International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 07 | July 2020 www.irjet.net p-ISSN: 2395-0072

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 attributes that limits traffic vibrations, torsional rigidity, less likely to break prematurely continuous span, quality and the most significant trademark is natural frequency of vibration hardly fits with vehicle frequency therefore attained great reputation in freeway, highway flyovers and in modern metro rail systems. As bridges are the significant structures ought to 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 utilizing Finite Element Method (FEM) based software so as to check the resonance criteria of bridge and also to determine most ideal alternative from over two. The outcomes show that response parameters for box girder such as shear forces, bending moment, deflection, longitudinal stresses, time period, base reaction, 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.*

Key Words: *T-beam girder, Box girder, Dynamic analysis, FEM, ANSYS*

1. 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.

1.1 T-Beam

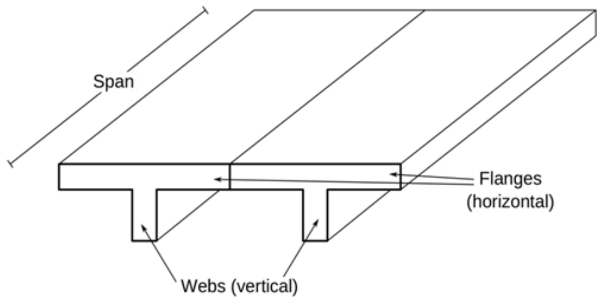


Fig 1. T-Beams

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.

1.2 Box Girder

A Box Girder Bridge is a Bridge in which the primary Beam involve girder in the shape of a hollow box. The box girder typically involves either pre-stressed concrete, structural steel, or a composite of steel and reinforced cement. The box is ordinarily rectangular in cross-area. Box Girder Bridge is usually utilized for dual carriageway flyovers and for current improved structures of mild rail delivery. Although frequently the crate box girder bridge is a form of beam bridge, box girder might also likewise be applied on cable stayed bridges and special structures.

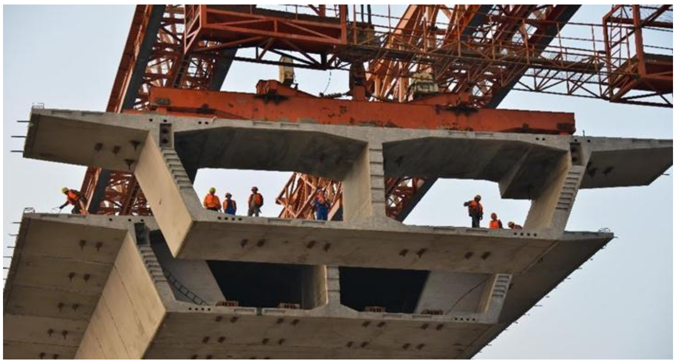
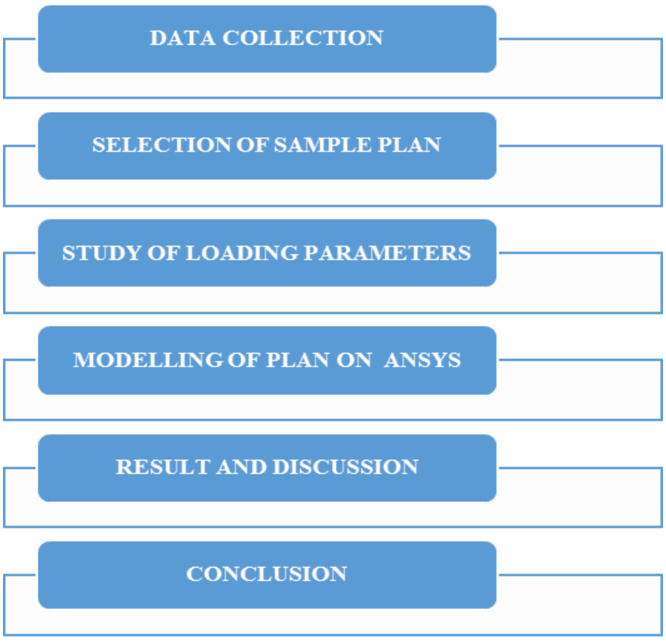


Fig 2. Box girder

2. 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.

3. METODOLOGY



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.

4. 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	35, 40, 45, 50m	
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
Design of bridge deck	Class-1 type of structure confirming to the codes IRC:6-2014,IRC:21-2000, IS:1893-1987,IS: 875 (Part-III) - 1987

5. 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

5.1 Box Girder Models and Results in ANSYS

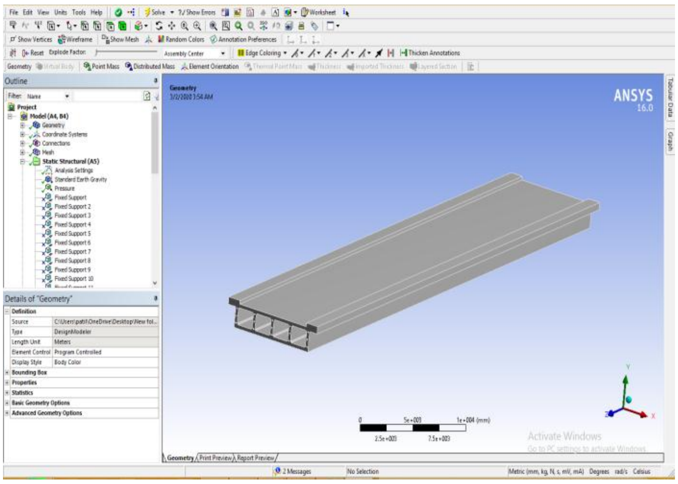
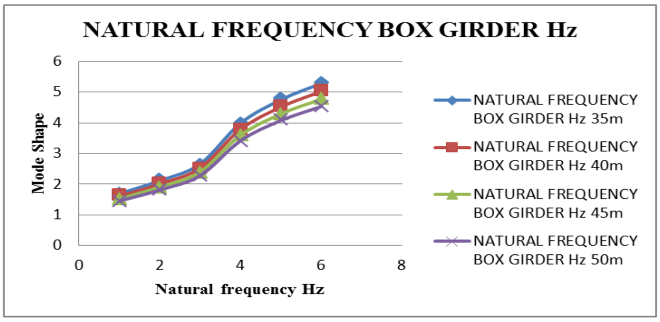


Fig 3: Modeling of box Girder in ANSYS

- **Natural Frequency Box Girder:**

NATURAL FREQUENCY BOX GIRDER Hz				
Mode Shape No.	**35m**	**40m**	**45m**	**50m**
1	1.694	1.6093	1.528835	1.452393
2	2.112	2.0064	1.90608	1.810776
3	2.6572	2.52434	2.398123	2.278217
4	3.9844	3.78518	3.595921	3.416125
5	4.7541	4.516395	4.290575	4.076046
6	5.2881	5.023695	4.77251	4.533885

Table 1: Natural Frequency



Graph 1: Natural Frequency Box Girder

5.2 PSC T- Beam Models and Results in ANSYS

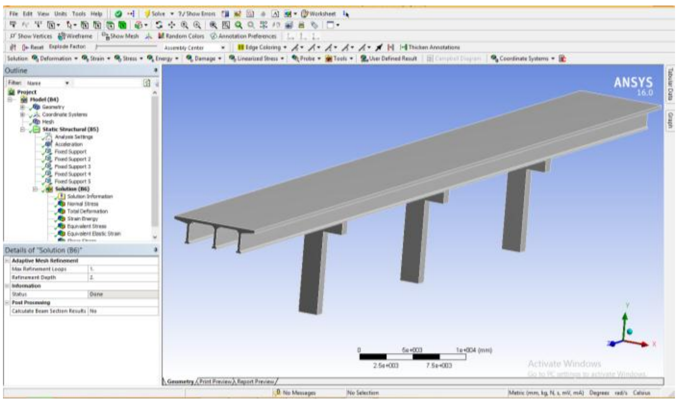
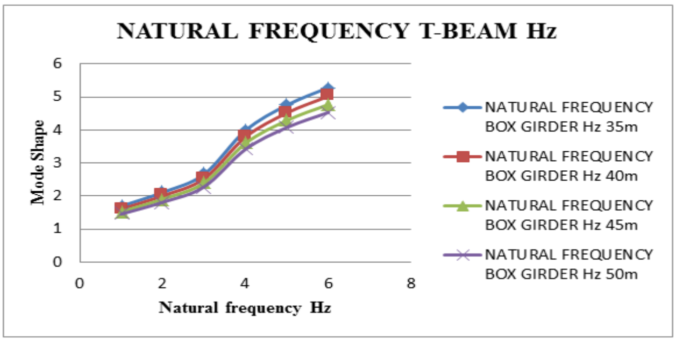


Fig 4 PSC T- Beam Bridge Structure

➢ **Natural Frequency T-beam:**

NATURAL FREQUENCY T-BEAM Hz				
MODE SHAPE NO.	**35m**	**40m**	**45m**	**50m**
1	1.4824	1.40828	1.337866	1.270973
2	1.992	1.8924	1.79778	1.707891
3	2.5016	2.37652	2.257694	2.144809
4	3.0112	2.86064	2.717608	2.581728
5	3.5208	3.34476	3.177522	3.018646
6	4.0304	3.82888	3.637436	3.455564

Table 2: Natural Frequency T-Beam



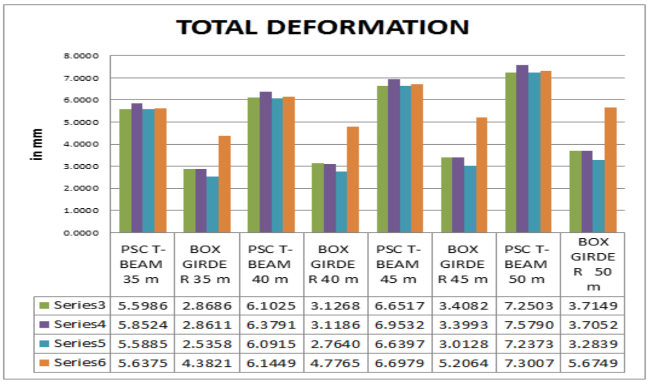
Graph 2: Natural Frequency T-Beam

5.3 Comparative Analysis of Bridge PSC T-Beam & Box Girder

A) Total Deformation:

TOTAL DEFORMATION mm								
LOAD STEP	PSC T-BEAM 35 m	BOX GIRDER 35 m	PSC T-BEAM 40 m	BOX GIRDER 40 m	PSC T-BEAM 45 m	BOX GIRDER 45 m	PSC T-BEAM 50 m	BOX GIRDER 50 m
0.2000	5.5986	2.8686	6.1025	3.1268	6.6517	3.4082	7.2503	3.7149
0.4000	5.8524	2.8611	6.3791	3.1186	6.9532	3.3993	7.5790	3.7052
0.6000	5.5885	2.5358	6.0915	2.7640	6.6397	3.0128	7.2373	3.2839
0.8000	5.6375	4.3821	6.1449	4.7765	6.6979	5.2064	7.3007	5.6749

Table 3: Total Deformation

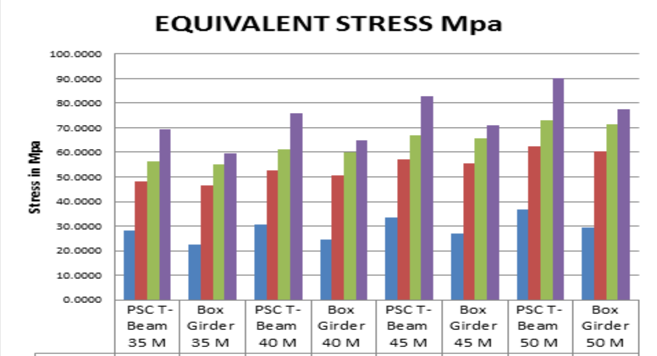


As the Above results shows that Total Deformation of PSC T-Beam & Box Girder for span 35m, 40m, 45m, 50m will be subject load steps 0.2 to 0.8. Whereas Total Deformation of PSC T beam is more than box girder in all spans by 25-30% for every load step.

B) Equivalent Stress:

EQUIVALENT STRESS Mpa								
Load Step	PSC T-Beam 35 M	Box Girder 35 M	PSC T-Beam 40 M	Box Girder 40 M	PSC T-Beam 45 M	Box Girder 45 M	PSC T-Beam 50 M	Box Girder 50 M
0.2000	28.1400	22.5120	30.7289	24.5831	33.5559	26.8447	36.6431	29.3145
0.4000	48.0390	46.4310	52.4586	50.7027	57.2848	55.3673	62.5550	60.4611
0.6000	56.2215	54.9772	61.3939	60.0351	67.0421	65.5583	73.2100	71.5897
0.8000	69.3600	59.4880	75.7411	64.9609	82.7093	70.9373	90.3186	77.4635

Table 4: Equivalent Stress



	PSC T-Beam 35 M	Box Girder 35 M	PSC T-Beam 40 M	Box Girder 40 M	PSC T-Beam 45 M	Box Girder 45 M	PSC T-Beam 50 M	Box Girder 50 M
Series1	28.1400	22.5120	30.7289	24.5831	33.5559	26.8447	36.6431	29.3145
Series2	48.0390	46.4310	52.4586	50.7027	57.2848	55.3673	62.5550	60.4611
Series3	56.2215	54.9772	61.3939	60.0351	67.0421	65.5583	73.2100	71.5897
Series4	69.3600	59.4880	75.7411	64.9609	82.7093	70.9373	90.3186	77.4635

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.

6. CONCLUSION

The behavior 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 steps 0.2 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 results shows that Natural Frequency of Box Girder is more than PSC T-Beam subjected to mode shapes 1 to 6 by 10-15%.

ACKNOWLEDGEMENT

It gives me great pleasure in bringing out the project report entitled “Dynamic Analysis of PSC T-Beam & Box Girder Bridge Superstructure for Different Span Lengths”

Though the following dissertation is an individual work, I could never have reached the heights or explored the depths without the help, support, guidance and efforts of lots of peoples. It gives the immense pleasure, to express my sincere and heartfelt gratitude to everyone who has contributed towards making my project work a memorable experience.

I express a deep sense of gratitude and appreciation and indebtedness to my project guide **Asst. Prof. V.G. Patwari** & Co-ordinator of M.Tech (Structure) **Asst. Prof. Hamane** and Head of the Department **Prof. Deshpande S.G.** for their constant support and motivation throughout the project work. It was their interest and support which has leads me to this stage.

It is a genuine pleasure to express my deep sense of thanks and gratitude to my mentor, philosopher Principal **Prof. N.B. Khatod,** for their encouragement and motivation throughout the project work.

My sincere thanks to the Civil Engineering Staff for offering me valuable suggestions and time to time support at the time of need.

I am extremely thankful to my friends for providing me necessary technical suggestions during my project report.

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