



IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 Issue: IX Month of publication: September 2022 DOI: https://doi.org/10.22214/ijraset.2022.46750

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## Analysis of Warehouse Structure in Pre-Engineered Building with Conventional Steel Building

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Abstract: The concept of Pre-Engineered Building in creation format of structures has helped into optimizing a design of steel structure. Steel industry sector is developing more hastily in almost throughout elements of the world. In a hazard of global warming the usage of steel structures is not only efficient but also sustainable at the time. In Pre-Engineered Buildings (PEB) steel structures (Pre-fabricated) time is being the maximum significant aspect is built in very short duration period. In any type of Industrial structures and Pre-Engineered Buildings (PEB) Maximum Span, Column free suitable structures are the most vital in fulfills this requirement at the aspect of decreased time and price in comparison to conventional structures. Here this is study is achieved by planning 3D frame of an Industrial Warehouse constructing the use of the thoughts and studying the frames using appropriate assessment and design software after due validation. In this research, an industrial structure warehouse is analyzed and designed according to the Indian standards (IS 800-2007) and additionally through referring American Standard (AISC LRFD). The various loads like dead, live, wind, seismic and snow loads according as per IS codes are considered for the present work for relative study of Pre-Engineered Buildings (PEB) and Conventional Steel Building (CSB). To compare the consequences of the numerous parametric study to perform the variations in terms of shear force, support reaction, weight correlation and cost evaluation.

Keywords: PEB, Conventional Steel Building, Ware House, Pre-fabricated , Tapered Section,

#### I. INTRODUCTION

Buildings & companies are one of the primeval creation activities of people. The present modern concept of house buildings the technology of creation has progressive since the established order from simple construction. India has emerged as one of the key worldwide markets for pre-engineered buildings steel structures. A plenty of growth has been given to do with the way how recognition towards steel buildings had been changing to developed a country. Today's the scene is such that PEB's are expected to about 25% to 30% of marketplace share within the creation industry sector.

The most recent improving technology was continuously increasing the maximum clear-span competencies of steel structures. In India the industry has fast development of steel building makes for exciting analyzing and it can have commenced all with the on location fabrication model. With the opening up of the economy during the 1990s but, such things started to change. In the might of the PEB enterprise this became the cause for predominantly "manufacturing plant constructed" structures and to achieve economy growth. In PEB technology steel is one of the world's most reused material and toward the finish of any steel product's life, practically 100% of it tends to be reused without losing its engineering properties, preferred and ecological construction methods. The tropical nation like in India to give great protection impact and would be highly suitable for a PEB structures. PEBs is an ideal construction sector for in remote & hilly areas.

A recently survey through the Metal Building Associations (MBMA) shows that nearby 50% to 60% of the non-residential near to the ground rises constructing in USA are pre-engineered buildings. This flexibility would seem to with ease provide itself to optimization of member cross-section shapes. In Industrial building systems, the partitions can be formed of steel columns with cladding which may be of profiled or plain sheets, Galvanized Iron sheets, roofing, precast concrete, or masonry work. The wall must be effectively in strong to resist the lateral pressure because of wind or seismic activity resistance.

As the PEBs offers fastest technique to construct the warehouses structures as compared to conventional methods and its demand for a broad range activities of construction will growth over the afterward four years. A growing range of distinguished International contractors and designers, who formerly certain conventional steel structural buildings entirely, have recently converted to the PEB approach.



ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538 Volume 10 Issue IX Sep 2022- Available at www.ijraset.com

#### II. FRAMING SYSYTEM

#### A. Concept of Conventional Steel Building

Conventional steel buildings (CSB) are small rise steel buildings with roofing structures of truss with roof coverings. The criterion selection process of roof truss also includes the gradient of the roof, pitch of the roof, fabrication and transport techniques, aesthetics, climatic conditions, etc. In a Conventional steel building design uses selected hot rolled "T" type steel sections that are regular in period but need to be reduce, punched, and bolted on site. The necessity of materials is delivered or produced in the plant and are placed to the site. The need for further economy of creation region and the design of the conventional buildings is governed through beneficial necessities. The Structural members are very hot rolled and are utilized in conventional buildings. Steel roof trusses are normally used for industrial buildings, work shop buildings, packaging areas, warehouses and even for residential buildings, faculty buildings, places of work whereas the construction work is to be completed in a short length of time. In high winds the structural performance of these buildings is well agreed and for the maximum part, suitable code provisions are presently in area to that that make certain excellent behavior. In a roof truss the entire section of every member is subjected to uniform stress and consequently the strength of every member is wholly utilized. A roof truss is essentially frame structure formed through connecting various members at their ends to form a system of triangle, organized in pre-determined pattern depending upon the distance, type of loading and functional requirements.

#### B. Concept of Pre-Engineered Building

Pre-Engineered steel structures are fabricated or created necessity in the plant itself. The production of structural members is done on customer requirements. The buildings were pre-engineered due to the fact they actually depend on general engineering designs for the limited amount of configurations. A pre-engineered building (PEB) is designed by the producer to be fabricated using a predetermined inventory of raw materials and production techniques that may be efficiently satisfy a wide variety of a structural and aesthetic view of design requirements within a few geographic manufacturing sectors these buildings are also called as Pre-Engineered Steel Buildings. Generally, a PEB is an inflexible jointed plane frame from hot-rolled or cold-rolled sections, helping the roofing and side cladding through hot-rolled or cold-formed sections purlins and sheeting rails. Z and C- shaped cold formed steel members may be used as secondary structural elements to fasten and support to the outside cladding. Steel building system usually a variety of wall materials, the unique creations and still the maximum popular being steel siding, supported by means of sidewall or end wall girts. In order to perfectly layout a pre-engineered building, engineers consider the clear span among the bearing factors, bay spacing, roof slope, dead loads, superimposed loads, collateral loads, wind uplift, deflection criteria, internal crane system and maximum realistic size and weight of the fabricated members. The use of an optimum least section leads to the equipped savings in steel and price reduction.



Fig. 1: Pre-Engineered Warehouse Structure

#### III. METHODOLOGY

In the research work, by using STAAD Pro V8i structural software three dissimilar types of 3D steel buildings are designed for static and vibrant forces. In this work, an industrial warehouse structure of length 60m with bay spacing at 6m along the length, 24m width and 8.402m eave height in which 2.1 m from ground level is used for brick work and remaining 6.3 m is used for cladding. The slope of roof is taken as 9.91° for both Pre-Engineered Steel Building and Conventional steel buildings and roofs are protected with GI sheet. The spacing of the purlins is maintained as 1.5m and girts is maintained as 2.1m. Pinned type of support condition can be used. The building layout plan of the proposed industrial warehouse structure considered for the study is as shown below in figure:





Fig 2. Plan Layout of Warehouse Structure



Fig. 3: Elevation of Warehouse Structure



A. Dead Load

Dead load calculation (IS 875-1987 Part-I):

Total load on purlin:

Weight of sheet= $0.058 \text{ kN/m}^2$  Weight of fixing=  $0.025 \text{ kN/m}^2$  Weight of services =  $0.1 \text{ kN/m}^2$  Spacing of Purlin = 1.523 m Total weight on Purlin =  $0.183 \text{ kN/m}^2$ 

Total weight on Purlin = weight  $(kN/m^2) \times$  spacing of Purlin

 $= 0.183 \times 1.523$ 

= 0.278 kN/m Assume weight of purlin

= 0.10 kN/m Weight of truss

= (Span/3+5)  $\times$  10

 $= (24/3+5) \times 10$ 

 $= 0.130 \text{ kN/m}^2$ 

 $= 0.103 \times \text{plan length}$ 

 $= 0.103 \times 1.5$ 

= 0.154 kN/m Total dead load = 0.532 kN/m

B. Live Load

=750-20(9.91-10)

 $= 0.751 \text{ kN/m}^2$ 

 $= 0.751 \times 1.523$ 

= 1.143 kN/m

 $= 2/3 \times 1.143$ 

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= 0.762 \text{ kN/m}
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ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538 Volume 10 Issue IX Sep 2022- Available at www.ijraset.com

C. Wind Load Wind load calculation (IS 875-1987 Part-III): Basic wind speed = Vb = 39 m/sDesign wind speed=  $Vz = K_1 K_2 K_3 V_b$  Design wind pressure=  $Pz = 0.6 Vz^2$ Wind pressure on roof =  $(C_{pe} - C_{pi})$  Where,  $C_{pe} = Coefficient$  of external wind pressure  $C_{pi} = Coefficient$  of internal wind pressure  $K_{1} = Risk$  coefficient  $K_2$  = Terrain height and structure size factor  $K_3$  = Topography factor For all general building and structure, Mean probable design life = 50 years Risk coefficient  $K_1 = 1.0$ Terrain category = 3 ..... (As height of building 10 m) Class B..... (As horizontal or vertical dimension in between 20 to 50 m) K2 = 0.99K3 = topography factor K3=1 $= 1.0 \times 0.99 \times 1.0 \times 39$ = 38.61 m/s Design wind pressure =  $Pz = 0.6 \times Vz2$  $= 0.6 \times 38.61^2$  $= 894 \text{ N/m}^2$ 

D. Load Combinations

Table 1. Load Combinations as per Design Codes

AISC-89/MBMA-86	IS 800-2007
Limit state of serviceability	Limit state of serviceability
(DL+LL)	(DL+LL)
(DL+WL/EL)	(DL+WL/EL)
(DL+CL)	(DL+LL+CL)
(DL+.05WL/EL+CL)	(DL+0.8LL+0.8WL/EL+0.8CL)
Limit state of strength	Limit state of strength
(DL+LL)	1.5(DL+LL)
(DL+CL)	1.5(DL+WL/EL)
0.75(DL+WL/EL)	(0.9DL+1.5WL/EL)
0.75(DL+WLRL-P)	(1.5DL+1.5LL+1.05CL)
0.75(DL+0.58WL/EL+CL)	(1.5DL+1.05LL+1.5CL)
	(1.2DL+1.2LL+0.6WL/EL+1.05CL)
	(1.2DL+1.2LL+0.6WL/EL+1.2CL)
	(1.2DL+1.2LL+1.2WL/EL+0.53CL)
	(1.2DL+1.2LL+1.2WL/EL+0.53CL)

#### V. STAAD PRO PROCESS

In the modern study, STAAD Pro V8i programming has been utilized in order to analyses and design PEB and CSB. The industrial warehouse structures we are designing is of Pre- Engineered structure. The sizable majority of the channel sections and angle sections are available in the steel tables of STAAD Pro V8i are the C or else I sections. In any case, for the design of PEB, there is likewise one command known as tapered sections. Optimum Tapered sections are one in which we can assemble the web, flange, their thicknesses, and so on. STAAD Pro is the structural engineering professional's decision for steel, concrete, timber, aluminum, and cold- formed steel design of practically any structure including of culverts, petrochemical plants, tunnels, bridges, piles, and substantially more through its adaptable demonstrating condition, propelled highlights. For making plans or breaking down any shape on STAAD Pro V8i, we first of all need to create a model of it. For demonstrating in STAAD Pro V8i various types of section properties, members, steel tables, materials are presented.



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Not just this, there are the plan codes of different countries feed. In the beams and columns act as line component and slabs, walls and shear walls, and so forth go about as plate component.

Optimum Tapered sections are for the most part accommodated for rafters & columns. The modelling of warehouse structure using software and how the tapered sections are collected and placed as below:



Fig. 4: Modelling and Rendered View of CSB Structure



Fig. 5: Modelling and 3D View of PEB Structure



Fig. 6: Assembled Tapered Section



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 IX Sep 2022- Available at www.ijraset.com



Fig. 7: Assembled I-Section OF CSB Section

#### VI. **RESULTS AND PERFORMED ANALYSIS**

The structural analysis and design of the structural constructing taken into consideration changed into executed using the Staad Pro software database which may be very user pleasant and powerful. Graphical representation shows results obtained from software as below:



Fig. 8

Table 2 : Sectional Details OF PEB-IS 800:2007 Frame			
Profile	Length (m)	Weight (t)	
Tapered Member No: 1	12	5.006	
Tapered Member No: 2	37.68	26.925	
Tapered Member No: 3	37.68	23.763	
Tapered Member No: 4	12	6.616	
ST ISMB300	7.5	3.243	
ISA 75X75X6	502.65	8.150604	
ISA 50X50X6	501.143	22.04178	
ST 200Z60X2	3680	20.16215	

Total =115.9015



Fig. 9: Typical Section OF PEB- AISC/LRFD Frame



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Profile	Length (m)	Weight (t)
Tapered Member No: 1	12	5.006
Tapered Member No: 2	28.68	20.49387
Tapered Member No: 3	28.68	18.08712
Tapered Member No: 4	12	6.616
ST ISMB300	7.5	3.243
ISA 75X75X6	506.851	8.218725
ISA 50X50X6	506.843	22.29248
ST 200Z60X2	3680	20.16215
	T	1 101 2054

Table 3 : Sectional Details of PEB-IS 800:2007 Frame

Total =104.3854

As consistent with the design outcomes acquired for the duration of this dissertation work it is noted that the Purlin weight of PEB as consistent with Indian code structure by 56.80% and Purlin weight of PEB as consistent with American code structure with the aid of 68.51% as compared to lesser than the weight of CSB structure.

Table 4 : Comparish Of weight Between Csb & Peb Frame		
Type of Frame	Weight in KN	
CSB FRAME IS 800:2007	1394.289	
PEB FRAME IS 800:2007	935.619	
PEB FRAME AISC LRFD	879.151	



FRAME IS

800-2007

935.619

FRAME

AISC LRFD

879.151

As consistent with the design outcomes acquired for the duration of this dissertation work it is noted that the weight of PEB as consistent with Indian code structure by 33% and weight of PEB as consistent with American code structure with the aid of 37% as compared to lesser than the weight of CSB structure.

FRAME IS

800-2007

1394.289

Series1



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TYPES OF FRAME	GHT IN KN	
CSB FRAME (Hot Rolled Steel Section) IS 800:2007	333.796	
PEB FRAME (Cold Formed Steel Section) IS 800:2007	144.19	
PEB FRAME (Cold Formed Steel Section) AISC LRFD	105.09	





Fig. 11 : Steel Quantity required for Hot Rolled Section and Cold Formed Steel section used for Purlin members

Table 6: Steel Quantity For Grit Members		
Types of Frame	Weight in KN	
(Hot Rolled Steel Section) IS 800:2007	352.118	
Cold Formed Steel Section) IS 800:2007	56.807	
Cold Formed Steel Section) AISC LRFD	39.439	

Table 6 · Steel Quantity For Grit Members



Fig.12: Quantity of steel required for Hot Rolled Section and Cold Formed Steel used for Girt members



In this dissertation work it is noted that the Grit Member weight of PEB as consistent with Indian code structure by 83.86 % and Grit Member weight of PEB as consistent with American code structure with the aid of 88.79% as compared to lesser than the Grit Member weight of CSB structure.

Table 7. Maximum bhear Toree in Kir		
Types Of Frame	Shear Force in Kn	
CSB FRAME IS 800:2007	403.064	
PEB FRAME IS 800:2007	204.744	
PEB FRAME AISC LRFD	151.018	

Table 7:	Maximum	Shear	Force	In	Kn



Fig. 13 : Maximum Shear Force

In this dissertation work it is noted that the Maximum Shear Force of PEB as consistent with Indian code structure by 49.27% and Maximum Shear Force of PEB as consistent with American code structure with the aid of 62.53% as compared to lesser than the Maximum Shear Force of CSB structure.

ruble of maximum support redection in rite		
Types Of Frame	Support Reactions In KN	
CSB FRAME IS 800:2007	193.067	
PEB FRAME IS 800:2007	159.603	
PEB FRAME AISC LRFD	121.266	

Table 8 : Maximum Support Reaction In KN

In this dissertation work it is noted that the Maximum Support Reaction of PEB as consistent with Indian code structure by 17.33% and Maximum Support Reaction of PEB as consistent with American code structure with the aid of 37.18 % as compared to lesser than the Maximum Support Reaction of CSB structure.

#### VII. CONCLUSION

In our everyday existence steel is versatile material that each object we see used in steel immediately or circuitously. In Preengineered steel structures building offers low cost, strength, durability, design flexibility, adaptability and recyclability. Steel is the basic material that is used in the materials that are used for Pre-engineered steel building. It negates from regional sources. Infinitely recyclable, steel is the material that reflects the imperatives of sustainable development. Based on the analytical and design results thereon of conventional and pre- engineered steel buildings, the following conclusions are drawn. In our everyday existence steel is versatile material that each object we see used in steel immediately or circuitously. In the observe of self-weight of the models indicated that the self- weight for PEB is much less than that of CSB in the equivalent geometry.

 As consistent with the design outcomes acquired for the duration of this dissertation work it is noted that the weight of PEB as consistent with Indian code structure by 33% and weight of PEB as consistent with American code structure with the aid of 37% as compared to lesser than the weight of CSB structure.



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- 2) In this dissertation work it is noted that the Purlin weight of PEB as consistent with Indian code structure by 56.80% and Purlin weight of PEB as consistent with American code structure with the aid of 68.51% as compared to lesser than the weight of CSB structure.
- 3) In this dissertation work it is noted that the Grit Member weight of PEB as consistent with Indian code structure by 83.86 % and Grit Member weight of PEB as consistent with American code structure with the aid of 88.79% as compared to lesser than the Grit Member weight of CSB structure.
- 4) In this dissertation work it is noted that the Maximum Shear Force of PEB as consistent with Indian code structure by 49.27% and Maximum Shear Force of PEB as consistent with American code structure with the aid of 62.53% as compared to lesser than the Maximum Shear Force of CSB structure.

In this dissertation work it is noted that the Maximum Support Reaction of PEB as consistent with Indian

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