Advances in FRP Composites
Education ↔ Professional Engagement ↔ Research

University at Buffalo
Institute of Bridge Engineering
School of Engineering and Applied Sciences

AASHTO SCOBS T6 2016 Minneapolis
Presentation Outline

I. Introduction
   What is a scan?
   What are the objectives of the FRP scan?
   What is FRP?

II. Body
    FRP Uses for Existing Infrastructure
    FRP for New Construction and components
    What is Practice ready?

III. Conclusions
     Successes, barriers and recommendations
What is a Domestic Scan?

- Information exchange
- State of practice
- Identification of barriers
- Recommendations
Scan Team & Host States

West coast scan
Mid July, 2015

East coast scan
1st week of June, 2015

Team Member Home State
Host Agency State

FHWA
(SME)

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What are the issues?

- Traffic congestion
- Condition of aging bridges
- Preservation (of existing bridges)
- Service life extension (of new bridges)
- Hazard mitigation
Why FRP?

Vision for the Future of Structural Engineering

“…………ultimately we must embrace innovation in materials as a key part of what it means to be a structural engineer.”

Structural Engineering Institute 10/16/13
What is FRP?

- **Fibers** are analogous to reinforcement in concrete. FRP derives its tensile strength from the fibers.
- **Resin** matrix
  - Distributes load to fibers
  - Binds and protects fibers
FRP is not...

- **One thing**. It is a *class* of materials with a wide range of properties.
- **New**. It’s been used since WWII under extreme conditions and is common in other industries.
- **Familiar**. It is not understood by many civil engineers.
- **Expensive**, if it can solve a difficult problem fast.
Results of the scan?

✓ inherent properties and benefits of FRP
✓ how are they being used
✓ what is “practice-ready”
✓ where to go for answers
What’s in a Scan Report?

“Best Practices in FRP Composites”
(due out Aug. 2016)

• Objectives
• Uses on existing infrastructure (14)
• Uses on new construction (22)
• What is “practice-ready”
• Barriers / lessons learned
• Suggestions to AASHTO T6
• Resources:
  • Case studies, specs, plans
  • Contacts
  • Extensive bibliography (2055)

www.domesticscan.org
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How are DOTs using FRP?

**Existing infrastructure**
- Concrete repair
  - Truck impacts
  - Corrosion
- Concrete Strengthening
  - Design issues
  - Increase capacity
- Seismic retrofit
- Heritage structures
- Preservation activities
- Timber, metal, aerodynamic

**New construction**
- Deck reinforcement
- P/S strands (in beams & piles)
- Beams & slabs
- Fender piles
- ABC
- Unique problems
## Existing Infrastructure

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<tr>
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E3 Seismic retrofit of concrete
E4 Protective wrapping of concrete
E5 Strengthening concrete w/ externally bonded FRP
E5 Strengthening concrete with externally bonded FRP
E5 Strengthening concrete with externally bonded FRP

Poor detailing
E6 Strengthening concrete w/ NSM FRP
E7 Strengthening concrete w/ FRP post-tensioning
E8 Strengthening concrete with *mechanically-fastened* FRP

http://transportation.mst.edu/media/research/transportation/documents/064-cr.pdf
E9 Strengthening structural steel w/ FRP post-tensioning

E10 Culvert liner

Erie County, NY

http://www.materialstoday.com/composite-applications/features/frp-super-laminates-present-unparalleled/
E11 Repair of impact-damaged poles
E12 Repair of fatigue-damaged aluminum overhead sign structures
E13 Repair and strengthening of timber

https://www.ideals.illinois.edu/bitstream/handle/2142/90090/FHWA-ICT-16-011.pdf?sequence=2
E14 Other
FRP for New Construction
### New Components and Systems

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<tr>
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<td>Superstructures - FRP beams and slabs</td>
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N1 Concrete reinforcement
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N2 Concrete prestressing tendons pre-tensioning
N3 Concrete prestressing tendons post-tensioning (PT)
N4 Stay-in-place (SIP) concrete forms for decks and substructures
N5 Superstructure beams and slabs
N6 Hybrid superstructure systems, beams and slabs
HC Beams
N7 Hybrid superstructure systems, concrete-filled FRP tubes
N8 Hybrid superstructure systems, FRP w/ glu-lam
N9 Structural deck (FRP or hybrid)
N9 Structural deck (FRP or hybrid)
N10 Pedestrian bridges
N11 Sidewalks
N12 Bridge drains and scuppers
N13 Load bearing pile foundations (FRP or hybrid)
N14 Marine fenders (piles & wales)
N15 Marine floats
N16 Sheet piling

Source: www.strongwell.com
N18 Wind fairing
N20 Culverts
N22 Other
Which FRP uses are ready now?

<table>
<thead>
<tr>
<th>Readiness Index</th>
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Readiness Index = 1

Practice ready
Applications in this category (RI=1) are ready for deployment because there is sufficient experience to demonstrate their effectiveness and resources are available to support use by other DOTs.
Readiness Index = 2

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**Maturing**

In summary, applications in this category (RI=2) are generally ready for trial deployment but there are still improvements that can be made to practice and guidance as experience is gained, documented and shared.
Readiness Index = 3

**Under development**
Applications in this category (RI=3) are beginning to move from the laboratory to field, but there is little support available to perspective users (past case studies, drawings, specifications, costs, training).
Emerging
These uses (RI=4) are conceivable but additional R&D is necessary because little investigation has been done within the transportation community.
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What are then best uses for FRP?

• Repair damaged structures
• Retrofit existing structures
• Preserve cultural resources
• Capitalize on constructability and service life benefits
What’s holding us back?

- Guidelines & examples
- Training and experience
- Proprietary products
- Information sharing
- Liability concerns
- Performance history
- Research
What does the Scan Team suggest?

1. Guidelines
2. Design examples
3. Training
4. Track FRP use.
5. Share info.
6. Webinars
7. Research.
8. Team on an FRP strategy
Final Report will be posted online
[www.domesticscan.org](http://www.domesticscan.org) approx. 9/1/16

NCHRP 20-68A Scan 13-03
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What does a T6 “stamp of approval” look like?

• Is there a process for each application that addresses each technical thrust area and bridge phase?

• Who has ownership of the problem?
  • Is FRP a material? (Engineer owns it)
  • Is FRP a product? (Supplier owns it)
  • Does it have to be the same for all FRP uses?