International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 02 | Feb 2019 www.irjet.net p-ISSN: 2395-0072

Relative Investigation of Multi-storey Structure into PEB and RCC

Jyoti Aher

Assistant Prof.: Department of Civil Engineering, S.S.Jondhale College of Engineering and technology, Asangaon, Shahapur

---***---

Abstract— *Pre-engineered Building constructions in the present day more popular to their advantages over conventional Concrete and Steel constructions. PEB Construction combines the best properties of both steel and concrete along with speedy construction, lesser cost, best quality manage, sustainability etc. Concrete structures are impart and bulky less deflection and more seismic weight. Whereas Steel structures educate more deflections and ductility to the structure, which is helpful in resisting earthquake forces.. STAAD PRO software is used for analysis and design the results are to be compared with the help of this software . By using this software the goal of the present study is to equate performance of a G+2 story RCC and PEB frame. Both frames are planned for same loading combinations. Colum and Beam sections are prepared of either RCC, Steel sections. Cost effectiveness based on material cost for both building frames.*

Keywords—multistoried building,Pre-engineered Building, RCC Building, STAAD PRO software

INTRODUCTION

Currently for people houses are the one of the basic requirements. The present construction methodology for buildings requires the best aesthetic look, innovative touch, cost effective, high quality and fast construction, The construction technology has the started from primitive construction technology to existing concept of modern house building. Daily new techniques are being developed for the structure of houses and buildings sparingly, speedily. The PEB perception is one of them. This perception originated in USA in the year 1991.Since then the use of pre-engineered building has spread all over the world, now been widely used for industrial purpose.In pre-engineered building, the complete work from designing to manufacturing is doing in the factory and then after completion of work, the building components are brought to the site for fixing. In order to build a building that is strong, durable, and quick to construct and then pre-engineered buildings are the main solution. PEB are economical and efficient method of designing and construction [P Pravin kumar Venkat rao]. Steel is the basic material that is used for Pre-engineered steel building. Steel material chooses in such way that, it offers rapid site installation and less energy consumption, to commit to the principles of sustainability, infinitely recyclable [Firoz et.al]. PEB structures are more advantageous in terms of quality control, simplicity in erection process, cost effectiveness, speed in construction [C. M. Meera]. The weight of the PEB depends on the Bay spacing, as we increased the Bay spacing at certain limit the weight reduces and further increase makes the weight heavier [Naidu et.al].The entire sectional properties of PEB will depends just upon the moments at that specific locations so there won't be any excess steel used in the thus it is economical [Kumar et.al]. PEB structures can be easily designed by simple design procedures in peace with country standards, it is energy efficient, saves cost, speedy in construction, and sustainable and most important it's reliable as compared to predictable buildings.PEB methodology must be and researched and implemented for more outputs [Bhagatkar et.al].

Pre-engineered Building

"Pre-engineered steel buildings" are special class of structures that are totally designed and manufactured in the factory and then transported to the site for jointing /fixing. In pre -engineered building generally I shaped members also called as I beams are preferred. These beams are formed in factory by welding together steel plates. In some cases during manufacture tapering the sections are used. Tapering section means decreasing the size of web at the bottom. Engineers consider the clear span between column, bay spacing, dead loads, live loads, earthquake effect, wind loads, internal crane provision, deflection criteria, etc. for accurately design a pre-engineered building. Primary framing contains the main frame which resembles to bending moment diagram. It is observed that the BM is maximum at mid span and also at fixed support. This ensures that at maximum BM the depth of section is great and depth is decreases depending on BM. Other secondary framing are Purlins, girts and eave struts. In case of cold form members, Z and C-shaped sections are used to fasten and support the external cladding.

METHODOLOGY

The buildings generally contain system of beam and slab system. First initial sizing of various structural members is done and then a computer model of the structural frame of the building is created for model study for the finding the effects of lateral and vertical load that are likely to be imposed on the structure during its life time. The building structure will be analyzed using the STAAD PRO software. Geometrical dimensions, member properties and member-node connectivity, including eccentricities will be modeled in the analysis problem. The seismic analysis would be carried out for static loading in accordance with the relevant code of Practice. The computer analysis provides data about internal member forces in members, reactions at foundation level and deflection pattern of the structures as well as the individual members. This data will then be used to verify adequacy of the member *sizes adopted and after further iterations arrive at the. Most appropriate design of the structural members. To get the optimum structural space frame characteristics that satisfy the strength and stability criteria in all respects, many reruns of analysis are needed.[1][9][10][11]*

Building Details

For completion of this project, plan of existing Ground+2 Hospital structure is considered whose plan dimensions are 64M X 52M .This building is located at Satara , Maharashtra. The study is carried out on both RCC and PEB construction. The load combination is same for both types of structure.

Structural Data for RCC Building

The plan of RCC building is shown in Figure1.Separate provisions are made for staircase, lift, car parking, operation rooms and other utilities.

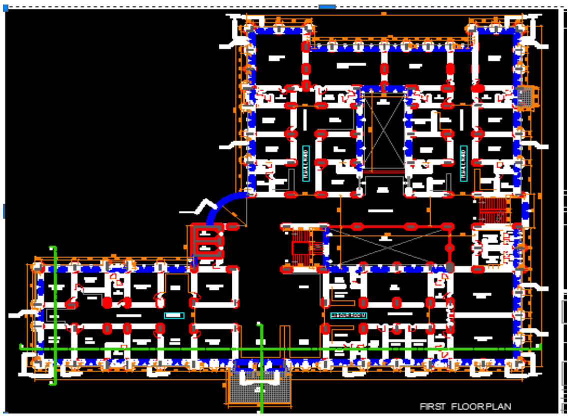

Figure 1. Plan of RCC building

Other data for RCC building like total height of Building, elevation of each storey, elevation of parapet wall, Thickness of wall, Size of beams, Size of columns, Grade of steel, Grade of concrete, Soil condition, Bearing capacity of soil as shown in TABLE I.

TABLE I; STRUCTURAL DATA FOR RCC BUILDING

Total height of Building	14 m
Height of each storey	4m
Height of parapet wall	1m
Type of Beams	Size of beams
B1	0.23m X 0.45m
B2	0.23m X 0.59m
B3	0.3m X 0.45m
B4	0.4m X 0.6 m
B5	0.3m X0.76m
Type of columns	Size of columns
C1	0.45 m X 0.67 m
C2	0.25m X 0.85m
Thickness of wall	
External wall	300 mm
Internal wall	230 mm
Seismic zone	IV
Grade of concrete	M20 –Beam & Column
	M25-Footing
Grade of steel	Fe 500
Soil condition	Hard soil
Bearing capacity of soil	130kN-m^2

Structural Data for Pre-engineered Building

The plan of Pre-engineered building is shown in Figure 2.

As the bay spacing in PEB should be greater than 6m, the numbers of columns are reduced in PEB.

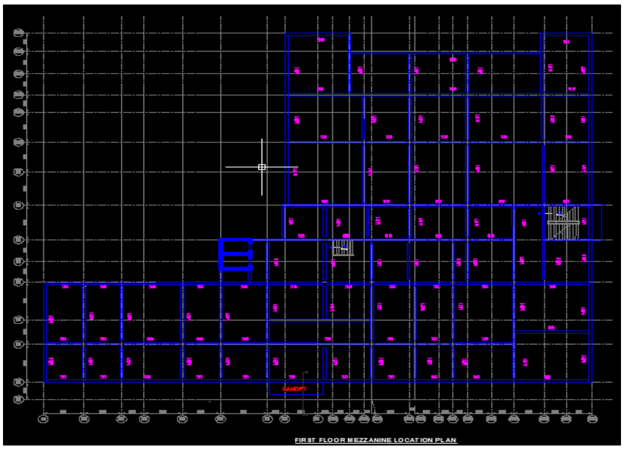

Figure 2. Plan of Pre-engineered building

Other data for Pre-engineered building like total height of Building, Height of each storey, Height of parapet wall, Size of plinth beams, Size of rafters, Size of columns, Thickness of wall, Grade of concrete, Grade of steel, Soil condition, Bearing capacity of soil as shown in TABLE II

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 02 | Feb 2019 www.irjet.net p-ISSN: 2395-0072

TABLE II. STRUCTURAL DATA FOR PRE-ENGINEERED BUILDING

Total height of Building	14 m
Height of each storey	4m
Height of parapet wall	1m
Type of Plinth Beams	Size of Beams
B1	0.3 m X 0.6 m
B2	0.23m X0.45m
B3	0.3 m X0.75m
Type of Rafters	Sizes of Rafters
MB1	0.346 m X0.005 m /0.300m X 0.02m
MB2	0.292 m X0. 005m /0.250m X 0.02m
MB3	0.280 m X0.005 m /0.300m X 0.02m
MB4	0.400 m X0.005 m /0.300m X 0.02m
MB5	0.396 m X0.005 m /0.275 m X 0.02m
MB6	0.600 m X0.005 m /0.300m X 0.02m
MB7	0.34 m X0.005 m /0.300m X 0.02m
MB8	0.396 m X0.005 m /0.250 m X 0.02m
SB1	0.690 m X0.005 m /0.300m X 0.02m
SB2	0.910 m X0.005 m /0.300m X 0.02m
SB3	0.700 m X0.005 m /0.300m X 0.02m
SB4	0.700 m X0.005 m /0.300m X 0.02m
SB5	0.800 m X0.005 m /0.300m X 0.02m
SB6	0.550 m X0.005 m /0.350m X 0.02m
SB7	0.826m X0.005 m/0.300m X 0.02m
Types of columns	Size of columns
C1	0.900 m X0.005 m/0.300m X 0.018m
C2	0.900 m X0.005 m/0.300m X 0.016m
C3	0.916 m X0.005 m/0.300m X 0.010m
C4	0.940 m X0.005 m/0.300m X 0.026m
C5	0.920 m X0.005 m/0.300m X 0.012m
C6	0.940 m X0.005 m/0.370m X 0.026m
C7	0.930 m X0.015 m/0.550m X 0.016m
C8	0.920 m X0.005 m/0.350m X 0.021 m
C9	0.800 m X0.005m /0.300m X 0.021m
Thickness of wall	
External wall	260 mm
Internal wall	180 mm
Seismic zone	IV
Grade of concrete	M20 –Plinth Beam
	M25-Footing
Grade of steel	Fe 500
Soil condition	Hard soil
Bearing capacity of soil	130 kN-m²

ANALYSIS AND DESIGN

The both building frame is analyzed using Equivalent static method by STAAD pro software. Important parameters such as maximum story deflection, maximum rotation, maximum moment, maximum base shear, maximum compressive stress, and maximum tensile stress are computed and studied for both models. After the completion of analysis, the relevant IS codes are used Concrete and for PEB sections and Seismic forces. [9][10][11]The plinth beam designed for RCC frame is provided in PEB frame.

Bending Moment Diagram For RCC Building

Bending moment diagram for RCC building is shown in Figure 3.

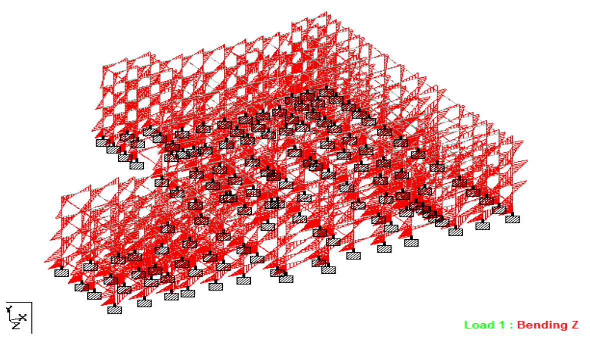

Figure 3 Bending Moment Diagram for RCC Building

Shear Force Diagram For RCC Building

Shear force diagram for RCC building is shown in Figure 4.

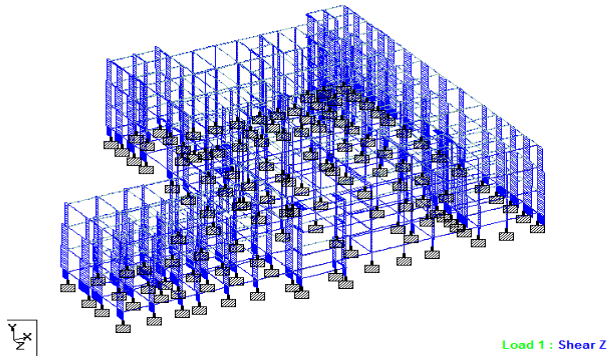

Figure 4 Shear Force Diagram for RCC Building

Bending Moment Diagram For PEB

Bending moment diagram for Pre-engineered building is shown in Figure 5.

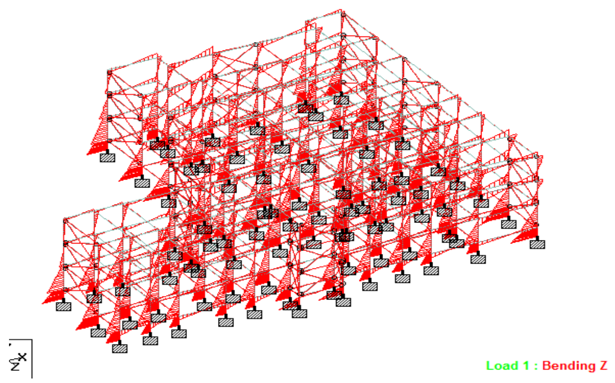

Figure 5 Bending Moment Diagram for PEB

Shear force Diagram For PEB

Shear force diagram for Pre-engineered is shown in Figure 6.

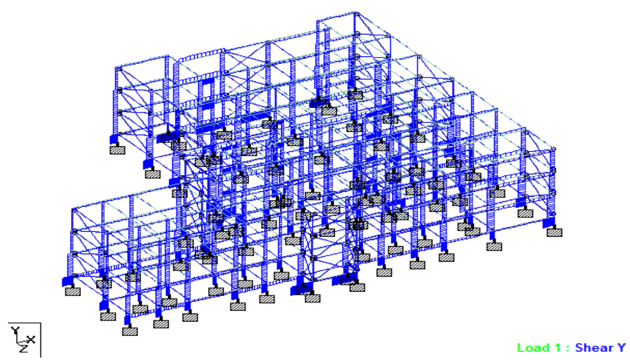

Figure 6 Shear Force Diagram for PEB

RESULTS AND DISCUSSIONS

A Results from Software Analysis

The various results like maximum axial force, maximum shear force, maximum moment in column and beam are evaluated as shown in TABLE III.

TABLE III. RESULTS FROM SOFTWARE ANALYSIS

Sr.No.	Parameters	PEB Performance	RCC Performance
1	Maximum Axial Force In Column	1981.776 kN	2445.879 kN
2	Maximum Shear Forces In Column In Y Direction	149.14 kN	382.951 kN
3	Maximum Shear Forces In Column Z Direction	376.35 kN	82.38 kN
4	Maximum Moment In Column In X Direction	17.769 kN-m	1.731 kN-m
5	Maximum Moment In Column In Y Direction	327.61 kN-m	115.081kN-m
6	Maximum Moment In Column In Z Direction	252.566 kN-m	307.788 kN-m
7	Maximum Axial Force In Beam	150.699 kN	94.148 kN
8	Maximum Shear Forces In Beam Y Direction	255.259 kN	312.012 kN
9	Maximum Shear Forces In Beam Z Direction	34.909 kN	6.943 kN
10	Maximum Moment In Beam In X Direction	17.769 kN-m	74.291 kN-m
11	Maximum Moment In Beam In Y Direction	28.534 kN-m	14.983 kN-m
12	Maximum Moment In Beam In Z Direction	308.797 kN-m	453.849 kN-m

Figure 7 shows the maximum shear forces in column, from figure we can observe that, shear force in RCC column in X direction is maximum as compared to PEB column. Shear force in RCC column in Y direction is maximum as compared to PEB column and shear force in RCC column in Z direction is minimum as compared to PEB column.

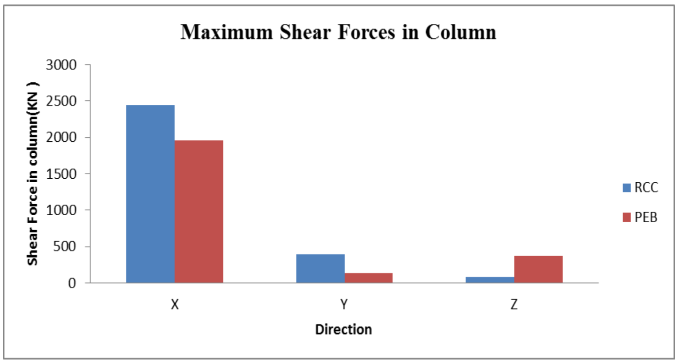

Figure 7. Maximum Shear Forces in Column

Figure 8 shows the maximum moment in column, from figure we can say that, moment in RCC column in X direction is minimum as compared to PEB column. Moment in RCC column in Y direction is minimum as compared to PEB column and moment in RCC column in Z direction is maximum as compared to PEB column.

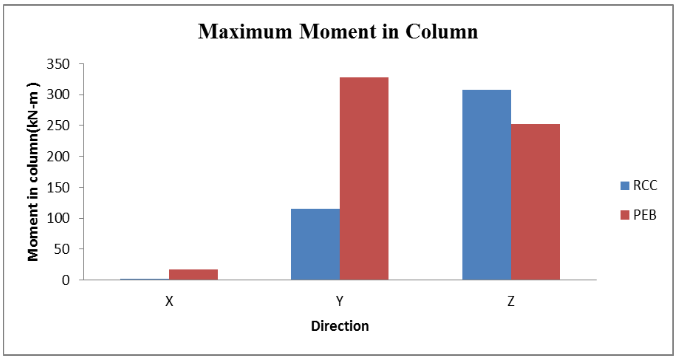

Figure 8. Maximum Moment Column

Figure 9 shows the maximum shear forces in beam, from figure we can say that, shear force in RCC beam in X direction is minimum as compared to PEB beam. Shear force in RCC beam in Y direction is maximum as compared to PEB beam and shear force in RCC beam in Z direction is maximum as compared to PEB beam.

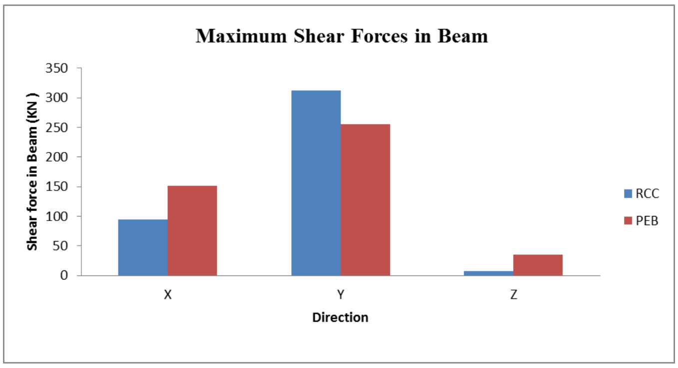

Figure 9. Maximum Shear Forces in Beam

Figure 10 shows the maximum moment in beam, from figure we can observe that, moment in RCC beam in X direction is maximum as compared to PEB beam. Moment in RCC beam in Y direction is minimum as compared to PEB beam and shear force in RCC beam in Z direction is maximum as compared to PEB beam.

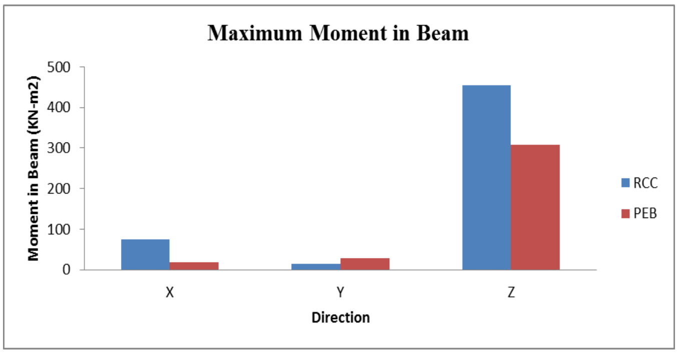

Figure 10 Maximum Moment in Beam

B Cost comparison Analysis

The total cost of project is divided into four major construction activities such as, beam, column, slab and foundation.

- RCC Frame structure

TABLE IV indicates the cost analysis for RCC Frame structure, considering the quantity of concrete only. Quantity of concrete in structural elements is calculated by manual calculation. Rate of material is taken from District schedule of rates.

TABLE IV.COST ANALYSIS RCC BUILDING (CONCRETE)

Sr.No.	Structural Element	Quantity of concrete Used(m^3)	Rate of material/m^3	Amount
1	Beam	548.264	6978	3825786.1925
2	Column	455.348	7859	3578579.932
3	Slab	723.867	8753	6336007.851
4	Footing	385.92	5144	1985172.48
	Total			15725546

TABLE V indicates the cost analysis for RCC Frame structure, considering the quantity of Steel only. Quantity of steel in beam and column is calculated by steel take off from staad pro. Rate of material is taken as per market rate.

TABLE V.COST ANALYSIS RCC (STEEL)

Sr.No.	Structural Element	Quantity of steel Used(kg)	Rate of material/MT	Amount
1	Beam and Column	72422.31	58000	4200493.98
2	Slab	43432.02	58000	2519057.16
3	Footing	13620.564	58000	789992.712
	Total			7509543.852

Total cost in RCC Structure = Rs.15725546+Rs 7509543.852=Rs 2, 32, 35,089.85/-

- *PEB Frame Structure*

TABLE VI indicates the cost analysis for PEB frame structure, considering the quantity of concrete only. Quantity of concrete in structural elements is calculated by manual calculation. Rate of material is taken from District schedule of rates.

TABLE VI. COST ANALYSIS PEB (CONCRETE)

Sr.No.	Structural Element	Quantity of concrete Used(m^3)	Rate of material/m^3	Amount
1	Plinth Beam	108.67	6978	758299.26
2	Footing	196.8	5144	1012339.2
	Total			1770638.46

TABLE VII indicates the cost analysis for PEB frame structure, considering the quantity of steel only. Quantity of steel in structural elements is calculated by manual calculation. Rate of material is taken from District schedule of rates and from market rate.

TABLE VII. COST ANALYSIS PEB (STEEL)

Sr.No.	Structural Element	Quantity of steel Used(kg)	Rate of material/MT	Amount
1	Beam and Column	256229.089	48255	12364334.69
3	Plinth beam	7041.62	58000	408413.96
4	Slab	191383	40000	7655320
5	Footing	6548.848	58000	379833.184
	Total			20807901.83

Total cost in PEB structure = Rs. 1770638.46+Rs. 20807901.83 = 2, 25, 78540.29/

C Total Cost comparison Analysis

TABLE VIII indicates the Total cost comparison analysis between RCC frame structure and PEB frame structure. From it is observed that the cost of PEB frame structure is less as than RCC frame structure.

TABLE VIII.TOTAL COST COMPARISON ANALYSIS

Sr No	Total Cost of RCC Structure(Cr)	Total Cost of PEB Structure(Cr)	Difference
1	2,32,35,089.85	2,25,78540.29	656549.56

Figure 11 shows the total cost between RCC and PEB, from figure we can say that the cost of RCC frame structure is more than PEB frame structure.

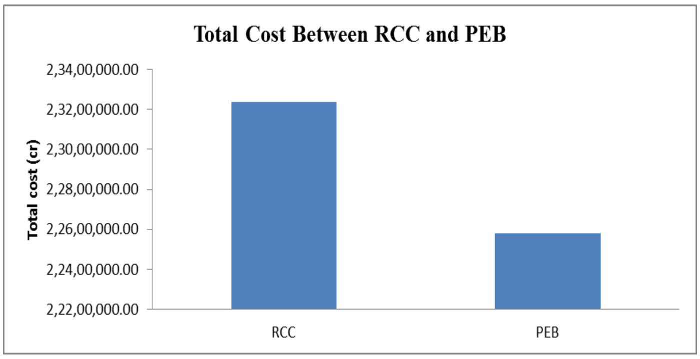

Figure 11. Total cost comparison analysis

CONCLUSIONS

- *Base Shear for RCC frame is maximum because the weight of the RCC frame is more than the PEB frame.*

- *Moment in Column in X Direction and Y Direction is more in PEB Frame as compared to RCC frame.*
- *Moment in Column in Z Direction is more in RCC frame as compared to PEB frame.*
- *Moment in beam in X Direction and Z Direction is more in RCC Frame as compared to PEB frame.*
- *Reductions in cost of PEB frame as compared with cost of RCC frame. This involves material cost only.*

References

[1] Syed Firoz, Sarath Chandra Kumar B, S.Kanakambara Rao,(2012)"Design concept of pre-engineered building". International Journal of Engineering Research and Applications, Volume 2 Issue 2, pp: 267-272

[2] Meera C.M. (2013). "Pre-Engineered Building Design of an Industrial Warehouse."International Journal of Engineering Sciences and Emerging Technologies, Volume: 5, Issue: 2,pp:75-82.

[3] Pradip S. Lande, Vivek V. Kucheriya(Aug.2014), "Comparative Study of an Industrial Pre-Engineered Building with Conventional Steel Building". Journal of Civil Engineering and Environmental Technology Volume 2, Number 10; April-June, 2015 pp. 77-82

[4] G. Durga Rama Naidu, K. Srinivasa Vengala Rao, V. Divya Sri,M. Navakanth, G.V. Rama Rao (Sept.2014). "Comparative Study of Analysis and Design of Pre-Engineered Buildings and Conventional Frames", International Journal of Engineering Research and Development e-ISSN: 2278-067X, p-ISSN: 2278-800X Volume 10, Issue 9.

[5] Kavya.Rao.M.N, K.N.Vishwanath (Sept.2014). "Design Optimisation of an Industrial Structure from Steel Frame to Pre-Engineered Building", International Journal of Research in Advent Technology, Vol.2, No.9, September 2014 E-ISSN: 2321-9637.

[6] A. Sravan Kumar, Sanjeev Rao,Madan Mohan, DR. Sreenatha Reddy (Nov. 2014). "Design and Analysis of Pre Engineered Industrial Buildings (PEB)", International Journal of Applied Sciences, Engineering and Management ISSN 2320 – 3439, Vol. 03, No. 06, November 2014, pp. 26 – 29.

[7] Shrunkhal V Bhagatkar, Farman Iqbal Shaikh, Bhanu Prakash Gupta and Deepak Kharta (March 2015). "A Study On Pre-Engineered Building – A Construction Technique",Int. Journal of Engineering Research and Applications www.ijera.com ISSN : 2248-9622, Vol. 5, Issue 3, (Part -2) March 2015, pp.05-09

[8] Mr. Saurabh A. Shah, Prof. M. B. Kumthekar (May 2015). "Guidelines for Erection process of Pre-Engineered Building", International Journal of Engineering and Technical Research (IJETR) ISSN: 2321-0869, Volume-3, Issue-5

[9] IS 456: 2000, "Code for practice of plain and reinforced concrete code of practice, Bureau of Indian Standards", New Delhi.

[10] IS 1893: 2002, "Code for earthquake resistant design of structures- general provisions for buildings, Part I, Bureau of Indian Standards", New Delhi.

[11] IS 800:2007, "Indian Standard Code of practice for General Construction of Steel in India,Bureau of sIndian Standards",New Delhi