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Dynamic Analysis of Multi-Storey Buildings of Different Shapes

Gaurav Patidar[1], Ankur Pandey[2]
[1]*P.G. Student, SVVV, Indore*
[2]*Assistant Professor, SVVV, Indore*

Abstract: ***The construction of high-rise reinforced concrete buildings, mainly in major cities, is on the flow. So, as the structure becomes tall, it becomes sensitive to lateral loads like wind load and earthquake load. So, it is very important that the building should be safe in dynamic loads because it varies in magnitude with time. This paper presents a summary of research work already done in the seismic & wind analysis of multi-storied buildings with different irregular and complex plan shapes. The effect of shear wall, variation of seismic zone & wind speed also considered along with it. Methods used in the analysis of the seismic & wind analysis for different shaped buildings by different researchers are studied. The Effect of plan shape are studied in this paper in terms of storey drift, lateral displacement, base shear, storey shear, soft storey, axial force, moments, etc.***
Keywords: Plan irregularity, conventional RC framed, Seismic loading, ETABS, STAAD Pro.

I. INTRODUCTION

The size and geometry of a high-rise building determine how it behaves towards earthquake shaking in high earthquake zones. Buildings having non-uniform geometry behaves differently against seismic activity. Mostly, the high-rise buildings are irregular in both horizontal and vertical geometry. Irregularities and discontinuity give rise to eccentricity between the building mass and stiffness, produce damages to the structure. So, to design and analyze an irregular building a high level of engineering and designer effort are needed.

II. LITERATURE REVIEW

1) Himanshu Upadhyay et. al. (2021) [1] used ETABS software, applying code IS1893(Part 1):2016, a dynamic analysis has been performed on six G+15 RCC commercial building with various shapes like rectangular, L-shape, I-shape, O-shape, T-shape, and U-shape in seismic zone V. The findings suggest that most of the buildings exceed the permissible drift limit by about 36 % and the permissible displacement limit by about 96 %. Buildings of irregular shapes (L, I, T, and U) perform badly compared to regular buildings (rectangular and O). The performance of a U-shaped building is one of the worst. Although irregular shapes deform more quickly, they should be avoided.

2) Mr. Gaurav Narendra Chauhan et. al. (2020) [2] performed a non-linear dynamic analysis of a G+15 multi-storey RCC framed building with varying geometrical shapes considering time history of EI Centro Earthquake 1940 using ETABS to study the behaviour of structure in terms of lateral force, base shear, storey drift, Displacement using IS1893-(Part1)-2016. For dynamic analysis, square RCC geometry is preferable than rectangular and circular geometry.

3) Mohammed Mohiuddin et. al. (2018) [3] studied a seismic analysis G+14-storey structure with one conventional and one irregular plan (Hexagonal, Circular, Elliptical, sector and Y shape) in ETABS 2016 v16.2.1 It has been concluded considering analysis of all shapes that rectangular shape model has less base shear and more displacement in X- direction when compared to other shaped buildings. Y-shaped model have very less base shear and very less time period. Sector shape has maximum eccentricity. Y-shape model is more stable and sector shaped model is more critical.

4) T. Prasanthi et. al. (2017) [4] performed a seismic analysis of a G+20 Storey with plan shape of C-shape and Rectangle shape in Zone III for medium soil to study the behaviour of the structure in terms of Structural displacement, drifts, Storey Shear, Overturning Moment. It has concluded that displacement in rectangular shaped building is less than C shaped Building. The base shear value from dynamic analysis is 9% more than the base shear from static analysis for both shape of building. Overturning moment is more in rectangular shaped building than in C-shaped building. The stiffness decreases with increase in storey height of the building.

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5) Dhananjay Shrivastava et. al. (2017) [5] investigated G+25 Storeys of L-shape and I-shaped RCC Framed buildings for earthquake load in STAAD Pro v8i using IS1893:2002 in seismic zone IV and V and all soil types. The value of base shear acts at the base of the building is always minimum for the rectangular section for both the zones on different type of soils. Response of the building towards the earthquake decreases as the base width increases.

6) Ayush Agrahari *et. al.* (2017) [6] analysed a dynamic analysis of G+15 storey RC framed building with shapes as T-shaped and L-shaped building are used for comparison of Storey displacement, storey drift, Maximum bending moment and shear force at different storey height in ETABS 2013. The analysis is performed zone IV . It is concluded that T-shaped building undergo more deformation than L-shaped building. Storey drift first increase with height and then decreases. Storey drift is least in L-shaped building so it is efficient.

7) Malavika Manilal et. al. (2017) [7] analysed a 30-storey regular and re-entrant structures for both gravity and lateral loads in ETABS v9.7.4 in seismic zone V. The horizontal irregularity re-entrant corner is studied by conducting time history analysis of BHUJ earthquake. It concluded that building with 80% re-entrant deflects more compared to other building. The storey drift of 80% re-entrant building is maximum. The stress and forces for the columns of periphery are higher. The regular model is having higher base shear indicating greater stiffness.

8) Gauri G. Kakpure *et. al*. (2017) [8] analysed two tall building having storey as G+10 and a G+25 in zone III of earthquake by using both methods of dynamic analysis using ETABS 15 to observe the values of storey drift, storey displacement, axial load, bending moment at different points in the building. It has been concluded that storey drift value for both the structure is 22 and 25% less in dynamic analysis than static analysis. In dynamic analysis the load on columns of corner is more as compared in static analysis.

9) Akhila lekshmi et. al. (2015) [9] analysed a H-shaped building with different type of bracing (Diagonal, V type, V type, Inverted V type, X type, K type) is carried out by using ETABS software in zone III. The maximum storey displacement of the building is reduced by the use of X type bracing system. Displacement value decreases from top storey to base. Storey drift is maximum at intermediate storey levels and minimum the top storey. Building with X type of bracing is found to be most effective. Storey shear is higher for building with X brace.

10) Mohammed Rizwan Sultan *et. al.* (2015) [10] analysed a structure of G+10 storey RCC building with shapes as rectangle, H-shaped, C-shaped, L-shaped building are used for comparison of Storey Overturning moment, storey drift, displacements, design lateral forces at different storey height in ETABS version 9.7.1 in zone V. It has been concluded that structures with irregular geometry affects most in extreme seismic zones and irregular shape building undergo more deformation so regular shaped buildings should be used. C-shaped building is more vulnerable as compared to all other shapes.

III. CONCLUSION

Based on the findings of several studies, the following conclusions have been reached:

1) The regular building having higher base shear indicating greater stiffness.

2) The stiffness decreases with increase in storey height of the building.

3) Storey drift is maximum at intermediate storey levels and minimum the top storey.

4) The displacement of irregular building is more compared to regular building under wind loads. While The displacement in irregular is less compared to regular building under seismic loads.

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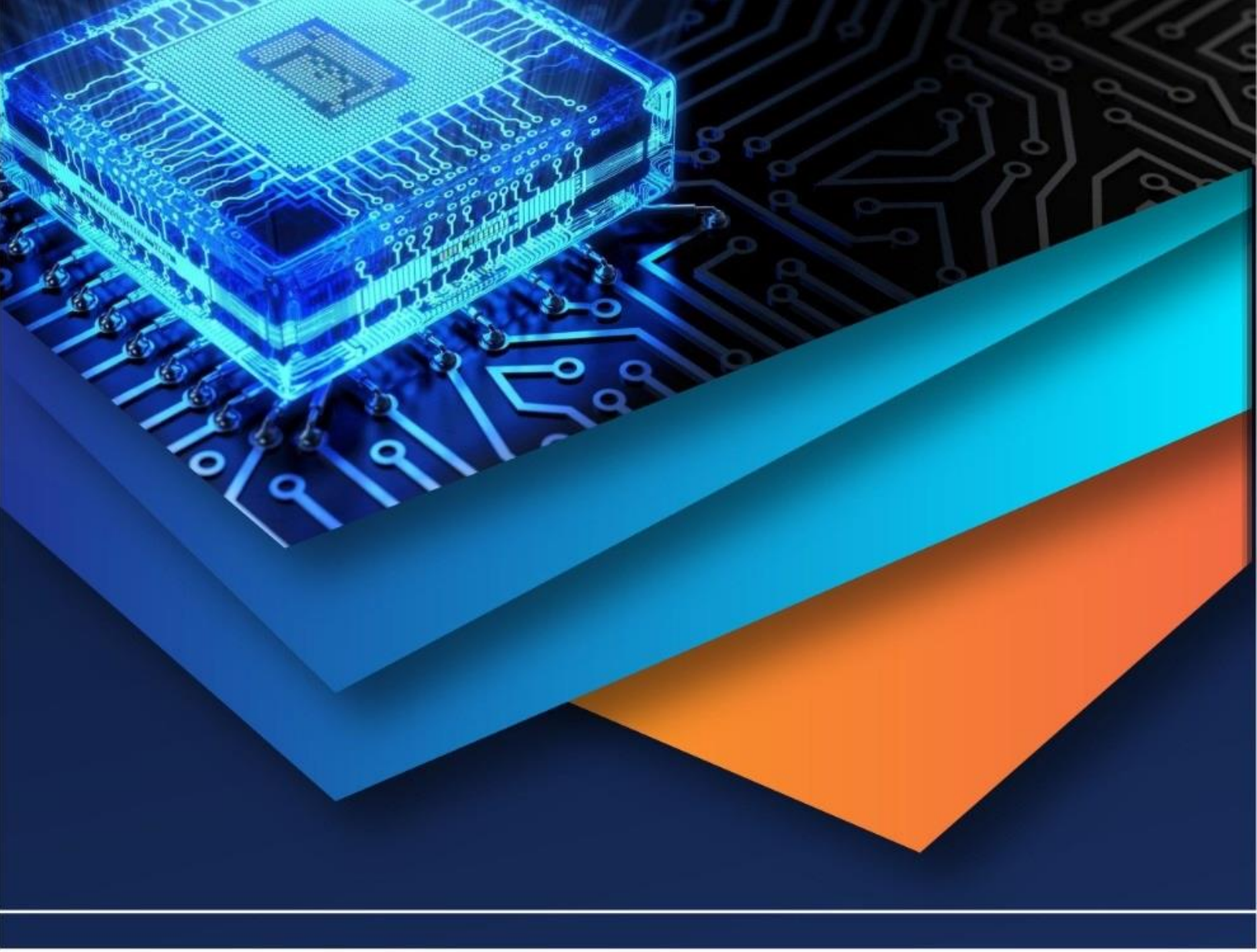
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