

REPORT
THIRD PARTY AUDITING OF RAILWAY BRIDGES (PHASE I)

(Job No: CED/CON/TMMP/SAS/2019312)

**Br. No. 872A (1 × 21.5m) RCC Girder at km. 623/300-400 between
Tirunavaya and Tirur station**

CLIENT



SOUTHERN RAILWAY PALGHAT DIVISION

CONSULTANT



Department of Civil Engineering
NATIONAL INSTITUTE OF TECHNOLOGY CALICUT

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1. PREAMBLE

Director, NIT Calicut received a request from Chief Bridge Engineer, Headquarters office, Chennai Works Branch, Southern Railway vide letter No. W.439/4/61/Vol. IV (W.245/I/1 Spl. Drive) dated 18 – 09 - 2018, exploring the possibility of whether NIT Calicut can undertake a one-time third party auditing of some selected railway bridges. This was consequent to the instruction issued by Railway Board to various railway divisions for undertaking such inspections of railway bridges through expert institutions. The letter was forwarded to the Civil Engineering Department (CED) and the Structural Consultancy Group of CED followed the matter up. The Railway Board was represented by Palakkad division of Indian Railway. Subsequently, on 05 – 10 - 2018 railway officials came to CED, NITC for discussions. Soft copies of the available drawings of some of the bridges were also shared by Railways to CED for initial assessments. Subsequently, CED expressed its willingness to take up the work and communicated the matter by letter, No. CED/CON/RLY/TPAUD/2018/1 dated 08-11- 2018. Through this letter it was conveyed to Railways that the work could be taken up in two phases, outlining the scope of work to be carried out in the different phases. This was accepted by Railways and they requested the details of consultancy charges for carrying out phase I of the work.

CED replied vide letter No. CED/CON/RLY/TPAUD/2019/1 dated 10 - 01- 2019, the requisite details regarding consultancy charges and scope of the work. Railways replied to this letter showing their interest to award the work to NITC and sought the signing of an MoU to proceed further. Mutual discussions followed and an MoU was signed in the FN of 19-09-2019.

The details of communications are given below:

- i. W.439/4/61/Vol.IV(W.245/I/1 Spl. Drive) dated 18-09-2018.
- ii. Meeting held on 28-09-2018 at NIT Calicut with railway officials.
- iii. J/W/71/G dated 23-10-2018 from Divisional Office, Palakkad division furnishing details of some of the bridges.
- iv. CED/CON/RLY/TPAUD/2019/1, dated 10th January 2019
- v. MoU between Southern Railway and NIT Calicut, dated 19-09-2019.
- vi. CED/CON/HOD/TMMP/SAS/2019312, dated 3rd October 2019
- vii. J/W.71/G, dated 03-12-2019
- viii. CED/CON/HOD/TMMP/SAS/2019312/1, dated 02-01-2020
- ix. CED/CON/HOD/TMMP/SAS/2019312/2, dated 02-01-2020
- x. CED/CON/HOD/TMMP/SAS/2019312/3, dated 23-01-2020

- xi. CED/CON/HOD/TMMP/SAS/2019312/4 dated 11-03-2020
- xii. CED/CON/HOD/TMMP/SAS/2019312/5 dated 12-03-2020
- xiii. CED/CON/HOD/TMMP/SAS/2019312/6 dated 13-03-2020
- xiv. CED/CON/HOD/TMMP/SAS/2019312/7 dated 11-05-2020
- xv. No. J/W.71/G dated 27-07-2020
- xvi. CED/CON/HOD/TMMP/SAS/2019312/8 dated 22-07-2020
- xvii. CED/CON/HOD/TMMP/SAS/2019312/9 dated 22-07-2020
- xviii. CED/CON/HOD/TMMP/SAS/2019312/10 dated 14-08-2020
- xix. No. J/W.71/G dated 26-09-2020
- xx. CED/CON/HOD/TMMP/SAS/2019312/13 dated 21-09-2020
- xxi. CED/CON/HOD/TMMP/SAS/2019312/15 dated 17-11-2020
- xxii. CED/CON/HOD/TMMP/SAS/2019312/17 dated 24-12-2020
- xxiii. CED/CON/HOD/TMMP/SAS/2019312/18 dated 19-01-2021

2. SCOPE AND METHODOLOGY

Road Over Bridges (ROBs) which are known for their permanent resistance to vehicle loads, are exposed to large stress ranges and severe environmental conditions that may lead to damage and failure of the system if timely maintenance is not carried out. Keeping in mind the large risk and economic ramifications, it is necessary to assess the health of these structures systematically. As part of this audit it is not intended to check the design of this ROB, as the loading conditions of the bridge have not changed over the period of its use. Moreover, as it is a single span structure with a standard design (with deck supported on abutments with bearing), it is presumed that the structure is safe for extreme lateral loads such as the ones due to earthquakes. In view of the above and based on the terms and conditions laid down in the MoU, the scopes of the present investigation are identified as below.

- i. Inspection of the main structural elements of the bridge.
- ii. Visual examination of cracks and other types of distress, if any, in the bridge
- iii. Visual examination followed by a suitable non-destructive test to check if there is any distress
- iv. Overall assessment of the bridge for its integrity.

3. INSPECTION OF BRIDGE

3.1 Visual Examination

The visual inspections along with field measurements were carried out on the bridge on 24-02-2020 (Monday) at 2.30 pm. Officials from Palakkad Railway section were also present during the inspection. Photographs of the bridge showing various elements are shown in Figure 1 to Figure 4. The bridge is a RCC girder type with a span of 21.5m, supported on Concrete abutments. On 03-03-2021 the ROB was again visited to take the necessary non-destructive tests.



Figure 1. View of Br.872A RCC Bridge



Figure 2. Concrete abutment



Figure 3. Bottom main beams and Cross beams



Figure 4. Bearing under girder

3.2 Field measurements and condition assessment

The Table 1 shows the defects in various elements of the bridge.

Table 1: Condition assessment of bridge elements

Sl. No.	Elements	Remarks
1	Abutment	Both abutments are found in sound condition. No cracks / bulging of concrete is noticed. Spalling of concrete is noticed at some locations on abutment at eastern side as shown in Figure 8.
2	Bearing	Bearings are found to be in good condition. However spalling of concrete is noted near the bearing (Fig.4) which shall be repaired.
3	Main Girder	Side cover and bottom cover concrete spalling are noticed at several locations (Especially at end girders) as shown in Figure 5 and Figure 6.
4	Cross Girder	Cross girders are found in good condition
5	Deck slab	Epoxy coating is spalled and re-bar is exposed at several locations. (Especially at end projections after end girders) as shown in Figure 7.



Figure 5. Concrete cover is spalled and reinforcement is exposed at the mid span of end main girder at Calicut side



Figure 6. Concrete cover is spalled and reinforcement is exposed at near the support of end main girder at Calicut side



Figure 7. Concrete is spalled and rebar is exposed at bottom of the deck slab at Calicut side



Figure 8. Spalling of concrete at abutment at eastern side

4. REBOUND HAMMER TEST

The rebound hammer test was carried out on the bridge on 03-03-2021 (Wednesday) at 10.30 am. Officials from Palakkad Railway section were also present during the inspection. Photographs of the bridge showing typical testing points on various elements of the bridge are shown in Figure 9 and Figure 10. The step by step methodology adopted for the rebound hammer test is as follows:

- Uneven top surfaces at each test point were smoothened using a carborundum stone.
- Rebound hammer tests were conducted at all the selected test points with 15 shots at every test point. Mean value of the 15 readings were considered as the 'Rebound Number (R)' of a test point.
- The test points and corresponding results are shown in Table 2 and the photographs of typical test points are shown in Figure 9 and Figure 10.
- The correlation between rebound number and compressive strength of concrete was established by finding the compressive strength of the concrete cubes in the laboratory as per Clause 5.2 of IS: 13311 (Part-2): 1992. Concrete cubes available in the laboratory were used to establish the correlation.
- The readings were taken only on those elements in which distresses were noted during the visual examination.

Table 2: Locations of test points and the estimated compressive strength.

Sl No.	Test point	Location	Estimated compressive strength (MPa)
1	A	Abutment at western side	31.94
2	B	Abutment at Eastern side	24.62
3	C	End cross girder at western side	22.49

It is noted that the strength estimated by rebound hammer tests are by and large satisfactory. Hence it is inferred that the structure is in good condition.



Figure 9. Testing points at



Figure 10. Testing points at Cross girder at western side

5. COMMENTS AND INFERENCE

As outlined in the beginning, the scope of the audit is limited to the visual examination and overall assessment of integrity of the bridge. Careful examination of the bridge revealed only minor distresses in the various elements of the bridge. All the minor distresses noted are tabulated in the report. Neither signs of settlements of foundations nor major distresses of concerns are noted as part of the site inspection. Moreover, the NDT test using Rebound hammer showed satisfactory strength results. In view of the above, the ROB is **deemed to be safe in the present condition**. However, it is recommended to maintain the bridge by undertaking repair works at location identified in this report. The spalling and exposure of re-bars observed at bottom of the deck slab is mainly due to the improper drainage noted. Adequate measures may be taken to avoid such issues and subsequent distress.

Members of the Investigation team

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