UHPC for Accelerated Bridge Construction

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What is Ultra-High Performance Concrete?

- Advanced cementitious material
- High strength, high stiffness
- Exceptional durability
- Internal steel fiber reinforcement for added ductility
- Self-consolidating

UHPC, UHPFRC, RPC
Ductal, CoreTUFF, BSI, Densit, Cemtec, …
UHPC Properties: Some Ballpark Values

- Compressive Strength – 18 to 35 ksi
- Modulus of Elasticity – 6200 to 8000 ksi
- Creep Coefficient – 0.3 to 0.8
- Sustained Tensile Capacity – 0.9 to 1.5 ksi
- Rapid Chloride Permeability – 20 to 360 Coulombs
- Freeze/Thaw Resistance – RDM > 95%

Source: FHWA Report FHWA-HRT-06-103
Material Property Characterization of Ultra-High Performance Concrete
UHPC Mixing
Compression Behavior
Tensile Behavior
UHPC Connections

- Deck-to-Deck
- Deck-to-Girder
- Deck Beam-to-Deck Beam
- Column-to-Footing/Cap
- Girder-to-Girder
- Deck-to-Barrier
- Headers for Expansion Joint
#4 BARS (BLACK & EPOXY) – 3” EMBEDMENT
#5 BARS (BLACK & EPOXY) – 4” EMBEDMENT
#6 BARS (BLACK & EPOXY) – 5” EMBEDMENT
Field-Cast “Splice” Connections

- Simple Lap-Splice Cxn.
- Smaller Grout Volumes
- Shortened Bar Lengths
- Emulates Monolithic Component
**Field-Cast “Splice” Connections**

- **Precast Deck Panels and Slabs**
  - 96 in. Deck Bulb Tee Girders
  - 61 in. Deck Bulb Tee Girders
  - UHPC Closure Pour
  - Precast Deck Panel

- **Deck Bulb Tee Girders**
  - 41 in.
  - 61 in.
  - 6 in.
  - Closure Pour (UHPC)
  - Prestressed Girder
Joint Testing by FHWA for Strength Durability and Performance

- 8” THICK PANEL - #4 EPOXY COATED HAIRPIN BARS
- 8” THICK PANEL - #5 GALV. STRAIGHT BARS (6” LAP)
- 8” THICK PANEL - #5 BLACK STRAIGHT BARS (6” LAP)
- 8” THICK PANEL - #5 BLACK HEADED BAR (3 ½” LAP)
- 6” THICK PANEL - #5 BLACK STRAIGHT BARS (6” LAP)
- 6” THICK PANEL - #5 BLACK HEADED BARS (3 ½” LAP)
Test Conclusions

1. Joint system emulates or surpasses CIP monolithic decks hence can be designed similar to CIP decks
2. No interface de-bonding during testing was observed
3. No de-bonding of reinforcing bars during testing
NYSDOT collaborated with the industry, trade associations and the FHWA in developing and testing field cast UHPC joints for precast deck systems. The results are documented in the following report:

Development of a Field-Cast Ultra-High Performance Concrete Composite Connection Detail for Precast Concrete Bridge Decks

NTIS Accession No. PB2012-101995

FHWA Publication No. FHWA-HRT-12-038
UHPC Composite Connection

Steel Girder Connection

Concrete Girder Connection
Field-Cast Deck-to-Girder Connections

- Simple Connection
- No Interference
- Hidden Connection
- Emulates Cast-in-Place
Field-Cast "Interface" Connections
NYSDOT collaborated with the industry, trade associations and the FHWA in developing and testing Composite Connections between Precast Decks and steel/concrete girders using UHPC. The results are documented in the following report:

Composite Connections for Precast Concrete Bridge Decks.

NTIS Accession No. PB2012-107569
FHWA Publication No. FHWA-HRT-12-041
- No Prestressing or PT
- Inverted Cast w/ Integrated Barrier
- Exposed Aggregate
- UHPC Connections
- ½” Sacrificial Surface...Ground
- Closure time as low as 3 days
- Single span bridges
- Two bridges with 3 spans each in 10 days
1" RADIUS (TYP.)

2" Ø FORMED VENT/GROUT HOLES @ 2'-0" O.C. (MAX.)

SECTION E-E

5 NON-SHRINK GROUT JOINT OVER INTERIOR BEAMS
ISOMETRIC VIEW-INTERIOR JOINT

NOTE: ALL SURFACES IN JOINT TO BE EXPOSED AGGREGATE
Underside of the deck panel with hidden haunch pocket.

Long studs to engage transverse bars.
SECTION C-C

C5 LONGITUDINAL UHPC JOINT OVER BEAMS
FORM STRIPPING SECTION F-F

TYPE 6 BRIDGE PANELS
Deck Link Slab
Finished Link Slab
Finished Link Slab
The latest generation of precast deck system for accelerated construction used by NYSDOT has:

a) Exposed stud pockets  
b) No Studs  
c) Hidden haunches with studs  
d) Hidden haunches without studs
Precast post-tensioned deck systems are:

a) More complex to design
b) Thicker than C I P decks
c) Construction is complex
d) All of the above
PBES using UHPC connections:

a) Results in high quality structures
b) Usually cost more conventional construction
c) Drastic reduction in construction time
d) All of the above
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