International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 3.45 (SJIF-2015), e-ISSN: 2455-2584
Volume 3, Issue 04, April-2017

Analysis & Design of Conventional & Pre-engineered G+4 storey Industrial steel building

Monika Nakum[1], Jigar Zala[2], Darshan Shah[3]

[1]*M.E (Student, Structural Engineering) Civil, Arham Veerayatan Institute of Engineering and Research*
[2]*Assistant Professor civil Engineering Department, Arham Veerayatan Institute of Engineering and Research*
[3]*Structure Designer, Jaydipdarshan Consultants Pvt. Ltd. Ahmedabad*

Abstract— PEB is one of fastest emerging industry in world. By adapting the use of PEB Structure compared to CSB structure results many advantages. In this paper, CSB (Conventional steel building) & PEB (Pre engineered steel building) were designed as per IS 800:2007. Here, we have considered 5 different types of plan area. Models were being analysed in STAAD-pro. After analyzing the results of PEB & CSB Structure, the PEB Structure is lighter than CSB structure. Also the governing lateral force found in the model is seismic.

Keywords— PEB, CSB, STAAD-pro, Multi storey, IS: 800:2007

I. INTRODUCTION

Pre Engineered Building is construction technology which is recently evolved, that uses the assembling system, just like a Building Block game. Pre-engineered buildings are pre designed, pre-cut and pre fabricated sections provided by the building manufacturing company. It comprises of pre designed building components of steel girder and sections for specific projects. Connections are very simple just using nuts, bolts and welding mechanism."A Pre-Engineered Steel building is a Shop Fabricated Site bolted Structure". In India, the concept of PEB construction started in 1999-2000. In the last few years about three lakh tons of materials were shaped. The production of PEB sections is linearly increasing by 20 percent annually. Pre-engineered building are generally made of built-up sections, hot rolled sections and cold-formed elements, which provide the basic steel frame, framework of primary and secondary members (rigid frame, beams, purlins and grits and columns).

II. OBJECTIVE & SCOPE OF WORK

(A) *THE MAIN OBJECTIVE OF PRESENT WORK IS AS FOLLOWS:*

1. Observe the structural behaviour of Multi Storey Industrial Buildings.
2. Design primary & secondary element of P.E.B & C.S.B. to Prepare detailed drawings.
3. Compare the size of member, reaction, building weight & lateral force.

(B) *SCOPE OF PRESENT WORK IS AS FOLLOWS:*

1. Keeping the same configuration of Storey Height (20 meter), Fifteen Models were prepared of area covered approx. 3600,4320,6300,7220,9720 m^2 , for both Pre Engineered building & Conventional Steel Building.
2. Load analysis carried out using Software STAAD Pro.
3. Analysis & Design of steel section like Joist, Beam, Column that forms PEB steel building was done using IS: 800:2007.

III. MULTI-STOREY STEEL BUILDING

The natural resources which are depleting at a great cost needs to be saved, and hence there is need of an alternate to traditional, civil-construction methods. With the help of PEB structures the time can be effectively saved along with substantial cost savings and many more benefits: “Super Fast Construction – at least 6-8 times faster than the conventional RCC Construction”

- Cost Effective
- Dry & Mechanized construction method.
- No Shuttering of structural member required
- Earthquake resistant designs can easily be designed.
- Multiple floors can be laid out simultaneously

This is a very versatile building system and can be finished internally to serve any required purpose and accessorized externally to achieve attractive and distinctive architectural styles. It is most suitable for any high rise building and offers numerous benefits over low-rise or conventional buildings.

Pre-Engineered steel construction market is growing rapidly double figure year-by-year since the last few years; also it would certainly not be a hyperbole if we say the industry are growing very rapidly. In fact, pre-engineered building sector has started getting its due credit as a favourable alternative construction methodology in India today.

IV BUILDING CONFIGURATION:

BUILDING CONFIGURATION			"PLAN 1"	"PLAN 2"	"PLAN 3"	"PLAN 4"	"PLAN 5"
Building Length	L	m	36	43.2	50.4	57.6	64.8
Building Width	B	m	20	20	25	25	30
Building height	H	m	20	20	20	20	20
Numbers of floor	N	m	5	5	5	5	5
Floor height	H	m	4	4	4	4	4
Area	A	m^2	3600	4320	6300	7200	9720
Bay spacing along Length	L_s	m c/c	7.2	7.2	7.2	7.2	7.2
Bay numbers along Length	L_n	nos.	5	6	7	8	9
Bay spacing along width	B_s	m c/c	4	4	5	5	6
Bay numbers along width	B_n	nos.	5	5	5	5	5

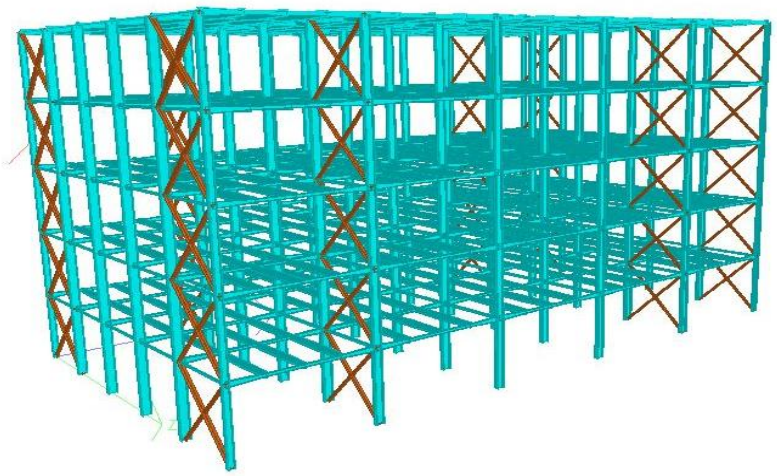

FIG X: 3D GEOMETRY OF TYPICAL BUILDING

V. LOAD DATA:

Referring to the Clause 3.2 of IS 800:2007 specifies the various loads and forces that has to be considered while performing the design of steel structures.
(a) Dead loads;
(b) Imposed loads;
(c) Wind loads;
(d) Earthquake loads;

Dead Load: (As per IS:875- part 1, 1987)

DEAD LOAD		
Floor load:-		
Deck sheet (0.8 mm thick)	0.083	kN/m^2
R.C.C Slab (100 mm thick)	2.5	kN/m^2
R.C.C Slab Corrugation (40 mm thick)	1	kN/m^2
Floor finish:-		
Floor finish	1	kN/m^2
Uniform distributed load :-		
Cladding sheet load	0.15	kN/m^2

Live Load: (As per IS:875- part 2, 1987)

LIVE LOAD		
On Typical floor:-		
Live load	3	kN/m^2
On roof floor:-		
Roof live load	1.5	kN/m^2

Wind Load: (As per IS:875- part 3, 1987)

WIND LOAD		
Location	Ahmadabad	
Wind speed	39	m/s
Building height	20	m
design life of structure	50 years	

Earthquake Load: (As per IS:1893-part 1, 2002)

EARTHQUAKE LOAD	
Location	Ahmadabad
Zone factor	III
Importance factor	1
Type of frame	SMRF
Response reduction factor	5
Type of soil	Medium

LOAD COMBINATIONS:

Load combinations for design purposes shall be those that produce maximum forces and effects and consequently maximum stresses and deformations. Combination of loads with appropriate partial safety factors as given in Table 4 of IS 800:2007 was considered.

VI ANALYSIS RESULT:

After analysis of all models structure behaviour like column reactions, beam deflection, lateral deformation checked.

BUILDING MAIN FRAME WEIGHT:

TABLE 1: MAIN FRAME WEIGHT OF CSB-250 MODELS.

	Building	Weight (Metric Tonne)	Weight / sq.m	Area (m^2)
CSB (250 MPA)	CSB_250_1	188.49	52.36	3600
	CSB_250_2	240.02	55.56	4320
	CSB_250_3	342.19	54.32	6300
	CSB_250_4	397.75	55.24	7200
	CSB_250_5	565.10	58.14	9720

TABLE 2: MAIN FRAME WEIGHT OF PEB-250 MODELS.

	Building	Weight (Metric Tonne)	Weight / sq.m	Area (m^2)
PEB (250 MPA)	PEB_250_1	153.16	42.55	3600
	PEB_250_2	202.25	46.82	4320
	PEB_250_3	271.51	43.10	6300
	PEB_250_4	308.34	42.83	7200
	PEB_250_5	415.67	42.76	9720

TABLE 3: MAIN FRAME WEIGHT OF PEB-345 MODELS.

	Building	Weight (Metric Tonne)	Weight / sq.m	Area (m^2)
PEB (345 MPA)	PEB_345_1	142.76	39.66	3600
	PEB_345_2	176.35	40.82	4320
	PEB_345_3	269.91	42.84	6300
	PEB_345_4	282.78	39.27	7200
	PEB_345_5	384.97	39.61	9720

GOVERNING LATERAL LOAD:

Here, I present one Typical model (PEB_345_01) analysis result, we are getting lateral load results as follow:-
From these results, Studied that Earthquake load is more governing compared to wind load

For example

Lateral Load	**Wind - X**	**Wind Z**
	403 kN	532 kN
	EQ-X	**EQ-Z**
	564 kN	564 kN

CHECK FOR HORIZONTAL SWAY / LATERAL DEFORMATION:

Following graphs shows the comparison of lateral force EQx & EQz in all conventional & pre engineered building. This values shown Output results from STAAD-pro for horizontal sway.

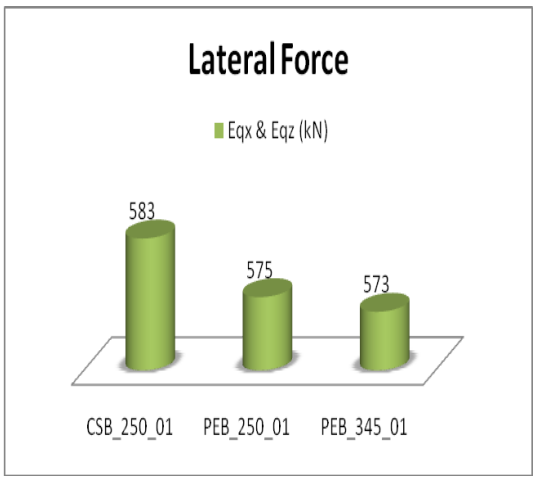

FIG 1 : LATERAL FORCE COMPARISON OF PLAN-1

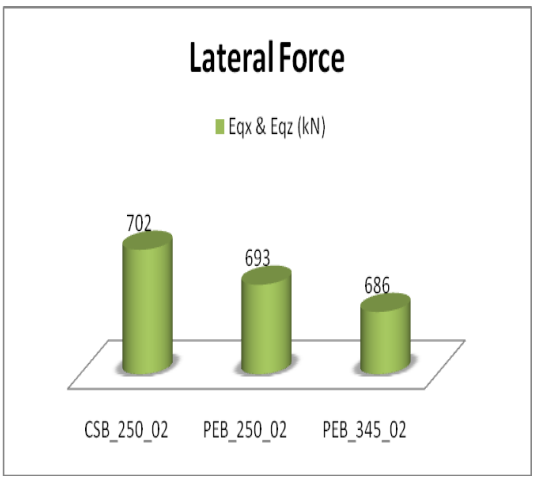

FIG 2: LATERAL FORCE COMPARISON OF PLAN-2

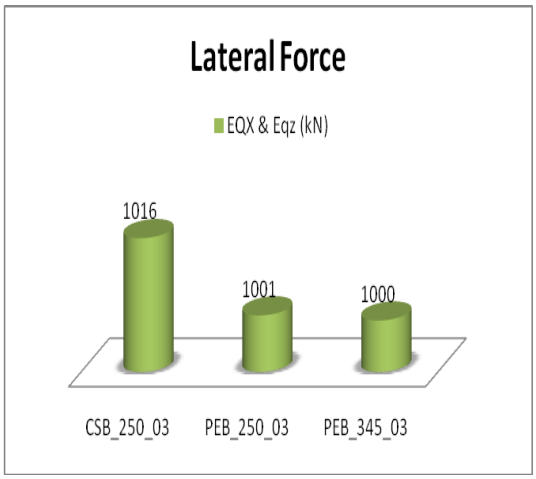

FIG 3 : LATERAL FORCE COMPARISON OF PLAN-3

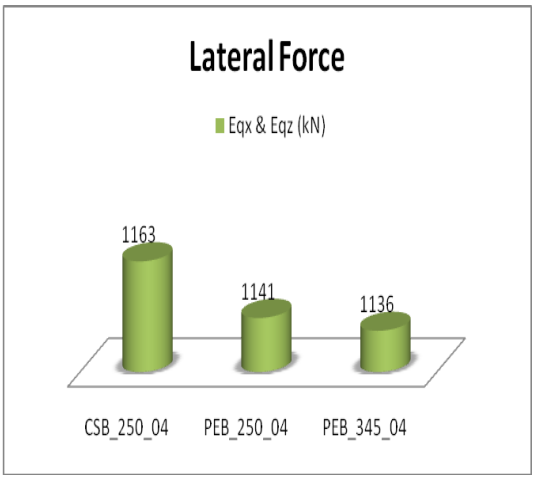

FIG 4: LATERAL FORCE COMPARISON OF PLAN-4

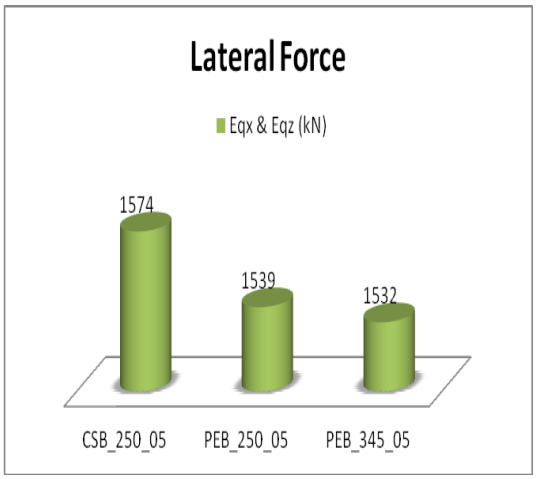

FIG 5: LATERAL FORCE COMPARISON OF PLAN-5

VII. DESIGN RESULT:

WEIGHT OF FRAME IN METRIC TONNE:

Following graphs shows the comparison of Main Frame weights includes beam, columns and connections.

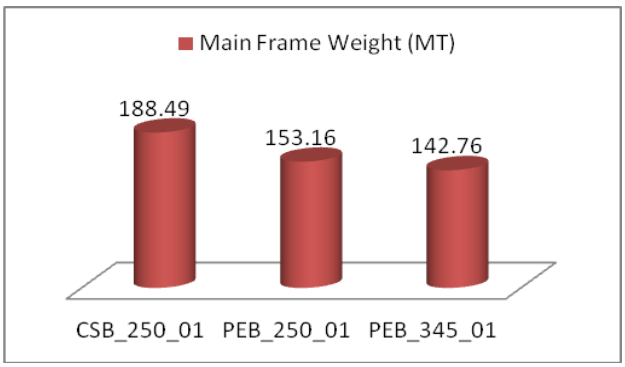

FIG 6: COMPARISON WEIGHT OF FRAME OF PLAN-1

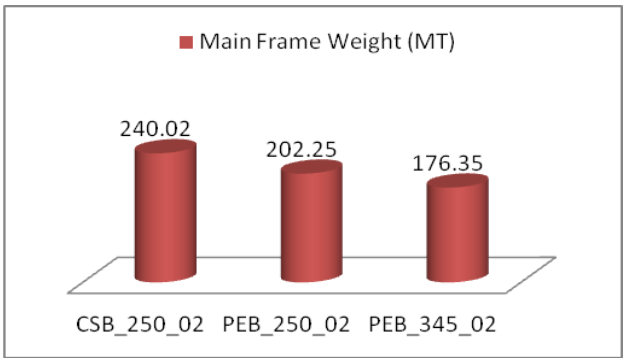

FIG 7 : COMPARISON WEIGHT OF FRAME OF PLAN -2

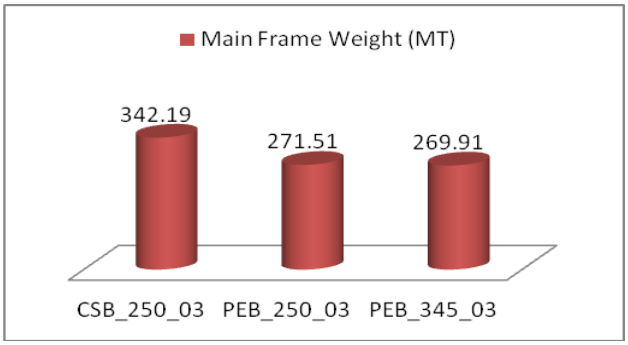

FIG 8: COMPARISON WEIGHT OF FRAME OF PLAN -3

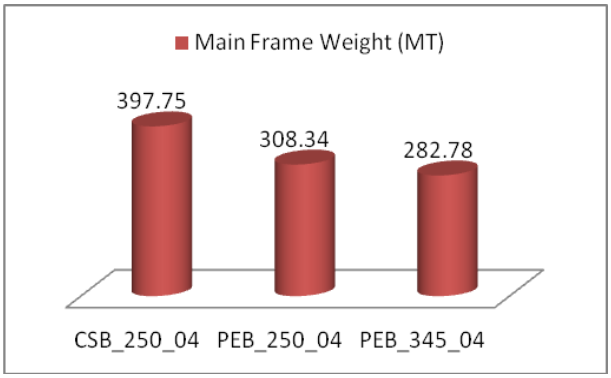

FIG 9: COMPARISON WEIGHT OF FRAME OF PLAN -4

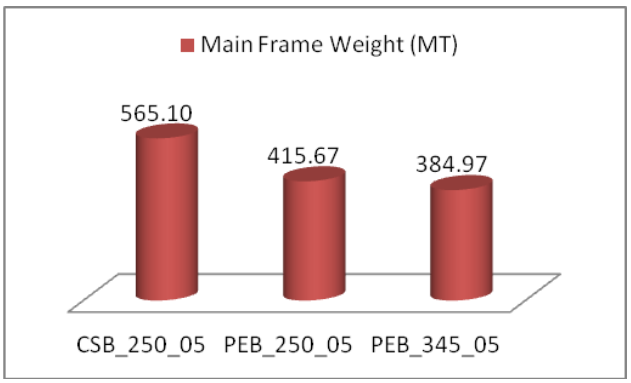

FIG 10 : COMPARISON WEIGHT OF FRAME OF PLAN -5

TOTAL WEIGHT OF BUILDING IN METRIC TONNE:

Following graphs shows the comparison of total weights of building including all building components like main Frame, deck sheet, bracings, girts, cladding & connections.

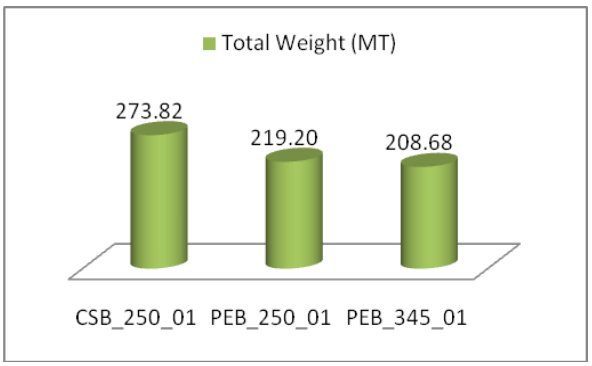

FIG 11: COMPARISON TOTAL WEIGHT OF PLAN -1

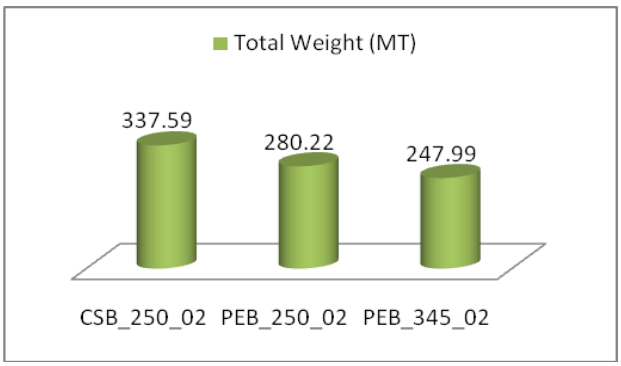

FIG 12 : COMPARISON TOTAL WEIGHT OF PLAN -2

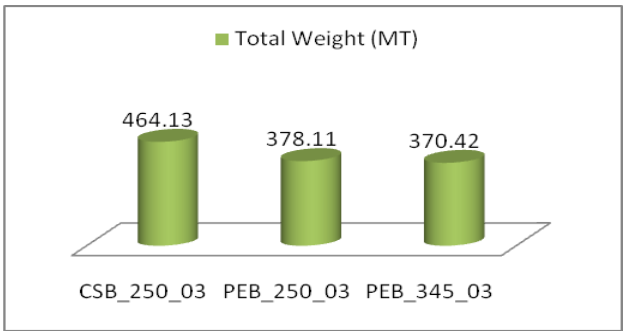

FIG 13: COMPARISON TOTAL WEIGHT OF PLAN -3

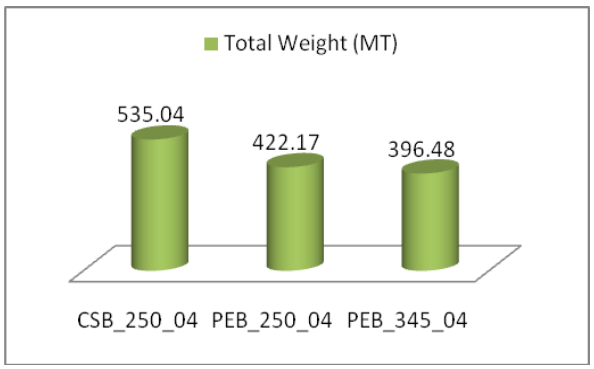

FIG 14: COMPARISON TOTAL WEIGHT OF PLAN -4

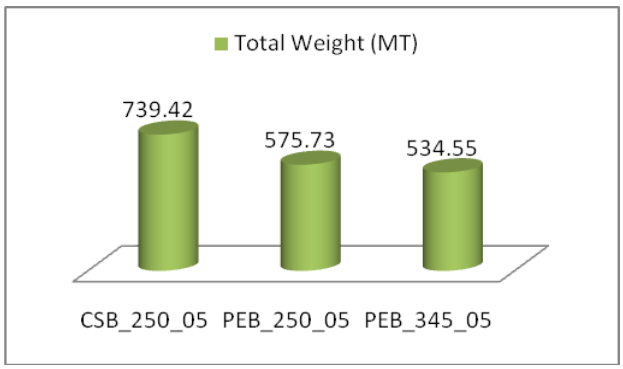

FIG 15: COMPARISON TOTAL WEIGHT OF PLAN -5

VII. CONCLUSION:

1. Weight of primary and secondary beam of PEB-345 as compared PEB-250 and CSB-250 is quite less.
2. Column reactions of PEB-345 structure in dead load (self weight) as well as earthquake acting is quite less which leads to less moment compared to CSB-250 and PEB-250, due to that R.C.C. foundation and column design were lighter.
3. We have used full section capacity in PEB-345 and PEB-250 model by keeping the cross section into the plastic ranges.
4. By keeping the material grade same in CSB-250 and PEB-250, the quantity of material used in PEB-250 is comparatively less than CSB-250.
5. During the study, we observed that the lateral force that governs in the building is Seismic force.
6. From figures 1 to 5 We conclude that lateral force are more in all CSB building compared to PEB building. & from figures 6 to 10 We conclude that the weight of main frame is comparatively less in all PEB_345 Models.

REFERENCES

[1] C. M. Meera, Pre-Engineered Building Design of an Industrial Warehouse, International Journal of Engineering Sciences & Emerging Technologies, June 2013.
[2] G. Sai Kiran, A. Kailasa Rao, R. Pradeep Kumar, Comparison of Design Procedures for Pre Engineering Buildings (PEB) International Journal of Civil, Arch, Structural and Construction Engineering 2014.
[3] D V SWATHI, "Design And Analysis of Pre-Engineered Steel Frame" OCT-DEC 2014
[4] L. Maria Subashini, Shamini Valentina, "Comparative Study of Pre Engineered an Conventional Industrial Building Economizing Steel Building using Pre-engineered Steel Sections" November 2015
[5] S.D. Charkha, Latesh S Sanklecha "Economizing Steel Building using Pre-engineered Steel Sections" April-June, 2014
[6] L. Maria Subashini, Shamini Valentina, "Comparative Study of Pre Engineered an Conventional Industrial Building Economizing Steel Building using Pre-engineered Steel Sections" November 2015
[7] Kirby Building System. Kirby Technical Manual. Kirby. January,2007.
[8] Era Group. Era Group Technical Detail. Era Building System Limited. 2007.
[9] Fedders Lloyd. P.E.B Brochure. August,2004.
[10] Zamil steel design manual. Zamil Steel Engineers Pvt Ltd. Octo-ber,2003
[11] N Subramanium (2008). Design of Steel Structure. 2008.
[12] MBMA: Metal Building Manufacturers Association-2006, Metal Building Systems Manual,.
[13] Basic Detailing Technology Manual. Blue Scope Building. January-2006.

[14] Indian Standard: 1893 (Part1); 2002. Criteria for Earthquake Resistant Design Structures: New Delhi: BIS; 2002.
[15] IS 875: Part 1 to 5 Code Of Practice For Design Loads (Other Than Earthquake) For Buildings and Structures,1st Revision, New Delhi: BIS.
[16] Indian Standard: 800 – 2007; General Construction in Steel — Code of Practice; 3rd S Revision, New Delhi: BIS.