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Numerical approach towards modelling of Masonry infill with opening in Reinforced Concrete frame subjected to Earthquake loading

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Abstract:-*In this research an effort is made to numerically model masonry infill with openings using a finite element based program ATENA. Masonry infills are provided within reinforced concrete (RC) frame for various purposed that include partitions, safety, security, aesthetics etc. Parameters like Load, displacement and energy dissipation are investigated and compared for the experimental and numerical models. It was concluded that up to yield the program could successfully model the behavior of masonry infill*.

Keywords*: Numerical Model, Finite Element Modelling, RC frames, Masonry infill with openings.*

1. Introduction

Masonry infill walls are provided for separation of internal spaces with that of external surroundings. These walls are usually provided with that of openings for aesthetics, architectural purposes like door, windows and ventilation etc. and usually considered non – structural elements. The design practice does not include the stiffness and strength of these infills but their presence is going to affect the behavior of structures under seismic loads and can lead into ruinous consequences. Presence of openings will influence that response too extensively (Ozturkoglu, et al., 2017, Kuang & Zhang, 2014).
Masonry infill stiffen the RC frame and therefore attracts most of the shear forces and will reduce demands of shear on RC members. These walls possess high initial stiffness and thus vary the load transfer mechanism from frame to truss action (Kaushik, et al., 2006).
Interaction of masonry wall with surrounding frame is influenced by various parameters including level of vertical loads that is usually neglected but should not be (Amato, et al., 2008).
Infill walls strengthen the RC frames laterally as compare to that of bare frame and their load degradation starts at higher drift level as that of bare frame and frame having an open ground storey (Amato, et al., 2008).
If the infill is spaced out from the bounding frame, this can considerably improve the seismic performance of infills by minimizing their interaction with the frame and moreover, can improve the energy dissipation capacity of the frame and its ductility (Kuang & Zhang, 2014).
Since infill walls must be provided with openings as they can't be avoided, these kind of infill walls depends on various parameters like position of the opening, as opening is moved towards the center, this affects the composite action of frame and infill. It is suggested to provide door in the center while window towards the side of a panel in mid height region (Mallick & Garg, 1971).
But in order to predict the behavior of these infill, it is difficult almost nearby to impossible due to various parameters involved in case of infill walls and especially those carrying openings. So, in this research work an effort were made to develop a numerical model that could be used by researchers to carry out research regarding masonry walls carrying openings effectively within a computer. That numerical model is tested for an experimental work of (Azmat, 2019).

2. Experimental Work

The frame that is used for the experimental work is given in Figure 1 for its various dimensions. Cross section of columns and beams is 12"x12" with columns carrying 8#5 longitudinal bars with ties #3@6"c/c while beam carrying 6#5 in edges while 5#5 in center with #3@6"c/c as tie bars. Base of the frame was 18" wide and 12" deep with 8#5 as long bars and #3@6"c/c as tie bars. Lintel beam had 4#4 as long bars and #3@6"c/c as tie bars with 9" width. Thickness of infill wall was 9"

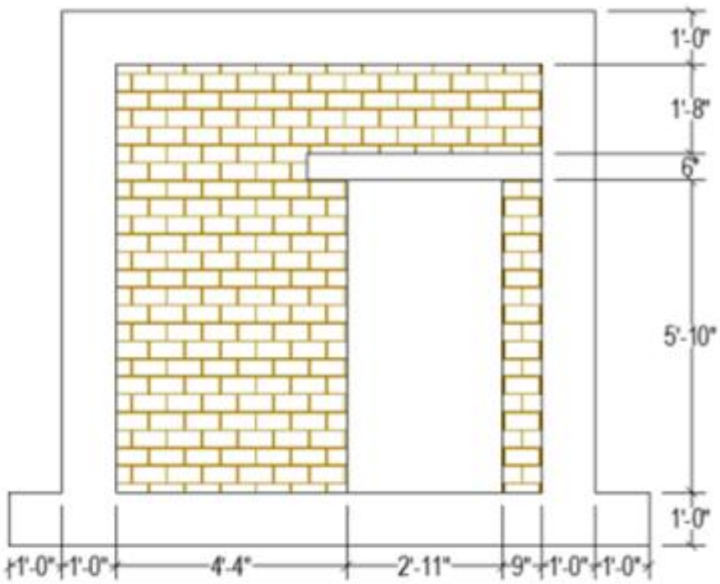

Figure 1. Dimensions of frame used in this study (Shah, 2019)

Quasi – static cyclic loading was applied on this frame with specified increments. Load and its corresponding displacement were recorded by means is recording instruments. From that data, hysteresis curve was created, from back – bone and bilinear curves were created to calculate various parameters used in this study.

3. Numerical Model

Detail micro – modelling technique was used in order to model the experimental work in this study. Every constituent of masonry infill was created discretely in ATENA 2D software. Steel plates were provided at the ends of RC beam and were connected by pre – stress wire. Force was applied on side of the highly elastic steel plate for loading, unloading, reloading and again unloading purposes. Displacement and force were recorded using monitoring point at that plate. Detail micro – model created within the software is given in Figure 2.

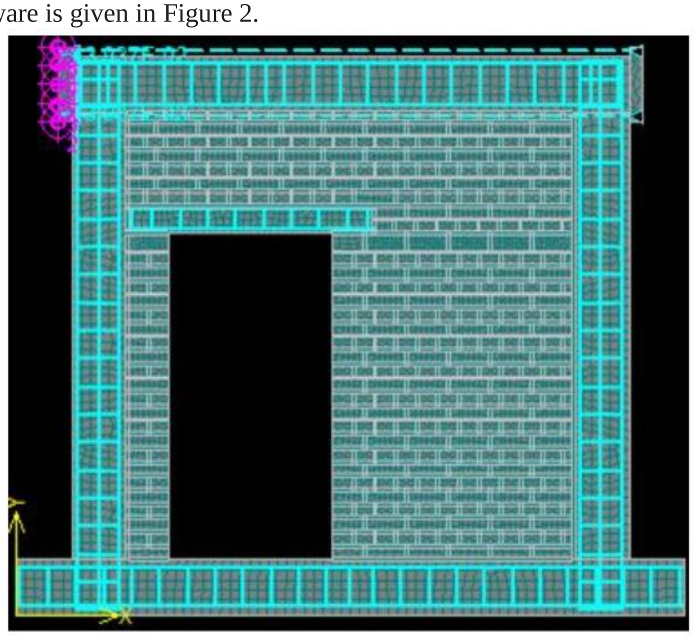

Figure 2. Micro – model developed in software

4. Results and discussions

Backbone curves were plotted for both the experimental and numerical models as shown in Figure 3 and it can be seen that both the curves depict a good match in elastic zone.

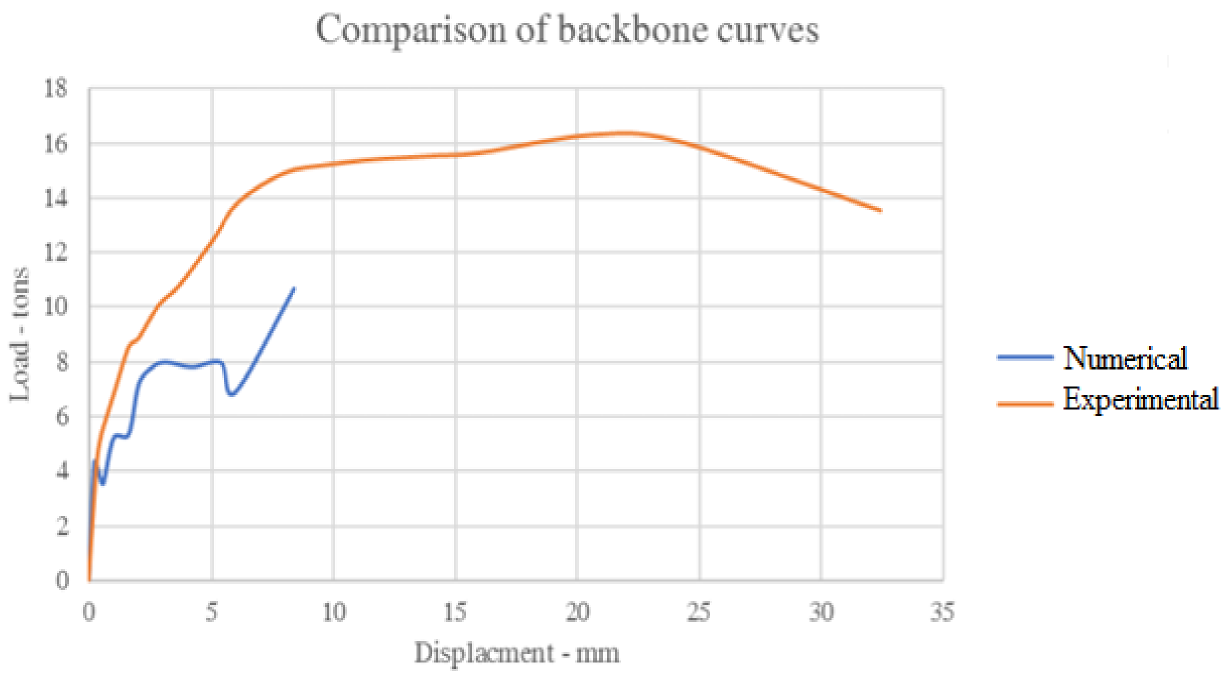

Figure 3. Back bone curves for numerical and experimental models.

Various parameters were determined from the backbone curve and bi – linear curve of the experimental and numerical models and those parameters are presented graphically in Figure 4.

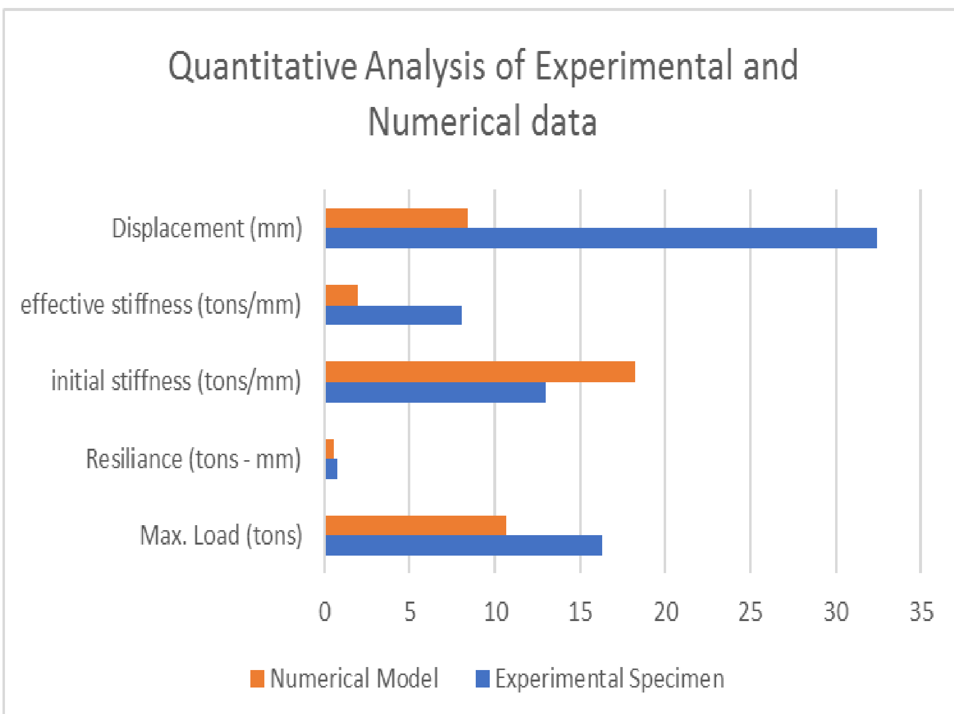

Figure 4. Quantitative analysis for experimental and numerical data

For parameters like Resilience, load and initial stiffness the match is good while difference is prominent in displacement and effective stiffness that is taken care of by prescribing the multiplicative correction factor for numerical model that are presented in Figure 5.

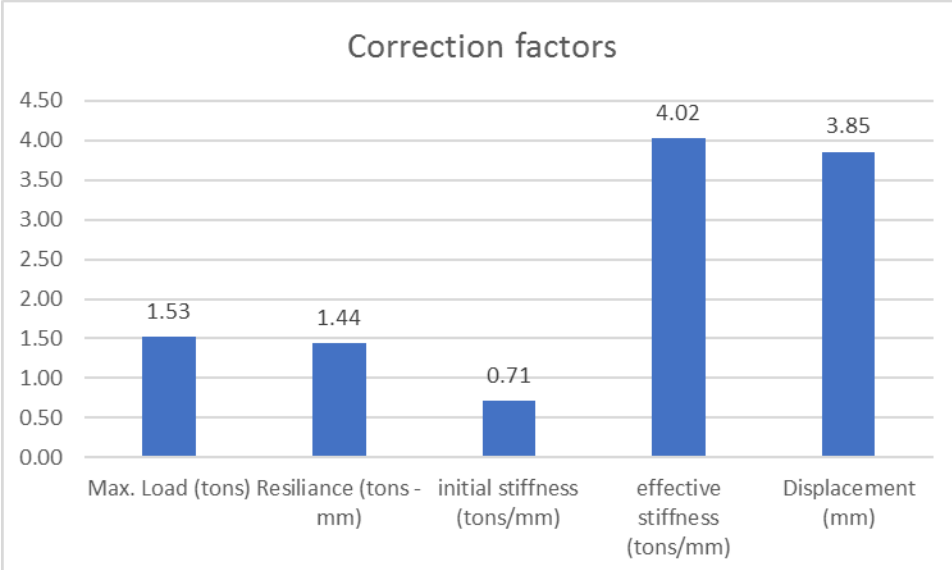

Figure 5. Correction factors suggested for numerical model

Conclusions

- Model can be effectively used to predict parameters like load, displacement, resilience, initial stiffness and final stiffness in the elastic limits.
- In plastic region, model can be utilized but corresponding correction factors shall be multiplied with its parameters.
- Experimental work cannot be exactly model in the computer.

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