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Extended Abstract (no paper submission)

Prefabricated UHPC Structural Formwork for Cap Beams

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Experimental Investigation
Accelerated Bridge Construction

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Extended Abstract

Stay in place (SIP) formwork offers alternative to conventional construction methodologies by integrating formwork with the structural element. The formwork provides a durable protective layer, and in most cases, improves the structural performance of the infill material. Recent advancements in construction materials have led to development of ultra-high performance concrete (UHPC) whose superior mechanical and material properties allows its use for SIP formwork. In this research, an application of SIP formwork for cap beams is presented. The concept utilizes UHPC to prefabricate a shell formwork element which is transported to site. After placement on pier bent, the shell formwork is completed by placing reinforcing steel and in-filled with normal strength concrete (NSC). This sequencing of construction stages makes UHPC formwork a feasible choice for accelerated bridge construction (ABC) applications.

The objective of this study is to investigate the structural performance of a UHPC shell beam. A formwork beam (B-1) was constructed with a reinforced 1.25-in thick UHPC shell. A reinforcement cage was placed inside the shell and finally filled with NSC. To improve the interface between shell and normal concrete, shear connectors were embedded in the walls of the

shell in a rhombus pattern 9-in apart. To provide a baseline comparison, a NSC beam (C-1) was constructed using conventional construction methodology. The length of both beams were 10-ft as shown in Figure 1. The compressive strength was 8.6 ksi for NSC and 26.2 ksi for UHPC.

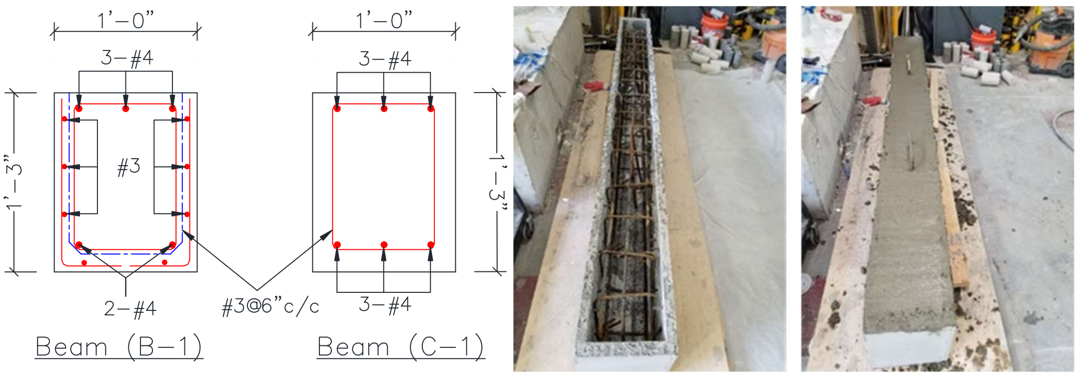

Figure 1:Reinforcement detail and construction of specimen

The beams were tested under a four-point loading setup. A monotonic loading was applied to the beams until failure occurred. The beams were instrumented with linear displacement transducers, load cells and steel strain gages. First cracks were observed in control beam C-1 around 8 kips and failure occurred at about 34 kip. For shell beam B-1, cracking initiated in normal concrete at 20 kips while the cracking in the UHPC was not observed until 36 kips. After peak load of 60 kips, the cracks in the UHPC shell widened followed by rebar fractures in the shell wall.

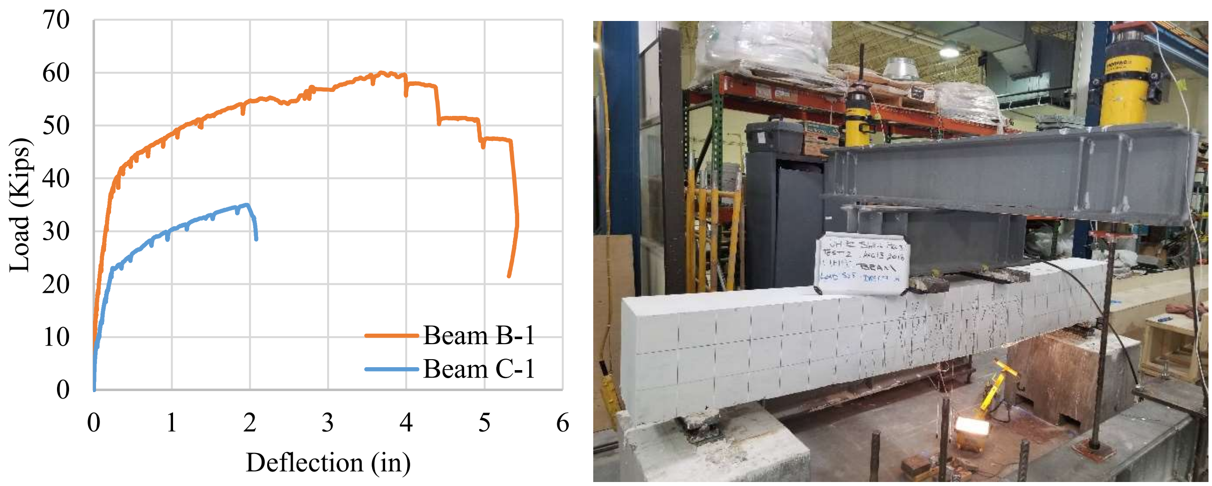

Figure 2: Load deflection plot and test setup

The shear connectors contributed to the composite behavior and no interface loss was observed between the UHPC shell and NSC. The results of the study demonstrate feasibility of using UHPC shell formwork for beam elements with significant improvement in ductility and flexure capacity.