Earthquake Resistant Design of Low Rise Open Ground Storey Framed Building: A Critical Review

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Abstract— During the fast urbanization there are problems come regarding the parking. Due to this the building is design as an open ground storey framed building. As we take the low rise open ground storey building because the performance is same as per the high rise open ground storey building. As per the design of building by the reference of IS 1893:2002, the stiffness due to infill wall of the building is not considered. Due to the conservative designing of the building we found the failures and variation in the building behaviour.

Key words: Earthquake Resistant Design, Low Rise Open Ground Storey Framed Building

I. Introduction

There are many advantages in open ground storey building but from the earthquake point of view these buildings becomes more vulnerable. As we saw that the stories having infill walls are much stiffer than the open ground storey. There are many soft storey building which collapsed in the Bhuj earthquake in India due to the strong ground motion of 6.9 on the Richter scale. In soft storey building we analysed that the basic failures of the building are snapping of lateral ties, buckling of longitudinal reinforcement bar, crushing of core concrete etc. The major role in the failure of the building was the absence of Infill walls in ground stories.

A. *Basic Concept of Soft Storey:*

The behaviour of the soft storey building is varying as compare to the 'Bare Frame Building' and fully infill frame building against lateral load. It resists the applied lateral load through frame action as well as it shows well distributed plastic hinges at failure. The fully infill building having less roof displacement, less inter storey drift, and it attract high base shear due to increase the stiffness, less force in the frame elements and released greater energy through infill walls. When the Earthquake occurred, here we also say that the building is swaying back and forth like an inverted pendulum Fig (1.2). And hence column and beam of the building get heavily stressed and the forces become more which causes failure of the building.

II. Literature review

Holmes (1961) tells that the frame and the infill wall stay intact initially under the lateral loading. As the lateral load increases, at the unloaded corner (tension) the infill wall get separated from the surrounding frame but at the comparison corner the infill walls are still intact. The length of contact of the wall with the frame is called length of contact. By an imaginary diagonal the load transfer occur then it acts like a compression strut in the member. Due to this behaviour of the infill walls, they can be modelled for connecting two compressive corners diagonally as an equivalent diagonal strut. The stiffness property should be such that the strut will active when the subject to compression only. At a time only one diagonal will be operate under the lateral loading.

Mallick and Severn (1967) by using finite element analysis was investigated that the effect of slip or interface friction among the frame and infill wall. The infill panels were simulated by means of linear elastic rectangular finite elements, with 2 degrees of freedom (DoF) at each of the four corner nodes. Between frame and infill wall are modelled and he calculated the length of contact. By using link element the slip between frame and infill wall was taken into account by considering frictional shear forces in the contact region. Every node of this element has 2 translational DoF. The element is capable to transfer of the compressive forces and bond forces but unable of resisting tensile forces.

Rao et. al. (1982) conducted experimental as well as theoretical studies on infill frames with opening strengthened by lintel beams. He was concluded that the lintel over the opening does not have any effect on the lateral stiffness of an infill frame.

Karisiddappa (1986) and Rahman (1988) conclude the effect of openings and their location on the behaviour of single storey RC frames with brick infill walls.

Choubey and Sinha (1994) have studied on infill frames under cyclic and dynamic loading condition. He investigate that the effect of various parameters such as separation of infill wall from frame, the plastic deformation, the stiffness and the energy dissipation of infill frames under the cyclic loading.

Arlekar et.al (1997) was reported the behaviour of RC framed soft storey building when subjected to seismic loads .A four storey OGS building was analysed by Equivalent Static Analysis (ESA) and Response Spectrum Analysis (RSA) to find the resultant forces and displacements. This paper tells that the behaviour of open ground storey frame is quite different from bare frame.

Riddington and Smith (1997) was studied the effect of different parameters of infill frame is plan aspect ratio, relative stiffness, and number of bays on the behaviour was studied by.

Scarlet (1997) studied about the qualification of seismic forces in soft storey buildings. He proposed a multiplication factor for base shear for OGS framed building. During this procedure modelling is required for the stiffness of the infill walls in the analysis. The study proposed a multiplication factor ranging from 1.857 to 3.279 as the number of storey increases from six to twenty.

Deodhar and Patel (1998) indicate that the brick masonry in infill frame are proposed to be non-structural, they have considerable influence on the lateral response of framed building.

Davis. and Menon. (2004) achieved that the presence of masonry infill panels modifies structural force distribution in an OGS building. In the presence of masonry infill at the upper floor of the building, total storey shear forces increases as stiffness of the building increases in the presence of masonry infill at the upper floor of building. Also, the bending moments in the ground floor columns are increase (more than two fold), and the mode of failure due to soft storey mechanism (formation of hinges in ground floor columns).

Das and Murthy (2004) analyze that infill walls when present in a structure, generally bring down the damage deteriorate by the RC framed members of a fully infill frame during earthquake shaking. The columns, beams and infill walls of lower stories are more dangerous to damage by those in upper stories.

Asokan (2006) studied the presence of infill walls in frames of a building changes the lateral stiffness and strength of the structure. In this research report he recommended a plastic hinged model for the infill wall to be used in nonlinear performance based analysis of a building and achieve that the ultimate load (UL) approach along with the recommended hinge property provides a better assessment for the inelastic drift of the structure.

Hashmi. and Madan. (2008) performed non-linear time history and pushover analysis on the open ground storey buildings. The analysis wrapped up that the magnification factor prescribed by IS 1893(2002) for such buildings is sufficient for preventing collapse.

G.V. Mulgund and D.M. Patil (2010), Investigated the behaviour of RC frames with various arrangement of infill when is subjected to the dynamic earthquake loading and result of bare and infill frame were compared. It highlighted that the masonry infill panels in the frame substantially diminish the overall damage.

Amit and S. Gawande (2013), Investigated the seismic performance and design of the masonry infill reinforced concrete structure with soft first storey under powerful ground motion.

Jinyawala Mohammad (2014) investigated that in this paper sixteen models are prepared for Static Linear analysis and Dynamic analysis (TH) results of models i.e. without strut and with strut of infill wall with central outer opening with 15% and 25% are compared. From this analysis he comes on conclusion that diagonal strut will change the response of RC building. Axial force in column increased, story displacement and story drift are decreased and base shear is increase with higher stiffness of infill. If in the ground level at least periphery wall is providing then the soft story effect of failure can be minimized and the increase in the percentage of opening leads to a decrease in the lateral stiffness.

Hiten L. Kheni and Anuj K. Chandiwala (2014), investigated many buildings that fallen down during the past earthquakes exhibited exactly the opposite strong beam weak column behaviour means the columns failed even before the beams yielded mainly due to soft storey effect. For proper assessment of the storey stiffness and strength of the buildings with the soft storey building, different models were analyzed by using software. The study concluded that the displacement evaluate of the codal lateral load patterns are observed that smaller for the lower stories and larger for the higher stories and are independent of the total number stories of the models.

Bård Hagberg Stana(2014), analyze and compare the result of linear and non linear analysis. He basically compares the base shear, maximum base moment and maximum displacement. After analysis he found that the mode shape variation by the different methods will play an important role for the building because the time period will change at each mode shape and they contribute the maximum variation.

Nesiya Yoosaf, Remya Raju, Hashim K Abdul Azeez (2015) are structures were modelled using ETABS. 20 models are there in which the five are G+5,G+10,G+15,G+20. In each case building is of bare framed, Brick Infilled frame, Fly ash brick Infill frame, Open ground storey Brick infilled and Open ground storey Fly ash Brick infilled. They perform dynamic static and non linear static analysis. After the analysis we find that all the three analysis displacement, base shear, and drift variation shows the same pattern in each height levels. Period of vibration is higher in case of bare frame and it is lesser in case of fly ash infilled structure. Period of vibration is higher in case of bare frame and it is lesser in case of fly ash infilled structure.

III. CONCLUSION

In soft storey building is modelled by using the compression equivalent strut for the infill. Researchers are modelled in different computer programs such as Staad Pro, ETABS, SAP2000 etc. Due to the conservative design of the building the stiffness is ignored by which the building time period was increased and during the strong ground motion failure will occur. In soft storey building there is large variation at the soft storey (where the infill is absent). So in case of with infill the building shows the variation in the performance as compare to the without infill. .They needs the improving for the design of the soft storey building.

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