Precast Concrete Bridge Decks

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Full-Depth Precast Deck Panels

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

Plan

Elevation
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

LOAD

dimensions:
- 24”
- 32”
Influence of keys

Load (kips)

Slip (in.)

no key

key
Failure: Key Key
Influence of embedment

Load (kips) vs. Slip (in.)

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

Load (kips) vs. Slip (in.)

- #4
- #6
Failure in New England
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 Results

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

Radius
- FF joint: 9.4 kips
- 8 in.: 17.3 kips
- 6 in.: 17.3 kips
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
Girder Reinforcement

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

Modified HN 36 49

Steel Section
Girder Construction
Completed Girders
Prototype System
Details
Specimen Construction
Cyclic Load

- 55 kip hydraulic actuator

Elevation (side)

Elevation (front)

G-1 G-2
Cyclic Load Results – 2M cycles

Load (kips) vs. Deflection (in.)

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

Loading Ram

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

Loading Ram
34 in.

Loading Ram
28 ft 12 ft

G-1

G-2

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

- Full-composite
- Partial-composite
- G-1

Load (kips) vs. Deflection (in.) graph showing the load-deflection characteristics of different girder types.
Static Load Test Results (G-2)

Load (kips) vs. Deflection (in.)

- Full-composite
- Partial-composite
- Girder

G-2
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