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PERFORMANCE'S EVALUATION OF BUILDING'S ENVELOPE TO EARTHQUAKES

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KEYWORDS
Masonry Infill, RC frames, In-plane damage, Out-of-plane behavior.

EXTENDED ABSTRACT

The building envelope in Europe is usually made of masonry walls, with enclosure and infill functions. Masonry walls have a major economical importance and contribute significantly to the building performance. Even if infill walls have no load-bearing function, they contribute significantly to the seismic behavior of buildings. Therefore, their adequate structural performance is needed, avoiding the occurrence of severe in-plane damage, with very large economical losses, and the out-of-plane expulsion, which additionally represents a large risk for human life.

Recent earthquake codes in Europe require the safety assessment of non-structural elements (parapets, veneer masonry walls, infill walls, etc.), when their collapse entails risks for people or for the main structure. The Eurocode standards, entering the mandatory stage now, incorporate new requirements to be fulfilled by buildings or their parts. Such is the case of masonry infilled RC frames whose panels, according to Eurocode 8, are explicitly required to withstand the out-of-plane movement induced by earthquakes. Appropriate measures should be taken to avoid brittle failure and premature disintegration of the infill walls, as well as the partial or total out-of-plane collapse of slender masonry panels.

This paper presents the experimental work and results achieved by applying cyclic out-of-plane loads to damaged masonry infilled RC frames. The masonry panels were previously damaged by applying an in-plane cyclic load after which the cyclic out-of- plane loads were applied. The frames and panels tested follow the traditional Portuguese RC structure construction system to which different types of reinforcement have been introduced in the panels.

EXPERIMENTAL PROGRAM AND SCOPE

For the walls, four different solutions were adopted:
1) WALL_REF – Reinforced concrete frame with infilled masonry;
2) WALL_JAR – Reinforced concrete frame with infilled masonry with bed joint reinforcement;
3) WALL_RAR – Reinforced concrete frame with masonry infilled with external reinforcement;
4) WALL_PD – Reinforced concrete frame with double infilled masonry. In order to get a better idea of the influence of each displacement reference level, a nonlinear finite element model was developed to assess the performance of different reinforcement solutions.

RESULTS

The main results (envelopes) obtained from the in-plane and out-of-plane tests are summarized in **Erro! A origem da referência não foi encontrada.** and **Erro! A origem da referência não foi encontrada.**.

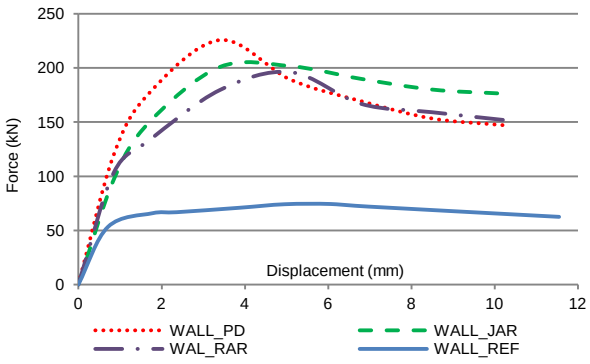

Figure 1: In-plane resutls

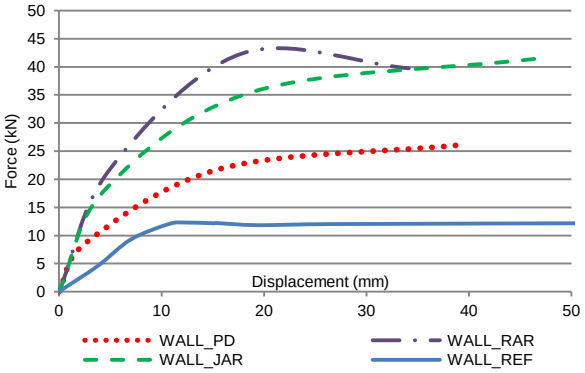

Figure 2: Out-plane results

CONCLUSIONS

For the in-plane test, in all the different solutions the interfaces are primarily responsible for the non-linear stage. The results shows that the relevance of masonry for the frame stiffness, thus to the level of drift under the influence of Eurocode 8 masonry is still significant, giving the panel a stiffness much higher than the bare frame.

For the out-plane-test, it is important to notice that the previous in-plane damage change the failure mode of the panel due the substantially change of support conditions of the masonry. Therefore, the upper interface no longer exists, so WALL_JAR and WALL_REF present a failure mode typical in cantilever structures. The reinforced plaster wall (WALL_RAR) shows a typical slab failure mode, because of as happened in the specimens, the plaster hold the masonry preventing the wall failure and masonry expulsion which is important to prevent the danger to humans lives.

The infill masonry panel in RC frame is able to mobilize a higher resistance to horizontal loads than the bare frame and to the expected drift present in Eurocode 8. Infilled masonry still plays an important role, giving the panel a higher stiffness than the bare frame. This last fact is in opposition to the current design practice, which ignores the masonry, and its contribution to the structure resistance and to the vibration buildings period in seismic analysis. If neglecting the resistance can be conservative, the higher stiffness and consequently the reduction of vibration period can give a lower demand for the seismic building design.

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