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Comparative Dynamic Analysis of RCC Framed Structure for Rectangular Columns

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ABSTRACT

In this paper, the term 'Dynamic' represent the seismic loading. The object of this study is to assess the seismic behavior of RCC Columns. The earthquake response of a symmetrical RCC Framed Structure is studied by manually and with the ETABS software. For the analysis of G+10 RCC flat scheme structure, response spectrum method recommended by IS 1893:2002 was used and structure was assumed to be situated in earthquake zone V on a medium soil (type II). The parameters evaluated were Base Shear and Displacements.

Keywords— Dynamic, RCC Columns, Response Spectrum Method, ETABS software, Base Shear

I. INTRODUCTION

Buildings in many areas of the world are susceptible to damage from moderate to severe earthquakes. In the last few years, the widespread damage to RCC structures due to Earthquake generated demand for seismic evaluation in Indian Sub-Continent. No structure can be entirely immune to damage from earthquake. Currently, there are several design philosophies in earthquake engineering, making use of experimental results, computer simulations and observations from past earthquakes to offer the required performance for the seismic threat at the site of interest.

ETABS is one of the leading design software in the market. Many design company's use this software for their project design purpose. So, this paper mainly deals with the comparative analysis of the results obtained from the analysis of a multi storey building structure when analyzed manually and using ETABS software separately. In this case, a 30.7m x 17.8m, 11 storey structure is modeled using ETABS software. The height of each storey is taken as 3 meter making the total height of the structure 33 meter. Analysis of the structure is done by Response spectrum method and then the results generated by this software are compared with manual analysis of the structure using IS 1893:2002.

In the response spectrum method, the response of a structure during an earthquake is obtained directly from the earthquake response (or design) spectrum. This procedure gives an approximate peak response, but this is quite accurate for structural design applications.

II. METHODOLOGY

A. Case:

The RCC framed G+10 symmetrical structure is considered for the study. Modeling and analysis of the structure is done on ETABS software.

B. Preliminary Data:

Length x Width	
No. of Storey	11(G+10)
Beam	300mm x 450mm
Column	300mm x 500mm
Slab Thickness	150mm
Full Brick Wall	300mm
Half Brick Wall	150mm
Support Condition	Fixed
Grade of Concrete & Steel	M25 & Fe500

C. Loadings and other Data:

The loads acting on the structure are Dead Load, Live Load, Floor Load and Wall Loads.

- L.L.= 3KN/m^2
- F.F.= 1KN/m^2
- Seismic Zone = V
- Soil Type = II
- Damping = 5%
- Response Reduction Factor = 3
- Importance Factor = 1

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III. MODELING AND ANALYSIS

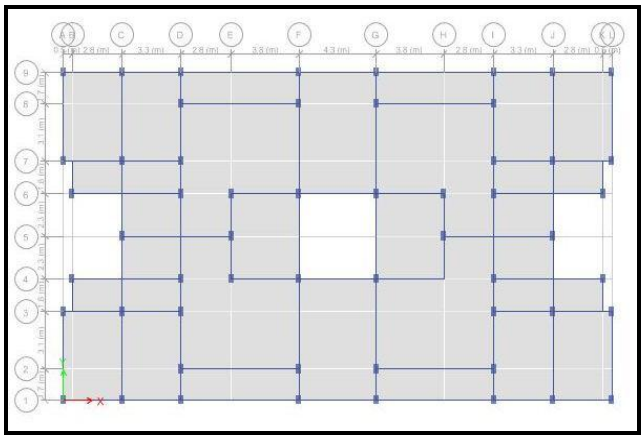


Figure 1: Plan of the Structure

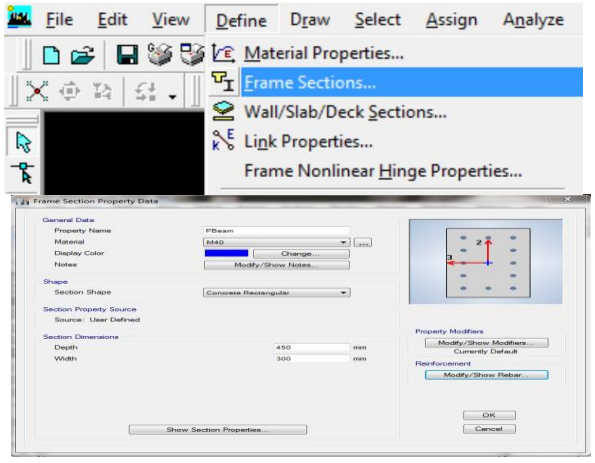
A. Dead Load Calculation:

TABLE I

Member	C/S Area (mm^2)	L or H	No.	Density (KN/m^3)	D.L. (KN)
Beam	0.3×0.45	299.2	-	25	1009.80
Column	0.3×0.5	3	56	25	630.00
Slab	401	0.15	1	25	1503.75
FBW	187.2×0.3	3	-	20	3240.00
HBW	92.8×0.15	3	-	20	835.20
				SUM	7218.75

In the calculation of seismic weight, for the Roof Floor 50% of the weight is considered for walls and columns.

DL at Roof Floor = 1009.8 + (630/2) + 1503.75 + (3240/2) + (835.2/2)
= 4866.15 KN.



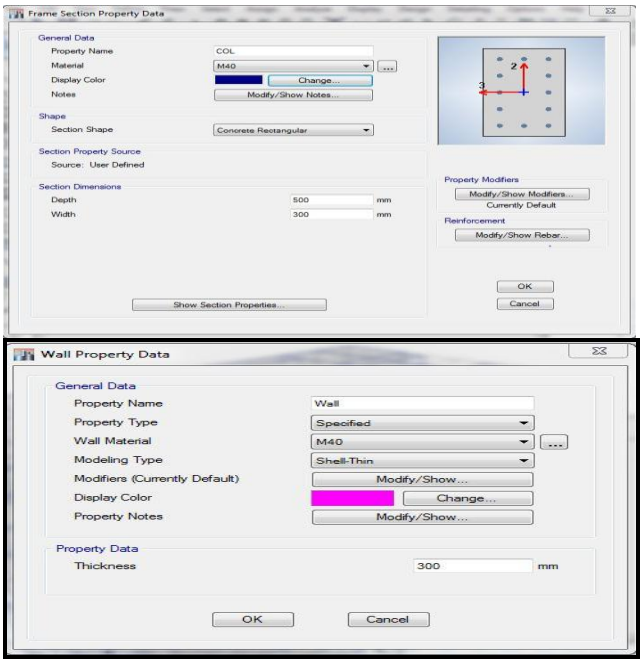


Figure 2: Procedure to model Beam, Column & Wall

B. UDL due to Parapet Wall:

Parapet wall is provided on top roof floor along the periphery of the building and also on the balcony of middle floors. Self-weight of parapet wall depends on its length on each floor.

DL at Middle Floor = 26.4 x 0.15 x 1.2 = 95.04 KN
DL at Roof Floor = 97 x 0.15 x 1.2 = 349.2 KN

Therefore total dead load of the building will be given as,

Total DL at middle floor = 7218.75 + 95.04 = 7313.79 KN
Total DL at roof floor = 4866.15 + 349.2 = 5215.35 KN

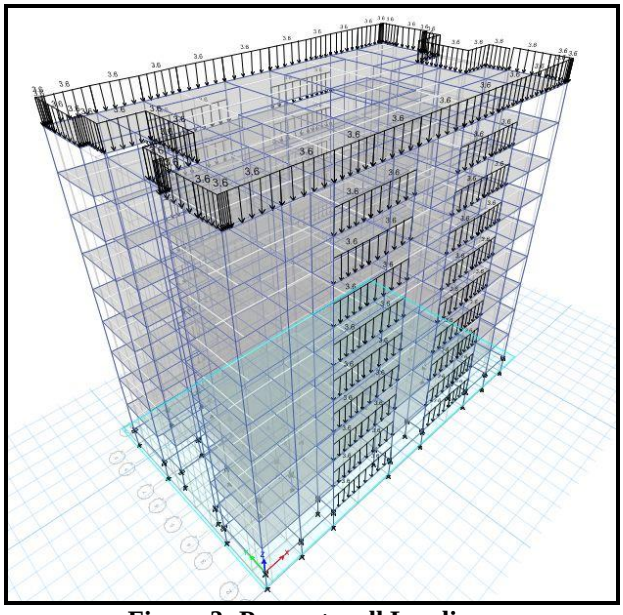


Figure 3: Parapet wall Loadings

C. Live Load on Floor Area:

As per IS 1893:2002, Clause no.7.3.1, Table no.8, actual intensity of Live Load is considered only 25% in seismic weight calculation.

25% Intensity of LL = 0.25 x 3 = 0.75 KN/m^2

25% L.L. on floor area = (352.44 – 68.92) x 0.25 x 3

= 300.75 KN

D. Load Combination:

As per IS 1893:2002, the load combination for each floor is given as DL + 25% LL.

DL = 7443.39 KN, 25%LL = 300.75 KN

DL + 25%LL = 7313.79 + 300.75 = 7614.54 KN

E. Seismic Weight Calculation:

The seismic weight is the sum of all weights including dead load and live load on each floor of the structure. Therefore,

$W_1 = W_2 = W_3 = W_4 = W_5 = W_6 = W_6 = W_7 = W_8 = W_9 = W_{10}$ = 7744.14 KN.

W_{11} = 5280.15 KN.

Total weight (W) = 10(7614.54) + 5215.35 = 81360.75 KN

IV. BASE SHEAR ANALYSIS

As per IS 1893:2002, the total design lateral force or design seismic base shear (VB) along X and Y direction shall be determined by the following expression.

$$VB = A_h \times W$$

Where,

W = Seismic Weight of the building.

A_h = Design horizontal spectrum value

$$A_h = \frac{Z\ I\ Sa}{2\ R\ g}$$

Where,

Z = 0.36, Zone Factor for V zone.

I = 1, Importance factor, It is depends on the functional use of the structure.

R = 3, Response reduction factor.

Sa/g = Average response acceleration coefficient.

The value of average response acceleration coefficient is determined from the graph given on page no.16 of IS 1893:2002.

For determination of average response acceleration coefficient, it is required to calculate time period. As per IS 1893:2002, Page No.7, time period T is given by

$$Ta = \frac{0.09h}{\sqrt{d}}$$

Where,

H= Height of the building in meter. = 33 m.

d = Base dimension of the building in meter.

a) Along X-direction

d = 30.7m, Ta = 0.536 sec,

From Graph, Sa/g = 2.5 and A_h = 0.15

VBx = 0.15 x 81360.75 = 12204.11 KN

b) Along Y-direction

d = 17.8m, Ta = 0.3039sec

From Graph, Sa/g = 1.932 and A_h = 0.1159

VBy = 0.1159 x 81360.75 = 9431.02 KN

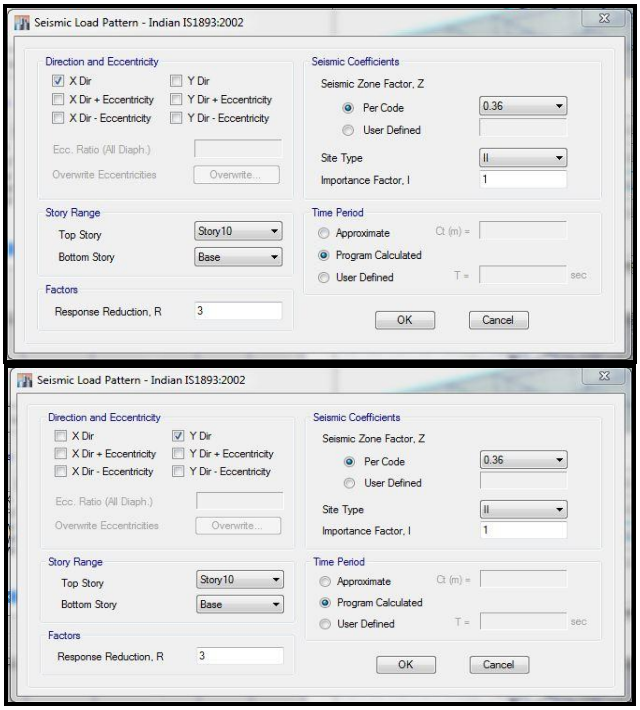


Fig 4: Window of ETABS showing IS 1893:2000 inputs Time Period, Zone factor, Soil factor, response reduction factor.

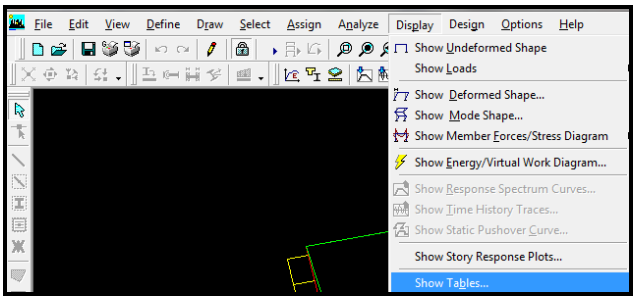
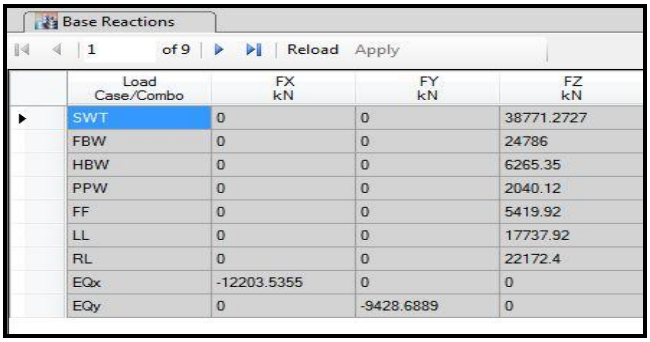


Fig 5: Procedure to display Base Shear



Load Case/Combo	FX kN	FY kN	FZ kN
SWT	0	0	38771.2727
FBW	0	0	24786
HBW	0	0	6265.35
PPW	0	0	2040.12
FF	0	0	5419.92
LL	0	0	17737.92
RL	0	0	22172.4
EQx	-12203.5355	0	0
EQy	0	-9428.6889	0

Fig 6: Results (Window of ETABS base shear value VBx and VBy)

V. CONCLUSION

From the data revealed by the manual as well as software analysis for the structures with seismic coefficient method using various loading combinations tried following conclusions are drawn:

1. Seismic analysis was done by using ETABS 2015 Ultimate 15.0.0 software and successfully verified manually as per IS 1893-2002.
2. There is a gradual increase in the value of lateral forces from bottom floor to top floor in both manual as well as software analysis.
3. Calculation of seismic weight by both manual analysis as well as software analysis gives exactly same result.
4. There is slight variation in the values of base shear in manual analysis as well as software analysis
5. Scale factor for applied loading used in X and Y direction are 3.438 and 2.04 respectively.
6. Base shear values obtained by manual analysis are slightly higher than software analysis.
7. Results as compared and approximately same mathematical values are obtained for 11-story building.
8. Complete guideline for the use of ETABS for seismic coefficient analysis is made available by this paper.
9. To conclude a complete design involving several parameters so as to result the earthquake has been done and a 3D prospective is shown for easy understanding and use.

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