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Design and Analysis of a Girder Bridge for Highway Structures using SAP 2000

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ABSTRACT

In this work, a comparison of two different bridge types—the deck type and the pre-stressed deck type—using finite element analysis in SAP 2000 is complete, taking into account the same loading class 70-R according to I.R.C. loading. Using S.O.R. C.P.W.D. 2014, we will also prepare a price analysis of both structures during this investigation. When connecting to short distances, this type of bridge is more preferred. Therefore, it's important to upgrade the analysis and styling techniques.

In this work, an attempt is made to compare the maximum bending moment caused by the super load on a girder and slab bridge. An equivalent bridge is analysed as a three-dimensional model in finite element software such as SAP2000, apply an equivalent loading finished conventional methods, and compare the results. The finite element model yields the maximum bending moment.

KEYWORDS: *IRC Live loadings, Longitudinal girder, SAP2000, Bending moment, Connectivity, Stressed*

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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. 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.

Fig 1.1 View of Ancient Bridge

Type of Bridges

A Bridge is a structure that is built over physical obstacles such as railway, river, or road for thepurpose of providing passage over the obstacle without closing the way underneath.

There are many types of bridges.

- Beam / Deck slab Bridge
- Arch Bridge
- Truss Bridge
- Suspension Bridge
- Cantilever Bridge
- Cable stayed Bridge

Modeling of structure psc superstructure in the SAP 2000.	FEBRAUARY-2022
To analyze psc and deck type bridge super structure.	MARCH-2022
To compare both the cases and cost analysis.	MAY-2022
Thesis writing	JUNE, JULY-2022

Table 1.1 Planning of work

II. LITRATURE REVIEW:

Neeladharan et al. (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 singlelane 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.

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 theIRC Class 70 R and IRC class A loadings.

Patel and Jamle (2019) Researched the analysis and design of box culverts using the manual approach. In this study, the design parameters of box culverts are considered, including earth pressure effect, the depth of cushion at the top slab, braking force, impact load, live load, dispersion of loads through tracked or wheeled vehicles, effective width, and so on. The objective of this work is to analyse culverts with and without cushions to obtain bending moments and shear forces with and without culvert cushions under different types of IRC loading conditions. The paper provides a detailed discussion of the provisions and justifications provided by Indian Standards while considering their design implications.

Bhujade and Gaikwad (2020) Researched the design of a RCC box culvert with and without a cushion. The purpose of this paper is to compare the performance of reinforced concrete box culverts without and with a cushion using the limit state method. In accordance with IRC, the culvert section is designed on the basis of vehicular loads. The thick culvert section and vehicular loads combined create a harmful effect for the structure. Using STAAD Pro, the engineering elements and requirements of steel are designed to withstand maximum bending moments and shear forces.

Chaithra et al. (2021) Discussion on "Parametric Study on Single Cell Box Culvert Design Considerations" and the fact that box culverts are a cost-effective alternative to bridges and an important part of transportation networks. The stiffness matrix method is used in this paper to analyse box culverts. Assume discrete boundary conditions for box culverts. Specifically, we assume that the structure consists of a top slab, bottom slab, and two vertical side walls that form a closed rigid box frame. We also assume that the structure has an external design.

III. EXPERIMENTAL PROGRAM:

No detailed study on suitability of materials has been done in past researches were conducted on different

materials including RCC, prestress foam concrete however information on techno-economic feasibility of materials to be used in bridges is lacking.

In this paper, 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.

SAP2000: SAP2000 speaks to the most modern and easy to understand arrival of the SAP arrangement of PC programs. At the point when at first discharged in 1996, SAP2000 was the primary rendition of SAP to be totally coordinated inside Microsoft Windows. It includes an amazing graphical UI that is unequaled as far as usability and efficiency. Creation and change of the model, execution of the investigation, and checking and advancement of the plan, and generation of the yield are altogether cultivated utilizing this single interface. A solitary basic model can be utilized for a wide range of sorts of examination and structure. The SAP2000 Advanced level expands the PLUS abilities by including a nonlinear connection component (holes, snares, isolators, dampers, and multi-direct pliancy), a multi-straight plastic pivot for use in edge components, link conduct, geometric nonlinearity, and recurrence ward springs. Investigation capacities incorporate static nonlinear examination for material and geometric impacts, including weakling examination; nonlinear time-history examination by modular superposition or direct reconciliation; clasping investigation; and recurrence area examination (both unfaltering state and power-phantom thickness types.) All of the above projects highlight ground-breaking and totally coordinated plan for steel, solid, aluminum, and cold-shaped steel, all accessible from inside a similar interface used to make and dissect the model. The structure of steel and aluminum outline individuals highlights introductory part measuring and iterative improvement.

IV. 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.

Following steps are required in a sequence for proper completion:

Step-1 Determine the site condition and position for casting bridge.

Step-2 Hydraulic design to determine required Bridge length and profile grade.

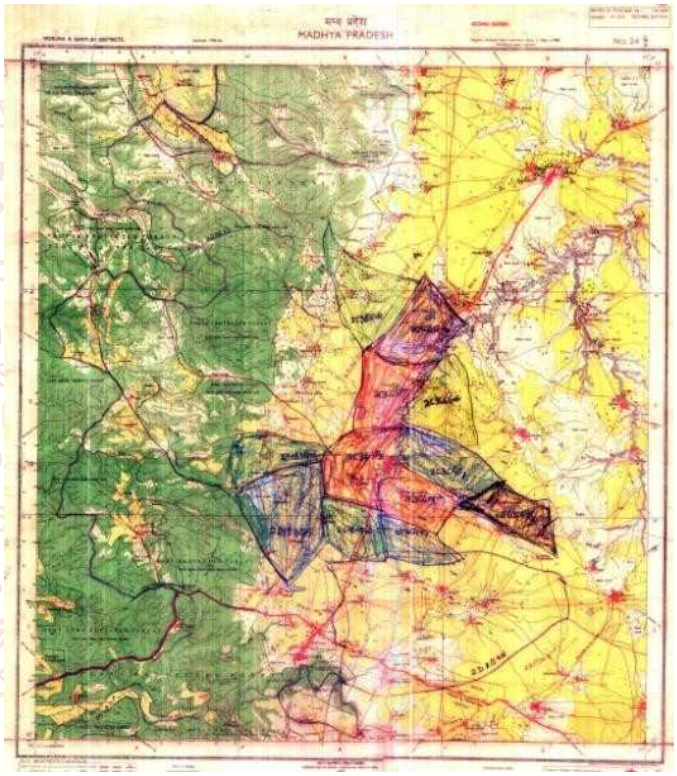


Fig 4.2: Topography Sheet of Proposed Site

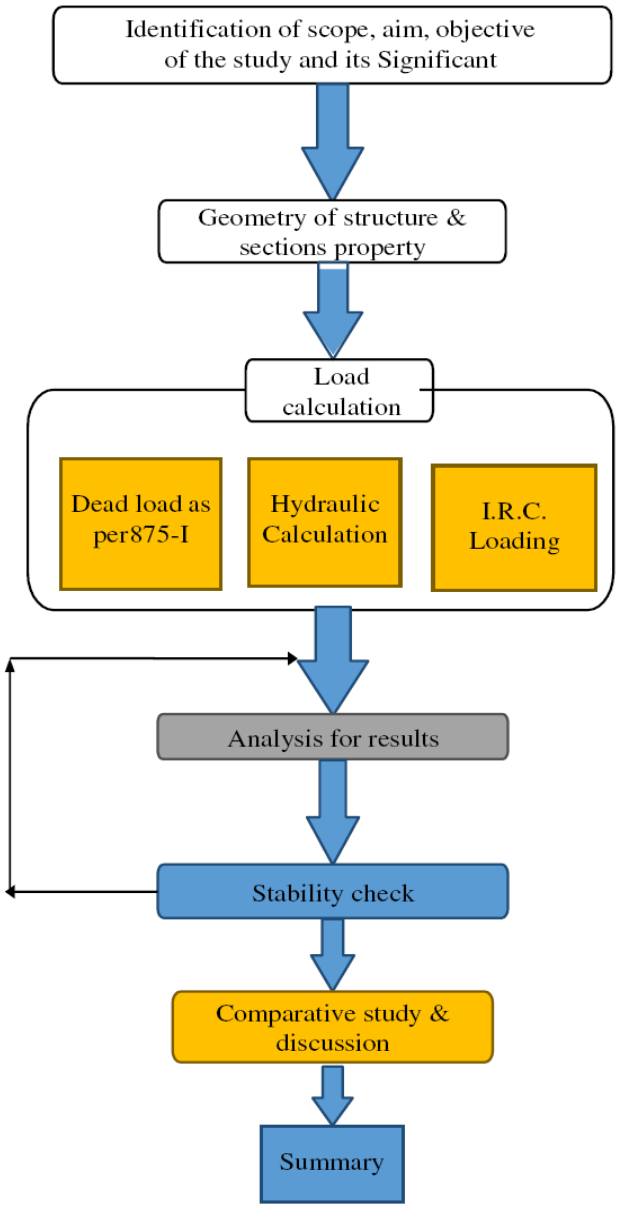


Fig: 4.8 Flow Chart of Activities

Fig 4.13 Site working

V. RESULT AND DISCUSSION

Finite element results

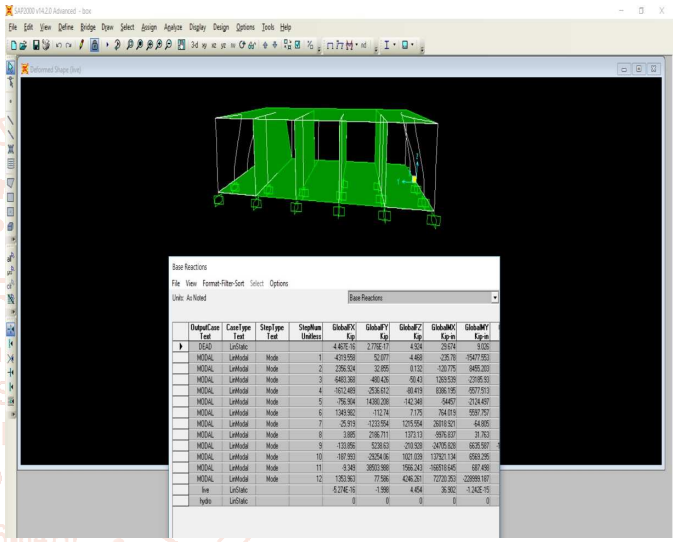


Fig 5.1 FEM

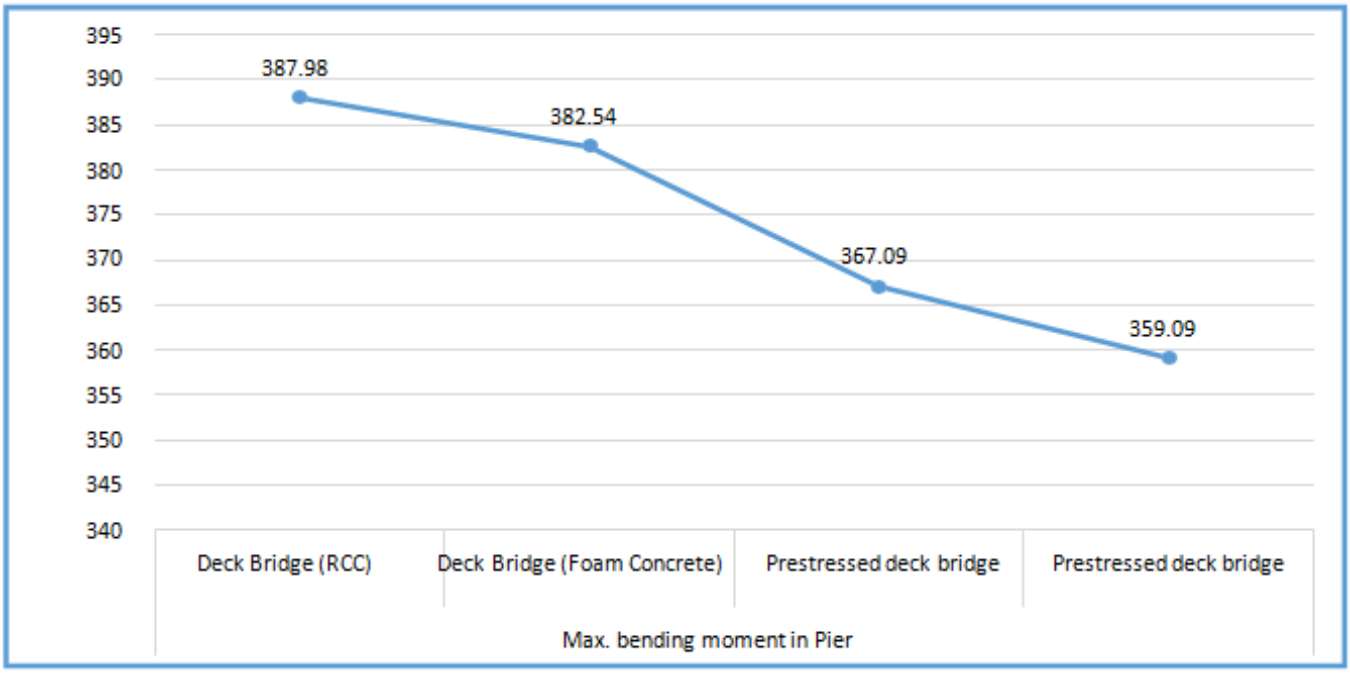
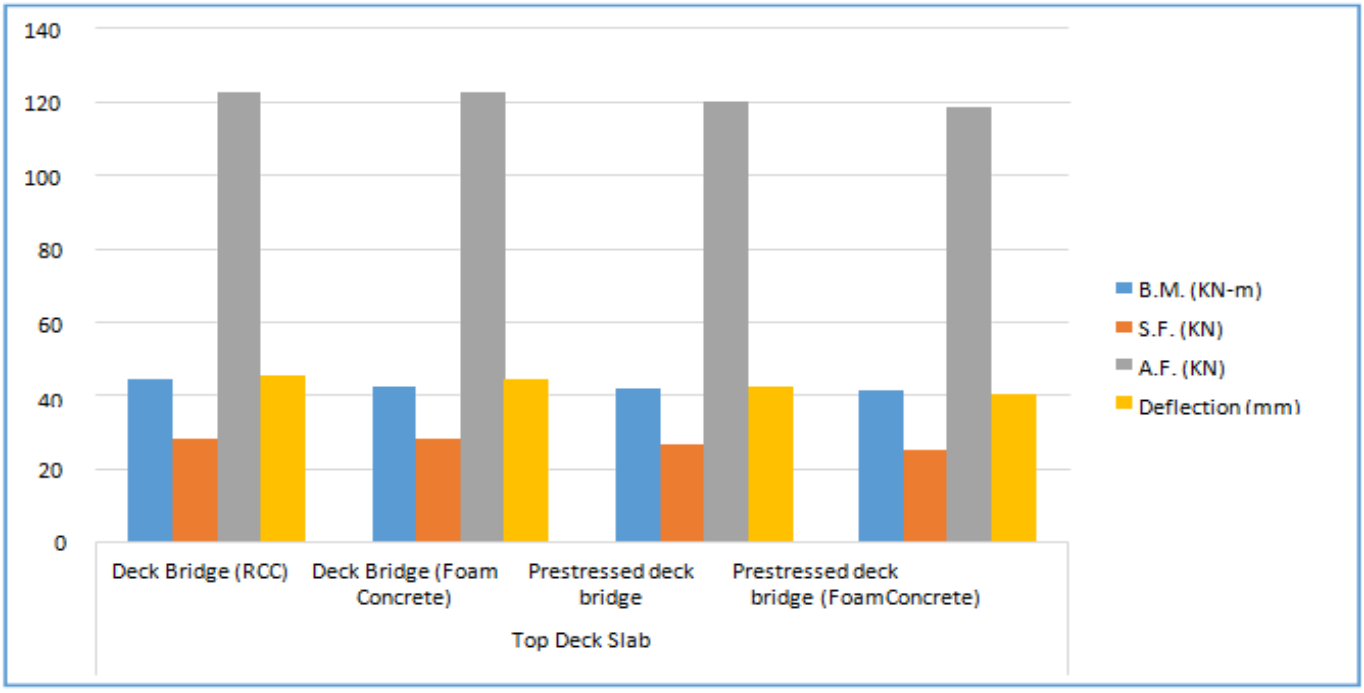


Fig 5.2 Maximum Bending Moment



VI. CONCLUSION:

In this comparative analysis it is clearly stated that Pre-stressed 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 morecostly than Pre-stressed Bridge.

I.R.C. loading is applied for justification of vehicular load analysis.

VII. SCOPE FOR FURTHER STUDY

1. Cable suspension bridge or any other type can be considered.
2. Seismic analysis can be proceed.
3. AASHTO specification can be preferred instead of I.R.C.

Midas Bridge designer can be used for analysis in future.

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