International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 6 June 2022, pp: 1052-1055 www.ijaem.net ISSN: 2395-5252

Design optimization of Pre-Engineered Building for Warehouse by alternating design parameters.

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Submitted: 01-06-2022 Revised: 10-06-2022 Accepted: 15-06-2022

ABSTRACT - In present years ,the concept of Pre-Engineered Building in creation format of structures has helped into optimizing a design. Steel industry sector is developing more widely in almost throughout elements of world.In a hazard global warning the usage of steel structures is not only efficient but also sustainable at the time. In PEB steel structures (Pre-fabricated) time is being maximum significant aspect is built in very short duration period. In any type of intertrial structures and pre-engineered buildings maximum span,column free suitable structures are the most vital in fulfills this requirement the aspect of decreased time and cost in comparison to conventional structures. The current construction approach calls for the best architectural look, high quality & quick construction, cost-effective & creative touch. The implementation of the Pre Engineered Building (PEB) is a modern-day concept in which utilizing the steel structure and optimizing the design by ensuring economical integrity. This impacts more growing state in structural engineering and demands lot of optimization method to be established for saving amount of steel to be used and its indirect costs like handling,logistics,material,man power used. Comparing traditional steel building design concepts & advanced pre-engineered building design concept has lot of great results including economy and easier fabrication. Long Span, Column free structures are the most essential in any type of industrial structures. In this study, an industrial structure (Ware House) is analyzed and designed by considering various types of sections using the structural analysis and design software ETAB. The ware house is modeled with all these sections and the economy of the structure is discussed in terms of its weight, cost and degree of fabrication.

I. INTRODUCTION

The most recent improving technology was continuously increasing the maximum clear-span competencies of steel structures. In India the industry has fast development of steel building makes for exciting analyzing and it can have commenced all with the on location fabrication model. With the opening up of the economy during the 1990s but, such things started to change. In the might of the PEB enterprise this became the cause for predominantly ―manufacturing plant constructed‖ structures and to achieve economy growth.

Pre-Engineered steel structures are fabricated or created necessity in the plant itself. The production of structural members is done on customer requirements. The buildings were pre-engineered due to the fact they actually depend on general engineering designs for the limited amount of configurations. A pre-engineered building (PEB) is designed by the producer to be fabricated using a pre-determined inventory of raw materials and production techniques that may be efficiently satisfy a wide variety of a structural and aesthetic view of design requirements within a few geographic manufacturing sectors these buildings are also called as Pre-Engineered Steel Buildings. Generally, a PEB is an inflexible jointed plane frame from hot-rolled or cold-rolled sections, helping the roofing and side cladding through hot-rolled or cold-formed sections purlins and sheeting rails. Z and C-shaped cold formed steel members may be used as secondary structural elements to fasten and support to the outside cladding. Steel building system usually a variety of wall materials, the unique creations and still the maximum popular

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being steel siding, supported by means of sidewall or end wall girts. In order to perfectly layout a pre-engineered building, engineers consider the clear span among the bearing factors, bay spacing, roof slope, dead loads, superimposed loads, collateral loads, wind uplift, deflection criteria, internal crane system maximum realistic size and weight of the fabricated members. The use of an optimum least section leads the reduction equipped savings in steel and price reduction.

Fig.1 Typical warehouse Structure

A warehouse is a building for storing goods. Warehouses are used by manufacturers, importers exporters, wholesalers, transport businesses, customsetc. They are usually large plain buildings in industrial parks on the outskirts of cities, towns, or villages Warehousing can also be defined as assumption of responsibility for the storage of goods. By storing the goods throughout the year and releasing them as and when they are needed, warehousing creates time utility.

Stages in Structural Design

Every structure follows a specific path from its initiation to ultimate design as follows:

1) Structural planning of the building.
2) Calculation of applied loads.
3) Structural analysis of the building
4) Design of the building as per analysis.
5) Drawing and detailing of the structural members.
6) Preparation of tables and graphs.
7) It is the responsibility of the structural engineer to construct the building structurally good, considering all the loads acting on the building. There are so many methods of conducting this design we use E-tab software.

II. OBJECTIVES:

Based on various detailed literature studies, find out some research gaps mentioned as future scope of work in the various sources.

- analysis for optimize PEB design by alternating shapes of overhead structural members like changing the shape of linkage & shape of structure.
- To design PEB structure for Industrial Warehouse analytically specifically to achieve large column free area.
- To conduct analysis of PEB designed structure for the different loading conditions on ETAB.
- To find effective Methodology of optimization for PEB Structure to achieve High Strength to weight ratio structure with cost effective in line with

III. LOAD CALCULATIONS:

Calculation of Dead Load :

Weight of sheeting , purlins and sag rods = 15.00 Kg / m2
Dead Load (DL) FOR 7.667 M center span = 1.15 KN/m
Dead Load (DL) FOR 7.242 M span(Gable End Span) = 0.54 KN/m

Calculation of Collateral Load :

Collateral Load on Rafter = 25.00 Kg / m2
Load due to HVAC , Services , Fire Proofing . Solar Panel etc.
Dead Load (DL) FOR 7.667 M center span = 1.92 KN / m
Dead Load (DL) FOR 7.242 M span(Gable End Span) = 0.91 KN/m

Calculation of Live Load :

Live load/unit area, roof= 75.00 Kg / m2
Live load(LL) FOR 7.667 M center span = 5.75 KN/m
Live load(LL) FOR 7.242 M span(Gable End Span) = 2.72 KN/m

Calculation of Wind Load :

Basic Wind Speed = 33 m/s
Design of Wind Speed = Vbx k1 x k2 x k3 X k4
K1 = probability factor (risk coefficient) = 1
K2 = terrain, height and structure size factor = 1
K3 = topography factor = 1
K4 = Cyclonic Factor = 1
Vz = 33 m/s
Wind pressure (pz) = $0.6xVz^2$ = 0.653 KN/m2
Design wind pressure (pd) = Pz X Kd X Ka X Kc
Wind Directionality Factor , Kd = 0.9 (Refer Clause 4.5.2.1 of NBC 2016)
Area Averaging Factor, Ka = 0.8
Combination Factor , Kc = 0.9
Design wind pressure (pd) = 0.457 KN/m2

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Modeling procedure

Step-1:

Modeling: With respect to the consideration of type of structure modeling has been done.

Step-2:

Generation of Joints Point: As per the planning with respect to the positioning of column in building, their respective nodal point has been created on that model.

Step-3:

Property Definition: Using General-Property command define the property as per size requirement to the respective building on ETABS. So, beam and columns have been generated after assigning to selected beam and columns.

Step-4:

Create and Assign Support & Member Property: After column definition at supports have been provided as fixed below each column and its cross-section assigning based on load calculations and property definition.

Step-5:

Load Assignment:

I. Dead load

The dead load contains of the weight of walls, partitions floor finishes, false ceilings, floors and the other permanent standing construction in the buildings. The dead load loads are estimated from the dimensions of various members of building and their unit weights. The unit weights of plain concrete and reinforced concrete taken as25kN/m3. As per IS: 1893 (Part 1)-2002, the dead load has been assigned on the basis of member load, floor load, self-weight of the beam's definition.

II. Live Load

As per IS: 875 (part 2)-1987, live load 2.0 kN/m has been assigned to the members.

IV. Load combination

Required load combinations cases for seismic analysis have been assigned to the model based on specified loading combinations provided in the Indian standard CODES that are also available in ETABS .

Step-7:

Structural analysis on ETABS. After adding Analysis/Print, using Run Analysis
Command, the structure is analyzed

Step-8:

The analyzed model is checked for the Deflection and Utilization Ratio.

Deflection of Warehouse Structure under applied Loading conditions

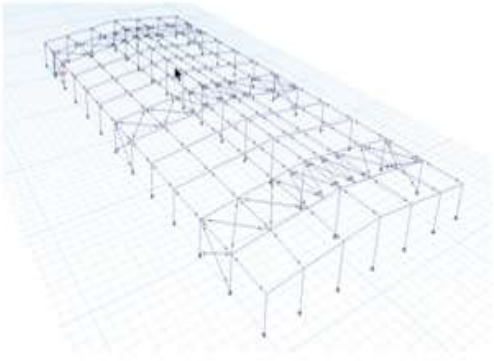

Fig.2 Bracing with Increasing in Thickness

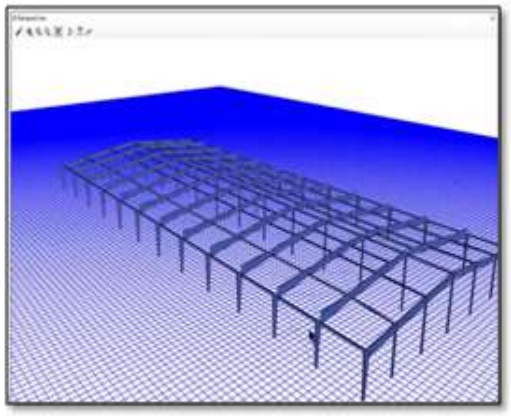

Fig.3 3D Modeling of warehouse structure

RESULTS

Component	Deflection in MM			
	X	Y	z	Remark
Left Rafter	4.5	5	9	**SAFE**
Left Column	8	7	7	**SAFE**
Right Rafter	6	5	10.2	**SAFE**

Right Column	9	8	7.2	**SAFE**
Bracings	10	5.8	15.6	**SAFE**

IV. CONCLUSIONS

- Successfully designed and analysed PEB Warehouse considering all loading conditions.
- Analysis done by altering the Material for Primary Structural Members and kept same material for secondary structural members.
- Weight of the whole Warehouse Structure is unaffected by altering the materials as Both materials has same density.
- Total Structural cost has been decreased by **25-30 %** for same structure if we alter the material.

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