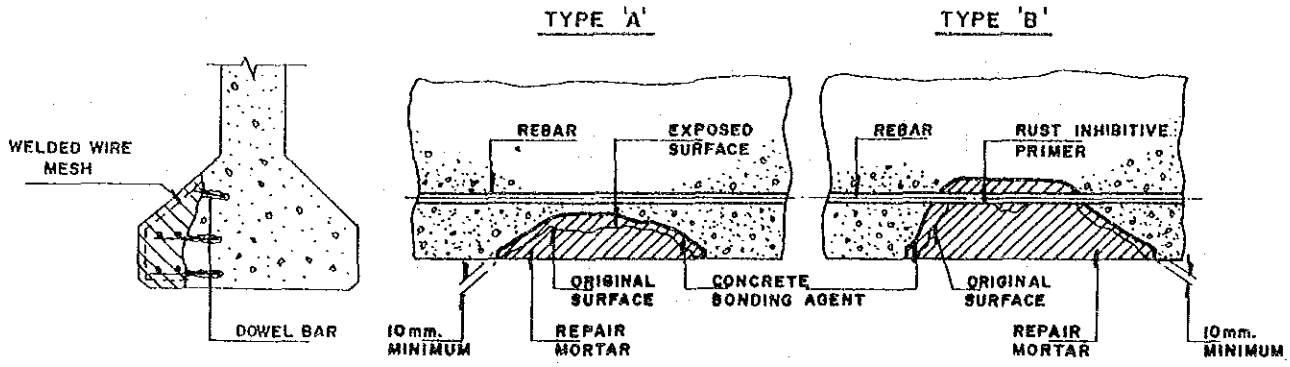
(1):In case of applying expansive cement grout, dry work is not required.

SPECIFICATION :

1) Epoxy resin material shall comply with the requirement of JIS A 6024.
2) Minimum material property of epoxy resin shall be as follows :
-Minimum compression strength at 7 days (Test Method: JIS K7208)...60N/mm².
-Flexural strength (Test method :JIS K7208).....40N/mm².
-Compressive elastic modulus (Test Method: JIS K7208).....3000N/mm².
-Specific gravity (Test Method: JIS K7112).....1.2±0.2.
-Viscosity (Test Method: JIS K6838).....5000 CPS.
-Hardness (Test Method: JIS K7215).....80 SD.
3) Injection pressure shall not be more than 40 psi (=3 kgf/cm²)
4) Minimum curing time of epoxy resin shall be 24 hours.

REHABILITATION PLAN : PROTECTION WORK TO CONCRETE
METHOD : PATCHING

DRAWING :



APPLICATION CRITERIA :

- Defects such as honeycomb, flaking, cavity etc. are not active.
- Reason for these defects are mainly due to inferior concrete or poor workmanship, or due to traffic collision.
- Minimal carbonation, no chloride attack and no water leak.
- Adequate concrete cover.
- Defective area is scattered.
- In case that cavity due to scaling, etc. is relatively small and shallow, apply epoxy resin based material as a repair material, but if the cavity is extensive and large, use polymer cement mortar from an economic view point.

WORK SEQUENCE :

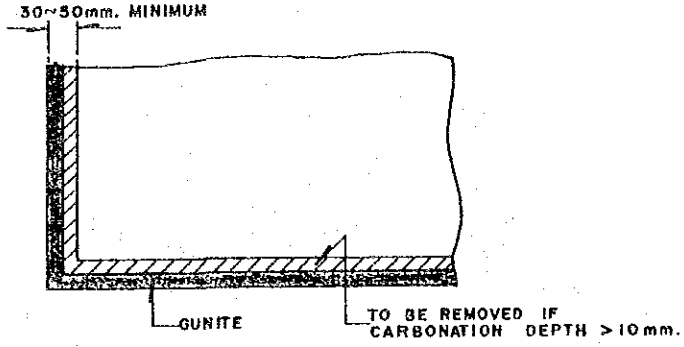
1) All spalled, loose and defective concrete shall be removed until sound concrete is reached. If rebar is exposed, removal of concrete shall be carried out to a further depth of 20mm behind the rebar.
2) All exposed reinforcement shall be cleaned of corrosion by wire brushing or other approved means to achieve a surface finish complying with BS 7079 second quality. The reinforcement shall immediately be primed with zinc-rich type primer complying with the requirements of BS 4652 or JIS K 5552-91.
3) Prior to patch repair, dry the concrete and apply a thin layer of concrete bonding agent.
4) Apply the repair mortar up to thickness of 10mm in consecutive layer by gloved hand or towel.
5) Make good the finished surface using a trowel or wood float and smoothen the completely cured surface with a grinder.

SPECIFICATION :

1) Minimum compressive strength of repair mortar shall be 40N/mm².
2) Minimum dry film thickness of steel primer shall be 40 microns.

REHABILITATION PLAN : PROTECTION WORK TO CONCRETE
METHOD : GUNITING

DRAWING :



APPLICATION CRITERIA :

- Cracks of which surface width is less than 0.20mm are not active.
- Concrete is slightly carbonated.
- Minimum concrete cover is inadequate.
- No water leak (or water leak prevention work has been completed).
- Defective area is extensive.

WORK SEQUENCE

1) Roughen the concrete surface by approved mechanical means and clean away all loose particles and dirt. If the concrete has carbonated more than 10mm the defective concrete shall be removed.
2) Wet the prepared surface with clean water until saturation but guniting shall commence only when the concrete has surface dry.
3) Spray gunite mortar with sufficient pressure in an even manner so as to give a dense and homogeneous covering to the surface. It shall be applied in two or more coats as necessary and the surface of each coat washed down before the next is applied.
4) After application of gunite, it shall be cured by constantly spraying water for at least 3 days.

SPECIFICATION

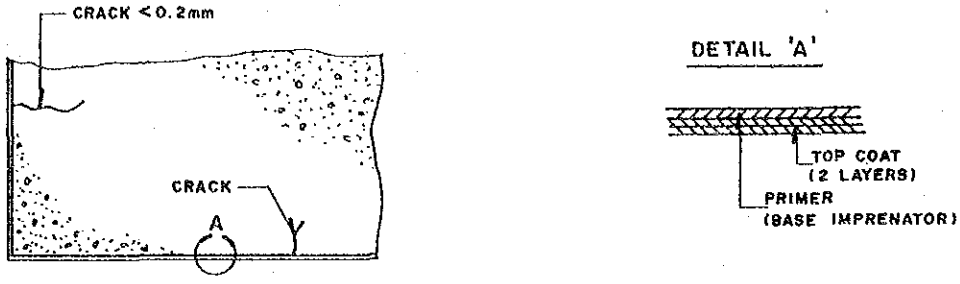
1) Minimum gunite cube strength after 28 days shall be 30N/mm²/Aggrigate size is 10~15mm.
2) Cement for guniting shall be ordinary portland cement conforming to M.S.522.
3) Minimum gunite thickness shall be 30 ~ 50 mm.
4) Minimum curing time of gunite shall be 3 days.

In case of applying steel fiber reinforced concrete with high early strength portland cement, standard mix proportion is as follows:

Steel fiber Content Ratio(%)	Water Cement Ratio(%)	Fine Aggregate Ratio(%)	Unit Weight (kg/m^3)			
			Water	Cement	Sand	Steel Fiber
1.1	4.3	100	187	430	1740	80

REHABILITATION PLAN : PROTECTION WORK TO CONCRETE
METHOD : PROTECTIVE COATING

DRAWING :



APPLICATION CRITERIA :

- Cracks are not active and surface width is less than 0.2 mm.
- No water leaks, no scaling, no flaking.
- Minimal carbonation and no chloride attack.
- Adequate concrete cover.

WORK SEQUENCE :

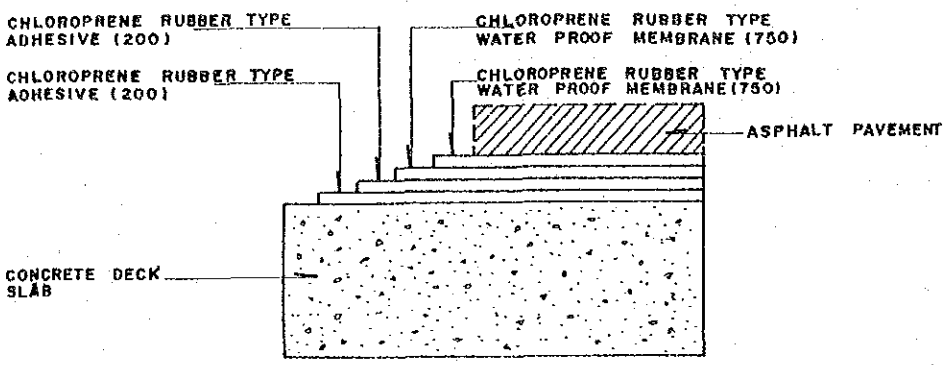
1) Clean the concrete surface by water blasting or other approved means to remove oil, grease, loose particles and other surface contaminants.
2) Allow the concrete to dry and apply epoxy resin primer by rolling.
3) Allow the primer to dry and apply two layers of acrylurethane or polyurethane resin paint as a top coat. The previous coat shall always be allowed to dry before overcoating.
4) The top coat shall be stirred well before application and shall be applied by roller.

SPECIFICATION:

1) Minimum dry film thickness of each layer of top coat shall be 30 microns and the standard unit application shall be more than 0.12 kg/m^2.
2) Standard unit application of the primer shall be more than 0.15 kg/m^2.

REHABILITATION PLAN : PROTECTION WORK TO CONCRETE
METHOD : WATERPROOFING

DRAWING :



NOTE : FIGURE IN ( ) SHOWS STANDARD UNIT RUBBER SOLVENT CONTENT (g/m^2).
STANDARD THICKNESS OF WATER PROOF LAYER IS 0·4 ~ 1·5 mm.

APPLICATION CRITERIA :

- Water stain, free lime and other associated defects are observed at slab soffit.
- Defects that are not active.
- Water is penetrating from top of slab through defective concrete or inferior joints between precast members.

WORK SEQUENCE :

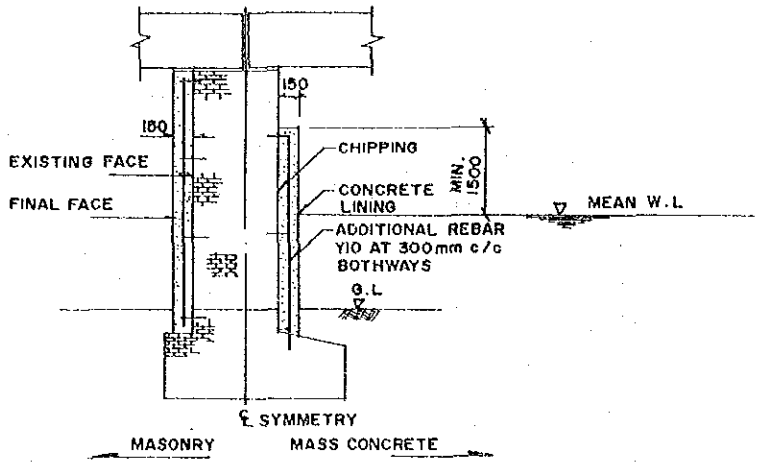
1) Removal of premix on deck by scrapping and milling.
2) Cleaning of deck surface by power grinder or other approved means.
3) Laying of base screed comprising of one part cement and four parts sand by volume using steel trowel.
4) Apply two layers of chloroprene rubber type adhesive and two layers of chloroprene rubber type waterproof membrane as shown in the drawing.
5) Each layer shall be allowed to cure for 2 hours before the application of the next layer.
6) Placing of new premix overlay.

SPECIFICATION :

1) Shearing strength shall be greater than 0.15N/mm^2 at 20°C.
2) Shearing elongation shall be greater than 1.0% at 20°C.
3) Adhesive strength shall be greater than 0.6N/mm^2 at 20°

REHABILITATION PLAN : PROTECTION WORK TO CONCRETE
METHOD : CONCRETE LINING

DRAWING :



APPLICATION CRITERIA :

- Minimum concrete cover is inadequate.
- Wide longitudinal cracks due to chloride attack or rebar corrosion.
- Abrasion of concrete surface or loss of concrete matrix due to inferior concrete or chemical attack.
- Concrete is carbonated.

WORK SEQUENCE :

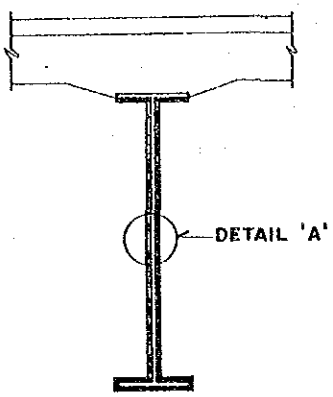
1) Remove all spalled,loose and defective concrete until sound concrete is reached, breaking out shall expose the full circumference of the rebar and to further depth of 20mm behind the rebar if it is corroded.
2) All exposed reinforcement shall be cleaned of corrosion products by wire brushing or other approved means to achieve a surface finish complying with B.S 7079 second quality.
3) Apply prime coat within 2 hours after preparing and cleaning of the rebar.
4) Securely fix additional rebar and anchor bar as shown in the drawing if required.
5) Construct the formwork to form a minimum concrete cover of 70mm. Formwork shall be sufficiently rigid and tight to prevent the loss of grout and to maintain forms in their correct position, shape, profile and dimension.
6) Wet all concrete surfaces sufficiently prior to placing concrete.
7) Place in concrete of grade 30/20 into the formwork.
8) Formwork shall be removed when the concrete has achieved the required strength and shall be immediately cured in accordance with good concrete practice.

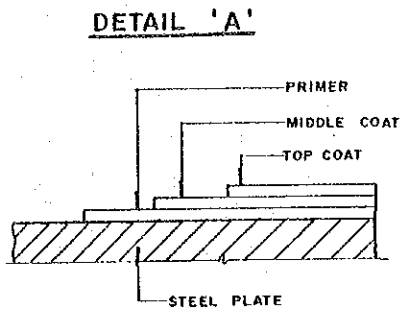
SPECIFICATION :

1) The cement used shall be ordinary portland cement conforming to M.S.522.
2) Minimum concrete cube strength at 28 days shall be 30 N/mm²/20mm.
3) Minimum concrete cover to main reinforcement to be 70mm.
4) Bars shall be bent and measured in accordance with B.S 4466.
5) Reinforcement to be weld shall comply with the requirements of B.S 4360.
6) Welding shall be carried out in accordance with B.S 5135 and B.S 638.
7) All mild steel and high yield bar to conform to M.S 146.
8) Lap length to be 32 x diameter of bar.
9) Primer shall be zinc-rich type primer complying with the requirements of B.S 4652 (1971)

REHABILITATION PLAN : PROTECTION WORK TO STEEL MEMBER
METHOD : REPAINTING SUPERSTRUCTURE

DRAWING :





APPLICATION CRITERIA :

- Adequate load carrying capacity.
- Non-active corrosion
- Paint deterioration.

WORK SEQUENCE :

1) Thoroughly remove rust,foreign material, oil, grease, loose or peeling paint and all non-adherent residues from the steel surface by electric disk sander or other approved means.
2) Immediately after surface preparation brush apply a layer of primer.
3) Allow the primer to dry and brush apply a layer of middle coat.
4) Finally, brush apply a layer of top coat after the middle coat has dried up.

SPECIFICATION :

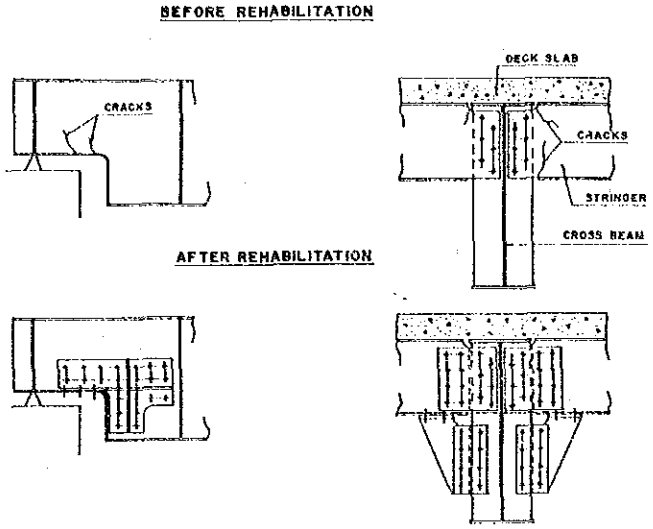
1) **Normal protective coating.**
- Primer shall be lead based anti-rust paint complying with the requirement of JIS K5622 and shall provide a minimum dry film thickness of 60 microns.
- Middle coat shall be silicone-alkyd resin based paint and shall provide a minimum dry film thickness of 30 microns.
- Top coat shall be silicone-alkyd resin based paint and shall provide a minimum dry film thickness of 30 microns.

2) **Heavy-duty coating for severe environmental condition.**
- Primer shall be epoxy based red oxide primer and shall provide a minimum dry film thickness of 100 microns.
- Middle coat shall be polyurethane resin based paint and shall provide a minimum film thickness of 100 microns.
- Top coat shall be polyurethane resin based paint and shall provide a minimum dry film thickness of 50 microns.

3) Each layer of coatings shall be of different colours.

REHABILITATION PLAN : PROTECTION WORK TO STEEL MEMBER
METHOD : ADDING COVER PLATE

DRAWING :



APPLICATION CRITERIA :

- Adequate load carrying capacity.
- Cracking of steel member due to fatigue damage or stress concentration.
- Stress due to total load including additional load is still within allowable stress

WORK SEQUENCE :

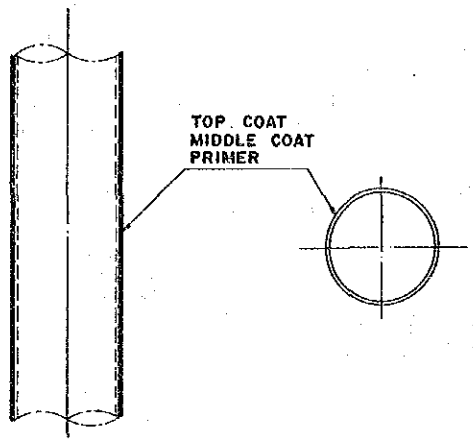
1) Remove thoroughly paint, rust,foreign material, oil or grease, loose or peeling paint and all non-adherent residues from both the steel surfaces where the steel cover plates shall be attached.
2) Mark the location for the bolts at both the beam and the steel cover plates and drill holes in both of them.
3) Attach the steel cover plates to the steel member by using high-tensile bolts.
4) Painting shall be carried out according to approved methods (refers to "repainting superstructure")

SPECIFICATION :

1) Work sequence and quality of the painting shall be in accordance with "repainting superstructure".
2) All mild steel shall comply with BS 4360 or MS 146.
3) Holes for high tensile bolts shall comply with the requirements of BS-4604.
4) High tensile bolts shall comply with the requirements of BS-4395 and use in accordance to BS-4604.

REHABILITATION PLAN : PROTECTION WORK TO STEEL MEMBER
METHOD : REPAINTING STEEL PILE

DRAWING :



APPLICATION CRITERIA :

- Steel surface is slightly corroded but load carrying capacity is still adequate.
- Bridge is located at non-severe environmental condition.
- No chloride attack.

WORK SEQUENCE :

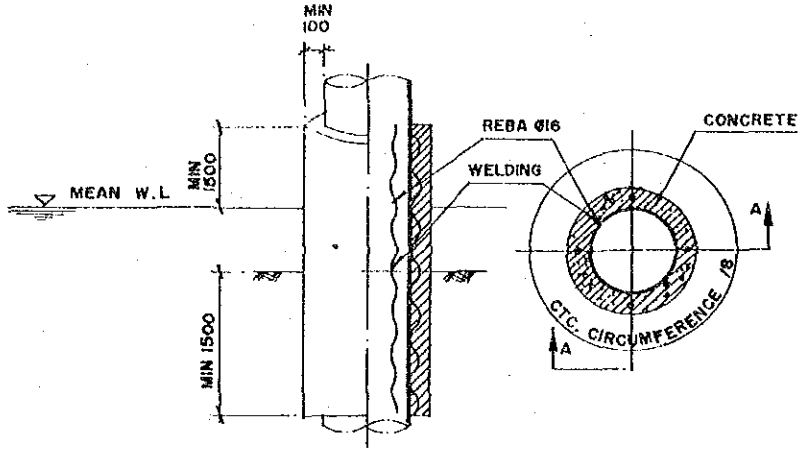
1) Thoroughly remove rust, foreign material, oil, grease, loose and all non-adherent residues from or peeling paint on the steel surface by wire brushing or other approved means.
2) Immediately after surface preparation brush apply a layer of epoxy primer.
3) Allow the primer to dry and brush apply a layer of tar-epoxy resin based middle coat complying with the requirement of JIS K 5664.
4) Finally brush apply a layer of tar-epoxy resin based coating after the middle coat has dried up.

SPECIFICATION :

1) Minimum dry film thickness of prime coat shall be 40 microns.
2) Minimum dry film thickness of middle coat shall be 120 microns.
3) Minimum dry film thickness of top coat shall be 120 microns.

REHABILITATION PLAN : PROTECTION WORK TO STEEL MEMBER
METHOD : CONCRETE LINING STEEL PILE

DRAWING :



SECTION A-A

APPLICATION CRITERIA :

- Steel surface is considerably corroded but load carrying capacity is still adequate.
- Bridge is located at severe environmental condition.
- Chloride attack is considerable.

WORK SEQUENCE :

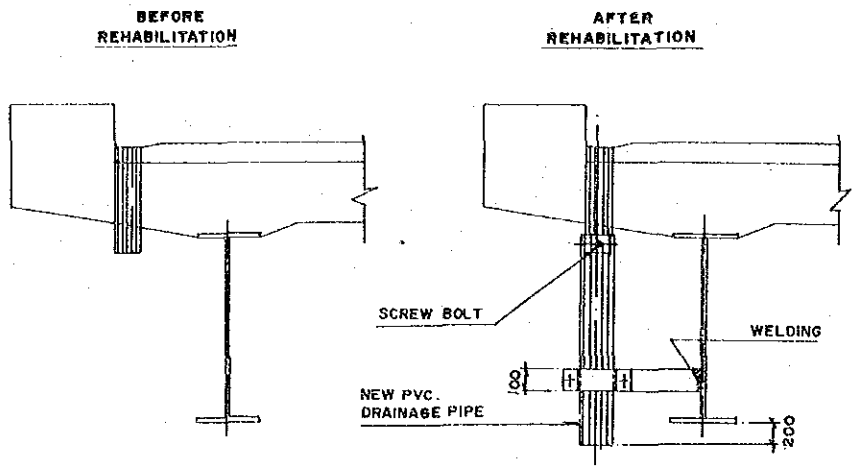
1) Pile column shall be cleaned of corrosion by grit blasting or other approved means to achieve a surface finish complying with B.S 7079 second quality.
2) Securely fix the corrugation rebar as shown in the drawing to the pile column by welding.
3) Construct the formwork to form a minimum concrete cover of 70mm.Formwork shall be sufficiently rigid and tight to prevent the loss of grout and to maintain forms in their correct position,shape,profile and dimension.
4) Place in concrete of grade 30/20 into the formwork.
5) Formwork shall be removed when the concrete has achieved the required strength and shall be immediately cured in accordance with good concrete practice.

SPECIFICATION :

1) Minimum concrete cube strength at 28 days shall be 30 N/mm²/20mm.
2) Minimum cover to main reinforcement shall be 70mm.
3) Bars shall be bent and measured in accordance with B.S. 4466.
4) Reinforcement to be welded shall comply with the requirements of B.S 4360.
5) Welding shall be carried out in accordance with B.S 5135 and B.S.638.

REHABILITATION PLAN : PROTECTION WORK TO INCIDENTAL FACILITY
METHOD : EXTENSION OF DRAINAGE PIPE

DRAWING :



APPLICATION CRITERIA :

- The drainage pipe is too short or missing.
- The water through the pipe which is improperly installed splash the structural members.

WORK SEQUENCE :

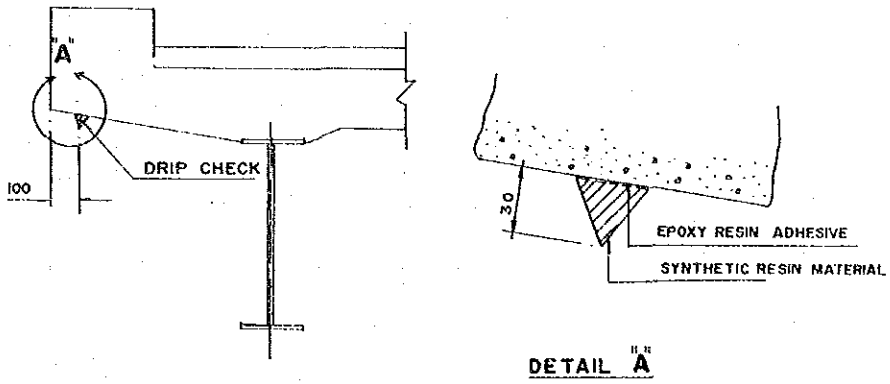
1) Clean the existing drainage pipe. Remove the rusted section. Drill holes through the pipe wall.
2) Fix the P.V.C pipe to the existing pipe as shown in the drawing.

SPECIFICATION :

1) P.V.C pipe shall comply with the requirement of JIS K6741 or BS 3505.

REHABILITATION PLAN : PROTECTION WORK TO INCIDENTAL FACILITY
METHOD : INSTALLATION OF DRIP CHECK

DRAWING :



APPLICATION CRITERIA :

- Water stain at soffit of cantilever slab and external face of beam web.

WORK SEQUENCE :

1) Clean the concrete surface by water blasting or other approved means to remove oil, grease, loose particles and other surface contaminations.
2) Apply epoxy resin adhesive to the clean surface.
3) Fix the water drop made of synthetic resin.

SPECIFICATION :

1) The synthetic resin shall comply with the requirement of JIS K 6735.
2) The epoxy resin adhesive shall comply with the requirement of JIS A6024.

(B) Strengthening work is applicable to a bridge member which has major material/structural defects or which has inadequate load carrying capacity. The major defects include active cracks due to bending or shear force, live or progressing settlement and serious section loss.

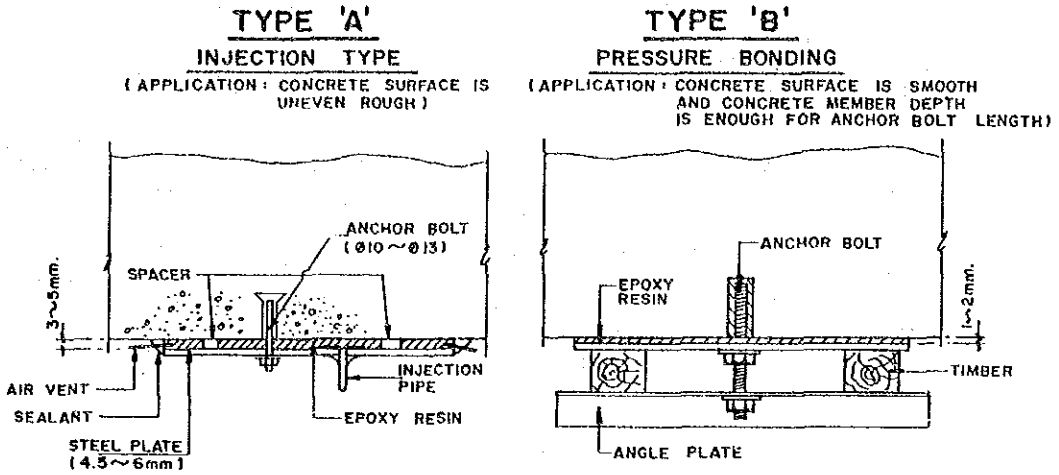
Selection of a specific rehabilitation technique under the strengthening works also depends on construction material used, extent of excess stress, and type of associated damage, its extent and degree. Each type of the rehabilitation technique is shown in Table 5-5 together with the corresponding application criteria. The drawing, work sequence and indicative specification of each technique is presented on one sheet in the following pages.

Table 5-5 Strengthening Technique and Corresponding Application Criteria

Rehabilitation Plan	Method	Application Criteria
Strengthening work to concrete	– Steel Plate Bonding	o Inadequate load carrying capacity (Inadequate amount of reinforcement bar) o No water leak and no carbonation. o Active cracks due to bending moment or shear force. o Adequate concrete cover.
	– Guniting with additional rebar	o Inadequate loading capacity. o Various active cracks due to bending moment or shear force. o Adequate for additional stress in beams and slab due to additional load. o Bridge is located in relatively severe chloride environment. o Advance carbonation. o Defective area is extensive. o Bridge can be close at least 3 consecutive days. If not, apply high early strength cement mortar instead of portland cement mortar.
	– Jacketing for Concrete Girders/Beams	o Active shear cracks due to shear force. o Defective area is not extensive. o Stresses due to total load including additional dead load are within the allowable stress. o Total load including additional dead load within allowable stress. o No water leak and no liquid rust. o No chloride attack.
	– Prepacked concrete lining with additional rebar	o Inadequate loading capacity. o Various active cracks due to bending moment or shear force. o Inadequate concrete cover. o Suffered mild chloride attack or advanced carbonation. o Defective area is extensive. o In case that bridge cannot be closed more than 3 hrs but less than 7 hrs, apply high early strength cement mortar. o Soffit of member such as soffit of beam and slab where it is difficult to pour concrete.
	– Additional prestressing	o Inadequate load carrying capacity. o Various active cracks due to bending moment or shear force. o Working stress of rebar or concrete exceeds about 120% of the allowable stress. o Stress due to total load including additional dead load is within the allowable stress. o Defective area is extensive.
	– Concrete lining to piles	o Inadequate minimum cover or rebars are exposed. o Abrasion of concrete surface or loss of concrete matrix due to inferior concrete or chemical attack. o Concrete is carbonated.
	– Underpinning with additional piles	o Progressive settlement of substructure due to inadequate existing pile capacity. o Increase of design load due to upgrading of the bridge.
	– Sheet piling	o The backfill behind the abutment fall out due to broken precast wall panels. o Active bending cracks on concrete piles due to earth pressure.
	– Extension of bridge seat	o Inadequate bridge seat width from bearing edge to bridge seat edge. o Active shear cracks at bridge seat due to stress concentration. o Defective area is not extensive.
Strengthening work to steel	– Adding Stringer	o Excess bending stress of deck slab is more than 20% of the allowable stress. o Stress of each member due to total loading additional dead load is within the allowable stress.
	– Attachment to Steel Plate	o Inadequate load carrying capacity. o Excess bending stress is less than 20% allowable stress. o Non-active corrosion, paint deterioration.
	– Concrete Lining with rebars	o Steel surface is considerably corroded and its load carrying capacity is inadequate due to section loss. o Bridge is located at severe environmental condition.

REHABILITATION PLAN : STRENGTHENING WORK TO CONCRETE MEMBER
METHOD : STEEL PLATE BONDING

DRAWING :



APPLICATION CRITERIA :

- Inadequate load carrying capacity (Inadequate amount of reinforcement bar)
- No water leak and no carbonation.
- Active cracks due to bending moment or shear force
- Adequate concrete cover.

WORK SEQUENCE :

1) Clean the surface of the slab soffit to receive the steel plate bonding with a power grinder or other approved means.
2) Drill holes into the slab and install anchors for anchor bolts.
3) Clean the surface of the steel plate by wire brush so as to bring out its texture.

TYPE A

4) Drill holes on the steel plate for anchor bolts and injection pipes.
5) Attach the injection pipes and air vent pipes.
6) Fit in steel plate to the prepared surface together with spacer blocks and clamp it with anchor bolts to provide a consistent gap of 5mm between the plate and the slab surface.
7) Seal the peripheral area of the steel plate as well as the area surrounding the injection holes.
8) Inject the epoxy resin through the injection holes.
9) After the epoxy resin has been cured, protect the steel from corrosion by applying protective coatings.

TYPE B

4) Drill holes on the steel plate for anchor bolts.
5) Apply epoxy resin to the plate surface and concrete surface.
6) Pressure bonding the steel plate to the slab using anchor bolt with angle plate.
7) After the epoxy resin has cured, withdraw the pressure bonding equipment and protect the steel from corrosion by applying protective coatings.

SPECIFICATION :

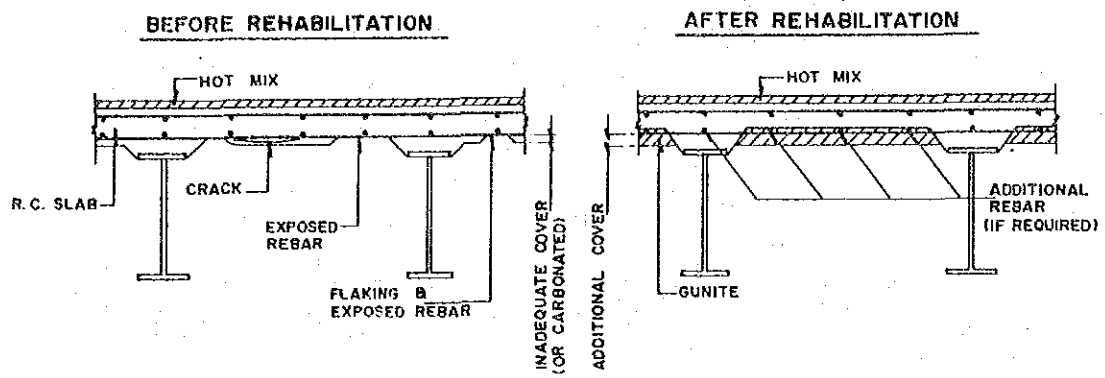
1) The epoxy resin shall have the properties listed below when tested in accordance with the relevant standards as stated in "Injection Method".

Property	Unit	Type A	Type B
Minimum compressive strength at 7 days	N/mm^2	70	70
Flexural strength	N/mm^2	40	40
Compressive elastic modulus	N/mm^2	3000	3000
Specific gravity		1.1-1.9	1.1-1.9
Viscosity	cP	40,000	6000

2) Minimum curing time of epoxy resin shall be 24 hours.

REHABILITATION PLAN : STRENGTHENING WORK TO CONCRETE MEMBER
METHOD : GUNITING WITH ADDITIONAL REBAR

DRAWING :



APPLICATION CRITERIA :

- Inadequate loading capacity.
- Various active cracks due to bending moment or shear force.
- Adequate for additional stress in beams and slab due to additional load.
- Bridge is located in relatively severe chloride environment
- Advance carbonation.
- Defective area is extensive.
- Bridge can be closed at least 3 consecutive days. If not, apply high early strength cement mortar instead of portland cement mortar.

WORK SEQUENCE :

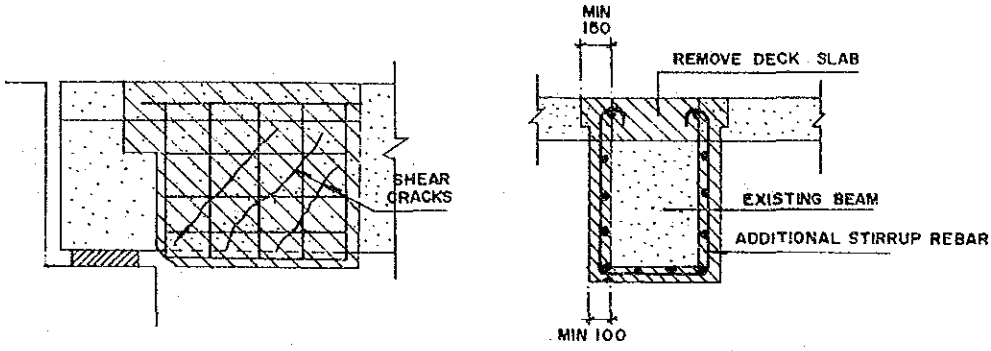
1) Remove all spalled, loose and defective concrete until sound concrete is reached. Breaking out shall expose the full circumference of the rebar and to a further depth of 20mm behind the rebar if it is corroded.
2) All exposed reinforcement shall be cleaned of corrosion products by wire brushing or other approved means.
3) Prime coat shall be brush applied within 2 hours after preparing and cleaning of the rebar.
4) Securely fix additional rebar as shown in the drawing if required.
5) Wet the prepared surface with clean water until saturation but guniting shall commence only when the concrete surface has dried.
6) Spray gunite mortar with sufficient pressure in an even manner so as to give a dense and homogeneous covering to the surface. It shall be applied in two or more coats as necessary and the surface of each coat washed down before the next is applied.
7) After application of gunite mortar, it shall be cured by constantly spraying water for at least 3 days.

SPECIFICATION :

1) The cement used shall be ordinary portland cement conforming to M.S. 522.
2) Minimum concrete cube strength at 28 days shall be 30N/mm2/10-15mm.
3) Minimum concrete cover to main reinforcement shall be 30mm.
4) Bars shall be bent and measured in accordance with B.S 4466.
5) Reinforcement to be welded shall comply with the requirement of B.S4360.
6) Welding shall be carried out in accordance with B.S 5135 and B.S638.
7) All mild steel and high yield bar shall conform to M.S 146.
8) Lap length shall be 32 x diameter of bar.

REHABILITATION PLAN : STRENGTHENING WORK TO CONCRETE MEMBER
METHOD : JACKETING FOR CONCRETE GIRDERS/BEAMS

DRAWING :



Note: Required area and size of additional stirrup rebar shall be calculated based on structural analysis

APPLICATION CRITERIA :

- Active shear cracks due to shear forces.
- Defective area is not extensive.
- Stresses due to total load including additional dead load are within allowable stress.
- No water leak and no liquid rust.
- No chloride attack.

WORK SEQUENCE :

1) Remove all loose and defective concrete if any or, chip, and remove the deck slab from the top of girder/beam as shown in the drawing.
2) Seal the shear cracks by the injection method.
3) All exposed reinforcement of the removed deck slab shall be cleaned thoroughly by wire brushing or other approved means.
4) Securely fix additional rebar and stirrups as shown in the drawing.
5) Construct the formwork to form a minimum concrte cover of 30mm.Formwork shall be sufficiently rigid and tight to prevent the loss of grout and to maintain forms in their correct position, shape, profile and dimension.
6) Wet all concrete surfaces sufficiently prior to placing concrete.
7) Place in concrete of grade 30/20 into formwork.
8) Formwork shall be removed when the concrete has achieved the required strength and shall be immediately cured in accordance with good concrete practice.

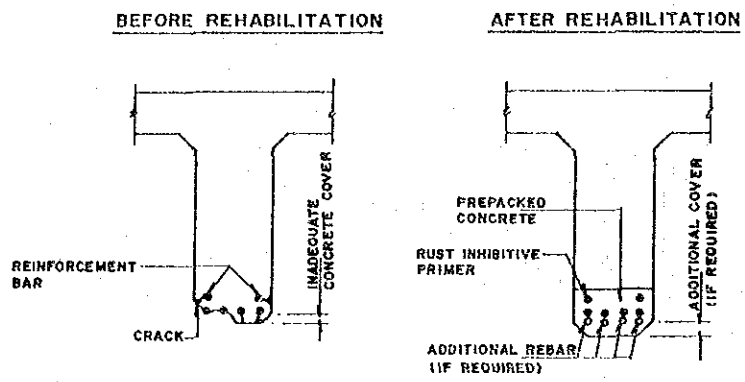
Note: In order to achieve adequate bonding between old and new concrete i.e. avoiding vibrational effects by vehicles, the bridge shall be closed to traffic at least 12 hours for the concrete pouring and curing work.

SPECIFICATION :

1) The cement used shall be high early strength portland cement conforming to MS522.
2) Minimum concrete cube strength at 28 days shall be 30 N/mm2.
3) Minimum concrete cover to main reinforcement shall be 30mm.
4) Bars shall be bent and measured in accordance with BS4466.
5) Minimum lap length shall be 32 x diameter of rebar.

REHABILITATION PLAN : STRENGTHENING WORK TO CONCRETE MEMBER
METHOD : PREPACKED CONCRETE LINING WITH ADDITIONAL REBAR

DRAWING :



APPLICATION CRITERIA :

- Inadequate loading capacity.
- Various active cracks due to bending moment or shear force.
- Inadequate concrete cover.
- Suffered mild chloride attack or advanced carbonation.
- Defective area is extensive.
- In case the bridge cannot be closed more than 3 hrs, apply epoxy resin mortar.
- In case the bridge can be closed more than 3 hrs but less than 7 hrs, apply high early strength cement mortar.
- Soffit of member such as soffit of beam and slab where it is difficult to pour concrete

WORK SEQUENCE :

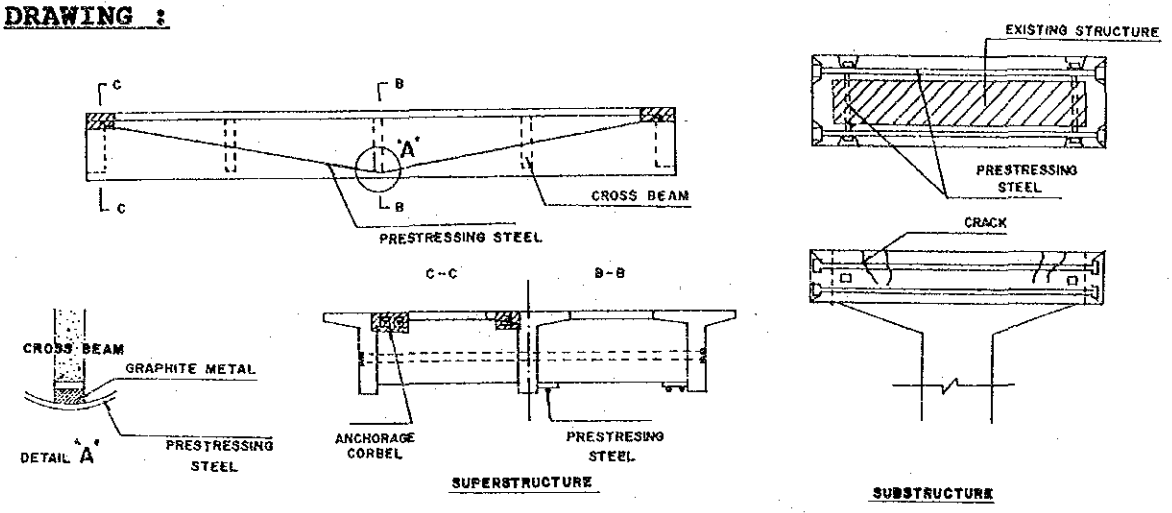
1) Remove all spalled, loose and defective concrete until sound concrete is reached. Breaking out shall expose the full circumference of the rebar and to a further depth of 20mm behind the rebar if it is corroded.
2) All exposed reinforcement shall be cleaned of corrosion products by wire brushing or other approved means.
3) Apply prime coat within 2 hours after preparing and cleaning of the rebar.
4) Securely fix additional rebar and anchor bar as shown in the drawing if required.
5) Construct the formwork to form a minimum concrete cover of 30mm. Formwork shall be sufficiently rigid and tight to prevent the loss of grout and to maintain forms in their correct position, shape, profile and dimension.
6) Pack single-sized coarse aggregate behind the forms to fill the voids.
7) Injection openings are to be provided at the bottom face of the form for the purpose of injecting grout into the prepacked aggregates.
8) Pump in the grout to fill the spaces between the aggregates by pressure grouting via the injection openings from the farthest point of the void.
9) Formwork shall be removed when the concrete has achieved the required strength and shall be immediately cured in accordance with good concrete practice.

SPECIFICATION :

1) The cement used shall be high early strength cement conforming to MS 522.
2) Minimum concrete cube strength at 28 days shall be 30N/mm2
3) Minimum concrete cover to main reinforcement to be 30mm.
4) Bars shall be bent and measured in accordance with B.S 4466.
5) Reinforcement to be weld shall comply with the requirements of B.S 4360.
6) Welding shall be carried out in accordance with B.S 5135 and B.S 638
7) All mild steel and high yield bar to conform to M.S 146.
8) Lap length to be 32 x diameter of bar.
9) Primer shall be Zinc-rich type primer complying with the requirements of B.S 4652 (1971).
10) Mix proportion of epoxy resin mortar shall be one of resin to three of silica sand in weight.

REHABILITATION PLAN : STRENGTHENING WORK TO CONCRETE MEMBER
METHOD : ADDITIONAL PRESTRESSING

DRAWING :



APPLICATION CRITERIA :

- Inadequate load carrying capacity.
- Various active cracks due to bending moment or shear force.
- Working stress of rebar or concrete exceeds more than about 120% of the allowable stress.
- Stress due to total load including additional dead load is within the allowable stress.
- Defective area is extensive.

WORK SEQUENCE :

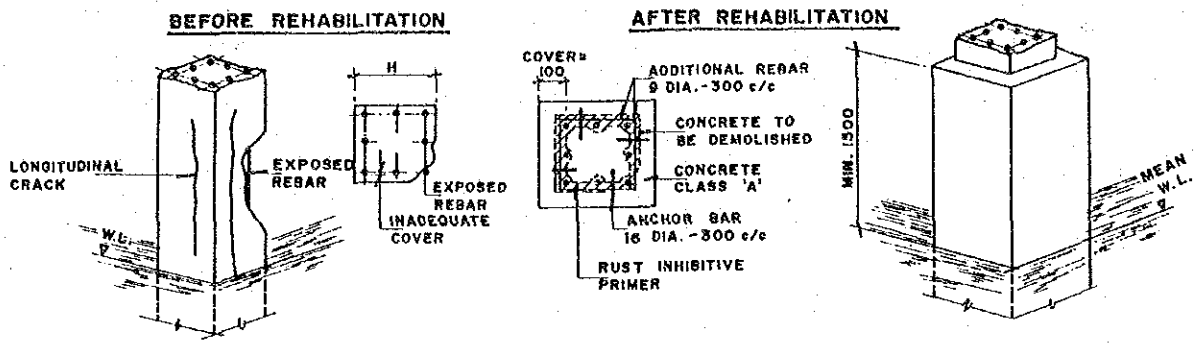
1) Repair any cracks or spalling on concrete surface by injection or patching method.
2) Remove the specific part of existing concrete structure in order to construct the anchorage corbels for prestressing steels if required.
3) Roughen the existing concrete surface to be in contact with the anchorage corbels or new concrete to be poured by approved means.
4) Securely fix additional rebar and dowel bars as well as sheaths and mechanical devices for prestressing.
5) Construct formwork and pour the concrete of grade 35/20.
6) Wet all concrete surfaces sufficiently prior to pouring concrete.
7) Remove the formwork after the required concrete strength is reached.
8) Post tensioning operation shall be carried out after installation of prestressing steels into the sheaths.
9) Grout cement mortar into the sheaths in which prestressing steels are installed.

SPECIFICATION :

1) All the requirements for prestressing work shall comply with Section 11 of JKR Standard Specification for Road Work.

REHABILITATION PLAN : STRENGTHENING WORK TO CONCRETE MEMBER
METHOD : CONCRETE LINING TO PILES

DRAWING :



APPLICATION CRITERIA :

- Inadequate minimum cover or rebars are exposed.
- Abrasion of concrete surface or loss of concrete matrix due to inferior concrete or chemical attack.
- Concrete is carbonated.

WORK SEQUENCE :

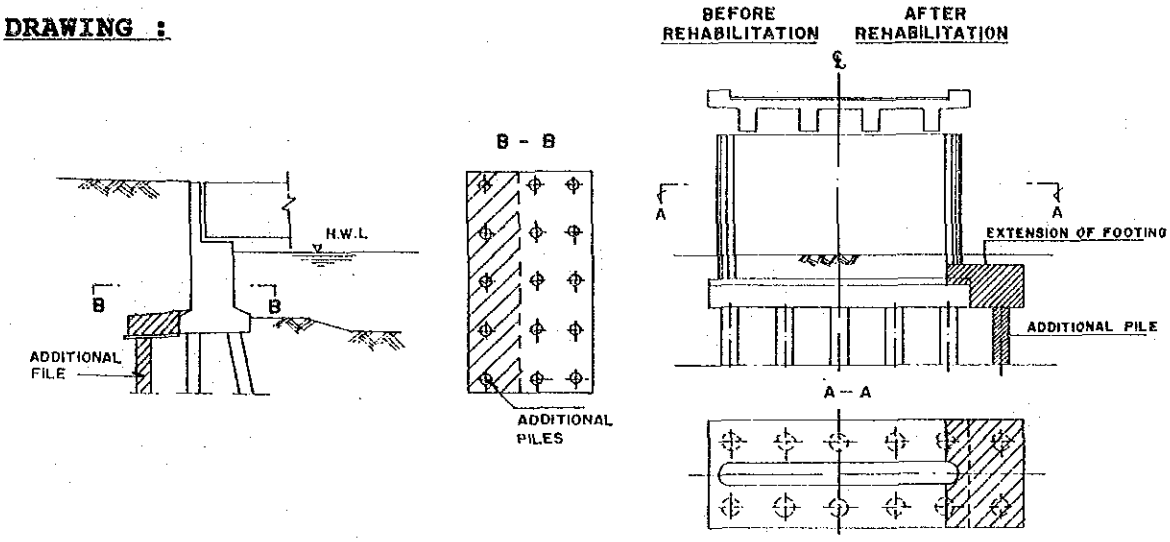
1) Remove all spalled, loose and poor quality mortar. Particular care should be taken to ensure all surfaces are completely free from laitence, oil, dust, grease, plaster and any other deleterious substances. Laitence should be mechanically removed by high pressure water blasting. Smooth surface should be mechanically roughened by scrabbling or needle gun to form a good mechanical key.
2) Provide drilled holes of 20mm diameter at 300mm c/c bothways on all the vertical surfaces. Drilled holes shall be rough sided and free of dust.
3) Insert non-shrink cementatious grout stage to stage to rear of the hole to avoid air entrapment.
4) Securely fix dowell 16mm diameter round bar by inserting into the hole.
5) Provide hoop of 10mm diameter high yield at 300mm c/c bothway by tying to the dowell bar.
6) Wet all surfaces sufficiently.
7) Construct the formwork to form a minimum cover of 70mm. Formwork shall be sufficiently rigid and tight to prevent the loss of grout and to maintain forms in their correct position , shape, profile and dimension.
8) Place in concrete of grade 30/20 into the formwork.
9) Formwork shall be removed when the concrete has achieved the required strength and shall be immediately cured in accordance with good concrete practice.

SPECIFICATION :

1) The cement used shall be ordinary portland cement conforming to M.S. 522.
2) Unit cement content shall be more than 300kg/m^3
3) Minimum concrete cube strength at 28 days shall be 30n/mm2.
4) Bar shall be bent and measured in accordance with BS 4466.
5) Reinforcement to be weld shall comply with the requirements of BS 4360.
6) Welding shall be carried out in accordance with BS 5135 and BS 638
7) All mild steel and high yield bar to conform to MS 146
8) Lap Length to be 32 x diameter of bar.

REHABILITATION PLAN : STRENGTHENING WORK TO CONCRETE MEMBER
METHOD : UNDERPINNING WITH ADDITIONAL PILES

DRAWING :



APPLICATION CRITERIA :

- Progressive settlement of substructure due to inadequate existing pile capacity.
- Increase of design load due to upgrading of the bridge.

WORK SEQUENCE :

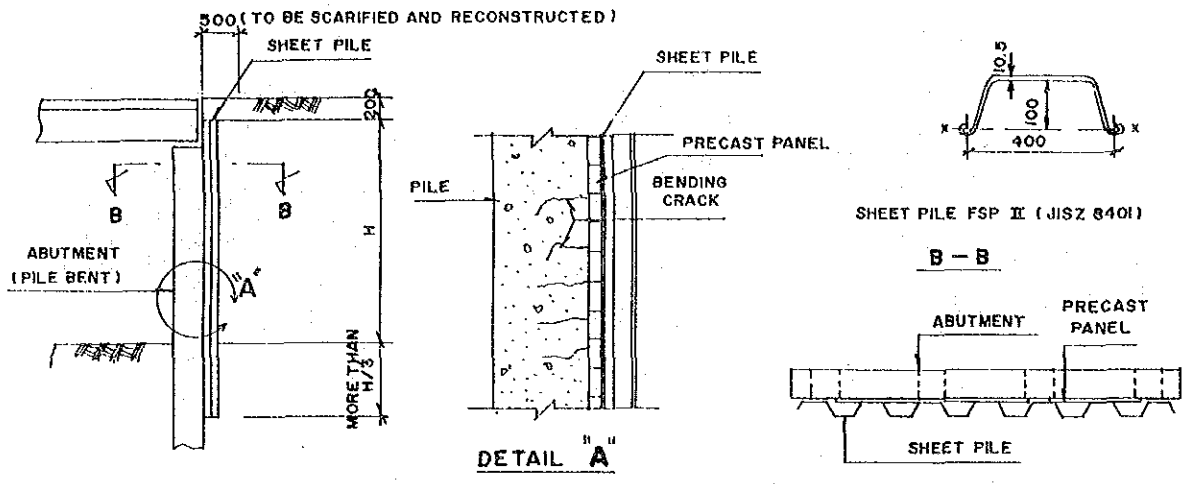
1) Excavate to the soffit level of all fill material.
2) Drive additional piles at specific location.
3) Hacked concrete to exposed reinforcement and clean the reinforcement.
4) Connect the new reinforcement to the existing reinforcement
5) Construct the formwork to form a minimum concrete cover of 100mm.
6) Wet all concrete surfaces sufficiently prior to placing concrete.
7) Place in concrete of grade 30/20 into the formwork.
8) Formwork shall be removed when the concrete has achieved the required strength and shall be immediately cured in accordance with good concrete practice

SPECIFICATION :

1) In case additional piles are required, open end steel pipe pile shall be adopted so as to prevent any load reduction to the existing piles due to disturbances of the ground around the existing piles during pile driving.
2) The cement used shall be ordinary portland cement conforming to M.S. 522.
3) Minimum concrete cube strength at 28 days shall be 30N/mm2.
4) Bars shall be bent and measured in accordance with B.S 4466.
5) Reinforcement to be weld shall comply with the requirements of B.S4360.
6) Welding shall be carried out in accordance with B.S 5135 and B.S 638
7) All mild steel and high yield bar to conform to M.S 146

REHABILITATION PLAN : STRENGTHENING WORK TO CONCRETE MEMBER
METHOD : SHEET PILING

DRAWING :



APPLICATION CRITERIA :

- The backfill behind the abutment fall out due to broken precast wall panels.
- Active bending cracks on concrete piles due to earth pressure.

WORK SEQUENCE :

1) Close one lane of existing road during the period of the field operation.
2) Scarify the existing premix where is specified in above drawing.
3) Drive sheet piles into the ground using a drop hammer behind the abutment just adjacent to the precast panels.
4) Reconstruct subbase, base and surface layer with adequate compaction after driving of sheet piles has been completed.

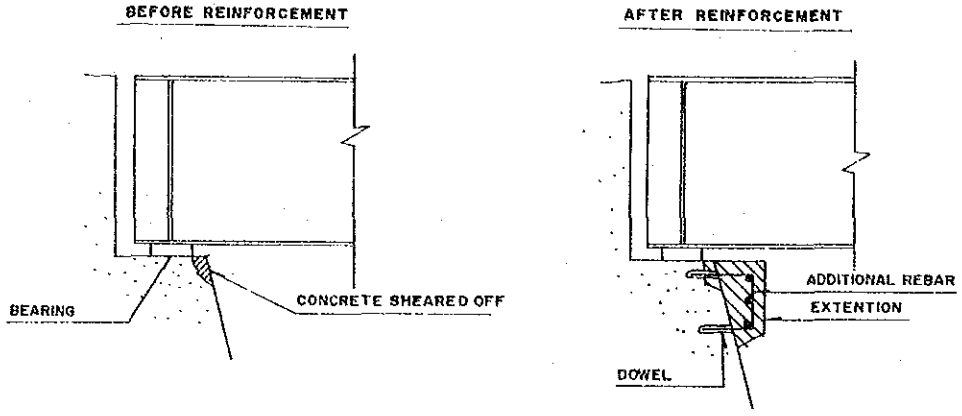
It should be noted that the defective concrete piles should be protected by the concrete lining.

SPECIFICATION :

1) Steel sheet pile shall comply with the requirements of B.S 4360 or JIS Z 8401.

REHABILITATION PLAN : STRENGTHENING WORK TO CONCRETE MEMBER
METHOD : EXTENSION OF BRIDGE SEAT

DRAWING :



APPLICATION CRITERIA :

- Inadequate bridge seat width from bearing edge to bridge seat edge.
- Active shear cracks at bridge seat due to stress concentration.
- Defective area is not extensive.

WORK SEQUENCE :

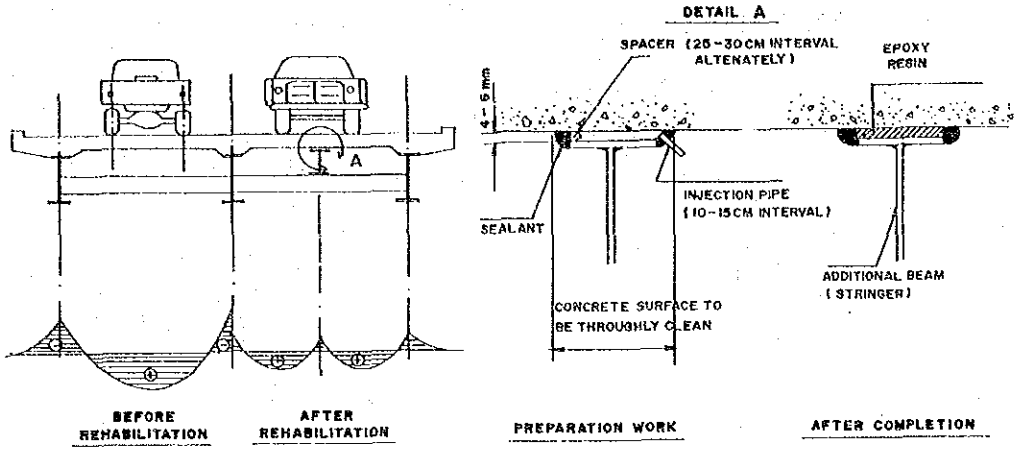
1) Remove all spalled and loose concrete until sound concrete is reached . Roughen the concrete surface by chipping.
2) Drill holes of 150mm apart from the bridge seat surface. Clean thoroughly the cracks and holes with clean oil-free compressed air.
3) Insert dowel bars in the holes as shown in the drawing and, fill them with epoxy grout under low pressure.
4) Seal the remain shear cracks if any by the specified injection method (Refer to injection)
5) Securely fix additional rebar lapped to the dowells as shown in the drawing.
6) Construct the formwork to form a minimum concrete cover of 70mm. Formwork shall be sufficiently rigid and tight to prevent the loss of grout and to maintain forms in their correct position, shape, profile and dimension.
7) Wet all concrete surfaces sufficiently prior to concrete pouring.
8) Pour concrete of grade 30/20 into the formwork.
9) Formwork shall be removed when the concrete has achieved the required strength and shall be immediately cured in accordance with good concrete practice.

SPECIFICATION :

1) The cement used shall be ordinary portland cement conforming to M.S. 522.
2) Minimum concrete cube strength at 28 days shall be 30N/mm.
3) Minimum concrete cover to main reinforcement shall be 70mm.
4) Bars shall be bent and measured in accordance with B.S 4466.
5) Minimum lap length shall be 32 x diameter of bar.

REHABILITATION PLAN : STRENGTHENING WORK TO STEEL MEMBER
METHOD : ADDING STRINGER

DRAWING :



APPLICATION CRITERIA :

- Excess bending stress of deck slab is more than 20% of the allowable stress.
- Stress of eaach member due to total loading including additional dead load is within the allowable stress.

WORK SEQUENCE :

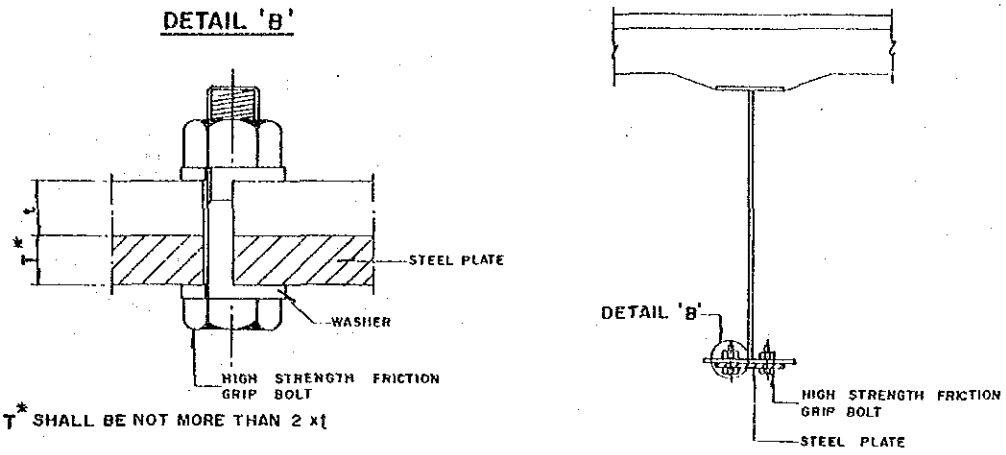
1) Clean the surface of the slab soffit where receive the steel plate of the stringer with a power grinder or other approved means.
2) Install the stringers, which have been fabricated in accordance with the lines and dimensions required resulting from structural analysis, onthe cross beams. Forbonding purpose, a gap of about 4 to 6 mm between the slab surface and the upper flange plate shall be provided.
3) Attach the injection pipes and air vent pipes and seal the peripheral area of the steel plate as well as the area surrounding the injection pipes as shown in the drawing.
4) Inject the epoxy resin through the injection pipes. In order to avoid vibrational effect due to the traffic, the bridge must be closed to the traffic until epoxy resin has been completely cured.
5) After epoxy resin has been cured, protect the steel from corrosion by applying protective coatings.

SPECIFICATION :

1) Holes for high tensile bolts shall comply with the requirements of BS 4604.
2) High tensile bolts shall comply with requirements of B.S 4395 and use in accordance to B.S 4604.
3) Epoxy resin shall comply with the properties specified for epoxy resin in "Steel plates bonding" operation.
4) Minimum curing time of epoxy resin shall be 24 hours
5) Protective coating shall follow the specification for "Repainting,to supperstructure".
6) All the steel work shall comply with the requirements stated in Section 12 of "JKR Standard Specification for Road Works".

REHABILITATION PLAN : STRENGTHENING WORK TO STEEL MEMBER
METHOD : ATTACHMENT TO STEEL PLATE

DRAWING :



APPLICATION CRITERIA :

- Inadequate load carrying capacity.
- Excess bending stress is less than 20% of allowable stress.
- Non-active corrosion, paint deterioration.

WORK SEQUENCE :

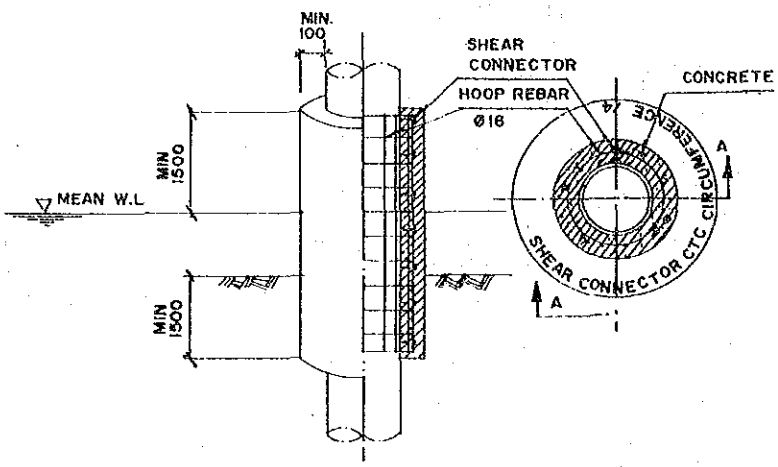
1) Mark the positions for the bolts and drill holes on both the beam and the steel plate.
2) Thoroughly remove corrosion, oil, grease, foreign material, loose or peeling paint and all non-adherent residues form both the beam surface to be in contact with the steel plate as well as the steel plate.
3) Attach the plate to the beam by using high tension friction bolts as shown in the drawing.
4) Protect the working area against corrosion once all the bolts have been tightened by applying protective coating.

SPECIFICATION :

1) Holes for high strength friction grip bolts shall comply with the requirements of B.S 4604.
2) High strength friction grip bolts shall comply with requirements of B.S 4395 and use in accordance to B.S 4604.
3) Steel plates shall comply with the requirements of B.S 4360.
4) Protective coating shall follow the specification for "Repainting superstructure".

REHABILITATION PLAN : STRENGTHENING WORK TO STEEL MEMBER
METHOD : CONCRETE LINING WITH REBARS

DRAWING :



SECTION A-A

APPLICATION CRITERIA :

- Steel surface is considerably corroded and its load carrying capacity is inadequate due one to section loss.
- Bridge is located at severe environmental condition

WORK SEQUENCE :

1) Pile column shall be clean of corrosion by grit blasting or other approved means to achieve a surface finish complying with B.S 7079 second quality.
2) Weld in shear connectors to the steel surface as shown in the drawing.
3) Fix in place the main vertical bar and hoop rebar links in accordance to the drawing by using binding wires.
4) Construct the formwork to form a minimum concrete cover of 70mm. Formwork shall be sufficiently rigid and tight to prevent the loss of grout and to maintain forms in their correct position, shape, profile and dimension.
5) Place in concrete of grade 30/20 into formwork.
6) Formwork shall be removed when the concrete has achieved the required strength and shall be immediately cured in accordance with good concrete practice.

SPECIFICATION :

1) Minimum concrete cube strength at 28 days shall be 30N/mm2/20mm.
2) Minimum concrete cover to main reinforcement shall be 70mm.
3) All mild steel shall conform to M.S 146.
4) Welding shall be carried out in accordance with B.S 5135 and B.S 638.
5) Lap length shall be 32 x diameter of bar.

(C)Replacement technique is applicable to a bridge member or a whole bridge of which rehabilitation and strengthening work(s) is likely to be beyond economic repair. If a bridge member which has critical structural/potential defects and inferior load carrying capacity, it is appropriate to replace the bridge member.

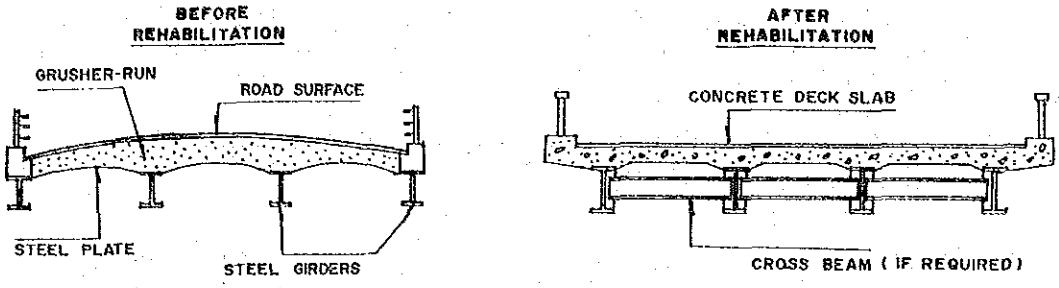
Each type of replacement technique is shown in Table 5-6 together with the corresponding application criteria. The drawing, work sequence, indicative specification of each replacement technique is presented on one sheet in the succeeding pages.

Table 5-6 Replacement Technique and Corresponding Application Criteria

Rehabilitation Plan	Method	Application Criteria
o Replacement Work of Structure Member	– Deck Slab Replacement	o Inadequate loading capacity. o Severe damage of steel buckle plate deck slab due to steel corrosion. o Stress of each member due to total load after rehabilitation completed is within the allowable stress.
	– Bearing Replacement	o Bearing is missing or not functional due to severe damage.
	– Replacement of Expansion Joint	o Critical defects such as water-leaking, abnormal noise, difference in level etc. due to damaged expansion joint. o Remarkable crack of the pavement overlaid on the existing expansion joint. o Transvere open crack or gap due to missing expansion joint.
	– Replacement of Steel Truss Member	o Inadequate load carrying capacity. o Critical deformation or rupture of steel members due to vehicle collision. o Severe section loss due to corrocion.

REHABILITATION PLAN : REPLACEMENT WORK OF STRUCTURE MEMBER
METHOD : DECK SLAB REPLACEMENT

DRAWING :



APPLICATION CRITERIA :

- Inadequate loading capacity.
- Severe damage of steel buckle plate deck slab due to steel corrosion.
- Stress of each member due to total load after rehabilitation completed is within the allowable stress.

WORK SEQUENCE :

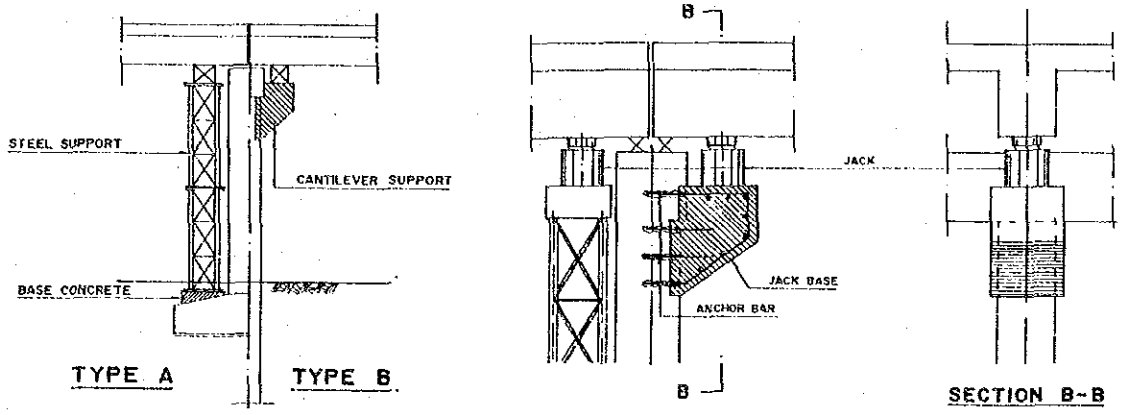
1) A detour load for temporary traffic diversion shall be provided.
2) Demolition of steel buckle plate without damaging the existing beams.
3) Remove paint,rust and foreign material thoroughly from the top of upper flange of the main beams by brushing or other approved method.
4) Install new cross beams in between the main beams at specified positions by high tensile bolts (if required).
5) Construct the formwork to form a minimum cover of 30mm. Formwork shall be sufficiently rigid and tight to prevent the loss of grout and to maintain forms in their correct position, shape, profile and dimension.
6) Securely fix the reinforcement.
7) Place in concrete of grade 30/20 into the formwork.
8) Formwork shall be removed after the required concrete strength has been reached, and shall be immediately cured in accordance with a good concrete practice.

SPECIFICATION :

1) The cement used shall be ordinary portland cement conforming to M.S. 522.
2) Minimum concrete cube strength at 28 days shall be 30 N/mm^2.
3) Minimum concrete cover to main reinforcement to be 30mm.
4) Bars shall be bent and measured in accordance with B.S 4466.
5) All mild steel and high yield bar to conform to B.S 146.
6) Lap length to be 32 x diameter of bar.

REHABILITATION PLAN : REPLACEMENT WORK OF STRUCTURE MEMBER
METHOD : BEARING REPLACEMENT

DRAWING :



APPLICATION CRITERIA :

- Bearing is missing or not functional due to severe damage.

WORK SEQUENCE :

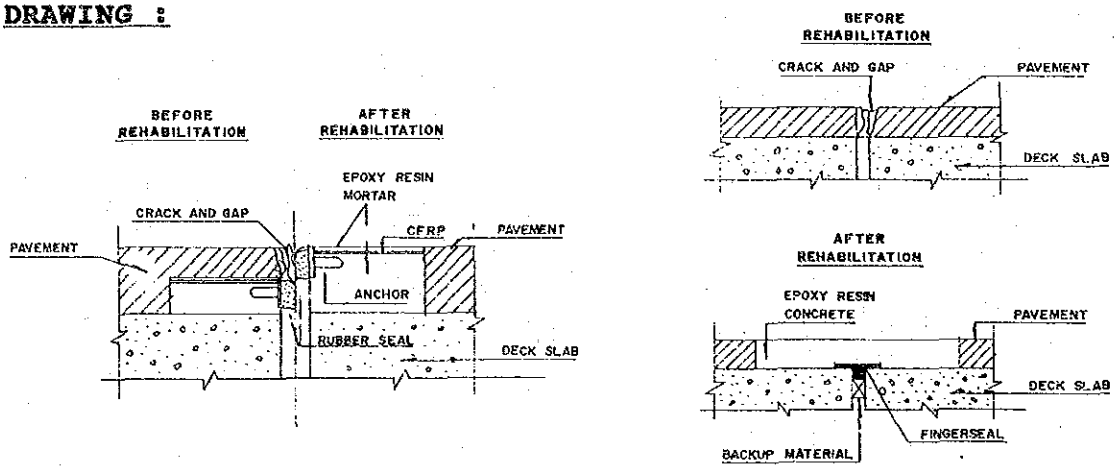
1) Temporary steel supports (Type - A) or concrete cantilever support (Type - B) shall be installed as shown in the drawing. In case the clearance between the beam soffit and ground level is less than about 5m and the soil condition is solid, Type - A shall be applied. To contrary, if the clearance is more than 5m or the ground condition is soft, or the bridge spans over a river, Type - B is applicable.
2) Erection of Type - A support and construction of Type - B support shall be carried out in accordance with Section 12 of JKR Standard Specification for Road Works and the work sequence and specification of "Adding sidewalk by cantilever support" enclosed in this Manual respectively.
3) Install jack with appropriate capacity and jack up all the girders.In order to prevent unexpected stresses in the deck slab, the whole girders shall be jacked up simultaneously.
4) Replace the damaged bearings by appropriate bearing units or install the new one after completion of the bearing base work.
5) Jack down all the girder simultaneously and remove the jack system and temporary supports.

SPECIFICATION :

1) The appropriate type of bearings shall be selected from standard bearings approved by JKR.
2) The loading capacity of the jack to be used shall be 1.5 times the working load.
3) The cement used shall be ordinary portland cement conforming to M.S. 522.
4) Minimum concrete cube strength at 28 days shall be 30N/mm².
5) Minimum concrete cover to main reinforcement shall be 70mm.
6) Bars shall be bent and measured in accordance with BS4466.
7) Minimum lap length shall be 32 x diameter of the bar.

REHABILITATION PLAN : REPLACEMENT WORK OF STRUCTURE MEMBER
METHOD : REPLACEMENT OF EXPANSION JOINT

DRAWING :



APPLICATION CRITERIA :

- Critical defects such as water-leaking,abnormal noise, difference in level etc. due to damaged expansion joint.
- Remarkable crack of the pavement overlaid on the existing expansion joint.
- Transverse open crack or gap due to missing expansion joint

WORK SEQUENCE :

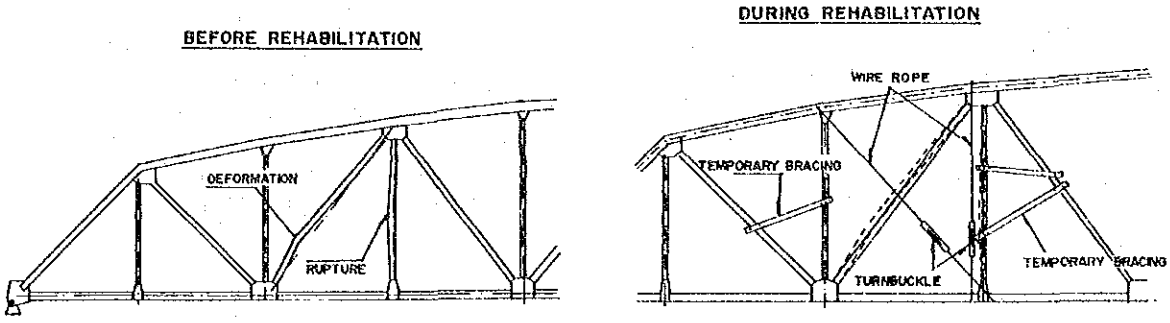
1) Cut off existing premix directly above the joints and remove the premix and damaged existing joint.
2) Scarify the exposed concrete surface of deck slab by jack hammer or other proved mechanical means.
3) After cleaning all loose particles and dirt at the surface, construct formwork and install new appropriate type of expansion joint taking into account the girder length.
4) If thick layer of premix is overlaid on the existing joint, the new joint must be set up considering existing road surface level.
5) Before the resin mortar is placed, primer is applied at the concrete surface to provide a good bond.
6) Remove formwork and repave with premix at the circumference of the joint.

SPECIFICATION :

1) Appropriate type of expansion joint shall be selected from standard type of joints approved by JKR.
2) End welded studs shall conform to the requirement of cold finished carbon bars and shafting ASTM A280.The tensile properties determine in accordance with A3370.
3) Anchors shall be fabricated from hot rolled mild steel deformed bars conforming to B.S 4449 and shall be of weldable quality.
4) Bolts,nuts and washers shall be high strength conforming to the require ments of B.S. 4395:Part 1 general grade or ASTM 4325, type 3.
5) All the metallic components shall be shop and field painted in accordance with the requirements of B.S. 5493.
6) The metal surface in direct contact with the neoprene seal elements, shall be sandblasted and treated as recommended by the manufacturer so as to provide a high strength bond between the neoprene seal and mating metal surfaces.
7) The elastomer portion of the elastrometric expansion joint shall be of the compound known as neoprene.

REHABILITATION PLAN : REPLACEMENT OF STRUCTURE MEMBER
METHOD : REPLACEMENT OF STEEL TRUSS MEMBER

DRAWING :



APPLICATION CRITERIA :

- Inadequate load carrying capacity.
- Critical deformation or rupture of steel members due to vehicle collision.
- Severe section loss due to corrosion.

WORK SEQUENCE :

1) A detour load for vehicle traffic shall be provided and the bridge shall be closed to traffic during rehabilitation work.
2) Prior to commencement of the replacement work, the rivets if connected between the defective member and other member shall be removed and replaced with high tensile bolts.
3) Remove thoroughly paint, rust, foreign material, oil or grease, loose or peeling paint and non-adherent residues from the steel surface in contact with the gusset plate and member to be replaced.
4) Install temporary bracings or wire ropes by welding or high tensile bolts in order to reinforce other members or to transfer actual working force of the member to be replaced to those members.
5) Replace the defective member with a new member using high tensile bolts which has been fabricated with proper lines and dimensions in a steel shop.
6) Remove all temporary members and protect the working area against corrosion by painting according to specified method of "repainting superstructure" operation.

SPECIFICATION :

1) All the steel work shall comply with the requirement stated in Section 12 of JKR Standard Specification for Road Works.
2) Painting shall be in accordance with the specification for "Repainting superstructure" operation.
3) Steel plates shall comply with the requirements of B.S 4360.
4) Holes for high tensile bolts shall comply with requirements of B.S.4604.
5) High tensile bolts shall comply with requirements of B.S.4395 and used in accordance to B.S 4604.

5.3.2 Functional Rehabilitation Techniques

Functional rehabilitation techniques are divided into three categories consisting of widening carriageways, adding sidewalks and raising grade. Criteria for applying these rehabilitation techniques are discussed below:

- Widening carriageways

The necessity for widening carriageways on the bridges shall be assessed in accordance with the method described in Chapter 3; comparison of the traffic capacity on a bridge and current demand volume at the same bridge location. Application of a specific rehabilitation technique relies on type and residual durability of the existing bridge to be rehabilitated.

- Adding sidewalks

The necessity criteria for adding sidewalks are based on whether a bridge without sidewalk is located in an urban area or not or its proximity with institutional public facilities such as schools, hospitals, mosques and other landmarks, as mentioned in Chapter 3.

Application of a specific rehabilitation technique depends on the type of the superstructure, residual durability of the substructure and estimated pedestrian volume.

- Raising grade or Extension of bridge length

If a bridge is found to be submerged based on an interview survey with local residents living in the vicinity of the bridge site or hydrological assessment results, the functional rehabilitation of either raising grade or extension of bridge length will be applied to cope with hydraulic problems. A specific rehabilitation technique shall be selected based on the magnitude of run-off discharge and flood level and flow capacity of the river.

Each type of standard rehabilitation techniques mentioned above is tabulated in Table 5-7 together with the corresponding application criteria. The drawing , work sequence and indicative specification of each technique is presented on one sheet in the succeeding pages.

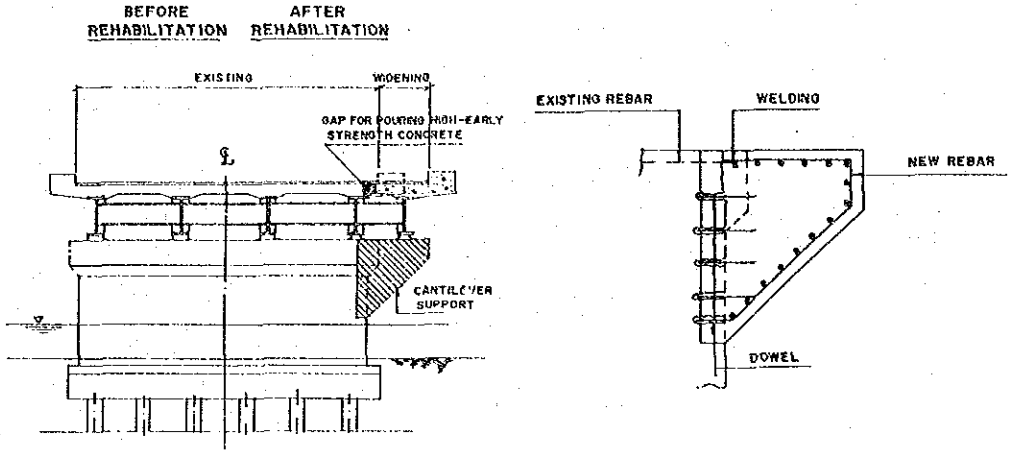
Table 5-7 Functional Rehabilitation Techniques and Corresponding Application Criteria

Rehabilitation Plan	Method	Application Criteria
o Functional Rehabilitation for Traffic Capacity of Bridges	– Widening Carriageway by Cantilever Support Attached to Substructure	o Inadequate carriageway width. o Adequate loading capacity of existing sub-structure for additional dead load and live loads.
	– Widening Carriageway by Extension of Both Super and Substructures	o Inadequate carriageway width. o Inadequate load carrying capacity of existing foundation for total load including additional dead and live loads.
o Functional Rehabilitation for Pedestrian Flow Capacity of Bridges	– Adding Sidewalk by Cantilever Support Attached to Superstructure	o Absence of sidewalk o Adequate loading capacity of both existing superstructure and substructure for total load including additional dead and live loads.
	– Adding Sidewalk by Cantilever Support Attached to Substructure	o Absence of sidewalk o Adequate loading capacity of existing sub-structure for total load including additional dead and live loads.
	– Adding Sidewalk by Construction of an Independent Bridge	o Absence of sidewalk o Inadequate loading capacity of existing sub-structure for total load including additional dead and live loads.
o Functional Rehabilitation for River Flow Capacity of Bridges	– Raising of Bridge Grade	o Inadequate bridge opening. o Required raising height is less than 1.0m.
	– Extension of Bridge Length	o Inadequate bridge opening. o Raising height requirement is more than 1.0m. o Adequate loading capacity of existing abut-ment at extension side for total load including additional load due to bridge extension.

REHABILITATION PLAN : **FUNCTIONAL REHABILITATION FOR TRAFFIC CAPACITY OF BRIDGE**

METHOD : **WIDENING CARRIAGEWAY BY CANTILEVER SUPPORT ATTACHED TO SUBSTRUCTURE**

DRAWING :



APPLICATION CRITERIA :

- Inadequate carriageway width
- Adequate loading capacity of the existing substructure for additional dead and live loads.

WORK SEQUENCE :

1) Chip off the existing concrete surface and install dowel bars by applying epoxy resin mortar or non-shrinkage cement mortar as shown in the drawing.
2) Construct the cantilever support attached to the substructure by approved methods and using appropriate materials.
3) Cut through the specified section of deck slab without damaging the existing reinforcement bars.
4) Construct the new part of bridge superstructure, of which type should be the same as the existing superstructure, providing a gap of 30 to 50cm between the existing and new deck slab (gap is shown in the drawing).
5) Prior to pouring concrete using high-early strength portland cement with expansive agent into the gaps, traffic shall be interrupted until the required concrete strength is obtained.
6) Apply asphaltic concrete surface layer on the deck slab.

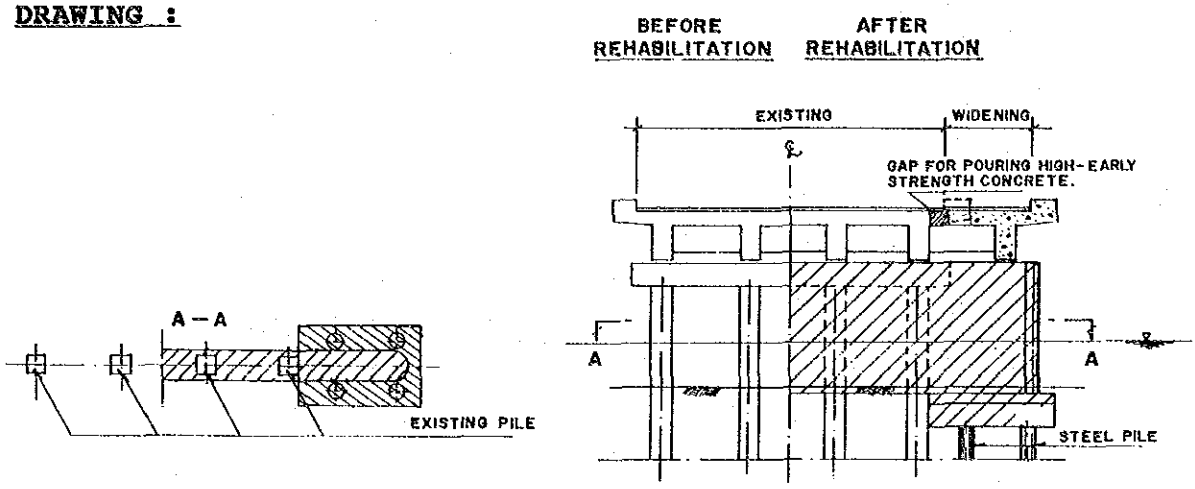
SPECIFICATION :

1) The cement used shall be ordinary portland cement conforming to M.S.522.
2) Minimum concrete cube strength at 28 days shall be 30 $N/mm^2/20mm$
3) Minimum concrete cover to main reinforcement shall be 70mm for substructure and 30mm for superstructure.
4) Bars shall be bent and measured in accordance with BS4466.
5) Minimum lap length shall be 32 x diameter of bar.
6) High early strength portland cement and expansive additive agent to be used in the joint concrete shall be in accordance with JIS-R5210 and A6202 respectively.
7) Minimum curing time of epoxy resin shall be 24 hours.

REHABILITATION PLAN : **FUNCTIONAL REHABILITATION FOR TRAFFIC CAPACITY OF BRIDGES**

METHOD : **WIDENING CARRIAGEWAY BY EXTENSION OF BOTH SUPER AND SUBSTRUCTURES**

DRAWING :



APPLICATION CRITERIA :

- Inadequate carriageway width.
- Inadequate load carrying capacity of the existing foundation for total load including additional dead and live loads.

WORK SEQUENCE :

1) Cofferdam and temporary roads shall be provided for the construction if required.
2) Drive additional piles at specified locations. In order to prevent disturbance to the existing foundation steel piles shall be used.
3) Chip off the existing concrete surface and install dowel bars applying epoxy resin mortar or non-shrinkage cement mortar.
4) Construct the extension part of substructure by approved methods and using appropriate materials and provide concrete lining to the existing substructure as shown in the drawing.
5) Cut through the specified section of deck slab concrete without damaging the existing reinforcements.
6) Construct the new part of superstructure, of which type should be the same as the existing superstructure, providing a gap of 30 to 50cm between existing and new deck slab as shown in the drawing.
7) Prior to pouring concrete using high-early strength portland cement with expansive additive agent into the gap, traffic shall be interrupted until the required concrete strength is obtained.
8) Apply asphaltic concrete surface layer on the deck slab.

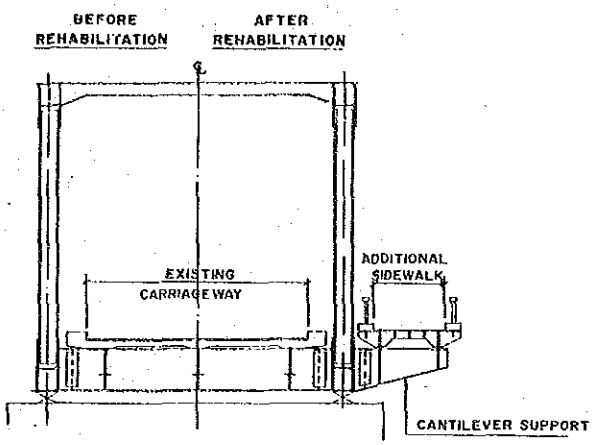
SPECIFICATION :

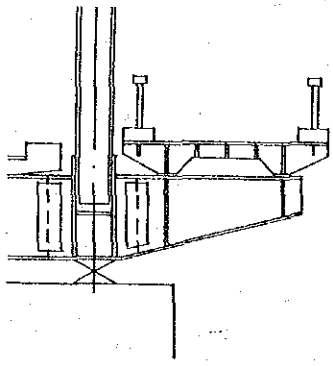
1) The cement used shall be ordinary portland cement conforming to M.S.522.
2) Minimum concrete cube strength at 28 days shall be 30 N/mm²/20mm
3) Minimum concrete cover to main reinforcement shall be 70mm for substructure and 30mm for superstructure.
4) Bars shall be bent and measured in accordance with BS4466.
5) Minimum lap length shall be 32 x diameter of bar.
6) High early strength portland cement and expansive additive agent to be used shall be in accordance with JIS-R5210 and JIS-A6202 respectively.
7) Minimum curing time of epoxy resin shall be 24 hours.

REHABILITATION PLAN : **FUNCTIONAL REHABILITATION FOR PEDESTRIAN FLOW CAPACITY OF BRIDGES**

METHOD : **ADDING SIDEWALK BY CANTILEVER SUPPORT ATTACHED TO SUPERSTRUCTURE**

DRAWING :





DETAIL

APPLICATION CRITERIA :

- Absence of sidewalk.
- Adequate loading capacity of both existing superstructure and substructure for total load including additional dead and live loads.

WORK SEQUENCE :

1) Remove thoroughly paint, rust, foreign material, oil or grease, loose or peeling paint and all non-adherent residues from the steel surface by brusing or other approved methods.
2) Weld the steel plates to the lower chord at specified position for attaching the cantilever supports.
3) Attach the cantilever supports, which have been fabricated with proper lines and dimension in a steel shop, to the steel plates by using high-tensile bolts.
4) Erect the superstructure on the cantilever support as shown in the drawing.
5) Protect the working area against corrosion by painting according to specified methods (refer to "Repainting supperstructure" operation).

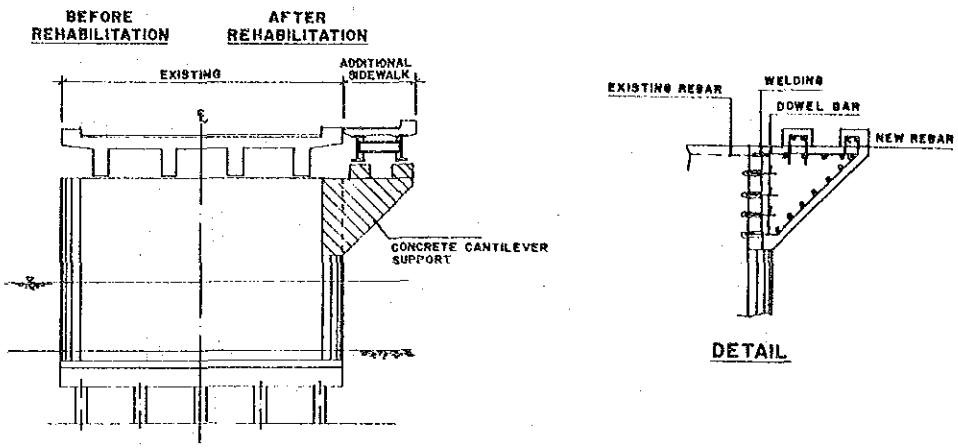
SPECIFICATION :

1) All the steel work shall comply with the requirements stated in Section 12 of JKR Standard Specification for Road Works.
2) All mild steel shall conform to MS-146.
3) Welding shall be carried out in accordance with BS-5135 and BS-638.
4) Holes for high tensile bolts shall comply with the requirements of BS-4604.
5) High Tensile Bolts shall comply with the requirements of BS-4395 and use in accordance to BS-4604.

REHABILITATION PLAN : **FUNCTIONAL REHABILITATION FOR PEDESTRIAN FLOW CAPACITY OF BRIDGES**

METHOD : **ADDING SIDEWALK BY CANTILEVER SUPPORT ATTACHED TO SUBSTRUCTURE**

DRAWING :



APPLICATION CRITERIA :

- Absence of sidewalk.
- Adequate loading capacity of the existing substructure for total load including additional dead and live loads.

WORK SEQUENCE :

1) Chip off the existing concrete surface and install dowel bars by applying epoxy resin mortar or non-shrinkage cement mortar as shown in the drawing.
2) Construct the cantilever support attached to the existing by approved methods and using appropriate materials.
3) After the required strength of the concrete is obtained, erect the beams/girders of the superstructure.
4) Securely fix the reinforcement and construct the formwork for the concrete deck slab.
5) Pour concrete of grade 30/20 for the deck slab and cure the concrete properly.
6) Formwork shall be removed after the required concrete strength has been reached.
7) Apply field painting for the steel members and surface layer on the deck slab.

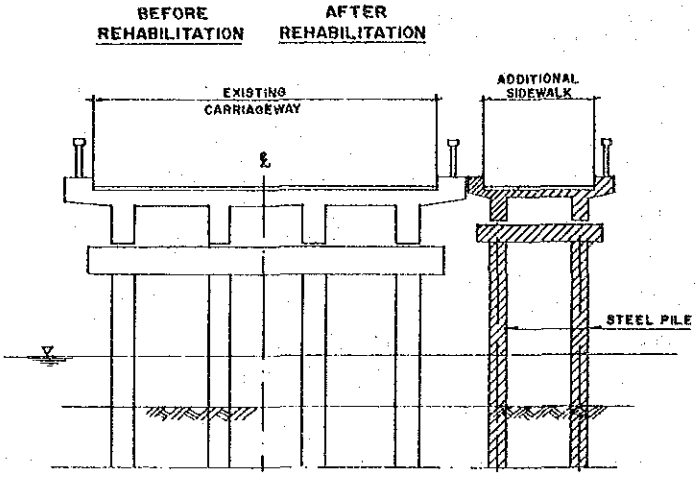
SPECIFICATION :

1) All the works shall comply with the relevant sections of JKR Standard Specification for Road Works.
2) The cement used shall be ordinary portland cement conforming to M.S.522.
3) Minimum concrete cube strength at 28 days shall be 30 N/mm²/20mm
4) Minimum concrete cover to main reinforcement shall be 70mm for substructure and 30mm for superstructure.
5) Bars shall be bent and measured in accordance with BS4466.

REHABILITATION PLAN : **FUNCTIONAL REHABILITATION FOR PEDESTRIAN FLOW CAPACITY OF BRIDGES**

METHOD : **ADDING SIDEWALK BY CONSTRUCTION OF AN INDEPENDENT BRIDGE**

DRAWING :



APPLICATION CRITERIA :

- Absence of sidewalk
- Inadequate loading capacity of existing substructure for total load including additional dead and live loads.

WORK SEQUENCE :

1) Drive the piles at specified location. In order to prevent disturbance to the existing foundation, steel piles shall be used.
2) Construct the additional substructure by approved methods and using appropriate materials as shown in the drawing.
3) After the required strength of the substructure concrete is obtained, construct the new superstructure by approved methods and using appropriate materials.
4) Remove the formwork after the required concrete strength is reached.

It should be noted that types of super and substructures for a new pedestrian bridge should be the same as the existing types.

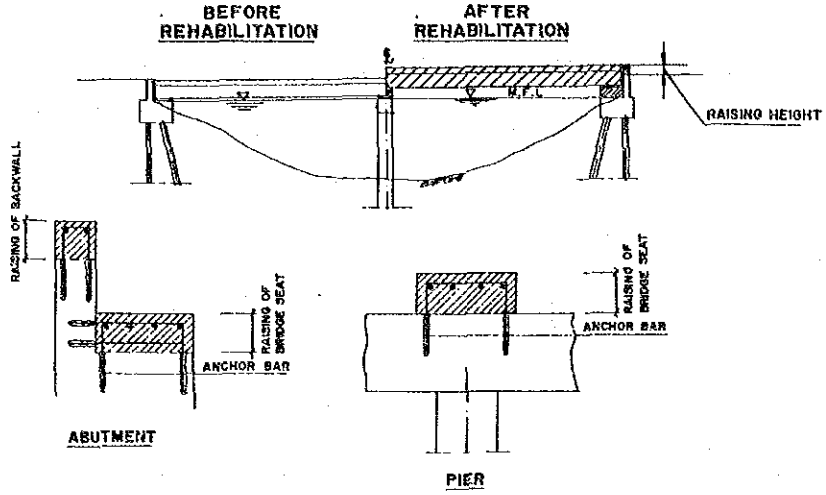
SPECIFICATION :

1) All the works required shall comply with the requirements stated in relevant sections of JKR Standard Specification.
2) The cement used shall be ordinary portland cement conforming to M.S.522.
3) Minimum concrete cube strength at 28 days shall be 30N/mm²/20mm
4) Minimum concrete cover to main reinforcement shall be 70mm for substructure and 30mm for superstructure.
5) Bars shall be bent and measured in accordance with BS4466.
6) Minimum lap length shall be 32 x diameter of bar.

REHABILITATION PLAN : FUNCTIONAL REHABILITATION FOR RIVER FLOW CAPACITY OF BRIDGES

METHOD : RAISING OF BRIDGE GRADE

DRAWING :



APPLICATION CRITERIA :

- Inadequate bridge opening.
- Required raising height is less than 1.0m.

WORK SEQUENCE :

1) A detour road for vehicle traffic shall be provided.
2) Remove expansion joints at both abutments and at piers without any damages.
3) Construct jack-bases at both abutments and piers and jack up the super structure simultaneously at both sides. Remove the existing bearings (refers to the method and specifications of "bearing replacement" operation)
4) Chip off the concrete surface of the existing bridge seats and backwalls piers and install dowel bars by applying epoxy resin mortar or non-shrinkage cement mortar as shown in the drawing.
5) Raise the new bridge seats and backwalls by approved methods and using appropriate materials.
6) Reinstall the bearings or install new bearing units if required.
7) After the required strength of the concrete is obtained, jack down the superstructure.
8) Install expansion joints to the gap between the backwall and the deck slab.
9) Raise both side approach roads.

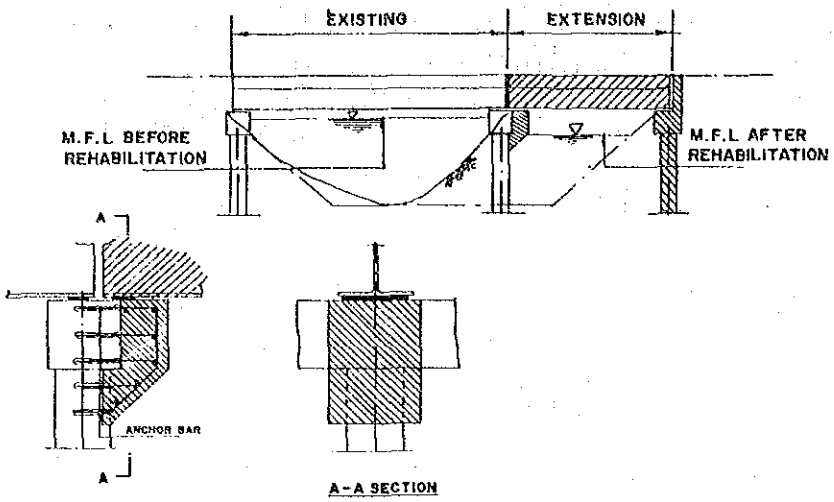
SPECIFICATION :

1) All the works shall comply with the requirements stated in the relevant Sections of JKR Standard Specification.
2) The cement used shall be ordinary portland cement conforming to M.S.522.
3) Minimum concrete cube strength at 28 days shall be 30N/mm²/20mm.
4) Minimum concrete cover to main reinforcement shall be 70mm for substructure and 30mm for superstructure.
5) Bars shall be bent and measured in accordance with BS4466.
6) Minimum lap length shall be 32 x diameter of bar.
7) Epoxy resin shall comply with properties specified in "steel plate bonding" operation.
8) Minimum curing time of epoxy resin shall be 24 hours.

REHABILITATION PLAN : **FUNCTIONAL REHABILITATION FOR RIVER FLOW CAPACITY OF BRIDGES**

METHOD : **EXTENSION OF BRIDGE LENGTH**

DRAWING :



APPLICATION CRITERIA :

- Inadequate bridge opening
- Raising height required is more than 1.0m.
- Adequate loading capacity of existing abutment at extension side for total load including additional load due to bridge extension.

WORK SEQUENCE :

1) A detour road for vehicle traffic shall be provided.
2) Construct new abutment by approved methods and using appropriate materials.
3) Attach the concrete cantilever support to the existing abutment according to the method and specifications for "widening carriageway by cantilever support attached to substructure".
4) Remove expansion joints at the abutment.
5) After the required strength of the new substructure concrete is obtained, construct the new superstructure (bridge expansion) by approved methods and using appropriate materials.
6) Excavate the ground under the existing bridge and extension part for the river flow.
7) Install new expansion joints to the both ends of new constructed bridge.

SPECIFICATION :

1) All the works shall comply with the requirements stated in the relevant Sections of JKR Standard Specification.
2) The cement used shall be ordinary portland cement conforming to M.S.522.
3) Minimum concrete cube strength at 28 days shall be 30 N/mm²/20mm
4) Minimum concrete cover to main reinforcement shall be 70mm for substructure and 30 mm for superstructure.
5) Bars shall be bent and measured in accordance with BS4466.
6) Minimum lap length shall be 32 x diameter of bar.
7) Epoxy resin shall comply with properties specified in "Steel plate Bonding" operation.
8) Minimum curing time of epoxy resin shall be 24 hours.

5.3.3 Hydraulic Rehabilitation Techniques

Hydraulic rehabilitation techniques include slope protection, foot protection, river bed protection and river realignment depending on the extent and nature of the hydraulic problems encountered such as scour, erosion, flood flow.

- Slope protection is applicable to river banks adjacent to abutments where erosion is observed.

- Foot protection is applicable to footings of the slope protection in order to prevent slope failure caused by scouring action on the river bed.

- River bed protection is applicable to river bed surrounding the river piers where local scouring or river bed lowering is observed.

- River realignment (Rechanneling) work is applicable to extremely eroded banks of a meandering river located at the vicinity of a bridge upstream.

Selection of a specific rehabilitation technique depends on the stream type, river scale, flood flow velocity, foundation type and geology of each site. Each type of the rehabilitation technique is shown in Table 5-8 together with the corresponding application criteria.

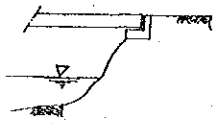
Table 5-8 Hydraulic Rehabilitation Techniques and Corresponding Application Criteria

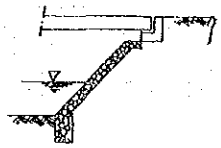
Rehabilitation Plan	Method	Application Criteria
o Slope Protection	– Stone Masonry	o Slope ; 1 : 0.5 – 1.5 o Height ; Less than 5m o Application Small to medium scale river
	– Concrete Block Masonry	o Slope ; 1 : 0.3 – 1.0 o Height ; Less than 3m o Application Rapid stream and small to medium scale river.
	– Concrete Block Pitching	o Slope ; 1 : 1.5 – 2.0 o Height ; Less than 5m o Application Medium to large scale river.
	– Concrete Frame	o Slope ; 1 : 1.5 – 2.0 o Height ; Less than 5m o Application Tidal river and bank subjected to wave force.
o Foot Protection	– Dumped stone	o Small to medium scale river and foundation ground is relatively solid.
	– Wire Mesh Gabion	o Small scale river and foundation ground is soft.
	– Concrete Block Matress	o Medium to large scale river or rapid flow velocity.
	– Sheet Pile	o Normal water level at slope toe is more than about 3.0m and it is difficult to provide base concrete under river bed at slope toe.
o River Bed Protection	– Wire Mesh Gabion	o Foundation protection.
	– Dumped Stone & Wire Mesh Gabion	o Local scouring.
o River Realignment	– Spur Dike by Stone Masonry	o Large scale river.
	– Spur Dike by Concrete Pile	o Medium to large scale river.

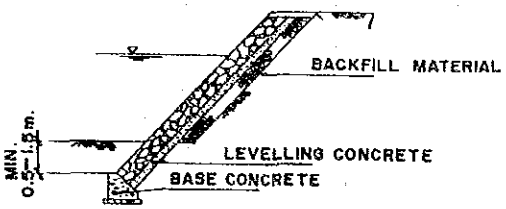
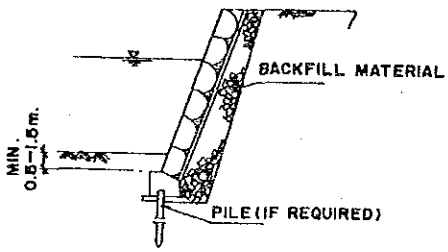
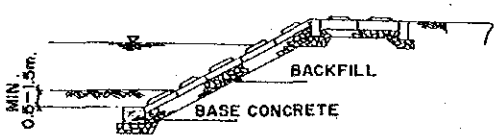
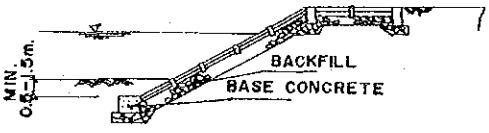
REHABILITATION PLAN : HYDRAULIC REHABILITATION
METHOD : SLOPE PROTECTION

DRAWING

BEFORE REHABILITATION **AFTER REHABILITATION**





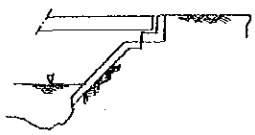
TYPE AND MATERIAL	SLOPE	HEIGHT	APPLICATION
1) Stone masonry (Type A) 	1:0.5 - 1.5	less than 5m	small to medium scale river
2) Concrete Block Masonry (Type B) 	1:0.3 - 1.0	less than 3m	rapid stream and small to medium scale river
3) Concrete Block Pitching (Type C) 	1:1.5 - 2.0	less than 5m	medium to large scale river
4) Concrete Frame (Type D) 	1:1.5 - 2.0	less than 5m	tidal river and bank subjected to wave force

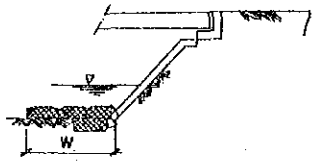
REHABILITATION PLAN : HYDRAULIC REHABILITATION
METHOD : FOOT PROTECTION

DRAWING **BEFORE REHABILITATION** **AFTER REHABILITATION**

REQUIRED WIDTH OF FOOT PROTECTION

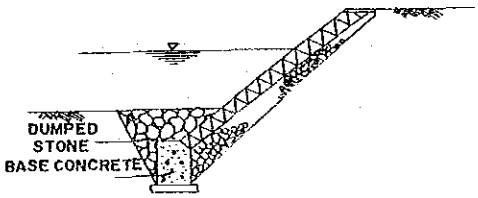
	MEAN FLOOD FLOW VELOCITY (V)		
	2m/s > V	2 < V < 4m/s	V > 4m/s
WIDTH	2-5m	4-6m	MORE THAN 6m





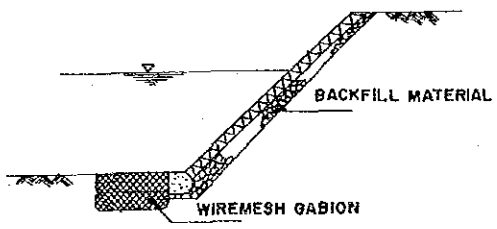
TYPE AND MATERIAL **APPLICATION CRITERIA**

1) Dumped Stone (Type A)



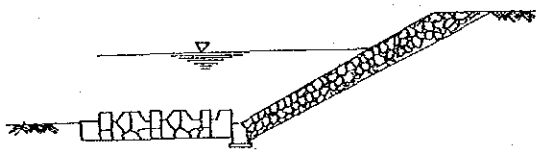
- Small to medium scale river and foundation ground is relatively solid.

2) Wire Mesh Gabion (Type B)



- Small scale river and foundation ground is soft.

3) Concrete Block Mattress (Type C)

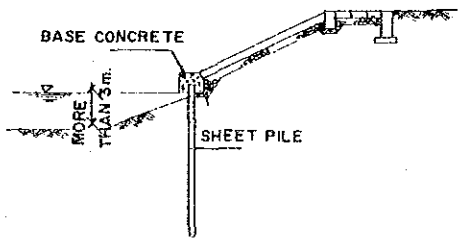


- Medium to large scale river or rapid flow velocity.

REQUIRED WEIGHT OF A CONCRETE BLOCK

	MEAN FLOOD FLOW VELOCITY (V)		
	2m/sec > V	2 < V < 4m/sec	V > 4m/sec
WEIGHT	0.2-1.5ton	1 - 3 ton	MORE THAN 2ton

4) Sheet Pile (Type D)

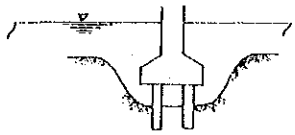


- Normal water level at slope toe is more than about 3.0m and it is difficult to provide base concrete under river bed at slope toe.

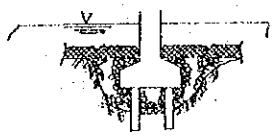
REHABILITATION PLAN : HYDRAULIC REHABILITATION FOR THE BRIDGE
METHOD : RIVER BED PROTECTION

DRAWING

BEFORE REHABILITATION



AFTER REHABILITATION

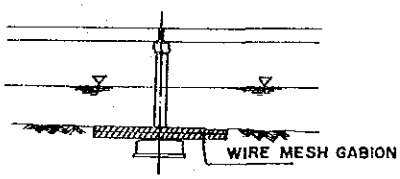


TYPE AND MATERIAL

APPLICATION CRITERIA

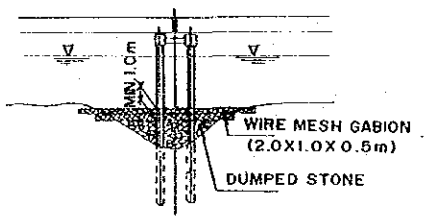
1) Wire Mesh Gabion (Type A)

- Foundation Protection



2) Dumped Stone & Wire Mesh Gabion (Type B)

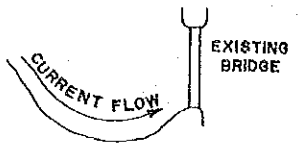
- Local Scouring



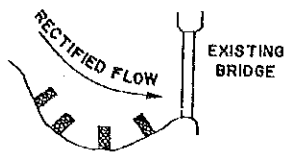
REHABILITATION PLAN : HYDRAULIC REHABILITATION
METHOD : RIVER REALIGNMENT

DRAWING

BEFORE REHABILITATION

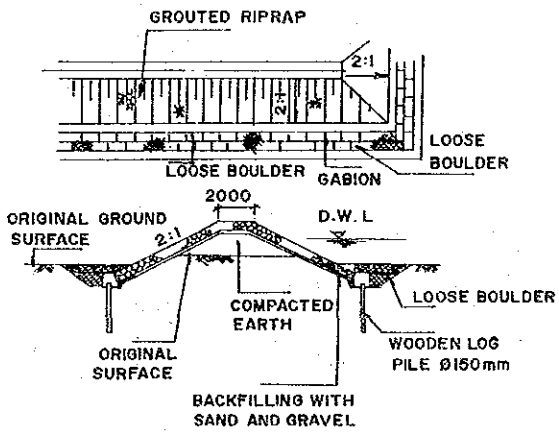


AFTER REHABILITATION

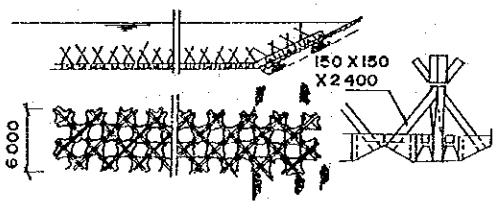


TYPE AND MATERIAL

1) Spur Dike by Stone Masonry (Type A)



2) Groyne by Concrete Pile (Type B)



APPLICATION CRITERIA

- Large scale river

- Medium to large scale river

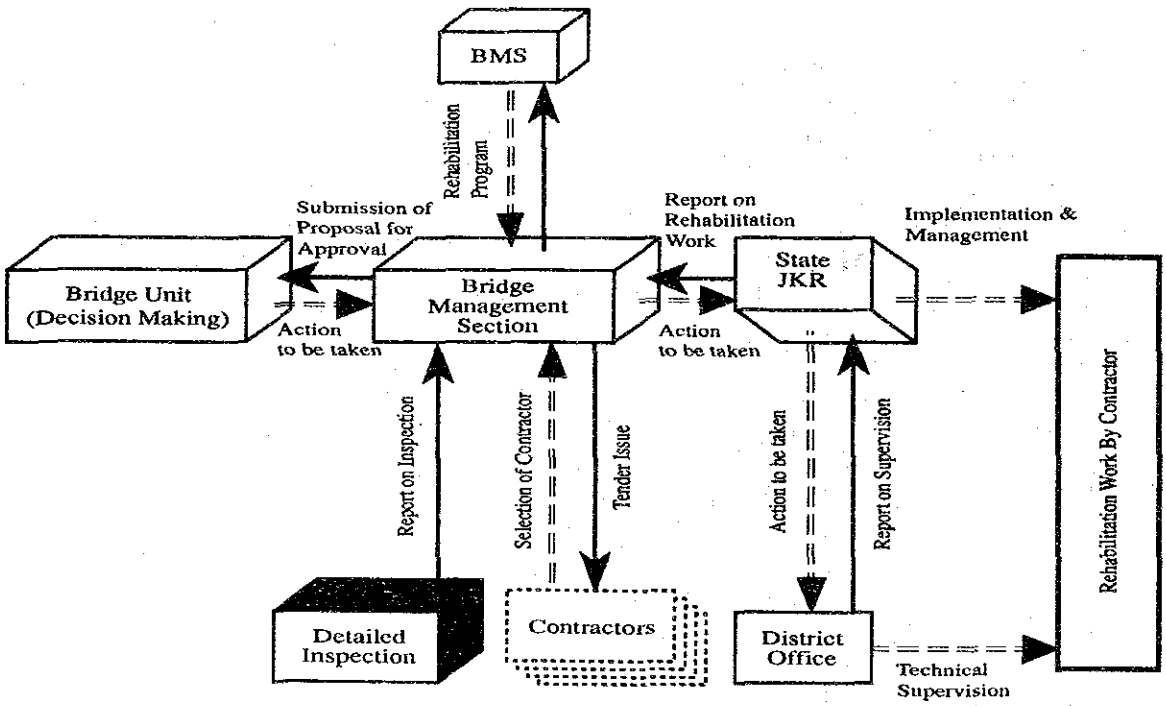
5.4 Management and Implementation

Rehabilitation and strengthening work should be accomplished with the aim of meeting the Government's policy and with the required structural durability. Regardless of the magnitude and type of rehabilitation required, the work cannot be accomplished satisfactory without a comprehensive assessment and planning as well as an efficient organization with adequate staffing.

In this regard, this section presents programming and prioritizing methods for bridge rehabilitation, contents of detailed engineering design for the implementation and organization of construction management.

Schematic flow of the bridge rehabilitation works including detailed inspection, programming, implementation and bridge documentation are depicted in Figure 5-2 together with the responsible agency concerned with each task.

Figure 5-2 Schematic Flow of Bridge Rehabilitation



5.4.1 Establishment of a Rehabilitation Program

It is essential that the concept of a bridge rehabilitation program shall fit into the JKR's general road maintenance policy as well as the general bridge policy. Important factors which should be taken into consideration in establishment of the rehabilitation program are as follows;

- Road development policy and road rehabilitation strategy;
- Traffic trends with regards to traffic volume, vehicle loads and size;
- Thorough diagnosis of the cause of deterioration, faults and weaknesses and a comprehensive assessment of current condition;
- Environmental constraints;
- Availability of annual rehabilitation funds;
- Transfer of rehabilitation technology to JKR State and District staff;
- Present organization and staffing involved in the rehabilition work;
- Enhancement of the local contractors' capability;

In developing the rehabilitation program for a large number of the bridges, the decisions reached should tend towards an overall optimization from an economic point of view. In this respect, "Economic Evaluation" by means of calculation of several economic indicators such as Internal Rate of Return(IRR), Net Present Value(NPV) and Benefit/Cost Ratio(B/C) could be the best method to justify the viability of an individual scheme, to establish their ranking or to compare one scheme to another. The economic evaluation method is elaborated in Annex-I.

Based on the evaluation results as well as the other factors listed above, the practical programming of the rehabilitation work shall be carried out by the Bridge Management Section in the Bridge Unit using the Bridge Management System.

5.4.2 Detailed Engineering Design and Tendering

The Bridge Unit in the Federal JKR is responsible for preparation of the detailed design of the rehabilitation work and carrying out the tendering to select a prospective contractor.

In this regard, the detailed engineering design includes the following works;

-Field survey
  Supplemental traffic study, Topographic survey, Subsoil investigation, Hydrological survey, and Structural investigation;
-Detailed design
  Review of current design criteria,
  Structural analysis of the existing bridge and selection of rehabilitation methods and
  Estimation of the work quantity.
-Construction planning
  Packaging
  Construction schedule and method
  Study on advanced materials and rehabilitation methods
-Cost estimate
  Unit price analysis
  Project cost estimate
  Financing schedule

-Preparation of Tender Documents
  Instructions to tenderers
  Form of contract
  Condition of contract
  Technical specification
  Bill of quantities
  Tender drawings

While the tendering activities consists of as follows;

-Tender issue and Prebid conference
-Site orientation
-Tender evaluation
-Negotiation with the contractor
-Preparation of contract documents

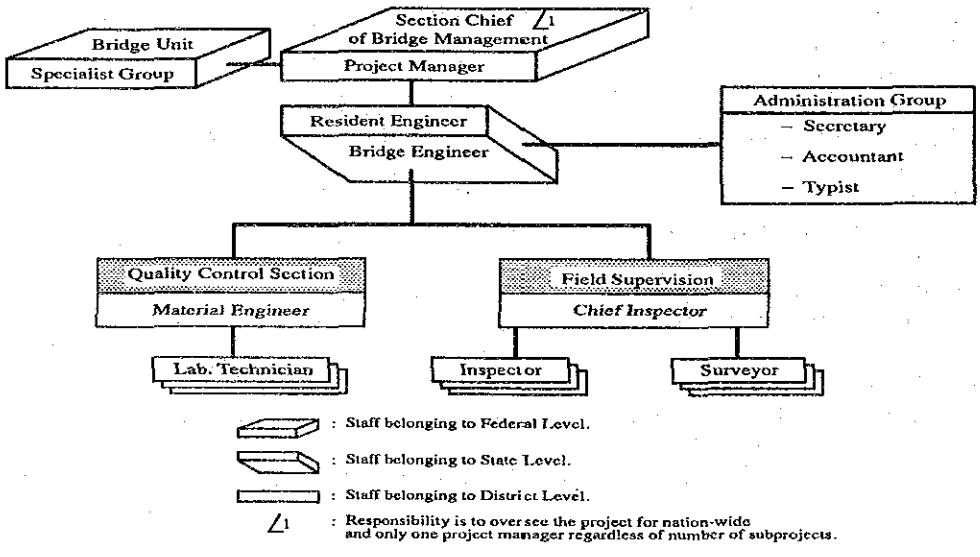
5.4.3 Implementation of Rehabilitation Work

Implementation of the rehabilitation work is under the overall responsibility of the Bridge Unit represented by the Chief of Bridge Management Section, the Project Manager. The work shall be executed on a contract basis in principle by a contractor selected through competitive biding.

While a team for construction supervision shall be organized to manage and supervise the contractor's field work but the size and staffing of the organization depend on number of the bridges to be rehabilitated, their locations and scale of the respective rehabilitation works. For reference purpose, a typical organization is depicted in Figure 5-3 assuming to manage and supervise about 15 to 20 bridges.

After the work has been completed, the completion report shall be prepared by the project manager in accordance with the standard reporting form attached in Annex-H and be submitted to the Bridge Unit though the State JKR concerned.

Figure 5-3 Typical Organization for Construction Supervision



ANNEX - A
BRIDGE INVENTORY SURVEY SHEETS

BRIDGE NO: 5/07 NAME OF BRIDGE OR RIVER: SUNGAI BELANAKAN ROUTE: N 7

STATE: NEGERI SEMBILAN DISTRICT: SEREMBAN

STRUCTURE DATA

YEAR BUILT: 1940'S (ASSUMED)

DESIGNED BY:

CONSTRUCTED BY:

COST OF CONSTRUCTION:

BRIDGE TYPE: STEEL BEAM BUKLE PLATE WITH R.C. BOX CULVERT EXTENSION

CROSSING ROAD / RAILWAY / RIVER / RIVER

SKEW ANGLE ☐

SPAN LENGTH: 5·7m.

MAX. SPAN:

INTERNAL WIDTH BETWEEN PARAPETS: 7.8 m

CARRIAGEWAY WIDTH: 7.8 m

RIVER NAVIGABLE: YES ☐ NO ☑

CLEARANCES: WIDTH: m HEIGHT m

BRIDGE OPENING : ADEQUATE ☐ INADEQUATE ☑

TRAFFIC RESTRICTION:

WIDTH: m HEIGHT: m

WEIGHT: T AXLE: T

DATE OF ENTRY: NOVEMBER , 1990

DESIGN LOAD: UNKNOWN

DESIGN CODE:

CAPACITIES:

BENDING MOMENT:

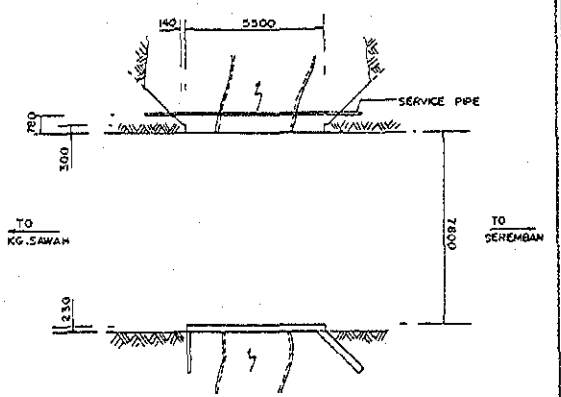
SHEAR FORCE:

SERVICES CARRIED:

L.L.N. ☐ TELEPHONE ☐ LIGHTING ☐

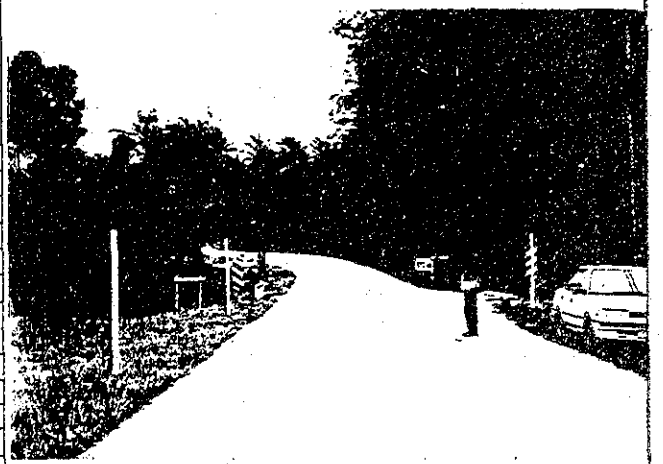
WATER ☑

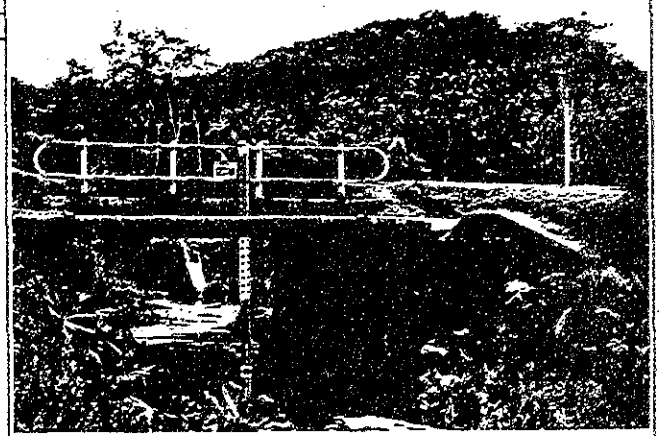
LOCATION PLAN



SCALE 1 : 200

PHOTOGRAPHS:





NA-1

A – 1

CONDITION			
BRIDGE PARTS	MATERIAL/TYPE	CONDITION ANALYSIS	RATING (1 – 5)
FOUNDATION	BANKSEAT		N/A
ABUTMENT	MASS CONCRETE WALL		1 (1)
PIER.	–		N/A
BEARING.	–		N/A
BEAM / GIRDER.	STEEL (R.S.J)		4 (4)
DECK.	BUCKLE PLATE		1 (1)
SURFACING.	PREMIX		1
WINGWALL	MASS CONCRETE		4
EXPANSION JOINT.	–		N/A
PARAPET / RAILING.	STEEL		3
DRAINAGE	–		N/A
APPROACH SLAB.	–		N/A
SLOPE / SCOUR PROTECTION.	GABION WALL		1

DRAWING NUMBERS. CALCULATION REFERENCES AND MAINTENANCE NOTES:

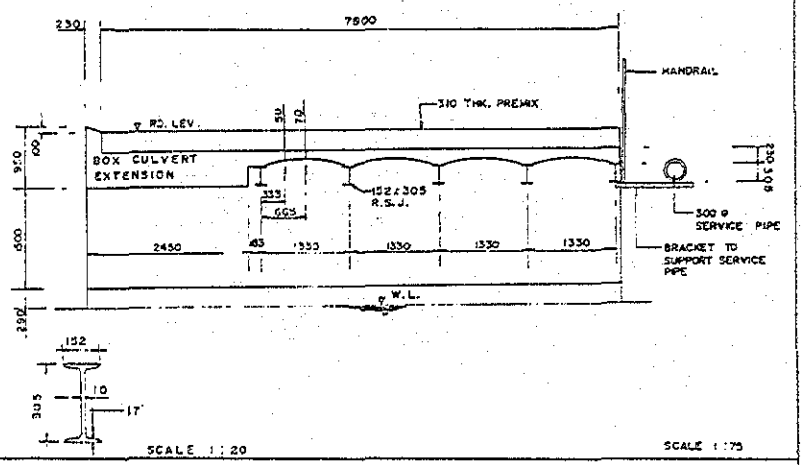
OVERALL RATING FROM MAINTENANCE VIEW POINT 2·2

OVERALL RATING FROM BRIDGE SAFETY VIEW POINT 2·1

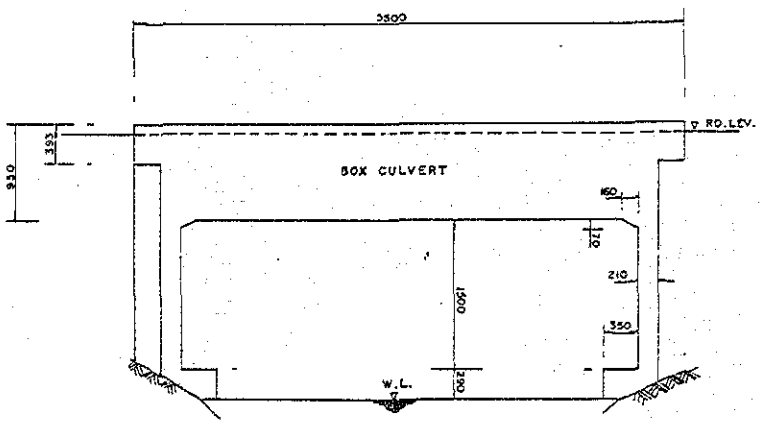
REPLACEMENT / RECONSTRUCTION :

PLANNED REPLACEMENT YEAR :

CROSS SECTION



LONG SECTION



Axle Load Study

Bridge Group - Visual Inspection Sheet 1

Team Number _____

Team Leader _____

Date _____

Bridge Location Data

Vehicle Mileometer Reading | | | . | | | |

Zeroed at _____ Km

Travelling In Direction of Increasing/Decreasing Km

Bridge Number | | | | | | |

Route _____

Between _____ and _____

State _____

District _____

Name of Bridge or River _____

Notes on Location

_____

_____

_____

Sketch Plan (Dimension all Spans, Skew Angle Sketch in River)

Axle Load Study
Bridge Group Visual Inspection Sheet 2

Bridge Number							

Dimensioned Sketch of Main Beams (MM)

If Standard Beam Give Type _____

Centres of Main Beams _____(M)

Dimensioned Sketch of Cross Girders/Bracings (MM)

Centres of Cross Girders _____(M)

Axle Load Study

Bridge Group - Visual Inspection Sheet 3

Bridge Number						

Cross Section of Bridge (Show O/All Width, Road Width, Footway Width, Depth of Slab, Edge Detail) Metres

Long Section of Bridge (Show O/All Length, Position of River, Depth to Water Level from edge, Sketch Piers) Show Articulation.

Estimated Distance Bearing Centre Line to Span End _____ m

Axle Load Study
Bridge Group - Visual Inspection Sheet 4

Bridge Number: | | | | | | |

Structure Data
Year Built:
Bridge Crosses
Is River NavigableYES/NO Over What Width _____M
Lighting YES/NO
Services Carried _____

Catchment Vegetation
Jungle/Agricultural/Urban/Swamp

Conditon Rating

Bridge Parts	Material/Type	Condition Rating (1-5)
Foundation		N/A
Abutment (2 Nos)		( )
Pier		( )
Bearing		( )
Beam/Girder		( )
Deck		( )
Surfacing		
Wingwall		
Expansion Joint		
Railing		
Drainage		
Bank Protection		

Figures with and without ( ) show part ratings from bridge safety view point and from maintenance view point respectively

Axle Load Study
Bridge Group Visual Inspection Sheet 5

Bridge Number | | | | | | |

Engineers Comments

Form - C

Axle Load Study (Supplemented by JICA)
Bridge Group - Visual Inspection Sheet 6

Bridge Number: | | | | | | |

Name of Bridge or River :

- Flood water level (based on interview to residents who are living at this bridge vicinity)

_____Adequate _____Inadequate

_____Flood time duration
(_____min)

_____Flood frequency/year
(_____times)

- Availability of Bridge Drawing (As built or As measured)

_____Yes _____No

- Availability of Subsoil data (Boring log or subsoil profile)

_____Yes _____No

- Availability of detour road in case of bridge collaped

_____Yes _____No

Detour Route

A:( )-B:( ) -C:( )

How far compared normal route?
(Approx. _____Km)

- Necessity of sidewalk in case of the absence of sidewalk at present.

_____Yes _____No

because : _____

_____

ANNEX - B
STRUCTURAL CONDITION CHECKLIST DURING SUPERFICIAL INSPECTION

STRUCTURAL CONDITION CHECKLIST DURING SUPERFICIAL INSPECTION

KEY : STATE / DISTRICT : / BRIDGE TYPE :

DATE : / / / NAME OF INSPECTOR : NAME OF RIVER :

BRIDGE MEMBER		CODE	TYPE OF DAMAGES	PATTERNS (X)	DEPTH (Y)	EXTENSIONS (Z)	RATING OF DAMAGE	RATING OF MEMBER
[ ] Main Beam/Girder	[ ] Steel	Ms	[ ] (1)Corrosion	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally		
			[ ] (5)Rupture	–	[ ] Detected –	–		
			[ ] (23)Abnormal Noise	–	[ ] Detected –	–		
			[ ] (26)Deformation	–	[ ] Remarkable [ ] Slight	–		
			[ ] (26)Sediement (On Lower Flang)	–	[ ] Remarkable [ ] Slight	–		
	[ ] Concrete	Mc	[ ] (32)Defect	–	[ ] Remarkable [ ] Slight	–		
[ ] Deck Slab	[ ] Buckle Plate	Ds	[ ] (1)Corrosion	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally		
			[ ] (26)Deformation	–	[ ] Remarkable [ ] Slight	–		
	[ ] Concrete	Dc	[ ] (32)Defect	–	[ ] Remarkable [ ] Slight	–		
[ ] Pier	[ ] Steel	Ps	[ ] (1)Corrosion	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally		
			[ ] (5)Rupture	–	[ ] Detected –	–		
			[ ] (26)Deformation	–	[ ] Remarkable [ ] Slight	–		
			[ ] (27)Sediement/Vegetation /Clogging Bridge Opening	–	[ ] Remarkable [ ] Slight	–		
			[ ] (31)Scouring	[ ] Direct [ ] Pile,Caisson	[ ] Remarkable [ ] Slight	–		
	[ ] Concrete	Pc	[ ] (27)Sediement/Vegetation /Clogging Bridge Opening	–	[ ] Remarkable [ ] Slight	–		
			[ ] (31)Scouring	[ ] Direct [ ] Pile,Caisson	[ ] Remarkable [ ] Slight	–		
			[ ] (32)Defect	–	[ ] Remarkable [ ] Slight	–		
[ ] Abutment	[ ] Concrete	Ac	[ ] (27)Sediement/Vegetation /Clogging Bridge Opening	–	[ ] Remarkable [ ] Slight	–		
			[ ] (31)Scouring	[ ] Direct [ ] Pile,Caisson	[ ] Remarkable [ ] Slight	–		
			[ ] (32)Defect	–	[ ] Remarkable [ ] Slight	–		
[ ] Steel Bearing		Bs	[ ] (1)Corrosion	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally		
			[ ] (32)Defect (Freezing)	–	[ ] Remarkable [ ] Slight	–		
[ ] Drainage / Gutter		Dr	[ ] (22)Water Leak	–	[ ] Detected –	–		
			[ ] (27)Sediement/Vegetation	–	[ ] Remarkable [ ] Slight	–		
			[ ] (32)Defect(Missing Pipe /Inadequate Length)	–	[ ] Remarkable [ ] Slight	–		
[ ] Sidewalk / [ ] curb	[ ] Concrete	Sw	[ ] (27)Sediement/Vegetation	–	[ ] Remarkable [ ] Slight	–		
		Kb	[ ] (32)Defect /Damaged Precast Pannel)	–	[ ] Remarkable [ ] Slight	–		
[ ] Railing(Parapet)	[ ] Steel	Rs	[ ] (5)Rupture	–	[ ] Detected –	–		
			[ ] (6)Paint Deterioration	–	[ ] Come Off [ ] Colour Changed	[ ] Widely [ ] Locally		
			[ ] (26)Deformation	–	[ ] Remarkable [ ] Slight	–		
	[ ] Concrete	Rc	[ ] (32)Defect(Section Loss)	–	[ ] Remarkable [ ] Slight	–		
[ ] Pavement	[ ] Asphalt	Pm	[ ] (17)Pot-Hole	–	[ ] Remarkable [ ] Slight	[ ] Widely [ ] Locally		
			[ ] (19)Rutting	–	[ ] Remarkable [ ] Slight	–		
	[ ] Concrete		[ ] (28)Settlement(Br. Approach)	–	[ ] Remarkable [ ] Slight	–		
			[ ] (32)Defect (Piping failure)	–	[ ] Remarkable [ ] Slight	–		
[ ] Expansion Joint	[ ] Steel	Js	[ ] (5)Rupture	–	[ ] Detected –	–		
			[ ] (15)Abnormal Spacing / Crack	–	[ ] Detected –	–		
			[ ] (16)Difference in Level	–	[ ] Remarkable [ ] Slight	–		
			[ ] (22)Water Leak	–	[ ] Detected –	–		
			[ ] (23)Abnormal Noise	–	[ ] Detected –	–		
	[ ] Rubber	Jr	[ ] (26)Deformation	–	[ ] Remarkable [ ] Slight	–		
			[ ] (27)Sediement/Vegetation	–	[ ] Remarkable [ ] Slight	–		
			[ ] (32)Defect(Damaged Nosing)	–	[ ] Remarkable [ ] Slight	–		
[ ] River Bank		Rb	[ ] (27)Vegetation	–	[ ] Remarkable [ ] Slight	–		
			[ ] (32)Defect(Illegal Disposal /Shack/Pen)	–	[ ] Remarkable [ ] Slight	–		
			[ ] (33)Erosion	–	[ ] Remarkable [ ] Slight	–		

ANNEX - C
STRUCTURAL CONDITION CHECKLIST DURING PERIODICAL INSPECTION

STRUCTURAL CONDITION CHECKLIST DURING PERIODICAL INSPECTION

KEY : _____ NAME OF BRIDGE/RIVER : _____ STATE : _____ DISTRICT : _____ SPAN NO. : _____

NO 1. SUPERSTRUCTURE (CONCRETE BEAM/GIRDER,DECK AND BEARING)

	MATERIAL	MEMBER	CODE	TYPE OF DAMAGES	PATTERNS (X)	DEPTH (Y)	EXTENTIONS (Z)	RATING OF DAMAGE	RATING OF MEMBER	RATING OF PART
[ ] * BEAM/GIRDER	CONCRETE	Main [ ] Girder* (Main Structure)	Mc	[ ] (7) Crack	[ ] Critical [ ] Uncritical	[ ] Wide Line [ ] Hair Line	[ ] Interval<50 cm [ ] Interval>50 cm			
				[ ] (8) Flaking,Rebar exposure	–	[ ] Rebar Corroded [ ] Flaking Only	[ ] Damaged Area>0.1 sq.m [ ] Damage Area<0.1 sq.m			
				[ ] (9) Free Lime	–	–	[ ] Damaged Area>0.1 sq.m [ ] Damage Area<0.1 sq.m			
				[ ] (21) Deterioration	–	–	[ ] Widely [ ] Locally			
				[ ] (22) Water Leak	–	[ ] Detected	–			
				[ ] (24) Abnormal Vibration	–	[ ] Detected	–			
				[ ] (25) Abnormal Reflection	–	[ ] Detected	–			
				[ ] (32) Defect (Section Loss)	–	[ ] Remarkable [ ] Slight	–			
		Cross [ ] Beam*	Cc	[ ] (7) Crack	[ ] Critical [ ] Uncritical	[ ] Wide Line [ ] Hair Line	[ ] Interval<50 cm [ ] Interval>50 cm			
				[ ] (8) Flaking,Rebar exposure	–	[ ] Rebar Corroded [ ] Flaking Only	[ ] Damaged Area>0.1 sq.m [ ] Damage Area<0.1 sq.m			
				[ ] (9) Free Lime	–	–	[ ] Damaged Area>0.1 sq.m [ ] Damage Area<0.1 sq.m			
				[ ] (21) Deterioration	–	–	[ ] Widely [ ] Locally			
				[ ] (22) Water Leak	–	[ ] Detected	–			
				[ ] (32) Defect (Section Loss)	–	[ ] Remarkable [ ] Slight	–			
		Stringer* [ ]	Sc	[ ] (7) Crack	[ ] Critical [ ] Uncritical	[ ] Wide Line [ ] Hair Line	[ ] Interval<50 cm [ ] Interval>50 cm			
				[ ] (8) Flaking,Rebar exposure	–	[ ] Rebar Corroded [ ] Flaking Only	[ ] Damaged Area>0.1 sq.m [ ] Damage Area<0.1 sq.m			
				[ ] (9) Free Lime	–	–	[ ] Damaged Area>0.1 sq.m [ ] Damage Area<0.1 sq.m			
				[ ] (21) Deterioration	–	–	[ ] Widely [ ] Locally			
				[ ] (22) Water Leak	–	[ ] Detected	–			
				[ ] (32) Defect (Section Loss)	–	[ ] Remarkable [ ] Slight	–			
[ ] * DECK		Deck [ ] Slab*	Dc	[ ] (8) Flaking,Rebar exposure	–	[ ] Rebar Corroded [ ] Flaking Only	[ ] Damaged Area>0.1 sq.m [ ] Damage Area<0.1 sq.m			
				[ ] (9) Free Lime	–	–	[ ] Damaged Area>0.1 sq.m [ ] Damage Area<0.1 sq.m			
				[ ] (12) Slipping Off	–	[ ] Detected	–			
				[ ] (14) Cracks	[ ] 2 ways [ ] 1 way	[ ] Rust Liquid [ ] Water Leak [ ] Crack Only	[ ] Interval<50 cm [ ] Interval>50 cm			
				[ ] (21) Deterioration	–	–	[ ] Widely [ ] Locally			
				[ ] (22) Water Leak	–	[ ] Detected	–			
[ ] * BEARING	STEEL	Main [ ] Body*	Bs	[ ] (1) Corrosion	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally			
				[ ] (4) Falling Off (B/R)	–	–	[ ] Many [ ] Few			
				[ ] (5) Rupture	–	[ ] Detected	–			
				[ ] (6) Paint Deterioration	–	[ ] Came Off [ ] Colour Changed	[ ] Widely [ ] Locally			
				[ ] (22) Ponding Water	–	[ ] Detected	–			
				[ ] (27) Sediment/Vegetation	–	[ ] Remarkable [ ] Slight	–			
				[ ] (28) Settlement	–	[ ] Remarkable [ ] Slight	–			
	RUBBER	Pad* [ ]	Br	[ ] (22) Ponding Water	–	[ ] Detected	–			
				[ ] (26) Deformation	–	[ ] Remarkable [ ] Slight	–			
				[ ] (27) Sediment/Vegetation	–	[ ] Remarkable [ ] Slight	–			
				[ ] (32) Defect (Section Loss)	–	[ ] Remarkable [ ] Slight	–			
	STEEL	Anchor Bolt* [ ]	Ba	[ ] (1) Corrosion	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally			
				[ ] (2) Cracks	–	[ ] Detected	–			
				[ ] (4) Falling Off (B/R)	–	–	[ ] Many [ ] Few			
				[ ] (5) Rupture	–	[ ] Detected	–			
				[ ] (26) Deformation	–	[ ] Remarkable [ ] Slight	–			

Simple Diagram of Span Arrangement (To provide Span No. & Pier No.(P) in case of Multi span bridge)

To( )----------To( )

(A1) (A2)

Note: Member with * and without * is main member and secondary member respectively

Field Notes :

STRUCTURAL CONDITION CHECKLIST DURING PERIODICAL INSPECTION

KEY :_____ NAME OF BRIDGE/RIVER :_____ STATE :_____ DISTRICT :_____ SPAN NO.:_____

NO 2. SUPERSTRUCTURE (STEEL,BEAM/GIRDER,DECK AND BEARING)

	MATERIAL	MEMBER	CODE	TYPE OF DAMAGES	PATTERNS (X)	DEPTH (Y)	EXTENTIONS (Z)	RATING OF DAMAGE	RATING OF MEMBER	RATING OF PART
[ ] * BEAM/GIRDER	STEEL	Main [ ] Girder* (Main Structure)	Ms	[ ] (1) Corrosion/Lamination	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally			
				[ ] (2) Cracks	–	[ ] Detected	–			
				[ ] (4) Falling Off(B/R)	–	–	[ ] Many [ ] Few			
				[ ] (5) Rupture	–	[ ] Detected	–			
				[ ] (6) Paint Deterioration	–	[ ] Came Off [ ] Colour Changed	[ ] Widely [ ] Locally			
				[ ] (23) Abnormal Noise	–	[ ] Detected	–			
				[ ] (24) Abnormal Vibration	–	[ ] Detected	–			
				[ ] (25) Abnormal Deflection	–	[ ] Detected	–			
				[ ] (26) Deformation/Buckling	–	[ ] Remarkable [ ] Slight	–			
		Cross [ ] Beam* (Sway Bracing)	Cs Sw	[ ] (1) Corrosion/Lamination	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally			
				[ ] (2) Cracks/Rapture	–	[ ] Detected	–			
				[ ] (6) Paint Deterioration	–	[ ] Came Off [ ] Colour Changed	[ ] Widely [ ] Locally			
				[ ] (26) Deformation/Buckling	–	[ ] Remarkable [ ] Slight	–			
		Stringer* [ ]	Ss	[ ] (1) Corrosion/Lamination	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally			
				[ ] (2) Cracks/Rapture	–	[ ] Detected	–			
				[ ] (6) Paint Deterioration	–	[ ] Came Off [ ] Colour Changed	[ ] Widely [ ] Locally			
				[ ] (26) Deformation/Buckling	–	[ ] Remarkable [ ] Slight	–			
		Lateral [ ] Bracing*	Lb	[ ] (1) Corrosion/Lamination	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally			
				[ ] (2) Cracks/Rapture	–	[ ] Detected	–			
				[ ] (6) Paint Deterioration	–	[ ] Came Off [ ] Colour Changed	[ ] Widely [ ] Locally			
				[ ] (26) Deformation/Buckling	–	[ ] Remarkable [ ] Slight	–			
[ ] * DECK	STEEL	Buckle [ ] Plate	Ds	[ ] (1) Corrosion/Lamination	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally			
				[ ] (2) Cracks/Rapture	–	[ ] Detected	–			
				[ ] (4) Falling Off(B/R)	–	–	[ ] Many [ ] Few			
				[ ] (6) Paint Deterioration	–	[ ] Came Off [ ] Colour Changed	[ ] Widely [ ] Locally			
				[ ] (22) Water Leak	–	[ ] Detected	–			
				[ ] (26) Deformation	–	[ ] Remarkable [ ] Slight	–			
	CONCRETE	Deck [ ] Slab*	Dc	[ ] (8) Flaking,Rebar exposure	–	[ ] Rebar Corroded [ ] Flaking Only	[ ] Area>0.1 sq.m [ ] Area<0.1 sq.m			
				[ ] (9) Free Lime	–	–	[ ] Area>0.1 sq.m [ ] Area<0.1 sq.m			
				[ ] (12) Slipping Off	–	[ ] Detected	–			
				[ ] (14) Cracks	[ ] 2 ways [ ] 1 way	[ ] Rust Liquid [ ] Water Leak [ ] Crack Only	[ ] Interval<50 cm [ ] Interval> 50cm			
				[ ] (21) Deterioration	–	–	[ ] Widely [ ] Locally			
				[ ] (22) Water Leak	–	[ ] Detected	–			
[ ] * BEARING	STEEL	Main [ ] Body*	Bs	[ ] (1) Corrosion	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally			
				[ ] (4) Falling Off (B/R)	–	–	[ ] Many [ ] Few			
				[ ] (5) Rupture	–	[ ] Detected	–			
				[ ] (6) Paint Deterioration	–	[ ] Came Off [ ] Colour Changed	[ ] Widely [ ] Locally			
				[ ] (22) Ponding Water	–	[ ] Detected	–			
				[ ] (27) Sediment/Vegetation	–	[ ] Remarkable [ ] Slight	–			
				[ ] (28) Settlement	–	[ ] Detected	–			
	RUBBER	Pad* [ ]	Br	[ ] (22) Ponding Water	–	[ ] Detected	–			
				[ ] (26) Deformation	–	[ ] Remarkable [ ] Slight	–			
				[ ] (27) Sediment/Vegetation	–	[ ] Remarkable [ ] Slight	–			
				[ ] (32) Defect(Section Loss)	–	[ ] Remarkable [ ] Slight	–			
	STEEL	Anchor Bolt* [ ]	Ba	[ ] (1) Corrosion	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally			
				[ ] (2) Cracks	–	[ ] Detected	–			
				[ ] (4) Falling Off (B/R)	–	–	[ ] Many [ ] Few			
				[ ] (5) Rupture	–	[ ] Detected	–			
				[ ] (26) Deformation	–	[ ] Remarkable [ ] Slight	–			

Simple Diagram of Span Arrangement (To provide Span No. & Pier No. in case of multi span bridge)

To ( ) ---------- To ( )
(A1) (A2)

Note: Member with * and without * is main member and secondary member respectively

Field Notes:

STRUCTURAL CONDITION CHECKLIST DURING PERIODICAL INSPECTION

KEY :_____ NAME OF BRIDGE/RIVER :_____ ABUTMENT/PIER NUMBER :_____

NO 3. SUBSTRUCTURE (ABUTMENT & PIER)

	MATERIAL	MEMBER	CODE	TYPE OF DAMAGES	PATTERNS (X)	DEPTH (Y)	EXTENTIONS (Z)	RATING OF DAMAGE	RATING OF MEMBER	RATING OF PART
[ ] * ABUTMENT	CONCRETE	Body [ ]	Ac	[ ] (7)Crack	[ ] Critical [ ] Uncritical	[ ] Wide Line [ ] Hair Line	[ ] Interval<50 cm [ ] Interval>50 cm			
				[ ] (8)Flaking,Rebar exposure	–	[ ] Rebar Corroded [ ] Flaking Only	[ ] Damaged Area>1.0 sq.m [ ] Damage Area<1.0 sq.m			
				[ ] (9)Free Lime	–	–	[ ] Damaged Area>1.0 sq.m [ ] Damage Area<1.0 sq.m			
				[ ] (11)Wear/Erosion	–	[ ] Up to rebar [ ] Covering Only	[ ] Damaged Area>1.0 sq.m [ ] Damage Area<1.0 sq.m			
				[ ] (21)Deterioration	–	–	[ ] Widely [ ] Locally			
				[ ] (22)Water Leak	–	[ ] Detected	–			
				[ ] (30)Dip	–	[ ] Remarkable [ ] Slight	–			
		Founda–tion [ ]	Fc	[ ] (28)Settlement	–	[ ] Remarkable [ ] Slight	–			
				[ ] (29)Abnormal Movement	–	[ ] Remarkable [ ] Slight	–			
				[ ] (31)Scouring	[ ] Direct [ ] Pile,Caisson	[ ] Remarkable [ ] Slight	–			
				[ ] (33)Erosion	–	[ ] Remarkable [ ] Slight	–			
[ ] * PIER		Body [ ]	Pc	[ ] (7)Crack	[ ] Critical [ ] Uncritical	[ ] Wide Line [ ] Hair Line	[ ] Interval<50 cm [ ] Interval>50 cm			
				[ ] (8)Flaking,Rebar exposure	–	[ ] Rebar Corroded [ ] Flaking Only	[ ] Damaged Area>1.0 sq.m [ ] Damage Area<1.0 sq.m			
				[ ] (9)Free Lime	–	–	[ ] Damaged Area>1.0 sq.m [ ] Damage Area<1.0 sq.m			
				[ ] (11)Wear/Erosion	–	[ ] Up to rebar [ ] Covering Only	[ ] Damaged Area>1.0 sq.m [ ] Damage Area<1.0 sq.m			
				[ ] (21)Deterioration	–	–	[ ] Widely [ ] Locally			
				[ ] (22)Water Leak	–	[ ] Detected	–			
				[ ] (30)Dip	–	[ ] Remarkable [ ] Slight	–			
		Founda–tion [ ]	Fc	[ ] (28)Settlement	–	[ ] Remarkable [ ] Slight	–			
				[ ] (29)Abnormal Movement	–	[ ] Remarkable [ ] Slight	–			
				[ ] (31)Scouring	[ ] Direct [ ] Pile,Caisson	[ ] Remarkable [ ] Slight	–			
				[ ] (33)Erosion	–	[ ] Remarkable [ ] Slight	–			
[ ] * ABUTMENT	STEEL	Body [ ]	As	[ ] (1)Corrosion	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally			
				[ ] (2)Cracks/Rapture	–	[ ] Detected	–			
				[ ] (4)Falling Off (B/R)	–	–	[ ] Many [ ] Few			
				[ ] (6)Paint Deterioration	–	[ ] Came Off [ ] Colour Changed	[ ] Widely [ ] Locally			
				[ ] (23)Abnormal Noise	–	[ ] Detected	–			
				[ ] (26)Deformation	–	[ ] Remarkable [ ] Slight	–			
				[ ] (30)Dip	–	[ ] Remarkable [ ] Slight	[ ] Widely [ ] Locally			
		Founda–tion [ ]	Fs	[ ] (28)Settlement	–	[ ] Remarkable [ ] Slight	–			
				[ ] (31)Scouring	–	[ ] Remarkable [ ] Slight	–			
				[ ] (33)Erosion	[ ] Direct [ ] Pile,Caisson	[ ] Remarkable [ ] Slight	–			
[ ] * PIER		Body [ ]	Ps	[ ] (1)Corrosion	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally			
				[ ] (2)Cracks/Rapture	–	[ ] Detected	–			
				[ ] (4)Falling Off (B/R)	–	–	[ ] Many [ ] Few			
				[ ] (6)Paint Deterioration	–	[ ] Came Off [ ] Colour Changed	[ ] Widely [ ] Locally			
				[ ] (23)Abnormal Noise	–	[ ] Detected	–			
				[ ] (26)Deformation	–	[ ] Remarkable [ ] Slight	–			
				[ ] (30)Dip	–	[ ] Remarkable [ ] Slight	[ ] Widely [ ] Locally			
		Founda–tion [ ]	Fs	[ ] (28)Settlement	–	[ ] Remarkable [ ] Slight	–			
				[ ] (31)Scouring	–	–	[ ] Remarkable [ ] Slight			
				[ ] (33)Erosion	[ ] Direct [ ] Pile,Caisson	–	[ ] Remarkable [ ] Slight			

Note: Member with * and without * is main member and secondary member respectively

Field Notes :

STRUCTURAL CONDITION CHECKLIST DURING PERIODICAL INSPECTION

KEY :_______________ NAME OF BRIDGE/RIVER:_________________

NO 4. WING WALL

	MATERIAL	MEMBER	CODE	TYPE OF DAMAGES	PATTERNS (X)	DEPTH (Y)	EXTENTIONS (Z)	RATING OF DAMAGE	RATING OF MEMBER	RATING OF PART
[ ] WING WALL	CONCRETE		Ww	[ ] (7)Crack	[ ] Critical [ ] Uncritical	[ ] Wide Line [ ] Hair Line	[ ] Interval<50 cm [ ] Interval>50 cm			
				[ ] (8)Flaking,Rebar exposure	–	[ ] Rebar Corroded [ ] Flaking Only	[ ] Damaged Area>1 sq.m [ ] Damage Area<0.1 sq.m			
				[ ] (9)Free Lime	–	–	[ ] Damaged Area>1 sq.m [ ] Damage Area<0.1 sq.m			
				[ ] (21)Deterioration	–	–	[ ] Widely [ ] Locally			
				[ ] (28)Settlement	–	[ ] Remarkable [ ] Slight	–			
				[ ] (29)Abnormal Movement	–	[ ] Remarkable [ ] Slight	–			
				[ ] (30)Dip	–	[ ] Remarkable [ ] Slight	–			
				[ ] (32)Defect(Section Loss)	–	[ ] Remarkable [ ] Slight	–			
			Ww	[ ] (7)Crack	[ ] Critical [ ] Uncritical	[ ] Wide Line [ ] Hair Line	[ ] Interval<50 cm [ ] Interval>50 cm			
				[ ] (8)Flaking,Rebar exposure	–	[ ] Rebar Corroded [ ] Flaking Only	[ ] Damaged Area>1 sq.m [ ] Damage Area<0.1 sq.m			
				[ ] (9)Free Lime	–	–	[ ] Damaged Area>1 sq.m [ ] Damage Area<0.1 sq.m			
				[ ] (21)Deterioration	–	–	[ ] Widely [ ] Locally			
				[ ] (28)Settlement	–	[ ] Remarkable [ ] Slight	–			
				[ ] (29)Abnormal Movement	–	[ ] Remarkable [ ] Slight	–			
				[ ] (30)Dip	–	[ ] Remarkable [ ] Slight	–			
				[ ] (32)Defect(Section Loss)	–	[ ] Remarkable [ ] Slight	–			
				[ ] (7)Crack	[ ] Critical [ ] Uncritical	[ ] Wide Line [ ] Hair Line	[ ] Interval<50 cm [ ] Interval>50 cm			
				[ ] (8)Flaking,Rebar exposure	–	[ ] Rebar Corroded [ ] Flaking Only	[ ] Damaged Area>1 sq.m [ ] Damage Area<0.1 sq.m			
			Ww	[ ] (9)Free Lime	–	–	[ ] Damaged Area>1 sq.m [ ] Damage Area<0.1 sq.m			
				[ ] (21)Deterioration	–	–	[ ] Widely [ ] Locally			
				[ ] (28)Settlement	–	[ ] Remarkable [ ] Slight	–			
				[ ] (29)Abnormal Movement	–	[ ] Remarkable [ ] Slight	–			
				[ ] (30)Dip	–	[ ] Remarkable [ ] Slight	–			
				[ ] (32)Defect(Section Loss)	–	[ ] Remarkable [ ] Slight	–			
				[ ] (7)Crack	[ ] Critical [ ] Uncritical	[ ] Wide Line [ ] Hair Line	[ ] Interval<50 cm [ ] Interval>50 cm			
				[ ] (8)Flaking,Rebar exposure	–	[ ] Rebar Corroded [ ] Flaking Only	[ ] Damaged Area>1 sq.m [ ] Damage Area<0.1 sq.m			
			Ww	[ ] (9)Free Lime	–	–	[ ] Damaged Area>1 sq.m [ ] Damage Area<0.1 sq.m			
				[ ] (21)Deterioration	–	–	[ ] Widely [ ] Locally			
				[ ] (28)Settlement	–	[ ] Remarkable [ ] Slight	–			
				[ ] (29)Abnormal Movement	–	[ ] Remarkable [ ] Slight	–			
				[ ] (30)Dip	–	[ ] Remarkable [ ] Slight	–			
				[ ] (32)Defect(Section Loss)	–	[ ] Remarkable [ ] Slight	–			

Note: Member with * and without * is main member and secondary member respectively

Field Notes :

STRUCTURAL CONDITION CHECKLIST DURING PERIODICAL INSPENTION

KEY :_____ NAME OF BRIDGE/RIVER:_____

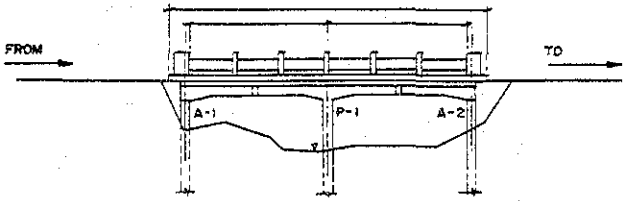
NO 5. ACCESSARIES AND RIVER BANK PROTECTION

	MATERIAL	MEMBER	CODE	TYPE OF DAMAGES	PATTERNS (X)	DEPTH (Y)	EXTENTIONS (Z)	RATING OF DAMAGE	RATING OF MEMBER	RATING OF PART
[ ] RAILING	STEEL [ ]	Railing	Rs	[ ] (1)Corrosion	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally			
				[ ] (7)Crack	–	[ ] Detected	–			
				[ ] (4)Falling Off (B/R)	–	–	[ ] Many [ ] Few			
				[ ] (5)Rupture	–	[ ] Detected	–			
				[ ] (6)Paint Deterioration	–	[ ] Came Off [ ] Colour Changed	[ ] Widely [ ] Locally			
				[ ] (26)Deformation	–	[ ] Remarkable [ ] Slight	–			
	CONCRETE [ ]		Rc	[ ] (7)Crack	[ ] Critical [ ] Uncritical	[ ] Wide Line [ ] Hair Line	[ ] Interval<50 cm [ ] Interval>50 cm			
				[ ] (8)Flaking,Rebar exposure	–	[ ] Rebar Corroded [ ] Flaking Only	[ ] Damaged Area>1 sq.m [ ] Damage Area<1 sq.m			
				[ ] (9)Free Lime	–	–	[ ] Damaged Area>1 sq.m [ ] Damage Area<1 sq.m			
				[ ] (32)Defect(Section Loss)	–	[ ] Remarkable [ ] Slight	–			
[ ] PAVEMENT	[ ] ASPHALT	Pavement	Pa	[ ] (17)Pot–Hole	–	[ ] Depth> 50 mm [ ] 10<Depth<50 mm	[ ] Dia >20 cm [ ] Dia < 20 cm			
				[ ] (18)Cracks	–	[ ] Width> 5 mm [ ] Width< 5 mm	–			
				[ ] (19)Rutting	–	[ ] Diff > 30 mm [ ] 20 mm<Diff<30 mm	–			
				[ ] (28)Settlement(Br. Approach)	–	[ ] Diff > 30 mm [ ] 20 mm<Diff<30 mm	–			
	CONCRETE [ ]		Pc	[ ] (17)Pot–Hole	–	[ ] Depth> 50 mm [ ] 10<Depth<50 mm	[ ] Dia >20 cm [ ] Dia < 20 cm			
				[ ] (18)Cracks	–	[ ] Width> 5 mm [ ] Width< 5 mm	–			
				[ ] (19)Rutting	–	[ ] Diff > 30 mm [ ] 20 mm<Diff<30 mm	–			
				[ ] (28)Settlement(Br. Approach)	–	[ ] Diff > 30 mm [ ] 20 mm<Diff<30 mm	–			
[ ] JOINT	STEEL [ ]	Expansion Joint	Js	[ ] (1)Corrosion	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally			
				[ ] (7)Crack	–	[ ] Detected	–			
				[ ] (4)Falling Off (B/R)	–	–	[ ] Many [ ] Few			
				[ ] (5)Rupture	–	[ ] Detected	–			
				[ ] (15)Abnormal Space	–	[ ] Detected	–			
				[ ] (16)Diff in Level	–	[ ] Diff > 20 mm [ ] 10 mm<Diff<20 mm	–			
				[ ] (22)Water Leak	–	[ ] Detected	–			
				[ ] (23)Abnormal Noise	–	[ ] Detected	–			
				[ ] (26)Deformation	–	[ ] Remarkable [ ] Slight	–			
	RUBBER [ ]		Jr	[ ] (1)Corrosion	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally			
				[ ] (5)Rupture	–	[ ] Detected	–			
				[ ] (15)Abnormal Space	–	[ ] Detected	–			
				[ ] (16)Diff in Level	–	[ ] Diff > 20 mm [ ] 10 mm<Diff<20 mm	–			
				[ ] (22)Water Leak	–	[ ] Detected	–			
				[ ] (23)Abnormal Noise	–	[ ] Detected	–			
				[ ] (26)Deformation	–	[ ] Remarkable [ ] Slight	–			
[ ] DRN	STEEL [ ] PVC [ ]	Drainage	Dr	[ ] (1)Corrosion	–	[ ] Section Loss [ ] Surface Rust	[ ] Widely [ ] Locally			
				[ ] (22)Water Leak	–	[ ] Detected	–			
				[ ] (27)Sediment/Vegetation	–	[ ] Remarkable [ ] Slight	–			
							–			
[ ] BANK		River Bank Protection	Rb	[ ] (31)Scouring	[ ] Direct [ ] Pile,Caisson	[ ] Remarkable [ ] Slight	–			
				[ ] (33)Erosion	–	[ ] Remarkable [ ] Slight	–			
							–			

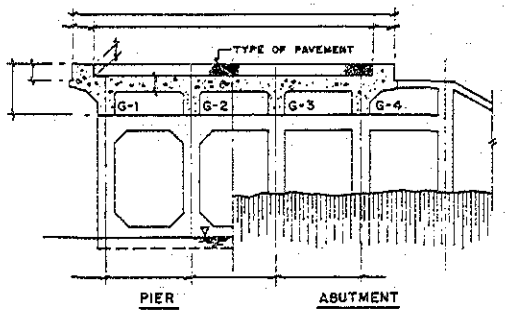
Note: Member with * and without * is main member and secondary member respectively

Field Notes :

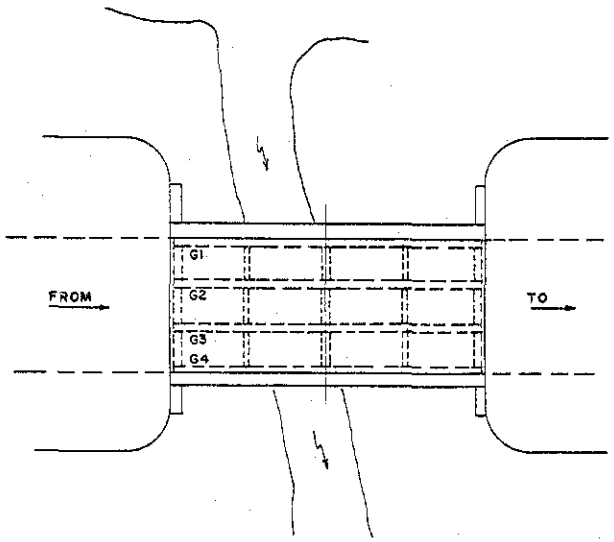
ANNEX - D
STANDARD DRAWING FORMS
ON DETAILED INSPECTION



PROFILE



CROSS SECTION



PLAN VIEW

BRIDGE DATA :

KEY NO. :	1/149/20		
STATE :	JOHOR		
DISTRICT :	SEGAMAT		
DESIGN LIVE LOAD :	H.A. LOADING		
MATERIAL YIELD STRENGTH	CONCRETE	SUPERSTRUCTURE :	DECK : 18 N/mm² BEAM : 14 N/mm²
		SUBSTRUCTURE :	11 N/m²
	STEEL	REBAR :	23 N/mm²
TYPE OF SUPERSTRUCTURE	R.C. BEAM W/R.C. SLAB		
TYPE OF SUBSTRUCTURE	ABUTMENT	R.C. PILE + CROSS HEAD	
	PIER	R.C. PILE + CROSS HEAD	
YEAR BUILT	1955 (ESTIMATED)		

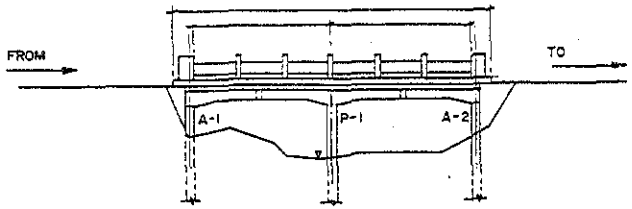
NOTE : UNIT SHALL BE IN MILLIMETER.
: MEMBER NUMBERING / NAMING PROCEDURE

1) NUMBERING / NAMING OF ABUTMENT, PIER, BEAM, ETC. ALWAYS BEGINS AT ORGIN SIDE (LOWER MILEAGE SIDE) OF THE BRIDGE.

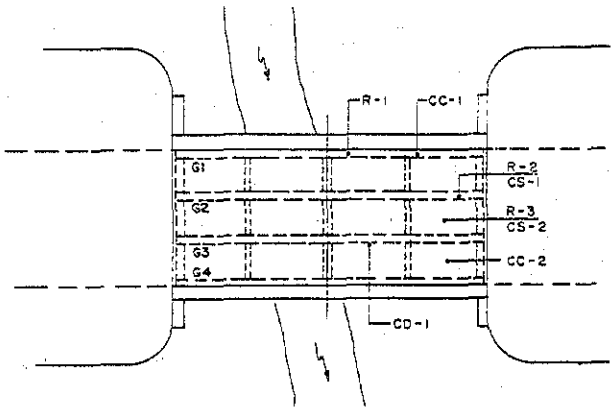
2) NUMBERING / NAMING OF DECK SLAB, BEAM ETC. ALWAYS BEGIN ON THE LEFT HAND SIDE DEFINED WITH ONE FACING TOWARDS HIGHE MILEAGE SIDE OF THE BRIDGE.

STANDARD DRAWING OF GENERAL VIEW

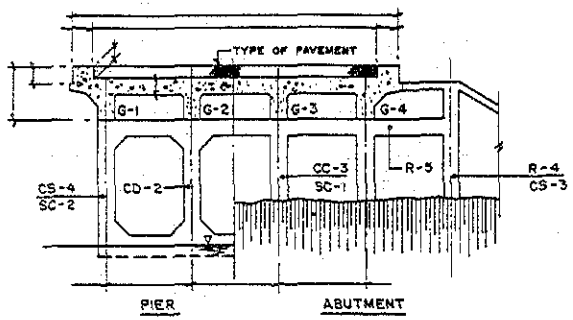
D-1



PROFILE

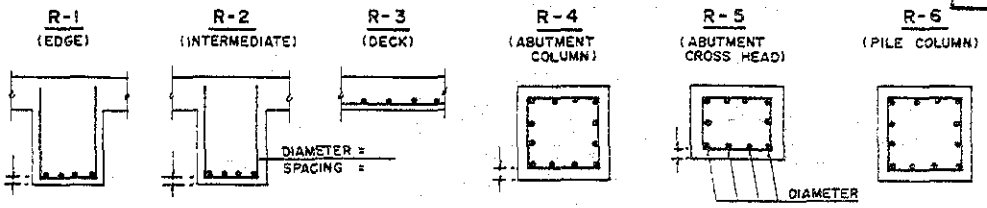


PLAN VIEW



CROSS SECTION

REBAR SPACING, DIAMETER AND CONCRETE COVER MEASUREMENT



NUMBER OF MEASUREMENT POINTS BY PROFORMETER PER EACH DIFFERENT SPAN※1

MEMBER	NO'S POINT	LOCATION
BEAM	2	CENTER OF SPAN ON THE EDGE AND INTERMEDIATE BEAMS
DECK	1	CENTER OF DECK SPAN
ABUTMENT	2~3	ONE POINT PER EACH MEMBER (COLUMN AND CROSSHEAD)
PIER	2~3	ONE POINT PER EACH MEMBER (COLUMN AND CROSSHEAD)

※1) IF SHEAR CRACK IS DETECTED AT WEB ON A BEAM, REBAR SPACING AND THE DIAMETER AT THE LOCATION SHALL BE MEASURED.

CONCRETE STRENGTH※5

NO.	MEMBER	C.S.※2	U.P.V.※3	S.H.※4
CS-1	G-2			
CS-2	DECK			
CS-3	A-1 COLUMN			
CS-4	P-1 COLUMN			

※2) CORE SAMPLING
※3) ULTRASONIC PULSE VELOCITY
※4) SCHMIDT HAMMER

CARBONATION DEPTH※5

NO.	MEMBER	DEPTH
CD-1	G-3	
CD-2	P-1 COLUMN	

CHLORIDE CONTENT※5

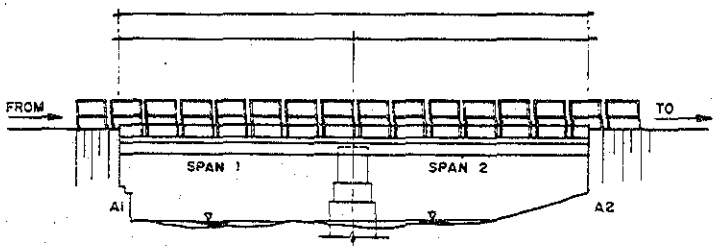
NO.	MEMBER	DEPTH		
		0-20	21-40	41-60
CC-1	G-1			
CC-2	DECK			
CC-3	A-1 COLUMN			

SULPHATE CONTENT※5

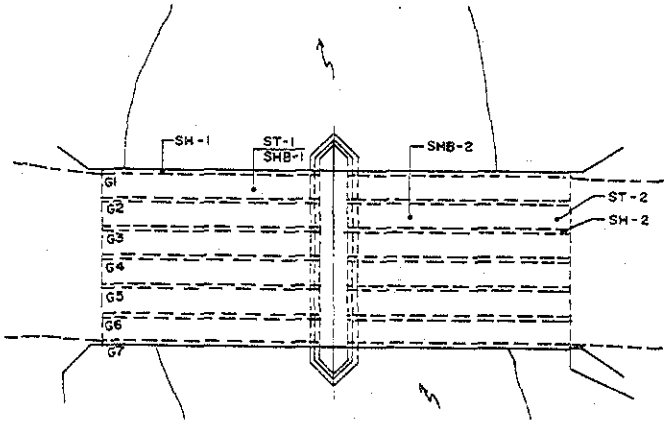
NO.	MEMBER	DEPTH		
		0-20	21-40	41-60
SC-1	A-1 COLUMN			
SC-2	P-1 COLUMN			

※5 NUMBER OF MEASUREMENT POINTS IS DEPENDING ON DETERIORATION DEGREE.

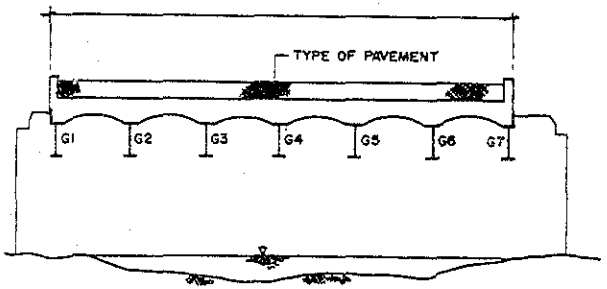
STANDARD DRAWING OF STRENGTH AND DETAILED MEASUREMENT FOR CONCRETE GIRDER



PROFILE



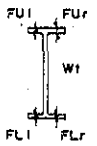
PLAN VIEW

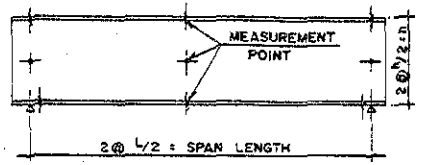


CROSS SECTION (BUCKLE PLATE)

STEEL THICKNESS

BEAM





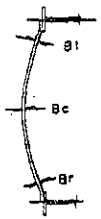
MEASUREMENT LOCATION

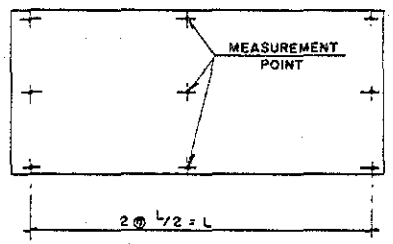
3 BEAMS PER A BRIDGE SPAN
(BOTH EDGE BEAMS AND ONE OF THE INTERMEDIATE BEAMS)

STEEL THICKNESS FOR BEAM

MEMBER	POINT	0	L/2	L
G-1	FU1			
	FUr			
	Wt			
	FL1			
	FLr			
G-2	FU1			
	FUr			
	Wt			
	FL1			

BUCKLE PLATE





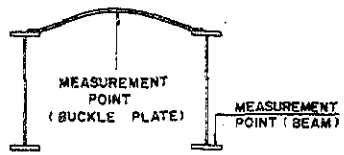
MEASUREMENT LOCATION

2 PANELS PER A BRIDGE SPAN

STEEL THICKNESS FOR BUCKLE PLATE

MEMBER	POINT	0	L/2	L
ST-1	Bl			
	Bc			
	Br			
ST-2	Bl			
	Bc			
	Br			
	Bl			

STEEL HARDNESS / STRENGTH



MEASUREMENT LOCATION

2 POINTS PER A BRIDGE SPAN

BUCKLE PLATE

NO.	HARDNESS	STRENGTH
SHB-1		
SHB-2		

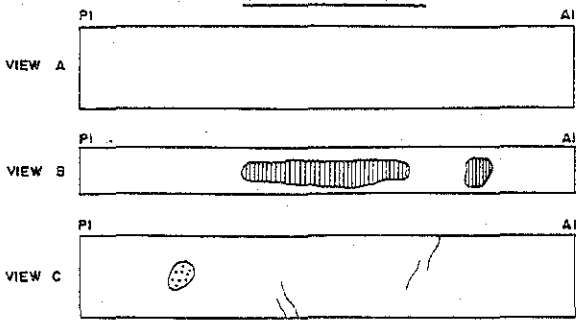
BEAM

NO.	LOCATION	HARDNESS	STRENGTH
SH-1	G-1		
SH-2	G-3		

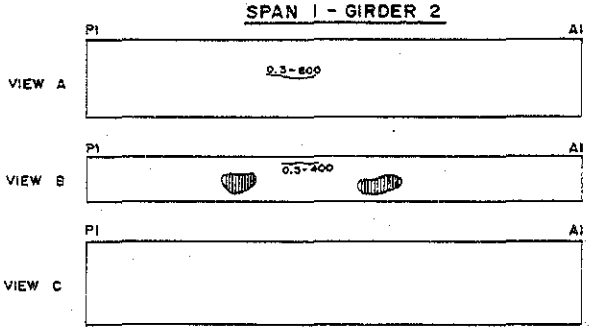
STANDARD DRAWING OF STRENGTH AND DETAILED MEASUREMENT FOR STEEL GIRDER

CRACK DIAGRAM OF GIRDERS

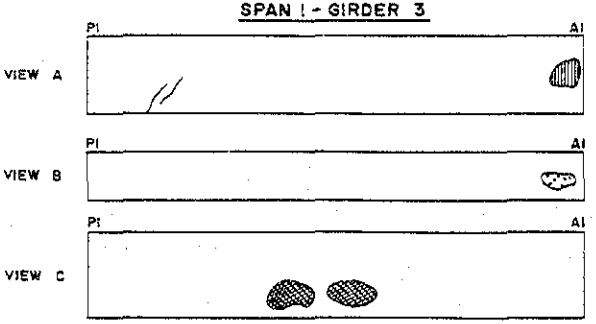
SPAN 1 - GIRDER 1

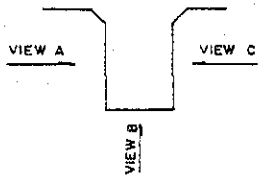


SPAN 1 - GIRDER 2

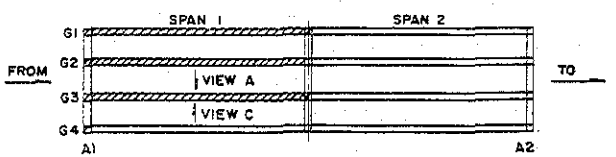


SPAN 1 - GIRDER 3





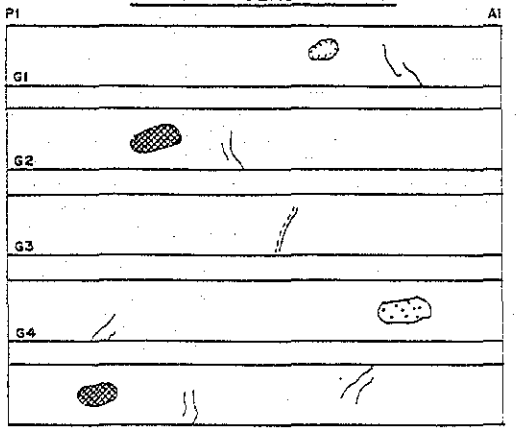
KEY MAP



NOTE : CRACK DIAGRAM OF GIRDERS INDICATED BY ▨ IS SHOWN ABOVE.

CRACK DIAGRAM OF DECK SLAB

SPAN 1 - SLAB SOFFIT



LEGEND OF DAMAGE (CONCRETE)

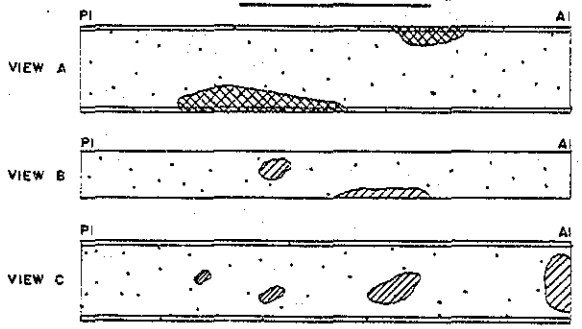
TYPE OF DAMAGES	INDICATION
CRACK *	□-○
FLACKING	
REBAR EXPOSURE	
FREE LIME	
HONEY COMB	
WEAR / EROSION	
WATER STAIN	
OTHERS	

* □ - MAXIMUM CRACK WIDTH
○ - THE LENGTH OF CRACK

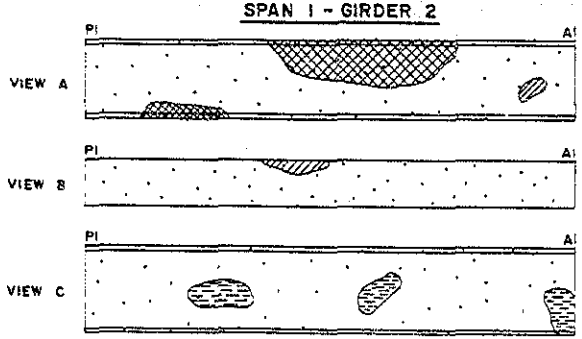
STANDARD DRAWING OF CRACK DIAGRAM FOR CONCRETE GIRDER

CORROSION DIAGRAM OF GIRDERS

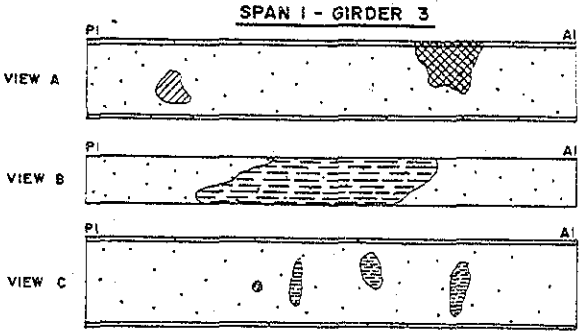
SPAN 1 - GIRDER 1

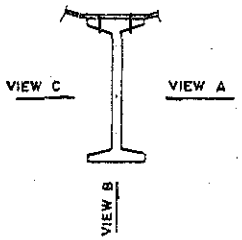


SPAN 1 - GIRDER 2



SPAN 1 - GIRDER 3





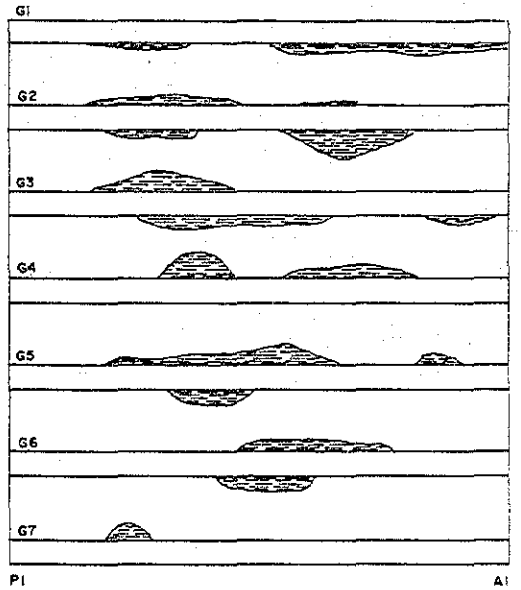
LEGEND OF DAMAGE (STEEL)

TYPE OF DAMAGES	INDICATION
CORROSION	
LAMINATION	
CRACK *	
FALLING OFF (BOLT)	× × ×
PAINT DETERIORATION	
DEFORMATION / BUCKLING	
WATER STAIN	
OTHERS	

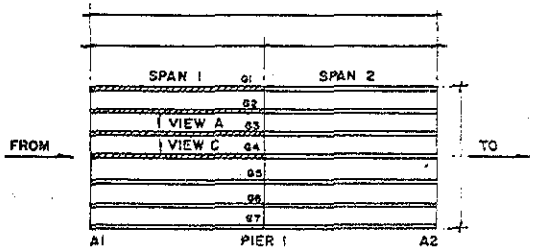
* o - THE LENGTH OF CRACK

* CORROSION DIAGRAM SHOULD BE PREPARED AT LEAST 3 SPANS.

CORROSION DIAGRAM OF BUCKLE PLATE



KEY MAP



NOTE : LOCATION OF CORROSION DIAGRAM FOR GIRDERS INDICATED BY ▨ IS SHOWN.

STANDARD DRAWING OF CORROSION DIAGRAM FOR STEEL GIRDER