

Third Party Audit of ROB's and FOB's of SCR



INSPECTION OF FOB AT MUSTABAD RAILWAY STATION

Final Report
SEPTEMBER | 2020

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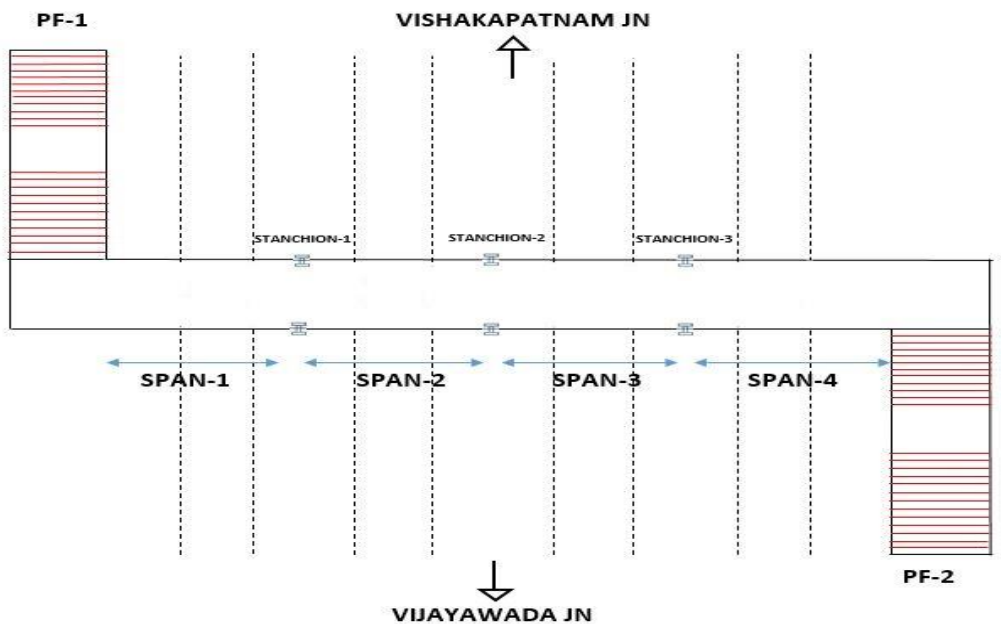
1. VISUAL INSPECTION

Name of the Project	:	VISUAL INSPECTION OF FOB AT MUSTABADA RAILWAY STATION
Location	:	MUSTABADA RAILWAY STATION
Location Co-ordinates	:	16°32'48.7"N 80°43'53.6"E
Date of Inspection	:	20 th OCTOBER, 2019



Visual inspection Summary:

- (a) Corrosion is observed on floor beams of all the Spans.
- (b) Truss Column Connection failure has been observed at Trestle 2.
- (c) Deformations observed at Diagonal bracing of truss and bottom lateral bracing of Span-2
- (d) Corrosion is observed at Staircase Landings and Column joints.

1.1 GENERAL INFORMATION AND OBSERVATION		
a	Name of the Bridge	FOB
b	Location	Mustabad Railway Station
	Location co-ordinates	16°32'48.7"N 80°43'53.6"E
c	Type of truss Structure	Warren Truss Type (Span - 1, 3 & 4) Lattice Truss (Span - 2)
d	Year of Construction	Not available
e	Description of the main use of the bridge	Pedestrians Crossing
f	Major Materials used in different parts of bridge	a. Rail, Structural Steel (Truss, frame), b. In Situ - cast RCC Slab panels (Floor slab, Staircase)
g	Width of the Pathway (m)	1.8 m
h	Length of the Pathway (m)	34.5 m
i	No of Railway Lines Crossings	4 No. of tracks Span 1 = 1 Span 2 = 1 Span 3 = 1 Span 4 = 1
j	Span arrangement (no x Span in meters)	1 x 8 m + 1 x 7.3 m + 1 x 6.5 m + 1 x 7.9 m = 29.7 m (clear span)
k	Vertical Clearance (from rail top to girder bottom)	5.918 m
l	Head Room	Open to Sky
m	Damages due to accidental hitting, Grazing Marks	No Visible signs appear
n	History of Repair/ Maintenance	Not available
o	Existing Structural Drawings	Not available
Key Plan 		

1.2 IDENTIFICATION OF LOADS ON BRIDGE			
		Yes/No	Notes
a	Dead Loads at Roof level		
	a) Pipeline - Utilities	No	Not observed in site
	b) Cables	No	Not observed in site
	c) Roof Truss	No	
	d) Roof Sheet	No	
	e) load of advertising hoarding	No	
	f) load of train/coach display boards	No	No train coach display boards are provided
	g) Additional load of overhead electrical equipment (OHE), Signal, Light Post	No	No electrical equipment and signal are provided
b	Dead Loads at Floor level		
	a) Additional wearing coat on Floor	No	Only RCC Cast In-situ Slab used for Flooring
	b) Provision of protective screen for passengers	Yes	Fence made of galvanized wire of 2 mm gauge and 2 mm galvanized sheet is used above OHE Line on both side of pathway is used for passengers Protection. (Refer fig :1.2)
	c) Type of Material used for mesh	GI wire mesh	

1.3 STRUCTURAL SYSTEM OF THE BRIDGE			
			Notes
a	Foundation details		Not visible at site
b	Trestles		Not visible at site
	Trestles Connection Details		
	No. of Bolts and size		
	Thickness of Base Plate	Not visible at site	
c	Roof Truss		
	Element of roof truss section		No roof truss is provided.
	Size of roof truss		
	Connection of Roof elements		
d	Steel Truss		
	Type /Shape of Truss Section	Warren Type (Span-1,3,4), Diamond Mesh (Span-2)	Span – 1, 3 & 4: a) Top and bottom Chord members are 45 x 90 x 90mm (Head x Height x Base) Rail sections. (Refer fig :1.4) b) 45 x 90 x 90mm Rail sections are used as Diagonal & Knee bracing members.
	Height of Girder/Truss (H)	1.68 m, 1.3 m	
	Truss Support Condition	Ridged connection	

	Type/Shape of Floor beam /Bracings	Rail section, Double Channel Section	c) 45 x 90 x 90mm Rail sections are used as Floor beams supported with Knee bracings 45 x 90 x 90mm rail sections to transfer load from slab to top chord member. d) Bottom Lateral Bracings 45 x 90 x 90mm Rail section in Zig-zag pattern are used to support Floor beams. Span – 2: a) Top and bottom Chord members are 75 x 100 x 12mm Double Angle Sections (Refer fig : 1) b) 50x10 mm MS Flat Sections are used as Inclined bracing members. c) ISMC 150 Double Channel sections are used as Floor beams supported with Knee bracings 65x65X8 Angle sections to transfer load from slab to top chord member.
	No of Floor beams/bracings	Span 1 = 3 No's Span 2 = 3 No's Span 3 = 3 No's Span 2 = 3 No's	
	Arrangement of Bracings	Zig-Zag bracing	
	Type of Beam-Column Joint (shape of gusset plate if any)	Gusset plate	
e	COLUMN		
	Type/Shape of Column section	I- Section Railing	a. FOB is supported on vertical column of ISMB 400, with bracings of 75 x 75 x 12 mm angle section. b. Trestles 1 and 5 have 4 columns whereas Trestles 2, 3 and 4 (Stanchions) have only 2 columns. (Refer fig: 1.3) c. Stanchion - 1 has ISMB 200 column section, Stanchion - 2 has ISMB 600 column section and Stanchion 3 2 has ISMB 150 column section d. Staircase landing is supported by ISMB 150, with bracings of 75 x 75 x 12 mm angle section (Refer fig :1.6)
	No of Columns/ support	4, 2	
	Dimensions of Column	140 x 200 mm	
	BEAM-Column joint (bolted, welded, riveted)	Cleat Angle	
f	Floor of the Pathway		
	Material of Slab	Cast In-Situ	a. Pre-cast Reinforced concrete slab panels are used for floor slab of 150 mm thick, RCC slab panels are resting on Floor beams, which are supported by Bottom Lateral Bracings and Bottom chord member. b. Cement concrete layer is used for flooring. (Refer fig : 1.2)
	Thickness of Slab	150 mm	
	Condition of Slab from Bottom	RCC slab is not visible, Covered with Sacrificial Plate	
	Condition of Slab from Top	Good (No Additional Wearing Coat Is Observed)	
g	Staircase Details		
	Number of Staircase	2 No's	Staircase is observed as Cast-In situ RCC Slab panels supported on 45 x 90 x 90mm Rail tie beam and 55 x 110 x 110mm Rail Stringer beam on both sides of stair case. (Refer fig : 1.5)
	Number of Steps from PF – 1	40 No's	
	Number of Steps from PF – 2	39 No's	
	Material used for steps	Cast In-Situ	

h	Staircase Railing		
	Type of Parapet Railing	Steel Railing	Staircase is provided with railing on both sides using 55 x 110 x 110 rail section and 50 x 12 mm M.S flats are used at landing only. (Refer fig : 1.6)
	Height of Railing	1.07 m	

1.4 SURVEY OF SIGNS OF DISTRESS, DEFORMATION IN BRIDGES

i ✓ Corrosion is observed in floor Beams all over the FOB



a) Corrosion of floor beams at Span-1



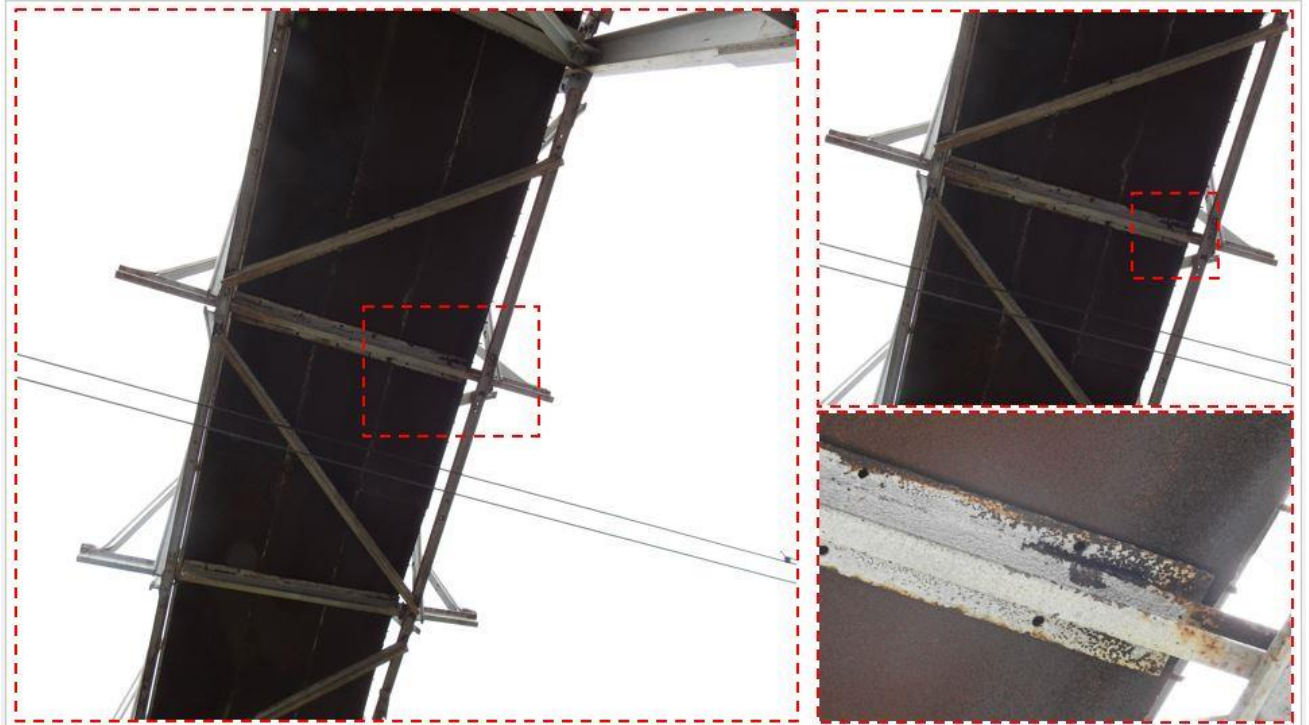
b) corrosion in splice joint at Span-2



c) Corrosion in floor beams at Span-3



d) Corrosion in floor beams at Span-4



e) Corrosion in Joints



f) Corrosion at Floor Beam

ii

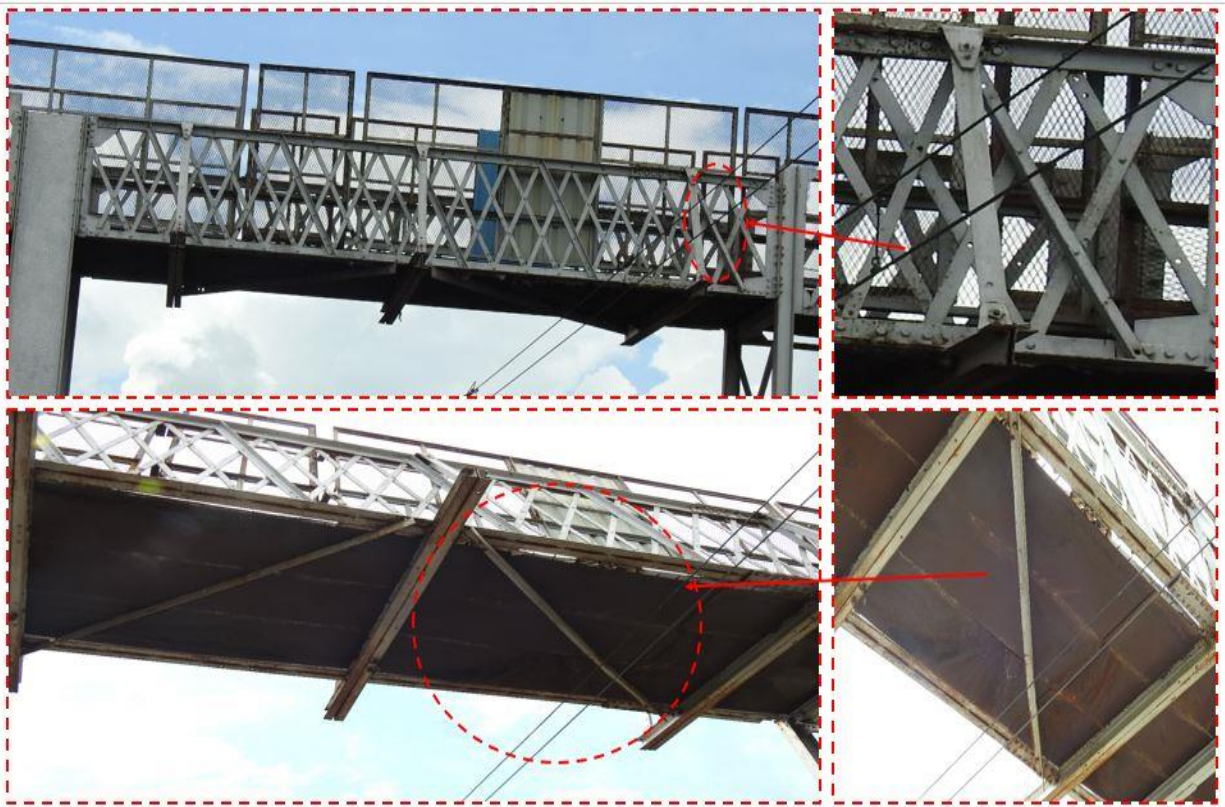
✓ Truss, Column joint connection failure is observed at span 4.



Connection failure at Stair Case-2

iii

✓ Deformation observed at Diagonal member and Slab bottom lateral bracing.



Deformation in Diagonal members, Slab bottom lateral bracing

SIGNS OF DISTRESS, DEFORMATION IN BRIDGES			
	Defects	Location	Notes
	Cracking in Steel Members		No cracks are observed in Steel during visual inspection
	Cracking in RCC components		No Cracks are observed, as the Slab bottom is covered with Sacrificial Plate.
	Water seepage		No visual signs appear.
	Spalling		No Spalling is observed.
	Corrosion	Floor level	Corrosion is observed at floor beams of all the Spans of FOB (Refer Part 1.4.1)
	Rust straining		Rusting is observed in Gusset plates (Refer Part 1.4.1)
	Corrosion at steel-Concrete joint		Slight Rusting is observed at steel-concrete joint. (Refer Part 1.4.1)



Fig 1.1: Front view of FOB



Fig 1.2: Pathway, Protective screen



Fig 1.3: Stanchion details



Fig 1.4: Bottom view of FOB



Fig 1.5: Stair Case Details

2. Repair and Retrofitting Recommendations

2.1 Repairs/Maintenance

a. Cleaning

- **Methodology for cleaning:** Generally foreign material are deposited or accumulated on bridge deck and in several bridge components which can deteriorate the bridge if proper action is not taken, so we support cleaning.
- **Debris removal:** The surface areas of a FOB should be cleaned and washed by brushing with fresh water or using high-pressure water blasting, including Deck slab top, sides along steel concrete joint on either side of deck, Supporting Railing and connecting staircase.

b. Corrosion:

Based on Steel Surface area effected by corrosion on steel member are classified into three grades as follows

- i. **Grade 1-** Mild Corrosion: 10 – 20 % of Surface area is affected with and peeled-off coating film is partially visible.
- ii. **Grade 2-** Moderate Corrosion: 20 – 30 % of Surface area is affected with corrosion and coating film is almost visible but partially deteriorated due to corrosion.
- iii. **Grade 3-** Severe Corrosion: 30% and more of Surface, area is affected by Corrosion and coating film is almost gone.

Methodology for Corrosion:

- If the paint condition is identified as Grade-1, aluminum paint shall be applied with a similar shade.
- Where condition of paint is evaluated as Grade-2 special anticorrosion paint shall be applied to restrict corrosion from progressing further.
- When the condition of the member is observed to be in Grade – 3, which might have occurred due to environmental conditions or age of the structure. In such cases section loss is calculated by using caliper where it is accessible and UPV at one accessible location. The first step in dealing with corrosion is to measure the section loss in the member. The member may be measured using calipers or other appropriate methods for totally exposed sections.
 - a. Section Loss < 15% - Clean the Surface and Apply the anticorrosion protective coat.
 - b. Section Loss 15% - 40% Repair the member as per design.
 - c. Section Loss > 40% - Replace the member.

SPAN - 1

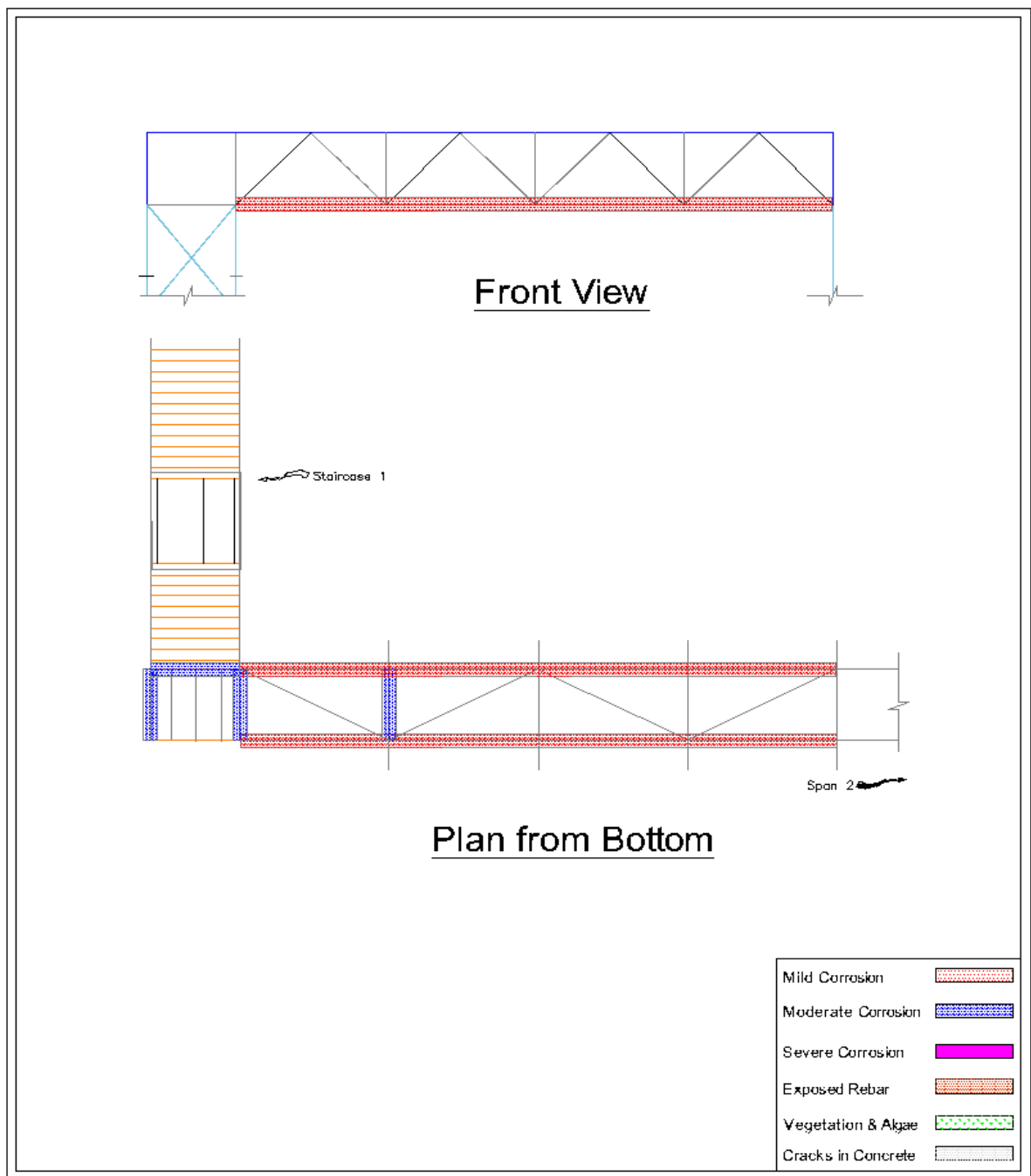


Fig.2.1 Locations of deteriorations and bottom view of span-1

Span one recommendations

- Structural members are in fair condition, displaying mild corrosion for top chord members, verticals, diagonals, and gusset plates and bottom chord members. Moderate corrosion for floor beams (locations are marked in figures below). (Photographs of the same can be see in **fig2.2**)

Table 2.1: Grading of corrosion in span 1

Span 1	Mild Corrosion	Moderate Corrosion	Sever Corrosion	Remark
Floor Beams/ Cross Girders		✓		
Bottom Chord	✓			
Top Chord	✓			
Bottom Lateral Bracings	✓			
Diagonals	✓			
Vertical	✓			
Gusset Plates	✓			
Bolts	✓			



Fig.2.2 Corrosion of floor beams at span-1

SPAN - 1

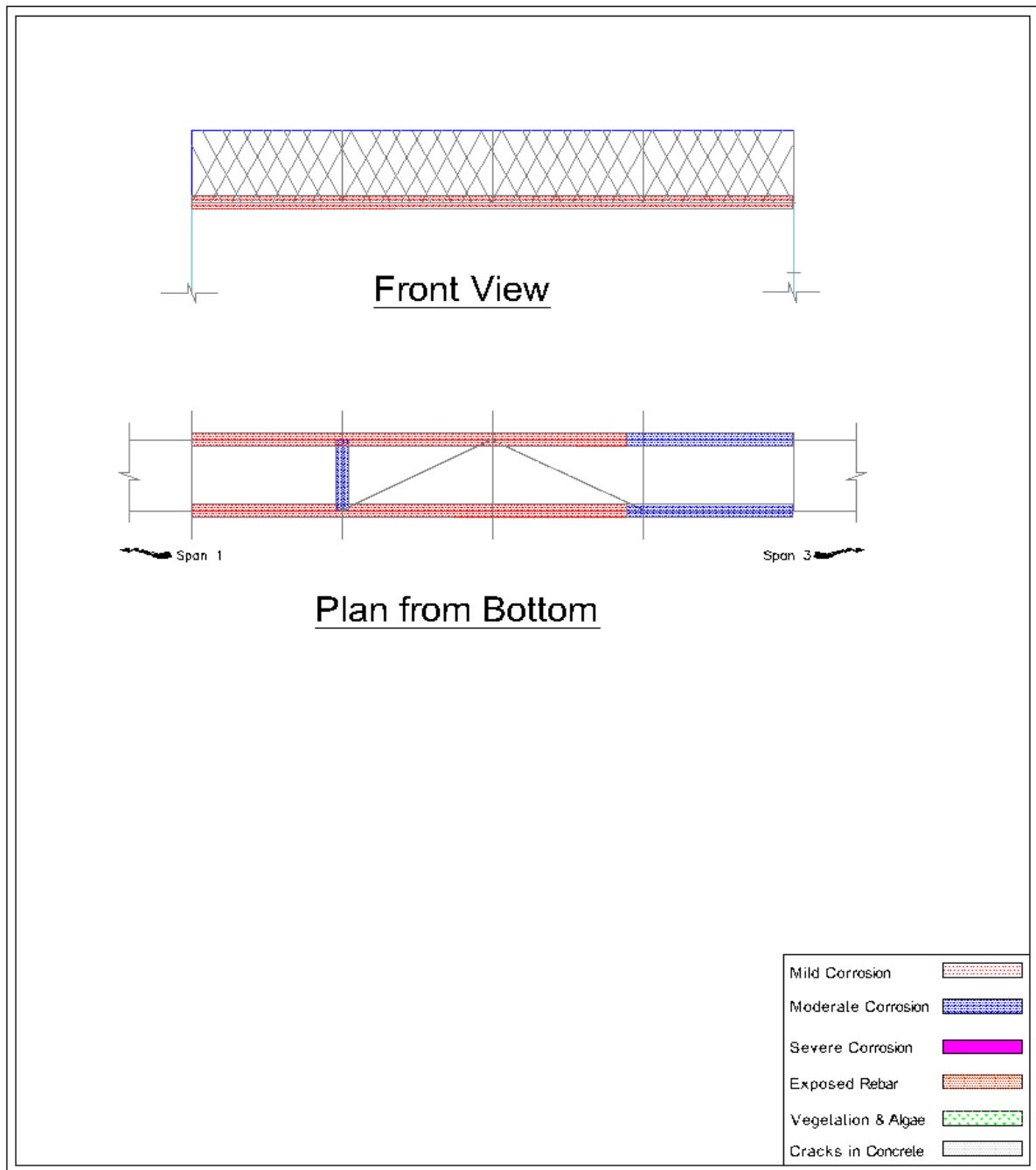


Fig.2.3 Locations of deteriorations from bottom view of span-2

Span two recommendations

- Structural members are in fair condition, displaying mild corrosion for top chord members, verticals, diagonals, and gusset plates. Moderate corrosion for floor beams and bottom chord member. Moderate corrosion at splice joint. (Locations are marked in figures below). (Photographs of the same can be see in **fig2.4**)

Table 2.2: Grading of corrosion in span 2

Span 2	Mild Corrosion	Moderate Corrosion	Sever Corrosion	Remark
Floor Beams/ Cross Girders		✓		
Bottom Chord		✓		
Top Chord	✓			
Bottom Lateral Bracings	✓			
Diagonals	✓			
Vertical	✓			
Gusset Plates	✓			
Bolts	✓			



Fig.2.4 Corrosion of floor beams and slice joint at span-2

SPAN - 3

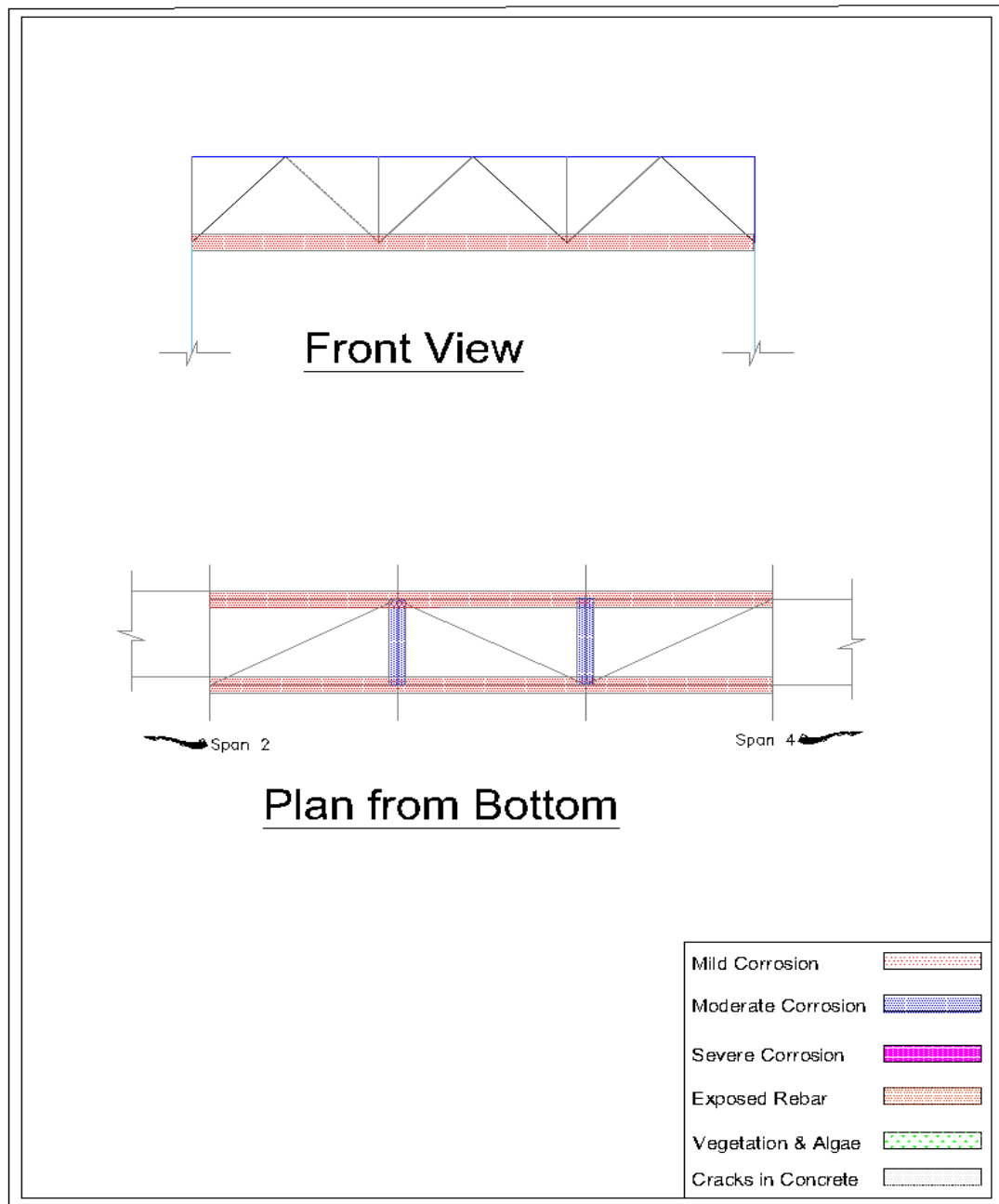


Fig.2.5 Locations of deteriorations from bottom view of span-3

Span three recommendations

- Structural members are in fair condition, displaying mild corrosion for top chord members, verticals, diagonals, bottom chord member and gusset plates. Moderate corrosion for floor beams. (Locations are marked in figures below). (Photographs of the same can be see in **fig2.5**)

Table 2.3: Grading of corrosion in span 3

Span 3	Mild Corrosion	Moderate Corrosion	Sever Corrosion	Remark
Floor Beams/ Cross Girders		✓		
Bottom Chord	✓			
Top Chord	✓			
Bottom Lateral Bracings	✓			
Diagonals	✓			
Vertical	✓			
Gusset Plates	✓			
Bolts	✓			



Fig.2.6 Corrosion of floor beams at span-3

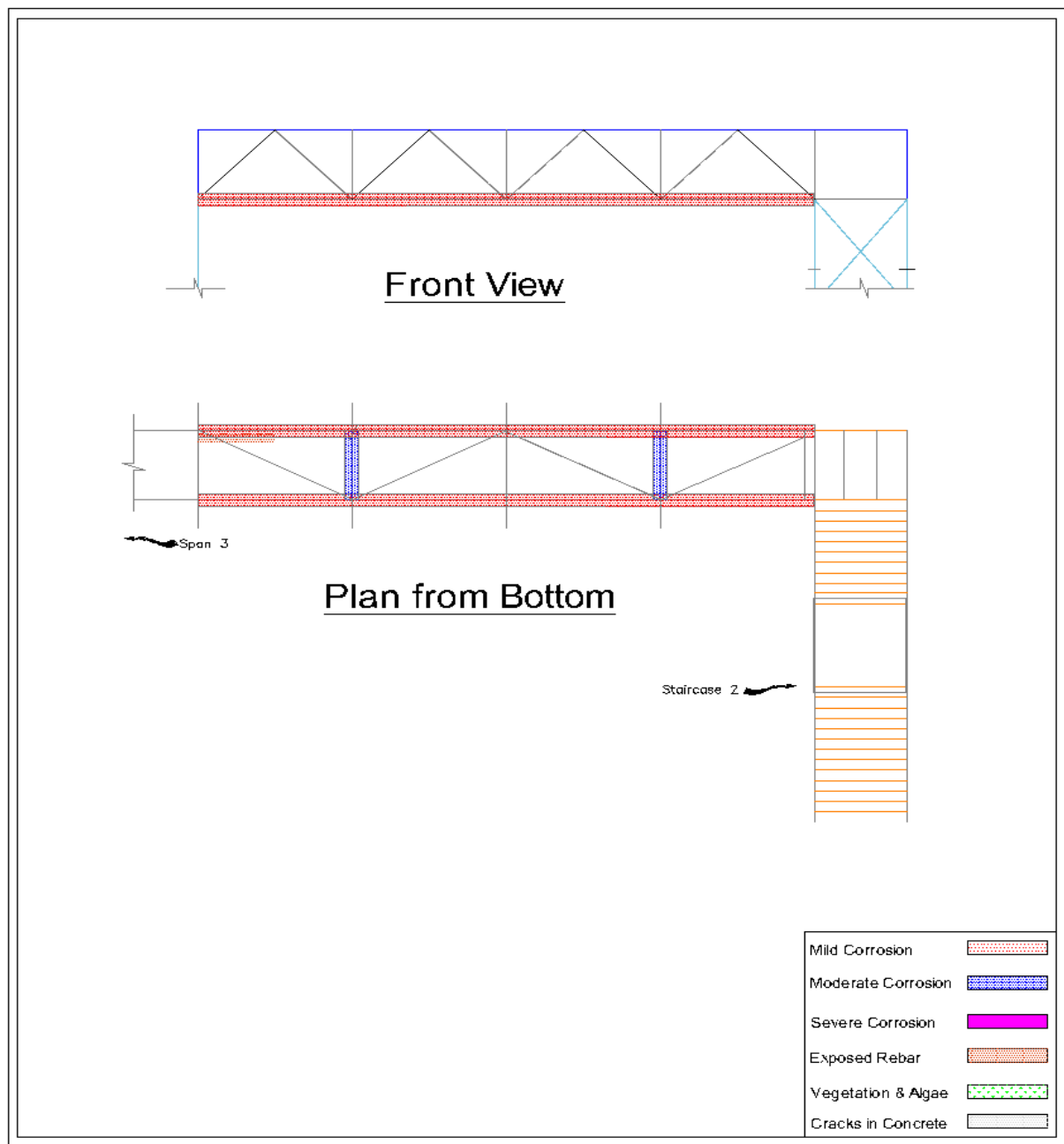


Fig.2.7 Locations of deteriorations from bottom view of span-4

Span four recommendations

- Structural members are in fair condition, displaying mild corrosion for top chord members, verticals, diagonals, bottom chord member and gusset plates. Moderate corrosion for floor beams. (Locations are marked in figures below). (Photographs of the same can be see in **fig2.7**)

Table 2.4: Grading of corrosion in span 4

Span 4	Mild Corrosion	Moderate Corrosion	Sever Corrosion	Remark
Floor Beams/ Cross Girders		✓		
Bottom Chord	✓			
Top Chord	✓			
Bottom Lateral Bracings	✓			
Diagonals	✓			
Vertical	✓			
Gusset Plates	✓			
Bolts	✓			



Fig.2.8 Corrosion of floor beams at span-4



Fig.2.9 Connection failure at Stair Case-2



Fig.2.10 Deformation in Diagonal members, Slab bottom lateral bracing

ANNEXURE

Annexure-1a: Repair methods

Defects/Deficiency	Minor corrosion of steel element
Remedial Measures	Touchup painting

Due to thin paint coverage on steel surfaces or formation of pin-holes in paint, the steel surface may get exposed to atmosphere resulting in initiation of corrosion. Touch up painting at the early stages prevents progress of corrosion. Work included in this section comprises field touchup painting on steel members at localized areas including surface preparation and other associated works. This section covers only painting on relatively small affected areas which can be carried out with the use of small power tools / hand tools. Painting of larger areas requiring sand blast cleaning should be carried out in accordance with the specifications covered under major repairs.

Work Sequence

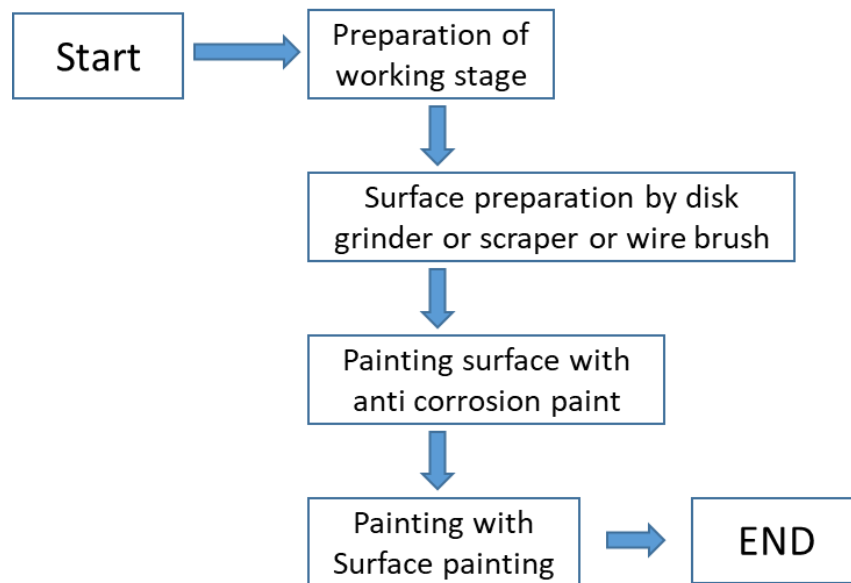


Figure: 1.2 Work sequence of Painting with anti-corrosion paint

Required Equipment / Tool and Material

i. Materials

- Aluminum paint / special anticorrosion paint as required
- Thinner
- Epoxy resin filler

ii. Tools/Equipment

- Scaffolding, inspection vehicle
- Portable generator (3 kVA)
- High pressure water blaster (8.0Mpa, 10.0 liters/min.)
- Sandpaper, portable power disk grinder

Requirement and Specifications

- Paint brush, roller

i. Material

Aluminum paint material shall be in accordance with the manufacturer's specifications and as approved by the Engineer.

For special anticorrosion paint, the materials shall satisfy the test requirements indicated in the relevant ASTM specifications as follows:

Table 1.4 Specification of Aluminum paint

Test	Test reference	Specification
Adhesive test	ASTM D7234	7days 1.0 N/mm ² , 28days 1.5 N/mm ²
Elongation	ASTM C190	7days 0.40 %, 28days 0.40 %
Saltwater test	ASTM D6943	No defection

ii. Work requirement

1) Scaffolding

Scaffolding shall be installed for close access to the corrosion-affected surfaces of the steel members to be repaired. Standard scaffoldings may be used however mobile scaffolding/inspection vehicle may be found suitable as it allows for free movement in most cases and provides access with convenience to various parts of a bridge.

2) Preparation of Steel Surface

Surface preparation shall conform to the paint manufacturer's specifications. Hand or power tools shall be applied for cleaning the surface. Groves and ridges formed on the affected surface shall be removed with power grinder. Where appropriate, as an alternative, epoxy resin filler may be used to fill the surface to a smooth and even finish. Where depth of roughness is within 0.5 mm, paint adequacy and durability can be achieved without application of multiple coats of surface leveling paints. Thickness of each coat shall not exceed the limiting value recommended in the paint

manufacturer's specifications. Application of aluminum paint material shall be in accordance with the manufacturer's specifications and as approved by the Engineer.

3) Application of Touchup Paint

Paint shall be applied with brush or roller. The paint shall be applied in such a way that a uniform and smooth surface is formed without wrinkles, runs, streaks, sags, or any other defects. Components of the paint shall be mixed in accordance with the manufacturer's instructions and the application shall also conform to such instructions and specifications. Paint shall be applied immediately after the surface preparation, preferably within 4 hours. Total dry film thickness for special anticorrosive paint shall be 500 μm (equivalent 1.5kg/m²) consisting of two layers of coating as follows: -

Layer-1: 250 μm and Layer-2: 250 μm

Anticorrosion paint shall be applied in accordance with the stipulations of paint manufacturer's specifications. Minimum total film thickness for aluminum paint shall be not less than 125 μm . Roval paint is recommended for galvanized member touchup painting. Total dry film thickness for Roval paint shall be 80 μm (equivalent 0.5kg/m²) consisting of two layers of coating as follows: -

Layer-1: 40 μm and Layer-2: 40 μm

Roval paint shall be applied in accordance with the stipulations of paint manufacturer's specifications.

Summary

- **Visual inspection of Mustabad railway station fob has been conducted on 20th Oct 2019, following observations were made**
 - i. Corrosion is observed on floor beams of all the Spans.
 - ii. Truss Column Connection failure has been observed at Trestle 2.
 - iii. Deformations observed at Diagonal bracing of truss and bottom lateral bracing of Span-2
 - iv. Corrosion is observed at Staircase Landings and Column joints.
- **Based on visual inspections and its interpretations following recommendations were made:**
 - a) Anti-corrosion treatment for Grade-1 and Grade-2 highlighted corrosive members for floor beams and bottom chord members.
 - b) Replacement of damaged or deformed members, bottom diagonal members at span 2.
 - c) Replacing of missing bolts near staircase-2 connecting column.

Note: Provided step wise procedure for each recommendation are detailed out in annexure based on requirements