ABSTRACT

Masonry infilled panels are normally used as partitions or as architectural elements in reinforced concrete (RC) structures. The need for incorporating openings to the walls of a building in order to provide natural lighting and ventilation leads to partial lateral confinement along the height of the column by rigid elements, such as internal partitions and facades. This situation introduces large shear stresses, when the structure is subjected to seismic forces and the columns are seriously damaged due to captive-column effect.

The objective of this research study is to develop a retrofit solution for strengthening of existing RC structures with captive-column defects. An experimental study was conducted with three partially infilled RC frames under quasi-static cyclic loads simulating seismic action. One of the specimens was the control frame tested to identify the captive-column behaviour and the other two specimens were retrofitted using glass fibre-reinforced polymer (GFRP) laminates and masonry inserts, respectively. Various parameters like lateral deflection, strength, stiffness, ductility, and energy dissipation capacity were considered for study on the behaviour of the
frames. The load-displacement response, specimen behaviour, and the crack pattern of the frames are studied. An analytical validation was performed using IDARC2D, a software package for the inelastic damage analysis of buildings.

Test results indicate that the control specimen experienced a brittle failure with shear cracks in the bottom-storey column, indicating a distinct captive-column effect. The retrofitted specimens exhibited a better performance with significant increase in the peak strength, stiffness, and displacement ductility and prevented the column shear failure due to captive-column effect. The software IDARC2D simulated the ultimate strengths, sequence of yielding of the members, and the non-linear behaviour of the frames satisfactorily.

From the present study, it is concluded that the retrofit scheme using GFRP laminates or masonry inserts could considerably improve the seismic resistibility of existing concrete structures with captive-column defects if used properly, and some suggestions were made for the structural designers to handle the problem of captive-column effect more seriously.