Geosynthetically Confined Soils (FABRIC) and other Technologies

Brian Keierleber P.E.
Regional Local Roads Conference
October 23, 2013
What we are faced with
Many of our bridges are old.
Our System Cannot meet Today’s Demands
We Have NOT kept up with Modern Agriculture
Postings Do Not Work unless I am there.
The sign says 3 ton Gross
WE KNOW WHAT THE RESULTS WILL BE!
10/09/10 & 10/14/10 & 10/10/18/10
Without Enforcement and legislation our problems will grow

- April 4, 2011
- Reports of 2-770 gal manure tanks crossing 22 ton bridge loaded
- April 7, 2011 reports of a semi crossing a 3 ton bridge
DUCT TAPE CANNOT FIX EVERYTHING
We MUST FIND NEW WAYS

ULTIMATE GCS™ DEMONSTRATION
- NO FACING
- 60 DEGREE NEGATIVE BATTER
- BRUTAL SURCHARGE

BUT EVEN WITH THIS DRAMATIC VISUAL OF THE AMAZING STABILITY OF GCS™, MOST WILL TRY TO DEFEND THE OLD MSE PARADIGM
UTILIZE NEW TECHNOLOGIES

BRIDGES AND BOXES on GCS™ Abutments
- 30% Less Cost
- One Day to Construct
- No Bump
- No Expansion Joint
- Longer life

DESIGNED BY BARRETT AND RUCKMAN
ADAPT TO LOCAL CONSTRUCTION METHODS
START AT THE BASE
Start With 2 LAYERS 1 As A CURTAIN WALL
COMPACT 8” LIFTS
NOTE THE PILING WERE VIBRATED IN
COMPLETE ONE SIDE
EXCAVATE FOR CURTAIN WALL
TIE RIPRAP UNDER STRUCTURE
COMPLETE BOTH ABUTMENTS
PLACE CURTAIN WALL PAST ABUTMENT
BUILD WINGS
SET SUPERSTRUCTURE
COMPLETE BRIDGE
EVALUATE the PROCESS

<table>
<thead>
<tr>
<th></th>
<th>6-24-10</th>
<th>7-22-10</th>
<th>9-17-10</th>
<th>12-3-10</th>
<th>3-25-11</th>
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<tr>
<td>NW</td>
<td>105.07</td>
<td>105.06</td>
<td>105.05</td>
<td>105.04</td>
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<tr>
<td>NE</td>
<td>105.02</td>
<td>104.99</td>
<td>104.98</td>
<td>104.97</td>
<td>104.97</td>
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<tr>
<td>SE</td>
<td>105.14</td>
<td>105.13</td>
<td>105.12</td>
<td>105.11</td>
<td>105.10</td>
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<tr>
<td>SW</td>
<td>105.15</td>
<td>105.15</td>
<td>105.15</td>
<td>105.15</td>
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<tr>
<td>Top Pipe North</td>
<td>104.64</td>
<td>104.63</td>
<td>104.63</td>
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<td>104.63</td>
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<tr>
<td>Top Pipe South</td>
<td>103.30</td>
<td>103.30</td>
<td>103.30</td>
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<td>103.30</td>
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<tr>
<td>Top Pipe Mid South</td>
<td>99.02</td>
<td>99.02</td>
<td>99.01</td>
<td>99.02</td>
<td>10.53</td>
</tr>
</tbody>
</table>

Slattery

Hood Bridge
Bench "PP" NE Bridge = 100°
Bench "PP" SE Bridge = 100°

Bench "PP"
LETS LEARN MORE
Various options
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Design for the Location

Flexible Facing –
Wrapped Geosynthetics, Concrete Blocks, Gabions, or Timber, etc.

Flexible wrapped geosynthetic facing
Spread Footing Foundation
Rock Fill for Scour/Erosion Protection
Reinforcement Length
Expansion Joint

Rigid Facing –
Sheet pile walls, Pre-Cast or Cast-In Place Concrete Walls

Tie rod anchors
Abutment cap
Spread footing
Bridge deck
Waler
Sheet pile wall
GRS system
Reinforced concrete deadman
Subdrain system

Hoods Bridge, Buchanan County

Boone Bridge, TR-568, IHRB Project
Iowa State University

- PIEZOMETERS
  - To Monitor water pressure

- INCLINOMETERS
  - To monitor ground movement during excavation, sheet piling, fill compaction, and after bridge loading

- EARTH PRESSURE CELLS
  - To monitor total stresses under the footing and at the ground at different elevations
Installation of Inclinometer
Inclinoimeter about 2 ft away from excavation
LOAD CELLS
LOADCELLS IN THE ABUTMENT
Light Weight Deflectometer (LWD) Tests on each lift to measure Modulus
ON Site Data Logger with Wireless Modem
HIGH SPEED TESTING
My Resources

Federal Highway Administration
Office of Infrastructure, R&D

MICHAEL ADAMS
Research Geotechnical Engineer

Office: (202) 493-3025
Fax: (202) 493-3477
mike.adams@fhwa.dot.gov
http://www.tfhrc.gov/

6300 Georgetown Pike
McLean, VA 22101

TerraTask, LLC
International Geotechnical Consultancy

ROBERT K. BARRETT

(+1) 303 909 2276
Bob@TerraTask.com

270 Wildwood Lane
Parrishburg, VA 24134

549 South Broadway
Grand Junction, CO 81507

564 Island Highway
Campbell River, B.C. V9WZ89
Geosynthetic Reinforced Soil
Integrated Bridge System
Interim Implementation Guide
Acknowledgments

• Iowa Department of Transportation
• Buchanan County Staff
  – Randy Andrews, Phil Fangman, Jeff White, Chuck Kivell, Dick Lehs, Alex Davis, Tom Reidy, Andy Monaghan, Ron Crawford, Rick Wendling, Jerry Slattery, Brian Donnelly, and Ned Johnson
• Iowa State University Staff
•  Pavana Venaposa  Heath Gieselman, David White, Wayne Klaiber
Scott Co. placing the lifts
Clayton County Bridge
8” lifts using block
Clayton County Construction in Progress
Clayton Co. Cherry Valley Rd Bridge completed
Launching was the concept
Plans are through Iowa State and the IDOT
Gerstenbergers Bridge
Not all things work SAFETY rules
Constantly Improve The Methods
Compacted Concrete on GRS
Completed Abutment face on a 1:1
Even Concrete Deteriorates
New Technology through organizations like the Short Span Steel Bridge Alliance

• National Association of County Engineers is a founding member

• Provides counties with Innovative and cost-effective solutions for short span steel bridges.
  • www.ShortSpanSteelBridges.org

• Free web-based design tool available for short span steel bridges
  • eSPAN140 (www.eSPAN140.com)
  • Used to design a steel bridge in Buchanan County, Iowa
New Technologies such as e-span 140 will impact how we do business
Case Study Bridges: Side-by-Side Comparison

**Steel**

Audrain County, MO Bridge 411  
Built 2012  
Steel 4 Girders  
47.5 ft Span, 24 ft Roadway Width  
2 ft Structural Depth  
No Skew

**Concrete**

Audrain County, MO Bridge 336  
Built 2012  
Precast 6 Hollowcore Slab Girders  
50.5 ft Span, 24 ft Roadway Width  
2 ft Structural Depth  
20° Skew
Total Bridge Costs
Material = $41,764
Labor = $24,125
Equipment = $21,521
GuardRail = $7,895
Rock = $8,302
Engineering = $8,246
TOTAL = $111,853

Case Study Bridges: Side-by-Side Comparison

Steel

Concrete

Total Bridge Costs
Material = $67,450
Labor = $26,110
Equipment = $24,966
GuardRail = $6,603
Rock = $7,571
Engineering = $21,335
TOTAL = $154,035
Folded Plate Steel Bridge Concepts

Folded Plate Bridge: Steel Alternative for Short Span Bridges

For more information visit foldedplate.com
Atorod Azizinamini Process

Bending Dimensions

Total Plate Width = 105.6012
Dr. Karl Barth From
West Virginia University.

and Dr. Michael Barker From
The University of Wyoming

**PRESS BRAKE TUB GIRDER**
Initial tests are very promising
Press-Brake Tub Girder

- **Short Span Research Program – Press-Brake Tub Girders**

- **IBRD Grant**
  - **$350,000**
    - Design – West Virginia University (Dr. Karl Barth)
    - Innovation Bridge Research and Development Program (IBRD)
    - Buchanan County, Iowa (Brian Keierleber)
The Bottom Line is the COST

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Alternate FAX 785-472-3729

**Quotation**

**Date:** 5/13/2012  
**To:** Brian Keierleber @ Buchanan County  
**From:** Jeff Weesner

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>DESCRIPTION</th>
<th>UNIT PRICE</th>
<th>AMOUNT</th>
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</thead>
<tbody>
<tr>
<td>4</td>
<td>Bridge Girder-With Hump (1/2&quot;x 108&quot;x 624&quot;) A572 Gr. 50</td>
<td>$10,514.00</td>
<td>$42,056.00</td>
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</table>

**Additional Service:**  
- Freight  
  (Per Legal Truck Load)  
  $1,755.00

- Galvanizing  
  (Per ASTM A123)  
  $2,723.00

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**ALWAYS PROVIDE MY QUOTE # W/ ORDER**

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**PRICE EXCLUDES:**  
- welding  
- welding studs  
- NDT  
- bearing plates  
- stiffeners  
- hardware  
- freight  
- galvanizing

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**PRICE INCLUDES:**  
- Material (A572-Gr. 50)  
- Plasma Cutting  
- Bending

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**Quotation:** J051212-3  
**Bridge Girder-52'**

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**TERMS:**  
Net 30 days

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**Total:** $42,056.00
# Bridging Options

**Cast on site slabs:**

<table>
<thead>
<tr>
<th>Item</th>
<th>2006</th>
<th>2010</th>
<th>2010+10%</th>
<th>2010+10%</th>
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<tbody>
<tr>
<td>23.11 C.Y. of concrete</td>
<td>$267.83</td>
<td>$331.93</td>
<td>$8437.99</td>
<td>$8437.99</td>
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<tr>
<td>8236 lb. steel</td>
<td>$0.70</td>
<td>$0.77</td>
<td>$0.85</td>
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<tr>
<td>Total 4 beams</td>
<td>$47,819</td>
<td>$56,050.48</td>
<td>$61,655.53</td>
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</table>

Red Book (my Mistake 2006) Costs estimates are based on Structural Concrete for box Bridges and reinforcing steel.

Suckow Construction          | $86,564 - $16,771 IBRC reimbursable = $69,793
Oden Enterprises             | $76,618 (includes neoprene pads and barrier rail)

**OTHER EFFORTS**

3-68 ft. railcars at $15,000 = $45,000

4 folded plates $42,056 (needs decking)

16'x8' precast box sections (limited locations) $68,912
ULTRA HIGH PERFORMANCE CONCRETE
UHPC Design Data

• Modulus of elasticity final = 7,500 ksi
• Compressive strength at release = 14.5 ksi
• Compressive strength final = 21.5 ksi
• Tensile strength ~ 1.20 ksi

– We actually broke cylinders at 32 ksi.
## Initial Cost

<table>
<thead>
<tr>
<th>Coating System</th>
<th>Initial Cost</th>
<th>Total</th>
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<tbody>
<tr>
<td>Inorganic Zinc</td>
<td>$1.35</td>
<td>$40,410</td>
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<tr>
<td>Hot-Dip Galvanizing</td>
<td>$1.60</td>
<td>48,000</td>
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<tr>
<td>Inorganic Zinc/Epoxy</td>
<td>$2.16</td>
<td>$64,800</td>
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<tr>
<td>Acrylic WB Primer/ Acrylic WB Intermediate/ Acrylic WB Topcoat</td>
<td>$2.55</td>
<td>$76,620</td>
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<tr>
<td>Inorganic Zinc Primer/ Epoxy/ Polyurethane Topcoat</td>
<td>$3.17</td>
<td>$94,950</td>
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</table>
Future Generations will Benefit
Internal Curing Concrete
Completed Roundabout
Pavements from BIO-OILS
Be Creative
ANY QUESTIONS?
THANK YOU