Flexural Strengthening of Masonry Walls with External Composite Bars

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Abstract:

Unreinforced masonry (URM) buildings constitute an important part of the building stock, and are vulnerable to earthquakes. Retrofitting of existing masonry walls with near-surface mounted, non-corrosive fiber-reinforced polymer (FRP) bars, is an attractive option. Previous research has shown that it is difficult to develop the full tensile strength of the bars, which are attached with epoxy in grooves pre-cut in the masonry and mortar joints. In this study, the use of epoxy strengthened with short glass fibers as a bonding agent allowed close to full strength development of 6.5 mm (¼ in) diameter glass FRP bars in 185 mm (7.3 in), or less than half a concrete masonry unit length. This fiber-reinforced epoxy should be effective for other types of bars as well.

With full anchorage assured, FRP bars provide an efficient method of strengthening masonry walls and beams against out-of-plane bending. Seven grouted beams and one ungrouted beam were tested in four-point bending. Of the grouted beams, three were narrow beams (2.85 m x 0.40 m x 0.20 m or 112 in x 16 in x 8 in) reinforced to 45% of balanced ratio and four were wide beams (2.85 m x 0.80 x 0.20 m or 112 in x 32 in x 8 in) reinforced to 66% of balanced ratio. All seven grouted beams exhibited consistent flexural behavior, with ultimate failure precipitated by tensile rupture of the reinforcement at an average ratio of span to maximum deflection of 42. The one ungrouted, narrow beam failed in shear.

The MSJC (2002) equations underpredict the flexural strength of these FRP externally reinforced concrete masonry beams or walls (conservatively), with a mean ratio of measured to predicted strength of 1.36 and a coefficient of variation of 0.054. As the reinforcement ratio increases, the level of conservativeness of the design equations decreases slightly. There was no difference in behavior, however, between reinforcement parallel or perpendicular to the mortar bed joints.

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