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Steel through Truss Bridge Analysis with Varying Height to Span Ratio for Two Lane Highway

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Abstract *- Steel-concrete composite structures have been used extensively in bridge structures, both highway and railway bridges, due to the benefits of combining the two construction materials, their higher span-to-depth ratio, reduced deflections, and higher stiffness ratios than traditional steel or concrete beam structures (Lin et al., 2016a).in this paper The analysis of a single span two lane composite bridge is carried out. The scope of this study is to confine to the design aspect related to variable parameters. Vary the Height to Span Ratio (H/L) of Through truss bridge and check the deflation of Deck slab. Depth of web, thickness of web, width of flange are the variable parameters considered during the design of Stringers of Steel Bridge by using SAP2000 v14the bridge models are subjected to the IRC class AA Tracked loading system and concluded that with the increase in shear force, bending moment and deflection in the girder and variation of stresses in slab*

Index Terms – Stringer Beam, Truss Bridge, IRC loading, stresses on Beam & Slab, etc.

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I. INTRODUCTION

Steel bridges are widely used around the world in different structural forms with different span length, such as highway bridges, railway bridges, and footbridges. The main advantages of structural steel over other construction materials are its strength, ductility, easy fabrication, and rapid construction. It has a much higher strength in both tension and compression than concrete, and relatively good strength to cost ratio and stiffness to weight ratio. Steel is a versatile and effective material that provides efficient and sustainable solutions for bridge construction, particularly for long span bridges or bridges requiring enhanced seismic performance. The structural steel for steel bridges should be selected according to the required material properties or the stress state where used, environmental conditions at the construction site, corrosion protection method, construction method, etc. (JSCE, 2007). The physical properties of structural steel such as strength, ductility, toughness, weldability, weather resistance, chemical composition, shape, size, and surface characteristics are important factors for designing and construction of steel bridges. Three categories of structural steel are often used for steel bridge construction including carbon steel, high strength steels, and heat-treated carbon steels (Kumar and Kumar, 2014).

Steel-concrete composite structures have been used extensively in bridge structures, both highway and railway bridges, due to the benefits of combining the two construction materials, their higher span-to-depth ratio, reduced deflections, and higher stiffness ratios than traditional steel or concrete beam structures (Lin et al., 2016a).

Components of composite Bridge
The Superstructure consists of the following components:

- Superstructure consists of following component.
- Slab (Deck and Cantilever)
- Margin, kerb if footpath, Cycle track provided
- Girders (longitudinal and Cross)
- Topcoat (Wearing coat)
- Top Chord
- Bottom Chord

- Stingers
- Diagonals Structs
- Portal frame

The Substructure consists of the following structures:

- Piers
- Abutment at end of the bridges
- Pedestal and Bearing
- Pile or Well Foundation

II. OBJECTIVES OF STUDY

The following are the objectives of the current study"

- The analysis of a single span two lane composite bridge is carried out. The scope of this study is to confine to the design aspect related to variable parameters.
- Vary the Height to Span Ratio (H/L) of Through truss bridge and check the deflation of Deck slab.
- Depth of web, thickness of web, width of flange are the variable parameters considered during the design of Stringers of Steel Bridge by using SAP2000 v14the bridge models are subjected to the
- IRC class AA Tracked loading system and concluded that with the increase in shear force, bending moment and deflection in the girder and variation of stresses in slab.

III. METHODOLOGY

A Simply supported, single spans, two lanes composite steel through bridge with concrete deck is taken into consideration. The bridge deck is analyzed for Dead load in addition to diverse elegance of live load i.e. IRC loading. Comparison of crucial structural response parameter. The analysis is accomplished for various Class of IRC loading. Analysis is done for various Class of IRC loading.

Description of bridge

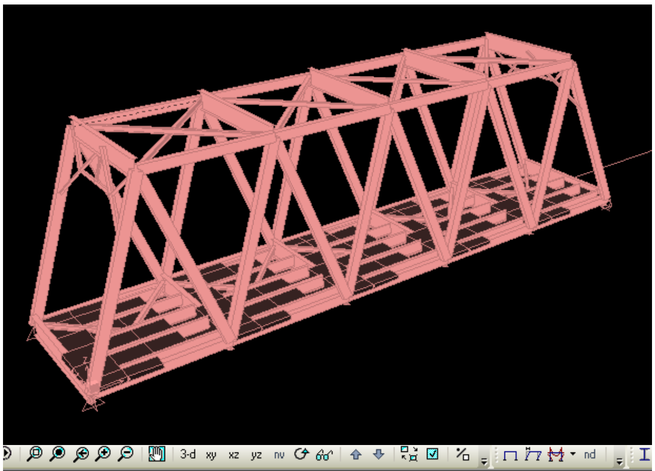
i) **Bridge Type**: Composite steel Through truss Bridge
ii) **Span**: 40,60,80,100 & 120 meters
iii) **Width of Bridge**: 10meter
iv) **Lane**: Two Lane
v) **Bridge Component**: Top Chord, Bottom chord, Top Bracing, Bottom Bracing, Floor Beam, Cross beam, Stringers. Diagonals, Portal
vi) **Loading**: IRC loading and Wind Load
vii) **Deck Slab** Thickness: 300mm

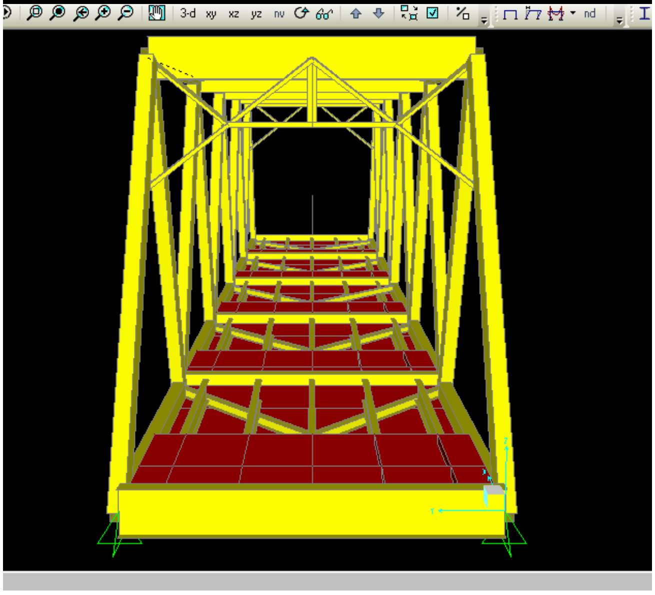
Table 1 Steel Bridge Element Description

Element	*Section to be used*	*Dimension (mm)*
Top Chord	Box Section	600x450x25
Bottom Chord	Box Section	600x450x25
Diagonal Chord	Box Section	600x450x25
Portal Bracing	Double angle	150x150x10
Top Bracing	I-section	300x250x10
Bottom Bracing	I-section	300x250x10
Strut/Cross beam	I-section	1300x320x20
Deck	Rectangular	300 thickness Concrete (M30)

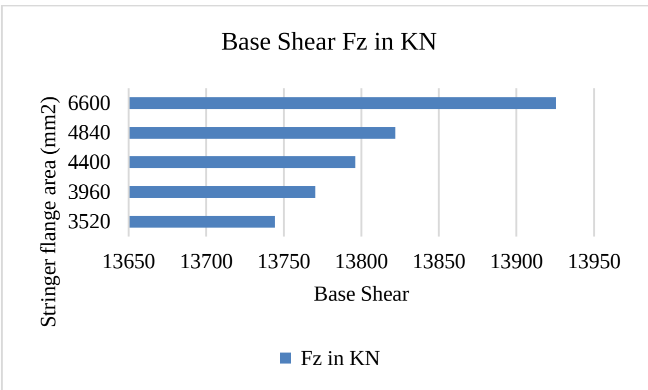
Table 2 height/Span Ratio

Span(m)	*Height(m)*	*Aspect ratio* **(Height/Span)**
40	**12**	**0.3**
60	**12**	**0.2**
80	**12**	**0.15**
100	**12**	**0.12**
120	**12**	**0.1**

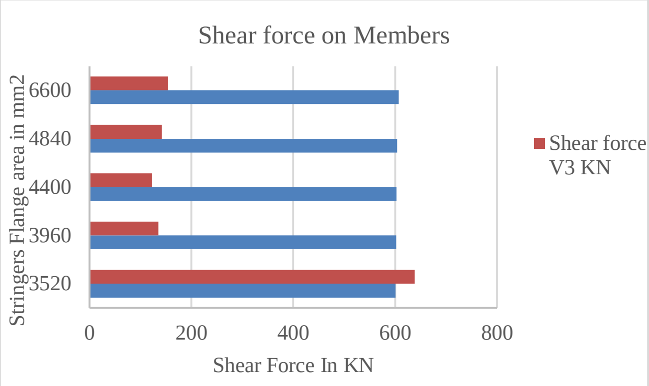




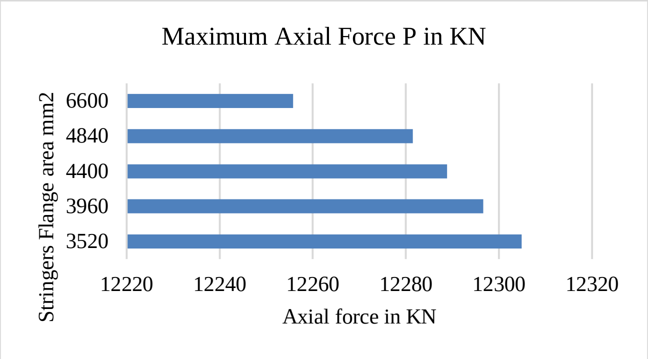
V. RESULTS



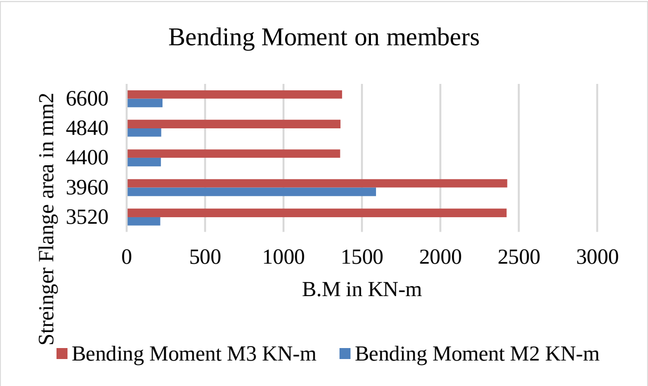
Graph no. 1 Stringer web area Vs Base Shear



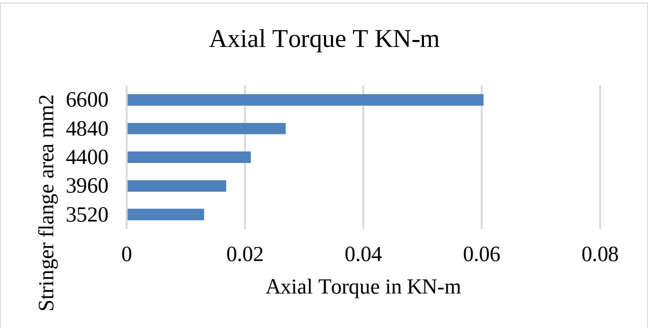
Graph no. 3 Stringer web area Vs Shear force on Member



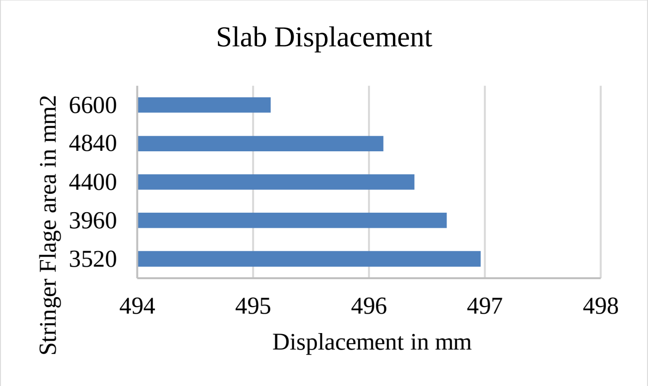
Graph no. 4 Stringer web area Vs Maximum Shear force



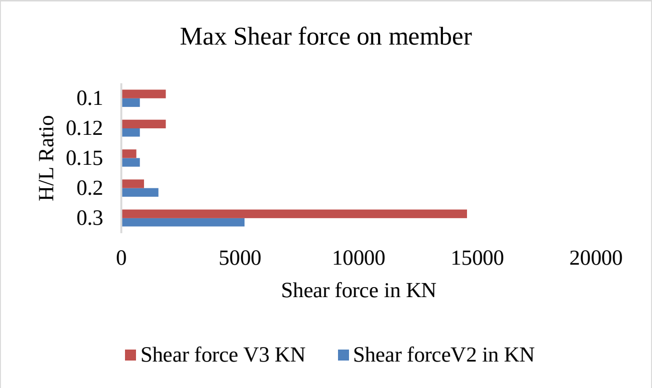
Graph no. 5 Stringer web area Vs Maximum Bending Moment



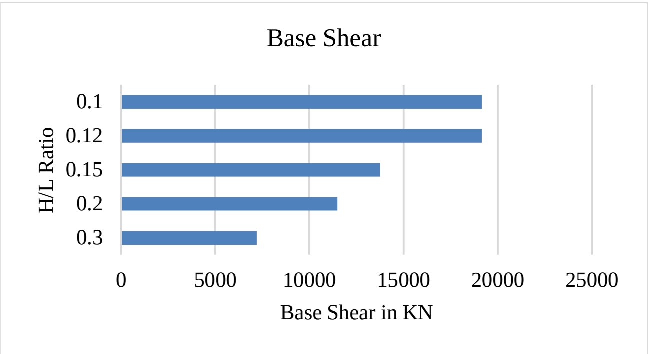
Graph no. 6 Stringer web area Vs Maximum Torque



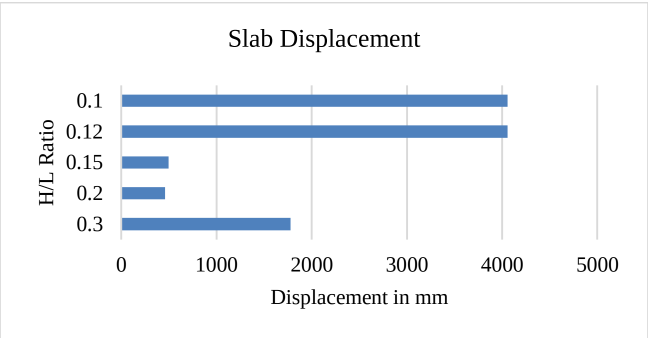
Graph no. 7 Stringer web area Vs Slab Displacement



Graph no. 8 H/L Vs Shear force



Graph no. 9 H/L Vs Base Shear



Graph no. 10 H/L Vs Slab Displacement

VI. CONCLUSION

In this study, bridge spans ranging from 40m to 120m were analyzed using different height-to-span ratios (H/L) under IRC loading conditions. The thickness of the stringer beam was varied from 16mm to 30mm for parametric study purposes. Based on the analysis, the following conclusions were drawn:

- The optimal H/L ratio varies depending on the span length, with different ratios showing varying performance under IRC loading.
- Increasing the stringer beam thickness generally improves the structural response and load-carrying capacity of the bridge.
- Longer spans require higher H/L ratios to maintain structural integrity and minimize deflection under IRC loading.
- Economic considerations, such as material usage and construction costs, should be balanced with structural performance when selecting the optimal span length and H/L ratio for bridge design.

These conclusions provide insights into optimizing bridge design parameters to ensure safety, durability, and cost-effectiveness in various span lengths under IRC loading conditions.: -

- Slab displacement in Y downward direction will be more Increase with increasing H/L Ratio. It observes that in H/L ration 0.2 & 0.15 minimize the displacement of slab.
- It concludes that the Maximum shear force in Longitudinal and cross girder will be increases when increasing the span of the bridge.
- Similarly, the max bending moment in Longitudinal and cross girder will be increases when increasing the span of the bridge form 40m to 120m. while the stringer flange thickness varied from 16mm to 30mm the moment will me minimize.
- Maximum PMM-ratio increases with increase in span length and it will be decreases with stringer flange thickness increases from 16mm to 30mm.
- The optimum height-to-span ratio for through-truss steel bridges of medium span falls within the range of 0.3 and 0.15 for two traffic lanes.

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