A Comparative Study on Seismic Analysis of Multistory Building Resting on a Sloping Ground and Flat Ground

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Abstract—The purpose of this paper is to perform linear static analysis of medium height RC building and investigate the changes in structural behavior due to consideration of sloping ground. This project report comprises of seismic analysis of a RC building with symmetrical plan. Building G+8 is analyzed using response spectrum method on various combination of shear wall at different position of building on same slope of ground with seismic zone III and it is analyzed by using STAAD-PRO V8i. In this paper angle of ground is taken as 170 and kept same for all models. Shear wall positions are nomenclature as SW-1 and SW-2 and SW-3. As the SW-2 shows better performance as compared to SW-1 and SW-3 with different position is analyzed. In shear wall 2. Inclined from front-setback building shows better result as compared to other. As per IS 1893(PART 1):200 medium soils are used.

Key words: Base Shear, Base Moment, Absolute Displacement, Axial Force and Bending Moment (My & Mz)

I. INTRODUCTION
Seismic behavior of asymmetric building structures has become a topic of worldwide active research. Many investigations have been conducted on elastic and inelastic seismic behavior of asymmetric to find out the cause of seismic vulnerability of such structures. Seismic analysis is done as per IS 1893:2002 and obtained results are compared with another building frame.

II. MODELLING
Building with G+8 storey having plan size 48 m x 32 m with 4 m spacing along width and 6 m spacing along length are considered and it is analyzed with different combination of shear wall. Height of each storey is 3 m.

General specification of the building discuss below

<table>
<thead>
<tr>
<th>Total height of building</th>
<th>27 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of each storey</td>
<td>3 m</td>
</tr>
<tr>
<td>Column size</td>
<td>0.85m X 0.75m (at bottom of building)</td>
</tr>
<tr>
<td></td>
<td>0.65m X 0.35m (at center of building)</td>
</tr>
<tr>
<td></td>
<td>0.55m X 0.35m (at top of building)</td>
</tr>
<tr>
<td>Beam size</td>
<td>0.55m X 0.25m</td>
</tr>
<tr>
<td>Grade of concrete</td>
<td>M40</td>
</tr>
<tr>
<td>Frame type</td>
<td>OMRF</td>
</tr>
<tr>
<td>Soil type</td>
<td>Medium soil</td>
</tr>
<tr>
<td>Live load</td>
<td>3 KN/m²</td>
</tr>
<tr>
<td>Dead load of slab</td>
<td>3.75 KN/m</td>
</tr>
<tr>
<td>External wall load</td>
<td>14.25 KN/m</td>
</tr>
<tr>
<td>Internal wall load</td>
<td>8.6 KN/m</td>
</tr>
<tr>
<td>Inner wall</td>
<td>150 mm</td>
</tr>
</tbody>
</table>

Table 1: Modelling

<table>
<thead>
<tr>
<th>Outer wall</th>
<th>250 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slab thickness</td>
<td>150mm</td>
</tr>
<tr>
<td>Unit weights of Concrete</td>
<td>25 KN/Cum</td>
</tr>
<tr>
<td>Unit weights of brick work</td>
<td>19 KN/Cum</td>
</tr>
<tr>
<td>Grade of concrete</td>
<td>M30</td>
</tr>
<tr>
<td>Grade of steel</td>
<td>Fe 415</td>
</tr>
</tbody>
</table>

III. MODELS
Description of model: model without any combination of shear wall are consider as main model. Main model and different combination of shear wall is described below.

A. Main Models without Shear Wall
1) Model 1: This model shows the building resting on flat ground.
2) Model 2: This model shows the building resting on slope which is inclined from front
3) Model 3: This model shows the building resting on slope which is inclined from front with setback frame along slope.
4) Model 4: This model shows the building resting on slope which is inclined from side.
5) Model 5: This model shows the building resting on slope which is inclined from side with setback frame along slope.
6) Model 6: This model shows the building resting on flat ground.
7) Model 7: This model shows the building resting on slope which is inclined from front
8) Model 8: This model shows the building resting on slope which is inclined from front with setback frame along slope.
9) Model 9: This model shows the building resting on slope which is inclined from side.
10) Model 10: This model shows the building resting on slope which is inclined from side with setback frame along slope.
11) Model 11: This model shows the building resting on flat ground.
12) Model 12: This model shows the building resting on slope which is inclined from front
13) Model 13: This model shows the building resting on slope which is inclined from front with setback frame along slope.
14) Model 14: This model shows the building resting on slope which is inclined from side.
15) Model 15: This model shows the building resting on slope which is inclined from side with setback frame along slope.

   Position of shear wall 3 at Periphery of the building
16) Model 16: This model shows the building resting on flat ground.
17) Model 17: This model shows the building resting on slope which is inclined from front
18) Model 18: This model shows the building resting on slope which is inclined from front with setback frame along slope.
19) Model 19: This model shows the building resting on slope which is inclined from side.
20) Model 20: This model shows the building resting on slope which is inclined from side with setback frame along slope.

Following figures shows the 3D view of models

Fig. 3.1: Plan of Building
Fig. 3.2: (Model 1) Flat Building
Fig. 3.3: (Model 2) Inclined from Front
Fig. 3.4: (Model 3) Setback
Fig. 3.5: (Model 4) Inclined From Side
Fig. 3.6: (Model 5) Setback
Fig. 3.7: (Model 6) Flat Building
Fig. 3.8: (Model 7) Inclined From Front
Fig. 3.9: (Model 8) Setback
IV. RESULT AND GRAPH

From analyzing the above models, five parameters are compared i.e. base shear, base moment absolute displacement, axial force and bending moment. Results of the above mentioned parameters are shown in graphical form.

A. Base Shear

This graph shows base shear comparison along x and along z direction of all models with combination of all shear walls. Calculated base shear are found same along x and z direction.

B. Base Moment

Following graph shows the comparison of base moment along x and along z of main models with shear wall combination.
C. Absolute Displacement
Following graph shows the comparison of absolute displacement along x and along z of main models with shear wall combination.

![Absolute Displacement of all model Along X](image)

Fig. 5: shows absolute displacement comparison of all models along x.

![Absolute Displacement of all model Along Z](image)

Fig. 6: Shows absolute displacement comparison of all models along z.

D. Axial force of column
Following graph shows axial forces of all models.

![Axial force of shear wall 1](image)

Fig. 8: Shows axial forces of all models with shear wall 1.

![Axial force of Shear wall 2](image)

Fig. 9: shows axial forces of all models with shear wall 2.

![Axial force of Shear wall 3](image)

Fig. 10: shows axial forces of all models with shear wall 3.

Following graph shows the comparison of axial force of all models with shear wall combination.

![Minimum axial force](image)

Fig. 11: shows minimum axial force comparison of all models with shear wall combination.

E. Bending Moment of Column (My)
Following Fig. shows bending moment of all models along y.

![BM of main model along Y](image)

Fig. 12: shows bending moment of all main models without shear wall.
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Fig. 13: shows bending moment of all models with shear wall 1.

Fig. 14: shows bending moment of all models with shear wall 2.

Fig. 15: shows bending moment of all models with shear wall 3.

Below Fig. shows the comparison of bending moment of all models with shear wall combination.

Fig. 16: shows minimum bending moment comparison of all models with shear wall along y

F. Bending Moment of Column: (Mz)

Following Fig. shows bending moment of all models along z.

Fig. 17: shows bending moment of all main models without shear wall.

Fig. 18: shows bending moment of all models with shear wall 1.

Fig. 19: shows bending moment of all models with shear wall 2.

Fig. 20: shows bending moment of all models with shear wall 3.

Below Fig. shows the comparison of bending moment of all models with shear wall combination.
Fig. 21: shows minimum bending moment comparison of all models with shear wall along z.

V. CONCLUSIONS

- Combination with shear wall 2 shows minimum base shear as compared to other.
- Shear wall have great effect to resist lateral displacement of building as compared to main models.
- Proper shear wall position resists lateral horizontal forces to great extent.
- Base moment in the building along x and z direction are found less in shear wall 2 combination as compared to other.
- Building combination with shear wall 2 shows minimum Absolute displacement as compared to other.
- Shear wall 1 shows minimum axial forces in the column of the building as compared to other.
- Shear wall 2 shows minimum bending moment along y and along z in the column of the building as compared to other.

The building combination with shear wall 2 shows minimum results as compared to another building.

Inclined from front - setback building frame shows minimum results as compared to other building. Hence Inclined from front - setback building frame is better as compared to other.

REFERENCES