STUDY OF SUITABILITY OF TYPES OF SUPERSTRUCTURES BASED ON THEIR SPAN ARRANGEMENT

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ABSTRACT

Bridges are the structural components that are required for the efficient movement of Trains and locomotives and under earth embankment for crossing of water course like streams across the embankment as road embankment cannot be allowed to obstruct the natural water way. Bridges can be of different shapes such as arch, slab and box. These can be constructed with different material such as masonry (brick, stone etc.) or reinforced cement concrete. Since bridge pass through the earthen embankment, these are subjected to same traffic loads as the road carries and therefore, required to be designed for such loads. The structural design involves consideration of load cases (box empty, full, surcharge loads etc.) and factors like live load, effective width, braking force, dispersal of load through fill, impact factor, co-efficient of earth pressure etc. Relevant IRCs are required to be referred. The structural elements are required to be designed to withstand maximum bending moment and shear force. This provides discussions on the provisions in the Codes, considerations and justification of all the above aspects on design , but in Recent developments in the field of Bridge engineering, Box Girder Bridges have heightened the need for improving the ability to carry the live load and undertaken as a result of code provisions. This paper deals with the response of Reinforced concrete and Prestressed concrete bridges when subjected to standard moving vehicular loads. Analysis of girder is done on the basis of Influence based moving load analysis: that will include Influence lines and Influence surfaces are generated to analyze the response of bridge structure subjected to live loading within designated lanes.

KEYWORDS: Brick, Stone, IRCs

BRIDGES

A bridge is a structure providing passage over an obstacle without closing the way beneath. The required passage may be for a road, a railway, pedestrians, a canal or a pipeline. The obstacle to be crossed may be a river, a road, railway or a valley. In other words, bridge is a structure for carrying the road traffic or other moving loads over a depression or obstruction such as channel, road or railway. A bridge is an arrangement made to cross an obstacle in the form of a low ground or a stream or a river without closing the way beneath.

Bridges constitute an essential link of a Railway system. With the introduction of heavier axle loads and higher speeds, clubbed with aging and fatigue, bridges need special attention and care, including rehabilitation w here warranted, so as to ensure safety of rail traffic. Any damage to a bridge may take considerable time for repairs and the financial implications may also be quite severe on account of high cost of repairs and interruptions to traffic. This study makes an attempt to develop efficient geometric models for new constructions, and to provide necessary structural configuration against live load bending moments, shear force and displacements. The determination of absolute maximum live shear and bending moment due to moving concentrated loads on the box girders is discussed.

TYPES OF BRIDGES

There are many types of bridges used for construction. Generally in construction sites , Arch type ,Slab type girder, PSC girder, RCC girder& Box type girders preferred, out of which we consider box type bridge. These girders are prefered on the basis of span, which will decided by thumb rule:-

1. when the span length lies in between 10 m – 15 m ,we prefere Solid slab girder type bridge.
2. when the span length lies in between 15 m – 25 m ,we prefere RCC girder deck composite section type bridge.
3. when the span length lies in between 25 m – 35 m ,we prefere PSC girder & RCC slab type bridge.
4. when the span length lies more than 35 m ,then we prefere Box girder type bridge.

BOX BRIDGE

Box Bridge which has got its name due to its orientation, shape and the way through which it looks like and its appearance defines its name. Box Bridge is a structure which provided the flexibility for the designer to design it in a very easy way, which is very feasible and easy to construct and design. It is highly capable for taking heavy loads coming on it from upper side without producing any cracks to it and is capable to distribute these loads to a wider area. Foundation requirement is very less

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and only little bit soil treatment will be required in case if the site consists of a soil having low bearing capacity and soil treatment required to be done as preferred by the site engineer.

Figure 1: Cross Section Of Box Girder

LITERATURE SURVEY

Fushun LIU et al. [1] deals with New Damage-Locating Method for bridges subjected to a moving load by introducing a new moving load damage-locating indicator (MLDI). From his study a vehicle is modeled as a moving load and the damage is simulated by a reduction of stiffness properties of the elements. His conclusion indicates, the method not only can determine a single damage location accurately, but also can determine multiple damages in a simply supported bridge or in a continuous bridge.

C Adam et al. [2] made studies on Reliable Dynamic analysis of an uncertained composite bridge under traffic loads. According to his studies, the main structure is modeled as a two-layer beam consisting of a steel girder connected elastically to the concrete deck. The governing sixth-order partial differential equation of motion of the homogenized beam is extended to include uncertainty in the mechanical property of the interface. He concluded that the above efficient analysis can be performed without reliable knowledge of the uncertainty of the material parameters by considering structural inherent worst case scenarios.

OBJECTIVES

- Evaluation of various bridge parameters as per IRS codes and RDSO(Research Designs and Standards Organization).
- To analyze R.C.C box bridge by using STAAD pro software and MDM.
- Comparison of analysis from STAAD pro and MDM to observed that which method is more competent.
- To Design all structural elements of box bridge.
- To check safety of bridge.
- Analysis of Girder, which is restricted up to fixed span, on the basis of thumb rule by using software.

SPECIFICATION

Keywords- Prestressed concrete I-beam, railway block cost, reinforced concrete T-beam, reinforced concrete I- beam, sacrificial shuttering, steel composite I-beam.

CODAL PROVISIONS

Influence based moving load analysis had important application for the design of bridge super-structures that resist large live loads. Influence lines and Influence surfaces are generated to analyse the response of bridge structure subjected to moving vehicle live loading within designated lanes. The theory is applied to the structures subjected to uniformly distributed load, or a series of concentrated forces developed by the vehicle on the span. It was well known that shear and moment diagrams represent the most descriptive methods for displaying the variation of loads in a member. If a structure is subjected to a live load or moving load, the variation of shear and bending moment in the member is best described using the influence line. An influence line represents the variation of the reaction, shear, moment or deflection at a specific point in a member as a concentrated force moves over the In this context, this paper explains how different types of box girder bridge decks perform under different standard moving load cases. 70 m continuous span length for RCC & PSC box girders with 12.6 m of top flange width, in which 9.6 m of effective carriage way designed for two lanes and footpaths of 1.5 m on either side are adopted for the analysis purpose. Moving load cases are defined as per Indian Roads Congress (IRC: 6-2000) codal provisions i.e., one lane of 70R loading or two lanes of Class A loading, if the effective width of carriage way is up to 9.6 m. Out of two load cases Class A loading is the heavy loading and all the National Highways built in India should design for this heavy loading. Dimensions of box girders are taken with respect from clause 9.3.2 of IRC: 18-2000. Analysis is carried out at different positions on each key element to produce live bending moments, shear forces and Displacements. The design aspects, detailing of

reinforcement, sub-structure details like pier cap, pier and foundation details are excluded from the current study.

METHODOLOGY

- Analysis and design by STAAD pro.
- Analysis method adopted for RCC box is MDM (Moment Distribution Method).
- Designing Box Bridge considering LSM.

Various cases those are to be generally adopted for designing:

- Case 1: Dead load and live load acting from outside as well as earth pressure, while no water pressure from inside (i.e. Design of Box Bridge by considering the box as in empty conditions, no water will flow from it)
- Case 2: Dead load and live load acting from outside as well as earth pressure, while water pressure acting from inside (i.e. designing the by considering that it is half full)
- Case 3: Dead load and live load acting from outside as well as earth pressure, while water pressure acting from inside (i.e. designing the box by considering that it is full).

Considering case one, as it is the worst possible case for designing bridge. Serviceability Limit State – For the limitations given in 10.2.1.load combination only shall be considered. For the stress limitations given in 10.2.2, load combinations 1 to 5 shall be considered. The value of YfL for creep and shrinkage of concrete and prestressed (including secondary effects in statically indeterminate structures) shall be taken as 1.0.

Ultimate Limit State – To check the provisions of 10.3 load combinations 1 to 4 shall be considered. The value of YfL for the effects of shrinkage and, where relevant, of creep shall be taken as 1.2. In calculating the resistance of members to vertical shear and torsion YfL for the prestressing force shall be taken as 1.15 where it adversely affects the resistance and 0.87 in other cases. In calculating secondary effects in statically indeterminate structures YfL for prestressing force may be taken as 1.0.

CASE STUDY

Live Project photos of Nagpur Metro Railway Corporation Ltd.(NMRCL)

OUTCOME

The outcome are drawn for different ground conditions, different shuttering types, different shapes and their effects on approaches. The lifecycle cost of superstructure considering the initial capital cost and periodic maintenance cost is considered for evaluating various options.

Normal Ground Conditions

1. Considering total capital cost:-

It is clear that the total cost of superstructure consisting of fabrication/casting cost (Material Cost) and placement cost in normal ground conditions using conventional shuttering is minimum for reinforced cement concrete-T beam and the total cost using combination of conventional and sacrificial shuttering is also minimum for reinforced cement concrete-T beam among the four options used for comparison.

In normal ground conditions, the total superstructure cost with sacrificial shuttering is higher than the total cost with conventional shuttering. However, the difference in both the cases is small, but where the time is essence for early completion of the project; the sacrificial shuttering may proves to be better choice.

2. Considering maintenance cost (Life Cycle Cost): -

Considering the periodic maintenance requirement, the composite steel I-beam becomes the costliest option and reinforced concrete T beam is again the most economical option among all the four superstructure types.

3. Considering the effects on approaches :-

After adding the additional cost of approaches due to increase in the height of superstructure, the cost of superstructure with reinforced concrete T-beam and prestressed concrete I-beam is almost same subject to the condition that, approaches are built with reinforced earth walls. If the approaches are built with reinforced concrete retaining wall then prestressed concrete I-beam is the most economical option.

Box bridge is structurally very strong, rigid & safe. Box bridge does not need any elaborate foundation and can easily be placed over soft foundation by increasing base slab projection to retain base pressure within safe bearing capacity of ground soil. Box Bridge is easy to construct, practically no maintenance. It can have multi cell to match discharge within smaller height of embankment. The designer has option to select the number of cells with desired span to depth ratio suiting to hydraulic conditions at site.

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