International Journal of Scientific Research in Civil Engineering
© 2018 IJSRCE | Volume 2 | Issue 6 | ISSN : 2456-6667

Finite Element Analysis of Bridge under Heavy Traffic Loading Using SAP-2000

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ABSTRACT

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 bearings 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. Prestressed 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 research work we are analyzing a girder bridge with the effect of prestressed concrete and compare it with general deck bridge. In terms of finite elemental analysis, forces and cost analysis. Here it is concluded that implementation of prestressed deck is resulting in economical, stable and load resisting member.

Keywords: Structural Analysis, SAP2000, I.R.C, Cost analysis, S.O.R, Pretensioning.

I. 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. Prestressed 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.

Foam Concrete

Foam concrete is a versatile building material with a simple production method that is relatively inexpensive compared to autoclave aerated concrete.[1] Foam concrete compounds utilising fly ash in the slurry mix is cheaper still, and has less environmental impact. Foam concrete is produced in a variety of densities from 200 kg/m³ to 1,600 kg/m³ depending on the application. Lighter density products may be cut into different sizes. While the product is considered a form of concrete (with air bubbles replacing aggregate), its high thermal and acoustical insulating qualities make it a very different application than conventional concrete.

Post tensioning Deck or span:

One of the fundamental segments of the bridge that associates every one of the Piles shafts. It can comprise from different basic ranges, a solitary nonstop range that is bolstered by various bars, cantilever ranges and cantilever ranges with the suspended range between them. They are generally produced using metal or fortified cement and furthermore can be made as backside braced that can convey more load. Brace segments are normally not produced using a straightforward square of material but rather are produced using bracket system (or Orthotropic pillars) that expands their protection from stack. Supports can likewise be utilized as a piece of unbending edge organize where they are completely associated with outline legs (which can be slanted or fit as a fiddle).

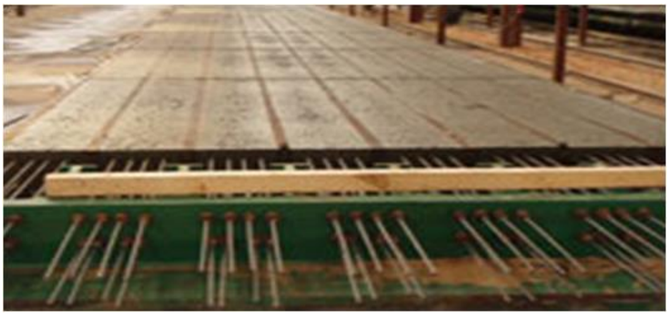

Fig 1: Pretensioning Hinges

II. LITERATURE REVIEW

Sharad pagar and Rajashekhar (2016) (Comparative Study of different configuration minor bridges)

Studied that Culverts are required to be provided under earth embankment for crossing of water course like streams, Nallas across the embankment, as road embankment cannot be allowed to obstruct the natural water way. Culverts are also used 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 to reduce the flood problems. Culverts can be of different materials and different shapes as per their use and need. Considering the need of new drainage system at Chhatrapati Shivaji International Airport Mumbai here an analysis Box Culvert for Storm Water Drainage System is made under the aircraft loading.

Neeladharan.C et.at (2017) (optimization and analysis of cable suspension bridges) In general, a suspension bridge, the pinnacle of bridge technology is highly capable of spanning upto 7000 feet managing such feat dealing with the two forces namely compression and tension. The authors report is based on a Suspension Cable Bridge of 1000m span with single lane road where the intensity of road was captured as 20 number of vehicles each loading with 350 KN using the application SAP1000. The maximum bending moment along with the values of shear force were analyzed on the application software SAP 1000 and a detailed comparison was done with the manual design of Suspension Cable Bridge.

Vikas Shrivastava (2017) (**analysis of Box culvert minor bridge under the action of vehicular and seismic loads**)The author demonstrated the structure analysis and design of RCC box type minor bridge using MDR Method along with computational approach using IRS-CBC codes. The results generated from the author's analysis proved that the maximum design forces developed for the loading conditions when the top slab was subjected to the dead load and live load and sidewall was subjected to earth pressure and surcharges when the culvert was empty. While estimating the positives and negative's it was observed that Computational method (Stadd.pro) was comparatively more competent than Moment Distribution Method (MDM) in terms of time consumption along with efficiency of results.

Manohar et. al. (2018) (Finite Element Analysis of slabs, cross girders and main girders in RC T-Beam Deck Slab Bridge) Studied that the analysis of a single span two lane T-beam bridge is carried out by varying the span of 8m, 28m for analysis of girders and size of slab 3x2, 3.5x2.5, 4x3, 4.5x3.5, 5x4m by varying the spans of the bridges, deck slab depth as 200,225,250,275,300mm using software SAP 2000. In order to obtain maximum bending moment shear force and deflection, the bridge models are subjected to the IRC class AA Tracked, IRC class 70R and IRC class A loading system. The cross girders and deck slab of varying depth for different live loadings also presented in the study. It can be observed that with the increase in the span shear force, bending moment and deflection in the girder increases and also the models subjected to the IRC Class AA Tracked vehicle gives higher values of shear force, bending moment and deflection in comparison to those subjected to the IRC Class 70 R and IRC class A loadings.

III. Objectives

1. To understand The Behavior of Prestressed Concrete Superstructure of Bridge under I.R.C. Vehicle Loading Condition.
2. To Design Prestressed Concrete Superstructure Design with Indian standards and codes using SAP 2000 Software.
3. To fix various sectional properties and dimension of Prestressed concrete superstructure of Bridge.
4. To model the superstructure of the Prestressed concrete Bridge in SAP:2000 considering cost effectiveness.
5. To analyze super structure Bridge considering mentioned load combination and find out maximum Bending Moment, Shear forces and Torsion for comparison.
6. To Design the Prestressed Concrete Superstructure with maximum Bending Moment, Shear forces and Torsion
7. To Perform Finite elemental analysis of two different bridges using Analysis tool.

IV. Methodology

Step-1 Determine the site condition and position for casting bridge.
Step-2 Hydraulic design to determine required Bridge length and profile grade.
Step-3 Preparation of geometry of Bridge in SAP 2000
Step-4 Assigning of Loads and section properties with support conditions.
Step-5 Assigning hydraulic load and vehicle load as per I.R.C.
Step-6 Analysis (finite element)
Step-7 assigning prestressed deck

V. Analysis Result

Max. Bending Moment

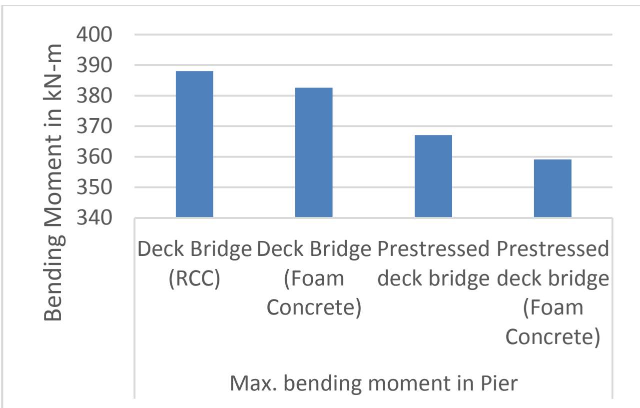

Fig 2: Bending moment

Max. Shear Force

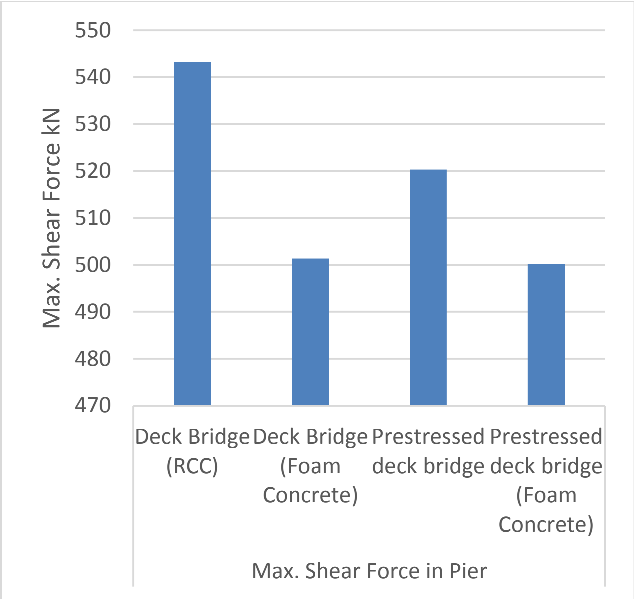

Fig 3: Max. Shear Force

Max. Axial Force:

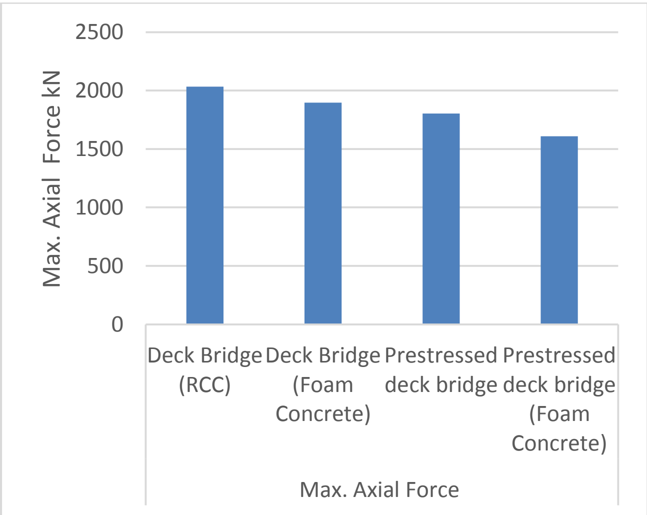

Fig 4: Max. Axial force

Max. Deflection:

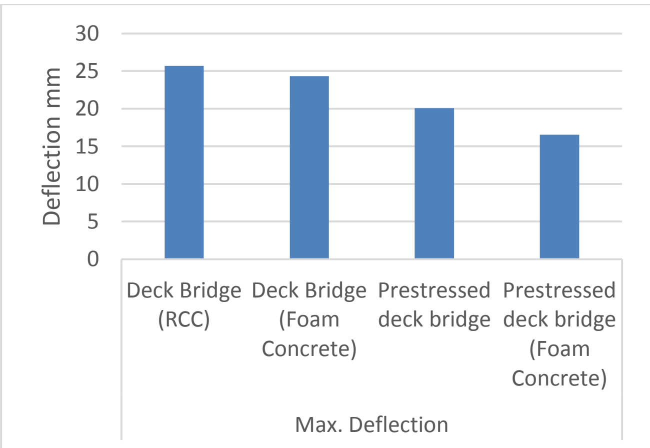

Fig 5: Deflection

Cost Analysis:

Table 2: Cost Analysis

Type	concrete (cu.m)	Rebar (kg)	S.O.R. rate concrete	S.O.R. rate rebar	total concrete	total rebar
Deck Bridge (RCC)	352.75	2215.05	4500	56	1587375	124042.8
Deck Bridge (Foam Concrete)	302.98	2096.45	4500	56	1363410	117401.2
Prestressed deck bridge	290.76	2103	4500	56	1308420	117768
Prestressed deck bridge (Foam Concrete)	220.76	1800	4500	56	993420	100800

VI. CONCLUSION

- In this comparative analysis it is clearly stated that Prestressed bridge (Foam concrete) is more stable in resisting load.
- In this study Hydraulic calculation is determined using topography sheet available as per Indian standard using dickens formulae.
- In this study we manually calculate the total discharge and assigned it in software.
- It is concluded that in terms of cost Deck type bridge R.C.C. is comparatively more costlier than Prestressed bridge.
- Here vehicle load using I.R.C. loading is applied to justify its implementation using SAP-2000

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Cite this article as :

Ankur Gupta, Pratiksha Malviya, "Finite Element Analysis of Bridge under Heavy Traffic Loading Using SAP-2000", International Journal of Scientific Research in Civil Engineering (IJSRCE), ISSN : 2456-6667, Volume 2 Issue 6, pp. 01-05, November-December 2018.
URL : http://ijsrce.com/IJSRCE182519