FHWA Bridge Research Update

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Federal Highway Administration
Presentation Topics

- FHWA RD&T Strategic Plan
- Bridge and Structures R&D Program
- FHWA RD&T Websites
- The Future
FHWA RD&T Strategic Plan
FHWA RD&T Vision and Mission

**TFHRC Vision**
To shape the future of transportation as the Nation's premier center for highway research and innovation.

**TFHRC Mission**
We conduct and coordinate research and advance innovation for a mobile society. We provide objective, high-quality technical expertise, leadership, and results.
Strategic Goals

1. FHWA conducts and sponsors the right research and technology development to improve performance of our Nation’s highways.

2. FHWA engages in strategic partnerships to enhance and leverage research, development, and implementation.

3. FHWA and TFHRC maintain a flexible organization and agile research workforce to meet new and evolving transportation challenges.
Strategic Goals (cont.)

4. First-rate *research infrastructure* is developed and sustained through long-range planning and adequate capital investment.

5. Research activities and outcomes are appropriately advanced through effective alignment of resources, dissemination of knowledge and *technology transition*.

6. TFHRC provides *national leadership* to highway and intermodal transportation research.
FHWA Bridge and Structures R&D Program
FHWA Bridge and Structures R&D Activities

- Research and development
- Technical assistance
- Forensic engineering
FHWA Bridge and Structures R&D Teams

• Bridge and Foundation Engineering Team
  – Ben Graybeal, Team Leader
  – Structures and Geotech Labs, Steel and Concrete

• Hazard Mitigation Team
  – Sheila Duwadi, Team Leader
  – Hydraulics and Aerodynamics Labs, Bridge Security

• Infrastructure Management Team
  – Hamid Ghasemi, Team Leader
  – NDE and Durability (Corrosion) Labs, LTBPP
Selected Current FHWA Programs and Projects
Long-Term Bridge Performance Program

- Selecting representative bridges in partnership with DOTs
- Continuing field data collection in mid-Atlantic states; initiating data collection in other regions
- Continuing development of strategic and operational bridge performance matrices
- Publications: data collection protocols and technical reports
Structural Performance of Lightweight Concrete

- Unify treatment of LWC
- Move toward weight-based definition...not constituent
- Working with T-10 to draft LRFD provisions
- Potential 2015 ballot item
Structural Performance of Lightweight Concrete

- Shear
- Bond and Development
- Mechanical Properties
- Dimensional Stability
UHPC for Field-Cast Connections

UHPC Connections

UHPC State-of-the-Art

UHPC Memo

https://www.fhwa.dot.gov/research/resources/uhpc
Guidance on Use of UHPC Connections

FHWA document being drafted
- Design guidance
- Construction guidance
- Case Studies

Publication within 6 months
UHPC Connections

- Deck-to-Deck
- Deck-to-Girder
- Column-to-Footing/Cap
- Girder-to-Girder
- Deck-to-Barrier
- Deck-to-Expansion Joint
Field-Cast “Splice” Connections

Precast Deck Panels and Slabs

Deck Bulb Tee Girders

Closure Pour (UHPC)

Deck Bulb Tee Prestressed Girder
Adjacent Box Beam Connections

No. 4 rebar lap splice
(No Post-Tension needed)
Optimized Shear Stud Spacing for Precast Decks on Steel Superstructures

ABC shear stud considerations

- Precast decks w/pockets
- Cluster studs close together
- Large distance between clusters
- Easier fit up
• Full-scale strength tests complete – no differences in strength between 12, 24, 36, or 48 inch stud spacing

• Full-scale fatigue tests halfway done – results to date show AASHTO design is conservative; adjusting testing schedule to accommodate Tappen Zee Bridge considerations

• Small scale testing to explore CAFL yet to begin

• Draft report completion next summer
Feasibility Evaluation For Detecting Hidden Corrosion Damage In Multi-layer Gusset Plates

- FHWA technical advisory 5140.31 recommends using NDE to evaluate section loss in steel gusset plates
- Usage of pocket UT and PAUT corrosion probes addressed this issue for single plate members
- Feasibility study using pulsed X-ray shows promise for multi-layered members

Detection and sizing of section loss in gusset mock-ups has been found to be fairly accurate using Pulsed Radiography Technique
Nondestructive Inspection Protocol for Reinforced Concrete Barriers

- Evaluated typical reinforced concrete barriers and anchorage systems subject to deterioration
- Evaluated existing technologies for detecting corrosion in the anchorage system (ultrasonic pulse echo, ground penetrating radar (GPR), infrared, and radiography)
- Future study to quantify section loss, voids, delamination, and other deterioration in reinforced concrete barriers

Simulated cross-section loss of rebar at New Jersey barrier connection

Ultrasonic B-scan image

GPR image
Shallow Foundations for Narrow Channels

Physical modeling of countermeasure installation
Shallow Foundations for Narrow Channels

CFD modeling of shear stresses near countermeasure installation
## GRS-IBS Instrumentation and Monitoring

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*Additional projects are being monitored in DE, HI, WI, CO, LA*

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**Center of Bearing**

- Concrete Pressure Cell (25 psi)
- Earth Pressure Cells (50 psi)
- Concrete pressure cell on cheek wall (25 psi)
- Survey target
- In-place inclinometer on the abutment face at the centerline

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**Mid Height of Abutment Stem Wall**

- Concrete Pressure Cell (25 psi)
GRS Long-Term Dead Load Experiments

- Four instrumented GRS piers at TFHRC with different aggregates and geotextiles
- Study of long-term performance
Countermeasure Development for Suspension Bridge Components

TPF 5(216)

- Blast load effects in early 20th century steel alloys
- Countermeasures for towers
- Countermeasures for main cables
- Countermeasures for suspenders
Characterization of Bridge Foundations (CBF)

- Objective: develop new and existing approaches for characterizing existing bridge foundations
- Determine geometry, material properties, integrity, and load carrying capacity
- Develop guidance and best practices
- Foundation characterization decisions will support asset management, life cycle cost analysis, and risk management frameworks
1. Define Bridge Foundation Performance Issues
   • Data needs/gaps

2. Analytical and Developmental Research Program
   • Technology evaluation and development
   • Physical testing and numerical analysis
   • Risk-based analysis and statistical methods

3. Experimental Program
   • In-service
   • Decommissioned bridges
   • Testbed with engineered defects

4. Outreach Program
   • Web site
   • Training and webinars
Corrosion Research Roadmap

- Multiyear corrosion engineering research roadmap being developed in collaboration with Department of Defense and University of Akron

- Roadmap publication ~September 2014

- Initial studies focusing on corrosion-resistant nano-coatings that can be used for DOD and FHWA applications
FHWA Geotechnical Engineering Publications

- Friction Angles of Open-Graded Aggregates from Large-Scale Direct Shear Testing (FHWA-HRT-13-068)
- GRS Performance Testing – Axial Load Deformation Relationships (FHWA-HRT-13-066)
- GRS Composite Behavior (FHWA-HRT-10-077)
- State of the Practice and Art for Structural Health Monitoring of Bridge Substructures (FHWA-HRT-09-040)
- Design for Deep Mixing for Embankment and Foundation Support (FHWA-HRT-13-046)
FHWA Aerodynamics Webinar Series

Available on the Web

- FHWA Aerodynamics Program—from galloping to cruising (Harold Bosch)
- Introduction to wind hazards in highway engineering (Peter Irwin)
- Wind load and aerodynamic design of bridges (Ted Zoli)
- Wind induced vibration of bridge cables (Guy Larose)
- Experimental methods for wind design (Stoyan Stoyanoff)

Upcoming

- Computational tools for aerodynamics of highway structures (July, 2014)
- Coastal wind hazard to bridges—hurricane, surge, waves (August, 2014)
- Wind load and aerodynamic design of signs, signals, and lighting structures (September, 2014)
- Field monitoring and field testing (October, 2014)
FHWA Aerodynamics Research Reports


NHI Welding Training Development

- FHWA delivered welding training in the early 80’s for engineers and inspectors; hasn’t been delivered for over 30 years
- Redeveloping previous course with new reference manual and approximately eight hours of web-based training
- Collins Engineers began work January 2014
- Reference manual scheduled completion October 2014
- Web-based training tentatively available in December 2015
FHWA R&T Agenda
Welcome to the FHWA Research and Technology Agenda. Discover how FHWA’s offices and programs are addressing six of the Nation’s key highway challenges.

**Challenges**
The FHWA Research and Technology Agenda targets six high-priority highway challenges that affect all of us:
- **Advancing safety**
- **Improving mobility**
- **Maintaining infrastructure integrity**
- **Enhancing performance**
- **Promoting sustainability**
- **Preparing for the future**

**Meeting the Challenges**
Learn how FHWA’s offices and programs are meeting today’s highway challenges through research.
- **Infrastructure**
- **Operations**
- **Safety**
- **Federal Lands**
- **Planning, Environment, and Realty**
- **Policy**
- **Exploratory Advanced Research**
- **Innovative Program Delivery**
Meeting the Challenges

Federal Highway Administration's Research and Technology Program Is Meeting Today's Highway Challenges

FHWA defines objectives and strategies that guide research, development activities across eight research areas. Each research area targets one or more of the Nation's six highway challenges.
Research and Development (R&D) Project Sites

FHWA

Federal Highway Administration Research and Technology

Project Information

- Project Id: FHWA-PROJ-12-8804
- Project Name: Abutment Interface Experiments for Integrated Approaches
- Status: Archive
- Start Date: January 7, 2013
- End Date: September 30, 2016

Contact Information

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- First Name: Jennifer E.
- Telephone: 202-493-3006
- E-mail: jennifer.nichols@dot.gov
- Office: Office of Infrastructure Research and Development
- Team: Bridge and Foundation Engineering Team [PH-40]
- Program: Turner-Fairbank Highway Research Center
- Laboratory: Geotechnical Laboratory

Project Description:
The in-service performance of many bridges built on the Geosynthetic Reinforced Soil (GRS) Integrated Bridge System (IBS) indicate the superstructure and approach fill need to maintain a smooth, bump-free transition without the need to include a traditional approach slab or special pavement system. This project will investigate the interaction between the end of different superstructure combinations and the GRS integrated approach. The project will involve a series of laboratory experiments and computer modeling to simulate thermal bridge cycles and measure the resulting passive earth pressure against the GRS integrated approach in an attempt to...
understand the interaction with the integrated approach that can be applied to the IBS and other systems.

Goals:
The key project objectives are:
(1) Define the mechanics of passive earth pressure against a geosynthetic reinforced soil (GRS) integrated approach.
(2) Define the interaction between the superstructure and abutment.
(3) Determine how the thermally induced force from the approach backfill affects the superstructure.
(4) Develop a computer model to simulate the GRS integrated approach for different bridge configurations.
(5) Apply the results of this work to the design of bridges with various abutment types (e.g., GRS, Integral, etc.).

Product Type:
Research report

Test Methodology:
Laboratory experiments, field tests, and computer modeling

Partners:
Federal Highway Administration: Office of Research, Development, and Technology - Office of Infrastructure Research and Development; Role(s): Advisory, Technical

Expected Benefits:
The expected benefit is an increased application of a geosynthetic reinforced soil integrated approach system to improve bridge performance.

Deliverables:
1. Name: Transportation Pooled Fund Research Report
   Product Type(s): Research report
   Description: A research report will be drafted to outline the results of the field testing and provide design guidance if necessary.
2. Name: Research report
   Product Type(s): Research report
   Description: A full research report will be developed outlining the entire project, including the results of the Transportation Pooled Fund study, along with laboratory and computer simulation results.

Related URL(s):
http://www.fhwa.dot.gov/erl/primenews/transportation/transportation.html
http://www.pooledfund.org/Details/Study660

FHWA Topics:
Roads and Bridges--Geotechnical

TRT Terms:
Construction
Infrastructure
Bridges
Research
Transportation
State of the Art
Innovation
Bridge Abutments

FHWA Disciplines:
Geotechnical

Subject Areas:
Bridges and other structures
Geotechnology
Research

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FHWA R&T Agenda Feedback Questions

• What are the most pressing highway problems in your state?
• Is FHWA addressing the right (nationally critical) challenges? If not, what other national challenges should FHWA address?
• Does FHWA’s overall research strategy align with the most critical challenges? If not, what areas are missing?
• Are you engaged in research that may contribute to FHWA’s research strategies?
The Future...
Thank you for your continued interest and support of FHWA’s bridge and structures research program!