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Comparitive study of pre engineered and conventional industrial buildings

C.Mohanraj[1], V.Preetha[2]

[1]mohanraj.st16@bitsathy.ac.in, [2]preethav@bitsathy.ac.in

[1]Post Graduate student, [2]Assistant professor –Senior Grade

Department of civil engineering, Bannari Amman institute of technology,Sathyamangalam,Tamilnadu

ABSTRACT:

The structural Concept of Industrial Buildings is planned mostly as steel buildings. In that Pre-Engineered buildings are being desired over conventional buildings for industrial construction due to its economy and fast construction. Pre Engineered Buildings are engineered at a factory and assembled at site. The pre-engineered building system is one of the fastest mounting building systems in the world. Long Span, Column free structures are the most essential in any type of industrial structures and Pre Engineered Buildings (PEB) fulfils this requirement along with reduced time and cost as compared to conventional structures. After introducing the concept of pre-engineered building (PEB), the design helps in optimizing the materials involved in the design. The adoptability of PEB in the place of Conventional Steel Building (CSB) design concept resulted in many advantages, includes economy and easier fabrication. Possibilities of long span column free structures are more essential for industrial structures. PEB concept is versatile not only due to its quality pre-designing and prefabrication, but also due to its light weight and economical construction. The concept includes the technique of providing the best possible section according to the optimum requirement. This paper is a comparative study of PEB concept and CSB concept. The study is achieved by designing a typical frame of a proposed Industrial Warehouse building using both the concepts and analysing the designed frames using the structural analysis and design software Staad.Pro.

Keywords: Pre-Engineered Building, Conventional Steel Building.

I. INTRODUCTION

Steel industry is escalating promptly 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 (Prefabricated) is built in very short period and one such is Pre Engineered Buildings. Pre-engineered buildings are nothing but steel buildings in which excess steel is avoided by tapering the sections as per the bending moment's requirement. One may think about its possibility, but it's a fact many people are not aware about Pre Engineered Buildings. In regular steel structures, time frame will be more, and also cost will be more, and both together i.e. time and cost, makes it uneconomical. Thus in pre-engineered buildings, the total design is done in the factory, and as per the design, members are pre-fabricated and then transported to the site where they are erected in a time less than 6 to 8 weeks. The structural performance of these buildings is well understood and, for the most part, adequate code provisions are currently in place to ensure satisfactory behavior in high winds Steel structures also have much better strength-to-weight ratios than RCC and they also can be easily dismantled. 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

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. Technological upgrading over the year has contributed enormously to the enhancement of quality of life through various new products and services. One such revolution was the PEB buildings. Through its origin can be traced back to 1960's its potential has been felt only during the recent years. This was mainly due to the development in technology, which helped in computerizing the analysis and design. A recent survey by the Metal Building Associations (MBMA) shows that about 60% of the non-residential low rise buildings are PEB buildings.

Although PEB systems are extensively used in industrial and many other non-residential constructions worldwide, and it is relatively a new concept in India. The market potential of PEB's is 1.2 million tonnes per annum. The current PEB manufacturing capacity is 0.35 million tonnes per annum. The industry is growing at the compound rate of 25 to 30 %.

II. COMPARISION OF PEB WITH CSB

STRUCTURAL WEIGHT

With respect to design of the structure PEB are on average 30% lighter because of efficient use of steel. The primary frame members are tapered built up section, with large depths in areas of higher stress. whereas in conventional building primary steel members are selected as hot rolled T sections. Mostly those segments are too heavier than that actually requires. Members have constant cross section regardless of varying magnitude of local stresses along the member length.

DESIGN

Since PEB are mainly formed by standard sections and connection design is quick and efficient. So, the time is significantly reduced. In case of conventional design it is to be designed from scratch with fewer design aids available to the engineer.

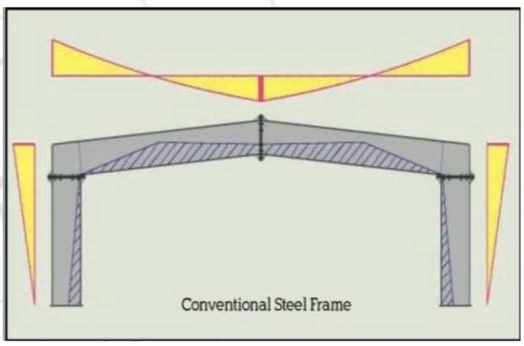

Fig: 1 Conventional steel frame

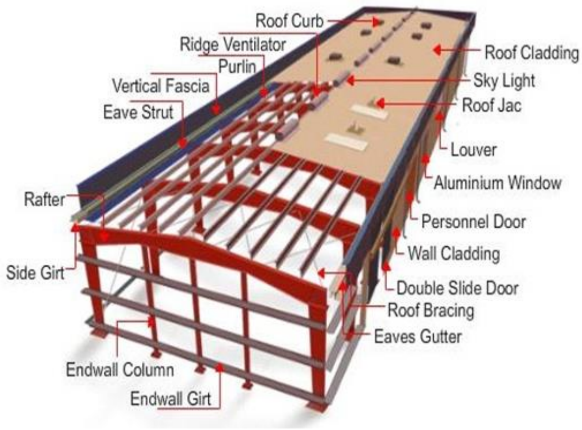

Fig: 2 Pre Engineered steel frame

III. PARAMETERS OF PRE ENGINEERED BUILDINGS

Building Width:

No matter what primary framing system is used, the building width is defined as the distance from outside of eave strut of one sidewall to outside of eave strut of the opposite sidewall. Building width does not include the width of Lean - to buildings or roof extensions.

Building Length:

The longitudinal length of the building measured from outer to outer distance of end wall steel lines.

Building Height:

Building height is the eave height which usually is the distance from the bottom of the main frame column base plate to the top outer point of the eave strut. When columns are recessed or elevated from finished floor, eave height is the distance from finished floor level to top of eave strut.

Roof Slope:

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The angle of the roof with respect to the horizontal. The most common roof slopes are 0.5/10 and 1/10. Any practical roof slope is possible.

End bay length:

The distance from outside of the outer flange of endwall columns to center line of the first interior frame column.

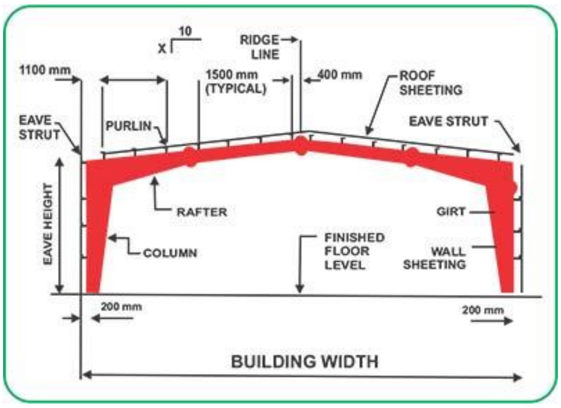

Fig : 3 Parameters of PEB

Secondary Framing

Purlins, girts and eave struts are secondary structural members used to support the wall and roof panels. Purlins are used on the roof; girts are used on the walls and eave struts are used at the intersection of the sidewall and the roof.

DESIGN DATA :

Table 1: Structural parameters

Type of building	Industrial building
Structure	Ware house
Location	Coimbatore
Total area	10000 m^2
Plan dimension	60m X 30m
Eaves height	10m
Spacing for frame	6m
Roof slope	18.43
Wind zone	Coimbatore

V. Load calculation

DEAD LOAD

- Dead load from (IS875 PART-1)

Assumed as be GI sheeting

Roof covering = 150N/m^2

Purlin = 80N/m^2

Trusses (30/3 +5) = 150N/m^2

Bracing = 12N/m^2

Total load = 392N/m^2

Load on intermediate panel

=(392 x(2.64x6))

= 6.21KN

Load on end panel = 6.21/2

= 3.1KN

LIVE LOAD

- Live load from (IS875, PART-2)

Ø = 18.43

Live load ` = (750-20(18.43-10))

= 581.4N

= 581.4 X 6 X 2.64

= 9.21`KN

Load on intermediate panel

= 9.21/2

=4.61kN

Wind load

The building is located at outer of Coimbatore city

Let as assume the life of industrial building as 50 years and the land to be plain and surrounded by small buildings

WIND DATA

Basic wind speed - 39m/s

Risk co efficient,

K1 -1 (50 years for general bilding)

- Terrain category – II
- Building class - C

K2 – 0.98

K3 -1 (Terrain topography)

Design basic wind speed

Vz =Vb x K1 x K2 x K3

Vz =39 x 1 x 0.98 = 38.2 m/s

Design wind pressure

$Pz = 0.6Vz^2$

= 0.6 x 38.2 x 38.2

= $0.88N/m^2$

Height of building h = 10m

Width of building w = 30m

h/w = (10/30)

= 0.33

Table 2 Wind co efficient

ANGLE	Co efficient for wall		Co efficient for Roof	
FACE	LEFT	RIGHT	LEFT	RIGHT
0 degree	-0.53	0.5	-0.4	0.5
	-0.53	-0.5	-0.4	-0.4
90 degree	0.72	0.5	-0.6	0.5
	-0.72	0.5	-0.6	0.5

i) Wind ward side

= (-0.72-0.5) x0.88 x 6 x 2.64

= -17 KN

ii) Leeward side

= (-0.6-0.5) x 0.88 x (6 x 2.64)

= -15.3 KN

VI. STAADPRO PROCEDURE

In the present study staad pro software has been used to analyse and design the Pre engineered and Conventional steel building. The comparision of results such as bending moment, Shear force, Axial force, and weight of the steel structure so that the design can be done as tapered I section.

VII. RESULTS

SUPPORT REACTION

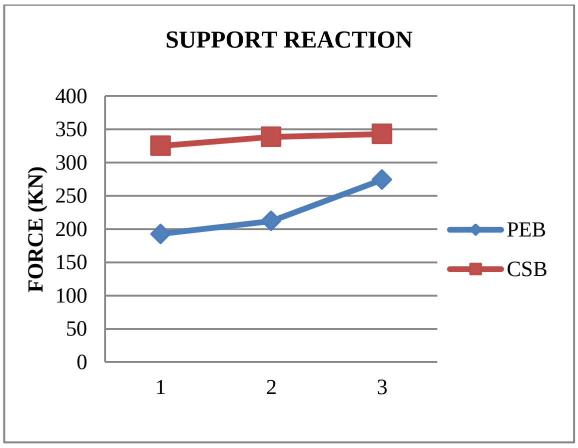

Fig : 4 Support reaction

BENDING MOMENT

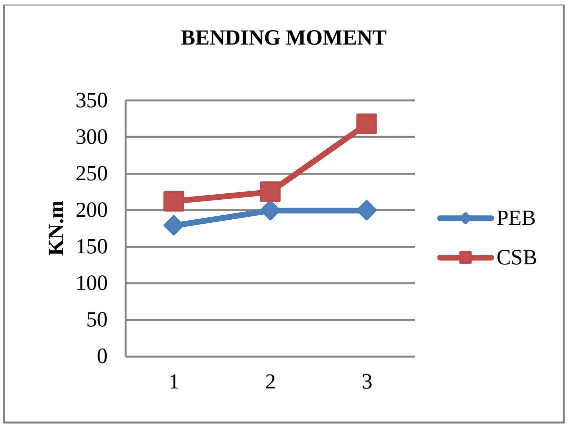

Fig : 5 Bending moment

WEIGHT COMPARISON

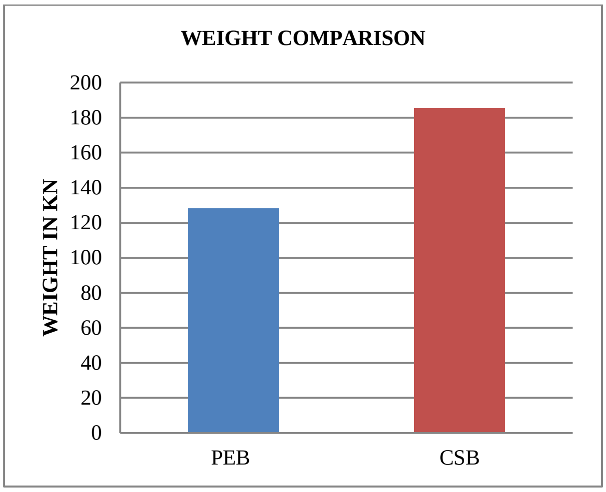

Fig : 6 Weight comparison

COST COMPARISON

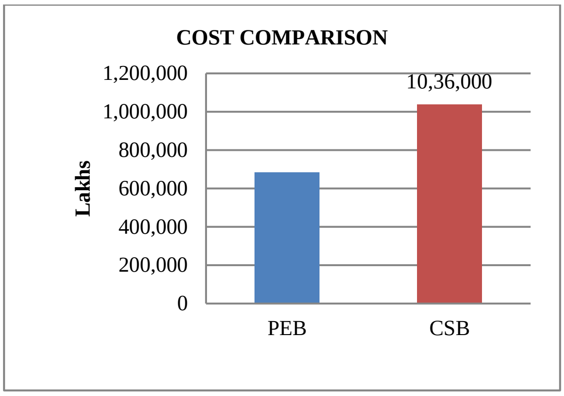

Fig :7 Cost comparison

VIII. RESULTS & DISCUSSION

PEB system is becoming an eminent segment in pre-engineered construction industry. Pre-engineered steel structures building offers low cost, strength, durability, design flexibility, adaptability and recyclability.

- After Analyzing, at different load cases it is observed that the support reactions at supports in PEB is less when compared to that in CSB.
- The Bending Moments at supports in PEB is less when compared to that in CSB.
- The support reaction and support Bending moment is comparatively lesser in the case of PEB structure. It shows that the quantity of steel usage is comparatively lesser in PEB.
- The axial force at column is considerably reduced by 37% in PEB.
- Significant cost reduction is achieved through PEB, due to lesser steel take off of about 33.33% comparing to conventional methods.

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