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Analysis Different Roof Trusses Under Wind Load

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ABSTRACT

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. Trusses are used in roofs of single storey industrial buildings and multi storey industrial buildings. The loads on the roof truss are dead load, live load, wind load and earthquake load. Trusses are also used to support long span floors of multi storey building to resist gravity load. The axial forces in members are calculated by taking these loadings and their critical combinations. For design of trusses, effect of wind force is predominant to calculate the member forces. SP 38(S&T):1987-provides designing for structures with steel roof trusses and their weight comparison. It gives details of specific roof truss configuration. This Paper represents analysis and design of roof trusses whose configuration are other than that specified in SP 38(S&T):1987. However their span to depth ratio is same as the truss configuration given in SP 38(S&T):1987. The trusses which has been analysed having span 12m, 18m and 24 m and angle section has been used for design purpose. The analysis has been done for three basic wind pressure 100 kg/m2, 150 kg/m2 and 200 kg/m2, So that we can compare the weight of these trusses with A-type roof truss of having same span which is specified in SP 38(S&T):1987.The purpose of this study is to suggest the most feasible truss section, when longer span roof sheets are used. Now a days roof sheets of longer span are available in market. So we can use the configuration which have less number of purlins or wider panel

1. INTRODUCTION

1.1 General

Wind effect should be considered for both tall, slender structures as well as Low risestructures. And coming into material point of view steel structures which are very light arehighly susceptible to wind compared to the heavy massive reinforced concrete structures. The components like cladding units, walls window panels etc., are also affected by wind. Firstly wind load should be assessed properly. For resisting these wind loads on steel structures various arrangements are done like providing proper openings to flow wind freely (permeability) and providing good system of bracings which will work for the lateral loads coming into picture. And claddings should be properly connected with the purloins which if failed causes adverse effects on the structure.

1.2 Roof truss

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. Trusses are extensively used, especially to span large gaps. These are used in roofs of single storey industrial buildings, long span floors and roofs of multi storey buildings, to resist gravity loads. Trusses finds a substantial use in modern construction, for instance as towers, bridges, scaffolding, industrial buildings. Trusses are used to span long lengths in the place of solid web girders and they are light weight as compared any other system. Generally truss members are assumed to be joined together so as to transfer only the axial forces and not moments and shears from one member to the adjacent members. The joints of trusses are assumed to be pinned. Trusses are made up of different materials and different shapes. The loads on the truss are dead load, live load, wind load and earthquake load. The axial forces in members are calculated by taking different types of loading and their critical combination. In India the load should be taken as per IS875:1987. The complexity of truss starts from the selection of truss. There are various types of truss configuration; choice of truss depends upon many factors like purpose of that structure, atmospheric conditions, loading etc. The truss configurations distinguish between three categories namely Pitched roof trusses, Parallel chord trusses and Trapezoidal trusses.

1.3 Objectives of study

Load in the truss members are to be determined for different configuration which is not specified in SP 38 and their comparative study. The purpose of this study is to suggest the most feasible truss section when longer span roof sheets are used. Now a day's roof sheets of longer span are available in market. So that we can use the configuration which have less number of purloins or wider panel. The section designed in SP 38 follows the provisions of IS 800:1984.So we can design the same section using the provisions of IS 800:2007 and compare the section.

2. DESIGN COMPARISON OF DIFFERENT TRUSCONFIGURATION

Analysis and design of three types of roof truss configuration has been done which are not given in SP 38. The analysis has been done for three basic wind pressure 100 kg/m^2,150kg/m^2 and 200 kg/m^2 The purpose of analysis is to find out the section which is less in weight and are frequently in use.

Table 1 Design forces and section of member for wind pressure100 kg/m2 for Fan truss

Member Number	Length of Member (m)	Force in the Member for DL+LL (KN)	Wind Load (KN)	Member section	Weight of section per metre (kg)	Weight of member (kg)
		W=8.78	W= 3.89			
		H=0	H=2.35			
1	4.00	76.87	-63.43	2 ISA 65×65×6	11.60	46.40
2	4.00	46.47	-34.13	2 ISA 65×65×6	11.60	26.40
3	2.11	-80.74	68.68	2 ISA 65×65×6	12.60	26.59
4	2.11	-65.71	56.00	2 ISA 65×65×6	12.60	26.59
5	2.11	-65.78	56.28	2 ISA 65×65×6	12.60	26.59
6	2.11	-23.7	15.92	ISA 65×65×6	5.80	12.24
7	1.33	0.49	10.12	ISA 40×40×6	3.50	4.66
8	2.83	5.72	-20.2	ISA 60×60×6	5.40	15.28
					Total Weight of truss	363.08

Table 4.3 shows member forces and designed section of Fan truss for wind pressure 00 kg/m^2.The member forces from the analysis are given in column 3 and 4. In column 3member forces due to dead load and live load are shown and in column 4 forces in the member due to wind load is given. W is vertical component and H is the horizontal component of the load. (-)ve sign shows the compressive force in the member.

Wind load is suction in nature from calculation and acting upward.

Table 2 Design forces and section of member or wind pressure100 kg/m2 for compound fink truss

Member Number	Length of Member (m)	Force in the Member for DL+LL (KN)	Wind load(KN)	Member section	Weight of section per metre (kg)	Weight of member (kg)
		W=8.78	W= 9.40			
		H=0	H=3.13			
1	2.00	82.07	-67.41	2 ISA 50×50×6	9.00	18.00
2	2.00	70.36	-56.3	2 ISA 50×50×6	9.00	18.00
3	2.00	46.97	-34.45	2 ISA 50×50×6	9.00	18.00
4	1.58	-86.5	72.29	2 ISA 60×60×6	10.80	17.06
5	1.58	-80.82	68.76	2 ISA 60×60×6	10.80	17.06
6	1.58	-74.44	65.67	2 ISA 60×60×6	10.80	17.06
7	1.58	-68.67	62.12	2 ISA 60×60×6	10.80	17.06
8	0.71	-7.46	8.07	ISA 40×40×6	3.50	2.49
9	1.41	-16.03	15.77	ISA 50×50×6	3.50	4.94
10	0.71	-7.65	8.07	ISA 40×40×6	3.50	2.49
11	1.41	8.53	-7.64	ISA 40×40×6	3.50	4.94
12	2.00	11.1	-11.28	ISA 40×40×6	3.50	7.00
13	1.41	17.41	-15.1	ISA 40×40×6	3.50	4.94
14	1.41	25.41	-22.99	ISA 40×40×6	3.50	4.94
					Total Weight of truss	289.29

In the member due to wind load is given. W is vertical component and H is the horizontal component of the load. (-)ve sign

shows the compressive force in the member. Wind load is suction in nature from calculation and acting upward. The section is designed for these forces and the weight of the section is calculated. Total weight of compound fink truss for 100 kg/m2 is 289.29 kg.

Table 4.5 shows member forces and designed section of Pratt roof truss for wind pressure 150 kg/m2 .The member forces from the analysis are given in column 3 and 4. In column 3 member forces due to dead load and live load are shown and in column 4 forces in the member due to wind load is given. W is vertical component and H is the horizontal component of the load. (-) ve signshows the compressive force in the member. Wind load is suction in nature from calculation and acting upward. The section is designed for these forces and the weight of the section is calculated

Table 3 Design forces and section of member for wind pressure150 kg/m2 for Pratt truss.

Member Number	Length of Member (m)	Force in the Member for DL+LL (KN)	Wind Load (KN)	Member section	Weight of section per metre (kg)	Weight of member (kg)
		W=8.78	W= 14.14			
		H=0	H=4.70			
1	2.00	76.87	-97.89	2 ISA 50×50×6	9	18.00
2	2.00	76.87	-97.89	2 ISA 50×50×6	9	18.00
3	2.00	61.81	-75.32	2 ISA 50×50×6	9	18.00
4	2.11	-81.12	105.66	2 ISA 75×75×6	13.6	28.70
5	2.11	-65.28	86.83	2 ISA 75×75×6	13.6	28.70
6	2.11	-23.7	86.16	2 ISA 75×75×6	13.6	28.70
7	0.67	0.49	0.23	ISA 50×50×6	4.5	3.02
8	1.33	5.72	-7.19	ISA 50×50×6	4.5	5.99
9	2.00	21.54	-29.79	ISA 50×50×6	4.5	9.00
10	2.11	-15.81	23.79	ISA 75×75×6	6.8	14.35
11	2.40	-18.4	26.94	2 ISA 50×50×6	9	21.60
					Total Weight of truss	379.07

Table 4 Design forces and section of member for wind pressure 150 kg/m2 for Fan truss

Member Number	Length of Member (m)	Force in the Member for DL+LL (KN)	Wind Load (KN)	Member section	Weight of section per metre (kg)	Weight of member (kg)
		W=8.78	W= 7.41			
		H=0	H=4.70			
1	4.00	76.76	-98.08	2 ISA 50×50×6	14.60	58.40
2	4.00	46.47	-52.92	2 ISA 50×50×6	14.60	58.40
3	2.11	-80.74	105.08	2 ISA 50×50×6	13.60	28.70
4	2.11	-65.71	86.56	2 ISA 75×75×6	13.60	28.70
5	2.11	-65.78	91.50	2 ISA 75×75×6	13.60	28.70
6	2.11	-15.04	24.18	2 ISA 75×75×6	6.80	14.35
7	1.33	-9.40	15.34	ISA 50×50×6	4.00	5.32
8	2.83	22.45	-31.29	ISA 50×50×6	6.30	17.83
					Total Weight of truss	422.37

Table 4.6 shows member forces and designed section of Fan truss for wind pressure 150 kg/m2.The member forces from the analysis are given in column 3 and 4. In column 3member forces due to dead load and live load are shown and in column 4 forces in themember due to wind load is given. W is vertical component and H is the horizontalcomponent of the load. (-)ve sign shows the compressive force in the member. Wind loadis suction in nature from

calculation and acting upward. The section is designed for theseforces and the weight of the section is calculated. Total weight of Fan truss for 150 kg/m2is 422.37 k

Table 5 Design forces and section of member for wind pressure150 kg/m2 for compound fink truss

Member Number	Length of Member (m)	Force in the Member for DL+LL (KN)	Wind load(KN)	Member section	Weight of section per metre (kg)	Weight of member (kg)
		W=8.78	W= 10.59			
		H=0	H=3.53			
1	2.00	82.07	-103.99	2 ISA 65×65×6	11.60	23.20
2	2.00	70.36	-86.98	2 ISA 65×65×6	11.60	23.20
3	2.00	46.97	-53.43	2 ISA 65×65×6	11.60	23.20
4	1.58	-86.5	111.48	2 ISA 70×70×6	12.60	19.91
5	1.58	-80.82	106.07	2 ISA 70×70×6	12.60	19.91
6	1.58	-74.44	101.12	2 ISA 70×70×6	12.60	19.91
7	1.58	-68.67	95.71	2 ISA 70×70×6	12.60	19.91
8	0.71	-7.46	12.24	ISA 40×40×6	3.50	2.49
9	1.41	-16.03	24.12	ISA 55×55×6	4.90	6.91
10	0.71	-7.65	-11.81	ISA 40×40×6	3.50	2.49
11	1.41	8.53	-17.18	ISA 40×40×6	3.50	4.94
12	2.00	11.1	-17.18	ISA 40×40×6	4.50	9.00
13	1.41	17.41	-23.44	ISA 40×40×6	4.50	6.35
14	1.41	25.41	-35.51	ISA 40×40×6	4.50	6.35
					Total Weight of truss	352.27

Table 4.7 shows member forces and designed section of compound fink truss for wind pressure 150 kg/m2. The member forces from the analysis are given in column 3 and 4. In column 3 member forces due to dead load and live load are shown and in column 4 forces in the member due to wind load is given is vertical component and H is the horizontal

Component of the load. (-)ve sign shows the compressive force in the member. Wind load issuction in nature from calculation and acting upward. The section is designed for these forces and the weight of the section is calculated. Total weight of compound fink truss for 150 kg/m2 is 352.27 kg.

Table 6 Design forces and section of member for wind pressure 200 kg/m2 for Pratt truss

Member Number	Length of Member (m)	Force in the Member for DL+LL (KN)	Wind Load (KN)	Member Section	Weight of section per metre (kg)	Weight of member (kg)
		W=8.78	W= 14.14			
		H=0	H=4.70			
1	2.00	76.87	-97.89	2 ISA 60×60×6	10.8	21.60
2	2.00	76.87	-97.89	2 ISA 60×60×6	10.8	21.60
3	2.00	61.81	-75.32	2 ISA 60×60×6	10.8	21.60
4	2.11	-81.12	105.66	2 ISA 80×80×6	14.6	30.81
5	2.11	-65.28	86.83	2 ISA 80×80×6	14.6	30.81
6	2.11	-23.7	86.16	2 ISA 80×80×6	14.6	30.81
7	0.67	0.49	0.23	ISA 60×60×6	5.4	3.62
8	1.33	5.72	-7.19	ISA 60×60×6	5.4	7.18
9	2.00	21.54	-29.79	ISA 60×60×6	5.4	10.80
10	2.11	-15.81	23.79	ISA 80×80×6	7.3	15.40
11	2.40	-18.4	26.94	2 ISA 60×60×6	10.8	25.92
					Total Weight of truss	429.28

Table 4.8 shows member forces and designed section of Pratt truss for wind pressure 200 kg/m2 .The member forces from the analysis are given in column 3 and 4. In column 3 member forces due to dead load and live load are shown and in column 4 forces in the member due to wind load is given. W is vertical component and H is the horizontal component of the load. (-)ve sign shows the compressive force in the member. Wind load is suction in nature from calculation and acting upward. The section is designed for these forces and the weight of the section is calculated. Total weight of Pratt truss for 200 kg/m2 is 429.48 kg.

Table 4.9 shows member forces and designed section of Fan truss for wind pressure 200 kg/m2 The Member forces from the analysis are given in column 3 and 4. In column 3 member forces due to dead Load and live load are shown and in column 4 forces in member.

Table 7 Design forces and section of member for wind pressure 200 kg/m2 for Fan truss

Member Number	Length of Member (m)	Force in the Member for DL+LL (KN)	Wind load(KN)	Member section	Weight of section per metre (kg)	Weight of member (kg)
		W=8.78	W= 10.95			
		H=0	H=4.70			
1	4.00	76.76	-132.62	2 ISA 90×90×6	16.40	65.60
2	4.00	46.47	-71.81	2 ISA 90×90×6	16.40	65.60
3	2.11	-80.74	143.12	2 ISA 80×80×6	14.60	30.81
4	2.11	-65.71	117.26	2 ISA 80×80×6	14.60	30.81
5	2.11	-65.78	123.86	2 ISA 80×80×6	14.60	30.81
6	2.11	-15.04	32.47	ISA 80×80×6	7.30	15.40
7	1.33	-9.40	20.58	2 ISA 60×60×6	10.80	14.36
8	2.83	22.45	-42.41	ISA 80×80×6	7.30	20.66
					Total Weight of truss	482.49

due to wind load is given is vertical component and H is the horizontal component of the load. (-) ve sign shows the compressive force in the member. Wind load is suction in nature from calculation and acting upward. The section is designed for these forces and the weight of the section is calculated. Total weight of Fan truss for 200 kg/m2 is 482.49 kg.

Table 4.10 shows member forces and designed section of compound fink truss for wind pressure 200 kg/m2 .The member forces from the analysis are given in column 3 and 4. In column 3 member forces due to dead load and live load are shown and in column 4 forces in the member due to wind load is given. W is vertical component and H is the horizontal component of the load. (-)ve sign shows the compressive force in the member. Wind load is suction in nature from calculation and acting upward. The section is designed for these forces and the weight of the section is calculated. Total weight of compound fink truss for 200 kg/m2 is 392.18 kg. The comparisons of weight of trusses which are analyzed and designed above are given in table below. Weight is given in kg and the basic wind pressure is in kg/m2

Table 8 Design forces and section of member for wind pressure 200 kg/m2 for compound fink truss

Member Number	Length of Member (m)	Force in the Member for DL+LL (KN)	Wind Load (KN)	Member section	Weight of section per metre (kg)	Weight of member (kg)
		W=8.78	W= 14.10			
		H=0	H=4.70			
1	2.00	82.07	-140.36	2 ISA 75×75×6	13.60	27.20
2	2.00	70.36	-117.49	2 ISA 75×75×6	13.60	27.20
3	2.00	46.97	-72.1	2 ISA 75×75×6	13.60	27.20
4	1.58	-86.5	150.44	2 ISA 75×75×6	13.60	21.49
5	1.58	-80.82	143.16	2 ISA 75×75×6	13.60	21.49
6	1.58	-74.44	136.36	2 ISA 75×75×6	13.60	21.49
7	1.58	-68.67	129.1	2 ISA 75×75×6	13.60	21.49
8	0.71	-7.46	16.39	ISA 40×40×6	3.50	2.49
9	1.41	-16.03	32.42	ISA 60×60×6	5.40	7.61
10	0.71	-7.65	16.39	ISA 40×40×6	3.50	2.49
11	1.41	8.53	-15.96	ISA 40×40×6	3.50	4.94
12	2.00	11.1	-23.05	ISA 60×60×6	5.40	10.80

13	1.41	17.41	-31.76	ISA 55×55×6	4.90	6.91
14	1.41	25.41	-47.95	ISA 55×55×6	4.90	6.91
					Total Weight of truss	392.18

Table 4.11 shows the comparison of the weight of roof trusses of 12m span which have been analyzed above. For 100 kg/m2 Pratt Truss, Fan Truss and Compound fink Truss have weight 343.85 kg,363.07 kg, and 289.29 kg respectively.

Table 9 Weight comparison of trusses for 12 m span

Basic wind pressure (kg/m^2)	Weight of truss (kg)		
	Pratt truss	Fan truss	Compound fink truss
100	343.85	363.07	289.29
150	379.07	422.37	352.27
200	429.48	482.49	392.18

For 150 kg/m2 Pratt Truss, Fan Truss and Compound fink Truss have weight 379.07 kg, 422.37 kg, and 352.27 kg respectively. For 200 kg/m2 Pratt Truss, Fan Truss and Compound fink Truss have weight 429.48 kg,482.49 kg, and 392.18 kg respectively.

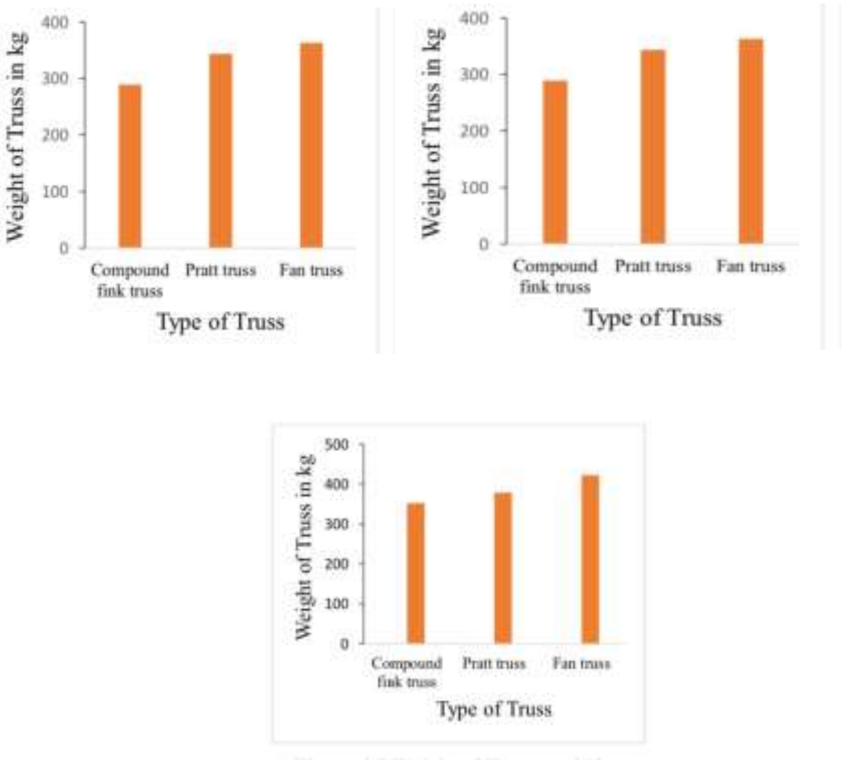

Figure 4.4 Weight of Trusses of 12 m span for 100 kg/m2

Conclusion

A total of 3 span of roof trusses have been analyzed and designed for very high to very low wind pressure and importance of analysis of temperature change on structure is also given. A-type of roof truss has been designed using the provisions of IS 800:2007 and compared with designed section which is specified in SP 38.From the work following conclusion can be made.

- Now a day's different type of roof sheets of longer span are available in market so that we can increase the panel length of the truss.
- If the number of purling is decreasing then forces are increasing per node and designed section is becoming heavier.

- When we are using the configuration which have wider panel, number of purlin required is less. So weight of purlin is reducing. But for all three span 12 m, 18 m and 24 m weight of truss is increasing when we are using configuration of wider panel.
- The section of A-type roof truss which are designed using the provisions of IS 800:2007 having section lighter than the section which are designed by the provisions of IS 800:1984.
- The section which are designed using the provisions of IS 800:2007 having section lighter than the section which are given in SP 38. Which are designed by using the provisions of IS 800:1984?
- There is large variation in the weight when comparing the designed section of A-type roof truss using the provisions of IS 800:1984 and IS 800:2007. The minimum and maximum variation in the weight is 0.85 % to 4.98 % respectively for slope 1/3.
- The variation in the weight is increasing when slope of the roof truss is decreasing; variation in the weight of roof truss is 5.88 % to 7.35% for slope 1/4 and 4.42 % to 14.5% for slope 1/5.

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