ADJACENT PRESTRESSED, PRECAST BOX BEAM BRIDGES

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AN ADJACENT BOX BEAM BRIDGE

- Box Girders
- Shear Keys
- Tie Rods
- Wearing Surface
PROJECT MOTIVATION

- History of poor durability and performance
- Economical and simple to build
- Over 43,000 in US and 4,000 in Indiana

RESEARCH PLAN

- Acquire decommissioned bridge girders
- Research and acquire NDT equipment
- Conduct non-destructive evaluation
- Perform structural tests
- Load test an existing bridge to determine load distribution of a non-composite deck on a bridge without shear keys
SPECIMEN ACQUISITION

- Determine those bridges that will be replaced
- Inspect bridges to determine specimen quality
- Contact County, Engineer, or Contractor to coordinate girder salvage

COMMON DETERIORATION

- Longitudinal Cracking
- Exposed or Broken Strand
BOX BEAM SPECIMENS
Wells Co. Bridge 79

BOX BEAM SPECIMENS
Newton Co. Bridge K5
BOX BEAM SPECIMENS
Elkhart Co. Bridge 102

NONDESTRUCTIVE TESTING
NON-DESTRUCTIVE EVALUATION (NDE)

Ground Penetrating Radar (GPR)
Connectionless Electrical Pulse Response Analysis (CEPRA)
Half-cell potential measurement

PRELIMINARY NDE RESULTS

Specimen 409-1-ES
Span: 50’
Depth: 29”
Width: 36”
PRELIMINARY NDE RESULTS

Longitudinal Location (ft)

Transverse Location (in.)

Low  Moderate  High

0 5 10 15 20 25 30 35 40 45 50

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STRUCTURAL TESTING

BEAM TEST

Load Points

Roller Bearing (TYP)

Reaction Block (TYP)

String Potentiometers (two at midspan)
**BEAM TEST**

Specimen 409-1-ES
- Three exposed strands at L/8 from support

Specimen 409-2-UD
- No damage

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**BEAM TEST**

![Graph showing midspan deflection vs. applied force for different capacities: 42 kip - Undamaged Capacity, 52 kip - Test, 34 kip - Damaged Capacity, 47 kip - Theory.](graph.png)
**BEAM TEST**

- **Applied Force (kip)** vs. **Midspan Deflection (in.)**
- **42 kip - Undamaged Capacity**
- **50 kip - Test**
- **47 kip - Theory**

**BEAM TEST**

- **52 kip - Test**
- **50 kip - Test**
- **47 kip - Theory**
FIELD TESTING

TIPPECANOE COUNTY BRIDGE 115

• Built: 1957
• Rehabilitated: 1993
• Span: 40 ft
• Beam Depth: 21 in.
• Beam Width: 45 in.
• 7 Beams

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INTRODUCTION

INSTRUMENTATION

LOADING

Dump Truck
- Weight: ~ 58,000 lb
- 30% to front axle
- 70% to tandem axle
- Wheelbase: 16’ – 4”
FIELD TESTING

Bridge Deck Modifications

- Milling
- Shear Key Cutting
- Surface Preparation
- Bridge Deck Cast
East  West

0 10' 10' 10' 10'

1 2 3 4 5 6 7

Midspan Deflection (in.)

Beam Number

LT1 - Original Condition
LT2 - Asphalt Removed
LT3 - Shear Keys Disabled
LT4 - Concrete Deck Placed

Midspan Deflection (in.)

Beam Number

Concrete Deck Placed
35% reduction in deflection
LOAD DISTRIBUTION

- The proportion of load carried by a given beam was calculated as follows

\[ DF_i = \frac{\Delta_{\text{midspan}_i}}{\sum \Delta_{\text{midspan}_i}} \]
LOAD DISTRIBUTION SUMMARY

Experimental Distribution Factors

<table>
<thead>
<tr>
<th>Load Test</th>
<th>Interior</th>
<th>Exterior</th>
</tr>
</thead>
<tbody>
<tr>
<td>LT01</td>
<td>22%</td>
<td>23%</td>
</tr>
<tr>
<td>LT04</td>
<td>22%</td>
<td>25%</td>
</tr>
</tbody>
</table>

Design Distribution Factors

AASHTO Standard Specification 2002

- **Load Fraction (truck)**
  - 32%

AASHTO LRFD 2017

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FIELD TEST CONCLUSIONS

- Concrete deck restored load distribution to a code level
- Durability and stiffness were added to the system
- Composite action between the deck and the beams was achieved

IMPLICATIONS TO BEST PRACTICE

- Recommend all new construction use concrete decks
- Potential new design of adjacent box beam bridges without shear keys

Concrete Deck Sealant

Standard Box Beam Shape
PROJECT BENEFITS

- Improved inspection capability for bridge inspectors
- Increase in bridge load rating accuracy
- Development of next generation box beams

ACKNOWLEDGMENTS
THANK YOU