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Comparison of C- Section and H -Section Pre-Engineering Aircraft Hangar

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Abstract: The advent of the Pre-Engineered Building concept in recent years has aided in design optimization. Long span, column-free buildings are critical in any sort of engineering construction, and Pre-Engineered Building meet this criterion while optimization of money& time over traditional structures. This approach is adaptable not only because of its high-quality predesigned and prefabrication, but also because of its light weight and cost-effective construction. In this study, a 60m clear span aircraft hangar is developed using STAAD.Pro and compared to a C- Section and H- section PEB.
Keywords: Aircraft Hangar, Bay spacings, Hollow section Pre-Engineered Building (H – PEB), Channel section Pre-Engineered Building (C – PEB)

I. INTRODUCTION

In practically every corner of the world, the steel sector is one of the fastest expanding industries. As the world's second fastest expanding economy, India's construction sectors account for a significant portion of its growth. Steel is hundred percent eco-friendly and the majority recycled items, making it not only cost-effective but also extremely environmentally friendly. As a result, each tone of recycled steel saves around 1,000 pounds of coal and 2,500 pounds of iron ore. Steel members are also characterized by strong tensile strength and ductility. When concrete is not practical or construction time is important, steel is commonly employed in the construction of industrial buildings with wider spans.
A pre-engineered building (PEB) is a structure designed by a manufacturer to be manufactured using a pre-determined inventory of raw materials and manufacturing techniques to fulfill a variety of structural and aesthetic design standards at a reasonable cost. In some industrial locations, these structures are referred to as Pre-engineered Metal Buildings.
A hangar is a closed structure to hold aircraft or spacecraft in protective storage. Hangars are used for protection from weather, protection from direct sunlight, maintenance, repair, manufacture, assembly and storage of aircraft on airfields, aircraft carriers and ships. Hangars need special structures to be built. The width of the doors is too large and spans from 30 meters to 120 meters, thus enables the aircraft entrance. The bigger the aircraft are to be introduced; the more complex structure is needed. Hence Pre-Engineered buildings are specially designed and engineered to fit together to satisfy the unique requirements of specific end-uses
Advantages of pre-engineered buildings over conventionally designed buildings. Cost of construction is less as compare to truss placed along width of span & this gives new method of truss placing in roofing system. The result shows that these structures are energy efficient and flexible in design.
Pre-engineered-structures are energy efficient, energy efficient and flexible in design. Cost of construction is less as compare to truss placed along width of span &this gives new method of truss placing in roofing system. Conventional steel-structure is 30% heavier than pre-Engineered-Structure and size of foundation is reduced.

II. METHODOLOGY

The current research is being used in the design of an aircraft hangar at Prayagraj, Uttar Pradesh. The construction will be a Pre-Engineered Building with a width of 60 meters, ten bays of 8.48 meters each, and an eave height of 22 meters. A PEB frame with a width of 22 meters is used in this work, and the design is carried out with wind load as the critical load for the structure. The designs are made in compliance with Indian Standards and with the use of structural analysis and software design.
The complete structure configuration details are given below:
1) Type of Structure: Aircraft Hangar
2) Location: PRAYAGRAJ
3) Length: 63m
4) Width: Primary Building - 60m (Clear span)

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5) Secondary Building - 6m
6) Total Building - 72m
7) Eave height: 23.15m
8) Ridge angle: PEB - 1in10
9) Bay spacing: PEB – 6m

III. MATERIAL

The material used to create the PEB structure has a yield strength of 350 Mpa, a density of 7850 kg/m3, and a Young's modulus (E) of 2.0 x 1011 N/m2

IV. LOAD CALCULATION

A. Dead load

Dead load consists of the structure's own weight as well as the weights of the roof, the steel sheets, the purlins, the sag rods, the bracing, and other accessories.

TABLE.1. STRUCTURE CONFIGURATION

Roof Sheet	GI Sheet with unit weight of 5.6 kg/m2
Purlin	Assuming purlin unit weight of 6.4 kg/m2
Total Dead load on plan area	5.6 + 6.4 = 12 kg/m2
Dead load on Rigid frame	Total dead load on plan area ×Bay Spacing = 0.12 kN/m2 × 6m = 0.72 kN/m Side Cladding load same as dead load w.r.t different effective width.

B. Live load

According to IS: 875 (Part 2) – 1987, for roof with no access provided, the live load can be taken as 0.75 kN/m2

Total Live load on plan area = 0.75 kN/m2

Live load on Rigid frame = Total Live load on plan area * Bay Spacing

= 0.75 kN/m2 * 6m

= 4.5 kN/m

C. Collateral Load

A particular kind of dead load called collateral or superimposed dead load comprises the weight of all objects except the permanent structure.

Total Collateral load on plan area = 0.05kN/m2

Collateral load on Rigid frame = Total collateral load on plan area * Bay spacing

= 0.05 kN/m2 * 6m

= 0.3 kN/m

D. Earthquake Load

Zone = III Zone factor (Z) = 0.16

Important Factor (I) = 1 Response Reduction Factor (R) = 5

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E. Wind Load

Wind load is calculated as per IS: 875 (Part 3) – 2015.

The wind load is applied to side walls as evenly distributed loads that move either inward or outward from the walls depending on the wind situation. A uniformly distributed force operating outward over a PEB rafter can be used to represent the wind load over the roof.

Basic Wind speed (V_b) = 44 m/sec

- Risk coefficient (k1) = 1
- Terrain & Height factor for category 2 (k2) = 1.08
- Topography factor (k3) = 1
- Importance factor for cyclonic region (k4) = 1
- Design wind speed, Vz = Vb * k1 * k2 * k3 * k4
  = 44* 1 * 1.08 * 1 * 1
  = 47.52 m/s
- Wind pressure, pz = 0.6 * Vz2
  = 0.6 *47.52^2
  = 1.354 kN/m2
- Design wind pressure, pd = K_d * Ka * Kc* pz
- Wind directionality factor (Kd) =0.9
- Area averaging factor (Ka) = 0.8,
- Combination factor (Kc) = 0.9,
- Design wind pressure, pd = 0.9 * 0.8 * 0.9 * 1.75
  = 1.13 kN/m2 or 1.225 kN/m(pd should not be less than 0.7pz)

V. MODELLING

STAAD PRO V8i is used to conduct the analysis. A total of 152 load combinations, as defined by IS 875, are analyzed, including dead, live, collateral, wind, earthquake, and crane loads. The structure is created for the characteristics specified above; the ridge angle and bay spacing are both adjusted, one at a time, with the remaining constant. The parameter combination that results in the low quantity of steel is indicated.

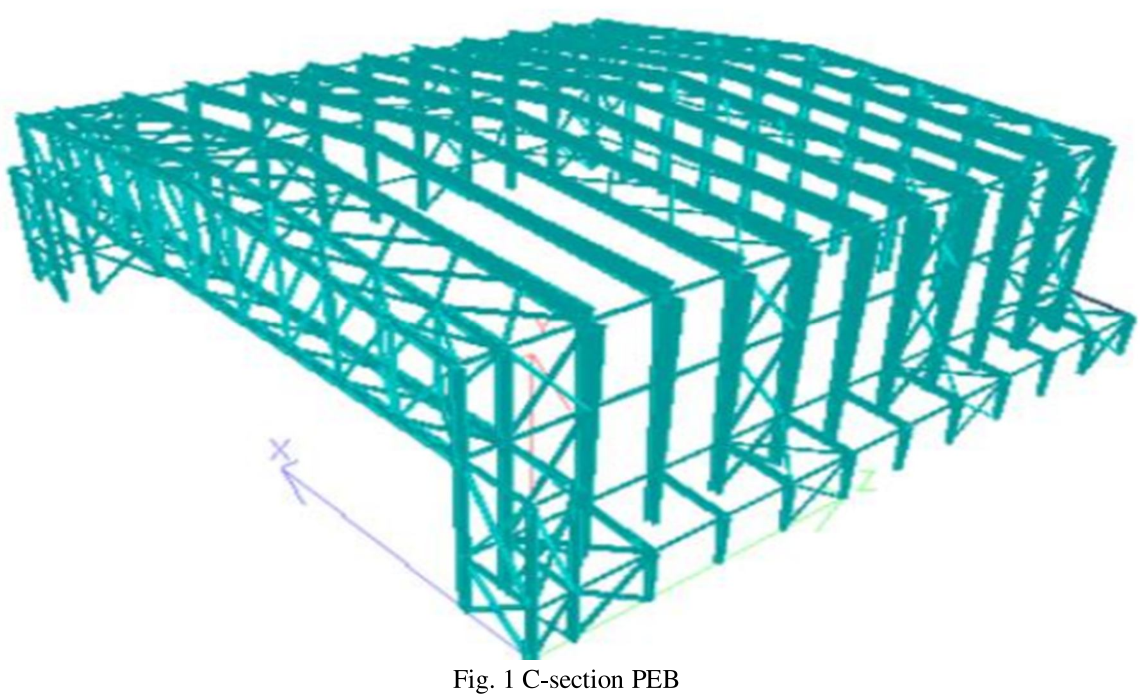

Fig. 1 C-section PEB

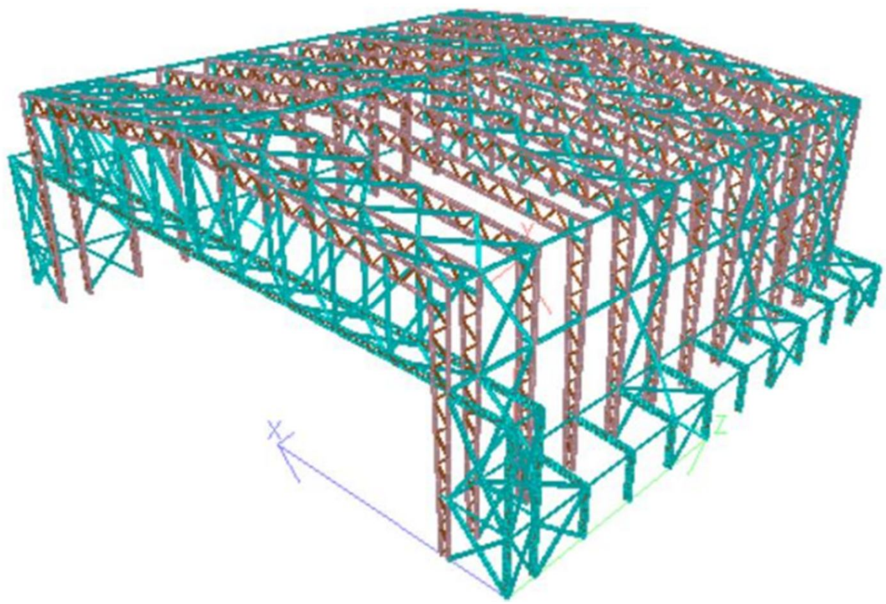

Fig.2 H-section PEB

VI. RESULT

TABLE.2OUTPUT COMPARISON C-PEB VS H-PEB

	C-PEB	H-PEB
Maximum Value of Reaction at Support (kN)	1544	2095
Maximum Value of Moment at Support (kNm)	2034	308
Maximum Value of Moment at Beam Rafter Junction (kNm)	4003	678
Maximum Value of Moment at Ridge of Rafter (kNm)	1795	103
Steel Consumption (t)	485	453

TABLE.3DEFLECTION COMPARISON C-PEB VS H-PEB

Deflection Check	Allowable Deflection (mm	Deflection values from STAAD (mm)	
		C-PEB	H-PEB
Lateral Deflection	154.3	88.3	117.4
Vertical Deflection	333.3	213.8	267.2

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A. Bay Spacings And Ridge Angles

By altering bay spacings (B) and ridge angles, C-PEB is examined in more detail. The structure with bay spacing of 6m, 6,667m and 7.5m is braced on 4 bays, while the structure with Bay spacing of 8.57m is straddled on 3 bays. For each bay spacing (B) the ridge slope of the structure is changed to 1in5, 1in6, 1in7.5, 1in10,1in15 & 1 in 20.

TABLE.4 Output Comparison -Moment at Support

Maximum Value of Moment at Support (kNm)						
B/Ø	1 in 5	1 in 6	1 in 7.5	1 in 10	1 in 15	1 in 20
6m	2055	2148	2043	1976	1835	1803
6.667m	2458	2437	2308	2058	2078	2037
7.5m	2607	2678	2593	2338	2287	2258
8.57m	3044	3208	3005	3769	2704	2697

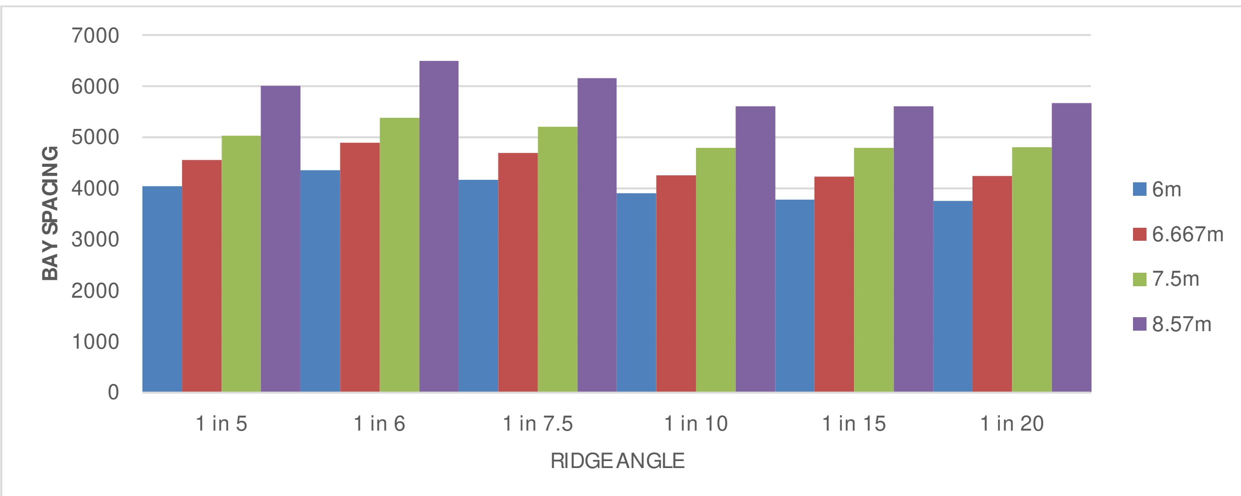


Fig3.Output Comparison - Moment at Beam Rafter Junction

TABLE.5DEFLECTION COMPARISON BAY SPACINGS AND RIDGE ANGLES

B/Ø	1 in 5		1 in 6		1 in 7.5	
	Lateral	Vertical	Lateral	Vertical	Lateral	Vertical
6m	130	200.4	128.4	234.3	102.5	223.7
6.667m	143.5	224.8	142.7	251.8	113.8	246.8
7.5m	156.3	248.3	152.4	280.3	122.7	276.1
8.57m	187.2	291.6	185.8	239.7	150.3	328.4

B/Ø	1 in 10		1 in 15		1 in 20	
	Lateral	Vertical	Lateral	Vertical	Lateral	Vertical
6m	98.3	213.4	81.5	221.3	78.3	226.1
6.667m	107.2	232.8	90.8	240.7	86.7	244.9
7.5m	115.7	268.3	98.9	272.4	97.1	279.3
8.57m	136.9	308.1	119.3	315.6	114.9	318.6

TABLE.6 AVERAGE INCREASE IN LATERAL DEFLECTION (B/θ)

B/ Ø	% increase in Bay spacing	1 in 5	1in 6	1in 7.5
6m to 6.667m	11.12%	10.38%	11.14%	11.02%
6m to 7.5m	25.00%	20.23%	18.69%	19.70%
6m to 8.57m	42.83%	44%	44.70%	46.63%

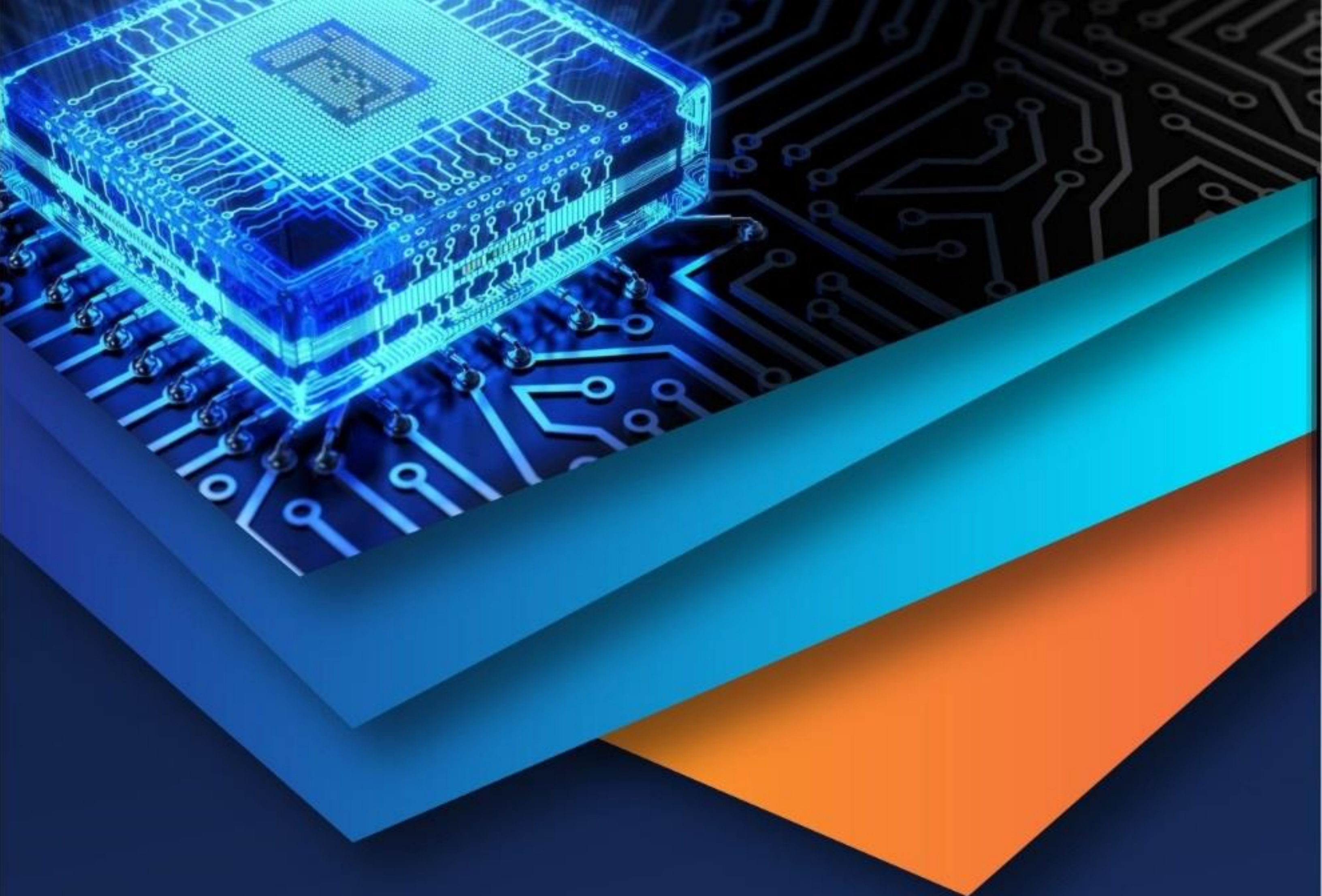
1 in10	1 in 15	1 in 20	Average increase in Lateral Deflection
9.05%	9.3%	10.72%	10.27%
17.70%	21.35%	21.01%	19.78%
39.26%	46.38%	46.74%	44.62%

VII. CONCLUSION

1) As bay spacing is increased and ridge angle is reduced, the consumption of steel lowers.
2) Hollow sections are used in PEB replacing bracings, tie members made of angle and channel sections saved 20.3% of steel used
3) A ridge angle of 1 in 20 demonstrated less use of steel for a clear span of 60 m with bay spacing of 8.57 m.
4) Regarding BM, reactions, and the use of steel, the 1 in 10 ridge angles was very successful and efficient.
5) For a constant frame depth if there is 11.1%, 25% and 42.83% increase in bay spacing there was about 10.27%, 19.78% and 44.62% increase in lateral deflection.

REFERENCES

[1] Aijaz Ahmad Zende, Prof. A. V. Kulkarni, Aslam Hutagi (Feb 2013). "Comparative Study of Analysis and Design of Pre-Engineered Buildings and Conventional Frames
[2] Balaji A Raju and A Praveen (2013) on "Innovative Cold form based composite section for enhancing sustainability in built environment".
[3] Aditya Dubey, AkshataSahare (Nov 2016) on "Main frame design of pre-engineered building
[4] MilindBhojkar and Milind Darade (December 2014) on "Comparison of Pre Engineering Building and Steel Building with Cost and Time Effectiveness
[5] B K Raghu Prasad, Sunil kumar, Amaranth K (September 2014) on "Optimization of Pre-Engineered Buildings".
[6] C. M. Meera (June 2013). "Pre-engineered building design of an industrial warehouse"
[7] P.S.Lande ,Vivek. V. Kucheriy, "Comparative study of pre-engineered building with conventional steel building",
[8] Sai Kiran Gone, Kailash Rao, Pradeep Kumar Ramancharl, "Comparison of Design Procedures for Pre-Engineering Buildings (PEB)"
[9] Charkha and LateshS.Sanklecha, "Economizing Steel Building using Pre-engineered Steel Sections"
[10] Balaji A Raju, A Praveen, "An Innovative cold form based composite section for enhancing sustainability in built environment".
[11] Pradeep V, Papa Rao G, "Comparative Study of Pre-Engineered and Conventional Industrial Building".



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