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STUDIES ON MAJOR ELEMENTS OF AN ELEVATED METRO BRIDGE

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ABSTRACT:

A metro system is a railway transport system in an urban area with a high capacity, frequency and the grade separation from other traffic. Metro System is used in cities, agglomerations, and metropolitan areas to transport large numbers of people. An elevated metro system is more preferred type of metro system due to ease of construction and also it makes urban areas more accessible without any construction difficulty. Bridges are the lifelines and supporters for the improvisation of the road network. Not only do the bridges help in traffic flow without any interference but also maintain the safety of roads. Due to this reason the bridges design has gained much importance. This project is basically concerned about the analysis and design of elevated metro bridge by STAAD Pro using IRC Loading. Which contains a span of 100m X 16m and has a 4-girder system? The objective is to check the result for particular input design, properties and parameters and the approach has been taken from AASHTO standard design. The nodal displacement, beam property, vehicle loading details, concrete design can be easily found out performing the analysis and design method.

Keywords: AASHTO, STAAD pro, Metro building, Analysis.

1. INTRODUCTION:

A metro system is an electric passenger railway transport system in an urban area with a high capacity, frequency and the grade separation from other traffic. Metro System is used in cities, agglomerations, and metropolitan areas to transport large numbers of people at high frequency. The grade separation allows the metro to move freely, with fewer interruptions and at higher overall speeds. Metro systems are typically located in underground tunnels, elevated

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viaducts above street level or grade separated at ground level. An elevated metro structural system is more preferred one due to ease of construction and also it makes urban areas more accessible without any construction difficulty. An elevated metro structural system has the advantage that it is more economic than an underground metro system and the construction time is much shorter.

Metro systems

A metro system is an electric passenger railway in an urban area. Characteristics of a metro system are the high capacity and frequency at which it transports people and the grade separation from other traffic. The grade separation allows the metro to move freely, with fewer interruptions and at higher overall speeds. Furthermore, there are fewer conflicts between traffic movements, which reduce the number of accidents, making it a safer way to travel. Grade separation for metro systems is realised by placing it in underground tunnels, elevated above street level or grade separated at ground level. Often a metro system is a combination of these three options. Beside the traditional metro using electric multiple units on rails, nowadays one can find also some systems using magnetic levitation or monorails. By changing the capacity of the trains, the frequency and the distance between the stations, variations on traditional metros like people movers and light metros have appeared. At the same time, technological improvements have allowed new driverless lines and systems. With all these variations in metro systems it is sometimes difficult to determine to what type a system belongs. Despite all these variations, they have in common that they are executed more and more as elevated railways in dense urban areas.

An elevated metro system has two major components pier and box girder. A typical elevated metro bridge model is shown in Figure 1.1 (a). Viaduct or box girder of a metro bridge requires pier to support the each span of the bridge and station structures.

Fig.1.1. Typical Elevated Metro Bridge.

OBJECTIVE:

- The project gives an idea about the analysis and design of Elevated metro Bridge using IRC Loading 70R by STAAD.Pro V8i.
- Here the model is being designed as per IRC 70R loading which is applicable on all roads on which the permanent bridges and culverts can be constructed.
- Analysis and Design process by STAAD Pro determines the performance of Structures. The designing by the software saves the design time and by this way we can check the safety of the structure very easily.

2. LITERATURE SURVEY:

Khaled et al. (2001, 2002) have conducted detailed literature review on analysis of box girder bridges. Based on Khaled et al.(2001, 2002), the following literature review has been done and presented. Malcolm and Redwood (1970) and Moffatt and Dowling (1975) studied the shear lag phenomena in steel box-girder bridges.Sisodiya et al. (1970) approximated the curvilinear boundaries of finite elements used to model the curved box-girder bridges by a series of straight boundaries using parallel ogramelements. This approximation would require a large number of elements to achieve a satisfactory solution. Such an approach is impractical, especially for highly curved box bridges.

[1] Komatsu and Nakai (1966, 1970)

presented several studies on the free vibration and forced vibration of horizontally curved single, and twin box-girder bridges using the fundamental equation of motion along with Vlahos's thin-walled beam theory. Field tests on bridges excited either by a shaker or by a truck travelling at various speeds showed reasonable agreement between the theory and experimental results.

[2] Chu and Pinjarkar (1971)

Proposed a finite element formulation of curved box-girder bridges, consisting of horizontal sector plates and vertical cylindrical shell elements. The method can be applied only to simply supported bridges without intermediate diaphragms. Carried out a finite element analysis on steel and concrete box-girder bridges to study the effect of intermediate diaphragms on the warping and distortional stresses. Proposed an element that has a beam-like-in-plane displacement field. The element is trapezoidal in shape, and hence, can be

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used to analyse right, skew, or curved box-girder bridges with constant depth and width.

[3] William and Scordelis (1972)

Presented an elastic analysis of cellular structures of constant depth with arbitrary geometry in the plane using quadrilateral elements. Described the application of the finite-strip method for the determination of the natural frequencies and mode shapes of vibration of straight and curved beam-slab or box-girder bridges. Utilized the thin-walled beam theory to estimate the natural modes and frequencies of a curved simply supported girder of asymmetric multi cell section. Results from testing two curved cellular Plexiglas models were used to verify the proposed method studied the behaviour of curved box-girder bridges using the finite-element method for applied dynamic loads. Results from testing a single-cell Plexiglas model having high curvature were used to verify the proposed method.

[4] Bazant and El Nimeiri (1974)

Attributed the problems associated with the neglect of curvilinear boundaries in elements used to model curved box beams to the loss of continuity at the end cross sections of two adjunct elements meeting at an angle. They developed a skew-ended finite element with shear deformation using straight elements and adopted a more accurate theory that allows for transverse shear deformations.

[5] Fam and Turkstra (1975)

described a finite-element scheme for static and free-vibration analysis of box girders with orthogonal boundaries and arbitrary combinations of straight and horizontally curved sections using a four-node plate bending annular element with two straight radial boundaries, for the top and bottom flanges, and conical elements for the inclined web members. Conducted a finite-element method for the dynamic analysis of curved multiple box-girder bridges, which formed the basis for the impact factor adopted by AASHTO (1980). The vehicle was simulated by two sets of concentrated forces having components in the radial and transverse directions, and moving with constant angular velocities on circumferential paths of the bridge.

3. MATERIALS AND METHODOLOGY

Hyderabad is a mega city that covers 625 sq. km. of municipal corporation area and 6852 sq. km. of metropolitan area. It is fast emerging as the hub of IT, Biotech, Parma and Tourism sector. Its strategic geographical location,

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multilingual and cosmopolitan culture, tremendous growth potential and investment-friendly economic policy are all making it an attractive destination for corporate, entrepreneurs, academicians and homemakers alike. The increasing pressure of the burgeoning population is putting Hyderabad's Transportation System under constant pressure. The need of the hour is a robust system that is dependable, comfortable, affordable and sustainable. Its population stands at 8 million and is projected to touch 13.64 million by 2021. Currently, over 2.8 million personalized vehicles ply on Hyderabad roads, with an addition of 0.20 million vehicles every year. 8 million motorized trips are made every day, of which, only about 3.36 million or 42% are made by the Public Transportation System (PTS) i.e., buses and local trains. That means the rest of the trips are made by personal vehicles leading to traffic bottlenecks, high pollution levels and a steep increase in fuel consumption.

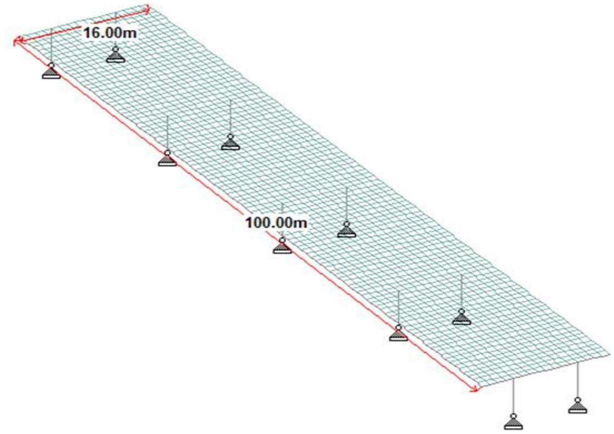

Fig.3.1. Staad pro model.

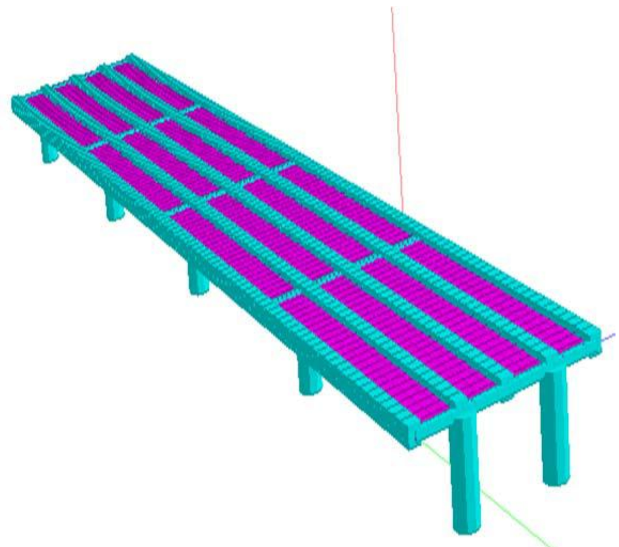

Fig.3.2. 3D Rendering View.

The output data for the IRC Class 70R bogie loadings are considered which include nodal displacement, nodal displacement summary, beam forces, beam end displacements, beam end displacement summary, reactions, reaction summary, axial forces, beam moments, live load effect and many more by STAAD. Pro V8i. As all of them cannot be described in this project, the

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data result tables being very large, some of the glimpse of the output results in the tabular forms is provided in this below

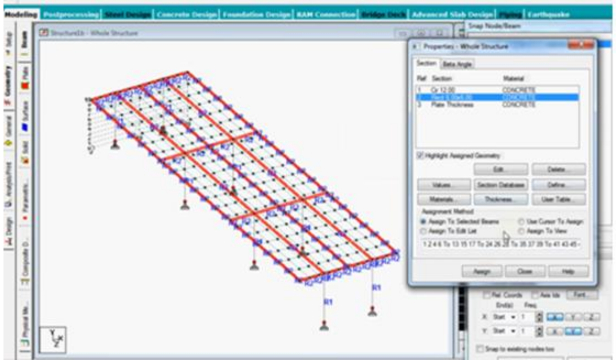

Fig.3.3. Whole structure.

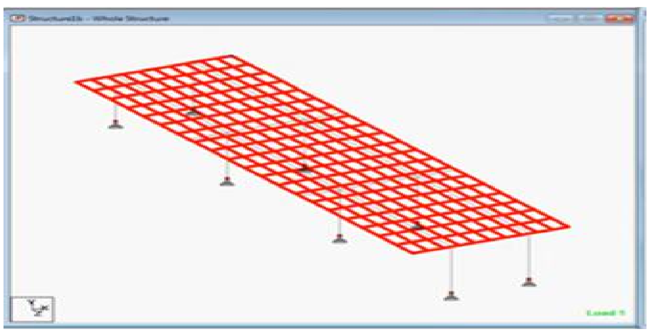

Fig.3.4. Load impact of the hole structure.

CONCLUSION

1. Analysis and design of the elevated Metro Bridge as per IRC codes (here IRC 70R loading) can be easily done by STAAD.Pro. in connection with STAAD.beava. mechanism is well understood.
2. The maximum resultant nodal displacement is for node1529; 0..015mm in x, -51.203mm in y and -.287mm in x.
3. The maximum resultant beam end displacement is for beam 1930 and node 1529 equivalent to 51.204.
4. The maximum and minimum values for beam maximum forces by section property are computed for axial, shear and bending.
5. The effect of vertical loading for 6 traffic lanes showing width, front clearance, rear clearance, no. of axles, positon in x, position in y with orientation can be determined. The orientation varies from 0 to 1.5708.
6. The concrete design for element 61 gives the top and bottom longitudinal reinforcement is 0.540 and 0.545. The top and bottom transverse reinforcement are 0.540 and 0.780 for element 61. Similarly, for other element, it can be found out.
7. It is must for today's engineers, designers, research scholars to make an effective contribution to what is the purpose of each high quality design and for the improvement of quality of environment in which we all are residing. Thus evolution of software must be properly used so that it meets the beneficiary needs.

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