LINKING MATERIAL BEHAVIOR TO THE SEISMIC PERFORMANCE OF FIBER REINFORCED CONCRETE COUPLING BEAMS WITHOUT DIAGONAL REINFORCEMENT

by

Ángel Pérez-Irizarry¹ and Gustavo Parra-Montesinos²

1 Structural Engineering Graduate Student, Department of Civil & Environmental Engineering, University of Wisconsin-Madison
2 C.K. Wang Professor of Structural Engineering, Department of Civil & Environmental Engineering, University of Wisconsin-Madison

Abstract:
Coupled wall systems are commonly used in medium and high-rise buildings to provide lateral stiffness and strength needed to withstand major earthquakes. The behavior of these systems during earthquakes is highly dependent on the performance of coupling beams, as these members greatly contribute to the system lateral strength, stiffness and energy dissipation capacity. Current design provisions for coupling beams require intricate reinforcement detailing to ensure adequate strength and drift capacity. In most cases, reinforcement detailing includes diagonal bars designed to resist the entire shear demand, along with closely spaced confinement reinforcement, similar to that required for columns in Special Moment Resisting Frames.

Results from previous research have shown that the use of 1.2 in. long, 0.015 in. diameter hooked steel fibers with a tensile strength of 330 ksi and in 1.5% volume fraction allows the elimination of diagonal bars and substantial reductions in transverse reinforcement in coupling beams with a span-to-depth ratio of approximately 2.2 and greater. In order to evaluate the possibility of using other types of steel fibers, particularly with lower tensile strength and in reduced amounts, a new experimental program that includes the testing of eight large-scale coupling beams with a span-to-depth ratio of either 2.0 or 3.0 is currently underway. Hooked steel fibers with tensile strength of either 275 ksi and 160 ksi, lengths ranging between 1.2 and 1.4 in., and length-to-diameter ratio of either 55 or 80, are being evaluated in volume fractions ranging between 1.0 and 1.5%. The main goal of this experimental program is to allow the establishment of a link between FRC mechanical properties and coupling beam seismic behavior.

Results from reversed cyclic load tests of coupling beams with various FRC materials, as well as from companion FRC tensile and flexural tests, will be presented. Emphasis will be placed on relating coupling beam drift capacity, peak shear stress and FRC post-cracking behavior. Test results to date indicate that adequate strength and drift capacity can be achieved in coupling beams with span-to-depth ratio of 3.0 with the use of either 160 ksi or 175 ksi hooked steel fibers in a 1.25% volume fraction without the need for diagonal reinforcement. For coupling beams with span-to-depth ratio of 2.0, preliminary results indicate that the use of 330 ksi hooked steel fibers may be required at a volume fraction of at least 1.25% in order to allow elimination of diagonal reinforcement without detrimental effect on seismic performance.