Comparison of Different Steel Roof Truss Design For Long Span Structure

Aesha P. Shah[1], Prof. C. D Patel[2], Assi. Prof. Vilay Patel[3]
[1, 3] Merchant Institute of Technology, Piludara ,Mehsana
[2]L.D. College of Engineering, Ahmedabad

Abstract- *For Design of steel trusses there are different types of geometries (A-type truss, Fink truss, Pratt truss, Howe truss, King post truss, Queen post truss etc) and sections (Angle section, Tube section, square hollow section etc) are available. In present work, roof truss of span ranging from 20m to 60m have been analyzed for different geometries (Howe type, N type trapezoidal, Warron type trapezoidal, Tapering trapezoidal and double lattice truss) and sections to get the desired optimum truss design. The design is further optimized for varying slopes of truss. The support conditions area assumed as fixed. Type of connection (welded/bolted) between truss members also effect the forces in truss members are bolted.The various truss analyses are performed by using structural analysis software i.e. STAAD Pro. The analysis results are compared to obtain optimum and accurate truss design. The results indicate that Howe type and N type trapezoidal trusses has lesser weight compared to other truss geometries for long span. The truss consists of tube/square hollow section is having much lesser weight compared to angle section. The objective of the study is to presents the simultaneous cost, weight and standard cross-section optimizationation of temporary long span steel roof structures. Recent growth in India for construction of large span roof steel structure using shop fabricated steel sheet are facing challenges in transportation and erection from shop to site. Modern long-span space structures, developed during the 1970s and 1980s, are light weight and effective structures based on new technologies. Long span structure as a Steel roof structure are used for sports areas,exhinition halls, assembly halls , transport terminals , airplane hangers , ware houses, workshops , etc.Industrial roof Structures have been developed by the combination of different structural forms and materials which need to cover large areas while maintaining unobstructed interior spaces. This research follows two consecutive steps: the first one aims at developing an optimized procedure of preliminary designs for temporary long span roof; the second one focuses on the study of wind action on these structures.*

Keywords- Truss optimization, Howe-type truss trapezoidal type, Staad Pro.

I. INTRODUCTION

Various structural forms have been developed over the last 30 years that optimize the cost of the steel structure in relation to the space provided. However, in recent years, forms of expressive structure have been used in architectural applications of industrial buildings, notably suspended and tubular structures.

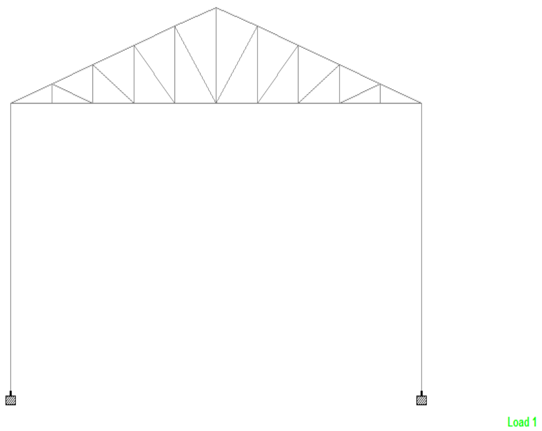
A single large hall is the main feature of most industrial buildings. The construction and appearance of an industrial building provides the design engineer with a wide range of possible configurations in order to realize the architectural ideas and the functional requirements. Generally, an industrial building has a rectangular floor space, which is extendable in its longdirection. Thedesign of the building has to be coordinated with functional requirements and the energy-saving concept, including lighting.

. For temporary design of steel structures can be arch structure, foldable vaultstructure,and foldable dome structure for varying range. Ex: - 10 m to 30 mtrs. As per different literature review there are number of steel roof truss designs. I have studied roof design and material for optimized used in this review paper.

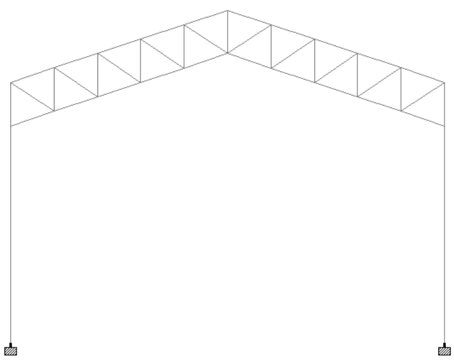
II. MODELLING

Truss with different geometries and sections are made in Staad Pro software to select most optimum truss geometry and section. Different type of truss geometries and sections used in modeling are shown in below figures.Five types of trusses geometry are made in stadd pro. For span ranging from 20 m to 60 m. And pitch angle 1/4, 1/5 and 1/6.

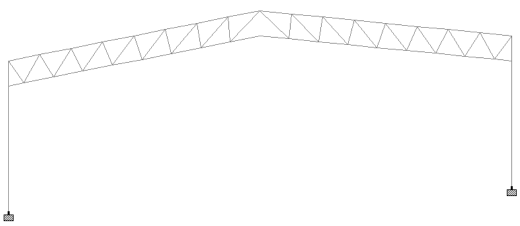
Truss	span (m)	Pitch		
Howe type	20,30,40,50,60	1/4	1/5	1/6
N type	20,30,40,50,60	1/4	1/5	1/6
Trapezoidal	20,30,40,50,60	1/4	1/5	1/6
Tapering trapezoidal	20,30,40,50,60	1/4	1/5	1/6
Double Lattice	20,30,40,50,60	1/4	1/5	1/6



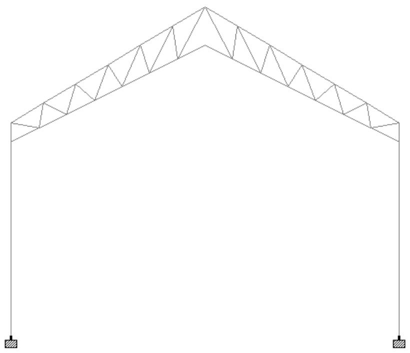
Howe type truss



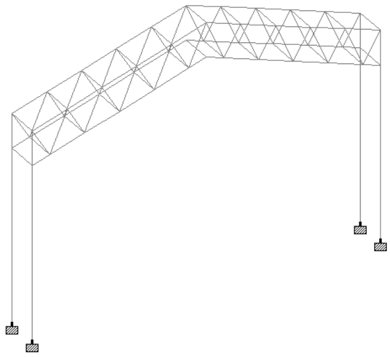
N type trapezoidal truss



Trapezoidal type



Tapering trapezoidal truss



Double lattice type truss

Parameters of truss design:-

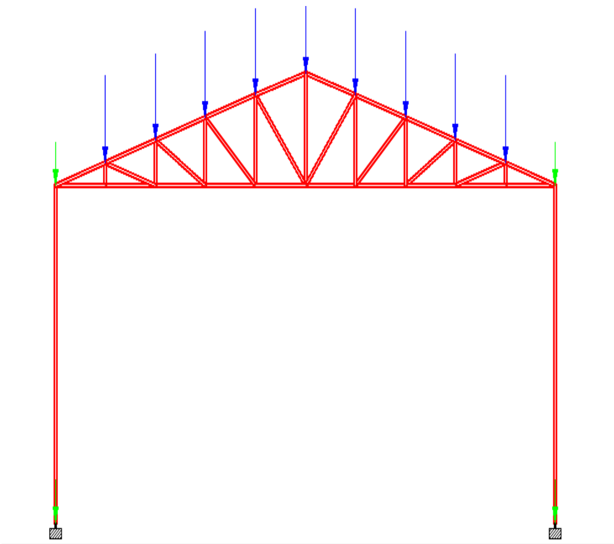
Sr no	Parameters for truss design	
1	Span of truss	20m to 60 m
2	spacing b/w truss	6 m
3	Location	High wind speed
4	Roofing	112 N/m2
5	Basic wind speed	55 m/s
6	Risk coefficient (k1)	0.7 (5 years- temporary roof)
7	Terrain height and structure size factor (K2)	0.98 -1.1
8	Topography factor (k3)	1
9	Vz	Vb*K1*K2*K3
10	Pd	0.6(Vz*Vz)

III. ANALYSIS

Total 95 models are made in stadd pro. For span and pitch variation. Different load combination considered are as follow.

1.5 DL + 1.5 LL
1.5 DL + 1.5 WL
1.2 DL + 1.2 LL +1.2 WL
0.9 DL +1.5WL.

For long span structure not all geometry will give great results. With all maximum parameters we can find out suitable geometry for design purpose. After selection of that design of truss member will take place with angle,tube,and channel material. I have consider all three material in which truss gave better results.



Howe type truss with Nodal loads

III. RESULTS AND DISCUSSION

1. Howe type truss member and weight data.

Type of truss	PROPERTY TOP	BOTTOM	VERTICAL	COLUMN	WEIGHT(KN)
HOWE TYPE 20-4	TUBE 125 125 4.5	TUBE 70 70 4.9	TUBE 70 70 3.9	ISHB 150 D	18
HOWE TYPE 20-3.33	TUBE 70 70 3.3	TUBE 90 90 4.5	TUBE 90 90 4.5	ISHB 150 D	17.78
HOWE TYPE 20-5	TUBE 70 70 4	TUBE 70 70 4	TUBE 70 70 4	ISHB 150 D	17.86
HOWE TYPE 30-4	ISA 200 200 20	ISA 150 150 15	ISA 150 150 15	ISHB 150 D	55
HOWE TYPE 30-5	TUBE 150 150 6	TUBE 150 150 6	TUBE 90 90 4.5	ISHB 150 D	33
HOWE TYPE 30-6	TUBE 150 150 6	TUBE 150 150 6	TUBE 150 150 6	ISHB 150 D	46
HOWE TYPE 30-7.5	TUBE 110 110 4.9	TUBE 110 110 4.9	TUBE 100 100 5	ISHB 150 D	31
HOWE TYPE 40-4 MSR C	ISA 180 180 20 D	ISA 200 200 25	ISA 200 200 25	ISHB 150 D	123
HOWE TYPE 40-6.66	ISA 200 200 20	ISA 200 200 20	ISA 200 200 12	ISHB 150 D	90
HOWE TYPE 40-8F	TUBE 150 150 6	TUBE 150 150 6	TUBE 125 125 5	ISHB 150 D	55
HOWE TYPE 40-10	TUBE 150 150 6	TUBE 150 150 6	TUBE 150 150 6	ISHB 150 D	63
HOWE TYPE 50-4	ISA 200 200 20 D	ISA 200 200 20 D	ISA 200 200 20 D	ISHB 200 D	274
HOWE TYPE 50-8.33	ISA 150 150 20 D	ISA 150 150 10	ISA 150 150 10	ISHB 200 D	139
HOWE TYPE 50-10	ISHB 150 150 2 D	ISA 200 200 25	ISA 180 180 15 D	ISHB 200 D	208
HOWE TYPE 50-12.5	ISA 180 180 15	ISA 120 120 12	ISA 200 200 25 D	ISHB 150 D	298
HOWE TYPE 60-4	ISA 200 200 25 D	ISA 200 200 25 D	ISA 200 200 25 D	ISHB 200 D	297
HOWE TYPE 60-10	ISA 200 200 25 D	ISA 200 200 25 D	ISA 200 200 25 D	ISHB 200 D	384
HOWE TYPE 60-12	ISA 200 200 25 D	ISA 200 200 25 D	ISA 200 200 25 D	ISHB 225 D	417
HOWE TYPE 60-15	ISA 200 200 25 D	ISA 200 200 25 D	ISA 200 200 25 D	ISHB 225 D	509

2. N type truss:-

N TYPE 20-4	TUBE 110 110 4.5	TUBE 90 90 4.5	TUBE 100 100 4	ISHB 150 D	22
N TYPE 20-3.33	TUBE 110 110 4.5	TUBE 90 90 4.5	TUBE 100 50 4	ISHB 150 D	19.86
N TYPE 20-5	TUBE 110 110 4.5	TUBE 90 90 4.5	TUBE 100 50 4	ISHB 150 D	20
N TYPE 30-4 MSR	ISA 150 150 20	ISA 150 150 20	ISA 120 120 8	ISHB 150 D	46
N TYPE 30-5	ISA 150 150 20	ISA 150 150 20	ISA120 120 15	ISHB 150 D	56
N TYPE 30-6	ISA 150 150 20	ISA 150 150 12	ISA120 120 15	ISHB 150 D	51
N TYPE 30-7.5	ISA 200 150 20	ISA120 120 15	ISA120 120 15	ISHB 150 D	50
N TYPE 40-4 MSR	ISA 200 200 20 D	ISA 200 150 20 D	ISA 90 90 12	ISHB 150 D	131
N TYPE 40-6.66	ISA 200 150 20 D	ISA 200 200 25 D	ISA 200 200 25 D	ISHB 200 D	144
N TYPE 40-8	ISA 150 150 20 D	ISA 200 200 25	ISA 200 200 25	ISHB 150 D	134
N TYPE 40-10	ISA 200 150 20 D	ISA 200 200 20	ISA 200 200 20	ISHB 150 D	126
N TYPE 50-4	ISA 200 200 25 D	ISA 200 200 25 D	ISA 150 150 20	ISHB 150 D	207
N TYPE 50-8.33	ISA 200 200 25 D	ISA 200 200 25 D	ISA 180 180 18	ISHB 200 D	217
N TYPE 50-10	ISA 200 200 25 D	ISA 200 200 25 D	ISA 150 15020	ISHB 200 D	213
N TYPE 50-12.5	ISA 200 200 25 D	ISA 200 200 25 D	ISA 180 180 20	ISHB 200 D	224
N TYPE 60-4	ISA 200 200 25 D	ISA 200 200 25 D	ISA 200 200 25 D	ISHB 200 D	252
N TYPE 60-10	ISMC 400 D	ISMC 400 D	ISMC 400 D	ISHB 200 D	227
N TYPE 60-12	ISMC 400 D	ISMC 400 D	ISMC 400 D	ISHB 200 D	227
N TYPE 60-15	ISA 200 200 25 D	ISA 200 200 25 D	ISA 200 200 25 D	ISHB 200 D	372

Above are design give for Howe type and N type truss roof structure same has been done for rest of 3 truss geometries. From all five this two truss design gave lesser weight in comparison.

Up to 40m span Howe type and N type truss give good results. Now for weight calculation 30 m span Howe type is better with 31 kN weigh of structure.

IV. CONCLUSION

Followings are the major conclusion of the study:-

1. Howe type truss can be used for 30 m span of industrial area. Weight of truss is although high but pin joint connection will be used for flexible working.
2. Tube section is lighter in weight then angle section for any truss geometry. Howe type truss tube section and angle section ration is 0.77.
3. Span >40 m gives heavy weight structure which is not economical for temporary roof design.
4. Pitch angle in different geometry gives good result at 1/5. The frigidity of the support causes bending moment in top chord members of truss therefore section requirement of top chord increases. The overall weight also increases.
5. This research gives overall design geometry of truss. For any structure design criteria will be varying with different parameter condition.

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