Joint Elimination as a Preservation Technique

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Why Joint Elimination?

1. Degradation due to water penetration.
2. Fixed is not really fixed!
   • Cantilever substructures are flexible
3. Theoretical expansion is based on ambient air temperatures vs. beam temperature.
4. Bridges respond better to seismic forces if continuous.
5. Overall life cycle cost savings
Longest Jointless Bridges in the US

Longest Composite Jointless Steel Bridge in the U.S. – Bradley Ferry Road over Obion River, Dyer County, Tennessee.

538 feet
Longest Jointless **Concrete** Bridge (Bulb T’s) in the U.S. – State Route 50 over Happy Hollow Creek, Hickman County, Tennessee.

1,975 feet
Longest Jointless Bridges in the US

Longest Continuous Bridge (PS Concrete) between Joints Bridge in the U.S. – I-26 over South Fork Holston River, Tennessee.

2,550 feet
Why such high degrees of variability across the country?

• Comfort level with eliminating joints.
• Lack of simplified design procedures.
• AASHTO LRFD Bridge Design specification states the following:

14.5.2.1—Number of Joints
The number of movable deck joints in a structure should be minimized. Preference shall be given to continuous deck systems and superstructures and, where appropriate, integral bridges.
• Loveall (1985) and Wasserman (1987)
• Oesterle et al. (1989)
• Russell and Gerken (1994)
• Almapalli and Yannotti (1998)
• Thippeswamy et al. (2002)
• Caner et al. (2002)
“Expansion Joint Elimination for Steel Highway Bridges”

George Tsiatas
William G. Boardman
5 Methods of Connection

**Moment Splice**
- Increases live load capacity the most
- Low top mat reinforcing stresses for equal spans, however, stresses for unequal spans may be higher
- Low potential for cracking
- Most costly and most difficult to construct

**Deck, Top and Bottom Flange**
- Significant increase in live load capacity
- Low top mat reinforcing stresses
- Low potential for cracking
- Costly and difficult to construct

**Deck and Bottom Flange**
- Little increase in live load capacity
- High top mat reinforcing stresses
- High potential for cracking
- Costs more and is more difficult to construct than Deck Only scheme

**Deck Only**
- No increase in live load capacity
- Slight increase in top mat reinforcing stresses
- Highest potential for cracking
- Lowest cost and easiest to construct
Joint elimination has been done since the 1960.
Several states are routinely eliminating joints as part of their bridge preservation programs.
It is critical that compression members be analyzed in negative moment regions.
Aligned beams should be field measured prior to fabricating splice plates.
“Partial Continuity in Bridge Girders with Jointless Decks”
Ayman Okeil, P.E.
Adel ElSafty, P.E.

- Calculating the tensile stresses in Link Slabs.
- At expansion bearings, the continuity moment is 9-22% of a fully continuous system.
- Cracking check from AASHTO.
SCOPE OF WORK

1. Remove existing deck, backwalls and bearings.
2. Construct new pedestals.
3. Paint beam ends.
4. Retrofit Bridge for New Loading Configuration
   • Add cover plates and compression blocks to bottom flanges in negative moment regions.
5. Place new deck, diaphragms and bearings.
Plan & Elevation

PROPOSED DECK & PARAPET PLAN

PROPOSED ELEVATION

BEGIN PROPOSED DECK, PARAPETS & BEAM END ENCASEMENT  STA. 91+20.42

LIMIOTS OF CLASS 3 EXCAVATION  STA. 91+13

BEGIN PROPOSED DECK, PARAPETS & BEAM END ENCASEMENT  STA. 93+19.58

END PROPOSED DECK, PARAPETS & BEAM END ENCASEMENT  STA. 93+19.58

F.G.ELEV. 1071.36

END PROPOSED DECK, PARAPETS & BEAM END ENCASEMENT  STA. 93+19.58

F.G.ELEV. 1073.51

S.R. 2005

STRA. AHEAD

STRA. 92+07.50

END SUPERELEVATION RUNOUT
P.G.ELEV. 1071.39

BEGIN SUPERELEVATION RUNOUT
P.T. STA. 91+35.57
ELEV. 1071.46

42'-6" SCUPPER TO PIER (TYP.)

PIER 1

STRUCTURE
STA. 92+50

PIER 2

CURB TO CURB

PIER 1

FRENCH DECK

NOTE: FIXITY IN () INDICATES THE EXISTING CONDITION.
SEE EXISTING PLANS, (S-8022B).
Typical Abutment Encasement Section

- SAW CUT AND FILL WITH AN APPROVED SEALER, ITEM NO. 0515-0001
- BITUMINOUS PAVEMENT, 2'-8"
- WATERPROOF MEMBRANE, 3" CLR.
- 1" MIN. THICK STYROFOAM, 0" CLR. (TYP.)
- 6" STRUCTURE FOUNDATION DRAIN
- NO. 57 COARSE AGGREGATE, 2' X 2' CONTINUOUS ENCASED IN GEOTEXTILE, CLASS 1, SEE PUB. 408, SECTION 1001.3 (d).

- ES501: 7" TOP, ES501: 8" BOTTOM
- EA501: 0" CLR.
- EA504: 4" TO 6 HOLES
- EA501: 2½" CLR.
- 2½" CLR.
- 2½" CLR.
- FRONT FACE PROPOSED ENCASEMENT
- PROPOSED PEDESTAL

- 1'-10½"
- 3'-7"

- **2" HOLES IN 36WF-1194 FOR EA601 BARS, 8 HOLES REQUIRED IN EACH BEAM (TYP.).
- BOTTOM OF BEAM ELEVATION IS THE SAME FOR PROPOSED AND EXISTING CONDITIONS. ADJUST PEDESTAL DEPTH ACCORDINGLY.
- SOLE R+, SEE BEARING DETAILS SHEET.
Typical Pier Encasement Section

- ES601 @ 7" TOP
- ES501 @ 8" BOTTOM
- DECK 8" MIN.
- 0" CLR. (TYP.)
- 2 1/2" CLR. (TYP.)
- EP801 OR EP803 4" @ 12" MAX.
- EP501
- EP502
- EP603 (TYP.)
- 2" CLR.
- 0" CLR.
- 1" CLR.
- EP604 (TYP.)
- 5" (TYP.)
- 4" 8-EP801 OR EP803 (4"
- @ 12" MAX.
- ⚠️ SEE PROPOSED DECK REINFORCEMENT
- ⚠️ ALTERNATE EP502 @ 12" & TIE TO
- ⚠️ PROPOSED COVER PLATE,
- SEE SHEET 15 FOR DETAILS.

*** 2"Ø HOLE IN 36WF1194
FOR EP801 OR EP803 BARS
16 HOLES REQUIRED
IN EACH BEAM (TYP.)
New Bottom Cover Plate
Compression Block

Beams marked for rebar holes
Painting
Diaphragm Steel
Deck Steel
Finished Product – End Bend 1
Finished Product – Bent 2
Cost

$1,119,000
Example 2: Continuous Three Span Steel Beam Bridge over RR. Both Exp. Joints Eliminated
Constructed 1954
SCOPE OF WORK

1. Remove existing AWS, repair concrete deck
2. Removal of the existing expansion joint and end of the deck and parapets (~7ft)
3. Removal of the backwall, rocker bearings, existing sole plates and steel diaphragms
4. Blast clean and paint beam ends
5. Construct new concrete pedestals
6. Place new elastomeric bearing pads
7. Encase beam ends in concrete
Plan & Elevation

--Concrete Bridge Deck Repair, Type 2 Modified-
  (Approx. 1200 SF at various locations on the deck)
  See Details Sheet 10.

**NEW CONCRETE PARAPET**
  See Details Sheet 10.

**ABUTMENT 1**
  Limits of Deck Removal
  Sta. 655+58.13

**EXISTING GAS UTILITY LINE TO BE REDIRECTED BY**
  NATIONAL FUEL GAS, ALL RELOCATION WORK TO BE
  COORDINATED WITH THE CONTRACTOR.

**ITEM NO. 3000-0600**
  Plug existing drain
  Existing drain to be plugged & overlaid.

**ABUTMENT 2**
  Limits of Deck Removal
  Sta. 657+06.36

**GENERAL PLAN**

**ELEVATION**

20-4-8-12 FEET
Deck Repair
Before Concrete Encasement
New Concrete Pedestals
Beam Ends Painted – New Elastomeric Bearings
Reinforcing for Concrete Encasement
Concrete Encasement
Concrete Encasement – Side View
Concrete Encasement – Elevation View
Cost

$730,000
Other Projects
Parapet Joint Closing
Parapet Joint Closing
231FT – 4 SPAN - INTERSTATE OVERPASS WITH NO JOINT

For longer spans, can use expansion joints at the end of integral approach slabs.
Tied Deck, Encased Diaphragms
Tied Deck, Encased Diaphragms
2-Span Steel Stringer Bridge – Previously Non-Composite Simple Spans made Composite and Continuous for LL by Tying Deck and filling Diaphragms – Rehabbed 2000
2009 - Nine years after construction, No Leaks or Cracks
Conclusions

• Typical overpasses are candidates for Joint Elimination.
• Joint Elimination is an accepted preservation practice on bridges up to 300ft.
• There is a growing body of quantitative data to assist the engineer in deciding where to eliminate joints.