IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁙ Impact Factor 7.12 ⁙ Vol. 9, Issue 10, October 2022

DOI: 10.17148/IARJSET.2022.91002

STRUCTURAL EVALUATION OF AN EXISTING RC BRIDGE DECK ON MDR-10 AT MADAVEPURBRIDGE USING STAAD PRO SOFTWARE

Manjunath[1], Meghashree M[2]

Department of Civil Engineering, Dayananda Sagar College of Engineering, Bengaluru, Karnataka, India[1]

Assistance Professor, Department of Civil Engineering, Dayananda Sagar College of Engineering, Bengaluru, Karnataka, India[2]

Abstract: A bridge is being built to connect two or more levels. SHM has been widely used in a variety of engineering fields because to its capacity to adapt to unfavourable structural changes, improve structural dependability, and life cycle management, all of which will improve the condition of the structure. Structural health monitoring (SHM) is a method that detects, locates, and quantifies deterioration in structures at such an early stage in order to avert unexpected failure. It also aids in work monitoring. The goal of structural health monitoring is to give quantified and reliable data on the actual state of a bridge, as well as to track its development and detect the advent of degradations. Non-destructive testing (NDT) is now a technique for evaluating and analysing the qualities of a materials, component, structure, or systems. It is frequently necessary to assess buildings after they have hardened to verify whether they are fit for their intended usage. The goal of this study is to review the structural evaluation of an existing bridge by performing a non-destructive test called rebound hammer along the bridge by the concerned authority in order to obtain the reduced compressive strength parameter of the bridge's superstructure and modelling and analysing it by FEM software specifically STAAD Pro V.i8 and comparing the results such as Bending moments, Forces, Deflections, and Stresses and providing necessary repair and rehabilitation advanced technologies.

Keywords: Concrete bridges; Staad pro; Structural Health Monitoring.

I. INTRODUCTION

A bridge is a structure built over a physical obstacle, such as a body of water, a valley, or a road, with the purpose of providing a crossing over that obstruction. It is designed to be strong enough to withstand both its own weight and the weight of anything that passes over it. The number of bridges has increased significantly due to the tremendous development of the road and railway networks during the previous several decades. Over time, certain elements of them are exposed to severe conditions, limiting their service life. Some of such structures are now riddled with faults. The practise of recognising and monitoring structural integrity and evaluating the degree of degradation in a structure is known as health monitoring. Maintenance and operation have become increasingly difficult as the buildings have aged. The deck of a bridge is one of the most vulnerable components. It has a shorter life span than the other components and is designed to be replaced or repaired often. In bridge structures, concrete deterioration, steel corrosion, changes in boundary conditions, and the weakening of structural connections with time are all major concerns. If a broken bridge is not restored, its integrity and serviceability will deteriorate over time. Visual examination is the most often used non-destructive evaluation method for bridge inspections. Non-destructive testing can assist both old and new constructions.

II. METHODOLOGY

Selecting the bridge and its data is collected from Planning and Road Asset Management Centre (PRAMC).Conducting NDT test specifically Rebound Hammer test to derive compressive strengths of each span either completely or almost entirely without impairing traffic flow over the bridge. Modelling of bridge structure in a STAAD Pro. Assigning the IRC 70R and class AA loading and do the analysis. Inducing the damage to structure and run analysis and finally representation of results.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⋇ Impact Factor 7.12 ⋇ Vol. 9, Issue 10, October 2022

DOI: 10.17148/IARJSET.2022.91002

Fig1: **RCC Bridge.** **Fig2**: **Rebound hammer test**

Modelling of superstructure of bridge is done by Grillage method in STAAD Pro. As each span of bridge is same throughout the overall length of bridge, a single span is modelled and analysed for the whole bridge by applying deadload and live load in the form of vehicular or moving load in FEM software specifically STAAD Pro. The results of deflections and stresses are obtained and compared after analysis with that of the deteriorated members after inducing damages specifically reduced compressive strengths.

- Firstly, as the bridge was constructed in the year 1983 the grade of concrete used in that period is
- assumed to be M20 and that of steel is assumed to be 415 N/mm2.
- The longitudinal girders and deck slab are considered as a single unit and are hence modelled as a tee
- beam having grade of concrete as M20 N/mm2.
- Cross girders are provided as general T sections by calculating their area and moment of inertia.
- Hinged supports are provided when the girders are resting on the bearings.

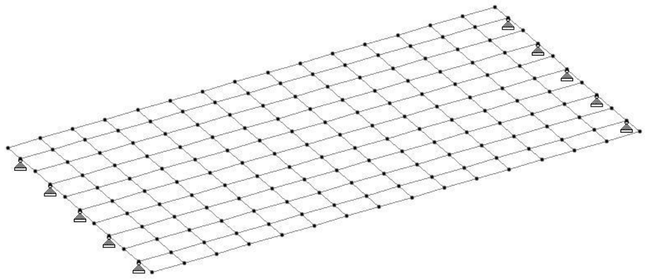

Fig2: Geometry of a span.

The bridge span was modelled for M20 grade of concrete as a standard structure by assigning vehicular load office class 70R loading and Class AA loading by referring IRC 6. Dead load consisted of self-weight of structural members, weight of transverse and cross girders, dead load of wearing coat, kerb and railing post. The maximum bending moments and shear forces obtained after analysis between these load cases is considered for design as reinforcement details were not available the reinforcement was cross checked against authorized drawings which proved to be satisfactory.
The maximum bending moments and shear forces are considered at supports, 0.9D, L/8, L/4, 3L/8, L/2 distances from both sides of all three longitudinal girders and transverse girders. The deflections were checked after analysis

for M20 grade of concrete which is assumed to be standard grade of concrete at the time of construction, the maximum deflection obtained with impact factor is 7.217 mm.

ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁙ Impact Factor 7.12 ⁙ Vol. 9, Issue 10, October 2022

DOI: 10.17148/IARJSET.2022.91002

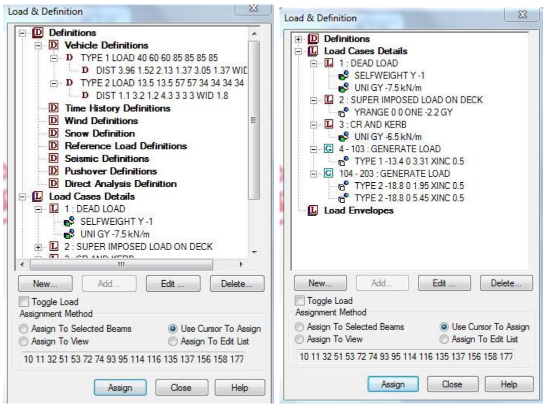

Fig3: Load and Definitions.

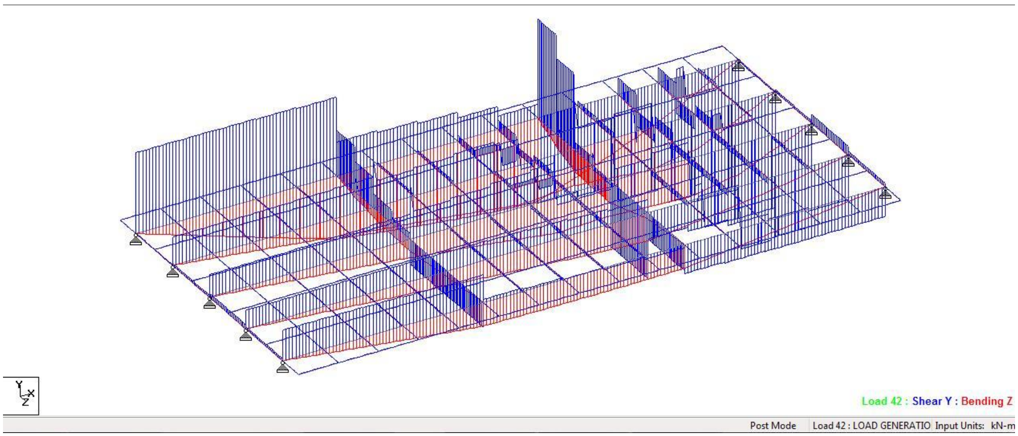

Fig4: BMD and SFD for critical load.

Inducing damage refers to modelling and analysing the bridge superstructure by using the compressive strength values obtained by carrying out Rebound Hammer Test by concerned authority and keeping the rest of the structure properties same as the original structure, that is:

SPAN NO.	COMPRESSIVE STRENGTH (MPa)
5,3,7,10,19	40
1,4,11,15,20	42
2,8,9,13,14,16,17,18,21,22	45
6,12	48

Table 1: Grouping of Spans with respect to Compressive Strength.

The deflections and the stresses in concrete and steel obtained after analysis from all spans are compared with those ofstandard one.

III. RESULTS AND DISCUSSION

DEFLECTIONS: According to IRC 112-2011, appropriate limiting values of deflection taking into account the nature of the structure, bridge deck furniture and functional needs of the bridge, the followingdeflection limits must be considered;

- Vehicular: Span/800 = 16600/800 = 20.75mm
- Vehicular and pedestrian or pedestrian alone: span/1000 = 16600/1000 = 16.6mm

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⋈ Impact Factor 7.12 ⋈ Vol. 9, Issue 10, October 2022

DOI: 10.17148/IARJSET.2022.91002

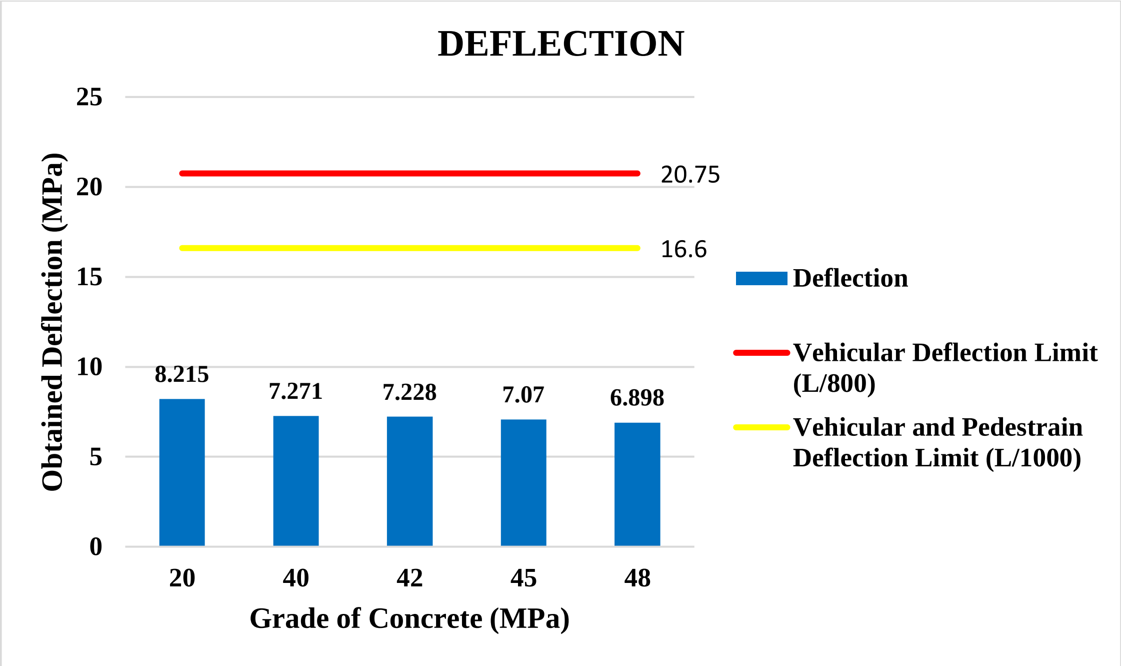

Fig 6: Deflections obtained after analysis.

STRESSES: The Stresses in concrete and steel are compared individually with the permissible limits and it is seen that the stresses in concrete and steel in all spans are within permissible limits.

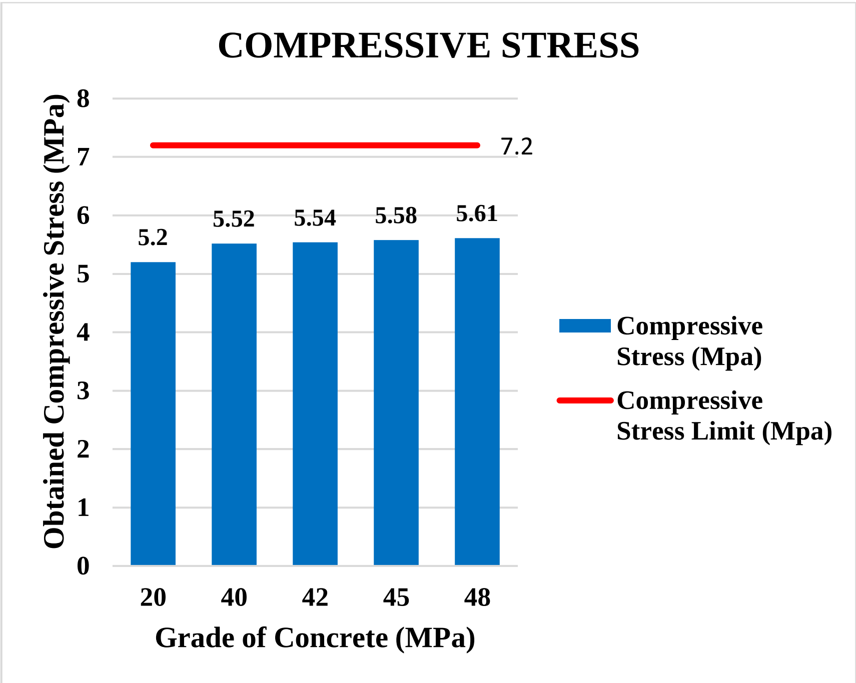

Fig 7: Stresses obtained after analysis in concrete.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁜ Impact Factor 7.12 ⁜ Vol. 9, Issue 10, October 2022

DOI: 10.17148/IARJSET.2022.91002

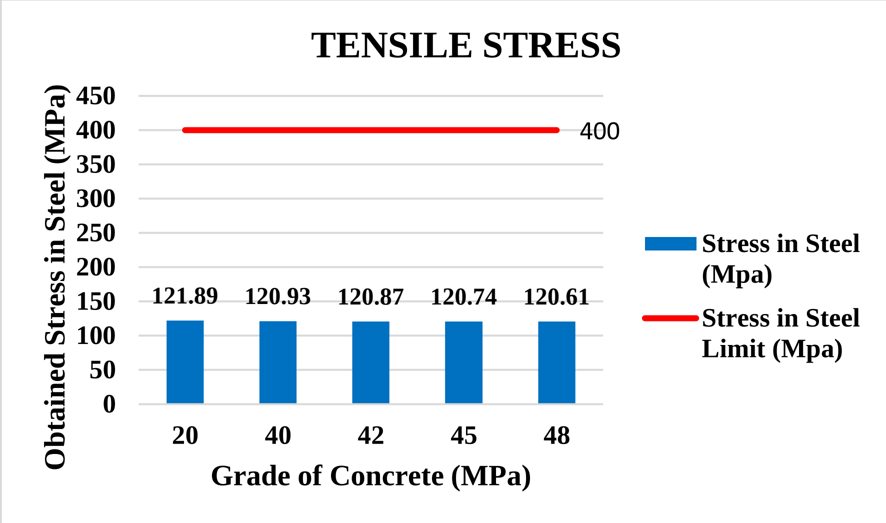

Fig 8: Stresses obtained after analysis in steel.

IV. CONCLUSION

Concrete and steel stresses are within acceptable limit for all spans. The deflection in all spans under vehicle load is within permissible limits, as is the combination of pedestrian and vehicular load. The bridge is in good condition, although it has a few flaws, and its risk score is 7, according to the IOP Conference Series: Earth and Environmental Studies.

V. REMEDIAL MEASURES

All of the Girders must be restored where necessary, particularly in honeycombed and bearing areas. The primary girders, transverse girders, and cantilever slab must be gunite/grouted as required. Bearings that need to be repaired/replaced The Expansion Joint will be addressed. The railings will be repaired. Drainage spouts must be fixed or replaced.

SCOPE FOR FUTURE STUDY:

- Analysis of bridge after Repair.
- Study of fluid structure interaction model.

REFERENCES

[1] H. Wang and T. Nagayama, ‘Response spectrum model of vehicle dynamic load for the prediction of bridge vibration level due to single vehicle-passage’, *Eng. Struct.*, vol. 260, p. 114180, Jun. 2022, doi: 10.1016/j.engstruct.2022.114180.

[2] T. Nagayama, A. P. Reksowardojo, D. Su, and T. Mizutani, ‘Bridge natural frequency estimation by extracting the common vibration component from the responses of two vehicles’, vol. 150, pp. 821–829, 2017, doi: 10.1016/j.engstruct.2017.07.040.

[3] D. S. Yang and C. M. Wang, ‘Modal properties identification of damped bridge using improved vehicle scanning method’, *Eng. Struct.*, vol. 256, Apr. 2022, doi: 10.1016/j.engstruct.2022.114060.

[4] [K. A. Shaik and C. G.P., ‘Investigation of Indian standard plans issued by Ministry of Surface Transport for T-beam bridges’, *Mater. Today Proc.*, vol. 52, pp. 724–730, 2022, doi: 10.1016/j.matpr.2021.10.132.

[5] K. Chilamkuri and V. Kone, ‘Monitoring of varadhi road bridge using accelerometer sensor’, in *Materials Today: Proceedings*, Jan. 2020, vol. 33, pp. 367–371. doi: 10.1016/j.matpr.2020.04.159.

[6] S. Ali, D. Thambiratnam, S. Fawzia, K. D. Nguyen, H. Van Den Elsen, and I. A. Fujii, ‘Damage detection of an innovative composite slab-girder pedestrian bridge using vibration characteristics’, *Struct. Infrastruct. Eng.*, 2021, doi: 10.1080/15732479.2021.1880447.

[7] R. Lalthlamuana and S. Talukdar, ‘Conditions of Visibility of Bridge Natural Frequency in Vehicle Vertical Acceleration’, *Procedia Eng.*, vol. 144, pp. 26–33, 2016, doi: 10.1016/j.proeng.2016.05.003.

[8] P. Kumar and A. Kumar, ‘Modelling of Lateral Human Walking Force by Self-Sustained Oscillator’, *Procedia Eng.*, vol. 144, pp. 945–952, 2016, doi: 10.1016/j.proeng.2016.05.121.

DOI: 10.17148/IARJSET.2022.91002

[9] S. Rahmatalla, K. Hudson, Y. Liu, and H. C. Eun, ‘Finite element modal analysis and vibration-waveforms in health inspection of old bridges’, *Finite Elem. Anal. Des.*, vol. 78, pp. 40–46, 2014, doi: 10.1016/j.finel.2013.09.006.

[10] Z. Shi, Q. Su, F. Kavoura, and M. Veljkovic, ‘Behavior of short-headed stud connectors in orthotropic steel-UHPC composite bridge deck under fatigue loading’, *Int. J. Fatigue*, vol. 160, Jul. 2022, doi: 10.1016/j.ijfatigue.2022.106845.

[11] E. OBrien, M. A. Khan, D. P. McCrum, and A. Žnidarič, ‘Using statistical analysis of an acceleration-based bridgeweigh-in-motion system for damage detection’, *Appl. Sci.*, vol. 10, no. 2, Jan. 2020, doi: 10.3390/app10020663.

[12] Y. Fujino & D.M. Siringoringo(2008), Structural Health Monitoring Of Bridges In Japan: An Overview Of The Current Trend” Bridge And Structure Laboratory, Department Of Civil Engineering, University Of Tokyo, Tokyo, Japan.

[13] Christopher C. Ferraroa, Andrew J. Boydb, Gary R. Consolazioa(2012) “Evaluation Of Damage To Bridge Piers Using Pulse Velocity Tomography” Department Of Civil And Coastal Engineering, University Of Florida, P.O. Box 116580, 365 Weil Hall, Gainesville, FL 32611, USA, Department Of Civil Engineering, Mcgill University, 817 Sherbrooke Street West, Montreal, QC, Canada H3A 2K6 Chatham, Ukcdepartment Of Civil Engineering, Izmir University Of Economics, Izmir, Turkey

[14] J. R. Gaxiola-Camacho, J. A. Quintana-Rodriguez, G. E. Vazquez-Becerra, F. J. CarrionViramontes, J. R. Vazquez-Ontiveros, and F. J. Lopez-Varelas, “Structural Health Monitoring of Bridges in Mexico -Case Studies,” in Fifth Conference on Smart Monitoring, Assessment and Rehabilitation of Civil Structures, 2019, no. August, pp. 1–9.

[15] M. Gatti, “Structural health monitoring of an operational bridge: A case study,” Eng. Struct., vol. 195, no. June, pp. 200–209, 2019, doi: 10.1016/j.engstruct.2019.05.102.

[16] IRC 112-2011: Code of Practice for Concrete Road Bridges.

[17] IRC 6: Standard Specifications and Code of Practice for Road Bridges, Section II – Loads and Stresses.

[18] Planning and Road Asset Management Centre (PRAMC) of PWP & IWTD Bridge Inspection Report: BR – 01.

[19] IOP Conf. Series: Earth and Environmental Science 768 (2021) 012103 IOP Publishing doi:10.1088/1755-1315/768/1/012103.