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No: CBS/Load Testing,

Dated 21.01.2021

Chief Bridge Engineer:

1. Central Railway, Mumbai CST - 400 001
2. Eastern Railway, Fairlie Place, Kolkata - 700 001
3. East Central Railway, Hazipur - 844 101
4. East Coast Railway, Bhubaneswar - 751 016
5. Northern Railway, Baroda House, New Delhi - 110 001
6. North Central Railway, Allahabad - 211 001
7. North Eastern Railway, Gorakhpur - 273 001
8. Northeast Frontier Railway, Maligaon, Guwahati - 781 061
9. North Western Railway, Jaipur - 302 001
10. Southern Railway, Park Town, Chennai - 600 003
11. South Central Railway, Rail Nilayam, Secunderabad - 500 371
12. South East Central Railway, Bilaspur - 495 004
13. South Eastern Railway, Garden Reach, Kolkata - 700 043
14. South West Railway, Hubli - 580 023
15. Western Railway, Mumbai - 400 020
16. West Central Railway, Jabalpur - 482 001

Sub : Guidelines for Load Testing of Bridges.

- Ref : 1. Railway Board Video Conference Minutes dated 12.01.2021.
2. Railway Board letter No. 2019/9/CE-11/BR/RDSO Misc dated 14.10.2020.

Existing provisions on the subject of load testing of various types of Railway Bridges are tabulated below: -

SN	Reference	Issued in	Description
1	BS 128	October 2019	Guidelines for carrying out load deflection test of Plate, Open Web & Composite Girders
2	BS 116R	June 2017	Load Testing of Arch Bridges
3	BS 106R	December 2016	Guideline for Instrumentation of Bridges
4	Concrete Bridge Code	September 2014	Clause 18 covers the Load Testing of concrete bridges.

In addition guidelines for load tests of ROB are contained in IRC SP-51 and IRC SP-37.

In terms of Clause 2.4.1.1 of IRS:Bridge Rules "the augmentation in load due to dynamic effects should be considered by adding a load Equivalent to a Coefficient of Dynamic Augment (CDA) multiplied by the live load giving the maximum stress in the member under consideration". Hence Load Testing Can be done either by applying static load of Live Load*(1+CDA) or by running Live Load at Test/Design Speed.

In furtherance of the subject, an explanatory note covering relevant aspects like purpose & type of load tests, the circumstances requiring load test, stages and methodology, safety precautions, etc. is enclosed for information and necessary action please.

DA: As above (Four pages)

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Copy :

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2. Principal Executive Director, Bridge, RDSO for information please.
3. Executive Director Civil Engg./B&S, Railway Board, Rail Bhawan, New Delhi – 110001 for information please.
4. The Managing Director, RITES Ltd., RITES Bhawan, Plot No.1, Sect.29, Gurgaon (Haryana) - 122001
5. The Managing Director, IRCON, Palika Bhawan, Sector-XIII, R.K. Puram, New Delhi - 110066
6. The Chairman & Managing Director, Konkan Railway Corporation Ltd., Belapur Bhavan, Plot No. 6, Sector-II CBD Belapur, Navi Mumbai - 400 614
7. The Managing Director, Rail Vikas Nigam Ltd., 1st floor, August Kranti Bhawan, Bhikaji Cama Place, Africa Road, R.K. Puram, New Delhi - 110 016
8. The Managing Director, DFCCIL, 5th Floor, Pragati Maidan, Metro Station Building Complex New Delhi – 110001
9. The General Manager, Delhi Metro Rail Corporation Ltd., NBCC Place, Bhishma Pitamah Marg, Pragati Vihar, New Delhi – 110003
10. The Managing Director, Mumbai Railway Vikas Corporation Ltd. 2nd floor, Churchgate Railway Station Building, Churchgate, Mumbai – 400 020.

Explanatory Note on Load Testing of Bridges

1 Purpose of Load Tests

Load tests generally measure the elastic response of the bridge superstructure to static and/or dynamic loading for load rating (live load carrying capacity) of the bridge. Various objectives of load tests are listed below: -

- a) Validating the design of atypical and innovative type of bridge super-structures about which Indian Railways does not have prior experience.
- b) Evaluating the safe load capacity of existing bridges.
- c) Investigating the adequacy or otherwise of the bridge superstructure in case of doubt.
- d) Monitoring the condition of distressed bridges.
- e) Assessing the results of major structural repairs or strengthening.
- f) Validating the mathematical models.
- g) Complying the contractual conditions.

The load tests are not a substitute for adequate quality control during construction. The primary objective of the load tests is to understand bridge's response to static and dynamic loadings. The levels of loading necessary should be such that they are sufficient to obtain measurable responses from the structure without causing any permanent structural damage.

2 Type of Load Tests

2.1 Static Load Testing

Static load tests are carried out to verify and ascertain the actual structural behavior of the bridge compared with theoretical designs. Static load testing is performed to measure response of the bridge. The type of response may be strains, rotations, deflections, etc. Measurement of recovery of response is also a part of static load testing.

2.2 Dynamic Load Testing

The purpose of dynamic load test is to verify the dynamic behavior of bridges and specialist literature may be referred for details of carrying out such tests.

3 Circumstances requiring load tests

Circumstances requiring load testing are mentioned in RDSO guidelines BS-128, BS-116 R, and IRS Concrete Bridge Code. Based on the provisions, following circumstances may be considered for Load Test on a Bridge: -

- 3.1 Any new design being used for the first time on Indian Railways even if it is Standard Design of RDSO. Any design which has been modified after any adverse observation regarding performance should be treated as a new design.

- 3.2 Any Standard or Non-standard design which has been found fit for higher loading based on analysis unless the higher load has been already running on it.
- 3.3 Any Girder where signs of distress have been observed.
- 3.4 Any concrete superstructure where load test is considered necessary in light of IS:456 and IRS:CBC for Railway bridges and IS:456 and IRC:112 for ROBs.
- 3.5 The circumstances mentioned above also apply to superstructure of ROBs. In addition, latest stipulations of MoRTH and IRC should also be followed for superstructures of ROBs.
- 3.6 Test on superstructure during opening of Railway for Public Carriage is covered in clause 17 of Rules for Opening of Railway for Public Carriage, however provisions of IS: 456 may be kept in view which provides that if quality of construction is in doubt based on construction records and NDT, the structural integrity may be assessed from load test.
- 3.7 Notwithstanding the above circumstances, any superstructure of Railway bridge/ROBs may be subject to load tests prior to commissioning or during the service by CCRS/CRS/PCE/CBE/CAO/CE(Cons).

The above circumstances listed above are considered indicative and minimum only.

4 Stages & Methodology of Load Test

Various stages are-

4.1 Planning

- a) Site Visit.
- b) Traffic Management
- c) Methodology for loading
- d) Instrumentation
- e) The correct type, number and location of instrumentation used on a structure during a load test is important for effective load testing.
- f) Deflections can be measured with Linear Variable Displacement Transducer (LVDT) system, Dial gauges, Laser based systems, etc. All testing instruments shall be duly calibrated at accredited laboratories before start of the load testing. The frequency of calibration of testing instruments shall not exceed the periods specified by the manufacturer or 1 year whichever is less.
- g) LVDTs and/or dial gauges shall be fixed to magnetic stands. They shall be placed on firm scaffolding platforms with steel plates so that the magnetic stands are firmly located. Wherever dial gauges are used, the reading shall be recorded at height from the closest range possible to avoid parallax.
- h) Based on the information gathered during the planning stage, a detailed test plan/method statement incorporating Date & Time of load test, Track possession time, duration of activities involved, positioning of loads & instrumentation, roster and duties of personnel engaged, required T&P, liaison with civil authorities where required, emergency plans, emergency contact details, etc. should be prepared. The method statement should generally include the detailed activity schedule and the following-

- (i) Application of whitewash on bridge
- (ii) Mobilization of testing personnel to site
- (iii) Visual inspection of bridge
- (iv) Recording existing status
- (v) Fixing of instrumentation
- (vi) System of measurements for temperature correction
- (vii) Recording of measurement.
- (viii) Visual inspection during and after load testing
- (ix) Preparation of report

4.2 Execution

- a) The test load is applied in steps and the response of the bridge recorded using appropriate instruments. The observed response is compared with the permitted response.
- b) The ambient temperature data are generally collected for two or three consecutive days at 1-hour intervals.
- c) Temperature corrections, if any, are made to the observed response.
- d) In case of excessive deflections, beyond allowable limits, test shall be stopped.
- e) Additional information, as much as possible is extracted from the test to decide further course of action.
- f) Deflection measurement shall be recorded through LVDTs, Laser based systems, or Dial Gauges with 0.01 mm least count. Total stations and precision digital levels can be used wherever water flow exists or head room is more than 6 m.
- g) Wherever deflection measuring instruments can not be fixed from bottom of span due to water flow or due to large head room, prisms of total station can be fixed to bottom of girder or at any location in girder along critical section.
- h) A precision digital level can also be used to record deflection from top of the superstructure.

5 Safety precautions

- 5.1 Only qualified technical personnel shall be engaged for bridge load testing. Since the load test is a process involving working continuously for a large duration, all personnel involved shall be alert and cautious, while load test is in progress.
- 5.2 The bridge shall be constantly monitored for appearance and widening of cracks at every stage of loading. The entire span under test, i.e. underneath and all critical locations shall be flood lit for easy visibility of cracks or distress, during nights. Only authorized personnel shall enter the area of load test which should be suitably cordoned.
- 5.3 Whenever spans are tested in urban limits, where pedestrian or vehicular traffic passes below, a safely scaffolding system shall be provided, as a safety measure. The scaffolding shall be able to take full load of test span in case of any eventuality.
- 5.4 The test load shall be applied in stages, so that timely action, such as stopping the test, can be taken, if any untoward distress is observed at any stage.

- 5.5 The load-deflection characteristics at every increment should normally be linear and any abnormal behavior will get reflected in the load vs deflection data. If the observed deflection exceeds the permitted deflections at any stage, further loading, shall be stopped.

6 Acceptance Criteria

The measured deflections and recovery of deflections for various types of bridges for specified period of retention of loading should be as per the respective Codes/ Guidelines. Structures which do not meet the prescribed criteria shall be considered as non-compliant.