



Comparative study of pre-engineered building and space truss building with different span

K Selvakumar, & K Srinivasan

Dr. Mahalingam College of Engineering and Technology, Pollachi, Tamilnadu 642 003, India.

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Steel building gives a major support for structural development. Now a day's most of the buildings are built as Pre-Engineering Building (PEB) such as ware house, industrial buildings, residential buildings, malls, metro stations, etc. Space truss are provided for auditoriums, railway stations, etc. This paper provides a comparative study of PEB and space truss structure for 20m and 30m span. The length of the building was 60m which consists of 5 bays and eave height 7 m. The dead load, live load and wind loads were taken as per IS codes. The location of the building was selected in Coimbatore district, Tamil Nadu. The buildings were designed and analysed using STAAD Pro. Software.

Keywords: Industrial Building, Indian Codes, Pre-engineered Building, Space Truss, STAAD Pro

1 Introduction

PEB becomes more popular now a day because these buildings are most economical, short erection time period, low cost, light weight, etc. PEB are engineered at factory and assemble at site. PEB consists of primary elements and secondary elements, I-shaped members such as taper rafter, taper columns, etc. comes under primary elements, cold form members like "Z", "C"- purlins, bracings, etc. comes under secondary elements. For building up an I-section, taper sections were taken for required size of flange and web and fixed them together¹⁻². Space truss is a 3D structure, here connections gives a major support to the building. Space truss are light weight, bears heavy loads, give minimum deflection, efficient, etc. Tubular sections are used for the construction of truss. Top chord, bottom chord, truss bracings etc. are the components of space truss. In 3D truss ball and socket joints are provided, which connects the members from three directions³⁻⁶. From this paper the variation between PEB and space truss were studied.

2 Materials and Methods

In this paper, a Pre-Engineered Building and space truss of length 60m with 5 bays and span length 20m and 30m was designed and analysed by STAAD Pro. Software. For these building dead load, live load and

wind load were assigned as per IS: 875⁷⁻⁸ codes. The location of the building is selected in Coimbatore district, Tamil Nadu. The buildings are designed as per IS: 800-2007⁹. The weight/area ratio is calculated for PEB and space truss and compared. The economical conclusion is given as per the weight/area comparison of these two buildings¹⁰⁻¹¹.

The PEB and space truss are designed for 20m and 30m span length. The design were done as per IS: 800-2007

2.1 Design of PEB 20m span:

As per IS: 875 dead load, live load and wind load was calculated.

2.2 Dead load calculation and values for each parameters

The design parameters and design calculation were presented in Table 1 and Table 2 as per the Indian standards.

The above calculated dead load and wind load was imported in 20m span frame. Similarly loads were calculated for 30m span frame.

As per the STAAD result the total weight of the 20m span PEB structure was 203.863kN. The model of the 20m span PEB structure was shown in Fig. 1.

2.3 Design of space truss 20m span:

As per the STAAD result the total weight of the 20m span space truss structure was 215.23kN. The

Table 1 — Design parameters Span of Buildings

Span of Buildings	=	20 m
Slope of roof	=	6°
Weight of roof Covering	=	150 N/Sqm
Weight of Purlin	=	80 N/Sqm
Weight of wind Bracings	=	13 N/Sqm
Total Dead load in Plan Area	=	263 N/Sqm
Total Dead load under slope area	=	252 N/Sqm
Width of the Building - m (O/O steel line)	W =	20.0 m
Length of the Building - m (O/O steel line)	L =	60.0 m
Bay spacing - m (C/C of Main Frame)	S =	7.5 m
Eave Height (m)	H =	7
Risk Coefficient	K1 =	1
Terrain roughness and Height Factor	K2 =	0.9
Topographic Factor	K3 =	1
Importance Factor for cyclonic region	K4 =	1.15
Basic Wind speed	V =	39.0 m/s
Combination Factor	Kc =	0.9
Directionally Factor	Kd =	0.9
Area Averaging Factor	Ka =	0.868
Importance Factor	Iw =	1
Internal Pressure co-efficient	Cpi =	+/- 0.50
External Pressure co-efficient as per code		
Design Wind speed	Vz =	$V_b \times K_1 \times K_2 \times K_3 \times K_4$ = 40.4 m/s
Wind Pressure	Pz =	$0.6 \times V_z^2$ = 977.6 N/Sqm
Design Wind Pressure	Pd =	$P_z \times K_d \times K_c \times K_a$ = 687.3 N/Sqm
The value of Pd should not be less than 0.7 x Pz		684.3 N/Sqm
Design Wind Pressure	=	0.7 kN/Sqm
Wind load (Main frame bay spacing)	7.5 m =	5.2 kN/m
Wind load (Wind Column bay spacing)	6.7 m =	4.6 kN/m

model of the 20m span space truss structure was shown in Fig. 2.

2.4 Design of PEB 30m span:

As per the STAAD result the total weight of the 30m span PEB structure was 311.18kN. The model of the 20m span space truss structure was shown in Fig. 3.

2.5 Design of space truss 30m span:

As per the STAAD result the total weight of the 30m span space truss structure was 286.405kN. The

Table 2 — Design calculation

Calculation

$$L/B = 3 \quad H/B = 0.35$$

$$F = (C_{pe} - C_{pi}) \times A \times P_d$$

1. Wind load 0 deg with +ve wind pressure

Right side wall	=	1.0 kN/m
Right side roof	=	-7.2 kN/m
Left side roof	=	-4.6 kN/m
Left side wall	=	-3.9 kN/m
Front side gable	=	-5.7 kN/m
Back side gable	=	-5.7 kN/m

2. Wind load 0 deg with -ve wind pressure

Right side wall	=	6.2 kN/m
Right side roof	=	-2.1 kN/m
Left side roof	=	0.5 kN/m
Left side wall	=	1.3 kN/m
Front side gable	=	-0.5 kN/m
Back side gable	=	-0.5 kN/m

3. Wind load 90 deg with +ve wind pressure

Right side wall	=	-5.2 kN/m
Right side roof	=	-6.7 kN/m
Left side roof	=	-6.7 kN/m
Left side wall	=	-5.2 kN/m
Front side gable	=	1.0 kN/m
Back side gable	=	-3.1 kN/m

4. Wind load 90 deg with -ve wind pressure

Right side wall	=	0.0 kN/m
Right side roof	=	-1.5 kN/m
Left side roof	=	-1.5 kN/m
Left side wall	=	0.0 kN/m
Front side gable	=	6.2 kN/m
Back side gable	=	2.1 kN/m

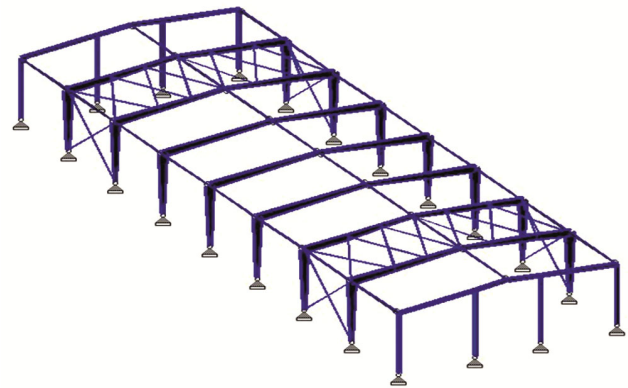


Fig. 1 — View of the 20m length pre- engineering building structure of STAAD pro software

model of the 20m span space truss structure was shown in Fig. 4.

Table 3 — Structural weight of PEB vs Space

Parameters	PEB 20		SPACE 20		PEB 30		SPACE 30	
	kN	Tonne	kN	Tonne	kN	Tonne	kN	Tonne
Area	20 x 60		20 x 60		30 x 60		30 x 60	
Hot Rolled Section	203.4	20.73	215.23	21.93	311.18	31.71	286.4	29.18
Cold Formed Section	-	6.62	-	NA	-	9.26	-	NA
Total Weight	-	27.35	-	21.93	-	40.97	-	29.18

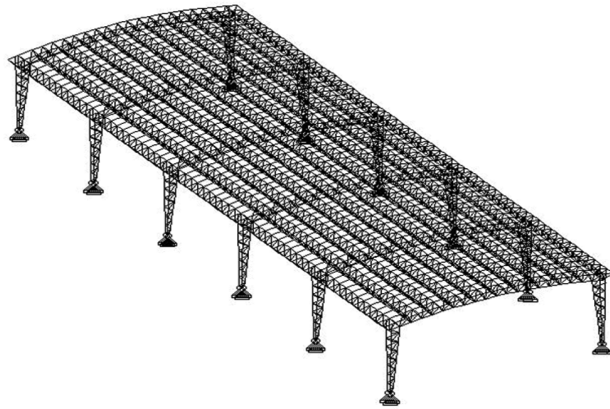


Fig. 2 — The model of the 20m Length span space truss structure of STAAD pro software

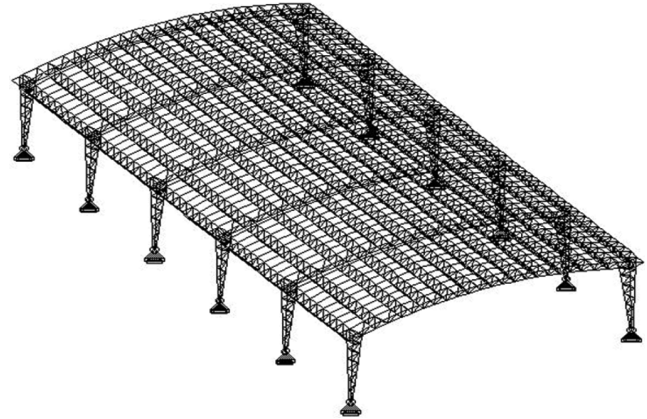


Fig. 4 — View of the 30m length span space truss structure of STAAD pro software

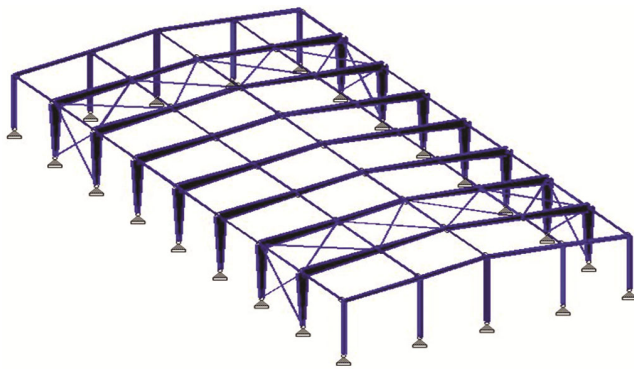


Fig. 3 — View of the 30m length pre engineering building structure of STAAD pro software

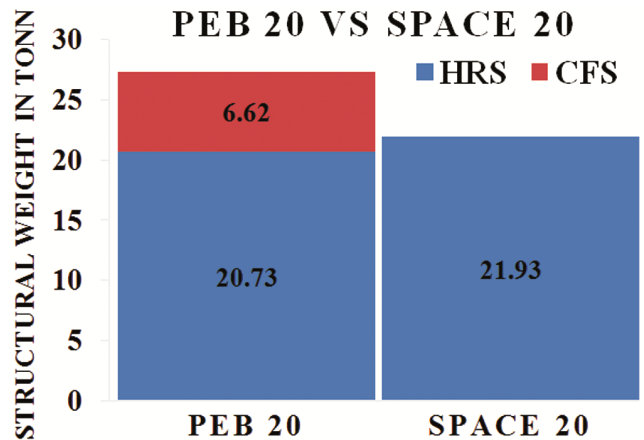


Fig. 5 — Graphical representation of PEB and space for 20m span

3 Results and Discussion

The buildings with different span length was designed and analysed, it was found that total weight of the space truss building was minimum when compared with PEB. The design result for each building was shown in Table 3. The variation between the weights of the 20m span buildings were shown graphically in Fig. 5. From the graph it was found that, while considering Hot Rolled Section (HRS) the weight of the space truss is maximum than the PEB but in PEB the weight of the Cold Formed Section (Purlin) is also included. Hence the weight of the PEB increases.

The variation between the weights of the 30m span buildings were shown graphically in Fig. 6. From the graph it was found that, while considering Hot Rolled Section (HRS) the weight of the space truss is minimum than the PEB, in addition to for PEB the weight of the Cold Formed Section (Purlin) is also included. Hence the weight of the PEB keep increases.

From the weights of the building, the weight/area ratio was calculated and compared each other. Table 4 shows the weight/area ratio and Fig. 7 represents the graphical comparison of the buildings.

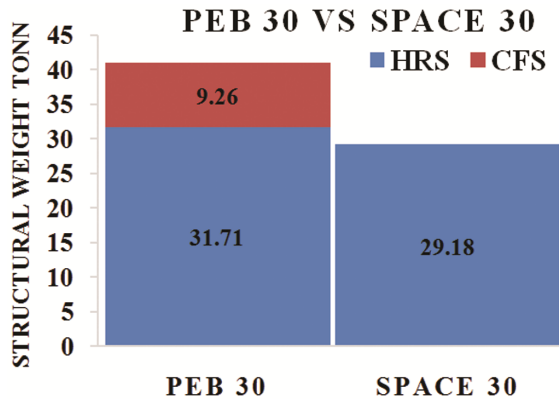


Fig. 6 — Graphical representation of PEB and space for 30m span

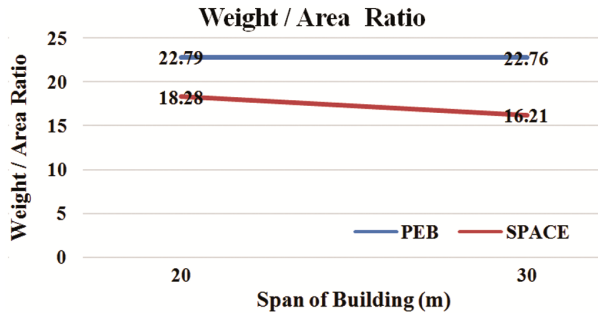


Fig. 7 — Weight/Area comparison

Table 4 — Weight/Area ratio of structures

Building	Area of building M2	Total weight Kg	Weight/area Ratio
PEB 20	1200	27350	22.79
PEB 30	1800	40970	22.76
SPACE 20	1200	21930	18.28
SPACE 30	1800	29180	16.21

4 Conclusion

The conclusion was shown below as per the result and discussion, for 20m span building the structural weight of the Space Truss reduces up to 20% than the Pre Engineered Building. For 30m span building the structural weight of the Space Truss reduces up to 28% than the Pre Engineered Building. It is found that, if the span increases the Space truss becomes more economical then the Shortest span. The Weight/Area ratio decreases for Space truss when the span increases but in PEB Weight is directly proportion to the area of the building so that Weight/ratio is constant when the Span of the building increases.

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