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Review of Multistoreyed RC Building Seismic Design Using Various Codes

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ABSTRACT—

The yielding and inelastic behavior of structural elements that are detailed to display such behavior during earthquakes is dealt with in seismic design. The building is built with enough strength to respond elastically to earthquakes. The multistory RC building's seismic design is intended to withstand the ground motion brought on by an earthquake. The numerous seismic design codes must be thoroughly understood by an engineer in order to build an earthquake-resistant construction. In this essay, the literature from diverse study projects was examined. These publications provide greater details regarding the static and dynamic analyses performed on different kinds of structures. The time required for seismic analysis and the number of errors in the structure's analysis and design will decrease with the usage of software. The seismic performance of the structure was assessed by the researchers using codes from different nations. We looked at variables including displacement, base shear, storey drift, duration, axial force, and shear force bending moment. These studies have sparked interest in seismic design of multistory buildings utilizing different codes to see which codal provisions provide the most effective designs that perform well during earthquakes.

Keywords—Base shear, Displacement, Seismic analysis , Storey drift, stiffness.

1. INTRODUCTION

Structures built to withstand earthquakes are able to withstand both lateral and vertical forces. However, no building can completely withstand an earthquake without suffering damage. According to rules, earthquake-resistant structures are made to withstand earthquakes that are predicted to happen at least once during the structure's design life. Buildings made of reinforced concrete are examined and developed to comply with applicable codes of practice. Buildings that are constructed in accordance with statutory requirements will withstand earthquakes with only minor structural component damage. Many nations have their own standards for building earthquake-resistant constructions. Buildings are planned and finished in accordance with codes. The performance of structures against seismic loads for various designs is reviewed in this research. The review explains the need of improvement in codes, thus improve the performance of structures better during earthquake.

2. LITERATURE REVIEW AND METHODS

Jaya Prakash Kadali et al*[1]*(2015) conducted study on static analysis of multistoreyed RC buildings by using pushover methodology. According to IS 1893 (2002), the frames with different configurations are constructed and described as Special Moment Resisting Frames (SMRF) and Ordinary Moment Resisting Frames (OMRF). A total of 10 frames are chosen, with different infill wall designs, storey counts, bay counts, and design methodologies. Buildings for SMRF are designed utilizing IS13920 (2002). In SAP2000, the buildings are simulated and Pushover Analysis is run. Pushover analysis is a static nonlinear method of analyzing a building that identifies the weak points and failure mechanisms as the amount of loads increases. Buildings that need to withstand seismic forces are equipped with Special Moment Resisting Frames (SMRF). Strong earthquake shaking is resisted by SMRF without a loss of stiffness or strength. The buildings designed as SMRF perform much better compared to the SMRF building. Ductility and base shear of SMRF is more compared to OMRF.

Mr.K.Lova Raju et al*[2] *(2015) studied the effective location of shear wall on performance of building frame subjected to earthquake load. In this study, three frames with shear walls at various locations and one frame without a shear wall are among the four types of constructions with G+7 that are discussed. The Non Linear Static analysis is carried out using the program ETABS v9.7.2. The structure is designed to stand up to seismic zones II, III, IV, and V. In a pushover study, the lateral force increases as the height of the building does. The behavior of the structure, including the maximum deflection and ultimate load, is established. The pushover curve results from the plotting of base shear and roof displacement. The performance of the former is enhanced, and the base shear is elevated when compared to a frame without a shear wall. When compared to a frame without a shear wall, shear wall performance is superior in terms of lateral displacement and it reduces.

Md. Rashedul Kabir et al*[3]*(2015) has determined response of multi-storey regular and irregular buildings of identical weight under static and dynamic loading in context of Bangladesh. In this study, a 15 storey structure with regular and irregular shapes was modeled using the ETABS 9.6 program for Dhaka, Bangladesh (seismic zone 2). Analysis is done on the impact of wind load, dynamic load, and static load. Each building's mass was regarded as being the same. shift brought on by the wind In all types of buildings, the load is highest. Less variation in displacement is obtained from static and dynamic analyses.

When compared to dynamic analysis, the displacement produced by static analysis is greater. The displacement grows as the number of stories rises. Structures in the C and L shapes have more displacement. When the overall mass is constant, the displacement of a structure that is rectangular and one that is irregular show approximately similar displacement.

Akshay V. Raut et al[4] ***(2014)*** has performed pushover analysis of G+3 reinforced concrete building with soft storey. They have created the basic computer model of four storey building frame structure and define properties and acceptance criteria for the pushover hinges . The software comes with a number of built-in default hinge qualities that are based on average values from FEMA-356 for steel members and ATC-40 for concrete members. Weak links and failure mechanisms of the building are discovered when the size of the stresses increases. The graphs demonstrate how the frame behaves in terms of stiffness and ductility. According to pushover studies, the maximum base shear for bare frames is 951.78 KN, and the maximum displacement is 240.65 mm in the X direction. By superimposing the demand spectrum onto the capacity curve that has been translated into spectral coordinates, the performance point is achieved. At a base shear level of 550 KN and a displacement of 45 mm in the X direction, the performance point is reached. Hinges have developed in the beams and columns showing the three stages immediate occupancy, Life safety, Collapse prevention. The column hinges have limited the damage.

Lakshmi K.O et al*[5] *(2014) determined effect of shear wall location in buildings subjected to seismic loads. Analysis software ETABS 9.5 is used to create the 3D model and run the linear static and dynamic analysis. The pushover analysis in SAP2000 V.14.1 is performed. We looked at eight distinct models. A 16-story (G+15) residential building with a 3 m floor height and a ground storey height is examined for the soil type medium. These loads come from IS:875(Part 2). For the analysis and design, load combinations were taken into account in accordance with IS:1893-2002. The complete DL plus 25% of the LL are used to determine the seismic weight. At the base, fixed supports are offered. Shear walls are shown to be useful in enhancing the overall seismic capacity of medium-rise buildings. When a corner shear wall is present, drift value is decreased. The position and orientation of adjacent shear walls and columns effect the need for reinforcement in columns. Push over analysis results provides a detail about the performance of structures in post elastic range.

Nitin Choudhary et al*[6]*(2014) performed pushover analysis of RC frame building with shear wall. For the purposes of this project, a four-story reinforced concrete frame building in Zone IV is chosen for examination. Performance-based design is also the foundation of the Eurocodes EC2 and EC8, however Indian codes are still mum on the subject. The non-linear pushover analysis comprehensive procedure is provided in FEMA-273, FEMA-356, and ATC-40. The performance-based seismic design produced by the aforementioned process meets the requirements for immediate occupancy and life safety limit states for a range of earthquake intensities. When compared to code-based seismic design (IS 1893:2002) generated by STAAD, performance-based seismic design results in a little reduction in steel reinforcement.Pro.

Riza Ainul Hakim et al*[7] *(2014) performed a seismic assessment of an RC building using pushover analysis. In this paper, a 6- story reinforced concrete structure located in Saudi Arabia with a story height of 4.0 m was used in the static pushover analysis. According to Saudi Building Code 301, the site class C or soft rock type of soil is chosen. For the acceptance criteria, the FEMA 356 rule, which is incorporated into SAP 2000 with the IO (Immediate Occupancy), LS (Life Safety), and CP (Collapse Prevention) limit states for hinge rotation, was employed. A pushover curve, also known as a capacity curve, is created by the pushover analysis and shows how the base shear (V) and roof displacement () relate to one another. The Pushover curve is dependent on the structure's strength and deformation capabilities, and it describes how the structure behaves once it has reached its elastic limit. According to SBC 301, the structural system was constructed utilizing an IMRF and a design that was solely focused on the gravity load. The pushover curve comparison reveals that the frame stiffness in IMRF (SBC301) is greater than that in the gravity load design. Compared to gravity load design, SBC design is better able to resist lateral load (seismic load). The building has little damage because the performance point position is at IO (Immediate Occupancy) level. According to ATC 40, the design meets the pushover analysis.

Praveen Rathod et al*[8] *(2014) performed Non-Linear Static analysis of G+6 storeyed RC buildings with openings in infill walls. This study examines a two-dimensional model of a seven-story reinforced concrete (RC) building with openings of 5%, 25%, and 35%. For medium soil profiles in zone III, bare frame and soft story buildings are modeled using special moment resistant frames (SMRF). SAP2000 is used for pushover analysis in accordance with FEMA 440. SAP2000 replaces the default hinge values with moment-curvature values for the beam column and load deformation curve values for the strut. For each building model, the base force and longitudinal displacement are determined. For both default and user-defined hinges, as the percentage of openings rises, the base force at performance point falls. Due to its simplicity, the default-hinge model is chosen. The user-defined hinge models are more successful in capturing the hinging mechanism compared to the default hinge models.

A. Cinitha et al*[9] *(2012) ran a nonlinear static analysis to evaluate the RC buildings' seismic performance and vulnerability. In this study, the seismic rehabilitation of structures is carried out using the nonlinear analysis outlined in the National Earthquake Hazards Reduction Program (NEHRP) standards. SAP2000 is used for analysis. Buildings of 4 and 6 stories are planned in accordance with IS456:2000 and IS1893:2002, respectively. Gravity load design ground acceleration of 0.36 g and seismic load design ground acceleration of 0.16 g with medium soil are the data used for analysis. The buildings are designed for two cases, such as ordinary moment resisting frame (OMRF) and special moment resisting frame (SMRF). A 100% dead load + 50% live load is applied to the lateral load on the structure. Inelastic beam and column members are modelled as elastic elements with plastic hinges at their ends. The analysis results observed for displacement shows that the modern codes for framed structure are within collapse prevention level.

C. Bhatt et al*[10] *(2012) performed a comparison between American and European codes on the Non Linear Static analysis of RC buildings. The nonlinear static procedure (NSP), which is a seismic design based on seismic performance and acts more sensibly under seismic force than a strength design based on force-based philosophy, was discussed in this study. Deformation is assessed at the global and component levels. In FEMA 440, ATC 40, and EURO 8, the N2 and capacity spectrum technique is employed. Static pushover analysis was performed on a 5-story RC building that was unharmed during the 1997 earthquake. The structure is suitably constructed to withstand shear and collapse. SeismoStruct software uses a fiber element model to model the structure. While non-hysteric damping is 5% of tangent stiffness proportional damping, hysteric damping is predefined in the model. The N2 technique is used to compute the displacement. By amplification of the displacement findings, the torsional effect is determined using the torsional correction factor. Mass proportional force and Modal proportional force are applied in the N2 method of pushover analysis. However, the CSM technique utilizes modal-proportional load patterns. Both techniques were used to calculate top displacements, lateral displacement profiles, and interstorey drifts. Typically, the CSM-FEMA440 was nearer to time-history.The target displacement may be calculated accurately using CSM-FEMA440. The only method that accurately predicts the building's torsional motion is the N2 method.

3. Conclusion

The above research papers give following conclusions;

In comparison to Indian standard (IS1893:2002) and American (ATC40 and FEMA440) standards, the performance of a building designed utilizing Eurocode is better. Therefore, performance-based design needs to be improved in Indian and American code.

When compared to a frame without a shear wall, the performance of the frame with a shear wall is improved, and the base shear rose by 9.82%. When compared to a frame without a shear wall, the shear wall is more effective in reducing lateral displacement and does so by a factor of 26.7%.

Due to the significant confinement of concrete caused by splicing and the use of additional stirrups as ductile reinforcement, SMRF buildings have greater ductility than OMRF buildings. OMRF structures have a base shear capacity that is 7 to 28% higher than SMRF structures. Therefore, in order for a building to endure seismic loads, its strength and stiffness must be increased.

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