16th World Conference on Earthquake Engineering, 16WCEE 2017

Santiago Chile, January 9th to 13th 2017

Paper N° 3287

Registration Code: S-R1464734876

ISOLATION DEVICE FOR MASONRY INFILLS IN BUILDING FRAMES

F. J. Pallarés[(1)], L. Pallarés[(2)], I. Ferrer[(3)] , J. Orozco[(4)]

[(1)] *Associate Professor, Universitat Politècnica de Valencia, frapalru@fis.upv.es*
[(2)] *Associate Professor, Universitat Politècnica de Valencia, luipalru@cst.upv.es*
[(3)] *Assistant Professor, Universitat Politècnica de Valencia, igferbal@mes.upv.es*
[(4)] *Associate Professor, Universitat Politècnica de Valencia, jaormes@cst.upv.es*

Abstract

This paper deals with an innovative seismic isolation system to avoid the great influence of the masonry infills on the seismic response of buildings located in earthquake prone areas. As shown in numerous disasters, the influence of the masonry infills stiffens the building to a great extent and enables the creation of diagonal struts on the walls, which discharge on the columns and beams of the frames, usually leading to shear failure and the consequent building collapse. In this sense, the Universitat Politècnica de Valéncia has developed a novel seismic isolator through an investigation funded by the Ministerio de Economía y Competitividad from Spain, and FEDER from the European Commission, in which a high degree of structural independence is achieved between the seismic response of the building structure and the influence of the masonry infill, by installing this novel device. Conclusions are outlined regarding energy dissipation and isolation achieved when using this isolator developed for the seismic isolation of the masonry infill.

Keywords: Masonry Infill; seismic isolation, steel frame, in-plane behavior, novel isolator.

1. Introduction

Masonry is a building material widely used in construction to achieve partitioning buildings and create the necessary spaces proposed by the architectural design.

In many countries around the world, this construction system is being used successfully, mostly where the main loads to be resisted are gravitational.

However, under dynamic loads, as occurs in countries subjected to earthquakes, the behavior of the buildings that have brick infill walls is very different from the originally planned.

As shown in numerous disasters, the influence of the masonry infills stiffens the building to a great extent and enables the creation of diagonal struts on the walls, which discharge on the columns and beams of the frames, usually leading to shear failure and the consequent building collapse, as can be seen in Figure 1.

This figure is taken from one of the buildings that collapsed in the earthquake in Lorca, 2011, Spain.

Figure 1: Building failure in Lorca earthquake (Spain, 2011)

Usually, the international Standards [1,2,3,4] consider the masonry infill walls without reinforcements as a non-structural element, which seems to be not very adequate when dynamic loads are taken into account, as many researchers have pointed out from many years ago to current days [5,6,7].

Recent earthquakes in Spain (2011), and all around the world every year, make clear the fact that non structural masonry has deep impact in the seismic behavior of framed buildings causing high economic losses and human casualties.

It is known the way in which masonry walls interact with the resisting structure of buildings, modifying their seismic response.

In such circumstances, there are two ways of acting [1,2,8]: a) make the building with more resistant partitions, taking them into account in the design process, which contribute to the structural response of the building, or b) perform seismic isolation of these elements not involving them in the seismic response of the building.

The first one has been proven effective, but involves taking into account the masonry infills in the calculation models, whose behavior is complicated and not clearly understood to date. Furthermore, it also varies as the seismic action is progressing, complicating the proper design.

As for the second acting way, nothing has been found by the authors in the scientific literature but references [9,10], which refer to a complicated installation mechanism to solve the problem.

The Universitat Politècnica de Valéncia has developed an investigation funded by the Ministerio de Economía y Competitividad from Spain, and FEDER, from European Commission, in which a high degree of structural independence is achieved between the seismic response of the building structure and the influence of the masonry infill, by installing a novel seismic isolator.

In this document, the tests performed to validate this novel device are described, beside results of seismic isolation achieved because of its use.

2. Test layout

A steel frame was used in the tests with the aim to re-use it every time for the different experiments. In this sense, the final load of the experiment was limited to the elastic range. Only the two last experiments were done until failure of the specimens.

Up to five different configuration schemes were tested to know the influence of the new isolator device in the cyclic response of the specimens.

The test layout can be observed in Figure 2.

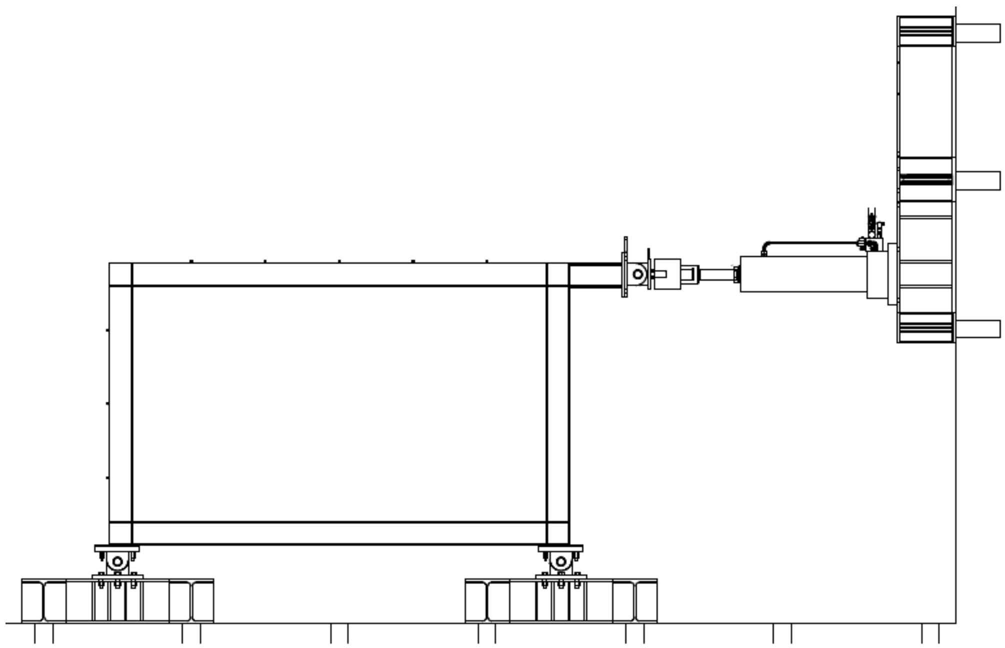

Figure 2: Layout to test the steel frame

The steel frame is a closed frame, clamped at the corners but pinned at the supports to ground. On the top corner, a cyclic load is applied through a jack acting against a reaction wall.

3. Test results

A comprehensive series of experiments were developed to test the seismic isolator SISBRICK, and its influence isolating structure-panel in cyclic movements depending on the configuration adopted. Figures 3, 4 and 5 show three configurations that were tested: bare frame, conventional frame and isolated.

Figure 3. Bare frame

Figure 4 Conventional infill (MM0)

Figure 5. Layout 1 (MM1)

The following Figure 6 shows results in terms of force vs displacement,

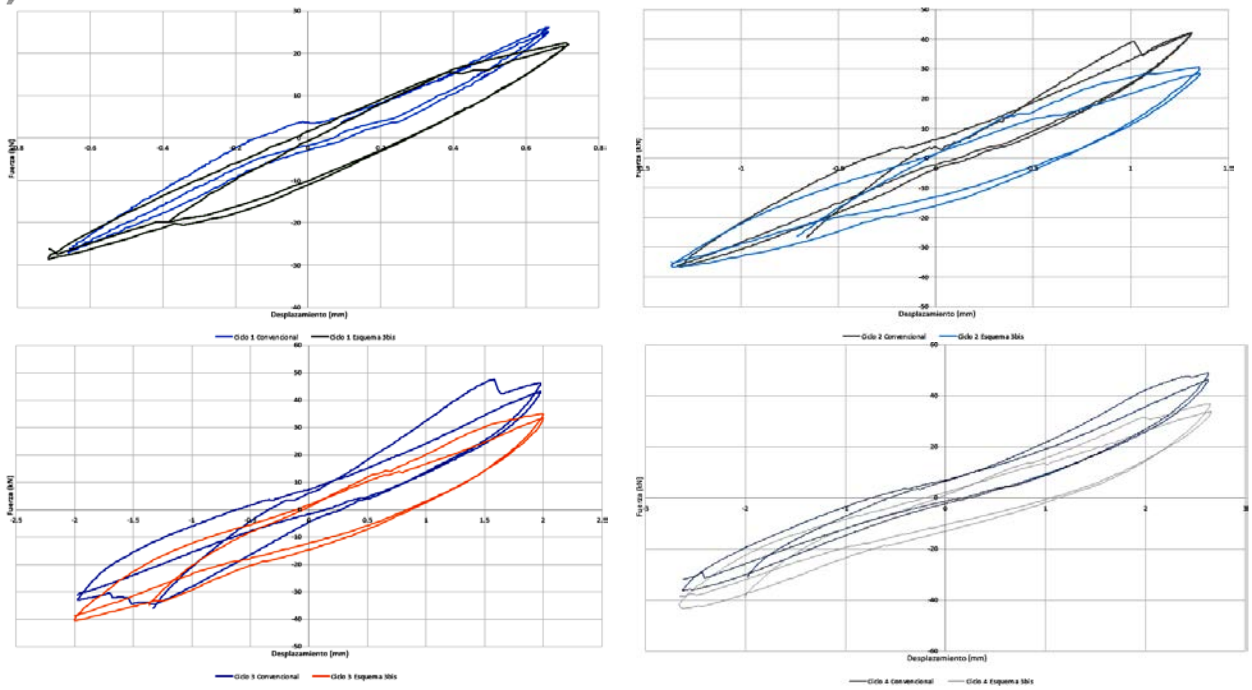

Figure 6. Force vs displacement for different specimens

While Figure 7 displays the cumulative dissipation energy for different specimens.

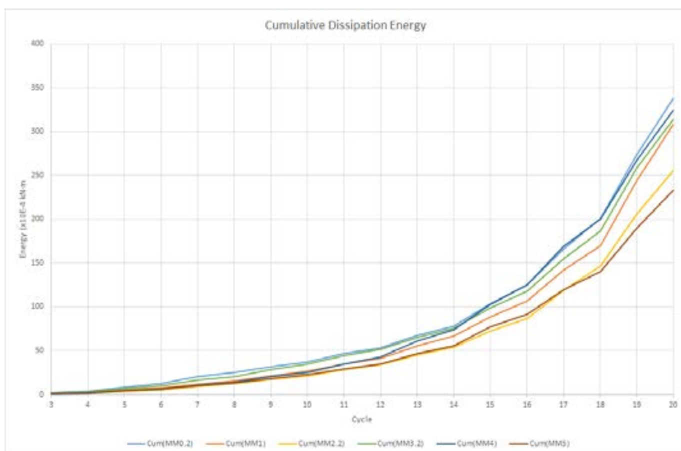

Figure 7. Layout 1 (MM1)

4. Conclusions

An experimental investigation has been described aiming to provide seismic isolation to masonry infills in steel frames. It is a novel point of view, where a new device has been developed by the Universitat Politècnica de Valéncia to provide seismic isolation when used in masonry walls.

The device has been placed in different locations, obtaining a different level of isolation when compared to the conventional masonry infill. The cumulative dissipation energy is also studied to know the contribution of this isolator to dissipation energy.

When using this device in masonry walls, depending on the use and location, a variable degree of structural independence is achieved between the seismic response of the building structure and the influence of the masonry infill, which leads to structure responses closer to the ones designed.

5. Acknowledgements

Authors want to express their gratitude to the Ministerio de Economía y Competitividad from Spain and FEDER from European Commission for providing the financial support that made possible this study through the research projects BIA2012-35186 and BIA2015-70651-R.

6. References

[1] EN 1998-1, (2004). Eurocode 8: Design of structures for earthquake resistance – Part 1: General rules, seismic actions and rules for buildings.

[2] NCSE-02. (2002).Norma de construcción sismorresistente: parte general y edificación. *Ministerio de Fomento*.

[3] NEHRP (2009). Recommended Provisions for Seismic Regulations for New Buildings and Other Structures.

[4] INN 1996. (2009). Earthquake Resistant Design of Buildings (INN, 1996). *Norma Chilena Oficial* NCh 433.Of1996 Modificada en 2009.

[5] NSR-10 (2010). Reglamento Colombiano de Construcción Sismo Resistente. Bogotá D.C., Colombia, Enero.

[6] V. Bertero; S. Brokken. (2011). Infills in seismic resistant building. *Journal of Structural Engineering*, 109, 6.

[7] P. Negro; G. Verzeletti, (1996). Effect of infills on the global behaviour of R/C frames: Energy considerations from pseudodynamic tests". *Earthquake Engineering and Structural Dynamics*, 25.

[8] W. W. El-Dakhakhni; M. Elgaaly; A. A. Hamid. (2003). Three-Strut Model for Concrete Masonry-Infilled Steel Frames. *Journal of Structural Engineering*, 129, 2.

[9] T. Paulay; M. J. N. Priestley. (1992) Seismic design of reinforced concrete and masonry buildings. *John Wiley&Sons, Nueva York*.

[10] [M. Aliaari; A. M. Memari. (2005). Analysis of masonry infilled steel frames with seismic isolator subframes. *Engineering Structures, 27, 4.*