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DESIGN AND ANALYSIS ON BOX GIRDER BRIDGE SUPER STRUCTURE

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Abstract - Bridges are now days, a trending mode of transport. Based on the type of load which carries, based on the range and shape, the bridges are designed. Different types of bridges are available, but in this work, Box Girder bridge type bridges are considered. Two span bridges with different length such as 40m, 60m and 80m are chosen. The entire Modeling and analysis is performed in simulation software CIS SAP2000. Normally the loads which acts on the bridges are considered in this work, such as dead load, vehicle load, torsion load and wind load. The length of the bridge is considered as 5 length ratios and each and every load's bending moment value for section with and without longitudinal beams are noted from the software and using these data, what is the best bridge super structure was found for different span length is done in this work.

***Key Words*: SAP2000, Box Girder bridge.**

1.INTRODUCTION

Built up solid areas, utilized in the bridge superstructures, for the most part comprise of sections, T-radiates (deck supports), and box braces. Security, cost-adequacy, and style are by and large the controlling variables in the choice of the legitimate kind of bridges. The "bridge" has been an element of human advancement and development since the time the hunter-gatherers became interested around the rich land-dwelling, creatures and organic product prospering on trees of a waterway or chasm. The most ancient set up account of a bridge construction gives off an impression of being a scaffold worked across the Euphrates around 600 BC as portrayed by Herodotus, the fifth-century Greek history specialist. There have been disappointments of bridges during the set of experiences. They have been caused either by natural powers by wind, waves and downpour, too striking plan, material disappointment, wrong investigation, or terrible assembling or development. Mishaps, for example, transport impacts, and war activities may likewise have obliterated bridge structures. The breakdown of Tacoma Narrows Bridge because of wind choppiness is maybe the most popular bridge disaster over the last 50 years. 77 individuals killed at the disaster of the Tay Bridge in Scotland 1879, and during the structure time of the Quebec Bridge 95 people were lost. As of late authentic scaffolds as the Stari Most bridge and different bridges in Yugoslavia were annihilated by war activity.

Box-girder spans have an upper floor, a longitudinal network, and a foundation piece and yet are commonly used with spans of 15 - 36 mts of braces separated at 1.5 times the building profundity. Beyond this range, it's also probably better to use a certain kind of scaffold, such as a post pressured box-brace / reinforced-steel support structure. It is a direct product of a colossal increase in size and commodities. They are T-bar systems with both beneficial and harmful minutes. The crate brace's large tensile stresses strength renders it particularly suitable for tight twist arrangements, slanted docks and projections, super height, and improvements, such as trade slope systems.

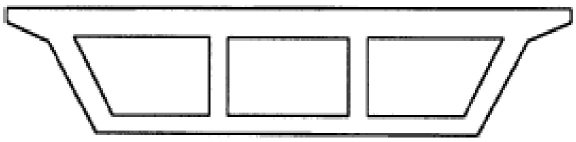

Figure 1: Box-Girder Bridges

2. METHODOLOGY

Type of bridge super structure and shape is very important to give proper bridge design and it is depending on type of soil, load carrying type etc. SAP 2000 software has Indian bridge codes. Using this we can perform the analysis on different types of bridge models. Using these bridge models, three types of lengths are considered in this work such as 40m, 60m and 80m. As well as, T beam bridge and box girder bridge super structure are considered to find out the optimum length, type of bridge model. The required dimensions to create the geometry model of the bridge are taken from reviewed articles as shown in the below table.

Table -1: Table 1: Geometry parameters of bridge section.

Span of the Bridge	20 m	30 m	40 m
Width of the Bridge	7.2 m	7.2 m	7.2 m
Over all depth	1.52 m	1.52 m	1.52 m
Number of Lane	2	2	2
Lane width	3.6 m	3.6 m	3.6 m
Number of interiors girders	3	3	3
Girder width	10.98 m	10.98 m	10.98 m
Slab thickness	0.305 m	0.305 m	0.305 m
Diaphragm thickness	0.3 m	0.3 m	0.3 m
Diaphragm depth	1 m	1 m	1 m
Abutment depth t3	1.52 m	1.52 m	1.52 m
Abutment width t2	1.22 m	1.22 m	1.22 m

3. COMPUTER AIDED MODELING

SAP2000 is universally useful structural designing programming ideal for the investigation and plan of a primary framework. Essential and progressed frameworks, going from 2D to 3D, of straightforward calculation to complex, modelled, investigated, planned, and enhanced utilizing a reasonable and natural object-oriented demonstrating climate that improves and smoothest out the designing interaction. The software SAPFire Analysis Engine vital to SAP2000 utilizes a modern FEA method. An extra set-up of cutting-edge studies are

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accessible to clients best in class with nonlinear/dynamic thought.

Made by engineers for compelling designing, software SAP2000 is the perfect programming instrument for consumers with any skill level, planning any primary framework.
Total SAP procedure can be divided as

1. modeling
2. loading
3. analsyis
4. design and output

Modelling:
Implicit modelling templates and layouts, an adaptable and easy to understand interface, natural controls and highlights all consolidate to rearrange and assist a refined item based demonstrating measure. An expansive scope of demonstrating alternatives accommodate strategies and innovations at the front line of primary designing. Model area might be part, framework, or global in space, while including sub-grade segments and soil properties and structure cooperation. Frameworks' snap, line, and replication instruments are a couple of the numerous functional highlights which make the displaying climate and interaction available to fledglings, and modern for cutting edge clients.

Loading:
Incredible inherent layouts additionally improve and facilitate the heap application measure. Seismic activity, automotive, gale forces, and warm powers are all consequently created and doled out as indicated by a set-up of algorithmic rules. Clients are allowed to characterize and encapsulate a limitless options of load conditions and scenarios.

Analysis:
SAP2000's strengths include a variety of cutting-edge research methods. Customers have the opportunity of supplementing the traditional and specialized evaluation technique with specialised capabilities for nonlinear and complex evaluation. Because of its flexibility, SAP2000 is a useful and efficient method for any form of study from basic stationary, linear-elastic toward more complicated and variable nonlinear-inelastic. To boot, the SAP Fire Processing Engine improves research refinement with several 64-bit solvers. Eigen assessment (with auto switching for poorly relations) and Ritz evaluation are also possibilities.

Design & Output:
The design process is completely combined with the research phase enclosing conclusions before systematically defining structural components and constructing strengthened parts. Automatic steel, reinforced-concrete, aluminium members, and cold rolled framework construction code inspections guarantee that buildings follow the requirements of United states, Canadian, and international specifications. The outcome and view choices are simple and useful. Any of the illustrations accessible upon completion of study include finalised member configuration, deformed configuration per load case or modal evaluation moments, tensile stress, and axial-force illustrations, segment response visuals, and visualization of time-dependent separations. SAP2000 produces documentation for image processing instantaneously.

4. ANALYSIS OF BRIDGE SUPER STRUCTURE

In this section the T-bar and box girder connect have been displayed and examined in SAP2000. System

- Open SAP2000V14
- Go to record and snap on new model then discourse box will opens.

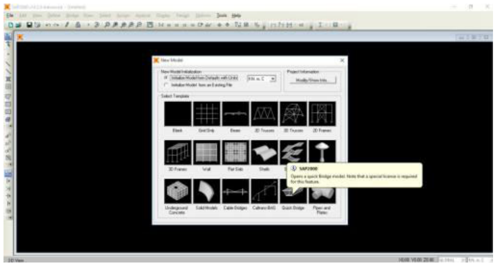


Fig 5.1: preference window.

After the inclination window, T beam connect model has chosen just as all information withrespect to Reviewed article.

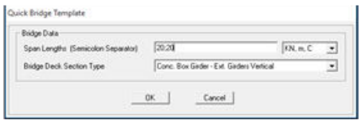
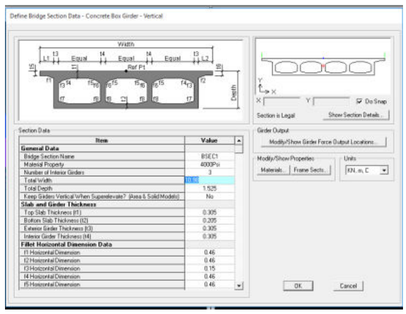


Fig 5.3: Box girder bridge model selection.

After the preference window, Box girder bridge model has chosen just as all information withrespect to Reviewed article.



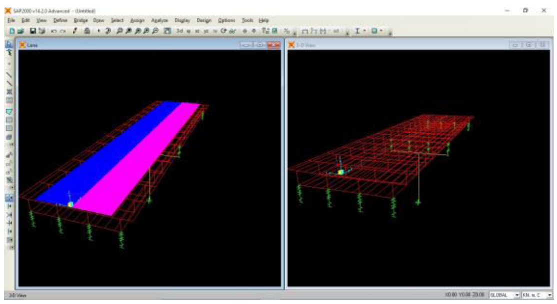


Fig 5.6: 3d model of Box girder bridge.

Mesh generation is the act of creating a work that approximates a mathematical area." Common uses are for delivering to a PC screen, for example, limited component examination. Cross section is a typical term to downgrade the pre-handling period of the Finite Element Analysis (FEA). It is an instrument that specialists use to finish their investigation of a specific structure.

- Now select all the base hubs of the structure with the assistance of set select mode device to allot fixed backings.
- Go to Assign, joint, control at that point limits exchange box opens click on fixed backings, at that point fixed backings were allotted to show
- Select circulated loads.
- Load design name is dead load.
- Click on add to existing loads.

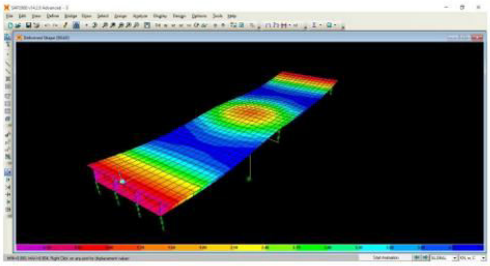


Fig 5.9: Dead load deflection of Box Girder Bridge.

In the above picture shows the deformation of Box Girder Bridge model. Dead load applied on connect and the red demonstrate the minimum deformation and blue shows maximum deformation. high deformation happens at the middle. Since there is no help at focus, so there is a high possibility of the deck to get bowed. low deformation shows up at supports and we can obviously ready to find in the above picture. All together greatest deformation is 4 mm.

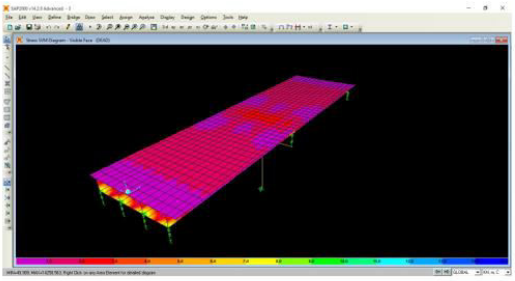


Fig 5.10: Dead load stress of Box Girder Bridge.

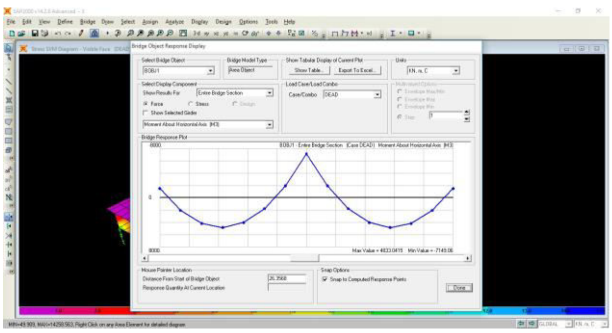


Fig 5.14: Bending moment curve along the length of Box Girder Bridge.

The above image shows, bridge forces after applying dead load. The curve is representing theentire box girder bridge section without longitudinal girders. Due to the dead load, the minimum bending moment is observed at start and end abutment of the bridge length. At middle and near the pier, there might be chance of maximum bending moment. At length ratio

0.25 and 0.75 a positive bending moment is seen in the above image.

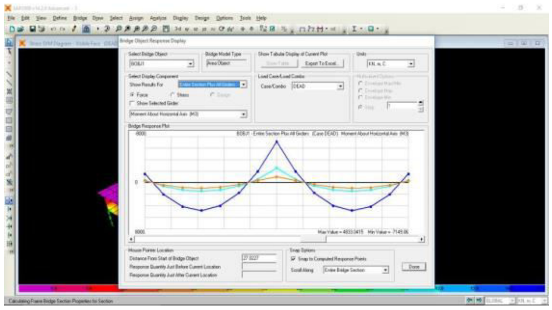


Fig 5.15: Bending moment curve along the length of Box Girder Bridge at longitudinalbeam.

The above image shows, bridge forces after applying dead load. The curve is represents the entire box girder bridge section with longitudinal girders. Due to the dead load, the minimumbending moment is observed at start and end abutment of the bridge length. At middle and near the pier, there might be chance of maximum bending moment. At length ratio 0.25 and

0.75 a positive bending moment is seen in the above image.

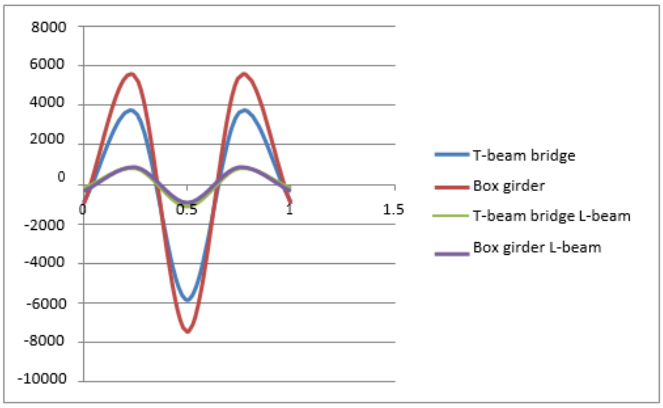
5. RESULTS AND DISCUSSION

SAP 2000 software is used to perform the modeling and analysis of bridge models. Using these bridge models, three types of lengths are considered in this work such as 40m, 60m and 80m. As well as, T beam bridge and box girder bridge super structure are considered to find out the optimum length, type of bridge model. The required dimensions to create the geometry model of the bridge are taken from reviewed articles as shown in the below table.

length ratio	T-beam bridge	Box girder	T-beam bridge Longitudinal girders	Box girder Longitudinal girders
0	-892	-986	-205.2	-341
0.25	3641	5451	817	871
0.5	-5847	-7454	-1112	-922
0.75	3641	5451	817	871
1	-892	-986	-205.2	-341

Table 6.1: Moment for dead load span 40 m bridge length.

The above table represents bending moment of dead load span of 40m bridge length. The length ratio for T-beam bridge, box girder, T beam bridge on longitudinal beam and box girder on longitudinal girder are taken.

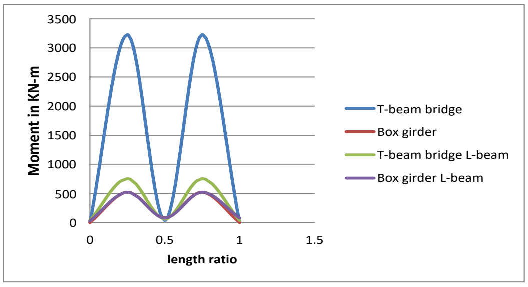


Graph 6.1: Moment for dead load span 40 m bridge length.

The graph above represents length ratio with respect to bending moment for different beams and girders at 40m bridge length for dead load. The blue line represents T-beam bridge section, the red line represents box girder section, the green line represents T beam bridge section by considering longitudinal beam and purple box represents box girder section by considering longitudinal beam. The bending moment is measured in KN-m. Before the pier, and after the pier we have maximum bending moment nearby 6000 KN-m and at the pier location, we have negative bending moment nearby 8000KN-m.

length ratio	T-beam bridge	Box girder	T-beam bridge Longitudinal girders	Box girder Longitudinal girders
0	0	0	34	27
0.25	3231	522	755	522
0.5	35	80	57	77
0.75	3231	522	755	522
1	0	0	34	77

Table 6.2: Moment for live load span 40 m bridge length.



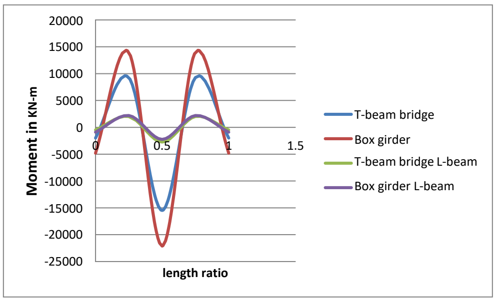
Graph 6.2: Moment for live load span 40 m bridge length.

The graph above represents length ratio with respect to bending moment for different beams and girders at 40m bridge length for live load. The blue line represents T-beam bridge section, the red line represents box girder section, the green line represents T beam bridge section by considering longitudinal beam and purple box represents box girder section by considering longitudinal beam.

The bending moment is measured in KN-m. Before the pier, and after the pier we have maximum bending moment above 3000 KN-m and at the pier location the T-beam bridge has high bending moment compared to other. The low bending moment is seen in both box girder section by considering longitudinal beam and box girder.

length ratio	T-beam bridge	Box girder	T-beam bridge Longitudinal girders	Box girder Longitudinal girders
0	-1991	-4810	-501	-904
0.25	9273	13991	2013	2199
0.5	-15482	-22111	-2747	-2242
0.75	9273	13991	2013	2199
1	-1991	-4810	-501	-904

Table 6.3: Moment for wind load span 40 m bridge length.

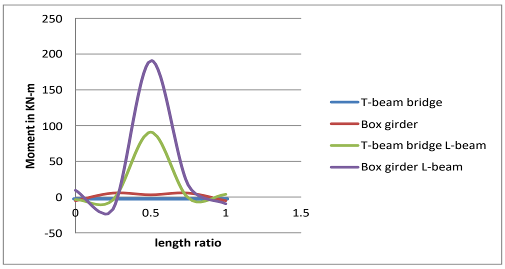


Graph 6.3: Moment for wind load span 40 m bridge length.

The graph above represents length ratio with respect to bending moment for different beams and girders at 40m bridge length for wind load. The blue line represents T-beam bridge section, the red line represents box girder section, the green line represents T beam bridge section by considering longitudinal beam and purple box represents box girder section by considering longitudinal beam. The bending moment is measured in KN-m. Before the pier, and after the pier we have maximum bending moment above 10000 KN-m and, we have negative bending moment above 20000KN-m. The high bending moment is seen in box girder section by considering longitudinal beam. the low bending moment is observed at T- beam bridge section by considering longitudinal beam which is nearby2000.

length ratio	T-beam bridge	Box girder	T-beam bridge Longitudinal girders	Box girder Longitudinal girders
0	-2.22	-5.12	-3.6	9.4
0.25	-2.67	5.6	-4.1	-17
0.5	-3.01	3.13	90.8	190.9
0.75	-2.67	5.6	-1.5	17
1	-2.22	-5.12	3.69	-9.4

Table 6.4: Moment for Torsion load span 40 m bridge length.

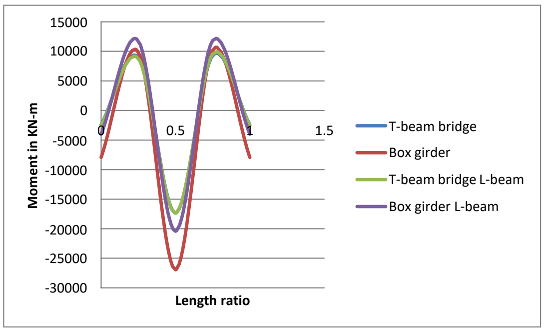


Graph 6.4: Moment for Torsion load span 40 m bridge length.

The graph above represents length ratio with respect to bending moment for different beams and girders at 40m bridge length for torsion load. The blue line represents T-beam bridge section, the red line represents box girder section, the green line represents T beam bridge section by considering longitudinal beam and purple box represents box girder section by considering longitudinal beam. The bending moment is measured in KN-m. Before the pier, and after the pier we have maximum bending moment above 150 KN-m and at the pier location the T-beam bridge has high bending moment compared to other? The low bending moment is seen in both box girder and T beam bridge.

length ratio	T-beam bridge	Box girder	T-beam bridge Longitudinal girders	Box girder Longitudinal girders
0	-2415	-7918	-2553	-4013
0.25	8993	9945	8797	11830
0.5	-17321	-26923	-17390	-20414
0.75	9313	10293	9555	11830
1	-2415	-7918	-2553	-4013

Table 6.5: Moment for dead load span 60 m bridge length.

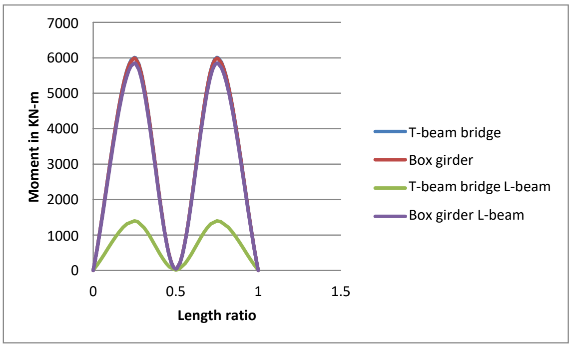


Graph 6.5: Moment for dead load span 60 m bridge length.

The graph above represents length ratio with respect to bending moment for different beams and girders at 60m bridge length for bridge load. The blue line represents T-beam bridge section, the red line represents box girder section, the green line represents T beam bridge section by considering longitudinal beam and purple box represents box girder section by considering longitudinal beam. The bending moment is measured in KN-m. In this graph almost all beams and girders seem to high compared to other loads. Before the pier, and after the pier we have maximum bending moment above 10000 KN-m and, we have negative bending moment above 25000KN-m. The high bending moment is seen in box girder section by considering longitudinal beam. The low bending moment is observed at T- beam bridge section by considering longitudinal beam which is above -15000KN-m.

length ratio	T-beam bridge	Box girder	T-beam bridge Longitudinal girders	Box girder Longitudinal girders
0	0	0	9.4	0
0.25	6008	5989	1397	5851
0.5	19	40	10.7	41
0.75	6008	5989	1397	5851
1	0	0	9.4	0

Table 6.6: Moment for Live load span 60 m bridge length.

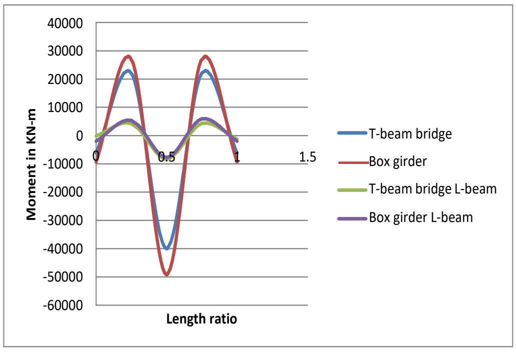


Graph 6.6: Moment for Live load span 60 m bridge length.

The graph above represents length ratio with respect to bending moment for different beams and girders at 60m bridge length for live load. The blue line represents T-beam bridge section, the red line represents box girder section, the green line represents T beam bridge section by considering longitudinal beam and purple box represents box girder section by considering longitudinal beam. The bending moment is measured in KN-m. Before the pier, and after the pier we have maximum bending moment nearby 6000 KN-m and at the pier location The box girder has high bending moment compared to other. The low bending moment is seen in T beam bridge section considering longitudinal beam which is nearby 1500KN-m.

length ratio	T-beam bridge	Box girder	T-beam bridge Longitudinal girders	Box girder Longitudinal girders
0	-6217	-9337	-125	-2032
0.25	22112	27131	4287	5375
0.5	-40037	-49213	-8311	-7759
0.75	22112	27131	4292	5898
1	-6217	-9337	-1255	-2032

Table 6.7: Moment for Wind load span 60 m bridge length.

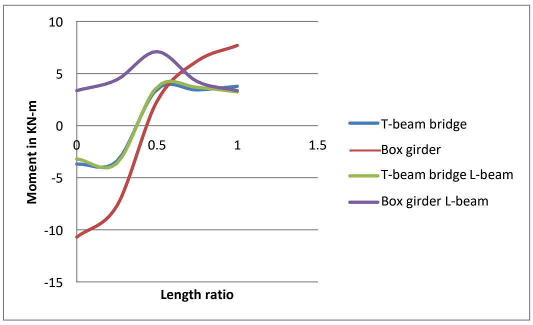


Graph 6.7: Moment for Wind load span 60 m bridge length.

The graph above represents length ratio with respect to bending moment for different beams and girders at 60m bridge length for bridge load. The blue line represents T-beam bridge section, the red line represents box girder section, the green line represents T beam bridge section by considering longitudinal beam and purple box represents box girder section by considering longitudinal beam. The bending moment is measured in KN-m. In this graph almost all beams and girders seem to high compared to other loads. Before the pier, and after the pier we have maximum bending moment above 20000 KN-m and, we have negative bending moment above 50000KN-m. The high bending moment is seen in box girder section by considering longitudinal beam. The low bending moment is observed at T- beam bridge section by considering longitudinal beam and box girder section considering longitudinal beam.

length ratio	T-beam bridge	Box girder	T-beam bridge Longitudinal girders	Box girder Longitudinal girders
0	-3.7	-10.7	-3.2	3.36
0.25	-3.42	-77	-3.61	4.4
0.5	3.49	234	3.71	7.1
0.75	3.42	62	3.67	4.23
1	3.77	7.7	3.24	-2.3

Table 6.8: Moment for Torsion load span 60 m bridge length.

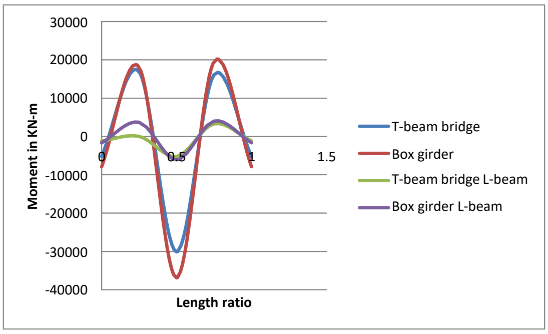


Graph 6.8: Moment for Torsion load span 60 m bridge length.

The graph above represents length ratio with respect to bending moment for different beams and girders at 60m bridge length for torsion load. The blue line represents T-beam bridge section, the red line represents box girder section, the green line represents T beam bridge section by considering longitudinal beam and purple box represents box girder section by considering longitudinal beam. The bending moment is measured in KN-m. Comparing with other load at 60m bridge length, the torsion load has low value compared to other loads.

length ratio	T-beam bridge	Box girder	T-beam bridge Longitudinal girders	Box girder Longitudinal girders
0	-5193	-7919	-1155	-1668
0.25	16919	18091	30.19	3712
0.5	-30127	-36921	-5224	-6096
0.75	16117	19553	3296	4021
1	-5213	-7919	-1156	-1653

Table 6.9: Moment for Dead load span 80 m bridge length.

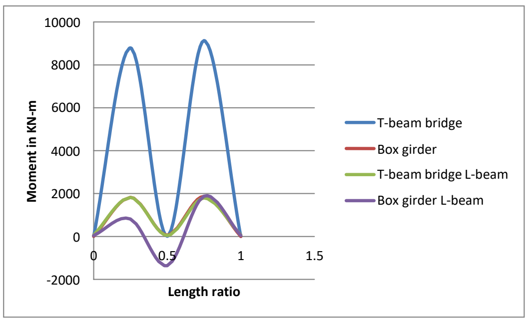


Graph 6.9: Moment for Dead load span 80 m bridge length.

The graph above represents length ratio with respect to bending moment for different beams and girders at 80m bridge length for dead load. The blue line represents T-beam bridge section, the red line represents box girder section, the green line represents T beam bridge section by considering longitudinal beam and purple box represents box girder section by considering longitudinal beam. The bending moment is measured in KN-m. Before the pier, and after the pier we have maximum bending moment nearby 20000 KN-m and, we have negative bending moment above 30000KN-m. The high bending moment is seen in box girder. The low bending moment is observed at T- beam bridge section by considering longitudinal beam.

length ratio	T-beam bridge	Box girder	T-beam bridge Longitudinal girders	Box girder Longitudinal girders
0	5.7	51	65	42
0.25	8792	1822	1822	811
0.5	9.5	59	46	-1363
0.75	9131	1870	1795	1876
1	0	53	69	45

Table 6.10: Moment for Live load span 80 m bridge length.

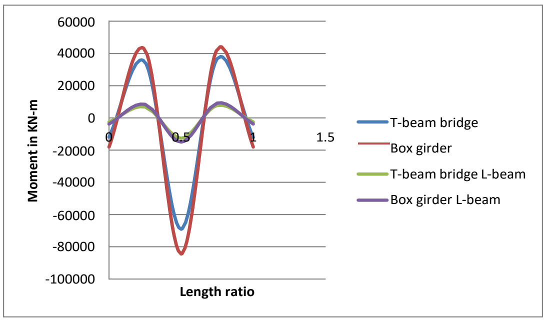


Graph 6.10: Moment for Live load span 80 m bridge length.

The graph above represents length ratio with respect to bending moment for different beams and girders at 80m bridge length for live load. The blue line represents T-beam bridge section, the red line represents box girder section, the green line represents T beam bridge section by considering longitudinal beam and purple box represents box girder section by considering longitudinal beam. The bending moment is measured in KN-m. Before the pier we have maximum bending moment above 8000 KN-m and the high bending moment is seen in T-beam bridge. The low bending moment is observed at box girder section by considering longitudinal beam.

length ratio	T-beam bridge	Box girder	T-beam bridge Longitudinal girders	Box girder Longitudinal girders
0	-11997	-18123	-2595	-3791
0.25	34541	42135	6793	8414
0.5	-69121	-84516	-12673	-14993
0.75	36719	42622	7694	9211
1	-12218	-18123	-2595	-3797

Table 6.11: Moment for Wind load span 80 m bridge length.

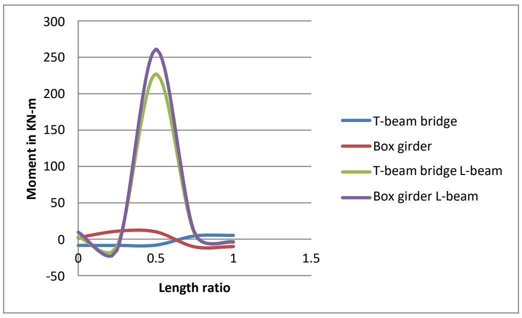


Graph 6.11: Moment for Wind load span 80 m bridge length.

The graph above represents length ratio with respect to bending moment for different beams and girders at 80m bridge length for wind load. The blue line represents T-beam bridge section, the red line represents box girder section, the green line represents T beam bridge section by considering longitudinal beam and purple box represents box girder section by considering longitudinal beam. The bending moment is measured in KN-m. Before the pier, and after the pier we have maximum bending moment above 40000 KN-m and, we have negative bending moment above 80000KN-m. The high bending moment is seen in box girder. The low bending moment is observed at T- beam bridge section by considering longitudinal beam.

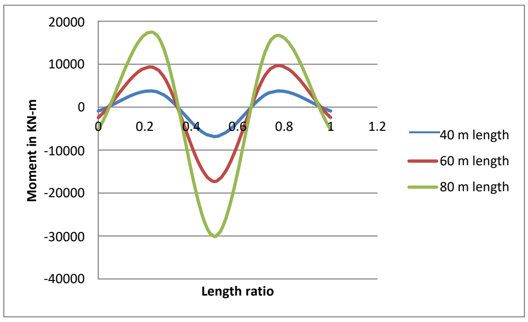
	T-beam bridge	Box girder	T-beam bridge Longitudinal girders	Box girder Longitudinal girders
0	-8.6	2.11	3.12	9.5
0.25	-8.6	10.9	-10.24	-15.2
0.5	-8.3	10.2	227	261
0.75	4.4	-10.67	7.5	8.3
1	5.2	-10.2	-3.21	-4.1

Table 6.12: Moment for Torsion load span 80 m bridge length.



Graph 6.12: Moment for Torsion load span 80 m bridge length.

The graph above represents length ratio with respect to bending moment for different beams and girders at 80m bridge length for torsion load. The blue line represents T-beam bridge section, the red line represents box girder section, the green line represents T beam bridge section by considering longitudinal beam and purple box represents box girder section by considering longitudinal beam. The bending moment is measured in KN-m. The maximum bending moment is observed at above 250KN-m on box girder section considering longitudinal beam. The low bending moment is seen in both box girder and T beam bridge.



Graph 6.13: Moment comparison for different span of T beam bridge.

The graphical representation of bending moment for different span on T beam bridge is shown above. The span lengths taken are 40m, 60m and 80m of length. The green line represents 80m length, the red line represents 60m of length and blue line represents 40m of length. The bending moment is measured in KN-m. From the graph, it is evident that 80m of span length shows maximum bending stress compared to other span length. The minimum bending stress is observed at 40m span length.

6. CONCLUSION

1. Bridge analysis is a complicated task while performing manually. But using bridge design codes, 3D simulation is performed in SAP 2000 software. Different types of bridge models' templates are available in this software. Within short time, we can perform the analysis.

2. Deformation, stresses, bending moments are considered in this work. But this work is mainly concentrated on bending moment along the length ratio of different bridge structures.

3. When compared to all loads, structure mainly affects mainly due to dead load. Torsion load effect on bridge structure is found to be negligible.

4. For different loads, T Beam Bridge has low bending moments compared to box girder model.

5. The maximum bending moment is observed at 0.25 and 0.5 length ratio. 33.2% of bending moment is reduced by T Beam Bridge when compared to Box Girder Bridge. 84% of bending moment is reduced with longitudinal beam when compared to without longitudinal beam in T beam Bridge.

6. If the length of the span increases, bending moment increases. Nearly 66.6% of bending moment is increased for 80m length span when compared to 40m length span of the bridge.

7. After analyzing all the data reports, T Beam Bridge with short span has minimum bending moment and it gives more life.

8. If the length of the bridge is increased, the pre stress effect is very important to reduce more bending moment.

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