Analysis & Design of G+5 Residential Building with Seismic Load Using Staad.Pro

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Abstract - The principle objective of this project is to analyze and design a [G + 5 (3 dimensional frame)] residential building with seismic load and analyzing it under different earthquake zones in India using STAAD.Pro. The design involves load calculations and analyzing the whole structure by STAAD.Pro. The design methods used in STAAD.Pro analysis are Limit State Design conforming to Indian Standard Code of Practice.

I considered a 3-D RCC frame with the dimensions of 4 bays @5m in x-axis and 3 bays @5m in z-axis. The y-axis consisted of G + 5 floors. Floors had a height of 3m. The structure was subjected to self weight, dead load, live load, and seismic loads under the load case details of STAAD.Pro. Seismic load calculations were done following IS 1893-2002/2005. The materials were specified and cross-sections of the beam and column members were assigned. The supports at the base of the structure were also specified as fixed. Then STAAD.Pro was used to analyze the structure and design the members. In the post-processing mode, after completion of the design, I can work on the structure and study the bending moment and shear force values with the generated diagrams. I may also check the variations in quantities of concrete & steel required in each zone. The design of the building is dependent upon the minimum requirements as prescribed in the Indian Standard Codes.

Keywords: Analysis & Design of G+5 Residential Building, Seismic Load, Staad.pro, Zone.

1. Introduction

In modern times many multi-storey buildings in cities are in high demand owing to increase in population in one hand and limited available space in the country in general and cities in particular on the other hand. Recent advances in the technology are also encouraging us to go for multi-storey buildings. Such multi-storey buildings demand for extra safety while its construction as well as its performance after it has been constructed. Severe earthquakes occur relatively infrequently. Although it is technically possible to Design and construct buildings for these earthquake events, it is generally considered Uneconomical and unnecessary to do so. The seismic design is performed with the Anticipation that the severe earthquake would cause some damage, and a seismic Design philosophy on this basis has been developed over the years. The goal of the seismic design is to limit the damage in a building to an acceptable level.

My project involves analysis and design of multi-storied [G + 5] residential building with seismic load using a very popular designing software STAAD Pro. I have chosen STAAD Pro because of its following advantages:

- It is easy to operate, fast and 99% accurate result is obtained.
- Conformation with the Indian Standard Codes,
- Versatile nature of solving any type of problem,
- Accuracy of the solution.

STAAD.Pro has a very interactive user interface which allows the users to draw the frame and input the load values and dimensions. Then according to the specified criteria assigned it analyses the structure and designs the members with reinforcement details for RCC frames. The design of the building is dependent upon the minimum requirements as prescribed in the Indian Standard Codes. The minimum requirements pertaining to the structural safety of buildings are being covered by way of laying down minimum design loads which have to be assumed for dead loads, imposed loads, and other external loads, the structure would be required to bear. Strict conformity to loading standards recommended in this code, it is hoped, will not only ensure the structural safety of the buildings which are being designed.

2. Methodology

The basic methodology followed during the course of the study is as follows. Firstly, a G+5 building was planned. In the earthquake analysis along with earthquake loads, vertical loads are also applied. For the earthquake analysis, IS 1893-2002/2005 code was used. The seismic definitions for particular zone (zone-II) were specified and the building was modeled and analyzed in STAAD.Pro.V8i. The main members of the building- columns and beams were designed as per the respective standard. Same process is performed for remaining three zones.
(zone-III, IV & V) once the design was completed, the seismic performance of the building was checked and required quantities of steel & concrete is compared for each zone.

**Structure data-**

- Total length: 20m. Number of bays along length are 4.
- Total width: 15m. Number of bays along width are 3.
- Height: 18m. Number of bays along height are 6.
- Wall thickness- 300mm
- Column size- 0.6m*0.3m
- Beam size- 0.5m*0.45m
- Thickness of slab- 0.2m
- Floors- G.F. : + 5 Upper floors
- Ground floor height- 3m
- Each storey height- 3m
- Wall load- 16.965 kN/m²
- Live load- 2 kN/m²
- Type of soil- Medium Soil as per IS-1893:2002(part-1)

**3. Result**

<table>
<thead>
<tr>
<th>Earthquake Zone</th>
<th>Volume Of Concrete (Cu.m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone-II</td>
<td>267.6</td>
</tr>
<tr>
<td>Zone-III</td>
<td>266.5</td>
</tr>
<tr>
<td>Zone-IV</td>
<td>244.9</td>
</tr>
<tr>
<td>Zone-V</td>
<td>226.5</td>
</tr>
</tbody>
</table>

1. **VOLUME OF CONCRETE FOR THE TOTAL BUILDING FOR EARTHQUAKE DESIGN:**

The total quantity of the concrete for the building has shown in table 1, for the entire earthquake zones:

![Fig 1. 3D View Of Whole Structure](image1)

![Fig 2. Whole Structure Subjected To Live Load](image2)

![Fig 3. Structure Subjected To Earthquake Load In +Ve X-Direction](image3)

![Fig 4. Structure Subjected To Earthquake Load In +Ve Z-Direction](image4)

![Fig 5. Volume of concrete in all the earthquake zones](image5)
2. QUANTITY OF STEEL FOR THE TOTAL BUILDING FOR EARTHQUAKE DESIGN:

The total quantity of the steel for the building has shown in Table 2, for the entire earthquake zones:

<table>
<thead>
<tr>
<th>Earthquake Zone</th>
<th>Weight of steel (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone-II</td>
<td>22.650</td>
</tr>
<tr>
<td>Zone-III</td>
<td>25.517</td>
</tr>
<tr>
<td>Zone-IV</td>
<td>25.926</td>
</tr>
<tr>
<td>Zone-V</td>
<td>27.162</td>
</tr>
</tbody>
</table>

Fig6. Quantity of the steel in all the earthquake zones

4. Conclusion

1. The weight of steel in edge columns increases in each level. Having minimum area of steel in ground level to higher area of steel in top level.
2. The support reactions in exterior columns and in edge columns increasing in seismic Zones II to V. However the variations of support reactions are very small in interior columns.
3. The volume of concrete in exterior and edge column footings is increasing in seismic zones III, IV and V due to increase of support reactions.

Acknowledgements

I would like to thank the authors of various research articles that were referred during this work.

References


