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Influence of Transverse Steel and Casting Direction on Shear Response and Ductility of Reinforced Ultra High Performance Concrete Beams

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Abstract : Ultra high performance concrete (UHPC) is a class of cementitious composites with a relatively large percentage of cement generating high compressive strength. Additionally, UHPC contains disbursed fibers, which control crack width, carry the tensile load across narrow cracks, and limit spalling. These characteristics lend themselves to a wide range of structural applications when UHPC members are reinforced with longitudinal steel. Efficient use of fibers and longitudinal steel is required to keep lifecycle cost competitive in reinforced UHPC members; this requires full utilization of both the compressive and tensile qualities of the reinforced cementitious composite. The objective of this study is to investigate the shear response of steel-reinforced UHPC beams to guide design decisions that keep initial costs reasonable, limit serviceability crack widths, and ensure a ductile structural response and failure path. Five small-scale, reinforced UHPC beams were experimentally tested. Longitudinal steel, transverse steel, and casting direction were varied. Results indicate that an increase in transverse steel in short-spanned reinforced UHPC beams provided additional shear capacity and increased the peak load achieved. Beams with very large longitudinal steel reinforcement ratios did not achieve yield and fully utilized the tension properties of the longitudinal steel. Casting the UHPC beams from the end or from the middle affected load-carrying capacity and ductility, but image analysis determined the fiber orientation was not significantly different. It is believed the presence of transverse and longitudinal steel reinforcement minimized the effect of different UHPC casting directions. Results support recent recommendations in the literature suggesting a 1% fiber volume fraction is sufficient within UHPC to prevent spalling and provide compressive fracture toughness under extreme loading conditions.

Keywords : fiber orientation, reinforced ultra high performance concrete beams, shear, transverse steel
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