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A Review - Comparative Structural Analysis of Tall Building having Different Geometrical Plan using Floor Diaphragm

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Abstract: The effect of earthquake and wind has reliably been a risk to human progress, destructive human lives, property and man-made structures. Then there is continuous research works around the world, revolves around improvement of new and better methods that can be used in structures for better earthquakes and wind performance. Most used systems that can be used for building reinforcement earthquakes and wind load effect are horizontal structural systems such as (aperture and trussing) and vertical structural systems such as (braced frames, momentary frames and shear walls). Roofs and floors, called "diaphragms", are relatively thin but rigidly horizontal or almost horizontal construction systems that transfer lateral forces in the plane to, or between, vertical lateral force that resists structural elements. In addition to the primary role of dividing lateral forces on vertical structural elements, the diaphragms bind a whole structural system together.
Keywords: Bending moment; Displacement; Floor diaphragm, Seismic load, Wind load.

I. INTRODUCTION

In the 21st century, the number of areas in units because of the enormous population is decreasing by the day. A few decades ago, the populations were not that big, so they stayed in a horizontal system (because of the large available area per person). However, today people prefer a vertical system (high-rise due to scarcity of surface area). In high buildings, it is more about all the forces that affect a building. For external forces acting on the building, the beam, column and reinforcement must be good enough effectively counteract these forces and the ground must be good enough to successfully transfer the load to the foundation. For a loose soil, a deep foundation (pool) is preferred.

II. LITERATURE REVIEW

Phillips et al. (1993) constructed full-scale single-story wooden house and tested under sideways loads at different stages of loading to evaluate the load-sharing techniques and the structural response. Different enclosures, fastening constructions and openings are included to create shear walls with varying stiffness. The result shows that the roof membrane influenced the distribution of the lateral load to the scissor walls of the building. The roof membrane behaved almost like a stiff diaphragm. The distribution of the load between the winding walls is a function of wall stiffness and position within the building. The walls transverse to the load direction are supported between 8% and 25% of the applied lateral load.

Moon and Lee (1994) proposed efficient high-rise model, including the flexibility of the flat floor slab without reducing the accuracy of the analysis, and also proposed a soil flexibility index whose impact is investigated through parametric studies in terms of seismic base shift and its distribution, and displacement on the roof. The result shows that it is desirable to incorporate the inplane deformation of floorboards into the analysis of structures of the earthquake for an economical and safe design when the inplane deformation of floorboards is expected to be large.

Kim et al. (2003) landscaped building structures without the floor plates assuming that they would have negligible consequences for the reaction of a structure. The floor slabs are easily replaced by rigid floor membranes for efficiency in the analysis. Beams and floor slabs are divided into different elements, so that more time is required for the analysis procedure and the problems are solved, efficient analytical modeling methods using the substructuring techniques, super elements and stiff diaphragms have been adapted. The analytical results of time-historical analysis and the computer time of different analyzes, for example structures, are compared to examine the validity of the modeling techniques proposed in this study. The proposed model does offer seismic response of the example structures in considerably shorter computer time, while the accuracies in the analysis results are very close to those obtained from the sophisticated model. The efficiency and accuracy of the proposed analytical models are verified and the conclusions can be obtained.

Basu and Jain (2004) defined the center of stiffness for rigid floor aperture buildings that has been extended to asymmetrical buildings with flexible floors. They proposed a procedure to ensure that the resulting member force is close to that of rigid floor buildings, while the stiffness of the floor diaphragm increases. A superposition-based methodology was proposed for performing code-specific torque determinations for constructions with flexible floor membranes. The result showed that the resulting member force is close to that of the rigid floor diaphragm buildings as the stiffness of the floor diaphragm increases and it was also seen that treating the diaphragms of structures as rigid for torsional analysis can cause a considerable error.

Bull (2004) gave a designing concept of diagram under seismic loading. Also suggestions for maintaining the integrity of precast concrete type of diaphragms are given.

Lee et al. (2007) described an easy and accurate method to estimate peak interstory drifts for low rise shear wall structures having rigid or flexible floor diaphragm. The method was based on principal modes acquired from a principal components analysis (PCA) of computed dynamic response data and is applicable for both elastic and inelastic response.

Bull et al. (2008) explored the trends and magnitude of forces in concrete floor diaphragms for seismic loading. A new pseudo-Equivalent Static Analysis (pESA) method for determining inertial forces in floor diaphragms was analyzed.

Fouad et al. (2012) examined the deformability of the floor in plan under the effect of horizontal seismic actions. It was observed that the seismic response as well as shear forces, periods of vibrations and displacements, shows the reduced value for flexible type of floor diaphragm.

Ambadkar and Bawner (2012) considered wind loads as specified in IS: 875 (Part 3) - 1987. G+11 story building was analyzed by using STAAD PRO. The analysis was done for various variations in obstructions height and results obtained by analysis were used for relations of forces, displacements and moments.

Bhuiyan and Leon (2013) investigated the impact of diaphragm flexibility on structural response of high rise buildings. A model of floor was constructed which consist of all primary structural members and an equivalent shell element floor model was constructed. The result showed that accelerations and displacements in flexible diaphragm structural model was more than rigid diaphragm structural model. And also the fundamental periods of vibration was more in case of flexible diaphragm structural model.

Hadianfard and Sedaghat (2013) explained the non-linear response of flexible concrete floor diaphragm with reinforced steel building examined under both dynamic ground movements and static lateral loads and were compared with stiff diaphragms. The study explained that the span ratio was an important parameter for the flexibility of the floor aperture. The results showed that the maximum drift and displacement of flexible floor diaphragm was higher than in a rigid floor membrane. Application base shears and initial stiffness of flexible floor diaphragm were higher than for rigid diaphragms. For overvoltage ratios of more than 3: 1 in low-rise buildings, the final base shear capacity significantly reduces in flexible membrane analysis of the floor rather than in the case of rigid floor aperture analysis.

Vyas and Pathak (2013) carried out seismic analysis of plaza building frames by considering four building plans, three diaphragms and one seismic zone (seismic zoneIII). In total twelve frames were analysed for twenty six load combinations. Staad pro software has been used for analysis. The results showed that rigid diaphragm was more efficient in reducing the moment and storey displacement than other diaphragms.

Rehan and Mahure (2014) discussed the design and analysis of G+15 stories R.C.C., steel and composite building under effect of earthquake and wind using STAAD Pro. The result showed that steel-concrete composite building was better alternative.

Shivare et al. (2014) analysis of earthquakes carried out for high-rise buildings taking into account 4 buildings of the same area, but with a different geometrical design for 4 seismic zones and 3 membranes. The result showed that diaphragm modeling has a great influence on moment and displacement. It has been found from the analysis of different buildings with different geometry plans, but the same area that the Starre aperture is more effective in the case of a building with an almost rectangular floor plan.

Suneetha (2015) investigated the difference between a building with diaphragm discontinuity and a building without diaphragm discontinuity.

Patil et al. (2015) analyzed and designed a high-rise building under wind load. G + 19-storey building was studied because of its behavior in wind load. The results of the study were in terms of aperture displacement due to wind force, change in the reinforcement in the column, change in the behavior of the beam, floor deviation, floor slider, displacement of the structure, and torsion due to wind force. Due to the high wind pressure in high structures, displacement of the diaphragm is more and this creates extra stresses in building components.

III. PROBLEM STATEMENT

From the above literature study it is clear that none of the available studies have been conducted with regard to the use of rigid diaphragm modeling on 20-storey buildings for different seismic and wind zones with different geometrical plan and height and none of these models predicted the comparative structural analysis of high-rise buildings with different geometrical plan and height using floor diaphragm. The reason is the non-availability of design codes and specifications regarding the use of diaphragms in civil constructions. This study can be a guideline for designing a diaphragm in tall buildings.

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