Influence of Masonry Infills with and without Opening on Progressive Collapse of Buildings (A Case Study: San Diego Hotel)

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Progressive collapse starts with local destruction of a few elements of structures, which extends into a significant part of the building. Regular buildings are designed for dead, live, wind, earthquake and other normal loads. Nevertheless, there are other possible risks and loads, including firing, vehicle collision, gas explosion, design or construction error, bomb blast, etc. These risks occur very rarely, but they may cause a catastrophic collapse; therefore, for very important structures, they should be considered in the designing phase [1].

Infills have a considerable improvement in the stiffness and the strength of the frame. Therefore, their influences on progressive collapse of buildings should be considered. Considering such elements in structural modelling is very complicated, that's why many standards and codes ignore their local and global effects and just consider their effects in decreasing the building natural period of vibration [2]. However, they are considered in rehabilitation projects and should be considered in progressive collapse analyses [3-4]. Many methods have already been proposed to model solid infills in the structure; the most common approach is modelling by diagonal struts [4, 5]. For infills with openings, there is not a verified approach for the modelling.

This study is to propose a method for modelling infills with and without opening and investigating their effects on progressive collapse of buildings. Perforated infills are modelled by the equivalent struts, considering the influence of the opening as a reduction factor for the width of the strut, verified in previous studies [6].

The proposed model is verified by the results of an experimental study on San Diego Hotel, obtained by Sasani [3]. The plan of the hotel is shown in Figure (1). The hotel had reinforced concrete structure and was destructed by explosion in two columns (A2 and A3 in Figure 1) of the first story.

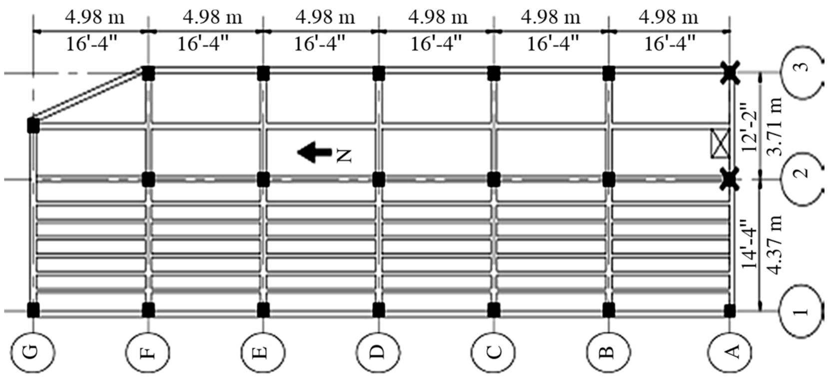

Figure 1. Plan of San Diego hotel

Opensees is applied to model the structures; "Nonlinear Beam Column Elements" with Fiber section is used for modelling the beams and columns. Concrete01 and Concrete02 are used for non-confined and confined concrete of the sections, respectively. "Elastic Beam Column Element" is applied to model infill equivalent strut. Comparing the results of the modelling with the experimentally obtained values, for column forces (before and after columns explosion) as well as the displacement history of the top point in the removed columns shows robustness of the modelling, which is more accurate than Sasani models, as shown in Figure (2).

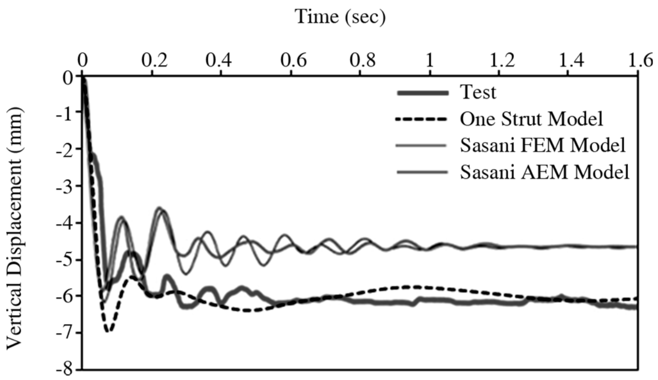

Figure 2. Comparing the results of the present study with Sasani models [3] for vertical displacement of point A2 of the second

To study the influence of infills on progressive collapse, the structure of the hotel is modelled and the proposed scenarios of GSA [1] are investigated. As shown in Table (1) for all scenarios, the presence of infill panels decreases the vertical displacement of the removed columns. This shows that infills improve the building against progressive collapse considerably.

Table 1. Displacement of the removed columns for different scenarios

Scenario	Maximum Vertical Displacement of Top Point in the Removed Column (mm)		Improvement (%)
	Model without Infills	Model with Infills	
Removing the Column A2	7.20	4.30	40.27
Removing the Column A1	14.60	4.13	71.71
Removing the Column A3	9.48	3.77	60.23
Removing the Column D1	11.70	4.04	65.47

Keywords: Progressive Collapse; Infill; Opening; Dynamic Analysis

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