ICRRD HIGH INDEX RESEARCH JOURNAL
(An Initiative of International Center for Research and Resources Development)
ISSN Number: 2773-5958, SSM Number: 201901038138(1347468-T), www.icrrd.com

Effect of Soft Story on RCC Building for Seismic Resistance

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KOD JALUR / BARCODE
e ISSN 2773-5958

Date Received: 30 December 2020
Date Accepted: 29 January 2021
Date Published: 20 February 2021
Volume -2, **Issue**-1, February 2021

Abstract: Nowadays severe earthquake is major issues in modern life more natural hazardous of building, damages and collapse. In this paper it is shown that a huge figure of breath reinforced, and masonry buildings are affected and serious destruction to the structural elements and sometimes collapse around the world. Therefore, the reason for the soft story of the building. Whereas destruction and subside because of the soft story are consistently distinguish in buildings, it in addition be enlarged in different structures. In this paper shown that the lower portion of the building throughout the concrete columns seemed to have a soft story in where the columns give sufficient resistance to the shear during the entire earthquake. The aim of the review paper is studying this problem using some economical techniques like infill of a masonry wall or proper bracing or retrofitting of building. Proper placement of the attaching of bracing in different position to design consecutively to reduce soft story impact of that same the existing of the building.

Keywords: Soft Story, Reinforced concrete, Infill walls, Shear-wall, Eccentric Bracing, Retrofitting.

Introduction

Enormous damage to property and human being is happening due to earthquake. Before 20th century people didn't have sufficient knowledge about earthquake though they were promoting fear and destruction around the world since ancient times. Seismology, containing the research study from all parts of earthquakes, has presentenced feasible solution to fast-standing answers such as whether as well as how earthquakes happen.

Earthquakes are affected by components of the Earth's surface, which instantly transfer relative with each other, as per the Elastic Rebound Theory (Reid 1906). Faulting is now the most common reason for earthquakes; i.e., splits throughout the crust plates of the earth, especially in which the plates force or slide down one another. Sometimes the geological plate boundaries, especially where the plates are pushing together or sliding past each other. The plates are sometimes stuck around each other, able to immediately start releasing the power that building up. The plates move away once this power develops powerful enough. When two components are pushed in different directions next to each other, they may well remain together for several years, but gradually the forces working on them will help to prevent them to crack off and shift. This dramatic shift through the rock is shaking the adjacent surface. According to Al-Taie and Albusoda (2019), Liquefaction is the one of the main reason of earthquake. Earthquake does not happen due to impervious soil deposit liquefaction. Disturbance occurs due to being strong enough to conduct or cause it. Based on historical, geological, compositional and state considerations, liquefaction sensitive can evaluated. The nature of the ground motion can be carried out by liquefaction.

Irregularities like soft story is one of the most important causes of building damages during recent earthquakes identify in almost investigative articles and researches (Ozcebe, 2004 and ogangun, 2004). Infill wall that is not considered the load-bearing wall that is not used between stories is known as a soft story. This study analyses soft story by using believed nonlinear static and dynamic analyses of history for mid-rise RC structures. The 4 and 7 story 3D building modes are structured (TEC 1975).

Nowadays masonry walls are generally used in the construction of reinforced concrete structures in the world. The lower story of the high-rise multi-story building is free of the masonry wall. This type of structure is done because the parking requirements are fully equipped. Because of this, the building's structural stiffness is decreasing and also increases the building's potential for damage during earthquake. The soft story may occur in any story but in bottom story our general practice is provided(Khan and Rawat 2016).The existence of masonry walls has played a key role in the seismic response to RC framed construction. This block up panels or infills are not considered in the structural design process and considered as non-structural or architectural component. Open parking level at ground floor of a building has soft story action (figure-1). Parking provisions has become an inescapable feature for the most multi-storied or present day building (figure-2). Proper mechanism is needed to extend the lateral strength and stiffness of the soft story (Manual for seismic design of reinforced concrete, PWD, Bangladesh). Retrofitting is one of the soft story's most feasible methods to increase the lateral stiffness and strength of RCC frames. Steel braced frames are used inside soft story frames as another retrofitting method(Javadi and Yamakawa 2019).

In this paper an attempt has made to review the past researcher about the building design as an earthquake resistance structure which has sufficient ductile to withstand during the earthquake. Researchers also has made to review the minimize damage of building during the earthquake and reduction of the human life death. In this paper researcher also attempt to economical various structural system uses during earthquake.

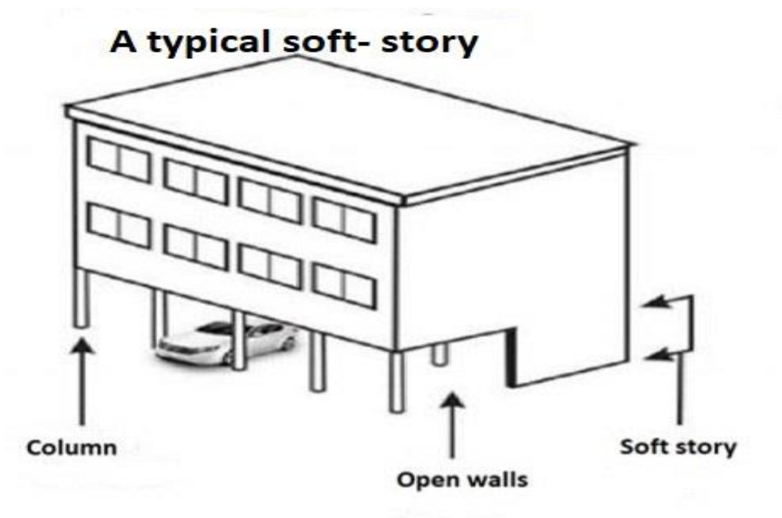

Figure:1 Soft story building cross section (Massah and Davor,2011)

Figure: 2 Ground floor soft story example (Massah and Davor,2011)

Soft Story

A weak building story that has significantly reduced resistance or in adequate ductility or stiffness to withstand the earthquake includes building stress. According to Massah and Dorvar (2011), soft story building are distinguish as which has a lot of open space. The bottom floor of a building with open space for parting is characterized as spilt building and this open-space story is defined as a soft story (BNBC 1993). According to UBC-1997 and ASCE-2002 and the story is considered a soft one if the lateral stiffness ratio is less than seventy percent of the above or less than Eighty percent of the average lateral stiffness ratio of three stories.

Extreme Soft story

In the above story 60 percent lower lateral stiffness or 70 percent lower than the common lateral stiffness of the three stories above is called and extreme soft story.

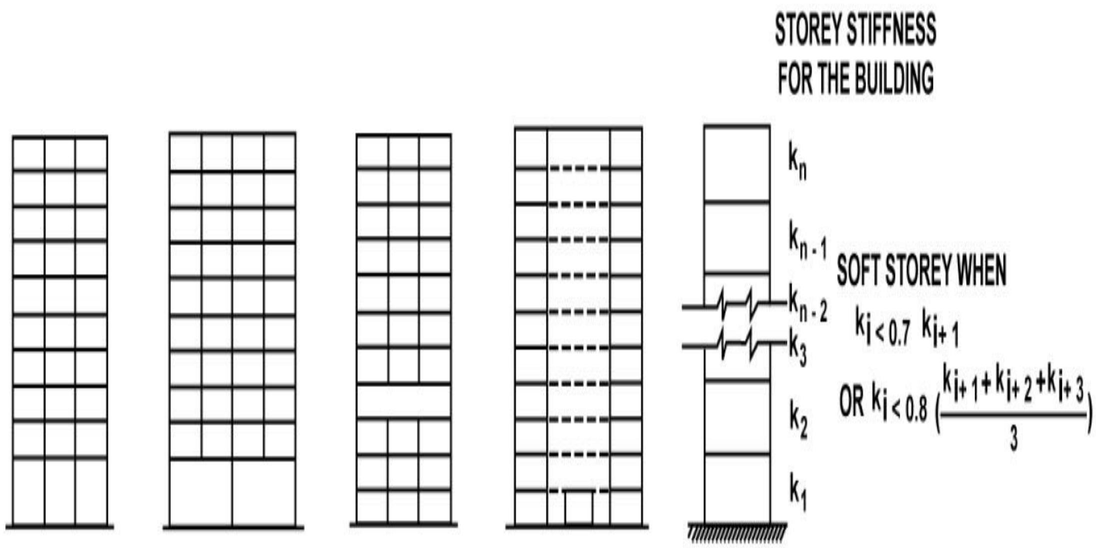

Figure:3 Soft story of building (BNBC 1993)

Irregularities

Horizontal inertia forces are generated in building when a building undergo an application of seismic energy i.e. excitation. Presume that, the resultant of these forces act thought the center of mass (C.M) of the building structure. These forces are resisted by the vertical members of the structure. The total resultant of arrangement of forces act through a point named as center of stiffness (C.S). Eccentricities are developed in the structure when center of mass and center of stiffness unable to coincide, also generate torsion. When the building experiences lateral loads, the event of Torsional coupling happens when lateral loads and resistant force interacting. Torsional coupling produce greater amount of damage in the structure or buildings (Varadharajan, Sehgal, and Saini 2016). Moreover, Placement of the RC masonry wall building seismic damage impacts from irregularity in-plan. The nonlinear time-history analysis analyzes five different building with a large range of different infill wall and seismic damage assessment. The degree of interdependence is achieved in the irregularities between infill wall and the analysis of the damage response. Significantly, the irregular placement of infill walls causes significant seismic damage to the irregularities of the infill wall(Kostinakis and Athanatopoulou 2019). Apart from this, the increase in seismic demand in comparison with regular structures has observed for the first-story weak and soft structures.

The effect of stiffness irregularity has found less than the effect of strength irregularities and the effect of force irregularities has shown to be greater in building with discontinuous distribution in strength, stiffness, and mass(Soni and Bharat B. Mistry 2006).

The soft story failure

Generally bottom portions of a building with open spaces and car parking have no infill and considered as soft story. When soft story collapse during earthquakes, consequently whole structure collapse resulting major damage of the building. As a result whole building totally not usable. So special arrangement is required to extend the lateral strength and stiffness of the soft story. For designing these type of building, dynamic analysis may be carried out intergrading the strength and stiffness of infill wall and inelastic deformation of the soft story. As an alternative, structural elements of a building of particular soft story are to be designed for 2.5 times of story. Shears also neglecting effect of infill walls, moments calculation under seismic loads. Shear walls are considered symmetrically in both directions of the structure, feasible are to be designed for 1.5 times the lateral shear force calculated before. According to Arunkumar and Devi (2015), Soft story building is known as soft story failure during moderate and severe earthquake.

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Figure: Soft story of failure (Khan and Rawat 2016)

Eccentric Bracings in Soft Story buildings

These are many strengthening system for soft story. Considering economy, steel bracing is a choice for infill RCC structure. Steel bracing system provides expected stiffness to the soft story. X-bracing is more popular for investigated strengthening of weak story by various researchers. (T.A. Antonopoulos and S.A. Anagnostopoulos, 2011 and F. Hejazi, S. Jilani, 2011).

Review of Effect of Soft Story on RCC Building for Seismic Resistance

Fintel and Khan (1969) perceived the idea of the soft story long ago. The goal of this idea is to decrease the top speed of a building by allowing the first story column to produce though an earthquake and generate energy digitization activity. Due to excessive drift on the first floor and P-Δ, the building seems to collapse on the output column.

On the other hand, another methodology for soft story building that places Teflon sliders at the highest point of the reinforced concrete framed shear-wall in this framework. All such shear walls are limited by columns and beams and are designed to demonstrate a component of the superstructure's heaviness and lateral load controlled by the Teflon sliders' frictional characteristics. The first story staying columns are intended to suit large drift for ductile behaviour. Thereby also, in the seismic analysis of structures (Mo and Chang 1995)

Besides, the resistance of lateral force due earthquake is more effective with shear wall framed structure rather than non-shear wall framed structured. The displacement of the building increases due to the opening in the shear wall. Changing the placements of the shear wall affect the forces' attraction. The significant reduction in the building's impact and movement occurs due to the position of the shear wall. Building constructed without a shear wall is a problem and adaption should be taken in high seismic places.(Paul and Khedikar 2000).

For this reason, Lee and Co (2004) therefore evaluated the effect on the overall seismic response characteristics of the shear-wall located in the bottom soft stories. Therefore, Mastrandrea and Piluso (2009) proposed a structural approach to enhance the destruction of a global such in soft story structures for the irregular braced frame.

Moreover, 15 soft stories are considered for soft-story building frame seismic analysis. The soft story is caused by various types of floor height and ignored the masonry wall. Frames are analysed and the results obtained are maximum moments, maximum axial forces, maximum shear force and maximum story drift performed by various parameters (Ali et al. 2017).

Arlekar (1997) featured the significance of specifically understanding the connectedness of the open first story. The blunder involved in displaying such building as total bare frames, ignoring the proximity of Infills in the upper stories, was brought out with different models of analysis. Kanitkar (2004) therefore studied a five-story soft-story building with the intension of evaluating the new measures for the earthquake resistant layout of structures covered by code IS1893:2002.

Apart from this, the soft story building for commercial and residential purpose is more useful. Under the effect of earthquake, both frames are prepared and checked under the bare frame and braced frame. The base shear in the bare frame is larger and the bracing in the bare frame reduces the base shear. More displacement and drift found in the bare frame. By using bracing stiffness of the story increases(Akbar and Kalwane 2018).

Alternatively, Umadevi et al (2015) studied the construction of RC frames with different models implementing bare frame, filled frame and open first story frame. For example, the parameters are considered for base shear, period, natural frequency, story drift and bending moments. The SAP2000 product is used to examine the entire frame models. Modal analysis was completed to get characteristic frequencies and mode shapes and the outcomes are contrasted and accessible trial results got from earthquake table tests results directed at CPRL, Bangalore and the models are authorized. Equal static and response spectrum analysis are performed using Bhuj earthquake information to acquire displacement for each of the zones (Zone II-V0 as per IS 1893 (part1):2002, the time history examination is performed using Bhuj earthquake information.

The natural soft story frequency decreases in contrast to MI by 60%. Base shear is seen to be the best for exposed edges and the most significant for contours of MI. It is being used that, when contrasted with the other two conditions the displacement in the soft story is greatest in the lower stories, showing it's critically in the earthquake resistance. Although in the above floors, when compared with soft story situation, the displacement is higher in bare frame. It can be concluded that Umesh P. Patil et al (2015) examined the seismic performance of two G+15 structures, one of which is made of composite steel concrete material and the other of which is made of RCC, situated in the earthquake zone III. For the analysis of RCC and soft story composite structures, the equivalent static and response spectrum method is used. Multiple vibration modes are considered in this method where each mode's base shear can be calculated separately. In composite models, story drift is reduced by 10% compared to soft story level RCC. The drift in soft story can be controlled by providing1) Shear walls 2) Bracings 3) Stiffer column 4) Lateral load resisting system. The beams and columns in the soft story are structured by a component of 1.5 times the story shear by 2.5 times of acquired bending moments and shear forces and shear walls.

Thus, Tesfarariam and Liu (2010) used extraordinary soft story documents as a grouping of vulnerability systems for seismic hazard assessment of the reinforced building. Afterwards, It is seen that due to the fact that IS 1893's new soft story structures are a good thing overall, more assessments are required to fully classify the consequent structures in terms of their ductility capacity and secure inelastic activity under normal seismic loads. As a result, the goal of this paper is to think through bracing systems about the impact of soft story on structural behaviour of tall structures and retrofitting and seismic rehabilitation of soft-story structures. In addition, look at about the soft story structural reaction of the tall structure of various types of bracing provisions on the construction and consider the absolutely perfect structure of soft-story structures of earthquake resistance by acknowledging the necessary level of implementation.

Apart from this, the location of the attentiveness soft story demands due to th the building's soft story. The primary seismic analysis tools are being used as score modifier for the different soft intensity from the pushover statistical data(Dya and Oretaa 2015).

Furthermore, soft basement of RCC building performed during earthquake. Soft RCC building basement performs during the earthquake. The location of the severe same seismic hazard zone, according to IS code, designed the five storied RCC building with masonry infill wall. Exposure of dynamic earthquake loading subject to different RC frame behaviour arrangements. As per the IS 18936 (2000) code, the outcome of the soft ground floor, soft basement, bare frame and infill frame comparison is made. Compared to the soft story and infill walls below the plinth, the earthquake resistance structure provides better results below the plinth infill wall(Halde and Deshmukh 2015).

In addition, the soft-story irregularities occur due to different ground floor heights and masonry wall-filling. Building height variations 4 models are crated. Analyze the models individually on the ground floor with infill wall and without the infill walls. The story irregularity doesn't occur because the height of the ground story increase the soft story coefficient. The soft story irregularities gives more critical results on the ground story without in the wall rather than the height of the ground story. Using the infill wall on the ground floor, the structural behavior is more linear even though the height of the ground floor increases(Uzun and Cogurcu 2018).

Moreover, ETABS 2013 is using a time history analysis, static analyzes and an analysis of the response spectrum analyze ten models as a special time-resistant frame. The model contains the top floor masonry infill wall including bare model swimming pool. The periphery of the building brick masonry wall is used in the diagonal strut form. The model is similar to model 2, but it does not fill the top floor with a masonry wall. The model has no ground and top floor masonry infilling, but only the periphery of all floors is brick masonry filling in the form of a diagonal strut. The corner is provided with additional L shape, T shape, swastika shape, I shape and channel shape shear wall and also plane shear walls at the center of the building periphery are furnished. Compared with the other models, model 1 produces higher drift values.

The dangerous sway method occurs that has the highest story drift value found in the bottom story. To avoid the soft-story failure, shear wall is necessary in the building frame. (Kalyani 2015).

Conclusion

This literature review paper intends to review the previous studies conducted at the bottom of the story by different types of structural systems such as bracing, infill wall. In the following important points, the conclusion of this review paper can be summarized:

- RC outline structures with open first stories no perform effectively against shaking generated by severe earthquake. The enormous opening which is situated on the lowest floor makes rigidity relatively low think about rigidity of the above story. The lower floor's stiffness is 70% lesser than the above floor's stiffness. This ultimate causes occurrences of soft story. The stiffness determines the lateral stiffness of a structure means all the stiffness created by the column, every story includes bracing & shear wall. So the low strength that causes the failure in the lowest floor happiness especially in the time of earthquake. For a structure which has not an opposition lateral load resistant segment like shear wall or bracing that strength is considered to be exceptionally week simple during the earth quake.
- It is being investigated the efficacy of additional bracing in different arrangement to a building for the reduction of soft story seismic response.
- The location and numbering of bracing is an important factor for the displacement of soft story structure at period of earthquake. The soft story can be eliminated by adding the bracing to consider floor. But there is no bracing at top floor. So the amount of displacement top floor remains very high. This result proves that bracing makes different result only in that is provided with bracing.
- The vertical movements and the horizontal movements of a building are much reduced at the period of earthquake which have installed bracing in compared to those models which has no bracing. So, it proves that using bracing is effective to reduce the soft story effective structure in the response to shaking during earthquake.
- This result proves that bracing makes different result only in that story is provided within bracing.
- Because of, uses of the infill wall in the bottom story reduce the soft story effect where not use infill wall open space in the bottom story.
- Because of, using the shear wall, stiffener and bracing in the structure reducing the story drift and increase the story shear and bending moments which are very effective during the earthquake.

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