International Journal of Scientific Research in Civil Engineering
© 2021 | IJSRCE | Volume 5 | Issue 6 | ISSN : 2456-6667

Design and Analysis of a Pre-Engineered Warehouse Building Considering Lateral Load Using Etabs

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Article Info
Volume 5, Issue 6
Page Number : 105-110

Publication Issue :
November-December-2021

Article History
Accepted : 01 Dec 2021
Published : 08 Dec 2021

ABSTRACT

Pre Engineered Building (PEB) is a concept of performing optimization of structures providing economical design. Steel is a tensile material which provide more strength and available in sections as per requirements. These sections are utilize in pre-engineering building. As per Indian standard I.S 8020:2007 code is prescribed for designing of steel structures. Based on limit state design. P.E.B. structures are high in demand as compared to conventional structure i.e Conventional Steel Building (CSB). CSB design concept is comparatively more easy in fabrication and provide easy restoration. Steel structures are generally utilized in long span structures such as industrial buildings where gantry cranes are installed. Steel structures are easy to assemble in any place as compared to RCC structure where cost and time both are high in comparison. PEB building structure is in demand as it requires less time and provide proper strength. Industrial structures also associate high dead load as it provides residence to heavy sized members. Therefore, this is necessary to investigate seismic response of buildings with various bracings and dampers to control vibration, lateral displacement and storey drift. Natural time period, frequency, roof displacements are the major parameters considered for observing response of structures. Response spectrum analysis of 3D industrial structure with distinct concentric bracings and dampers using SAP 2000 will be carrying in this research under respective base shear . In this study we are comparing different segments of building structure where analysis is performed considering lateral loading condition.
Keywords- Steel Structure, Conventional Steel Building (CSB), Pre Engineered Building (PEB), Bracing Systems, Wind Analysis, Cross Bracing, Diagonal Bracing, K-Bracing.

I. INTRODUCTION

- Steel structures are considered as most durable and fast setup structure around the world, these structures are more advantageous than general RCC structures. These structures are used not only in industrial or commercials places but even in residential projects.
- Buildings with long spans, arch building and for proper elevations where high strength is required steel structures are utilized. Pre-engineering building currently most preferred structure where steel sections are assigned together to setup a proper building structure.
- Ware houses, industrials buildings with gantry crane setups and other high load bearing structures need such setups. In Pre-engineered structure came into existence in 1960's. It had roof, floor, outline and so forth These parts were assembled to make the entire structure. This made development simpler.

Steel structures are utilized in a wide range of uses and their interest is expanding. There are basically two classifications in steel structures.

1) Conventional-Steel Building [C.S.B]

2) Pre-Engineered Building [P.E.B]

FIG 1 : Conventional Structure

Fig 2. Pre Engineered Building

II. Literature Review

Muhammad Umair Saleem and Hisham Jahangir Qureshi (2018) Research paper zeroed in on the advancement of steel building costs with the utilization of pre-designed structure development innovation. Development of customary steel structures (CSB) joins the utilization of hot-moved areas, which have uniform cross-segments all through the length. Be that as it may, pre-designed steel structures (PEB) use steel areas, which are customized and profiled dependent on the necessary stacking impacts. The exhibition of PEB steel outlines as far as ideal utilization of steel segments and its examination with the ordinary steel building was introduced. A progression of PEB and CSB steel outlines were chosen and exposed to different stacking conditions. Casings were investigated utilizing a Finite Element Based examination instrument and configuration was performed utilizing American Institute of Steel Construction plan details. Correlation of the edges was set up as far as edge loads, horizontal removals (influence) and vertical relocations (diversion) of the casings. T D Mythili (2021) the examination paper similar investigation of customary and Pre-designed steel structures which is a bracket of length 30m conveying a crane of 10 ton, 15t and 20t. Further examination focused on correlation of regular steel working with Pre-Engineered steel structures for modern distribution centers outfitted with Electrical Overhead Traveling (EOT) cranes. The fundamental casing for regular steel building is a developed section with bracket as a material framework and the essential edge for pre-designed steel building is a pitched rooftop entryway with tightened segments. The range to be utilized for the gateway is 30m. Separating of entryway is 5m c/c. Tendency plot for PEB gateway is 6° regarding level. The Crane of limit of 10t is utilized on each edge viable. Results expressed that utilization of PEB rather than CSB might be diminishing the steel amount. Decrease in the steel amount certainly lessening the dead burden. Decrease in the dead burden diminishing the size of Foundation. Utilizing of PEB increment the Esthetic perspective on structure.

Objectives of the study

Following objectives are considered in this study are as follows

- Comparative analysis of Pre-Engineering Building (PEB) and Conventional Steel Building by using ETABS software.
- To analyze and design the building as per Indian standard code I.S 800:2007 (LSM).
- Techno economic design of the ware house building using analysis tool
- Evaluate the steel consumption in both the design system.
- Reduce the steel consumption and compare the results for both the design procedure

III. Methodology

General Steps of Designing and analysis

Step 1 Numerous research papers were studies in order to understand the research done till date on Pre Engineered Structures (PEB).

Step 2 : Model Initialization was done defining the Display Units, Steel Section Data base as its Indian in this Case. Steel Design code as per IS 800-2007 and Concrete Design code IS 456:2000. AS ETABS supports codes of different countries namely American, Austrian, Indian, Chinese etc.

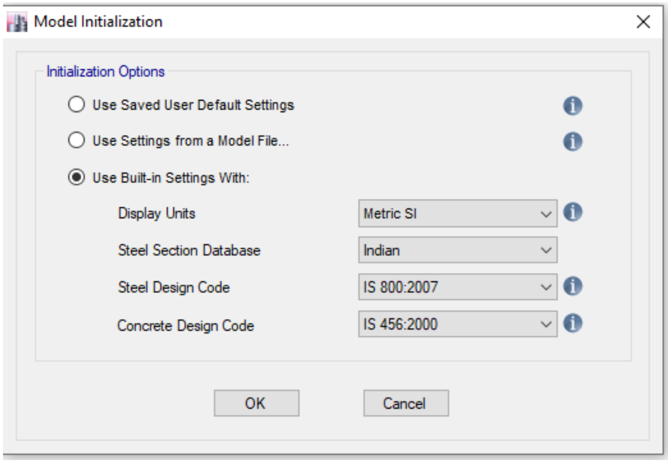

Fig 3: Model Initialization

Step 3: Defining shape for the frame of the structure for steel and concrete where the application pre-defined shapes and even offer the leverage to customize the shape of the frame.

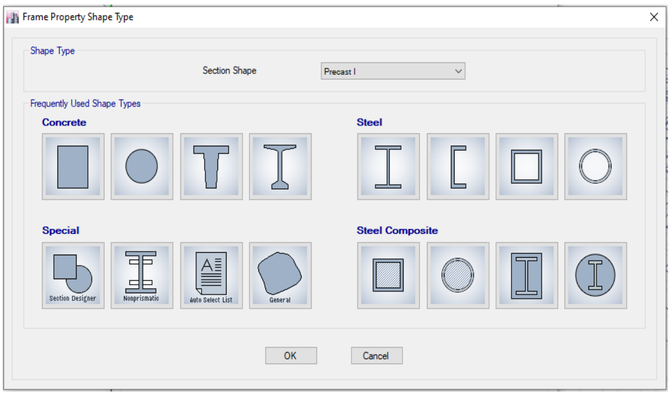

Fig 4 Frame Property Shape Type

Step 4: This step presents the modelling of the frame for both cases.

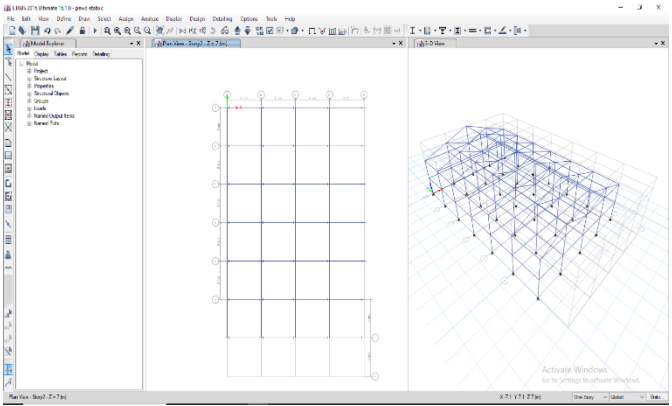

Fig 5 Modelling of the Frame

Step 5 Defining Material Properties namely column and beam to the frame

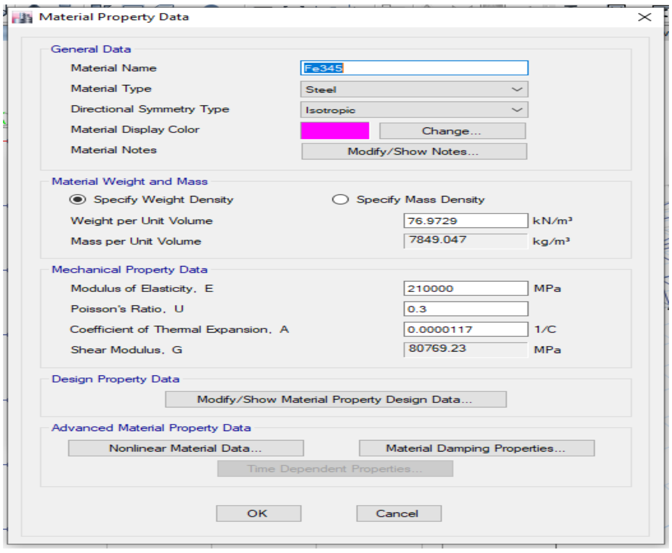

Fig 6 Defining material properties

Step 6: Defining loading condition Live load, Dead load and wind loads on the structure.

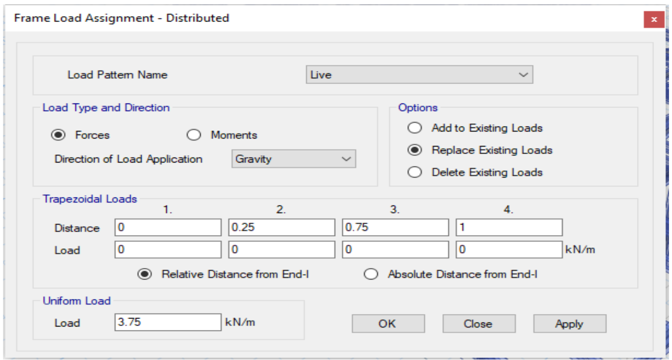

Fig 7 Frame Load Assessment and Distribution

Step 7: Defining wind load

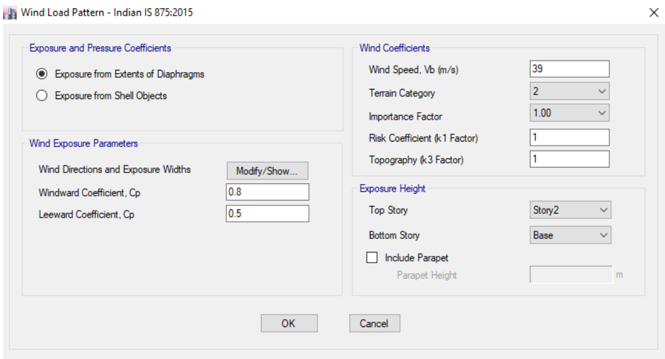

Fig 8 Defining wind load Pattern as per IS 875-2015

Step 8 Defining load pattern and assigning load combination as per Indian Standard.

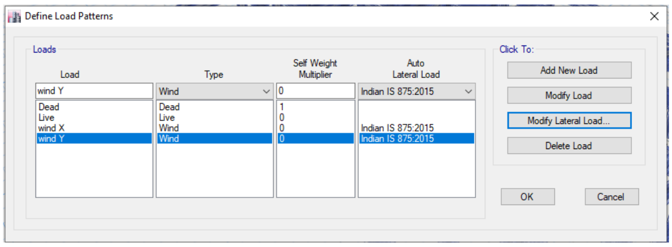

Fig 9 Load Combination

Step 9 Analysing both the cases at different checkpoints.

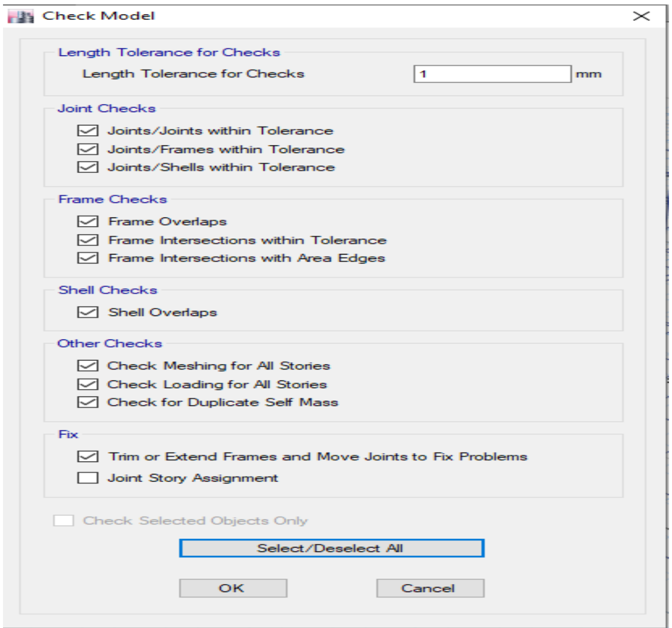

Fig 10 Checking model stability and assessment

Step 10 Output of the structure

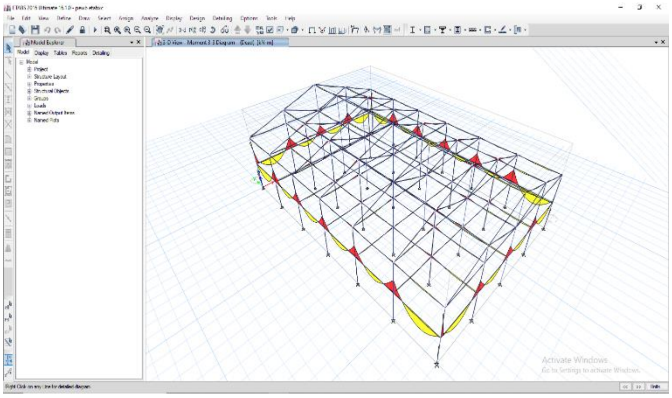

Fig 11 dead load output

Table 1: Geometrical Description

Bay Frame	
Length	20 m
Height	7 m
Width	30 m
No. of Bays along length	4
No. of Bays along height	2
No. of Bays along width	6

IV. RESULTS AND DISCUSSION

Calculation for Main column		
Analysis	P.E.B.	C.S.B.
Displacement Maximum mm	4.357	8.708
Support Reaction (Fy) KN	1457.18	1101.24
Axial Force KN	1457.18	1101.24
Shear Force (sy) KN	251.052	249.763
Bending Moment (Mz) KN.M	533.195	402.965
Steel Quantity KN	15.671	8.636

Calculation for Rafter		
Analysis	P.E.B.	C.S.B.
Displacement Maximum mm	30.063	104.078
Axial Force KN	967.401	459.152
Shear Force (sy) KN	134.877	119.443
Bending Moment (Mz) KN.M	281.981	521.235
Steel Quantity KN	84.793	19.834

Calculation for Purlin		
Analysis	P.E.B.	C.S.B.
Displacement Maximum mm	3.193	3.717
Shear Force (sy) KN	17.81	11.14
Bending Moment (Mz) KN.M	26.673	16.684
Steel Quantity KN	2.247	1.751

V. Conclusion

Following conclusions can be drawn from the study The following are the different conclusions of the project.

Displacement :- The PEB structure model designed by IS 800:2007 has more displacement as compared to CSB structure due to less weight of the structure.

Support Reaction :- The PEB structure model designed by IS 800:2007 has less support reaction as compared to CSB structure due to less weight of the structure.

Axial, shear Force and Bending Moment:- The PEB structure model designed by IS 800:2007 has less axial, shear force and Bending Moment as compared to CSB structure.

Steel Quantity:- The PEB structure model designed by IS 800:2007 lightweight as compared to CSB structure. PEB structure is 64% lighter as compared to CSB Structure.

Wind Resistance:- The PEB structure model designed by IS 800:2007 higher resistance to wind as compared to CSB structure.

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Cite this article as :

Antim Jatav, Rahul Sathbhaiya, "Analysis of a Cement Storage bin