

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



INSPECTION OF ROB NO.117/A NEAR RAGHAVAPURAM RAILWAY STATION

Final Report
SEPTEMBER | 2020

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1. VISUAL INSPECTION

Name of the Project : VISUAL INSPECTION OF ROB-117/A

Location : NEAR RAGHAVAPURAM

Location Co-ordinates : 18°44'20.8"N 79°25'48.9"E

Date of Inspection : 29th NOVEMBER, 2019



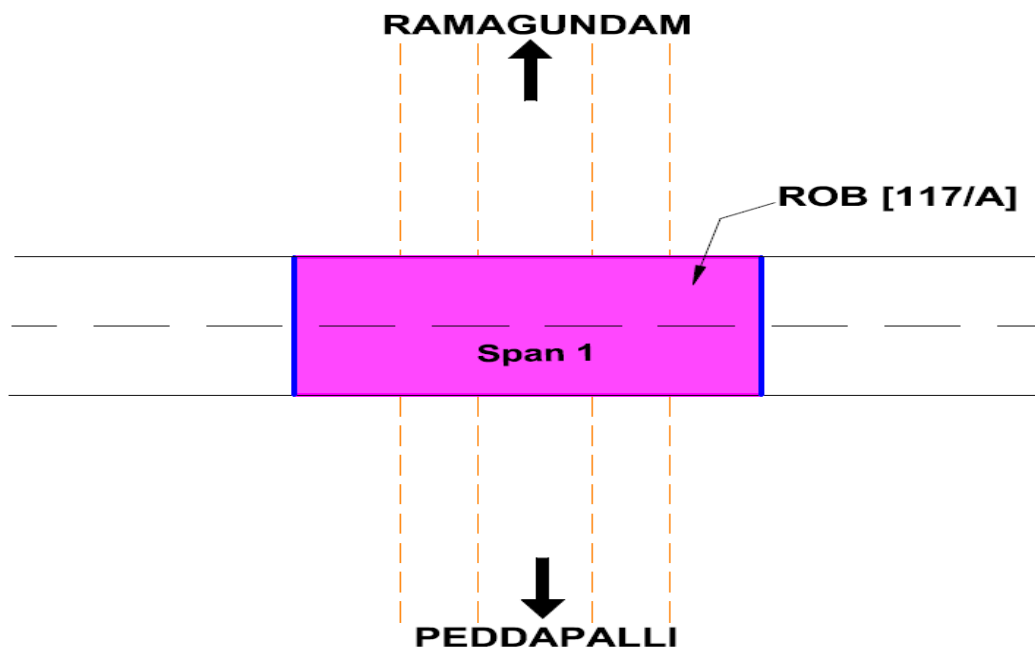
Summary:

- a) Minor spalling and Reinforcement exposed at overhang portion of slab
- b) Minor spalling is observed at Main girder, secondary girder, and abutment.
- c) Cracks are observed at main girder resting location.
- d) Shrinkage cracks are observed at girders and abutments.
- e) Leaching has been observed at Abutments and deck slab.
- f) Vegetation growth is observed at Abutment and at drainage spouts

PART 1.1 GENERAL INFORMATION AND OBSERVATION

a.	Name of the Bridge	Visual inspection of ROB 117/A
b.	Location	Near Kondagattu
	Location co-ordinates	18°44'20.8"N 79°25'48.9"E
c.	Type of Bridge	RCC Bridge
d.	Year of Construction	1981
e.	Grade of Concrete (Slab)	Data Not Available
f.	Design Load	Data Not Available
g.	Carriageway Width	7.1 m
h.	Overall Deck Width	8.35 m
i.	Average Skew	Not in skew
j.	Span arrangement (no x Span in meters)	1 x 12.2 m
k.	No of Railway Lines Crossings	2 tracks
l.	Vertical Clearance (from rail top to girder bottom)	5.8 m
m.	Horizontal Clearance (Pole to Rail track)	1.5 m
n.	History of Repair/ maintenance	Not visible
o.	Existing structural drawings	Not available

Key Plan



PART 1.2 STRUCTURAL SYSTEM OF THE BRIDGE			
		Yes/No	Photo ID
a.	Foundation details		
	Type of foundation		Not observed at site
	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	RCC Wall	
	Maximum height of Abutment from Ground level	6.4 m	
	Abutment width along the Track	12 m	
	Abutment thickness	1.8 m	
	Condition (Crack, Settlement, Scour, Tilting, Steel Corrosion, Strains, and other damages etc...)		Minor spalling and Shrinkage cracks observed
	Efficiency of drainage of backfill Behind Abutments (Check functioning of weep holes, evidence of moisture on Abutment faces, etc.)	Good	Weep holes are functioning properly.
c.	Pier		
	Type (Shape)		There is no Pier, as bridge is having only one span.
	Material		
	No. of Piers in a row/column		
	Maximum Height of Pier		
	Pier Diameter/Dimension		
	Pier Cap Material		
	Pier Cap Condition		
	Pier Condition (Crack, Settlement, Scour, Tilting, Steel Corrosion, Strains and other Damages etc...)		
d.	Bearing & Pedestal		
	Type of Bearings		Bearings are covered with mortar (Refer Fig-4,5)
	General condition (Check Corrosion, cleanliness, seizing of plates silting, accumulations of dirt in case of submersible bridges)		

	Type/ shape of Pedestal		No pedestal observed
	General condition (Check Corrosion, cleanliness, seizing of plates silting)		
e.	Super Structure (Concrete Girder)		
	Type/Shape of Girder (I-beam, box - Girder etc.)	T-Girder	
	Material of Girder	RCC	
	No of Girder	03 Nos.	
	Dimensions of Girder	1.32 x 0.56m	
	Structural System of Girder	Simply Supported	
	Condition of Girder		Spalling and cracks observed
	Type/Shape of Secondary Girder	Rectangular	
	Material of Secondary Girder	RCC	
	No of Secondary Girders	3 Nos.	
	Condition of Secondary Girder		Minor spalling observed. (Refer Fig-7)
f.	Slab		
	Material of Slab	RCC	
	Thickness of Slab	200mm	
	Condition of Slab from Bottom		Leaching and vegetation growth observed. (Refer Fig-3,)
	Condition of Slab from Top		Not visible, as covered with wearing coat
	Condition of Flooring/Wearing Coat		Good condition (Refer Fig-13)
	Parapet wall/Railing		
	Type of Parapet wall/Railing	RCC wall	
	Height	1.2 m	
	Condition of Wall/Railing		No Accidental hit marks are observed on wall (Refer Fig-13)

PART 1.3 SURVEY OF SIGNS OF DISTRESS, DEFORMATION IN BRIDGES			
	Defects	Location	Notes
	Cracking in RCC components	Girder, abutments	Shrinkage cracks are observed on abutments.
	Water seepage		No water seepage is observed during visual inspection.
	Leaching	Slab, Abutment	Leaching is observed Minor Reinforcement Exposure is observed.
	Spalling		Minor spalling is observed at abutments and main girder
	Reinforcement Exposure	Slab	Minor Reinforcement Exposure is observed.



Fig: 1 Front View of ROB



Fig: 2 Abutments (A1 and A2)



Fig: 3 Bottom view, Leaching observed



Fig 4: Bearings at Abutment 1



Fig 5: Bearings at Abutment 2



Fig 6: Spalling and crack at main girder resting location



Fig 7: Minor Spalling, leaching at Abutment



Fig 8: shrinkage cracks at main girders



Fig 9: Minor spalling at secondary and main girder



Fig 10: Spalling at Overhang Slab portion



Fig 11: Shrinkage cracks and minor spalling at Abutment 1



Fig 12: Vegetation observed at abutment and Drainage spouts



Fig 13: Wearing coat & Parapet wall

2. Repair and Retrofitting Recommendations

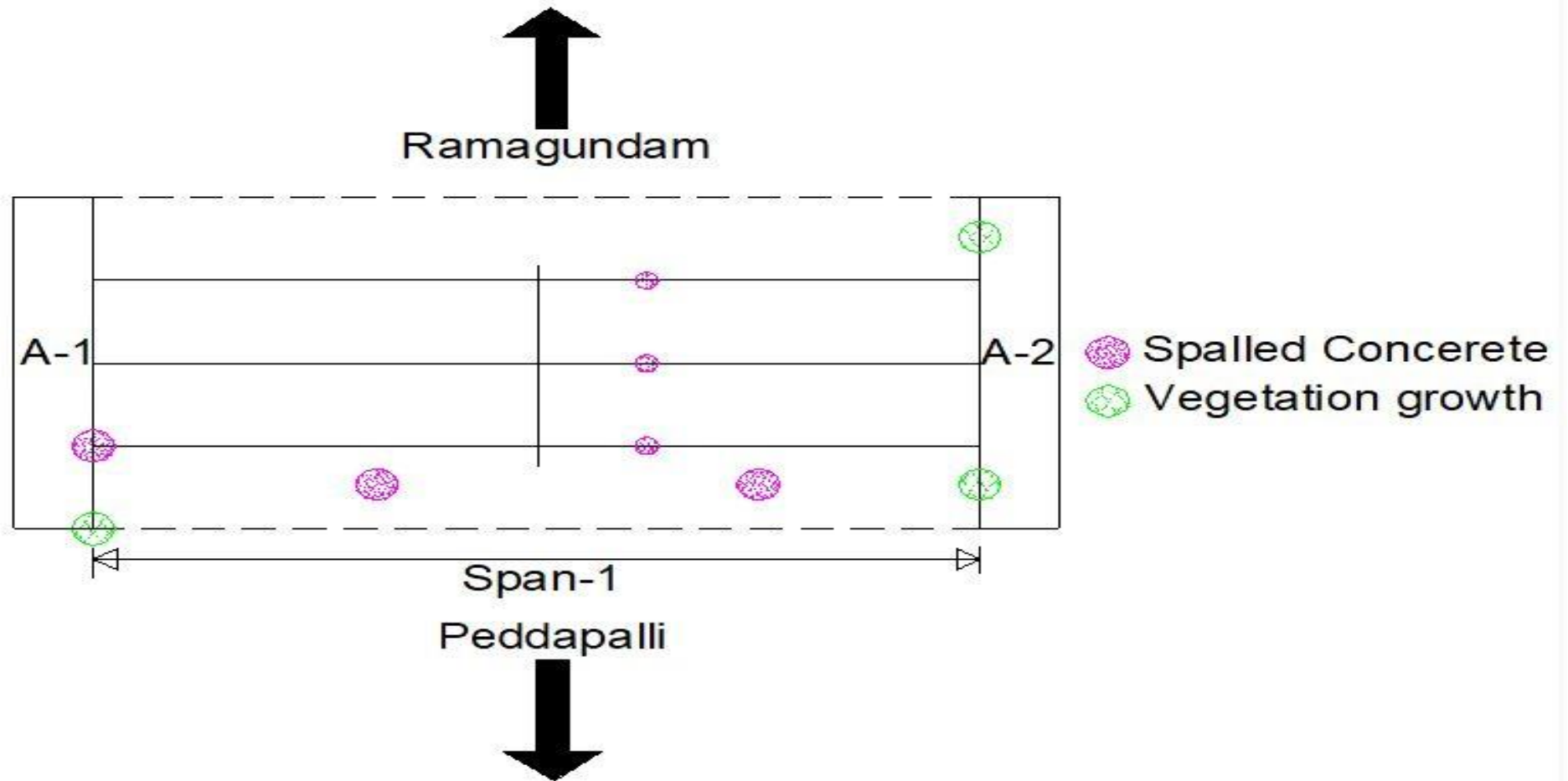


Fig: 14 Bottom view of ROB with damaged locations

The detailed visual observation of ROB, the following observations are made. Minor Reinforcement exposure observed at overhang portions of ROB. Spalling of concrete at Girder resting locations. Vegetation growth is also observed at abutments and drainage spouts.



Fig: 15 Spalling of concrete at girders and overhang slab portion



Fig: 16 Vegetation growth at abutments and slab

ANNEXURE

Annexure-1a: Repair methods

Defects/Deficiency	Debris accumulation
Remedial Measures	Cleaning

Work sequence

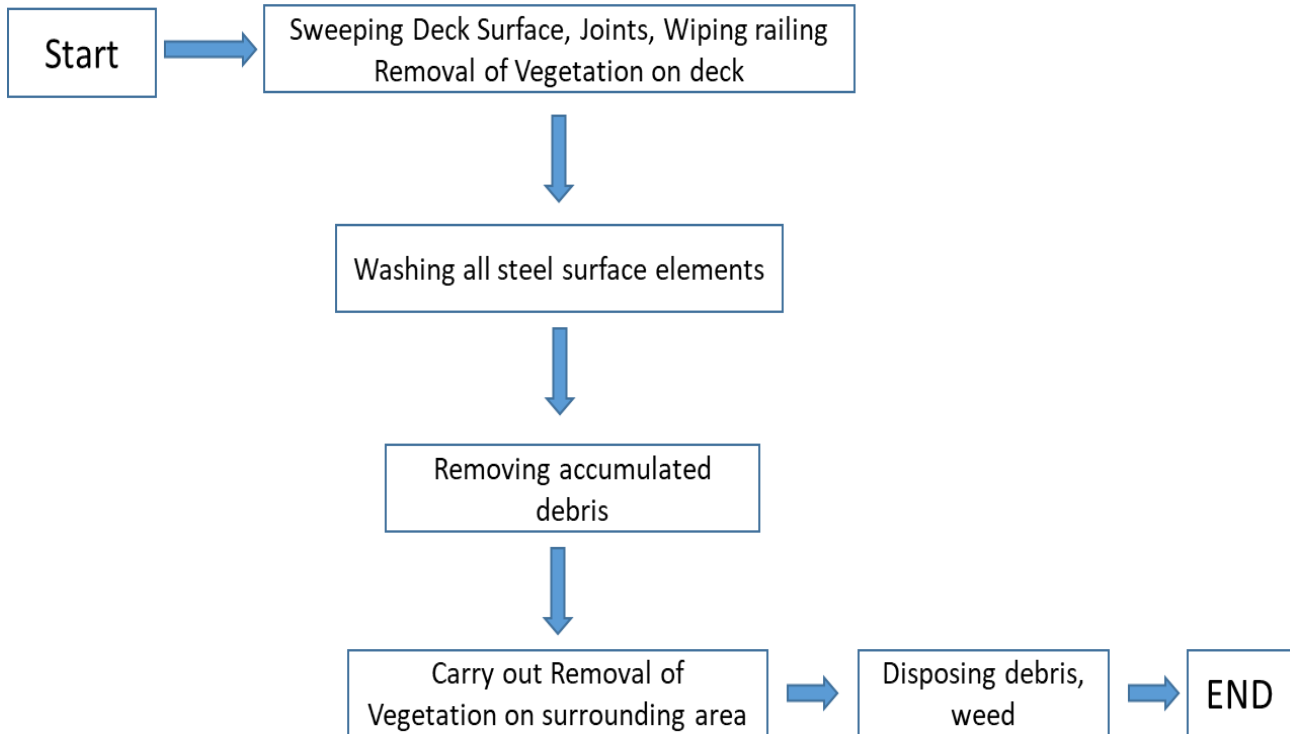


Figure:1.1 Work sequence of removal of vegetation and accumulated debris

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

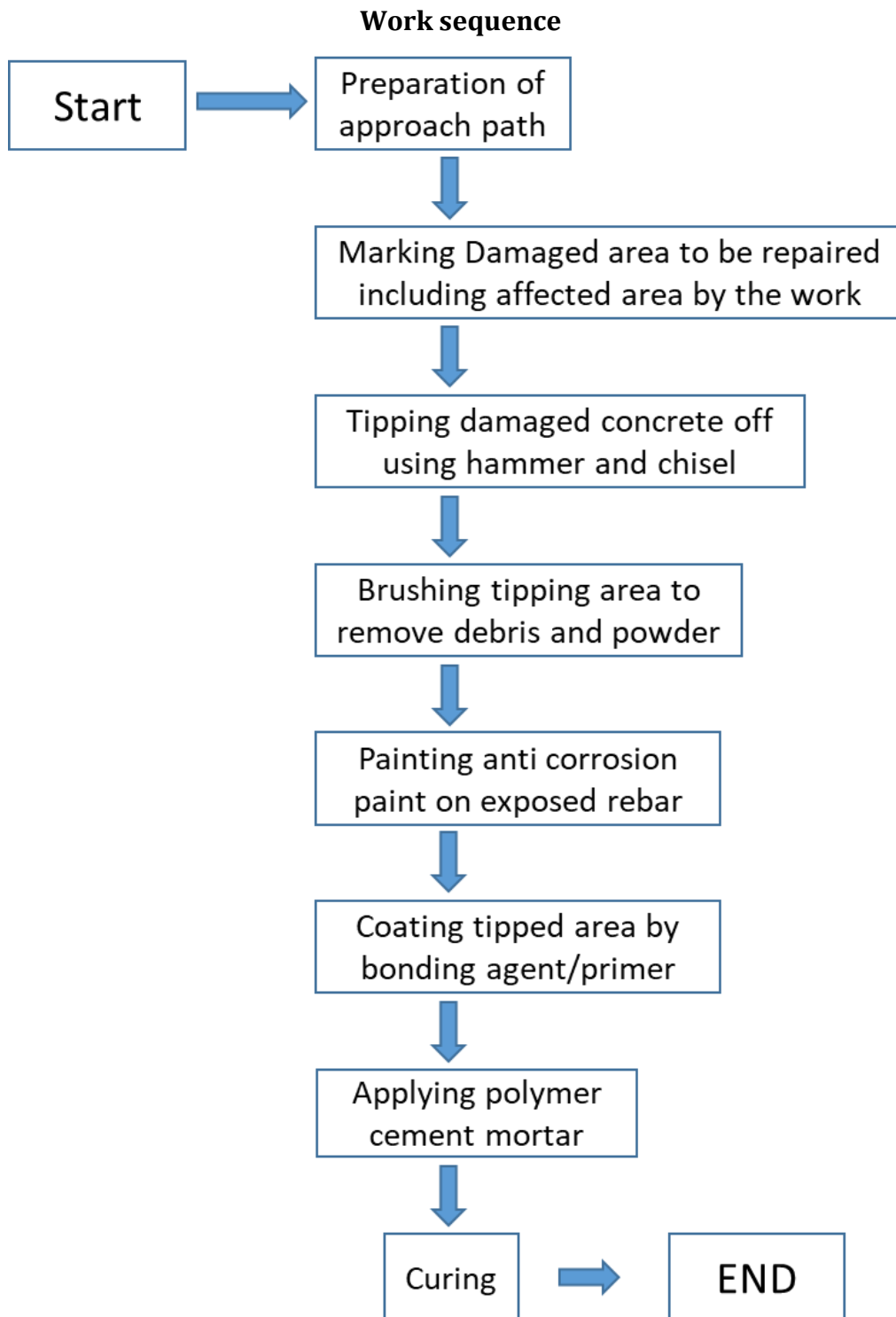


Figure: 1.2 Work sequence of Epoxy Coating

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 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

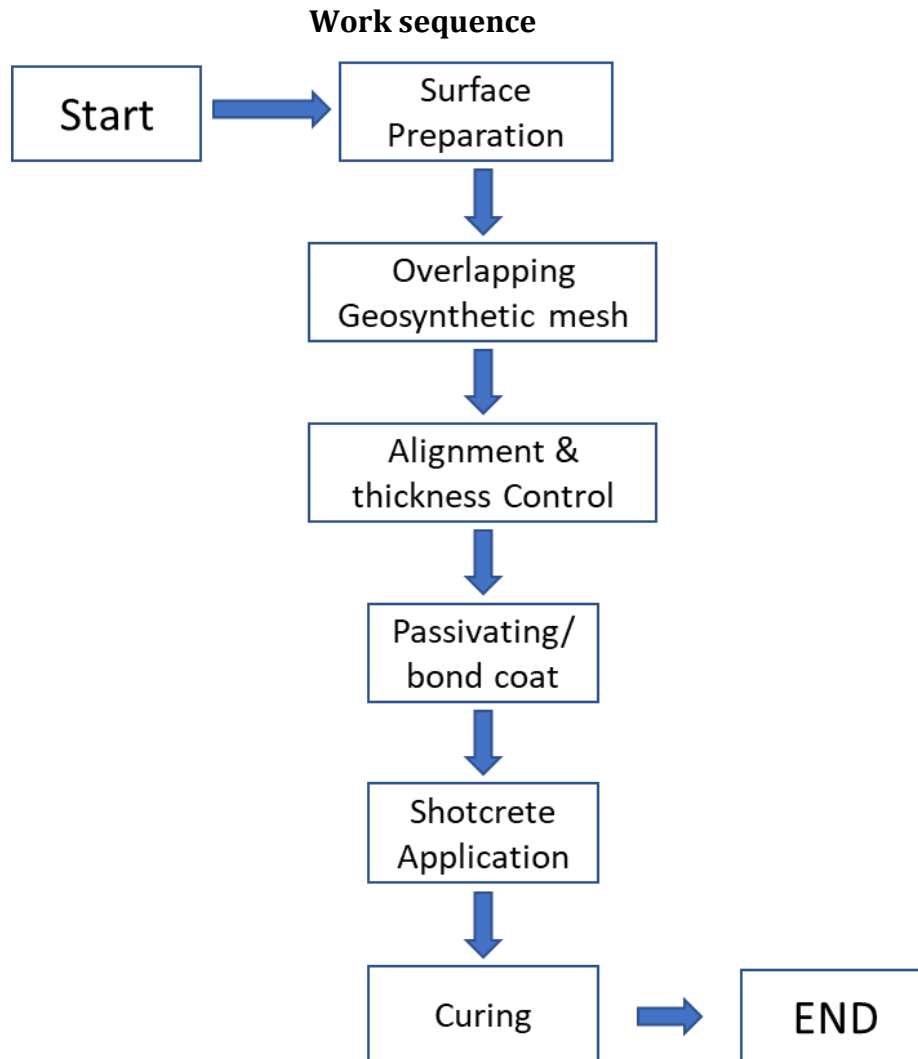


Figure: 1.4 Work sequence of Shotcrete

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 (117/A) near Ragavapuram has been conducted on 29th November 2019, following observations were made
 - a) Minor spalling and Reinforcement exposed at overhang portion of slab
 - b) Minor spalling is observed at Main girder, secondary girder, and abutment.
 - c) Cracks are observed at main girder resting location.
 - d) Shrinkage cracks are observed at girders and abutments.
 - e) Leaching has been observed at Abutments and deck slab.
 - f) Vegetation growth is observed at Abutment and at drainage spouts
- Based on visual inspections its interpretations following recommendations were made:
 - a) Patching of Spalled concrete locations with Polymer modified concrete
 - b) Clearing of Vegetation growth

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