NEW APPROACH SLAB DESIGN AND SPECIAL DETAILS

PAUL VAUGHT III, P.E.  MARCH 1, 2016
POINTS OF DISCUSSION

- PREVIOUS APPROACH SLAB DETAILS
  - WHY THEY ARE OBSOLETE

- IMPROVEMENTS TO THE PREVIOUS DESIGN
  - LTRC PROJECT RESEARCH

- NEW APPROACH SLAB SPECIAL DETAILS
  - APPLICABILITY
  - NEW AND REVISED SHEETS
  - EXAMPLE SET OF PLANS

- DESIGN OF NON-STANDARD APPROACH SLABS

- REVISIONS TO RELATED STANDARDS AND SPECIAL DETAILS
  - SLAB SPAN STANDARDS
  - CP-01 – CONCRETE PAVEMENT DETAILS
PREVIOUS APPROACH SLAB DETAILS

LADOTD BRIDGE DESIGN MANUAL (ENGLISH 4TH ED.):
PREVIOUS APPROACH SLAB DETAILS

SLAB SPAN STANDARDS:
PREVIOUS APPROACH SLAB DESIGN

- TOO THIN AND FLEXIBLE UNDER CURRENT LIVE LOADS (LADV-11)
- STRUCTURAL THICKNESS = 1’-0”
- REINFORCEMENT:
  - #4 BARS @ 1’-0” SPACES (TOP)
  - #6 BARS @ 6” SPACES (BOTTOM)
TYPICAL APPROACH SLAB FAILURE

\[ \delta = \text{DIFFERENTIAL SETTLEMENT BETWEEN ROADWAY EMBANKMENT AND BRIDGE END BENT} \]

\[ \Delta_1 = \text{SETTLEMENT DUE TO ADDITIONAL LOADING TAKEN BY THE ROADWAY END OF THE APPROACH SLAB DUE TO LOSS OF CONTACT WITH EMBANKMENT SOIL} \]

\[ \Delta_2 = \text{SLAB DEFLECTION DUE TO LOADING} \]
NEW APPROACH SLAB DESIGN

- LTRC PROJECT NO. [03-4GT] – “DETERMINATION OF INTERACTION BETWEEN BRIDGE CONCRETE APPROACH SLAB AND EMBANKMENT SETTLEMENT”
- USED 3D FINITE ELEMENT ANALYSIS TO CONSIDER THE INTERACTION BETWEEN APPROACH SLAB AND EMBANKMENT SOIL, INCLUDING SEPARATION BETWEEN THE SLAB AND SOIL
- IN-HOUSE MODELS WERE BUILT USING HL-93 TO VERIFY RESULTS OF THIS PROJECT
NEW APPROACH SLAB DESIGN

- APPLY LADV-11 LOADS TO 3D FINITE ELEMENT MODELS (STAAD AND LUSAS)
- ASSUMED WORST-CASE CONDITION — LOSS OF ALL CONTACT WITH EMBANKMENT SOIL
NEW APPROACH SLAB DESIGN

- PARTIAL LOSS OF CONTACT WITH EMBANKMENT WAS ALSO CONSIDERED
- THE DIFFERENCE IN REQUIRED REINFORCEMENT BETWEEN CASES WAS MINIMAL
- FULL LOSS OF CONTACT WITH SOIL (SIMPLY-SUPPORTED SLAB) WAS SELECTED AS THE DESIGN CONDITION
NEW APPROACH SLAB DESIGN

- LTRC PROJECT NO. [05-1GT] – “FIELD DEMONSTRATION OF NEW BRIDGE APPROACH SLAB DESIGNS AND PERFORMANCE”

- OBJECTIVE: PERFORM FIELD TESTS ON CONCRETE APPROACH SLABS TO VALIDATE THE FINDINGS AND DESIGN RECOMMENDATIONS DEVELOPED IN PREVIOUS RESEARCH PROJECTS

1. INCREASING SLAB THICKNESS AND REINFORCEMENT WILL ALLOW FOR SOME EMBANKMENT SETTLEMENT WITHOUT A DECREASE IN RIDE QUALITY

2. ADDING A SLEEPER SLAB AND GEOSYNTHETIC SOIL REINFORCEMENT UNDER THE ROADWAY END OF THE APPROACH SLAB WILL HELP MITIGATE ADDITIONAL SETTLEMENT

- PROJECT SITE - BAYOU COURTABLEAU BRIDGE (H.002706) ON LA 103 IN ST. LANDRY PARISH
NEW APPROACH SLAB DESIGN

LTRC PROJECT 05-1GT AT BAYOU COURTABLEAU

Broken down:
- **APPROACH SLAB WAS THICKENED TO REDUCE LIVE-LOAD DEFLECTIONS DUE TO HEAVIER VEHICLES**

- **A SLEEPER SLAB AND GEOSYNTHETIC SOIL REINFORCEMENT WERE ADDED AT THE ROADWAY END OF THE APPROACH SLAB TO DISTRIBUTE THE LOAD INTO A LARGER AREA OF THE EMBANKMENT, REDUCING SETTLEMENT OF THE SLAB**

- **STRAIN GAUGES AND PRESSURE CELLS WERE INSTALLED AND USED TO MEASURE:**
  - DEFORMATION AND INTERNAL STRESSES IN THE SLAB
  - CONTACT STRESSES BETWEEN THE SLAB AND EMBANKMENT SOIL
  - STRESS DISTRIBUTIONS WITHIN THE REINFORCED SOIL REGION
  - STRAIN DISTRIBUTIONS ALONG THE GEOSYNTHETIC SOIL REINFORCEMENT
NEW APPROACH SLAB DESIGN

- SLEEPER SLAB, GEOSYNTHETIC SOIL REINFORCEMENT, STRAIN GAUGES AND PRESSURE CELLS AT BAYOU COURTABLEAU
NEW APPROACH SLAB DESIGN

- RESULTS AT BAYOU COURTABLEAU BRIDGE:
  - EAST APPROACH SLAB – USED THE PREVIOUS STANDARD DESIGN
  - WEST APPROACH SLAB - PROPOSED NEW METHOD (THICKER SLAB, SLEEPER SLAB, GEOSYNTHETIC SOIL REINFORCEMENT)

- STATIC LOAD TESTS AND I.R.I. (INTERNATIONAL ROUGHNESS INDEX) MEASUREMENTS WERE TAKEN

- I.R.I. RESULTS:
  - EAST APPROACH SLAB I.R.I. INCREASED: 360 in./mi. TO 540 in./mi. (EASTBOUND)
    530 in./mi. TO 700 in./mi. (WESTBOUND)
  - WEST APPROACH SLAB I.R.I. REMAINED ALMOST CONSTANT AROUND 300 in./mi.
    OVER THE 34 MONTH TEST PERIOD.

- NEW DESIGN METHODOLOGY SHOWED A CLEAR IMPROVEMENT OVER THE PREVIOUS STANDARD DESIGN
NEW APPROACH SLAB DETAILS

- A THICKER SLAB AND MORE REINFORCEMENT ARE REQUIRED TO ACCOUNT FOR LADV-11 LOADING
  - 1’-6” THICK SLAB
  - LONGITUDINAL STEEL - #8 BARS @ 6” SPS. (TOP)
    #10 BARS @ 6” SPS. (BOTTOM)
  - TRANSVERSE STEEL - #8 BARS @ 6” SPS. (TOP AND BOT.)

- A SHALLOW “EDGE BEAM” WAS ADDED TO LIMIT LIVE LOAD DEFLECTIONS
NEW APPROACH SLAB DETAILS

- SLEEPER SLAB AND SOIL REINFORCEMENT:

- TROWEL BEARING SURFACE
- 501 (TYP.)
- 502 @ 9" SPS. (TOP & BOT.)
- POLYETHYLENE SHEETING
- BEDDING MATERIAL
- 6" Ø PERFORATED PIPE (SEE DRAINAGE DETAILS)

GEOTEXTILE FABRIC
CLASS "C" OR "D"
AT FULL WIDTH OF EMBANKMENT
SEE TABLE BELOW FOR NO. OF REQUIRED LAYERS

GEOTEXTILE FABRIC

12'-6"

18'
2'-6' 2'-6' 6'

5'-0"

3'
6 EQ. SPS. = 4'-6"
501 (TOP & BOT.)

FILL DEPTH (TO NATURAL GROUND)
CONCRETE PAVEMENT GROWTH
NEW APPROACH SLAB DETAILS

- **4” PAVEMENT RELIEF JOINT:**
  - Preventative measure against concrete pavement growth pushing the approach slab into the bridge. This can close the bridge joint, and damage the end bent backwall.

[Diagram of a pavement relief joint]
NEW APPROACH SLAB DETAILS

- **6” SACRIFICIAL SECTION:**
  - **IF** PAVEMENT GROWTH CLOSES THE BRIDGE JOINT, A PORTION OF THIS CANTILEVERED SECTION CAN BE REMOVED IN ORDER TO RE-ESTABLISH THE JOINT

- **PROJECTS USING THIS DETAIL:**
  - H.001120 – HARRISONBURG
  - H.008345 – BAYOU ALEXANDRE
  - H.000397 – RR OVERPASS NEAR BENTON
  - H.000101 - GREENWOOD
## APPROACH SLAB PLAN SET – COMMON DETAILS

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<th>BRIDGE STANDARD INDEX NO.</th>
<th>SERIES</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>BD.2.10.1.0.01</td>
<td>1 OF 6</td>
<td>APP. SLAB COMMON - GENERAL NOTES AND INDEX</td>
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<td>BD.2.10.1.0.02</td>
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<td>APP. SLAB COMMON - PLANS AND SECTIONS - (SLAB SPAN &amp; QUAD BEAM BRIDGES)</td>
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<td>APP. SLAB COMMON - BRIDGE END DRAIN (OPEN)</td>
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## APPROACH SLAB PLAN SET – SPECIFIC RDWY WIDTH DETAILS

When complete, the set will include the following “slab length/clear width” combinations:

- 40’ Long / 32’ Wide
- 40’ Long / 36’ Wide
- 40’ Long / 40’ Wide
- 40’ Long / 44’ Wide
- 20’ Long / 24’ Wide
- 20’ Long / 28’ Wide
- 20’ Long / 32’ Wide
- 20’ Long / 36’ Wide
- 20’ Long / 40’ Wide
- 20’ Long / 44’ Wide

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<tr>
<th>SPECIFIC DETAILS</th>
<th>40’ CLEAR RDWY / 40’ LONG - DETAILS (SLAB SPAN &amp; QUAD BEAM BRIDGES)</th>
<th>40’ CLEAR RDWY / 40’ LONG - QUANTITIES (SLAB SPAN &amp; QUAD BEAM BRIDGES)</th>
<th>40’ CLEAR RDWY / 40’ LONG - DETAILS (GIRDER SPAN BRIDGES)</th>
<th>40’ CLEAR RDWY / 40’ LONG - QUANTITIES (GIRDER SPAN BRIDGES)</th>
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<td>40’ CLEAR RDWY / 40’ LONG - QUANTITIES (SLAB SPAN &amp; QUAD BEAM BRIDGES)</td>
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### Approach Slab Special Details Index

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### Approach Slab General Notes

1. Design Specifications: ASHATO LEAD BRIDGE DESIGN SPECIFICATIONS 7TH EDITION. DESIGN LIVE LOAD = 190kN.
2. Generation of this construction shall be in accordance with the latest edition of the Louisiana Standard Specifications for Roads and Bridges.
3. All concrete is to be the same type as the Standard Concrete used for the Approach Roadway Pavement or Curb.
4. Inches of asphaltic concrete, if required, to be paid for under item "Superpave Asphalitic Concrete" of the Standard Specifications for Roads and Bridges. All other materials and work associated with the Approach Slabs shall be paid for under item "Concrete Approach Slabs" of the Standard Specifications for Roads and Bridges.
5. These Standards are only applicable for approach slabs with uniform width on a straight alignment.
6. Not every sheet listed in the Index is applicable for every project. The engineer shall select the applicable sheets per project, noting that sheets in a series shall be kept together.
COMMON DETAILS “A” – “G” - SLAB SPAN AND QUAD BEAM BRIDGES
PLANS AND SECTIONS – GIRDER SPAN BRIDGES
COMMON DETAILS “H” – “M” – GIRDER SPAN BRIDGES

NOTES:
1. FOR REINFORCEMENT LOCATION AND QUANTITIES, SEE APPROACH SLAB SPECIFIC DETAILS.
2. TOP, MID, AND FIBER BARS IN THE BOTTOM OF THE SLAB ARE FOR A 45° CHARGE.
3. FOR A 60° CHARGE, THESE BARS SHALL BE NO. 6, 8, AND 10.
4. FOR BARS ARE USED IN SKEWED SLAB ONLY.
COMMON DETAILS “N” – “S”
DRAINAGE DETAILS – SLAB SPAN AND QUAD BEAM BRIDGES

- FORMERLY SPECIAL DETAIL “ASD-SS”
DRAINAGE DETAILS – GIRDER SPAN BRIDGES, EXCLUDING QUAD BEAMS

- FORMERLY SPECIAL DETAIL “ASD-SA”
BRIDGE END DRAIN SYSTEM (CLOSED DRAIN)

- “BRIDGE END DRAIN SYSTEM”
- NEW BID ITEM CREATED TO COVER ALL ITEMS DIRECTLY RELATED TO A CLOSED BRIDGE END DRAIN
- FORMERLY SPECIAL DETAIL “BRIDGE END DRAIN DETAIL”
BRIDGE END DRAIN SYSTEM (OPEN DRAIN)

- NEW DETAIL AND BID ITEM
  - NEW BID ITEM CREATED TO COVER ALL ITEMS DIRECTLY RELATED TO AN OPEN BRIDGE END DRAIN
  - TYPICALLY INTENDED FOR RURAL APPLICATIONS
SPECIFIC DETAILS - 40’ CLEAR ROADWAY/40’ LONG SLAB

- Applicable for slab span and quad beam bridges
- One way and two-way cross slopes
- Straight alignments only
- Skews of 0°, 15°, 30° and 45°
SPECIFIC DETAILS - 40’ CLEAR ROADWAY/ 40’ LONG SLAB

- Applicable for other girder span bridges
- One way and two-way cross slopes
- Straight alignments only
- Skews of 0°, 15°, 30° and 45°
**SAMPLE QUANTITIES SHEET**

### Estimated Quantities (One of Skewed Approach Slab)

<table>
<thead>
<tr>
<th>BAR NO.</th>
<th>SHORT BAR VAR.</th>
<th>LONG BAR</th>
<th>TOTAL LENGTH</th>
<th>LOCATION</th>
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<tr>
<td>1001</td>
<td>78</td>
<td>59' 1&quot;</td>
<td>1,067'-0&quot;</td>
<td>505'-30&quot;</td>
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<tr>
<td>1002</td>
<td>1</td>
<td>59' 1&quot;</td>
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<tr>
<td>1003</td>
<td>1</td>
<td>39' 11&quot;</td>
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<tr>
<td>1004</td>
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<tr>
<td>TOTAL N.</td>
<td>8 BARS</td>
<td>973'-5&quot;</td>
<td>14,395 LBS</td>
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**TOTAL DEFORMED REINFORCING STEEL, 4,401 LBS.**

**CONCRETE APPROACH SLAB, 177.76 SQ. YD.**

**Sawcut and Seal, 28 L.F.**

### Estimated Quantities (One 15° Skewed Approach Slab)

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**TOTAL DEFORMED REINFORCING STEEL, 4,401 LBS.**

**CONCRETE APPROACH SLAB, 177.76 SQ. YD.**

**Sawcut and Seal, 28 L.F.**

### Estimated Quantities (One 30° Skewed Approach Slab)

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**TOTAL DEFORMED REINFORCING STEEL, 4,401 LBS.**

**CONCRETE APPROACH SLAB, 177.76 SQ. YD.**

**Sawcut and Seal, 28 L.F.**

### Estimated Quantities (One 45° Skewed Approach Slab)

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**TOTAL DEFORMED REINFORCING STEEL, 4,401 LBS.**

**CONCRETE APPROACH SLAB, 177.76 SQ. YD.**

**Sawcut and Seal, 28 L.F.**
EXAMPLE PROJECT

- **TYPE III GIRDER BRIDGE ON A STRAIGHT ALIGNMENT**
  - 40’ CLEAR ROADWAY
  - FILL EMBANKMENT (REQUIRES A 40’ LONG APPROACH SLAB)
  - CLOSED END DRAIN SYSTEM

- **REQUIRED APPROACH SLAB SHEETS:**
  - BD.2.10.1.0.01 - BD.2.10.1.0.06 (COMMON DETAILS)
  - BD.2.10.1.0.08 (DRAINAGE DETAILS FOR GIRDER SPAN BRIDGES)
  - BD.2.10.1.0.09 (BRIDGE END DRAIN SYSTEM)
  - BD.2.10.2.5.03 – BD.2.10.2.5.04 (PLAN, SECTION & QUANTITIES FOR 40’/40’ APP. SLAB)
DESIGN OF NON-STANDARD APPROACH SLABS

- PROJECTS WITH A 20’ OR 40’ LONG APPROACH SLAB
  A. ON A CURVED ALIGNMENT
  B. WITH A UNIQUE SHAPE (ROADWAY OR DRIVEWAY TURNOUT), AND/OR
  C. WITH A SKEW OTHER THAN 0°, 15°, 30° OR 45°

- FOLLOW THE DESIGN USED IN THE STANDARDS (SLAB THICKNESS AND REINFORCEMENT SIZES)
  - MODIFY THE LAYOUT AND GEOMETRY AS NEEDED
  - COMMON DETAILS SHOULD STILL BE USED FOR NON-STANDARD-SHAPED APPROACH SLABS

- SLABS WITH A SKEW LARGER THAN 45° OR THAT ARE NOT 20’ OR 40’ LONG (AT CENTERLINE) REQUIRE APPROVAL BY DOTD
  - MAY REQUIRE ADDITIONAL DESIGN ANALYSIS (STANDARD REBAR SIZES MAY NOT BE ADEQUATE)
PILE-SUPPORTED APPROACH SLABS

LTRC PROJECT 97-4GT EVALUATED LADOTD’S PILE-SUPPORTED APPROACH SLAB STANDARD.

- RESULTS INDICATED THAT THE STANDARD DESIGN DID NOT ALWAYS PERFORM AS EXPECTED.
- IMPOSSIBLE TO ACCURATELY PREDICT THE SURFACE SETTLEMENT OF A PILE/EMBANKMENT COMPOSITE, WHICH IS NECESSARY TO CREATE A SMOOTH TRANSITION BETWEEN THE ROADWAY AND THE BRIDGE.
- IT IS NO LONGER RECOMMENDED TO USE A PILE-SUPPORTED APPROACH SLAB.
- FOR PROJECT SITES THAT NEED SPECIAL ATTENTION IN CONTROLLING SETTLEMENT, THE DESIGNER SHOULD WORK WITH THE GEOTECHNICAL ENGINEER AND MAY UTILIZE OTHER MEANS TO CONTROL OR MITIGATE THE SETTLEMENT.
REVISIONS TO EXISTING STANDARDS

- **SLAB SPAN SPECIAL DETAILS:**
  - EXISTING APPROACH SLAB SHEETS IN THE SLAB SPAN STANDARDS ARE NOW OBSOLETE
  - SLAB SPAN END BENT DETAILS WILL BE REVISED TO ACCOMMODATE NEW APPROACH SLAB

- ROAD DESIGN STANDARD PLAN **CP-01** *(PORTLAND CEMENT CONCRETE PAVEMENT DETAILS)*
  - TWO NEW 4” PAVEMENT EXPANSION JOINTS WERE ADDED TO THE ROADWAY
  - PREVENTATIVE MEASURE AGAINST DAMAGE TO THE BRIDGE DUE TO PAVEMENT GROWTH
That's all Folks!
Any Questions?