Analysis of Steel Roof A-Type Truss for Four Different Spans (Comparison of Design Presented in SP38 and IS875)

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Abstract- In a developing country like INDIA the annual expenditure on construction of industrial building is very high. In almost every industrial building like light engineering industries, warehouses, workshops, and storage sheds the key element is roof truss. To achieve a mass production and economy under a project B-8 Indian government standardized some parameters of steel truss on broad norms. In this paper the comparative study is carried out on four different spans of A-type truss given in SP 38(S&T):1987; Handbook for typified designs for structures with steel roof trusses. A detailed comparative study is carried out on a 9m span truss by using Indian standard code IS 875(Part 3):1987 and SP38:1987. In IS 875 (Part 3):1987 the intensity of wind load is calculated considering different conditions of class of structure, terrain, height and structure size factor, topography factor and permeability conditions. Therefore the comparative study is carried out with the help of commercial software ANSYS 11.0.

Keywords – Industrial building, Structure size factor, Permeability condition, IS 875(part 3):1987, SP(S & T):1987

I. INTRODUCTION

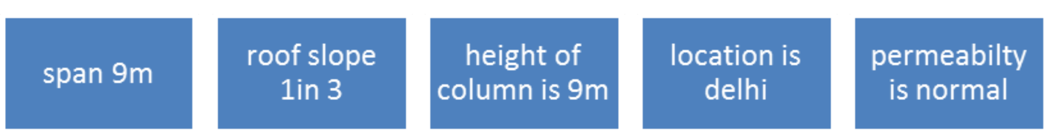
Trusses are triangular frame works, consisting of essentially axially loaded member which are more efficient in resisting external loads since the cross section is nearly uniformly stressed. These are extensively used, especially to span large gaps like in industrial buildings. The A-type truss is configuration achieved from a combination fink and N-type truss. The steel truss has been designed as simply supported on columns.

The following parameters used in SP38:1987 and the member forces calculated and compared with the calculations as per IS: 875 (part 3). Spans of truss taken are 9m, 18m, 24m, and 30m. The spacing and roof slope is taken as constant 6m and 1 in 3 respectively. The detailed calculations are carried out on 9m span truss for Terrain category 1 and three different classes of structures. The permeability condition of a roof is taken for a worst possible internal and external pressure coefficient by considering solidity ration.

Wind load calculations according to IS 875 (part 3): 1987 are considered different topography factor, risk coefficients, terrain and height coefficient and different permeability coefficients. The design wind speed is calculated as Vz = Vb.K1.K2.K3

The Vb is basic wind speed and Vz is design wind speed at any height z. The k1, k2, k3 are the risk coefficient, terrain factor and topography factor respectively. The basic wind speed is worked out for 50 year mean return period. The design wind pressure is obtained from design wind speed as $Pz = 0.6\ Vz^2$. The wind force on any surface depends on its cladding unit and pressure coefficients. The wind force acting on a surface normal to the direction is obtained by the relation F = (Cpe - Cpi) × A × Pz.

The analysis is carried out in ANSYS 11.0 software which is based on finite element method. The detailed analysis is carried out on a 9m span truss for following parameters.



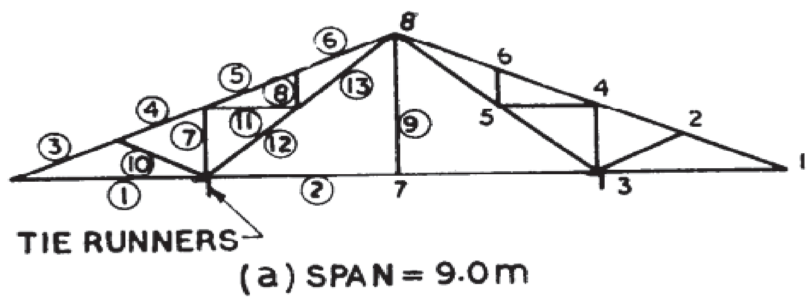


Fig1. A-type truss of span 9m

II. SYSTEM ARCHITECHTURE

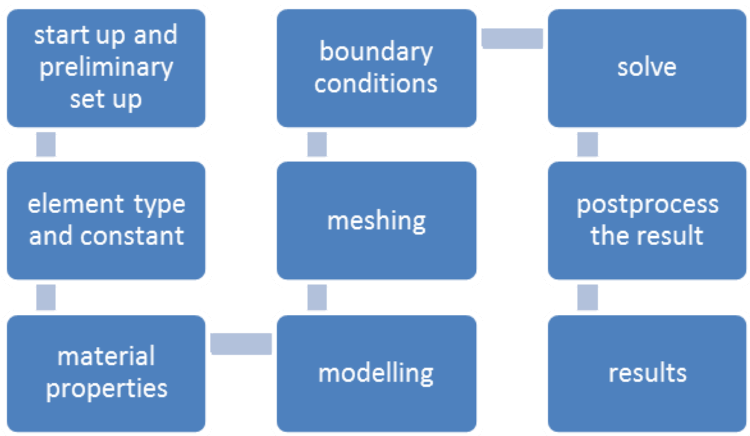


Fig2. System Development of proposed System in ANSYS 11.0

The element used in ANSYS 11.0 is LINK1 which have two degrees of freedom. The wind load calculation for 9m span truss as per IS: 875 (Part 3) – 1987 are as follows

- Wind load = (Cpe - Cpi) × A × Pz
- Risk coefficient (K1) = Topography factor = 1
- Basic wind speed = 47m/s , Area = 6 × 4.74 × 2
- Wind load on one panel point = {(Cpe-Cpi) ×A × Pz}/8 ; Number of panels = 8.

The analysis is carried out by modeling a steel truss in ANSYS 11.0. The DL+WL are resolved in two components along x-axis and y-axis as W and H and it is taken as 75% of the value. As per IS 875:1987 33% allowance is made for wind load combination.

For category 1 and class of structure value of vertical and horizontal components are calculated as per above procedure as W = 0.75(2.8 – 10.38 Cos (18.44)) = 5280N

And H= 0.75 (10.38 Sin (18.44)) = 2370N

The contour plot of obtained member forces is shown in figure. It shows the maximum and minimum force member. The calculated forces are compared to that with member forces obtained from SP38(S&T) and tabulated in Table 1.for three different class of structure.

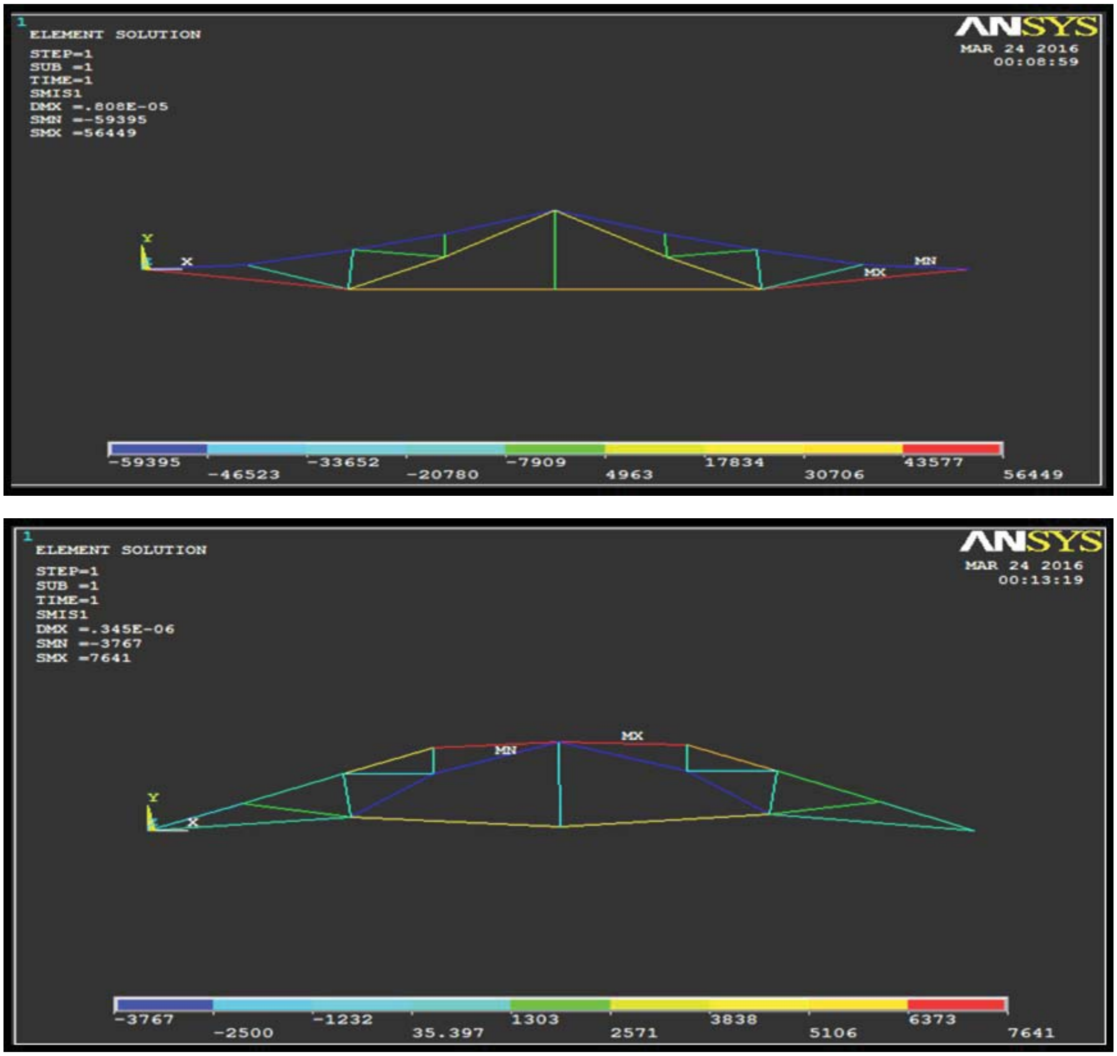


Fig3. Contour plot of Element solution for a load component W and H

The same procedure mentioned in system development is carried out on a 18m , 24m and 30m span A-type steel truss keeping all the parameters same. The maximum percentage variation of member forces is shown in figure 4. The results show from a table 1 that there is a considerable amount of difference in member forces and it is due to the variation of wind load considerations in IS875 and SP38.

IV.RESULT

Table no 1. Percentage of variation of member forces for a 9m span steel truss

M. no	D.L. + L.L. as per SP 38 (KN)		(D.L. + L.L.) as per IS875 Part 3 for Terrain category 1 (KN) Class of Structure			percentage variation in design forces as compared to SP 38		
			A	B	C	Class of Structure		
		W	-5.28	-5	-4.48			
		H	2.46	2.37	2.19	A	B	C
1	-41.09		-56.59	-53.61	-48.04	37.72	30.46	16.91

2	-21.11		-35.47	-30.96	-30.27	68.02	46.66	43.39
3	44.48		59.6	56.44	55.82	33.39	26.88	25.49
4	39.89		49.3	46.68	37.02	23.58	17.02	-7.19
5	47.3		49.43	46.73	41.8	4.51	-1.21	-11.62
6	48.48		46.88	43.33	38.66	-3.31	-10.62	-20.25
7	7.04		7.07	6.59	5.78	0.42	-6.34	-17.89
8	3.42		1.47	1.39	0.49	-57.05	-59.65	-85.67
9	0		0	0	0	0	0	0
10	6.56		7.75	7.33	6.53	18.14	11.73	-0.45
11	-4.85		-2.1	-1.98	-1.75	-56.7	-59.73	-63.49
12	-16.45		-16.51	-8.59	-19.13	0.36	-47.89	16.29
13	-21.85		-18.98	-17.9	-22.66	-13.13	-18.28	3.71

Table no 1 show the percentage variation of member forces for a 9m span steel truss for three different class of structure of category 1. Negative sign indicates compression and positive sign indicates tension in member. Similar procedure is carried out for 18m, 24m and 30m span for terrain category 1 and class A type structure. The maximum percentage variation in any member of these trusses are compared and given in figure 4. The maximum calculated percentage variation of member force is increases with increase in span of steel truss. but the location of that member is constant.

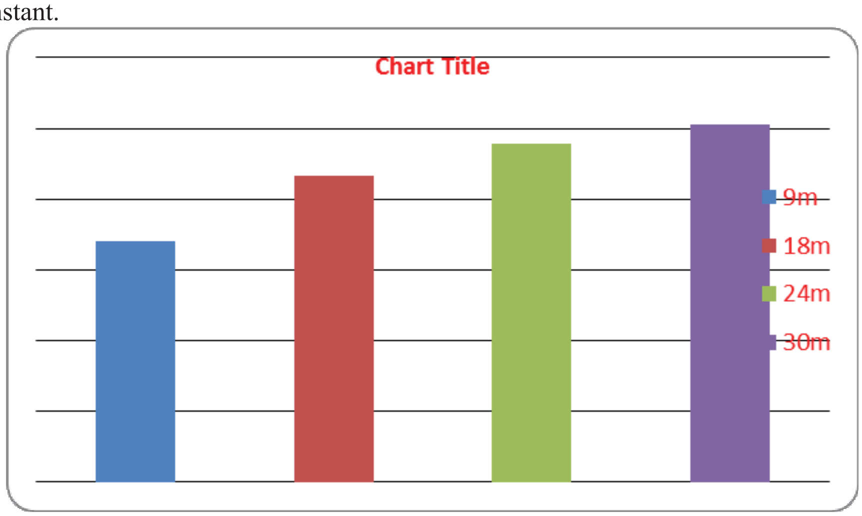


Fig4 Chart of percentage variation of member forces for different span of truss

V.CONCLUSION

The result show that calculated member forces are different from the calculations made in SP (S & T):38-1987. There is increase in member forces of tension members but there are slightly decrease in member forces of compression member. Hence it can be concluded that the calculations made in SP 38 cannot be directly applied without considering the class of structure, topology, terrain factor, risk coefficient and permeability mentioned in IS:875-1987. The maximum available percentage variation of member force is found in second member in each span. The chart clearly shows as the span increases the percentage variation of member forces also increase but the location of that member is constant.

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