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Finding Span to Depth Ratio of Double Warren Steel Truss for Least Weight Subjected To Double Track Railway Loading

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ABSTRACT
Steel truss bridges are widely adopted for railways in India for long span bridges (span > 30m). The most significant advantage of using trusses for bridges is that it allows us to span a considerable distance without creating a massive weight penalty for the structure. This design makes it possible to install a bridge in places where the volume of the structure impacts the surrounding environment.
In this paper most economic span to depth ratio for lease weight of Double warren truss is found out. Span of the truss is 121.320m c/c and caring double track 25T railway loading.
***Keywords*— Truss, Double warren, etc.**

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I. INTRODUCTION

The load bearing capacity of the trusses is very huge as compare to same span bridge of girder type. By spreading load from floor arrangement to the truss nodes and then to whole truss, it manages by compression and tension. This triangular arrangement insures nearly proportionate amount of force carried by each member. The building of a large truss bridge can be a very economical option, when compared to other bridge designs. Truss bridges withstands extreme conditions where other bridges such as beam and arch bridges may not be a reliable option. They are able to span great lengths, and often used in precarious locations such as deep valleys between mountain regions. You will see in India almost every large spans and spans in mountain regions are truss only.

In this paper double warren truss is analyzed and designed for double track railway loading. Initially, 17m depth is analyzed which is existing in Railway bridge of Mokama, Patna across river Ganga.

After analyzing and designing this existing configuration of double warren truss (17m depth) following points are observed.

- Bottom and top chord members are having less utilization ratio. Means they are not fully utilized for stress.
- Bottom and top chord members are governed for deflection.
- Deflection can be controlled by increasing moment of inertia of overall truss.
- It can be done by increasing sections of bottom and top chords or increasing depth of truss.
- Increasing section will lead to increase in weight of truss.
- Increasing depth of truss will reduce the bottom and top chord sections and satisfying deflection.
- On the same line increase in depth of truss will also increase lengths of diagonals and verticals.
- Hence, we will find the most economic truss depth considering weight of truss in our study.

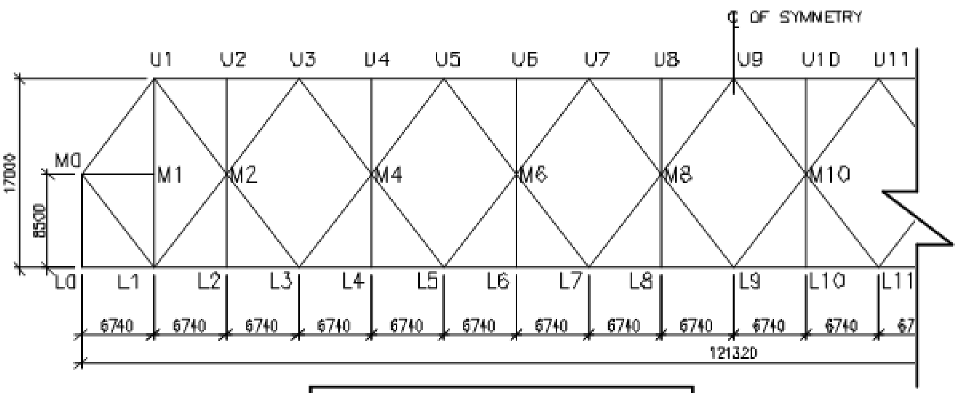
Table 1. Interaction ratio of members

	MEMBER MARKED	CRITICAL STRESS RATIO
BOTTOM CHORD	L0-L3	0.97
	L3-L5	0.91

	L5-L7	0.92
	L7-L9	0.83
TOP CHORD	U1-U3	0.75
	U3-U5	0.71
	U5-U7	0.78
	U7-U9	0.81
DIAGONALS	M0-L1	0.87
	U1-L3	0.86
	L1-U3	0.74
	U3-L5	0.90
	L3-U5	0.80
	U5-L7	0.90
	L5-U7	0.81
	U7-L9	0.84
	L7-U9	0.78
END PORTAL	M0-U1	0.86
	M0-L0	0.97
VERTICALS	VERTICALS	0.96

Following diagram represents the double warren configuration of 17m depth. The truss has 18 numbers of panels with each panel length of 6.740m.

For optimization of weigh of the truss only depth of the truss is varied. rest of the parameters i.e., number of panels, panel length is kept constant. For each depth of truss each and every section is modified according to the forces generated.



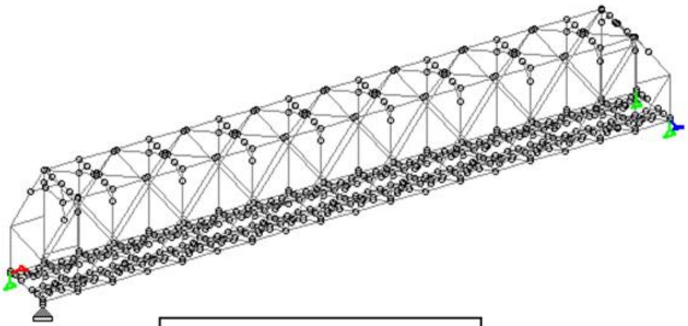
Double warren truss

II. METHODOLOGY:

1. Analysis will be done on STAAD-pro by modeling 3-D truss.
2. 3-D truss is not released for any moments because of the connection detailing. But top and bottom bracing system are released for moments and assumed to carry only axial forces.
3. Loading is applied on truss as per RDSO bridge rules.
4. Force and moment resultants are extracted from STAAD-pro and put in excel design files.
5. Design excel files are as per code RDSO steel bridge code.
6. Then design section is updated and new section is put into STAAD model and again analysis run is taken.
7. This process is done 2 to 3 times till we get final section.
8. Using final sections truss weight is calculated.

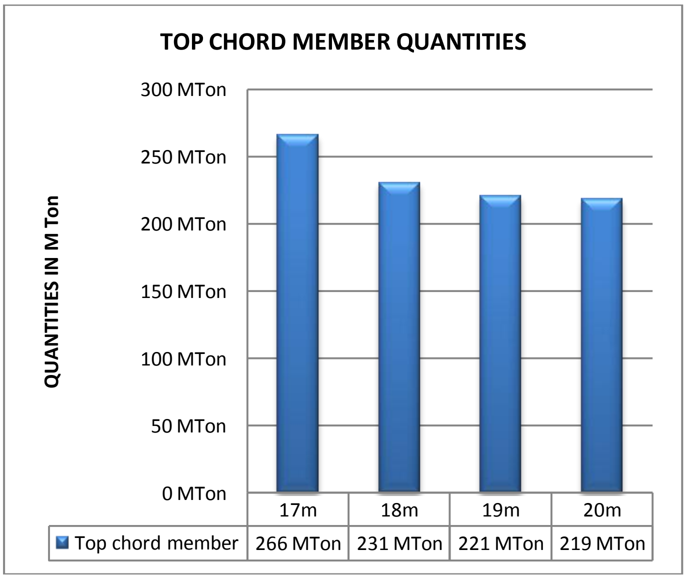
Table 2. Common Geometry & Design Input

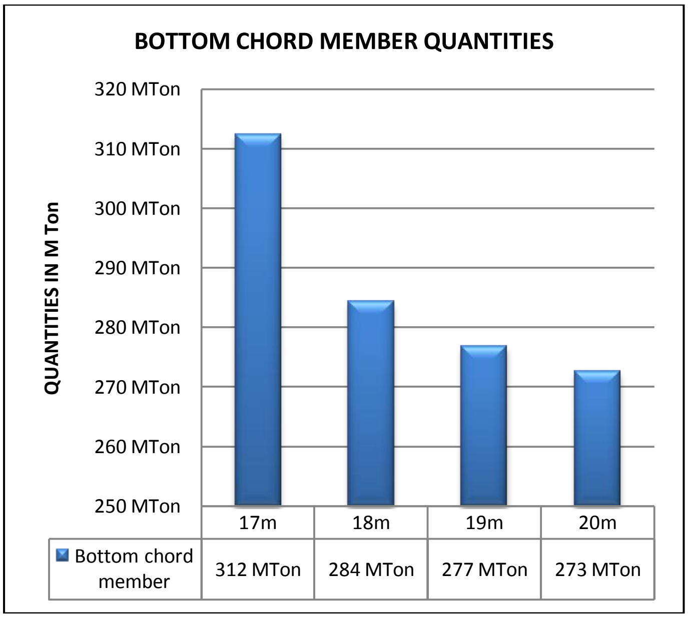
Span (m)	121.32m
Truss Height (m)	17 m
No. of Bays (nos.)	18
Bay length	6.740m
Truss Spacing (m)	11.1 m
Basic Wind Speed	47 m/sec (PATNA)
Life of structure	100 years
Allowable Deflection	span/600
Seismic zone	IV
Gauge	Broad gauge
Loading Standards	25T-2008
No. of tracks	2
Design codes	RDSO railway codes



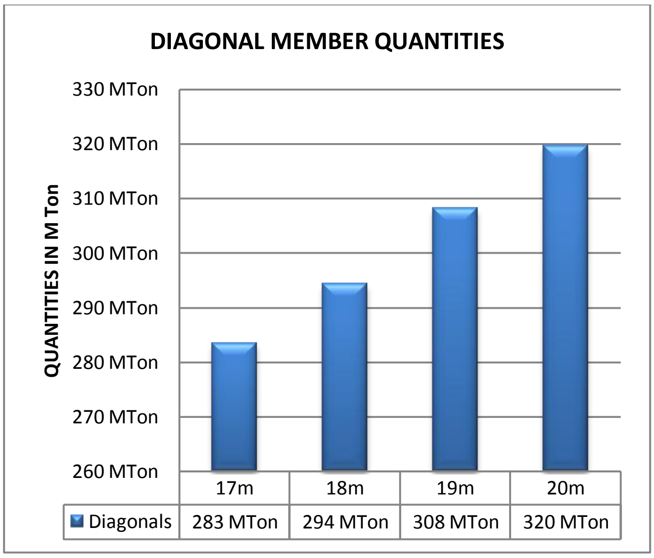
Double warren truss 3D model

Result Interpretation:
All trusses analyzed and designed as per RDSO steel bridge code. Considering weight of different components following results can be interpreted.

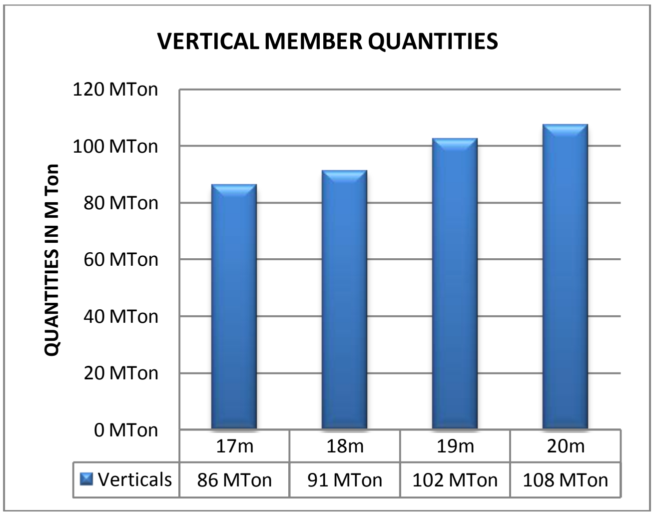




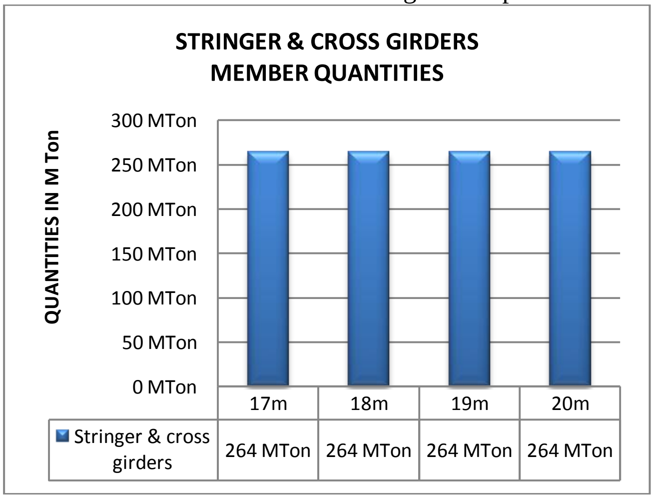
It is observed that by increasing depth of the truss axial forces in top and bottom chords are reducing. Hence with reduced sections, weight of the top and bottom chords are also reducing.



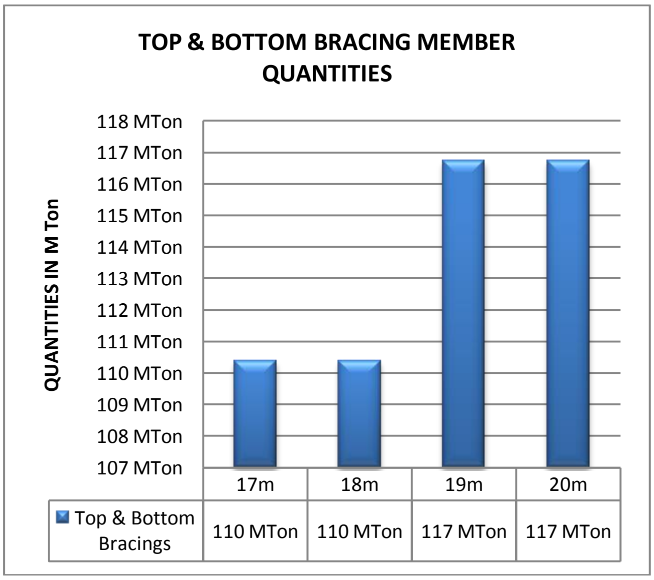
In case of diagonals, forces are not reducing much. Also, length of diagonals increased with depth of truss. Ultimately weight of the diagonal members are increasing with depth of truss.



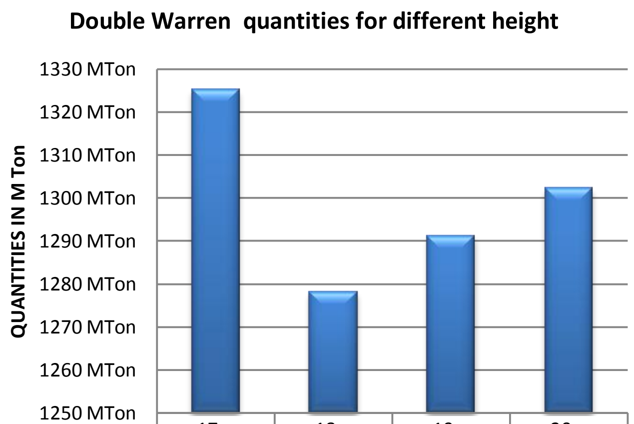
As diagonals, weight of the vertical members are also increasing with depth of truss.



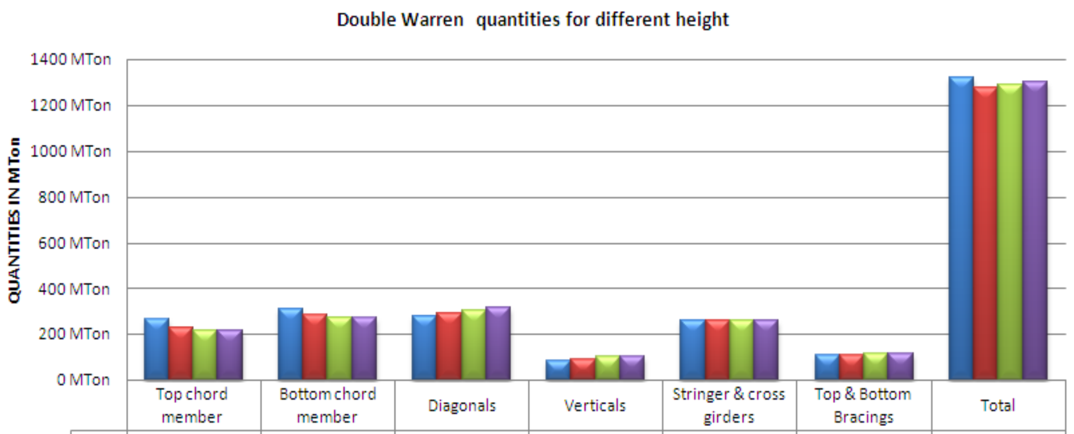
As the panel length are same in both trusses stringer span is same (i.e. 6.740m). Also, transverse spacing of two trusses are same hence cross girder span is same (i.e., 11.1m). Hence, weight of stringer & cross girder remains same.



Due to portal action of vertical and sway girders axial force and moments are generating for transverse loading. As the depth of truss is increasing, moments in portal action are also increasing. Hence, with increase in truss depth top and bottom bracing weight is increasing.



	17m	18m	19m	20m
Total	1325 MTon	1278 MTon	1291 MTon	1302 MTon



	Top chord member	Bottom chord member	Diagonals	Verticals	Stringer & cross girders	Top & Bottom Bracings	Total
17m	266 MTon	312 MTon	283 MTon	86 MTon	264 MTon	110 MTon	1325 MTon
18m	231 MTon	284 MTon	294 MTon	91 MTon	264 MTon	110 MTon	1278 MTon
19m	221 MTon	277 MTon	308 MTon	102 MTon	264 MTon	117 MTon	1291 MTon
20m	219 MTon	273 MTon	320 MTon	108 MTon	264 MTon	117 MTon	1302 MTon

Above graphs clearly indicate the weights of different components of the Double warren truss for different depth. Comparing 17m to 20m depth, it is found that 18m depth truss shows least weight amongst all.

RDSO recommends span by depth ratio not greater than 10.

In our case span to depth ratio (121.320 /15 = 6.74) is the most economic to get the least weight of the truss of double warren configuration subjected to double track railway loading.

III. CONCLUSION:

- Double warren configuration with 18m depth has least weight for 121.32m span.
- For span 121.32m most economic span by depth ratio in terms of weight, 121.32 / 18=6.74.

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