year	month	day
2013	06	19

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A b s t r a c t

Title	Modeling of Brick Masonry Infill for Seismic Performance Evaluation of RC Frame Buildings

(800 words)

Brick masonry walls are commonly used as infill in Indonesian RC buildings. However, the presence of brick masonry infill in such buildings is usually neglected in seismic design calculations, assuming it to be a nonstructural element. According to experimental and analytical past studies by several researchers, the brick masonry infill significantly contributed to the seismic performance of this kind of building.

The current study focuses on evaluation of brick masonry infill contribution to the seismic performance of RC frames. In this study, site observation on two 3-story earthquake-damaged RC buildings with brick masonry infill was conducted after the 2007 Sumatra, Indonesia earthquakes. The two damaged buildings had similar structural characteristics, however, one of them totally collapsed and the other moderately damaged. The seismic capacities of both buildings were evaluated for the first story, where the most severe damage was observed, based on the current Japanese standard without considering the brick infill effects. As the result, a similar seismic capacity was obtained for both buildings. It seemed that the brick infill, which was much larger in the surviving building, contributed to resist seismic loads and protected the building from collapsing.

To investigate the contribution of nonstructural brick infill to the actual performance of damaged building, a series of experimental tests on RC frames with/without brick infill representing the moderately damaged building was conducted. Four 1/2.5 scale one-bay RC frames with rigid beams were prepare: one bare frame and three infilled frames with different brick infill. One of brick wall was extracted from the moderately damaged building in Indonesia, transported to Japan, and then installed into one of the RC frames. On the other hand, two other brick walls consisted of 1/2.5 scale bricks having the dimensions of 88 mm in length, 44 mm in width and 20 mm in height. One of them was applied finishing mortar with a thickness of 8 mm to both surfaces of the wall which resulted in infill thickness of 60 mm. These specimens were tested under quasi-static cyclic loading and constant vertical loading. The behavior and performance of test structures were observed at every peak and residual drift throughout loading. The brick wall contributions were quantitatively evaluated comparing the seismic performance and failure mechanism between bare frame and infilled frames.

An analytical model of masonry infilled frames was developed to evaluate the contribution of brick masonry infill to the seismic performance of RC frames. In this model, the masonry infill was replaced by a diagonal compression strut having the same thickness and material properties as those of the panel. The equivalent diagonal strut represents a distributed compression transferred diagonally between infill/frame interfaces. The Infill/frame contact length was determined by solving two equations, i.e., static equilibriums related to compression balance at infill/frame interface and lateral displacement compatibility. Consequently, the strut width was presented as a function of infill/column contact length, however, which was defined as the smallest contact lengths between both ends of strut. The lateral strength and stiffness of infill at yield were given based on the evaluated strut width.

Verification of the proposed analytical method was conducted through simulating the experimental results of brick masonry infilled frames. As the result, good agreements were observed between the experimental and analytical results on lateral stiffness, lateral strength, and ductility. It means that the performance of boundary frame as well as infill can be reproduced based on the proposed method. Moreover, the column performance was evaluated by considering the infill effects and displacement compatibility. Consequently, deformation capacities of columns in infilled frames were also evaluated appropriately.

The proposed analytical method was applied to non-structural brick infill in collapsed and surviving buildings to recalculate the seismic performance of both buildings by considering the infill effects. Calculations were conducted in the East-West direction, to which the collapsed building actually toppled, on the basis of the Japanese standard. Although the brick infill was considered as an analytical parameter, the wing walls or walls with openings were neglected in calculations. The spandrel walls were considered to evaluate the clear height of columns. The seismic performance of both buildings was compared between the analyses with and without infill effects. A distinct difference was observed between the maximum strengths of buildings: it was higher in the case considering the infill. The strength of collapsed building drastically dropped when several short columns failed in shear. On the other hand, the strength of the surviving building was maintained up to much higher ultimate deformation of columns. These are possible reasons why one of the buildings could survive during the severe earthquake. It indicates that the nonstructural infill significantly contributed to prevent the surviving building from collapsing.