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Comparative study of box girder, suspension bridge & T Girder Bridge with varying spans

P. PADMAJA[1](M.tech), V.BHARGAVI[2], M.E (Ph.d)
[1]*PG Student in* visakha technical campus, *Visakhapatnam (INDIA)*
pathivadapadma@gmail.com, +91-7382561136
[2]Asst. Professor, visakha technical campus, *Visakhapatnam (INDIA),*
vbhargavi1974@gmail.com, +91-8978911793

ABSTRACT

In the present study three bridge models are considered box Girder Bridge, suspension bridge T girder bridge of lengths 100m, 120m and 140m consisting of two lane road network and the materials considered are M60 and Fe550 for concrete and steel and the structures modeled in CSIBRIDGE structural analysis and design software by considering various loads and load combinations such as dead load, live load, wind and seismic loads. And the results are compared between displacements due to dead and live loads, shear and bending moments in the sections and support reactions, suspension bridges shown better performance than box and T girder bridges.

INTRODUCTION

A bridge is a structure built to span a physical obstacle, such as a body of water, valley, or road, without closing the way underneath. It is constructed for the purpose of providing passage over the obstacle, usually something that can be detrimental to cross otherwise. There are many different designs that each serve a particular purpose and apply to different situations. Designs of bridges vary depending on the function of the bridge, the nature of the terrain where the bridge is constructed and anchored, the material used for construction.

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Fig1: suspension bridge across the river

1. Economical advantage and disadvantages of RCC and steel bridges

Conventional bridges spans range from 20-50m in between the bridges piers for different bridge configurations. T girder bridges are mostly used they are possible for limited spans up to 25m there after it seems to be uneconomical, and a box girder bridges are used for higher spans and loads are heavy, but concrete bridges doesn't have high strength to weight ratio when compared to steel bridges

Steel bridges are having high tensile strength, they have high strength to weight ratio thus resulting in slender sections when compared to RCC bridges steel bridges such as suspension bridges being widely used to longer spans range from 100-300m, but steel bridge are subjected to corrosion attacks thus it requires periodical maintenance. Steel structures elements are subjected to higher buckling forces and have lesser fire resistance.

2. Types of bridges

1. T Girder Bridge
2. Box Girder Bridge
3. suspension bridge
4. Cantilever bridge
5. Cable stayed bridge

3. Loads acting on bridges

1. Dead load
2. Live load
3. Impact load
4. Wind load
5. Longitudinal forces
6. Centrifugal forces
7. Seismic loads

4. Dead loads on bridges

1. Self weight of structure
2. Dead weight of pavements and roads
3. Self weight of crash barrier walls

5. Live load classification as per IRC-6

1. IRC class 70r loading
2. IRC class AA loading
3. IRC class A loading
4. IRC class B loading

6. Seismic data as per IS: 1893-2002

Based on magnitude of the earthquake India is classified into four zones (II, III, IV, and V) where zone V is high severity zone

Table 2 Zone Factor, Z
(*Clause* 6.4.2)

Seismic Zone	II	III	IV	V
Seismic Intensity	Low	Moderate	Severe	Very Severe
Z	0.10	0.16	0.24	0.36

LITERATURE SURVEY

Pengzhen Lu,1,2 Jianting Chen,3 Jingru Zhong,2 and Penglong Lu4(2014)[1] made optimization analysis model of self-anchored Suspension has been developed based on optimization theories, such as minimum bending energy method, and internal force balanced method, influence matrix method. Meanwhile, combined with the weak coherence of main cable and the adjacently interaction of hanger forces, a simplified analysis method is developed using MATLAB, which is then compared with the optimization method that consider the main cable's geometric nonlinearity with software ANSYS in an actual example bridge calculation and concluded that A new optimization analytical model of cable force of self anchored suspension bridge is developed and solved by the optimization analytical method.

Epuri pavan kumar1, arepally naresh2, sri ramoju praveen kumar3, Amgoth ashok4(2015)[2] made a comparative study of precast i-girder bridge by using The irc and aashto codes We considered the three span bridge model with lane width is 14.8m. Each span length is having 40m and total length of the bridge is 120m. The live loads assigned for the bridge model is class AA and class A from IRC code and HL -93K and HL-93M from AASHTO code. The Codes considered for bridge design like Indian code (IRC-2000) and American code (AASHTO LRFD-2007). The design of the bridge and structural analysis is done by using the computer software CSi Bridge v17.0.

R. Shreedhar shreyansh patil(2016)[3] made comparative study of psc box girder bridge design Using irc 112-2011 and irc 18-2000 the present study has been performed to know the Difference in design using irc-112:2011 and irc-18:2000 and attempt is made to study undefined parameters of irc: 112-2011 such as span to depth (l/d) ratio. The present study is based on the design of psc box girder by working stress Method using irc- 18-2000 and limit state method using irc- 112: 2011 code specifications ·in case of the design of box girder psc bridges using The limit state method as per irc: 112-2011, l/d ratio of 31 To 36 can be adopted.

MODELLING & METHODOLOGY

In the present study three bridge models are considered box Girder Bridge, suspension bridge T girder bridge of lengths 100m, 120m and 140m consisting of two lane road network and the materials considered are M60 and Fe550 for concrete and steel and the structures modeled in CSIBRIDGE structural analysis and design software by considering various loads and load combinations such as dead load, live load and seismic loads

Structure-1: box Girder Bridge of span 100, 120 and 140m

Structure-2: suspension Bridge of span 100, 120 and 140m

Structure-3: T Girder Bridge of span 100, 120 and 140m

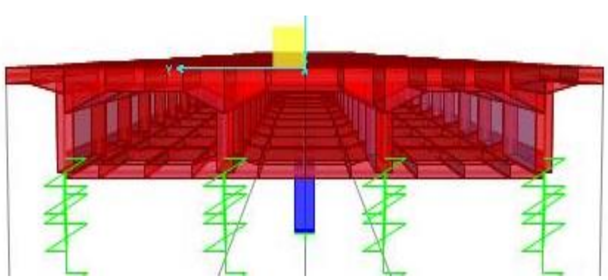

Fig2: Box Girder Bridge

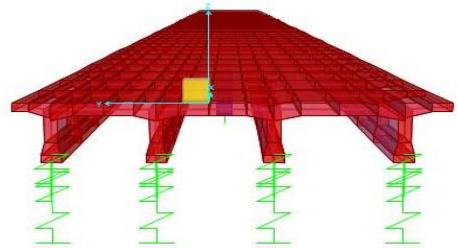

Fig 3: T Girder Bridge

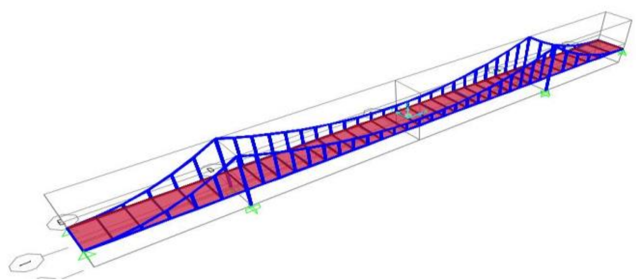

Fig4: Suspension bridge model

Table-A: Design data for bridges

Types of bridges considered in study	Box Girder Bridge Suspension bridge T girder bridge
Length of bridges	100m,120m, 140m
Number of spans	02
Loads considering	Dead, vehicle live, wind and seismic loads
Software	CSI bridge
Grade of concrete	M60
Grade of rebar	HYSD 550
Vehicle Loading	IRC track A vehicle
Beam size	1.5mx1.2m
Slab thickness	0.25m
Width if bridge	7.5m
Number of lanes	02
Bridge supports	Pinned

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RESULTS AND DISCUSSION

Table1: Displacement due to dead load in bridges

Length of bridge	Box girder bridge(mm)	Suspension bridge(mm)	T girder bridge(mm)
100m	63	560	150.2
120m	129.3	920	206
140m	233	1376	541

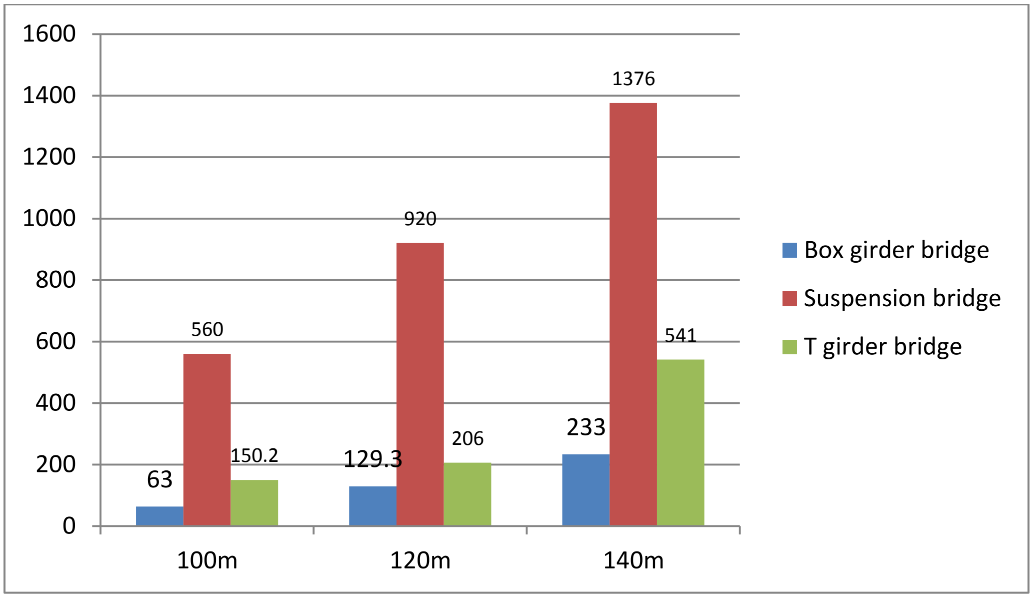

Chart1: Displacement due to dead load in bridges

Table2: Displacement due to live load in bridges

Length of bridge	Box girder bridge(mm)	Suspension bridge(mm)	T girder bridge(mm)
100m	21	49	12.9
120m	80	105	13.7
140m	111	160	31.7

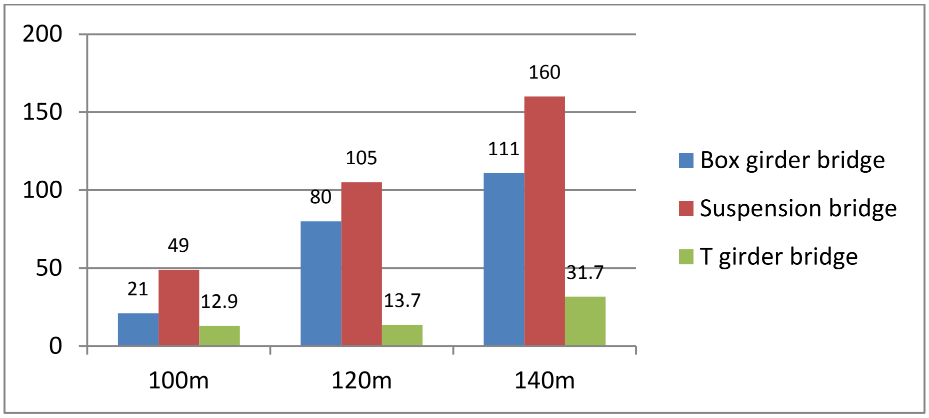

Chart 2: Displacement due to live load in bridges

Table 3: Displacement due to earthquake load in bridges

Length of bridge	Box girder bridge(mm)	Suspension bridge(mm)	T girder bridge(mm)
100m	3.2	18.7	4
120m	6.8	20.2	4.5
140m	8.1	30.5	5

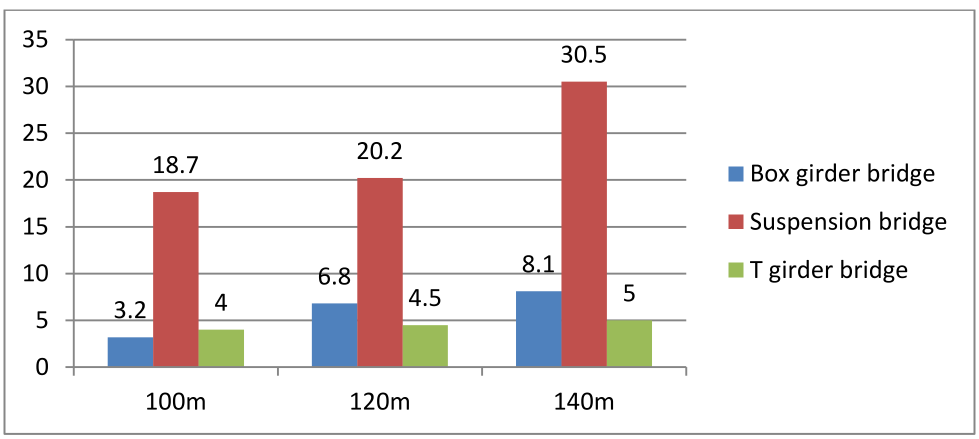

Chart 3: Displacement due to earthquake load in bridges

Table 4: Maximum shear due to moving loads in bridges

Length of bridge	Box girder bridge(kN)	Suspension bridge(kN)	T girder bridge(kN)
100m	619.16	144.12	645.76
120m	625.76	202.74	1495

140m	633.25	245.75	1624

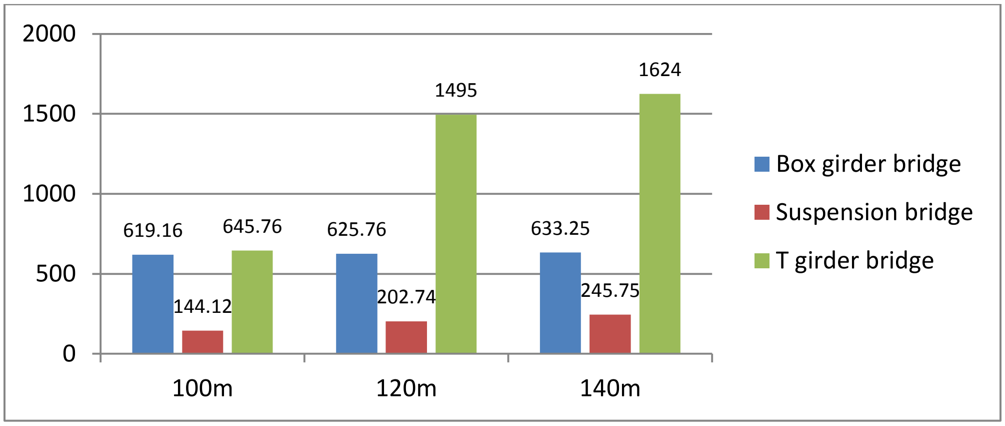

Chart 4: Maximum shear due to moving loads in bridges

Table 5: Maximum bending due to moving loads in bridges

Length of bridge	Box girder bridge(kNm)	Suspension bridge(kNm)	T girder bridge(kNm)
100m	119.24	159.20	89.25
120m	128.34	225.14	160.5
140m	137	275.49	188.57

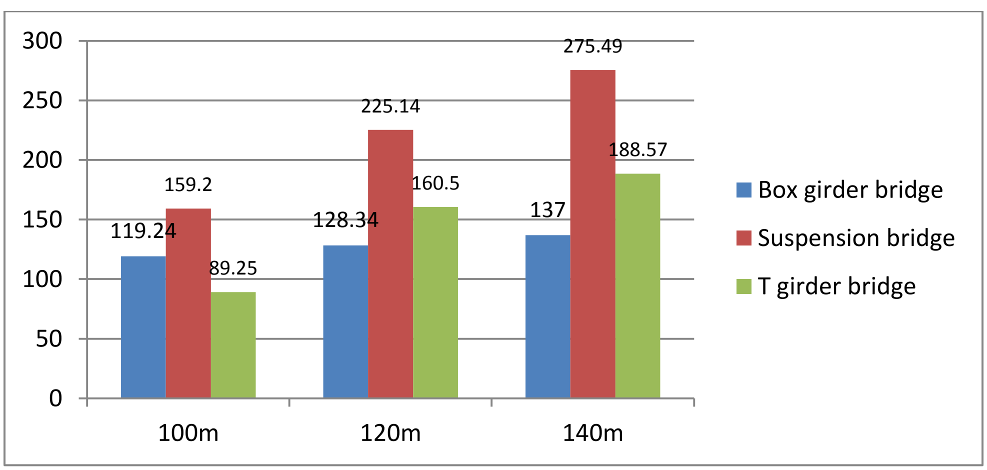

Chart 5: Maximum bending due to moving loads in bridges

Table 6: Maximum support reaction in bridges

Length of bridge	Box girder bridge(kN)	Suspension bridge(kN)	T girder bridge(kN)
100m	443.75	89.77	501
120m	655.91	129.4	642.85
140m	788.86	166.39	735

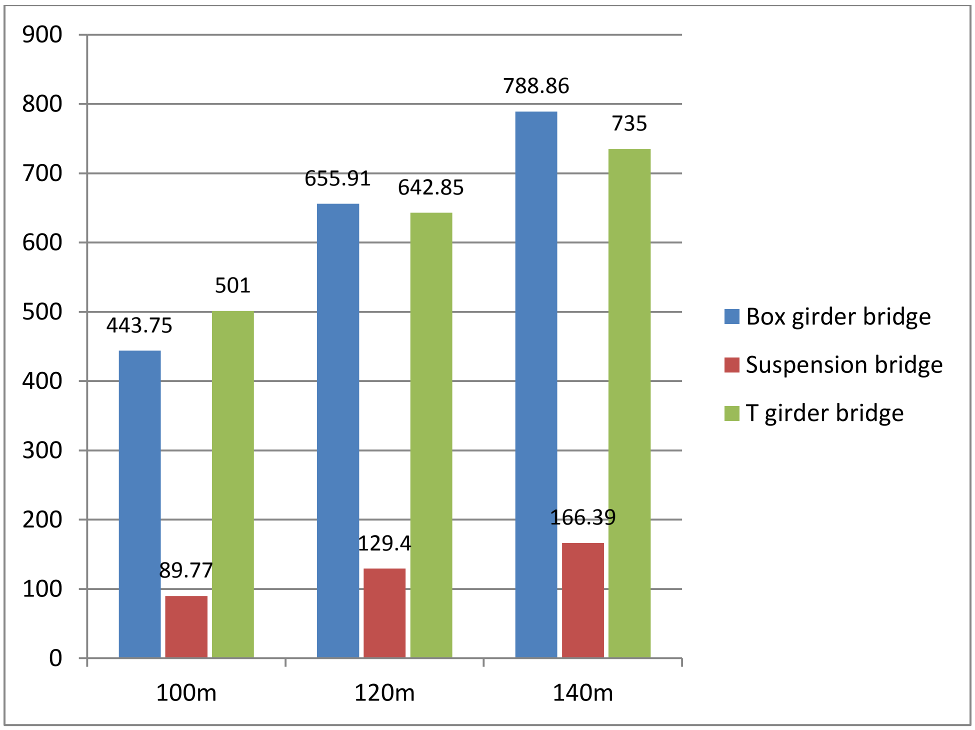

Chart 6: Maximum support reaction in bridges

Table 7: Maximum support moment in bridges

Length of bridge	Box girder bridge(kNm)	Suspension bridge(kNm)	T girder bridge(kNm)
100m	2563.2	302.4	375.37
120m	3898.93	435.78	465.45
140m	4823.64	560.08	639.77

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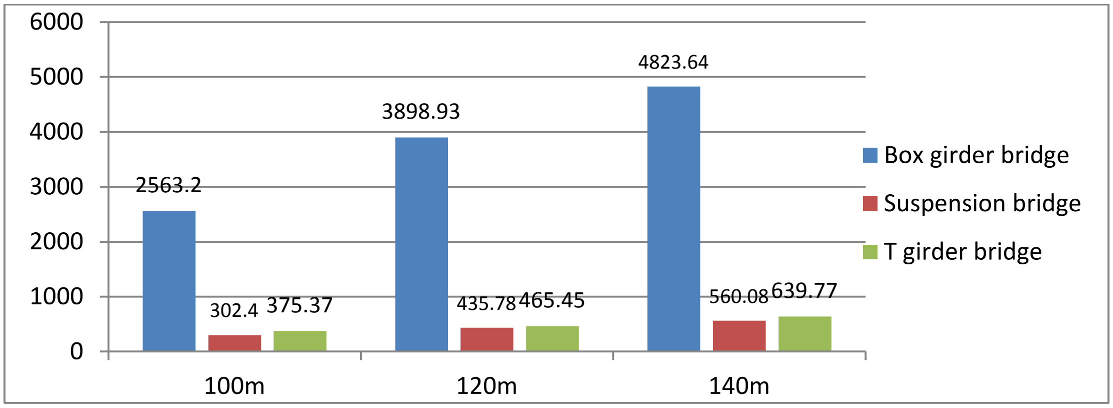

Chart 7: Maximum support moment in bridges

CONCLUSIONS

1. It is observed that displacement due to dead load is higher than live load and seismic loads.
2. Displacements due to dead load are lesser in structure-1 when compared to structure-2 and structure-3.
3. Displacements due to live load are lesser in structure-3 when compared to structure-1 and structure-2.
4. Displacements due to seismic load are lesser in structure-3 when compared to structure-1 and structure-2.
5. Shear due to moving loads is lesser in structure-2 when compared to structure-1 and structure-3.
6. Bending due to moving loads is lesser in structure-1 when compared to structure-2 and structure-3.
7. Support reaction is lesser in structure-2 when compared to structure-1 and structure-3.
8. Support moment is lesser in structure-2 when compared to structure-1 and structure-3.
9. Suspension bridges shown economic results when compared to box and T girder bridges for spans of range 100m, 120m and 140m.

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