A Review of Magnification Factor on Open Ground Multi Storey Building Structure

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ABSTRACT

This work concerns with a behavior of infilled frames. The feasibility of possible immediate implementation of some recent developments both in analysis and design of infilled frames for practical design is study. It is now widely recognized that masonry infill panels used in reinforced concrete frame structures, significantly enhance both the stiffness and the strength of the surrounding frame. However, their contribution is often not considered because of the lack of knowledge of the composite behaviour of the surrounding frame and the infill panel. Currently, Seismic Design Codes contain provisions for the calculation of stiffness of solid infilled frames mainly by modeling infill as a 'diagonal strut.' However, such provisions are not provided for infilled frames with openings. The present study, proposes analytical equations of the reduction factor, which is expressed as the ratio of the effective width of the diagonal strut of an infill with openings over that of a solid infill, in order to be able to calculate the initial lateral stiffness of reinforced concrete frames with infills that have openings.

Keywords: *Multi Storey building structure, Magnification factor, Open ground building*.

I. INTRODUCTION

Earthquakes are one of the most devastating of all-natural hazards and are the most powerful natural disasters which are unavoidable. The hazards associated to earthquakes are referred to as seismic hazards. Most earthquake-related deaths are caused by the collapse of structures. Day by day need of space became very important in urban areas due to increase in population especially in developing countries like India. However, to fulfill the need of parking spaces ground story of building is utilized which makes building more vulnerable under lateral loads. These types of buildings having no infilled walls in ground storey, but in-filled in all upper stories, are called Open Ground Storey (OGS) buildings. Many apartments or building constructed are falls in this category.

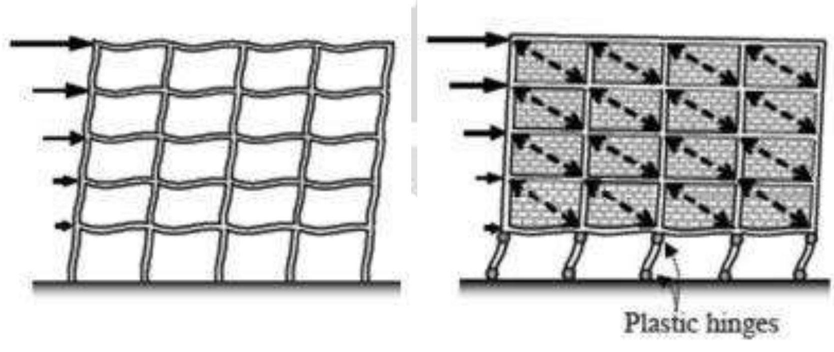

Fig 1. Behavior of bare frame (left) and OGS building (Right)

1.1 Magnification Factor

The magnification factor (MF) is applied to open ground storey buildings to compensate the stiffness irregularity in ground storey due to absence of infills. The Indian seismic code IS 1893- 2002 recommends that the members of the soft story to be designed for 2.5 times the seismic story shears and moments, obtained without considering the effects of masonry infill in any story. The factor of 2.5 is specified for all the buildings with soft stories irrespective of the extent of irregularities and the method is quite empirical and may be too conservative and thus have further scope for improvement.

$$\text{Magnification Factor} = \frac{\text{Member force of infilled frame}}{\text{Member force of bare frame}}$$

II. LITERATURE REVIEW

In this section the literature review of previous and related work, in the proposed area of research has been carried out and briefly presented.

Dakhakhni et. al., [1], masonry infill panels in framed structures have been long known to affect strength, stiffness, and ductility of the composite structure. In seismic areas, ignoring the composite action is not always on the safe side, since the interaction between the panel and the frame under lateral loads dramatically changes the stiffness and the dynamic characteristics of the composite structure, and hence, its response to seismic loads. This study presents a simple method of estimating the stiffness and the lateral load capacity of concrete masonry-infilled steel frames (CMISFs) failing in corner crushing mode, as well as the internal forces in the steel frame members. In this method, each masonry panel is replaced by three struts with force-deformation characteristics based on the orthotropic behavior of the masonry infill. A simplified steel frame model is also presented based on the documented modes of failure of the CMISF. The method can be easily computerized and included in nonlinear analysis and design of three-dimensional CMISF structures.

Kose [2], in this study, the effects of selected parameters i.e. building height, number of bays, ratio of area of shear walls to area of floor, ratio of infilled panels to total number of panels and type of frame on the fundamental period of RC buildings were investigated. In general, the fundamental period of RC frames are determined by a modal analysis, by discarding the effect of infill walls on the total mass and rigidity of the structure. 189 building models with selected parameters were generated and analyzed in 3D using a finite element method. Due to the nonlinear behavior of infill walls, an iterative modal analysis was used to determine the fundamental period of models. It was found that RC frames with infill walls had a shorter period, about 5%–10%, compared with RC frames without infill walls regardless of whether they had shear walls or not. The presence of shear walls also led to a reduction in the fundamental period, about 6%–10%, between models with and without infill walls. The fundamental periods obtained by an iterative modal analysis were also compared with current code predictions, which are based on measurements taken during earthquakes on real buildings. It was seen that the current code equations under-predict the fundamental periods of the models from 2% to 47%, depending upon the model parameters. A new equation, which was a function of the selected parameters, was also proposed for predicting the fundamental period of buildings, based on results of this study using multiple linear regression analysis. The proposed equation gives a better estimate of fundamental periods, compared with the code equations.

Smith [3], An investigation of the behavior of diagonally-loaded square infilled frames is described first. Series of experiments on diagonally-loaded models with a range of frame stiffness's indicated that a small increase in frame stiffness has a magnified effect on the over-all stiffness and strength of the structure. Approximate theoretical analyses, based on the length of contact between the frame and infill, are developed to explain this composite behavior, and to provide methods of predicting the over-all diagonal stiffness and strength. The behavior of laterally-loaded infilled frames is considered next. The methods proposed for the diagonally-loaded case are adapted to predict the lateral stiffness and strength of single or multi-story square infilled frames. The results of experiments on single and double-story models support the pro-posed methods of prediction.

Santhi et. al., [4], the seismic performance of reinforced concrete frames designed for gravity loads is evaluated experimentally using a shake table. Two 1:3 scale models of one-bay, three-storied space frames, one without infill and the other with a brick masonry infill in the first and second floors, are tested under excitation equivalent to the spectrum given in IS 1893-2002. From the measured response of the models during excitation, the shear force, inter story drift, and stiffness are evaluated. The effect of masonry infill on the seismic performance of reinforced concrete frames is also investigated. Then, the frames are tested to failure. Severe damage is observed in the columns in the ground floor. The damaged columns are strengthened by a reinforced concrete jacket. The frames are again tested under the same earthquake excitations. The test results showed that the retrofitted frames could sustain low to medium seismic forces due to a significant increase in strength and stiffness.

Liauw and Kwan [5], The nonlinear behaviour of non-integral infilled frames (in which the infill and the frame are not bonded together) is studied both experimentally and analytically. In the theoretical study, finite element method is used and the nonlinearities of the material and the structural interface are taken into account. It is shown that the stress redistributions towards collapse are significant, and that the strength of non-integral infilled frames is very much dependent on the bending strength of the frame. The effects of initial lack of fit and friction at the interface are also studied theoretically. Furthermore, an empirical formula for estimating the equivalent strut width is proposed.

Asteris [6], In a companion paper, a new finite element technique for the analysis of brickwork infilled plane frames under lateral loads has been presented. In the present paper, the influence of the masonry infill panel opening in the reduction of the infilled frames stiffness has been investigated by means of this technique. A parametric study has been carried out using as parameters the position and the percentage of the masonry infill panel opening for the case of one-story one-bay infilled frame. The investigation has been extended to the case of multi-story, fully or partially infilled frames. In particular, the redistribution of action effects of infilled frames under lateral loads has been studied. It is shown that the redistribution of shear force is critically influenced by the presence and continuity of infill panels. The presence of infills leads, in general, to decreased shear forces on the frame columns. However, in the case of an infilled frame with a soft ground story, the shear forces acting on columns are considerably higher than those obtained from the analysis of the bare frame.

Asteris [7], In this paper, a realistic criterion is proposed to describe the frame-infill separation, in order to better simulate the complicated behavior of infilled frames under lateral loads. The basic characteristic of this analysis is that the infill/frame contact lengths and the contact stresses are estimated as an integral part of the solution, and are not assumed in an ad-hoc way. In order to implement the method, a specific computer program for the analysis of infilled plane frames, under lateral loads, has been developed. Using this method, the response of a single-bay single-story masonry infilled R.C frame, under a lateral load in the beam level, has been investigated. The large magnitude of the variation of the contact lengths between the infill and the different frame members is clearly shown.

Asteris et. al., [8], This work presents an assessment of the behavior of infilled frames. The feasibility of possible immediate implementation of some recent developments both in analysis and de-sign of infilled frames for practical design is investigated. It is now widely recognised that masonry infill panels, used in reinforced concrete (R/C) frame structures, significantly enhance both the stiffness and the strength of the surrounding frame. However, their contribution is often not taken into account because of the lack of knowledge of the composite behaviour of the surrounding frame and the infill panel. Currently, Seismic Design Guidelines (EC8 – Part 3, FEMA – 440, ASCE 41-06) contain provisions for the calculation of the stiffness of solid infilled frames mainly by modeling infill walls as "diagonal struts." However, such provisions are not provided for infilled frames with openings. The present study, based on available finite element results, proposes analyti-cal equations for obtaining the reduction factor, which is the ratio of the effective width of a diagonal strut representing a wall with an opening over that of the solid RC infilled frame. That will allow the calculation of the initial lateral stiffness of infills when an opening is present. The validity of the proposed equations is demonstrated by comparing our results, against work done by various researchers.

Asteris et. al., [10], the in-plane contribution of infill walls on the structural response of infilled frame structures is an important problem and many research initiatives, via experimental and numerical methods, have been conducted in order to investigate it thoroughly. As a result, the need to consider these research findings on the structural performance has been acknowledged in the latest generation of structural design codes. However, due to the uncertainties concerning the behavior of masonry at the material and structural level, these elements are usually ignored during practical structural analysis and design. They are overtly considered only when there is suspicion that their influence is detrimental to the overall structural response or to the behavior of individual load bearing elements or when it is necessary to justify an improvement in the overall load-carrying capacity or structural performance in general. In this paper, a thorough overview of the different micromodels proposed for the analysis of infilled frames is presented, and the advantages and disadvantages of each micromodel are pointed out (this paper follows our recent review paper on the state-of-the-art of the mathematical macro-modeling of infilled frames, thus completing the overview of both macro- and micro- models in the field). Practical recommendations for the implementation of the different models are also presented.

III. CONCLUSION

In this work, the attempts of researchers through many decades to model infill walls are summarized and the most commonly used are presented. One of the main difficulties to introduce infill walls, which are universally accepted as having a significant influence in the response of frames in the modeling of structures, is the absence of a way to represent openings in the infills.

In this work, a reduction factor is proposed that can be used as a multiplication factor on well-known equations to calculate the reduced equivalent width of compression struts, so as to be able to model infill walls with openings. The same reduction factor can be used in models of multiple-struts, so to be able to idealize the behaviour of infill walls with openings.

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