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

INSPECTION OF ROB NO.295A NEAR KOMMALAPUDI RAILWAY STATION

Final Report

SEPTEMBER | 2020

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1. VISUAL INSPECTION

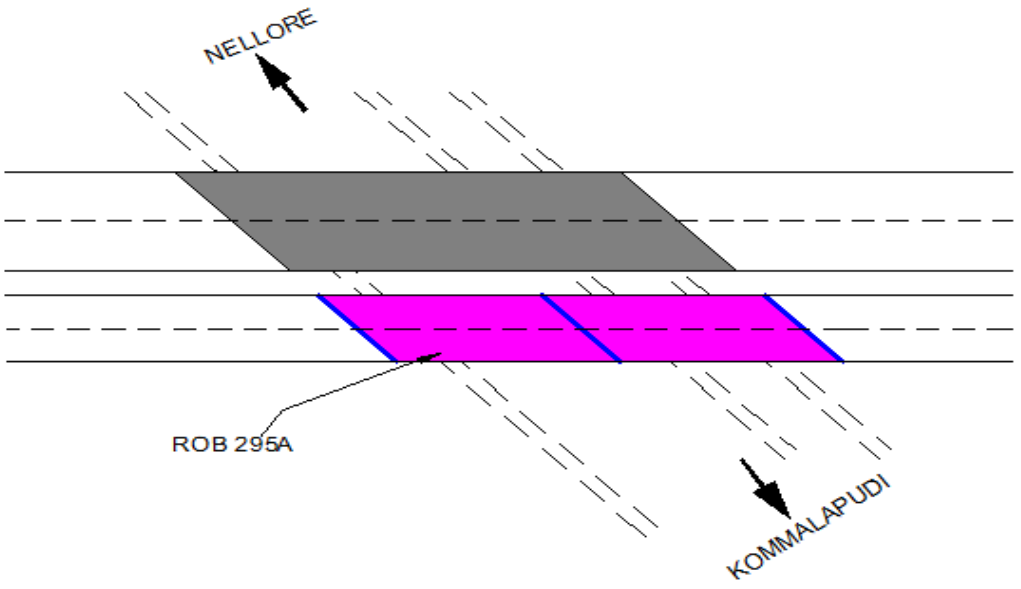
Name of the Project	:	**VISUAL INSPECTION OF ROB 295A**
Location	:	**NEAR KOMMALAPUDI RAILWAY STATION**
Location Co-ordinates	:	**14°17'25.2"N79°54'24.2"E**
Date of Inspection	:	**28th NOVEMBER, 2019**

Summary:

a) Cracks, Spalling, Reinforcement exposure has been observed in mid span of exterior girders.
b) Cracks, Spalling, Reinforcement exposure has been observed in girder end portions.
c) Leaching observed in Abutment, Pier, slab & exterior girders.
d) Accidental hitting marks observed on crash barrier.
e) Cracks, Spalling & Reinforcement exposure has been observed in Abutments & pier.
f) Epoxy grouting has done on Abutment-1 & Pier of the bridge.
g) Moderate vibrations are observed in the Bridge.

PART 1.1 GENERAL INFORMATION AND OBSERVATION		
a.	Name of the Bridge	ROB 295A
b.	Location Location co-ordinates	Near Kommalapudi Railway station 14°17'25.2"N 79°54'24.2"E
c.	Type of Bridge	RCC 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	7.0 m
h.	Overall Deck Width	8.5 m
i.	Average Skew	45^0
j.	Span arrangement (no x Span in meters)	2 x 13.6 m
k.	No of Railway Lines Crossings	03 tracks
l.	Vertical Clearance (from rail top to girder bottom)	6.0 m
m.	History of Repair/ Maintenance	Yes , Patch works and Epoxy grouting done
n.	Existing Structural Drawings	Not available

Key Plan



	PART 1.2 STRUCTURAL SYSTEM OF THE BRIDGE		
			Notes
a.	**Foundation details**		
	Type of foundation		
	Foundation Details (if available…)		
	Foundation Status (Check Settlement, abnormal Scour and Tilting, if any etc.…)		Not visible at site
	Type of Damage (Check cracking, disintegration, decay, erosion,		
b.	**Abutment (A1 & A2)**		
	Type	RCC Wall	
	Maximum height of Abutment from Ground level	5.15 m	
	Abutment width along the Track	13.4 m	
	Abutment thickness	2.2 m	
	Condition (Crack, Settlement, Scour, Tilting, Steel Corrosion, Strains, and other damages etc...)		Cracks, Spalling, Honeycombing, Reinforcement exposure are observed at Abutment
	Efficiency of drainage of backfill Behind Abutments (Check functioning of weep holes, evidence of moisture on		Weep holes are in dry condition.
c.	**Pier**	01 No.	
	Type (Shape)	Wall	Cracks, Spalling, Reinforcement exposure has been observed on Pier. Patching works and Epoxy grouting done.
	Material	RCC	
	No. of Piers in a row/column	-	
	Maximum Height of Pier	5.9 m	
	Pier Diameter/Dimension	1.1 m	
	Pier Cap Material	RCC	
	Pier Cap Condition	Distresses	
	Pier Condition (Crack, Settlement, Scour, Tilting, Steel Corrosion, Strains and other Damages etc...)	Distresses Found	

d.	**Bearing & Pedestal**		
	Type of Bearings	Metal plate bearings	
	General condition (Check Corrosion, cleanliness, seizing of plates silting, accumulations of dirt in case of submersible bridges)		Debris accumulated at all bearings and filled with Mortar **(Refer Fig-9)**
	Type/ shape of Pedestal		There is no Pedestal
	General condition (Check Corrosion, cleanliness, seizing of plates silting)		
e.	**Super Structure (Concrete Girder)**		
	Type/Shape of Girder (I-beam, box-Girder etc.)	I-Girder	
	Material of Girder	RCC	
	No of Girder	06 Nos.	
	Dimensions of Girder		Girder Depth = 0.9 m Width of the bottom flange = 0.3 m
	Structural System of Girder		Simply Supported
	Condition of Girder	Distresses Found	Cracks, Spalling, Reinforcement exposure has been observed **(Refer Fig-4 & 5)**
	Type/Shape of Secondary Girder	Rectangular	
	Material of Secondary Girder	RCC	
	No of Secondary Girders	7 Nos.	
	Condition of Secondary Girder	Distresses Found	
f.	**Slab**		
	Material of Slab	RCC	
	Thickness of Slab	-	
	Condition of Slab from Bottom		Leaching has been Observed.
	Condition of Slab from Top		Not visible, as covered with wearing coat
	Condition of Flooring/Wearing Coat	Fair	**(Refer Fig-9)**

g.	**Parapet wall/Railing**		
	Type of Parapet wall/Railing	Crash Barrier	
	Height	1.1 m	
	Condition of Wall/Railing		Accidental hit marks are observed on Crash Barrier as Bridge is Narrow **(Refer Fig-11)**

PART 1.3 SURVEY OF SIGNS OF DISTRESS, DEFORMATION IN BRIDGES			
	Defects	**Location**	**Notes**
	Cracking in RCC components	Girders, Abutment & Pier	Cracks are observed on Girders, Abutments & Pier
	Water seepage	Girder & Slab	Water seepage is observed on Girders & Slab
	Spalling	Girders, Abutment & Pier	Spalling is observed on Girders, Abutments & Pier
	Reinforcement Exposure	Girders, Abutment &	Reinforcement Exposure is observed on Girders, Abutments & Pier

Fig: 1 View of ROB

Fig: 2 View of Abutments (A1 and A2)

Fig: 3 *B*ottom view of Bridge

Fig 4: Cracks observed in Exterior girder

Fig 5: Reinforcement exposed in exterior girder

Fig 6: Reinforcement exposed in exterior girder, pier and slab at drainage spout

Fig 7: Reinforcement exposed, Leaching and cracks at girder end and Pier haunch

Fig 8: Distresses observed at Bearings

Fig 9: Cracks observed on pier

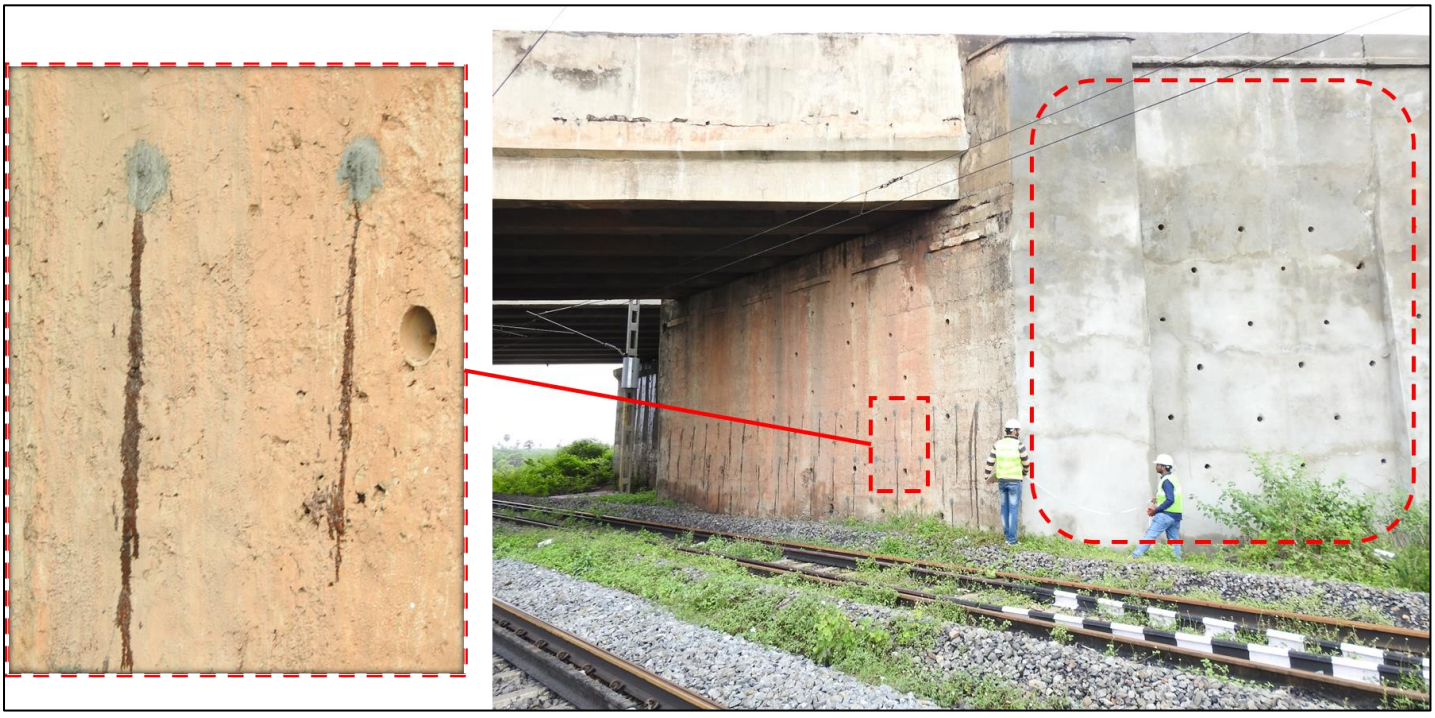


Fig 10: Epoxy grouting on Abutment & newly constructed retaining wall

Fig 11: Wearing Coat condition & Accidental hitting marks on Crash Barrier.

3. Repair and Retrofitting Recommendations

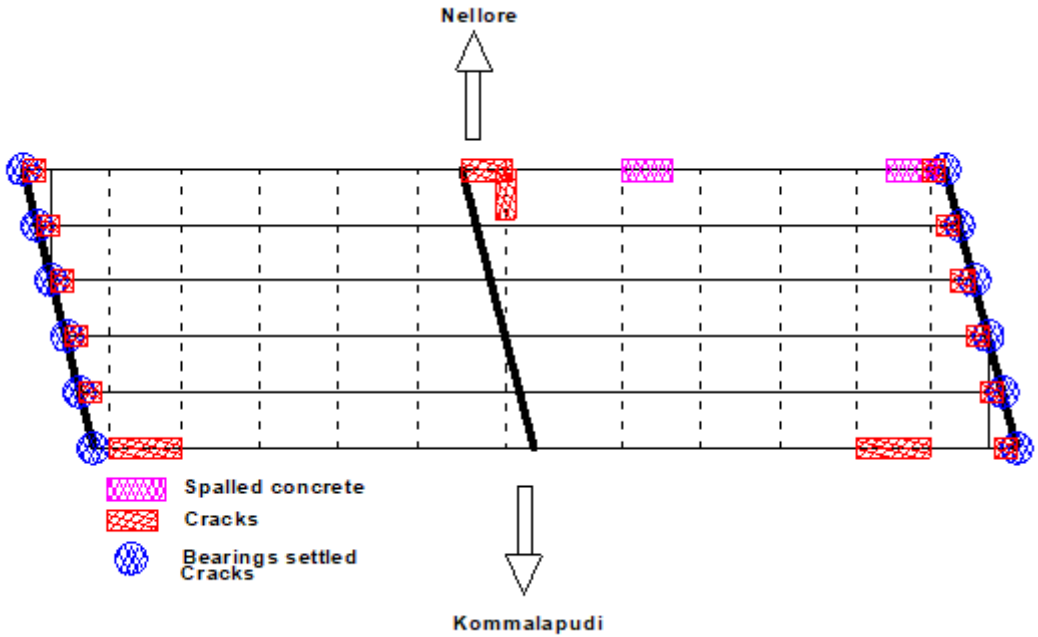


Fig: 12 Bottom view of ROB with damaged locations

The detailed visual observation of ROB, the following observations are made spalling of concrete and cracks observed and bearings are setteled.(Refer ***fig 4,5,6,7,8***)

Fig 13: Reinforcement exposed at girder end and Pier haunch

Fig 14: cracks observed at Abutment.

Fig 15: Bearings settled.

Fig 16: Minor spalled concrete holes on main girder.

ANNEXURE

Annexure-1a: Repair methods

Defects/Deficiency	**Debris accumulation**
Remedial Measures	**Cleaning**

Work sequence

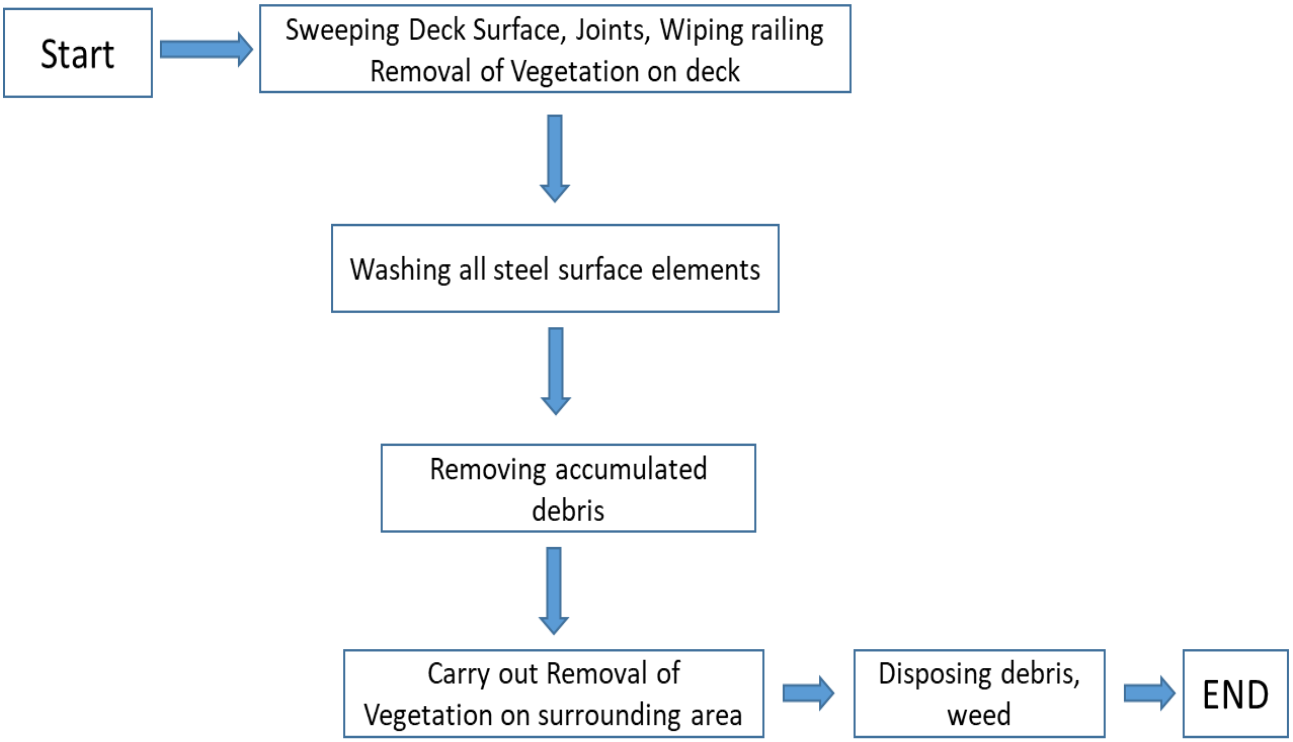


Figure:1.1 Work sequence of removal of vegetation and accumulated debris

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, 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 the structure. If high-pressure water is used, the maximum water pressure shall not be so high that may cause damage. The cleaning operation shall be discontinued if the foreign materials have not been easily removed or if cleaning operation is causing damage to existing structure.

   All deck drains and its accessories shall be flushed with high-pressure water after the accumulated foreign material has been carefully 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.

Annexure-1b: Repair methods

Defects/Deficiency	**Spalling, Honeycomb**
Remedial Measures	**Patching**

Work sequence

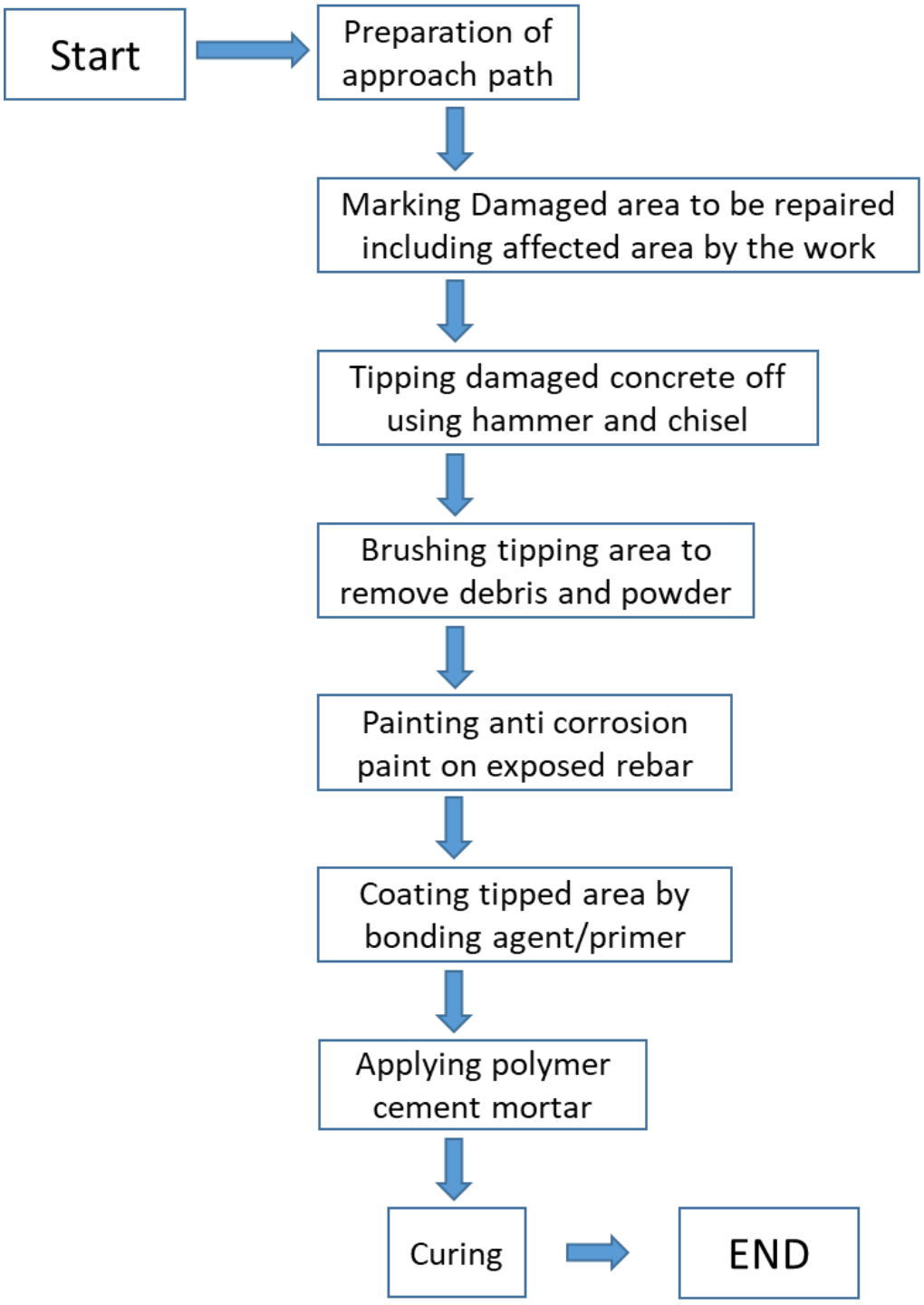


Figure: 1.2 Work sequence of Epoxy Coating

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	$2.0x10^{-5}$ mm/mm/ ^{o} 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 sledgehammer 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 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	**Reinforcement Exposure, Spalling and Cracking**
Remedial Measures	**Shotcrete**

Work sequence

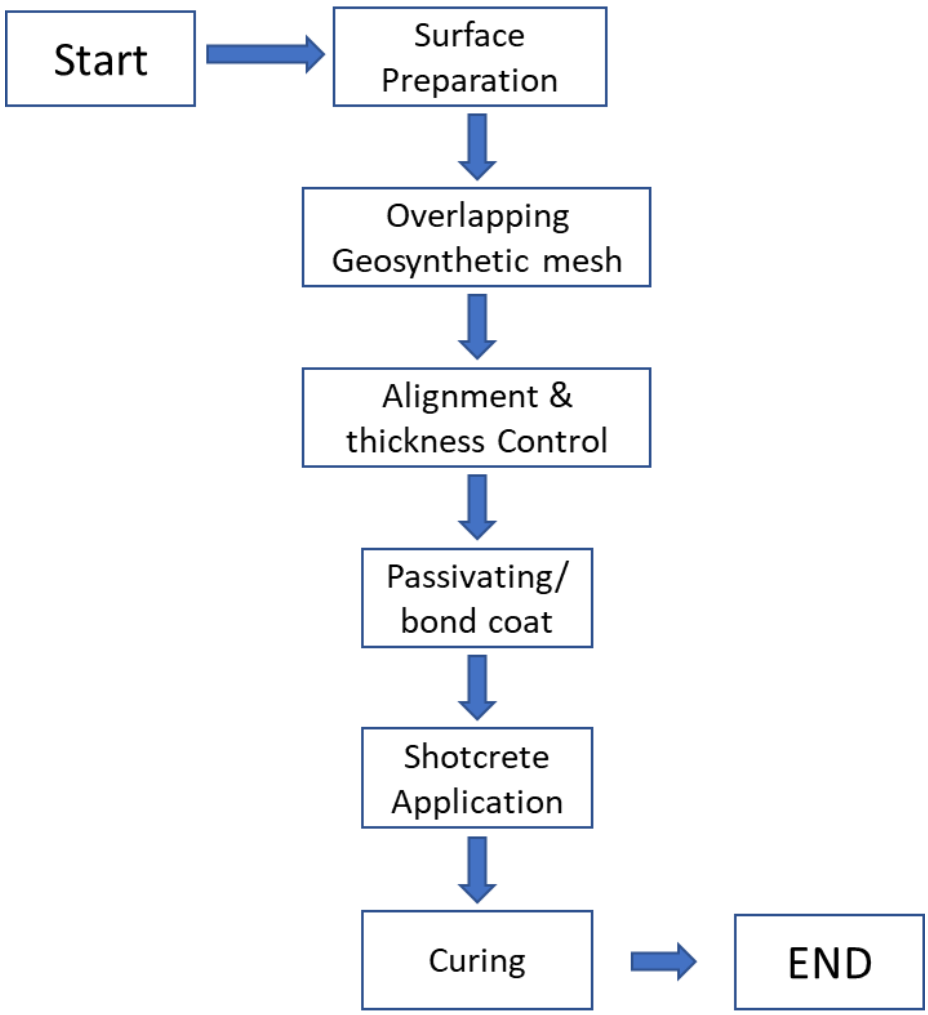


Figure: 1.4 Work sequence of Shotcrete

Required Equipment/Tool and Material

Materials

- Cement
- Fine Aggregate
- Coarse 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.

Note: Grouting is done only after shotcrete to fill any leftover voids in the concrete slab.

Summary

- Visual inspection of ROB (295A) near Kommalapudi Railway Station has been conducted on 28th Nov 2019, following observations were made
    a) Cracks, Spalling, Reinforcement exposure has been observed in mid span of exterior girders.
    b) Cracks, Spalling, Reinforcement exposure has been observed in girder end portions.
    c) Leaching observed in Abutment, Pier, slab & exterior girders.
    d) Accidental hitting marks observed on crash barrier.
    e) Cracks, Spalling & Reinforcement exposure has been observed in Abutments & pier.
    f) Epoxy grouting has done on Abutment-1 & Pier of the bridge.

- Based on visual inspections and its interpretations following recommendations were made:
    a) Patching of Spalled concrete with polymer modified concrete
    b) Replacement of distressed bearings.
    c) Grouting of cracks and minor spalled concrete holes on girders.
    d) Cleaning of debris.

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