

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



INSPECTION OF ROB NO. 7A NEAR LAKDIKAPUL RAILWAY STATION

Final Report
SEPTEMBER | 2020

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1. VISUAL INSPECTION

Name of the Project	:	INSPECTION OF ROB (7A) NEAR LAKDIKAPUL RAILWAY STATION
Location	:	LAKDIKAPUL (186/33-35) `
Location Co-ordinates	:	17°24'24.1"N 78°27'43.0"E
Date of Inspection	:	22 nd OCTOBER, 2019



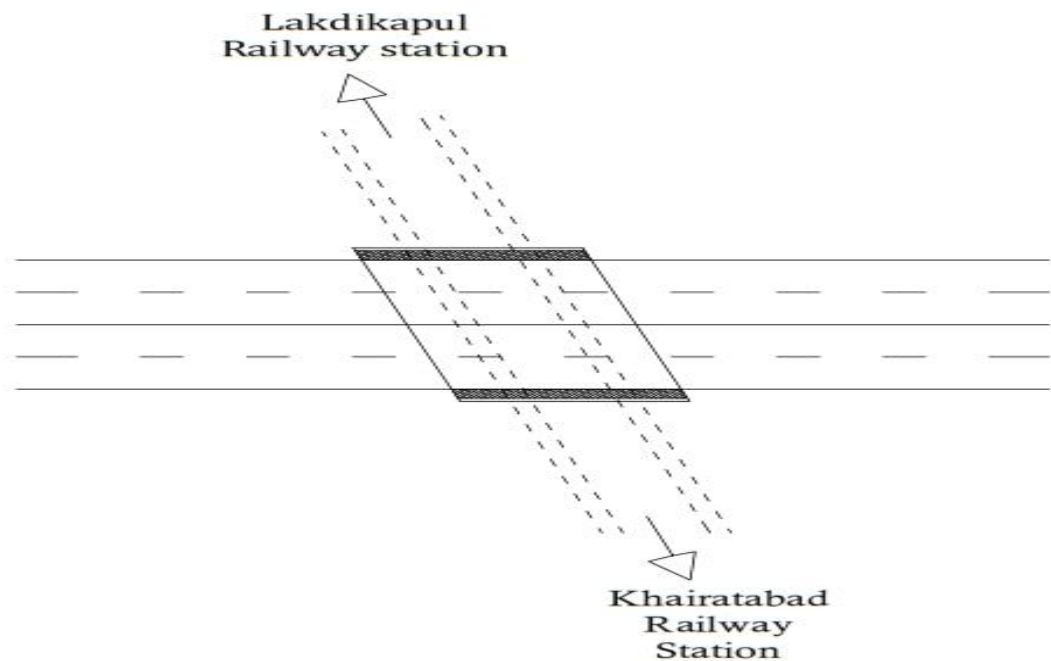
Summary:

- a) Structural Cracks have been observed in the Mid spans of Longitudinal Girders.
- b) Spalling and Reinforcement exposure is observed at the bottom of slab.
- c) Cracks are observed in the Secondary Girders.
- d) Distresses are found in the Elastomeric Pad bearings.

PART 1.1 GENERAL INFORMATION AND OBSERVATION

1.1	Name of the Bridge	ROB (7A)
1.2	Location Location co-ordinates	Lakdikapul (186/33-35) 17°24'24.1"N 78°27'43.0"E
1.3	Type of Bridge	RCC Girder Bridge
1.4	Year of Construction	1992
1.5	Grade of Concrete	Not Available
1.6	Design Load	Class AA-70R (Assumed)
1.7	Roadway Width	2 x 10.5 m
1.8	Overall Deck Width	2 x 12.5 m
1.9	Average Skew	20°
1.10	Span arrangement (no x Span in meters)	1x 18.3 m (Sq.) / 1x 19.475 m (Sk.)
1.11	No of Railway Lines Crossings	2 tracks
1.12	Vertical Clearance (from rail top to girder bottom)	6.264 m
1.13	History of Repair/ Maintenance	Not Available
1.14	Existing Structural Drawings	Not available

1.15 Key Plan



PART 1.2 STRUCTURAL SYSTEM OF THE BRIDGE			
			Notes
2.1	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.,)		
2.2	Abutment (A1 & A2)		
	Type	RCC Wall Type	
	Maximum height of Abutment from Ground level	6.5m	
	Abutment width along the Track	2 x 13.3m	
	Abutment thickness		Not Accessible
	Condition (Crack, Settlement, Scour, Tilting, Steel Corrosion, Strains, and other damages etc...)		All abutments are in fair condition
	Efficiency of drainage of backfill behind Abutments (Check functioning of weep holes, evidence of moisture on Abutment faces, etc..)		Weep holes are functioning properly.
2.3	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...)		
	Efficiency of drainage of backfill behind Abutments (Check functioning of weep holes, evidence of moisture on Abutment faces, etc..)		

2.4	Bearing & Pedestal		
	Type of Bearings	Elastomeric Pad	
	General condition (Check Corrosion, cleanliness, seizing of plates silting, accumulations of dirt in case of submersible bridges)		All the bearings are in distressed condition
	Type/ shape of Pedestal		
	General condition (Check Corrosion, cleanliness, seizing of plates silting)		There is no Pedestal
2.5	Super Structure (Concrete Girder)		
	Type/Shape of Girder (I-beam, box-girder etc.)	I-Girder	
	Material of Girder	RCC	Precast RCC Girders
	No of Girder	2x 5 Nos.	
	Dimensions of Girder		Total Depth = 1.6m Width of the Web = 0.3m Width of the Bulb = 0.6m
	Structural System of Girder		Simply Supported
	Condition of Girder		Structural cracks have been observed in mid span of the girders (Refer Fig-1)
	Type/Shape of Secondary Girder	Rectangular Girder	
	Material of Secondary Girder	RCC	
	No of Secondary Girders	2 x 5 Nos.	
	Condition of Secondary Girder		Distresses are observed near main & secondary Girder junctions (Refer Fig-4)
2.6	Slab		
	Material of Slab	RCC	
	Thickness of Slab	-	Not Accessible
	Condition of Slab from Bottom		Spalling & Reinforcement exposure has been observed. (Refer Fig-2)
	Condition of Slab from Top		Not visible, as covered with wearing coat
	Condition of Flooring/Wearing Coat	Good	
	Parapet wall/Railing		
	Type of Parapet wall/Railing	Parapet wall	
	Height	1.8 m	
	Condition of Wall/Railing	Good	

PART 1.3 SURVEY OF SIGNS OF DISTRESS, DEFORMATION IN BRIDGES

1.3.1

- ✓ Structural Cracks have been observed in the Mid spans of Longitudinal Girders.



Fig.1

1.3.2

- ✓ Spalling and Reinforcement exposure is observed at the bottom of slab.



Fig.2

1.3.3

✓ Corrosion and Spalling observed near Drainage Spout



Fig.3

1.3.4

✓ Cracks are observed in the secondary girders.



Fig.4

1.3.5 ✓ Distresses are found in the Elastomeric Pad bearings.



Fig.5

PART 4 SURVEY OF SIGNS OF DISTRESS, DEFORMATION IN BRIDGES			
	Defects	Location	Notes
	Cracking in RCC components	Main Girders, Secondary Girders	cracks are observed in Main and secondary girders
	Water seepage		No water seepage is observed
	Spalling	Slab and Secondary Girder	Spalling is observed in Slab & Secondary Girder.
	Reinforcement Exposure	Slab	Reinforcement Exposure is observed in Slab

2.0 Numerical Model

- Three-dimensional numerical model has been developed from the dimensions obtained by visual inspection and the assumptions. obtained model and results are shown below.

Assumptions:

Grade of Concrete: M30

Loading Condition: 1 Lane of Class A + 1 Lane of Class AA-70R

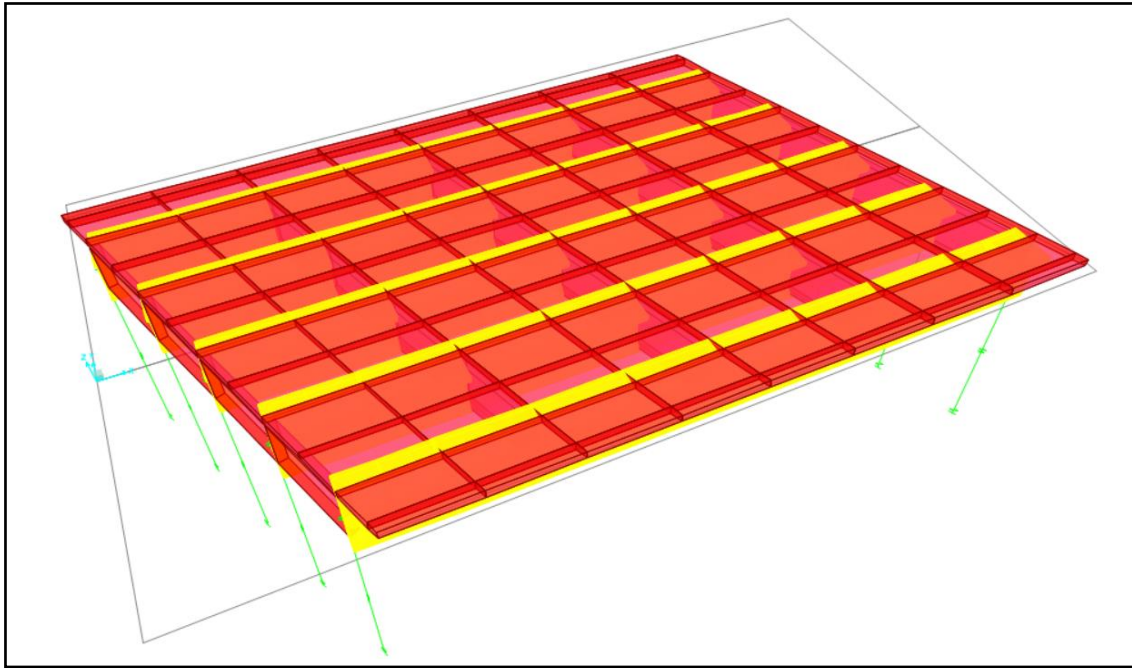


Fig: 5.1 Numerical Modeling of Lakdikapul ROB (Developed from the Visual inspection).

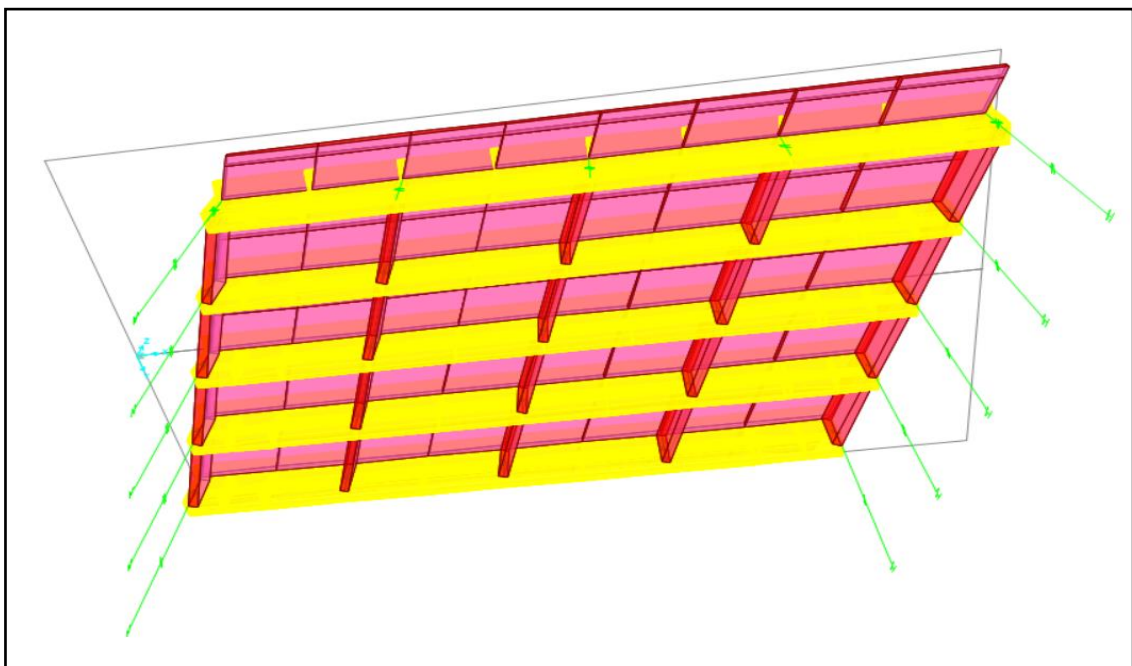


Fig: 5.2 Numerical Modeling of Lakdikapul ROB (Developed from the Visual inspection).

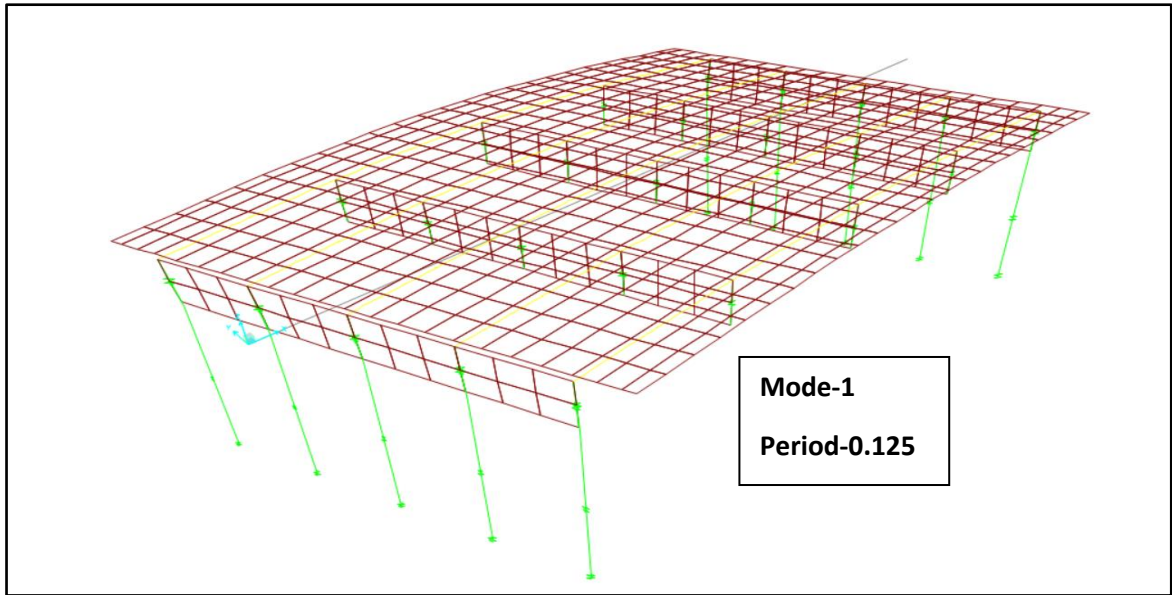


Fig: 5.3 Modal analysis of ROB (MODE-1)

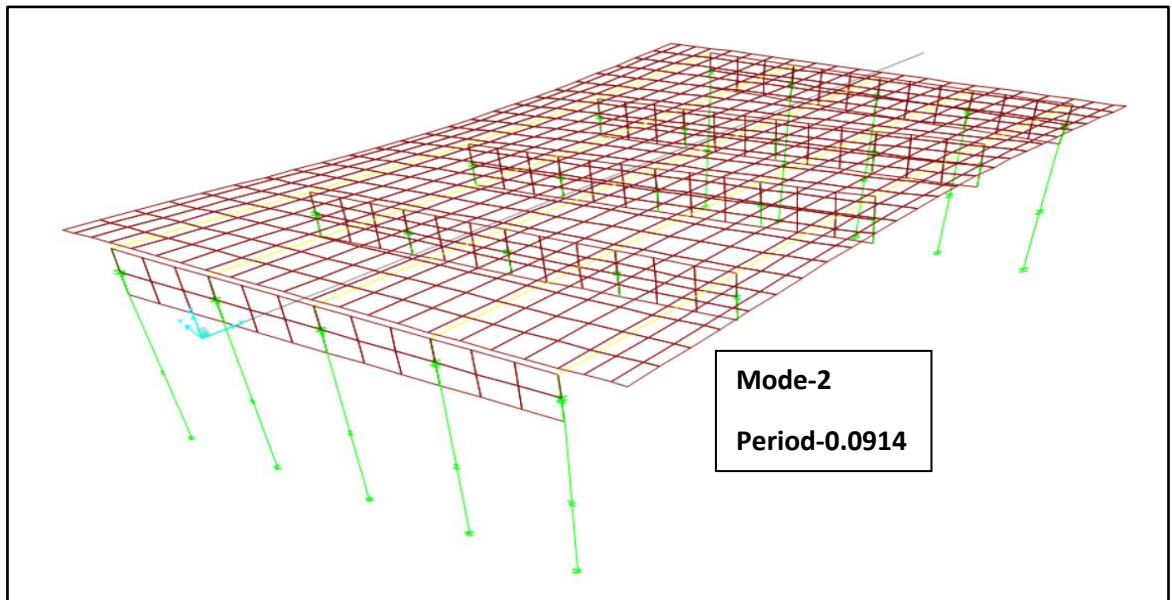


Fig: 5.4 Modal analysis of ROB (MODE-2)

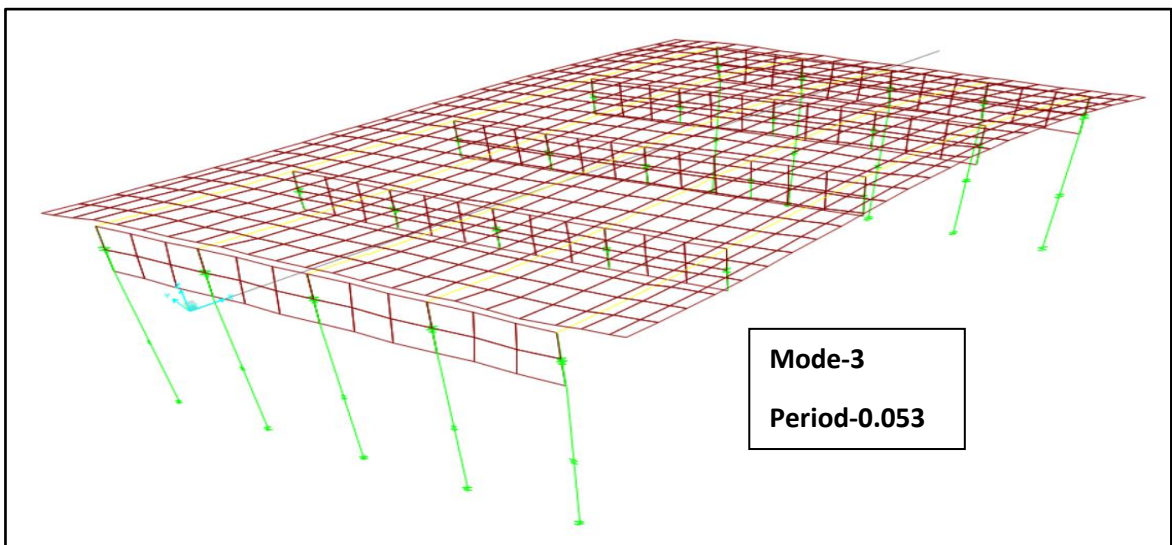


Fig: 5.5 Modal analysis of ROB (MODE-3)

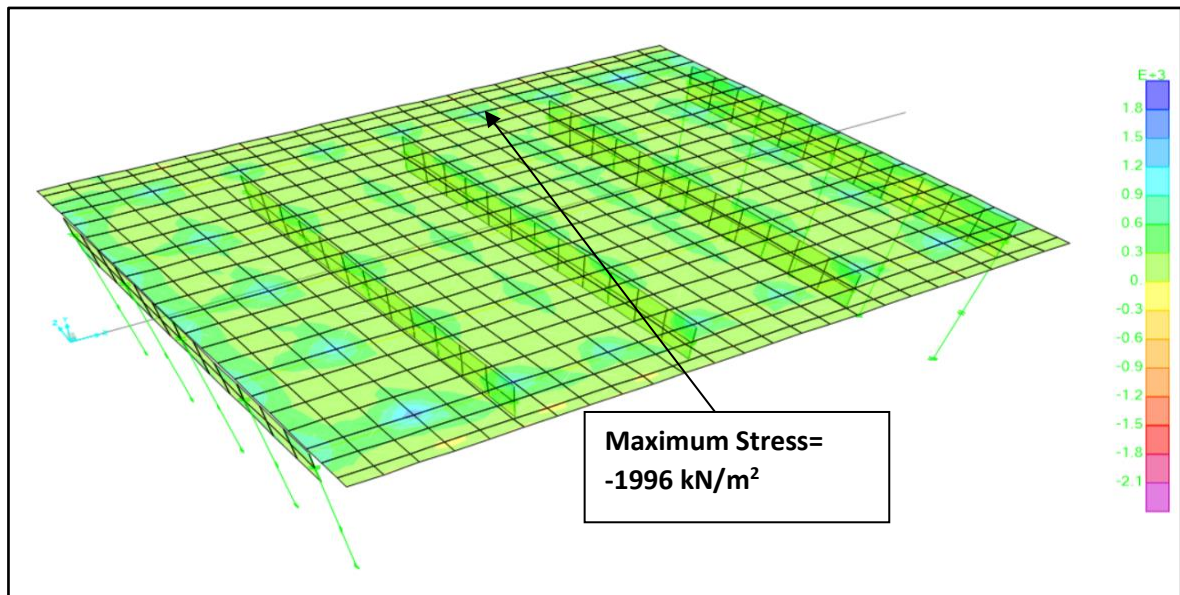


Fig: 5.6 Stress Diagram in the slab due to Dead Load

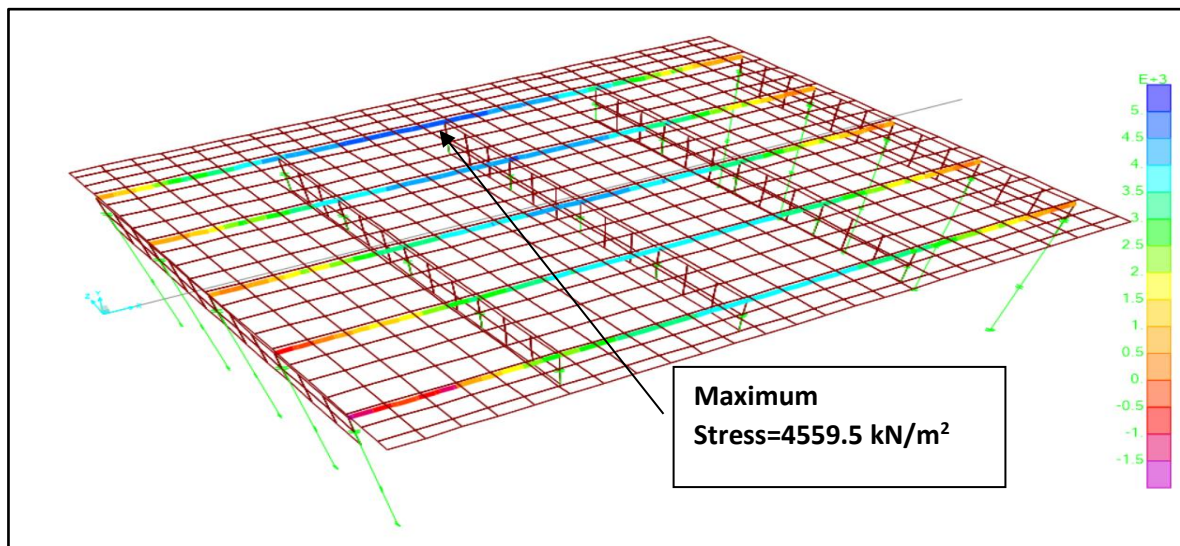


Fig: 5.7 Stress Diagram in the Girder due to Dead Load

3. NON-DESTRUCTIVE TESTING

The following tests were carried out to investigate strength and quality of “Lakdikapool ROB (7A)” elements such as piers, girder and abutment as specified:

- Rebound Hammer test by Schmidt Rebound Hammer as per IS: 13311 part 2
- Ultrasonic Pulse velocity test, ZC3-B as per IS:13311 Part 1
- Carbonation Test
- Crack depth.
- Profometer Test

A. RESULTS AND OBSERVATIONS OF REBOUND HAMMER TEST:

The test results of rebound hammer test carried out on Abutment, Main girders, cross girder, Abutments and Slab are presented in the Table1.

Table 1: Shows Observations of Rebound hammer test

Sl. No	Member	Location ID	Method	Rebound Numbers	Corrected Rebound Number	Estimated Compressive Strength (N/mm ²)
1	Abutment-1	Bridge-2, 1.5M from Nampally end	Horizontal	47,73,42,51,56, 45,43,45,41	47	39
2	Abutment-1	Bridge-2, 11m from Nampally end	Horizontal	45,45,46.5,43,3 7,41,40,36.5,49	42	33
3	Abutment-1	Bridge-1, 8m from Nampally end	Horizontal	39,44,41,41,41, 38,40,49,48	38	28
4	Abutment-1	Bridge-1, 3m from Khairtabad end.	Horizontal	33,43,45,44,49, 39,41,49,48	43	34
5	Abutment-2	2m from Khairtabad end.	Horizontal	47,45,44,43,49, 49,50,68,48	47	39
6	Abutment-2	6m from Khairtabad end.	Horizontal	63,52,44,47,44, 61,36,56,52	51	45
7	Abutment-2	4m from Nampally end.	Horizontal	53,52,53,54,61, 41,53,52,48	52	47
8	Main Girder-9	0.7m from CG2 R/S	Horizontal	67,62,66,64,64, 70,65,70,67	66	76
9	Cross Girder-2	b/w MG9 and MG10	Horizontal	62,62,55,62,55, 70,68,62,60	62	66
10	Slab	0.5m from CG2	Vertical	59,66,54,53,67, 66,54,50,52	58	58
11	Main Girder-5	b/w CG2 and CG3	Horizontal	59,61,57,68,71, 68,65,66,64	64	71

Note: Estimated compressive strength is referred from the standard charts developed for strength. Probable accuracy is $\pm 25\%$

B. RESULTS AND OBSERVATIONS OF ULTRASONIC PULSE VELOCITY TEST (UPV Test):

The test results of UPV test carried out on Abutment, Main girders, cross girder, and Abutments are presented in the Table2.

Table 2: Shows Observations of Ultrasonic Pulse Velocity test

Sl. No	Member Id*	Location	Test Method	Path Thickness (mm)	Pulse Velocity (km/sec)	Corrected Pulse Velocity (km/sec)	Concrete Quality As per Referred Table – II
1	Abutment-1	Bridge-2, 1.5M from Nampally end	In-Direct	400	3.160	4.160	Good
2	Abutment-1	Bridge-2, 11m from Nampally end	In-Direct	400	4.396	5.396	Excellent
3	Abutment-1	Bridge-1, 8m from Nampally end	In-Direct	400	2.339	3.339	Medium
4	Abutment-1	Bridge-1, 3m from Khairtabad end.	In-Direct	400	4.819	5.819	Excellent
5	Abutment-2	2m from Khairtabad end.	In-Direct	400	4.419	5.419	Excellent
6	Abutment-2	6m from Khairtabad end.	In-Direct	400	3.922	4.922	Excellent
7	Abutment-2	4m from Nampally end.	In-Direct	400	4.010	5.010	Excellent
8	Main Girder-9	0.7m from CG2 R/S	In-Direct	400	3.810	4.810	Excellent
9	Cross Girder-2	b/w MG9 and MG10	Direct	400	3.363	3.363	Medium
10	Slab	0.5m from CG2	In-Direct	400	2.454	3.454	Medium
11	Main Girder-5	b/w CG2 and CG3	In-Direct	400	6.494	7.494	Excellent

CONCRETE QUALITY GRADE CHART FOR ULTRASONIC PULSE VELOCITY TEST (As per IS: 13311 Part 1, Table –II)

PULSE VELOCITY(Km/Sec)	CONCRETE QUALITY
Above 4.5	Excellent
3.5 to 4.5	Good
3.0 to 3.5	Medium
Below 3.0	Doubtful

Note:

1. In the case of “doubtful “quality, it may be necessary to carry out the further test.
2. As per IS: 13311 (Part 1) Clause 5.4.1, Surface probing, in general, gives lower pulse velocity than in case of cross-probing and depending on a number of parameters, the difference could be of the order of about 1km/sec.

C. OBSEVATIONS OF CARBONATION TEST

Table 3: Shows Observations of Carbonation test

S. No.	Member	Location ID	Observation	Carbonation	pH	Soluble Chloride
1	Main Girder-9	0.7m from CG2 R/S	Pink colour at 5mm	Non-Carbonated	11.30	0.012
2	Main Girder-5	b/w CG2 and CG3	Pink colour at 5mm	Non-Carbonated	11.64	0.011

General Remarks

The maximum chloride limit for Reinforced concrete construction is Considered as 0.6% per cubic meter of concrete IS:456-2000. The amount of chloride required for initiating corrosion is partly dependent on the pH value. At a pH value less than 11.5 corrosion may occur without the presence of chloride. At a pH value greater than 11.5 a good amount of chloride is required to be prone for corrosion

D. OBSERVATIONS OF CRACK DEPTH:

Table 4: Shows Observations of Crack depth

S. No.	Member	Location ID	Crack Depth	Remarks
1	Main girder 5	b/w CG2 and CG3	91mm	-

E. OBSEVATIONS OF PROFOMETER TEST

Table 5: Shows Observations of Profometer test

S. No.	Member	Location ID	Cover(mm)
1	Main Girder-9	0.7m from CG2 R/S	50
2	Slab	0.5m from CG2	34.5

CONCLUSIONS:

- i. Estimated strength as per rebound hammer test indicated that concrete strength is $>28\text{MPa}$.
- ii. Ultrasonic Pulse Velocity test also in conformation with Rebound hammer test and quality varies from Medium to Excellent.



Fig.6.1 UPV test at site

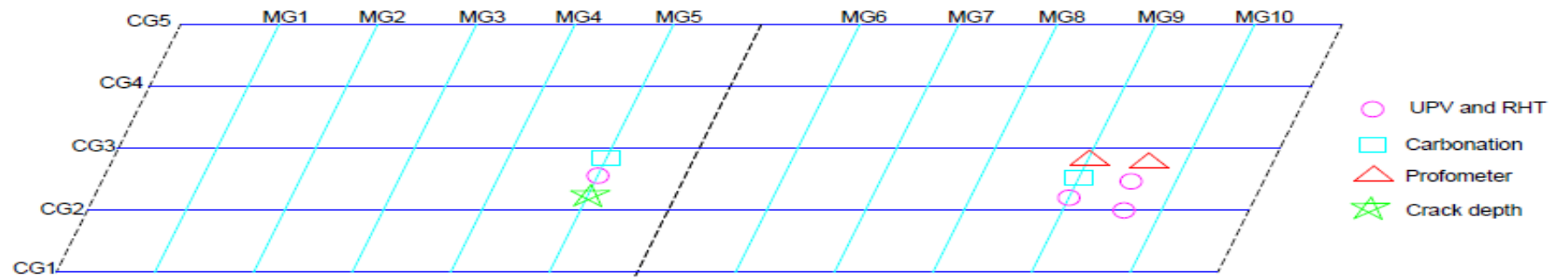


Fig.6.2. Rebound Hammer test

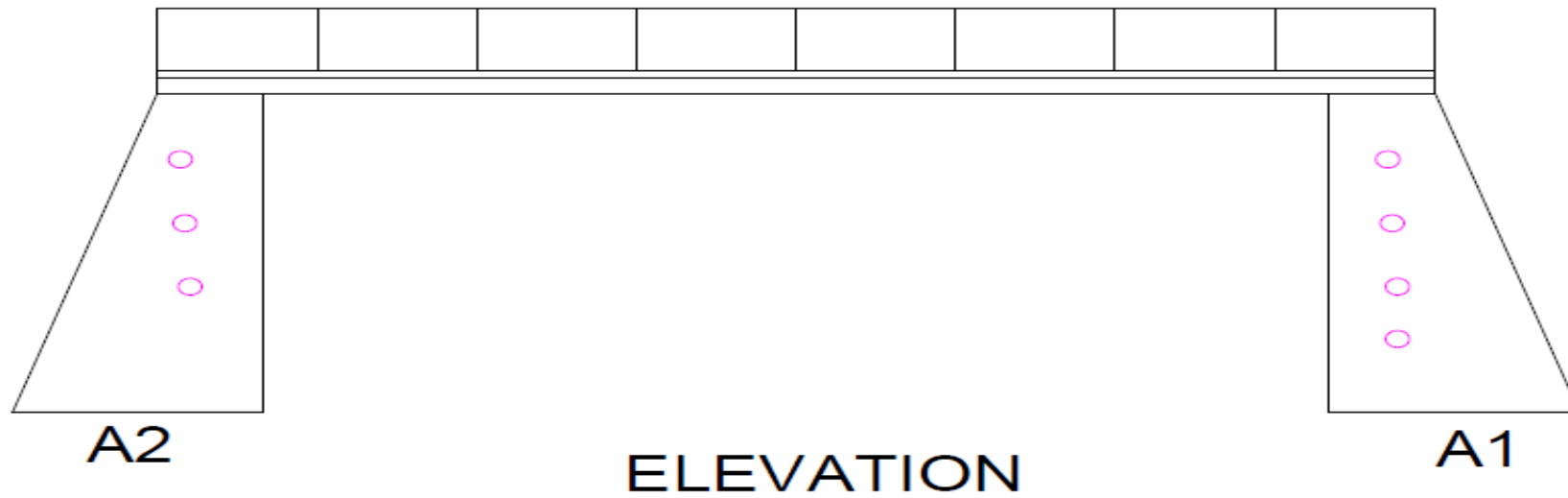


Fig. 6.3. Inspection team at Lakdikapul ROB

NDT Test Locations



PLAN



4. Repair Methods and Retrofitting Recommendations

A. Spalling and Cracks at Deck slab and Girders

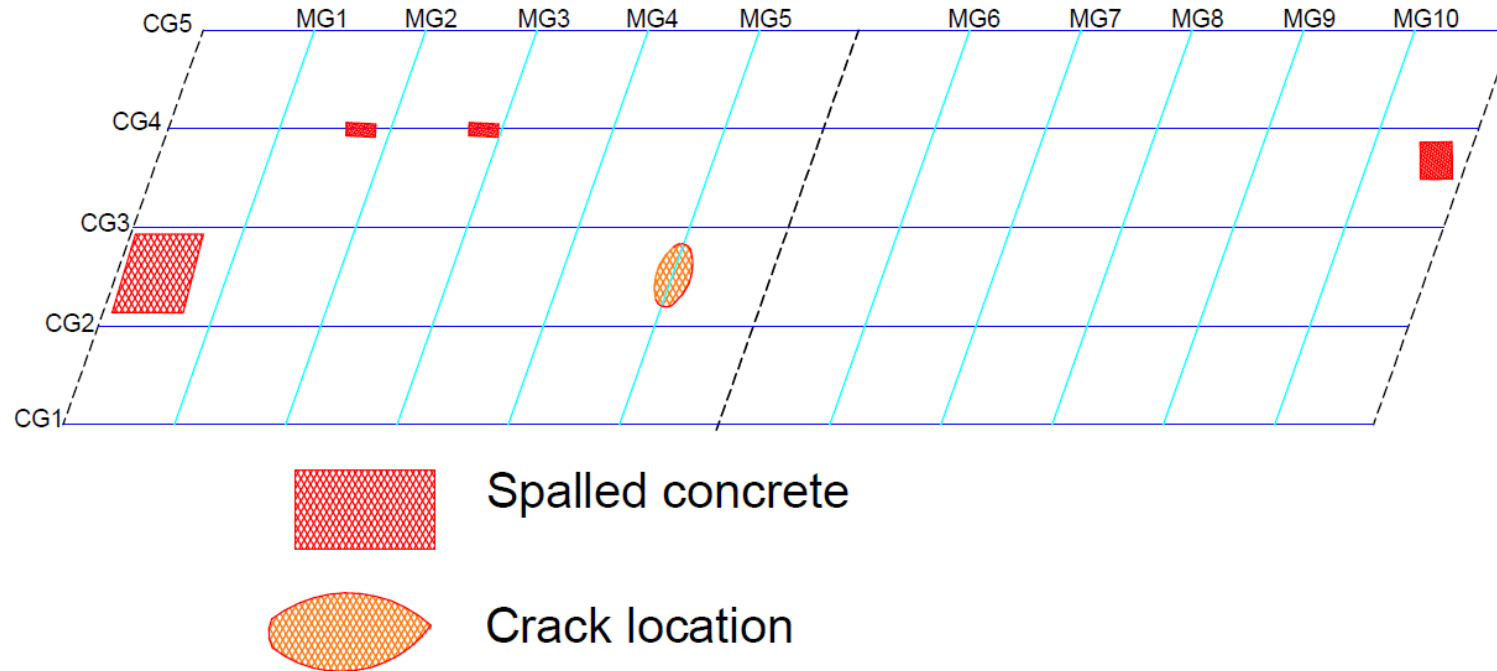


Fig 7.1 Bottom view of Deck slab with Spalled concrete and Crack locations

During the detailed visual observation at bottom of Deck slab on the above said locations and the following observations are made, spalling and Reinforcement exposure was noticed at overhang portion of deck slab (**Refer** Fig 2,3,4/ page 5,6,7) and is effected with dampness, Structural cracks were noticed at Main girder (**Refer** Fig 1/ page 5).

So, Shotcrete and Grouting should be done at all the spalled concrete locations, and Injection Grouting should be done at Crack locations.

SHOTCRETE AND GROUTING

- This specification covers only to the extent of restoring the concrete slab by way of shot creating and injection grouting.
- Remove all loose and spalling concrete and expose the corroded reinforcement wherever possible by careful chipping.
- Carryout thorough sand blasting using dry coarse sand or by grinding.
- 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.
- 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.
- Fix 50 mm x 50 mm x 4 mm Geo grid tied to the exposed reinforcement / shear connectors.
- Carryout 40 to 50 mm thick shot - creating to underside of slab etc, using a mix proportion of 1: 2: 2 (cement: sand: aggregate).
- Now carryout cement injection grouting through the nozzles in sequential manner until rejection.
- Carryout curing for 7 days.

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

B. Distressed Bearing Locations:

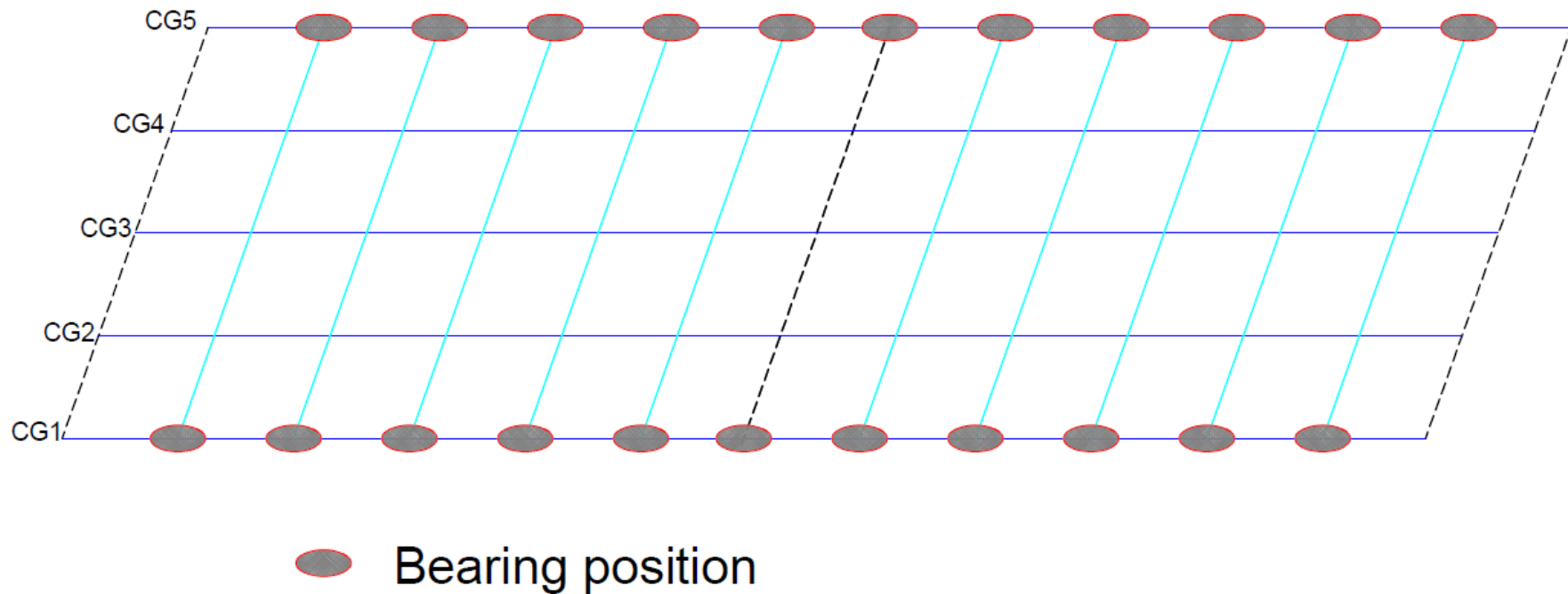


Fig 7.2 Bottom view of Deck slab with Elastomeric bearing locations

The distresses are observed on almost all the bearings (**Refer** Fig.5/ Page 7) of the bridge on the above said locations i.e. bearings have been settled down. So, all the distressed bearings should be replaced for proper functioning and increase in service life of bridge.

Cleaning applied to the bridge including its deck and substructure are recommended below

1) 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.

2) Bridge substructure:

All areas under the superstructure should be cleaned, including the bearing shoe bed, concrete diaphragms, and abutment 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.

3) 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

Summary

- Visual inspection of Lakdikapul ROB (7A) has been conducted on 22nd October 2019, following observations were made
 - a) Structural Cracks have been observed in the Mid spans of Longitudinal Girders.
 - b) Spalling and Reinforcement exposure is observed at the bottom of slab.
 - c) Cracks are observed in the Secondary Girders.
 - d) Distresses are found in the Elastomeric Pad bearings.
- Non-Destructive Testing of Lakdikapul ROB (7A) has been conducted and the following observations were made
 - a) Estimated strength as per rebound hammer test indicated that concrete strength is >28MPa.
 - b) Ultrasonic Pulse Velocity test indicates that the quality of concrete varies from Medium to Excellent.
- Based on visual inspections and NDT Testing and its interpretations following recommendations were made:
 - a) Epoxy Grouting of the Cracks observed at the Girders.
 - b) Shotcreting of the Spalled concrete locations after the application of Anti corrosive paint for exposed rebars with Minimal deterioration.
 - c) Replacement of the distressed bearings.
 - d) Extension of the drainage spouts pipe so that the surrounding concrete should not be deteriorated.