Review on Retrofitting of Soft Storey Building Using Different Structural Systems

Rahul Singh Bhadoria[1], Ms. Chaitali Gangwal[2], Dr. Chaitanya Mishra[3]
[1]Dept of Civil Engineering
[2]Assistant Professor, Dept of Civil Engineering
[3]Professor & Head, Dept of Civil Engineering
[1, 2, 3] ORIENTAL UNIVERSITY, INDORE (M.P.)

Abstract- *In this segment we will be discussing about two different sub topics. In the very unit we will discuss the summary of some latest research papers in this domain. In the next one we will discuss an overview of existing design provisions for OGS buildings as per various design codes and about different concepts and literatures given by the researchers.To supplement automated search, a manual search was also done. The manual procedure involved searching the reference sections of the papers identified by the automated search and referring the text/reference books. Any relevant references within those papers/reference books were followed up on.*

Keywords: Base Shear, Boundary conditions, Infill walls, Maximum story drift, Soft storey, Seismic analysis.

I. INTRODUCTION

The presence of infill walls in the upper storeys of the OGS building increases the stiffness of the building globally, as seen in a typical infilled framed building. Due to the increase of global stiffness, the base shear demand on the building increases. In the case of typical infilled frame building, the increased base shear is shared by the both frames and infill walls in all the storeys. In OGS buildings, where the infill walls are not present in the ground storey (no truss action), the increased base shear is resisted entirely by the ground storey columns, without any load sharing possible by adjoining infill walls. Buildingsoscillateduringearthquakeshaking.Theoscillationcausesinertiaforceto beinducedinthebuilding.Theintensityanddurationofoscillation,andtheamountofinertiaforceinducedinabuildingdependonfeaturesofbuildings,calledtheirdynamiccharacteristics,inadditiontothe characteristics of the earthquake shaking itself. The important dynamic characteristics of buildings are modes ofoscillation and damping. A mode of oscillation of a building is defined by associated Natural Periodand Deformed Shape in which it oscillates. Column is the most critical member in the buildingsubjected to earthquake loading because failure of a column can affect the stability of the wholebuilding. Column mayfails due to lackof ductility,strengthand weakbeam column joint.

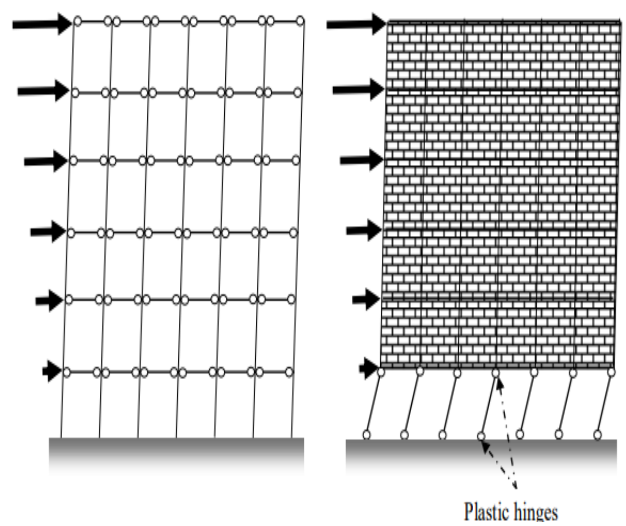

Figure1: Difference in behaviour between bare frame and soft storey building system

II. REPRESENTATION OF IMPORTANT DATA

- Omkar P. Khandagale and Prof.Jayant.S. Kanase(2024) In this paper The building with soft storey is analysed using softwares like E-tabs, Staad-Pro and SAP 2000, and by methods such as time history analysis, response spectrum analysis and pushover analysis. In this proposed paper, we are going to study the literature using the previous researches for further analysis and design of multi-storey building with multiple soft stories. It shows that use of shear wall is a good way to provide more level of ductility and getting more stable behaviour and appear to be a novel approach to reduce effect of soft story in seismic response .in the other hand, vulnerability level of existing high-rise building can be increased by adding different arrangement of shear wall on building and it will help for retrofitting of structure to resist the major portion of lateral load induced by an earthquake.
- Mohammad AreebKhaleqy and Abdul TawfiqPouya(2023) in this article, all of the irregularities

introduced by ASCE/SEI 7-19 were studied using 11 models, one with all of the regular configuration and ten with one irregular configuration, and at the end, all of the maximum storey displacement, maximum storey drifts, diaphragm max over average drifts, and stability index of the ten models were compared with the regular model for a better understanding of the behaviour of the irregularity in a structure. The result marks the conclusion that most of the irregularities had various outcomes compared to the regular model. The most unexpected result was with the mass irregularity model, that the structure behaviour got better with the mass irregularity on the top floor.

- MdKhairuzzaman and MdZahid Hasan Sabuz (2021) 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. 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.
- Santiago Mota-Páez and David Escolano-Margarit (2021) Reinforced concrete (RC) frame structures with open first stories and masonry infill walls at the upper stories are very common in seismic areas. Under strong earthquakes, most of the energy dissipation demand imposed by the earthquake concentrates in the first story, and this eventually leads the building to collapse. A very efficient and cost-effective solution for the seismic upgrading of this type of structure consists of installing hysteretic dampers in the first story. This paper investigates the response of RC soft-story frames retrofitted with hysteretic dampers subjected to near-fault ground motions in terms of maximum displacements and lateral seismic forces and compares them with those obtained by far-field earthquakes. It is found that for similar levels of total seismic input energy, the maximum displacements in the first story caused by near-fault earthquakes are about 1.3 times larger than those under far-field earthquakes, while the maximum inter-story drift in the upper stories and the distribution and values of the lateral forces are scarcely affected. It is concluded that the maximum displacements can be easily predicted from the energy balance of the structure by using appropriate values for the parameter that reflects the influence of the impulsivity of the ground motion: the so-called equivalent number of cycle.
- Hitenkumar L. Kheni and Krishna Kakadiya (2019) In order to take into account 8 and 10 storey frames with 5*5 bays are modelled since most of the framed structures in Surat have number of stories ranging between five to twelve with minimum 3*3 to maximum 6*6 bays. The span length for the bays is chosen as 4.5m in all the models considered. The story height in the models is chosen as 3.2m for all the floors except the first floors. In order to carry out a parametric study to examine the soft story irregularity, the height of the first story of the models is kept as the selected variable. Three different heights that are considered for the first floor are: 3.2m, 4.2m and 6m. With these three different heights for the first floor the total number of analyzed models reaches to 12. In view of the results obtained by the seismic analysis of the considered building structures, following primary conclusions on the observations of behavior of the models are obtained as: The displacement estimates of the codal lateral load patterns are observed to be smaller for the lower stories and larger for the upper stories and are independent of the total number stories of the models. The uniform lateral load pattern leads to overestimations of displacements for all of the models and deformation levels. The estimations of the first mode lateral load pattern leads to more accurate displacement, the deviations on the results of this lateral load pattern decreases due to the existence of the soft stories as the number of stories and number of spans increase. Depending on the increase in the height of soft story irregularity level of the models, the results of the first mode, code and uniform lateral load patterns approach to the results of nonlinear time history analyses.
- Vismay Patel and Dhruv Patel (2020) From the study of above literature it can be conclude that, • In multi-storey buildings, provision of shear walls is found to be effective in increasing the overall seismic response and characteristics of the structure. Shear wall ultimately increases the stiffness and strength of the structure and affect the seismic behavior of the structure. The considerable reduction in lateral displacement is observed in the structures having shear wall as compare to structure without shear wall. The reduction of displacement of storey is due to increase in stiffness of structure. For better seismic performance, a building should have proper lateral stiffness. Low lateral stiffness leads to large

deformation and strains, damage to non structural elements.

- Rozaina Ismail, Khalid Ismail and IzzulSyazwanIshak (2018) In this research, one residential building of soft storey situated at Seremban, Negeri Sembilan is selected. SAP 2000 which is structural analysis software is being used to determine the maximum displacement and base shear of the soft storey. Four different types of model are introduced to do the modeling. Acheh, Indonesia earthquake data is considered for time history analysis. The comparison of these models for different type of bracing system like X bracing type and V bracing type is carried out. Based on this comparative study, it can conclude that model 3 which is V bracing type is the best and effective method of bracing system for soft storey building. From the result obtained, it shown that V bracing has the lowest value for maximum displacement compared other 3 models. In addition, V bracing type also showed the lowest value of base shear. Thus, it proved that V bracing type reduces the maximum displacement and base shear of the soft storey building.
- Akshay S. Paidalwar and G.D. Awchat (2017) This study investigates the soft storey behavior due to lack of infills at ground floor storey and existence of this case by means of linear static and nonlinear static analysis for midrise reinforced concrete building. Soft storey behavior due to change in infill's amount is evaluated in view of the displacement, drift demand and structural behavior. Stiffness of the structure is an important factor in case of OGS type building, in the present study infill can improve stiffness of structure but in to some extent, that is not enough to save structure against seismic effect. Problem of OGS buildings cannot be identified properly through elastic analysis as the stiffness of OGS building and Bare-frame building are almost same
- Romanbabu et.al. (2017) in this study, three geometrically similar frames, having different configurations of masonry infills, has been investigated. The frames have been modelled in OpenSees simulation platform, utilising material and section properties available in its library. This paper mainly focusses on studying the effect of masonry infills in the RC frames and its hysteretic response during an earthquake event, where it is expected to go into the non-linear range. Static non-linear cyclic pushover analysis has been carried out to predict the seismic performance of the study frames. A detailed discussion on the modelling, hysteretic response, lateral strength and ductility of the RC frames with masonry infills has been presented. It has been observed that the lateral strength of the infill frame is significantly higher compared to bare frame and open ground frame. All the frames started yielding from 0.75% drift level. The bare frame and open ground frame started showing load degradation after 2.75% drift level, while fully infilled frame started degrading after 3.5% drift level. Overall performance of fully infilled frame is far better than that of the bare frame and open ground frame.
- Kiran et.al. (2017) This paper focuses on studying the effects of soft storey configuration in the buildings and remedying it by using different structural arrangements, such as shear walls, diagonal steel bracing and cross steel bracings. The linear dynamic analysis (response spectrum analysis) has been adopted for various symmetrical buildings such as low rise (G+6), medium rise (G+14) and high rise (G+24). The responses of the models, in terms of storey drift, lateral displacement, storey shear, storey stiffness and bending moment variation are compared for different configurations and presented. It can be effectively concluded that the provision of shear walls can reduce the effects of soft storey to a much greater extend. Cross steel bracings also play an inevitable role in reducing the soft storey effect in the buildings. As the height of the building increases, the factors evaluated in this paper exert a major impact on the building's stability, thus necessitating the need for in depth study in this area.
- Lakshmi Baliga, Bhavani Shankar (2017) In the present study infill walls are modeled as equivalent diagonal strut and bracings are provided by considering different steel sections and whole performance is done through Equivalent static analysis method by using Etabs-15 software. From the above data collected it is observed that the storey shear for the M3 is 57.13% more than the M1 at the roof level in X-direction. From this it is concluded that providing bracing in a building increases its storey shear.

III. SUMMARY OF LITERATURE REVIEW

The OGS buildings is considered to be as extreme soft-storey type of buildings in most of the practical situations, and shall be designed considering special provisions so as to increase the stiffness in lateral direction or strength of the soft/open ground storey. A dynamic analysis is suggested which includes the strength and stiffness effects of infill walls and also the inelastic deformations of members, particularly suggested in those soft-storey of such buildings. The members in the soft/open storey shall be designed as per suggested by the codes considered in this project. However, IS 1893-2002, does not give any explicit recommendations on the modelling of the infills for the open ground stroey building frame. In the absence of infill wall, more accurate analysis such as dynamic analysis, an equivalent static lateral load analysis neglecting the infill walls, that is, a bare frame analysis, can be employed provided the bending moments and the shear forces in the critical members (columns in the ground storey) shall be enhanced by the factor as recommended by the code.

IV. METHODOLOGY

This project work is carried out using ETABS that is a very powerful tool which is widely used for design and analysis of multistory buildings. It is used to evaluate basic and advanced systems under static or dynamic conditions. For a refined assessment of seismic performance, modal and direct integration time-history analysis, may couple with p-delta and large displacement effects. The modeling of various regular and building is very easy in ETABS.

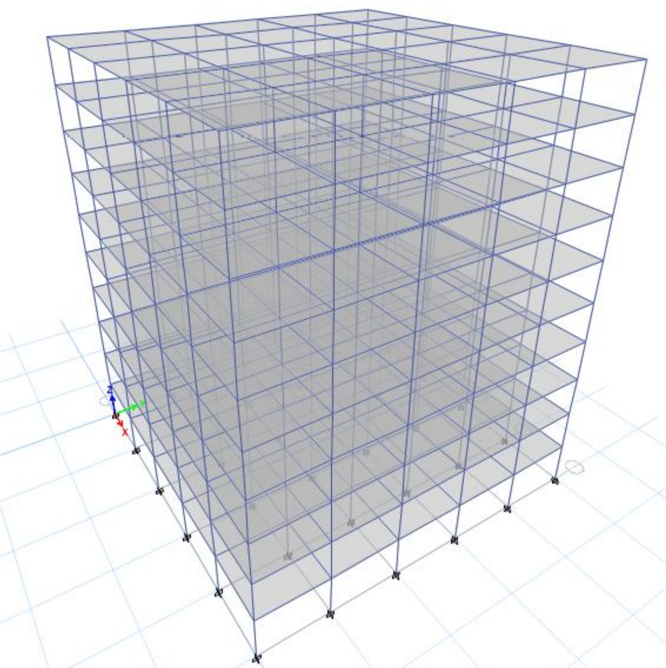

Figure 3: 3D view of the structure

Table 1: Cases Considered for the Study

Model
Model 1 (Bare frame)
Model 2 (Building frame with soft storey in GF)
Model 3 (Building frame with infill at floors)
Model 4 (Building frame with soft storey & shear wall)
Model 5 (Building frame with soft storey & Bracing)

V. RESULTS

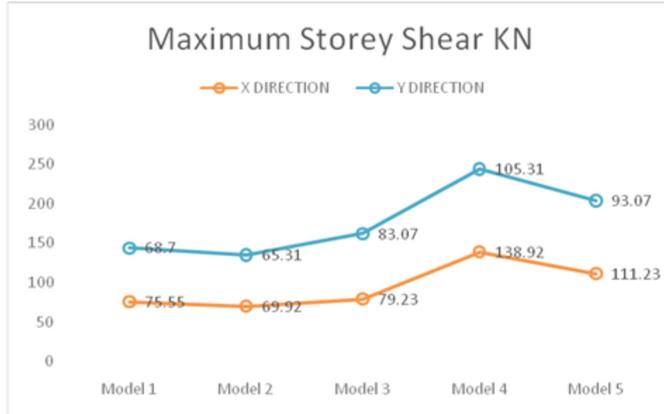

Figure 5: *Comparison of Storey shear*

As the height of the building increases, the storey shear gets reduced. The maximum storey shear occurred at the bottom storey of the buildings. By the provision of different structural arrangements in the building, the storey shear is increased for which the buildings need to be redesigned. From Fig. 5, it can be stated that shear wall configuration can resist larger lateral force which means that it can take larger force at bottom storey.

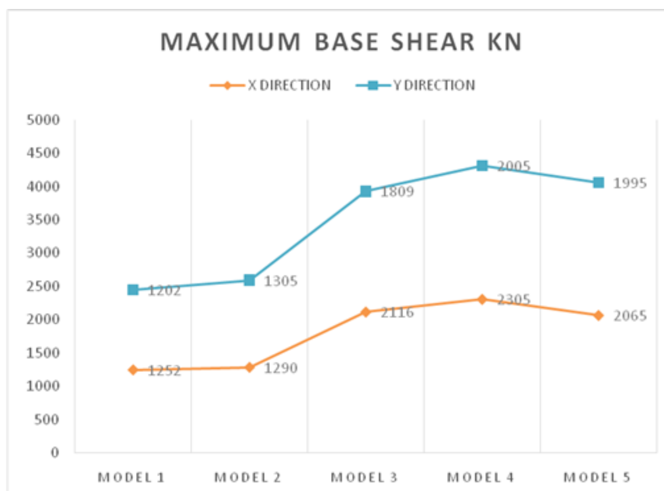

Figure 6: *Comparison of Base shear*

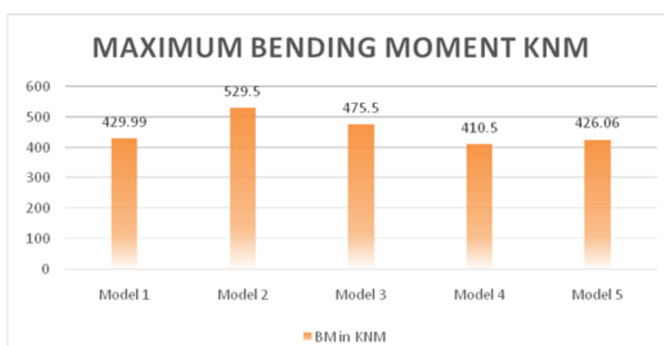

Figure 7: *Comparison of Bending Moment*

VI. CONCLUSIONS

In open ground storied building since there is no infill wall at the bottom storey, there will be large displacement occurring at the bottom part. From Fig, it can be seen that there is large displacement occurring at the bottom storey of the building. But by the provision shear wall the overall displacement of the building can be reduced to much extent. Cross steel bracings also reduce the displacement to certain extent. Seismic analysis of Bare frame structure leads to under estimation of base shear. Under estimation of base shear leads to collapse of structure during earthquake shaking. Therefore its important to consider the infill walls in the seismic analysis of structure. It can be pointed out that the maximum storey drift is occurring in the case of open ground storey building. As the height of the building increases, the storey drift is considerably reducing, i.e. there is a larger drift at bottom storey as compared to other storey of the open ground storey building. It can be seen that the addition of shear wall greatly reduces the ground storey drift. As compared to the provision of diagonal steel bracing, the cross-steel bracing reduces the storey drift to a greater extent.

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