Illinois’s First Precast Deck Panel Bridge with UHPC Joints

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OUTLINE

- Precast Deck Panels
- 3 Approaches for Continuity
- UHPC and UHPC Joints
- Peoria Street Bridge (Circle Interchange)
NYSDOT PROJECT
NYSDOT PROJECT
PANEL-TO-PANEL CONNECTION

FHWA – Ben Graybeal and NYSDOT
Most Popular ABC (Accelerated Bridge Construction) System

- Speeds Up Construction
- Increases Quality of Concrete Members
- Increases Construction Safety
- User Convenience

FULL DEPTH PRECAST DECK PANEL
FULL DEPTH PRECAST DECK PANEL

- Precast Deck Panel in 1965

- IDOT – Precast Deck Panel in 2000 (used Post-Tensioning)

- Over 70 Projects in US - Precast Deck Panels
WHAT ARE THE NEGATIVES?

- Higher Construction Cost
- Complexity of Design
- Complexity of Construction
- Joint Performance
CONTINUITY AT PANEL JOINTS

- Internal Post-Tensioning
- AccelBridge system
- UHPC
INTERNAL POST-TENSIONING

- Transverse Closure Pour – Abutments
- Longitudinal Closure Pour - Wider Bridge
- Cracking in Joint - PT Corrosion
ACCELBRIDGE SYSTEM

Invented by Eddie He

Jacking

External Post-Tensioning

Louisiana, Canada
Pre-cast deck panels at both ends of the bridge is composite to the girder.

Pre-cast deck panels in between is not composite to the girder at time of jacking.
ACCELBRIDGE SYSTEM EXTERNAL PT

Longitudinal PT force becomes deck compression

Vertical PT deviation force helps the girder resist load

Girder post-tensioning tendon

Step 4-1 Install and stress girder post-tensioning
UHPC JOINTS

- No Post-Tensioning
- Less Construction Time
- Higher Ductility and Durability
- Higher Initial Unit Cost
Research on UHPC – Early 1990

1st UHPC Bridge in Quebec – 1997

Commercial Use in US – 2000

PP UHPC Beam Bridge in Iowa – 2006

Precast Deck Panel w/ UHPC Jt - 2009
Cementitious Composite Material

21 to 29 ksi  - 28 Days

12 ksi  - 12 Hours
TENSILE STRESS-STRAIN OF UHPC
TENSILE STRESS-STRAIN - CONCRETE
Ductility
Greater capacity to deform and support flexural and tensile loads, even after initial cracking!
Durability

Impermeability & Longevity

US Army Corp, Exposure Site
Treat Island, Maine

EXPOSURE: 500 freeze/thaw cycles and 4500 wet/dry cycles in saturated sea water
#4 BARS (BLACK & EPOXY) – 3” EMBEDMENT
#5 (16mm) BARS (BLACK & EPOXY) – 4” (100mm) EMBEDMENT
#6 (19mm) BARS (BLACK & EPOXY) – 5” (130mm) EMBEDMENT
PULL OUT TEST (NYSDOT)
FATIGUE TEST

Cyclic Loading (Fatigue):

2000 to 16,000 Pounds
For 8,900,000 cycles
2000 to 21,300 pounds
For 5,200,000 cycles

“No Leakage through the Joint”
Illinois’s First Precast Deck Panel Bridge with UHPC Joints
- Cross Road Bridges
- Flyover Ramps
- Other Bridges
$450 MILLION CIRCLE INTERCHANGE

- 22 Existing Bridges
- 18 New Bridges
- 7 Curved Steel Girder Bridges, R=220’
- 49 Retaining Walls
CIRCLE INTERCHANGE

- Galvanized Steel Plate Girder
- Metalized Steel Plate Girder
- Drilled Shaft / Micropile
PEORIA STREET BRIDGE

3-span, Galvanized Steel Plate Girder

Total L = 273 ft, 56 ft Wide

52 Precast Deck Panels

Transverse and Longitudinal UHPC joints
PRECAST DECK PANEL PLAN

5'-11/4"

10"

D Opening, typ.

5" Joint

*2'-1"

Bk. of S. Abut.
Sta. 3702+57.64

8 Spaces 6'-31/2" = 50'-4"

Panel Joint, typ.

A1 A2 A2 A2 A2 A2

A B C B


D

3'-0"

56'-4"

3'-0"

5'-11/4"

1

2

3

4

5

6

7

8

9

34
Ultra High Performance Concrete

Fillet Varies

1\frac{1}{2}" typ.

7"

2" cl. min.

6\frac{1}{2}" min.

5\frac{1}{2}" min. lap

3'-3"

2\frac{1}{4}" cl.

1\frac{1}{2}"

1"

2\frac{3}{4}" 2\frac{1}{4}" 2" min.

1\frac{3}{4}"

1\frac{3}{4}"

\frac{7}{8}" Granular or solid flux filled headed studs, automatically end welded to flange.
7/8” φ Granular or solid flux filled headed studs, automatically end welded to flange. (No. Req’d = 6,048) Girders 1-4 & 6-9 only.

Fill with non-shrink grout

#5 bar passing through pocket

Fillet Varies

Form or shim, typ.
SEMI-INTEGRAL ON TALL WALL
PANEL CASTING SITE
ERECTING PANEL
FIBERGLASS FORMS AT TRANS JOINT
UHPC TRANSVERSE & LONG JOINT
SHEAR STUD POCKET
MIXING UHPC
CAST UHPC
FORM AT TOP OF UHPC
TOP OF UHPC JOINT
BOTTOM OF JOINT
BEFORE OVERLAY
LESSONS LEARNED

- SP to Prevent VE for CIP Deck
- A+B Bidding
- Non-Shrink Grout – Shear Pocket
LESSONS LEARNED

- Forms for UHPC
- Special Provision
- Mock up – Precast Deck Panel
CONCLUSION

- Higher Compressive Strength (\(\geq 21\)ksi)
- Higher Tensile Strength with Ductility
- Increased Durability
- Less Construction Time
- Higher Initial Unit Cost
UHPC - Other Applications
Deck Bulb T-Beam w/ UHPC Joints
Double T-Beam w/ UHPC Joints
Adjacent Box Beam w/ UHPC Joints

Eric P. Steinberg
Steel Beam Module w/ UHPC Joints
UHPC Overlay (Iowa)
UHPC Overlay (Switzerland)

Dr. Eugen Brühwiler
UHPC link slab (NYSDOT)

Figure 5-Link Slab Cross Section

NYSDOT, Mathew Royce
PIER REPAIR/RETROFIT

Lafarge Ductal, Gaston Doiron
OTHER UHPC APPLICATIONS

- Exp joints
- Concrete cover
- Girder End Repair
Questions?