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In-depth Review of Crucial Elements in an Elevated Metro Bridge

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Abstract: Elevated metro bridges play a pivotal role in the urban transportation network, serving as essential conduits for the seamless movement of commuters in densely populated areas. This review explores the fundamental elements essential for ensuring the structural integrity, safety, and operational efficiency of elevated metro bridges. Through a systematic examination of critical aspects including design considerations, material selection, construction methodologies, maintenance protocols, and environmental implications, this study endeavors to offer a holistic comprehension of the determinants shaping the functionality and longevity of these indispensable infrastructural assets. The design phase of elevated metro bridges encompasses meticulous planning to accommodate factors such as load-bearing capacity, dynamic forces, and geometric constraints, ensuring robustness and resilience against operational stresses. Material selection is a crucial aspect, involving the assessment of durability, strength-to-weight ratio, corrosion resistance, and lifecycle costs to optimize performance and longevity. Construction techniques, ranging from traditional methods to innovative approaches like precast segments and modular assembly, significantly influence project timelines, costs, and quality. Moreover, effective maintenance strategies are imperative for preserving structural integrity and mitigating deterioration over the bridge's service life. Regular inspections, structural health monitoring, and timely repairs are essential components of a proactive maintenance regime. Additionally, the environmental impacts of elevated metro bridges, including emissions, noise pollution, and habitat disruption, necessitate comprehensive mitigation measures to minimize ecological footprints and promote sustainability in urban transportation infrastructure. By synthesizing insights from these diverse facets, this review aims to provide a comprehensive framework for stakeholders involved in the planning, design, construction, and operation of elevated metro bridges, fostering informed decision-making and continuous improvement in infrastructure development and management.

Keywords: Elevated metro bridge, Structural integrity, Safety, Design considerations, Material selection, Construction techniques, Maintenance strategies, Environmental impacts, Urban transportation infrastructure

Introduction:

An electric explorer railway transport structure in a city with a high cutoff, repeat and level division from other traffic is called a metro system. To transfer enormous numbers of people at high repeat, metro structures are employed in metropolitan networks, agglomerations, and metropolitan districts. The metro can travel directly, with fewer resistances, and at higher speeds for the most part thanks to the grade separation. Metro systems are usually laid out as raised viaducts that rise over the street, underground sections, level separations at base level. Because it is easier to upgrade and also makes metropolitan areas more open with little to no disturbance, an elevated metro essential construction is increasingly popular. The advantages of an elevated metro foundation system include lower construction costs and a far shorter improvement period than those of a subterranean metro structure. Dock and box support are two essential components of an elevated metro system. In Figure 1.1 (a), a typical raised metro range model is displayed. A metro length's viaduct or box support assumes that the wharf will support the station buildings and every aspect of the development. Docks are designed in a variety of cross-sectional configurations, including square, rectangular, round, and empty. The wharfs under consideration for the current study have a rectangular cross section and are positioned beneath the station building. Figure 1.1 (b) displays a typical dock that is taken into consideration for the current audit. In order to improve the length of metro trains, bind upholds are utilized extensively. Additionally, modern metro rail systems make complete sense by using equitably twisted enclose support traverses, which counteract torsional and winding effects caused by repeating patterns. Due to the closed portion of the box support, it is torsional and misshaping unyielding. Additionally, the carton region is highly winding strong and makes good use of the entire cross fragment. As seen in Figure 1.2, box support cross areas may appear as single cells, multiple spines, or multiple cells.

Importance of the Research:

When designing a metro length wharf, a power-based seismic arrangement approach is typically employed. The method used to act on raised ranges during a seismic stacking primarily depends on the wharf's flexibility and ability to dislodge its farthest reaches. Verifying the malleability of these single docks is crucial. Nothing is expressly verified at the arranging phase by force-based methods. The codes are currently going towards a plan method that is display based, or dislodging based, and takes into account the arrangement based on the goal displays at the arrangement stage. Based on this viewpoint, a certain number of studies have been conducted.

Objectives:

- To assess the critical design considerations influencing the structural integrity and safety of elevated metro bridges, including load-bearing capacity, dynamic forces, and geometric constraints.
- To evaluate the suitability and performance characteristics of various materials used in the construction of elevated metro bridges, considering factors such as durability, strength-to-weight ratio, corrosion resistance, and lifecycle costs.
- To analyze different construction techniques employed in the erection of elevated metro bridges, ranging from traditional methods to innovative approaches like precast segments and modular assembly, in terms of their impact on project timelines, costs, and quality.
- To investigate effective maintenance strategies essential for preserving the structural integrity and mitigating deterioration of elevated metro bridges throughout their service life, encompassing regular inspections, structural health monitoring, and timely repairs.

(a) Typical Elevated Metro Bridge **(b) Typical Pier**

Figure 1.1: Typical Elevated Metro Bridge and its Elements

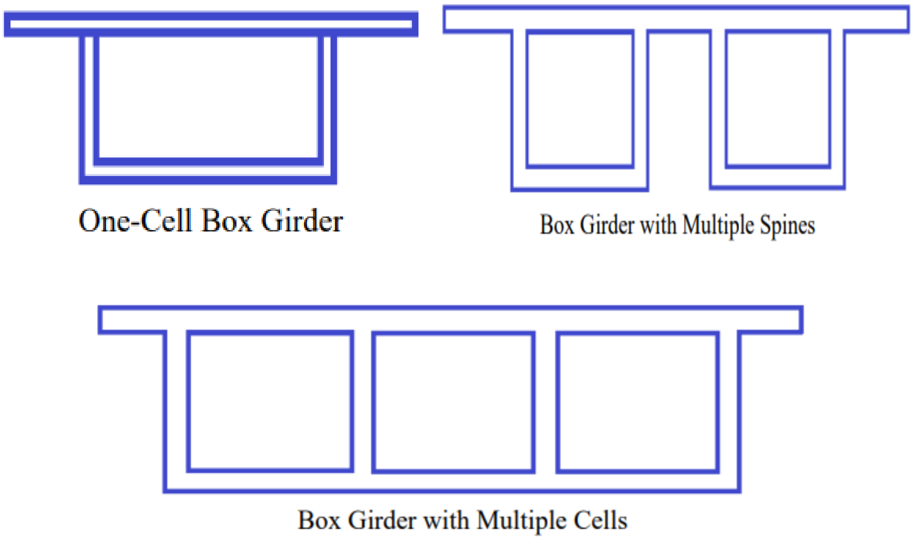


Figure 1.2: Box Girder Types

Pretensioning of the Strands Through the Girders:
Pretensioning strands are placed from one anchor end after the reinforcing cage and formwork are in place. The anchor end's purpose is to support the entire prestressing force on the bed. As seen below, it is composed of a massive RCC section and an outer-surface steel plate with holes to support the heavy bearing strains on the anchor end.

Fig. 1.3 A Normal Anchor Termination

Depending on the prestressing system being utilised, the HTS (High Tensile Strength) strands are secured after being inserted through the anchor end. Below is an example of a standard anchorage end with wedges:

Fig. 1.4 Strands Secured at the Anchor End by Wedges

Girders casting:

Fig 1.5 Girder Casting

Because U-girders are pretension, casting is done after prestressing is finished. When casting U-girders, caution should be exercised. It should be possible to deal with concrete in all areas. To attain the minimal strength needed for prestressing the first stages, high strength concrete is utilised. In order to avoid any building joints, single stage concreting is also carried out.

Cutting the Strands After the Concrete has First Cured and Hardened:

After the strands achieve the necessary compressive strength, they are chopped against the cured concrete. Prestress transfer stage refers to the cutting of strands against cemented concrete. Clause 3.2.1 of IRC: SP: 71 - 2006 states that the minimum strength of concrete upon transfer must meet stress check requirements at every stage of construction. Concrete must have a minimum characteristic strength (fck) of M40 and a minimum strength at prestress transfer of 0.8 fck or 35MPa, whichever is less. Low Relaxation Stress Relieved Without Coating In general, seven-ply strands in compliance with IS: 14268-1995 are employed.

Fig 1.6 Seven – Ply Strand

Literature review:

Chu and Pinjarkar (1971) suggested a FEM for curvy box-girder bridges that included componentsofshallwithverticalcylindricalandhorizontalsectorplates.Onlybridgeswith simple support and no intermediate diaphragms can use this technique.

Fam and Turkstra (1975) created 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 to analyse box girders with orthogonal boundaries and any combination of straight and horizontally curved sections using a finite-element scheme.

Rabizadeh and Shore (1975) performed a finite-element analysis for the curved multiple box-girder bridges, which served as the foundation for the impact factor that AASHTO (1980) approved. The vehicle simulation consisted of two sets of focused forces with components in the radial and transverse directions that moved at fixed angular velocities on the circumferential pathways of the bridge.

Ramesh et al. (1976) In order to add a curved element with six degrees of freedom at each node, the forces acting on and off the plane were divided and shear deformation was ignored. Their method works with both single and multi-cell sections. Moffat and Lim devised a finite-element approach in 1976 for the analysis of straight composite box-girder bridges with complete or incomplete interaction with respect to the shear connection distribution.

Chu and Jones (1976) broadened the use of the suggested finite-element framework for the dynamic analysis of curved box-girder bridges (Chu and Pinjarkar 1971).

Turkstra and Fam (1978) demonstrated the relationship between the warping and distortional stresses in a single-cell curved bridge and the longitudinal normal bending stresses obtained from curved beam theory.

Sargious et al. (1979) investigated the behaviour of the end diaphragm with opening in single-cell concrete box-girder bridges supported by a central pier.

Daniels et al. (1979) presented the results of a finite-element study on the effect of rigid inner diaphragm spacing on the fatigue strength of curved steel box girders. The results showed that bending loads and distortional normal loads may be effectively managed by reducing the inner diaphragm spacing and raising the fatigue strength of curved steel box girders.

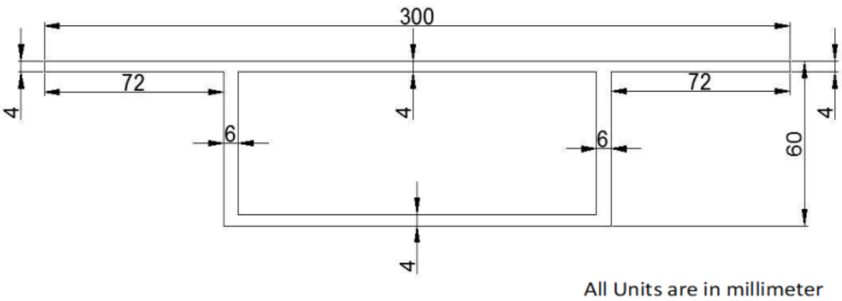
Cheung and Megnounif (1991) investigated the effects of diaphragms, cross bracings, and bridge aspect ratio on the dynamic response of a 45-meter-spanning straight twin box-girder bridge analytically using the finite-element method.

Mishra (1992) offered a work on the viability of using a closely related finite-difference methodology as a substitute for the finite element method in the analysis of right box-girder bridges. The technique divides the overall energy of the structure into two parts: the energy from shear and twisting, and the energy from bending and extension, which are contributed by two different sets of rectangular components made by an appropriate finite-difference network.

Kashif (1992) created a finite-element method to assess the dynamic response of numerous box-girder bridges with simple supports while taking vehicle-bridge interaction into account.

Medhodology:

A Parametric Analysis of Curved Box Girderbridge Behaviour: A numerical model from the composition is taken into consideration to support the restricted part model of box support traverses in SAP 2000 (Gupta et al., 2010). The cross section of recently maintained Box Support Expansion taken into consideration for restricted component model endorsement is shown in Figure 4.1. At the two mid-reach catches, two focused loads (P = 2 X 800 N) are given consideration for box support. The investigation acknowledges a range length of 800 mm, and the material characteristics taken into account are the modulus of resoluteness (G) = 1. 015GPa and the modulus of flexibility (E) = 2. 842GPa. Table 4.1 presents the differentiation and composition of the mid reach redirection of the shown box support length. It may be inferred from Table 4.1 that the current model produces the precise outcome.

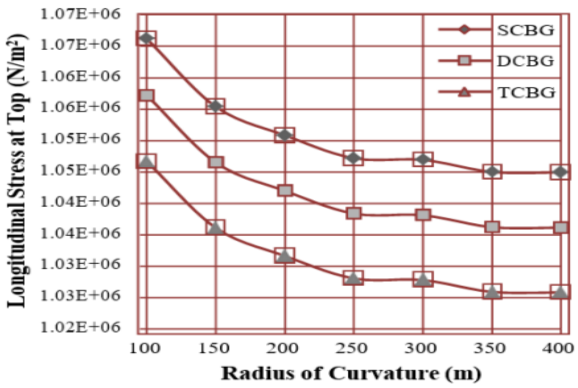


Simply Supported box Girders Bridge's Cross Section

The Simply Supported Box Girders Bridge's Mid-Span Deflection

Parameter	Gupta et al. (2010)	Present Study
Mid Span Deflection (mm)	4.92	4.91

Curvature's Radius



Variation of Longitudinal Stress at the Top of the Box Girder with Radius of Curvature

Result:

With a high breaking point, an electrical voyager train transit system in a city recurrence and level division from other traffic is called a metro structure. The most popular type of metro structure is an elevated metro system since it is less expensive and easier to improve than several kinds of metro systems. Wharf and box support are the two essential components of a raised metro system. In this endeavour, emphasis has been completed on these two major components. The show assessment on the dock effectively based plan and the direct dislodging based plan is completed in the survey's underlying section. Both the direct migration based plan technique and the power based plan methodology are used to arrange the dock. The parametric focus on lead of box support ranges is completed in the following section with the use of restricted part process. The restricted part model's numerical evaluation is supported by the Gupta et al. (2010) model. The constraints that are considered to offer the approach to acting of Single Cell Box Support, Double Cell Box Backing, and Triple Cell Box Backing ranges are the scope of rhythmic movement, length, and length to the compass of curve extend. To be more precise, the response limit of box support traverses is evaluated using longitudinal weights at the top and base, shear, curve, second, aversion, and head repeat of three distinct types of box support ranges.

Conclusion:

The evaluation of the chosen and organized wharf revealed that, Plan Based on Force The process might not ensure the necessary presentation limit, and in the current situation, the wharf has only improved the desired outcome.

- The chosen dock exceeded the prescribed values for the lead elements in the Direct Expulsion Based Plan Procedure.
- Only the selected dock may be given consideration for these finishes. Large volumes of logical analysis are needed for general closures, and this is considered a degree of future work.The direct of box support ranges parametric focus revealed that,
- Because of the constant territory length, shear, contort, second, and redirection are diminished for three types of box support augmentations as the extent of the curve grows.
- It also exhibits little variation for the basic repeat of three types of box support ranges. Shear, turn, second, and redirection are enhancements for three types of box support platforms, and fundamental repeat decreases for three types of box support ranges.
- As the reach length increases, responses limit longitudinal stresses at the top and base.Responses restrict longitudinal weights at the base and top; head repeat lowers for three types of box support ranges as reach length grows to the scope of rhythmic movement extent; shear, wind, second, and redirection are additions for three types of box support ranges.

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