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Structural Analysis of (PEB) Pre-Engineered Building Using Different Types of Bracing on Lateral Load

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ABSTRACT: Steel industry is growing rapidly within the majority of parts of the world. the use of steel structures is not exclusively economical but collectively eco-friendly. The structure ought to accommodate strength, stability, and malleability to accommodate each horizontal and vertical loading. Horizontal Loading results in the assembly of sway and any ends up in vibration and construction drift. Strength and stiffness are the two major keys for any structure to resist gravity and lateral masses. Provision of bracing and dampers results in lateral stability. once distribution dampers or bracings, the overall system changes to a lateral load resisting system (LLRS). If the buildings aren't designed to resist the lateral masses, then perhaps collapse leading to the loss of the life or its content. The main objective of this paper is to grasp the ideas of PEB and to reduce the usage of price and time. whereas compared to different technologies in construction Pre-Engineered Building is a lot of property and stands within the prime position compared with different technologies. The paper presents comparative results of the study to urge optimum style of steel industrial Building structure. Bentley STAAD-PRO, SAP-2000 is used for the analysis of PEB Industrial building is done to optimize, Eco-friendly and Re-usable in nature. The analysis is done for lateral Loading (i.e. Earthquake, Wind-Load). The PEB building is analysed for both Lateral forces acting together on a same Structure. Six-different Kinds of bracing are provided for lateral stiffness (including Tie-Runner). Bracing used are Inverted V-Bracing, V-Bracing, Diagonal Bracing, K-bracing, X-Bracing, and Tie Runner. Analysis is done 4 different Zones (II, III, IV, V) & Wind-Speed (39m/s, 44m/s, 47m/s, and 50m/s). form the analysis of all models and by comparing with each other results came that Inverted V-bracing proves to be economical in nature, Shear force, axial force, bending moment, steel take-off, displacement is coming very less than the rest of the bracing used. Bracing proved gives lateral stiffness and proves economical in nature. Then model without bracing. Thus, PEB proves to be more Economical than CSB.

KEYWORDS:STADD-Pro, Tapered Section, (PEB) Pre-Engineered Building,Optimizations, Bracing System, Seismic Load, Wind Load, Minimum Weight, Wind-Speed = Vb, Zones = For Earthquake, Dahod = Zone II, Vb = 39m/s, Surat = Zone III, Vb = 44m/s, Patna = Zone IV, Vb = 47m/s, Bhuj = Zone V, Vb = 50m/s, (CSB) Conventional Steel Building, Steel Consumption.

I. INTRODUCTION

Pre-Engineered Building (PEB) are the buildings which are engineered at a factory and assembled at the site. Usually, PEB’s are the steel structure. built-up sections are fabricated at the Factory to exact Size, transported to site and assembled at the site with bolted or Welded Connections.The current study is formulated to accomplished the staggered plan-based enhancement of pre-engineered steel structure. To accomplish it, a wide range of PEB and CSB structures are considered for the study and will be planned under specific parameters to make the structure increasingly effective.The concept of the pre-designing structure is comparatively a new idea when contrasted with conventional steel building (CSB).

As the name shows, it incorporates the pre-designing of every single basic part of the structure considering the engineering and

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architectural prerequisites. The structural concept of PEB is to utilize just the necessary profundity of the part that is required at that specific spot contingent on the bending moment. The output comes in the tapered sections all through the range of the structure. The decreased shape is got by built -up members. The utilization of tapered sections brings out the de-minimizing the expense of the structure by cutting off superfluous steel.

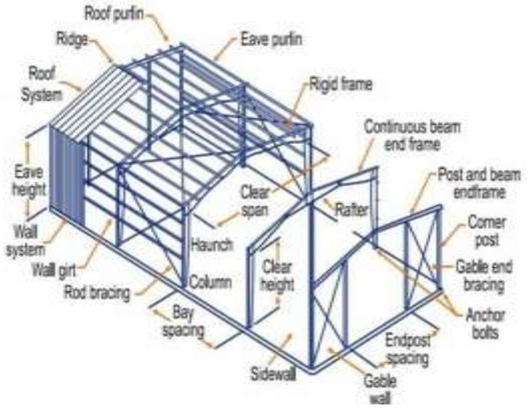

Fig-1: - Components of Industrial Building

1.1 Need of Pre-Engineered building

In almost all part of world, the steel industry is Developing Speedily. The use of Steel Structures at a time is not only economical but it is environment friendly. If we go for the standard steel structure, the time consumption will be more and price will be higher. i.e. time and cost, will make PEB inexpensive. Therefore, the complete construction is performed in the factory in present engineering structures, and according to the design, members are prefabricated and then transported to the site where they are erected in less than 6-8 weeks.

1.2 Benefits of PEB

- Economical and Speedy in construction.
- Good quality, manufacturing and erection, therefore the project time is saved by 30%-40%.
- Suitable for long span Construction.
- Resistant to all types of weather and fire.
- Economical design, thereby reducing the overall weight.
- Expansion and modification can be done easily in future.
- Less maintenance cost.
- It can be easily disassembled and shifted.
- It is eco-friendly in nature.

1.3 Application of PEB

- Industrial Shed
- Ware-houses
- Railway Stations
- Office building
- Exhibition halls
- Cold Storage building
- Convention centres
- Factories
- Power-plants
- Boiler houses
- Apartments
- Stadiums
- Bridges
- Shipyard, etc.

The adaptability of PEB in the place of conventional steel building design concept resulted in many advantages, including economy and easier fabrication. These types of building structure can be finished internally to serve any functions that is actually help in low rise building design. Steel structures also have much better strength to weight ratios than RCC and they can also be reused after dismantling. PEB can be shifted and/or expanded as per the requirements in future. With the improvement in technology, computer software's have contributed immensely to the enhancement of quality of life through new researches. PEB is one such revolution. [1-11]

II. LITERATURE REVIEW

1) **Amin Tahmasebi, Mostafa Rahimi (2021) [1]:**They have studied three types of steel buildings were defined for seismic analysis, including five, eight, and fifteen-storey steel building as the representative of multi-storey, middle rise, and small high-rise building, respectively. The designed building wasanalyzed statically and dynamically as per the criteria determined in the FEMA-P750, Standarad code-2800, FEMA-356, and FEMA-P695, and then, force and displacement-based seismic design (FBD & DBD) results were compared. Non-linear and steel structure design were done by SAP-2000 and Opensees Software. The result shows, the storey displacement in seismic demand, the braced frames subjected to near-field earthquake showed an admissible performance especially in multi-storey building. The drift of 0.5% is threshold of replacing in brace, the values of drift in the multi-story (5-story) and middle-rise (8-story) buildings did not exceed the allowable drift values designated in FEMA 356 (2%), i.e., the results met FEMA 356 criteria.

2) **B. Ravali, P. Poluraju (2019) [2]:** Seismic analysis of the building using bracing and dampers is done. The study involves in proposing the suitability of type of dampers and bracing for controlling the seismic activity on industrial structures in respective seismic zones III & V of India. To control vibration, lateral displacement and storey drift. Response spectrum analysis of 3-D Industrial structure with concentric bracing and dampers using SAP-2000 & E-Tabs. For these three different types of bracing and two types of dampers are used. The result shows the X-bracing is more effective and economical for structure in seismic zone-V. As Stiffness of structure increase, time-period decreases. when compared bracing with damper, bracing reduces the time-period. Acceleration is inversely proportional to time-period and as time-period decrease, acceleration of structure increase. X-bracing system greatly influences the base-shear of structure and reduce it. When compare to other bracing and dampers X-bracing greatly reduces the lateral displacement. Dampers require regular maintenance for their effective behavior. From this bracing proves the economical in nature.

3) **Shaik Kalesha, B.S.S. Ratnamala Reddy, Durga Chaitanya Kumar Jagarapu (2020) [3]:** The main objective of this paper is to understand the concepts of PEB and to minimize the usage of cost and time. PEB & CSB are designed for forces like wind and seismic using Indian Standarad code IS 875 (Part-3)-1987 for wind and IS 1893-2002 for seismic analysis. A 2-D Model is prepared.If we go for standard steel structure the time -taken will be more and the price will be higher in comparison with PEB. Using STAAD-Pro V8i Software. The result shows the material used here is not only eco-friendly but also reusable. The cost study shows that the PEB structures are economical as the effective size of Structural member in PEB Structure are smaller than the CSB Structure. The weight of PEB is almost 50% or Less than of the Steel used in Conventional Steel Structures. PEB Structure is approximately 35% Cost Saving as compared to CSB. From the analysis the weight of the member in both cases are 1301Kg and 2013Kg for PEB and CSB. It clearly states that half the steel usage is reduced in PEB.

4) **Sneha G. Hirekhan, Pranoti D. Wadaskar, Abhay G.Hirekhan (2021)[4]:**A Comparative Study on design wind pressure for Industrial Steel Shed according to IS 875 (Part-3): 1987 , IS 875 (part-3): 2015, MBMA Code. To give optimum and economical design for the structure. A 3-D model of warehouse is prepared in STAAD-Pro Software. Taking Vb= 44m/s for three different cities. Based on analysis result shows the “Serviceability Criteria”: Deflection limits by IS-Code are higher than deflection limits by MBM. There is considerable increase in quantity of steel only in Coastal Zone. The main difference between the Indian code (IS 800:2000) and the other equivalent American codes are in the classification of cross-section of the steel member. Limiting Ratio of section are higher in IS 800:2007 than MBMA. Loadings values are higher as per Indian Codes than MBMA code. They had made increase in wind pressure by 24% and 44% by IS 875 (P-3): 1987 & IS 875 (P-3): 2015 respectively. It shows that higher wind pressure will give higher usage of steel so the for 44% Increase in wind Pressure shows higher tonnage of Steel Quantity 16.788 (Tone).

5) **Mr. Hitesh Jibhkate, Prof. Dilip L. Budhlani (2021) [5]:** A Comparative analysis of PEB and CSB by STAAD-Pro. A G+3 Industrial warehouse structure in Nagpur is designed and examined in this study in accordance with Indian Standard Code IS 800: 2007 (LSM). A comparative study is also conducted for the hot-rolled section used in CSB and the cold-formed purlins used in PEB. 3-D model of PEB structure are accomplished by employing wind load as a critical load for the structure. Analysis is done to reduce the steel usage and compare the outcomes for both design procedures. The result shows, Displacement: - the PEB structure designed by IS 800-2007 has more displacement as compared to CSB due to less weight of the structure. Support Reaction: - As compared to CSB the PEB Structure has less support reaction. Due to its light weight. Axial, Shear-Force and bending moment: - Peb Structure has less Axial, Shear Force and Bending Moment as compared to CSB. Steel Quantity: - PEB structure are light in weight as compared to CSB. PEB are 64% lighter in weight than CSB. Wind Resistance: - PEB has Higher Resistance to wind than CSB. Purlin: - The

Cold formed purlin is 32.5% Lighter as Compared to hot Rolled Purlin.

6) **Anisha Goswami, Dr. Tushar Shende(2018) [6]:**PEB was designed and analysed and compared with CSB. An Industrial Warehouse is designed by considering wind load as the critical load for the structure. CSB is also designed for same span considered. Then the designs are compared to find out economical Section. The design is carried out in accordance with the Indian standard and by the help of STAAD-Pro V8i Software. The comparative result shows that the PEB structure gives lesser value in Support Reaction, Self-weight, Steel Consumption as compared to CSB. PEB gives more displacement value as compared to CSB due to its light weight. Steel quantity depends on primary members and purlins. As spacing of Frame is increased steel Consumption decreased for primary members and increased for secondary members.by reducing dead load the size of foundation is also reduce.Cold formed steel section over hot rolled section as purlin is almost lighter in weight than 32%. The (Table-2) shows the comparative result.

7) **Sulaiman Al‐ Safi, Ibrahim Alameri, Waleed Abdullah Wasel, Amjad Basheer Al‐ kadasi (2021) [7]:**They had investigated the effects of wind and seismic loads on 5, 10, and 15 Storey Steel Building with different types of bracing system. Linear Static and non-linear dynamic analysis were performed to assess the base-shear, base-moment, and storey drift for kinds of bracing systems. The cost analysis was taken into the consideration. Five Structural configurations were used: V-bracing, Inverted V-bracing, one-storeyX-bracing, and multistorey X-bracing. The purpose of this article is to find the best bracing system that causes minimum displacement, which indicates maximum lateral stiffness. The conclusion shows the use of bracing systems for earthquake resistant steel structures significantly affected the base shear and displacement of the structure; these systems can be success-fully used to increase the strength and rigidity properties against horizontal loads. Static linear analysis results showed that the best bracing systems to reduce lateral displacement were the one-story X-bracing system for 5 and 15 story buildings and the V-bracing system for 10 story buildings. On the other hand, nonlinear dynamic analysis results showed that lateral displacement was minimum in unbraced, V-bracing, and one-story X-bracing systems for 5, 10, and 15 stories, respectively.

8) **AdvaitSagavekar, Prof. Virupaksh Khurd (2021) [8]:**Experimental study is conducted to analyze the effect of different parameters on Pre-Engineered buildings and comparison of PEB and CSB. In first stage effect on structure for different roof angles and bay spacing is checked and the optimum structure is selected. The effect on column height of structure are studied. Comparison based on steel consumption, displacement, base-reaction, and bending moment values. From the models most optimized is selected and compared with conventional roof-truss model. From the analysis the result shows that with change of roof angle there is not much variation in steel consumption. For different roof angle and bay-spacing, it shows that model with 7m bay spacing and roof angle of 5.71 is optimum for every parameter and shows the optimum steel consumption. when models are compared for different column height it shows that column with 2m height shows less consumption of steel, but in practical column with height of 5-7m are more used. CSB shows more vertical reaction at base. When compared for displacement, values for conventional building are on higher side.

9) **V. Vishnu Sai, P Poluraju, and B Venkat Rao (2021) [9]:**The comparison has been made on the structural performance of multiple bay system with different wind zones [Location: Vijayawada & Hyderabad]. Analysis and design have been carried-out using STAAD-Pro Software. The structural performance of PEB has been assessed through the shear-force (SF) and bending moment (BM) magnitudes.3-D model of ware house is used for analysis. Result shows the PEB structure located in vijayawada is 1074.10 KN& for Hyderbad is 955.51 KN. Results concludes structure weight located in vijayawada is 11.04% higher than that of the structure in Hyderabad. The section sizes of columns and rafters are less for the structure located in Hyderabad then Vijayawada. The BM & SF are less for the structure located in Hyderabad. The parameters that affect the

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structural weight and section sizes are wind speed and seismic-zone.

III. OBJECTIVE

The main aim of this work is to study static, dynamic, and wind load analysis for investigating the performance of the structure by usingthe different kinds of bracings. To find out the best bracing option for different wind speeds and for different Seismic zones.

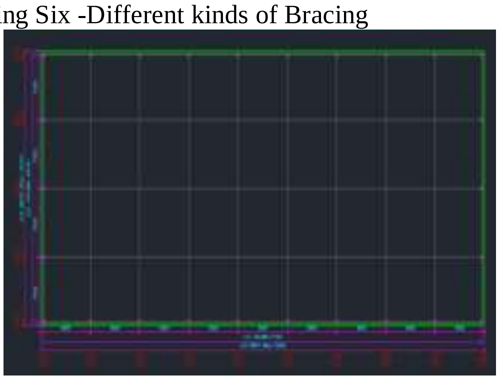
To Investigate the performance of the structure under the combined effect oflateral load (Wind and Seismic), for providing the lateral stability to the structure by means of bracings. And also, to find does it is helpful for creating optimization in design.

To find out what kind-off bracing the structure gets stability at the minimum take-off of steel. For Economy, Speedy Construction, and Eco-Friendly.

IV. METHODOLOGY

For the Purpose of Structural Analysis and Design. The software used is STAAD-Pro. For Wind and Seismic-Zone in India. In Accordance with Indian Standard Code I.S. 800-2007 (LSM). Different Types of Bracing Used for Analysis are V-Bracing, Inverted V-Bracing, Diagonal Bracing, X-Bracing, K-Bracing, and Tie-Runners.

To investigate the (PEB) Pre-engineered Building 3D-Model Industrial warehouse structure for different locations under different zones and wind speeds. Fe-310MPa is taken as the yield strength of steel. 24-Models were made and analyzed for 4-Seismic Zones and 4-different wind speeds by using Six -Different kinds of Bracing



(Fig-2: - Industrial Building Plan)

Building Dimensions are 72 meters long by 30 meters wide (Clear Span) with 12 bays, sidewall bay spacing of 7.5meters, end wall bay spacing of 6 meters, and Clear eave height of 7.5 meters. In this paper, the analysis and design of a 30-meter-wide. 3D-PEB structures are accomplished by employing a Combination of Lateral forces like; (wind and Earthquake Load).As the critical load for the structure and the Indian code I.S 800:2007 Limit state technique (LSM).

1.4 MODEL DESCRIPTION

The analysis of (PEB) Industrial warehouse building is done in Staad-pro software. In accordance with IS-875-Part-1, IS-875-Part-2, IS-875-2015-Part-3, IS-1893-2016, and IS-800-2007, Load combinations are considered, with static linear analysis of earthquake and wind load analysis. A Combine lateral force is taken for study. The parameters of the structure are shown below in Table-1;

Building Dimension	**72m X 30m**
Clear Eave Height	7.5m
Roof Slope (α)	1:10
CPI	0.7
Bay Spacing	6.0 m
Location	
Seismic-Zone	**Basic Wind-Speed**
Dahod - II	39m/s
Surat-III	44m/s
Patna-IV	47m/s
Bhuj-V	50m/s

Table-1: - Building Dimension and parameters

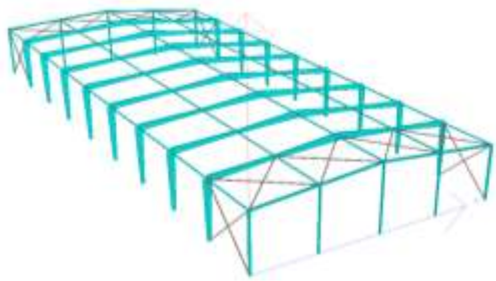
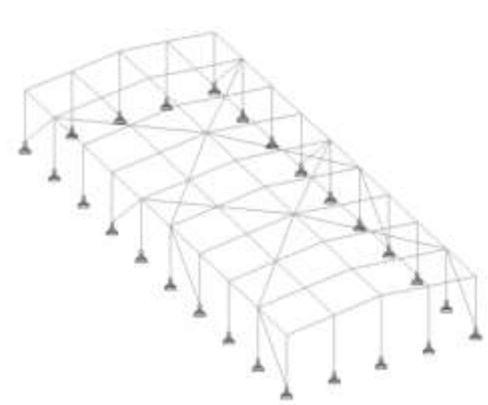
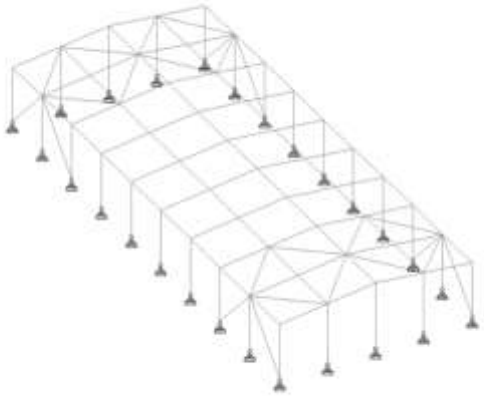


Fig-3: - PEB Model

The Six-Different types of bracing used with Tie-Runner, Diagonal Bracing, Inverted V- Bracing, V-bracing, K-bracing, X-Bracing, and Tie-Runner. Fig is shown below;



(A) Diagonal Bracing



(B) Inverted V-Bracing

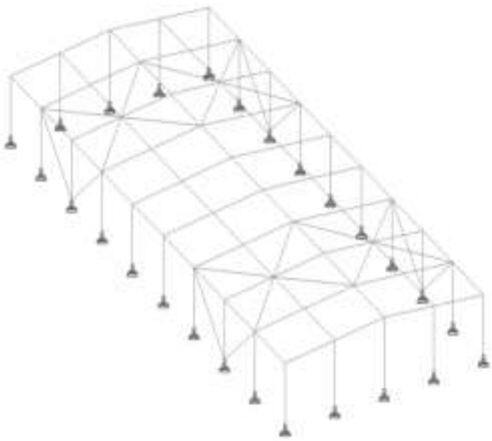
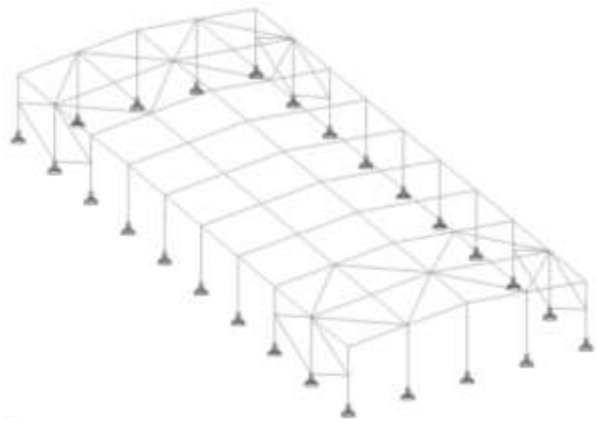
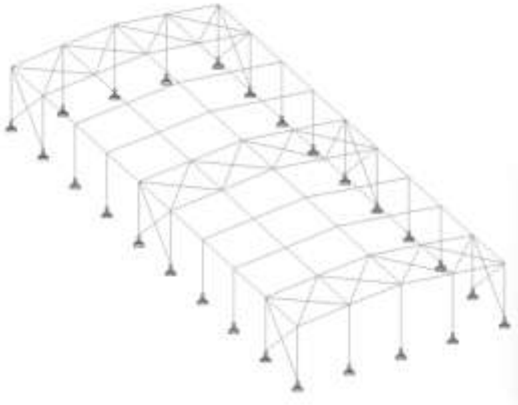


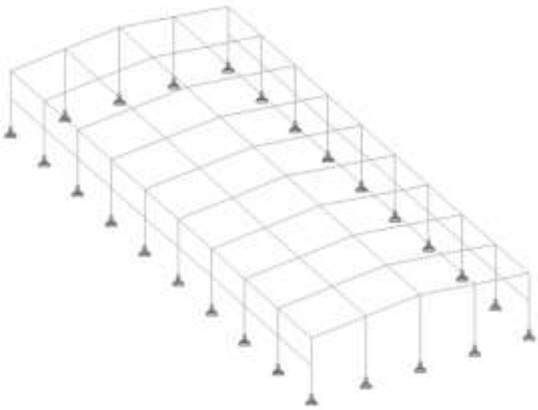
Fig: -4 Six Different types of Bracing of Industrial Building
(C) V-Bracing



(D) K-Bracing



(E) X-Bracing



(F) Tie-Runner

1.5 LOAD COMBINATIONS

Load combination can be adopted as per the Indian standards from IS: 800-2007. 64 load combinations adopted for the analysis of the frame in both the concepts are listed as follows;

IS: 800-2007
Limit State of Serviceability;
D.L.+L.L. D.L.+W.L./E.L. D.L.+L.L.+C.L. D.L.+0.8L.L.+0.8W.L./E.L.+0.8C.L.
Limit State of Strength;
1.5(D.L.+L.L) 1.5(D.L.+W.L./E.L.) 0.9D.L. +1.5W.L./E.L. 1.5D.L.+1.5L.L.+1.05C.L. 1.5D.L.+1. 05L.L+1.5C.L. 1.2D.L.+1.2L.L.+0.6W.L./E.L.+1.05C.L. 1.2D.L.+1.05L.L.+0.6W.L./E.L.+1.2C.L. 1.2D.L.+1.2L.L.+1.2W.L./E.L.+0.53C.L. 1.2D.L.+1.2L.L.+1.2W.L./E.L.+0.53C.L.

(Table-2: - Load Combination as per IS Standards)

For Strength;
1) 1.5 (D.L.+ L.L.)
2) 1.5 (D.L. + EQX (+))
3) 1.5 (D.L. + EQX (-))
4) 1.5 (D.L. + EQZ (+))
5) 1.5 (D.L. + EQZ (-))
6) 0.9 D.L. + 1.5 EQX (+)
7) 0.9 D.L. + 1.5 EQX (-)
8) 0.9 D.L. + 1.5 EQZ (+)
9) 0.9 D.L. + 1.5 EQZ (-)
10) 1.2 D.L. + 1.05L.L. + 0.6 EQX (+)
11) 1.2 D.L. + 1.05L.L. + 0.6 EQX (-)
12) 1.2 D.L. + 1.05L.L. + 0.6 EQZ (+)
13) 1.2 D.L. + 1.05L.L. + 0.6 EQX (+)
14) 1.2 D.L. + 1.05L.L. + 0.6 EQZ (-)
15) 1.2 D.L.+ 0.53L.L.+ 1.2 EQX (+)
16) 1.2 D.L.+ 0.53L.L.+ 1.2 EQX (-)
17) 1.2 D.L.+ 0.53L.L.+ 1.2 EQZ (+)
18) 1.2 D.L.+ 0.53L.L.+ 1.2 EQZ (-)
19) 1.5 D.L. + 1.5 W.L. TETA (0 +CPI)
20) 1.5 D.L. + 1.5 W.L. TETA (0 -CPI)
21) 1.5 D.L. + 1.5 W.L. TETA (90 +CPI)
22) 1.5 D.L. + 1.5 W.L. TETA (90 -CPI)
23) 1.5 D.L. + 1.5 W.L. TETA (180 +CPI)
24) 1.5 D.L. + 1.5 W.L. TETA (180 -CPI)
25) 1.5 D.L. + 1.5 W.L. TETA (270 +CPI)
26) 1.5 D.L. + 1.5 W.L. TETA (270 -CPI)
27) 0.9 D.L. + 1.5 W.L. TETA (0 +CPI)
28) 0.9 D.L. + 1.5 W.L. TETA (0 -CPI)
29) 0.9 D.L. + 1.5 W.L. TETA (90 +CPI)
30) 0.9 D.L. + 1.5 W.L. TETA (90 -CPI)
31) 0.9 D.L. + 1.5 W.L. TETA (180 +CPI)
32) 0.9 D.L. + 1.5 W.L. TETA (180 -CPI)
33) 0.9 D.L. + 1.5 W.L. TETA (270 +CPI)
34) 0.9 D.L. + 1.5 W.L. TETA (270 -CPI)
35) 1.2 D.L. + 1.05 L.L. + 0.6 W.L. TETA (0 +CPI)
36) 1.2 D.L. + 1.05 L.L. + 0.6 W.L. TETA (0 -CPI)
37) 1.2 D.L. + 1.05 L.L. + 0.6 W.L. TETA (90 +CPI)
38) 1.2 D.L. + 1.05 L.L. + 0.6 W.L. TETA (90 -CPI)
39) 1.2 D.L. + 1.05 L.L. + 0.6 W.L. TETA (180 +CPI)
40) 1.2 D.L. + 1.05 L.L. + 0.6 W.L. TETA (180 -CPI)
41) 1.2 D.L. + 1.05 L.L. + 0.6 W.L. TETA (270 +CPI)
42) 1.2 D.L. + 1.05 L.L. + 0.6 W.L. TETA (270 -CPI)
43) 1.2 D.L. + 0.53 L.L. + 1.2 W.L. TETA (0 +CPI)
44) 1.2 D.L. + 0.53 L.L. + 1.2 W.L. TETA (0 -CPI)
45) 1.2 D.L. + 0.53 L.L. + 1.2 W.L. TETA (90 +CPI)
46) 1.2 D.L. + 0.53 L.L. + 1.2 W.L. TETA (90 -CPI)
47) 1.2 D.L. + 0.53 L.L. + 1.2 W.L. TETA (180 +CPI)
48) 1.2 D.L. + 0.53 L.L. + 1.2 W.L. TETA (180 -CPI)
49) 1.2 D.L. + 0.53 L.L. + 1.2 W.L. TETA (270 +CPI)
50) 1.2 D.L. + 0.53 L.L. + 1.2 W.L. TETA (270 -CPI)

For Serviceability;
1) D.L. + L.L.
2) D.L. + EQX (+)
3) D.L. + EQX (-)
4) D.L. + EQZ (+)
5) D.L. + EQZ (-)
6) D.L. + L.L. + EQX (+)
7) D.L. + L.L. + EQX (-)
8) D.L. + L.L. + EQZ (+)
9) D.L. + L.L. + EQZ (-)
10) D.L. + W.L. TETA (0 + CPI)
11) D.L. + W.L. TETA (0 - CPI)
12) D.L. + W.L. TETA (90 + CPI)
13) D.L. + W.L. TETA (90 - CPI)
14) D.L. + W.L. TETA (180 + CPI)
15) D.L. + W.L. TETA (180 - CPI)
16) D.L. + W.L. TETA (270 + CPI)
17) D.L. + W.L. TETA (270 - CPI)
18) D.L. + L.L. + W.L. TETA (0 +CPI)
19) D.L. + L.L. + W.L. TETA (0 -CPI)
20) D.L. + L.L. + W.L. TETA (90 +CPI)
21) D.L. + L.L. + W.L. TETA (90 -CPI)
22) D.L. + L.L. + W.L. TETA (180 +CPI)

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23) D.L. + L.L. + W.L. TETA (180 -CPI)
24) D.L. + L.L. + W.L. TETA (270 +CPI)
25) D.L. + L.L. + W.L. TETA (270 -CPI)

<table>
<tr><th colspan="4">Deflections Limit</th></tr>
<tr><th colspan="2"></th><th>Vertical</th><th>Lateral</th></tr>
<tr><td colspan="2">Main Frame</td><td>L/180</td><td>H/150</td></tr>
<tr><td colspan="2">Main Frame with Crane (Pendent)</td><td>L/180</td><td>H/150</td></tr>
<tr><td colspan="2">Main Frame with Crane (Cab Operated)</td><td>L/180</td><td>H/200</td></tr>
<tr><td rowspan="2">Crane Beam</td><td>Electric < 50t</td><td>L/750</td><td>H/400</td></tr>
<tr><td>Electric > 50t</td><td>L/1000</td><td></td></tr>
<tr><td colspan="2">Mezzanine Beam</td><td>L/240</td><td>H/150</td></tr>
<tr><td colspan="2">Under Slung Crane</td><td>L/750</td><td></td></tr>
<tr><td colspan="2">Purlin</td><td>L/150</td><td></td></tr>
<tr><td colspan="2">Girt</td><td>L/150</td><td></td></tr>
<tr><td rowspan="2">Minimum Thickness</td><td>Primary</td><td colspan="2">4.0 mm</td></tr>
<tr><td>Secondary</td><td colspan="2">1.6 mm</td></tr>
</table>

Table-3: - Deflection Limit

1.6 Figure Shows the Application of Load;

1) Application of Load EQX (+)

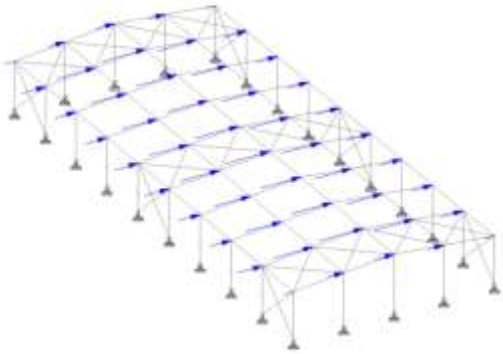

Fig:-5 of Load EQX (+)

2) Application of Load EQX (-)

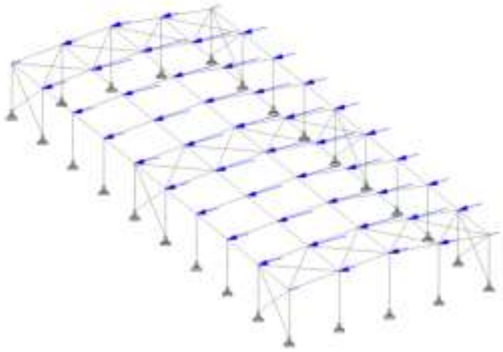

Fig:-6 of Load EQX (-)

3) Application of Load EQZ (+)

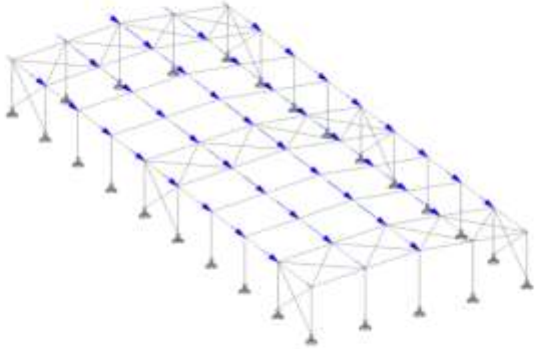

Fig:-7 of Load EQZ (+)

4) Application of Load EQZ (-)

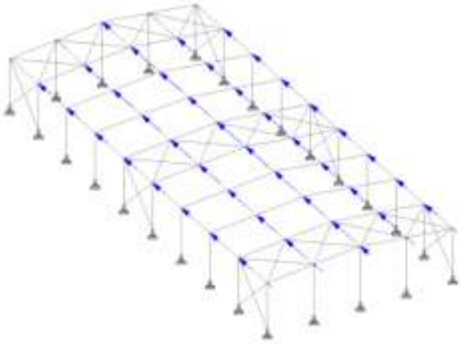

Fig:-8 of Load EQZ (-)

5) Application of Dead Load

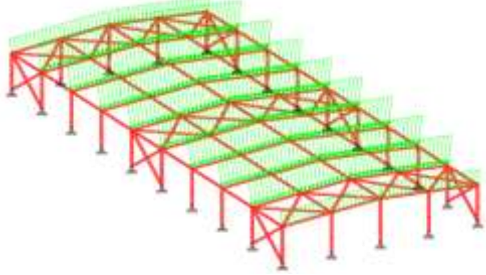

Fig:-9 of Self Weight

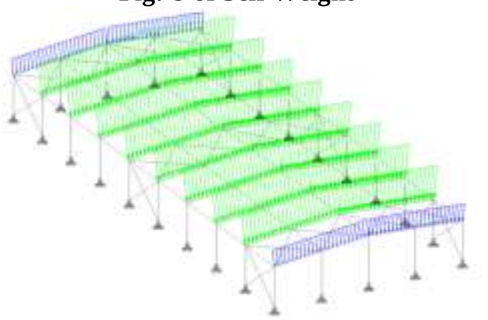

Fig:-10 of Half D.L.

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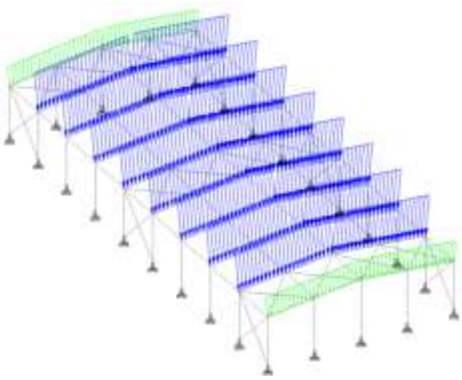

Fig: - 11 of Full D.l.

6) Application of Live Load

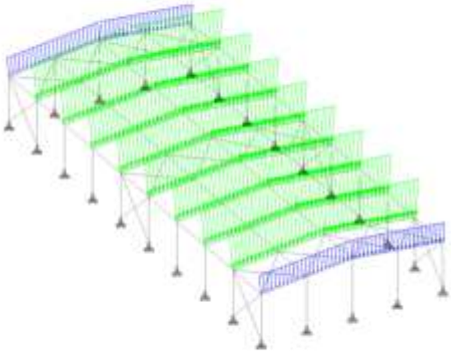

Fig: - 12 of Half L.L.

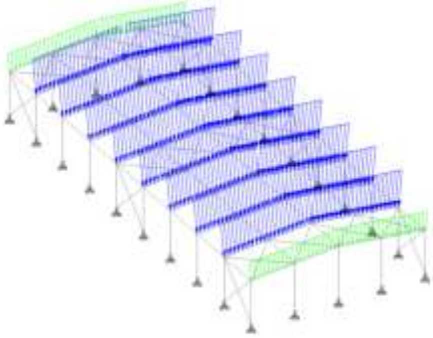

Fig: - 13 of Full L.l.

7) Application of Wind Load

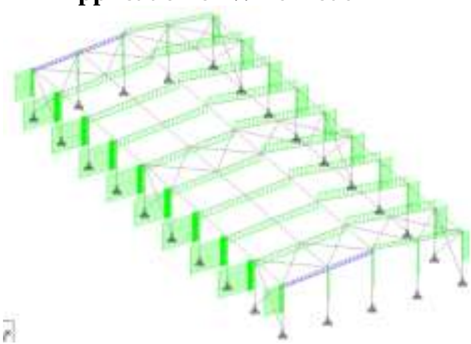

Fig: - 14 of Half Load on Right Rafter

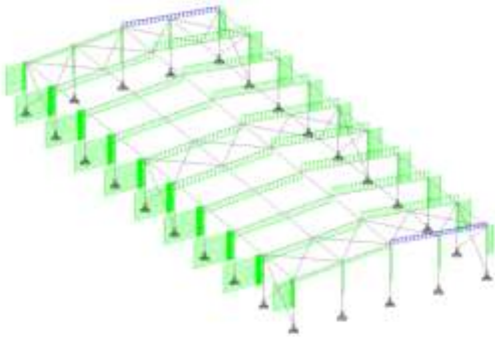

Fig: - 15 of Half Load on Left Rafter

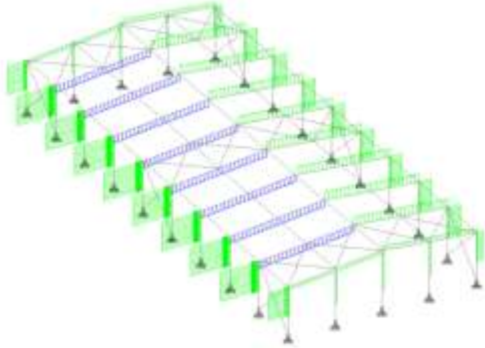

Fig: - 16 of Full Load on Right Rafter

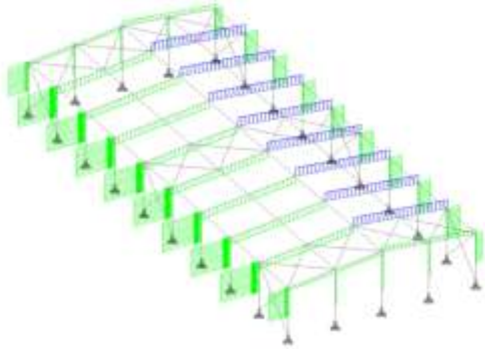

Fig: - 17 of Full Load on Left Rafter

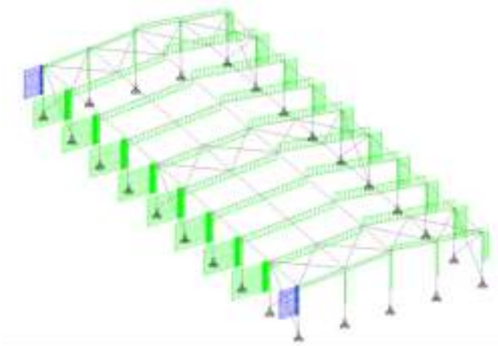

Fig: - 18 of Half Load on Right Column

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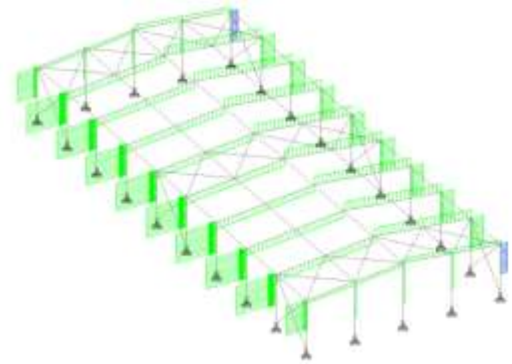

Fig: - 19 of Half Load on Left Column

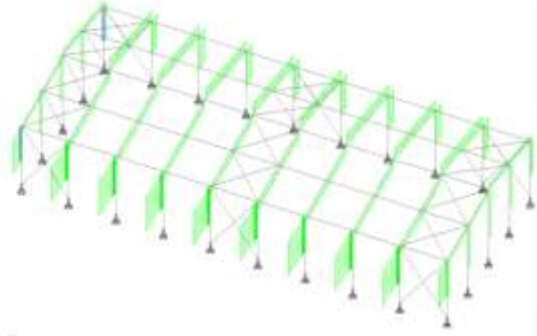

Fig: - 20 of Half Load on Back Column

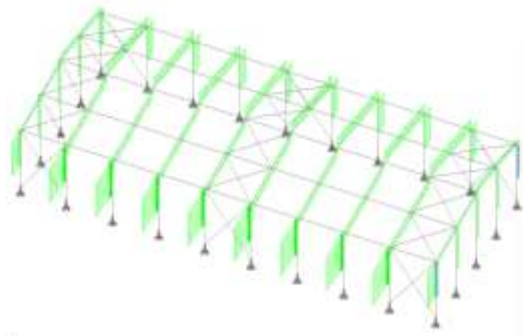

Fig: - 21 of Half Load on Front Column

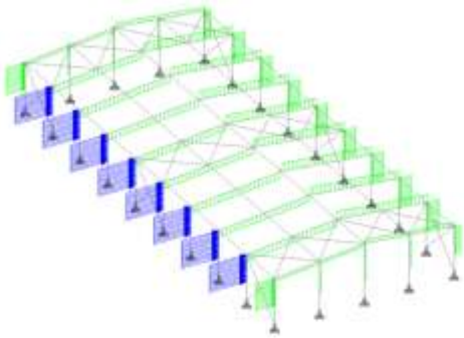

Fig: - 22 of Full Load on Right Column

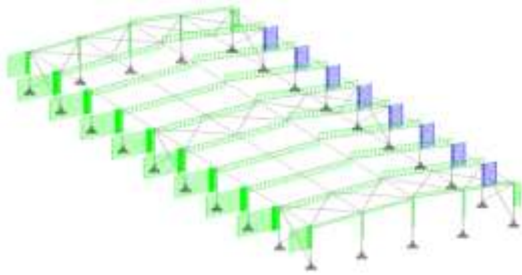

Fig: - 23 of Full Load on Left Column

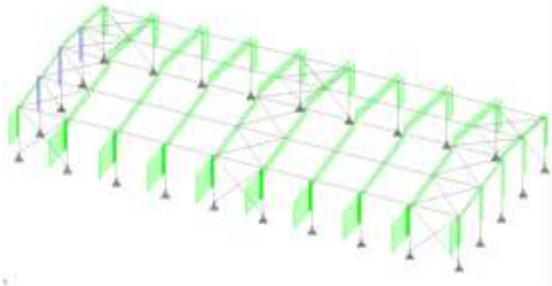

Fig: - 24 of Full Load on Back Column

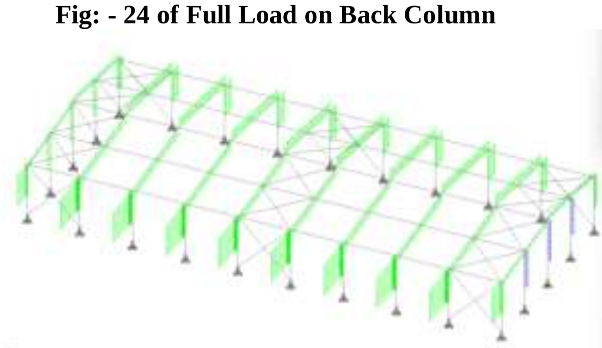

Fig: - 25 of Full Load on Front Column

V. RESULT

The result itself indicates the behaviour of PEB Industrial structure with bracings under lateral loading. Here each model with a Specific type of bracing are given with its location and Bracing type.

From the analysis, forces and displacements obtained from the analysis are represented in the graphs shown below;

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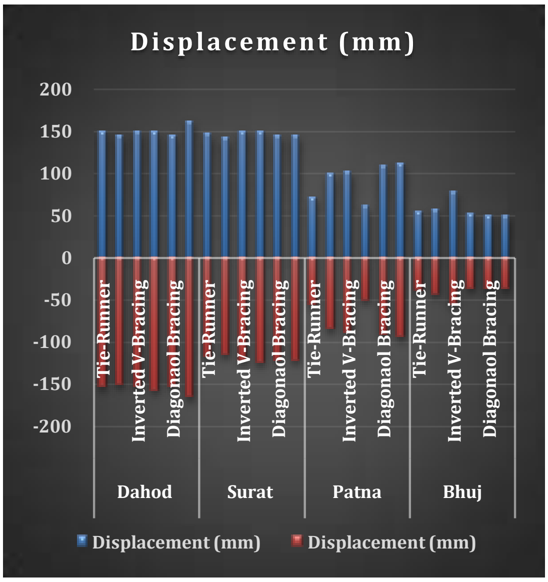
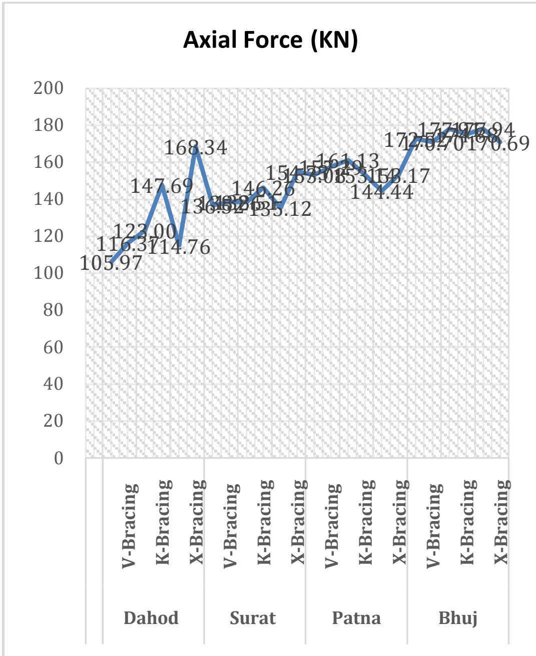
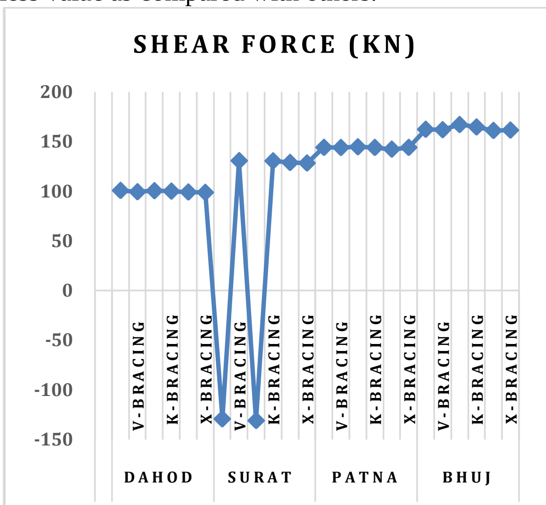


The result of displacement is compared with different kind of bracing with different zones of earthquake and wind speed (vb). From the result we conclude that as per zones and wind speed the thickness of member also changes. For zone - II and III thickness of bracing member required is lesser as compared to the zone IV and V same in case for wind speed (39 & 44m/s) as compared with wind Speed (47 & 50m/s). it also shows that the utilization ratio of member is more for Zone (II and III) and for Wind Speed (39 and 44m/s) as compared for Zone (IV & V) and for Wind Speed (47 & 50m/s).

For location Dahod V and K-Bracing gives less Displacement values as Compared with different kind of Bracing. For location SuratV and X-Bracing gives lesser displacement values as compared with different bracings. For location Patna V and K-Bracing gives lesser displacement values as compared with different bracings. For Location Bhuj K and X-Bracing gives lesser displacement values as compared with different bracings.



Axial force graph shows the diagonal bracing gives less value as compared with others.



Shear Force in V-Bracing, Diagonal-Bracing and X-Bracing gives less value as compared with others.

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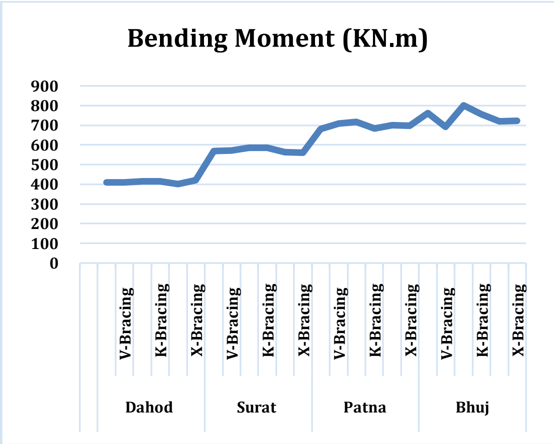
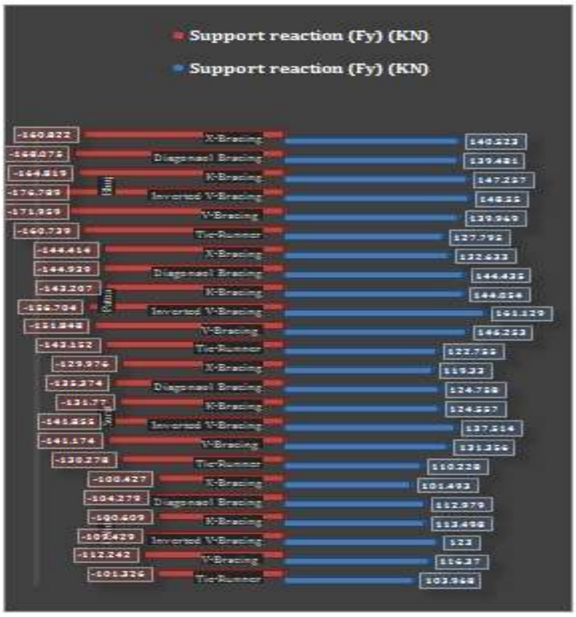
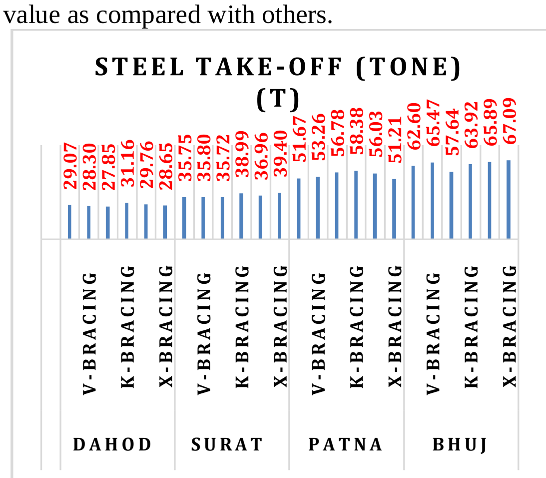


Bending Moment with Tie, V-Bracing and Diagonal Bracing gives less value as compared with others.

Support Reaction Graph



Support Reaction in Tie and X-Bracing gives less value as compared with others.



For Dahod, Surat, Bhuj (Zone – II, III, and V) (Vb=39, 44, and 50m/s), Inverted V-Bracing gives Economy.
For Patna (Zone – IV) (Vb = 47m/s), Tie-Runner and X-Bracing prove to be Economical. Overall Inverted V-Bracing Proves to be Economical.
We conclude that the provision of bracing gives more stiffness to the structure against lateral loading. Results are shown in the graph given above;

VI. CONCLUSION

From the result, we conclude that the PEB structure proves to be economical and it is environmentally friendly.

- For lateral stiffness the use of Inverted V-Bracing proves to be more economical than the other bracings.
- Support reactions are lesser in Tie-Runner and X-Bracing for all zone and for different wind speeds.
- For zone-(II) and Wind Speed (39m/s) - V, K, and Inverted V-bracing give lesser results of displacement as compared to other bracings. But V-Bracing gives very less results as compared to K, and V-Bracing. For Location Dahod (Zone-II, Vb=39m/s) – Inverted V-Bracing steel Take-off = 27.85 Tone.
- For Zone-(III), Wind Speed (Vb = 44m/s) – V, X, and K-bracing gives lesser displacement value than other bracings. V-bracing gives very less results as compared to K, & X-bracing. For Location Surat (Zone-III, Vb=44m/s) – Inverted V-Bracing steel Take-off = 35.72 Tone.
- For Zone-(IV), Wind Speed (Vb = 47m/s) – V, Inverted V-Bracing, and K-bracing give lesser displacement value than other bracings. K-bracing gives very less results as compared to V, &Inverted V-bracing. For Location Patna (Zone-IV, Vb=47m/s) – X-Bracing steel Take-off = 51.21 Tone.
- For Zone-(V), Wind Speed (Vb = 50m/s) – X, Inverted V-Bracing, and K-bracing give lesser displacement value than other bracings. K-bracing gives very less results as compared to V, & X-bracing. For Location Bhuj (Zone-V, Vb=50m/s) – Inverted V-Bracing steel Take-off = 57.64 Tone.
- For all Zone and for Different Wind Speed Overall-Inverted V-Bracing Proves to Economical.
- PEB structure give less Support reaction then CSB.

- PEB Structure have more displacement than CSB.
- PEB structure has less Axial Force reaction then CSB.
- PEB structure has less Shear Force reaction then CSB.
- PEB structure has less Bending Moment then CSB.
- PEB structure has less Steel Take-off then CSB.

Hence, more research is required for more outputs for design methods and reducing material in PEB structures.

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