A Review of Seismic Response of Three Different High-Rise Multistorey Structure

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ABSTRACT

Extreme lateral drift can contribute significantly to cracking in formation, causing structural damage. Structural damage in turn will reduce the capacity of the structure and weaken it to the intended design capacity. Typically, lateral drift is more pronounced on tall and tall structures such as tall buildings and bridges. A specific method used to control lateral drift is structural bracing, which works by increasing the stiffness and stability of the structure. This article reviews the effect of various types of structural bracing on the structural performance of buildings. The history of structural bracing is visited and the differences between several types of buildings and loads, mechanisms, technical details, suitability for advantages and limitations, and several structural bracing for general effects on structural behavior and performance are analyzed. Adequate and efficient structural reinforcement is relevant to each high-rise building, as it will create safer, more durable and more economical buildings, which are cheaper to maintain throughout the lifetime of buildings in the future.

Keywords: High-Rise Building, Seismic Response, Bracing, Stiffness.

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1. INTRODUCTION

Seismic analysis is a subset of structural analysis and is a calculation of the response of a building and other structures to earthquakes. It is part of the process of structural design, seismic engineering or structural assessment and modernization in areas where earthquakes occur frequently. The first provision for seismic resistance needed to be designed for a lateral force that is proportional to the weight of the building (applied at each floor level). Earthquake engineering has evolved a lot since the early days, and some of the more complex designs now use special earthquake protection elements, either only foundations (base isolation) or distributed throughout the structure. Analyzing these types of structures requires particularly explicit finite element computer code, which divides time into very small quantities and real physics, as is often the "physics engine" in common video games. Very large and complex buildings (such as the Osaka International Convention Center) can be modeled in this way.

The vertical or gravity load carrying system of a multi-story steel frame building includes a system of vertical columns connected by horizontal beams, which support the floor and roof. Resistance to lateral loads is provided by diagonal bracing or shear walls or the action of a rigid frame between beams and columns. Therefore, the components of a typical steel frame structure are:

a. Beams
b. Columns
c. Floors
d. Bracing Systems
e. Connections

Storey Shear is the sum of design lateral forces at all levels above the storey under consideration. The design base shear V_B computed shall be distributed along the height of the building as per the following expression as:

$$Q_i = V_B \times \frac{W_i h_i^2}{\sum W_i h_i^2} \tag{1}$$

Where, Q_i= Design lateral force at floor *i*,
W_i = Seismic Weight of floor *i*,
h_i = Height of floor *i* from base.

2. LITERATURE REVIEW

Takey and Wisley [1] (2011) have studied one of the seismic natural hazards. In the last three decades, significant progress has been made in the study of the effect of variation in seismic response of civil structures. Takei and Wisley have considered and analyzed high-steel steel moment-resisting building frames with and without separate steel bracing system sections. The author in his work, did the static analysis according to IS 1893: 2002 for the G+9 multistorey building structure located in Zone III by the Response Spectrum method using SAP2000 software in which the main parameters considered in the work are seismic performance of buildings i.e. bending moment, shear force, drift of the story and axial force were to be compared. The author also carried out the asymmetrical and unsymmetrical constructions with braces and found the suitability of bracing systems to resist seismic loads efficiently, and in comparatively braced systems such as diagonal, inverted V, X bracing and without bracing buildings that are horizontal or lateral loading was subject to the structure.

Kolekar and Pawar [2] (2017) in recent years, India's infrastructure system has grown at a time when a lot of research has been done in the construction sector. Along with the utmost importance of comfort and economy, safety also plays an important role in the design of any structure. Author has taken four types of mulltistorey structures in his work which are G + 3, G + 5, G + 7 and G +9 structure and is analyzed for two different plan layouts and different seismic zones. The two-plan area is assumed to be 9x12m and 12x15m for all cases. Analysis and results of the work have been obtained from the STAAD.Pro software. The author concludes that increasing the number of base shears, storey shear and base moment increases while increasing in storey. Furthermore, for a same storey, if extend zones from zone II to zone V, then the base shear, story shear, and base moment also increase and this is the maximum in zone V.

Raj and Philip [3] (2017) multistorey structures spanning urban areas are an unavoidable feature in the form of an open ground storey (OGS) structure, essentially to accommodate parking or reception lobbies on the ground floor. These structures have a high affinity that collapses during an earthquake due to the absence of filler as the soft bottom mechanism develops. Raj and Philip taken four types of multistorey structure i.e. G+4, G+9, G+14 and G+19 having rectangular and L shaped plane with same areas. The building was considered to be located in Zone IV as per IS 1893:2002. The response spectrum method was carried out for analysis and it was applied in the ETABS software. The author concludes that the time period obtained for the filled frame was much shorter than for the bare frame. The base shear obtained for the filled frame was much higher than the bare one. The increase in base shear is due to the stiffness of the infill walls, indicating that when OGS buildings are analyzed as bare frames, the base shear is underestimated. Also, the results show that MF is not required to be applied to the soft floor beam since the surge is enhanced. Due to the strong beam the demand will make it even higher. Increase seismic demands on columns. Indian standards recommend a higher MF value for low-rise buildings and at the same time it was unsuitable for high-rise buildings.

Deshmukh and Wankhade [4] (2020), the main challenge in front of structural engineers is to develop a lateral load resisting system which is effective in resisting the seismic loads and will get repaired easily as well as economically after an event of earthquake. The objective of the author was to achieve the rapid return to occupancy criteria. The link column frame (LCF) technique was applied. The LCF system overall exhibits three performance criteria, linear elastic, rapid return to occupancy and collapse prevention. In his work, the normal RC building (RCNB) was compared with the link RC-column frame system and link CFST-column frame system and it was concluded that in the case of RC_LCF structures the base shear of the structure increases and Increases even more. In the case of RC_CFLCF structures. The floor displacement and floor drift of the structure are reduced in the case of RC_LCF structures and further reduced in the case of RC_CFLCF structures.

Shoeibi et al [5] (2019) many structural systems have been studied and developed by researchers with a rapid return to occupancy capacity. Development and use of structural systems with altered buckling bracing, self-centred structural systems, and more. In it, it was concluded that the proposed method is a force-based method, with the DBE risk level in earthquakes, damage in members of the MF system being negligible and up to 5%. Furthermore, based on the evaluation of prototype structures by non-linear dynamic analysis, the proposed method successfully achieves the desired performance objectives. Results of nonlinear dynamic analysis indicate that the history deviations of the prototype structures are less than the deviations from the target at the DBE hazard level.

Siva et al [6] (2019) behavior of multistorey building during a strong seismic movement depends on the structural configuration. Irregular configuration, either in aircraft or altitude, is recognized as one of the main causes of failure during earthquakes. These irregular structures, especially those located in seismic zones, are a cause for concern. The author concluded that all cases of individual irregularities showed increased response compared to regular configurations under seismic loads. In these cases, the configuration with vertical geometric irregularity gave the maximum response. The combination of stiffness and vertical geometric irregularities showed a maximum displacement response, while a combination of recurrent corners and vertical geometric irregularities showed a low displacement response.

Gowda and Kumar [8] (2018) present scenario buildings with floating columns are a distinguishing feature of modern multi-storey building practices in urban India. Such features are highly undesirable in buildings constructed in seismically active areas. He studied a G + 30 floor analysis and concluded that the internal floor drift values would increase as we move to the lower floors and after a few levels, it would inversely vary. Dynamic analysis shows several practical results compared to static analysis. Model 4 is the highest in static, dynamic, and the lowest is 5. There is a considerable reduction of about 20% for response spectrum analysis compared to static analysis. The time period and the base shear value will not differ much compared to static and dynamic analysis, as these values depend on building parameters, not earthquake behavior.

Hadad et al [9] (2017) To make mulltistorey structures more robust and more rigid, which are more susceptible to seismic and air forces, the cross sections of the member extend from top to bottom and this makes the structure informal due to the safety of the structure. Therefore, it is necessary to provide a special mechanism and / or mechanism that improves the lateral stability of the structure. The oblique frames develop their collision with lateral forces through the bracing action of the diagonal members. The author concluded that the use of either type of bracing increases the lateral resistance of the bare frame depending on the type of bracing. The increase in lateral resistance of concrete and steel reinforcement was 200%, 142% respectively. The cracks in the backfill material and the separation of the surrounding concrete frames occurred in the initial stage of failure and this was evident from sample 4. The energy dissipation for reinforced and filled frames is always greater than for bare frames until the moment of failure. The increased values were 20%, 18% and 21% of bare frames for frames F2, F3 and F4, respectively.

Deshpande et al [10] (2017) a vertical load carrying member whose width is more than four times its thickness is called a wall. Earthquake damage depends on many parameters, intensity of ground movement, duration and frequency of material, geological and soil conditions, quality of construction, etc. The author concluded that different bricks with different densities affect the mass of the structure. When an earthquake occurs, the natural period of vibration occurs in a heavy-duty building and is shorter in a light-duty building. When the mass of each building is different from the natural time period of the building, it also varies, but a formula in IS 1893: 2000 does not include the effect of mass, which he referred to as a brick structure. is. When the natural time period of each structure is calculated from the time period formula described in IS Code 1893-2000, it is the same for all types of structures, but when calculating the time period by analyzing the structure from the ETAB software.

3. CONCLUSION

After reviewed the various literature it has been concluded that the work is extended to analysis the bare and braced frame structure by varying the floor level. Models of the frame are developed for multi-storey RC buildings with and without bracing systems to carry out comparative analysis of structural parameters such as base shear, lateral deformation, storey displacement, storey drift, bending moment and frequency under seismic excitation. In this work, G+10, G+15 and G+20 multistorey regular structure with six bays in the X-direction and four bays in the Z-direction has been considered. Additionally, the different types of bracing system have been considered to achieved the effect of structures.

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