Dynamic Analysis Of Psc T-Beam & Box Girder Bridge Superstructure For Different Span Lengths

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Abstract- *The pre-stressed concrete bridges have excellent riding characteristics that minimize traffic vibrations, torsional rigidity, less likely to crack prematurely continuous span, strength and the most noteworthy characteristic is natural frequency of vibration hardly matches with vehicle frequency therefore attained spacious acceptance in freeway, highway flyovers, and in modern metro rail systems. As bridges are the important structures should be capable to withstand static as well as dynamic loads specially, earthquake-induced load to achieve a structure that behave at the level of life safety under enormous earthquakes. The present article shows the linear dynamic behavior of T-beam girder and box girder bridge deck and compares static as well as dynamic behavior. Response spectrum analysis has been performed by using FEM based software in order to check the resonance criteria of bridge and to determine most favorable option from above two. The results show that response parameters for box girder such as bending moment, shear forces, deflection, time period, base reaction, longitudinal stresses and shear stresses are increases as the span length increases while fundamental frequency decreases. From the study it is finalized that box girder is the conservative solution as compared to T-beam girder bridge superstructure.*

Keywords- T-beam girder, Box girder, Dynamic analysis, ANSYS

I. INTRODUCTION

Bridges are the life line of road network, both in urban and country zones. With fast innovation development, the commonplace bridge has been supplanted by creative practical structural system. One of these courses of action presents basic RCC framework that is T-Beam and Box Girder.

Bridge design is a goal and what's more personalities boggling approach for an structural design. Just as there should rise an occasion of Bridge design, span length and live loads are consistently fundamental variables. These parts affect the conceptualization time of plan. The impacts of live load for different extents are moving. Choice of structural system for a cross is continually a range in which investigate should be possible. Structural system got is influenced by fragments like economy and fancy being created. Code strategy engages us to pick structural system i.e. T- Beam Girder and Box Girder. The decision of sparing and constructible basic framework relies on upon the outcome.

A. T-Beam

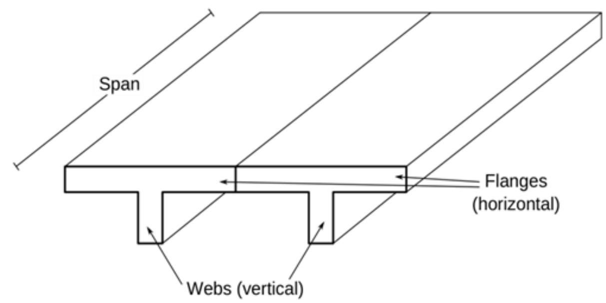


Fig 1. T-Beams

T-beam utilized as a part of construction, is a load bearing structure of reinforced concrete, wood or metal, with a t-formed cross area. The highest point of the t-molded cross segment fills in as a flange or pressure part in opposing compressive stress. The web (vertical area) of the beam beneath the compression flange serves to oppose shear stress and to give more noteworthy detachment to the coupled strengths of bending

B. Box Girder

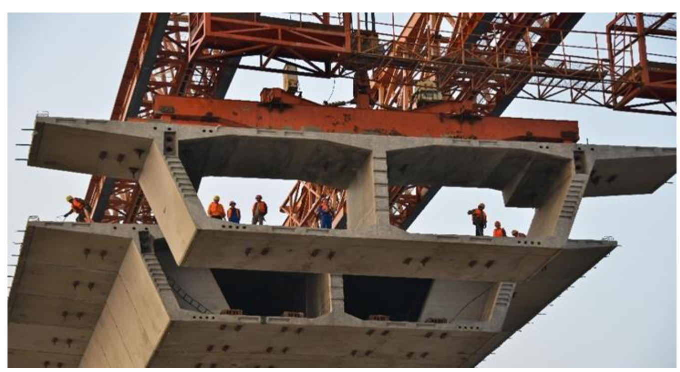
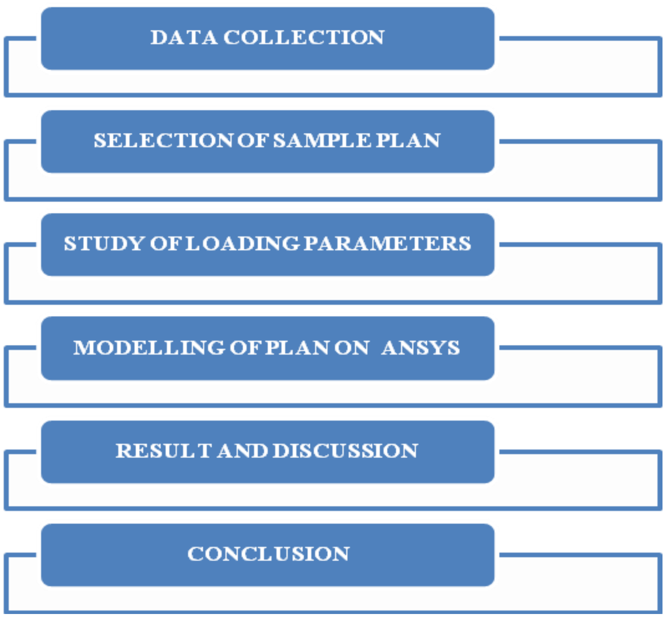


Fig 2. Box girder

II. OBJECTIVES

- To concentrate the conduct of basic simple RCC T-beam beam and Box Girder bridge under standard IRC loading, and the comparing analysis depends on the analytical modeling by FEM for various spans in ANSYS software for various spans of bridge
- To study the deck slab interaction with the loading considered as IRC Codes.
- To evaluate the suitability of the bridges for short as well as long spans
- To evaluate code expressions for live-load distribution factors for concrete girder bridges.

III. METHODOLOGY



The design parameters are check and verify by the structural analysis program (ANSYS). The structural design is a very important part of the bridge which defines safety in overall context and the major cost of the project. Therefore, the choice of the correct and appropriate code will save a high value of the cost of construction, in addition to the safe and successful design. To decide the size (dimension) of the member and the amount of reinforcement required. To check the weather adopted section will perform safely and satisfactorily during the life time of the structure. Design Philosophy, Loading and pattern of loading, Safety factors. Shear force and Bending Moment induced in the components, Reinforcement required for each design, from these comparative studies, we can have idea about the best design standards.

IV. PROBLEM STATEMENT

Type of Bridge Superstructure	T-beam Girder Bridge	Trapezoidal Box Girder Bridge
Cross section	T-beam girder	Multi celled box girder
Carriageway width	7.5 m	
Kerbs	600 mm on each side	
Foot Paths	1.25 m wide on each side	
Thickness of wearing coat	80 mm	
Lane of bridge	Two lane	
Longitudinal girders	4 main girders at 2.5 m interval	
Spacing of cross girders	5 m	
Cell dimensions		2 m wide by 1.8 m deep
TH. of Top &Bottom Slab	250 mm & 300mm	300 mm
Overhang Th.	180 mm	180 mm
Thickness of web	200 mm	300 mm
Span	25,30, 35, 40m	
Grade of concrete	M60	
Material	Pre-stressed Concrete	
Loss Ratio	0.8	
Type of tendons	High tensile strands of 15.2 mm dia. Confirming to	
	IRC: 6006-2000.	
Anchorages Type	27K-15 Freyssinet type anchorages.	
Type of Supplementary r/f	Fe-415 HYSD bars	
Loading Considered	Dead load, wind &Pre-stress, Class 70R-Wheeled vehicle, and Seismic forces	
	Class-1 type of structure confirming to the codes IRC:6-2014,IRC:21-2000,	
Design of bridge deck	IS:1893-1987,IS: 875 (Part-III) - 1987	

V. RESULTS AND DISCUSSION

Idealization of above problem statement is modeled in finite element analysis tool ANSYS .Following models are prepared for comparative analysis of bridge structure

	BOX GIRDER	PSC T- BEAM
MODEL NO.1	35m span	35m span
MODEL NO.2	40m span	40m span
MODEL NO.3	45m span	45m span
MODEL NO.4	50m span	50m span

A. Box Girder Models and Results in ANSYS

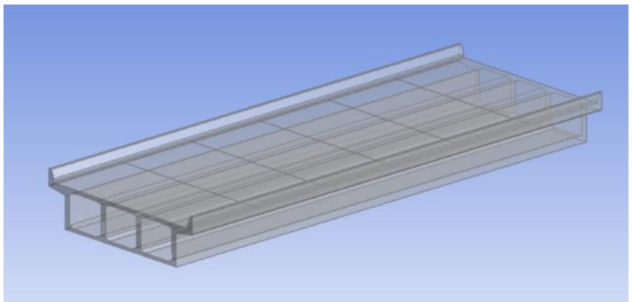


Fig 5.1 Modeling of box Girder in ANSYS

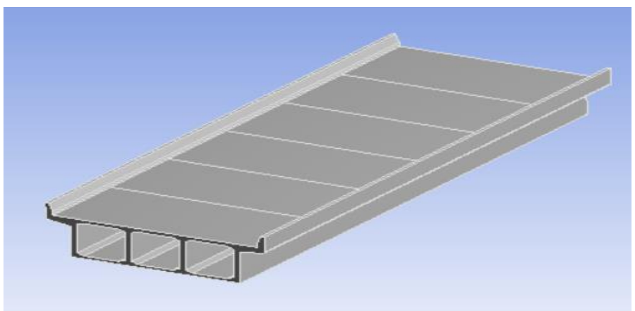


Fig 5.2 Modeling of box Girder in ANSYS

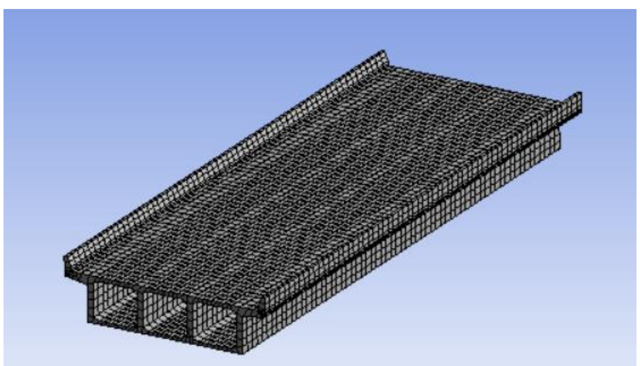


Fig 5.3 Meshing of box girder

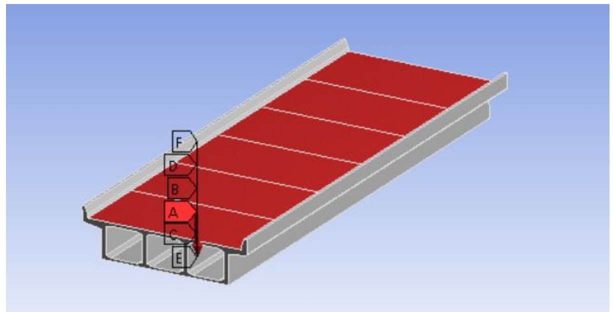


Fig 5.4 Pressure applied on bridge

35m Span Length

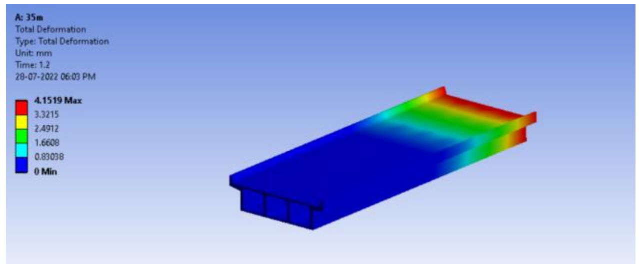


Fig 5.5 Total deformation

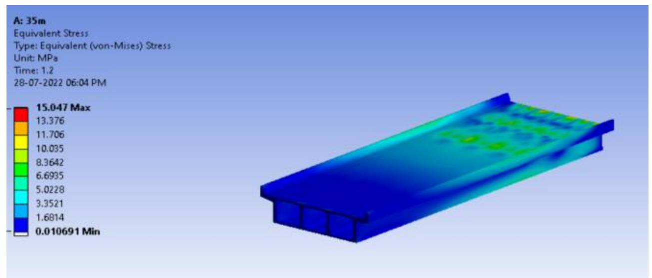


Fig 5.6 Equivalent Stress

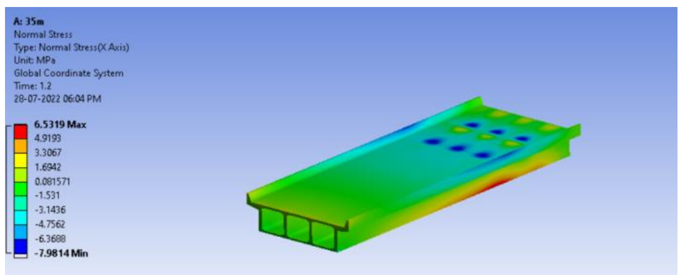


Fig 5.7 Normal Stress

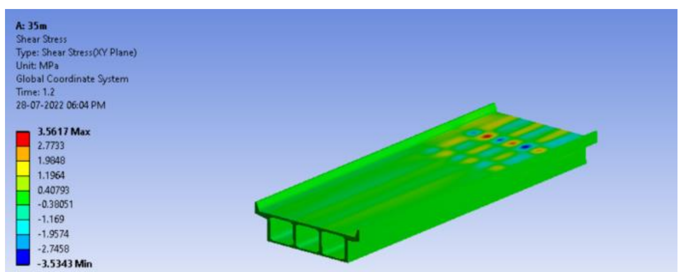


Fig 5.8 Shear Stress

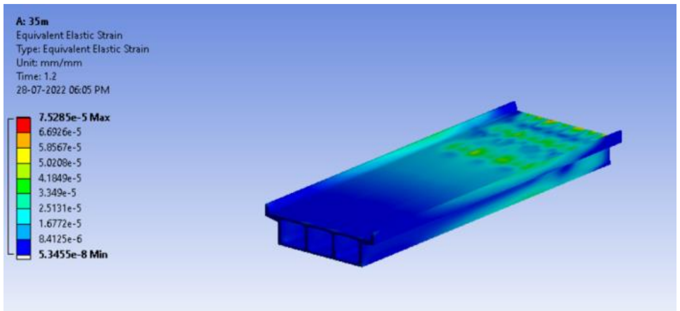


Fig 5.9 Equivalent Elastic Strain

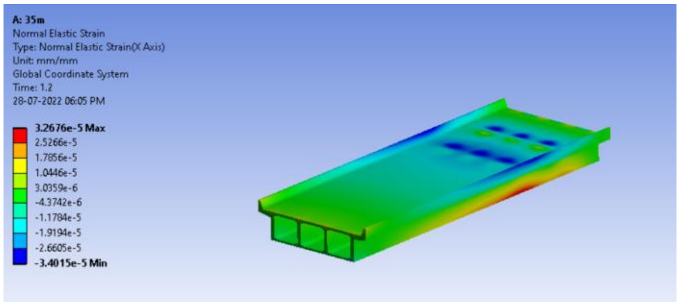


Fig 5.10 Normal Elastic Strain

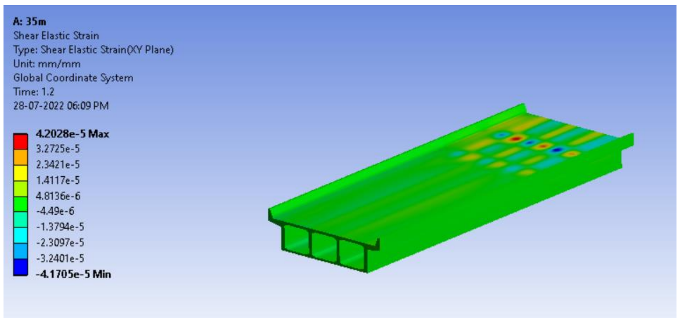


Fig 5.11 Shear Elastic Strain

5.3 PSC T- BEAM MODELS AND RESULTS IN ANSYS

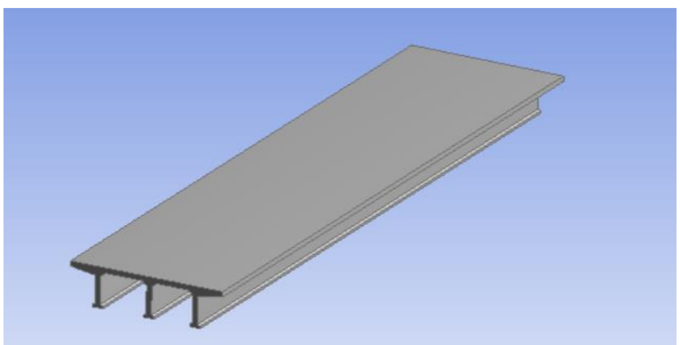


Fig 5.12 PSC T- Beam Bridge Structure

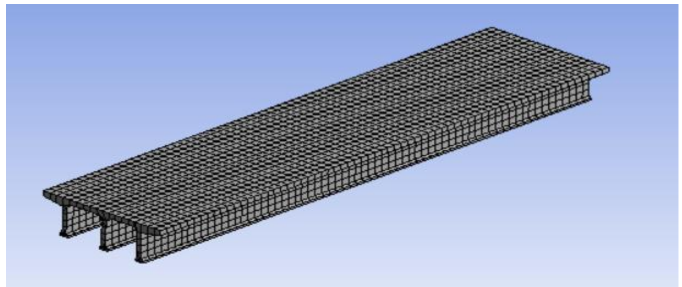


Fig 5.13 Meshing of PSC T- Beam Bridge Structure

35m Span Length

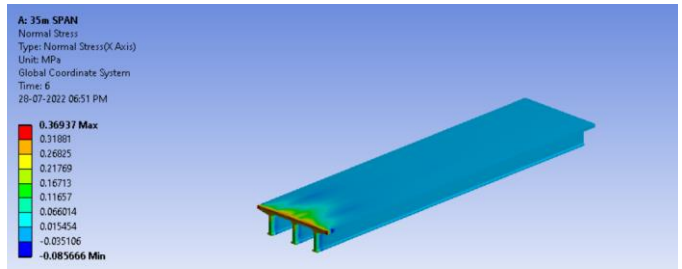


Fig 5.14 Normal Stresses

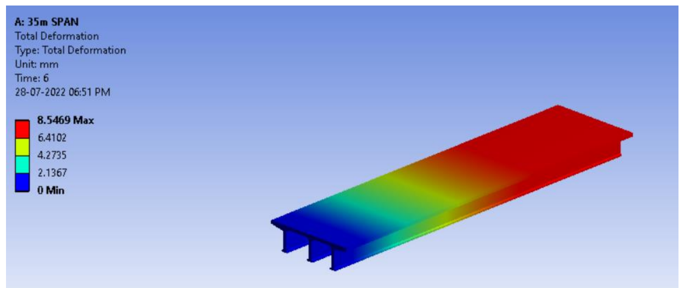


Fig 5.15 Total Deformation

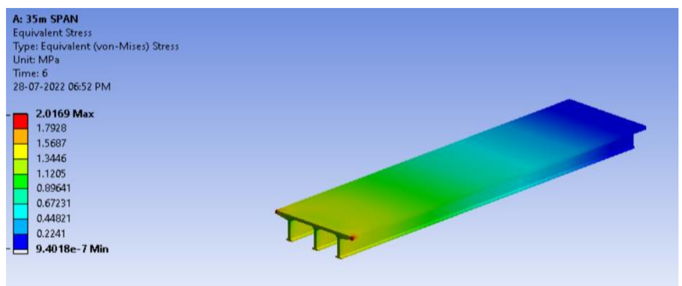


Fig 5.16 Equivalent Stress

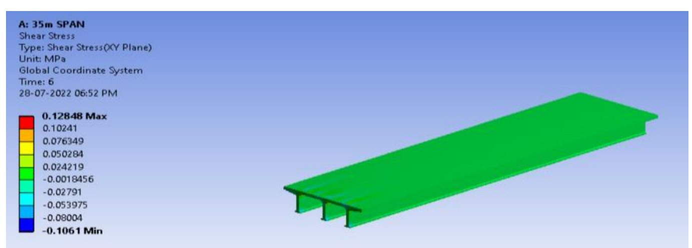


Fig 5.17 Shear Stress

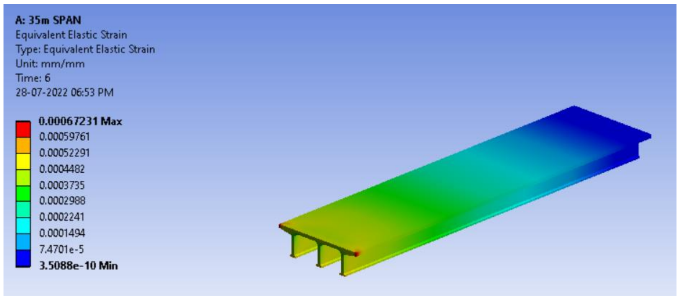


Fig 5.18 Equivalent Elastic Strain

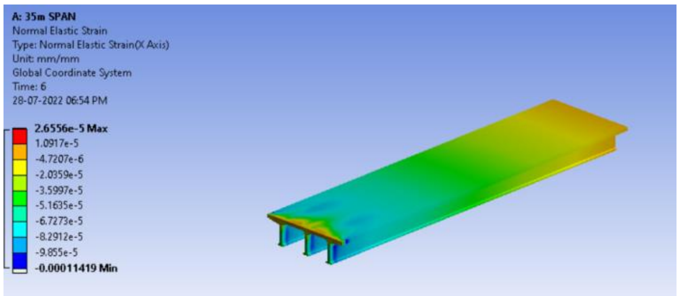


Fig 5.19 Normal Elastic Strain

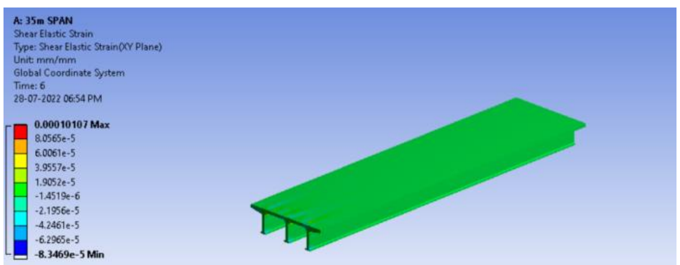
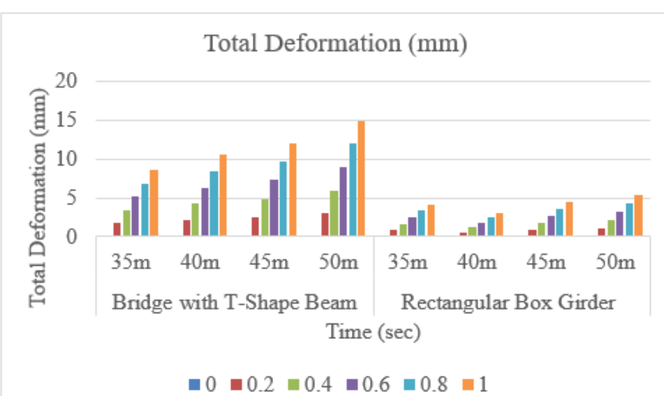


Fig 5.20 Shear Elastic Strain

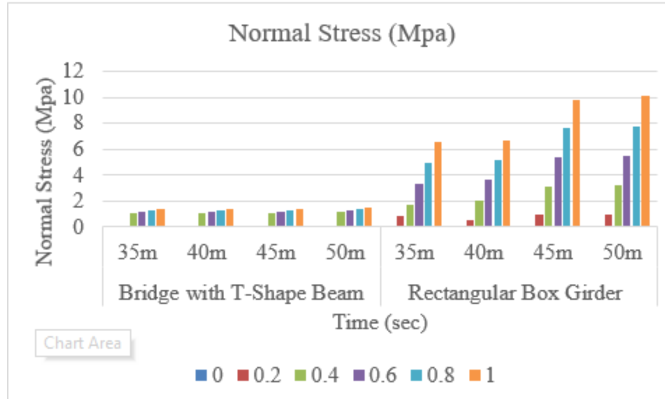
5.4 COMPARATIVE ANALYSIS OF BRIDGE PSC T-BEAM & BOX GIRDER

5.4.1 TOTAL DEFORMATION



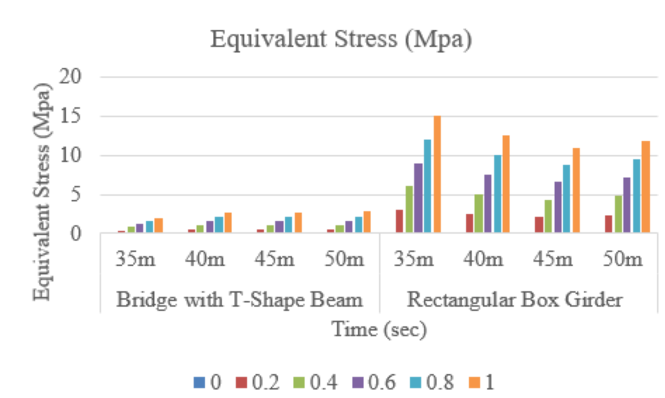
As the Above results shows that Total Deformation of PSC T-Beam & Box Girder for span 35m ,40m 45m, 50m will be subject load steps0.2 to 0.8. Whereas Total Deformation of PSC T beam Is more than box girder in all spans by 25-30% for every load step.

5.4.2 NORMAL STRESS Mpa



As the Above results shows that Normal Stress of PSC T-Beam & Box Girder for span 35m ,40m 45m, 50m will be subject load steps 0.2 to 0.8. Whereas Normal Stress of PSC T beam Is less than box girder in all spans by 20-25% for every load step.

5.4.3 EQUIVALENT STRESS (MPA)



As the Above results shows that Equivalent Stress of PSC T-Beam & Box Girder for span 35m ,40m 45m, 50m will be subject load steps 0.2 to 0.8. Whereas Equivalent Stress of PSC T beam Is less than box girder in all spans by 5-10% for every load step

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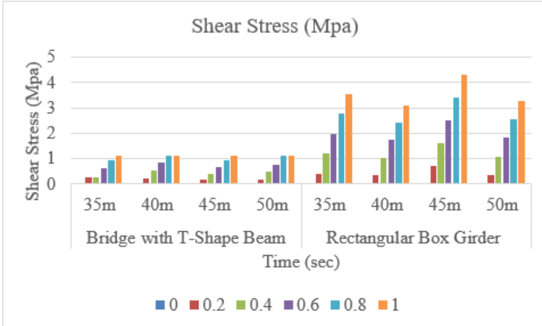
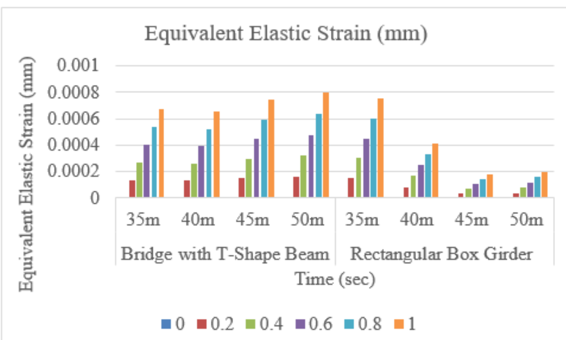
5.4.4 SHEAR STRESS (MPA)



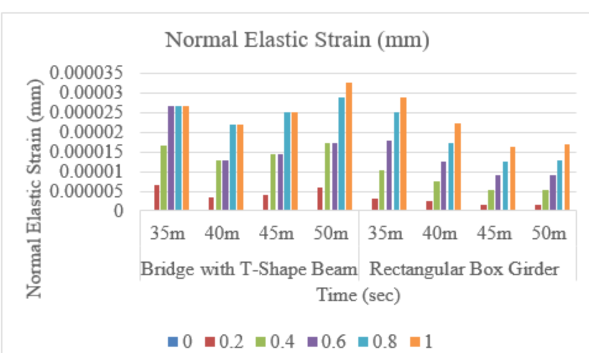
As the Above results shows that Shear Stress of PSC T-Beam & Box Girder for span 35m ,40m 45m, 50m will be subject load steps 0.2 to 0.8. Whereas Shear Stress of PSC T beam Is less than box girder in all spans by 10-15% for every load step.

5.4.5 EQUIVALENT ELASTIC STRAIN (MM)



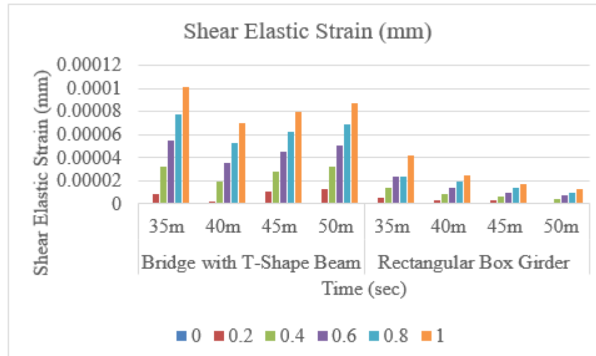
As the Above results shows that Equivalent Elastic Strain (mm) of PSC T-Beam & Box Girder for span 35m ,40m 45m, 50m will be subject load steps 0.2 to 0.8. Whereas Equivalent Elastic Strain (mm) of PSC T beam Is more than box girder in all spans by 10-15% for every load step.

5.4.6 NORMAL ELASTIC STRAIN (MM)



As the Above results shows that Normal Elastic Strain (mm) of PSC T-Beam & Box Girder for span 35m ,40m 45m, 50m will be subject load steps 0.2 to 0.8. Whereas Normal Elastic Strain (mm) of PSC T beam Is more than box girder in all spans by 10-15% for every load step.

5.4.7 SHEAR ELASTIC STRAIN (MM)



As the Above results shows that Shear Elastic Strain (mm) of PSC T-Beam & Box Girder for span 35m ,40m 45m, 50m will be subject load steps 0.2 to 0.8. Whereas Shear Elastic Strain (mm) of PSC T beam Is more than box girder in all spans by 10-15% for every load step.

VI. CONCLUSION

The behaviour of T-beam girder and box girder proposed for bridge Superstructure of spans span 35m ,40m 45m, 50m is studied. By conducting Dynamic analysis, it was clear that box girder is an efficient and economical girder system by optimization of cross-section as compared to T-beam girder section by comparing following static and dynamic responses

1. As the Above results shows that Total Deformation of PSC T-Beam & Box Girder for span 35m ,40m 45m, 50m will be subject load steps0.2 to 0.8. Whereas Total Deformation of PSC T beam Is more than box girder in all spans by 25-30% for every load step
2. As the Above results shows that Equivalent Stress of PSC T-Beam & Box Girder for span 35m ,40m 45m, 50m will be subject load steps 0.2 to 0.8. Whereas Equivalent Stress of PSC T beam Is more than box girder in all spans by 20-25% for every load step.
3. As the Above results shows that Maximum Shear Stress of PSC T-Beam & Box Girder for span 35m ,40m 45m, 50m will be subject load steps 0.2 to 0.8. Whereas Maximum Shear Stress of PSC T beam Is

more than box girder in all spans by 5-10% for every load step.

4. As results shows that Natural Frequency of Box Girder is more than PSC T-Beam subjected to mode shapes 1 to 6 by 10-15%.
5. As the Above results shows that Time Period of Box Girder Box Girder is less than PSC T-Beam subject mode shapes 1 to 6 by 10-12%.

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