Multistorey RC Frame Pushoveranalysis Using with or Without Infillwalls: A Review

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Abstract: ***Reinforced concrete frames with masonry infill walls are widespread systems in many earthquake-prone regions of the world. The infill walls are used for insulation, partition and aestheticpurposes rather than structural purposes and generally considered as non-structural elements in structural design.But various experiments and studies proves that it also contributes to Lateral stiffness and resistance of buildings.***

Keywords: Infill walls, Pushover Analysis,Base Shear, Drift Ratio

1. Introduction

RC frames are important construction technique in India, so it carries significant role in structural engineering. While using the infill walls in panel frame, it is generally considered that it does not impart the structural parameter like stiffness and strength. The performance of this configuration is superior as compared to the bare frame during earthquake has been proved in many cases. Using Indian codes we can design the building as earthquake resistant but how we check the performance of the building? So the Performance based design will serve our intention to pass over the catastrophic failure. The performance design is known as pushover analysis. In this paper, a review of studies carried out on RC framed infill walls and check their performance by pushover analysis is presented.

2. Pushover Analysis

Pushover analysis is an approximate analysis method in which the structure is subjected to monotonically increasing lateral forces with an invariant height-wise distribution until a target displacement is reached. Pushover analysis consists of a series of sequential elastic analyses, superimposed to approximate a force-displacement curve of the overall structure. A two or three dimensional model which includes bilinear or tri-linear load-deformation diagrams of all lateral force resisting elements is first created and gravity loads are applied initially. A predefined lateral load pattern which is dispersed along the building height is then applied. The lateral forces are increased until some members yield. The structural model is modified to account for the reduced stiffness of yielded members and lateral forces are again increased until additional members yield. The process is continued until a control displacement at the top of building reaches a certain level of deformation or structure becomes unstable.

3. Structural Configuration of Infill Walls and their Effect on RC Frames

Deflection is very large in case of bare frame as compared to that of infill walls with opening. If the effect of infill walls considered then the deflection reduced drastically. And also deflection is more at last storey because earthquake force acting on it more effectively.[N. Agrawal, 2013]

The different structural arrangement and integral of RC frame and Infill walls:

1) Infill walls are adequately separated from the RC frame such that they do not interference with the frame under lateral deformation. The entire lateral force on the building is carried by bare RC frame alone.
2) Infill walls are built integral with the RC frame but considered as non structural elements. The entire lateral force on the building is carried by bare RC frame alone. This is the most common design practice in the developing countries.
3) Infill walls are built integral with the RC frame and considered as structural elements. The in-plane stiffness offered by the infill walls is considered in the analysis of the building. The forces from the analysis are used in the design of RC frame member and joints. [CVR Murty and SK jain, 2000]

4. Review of Studies

There are so many studies have been considered on performance based pushover analysis. Review of some studies is being presented as fellow:

Fiorato et al. (1970) tested several 1/8 scale, masonry brick infill non-ductile frames and concluded that the infill added significant stiffness and strength to the frames but caused a decrease in their ductility.[15]

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 addition of the masonry panels reduces the fundamental periods of the structures. There is a considerable 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 radical 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 give 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 usually not considered in the design of columns as well as other structural components of RC frame structures. The lateral deflection is reduced considerably 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 behaviour 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 a variety of 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 considerably greater compared to the number of exterior and corner columns.

KasımArmaganKorkmaz et al., (2007) The diagonal strut approach is adopted for modelling 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. Present study shows that 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 FahmyTaher 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.

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.

5. Conclusion

It is generally considered that infill walls do not contribute structural parameter like stiffness and strength in RC frame. And also there is no any provision of considering the infill walls as a structural elements in IS codes design. From the literature review, it is observed that infill walls also contribute in the structure as integral element with the RC frame. And enhance the overall ductility, strength, stiffness and energy dissipation of the building.Pushover analysis is performance based analysis, which provides realistic result of inelastic deformation in the structure. Further works are undergoing to take into account the exact effect of infill walls with respect to height and opening provides in building.

References

[1] Fiorato et al., (1970), "An Investigation of the interaction of Reinforced Concrete Frames with masonry Filler Walls" Report No. UILU-ENG 70-100, University of Illinois, Urbana-Champaign, IL.
[2] T. Elouali et al., (1998) "Effect of infill masonry panels on the seismic Response of Frame buildings" ProcASCe. Structural Division Journal ST- 1 Vol 92 331-403.
[3] Hossain Mohammad Muyeed-Ul-Azam1 et al., (2005) "Effect of infill as a Structural Component Design of Multi-Storied Building" UAP Journal of Civil and Environment Engineering Vol. 1, No. 1.
[4] KasımArmaganKorkmaz et al., (2007) "Earthquake Assessment of R/C Structures with Masonry Infill Walls" Intereational Journal of Science & Technology Vol. 2, No. 2, 155-164.
[5] Salah El-Din FahmyTaher at el., (2008) "Role of masonry infill in seismic resistance of RC structures" The Arabian Journal for Science and Engineering, Vol.33, No. 2B 291.
[6] R. Vicente, H. Rodrigues, A. Costa at el., (2010) "Simplified Macro-Model for infill Masonry Panels" Journal of Earthquake Engineering, Vol. 14, No. 3, pp. 390-416 2010.
[7] T.C. Nwofor at el., (2012) "Finite Element Modeling of Shear Strength of Infilled Frame with openings" International Journal of Engineering and Technology, Vol. 2, No. 5.
[8] Prof. P.B Kulkarni at el., (2013) "Analysis of Masonry Infilled R.C. Frame with & without Opening Including Soft Storey by using Equivalent Diagonal Strut Method" International Journal of Scientific and Research Publications, Vol. 3, Issue 9.
[9] Waleed Abo El-Wafa Mohamed at el., (2012) "Parametric Study on The Effect of Masonry Infill Walls on the Seismic Resistance of RC Building" Journal of Engineering Science, Vol. 40, No. 3, pp 701-721.
[10] Dr. S.S.Jamkar et al., (2013) "Study of Seismic Performance for Soft Basement of RC Frame" International Journal of Engineering Sciences & Research technology, ISSN, 9-14.