ANALYSIS OF BRIDGE GIRDER-2 WAY BEAM

SP Vijaykumar[1], Kalpana Mohan[2]

[1]Assistant Professor, Department of Civil Engineering, Saveetha School of Engineering, Saveetha University, Thandalam, Chennai-602105
[2]Assistant Professor, Department of Civil Engineering, Saveetha School of Engineering, Saveetha University, Thandalam, Chennai-602105

Abstract

Bridge girder material, size, shape and selection are based on engineering and economic criteria. Steel concrete composite construction has gained wide acceptance as an alternative to pure steel and pure concrete construction, there is no need for formwork because the steel beam is able to sustain the self-weight of steel and concrete with few temporary props. In this paper, we present analysis and results of steel and steel reinforce bridge girders, based on STAAD Pro analysis and manual analysis. Various types of 2 way beams are taken and compared:
*1. RCC 0.5*1 WITH 2 WAY BEAM*
*2. RCC 0.4*0.8 WITH 2 WAY BEAM*
3. RCC I SHAPE WITH 2 WAY BEAM
4. STEEL I SHAPE WITH 2 WAY BEAM

The analysis was conducted between steel girders and reinforced concrete bridge girders. Based on the design calculations, effect of each girder with respect to shear, bending moment, dead load, live load, deflection and most importantly cost of each combination is analysed.

Keywords: *Bridge Girder, Beam, STAAD Pro etc.*

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1. INTRODUCTION

1.1 Bridge

A Bridge is a structure built to span physical obstacles without closing the way underneath such as a body of water, valley, or road, for the purpose of providing passage over the obstacle. 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 to make it, and the funds available to build it.

Types of bridges:
- Girder bridges
- Arc bridges
- Truss bridges
- Suspended bridges
- Prestressed bridges
- Rigid Frame Bridges

2. LITERATURE REVIEW

Various journals and thesis were refereed and the design aspects were studied. Steel bridge based on Indian and European standards were done and the results were compared. They took Indian code IS 800:2007 and Europian code BS EN 1993. For constant span and depth, the total deflection of the girder increases as the grade of steel increases but the total weight decreases according to the Indian standards design. A similar behaviour is found for European standards i.e., as grade of steel increases, deflection increases and weight reduces.

A life cycle inventory analysis of steel and steel-reinforced concrete bridge girders, based on publicly available data was also conducted. Here for the initial construction of equivalent designs for a particular location, a steel-reinforced concrete bridge generally has lower environmental effects than a steel bridge Reuse and recycling of steel has used for construction of bridge for steel super structure reuse material upto 17% and recycle for 21%**.**

3. METHODOLOGY: GIRDER BRIDGE

A girder bridge, in general, is a bridge that uses girders as the means of supporting the deck. A bridge consists of three parts: the foundation (abutments and piers), the superstructure (girder, truss, or arch), and the deck. A girder bridge is very likely the most commonly built and utilized bridge in the world. Its basic design, in the most simplified form, can be compared to a log ranging from one side to the other across a river or creek. In modern girder steel bridges, the two most common shapes are plate girders and box-girders. The term "girder" is often used interchangeably with "beam" in reference to bridge design.

3.1 Different Types of Girder in Bridge

According to Shape

Box Shape, I Shape, T Shape, C Shape

According to Length of Bridge

Culvert bridge(less than 6 m) , Minor bridge(less than 6 m-60m), Major bridge(more than 60 m), Long span bridge(more than 120 m)

3.2 Input of Bridge

- Length of bridge =15m
- Width of carriage bridge=8.550m
- Width of footpath = 1.5m
- Total width =11.550m
- Thickness of deck slab =0.225m
- Thickness of wearing coat=0.075m
- Number of girders=4
- Spacing of main girder =2.850m

3.3 Unit Weights & Loads

- reinforced cement concrete =40kn/m3
- wearing coat = 22kn/m3
- structural steel =78.5 kn/m3
- steel used fe 415
- irc class aa& class a wheeled loads calculated as per irc :6-2000
- if span 7.5m to 30m
- where p'=400 or500kg/m2 from sub class 209.1 irc6
- formula cal. for ll for footpath =4.5kn/m

$$P = P^{1} - \left(\frac{40L - 300}{9}\right)$$

STEP 1: Analysis of Bridges using Staad Pro

3.1.1 Rectangular Girder Size 0.5 x 1 m with Beam (2way)

Step for doing rectangular girder size 0.5 x 1m with 2 way beam. Here in 'y' axis beams are known as girder and giving property as width 0.5m and depth as 1 m. Support is fixed. Our bridge width is 11.55m and carriage width is 8.55m. No. of lanes for design purposes is two lanes. Load combination is one lane of class 70R or two lanes of Class A. Moving load at tires are 2.7,2.7,11.4,11.4,6.8,6.8,6.8,6.8 tons at distance of 1.1,3.2,1.3,4.3,3,3,3 respectively. Width of vehicle is 1.8 m. These loads are places at vehicle definition in STAAD Pro. Make the load generation as 250 combinations.

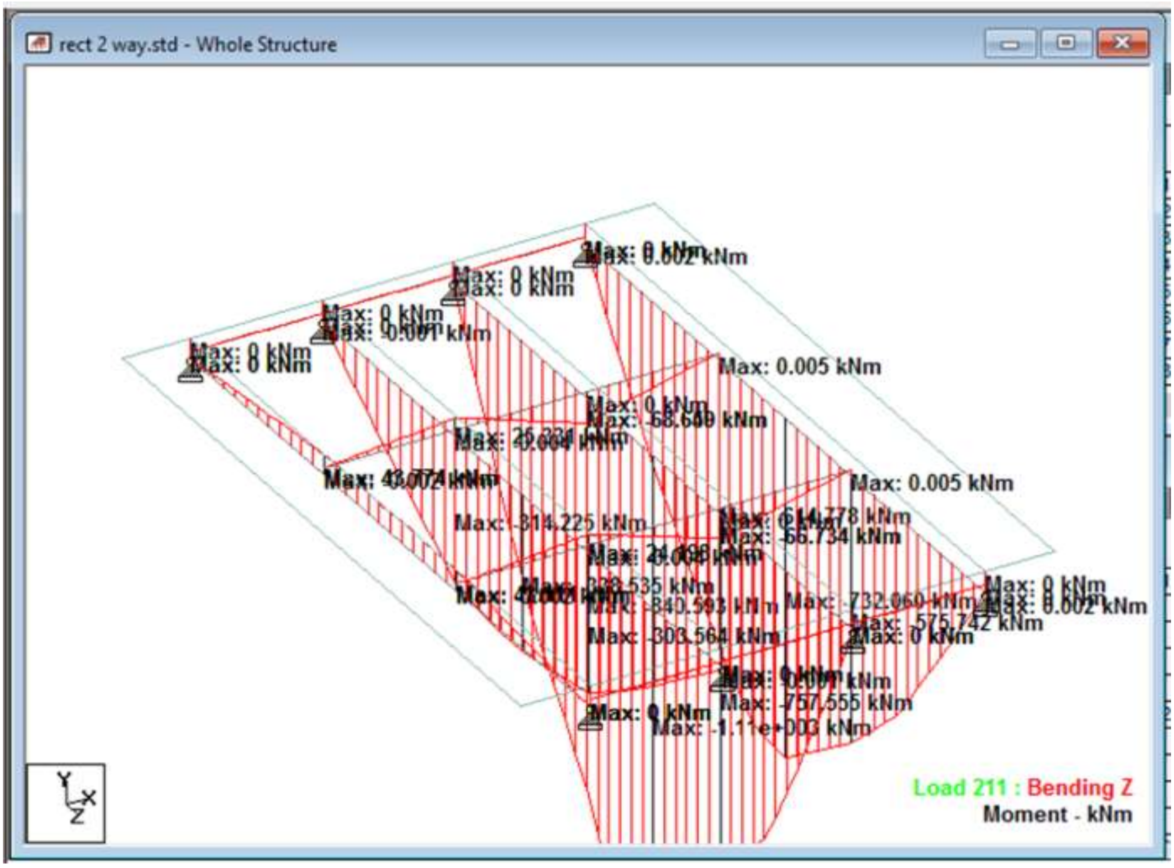

Fig 3.1 Bending of Rectangular girder size 0.5 x 1 m with 2 way beam

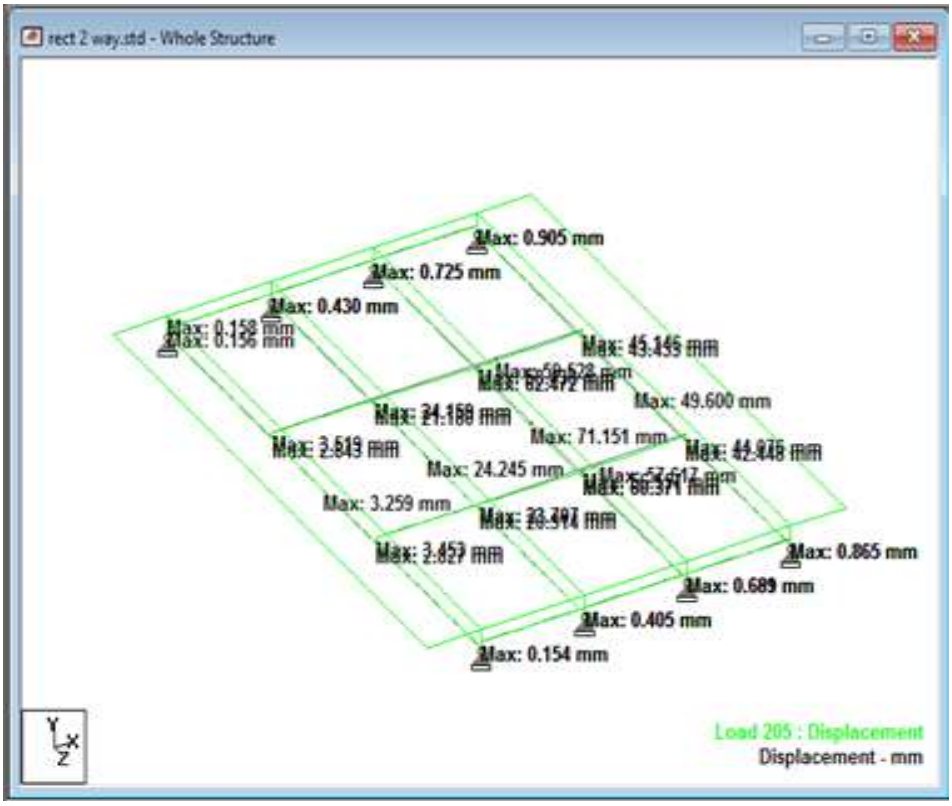

Fig 3.2 deflection of Rectangular girder size 0.5 x 1 m 2way beam

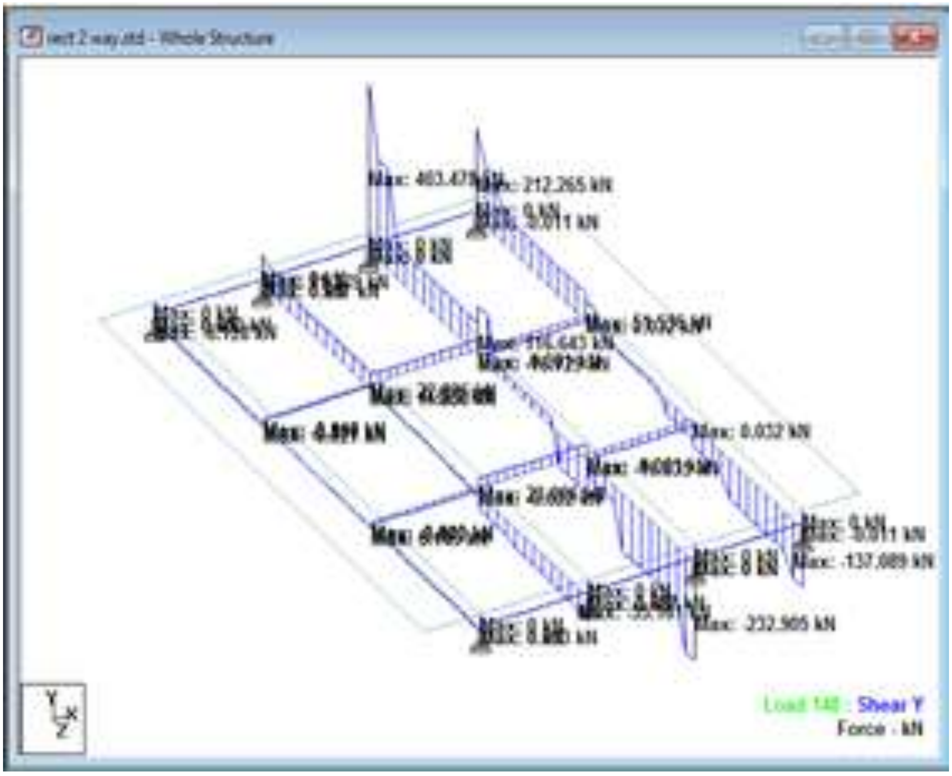

Fig 3.3 shear of Rectangular girder size 0.5 x 1 m with beam (2 way):

3.1.2 Rectangular Girder Size 0.4 x 0.8 m with 2 Way Beam:

It is similar to Rectangular girder size of 0.5 x 1 m with 2 way beam. Here only girder size in y axis is changed. Width of the girder is 0.4 meter and depth of the girder is 0.8 meters. Supports and vehicle load combination is similar. Here also 250 load combinations is generated. Values of Deflection, bending moment and Shear force is changed compared with the rect 0.5 x 1m.

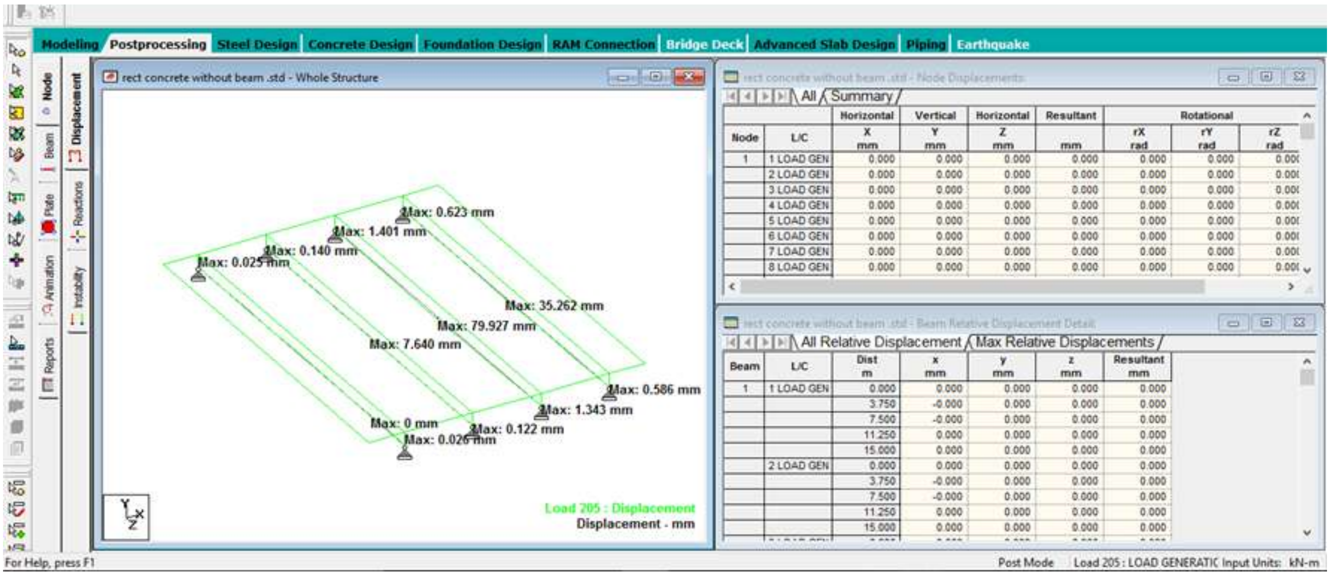

Fig 3.4. 4 displacement of Rectangular girder size 0.4 x 0.8 m with 2 way beam

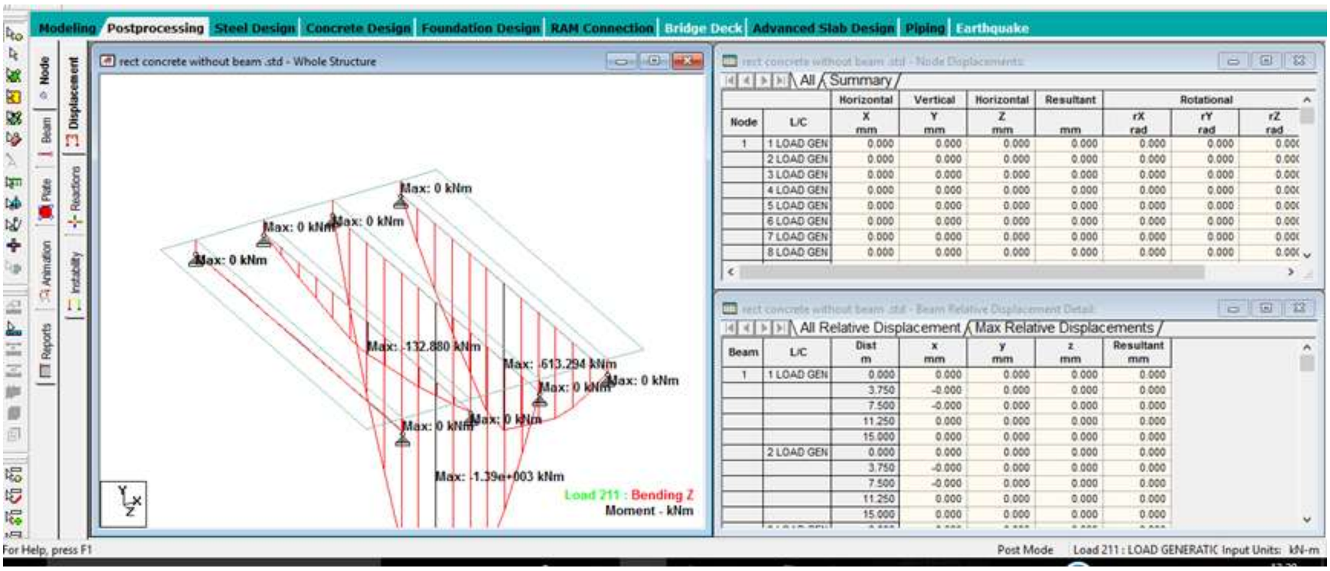

Fig 3.5: bending of Rectangular girder size 0.4 x 0.8 m with 2 way beam

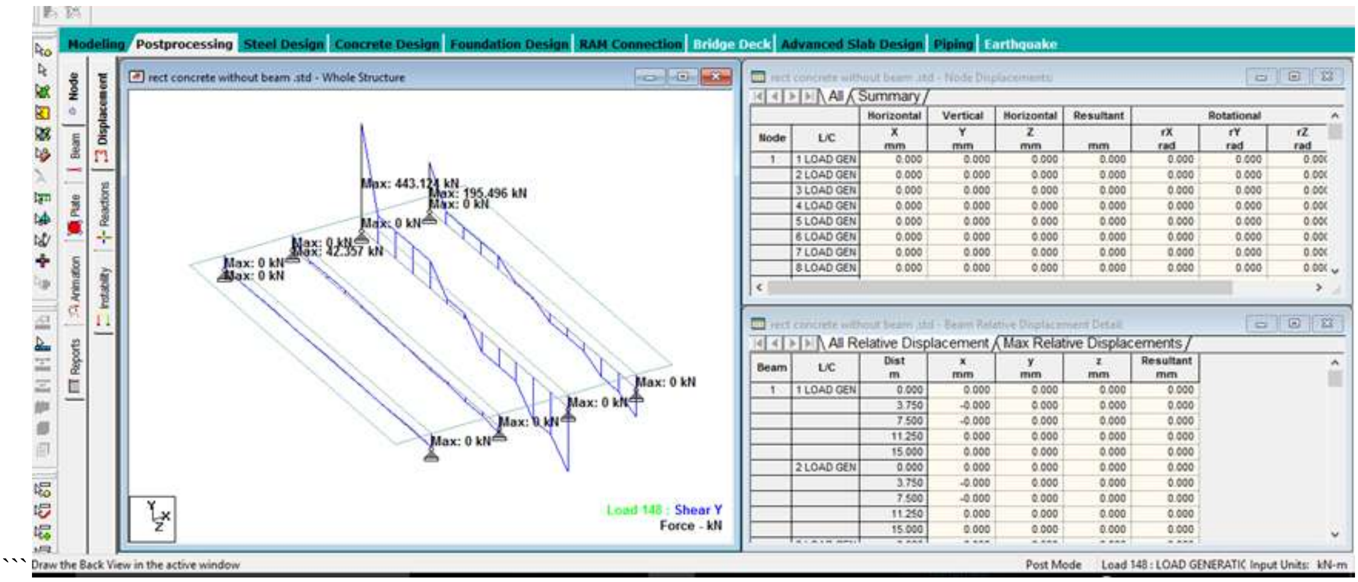

Fig 3.6: Shear of Rectangular girder size 0.4 x 0.8 m with 2 way beam

3.1.3 I Shaped Rcc Girder with Beam (2way)

It is similar to I shaped Rcc girder without beam. Beams are placed at starting point of bridge and ending point of bridge that is zero meter and 15 meter. Cross Beam sized in I Shaped RCC girder size of 0.3 * 0.15m. Similar load are given in bridge as given before for without beam. Take Maxmium Deflection , Bending Moment ,Shear force at 205,211, 148 combinations respectively.

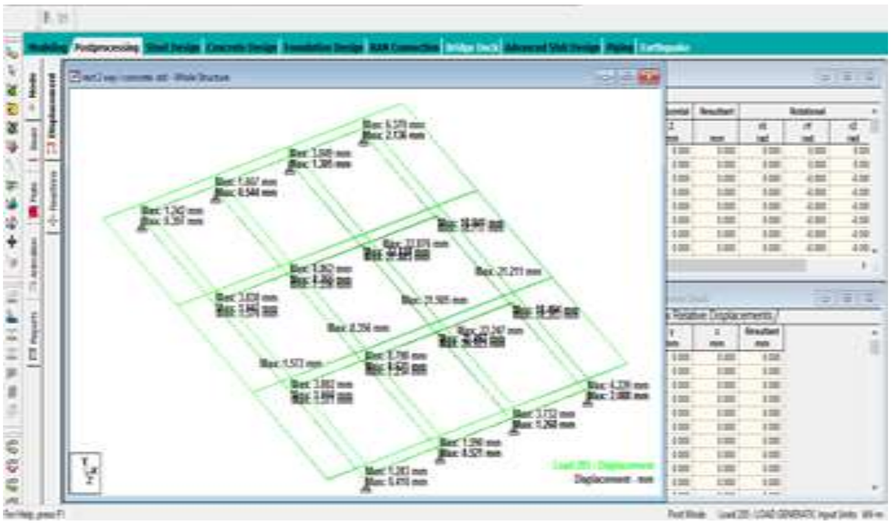

Fig 3.7: Displacement I shaped rcc girder with beam (2way)

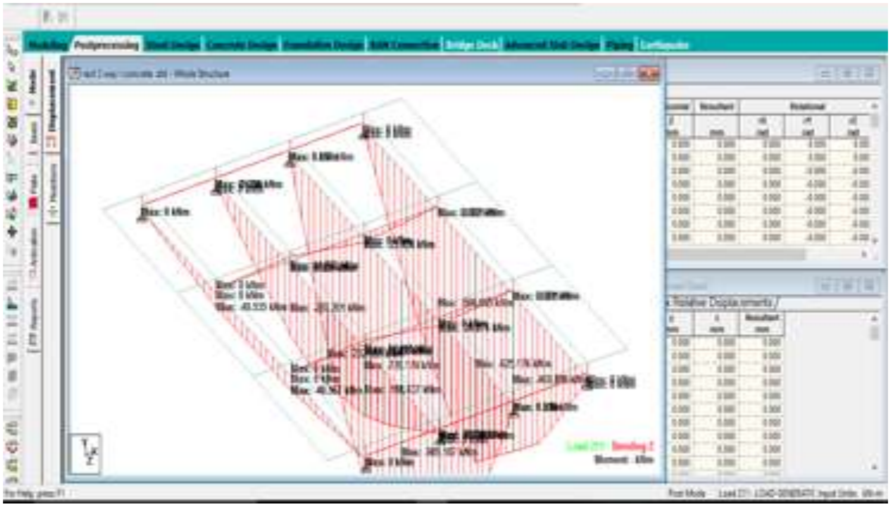

Fig 3.8: Bending I shaped rcc girder with beam (2way)

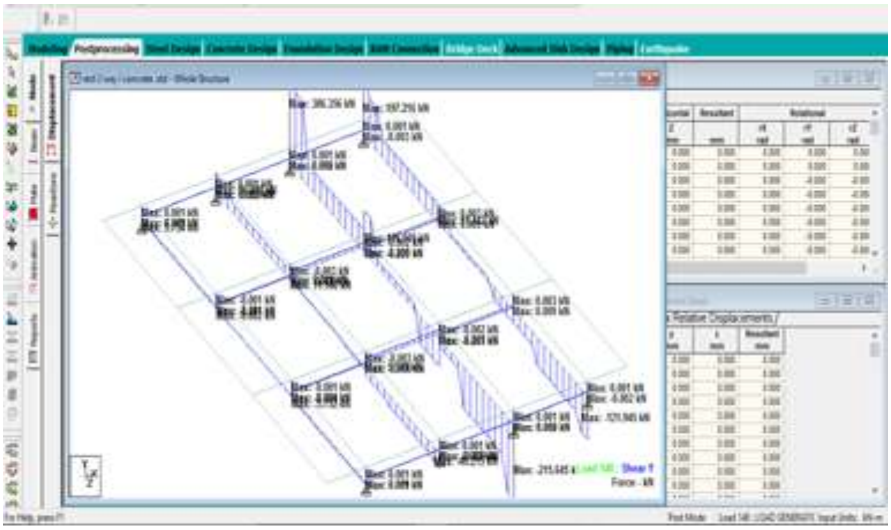

Fig 3.9: shear I shaped rcc girder with beam (2 way)

3.1.4 I Shaped Steel Girder with Beam (2way)

It is similar to I shaped rcc girder with beam (2 way).

4. RESULTS AND DISCUSSIONS

In this results and discussion the values for Deflection, Bending moment and Shear force is taken from the staad pro. Maximum Deflection occur at combination number :205. Maximum Bending moment occur at combination number :211. Maximum Shear force occur at combination number :148. From the above values without beam and beam (one way) have approximately values. All these values are in dynamic conditions. Because in 15 meter span we are giving cross beam at 5 m and 10m distance. When moving load is at from 0 to 5m and 10 to 15m then deflection, bending moment, shear at 5 to 10m it become lesser than without beam and beam

4.1 Estimation

Table 4.1 Values Form Staad pro Rectangular 0.5 X 1m sized girder

		DEFLECTION				**BENDING MOMENT**				**SHEAR**			
DESCRIPTION	**COMBINATION**	**G1**	**G2**	**G3**	**G4**	**G1**	**G2**	**G3**	**G4**	**G1**	**G2**	**G3**	**G4**
2 WAY	205	0.846	2.551	29.041	12.35	0.1	120.082	1230	575.434	0	-14.881	254.714 -280.695	135.027 -131.141
2 WAY	211	0.35	2.481	28.791	12.199	0.1	120.508	1230	585.434	0	-24.937	231.265 -304.926	128.274 -130.581
2WAY	148	0.590	1.558	20.134	9.315	22.052	60.411	783.006	357.830	0	-39.685 +509.949	-250.644 +421.182	-129.074 204.272

Table 4.2 Values Form Staad pro Rectangular 0.4 X 0.8m sized girder

DESCRIPTION	**COMBINATION**	**DEFLECTION**				**BENDING MOMENT**				**SHEAR**			
C0N CRETE .8x0.4		G1	G2	G3	G4	G1	G2	G3	G4	G1	G2	G3	G4
2 WAY	205	2.463	4.843	64.867	32.504	38.916	113.9	1140	510.774	0	+15.545- 13.777	236.612 - 262.992	+147.434- 128.388
2 WAY	211	2.433	4.247	64.346	32.101	37.666	110.915	1150	516.533	- 7.52	+10.889 - 17.543	213.416 - 287.354	136.542 - 138.762
2 WAY	148	1.718	3.549	44.952	19.520	26.460	65.198	720.514	266.895	5.27	37.489 - 31.252	408.707 - 238.154	180.076 - 134.892

Table 4.3 Values Form Staad pro I shaped rcc girder

DESCRIPTION	**COMBINATION**	**DEFLECTION**				**BENDING MOMENT**				**SHEAR**			
I SHAPE		G1	G2	G3	G4	G1	G2	G3	G4	G1	G2	G3	G4
2 WAY	205	0.572	8.356	31.505	21.211	41.032	123.490	980.57	601.617	8.193	-19.90 +47.62	-231.697 +204.522	-130.25 +128.56
2 WAY	211	0	8.352	31.500	21.10	40.565	123.559	989.11	605.176	8.107	- 52.010+45.061	- 256.075+181.915	- 130.668+48.085
2 WAY	148	1.103	5.860	22.022	14.852	28.770	65.076	608.231	352.305	5.754	36.489-40.215	386.356-215.645	193.216 -121.945

Table 4.4 Values Form Staad pro I shaped steel girder

DESCRIPTION	COMBINATION	DEFLECTION				BENDING MOMENT				SHEAR			
I SHAPE STEEL		G1	G2	G3	G4	G1	G2	G3	G4	G1	G2	G3	G4
2 WAY	205	0.107	0.744	9.401	4.143	13.360	122.962	1330	585.304	0	27.489 -39.823	274.335 -300.02	131.049 -142.276
2 WAY	211	0.106	0.730	9.319	3.902	0	123.811	1340	539.941	0	25.852 -42.011	250.577 -324.08	120.420 -132.789
2 WAY	148	0.075	0.534	6.521	2.553	0	80.436	850.953	310.192	0	45.369 -33.083	434.754 -264.262	190.751 -123.543

Estimation in 15 meter span we are giving cross beam at 5 m and 10m distance.

- When moving load is at from 0 to 5m and 10 to 15m then deflection , bending moment, shear at 5 to 10m it become lesser than without beam and beam

NO.	NAME OF BRIDGE	AMOUNT
3.	RCC 0.5*1 TWO WAY BEAMS	1,79,481.95
6.	RCC 0.4*0.8 TWO WAY BEAMS	1,71,161.95
9.	RCC I SHAPE TWO WAYBEAMS	1,96,724.05
12.	STEEL I SHAPE TWO WAY BEAMS	1,70,206.3

5. CONCLUSION

Different arrangement of deck slab with girder was taken like, beams at edges taken as one way slab and beams in between making deck slab two way.. In two way deck slab shear force results has positive and negative values. With normal IRC loading bridge with girder spacing of 2.850m with span of 50 m the working load in bending moment the order of 1600-1800 kN.m and shear force values comes in the order of 400-450 kN. Where as per the staad pro terms 1390 & 440 it appears to be reasonable. Comparing rcc and steel girder bridge I shaped steel is more economical

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