Scientific Journal of Impact Factor (SJIF): 5.71
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406
International Journal of Advance Engineering and Research Development
Volume 6, Issue 10, October -2019

Instrumentation for finding seismic capacity of perforated infill wall

Muhammad Umar

M.Sc. Scholar, Department of Civil Engineering, University of Engineering & Technology Peshawar, Pakistan

Abstract: *This research aims to find the effect of perforation on the lateral stability of reinforced concrete frame structure. Unreinforced brick masonry (URBM) infill construction is very common practice in Pakistan. (URBM) is experimentally evaluated in this paper that how perforations in frame structures with masonry infill affect the lateral strength and over all stability, which include; Strength, Stiffness, Ductility and Energy dissipation response factor. A total of two full scale Reinforced concrete frames with unreinforced brick masonry infill has been constructed. Quasi-Static cyclic testing performed on each infill wall Reinforced concrete frame with unreinforced brick masonry to find its strength and stiffness. Perforation in infill walls reduced lateral strength and stiffness of frame structures considerably.*

Keywords- *Lateral strength; stiffness; Unreinforced Brick Masonry frame (URBM); Perforations; Hydraulic Actuator*

I. INTRODUCTION

Infills wall are used in reinforced concrete (RC) in steel structures. Due to seismic actions, infills interact with frames but essentially it does not increase structural performance, due to which severe damages may occurs.
Ghassan Al-Chaar evaluate strength and stiffness, through empirical relationships, of unreinforced masonry structures subjected to lateral loads (both in – plane and out – of – plane) based upon several experimental and computational research.
These guidelines actually provide Engineers with an alternative approach, strength design method, to FEMA 273 which will result in safe and economical construction.
The procedure presented in this reports is applicable to all structure whether steel or reinforced concrete infilled with concrete or brick masonry infill. But the infilled shall be considered as structural components of buildings as mentioned in categories 7 and 10 below. Isolated infill walls, where there are no chances of infill and bounding frame interaction, are not considered as structural elements and thus no the part of this report.
Ghassan Al-Chaar, Gregory E. Lamb, AND Daniel P. Abrams investigate influence of door and window opening upon reduction of lateral stiffness and strength of an infilled frame, tests were carried out on a multi – storey, multi – bay building reduced by half scale. Infill walls within a control structure were solids while other structure was having openings for doors and windows of different sizes and locations. Seismic detailing was not taken care of as it was representing typical structure of 1950s. These structures were subjected to cyclic in plane loading.
Empirical equations are provided to account for strength and stiffness reduction due to perforations provided within infill frames. And eccentric equivalent strut approach can be effectively used to analyses the structure having solid infill walls for its ultimate capacity, initial stiffness and displacement at ultimate. The strut approach can be used to model infill with openings too.
P. G. Asteris A new technique based upon FEM for the analysis of Masonry infill subjected to lateral loads is presented. Reduction within stiffness due to provision of opening within masonry infilled wall is investigated. Parametric study based upon opening percentage and position is carried out. This study was carried out for a single storey single bay structure which was extended to multi storey structure. Moreover, the redistribution of action effects of frame having infilled panels subjected to lateral loads is studied.
Opening reduced frame stiffness and 100 percent opening (bare frame) reduces the stiffness by 87%. Opening size more than 50% of infilled area, stiffness factor becomes constant. Infill walls reduced lateral deformation and increase lateral strength. Shear forces are reduced due to infill walls but in case of open storey, shear forces are enhanced and can be proved detrimental.
By V. SIGMUND and D. PENAVA Lateral deformations of this frame were prevented by bracing. Foundation beam of specimen was fixed to steel frame. Four hydraulic actuators of stroke ±150mm were used, two for vertical loading of capacity 500kN and two for lateral loading of capacity 350kN. Lateral load was applied quasi statically and cyclically. Forced control lateral loading was applied until yielding at an increment of 10kN repeating each step twice, after which displacement control lateral load was applied at an increment of 1mm until drift of 1-1.2% or out of plane infill failure. When infill wall is extensively damage then loading is applied from one direction only until collapse. For constant vertical load of 365kN simulating upper floor loading, pressure valves mounted on actuators were used
Infill contribution towards stiffness, lateral strength and hysteretic damping with and without opening was similar. Ductility values and behaviour factors were higher for unconfined Infilled RC frame. Infill wall's enhanced structural performance and its contribution is considered positive. Soft storey could be detrimental. Analytical equations could not depict actual experimental behaviour.

II. DESCRIPTION OF MODEL

In laboratory two full scales, single bay R.C. frames with eccentric openings for door and window were constructed. In one frame only window and the other frame both door and window openings was provided. Every wall was initiated above a 12ft x 2ft x 1ft deeply R.C. pad. The beam, columns dimension were 1' x 1'. The R.C. pad was fixed to the stout floor with the nut bolts having 1inch diameter to prevent the uplift of the wall during the test. In the construction of infill wall frames, 9inch brick masonry with English bond was used. As we shown in figure 3.1 and figure 3.2, 2D detail elevation and model of R.C. frames with door and window was constructed.

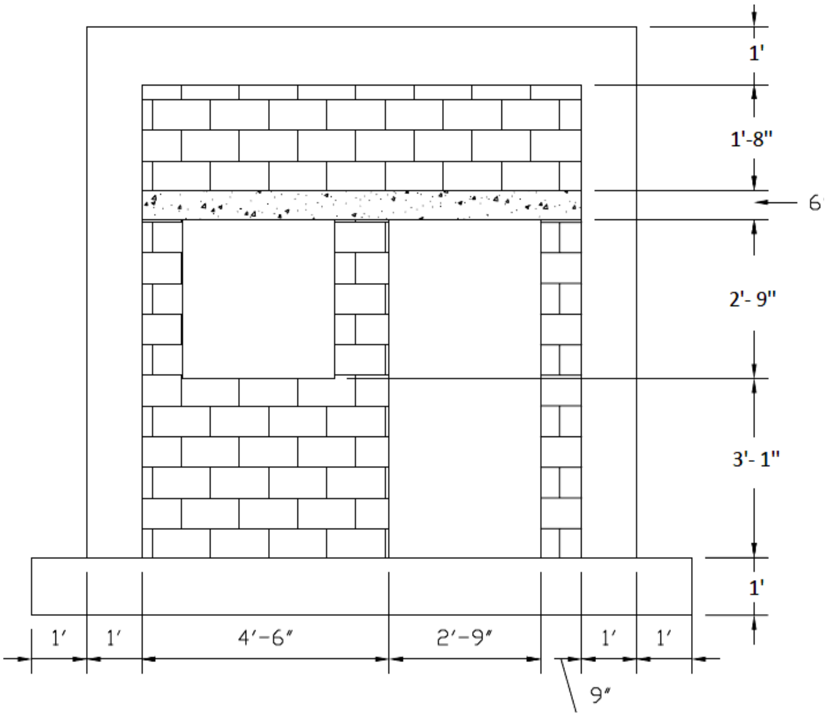

Figure 3.1 2D details Elevation with door and window of infill frame

Figure 3.2 Reinforced concrete infill wall frame with window and door opening fabricated in lab

As shown in figure 3.3 and figure 3.4, 2D detail elevation of R.C. frame fabricated model with window opening.

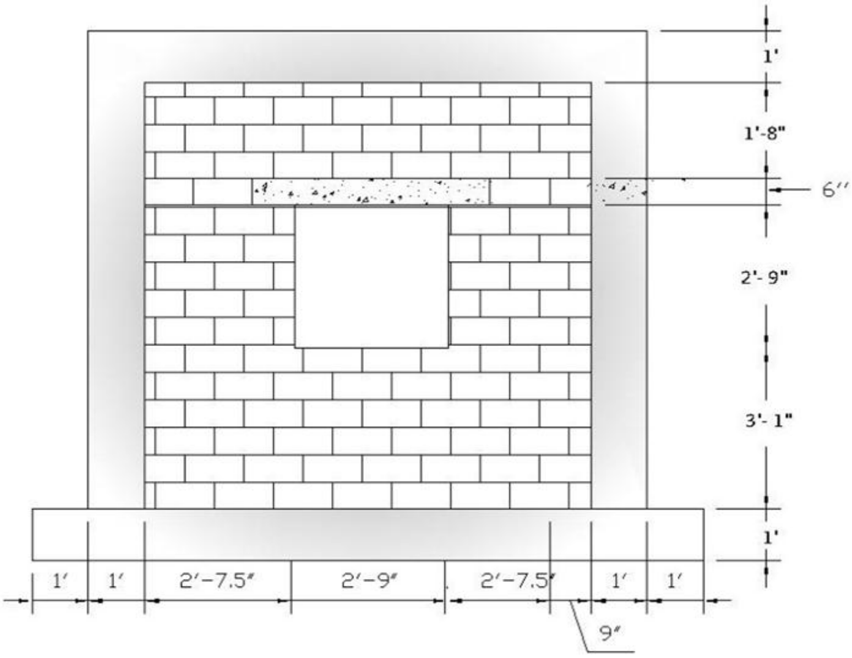

Figure 3.3 2D details Elevation of infill frame with window opening at center

Figure 3.4 Reinforced concrete infill wall frame with window opening fabricated in lab

III. METHODOLOGY

The piratical work regarding this project was executed by adopting the following strategy. This strategy was practically implemented by the systemic way, in the phases to conclude the final results according to up-to the mark standards.

3.1 Material

This research work was launched with the objective of determining the useful effective role of presence filled system with in R.C. frame structures. The traditional local materials used in Pakistan for constructing infills walls in concrete structure are concrete blocks (Different types in shapes and size) and stander size bricks. In majority of the cases in construction practices in Pakistan the fire burnt bricks are used for infilled walls in R.C. structures. To evaluate the potential use of these bricks regarding the strength and stability of R.C. structures this was initiated.

3.2 REINFORCED CONCRETE FRAME

The major part of the experimental setup required the construction of a reinforced concrete frame with the presence of infilled material in order to evaluate the lateral stiffness of the overall test specimen. This research study aimed at a comparative study of the lateral stiffness of RC frame construction with that of a bare frame construction. Therefore, there were two RC frame structure planned to be constructed i.e. one being the bare frame with door and window opening infilled wall material and the other RC frame with window opening as infilled wall as shown in Figure 3.1 and 3.2. This way, a clear distinction could be achieved in terms of stiffness parameters and structural deformation comparison.

It was finalized that the structural members should have fc' of 3000 psi in order to bring uniformity in construction and compatibility with the local construction practices.

A rectangular RC beam 12 x 12 inch was adopted to serve the purpose of supporting vertical loading in the frame with structural detailing of 3, #5 bars as main reinforcement and shear reinforcement was # 3 @ 6'' c/c.

The structure detailing of the RC column was kept as 8, # 5 bars as main longitudinal reinforcement with # 3 @ 6'' c/c with a cross-sectional dimension of 12 x 12 inch. Moreover, to support the overall test frame, an 8'' thick RCC foundation pad was # 4 @ 6'' c/c, both in shorter and longer direction.

It was further decided to place a 1 ton superimposed dead load over the beam of the frame in order to distribute the pointed loading from the vertical jack onto framed structure.

3.3 LOADING CONDITION

In order to determine the lateral stiffness of RC frame construction, there are various method adopted in laboratory as laboratory as were discussed in section 2, 3 of this document. In this research endeavour the quasi-static loading procedure has been agreed upon to be incorporated in evaluating the role of infilled material on structure stiffness. This method has been proved to be economical in structure. Where certain constraints lie in the availability of high precision testing assembly will apply the lateral force onto the structure and in displacement controlled scenario; the structural stiffness will be monitored with the help of deflection gauges set up at various predetermined positions. The loading arrangement is shown in figure 3.5.

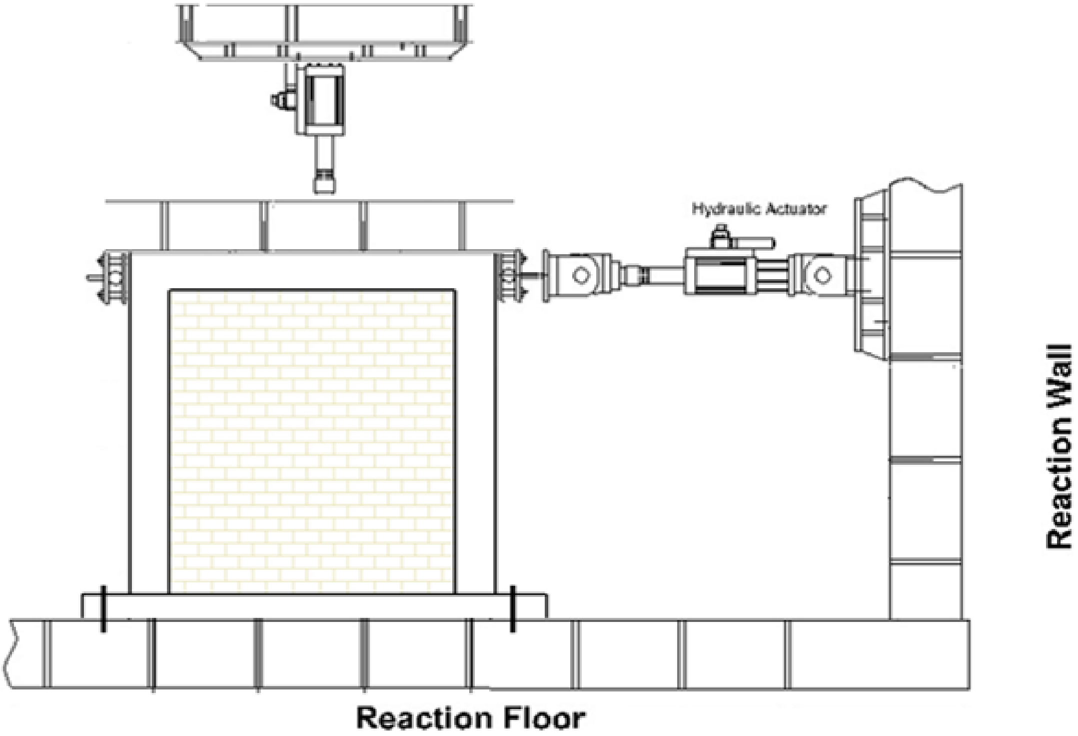

Figure 3.5 Representation schematic of loading

IV. CONCLUSION

As can be seen from results, that perforation in infill wall can reduce lateral strength and stiffness considerably. The lateral strength in case of window only is greater than that of door and window together. So it can be concluded that as the proportion of perforation in infill wall in a frame structures increases, there is decrease in lateral strength and stiffness.

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