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Seismic Response Analysis of Structure: A Perspective View

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ABSTRACT
From past earthquakes it is proved that many of structure are totally or partially damaged due to earthquake. So, it is necessary to determine seismic responses of such buildings. There are different techniques of seismic analysis of structure. Time history analysis is one of the important techniques for structural seismic analysis generally the evaluated structural response is nonlinear in nature. For such type of analysis, a representative earthquake time history is required. In this project work seismic analysis of RCC buildings with mass irregularity at different floor level are carried out. Here for analysis different time histories have been used. This paper highlights the effect of mass irregularity on different floor in RCC buildings with time history and analysis is done by using ETABS software.

Keywords: *Seismic Analysis, Time History Analysis, Base Shear, Storey Shear, Story Displacement*

1. INTRODUCTION

During an earthquake, failure of structure starts at points of weakness. Generally weakness is due to geometry, mass discontinuity and stiffness of structure. The structures having this discontinuity are termed as Irregular structures. These structures contain a large portion of urban infrastructure. Hence structures fail during earthquakes due to vertical irregularity. According to IS 1893: The irregularity in the building structures may be due to irregular distributions in their mass, strength and stiffness along the height of building. When this type of building are constructed in high intensity zones, the design and analysis of structure becomes complicated. There are two types of irregularities1. Plan Irregularities. 2. Vertical Irregularities. Vertical Irregularities are of five typesa) Stiffness Irregularity — Soft Storey-A soft storey is one in which the lateral stiffness is less than 70 percent of the storey above or less than 80 percent of the average lateral stiffness of the three storey's above. b) Stiffness Irregularity — Extreme Soft Storey-An extreme soft storey is one in which the lateral stiffness is less than 60 percent of that in the storey above or less than 70 percent of the average stiffness of the three storey's above. ii) Mass Irregularity-Mass irregularity shall be considered to exist where the seismic weight of any storey is more than 200 percent of that of its adjacent storey's. In case of roofs irregularity need not be considered. iii) Vertical Geometric Irregularity- A structure is considered to be Vertical geometric irregular when the horizontal dimension of the lateral force resisting system in any storey is more than 150 percent of that in its adjacent storey. Buildings are designed as per Design based earthquake, but the actual forces acting on the structure is more than the design earthquake. So, in higher seismic zones Ductility based design approach is preferred as ductility of the structure narrows the gap. The primary objective in designing an earthquake resistant structure is to ensure that the building has enough ductility to withstand the earthquake load.

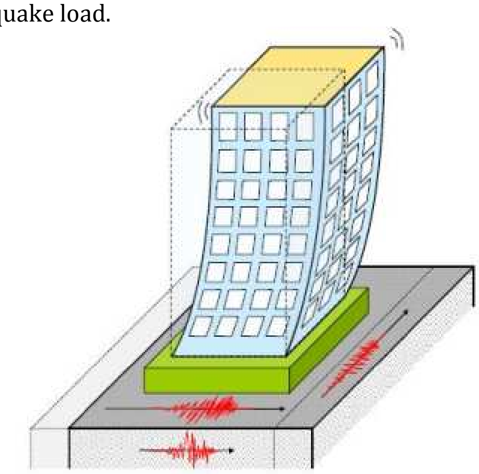

Figure 1: Earthquake behavior of building

2. Background

Seismic analysis is a major tool in earthquake engineering which is used to understand the response of buildings due to seismic excitations in a simpler manner. In the past the buildings were designed just for gravity loads and seismic analysis is a recent development. It is a part of structural analysis and a part of structural design where earthquake is prevalent.

In 2017[1], Seismic analysis is a subset of structural analysis which involves the calculation of the response of a structure subjected to earthquake excitation. This is required for carrying out the structural design, structural assessment and retrofitting of the structures in the regions where earthquakes are prevalent. The influence of diaphragm openings on the seismic response of multi-storeyed buildings played a major role in reducing the base shear, hence attracting lesser seismic forces. An attempt is made to try to know the difference between a building with diaphragm discontinuity and a building without diaphragm discontinuity.

This present paper makes a humble effort to portrait the behavior of multi storied buildings with diaphragm openings under earthquake static analysis and response spectrum analysis using STAAD. Pro. To achieve this objective various models with varying percentages of diaphragm openings were analyzed and compared for seismic parameters like base shear, maximum storey drifts, shear force, Bending Moment and Axial Force.

In the area of concrete design, American Concrete Institute Building Code ACI 318-08, addresses the impact of a gap on slabs in native terms. It restricts gap size in column strips and limits the allowable most openings size in middle strips. The interrupted reinforcement by a gap should be placed at one-half on both sides of the opening. ACI 318-08 doesn't address the general impact of a gap on the floor. This reinforcement replacement criterion has no restriction on the opening size as long because it is among the prescribed column and middle strips demand.

ASCE 7-05, the Guide to the planning of Diaphragms permits diaphragms of concrete slabs or concrete stuffed metal decks with span-to-depth ratio of 3:1 in structures that haven't any horizontal plan irregularities to be idealized as rigid, otherwise, the structural analysis shall expressly embody thought of the stiffness of the diaphragm while not explaining however.

In the field of concrete beams with net openings, Nasser et. al. (1993), Mansur et. al. (1999) and Abdalla and Kennedy (1988) shed light-weight on however a gap in rectangular RC or prestressed beams affects stress distributions and capability of a concrete beam. Sadly, the theory provided was mark against accessible experimental results with no proof that it is extended to incorporate alternative configurations. Kato et. al. (1991), Taylor et. al. (1992) and Daisuke et. al. (1959), investigated the planning of RC shear walls with one gap. Again, the results were solely applicable to the pertinent cases.

Other studies were conducted within the area of concrete panels, notably within the area of buckling. Swartz and Rosebraugh (1974), Aghayere and Macgregor (1971), and Park and Kim (1992) addressed buckling of concrete plates beneath combined in-plane and transverse loads. Since concrete diaphragms is thought-about as concrete plates with beams as web stiffeners, this buckling approach doesn't address openings.

Button et. al. (1984) investigated the influence of floor diaphragm flexibility on 3 totally different buildings, massive arrange aspect ratio, three-winged (Y-shaped) and separate towered. Notwithstanding the insight given into however lateral force distribution differs from rigid to flexible diaphragms, openings weren't thought-about. Basu (2004), Jain (1984) and Tao (2008) had analyzed differing kinds of structures starting from formed, Y-shaped to long and slender buildings. Although these studies proved to be contributing to understanding the dynamics of such style of structures, they didn't address the effects of diaphragm openings.

Kunnath et. al. (1991) developed a modeling theme for the inelastic response of floor diaphragms, and Reinhorn et. al. (1992) and Panahshahi et. al. (1988) verified it, using shake table testing for single-story RC, 1:6 scaled model structures, gap effects weren't incorporated within the model and also the projected model's ability to account for in-plane diaphragm deformations, confirmed the chance of building collapse, as a results of diaphragm yielding for low rise (one-, two-, and three-story) rectangular buildings with finish shear walls and building plan aspect ratio bigger than 3:1. Nakashima et. al. (1984) analyzed a seven story RC building exploitation linear and non-linear analysis final that the inclusion of diaphragm flexibility didn't considerably amendment the particular amount of the structure and also the most total base shear. Effects of diaphragm openings weren't a part of that analysis.

Anderson et. al. (2005) developed analytical models using commercial computer programs, SAP 2000 and ETABS to judge the seismic performance of low-rise buildings with concrete walls and versatile diaphragms. Again, openings weren't a part of the models devised. Barron and Hueste (2004) evaluated the impact of diaphragm flexibility on the structural response of 4 buildings having 2:1 and 3:1 set up plan ratios and were 3 and 5 stories tall, severally. The building diaphragms didn't yield and also the buildings in question didn't have diaphragm openings. Hueste and Bai (2004) analyzed a model five-story RC frame building designed for the mid-1980s code needs within the Central us. Recommending Associate in Nursing addition of shearwalls and RC columns jackets light-emitting diode to decrease within the likelihood of exceeding the life safety (LS) limit state. Unfortunately, retrofitting recommendations were specific to the current structure solely and no diaphragm opening effects were looked into.

Kunnath et al. (1987) developed associate analytical modeling theme to assess the damageability of RC buildings experiencing nonresilient behavior underneath earthquake loads. The results of the response analysis, expressed as damage indices, did not provide any respect to diaphragm openings. Jeong andElnashai (2004) projected a three-dimensional seismic assessment methodology for plan-irregular buildings. The analysis showed that plan-irregular structures suffer high levels of earthquake damage attributable to torsional effects. The analysis additionally verified that standard damage observation approaches may well be inaccurate and even unconservative. However, the assessment did not account for diaphragm openings.

Ju & lin (1999) and Moeini (2011) investigated the distinction between rigid floor and flexible floor analyses of buildings, using the finite element technique to analyze buildings with and while not shear walls. A slip formula was generated to estimate the error in column forces for buildings with plan regular arrangement of shear walls beneath the rigid floor assumption. Although 520 models were generated, none dealt with diaphragm openings. Kim and White (2004) proposed a linear static methodology applicable solely to buildings with flexible diaphragms. The procedure is predicated on the idea that diaphragm stiffness is tiny compared to the stiffness of the walls, which flexible diaphragms within a building structure tend to respond independently of one another. Though the proposed approach gave insight into the restrictions of current building codes, it did not deal with diaphragm opening effects.

Other related analysis addresses the consequence of presumptuous a rigid floor on lateral force distribution. Roper and Iding (1984) in brief examined the appropriateness of presumptuous that floor diaphragms are absolutely rigid in their plane. Two models were used, the primary was for a cruciform-shape building and also the second was for a rectangular building. Both models showed discrepancy between rigid and flexible floor diaphragm lateral force distribution. Specially, once shear walls exhibit an abrupt amendment in stiffness. Still, effects of openings on lateral force distribution weren't explored. Tokoro et al. (2004) replicated an existing instrumented 3 story building using ETABS and compared the model's diaphragm drift to the code allowable drift and judged the structure to be among the code's given drift limit; while not considering any diaphragm opening effects.

Saffarini and Qudaimat (1992) analytically investigated thirty-seven buildings, with diaphragm lateral deflection and inter-story shears as a comparison criterion between rigid and flexible diaphragms assumptions. The analysis showed wide distinction within the diaphragms' deflections and shears. The investigation in brief addressed gap effects as a part of different parameters being studied. it absolutely was terminated that a gap positively decreased the floor stiffness, and thence increased the inadequacy of the rigid floor assumption. Easterling and Porter (1992) conferred the results of an experimental analysis program during which thirty-two full-size composite (steel-deck and concrete floor slabs) diaphragms were loaded to failure. The most important analysis contribution was the event of a higher style approach for composite floor systems and stressing the importance of misshapen bars reinforcing to boost ductility and management cracking related to concrete failure around headed studs. The recommendations were solely pertinent to the cantilevered diaphragms tested and no gap effects were examined.

3. Objectives

The main objectives of this work is as per the following

1. To design the flexible of building.
2. To specify the constraint that usual modes does not affect the structure of building.
3. To maintain the seismic behavior of framed building significantly.

4. Conclusions

Many of the studies have shown seismic analysis of the RCC structures with different irregularities such as mass irregularity, stiffness and vertical geometry irregularity. Whenever a structure having different irregularity, it is necessary to analyze the building in various earthquake zones. From many past studies it is clear that effect of earthquake on structure can be minimize by providing shear wall, base isolation etc.

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