Optimization of Beam Using Castellation of PEB Section with Different Geometry

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Abstract- In existing years the introduction of pre engineering design of structures has helped in optimizing design. The construction of PEB in the place of Conventional Steel Building (CSB) design notion resulted in numerous advantages as the member are design as per bending moment diagram and thus reducing the steel requirement. PEB construction is nowadays popular owing to their advantages in excess of conventional Concrete and Steel constructions. Concrete structures are bulky and impart more seismic weight as well as less deflection while Steel structures instruct more deflections in addition to ductility to the structure, which is beneficial in resisting earthquake forces. PEB Construction combines the better properties of both steel and concrete along with lesser cost, speedy construction, better quality control, sustainability etc. Cost effectiveness based on material cost is determined.

***Key Words* -** Pre engineered Building, design, Steel structures, deflections.

I. INTRODUCTION

Technological development greater than the year have contributed enormously to the enhancement of dissimilarity of life through various new products and services. One such revolution was the pre engineered buildings. steel is the material of choice for design because it is inherently ductile plus flexible. In structural engineering, a pre-engineered building (PEB) is intended by a manufacturer, to be fabricated by means of a pre-determined record of raw materials and built-up method that can efficiently satisfy a extensive range of structural in adding to artistic design supplies. PEB know how to exist fitted by means of different structural accessories including mezzanine floors, canopy fasciae, periphery partitions, etc. The impression of PEB is the frame geometry which matches the shape of the internal stress diagram thus optimizing fabric usage in addition to plummeting the amount heaviness of the structure. The total designing is done at the factory and the building components are brought to the site in knock downhill condition. This mechanism be then fixed/ jointed at the site and raise with the help of cranes.

Technological improvement over the year has contributed immensely to the enhancement of superiority of life on or after beginning to end various new foodstuffs along with services. One such upheaval was the pre–engineered buildings. Steel industry is growing rapidly during almost all the part of the world. The create use of of steel structure is not merely economical but also ecological at the occasion at what time there is a threat of global warming. Pre-engineered buildings are nothing but steel building in which excess steel is avoided by tapering the sections as per the bending moment's obligation. One may believe regarding its likelihood, but it's a fact a lot of people are not alert about Pre Engineered Buildings.

If we go for regular steel structures, time frame will be more, and also cost will be more, and both together i.e. time in addition to cost, makes it uneconomical. Thus in pre-engineered buildings, the total intend is done in the factory, and as per the intend, member are pre-fabricated and then transported to the site anywhere they are erected in a time less than 6 to 8 weeks. Pre-engineered building is those which are fully fabricated in the factory after designing, shipped to site in CKD (completely knocked down) condition; and all components are assembled and erected at site by means of nut-bolts, thus reducing the occasion of completion.

➢ **Pre-Engineered Building [PEB]**

These are shaped in the plant, itself. Here according to the provisions of the client the urbanized of the member is complete. The machine is finished in wholly ready state for transportation. These are then sent toward the site and after that the erection development starts. The manufacturing process doesn't takes place at the site. The pre-engineered building are normally constructed for office, shop fronts, ware houses etc. Here the extra sum of steel is avoided since the sections are tapered according to the winding moment diagram.

➢ **Advantages of PEB**

- ✓ Faster Project Construction
- ✓ Lower Cost
- ✓ Flexibility of Expansion
- ✓ Larger Clear Span
- ✓ Quality Control
- ✓ Low Maintenance
- ✓ Energy Efficient for Roofing
- ✓ Erection

➢ **Components of PEBs**

- ✓ Primary Components
- ✓ Secondary Components
- ✓ Accessories

II. LITERATURE REVIEW

Santosh S. Patil, Sujay Deshpande, (2018), In recent years, the introduction of Pre Engineered Building (PEB) design of structures has helped in optimizing design. The construction of PEB in the place of Conventional Steel Building design concept resulted in many compensation as the member are designed as per roundabout moment diagram and thus plummeting the material requirement. This methodology is versatile not only due to its superiority pre-designing and prefabrication, but also due to its light weight in adding up to reasonably priced construction.

Sudhir Singh Bhadoria1, Yash Pathak, (2017), This document deals to resolve such issues by replacing conventional steel structure with PEBs. The concept and attracting feature of PEB such as members are designed as per the bending moment diagram of the steel frame, in order to make the structure inexpensive in terms of steel consumption and cost. In this term paper, various models of PEB span ranging from 10m to 50m i.e. 10m,20m, 30m,40m,50m are compared by means of another five models of conventional steel structure of length same as that of PEB. Models of both the arrangement are designed by means of Staad Pro Software and analyzed under Dead, live, wind and Seismic load to find out which system is economical.

Jinsha M S, Linda Ann Mathew, (2016), In this manuscript Pre-Engineered Building of 25m width & 6m Eave Height have been analyzed and designed by using STAAD Pro.2007 to understand the behaviour of Pre – Engineered structure & to check in which case it attain the financial system in steel quantity by varying bay spacing as 6m, 8m, 10m, & 12m. Long Span, Column free structures are the most essential in any type of industrial structures in addition to Pre Engineered Buildings fulfils this condition along by means of reduced time and cost as compared to conventional structures. In the present service Pre Engineered Buildings (PEB) is designed for wind forces. Wind analysis has been done manually as per IS 875 (Part III) – 1987.

III. DESIGN OF PEB SECTION

➢ Structure Configuration

Table 1.1: Structure Configuration

Location	Pune
Length	30m
Width	15m
Height	18m
Seismic Zone	IV
Wind Speed	39m/Sec
Wind Terrain Category	II
Wind Class	B
Soil Type	Medium
Importance Factor	1

➢ Dead Load Calculation

The structure first of all carries the dead load, which include its own weight, the weight of any everlasting non-structural partitions, built-in cupboards, floor developing materials and other finishes. It can be worked out precisely from the known weights of the materials and the dimensions on the working drawings. Dead load calculation includes the weight calculation of sheeting, sag angles, purlins and insulation material as follows in Table

Table 1.2: Dead Load Calculation

Sheeting Unit Weight	4.78 Kg/m^2
Spacing of Purlins	4.71 Kg/m^2
Purlin Weight	2.61 Kg/m^2
Sag Road Weight	0.667 Kg/m^2
Insulation Materials Weight	2 Kg/m^2
Total Dead Load	**0.1 KN/m^2**

➢ Live Load Calculation

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. Calculation of live loads includes consideration of live loads according to different codes.

As per Indian Live Loads - 0.75 KN/m2

➢ Wind Load Calculation

Table 1.3: Wind Load Calculation

Wind Speed (V_b)	39 m/sec
Risk Coefficient (K_1)	1.06
Probability Factor (K_2)	0.76
Topography Factor (K_3)	1

Design Wind Speed (Vz) = K1 x K2 x K3 x Vb

= 1.06 x 0.76 x 1 x 39

= 31.41 m/sec

Design Wind Pressure (Pz) = 0.6 x (Vz) 2

= 0.6 x (31.41)2

= 592 N/m2

= 0.592 N/m2

➢ **Load Combinations**

✓ **Wind Pressure and Forces on Structure**

$$F = (C_{pe} - C_{pi})\ X\ Av\ X\ P_d$$

Where,

C_{pe} - External Pressure Coefficients

C_{pi} - Internal Pressure Coefficients

A - Surface Area

P_d - Design Wind Speed

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

✓ **External Wind Pressure Coefficient For Roofs**

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

$$Roof\ Angle\ in\ Degree = [\frac{\left(\frac{1}{10}\right) x\ 180}{\pi}]$$

Roof Angle in Degree = 5.71

Table 1.4: External Wind Pressure Coefficient

Roof	Wind Angleq = 0°		Wind Angleq = 90°	
Angle	EF	GH	EG	FH
5	-0.90	-0.60	-0.90	-0.60
10	-1.10	-0.60	-0.80	-0.60
5.71	-0.93	-0.60	-0.89	-0.60

✓ **Internal Pressure Coefficient**

Internal wind pressure coefficient taken fro IS - 875 (Part -3) Table No - 14 for wind angle 00 and 900.

Table 1.5: Internal Pressure Coefficient

Openings not more than 5% of wall area	0.2
Openings between 5% to 20% of wall area	0.5
Openings larger than than 20% of wall area	0.7

The Section Openings between 5% to 20 % of wall area there for internal pressure coefficient is 0.5.

✓ **Roof Design**

Table 1.6: Roof Design

Wind Pressure	Wind Suction	
-0.059	-0.846	Purlins
-0.059	-0.846	Purlins, Gable Extension
-0.059	-0.846	Interior Roof Panels
0.415	-0.059	Long Bracing, Building
0.711	-0.355	Long Bracing, Wall Edge Zone
0.711	-0.355	Long Bracing, Facia/Parapet

Wind Pressure = (-0.059)

Wind Suction = (-0.846)

IV. RESULT DISCUSSION

1. Load Capacity of Castellated Steel Beam With Tapered Shape and Hexagonal Openings

Table 1.7: Result For Castellated Steel Beam With Tapered Shape and Hexagonal Openings

Sr. No	Span Length	Hole Of Diameter	Load carrying Capacity	% Differences
	Mm	mm	KN	
1	1500	40	196.99	-
2	2000	50	168.52	14.45
3	2500	60	160.72	4.63
4	3000	70	167.7	4.16
5	3500	80	181.25	7.48
6	4000	90	158.29	12.67
7	4500	100	170.27	7.04

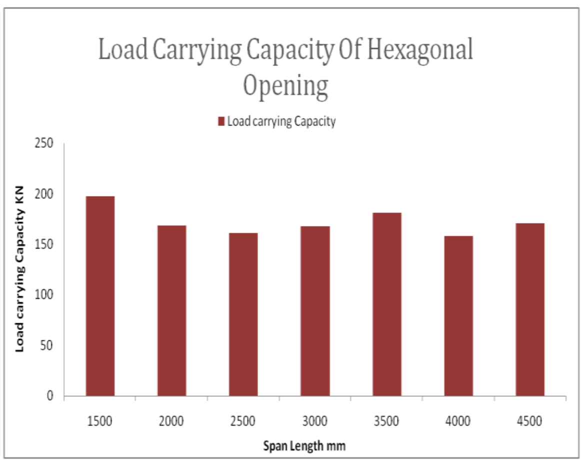

Fig. 1.1: Load Carrying Capacity of Tapered Shape and Hexagonal Opening

2. Rendering View Of Model

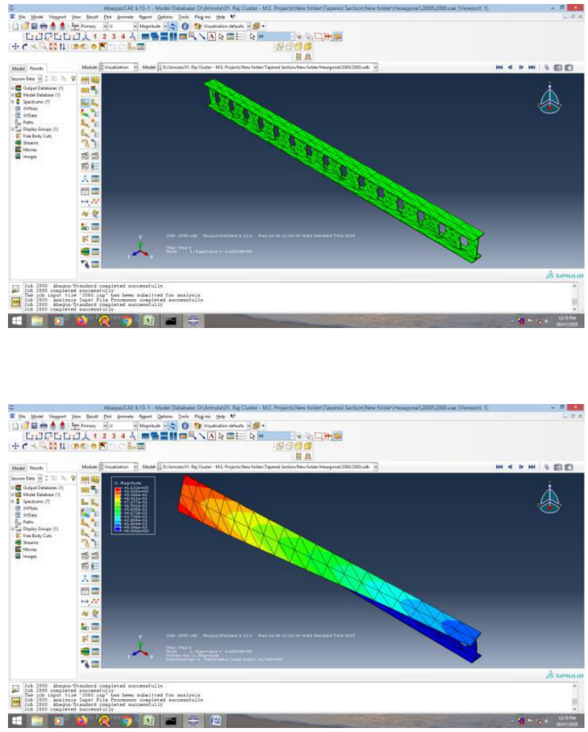

Fig. 1.2: Review View Of Model

V. CONCLUSION

- From the study concluded that the use of PEB is implemented and continuously increasing.
- It is reviewed that PEB structures can be easily designed by simple design procedures in accordance with country standards, it is energy efficient, speedy in construction, saves cost, sustainable and most important it's reliable as compared to conventional buildings.
- Hexagonal opening of tapered shape castellated beam are analyzed in ABAQUS software. Results are obtained when length of beam are increased load carrying capacity of beam also decreased.

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