Influence of Openings on the Behaviour of Masonry Infill Frames

Zybaczynski Andrei

Abstract—A rational and sustainable method for bringing the existing buildings to current antiseismic safety levels should take in consideration the effect of the infill masonry on the behaviour of the structure.

The possibility to quantify the seismic response of structures with masonry infill panels is a significant part of the design process. A model for quantifying the behaviour of masonry infill panels with openings is proposed, the accuracy of this model being checked up by comparing with the results provided by finite element models.

Keywords—infill masonry panels with openings, structural performance.

I. INTRODUCTION

A large proportion of the existing multi storey buildings have their structure made of reinforced concrete frames with masonry infill walls.

Due to the limited knowledge on seismic design at the time of their construction (1940 - 1970), these buildings do not meet the current standards from the point of view of the response to the seismic actions and interventions must be carried out in order to increase the capacity of the structure to withstand seismic action.

In practice, the infilling masonry is considered a non-structural element in the design and therefore is not taken into account in the evaluation of the strength and stiffness of the structure.

Current research both theoretical and practical demonstrated the significant effects that the infill masonry has on the behaviour of the structure. A more precise quantification of the effect that the infill masonry has on the overall behaviour of the structure leads to the development of more rational methods for retrofitting the existing buildings, involving lower consumption of resources and reducing the impact on the environment.

Because many of the masonry infill walls have functional openings, the evaluation of the effect of these openings in the overall behaviour of masonry infill frame is a very important issue.

II. METHODS FOR MODELING THE INFLUENCE OF OPENINGS

According to Sortis [1] the presence of openings changes the structural behaviour of infilled frames by reducing their stiffness and strength. Moreover, the presence of openings reduces the load corresponding to the initial crack and the appearance of cracks at the corners of the opening could be observed.

On the other hand, Liaw and Lee [2] show that, according to studies undertaken by them, the openings did not significantly affect panel strength and stiffness.

Bertoldi [3] proposed a set of expressions for calculation of the coefficient of reduction. Parameters used to characterize the strength and stiffness reduction are the ratio between the opening and the panel surface, ratio between width of the opening and width of the panel and the existence and type of opening borders.

In a different approach, Hamburger [4] proposed the modeling of the influence of openings by four compressed diagonal struts passing tangentially to the opening. A diagonal cross section is a rectangle with the width equal to that of the panel and height equal to twice the thickness of masonry.

Asteris [5] proposed reduction factors of stiffness for different percentages of openings after the analysis of one bay and one storey frames in different configurations. The problem was analyzed in the elastic range, using a new technique based on modeling contact between panel and frame.

III. NUMERICAL STUDIES ON THE INFLUENCE OF OPENINGS

In order to determine the influence of openings on masonry panels infill we performed a numerical study. The selected models have started from the masonry infill panel without openings, then providing openings representing 5%, 10% and 25% of the panel surface.

All frames were modeled using finite elements and for each frame a pushover analysis has been made taking in consideration the separation between reinforced concrete frame and masonry panel.
From the analysis of the state of efforts on the three models with openings we draw several conclusions:

- Horizontal forces are taken by two fields of inclined compression efforts on both sides of the opening.
- The starting points of diagonals within 30 cm inside the opening and angle of 60° remain unchanged regardless of the opening size.
- Areas of masonry panel above and below the opening are subjected to very low intensity stresses.

For the assessment of the global behaviour of masonry infill frame with openings of different sizes, the characteristic curves derived for each model will be compared. The comparison of results shows that the proposed method provides resistances very close to those provided by finite element models.

In terms of rigidity, the results obtained by the proposed method show a stiffness greater than that obtained by the finite element method. But the differences are not significant and decrease with the increase of the opening relative to the total surface area of the panel.
IV. CONCLUSIONS

After the analysis of the behavior of frame with masonry infill panels with openings, we proposed a method of modeling the effects induced by the presence of openings in the infill panel. The results obtained with this proposed model were evaluated against the results provided by finite element models. From this comparison it was concluded that the proposed method provides good results.

The studies described in this paper were performed on panels with symmetrical openings; the future research direction consists in extending these studies to randomly placed openings in the panel plane also.

REFERENCES


