Seismic Behavior of Reinforced Concrete Frame with New CFRP Units Infilled Wall

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Abstract

New infill blocks consisting of the Carbon Fiber Reinforced Plastic (CFRP) units have been developed for one of the seismic retrofit technologies for reinforced concrete frames. So called CFRP shear wall, infilled with those CFRP units, has a good performance in in-plane shear strength for its thinness and lightness. The shape of unit is a rectangular parallelepiped with dimensions of 100 mm in thickness, 300mm in height and 900mm in length. The weight of a unit is about 11 kg (4l kg/m^2). The units are bonded together with epoxy resin. In order to connect CFRP shear wall to the concrete frame, the boundary steel plates are installed on existing concrete with epoxy resin, and then CFRP shear wall and boundary plates are bonded. This construction features less noise and less dust because of lightness and easy installation.

An experimental research program consist of tensile lap-shear tests, unit and joint shear tests, large-scale CFRP wall shear tests and shear tests of the reinforced concrete frame with CFRP shear wall.

Tensile lap-shear tests of steel-to-steel, steel-to-CFRP, CFRP-to-CFRP and steel-to-concrete, bonded with epoxy resin respectively, were carried out.

Unit shear tests and joint shear tests were carried out. Failure mode of units was shear-buckling. The average of buckling stress was 10.0N/mm^2 for the area of bed face. The adhesive shear strength between units without splice plates was 8.8N/mm^2.

Large-scale CFRP shear walls were tested in cyclic diagonal compression. The wall, consisting of 3 $\times$ 4 units, was of 100 mm in thickness, 1200 mm in height and 2700 mm in length. The experimental parameters were pattern bonds and joints. The shear strengths of the walls were 5.5N/mm^2 for the stack bond wall without splice plates, 7.2 N/mm^2 for the stack bond wall with splice plates and 8.3 N/mm^2 for the running bond wall with splice plates.

Lateral cyclic loading tests were carried out on three of half-scaled specimens of the reinforced concrete frames with CFRP shear walls under a combination of axial loads. The experimental parameters were joints of units and bond boundary conditions of concrete. The dimensions of each CFRP shear wall were 50 mm in thickness, 1475 mm in height and 3266 mm in length, consisting of 58 units. The section of reinforced concrete columns was 325 mm $\times$ 325 mm. The behavior of specimens is discussed on modes of failure, deformation characteristics, and strength. The maximum

shear strengths, sustained by the wall, subtracting the assumed shear strength of columns from the maximum lateral load, were estimated as 4.8N/mm^2 for the specimen without splice plates, 6.7 N/mm^2 for one with splice plates and not enough bonded concrete and 7.9 N/mm^2 for specimen for one with splice plates and enough bonded concrete. The experimental shear capacities of the infilled frames were more than four times that of the beam-column open frame.

It is concluded that the CFRP shear wall shows a good performance for seismic retrofit to reinforced concrete beam-column frames.

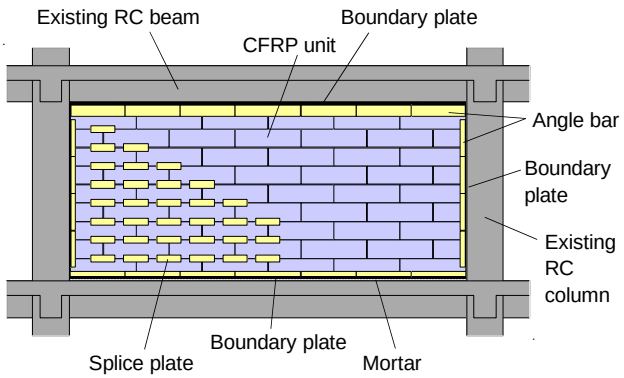

Fig.1 RC frames infilled with CFRP shear wall

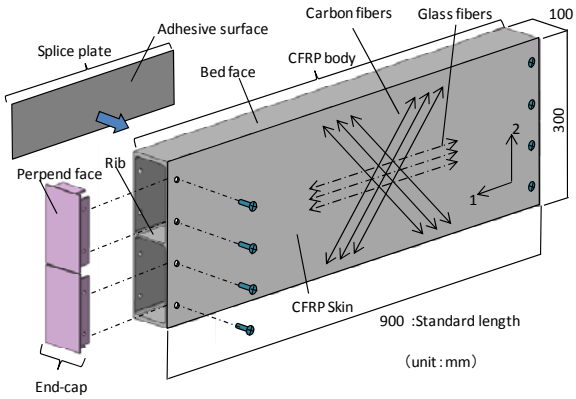

Fig.2 CFRP unit

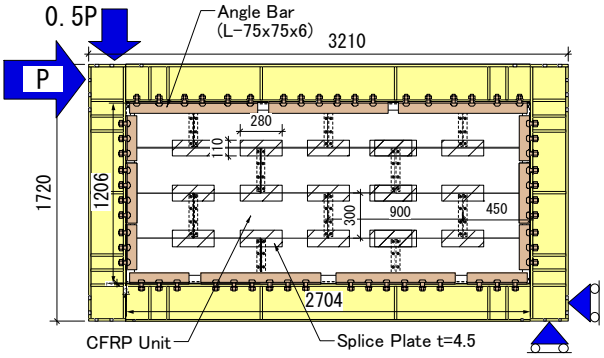

Fig.3 Configurations of large-scale CFRP wall test (A Type of Running Bonds with Splice Plate)

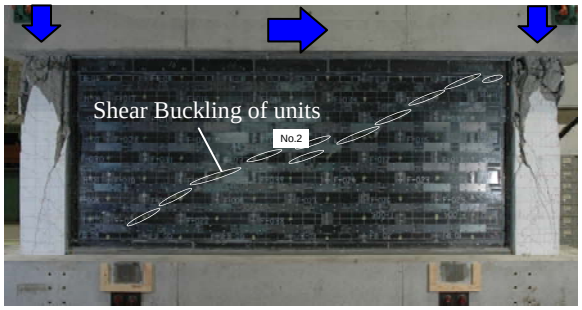

Fig.4 Failure mode of CFRP infilled frame specimen (No.2)

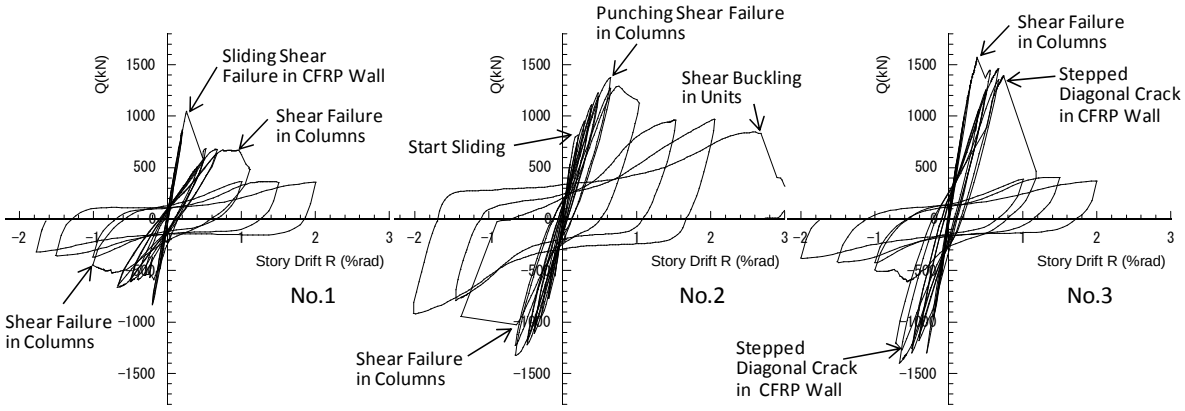

Fig.5 Relationships between lateral load and story drift angle for infilled frames