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ANALYSIS OF T BEAM IN RC DECK SLAB BRIDGE WITH VARYING THICKNESS

Engineering

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ABSTRACT

Bridges variety in period from some meters to several kilometres. They are among the most important structures built by way of guy. The demands on layout and on materials are very high. A bridge needs to be sturdy enough to assist its own weight further due to the fact the weight of the individuals and cars that use it. The shape additionally must face up to several natural occurrences, including earthquakes, sturdy winds, and changes in temperature. Numbers of bridges have a concrete, steel, or wood framework & an asphalt or concrete route on which people and cars tour. The analysis of a 3-span lane T-beam bridge is finished by various the span of 10m, 15m, 18m, with various span/Depth ratio and quantity of longitudinal & cross girders using software program Staad Pro v8i. To gain most bending second and shear force in girder, most Stresses in slab and maximum response and second on the guide, the bridge fashions are subjected to the IRC magnificence AA Tracked loading device and concluded that with the increase in shear force, bending moment and deflection inside the girder and version of stresses in slab.

KEYWORDS

Deck slab, IRC loading, Staad pro, stresses on Beam & Slab, etc.

INTRODUCTION

A Bridge is a structure imparting passage over partner obstacle at the same time as not remaining the method at a lower vicinity. The required passage can also be for a street, a railway, pedestrians, a canal or a pipeline. The obstacle to be crossed can be a river, a street, railway or a valley.[5]

Bridges variety in period from a few meters to several kilometers. They are among the largest systems built with the aid of man. The demands on design and on substances are very excessive. A bridge should be robust enough to support its personal weight in addition due to the fact the burden of the individuals and cars that use it. The structure moreover has to face up to several natural occurrences, which includes earthquakes, strong winds, and modifications in temperature. Numbers of bridges have a concrete, metallic, or wood framework & an asphalt or concrete route on which individuals and vehicles travel. The T-beam Bridge is a long way and away the most unremarkably followed type in the span range of ten to 20-five meter. The shape is so named because of the foremost longitudinal girders analyses & designed as T-beams imperative with a region of the deck block, that's cast monolithically with the girders. Simply supported T-beam span of over thirty meters are rare due to the fact the loading then turns into too critical.[2]

Components of a Bridge

The Superstructure consists of the following components:

I. Deck slab
II. Cantilever slab element
III. Footpaths, if provided, kerb and handrails or crash limitations.
IV. Longitudinal girders taken into consideration in the layout to be of T- section
V. Cross beams or diaphragms, intermediate and give up ones.
VI. Wearing coat
VII. Cross beams or diaphragms, intermediate and cease ones
VIII. Wearing coat

The Substructure consists of the following structures:

I. Abutments at the intense ends of the bridge.
II. Piers at intermediate helps in case of a couple of span bridges.
III. Bearings and pedestals for the decking.
IV. Foundations for each abutments and piers can be of the sort open, well, pile, and so forth.[10]

Table -1: Description of the bridge

Description Bridge	
Bridge type	T-Beam Deck Slab Bridge
Span	10m,15m and 18m
Lane of Bridge	Two lanes
Carriageway Width	7.5m
No. of longitudinal Girder	6
No. Cross girder	4
Thickness of girder	500mm
Depth of girder	500mm
slab thickness	150mm,200mm,250mm & 300mm
Live load	AA Class Tracked Vehicle
Spacing of longitudinal girder	2m c/c

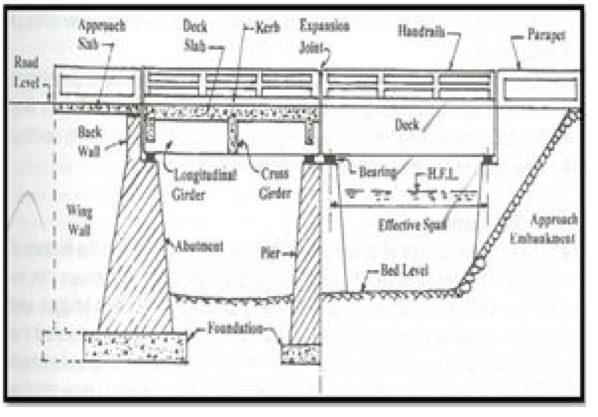

Fig -1: Components of the bridge

OBJECRIVES OF THE WORK

The analysis of a 3-span lane T-beam bridge is performed by mistreatment numerous the span of 10m, 15m, 18m, with numerous span/depth magnitude relation and range of longitudinal & move girders the usage of code program Staad professional v8i. to get most bending moment and shear force in beam, most Stresses in block and most reaction and second at the help, the bridge models square measure subjected to the IRC magnificence AA half-tracked loading device and ended that with the boom in shear pressure, bending moment and deflection within the beam and version of stresses in block

Parametric study

A merely supported, five spans, 2 lanes RCC block upper deck is taken into thought. The span is varied from 10m, 15m and 18m and intensity of the block varies from 150mm, 200mm, 250mm and 300mm for all spans. The upper deck is analyzed for burden additionally to various magnificence of loading i.e. IRC loading. Comparison of crucial structural response parameter. The analysis is accomplished for numerous category of IRC loading

Analysis of T-BEAM Bridge is completed with the help of the usage of Staad professional V8i code for special spans with numerous thickness. STAAD.Pro in mixture with STAAD. Beava could also be accustomed examine bridges as keep with the AASHTO code. STAAD.Pro is first accustomed construct the bridge structure and STAAD. Beava is employed to seek out the AASHTO 2002 load positions to make the most load response. These hundreds that make the most load responses will then be transferred into STAAD.

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Seasoned as load instances to load combos for equally analysis and layout. Variation in liquid ecstasy Von Mis stresses

1. The Principal stresses variation in deck block
2. Node Displacement
3. Compressive and Tensile Stresses in pier
4. Shear force and bending Moment in Beam

Methodology

Loads acting on Bridge

1. Dead Load

Dead or permanent loading is the gravity loading due to the structure and other items permanently attached to it. It is simply calculated as the product of volume and material density.

2. Live loads

Live load means a load that moves along the length of the span. These loads are categorized based on their configuration and intensity. Classification of several loadings is:
IRC class AA loading
IRC class70R loading
IRC class A loading
IRC class B loading

Loadings considered in this study are IRC class AA and class 70R tracked loadings which are almost similar

3. IRC class AA loading

Two different types of vehicles are specified under this category grouped as tracked and wheeled vehicles. The IRC Class AA tracked vehicle (simulating an army tank) of 700 KN and a wheeled vehicle (heavy duty army truck) of 400 kN. All the bridges located on National Highways and State Highways have to be designed for this heavy loading. These loadings are also adopted for bridges located within certain specified municipal localities and along specified highways. Alternatively, another type of loading designated as Class 70 R is specified instead of Class AA loading.

4. IRC Class 70 R Loading

IRC 70 R loading consists of the following three types of vehicles.

a) Tracked vehicle of total load 700 kN with two tracks each weighing 350 kN.
b) Wheeled vehicle comprising 4 wheels, each with a load of 100 kN totaling 400 kN.
c) Wheeled vehicle with a train of vehicles on seven axles with a total load of 1000 kN.

The tracked vehicle is somewhat similar to that of Class A, except that the contact length of the track is 4.87 m, the nose to tail length of the vehicle is 7.92 m and the specified minimum spacing between successive vehicles is 30 m. The wheeled vehicle is 15.22 m long and has seven axles with the loads totaling to 1000 kN. The bogie axle type loading with 4 wheels

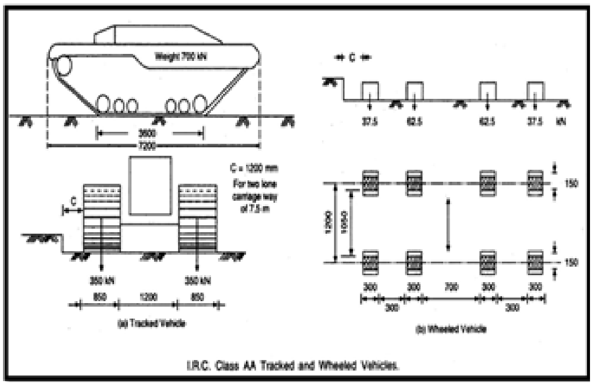

Fig -2: IRC Loading

5. Impact Load:

For I.R.C. Class AA or 70R loading

(i) For span less than 9 meters For tracked vehicle- 25% for a span up to 5m linearly reduced to a 10% for a span of 9m. For wheeled vehicles- 25%

ii) For span of 9 m or more
For tracked vehicle- for R.C. bridges, 10% up to a span of 40m. For steel bridges, 10% for all spans.

For wheeled vehicles- for R.C. bridges, 25% up to a span of 12m. For steel bridges, 25% for span up to 23 meters

RESULT AND DISCUSSION

Table -2: Principal Stresses on Deck

Span (m)	10		15		18	
Deck thickness (mm)	Principal stresses in top N/mm²	Principal stresses in bottom N/mm²	Principal stresses in top N/mm²	Principal stresses in bottom N/mm²	Principal stresses in top N/mm²	Principal stresses in bottom N/mm²
150	3500	3000	4500	4235	5500	4865
200	3800	3200	5234	3800	6254	4256
250	4000	2900	5123	3246	6353	3250
300	3750	3000	5024	2500	6154	3195

Table -3: Results of Node, Beam forces and B.M on Deck

Span (m)		10			15			18		
Axis		X	Y	Z	X	Y	Z	X	Y	Z
Node	150	0.2	3.8	0.35	0.25	8.5	0.35	0.2	14	1.35
	200	0.8	3.5	0.5	0.75	8.25	0.5	0.8	13	1.5
	250	0.2	3	0.5	0.15	7.75	0.5	0.2	11	1.75
	300	0.2	2.5	0.35	0.2	6.5	0.35	0.2	10	1.8
Beam forces	150	3500	3450	3450	4580	4700	3450	4800	4954	4954
	200	3500	3550	3550	4822	4880	3550	4800	4800	4800
	250	3430	3520	3520	4780	4890	3520	6500	6253	6253
	300	3250	3300	3300	5230	5100	3300	6854	6754	6754
Bending moment kN.m	150	57	225	210	98	305	300	80	510	412
	200	45	210	175	80	320	310	75	520	430
	250	40	190	152	50	350	310	60	550	430
	300	20	160	145	40	350	285	55	585	410

Table -4: MAX. Compressive Stresses on Deck

MAX. Compressive load on pier									
Node Point		6	7	19	20	32	33	45	45
10	150	12.5	21	11	17	0.5	1.5	2	2.2
	200	12	19	10.5	15.5	0.4	1.4	2	2.25
	250	11	17.5	9	14	0.3	1.3	2	2.35
	300	9	15	8	12.5	0.2	1.2	2	2.3
15	150	3	2	1	2.125	18	27	22	34
	200	3.01	2.15	1.265	1.2654	17	26	21	32
	250	3.11	2.516	1.564	1.549	16	23	20	30
	300	3.12	2.516	1.456	1.5468	15.5	21	18	28
18	150	30	42.45	25.56	34.5	3.45	3.55	4.5	3.254
	200	29.6	41.564	41.02	35.5	3.45	3.65	4.12	3.274
	250	28.8	37.55	22.745	35.2	3.45	3.45	4.0123	3.025
	300	27.5	32.56	32.5	21.05	3.45	3.35	4.457	3.058

Table -5: MAX. Tensile Stresses on Deck

MAX. Tensile load on pier									
Node Point		6	7	19	20	32	33	45	45
10	150	12	18	10	14	2	3	2	3.2
	200	11	17	8.5	13	2	2.8	2	3.2
	250	9	15	7.5	12	2	2.5	2	3.2
	300	7	12.5	6	8	2	2	2	3.2
15	150	3	2	1	2.125	19	28	23.5	35.567
	200	3.02	2.15	1.265	1.2654	18.5	27	22.546	33.5
	250	3.11	2.51	1.564	1.549	17.54	23.5	21.564	31.5
	300	3.12	2.51	1.456	1.5468	16.58	22.5	20.25	28.56
18	150	31.5	43.14	25.56	34.5	3.45	3.55	4.5	3.47
	200	30.5	42.54	41.02	35.5	3.45	3.65	4.12	2.998
	250	28.8	38.795	22.745	35.2	3.45	3.45	4.0123	3.765
	300	28.1	33.7945	32.5	21.0456	3.45	3.35	4.457	3.486

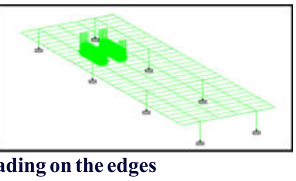

Fig -3: Vehicle loading on the edges

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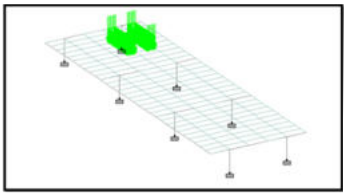

Fig -4: Vehicle loading middle of the edges

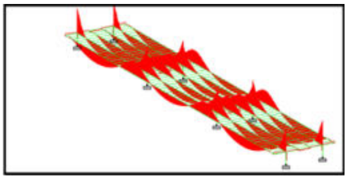

Fig -5: Stresses on the Girder

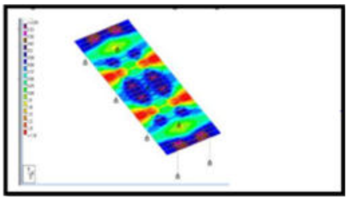

Fig -6: Stresses on the Deck slab

A. Principal Stresses on the Deck

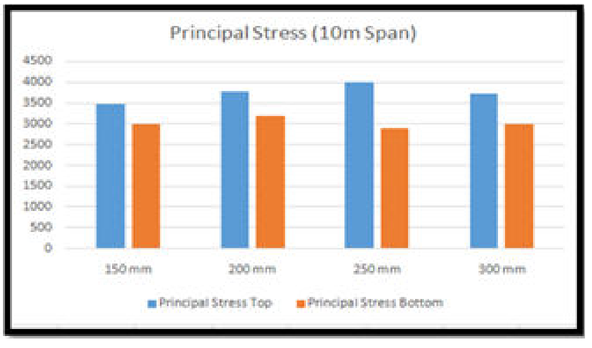

Fig -7: Principal Stresses on 10m Span with varying thickness

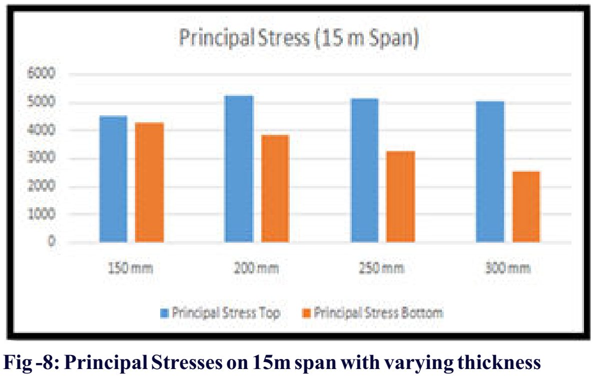

Fig -8: Principal Stresses on 15m span with varying thickness

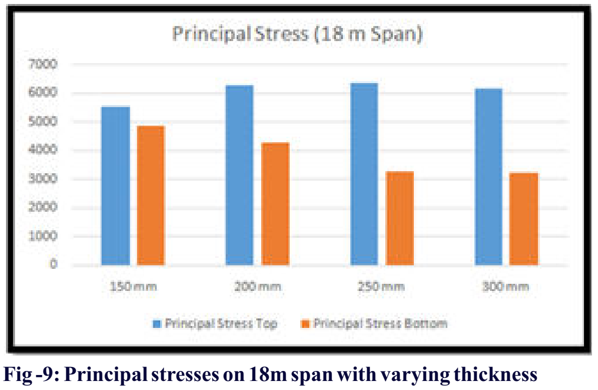

Fig -9: Principal stresses on 18m span with varying thickness

B. MAX. Von Mis Stresses on Deck

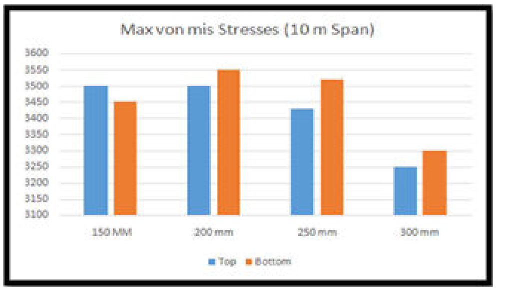

Fig -10: MAX. Von mis stresses on deck of 10m span with varying thickness

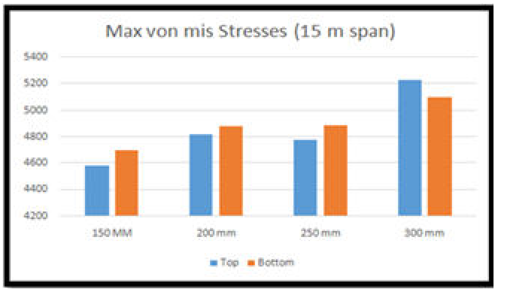

Fig -11: MAX. Von mis stresses on deck of 15m span with varying thickness

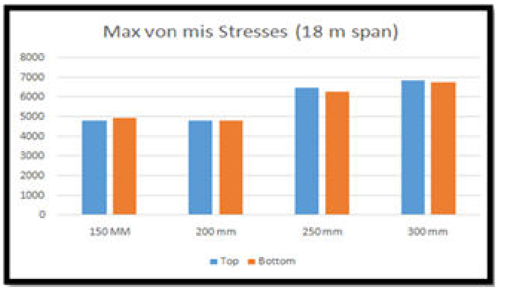

Fig -12: MAX. Von mis stresses on deck of 18m span with varying thickness

C. MAX. Node Displacement

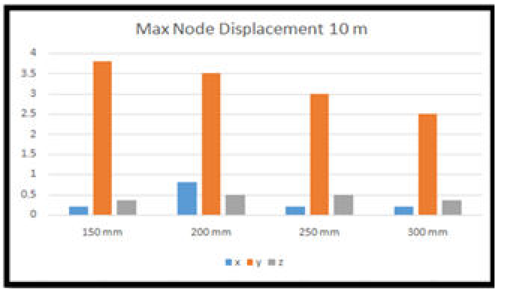

Fig -13: MAX. Node displacement on deck slab of 10m span of varying thickness

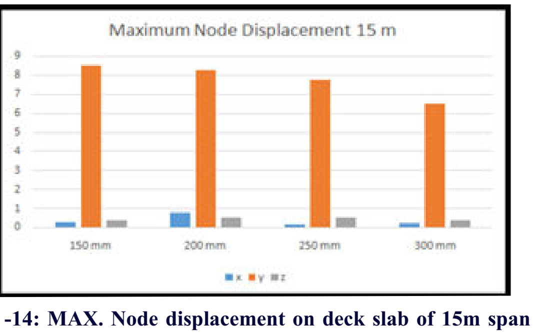

Fig -14: MAX. Node displacement on deck slab of 15m span of varying thickness

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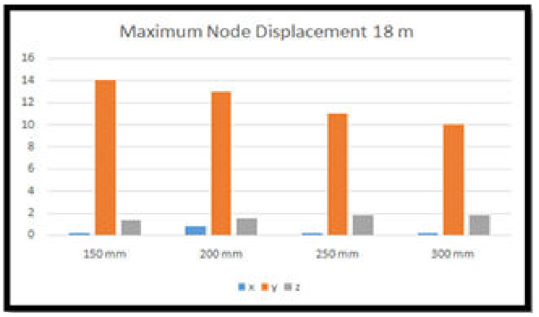

Fig -15: MAX. Node displacement on deck slab of 18m span of varying thickness

D. MAX. Shear forces on Deck Slab

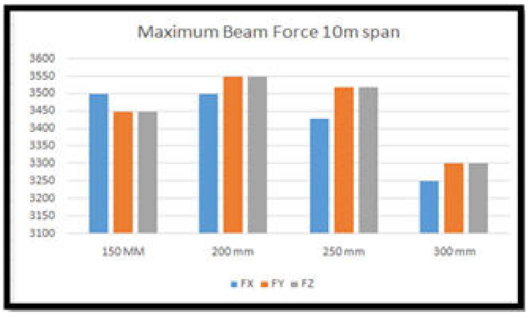

Fig -16: MAX. Shear forces on beam of 10m span with varying thickness

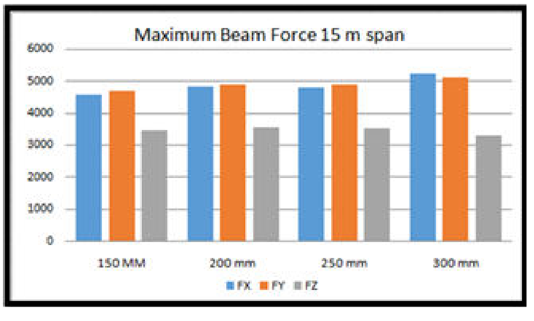

Fig -17: MAX. Shear forces on beam of 15m span with varying thickness

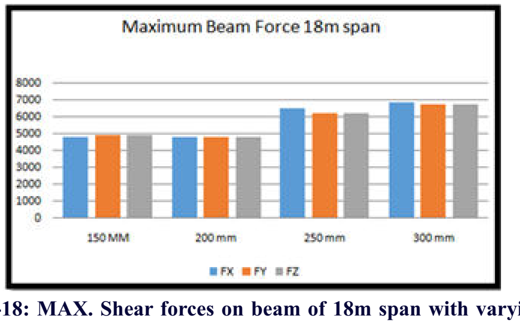

Fig -18: MAX. Shear forces on beam of 18m span with varying thickness

E. MAX. Bending Moment on Deck Slab

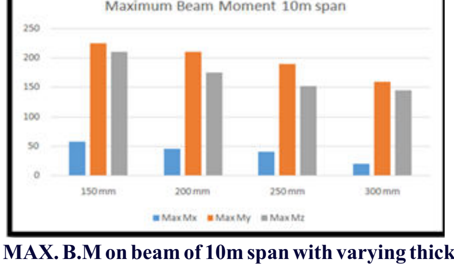

Fig -19: MAX. B.M on beam of 10m span with varying thickness

Fig -20: MAX. B.M on beam of 15m span with varying thickness

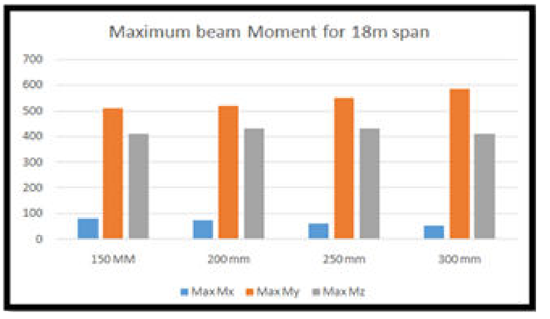

Fig -21: MAX. B.M on beam of 18m span with varying thickness

F. MAX. Support Reaction

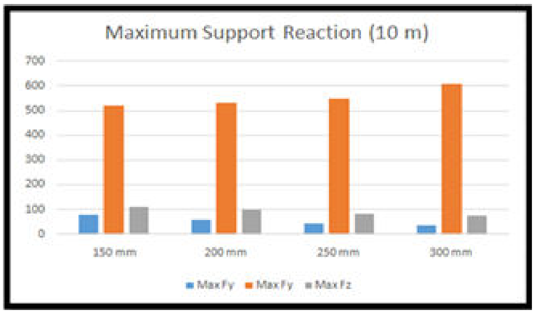

Fig -22: MAX. Support Reaction on 10m span with varying thickness

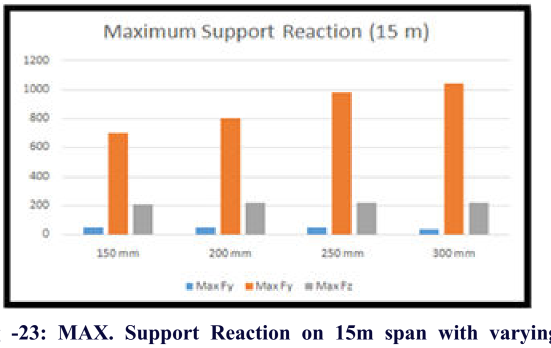

Fig -23: MAX. Support Reaction on 15m span with varying thickness

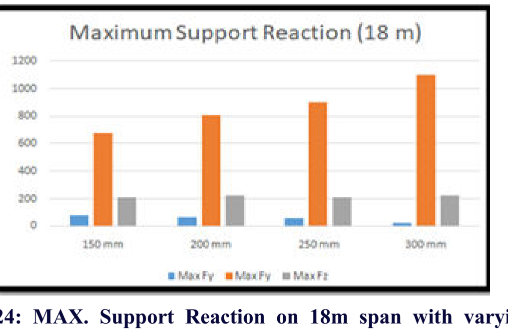

Fig -24: MAX. Support Reaction on 18m span with varying thickness

G. MAX. Compressive and Tensile Stresses on Pier

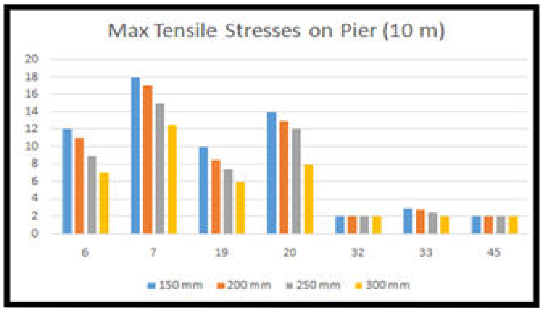

Fig -25: MAX. Tensile stresses on pier of 10m span with varying thickness

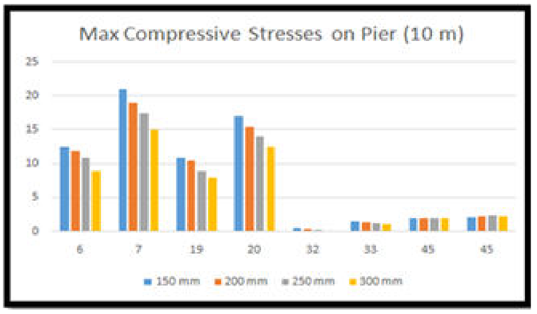

Fig -26: MAX. Compressive stresses on pier of 10m span with varying thickness

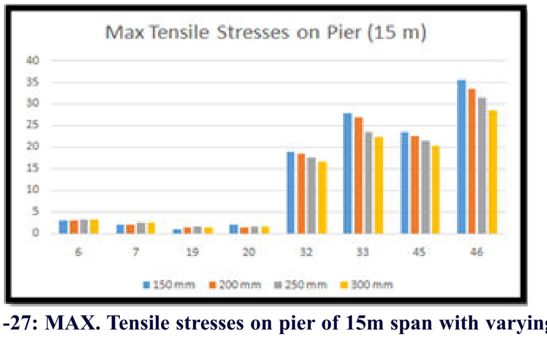

Fig -27: MAX. Tensile stresses on pier of 15m span with varying thickness

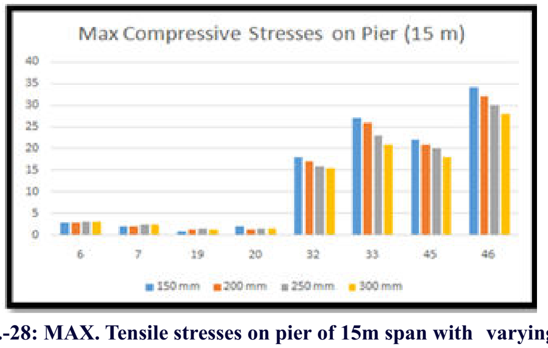

Fig.-28: MAX. Tensile stresses on pier of 15m span with varying thickness

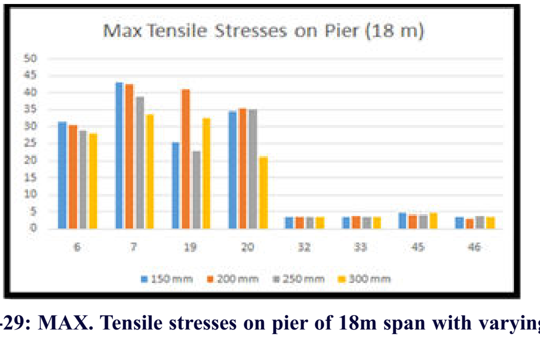

Fig -29: MAX. Tensile stresses on pier of 18m span with varying thickness

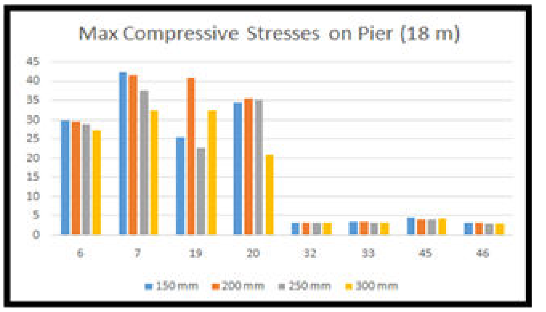

Fig -30: MAX. Compressive stresses on pier of 18m span with varying thickness

CONCLUSIONS

It's all over that the Principal pinnacle and backside stresses in deck block bigger will increase with growing span amount and high stresses will increase with thickness however bottom stresses lower with growing the thickness of deck block from 150mm to 300mm.

1. Its all over that the Von Mis high and backside stresses in deck block a lot of will increase with increasing span length. With short span (up to 10m) von Mis stresses will increase up to 250mm, however depth of block unbroken 300mm the von Mis stresses are decreases. Once span will increase 15m to 18m and depth varies from 150mm to 300mm the stresses additionally will increase with depth of block however it's quite minimum at thickness unbroken 300mm.

2. Node displacement in Y downward direction are a lot of Increase with increasing span length. It observes that double in 15m span bridge and thrice in 18m bridge as compares with 10m span bridge. Whereas the Node displacement in Y downward direction are decreases with the depth of block will increase from 150mm to 300mm for all span thought-about in study. Negligible variation seen in X and Z direction.

3. It concludes that the most shear force in Longitudinal and cross beam are will increase once increasing the span of the bridge kind 10m to 15m and 18m. Whereas the thickness varied from 150mm to 300mm the shear force are minimize.

4. Similarly, the bending moment in Longitudinal and cross beam are will increase once increasing the span of the bridge kind 10m to 15m and 18m. Whereas the thickness varied from 150mm to 300mm the moments will be minimize.

5. Most support reaction will increase with increase in span length and it'll be increase with deck block thickness will increase from 150mm to 300mm

6. Compressive and Tensile Stresses in piers are will increase with span length whereas the increasing the thickness of deck block each the stresses are decreases.

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