Effect of Bracing Location in PEB Under LTERAL Loads

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***Abstract*— In Industrial building to cover and shelter a large area without supports, different steel structural roofing system becomes the most effective and economical instead of a concrete structure. Pre engineering building (PEB) is new type of building framing system adopted in the industrial building, the concepts is steel framing system, supporting members and roof covering are connected each other. The aim of this research work is to optimize the bracings for Pre Engineering Building (PEB) and analyse the behaviour of structure under different loads by using Etabs software. Present study is to analyse and design a PEB structure for different bracing location and finding the best location using Etabs software.**

Keywords*— *PEB, Bracing

I. INTRODUCTION

Industrial buildings, a subset of low-rise buildings is normally used for steel plants, automobile industries, utility and process industries, thermal power stations, warehouses, assembly plants, storage, garages, small scale industries, aircraft hangar, etc. . Mostly industrial buildings are constructed with steel material. Ordinary steel structure are made up of truss as a roofing system with roof top covering, it is called as conventional steel building (CSB). Technological improvement over the year has contributed immensely to the enhancement of quality of life through various new products and services. One such revolution was the pre-engineered buildings.

Pre engineering building (PEB) is new type of building framing system adopted in the industrial building, the concepts is steel framing system, supporting members and roof covering are connected each other. Pre-engineered steel buildings can be fitted with different structural accessories including mezzanine floors, canopies, fascias, interior partitions, etc. and the building is made waterproof by use of special mastic beads, filler strips, and trims. This is a very versatile building's systems and can be finished internally to serve many functions and accessorized externally to achieve attractive and unique designing styles. It is very advantageous over conventional buildings and is helpful in the low-rise building design. They PEB sections are used according to the bending moment requirement and are generally built up sections.

II. OBJECTIVES

The industrialization leads to the development of new advancement in the construction of industries. Large column free area and lower cost enhance the use of PEB in industrial building construction. The main objectives of the study are

- To analyse and design a pre-engineered building
- To analyze PEB structure under wind load.
- To optimize the bracing for lateral loads.
- To compare and evaluate the effectiveness of steel brace at different location.

III. SUMMARY OF LITERATURE REVIEW

From literature review, it is found that PEB have better performance compared to conventional steel structure and addition of bracing provide stability to the structure. They have good aesthetic view. In PEB the excess steel is avoided by tapering the section and is done as per the bending moment requirements in the structure. It is also seen that the weight of PEB depends on the Bay Spacing, with the increase in Bay Spacing up to certain spacing, the weight reduces and further makes the weight heavier.

IV. METHODOLOGY

The structure contain single storey PEB industrial warehouse. The plan is prepared using auto CADD. All the supports are pinned. Two types of models are analysed using ETABS software. The specification of structure are

Building Dimensions	40m x 100m
Type Of Roofing	G.I Sheet
Location Of Building	Bangalore
Bay Spacing for centre	7.727 m
Bay Spacing for gable end	7.500 m
Number of bays	13 No.
Wind Speed	33 m/s
Roof Slope	1in10
Clear eave height	5 m
Max eave height	7 m
Purlin Spacing	1.5 m c/c
Column Section(PEB)	Tapered
Rafter Section(PEB)	Tapered

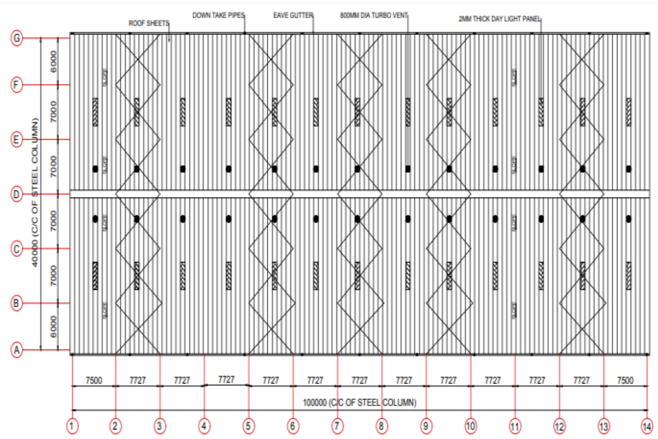

Fig.1. Roof Plan

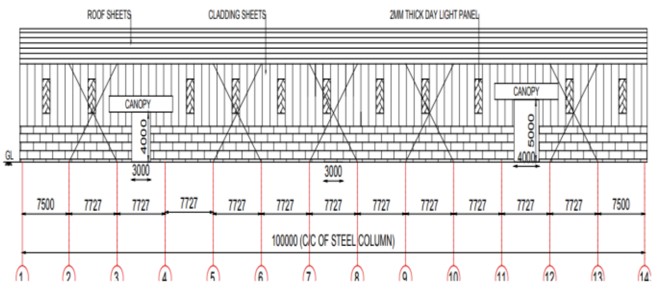

Fig 2. Elevation

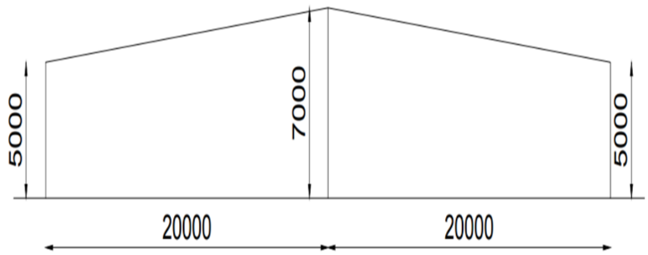

Fig 3. Main frame section along grid 2 to 13

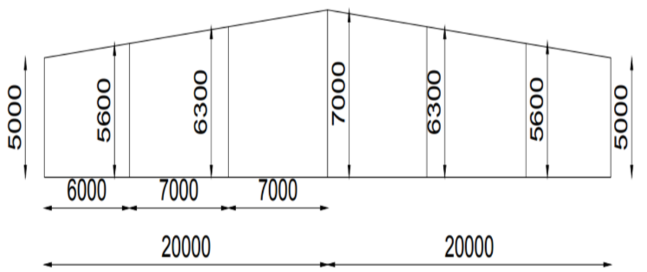

Fig 4. Main frame section along grid 1 to 14

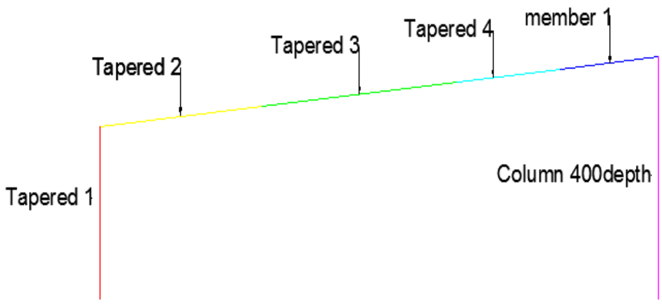

Fig 5. Cross sectional view of various Tapered Sections assigned for PEB

TABLE 1. Section properties

Description	Taper 1	Taper 2	Taper 3	Taper 4
Depth of section at start node (mm)	400	800	700	900
Depth of section at end node (mm)	750	700	900	700
Width of top flange (mm)	300	350	300	300
Thickness of top flange (mm)	16	16	16	30
Width of bottom flange (mm)	300	350	300	300
Thickness of bottom flange (mm)	16	16	16	20

TABLE 2. Section properties

Member 1	
Depth of section (mm)	700
Top flange width (mm)	300
Top flange thickness (mm)	16
Web thickness (mm)	8
Bottom flange width (mm)	300
Bottom flange thickness (mm)	16

Bracing: Box 100x100x8 mm

TABLE 3. Section properties

Purlin (cold formed Z section)	
Web depth (mm)	230
Flange width (mm)	75
Thickness (mm)	2.6
Radius (mm)	21.4
Lip depth (mm)	20
Angle of lip (degree)	90

A. MODEL 1

The first model of the study consists of the Pre-engineered building with bracing location as shown

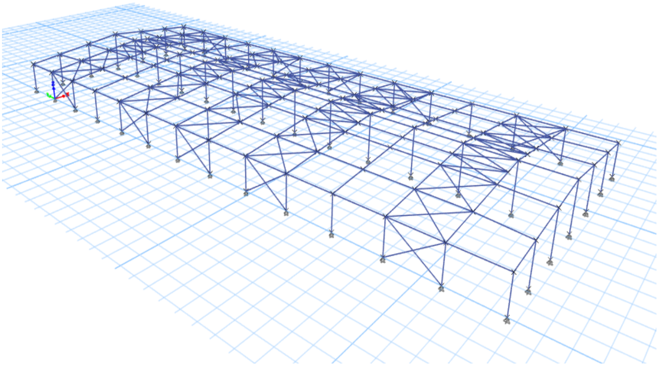

Fig 6. 3D model

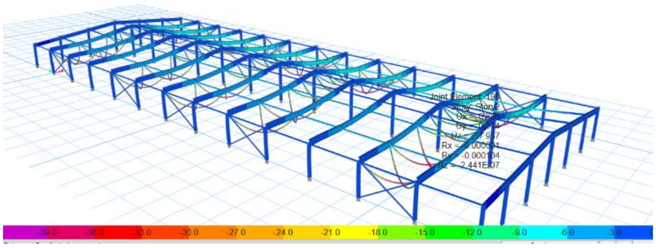

Fig 7. Deflection

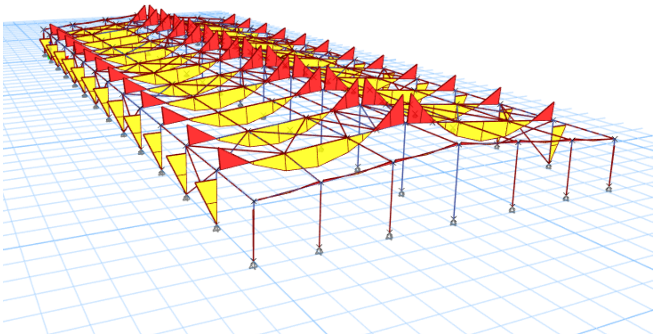

Fig 8. Bending moment diagram

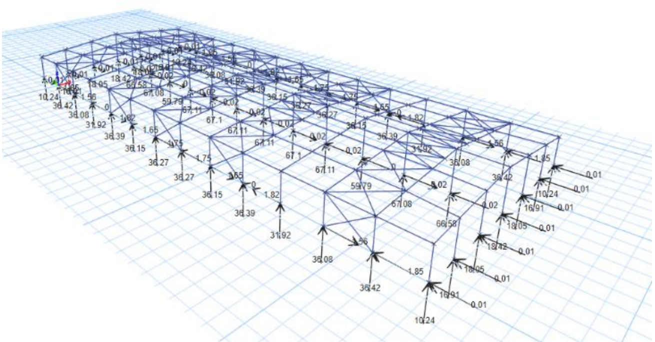

Fig 9. Base reaction

B. MODEL 2

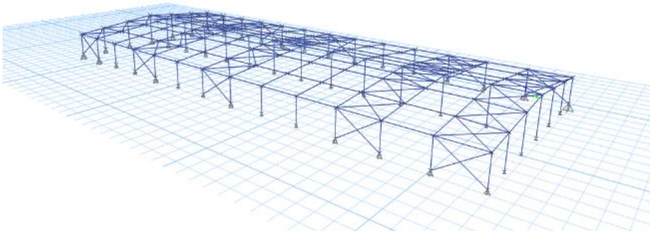

Fig 10. 3D model

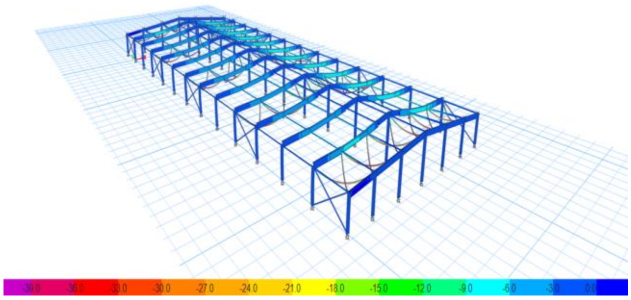

Fig 11. Deflection

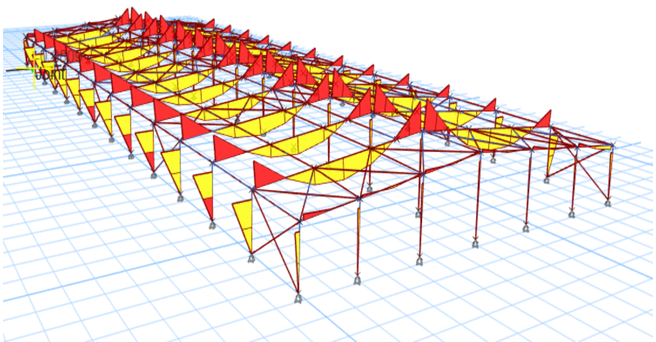

Fig 12. Bending moment diagram

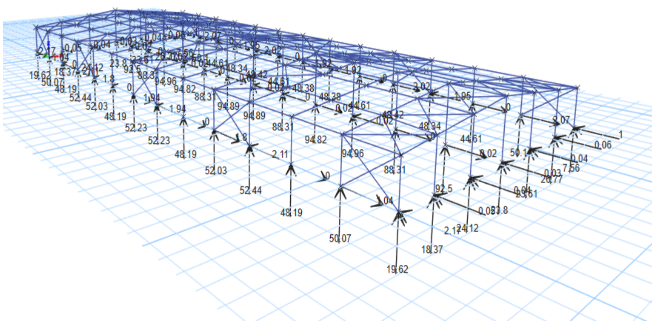

Fig 13. Base reaction

TABLE 4. Load and load combinations

1	Dead
2	Collateral Load
3	Live
4	EL X
5	EL Y
6	WL 1
7	WL 2
8	WL 3
9	WL 4
10	0.9(DL+CL)-1.5ELX
11	0.9(DL+CL)-1.5ELY
12	0.9(DL+CL)+1.5ELX
13	0.9(DL+CL)+1.5ELY
14	0.9(DL+CL)+1.5RSX
15	0.9(DL+CL)+1.5RSY
16	0.9(DL+CL)+1.5WL1
17	0.9(DL+CL)+1.5WL2
18	0.9(DL+CL)+1.5WL3
19	0.9(DL+CL)+1.5WL4
20	1,5(DL+LL+CL)
21	1.2(DL+LL+CL)+0.6 WL1
22	1.2(DL+LL+CL)+0.6WL2
23	1.2(DL+LL+CL)+0.6WL3
24	1.2(DL+LL+CL)+0.6WL4
25	1.2(DL+LL+CL+ELX)
26	1.2(DL+LL+CL+ELY)
27	1.2(DL+LL+CL+RSX)
28	1.2(DL+LL+CL+RSY)
29	1.2(DL+LL+CL+WL1)
30	1.2(DL+LL+CL+WL2)
31	1.2(DL+LL+CL+WL3)
32	1.2(DL+LL+CL+WL4)
33	1.2(DL+LL+CL-ELX)
34	1.2(DL+LL+CL-ELY)
35	1.5(DL+CL)
36	1.5(DL+CL+ELX)
37	1.5(DL+CL+ELY)
38	1.5(DL+CL+RSX)
39	1.5(DL+CL+RSY)
40	1.5(DL+CL+WL1)
41	1.5(DL+CL+WL2)
42	1.5(DL+CL+WL3)
43	1.5(DL+CL+WL4)
44	1.5(DL+CL-ELX)
45	1.5(DL+CL-ELY)

V. RESULTS

The different load combinations are applied and the base reactions, deflection, shear force and bending moments are obtained.

A. MODEL 1

TABLE 5.Analysis result

Load	P(KN)	V2(kN)	V3(kN)	M2(kNm)	M3(kNm)
Dead	-5.3482	0.5438	0.0353	0.1574	60.6086
Collateral Load	-2.5319	0.3017	0.0012	0.0075	40.5708
Live	-7.5686	0.9019	0.0036	0.0227	121.9225
EL X	1.7921	3.4663	0.0003	0.0011	14.613
EL Y	3.8781	0.1072	0.0038	0.0005	0.4518
WL 1	25.7811	23.4482	1.2182	2.1017	20.9204
WL 2	94.7575	28.2397	13.4351	23.179	41.8655
WL 3	85.0479	28.5013	14.6536	25.2814	9.0224
WL 4	15.8305	4.5818	8.3535	14.4119	9.0224
0.9(DL+CL)-1.5ELX	-4.4039	1.4038	0.0324	0.1365	112.9765
0.9(DL+CL)-1.5ELY	-7.0897	0.759	0.032	0.1687	91.7251
0.9(DL+CL)+1.5ELX	-4.4039	2.9257	0.0324	0.1365	112.9765
0.9(DL+CL)+1.5ELY	-7.0896	0.7629	0.032	0.135	91.7251
0.9(DL+CL)+1.5RSX	-2.7797	4.2329	0.0326	0.1375	126.1082
0.9(DL+CL)+1.5RSY	-7.0881	0.7642	0.032	0.1913	92.1613
0.9(DL+CL)+1.5WL1	-0.3777	14.703	1.8324	3.1686	112.6901
0.9(DL+CL)+1.5WL2	54.7029	21.7066	20.1578	34.7845	62.7983
0.9(DL+CL)+1.5WL3	39.0772	22.1038	21.9753	37.906	13.5336
0.9(DL+CL)+1.5WL4	-4.9994	0.6189	12.5353	21.634	74.7852
1,5(DL+LL+CL)	-23.1731	2.6212	0.0542	0.2286	334.6326
1.2(DL+LL+CL)+0.6 WL1	-15.8527	3.8157	0.7379	1.2829	276.3588
1.2(DL+LL+CL)+0.6WL2	-14.4656	2.9197	8.068	13.9293	210.7901
1.2(DL+LL+CL)+0.6WL3	-14.3045	4.0512	8.7852	15.1469	218.6361
1.2(DL+LL+CL)+0.6WL4	-17.7015	2.0401	5.019	8.6691	261.1709
1.2(DL+LL+CL+ELX)	-16.3879	3.8288	0.0437	0.1842	285.2406
1.2(DL+LL+CL+ELY)	-18.5365	2.0985	0.0434	0.1831	268.2179
1.2(DL+LL+CL+RSX)	-15.0886	4.8745	0.0439	0.1851	295.7459
1.2(DL+LL+CL+RSY)	-18.5353	2.0995	0.0434	0.1967	268.5669
1.2(DL+LL+CL+WL1)	-13.167	6.1717	1.4688	2.5439	285.0114
1.2(DL+LL+CL+WL2)	-10.3927	3.7425	16.1291	27.8367	154.0258
1.2(DL+LL+CL+WL3)	-10.0706	6.0054	17.5773	30.3157	169.5965
1.2(DL+LL+CL+WL4)	-16.8644	1.9833	10.0311	17.3162	254.666
1.2(DL+LL+CL-ELX)	-16.3879	0.3651	0.0437	0.1843	285.2406
1.2(DL+LL+CL-ELY)	-18.5366	2.0954	0.0434	0.183	268.2179
1.5(DL+CL)	-11.8201	1.2683	0.0533	0.2255	151.764
1.5(DL+CL+ELX)	-9.1319	3.433	0.0537	0.2263	173.6821
1.5(DL+CL+ELY)	-11.8176	1.2702	0.0533	0.2248	152.4234
1.5(DL+CL+RSX)	-7.5077	4.7402	0.0539	0.2273	186.8138
1.5(DL+CL+RSY)	-11.8162	1.2715	0.0533	0.2799	152.8596
1.5(DL+CL+WL1)	-5.1057	9.0675	1.8358	3.1793	173.3957
1.5(DL+CL+WL2)	19.1121	8.0704	20.1612	34.7952	62.7983
1.5(DL+CL+WL3)	2.0986	8.4676	21.9719	37.8953	29.1466
1.5(DL+CL+WL4)	-9.7275	1.1262	12.5387	21.6447	135.4835
1.5(DL+CL-ELX)	-9.1319	0.8965	0.0537	0.2263	173.6821
1.5(DL+CL-ELY)	-11.8178	1.2663	0.0533	0.2574	152.4234

TABLE 6. Deflection

Load Case	Ux (mm)		Uy (mm)	
	Maximum	Minimum	Maximum	Minimum
Dead	0.475	-0.475	0.017	-0.017
Collateral Load	0.313	-0.313	0.012	-0.012
Live	0.941	-0.941	0.037	-0.037
ELX	2.048	-2.048	0.132	-0.132
ELY	0.053	-0.053	0.734	0
WL1	0.616	-1.04	0.185	-0.185
WL2	0	-6.042	1.427	-1.427
WL3	0.03	-1.78	1.432	-1.432
WL4	0	-1.158	0.81	-0.802

B. MODEL 2

TABLE 7. Analysis result

Load	P(KN)	V2(kN)	V3(kN)	M2(kNm)	M3(kNm)
Dead	-5.3482	0.5438	0.0353	0.1574	60.6086
Collateral Load	-2.5319	0.3017	0.0012	0.0075	40.5708
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WL4	0	-1.158	0.81	-0.802

VI. CONCLUSIONS

The PEB is analyzed and designed under different load and load cases. The result shows that the bracing and its location has significant effect on the structure and its performance.

VII. REFERENCES

[1] Patxi Uriz et al, “Seismic Performance Assessment of Concentrically Braced Steel Frames”, 13th World Conference on Earthquake Engineering, 2004.

[2] R.S. Londhe et al, “Non Linear Static Analysis of Knee Bracing in Steel Frame Structures” Volume 5, Issue 4 (Jan. - Feb. 2013) (IOSRJMCE).

[3] S. M. Zahrai, “Application of Friction Pendulum Damper in Braced Frames and Its Effects on Structural Response” International Journal of Engineering and Technology, Vol. 6, No. 6, December 2014.

[4] Adithya. M et al , “Study on Effective Bracing Systems for High Rise Steel Structures” , volume 2 Issue 2 February 2015, (IJCE). Gia Toai Truong et al. (2017) Seismic Performance of Exterior RC Beam–Column Joints Retrofitted using Various Retrofit Solutions, International Journal of Concrete Structures and Materials, 415–433.

[5] Navya P et.al “Structural Behavior of Industrial Structure Subjected to Lateral Loads” Vol. 4 Issue 05, (IJERT) May-2015.

[6] Chandrashekhar B Adin et al,“Dynamic Analysis of Industrial Steel Structure by using Bracings and Dampers Under Wind Load and Earthquake Load” Vol. 5 Issue 07, July-2016 (IJERT).

[7] Seena Somasekharan et al,“Wind load analysis for industrial building with different bracing patterns and its comparison with pre-engineered building” Volume 8, Issue 4, April 2017 (IJCIET).