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Short Communication

Comparison of Design of Steel Roof Truss using IS 875 and SP 38

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Abstract

In this paper, the steel roof truss having 12 m span has been analyzed with design of tubular sections of truss members. The analysis presents comparison for weight of tubular member sections, with the help of which, comparative study has been done between design of truss as per revised provisions of wind load calculations given in IS 875 (Part 3):1987 and designs obtained as per calculations made in SP 38(S&T):1987; Handbook for typified designs for structures with steel roof trusses. Indian Standard Code IS: 875(Part 3)-1987 includes consideration for different conditions of class of structure, topography factor, enlarged provisions of permeability conditions, Terrain, height & structure size factor and various wind zones. These provisions of wind load calculations are different from the considerations used in SP 38(S&T):1987.Because of which, there are considerable variations in design of truss. Hence comparative analysis of design of steel roof truss is needed.

Keywords: Terrain, topography, permeability condition, typified designs.

Introduction

A standard truss is a series of triangles - a stable geometric shape that is difficult to distort under loads. Regardless of its overall size and shape, all the chords and webs of a truss form triangles. These triangles combine to distribute the load across each of the other members, resulting in a light structure that is stronger than the sum of the strength of its individual components.

Trusses are provided to support roof covering. The weight of roof covering through purlins is transferred at joints along the rafters. These joint loads cause axial forces – tensile or compressive – in all the members of a truss since all the joints of a truss are assumed to be hinged. Finally all loads including self-weight are transferred to the supports through the joints at supports. The trusses may be constructed of wood or of steel. Wooden trusses may be used for smaller moderate span; whereas steel trusses may be provided for smaller to larger spans as steel is stronger than wood. Trussed roof covering is economical proposition for warehouses, assembly halls, hangers, etc. Steel trusses are economical, lighter in weight, more durable, more fire-resistant and easier to fabricate.

Truss Configuration used – A configuration which is compound of (a) Fink or fink fan, (b) N-truss has been used and A-type truss has been analyzed.

The analysis of A-type truss has been done as simply supported on columns on the basis of relevant Indian Standards for the following different parameters:

Span length of A-type trusses (metres) = 12, Spacing between trusses (metres) = 6.0, Roof slope=1 in 3, Column height = 9(metres), Wind zone = III, Permeability = Large, Classes of structure = A, B, C and Terrain category = 1 and 2

They studied to optimize the roof trusses under loads specified according to current Turkish code, TS 498 and to show the differences between the optimum designs of roof trusses[1]. The spatial trusses using hollow section steel are introduced at the roof structures of hall in Ningbo International Conference Exhibition Center. Built up columns that consist of four steel pipes, batten beams and diagonal cable bracings are arranged at the interior of the exhibition halls to reduce span of the roof structures so that it can have much lower material cost compared to without interior columns[2].They have done the optimization of steel roof truss calculating design forces for members of truss considering various permeability conditions[3]. They analysed steel roof truss for large permeability condition comparing design forces[4].

Methodology

Wind load calculations according to IS: 875(Part 3)-1987[5].

Design Wind Speed (Vz): Design Wind Speed can be expressed as follows:
$V_Z = V_b.K_1.K_2.K_3$

Where, Vz = design wind speed at any height z in m/s, V_b=basic wind speed in m/s, K_1= probability factor (risk coefficient) given in Table 1 of IS: 875(Part 3)-1987, K_2= terrain, height and structure size factor and K_3= topography factor.

Design Wind Pressure (Pz): The design wind pressure can be expressed as follows: $Pz = 0.6\ V_z^2$
Where, Pz = design wind pressure in N/m^2 at height z, Vz = design wind velocity in m/s at height z.

Wind Pressures and Forces on Buildings/Structures: The wind load, F, acting in a direction normal to the individual structural element or cladding unit is: $F = (C_{pe} – C_{pi}).A.P_z$

Where, C_{pe} = external pressure coefficient, C_{pi} = internal pressure coefficient, Pz = design wind pressure, A = surface area of structural element or cladding unit.

Design Problem: Plan area = 12.0 m X 42.0 m, Roof truss span = 12.0 m, Roof slope=1 in 3, Height of column = 9.0 m, Basic wind speed = 47 m/s, Type of roofing = A.C. Sheeting, Location of shed = Delhi, Type of truss = A-type, Permeability = Large

Results and Discussion

Analysis of Truss: Criteria for Wind Load Calculations Given in SP: 38-1987[6, 7]: Basic parameters for the analysis are:
Basic wind pressure = 1.5kN/ m^2,
Weight of roofing materials = 0.17kN/sq-m (including extra weight due to overlaps and fasteners),
Governing wind pressure for design with large permeability = (0.6 + 0.5) x 1.5 = 1.65kN/ m^2,
Miscellaneous loads = 0.035kN/ m^2, Live load = 75-2x (18.435^0 – 10^0) = 0.58kN/m^2

Wind Load Criteria According to IS: 875(Part 3)-1987[5]
Wind Load = $(C_{pe}-C_{pi}).A.P_z$,
Risk coefficients (K_1) = Topography factor (K_3) = 1.0
Basic wind speed (m/s) Vb = 47 (For Delhi),
Area = 6*6.32*2,
Total wind load = $(C_{pe}-C_{pi}).A.P_z$
Wind Load on one panel point = $\{(C_{pe}-C_{pi}).A.\ P_z\}/10$; no. of panels = 10
For Large permeability, $(C_{pe}-C_{pi})$ = 1.5

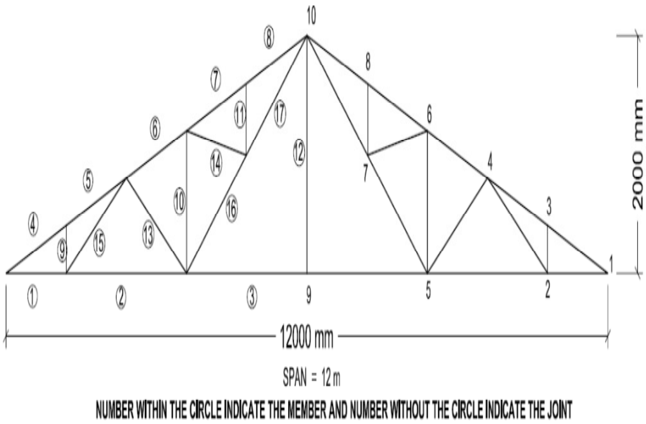

Figure-1
A shaped steel roof truss

Table-1
A type Steel Roof Truss (Large permeability, terrain category 1)

Steel A-Type Roof Trusses (Tube Section , 12 m)						
Span=12 m		**Slope=1 in 3**		**Permeability=Large**		
Members	**Nos.**	**Length(m)**	**As per SP:38**	**As per IS:875 for Terrain Category-1**		
				Class of structure		
				A	**B**	**C**
TIE	1	1.2	80L	80H	90L	80M
TIE	2	2.4	80L	80H	90L	80M
TIE	3	2.4	80L	80H	90L	80M
RAFTER	4	1.27	65L	80M	65H	65M
RAFTER	5	1.27	65L	80M	65H	65M
RAFTER	6	1.27	65L	80M	65H	65M
RAFTER	7	1.27	65L	80M	65H	65M
RAFTER	8	1.27	65L	80M	65H	65M
WEB	9	0.4	20M	25L	25L	25H
WEB	10	1.2	20M	25L	25L	25H
WEB	11	0.6	20M	25L	25L	25H
WEB	12	2	20M	25L	25L	25H
WEB	13	1.44	25L	32M	32L	32L
WEB	14	1.22	20M	25L	25L	25H
WEB	15	1.44	25L	32M	32L	32L
WEB	16	1.56	50L1	65L	65L	50M
WEB	17	1.56	50L1	65L	65L	50M
Total sum of Tubes Weight(N)			1978.744	2938.82	2692.73	2358.07
Difference in weight(N) w.r.t. SP:38				-960.076	-713.986	-379.326

Table-2
A type Steel Roof Truss (Large permeability, terrain category 2)

Steel A-Type Roof Trusses (Tube Section ,12m span)						
Span=12 m		**Slope=1 in 3**		**Permeability=Large**		
Members	**Nos.**	**Length(m)**	**As per SP:38**	**As per IS:875 for Terrain Category-2**		
				Class of structure		
				A	**B**	**C**
TIE	1	1.2	80L	80M	90L	80L
TIE	2	2.4	80L	80M	90L	80L
TIE	3	2.4	80L	80M	90L	80L
RAFTER	4	1.27	65L	65H	80L	80L
RAFTER	5	1.27	65L	65H	80L	80L
RAFTER	6	1.27	65L	65H	80L	80L
RAFTER	7	1.27	65L	65H	80L	80L
RAFTER	8	1.27	65L	65H	80L	80L
WEB	9	0.4	20M	25L	20H	20M
WEB	10	1.2	20M	25L	20H	20M
WEB	11	0.6	20M	25L	20H	20M
WEB	12	2	20M	25L	20H	20M
WEB	13	1.44	25L	32L	32L	32L
WEB	14	1.22	20M	25L	20H	20M
WEB	15	1.44	25L	32L	32L	32L
WEB	16	1.56	50L1	50M	50M	50L1
WEB	17	1.56	50L1	50M	50M	50L1
Total sum of Tubes Weight(N)			1978.744	2543.54	2436.73	2137.42
Difference in weight(N) w.r.t. SP:38				-564.796	-457.986	-158.676

Conclusion

This can be observed from Table 1 and 2 that the weight of designed tubular sections obtained as per IS 875:1987 are greater than that of obtained as per calculations made in SP 38:1987in case of terrain category 1 and 2 for large permeability condition. .Above result shows large variations in design of sections of truss members due to difference of considerations of wind load calculations in SP 38 andIS 875. Methodology of analysis given in SP38:1987 should be reviewed and various criteria of wind load calculations given in IS 875:1987 (such class of structure, risk coefficient, terrain conditions, topography factor and permeability conditions) should be incorporated.

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