Precast Concrete Bridge Decks

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Full-Depth Precast Deck Panels

- Girder Lines
- Shear Stud Blockout
- Transverse joint
- 8 ft
- Girder
- Elevation
- Grout
- Shear Stud
- Grout
- Shear Key
Benefits

- Quality control
- Construction without formwork
- Speed of construction
Extended New England System
Limitations

• Full-depth penetrations of the deck panel
  – Shrinkage cracking
• Use of rapid setting grout material
  – Not readily available
  – Difficult to place
Research Objective

• Improve durability
  – Minimize deck penetrations
• Improve constructability
Panel-to-Girder Connection

- Precast Deck Panel
- Shear Stud
- Trough
- AASHTO Girder
Test Specimen

Variables:
- Shear connector
- Connection type
- Embedment
- Concrete strength
- Shear keys
- Stud spacing

24”

32”

LOAD
Group 2
Influence of keys

Load (kips)

Slip (in.)

no key

key
Failure: Key Key

![Image of concrete failure]
Influence of embedment

Load (kips) vs. Slip (in.)

- 8 in.
- 6 in.
Influence of stud size

Load (kips) vs. Slip (in.)

- #4
- #6
Joint Detail

Load (kips) vs. Slip (in.)

New England

New Joint
Failure: New England
Stud Strength

Load (kips)

- #4: 22.4 kips
- #6: 48.5 kips
Findings

• Adhesion controls initial response
  – Stiffness
  – Strength
• Keyed trough required
• Headed studs
  – 6 in. embedment sufficient
• Connection design philosophy
  – Strength controlled by shear stud
Panel-to-Panel Connection

Precast Deck Panel

Epoxy (Transverse Joint)
Test Setup

Load

Variables

• Radius
• Epoxy
Test Specimen
New England
Test Results

**Epoxy**
- FF joint: 9.4
- Sika: 16.8
- Unitex: 17.8

**Radius**
- FF joint: 9.4
- 8 in.: 17.3
- 6 in.: 17.3
Findings

- Radius did not affect strength
- Failure strength controlled by concrete
- Both epoxies had similar performance
- New joint design had improved
  - Behavior
  - Strength
Prototype Bridge

- Fatigue
- Connection Shear Strength

Load

14 ft

8 ft
Girder Reinforcement

No. 4 stirrups @ 6"
No. 3 bars @ 6"
17 – 1/2 in. special strand

Steel Section

Modified HN 36 49
Girder Construction
Completed Girders
Panel Construction
Prototype System
Specimen Construction
Cyclic Load

55 kip hydraulic actuator

Elevation (front)
Cyclic Load Results – 2M cycles

- Load (kips) vs. Deflection (in.)

- G1-Before
- G2-Before
- G1-After
- G2-After
- South (Before)
- South (After)
- North (Before)
- North (After)
Static Load

Loading Ram

Hybrid HN 36-49  40 ft
 42 ft
Elevation (side)
Elevation (front)
 34 in. 34 in.

Loading Ram
 34 in.  34 in.

Loading Ram
 28 ft  12 ft

G-1

G-2

Elevation (front)
Static Load Test Results (G-1)
Static Load Test Results (G-2)

![Graph showing load vs. deflection for different composite types and a girder.]

- **Full-composite**
- **Partial-composite**
- **Girder**
Summary

• Demonstrated ease in constructability
  – Precaster
  – 30 man hours
  – Trough width

• Cyclic loading – Transverse joint

• Ultimate loading – Panel-to-girder joint

• Excellent performance
Conclusions

• New system developed
  – Design and detailing recommendations

• Significant advantages
  – Increased durability
  – Increased speed of construction
Acknowledgments