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REVIEW OF BEHAVIOUR OF INFILLED WALLS

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ABSTRACT

The effect of masonry infill panel on the response of RC frames subjected to seismic action is widely recognized and has been subject of numerous experimental investigations, while several attempts to model it analytically have been reported.Masonry infills in reinforced concrete buildings cause several undesirable effects under seismic loading: short-column effect, soft-storey effect, torsion, and out-of-plane collapse. Many researchers have changed various different parameters and analyzed the same. This paper presents a short summary of these investigations and helps in understanding the behavior of Infill Walls.

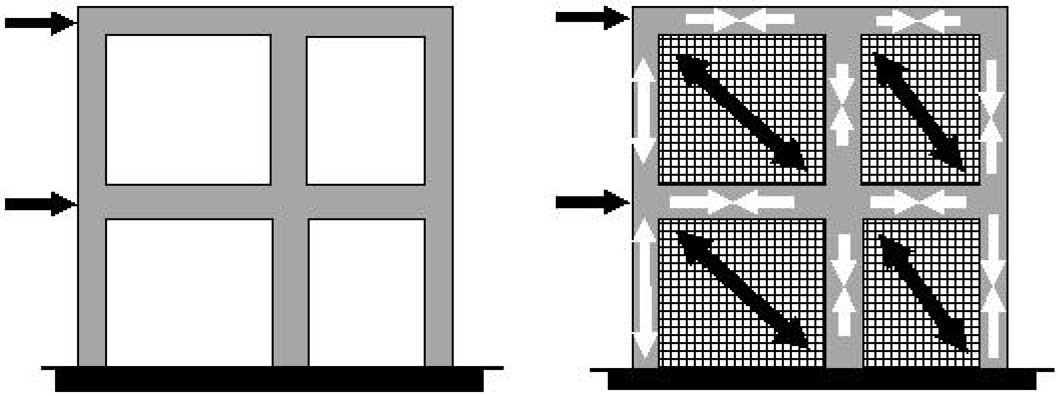
I INTRODUCTION

A large number of buildings are constructed with masonry infills for architectural needs or aesthetic reasons. However, because of complexity of the problem and absence of a realistic, yet simple analytical model, the combination of masonry infill panels is often neglected in the non-linear analysis of building structures. Such an assumption may lead to substantial inaccuracy in predicting the lateral stiffness, strength and ductility of the structure.

The behavior of masonry infilled frames has been extensively studied in the last four decades in attempts to develop a rational approach for design of such frames. In general design practices in India, the strength and stiffness of infill walls are ignored because of the idea of conservative design. In practical, infill walls provide considerable strength and rigidity to the structure and their absence may cause failure of many multi-storeyed buildings.

Infills do not contribute towards resisting gravity loads but contribute significantly in resisting lateral loads. However, in practice, infill stiffness is commonly ignored in frame analysis, resulting in an under estimation of stiffness and natural frequency. Infills have energy dissipation characteristics that contribute to improved seismic resistance.

Behavior of infill walls have been analyzedand studied by many researchers manipulating with various parameter and verticals of structural analysis and civil engineering by changing in percentage of openings in infills, with and without infills, open first storey, change in infill material, analysis with different software accompanied by different methods of analysis, etc.



II METHODS OF ANALYSIS

2.1 Equivalent Static Analysis

The equivalent static lateral force method is a simplified technique which substitutes the effect of dynamic loading of an expected earthquake by a static force distributed laterally on a structure. Generally, the total seismic force is evaluated in two horizontal directions which is parallel to main axes of the building. This method assumes that the building responds in its fundamental lateral mode, this assumption is conserved true when the building is low rise and must be symmetric to avoid torsional movement under ground motion. The effects caused by seismic forces must be resisted by the structure in either direction, but not in both the directions simultaneously.

2.2 Response Spectrum Method

In order to perform the seismic analysis and design of a structure to be built at a particular location, the actual time history record is required. However, it is not possible to have such records at each and every location. Further, the seismic analysis of structures cannot be carried out simply based on the peak value of the ground acceleration as the response of the structure depend upon the frequency content of ground motion and its own dynamic properties. To overcome the above difficulties, earthquake response spectrum is the most popular tool in the seismic analysis of structures. There are computational advantages in using the response spectrum method of seismic analysis for prediction of displacements and member forces in structural systems. The method involves the calculation of only the maximum values of the displacements and member forces in each mode of vibration using smooth design spectra that are the average of several earthquake motions.

2.3 Time History Analysis

In order to examine the exact non-linear behavior of building structures, nonlinear time history analysis has to be carried out. In this method, the structure is subjected to real ground motion records. This makes this Analysis of Masonry Infill in a Multi-Storied Building analysis method quite different from all of the other approximate analysis methods as the inertial forces are directly determined from these ground motions and the responses of the building either in deformations or in forces are calculated as a function of time, considering the dynamic properties of the building structure.

2.4 Pushover Analysis

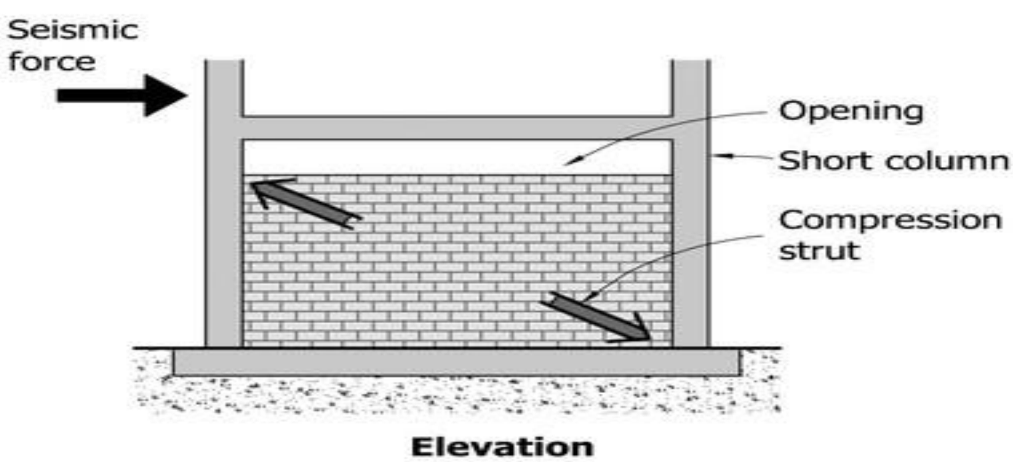
Pushover analysis is a static, nonlinear procedure in which the magnitude of the lateral forces is incrementally increased, maintaining the predefined distribution pattern along the height of the building. With the increase in magnitude of the loads, weak links and failure modes are found. Pushover analysis can determine the behavior of a building, including the ultimate load and maximum inelastic deflection. Local nonlinear effects are modeled and the structure is pushed until a collapsed mechanism is developed. At each step, the base shear and roof displacement can be plotted to generate the pushover curve.

III UNDESIRABLE EFFECTS UNDER SEISMIC LOADING

3.1 Short-Column Effect

Columns those are short-heighted or with shorter effective heights to that of the other regular (taller) columns within the same storey are called Short Columns. Formation of Short Columns could be due to presence of intermediate beams or due to other reasons as shown in Figs-11, 12 & 13 below. These are the typical cases that introduce Short Columns in buildings. In general, there would be presence of Short Columns wherever effective column heights vary within the same storey due to various structural configurations or boundary conditions.

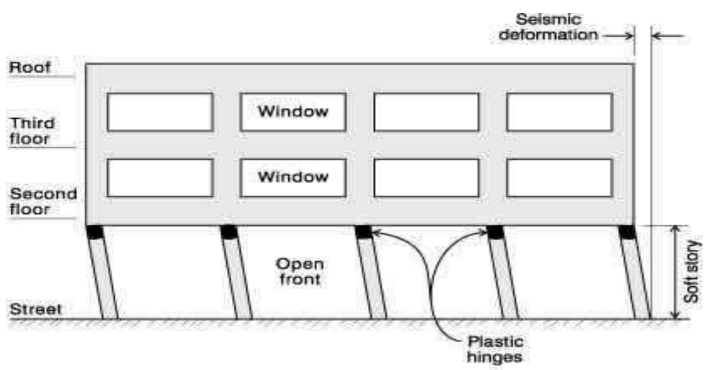
Short columns are relatively stiff in comparison to other regular columns due to their lower effective heights hence have increased Seismic Demand. These columns attract higher value of earthquake induced forces than their counterparts; thereby making it highly vulnerable in earthquakes. This effect is termed as "Short Column Effect" in frame structures.



3.2 Soft-Storey Effect

A soft storey, also known as a weak story, is defined as a story in a building that has substantially less resistance, or stiffness, than the stories above or below it. In essence, a soft story has inadequate shear resistance or inadequate ductility (energy absorption capacity) to resist the earthquake-induced building stresses. Although not always the case, the usual location of the soft story is at the ground floor of the building. This is because many buildings are designed to have an open first-floor area that is easily accessible to the public. Thus the first floor may contain large open areas between columns, without adequate shear resistance. The earthquake-induced building movement also causes the first floor to be subjected to the greatest stress, which compounds the problem of a soft story on the ground floor.

Soft storey buildings are characterized by having a storey which has a lot of open space. Parking garages, for example, are often soft stories, as are large retail spaces or floors with a lot of windows. While the unobstructed space of the soft story might be aesthetically or commercially desirable, it also means that there are fewer opportunities to install shear walls, specialized walls which are designed to distribute lateral forces so that a building can cope with the swaying characteristic of an earthquake



IV LITERATURE REVIEW

4.1 Seismic Evaluation of RC Frame with Brick Masonry Infill Walls.

M.Tech Scholar Nitesh Singh, Asst. Prof. V.K.Verma

Infill panels are only used in RC frame structure as partition walls and as external walls. These are considered as non-structural elements and can provide with considerable stiffness to the building improving the performance under-ground motions. In this paper two methods are used to analyze the behavior of Infill walls i.e. Equivalent Lateral Force method and Response Spectrum Method. Two models are considered one without infill and another with infill. The one with infill has been modeled as an equivalent diagonal strut element using Hendry formula. Both the models are analyzed with Pushover analysis. The software used is STAAD Pro and the results obtained are compared in terms of strength and stiffness with bare frame.

4.2 Influence of Masonry Infill Walls on Seismic Performance of RC Framed Structures- A Comparison of AAC and Conventional Brick Infill.

M.Tech Student Ms. KajalGoel

This paper deals with the analysis of RC frame with different infill material one is AAC (Autoclaved Aerated Concrete) and the other is Conventional concrete block. This paper has used the STAAD Pro software for analysis. The methodology used in this paper is Equivalent Static Force Analysis. Comparison of these two materials with different parameters such as Base Shear, End Displacement and Deflection of frames are depicted in this paper.

4.3 Beneficial Influence of Masonry Infill Walls on Seismic Performance of RC Frame Building

C V R Murty and Sudhir K Jain.

Masonry Infills contribute significant lateral stiffness, strength, overall ductility and energy dissipation capacity. With suitable arrangements to provide reinforcement in masonry that is well anchored in frame column, it is possible i=to also improve the out-of-plane response of such infills. Infills interfere with the lateral deformation of RC frame; separation of frame and infill takes place along one diagonal and compression strut forms along another. Therefore, infills add lateral stiffness to the building.

4.4 Effect of Infill Stiffness onSeismic Performance of Multi-Storey RC Framed Buildings in India.

Robin DAVIS, Praseetha KRISHNAN, Devdas MENON, Meher PRASAD

Most of the Multi-Storey buildings in India comprises of Reinforced Concrete frames with brick masonry as infills. The use of unreinforced masonry infill walls may not contribute towards resisting gravity loads but may significantly enhance stiffness and strength of the frame under earthquake or wind resulting in an under estimation of stiffness and natural frequency. It has been observed from the experiments that infills have energy dissipation characteristics that contribute to improved seismic resistance. In this paper two typical buildings located in moderate seismic zones of India are considered. The difference between two buildings are one exists with plan irregularity vertical irregularity (soft-storey) and the other exists with symmetricity. The infills were modelled using equivalent strut approach. Static analysis (for gravity and lateral loads), response spectrum analysis and non-linear pushover analysis (assigning the hinge properties to beams and column sections) were performed. It is observed that the seismic demand at the soft storey level is significantly large when infill stiffness is considered, with larger base shear and larger displacements. This effect, however, is not found to be significant in the symmetric building (without soft storey). Seismic performance was compared in the pushover analysis for the two cases. The results are described in detail in this paper.

4.5 Earthquake Analysis of Highrise Buildings with and without Infill Walls.

Wakchaure M.R., Ped S.P

The effect of masonry infill panel on the response of RC frames subjected to seismic action is widely recognized and has been subject of numerous experimental investigations, while several attempts to model it analytically have been reported. In analysis of buildings, infill walls are modeled as equivalent strut approach there are various formulae derived by research scholars and scientist for width of strut and modelling. Infill behaves like compression strut between column and beam and compression forces are transferred from one node to another. In this study the effect of masonry walls on high rise building is studied. Linear dynamic analysis on high rise building with different arrangement is carried out. For the analysis G+9 R.C.C. framed building is modelled. Earthquake time history is applied to the models. The width of strut is calculated by using equivalent strut method. Various cases of analysis are taken. All analysis is carried out by software ETABS. Base shear, storey displacement, story drift is calculated and compared for all models. The results show that infill walls reduce displacements, time period and increases base shear. So it is essential to consider the effect of masonry infill for the seismic evaluation of moment resisting reinforced concrete frame.

V **CONCLUSION**

1. The Indian Standard code provisions do not provide any guidelines for the analysis and design of RC frames with infill panels.
2. Due to the presence of infill walls the displacement capacities of the structure enhances and the structural force distribution modifies significantly.
3. As the density of the infill material reduces the base shear also is on a smaller scale as compared with the infill material of higher density. For example, the base shear was significantly smaller for AAC blocks than with conventional clay bricks which results in reduction in member forces which in turn results in reduction of area of steel. With this we can reduce the cost in construction.
4. The bare frame has higher time period than that of infilled frame as given by equivalent static method concluding that presence of infill panels increases stiffness of the structure.
5. The storey drift decreases in infilled frame when compared with bare frame verifying the importance of stiffness in absorbing shocks.
6. Infills interfere with lateral deformation of RC frame; separation of frame and infill takes place along one diagonal and a compression strut forms along another. Therefore, infills add lateral stiffness to the building.
7. Load transfer mechanism changes from frame action to truss action. The columns now experience increased axial forces but reduced bending moments and shear forces.

8. In bare frame, inelastic effects in RC frame members and joints cause energy dissipation while in an infilled frame, inelastic effects in infills also contribute to it. Therefore, energy dissipation in infill is higher than in bare frame.
9. The increase in opening percentage leads to decrease on lateral stiffness of infilled frame.
10. The results from equivalent static analysis, the displacement values are higher than Response Spectrum and Time history analysis.

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