iJRASET
International Journal For Research in
Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 10 **Issue:** VII **Month of publication:** July 2022

**DOI:** https://doi.org/10.22214/ijraset.2022.46075

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

# Comparison of Pinned Support and Fixed Support Pre-Engineering Aircraft Hangar

Ashutosh Kumar[1], Prince Yadav[2]
[1]M. Tech, Structural Engineering, Institute of Engineering and Technology, Lucknow, Uttar Pradesh, India
[2]Assistant Professor, Department of civil engineering Institute of Engineering and Technology, Lucknow, Uttar Pradesh, India

***Abstract: Conventional steel buildings are an old concept that requires a significant amount of time and money. To modify A pre-engineering concept is being developed for this problem. It introduced to the Indian market in 1990's.PEB concept is totally versatile due to its quality, prefabrication, light weight and economical construction. In structural engineering, a pre-engineered building (PEB) is designed by a manufacturer to be fabricated using a pre-determined inventory of raw materials and manufacturing methods that can efficiently satisfy a wide range of structural and aesthetic design requirements. Pre engineered steel buildings can be fitted with different structural accessories including mezzanine floors, canopies, fascias, interior partitions etc. and the building is made water proof by use of special mastic beads, filler strips and trims. 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. 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 spacing, Hollow Pre-Engineered Building (H – PEB), Pre-Engineered Building***

## I. INTRODUCTION

Because steel is ductile and flexible by nature, steel is the material of choice for design. Under heavy weights, it flexes rather than breaking and disintegrating building construction continues to prefer structural steel because of its low cost, strength, durability, design flexibility, adaptability, and recyclability. Today's structural steel frame offers new chances and solutions to build complex structures that were previously thought to be unachievable, fusing grace, beauty, and utility in virtually unlimited ways.

Pre-engineered buildings are new steel structures that are being developed and built to replace traditional steel structures. The pre-engineered components are created in accordance with design specifications and standards in a controlled environment, resulting in high quality, precision products that are later transported and assembled on-site .Pre-engineered buildings are used for long span structures because they are cost effective, give flexibility for future expansion, and require little maintenance. The pre-engineered building concept uses steel building systems that are predesigned and prefabricated. The PEB approach is based on giving the section only at the point where it is needed. According to the bending moment diagram; the sections may vary along the length. When planes are not in use, they are stored in the hangar. A hangar is a covered building used to park aircraft or spacecraft safely. Aircraft are maintained, repaired, manufactured, assembled, and stored in hangars on airfields to keep them safe from the weather and direct sunlight. 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 structure will be a Pre-Engineered Building with a width of 60 meters, bays of 6 meters each, and an eave height of 24 meters. In this work, a PEB frame with a width of 60 meters is used, and the design is carried out with wind load as the critical load for the structure. The designs are made in accordance with Indian Standards and employ structural analysis and software design by STAAD PRO V8i.The complete structure configuration details are given below:

*A.* Type of Structure: Aircraft Hangar
*B.* Location: PRAYAGRAJ
*C.* Width: 60m (Clear span)
*D.* Eave height: 24 m

*E.* Ridge angle: PEB – 1 in 10
*F.* Bay spacing: PEB – 6m

## III. MATERIAL

The PEB structure's material 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*

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 = .72 kN/m<br><br>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. Wind Load*

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

Basic Wind speed ($V_b$) = 50 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
  = 50 * 1 * 1.08 * 1 * 1
  = 54 m/s
- Wind pressure, pz = 0.6 * Vz2

= 0.6 *542

= 1.75 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. . IS 875 load combinations are analyzed, including dead, live, collateral, wind, earthquake, and crane loads.

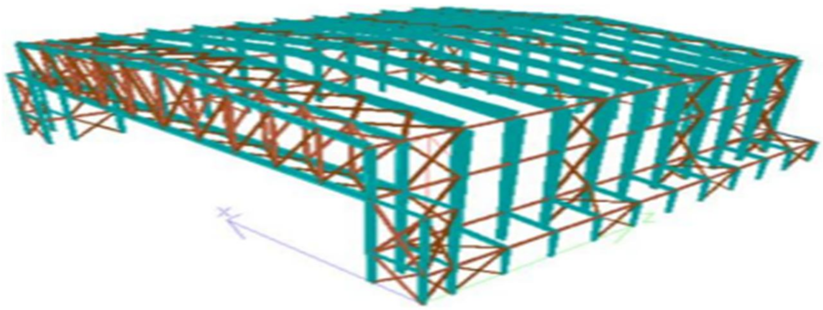


Fig. 1 PEB Fixed

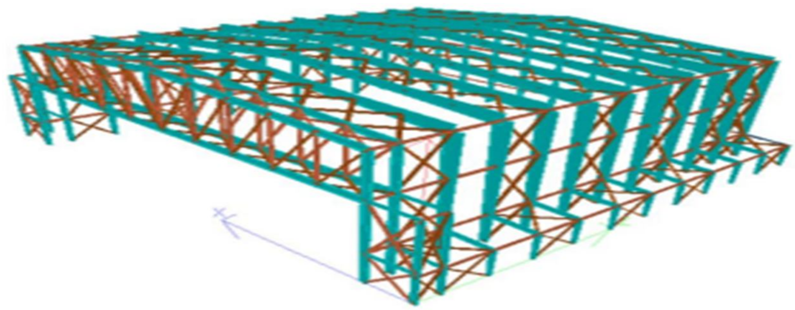


Fig.2 PEB Pinned

## VI. RESULTS

Table 2 –Comparison between PEB (Fixed) VS PEB (Pinned)

| | PEB (Fixed) | PEB (Pinned) |
|---|---|---|
| Maximum Value of reaction at support (kN) | 1412 | 1518 |
| Maximum Value of moment at support (kNm) | 1697 | 0 |
| Maximum Value of moment at beam rafter junction (kNm) | 3795 | 3557 |
| Maximum Value of Moment at Ridge of Rafter (kNm) | 1702 | 1786 |
| Steel Consumption (t) | 449 | 502 |

Table 3 – Deflection Comparison PEB (Fixed) VS PEB (Pinned)

| Deflection Check | Allowable Deflection (mm) | Deflection values from STAAD (mm) PEB | |
|---|---|---|---|
| | | PEB (pinned) | PEB (fixed) |
| Lateral Deflection | 154.3 | 141.02 | 84.7 |
| Vertical Deflection | 333.3 | 238.6 | 212.5 |

## VII.CONCLUSION

*A.* For this 60 meter clear-span structure, the PEB with fixed support weighed 10.8% less than the PEB with pinned support. As a result, suitable support conditions can be chosen based on client needs and soil conditions to optimise steel take off.

*B.* The maximum value of reaction at support at pinned support is 106 KN more than fixed support.

*C.* The maximum value of moment at beam rafter junction at pinned support is 238 kN more than fixed support.

*D.* The Lateral Deflection in case of fixed support is 40% less than pinned support.

*E.* The Vertical deflection in case of fixed support is 11% less than pinned support.

*F.* The steel consumption in the case of pinned support is 53 tonnes less than for fixed support.

## REFERENCES

[1] P.S.Lande ,Vivek. V. Kucheriy, "Comparative study of pre-engineered building with conventional steel building", International journal of pure and applied research in engineering and technology]

[2] Sai Kiran Gone, Kailash Rao, Pradeep Kumar Ramancharl, "Comparison of Design Procedures for Pre Engineering Buildings (PEB)", International Journal of Civil, Architectural, Structural and Construction Engineering, August 2014 Report No: IIIT/TR/2014/-1]

[3] Charkha And Latesh S.Sanklecha, " Economizing Steel Building using Pre-engineered Steel Sections", International Journal of Research in Civil Engineering, Architecture & Design Volume 2, Issue 2, April-June, 2014]

[4] Balaji A Raju, A Praveen ,"A Innovative cold form based composite section for enhancing sustainability in built environment", [International journal of pure and applied research in engineering and technology]

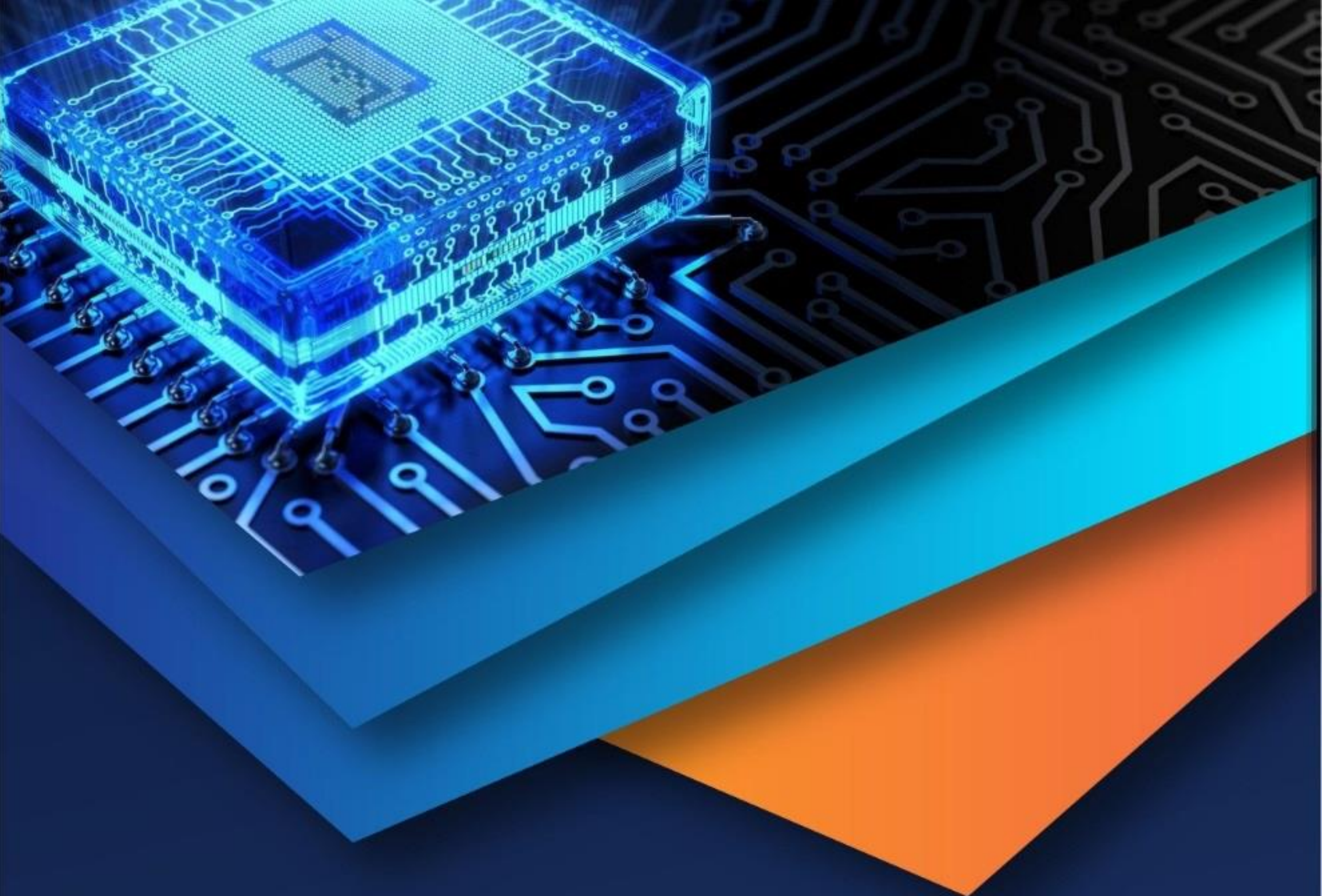
[5] Pradeep V, Papa Rao G, "Comparative Study of Pre Engineered and Conventional Industrial Building", International Journal of Engineering Trends and Technology (IJETT) – Volume 9 Number 1 - Mar 2014].

[6] 4.IS: 800 -2007:-General Construction In Steel -Code of Practice.

[7] 5.IS: 875 (Part 1) -1987:-Code of Practice for Design Loads (Other Than Earthquake)for Buildings and Structures-Dead Loads.

[8] IS: 875 (Part 2) -1987:-Code of Practice for Design Loads (Other ThanEarthquake)for Buildings and Structures-Live Loads.

[9] IS: 875 (Part 3) -1987:-Code of Practice for Design Loads (Other Than Earthquake) for Buildings and Structures




10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR:
7.429


# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY