CHAPTER 5

NUMERICAL COMPARISON BETWEEN THROUGH TYPE AND DECK TYPE TRUSS BRIDGES WITH COMPOSITE AND NON-COMPOSITE DECKS

5.1 GENERAL

The most common type of steel bridges are through-type and deck-type bridges. In the through-type bridge system, the carriageway is located at the bottom level of the load-carrying structure (Figure 5.1(a)), whereas in the deck-type system the carriageway is located on the top of the load-carrying system (Figure 5.1 (b)).

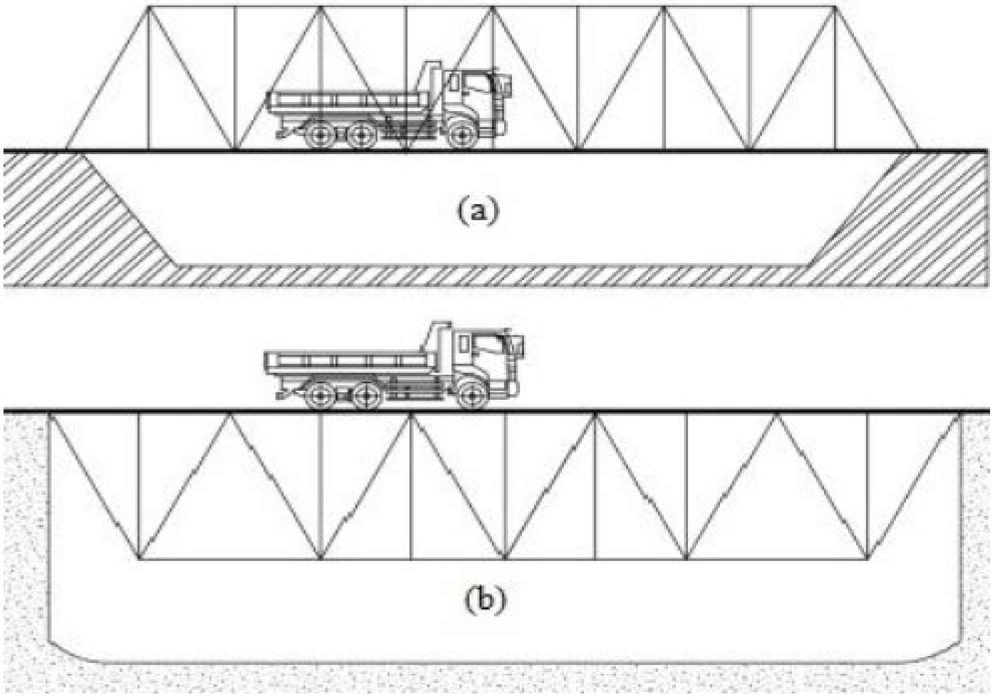


Figure 5.1 Bridge system (a) Through type truss bridge (b) deck type truss bridge.

Depending on the configuration, truss bridges are broadly classified as deck type and through type bridges. Truss bridges can be constructed as composite bridge to take advantage of composite action of RCC deck with steel members. In the case of a simply supported deck type truss bridge, it is advantageous to make deck slab composite with top chord compression members. Buckling of the top chord compression members is effectively prevented by deck slab using shear studs with adequate spacing. The steel used in the top chord members can also be reduced in the case of composite deck type bridges. However, in the case of through type truss bridge, the deck is constructed at the level of bottom chord members, which remains in tension. Due to this composite action of the RCC deck with bottom chord members may not be advantageous as concrete is week in tension. Moreover, tension in concrete will lead to the development of tension cracks which results in quick deterioration of the deck slab.

In this chapter, through type and deck type truss bridges of span 60.0m having similar configuration and same members are analyzed using STAAD.Pro v8i under the loading provisions of IRC 6-2017. The bridges are also studied with composite and non-composite decks. The purpose of the study is to analyze the difference of internal stresses produced in through type and deck type bridges and to determine the extent up to which the composite deck can be useful.

5.2 GEOMETRIC DETAILS OF THE BRIDGES

Two identical truss configurations of 60.0m span were analyzed for a composite deck and non-composite decks. In the case of the non-composite bridge, all loads are taken by the steel truss and the deck slab is not a structural component of the bridge. In the composite bridge, the deck also participates in load sharing along with the truss members.

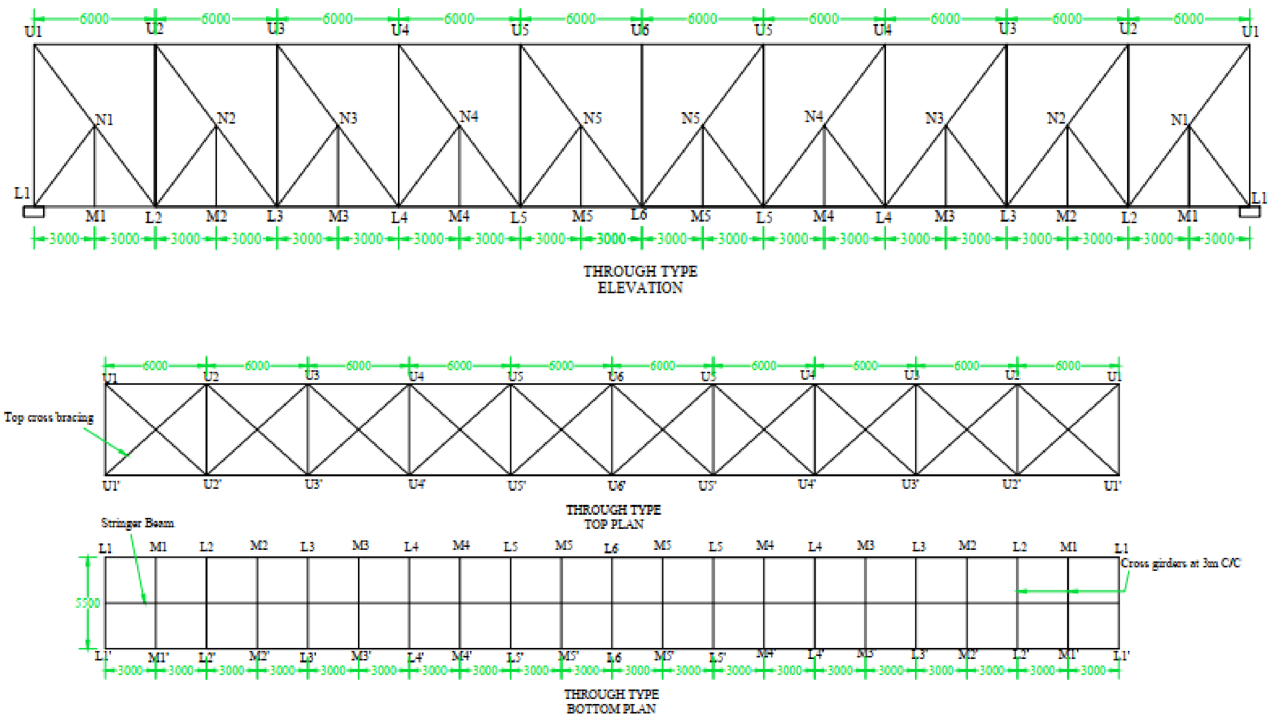
The two bridges were analyzed following the detailed procedure given below under various loading conditions as per Indian codes IRC 6-2017 and IRC 24-2010. To understand the effect of deck location in case of through type and deck type bridges, loading and members of open web girder bridge are kept same. The following steps have been followed for the analysis of the two types of bridges using STAAD Pro. V8i software.

A. Geometric modelling of bridges

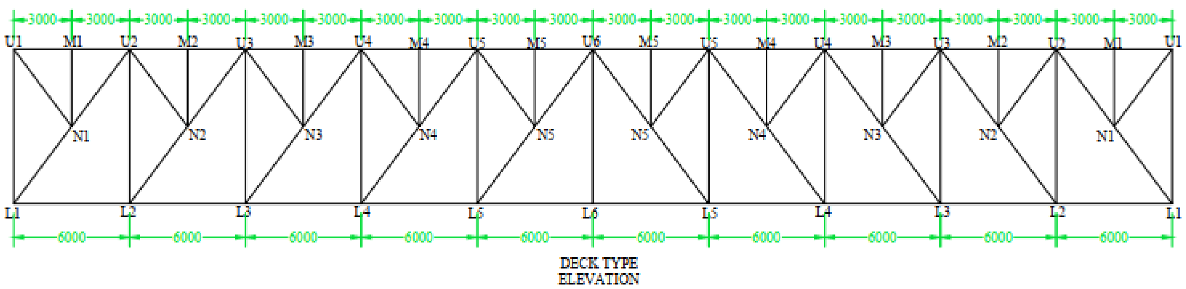
B. Assigning member properties

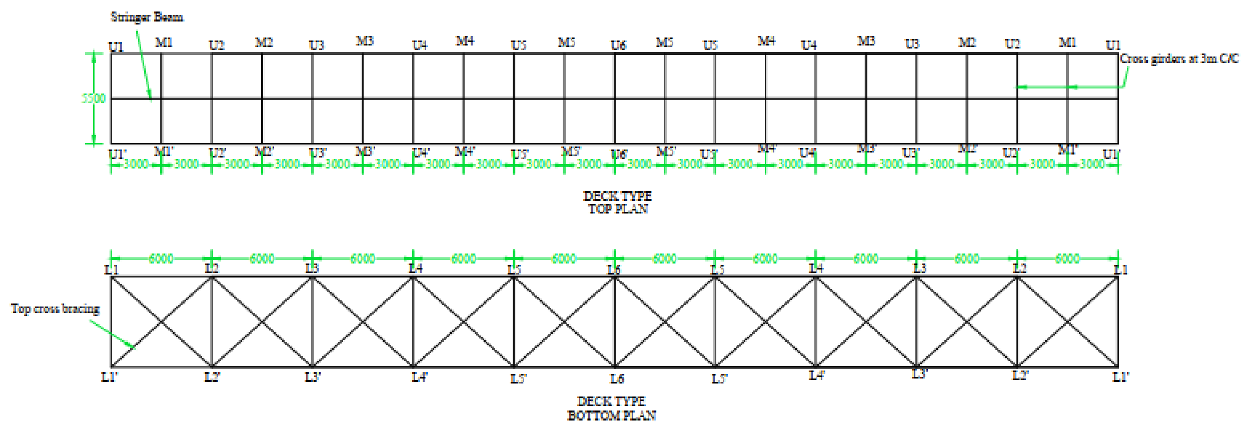
C. Analysis under various loading conditions

D. Stress calculation for various load combinations



(a)





(b)

Figure 5.2 Bridge configuration (a) Through type bridge (b) Deck type bridge

A 3D space frame model was prepared using STAAD Pro. V8i software for the analysis of the 60m span truss bridges, for non-composite bridges the deck slab was not considered as a structural element in the model and the weight of the slab, was distributed on the connecting points of bottom chord beams. For composite type bridges, 4-noded plate elements were used to model the deck slab which was connected with the adjacent truss member. Section builder was used for generating built-up sections.

Geometric details of the 60 m span bridge model are given below.

i. Height of Truss (C/C distance between top chord and bottom chord members) = 8.0 m.

ii. C/C distance between two 2-dimensional trusses = 7.0 m

iii. Width of roadway = 5.5 m

iv. Thickness of deck slab = 225mm

v. Number of 3m top panels (deck type bridge) = 20

vi. Number of 6m top panels (through type bridge) = 10

vii. Number of 6m bottom panels (deck type bridge) = 10

viii. Number of 3m bottom panels (through type bridge) = 20

Figure 5.2 shows a 2-D elevation, top plan and bottom plan views of two alternatives of 60.0m span bridges

M40 grade concrete was used in the deck slab. E250 grade mild steel having yield stress of 250 N/mm^2 was used for the truss members having the following properties.

Young's modulus of elasticity, $E_s = 2.11 \times 10^5$ N/mm^2

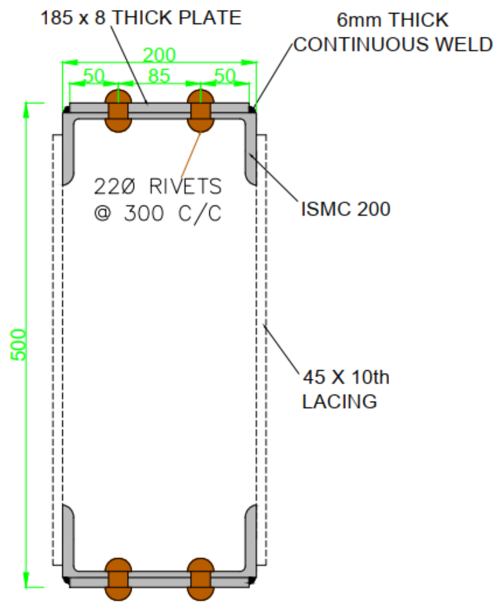
Poisson's ratio = 0.3

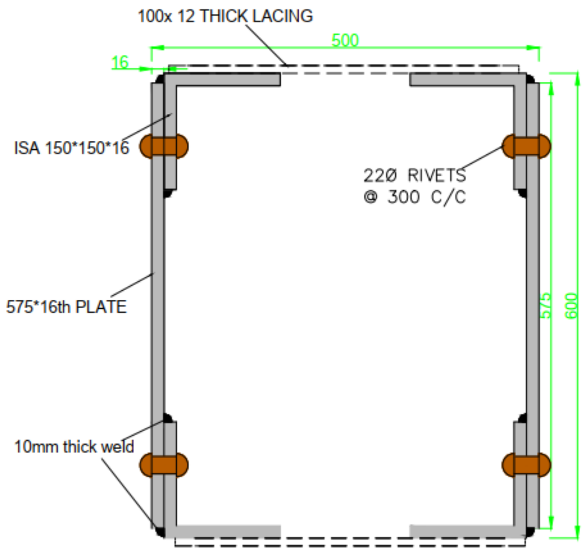
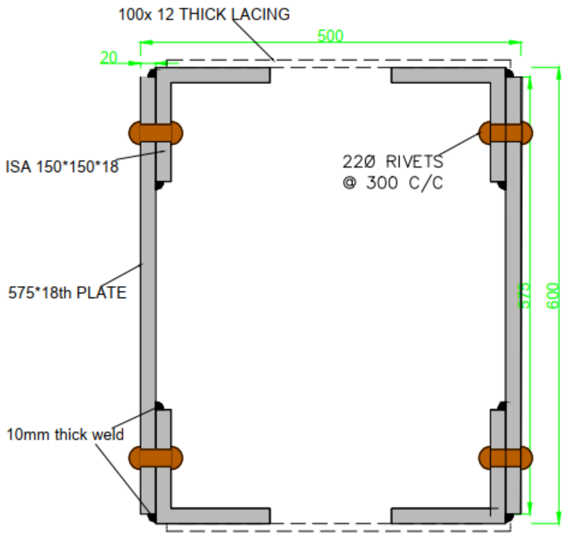
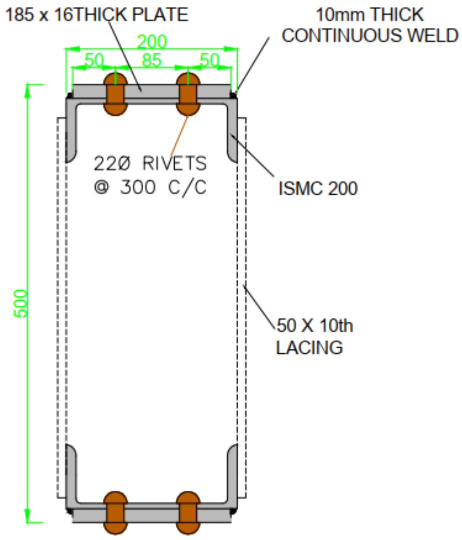
Shear modulus = 77×10^3 N/mm^2

Coefficient of thermal expansion = 1.17×10^{-5} /°C

Member cross-sections are shown in Table 5.1

Table 5.1 Cross-sections used in modeling of 60.0m span bridges.

S.No.	Through type members	Deck type members	Cross-sections
1	U1U1`, U2U2`, U3U3`, U4U4`, U5U5`, U6U6`, U1U2`, U2U1`, U2U3`, U3U2`, U4U3`, U3U4`, U4U5`, U5U4`, U4U5`, L1N1, N1M1, L2N2, N2M2, L3N3, N3M3, L4N4, N4M4, L5N5, N5M5	L1L1`, L2L2`, L3L3`, L4L4`, L5L5`, L6L6`, L1L2`, L2L1`, L2L3` L3L2`, L4L3`, L3L4` L4L5`, L5L4`, L4L5`, U1N1, N1M1, U2N2, N2M2, U3N3, N3M3, U4N4, N4M4, U5N5, N5M5	

<table>
<tr><td>2</td><td>U1U2, U2U3</td><td>L1L2, L2L3</td><td></td></tr>
<tr><td>3</td><td>U3U4, U4U5,
U5U6, L1L2,
L2L3, L3L4,
L4L5, L5L6,</td><td>L3L4, L4L5,
L5L6, U1U2,
U2U3, U3U4,
U4U5, U5U6,</td><td></td></tr>
<tr><td>4</td><td>U1L1, U4L4,
U5L5, U6L6,
U4L5, U5L6</td><td>U1L1, U4L4,
U5L5, U6L6,
U4L5, U5L6</td><td></td></tr>
</table>

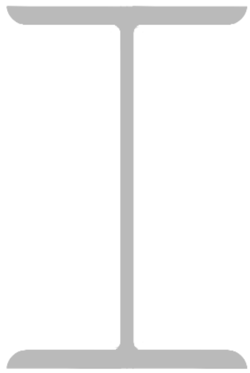
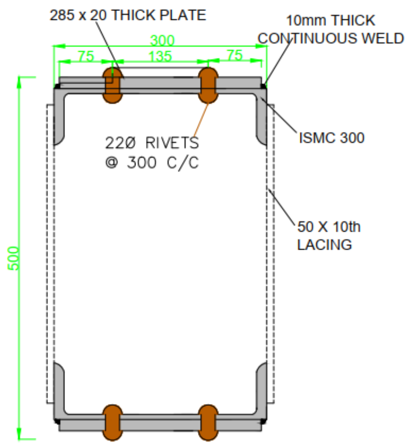
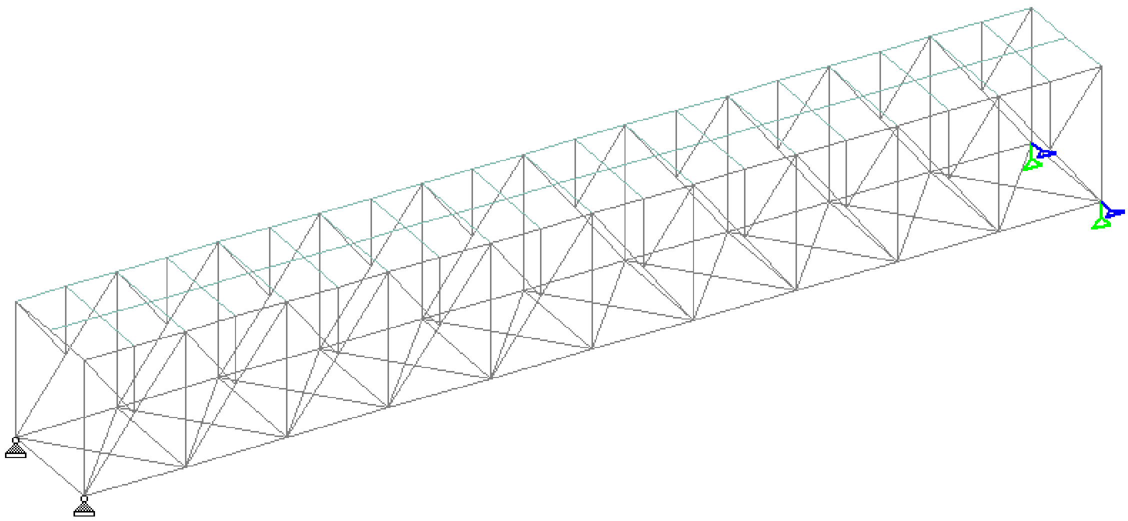
5	STRINGER AND CROSS BEAMS	STRINGER AND CROSS BEAMS	
6	U2L2, U3L3, U1L2, U2L3, U3L4	U2L2, U3L3, L1U2, L2U3, L3U4	

Figure 5.3 shows 3-D figures of a 60.0m span bridge with two configurations.



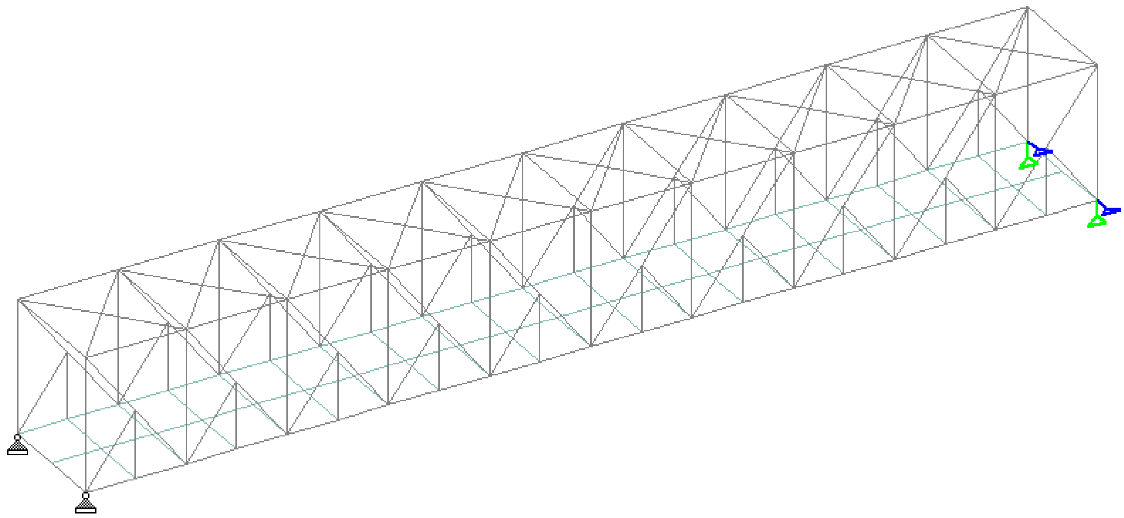


Figure. 5.3 STAAD model for through type and deck type 60.0m span bridges

5.3 ANALYSIS OF THE BRIDGES

Analysis of the models were carried out using STAAD Pro. v8i as per the following sequence.

5.3.1 Modelling

3D models are prepared in STAAD as per geometric details given in Figure 5.2. As members used in these models are built-up sections, the section builder facility in STAAD is used to assign a cross-section of the truss members as per table 5.1. For making the composite deck 4 noded plate elements are used. The STAAD editor file for composite deck and through type bridges are attached as annexure C and annexure D respectively.

5.3.2 Loading

The 60.0 m span bridge model was designed for loading taken as per IRC 6-2017. The primary loads considered for the bridges are shown in table 5.2.

Table 5.2 Primary Loads

Load no.	Name	Remark
1	EQZ	EQ in the transverse direction
2	EQX	EQ in the longitudinal direction
3	SW	Self-weight of truss members including 20% extra for lacings gussets plates
4	SL	3.5 kN/m^2 extra load during deck slab casting due to shuttering and equipment.
5	DS	Wt. of av. 225mm thick deck slab and wearing coat applied on top chord and stringers as distributed longitudinally
6	CB	Load due to crash barrier on top chord members as UDL
7	WL	Wind load in the transverse direction (2.0kN/m^2)
8	FPLL	4.0 kN/m^2 load on the footpath.
9	DL	1.1xSW+DS+WC+CB
10	LL	LL as per IRC 6-2017

Dead load

i. Self-weight of the truss was taken by the SELFWEIGHT command in STAAD. Additional 10% weight due to gusset plate, lacings, batten plates and rivets or bolts were included in the self-weight.

ii. Load due to deck slab.

The thickness of the deck slab is 250mm at the centre and uniformly decreases to 200mm towards the curb. Therefore, the average thickness of the deck slab was taken as 225mm. Loads from the deck slab are primarily taken as UDL on top chord members for deck type bridges and bottom chord members for through type bridges.

iii. Load due to wearing a coat.

The wearing coat was 56mm thick and its unit weight was taken as 22 kN/m^3.

iv. Self-weight of crash barrier

The cross-sectional area of the crash barrier is 0.27m^2 and loading on top chord member due to this was taken as 7.5 kN/m

v. Temporary load due to shuttering and equipment

During the casting of the deck slab, temporary load due to shuttering and equipment was taken as 3.5 kN/m^2 (cl. 202.3 IRC 6-2017). Nodal loads of 90kN and 45kN was used for intermediate and end nodes.

Live load

The bridge is analyzed for two trains of single-lane Class-A wheeled vehicles running parallel as per IRC 6-2017. Impact factor of 12.25% was used as per the code. The load used for the analysis is shown in table 5.3.

Table 5.3 Load for Class A vehicle

Distance	Axle Load	Wheel load	Wheel Load (with impact)
0	27	13.5	15.15
1.1	27	13.5	15.15
3.2	114	57	63.98
1.2	114	57	63.98
4.3	68	34	38.16
3	68	34	38.16
3	68	34	38.16
3	68	34	38.16

Wind load

Wind load is calculated as per CL 209.3.3 of IRC 6-2017.

Wind calculation for through type bridge is shown here.

F = Pz x Af x G x Cd

The basic speed of wind for the site location is 39m/s.

Pz = 0.859, G= 2, Cd =2.906

The exposed area for wind forces is calculated and shown in table 5.4

Table 5.4 Calculation of Wind load

S.No.	Member	Number	Length/member	Total length	Exposed Area per meter (m2)	Total exposed area
1	Bottom chord & Deck System	10	6	60	0.6	43.2
2	Verticals	11	6.3	69.3	.25	17.33
3	Sub verticals	10	3.15	37.8	.2	7.56
4	Diagonals	10	10	120	0.26	32
5	Short diagonals	10	4.35	52.2	0.2	10.44
6	Top chord	10	6	60	0.6	36

Total exposed area, 132.165 m2

Total force = 659.87 kN

Force per node = 33.0 kN for central nodes and 16.5 kN for end nodes.

Seismic Load

The bridge is analyzed for seismic zone V. Seismic forces are calculated as per Cl 219 of IRC 6-2017.

Parameters considered for design:

Z = 0.36

Importance factor = 1.2

Soil type is medium, Sa/g = 2.5

Response reduction factor for

Substructure = 3

Bearing and seismic arrestor = 1

Superstructure = 1

Live load considered = 20%

Structural part	Horizontal seismic coefficient	Vertical seismic coefficient
A_h for substructure	0.18	0.12
A_h for bearing and seismic arrestor	0.54	0.36
A_h for superstructure	0.54	0.36

Weight of steel used (steel offtake as per STAAD) = 1729.49 kN

Weight of deck system = 3452.4 kN

Horizontal force on steel structure = 1046.81 kN

Horizontal force on deck = 1864.3 kN

For the deck type bridge,

Horizontal force per node at top of steel truss = 51.23 kN at the centre and 25.61 kN at ends

Horizontal force per node at bottom of steel truss = 151.50 kN at the centre and 75.75 kN at ends

For the through type bridge,

Horizontal force per node at bottom of steel truss = 51.23 kN at the centre and 25.61 kN at ends

Horizontal force per node at top of steel truss = 151.50 kN at the centre and 75.75 kN at ends

5.4 NUMERICAL COMPARISON OF BRIDGES

Through type and deck type bridges with and without composite decks were compared based on member stresses and maximum deflections. The bridges were analyzed in service condition for three load conditions as per table 1 (clause 202.3) of IRC 6-2017.

i. 1 Dead load+1 Live Load + 1 Breaking load (permissible stress 100%)

ii. 1 Dead load+1 Live Load + 1 Breaking load + 1 Wind load (permissible stress 133%)

iii. 1 Dead load+ 0.2 Live Load + 0.2 Breaking load + 1 Earthquake load (permissible stress 150%)

After analysis, member stresses as per the load combinations are shown in the tables below.

Table 5.5 Member stresses for non-composite deck type bridge

	1DL+1LL+1BL		**1DL+1LL+1BL+1WL**		**1DL+0.2LL+0.2BL+1EL**	
Members	**Comp**	**Tensile**	**Comp**	**Tensile**	**Comp**	**Tensile**
U1U2	14.19	-0.88	14.37	-1.06	5.24	-0.90
U2U3	47.43	-0.16	49.63	-2.36	37.92	-9.04
U3U4	73.11	-0.15	76.58	-3.62	61.37	-14.36
U4U5	87.32	-0.13	91.50	-4.32	76.77	-17.44
U5U6	95.19	-0.13	99.67	-4.61	84.82	-18.75
L1L2	27.25	-56.57	38.90	-68.29	41.35	-66.21
L2L3	0.00	-84.84	8.20	-93.17	26.63	-77.79
L3L4	0.00	-96.97	9.50	-106.59	30.16	-90.01
L4L5	0.00	-104.41	10.21	-114.73	31.79	-98.65
L5L6	0.00	-107.31	9.69	-117.11	29.77	-99.28
U1L1	57.17	-0.02	59.38	-2.23	31.94	-8.56
U2L2	7.49	-76.22	11.18	-79.91	16.59	-62.06
U3L3	4.50	-59.53	6.85	-61.88	10.72	-45.55
U4L4	35.87	-75.75	38.15	-78.03	16.92	-51.00
U5L5	26.78	-47.71	27.72	-48.65	9.44	-24.11
U6L6	1.37	-16.82	1.63	-17.09	1.56	-6.90
L1U2	127.99	-9.16	134.57	-15.75	105.09	-28.39
L2U3	97.30	-32.59	101.58	-36.87	76.67	-24.17
L3U4	74.79	-29.68	77.44	-32.33	55.12	-17.10
L4U5	94.13	-19.37	96.59	-21.82	60.31	-14.37
L5U6	60.87	-33.83	61.66	-34.62	27.06	-10.29

Table 5.6 Member stresses for composite deck type bridge

Members	1DL+1LL+1BL		1DL+1LL+1BL+1WL		1DL+0.2LL+0.2BL+1EL	
	Comp	Tensile	Comp	Tensile	Comp	Tensile
U1U2	13.06	-2.57	13.26	-2.85	4.28	-3.05
U2U3	33.14	-0.07	34.49	-1.44	20.20	-5.60
U3U4	47.20	-0.07	48.84	-1.72	28.14	-7.01
U4U5	52.90	-0.06	54.37	-1.55	31.61	-6.68
U5U6	55.93	-0.08	57.18	-1.34	32.81	-6.01
L1L2	27.25	-56.61	37.36	-66.80	35.65	-60.55
L2L3	0.00	-84.85	7.09	-92.08	22.90	-74.07
L3L4	0.00	-97.02	7.93	-105.07	24.70	-84.61
L4L5	0.00	-104.46	8.34	-112.92	25.19	-92.11
L5L6	0.00	-107.27	7.84	-115.23	23.17	-92.64
U1L1	57.30	-0.02	59.69	-2.41	32.77	-9.25
U2L2	7.49	-76.02	11.10	-79.63	16.05	-61.32
U3L3	4.50	-59.23	6.56	-61.29	9.45	-43.97
U4L4	35.87	-75.12	37.77	-77.02	15.24	-48.68
U5L5	26.78	-46.81	27.62	-47.65	8.90	-22.67
U6L6	1.37	-16.24	1.54	-16.41	1.20	-5.96
L1U2	128.13	-9.17	135.27	-16.31	106.83	-30.00
L2U3	97.08	-32.59	101.18	-36.69	75.50	-23.22
L3U4	74.52	-29.68	76.78	-31.94	53.16	-15.40
L4U5	93.63	-19.36	95.54	-21.27	57.49	-12.04
L5U6	59.71	-33.83	60.39	-34.51	25.27	-9.66

Table 5.7 Member stresses for non-composite through type bridge

Members	1DL+1LL+1BL		1DL+1LL+1BL+1WL		1DL+0.2LL+0.2BL+1EL	
	Comp	Tensile	Comp	Tensile	Comp	Tensile
U1U2	53.92	-39.17	54.08	-39.44	32.21	-11.00
U2U3	82.91	0.00	85.93	-3.15	63.78	-13.45
U3U4	95.41	0.00	101.21	-5.91	80.39	-21.24
U4U5	103.02	0.00	110.96	-8.05	93.32	-27.14
U5U6	106.15	-38.72	115.05	-47.73	98.40	-37.28
L1L2	61.17	-21.07	62.44	-22.33	15.26	-10.12
L2L3	0.00	-56.23	2.82	-59.05	4.83	-35.47
L3L4	0.00	-84.79	3.07	-87.86	3.82	-53.20
L4L5	0.00	-100.08	2.82	-102.90	2.18	-64.09
L5L6	14.85	-107.92	17.39	-110.46	3.94	-69.61
U1L1	185.46	0.00	193.10	-7.63	123.04	-8.29
U2L2	99.99	-1.39	101.00	-2.40	55.42	-3.80
U3L3	59.18	-3.98	59.92	-4.72	40.73	-5.89

U4L4	75.10	-14.97	76.50	-16.36	47.84	-9.70
U5L5	47.12	-24.63	47.72	-25.23	22.49	-7.50
U6L6	30.63	-7.28	30.74	-7.39	8.59	-1.67
U1L2	15.76	-117.61	19.60	-121.46	6.27	-75.41
U2L3	1.17	-99.47	1.67	-99.97	6.49	-66.92
U3L4	5.04	-74.26	6.39	-75.61	8.05	-50.84
U4L5	18.05	-93.29	20.11	-95.34	12.13	-58.17
U5L6	36.20	-60.13	36.98	-60.91	9.87	-26.02

Table 5.8 Member stresses for composite through type bridge

Members	**1DL+1LL+1BL**		**1DL+1LL+1BL+1WL**		**1DL+0.2LL+0.2BL+1EL**	
	Comp	**tensile**	**Comp**	**tensile**	**Comp**	**tensile**
U1U2	53.90	-39.16	55.94	-41.30	31.92	-10.71
U2U3	82.91	0.00	86.04	-3.26	54.60	-4.25
U3U4	95.45	0.00	98.34	-3.01	62.92	-3.72
U4U5	103.06	0.00	105.66	-2.71	69.37	-3.14
U5U6	106.08	-38.68	108.41	-41.13	71.50	-10.41
L1L2	62.34	-14.57	70.94	-23.18	34.55	-25.42
L2L3	0.00	-33.39	3.62	-37.03	8.97	-23.59
L3L4	0.00	-47.60	4.74	-52.36	11.67	-33.01
L4L5	0.00	-53.29	5.19	-58.49	12.54	-37.69
L5L6	14.85	-56.21	19.87	-61.24	15.32	-39.34
U1L1	185.35	0.00	194.49	-9.13	127.04	-12.33
U2L2	99.85	-1.41	103.06	-4.62	56.08	-4.55
U3L3	58.73	-4.03	60.64	-5.94	37.76	-3.27
U4L4	74.31	-15.08	76.09	-16.86	42.73	-5.28
U5L5	45.97	-24.83	46.74	-25.59	20.03	-6.04
U6L6	29.79	-7.41	30.12	-7.74	8.25	-1.98
U1L2	15.88	-117.55	21.27	-122.94	10.42	-79.51
U2L3	1.22	-99.24	5.01	-103.03	5.27	-65.57
U3L4	5.21	-73.83	7.26	-75.88	3.66	-46.11
U4L5	18.31	-92.61	20.04	-94.35	6.07	-51.53
U5L6	32.64	-58.61	33.24	-59.22	7.81	-23.45

From the above tables, member stresses can be compared for two types of bridges and difference of stresses can also be observed for composite and non-composite bridges. Maximum stresses in the member locations can also be observed in table 5.9 and 5.10 for deck type and through type bridges respectively.

Table 5.9 Maximum stresses at member locations for deck type bridges.

FOR NON-COMPOSITE DECK TYPE BRIDGE						
Members	**1DL+1LL+1BL**		**1DL+1LL+1BL+1WL**		**1DL+0.2LL+0.2BL+1EL**	
	Comp	**Tensile**	**Comp**	**Tensile**	**Comp**	**Tensile**
Top chord	95.19	-0.88	99.67	-4.61	84.82	-18.75
Bottom Chord	27.25	-107.31	38.90	-117.11	41.35	-99.28
Verticals	57.17	-76.22	59.38	-79.91	31.94	-62.06
Inclined	127.99	-33.83	134.57	-36.87	105.09	-28.39
FOR COMPOSITE DECK TYPE BRIDGE						
Members	**1DL+1LL+1BL**		**1DL+1LL+1BL+1WL**		**1DL+0.2LL+0.2BL+1EL**	
	Comp	**Tensile**	**Comp**	**Tensile**	**Comp**	**Tensile**
Top chord	55.93	-2.57	57.18	-2.85	32.81	-7.01
Bottom Chord	27.25	-107.27	37.36	-115.23	35.65	-92.64
Verticals	57.30	-76.02	59.69	-79.63	32.77	-61.32
Inclined	128.13	-33.83	135.27	-36.69	106.83	-30.00

Table 5.10 Maximum stresses at member locations for through type bridges.

FOR NON-COMPOSITE THROUGH TYPE BRIDGE						
Members	**1DL+1LL+1BL**		**1DL+1LL+1BL+1WL**		**1DL+0.2LL+0.2BL+1EL**	
	Comp	**Tensile**	**Comp**	**Tensile**	**Comp**	**Tensile**
Top chord	106.15	-39.17	115.05	-47.73	98.40	-37.28
Bottom Chord	61.17	-107.92	62.44	-110.46	15.26	-69.61
Verticals	185.46	-24.63	193.10	-25.23	123.04	-9.70
Inclined	36.20	-117.61	36.98	-121.46	12.13	-75.41
FOR COMPOSITE THROUGH TYPE BRIDGE						
Members	**1DL+1LL+1BL**		**1DL+1LL+1BL+1WL**		**1DL+0.2LL+0.2BL+1EL**	
	Comp	**Tensile**	**Comp**	**Tensile**	**Comp**	**Tensile**
Top chord	106.08	-39.16	108.41	-41.30	71.50	-10.71
Bottom Chord	62.34	-56.21	70.94	-61.24	34.55	-39.34
Verticals	185.35	-24.83	194.49	-25.59	127.04	-12.33
Inclined	32.64	-117.55	33.24	-122.94	10.42	-79.51

From table 5.9, it can be seen that due to composite action in deck type bridges, maximum compressive stress in the compression member decreased from 95.19 N/mm^2 to 55.93 N/mm^2. This 41.24% reduction in stress in compression zone will help in preventing buckling of the members. Also from table 5.10, member stresses for the composite bottom chord members also reduced from 107.92 N/mm^2 to 56.21 N/mm^2. This reduction of stress is in tension zone and the top chord of the through type bridge continues to have a stress of 106.08 N/mm^2 stress. Hence, use of composite RCC deck in prevention of buckling is utilized in case of deck type bridges.

The steel off-take for both the bridges was 1729.49 kN as all the members used in both the bridge systems were identical. The same structures were then analyzed with composite RCC decks of 225mm thickness. The deflection obtained from the analysis of through type and deck type bridge with and without composite decks are compared in table 5.11.

Table 5.11 Deflection obtained from analysis

Deflections		**Through type truss system**		**Deck type truss system**	
		Composite deck	**Non-Composite deck**	**Composite deck**	**Non-Composite deck**
Vertical deflection in mm	Deflection under dead load (SW+SIDL)	42.12	49.70	38.62	44.92
	Deflection under live load	46.24	48.4	44.13	46.24
	Total vertical deflection	88.36	95.1	82.75	91.16
Horizontal deflection in mm	Deflection due to the seismic load	42.62	357.50	128.76	181.38
	Deflection due to wind load	25.66	89.38	30.33	42.8

From the above observations, following inferences can be drawn

1. In seismic conditions, due to the composite action of the deck slab for the deck type bridge, maximum horizontal deflection in the top chord decreases from

181.38 mm to 128.76 mm by 29 %. Similarly, for the through type bridge maximum deflection occurring in the bottom chord in the mid-span decreases from 357.50 mm to 42.62 mm by 88.06%. Maximum deflection in composite deck type bridge was observed in the deck slab above the support location and is large compared to through type bridge because the deck slab is located at some elevation, whereas for through type bridge, deck slab is located at the support level.

In the wind load condition due to composite action of the deck slab for the through type bridge, maximum horizontal deflection decreases from 89.38 mm to 25.66 mm by 71.3 %. Similarly for the deck type bridge maximum deflection decreases from 42.8 mm to 30.33 mm by 29.13%. Maximum deflection due to wind load in case of deck type bridge was also observed on the top chord above the supports.

The horizontal deflection is considerably reduced by making the deck composite in both deck type and through type bridge systems. This is because the composite deck provide diaphragm action in the horizontal direction and due to this the rigidity of the structure increases significantly.

2. For through type bridge, the vertical deflection at the mid-span decreases from 95.1 mm to 88.36 mm by 7.1 %. Similarly, for the deck type bridge maximum deflection occurring in the bottom chord in the mid-span decreases from 91.16 mm to 82.75 mm by 9.2%. This decrease in deflection suggests that due to composite action the bridge becomes stiffer. This increase in stiffness is attributed to the composite action between the steel truss and RCC deck.
3. In the through type bridge, considerable decrement in maximum stress in the bottom chord at the mid-span was observed for all three load combinations. The

average decrease in stress was 45.31%. Similarly for the deck type bridge maximum stress in the top chord at the mid-span also reduced. The average decrement in stress for deck type bridge was 48.4%. Apart from eliminating the bucking tendency of top chord compression members, the composite deck slab also participated in load sharing and significantly reduced stresses in the top chord section.

Steel offtake for all the bridges was 1729.49 kN, as all the members were kept identical. A significantly high proportion of the compressive force in the top members of a deck type bridge is shared by the deck slab while preventing buckling of the steel members. The enhanced stiffness of the composite deck will result in reduced section of compression members. This will lead to an economical design of the bridge. Vertical deflection of the composite bridges is also lower in comparison to the non-composite bridges, resulting in their better serviceability.