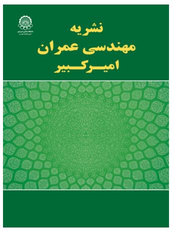

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Analytical Study of the Effect of Different Parameters on the Seismic Performance of Masonry Infilled RC Frames

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ABSTRACT: The construction of reinforced concrete buildings with masonry infill walls has been a very common practice in Iran. Nowadays, the impact of the RC frame and masonry infill on the structure is one of the major challenges in engineering researches, and often engineers ignore infill in designing the building. Due to the damages observed in past earthquakes, masonry infill can have both positive and negative impacts on the seismic performance of RC structure. In this paper, the effect of masonry infill on the in-plane behavior of the concrete frames and the impact of seismic and non-seismic details with the effect of level of axial load and thickness of infill in lateral resistance of concrete frames is investigated, by the nonlinear finite element method. First, the proposed models have been validated using the experimental results in ABAQUS finite element software. Results show that the increasing axial load causes to increase in ultimate strength and effective stiffness and reduces the ductility of the seismic frame. The ultimate strength, effective stiffness, and ductility of frame and infill-frame with seismic detailing were increased compared to the frame and infill-frame with non-seismic properties. Increasing the thickness of masonry enhance the infill behavior in terms of strength, effective stiffness and ductility in both seismic and non-seismic frame.

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1. Introduction

Nowadays, the impact of the frame and infill on the structure is one of the major challenges in engineering researches; because engineers ignore infill in designing the building; and consider it as a non-structural part and just consider its weight. Due to the damages that have been observed in recent earthquakes of Iran, such as the Kermanshah which occurred in 2017. When the masonry infill is placed in the concrete frame, significantly changes its mechanical properties, the stiffness and strength of the structure increase and the ductility of the concrete frame reduce. There is an interaction between masonry infill and its frame, so, the frames with infill behave differently than those frames without infill. Disregarding the effect of masonry infill, they can be safe and reliable in terms of resistance in design, since the increasing strength around the frame has a positive effect on earthquake strength and overall structural stability, however, it should also be considered that masonry infill will increase the stiffness of the infill-frame and larger portion of the lateral load would be attracted by frames. This can be a negative factor when ignoring the infill masonry in the design.

The purpose of this paper is to investigate the seismic performance of reinforced concrete frame and infill-frame masonry with seismic and non-seismic details by investigating the simultaneous effect of different levels of axial loads and increasing the thickness of infill-frame masonry. For this purpose, single-story and single-bay reinforced non-seismic concrete frame [1], reinforced seismic concrete frame [2], and non-seismic infill-frame masonry [1], modeled in ABAQUS software and validated with experimental models, Fig. 1.

2. Analytical Models and parametric study

In this paper, six specimens of reinforced concrete frame and six specimens of masonry infill-frame with seismic and non-seismic details under different levels of axial loads of 0.1, 0.2, and 0.3 of the ultimate axial capacity of the columns with thickness infill masonry 100 mm and six specimens of masonry infill-frame with seismic and non-seismic details under different levels of axial loads of 0.1, 0.2 and 0.3 of the ultimate axial capacity of the columns with thickness infill masonry 50 mm have been modeled and analyzed in ABAQUS finite element software [3]. The dimensions of the masonry infill placed inside the concrete frame are equal to (2100 × 1300 × 106) mm means that length × height× thickness and the dimensions of brick units were (106 × 49 × 31) mm. The three specimens of the non-seismic concrete frame were modeled under different levels of axial load 0.1, 0.2, and 0.3 and the three specimens of the seismic concrete frame were designed and modeled based on seismic criteria of the 9th issue of national regulations. In reinforced concrete frame with masonry infill, the first three specimens are under different levels of axial loading of 0.1, 0.2, and 0.3 and masonry infill thickness of 100 mm, and the concrete frame is non-seismic. The second three specimens are under different levels of axial loading of 0.1, 0.2, and 0.3 and masonry infill

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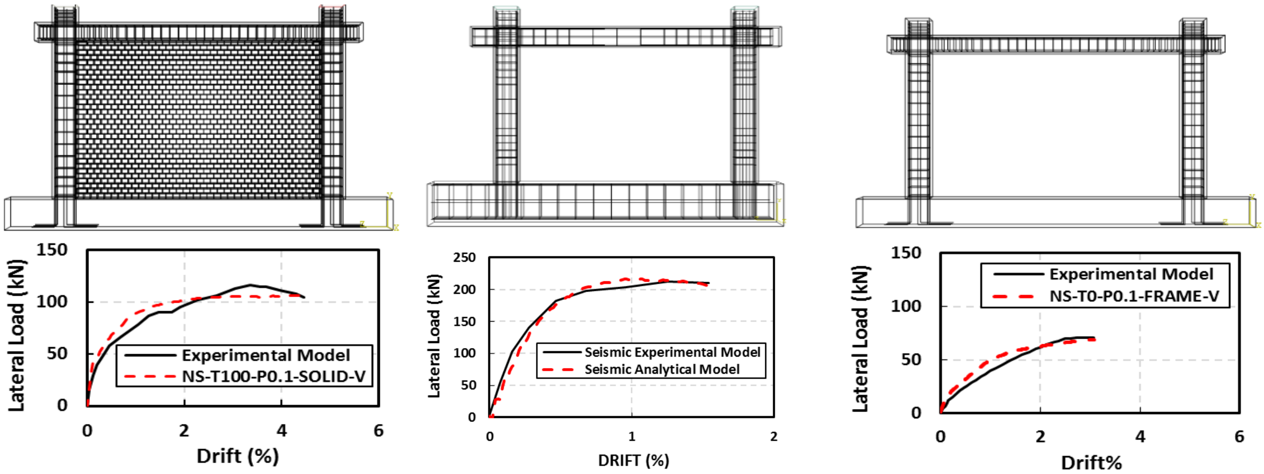

c. infill-frame masonry [1] b. seismic reinforce concrete frame [2] a. non-seismic reinforce concrete frame [1]

Fig. 2. Inclined-plane apparatus

thickness of 100 mm. The third three specimens are under different levels of axial loading of 0.1, 0.2, and 0.3, and masonry infill thickness of 50 mm, and the concrete frame is non-seismic. The fourth three specimens are under different levels of axial loading of 0.1, 0.2, and 0.3 and masonry infill thickness of 50 mm, and the concrete frame is seismic After analyzing the specimens in ABAQUS finite element software, the force-displacement graph was extracted and by bilinear FEMA356 method [4] the ultimate strength, effective stiffness, and ductility were obtained.

3. Analytical results of RC frame and infill-frame masonry

Percentage of ultimate strength difference, effective stiffness, and ductility in the seismic concrete frame compared to the non-seismic concrete frame under the level of axial load of 0.1% columns load capacity bearing respectively 0.8%, 11.12%, 6.6%, At axial load level 0.2 the compressive capacity of columns is equal to 6.5%, 13.5%, 23.6% and at an axial load level of 0.3 column capacity, in concrete frame with seismic details equal to non-seismic details is equal to 6.4%, 0.72%, 38.18%. The seismicity of the reinforced concrete frame increases the ultimate strength, effective stiffness, and ductility compared to the non-seismic reinforced concrete frame, which is due to increased ductility, increased stiffness, and reduced δy such as flow.

In reinforced concrete frames in seismic and non-seismic specimen's increases with increasing axial load strength and initial stiffness, but after pick strength for causing effects of p-Δ resistance and hardness decreasing. Reinforced concrete also reduces ductility. In addition, with increasing axial load the reinforced concrete frame columns also decrease ductility.

In seismic and non-seismic infill-frames masonry with thickness 100 mm and 50 mm as reinforced concrete frame specimens in seismic and non-seismic specimens, increasing the axial load of reinforced concrete frame columns increases the effective toughness and hardness, but after the picking strength for the effects of P Δ resistance and hardness is reduced In addition, the presence of axial load in the building material interfaces increases the frictional adhesion of mortar and brick, which can increase the hardness and toughness before to surrender a point. Results indicate that when the frame has an infill, its members don't have any flexure. The nonlinear behavior of masonry infill and the increased stiffness and ultimate strength can be considered as other behavioral differences of frames with masonry infill and concrete frame without infill which results in different mechanisms of failure and indicates the type of interaction in the behavior of the components of the masonry infill-frame. When masonry infill is placed inside a reinforced concrete frame, the ultimate strength, effective stiffness, and ductility toward the concrete frame increase 60% and 100%, and 75%, respectively.

4. Conclusions

The most important results are as follow:

1- The seismic concrete frame compared to the non - seismic concrete frame at different levels of axial loading was 0.1, 0.2, and 0.3, the compressive capacity of the columns average the ultimate strength 2.84% increase, effective stiffness 8.45% increase, ductility 22.9% increase.

2-The percentage difference between the seismic infill-frames compared with the non-seismic masonry infill-frames under different levels of axial loading 0.1, 0.2, and 0.3 with thickness 100 mm, had been ultimate strength of 2%, 0, 4.5%, respectively, with an average of 5.5% increase in it. The percentage difference of effective stiffness is 17%, 11.32%, 12.57%, respectively. The percentage difference of ductility is 13.25%, 12.57%, 12.9%, respectively.

3-The percentage difference between the seismic infill-frames compared with the non-seismic masonry infill-frames under different levels of axial loading 0.1, 0.2, and 0.3 with thickness 50 mm, had been ultimate strength of 2%, 0, 1.6%, respectively, with an average of 1.8% increase in it. The percentage difference of effective stiffness is 11.4%, 11.4%, 10.6%, respectively. The percentage difference of ductility is 9.03%, 11.31%, 12.4%, respectively.

4- In non-seismic infill frame specimens, when the infill masonry thickness is increased from 50 mm to 100 mm, with increasing axial load levels of 0.1, 0.2, and 0.3, the average ultimate strength is 5.4%, effective stiffness is 8.37%, Ductility 6.38% increases.

5- In seismic infill frame specimens, when the infill masonry thickness is increased from 50 mm to 100 mm, with increasing axial load levels of 0.1, 0.2, and 0.3, the average ultimate strength is 6.64%, effective stiffness is 12.37% and Ductility is 8.4% increases.

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