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Fabrication of reinforced concrete infilled frames having window opening for quasi static cyclic test

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Abstract: *Infill walls in reinforced concrete frames or any other type of frames are considered as non-structural components in most of the design codes and are not taken into consideration in design phase. They are only considered as partition walls in frame structures. However, it has been observed from past earthquake events and experimental studies that the infill walls greatly affect the overall seismic performance of reinforced concrete frames. Infill walls have both beneficial and adverse or negative effects on the overall response of frames during earthquakes. In this research study, two full scaled, reinforced concrete infilled frames having brick masonry infill walls were constructed. Both the RC infilled frames were having window openings. One of the RC infilled frames was having polyethylene foam at the interface of infill wall and surrounding frame. The beams, columns and footings of both reinforced concrete frames were having a concrete mix ratio of 1:2:4 and water-cement ratio of 0.45. After 28 days of moist curing, white washing of both reinforced concrete frames was done.*

Keywords: *Non-structural components; RC infilled frames; seismic performance; quasi static cyclic test; beneficial effects.*

I. INTRODUCTION

Reinforced concrete (RC) frame structures having masonry infill walls is a common construction practice throughout the world. Infill masonry walls have some positive as well as negative effects on the overall behavior of reinforced concrete frames during earthquake events. Various types of damages occur in reinforced concrete infilled frames during earthquakes, if they are not properly designed and constructed according to codes. The various types of damages produced are vertical and horizontal cracks in masonry walls, diagonal cracks, beam column joints failure etc. Usually, it is a common practice that the infill walls in RC frames or all other types of frames are considered as non-structural walls. They are provided only for partition purposes. In analysis and design stage of RC frame buildings, masonry infill walls are not taken into consideration, however, during earthquakes infill walls interacts with frames and influences the local and global response of reinforced concrete frames [1]. The adverse effects caused due to infill and surrounding frame interaction during seismic events are soft storey failure, short column effects, torsion etc. But if the masonry infilled reinforced concrete frames are properly designed and constructed, then these effects can be eliminated.

II. PREVIOUS RESEARCH STUDIES

Different experimental studies have been performed in order to study the effects of masonry infill walls on surrounding frames. Paulay and Priestley, 1992 investigated analytically and experimentally that the infills have positive as well as negative effects on the overall behavior of infilled frames. It was found that the masonry infills improves the stiffness and strength of infilled reinforced concrete frames on one side, but on another hand due to infill-frame seismic interaction, damages are also produced in reinforced concrete infilled frames [2].

Ch. G. Karayannis et al., 2005 conducted study in order to determine the effects of infill walls on the overall seismic response of RC frames. The experimental setup mainly consists of fabrication of 1/3 scale, one bay and one storey reinforced concrete frames. Quasi static test procedure was adopted. It was concluded that by providing masonry infill walls in RC frames, the stiffness of frames was improved. Diagonal cracks were observed in the infill walls and infill walls mainly failed due to these cracks [3].

Ruey-Shyang Ju et al., 2011 introduced the concept of providing slits or gaps for the separation of reinforced concrete infilled walls from the steel moment frames. In this research, cyclic loading tests were conducted on total of four one bay, one storey steel moment frame specimens (4/5 scale), which included one bare frame, one with ordinary RC infill wall and two frames with side slits between RC walls and frame members. It was concluded that by providing slits between reinforced concrete infill walls and steel moment frames, the damages caused due to soft-story effects can be reduced [4].

Marco Preti et al., 2013 conducted quasi static tests of two full scale frame specimens with masonry infill walls and having sliding joints. Due to presence of sliding joints the damages were reduced in infilled frames [5].

Huanjun Jiang et al., 2015 conducted quasi static tests on RC infilled frames (full scale) to study experimentally the influence of masonry infill walls on surrounding RC frames. It was found that by providing rigid connection between masonry infill walls and RC frame the stiffness, strength and energy dissipation capacity were enhanced [6].

III. METHODOLOGY

The different types of materials required for the construction of reinforced concrete infilled frames were ordinary Portland cement, first class bricks, grade 60 steel reinforcement (# 3 and # 5 diameter steel bars), fine aggregates, coarse aggregates and polyethylene foam having thickness of 10 mm. All these materials were purchased from the local market. According to (ACI) Standard 211.1 [7], concrete mix design was conducted and it was found that the mix ratio was 1:2:4 and water-cement ratio was 0.45.

The dimensions of two reinforced concrete infilled frames were finalized. The total height of infill reinforced concrete frames was 10 feet including footing of 1 feet height and width of the reinforced concrete frame was 12 feet. The width of brick masonry infill wall was 9 inches. Both the reinforced concrete infilled frames (RC frame 1 and 2) were having a window opening. The window height was 2 feet and 9 inches and its width was also 2 feet and 9 inches. The reinforced concrete infilled frames were constructed in Structural engineering laboratory, Civil engineering department, UET Peshawar, Pakistan. RC frame 1 was an ordinary reinforced concrete infilled frame and RC frame 2 was having polyethylene sheet at the interface of masonry infill and surrounding reinforced concrete frame.

3.1. Construction of reinforced concrete infilled frames

After finalizing the dimensions of reinforced concrete infilled frames, both the RC frames were constructed in Structural engineering laboratory. First of all, the holes were drilled in the ground for fixing the anchorage bolts of reinforced concrete footing in the ground, in order to avoid the slip of reinforced concrete footings during test. All the holes were drilled according to standard layout. The anchorage bolts were then fixed with the help of epoxy.
Reinforced concrete footings were constructed. The dimensions of reinforced concrete footing were: width = 18 inches, depth = 12 inches and length = 144 inches. Eight #5 steel bars were provided as longitudinal steel and stirrups were #3 bars at 6 inches center to center The construction of RC footing is shown in Figure 3.

Figure 3: RC footing after concreting

Reinforced concrete columns were constructed having square cross section of 12 inches each and height of RC columns was 9 feet as shown in Figure 4. Eight #5 steel bars were provided as longitudinal steel and stirrups were #3 bars at 6 inches center to center.

Figure 4: RC columns erection

The formwork for RC beams was fixed and construction of RC beams was done. The RC beams were having square cross section of 12 inches each as shown in Figure 5. Six #5 steel bars were provided as main bars and #3 steel bars were provided as stirrups at 6 inches center to center distance.

Figure 5: RC beams after concreting

Curing of RC frames was done for 28 days by using jute bags as shown in Figure 6.

Figure 6: Curing of RC frame by using jute bags

Brick masonry infill walls were constructed in RC frames. English bond was used for walls construction. The thickness of walls was 9 inches. First class bricks were used. The RC infilled frames were finally white washed, in order to identify the cracks produced in RC infilled frames during quasi static cyclic testing of fames. The final RC frames are shown in Figure 7.

Figure 7: RC infilled frames after white washing

IV. FUTURE WORK

Quasi static cyclic test will be performed in displacement controlled manner. The instrumentation of both the reinforced concrete infilled frames will be done. Load will be applied on both the RC frames with the help of hydraulic actuators and different types of the instruments such as LVDTs, string pot, dial gauges etc will be used to measure displacements produced in RC frames. The results of both the RC infilled frames will be compared with each other.

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