Seismic Response of Podium Type Building considering Static and Dynamic Analysis
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Abstract—Podium building is very beneficial type of building in terms of residential as well as commercial. In podium type building up to 3 or 4 floors commercial shops are constructed and after third or fourth floor plan area is reduced and residential flats are constructed. As the lateral stiffness of building suddenly changes the buildings are severely affected in earthquake. So, in this paper podium type building is compared with normal building by applying time history of different Indian earthquakes and response of the building is studied.

Key words: podium type building, time history analysis, dynamic analysis

I. INTRODUCTION

In the normal buildings the plan area is kept constant at all the floors. But in podium type building the plan area at lower storey is higher than in the upper stories. Public podium is a community that serves a variety of users including building tenants and visitors and members of the public. With respect to business point of view or real estate podium building is more profitable than other type of building.

Due to increasing of population, shortage of supply in land, and centralized service requirements, modern cities often needs many tall buildings. Some of tall buildings are built as a tower structure with a large podium structure to achieve large open space for parking, shops, restaurants, and hotel lobby at the ground or lower levels.

It is well known that Podium and Tall type buildings play very important roles in modern cities. First of all, tall buildings can be effectively used to meet the requirements of modern society and solve the problem of limitation of construction site resources. On the other hand, they are the signals of economic properties and civilization.

But structurally if these buildings are subjected to earthquake forces they are very weak at the level, where the plan area suddenly changes. So, we have compared podium building with normal buildings and response of structure due to earthquake has been studied.

II. STRUCTURAL MODELLING

Three dimensional space frame analysis is carried out for three different configurations of buildings under the action of seismic load. In the first case, building is simple tall building as shown in fig.1. While in the second case, podium structure is considered at centre as shown in fig.2 and in third case, podium structure is considered on left side as shown in fig.3. Buildings have been analyzed for seismic loads including static and dynamic analysis. Dynamic response of these buildings, in terms of base shear, fundamental time period and top floor displacement is presented, and compared within the considered configuration as well as with other configurations.
The following data has been considered in analysis:

- Height of storey: 3 m
- Grade of concrete: M20
- Modulus of elasticity: 25000 N/mm²
- Poisson's ratio: 0.20
- Soil type: II
- Importance factor: 1.0
- Damping: 5%
- Response Reduction Factor: 3.0
- Live load: 3 kN/m² for all typical floor
- Lateral load: Earthquake load as per IS:1893-2002
- Geometrical properties of members (Beam & Column) for different buildings are in the following table:

<table>
<thead>
<tr>
<th>Building Configuration</th>
<th>Size of Beam</th>
<th>Size of column</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple</td>
<td>300 x 500</td>
<td>400 x 500</td>
</tr>
<tr>
<td>Center Plaza</td>
<td>300 x 500</td>
<td>400 x 500</td>
</tr>
<tr>
<td>Left</td>
<td>300 x 500</td>
<td>400 x 500</td>
</tr>
</tbody>
</table>

In addition to this time history of Bhuj, Chamoli and Uttarkashi earthquake has been applied on all buildings and response of the building is studied.
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III. RESULTS AND DISCUSSIONS

DEAD/LIVE LOAD

![Dead/live load diagram](image1)

Fig. 7: dead/live load

BASE SHEAR FOR DIFFERENT BUILDING

![Base shear diagram](image2)

Fig. 8: Base shear for different building

B.M. FOR DIFFERENT BUILDING

![B.M. diagram](image3)

Fig. 9: B.M. for different building

MOMENT IN COLUMN

![Moment in column diagram](image4)

Fig. 10: Moment in column

SHEAR IN COLUMN

![Shear in column diagram](image5)

Fig. 11: Shear in column

IV. RESULTS AND DISCUSSIONS

Based on the results and observations of various geometries of buildings static and dynamic analysis are done and the following points were observed considering only seismic forces:

III.

<table>
<thead>
<tr>
<th>Geometry</th>
<th>Dead</th>
<th>Live</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>263,391.676</td>
<td>179,318.948</td>
</tr>
<tr>
<td>Centre</td>
<td>139,635.87</td>
<td>92,513.447</td>
</tr>
<tr>
<td>Left</td>
<td>143,619.952</td>
<td>98,219.561</td>
</tr>
</tbody>
</table>

IV.

- Normal: 92, 74, 54, 27, 5, 3.5
- Centre: 161, 134, 118, 80, 57, 30
- Left: 58, 37, 21, 28, 42, 61
(1) In the case of normal building the dead and live load is higher than plaza building but dead and live load is approximately same for centre and left plaza building.

(2) As the mass of building is more in normal building we are getting very high base shear in plaza type building.

(3) The static and dynamic participation factor for all building is more than 90 percentages so we are satisfying the clauses given in I.S. 1893-2002.

(4) The time period in first mode is higher for regular building because it has more mass while time period for centre plaza building is higher than left side plaza building, and after mode 6 time period is almost same for all the buildings.

(5) In case of plaza building as mass is distributed unequally at all floors we are getting torsion modes in dynamic analysis of building.

(6) We are getting approximate same value of base shear by static and response spectrum analysis but for plaza type building the base shear is different in static and dynamic method so we must use dynamic method for unsymmetrical buildings.

(7) We are getting highest value of base shear in time history analysis for Bhuj earthquake which is approximately 6 times higher than static base shear so we must perform response spectrum or time history analysis for irregular buildings like plaza buildings.

(8) As the mass of building is higher in normal building compared to plaza building, though bending moment in the bottom columns due to earthquake is higher in the centre plaza building and left plaza building compared to normal building. The reason is that lateral stiffness of building is suddenly changes and in plaza building the lateral stiffness of building reduces in higher floors.

(9) From figure: 9, we can say that outermost column of plaza building is very severely affected in earthquake and bending moment due to earthquake is 2 times higher compared to normal buildings.

(10) In case of left side plaza building the top floors are at left side so torsion is developed in building and shear force and axial force due to earthquake is higher at upper columns compared to normal buildings.

(11) Deflection at top building is more in Time history analysis than Static and Response spectrum Analysis.

(12) For plaza type buildings higher deflection occurs than regular buildings.

(13) The magnitude of Earthquake i.e., time history analysis of Bhuj earthquake gives higher deflection at top of the building.

V. CONCLUSION

So from above we can conclude that though the mass of plaza type building is less than the normal buildings it is severely affected in the earthquakes due to sudden change in lateral stiffness at plaza level so we must avoid this type of buildings. Or the outer columns of plaza building must be properly designed to avoid worst effects of sudden change in lateral stiffness of buildings.

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