Study on Effect of Open Ground Storey on Seismic Performance of High Rise Building

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Abstract— This study on effect of open ground storey on seismic performance of high-rise building current era residential and commercial building need to provide car parking space at ground level populated cities is a matter of major concern. Hence the trend has been to utilize the ground storey of the building itself for parking. “Open Ground Story” (OGS) buildings are those types of buildings in which the ground storey is free of any infill masonry walls. These types of buildings are very common in India for parking provisions. Open ground storey is a common feature in the modern high-rise buildings constructions in India. Most of region of India goes under high seismic regions. This features of high-rise building inherent vulnerable to collapse of structure. Also Indian cities expanding vertically so, higher demand of parking space required increase In that case open ground storey building become critical point for failure of building. Ground-story column, were either damaged severely or failed completely, thereby damaging the buildings due to sudden reduction in lateral stiffness and mass in the ground storey results in higher under seismic loading. For proper assessment of the storey stiffness of buildings with soft storey, different models were analyzed using ETABS V_9.6.0 software.

Key words: parking provisions, ground storey

I. INTRODUCTION

Need of space became very important requirement in urban areas due to cities expanding vertically in India. Space required for parking takes very important role while planning a structure. Ground storey of the building has utilized as parking spaces. These types of buildings (Figure 1.1) having no infilled walls in ground storey, Infill wall in all upper stories are provided is known as Open Ground Storey (OGS) buildings. The majority of apartments are of this type and the infill walls used are of mainly brick masonry. An earthquake causes the ground to vibrate and structures rested on ground in turn subject to this motion. Thus, the dynamic loading on the structure during an earthquake is not external loading, but the inertial effect due to motion of support.

The various factors contributing to the structural damage during an earthquake are vertical irregularities, irregularity in strength and stiffness, mass irregularity, torsional irregularity etc.

In buildings with soft storey, the stiffness of the lateral load resisting systems at those storeys is quite less than the adjacent storeys. Other storeys’ being stiff undergoes smaller inter-storey drifts. During an earthquake, if abnormal inter-storey drifts between adjacent storeys occur, the lateral forces cannot well distribute along the height of the structure. This situation causes the lateral forces to concentrate on the storey having large displacement. If the inter-storey drifts are not limited, a local failure mechanism or, even worse, a storey failure mechanism, which may lead to the collapse of the system. Upper stories of these buildings are stiff and the inter-storey drifts will be small, resulting in large displacement, shear forces and bending moments of the open ground storey columns. Hence, the strength demand on the open ground story columns in the ground storey of the buildings is very high. The majority of this type of buildings had collapsed in the past earthquakes in many countries. The failure of OGS (Open ground storey) buildings is observe to be due to storey failure mechanism in the ground storey. The sudden reduction in lateral stiffness and mass in the open ground storey results in higher stresses in the open ground storey columns under seismic loading. In most cases, open ground-storey columns were either damaged severely or failed completely. The building is OGS frame, completely collapsed due to soft-storey mechanism in the ground storey due to the absence of infill walls as shown in fig 1.2 (Bhuj earthquake-2002).

- As per IS-1893:2002 An Soft Storey is 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 storeys above.
- Extreme Soft Storey An extreme soft storey is one in which the lateral stiffness is less than 60 percent of that in the storey above or less than 70 percent of the average stiffness of the three storeys above.

Fig. 1.1: Typical example of OGS building

Fig. 1.2: Failure of OGS building in Bhuj Earthquake (2002)
II. PROBLEM STATEMENT

The most important and destructive are the most general Indian building structures that lead collapse certainly the soft story irregularity. The commercial and parking areas with higher story buildings and no infill walls so, reduce the stiffness of the lateral load resisting system of structure. Than soft story and progressive collapse becomes unavoidable in a severe earthquake for open ground story buildings.

Whereas the total seismic base shear of building during an earthquake is dependent on its natural period of building. The distribution of stiffness and mass along the height of building control the seismic force distribution. In buildings with open ground story, the upper story is stiff, so that smaller inter-story drifts. However, the inter-story drift in the open ground story is large. The strength demands of the open story’s columns are also large, as the base shear in the open ground story is highest. For the upperstory, however, The columns forces are reduced effectively due to the presence of infill walls changes in story stiffness’s have uneven lateral force distribution along the height of building, there was likely to induce locally stress concentration in open ground story column. That was unfavorable effect on the buildings performance during earthquake.

Soft stories are concentrated to higher lateral forces during ground shaking and under lateral forces, their deformations are higher than upper storeys so, the structural design of soft stories elements is critical and it should be differ from the upper story. Such features are highly undesirable in buildings built in seismically active areas, which has verified in numerous of experiences of the strong past earthquakes.

Nevzat Kirac et al[1] “Following factors or parameters affect the weak-story irregularity formation in structures, Height of the weak-story, Existence of mezzanine floor, Rigidity, stiffness distribution of columns in soft story, cantilever projection existence in weak-story, Infill wall material properties, Soil class and properties, Height of the weak-story, Rigidity and stiffness distribution of columns in soft story, cantilever projection existence in soft story, infill wall material properties, Soil class and properties.

I. REVIEW OF LITERATURE

Infill walls are one of the most efficient lateral forces resisting elements in multistoried buildings. Infill walls are supporting reinforced concrete moment resisting frame to resist the major portion of lateral load induced by an earthquake ground shaking. Many investigators have done a significant amount of research work on various structural aspects of infill walls and till date the infill walls are among the major concern in the research area.

Saurabh Singh, Saleem Akhtar and Geeta Batham[2] 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 storey buildings. 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.

P.B.Lamb, Dr R.S. Londhe[3] 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 story 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 existing components 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.

Dr. Saraswati Setia and Vineet Sharma[4] With urbanization and increasing unbalance of required space to availability, it is becoming imperative to provide open ground storey in commercial and residential buildings. These provisions reduce the stiffness of the lateral load resisting system and a progressive collapse becomes unavoidable in a severe earthquake for such buildings due to soft storey. Softer storey behavior exhibit higher stresses at the columns and the columns fail, as the plastic hinges are not form on predetermined positions. Thus, the vulnerability of soft story effect has caused structural engineers to rethink the design of a soft storey building in areas of high seismicity. Parametric studies on displacement, inter storey drift and storey shear have been carrying out using equivalent static analysis to investigate the influence of these parameter on the behavior of buildings with soft storey.

Diana Samoila[5] 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.

Rahiman G. Khan, Prof. M. R. Vyawahare [6] 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...
In the infilled structures, the use of infill walls reduces seismic response significantly [1,2,3]. This method has been applied in a variety of studies to consider the effects of infill walls in the seismic response of framed structures. The structural behavior of brick infills is generally not considered in the design of buildings; however, they are an important component of RC frame structures. The brick walls contribute to the in-plane stiffness of the frame against lateral loads. The lateral deflection is reduced significantly in the infilled frame compared to the deflection of the frame without infill. Non-linear static analyses were performed on proper structural models of buildings considering both bare framed structures and the infilled ones, to understand the influence of infill walls on the failure mechanisms.

VOJKO KILAR and PETER FAJFAR [8] proposed the methodology in a probabilistic context. Thus, the methodology may be used as guidelines for the analysis of asymmetric structures. The developed computer program could perform linear static (pushover) analyses, inelastic analysis of RC framed structures subjected to earthquake excitation; the pushover (nonlinear static) analysis and the development of plastic hinges throughout the structure can be monitored. During the analysis, the development of plastic hinges throughout the building can be monitored. The method has been implemented into a prototype computer program. The methodology has been applied for the analysis of a symmetric planar macro element of a seven-story reinforced concrete frame-wall building.

C. M. Ravi Kumar, K. S. Babu Narayan, Reddy D. Venkat [9] have shown that a simple bilinear or multi-linear base shear-top displacement relationship is assumed by a step-by-step analysis. This relationship between the global base shear and top displacement is computed. During the analysis, the development of plastic hinges throughout the building can be monitored. The methodology has been implemented into a prototype computer program. The methodology has been applied for the analysis of a symmetric planar macro element of a seven-story reinforced concrete frame-wall building.

RC frame buildings with open first stories are performing poorly during the earthquake. The open story on the lowest level causes the relative low compare to the above story stiffness so, there is required of immediate to prevent to haphazard use of soft story in structure which are analyze and design without considering to increase the story drift, column demand, ductility and disacement theopen ground story this paper highlight the various parameters which are effects for failure of high-rise building under lateral forces and also argues the importance of infill wall as a one of the efficient approach to eliminate seismic failure of soft story high rise building This paper has tried to discuss various aspects regarding infill wall discussed by many of the investigators on adding infill wall to the building in different methods in order to reduce soft story effect on building seismic response in earthquake. It was found that location, number and curtailment of infill wall acts an important factor for the soft story structures to displace during earthquake. From the review of literature its shows that use of infill wall is a good way to getting more stable behavior. In the other hand, vulnerability level of existing high-rise structures can be increased by analyze of infill wall on building and it will help for retrofiting of structure to resist the major portion of seismicforce induced by an earthquake.

REFERENCES

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