Effect of Soft Story Building With Respect To Different Types of Infills

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Abstract- *Soft storey building played an important role in development of multistoried buildings in India. Functional and Social need to provide car parking space at ground level and for offices open stories at different level of structure far out-weighs the warning against such buildings from engineering community. With the availability of fast computers, so that software usage in civil engineering has greatly reduced the complexities of different aspects in the analysis and design of projects. In this paper an investigation has been made to study the seismic behavior of soft storey building with different arrangement in soft storey building when subjected to static and dynamic earthquake loading. It is observed that, providing infill improves resistant behavior of the structure when compared to soft storey provided*

Keywords- seismic loads, soft storey, static and dynamic analysis

I. INTRODUCTION

Open storey building provides facility for car parking in highly populated areas. Hence the trend has been to utilize the ground storey of the building itself for parking or reception lobbies in the first storey. These types of buildings having no infill masonry walls in ground storey, but all upper storey's unfilled in masonry walls are called "soft first storey or open ground storey building." Experience of different nations with the poor and devastating performance of such buildings during earthquakes always seriously discouraged construction of such a building with a soft ground floor. This storey known as weak storey, because this storey stiffness is lower compare to above storey. So that easily collapses by earthquake. Due to wrong construction practices and ignorance for earthquake resistant design of buildings in ourcountry, most of the existing buildings are vulnerable to future earthquakes. So, prime importance to be given for the earthquake resistant design. The Indian seismic code IS 1893 (Part1): 2002 classifies a soft storey as "one in which the lateral stiffness is less than 70 percent of that in the storey above or less than 80 percent of the average lateral stiffness of the three storey's above.

II. LITERATURE REVIEW

Aditya deshmukh, analysed RC framed building (G+10) with open ground storey located in Seismic Zone-II, III, IV and V is considered. The main objective of present study is the study of strengthing performance of Open ground storey(OGS) buildings according to various cases such as: (a) bare frame building (b)building with uniform infill in all storey (c) building with OGS (d) OGS with stiffer column (e) OGS with corner shear wall (f) OGS with corner cross bracing (g) OGS with composite columns. The separate models were generated using commercial software ETABS. Infill stiffness was modeled using an equivalent diagonal strut approach. Parametric studies on displacement, storey drift, shear force, bending moment and base shear have been carried out using equivalent static analysis to investigate the influence of this parameter on the behavior of building with OGS.

Akhilesh Yadav and Dr. A. K. Mishra, analysed open ground storey building have infill wall in all the storey except ground storey of the building due to irregularities of the structure of the building have altered under the lateral loads toward the building. For the designing of the building engineer ignores the stiffness and strength of the infill wall because it is believes that it is conservative design and for the open ground storey beam and column is used the 2.5 multiplication factor to all the beam and column for ground storey is recommended by Indian slandered code IS1893:2002. In the design offices engineer experienced that the multiplication factor 2.5 is not realistic for the open ground storey low rise building and required critical assessment of the multiplication factor for open ground storey building. Therefore, in this thesis the objective is to assess the effect of infill wall, check the multiplication factor and effect of support condition of the building. In this analysis, the multiplication factor 2.5 is seen that too high for the open ground storey low rise building. The problem the problem of open ground storey low rise building cannot be properly identified through the elastic analysis as the stiffness of open ground storey building and similar bare frame is same. According to the nonlinear analysis of the OGS low rise building fails through the soft storey mechanism at a comparatively low base shear and displacement and the mode of failure is found to be brittle. In this analysis shows that the support condition of the building influence the considerable and important parameter for the multiplication factor.

Amol Karemore and Shrinivas Rayadub analyzed urban ground storey of frame building is generally kept open (i.e. soft storey) for parking or reception lobbies. Upper storey have brick infill panels which provide certain stiffness to upper storey of structure, this increases forces, displacement, storey drift and ductility demand in ground storey. OGS (i.e. open ground storey) buildings are generally collapse during the earthquake due to soft storey effect. Indian Standard IS 1893:2002 allows analysis of OGS buildings without considering infill stiffness but in compensation of stiffness discontinuity, magnification factor 2.5 is to multiplied to shear force and bending moments of beams and column calculated under seismic loads of bare frame.(i.e. ignoring infill stiffness).However many structural engineer experienced that magnification factor 2.5 is not realistic for OGS building. Engineer believes that ignoring infill stiffness leads to conservative design. This leads assessment and review of code recommended magnification factor 2.5 for open ground storey building. The objective of paper is to check applicability of magnification factor 2.5 for OGS building.

Deepak and Mr. Vaibhav gupta investigated Building an open ground floor are considered vertically irregular buildings to IS 1893: 2002 requires a dynamic analysis considering the strength and rigidity of infill walls. IS 1893: 2002 also allows the equivalent static analysis (ESA) of CGO buildings ignoring the strength and rigidity of infill walls, provided a multiplication factor of 2.5 is applied to the design forces (moments bending and shear forces) in the columns and beams of a floor on the ground. The objective of this study is to examine the rationality of this approach. A framed existing RC building (G + 3) open floor land located in seismic zone V is analyzed for two different cases: (a) given the filling strength and stiffness and (b) without taking into account the filling strength and rigidity (frame). The infill weight (and associated masses) has been modeled in both cases by applying the static dead load. Non-integral filler walls subjected to lateral load behave like diagonal struts. Thus, a filling wall can be modeled as a "compression only equivalent leg in the building model. Rigid joints connect the beams and columns but pin joints connecting thespacers equivalent to the beam-column joints. Infill stiffness was modeled using a diagonal approach according to Smith and Carter (1969). Linear static and dynamic analyzes of the two building styles are performed to compare the strength of demand in the frames open ground floors. The specified multiplication factor code is compared with the ratio of their strength demands. Two different support conditions are taken into account in the analysis to check the effect of supportive conditions for the relative strength frame application. Considered support conditions are: pinned end and fixed-end conditions. Non-linear static (pushover) analysis is performed for all building models considered. First pushover analysis is made for incremental gravity loads as load control. The lateral pushover analysis is followed after the pushover of seriousness, movement control.

C. M. Ravi Kumar, K. S. Babu Narayan and Reddy D. Venkat, analyzed as more and more emphasis is being laid on inelastic analysis of RC framed structures subjected to earthquake excitation; the pushover (non-linear static) analysis is in forefront compared to time history (nonlinear dynamic) analysis. Since the country lie in earthquake prone area and many of the destructive earthquakes occurred in the history so far resulting in high number of casualties due to collapse of buildings and dwellings. Hence, the study proposes the methodology in a probabilistic manner to assess the seismic performance of Reinforced Concrete structure by considering uncertainties based on pushover analysis due to non-existence of code of practices in Indian context. Thus, the methodology may use as guidelines for seismic risk evaluation of building structure.

Diana Samoila investigated the analytical modeling of the infills implies the determination of their geometrical and mechanical characteristics. The paper presents three one- bay, one- story frames, for which the diagonal strut width and the strength to different failure types are determined. The effects of the masonry infill panels upon the seismic behavior of the frames structures was rendered by the capacity curves obtained from the pushover analysis carried out on a series of concrete frames with different number of stories.

J. Prakashvel, C. UmaRani, K. Muthumani and N. Gopalakrishnan, analyze open ground storey buildings have consistently shown poor performance during past earthquakes across the world. For example during 1999 Turkey, 1999 Taiwan and 2003 Algeria earthquakes, a significant number of them have collapsed. For instance, the city of Ahmedabad alone has about 25,000 five-storey buildings and about 1,500 eleven-storey buildings; majority of them have open ground storey. There are huge numbers of such buildings in urban areas of moderate to severe seismic zones of the country. The collapse of more than a hundred reinforced concrete frame buildings with in Ahmedabad (~225km away from epi-centre) during the 2001 Bhuj earthquake has emphasized that such buildings with open ground storey areextremely vulnerable under earthquake shaking. The presence of walls in upper storeys makes them much stiffer than the open ground storey. Still Multi storey reinforced concrete buildings are continuing to be built in India which has open ground storeys. These buildings are not designed as per the earthquake resistant design. It is imperative to know the behaviour of soft storey building to the seismic load for designing various retrofit strategies. Hence it is important to study and understand the response of such buildings and make such buildings earthquake resistant based on the study to prevent their collapse and to save the loss of life and property. Based on the above an attempt is made in this paper to assess the seismic performance of the soft storey reinforced concrete building by shake table test.

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In this paper in conventional design practice, the contribution of stiffness of infill walls present in upper storeys of open ground storey framed buildings are ignored in the structural modeling. In this study, static and dynamic analysis of open ground storey RC frame with different infill materials using ETABS will be evaluated and the results compared. The three dimensional RC frame will be considered with assumed sizes of structural members like size of columns, size of beams and thickness of slab. Initially, the material properties are assumed as per code specified. The response simulations will be performed for different categories of bare frame and in filled frame. In this project two types of blocks are used, that is clay brick and fly ash brick. Masonry infill walls have been used in reinforced concrete frame structures as interior and exterior partition walls. Infill substantially alters the behaviour of the building subjected to lateral loads such as wind and earth quake forces. However when subjected to a strong lateral loads, infill panels tends to interact with bonding frame and may induce a load resistance mechanism that is not accounted for the design. From the studies fly ash infilled structure having low value of displacement, driftand period of vibration, due to this it is hypothetically concluded as fly ash is better infill material than brick infill.

P. Sudheer Kumar, M. Satish, Rahul Shinde and Dr M. Palanisamy, investigated presence of infill walls in the frames alters the behaviour of the building under lateral loads. However, it is common industry practice to ignore the stiffness of infill wall for analysis of the framed building. Engineers believe that analysis without considering infill stiffness leads to a conservative design. But this may not be always true, especially for vertically irregular buildings with discontinuous infill walls. Hence, themodeling of infill walls in the seismic analysis of framed buildings is imperative. Indian Standard IS 1893: 2002 allows analysis of open ground storey buildings without considering infill stiffness but with a multiplication factor 2.5 in compensation for the stiffness discontinuity. As per the code, the columns and beams of the open ground storey are to be designed for 2.5 times the storey shears and moments calculated under seismic loads of bare frames (i.e., without considering the infill stiffness). However, as experienced by the engineers at design offices, the multiplication factor of 2.5 is not realistic for low rise buildings. This calls for an assessment and review of the code recommended multiplication factor for low rise open ground storey buildings.

P. B. Lamb and R. S. Londhe analyzed there are several numbers of factors affecting the behavior of building. Stiffness irregularity in vertical direction is one of them, as a result of which soft storey has formed. It has intended to describe the performance characteristics such as stiffness, shear force, bending moment, drift. The study is carrying out on a building with the help of different mathematical models considering various methods for improving the seismic performance of the building with soft first storey. Analytical models represent all existingcomponents that influence the mass, strength, stiffness and deformability of structure. The equivalent static and multimodal dynamic analysis is carrying out on the entire mathematical 3D model using the software SAP2000 and the comparisons of these models are present. Finally, the performance of all the building models has observed in high seismic zone V.

Piyush Tiwari and Prof. P. J. Salunke investigated open ground building (OGS) has taken its place in the Indian urban environment due to the fact that it provides much needed parking facility in the ground storey of the building. Surveys of buildings failed in past earthquakes show that this types of buildings are found to be one of the most vulnerable. Presence of infill walls in the frame alters the behavior of the building under lateral loads. However, it"s common industry practice to ignore the stiffness of infill wall for analysis of framed building. Design based on such analysis results in under-estimation of building moments and shear forces in the columns of ground storey and hence it may be one of the reasons responsible for the failure observed. IS code 1893:2002 allows the analysis of open ground storey RC framed building without considering infill stiffness but with a multiplication factor of 2.5 in compensation for stiffness discontinuity. As per the code" The columns and Beams of soft storey building are to be designed for 2.5 times the storey shears and bending moments calculated under seismic loads of bare frames. However, as experienced by the engineer at design offices, MF of 2.5 in not realistic for low and mid-rise buildings. This calls for assessment and review of the code recommended multiplication Factor for low rise and mid-rise OGS buildings. Therefore objective of this study is to check the applicability of multiplication factor of 2.5 and to study the effect of infill strength and stiffness in seismic analysis of OGS buildings. Three Different models of existing RC framed building with open ground storey located in Seismic Zone V is considered for the study using commercial ETabs Software. Infill Stiffness with openingswas modeled using a Diagonal Strut approach. Linear and Non-Linear analysis is carried out for these models and results were compared.

R. Davis , D. Menon and A. M. Prasad investigated Open Ground Storey (OGS) framed buildings, with soft-storey at ground storey are commonly analysed in practice, ignoring the infill wall stiffness (linear „bare frame" analysis). Design codes impose a magnification factor (MF) on the design forces in the columns of the ground storey, based on such analysis. The present study attempts to estimate typical variations in MF, by modeling infill walls using Smith and Carter (1961) for linear analysis and Crisafulli (1999) for nonlinear analysis, accounting for the variability of compressive strength and modulus of elasticity of infill walls. Response Spectrum Analysis (RSA) and Nonlinear Dynamic Analysis (NDA) are carried out on a four storeyed and a seven storeyed building, for various infill wall arrangements. The results from RSA (linear analysis) indicate MF values in the range 1.04-1.13, for the four storeyed building and 1.11-2.39 for the seven storeyed building. However the results of NDA (nonlinear analysis) including hysteresis effects in frame and infill, suggest that there is no need for applying MF to low-rise building frames. In the case of the seven-storeyed building frame, values of MF in the range 1.14 to 1.29 were observed, applicable to the base shear. However, this is not applicable to column bending moments, where MF values were found to be less than unity.

Rahiman G. Khan and Prof. M. R. Vyawahare analyzed open first storey is a typical feature. These have been verifying numbers of experiences of strong past earthquakes. We are concentrating on finding the best place for soft stories in high rise buildings. With the availability of fast computers, so-called performance based seismic engineering (PBSE), where inelastic structural analysis is combined with seismic hazard assessment to calculate expected seismic performance of a structure, has become increasingly feasible. With the help of this tool, structural engineers too, although on a computer and not in a lab, can observe expected performance of any structure under large forces and modify design accordingly. PBSE usually involves nonlinear static analysis.

S. Niruba, K. V. Boobalakrishnan and K. M. Gopalakrishnan, analyzed Infills modify the behavior of framed structures under lateral loads; the contribution of panels is generallyneglected in common structural analyses. The structural effect of brick infill is generally not consider in the design of columns as well as other structural components of RC frame structures. The brick walls have significant in-plane stiffness contributing to the stiffness of the frame against lateral load. The lateral deflection is reduced significantly in the infilled frame compared to the deflection of the frame without infill. A number of non-linear static (pushover) analyses were performed on proper structural models of the building, considering both bare framed structure and the infilled one, in order to appraise the influence of infill walls on the failure mechanisms.

Saurabh Singh, Saleem Akhtar and Geeta Batham investigated presence of infill walls in the frames alters the behavior of the building under lateral loads. However, it is common industry practice to ignore the stiffness of infill wall for analysis of framed building. Engineers believe that analysis without considering infill stiffness leads to a conservative design. But this may not be always true, especially for vertically irregular buildings with discontinuous infill walls. Hence, the modeling of infill walls in the seismic analysis of framed buildings is imperative. However, as experienced by the engineers at design offices, the multiplication factor of 2.5 is not realistic for low-rise buildings. This calls for an assessment and review of the code recommended multiplication factor for low-rise open ground storeybuildings. Therefore, the objective of this study is define as to check the applicability of the multiplication factor of 2.5 and to study the effect of infill strength and stiffness in the seismic analysis of open first storey building.

Shailesh Ghildiyal, Sangeeta Dhyani and Chandra Prakash Gusain analyzed today in the world of concrete we are rapidly constructing multi-storey building for commercial and residential purposes, but providing a proper parking space is major concern especially in metropolitan cities. Hence the trend has been utilize the basement of building for parking purpose for this engineer provides the solution they make the basement of the building open, no infill masonry walls is provided in the basement .they did not consider the stiffness and strength of the masonry wall .But this conservative design is not always right .We see when the earthquake occur the column of the ground storey collapse down and the upper storey inclined towards the ground because the upper stories are more stiffer than the lower storey. This failure is termed as soft storey effect because ground storey is more flexible in comparison of upper stories. Open ground storey is also known as weak stories because it is also weaker in strength in comparison of upper stories .After the BUJH Earthquake in Gujarat, India the failure of upper stories emphasis to consider the strength and stiffness of the infill masonry .Therefore IS Code 1893:2002 suggests that we need not to consider the strength of infill masonry but simply consider a factor 2.5 which is known as the multiplication factor for the neutralization the effect of soft storey. It is in clause 7.10.3 (A) of IS 1893:2002 that the beams and columns of the storey need to be taken 2.5 times more the storey shear and moments calculated under specific loads of the bare frame. Nonetheless, by the expertise of the structural design the value suggested by IS CODE 1893:2002 is not realistic. For the validation of the multiplication factor we prepare a separate model for infill wall and walls without any infill i.e. bare frame, and do the linear and non-linear analysis and compare their results. Linear analysis shows stiffness is constant in both open ground storey and bare frame while nonlinear shows the multiplication factor can be reduced.

Sukanya V Raj and Vivek Philip investigated the multistoried structures that extant in urban areas have open ground storey (OGS) as an inevitable feature, essentially to accommodate parking or reception lobbies in the ground storey. These structures have greater affinity to collapse during earthquake because of the soft storey mechanism developed in ground storey, due to absence of infill. In conventional practice the effect of infill stiffness is neglected, however this is not factual in the case of OGS buildings for the reason that, when OGS buildings are analyzed as bare frames the member forces are under estimated. Therefore the bending moment and shear forces of ground storey columns and beams need to be magnified. The Indian seismic code IS 1893- 2002 recommends that the members of the open ground story to be designed for 2.5 times the member forces obtained without considering the effects of masonry infill in any story. This Magnification factor (MF) is specified for all the buildings with soft stories irrespective of the extent of irregularities and the method is quite empirical. This paper is an attempt towards the study of Magnification Factor for Regular and Plan irregular open ground storey buildings for different storey heights. The Magnification Factor is computed by comparison of Response spectrum Analysis of bare frame and infilled frame of different models using ETABS 2015.The results shows that there is no need for applying MF to soft storey beams, as increased demands due to stronger beams would further increase the seismic demands on the columns. Indian standards recommends a higher value of MF for low rise buildings and at the same it is inadequate for high rise buildings. It is also advisable to analyze OGS buildings as infilled fames considering infill stiffness rather than bare frames.

Vojko Kilar and Peter Fajfan investigated the structure consists of planar macro elements. For each planar macro element, a simple bilinear or multi linear base shear - top displacement relationship is assumes. By a step-by-step analysis an approximate relationship between the global base shear and top displacement is computed. During the analysis, the development of plastic hinges throughout the building can be monitor. The method has been implementing into a prototype computer program. The method has been applying for the analysis of a symmetric and an asymmetric variant of a seven-story reinforced concrete frame-wall building.

III. CONCLUSION

RC frame buildings with open ground storeys are known to perform poorly during in strong earthquake shaking. The lateral strength of a building is sum of all the stiffness from column, shear wall and bracing are added at each storey. So the low strength in the lowest floor causing the failure occurs especially during earthquake. For a building that is not provided any lateral load resistance component such as bracing or shear wall, the strength is consider very weak and easy fail during earthquake.

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