FINAL REPORT

KAJIAN BAGI MENGGANTIKAN JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK - THE STRUCTURAL ASSESSMENT AND REHABILITATION OF JAMBATAN SULTAN ISKANDAR

VOLUME 1 OF 4 : MAIN REPORT

PREPARED FOR

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JULY 2015

RPT/TC/275/14/40-FinalReport - Vol 1 of 4

FINAL REPORT

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EXECUTIVE SUMMARY

1.0 APPOINTMENT OF CONSULTANT

T-Corp Engineers Sdn. Bhd. was appointed to carry out the "Structural assessment and Rehabilitation of Jambatan Sultan Iskandar along Federal Route 1 at Kuala Kangsar, Perak" from 24 November 2014 to 24 July 2015.

The team of Professional Engineers was led by Ir. Tham Kum Weng who has fourty (40) years of working experience with specialisation in structure and bridge engineering and in the engineering inspection and assessment of structures.

2.0 SCOPE OF WORKS

The basic Scope of Works covered:-

a) Preliminary study

b) Inspection and condition assessment of bridge superstructures, bridge piers and bridge abutments.

c) Bridge Capacity Assessment involving Structural Analysis & Design Check of the bridge superstructural components with respect to MTAL (Mid Term Axle Load) traffic Live Load.

d) Bridge Material & Structural Condition Assessment.

e) Preparation of "As-built Structural Details" drawings.

f) Preparation of Rehabilitation Documents which includes drawings, Bills of Quantities & Addendum Specifications.

The Organisation Chart, Work Flow Process and Work Schedule of the Study Team are as per Lampiran "A" and Lampiran "B".

3.0 BRIDGE STRUCTURE

The Bridge was built around 1932. It has seven (7) steel arch spans (longest span = 48.77m) for total length of 284.07m. The Bridge width is 10.16m for 2 lane traffic and two kerbs separated pedestrian walkways. The Bridge Deck consisted of RC Slab on transverse steel troughs.

In year 1986, the Bridge Deck superstructure was strengthened with the introduction of four (4) new 16" x 7" x 45 lb longitudinal stringers (Steel Universal Beam) to enhance the capacity of the existing 13" x 5" x 35 lb RSJ. The strengthening and rehabilitation works in year 1986 were necessitated by the extensive corrosion of the steel troughs supporting the R.C. Bridge Deck.

4.0 NOMINAL MATERIAL TESTINGS (Volume 2 of 4)

Some necessary nominal testings were carried out on the reinforced concrete (RC) components of the Bridge. There included covermeter, break-out test, coring for concrete compressive strength and carbonation test, dust samplings for determination of chloride and sulphate content in concrete.

For the steel components, the following testings were carried out:-

a) Determination of the steel strength.

b) Thickness verification of the steel components using Ultrasonic Thickness Gauge.

From the testings, the following material strength and condition were adopted for this study:-

a) Concrete Compressive Strength, fcu
   - i. Bridge Deck, *fcu* = 40N/mm^2
   - ii. Bridge Piers & Abutments, *fcu* = 25N/mm^2

b) Concrete Condition
   - i. Carbonation : Not Detected
   - ii. Chloride Content : <<0.001% by weight of concrete (Limit 0.007% Ok)
   - iii. Sulphate Content : < 3.3% by weight of cement (JKR Limit 4.0% Ok)

c) Steel Yield Strength, *fy* = 220N/mm^2

d) Steel thickness total loss due to corrosion = Maximum 5%

5.0 BRIDGE CONDITION

Overall, the Bridge was found to be in good material and structural condition. There were no observations of concrete deterioration or structural defects. Corrosion of steel sections was generally of less than 5% steel section thickness. In any case, the bridge structural integrity would not be affected as the sections tended to have more than the required minimum structural capacity.

6.0 BRIDGE CAPACITY (Volume 3 of 4)

Bridge Superstructure Components

Structural Analysis & Design Check of the bridge superstructure components were carried out with respect to MTAL traffic live load.

The assessment of the main components revealed the Bridge as designed and as-built has adequate structural capacity to sustain the MTAL traffic live load for the following main components:-

a) Bridge Deck : Concrete Slab on steel trough.

b) Bridge Deck Support : Longitudinal RSJ Members.

c) Vertical RSJ Column Members Supporting the Bridge Deck for the two (2) outer arches (i.e. Arch A & Arch D).

- Most of the Vertical RSJ Column Members Supporting the Bridge Deck for the two (2) inner arches (i.e. Arch B & Arch C) are adequate with some minor exceptions for the end columns.
- These slightly overstressed (up to 14.5 %) RSJ Columns (i.e. Steel Stresses exceeding 220N/mm^2 x 1/1.05 or 190N/mm^2) are limited to only:-

Span	RSJ Column No
1	V 10 only
2	V 12 only
3	V 1 & V 14
4	V 1 & V 15
5	V 1 & V 14
6	V 1 only
7	V 1 only

- These RSJ Column members will need to be suitably strengthened to match MTAL Loading analysis outcome.

Bridge Piers

The Mass Concrete Bridge Piers have overall adequate capacity to safely sustain the traffic Live Load.

7.0 BRIDGE REHABILITATION (Volume 4 of 4)

Suitable Structural Rehabilitation has been proposed to:-

- Ensure sustained Bridge structural material durability
- To adequately ensure several Vertical RSJ Column members as described in Para 6.0(C) are strengthened to match analysis outcome.

8.0 AS-BUILT STRUCTURAL DETAILS DRAWINGS

Fifty-Four (54) As-Built Structural Details Drawings have been produced for ease of future reference by JKR.

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1.0 INTRODUCTION

1.1 The Government of Malaysia, hereinafter referred to as "the Government", is desirous of carrying out a thorough "Structural Assessment and Rehabilitation to Jambatan Sultan Iskandar along Federal Route 1 at Kuala Kangsar, Perak" (the Bridge), hereinafter referred to as "The Study".

1.2 Jambatan Sultan Iskandar is a steel arch bridge constructed in year 1932. The Bridge crosses over Sungai Perak and has 7 spans with the longest span being 48.77 meters. The total length of the Bridge is 284.07 meters with a total width of 10.16 meters. The structural assessment and rehabilitation works are necessary to ensure sustained structural integrity of the Bridge for the years to come. The location of the existing Bridge is as per ***Appendix 1***. The typical elevation and cross-section sketches and the overall general views of the Bridge are also attached as per **Appendix 1**.

1.3 The Bridge is located on Federal Route FT001 which has been gazetted for 12-tonne single axle load as per List 1 of the Second Schedule of the Weight Restriction (Federal Roads) (Amendment) Order 2003, hereinafter referred to as WRO 2003.

1.4 **The objective of The Study is to assess the structural capacity of the Bridge for compliance with WRO 2003, including an assessment of the existing level of safety of the Bridge. The Study also includes proposal for necessary rehabilitation works in order to reinstate the structural integrity of the Bridge to its existing as-designed capacity.**

1.5 The typical elevation sketch and Bridge Cross-Section with the as-built Bridge Deck Rehabilitation/Strengthening in year 1985/1986 are also attached in **Appendix 1**. Also, photographic record of the "General Views of the Bridge" is attached for reference.

2.0 APPOINTMENT OF ENGINEERING CONSULTANCY FIRM

2.1 T-Corp Engineers Sdn Bhd, a Specialist Professional Civil and Structural Consulting Firm with focus on Engineering Inspection, Assessment and Evaluation of bridges, buildings and structures was invited by the Government (through Ibu Pejabat JKR Malaysia, Cawangan Kejuruteraan Awam, Struktur dan Jambatan: Bahagian Forensik Struktur & Jambatan) to submit a proposal (Technical and Financial) for the proposed study. The proposal of 9 December 2013 was extensively evaluated by JKR.

2.2 A Letter of Appointment ref. Bil (57) dlm.JKR.CKASJ/10.500/020/19 Jld.2 dated 4 November 2014 was issued to T-Corp Engineers Sdn Bhd. The approved time frame for The Study is eight (8) months, i.e. from 24 November 2014 to 24 July 2015.

2.3 a) The full Memorandum of Agreement (MoA) as signed by Ir Tham Kum Weng of T-Corp Engineers Sdn Bhd was forwarded to JKR on 30 January 2015 for signing by JKR.

b) The MOA was received from JKR on 2 February 2015 and sent for Stamp Duty Registration on 4 February 2015. Ten (10) copies of the MoA as signed by both parties and as stamped were returned to JKR on 11 February 2015.

2.4 The Study Report and all associated documentations are prepared by T-Corp Engineers Sdn. Bhd. Solely for the exclusive reference and applications by Jabatan Kerja Raya Malaysia.

3.0 TERM OF REFERENCE AND SCOPE OF WORKS

3.1 SCOPE OF WORKS

The following Scope of Works are:-

a) Preliminary study of all available information including available drawings for planning of access and work methodology.

b) Comprehensive inspection and condition assessment of the bridge superstructures and substructures:
- Defect mappings.
- Verification of as-built details.
- Nominal material testings.

c) Bridge Capacity Assessment

Structural analysis of the bridge superstructures and substructures with regards to MTAL loading. For superstructures, the capacities are also individually assessed for:
- Bridge deck.
- Bridge deck support RSJ.
- Vertical members supporting Bridge deck.
- The arch capacity.

d) Comprehensive Structural Assessment Report
- Engineering assessment, evaluation and recommendations.
- Design for necessary rehabilitation to reinstate the structural integrity of the Bridge to ensure continued safety and functionality.

e) Preparation of Rehabilitation Documents
- Bill of Quantities.
- Drawings.
- Addendum Specifications.

(Completion of the full Tender Documentation shall be by JKR.)

3.2 The Works also include the provisions of temporary access working platforms, scaffoldings, equipments, safety tools, etc. as required for the inspection and assessment of the Bridge.

3.3 NOMINAL MATERIAL TESTINGS

To complement The Study objective, some necessary nominal testings were be carried out on the reinforced concrete (RC) components of the Bridge (e.g. Cover meter, coring, carbonation testings, etc.) with limited testing on the steel components such as thickness verifications using Ultrasonic Thickness Gauge and the determination of the steel strength.

3.4 MAJOR STUDY COMPONENTS

Basically, the whole Study is divided into the following six (6) major assignments:-

a) Preliminary Inspection/Collection and Review of Initial Data.
b) Comprehensive Bridge Inspection.
c) Bridge Capacity Assessment.
d) Preparation of As-Built Drawings.
e) Engineering Assessment and Evaluation of the Bridge.
f) Preparation of Rehabilitation Documents.

4.0 THE CONSULTANT'S TEAM (Lampiran "A")

4.1 In order to execute the works to achieve the study objective, the organisation set-up for the various assignments is as per appendix in ***Lampiran "A"***.

4.2 The team of professional engineers was being led by Ir Tham Kum Weng who has 18 years of experience in Jabatan Kerja Raya (JKR) with six (6) years with JKR Bridge Unit and three (3) years with JKR Structure Unit and Twenty two (22) years of subsequent working experience as a practising consulting engineer. T-Corp Engineers Sdn. Bhd. commenced its professional practice since the year 2000.

5.0 WORK SCHEDULE

5.1 GENERAL WORK SCHEDULE (LAMPIRAN "B")

The general Work Schedule is as per ***Lampiran "B"***. Since the contractual work commencement date of 24 November 2014 was within the very wet season of heavy monsoon rainfall and potential flooding of the Bridge vicinity, the significant commencement of site works could only begin from 30 December 2014.

5.2 The actual percentage progress of works for each activity is as marked in the same ***Lampiran "B"***. Overall, the Study Team had adhered closely to the planned schedule for each activity of the study. The whole study, therefore, was successfully completed by 24 July 2015 as per contract stipulation.

6.0 REPORTS

In the duration of the whole study, the following reports (ten (10) copies each) have been submitted to JKR:-

6.1 Inception Report (RPT/TC/275/14/40-Inception dated 4 December 2014)
The Report was prepared and submitted within the first two (2) weeks from the contractual date of the commencement of works (i.e. 24 November 2014).

6.2 Progress Report No. 1 (RPT/TC/275/14/40-Progress No.1 dated 30 January 2015)
The Report recorded the progress of the various site works ending 31 January 2015. This includes the provision of temporary works, scaffolding, assess system and on-site measurements and verifications of structural details (eg. dimensions, thickness and size etc).

6.3 Progress Report No. 2 (RPT/TC/275/14/40-Progress No.2 dated 26 February 2015)
The Report described the further site works. This includes the complete measurements and verification of structural details, comprehensive bridge inspection and condition assessment, preliminary findings on the Bridge condition.

6.4 Progress Report No. 3 (RPT/TC/275/14/40-Progress No.3 dated 23 March 2015)
The Report presented:-

- Bridge Material Condition
- Bridge Structural Condition
- Material Testing results (Tensile Strength, Concrete Core Compressive Strength, Concrete Carbonation, Chloride and Sulphate Content, Ultrasonic Thickness Measurements on steel members, Covermeter Scanning).

6.5 Progress Report No. 4 (RPT/TC/275/14/40-Progress No.4 dated 23 May 2015)
The Report presented the outcome of the complete structural analysis and design check of the bridge superstructure component with respect to MTAL (Mid Term Axle Load) traffic live load and assessment of the effect on the bridge substructure.

6.6 Progress Report No. 5 (RPT/TC/275/14/40-Progress No.5 dated 6 June 2015)
The Report presented:-

a) A draft of the Final Report due for 24 July Submission.
b) Bridge Strengthening and Rehabilitation Works documentation comprising:-
   i. Instruction to Tenderers
   ii. Bill of Quantities
   iii. Relevant Drawings
   iv. Addendum Specifications.

6.7 Final Report
This Final Report has the complete documentation of the Study. For ease of reference, it is presented in four (4) volumes as follow:-

a) Volume 1 of 4 : Main text of overall findings.
b) Volume 2 of 4 : Factual Report on Materials Testing.
c) Volume 3 of 4 : Structural analysis and design check on the Bridge Capacity Assessment.
d) Volume 4 of 4 : Full technical documents for Rehabilitation Works.
   - Cadangan Membaikpulih & Memperkuatkan Struktur
   (Bill of Quantities, Drawings and Addendum Specifications).
e) Full sets of "As-built Structural Details" drawings are also attached.

7.0 MATERIAL TESTINGS (Volume 2 of 4 of Final Report)

7.1 The complete material testing results were previously submitted in Progress Report No. 3. Following certain useful feedback from JKR, the full description of the various test and test results are presented in Volume 2 of 4 of the Final Report.

7.2 In general, the followings are adopted for the engineering assessment and bridge capacity evaluation.

i.	Steel Yield Strength, fy	= 220 N/mm^2
ii.	Concrete Compressive Strength, fcu	
	• Bridge Deck	= 40 N/mm^2
	• Bridge Piers	= 25 N/mm^2
iii.	Concrete Carbonation	= Not detected
iv.	Concrete Chloride Content	<< 0.001% by weight of concrete. (Limit 0.007%)
v.	Sulphate content	< 0.48% by weight of concrete. (or about 3.3% by weight of cement. JKR Limit + 4% by weight of cement)
vi.	Steel Thickness loss due to corrosion	= Generally of less than 5%.

8.0 ENGINEERING ASSESSMENT OF THE BRIDGE CONDITION

8.1 BRIDGE MATERIAL CONDITION

Complete visual inspection of all superstructure bridge components generally confirms the followings:-

a) The Bridge Deck (Reinforced Concrete) and the Steel Bridge superstructure components were in good stable condition with no observed significant material deterioration or degradation as to affect the bridge structural integrity and safety.

b) There were various observation of minor (<1%) to moderate (up to 5%) corrosion on certain steel structural components particularly at:-
   - The top flange of the arch beams.
   - The end connections and bracing members near to bridge piers due to leaking water from damaged bridge deck joints.
   - Those steel members directly exposed to rain water.

c) In several locations, plant growth and debris had covered some of the surfaces of the steel members. It must be stated that the Bridge was built from 1928 to 1930. The only known significant rehabilitation was the strengthening of bridge deck in 1986 (some 29 years back). Back then, the whole steel superstructure was substantially repaired. The repainting system has lasted remarkably very well till now.

8.2 BRIDGE STRUCTURAL CONDITION

The Bridge was assessed to be in good stable structural condition with no obvious signs significant deformations, deflections or any other signs of structural instability. However, the followings are noted for subsequent repair works:-

a) Missing rivets at some connections.

b) Damaged expansion joints.

c) Observation of crack line on the end plate of the vertical post of the steel truss at the bridge pier location. (It must be noted that the crack could not be caused by inadequate design provision. The crack was already there some twenty years back during the early inspection. However, the crack line had remained stable and did not propagate). Further assessed in the detailed structural analysis and design check confirmed that there was no structural integrity issue as the section would only be subjected to pure compression. However, repairs to these crack lines have been recommended.

d) The Bridge steel bearings were inspected and found to be generally in good operating condition though there were some observation of debris accumulation and minor rusting. These bearings were generally termed "rocker type" bearings, though essentially for this Bridge, the bearings function more like "rotating hinge". Some cleaning and greasing works would be in order.

9.0 BRIDGE "STRUCTURAL DETAILS" DRAWINGS

9.1 Based on the limited available drawings from JKR, site inspections, verification and measurements on-site, a complete set of "near as-built" drawings have been prepared so as to serve as future reference for the maintenance of the Bridge Structure. It must be stated that the nature of this exercise yielded drawings which contain the as-built structural details.

9.2 The complete list of drawings (submitted seperately) are:-

- JKR/JSI/TC/BR/01 General Arrangment
- JKR/JSI/TC/BR/02 Span 1 Vertical Bracing (sheet 1 of 2)
- JKR/JSI/TC/BR/03 Span 1 Vertical Bracing (sheet 2 of 2)
- JKR/JSI/TC/BR/04 Span 2 Vertical Bracing (sheet 1 of 3)
- JKR/JSI/TC/BR/05 Span 2 Vertical Bracing (sheet 2 of 3)
- JKR/JSI/TC/BR/06 Span 2 Vertical Bracing (sheet 3 of 3)
- JKR/JSI/TC/BR/07 Span 3 Vertical Bracing (sheet 1 of 3)
- JKR/JSI/TC/BR/08 Span 3 Vertical Bracing (sheet 1 of 3)
- JKR/JSI/TC/BR/09 Span 3 Vertical Bracing (sheet 2 of 3)
- JKR/JSI/TC/BR/10 Span 4 Vertical Bracing (sheet 1 of 4)
- JKR/JSI/TC/BR/11 Span 4 Vertical Bracing (sheet 2 of 4)
- JKR/JSI/TC/BR/12 Span 4 Vertical Bracing (sheet 3 of 4)
- JKR/JSI/TC/BR/13 Span 4 Vertical Bracing (sheet 4 of 4)
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- JKR/JSI/TC/BR/16 Span 5 Vertical Bracing (sheet 3 of 3)
- JKR/JSI/TC/BR/17 Span 6 Vertical Bracing (sheet 1 of 3)
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- JKR/JSI/TC/BR/23 Middle Frame at Pier 2
- JKR/JSI/TC/BR/24 Middle Frame at Pier 3
- JKR/JSI/TC/BR/25 Middle Frame at Pier 4
- JKR/JSI/TC/BR/26 Middle Frame at Pier 5
- JKR/JSI/TC/BR/27 Middle Frame at Pier 6
- JKR/JSI/TC/BR/28 Outer Girder G1 & G4 of Span 1 & 7 (sheet 1 of 2)

- JKR/JSI/TC/BR/29 Outer Girder G1 & G4 of Span 1 & 7 (sheet 2 of 2)
- JKR/JSI/TC/BR/30 Inner Girder G2 & G3 of Span 1 & 7 (sheet 1 of 2)
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- JKR/JSI/TC/BR/34 Inner Girder G2 & G3 of Span 2 & 6 (sheet 1 of 2)
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- JKR/JSI/TC/BR/37 Outer Girder G1 & G4 of Span 3 & 5 (sheet 2 of 2)
- JKR/JSI/TC/BR/38 Inner Girder G2 & G3 of Span 3 & 5 (sheet 1 of 2)
- JKR/JSI/TC/BR/39 Inner Girder G2 & G3 of Span 3 & 5 (sheet 2 of 2)
- JKR/JSI/TC/BR/40 Outer Girder G1 & G4 of Span 4 (sheet 1 of 2)
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- JKR/JSI/TC/BR/45 Horizontal Bracing Between Girders for Span 2 & 6
- JKR/JSI/TC/BR/46 Horizontal Bracing Between Girders for Span 3 & 5
- JKR/JSI/TC/BR/47 Horizontal Bracing Between Girders for Span 4
- JKR/JSI/TC/BR/48 Horizontal Member Below Trough for Span 1 & 7
- JKR/JSI/TC/BR/49 Horizontal Member Below Trough for Span 2 & 6
- JKR/JSI/TC/BR/50 Horizontal Member Below Trough for Span 3 & 5
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- JKR/JSI/TC/BR/53 Layout Plan of Trouching for Span 2 & 6
- JKR/JSI/TC/BR/54 Layout Plan of Trouching for Span 3 & 5
- JKR/JSI/TC/BR/55 Layout Plan of Trouching for Span 4

10.0 BRIDGE CAPACITY ASSESSMENT (Volume 3 of 4 of Final Report)

10.1 The Terms of Reference calls for structural analysis and design check of the bridge superstructure components with respect to MTAL (Mid Term Ayle Load) traffic live load and to assess the effect on the bridge substructure. The full details are as per contents of Volume 3 of 4 of the Final Report.

10.2 For ease of comparison, the live loading regime for each of the usual bridge loadings are as tabulated:-

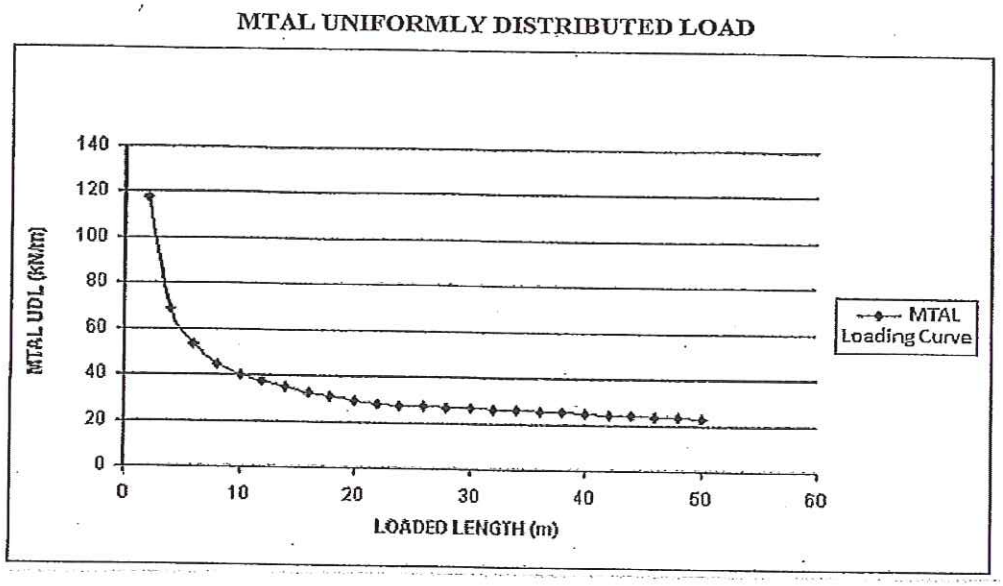
Loaded Length m	MTAL (HA-UDL) kN/m	BD 37/01 (HA-UDL) kN/m	BS 5400 (HA-UDL) kN/m
2	117.5	2112	30.0kN/m
4	68.8	132.7	
6	53.6	101.2	
8	44.5	83.4	
10	40.4	71.8	
12	37.7	63.6	
14	34.8	57.3	
16	32.5	52.4	
18	31.2	48.5	
20	29.1	45.1	
22	28.0	41.1 (23m)	
24	27.4		
26	27.2	37.9	
28	27.0	35.2 (29m)	
30	26.6		
32	26.3	31.0 (35m)	29.1
34	26.0		28.3
36	25.7		27.5
38	25.4	29.4	26.8
40	24.9	27.9 (41m)	26.2
42	24.5		25.6
44	24.0	26.6	25
46	23.7	25.5 (47m)	24.5
48	23.4		23.8 (49m)
50	23.1	24.4	

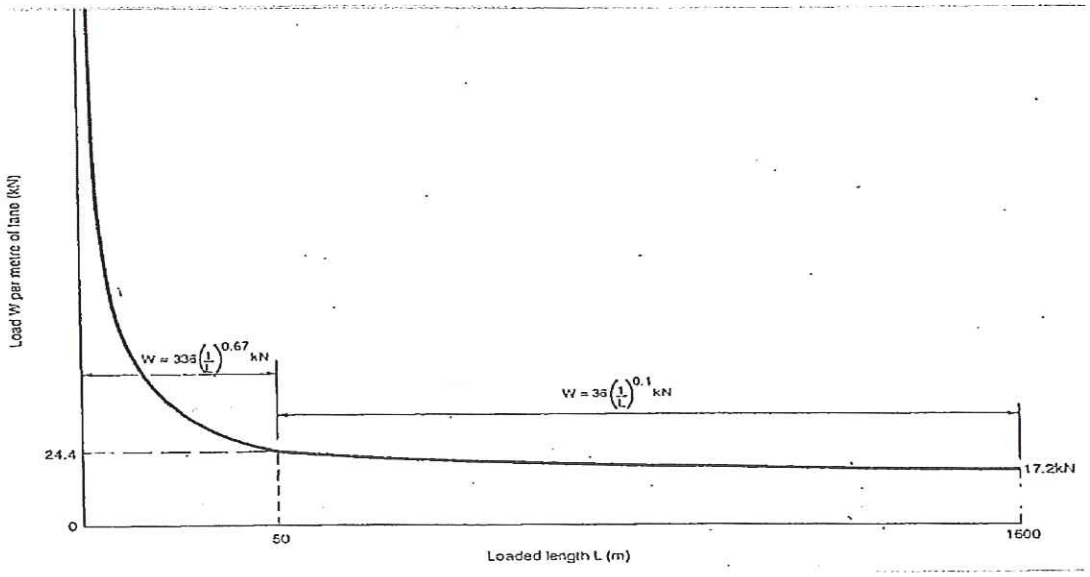
Comments:-

- Both BD 37 & MTAL has cut-off point of HA-UDL at 50m loaded length with about similar order (i.e. 23.1kN/m versus 24.4kN/m).
- BS 5400 HA-UDL has similar 23.8kN/m at 49m. However, the values drop off after that.
- For the Kuala Kangsar Bridge,

  Spans are 104 feet = 31.7m (Span 1, Span 7)
  130 feet = 39.6m (Span 2, Span 6)
  150 feet = 45.7m (Span 3, Span 5)
  160 feet = 48.8m (Span 4)
- Hence, almost near similar order of magnitudes of the HA-UDL Loadings would be encountered at these loaded length range.

10.3 For better appreciation of the load regimes, the graphical presentation of MTAL and HA-UDL (BS5400).
Loadings are as shown:-





10.4 SUMMARY RESULTS OF STRUCTURAL ANALYSIS AND DESIGN CHECK

The full contents of the Structural Analysis & Design Check of the Bridge Superstructural components with respect to MTAL traffic Live Load is presented as volume 3 of 4 of the FINAL REPORT (RPT/TC/275/14/40-Final Report vol 3 of 4) for record and reference.

10.4.1 Bridge Superstructure

The Structural Analysis and Design check was carried out as per current Bridge Design Code BD37 but adopting MTAL traffic live load. The assessment of the as-built Bridge superstructure capacity was carried out for:-

- Bridge Deck.
- Bridge Deck support RSJ members.
- Vertical RSJ column members supporting the Bridge Deck.
- The Steel Arch member.

10.4.1.1 Bridge Deck

a) The Bridge Deck consist of Composite concrete (fcu=40N/mm^2 was adopted) 225mm thick with BRC-A10 top reinforcement on 10mm thick trapezoidal Steel Trough. The composite deck was supported by :-
   i. 4 numbers of year 1932 as-built RSJ 13"x5"x35lb
   ii. Additional 4 numbers of year 1987 Rehabilitation Works of 16"x7"x45lb Universal Beam (UB).

b) The Bridge Deck was found to be very adequate to sustain the MTAL Loading with significant reserve capacity.

Hogging BM	= 29kN-m	Ast Required	=	713mm^2/3m width
		Ast Provided	=	BRC – A10 =1178mm^2
Sagging BM	= 25kN-m	Ast Required	=	563mm^2/3m width
		Ast from Trough	=	3810mm^2
			>>	563mm^2

Hence, it can be observed that the Bridge Deck has very adequate capacity to sustain the MTAL traffic Live Loading.

10.4.1.2 Bridge Deck Support Longitudinal RSJ Members

a) The Structural Analysis and Design Check on the two (2) types of longitudinal steel members (i.e. 13"x5"x35lb RSJ / 330x127x52kg/m & 16"x7"x45lb UB / 406x178x67kg/m) confirmed that these steel elements were able to support the composite Bridge Deck to sustain the MTAL Loading very adequately.

b) For the design check, the basic yield strength of the steel adopted is 220 N/mm^2. With a Partial Factor for Materials of 1.05, the "permissible" steel strength = 190 N/mm^2.

c) The steel stressess obtained were:-
   - 13"x5"x35lb RSJ (Z=6.307x10^{5}mm^3) = 102.3N/mm^2 <190N/mm^2
   - 16"x7"x45lb UB (Z=11.89x10^{5}mm^3) = 59.9N/mm^2 <<190N/mm^2

d) Hence, the RSJ longitudinal members have very adequate structural capacity.

10.4.1.3 Vertical RSJ Column Members Supporting the Bridge Deck (9"x7"x50lb / 229x178x74kg/m)

a) The Vertical RSJ Column Members (Steel area = 6668mm^2) were checked for the two (2) categories of steel arches, ie:-

   i. the two (2) outer arches

   ii. the two (2) inner arches

   The extreme steel fibre stresses on the RSJ members on the inner arches (being more loaded) were checked.

b) Inner Arches

   For the two (2) inner arches the vertical RSJ column members inherently carried much more Bridge Deck and traffic loadings than those of the two (2) outer arches:-

   i. Certain longer RSJ Vertical members when subjected to the maximum MTAL Loadings could be stressed to slightly beyond the Design Code provision of 190N/mm^2. However, it must be stated that this is still below the adopted steel strength of 220N/mm^2 and the adopted steel strength was based on the lowest steel strength obtained from the three (3) test samples.

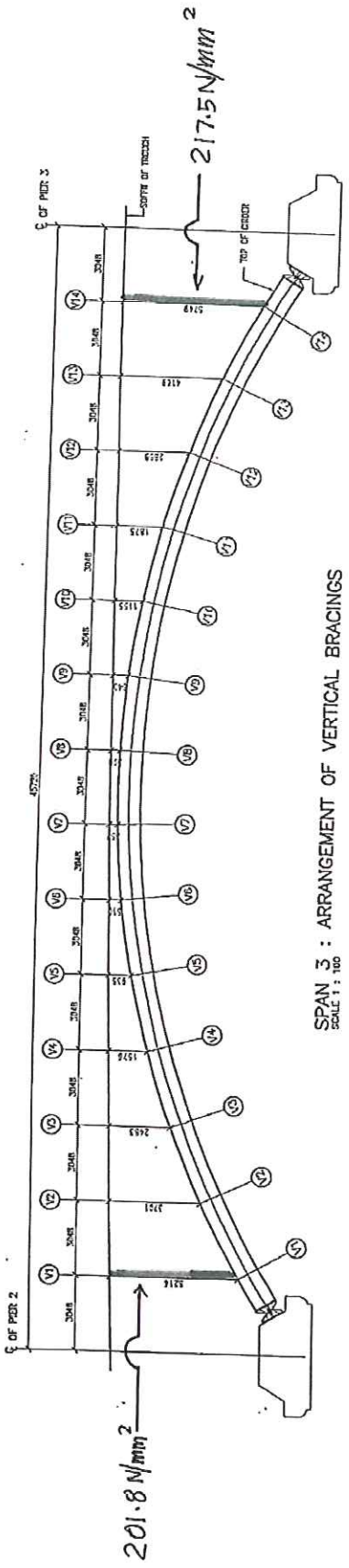
   ii. Summary of the steel stresses on critical verlitical RSJ members are tabulated.

Span	RSJ Column	Steel Stress on 229x178x74kg/m RSJ	
		Maximum, N/mm^2	Minimum, N/mm^2
Span 1 & Span 7	V 10	188.5 N/mm^2	- 84.9 N/mm^2
	V 1		
Span 2	V 12	*196.7 N/mm^2	- 93.0 N/mm^2
Span 6	V 1		
Span 2	V 1	175.0 N/mm^2	- 71.6 N/mm^2
Span 6	V 12		
Span 3 & Span 5	V 14	*206.7 N/mm^2	- 105.2 N/mm^2
	V 1		
Span 3	V 1	*191.1 N/mm^2	- 89.8 N/mm^2
Span 5	V 14		
Span 3	V 13	163.3 N/mm^2	- 62.2 N/mm^2
Span 5	V 2		
Span 4	V1	*202.2 N/mm^2	- 102.2 N/mm^2
	V 15		
Span 4	V 2	161.9 N/mm^2	- 62.3 N/mm^2
	V 14		

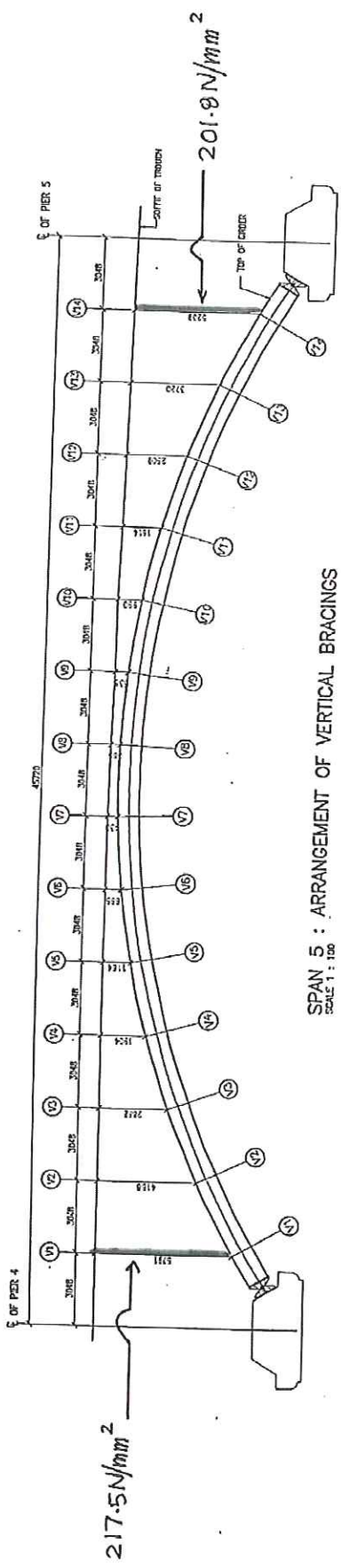
*=The Compressive stress has exceeded the permitted steel stress capacity of 190N/mm^2 .

a) Allowance for 5% Steel Corrosion (Inner Arches)

i. To reflect the actual condition at the site and taking into account 5% reduction in steel thickness due to steel corrosion, the stresses on the RSJ members have been rechecked.



SPAN 3 : ARRANGEMENT OF VERTICAL BRACINGS
SCALE 1 : 100



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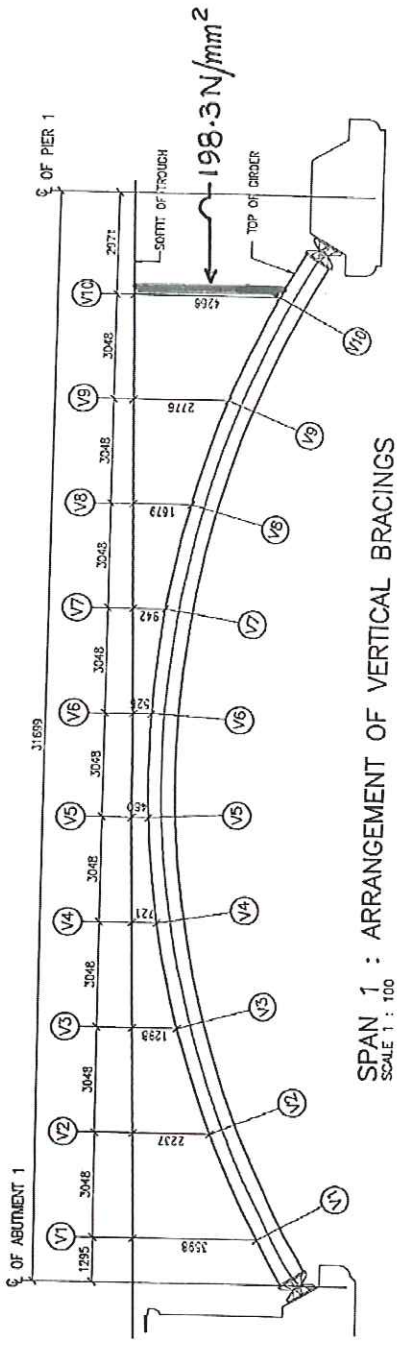
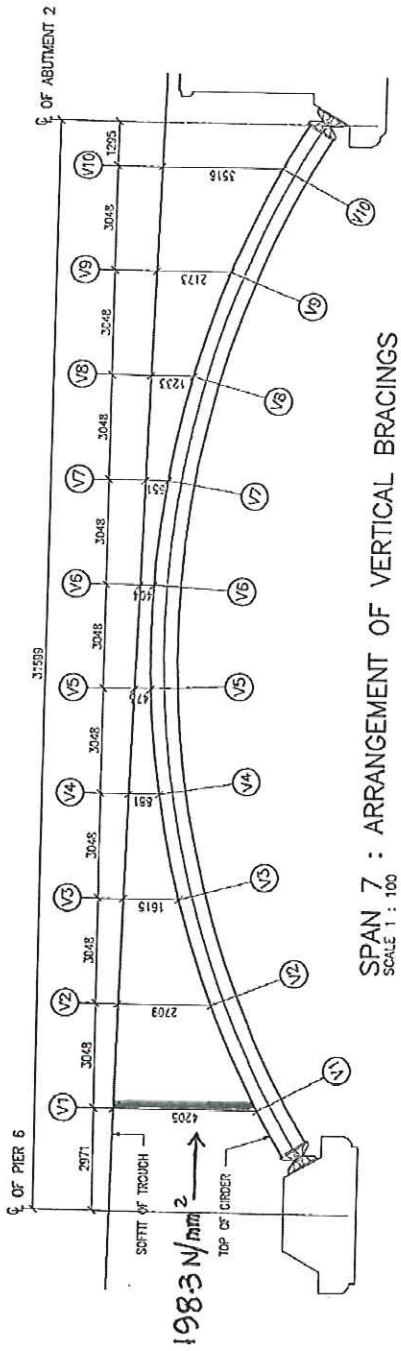
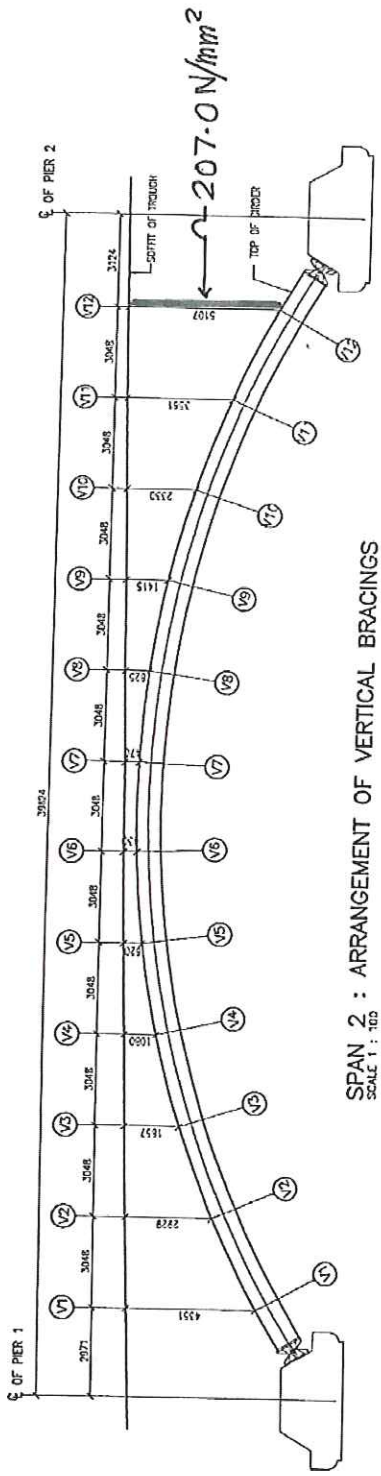
SCALE 1 : 100



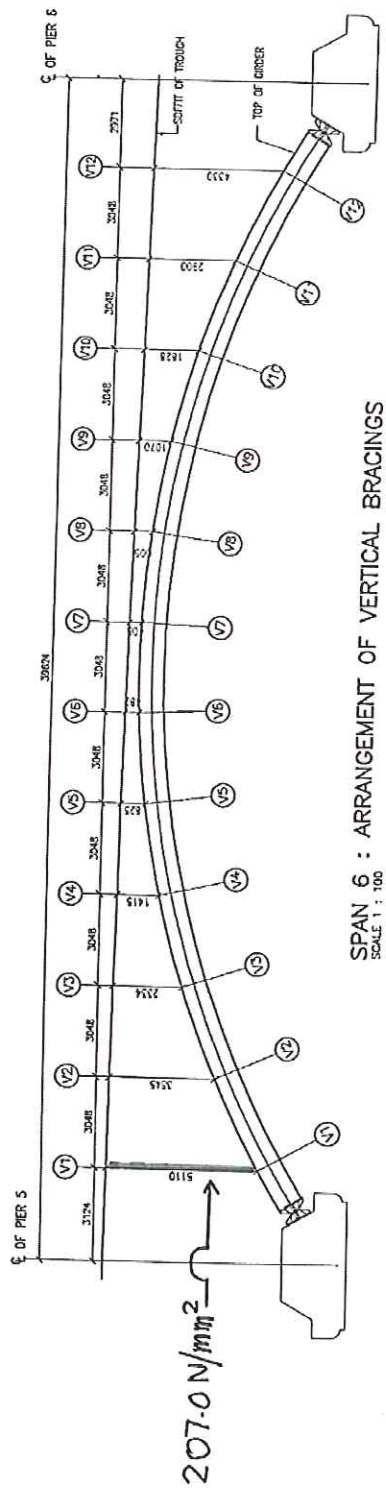
SPAN 1 : ARRANGEMENT OF VERTICAL BRACINGS
SCALE 1 : 100



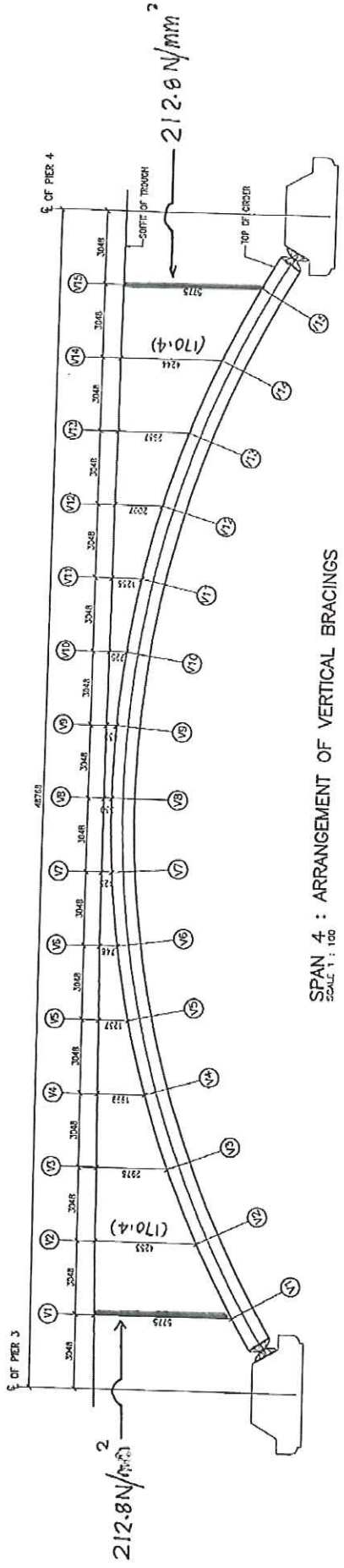
SPAN 7 : ARRANGEMENT OF VERTICAL BRACINGS
SCALE 1 : 100



SPAN 2 : ARRANGEMENT OF VERTICAL BRACINGS
SCALE 1 : 100



SPAN 6 : ARRANGEMENT OF VERTICAL BRACINGS
SCALE 1 : 100



SPAN 4 : ARRANGEMENT OF VERTICAL BRACINGS
SCALE 1 : 100

The summary results of critical RSJ columns are:-

Span	RSJ Column	Steel Stress on 229x178x74kg/m RSJ	
		Maximum	Minimum
Span 1	V 10	*198.3 N/mm^2	- 89.3 N/mm^2
Span 7	V 1		
Span 1	V 1	175.7 N/mm^2	- 66.9 N/mm^2
Span 7	V 10		
Span 2	V 12	*207.0 N/mm^2	- 97.8 N/mm^2
Span 6	V 1		
Span 2	V 1	184.3 N/mm^2	- 75.3 N/mm^2
Span 6	V 12		
Span 3	V 14	*217.5 N/mm^2	- 110.7 N/mm^2
Span 5	V 1		
Span 3	V 1	*201.8 N/mm^2	- 95.2 N/mm^2
Span 5	V 14		
Span 3	V 13	171.8 N/mm^2	- 65.3 N/mm^2
Span 5	V 2		
Span 4	V1	*212.8 N/mm^2	- 107.5 N/mm^2
	V 15		
Span 4	V 2	170.4 N/mm^2	- 65.5 N/mm^2
	V 14		

*=The Compressive stress has exceeded the permitted steel stress capacity of 190N/mm^2.

ii. As can be seen, with the 5% steel corrosion factored in the additional RSJ column members that may need to be strengthened now include Span 1 (V 10) & Span 7 (V 1) members besides those identified previously. Note that the maximum overstress is 14.5% after allowing for 5% reduction in steel area due to corrosion.

iii.
- In terms of actual material strength, the Bridge can be assessed as to able to sustain the maximum MTAL Loading marginally within the conventional design code practice.
- Nevertheless, some structural enhancement can be contemplated with nominal steel structural strengthening to those identified RSJ column members of the inner arches.

b) Structural Strengthening to RSJ Column Members of The Inner Arches

The maximum stress exceeded the permitted steel stress of 190 N/mm^2 by some 14.5%. Hence, additional steel section area for structural enhancement will be required for:-

Span	RSJ Column at
1	V 10
2	V 12
3	V 1 & V 14
4	V 1 & V 15
5	V 1 & V 14
6	V 1
7	V 1

10.4.1.4 The Steel Arch Members

a) The four (4) main Steel Arch members consist of riveted Steel Plate girders.
b) The Steel fibre stresses were checked for the Steel Arch members with summary results as follow:-

No	Spans	Steel Fibre Stressess, N/ mm^2	
		Outer Arches	Inner Arches
1	1 & 7	27.8 N/mm^2 & 91 N/mm^2	17.6 N/mm^2 & 107.6 N/mm^2
2	2 & 6	19.5 N/mm^2 & 60.6 N/mm^2	12.7 N/mm^2 & 70.2 N/mm^2
3	3 & 5	20.5 N/mm^2 & 64.1 N/mm^2	13.5 N/mm^2 & 72.7 N/mm^2
4	4	20.7 N/mm^2 & 61.1 N/mm^2	14.5 N/mm^2 & 68.0 N/mm^2

It is thus seen that the Steel Arch members have significant extra structural capacity as maximum steel stresses would only be 108 N/mm^2, much below the permitted 190N/mm^2. Hence they are able to sustain the MTAL Loading very adequately.

10.4.2 Bridge Substructure

The Bridge Substructure consists of mass concrete piers on concrete pile cap sitting on caissons. As part of the Bridge analysis and design check, the stability and stresses at the bases of the mass concrete piers were checked in the overall engineering assessment. Conservatively, the piers were checked as independent free bodies.

10.4.3 Mass Concrete Pier Stability

a) Based on MTAL traffic loading design check on identified piers were carried out. The following design check results were obtained:-

Pier		Safety Factor (overturning)	
Pier No	Height	Live Load On Both Spans	Live Load on One Span
1	10.50m	2.93 > 1.50	1.08
4	9.95m	5.33 > 1.50	1.217

b) Safety Factor (Overturning)

i. When checked as free bodies, the piers were found to have Safety Factor against overturning of below 1.50, though still above 1.0 when checked for the worst case of only one span loaded with live loads to produce the worst Bending Moment effect.

ii. However, our engineering assessment found that the concrete piers would still have adequate stability due to the followings:-

- The piers were checked as totally independent free bodies, though in actual fact the pier tops were propped by the end of the steel arches. So the actual occurrence of any overturning would not be possible.
- The computed lowest overturning factor would still be greater than 1.0. The engineering assessment therefore concluded that the concrete structure in the as-built condition would have adequate stability against MTAL Loading.

c) Concrete Stresses

i. The Investigation Team found that the bridge piers were of mass concrete construction with no steel reinforcement bars. The determination of the as-built concrete strength of the concrete piers were carried out in two sequences:-

- The first series of three (3) cores using 75mm diameter nominal cores (actual core diameter 68mm) revealed very high concrete strength far exceeding 45N/mm^2. It was suspected that the strength could be influenced by the marginally smaller core diameter.
- A second series of five (5) samples were extracted using 100mm diameter cores. The concrete strength as obtained exceeded 25 N/mm^2 but conservatively adopted as 25 N/mm^2 for structural analysis and design check (Para 7.2).

ii. For this engineering assessment, a conservative concrete compressive strength of 25N/mm^2 was adopted.

iii. The following concrete stresses were obtained for the pier bases when the Bridge was loaded with full MTAL Loading:-

Pier No	Live Load on Both Spans		Live Load on One Span	
	Maximum (N/mm^2)	Minimum (N/mm^2)	Maximum (N/mm^2)	Minimum (N/ mm^2)
1	0.835	0.008	1.466	-0.689 tension
4	0.6658	0.1986	1.3421	- 0.558 tension

iv. Discussion

- Taking fcu = 25N/mm^2, the allowable capacity of the concrete for the masonry piers can be taken as:-

  Concrete compression capacity = 0.25fcu
  = 6.25N/mm^2

  Concrete tensile capacity = 0.36$\sqrt{}$fcu
  = 1.80N/mm^2

- The maximum allowable concrete compressive or tensile stress capacity are not exceeded. Hence, adequate concrete strength for the masonry piers were assured. The maximum compressive stress would only be 1.47 N/mm^2 (<< 6.5 N/mm^2).
- Since the mass concrete piers have no reinforcement bars the possibility of minor tension crack which may lead to more rapid reinforcement bars corrosion would be of no consideration. Site observations at the pier bases also did not reveal any occurrences of such unlikely tensile cracks on the concrete surfaces.
- More significantly, even though the analysis was conservatively based on free bodies condition, the piers were actually propped at the top ends by the steel arches. Hence, the theoretical computation of some minor tensile stresses would not even occur in the as-built condition of the Bridge.

d) Overall Bridge Pier Capacity

In conclusion, the bridge piers have adequate capacity to safely sustain the MTAL traffic loadings on the Bridge Deck.

11.0 BRIDGE REHABILTATION

11.1 The full scope of Rehabilitation and Strengthening Works Comprising Instruction to Tenderes are, presented in other accompaying documentation (Volume 4 of 4).

11.2 The detailed Scope of Works, Bill of Quantities and Addendum Specification requirements for the Bridge Strengthening and Rehabilitations Works are specifically prepared and attached as separate documentation for easy reference.

The Works shall cover:-

a) General Preliminaries.
b) Contractor's Engineering Input (Optional).
c) Bridge Deck Works – Replacement of Expansion Joints.
d) Steel Strengthening Works Type 1 (Internal arches Arch B & C)
e) Steel Strengthening Works Type 1 (Internal arches Arch A & D)
f) Steel Strengthening Works Type 1 (Internal arches Arch A & D)
g) General Structural Steel Works Type A (for identified corroded steel member)
h) General Structural Steel Works Type B (for replacement of missing rivets)
i) General Structural Steel Works Type C (Overall repainting to steel members)
j) General Structural Steel Works Type D (Overall repainting to soffits of Bridge Metal Deck)
k) General Structural Steel Works Type E (General maintenance Works to "rocker" type bearings for steel arches)
l) Repair to crack lines in Piers 4.
m) Other Works: Inclusive of design and build a new concrete access pathway and steps (with railings) from the Bridge Deck level down to the base of Abutment 1 (Sg Siput end).

12.0 CONCLUSION

12.1 The study confirmed the followings on the Jambatan Sultan Iskandar:-

a) Overall, the Bridge structure is in satisfactory material condition with no significant deterioration to the concrete components. However, there were some minor to moderate steel corrosion on some steel components of the steel arch superstructure.

b) The Bridge is also observed to be on good structural condition with no observed structural defects.

c) Generally the steel arches are able to sustain MTAL traffic Live Loading with some minor exceptions for the two (2) inner arches (Para 10.4.1.3). Some structural strengthening to ten (10) vertical RSJ column members will be needed to match the MTAL Loading analysis outcome.

d) The Bridge piers have adequate capacity to safety sustain the MTAL traffic Live Loading.

12.2 The proposed Rehabilitation and Strengthening Works will ensure good satisfactory performance of the Bridge structure for years to come.

Independent Report by

Ir Tham Kum Weng, AMN
B.Eng. (Hons) M.Sc. P.Eng. FIEM MICE C.Eng.

24 July 2015

FINAL REPORT

KAJIAN BAGI MENGGANTIKAN JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK - THE STRUCTURAL ASSESSMENT AND REHABILITATION OF JAMBATAN SULTAN ISKANDAR

LAMPIRAN "A"

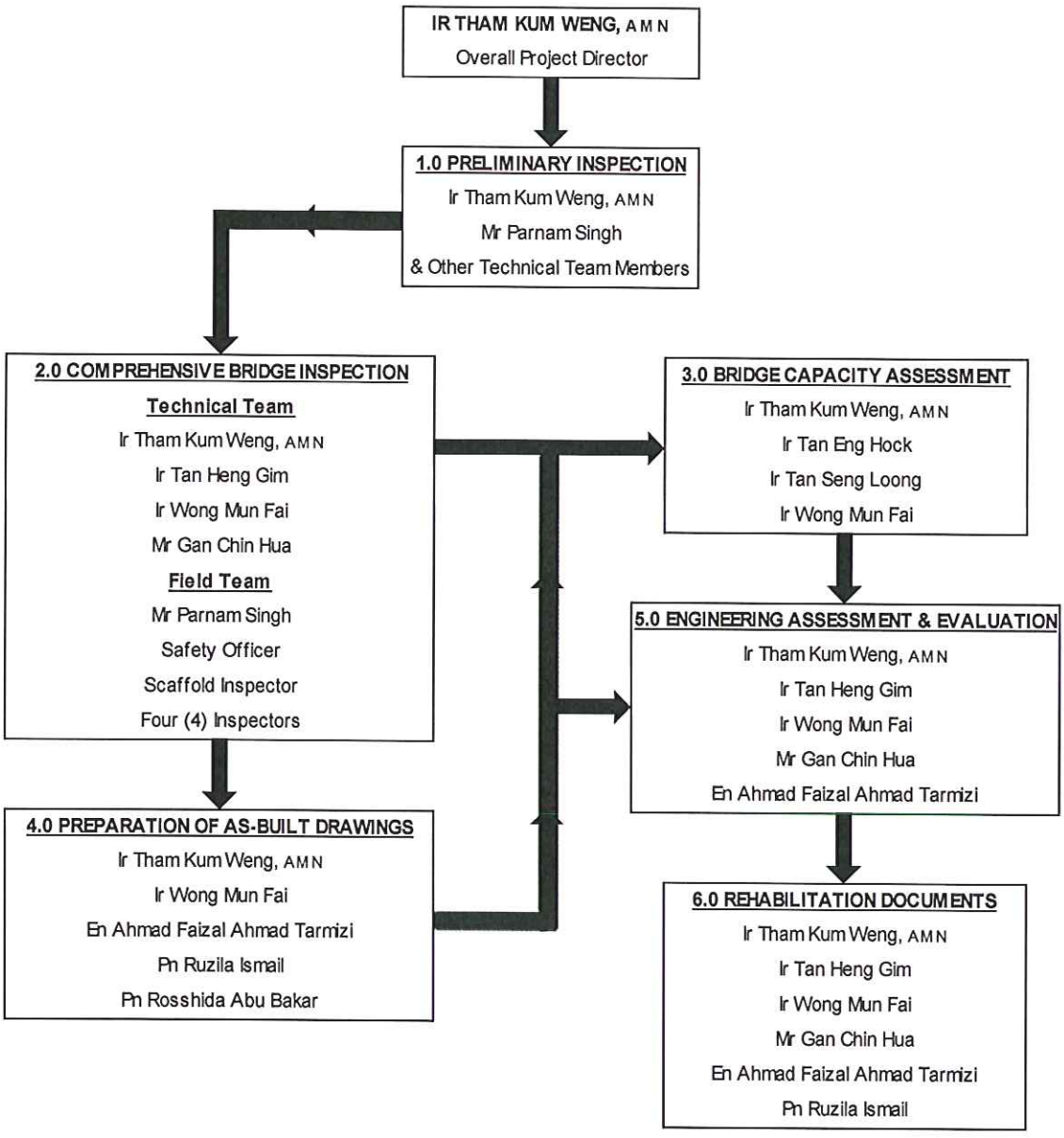
Organisation Chart & Work Flow Process

Lampiran A

(July 2015)

"THE STRUCTURAL ASSESSMENT AND REHABILITATION OF JAMBATAN SULTAN ISKANDAR (FT001/639/90), KUALA KANGSAR, PERAK"

- ORGANISATION CHART & WORK FLOW PROCESS



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LAMPIRAN "B"

Work Schedule

Lampiran B
(24.07.2015)

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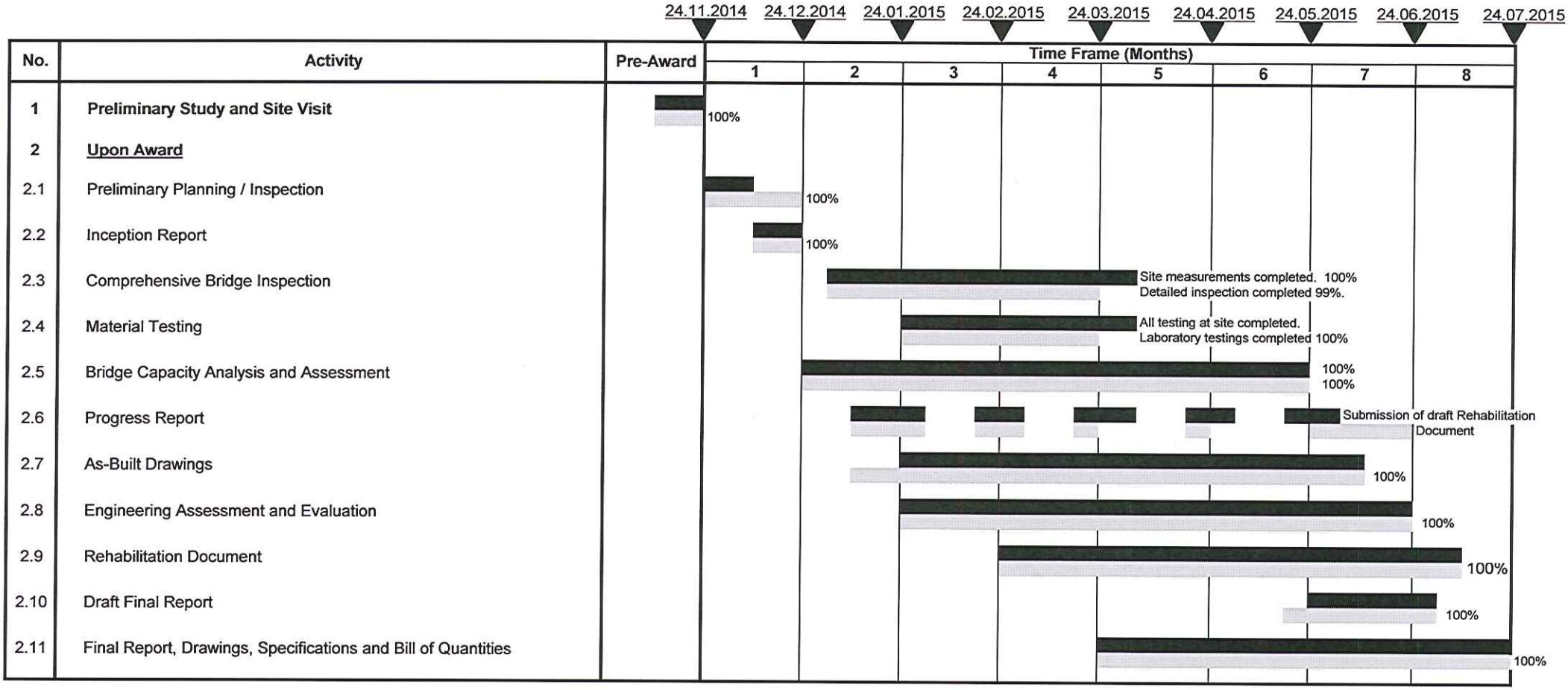
- THE STRUCTURAL ASSESSMENT AND REHABILITATION OF JAMBATAN SULTAN ISKANDAR



No.	Activity	Pre-Award
1	**Preliminary Study and Site Visit**	
2	**Upon Award**	
2.1	Preliminary Planning / Inspection	
2.2	Inception Report	
2.3	Comprehensive Bridge Inspection	
2.4	Material Testing	
2.5	Bridge Capacity Analysis and Assessment	
2.6	Progress Report	
2.7	As-Built Drawings	
2.8	Engineering Assessment and Evaluation	
2.9	Rehabilitation Document	
2.10	Draft Final Report	
2.11	Final Report, Drawings, Specifications and Bill of Quantities	

Submitted by : T-CORP ENGINEERS SDN BHD
Status : Overall Work Progress 100% On 24 July 2015

KAJIAN BAGI MENGGANTIKAN JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK.
- THE STRUCTURAL ASSESSMENT AND REHABILITATION OF JAMBATAN SULTAN ISKANDAR.

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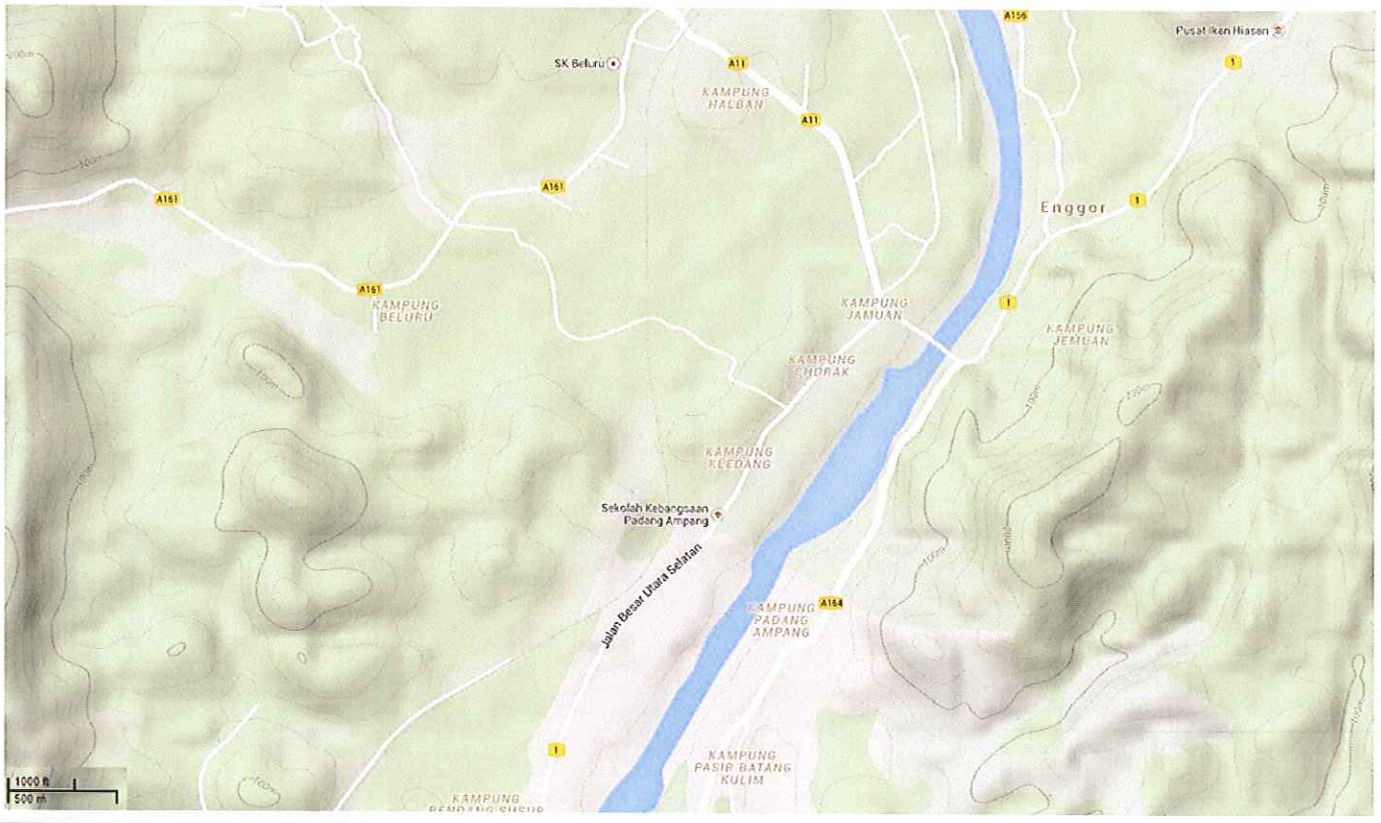
APPENDIX 1
Location Map

LOCATION OF JAMBATAN SULTAN ISKANDAR, KUALA KANGSAR, PERAK DARUL RIDZUAN



LOCATION OF JAMBATAN SULTAN ISKANDAR, KUALA KANGSAR, PERAK DARUL RIDZUAN

KAJIAN BAGI MENGGANTIKAN JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK.
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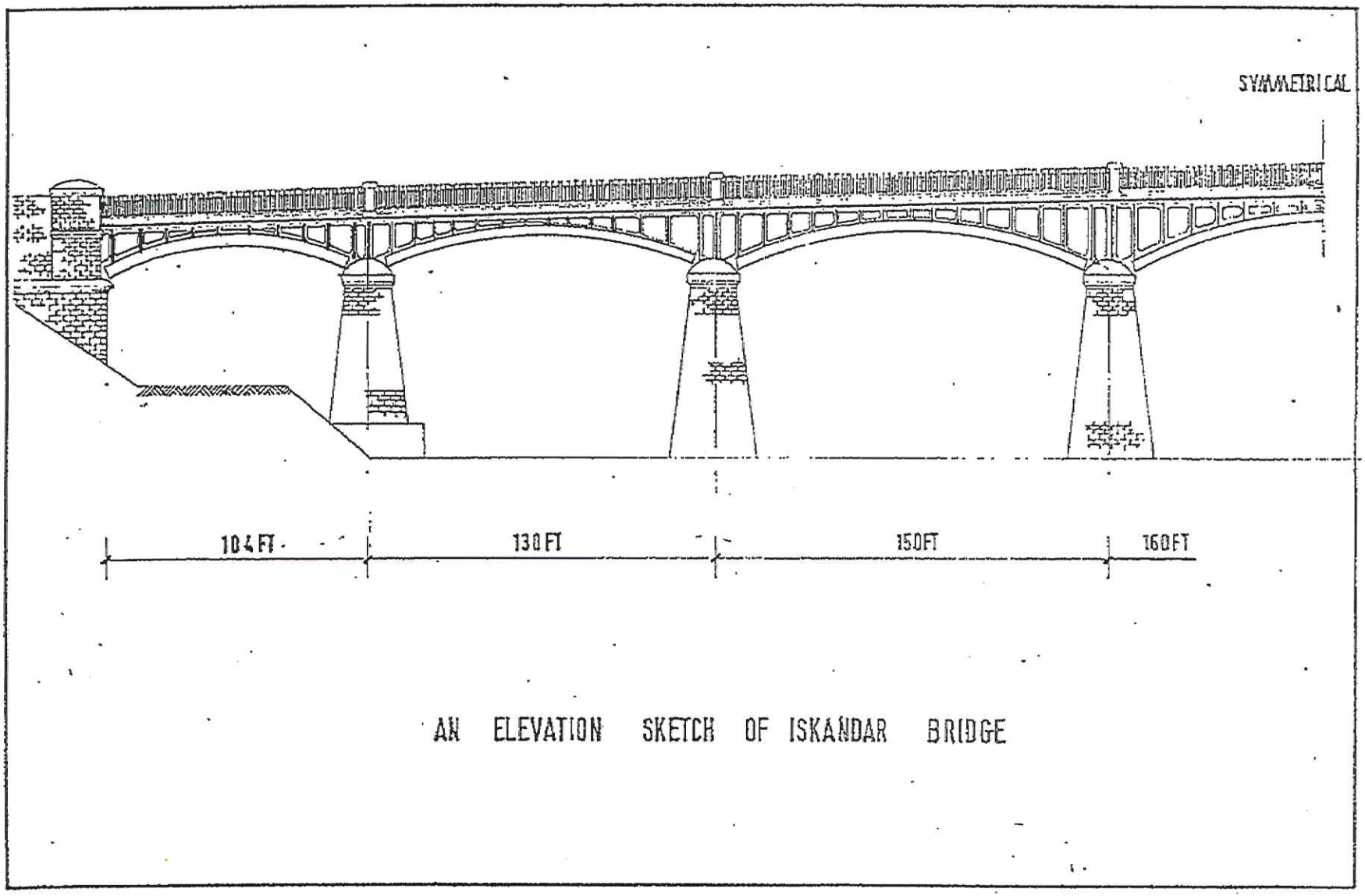
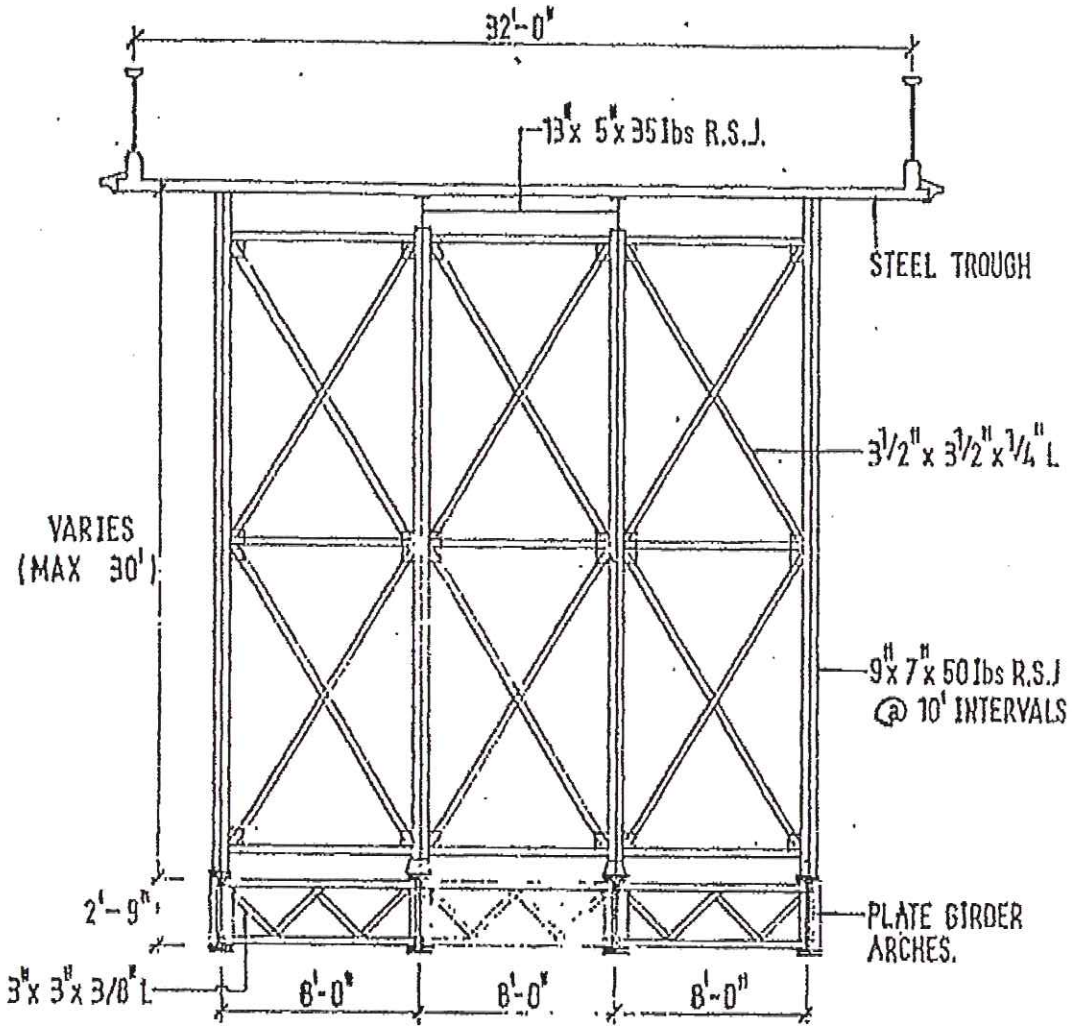
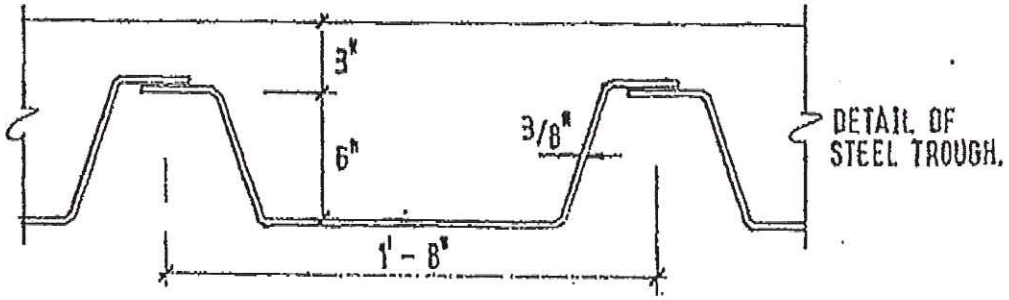
APPENDIX 2
Typical Elevation & Cross-Section Sketches of the Bridge

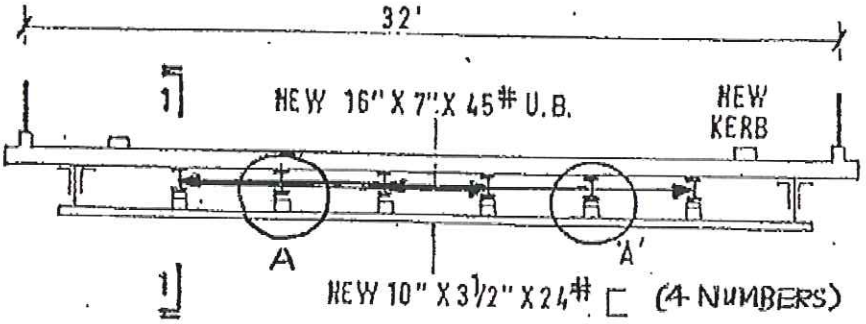


AN ELEVATION SKETCH OF ISKANDAR BRIDGE

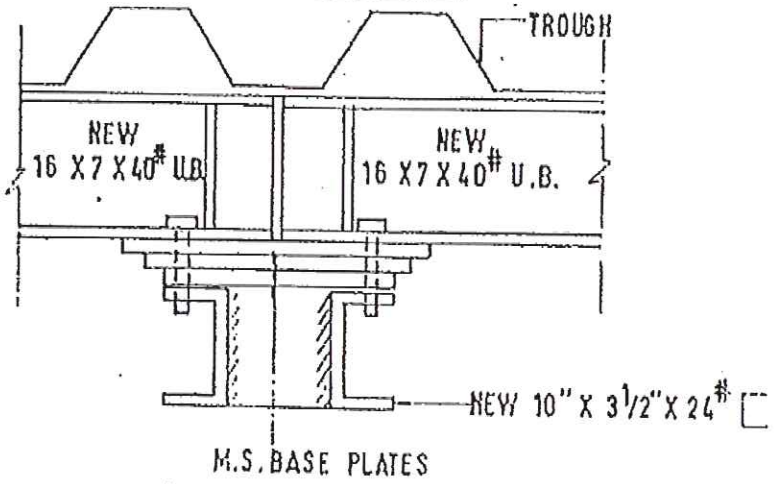




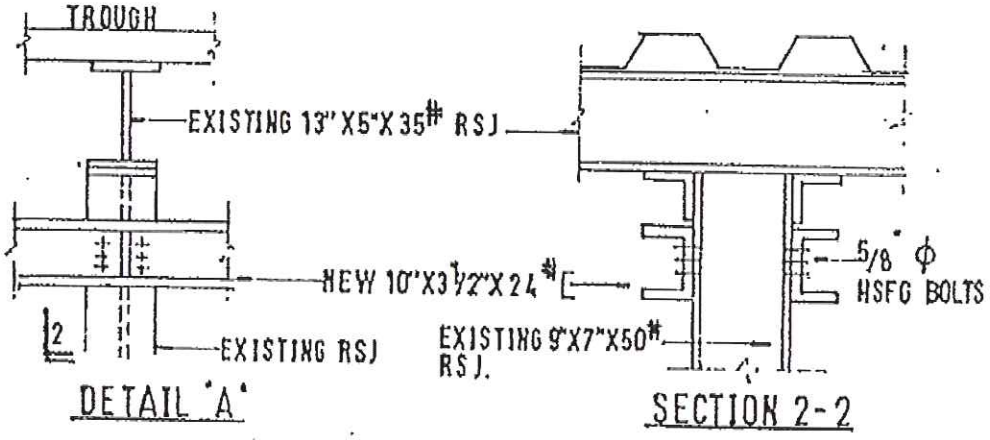
AN ELEVATION SKETCH OF ISKANDAR BRIDGE.



ELEVATION OF DECK



2 SECTION 1-1



DETAIL 'A'

SECTION 2-2

REHABILITATION OF BRIDGE DECK (1985/1986)

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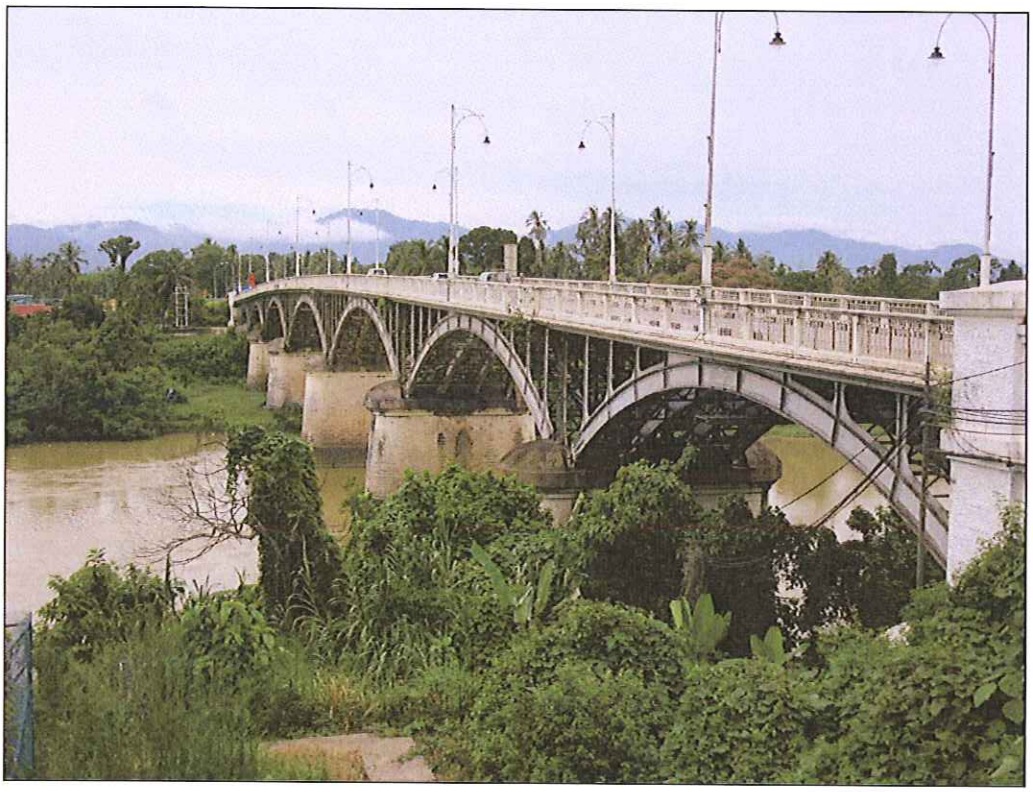
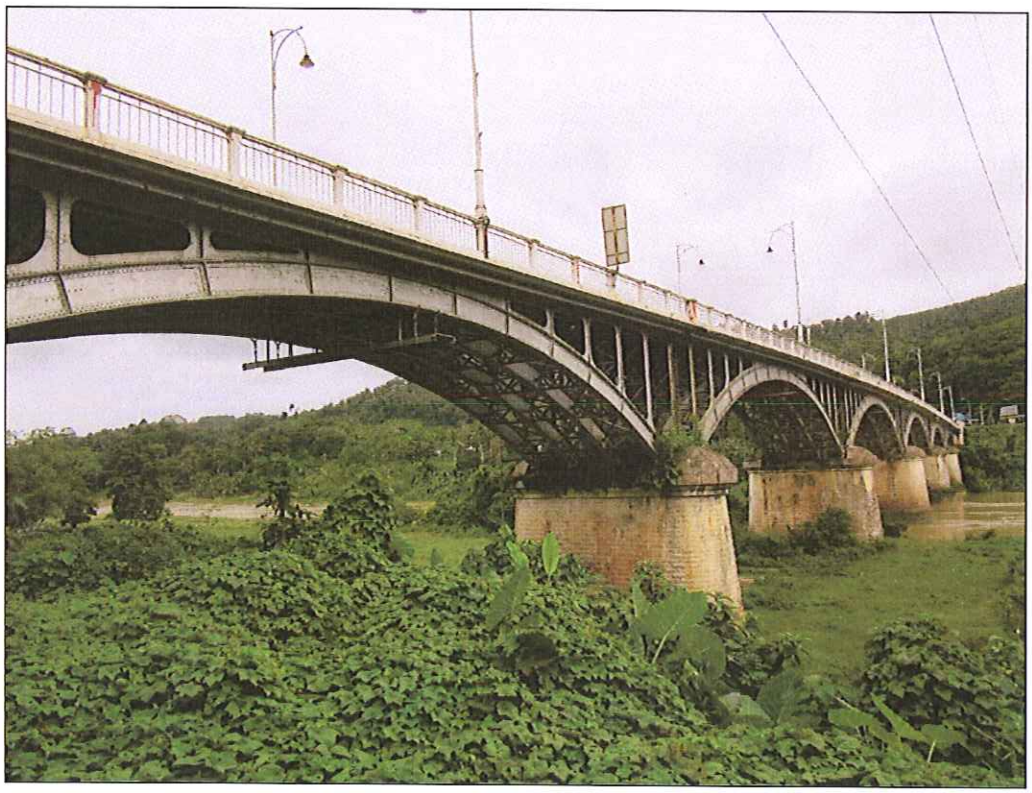
APPENDIX 3

Overall General Views of the Bridge





Picture 1 & 2 : General South-West views of Jambatan Sultan Iskandar Kuala Kangsar.

Picture 3 & 4 : General North-East views of Jambatan Sultan Iskandar Kuala Kangsar.

Picture 5 : General view of the North-West end of the bridge.

Picture 6 : General view of the South-East end of the bridge.

Picture 7 & 8 : General views of the bridge's soffit at the North-West end span.

Picture 9 & 10 : General views of the bridge's soffit at the South-East end span.

Picture 11 & 12 : Typical pictures of the bridge's intermediate piers.

KAJIAN BAGI MENGGANTIKAN JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK - THE STRUCTURAL ASSESSMENT AND REHABILITATION OF JAMBATAN SULTAN ISKANDAR

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APPENDIX 4

Detailed Visual Inspection Observations on Bridge Spans (Span 1 to Span 7)

- **Overall, the Bridge is in good stable material and structural condition with no critical damages or structural deficiencies. The as observed minor (Condition 2) or moderate (Condition 3) corrosion as occurred on certain members of the category of component generally will not affect the bridge integrity and safety due to lower stress range or larger section reserved capacity.**

- **The locations of structural members (with Condition Rating 2 or 3) are referenced to the markings on the drawing for each span.**

KAJIAN BAGI MENGGANTIKAN JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK
THE STRUCTURAL ASSESSMENT AND REHABILITATION OF JAMBATAN SULTAN ISKANDAR

CONDITION RATING OF STRUCTURAL COMPONENTS

Following our comprehensive visual inspections the various structural components condition have been categorised and appropriate photographic records captured:-

Condition Rating	Description
1	No structural or material damage found and no particular maintenance needs are required. (Most members were in this good condition rating).
2	Some minor damages detected. Damages recorded for observation purpose. No significant structural integrity issue. (Photographic record as presented).
3	Some moderate damages detected. These damages warrant implementation of certain maintenance and rehabilitation works. (Photographic record as presented).
4	Critical damages detected. Detailed inspection to implementation of significant repair and strengthening works. (No members exhibited this condition rating).
5	Heavily and critically damaged and possibly affecting the safety of the traffic and road users. Emergency temporary repair and urgent rehabilitation works required. (No members exhibited this condition rating).

Overall, The Bridge condition was in good stable condition with only isolated minor corrosion issues at specific locations. Issues affecting serviceability involve the following components:-

a) Bridge Deck Expansion Joints

Such joints were not in satisfactory condition and would need to be replaced in accordance to joint replacement schedule.

b) "Rocker" type Bearings

These steel bearings were generally in good operating condition. They operated more like hinges. Some debris accumulation and minor corrosion were detected. Some cleaning and servicing of such bearings would be in order.

KAJIAN BAGI MENGGANTIKAN JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK
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: BRIDGE COMPONENTS CONDITION RATING
SPAN NO: 1 Between Abutment A and Pier P1

No	Bridge Part / Component	Material Type	Condition Rating	Remarks
1	Bridge Deck			
	a) Premix / pavement	Asphaltic Concrete	2 to 3	Average
	b) Concrete Deck	Concrete	1	Good with fcu > 40N/mm^2
	c) Expansion Joint	Mechanical Proprietary Surface Joint	3	Abutment 1: Damaged parts partically filled with asphalt. (Condition affects serviceability but not bridge structure integrity)
	d) Steel Trough	Steel Section (10mm thick trapezoidal)	1 to 2	Fairly good condition. (Repainting works since 1987 remained good)
2	Bridge Deck Support Longitudinal Girders			No structural integrity issue. (Large reserved capacity).
	a) 13"x5"x35" lb RSJ	Steel Section	2 to 3	
	b) 16"x7"x45" lb UB	Steel Section	2 to 3	
3	Vertical RSJ Members Supporting Bridge Deck 9"x7"x50 lb	Steel Section	1 to 2	Minor corrosion on steel surfaces at ends near bridge piers.
4	Steel Arch Members	Steel Plate Girder	1 to 2	Minor corrosion to some parts of top flange. Corrosion rate is very small and will not affect bridge integrity as long as maintenance protective works are carried out now since the last repainting in 1987.
5	Lateral Bracings	Steel Angles & Steel Sections	1 to 3	Minor to moderate corrosion detected on some components. (However stress levels are low and as such will not affect bridge structural integrity). Structural enhancement maintenance works will restore all components to good condition.
6	Bearings	"Rocker" type steel	3	Generally in good operating condition. However, some debris accumulation and minor corrosion observed. Some cleaning and servicing of such bearings would be in order.
7	Abutment (Abutment 1)	Mass Concrete without reinforcement bars	1 to 2	No observed material defects or structural deficiencies. Concrete fcu >25N/mm^2
8	Pier P1	Mass Concrete without reinforcement (on caissons foundations)	1 to 2	No observed material defects or structural deficiencies. Concrete fcu >25N/mm^2.

Overall Rating: The Bridge Span is in good stable condition

KAJIAN BAGI MENGGANTIKAN JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK
- THE STRUCTURAL ASSESSMENT AND REHABILITATION OF JAMBATAN SULTAN ISKANDAR
: BRIDGE COMPONENTS CONDITION RATING
SPAN NO: 2 Between Pier P1 and Pier P2

No	Bridge Part / Component	Material Type	Condition Rating	Remarks
1	Bridge Deck			
	a) Premix / pavement	Asphaltic Concrete	2 to 3	Average
	b) Concrete Deck	Concrete	1	Good with fcu > 40N/mm^2
	c) Expansion Joint	Mechanical Proprietary Surface Joint	2	Pier P1: Condition satisfactory with some exposed holding down bolts.
	d) Steel Trough	Steel Section (10mm thick trapezoidal)	1 to 2	Fairly good condition. (Repainting works since 1987 remained good)
2	Bridge Deck Support Longitudinal Girders			No structural ihtegrity issue. (Large reserved capacity).
	a) 13"x5"x35" lb RSJ	Steel Section	2 to 3	
	b) 16"x7"x45" lb UB	Steel Section	2 to 3	
3	Vertical RSJ Members Supporting Bridge Deck 9"x7"x50 lb	Steel Section	1 to 2	Minor corrosion on steel surfaces at ends near bridge piers.
4	Steel Arch Members	Steel Plate Girder	1 to 2	Minor corrosion to some parts of top flange. Corrosion rate is very small and will not affect bridge integrity as long as maintenance protective works are carried out now since the last repainting in 1987.
5	Lateral Bracings	Steel Angles & Steel sections	1 to 3	Minor to moderate corrosion detected on some components. (However stress levels are low and as such will not affect bridge structural integrity). Structural enhancement maintenance works will restore all components to good condition.
6	Bearings	"Rocker" type steel	3	Generally in good operating condition. However, some debris accumulation and minor corrosion observed. Some cleaning and servicing of such bearings would be in order.
7	Pier P1	Mass Concrete without reinforcement (on caissons foundations)	1 to 2	No observed material defects or structural deficiencies. Concrete fcu >25N/mm^2.
8	Pier P2	Mass Concrete without reinforcement (on caissons foundations)	1 to 2	No observed material defects or structural deficiencies. Concrete fcu >25N/mm^2.

Overall Rating: The Bridge Span is in good stable condition

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- THE STRUCTURAL ASSESSMENT AND REHABILITATION OF JAMBATAN SULTAN ISKANDAR
: BRIDGE COMPONENTS CONDITION RATING
SPAN NO: 3 Between Pier P2 and Pier P3

No	Bridge Part / Component	Material Type	Condition Rating	Remarks
1	Bridge Deck			
	a) Premix / pavement	Asphaltic Concrete	2 to 3	Average
	b) Concrete Deck	Concrete	1	Good with fcu > 40N/mm^2
	c) Expansion Joint	Mechanical Proprietary Surface Joint	2	Pier P2: Condition satisfactory with some exposed holding down bolts.
	d) Steel Trough	Steel Section (10mm thick trapezoidal)	1 to 2	Fairly good condition. (Repainting works since 1987 remained good)
2	Bridge Deck Support Longitudinal Girders			No structural integrity issue. (Large reserved capacity).
	a) 13"x5"x35" lb RSJ	Steel Section	2 to 3	
	b) 16"x7"x45" lb UB	Steel Section	2 to 3	
3	Vertical RSJ Members Supporting Bridge Deck 9"x7"x50 lb	Steel Section	1 to 2	Minor corrosion on steel surfaces at ends near bridge piers.
4	Steel Arch Members	Steel Plate Girder	1 to 2	Minor corrosion to some parts of top flange. Corrosion rate is very small and will not affect bridge integrity as long as maintenance protective works are carried out now since the last repainting in 1987.
5	Lateral Bracings	Steel Angles & Steel Sections	1 to 3	Minor to moderate corrosion detected on some components. (However stress levels are low and as such will not affect bridge structural integrity) structural enhancement maintenance works will restore all components to good condition.
6	Bearings	"Rocker" type steel	3	Generally in good operating condition. However, some debris accumulation and minor corrosion observed. Some cleaning and servicing of such bearings would be in order.
7	Pier P2	Mass Concrete without reinforcement (on caissons foundations)	1 to 2	No observed material defects or structural deficiencies. Concrete fcu >25N/mm^2.
8	Pier P3	Mass Concrete without reinforcement (on caissons foundations)	1 to 2	No observed material defects or structural deficiencies. Concrete fcu >25N/mm^2.

Overall Rating: The Bridge Span is in good stable condition

KAJIAN BAGI MENGGANTIKAN JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK
- THE STRUCTURAL ASSESSMENT AND REHABILITATION OF JAMBATAN SULTAN ISKANDAR
: BRIDGE COMPONENTS CONDITION RATING
SPAN NO: 4 Between Pier P3 and Pier P4

No	Bridge Part / Component	Material Type	Condition Rating	Remarks
1	Bridge Deck			
	a) Premix / pavement	Asphaltic Concrete	2 to 3	Average
	b) Concrete Deck	Concrete	1	Good with fcu > 40N/mm^2
	c) Expansion Joint	Mechanical Proprietary Surface Joint	3	Pier P3: Damaged partspartically filled with asphalt. (Condition affects serviceAbility but not bridge structure integrity)
	d) Steel Trough	Steel Section (10mm thick trapezoidal)	1 to 2	Fairly good condition. (Repainting works since 1987 remained good)
2	Bridge Deck Support Longitudinal Girders			No structural integrity issue. (Large reserved capacity).
	a) 13"x5"x35" lb RSJ	Steel Section	2 to 3	
	b) 16"x7"x45" lb UB	Steel Section	2 to 3	
3	Vertical RSJ Members Supporting Bridge Deck 9"x7"x50 lb	Steel Section	1 to 2	Minor corrosion on steel surfaces at ends near bridge piers.
4	Steel Arch Members	Steel Plate Girder	1 to 2	Minor corrosion to some parts of top flange. Corrosion rate is very small and will not affect bridge integrity as long as maintenance protective works are carried out now since the last repainting in 1987.
5	Lateral Bracings	Steel Angles & Steel sections	1 to 3	Minor to moderate corrosion detected on some components. (However stress levels are low and as such will not affect bridge structural integrity). Structural enhancement maintenance works will restore all components to good condition.
6	Bearings	"Rocker" type steel	3	Generally in good operating condition. However, some debris accumulation and minor corrosion observed. Some cleaning and servicing of such bearings would be in order.
7	Pier P3	Mass Concrete without reinforcement (on caissons Foundations)	1 to 2	No observed material defects or structural deficiencies Concrete fcu >25N/mm^2.
8	Pier P4	Mass Concrete without reinforcement (on caissons foundations)	1 to 2	Some Vertical cracks appeared on the faces of Pier (no structural integrity issue).

Overall Rating: The Bridge Span is in good stable condition

KAJIAN BAGI MENGGANTIKAN JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK - THE STRUCTURAL ASSESSMENT AND REHABILITATION OF JAMBATAN SULTAN ISKANDAR : BRIDGE COMPONENTS CONDITION RATING

SPAN NO: 5 Between Pier P4 and Pier P5

No	Bridge Part / Component	Material Type	Condition Rating	Remarks
1	Bridge Deck a) Premix / pavement b) Concrete Deck c) Expansion Joint d) Steel Trough	 Asphaltic Concrete Concrete Mechanical Proprtary Surface Joint Steel Section (10mm thick trapezoidal)	 2 to 3 1 2 1 to 2	 Average Good with fcu > 40N/mm^2 Pier P4: Condition satisfactory with some exposed holding down bolts. Fairly good condition. (Repainting works since 1987 remained good)
2	Bridge Deck Support Longitudinal Girders a) 13"x5"x35" lb RSJ b) 16"x7"x45" lb UB	 Steel Section Steel Section	 2 to 3 2 to 3	No structural integrity issue. (Large reserved capacity).
3	Vertical RSJ Members Supporting Bridge Deck 9"x7"x50 lb	Steel Section	1 to 2	Minor corrosion on steel surfaces at ends near bridge piers.
4	Steel Arch Members	Steel Plate Girder	1 to 2	Minor corrosion to some parts of top flange. Corrosion rate is very small and will not affect bridge integrity as long as maintenance protective works are carried out now since the last repainting in 1987.
5	Lateral Bracings	Steel Angles & Steel sections	1 to 3	Minor to moderate corrosion detected on some components. (However stress levels are low and as such will not affect bridge structural integrity). Structural enhancement maintenance works will restore all components to good condition.
6	Bearings	"Rocker" type steel	3	Generally in good operating condition. However, some debris accumulation and minor corrosion observed some cleaning and servicing of such bearings would be in order.
7	Pier P4	Mass Concrete without reinforcement (on caissons foundations)	2	Some vertical cracks appeared on the faces of the Pier. (No structural integrity issue).
8	Pier P5	Mass Concrete without reinforcement (on caissons foundations)	1 to 2	No observed material defects or structural deficiencies. Concrete fcu >25N/mm^2.

Overall Rating: The Bridge Span is in good stable condition

KAJIAN BAGI MENGGANTIKAN JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK
- THE STRUCTURAL ASSESSMENT AND REHABILITATION OF JAMBATAN SULTAN ISKANDAR
: BRIDGE COMPONENTS CONDITION RATING
SPAN NO: 6 Between Pier P5 and Pier P6

No	Bridge Part / Component	Material Type	Condition Rating	Remarks
1	Bridge Deck			
	a) Premix / pavement	Asphaltic Concrete	2 to 3	Average
	b) Concrete Deck	Concrete	1	Good with fcu > 40N/mm^2
	c) Expansion Joint	Mechanical Proprietary Surface Joint	2	Pier P5: Condition satisfactory with some exposed holding down bolts.
	d) Steel Trough	Steel Section (10mm thick trapezoidal)	1 to 2	Fairly good condition. (Repainting works since 1987 remained good)
2	Bridge Deck Support Longitudinal Girders			
	a) 13"x5"x35" lb RSJ	Steel Section	2 to 3	No structural integrity issue. (Large reserved capacity).
	b) 16"x7"x45" lb UB	Steel Section	2 to 3	
3	Vertical RSJ Members Supporting Bridge Deck 9"x7"x50 lb	Steel Section	1 to 2	Minor corrosion on steel surfaces at ends near bridge piers.
4	Steel Arch Members	Steel Plate Girder	1 to 2	Minor corrosion to some parts of top flange. Corrosion rate is very small and will not affect bridge integrity as long as maintenance protective works are carried out now since the last repainting in 1987.
5	Lateral Bracings	Steel Angles & Steel Sections	1 to 3	Minor to moderate corrosion detected on some components. (However stress levels are low and as such will not affect bridge structural integrity). Structural enhancement maintenance works will restore all components to good condition.
6	Bearings	"Rocker" type steel	3	Generally in good operating condition. However, some debris accumulation and minor corrosion observed. Some cleaning and servicing of such bearings would be in order.
7	Pier P5	Mass Concrete without reinforcement (on caissons foundations)	1 to 2	No observed material defects or structural deficiencies, concrete fcu >25N/mm^2.
8	Pier P6	Mass Concrete without reinforcement (on caissons foundations)	1 to 2	No observed material defects or structural deficiencies concrete fcu >25N/mm^2. Two vertical minor cracks occurred at the top of Pier face. (No structural integrity issue).

Overall Rating: The Bridge Span is in good stable condition

KAJIAN BAGI MENGGANTIKAN JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK - THE STRUCTURAL ASSESSMENT AND REHABILITATION OF JAMBATAN SULTAN ISKANDAR : BRIDGE COMPONENTS CONDITION RATING

SPAN NO: 7 Between Pier P6 and Abutment 2

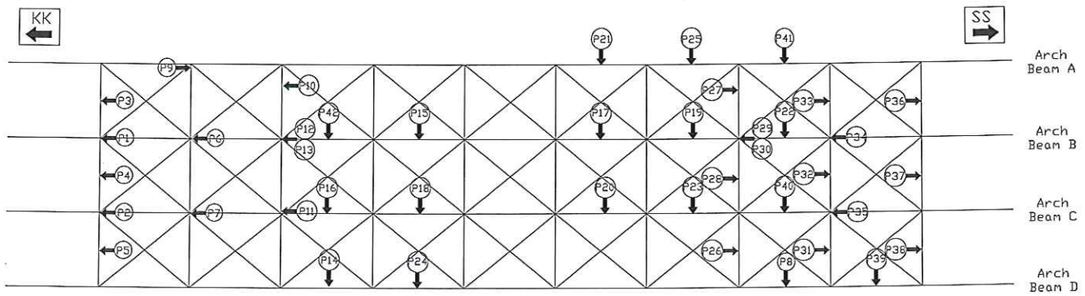
No	Bridge Part / Component	Material Type	Condition Rating	Remarks
1	Bridge Deck			
	a) Premix / pavement	Asphaltic Concrete	2 to 3	Average
	b) Concrete Deck	Concrete	1	Good with fcu > 40N/mm^2
	c) Expansion Joint	Mechanical Proprietary Surface Joint	3 2	Abutment 2: Some damaged premix beyond joint. (Condition affects serviceability but not bridge structure integrity). Pier P6: Condition satisfactory with some exposed holding down bolts.
	d) Steel Trough	Steel Section (10mm thick trapezoidal)	1 to 2	Fairly good condition. (Repainting works since 1987 remained good)
2	Bridge Deck Support Longitudinal Girders			No structural integrity issue. (Large reserved capacity).
	a) 13"x5"x35" lb RSJ	Steel Section	2 to 3	
	b) 16"x7"x45" lb UB	Steel Section	2 to 3	
3	Vertical RSJ Members Supporting Bridge Deck 9"x7"x50 lb	Steel Section	1 to 2	Minor corrosion on steel surfaces at ends near bridge piers.
4	Steel Arch Members	Steel Plate Girder	1 to 2	Minor corrosion to some parts of top flange. Corrosion rate is very small and will not affect bridge integrity as long as maintenance protective works are carried out now since the last repainting in 1987.
5	Lateral Bracings	Steel Angles & Steel Sections	1 to 3	Minor to moderate corrosion detected on some components. (However stress levels are low and as such will not affect bridge structural integrity). Structural enhancement maintenance works will restore all components to good condition.
6	Bearings	"Rocker" type steel	3	Generally in good operating condition. However, some debris accumulation and minor corrosion observed. Some cleaning and servicing of such bearings would be in order.
7	Abutment (Abutment 2)	Mass Concrete without reinforcement bars	1 to 2	No observed material defects or structural deficiencies. Concrete fcu >25N/mm^2
8	Pier 6	Mass Concrete without reinforcement (on caissons foundations)	1 to 2	No observed material defects or structural deficiencies. Concrete fcu >25N/mm^2.

Overall Rating: The Bridge Span is in good stable condition

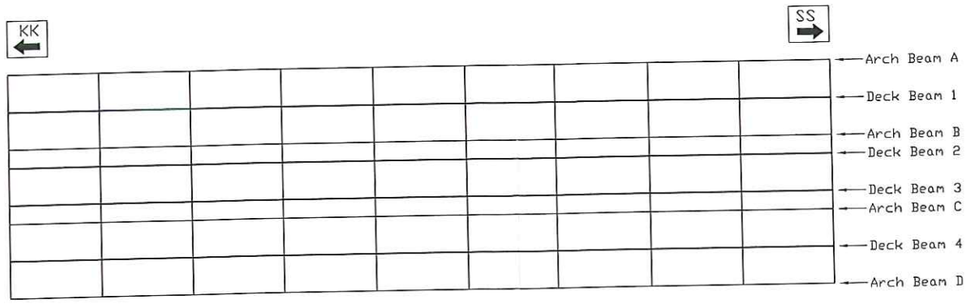
KAJIAN BAGI MENGGANTIKAN JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK.
- THE STRUCTURAL ASSESSMENT AND REHABILITATION OF JAMBATAN SULTAN ISKANDAR.

FINAL REPORT
VOLUME 1 OF 4 : MAIN REPORT

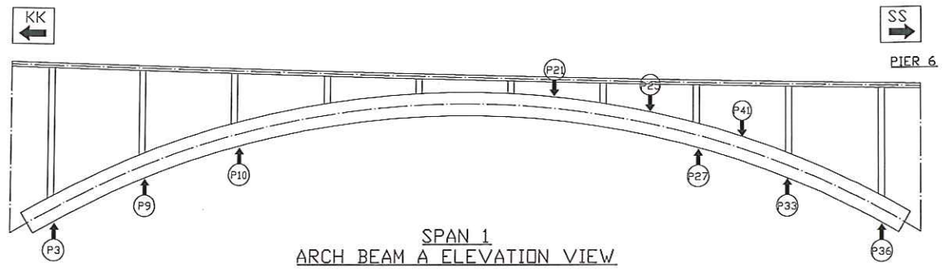
APPENDIX 4a
Detailed Visual Inspection Observations on Bridge Spans
(Span 1)



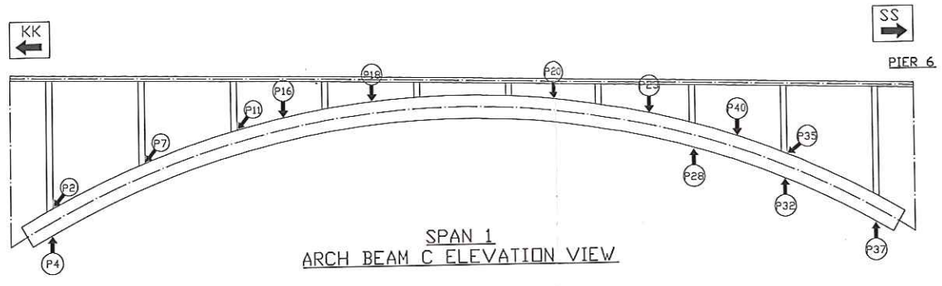
SPAN 1
ARCH BEAMS LAYOUT PLAN



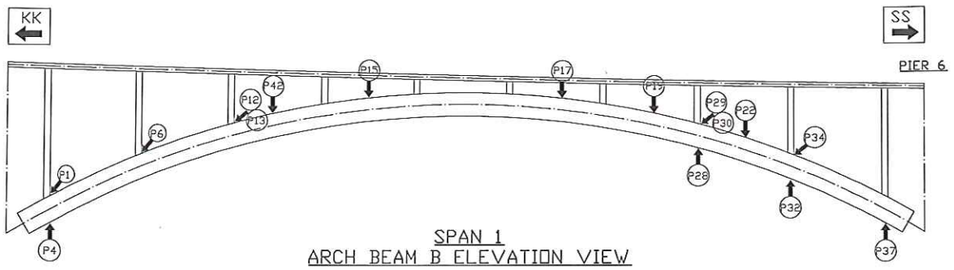
SPAN 1
DECK BEAMS LAYOUT PLAN



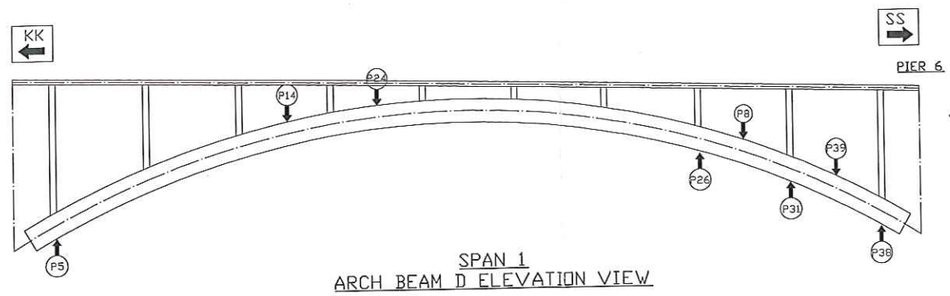
SPAN 1
ARCH BEAM A ELEVATION VIEW



SPAN 1
ARCH BEAM C ELEVATION VIEW



SPAN 1
ARCH BEAM B ELEVATION VIEW



SPAN 1
ARCH BEAM D ELEVATION VIEW

JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK
LAYOUTS / ELEVATIONS FOR PHOTOGRAPHIC RECORD OF THE CONDUCTED VISUAL INSPECTION FOR VISIBLE STRUCTURAL DISTRESS, DETERIORATION AND DAMAGES OF BRIDGE SPAN 1

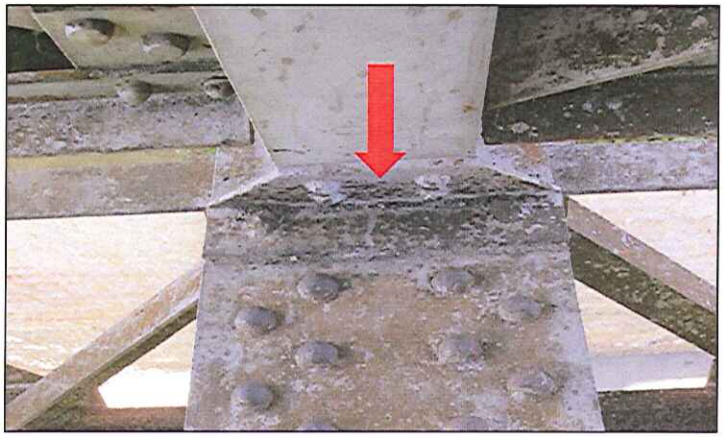
LEGEND

- ← P1 Refer Photographic Record M-S1-P1
- ← P2 Refer Photographic Record M-S1-P2
- ← P3 Refer Photographic Record M-S1-P3

..... etc .....

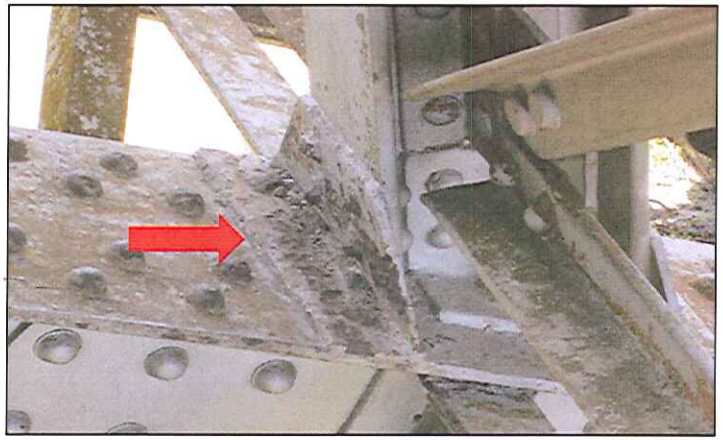
NOTE

Visual Inspections for any visible structural distress, deterioration and damages were conducted between January 2015 to March 2015.



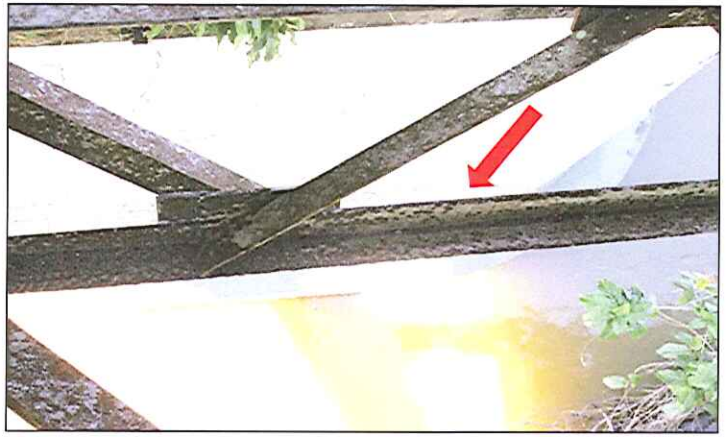
Picture M – S1 – P1

Minor corrosion on vertical bracing joint of arch beam.



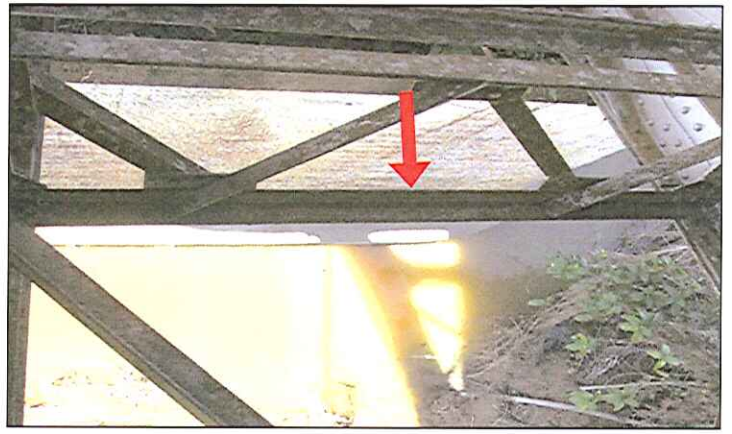
Picture M – S1 – P2

Minor corrosion on vertical bracing of arch beam.



Picture M – S1 – P3

Minor corrosion on inclined cross bracing.

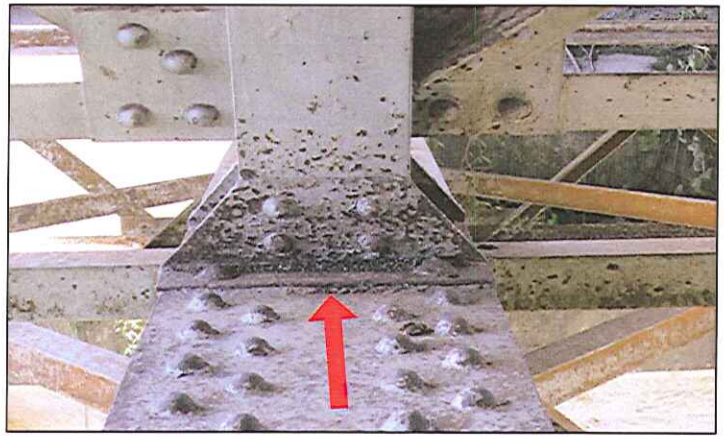


Picture M – S4 – P4

Minor corrosion on inclined cross bracing.

Picture M – S1 – P5

Minor corrosion on inclined cross bracing.



Picture M – S1 – P6

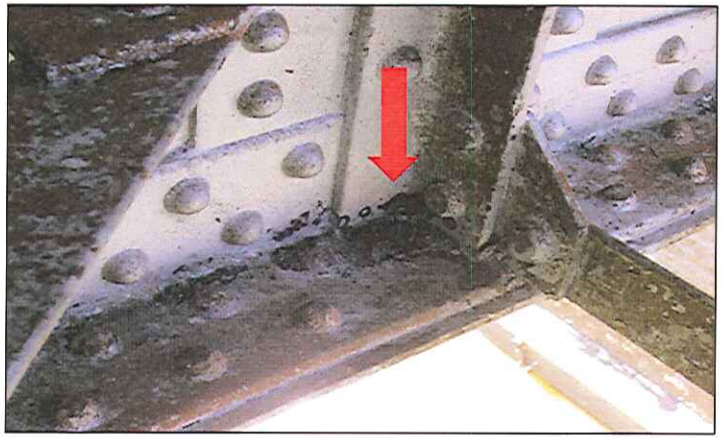
Minor corrosion on vertical bracing joint of arch beam.

Picture M – S1 – P7

Minor corrosion on vertical bracing of arch beam.

Picture M – S1 – P8

Minor corrosion on top flange of arch beam.



Picture M – S1 – P9

Minor corrosion on bottom flange of arch beam.

Picture M – S4– P10

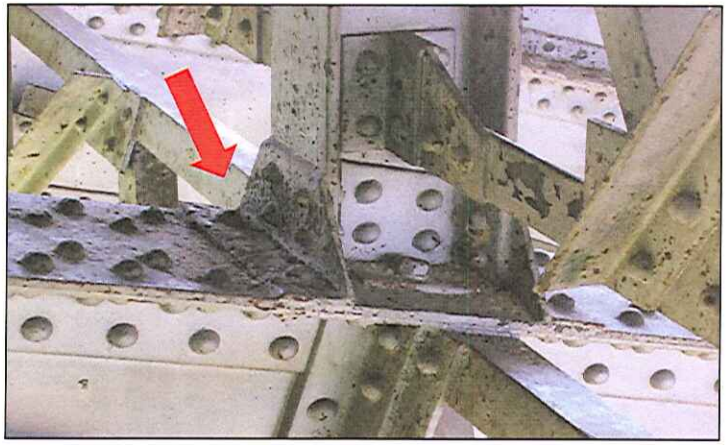
Minor corrosion on inclined cross bracing.

Picture M – S1 – P11

Minor corrosion on vertical bracing joint of arch beam.

Picture M – S1 – P12

Minor corrosion on vertical bracing joint of arch beam.



Picture M – S1 – P13

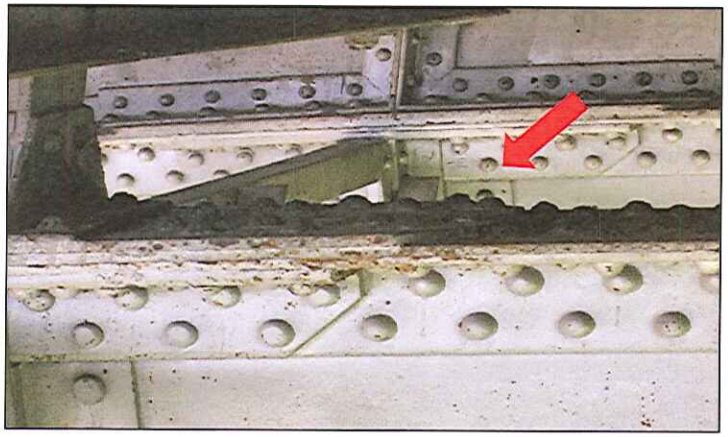
Minor corrosion on vertical bracing joint of arch beam.

Picture M – S1 – P14

Minor corrosion on vertical bracing joint of arch beam.

Picture M – S1 – P15

Minor corrosion on top flange of arch beam.

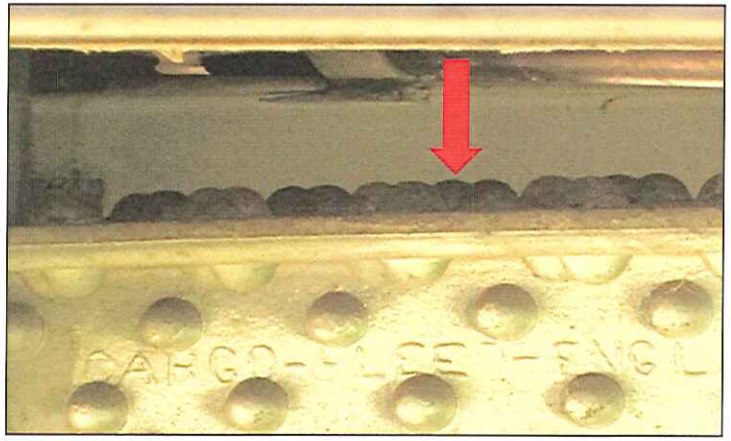


Picture M – S1 – P16

Minor corrosion on top flange of arch beam.

Picture M – S1 – P17

Minor corrosion on top flange of arch beam.

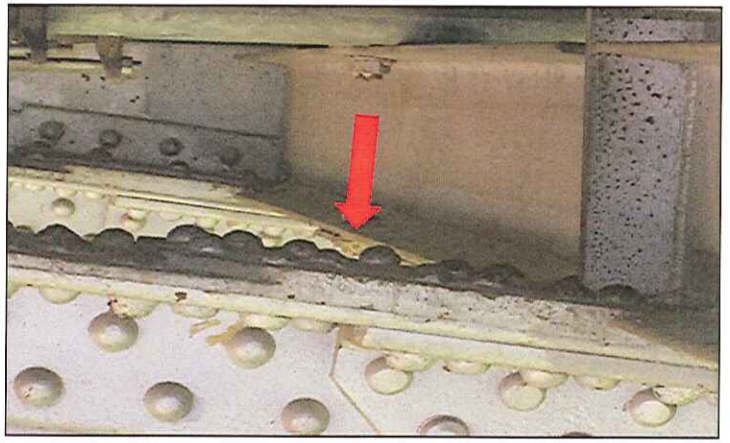


Picture M – S1 – P18

Minor corrosion on top flange of arch beam.

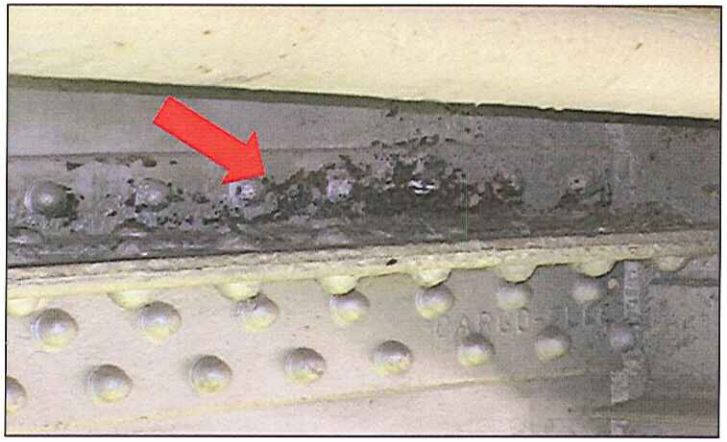
Picture M – S1 – P19

Minor corrosion on top flange of arch beam.



Picture M – S1 – P20

Minor corrosion on top flange of arch beam.

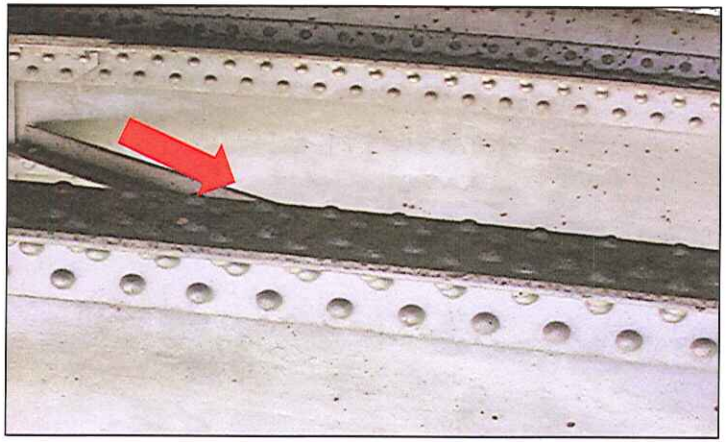


Picture M – S1 – P21

Minor corrosion on top flange of arch beam.

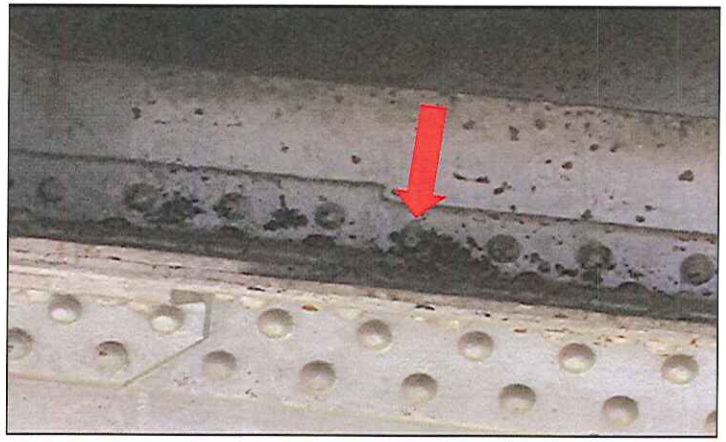
Picture M – S1 – P22

Minor corrosion on top flange of arch beam.



Picture M – S1 – P23

Minor corrosion on top flange of arch beam.



Picture M – S1 – P24

Minor corrosion on top flange of arch beam.

Picture M – S1 – P25

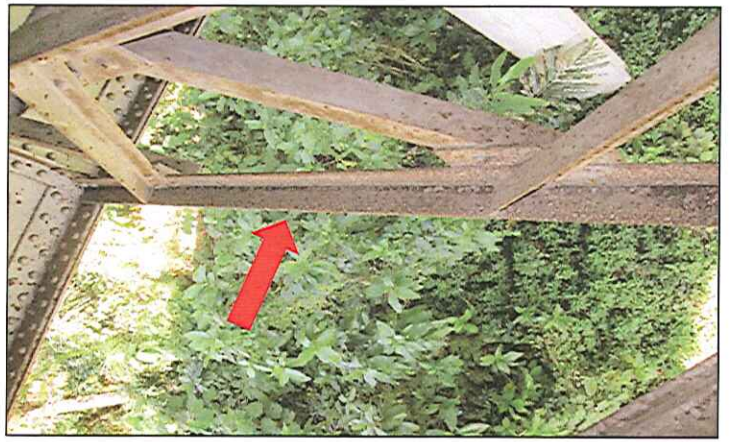
Minor corrosion on bottom flange of arch beam.

Picture M – S1 – P26

Minor corrosion on inclined cross bracing.

Picture M – S1 – P27

Minor corrosion on inclined cross bracing.



Picture M – S1 – P28

Minor corrosion on inclined cross bracing.

Picture M – S1 – P29

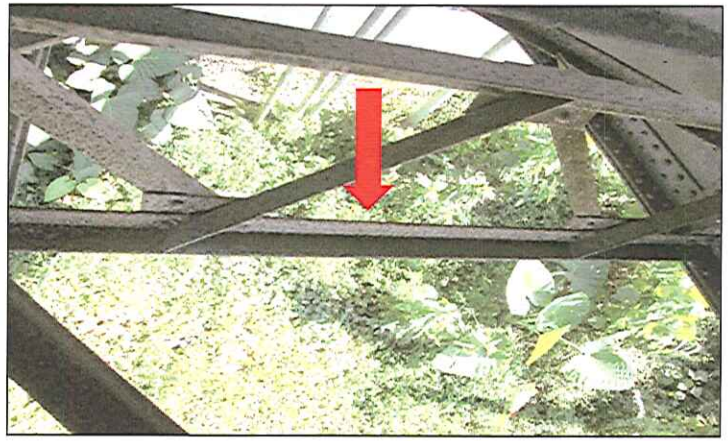
Minor corrosion on vertical bracing joint of arch beam.

Picture M – S1 – P30

Minor corrosion on vertical bracing joint of arch beam.

Picture M – S1 – P31

Minor corrosion on inclined cross bracing.

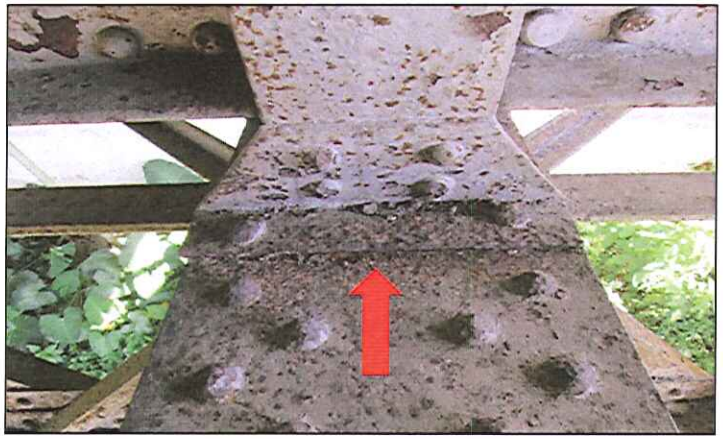


Picture M – S1 – P32

Minor corrosion on inclined cross bracing.

Picture M – S1 – P33

Minor corrosion on inclined cross bracing.



Picture M – S1 – P34

Minor corrosion on vertical bracing joint of arch beam.

Picture M – S1 – P35

Minor corrosion on vertical bracing joint of arch beam.

Picture M – S1 – P36

Minor corrosion on inclined cross bracing.

Picture M – S1 – P37

Minor corrosion on inclined cross bracing.

Picture M – S1 – P38

Minor corrosion on inclined cross bracing.

Picture M – S1 – P39

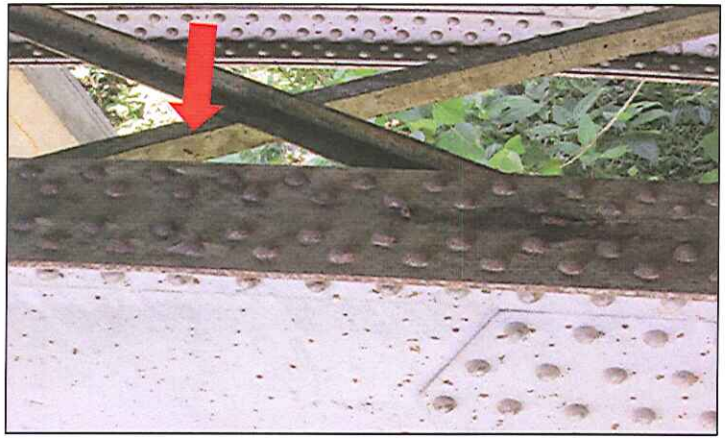
Minor corrosion on top flange of arch beam.

Picture M – S1 – P40

Minor corrosion on top flange of arch beam.

Picture M – S1 – P41

Minor corrosion on top flange of arch beam.



Picture M – S1 – P42

Minor corrosion on top flange of arch beam.

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FINAL REPORT
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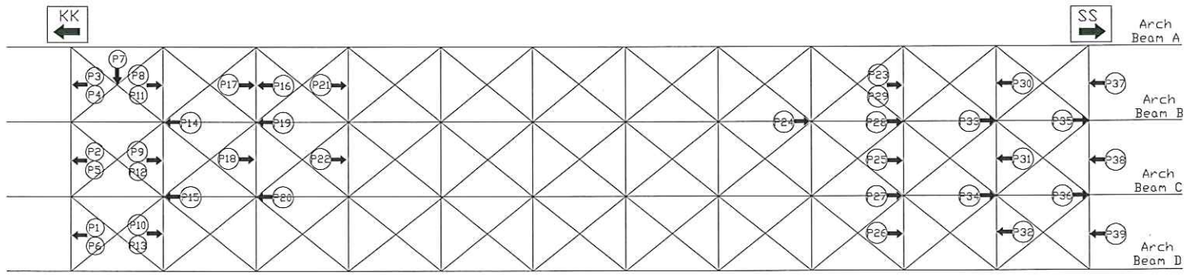
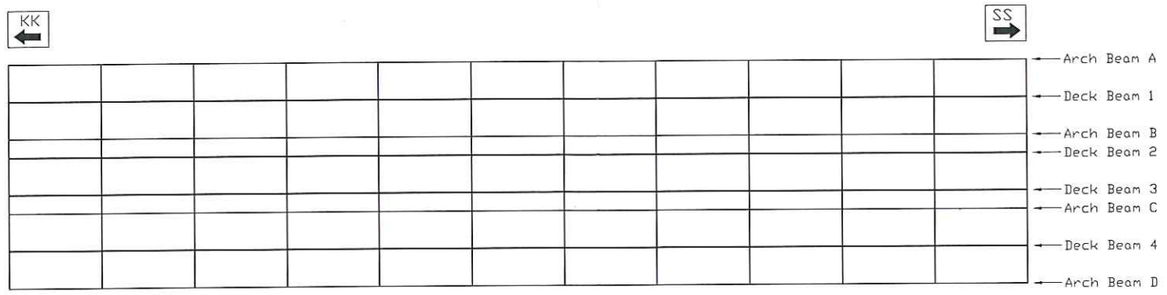
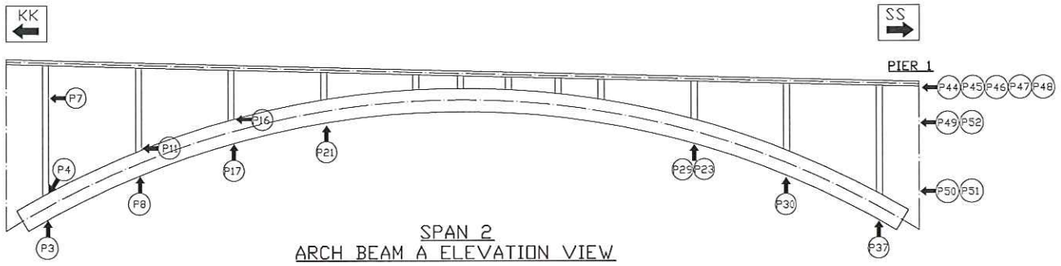
APPENDIX 4b
Detailed Visual Inspection Observations on Bridge Spans
(Span 2)



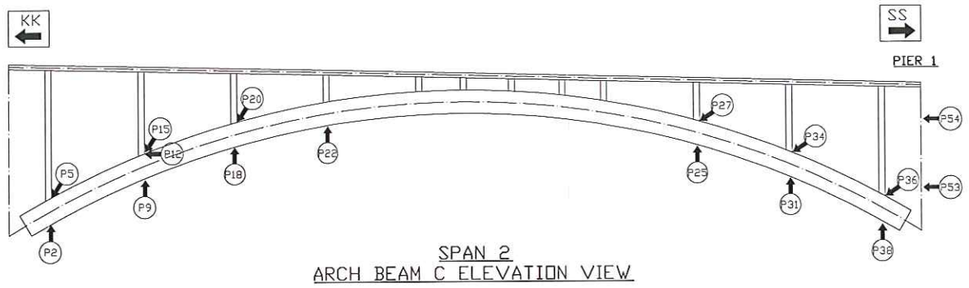
SPAN 2
ARCH BEAMS LAYOUT PLAN



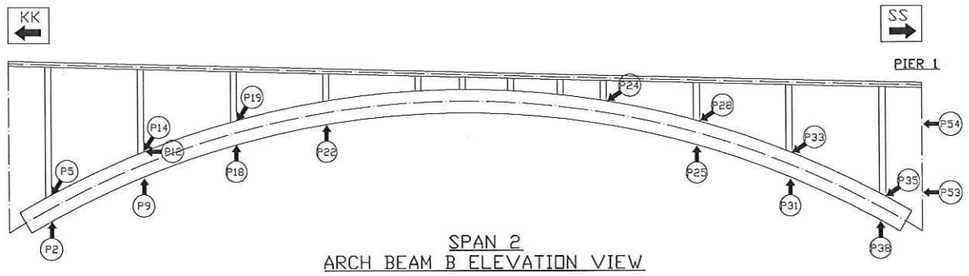
SPAN 2
DECK BEAMS LAYOUT PLAN



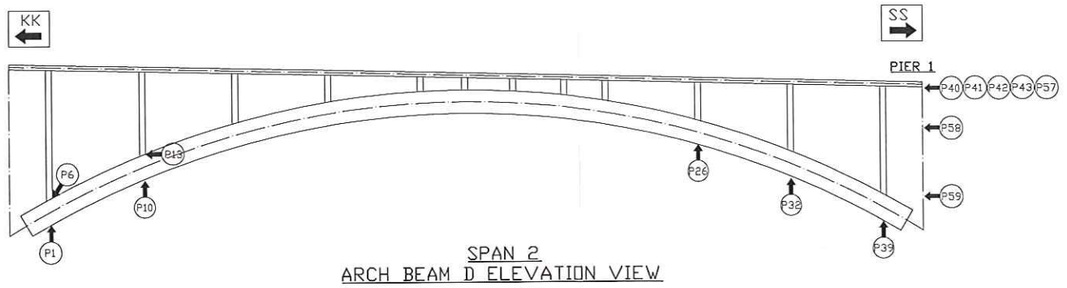
SPAN 2
ARCH BEAM A ELEVATION VIEW



SPAN 2
ARCH BEAM C ELEVATION VIEW



SPAN 2
ARCH BEAM B ELEVATION VIEW



SPAN 2
ARCH BEAM D ELEVATION VIEW

JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK
LAYOUTS / ELEVATIONS FOR PHOTOGRAPHIC RECORD OF THE CONDUCTED VISUAL INSPECTION FOR VISIBLE STRUCTURAL DISTRESS, DETERIORATION AND DAMAGES OF BRIDGE SPAN 2

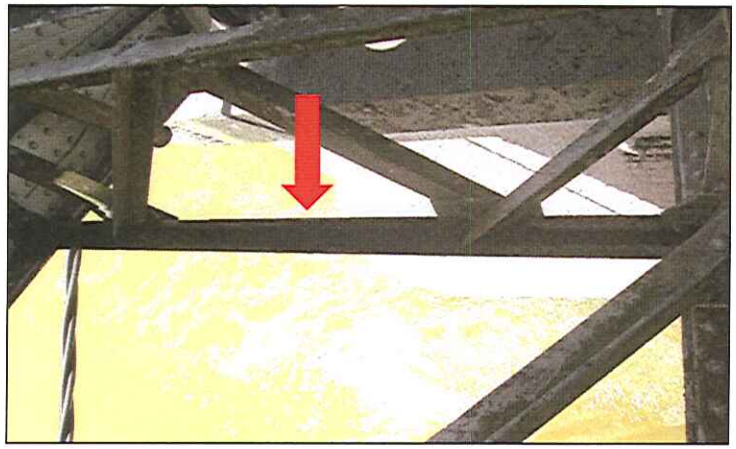
LEGEND

- ← P1 Refer Photographic Record M-S2-P1
- ← P2 Refer Photographic Record M-S2-P2
- ← P3 Refer Photographic Record M-S2-P3

..... etc .....

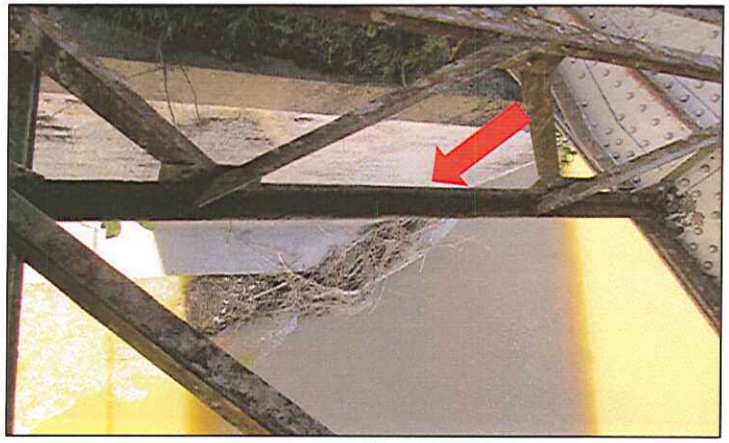
NOTE

Visual Inspections for any visible structural distress, deterioration and damages were conducted between January 2015 to March 2015.



Picture M – S2 – P1

Minor corrosion on inclined cross bracing.



Picture M – S2 – P2

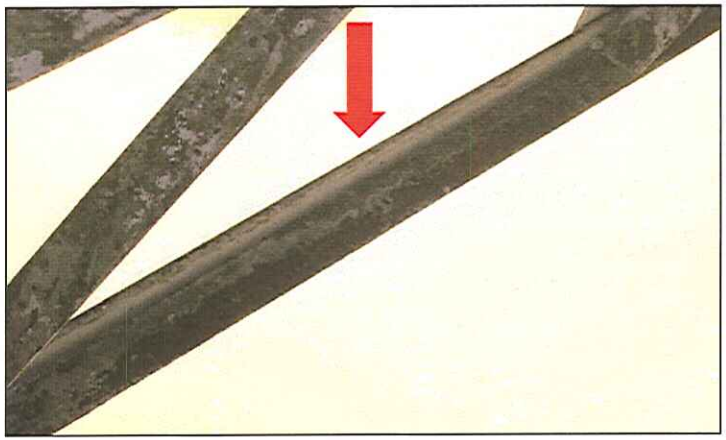
Minor corrosion on inclined cross bracing.

Picture M – S2 – P3

Minor corrosion on inclined cross bracing.

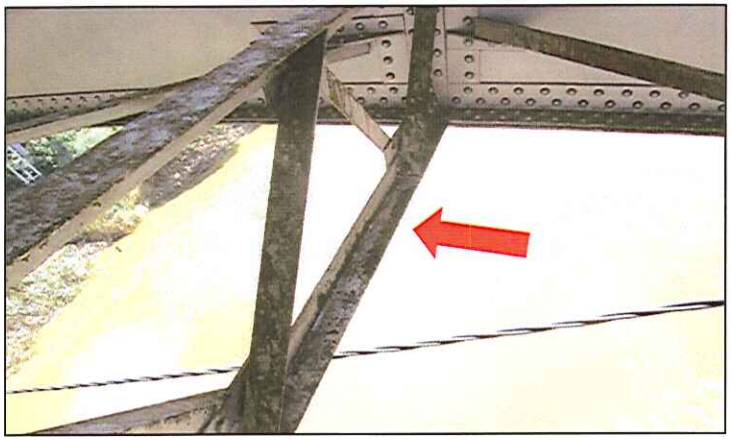
Picture M – S2 – P4

Minor corrosion on vertical cross bracing.



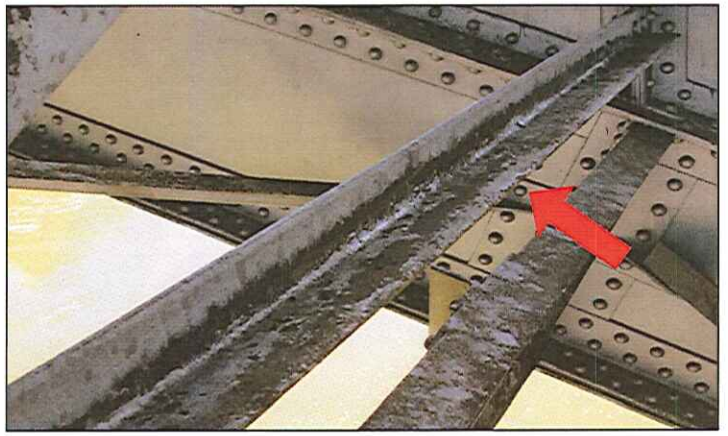
Picture M – S2 – P9

Minor corrosion on inclined cross bracing.



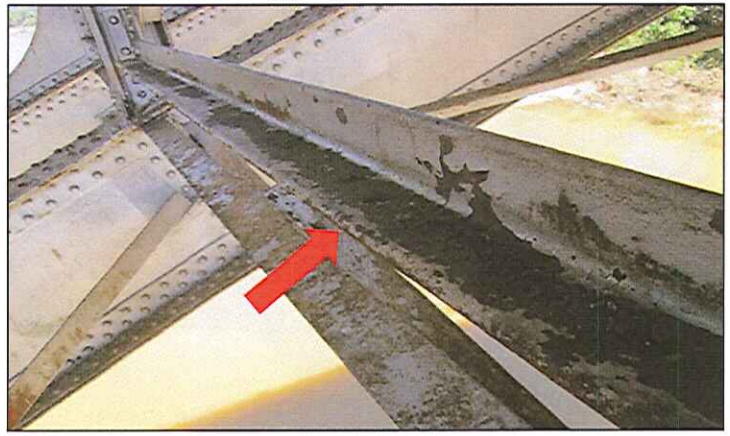
Picture M – S2– P10

Minor corrosion on inclined cross bracing.



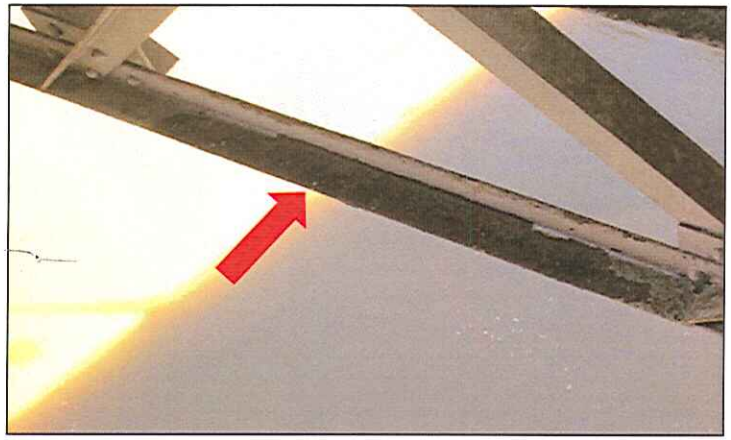
Picture M – S2 – P11

Minor corrosion on vertical cross bracing.



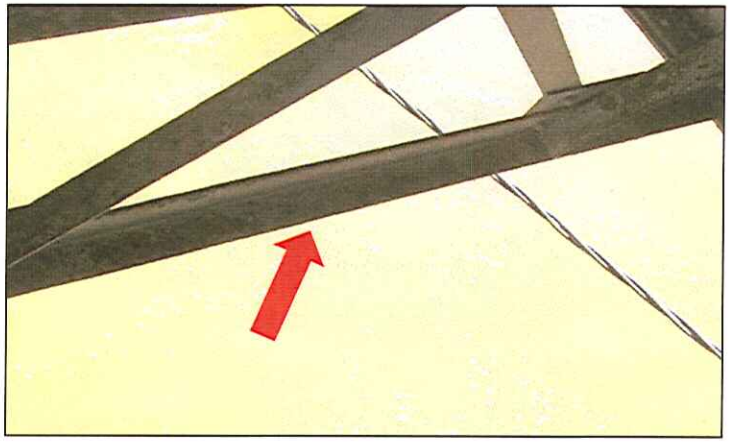
Picture M – S2 – P12

Minor corrosion on vertical cross bracing.



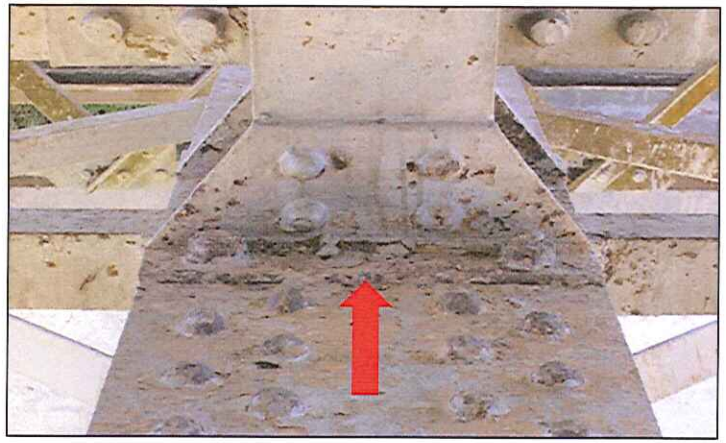
Picture M – S2 – P17

Minor corrosion on inclined cross bracing.



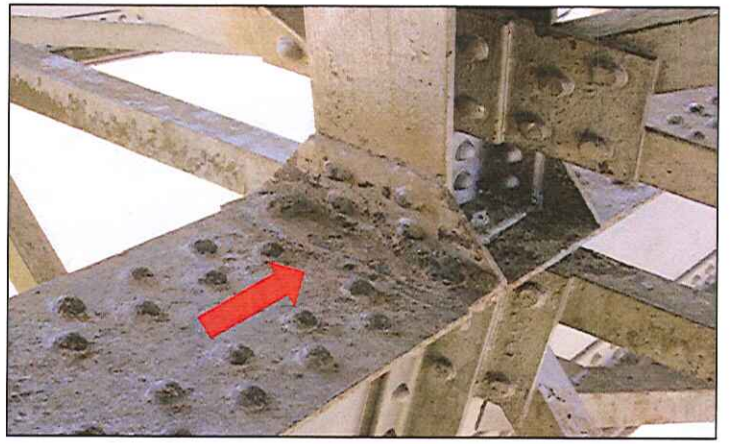
Picture M – S2 – P18

Minor corrosion on inclined cross bracing.



Picture M – S2 – P19

Minor corrosion on vertical bracing joint of arch beam.

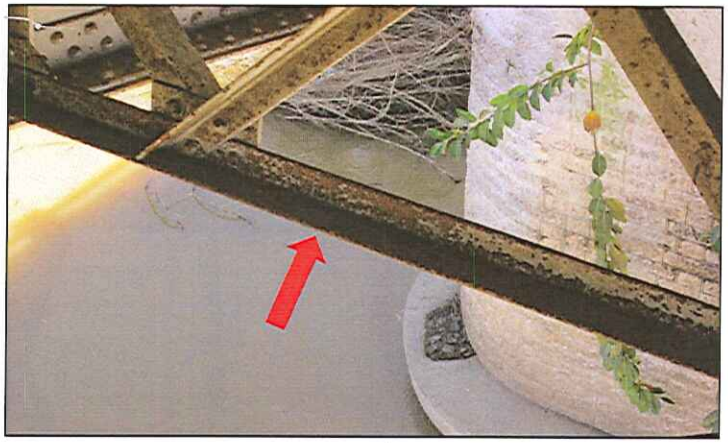


Picture M – S2 – P20

Minor corrosion on vertical bracing joint of arch beam.

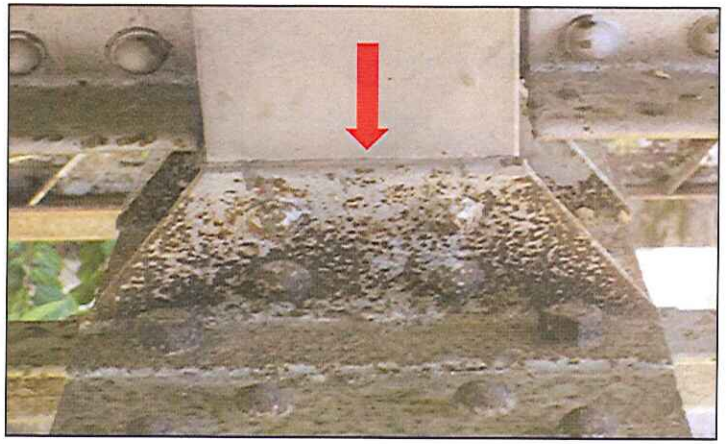
Picture M – S2 – P25

Minor corrosion on inclined cross bracing.



Picture M – S4 – P26

Minor corrosion on inclined cross bracing.



Picture M – S2 – P27

Minor corrosion on vertical bracing joint of arch beam.

Picture M – S4 – P28

Minor corrosion on vertical bracing joint of arch beam.

Picture M – S2 – P33

Minor corrosion on vertical cross bracing joint of arch beam.

Picture M – S2 – P34

Minor corrosion on vertical bracing joint of arch beam.

Picture M – S2 – P35

Minor corrosion on vertical bracing joint of arch beam.

Picture M – S2 – P36

Minor corrosion on vertical bracing joint of arch beam.

Picture M – S2 – P41

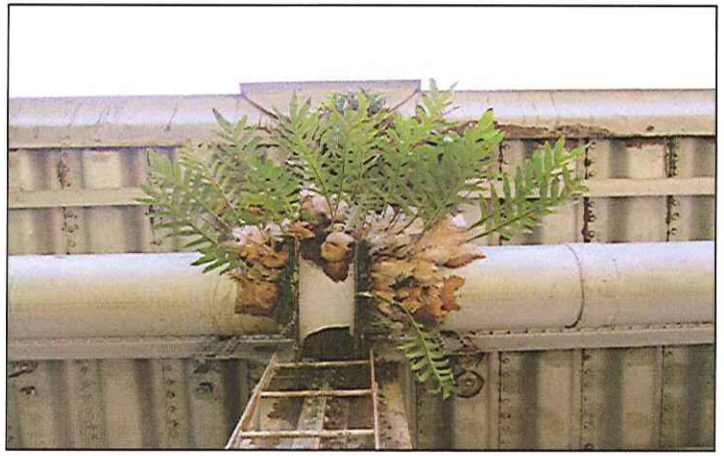
Moderate corrosion and crack line on steel plate.

Picture M – S2 – P42

Moderate corrosion and crack line on steel plate.

Picture M – S2 –P43

Moderate corrosion and crack line steel plate.

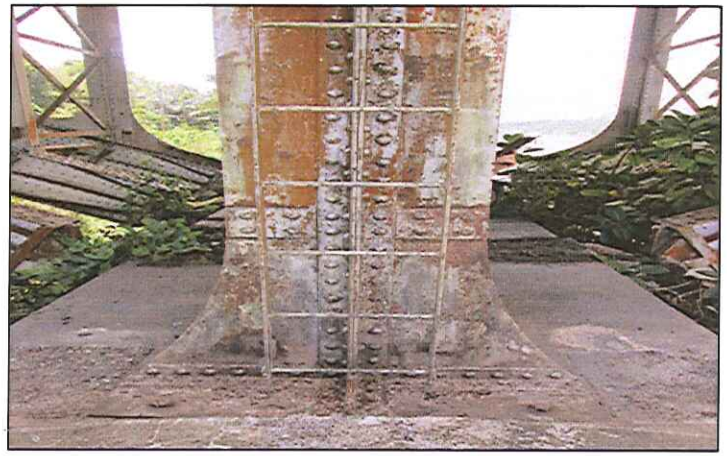


Picture M – S2 – P44

Moderate corrosion, vegetation and crack line on steel plate.

Picture M – S2 – P49

Minor corrosion on overall middle frame.



Picture M – S2 – P50

Minor corrosion on overall middle frame.

Picture M – S2 – P51

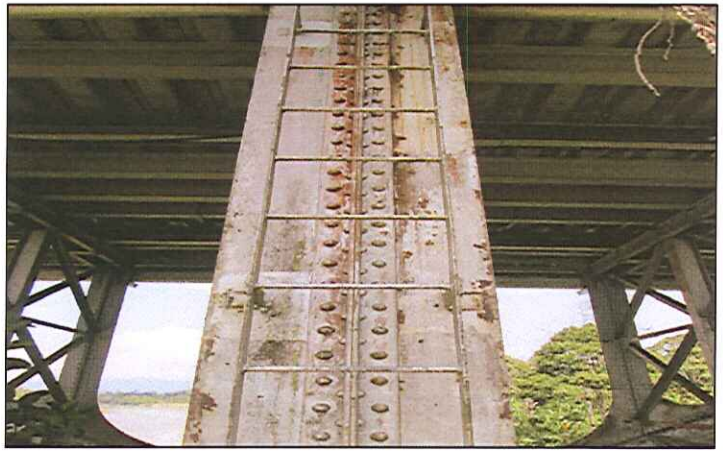
Minor corrosion on overall middle frame.

Picture M – S2 – P52

Moderate corrosion on overall middle frame.

Picture M – S2 – P57

Moderate corrosion on overall middle frame.



Picture M – S2 – P58

Minor corrosion on overall middle frame.

Picture M – S2 – P59

Minor corrosion on overall middle frame.

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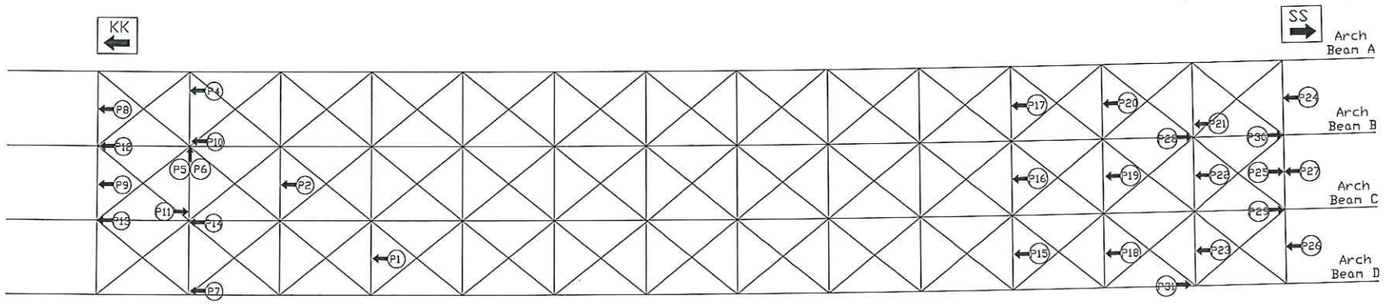
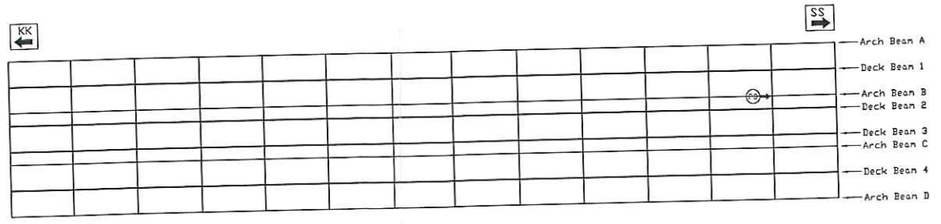
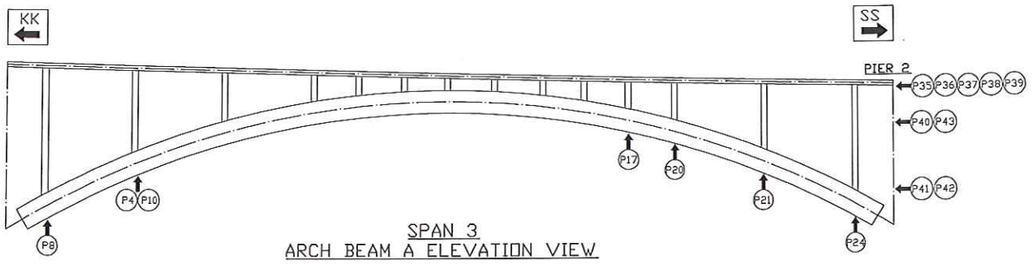
APPENDIX 4c
Detailed Visual Inspection Observations on Bridge Spans
(Span 3)



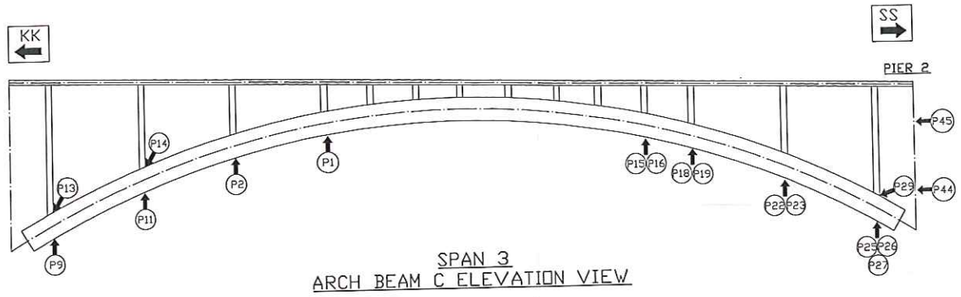
SPAN 3
ARCH BEAMS LAYOUT PLAN



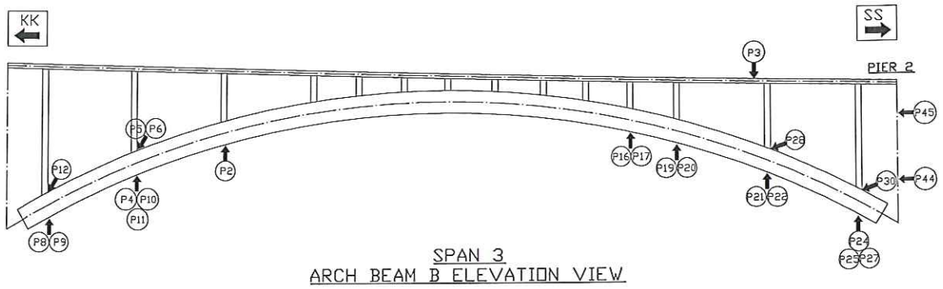
SPAN 3
DECK BEAMS LAYOUT PLAN



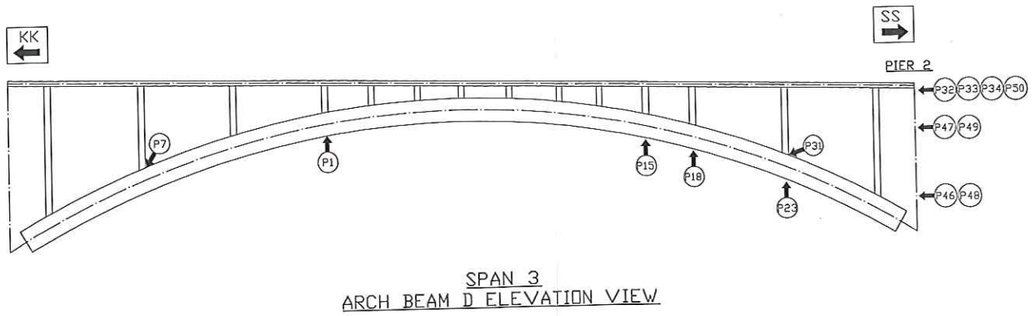
SPAN 3
ARCH BEAM A ELEVATION VIEW



SPAN 3
ARCH BEAM C ELEVATION VIEW



SPAN 3
ARCH BEAM B ELEVATION VIEW



SPAN 3
ARCH BEAM D ELEVATION VIEW

JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK
LAYOUTS / ELEVATIONS FOR PHOTOGRAPHIC RECORD OF THE CONDUCTED VISUAL INSPECTION FOR VISIBLE STRUCTURAL DISTRESS, DETERIORATION AND DAMAGES OF BRIDGE SPAN 3

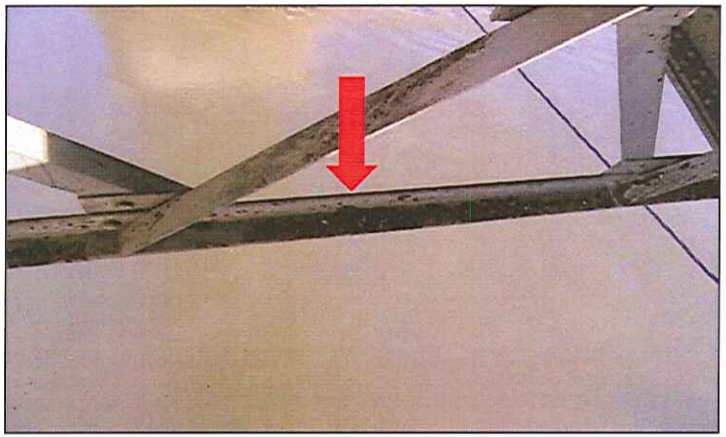
LEGEND

- ←(P1) Refer Photographic Record M-S3-P1
- ←(P2) Refer Photographic Record M-S3-P2
- ←(P3) Refer Photographic Record M-S3-P3

..... etc .....

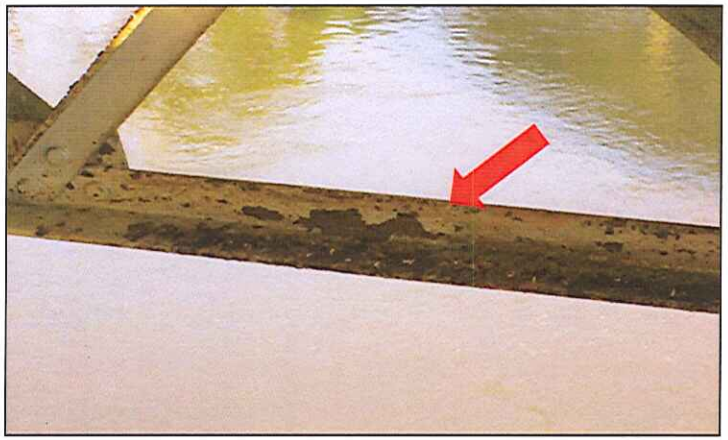
NOTE

Visual Inspections for any visible structural distress, deterioration and damages were conducted between January 2015 to March 2015.



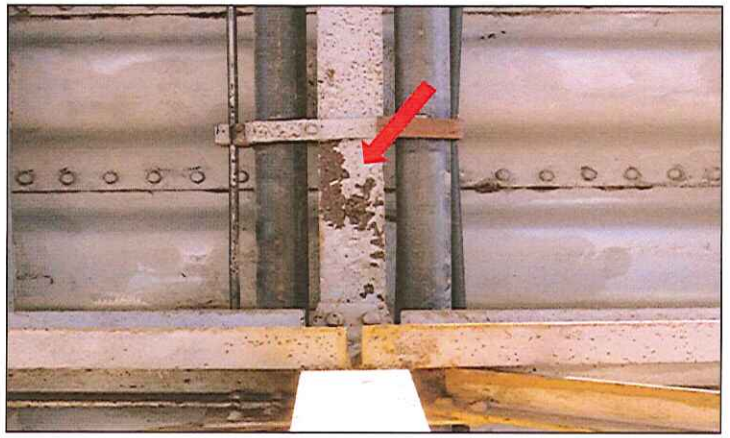
Picture M – S3 – P1

Minor corrosion on inclined cross bracing.



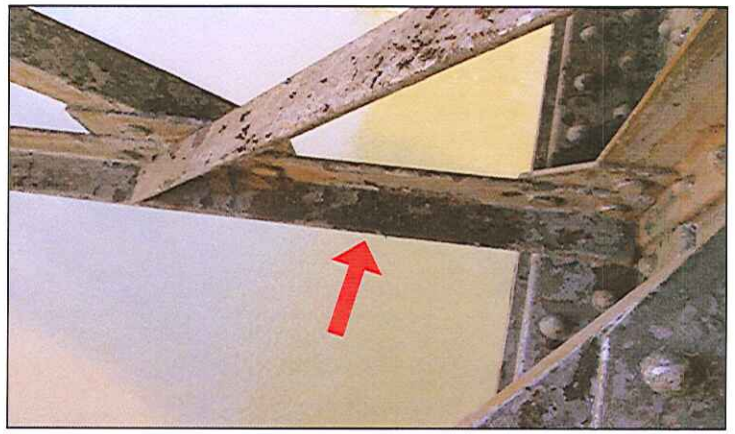
Picture M – S3 – P2

Minor corrosion on inclined cross bracing.



Picture M – S3 – P3

Minor corrosion on I-beam.



Picture M – S3 – P4

Minor corrosion on inclined cross bracing.

Picture M – S3 – P5

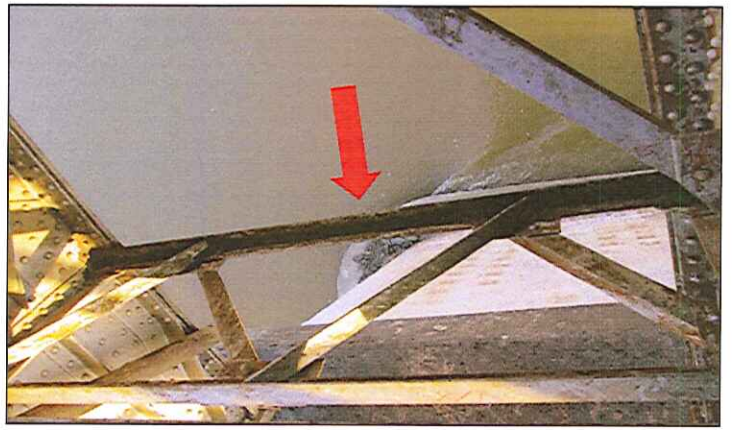
Minor corrosion on vertical bracing of arch beam.

Picture M – S3 – P6

Minor corrosion on vertical bracing of arch beam.

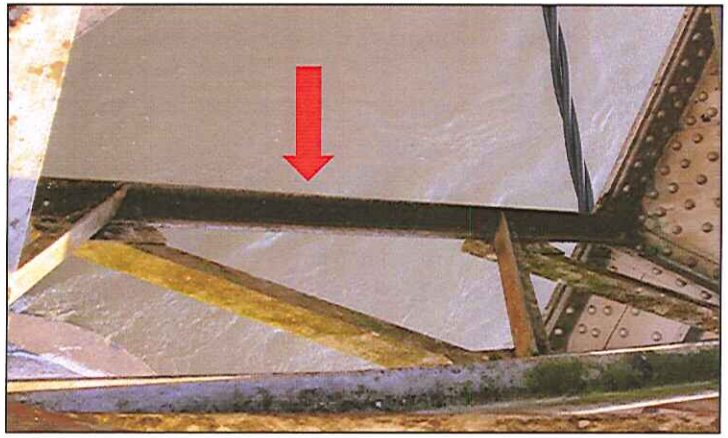
Picture M – S3 – P7

Minor corrosion on top flange of arch beam.



Picture M – S3 – P8

Moderate corrosion on inclined cross bracing.



Picture M – S3 – P9

Moderate corrosion on inclined cross bracing.

Picture M – S3 – P10

Minor corrosion on inclined cross bracing.

Picture M – S3 – P11

Minor corrosion on inclined cross bracing.

Picture M – S3 – P12

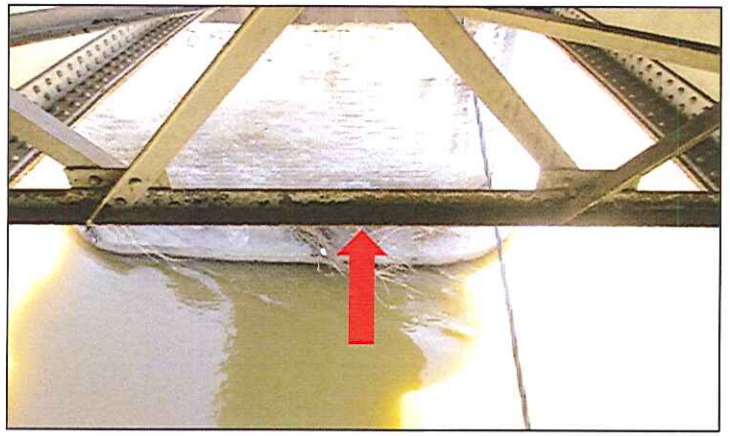
Moderate corrosion on vertical joint bracing of arch beam.

Picture M – S3 – P13

Minor corrosion on vertical bracing joint of arch beam.

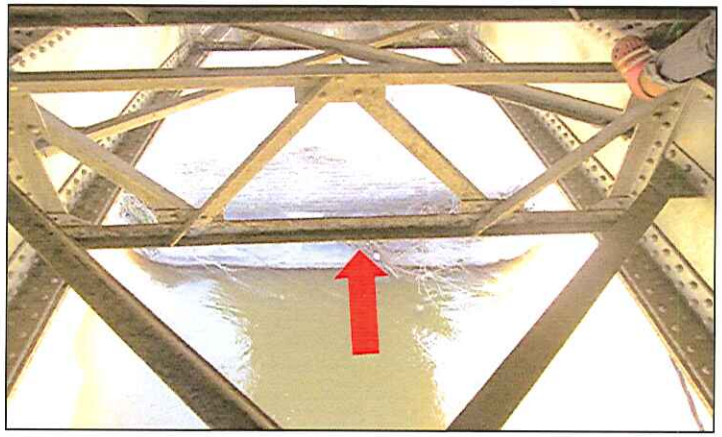
Picture M – S3 – P14

Minor corrosion on vertical bracing joint of arch beam.



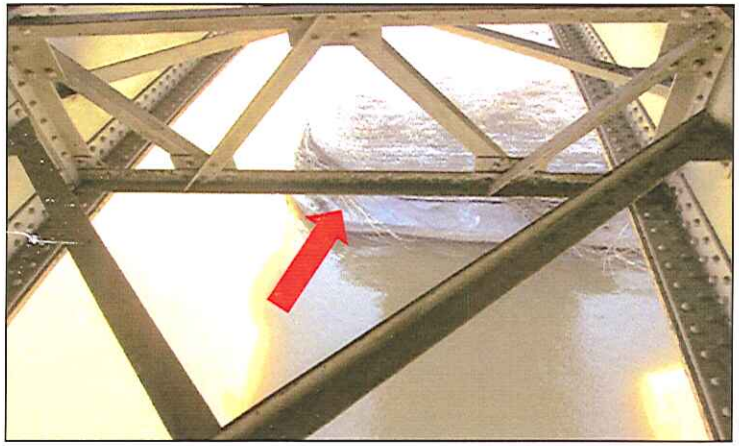
Picture M – S3 – P15

Moderate corrosion on inclined cross bracing.



Picture M – S3 – P16

Minor corrosion on inclined cross bracing.

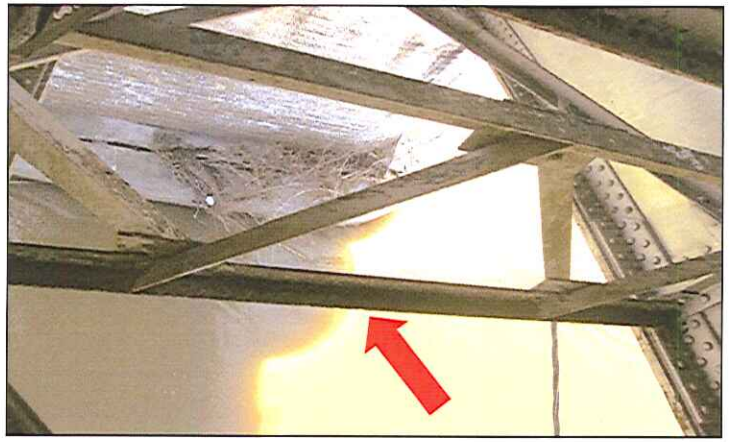


Picture M – S3 – P17

Minor corrosion on inclined cross bracing.

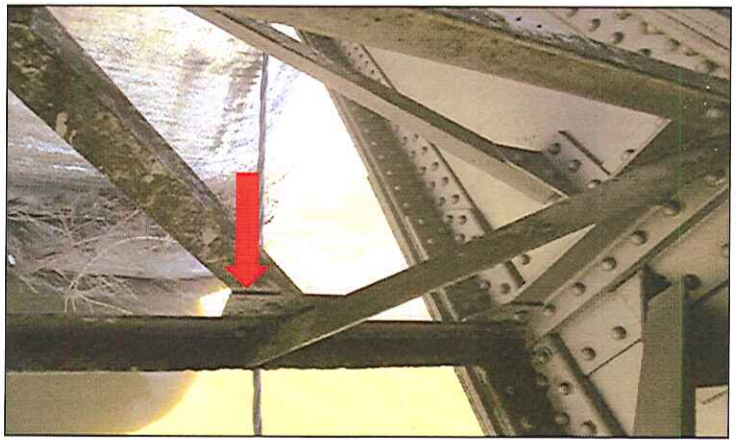
Picture M – S3 – P18

Minor corrosion on inclined cross bracing.



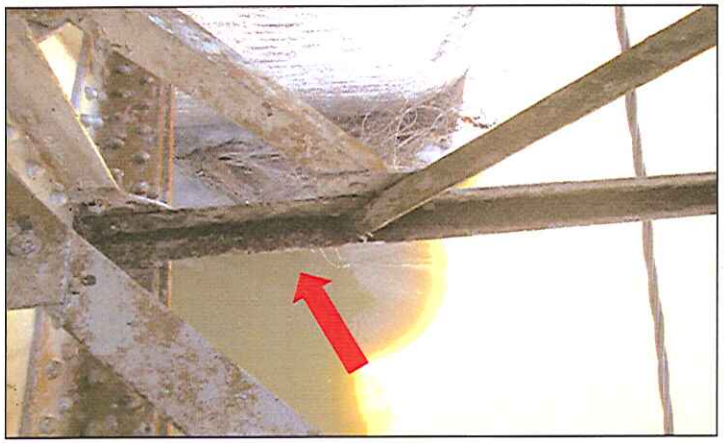
Picture M – S3 – P19

Minor corrosion on inclined cross bracing.



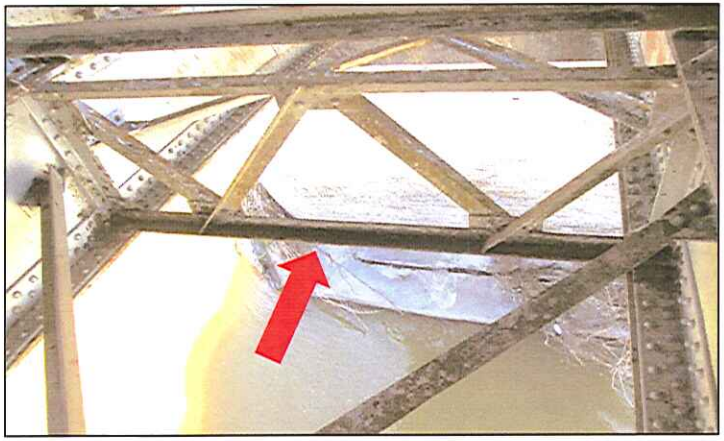
Picture M – S3 – P20

Moderate corrosion on inclined cross bracing.



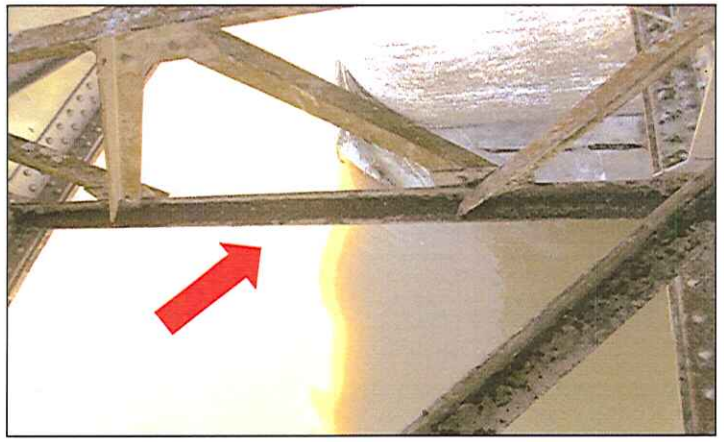
Picture M – S3 – P21

Minor corrosion on inclined cross bracing.



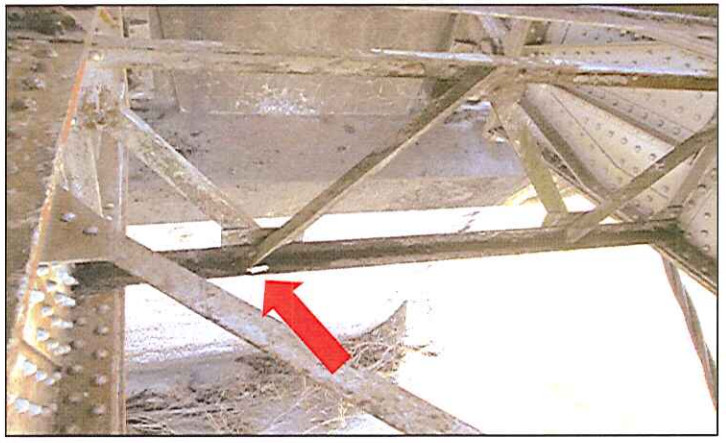
Picture M – S3 – P22

Minor corrosion on inclined cross bracing.



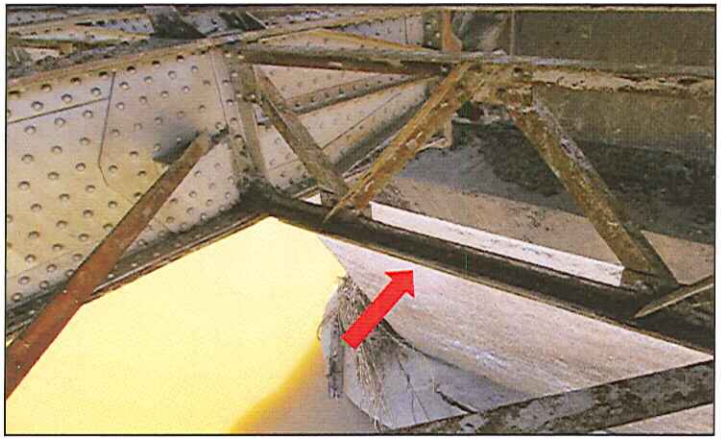
Picture M – S3 – P23

Minor corrosion on inclined cross bracing.



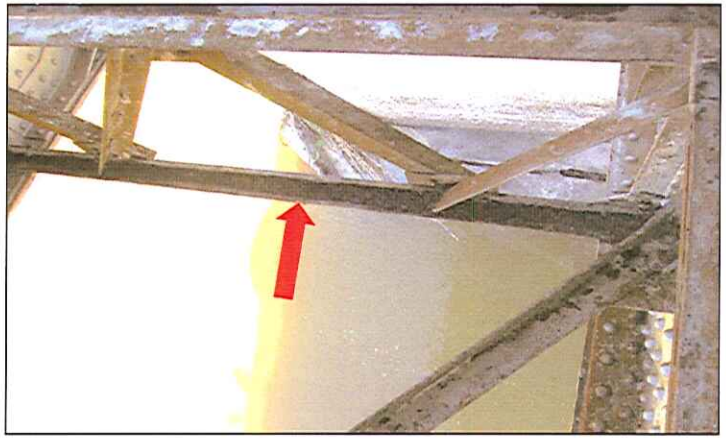
Picture M – S3 – P24

Moderate corrosion on inclined cross bracing.



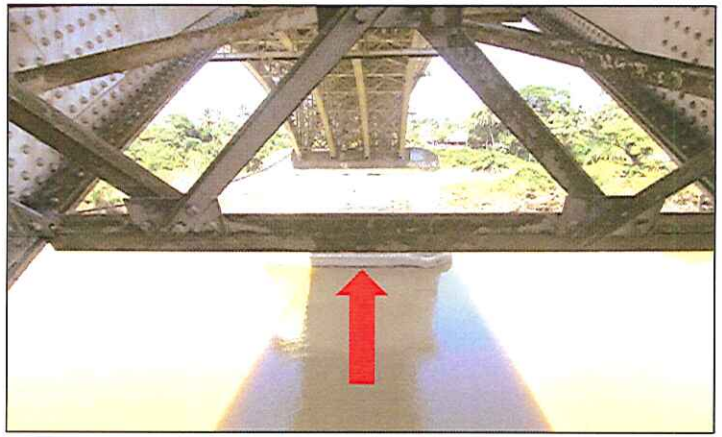
Picture M – S3 – P25

Minor corrosion on inclined cross bracing.



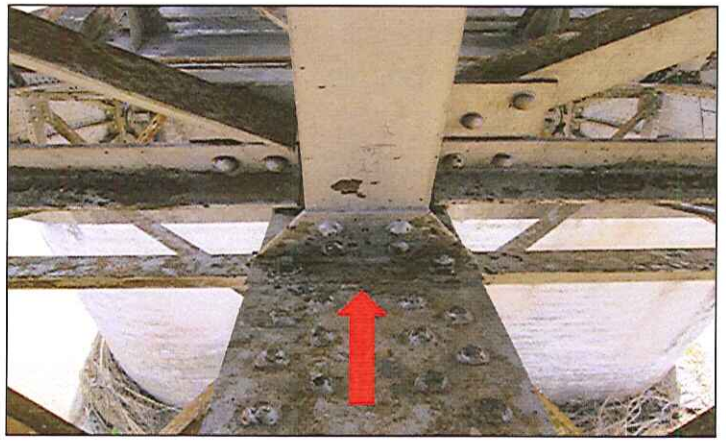
Picture M – S3 – P26

Minor corrosion on inclined cross bracing.



Picture M – S3 – P27

Minor corrosion on inclined cross bracing.



Picture M – S3 – P28

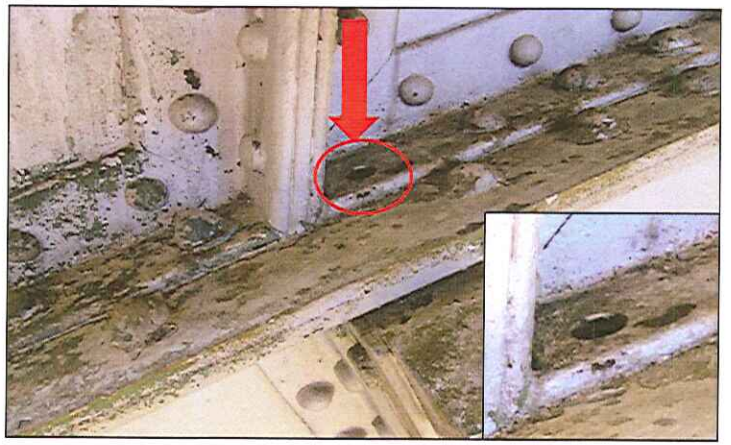
Minor corrosion on vertical bracing joint of arch beam.

Picture M – S3 – P29

Minor corrosion on vertical bracing joint of arch beam.

Picture M – S3 – P30

Minor corrosion on vertical bracing joint of arch beam.



Picture M – S3 – P31

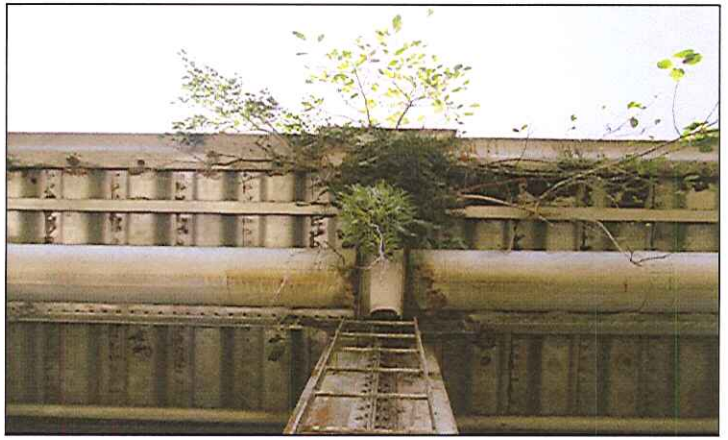
Minor corrosion and missing rivet on bottom flange of arch beam.

Picture M – S3 – P32

Moderate corrosion on steel frame.

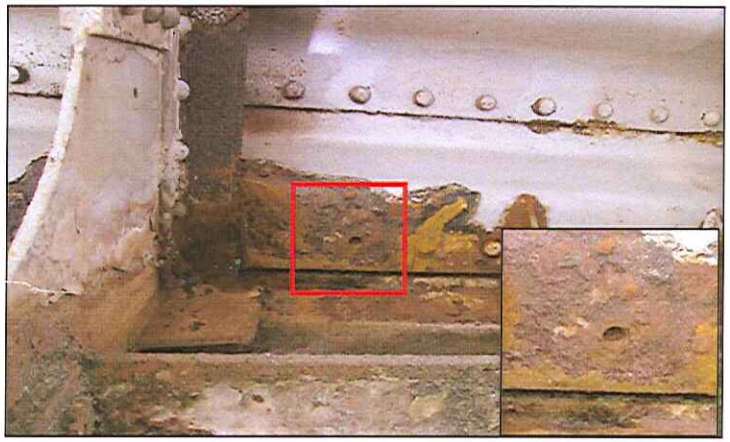
Picture M – S3 –P33 andM – S3 –P34

Moderate corrosion on steel frame.



Picture M – S3 – P35 and M – S3 – P36

Moderate corrosion on steel plate.



Picture M – S3 –P37 andM – S3 –P38.

Moderate corrosion and missing bolt on steel plate.

Picture M – S3 – P39

Minor corrosion on overall middle frame.

Picture M – S3 – P40

Minor corrosion on overall middle frame.

Picture M – S3 – P41

Minor corrosion on overall middle frame.

Picture M – S3 – P42

Minor corrosion on overall middle frame.

Picture M – S3 – P43

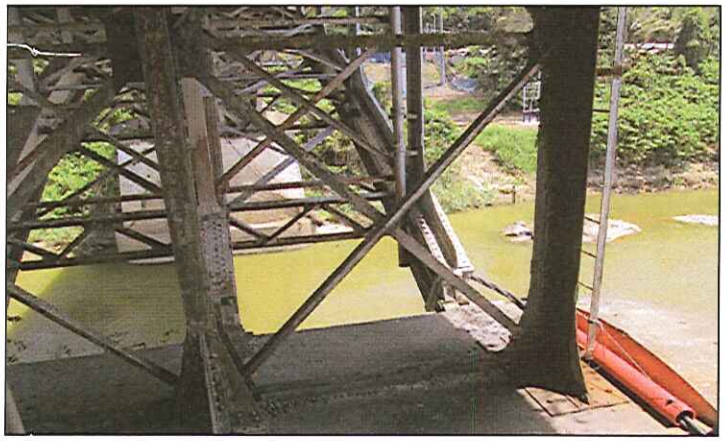
Moderate corrosion on overall middle frame.

Picture M – S3 – P44

Minor corrosion on overall middle frame.

Picture M – S3 – P45

Moderate corrosion on overall middle frame.



Picture M – S3 – P46

Minor corrosion on overall middle frame.

Picture M – S3 – P47

Moderate corrosion on overall middle frame.

Picture M – S3 – P48

Minor corrosion on overall middle frame.

Picture M – S3 – P49

Minor corrosion on overall middle frame.

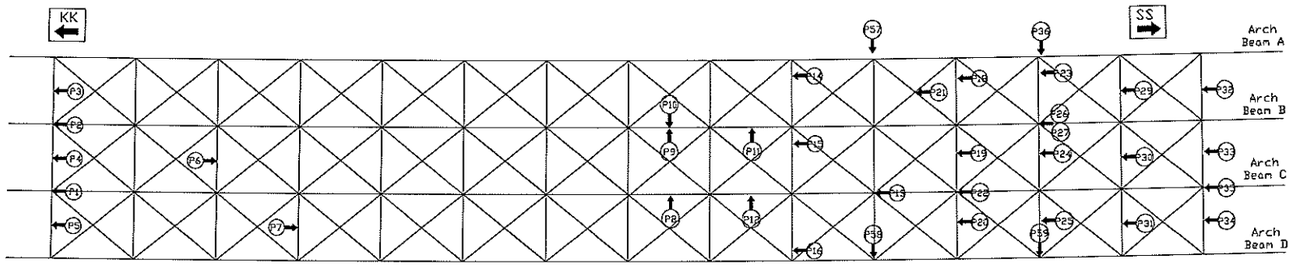
Picture M – S3 – P50

Moderate corrosion on overall middle frame.

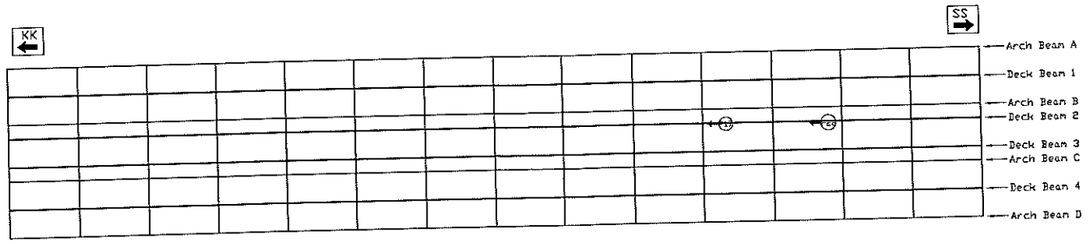
KAJIAN BAGI MENGGANTIKAN JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK.
- THE STRUCTURAL ASSESSMENT AND REHABILITATION OF JAMBATAN SULTAN ISKANDAR.

FINAL REPORT
VOLUME 1 OF 4 : MAIN REPORT

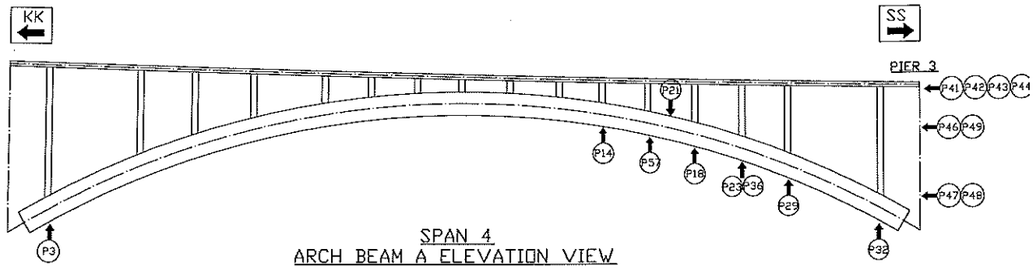
APPENDIX 4d
Detailed Visual Inspection Observations on Bridge Spans
(Span 4)



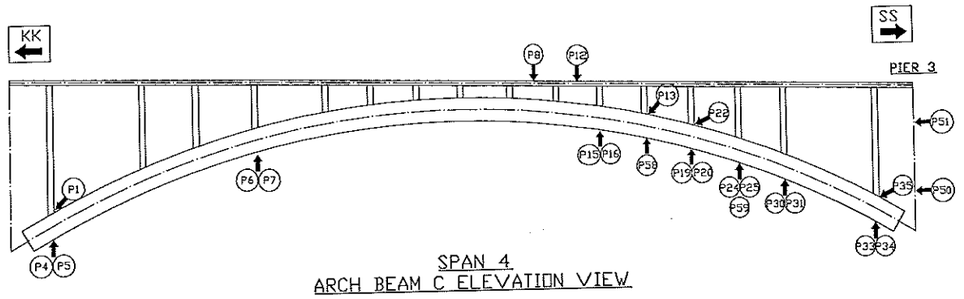
SPAN 4
ARCH BEAMS LAYOUT PLAN



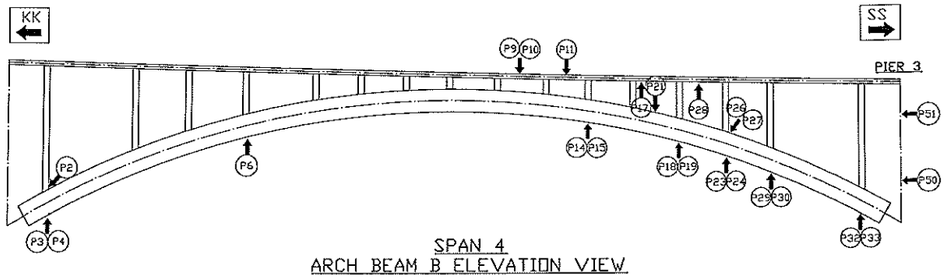
SPAN 4
DECK BEAMS LAYOUT PLAN



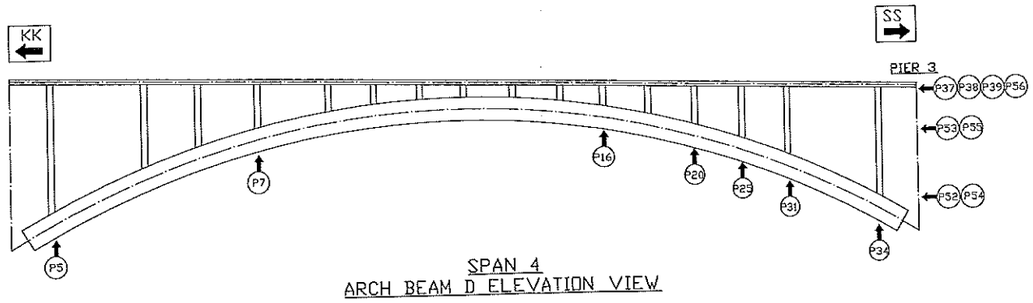
SPAN 4
ARCH BEAM A ELEVATION VIEW



SPAN 4
ARCH BEAM C ELEVATION VIEW



SPAN 4
ARCH BEAM B ELEVATION VIEW



SPAN 4
ARCH BEAM D ELEVATION VIEW

JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK
LAYOUTS / ELEVATIONS FOR PHOTOGRAPHIC RECORD OF THE CONDUCTED VISUAL INSPECTION FOR VISIBLE STRUCTURAL DISTRESS, DETERIORATION AND DAMAGES OF BRIDGE SPAN 4

LEGEND

- ←(P1) Refer Photographic Record M-S4-P1
- ←(P2) Refer Photographic Record M-S4-P2
- ←(P3) Refer Photographic Record M-S4-P3

..... etc .....

NOTE

Visual Inspections for any visible structural distress, deterioration and damages were conducted between January 2015 to March 2015.

Picture M – S4 – P1

Moderate corrosion on vertical bracing of arch beam.

Picture M – S4 – P2

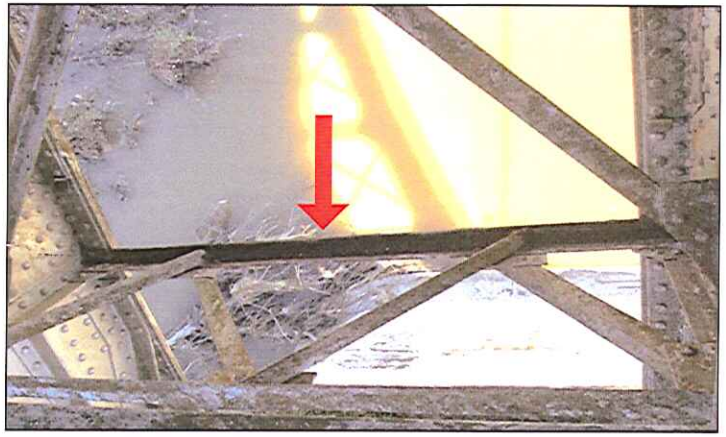
Moderate corrosion on vertical bracing of arch beam.

Picture M – S4 – P3

Minor corrosion on inclined cross bracing.

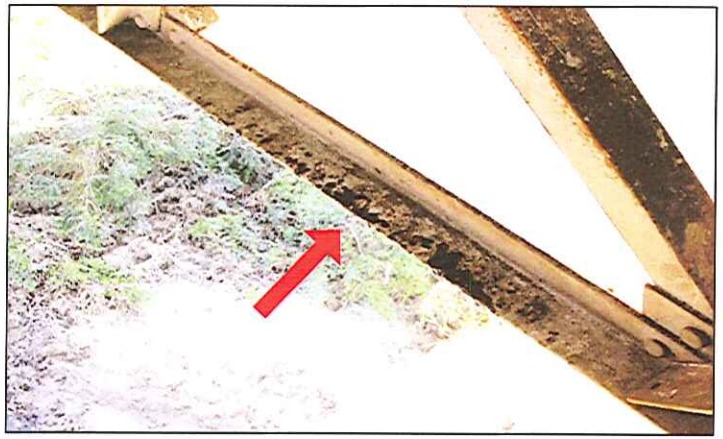
Picture M – S4 – P4

Minor corrosion on inclined cross bracing.



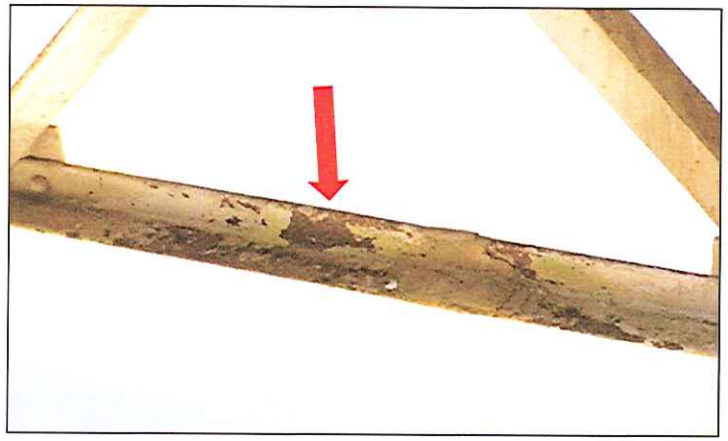
Picture M – S4 – P5

Minor corrosion on inclined cross bracing.



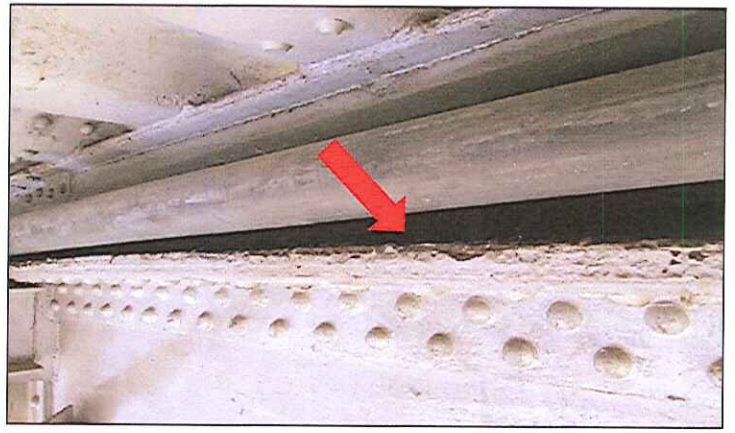
Picture M – S4 – P6

Minor corrosion on inclined cross bracing.



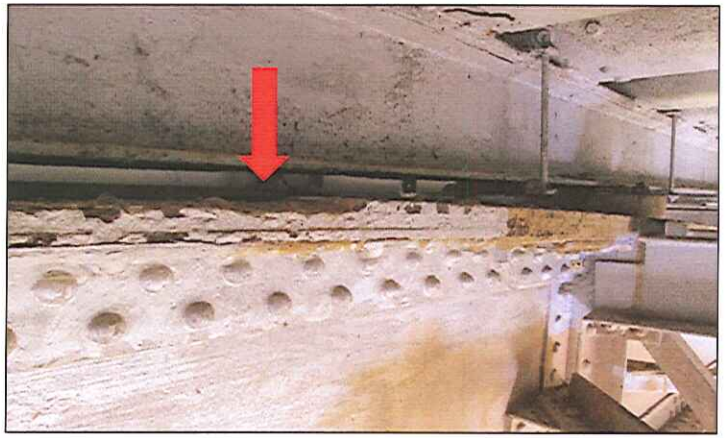
Picture M – S4 – P7

Minor corrosion on inclined cross bracing.



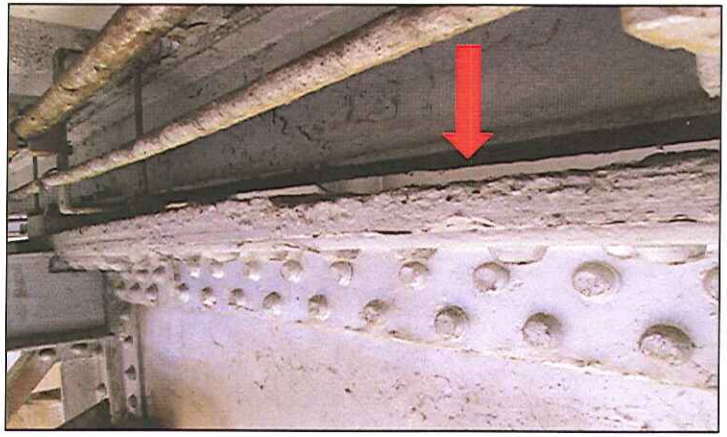
Picture M – S4 – P8

Minor corrosion on top flange of arch beam.



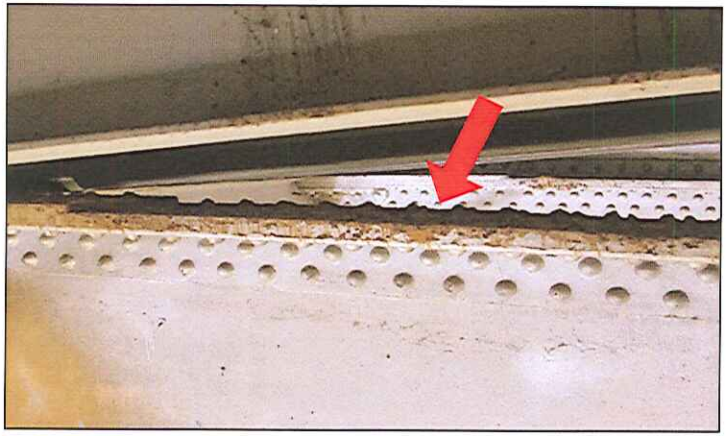
Picture M – S4 – P9

Moderate corrosion on top flange of arch beam.



Picture M – S4– P10

Minor corrosion on top flange of arch beam.



Picture M – S4 – P11

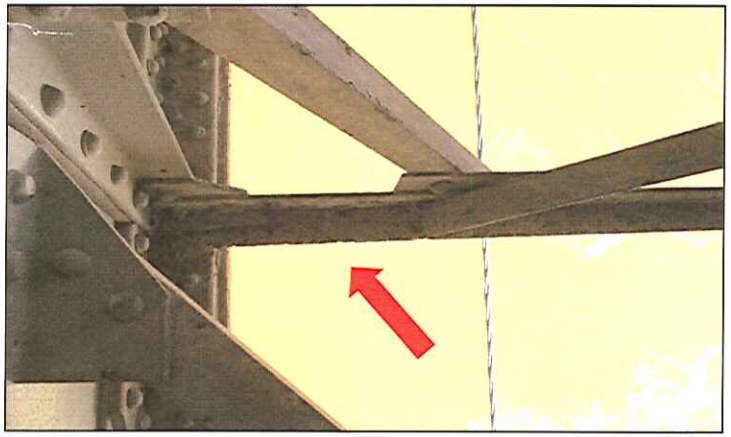
Minor corrosion on top flange of arch beam.

Picture M – S4 – P12

Minor corrosion on top flange of arch beam.

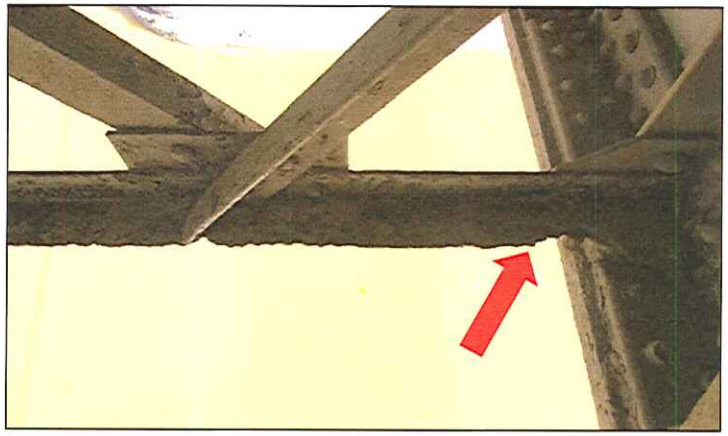
Picture M – S4 – P13

Minor corrosion on vertical bracing joint of arch beam.



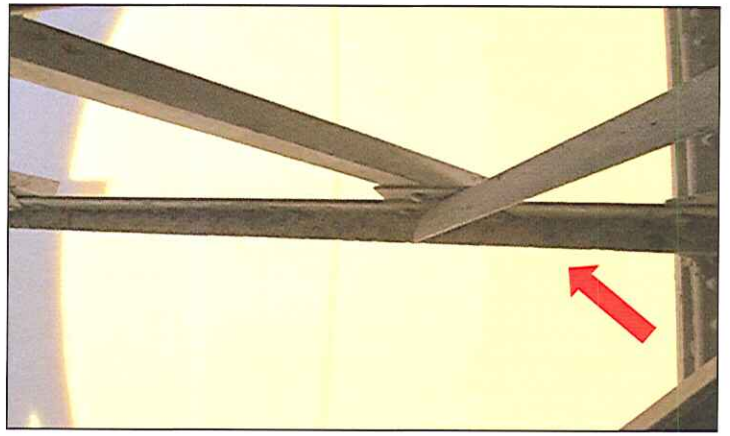
Picture M – S4 – P14

Minor corrosion on inclined cross bracing.



Picture M – S4 – P15

Moderate corrosion and localized section loss on inclined cross bracing.

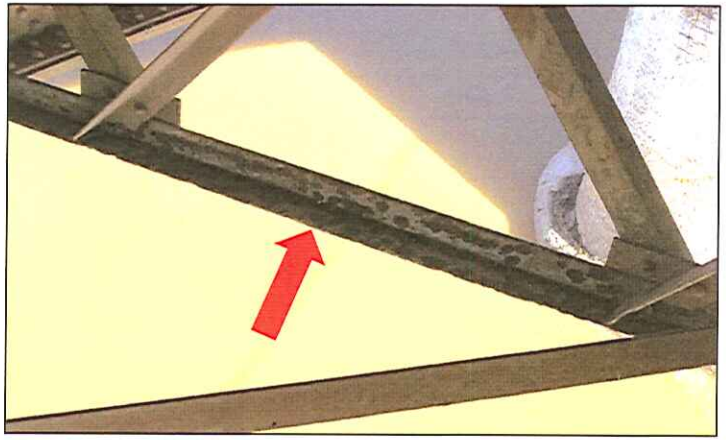


Picture M – S4 – P16

Minor corrosion on inclined cross bracing.

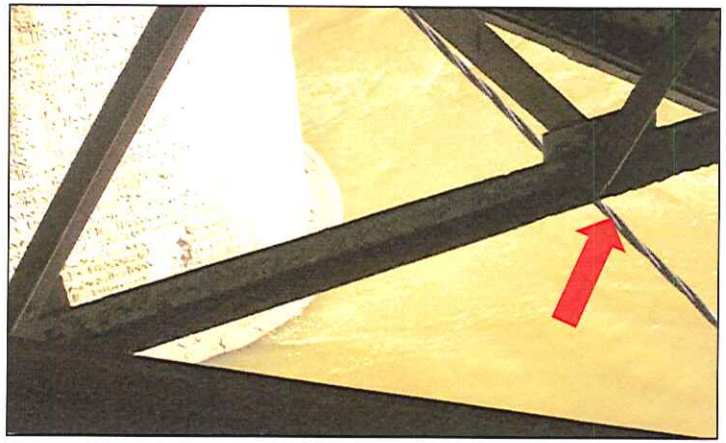
Picture M – S4 – P17

Minor corrosion on deck slab.



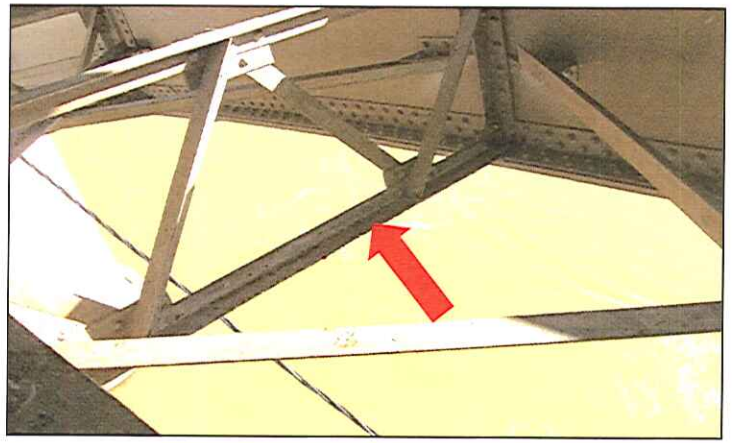
Picture M – S4 – P18

Minor corrosion on inclined cross bracing.



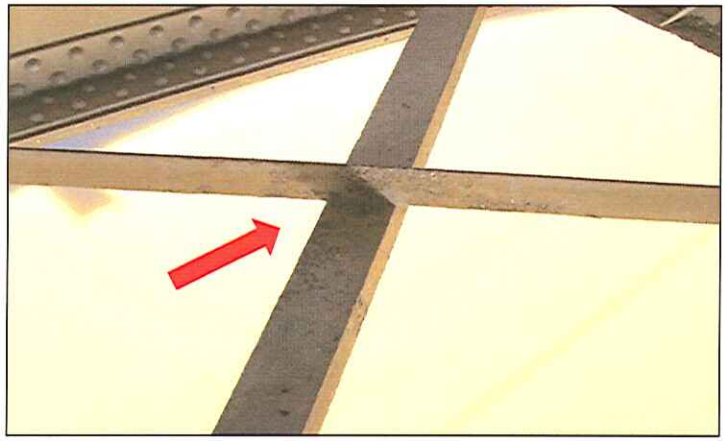
Picture M – S4 – P19

Minor corrosion on inclined cross bracing.



Picture M – S4 – P20

Minor corrosion on inclined cross bracing.

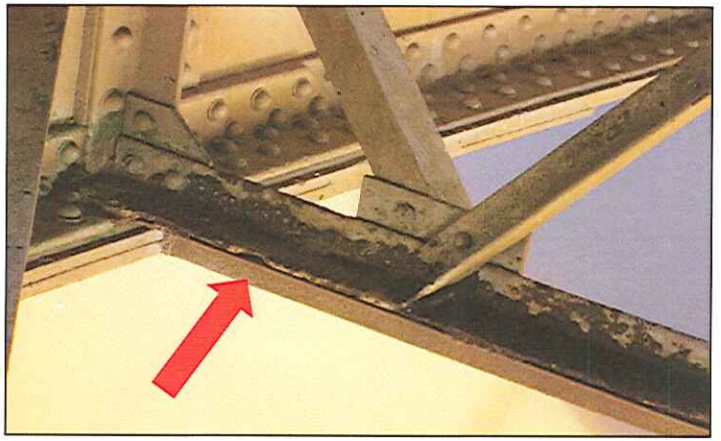


Picture M – S4 – P21

Minor corrosion on horizontal cross bracing.

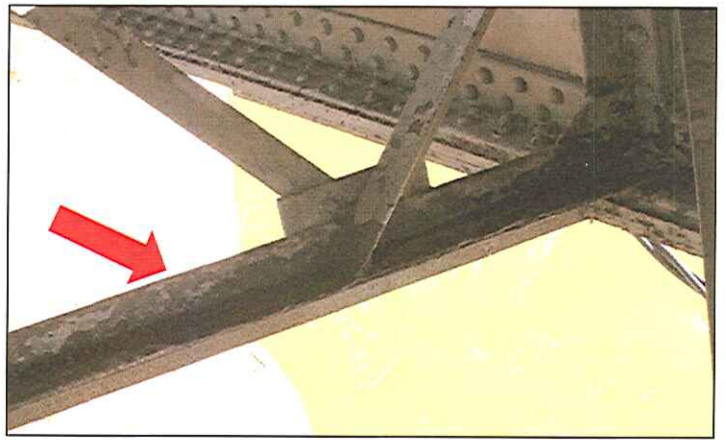
Picture M – S4 – P22

Moderate corrosion on vertical bracing joint of arch beam.



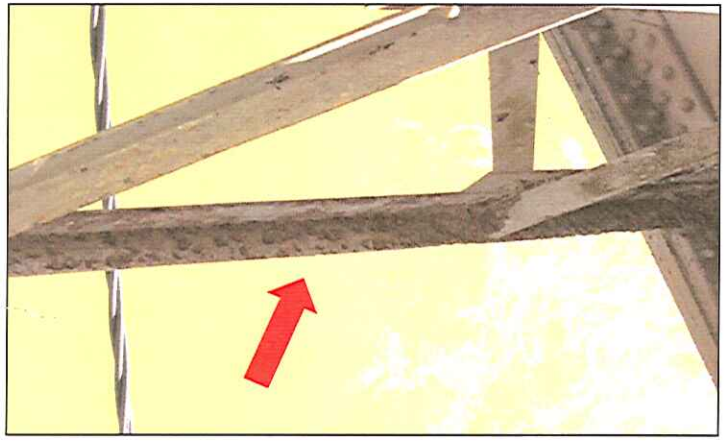
Picture M – S4 – P23

Moderate corrosion on inclined cross bracing.



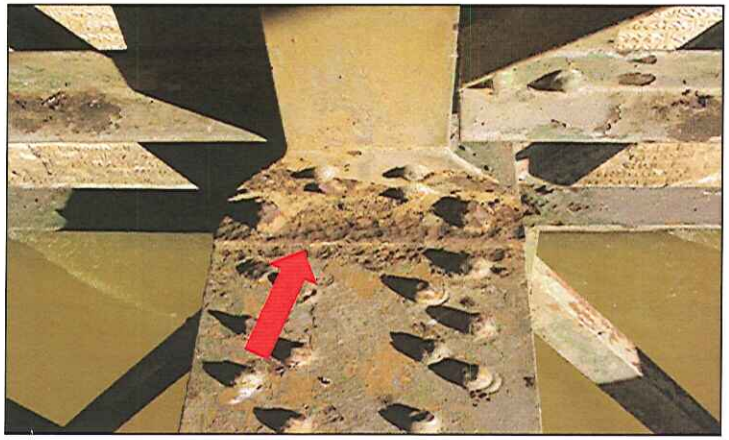
Picture M – S4 – P24

Minor corrosion on inclined cross bracing.



Picture M – S4 – P25

Moderate corrosion on inclined cross bracing.

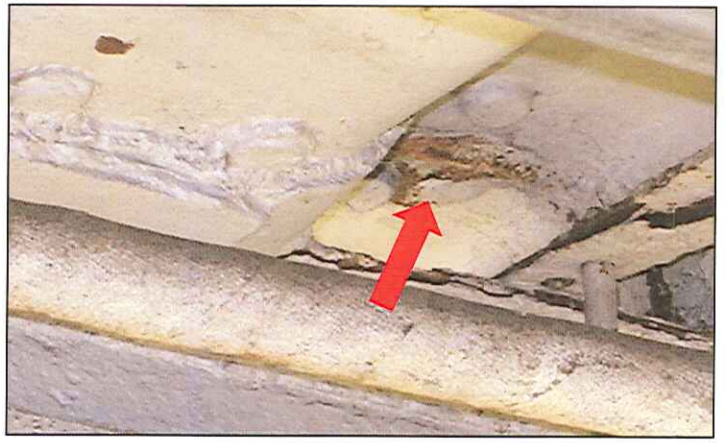


Picture M – S4 – P26

Moderate corrosion on vertical bracing joint of arch beam.

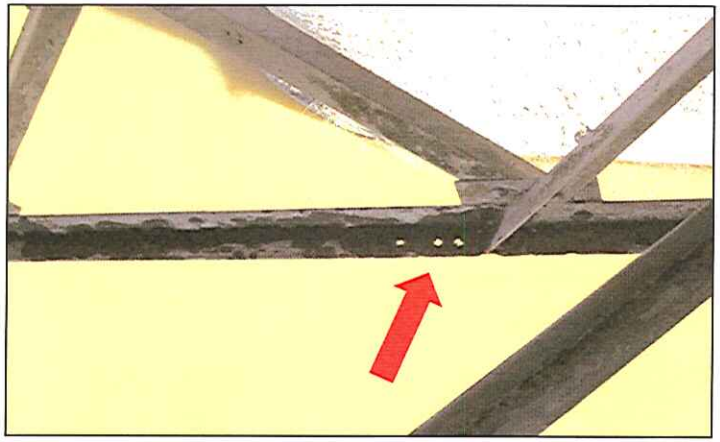
Picture M – S4 – P27

Moderate corrosion on vertical bracing joint of arch beam.



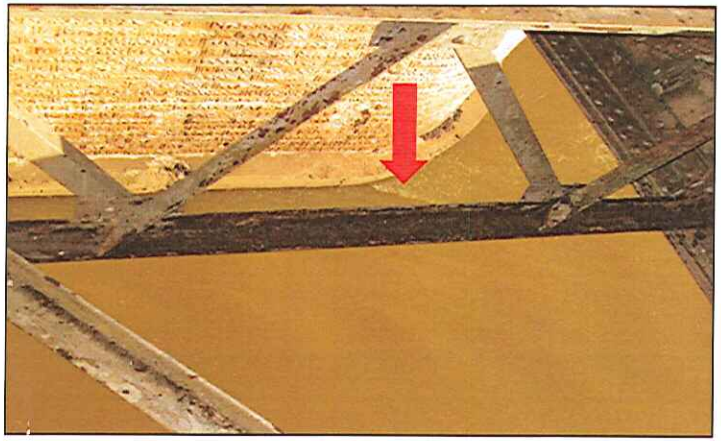
Picture M – S4 – P28

Minor corrosion on deck slab.



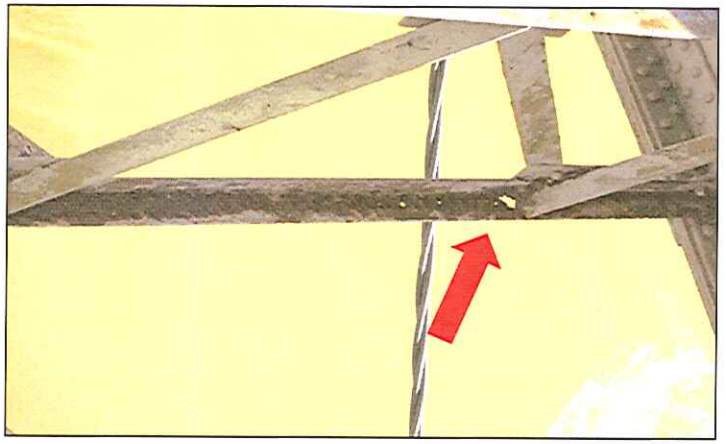
Picture M – S4 – P29

Minor corrosion with localized unused rivet holes on inclined cross bracing.



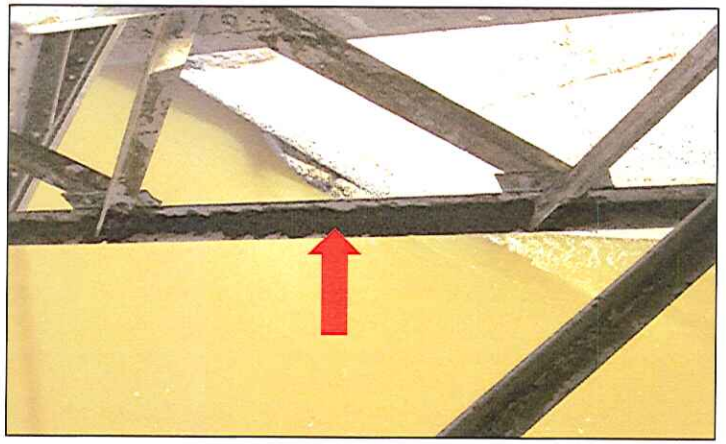
Picture M – S4 – P30

Moderate corrosion on inclined cross bracing.



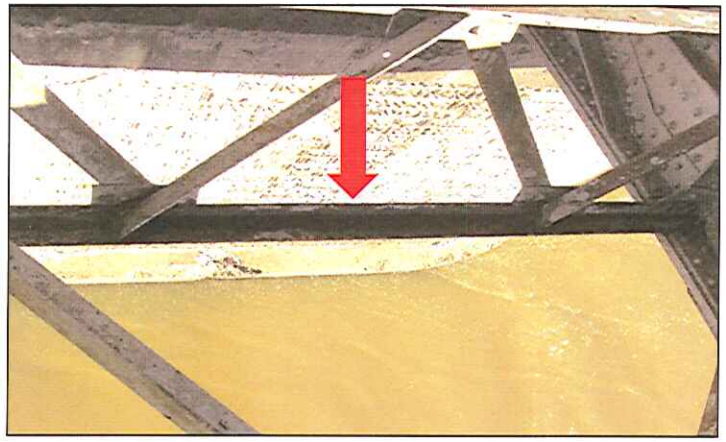
Picture M – S4 – P31

Moderate corrosion on inclined cross bracing.



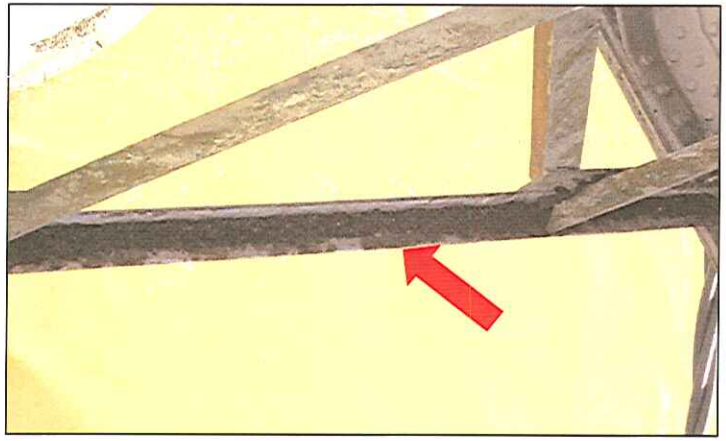
Picture M – S4 – P32

Moderate corrosion on inclined cross bracing.



Picture M – S4 – P33

Minor corrosion on inclined cross bracing.

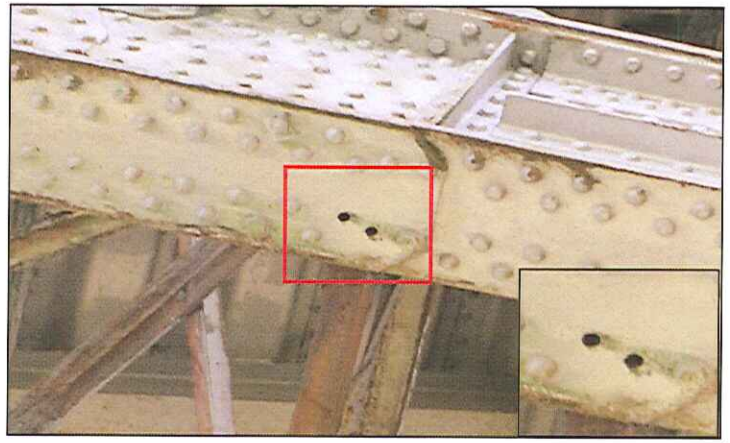


Picture M – S4 – P34

Minor corrosion on inclined cross bracing.

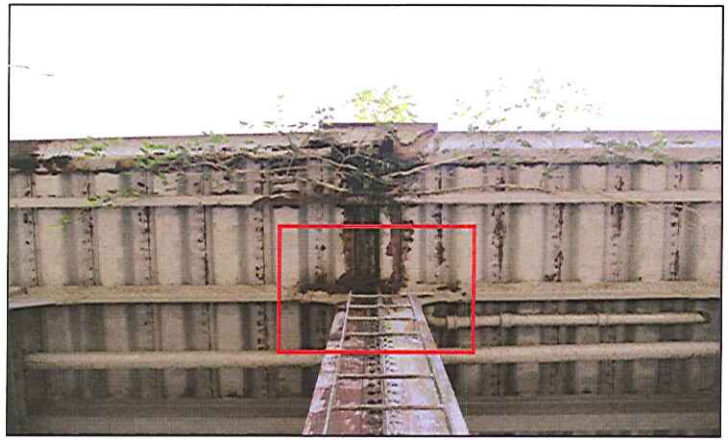
Picture M – S4 – P35

Moderate corrosion on vertical bracing joint of arch beam.



Picture M – S4 – P36

Minor corrosion and rivet missing on bottom flange of arch beam.

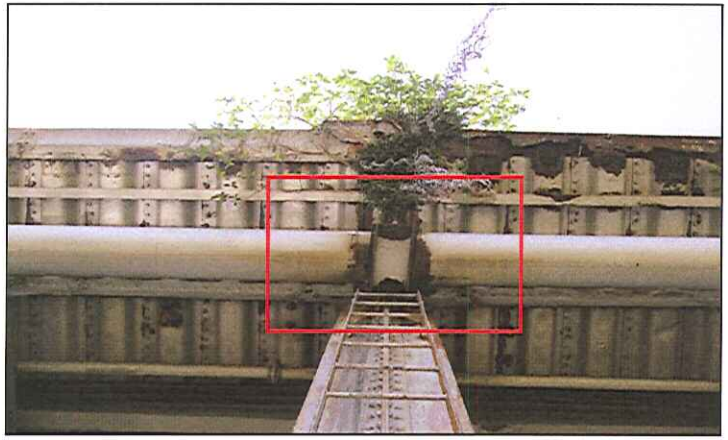


Picture M – S4 – P37 and M – S – P38

Moderate corrosion on steel plate.

Picture M – S4 –P39 and M – S4 – P40

Moderate corrosion and crack line on steel plate.



Picture M – S4 – P41 and M – S4 – P42

Moderate corrosion and crack line on steel plate.

Picture M – S4 – P43 and M – S4 –P44

Moderate corrosion and crack line on steel plate.

Picture M – S4 – P45

Moderate corrosion on overall middle frame.

Picture M – S4 – P46

Minor corrosion on overall middle frame.

Picture M – S4 – P47

Minor corrosion on overall middle frame.

Picture M – S4 – P48

Minor corrosion on overall middle frame.

Picture M – S4 – P49

Moderate corrosion on overall middle frame.

Picture M – S4 – P50

Minor corrosion on overall middle frame.

Picture M – S4 – P51

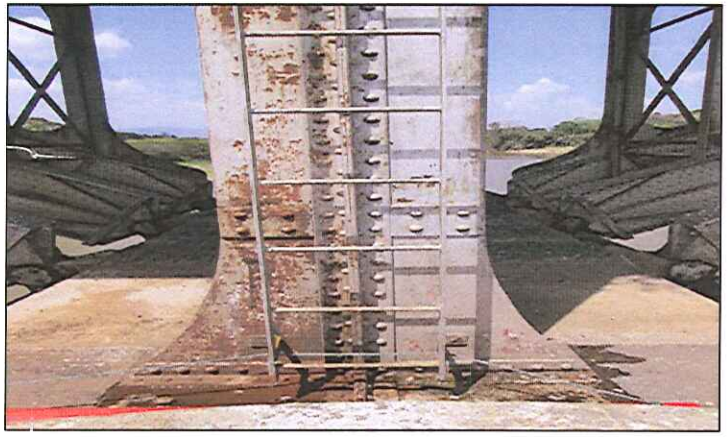
Moderate corrosion on overall middle frame.

Picture M – S4 – P52

Minor corrosion on overall middle frame.

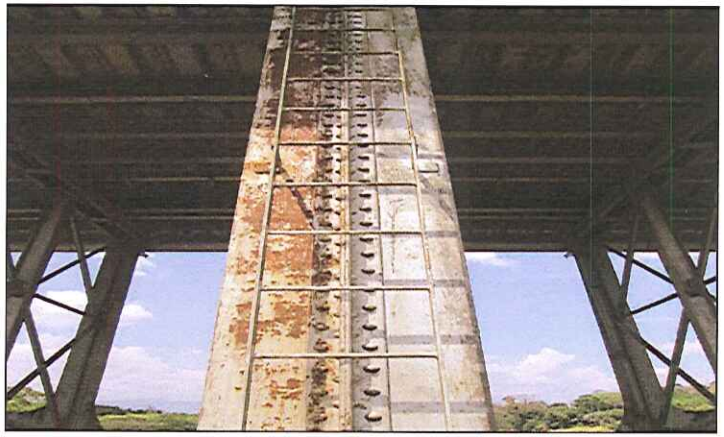
Picture M – S4 – P53

Moderate corrosion on overall middle frame.



Picture M – S4 – P54

Minor corrosion on overall middle frame.

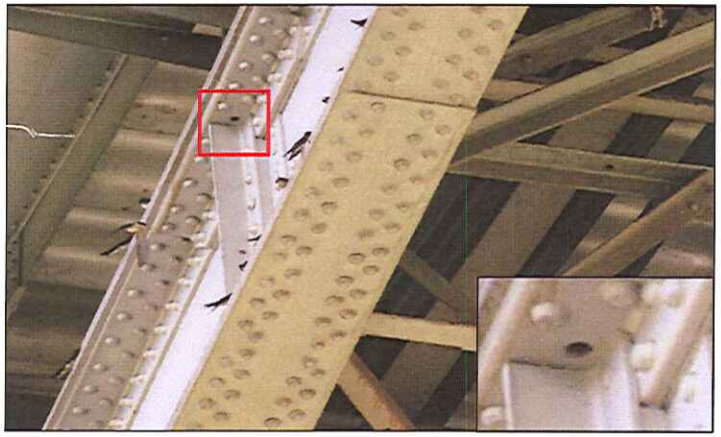


Picture M – S4 – P55

Minor corrosion on overall middle frame.

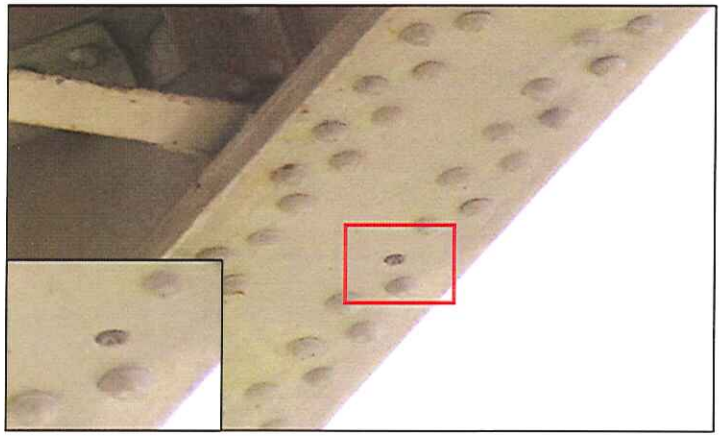
Picture M – S4 – P56

Moderate corrosion on overall middle frame.



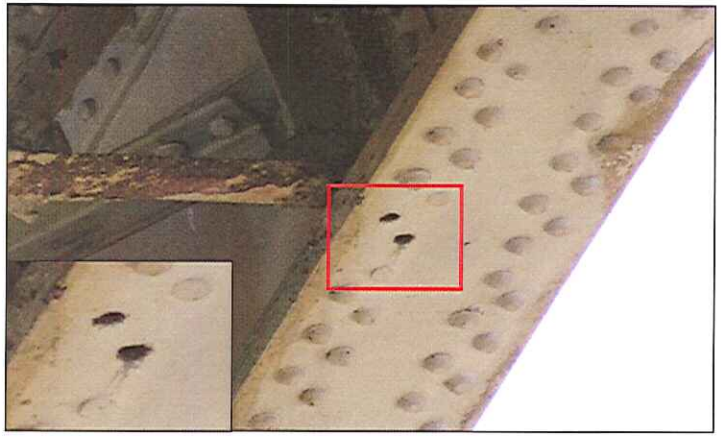
Picture M – S4 – P57

Missing rivet on top flange of arch beam.



Picture M – S4 – P58

Missing rivet on bottom flange of arch beam.



Picture M – S4 – P59

Missing rivet on bottom flange of arch beam.

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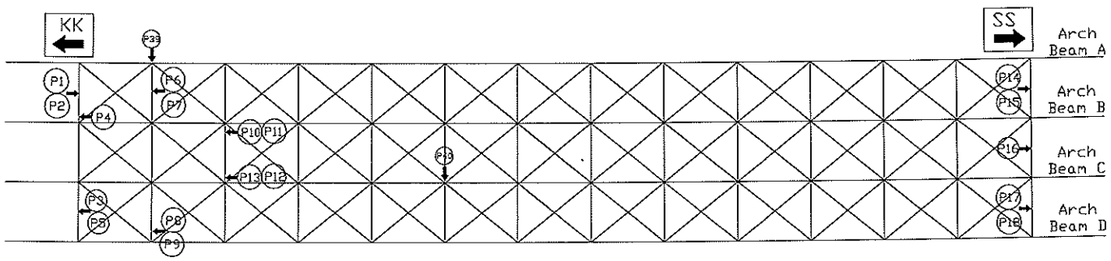
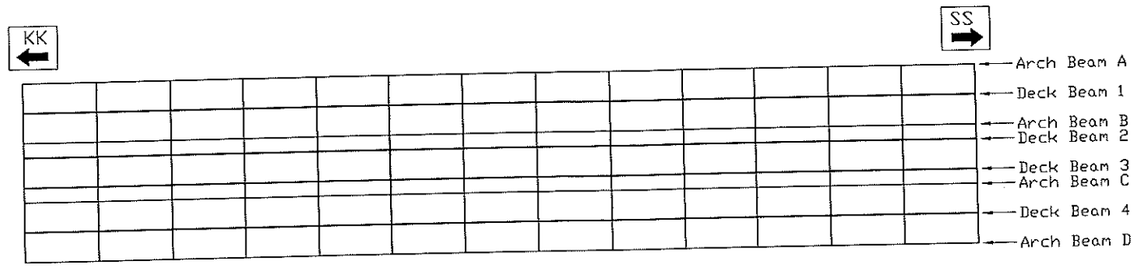
FINAL REPORT
VOLUME 1 OF 4 : MAIN REPORT

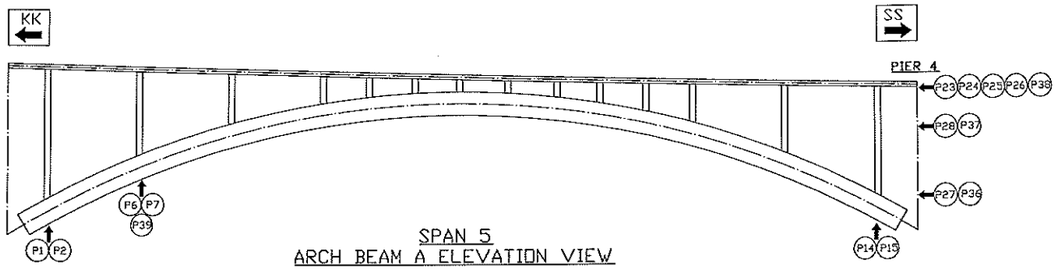
APPENDIX 4e
Detailed Visual Inspection Observations on Bridge Spans
(Span 5)



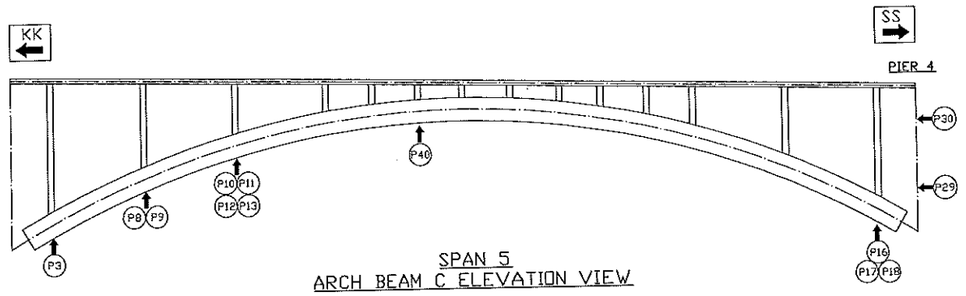
SPAN 5
ARCH BEAMS LAYOUT PLAN



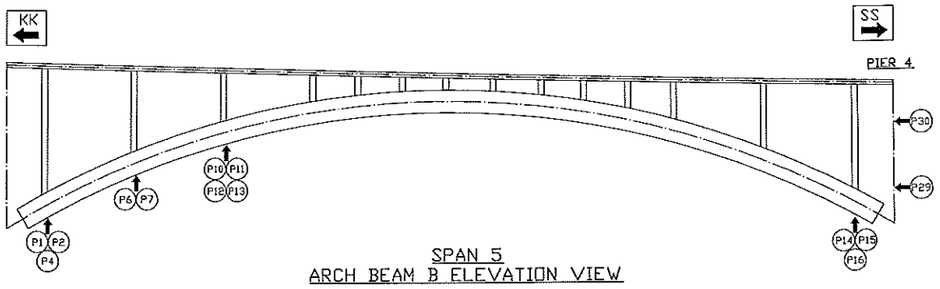
SPAN 5
DECK BEAMS LAYOUT PLAN



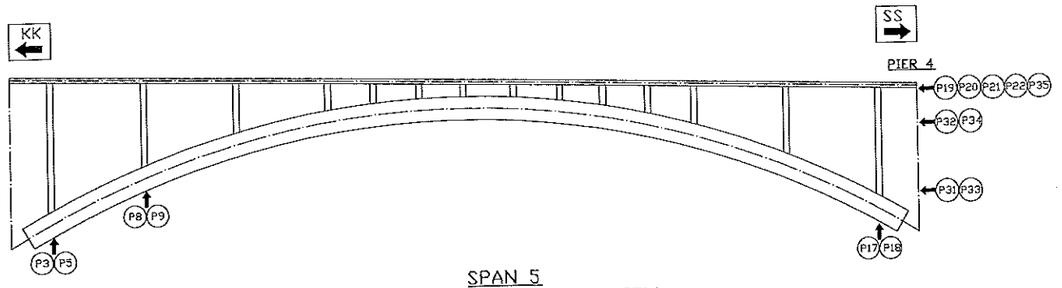
SPAN 5
ARCH BEAM A ELEVATION VIEW



SPAN 5
ARCH BEAM C ELEVATION VIEW



SPAN 5
ARCH BEAM B ELEVATION VIEW



SPAN 5
ARCH BEAM D ELEVATION VIEW

JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK
LAYOUTS / ELEVATIONS FOR PHOTOGRAPHIC RECORD OF THE CONDUCTED VISUAL INSPECTION FOR VISIBLE STRUCTURAL DISTRESS, DETERIORATION AND DAMAGES OF BRIDGE SPAN 5

LEGEND

- ←(P1) Refer Photographic Record M-S5-P1
- ←(P2) Refer Photographic Record M-S5-P2
- ←(P3) Refer Photographic Record M-S5-P3

..... etc .....

NOTE

Visual Inspections for any visible structural distress, deterioration and damages were conducted between January 2015 to March 2015.

Picture M – S5 – P1

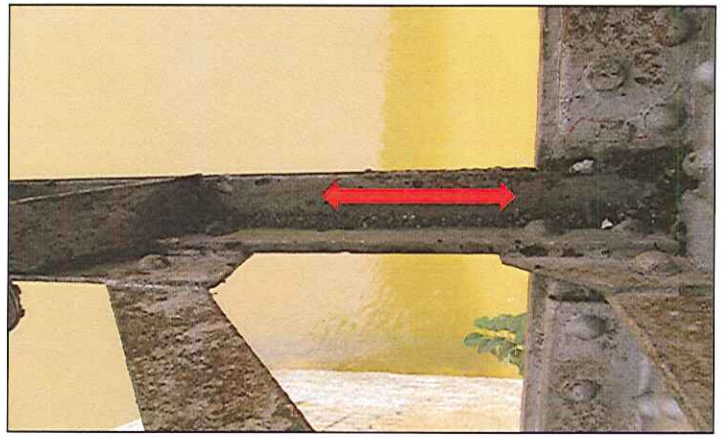
Minor corrosion on top flange of arch beam.

Picture M – S5 – P2

Circular hole on top flange of arch beam.

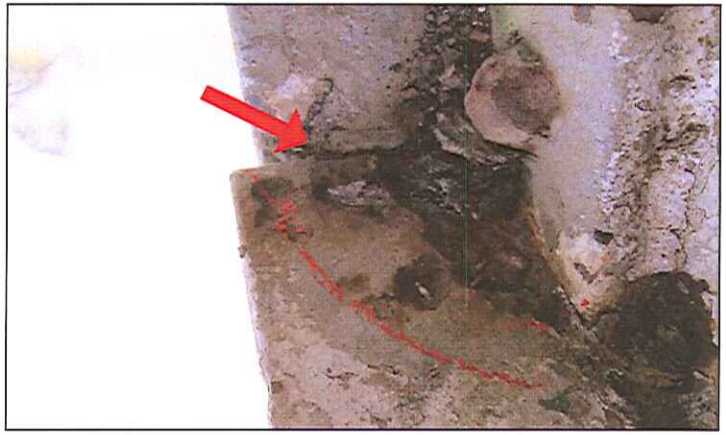
Picture M – S5 – P3

Minor corrosion on inclined cross bracing.



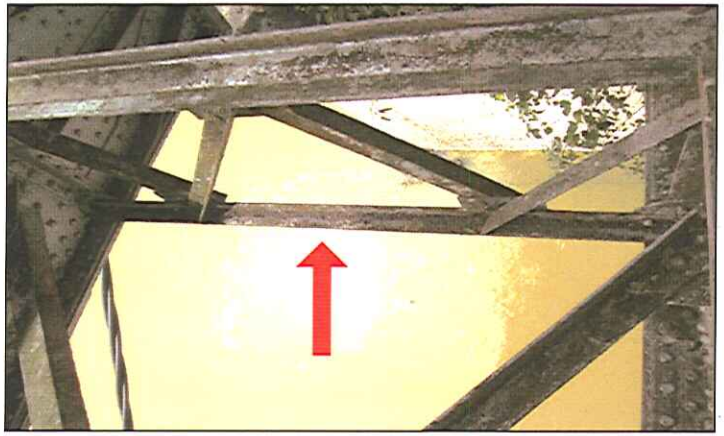
Picture M – S5 – P4

Minor corrosion on inclined cross bracing.



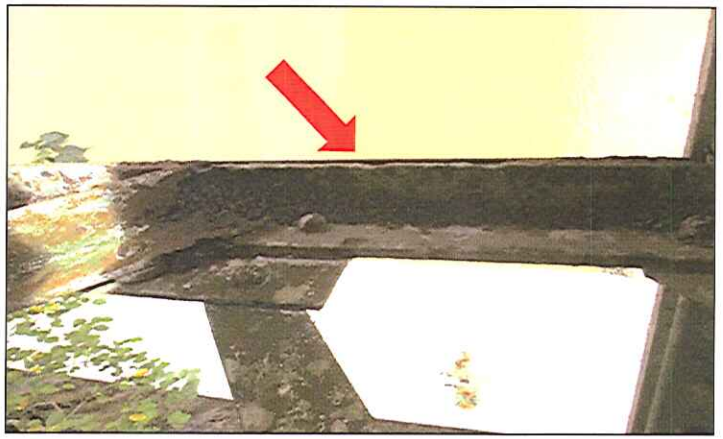
Picture M – S5 – P5

Moderate corrosion on inclined cross bracing.



Picture M – S5 – P6

Minor corrosion on inclined cross bracing.



Picture M – S5 – P7

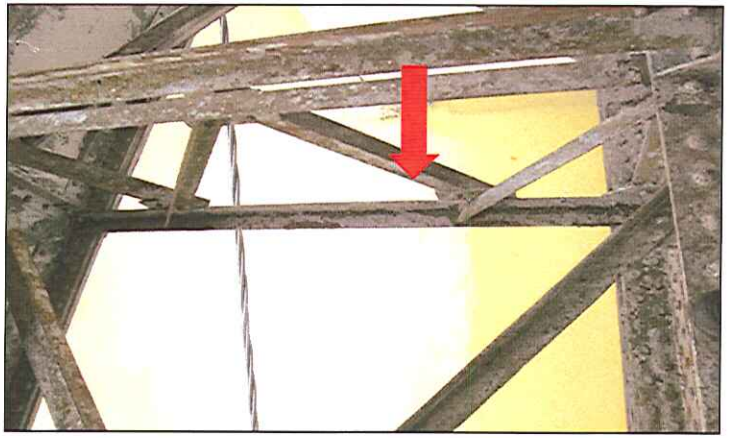
Minor corrosion on inclined cross bracing.

Picture M – S5 – P8

Moderate corrosion on inclined cross bracing.

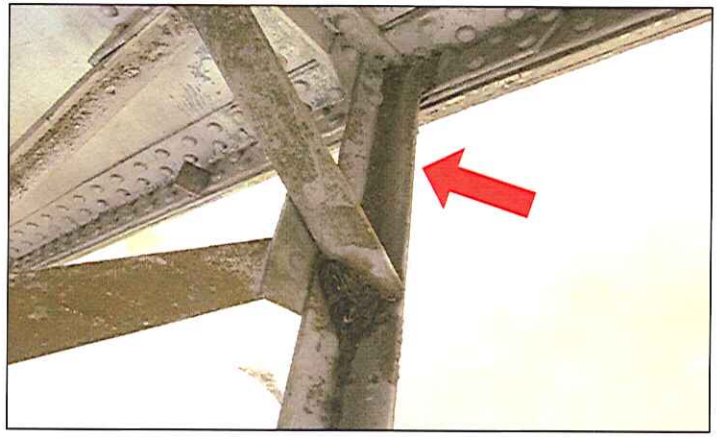
Picture M – S5 – P9

Moderate corrosion on inclined cross bracing.



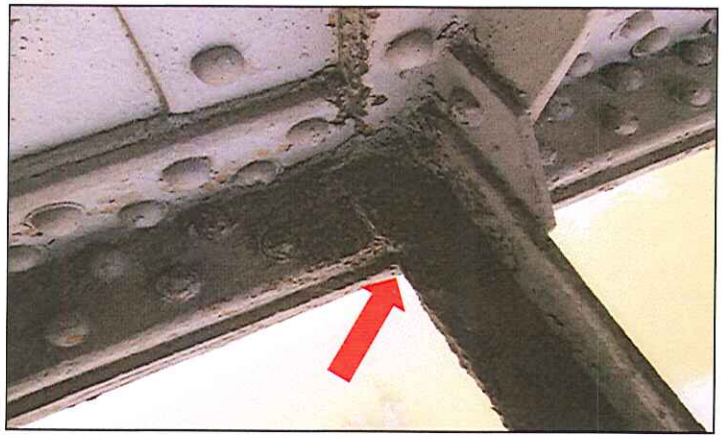
Picture M – S5 – P10

Minor corrosion on inclined cross bracing.



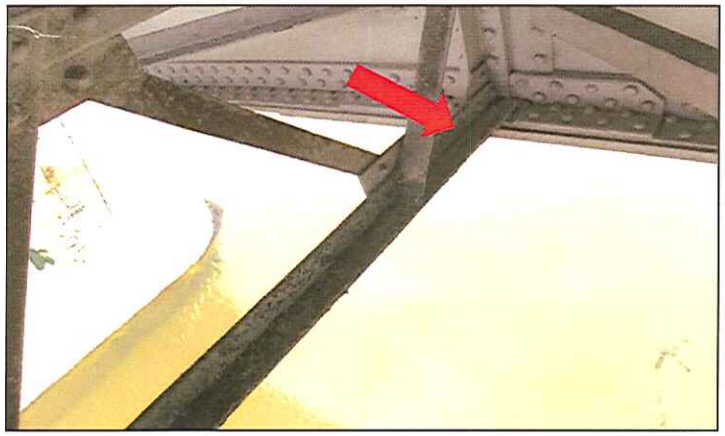
Picture M – S5 – P11

Minor corrosion on inclined cross bracing.



Picture M – S5 – P12

Minor corrosion on top flange of arch beam.

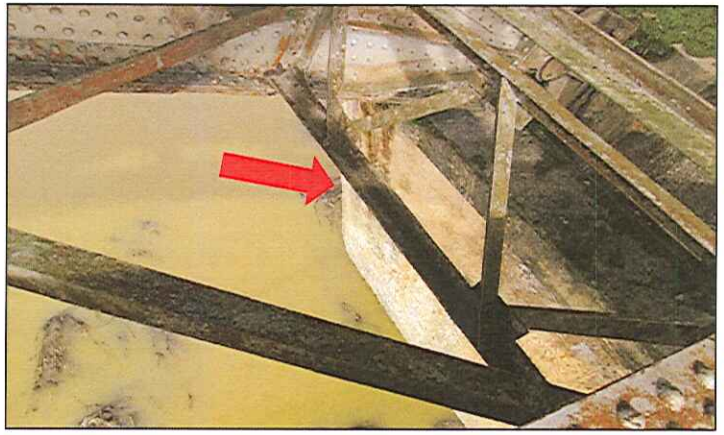


Picture M – S5 – P13

Minor corrosion on inclined cross bracing.

Picture M – S5 – P14

Minor corrosion on inclined cross bracing.



Picture M – S5 – P15

Minor corrosion on inclined cross bracing.

Picture M – S5 – P16

Minor corrosion on inclined cross bracing.

Picture M – S5 – P17

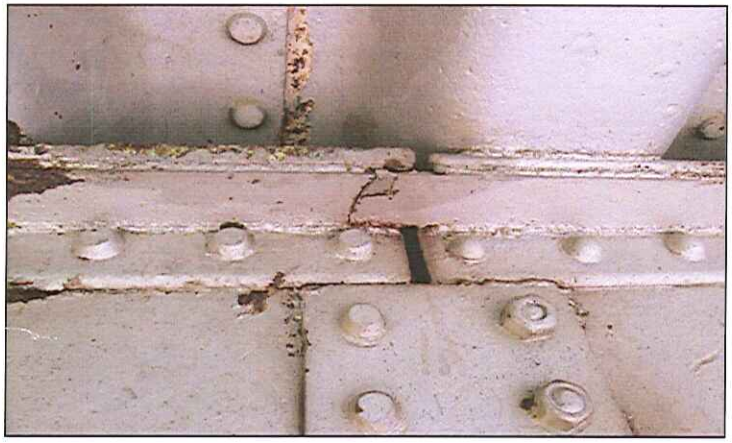
Moderate corrosion and rivet head deteriorate on inclined cross bracing.

Picture M – S5 – P18

Moderate corrosion and rivet head deteriorate on inclined cross bracing.

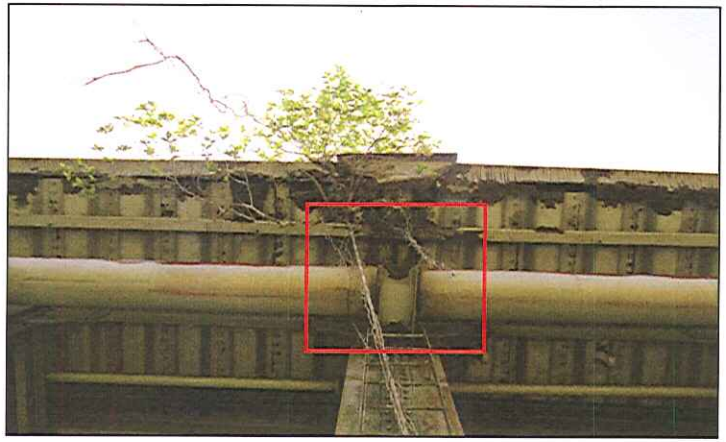
Picture M – S5 – P19 and M – S5 – P20

Moderate corrosion and crack line on steel plate.



Picture M – S5 – P21 and M – S5 – P22

Moderate corrosion and crack line on steel plate.



Picture M – S5 – P23 and M – S5 – P24

Moderate corrosion and crack line on steel plate.

Picture M – S5 –P25 and M – S5 – P26

Moderate corrosion and crack line on steel plate.

Picture M – S5 – P27

Minor corrosion on overall middle frame.

Picture M – S5 – P28

Moderate corrosion on overall middle frame.

Picture M – S5 – P29

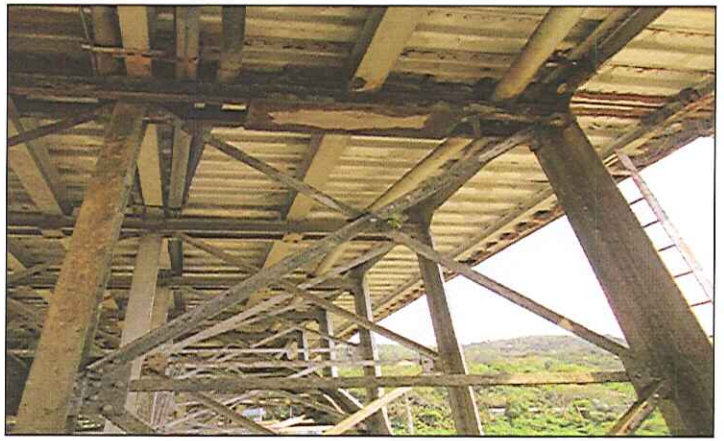
Minor corrosion on overall middle frame.

Picture M – S5 – P30

Moderate corrosion on overall middle frame.

Picture M – S5 – P31

Minor corrosion on overall middle frame.



Picture M – S5 – P32

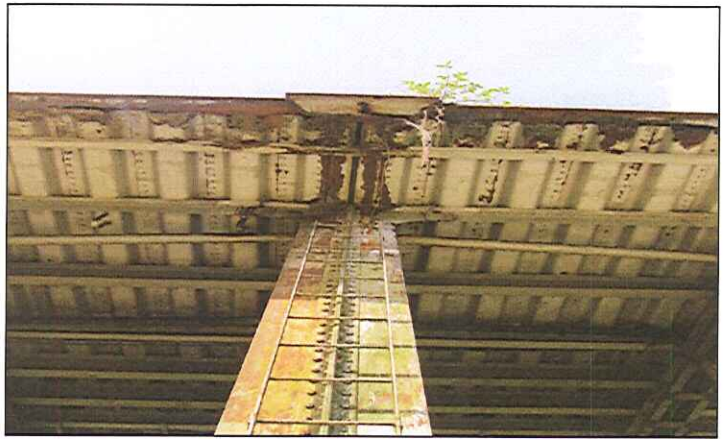
Moderate corrosion on overall middle frame.

Picture M – S5 – P33

Minor corrosion on overall middle frame.

Picture M – S5 – P34

Minor corrosion on overall middle frame.



Picture M – S5 – P35

Moderate corrosion on overall middle frame.

Picture M – S5 – P36

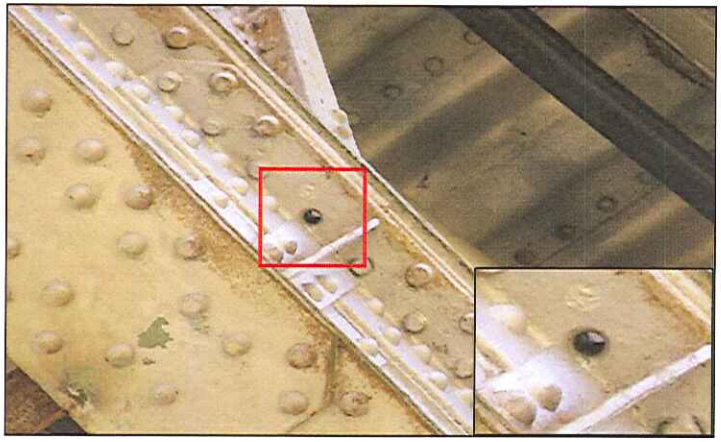
Minor corrosion on overall middle frame.

Picture M – S5 – P37

Minor corrosion on overall middle frame.

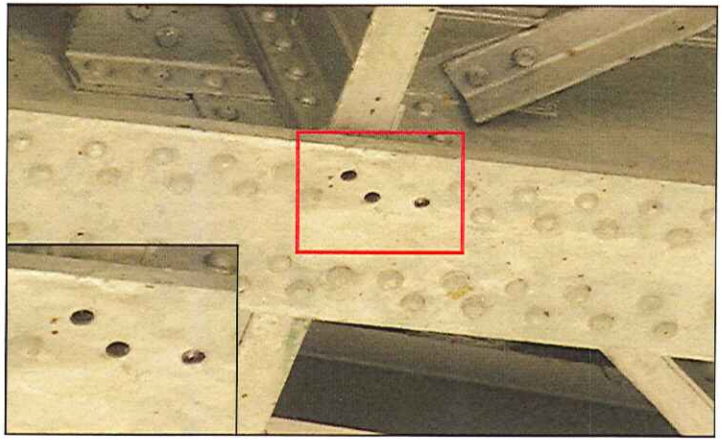
Picture M – S5 – P38

Moderate corrosion on overall middle frame.



Picture M – S5 – P39

Missing rivet on top flange of arch beam.



Picture M – S5 – P40

Missing rivet on bottom flange of arch beam.

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FINAL REPORT

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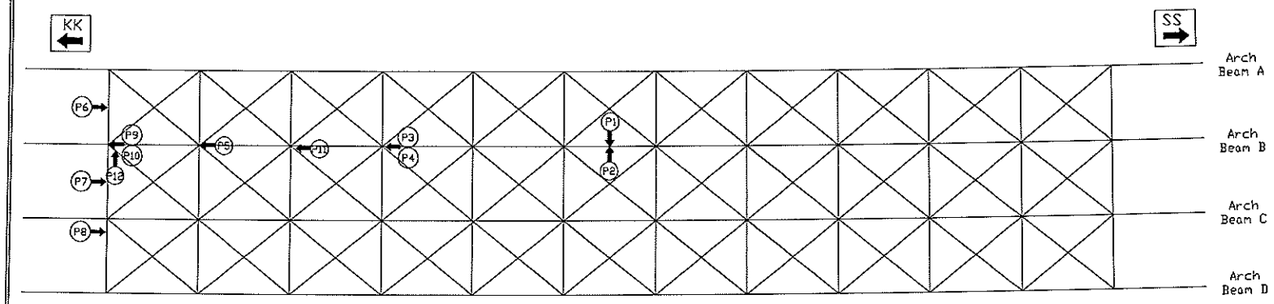
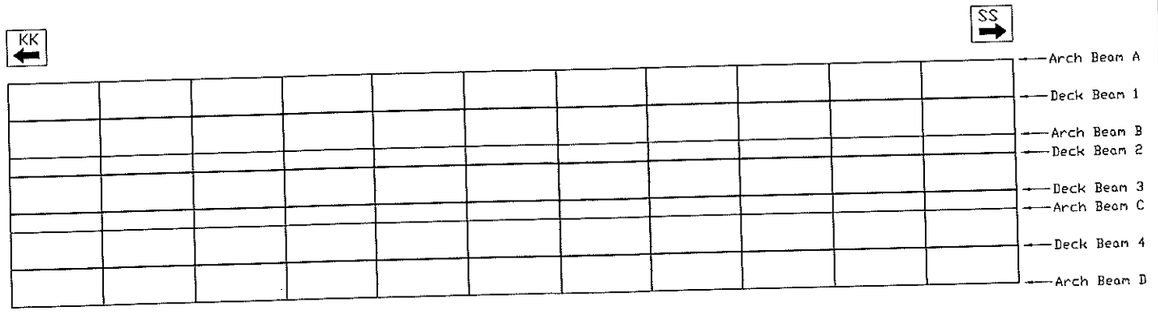
APPENDIX 4f

Detailed Visual Inspection Observations on Bridge Spans

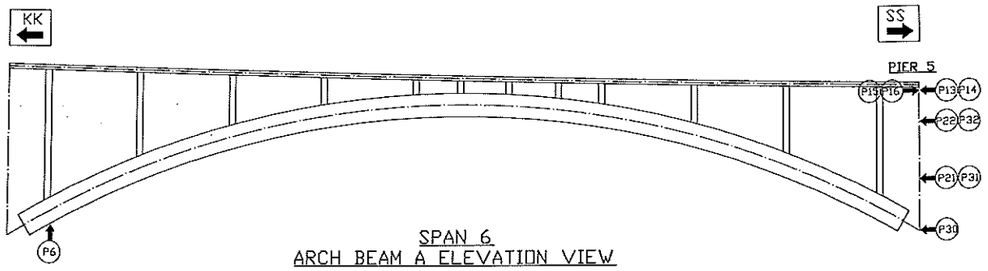
(Span 6)



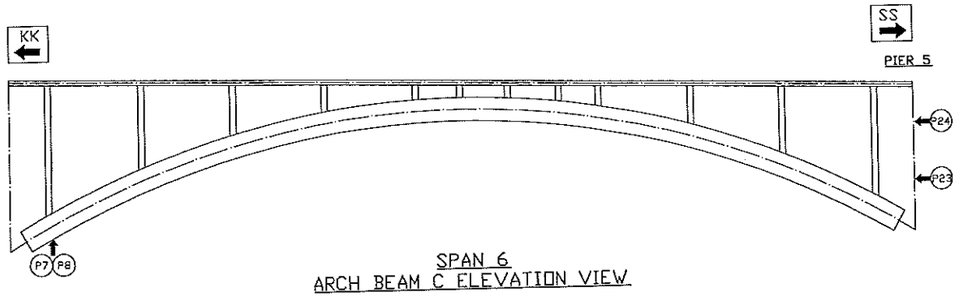
SPAN 6
ARCH BEAMS LAYOUT PLAN



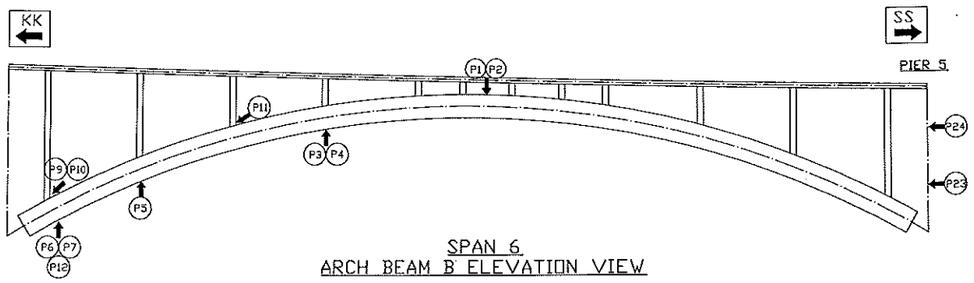
SPAN 6
DECK BEAMS LAYOUT PLAN



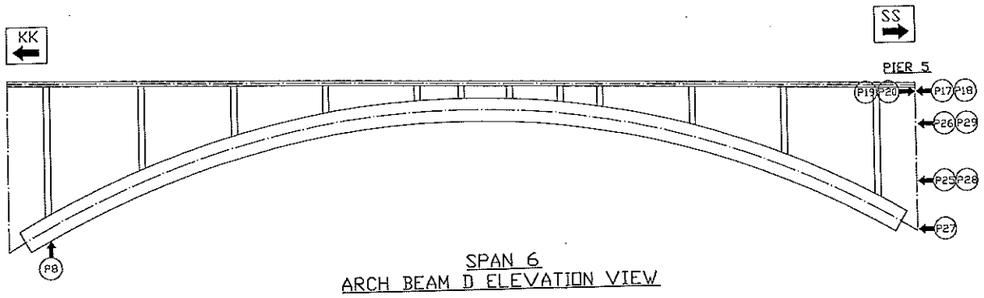
SPAN 6
ARCH BEAM A ELEVATION VIEW



SPAN 6
ARCH BEAM C ELEVATION VIEW



SPAN 6
ARCH BEAM B ELEVATION VIEW



SPAN 6
ARCH BEAM D ELEVATION VIEW

JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK
LAYOUTS / ELEVATIONS FOR PHOTOGRAPHIC RECORD OF THE CONDUCTED VISUAL INSPECTION FOR VISIBLE STRUCTURAL DISTRESS, DETERIORATION AND DAMAGES OF BRIDGE SPAN 6

LEGEND

- ← P1 Refer Photographic Record M-S6-P1
- ← P2 Refer Photographic Record M-S6-P2
- ← P3 Refer Photographic Record M-S6-P3

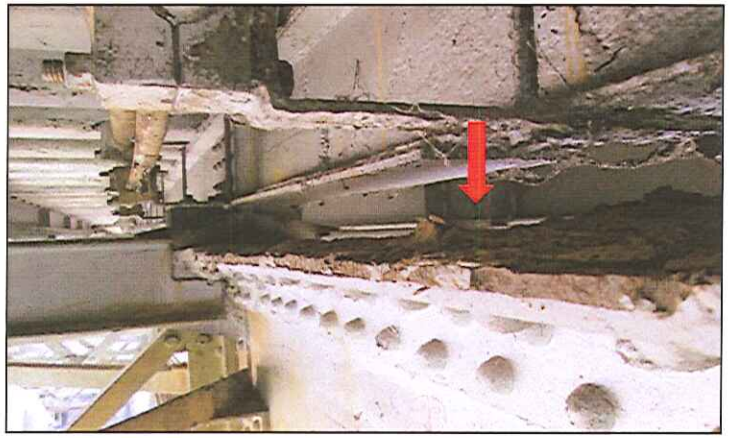
..... etc .....

NOTE

Visual Inspections for any visible structural distress, deterioration and damages were conducted between January 2015 to March 2015.

Picture M – S6 – P1

Minor corrosion on top flange of arch beam.

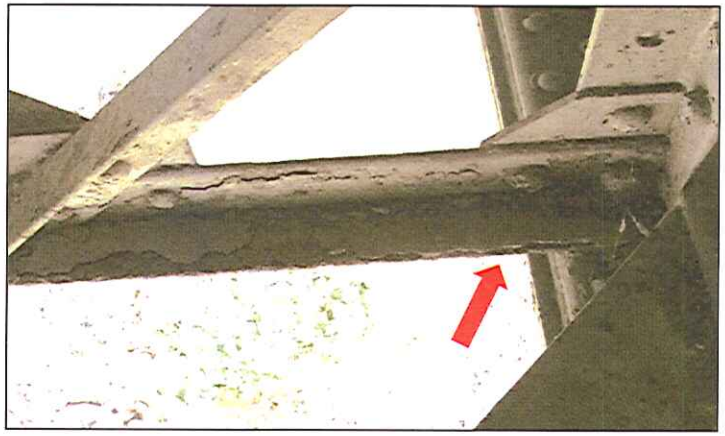


Picture M – S6 – P2

Moderate corrosion on top flange of arch beam.

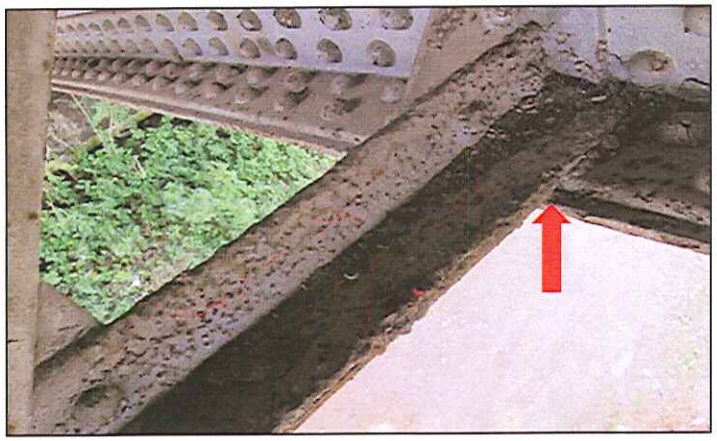
Picture M – S6 – P3

Moderate corrosion on inclined cross bracing.



Picture M – S6 – P4

Minor corrosion on inclined cross bracing.

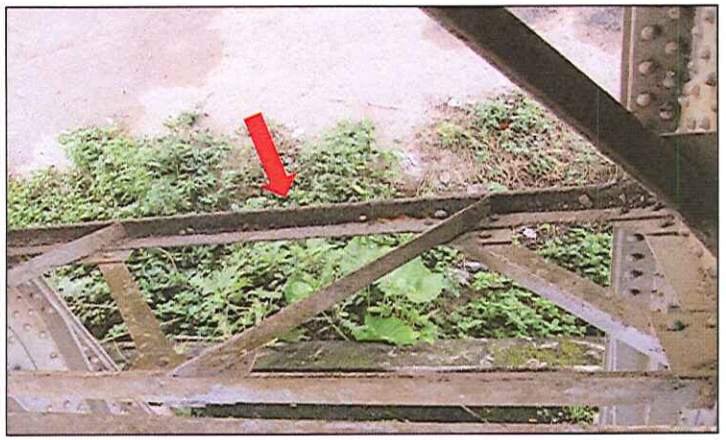


Picture M – S6 – P5

Minor corrosion on inclined cross bracing.

Picture M – S6 – P6

Minor corrosion on inclined cross bracing.



Picture M – S6 – P7

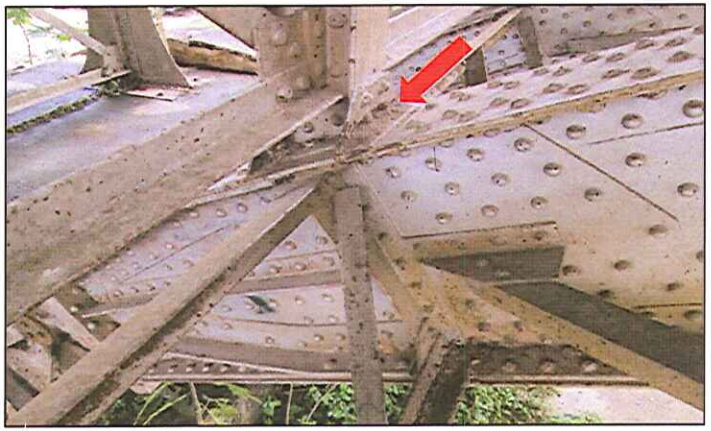
Minor corrosion on inclined cross bracing.

Picture M – S6 – P8

Moderate corrosion on inclined cross bracing.

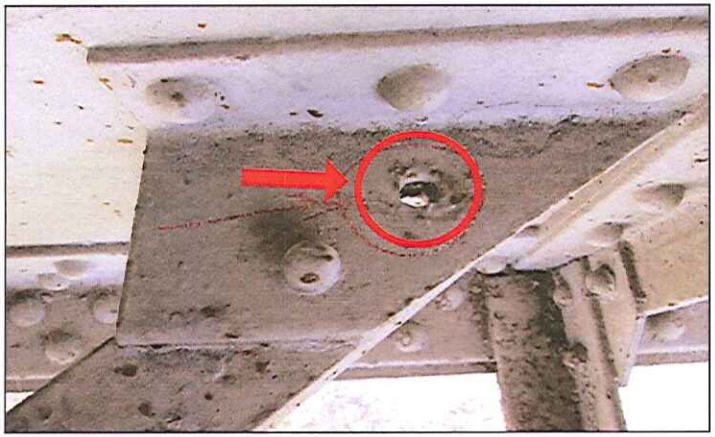
Picture M – S6 – P9

Moderate corrosion on vertical bracing joint of arch beam.



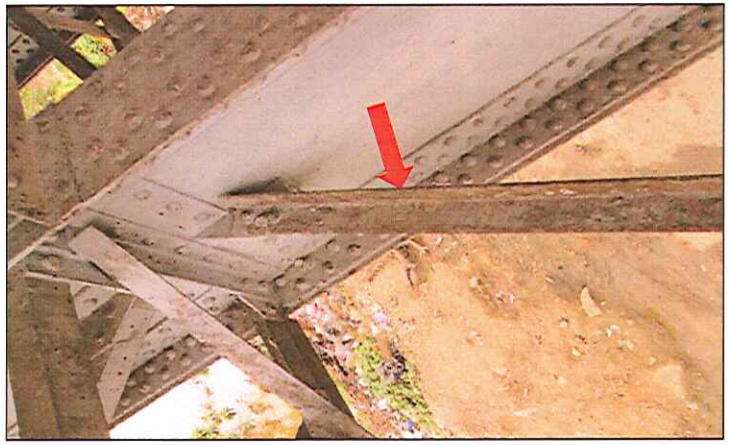
Picture M – S6 – P10

Moderate corrosion on vertical bracing joint of arch beam.



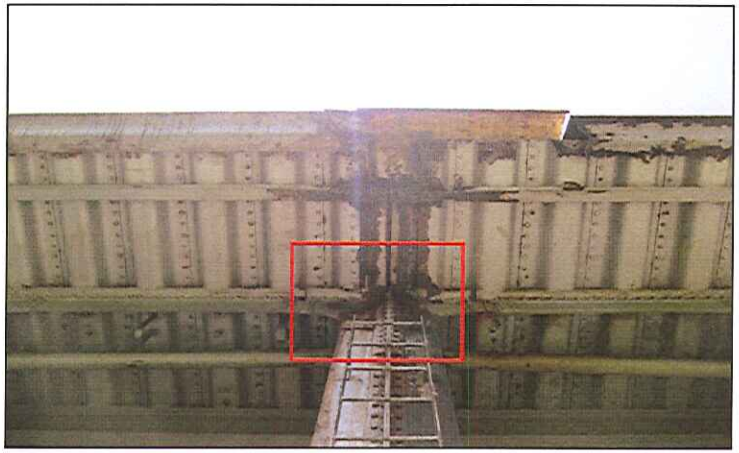
Picture M – S6 – P11

Missing rivet on horizontal cross bracing of member.



Picture M – S6 – P12

Minor corrosion on horizontal cross bracing.

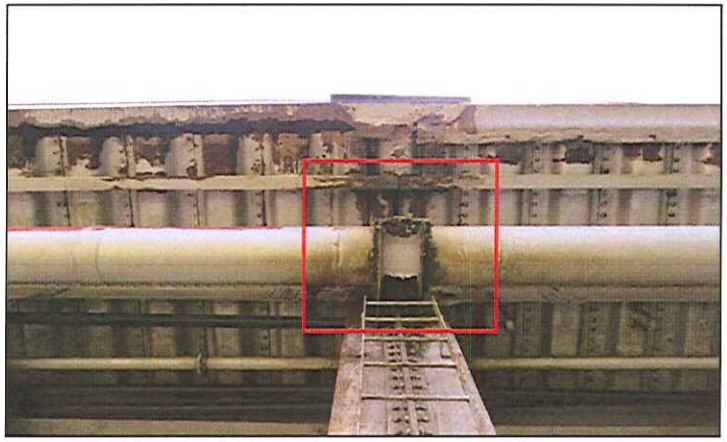


Picture M – S6 – P13 and M- S6 –P14

Moderate corrosion and crack line on steel plate near expansion joint.

Picture M – S6 – P15 and M – S6 –P16

Moderate corrosion and crack on steel plate near expansion joint.



Picture M – S6 – P17 and M – S6 –P18

Moderate corrosion and crack line on steel plate near expansion joint.

Picture M – S6 – P19 and M – S6 –P20

Moderate corrosion on steel plate.

Picture M – S6 – P21

Minor corrosion on overall middle frame.

Picture M – S6 – P22

Moderate corrosion on overall middle frame.

Picture M – S6 – P23

Minor corrosion on overall middle frame.

Picture M – S6 – P24

Moderate corrosion on overall middle frame.

Picture M – S6 – P25

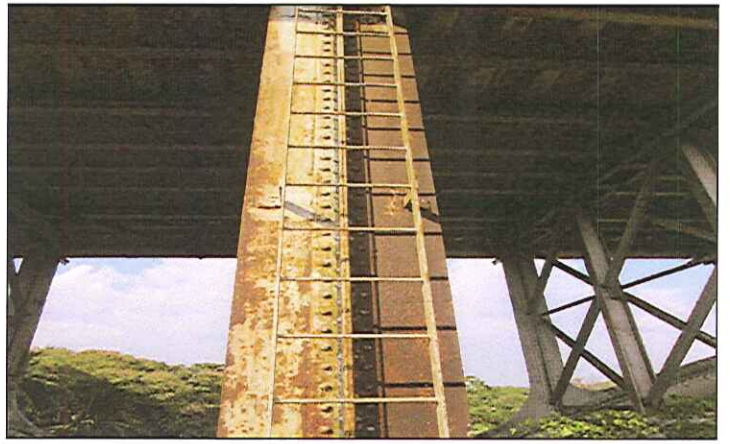
Minor corrosion on overall middle frame.

Picture M – S6 – P26

Moderate corrosion on overall middle frame.

Picture M – S6 – P27

Moderate corrosion on overall middle frame.



Picture M – S6 – P28

Moderate corrosion on overall middle frame.

Picture M – S6 – P29

Moderate corrosion on overall middle frame.

Picture M – S6 – P30

Minor corrosion on overall middle frame.

Picture M – S6 – P31

Minor corrosion on overall middle frame.

Picture M – S6 – P32

Minor corrosion on overall middle frame.

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FINAL REPORT
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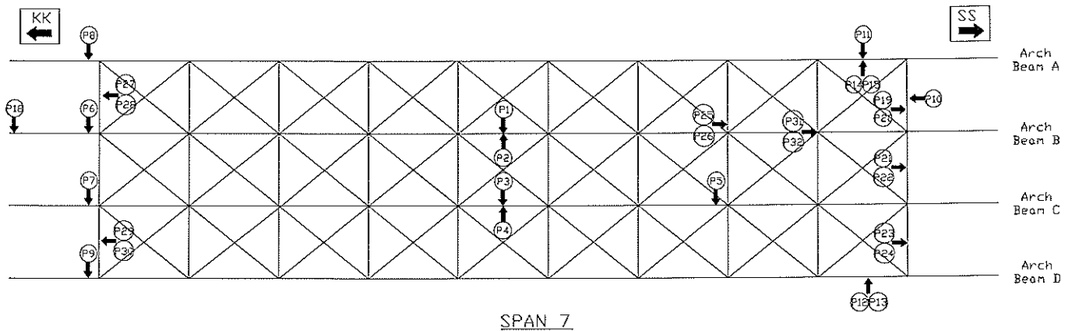
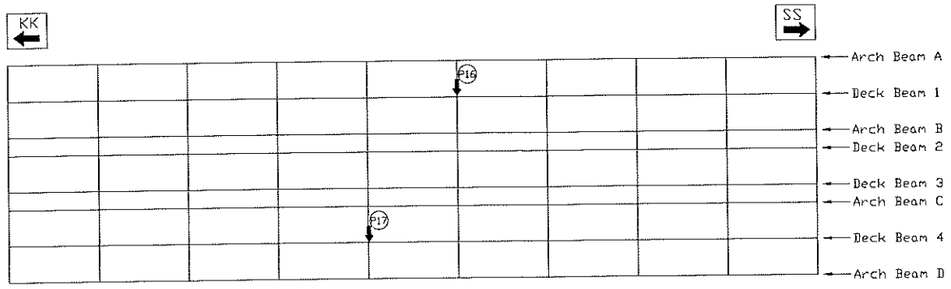
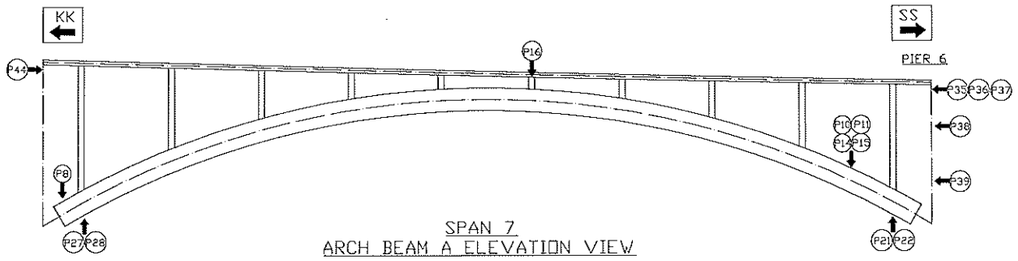
APPENDIX 4g
Detailed Visual Inspection Observations on Bridge Spans
(Span 7)



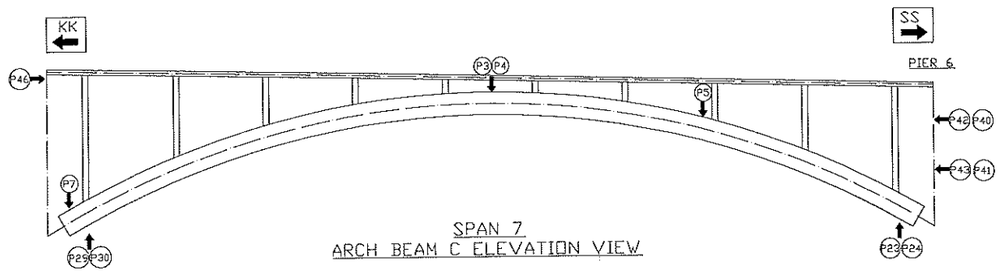
SPAN 7
ARCH BEAMS LAYOUT PLAN



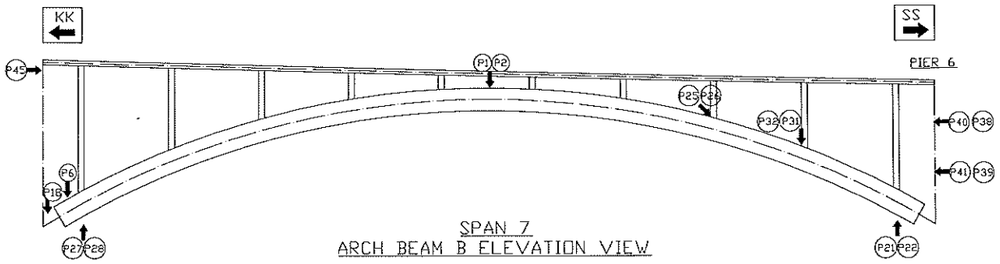
SPAN 7
DECK BEAMS LAYOUT PLAN



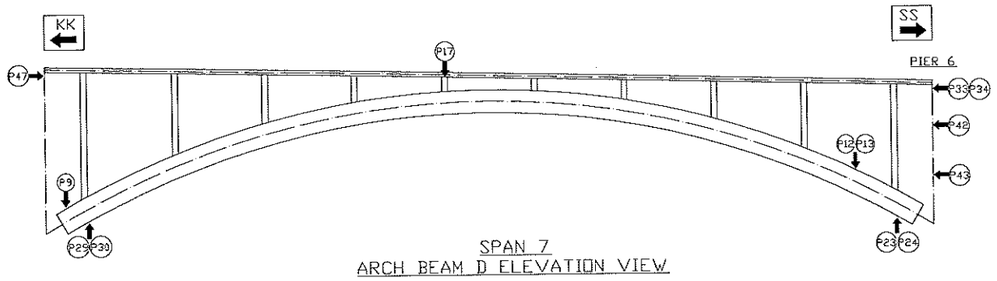
SPAN 7
ARCH BEAM A ELEVATION VIEW



SPAN 7
ARCH BEAM C ELEVATION VIEW



SPAN 7
ARCH BEAM B ELEVATION VIEW



SPAN 7
ARCH BEAM D ELEVATION VIEW

JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK
LAYOUTS / ELEVATIONS FOR PHOTOGRAPHIC RECORD OF THE CONDUCTED VISUAL INSPECTION FOR VISIBLE STRUCTURAL DISTRESS, DETERIORATION AND DAMAGES OF BRIDGE SPAN 7

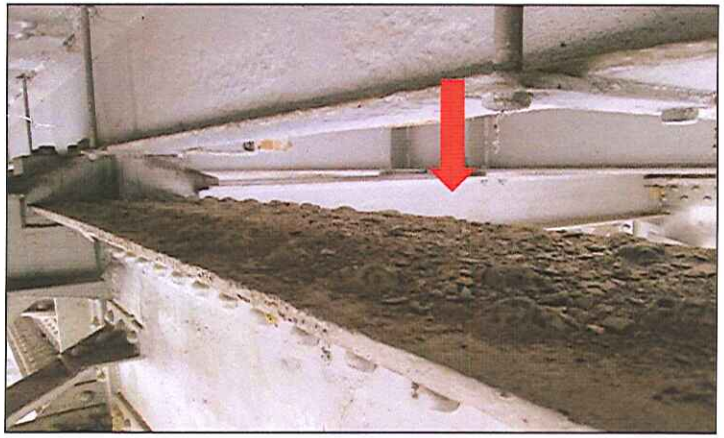
LEGEND

- ← P1 Refer Photographic Record M-S7-P1
- ← P2 Refer Photographic Record M-S7-P2
- ← P3 Refer Photographic Record M-S7-P3

..... etc .....

NOTE

Visual Inspections for any visible structural distress, deterioration and damages were conducted between January 2015 to March 2015.



Picture M – S7 – P1

Minor corrosion on top flange of arch beam.

Picture M – S7 – P2

Minor corrosion on top flange of arch beam.

Picture M – S7 – P3

Minor corrosion on top flange of arch beam.

Picture M – S7 – P4

Minor corrosion on top flange of arch beam.

Picture M – S7 – P5

Minor corrosion on top flange of arch beam.

Picture M – S7 – P6

Minor corrosion on top flange of arch beam.

Picture M – S7 – P7

Minor corrosion on top flange of arch beam.

Picture M – S7 – P8

Minor corrosion on top flange of arch beam.

Picture M – S7 – P9

Minor corrosion on top flange of arch beam.

Picture M – S7 – P10

Minor corrosion on top flange of arch beam.

Picture M – S7 – P11

Minor corrosion on top flange of arch beam.

Picture M – S7 – P12

Minor corrosion on top flange of arch beam.

Picture M – S7 – P13

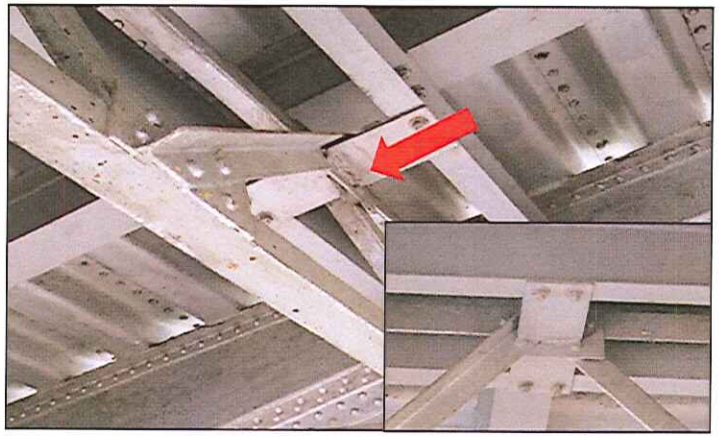
Minor corrosion on top flange of arch beam.

Picture M – S7 – P14

Minor corrosion on top flange of arch beam.

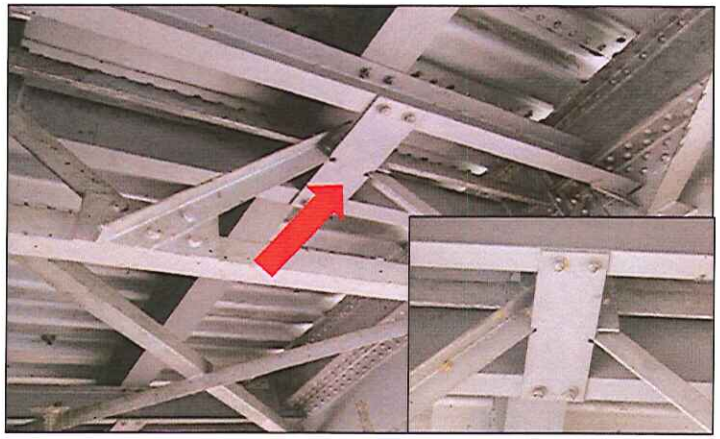
Picture M – S7 – P15

Minor corrosion on top flange of arch beam.



Picture M – S7 – P16

Welding C-channel plate on inclined cross bracing.

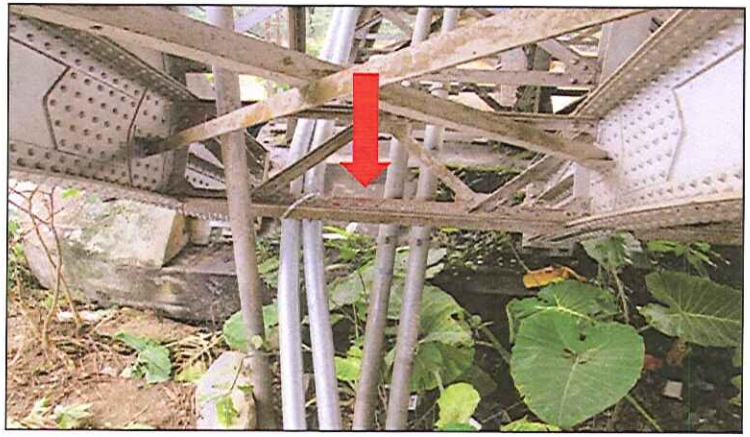


Picture M – S7 – P17

Cutting C-channel plate on inclined cross bracing.

Picture M – S7 – P18

Minor corrosion on end connection.

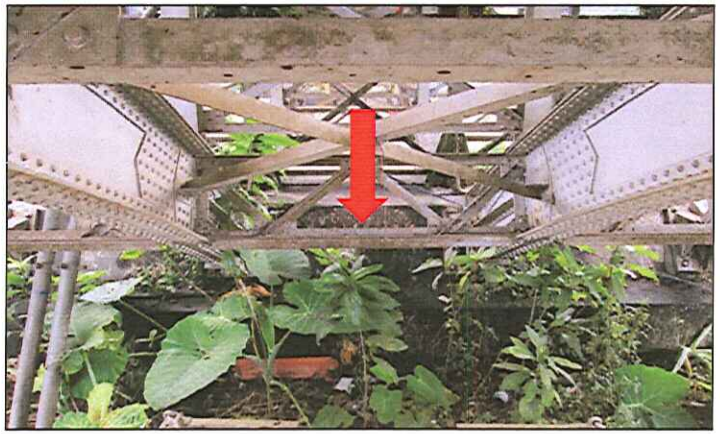


Picture M – S7 – P19

Minor corrosion on inclined cross bracing.

Picture M – S7 – P20

Minor corrosion on inclined cross bracing.



Picture M – S7 – P21

Minor corrosion on inclined cross bracing.

Picture M – S7 – P22

Minor corrosion on inclined cross bracing.

Picture M – S7 – P23

Minor corrosion on inclined cross bracing.

Picture M – S7 – P24

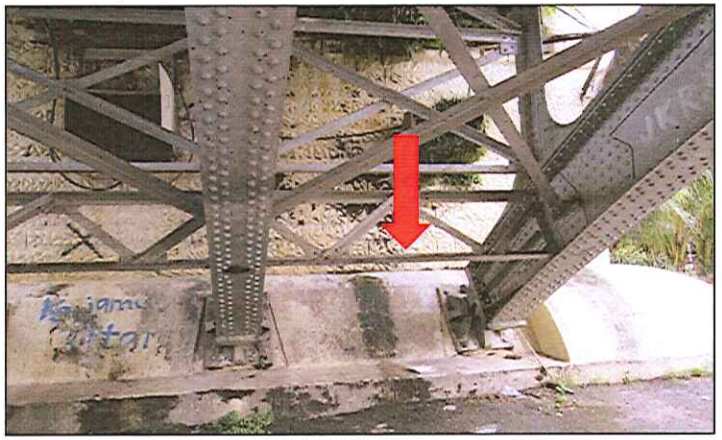
Minor corrosion on inclined cross bracing.

Picture M – S7 – P25

Minor corrosion on inclined cross bracing.

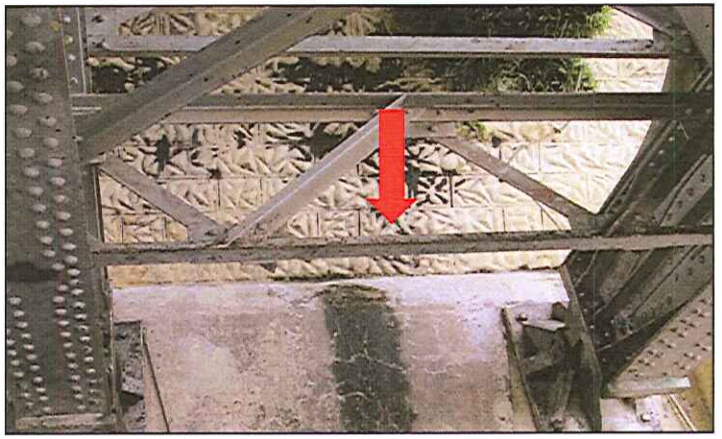
Picture M – S7 – P26

Minor corrosion on inclined cross bracing.



Picture M – S7 – P27

Minor corrosion on inclined cross bracing.



Picture M – S7 – P28

Minor corrosion on inclined cross bracing.

Picture M – S7 – P29

Minor corrosion on inclined cross bracing.

Picture M – S7 – P30

Minor corrosion on inclined cross bracing.

Picture M – S7 – P31

Minor corrosion on vertical bracing joint of arch beam.

Picture M – S7 – P32

Minor corrosion on vertical bracing joint of arch beam.

Picture M – S7 – P33 and Picture M – S7 – P34

Moderate corrosion and crack line on steel plate.

Picture M – S7 – P35 and M – S7 –P36

Moderate corrosion and crack line on steel plate.

Picture M – S7 – P37

Moderate corrosion on T-beam.

Picture M – S7 –P38

Moderate corrosion on overall middle frame.

Picture M – S7 –P39

Minor corrosion on overall middle frame.

Picture M – S7 –P40

Moderate corrosion on overall middle frame.

Picture M – S7 –P41

Minor corrosion on overall middle frame.

Picture M – S7 –P42

Moderate corrosion on overall middle frame.

Picture M – S7 –P43

Minor corrosion on overall middle frame.

Picture M – S7 –P44

Moderate corrosion on abutment support.

Picture M – S7 –P45

Moderate corrosion on abutment support.

Picture M – S7 –P46

Moderate corrosion on abutment support.

Picture M – S7 –P47

Moderate corrosion on abutment support.

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FINAL REPORT

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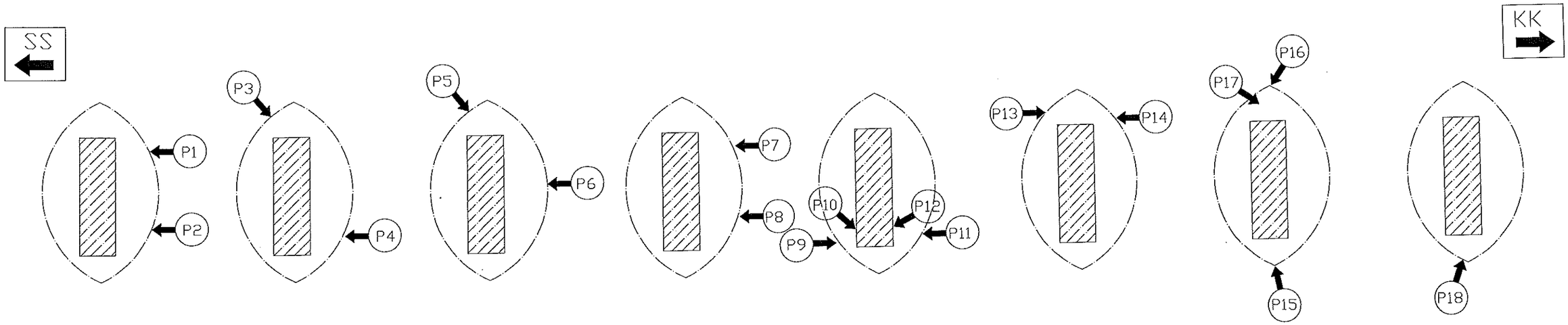
APPENDIX 5

Detailed Visual Inspection Observations on Bridge Piers and Abutments



Abutment 1 | Pier 1 | Pier 2 | Pier 3 | Pier 4 | Pier 5 | Pier 6 | Abutment 2

JAMBATAN SULTAN ISKANDAR DI FT001/639/90, KUALA KANGSAR, PERAK

LAYOUT FOR PHOTOGRAPHIC RECORD OF THE CONDUCTED VISUAL INSPECTION FOR VISIBLE STRUCTURAL DISTRESS, DETERIORATION AND DAMAGES OF BRIDGE ABUTMENTS & PIERS

LEGEND

- (P1) Refer Photographic Record "Picture 1"
- (P2) Refer Photographic Record "Picture 2"
- (P3) Refer Photographic Record "Picture 3"

..... etc .....

NOTE

Visual Inspections for any visible structural distress, deterioration and damages were conducted between January 2015 to March 2015.

Picture 1 – Abutment 1

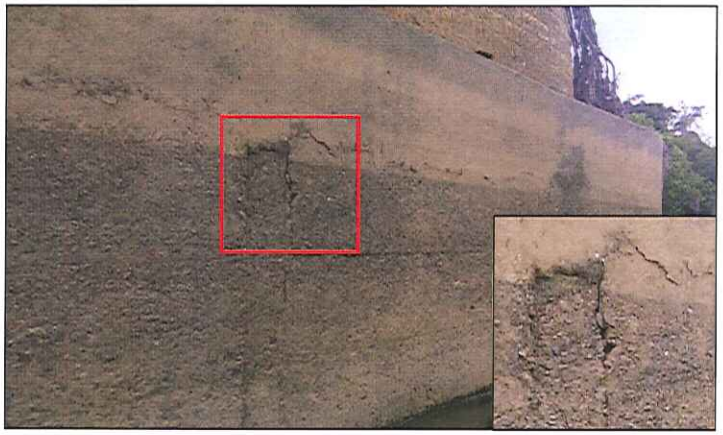
General picture of Abutment 1.

Picture 2 – Abutment 1

General picture of Abutment 1.

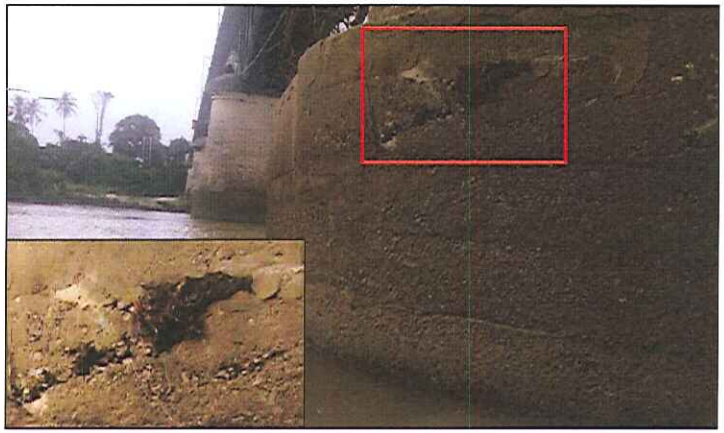
Picture 3 – Pier 1 (toward Sungai Siput)

Minor plaster spalling on the surface of the pier's pile cap.



Picture 4 – Pier 1 (toward Kuala Kangsar)

Vertical crack lines on the surface of the pier's pile cap.



Picture 5 – Pier 2 (toward Sungai Siput)

Minor honeycombed concrete on surface of the pier's pile cap.

Picture 6 – Pier 2 (toward Kuala Kangsar)

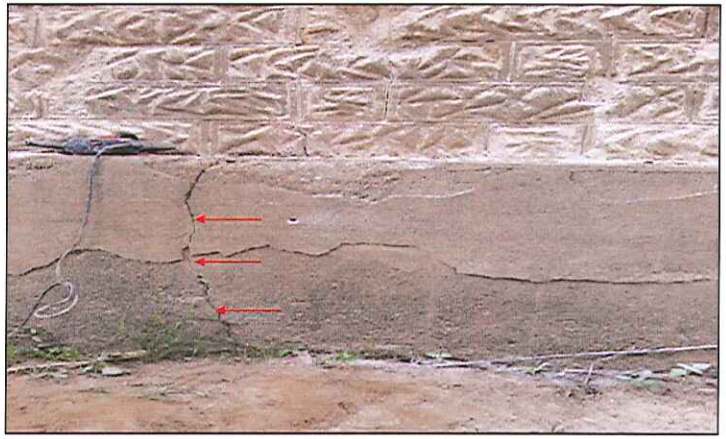
Honeycombed concrete on surface of the pier's pile cap.

Picture 7 –Pier 3 (toward Kuala Kangsar)

Minor edge spalling and delamination of surface plaster of the pier's pile cap.

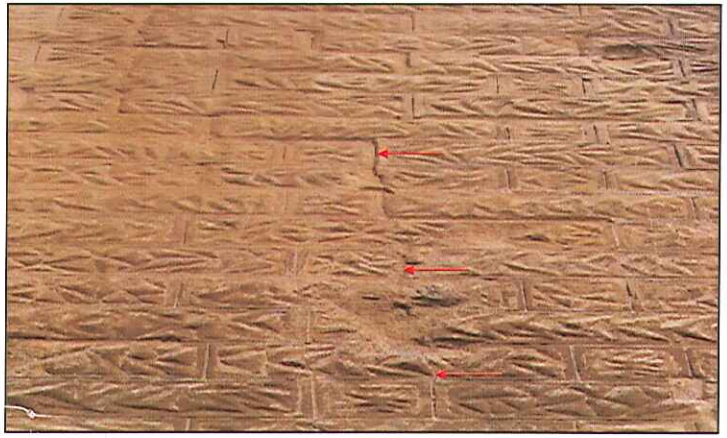
Picture 8 – Pier 3 (toward Kuala Kangsar)

Minor edge spalling and delamination of surface plaster of the pier's pile cap.



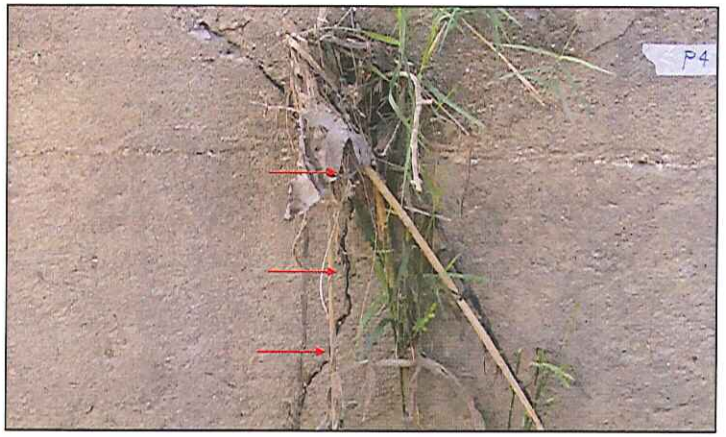
Picture 9 – Pier 4 (toward Sungai Siput)

Vertical crack line on the pier's pile cap.



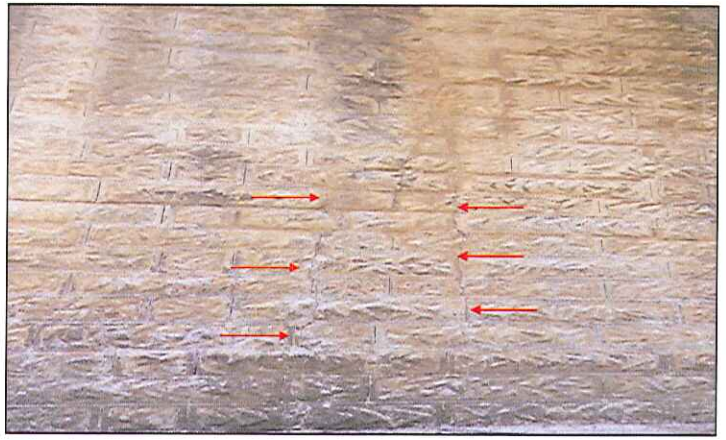
Picture 10 – Pier 4 (toward Sungai Siput)

Vertical crack line on the surface of the pier's wall.



Picture 11 – Pier 4 (toward Kuala Kangsar)

Vertical crack line on the surface of the pier's pile cap.



Picture 12 – Pier 4 (toward Kuala kangsar)

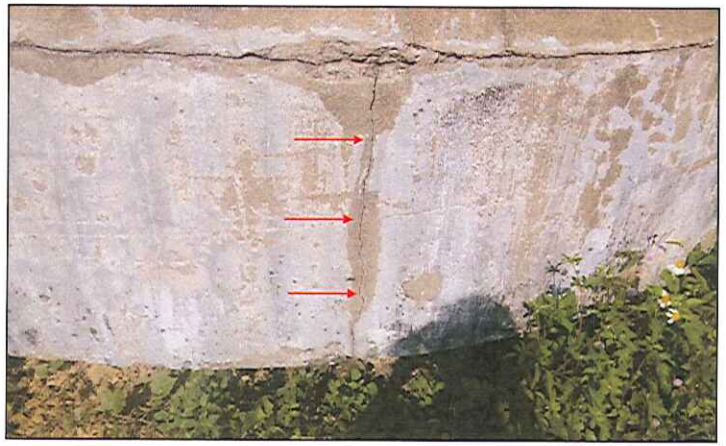
Vertical crack lines on the surface of the pier's wall.

Picture 13 – Pier 5 (toward Sungai Siput)

Minor spalling of pile cap's edge.

Picture 14 – Pier 5 (towardKuala Kangsar)

Minor honeycombed concrete on surface of pier's pile cap.



Picture 15 – Pier 6 (toward Sungai Siput)

Vertical crack line on the surface of the pier's pile cap.

Picture 16 – Pier 6 (toward Kuala Kangsar)

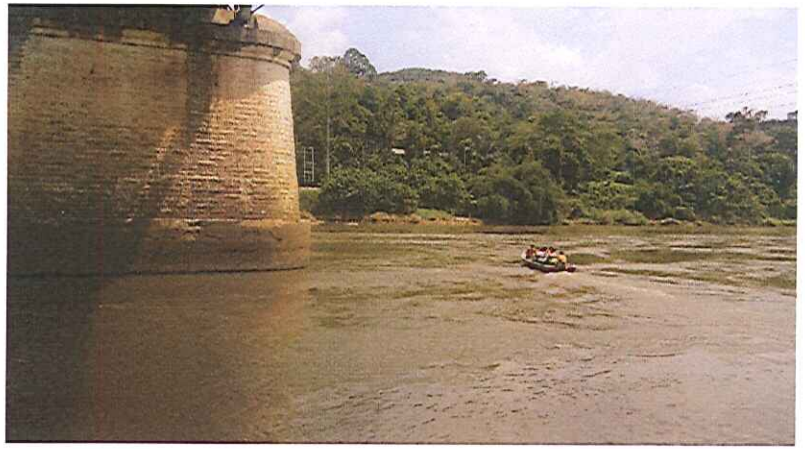
Separation crack line on the surface of the pier's pile cap.

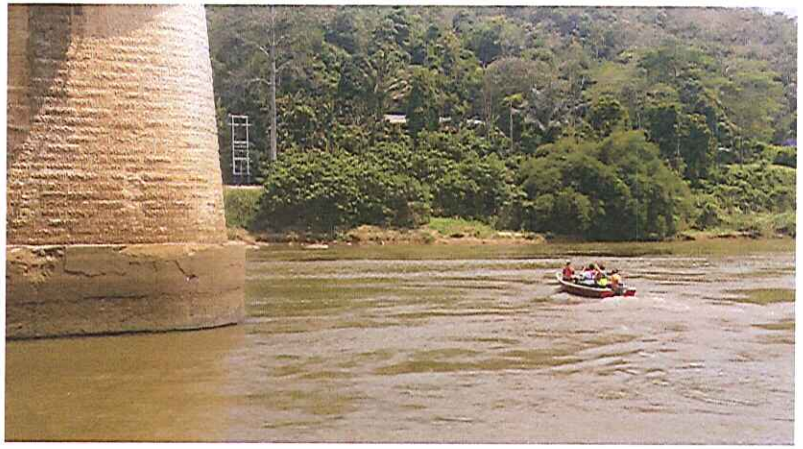
Picture 17 – Pier 6 (toward Kuala Kangsar)

Delamination of the surface plaster.

Picture 18 – Abutment 2

Horizontal crack line on the surface of the abutment.





Picture 19 & 20

General pictures of the conducted boat inspection to the piers and pile caps.

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FINAL REPORT

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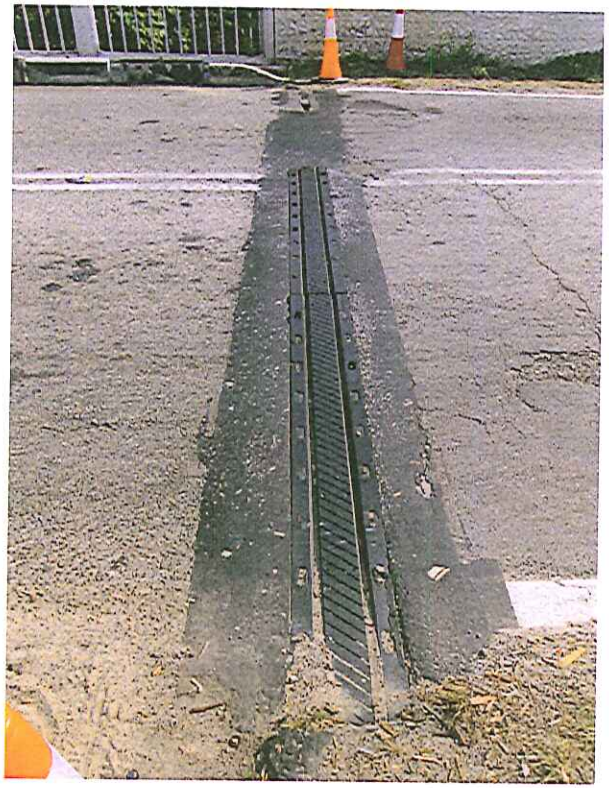
APPENDIX 6

Visual Inspection Observation on Bridge Expansion Joints & Bearings



Picture EJ1

Expansion Joint at Abutment 1

Picture EJ2

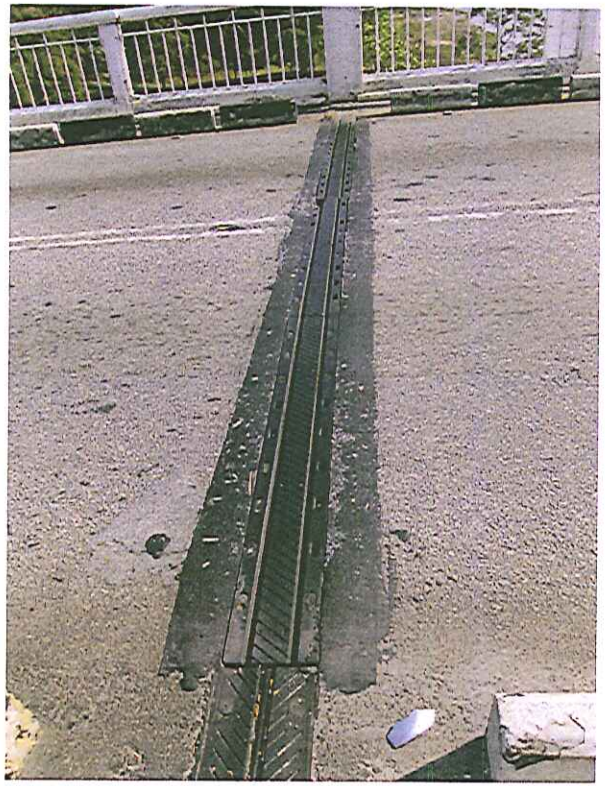
Expansion Joint at Pier 1

Picture EJ3

Expansion Joint at Pier 2

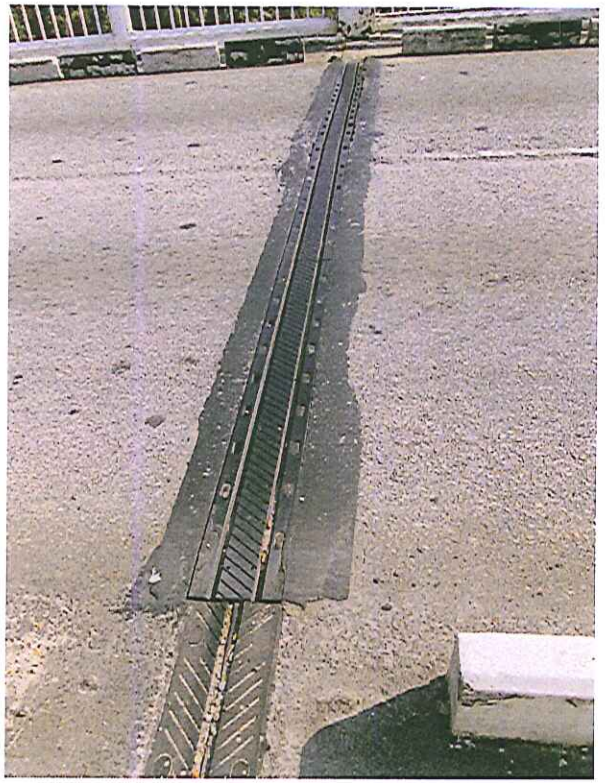
Picture EJ4

Expansion Joint at Pier 3



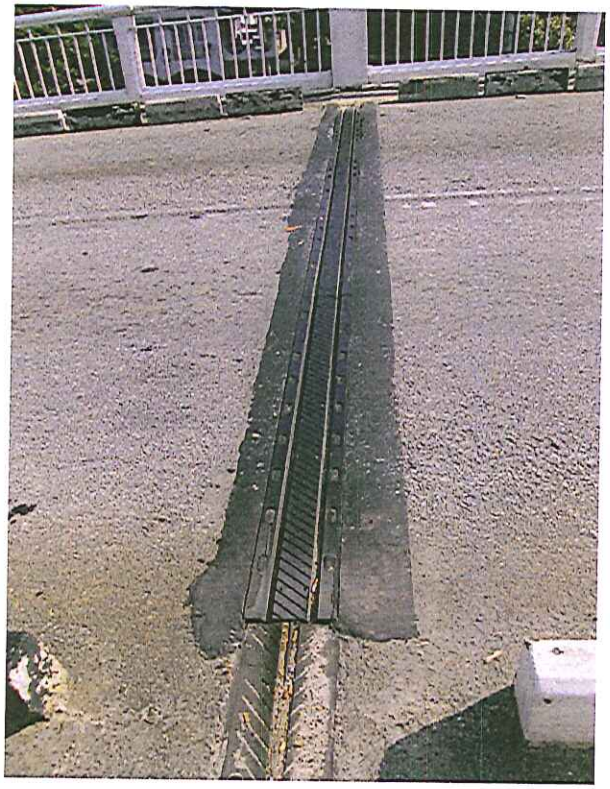
Picture EJ5

Expansion Joint at Pier 4



Picture EJ6

Expansion Joint at Pier 5



Picture EJ7

Expansion Joint at Pier 6

Picture EJ8

Expansion Joint at Abutment 2

Picture B1 & B2 :- The bridge's steel bearings were found to be generally in good operating condition. General maintenance works for cleaning and re-greasing have been recommended.

Picture B3 & B4 :- Some of the bridge's steel bearings with debris/vegetation accumulation and minor rusting. General maintenance works to remove all such vegetation growth with cleaning of the minor rust and re-greasing have been recommended.