8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

PUNCHING MECHANISM IN REINFORCED CONCRETE FRAMES RETROFITTED BY STEEL FRAME

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Keywords: Seismic retrofit, RC frame, steel frame, Punching, Diagonal Brace

In recent years, steel elements such as shear walls and steel braces have been frequently applied as the lateral load resisting system in design and retrofit of structures. The low-cost construction, quick installation, high energy absorption potential, etc. have made this system an appropriate system for retrofitting of existing structures (Rutherford et al., 2006), since these systems are currently has found many usages in buildings retrofitting in countries such as: The United States, Japan and Canada. The early experimental investigations by Sugano and Fujimura pointed out the efficiency of retrofitting RC frames by steel braced frames (Sugano, 1981). Kawamata and Ohnuma (1981) proposed a technique for retrofitting RC frames by eccentric steel braces. Generally, by reviewing the associated works, the connections between RC frames and steel frames can be classified into two main types including direct and indirect connections. Ohishi *et al.* (1988) and Sekiguchi *et al.* (1988) have suggested the indirect connection for retrofitting RC frames by steel braced frames. In the indirect connection, a steel braced frame is installed inside an RC frame using studs, anchors and high strength grout. Anchors are installed in the epoxy-injected holes provided on the boundary elements of RC frames. Studs are welded on the boundary of the steel braced frame. Finally, the high-strength grout fills the provided space between the RC frame and the steel braced frame, to strongly interlock the anchors and studs.

Steel shear walls and steel brace can be easily added to existing concrete frames, but a review of past activities indicates that drilling in principle structural elements such as columns will weaken the resistance of the boundary elements. However, the study of preceding works demonstrates that the columns of the frame should also be of specific consideration to enhance the frame's strength. Another subject that must be considered is whole system interaction, in another word different stiffness and ductility of steel braced frame and RC moment frame may cause some undesirable behavior such as stress concentration. In this study, two one-bay one-story RC frames are tested to verify the effect of added braced frame on RC frame. The scale factor of the test specimens is 1/3~1/4, to model a low-rise RC building. One specimen is non-retrofitted, and another one is retrofitted by steel braced frames. First, a vulnerable reinforced concrete frame has been constructed and after the 28-days strength obtaining of the sample, it was taken under the lateral load to get the structural capacity curve. Furthermore, the frame is retrofitted by a steel braced frame. After installing the steel braced frame, the dominant mechanism, which is column's punch, is observed. Finally, with considering of occurring

mechanism, it can be concluded that, in order to prevent the column's punch, steel frame at the top of the column, which is a vulnerable point, should be connected to concrete beam properly.

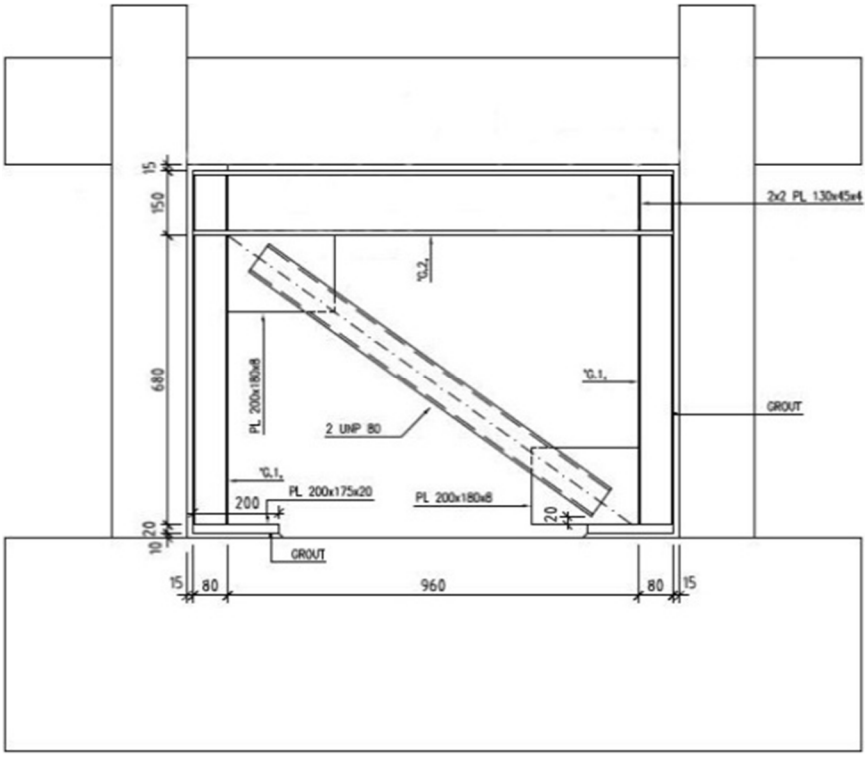

Figure 1. Retrofitted frame.

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