Comparative Analysis of Structure with and without Seismic Load

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Abstract
Engineers are mostly adopting complex non-linear methods to research multi-storey residential apartment structure to withstand earthquake forces. This paper uses much simpler Equivalent Static method to analyse G+5 storey structure to repel earthquake forces using Staad pro software. The seismic analysis is further compared with non-seismic analysis of an equivalent structure using dead load + super load combination. It had been observed that the seismic results obtained consisted of significantly increased maximum moments and shear forces than the non-seismic analysis. From past earthquakes it is proved that many of structure are completely or partly broken because of earthquakes. So, it’s a necessity to figure out unstable responses of such structures. The main aim of the present work is to make a comparative study of seismic and non-Seismic structure. The analysis was performed as per the specification of IS codes IS 1893, IS 875, IS 456:2000.

Keywords- axial force, bending moment, earthquake, Loads, Non-seismic, shear force, Seismic.

1. Introduction
An earthquake is considered a natural disaster. Many people die every year as a result of failure of structure caused by earthquakes. For example the magnitude of 7.8 earthquakes on the Richter scale struck on April 16, 2016. It killed more than 650 people with structures that collapsed hundreds of miles from the epicentre where the actual earthquake occur. Damage to structures can be minimized by adopting earthquake-resistant design principles. This paper presents a comparative analysis of the G+5-storey residential structure between a non-earthquake analysis (with dead and live loads)[10] and an earthquake analysis (with dead, living loads and earthquakes). Earthquake response to a structure can be achieved by using direct, non-linear, vertical, dynamic analysis. The various methods of seismic analysis include (i) Fixed Equilibrium Evaluation, (ii) Response to Analysis Issues, (iii) Linear Dynamic Analysis, (iv) Static Linear Analysis and (v) Dynamic Nonlinear Analysis also known as Pushover Analysis. This paper uses Equivalent Static Analysis to determine the seismic response of a G+5-storey residential structure.[11] The analysis was performed using software Stad pro. First the structure is modeled and then a combination of different loads is provided. The load combination that provides the critical value is considered for comparison.[9]

2. Objective of the work
To determine the effect of seismic and non-seismic loads on same structure.
3. Methodology

4. Structure Data
The investigation of G+5 is accepted out using STAAD.pro[15] software for ordinary moment resisting frame situated in zone II. Table 1 contains the plan range, beam dimension, column dimension, slab wideness, the tallness of the structure. Seismic parameters such as Seismic Zone, Zone factor, Importance factor, Response Reduction factor, Soil type are measured as criteria for earthquake resistant design of structures as per IS 1893-2002[12] The properties of the structure and its components are given below. The prototype was generated in commercial software STAAD.pro.[13] Different load cases is taken like dead load, live load, and earthquake load[14] are applied to the structure. Table I gives the information about detailed plan details.

| Table 1 Plan Details |
|----------------------|
| Plan Area(Structure) | 106.50m² |
| Column Size          | 350x350mm |
| Beam Details         | 350x300mm |
| Slab Thickness       | 125mm |
| Utility of structure | Residential Structure |
| Height of structure  | 18m |
| Type of construction | RCC Frame structure[2] |
| Grades(concrete,steel)| M25, Fe415 |
| Seismic Zone         | II |
| Zone Factor          | 0.1 |
| Importance factor    | 1 |
| Response Reduction factor | 3 |

Table.1 shows the Details of components Used for construction of Structure.

Fig1. Structure Plan

Fig2. 3d View of Structure
Fig1. Shows Plan is framed in AutoCAD and STAAD.PRO software in order to analyse the respective structure. Fig.2 shows Elevated view of structure.[8]

Fig3. Loads acting on structure.
Fig4. Loads seismic acting on structure.

Figure 3 and Figure 4 shows the various load applied to the structure such as dead load, live load, wind load, earthquake load.[7]

Fig5. Detail of Column.
Fig6. Detail of Beam.

5. and figure 6. shows the beam and column detailing.

Figure 7. Deflection due to earthquake load.
Figure 8. Deflection due to earthquake load.[1]

Figure 7. shows the deflection caused due to earthquake load[16] in x direction which then causes the instability to the structure and figure 8. shows the deflection caused due to earthquake load in z direction which then causes the instability to the structure.[5]
Figure 9. Deflection due to wind load.

Figure 10. Deflection due to wind load.

Figure 9. shows the deflection caused due to wind load in x and figure 10. shows the deflection caused due to wind load acting on the structure in z direction.[7]

Figure 11. Deflection due to dead load.[3]

Figure 12. Deflection due to live load.[4]

Figure 11. and 12. shows the deflection caused due to dead load and live load acting on the structure.

5. Results

Fig 13. Bending Moment Diagram With Seismic Load.

In figure 13, a point load of 4.01kn is applied which causes a continuous bending moment in a beam it is of 1.07 to -0.93.

Fig 14. Bending Moment Diagram Without Seismic Load.

In figure 14, a point load of 0kn is applied which causes a continuous bending moment in a beam. There is no bending moment occur in the beam of nonseismic building.
Fig 15. Shear Force Diagram With Seismic Load. Figure 15 shows shear force diagram of beam 188 in which the shear force of 0.27mm.[6]

Fig 16. Shear Force Diagram Without Seismic Load. Figure 16 shows shear force diagram of beam 188 in which the shear force of 0mm.

Fig 17. Deflection due to seismic load. Figure 17 shows shear force diagram of beam 188 in which the deflection of 1.201 to 0.774 occur.

Fig 18. Deflection without seismic load. Figure 18 shows shear force diagram of beam 188 in which the deflection of 0.002 to 0.002 occur.

Graph No.1 shows maximum Axial Force in Seismic structure is 692.144KN and in Non-Seismic structure is 683.489KN. The axial force of seismic structure is more than non-seismic load because the vibration in vertical direction due to earthquake force.

Graph No.2 shows maximum Bending Moment in Seismic structure is 233.361KN and in Non-Seismic structure is 233.361KN. The bending moment in both seismic and non-seismic structure is same because there is same equivalent lateral force during earthquake.
Graph No.3 shows maximum Shear Force in Seismic structure is 86.464KN and in Non-Seismic structure is 86.464KN. The shear force in both seismic and non-seismic structure is same because there is same equivalent lateral force during earthquake.

\[ \text{Table.2 Comparing Of Maximum Displacement.} \]

| Displacement | X-axis         | Y-axis         | Z-axis         |
|--------------|----------------|----------------|----------------|
| Seismic      | 5.445 mm       | 0.707 mm       | 2.719 mm       |
| Non-Seismic  | 2.284 mm       | 0.141 mm       | 0.991 mm       |

Table.2 shows the comparison between Seismic and Non-Seismic Structure about Maximum Displacement.

6. Conclusion
This research paper aimed to analyse the seismic load acting on G+5 building. The analysis is done with STAAD.PRO software so as to get better results. STAAD.PRO software evaluates any structure subjected to dynamic loading and gives an accurate result. From the above analysis it is observed that the bending moment and shear force of seismic and non-seismic structure is same while there is difference between axial force and displacement.

\[ \text{Table.3 Result comparison} \]

|                  | Axial Force (KN) | Bending Moment (KN) | Shear Force (KN) | Displacement (mm) |
|------------------|------------------|---------------------|------------------|-------------------|
| Seismic Structure| 692.144          | 233.361             | 86.464           | 5.445(x), 2.719(z) |
| Non-Seismic Structure| 683.489         | 233.361             | 86.464           | 2.284(x), 0.991(z) |

In Table.3 shows the comparison between the value of axial force, bending moment, shear force, displacement.

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