Analysis of PEB structures and comparison with conventional steel buildings with varying parameters

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Abstract – *From ancient days Pre-Engineered buildings are commonly used for single story buildings especially for industrial purpose. But now a days this types of construction is very common for multy-storied buildings and buildings with large span. Pre-Engineered buildings are designed according to the bending moment diagram of elements so that the sections are tappered according to the bending moment. This makes the structure more simple and light weight. In this paper a comparative study is made in terms of weight between CSB and PEB structures and PEB structures are designed for different span. Also it gives more importance to the analysis of multy storied buildings that constructed as Pre-Engineered building.*

Key Words: Pre-Engineered buildings, Conventional steel buildings, MBMA, STAAD Pro, connections

1.INTRODUCTION

In our country houses and small buildings are the ancient construction practice. Apart from this, now our construction industry has many changes and developed to a primitive and prompt modern construction practices. Current construction industry highly recommends the use of steel so the steel structures are becoming the most simple and cost effective construction. By knowing the advantages of steels engineers mostly recommends steel for the construction. Steel can be used for both residential and non-residential buildings. But steel is most common for industrial buildings because steel has high strength per unit mass. Industrial buildings are sometimes may be storage units, ware houses, workshops etc. which demand high utility space without any intermediate obstruction.

In this fast development of construction industry, PEB concept have the prior importance. PEB concept comes into exist on 1960's now a days this become most popular. In PEB concept configurations are more simple and we can save a much amount of steel. Normally conventional steel buildings includes truss works that require a large amount of steel. But in PEB it makes the structure so flexible and less in weight. Because of that amount of steel required for the construction is get reduced. PEB structure are mainly the combination of built up sections, hot rolled section, cold framed element and profiled sheets. So this structures are designed and analysed as a tapered section. The bending moment diagram of the particular element is determined and that section is tapered according to the bending moment obtained.

PEB structures offers many advantages that conventional steel structures. The main advantage of steel structures are they have much better strength to weight ratio as compared to the reinforced cement concrete structures and they can be easily dismantled. They are jointed with proper connections so that it can be reused after dismantling. Generally they are low rise buildings with eave height is varying from 25 to 30m. But in this paper an attempt is made to check whether PEB concept is possible or suitable for multy-storied buildings. Similiarly PEB offers a large span upto 90m. So this paper includes the design and analysis of PEB with varying spans. PEB concept makes an envelope system which is air tight and provide much optimum energy. According to the survey conducted by MBMA, in USA 60% of the building constructions are coming under PEB structure.

In this paper a building with same specification is designed and analysed as CSB and PEB and a comparative study ids made in order to know the difference in weight of both structures. Similiarly tree models each for CSB and PEB with different values of span and height are analysed.

Conventional steel buildings

Steel has many advantages like ductility, flexibility, strength etc. because of this factors they are more stable and steel offers high speed for the construction from the start of work. Usually for conventional steel buildings hot rolled structural members are used. In CSB all the steel members are fabricated at the manufacturing unit and transported to the site. By welding and cutting erection process is done. Trusses are the examples of conventional steel buildings.

Pre-Engineered buildings

In this type of buildings all the structural elements are designed as per the bending moment diagram obtained. According to the bending moment diagram the steel sections are tapered. The specimens are manufactured at the factories as per the customers requirement and then it is transported to the site. At the site by proper cutting and welding erection process is completed.

Modelling of CSB and PEB

The data's required for the modelling of CSB and PEB are given below.

Table -1: Data's adopted for CSB and PEB

Specifications	CSB	PEB
Total length	40m	40m
Total width	20m	20m
Clear height	6m	6m
Slope of roof	21.8	5.71
Single bay length	4m	4m
Column section	ISHB 200@40 kg/m	Tapered ISHB 350
Purlun section	ISMC 200 @22.1 kg/m	200X800X5

Loads taken for the analysis of both CSB and PEB are:

I. Dead load
II. Live load
III. Wind load 0^0
IV. Wind load 90^0

Load combinations taken are:

I. 1.5(DL + LL)
II. 1.5(DL + Wind load 0^0)
III. 1.5(DL + Wind load 90^0)

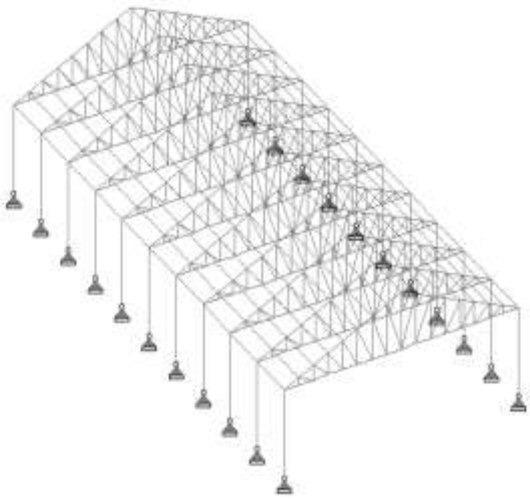

Fig -1: CSB structure

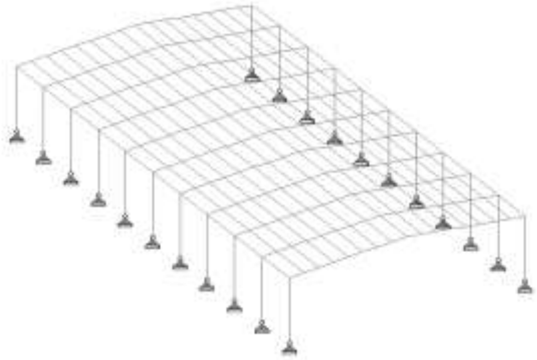

Fig -2: CSB structure

Load calculation

Dead load

Dead load intensity = 0.05 KN/m^2
Dead load on purlin = 0.05 x spacing of purlin
= 0.675 KN/m

Live load

Live load intensity = 0.75 –(0.02 x 11.7)
= 0.516 KN/m^2
Live load on purlin = 0.516 x 1.35 = 0.7 KN/m

Wind load

Basic wind speed (V_b) = 33 m/s
Design wind speed (V_z) = V_b x k1 x k2 xk3
k1 = Probability factor (risk coefficient) = 1
k2 = 0.93 Terrain Category = **2**
Class = B

K3 = Topography factor = **1**

Vz = 30.69 m/s

Design wind pressure (Pz) = 0.6 xVz^2 = 0.565KN/m

PRESURE COEFFICIENTS

Enclosure condition of the building = Partially Enclosed
Internal Pressure Coeff. (Cpi) = +/- 0.50

h/w = 0.32 ➔ h/w<=1/2
l/w = 2.00 ➔ 3/2<=l/w<4

External Pressure Coeff. (Cpi)

Wind Angle (ɵ)	Table 4		Table 5	
	Coeff. For Wall		Coeff. For Roof	
	Left	Right	Left	Right
0 degree	0.70	-0.25	-0.4000	-0.40
90 degree	-0.50	-0.50	-0.70	-0.60

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Wind Load on Purlins F = (Cpe – Cpi) A Pd

Load cases with max value (+or-)is taken for Staad loading.

The steel take off obtained for both CSB and PEB are obtained as:

Table -2: Name of the chart

Steel take off					
	Rafter ISA 110X110 X15	Column ISHB 200H	Purlin ISMC 200	Connections 12%	Total
CSB	29.8	5.3	14.88	6.22	56.03
PEB	13.727	8.972	3.478	1.96	26.27

From table it is understood that the weight and steel take off for CSB structure is too high. But in case of PEB structure steel take of value is low and there is a difference of 30% for steel take off.

MODELLING OF CSB AND PEB WITH VARYING PARAMETERS

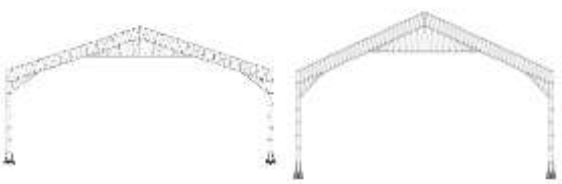


Fig -3: CSB (span 50m , 60m)

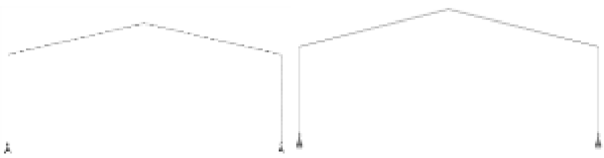


Fig -4: PEB (span 50m, 60m)

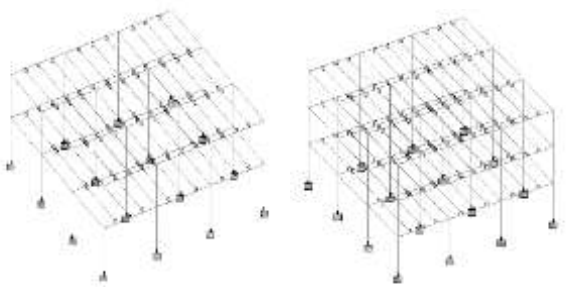


Fig -5: CSB (multi storied G+1, G+2)

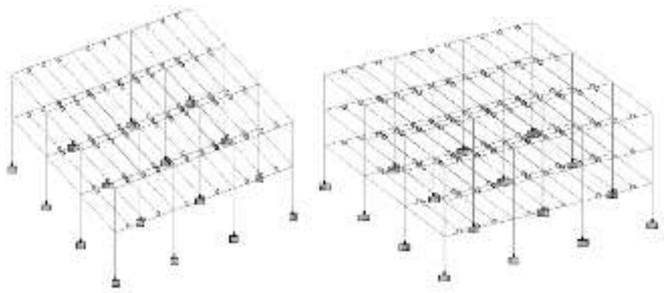


Fig -6: CSB (multi storied G+1, G+2)

RESULT

Table -3: Gross weight of CSB and PEB(Span 50m, 60m, 70m)

	Span (m)	Main frames	Purlins	Sheetings	Connections	Gross Weight
PEB	50	68.272	10.73	15.75	9.87	104.63
CSB		96.518	39.72		20.43	172.42
PEB	60	89.3	13.25	18.9	12.81	134.27
CSB		145.2	49.06		29.13	242.3
PEB	70	123.8	15.78	22.05	17.44	179.08
CSB		193.6	58.41		37.8	311.90

Table -3: Gross weight of CSB and PEB(G+1, G+2, G+3))

	Height (m)	Main frames	Purlins	Connections	Gross Weight
PEB	G+1	24.39		3.04	29.86
CSB		31.79	2.43	4.76	38.98
PEB	G+2	36.44		4.55	45.86
CSB		48.44	4.86	7.26	60.57
PEB	G+3	48.50		6.06	61.55
CSB		65.66	7.29	9.84	82.80

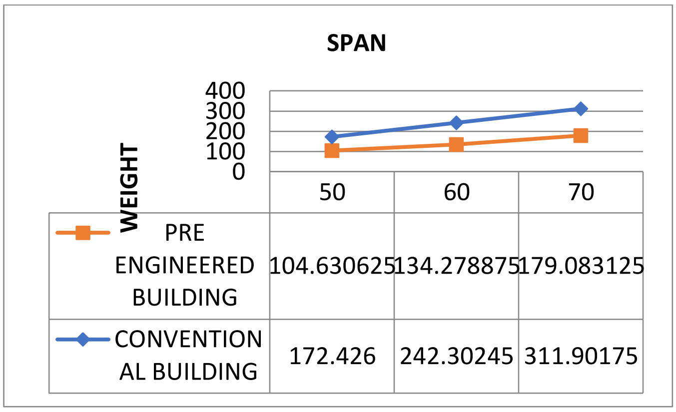
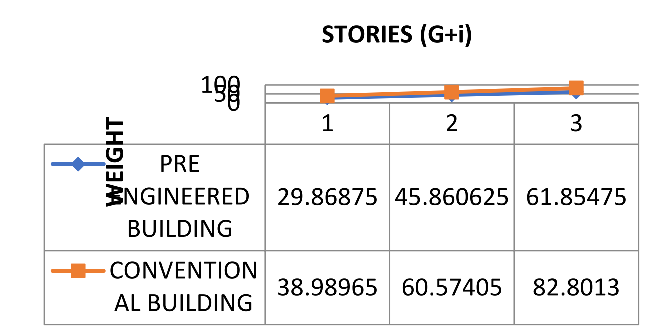


Fig -7: Variation in weight for CSB and PEB (Span 50m, 60m, 70m)



	1	2	3
PRE ENGINEERED BUILDING	29.86875	45.860625	61.85475
CONVENTIONAL BUILDING	38.98965	60.57405	82.8013

Fig -7: Variation in weight for CSB and PEB (G+1, G+2, G+3)

CONCLUSIONS

- Now a days PEB concept has been very successful and well established
- PEB construction reduces the weight of building compared to CSB structures
- It reduces the amount of steel requirement, reduction in dead load reduces the size of foundation
- PEB construction is 30 to 40% faster than conventional steel structures
- Provide good insulation effect and would highly suitable for a tropical country like India
- PEB is ideal for construction in remote and hilly areas

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