DESIGN AND ANALYSIS OF ROOF TRUSS USING STADD

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ABSTRACT

To describe a structure used for the storage of raw materials or the production of industrial products, we call it an industrial building. Purlins, rafters, roof trusses, wind bracing, and columns are all critical components of industrial structures. As a workshop or warehouse, these structures are ideal. The use of steel is common in the construction of large-scale industrial buildings, where concrete construction is either impractical or time-sensitive. Selected, well-analysed, and planned is a multi-story industrial structure. By hand, the analysis and design were carried out. All of the structural components were developed by manually, as was the study of the structure. The Industrial Steel Truss Building has a lot of weight to it. IS code specifying a number of combinations of loads that are evaluated in the modelling process. These include dead loads, live loads, and wind loads. Results can be found in the column base. Steel purlins cross between stiff frames in this metal structure, which is coated with light gauge metal wall cladding. Determined by the specified loads and/or external impacts, these values are generally implemented in structural analysis.

1.0 INTRODUCTION

STAAD.pro is structure analysis and design computer program. Actually, the design of steel roof truss using in this study the steel truss is a framework, typically consisting of rafter, posts and supporting a roof, bridge or other structure. In this steel truss having different types. In engineering a truss is structure that consists of two force members. In roof truss having different types of spacing and span length and location, roofing type. And the roofing trusses having different loads (dead load, live load, wind load, seismic load). To find the dead load code is (IS875 -1987 PART 1). And the loads is distubuted.STAAD.pro having different load combinations and live loads, wind loads and the design codes in trusses

Figure 1.1: Roof truss model

Industrial Buildings: In industrial building structures, the walls can be formed of steel columns which may be plain sheets, precast concrete. The wall must be adequately strong to resist the lateral force. And the industrial buildings having location, roof truss, geometry of truss, length and spacing of truss.

Convential Frame: Wood frame buildings are economical to build, heat and cool, and provide maximum comfort of occupants. Wood construction is readily adaptable to traditional and building styles. The application of construction rules may be limited by building codes requirements is used where the building id being constructed. The strength of wood construction is due to its frame work structural combined with a covering of subflooring. Steel roof trusses are commonly used for industrial buildings, workshop buildings, godowns, ware houses and even for residential buildings, school buildings and offices where the construction is work to be completed in a short duration of time temporary structures are invariably constructed with roof truss of steel or timber.

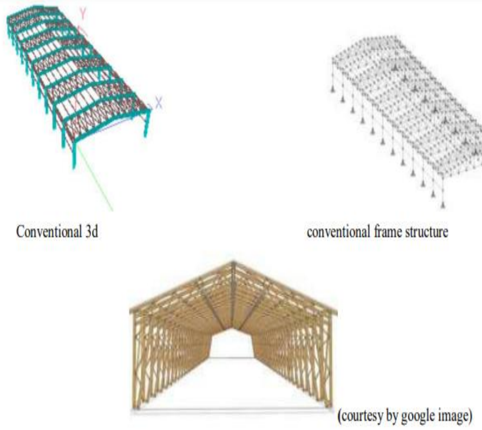

Figure 1.2: Convential Frame

Prefabricated Truss:

Prefabricated roof trusses have many advantages and benefits over conventional hand framed rafters. Trusses are extremely cost effective, easy to install, they can create unique framing systems and they are consistently built with quality grades of lumber. They are shipped to your construction site and installed using a crane after the home's walls have been framed. Nearly 80% of new homes constructed today use pre-manufactured roof trusses instead of traditional rafters to support the roof. The key benefits of using pre-fabricated roof trusses are cost savings and construction speed. They are also increasingly popular because they allow great flexibility and complexity in roof design.

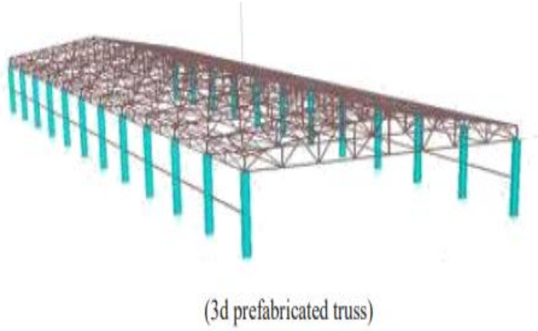

Figure 1.3: (3d prefabricated truss)

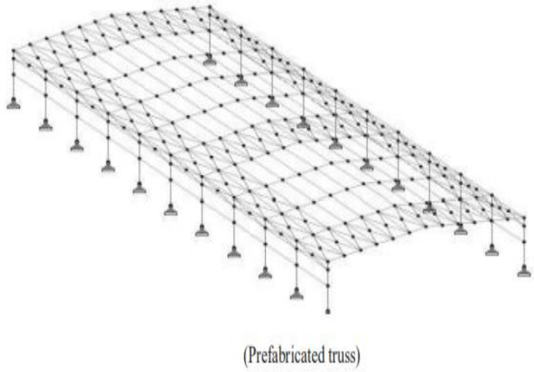

Figure 1.4: (Prefabricated truss)

Objective of the Study

Objective of the project is to analyse and design the industrial building. These includes the calculations of loads, analysis of loads, design of columns, design of slab base, design of purlins and design of connections. Mostly industrial buildings are steel structures because it is economical and light weight. It is economical because of more scrap value for steel. The steel column may be of any section depending on compression load. That required section is to be designed to acquire the dimensions of the section. Mostly for steel structures concrete foundation is not preferred because of use of steel column, which results in improper connections. So, slab bases are designed as foundation for steel structures. For heavy loads gusseted base is designed and for light loads cleat angles base is designed. So, finally we design our steel structure on the basis of loads, span, roofing, lighting etc. The required compression and tension loads of members can be obtained from analysis of loads. Column, slab base, purlin and connections are designed on the basis of loads, span etc.

2.0 LITERATURE REVIEW

The chapter involves the discussion of various research papers reviewed for achieving the aim of the project. The following research papers have discussed about behaviour of the steel, analysis and design of truss and industrial building. In this research papers they discussed different methods for analysis and design of truss members. They aimed to design an economical structure with good efficiency to resist the loads.

Dr. K. Manjunath, Santhosh Kumar [1] to assess the reliability of the members of a steel truss. Using random values, the truss is analyzed by using STAAD PRO. This is done for 100 cycles. Randomness of each member is modeled then after resistance part is modeled. This is done by applying equations as per IS 800 – 2007, again using Monte Carlo technique. Dr. S. K. Dubey, Prakash [2] the analyzation of steel roof truss under the normal permeability condition of wind according to IS: 875 (part 3) – 1987 by considering different conditions. They compare the results so obtained with the calculations made in SP-38 (S&T): 1987. According to IS code in which, intensity of wind load is calculated considering different conditions like class of structure, terrain, topography factor and permeability conditions etc. Where as in SP-38 there are no considerations of different conditions. They concluded that analysis made in SP38:1987 cannot be followed without considering various conditions. Jyoti P Swawant, [3] the analysis and design of truss by paper post-tensioning method is discussed. The application of post-tensioning using tendons is a simple and economical method of increasing load carrying capacity of the truss. The Post-tensioning has been applied to both angular and tubular trusses of 30m span with single and double drape tendons using SAP 2000v15 software. Kim, Moon Ho Park, Se Hyu Choi [4] the steel roof truss having 12m span has been analyzed with design of tubular sections of truss members by the comparative analysis and design of steel roof truss using IS 875 and SP 38. From this they observed that the weight of designed tubular section obtained as per IS 875 are greater than that of obtained as per calculations made in SP 38. They concluded that analysis given in SP 38 is reviewed and various criteria of win load calculations given in IS 875 should be incorporated Kim Jai B [5] gives a procedure to develop a semi-rigid non-linear heel joint model by using the software SAP 2000. A good agreement exists between experimental data gathered by Guinther and the heel joint model developed. The design and testing methodology for metal plate is done by both TPI N Arlekar, C. V. R. Murthy [6] Jaswant presents the results of 18 strong-axis steel welded beam- column sub assemblages with reinforcement connections by using finite element analysis. The connections scheme used most in steel MRF (moment resisting frame). They also present a non-iterative procedure for design of beam to column connection using a truss for obtaining connection forces, in this they use the plastic hinge.

3.0 DESCRIPTION OF ROOF TRUSS

Steel trusses are commonly used in commercial construction. They are pre-manufactured to order and are made in an open web design. They are essentially axially loaded members which are more efficient in resisting external loads since the cross section is nearly uniformly stressed. They are extensively used, especially to span large gaps. Trusses are used in roofs of single storey industrial buildings, long span floors and roofs of multi-story buildings, to resist gravity loads. The advantage of using steel trusses for building is that they are stronger than wood and greater open space inside a building is possible. They are ideal for barns, large storage buildings and commercial construction.

3.2 Selection of Truss

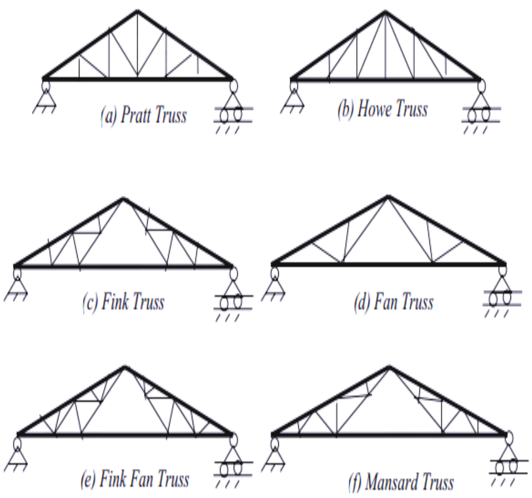

Figure 3.1: Types of pitched roof trusses

Most common types of roof trusses are pitched roof trusses wherein the top chord is provided with a slope in order to facilitate natural drainage of rainwater and clearance of dust/snow accumulation. These trusses have a greater depth at the mid-span. Due to this even though the overall bending effect is larger at mid-span, the chord member and web member stresses are smaller closer to the mid-span and larger closer to the supports. The typical span to maximum depth ratios of pitched roof trusses are in the range of 4 to 8, the larger ratio being economical in longer spans. Pitched roof trusses may have different configurations.

Truss Configuration

Rectangular area=2250 SFT

Dimensions

$=75' \times 30'$

Span

$= 30' = 9.144\text{m}$

As per IS code specifications

Depth (or) height of truss

$$= \frac{span}{6} \text{ to } \frac{span}{5}$$

Height (H)

$$= \frac{span}{5} = \frac{30}{5} = 6'$$

Pitch

$$= \frac{height}{span} = \frac{6'}{3'} = 0.2$$

Slope

$$= \frac{height}{(span/2)} = 2\times\text{pitch} = 2\times 0.\ 2 = 0.4$$

Roof angle (θ)

$$= \tan^{-1}(\text{slope}) = \tan^{-1}(0.4) = 21.8^\circ$$

Length of rafter

$$= \sqrt{\left(\left(\frac{9.144}{2}\right)^2 + 1.8288^2\right)} = 4.924\text{m}$$

Length of each panel

$$= \frac{4.924}{4} = 1.231\text{m}$$

Length of panel in plan
= 1.231× cos22° = 1.141m

Truss spacing
= 15′ = 4.572m

Area of panel
= 1.141×4.572 = 5.218m^2

For a span of 30', a pitched roof truss is considered in that fink truss is selected on the basis of span and roof shape. The dimensions of truss are derived from the formulas and code specifications. The shape of the truss is triangular. It consists of 8 panels and 27 members. The length of the rafter is obtained from the triangular law. The area of each panel is determined by considering plan view, in the plan view it look like a rectangle.

4.0 RESULTS AND DISCUSSIONS

Structural loads or actions are forces, deformations or accelerations applied to a structure or
it's components. Loads cause stresses, deformations and displacements in structures. There are different types of loads acting on industrial building. Loads differ from area to area and depend on climatic conditions. As per our climatic conditions, the following loads are considered The loads are assumed to be acting only at the nodes of the trusses. The trusses maybe provided over a single span, simply supported over the two end supports, in which case they are usually statically determinate. Such trusses can be analysed manually by the method of joints or by the method of sections. STAAD Pro is used for the analysis of truss

Analysis of dead load

Total dead load on each panel = 3.09 KN

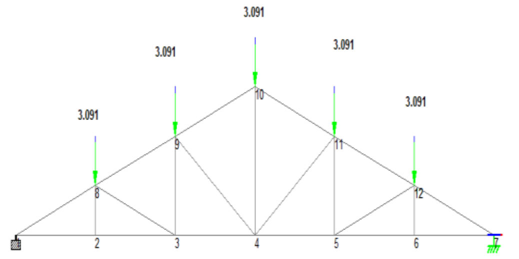

Figure 4.1: Dead loads at panel points

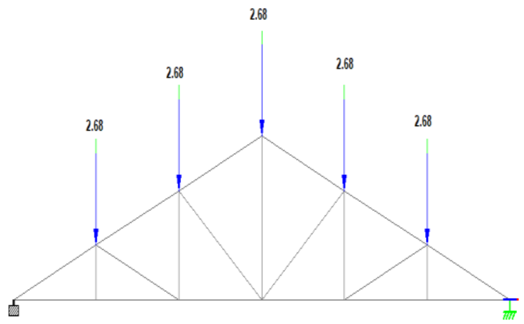

Figure 4.2: Live load at panel points

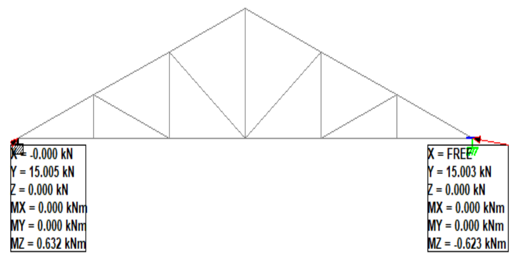

Figure 4.3: Support Reactions

Table 4.1: Support reactions

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	7	1 LOADING	0	15.003	0	0	0	-0.623
Min Fx	1	1 LOADING	0	15.005	0	0	0	0.632
Max Fy	1	1 LOADING	0	15.005	0	0	0	0.632
Min Fy	7	1 LOADING	0	15.003	0	0	0	-0.623
Max Fz	1	1 LOADING	0	15.005	0	0	0	0.632
Min Fz	1	1 LOADING	0	15.005	0	0	0	0.632
Max Mx	1	1 LOADING	0	15.005	0	0	0	0.632
Min Mx	1	1 LOADING	0	15.005	0	0	0	0.632
Max My	1	1 LOADING	0	15.005	0	0	0	0.632
Min My	1	1 LOADING	0	15.005	0	0	0	0.632
Max Mz	1	1 LOADING	0	15.005	0	0	0	0.632
Min Mz	7	1 LOADING	0	15.003	0	0	0	-0.623

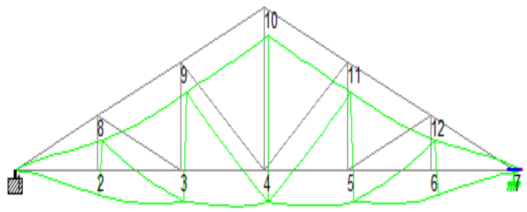

Figure 4.4: Displacements

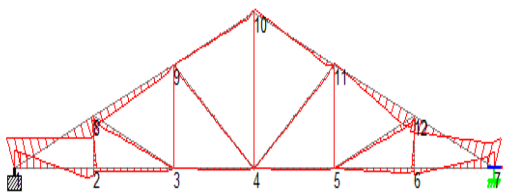

Figure 4.5: BMD of TRUSS

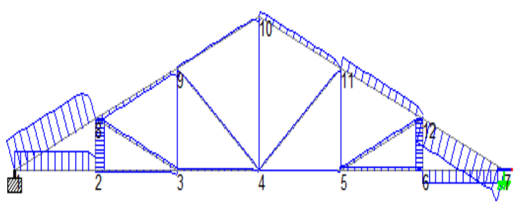

Figure 4.6: SFD of TRUSS

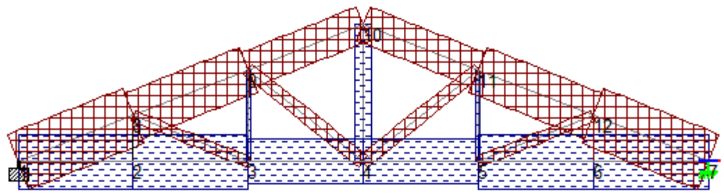

Figure 4.7: axial diagram of truss

Table 4.2: Results

S. No	Specifications	Results
1	Span of truss	30feet (9.144m)
2	Height	6 feet
3	Roof angle	21.8˚
4	Total dead load	3.09KN
5	Live load	2.68KN
6	Wind load	E & F=17.93 KN, G & H=15.7KN
7	Latticed I-section Column	C-channel section ISJC 125 @10.07cm^2 6mm flats are connected with 16mm diameter bolts
8	Slab base	Provide 190x140x20mm steel plate
9	Purlins	Provide ISMB 100 @ 1.4m c/c spacing
10	Connection between I-angle and slab base	It requires 6 bolts
11	Connection between I-angle and C-section	It requires 6 bolts
12	Both C-section	It requires 6 bolts
13	Connection of truss members	
	a) rafter	ISA 60x40x8mm,2

		bolts of 20mm diameter with gusset plate of 10mm thickness
	b) main tie	ISA 75x45x8mm,2 bolts of 20mm diameter with gusset plate of 10mm thickness
	c) strut	ISA 55x55x10mm,1 bolts of 20mm diameter with gusset plate of 10mm thickness
	d) minor sling	ISA 60x60x8mm,2 bolts of 20mm diameter with gusset plate of 10mm thickness
	e) main sling	ISA 75x50x8mm,2 bolts of 20mm diameter with 10mm thick plate

Conclusion

- Latticed column is designed and I-section is provided for column.
- For column design provide 48 ISF 6mm flats at 45˚ and connect them to centre of gravity of channels with one bolt of 16mm nominal diameter.
- A rectangular steel base plate is used for slab base. The dimensions are 190 × 140 × 20 mm. The steel plate is fixed on concrete base with bolted connections.
- I-section of ISMB 100 with 1.4m c/c spacing is provided for purlins.
- 4 bolt of 25mm diameter are provided for connections of L Angle & slab base and L angle & C section and both the C sections.
- For the connections of truss members trial and error method is followed.

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