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Comparative Seismic Analysis of PEB and Conventional Industrial Steel Structure using Pratt Truss with different Span/Rise Ratio

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Abstract: -
In recent years, the introduction of prefabricated steel buildin gs (PEB) has helped to simplify the design and reduce the de ad load of the structure. PEB buildings bring many advantage s by basically replacing the structural steel structure (CSB) co nceptwith construction. He dimensioned the PEB structureac cording to the bending moment diagram distributed over all b eams and columns and reducedthe steel required thanks to the conical IS profiles. Inthis study, he performed seismic analys is of PEB frame and steel frame structure of industrial buildin g and designed them according to IS 800-1984, IS 8002007 and IS 1893:2016 Indian Standards.
Traditional steel and prefabricated buildings require beautiful , high-quality structures that can be built very quickly.
Steel structures and prefabricated structures can be widely us ed in construction andhousing construction.
This article aims to review various studies on the analysis of PEB and similar metal structures. The Pre-Engineered Industrial Building (PEIB) concept is a new conc ept forindividual industrial buildings. This method is versatile not onlybecause of the quality of pre-planning and prefabrication, but also because of its lightnessand economy.
This concept has many advantages over thestandard steel stru cture (CSB) concept of theroof truss. This article is a compari son of PEIB and CSB content.
This documentdemonstrates thatPEIB standards can be easily developedwith a simple design based on nationa l standards. Based on this study, it can be concluded that PEIB structure has good cost-effectiveness, speed of construction and many advantages of CSB structure is easy to install.
This article also provides basic and commercial ideasfor the d esign concept of PEIB. The presentation will help you unders tand the design process of the PEIB concept.

Keywords: *Computer, structure building, earthquakes, construction, PEB, Conventional etc.*

1. INTRODUCTION

The concept of pre-engineered steel structure design has become the future trend of Indian structural design. In this way, reduction based on the bending mom ent analysis program is important to determine the type and damage to evaluate the structural response to load an dseismic conditions. Analysis software is a simple metho d foranalyzing single-degree and multi-degree-of-freedom systems up to collapse.

This constant pursuit of height offers an incredible oppor tunity to build a career. Buildingstandards have come a l ong way from early frames to today's ultra-compact mega-support structures.

Recent advances in structuralanalysis and design softwar e, combined with endlessprocessadvances, have spawned many new forms ofdesign andarchitecture. However, in creasedreliance on computer analysis does not solve the problems faced by businesses.

A critical understanding of behavior when using comput ational tools is what will change design and construction. The construction of the structure is controlled by our strength, rigidity and service management, resulting from the impact of external loads such as earthquakes and winds.

Prefabricated steel house offering steel structure using a combination of composite materials, hot rolled and cold formed profiles, with a choice of single skin panels with additional insulation or insulated sandwich panels for roof and wall cladding.

The idea is to provide a complete building envelope system that is airtight, energy efficient, affordable in weight and cost, and above all designed to meet the needs of users like a good glove.

2. OBJECTIVE

1) To understand the behavior of Pre-engineering material building and conventional building.
2) To understand the linear Analysis or Seismic analysis.
3) To find out the maximum and minimum axial

forces in columns from different load combinations.

4) To understand the formation of lateral displacement under the action of Seismic analysis from IS 1893:1984.

5) To find out a factored load on the base column under the action of different load combinations according to IS code.

3. ASSUMPTIONS IN RESEARCH

- The material of the structure and the structural components are linearly elastic. Therefore, the assumption allows the superposition of actions and deflections. Hence, the use of linear methods of analysis. The development of linear methods and non-linear methods having their solution by computer software has made it possible to analyze large complex statically indeterminate structures.
- Floor slabs are assumed to be rigid in plane. This assumption causes the horizontal place displacements of all vertical elements at a floor level to be definable in terms of the horizontal plane rigid-body rotation and translations of the floor slab.

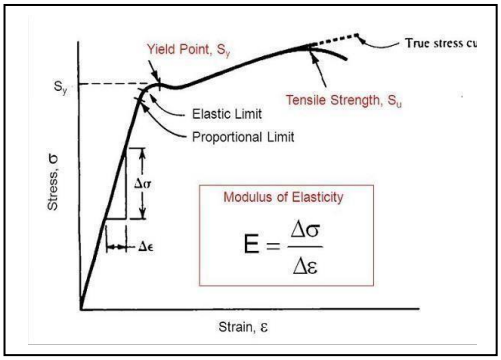
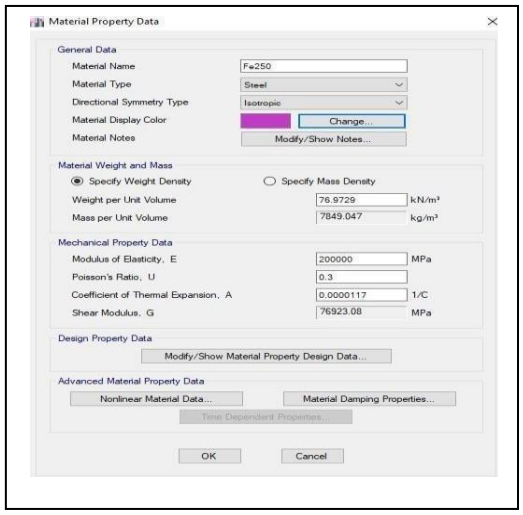


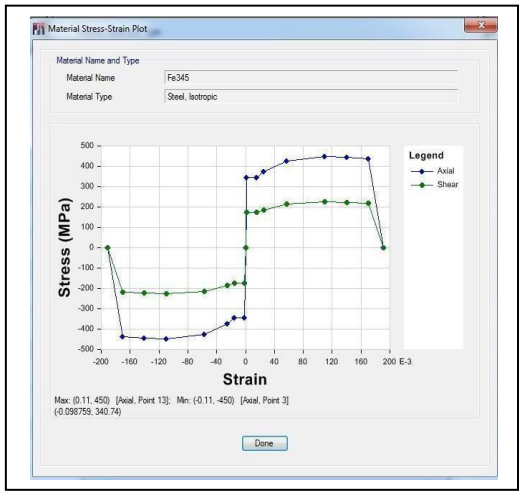
Figure 3.1 Stress-strain curve of steel

4. MODELLING AND METODOLOGY

In ETAB v13 first of all material properties are defined by clicking at >> Define menu bar >> Define material >> add new material >> input the required value >> OK. Elastic material properties of concrete and steel materials are taken as per IS456:2000 and IS800 respectively. The characteristics yield strength of steel is assumed as minimum yield stress or 0.2 % of proof stress for steel having no definite yield point. The modulus of elasticity of steel is taken as 200000 MPa.



DEFINATION OF STEEL SECTION MATERIAL



Stress-Strain curve of steel material

ADVANTAGES OF STEEL CONSTRUCTION

- High-quality, aesthetic
- Lower maintenance costs. Non-combustible to fire
- Steel is environmentally friendly
- Components can be used again and again
- Steel components are frequently functional
- Steel construction is strong, durable, and stable
- Steel Construction promotes good design and safety
- Construction with Steel is sustainable to Temperature effects
- Steel frame construction is rigid in structure and dimensionally stable
- Steel can be re-used without affecting the environment
- Construction with Steel components is very fast compared to other materials
- Steel construction of buildings with steel components is resistant to termites and other destructive insects.
- Steel constructions are cheaper than

any other construction method.

Use of section designer for definition the column and beam properties as per

Name	Shape	Material
Column	Non prismatic	STEEL
Beam	Non prismatic	STEEL

Table3.1: Cross-section of column and beam of pre-engineering steel section

Name	Shape	Area	Material
Column	I section	m^2	STEEL
Beam	I section	m^2	STEEL

Table3.2: Cross-section of column and beam of conventional steel section

5. LITRATURE REVIEW

A brief review of previous studies on the application of PEB (prefabricated structures) in different systems. This literature review also includes previous studies on different applications of PEB (predesigned buildings). This article reviews recent programs on cost analysis of designs for PEB and lega cy buildings.

KEYVAN VAN ROOSMALEN AND ARJAN VAN WEELE

Streamlining demand fulfillment chain in construction projects: the case of pre-engineered red steel building manufacturer

PEB systems are extensively used in industrial and many other constructions worldwide, it is relatively a new concept in India. That concept includes the technique of providing the best possible section according to the optimum requirement & cost-effectiveness. In the present work, the study of PEB with CSB has been carried out; the observations made based on this study are very much useful to practicing structural engineers. In this paper, CSB (Conventional steel building) & PEB (Pre-engineered steel building) were compared after being analyzed in STAAD-pro & design using IS: 800:2007.

AIJAZ AHMAD ZENDEET

Comparative study of analysis and design of pre-engineered buildings and conventional frames

Long Span, Column free structures are the most essential in any type of industrial structure and Pre-Engineered Buildings (PEB) fulfill this requirement along with reduced time and cost as compared to conventional structures. The present work involves the comparative study of static and dynamic analysis and design of Pre-Engineered Buildings (PEB) and Conventional steel frames. Design of the structure is being done in Staad Pro software and the same is then compared with conventional type, in terms of weight which in turn reduces the cost.

Three examples have been taken for the study. A comparison of Pre-Engineered Buildings (PEB) and Conventional steel frames is done in two examples and in the third example, longer span Pre-Engineered Building structure is taken for the study. In the present work, Pre- Engineered Buildings (PEB) and Conventional steel frames structure is designed for dynamic forces, which include wind forces and seismic forces. Wind analysis has been done manually as per IS 875 (Part III) – 1987 and seismic analysis has been carried out as per IS 1893 (2002). A pre-engineered steel structure building offers low cost and strength.

VAIBHAV B. CHAVAN

Economic evaluation of open and hollow structural sections in industrial trusses

The study aims to evaluate the economic significance of the Hollow Structural Sections (HSS) in contrast with open sections. This study was carried out to determine the percentage economy achieved using Hollow Structural Sections (HSS) so as to understand the importance of cost-effectiveness. The technique used in order to achieve the objective included the comparison of different profiles for various combinations of height and material cross-section for given span and loading conditions. The analysis and design phase of the project was performed using STAAD PRO V8i. The sample results of STAAD analysis were validated with the results of Manual analysis.

KAVITA K. GHOGARE AND DR. S.K. DESHMUKH
Seismic Analysis & Design of Multistory Steel Building",

The present paper describes the stability analysis of an industrial shed subjected to wind load. For the present work, the equivalent static analysis is carried out for a single-node steel building with a pitched roof in zone II. It is nothing but an industrial structure. The industrial structures shall be designed and constructed to resist the wind effects in accordance with the requirements and provisions of IS:875 (Part 3):1987. This standard describes the procedure for wind resistance of such structures. The stability analysis of a single node steel building with a pitched roof is carried out using Software Computer Aided Design i.e., (STAADPRO). The main parameters considered in this paper to compare the wind performance of buildings are bending moment, shear force, deflection, and axial force. In this paper, we only focus on industrial sheds i.e., pitched roof trusses. A building has to perform many functions satisfactorily. Amongst these functions are the utility of the building for the intended use and the occupancy, structural safety,

G. DURGA RAMA NAIDU
Comparative Study of Analysis and Design of Pre-Engineered Buildings and Conventional Frames

Long Span, Column free structures are the most essential in any type of industrial structure and Pre-Engineered Buildings (PEB) fulfill this requirement along with reduced time and cost as compared to conventional structures. The present work involves the comparative study and design of Pre-Engineered Buildings (PEB) and Conventional steel frames. Design of the structure is being done in Staad Pro software and the same is then compared with conventional type, in terms of weight which in turn reduces the cost.

6. RESULT AND DISCUSSION

In this analysis, using IS 875 (part3) 2015 code (Design for Seismic Analysis of Structures), seismic model analysis was performed with risk k1 = 1 and terrain category B, and axial and nodal displacements in the Y direction were calculated. Lateral displacement is the movement of floors towards or from their original position by the action of seismic forces on the structure.

According to IS 456:2000, the variation should not be more than 500, which is the ratio of the height of the structure at the time of inspection.

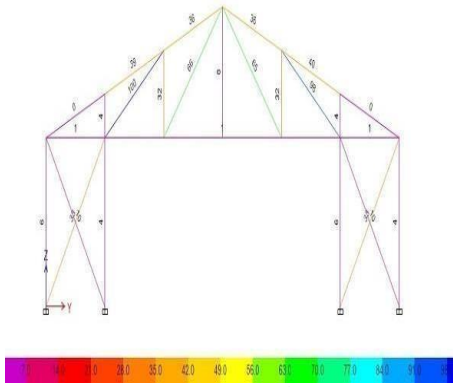
From the Seismic analysis of PEB and conventional steel structure for different model consideration followings output comes.

- The values of node displacement in Y-direction for different models are compared in table 4.2 and figure 4.2. It is observed that minimum roof displacement 1.29 mm is obtained in model2 because more stiffness is providing with the help of conventional steel.
- Maximum roof displacement 19.802mm is obtained in model5 as there is shorter span and reduced stiffness present to support the structure.
- The value of Base force in Z-direction on comparing between different models is analysis. It is found that minimum force value of model5 (pre- engineered building having span 24m) because of larger shorter span and tapered steel section are used as compare to other models.
- On comparing between model 1 (PEB 30m span) and model2 (conventional 30m span) in table 4.1 and figure 4.1. It is observed that total dead load of model1is 946.65kN and model2 is 970.1kN having same span but show reduced value in dead load which provide economical or cheaper section for same loading and span condition.
- On comparing between model1 (PEB 30m span) and model4 (conventional 24m span) in table 4.1 and figure 4.1. It is observed that total dead load of model 1 is 946.65 KN and model 4 is 866.11 KN having different span.

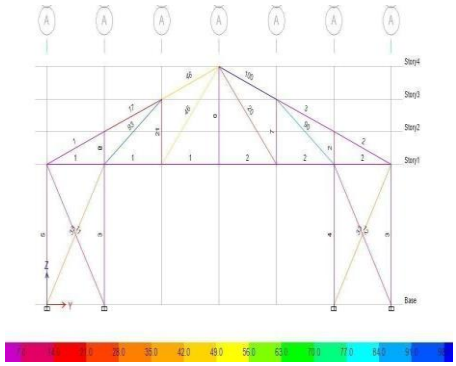
Analysis done on all models for load combinations gives following results

- The value of force in model1 (PEB 30m span) and model2 (conventional 30m span) for maximum load combination 3 (DL+LL+ELy) due to Seismic load show lesser value because of generating outward Seismic pressure at roof truss which balancing dead load of structure.
- The maximum value of load combination obtained in model 2 (conventional steel structure having 30m span) due to larger span and conventional steel issued in structure.
- 30 m span of PEB is much cost effective than the other 30m span conventional, 27 m and 24 m span in both PEB and Conventional truss.
- 30 m span of PEB carries lesser dead load in comparison with 30 m span conventional which is 2.477%.

- PEB truss of 30 m span is much more stable and reliable than other 27 m and 24 m truss as per the analysis of bending moment and overturning moment diagram.
- Among the PEB and Conventional type truss PEB truss is more efficient and easy to construct.
- As per the analysis cost effectiveness depends upon the use, type and need of structure.
- So, larger the span greater is the effectiveness.



Energy diagram of Pre – Engineered building having 30m span Pratt truss



Energy diagram of Pre – Engineered steel building having 27m span Pratt truss

7. CONCLUSIONS

The results of 3-dimensional modeling of PEB and conventional steel frame structure from ETAB Vs.17 software with the help of IS875 (part3) 2015 and IS800:2007. Six different models having Beam-column Cross-sectional areas and different plan sections are prepared by software with the help of IS code and comparative analysis studied between them. This project has introduced PEB and conventional Steel frame structures which analyzing to determine their structural performance.

The Result section contains all the results and graphs for the designed industrial buildings which include bending moment and virtual work/energy diagram at different levels and capacity of structural elements. After studying all curves and tables in the result section came to the following conclusion, the overturning moment shows that the buildings were able to achieve the safety point within the range. But due to different configurations with constant pitch results conclusions are analyzed in this chapter.

Following are the important conclusion made from the present study.

- The performed Seismic analysis for the present work clearly shows that there is an important difference in the dead load of the PEB and conventional steel structure with different configurations of span.
- Maximum dead load at performance level is obtained in model 2 (conventional steel structure having span 30m) which is 2.477% higher than model1 (PEB having span 30m).
- On comparing model 1 (PEB having span 30m) and model 4 (conventional steel structure having span 27m) with respect to plan area ratio1.33 to dead load ratio 1.09 about 24% steel consumption is seen.
- Comparison between load combinations Seismic load in y direction reduced the overall load so in this analysis dead load and live load is an important considerations in design analysis.

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