Analysis and Design of Proposed Auditorium At Sanghavi College Of Engineering ,Nashik-422202

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Abstract *The configuration of roof trusses is a pivotal element in both structural engineering and architectural planning. These trusses, fundamental for providing support and stability to building roofs, undergo meticulous design processes to ensure structural integrity, safety, and aesthetic appeal. This overview outlines the essential factors involved in their design. Initiating with a thorough analysis of structural requirements, encompassing roof span, loads (such as snow, wind, and dead loads), and desired pitch, engineers employ mathematical and computational techniques like finite element analysis to determine optimal truss configurations in terms of efficiency and cost. The selection of materials—be it timber, steel, or engineered wood—significantly impacts truss design, considering factors such as strength, durability, availability, and cost-effectiveness. Equally crucial is the choice of connectors and fasteners to guarantee stability and safety. Various truss forms exist, each with distinct advantages and disadvantages, including common trusses, scissor trusses, and hip trusses, all influencing architectural style and appearance. With a rising emphasis on energy efficiency and sustainability, innovative features like attic trusses and the use of eco-friendly materials are increasingly integrated into designs to reduce energy consumption and environmental impact. This abstract underscores the intricate and multidimensional nature of roof truss design, stressing the necessity of a holistic approach that encompasses structural, aesthetic, and environmental considerations. A well-executed roof truss system not only upholds a building's structural integrity but also enhances functionality, visual appeal, and addresses contemporary sustainability challenges.*

***Key Words*: Roof Truss, Design**

1.INTRODUCTION

1.1 Design Of Roof truss

A truss is an assembly of structural members, like beams, interconnected at nodes to form a rigid framework. In engineering, a truss is specifically defined as a structure comprising only two-force members, meaning each member experiences force at only two points. While trusses can theoretically have any shape and configuration, they typically consist of five or more triangular units made of straight members joined at nodes. External forces and reactions in trusses are typically considered to act solely at the nodes, resulting in either tension or compression forces in the members. Moments (torques) are excluded from consideration in straight members, as all joints are treated as revolutes to maintain the two-force member characteristic.

Trusses can be categorized as planar or space trusses based on whether their members and nodes lie within a two-dimensional plane or extend into three dimensions, respectively. The top members of a truss are known as top chords and typically experience compression forces, while the bottom members, called bottom chords, usually endure tension forces. Interior members are referred to as webs, and the spaces enclosed by these members are termed panels or polygons, as per concepts from graphic statics like the Cremona diagram. In structural engineering, the term "truss" commonly refers to a triangular framework capable of supporting inclined, vertical, or horizontal loads. Trusses are constructed using various components such as angles, channels, plates, and eye bars. Designing a truss entails analyzing its response to loads using statics, typically employing methods like the method of joints or sections to determine internal forces in the members. Subsequently, a trial section is verified for adequacy. When designing a roof truss, factors such as span, load, and material selection are

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crucial considerations. For precise specifications tailored to your project's requirements, it's advisable to consult a structural engineer.

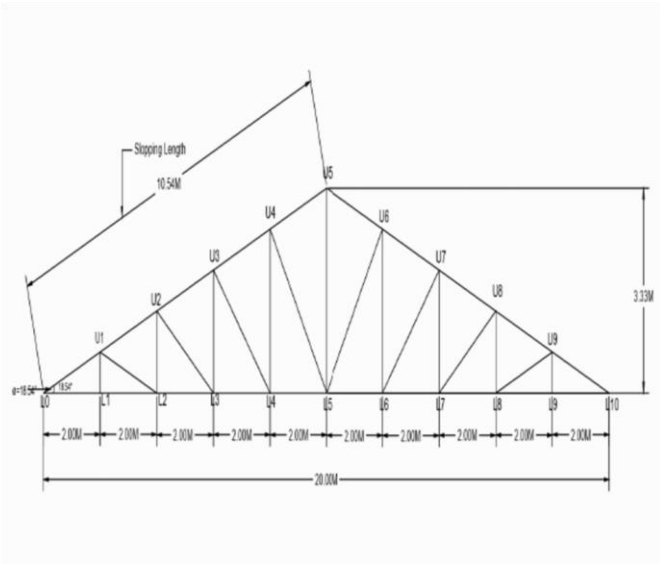
1.2 The Design Of Howe Truss

The Howe truss, a type of truss bridge, comprises chords, verticals, and diagonals, with the vertical members under tension and the diagonal ones under compression. William Howe invented this design in 1840, and it saw widespread use as a bridge during the mid to late 1800s.

Early bridges in North America were predominantly constructed from wood due to its abundance and affordability compared to stone or masonry. Initially, bridges followed designs like the Towne lattice truss or Burr truss. Later developments included the McCallum truss, a modification of the Burr truss, and the Pratt truss, which employed wooden vertical members in compression with diagonal iron braces. By around 1840, iron rods began to supplement wooden bridges. Both the Pratt and Howe trusses utilized counter-bracing, crucial for supporting heavy railroad trains.

In 1830, Stephen Harriman Long patented an all-wood parallel chord truss bridge featuring prestressed diagonal braces with wedges, allowing the truss to remain in compression even as the wood contracted. William Howe, a construction contractor in Massachusetts, patented the Howe truss design in 1840 and established the Howe Bridge Works to construct bridges based on his design. The first Howe truss built was a 75-foot single-lane bridge in Connecticut, followed by a 180-foot railroad bridge over the Connecticut River in Springfield, Massachusetts, in the same year.

One of Howe's employees, Amasa Stone, acquired the rights to Howe's patented design in 1842 for $40,000 ($1,172,533 in 2023 dollars). Teaming up with financial backer Azariah Boody, Stone formed the bridge-building firm of Boody, Stone & Co., which erected numerous Howe truss bridges across New England. Howe continued to refine his design, patenting a second version in 1846.

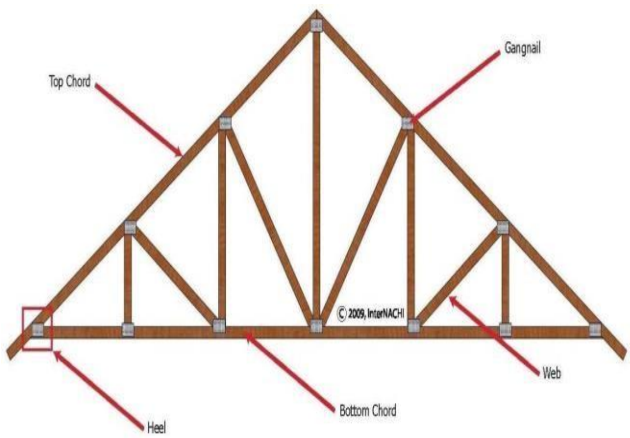


2. Methodology

- **Available Data**

1. **Surface area**- 20M*40M
2. **Type of Truss**- Howe Truss
3. **Span of Truss**- 20M
4. **Type of Roof Covering Sheet Used-** G.I. [Galvanized Iron]

GEOMETRIC OF TRUSS



1.Rise of truss-

Pitch or slope describes the vertical measurement (rise) compared to the horizontal measurement (run). In terms of roof trusses, the pitch should ideally range from 1/4 to 1/6 of its span to ensure proper drainage.

Description	Obtained Value	Clause No.
Pitch*Span = 0.1667*20.	3.33m	IS-875Part3.7.3.1

2.Angle of inclination of the roof(α)

The angle of inclination in a roof truss represents the slope of the roof, formed by the angle between the inclined member (rafter) and the horizontal plane. This angle plays a pivotal role in establishing the pitch of the roof, impacting the design and visual appeal of the structure.

Description	Obtained Value	Clause No.
Tanα = Rise/(L/2) = 3.33/(20/2)	α= 18.42°	_

3.Spacing of Truss

Truss spacing denotes the separation between successive truss structures or members across the span of a building. This spacing is a vital aspect of structural design, influencing load distribution and the overall stability of the roof or floor system. Factors such as the structure's span, the type of truss employed, and load-bearing necessities dictate truss spacing. It's typically determined by a structural engineer, who assesses these factors to establish the optimal spacing for the structure.

Description	Obtained Value	Clause No.
Span of truss/4=20/4	5m	-

4.Slopping Length

The sloping length of a roof truss represents the diagonal measurement along one of the sloping members (rafters) from the bottom chord to the peak or ridge of the roof. This dimension holds importance in structural calculations, aiding in the determination of forces and stresses on the truss members. The sloping length is influenced by factors such as the roof pitch and span, and it contributes to the design of a structurally robust and stable roof system.

Description	Obtained Value	Clause No.
$[Rise^2+(L/22)^2]$ ^ $(1/2)=[3.33^2+(20/2)^2]$ ^ (1/2)	10.54m	IS-875 Part-3

5.Spacing of Purlin

Purlin spacing in a roof structure pertains to the gap between successive horizontal members responsible for supporting the roof covering and transmitting loads to the primary structure. Typically oriented perpendicular to the roof trusses or rafters, purlins' spacing is contingent on factors including the roofing material type, design loads, and roof span. Correct spacing is vital to evenly distribute loads and uphold the roof's structural integrity. To ascertain the suitable purlin spacing for your project, seek guidance from a structural engineer or adhere to local building codes.

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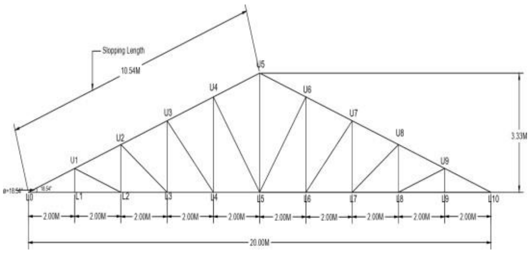
Description	Obtained Value	Clause No.
Slopping length/(no. of panel paints on one side-1) = 10.54/(51)	2.635m	–

6 .No. of Purlins

The determination of the number of purlins in a roof truss system is contingent upon various factors specific to the design and needs of the structure.

Description	Obtained Value	Clause No.
2*(Slopping length spacing of purlins)+1 = 2*(10.54/2.635) +1	9 Nos.	–

From the Above Criteria the structure of truss is obtained as belows



LOAD CALCULATIONS [On Purlin]

Dead Load calculations[For Purlins]

1. Self Weight of Roofing Sheet

The weight of a roofing sheet is influenced by its material and thickness, which commonly include steel, aluminum, or polycarbonate. For precise specifications, it's essential to consult the manufacturer's data sheets, as the weight can vary depending on sheet dimensions and design.

Description	Obtained Value	Clause No.
As per IS specifications the self weight of roofing sheet should be 100N/m to150N/m	130N/m	IS-875 Part-1

Total weight of roofing sheet

Description	Obtained Value	Clause No.
Self wt.of sheet* No.of sides sides of truss*slopping length*spacing of truss	130*2* 10.54*5 =13.70 2 KN	IS-875 Part-3

2. Self Weight of Purlin

The self-weight of purlins is determined by several factors, including the material type (such as steel or aluminum), section dimensions (height, width, and thickness), length of the purlins, and the specific profile design. For accurate information regarding the self-weight of purlins, it is advisable to consult the manufacturer's technical specifications.

Description	Obtained Value	Clause No.
Self wt. of/M *No. of Purlins*Spacing of Purlin	9*5*100=4. 5 KN	IS-875 Part-3

3. Total Dead Load On Purlin

Description	Obtained Value	Clause No.
[Self wt. of sheet+self wt. of purlin] * Spacing of Purlin	[13.702+ 4.5] *2.635	IS-875 Part-3

Live Load calculations

Live Load on Purlin

As per IS 875 Part-2, the live load on purlin for roofing angle more than 10° is

Description	Obtained Value	Clause No.
750-20[α-10] = 75020[18.20°10]	581.6N/ mm²=0.5 82KN	IS-875 Part-3

Total Live Load On Purlin

Description	Obtained Value	Clause No.
L.L on Purlin * Spacing On Purlin	581.6*2.635 =1532. 52KN	IS-875 Part-3

Wind Load calculations

1. Basic Wind Speed Of the Location(V1) [Nashik]= 39 m/s [As per IS 875 Part-3]
2. Design wind Speed(V2)=K1[Risk coefficient]=1.0 [As per IS 875 Part-3 Table 1]

K2[Terrain height and structure size factor]= 0.98 [As per IS 875 Part-3]

K3[Topography Factor] Up Wind Slope is 3°=1 [As per IS 875 Part-3 Clause No.5.3.2.1]

Design Wind speed (Vz) is

Description	Obtained Value	Clause No.
K1* K2* K3*V1 = Vz	1*0.98 *1*39 = 38.22 N/m	IS-375 Part-3

Design Wind pressure (Pz)

Description	Obtained Value	Clause No.
0.6* Vz²= 0.6* 38.22²	876.64 N/m	IS-375 Part-3

External Wind pressure

Description	Obtained Value	Clause No.
(Cpe)	-0.72	IS375Part-3 Table-5

Internal Wind pressure

Description	Obtained Value	Clause No.
(Cpi)	+0.52	IS375 Part-3 Table -5

Hence, Wind pressure difference

(Cpe)-(Cpi)= -0.72+0.52 = -0.22

Wind pressure On Roof (f)

Description	Obtained Value	Clause No.
(Cpe)-(Cpi)* Pz *A	-0.22*876.66*2.635	IS-375 Part-3

Total Wind Load

Description	Obtained Value	Clause No.
Pz*Spacing oftruss*No. Of side of truss	876.66*5*2=8766.4N =8.77KN	IS-375 Part-3

LOAD CALCULATION [ON ROOF TRUSS]

1 . Dead Load Calculation

Self weight of truss

Description	Obtained Value	Clause No.
[L/3 +5]*10 * span of truss*Spacing of truss	[20/3 +5]*20*5=11.67 KN	IS-375 Part-3

Total Dead Load on truss

Description	Obtained Value	Clause No.
Wt.ofsheet+load of purlin+self wt.of truss	13.702+47.96+11.67=73.33KN	IS-375 Part-3

Live Load Calculations

Description	Obtained Value	Clause No.
2/3*L.L on purlin*spacing of truss*span of truss	581.6*5*20=38.77KN	IS-375 Part-3

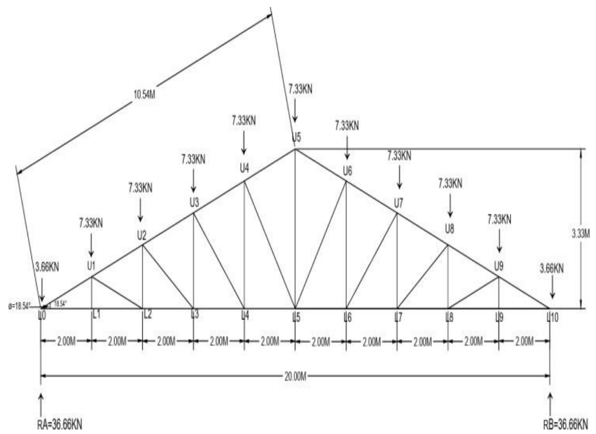
Wind Load Calculations

Descriptions	Obtained Value	Clause No.
Design wind pressure* slopping length*spacing of truss* no.side of truss	876.66*10.54*5*2=92.40KN	IS-375 Part-3

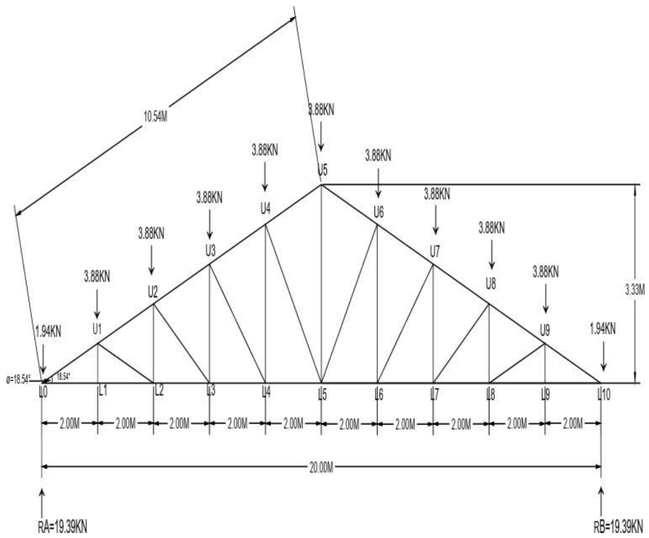
Panel Point Load

1. D.L= D.L/ No.of panals =73.33/10 = 7.33KN
2. L.L = L.L/ No.of panals =38.77/10 = 3.88KN
3. W.L = W.L/ No.of Panals =92.40/10= 9.24KN

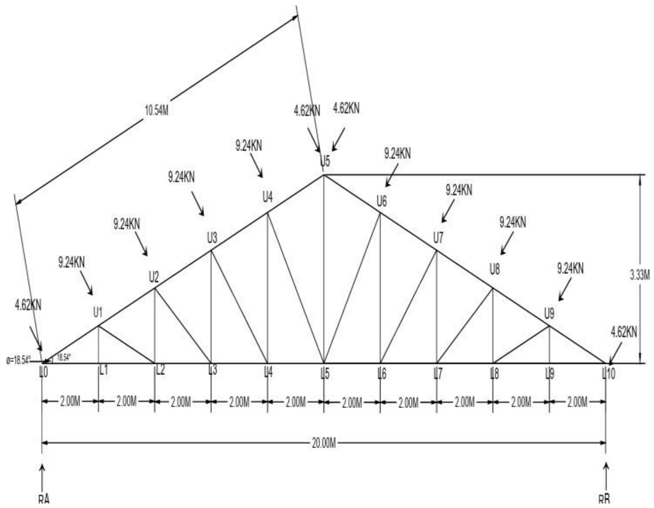
Load Distribution On Truss[Dead Load]



Load Distribution On Truss[Live Load]



Load Distribution On Truss[Wind Load]



3. CONCLUSIONS

 Constructing a Howe truss for an industrial shed using angle sections requires less steel compared to constructing the truss with I-sections. Therefore, an angle section Howe truss is considered more economical.

Sr. No	Member	Section Size	Weight(N/m)
1	Principle Rafter	ISA200X200X12	359.00
2	Vertical Strut	ISA150X150X10	223.7
3	Purlin	ISJC100	56.9

4. REFERENCES

1. SP38(S&T)-1987-Handbook of typified designs of structures with steel roof trusses (with or without cranes) based on IS Codes (1987).
2. IS 875(Part I) – 1987: Dead Loads. IS Code of Practice of design loads (except than earthquake) for all buildings and structures.
3. IS 875(Part II) – 1987: Code of Practice for Calculation for the Live Loads. IS Code of Practice for design loads (other than earthquake) for all buildings and structures.
4. IS 875(Part III) – 1987: Wind Loads. Code of practice for design loads (other than earthquake) of the buildings and structures.
5. IS 800:2007 Code of Practice (Third Revision) for General Construction in Steel.
6. Duggal S. K. (1993) Design of steel structures, Tata McGraw Hill Publications: Chapter 14: Roof trusses.
7. Design of steel structure by S. Ramamrutham.
8. Rakesh R. Nora, Umarfarukh D. Masud and Maske Ravi (Oct-2015), “Comparison between Conventional (Angular) Steel Section and Tubular Steel Section”, International Journal of Engineering Research, Volume 4, Issue 10, PP. 539-541.
9. Jyoti P. Sawant and Prof. Vinayak Vijapur (Aug 2013), “Analysis and Design of Tubular and Angular Steel Trusses By Post-Tensioning Method”, Journal of Engineering, Computers & Applied Sciences, Volume 2, Issue 8, PP. 30-44.
10. Code of practice for use of steel tubes for buildings and structures IS 806:1968.