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STRUCTURAL EVALUATION OF AN EXISTING RC BRIDGE DECK ON MDR-09 NEAR SRIRANGAPATTANA USING NDT AND FEM

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Abstract: Bridges are the major part of infrastructure allowing the flow of human beings, goods and vehicles. SHM has been widely applied in various engineering sectors due to its ability to respond to adverse structural changes, improving structural reliability and life cycle management. Structural health monitoring (SHM) is a process that aims at detecting, locating, and quantifying damage in structures at an early stage in order to avoid unexpected failure. Structural health monitoring aims to provide quantitative and reliable data on the real conditions of a bridge, observe its evolution and detect the appearance of degradations. Non-destructive testing (NDT) is a testing and analysis technique used by industry to evaluate the properties of a material, component, structure or system. It is often necessary to test concrete structures after the concrete has hardened to determine whether the structure is suitable for its designed use. The purpose of this study is to review Structural Evaluation of an existing bridge by carrying out non-destructive test named rebound hammer along the bridge by concerned authority to obtain the reduced compressive strength parameter of superstructure of bridge and modelling and analyzing it by FEM software specifically STAAD Pro and comparing the results such as bending moments, forces, and deflections and stresses and providing required repair and rehabilitation techniques.

Keywords: Concrete bridges; FEM; Structural Health Monitoring.

I.INTRODUCTION

A bridge is a structure which is built over some physical obstacle such as a body of water, valley, or road, and its purpose is to provide crossing over that obstacle. It is built to be strong enough to safely support its own weight as well as the weight of anything that should pass over it. Because of the considerable growth of the road and railway networks over the last several decades, the number of bridges has expanded significantly. Various sections of them are exposed to severe environments over time, reducing their service life. Some of those constructions now have a wide variety of flaws. Health monitoring is the process of identifying and tracking structural integrity and analysing the degree of deterioration in a structure. With the ageing of the structures, operations and maintenance have gotten increasingly complicated. A bridge's deck is one of its most susceptible components. It has a shorter service life than the other parts and is intended to be changed or repaired on a frequent basis. In highway bridges, concrete deterioration, steel corrosion, changes in boundary conditions, and the weakening of structural connections with time are all major concerns. The structural integrity and serviceability of a damaged bridge will degrade over time if it is not repaired. The most common non-destructive assessment approach for bridge inspections is visual examination. Both ancient and new structures can benefit from non-destructive testing.

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 FEM software (STAAD Pro).

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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.

Fig 1: **RCC Bridge.**

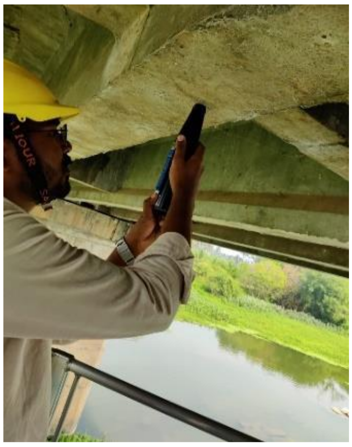

Fig 2: **Rebound hammer test**

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 dead load 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 2005 the grade of concrete used in that period is assumed to be M30 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 M30 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.

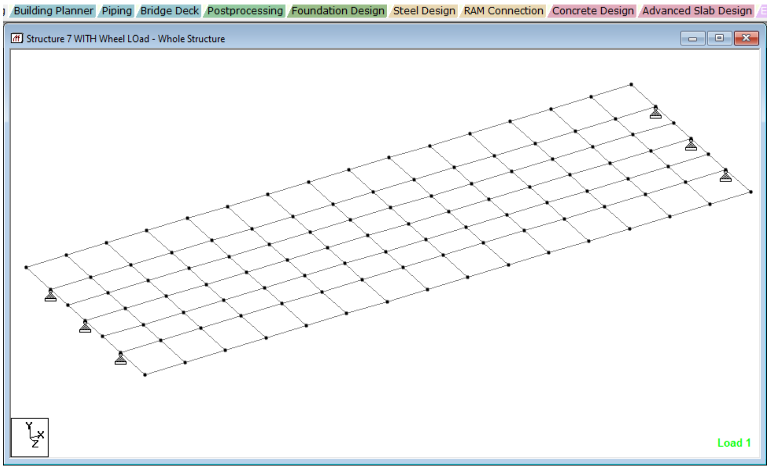

Fig 3: Geometry of a span.

The bridge span was modelled for M30 grade of concrete as a standard structure by assigning vehicular load of IRC 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

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for M30 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 15.459 mm.

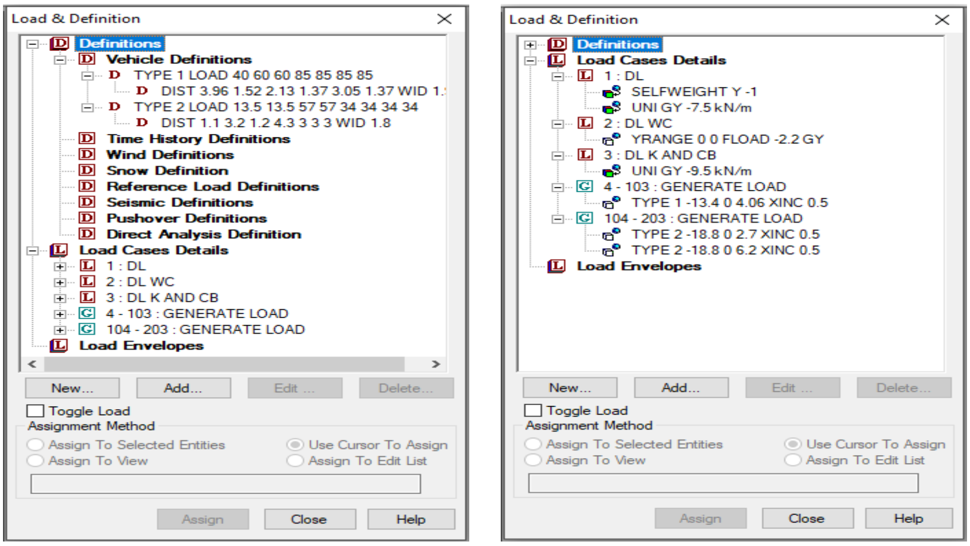

Fig 4: Load and Definitions.

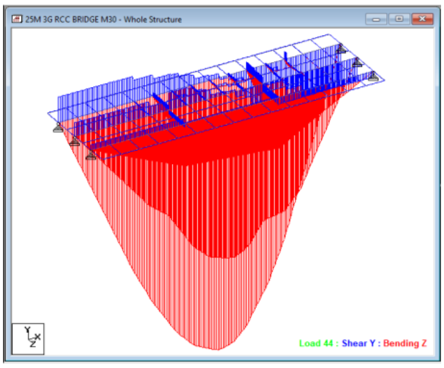

Fig 5: BMD and SFD for critical load.

Inducing damage refers to modelling and analyzing 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	40
3	42
1,2,6,8,11,12	45
4,7	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 of standard 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 following deflection limits must be considered;

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- Vehicular: Span/800 = 25000/800 = 31.25mm
- Vehicular and pedestrian or pedestrian alone: span/1000 = 25000/1000 = 25mm

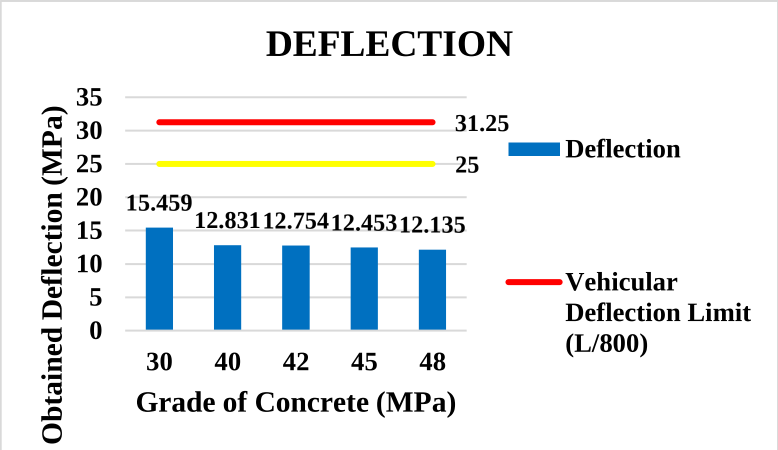

Fig 6: Deflections obtained after analysis.

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.

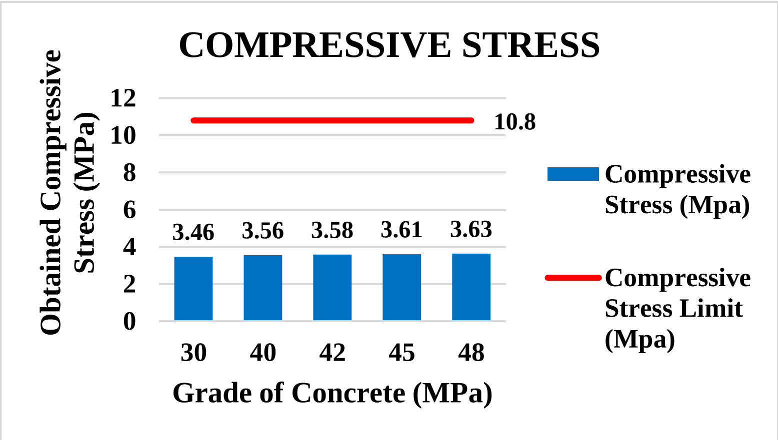

Fig 7: Stresses obtained after analysis in concrete.

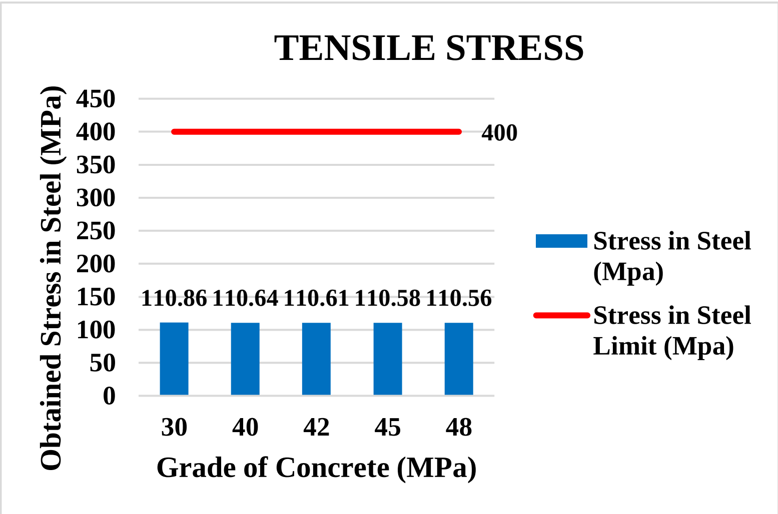

Fig 8: Stresses obtained after analysis in steel.

CONCLUSION:

Stresses in concrete and steel are with in permissible limits for all spans. The deflection in all spans under vehicular load and the combination of pedestrian and vehicular load is with in permissible limits. Bridge is in good condition but it has minimal defects and its risk score is 7. referring to IOP Conf. Series: Earth and Environmental Science.

REMEDIAL MEASURES:

All the Girders have to be rehabilitated wherever required, especially at the honeycombed locations and at bearing locations. The main girders, cross girders and the cantilever slab shall be done guniting/grouting as per requirement. Bearings to be repaired/replaced. Expansion Joint to be treated. Railings to be repaired. Drainage spouts to be repaired / provided.

SCOPE FOR FUTURE STUDY:

- ❖ Analysis of bridge after retrofitting.
- ❖ Study of fluid structure interaction model.
- ❖ Perform NDT to find the quality of reinforcement.

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