Precast Concrete Bridge Decks

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Full-Depth Precast Deck Panels

Girder Lines
Shear Stud Blockout

8 ft

Transverse joint

Plan

Elevation

Grout
Shear Stud

Girder

Shear Key

Grout

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

24”

32”
Group 2

[Diagram of two groups]
Group 2
Influence of keys

Load (kips)

Slip (in.)

no key

key
Failure: KeyKey
Influence of embedment

![Graph showing the relationship between Load (kips) and Slip (in.) for different embedment depths (6 in. and 8 in.).]
Influence of stud size

![Graph showing the influence of stud size on load and slip. The x-axis represents slip in inches, and the y-axis represents load in kips. The graph compares two sizes of studs: #4 and #6.](image-url)
Joint Detail

Load (kips) vs. Slip (in.)

- New England
- New Joint
Failure: New England
Stud Strength

Load (kips)

#4: 22.4

#6: 48.5
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
New England
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

Steel Section

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

55 kip hydraulic actuator

Elevation (side)
Elevation (front)

G-1 G-2

Hybrid HN 36-49
100 in.
34 in. 34 in.
55 kip hydraulic actuator
50 in.  50 in.
40 ft
42 ft
292 in.  188 in.

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

Load (kips) vs. Deflection (in.)

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

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

Loading Ram
28 ft 12 ft

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

- Full-composite
- Partial-composite
- Girder

Graph shows the relationship between Load (kips) and Deflection (in.) for different composite girder configurations.
Static Load Test Results (G-2)

- Full-composite
- Partial-composite
- Girder

Load (kips) vs. Deflection (in.)
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