Study on Dynamic Behaviour of Shear walls with Staggered Openings in Irregular R.C. Framed Structures
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ABSTRACT
In this paper, an attempt is made to discovering the behavior of shear wall with a different pattern of openings under earthquake loads. Many buildings now a day’s have have irregular arrangements, both in plan and elevation. That courses the structures with undesirable distributions in their stiffness of the building. These unpremeditated changes in structural stiffness are courses bad impact to the buildings. The reason behind the lack of the seismic behavior of the structure is the plan irregularity or vertical irregularity present in it. The shear walls are the best and simple methods to sustain these lateral forces. And they provide required strength against seismic forces. Sometimes a shear wall may include openings due to the functional needs such as doors and windows. This study is carried out on plan irregular structures with shear wall contain staggered and regular openings. Analysis has been done to estimate the behavior of plan irregular structures when introducing the different pattern of openings in shear walls, at an advantageous position. The parameters considered are storey displacement, storey drift, storey shear and stress distributions that concern with the pattern of the openings. The dynamic analysis is carried out with the help of ETABS v 15 by using response spectrum method.

Keywords: Shear wall, Base shear, staggered opening, Regular opening, ETABS

I. INTRODUCTION
The earthquake and wind are nowadays major topic of study of structural engineering. Most of the buildings in the present days have asymmetrical configurations to satisfy architecture requirements or some other reasons. The irregularity may be plan or vertical, so that’s why the structure courses irregular distributions in their mass, stiffness and strength along the height of the building. Shear walls are the best earthquake resistance structural system used to increases the strength and sufficient amount of stiffness to concrete building. Which considerably decreases the lateral sway of the structure and so that lower the damages to the structure. By introducing shear wall the building become safe, durable and also more stable the main role of shear wall is to enhance rigidity for the lateral loads that may be induced by the effect of wind and earthquakes.

Shear walls generally beginning from the foundation level and are continuous throughout the building height. They are generally provided along both length and width of the building and are located at the sides of the buildings or arranged in the form of core. Shear walls can easily implemented at site and which also a cost effective technique to minimizing the earthquake injury. The position and size of shear walls is extremely critical. Properly designed and detailed structures with shear walls have shown good performance in past seismic actions.

Shear walls in high rise structures will be perforated with many openings that are essential for windows in external walls or corridors and door openings for internal walls. The location and size of opening depends on the role of the openings. However the size of the opening may affect the overall seismic response of the
system. The openings may arrange staggered or vertically ordered manner. In this present work attempt is made to study and investigate the RC framed different plan irregular structures by introducing staggered and regular opened shear wall on different positions. For this study G+15 buildings are considered and finding which opened shear wall is more advantageous and also their positions, by using finite element software ETAB v 15 at seismic zone V.

II. METHODS AND MATERIAL

A. Modelling and Analysis

A 16-storeyed (G+15) reinforced concrete structure with irregular plan shape “L”, “T”, and “I” with staggered and regular opened shear wall in Seismic Zone V has been considered for the current study the models are shown in figure 1 to figure 12. The shear wall having 10% opening compared to the area of wall in that storey. The structures considered for the present work is plan with 10 bays of 5m each in X-direction &Y-direction. The plan area of building is 50m×50m.

Table 1. Building Configuration:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of stories</td>
<td>16</td>
</tr>
<tr>
<td>Size of Column</td>
<td>600 x 600 mm</td>
</tr>
<tr>
<td>Size of Beam</td>
<td>300 x 300 mm</td>
</tr>
<tr>
<td>Depth Of Slab</td>
<td>150 mm</td>
</tr>
<tr>
<td>Thickness of Shear Wall</td>
<td>200 mm</td>
</tr>
<tr>
<td>Opening Size</td>
<td>140 x 120 mm</td>
</tr>
<tr>
<td>Height of each storey</td>
<td>3.5 m</td>
</tr>
<tr>
<td>Support condition</td>
<td>Fixed at base</td>
</tr>
<tr>
<td>Grade of concrete</td>
<td>M25</td>
</tr>
<tr>
<td>Grade of steel</td>
<td>Fe415</td>
</tr>
</tbody>
</table>

Table 2. Loads

<table>
<thead>
<tr>
<th>Source</th>
<th>Details</th>
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</thead>
<tbody>
<tr>
<td>Unit weight of concrete</td>
<td>25kN/m3</td>
</tr>
<tr>
<td>Dead load</td>
<td>As per structure</td>
</tr>
<tr>
<td>Live load</td>
<td></td>
</tr>
<tr>
<td>On Floors</td>
<td>4 kN/m²</td>
</tr>
<tr>
<td>On Roof</td>
<td>1.5 kN/m²</td>
</tr>
<tr>
<td>Floor finish</td>
<td>1kN/m²</td>
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</tbody>
</table>

Table 3. Seismic data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
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</thead>
<tbody>
<tr>
<td>Seismic zone</td>
<td>V</td>
</tr>
<tr>
<td>Zone factor (Z)</td>
<td>0.36</td>
</tr>
<tr>
<td>Type of soil</td>
<td>Medium</td>
</tr>
<tr>
<td>Damping</td>
<td>5 %</td>
</tr>
<tr>
<td>Response reduction factor (R)</td>
<td>5</td>
</tr>
<tr>
<td>Importance factor (I)</td>
<td>1.5</td>
</tr>
</tbody>
</table>
III. RESULTS AND DISCUSSION

A. Storey Displacement:

Storey displacement is the lateral movement of the structure caused by lateral force. Storey levels versus
displacements of models are shown in figure 13 to figure 15.

Notations:
- Staggered opened shear wall at corner (SC)
- Staggered opened shear wall at periphery (SP)
- Regular opened shear wall at corner (RC)
- Regular opened shear wall at periphery (RP)

From results it is observed that due to the presence of staggered opened shear wall, it has less displacement compared to regular opened shear wall. By comparing the position of shear wall, the staggered opened shear wall at corner will shows the less displacement compared to shear wall at periphery for all models. The results shows that I frame have higher displacement compared to other models. From the results obtain T frames shows less displacement compared to other models.

B. Storey Drift

Story drift is the displacement of one level relative to the other level above or below. The storey Level versus Storey drifts diagrams of plan shapes are shown in figure 16 to figure 18.
From the results, it is observed that the storey drift is increase in ground and first floor and from second storey itself it gradually increases and has a tendency to decrease to top storey. Model with staggered opened shear wall shows lesser drift value compared to regular opened shear wall. There is considerable reduction in drift for models with shear wall at corner. The ‘I’ shaped model shows high drift value.

C. Base Shear:

It is an estimate of the maximum expected lateral force that will occur due to seismic ground motion at the base of a structure. Figure 19 shows the plan shapes versus base shear diagram.
Figure 2: Stress distribution in shear wall with vertical openings

From the shell stress diagram clearly observed that the stress around the opening in staggered shear wall is less compared to vertically ordered opening.

IV. CONCLUSION

1. From this study obtain the position of opening cause the seismic behavior of the structure.
2. The staggered opened shear wall structures have less displacement compared to regular opened shear wall structures, can reduce 4% of displacement compared to regular opened shear wall.
3. The models with ‘T’ shape plan perform better in controlling displacement value, with least storey drift when compared to other irregular models.
4. By comparing the position of shear wall, the staggered opened shear wall at corner can reduce 10% displacement compared to shear wall at periphery for all models.
5. The staggered opened shear wall at corner shows lesser drift value compared to shear wall at periphery.
6. The I shaped model shows high displacement and drift compared to other models.
7. The base shear is found to be much lesser for shear wall with staggered openings compared to regular opening.
8. The base shear is less for ‘T’ shaped plan structure and more for ‘I’ shaped structure.
9. And the base shear is less for shear wall at periphery of the structure.
10. Shell stress around the staggered openings is 18% less when compared with the stress around the vertical ordered opened shear wall.
11. Thus the staggered openings in shear wall shows highly advantageous and they were provide better lateral resistance strength to the structure compared to regular opened shear wall.
12. The structure with irregularity when provided with shear wall, the overall performance is enhanced. Especially the shear wall provided at corner will perform better in resisting lateral load in high rise structures.

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VII. REFERENCES

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