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ANALYTICAL STUDY OF PEB OVER CSB STRUCTURE

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ABSTRACT
In recent years, the introduction of Pre-Engineered Building (PEB) design of structures has helped in optimizing design. The construction of PEB in the place of Conventional Steel Building (CSB) design concept resulted in many advantages as the members are design as per bending moment diagram and thus reducing the steel requirement. In this study, an industrial structure PEB Frame & CSB Frame is analyzed and designed according to the Indian standards, IS 800-1984, IS 800-2007. The economy of the structure is discussed in terms of its weight comparison, between Indian codes (IS800-1984, IS800-2007) & in between PEB & CSB building structure.

Cost of steel is increasing day by day and use of steel has become inevitable in the construction industry in general and in industrial building in particular. Hence to achieve economic sustainability it is necessary to use steel to its optimum quantity. Long span, Column free structures are the most essential in any type of industrial structures and Pre-Engineered Buildings (PEB) fulfill this requirement along with reduced time and cost as compared to conventional structures. This methodology is versatile not only due to its quality pre-designing and pre-fabrication, but also due to its light weight and economical construction.

Keywords: Pre-Engineered Buildings PEB Sheds, Staad pro design, CSB frames, Tapered Section.

I. INTRODUCTION:

Explosive loading incidents have become a serious problem that must be addressed quite frequently. Many Steel industry is growing rapidly in almost all the parts of the world. The use of steel structures is not only economical but also eco-friendly at the time when there is a threat of global warming. Here, “economical” word is stated considering time and cost. Time being the most important aspect, steel structures (Pre-fabricated) is built in very short period and one such example is Pre-Engineered Buildings (PEB). Pre-Engineered Buildings have bolted connections and hence can also be reused after dismantling. Thus, Pre-Engineered buildings can be shifted and/or expanded as per the requirements in future. In this report, a comparison will be made between Pre-Engineered buildings and conventional steel structures. One of the great advantages of cold-formed steel (CFS) is the immense flexibility that the material affords in forming cross-sections. This flexibility would seem to readily lend itself to optimization of member cross-section shapes. Cold formed sections also having the great flexibility of cross-sectional profiles and sizes available to structural steel designers. Whereas, the low strength-to- weight ratio of hot rolled steel members leads to increase in overall load on structure as compared with cold-formed steel sections which is having high strength-to-weight ratio. In Industrial building structures, the walls can be formed of steel columns with cladding which may be of profiled or plain sheets, GI sheets, precast concrete, or masonry.

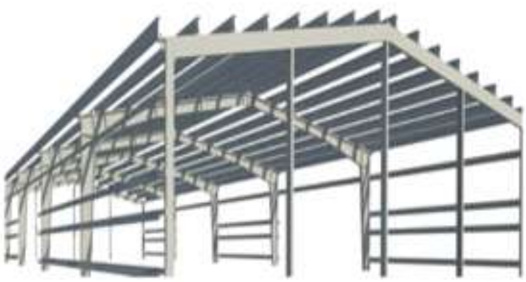

Fig.1 CSB Structure

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Fig. 2 PEB Structure

1.1 Objective

The objectives of the current study can be recognized as follows:

- The main objective of our project is to compare the design of pre-engineered steel structure with conventional steel structure system (industrial building) using IS 800:2007 IS 875 & IS1893.
- To provide stable and safe structure with economic perspective
- Design primary & secondary element of P.E.B & C.S.B and to study the optimized section of structure.
- Compare the weight of normal CSB structures to PEB structures.
- To give replacement to conventional steel structure by PEB structure.
- Compare the span length of CSB and PEB structure.
- To study comparative costing of various types of system.
- To give advance or easier methods of construction.
- Reduce the time span of construction by using of PEB structure.

1.2 Design of PEB Structure

In structural engineering, a pre-engineering (PEB) is design by a PEB supplier or PEB manufacturer, to be fabricated using best suited inventory of raw materials available from all source and manufacturing methods that can efficiently satisfied a wide range of structural and aesthetic design requirement. Each component of the building comes prepunched, marked, completely constructed to specifications OFF-SITE and shipped to site. This facilitates the minimum ON-SITE work and the erector has to simply assemble the pieces together at site by bolting is called Pre-Engineering steel Building.

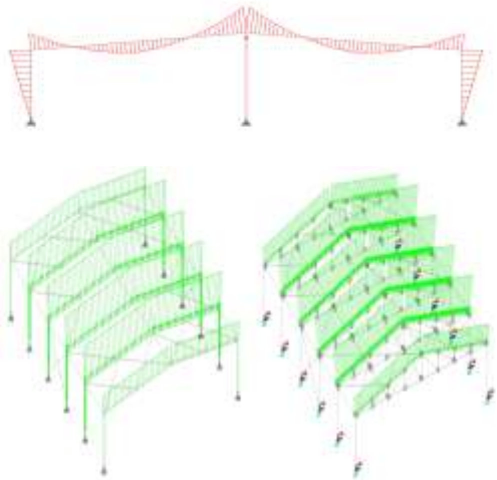

Fig.3 BMD of Pre-Engineering Frame With Intermediate Support

1.3 Design of CSB Structure

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

1.4 Geometry of Structure

- **Design Dimensions:**

The parameter considered for warehouse design is,
Building Input Data:
Width = 25 Meters
Length = 30 Meters
Eave Height = 5 Meters
Bay Spacing = 6 Meters
Roof Slope (for PEB) = 5.71 degrees
Roof Slope (for CSB) = 11.30 degrees
Rise of roof (for PEB) = 1.25 m
Rise of roof (for CSB) = 2.5 m

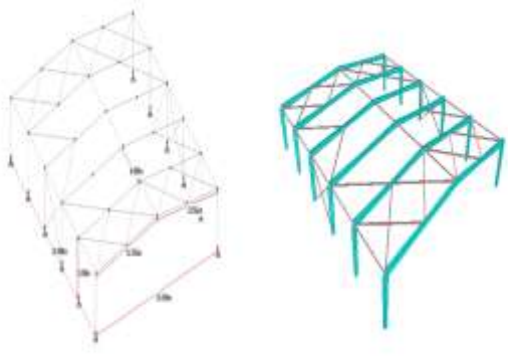

Fig. 4Elevation and 3D model of PEB Structure without Intermediate Support

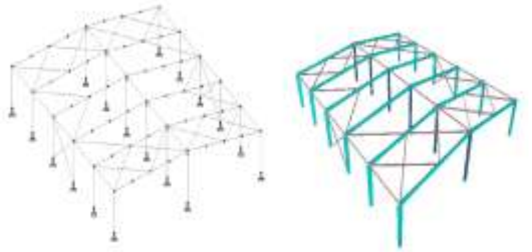

Fig.5 Elevation and 3D model of PEB Structure with Intermediate Support.

1.5 Loading Calculations

1.5.1 Dead load calculations:

Weight of GI sheet = 0.150 KN/m^2

DL of Sheeting on rafter and column = 0.15*6= 0.9 KN/m^2

Weight of purlins = 0.10 KN/m^2

Fig.6 Dead Load for PEB Structure and CSB Structure

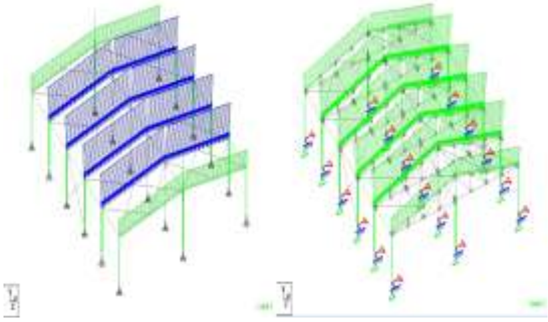

Fig.7 Dead Load for PEB and CSB Structure with Intermediate Support

1.5.2 Live load calculations:

Live load as per IS code 875 Part II for flat slopping or curved roof with slope up to 10^o (access not provided) taken as = 0.75 KN/m^2

Live load per meter run on rafter = 0.75 KN/m^2x6m (bay spacing) = 4.5 KN/m^2

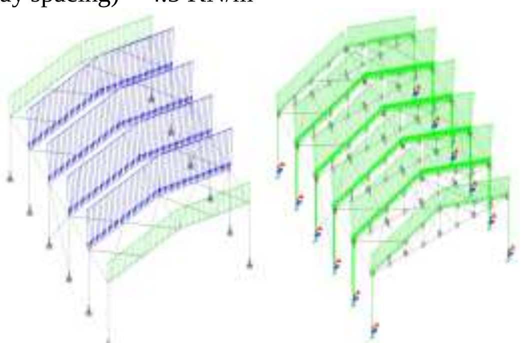

Fig.8 Live Load for PEB Structure And CSB Structure

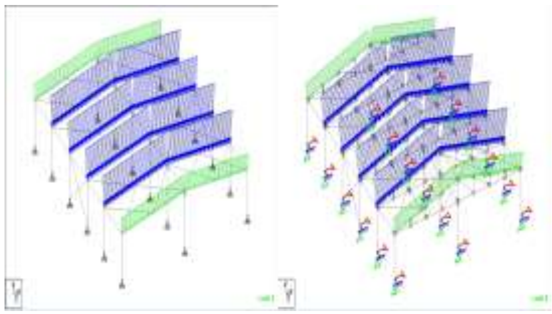

Fig 9 Live Load for PEB And CSB Structure With Intermediate Support

1.5.3 Wind load calculations:

Wind pressure calculation

Wind Speed V_b = 39 m/sec

Risk coefficient, k_1 = 1

Terrain, Ht& size factor, k_2 = 0.88 (Category 3 class B)

Topography Factor, k_3 = 1

Design Wind Speed,

$V_z = V_b \times k_1 \times k_2 \times k_3$

= 39 x 1 x 0.88 x 1 = 34.32 m/s

Design wind pressure,

P_z =0.6 x $(Vz)^2$ = 0.6 x 34.322= 707 KN/m^2 =0.707KN/m^2

Internal Pressure Coefficient (C_{pi}) = +/-0.2

External Pressure Coefficient for wall from IS 875 III tables (C_{pe})

From design dimensions

h/w = 5/30 = 0.16, (h/w< 0.5)

l/w = 30/30 = 1

City:Pune

Basic Wind Speed (Vb) =39m/s

Terrain Category =2 ...As per Table 2 (6.3.1)

(Exposed to open terrain with obstruction height between 1.5m to 10m)

HEIGHT	Category 2
	Pz (KN/m2)
10	1
15	1.05
20	1.07
30	1.12
50	1.17
100	1.24

Topographical Factor =1 ...Clause No 6.3.3

Importance Factor =1...Clause No 6.3.4

(For the Cyclonic Regions)

Vz=design wind speed = k1xk2xk3xk4xVb

Pz= wind pressure at height Z = 0.6xVz2

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HEIGHT	Category 2
	Pz (KN/m2)
10	0.91
15	1.01
20	1.05
30	1.15
50	1.25
100	1.40

Pd= Design wind pressure
Pd = kd x ka x kc xPz
Wind Directionality Factor= 0.9 ...As per Clause No 7.2.1
Area averaging factor= 0.9...As per Table-4
Combination factor=1...As per Clause No 7.3.13

Design Wind Pressure	
Height	Terrain Category 2
	Pd (KN/m^2)
10	0.74
15	0.82
20	0.85
30	0.93
50	1.01
100	1.14

External pressure coefficient (Cpe)
For Walls of rectangular shaped building ...as per Table 4-IS-875-Part3
Building Dimension:

Length (L) m	Width (W) m	Height (h) m
30.0	25.0	6.25

h/w = 0.25
L/w = 1.2
For above ratios (h/w) and (l/w) ...as per Table 5-IS-875-Part3 clause 7.3.3.1

Cpe for surface	A	B	C	D
When Wind angle is zero (0) degree	0.70	-0.20	-0.50	-0.50
When Wind angle is 90 degree	-0.50	-0.50	0.70	-0.20

Internal pressure coefficient (Cpi) Clause 7.3.2
For building with medium openings i.e. Openings between about 5% to 20% of wall area.

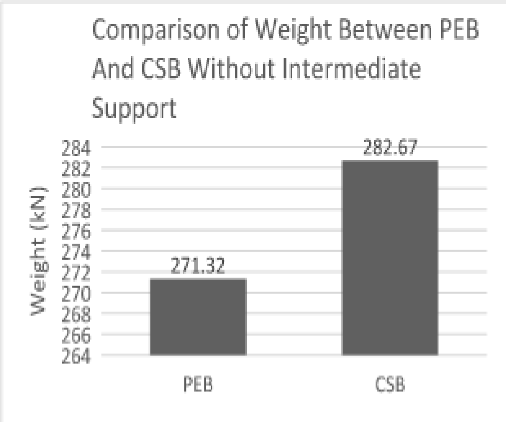
Cpi = 0.50
Cpi = -0.50
Sign Convention:
Cpe/Cpi _Positive Force Acting towards the wall

Cpe/Cpi _Negative Force Acting away from the wall

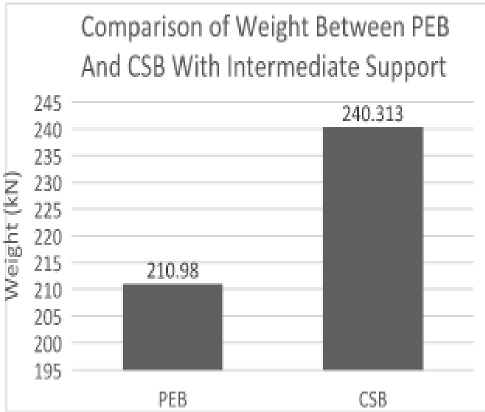
II. RESULTS AND DISCUSSION

2.1 comparison of Different parameters

- Comparison of Weight between PEB & CSB Structure Without Intermediate Support
PEB=271.32 KN
CSB=282.67 KN



- Comparison of Weight between PEB And CSB With Intermediate Support
PEB=210.98 KN
CSB=240.313KN



- Comparison of Axial Force between PEB & CSB Structure Without Intermediate Support.
PEB= 177.279 KN
CSB= 394.884 KN

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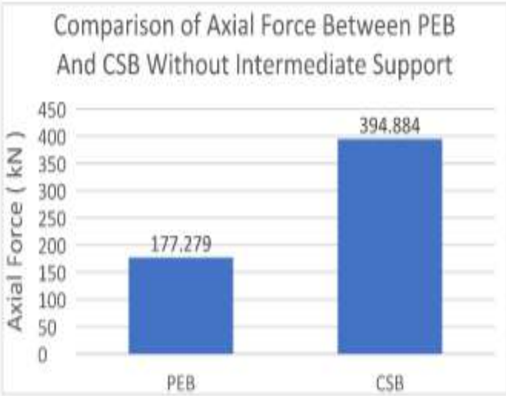
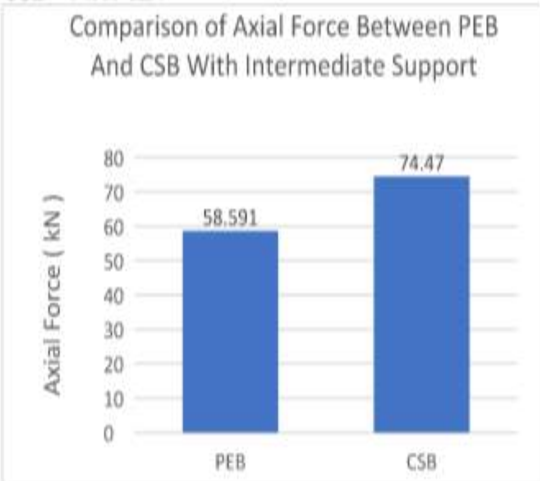


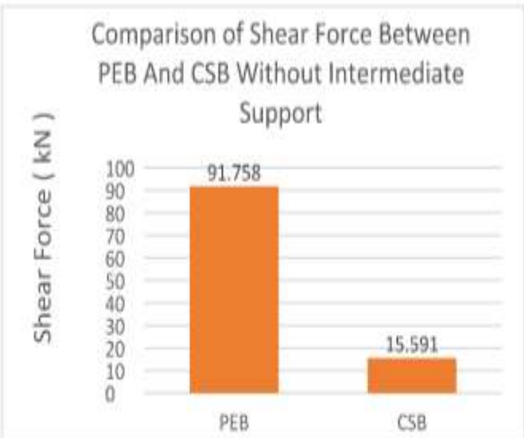
- Comparison of Axial Force between PEB & CSB Structure With Intermediate Support

PEB= 58.591 KN
CSB= 74.47 KN



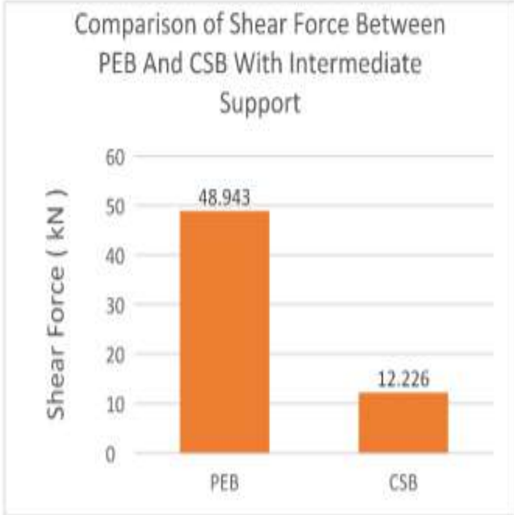
- Comparison of Shear Force between PEB & CSB Structure Without Intermediate Support

PEB=92.758 KN
CSB= 15.591KN



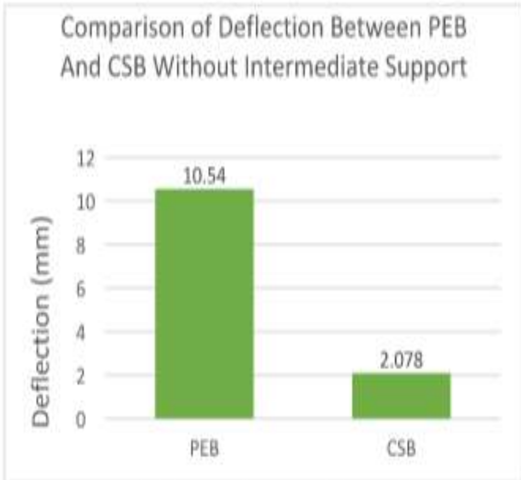
- Comparison of Shear Force between PEB & CSB Structure With Intermediate Support

PEB= 48.943 KN
CSB= 12.226 KN



- Comparison of Deflection between PEB & CSB Structure Without Intermediate Support

PEB= 10.54 mm
CSB= 2.078 mm



- Comparison of Deflection between PEB & CSB Structure With Intermediate Support

PEB= 19.81 mm
CSB= 2.63 mm

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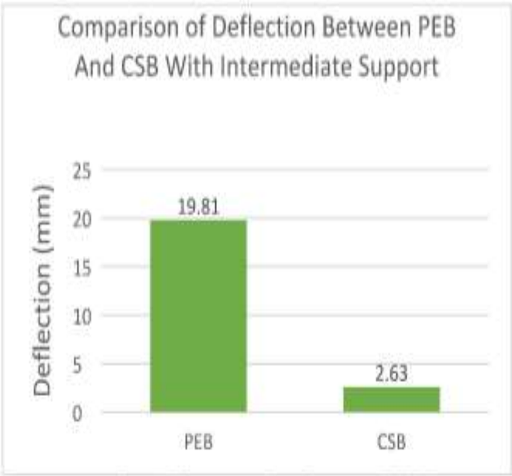
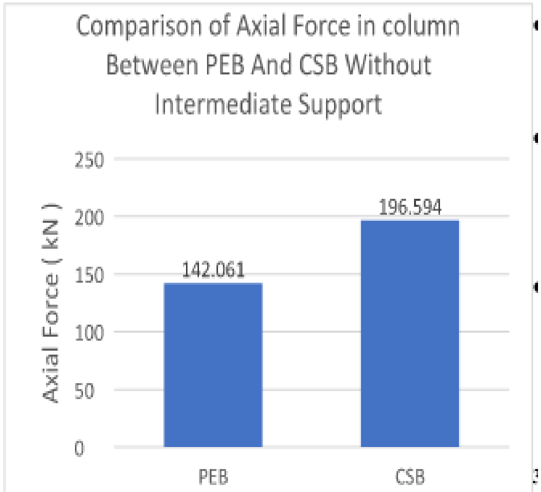


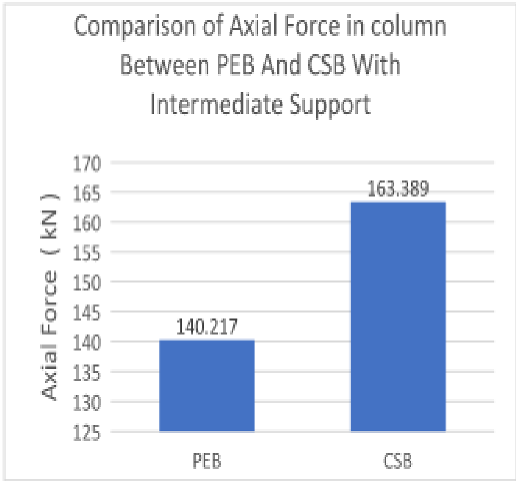
- Comparison of axial force in column between PEB & CSB Structure Without Intermediate Support

PEB= 142.061 KN
CSB= 196.594 KN



- Comparison of axial force in column between PEB & CSB Structure With Intermediate Support

PEB= 140.217 KN
CSB= 163.389 KN



2.2 Results

- The maximum axial force in PEB and CSB are found to be compression in nature having values 177.279 KN and 394.884 KN respectively without intermediate support.
- The maximum axial force in PEB and CSB are found to be compression in nature having values 58.591 KN and 74.47 KN respectively with intermediate support.
- The maximum shear force in PEB is 91.758 KN and in CSB 15.591 KN. without intermediate support.
- The maximum shear force in PEB is 48.943 KN and in CSB 12.226 KN with intermediate support.
- The maximum deflection in PEB is 10.54 mm and in CSB is 2.078 mm without intermediate support.
- The maximum deflection in PEB is 19.81 mm and in CSB is 2.63 mm with intermediate support.
- The maximum axial force in column for PEB and CSB are found to be 142.061 KN and 196.594 KN respectively without intermediate support.
- The maximum axial force in column for PEB and CSB are found to be 140.217 KN and 163.389 KN with intermediate support.
- As per IS 800:2007 and costing calculation the weight of steel utilized PEB is 271.32 KN and for CSB 282.67 KN in the absence of intermediate support.
- As per costing calculation the weight of steel utilized PEB is 210.98 KN and for CSB 240.313 KN with intermediate support.

III. CONCLUSION

- As per the above calculation PEB with intermediate support is going to be most economical design with total steel weight of 271.32 KN as compare to CSB as 240.313 KN.

- PEB offers strength, durability, design flexibility and economical structure.
- Due to reduction in size of member as per BM in section, Reduces weight of frame, hence optimizes the whole structure.
- By the reduction in the weight of structure. It reduces dead load on structure.
- For large span overall weight of structure decrease by adding intermediate support.
- Pre-Engineering Buildings are found to be economical for long span structures than Conventional steel buildings especially for low rise buildings spanning up to 90.0 meters with eave height up to 30.0 meters. PEB structures are found to be costly as compared to conventional structures in case of smeller span structures.
- It is also seen that the weight of PEB depends on the Bay Spacing, with the increase in Bay Spacing up to certain spacing, the weight reduces and further increase makes the weight heavier.
- Using of PEB increases aesthetic view of structure.

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