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EXTENDED ABSTRACT

Parametric Analysis of Out-of-Plane Behavior of Masonry Infilled RC Frames

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Masonry infill, Non-linear finite element method, Out-of-plane behavior, RC frame.

1. Introduction

Masonry Infills are assumed as non-structural elements and are not considered in the design process of the infilled frames while their presence can affect the local or global behavior of infilled frames. In the present study, the out-of-plane behavior of masonry infilled frames was studied numerically in the finite element software of DIANA. To have an accurate numerical model, an experimental test was performed and the numerical model was validated based on the experimental results. The influence of different parameters such as the presence of central opening and Infill's mechanical and geometrical properties were thoroughly investigated. The results showed that the presence of a central opening can have a major influence on the out-of-plane response of the infilled frames. It is also concluded that infills with higher compressive strength and larger thickness present better out-of-plane response in terms of strength and stiffness. Finally, it is obtained that using infills with higher tensile strength does not increase their out-of-plane strength.

2. Methodology

2.1. Experimental tests

Numerical and parametric analysis are based on the experimental results obtained in (Akhoundi, 2016). In the experimental campaign six reduced scale specimens were tested under uniform out-of-plane loading applied by an airbag. The geometry of the specimens is shown in Fig. 1.

The test setup designed for out-of-plane tests is shown in Fig. 2. As it is clear from the figures, two vertical jacks were placed at top of the columns to apply a vertical load of 160 kN, corresponding to 40% of the column's axial force capacity. The out-of-plane loading was applied by means of an airbag installed between the masonry infill and a stiff wooden sandwich panel that was attached to a L-shaped reaction steel structure composed of HEB360 steel profiles.

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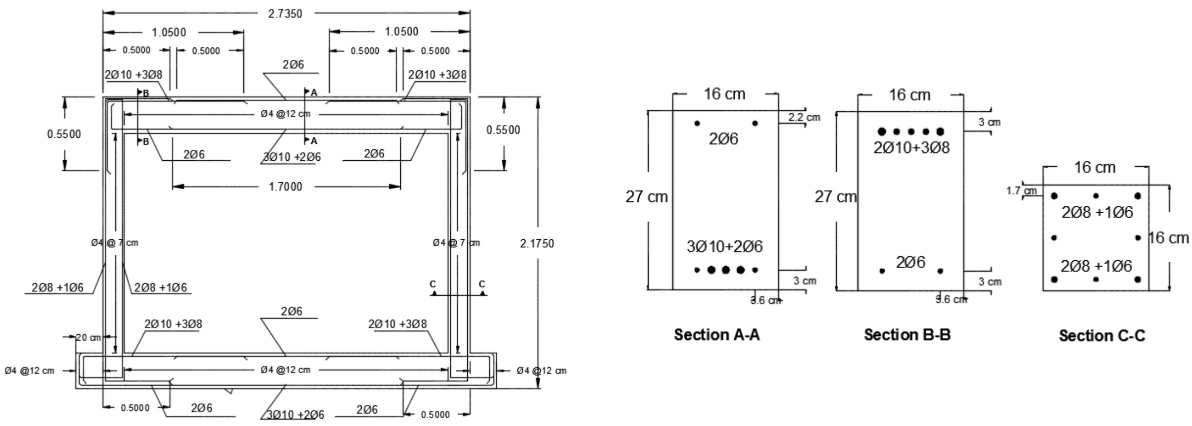

(a) (b)

Fig. 1. Test specimen: a) Geometry of the specimen, b) Cross-section of RC frame

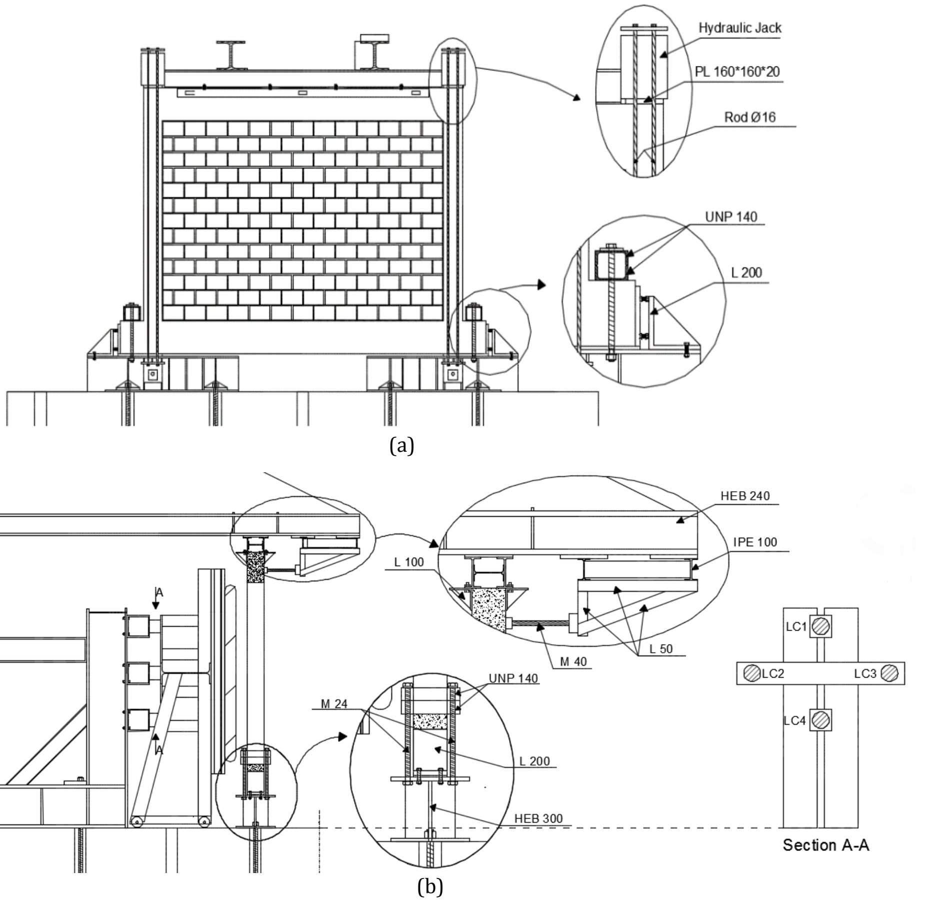

Fig. 2. Test setup for out-of-plane testing: a) Front view, b) Side view

2.2. Numerical Modeling

The numerical modeling of the specimens was carried out in DIANA software (2014) by using four-node shell elements for RC frame and masonry infill and 2+2 node interface elements for the interface between infill and RC frame. The non-linear behavior of the concrete and masonry was represented by a Total Strain Crack Model based on the fixed stress-strain law concept available in DIANA. Exponential and parabolic constitutive laws were used to describe the tensile and compressive behavior of concrete and masonry infill, respectively.

The Coulomb Friction Law was also used to describe the nonlinear behavior of the interface connecting the RC frame to masonry infill. The final representation of the numerical model is shown in Fig. 3.

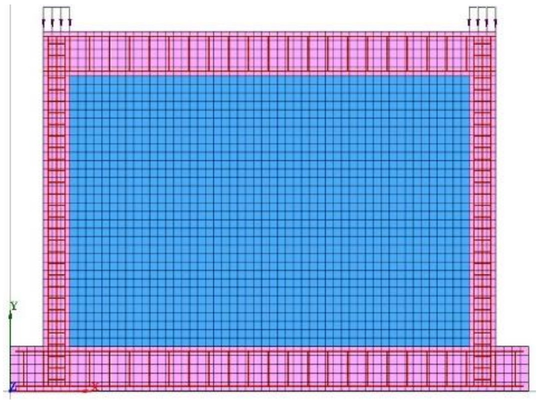

Fig. 3. Numerical model of the specimen

2.3. Validation of the Numerical Model

The numerical model was validated by considering the force-displacement diagrams of the experimental tests along with the propagation of the cracks due to out-of-plane loading. In the first step, the non-linear parameters of the interface were obtained to have a similar response with the experimental test as shown in Fig. (4-a). Then the validated model was analyzed to investigate how it could predict the out-of-plane response of the solid infilled frame. In this case, as shown in (4-b), it can satisfactorily predict the out-of-plane response of the solid infilled frame.

After the numerical model was validated, the parametric analysis was performed to deeply investigate the influence of parameters such as mechanical properties of the infill, its thickness, and presence of opening on the out-of-plane response of the specimens.

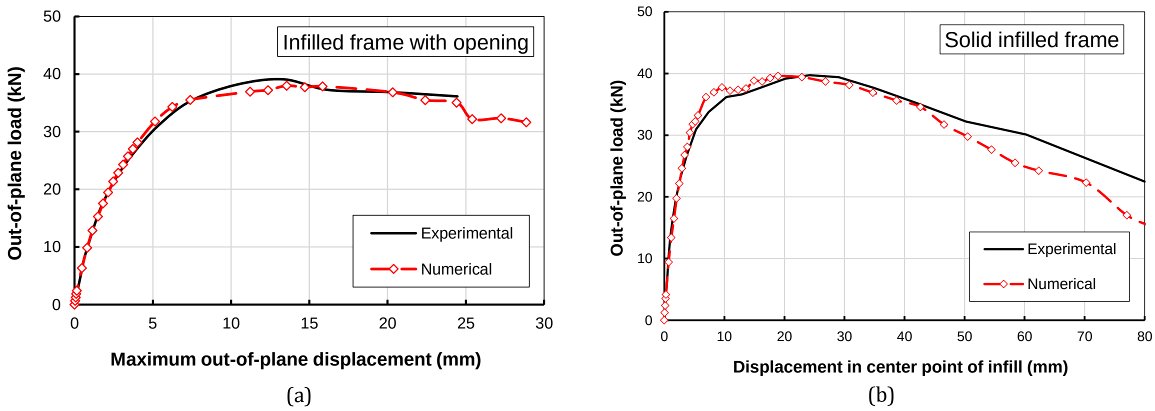

Fig. 4. Comparative analysis of the numerical model with experimental tests: a) Specimen with central opening, b) Solid infilled frame

3. Conclusions

An extensive parametric analysis was carried out on the validated numerical model and the influence of infill's compressive strength, infill's tensile strength, infill's thickness and presence of central opening on the out-of-plane response of the infilled frames was studied. The results show that;

1) Infills with opening areas of less than 30% (opening area/infill area) demonstrated higher out-of-plane strength while by increasing the opening area the out-of-plane strength decreased dramatically.

2) Higher opening areas resulted in higher out-of-plane stiffness.

3) Models with higher compressive strength and larger thickness demonstrated better out-of-plane response in terms of strength and stiffness.

4) Increasing the tensile strength of the numerical models resulted in higher effective stiffness of the specimens while their out-of-plane strength remained constant.

4. Acknowledgements

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5. References

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