A Review on the Walls in Soft Story Building Roof Displacement of Multi Storey Building

Abhishek Shankar[1] Dr. Ajay Swarup[2]
[1]M.Tech Scholar [2]Associate Professor
[1,2]Department of Civil Engineering
[1,2]SSSUTMS, Sehore, India

Abstract— This paper presents a review of the experimental efforts also as modeling approaches to review estimate typical variations in magnification factor of a midrise open ground storey building accounting for the variability of compressive strength and modulus of elasticity of infill walls with various infill arrangements so that it can help designers facing trouble with heavy designs for a structure of mid-size, with the given material properties, geometry and loadings in particular. The paper investigates Equivalent static analysis (ESA) and Response spectrum analysis (RSA) is considered for the comparative study. The building will be analyzed for two different cases: i) considering infill mass but without considering infill stiffness. ii) Considering both infill mass and infill stiffness. From the study Expected outcome have found that building with soft storey will exhibit poor performance during a strong shaking. But the open ground 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 under-lying principle of any solution to this problem is in i) increasing the stiffness of the ground storey; ii) provide adequate lateral strength in the ground storey. The possible schemes to avoid the vulnerability of open ground storey buildings under earthquake forces can be by providing stiff columns in open ground storey buildings or by providing adjacent infill walls at each corner of soft ground storey buildings.

Key words: Infills, OSG Building, Equivalent Static Analysis (ESA), Response Spectrum Analysis (RSA)

I. Introduction

Reinforced concrete frame buildings have become common form of construction with masonry infills in urban and semi urban areas in the world. The term infilled frame denotes a composite structure formed by the combination of a moment resisting plane frame and infill walls. The infill masonry may be of brick, concrete blocks, or stones. Ideally in present time the reinforced concrete frame is filled with bricks as non-structural wall for partition of rooms because of its advantages such as durability, thermal insulation, cost and simple construction technique. There is significant advantage of this type of buildings functionally but from seismic performance point of view such buildings are considered to have increased vulnerability. In the current practice of structural design in India infill walls are considered as non-structural elements and their strength and stiffness contribution are neglected. The effect of infill panels on the response of reinforced concrete frames subjected to seismic action is widely recognized and has been subject of numerous experimental and analytical investigations over last five decades. Covers a huge analysis area since every a part of the system has its own technical complexity. The open ground storey framed building behaves differently as compared to a bare framed building (without any infill) or a fully infilled framed building under lateral load. A bare frame is much less stiffer than a fully infilled frame; it resists the applied lateral load through frame action and shows well-distributed plastic hinges at failure. When this frame is fully infilled, truss action is introduced thus changing the lateral load transfer mechanism. A fully infilled frame shows lesser inter-storey drift, although it attracts higher base shear (due to increased stiffness). A fully infilled frame yields lesser force in the frame elements and dissipates greater energy through infill walls. The structural implications like strength and stiffness of infill walls in infilled frame buildings are ignored in the structural modelling in conventional design practice. The design in such cases will generally be conservative in the case of fully infilled framed building. But things will be not be the same for an open ground storey framed building. Open ground storey building is slightly stiffer than the bare frame, has larger drift (especially in the ground storey), and fails due to soft storey-mechanism at the ground floor as shown in Fig. 1.1. Therefore, it may not be conservative to ignore strength and stiffness of infill wall while designing open ground storey buildings. Performance of buildings in the past earthquakes clearly shows that the presence of infill walls has significant structural implications on them. Therefore, we cannot simply neglect the structural contribution of infill walls particularly in seismic regions where, the frame–infill interaction may cause significant changes in both stiffness and strength of the frame. Inclusion of stiffness and strength of infill walls in the open ground storey building frames decreases the fundamental time period compared to a bare frame and consequently increases the base shear demand and the design forces in the ground storey beams and columns. This increased design forces in the ground storey beams and columns of the open ground storey buildings are not captured in the conventional bare frame analysis. An appropriate way to analyse the open ground storey buildings is to model the strength and stiffness of infill walls.

II. Objectives

The salient objectives of the present study have been identified as follows:

1) To study the effect of infill strength and stiffness in the seismic analysis of open ground storey (OGS) buildings.
2) To check the applicability of the multiplication factor of 2.5 as given in the Indian Standard IS 1893:2002 for design of midrise open ground storey building.
3) To assess the effect of varying the infill arrangements on the analysis results by taking various combinations of infill thickness, strength, modulus of elasticity and openings.

III. NEED FOR THE PROPOSED WORK

The presence of infill walls in upper storeys of open ground storey (OGS) buildings accounts for the following issues:

1) Increases the lateral stiffness of the building frame.
2) Decreases the natural period of vibration.
3) Increases the base shear.
4) Increases the shear forces and bending moments in the ground storey columns.

IV. LITERATURE REVIEW

Inclusion of stiffness and strength of infill walls in the open ground storey building frames decreases the fundamental time period compared to a bare frame and consequently increases the base shear demand and the design forces in the ground storey beams and columns. This increased design forces in the ground storey beams and columns of the open ground storey buildings are not captured in the conventional bare frame analysis. An appropriate way to analyze the open ground storey buildings is to model the strength and stiffness of infill walls. Unfortunately, no guidelines are given in IS 1893: 2002 (Part-1) [1] for modelling the infill walls. In Infill thickness, strength, modulus of elasticity and openings are analyzed by two methods mentioned above. The modelling and analysis for the study is done with the aid of commercial software ETABS v 9.7.1[2] in compliance with the codes IS 456-2000[3] and IS 1893-2002. In existing systems, third party auditor demanding local copy of user outsourced data. So this will increase the possibility of the following research papers are consulted for obtaining an in-depth understanding of Asokan (2006) studied how the presence of masonry infill walls in the frames of a building changes the lateral stiffness and strength of the structure. This research proposed a plastic hinge model for infill wall to be used in nonlinear performance based analysis of a building and concludes that the ultimate load (UL) approach along with the proposed hinge property provides a better estimate of the inelastic drift of the building[7]. D Menon et. al. (2008) concluded that the MF increases with the height of the building, primarily due to the higher shift in the time period. Also when large openings are present and thickness of infills is less, there is a reduction in MF. The study proposed a multiplication factor ranging from 1.04 to 2.39 as the number of storey increases from four to seven [8]. J. Dorji and D.P. Thambiratnam (2009) concluded that the strength of infill in terms of its Young's Modulus (E) has a significant influence on the global performance of the structure. The stresses in the infill wall decrease with increase in (E) values due to increase in stiffness of the model. The stresses varies with building heights for a given E and seismic hazard[9] Sattar and Abbie (2010) in their study concluded that the pushover analysis showed an increase in initial stiffness, strength, and energy dissipation of the in filled frame, compared to the bare frame, despite the wall's brittle failure modes. Likewise, dynamic analysis results indicated that fully-infilled frame has the lowest collapse risk and the bare frames were found to be the most vulnerable to earthquake-induced collapse. The better collapse performance of fully-infilled frames was associated with the larger strength and energy dissipation of the system, associated with the added walls [10]. Dukuze (2000) investigated the failure modes of infilled structure on single storey specimens with and without opening. In general, three types of failures were observed under an in plane load such as sliding of bed joints, tensile cracking of

V. DESCRIPTION OF STRUCTURAL MODEL

The description of the structure and other important parameters are given below:

A. *Geometry*

The building has five bays in X direction and four bays in Y direction with the plan dimension 22.5 m × 14.4 m and a storey height of 3.5 m each in all the floors and depth of foundation taken as 1.5 m.

B. *Material properties*

M-25 grade of concrete and Fe-415 grade of reinforcing steel are used for all the frame models, the unit weights of concrete and masonry are taken as 25.0 kN/m3 and 20.0 kN/m3, the poison ratio of concrete is 0.2 and of masonry is 0.15.

VI. CONCLUSIONS

Reinforced concrete frame buildings with open first storeys are known to perform poorly during strong earthquake shaking. The open ground storey building frame is generally considered to be more vulnerable than a corresponding 'bare frame' under seismic loads. This hazardous feature of Indian reinforced concrete frame buildings needs to be recognized immediately and necessary measures should be taken to improve the performance of such buildings. Design code IS 1893 (2002), recommend a magnification factor of 2.5 to be applied on the calculated column shear forces and bending moments in the ground storey, based on simple bare frame analysis.

The objective of the present study is to study the seismic vulnerability of buildings with soft ground storey under earthquakes and also to review the rationality of the approach specified in code for the given particular building. An existing reinforced concrete framed building (G+5) with open ground storey located in Seismic Zone-IV is analysed for two different cases: (a) considering infill strength and stiffness and (b) without considering infill strength and stiffness (bare frame). Infill weights (and associated masses) were modelled in both the cases through applying static dead load. Non-integral infill walls subjected to lateral load behave like diagonal struts. So an infill wall can be modelled as an equivalent 'compression only' strut in the building architecture. Rigid joints connect the beams and columns, but pin joints connect the equivalent struts to the beam-to-column join. Infill stiffness was modelled using a diagonal strut approach as per Smith and Carter (1969).Variations are induced by changing the arrangements of infill in terms on infill thickness, modulus of elasticity and by providing certain openings. Therefore 5 buildings are analysed by linear static analysis and response spectrum analysis.

REFERENCES

[1] Kaushik H. B. (2006). Evaluation of strengthening options for masonry-infilled RC frames with open first

storey. Ph.D. Thesis. Indian Institute of Technology Kanpur.

[2] Liauw T. C. and Kwan K. H. (1983). Plastic theory of non-integral infilled frames. Proceedings of Institution of Civil Engineers. Part 2, 379-396.

[3] Madan A., ReinhornA. M., ManderJ. B. andVallesR.E. (1997). Modelling of masonry infill panels for structural analysis.ASCEJournal of Structural Engineering. 123, 1295–1301.

[4] Mainstone R. J. (1971). On the stiffness and strength of infilled frames. Proceedings of Institution of Civil Engineers. Supplementary, 57-90.

[5] Mallick D.V. and Severn R.T. (1967). The Behaviour of Infilled Frames under Static Loading. The Institution of Civil Engineers Proceedings. 39, 639-656.

[6] Mehrabi A. B.,ShingP. B., SchullerM. P. and NolandJ. L. (1996). Experimental evaluation of masonry infilled RC frames. ASCE Journal of Structural Engineering. 122, 228-237.

[7] Murty C. V. R. (2002). Performance of reinforced concrete frame buildings during 2001 Bhuj earthquake. Proceedings of the 7th US National Conference on Earthquake Engineering, Boston, USA. Paper no. 745.

[8] Murty C. V. R. and Jain S. K. (2000). Beneficial influence of masonry infill walls on seismic performance of RC frame buildings. Proceedings of the 12th World Conference on Earthquake Engineering. Paper no. 1790.

[9] Parducci A. &Mezzi M. (1980). Repeated horizontal displacements of infilled frames having different stiffness and connection systems – an experimental analysis. 7th World Conference on Earthquake Engineering, Istanbul.

[10] Saneinejad A. and HobbsB. (1995). Inelastic design of infilled frames. ASCE Journal of Structural Engineering. 121, 634-650.

[11] Sattar S. and Abbie B. L. (2010). Seismic Performance of Reinforced Concrete Frame Structures with and without Masonry Infill Walls, 9th U.S. National and 10th Canadian Conference on Earthquake Engineering, Toronto, Canada.

[12] Scarlet A. (1997). Design of Soft Stories – A simplified energy approach. Earthquake Spectra. 13, 305-315