Analysis of warehouse design with Pre-Engineered Building system resting on different soil strata.

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***Abstract*- Nowadays Pre-Engineered Building (PEB) concept is majorly used in industrial and commercial sectors due to its benefits of time optimization and economy. Pre-Engineered building means a steel building system that is predesigned and prefabricated. Various research on the comparison of displacement and weight parameters for conventional and PEB has been already done. This paper represents an investigation of PEB resting on different types of soil strata with pinned base and fixed base support. In this study a PEB structure of span 15m, 20m, and 40m resting on hard, medium, and soft soil strata with pinned and fixed base support is to be analyzed and designed according to Indian standard code IS 800, 2007, The design and analysis can be done using the software STAAD Pro.**

***Index Terms*- Pre-Engineered Building, STAAD Pro, pinned base support, fixed base support, tapered section.**

I. INTRODUCTION

The study is mainly focused on the Pre-engineered building structure with varying support conditions with different soil strata. Pre Engineered Building concept involves steel building systems that are predesigned and prefabricated. PEB concept lies in providing the section at a location only according to the bending moment deflection requirement at that actual condition. The concept of PEB is the frame geometry that matches the shape of the internal stress such as the bending moment diagram thus optimizing material usage and reducing the total weight of the structure. Pre Engineered Building material section involves the steel building systems which are predesigned and prefabricated

A typical cross-section can be molded based on the bending moment diagram achieved at that particular section. The sections can be varying throughout the length according to the bending moment diagram. Tapered I section made with built-up thin plates of highly stressed and tested are used to achieve this configuration. The use of the optimal least section leads to beneficiary savings of steel and cost reduction.

Presently, a large column-free area is an utmost requirement for any type of industry, and with the advent of computer software, it is now easily possible. With the improvement in technology, computer software has contributed immensely to the enhancement of quality of life through new research. Pre-engineered building is one such revolution that is fully fabricated in the factory after design, then transported to the site and all components are assembled and erected with nut bolts, thereby reducing the time of completion. Pre-Engineered Buildings have bolted connections and hence can also be reused after dismantling. This flexibility would seem to readily lend itself to the optimization of member cross-section shapes. India has the second fastest-growing economy in the world and a lot of it is attributed to its construction industry which figures just next to agriculture in its economic contribution to the nation. In its steadfast development, the construction industry has discovered, invented, and developed several technologies, systems, and products, one of them being the concept of Pre-engineered Buildings. Steel is a material that has high strength per unit mass. Hence it is used in the construction of structures with large column-free space. The scientific-sounding term pre-engineered buildings came into being in the 1960s. The buildings were pre-engineered because they rely upon standard engineering designs for a limited number of configurations. These buildings are mostly custom-designed metal buildings to fill the particular needs of the customer.

II. METHODOLOGY

The 18 Pre-engineered building warehouse structure were developed. As per the Soft, Medium, Hard Strata with Varying foundation supports Based on displacement and weight ratio optimized structure were found.

III. DESIGN OF WAREHOUSE WITH PEB

Problem Statement:

Warehouse PEB structure of span 20m, 40m and 60 m is modelled with following properties.

A. *Warehouse structure of Span 20m*

Plan Dimension: 20m x 60m.
Height of Column: 6 m.
Centre to Centre column spacing: 6 m.
Slope of roof: 1/10.

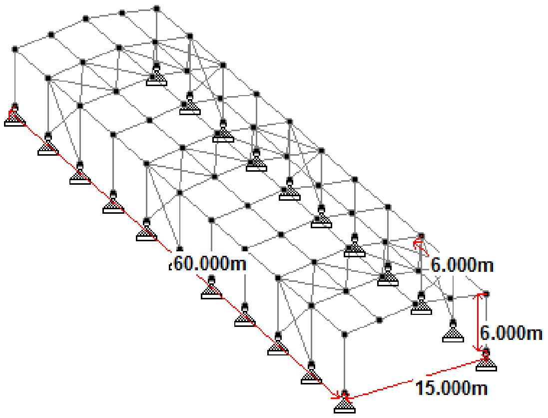
B. *Warehouse structure Span 40 m.*

Plan Dimension: 40m x 60m.

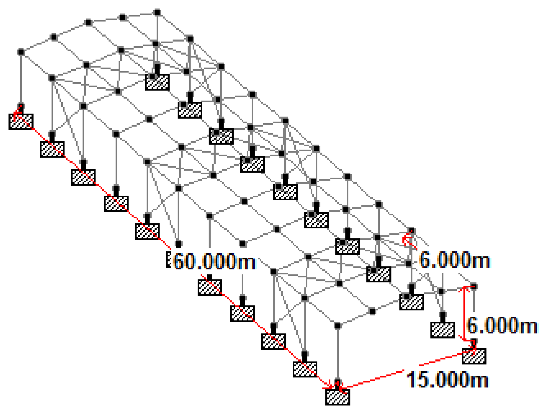
Height of Column: 6 m.
Centre to Centre column spacing: 6 m
Slope of roof: 1/10.

C. *Warehouse structure Span 60 m.*

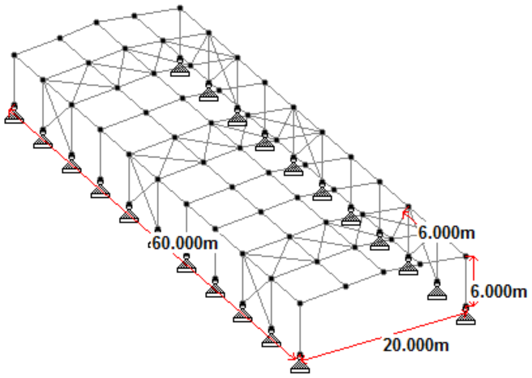
Plan Dimension: 60m x 60m.
Height of Column: 6 m.
Centre to Centre column spacing: 6 m
Slope of roof: 1/10.



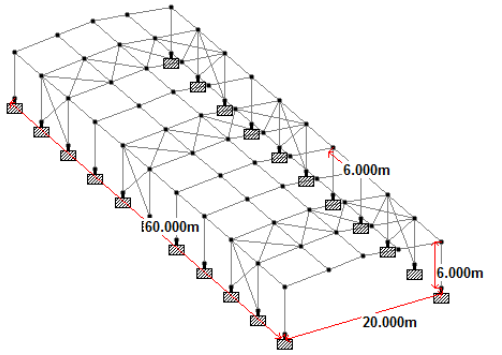
15m Span with Pinned End Support



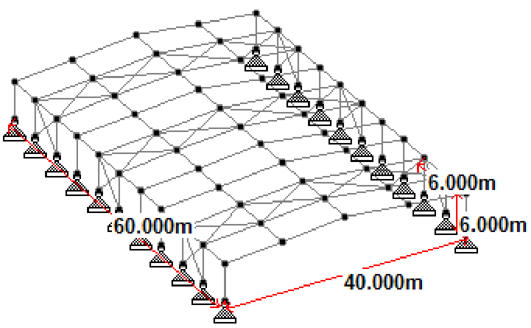
15m Span with Fixed End Support



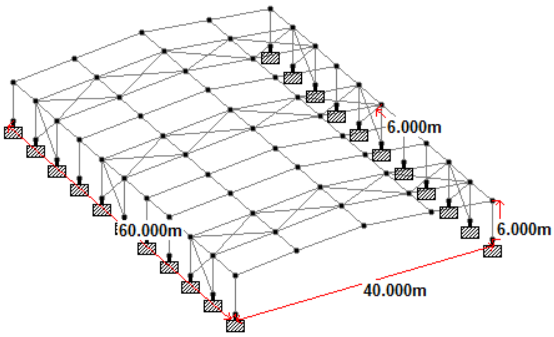
20m Span with Pinned End Support



20m Span with Fixed End Support



40m Span with Pinned End Support



40m Span with Fixed End Support

Figure 1. STAAD models of warehouse of span 15m, 20m and 40m

D. Material Input and Site Data.

Structural Steel grade = FE345.
Wind speed, Vb = 44 m/sec.
Terrain category= 2.
Structure class= C.
Risk coefficient K1= 1.
Topography k3= 1.
Terrain factor k2= 1.
Seismic Zone – II (Z=0.10)
Response reduction factor- 5.
Damping factor- 2%.
Importance factor-1.

E. Load combinations as per AISC:

Strength Combinations
1). DL+LL
2) DL+EQX
3) DL+EQZ
4) DL+0.75(LL+EQX)
5) DL+0.75(LL+EQZ)
6) DL+WLP
7) DL+WLS
8) DL+WPP
9) DL+WPS
10) DL+0.75(LL+WLP)
11) DL+0.75(LL+WLS)
12) DL+0.75(LL+WPP)
13) DL+0.75(LL+WPS)
Serviceability Combinations
1) 1.0(DL)+0.8(LL+EQX)
2)1.0(DL)+0.8(LL+EQZ)
3) 1.0(DL)+0.8(LL+WLP)
4) 1.0(DL)+0.8(LL+WLS)

F. Loadings

Dead Load- It includes self-weight of structure and weight of GI sheets etc.
Dead weight of galvanized sheet = 0.15 KN/m
hence total dead load = 0.15+ self weight
for 6 m tributary = 0.15*6 = 0.9 KN/m.
Live Load – It includes weight moving elements like access of human being
Roof live load= 0.75 KN/m
roof slope: 1:10 (5.71 degrees approx.)
total loading on frame (per running meter).
Roof LL = 0.75 x 6 m (bay spacing) = 4.5 K/m.
Wind Load –
Basic design wind speed = 44 m/sec
design wind speed vz = vb x k1 x k2 x k3
Vz = 44 x 1 x 1 x 1 x 1.15 =50.60 m/s.
Design pressure. pz = 0.6 x (vz)sq.
Pz = 0.6 x 50.60 x 50.60 = 1.23.kn/sqm

G. Closure

As per previous literature study most of research is carried out on conventional Pre-engineered building structure by considering parameter such as length to area ratio of conventional sections. Few research is carried out on innovative Pre-engineered building column section. It is need to be developing innovative Pre-engineered building column section to enhance its strength and durability. Paper includes the optimized design of Pre-engineered building structure.

Table No 1. Comparision of weight of 15m, 20m, and 40m span PEB Structure

Span Size	Soil Strata	Pinned Support(KN)	Fixed Support(KN)
15m	Hard	179.415	167.410
	Medium	183.472	175.359
	Soft	193.206	179.415
20m	Hard	209.001	204.126
	Medium	215.490	212.245

	Soft	228.470	220.358
40m	Hard	501.496	499.062
	Medium	503.930	501.960
	Soft	508.797	507.850

Table No. 2. Comparison of displacement of 15m, 20m, and 40m span PEB Structure

Span Size	Soil Strata	Pinned Support(MM)		Fixed Support(MM)	
		Vertical	Lateral	Vertical	Lateral
15m	Hard	71.82	13.42	58.28	36.98
	Medium	59.78	11.61	56.64	38.23
	Soft	48.89	10.95	53.66	34.34
20m	Hard	190.43	34.56	159.28	14.48
	Medium	201.203	31.87	141.45	12.55
	Soft	132.05	23.45	127.22	11.33
40m	Hard	346.90	32.56	271.70	23.58
	Medium	304.40	29.78	254.35	23.70
	Soft	272.395	35.67	231.13	21.68

The following are the main objectives of this project:
1. Design of Warehouse with PEB System having fixed support and pinned support with moment and shear connection which is resting on different soil strata such as Hard, Medium and Soft soil.
2. Investigate behaviour of PEB structure for various span such as 15 m, 20 m, and 40 m and soil strata such as Hard, Medium and Soft soil.
3. Establish the optimized design of Warehouse with PEB System.
4. To develop nomograph for PEB structures

Following below are results in graphical format,

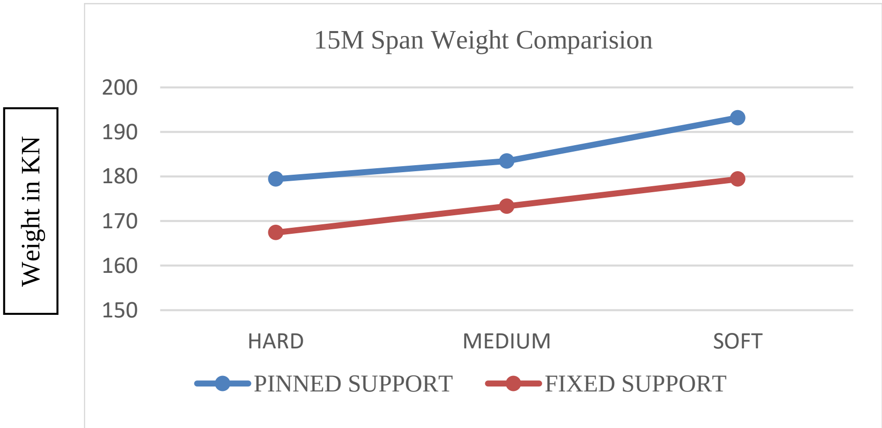


Figure no. 1 a) Weight comparison graph of 15 m span

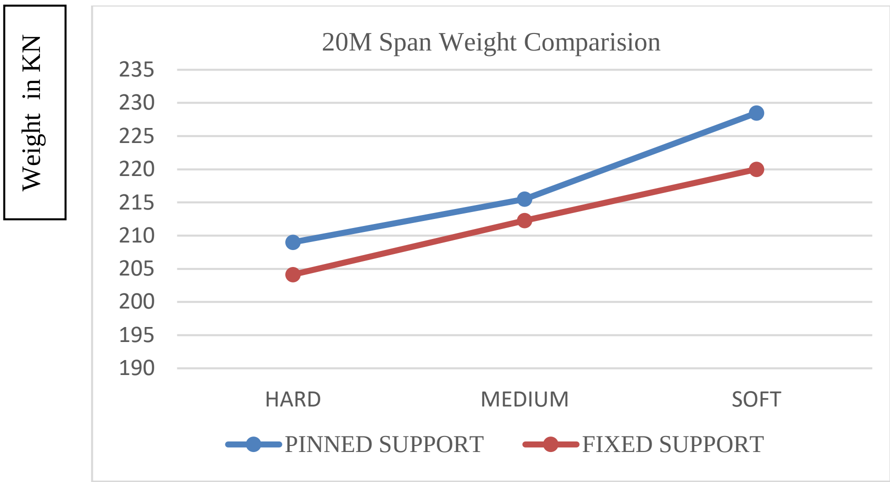


Figure no. 1 b) Weight comparison graph of 20 m span

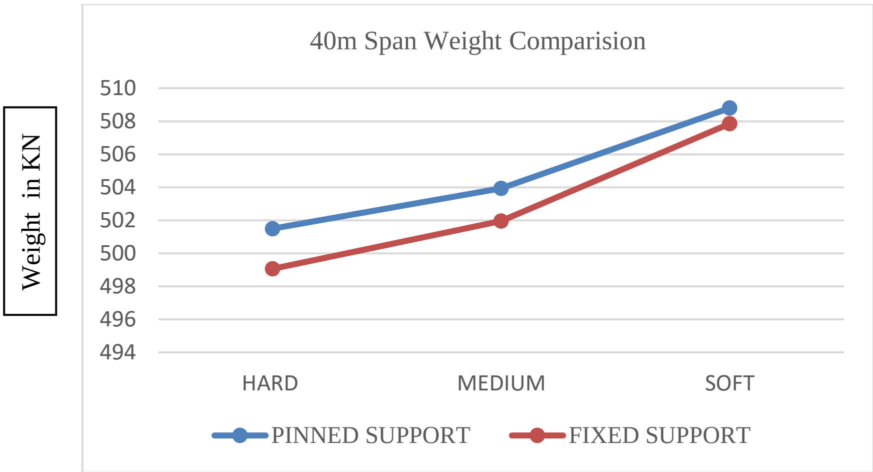


Figure no. 1 c) Weight comparison graph of 40 m span

In previous studies, research is carried out only on conventional and PEB steel structures. Also all studies are carried on the comparison of both types. But there is lack of research on different type of support and soil strata effect on the tapered sections. Also in general for construction and design of pre-engineered building a maximum cost is required, but there was no any optimum design or types are available to reduce the cost. Hence there will be optimization of ware house structure as per different soil strata

IV. CONCLUSION

1. The lateral displacements are minimized for the fixed support but the vertical displacements are increased in minor value thus to control the lateral displacements the fixed support can be used.
2. Local as well as global buckling were observed in innovative cold formed steel column sections, but for most of long column, global buckling governs the failure mode.
3. It was found that for most of innovative columns maximum deflection were observed at the mid length of the column.
4. Among nine different innovative cold formed steel column sections, it is observed that buckling mode depends on sectional geometry, stiffeners, centroid and column length.

V. ACKNOWLEDGMENT

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