Performance History and Lessons Learned

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Durability of ABC

Lessons Learned
• Utah DOT has an on-going study of the performance of ABC technologies
  • Investigate the performance of each element type and technology type
  • What is performing well and what is not
  • Goal: Continuous Improvement of Quality
Lessons Learned

Objectives:

- Document the performance of past ABC details
  - Details that are proving to be durable
  - Details that have substandard performance
- Estimate the remaining life-span of the details studied
- Estimate future maintenance needs for each bridge
- Determine if modifications to current ABC working standards are required
- Determine if programmatic changes to UDOT procedures are required
Lessons Learned

Bridge Types Studied

• Full Depth Deck Panels with welded tie connections (7)
• Full Depth Deck Panels with longitudinal Post-Tensioning (11)
• Full Depth Deck Panels with dowel bars in slot pockets (1)
• Full Depth Deck Panels with UHPC Connections (1)
• SPMT Bridge Systems (12)
• Lateral and Longitudinal Slide Systems (9)
• Precast Approach Slabs (6)
• Precast Abutments (3)
• Precast Piers (3)
• GRS/IBS (1)

Inspections took place:

• Five inspections have been completed between 2009 and 2016
Welded Tie Connections

Precast Full Depth Deck Panels
- Joint Leakage is widespread
- Shear transfer is still working

Bridge Built in 2008

Details courtesy of UDOT
Welded Tie Connections

Photo courtesy of UDOT
Bridge Built in 2008
Welded Tie Connections

Photo courtesy of UDOT
Bridge Built in 2008
Reflective cracking through thin overlay

Photo courtesy of UDOT Bridge Built in 2009
Welded Tie Connections

**Lessons Learned**

**Cause of Problems**

- Ties cannot transfer significant bending moment leading to cracking

**Estimated Life-span**

- 15 years

**Recommendation:**

- Discontinue use of this detail
  - Perhaps only use on low volume roads
  - This detail is no longer used (since 2005)
Post-tensioned Deck Panels

Post Tensioned Connections
- Example Bridge: 3 span continuous bridge

Photos courtesy of UDOT

I-215 at 3900 South Bridge Built in 2006
Post-tensioned Deck Panels

Post Tensioned Connections

- No Joint Leakage
- Even in negative moment areas

Bridge Built in 2003

Underside of deck
Post-tensioned Deck Panels

Photo courtesy of UDOT
Bridge Built in 2009
Post-tensioned Deck Panels

Photo courtesy of UDOT
Bridge Built in 2009
Post-tensioned Deck Panels

**Lessons Learned**

*Cause of Problems*
- No problems noted

*Estimated Life-span*
- 75 years

**Recommendation:**
- Continue use of post-tensioning for full depth deck panel connections
- Excellent performance from these connections
Dowel Bars in Pockets

Precast full-depth deck panel connections with dowel bars

Details courtesy of UDOT
Dowel Bars in Pockets

Area near piers after 3 years

Note: Costs were high for this detail

Bridge Built in 2010

Photo courtesy of UDOT
Lessons Learned
Cause of Problems
• Connection has problems in negative moments regions
Estimated Life-span
• 25 years
Recommendation:
• Discontinue use in negative moment regions
• Note: Recommendation is based on only one bridge
UHPC and RC Connections

Precast full-depth deck panel connections with UHPC Connections

Route 6 over UPRR

Bridge Built in 2016

Photo courtesy of UDOT
Precast full-depth deck panel connections with RC Connections
UHPC Connections

Photo courtesy of UDOT
Bridge Built in 2016
RC Connections

Photo courtesy of UDOT
Bridge Built in 2003
Lessons Learned

Cause of Problems
- No problems noted in performance

Estimated Life-span
- 75 years

Recommendation:
- Continue use of UHPC and RC connections for full depth deck panel connections
Integral Parapets

Precast full-depth deck panel connections with parapets

Route 6 over Wildlife Crossing

Photo courtesy of UDOT
Integral Parapets

Bridge Built in 2008
Some fit-up problems

Bridge Built in 2009
Others are very good

Photos courtesy of UDOT
Integral Parapets

**Lessons Learned**

Cause of Problems
- Build-up of fabrication tolerances

Estimated Life-span
- 75 years

Recommendation:
- Exercise special care during fabrication
  - Use special forming jigs
- Consider matching up adjacent panels when casting parapets
- Incorporate longitudinal closure pour to provide lateral adjustability
Shear Connector Pockets Composite Action

Lessons Learned

Cause of Problems

- No significant problems noted on any bridges
- Minor shrinkage gaps in grout noted during construction visit

Estimated Life-span

- 75 years

Recommendation:

- Continue use on all full-depth deck panel bridges

Photo courtesy of UDOT Bridge Built in 2008
Precast Abutments

Precast Cantilever Abutments
• Only a few have been built
  • Horizontal joints (Lego bridges)
  • Vertical threadbars
    • There were significant fit-up problems on one bridge
    • Next bridge was match cast
    • Can be resolved with appropriate casting tolerances
Precast Abutments

Precast Integral Abutments

- Only a few have been built
- Very minor leakage through joints
- Very good performance

Details courtesy of UDOT

Bridge Built in 2009

Photo courtesy of UDOT
Lessons Learned
Cause of Problems
• No significant problems noted on any bridges
• Minor leakage in one integral abutment joint
Estimated Life-span
• 75 years
Recommendation:
• Continue use
• Consider using vertical panels
  • Can accommodate larger tolerances
Precast Piers

Riverdale Road over I-84

Photo courtesy of UDOT
Precast Piers

Bridges Built in 2008

Parish Lane

Photos courtesy of UDOT
Lessons Learned
Cause of Problems
  • No problems noted
Estimated Life-span
  • 75 years
Recommendation:
  • Continue use
SPMT Bridge Moves

- Numerous Bridges have been moved
  - Steel Bridges
  - Prestressed Concrete Bridges
  - Single Spans
  - Continuous Spans

Photos courtesy of UDOT
SPMT Bridge Moves

• Numerous Bridges Moved
• Transverse Deck cracking was found
• Strain gage study was undertaken
• Diagonal cracking on corner bays
  • Caused by SPMT?

Photos courtesy of UDOT
SPMT Bridge Moves

Side-by-side comparison

• Cracking is due to other factors, not SPMTs
  • Shrinkage?
  • Thermal effects?

Traditional Bridge

SPMT Bridge

Photo courtesy of UDOT
Side-by-side comparison

- Cracking is due to other factors, not SPMTs
  - Shrinkage?
  - Thermal effects?
SPMT Bridge Moves

One option
• Support at lift points during casting (dog house)
• Drive SPMT Under dog house
• Lift and move
• Results in near zero lifting stresses in the superstructure
• No deck cracking

Another option
• Use lightweight concrete in deck
• Reduces bending stresses in deck
SPMT Bridge Moves

**Lessons Learned**

**Cause of Problems**

- Transverse cracking caused primarily by shrinkage during curing
- Diagonal cracking in corners may be due to thermal effects
- Some cracking caused by negative lifting moments (large cantilevers)

**Estimated Life-span**

- 75 years (with proper deck sealing)

**Recommendation:**

- Continue use
- Limit cantilevers to less than 0.15L
- Control deck stresses
- Design longitudinal reinforcing (similar to continuous girder design)
- Consider supporting at lift points during casting
- Consider lightweight concrete
Lateral Slide Bridge Moves

- Numerous Bridges have been moved
  - Steel Bridges
  - Prestressed Concrete Bridges
  - Slide approach slabs with bridge (faster and less problems)
Lateral Slide Bridge Moves

Bridge Built in 2009

Bridge Built in 2010

Photos courtesy of UDOT
Lateral Slide Bridge Moves

**Lessons Learned**

*Cause of Problems*
- No problems noted

*Estimated Life-span*
- 75 years

*Recommendation:*
- Continue use
- Should be first choice for bridge moves for bridges over low volume roads
CIP Concrete Closure Pours

• Some have shrinkage cracks
• Restraint of adjacent panels
• Some minor leakage through cracks
Lessons Learned

Cause of Problems
- Transverse cracking caused primarily by shrinkage combined with restraint of adjacent concrete

Estimated Life-span
- 75 years (with proper deck sealing)

Recommendation:
- Investigate use of low-shrinkage concrete mixes
Other technologies

GRS/IBS
• Performing well after 2 years (Interstate bridge)

Precast approach slabs
• Fit-up and seating has been problematic
• Consider grouting under slabs for proper seating
• Move slab with bridge on lateral slide projects
Lessons Learned

Recommendations

• Full Depth Deck Panels
  • Do not use welded tie details
  • Consider avoiding dowel bar connections in negative moment regions
• Use Post-Tensioning or Reinforced Concrete (Lapped Bar) Connections
• Use Female – Female Shear Keys with grout
• Consider low shrinkage concrete for closure joints
Lessons Learned

Recommendations

• Precast Abutments and Piers
  • Consider vertical joints in abutment stems and wall stems
    • Easier fit-up in the field
  • No problems noted with pier construction
Lessons Learned

SPMT Moves

• Monitoring Data study verifies issues found in the field
  • Pick bridges closer to ends (less than 0.15L)
  • Consider supporting girders at lift points during deck casting
  • Investigate the use of lightweight concrete to reduce deck and girder stresses
Lessons Learned

Lateral Slides

• No issues with this technology
• Lifting stresses are practically zero
• Large bridges can be moved
• Consider moving approach slabs with superstructure
Questions?