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Comparative Study of Dynamic Behavior of Various Types of Truss Bridge Structures

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ABSTRACT: The dynamic behavior of truss bridges plays a critical role in ensuring their safety, durability, and performance under various loading conditions. This study presents a comparative analysis of the dynamic characteristics of different types of truss bridge structures, including Pratt, Warren, Howe truss. Using finite element modeling and simulation tools, key parameters such as natural frequency, mode shapes, and dynamic response under moving loads were evaluated. The influence of structural geometry, material properties, and boundary conditions on dynamic performance was also examined. Results indicate significant differences in vibrational performance among the truss types, with implications for design optimization and structural resilience. This comparative study provides valuable insights for engineers and designers in selecting appropriate truss configurations for dynamic load conditions.

KEYWORD: Steel bridge, Staad-pro , IS 875, IS 1893, static and dynamic analysis

I. INTRODUCTION

Metallic truss has been used in the creation of railway bridges because Victorian instances, each in huge lengthy structures and in more modest spans including local motorways. many of those older metallic bridges are nevertheless in service way to an ongoing program of preservation, renovations and enhancements to meet changing demands. these days, maximum railway bridges are built as replacements for in advance systems, although some totally new systems are constructed on new routes or routes, extensively for the Channel Tunnel rail hyperlink. For replacement bridges, the metal structure can reach shallow production depths, that's important wherein the track degree is constant but sufficient clearance is needed beneath the bridge for motorways or other below-bridge offerings. The metallic shape is suitable for pre-fabrication and pre-assembly and, because of its highly low useless weight, it is able to be transported or lifted into location in very brief intervals in the course of which the railway may be closed to visitors.

A bridge is a structure that crosses a gorge, avenue, river, railway or different barriers and allows the smooth and safe passage of vehicles, trains and pedestrians. A pedestrian bridge is a bridge designed for pedestrians and in some instances cyclists, animal visitors and horse riders, instead of vehicular visitors. The railway bridge is intended best for rail delivery using rail loading (IRS). Bridges complement the panorama and can be used decoratively to visually connect disparate regions or to sign a transaction. For communities within the growing global, a footbridge can be the community's most effective access to clinical clinics, schools and markets that might in any other case be inaccessible when rivers are too high to cross. easy truss bridge designs had been advanced to be sustainable and easy to construct in such rural regions the usage of most effective local substances and labor. Truss systems include factors that are joined together to form a solid metal frame. This wide software may be used in lots of regions, including pedestrian bridge, Railway Bridge, street Bridge and other site visitors bridges. The person elements of the truss bridge are the load-bearing elements of the structure, they may be arranged in a triangular way, which results in the reality that the transmitted loads are either in tension or compression. today, truss bridges are used for many functions because they are smooth to collect and least expensive. A bridge is an essential shape needed for a shipping community. With the rapid innovation in generation, conventional bridges have been changed through a price-powerful established system. effective strategies are available for the evaluation and layout of these bridges. in this paper, a comparative have a look at on one-of-a-kind varieties of truss bridges became presented. At gift, a standard type of truss steel bridge is designed in India, even though the mild layout of the steel Bridge is needed to rise over the years due to better demands of rail site visitors and short distance routes. the primary objective of this examine is to research and design a truss bridge with railway masses and to conduct a comparative observe of those bridges.

A. Steel Truss Bridge

Metal is extensively used throughout the world for the development of bridges of various sizes. it's far a flexible and powerful material that offers green and sustainable answers. steel has lengthy been diagnosed as an economical choice

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for plenty bridges. It dominates the markets of long-span bridges, railway bridges, footbridges and medium-span highway bridges. it's far now an increasing number of the selection for motorway buildings with shorter spans. The organisation advantages in lots of methods from the advantages of metallic bridge answers. The landmark metal bridges epitomize desirable design, are brief to construct and feature stimulated the regeneration of many former industrial areas, docks and canal facet regions. Joints (usually directly) may be harassed in tension, compression, or every so often each in response to dynamic loading. those trusses can be manufactured from timber, metal or may be of composite creation. metallic trusses used for bridge production are taken into consideration in this observe. metallic has better power, ductility and longevity than many different structural materials inclusive of concrete or wood. but, the metal need to be painted to prevent rusting Like different kinds of bridges, there are unmarried and continuous truss bridges. Truss factors may be arranged in an almost unlimited number of ways, however the great majority of trusses encountered in a bridge are of one of the common types indexed underneath. The imperative elements of a metallic truss bridge are proven inside the parent.

Fig. 1: Steel Truss Bridge

1) Howe truss

A Howe truss is a sort of truss bridge consisting of flanges, purlins and diagonals, with the vertical members in anxiety and the diagonal individuals in compression.

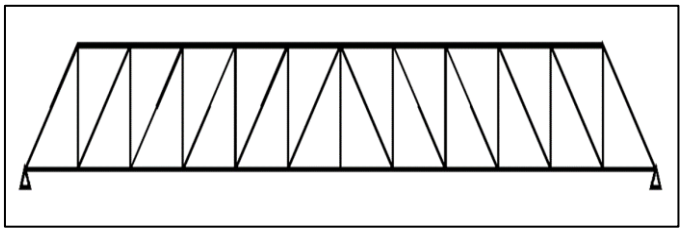

Fig. 2: Howe truss

2) Pratt truss

This kind of truss has diagonal individuals that slope down toward the middle; this type is quite one-of-a-kind from the Howe truss. The internal diagonals of the truss are in tension, even as the vertical participants are in compression.

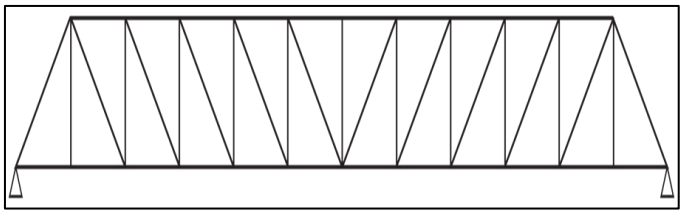

Fig. 3: Pratt truss

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3) Warren truss

The Warren Truss Bridge is an exceptionally famous bridge layout and lots of examples of it could be discovered around the sector. In this text we can take a look at a few thrilling information approximately this design consisting of its history, working, pros and cons and plenty more.

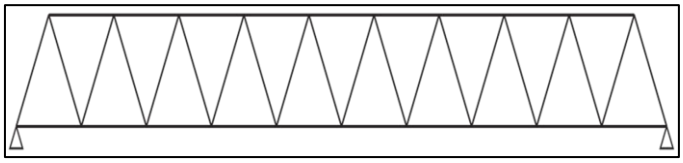


Fig.4 :Warren truss

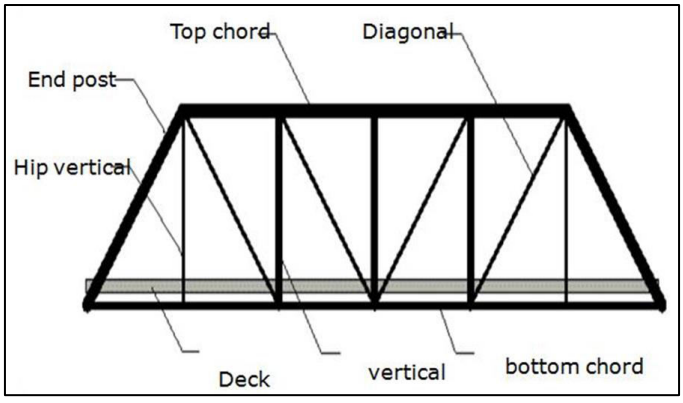
II. PROBLEM STATEMENT

In this dissertation, its miles proposed to carry out analysis and layout of various sorts of trusses for a metal bridge in Pune. The contemporary look at includes the evaluation and layout of the truss using STAAD pro software program. A length of 366 m and a width of seven.6 m are taken into consideration. The range of bays is 30 by means of 12.2 m, the quantity of tracks is two, a huge gauge is used for the track and the music width is 1.676 m. For seismic evaluation, seismic region III and IS 1893 are considered (component III) 2016. IS 875 (part III) is used for wind analysis. Warren truss, Pratt truss, Howe truss are taken into consideration for assessment.

A. Bridge Details

Table 1 Models

Model 1	Pratt Truss
Model 2	Howe Truss
Model 3	Warren Truss



Members Used For Analysis
1) Top Chord - ISMB 600
2) End Post - ISMB 600
3) Hip Vertical – ISMC 250
4) Vertical - ISMC 250
5) Bottom Chord - ISMB 600
6) Diagonal - ISMC 250

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III. MODELING

1) Pratt Truss

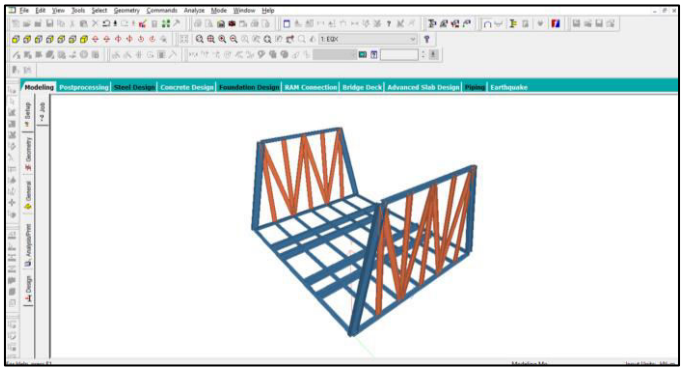

Fig. 5:Pratt Truss

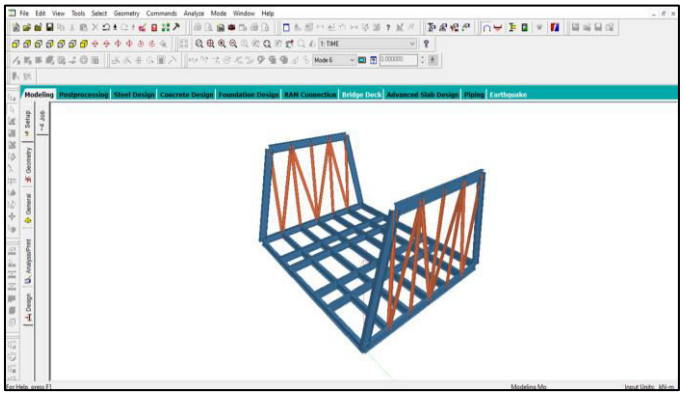

Fig. 6:Howe Truss

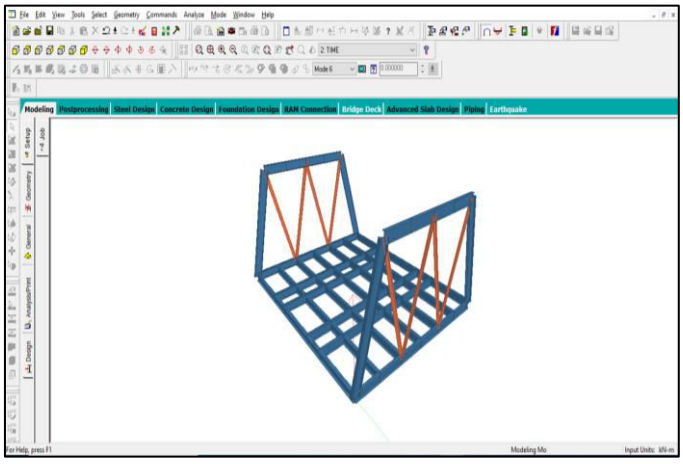

Fig. 7:Warren Truss

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IV. RESULTS AND DISCUSSION

A. Static Analysis

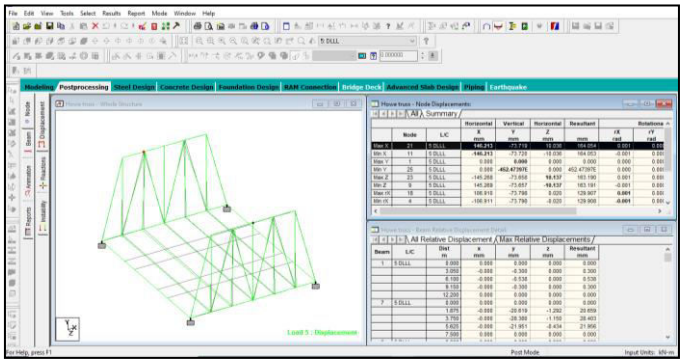

Fig. 8:Displacement of Howe Types

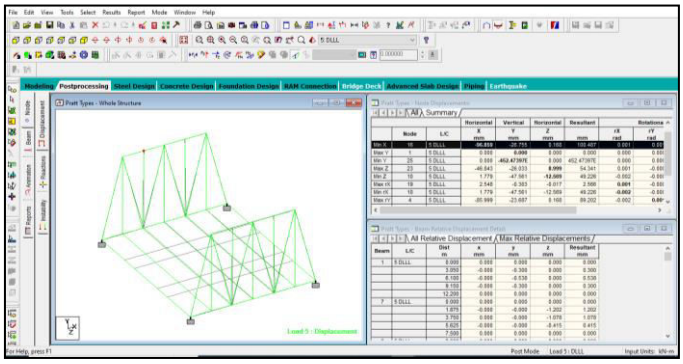

Fig. 9:Displacement of Pratt Types

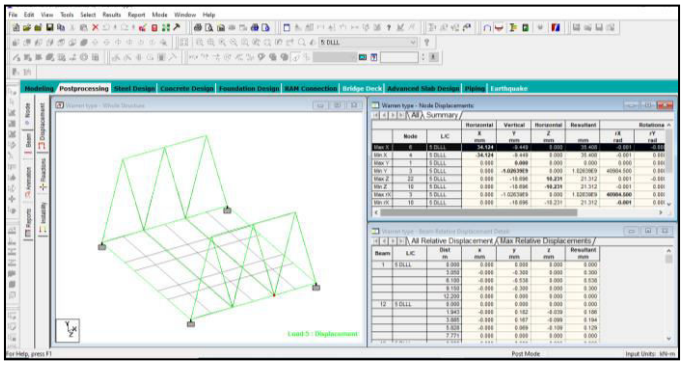

Fig.10: Displacement of Warren Types

Table 2: Displacement for Static Analysis

Displacement mm		
Howe Types	Pratt Types	Warren Types
146.211	96.852	34.123

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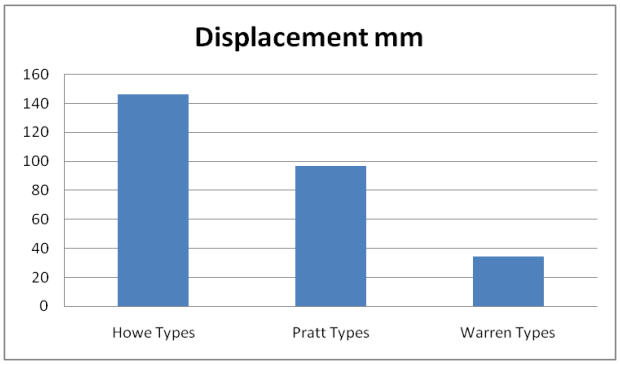


Graph 1: Displacement for Static Analysis

B. Dynamic Analysis

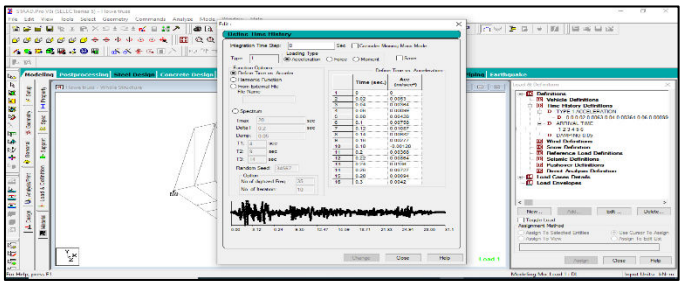
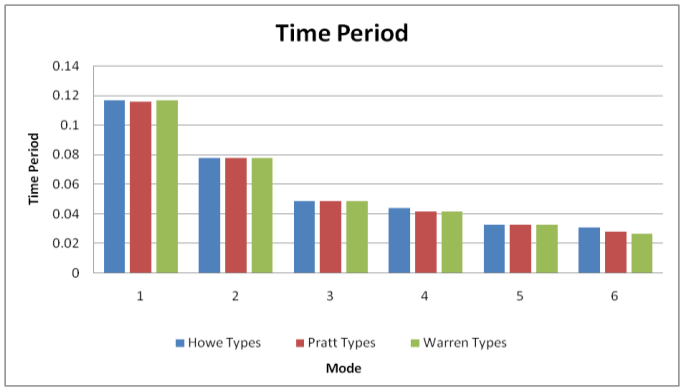


Fig. 11: Define Time History in Staad-Pro

Define time history Bhuj region is designated as high seismic hazard in IS 1893 building code for India.

Table 3: Time Period

Time Period			
Mode	**Howe Types**	**Pratt Types**	**Warren Types**
1	0.1171	0.1162	0.1171
2	0.0781	0.0781	0.0782
3	0.0491	0.0494	0.0492
4	0.0441	0.0421	0.0425
5	0.0332	0.0331	0.0334
6	0.0313	0.0282	0.0271



Graph 2: Time Period

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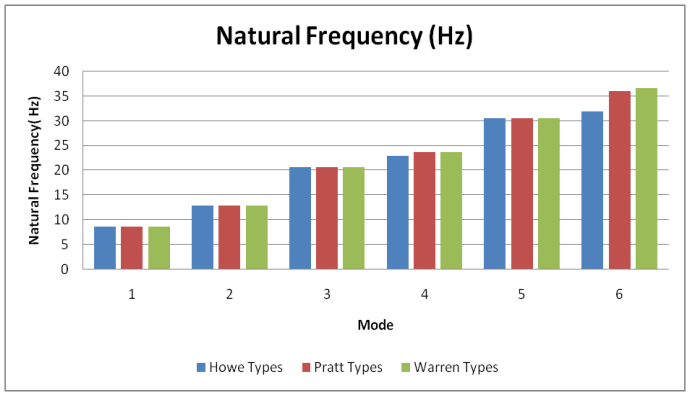
Table 5.3: Natural Frequency (Hz)

Natural Frequency (Hz)			
Mode	**Howe Types**	**Pratt Types**	**Warren Types**
1	8.5651	8.595	8.576
2	12.891	12.892	12.885
3	20.591	20.592	20.59
4	22.972	23.665	23.605
5	30.484	30.52	30.472
6	31.861	36.03	36.618



Graph 3: Natural Frequencies (Hz)

After static and dynamic analysis of different styles of bridges, it is concluded that truss kind of truss structure is extra reasonably-priced than pratt and howe truss truss structure. The analysis ought to advocate the sort of truss for the Bhima River Railway Bridge. Then it's far necessary to layout the Warren Bridge.

V. CONCLUSION

- Metallic truss is used to create maximum railway bridges. Truss systems consist of metallic components that are related to each different and form a strong body.
- Person elements of the truss bridge function as assisting elements of the device; they're arranged in a triangular shape so that after the truss is loaded, only the axial force (anxiety or compression) is transmitted to the participants. For the reason that a number of those bridges are positioned in earthquake-prone areas, it's far essential to assess numerous truss sections taking into consideration seismic forces and locomotive hundreds and then pick the maximum suitable phase.
- 3 sorts of sections (i.e. Warren beam, Pratt beam and Howe beam) are used on this studies and analyzed for both static and dynamic methods.
- For static analysis, keep in mind a moving train load. As consistent with IRC class a, set parameters as per IS1893 for seismic load and IS875 for wind for Pune sector for dynamic analysis. The bridges are modeled after the scale of the Bhima River Bridge.
- The static evaluation indicates that the Warren truss is 30-40% greater in your price range than the Pratt and Howe truss.
- Models for seismic and wind forces are executed for dynamic analysis. For seismic evaluation, its miles concluded that Warren truss types are extra cost-effective than Pratt and Howe truss types by means of 20-30%.

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18. IS 1893 – 2002 Earthquake Resistant Design of Structures
19. IS 800 (2007) Code for general construction in steel structures.
20. IRC-24-2001 for the design of steel or wrought iron bridges carrying rail
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