Comparison between Design and Analysis of Various Configuration of Industrial Sheds

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***Abstract*— Paper includes the comparison between various configurations of industrial shed. There are various types of industrial sheds. But here we compare the various configurations of industrial sheds, such as hot rolled steel shed such as shed using Howe truss, N-type with pre-engineered truss etc. This paper will gives us the suitable configuration of industrial shed by making and comparing design and analysis of various configurations of industrial sheds. Design of industrial shed, by using STAAD-Pro 2008 which gives results very quickly and accurately. This paper work compares the design of various configuration of industrial shed and concluded that which is suitable & economical in all views. The comparison gives us suitable configuration which suitable strength point of view**

***Key Words*: N- type truss, Howe frame, Pre-engineered type truss, STAAD-Pro 2008**

1. INTRODUCTION

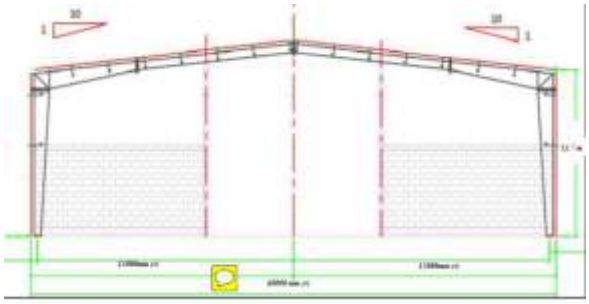
Comparison between various configurations of industrial shed using various types of truss type which gives us that which shed is suitable for the industrial shed and which is more effective in strength and economical point of view. Design of various types of industrial frame by using STAAD-Pro 2007 software which gives us there total design and suitability. A truss is essentially a triangulated system of (usually) straight interconnected structural elements; it is sometimes referred to as an open web girder. The individual elements are connected at nodes; the connections are often assumed to be nominally pinned. The external forces applied to the system and the reactions at the supports are generally applied at the nodes. When all the members and applied forces are in a same plane, the system is a plane or 2D truss. In a typical single-storey industrial building, trusses are very widely used to serve two main functions:

- To carry the roof load:
  - Gravity loads (self-weight, roofing and equipment, either on the roof or hung to the structure, snow loads)
  - Actions due to the wind (including uplift due to negative pressure).
- To provide horizontal stability:
  - Wind girders at roof level, or at intermediate levels if required
  - Vertical bracing in the side walls and/or in the gables.

In this paper we will design tree types of industrial shed using three types of truss which is portal frame type, A-type and saw tooth type by using STAAD-Pro which gives us steel required and strength and economy of different sheds. And then we compare all the results given by software of all three types and finally we got which type is suitable one.

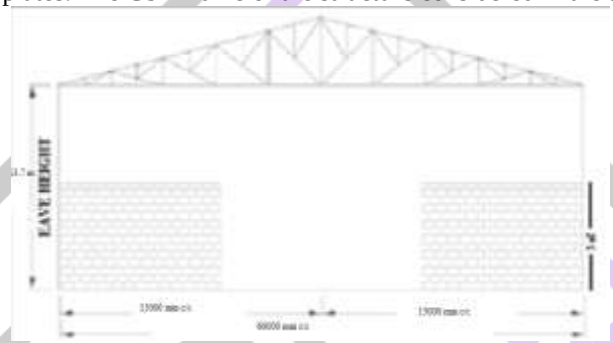
1.1. Pre Engineered Buildings

Pre-Engineered Building concept involves the steel building systems which are predesigned and prefabricated. As the name indicates, this concept involves pre-engineering of structural elements using a predetermined registry of building materials and manufacturing techniques that can be proficiently complied with a wide range of structural and aesthetic design requirements. The basis of the PEB concept lies in providing the section at a location only according to the requirement at that spot. The sections can be varying throughout the length according to the bending moment
diagram. This leads to the utilization of non-prismatic rigid frames with slender elements. Tapered I sections made with built-up thin plates are used to achieve this configuration. Standard hot-rolled sections, cold-formed sections, profiled roofing sheets, etc. is also used along with the tapered sections. The use of optimal least section leads to effective saving of steel and cost reduction.The typical PEB frame of the structure is as shown in the Figure.



1.2. Conventional Steel Buildings

Conventional steel buildings (CSB) are low rise steel structures with roofing systems of truss with roof coverings. Various types of roof trusses can be used for these structures depending upon the pitch of the truss. For large pitch, Fink type truss can be used; for medium pitch, Pratt type truss can be used and for small pitch, Howe type truss can be used. Skylight can be provided for day lighting and for more day lighting, quadrangular type truss can be used. The selection criterion of roof truss also includes the slope of the roof, fabrication and transportation methods, aesthetics, climatic conditions, etc. Several compound and combination type of economical roof trusses can also be selected depending upon the utility. Standard hot-rolled sections are usually used for the truss elements along with gusset plates. The CSB frame of the structure considered in the study is as shown in Figure.



1.3. ADVANTAGES OF PEB

Following are some of the advantages Pre-Engineered
Building Structures:

a) Buildings are generally constructed in just 6 to 8 weeks after approval of drawings. PEB will thus reduce total construction time of the project by at least 30%. This allows faster occupancy and earlier realization of revenue.

b) Because of systems approach, considerable saving is achieved in design, manufacturing and erection cost.

c) These can be easily expanded in length by adding additional bays. Also expansion in width and height is possible by pre designing for future expansion.

d) Buildings can be supplied to around 90m clear spans. This is one of the most important advantages of PEB giving column free space.

e) Buildings are manufactured completely in the factory under controlled conditions, and hence the quality can be assured.

f) PEB Buildings have high quality paint systems for cladding and steel to suit ambient conditions at the site, which in turn gives long durability and low maintenance coats.

g) Buildings are supplied with polyurethane insulated panels or fibre glass blankets insulation to achieve required "U" values (overall heat transfer coefficient).

h) Steel members are brought to site in CKD conditions, thereby avoiding cutting and welding at site. As PEB sections are lighter in weight, the small members can be very easily assembled, bolted and raised with the help of cranes. This allows very fast construction and reduces wastage and labour requirement.

2. STRUCTURAL DETAILS

Dimensional details:

Location: -	Nagpur
Width: -	60 m.
Length: -	216 m.
Height: -	13.7 m
Rise: -	6 m.
Inclination of truss: -	11.3 deg
purline spacing :-	1.7 m
Spacing of frame along length: -	6 m

2.1. LOAD CALCULATION:-

Loading calculation for all configurations of Industrial sheds is as follow-
Dead load (As per IS 875 Part –I)
Self weight of structure- Given by STAAD
Self weight of A.C. sheet = 0.138 KN/m²
= 0.138*1.7
= 0.23 KN/m
(As per IS 875-I Table no 9)
Live Load (As per IS-875 Part –II)
On pitch roof = 0.75 KN/m².
(As per IS 875-II net live load)
= 0.75- 0.02 (ø-10)
= 0.75 – 0.02 (11.3-10)
=0.724 KN/m²
Live Load on purlin = 0.724 * 1.7
= 1.23 KN/m
Wind Load (As per IS 875-III)
Basic wind speed = 44

Design wind speed (Vz) = Vb*k1*K2*k3
= 44*1*1.09*1
= 47.96 m/s
Design wind pressure (Pz) = 0 .6*Vz²
= 0.6*47.96²
= 1380 N/m²
=1.38 KN/m²

2.2. Staad load case

WIND PRESSURE ABOUT 0^0
ROOF
F=Cpnet*Anet*Pd
Windward side pressure = 1.6333 KN/M²
Leeward side pressure = 0.75383 KN/M²
WALL
Wall A pressure = 1.1.075 KN/M²
Wall B pressure = -0.0628 KN/M²
Wall C pressure = -0.5026 KN/M²
Wall D pressure = -0.5026 KN/M²
WIND PRESSURE ABOUT 90^0
ROOF
F=Cpnet*Anet*Pd
Windward side pressure = 1.21869 KN/M²
Leeward side pressure = 1.21869 KN/M²
WALL
Wall A pressure = -1.130 KN/M²
Wall B pressure = -1.130 KN/M²
Wall C pressure = 0.37692 KN/M²
Wall D pressure = -0.6282 KN/M²

2.3. LOAD FOR SINGLE FRAME MODELLING

Type	Panel pt load	Panel end load
DL	1.5	0.75
IL	7.5	3.75
WIND TH 0		
ROOF LEFT	16.6597	8.32984
RIGHT	7.68909	3.84454
WALL A	92.9475	
B	-5.1637	
C	-41.31	
D	-41.31	
WIND TH 90		

ROOF LEFT	12.4307	
RIGHT	12.4307	
WALL A	-92.947	
B	-92.947	
C	30.9825	
D	-51.637	

Load combinations are use as per IS 1893-2002. Steel required for this industrial shed are as follow.

2.4. LOAD COMBINATION:-

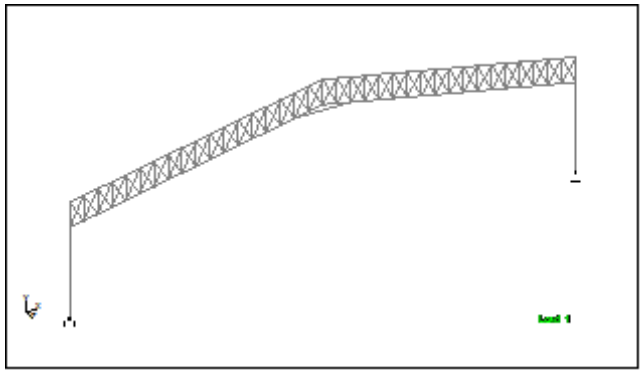
Load combinations can be adopted according to IS: 800 – 2007.Twenty different load combinations and six different load combination for serviceability as per limit state method adopted for the analysis of the frame in both the concepts, and are listed as follow

1) 1.5 DL+1.5 LL
2) 1.5 DL+1.5 WL 0^0
3) 1.5 DL-1.5 WL 0^0
4) 1.5 DL+1.5 WL 90^0
5) 1.5 DL-1.5 WL 90^0
6) 0.9DL+1.5WL 0^0
7) 0.9DL-1.5WL 0^0
8) 0.9DL+1.5WL 90^0
9) 0.9DL-1.5WL 90^0
10) 1.5 DL-1.5 EQX
11) 0.9DL+1.5 EQX
12) 0.9DL-1.5 EQX
13) 1.2 DL+1.2 LL+ 1.05 WL0^0
14) 1.2 DL+1.2 LL- 1.05 WL0^0
15) 1.2 DL+1.2 LL+ 1.05 WL90^0
16) 1.2 DL+1.2 LL- 1.05 WL90^0
17) 1.2 DL+1.2 LL+ 1.05 EQX
18) 1.2 DL+1.2 LL- 1.05 EQX
19) SERVICE DL+LL
20) SERVICE DL+0.8LL+ 0.8WL 0^0
21) SERVICE DL+0.8LL- 0.8WL 0^0
22) SERVICE DL+0.8LL+ 0.8WL 90^0
23) SERVICE DL+0.8LL- 0.8WL 90^0
24) SERVICE DL+0.8LL+0.8EQX
25) SERVICE DL+0.8LL- 0.8EQX

Note:
DL – Dead Load
LL – Live load
WL – Wind load
EQX-Earthquake load

3. DESIGN AND ANALYSIS OF TRUSSES USED INDUSTRIAL SHED BY STAAD-PRO

First configuration is N-type truss using industrial shed. Analysis and design of such type of truss is done by using STAAD-PRO software. And their front view and load combination views are as follow,



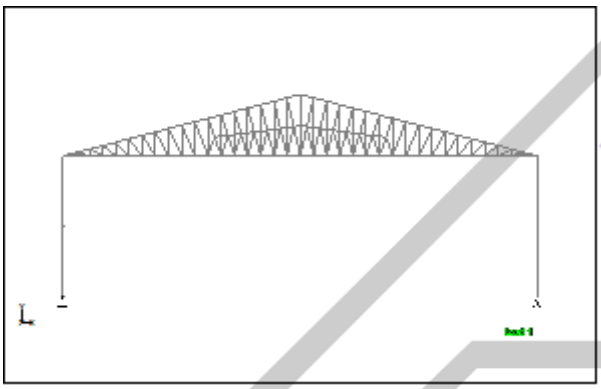
Industrial shed using N-type truss

STEEL TAKE-OFF OF N-TYPE INDUSTRIAL SHED ARE AS FOLLOWS.

3.1. INDUSTRIAL SHED USING N-TYPE TRUSS

PROFILE	LENGTH (METER)	WEIGHT(KN)
SD ISA200X200X20	122.38	143.646
FR ISMC400	27.40	26.858
SD ISA120X120X10	352.37	126.142
SD ISA150X150X10	6.67	2.991
	TOTAL =	299.636

Second configuration is Howe truss using industrial shed. Analysis and design of such type of truss is done by using STAAD-Pro software. And their front view and load combination views as follows,

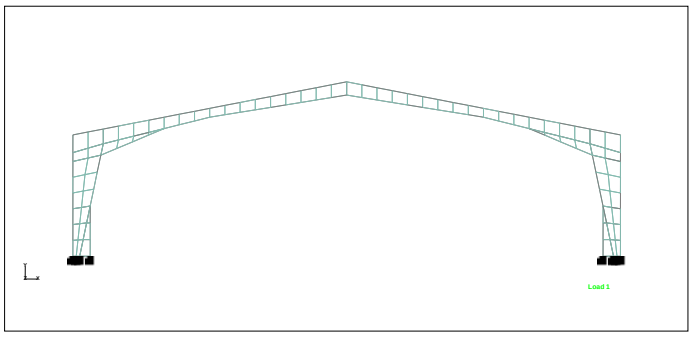


Industrial shed using Howe-type truss

3.2. INDUSTRIAL SHED USING HOWE TYPE TRUSS

PROFILE	LENGTH (METER)	WEIGHT(KN)
SD ISA180X180X20	127.19	133.466
TB ISMB550	27.40	47.991
SD ISA80X80X12	279.38	76.404
	TOTAL =	257.860

Third configuration is Pre-engineered truss using industrial shed. Analysis and design of such type of truss is done by using STAAD-Pro software. And their front view and load combination views as follows,



Industrial shed using Pre-engineered-type truss

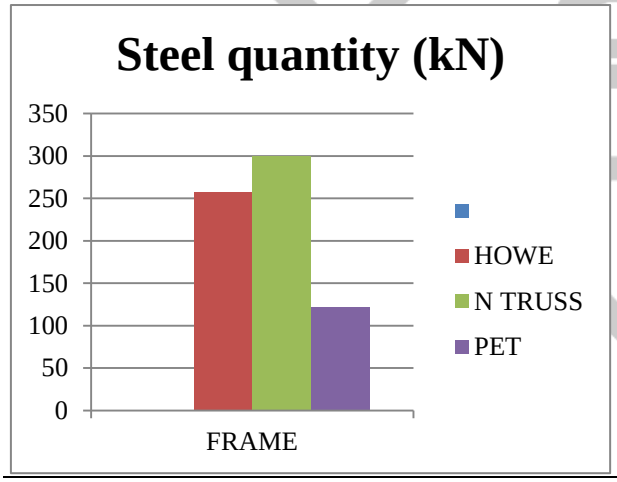
3.3. INDUSTRIAL SHED USING PRE-ENGINEERED TYPE TRUSS

	a	b	l	t	VOL	WT (N)
BEAM						
	2	1	15.29	0.003	0.0688	5298.57
	1	1.5	15.29	0.003	0.0573	4415.475
	2	1	15.29	0.003	0.0688	5298.57
	1	1.5	15.29	0.003	0.0573	4415.475
COL						0
	3.155	0.75	10.75	0.003	0.0629	4849.081
	3.155	0.75	10.75	0.003	0.0629	4849.081
ISA150 X150X10			205.24			92078
					TOTAL	121204.3
						121.204

4. CAMPARISION BETWEEN VARIOUS TYPE OF INDUSTRIAL SHED BY USING DIFFERENT TYPES OF TRUSS*:-*

STEEL QUANTITY

TYPE	KN	% LESS
HOWE	257.86	13.94225
N TRUSS	299.636	100
PET	121.204	59.54959



***5.* CONCLUSION:-**

N-type truss required more steel than industrial shed using Howe and Pre-engineered truss,hence it taken as 100 percent and camparing with it howe truss required 13.94 percent less steel and finally pre-engineered truss required very less steel. So pre-engineered truss is economically better than other and safe also.

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