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Research Paper on Analysis and Design of Steel Truss by using Angle and Tube Section

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Abstract - *Now a days many orthodox and complex structures having large span of steel roof truss are looking for the best truss section because due to large spacing required heavy concreting, large quantity of steel for beam, column and slab casting so that is why, it is economical and beneficial to do so. That's why the major solution for this condition steel truss is best alternative within the economy and other parameter like strength, durability, time saving, high flexural strength. Now a days many of the steel building are made up with critical sections of steel which are designed and built by conventional approaches, so that this results in heavy loads or too expensive structures. Tubular steel sections is the best possible alternatives to the conventional steel sections with their comparatively better specifications. The main aspects considered while selecting this section are the economy, load carrying capacity of all members and their relative safety measures. For making cost effective it is the main aim of the present work including comparison of conventional structures with tubular structure for given conditions. Literature review reveal that up to 15-20% saving in expense is accomplished by using tubular sections. Analysis of steel roof truss elements was carried out by STADD PRO V8i computer software, by manually applying Indian Standards codes of practices. The advantage of such buildings lies in the economy of roof. Hence, there is a need for an economical design in this condition. Now a days trusses are design for various loads condition by using traditional angle sections, which are Square hollow sections (SHS), Rectangular hollow sections (RHS) and Circular hollow sections (CHS). The research project shows that to provide which method is less cost-effective, more load transport capacity and high in the flexural strength. The main purpose of this paper is to analysis and design of steel roof truss section by using angle and tube section and study the effect of different spacing, span and pitches in order to find out which one will be the most economical truss by using angle section and tube section. Different types of truss analysis performed by using structural analysis software which is STADD PRO. After reviewing the all the review paper analysis results finally research paper is based on compared to obtain optimum and accurate truss design. Analysis and design of steel roof truss includes the calculation of dead load, live load and wind load with respect to Indian Standard Code of Practice IS 800:2007 and IS 875(Part 3)-1987. The process in which to find out loads at each intermediate panel point and end panel point and at joints are calculated manually and then the resulting loads are entered into STAAD PRO V8i software for analysis and designing. The STAAD PRO OUTPUT method is used for determining the quantity of steel (weight). The truss with a least value of quantity of steel is to be considered as most economical truss.*

Key Words: Structural Analysis, Conventional/Traditional Steel Truss, Angle Section, Tube Section, AutoCAD, STAAD PRO V8i, Steel Roof Truss, IS 800 : 2007, IS 806 : 1968, IS 875 : 1987 for Tube Section, etc.

1. INTRODUCTION

Truss can be defined as triangulation of interconnected element of small members, which form a lattice arrangement. The weight of steel roof truss is varies with respect to span length and slope of roof. Hence size and shape of steel roof truss is very important like strength of the individual member, and also more design options are available. In case of industrial warehouse truss is the best option for covering the roof truss. It is very cheap as compare to R.C.C. structure. Steel roof truss structures are a light weight structure as compare to RCC build-up structure. Trusses are particularly more popular and structurally more efficient for steel roof truss with large span and where height of structure is large. Trusses are more efficient and practically light in weight as compare to RCC concrete structure for long span. The material used in steel roof truss section is economical if the proper design is prepared and given to it. Now a days it is most common solutions for problems in large scale roofing for examples factories, workshops and railway stations. An economy of the structure requires for the purpose industrial building depends on the configuration of structure, type of roof truss and portal frame utilized, forces acting on truss section and selection of truss is mainly based on that of steel sections needed as per force is applied.

Steel roof truss are widely used in industrial warehouses, auditoriums, bridges, factory roof, aircraft hangers, airport terminals where unobstructed space is required. In case of that to give the required space for working purpose we must need to avoid columns. If in this case RCC slab is used, it requires of large areas, so it doesn't satisfy deflection condition and it became costly and uneconomical. The purpose of using steel roof trusses because they are having longer span, light in weight, reduces deflection percentages and gives opportunity to support various loading condition. Buckling is the major problem and its reaction caused due to excessive load act on the structural member and it is most important mode of failure which can happened suddenly without any warning to us. Buckling occurs physically when structure becomes unstable under a certain loading condition depend upon structure. Steel roof trusses are very important for a construction, for example construction for planning of steel roof truss, aircraft hangers, factories and industrial warehouse. Steel roof trusses can give high elegant value for large construction such as Eiffel Tower situated in Paris and for building like indoor sport stadia for football ground in Europe.

Steel roof truss is a structure interconnected by of slender members joined together at their end points by welded, bolted or rivet connection. Joint connections are created by bolted or welded connection by the end members together to a common plate which is known as a gusset plate. Double cantilever truss or roof truss. Every structure must have to fulfill the structural criteria and economical requirements. Hence there is need of perfection in truss design to obtain minimum weight and economy of the steel roof truss.

1.1 Importance of Research Topic

This research paper is study to understand and calculate the economic importance of tubular sections steel roof truss as compared to the traditional angle sections. Research paper is about to find out the percentage of economy as compared to the tubular sections so as to understand the importance of economy of the steel roof truss section. The various technique are used to find out the objectives involves the comparison of various parameters for different objective such as axial force, joint displacement, joint reaction and of the height and truss cross section with different span and various loading criteria. The analysis and designing phase of these project work was done by using STADD PRO V8i software. The result of STAAD analysis were validated with the results of Manual analysis. To determine the which one is better so planning of industrial shed is considered analysis and design is carried out using conventional steel and tubular steel sections and also cost comparison is made for both sections.

1.2 Problem Statement

"Analyze and Design the steel roof truss for industrial warehouse building of size 25m X 100m.The trusses are spaced 5m c/c. The building location is considered in Bhuj, Gujrat, India."

1.3 Objective of the study

(1) Firstly, choosing the eligible and economical steel roof truss and then study the various properties of selected truss and then comparing the different truss on their parameters like strength, life span, ductility, durability, economy of the structure and time required for completion etc.

(2) To analyse and design of industrial warehouse steel roof truss by using angle section and calculate the quantity of steel obtained.

(3) To analyse and design of steel roof truss which is prat type roof truss by using tube section and calculate the quantity of steel required.

(4) To govern the most effective truss geometry in terms of weight among the truss geometry.

(5) To match the price tag of materials (by using weight) of the different truss geometries generally used in the construction industry.

(6) To compare both the results.

(7) To analysis and design the both truss section on STADD PRO software.

2. METHODOLOGY

1. Project topic finalization.
2. Literature survey.
3. Planning of roof truss.
4. Calculation of forces on truss.
5. Analysis and design of truss using angle section.
6. Calculation of quantity of steel.
7. Analysis and design of truss using tube section.
8. Calculation of quantity of steel.
9. Comparison of results.
10. Comparing the respective results of both truss sections on STAAD PRO software.
11. Conclusion.

2.1 Truss Analysis

The steel trusses sections have been analysing as simply supported on columns. The support at both the ends is assume to be hinged for the purpose of analysis. The analysis of truss is done for dead load, live load and wind load according to IS: 875(Part 3)-1987.

2.2 APPROACH

i) Analysis of dead load is done by using the IS 875 (Part1) with the help of STAAD-PRO 8Vi software.

ii) Analysis of live load is carried out with the help of IS 875 (Part2) by the help of STAAD-PRO 8Vi. Designing parameters is carried out with the help of IS 800, IS806 and STAAD PRO 8Vi software.

3 WORK CARRIED OUT

3.1 Planning of Roof Truss

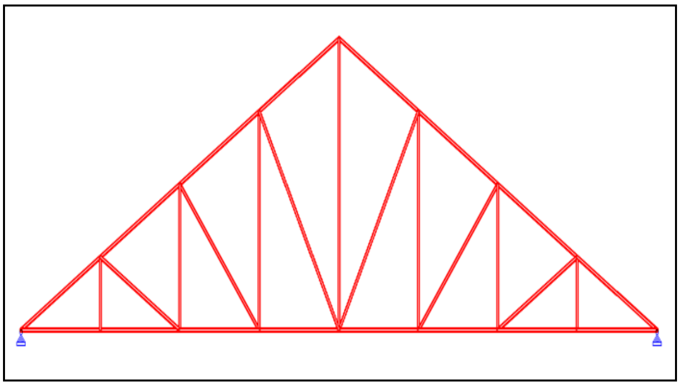


Fig 1.1 :- (Front View) 2-D Line Plan of Industrial Warehouse Pratt Roof Truss.

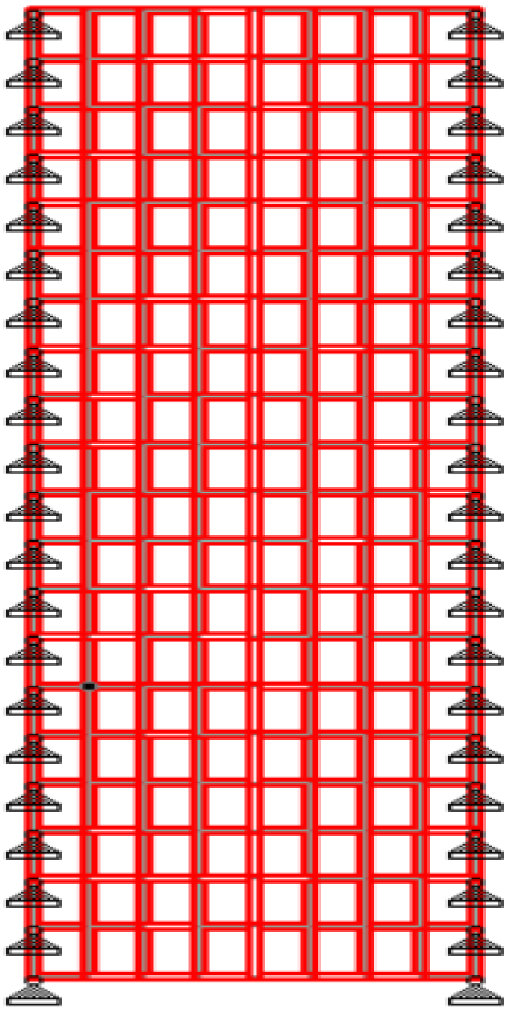


Fig. 1.2 :- Elevation Plan of steel roof truss by using angle section.

3.2 Calculation of Forces on Truss

Design of Pratt roof truss for an Industrial Warehouse building for following given data :-

i) Length of Industrial Warehouse Building = 100m

ii) Overall width of Industrial warehouse building = 25.5m

iii) Width of industrial warehouse building (c/c distance of roof column) = 25m

iv) c/c spacing of roof truss = 5m

v) Rise of steel roof truss = ¼ of span

vi) Self wt. of purlins = 318 N/m

vii) Ht. of column = 11m

viii) Roofing & Side covering = Asbestos Cement Sheet (171 N/m^2)

The building is located in industrial area, Bhuj, Gujrat, India. Both the end of truss are hinged. Use of steel grade Fe410.

Given Data :-

Span of truss = 25 m

Type of truss = Pratt roof truss

Roof Cover of roof truss = Asbestos cement sheet (171 N/m2)

Spacing of truss = 5 m c/c

Rise of steel roof truss = ¼ of span = 25/4 = 6.25 m

Ht. of shed = 11 m

Steel grade = Fe 410

1} Dimension of Truss :-

Central Rise of roof truss = ¼ of span = ¼ x 25 = 6.25 m

Let θ be the inclination of steel roof truss with horizontal

$\theta = \text{Tan}^{-1}$ (6.25/12.50) = 26.565°

Length of top chord/principle rafter = $\sqrt{(6.25)^2 + (12.5)^2}$ = 13.97 m

Distance between panel pt. of principle rafter which is Top Chord = 13.97/4 = 3.492 m

So that Purlins are provided at interval of 3.492 m principle rafter.

2} Load Calculation :-

2.1] :- Dead Load :-

i) Wt. of A.C. sheets = 171 N/m2

ii) Wt. of bracing = 12 N/m2 (Assume)

iii) Wt. of roof truss = (Span/3 + 5) x 10

= (25/3 + 5) x 10

=133.33 N/m2

iv) Wt. of purlins = 318 N/m (Assume)

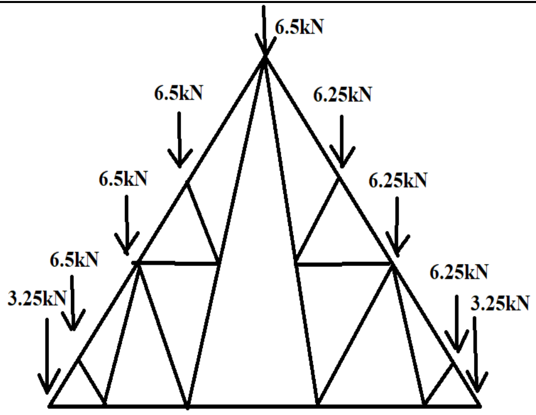
Wt. of purlins of steel roof truss = 318 x 5 = 1590 N

Panel length = 3.492 m

Panel length in plan = 3.492 cos (26.565) = 3 m

Load acting on each intermediate panel point due to Dead Load = (171+12+140) x (5 x 3) +1590
= 6435 N = 6.435 kN = 6.5 kN

Load on each end panel due to D.L. = 6.5/2 = 3.25 kN



Dead Load on Truss

2.2] :- Live Load :-

Angle θ = 26.565° Let us assume that no access is provided to roof. The L.L. is reduced by 20 N/m2 for each one degree above 10° slope.

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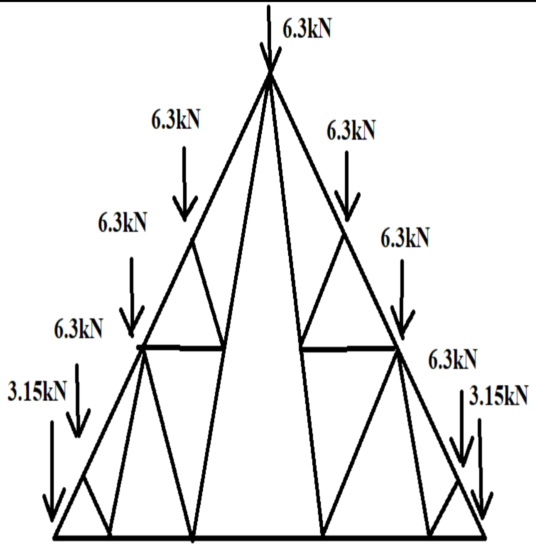
Angle θ = 26.565° Let us assume that no access is provided to roof. The L.L. is reduced by 20 N/m2 for each one degree above 10° slope.

L.L. = 750 – {20 x (26.565-10)} = 418.70 N/m2

Load on each intermediate panel due to L.L. = 418.70 x (5 x 3) = 6280.5 N = 6.280 kN = 6.3 kN

Loads on each end panels due to L.L. = 6.3/2 = 3.15 kN



Live Load on Truss

3} Wind Load :- (IS : 875 (Part-3) – 1987

i) Basic wind speed (Vb) :- [Cl. 5.2 pg-8 Appendix A pg-53)

Vb = 50 m/s for Bhuj, Gujrat.

ii) Design wind speed (Vz) :- (Cl. 5.3 pg-8)

Vz = k1 x k2 x k3 x Vb where, Vz = design wind speed at any height z in m/s.

k1 = probability factort (risk coefficient) (Table 1, pg- 11, Cl. 5-3.1)

k2 = Terrain ht. and structure size (factor Table 2, pg-12, Cl-5.3-2.2)

K3 = topography factor

a) Category 1 :- Average ht. of any object surrounding the structure/obstruction is less than 1.5m for ex. Open sea costs & flat treeless plains.

b) Category 2 :- Obstruction ht. between 1.5 m – 10 m. It includes airfields, open parklands and undeveloped partially buildup outside of towns and suburbs, open land adjacent to see coast.

c) Category 3 :- Closely spaced obstruction having the size of building structures upto <10m. Industrial areas fully or partially developed.

d) Category 4 :- Obstruction <25m city center, well developed industrial complexes, terrain with numerous large high closely spaced obstructions.

k1= 1.0

k2= Therefore Bhuj, Gujrat, (India) Terrain Category – 3, Class of building = C (>50m length consider) (100 length x 25Width x 11Height)

By interpolation :- k2 = 0.82 + [0.87-0.82/15-10] x (11-10) = 0.83

k3 = Assuming plane ground so that k3 = 1

Vz = Vb x k1 x k2 x k3= 1 x 0.83 x 1 x 50 = 41.5 m/s

iii) Design wind pressure :- Pz = 0.6 x $(Vz)^2$ = 0.6 x $(41.5)^2$ = 1033.25 N/m^2 = 1.033 kN/m^2

iv) Wind Load on roof truss :-

F = (Cpe – Cpi) x Ae x Pd Calculation of Cpe

I] For θ = 0° (Wind Angle) where Vz = design wind velocity in m/s at ht. z

Cpe = external pressure coefficient

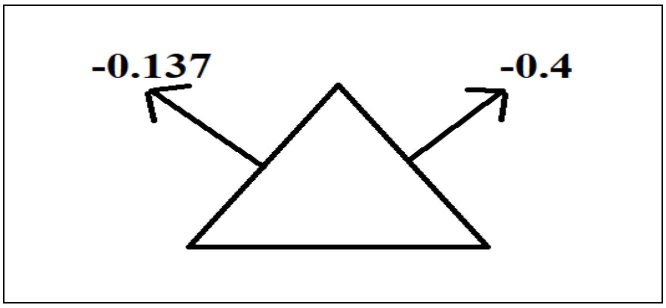
Cpi = internal pressure coefficient

A = Surface area the structural member or cladding unit

Pd = design wind speed

= 0.8 h/w = 11/25 = 0.44 θ = 26.565°

Θ	EF	GH
20°	-0.4	-0.4
26.565°	x	x
30°	0	-0.4



By interpolation :-

EF :- -0.4 + (0-(-0.4)) / 30-20 x (26.565-20) = Cpe = -0.137

GH :- 0.4 = -0.4 + (-0.4-(-0.4)/30-20 x (26.565-20) = -0.4

For θ = 90° (Wind Angle θ) = 90°

Θ	EG	FH
20°	-0.7	-0.6
26.565°	x	x
30°	-0.7	-0.6

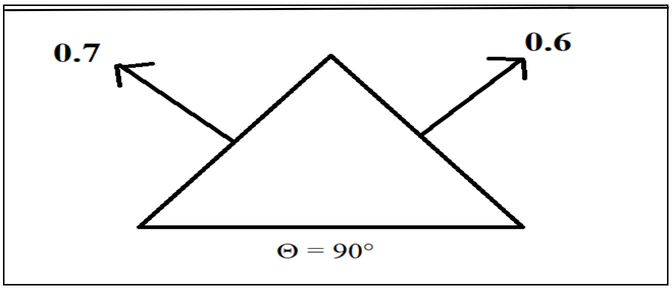
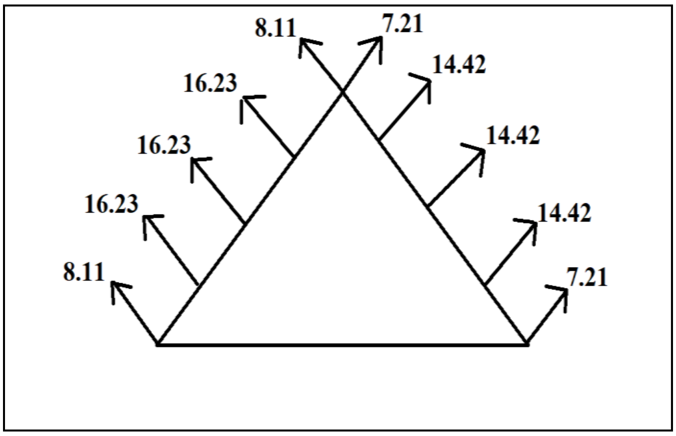


Table 5 :- External Pressure Coefficient (Cpe) for pitched roof of rectangular clad building (Cl. 6.2.2.2) pg-16

Wind load on end points = -16.23/2 = -8.11 kN

Wind load on end panel points = -14.42/2 = -7.21 kN



Load Combinations :-

1) 1.5 (DL+LL)
2) 1.2 (DL+LL+WL)
3) 1.2 (DL+LL-WL)
4) 1.5 (DL+WL)
5) 1.5 (DL-WL)

4. ANALYSIS AND DESIGN OF TRUSS USING ANGLE SECTION

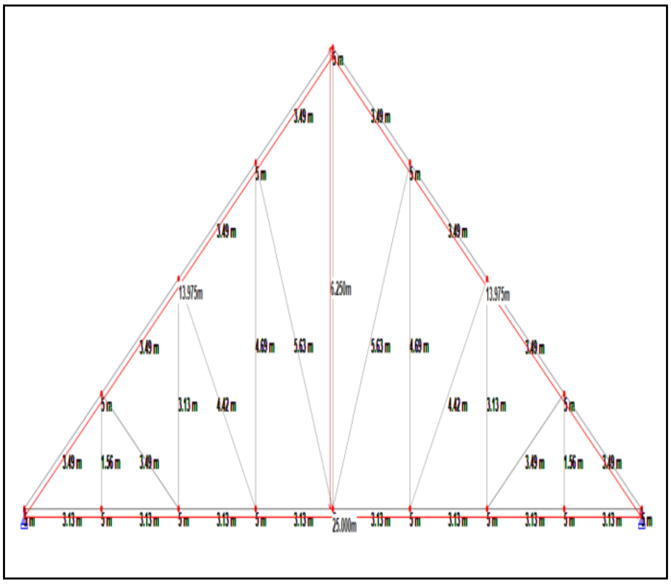


Fig. 1.3 :- 2-D Model of Steel Truss by using Angle Section.

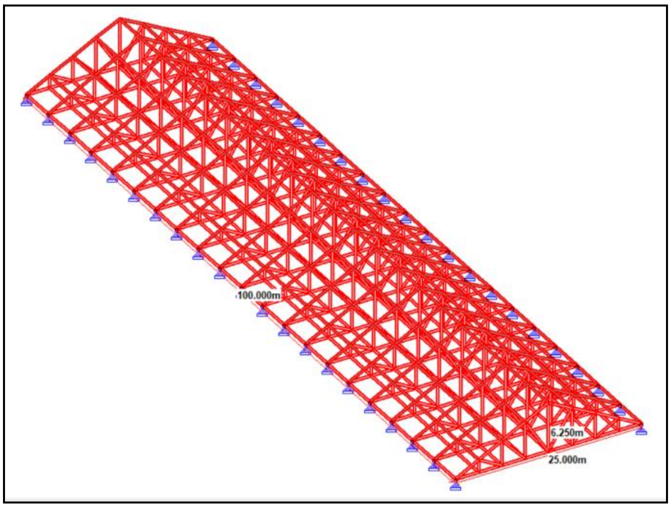


Fig. 1.4 :- 3-D Model of Steel Truss by using Angle Section

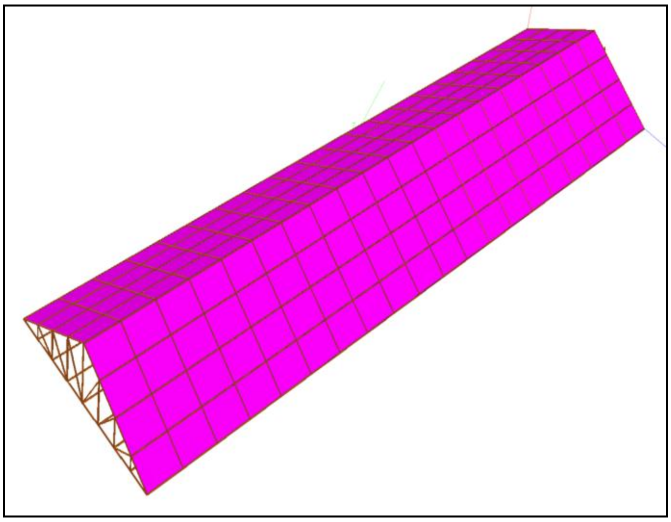


Fig. 1.5 :- 3-D Rendering View

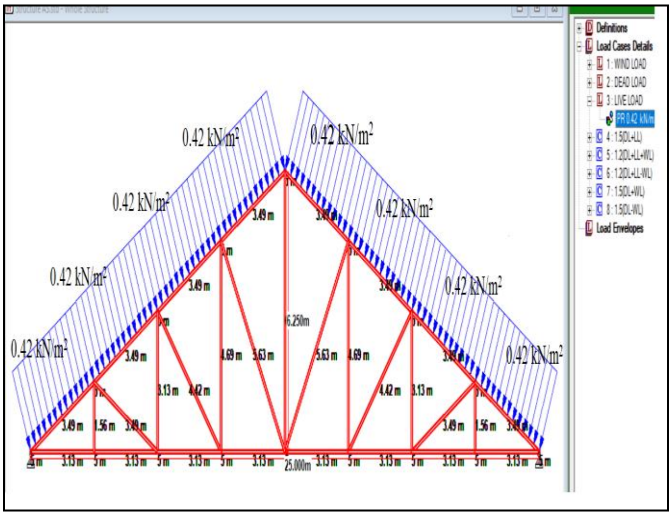


Fig. 1.6 :- Live Load on Truss

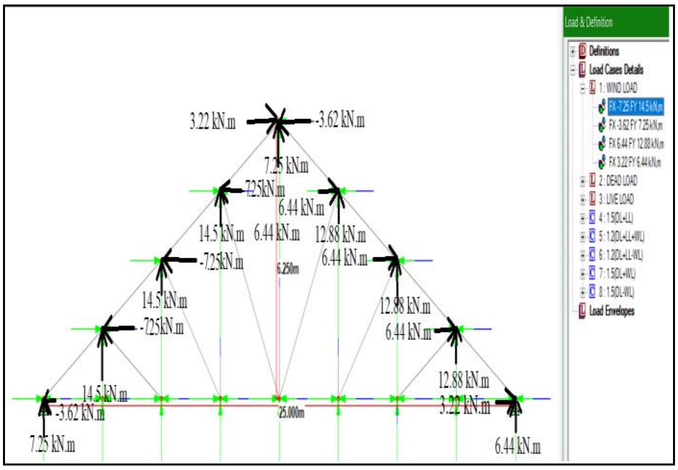


Fig. 1.7 :- Wind Load on Acting on Truss

	Node	L/C	Vertical Y mm
Max X	329	7 1.5(DL+WL)	10.789
Min X	324	7 1.5(DL+WL)	11.134
Max Y	332	7 1.5(DL+WL)	14.325
Min Y	315	4 1.5(DL+LL)	-2.374
Max Z	3	7 1.5(DL+WL)	6.6
Min Z	323	7 1.5(DL+WL)	11.347
Max rX	1	4 1.5(DL+LL)	0
Min rX	1	4 1.5(DL+LL)	0
Max rY	1	4 1.5(DL+LL)	0
Min rY	1	4 1.5(DL+LL)	0
Max rZ	1	4 1.5(DL+LL)	0
Min rZ	1	4 1.5(DL+LL)	0
Max Rst	332	7 1.5(DL+WL)	14.325

Table No. 1 :- Showing Max. & Min. Node Displacement Vertical Y (mm) Parameters.

	Node	L/C	Vertical Fy kN	Moment Mx kNm	Mz kNm
Max Fx	306	7 1.5(DL+WL)	-532.93	42.623	0.089
Min Fx	305	7 1.5(DL+WL)	-528.75	42.381	-0.092
Max Fy	305	4 1.5(DL+LL)	103.751	-3.605	0.018
Min Fy	306	7 1.5(DL+WL)	-532.93	42.623	0.089
Max Fz	322	7 1.5(DL+WL)	-397.72	-183.11	0.049
Min Fz	2	7 1.5(DL+WL)	-454.45	232.66	0.078
Max Mx	2	7 1.5(DL+WL)	-454.45	232.66	0.078
Min Mx	322	7 1.5(DL+WL)	-397.72	-183.11	0.049
Max My	2	7 1.5(DL+WL)	-454.45	232.66	0.078
Min My	1	7 1.5(DL+WL)	-451.11	230.644	-0.082
Max Mz	18	7 1.5(DL+WL)	-525.65	-124.496	0.114
Min Mz	17	7 1.5(DL+WL)	-521.35	-123.505	-0.119

Table No. 2 :- Showing Max. & Min. Node Reactions Fy, Mx and Mz Parameters.

	Beam	L/C	Node	Fx kN
Max Fx	597	7 1.5(DL+WL)	333	398.702
Min Fx	604	7 1.5(DL+WL)	326	-206.883
Max Fy	621	4 1.5(DL+LL)	177	0
Min Fy	621	4 1.5(DL+LL)	193	0
Max Fz	1	4 1.5(DL+LL)	1	13.801
Min Fz	1	4 1.5(DL+LL)	1	13.801
Max Mx	1	4 1.5(DL+LL)	1	13.801
Min Mx	1	4 1.5(DL+LL)	1	13.801
Max My	1	4 1.5(DL+LL)	1	13.801
Min My	1	4 1.5(DL+LL)	1	13.801
Max Mz	1	4 1.5(DL+LL)	1	13.801
Min Mz	1	4 1.5(DL+LL)	1	13.801

Table No. 3 :- Showing Beam Reactions Max. & Min. Axial Force Fx Parameter.

4.1 Properties Given to The Angle Section Steel Roof Truss

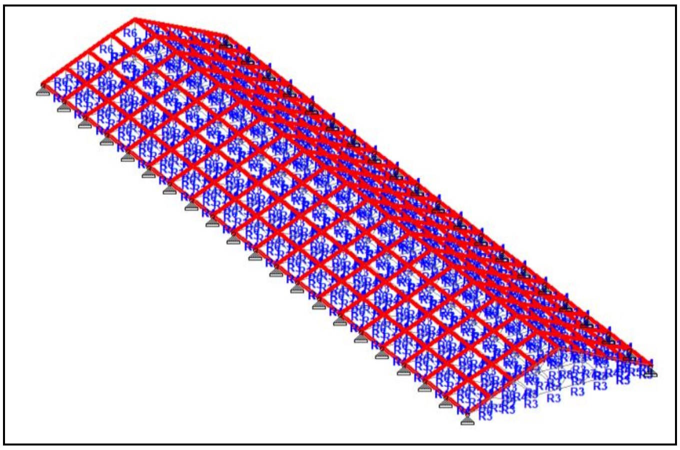


Fig. 2.1 :- Aluminum Plate Thickness of 0.008mm Provided to the Steel Roof Truss for Angle Section.

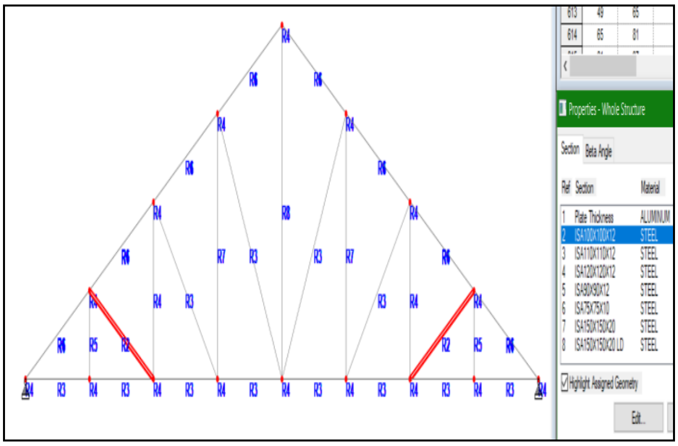


Fig. 2.2 :- Property of Steel ISA 100 X 100 X 12 mm provided for above red colored Member of Steel Truss.

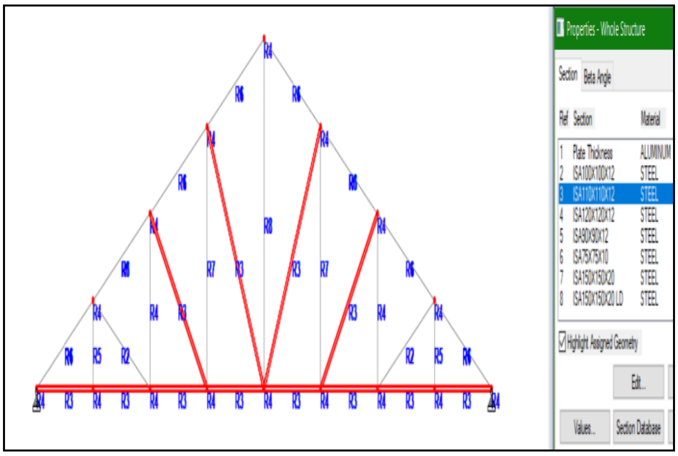


Fig. 2.3 :- Property of Steel ISA 110 X 110 X 12 mm provided for above red colored Member of Steel Truss.

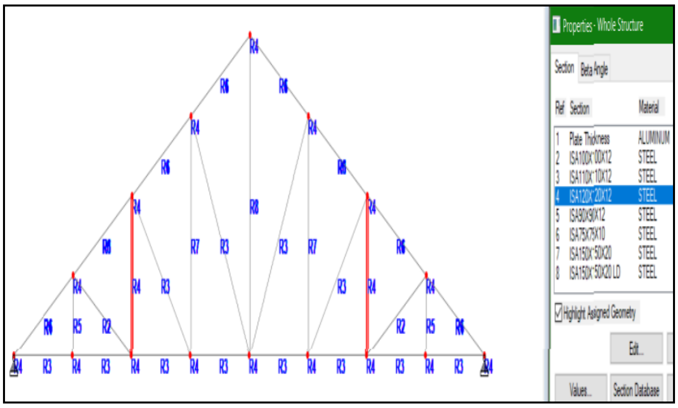


Fig. 2.4 :- Property of Steel ISA 120 X 120 X 12 mm provided for above red colored Member of Steel Truss.

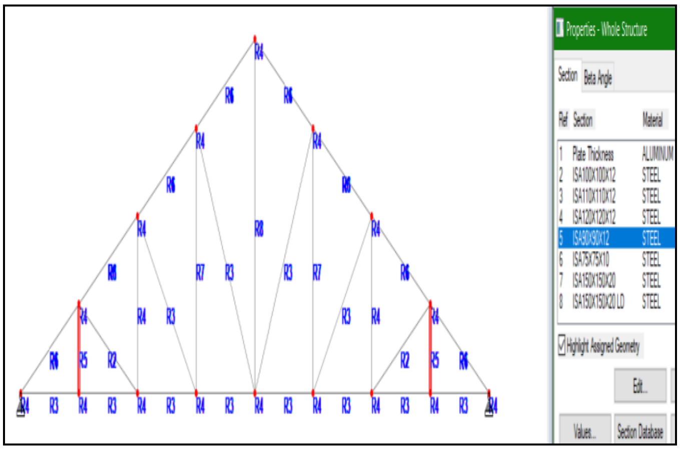


Fig. 2.5 :- Property of Steel ISA 90 X 90 X 12 mm provided for above red colored Member of Steel Truss.

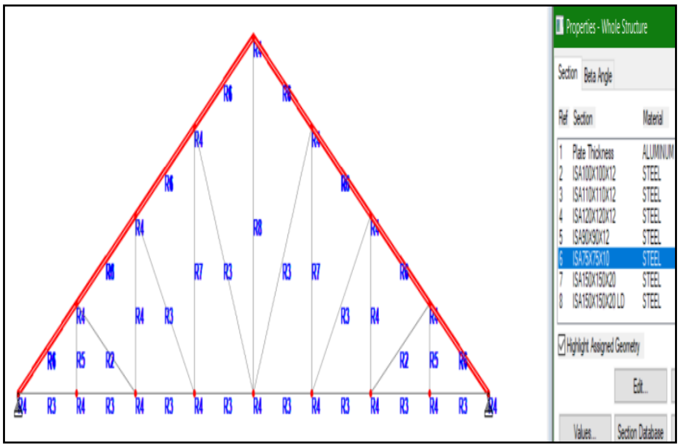


Fig. 2.6 :- Property of Steel ISA 75 X 75 X 10 mm provided for above red colored Member of Steel Truss.

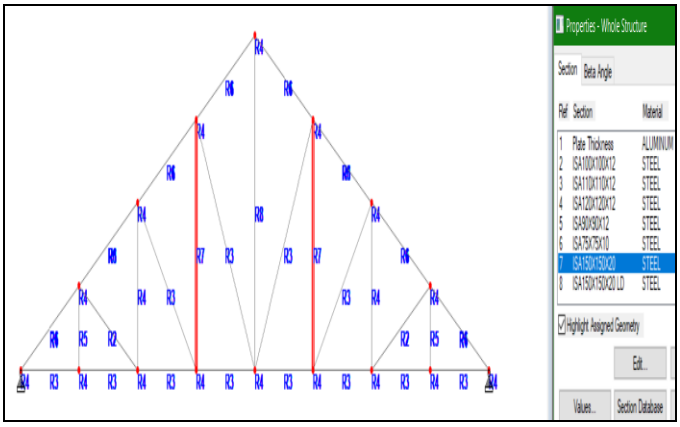


Fig. 2.7 :- Property of Steel ISA 150 X 150 X 20 mm provided for above red colored Member of Steel Truss.

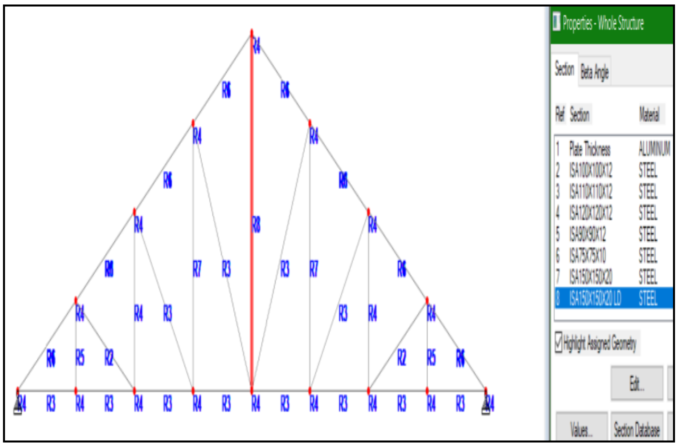


Fig. 2.8 :- Property of Steel ISA 150 X 150 X 20 (LD) mm provided for above red colored Member of Steel Truss.

4.2 Angle Section Information

If two legs of equal angle section is of same length then that angle section known as equal angle section and if not then it is known as unequal angle section.

The equal angle section are available in sizes varying from
Min. size of s/c 20 mm X 20 mm X 3 mm
Max. size of s/c 200 mm X 200 mm X 25 mm

The unequal angle sections are available in sizes are in market is varying from
Min. size of s/c 30 mm X 20 mm X 3 mm
Max. size of s/c 200 mm X 150 mm X 18 mm

In large scale it is used in the structural steel roof truss specially in the construction of steel roof truss and filler joints floors.

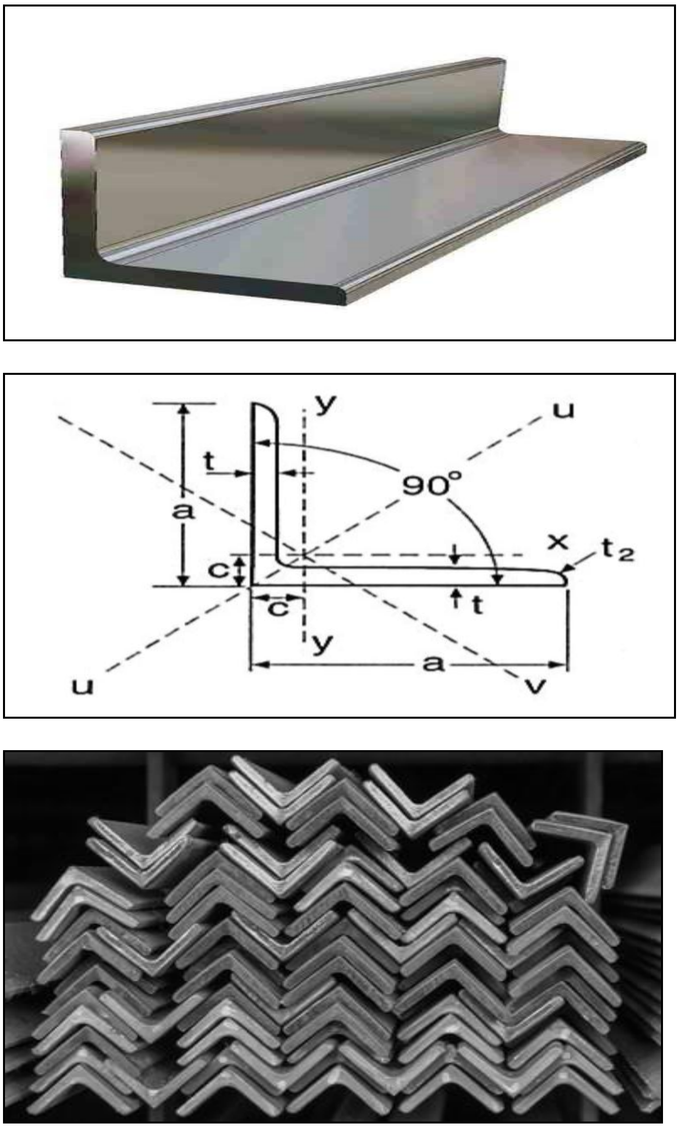
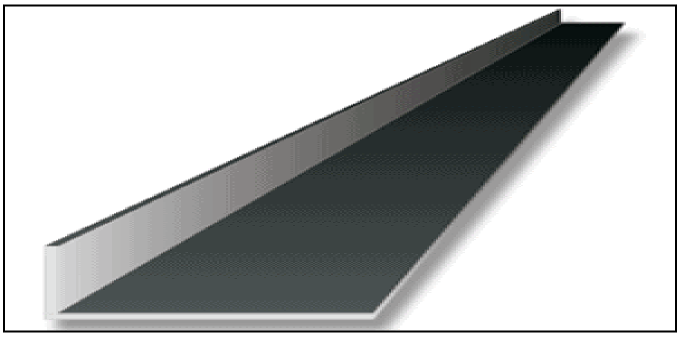


Fig. 2.9 :- Showing Equal Angle Section Image, Detailed Cross Section Diagram and Stock Photo.



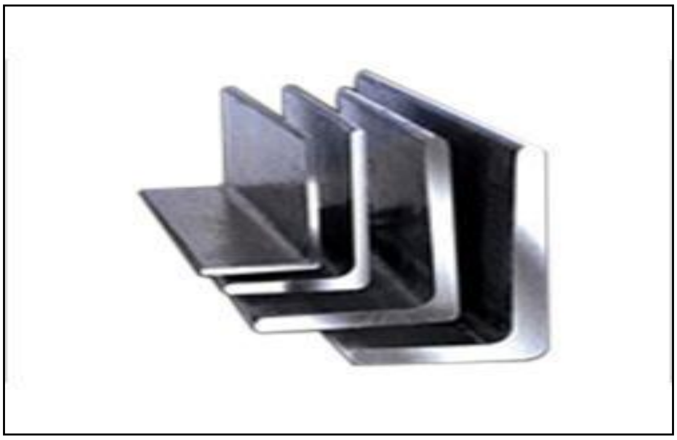


Fig 2.10 :- Showing Detailed Diagrams of Unequal Angle Section.

4.3 Tube Section Information

1} Tubular steel roof truss are specially made of steel commonly used for larger span in constructions such as factories, industrial warehouse, aircraft hanger, large exhibition centers, multiplexes etc. We at Sahu Steel manufacture the best quality of tubular trusses buildup which are extremely beneficial at multiple set ups.

2} Tubular steel sections are the best replacements to the traditional angle section steel trusses ones with their useful and comparatively better properties. It is understood that due to the cross sectional properties of the tube section, dead weight is likely to reduced for many structural members which resulted in the overall economical cost.

3} Advantages of tubular sections in steel structure :-
Tubular steel roof truss structures are the best replacement option as compare to the conventional angle section structures for their practicability and better performance. Finally, due to the cross-section properties of the tube, the weight should be decreases by many structural members.

Tube structure advantages :-

1. For tube steel roof truss structures, a higher strength to weight ratio can save up to 30% in quantity of steel.

2. Because of the high torsional stiffness and compressive strength of the angle steel pipe, tube section is more effective and cost efficient than conventional steel angle sections.

3. In case of the dynamic loads, vibration frequency of the pipe is higher than any other rolling section.

4. Easy to maintain.

5. No angularity.

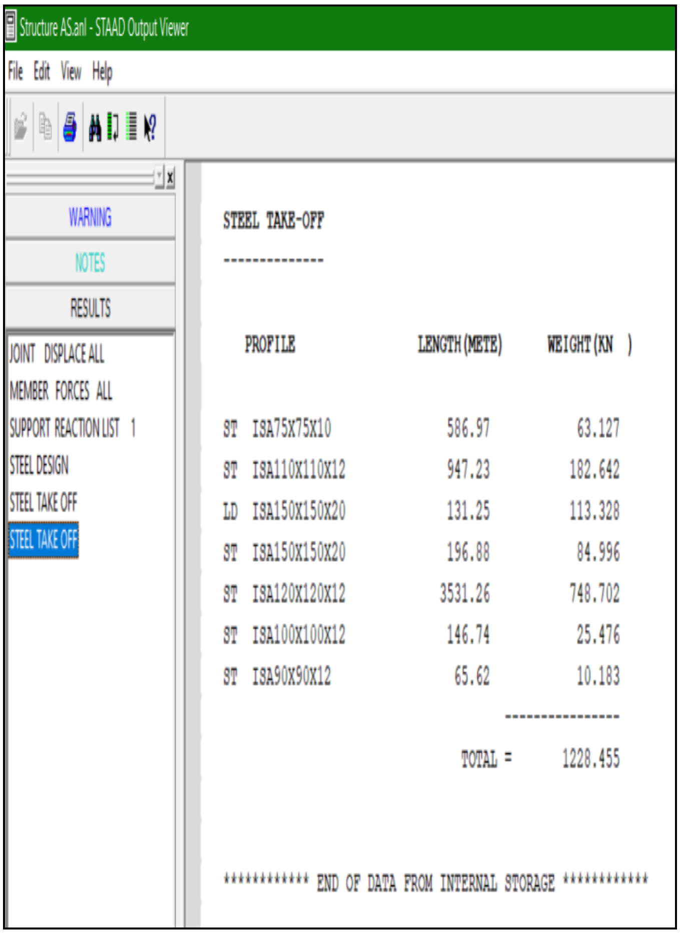
6. Easy to manufacture and install.

30% to 40% less surface area as compare to that of an equivalent rolled steel shape. So that is why, the cost of maintenance, protective coatings and cost of painting reduce simultaneously and reduce cost. The advantages of installing steel roof truss of tube trusses are as follows: It is very extremely useful in structural designing due to which for the use of material handling equipment's where weight savings is directly proportional to the necessary cost saving condition. Therefore, they are extremely beneficial in carrying more roof load along with providing a high stability and structure is to be safe.

Comparison of Price Range and Other Details of Both ISA Angle Section and Tube Section Roof Truss in Market of location Bhuj, Gujrat (India) :-

ISA Angle Section	Tube Section
Rs. 349/sq.ft. Rs. 39/kg Built Type :- Prefab Material :- Steel Usage / Application :- Industrial Thickness :- 10mm, 12mm :- Rs. 400/sq.ft., 20mm :- Rs. 600/sq.ft. Finishing :- Colour Coated Rust Proof :- Yes Minimum Order Quantity :- 100 sq.ft.	Rs. 65/kg (Standard Length = 6m) Rs. 64000/metric ton Build Type :- Tubular Material :- Customized Steel, Brand :- Customized, Waterproof :- Yes, Features :- Easily Assembled, Eco-friendly customized. Min. Thickness :- 1.6 mm Max. Thickness :- 12 mm Dimension :- Customized Length Available :- Customized For 3.6 mm thick. :- Rs. 135/sq.ft. For 4 mm thick. :- Rs. 150/sq.ft. For 3.2 mm thick. :- Rs. 115/sq.ft. For 4.5 mm thick. :- Rs. 175/sq.ft.

5. CALCULATION OF QUANTITY OF STEEL IN ANGLE S/C



	PROFILE	LENGTH(METE)	WEIGHT(KN)
ST	ISA75X75X10	586.97	63.127
ST	ISA110X110X12	947.23	182.642
LD	ISA150X150X20	131.25	113.328
ST	ISA150X150X20	196.88	84.996
ST	ISA120X120X12	3531.26	748.702
ST	ISA100X100X12	146.74	25.476
ST	ISA90X90X12	65.62	10.183
		TOTAL =	1228.455

************ END OF DATA FROM INTERNAL STORAGE ************

6. Design & Analysis of Industrial Warehouse Roof Truss by using Tube Section

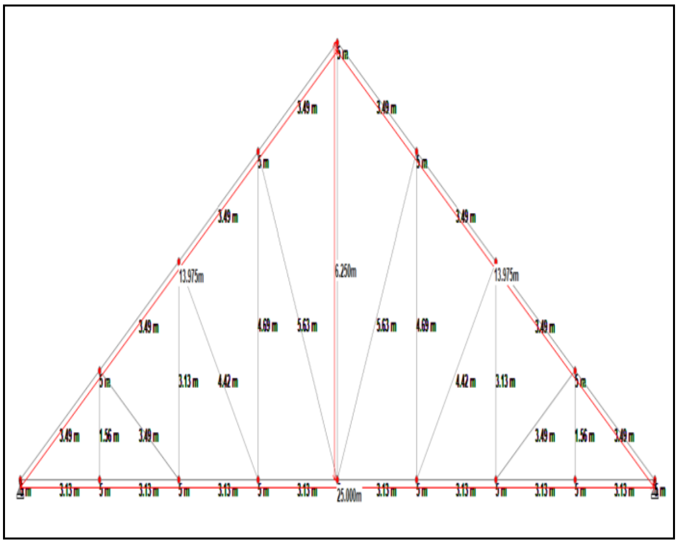


Fig. 3.1 :- 2-D Model of Steel Truss by using Tube Section

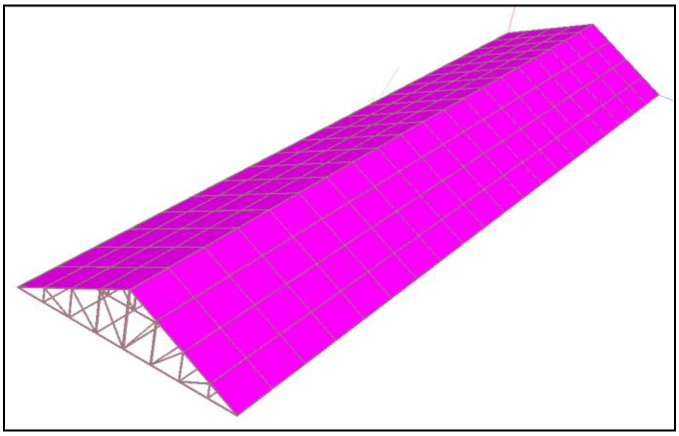


Fig. 3.2 :- 3-D Rendering View

			Vertical
	Node	L/C	Y mm
Max X	328	7 1.5(DL+WL)	19.399
Min X	325	7 1.5(DL+WL)	19.898
Max Y	331	7 1.5(DL+WL)	21.124
Min Y	315	4 1.5(DL+LL)	-2.762
Max Z	3	7 1.5(DL+WL)	7.291
Min Z	323	7 1.5(DL+WL)	12.951
Max rX	1	4 1.5(DL+LL)	0
Min rX	1	4 1.5(DL+LL)	0
Max rY	1	4 1.5(DL+LL)	0
Min rY	1	4 1.5(DL+LL)	0
Max rZ	1	4 1.5(DL+LL)	0
Min rZ	1	4 1.5(DL+LL)	0
Max Rst	331	7 1.5(DL+WL)	21.124

Table No. 4 :- Showing Node Displacement Parameters of Tube Section

			Vertical	Moment	
	Node	L/C	Fy kN	Mx kNm	Mz kNm
Max Fx	306	7 1.5(DL+WL)	- 565.019	50.782	0.136
Min Fx	305	7 1.5(DL+WL)	- 560.861	50.519	- 0.142
Max Fy	305	4 1.5(DL+LL)	79.564	-3.208	0.021
Min Fy	306	7 1.5(DL+WL)	- 565.019	50.782	0.136
Max Fz	322	7 1.5(DL+WL)	- 415.243	- 205.021	0.073
Min Fz	2	7 1.5(DL+WL)	- 479.482	254.607	0.123
Max Mx	2	7 1.5(DL+WL)	- 479.482	254.607	0.123
Min Mx	322	7 1.5(DL+WL)	- 415.243	- 205.021	0.073
Max My	2	7 1.5(DL+WL)	- 479.482	254.607	0.123
Min My	1	7 1.5(DL+WL)	- 476.168	252.537	-0.13
Max Mz	18	7 1.5(DL+WL)	- 553.424	- 137.503	0.181
Min Mz	17	7 1.5(DL+WL)	- 549.149	- 136.484	-0.19

Table No. 5 :- Showing Max. & Min. Node Reactions Fy, Mx and Mz Parameters for tube section.

	Beam	L/C	Node	Fx kN
Max Fx	597	7 1.5(DL+WL)	333	411.449
Min Fx	604	7 1.5(DL+WL)	326	-213.395
Max Fy	861	4 1.5(DL+LL)	189	0
Min Fy	861	4 1.5(DL+LL)	205	0
Max Fz	1	4 1.5(DL+LL)	1	6.487
Min Fz	1	4 1.5(DL+LL)	1	6.487
Max Mx	1	4 1.5(DL+LL)	1	6.487
Min Mx	1	4 1.5(DL+LL)	1	6.487
Max My	1	4 1.5(DL+LL)	1	6.487
Min My	1	4 1.5(DL+LL)	1	6.487
Max Mz	1	4 1.5(DL+LL)	1	6.487
Min Mz	1	4 1.5(DL+LL)	1	6.487

Table No. 6 :- Beam Reactions Max. & Min. Axial Force Fx of Tube Section.

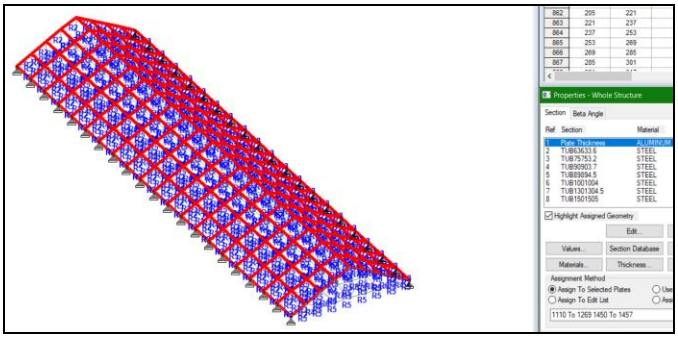


Fig. 3.2 :- Aluminum Plate Thickness of 0.008mm Provided to the Steel Roof Truss for Tube Section.

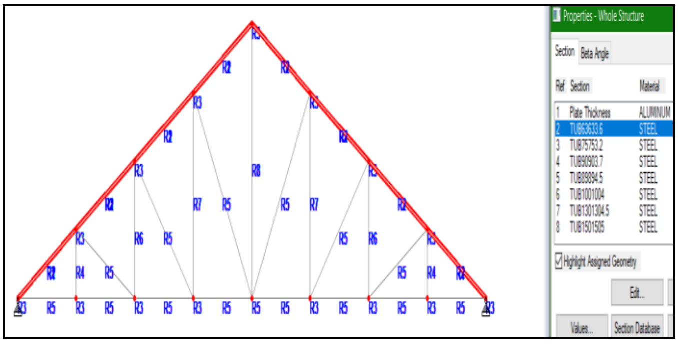


Fig. 3.3 :- Property of Steel TUB 63 X 63 X 3.6 mm provided for above red colored Member of Steel Truss.

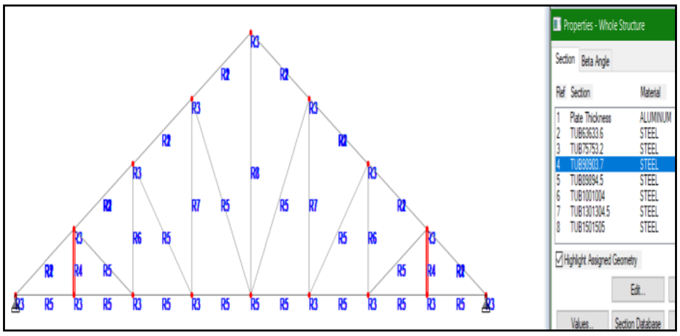


Fig. 3.4 :- Property of Steel TUB 90 X 90 X 3.7 mm provided for above red colored Member of Steel Truss.

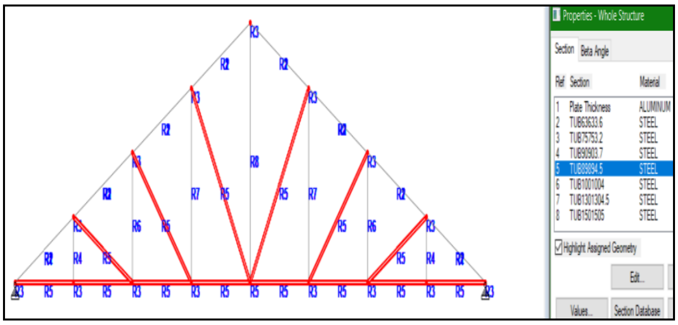


Fig. 3.5 :- Property of Steel TUB 89 X 89 X 4.5 mm provided for above red colored Member of Steel Truss.

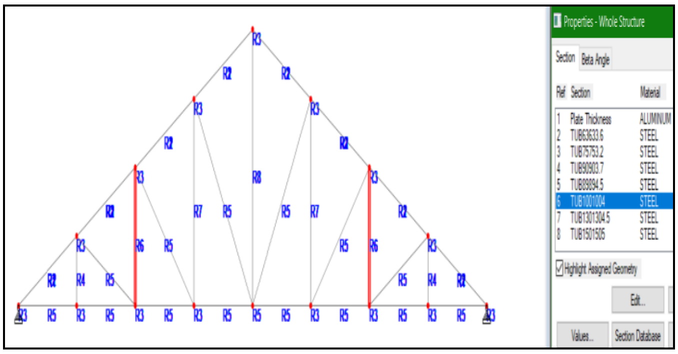


Fig. 3.6 :- Property of Steel TUB 100 X 100 X 4 mm provided for above red colored Member of Steel Truss.

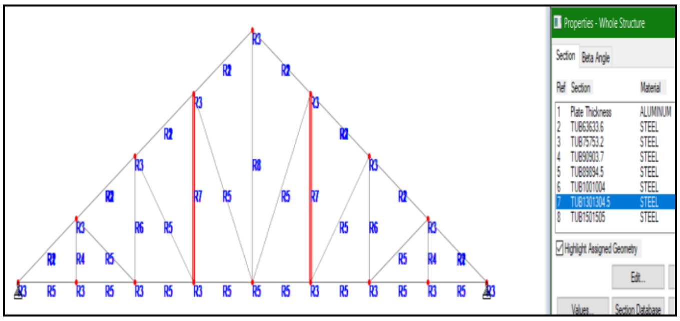


Fig. 3.7 :- Property of Steel TUB 130 X 130 X 4.5 mm provided for above red colored Member of Steel Truss.

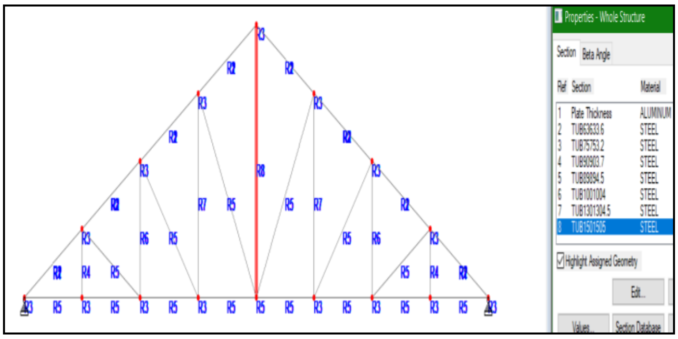
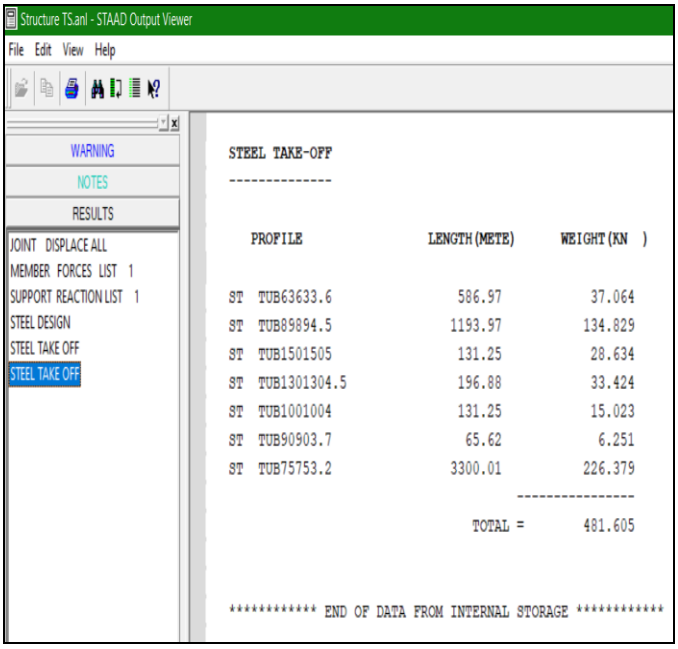


Fig. 3.8 :- Property of Steel TUB 150 X 150 X 5 mm provided for above red colored Member of Steel Truss.

7. CALCULATION OF QUANTITY OF STEEL IN TUBE S/C



STEEL TAKE-OFF

PROFILE	LENGTH (METE)	WEIGHT (KN)
ST TUB63633.6	586.97	37.064
ST TUB89894.5	1193.97	134.829
ST TUB1501505	131.25	28.634
ST TUB1301304.5	196.88	33.424
ST TUB1001004	131.25	15.023
ST TUB90903.7	65.62	6.251
ST TUB75753.2	3300.01	226.379
	TOTAL =	481.605

************ END OF DATA FROM INTERNAL STORAGE ************

8. COMPARISON OF RESULTS

{A} For Angle Section : Steel Take off = 1228 kN

Total Quantity in kg = 1228 x 102
= 1,25,256 kg of steel s/c required

Cost of the Angle s/c = 1,25,256 x 67
= Rs. 83,92,152/-

{B} For Tube Section :- Steel Take off = 481 kN

1} Total Quantity in Kg
= 481 x 102
= 49,062 kg of tube s/c required

9. CONCLUSION

Therefore, Cost of tube s/c = 49,062 x 67
= Rs. 32,87,154/-

Therefore, Total Cost Saving in Tube Section
= 83,92,152 – 32,87,154
= Rs. 51,04,998/-

Therefore 60.83% of the total cost saving in tube section so that tube section is proved to be economical section for steel roof truss of Industrial Warehouse.

Advantages of Tube Section over Angle Section :-

- ✓ Assured yield strength.

- ✓ Ideal surface for smooth paint finish.
- ✓ Low carbon content for a strong weld joint.
- ✓ Good formability and ductility.

10. COMPARING THE RESPECTIVE RESULTS OF BOTH TRUSS SECTIONS ON STAAD PRO SOFTWARE.

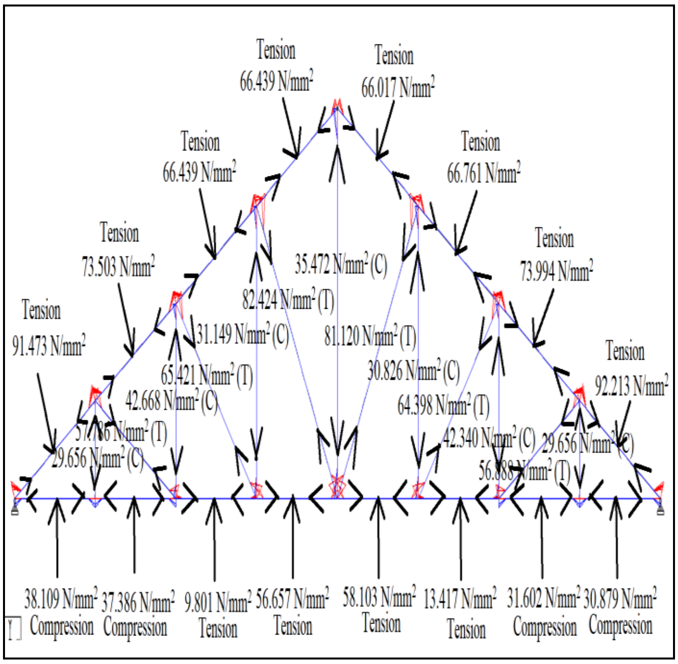


Fig 4.1. :- Showing Angle Section Truss Member Either in Compression or in Tension under after Analysis.

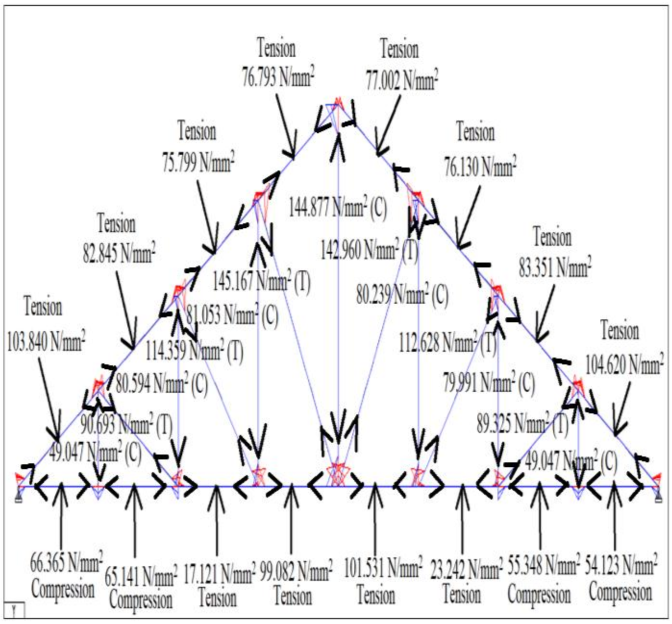


Fig. 4.2 :- Showing Tube Section Truss Member Either in Compression or in Tension under after Analysis.

11. FACTOR OF SAFETY FOR STEEL TRUSS

The factor of safety in steel roof truss is a very important term in engineering designing. So that is why designing any Engineering product, safety is the first priority and importance. To ensure the safety of that items, each component is designed to accept more loads than its actual operational loads. Hence, there will be always some percentage of margin as compare to its operating and working capabilities. This is ensured that at this design stage by evaluating a suitable and safe factor of safety. The factor of safety is known as ratio of ultimate stress (ultimate load) of the component material or member to the working stress (allowable load). It indicate the additional strength of the component or member in the truss than the required strength.

11.1 Importance of Factor of Safety

A factor of safety is directly related to safety of people. It reduces the risk of failure of a component in the truss section by adding some cushion in designing. Also, there always be some hidden conditions or unknown parameters which should not be considered accurate in design protocol. At that same time, the reliability and purity of material is not 100% and loading used in designing process calculation is not the maximum load. So that is why the factor of safety provides protection against that unknown event to some extent or reduced major problem that occur in design.

Although all components and member are designed with a safety factor, it is always suggested that to use that components under their design limit.

11.2 Factors Affecting Determination of Factor of safety

Component design codes & standards normally provide a minimum factor of safety for that component. Although, choosing the exact factor of safety is dependent on various different parameters like

1) Material type Ductile vs Brittle
2) Loading type Static vs dynamic
3) Whether cyclical loads
4) The intensity of stress concentration
5) Unforeseen Misuse of the component
6) Accuracy and stress complexity during a calculation
7) Environment and design temperature and pressure.
8) Impact of failure
9) Cost of component or material
10) Corrosion rate
11) Maintenance frequency

Defination :- The ratio of the load that would cause failure to the load for which the structure is designed is called the factor of safety.

Safety Factor=Ultimate Load (Strength)/Allowable Load (Stress) as we understand from the above equation the allowable load is always less than the ultimate failure stress.

Factor of safety = Ultimate Load (Strength)/Allowable Load (Stress)

As we understand from the above given equation the allowable stress/load is always less than the ultimate failure stress/load. So that is why the safety factor is always greater than 1. The ultimate stress/load for brittle material is consider as ultimate/maximum tensile strength and for ductile material is considered as yield strength of steel.

Also above equation is said that safety factor is the ratio of two stress or load values, the unit of it is dimensionless. The difference between the Safety factor and 1 is called as Margin of safety. Hence it is given as, Margin of safety= (Factor of safety-1).

In accordance with the Truss Plate Institute's ANSI/TPI 2 , metal connector plates are designed with a factor of safety of 3.2 for withdrawal, 1.44 for steel shear yield strength and 1.67 for steel tension yield strength. This factor of safety result in a steel roof truss is 2.0 for the overall steel strength.

11.3 General Recommendations

Applications	Factor of Safety *- FOS -*
For use with highly reliable materials where loading and environmental conditions are not severe and where weight is an important consideration	1.3 - 1.5
For use with reliable materials where loading and environmental conditions are not severe	1.5 - 2
For use with ordinary materials where loading and environmental conditions are not severe	2 - 2.5
For use with less tried and for brittle materials where loading and environmental conditions are not severe	2.5 - 3
For use with materials where properties are not reliable and where loading and environmental conditions are not severe, or where reliable materials are used under difficult and environmental conditions	3 - 4

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