ANALYSIS AND DESIGN OF PRE-ENGINEERED BUILDING

E.RAMYA[1] , S.DIVYA[2] ,B.GEETHA[3] ,D.PRITHIVI[4] ,C.SARANYA[5]

E.RAMYA[1] ASSISTANT PROFFESOR AT NEW PRINCE SHRI BHAVANI COLLEGE OF ENGINNERING AND TECHNOLOGY

S.DIVYA[2] UG STUDENT AT NEW PRINCE SHRI BHAVANI COLLEGE OF ENGINEERING AND TECHNOLOGY

B.GEETHA[3] UG STUDENT AT NEW PRINCE SHRI BHAVANI COLLEGE OF ENGINEERING AND TECHNOLOGY

D.PRITHIVI[4] UG STUDENT AT NEW PRINCE SHR` BHAVANI COLLEGE OF ENGINEERING AND TECHNOLOGY

C.SARANYA[5] UG STUDENT AT NEW PRINCE SHRI BHAVANI COLLEGE OF ENGINEERING AND TECHNOLOGY

ABSTRACT

Buildings and houses are the basic requirements of any human being. There are several changes in construction technology since the beginning. The basic requirements of construction nowadays are best aesthetic look,fast,economical and high quality. Pre-engineered building is best option for these all requirements. Pre-engineered buildings are cost effective,time consuming as compared to other conventional buildings. Generally pre-engineered buildings are faster than conventional buildings, 25% less time consuming & 30% lighter than conventional buildings. The plan & load on the building are calculated at the beginning. & the members are manufactured in factory & they are just assembled on actual site at time of construction.

KEY WORDS-*Conventional Steel Buildindg ,Pre-Engineered Building , Staad.pro , Tapered I Section.*

1.INTRODUCTION

A healthy trend in the form of growth in demand for construction works in residential, Commercial, Institutional, industrial and infrastructure sectors are being seen over the past decade. Modern Structures are much more complex and sophisticated as compared to earlier period. One of the major changes which are being felt by all is that the present structures are taller and thinner. Modern day requirement of structures is that these should be lighter yet not compromising on functionality. Civil engineering construction has seen a continual economic competition between steel, concrete and other construction materials.Pre Engineered Steel Buildings are manufactured or Produced in the plant itself. The manufacturing of structural members is done on customer requirements. The detailed structural members are designed for their respective location and are numbered, which cannot be altered; because members are manufactured with respect to design features. These components are made in modular or completely knocked condition for transportation. These materials are transported to the customer site and are erected. Welding and cutting process are not performed at the customer site.

Applications of PEB

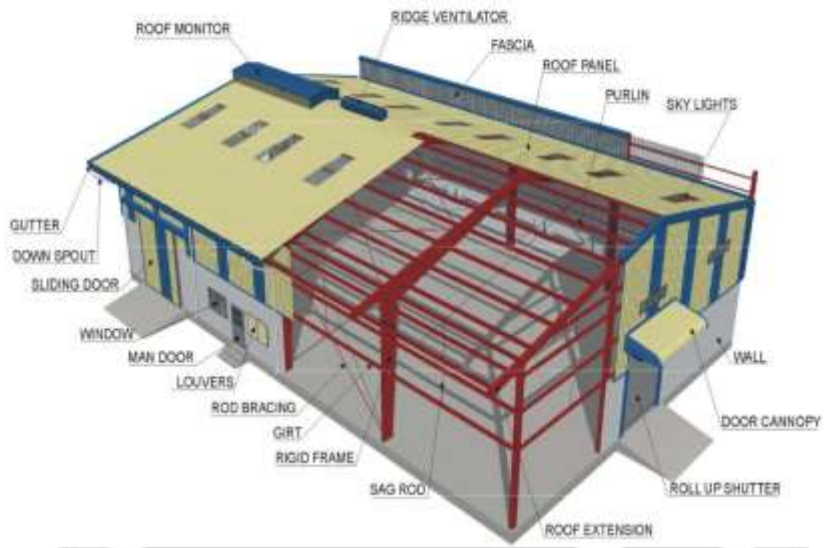
Almost every conceivable building use has been achieved with PEB; the most common applications are industrial, institutional and commercial. In India, Pre-engineered building systems find application primarily in the construction of Warehouses, & Industrial sheds & Buildings. The recent focus has also shifted to cover rural as well as urban, individual and mass housing projects, farmhouses, slum re-organization projects and rehabilitation projects, amenity structures like health centers, kiosks, primary schools, panchayat ghars etc. The pharmaceutical industries and exhibition centers, and functional requirements like offices, seminar halls, call centers, supermarkets, showrooms etc. have also attracted PEB. Earthquake-resistant buildings are the recent applications of PEB with wide and immediate acceptance.PEB concept has acted as a catalyst in the infrastructure development of the country. Single storied houses for living take minimum time for construction and can be built in any type of geographic location like extreme cold hilly areas, high rain prone areas, plain land, extreme hot climatic zones etc.

Applications of Pre Engineered steel buildings include

Aircraft Hangers

- Supermarkets
- Workshops
- Office Buildings
- Labor Camps
- Petrol Pumps/Service Buildings
- Schools
- Community centers
- Railway Stations

- Equipment housing/shelters.



2.METHODOLOGY

The present study is included in the design of an Industrial workshop structure located at Chennai. The actual structure is proposed as a Pre-Engineered Building with length 234m and width 120m it has four spans each of 30 meters width, 30 bays each of 7.4 meters length and an eave height of 19 meters. In this study, a typical PEB frame of 30 meter span is taken into account and the design is carried out by considering dead load, live load and wind load.

Methodology flow chart

3 .TECHNICAL PARAMETERS OF PEB

Pre Engineered Buildings are custom designed to meet client's requirements. PEB's are defined for definite measurements. The produced members fit to the designed dimensions. Measurements are taken accurately for the requirements. The basic parameters that can define a PEB are

WIDTH OR SPAN OF BUILDING

The centre to centre length from one end wall column to the other end wall column of a frame is considered breadth or span of the building. The width between two columns can be measured as span. The span length for different buildings varies. The design is done on span length given by customer. The basic span length starts from 10 to 150 meters or above with intermediate columns.

LENGTH OF BUILDING

The length of PEB is the total length extending from one front end to the rear end of the building. The length of PEB can be extendable in future.

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

This is the angle of the roof with respect to the horizontal. The most common roof slopes are 1/10 and 1/20 for tropical countries like India. The roof slope in snow fall locations can go up to 1/30 to 1/60. Any practical roof slope is possible as per customer's requirement.

DESIGN LOADS

Unless otherwise specified per-engineered buildings are designed for the following minimum loads. The designed loads play a crucial role in case of PEB. The failure of the structures occurs if not properly designed for loads.

The determination of the loads acting on a structure is a complex problem. The nature of the loads varies essentially with the architectural design, the materials, and the location of the structure. Loading conditions on the same structure may change from time to time, or may change rapidly with time.

Dead Load

The structure first of all carries the dead load, which includes its own weight, the weight of any permanent non-structural partitions, built-in cupboards, floor surfacing materials and other finishes. It can be worked out precisely from the known weights of the materials and the dimensions on the working drawings.

Live Load

All the movable objects in a building such as people, desks, cupboards and filing cabinets produce an imposed load on the structure. This loading may come and go with the result that its intensity will vary considerably. At one moment a room may be empty, yet at another packed with people. Imagine the `extra' live load at a lively party.

Wind loads

Wind has become a very important load in recent years due to the extensive use of lighter materials and more efficient building techniques. A building built with heavy masonry, timber tiled roof may not be affected by the wind load, but on the other hand the structural design of a modern light gauge steel framed building is dominated by the wind load, which will affect its strength, stability and serviceability.

Roof load

Live loads produced by maintenance activities, rain, erection activities, and other movable or moving loads by not including wind, snow, seismic, crane, or dead loads.

Roof snow load

Gravity load induced by the forces of wind blowing from any horizontal direction.

Collateral loads

The weight of any non-moving equipment or material such ceilings, electrical or mechanical equipment, sprinkler system, or plumbing.

Auxiliary loads

Dynamic loads induced by cranes, conveyers, or other material handling systems.

Seismic loads

Horizontal loads acting in any direction structural systems due to action of an earthquake

Floor Live loads

Loads induced on a floor system by occupants of a building and their furniture, equipment, etc.

DESIGN LOADS

DEAD LOADS

The dead load of the structure is generated by the program based on the member sizes.

SUPERIMPOSED DEAD LOADS

The superimposed dead load of Roof Sheet Load and wall cladding Load is calculated manually and applied at appropriate locations.

WIND LOAD

Wind load has been estimated based on following calculations.

The wind speed at 10m above mean sea level V_b = 50 m/s

Design wind speed V_z = $V_b \times k_1 \times k_2 \times k_3$ in (m/s)

Design wind pressure P_z = $0.6\ V_z^2$ in (N/m^2)

Wind Load Calculation F = $(C_{pe} - C_{pi}) \times A \times P_z$ (kN)

Where

Vb = Wind speed at 10m above MSL.

Cpe = External pressure coefficient

Cpi = Internal pressure coefficient

k1 = Probability factor (Risk coefficient) = 1.0

k2 = Terrain, Height and Structure size factor will vary according to height.

k3 = Topography factor = 1.0

WIND PRESSURE COEFFICIENT

The External and Internal wind pressure coefficient has been estimated based on following calculations.

Internal wind pressure coefficient for roof and walls

The Internal wind pressure coefficient is calculated based on the permeability of the building. As per section 6.2.3.2 in IS : 875(part 3)-1987, buildings with medium openings between about 5 to 20 percent of the wall area shall be examined once with an internal pressure coefficient of +0.5 and again with an internal pressure coefficient of -0.5.

Internal wind pressure coefficient = ± 0.5 for roofs and walls

External wind pressure coefficient for roof

The External wind pressure coefficient is given in table 6 in IS: 875(part 3)-1987.

Using the table 6 with roof angle 5°42' and h/w ≤ 0.5, pressure coefficients are given in table

Where,

h = Height of structure = 13m

w = Width of structure = 120m

h / w = 13 / 120 = 0.108 ≤ 0.5

External pressure coefficients

Portion of roof	**Wind incidence angle 90°**	
	0°	90°
Windward 5°	-0.9	-0.8
Leeward 5°	-0.4	-0.4
Windward 10°	-0.9	-0.8
Leeward 10°	-0.4	-0.6

Interpolation:-

Wind ward side (5°42') Cpe = -0.8

Lee ward side (5°42') Cpe = -0.42

Risk coefficient k1 = 1.0

Terrain category Class C k2 = 0.93 @ 10m & 1.97 @15m

Interpolating k2 = 1.346 @ 13m

Topography factor k3 = 1.0

The wind speed V_b = 50 m/s

Design wind speed V_z = V_b x k_1 x k_2 x k_3 in (m/s)

= 50 x 1.0 x 1.346 x 1.0 (m/s)

= 67.3

Design wind pressure P_z = $0.6\ V_z^2$ in (KN/m^2)

= 2.717 (KN/m2)

Wind Load Summary

Wind Angle	Pressure Co-efficient			Cpe + Cpi		Wind Load (F) KN	
	Cpe		Cpi				
	Wind Ward Side	LeeWard Side		Wind Ward Side	LeeWard Side	W (*A)	L(*A)
0	-0.94	-0.4	-0.5	-1.44	-0.9	-3.47	-2.17
			0.5	0.44	0.1	-1.06	0.24
90	-0.8	-0.43	-0.5	-1.3	-0.93	-3.13	-2.24
			0.5	-0.3	0.07	-0.723	0.17

CONCLUSION

Steel is such a versatile material that every object we see in our daily life has used steel directly or indirectly. There is no viable substitute to steel in construction activities. Steel remains and will continue to remain logical and wide choice for construction purpose, environmentally also, as much of the steel used is recycled. Pre-engineered Metal building concept forms a unique position in the construction industry in view of their being ideally suited to the needs of modern Engineering Industry. It would be the only solution for large speed of design and construction for buildings of various categories

REFERENCES

1. An explanatory handbook on proposed IS 875 (part3) Wind Loads on Buildings and structures by Department of Civil Engineering IIT Roorkee

2. Design of Steel Structures by R.Sathish Kumar and A.R. Santhakumar

3. Design Concept of Pre Engineered Building by Syed Firoz, Sarath Chandra kumar, S.kanakamba rao International Journal of Engineering Research and Applications.

4. Design Flexibility of steel by Rajesh Maheshwari,

5. Pre Engineered Steel Buildings a promising Future by Dr. Abhay Gupta,

6. Unicon Pre Engineered Buildings brochure

7. PEB a boon for Building Industry by Steel building systems India.