Analysis and Design of Concrete T-Beam Girder Bridge and Box Girder Bridge: A Comparative Study

A Thesis

Submitted in Partial Fulfillment of the Requirement for the Award of the Degree
of

Master of Technology

In

Structural Engineering

Under the supervision of

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CERTIFICATE

This is to certify that the work which is being presented in the thesis titled "**Analysis and Design of Concrete T-Beam Girder Bridge and Box Girder Bridge: A Comparative Study,"** in partial fulfillment of the requirements for the award of the degree of Master of Technology in "Structural Engineering," Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by SHIWALI VERMA (152663) during a period from July 2016 to May 2017 under the supervision of Dr. GYANI JAIL SINGH Assistant Professor, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

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DECLARATION

I hereby declare that the work reported in the M.tech thesis entitled "**Analysis and Design of Concrete T-Beam Girder Bridge and Box Girder Bridge: A Comparative Study"** submitted at **JayPee University of Information Technology, Waknaghat, Solan(H.P)** is an authentic record of my work carried out under the supervision of **Dr.Gyani Jail Singh.** I have not submitted this work elsewhere for any other degree or diploma.

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Date:- **Shiwali Verma**

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LIST OF SYMBOLS

RCC	Reinforcement Concrete
AASHTO	American Association of State Highway and Transportation officials
IRC	Indian Road Congress
SIDL	Superimposed Dead Load
DL	Dead Load
LL	Live Load
M	Bending Moment
f_y	Yield Strength
f_u	Ultimate Tensile Strength
A_{st}	Area of Steel
6_{cbc}	Permissible Flexural Strength in Concrete
6_{st}	Permissible Flexural Strength in Steel

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ABSTRACT

The reason for present review is the plan of Bridge structure for a few of span. The most clear decision of this span is T-Beam and Box Girder Support. They have their own particular attributes and impediments as T-Beam has simple development mythology, whereas girder and box Girder has complex and exorbitant formwork. In present review a two/four path essentially bolstered RCC T-Beam Girder Extension and Box Girder Bridge was investigations for dead load and IRC moving load. The dead load computation has been done physically and for live load straight examination is done on CSI Bridge 2016. The objective of study is to decide most positive alternative from above extension. The choices in view of clear component of designing that are security, serviceability and economy. Taking after these viewpoints a plan for T-Beam Bridge and Box Girder has been performed. After estimation two basic material utilization steel and cement the most practical has been chosen. This review is on the premise of snapshot of resistance of area, shear limit of segment and practical arrangement from both T-Beam and Box Girder Bridge Connect. T-Beam and Box Girder Bridge connect decks are one of the foremost sorts of cast set up solid decks. T-Beam connect decks comprise of a solid piece basic with supports. The limited component strategy is a general technique for basic investigation in which the arrangement of an issue in continuum mechanics is approximated by the examination of an array of limited components which are interconnected at a limited number of nodal focuses and speak to the arrangement area of the issue. A basic traverse T-Beam and Box Girder Bridge Extension was broke down by utilizing I.R.C. loadings as a one dimensional structure. A similar T-Beam and Box Girder Bridge Extension is examined as a three-dimensional structure utilizing limited component plate for the deck section and bar components for the principle bar utilizing programming CSI Bridge 2016. Both models are subjected to I.R.C. Loadings to deliver greatest twisting minute. The outcomes acquired from the limited component model are lesser than the outcomes got from one dimensional examination, which implies that the outcomes got from manual estimations subjected to IRC loadings are preservationist.

CHAPTER 1

INTRODUCTION

1.1 GENERAL

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.

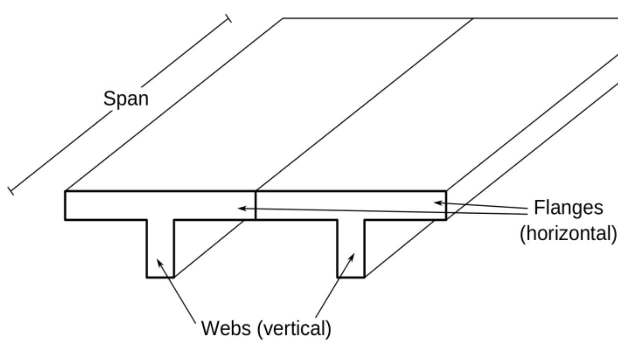


Figure 1.1. T-Beam

1.1.1 T-BEAM

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.

1.1.2 GIRDER

Girder is a term used in construction to refer to a supporting, horizontal beam that can be made from a variety of construction materials such as stainless steel, concrete, or a combination of these materials. A girder bridge is a basic, common type of bridge where the bridge deck is built on top of such supporting beams, that have in turn been placed on piers and abutments that support the span of the bridge. The types of beams used for girder bridges are usually either I-beam girders, so called because their shape is reminiscent of a capital Roman letter I, or box girder beams that are made of steel or concrete and shaped like an open box. Girder bridges are most commonly used for straight bridges that are 33-650 feet (10-200 m) long, such as light rail bridges, pedestrian overpasses, or highway fly-over. The longest girder bridge in the world is 2,300 feet (700 m) long and located in Brazil.

Figure 1.2. Girder (as usually built)

1.1.3 BOX GIRDER

A Box Girder Bridge is a Bridge in which the primary Beam involve girder in the shape of an hollow box. The box girder typically involves either prestressed concrete, structural steel, or a composite of steel and reinforced cement. The box is ordinarily rectangular or trapezoidal in cross-area. Box Girder Bridge is generally utilized for highway flyovers and for present day elevated structures of light rail transport. Although regularly the crate box girder bridge is a type of beam bridge, box girder may likewise be utilized on cable stayed bridges and different structures**.**

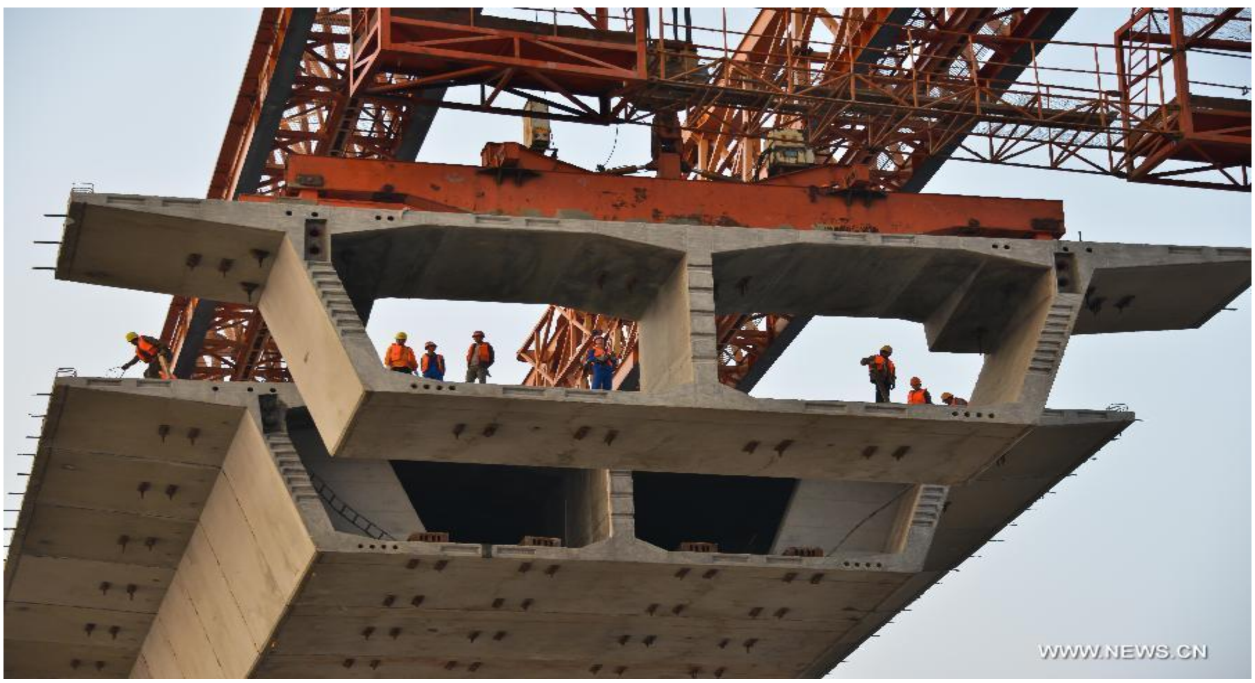


Figure 1.3. Box girder

In this case we considered three codes of vehicles loads in bridge analysis:-

- Indian Standard, Indian Road Congress (IRC codes) – Class AA and Class A
- AASHTO-LRFD Bridge Design Specifications – HL-93K and HL-93M

1.2 COMPUTERS AND STRUCTURES

CSI is an structural and earthquake building programming organization established in 1975 and situated in Walnt River, California with extra office area in New York The basic analysis and design programming CSI deliver incorporate SAP2000, CSi-Bridge, ETABS, SAFE, PERFORM-3D, and CSi COL. CSI-Bridge 2016v1811 as the name suggests is worked for the structural analysis and outline of bridges of different sorts (Prestressed I-Girder, Box Girder, Steel Girder, Curve).

1.3 ADVANTAGES OF T-BEAM AND BOX-GIRDER

1.3.1 ADVANTAGES

- Beam bridges are helpful for short spans.
- Long distances are normally covered by placing the beams on piers.
- It has simply geometry.
- Easy to cast in construction.
- It mostly adopted Bridge.
- Slab act as monolithically with beam.

Box-Girder

- Reduces the slab thickness and self-weight of bridge
- Cost effective
- Greater strength per unit area of concrete
- Quality assurance, as precast girders are made off-site

1.4 PARAMETERS

The design parameters are check and verify by the structural analysis program (**CSI BRIDGE**).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.

CHAPTER 2

LETRATURE REVIEW

- **N.K Paul,(2011)[1]** In this review, it is exhibited that, utilization of super elastic shape memory alloy bars consolidating with steel reinforcement with some rate in T-Beam concrete bridge longitudinal girder works successfully exceptionally well. The load carrying capacity can be increased. The failure mechanism of a reinforced concrete girder is demonstrated great utilizing FEA, and the failure load anticipated is near the failure load measured during trial testing. The whole load distortion reaction of the model created coordinates well with the reaction from trial result. This gave trust in the utilization of ANSYS 11.0 and the model created.

- **R.Shreedhar Spurti Namadapur,(2012)[2]** A straightforward span T-beam extension was analyzed by utilizing I.R.C. determinations and loading (dead load and live load) as a one dimensional structure. Finite Element analysis of a three-dimensional structure was done using Staad pro programming. Both models were subjected to I.R.C. Loadings to convey most outrageous bending moment. The results were broke down and it was found that the results got from the limited component model are lesser than the results got from one dimensional examination, which suggests that the results got from I.R.C. loadings are traditionalist and FEM gives practical design.

- **Amit Saxena,(2013)[3]** Dead load bending moment and Shear forces for T-Beam girder are lesser than two cell Box Girder Bridge. Which empower designer to have lesser heavier region for T-Bar Support than Box Brace for 25 m span. Moment of resistance of steel for both has been evaluated and conclusions drawn that T-Beam Girder has more noteworthy utmost with respect to 25 m span. Cost of concrete for T-Beam Girder is under two cell Box Girder as sum required by T-Beam Girder.

- **Mahesh Pokhrel,(2013)[4]** General design and analysis of a run of the mill T-Girder RCC Bridge has been completed with Assessment of reaction and design theories as per three worldwide codes to be specific IRC, AASHTO and Euro code. Among of all, the Euro code gave most moderate design. It might be because of the utilization of qualities load utilized with no component. Euro code is compensated for extensive variety of pertinence and scope so it can be referred for the design of bridges. In which truck loading is utilized for reaction in the superstructure and in which non-direct conduct of pier and abutment is not considered. Considering nonlinearity is one of the suggestions for the future work for more practical outcome.

- **M.G Kalyan Shetti,(2013)[5]** This review is done for four path and six Path scaffolds of traverses 15m, 20m, 35m, 30m, 35m utilizing IRC class A loading by differing various longitudinal girder. From the perceptions, it can infer that-load figure acquired by Courbon's technique is steady for all ranges and this demonstrates the impact of variety of traverse is not considered. In which need to revise the condition of load variable given by Courbon's hypothesis. The remedy calculate for each traverse by utilizing an allegorical capacity y= a+bx+cx2.

Load factor by modified Courbon's equation: By considering correction factor, Courbon's equation for Load factor is modified as

$$\mathbf{P_i = p/n[1 + \frac{ne.di}{\sum di2}] x\ correction\ factor}$$

Where,

P = total live load

e = eccentricity of the live load (or c.g of loads in case of multiple loads),

di = distance of girder i from the axis of the bridge,

n = number of longitudinal girders.

- **Supriya Madda,(2013)[6]** The review is done for two lane and four lane bridges, for two lane bridges, all the different span gave sensible outcome with the exception of 35m in light of the fact that its redirection/traverse proportion is (2.51x10-3)very near allowable limit(2.66x10-3). Furthermore, prompt serviceability issues in future. Also, four path spans, avoidance/traverse proportion are inside allowable confine up to 30m for all the blend of longitudinal support. However, for 35m traverse of 3 longitudinal girder (2.66x10-3) and 5 longitudinal girder (2.19x10-3) there is no minor distinction amongst real and passable esteem. Subsequently it is very conceivable that they may prompt serviceability issue.

- **Rajamoori Arun Kumar,(2014)[7]** Bending moment and shear force for PSC T-Beam Girder are lesser then RCC T-Beam girder bridge. Which allow designer to have lesser heavier section for PSC T-Beam Girder then RCC T-Beam Girder for 24m span. Moment of resistance of PSC T-Beam Girder is more as compare to RCC T-Beam Girder for 24 m span. Cost of concrete for PSC T-Beam Girder is less then RCC T-Beam Girder.

- **Manjeetkumar M Nagarmunnoli,(2014)[8]** Concentrate about on the effects of deck thickness in RCC T-Beam Bridge. For every decrement in deck segment thickness reduces the bending stiffness by around 40% to half. Stresses acting in the deck under truck wheel load are around 55 times more unmistakable than the allowable weights. For every decrement in the deck piece thickness from 280 mm to 150 mm would profoundly assemble the part slant by around 31% under the wheel stack. The uncracked depiction of inaction decays by around 45% for every decrement in the deck area thickness from 280 mm to 150 mm subjected to IRC Class A truck stacking. The Curve force made in the deck piece reduces by around 0.43% for every decrement in the deck segment thickness.

- **Praful NK,(2015)[9]** The near review was directed in view of the diagnostic displaying of basically bolstered RC T-pillar connect by rational method and Finite element method utilizing Staad pro. In view of this review Courbon's method gives the normal outcome with deference BM values in the longitudinal girder when contrasted with Guyon Massonet technique. While Guyon Massonet's strategy belittles the BM values when contrasted and Courbon's method.The Staad professional outcome nearly coordinates with the qualities gotten by Courbon's technique for class AA followed vehicle. For class AA Followed vehicle the Staad professional outcome is decreased by (0.01%) when contrasted with Courbon's technique and increment in result contrasted with Guyon-massonet strategy by (34.22%) for Bowing Moment.For class AA Followed vehicle the Staad star result is lessened by (33.73%) when contrasted with Courbon's strategy and increment in result contrasted with Guyon-massonet technique by (26.93%) for Shear Constrain.

- **Pallvi rai,(2016)[10]** To shield connect from blast loading, there is need to consider blast loading at the period of design of structure. For viably existing structures, retrofitting system can be gotten or an effect limit can be made all through the structure. It was found from the result that a typical T-Beam bridge will bomb due to effect stack associated by an impact of 226.8 kg of explosive above and underneath the augmentation deck. Some bit of the augmentation is depended upon not to bomb after utilization of effect load if region of effect is near the portion. In case affect happens close support, a segment of the props on various extents are typical not, It can be settled from this audit a common T-Beam connect with solid segments besides, wharfs is not prepared for restricting specific impact stacking.

- **Sandesh Upadhayaya,(2016)[11]** To obtain even better working results the T-beam configuration deck slab can be subjected to pre/post tensioning. The pre-stressing force can be applied more conveniently and computation of required jacking force is also simple. This problem can be overcome with greater ease in case of T-Beam deck slab configuration.

- **Phani Kumar.Ch,(2016)[12]** The different span depth proportion are taken for the analysis of box bridge spans, and for every one of the cases, deflection and stresses are inside as far as possible, As the profundity of box brace diminishes the prestressing power diminishes and of links abatements. New code(IRC:112)requires expanded cover for pre tensioned stands and post tensioned channels, which will prompt expanded thickness of networks and deck slab.

CHAPTER 3

OBJECTIVE AND RESEARCH METHODOLOGY

3.1 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 CSI Bridge software
- 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.

3.2 METHODOLOGY

3.2.1 DEAD LOAD ANALYSIS

Dead load response can be straight forwardly taken from the CSI-Bridge 2016 model or can be physically figured by considering the dead load because of superstructure (Brace, Stomach and Deck piece). Longitudinal moments are figured similarly by duplicating responses with the longitudinal unconventionality which is the separation between the centerline of wharf and bearing. The response on each bearing because of brace, stomach and deck piece and because of Superimposed Dead Load, SIDL (wearing coat and crash hindrance) is discovered independently.

3.2.2 LIVE LOAD ANALYSIS- The live load for each heap mix can be computed physically and in addition with the assistance of a CSI-Connect display. For the CSI-Connect display vehicle definitions must be given according to IRC 6-2010, for the heap counts and position of load must be inputted according to IRC 6-2010. A point important is that CSI-Connect requires the separation to the centerline of the furthest wheel far from the inception along the transverse course, while amid manual figuring of transverse minutes the unconventionality of the focal point of gravity from the centerline of the carriage-way is utilized. According to IRC6-2014 for 2lane and carriage way width 5.3m (1.2x2+2.9=5.3) basic load blends are conceivable.

- One Class70R + One Class A
- Three Class A

One Class 70R; this configuration is checked for criticality as it generates maximum transverse moment. The reactions on each bearing are noted down from the CSI-BRIDGE model for design of bent cap and for the calculation of transverse and longitudinal moments.

3.2.3 LOAD COMBINATIONS-

The following load combinations will be considered in the analysis for determination of critical values of bending moment and shear force.

1. DL + SIDL (without live load)

2. DL + SIDL + LL-70R + Longitudinal Frictional Strengths

3. DL + SIDL + LL-70R+Class A + Longitudinal Frictional Strengths

4. DL + SIDL + LL-3 Class A + Longitudinal Frictional Powers

5. DL + SIDL + LL-70R + Longitudinal Frictional Powers + Wind

6. DL + SIDL + LL-70R+Class A + Longitudinal Frictional Powers +Wind

7. DL + SIDL + LL-3 Class A + Longitudinal Frictional Powers + Wind

8. DL + SIDL + Long. Seismic Drive (without live load)

9. DL + SIDL + 20% LL-70R + Long. Frictional Strengths + Long. Seismic Constrain

10. DL + SIDL + 20% LL-70R+Class A + Long. Frictional Strengths + Long. Seismic

Force

11. DL + SIDL + 20% LL-3 Class A+ Long. Frictional Powers + Long. Seismic Constrain

12. DL + SIDL + Long. Frictional Strengths + Trans. Seismic Compel (without live load)

13. DL + SIDL + 20% LL-70R+Long. Frictional Strengths + Trans. Seismic Constrain

14. DL + SIDL + 20% LL-70R+Class A + Long. Frictional Strengths + Trans. Seismic

Drive

15. DL + SIDL + 20% LL-3 Class A+ Long. Frictional Strengths + Trans. Seismic forces

Just 20% of Live Load is taken for the load combination including Seismic powers under The presumption that exclusive 20% of the live load follows up on the super-structure in case of an Earthquake. (IRC 006-2014). The vertical force, flat constrain in transverse and longitudinal course and Moments in transverse and longitudinal heading are discovered for these heap blends at the base of wharf and base of establishment. All heap cases are checked on the off chance that they are inside allowable points of confinement of worries in steel and concrete.

3.2.4 BENT DESIGN

The area of concrete required for pier to resist axial load is calculated by isolating the most extreme axial load an incentive among all the heap blends by the permissible stress in concrete for the individual load case. The range of steel gave regardless might not be under 0.3% of the gross sectional region of concrete (IRC 21-2000). The cross-sectional range of longitudinal reinforcement should not be under 0.8% nor over 8% of the gross cross-sectional zone. (IRC 21-2000). According to code, the measurement of transverse reinforcement of any sort should not be short of what one quarter the distance across of the biggest longitudinal bar in that region of the section and for no situation under 8mm.

The pitch of transverse reinforcement won't not outperform 300mm or the base of the smallest parallel estimation of the area or 12 times the width of the tiniest longitudinal support in the section. It may be seen that allowable stress in steel additionally cement is extended by 33% for wind stack case and significantly for seismic cases. Base of the adjust and all moment are recalculated for lever arm remove by the depth of the footing.

3.2.6 DESIGN OF BENT CAP

Here only the critical reactions on bearings on one side of the Bent along the transverse direction are considered for each load case. Bent cap is designed at the face of the bent, which have higher values of shear force and moment and at a distance 'd' away from the face of the bent, where d is the effective depth, where the forces and moments are lower thereby reducing the reinforcement required. Checks for corbel action are performed where, if a/d >1, the bent cap is designed as a cantilever beam. The impact factor is calculated for class 70R and class A vehicle, and the total shear force and bending moment are adjusted accordingly. The shear force and bending moment due to self-weight of bent cap, bearing pedestal, dirt wall and centrifugal forces are also calculated and added to the obtained values. For the torsion (longitudinal moment) values in the bent cap, the equivalent bending moment and equivalent shear force are calculated as per IRC 21-2000, and the values are added to the values of shear force and bending moment already calculated. Design is carried out at bent face and at 'd' distance away from face of the bent by considering the maximum value of shear force and bending moment by working stress method where,

Effective depth required, d_{req} = (M/Qb)1/2

where d_{req}- Effective depth required

M – Bending Moment at the section

Q = (1/2) x j x k x σcbc

j = 1 – (k/3)

k = (280/(3 x σcbc)) / (280/(3 x σcbc) + σst)

σcbc & σst are the permissible flexural strength in steel and concrete respectively.

Area of steel required, Ast $_{req}$ = M / (σst x j x d)

Note : Value of Q & j varies for each load case as permissible stresses in steel and concrete are increased for wind by 33% and seismic case, it is increased by 50%. Side face reinforcement of 0.05% of gross area is provided on each face. The sections are also designed for shear and torsion by providing the appropriate reinforcement as per the design procedure in IRC 21-2000

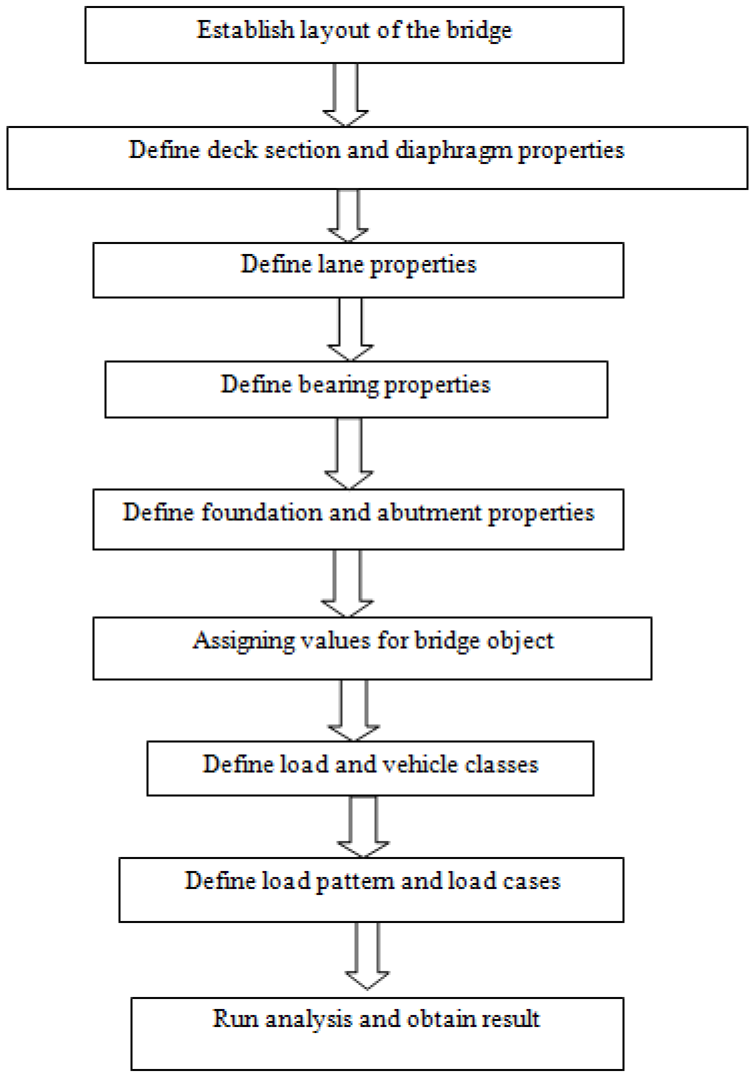
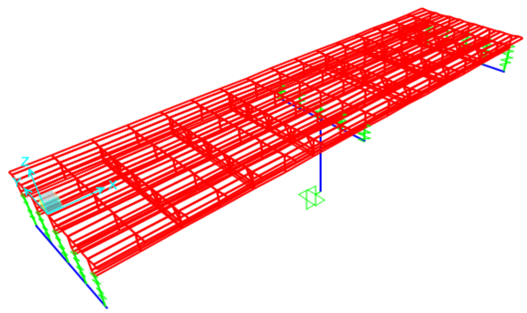


Figure 3.1.6. Steps to model the bridge in CSI-BRDIGE 2016

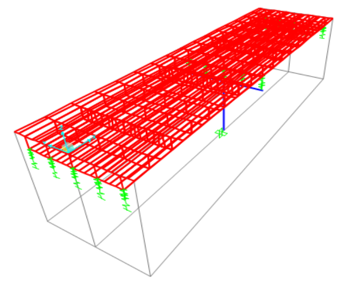
CHAPTER 4

MODELING OF T-BEAM AND BOX GIRDER

4.1 Modeling of Girder Bridges



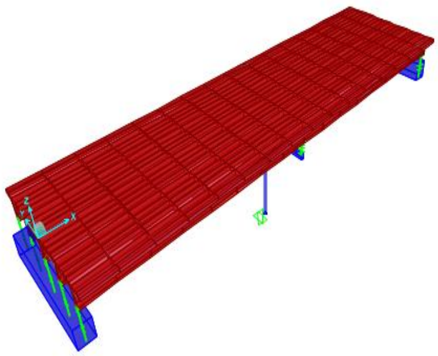
(a) T- Beam



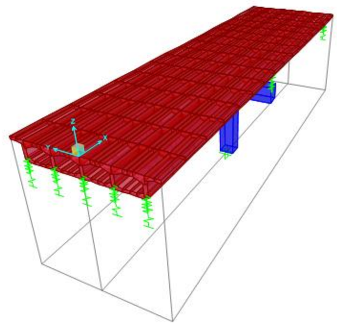
(b) Box girder

Figure 4.1.T-Beam Bridge and Box Girder

4.1.2 . 3D VIEW OF GIRDER BRIDGES



a) T-Beam



b) Box Girder

Figure 5.1.2. 3D view of T-Beam Bridge and Box Girder

4.1.3 LOAD ANALYSIS

The various load cases considered for the design on the superstructure are:

- Dead Load (Girder + Deck Slab + Diaphragm)
- Super-imposed Dead Load (Crash Barrier + Wearing Coat)
- Live Load Cases
- Class 70R eccentric
- Class 70R on the inner girder
- Class 70R + 1 Class A

The live load cases shown above are for a 2 lane carriage way. The live load combinations may be changed based on the carriageway width as per IRC 6-2014. The shear force and bending moment for each of these load cases are determined at a distance, ‘d’ away from the support m, at $0.25l_{eff}$ from the support and at the mid-span. The section is designed for the flexure requirement at mid-span. The longitudinal reinforcement obtained may be curtailed at a section of $0.25l_{eff}$ from the support based on the moments at that section.

CHAPTER-5

ANALYSIS AND DESIGN OF T-BEAM BRIDGE AND BOX GIRDER BRIDGE

FOR 20 m SPAN

Table 5.1 Specification of T-Beam and Box girder

Specifications	T-Beam/Box Girder
Span of the Bridge	20 m
Width of the Bridge	7.2 m
Over all depth	1.52 m
Number of Lane	2
Lane width	3.6 m
Centerline offset	1.8 m
Number of interior girder	3
Girder width	10.98 m
Slab thickness	0.305 m
Diaphragm thickness	0.3 m
Diaphragm depth	1 m
Abutment depth t_3	1.52 m
Abutment width t_2	1.22 m
Vehicles IRC	Class AA; Class70R; Class A
Load case	Dead, Move (linear static),Wind load Effect and Torsion

Table 5.1(a) Dead load moment of T-Beam and Box girder

Layout line distance	Moments (kN-m)	
	T-Beam	Box girder
0	-824	-1998
10	3582	5376
20	-6444	-8895
30	3582	5376
40	-824	-1998

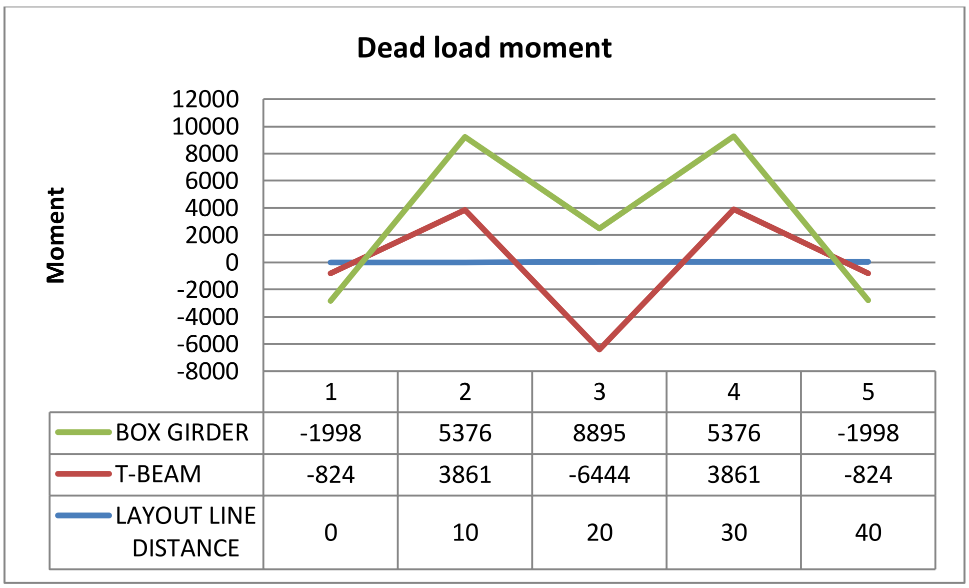


Figure 5.1. Variation of dead load moment in T-Beam and Box Girder

Table 5.2 Dead load moment of T-Beam and Box girder(entire section plus all girder)

Layout line distance	Moment kN-m	
	T-Beam	Box Girder
0	-202	-338
2.5	813	863
5	-1100	-912
7.5	815	863
10	-202	-338

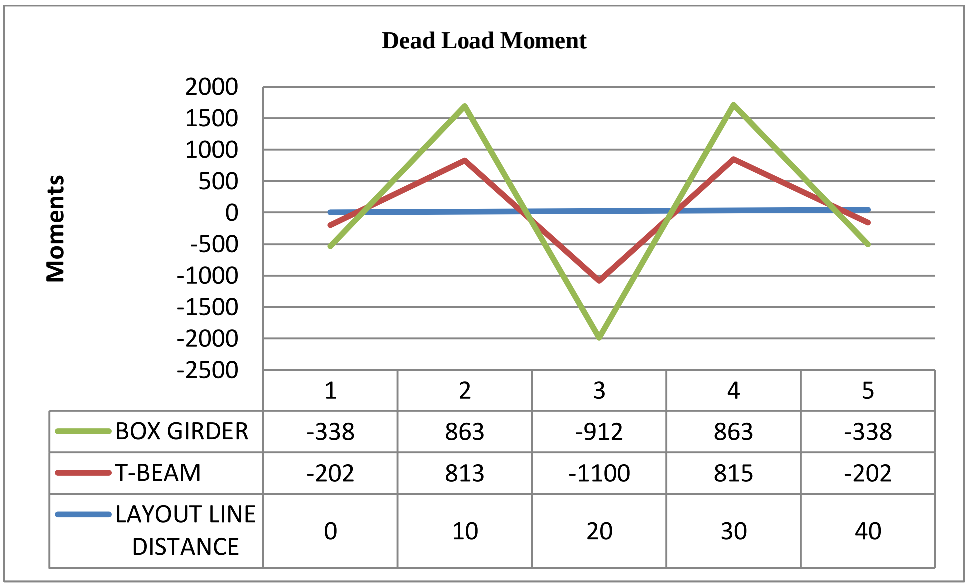


Figure 5.2. Variation of dead load moment in T-Beam and Box Girder Plus all Girder

Table 5.3 Live load moment of T-Beam and Box girder

Layout line distance	Moment KN-m	
	T-beam	Box Girder
0	0	0
10	3225	518
20	33	75
30	3225	519
40	0	25

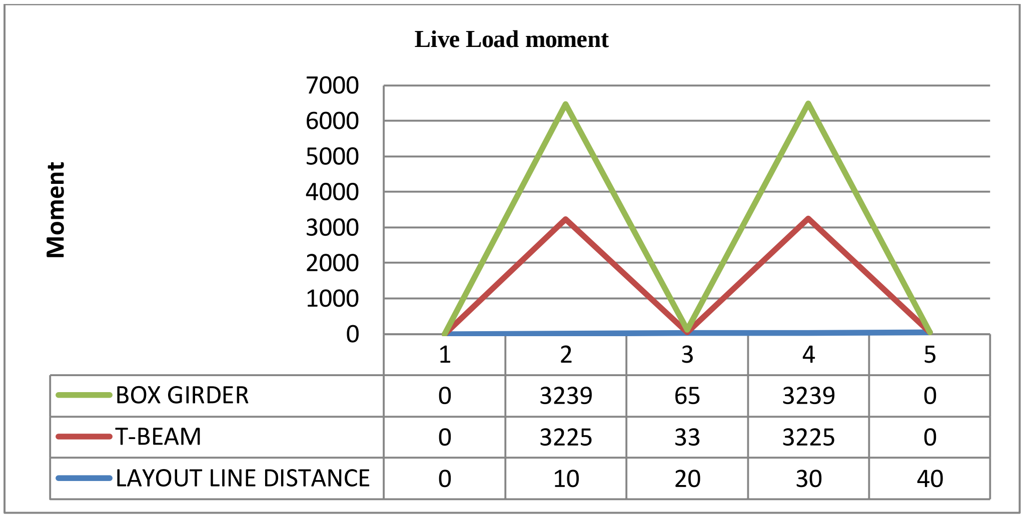


Figure 5.3. Variation of Live load moment in T-Beam and Box Girder

Table 5.4. Live load moment of T-Beam and Box girder Plus all girder

Layout line distance	Moment kN-m	
	T-Beam	Box Girder
0	32	25
10	750	518
20	54	75
30	750	519
40	32	25

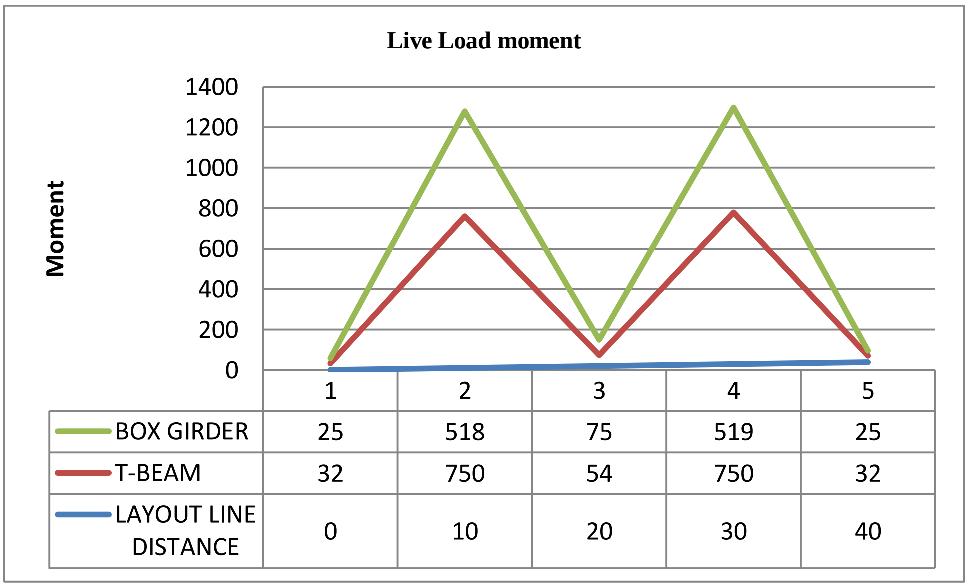


Figure 5.4. Variation of Live load moment in T-Beam and Box Girder Plus all Girder

Table 5.5 Wind load moment of T-Beam and Box girder

Layout line distance	Moment KN-m	
	T-Beam	Box Girder
0	-1979	-4797
10	9268	13412
20	-15467	-21349
30	9268	13412
40	-1979	-4797

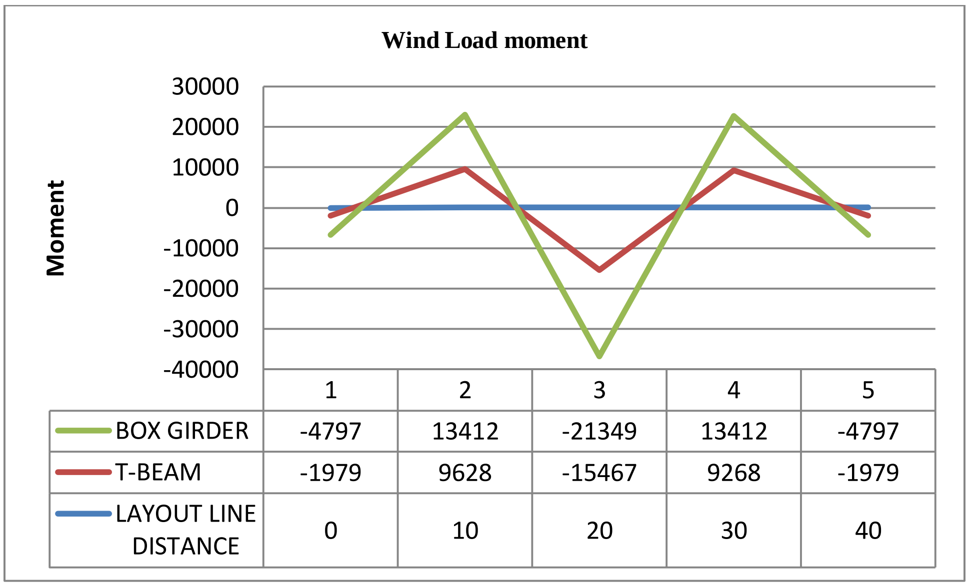


Figure 5.5. Variation of Wind load moment in T-Beam and Box Girder

Table 5.6. Wind load moment of T-Beam and Box girder

Layout line distance (m)	Moment kN-m	
	T-Beam	Box Girder
0	-486	-811
10	1956	2072
20	-2641	-2190
30	1956	2072
40	-486	-811

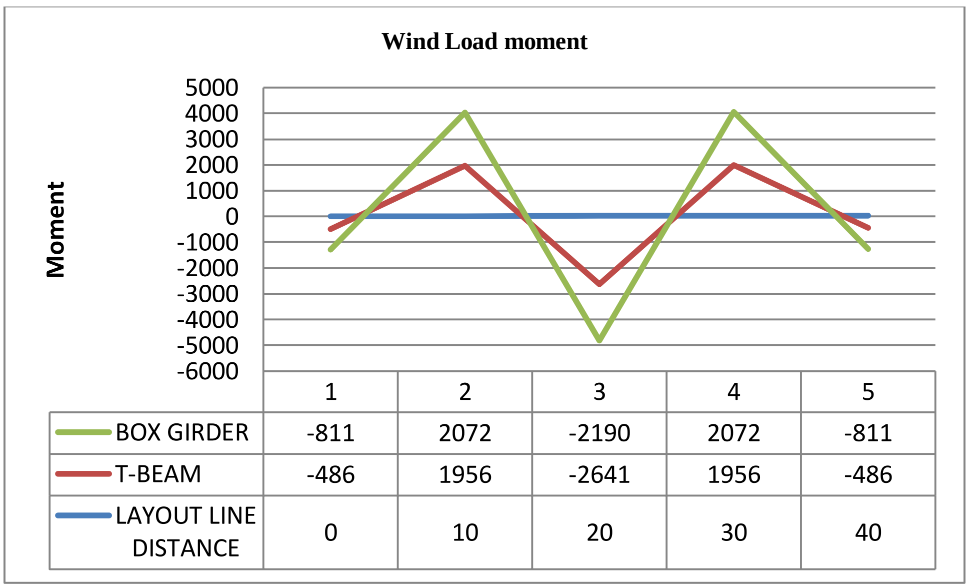


Figure 5.6. Variation of Wind load moment in T-Beam and Box Girder Plus all Girder

Table 5.7. Torsion load moment of T-Beam and Box girder

Layout line distance (m)	Moment kN-m	
	T-Beam	Box Girder
0	-1.79	-4.09
10	-1.89	4.3
20	-1.99	2.07
30	1.86	2.24
40	1.726	2.4

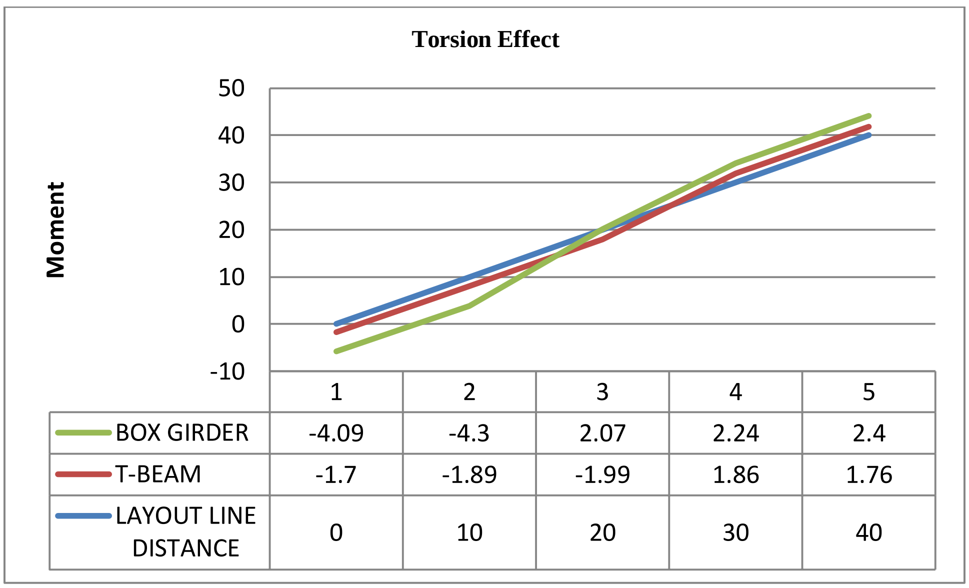


Figure 5.7. Variation of Torsion load moment in T-Beam and Box Girder

Table 5.8. Torsion load moment of T-Beam and Box girder Plus all Girder

Layout line distance (m)	Moment kN-m	
	T-Beam	Box Girder
0	-2.4	8.3
10	-3.3	-14
20	88.9	174.4
30	-0.8	14
40	2.43	-8.3

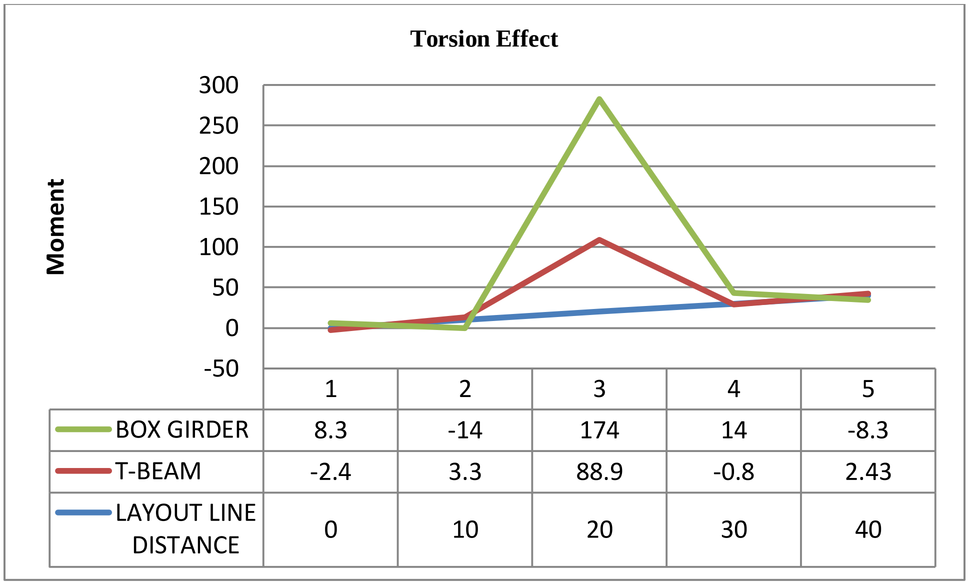


Figure 5.8. Variation of Torsion load moment in T-Beam and Box Girder Plus all Girder

Dead load moment (figure 5.1 to figure 5.2) because of accepted sufficient segment has been computed and examined with graph. The analysis demonstrates T-Beam Girder has delivered less moment than Box Girder unit. This implies T-Beam Girder has less substantial area than Box Girder.

Live load moment (figure5.3 to figure5.4) examined with graph. The analysis indicated T-Beam Girder has less moment than Box Girder unit. Most extreme moment of box girder is 3239m and lesser T-Beam moment is 3223m.

Wind load moment and Torsion impact of Box Girder additionally more as contrast with T-beam as indicated by length. However, wind load moment for unloaded span is 2.04kn\m^2 (from IS 875 section iii).

FOR 30 m SPAN:

Table 5.9 Specification of T-Beam and Box girder for 20m Span

Specifications	T-Beam/Box Girder
Span of the Bridge	30 m
Width of the Bridge	7.2 m
Over all depth	1.52 m
Number of Lane	2
Lane width	3.6 m
Centerline offset	1.8 m
Number of interior girder	3
Girder width	10.98 m
Slab thickness	0.305 m
Diaphragm thickness	0.3 m
Diaphragm depth	1 m
Abutment depth t_3	1.52 m
Abutment width t_2	1.22 m
Vehicles IRC	Class AA; Class70R; Class A
Load case	Dead, Move (linear static),Wind load Effect and Torsion

Table 5.10. Dead load moment of T-Beam and Box girder

Layout line distance (m)	Moment kN-m	
	T-Beam	Box Girder
0	-2377	-7210
15	8438	1728
30	-16196	-34725
45	9122	18659
60	-2377	-7210

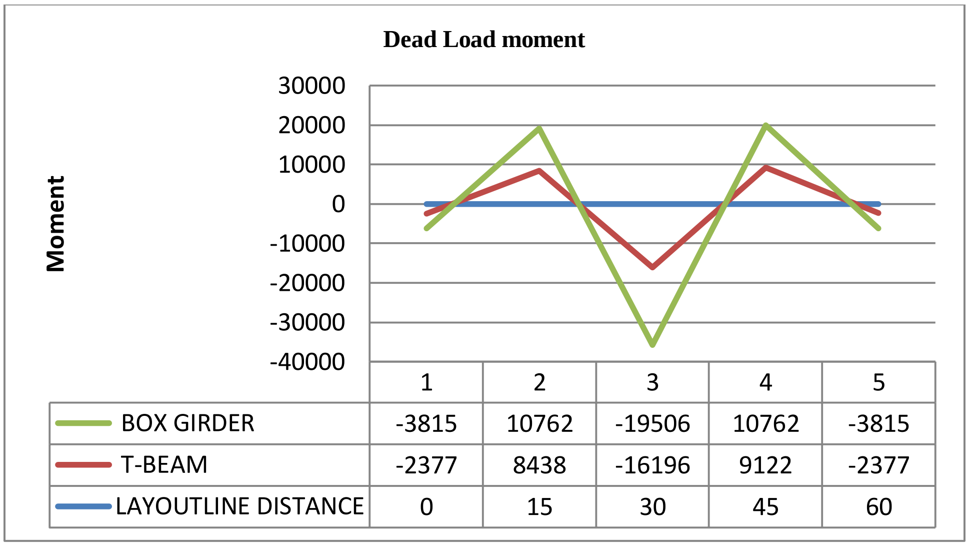


Figure 5.10. Variation of Dead load moment in T-Beam and Box

Table 5.11. Dead load moment of T-Beam and Box girder

Layout line distance	Moment kN-m	
	T-Beam	Box Girder
0	-2377	-3815
15	8483	10762
30	-16196	-19506
45	9122	10762
60	-2377	-3815

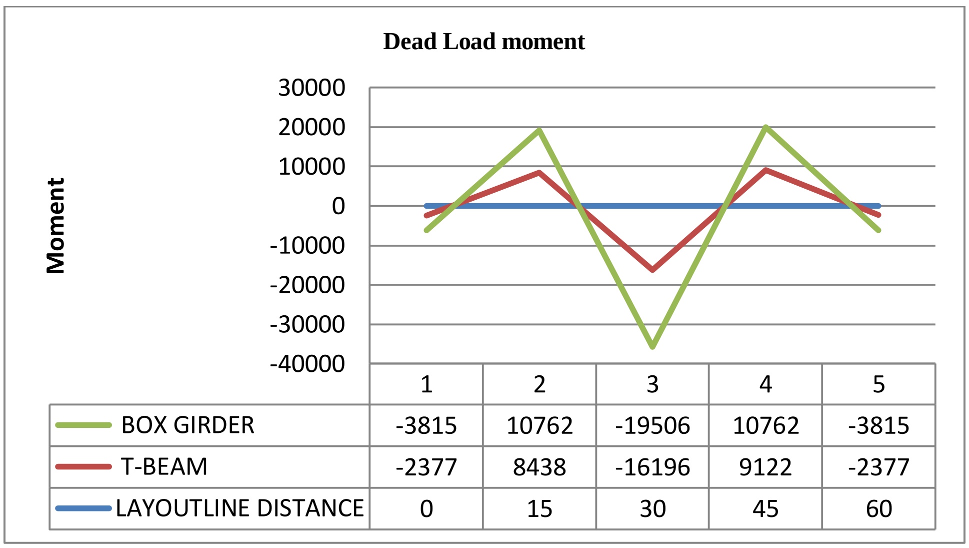


Figure 5.11. Variation of Dead load moment in T-Beam and Box Plus Girder

Table 5.12. Live load moment of T-Beam and Box girder

Layout line distance (m)	Moment kN-m	
	T-Beam	Box Girder
0	0	0
15	5706	5738
30	17	35
45	5706	5739
60	0	0

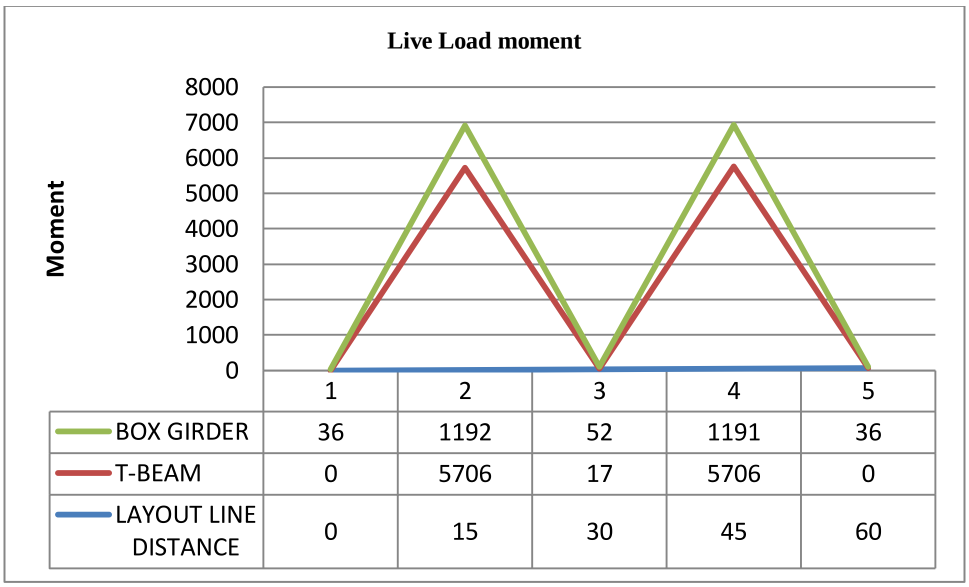


Figure 5.12. Variation of Live load moment in T-Beam and Box

Table 5.13. Live load moment of T-Beam and Box girder

Layout line distance	Moment kN-m	
	T-Beam	Box Girder
0	8.6	0
15	1247	5738
30	9.5	35
45	1247	5739
60	8.6	0

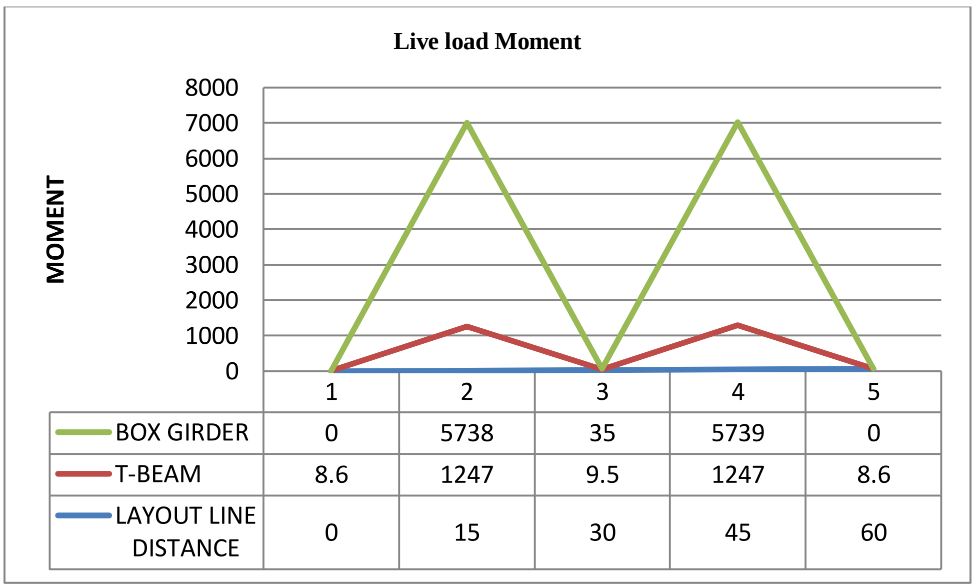


Figure 5.13. Variation of Live load moment in T-Beam and Box Plus all Girder

Table 5.14. Wind load moment of T-Beam and Box girder

Layout line distance (m)	Moment kN-m	
	T-Beam	Box Girder
0	-5704	-9157
15	20251	25830
30	-38870	-46815
45	20251	25830
60	-5704	-9157

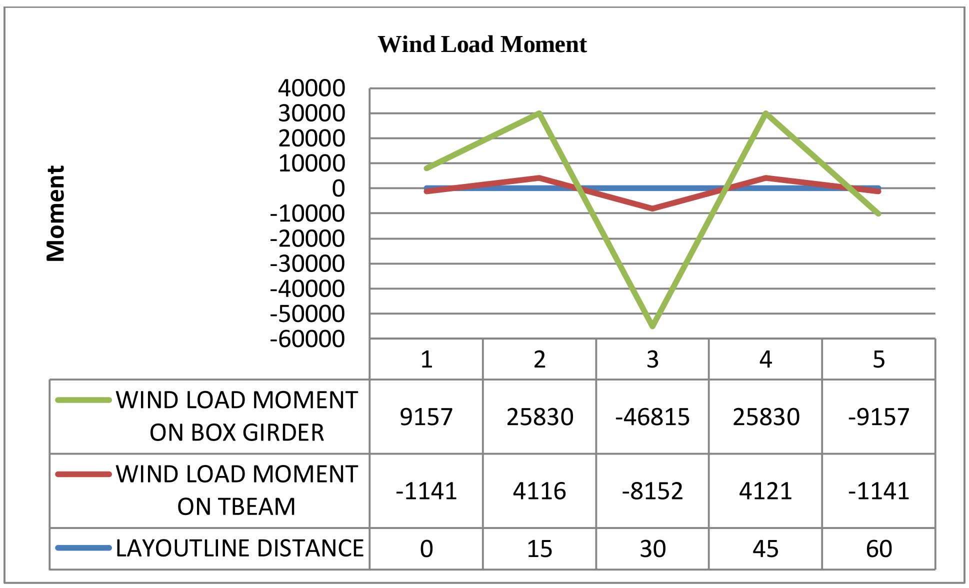


Figure 5.14. Variation of Wind load moment in T-Beam and Box Plus all Girder

Table 5.15. Wind load moment of T-Beam and Box girder

Layout line distance (m)	Moment kN-m	
	T-Beam	Box Girder
0	-114	-1937
15	4116	5230
30	-8152	-7631
45	4121	5783
60	-1141	-1937

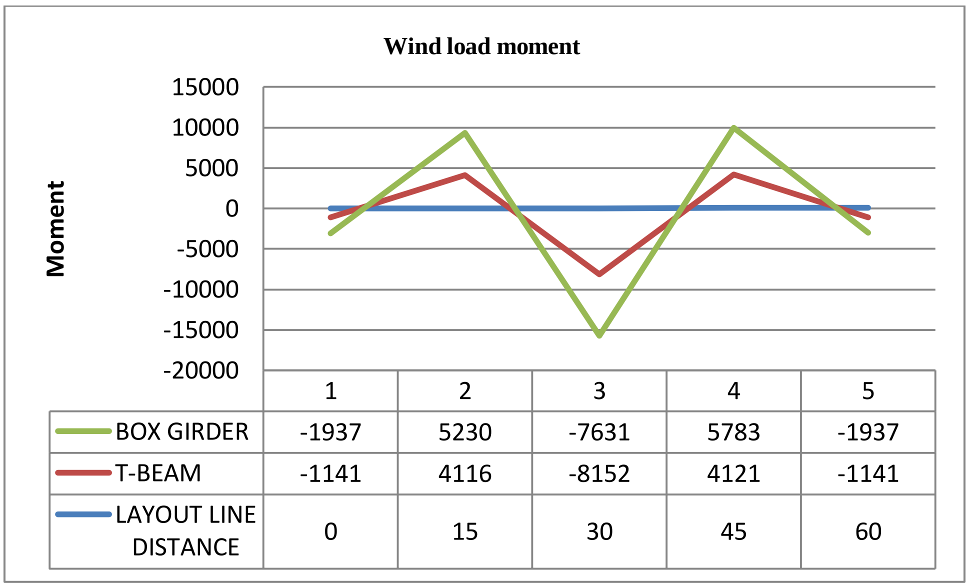


Figure 5.15. Variation of Wind load moment in T-Beam and Box Plus all Girder

Table 5.16. Torsion moment of T-Beam and Box girder

Layout Line Distance (m)	Moment KN-m	
0	-2.5	-9.9
15	-2.58	-63
30	2.59	215
45	2.58	55
60	2.56	6.8

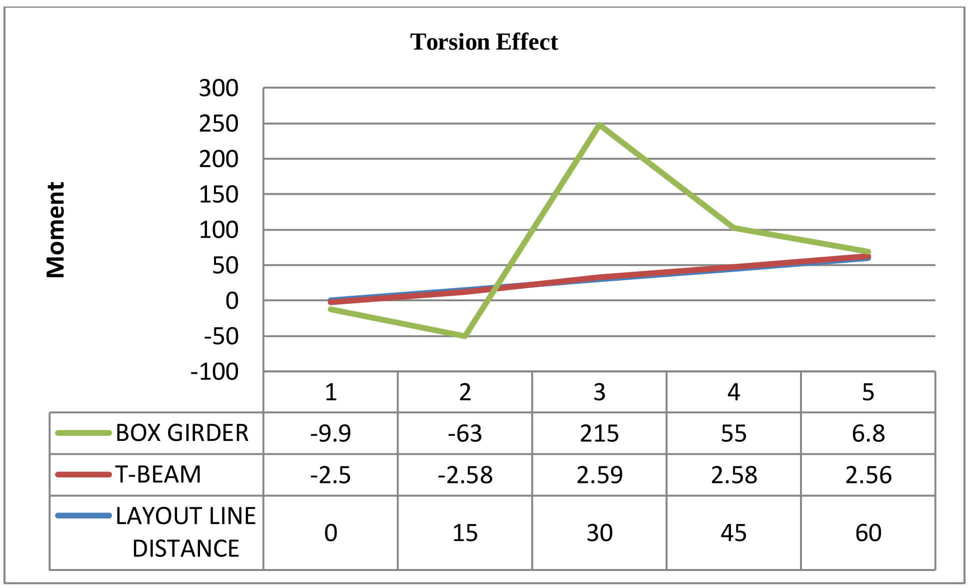


Figure 5.16. Variation of Torsion moment in T-Beam and Box Plus all Girder

Table 5.17. Torsion moment of T-Beam and Box girder

Layout line distance (m)	Moment kN-m	
	T-Beam	Box Girder
0	-2.5	2.15
15	-2.58	3.2
30	2.59	6.2
45	2.58	3.16
60	2.56	-1.3

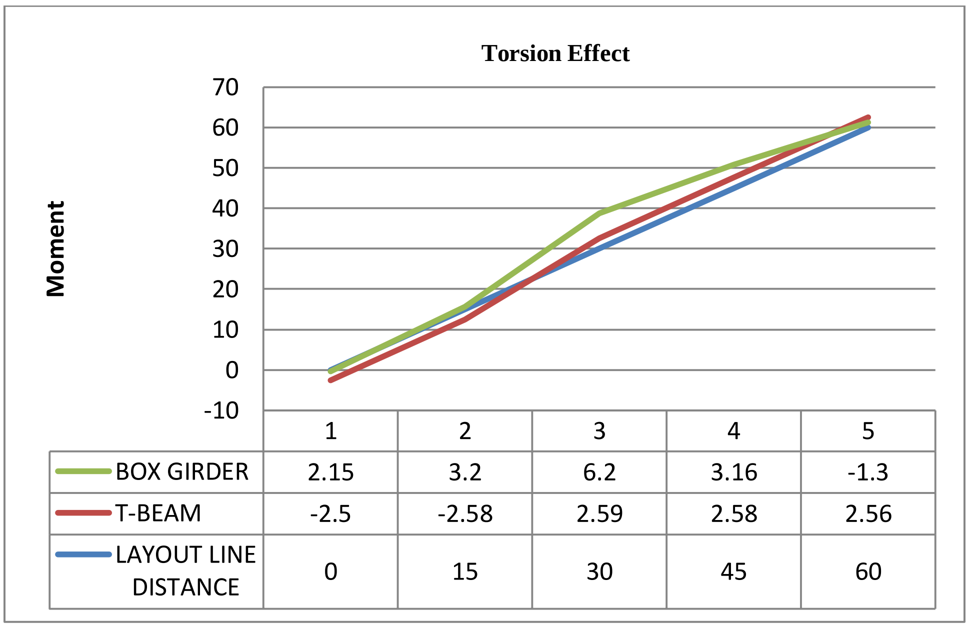


Figure 5.17. Variation of Torsion load moment in T-Beam and Box Plus all Girder

Dead load moment (figure 5.2 to 5.2.1) , Live load moment (figure 5.2.2 to 5.2.3), Wind load moment (figure 5.2.4 to 5.2.5) and Torsion effect (5.2.6 to 5.2.7) due to assumed adequate section has been calculated and studied with graph. The analysis shows T-Beam girder has produced less moment than Box girder. As span is increased as all moments are increased.

Graph shows that if span increased as Box girder gives you better result as compare to T-Beam

FOR 40 m SPAN

Table 5.18 Specification of T-Beam and Box girder

Specifications	T-Beam/Box Girder
Span of the Bridge	40 m
Width of the Bridge	7.2 m
Over all depth	1.52 m
Number of Lane	2
Lane width	3.6 m
Centerline offset	1.8 m
Number of interior girder	3
Girder width	10.98 m
Slab thickness	0.305 m
Diaphragm thickness	0.3 m
Diaphragm depth	1 m
Abutment depth t_3	1.52 m
Abutment width t_2	1.22 m
Vehicles IRC	Class AA; Class70R; Class A
Load case	Dead, Move (linear static),Wind load Effect and Torsion

Table 5.18 Dead moment of T-Beam and Box girder

Layout line distance (m)	Moment kN-m	
	T-Beam	Box Girder
0	-4941	-7210
20	15526	1728
40	-28276	-34725
60	14921	18659
80	-4937	-7210

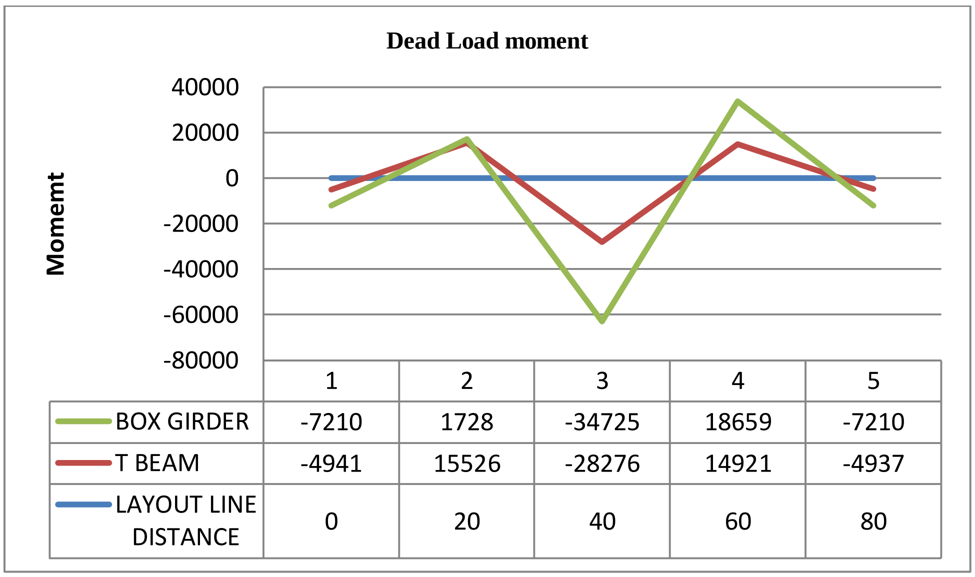


Figure 5.18 Variation of Dead load moment in T-Beam and Box

Table 5.19. Dead moment of T-Beam and Box girder

Layout line distance (m)	Moment kN-m	
	T-Beam	Box Girder
0	-988	-1526
20	2702	3492
40	-4975	-5916
60	2929	3754
80	-987	-1509

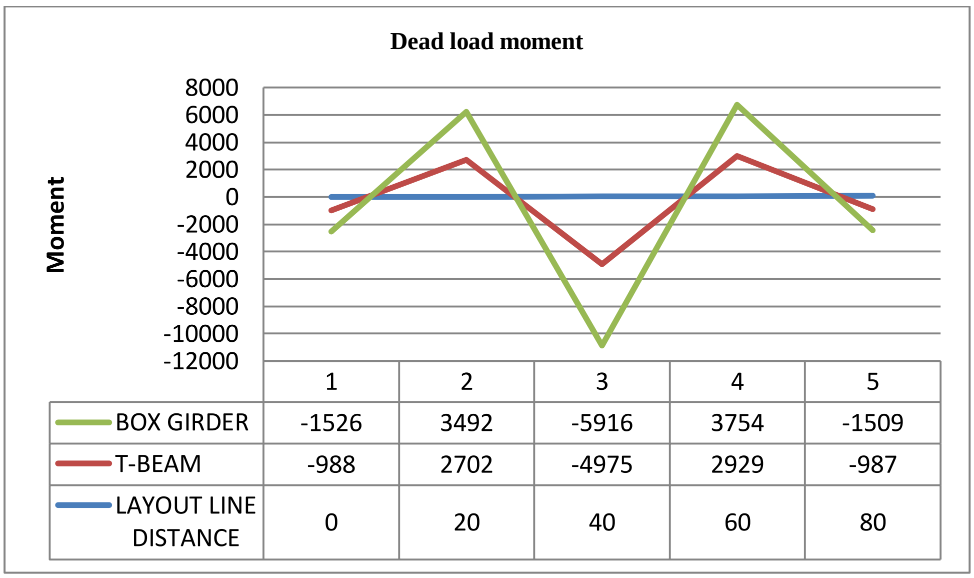


Figure 5.19. Variation of Dead load moment in T-Beam and Box Plus all Girder

Table 5.20. Live load moment of T-Beam and Box girder

Layout line distance (m)	Moment kN-m	
	T-Beam	Box Girder
0	4.5	45
20	8386	1682
40	8.9	50
60	8570	1715
80	0	46

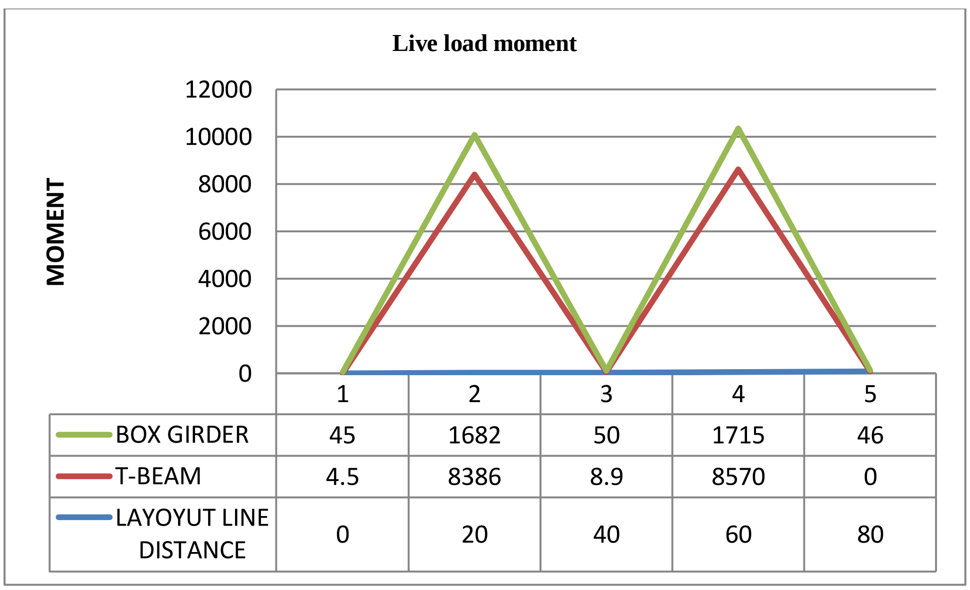


Figure 5.20. Variation of Live load moment in T-Beam and Box Girder

Table 5.21. Live load moment of T-Beam and Box girder

Layout line distance (m)	Moment kN-m	
	T-Beam	Box Girder
0	57	-30
20	1676	-699
40	38	-1255
60	1715	-1753
80	54	-2163

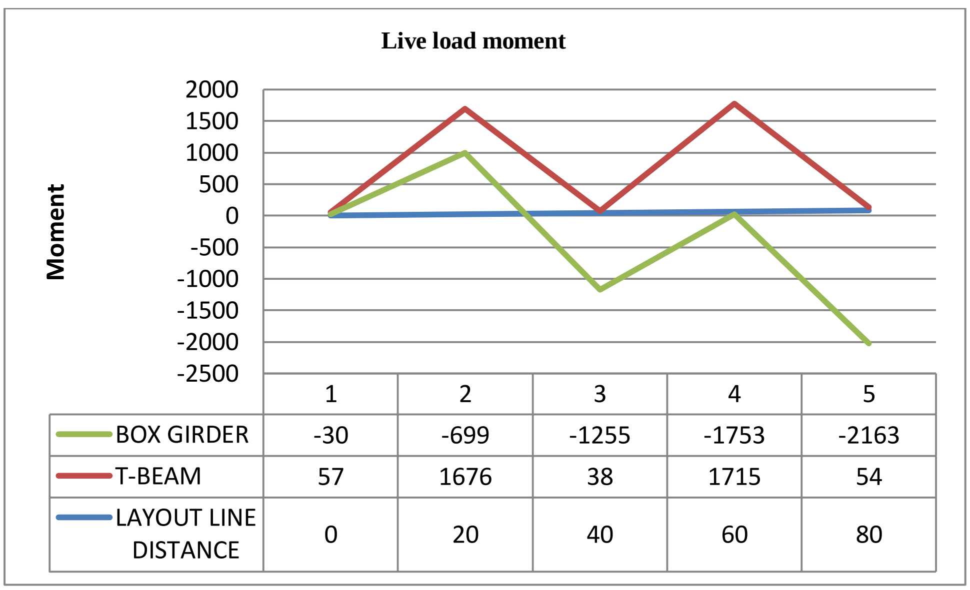


Figure 5.21. Variation of Live load moment in T-Beam and Box Girder Plus all Girder

Table 5.22. Wind load moment of T-Beam and Box girder

Layout line distance (m)	Moment kN-m	
	T-Beam	Box Girder
0	-11860	-17305
20	33003	41481
40	-67864	-83342
60	35812	4473
80	-11850	-17304

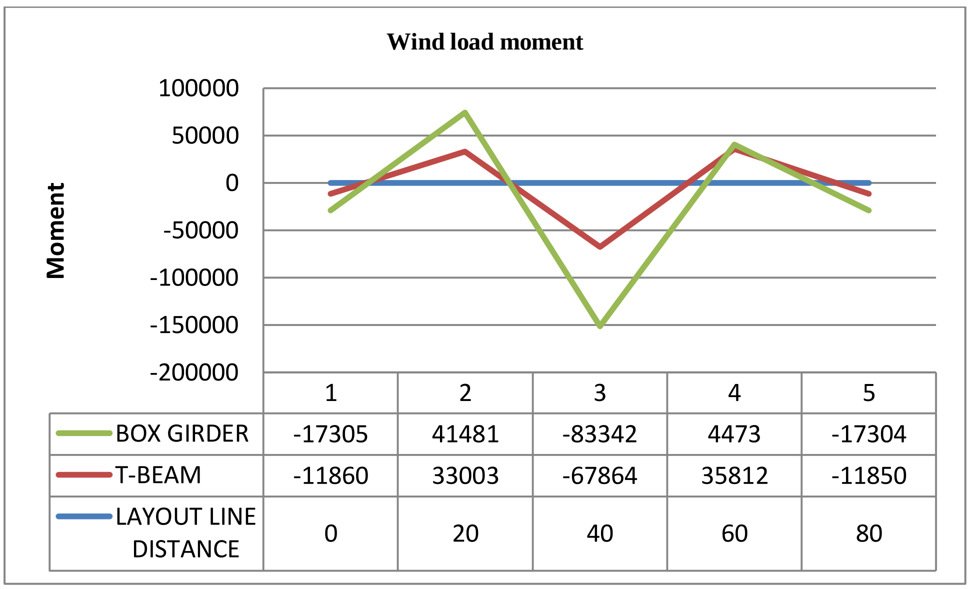


Figure 5.22. Variation of Wind load moment in T-Beam and Box Girder

Table 5.23. Wind load moment of T-Beam and Box girder

Layout line distance (m)	Moment kN-m	
	T-Beam	Box Girder
0	-2372	-3662
20	6486	8290
40	-11940	-14200
60	7039	9010
80	-2371	-3623

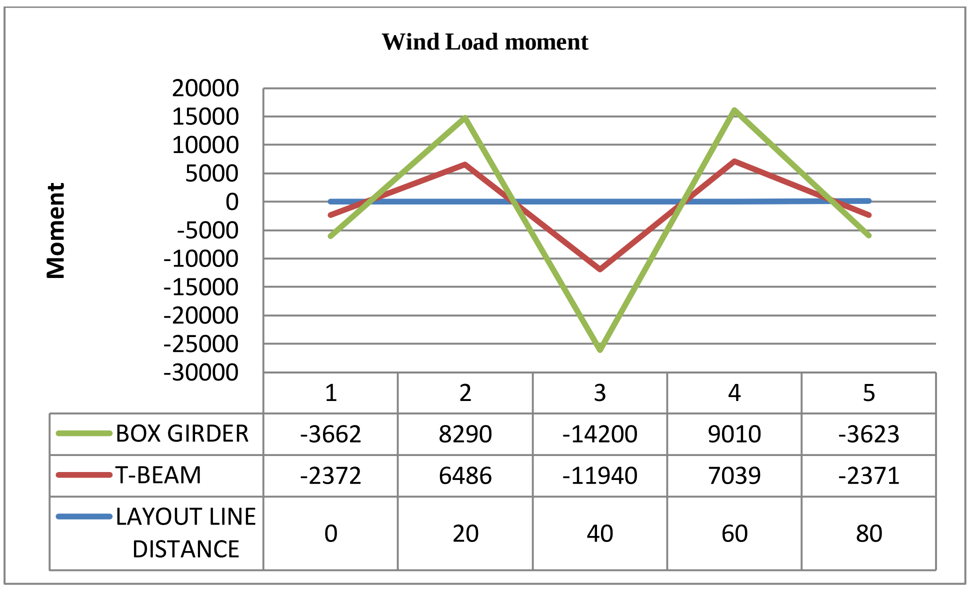


Figure 5.23. Variation of Wind load moment in T-Beam and Box Girder Plus all Girder

Table 5.24. Torsion moment of T-Beam and Box girder

Layout line distance (m)	Moment kN-m	
	T-Beam	Box Girder
0	-7.5	1.03
20	-7.5	9.73
40	-7.2	8.9
60	3.9	-9.21
80	4.3	-9.5

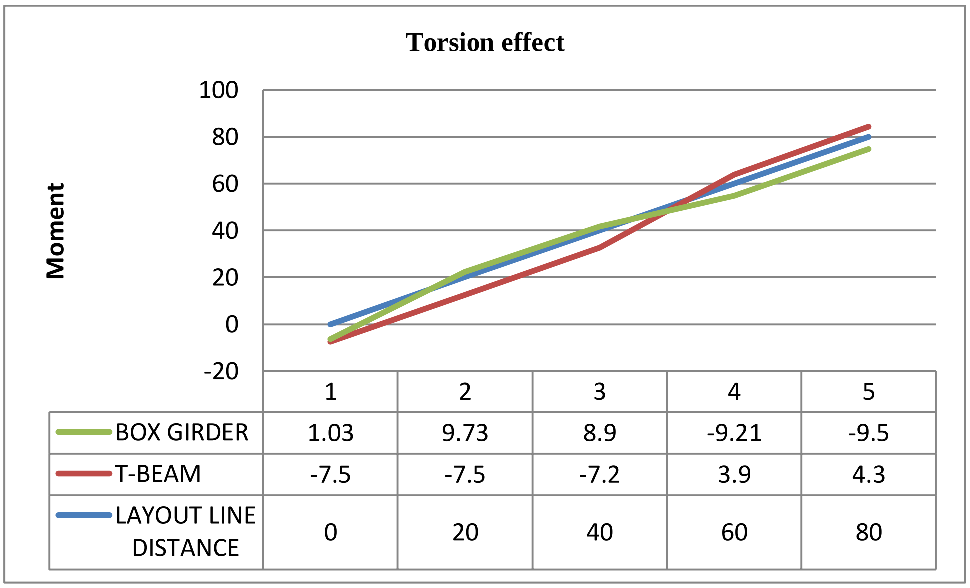


Figure 5.24. Variation of Torsion moment in T-Beam and Box Girder

Table 5.25. Torsion moment of T-Beam and Box girder

Layout line distance (m)	Moment kN-m	
	T-Beam	Box Girder
0	2.03	-89
20	-9.16	-136
40	191	243
60	6.3	79
80	-2.3	94

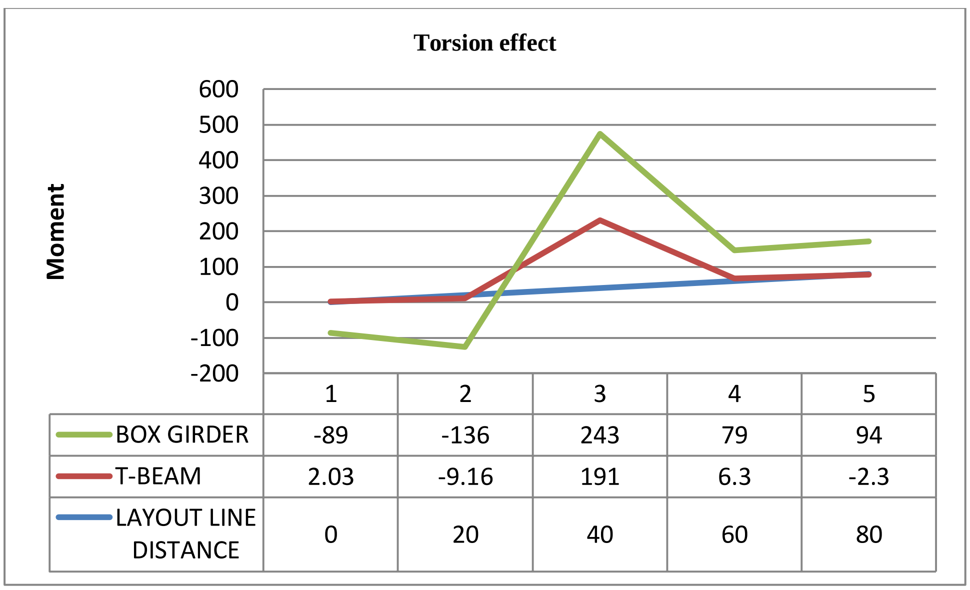


Figure 5.25. Variation of Torsion moment in T-Beam and Box Girder Plus all Girder

CHAPTER 6

CONCLUSION

Service Dead Load bending moments, live load moments, Wind load moments and Torsion moments are for T-Beam girder are lesser than Box Girder Bridge. Which allow designer to have heavier section for T-Beam Girder than Box Girder for 30m and 40m spans.

For 20m spans T-Beam Girder is more economical but if span is more than other span so, Box Girder is always suitable. This type of Bridge lies in the high torsional rigidity available because of closed box section.

Moments for both has been evaluated and conclusions drawn that T-Beam Girder has more capacity for 20 m span.

REFERENCES

1. N.K Paul,S.Shah, "Improvement of Load Carrying Capacity of a RCC T-Beam Bridge Longitudinal Girder by Replacing Steel Bars with S.M.A Bars", World Academy of Science, Engineering and Technology 2011.
2. R.Shreedhar, "Analysis of T-Beam bridge using FEM", International Journal of Engineering and Innovative Technology (IJEIT), September 2012, Volume 2, Issue 3.
3. Amit Saxena,Dr.Savita Maru, "Comparative study of the analysis and design of T-Beam Girder and Box Girder Superstructure", International Journal of Engineering and Innovative Technology(IJEIT),April-May 2013, Volume 1,Issue 2.
4. Mahesh Pokhrel, "Comparative study of RCC T-Girder bridge with different codes", Thesis, Feb-2013.
5. M.G Kalyanshetti, "Study of effectiveness of Courbn's theory in the analysis of T-Beam bridge", International Journal of Engineering Research, Volume 4, March 2013.
6. Supriya Madda, Kalyanshetti M.G, "Dynamic Analysis of T-Beam Bridge Superstructure", International Journal of Engineering and Innovative Technology (IJEIT), 2013, Volume 3.
7. Rajmoori, Arun Kumar, "Design of Prestress Concrete T-Beam", International Journal of Scientific Engineering and Research, 8 August 2014, Volume 2.
8. Manjeetkumar, M Nagarmunnoli, " Effect of Deck Thickness in RCC T-Beam Bridge", International Journal of Structural and Civil Engineering Research, Feb-2014, Vol. 3.
9. Praful NK, Balaso Hanumant, "Comparative Analysis oF T-BEAM Bridge by Rational Method and STADD PRO", International Journal of Engineering Science & Research Technology, June 2015.
10. Pallvi Rai, Rajneesh Kumar, "Analysis of T-Beam Bridge Subjected to Blast Loading using FEM-SPH Coupling", Journal of Civil Engineering and Environmental Technology, March 2016, Issue 3, Vol. 3.
11. Sandesh Upadhayay K, " A Comparative Study of T-Beam Bridge for Varying Span Lenghts" , International Journal of Research in Engineering Technology, June 2016, Issue 6, Vol. 5.
12. Phani Kumar Ch., S.V.V.K, "Analysis and Design of Prestressed Box Girder Bridge by IRC: 112-2011", International Journal of Constructive Research in Civil Engineering(IJRCC), 2016, Issue 2, Vol.2.