COMPARATIVE STUDY OF STRUCTURAL DESIGN OF PRE-ENGINEERED BUILDING AND CONVENTIONAL RCC FRAMED STRUCTURE USING E-TABS FOR MULTI STORIED BUILDING TO ACHIEVE ECONOMY IN CONSTRUCTION

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Abstract - In our country reinforced concrete structures are very commonly used for conventional buildings. However, in some countries steel sections are being used for the same structures in place of concrete columns and beams in order to finish the work quickly and achieve economy and also to reduce the section sizes. In this project an attempt has been made to create two models in Etabs. One with conventional R.C.C another with PEB for a G+8 storey building for earthquake zone II. Equivalent Static Method and Response Spectrum Method are used for seismic analysis.

KeyWords: Pre-engineered Building (PEB), Conventional RCC building, Structural analysis and design, Detailing and Estimate.

1. INTRODUCTION

In today's world steel industries are grooving rapidly. Use of steel is not only concerned about economical but also about eco-friendly in situation of global warming. Here economical word directed towards considering time and cost. Time is being most crucial aspect. Pre-fabricated structure requires minimum period to time to be builted. Eg. PEB. In PE buildings, it is totally designed in the factory and it is based on design and members are pre-fabricated and then it is transported to site where they take less than 6-8 week to be installed. The structural performance of these building is well understood and for the most part adequate code provisions are currently in place to ensure Satisfactory behaviour in high winds. Steel Structures also have much better strength to weight ratio than RCC and they also can be easily dismantled. Pre- engineered Buildings have bolted and welded connections, and hence can be reused after dismantling. Thus, PE building can be shifted or expanded as per the requirement in future.

1.1 Scope

The main scope of this project is to provide theriotical knowledge in the real world by designing a multi-storied residential building both as RCC structure and a PEB structure and compare various parameter. Requirement for building purpose is large and clear area unobstructed by the columns. The large floor area provides sufficient flexibility and facility for later change in the production layout without major building alterations.

1.2 RCC BUILDING

RCC buildings are made of cement concrete reinforced by steel bars. Steel bars are provided to enhance the tension capacity to the structure. Cement concrete resists the compression but it is weak in tension, whereas in case of steel, it is good for tension but weak for compression.

1.3 PRE-ENGINEERED BUILDING

Pre-engineered buildings are those which are design and manufactured in factory. After the manufacture the components of structure are shipped to the site and are assembled. In PE building mainly I shaped members called as I beams are used. These beams are formed by welding together with steel plates in factory. Clear span between the columns, dead load, live load, wind load, earthquake effect, deflection criteria, etc. are considered for designing a PE building.

1.4 ETABS

ETABS is popular software for structural analysis used by a structural engineer globally. This software is used for model creation, structural analysis and multi-material design. It has a very user-powerful analysis and design facilities when compared with several other design and modelling software products. The software is in good compatible with all operating systems but not for Windows XP.

1.5 OBJECTIVES

The main objectives of this project are as below
1. To model the G+8 storey RCC structure and PEB structure using ETABS software
2. To carry out the RS analysis and Wind analysis for both the structures
3. To compare both the structures regarding the stability or resistance w.r.t lateral loads
4. To compare the structures regarding economy like sizes of components of structure and construction cost of the structure

1.7 METHODOLOGY

1. The first model in ETABS is done for G+8 Storied building for are modelled using conventional RCC building as for IS 1893(part-1)-2002.
2. The second model is done for PEB structures.
3. For RCC structural elements, Grade of Concrete M30 for columns and footings, M25 for beams and slabs and Grade of Steel Fe 500 are used. For PEB elements, size of beam is IS 500, IS 600 for Columns.
4. After completing analysis further designing and detailing of the RCC and Steel members is done.
5. Further cost estimation is done and comparing the cost value for RCC and PEB structures.
6. Comparison of Results and obtaining the conclusions.

2. MODELLING

2.1 CAD FLOOR & STRUCTURAL PLANS

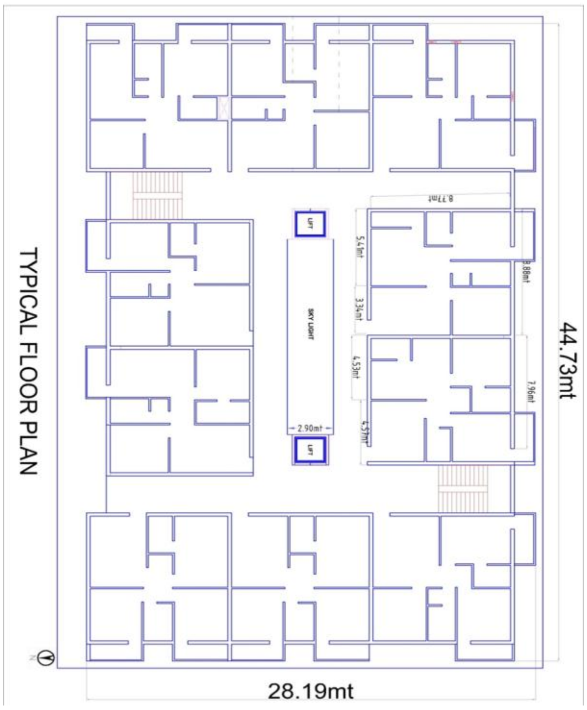


Fig - 2.1 Typical Floor Plan (Option1: RCC Structure, Option2: PEB Structure)

2.2 DESCRIPTION OF ETABS MODELS

- Model 1 = With Fixed Base for G+8 R.C.C Building
- Model 2 = With Fixed Base for G+8 PEB Building

2.3 BUILDING DETAILS

- Structure = RCC and PEB (OMRF)
- Structure Type = Plan regular structure
- Plan Dimension = As shown in the above figure
- Total Height of Building from Plinth
- (G+8 + Head Room) = 35.048m
- Height of each storey: 3.2m
- In x-direction = 10 bay of different lengths (as shown in the above figure)
- In y-direction = 9 bay of different lengths (as shown in the above figure)

2.2: 3-D View of the Whole Building, Staircase and Lift Shaft with Head Room for RCC Building

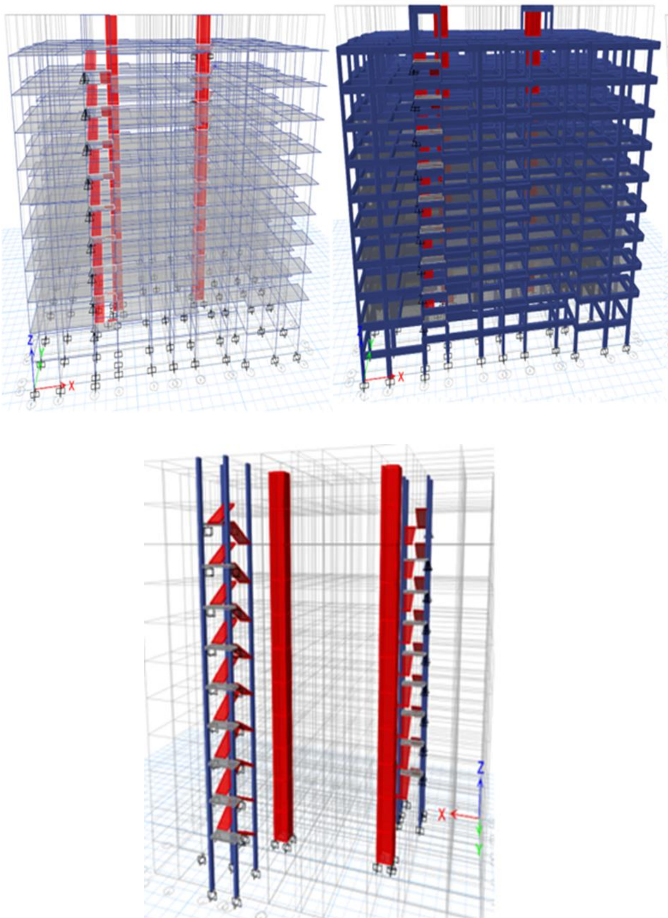


Fig - 2.2: 3-D View of the Whole Building, Staircase and Lift Shaft with Head Room for RCC Building

2.3 ELEVATIONS AT GRID-4

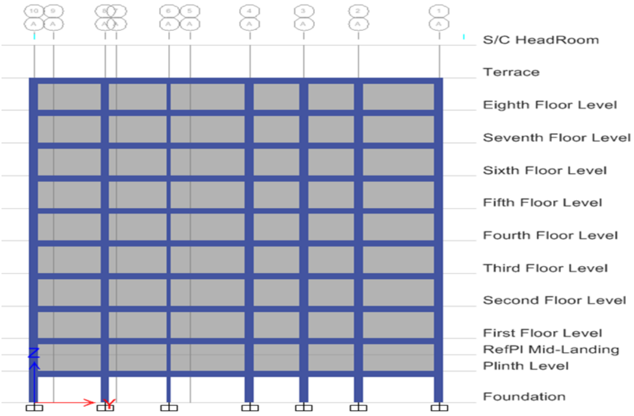
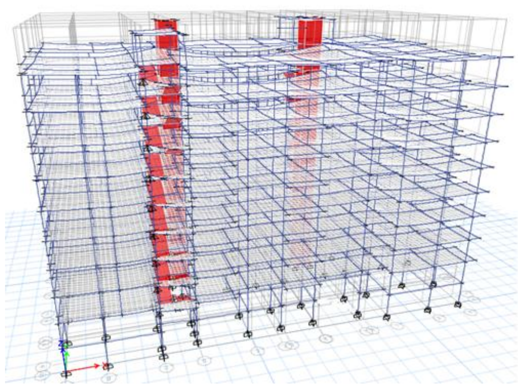


Fig - 2.3 ELEVATIONS AT GRID-4

3. ANALYSIS RESULTS

3.1 DEFLECTION SHAPE FOR 1.5(DL+LL)LOAD COMBINATIONS

3.1.1 FOR RCC BUILDING



3.1.2 FOR PEB BUILDING

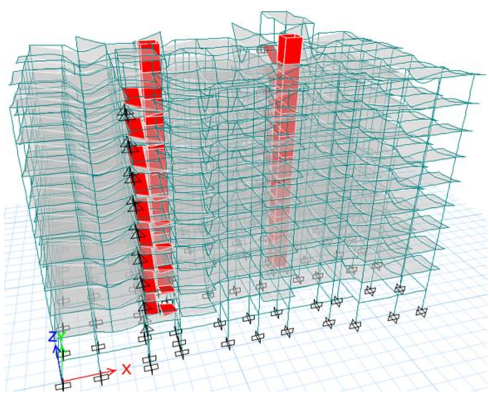
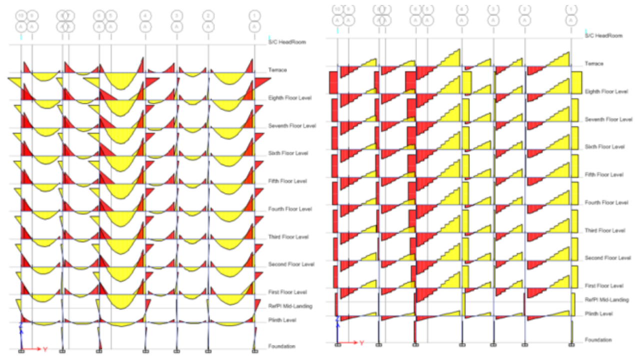


Fig 3.1: Deflection Shape for 1.5 (DL+LL) Load Combinations

3.2 BM & SF DIAGRAM FOR 1.5 (DL+LL) LOAD COMBINATIONS

3.2.1 FOR RCC BUILDING



3.2.2 FOR PEB BUILDING

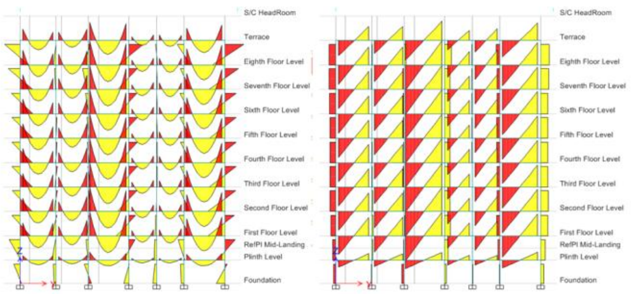


Fig 3.2: BM & SF Diagram for 1.5 (DL+LL) Load Combinations

3.3 MAXIMUM STOREY DRIFT

Table 3.1: Storey Drift in X Direction

Floor	Max Drift in X, mm	
	RCC	PEB
S/C HeadRoom	0.7	0.344
Terrace	0.282	0.109
Eighth Floor	0.174	0.052
Seventh Floor	0.105	0.026
Sixth Floor	0.047	0.017
Fourth Floor	0.032	0.015
Third Floor	0.064	0.018
Second Floor	0.103	0.024
First Floor	0.209	0.034
Plinth	0.161	0.035

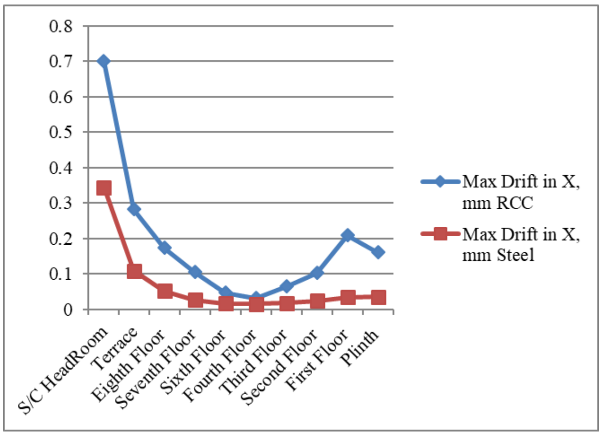
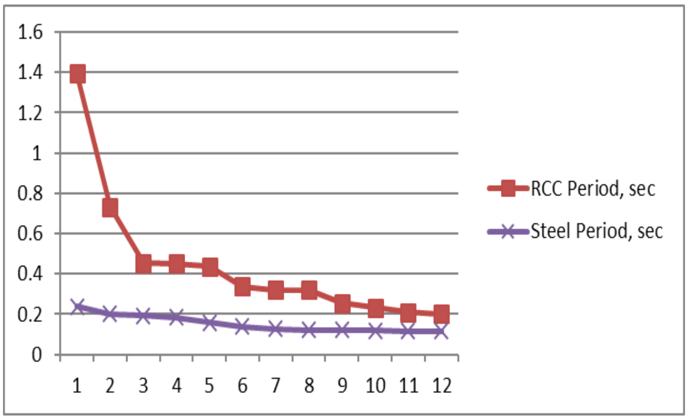


Fig - 3.3: Storey Drift in X Direction

3.4 MODAL ANALYSIS RESULTS

Table 3.2: Modal Analysis Results

Mode	RCC		PEB	
	Period, sec	Frequency, cyc/sec	Period, sec	Frequency, cyc/sec
1	1.395	0.717	0.239	4.181
2	0.731	1.367	0.202	4.955
3	0.455	2.199	0.191	5.232
4	0.45	2.222	0.184	5.432
5	0.436	2.295	0.159	6.287
6	0.337	2.97	0.138	7.268
7	0.32	3.122	0.127	7.845
8	0.319	3.131	0.122	8.164
9	0.255	3.918	0.12	8.321
10	0.231	4.321	0.117	8.575
11	0.21	4.764	0.116	8.623
12	0.202	4.943	0.116	8.638



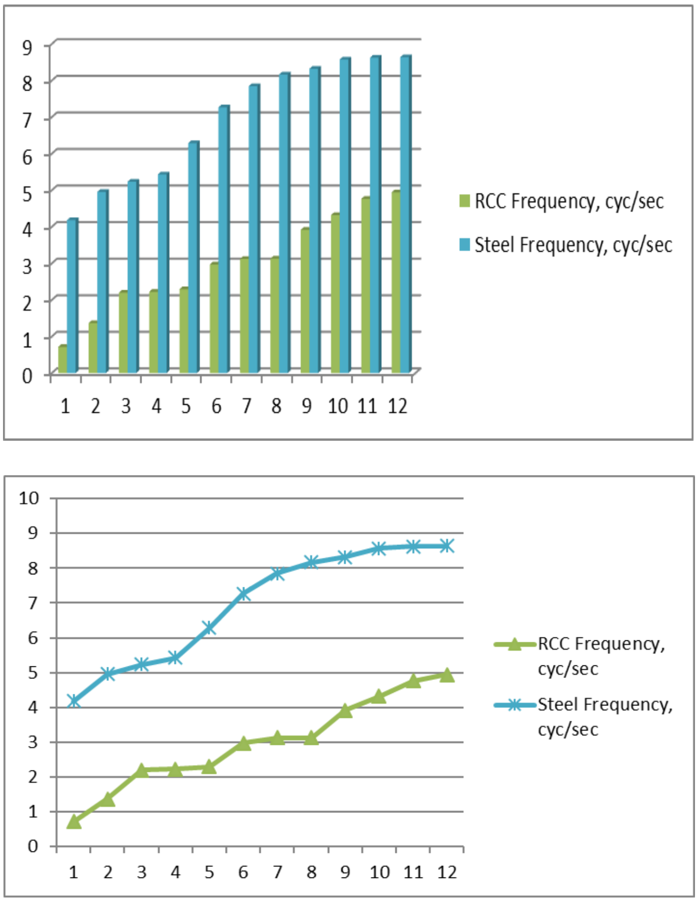


Fig - 3.4: Modal Analysis Results

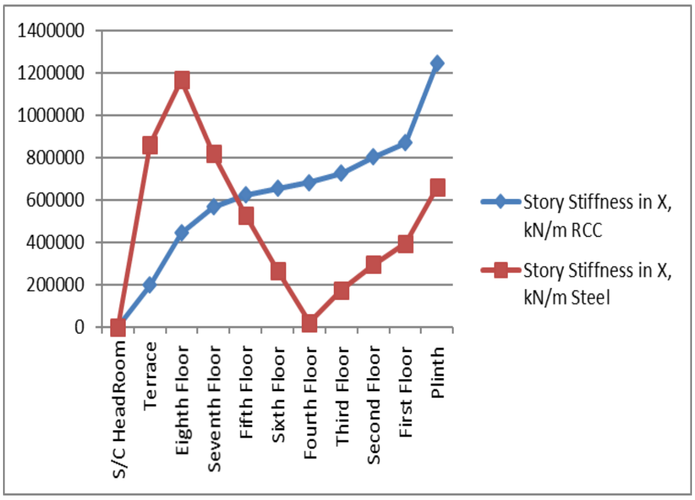


Fig - 3.5: Story Stiffness

4. DESIGN RESULTS AND DETALING

4.1 FOOTING DESIGN

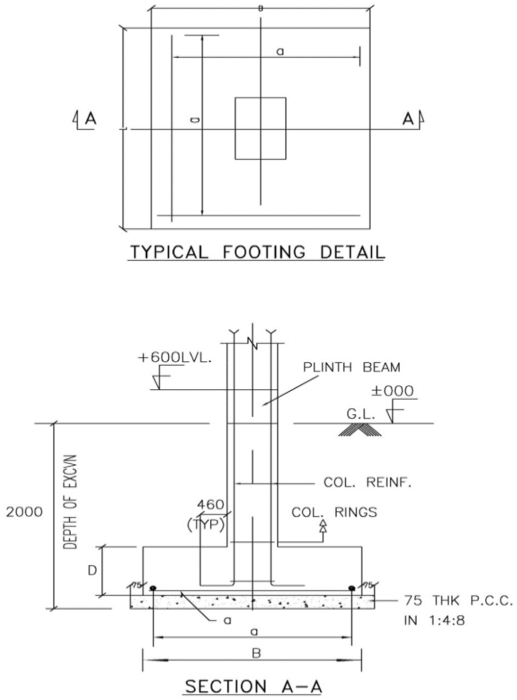


Fig - 4.1: Footing Design For RCC Building

FOOTING SCHEDULE:

ON GRID	DIMENSIONS L	DIMENSIONS B	DIMENSIONS D	REINFORCEMENT a
A-1	2.0	1.63	600	#10 @ 100 mm c/c
B-10	2.0	1.63	500	#10 @ 100 mm c/c
D-1	2.2	1.83	700	#12 @ 100 mm c/c
E-5	2.2	1.83	700	#12 @ 100 mm c/c
L-1	2.4	2.03	700	#12 @ 100 mm c/c
L-5	2.6	2.23	700	#12 @ 100 mm c/c
N-4	2.6	2.23	700	#12 @ 100 mm c/c

4.2 BEAM DESIGN

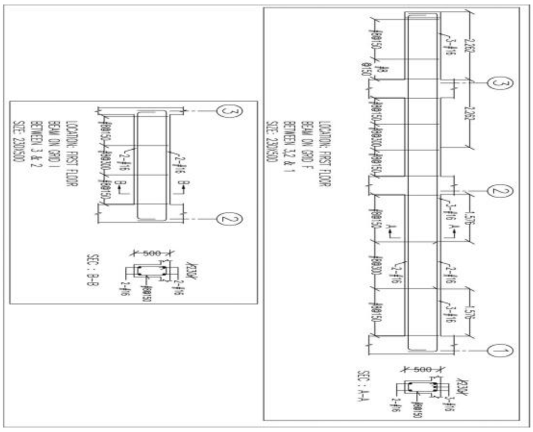


Fig - 4.2: Beam Design for RCC Building

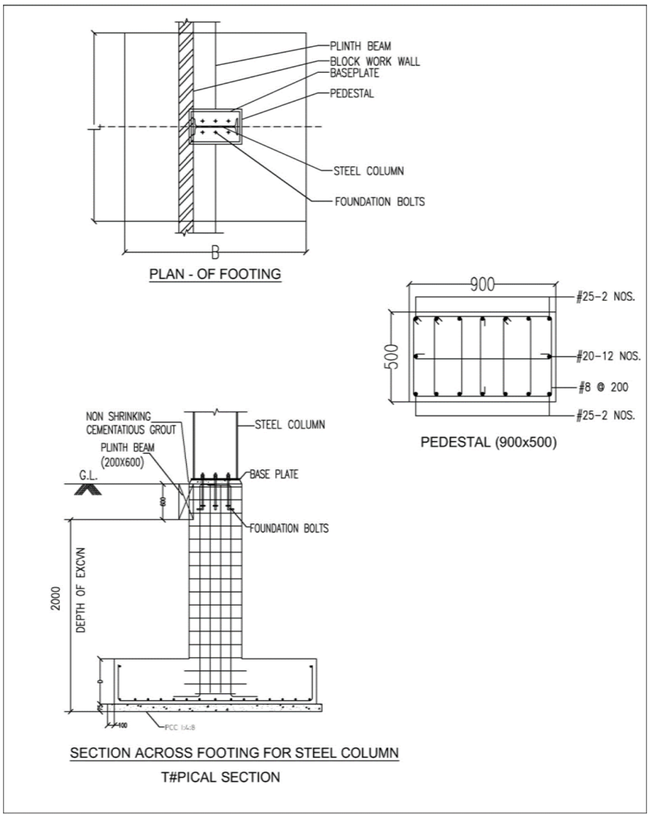


Fig - 4.3: Footing For PEB Building

FOOTING SCHEDULE:

ON GRID	DIMENSIONS L	DIMENSIONS B	DIMENSIONS D	REINFORCEMENT a
A-1	2.0	1.63	600	#10 @ 100 mm c/c
B-10	2.0	1.63	500	#10 @ 100 mm c/c
D-1	2.2	1.83	700	#12 @ 100 mm c/c
E-5	2.2	1.83	700	#12 @ 100 mm c/c
L-1	2.4	2.03	700	#12 @ 100 mm c/c
L-5	2.6	2.23	700	#12 @ 100 mm c/c
N-4	2.6	2.23	700	#12 @ 100 mm c/c

5. COST COMPARISON OF RCC AND PEB STRUCTURES

The cost of RCC structure is Rs2,89,00,000/- and PEB structure is Rs2,22,65,000/-. As compared to RCC structures there is a comparative reduction in cost by Rs66,35,000/- in PEB structures. And reduction of cost by 22.95% in PEB structures when compared to RCC structures. And from economical point of view it is better to provide PEB structures

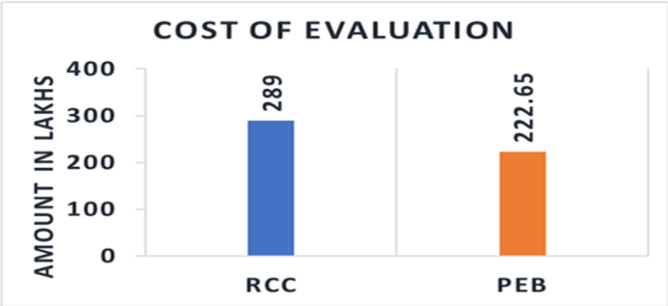


Fig 5.1: Cost comparison of RCC and PEB structures

6. CONCLUSIONS

Two models, one as a conventional RCC building and second as a PEB building for a G+8 stories were analyzed by equivalent static and Response Spectrum Method of analysis. From these models following conclusions can be made.

1. Base shear in PEB is reduced by 23% in comparison with RCC conventional building. As the base shear increases the forces in member will increase which leads to increase in the sizes of the structural members and increase in the weight of the building.

2. PEB structures can be easily provided for larger span, the weight of the element 10% lesser than conventional structures.

3. Axial Force carrying capacity of RCC structures is more than PEB structures.

4. The deflection & storey drift in PEB and R.C.C. Structures are nearly same.

5. PEB structures are more economical and better solution for long span structures.

6. When compared to RCC structure, PEB structure reduce the cost by 23%.

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