Design & Analysis of Industrial Roof Truss

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Abstract— The present paper describes design and analysis of industrial roof truss using manual method and staad pro method. For present work the equivalent static analysis is carried out for single storey steel building with pitched roof in zone II. It is nothing but the industrial structure. The industrial structures shall be designed and constructed to resist the wind effects in accordance with the requirements and provisions of IS: 875 (Part 3):1987. This standard describes the procedure for wind resistant of such structures .The stability analysis of single storey steel building with pitched roof is carried out using Software Computer Aided Design i.e., (STAAD PRO) .The main parameters consider in this paper to compare wind performance of buildings are bending moment ,shear force ,deflection and axial force. In this paper we only focus on industrial shed i.e., pitched roof truss. A building has to perform many functions satisfactorily. Amongst these Functions are the utility of the building for intended use and the occupancy, structural safety, fire safety and compliance with hygienic, sanitation, ventilation and day light standards. It included the provisions for the basic design loads to be assumed in the design of building. In this standards the whole calculations are done for the wind load which are most important for the design of the industrial shed i.e., pitched roof truss. The modal of the truss is analyze and design as per IS: 875 (Part1):1987, IS: 875 (Part2):1987, IS: 875(Part 3):1987 and IS: 800:2007. With the urge for sustainable, durable and economical construction various methods for designing, developing and constructing structures right from Class I structures like important service and community structures – Power plants, Reservoirs, health care centers, airports, frames, industrial structures like roof trusses to ordinary structures have been developed rapidly in the last few decades

Key words: Industrial Roof Truss

I. Introduction

Steel is a material which has high strength per unit mass. Steel is a common building material used throughout the construction industry. Industrial buildings are generally designed as enclosures that provide space for internal activities, which may involve use of overhead cranes or suspended equipments as well as provision of office space or mezzanine floors. Its primary purpose is to form a skeleton for the building or the structure essentially the part of the structure that holds everything up and together. Steel has many advantages when compared to other building materials such as concrete, timber, plastics and the newer composite materials. Steel is one of the friendliest environmental building materials. Steel is 100% recyclable material. Of all the structural building material in use today steel is perhaps the most universally acceptable as versatile material for engineering construction. Function of all the structure is to withstand stresses due to loads i.e., wind, earthquake etc. without failure or undue distress such as excessive deflections, dangerous vibrations etc. Steel as a building material has been studied and tested for many years.

In this paper the study is done for the stability analysis of industrial shed i.e., pitched roof truss. Trusses are triangular frame works, consisting of 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 multistory buildings, to resist gravity loads. Trusses are also used in walls and horizontal planes of industrial buildings to resist lateral loads and give lateral stability.

The loads are assumed to be acting only at the nodes of the trusses. The trusses may be provided over a single span, simply supported over the two end supports, in which case they are usually statically determinate. Such trusses can be analyzed manually by the method of joints or by the method of sections.

Computer programs are also available for the analysis of trusses.

The whole analysis and design of fink type roof truss is done as per IS : 875 (Part 1) : 1987, IS : 875(Part 2) : 1987, IS : 875 (Part 3) : 1987 and IS 800 : 2007. The whole analysis and design done as per static method.

II. Scope

Over here the study is done for stability analysis of industrial shed subjected to wind load. The analysis is done for stresses, bending moments, deflections and axial forces as per grid formation methodology.

III. Design philosophy

Before we proceed with the actual analysis and design of structure following points are considered:

1) The structural system and type
2) The choice of an open or covered structure
3) The selection of the construction material
4) The location, ground conditions i.e., geography of the area
5) The method which is used
6) The design concept
7) IS codes used

With the use of proper method, IS code and also all analysis and design done by STAAD PRO.

IV. Experimental work

Design is done for a how type roof truss for an industrial building for the following data: Overall length of the building = 35 m Overall width of the building =13.5m
Spacing of the trusses = 3.5 m
Rise of truss = 2m Self weight of purlin = 318 N/m
Height of column = 7 m

Roofing and side covering = Asbestos cement sheets = 171 N/m^2
The building is located in industrial area
MIDC, bhusaval .Both the ends of the trusses are hinge.
Use steel of grade Fe415.

1) Step 1: Given data.

Type of truss=HOWE TRUSS
L = 35
Span = 13.5m
Spacing of truss = 3.5
Rise of truss = 2.0M
Self-weight of purlin = 318 N/m Height of column = 7M
Roofing and side covering = Asbestos cement sheets
171 N/m^2 Industrial area = MIDC, BHUSAVAL SHIRPUR
Steel grade = Fe415. Both the ends are hinge.

2) Step 2: To find.

Design roof truss.

3) Step 3: Diagram.

4) Step 4: Calculation of θ.

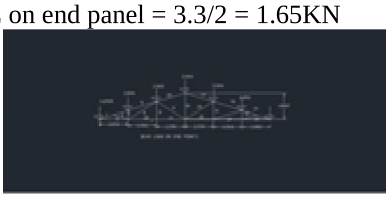
tan θ
=2/6.75
θ =17 deg

5) Step 5: Calculation of length of rafter.

Length of principal rafter= $\sqrt{2^2+6.75^2}$ = 7.04m
Length of each panel = 8.94/4
2.235 m

6) Step 6: Calculation of loads.

1) Dead load:
   1) Assume weight of bracing = 12 N/m^2
   2) Dead load of AC sheet = 171 N/m^2
   3) Self-weight of roof truss = (span/3 +5) × 10 = (13.5/3 +5) ×10 =95 N/m^2
      ≈110 N/m^2
   4) Self-weight of purlin = 318 N/m =318×spacing of truss
      =318×3.5
      =1113 N
   5) DL on intermediate panel = (12+171+95)×(3.5×2.25)+1113 =3.3 KN
   6) DL on end panel = 3.3/2 = 1.65KN



2) Live load:
   1) θ = 17
   2) Live load = 750-20(17-10)
      =610 N/m^2
   3) Live load on each intermediate panel = Live load × spacing of truss on both side
      610×3.5×2.25=4800 N =4.8KN
   4) Live load on each end panel = 4.8/2 = 2.4 KN

3) Wind load:
   – Basic wind velocity = Vb = 44 m/sec (Appendix A, clause 5.2, page no. 53)
   – Class of structure = All general building & structure
   – Mean probable design life of structure in years = 50 years
   – Risk coefficient (k1) :

Year	city	k1
50 years	bhusaval	1

Table 1:

k1 = 1 (from IS: 875: Part 3:1987, table no.1, page no. 11)

   – Terrain factor (k2) :-

From table no. 2 , page no. 12, IS: 875: Part 3:1987
For open structure = Category 2
Class A = Upto 20 m
From table no. 2 , category 2, class A

Height	k2
10	1
12	X
15	1.05

Table 2:

x = 1.05-((1.05-1)/(15-10))×(15-12)
Therefore, k2 = x = 1.02 for 12 m building height.

   – Topography factor (k3) :-
     k3 = 1 when θ is greater than 3˚ i.e., θ > 3˚ (as per IS: 875: Part 3:1987)
   – Calculation of wind speed (VZ) :-VZ = k1× k2× k3×Vb
     =1×1.02×1×44
   =44.88 m/s
   – Calculation of design wind pressure(pd) :-pd = 0.6× $(VZ)^2$
     =0.6× $(44.88)^2$
     =1208.59 N/m^2
     =1.21 KN/m^2
   – Calculation of external & internal air pressure coefficients:
   – External air pressure coefficient:
     Cpe for the condition ½ < h/w and
     For θ = 26.56, from IS: 875: Part 3:1987, table no. 5

θ	wind EF	lee
		EG
10	-1.2	-0.8
17	x1	x2
20	-0.4	-0.7

Table 3:

Therefore,
x1= -0.4-[(-0.4+1.2)/(20-10)]×(20-17)
= -0.64
x1≈ -0.64(windward side)
x2 = -0.7-[(-0.7+0.8)/(20-10)]×(20-17)
x2 = -0.73 (leeward side) Therefore,

Cpe (windward side) = -0.64
Cpe (leeward side) = -0.73

- Internal air pressure coefficients:

The internal air pressure coefficients (Cpi) = ± 0.5 when the opening in the building upto (5 % to 20 %)

- Calculation of wind load:
- Wind load = [Cpe – Cpi] × pd × A Where,

A = area, Pd = design wind pressure Wind load = [Cpe – Cpi] × pd × A
[- 0.73 - 0.5] × 1.21 × 3.5 × 2.25
-11.72KN
11.72 KN (Uplift)

- Wind load per unit length of purlin = 11.72/3.5= 3.34 KN/m
- Wind load on the panel points :-Windward side,

F = [Cpe – Cpi] × pd × A
[-0.64 – 0.5] × 1.21 × 3.5 × 2.25
-10.86 KN
Therefore, wind load on each intermediate panel point = -10.86 KN & wind load on end panel = (-10.86)/2
= - 5.43 KN
Leeward side,
F = [Cpe – Cpi] × pd × A
[-0.73 -0.5] × 1.21 × 3.5 × 2.25
-11.72 KN
Therefore, wind load on each intermediate panel point = -11.72KN
And wind load on each end panel = - 11.72/2
= - 5.86 KN.

V. RESULT & OBSERVATION

Example was taken under consideration with dimensions and material grade as follows – Design a howe type roof truss for an industrial building for the following data: Overall length of the building = 35m
Overall width of the building = 13.5 m Spacing of the trusses = 3.5 m Rise of truss = 2m
Self-weight of purline = 318 N/m Height of column = 7 m
Roofing and side covering = Asbestos cement sheet = 171 N/m^2
The building is located in industrial area MIDC, bhusaval shirpur MIDC. Both the ends of the trusses are hinge. Use steel of grade Fe415.

- All the values of constant are calculated usingIS:875(Part1):1987,IS:875(Part
- 1987,IS:875(Part 3):1987 and IS:800:2007
- Whole design is done in STAAD PRO Software using IS: 800:2007(LSD).
- For analysis and design static method is adopted.
- In this paper the above example solved and all analysis & design done.

Member	Steel Section	Nature of Member
1	ISA65X45X5	Tension
2	ISA130X130X8	Compression
3	ISA130X130X8	Compression
4	ISA130X130X8	Compression
5	ISA130X130X8	Compression
6	ISA130X130X8	Compression
7	ISA125X95X8	Tension
8	ISA100X75X6	Compression
9	ISA35X35X3	Tension
10	ISA70X70X5	Tension
11	ISA125X95X8	Compression
12	ISA50X50X3	Compression
13	ISA100X75X6	Compression
14	ISA50X50X3	Compression
15	ISA64X45X5	Tension
16	ISA130X130X8	Tension
17	ISA125X95X8	Compression
18	ISA25X25X3	Compression
19	ISA125X95X8	Compression
20	ISA25X25X3	Compression
21	ISA35X35X3	Tension
22	ISA70X70X5	Tension
23	ISA35X35X3	Tension
24	ISA70X70X5	Tension
25	ISA100X75X6	Compression
26	ISA25X25X3	Compression
27	ISA100X75X6	Compression
28	ISA25X25X3	Compression

Table 4: Table shows the results from solving above example.

VI. CONCLUSION

Result of the analysis done for static method gives approximately same values as obtained using IS codes.

Based on the results of this experimental work the following investigation is made. The result of analysis indicates that inclined members may subject to compression or tension, in this case maximum was noticed to be tensile in nature. Whereas vertical members are subjected to tension.

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