A COMPARITIVE STUDY ON CSB AND PEB STEEL STRUCTURE UNDER SEISMIC CONDITIONS USING ETABS

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Abstract : In past years the usage of Conventional steel building (CSB) design structures is more, but the advantages when compared to Pre engineered buildings with struss advantages are gone too high. 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.The more life span, low economical cost, and easy installation which are favoured to rise in PEB structures with there advanced design. In this comparative study PEB and CSB are compared with same bracings. This methodology is versatile not only due to its quality predesigning and prefabrication, but also due to its light weight and economical construction. In this study steel structure is designed and seismic evaluation is carried out in the by using Etabs software 2018. In this era, as urbanization is rapidly increasing the availability of land is becoming less, due to overpopulation and increased land cost. To overcome this rising problem, the only solution is to opt for multistorey buildings. The effective design and construction of earthquake resistant structures have much greater importance all over the world. For this ETABS provides both static and dynamic analysis for a wide range of gravity, thermal and lateral loads. This analysis mainly deals with the study of plans by using AutoCAD software. It is to analyze the design of G+5storey building. Seismic analysis of all types of structures is an important aspect when working in high seismic areas. With the help of seismic analysis, structures can be designed and constructed to withstand strong lateral movements of the crust during earthquakes. Multi-Story Building, Column Jacketing, ETABS V21, Designer, Modelling, Story Drifts, Maximum Story Displacement.

Keywords: Truss, Bracings, Etabs software, Response Spectrum

1. INTRODUCTION

When energy is released from the Earth crust then Earthquake is fashioned. Earthquake can arise certainly or manmade . Landslides, volcanic eruption, geological faults are the herbal happening manner of Earthquakes and Mining activities, nuclear checks are the one of the essential causes of man - made Earthquake. The foremost trouble of the Earthquake is it harm or fall apart the building in a fragment of second (Depends on the importance) and it leads to loss of assets and the lack of life.

During an earthquake building start shaking with respective to the floor movement then the factors inside the constructing undergoes deformation. Due to this deformation we observe the displacement within the building. In order to lessen the deformation and support the constructing we make our structure to withstand the vertical hundreds like Dead, stay, snow and lateral loads like wind, Earthquake forces. Vertical hundreds placed load on the constructing and lateral hundreds increase stresses and bring vibrations. Vertical forces can be reduced by using strengthen the shape and provide properly stiffness to face up to the lateral masses. To increase the stiffness and decrease the lateral forces we use Bracing systems.

In India consumption metal for creation Industry may be accelerated due to the fact its higher anxiety and compression resistance functionality as compared to concrete. Generally metal systems is composed three dimensional trusses for balance. Aesthetical factor of shape extended because of its minimal variety of partitions, walls and columns and so forth. In order to improve the resistance to the dynamic loading we provide bracings but there are so many styles of bracings machine are to be had. The main benefit of the bracings are it includes a tool that clamp components of a structure together so as the support or assist it.

Conventional Steel Buildings :

Conventional steel buildings are traditional metal structures constructed by rolled steel sections which are designed individually and fabricated at site using welding and cutting.

Steel frame is typically consisting of vertical column and horizontal beams which are riveted, bolted or welded together in a rectilinear grid. Steel beams are horizontal structural members that resist loads applied laterally to their axis. Columns are vertical structural members that transfer compressive loads. It can be used to form the skeleton of a building.

This immense strength is of great advantage to buildings. The other important feature of steel framing is its flexibility. It can bend without cracking, which is another great advantage, as a steel building can flex when it is pushed to one side by say,

wind, or an earthquake. The third characteristic of steel is its plasticity or ductility. This means that when subjected to great force, it will not suddenly crack like glass, but slowly bend out of shape. This property allows steel buildings to bend out of shape, or deform, thus giving warning to inhabitants to escape. Failure in steel frames is not sudden - a steel structure rarely collapses. Steel in most cases performs far better in earthquake than most other materials because of these properties.

However one important property of steel is that it quickly loses its strength in a fire. At 500 degrees celsius (930 degrees F), mild steel can lose almost half its strength. This is what happened at the collapse of the World Trade Towers in 2001. Therefore, steel in buildings must be protected from fire or high temperature; this is usually done by wrapping it with boards or spray-on material called fire protection.

Pre Engineered Buildings:

Pre Engineered Buildings (PEB) are the buildings which are engineered at a factory and assembled at site. Usually PEBs are steel structures. Built-up sections are fabricated at the factory to exact size, transported to site and assembled at site with bolted connections. This type of Structural Concept is generally used to build Industrial Buildings, Metro Stations, Warehouses etc.The adoptability of PEB in the place of Conventional Steel Building design concept resulted in many advantages, including economy & easier fabrication. These type of building structure can be finished internally to serve any functions that is actually help in low rise building design. Examples of Pre- Engineered Buildings are warehouses, Canopies, Factories, Bridges etc.

Components of PEB:

Pre Engineered Buildings consist different steel structural member which are as follows,

1) Primary Frame: Primary framing of a PEB is an assembly of builtup I-Shaped steel members & that framing consist trusses or castellated beams etc.

2) Secondary Structural Elements: It is actually Cold Formed Members, which can be in diff. shapeslike “Z”, “C” etc. In general known as “Purlins”.

3) Roof & Wall Panels : Tin shades & Curtain Wall made of Glass & Roll-formed steel sheets usually comes in this category.

4) Sandwich Panels: Sandwich Panel is made of three layers , in which a non-Aluminum Core is inserted b/w two aluminum sheet.

5) Other Accessories: Mezzanine floors, Bolts, Insulation, etc.

2. LITERATURE REVIEW

T.Subramani, P.Sankar, R.Anbalagan, P.Rama, C.Vijaya Structural steel is a commonplace building cloth used for the duration of the development industry. Its primary reason is to shape a skeleton for the shape, essentially a part of the form that holds the whole lot up and together. As consistent with the requirement of a commercial constructing, the right form of roof truss and the portal body is utilized. A roof truss is designed for self weight, lateral masses and their combinations as regular with Indian requirements in Staad software application. The guide layout of different additives are also given immoderate significance and calculations of desired reinforcement is located with excessive factorsof protection.

T D Mythili :In this paper PEB AND conventional steel structure are analyzed and compare those results.

The compared results are quantity of steel, reduction of loads and the aesthetic view, cost comparison, foundation size requirements. Crane loads are also considered in this paper.

Apurv Rajendra Thorat, Santosh K. Patil (2009):In the present look at Pre-engineered Buildings are designed and studied in accordance with Kirby Technical Specification which is based on ASCE-07.Two examples were taken for the observe. Comparison of Pre Engineered Buildings (PEB) with bracings and Pre Engineered Buildings (PEB) with out bracings iscompleted in two examples. Later Pre Engineered Buildings (PEB) is analyzed for Dynamic masses using El-centro designated floor movement.

Kankuntla Ashok Y. (2012):As the value of metallic is increasing each day and the use of metallic is unavoidable inside the industries. The creation practices requires the exceptional aesthetically look, high fine and fast creation, inexpensive with progressive thoughts as the steel is frequently used construction material in industry. Hence to obtain the economy inside the metal shape, it's miles vital to apply the premier amount of metallic. In this study, an try to present comparative take a look at of Conventional Steel Buildings (CSB), Pre Engineered Building (PEB) and Cold Formed Steel(CFS) Warehouses. The comparison has been carried out which incorporates the truss of span 20m, 25m and 30m with diverse column spacing and the duration of shed is 60m. All the trusses are modelled, analyzed and designed through the usage of STAAD-Pro V8i

software program. The economy of the structure is discussed in terms of quantity of metal.

Nattapat Wongpakdee , Sutat Leelataviwat , Subhash C. Goel , Wen-Cheng Liao (2017):A performance evaluation of a structural metal framing system referred to as Buckling-Restrained Knee Braced Truss Moment Frame (BRKB-TMF) turned into performed. This structural device combines the benefits of open-internet steel truss girders and Buckling Restrained Braces (BRBs). Key benefits of open- internet trusses encompass light weight, easy connections, and open passages for mechanical ductwork and pipes. In this system, the open-internet trusses are designed to be elastic, even as the BRBs are strategically located and designed to deplete seismic electricity. The blended capabilities of the open-internet trusses and BRBs cause a gadget with improved performance, protection, and economy. In this examine, a performance based totally design procedure turned into developed for the proposed gadget. A 4 tale constructing structure turned into selected as a observe case. The shape designed the usage of the offered technique become subjected to nonlinear static (pushover) and dynamic analyses. The pushover analysis changed into achieved to decide the general response, the sequence of inelastic pastime leading to disintegrate, and the failure mechanism. In the nonlinear dynamic analyses, the have a look at frame changed into subjected to a suite of selected earthquake records scaled to represent numerous stages of earthquake floor motion intensity. An incremental dynamic analysis (IDA) technique was implemented to look at the conduct of the shape at exclusive levels of ground motion intensity inclusive of the disintegrate degree. Using IDA consequences, fragility curves have been created and examined. The effects had been used to assess the disintegrate margin of the shape. The analyses furnished very promising consequences in phrases of the effectiveness and robustness of the system. The instance shape confirmed a low chance for fall apart under the maximum taken into consideration earthquake (MCE) floor motions. The key layout parameters have been decided to be the target glide and deformation capacity of the BRBs

Vijaya Bhaskar Reddy S. et al.presents data from a comparative study of static loads in 5 and 10 story multistory buildings. The importance of this work lies in assessing the design load of the structure. We concluded that the deflection of the members increases as no of floors increases. We can see that the axial strength of a 10-story building is greater than that of a 5-story building. Abhay Guleria [10] highlight the structural behaviour of high-rise buildings with different floor plan configurations such as rectangular, C-shaped, L-shaped and I-shaped. A 15-story reinforced concrete simulation building constructed using ETABS analysis software was used. After analysing the structure, the maximum lateral force, bending moment and maximum displacement for the floor are calculated and compared for all analysis cases. As a result of analysing the high-rise building, it was found that the floor overturn moment is inversely proportional to the floor height. The modal shape was derived through dynamic analysis, and it can be concluded that the asymmetric design deforms more than the symmetric design

A. Kale, S. A. Rasal proposed ETABS builds and tests four different forms of multi-layered models of the same region according to the recommendations of IS-875- Part3 and IS1893-2002-Part1. The behavior of 15, 30 and 4x5 storey buildings was studied. Dynamic effects can also be found in the response spectrum method. All parameters such as historical offset, historical drift, base shift, overturn moment, acceleration and duration are calculated. After comparing the results of all of buildings, it was concluded that which section is convenient, and the action of earthquakes or winds is important.

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provides an overview of previous work performed on multi-story buildings about seismic analysis. It focuses on the static and dynamic analysis of buildings. This article provides an overview of the comparison of static and dynamic analysis of multi-story buildings. Structural parameters such as displacement, bending moment, basic shear, floor displacement, torsion, and axial force were the focus of the study.

Pushkar Rathod et al. described seismic analysis can be used to design and build structures that can withstand strong lateral movements of the crust during earthquakes. Simple or complex structures that can be evaluated under static or dynamic conditions can be evaluated using ETABS. It’s an optimized and productive analysis and design tool for everything from simple 2D wireframes to modern skyscrapers, making it one of the best programs for structural analysis of building systems.

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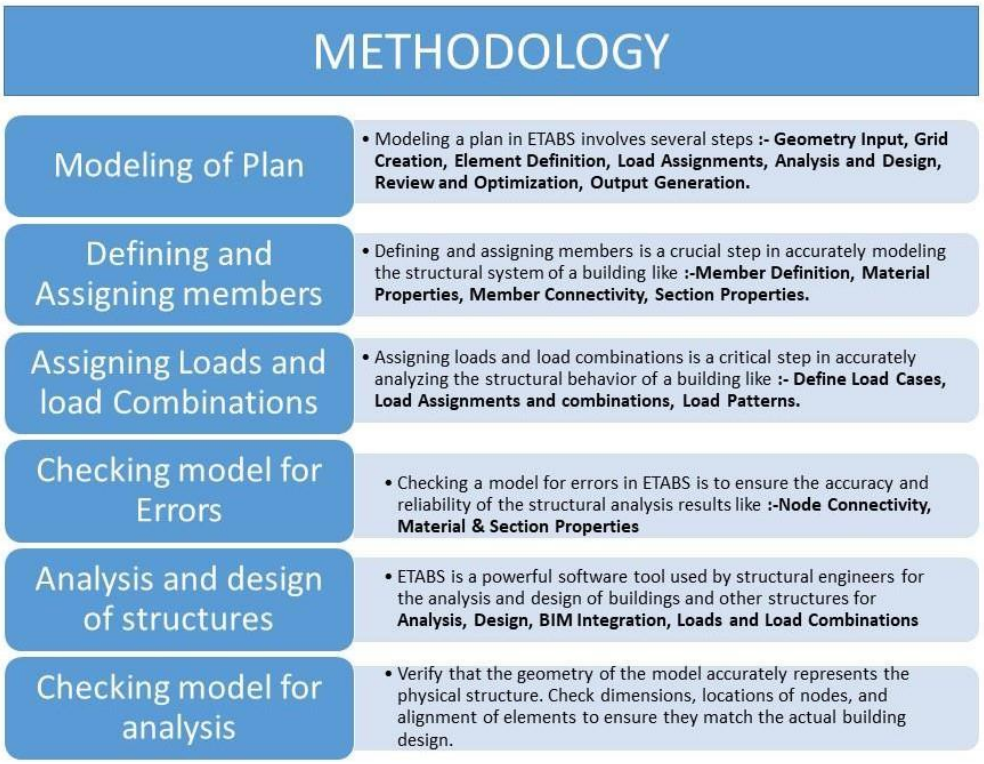
3. METHOLOGY

The methodology adopted in this work has been shown in the following figure:



Idealization of structure

Idealization of support

It deals with the fixity of the structure at the foundation level. In more detail terms, this idealization is adopted to assess the stiffness of soil bearing strata supporting the foundation. Although the stiffness of soil is finite in reality and elastic foundation design principles address this property to some extent, our adoption of rigid foundation overlooks it. Elastic property of soil is addressed by parameters like Modulus of Elasticity, Modulus of Subgrade reaction, etc. Idealization of support is done in the light of assessing the fixity of structure at the foundation level. Columns are assumed to be fully fixed at the raft surface with raft underneath supporting the load of the superstructure. Plinth beams are provided at a certain height from the existing ground surface as a means of tying the columns and also serve as Damp Proof Course (DPC).

Idealization of load

The load acting on the clear span of a beam should include floor or any types of loads acting over the beam on the tributary areas bounded by 450 lines from the corner of the panel i.e., Yield line theory is followed. Thus, triangular or trapezoidal types of load act on the beam

Idealization of joint constraints

Joints are defined with constraints to serve as rigid floor diaphragm at individual floor level. Due to this definition of joints, the slabs subjected to lateral loads behave in in plane action of thin shell and hence act as rigid floor diaphragm.

Idealization of Slabs

Idealization of slab element is done in earthquake resistant design to perform as a rigid floor diaphragm. This idealization is done for the slab to behave as a thin shell element subjected to out-of-plane bending only under the action of gravity loads. Due to infinite in-plane stiffness of the shell element, lateral loads are not taken by the floor slab and hence resisted completely by the columns. Hence, such an idealized slab is then modeled in ETABS2018 program for analysis.

Idealization of Staircase

Open welled staircase used in the building is idealized to behave as simply supported slabs, supported on beams at the floor and landing levels. This idealization helps us analyze the staircase slab in strips subjected to distributed loading on the landing strip and going of the slab. Detailing rules are then followed to address the negative bending moment that are induced on the joint of going and top flight in the staircase, the rigorous analysis of which is beyond or scope. Staircase being an area element is also assumed not to be a part of the integral load bearing frame structure. The loads from staircase are transferred to the supports as vertical reactions and moments.

Design Philosophy

There are three philosophies for the design of reinforced concrete viz.

1. Working Stress Method
2. Ultimate Load Method
3. Limit State Method

Limit State Method of Design for Reinforced Concrete Structures
Design of Reinforced Concrete Members is done based on the limit state method of design following
IS 456:2000 as the code of practice. The basic philosophy of design is that the structure is designed for strength at the ultimate limit state of collapse and for performance at limit state of serviceability. A check for these two limit states is done based on code of practice to achieve safe, economic and efficient design.

Limit state design has been originated from ultimate or plastic design. The object of design based on the limit state concept is to achieve an acceptable probability that a structure will not become unserviceable in its life time for the use for which it is intended, i.e. it will not reach a limit state. A structure with appropriate degrees of reliability should be able to withstand safely all the loads that are liable to act on it through-out its life and
it should satisfy the serviceability requirements. All relevant limit states must be considered in design to ensure an adequate degree of safety and serviceability.

Limit state of collapse
This state corresponds to the maximum load carrying capacity. Violation of collapse limit state implies failure in sense that a clearly defined limit state of structural usefulness has been exceeded. However, it does not mean a complete collapse. This limit state may correspond to:

1. Flexure,
2. Compression,
3. Shear and
4. Torsion.

Assumptions for the limit state of collapse in flexure:

a. The plane section normal to the axis of member remains plane after bending
b. The maximum strain in concrete at the outermost compression fiber is 0.0035.
c. The relationship between the compressive stress distribution in concrete and the strain in concrete may be assumed to be rectangle, trapezoid, parabola or any other shape. For design purpose, the compressive
strength of concrete in the structure shall be assumed to be 0.67 times the characteristic strength. The partial safety factor ym =1.5 shall be applied.
d. The tensile strength of concrete is ignored.
e. The stresses in the reinforcement are derived from the representative stress-strain curve for the type of steel used. For design purpose the partial safety factor ym =1.15 shall be applied.
f. The maximum strain in the tension reinforcement in the section at failure shall not be less than:

4. RESULTS AD DISCUSSIONS

This section presents the results and discussions of the experimental studies carried out. The results and discussions with respect to the experiments carried out are presented first, followed by the results and discussion.
Truss with different bracing configurations and comparison was made to propose thesuitable configurations. Here in order to look at the benefit of bracig in the lateral load condition the comparison has be made and finalized that bracing give the best performance.

STORY SHEAR:

STORY NO	PEB (kN)	CSB (kN)
2	0.7874	0.209
1	0.4843	0.051

MAXIMUM STORY DISPLACEMENT

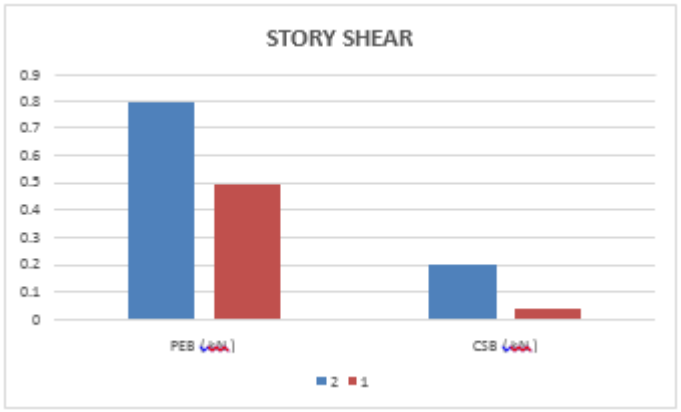
STORY NO	PEB (mm)	CSN (mm)
2	0.053	0.181
1	0.053	0.182

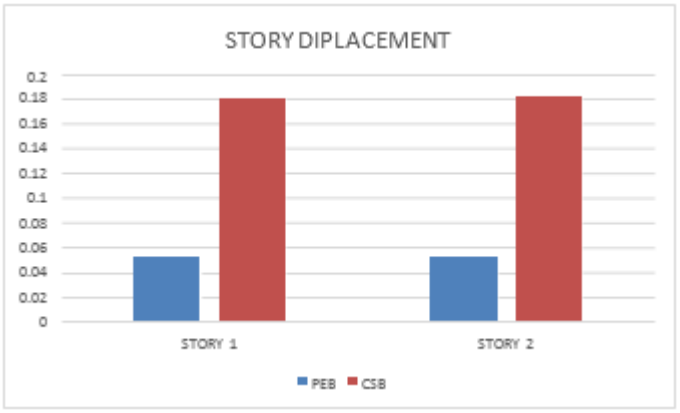
STORY OVERTURNING MOMENT

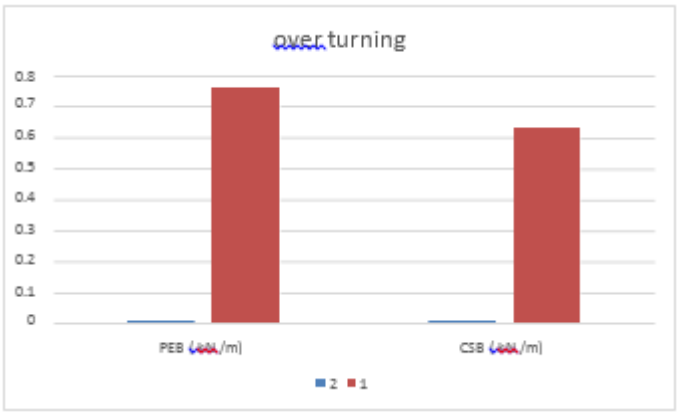
STORY NO	PEB (kN /m)	CSB (kN /m)
2	0.01	0.01
1	0.76	0.063

STORY DRIFT:

STORY NO	PEB (kN /m)	CSB (kN /m)
2	0.01	0.05
1	0.8	0.63


STORY SHEAR
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
PEB (kN)
CSB (kN)
2
1


STORY DIPLACEMENT
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
STORY 1
STORY 2
PEB
CSB


over turning
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
PEB (kN/m)
CSB (kN/m)
2
1


Story Acceleration
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
PEB
CSB
story 2
story 1

Advantages:

User-Friendly Interface:
E Tabs is renowned for its intuitive user interface, making it accessible even to those without extensive technical backgrounds. Its layout and functionality are designed to facilitate ease of use, allowing researchers to navigate through datasets and perform analyses efficiently.

Efficient Data Visualization:
One of the standout features of E Tabs is its robust data visualization capabilities. The software offers a wide range of charting options, including bar graphs, pie charts, scatter plots, and more. This enables users to represent complex datasets visually, making it easier to identify trends, patterns, and insights.

Streamlined Data Analysis Process:
E Tabs excels in streamlining the data analysis process. It can handle large datasets with ease, automating repetitive tasks such as data cleaning, coding, and computation. This automation not only saves time but also reduces the likelihood of errors that may occur during manual analysis.

Customization Options:
E Tabs provides users with ample customization options to tailor their analyses and reports according to specific requirements. Users can customize chart styles, colors, labels, and other visual elements to suit
their preferences or align with corporate branding guidelines. Additionally, the software allows for the creation of custom templates for standardized reporting.

Integration with Other Software Tools:
E Tabs offers seamless integration with other commonly used software tools in the market research domain, such as SPSS, Excel, and SQL databases. This integration facilitates smooth data import/export processes, enabling researchers to leverage data from various sources within a single platform.
Disadvantages:
Cost:
One of the primary drawbacks of E Tabs is its cost. The software typically requires a significant financial investment, which may be prohibitive for smaller research firms, independent researchers, or organizations with limited budgets.

Learning Curve:
While E Tabs aims to be user-friendly, there is still a learning curve associated with mastering its features and functionalities. New users may require time and resources to familiarize themselves with the software's capabilities, potentially slowing down the initial adoption process.

Dependency on Software Updates:
Like any software, E Tabs requires regular updates to address bugs, introduce new features, and ensure compatibility with evolving technologies. Users may face disruptions or compatibility issues if they do not keep their software version up to date, which can impact productivity and data integrity.

Limited Compatibility with Some Data Formats:
While E Tabs supports various data formats, there may be limitations in compatibility with certain proprietary or uncommon file formats. Users may encounter challenges when importing or exporting data from sources that are not fully supported by the software.

Varied Quality of Technical Support:
The quality and availability of technical support for E Tabs may vary depending on the vendor and service level agreement. Some users may experience delays or challenges in accessing timely support, which can hinder their ability to resolve technical issues or optimize their usage of the software

5. CONCLUSIONS

- Comparative study made on various models of Pre-Engineered building and Conventional steel structure shows that PEB is an economical option and it can be concluded that up to a certain value of clear span .
- Pre- engineered building are most economical option and after a specific span steel quantity in PEB is almost sameas that of conventional steel structure.
- Provision of tapered section in PEB makes it economical and taperingof section is done as per the bending moment diagram. From all the analysis made it can be concluded that steel consumption in PEB is on an average 30% lesser than conventional steel structure.
- PEB frames are lightand more flexible than conventional steel frames and provides higher resistance to seismic

forces.

- Pre- engineered Metal building concept forms a unique position in the construction industry in view of their beingideally suited to the needs of modern Engineering Industry. It would be the only solution for large industrial enclosures having thermal and acoustical features.
- The major advantage of metal building is the high speed ofdesign and construction for buildings of various categories.

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