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Comparative Study of Base Shear Value using Software and Manual Method

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ABSTRACT: Base shear is the expected lateral force that will act at the base of particular building when seismic ground motion takes place. We can find out the base shear using many techniques like manual method, software method. Many softwares are available(ETABS, STAAD.Pro, etc..)to find out base shear value of the building ETABS software was chosen for this purposes. This paper directs the study about how much percentage of base shear difference of multistoried building would be there between software method(ETABS) and manual method.

KEYWORDS: Manual method, Multistoried building, Lateral force, ETABS, Base shear.

I. INTRODUCTION

Base shear is the total lateral force that occur at the base of the building during earthquake or seismic motion and it is important property of the structure that we will calculate as result of structural analysis. Two methods are there to find out the base shear of the building. First one is Manual method and second on is software method. There are different softwares which is used to find out not only base shear but also widely used for seismic analysis and design of multistoried building. But we need know the how much percentage of base shear difference would be there between manual method and software method. This study mainly concentrate on how much percentage of base shear difference would be there between manual method and ETABS software method. Linear static analysis technique was used for analysis purposes in software method. Different code books like *IS875(Part-1)-1987, IS875(Part-2)-1987* and *IS1893(Part-1)-2002* were referred for this study.

II. LITRATURE REVIEW

[1] Arun et.al (2019):In this paper seismic analysis of regular and irregular(C-shape)building models were conducted using manual and software calculation method(STAAD.PRO) and results were compared to each other. For this study they took G+6 multistoried building model with different seismic zones(II, III, IV, V). From the observation they concluded that, results from the both methods were not similar to each other. And also results were more in regular models than irregular models because regular models have more dimension in between their bays.

[2] M. A Qureshi et.al (May-2018): In this paper they did the seismic study(base shear check)using both manual and software(i.e. Staad.pro)method on G+5multi-storeyed hospital building which is at different zones(II, III, IV, V)and final results were compared to each other. They stated that, manual and software method shows different results(base shear) for same models. They also determined that, Software analysis method(Staad.pro) shows 3% more seismic value(base shear) than manual method of analysis.

[3] Hardik Desai et.al (May-2016):In this paper they carried out comparison of base shear calculation of 4 story RCC building with and without infill walls in two various seismic zones(zone-III and zone-V) using *IS1893:2002(Part-1)*. From the results stated that, building with masonry wall will show higher base shear than building without infill wall. Building with larger weights i.e. building with infill walls shows higher base shear value.

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III. OBJECTIVES

- To calculate and find out the base shear of multistoried building (G+3) through linear static method using
  - ETABS software method.
  - Manual method
- Finding out the how much percentage variation is there between both methods.

IV. METHODOLOGY

- Considering the suitable sample model(16x9m grid).
- Conducting linear static method using ETABS software for sample model and obtaining the base shear.
- Obtaining the base shear value of the sample model using manual method of calculation according to *IS1893(Part 1):2002.*
- Based on results, concluding how much percentage of variation is there between both methods.

V. MODELLING AND CALCULATIONS

a) MODEL DESCRIPTIONS

In this study a (16m X 9m) rectangular grid model was considered as example model. Centre to centre distance between beam along X-direction is 4m and along Y-direction is 3m. Further details of the structural elements of the model are as follows.

- No. of story=G+3 (4-story building).
- Beam = 230mm X 450mm.
- Column = 230mm x 600mm.
- Slab= 150mm thick.
- Wall width=230mm.
- Height of building = 12000mm.
- Density of concrete = 25kN/m^3.
- Density of masonry wall = 20kN/m^3.
- Live load = 3kN/m^2.
- Floor finish = 1kN/m^2.
- Support type = Fixed.
- Seismic zone factor Z = 0.24
- Importance factor I = 1.0
- Response reduction factor R =3.0
- Type of soil = Type I (hard soil)
- Floor height =3000mm

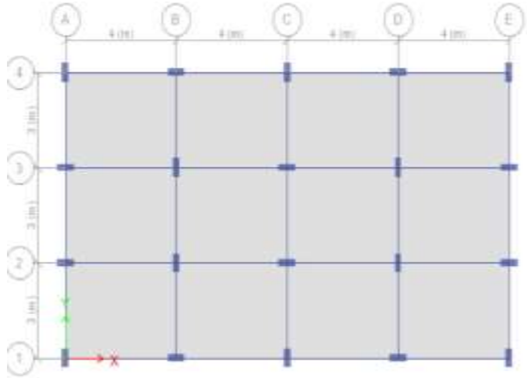

Figure No. 5.1: Plan of 16 x 9m grid.

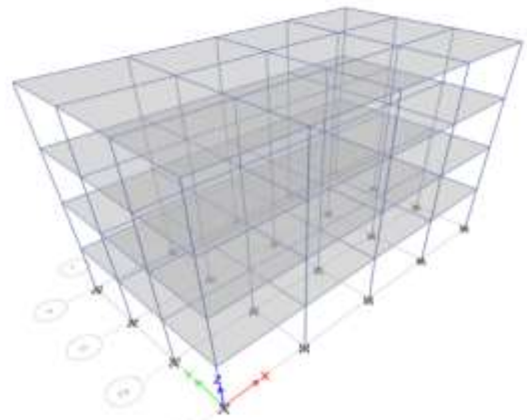

Figure No. 5.2: 3D view of example model.

b) ETABS SOFTWARE METHOD

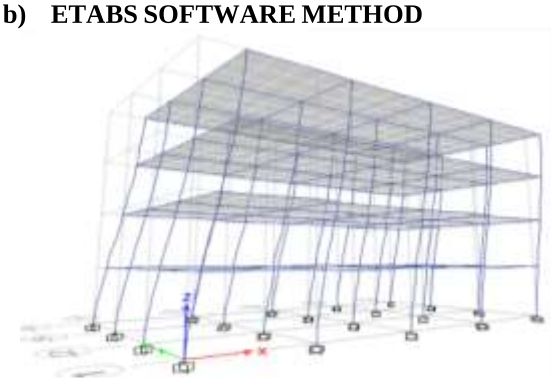

Figure No. 5.3: Analysed 3D view

Table No. 5.1 Base shear value of sample model using ETABS software.

Load Case /Combination	Fx in kN	Fy in kN	Fz in kN
Eqx	-861.7122	0	0
Eqy	0	-861.7122	0

In ETABS software linear static method of analysis was used for the analysis of sample model and base

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shear value was obtained. The obtained base shear value is 861.7122 kN.

c) MANUAL METHOD

Base shear calculation according to *IS1893 (Part 1): 2002*,

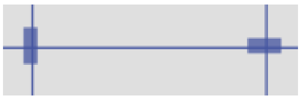
$$V_b = A_h \times W$$

Where,
V_b= Base shear in 'kN',
A_h=Design horizontal acceleration coefficient.
W=Seismic weight of the structure in 'kN'.

<u>Seismic weight of the structure (W):</u>

1) <u>X-direction</u>

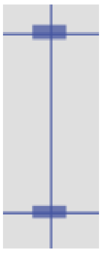
4mc/c



Length of single beam in X- direction
= [4-(0.6/2) -(0.23/2)]
= 3.585m.

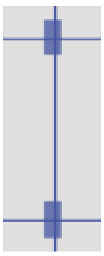
Total length of beam in X- direction
= Length of single beam x No. of beams
= 3.585 x 16 = 57.36m.

2) <u>Y- direction</u>



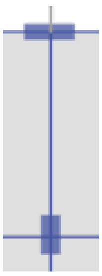
3m c/c

Length of single beam in Y-direction
= [3-(0.23/2) -(0.23/2)]
= 2.77m.



3m c/c

Length of single beam in Y-direction
= [3-(0.60/2) -(0.60/2)]
= 2.4m.



3m c/c

Length of single beam in Y-direction
= [3-(0.6/2) -(0.23/2)]
= 2.585m.

Total length of beam in Y- direction
= Length of single beam x No. of beams
= ([2.585x10]+[2.4x2]+[2.77x3])
= 38.96m.

A) Total length of beam = 57.36+ 38.96 = 96.32m.

B) Total length of column in single floor
= Column height x No. of columns
= 3 x 20
= 60m.

C) Area of single slab
= c/c beam length – beam width
= [4 - 0.23] x [3 - 0.23] = 10.443m^2.

Total area of single floor
= Area of single slab x numbers
= 10.443 x 12 = 125.316m^2.

D) {D.L} Dead load calculation:

[W_1] Weight of beam = (Width x Depth x Total length of beam x Density)
W_1 = 0.23 x 0.45 x 96.32 x 25
= 249.228 kN.
[W_2] Weight of column = (Width x Depth x Total length of column in single floor x Density)
W_2 = 0.23 x 0.6 x 60 x 25
= 207 kN.
[W_3] Weight of slab = (Thickness x Total area of single floor x density)
W_3 = 0.15 x 125.316 x 25
= 469.935 kN.

E) {W.L} Wall load calculation:
Weight of wall = (Thickness x Length of wall x Height x Density)
W.L = 0.23 x 96.32 x (3 -0.45) x 20
W.L = 1129.8336 kN.

F) {L.L} Live load calculation:
Area subjected to live load
= c/c beam length – beam width
= (4-0.23) x (3- 0.23)
= 10.443m^2.

Total area subjected to live load
= (Area subjected to live load x No. of slabs.)
= 10.443 x12 = 125.316m^2.

Live load on floor
= Live load x Total area subjected to live load.

= 3 x 125.316
= 375.948 kN.

25% of live load = 375.948 x (25/100) = 93.987 kN.

{F.F.S} Floor finish on single floor= 1 x 125.316
= 125.316kN.

{F.F.T} Floor finish on terrace = 1 x (16.23 x 9.23)
= 149.8029 kN.

(W_a)Total weight on 2nd& 3rd floor slab
= (D.L(W_1+W_2+W_3)+ L.L+F.F.S+W.L)
W_a = ((249.228 + 207 + 469.935) + 93.987+ 125.316+ 1129.8336)
W_a = 2275.2996 kN.

(W_b)Total weight on 1st floor slab
= (D.L(W_1+W_2+W_3)+L.L+F.F.S+(W.L /2))
W_b = ((249.228 + 207 + 469.935) + 93.987 + 125.316+ 564.9168)
W_b = 1710.3828 kN.

(W_c)Total weight on terrace
= (D.L(W_1+W_2 /2+W_3) + F.F.T+(W.L / 2) + (L.L =0))
W_c = ((249.228+(207 / 2)+469.935) +149.8029+ 564.9168))
W_c = 1537.3827 kN.

[W] Total seismic weight of structure
= (W_a x 2) + W_b + W_c
W = [(2275.295 x 2) + 1709.42 + 1537.379]
W = 7798.3647 kN.

Design horizontal seismic coefficient (A_h):-

$$A_h = \frac{\left(\frac{Z}{2}\right)\left(\frac{Sa}{g}\right)}{\left(\frac{R}{I}\right)}$$

Where,
Z = seismic zone factor (e.g. : 0.24 i.e. Zone IV),
I = Importance factor (e.g. :1.0),
R = Response reduction factor (e.g. : 3 i.e. ordinary moment resisting frame),
S_a/g = Design acceleration coefficient based on different soil type (Assume Hard soil),

$$T_{ax} = \frac{0.09\, h}{\sqrt{d}}$$

⇨ For X, $T_{ax} = \frac{0.09 \times 12}{\sqrt{9}} = 0.36$
For Y, $T_{ay} = \frac{0.09 \times 12}{\sqrt{16}} = 0.27$
S_a/g = 2.5 (0 < Tax or Tay <0.40s) for both x and y directions.

$$A_h = \frac{\left(\frac{0.24}{2}\right) x\ 2.5}{\left(\frac{3}{1}\right)} = 0.1$$

⇨ Base shear, $V_b = A_h$ x W
V_b = 0.1 x 7797.389
V_b = 779.8365 kN.

The base shear value of example model with help of manual calculation method is 779.8365 kN.

VI. CONCLUSIONS

From the above study it is clear that,

- Manual calculation method shows less base shear.
- ETABS software method shows maximum base shear value.
- Difference between software and manual calculation method is 81.8757kN.
- Base shear value from Software is 9.502% greater than manual method of base shear calculation.

If we compare manual method and software method, some percentage (usually within 15%) of base shear difference takes place. Thus we can trust upon software base shear values usage in allied projects.

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