International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 5 Issue 6, September-October 2021 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Design and Analysis of a Girder Bridge for Highway Structures Using Sap 2000

Nitin Singh Raghuwanshi[1], Abhay Kumar Jha[2], Barun Kumar[3]

[1]Research Scholar, [2]Associate Professor, [3]Assistant Professor,
[1, 2, 3]Department of Civil Engineering, LNCT, Bhopal, Madhya Pradesh, India

ABSTRACT

In this study, a comparative study supported two differing types of bridges i.e. Deck type and Pre-stressed deck type using finite element analysis in SAP 2000 is ready , considering same loading class 70-R as per I.R.C. loading. During this study we'll also prepare a price analysis of both the structures using S.O.R. C.P.W.D. 2014. This sort of bridges is more preferred when it involves connectivity to short distances. So, it's necessary to update the analysis and style methods. Here, during this paper, there's an effort to review the comparison of maximum bending moment thanks to super load during a girder and slab bridge an equivalent bridge is analyzed as a three-dimensional model in finite element software as SAP2000, apply an equivalent loading finished conventional methods and compared the results. The utmost bending moment results obtained from finite element model.

KEYWORDS: *IRC Live loadings, longitudinal girder, SAP2000, bending moment, connectivity, stressed*

How to cite this paper: Nitin Singh Raghuwanshi | Abhay Kumar Jha | Barun Kumar "Design and Analysis of a Girder Bridge for Highway Structures Using Sap 2000" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-5 | Issue-6, October 2021, pp.1158-1161, URL: www.ijtsrd.com/papers/ijtsrd47575.pdf

IJTSRD47575

INTRODUCTION

A Girder bridge is a bridge that utilizations braces as the methods for supporting the deck. A bridge comprises of three sections: The Foundation of projections and wharfs and Substructure of projection and dock and The Superstructure (brace, bracket, or curve) and deck. A Girder bridge is likely the most usually fabricated and used bridge on the planet. Its fundamental plan, in the most improved frame, can be contrasted with a log extending from one side to alternate over a stream or river. All bridges comprise of two principle parts: the substructure, and the superstructure. The Superstructure is everything from the bearing cushions, up - it is the thing that backings the heaps and is the most unmistakable piece of the bridge. The Substructure is the establishment, what exchanges the heaps from the superstructure to the ground. The two sections must cooperate to make a solid, durable bridge. Pre-stressed Concrete is fundamentally concrete in which interior worry of reasonable extent and dispersion are presented pressure coming about because of outer load are concentrated to wanted degree. In this dissertation work we will analyze a girder bridge with the effect of Pre-stressed concrete and compare it with general deck bridge. In terms of finite elemental analysis, forces and cost analysis.

Stages of Bridge Development

Bridge is a structure that gives section over hindrances, for example, valleys, harsh territory or waterways by crossing those deterrents with regular or artificial materials. They initially started be utilized in old occasions when first present day human advancements began ascending in the Mesopotamia. Starting there on, learning, designing, and produce of new bridge building materials spread past their fringes, empowering moderate yet consistent selection of bridges the whole way across the world.

To start with bridges were exceptionally straightforward structures that were worked from effectively available normal assets wooden logs, stone and earth. Therefore, they had capacity just to

traverse close separations, and their auxiliary uprightness was not high since mortar was not yet concocted and rain gradually but rather continually broke up earth fillings of the bridge. Upheaval in the bridge development came in Ancient Rome whose designers found that granulated out volcanic rocks can fill in as a great material for making mortar. This innovation empowered them to fabricate significantly more sturdier, ground-breaking and bigger structures than any human advancement before them. Seeing the intensity of streets and associations with removed terrains, Roman planners before long spread over the Europe, Africa and Asia, building bridges and streets of high caliber.

The seventies will be recorded by engineering historians as the decade in which Pre-stressed concrete segmental bridge construction came of age in North America.

Sinha et al. (2009) (static analysis of bridge system using various types of deck profiles) Bridges are required to be provided under earth embankment for crossing of water course like streams, Nallas across the embankment as road embankment can not be allowed to obstruct the natural water way. The culverts are also required to balance the flood water on both sides of earth embankment to reduce flood level on one side of road thereby decreasing the water head consequently reducing the flood menace. Culverts 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 culvert 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. This Paper deals with box culverts made of RCC, with and without cushion. The size, invert level, layout etc. are decided by hydraulic considerations and site conditions. The cushion depends on road profile at the culvert location. The scope of this Paper has been further restricted to the structural design of box. The structural design involves consideration of load cases (box empty, full, sur-charge 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 IRC Codes are required to be referred. The structural elements are required to be designed to withstand maximum bending moment and shear force. The Paper provides full discussions on the provisions in the Codes, considerations and justification of all the above aspects on design. Proper design covering these aspects has also been given in the Annexure. To our knowledge, these matters have neither been covered in any text book nor in any special publication at one place.

Serap Altin et al. (2012) (Analysis of T-beam girder bridge as per I.R.C. loading) Here the authors analysis was concerned with earthquake analysis of suspension bridges, where the effects of large deflections were taken into account. The author prescribed a procedure which enables the designer to evaluate the non-linear dynamic response of suspension bridges in a symmetry providing a realistic evaluation of the overall dynamic response of suspension bridge, a three dimensional idealization was desirable which permits a study of the torsional oscillations of the bridge deck. Hence, these general procedures supplied essential information on the study of aerodynamics of suspension bridge.

Shreedhar and Mamadapur (2012) (Analysis of T-beam Bridge Using Finite Element Method) Illustrated that T-beam bridge decks are one of the principal types of cast-in place concrete decks. T-beam bridge decks consist of a concrete slab integral with girders. The finite element method is a general method of structural analysis in which the solution of a problem in continuum mechanics is approximated by the analysis of an assemblage of finite elements which are interconnected at a finite number of nodal points and represent the solution domain of the problem. A simple span T-beam bridge was analyzed by using I.R.C. loadings as a one dimensional structure. The same T-beam bridge is analysed as a three- dimensional structure using finite element plate for the deck slab and beam elements for the main beam using software STAAD ProV8i. Both models are subjected to I.R.C. Loadings to produce maximum bending moment. The results obtained from the finite element model are lesser than the results obtained from one dimensional analysis, which means that the results obtained from manual calculations subjected to IRC loadings are conservative.

Shreedhar et al. (2013) (Hydraulic Analysis of minor bridge under soft soil condition) Talked about Multiple cell reinforced box culverts are ideal bridge structure if the discharge in a drain crossing the road is large and if the bearing capacity of the soil is low as the single box culvert becomes uneconomical because of the higher thickness of the slab and walls. In such cases, more than one box can be constructed side- by- side monolithically. The box culvert has to be analyzed for moments, shear forces and thrusts developed due to the various loading conditions by any classical methods such as moment distribution method, slope deflection method etc. It becomes very tedious for the designer to arrive at design forces for various loading conditions. Hence a

study is made to arrive at the coefficients for moments, shear forces and axial thrusts for different loading cases and for different ratios of L/H = 1.0, L/H = 1.25, L/H = 1.5, L/H = 1.75 and L/H = 2.0 for three cell box culvert. This enables the designer to decide the combination of various loading cases to arrive at the maximum design forces at the critical section thus saving considerable design time and effort.

Asli and Ahmad (2013) (Analysis and Design of Continuous Pre-stressed Concrete Bridge based on Construction Sequence) Explained the process of analysis and design of continuous Pre-stressed concrete bridge based on construction stages on site. In this study, the construction sequence is first studied and understood. Several analysis of loadings acted on continuous bridge is conducted using Staad Pro software to determine the bending moment of the bridge at various construction sequence. Then, the bending moments obtained from the Staad Pro is used to design the cable profile, prestress force and number of tendons of the continuous bridge. The bending moment value due to selfweight obtained from the first construction stages are higher than last construction stages thus it is used to design the prestress force and number of tendons required by the continuous bridge on the stage of transfer while the combination of bending moment due to selfweight obtained from the first construction and bending moment due to external loading gained from the last construction stages are used to design the prestress force and number of tendons required on the stage of service respectively. Analysis of construction sequence is important during the designing process as the value of bending moment on the first construction stages are more critical compared to the last construction stages.

Kolate et al. (2014) (Comparative Study of Deck and box type minor Bridge) Here the author has investigated the different design parameters of box culverts namely angle of dispersion or effective width of live load, effect of earth pressure and depth of cushion provided of top slab of box culverts. Other mandatory elements which was considered were depth of cushion, coefficient of earth pressure for lateral pressures on walls, width and angle

OBJECTIVE OF THE PRESENT STUDY

1. Study of existing design of Deck Bridge.
2. Study of bridge design using SAP 2000 based on F.E.M.
3. Study on suitability of different materials for bridge design.
4. Techno economic analysis of materials selected for bridge constructs.

FORMULATION

In this study, a comparative study based on two different types of bridges i.e. Deck type and Pre-stressed deck type using finite element analysis in SAP2000 is prepared, considering same loading class 70-R as per I.R.C. loading. In this study we will also prepare a cost analysis of both the structures using S.O.R. C.P.W.D. 2014.

Methodology

In this research work our motive is to justify the variation in strength and cost of four cases of bridges for same loading and hydraulic conditions to carry out the best of them.

In this study, I am focusing the analysis using finite element method using analysis tool SAP 2000, which is capable of applying all conditions and methods with respect to preferred standard code.

- Determine the site condition and position for casting bridge.
- Hydraulic design to determine required Bridge length and profile grade
- Preparation of geometry of Bridge in SAP 2000
- Assigning of Loads and section properties with support conditions.
- Assigning hydraulic load and vehicle load as per I.R.C. Analysis (finite element)
- Assigning Pre-stressed deck

RESULTS AND DISCUSSION

Maximum Bending Moment

Table 1. Maximum Bending Moment

Max. bending moment in Pier			
Deck Bridge (RCC)	Deck Bridge (Foam Concrete)	Pre-stressed deck bridge	Pre-stressed deck bridge (Foam Concrete)
387.98	382.54	367.09	359.09

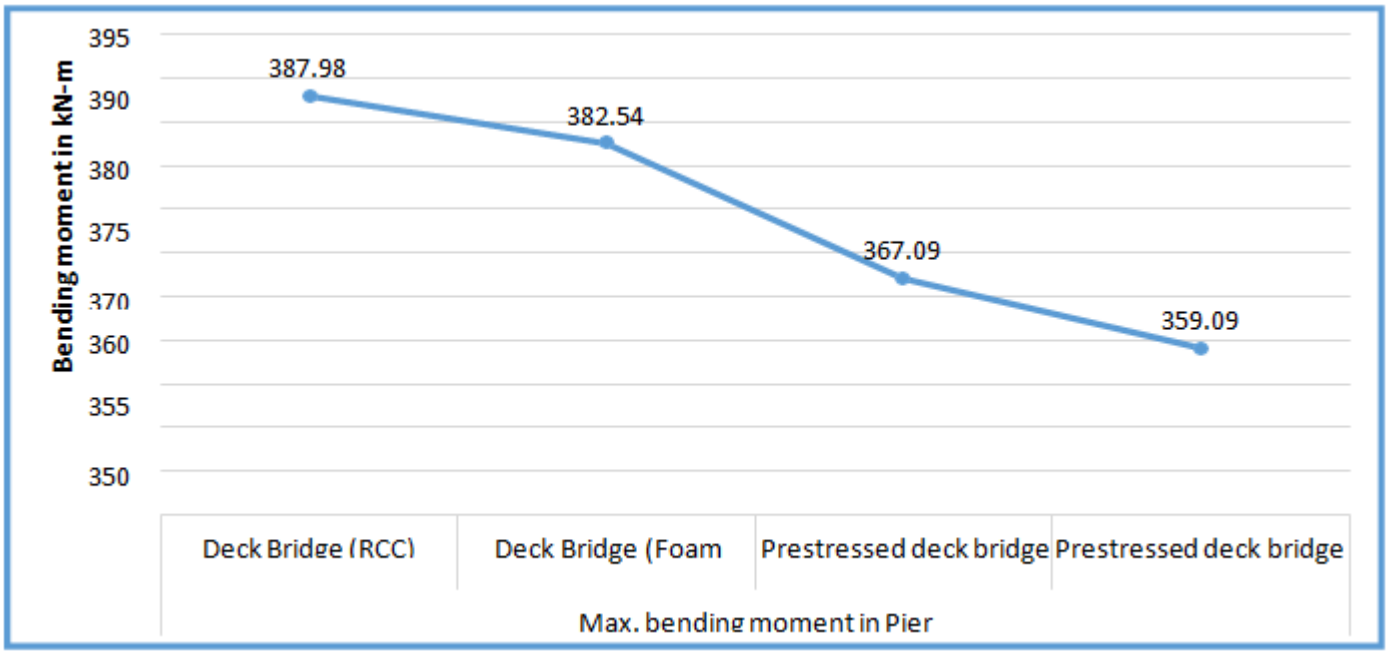

Fig 1. Maximum Bending Moment

CONCLUSIONS

1. In this study we manually calculate the total discharge and assigned it in software.
2. It is concluded that in terms of cost Deck type bridge R.C.C. is comparatively more costly than Pre-stressed Bridge.
3. I.R.C. loading is applied for justification of vehicular load analysis.

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