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COMPARATIVE STUDY ON CONVENTIONAL TRUSS AND PRE-ENGINEERED FRAME

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Abstract:

Long range, section free structures are the most basic in industrial structures and pre-engineered structures (PEB) satisfy this prerequisite alongside diminished time and cost when compared with regular structures. This philosophy is flexible not just because of its quality pre-planning and construction, yet in addition because of its light weight and conservative development. The present work exhibits the similar investigation and plan of regular steel outlines and pre-designed structures (PEB). In this work, Analysis of Conventional Steel Truss and Pre-engineered frame having 5m bay spacing with varying span 20m, 25m, 30m for having same DL, LL and WL (zone2,zone3,zone4,zone5) are by using STAAD ProV8i software.

Key Words: Pre-Engineered Structures, Conventional Steel Truss & STAAD ProV8i

1. Introduction:

Steel is such a material, that it having high strength per unit mass. Consequently it is utilized for enormous section free range structures. Nearly of the mechanical structures are finished by utilizing steel. These structures contain block brick work as a side divider and GI sheets are utilized for covers. Non-load bearing walls are constructed for side walls. These dividers are adequately solid to withstand horizontal forces like wind and earth quake loads. Plan of industrial structures incorporate basic components, for example, rooftop support, segment, segment bases, gusset plate, base plate, bracings and so on. Mix of the two models hot rolled and cold shaped areas, secured sheets, droop bars, and it is utilized for the development of industrialstructures. According to the design conceptindustrial structures can be classified as Conventional Steel Buildings (CSB), and Pre-built Buildings. A detail case study describes the PEB systems and CSB systems. For the analysis of structures various types' loads and the load combinations are well defined in the further chapter.Results acquired from the product examination are talked about in definite part.

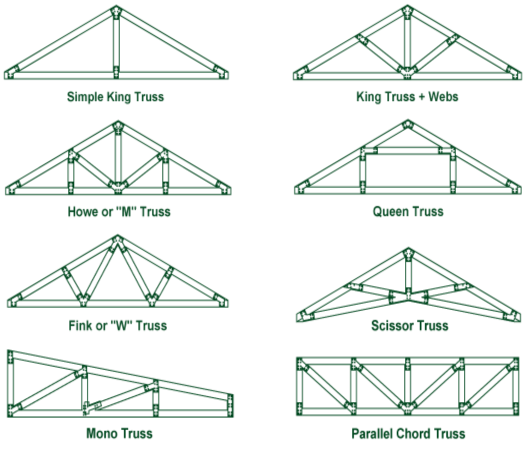

Figure 1.1: Conventional Steel Frame

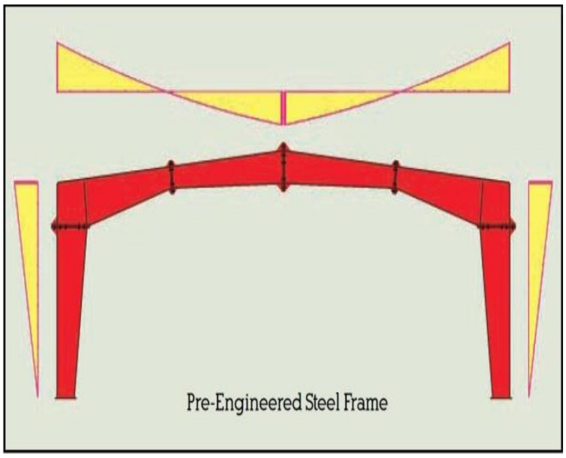

Figure 1.2: Pre-engineered Steel Fram

2. Methodology of the Project:

Conventional steel frame having Triangular Pratt truss and Indian standard I section used as a column as a roofing system. The PEB systems having a singlespan rigid frame with pinned support at base and combination of tapered column and rafter welded together.Analysis of Conventional Steel Truss and Pre-engineered frame having 5m bay spacing with varying span 20m,25m,30m for having same DL,LL and WL (zone 2, zone 3, zone 4, zone 5) are by using STAAD ProV8i software. To compare the design procedure of both PEB and Conventional systems.To compare the consequences of both the frames and analyze the utilization of steel in the two frame systems.

3. Modeling and Analysis:

In this project convention truss and PEB frame span ranging from 20m, 25m, 30m. Models are analyzed and designed using STAAD Pro V8i software. For analysis same dead load, live loads are considered mentioned above. Whereas different wind load [zone 2, zone 3, zone 4, zone 5] considered and compare the result of both the systems. The parameter considered is

Width = 20m, 25m, 30m
Length = 50 m,
Height of the eave = 8m
Spacing of bay = 5 m
Roof Slope = 15 degrees

3.1 Dead Loads

Dead loads shall generally be determined in accordance with IS: 875 (Part-I).Dead loads are taken same for both conventional truss and PEB systems.

G.I. Sheet Roof Coverings-0.150kN/m^2
Assume Purlin load -0.10kN/m^2
Spacing of purlin-1.29m
Bay spacing 5m c/c
Intensity of load on Nodal Point of truss-1.6125kN
Intensity of load on PEBrafter-1.25kN/m

3.2 Imposed Loads

Imposed loads shall be in general as per IS: 875 (Part-2). Following imposed loads shall be considered:

Roof angle for conventional steel building=15 degree.
Therefore Live load is taken as =0.75-0.02(24.22-10)=0.65kN/m^2
Spacing of purlin-1.29m
Bay spacing 5m c/c
Intensity of load on Nodal Point of truss-4.1925kN
Intensity of load on PEBrafter-3.25kN/m

3.3 Wind Loads

The wind forces acting on the building is considered as per IS 875 (Part 3). The basic speed for this building is considered as 39m/s. The internal and external pressure co-efficient is calculated as per procedure specified in IS 875 (Part3).

3.3.1 Case 1 - Wind Zone 2

Basic wind speed=39m/s
Risk coefficient factor k1=1(Design life of structures=50years)
Terrain factor k2 = 1.03(Terrain category 1,Class B)
Topography factor k3 = 1.00.
Design Wind speed=Vz=Vb*k1*k2*k3=40.17kN/m^2
pz=0.6Vz^2=0.969kN/m^2
Internal pressure Co-efficient[Cpi] =+/-0.5
Building Height ratio h/w<0.5
For wind angle 0^0 External Co-efficient (Cpe) for pitched roofs of Rectangular clad structures are taken as -1.30and -0.9 respectively
For wind angle 90^0 External Co-efficient (Cpe) for pitched roofs of Rectangular clad structures are taken as -1.25and -1.1 respectively.
Building plan Ratio 3/2<l/W<4
For wind angle 0^0 External Co-efficient (Cpe) for walls of Rectangular clad structures are taken as 1.20 and -0.75 respectively.
For wind angle 90^0 External Co-efficient (Cpe) for walls of Rectangular clad structures are taken as -1.0and -1.0 respectively
Wind load to be calculated by
[Cpe+Cpi]*A*Pz

3.3.2 Case 2 - Wind Zone 3

Basic wind speed=44m/s
Risk coefficient factor k1=1(Design life of structures=50years)
Terrain factor k2 = 1.03(Terrain category 1, Class B)
Topography factor k3 = 1.00.
Design Wind speed=Vz=45.32kN/m^2
pz=0.6Vz^2=1.233kN/m^2

3.3.3 Case 3 - Wind Zone 4

Basic wind speed=47m/s

Risk coefficient factor k1=1(Design life of structures=50years)
Terrain factor k2 = 1.03(Terrain category 1, Class B)
Topography factor k3 = 1.00.
Design Wind speed=Vz=48.41kN/m^2
pz=0.6Vz^2=1.407kN/m^2
Internal pressure Co-efficient[Cpi] =+/-0.5

3.3.4 Case 4 - Wind Zone 5

Basic wind speed=50m/s
Risk coefficient factor k1=1(Design life of structures=50years)
Terrain factor k2 = 1.03(Terrain category 1, Class B)
Topography factor k3 = 1.00.
Design Wind speed=Vz=51.50kN/m^2
pz=0.6Vz^2=1.592kN/m^2

3.5 Load Combinations

The following load combinations are considered with their respective load factors as per the codes.

Limit state of Strength

- 1.5DL+1.5LL
- 1.5DL+1.5WL0DEGREECPI=+0.5
- 1.5DL+1.5WL 0DEGREE CPI=-0.5
- 1.5DL+1.5WL 90DEGREE CPI=+0.5
- 1.5DL+1.5WL90DEGREE CPI=-0.5
- 0.9DL+1.5WL0DEGREECPI=+0.5
- 0.9DL+1.5WL 0DEGREE CPI=-0.5
- 0.9DL+1.5WL 90DEGREE CPI=+0.5
- 0.9DL+1.5WL90DEGREE CPI=-0.5
- 1.5DL+1.05LL
- 1.2DL+1.2LL+0.6WL0DEGREECPI=+0.5
- 1.2DL+1.2LL+0.6WL 0 DEGREE CPI=-0.5
- 1.2DL+1.2LL+0.6WL 90DEGREE CPI=+0.5
- 1.2DL+1.2LL+0.6WL 90 DEGREE CPI=-0.5
- 1.2DL+1.05LL+0.6WL0DEGREECPI=+0.5
- 1.2DL+1.05LL+0.6WL0 DEGREE CPI=-0.5
- 1.2DL+1.05LL+0.6WL 90DEGREE CPI=+0.5
- 1.2DL+1.05LL+0.6WL 90 DEGREE CPI=-0.5
- 1.2DL+1.2LL+1.2WL0DEGREECPI=+0.5
- 1.2DL+1.2LL+1.2WL0 DEGREE CPI=-0.5
- 1.2DL+1.2LL+1.2WL 90DEGREE CPI=+0.5
- 1.2DL+1.2LL+1.2WL 90 DEGREE CPI=-0.5

Limit state of Serviceability

- 1.0DL+1.0LL
- 1.0DL+1.0WL0DEGREECPI=+0.5
- 1.0DL+1.0WL0 DEGREE CPI=-0.5
- 1.0DL+1.0WL 90DEGREE CPI=+0.5
- 1.0DL+1.0WL 90 DEGREE CPI=-0.5
- 1.0DL+0.8LL+0.8WL0DEGREECPI=+0.5
- 1.0DL+0.8LL+0.8WL0 DEGREE CPI=-0.5
- 1.0DL+0.8LL+0.8WL 90DEGREE CPI=+0.5
- 1.0DL+0.8LL+0.8WL 90 DEGREE CPI=-0.5

4. Results

4.1. Support Reaction

4.1.1 Comparison of Support Reaction [DL+LL] of structures for wind zone 2

Table 4.1.Comparison of support reaction of Structures for wind zone 2

	20M	25M	30M
CSB	85.20kN	108.00kN	127.00kN
PEB	81.20kN	99.00kN	119.00kN

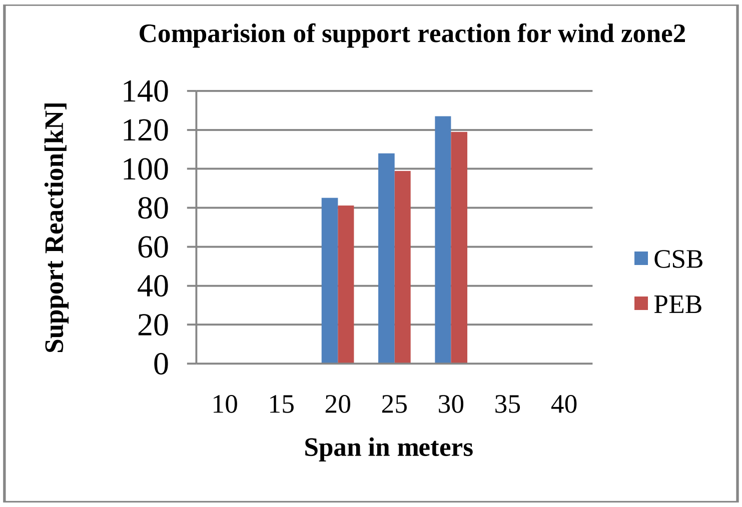

Figure 4.1: Comparison of support reaction of Structures for wind zone 2

4.1.2 Comparison of Support Reaction [DL+LL] of structures for wind zone 3

Table 4.2: Comparison of support reaction of Structures for wind zone 3

	20M	25M	30M
CSB	85.50kN	108.00kN	130.00kN
PEB	83.40kN	99.00kN	119.00kN

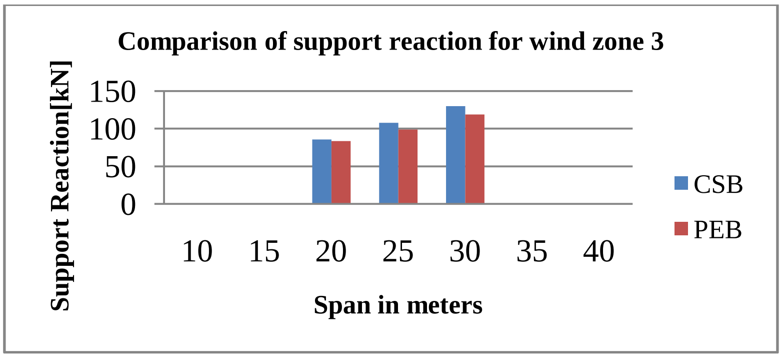

Figure 4.2: Comparison of support reaction of Structures for wind zone

4.1.3 Comparison of Support Reaction [DL+LL] of structures for wind zone 4

Table 4.3: Comparison of support reaction of Structures for wind zone 4

	20M	25M	30M
CSB	86.40kN	111.00kN	131.00kN
PEB	83.20kN	99.00kN	119.00kN

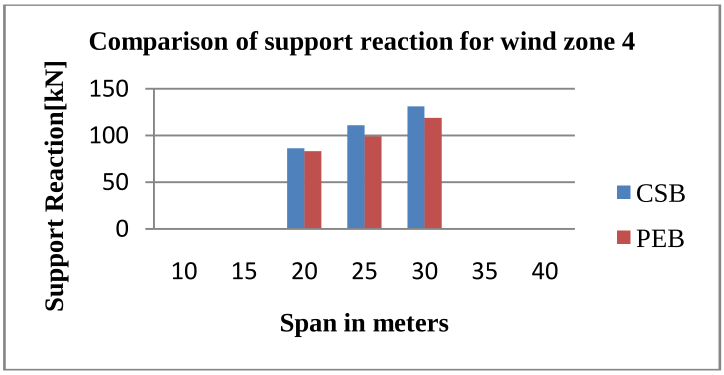

Figure 4.3: Comparison of support reaction of Structures for wind zone 4

4.1.4 Comparison of Support Reaction [DL+LL] of structures for wind zone 5

Table 4.4: Comparison of support reaction of Structures for wind zone 5

	20M	25M	30M
CSB	87.00kN	112.00kN	132.00kN
PEB	83.20kN	99.00kN	119.00kN

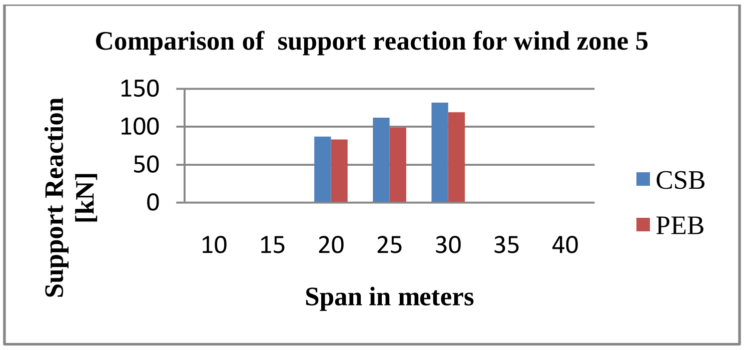

Figure 4.4: Comparison of support reaction of Structures for wind zone 5

4.2 Vertical Deflection:

4.2.1 Comparison of Vertical Deflection of structures for wind zone 2

Table 4.5: Comparison of vertical deflection of Structures for wind zone 2

	20M	25M	30M
CSB	38.75mm	50.61mm	65.93mm
PEB	134.39mm	223.35mm	383.66mm

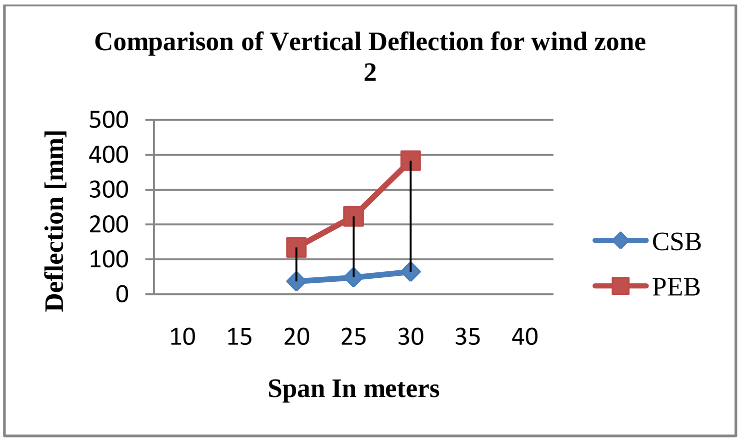

Figure 4.5: Comparison of vertical deflection of Structures for wind zone 2

4.2.2 Comparison of Vertical Deflection of structures for wind zone 3

Table 4.6: Comparison of vertical deflection of Structures for wind zone 3

	20M	25M	30M
CSB	41.449mm	50.323mm	60.36mm
PEB	115.912mm	223.35mm	383.66mm

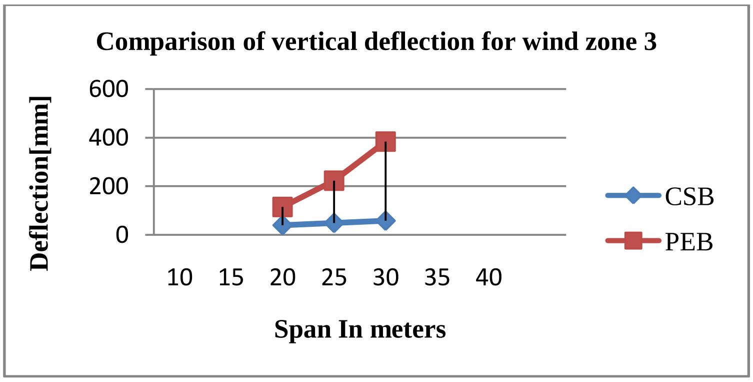

Figure 4.6: Comparison of vertical deflection of Structures for wind zone 3

4.2.3 Comparison of Vertical Deflection of structures for wind zone 4

Table 4.7: Comparison of vertical deflection of Structures for wind zone 4

	20M	25M	30M
CSB	36.51mm	43.13mm	58.86mm
PEB	119.627mm	227.945mm	389.97mm

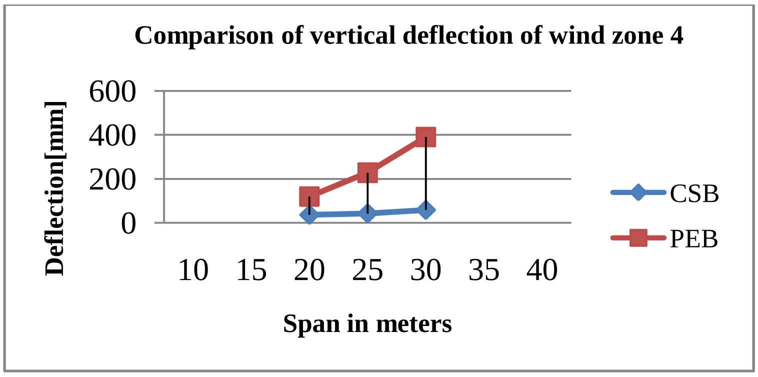

Figure 4.7: Comparison of vertical deflection of Structures for wind zone 4

4.2.4 Comparison of Vertical Deflection of structures for wind zone 5

Table 4.8 Comparison of vertical deflection of Structures for wind zone 5

	20M	25M	30M
CSB	39.19	50.20mm	54.21mm
PEB	70.53mm	267.549mm	458.06mm

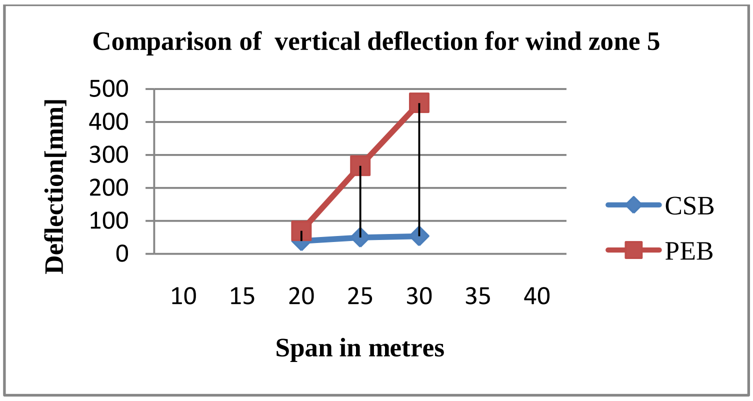

Fig 4.8.Comparison of vertical deflection of Structures for wind zone 5

4.3 Lateral Displacements

4.3.1Comparison of Lateral Displacements of structures for wind zone 2

Table 4.9: Comparison of Lateral displacements of structures for wind zone 2

	20M	25M	30M
CSB	9.595mm	9.179mm	10.48mm
PEB	226.978mm	120.814mm	117.915mm

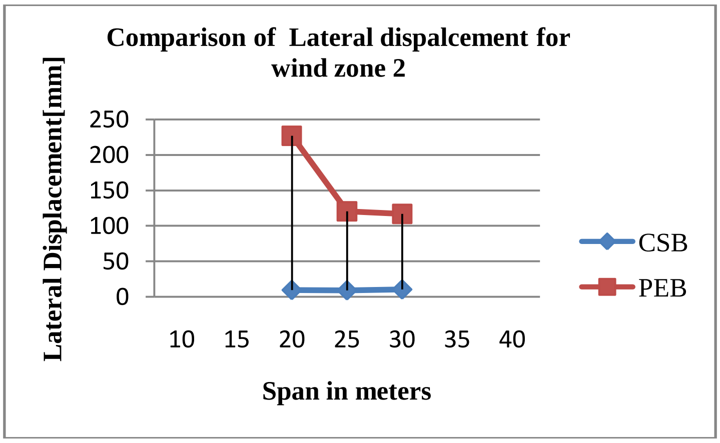

Figure 4.9: Comparison of lateral displacements of Structures for wind zone 2

4.3.2 Comparison of Lateral Displacements of structures for wind zone 3

Table 4.10: Comparison of Lateral displacements of structures for wind zone 3

	20M	25M	30M
CSB	12.65mm	12.28mm	12.77mm
PEB	289.563mm	158.149mm	157.24mm

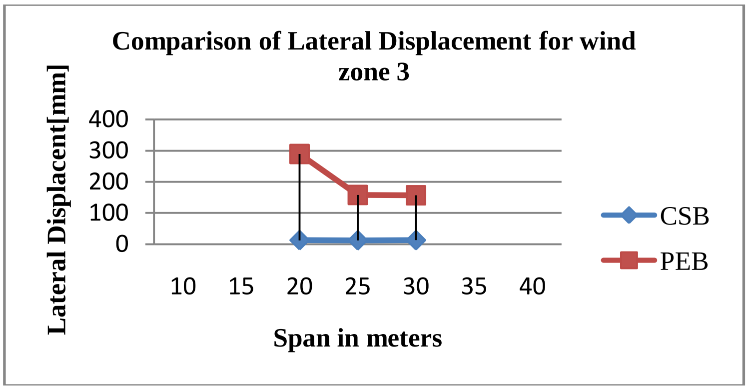

Figure 4.10: Comparison of Lateral Displacements of structures for wind zone 3

Table 4.11: Comparison of Lateral displacements of structures for wind zone 4

	20M	25M	30M
CSB	13.40mm	12.85mm	14.60mm
PEB	345.631mm	183.721mm	184.94mm

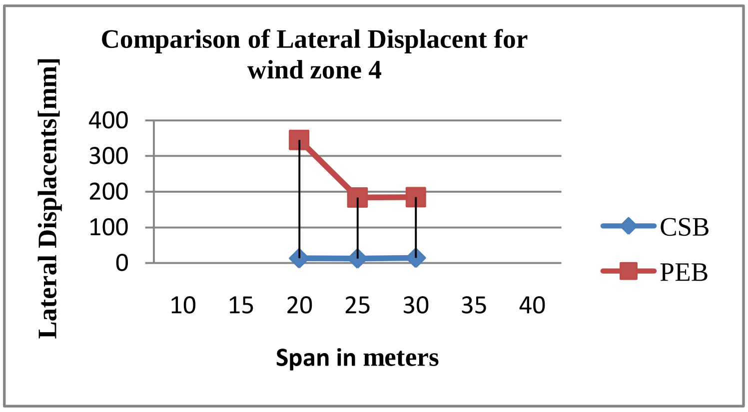

Figure 4.11: Comparison of lateral displacements of Structures for wind zone 4

4.3.4 Comparison of Lateral Displacements of structures for wind zone 5

Table 4.12: Comparison of Lateral displacements of Structures for wind zone 5

	20M	25M	30M
CSB	14.72mm	14.48mm	14.55mm
PEB	185.84mm	210.721mm	214.02mm

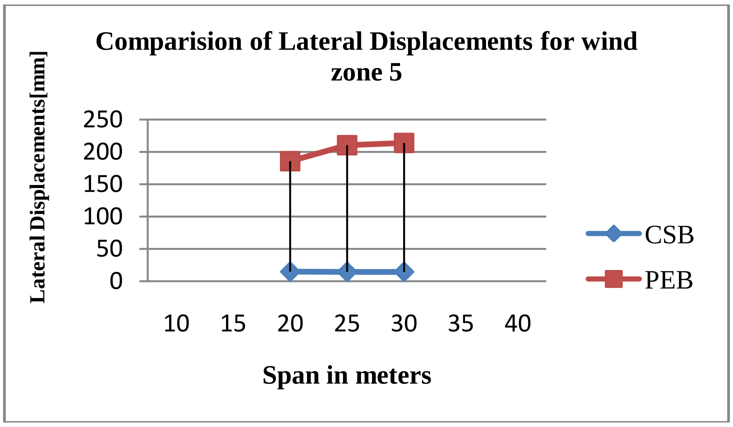

Figure 4.12: Comparison of lateral displacements of Structures for wind zone 5

4.4 Steel Quantity

4.4.1 Comparison of Steel quantity of structures for wind zone 2

Table 4.13: Comparison of steel quantity of structures for wind zone 2

	20M	25M	30M
CSB	23.17 ton	29.08 ton	30.98 ton
PEB	16.62 ton	17.01 ton	20.39 ton

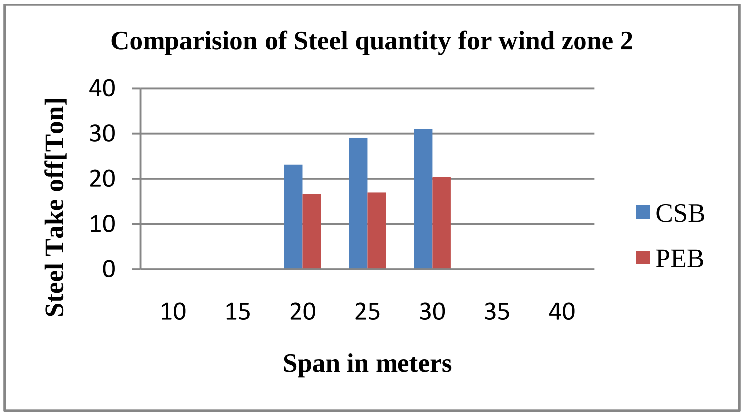

Figure 4.13: Comparison of Steel quantity of structures of wind zone 2

4.4.2 Comparison of Steel quantity of structures for wind zone 3

Table 4.14: Comparison of steel quantity of structures for wind zone 3

	20M	25M	30M
CSB	23.17 ton	29.30 ton	35.88 ton
PEB	19.83 ton	17.01 ton	20.39 ton

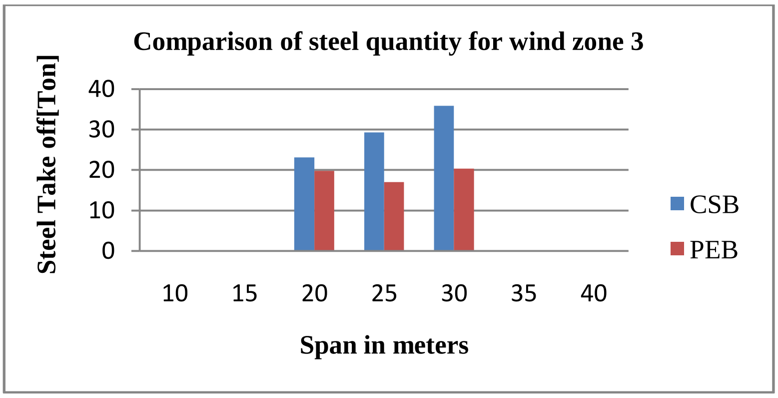

Figure 4.14: Comparison of Steel quantity of Structures of wind zone 3

4.4.3 Comparison of Steel quantity of structures for wind zone 4

Table 4.15: Comparison of steel quantity of structures for wind zone 4

	20M	25M	30M
CSB	24.58 ton	33.48 ton	36.65 ton
PEB	19.492 ton	17.01 ton	20.39 ton

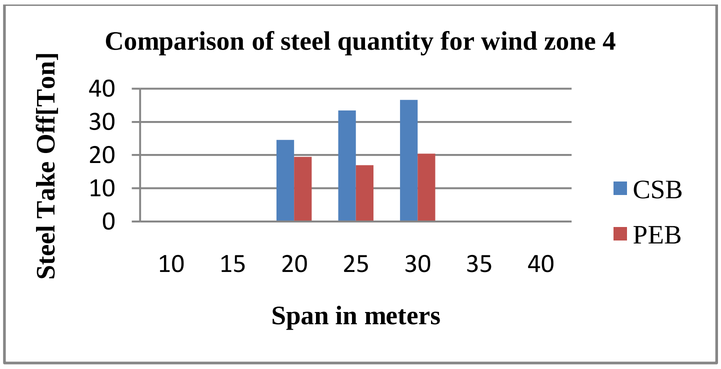

Figure 4.15: Comparison of Steel quantity of Structures of wind zone 4

4.4.4 Comparison of Steel quantity of structures for wind zone 5

Table 4.16: Comparison of steel quantity of structures for wind zone 5

	20M	25M	30M
CSB	25.43 ton	34.00 ton	38.15 ton
PEB	24.20 ton	17.01 ton	20.39 ton

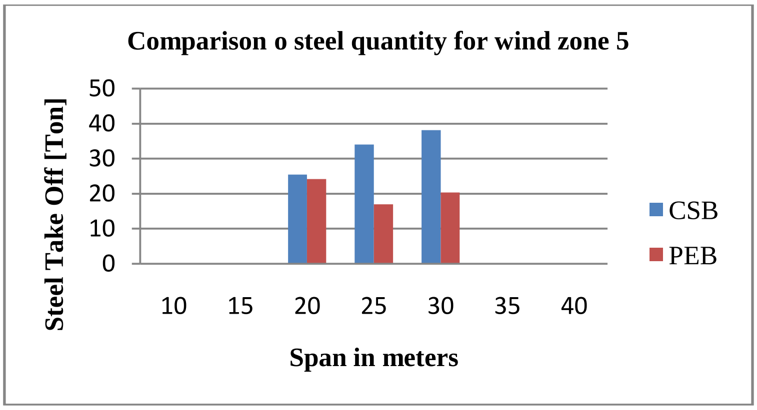

Figure 4.16: Comparison of Steel quantity of Structures of wind zone 5

4.5 Comparison of Cost

4.5.1 Comparison of cost of structures for wind zone 2

Table 4.17: Comparison of cost of Structures for wind zone 2

	20M	25M	30M
CSF	28035700.00	35186800.00	37485800.00
PEB	20110200.00	20582100.00	24671900.00

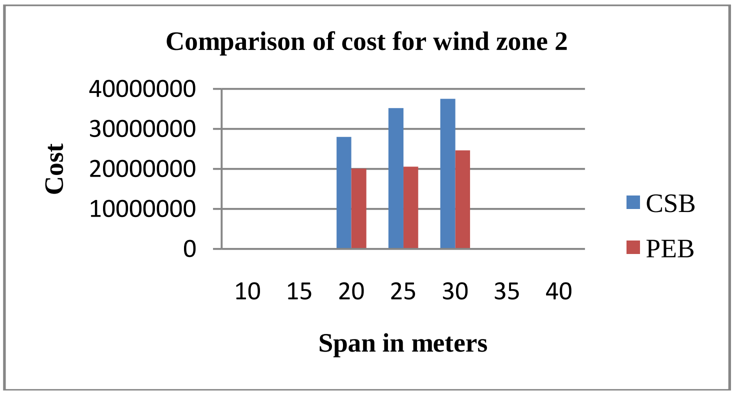

Figure 4.17: Comparison of cost of Structures of wind zone 2

4.5.2 Comparison of Cost of structures for wind zone 3

Table 4.18: Comparison of cost of Structures for wind zone 3

	20M	25M	30M
CSB	28035700.00	35453000.00	43414800.00
PEB	23994300.00	20582100.00	24671900.00

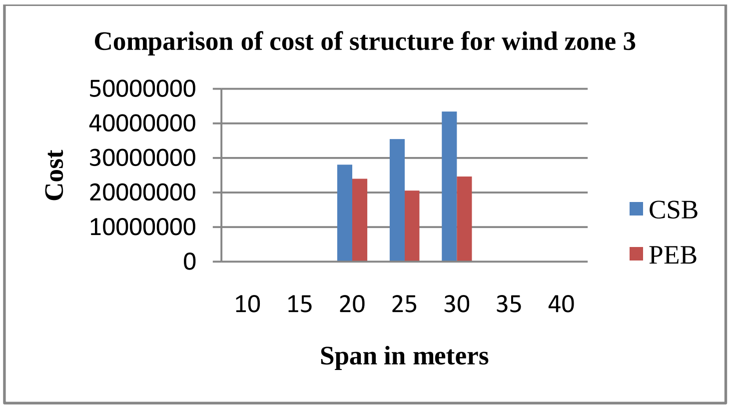

Figure 4.18: Comparison of cost of Structures for wind zone 3

4.5.3. Comparison of Cost of structures for wind zone 4

Table 4.19: Comparison of cost of Structures for wind zone 4

	20M	25M	30M
CSB	29741800.00	40510800.00	44346500.00
PEB	23585320.00	20582100.00	24671900.00

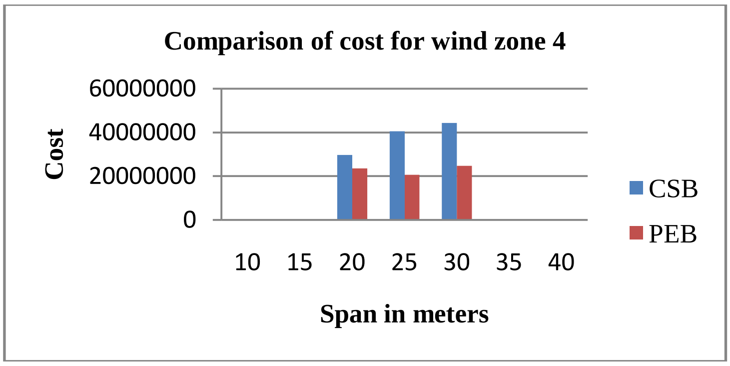

Figure 4.19: Comparison of cost of Structures for wind zone 4

4.5.4 Comparison of Cost of structures for wind zone 5

Table 4.20: Comparison of cost of Structures for wind zone 5

	20M	25M	30M
CSB	30770300.00	41140000.00	46161500.00
PEB	29282000.00	20582100.00	24671900.00

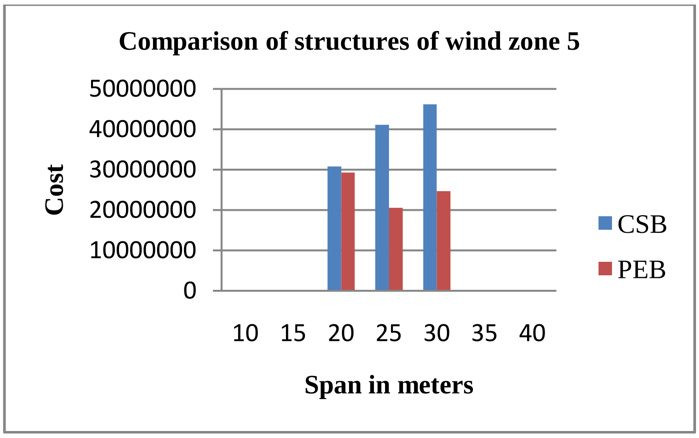

Figure 4.20: Comparison of cost of Structures for wind zone 5

5. Conclusion:

- By comparing the results obtained by the analysis of both the frames in different wind zones that the PEB structure is almost 34% lighter than the conventional steel structure. Material wastage is less in PEB structure so it plays a significant role in reducing the steel quantity.
- Pre-engineered structure cost is 34% lesser than the conventional steel structure.
- As wind intensity increases the steel consumption of primary and secondary member is also increases.
- Conventional steel frames are generally used for smaller span but for larger, column free structure it is better go with PEB structure.

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