Imperial Journal of Interdisciplinary Research (IJIR)
Vol.2, Issue-1 , 2016
ISSN : 2454-1362 , www.onlinejournal.in

Effects of Infill Wall with and without on RCC Frame Structure – A Review

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Abstract

In Reinforced concrete frames the masonry infill walls are a common practice in countries like India. In general, the masonry infill walls are treated as nonstructural element in structural analysis and only the contribution of its mass for is considered and it's structural parameters like strength and stiffness is generally ignored in practice, such an approach may lead to an unsafe design. The performance of such structures during earthquakes has proved to be superior in comparison to the bare frames. The effect of masonry infill panel on the response of RC frames subjected to seismic action is widely recognized and infill behaves like compression strut between column and beam and compression forces are transferred from one node to another. Infill walls resist lateral loads but because of the openings in the infill wall the resistance may slightly reduce. The IS code provisions do not provide guidelines for the analysis and design of RC frames with infill wall and for different percentage of openings. So it is essential to consider the effect of masonry infill for the seismic evaluation of moment resisting reinforced concrete frame. There are plenty of researches done so far for infilled frames however infilled frames are still the topic of interest. Though it has been understood that the infills play significant role in enhancing the lateral stiffness of complete structure, the past experience in various earthquakes have proved that the partially infilled framed structures somehow are affected adversely. This paper intends to highlight the need of knowledge on infilled frames and the composite action. It also summarizes the findings till date done by various researchers on the behavior of infilled frames under lateral loads.

1. Literature Review

T. Elouali at el., (1998) This paper presents the results of an experimental program investigating the behaviour of frame with masonry infill panels subjected to cyclic loadings. Two types of masonry frequently used were tested. The experimental results have been used to develop an analytical model for the determination of the stress-strain relationship to predict the inelastic behaviour of each type of infill.

It shows that the inclusion of the masonry panels reduces the fundamental periods of the structures. There is a significant increase in the horizontal base shear forces due to reduction of fundamental period. The displacement may be reduced or increased depending on the frequency contents. The equivalent diagonal representing the confined panels transform the rigid frame into trussed frame, and there is a definite change in the form in which the frame will resist lateral loads; flexural effects will decrease substantially. There is a drastic change in bending moments and axial forces. Then the presence of infill should be considered in the design of the frame structures in order to contribution the strength of the structure and to avoid the possible harmful effects.

Hossain Mohammad Muyeed-Ul-Azam1 et al., (2005) The structural effect of brick infill is generally not considered in the design of columns as well as other structural components of RC frame structures. The lateral deflection is reduced significantly in the infilled frame compared to the deflection of the frame without infill. This leads to different steel requirements for frame structures considering infill. In order to understand the behavior of frames and steel requirements of column having brick masonry infill and without infill a finite element investigation is performed.

A detailed investigation is performed using various loads and load combinations of the building considering infill and without infill to find out steel requirements and to see the effect of infill in the sway characteristics of the building. It is observed that frames with infill produce much smaller deflections as compared to frames without infill. It is also observed that there is no significant difference in steel requirements of interior column but there is moderate difference in steel requirements in exterior column and significant difference in steel requirements in corner column. This indicates considering stiffness of the infill may not result in an economy in the design of multi-storied buildings if the number of interior columns is significantly greater compared to the number of exterior and corner columns.

Kasım Armagan Korkmaz et al., (2007) The diagonal strut approach is adopted for modeling masonry infill walls. Pushover curves are obtained for the structures using nonlinear analyses option of commercial software SAP2000. Nonlinear analyses are realized to sketch pushover curves and results are presented in comparison and the effects of irregular configuration of masonry infill wall on the performance of the structure are studied. In the present study, the infill walls are under investigation via nonlinear analyses. To determine the earthquake performance of the structural systems, nonlinear static pushover analyses are used instead of time history analyses. The results of elastic analysis show that the presence of nonstructural masonry infill walls can modify the global seismic behavior of framed buildings to a large extent. Irregular distributions of masonry infill walls in elevation can result in unacceptably elastic displacement in the soft storey frame.

Salah El-Din Fahmy Taher at el., (2008) The influence of partial masonry infilling on the seismic lateral behavior of low, medium, and high rise buildings is addressed. The effect of number of stories, number of bays, infill proportioning, and infill locations are investigated. The most simple equivalent frame system with reduced degrees of freedom is proposed for handling multi-story multi-bay infilled frames. The system is composed of a homogenized continuum for the reinforced concrete members braced with unilateral diagonal struts for each bay, which are only activated in compression.

R. Vicente, H. Rodrigues, A. Costa at el., (2010) In this paper, appropriate measures are proposed to improve both in-plane and out-of-plane integrity and the performance behaviour under seismic actions of external leaf of double leaf cavity walls as well as premature disintegration of the infill walls.The infill masonry panels are commonly used in the reinforced concrete (RC) structures as interior or exterior partition walls. They are not considered structural elements; however it is recognized the influence in the global behaviour of RC frames subjected to earthquake loadings

T.C. Nwofor at el., (2012) Reinforced concrete frames are usually infilled by masonry walls, but in most designs, the shear strength response of these walls and also the contribution of the infill panel openings in the reduction of the shear strength of the infilled frame are ignored. In this work, two kinds of numerical models are used in order to validate the finite element micro-modeling method and the basic stiffness method for macro-modeling of infilled frames.

The macro-modeling technique which analyses an equivalent one-strut model used to replace the infill panel gave results which were validated against that of the micro-modeling procedure. From the foregoing both models will able to model the shear response of the frame up to a failure load. Finally the procedure for macro-modeling used in this work is not computationally tedious and gives quick results, hence is recommended for non-linear analysis of infilled frame structures.

The shear strength of infilled frames is reduced with an increase in the opening ratio and remains relatively constant as the opening ratio exceeds 0.5. For a frame without infill panel (i.e. a bare frame) the decrease in the shear strength may reach 75%, decrease in the lateral displacements. Shear strength response of the column was considerably lower than those obtained from a bare frame.

Anat Ruangrassamee at el., (2012) This research studies on RC building with masonry infill walls under tsunami loading and the effect of masonry infill walls in a tsunami load resisting capacity. It is found that masonry infill walls play a major role in the tsunami load resisting capacity of the building. If there is no wall in the building the load resistance of the building is limited to only 138 KN which is governed by flexural failure of columns. The wall in the middle frame significantly increases the lateral load capacity of the building to about 700 KN. If walls are provided in all frames, the load resistance is about 700 KN which is limited by shear failure of short columns. Damage on the masonry infill walls and middle frame resist lateral load of the top part load about 60% and 3 times higher than the resisting load of this building without masonry infill walls.

Prof. P.B Kulkarni at el., (2013) In the present study, it is attempt to access the performance of masonry infilled reinforced concrete (RC) frames with open first storey of with and without opening. In this paper, symmetrical frame of college building (G+5) located in seismic zone-III.

From this present result, deflection is very large in case of bare frame as compare to that of Infill frame with opening. If the effect of infill wall is considered then the deflection has reduced drastically. And also deflection is more at last storey because earthquake force acting on it more effectively. Deflection in case of centre opening is large compare to corner opening.

Waleed Abo El-Wafa Mohamed at el., (2012) In this study, a nonlinear numerical investigation on the lateral behavior of masonry infilled RC buildings is carried out. Variety of parameters for both MI (main infill) walls and buildings are considered. The MRF buildings have 6 floors, while the SW-MRF buildings have 5 different heights represented by the number of floors (from six to twenty floors). To check the behavior of infill walls taking into consideration the effect of opening sizes. Nonlinear static push-over analysis is carried out for the applied on buildings. While they can drastically reduce the displacement capacity of MRF buildings to values up to 50.0 %, the existence of uniform RC shear walls can highly restrict the reduction of peak displacement capacity to less than 8.0 %.Masonry infill walls with small thickness equal 0.12 m can significantly alter the response of the buildings, either MRF or SW-MRF, to which they are applied. The variation of masonry infill wall thickness between 0.12 m and 0.2 m yields relatively, minor change in the results of nonlinear lateral response.

MagarPatil H.R. at el., (2012) In this paper, the seismic vulnerability of building with soft storey is shown with an Example of G+10 three dimensional (3D) Steel Frame. The open first storey is an important functional requirement of almost all the urban multi-storey buildings, and hence, cannot be eliminated. Hence some special measures need to be adopted for this specific situation like to increasing the stiffness's of the first storey. In this paper, stiffness balancing is proposed between the first and second storey of a steel moment resisting frame building with open first storey and brick infills as described in models. The stiffness effect on the first storey is demonstrated through the lateral displacement profile of the building.

Dr. S.S.Jamkar et al., (2013) In this present paper to study the behaviour of RC frames with various arrangement of infill when subjected to dynamic earthquake loading. The result of bare frame, frame with infill, soft ground floor and soft basement are compared and conclusion are made in view of IS 1893(2002) code. It is observed that, providing infill below plinth improves earthquake resistant behaviour of the structure when compared to soft basement.Software (ETAB) is used as a tool for analyzing effect of infill on the structural behaviour. It is observed and which provide overestimated values of fundamental period.

Hemchandra Chaulagain at el., (2014) In this context, the paper presents an extensive case study of existing RC-framed buildings in a high seismic risk area in Nepal. A sensitivity analysis of the structures with masonry infill is performed. For this, the influence of different material properties is studied, namely diagonal compressive stress, modulus of elasticity and tensile stress of masonry infill panels. Result shows the influence on the structural behaviour particularly by variation of the diagonal compressive strength of infill masonry panels.

The results of the sensitivity analysis indicate that the variation of diagonal compressive stress on the structure is clearly apparent in all building models. The maximum IS drift is decreased by 34% and 64% when the diagonal compressive stress of masonry is increased by 25% and 50% respectively.

2. Literature Summary

- The reduction of diagonal compressive stress of the brick masonry wall plays an important role especially for increase in inter-storey drift in non-engineered building structures. The Young's modulus is also an important parameter in buildings.
- The results of the present study show that infill wall increases the stiffness while the increase in the opening percentage leads to a decrease on the lateral stiffness of infilled frame.
- The steel requirements in corner columns considering infill are significantly less compared to the steel requirements of corner columns without considering infill. Maximum Axial Force at the foundation level. In columns, without considering infill wall affects the value of, B.M and Ast are maximum above 1m height because of soft storey present.
- The plastic hinge rotation levels of the frames with infill walls are at less value than the one with no infill walls. Moreover, displacements exceed the limit level.
- Infill panels increases the lateral stiffness and strength of the bare frame. The initial stiffness, increase 7 times and lateral strength increase 1.9 times that of the bare frame. If the frame is rigid which shows about 70% decrease in the lateral displacement values obtained.
- Providing the wall in the middle frame is the most effective pattern to get a large lateral load resisting capacity.
- In reduction in displacement capacity is proportional to the building height. The effect of parameters as opening size, first soft storey and wall thickness fades as the building height increases.
- The open first storey is an important functional requirement of almost all the urban multi-storey buildings, and hence, cannot be eliminated. Alternative measures need to be adopted for this specific situation.
- The building height parameter is found to affect the results of masonry infilled buildings in a manner that the percentage increase in stiffness due to the contribution of MI walls is inversely proportional to the building height.

3. Conclusion

It is observed from the various research works that there is no doubt that the infill walls contribute in enhancing the structural strength. However, the contribution of partial infill walls must be well identified so that while analyzing models for real structures, the composite action of the frame and infill would be realized. The lessons from the past earthquakes also indicate that partial infilled frame structures are vulnerable to ground motions and if there is a method identified to model such structures, the earthquake hazard to structure would be reduced significantly.

4. Acknowledgements

This work was supported in part by a grant from the National Science Foundation. I express my deep sense of gratitude to my supervisor Dr.K.Muthumani, Professor, Structural Engineering Division, School of Mechanical and Building Science, VIT University, Chennai for helping in finding a new and interesting topic to study on and his valuable guidance

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