

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



INSPECTION OF ROB NO. 254B NEAR METTUGUDA

Final Report
SEPTEMBER | 2020

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1. VISUAL INSPECTION

Name of the Project	:	VISUAL INSPECTION OF ROB - (254B)
Location	:	NEAR METTUGUDA, HYDERABAD.
Location Co-ordinates	:	17°26'18.9"N 78°31'29.4"E
Date of Inspection	:	13th OCTOBER, 2019.



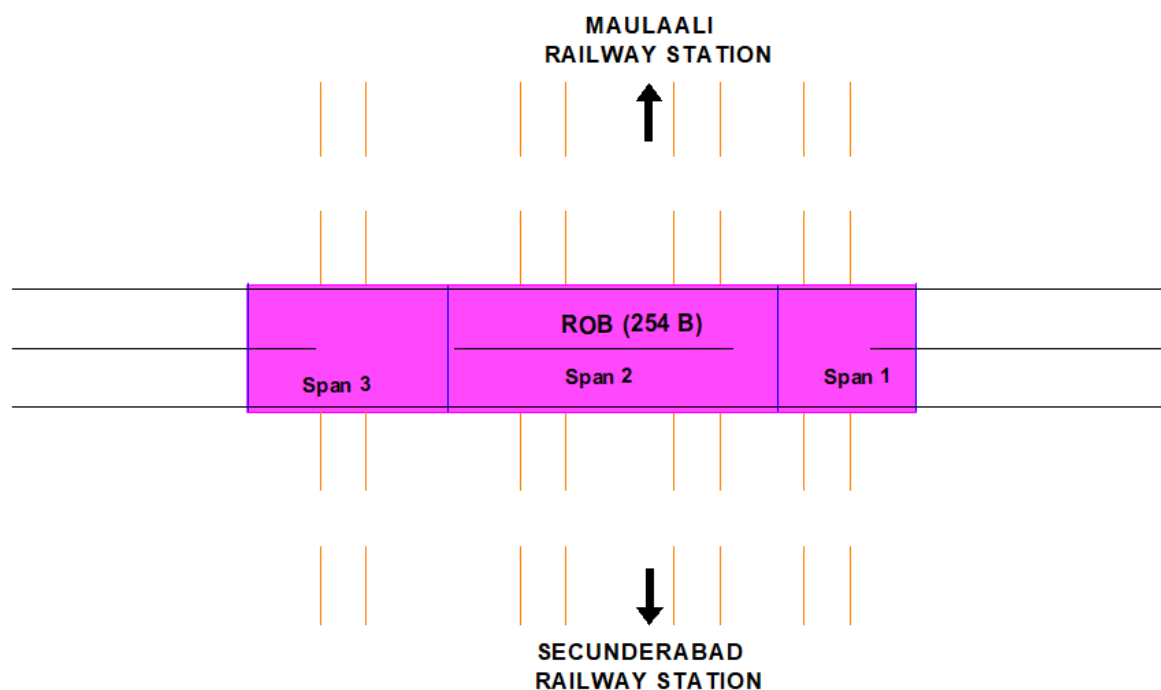
Visual inspection Summary:

- a) Spalling and Reinforcement exposure has been observed at deck slab
- b) Corrosion is observed at the steel concrete joint
- c) Reinforcement exposure is also observed at overhang portion of slab
- d) Pointing failure has been observed at pier.
- e) Leaching is observed at piers.
- f) Vegetation, algae growth is also observed on piers

1.1 GENERAL INFORMATION AND OBSERVATION

a	Name of the Bridge	ROB (254B)
b	Location Location co-ordinates	Near Mettuguda. 17°26'18.9"N 78°31'29.4"E
c	Type of Bridge	Composite Girder Bridge
d	Year of Construction	Data Not Available
e	Grade of Concrete (Slab)	Data Not Available
f	Design Load	Data Not Available
g	Carriageway Width	7.5 m
h	Overall Deck Width	8m
i	Average Skew	Not in skew
j	Span arrangement (no x Span in meters)	1x 5.17 m +1 x 13.7m + 1x 5.17 m (Clear span)
k	No of Railway Lines Crossings	4 tracks
l	Vertical Clearance (from rail top to girder bottom)	5.8m
m	History of Repair/ Maintenance	No Patch work observed
n	Existing Structural Drawings	Not available

Key Plan



1.2 STRUCTURAL SYSTEM OF THE BRIDGE			
			Notes
a	Foundation details		Not visible at site
	Type of foundation		
	Foundation Details (if available...)		
	Foundation Status (Check Settlement, abnormal Scour and Tilting, if any etc...)		
	Type of Damage (Check cracking, disintegration, decay, erosion, Cavitation's etc..)		
b	Abutment (A1 & A2)		
	Type	wall	
	Maximum height of Abutment from Ground level	6.4	
	Abutment width along the Track	8.6m	
	Abutment thickness	3.2m	
	Condition (Crack, Settlement, Scour, Tilting, Steel Corrosion, Strains and other damages etc...)		Leaching has been observed.
	Efficiency of drainage of backfill Behind Abutments (Check functioning of weep holes, evidence of moisture on Abutment faces, etc.)		functioning properly
c	Pier		
	Type (Shape)	wall	Leaching and Algae formation and vegetation growth has been observed on piers.
	Material	Masonry	
	No. of Piers in a row/column	2	
	Maximum Height of Pier	5.8m	
	Pier Diameter/Dimension	8.6 x 2m	
	Pier Cap Material	RCC Bed block	
	Pier Cap Condition	Cracks observed	
	Pier Condition (Crack, Settlement, Scour, Tilting, Steel Corrosion, Strains and other Damages etc...)	Good	
	Efficiency of drainage of backfill behind Abutments (Check functioning of weep holes, evidence of moisture on Abutment faces, etc...)	Good	

d	Bearing & Pedestal		
	Type of Bearings		Not accessible / visible
	General condition (Check Corrosion, cleanliness, seizing of plates silting, accumulations of dirt in case of submersible bridges)		
	Type/ shape of Pedestal		
	General condition (Check Corrosion, cleanliness, seizing of plates silting)		
e	Super Structure (Steel Girder)		
	Type/Shape of Girder (I-beam, box-Girder etc.)	I-girder	The Bridge is supported on 4 Longitudinal Built up Plate girders.
	Material of Girder	Steel	
	No of Girder	4 Nos.	
	Dimensions of Girder	1.2 m, 0.6m	Total Depth = 1.2m (span 2) Total Depth = 0.6m (span 1 & 3)
	Structural System of Girder		Simply Supported
	Condition of Girder	Distresses Found	corrosion is observed in along steel concrete joint (Refer Fig:6)
	Type/Shape of Secondary Girder		cross bracings of angle section is used as secondary girder
	Material of Secondary Girder	Steel	
	No of Floor beams	6 Nos.	
	Condition of Secondary Girder		Rusting is observed.
f	Slab		
	Material of Slab	RCC	
	Thickness of Slab	0.58m	
	Condition of Slab from Bottom	Distresses Found	Spalling & Reinforcement exposure has been Observed. (Refer Fig:4, 5)
	Condition of Slab from Top		Not visible, as covered with wearing coat
	Condition of Flooring/Wearing Coat	fair	
g	Parapet wall/Railing		
	Type of Parapet wall/Railing	RCC	
	Height	1.8m	
	Condition of Wall/Railing	Good	Cracks and spalling observed

1.3 SURVEY OF SIGNS OF DISTRESS, DEFORMATION IN BRIDGES			
	Defects	Location	Notes
	Cracking in RCC components	Pier cap	cracks are observed at pier cap (<i>Refer Fig:11</i>) & Pier (<i>Refer Fig:3</i>)
	Water seepage		No water seepage is observed
	Spalling	Slab	Spalling is observed in Slabs. (<i>Refer Fig:4, 5</i>)
	Reinforcement Exposure	Slab	Reinforcement Exposure is observed in Slabs (<i>Refer Fig:4,5,7</i>)
	Corrosion	Girder	Corrosion is observed at steel concrete joints of (<i>Refer Fig:6</i>)



Fig: 1.1 View of ROB



Fig:1.2 Bottom view of Slab



Fig: 1.3 Vegetation, algae growth, leaching, and cracks observed at Piers



Fig:1.4 Exposed reinforcement observed in span 2

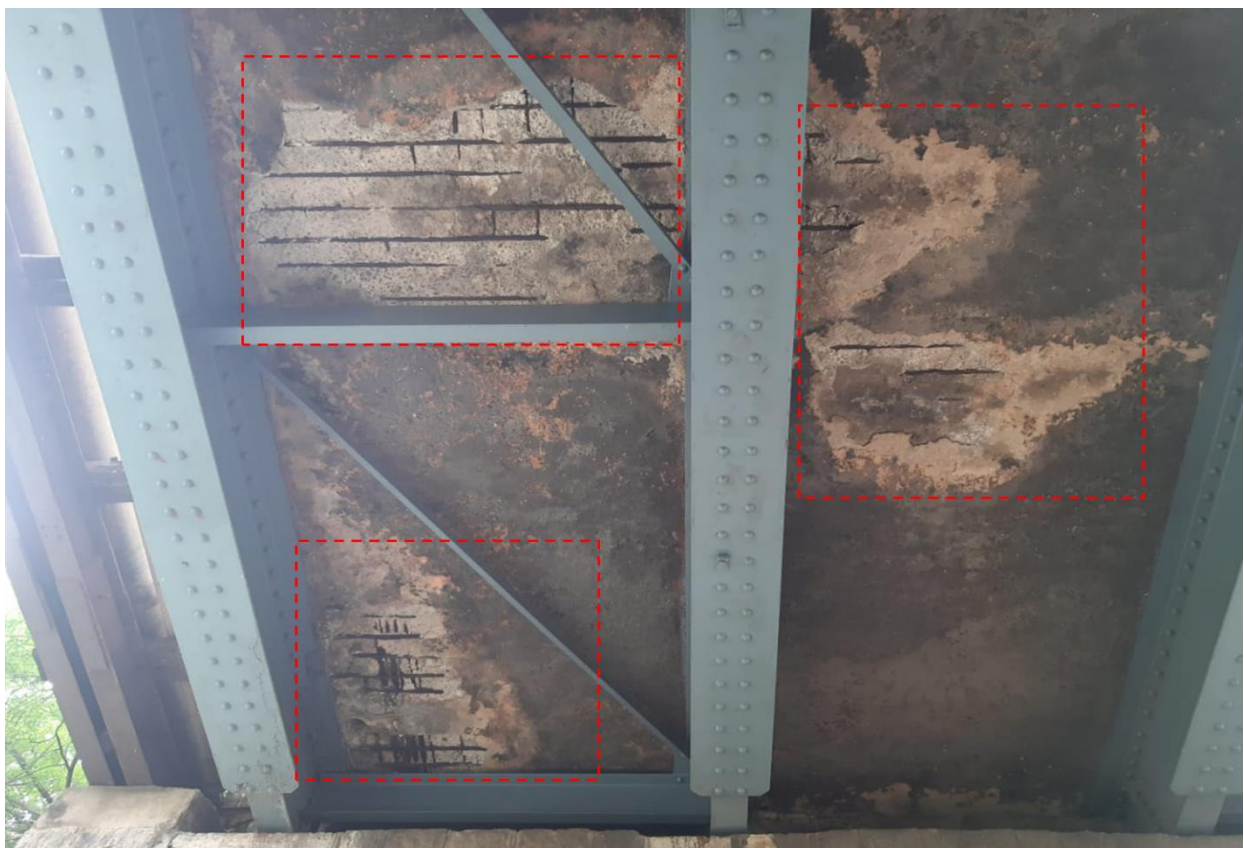


Fig: 1.5 Exposed reinforcement observed in span 3

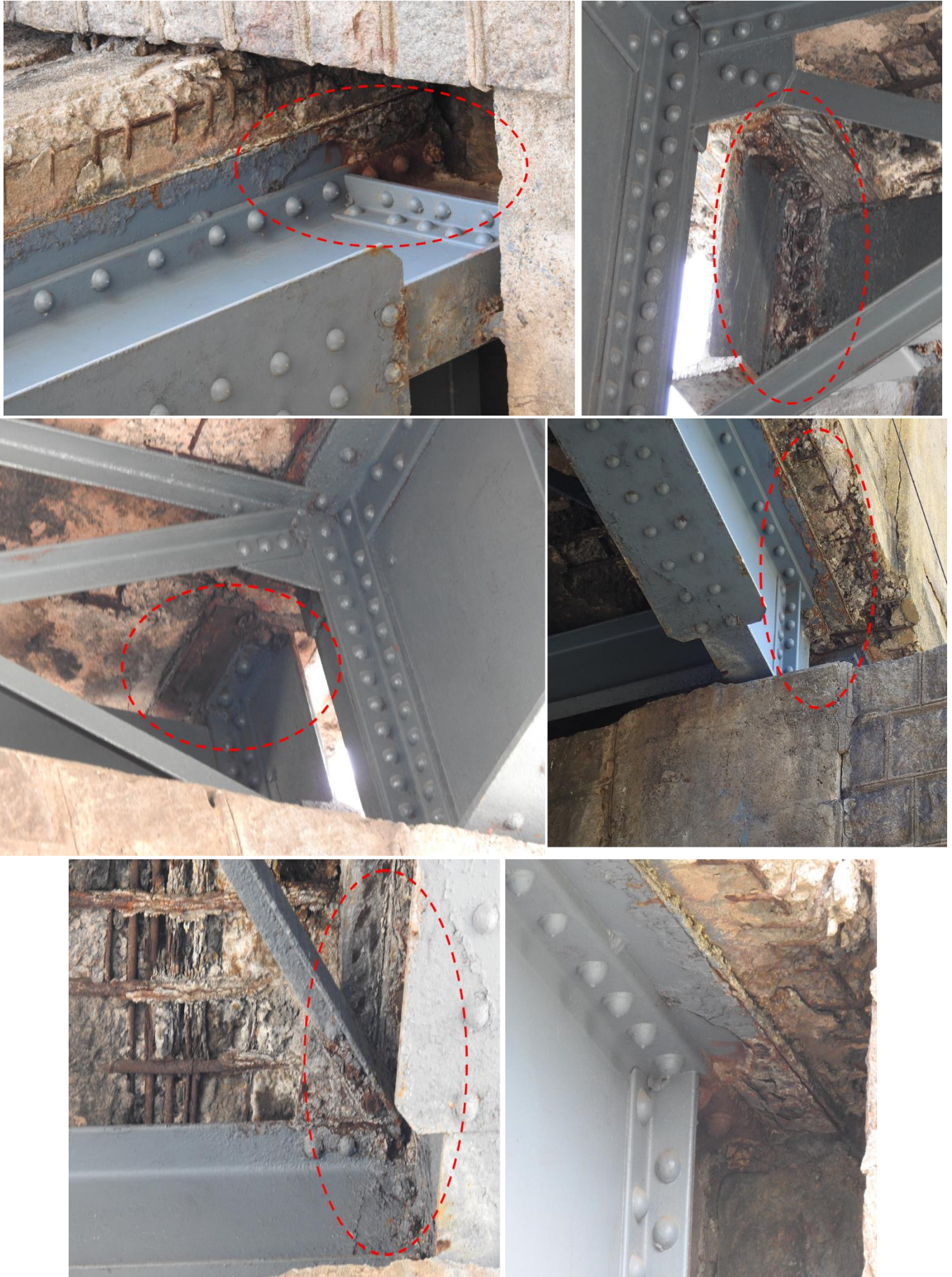


Fig: 1.6 Corrosion observed at steel concrete joint, severe damage observed at rivet head



Fig: 1.7 Spalling and reinforcement exposed at overhang portion of slab due to less cover



Fig: 1.8 Spalling and reinforcement exposed at span 1



Fig: 1.9 Additional load of utility is observed



Fig:1.10 Patch work observed (A- original concrete, B-old patch work, C-new patch work)



Fig: 1.11 Exposed reinforcement due to improper drain



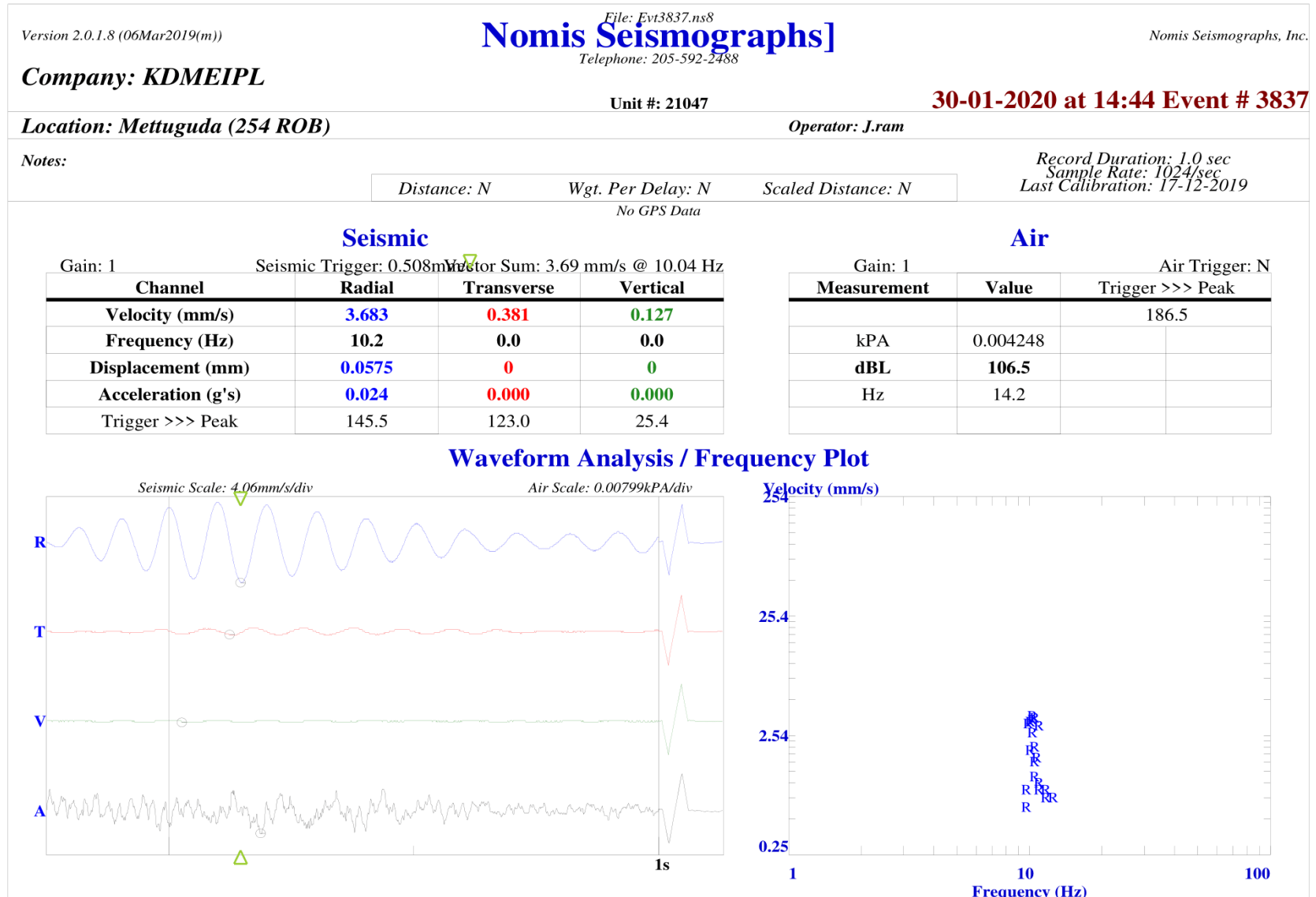
Fig: 1.12 pointing failure observed at the bed block



Fig: 1.13 Cracks on parapet wall

2. Vibration Analysis

2.1 Interpretation Vibration Analysis



Company: KDMEIPL

Unit #: 21047

30-01-2020 at 14:41 Event # 3826**Location: Mettuguda (254 ROB)****Operator: J.ram****Notes:**

Distance-Source: N

End Time: 15:43:18
 Sample Rate: 1024/sec
 Last Calibration: 17-12-2019

No GPS Data

Seismic

Gain: 1

Vector Sum: 3.69 mm/s

Channel	Radial	Transverse	Vertical
Velocity (mm/s)	3.683	0.508	0.508
Frequency (Hz)	8.8	15.3	341.3
Time	14:44:55	14:58:08	14:58:25
Displacement (mm)	0.0666	0.0053	0.0002
Acceleration (g's)	0.021	0.005	0.111

Air

Gain: 1

Measurement	Value		
kPA	0.017493		
dBL	118.8		
Hz	146.3		
Time	15:13:49		

BarGraph

Seismic Scale: 4.06mm/s/div

Air Scale: 0.03197kPA

Bar Samples total/shown: 61/61

Summary Interval (min): 15
 Bar Interval (sec) 60



The permissible amplitudes of vibration are generally specified during analysis and design of the structure. Below fig. suggested by Richart may be adopted during design or operation of the structure

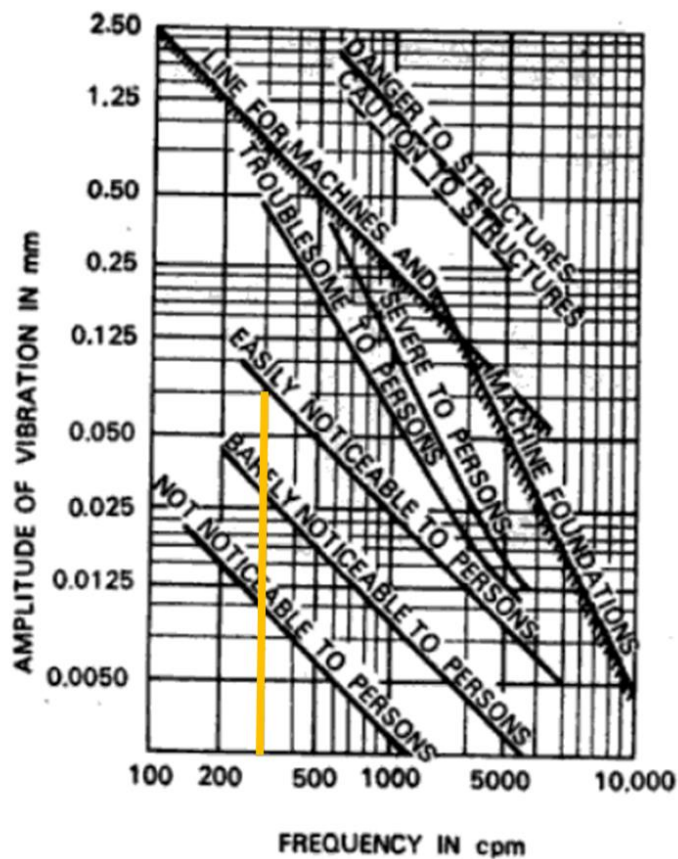


Fig. 1.4: Allowable Limits for Vertical Vibration Amplitudes (After Richart, F. E., Jr. *et al.*, *Vibration of Soils and Foundations*, Prentice-Hall Inc., New Jersey, USA, 1970; with permission).

Based on the vibration analysis carried out the structure is in permissible limit of vibrations. (Frequency observed is 300 cpm and maximum amplitude observed during the test time of complete 3hrs is 0.0575 mm)

3. Repair and Retrofitting Recommendations

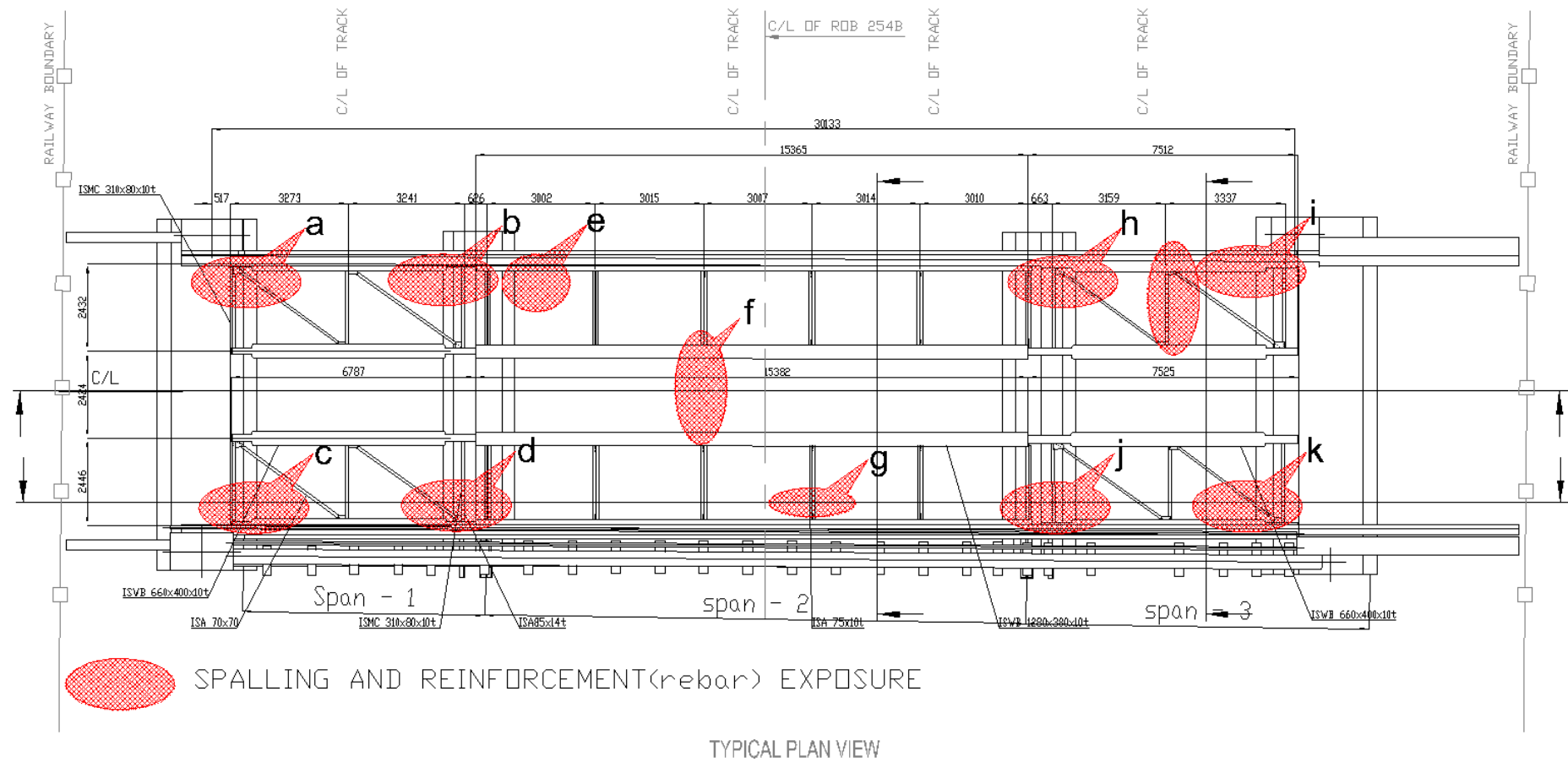


Fig 3.1: Bottom view of slab deck with reinforcement exposed (damaged) locations

During the detailed visual observation, is made of Deck slab on the above said locations and the following observations are made, excessive spalling was noticed in span 1, 2 & 3 in majority of the deck slab is affected with dampness, rebar corrosion and cracks were noticed at the steel concrete joints.

3.1 Repair Methods and Recommendations for Reinforced Concrete Deck Slab

- Spalling and Rebar exposure in deck slab



Fig 3.2: Damage locations identified in span 1 at “a, b, c & d”

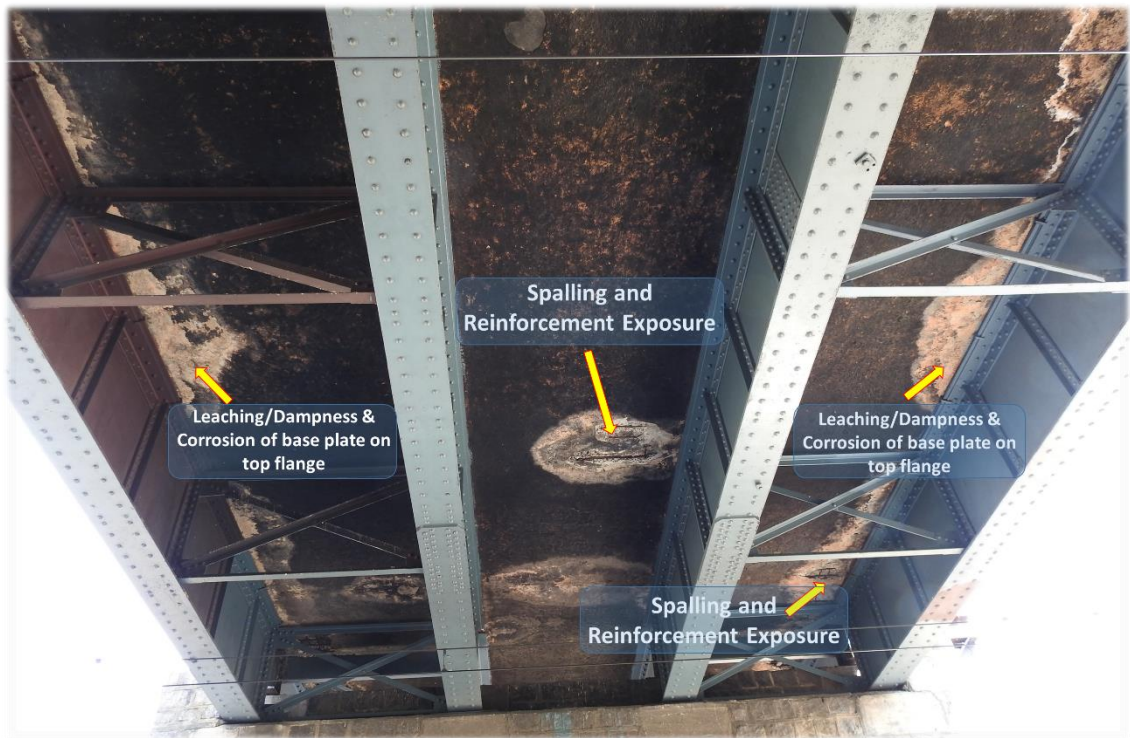


Fig 3.3: Damage locations identified in span 2 at “e, f & g”

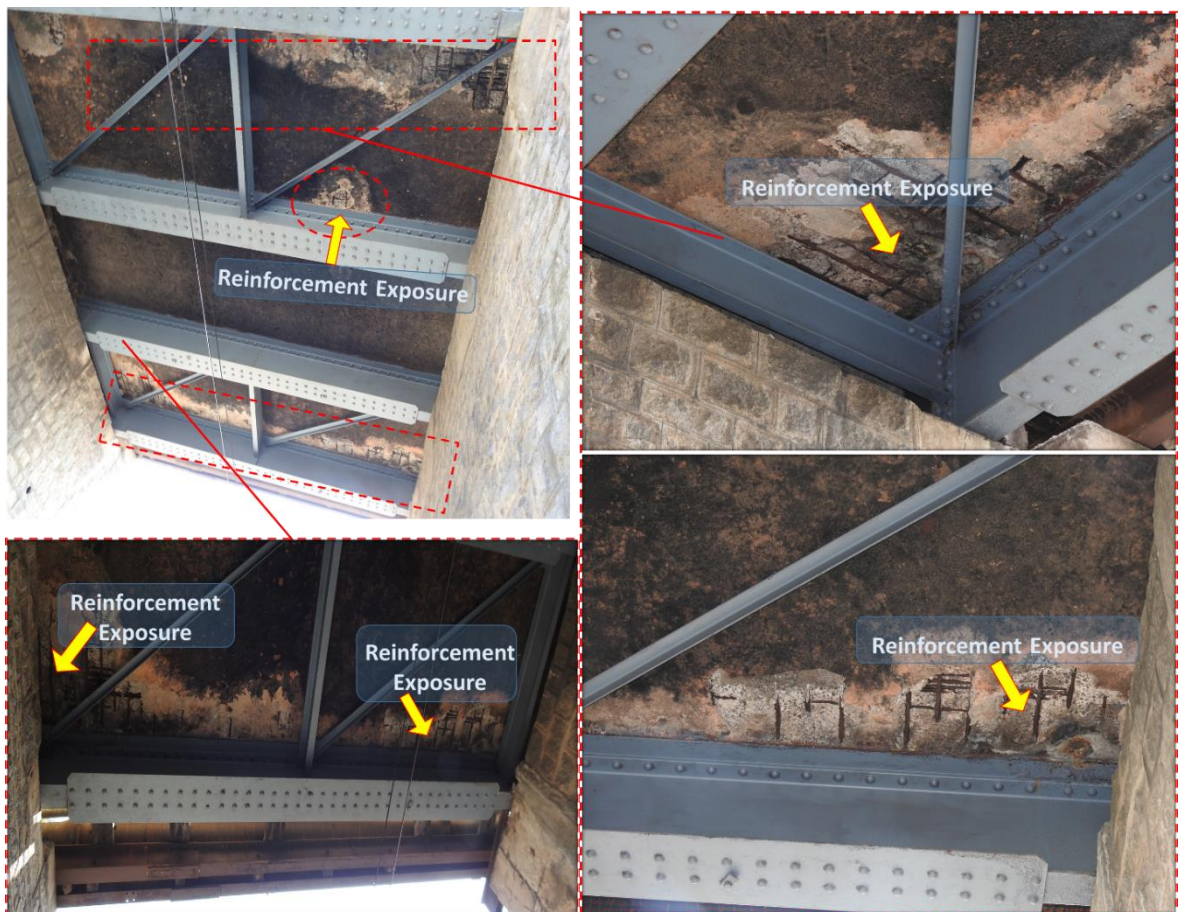


Fig 3.4: Damage locations identified in span 3 at “h, I, j & k”

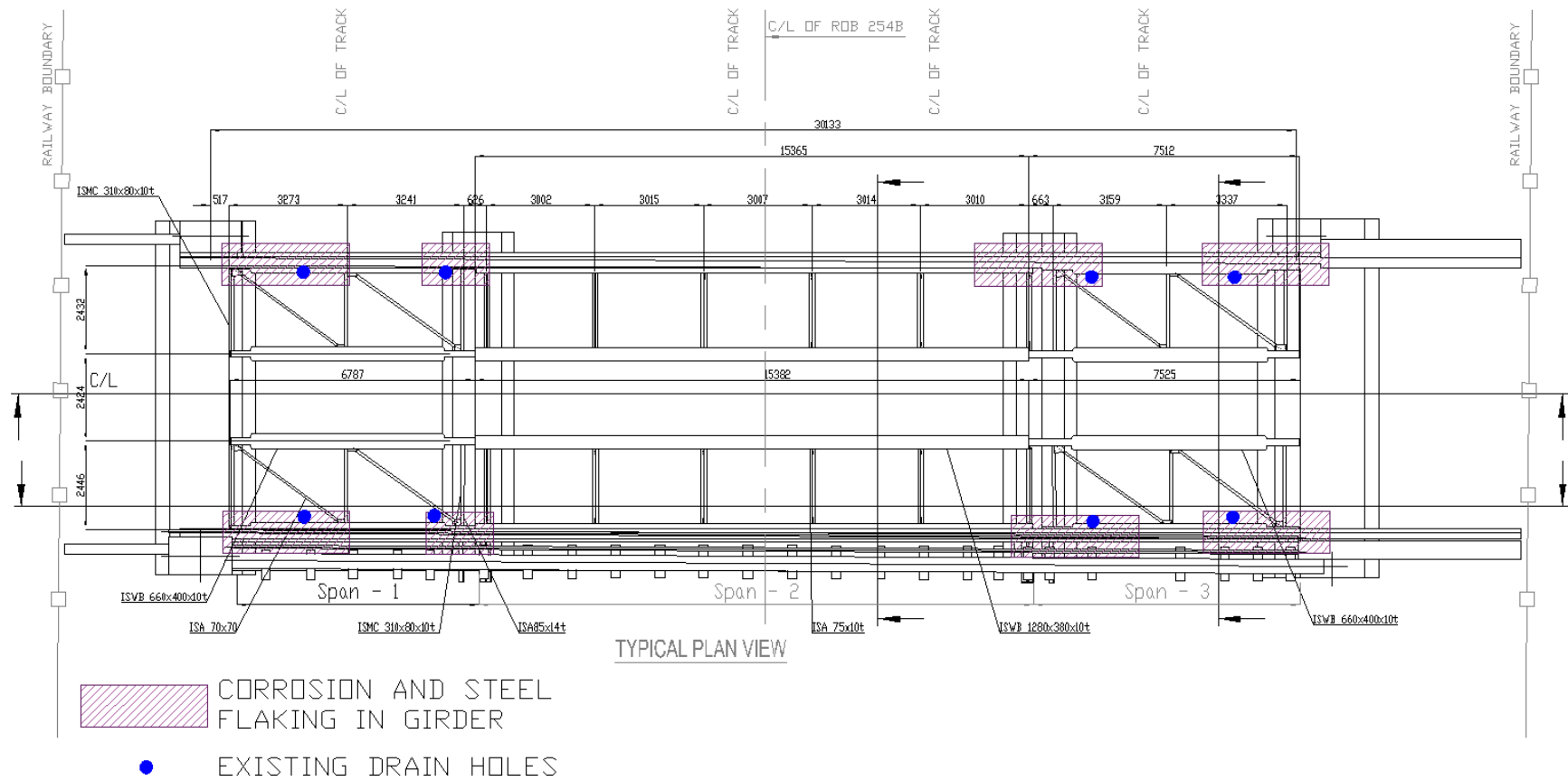


Fig 3.5: Bottom view of slab deck with Steel girder exposed (damaged) locations

A detailed visual observation is made on steel girders on the above said locations and the following observations are made, excessive corrosion and steel flaking was noticed in span 1, & 3 near drain holes and supports. Near steel concrete joints cover plate on the girders and angular bracing members connected with rivets are damaged.

3.2 Repair Methods and Recommendations for Steel Girders

Corrosion and steel flaking observed near support

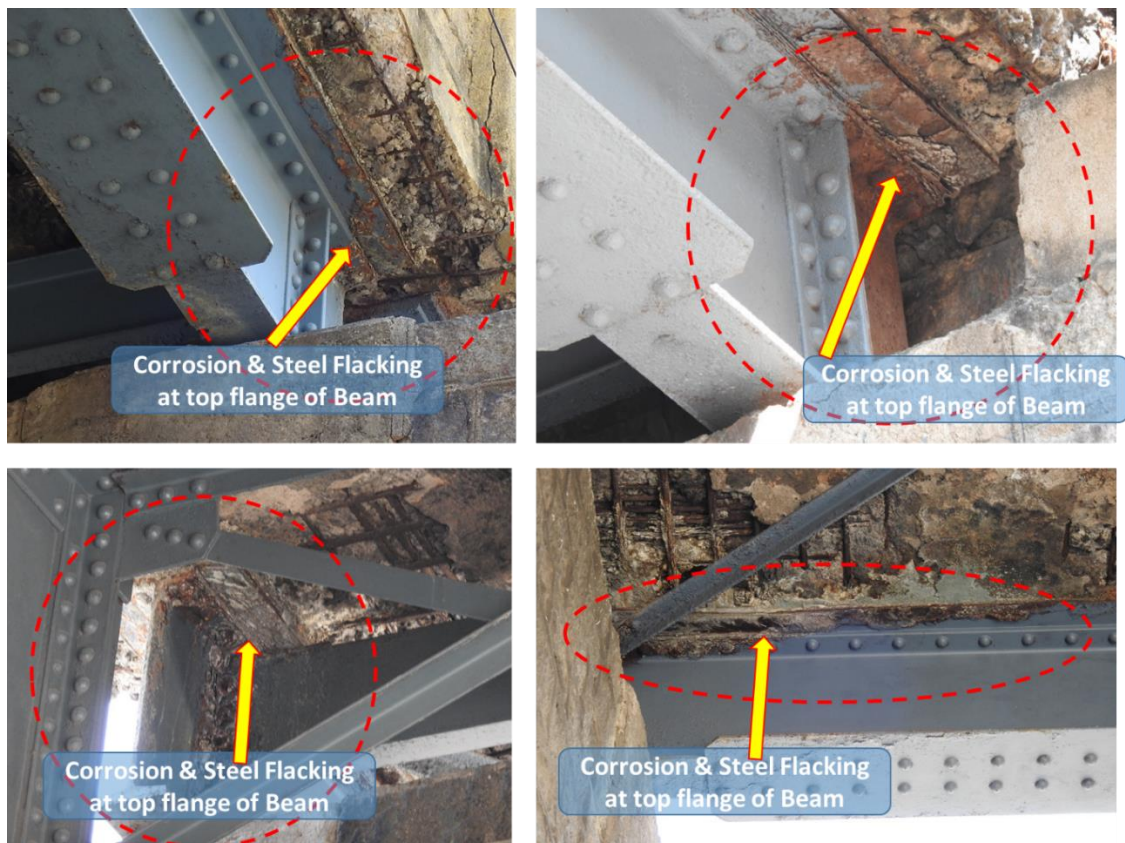


Fig 3.6: Damaged locations identified in span 1 and 3

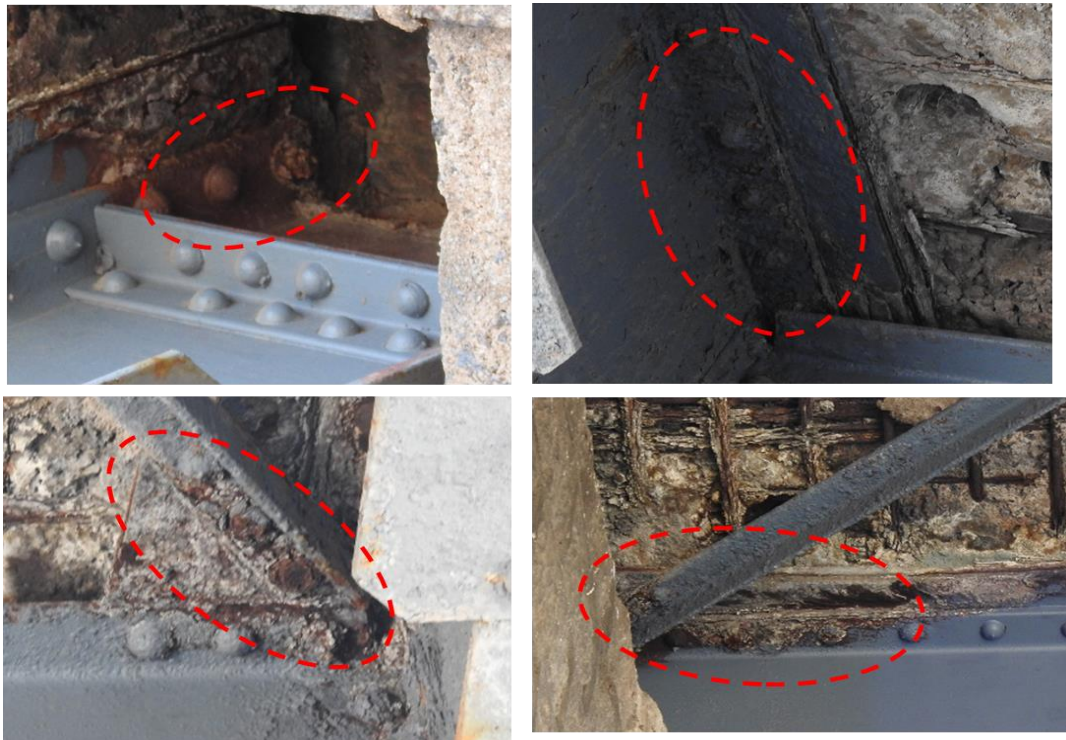


Fig 3.7: Rivet Damaged locations identified in span 1 and 3

CORROSION OF STEEL BRIDGE ELEMENTS

Corrosion is important and frequent causes of degradation of steel structure mainly in severe environmental condition. For steel elements embedded in concrete the corrosion generally arises from rainwater ponding at the interface of the steel element with concrete because of inadequate design details for draining water way.

Corrosion Damage

Extensive corrosion might have occurred to one or many members due to environmental conditions or age of the structure. Corrosion, by definition, involves the oxidation of a metal, or in other words, the conversion of a solid metal into ions of the metal, which in turn combine with 41 other elements to form rust. A more complete discussion of the mechanisms involved in corrosion.

There are many types of corrosion that might be present in bridge members including galvanic, pitting, and crevice. The mechanisms for these varieties of corrosion may differ. However, the result is identical, a net loss in available section to carry the applied loads.

Common areas in which corrosion can be exacerbated include:

- Top flange of floor-beams due to roadway leakage
- Bottom flanges of members due to debris build-up
- Lacing bars
- Pinned connections where small relative movements might trap moisture

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. If in the case of floor-beams, in which a portion of the member might be embedded in concrete, NDT methods such as ultrasonic inspection might be employed to evaluate the remaining section. An excellent reference for the evaluation of corroded members. In this article, a series of tests were completed to quantify the performance and remaining strength of corroded bridge members. This research confirmed the common approximation that the strength of a member can be determined by multiplying the remaining area by the ultimate stress. The researchers also found that corrosion did not affect ductility. Fatigue tests were also completed to quantify the influence of corrosion on fatigue strength. It was found that if the corrosion loss was less than 50%, notch effects rather than section loss governed fatigue capacity. Other articles, which discuss properties and evaluation of corroded members, include

Section Loss > 15% - Clean the Surface and Apply the protective coat.

Section Loss 15% - 40% Repair the member with Suitable method

Section Loss < 40% - Replace the member with Suitable method.

3.3 Repair Methods and Recommendations for Piers and Abutments

- Debris Accumulation on pier and abutments



Fig 3.8 : Vegetation observed on the top of the pier (abutment wall)

Various components of a bridge, namely deck surface, curbs and sidewalks, expansion joints, pier caps, abutment caps, trusses and their web members, lower flanges of beams and girders, wind bracings and drains shall be thoroughly cleaned of accumulated dust, debris and other foreign materials at regular intervals. This is to prevent deterioration of the bridge, which will therefore preserve the bridge components in their intended conditions resulting in increased service life of the bridge as well as provide safety and comfort to the road users. Areas which have been cleaned shall be ensure freedom from accumulated sand, gravel, dirt, and other foreign materials. Vegetation grown on the components of bridges shall be removed. In addition, vegetation near the bridge that might affect the normal performance of the bridge, such as free flow of water under the bridge, etc. shall be removed. Cleaning applied to the bridge including its steel girder; deck and substructure are recommended below:

1) Surface of steel plate:

The surface areas of a steel bridge should be cleaned and washed by brushing with fresh water or using high-pressure water blasting, including the top and bottom flanges, web plates, diaphragms, lateral members and gusset plates. For convenience, inspection vehicle may be utilized to carry out cleaning of the bridge soffit.

2) Bridge deck slab:

All surface areas of the bridge deck should be cleaned including the curbs, expansion joints, drain pits and railings. This may be performed by manual shoveling/sweeping or using high pressure water blasting.

3) Bridge substructure:

All areas under the superstructure should be cleaned, including the bearing shoe bed, concrete diaphragms and pier caps. This may be done by manual shoveling/sweeping or using high pressure water blasting. Accessing the top of piers, a higher ladder or hang ladder will be useful and an inspection vehicle can be utilized, if possible.

4) Vegetation growth:

These shall be removed from the components of the bridges as well as from near the bridges if it is found that they affect the soundness of the structure in course of time.

Annexure-1a: Repair methods

Defects/Deficiency	Debris accumulation
Remedial Measures	Cleaning

Work sequence

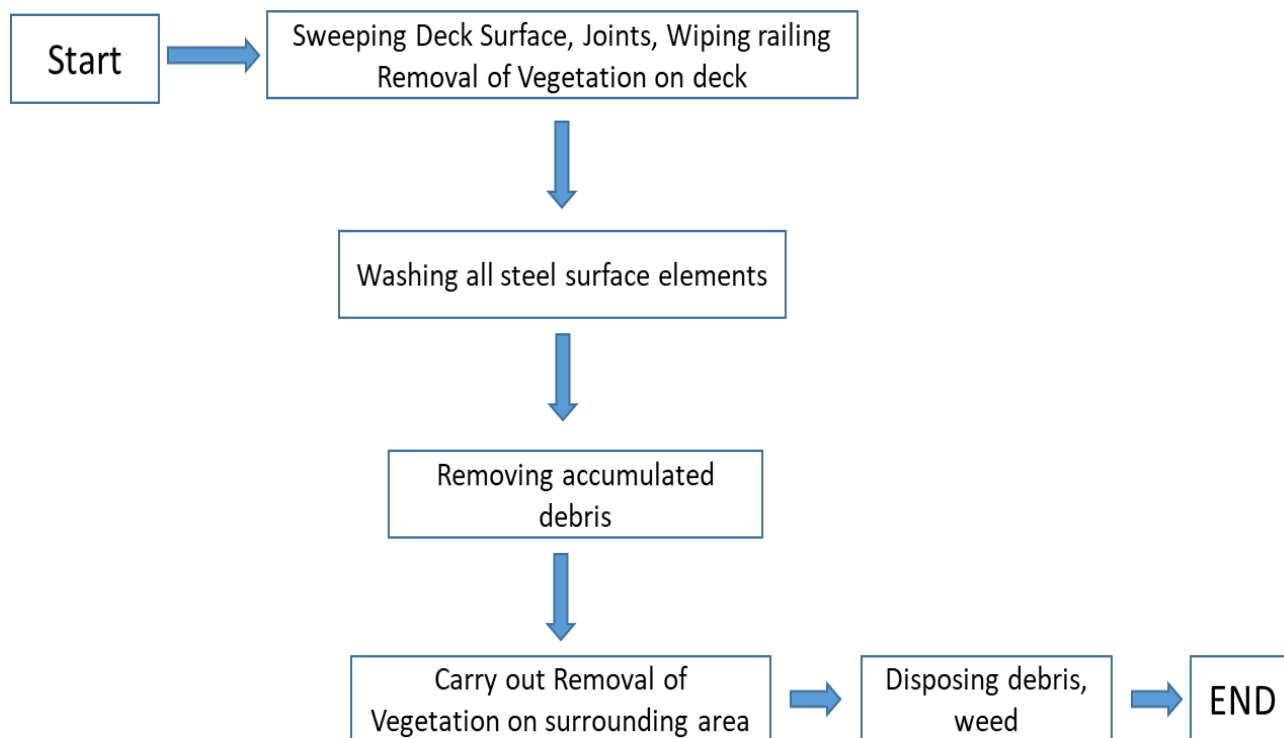


Figure:1.1 Work sequence of removal of vegetation and accumulated debris

REQUIREMENT, SPECIFICATION

Material Requirement

Water to be used for cleaning of the bridge components shall be clean and free from unwanted foreign materials such as sediments, salt contaminants, chemicals, grease, oil, rubbish and other substances which are harmful to the bridge components.

The contractor shall obtain necessary approvals of the source of water to be used for cleaning. Engineer's approval shall be taken on the source and quality of water. All necessary tests shall be performed on water samples at laboratories to be specified by the Engineer, and test certificates shall be provided as required.

Work Requirement

1. General

All accumulated foreign materials shall be removed from bridge sidewalks, bridge decks, top of curbs, beam flanges, gusset plates, abutment bridge seats, top of pier, truss joints, deck drain systems, and other locations specified and as directed by the Engineer, prior to cleaning with water pressure. Removal shall be performed using hand brooms, hand shovels, scrapers, vacuum cleaners or other methods acceptable to the Engineer. The removed materials shall be collected and disposed

at an approved waste area in accordance with governing local regulations. At no time shall these materials be allowed to be disposed into the river or on dry land portions below the bridge.

2. High pressure water

Salt contaminants, dirt, and other detrimental foreign matters shall be removed without damaging or peeling the paint from any structural steel. If high-pressure water is used, the maximum water pressure shall not be so high that any paint is damaged. The cleaning operation shall be discontinued if the foreign materials have not been easily removed or if cleaning operation is causing damage to existing paint coating. In this situation, the high-pressure water shall be adjusted to clean the surface without damaging the paint coating.

All deck drains and its accessories shall be flushed with high-pressure water after the accumulated foreign material has been properly removed. Drain systems may have to be disassembled to remove large blockages of accumulated foreign material. Should this be necessary, these shall be returned to their original configuration immediately after cleaning. Drainage systems shall drain properly after cleaning.

The Contractor shall flush out the interior surfaces of all girders and truss members using high-pressure water. This flushing shall continue until such time that clear water is being draining out. The exterior surfaces of all truss members, miscellaneous structural steel connecting the truss members, and floor beam-ends projecting outwardly from the row of exterior stringers shall be thoroughly washed down using high-pressure water.

The Contractor shall obtain approval of the source of water used. They shall use fresh water, which is free of sediments and salt contaminants, and be responsible for all expenses involved in securing the approved water.

Annexure-1b: Repair methods

Defects/Deficiency	Spalling, Honeycomb
Remedial Measures	Patching

Work sequence

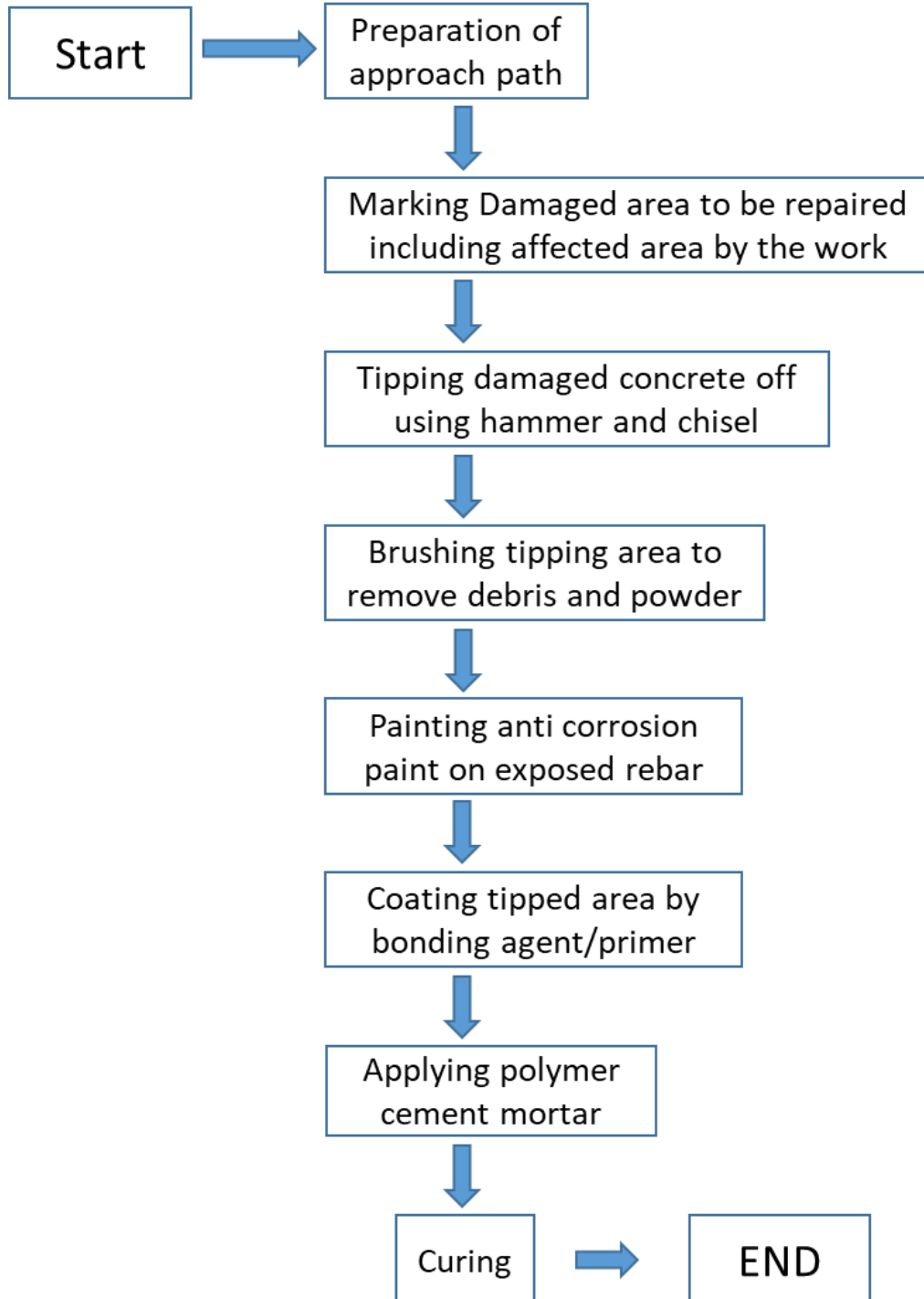


Figure: 1.2 Work sequence of Epoxy Coating

Required Equipment/Tool and Material

Material List –

- Polymer Cement Mortar
- Portland Cement
- Epoxy Bonding
- Zinc rich primer

Tool/Equipment List –

- Chisel
- Portable Generator
- Wire Brush

Requirement, Specification

Material Specifications

The Engineer through mill certificate of the supplier shall approve the material.

1) Polymer Cement

Polymer cement mortar shall conform to the requirements of the specifications shown in Table 1.1 or equivalent ASTM Specifications.

Table:1.1 Specification of Polymer Cement for Patching

Property	Test Method	Specification
Initial setting time	-	above 60 minutes
Shrinkage	ASTM D2566	below 0.05 %
Thermal expansion	ASTM C531	2.0×10^{-5} mm/mm/ ° C
Slant shear bond to concrete	ASTM C882	Concrete failure above 15 N/mm ²
Compressive strength	ASTM D695M	above 20 N/mm ²

2) Epoxy bonding agent

The epoxy-bonding agent to concrete surface shall conform to the requirements of the specification indicated in Table 1.2 (Anti-corrosion zinc rich primer shall be applied to exposed rebar).

Table 1.2 Specification of Epoxy Bonding Agent to Concrete Surface

Property	Test Method	Specification
Compressive strength	ASTM D695M	70 N/mm ²
Flexural strength	ASTM D790M	40 N/mm ²
Tensile strength	ASTM D638M	30 N/mm ²
Tensile shear bond to steel	ASTM 1002	15 N/mm ²
Slant shear bond to mortar	ASTM C882	15 N/mm ²
Bond Strength of Cured Concrete to Fresh Concrete	ASTM D7274	15 N/mm ²

- 3) Zinc Rich Primer The zinc rich primer to rebar shall be in accordance with the requirements of the specifications in Table 1.3

Table 1.3 Specification of Zinc Rich Primer for Rebar

Property	Test Method	Units	Specification
Gloss @ 60°Angle	ASTM D 523	-	Flat
Adhesion	ASTM D 3359	-	Minimum 3A
Salt Spray Resistance	ASTM D3-37	-	Excellent
%Zinc by Weight in Dried Film Test		%	87.5±2

Work requirement

1) General

Patching repair works using Portland cement mortar shall be carried out in accordance with provisions of relevant standards and manufacturer's specifications. Patching, as a minor repair work, should be carried out using an appropriate means to access the repair area, before the defect worsens. Patching repair work method using polymer cement mortar shall be carried out as follows:

2) Marking of patching area

Evaluate surface area to be patched using hammer for hollow sounding delaminated area (or by using instruments to detect unsound concrete).

Mark the area to be patch-repaired with paint or marker. Ensure complete coverage of the damage.

- 3) Tipping damaged concrete off Using a small sledge hammer and chisel, remove all damaged concrete at the edges and corners of area to be repaired. Use a wire brush to remove loose debris. Care should be taken to ensure that no reinforcement is damaged.

Surface shall be cut to expose the reinforcement and to reach the sound concrete substrate, without breaking the concrete behind the reinforcement. If rebar is exposed, anticorrosion agent coating should be applied on the bar surface prior to patching. All works shall be subjected to the approval of the designated Engineer.

Patch areas that are within 600 mm of each other should be combined into a single large patch. If necessary, provide formwork around the damaged concrete to straighten the edges of the damaged section.

- 4) Coating tipping area Concrete surfaces to receive repair mortar shall be prepared by mechanical scrubbing to remove loose materials, surface laitance, organic contaminants and moss. The clean and dust free surface shall then be coated by a bonding primer.

Care shall be taken to ensure that vibration associated with the repair works does not cause delamination of existing adjacent plaster or concrete.

- 5) Applying bonding agent and anti-corrosion paint

Apply bonding agent to the damaged area in order for the patch material to adhere. Additionally, concrete nails/bids may be set to reinforce the repair.

If rebar is exposed, anticorrosion coating should be applied on the bar surface prior to patching.

- 6) Patching

mortal Prepare the mortar mix in a bucket using equipment approved by the Engineer. Use a trowel to spread fresh mortar over the area, covering the concrete nails driven halfway in the old concrete. Smoothen and level the mortar with a trowel. Polymer cement mortar is suitable for both vertical and horizontal surface applications, with a thin coating of up to 15 mm.

- 7) Finishing

As may be required, the mortar surface can be smoothened using a trowel or broom finished. The texture of the finish of the final repair mortar layer shall match the finish of the existing surface. The repair mortar application shall be built up to the original surface profile in layers not exceeding 20 mm with the final layer not exceeding 15 mm, unless otherwise recommended by the manufacturer and approved by the Engineer.

The Engineer may approve repair mortar application thickness of up to 50 mm for lightweight mortars, provided the mortar manufacturer furnishes technical data to justify a layer thickness of greater than 20 mm.

- 8) Curing All types of concrete repair with repair mortar need thorough and continuous curing to develop strength and impermeability. Curing also minimizes drying shrinkage while bond strength is developing. Curing of the repair mortar shall be in accordance with the manufacturer's instructions related to the polymer modified additive. Where curing agents are specified by the manufacturer, they shall be applied immediately after the surfaces have been scarified for the next repair mortar layer or troweled to a finish.

Annexure-1c: Repair methods

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

Work sequence

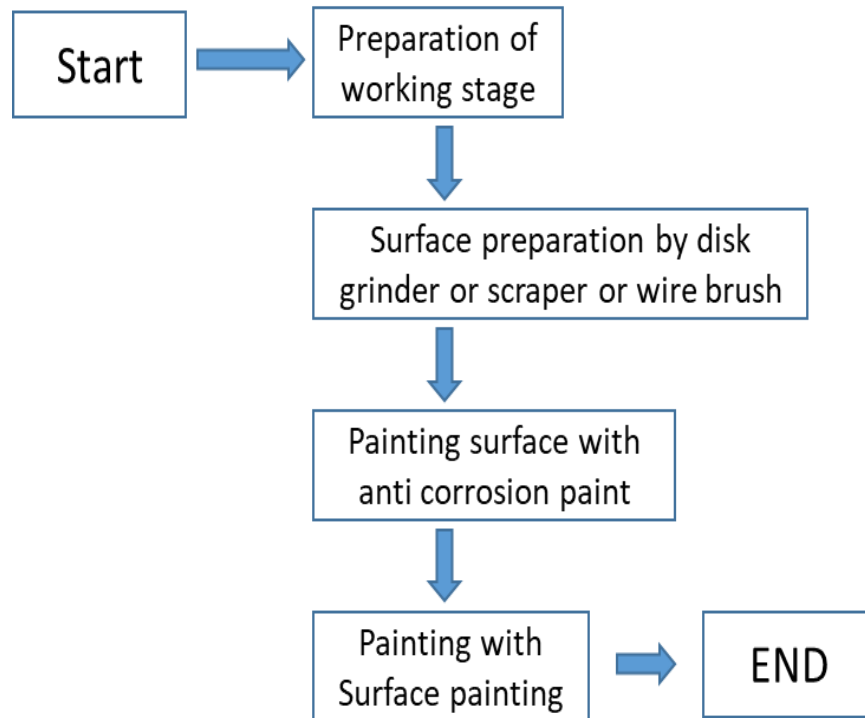


Figure: 1.2 Work sequence of Painting with anti-corrosion paint

Required Equipment/Tool and Material

Materials

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

Tools/Equipment

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

Requirement, Specification

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

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, particularly for bridges with high elevation or deep river crossings.

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 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

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

Layer-2: 40 μm

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

Annexure-1d: Repair methods

Defects/Deficiency	Reinforcement Exposure, Spalling and Cracking
Remedial Measures	Shotcrete

Work sequence

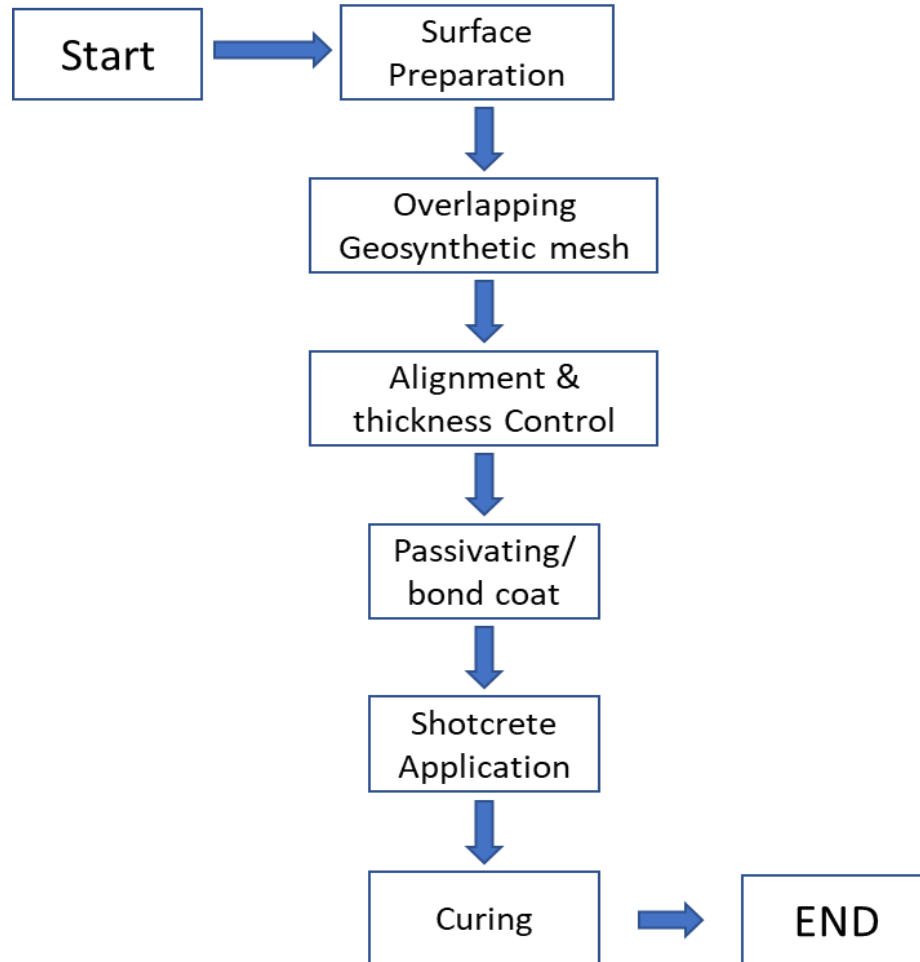


Figure: 1.2 Work sequence of Shotcrete

Required Equipment/Tool and Material

Materials

- Cement
- Fine Aggregate
- Course Aggregate
- Admixture
- Water

Tools/Equipment

- Batching and mixer
- Guniting equipment
- Compressor

Requirement, Specification

Materials

Cement: The cement shall be ordinary Portland cement of 43 grade conforming to relevant B.I.S. Code of Practice

Aggregates:

Sand for shotcrete shall comply with the requirements given in IS 383 and graded evenly from fine to coarse as per Zone-II and Zone III grading. Sand failing to satisfy this grading may, however, be used only if pre-construction testing establishes that it gives good results.

Coarse aggregate when used shall comply with the requirements of IS 383. It shall, generally conform to the grading given below:

Table 1.5 Gradation of the coarse aggregate

GRADING OF COARSE AGGREGATES	
IS Sieve Designation, mm	Percentage Passing by mass for aggregate of nominal maximum size
10	100
4.75	10 – 30
2.36	0 – 10
1.18	0 - 5

All over sized pieces of aggregate shall be rejected by screening. Gradation of the combined coarse and fine aggregate mixture used for shotcrete shall generally lie between the following limits.

Table 1.6 Gradation of the combined coarse and fine aggregate mixture

I.S Sieve	Percent passing by Weight Gradation
10 mm	100
4.75 mm	72 - 85
2.36 mm	52 - 73
1.18 mm	36 - 55
600 microns	28 - 38
300 microns	7 - 20
150 microns	0 - 8

Water used for shotcrete shall conform to the requirement of I.S. 456-2000

Admixture: Guniting admixtures & quick setting agents may be used to minimize the rebound loss and increase the bond & enable thicker layers per coat. The admixture shall meet the requirement of I.S. 456 and I.S. 9103

Concrete: The grade of concrete shall be as specified i.e. the characteristic compressive strength of 15 cm cube at 28 days should be as specified. The water cement ratio for shotcrete shall be within the range 0.45- 0.50 by mass.

Work requirement

- 1) This specification covers only to the extent of restoring the concrete slab by way of short creating. The specification excludes bearing replacement, expansion joint treatment etc.
- 2) Remove all loose and spalling concrete and expose the corroded reinforcement wherever possible by careful chipping.
- 3) Carryout thorough sand blasting using dry coarse sand or by grinding.
- 4) Fix 8 mm dia PVC nozzles at all honey combed areas and wherever cavities exist. At all other vulnerable areas drill 12/14 mm dia hole to a depth of 50 to 75 mm and fix 8 mm PVC nozzles.
- 5) Now drill 12/14 mm dia holes at a spacing of 500 mm c/c to a depth of 50 mm and fix 8 mm dia shear connectors using polyester resin grout.
- 6) Fix 50 mm x 50 mm x 4 mm Geo grid tied to the exposed reinforcement / shear connectors.
- 7) Carryout 40 to 50 mm thick short - creating to underside of slab etc, using a mix proportion of 1: 2: 2 (cement: sand: aggregate).
- 8) Now carryout cement injection grouting through the nozzles in sequential manner until rejection.
- 9) Carryout curing for 7 days.
- 10) Note: Grouting is done only after shotcrete to fill any leftover voids in the concrete slab.

Annexure -1e- Repair methods

Defects/Deficiency	Repair of stones in stone masonry Abutments
Remedial Measures	Repointing of stones

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, particularly for bridges with high elevation or deep river crossings.

2) Preparation of Repointing:

- It is recommended that 2 to 2-1/2 times the thickness of the mortar or a minimum of 3/4 inch be removed for repair. This will ensure the replacement mortar has adequate bond area.
- The mortar should be removed using hand tool or a small Pneumatic chisel. The use of power tools such as grinder is not recommended because it is difficult to control and can result in damage to adjacent masonry units. Square cuts at the limits of the removal are recommended.
- Debris should then be removed from the joint. This can be accomplished using a nylon brush, low pressure compressed air (40 to 60 psi) or low-pressure water (Less than 400 psi). Care should be taken during removal of the debris to ensure that additional mortar depth is not removed by the debris removal process.
- Any loose stones should be carefully removed, cleaned and re-set prior to repointing.
- Mortar used for repointing should be stiff, as stiff mortar will shrink less as it cures. Mortar should not be allowed to dry out during use and should be reworked at intervals prior to being placed in the joints.
- Re-tempering (or adding additional water) to mix is not allowed. Repointing should not be done if the temperature is below freezing. To help control suction and evaporation of water from the new mortar, the existing stones and mortar should be wetted to saturated surface dry (SSD) prior to the placement on any new mortar
- The mortar should be applied by hand and 1/4 inch lifts (Especially in the last 1-1/2 inch to be repointed) thicker lifts and use of pressure gun (or grout gun) to apply the mortar (or grout) can be used behind the final 1-1/2 inch if required. All lifts should cure to thumbprint hardness prior to the application of the next layer.

Summary

- **Visual inspection of ROB no. 254B near Mettuguda has been conducted on 13th October 2019, following observations were made**
 - i. Spalling and Reinforcement exposure has been observed at deck slab
 - ii. Corrosion is observed at the steel concrete joint
 - iii. Reinforcement exposure is also observed at overhang portion of slab
 - iv. Pointing failure has been observed at pier.
 - v. Leaching is observed at piers.
 - vi. Vegetation, algae growth is also observed on piers

- **Based on visual inspections and its interpretations following recommendations were made:**
 - a) Cleaning of debris to avoid deterioration of concrete and steel members.
 - b) Anti-corrosion treatment for Grade-1 and Grade-2 highlighted corrosive members.
 - c) Replacement of damaged members or severely corroded members of span
 - d) Shotcreting for deck slab.

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

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