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Comparative Study for Validation of Base Shear of Mono-Column Building

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ABSTRACT: Base shear is a very important parameter to be considered in the seismic analysis of buildings. Mono-column building or single column building is a building supported on one single column. This type of building needs less area for footing compared to multi-column building. The current paper deals with the calculation of base shear parameter both manually and by software for a mono-column building. The software used in this regard is ETABS. The paper compares the manual base shear value with the ETABS value and aims at validating the software for its use in the analysis field.

KEYWORDS: Base shear, Mono column building , Modelling, Validation, Shear wall, ETABS, Linear static analysis.

I. INTRODUCTION

Seismic analysis includes static and dynamic analysis. Static analysis is an important procedure in the design of a structure. Here, structure's response to exerted external forces is obtained. Base shear is one such response. Base shear is a measure of the maximum expected horizontal force on structure's base due to earthquake. So calculation of base shear is very important to analyse any structure seismically. ETABS is a popular structural software. ETABS helps in analysis and design of multi-storied building. Any software can be relied upon only after validation. Validation process involves comparison of manually calculated value of parameter with its software calculated value for the considered building model.

II. LITERATURE REVIEW

[1] Dr. K. Chandrashekar Reddy and G. Lalith Kumar (March-2019): In their paper, he studied on G+30 building using ETABS for the effect of base shear and story shear on different seismic zones. It was found that higher values were found for both in higher seismic zone than in lower seismic zone. Thus base shear plays a vital role in seismic analysis.

[2] Dipak M Kolekar and Mukund M Pawar (June-2017): In their paper they studied about base shear on multi-story building for different seismic zones using STAAD Pro. They applied earthquake load on G+3, G+5, G+7 and G+9 storey buildings for two different plan areas and seismic zones. It was observed that base shear increased with increase in number of stories and with increase from seismic zone II to V.

[3] Mohd Zain Kangda, et.al. (Feb-2015): In their paper, studied on two building plans of different plan areas with height variation 3m, 6m, 9m and 12m. STAAD Pro software was used and dynamic analysis was done. It was found that as the height and area of building increased, base shear also increased.

III. OBJECTIVES

- To model mono-column building using ETABS software.
- To calculate base shear of modelled building using ETABS software.
- To calculate base shear of modelled building manually.
- To compare and find out percentage variation between both ETABS and manual base shear values.

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IV. METHODOLOGY

- G+3 Mono-column building is modelled using ETABS software.
- Applying all required loads on the building, linear static analysis is conducted in ETABS software to find out base shear.
- Manually base shear is calculated and its value is compared with ETABS value.

V. MODELLING AND CALCULATIONS

a) MODELLING DETAILS

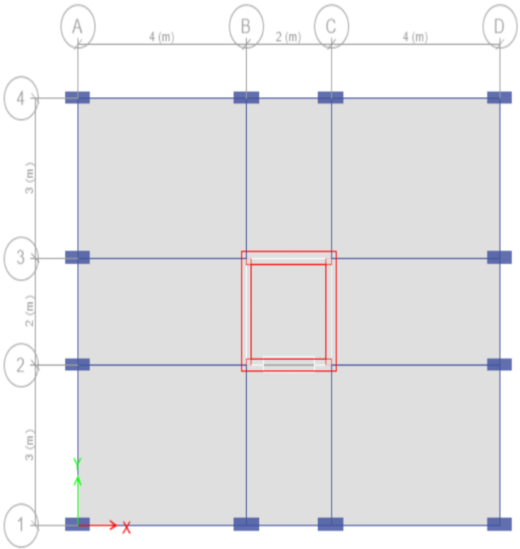

Figure No. 5.1: Plan of model

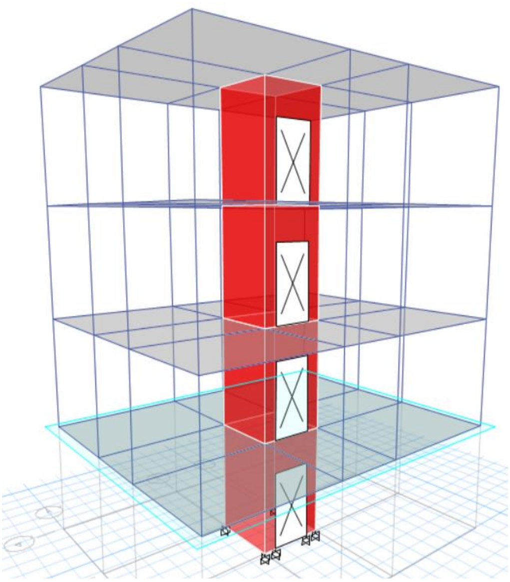

Figure No. 5.2: Elevation of model

The building model details are as follows:

- Column size= (230x600)mm
- Beam size= (230x450)mm
- Slab thickness= 150mm
- Shear wall thickness= 230mm
- Height of each story= 3m
- Total height of building = 12m
- Opening for door in shear wall= (1.2 x 2.1) m
- Density of concrete= 25kN/m^3
- Density of masonry= 20kN/m^3
- Zone factor, Z = 0.24
- Importance factor, I =1.2
- Response reduction factor, R = 3.0
- Type of soil = Type I (hard soil)
- Live load= 3kN/m^2
- Floor finish= 1kN/m^2

b) ETABS CALCULATION

Base shear obtained in ETABS is 649.475kN and is shown in the form of following table by the software:

Table No. 5.1: Base shear value from ETABS software

Load Case/ Combination	Fx (kN)	Fy (kN)	Fz (kN)
EQX	-649.4752	0	0
EQY	0	-649.4752	0

c) MANUAL CALCULATION

Manual base shear check calculations are as follows:

Total length of beam per floor =[(3.4x4)+(1.4x2)+(3.4x4)]+[(2.77x4)+(2.77x4)+(1.77x2)] = 55.7 m

Total length of column per floor= 3 x12= 36 m

Total area of slab per floor= [(3.77x2.77)x4]+[(1.77x3.77)x2] + [(1.77x2.77)x2] = 64.923 m^2

Weight of beam=55.7 x 0.23 x0.45 x25=144.123 kN

Weight of slab = 64.923 x 0.15 x 25= 243.461 kN

Weight of column = 36 x 0.23 x 0.6 x 25 = 124.2 kN

Volume of shear wall per floor =(2.23 x 0.23 x 3x 2) +(1.77 x 0.23 x 3 x 2)-(1.2 x 2.1 x 0.23) =4.9404 m^3

Weight of shear wall = (4.9404 x 25) = 123.51 kN

Weight of masonry wall = 55.7 x 0.23 x 20 x 2.55 = 653.361 kN

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Weight due to live load (take LL=3kN/m^2) on floor = 64.923 x 3 = 194.769 kN

Considering, 25% of Live load= 194.769 x (25 /100) = 48.692 kN

Weight due to floor finish on floor = 64.923 x 1= 64.923 kN

Weight of terrace slab = [64.923 + (2.23 x 2.23)] x 0.15 x 25 = 262.109 kN

Floor finish on terrace = (10.23 x 8.23 x 1)= 84.1929 kN

Total weights are,

Weight W1= Weight of (beam + slab+ (column/2)+ shear wall +masonry wall/2 +live load+ floor finish) =144.123+243.461+(124.2/2)+123.51+(653.361/2)+ 48.692+64.923 =1013.489kN

Weight W2=W3=Weight of (beam +slab +shear wall +live load +floor finish +column +masonry wall) =144.123 + 243.461 + 123.51 + 48.692 + 64.923 + 124.2 + 653.361= 1402.27 kN

Weight W4= Weight of (beam+ slab+ (shear wall/2) + live load + floor finish + (column/2) + (masonry wall/2))
=144.123+262.109+(123.51/2)+0+84.1929+ (124.2/2)+(653.361/2) = 940.9604 kN

Hence, total W=W1 +W2 +W3 +W4=<u>4758.9894 kN</u>

Data for A_h calculation are as follows:

Lateral dimension in x-direction, d_x=10 m
Lateral dimension in y direction, d_y = 8 m

A_h calculation are as follows:

Time period in x direction, T_x = [(0.09h) / ($\sqrt{d_x}$)]
=[(0.09 x 12) / ($\sqrt{10}$)]=0.341sec

Time period in y direction, T_y = [(0.09h) / ($\sqrt{d_y}$)]
=[(0.09 x 12) / ($\sqrt{8}$)]=0.381sec

(S_a/g)= 2.5 for 0 < T< 0.4 sec for hard soil according to IS 1893 (Part 1):2016

Hence, A_h= { [(Z/2) (S_a/g)] / [R/I] }
= { [(0.24/2) (2.5)] / [3/1.2] } = <u>0.12</u>

Therefore, Base Shear = V_B = A_h x W
= 0.12 x 4758.9894 = <u>571.078 kN</u>

VI. RESULTS AND CONCLUSIONS

The results of above study are:

- ETABS base shear value = 649.475 kN
- Manual base shear value= 571.078 kN
- Variation between ETABS and manual value= 12.07%

The conclusion is that since variation between ETABS and manual values is within15%, ETABS base shear value can be relied upon for its usage in realistic project.

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