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Analysis of Major Elements of Elevated Metro Bridge

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Abstract-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. An elevated metro system has two major elements pier and box girder. This research concentrates only on the design of pier and its performance. Conventionally the pier of a metro bridge is designed using a force based approach. During a seismic loading, the behaviour of a single pier elevated bridge relies mostly on the ductility and the displacement capacity. It is important to check the ductility of such single piers. Force based methods do not explicitly check the displacement capacity during the design. Conventionally the pier of a metro bridge is designed using a force based approach. During a seismic loading, the behavior of a single pier elevated bridge relies mostly on the ductility and the displacement capacity. It is important to check the ductility of such single piers. Force based methods do not explicitly check the displacement capacity during the design. The codes are now moving towards a performance-based (displacement-based) design approach, which consider the design as per the target performances at the design stage. Performance of a pier designed by a Direct Displacement Based Design is compared with that of a force-based designed one. , performance of a pier designed by a Direct Displacement Based Design is compared with that of a force-based designed one. The design of a pier is done by both force based seismic design method and direct displacement based seismic design method and performance assessment is done based on both the methods.

Keywords-Elevated Metro Structure, Bridge Pier, Box Girder Bridge, Direct Displacement Based Seismic Design, Performance Based Design, Force Based Design.

I. INTRODUCTION

The metro rail system is an electric railway transport (Passenger) system; it is used in an urban area with a high capacity and speed, 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 tunnels, underground and elevated viaductsabove street level or grade separated at ground level. An elevated metro rail system is more preferred because it makes urban areas more accessible without any difficulty. It is more economic than an underground metro system and the construction time is much shorter.

An elevated metro system has many component, but two major components pier and box girder. A typical elevated metro bridge model is shown in Figure. Viaduct or box girder of a metro bridge requires pier to support for each span of the bridge and station structures. Piers are constructed in various cross sectional shapes like cylindrical, elliptical, square, rectangular and other forms.

A typical pier considered for the present study. Box girders and segmental box girder are used extensively in the construction of an elevated metro rail bridge. This metro rail systems, is used in horizontally curved in plan box girder bridges. That is quite suitable in resisting torsional and warping effects induced by curvatures.

The torsional and warping rigidity of box girder is due to the closed section of box girder. The box section also possesses high bending stiffness and there is an efficient use of the complete cross section. Box girder cross sections like single cell, multi cell as shown in Figure bellow 1.2.

(a)Typical Elevated Metro Bridge (b) Typical Pier Figure
Fig 1. Typical Elevated Metro Bridge and its Elements.

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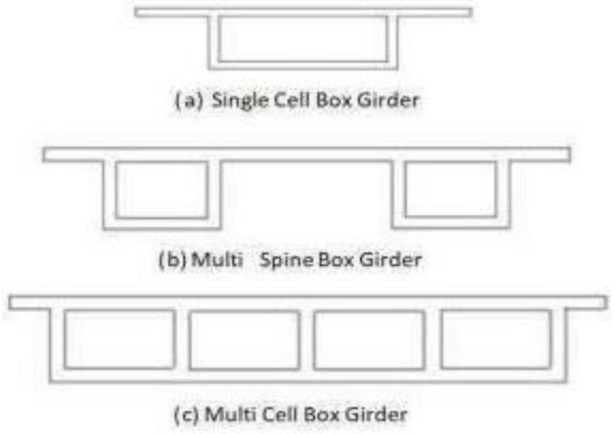

Figure 2: Types of Box Girder

Fig 2. Types of Box Girder.

II. PERFORMANCE STUDY OF A PIER DESIGNED BY FBD AND DDBD

Performance study of the typical pier designed by a Force Based Design (FBD) Method and Direct Displacement Based Design (DDBD) Method is described in this chapter.

The pier is designed based on FBD and DDBD Method. Performance assessment is carried out for the designed pier and the results are discussed briefly.

III. SUMMARY

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.

An elevated metro system is the most preferred form of metro structure due to ease of construction and less cost compared to other types of metro structures. An elevated metro system has two major components pier and box girder. In this project, study has been carried out on these two major elements.

In the first part of this study, the performance assessment on designed pier by Force Based Design and Direct Displacement Based Design is carried out. The design of the pier is done by both force based design method and direct displacement based design method.In the second part, parametric study on behaviour of box girder bridges is carried out by using finite element method.

The numerical analysis of finite element model is validated with model of Gupta et al. (2010). The parameter considered to present the behaviour of Single Cell Box Girder, Double Cell Box Girder and Triple Cell Box Girder bridges are radius of curvature, span length and span length to the radius of curvature ratio.

These parameters are used to evaluate the response parameter of box girder bridges namely longitudinal stresses at the top and bottom, shear, torsion, moment, deflection and fundamental frequency of three types of box girder bridges.

IV.CONCLUSIONS

The performance assessment of selected designed pier showed that, the design of the pier is done by both force based design method and direct displacement based designmethod.Displacement Based Design Method, selected pier achieved the behaviour factors more than targeted Values.

These conclusions concede to the selected pier only and to get further knowledge about directdisplacement approach large number of case studiesis to be carried out.

These conclusions can be considered only for the selected pier. For General conclusions largenumbers of case studies are required and it is treatedas a scope of future work.The parametric study on behaviour of box girderbridges showed that, As the radius of curvature increases, responses parameter longitudinal stresses at the top and bottom, shear, torsion, moment and deflection are decreases for three types of box girder bridges and it shows not much variation for fundamentalfrequency of three types of box girder bridges due to the constant span length.

As the span length increases, responses parameter longitudinal stresses at the top and bottom, shear, torsion, moment and deflection are increases for three types of box girder bridges and fundamentalfrequency decreases for three types of box girder bridges.

As the span length to the radius of curvature ratio increases responses parameter longitudinal stresses at the top and bottom, shear, torsion, moment and deflection are increases for three types of box girder bridges and as span length to the radius of curvature ratio increases fundamental frequency decreases for three types of box girder bridges.

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