Doctoral Dissertation Defense Announcement

Department of Civil & Environmental Engineering

Title: BEHAVIOR OF FRP STRENGTHENED RC PANEL ELEMENTS SUBJECTED TO PURE SHEAR

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Abstract

Several investigations have revealed that many aging civil engineering structures such as highway bridges are structurally deficient and need repairs and/or retrofitting. Among various solutions, fiber reinforce polymer (FRP) composites have shown a promising solution and have been increasingly used in rehabilitation and strengthening of reinforced concrete (RC) structures.

Although, researchers have devoted a tremendous effort on studies related to FRP shear strengthening of RC structures, the state of knowledge shows that the problem is not fully resolved and there are still controversies in the prediction of shear behavior in the presence of FRP. To predict the increase in shear capacity due to FRP strengthening, several analytical models have been proposed. However, when these models are compared using existing experimental database, they show inconsistencies and large scatter in the prediction. This is due in part to the high level of complexity associated with the shear behavior, but more importantly due to the lack of rational constitutive models for FRP shear strengthened elements.

This research study aims at establishing the shear constitutive behavior of externally bonded FRP strengthened RC elements subjected to pure shear through experimental investigations and development of associated analytical and finite element models. In order to evaluate such behavior, at the first part of the research, a series of full-scale FRP strengthened RC panels were constructed and tested under pure shear stress field using the University of Houston’s state of the art panel tester. It was found that that application of FRP sheets increased the shear capacity of RC panels. Also, the shear behavior of FRP strengthened RC members is influenced mainly by the FRP stiffness, wrapping scheme, and the internal shear reinforcement. Based on the test results, the Softened Membrane Model (SMM), which was developed for reinforced concrete, was modified and extended for application to FRP strengthened RC members.

The second part of this research involved the development of a computer program for analysis of FRP strengthened RC structures. The constitutive laws of FRP strengthened RC members, developed through previous research at UH, have been implemented into the finite element frame work OpenSees to predict the behavior of FRP strengthened RC panels and beams under monotonic loading. The analytical model was tested and validated using existing experimental data.

Furthermore, to investigate the serviceability conditions in FRP strengthened RC structures, the crack characteristics of a series of full-scale tensile tests of FRP strengthened RC prisms and test panels have been monitored by using a digital image correlation system. The experimental results were used to calibrate a newly developed equation to calculate crack spacing and crack width in RC elements externally strengthened with FRP.