American Association of State Highway and Transportation Officials

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TIG

Driving Innovation for Transportation

AASHTO Technology Implementation Group

BMDO | Bridge Material Design Options

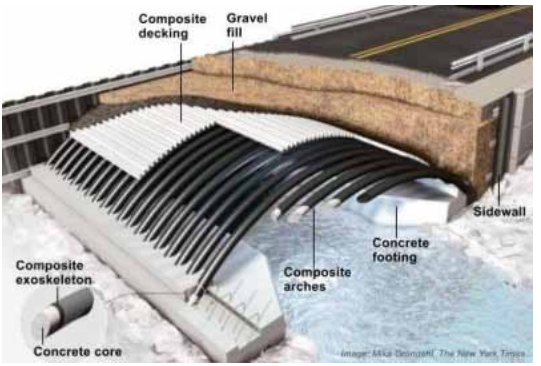
Innovation Through Composites

Why New Bridge Material Design Options? Why Now?

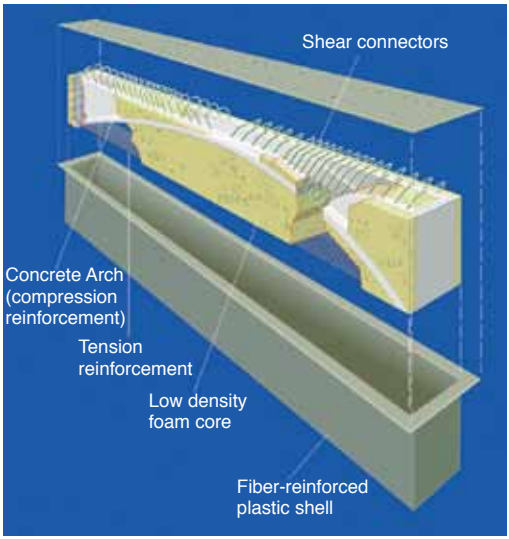
Two innovative bridge technologies now in use in several States offer transportation agencies significant cost, safety, strength, weight, design and sustainability benefits.

Each expands the range of proprietary bridge system options and may be particularly useful in accelerated bridge construction. Manufacture can take place in as little as 30 days. Even in more complex applications, each option generally requires lead time no longer than that of conventional materials.

Rigidified FRP Tube Arch (RFTA) bridge systems – commonly called "Bridge-in-a-Backpack™" systems -- are well suited to a variety of sites, including environmentally-sensitive areas and locations where it is difficult, damaging, or unfeasible to bring in heavy equipment or machinery. Early applications indicate that the technology will offer a much needed alternative to other proprietary bridge systems in such settings. Though comparable systems made of steel or aluminum can also be assembled with manual labor or using very lightweight equipment, they are generally limited to spans of 50' or less. "Bridge-in-a-Backpack™" can be used for spans up to 70'. RFTA's can also be a cost-effective, low carbon alternative in severe exposure settings, including marine environments. They have the potential for low life-cycle and maintenance costs.



Hybrid-Composite Beams (HCB) have the potential to be long-lasting, can weigh considerably less than standard concrete beams, and may be placed using smaller, lighter pieces of construction equipment. They show promise for long service life with corrosion resistance, and can provide a low overall carbon footprint for beam and bridge construction. These attributes may be particularly useful in a marine environment, though HCB's are currently used in both land and water crossings. HCB's offer a good bid alternate to conventional or other FRP bridge systems in a range of common applications.



Each technology offers elasticity and resilience for high seismic regions as well. Each can also provide the added benefits of low foundation costs and low to moderate tooling costs, depending upon the setting.

HOW DO THEY WORK?

Innovative use of materials helps each technology deliver solutions to common bridge construction and replacement challenges. They share common attributes, including the potential to:

- Simplify construction and afford rapid replacement of culverts and short- to medium-span bridges over water
- Be less expensive and potentially long-lasting in severe exposure settings, such as marine environments
- Reduce life-cycle and maintenance costs while lowering the structure's carbon footprint through the use of corrosion-resistant materials

"Bridge-in-a-Backpack™": Rigified FRP Tube Arch (RFTA) Bridge Systems

"Bridge-in-a-Backpack™" technology offers a highly efficient use of materials that can be transported to a site in remarkably small "packages." This makes the technology particularly useful for sensitive or hard to access areas, though the structures have advantages in many more conventional settings as well.

Specifically, RFTA Bridges:

- Use carbon fiber-reinforced polymer (FRP) composite tubes filled with cast-in-place self-consolidating concrete for the main bridge members
- Are designed so that the tubes provide external reinforcement to protect and strengthen bridge superstructure for increased durability and resistance to corrosive factors
- Can be used for spans up to 70 feet

Hybrid-Composite Beams (HCB)

HCBs:

- Use a composite shell, which is shipped to the bridge site, erected and filled with self-consolidating concrete
    - Shell then acts as a stay-in-place form for an internal parabolic concrete arch
- Employ prestressing strand tension reinforcement
    - Steel tension reinforcement is passive and completely encapsulated in the same resin as the composite shell
- Are light weight
    - A typical 70 foot HCB weighs 5,000 lbs.
    - A typical 70 foot conventional precast concrete girder weighs 60,000 lbs.
- Can be used for spans up to 120 feet

SUMMARY OF BENEFITS:

Lighter Weight, Ease of Installation, Lower Costs

- Lighter equipment for installation
- Accelerated construction option (with corresponding safety benefits)
- Reduced carbon emissions from shipping and erection
- Foundation costs reduced

Enhanced Material Properties

- High strength, low weight
- Corrosion resistant
- Environmentally-friendly
- Design flexibility
- Low moisture absorbency
- Sustainable materials and practices

Suitable for a Variety of Sites

- Adaptable for sites with limited access
    - Well suited for environmentally-sensitive areas and locations where it is difficult, damaging or unfeasible to bring in heavy equipment
- Resilient and elastic response for high seismic regions
- Corrosion resistant in marine environments

Laboratory-Tested Technology

with numerous applications in place

- RFTA bridge system tested with advanced structural characterization, predictive modeling, fatigue testing, along with environmental durability tests for ultra-violet, fire, and abrasion resistance.
- HCB bridge field tested with over 237 Million Gross Tons (MGT) of heavy axle, Class 1 Freight Railroad traffic.
- Several demonstration bridges of each type now being monitored.

Awards & Recognition

- "Bridge-in-a-Backpack™" received the 2011 Charles Pankow Award for Innovation from the American Society of Civil Engineers.
- Hybrid-Composite Beams are recognized with numerous awards including "Popular Science" *Top 10 Inventions of 2008*, American Council of Engineering Companies *National Grand Award 2009*, and Construction Innovation Forum *2010 NOVA Award*.

About TIG

Dedicated to sharing high-payoff, market-ready technologies among transportation agencies across the United States, TIG promotes technological advancements in transportation, sponsors technology transfer efforts and encourages implementation of those advancements. For more information visit www.aashtotig.org.

HOW DO I LEARN MORE?

TIG's Lead States Team includes DOT representatives who can help you implement these technologies in your agency. Turn to team members for insight, expertise and advice.

For more information about Bridge Material Design Options, contact:

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