South Dakota DOT
Connecting South Dakota and the Nation

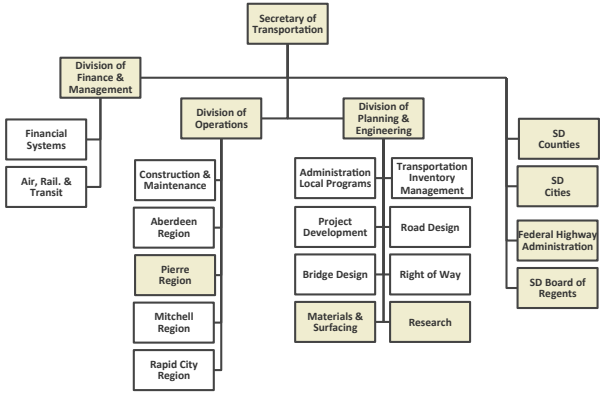
Local Road Research at the South Dakota Department of Transportation

David Huft, Research Program Manager
30th Regional Local Road Conference
October 21, 2015

Presentation Outline

- Local Role in SDDOT Research
- Precast Bridge Double-Tee Girder Details
- Structure Alternatives for Local Roads
- Gravel Surfacing Guidelines

Research Review Board & Office of Research



3

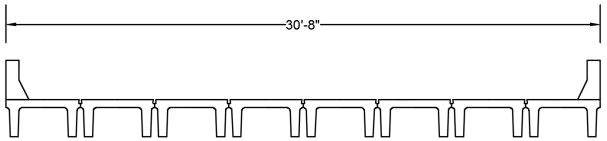
PRECAST BRIDGE DOUBLE-TEE GIRDER DETAILS

Nadim Wehbe, SDSU
Principal Investigator

South Dakota State University
SDSU
MPC
MOUNTAIN-PLAINS CONSORTIUM

Bridge Concept

- "Decked" precast/prestressed bridge girder
- Simply supported
- Rural/low traffic areas
- Reduced construction time and cost



5

Research Motivation

- Design service life 50 – 70 years
- Replacements needed <40 years or earlier
- Inadequate shear transfer
- Spalling & deterioration at longitudinal joint
- Reduced structural capacity

6

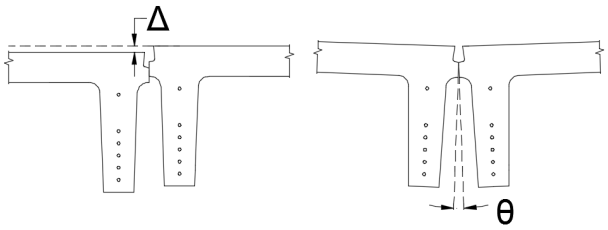
Study Objectives

- Develop "Modified" detail to improve performance of Double Tee bridge
- Examine the structural performance of Conventional and Modified girders under fatigue and monotonic loading

7

Cracking Mechanism

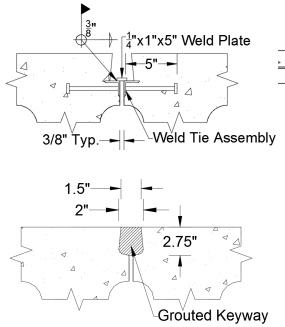
- Two contributions to cracking
  - Relative displacement Δ
  - Rotation θ



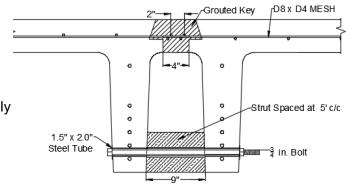
8

Design Details

Conventional

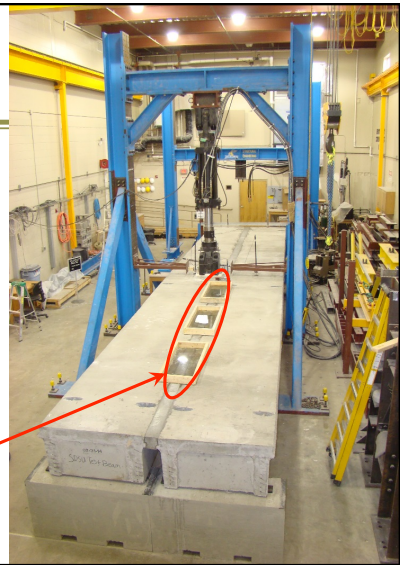


Modified



9

Load Testing at SDSU



10

AASHTO-LRFD (2012) Fatigue Performance Comparison

Conventional

- 21 kip fatigue
  - 80,000 total load cycles (14.6 service years)
  - Seepage at 19,500 cycles (3.6 service years)
  - First failure at 62,000 cycles (11.3 service years)

Modified

- 21 kip fatigue
  - 500,000 load cycles with struts (91 service years)
  - 200,000 load cycles without struts (36.5 service years)
  - No evidence of degradation
- 50% more load at flexural failure
- Stiffness degradation just 4% of Conventional
- Cost 3-4% more than Conventional

11

Implementation

- Adopt Modified Design for new Double-Tee bridges
- Design and evaluate retrofit options for several hundred existing Double-Tee bridges (research underway)
- Examine other alternatives for local road structures

12

STRUCTURE ALTERNATIVES FOR LOCAL ROADS

Allen Jones, SDSU
Principal Investigator

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MOUNTAIN-PLAINS CONSORTIUM

Study Objectives

- Develop catalog of locally available bridge construction techniques and materials
  - Literature review
  - Short span alternatives achievable by local contractors or agencies
  - Cost, equipment and site requirements, relevant experiences
- Develop construction planning and administration process guidance
  - Federal and local regulations
  - Funding mechanisms
  - Low-cost replacement methods when applicable

14

Structure Alternatives Catalog

>20 Alternatives

- Description
- Diagrams (PDF)
- Advantages
- Disadvantages
- Suppliers (for SD)
- Experienced Users
- Installation
- Durability
- Maintenance
- Regulations
- Other Factors
- Cost

UHPC Waffle Bridge Deck Panels

Sheet Pile Abutment

Locally Available Example Grant County, SD

- Prefabricated box beams
- Cast-in-place abutments
- Shallow spread footings
- Single span, 24-40 feet, 35 feet average
- 42 bridges since 1998
- 2-3 per year, 7 most in single year
- Placed by local (county, contractor) forces

16

Hydraulic Considerations

- Grant County identifies older functioning bridges with observed or perceived low scour for replacement
- If hydraulics "questionable" (angle of attack, flow rates, etc.), then an engineering firm reviews site and performs hydraulic analysis
- To date, formal analyses have predicted low scour depths
- Process not used on bridges with major flows

Construction

- Local forces (county and local contractors) build
- Major equipment typically consists of crane to place the deck, excavator for concrete demolition (if required), and commercial pump truck
- Materials(concrete, steel placement, compaction) not tested on site, but Grant County's experienced personnel observe
- Construction typically 13 to 30 working days (30 to 45 calendar days) for major elements

Original Structure Looking North

Original Structure Looking East

Original Structure
Pile Rot, South Backwall

Original Bridge,
Cracked Deck Plank

Original Bridge Demolition

Original Bridge Demolition

Preparation for Abutment

Footings

- 6” of rock placed under spread footings
- Footings 8’ wide, 2’ thick

26

Rock Placement

Footing Reinforcement

Abutment

- Walls typically two feet inboard, 5-11' high
- Reinforcing typically two rows of #4 bars spaced 9 inches longitudinal and 12 inches vertical
- Double reinforcing at stem wall bend to prevent overstressing from flow impact
- Sheet piles installed if flowline intersects the abutment

Concrete Placement with Abutment Reinforcement

Abutment Wall Reinforcement

Abutment Wall Formwork

Concrete Placement

Completed Abutment

Completed Abutment with Riprap

Precast Beams

- Pre-engineered and prefabricated by Cretex (Watertown) according the length of the bridge being replaced
- AASHTO HS-20 load used for design

Precast Girders Placed

Grade Restored, Railing Installed

Performance

- MUTCD used for signage
- Railings open metal – No performance problems to date
- No hydraulic failures
- Bridge replacement programmed for 70-year performance life
- Inspections performed on all bridges >20'

South Dakota State University SDSU MPC MOUNTAIN-PLAINS CONSORTIUM

39

Federal vs Local Funding

Program Differences

- formal hydraulic study
- scour study
- right-of-way issues
- historical studies
- environmental studies
- Army Corps of Engineers permitting

Cost

- Local Funded: $55-60K
- Federally Funded:
  - $240K construction
  - $30K engineering
  - 20% Grant County cost share ($54K)

Essential Considerations

- Alternatives must be appropriate to:
  - Need
  - Conditions
  - Acceptable Risk
  - Available Funding
- Project intent is to encourage—not circumvent—appropriate engineering

GRAVEL SURFACING GUIDELINES FOR SOUTH DAKOTA

David Peshkin
Principal Investigator

South Dakota LTAP

applied pavement TECHNOLOGY

Study Objectives

- >75% of local SD roads unpaved
- Biggest complaints:
  - rough condition, corrugation or washboard
  - too much loose aggregate on the surface
- How critical is gravel quality and how does it affect total cost?
- Objectives
  - Identify and describe current and best practices for design and maintenance
  - Assess the performance of test sections built with materials at, above, and below state specs
  - Develop gravel roads guidelines

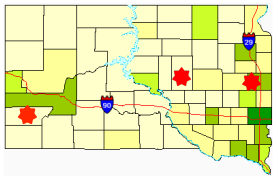
Findings from County Highway Superintendent Surveys

- Most use DOT spec gravel and confirm with tests (gradation, PI, fractured faces)
- About 30% use unprocessed or screened "bank run" materials
- A few use RAP millings or concrete rubble
- Some amend PI content above 5%, many do not
- Maintenance mostly performed according to scheduled cycles; some agencies use distress to trigger
- About half report grading frequencies >11 times/ year, generally once/month
- Most believe high quality materials are cost-effective

SDDOT Gravel Road Test Project

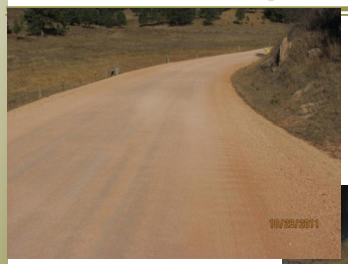
Three gravel types

- Substandard but commonly used: no spec, top size <1”
- SDDOT Gravel Surfacing Spec: % passing #200 sieve low, PI≈4
- Modified SDDOT Spec: >10% passing #200 sieve and PI>7
- Hand County – NE of Miller
- Custer County – NW of Custer
- Brookings County – S of Volga

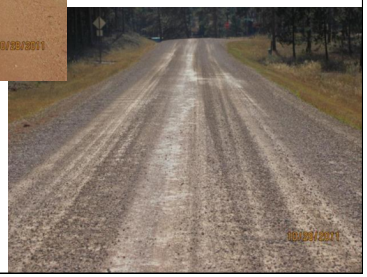


Sections built with 3-4” of new gravel after surfacing prep and shaping, compacted and not

Custer County Test Sections



Differences apparent soon after construction



Road Mixing Clay to Raise PI from 3 to 7 (Brookings County)

Final Finish on Brookings County Modified Specification Section

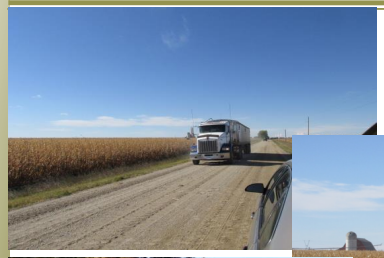
Brookings County Test Sections

One month after construction

Modified Section

Substandard Section

Rural SD Traffic



Loose (Float) Aggregate

Corrugation, Road Width Change

Observations

- Meeting basic SDDOT spec cuts loose aggregate by ⅓ to ½
- Biggest difference in Brookings County, near end of corn harvest with:
  - 405 tons/mile of loose aggregate on substandard section
  - 71 tons/mile on modified section
- Blading up to four times on substandard section to once on modified
- No corrugation or rutting on modified section

Benefits of Local Road Research

- Help local governments in SD
  - 80,000 miles local
  - 8,000 miles state
- Benefits to state system too
- Stay practical
- Public benefit, return on taxpayers' investments

Questions?

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Thank You!!

56