

PIANC WG 191 Composites for Hydraulic Structures Working Group  
Meeting, Feb 1, 2016, Brussels, Belgium

## FRP Composites Demonstrations in Collaboration with US Army Corps of Engineers and Industries

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Center for Integration of Composites into Infrastructure



\* Sponsored by USACE



US Army Corps  
of Engineers

## US NSF Industry/University Collaborative Research Center – Center for Integration of Composites into Infrastructure (CICI)

- NSF I/UCRC
  - Develop long-term partnerships among industry, academe, and government;
  - Promote research and development programs of mutual interest, and
  - Enhance the intellectual capacity of the engineering workforce through the integration of research and education
- CICI
  - Established with a planning grant in 2008 and full grant in 2009 from NSF
  - Only I/UCRC focusing on polymer composites for infrastructure applications

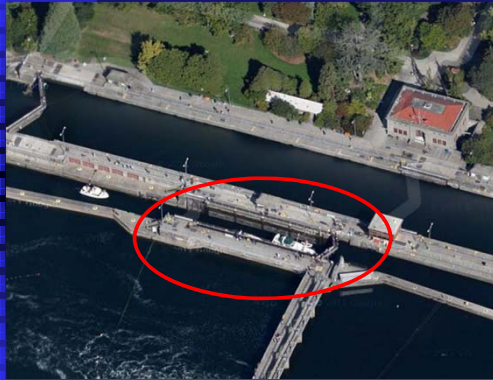
## CICI Mission

- To accelerate the adoption of polymer composites and innovated construction materials into infrastructure applications through collaborative research
  - ◆ Highway, railway and waterway
  - ◆ Buildings and housing
  - ◆ Pipelines
  - ◆ Utilities and energy industries

## Abrasion resistant coatings for Tainter-gates, Heflin Dam near Gainesville, Alabama



## Replacing Steel Miter Blocks with FRP Composite Miter Blocks



Small lock at Hiram Chittenden (Lake Washington Shipping Canal) Locks, Seattle, WA.

Corroded steel miter blocks



## Condition of Steel Blocks



Very corroded existing steel blocks.

Previous attempts to repair with epoxy material not very successful – repair lasted but a few months.



Credit: USACE

## Installing the Blocks



Lightweight, easier and safer to handle than steel.

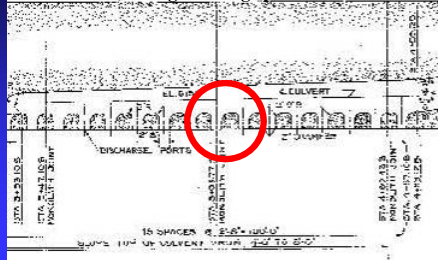
Credit: USACE

## Repair Concrete Discharge Ports at Chickamauga Dam in Tennessee



Video monitoring of installation – subsequent diving inspection has shown the composite wrap to look like the day it was installed.

Schematic showing discharge ports in lock structure



Credit: USACE

## Recess Panels at Willow Island Locks and Dam, Ohio

- Steel panels costly, heavy, and they corrode.



Current steel panels



Fabrication of composite structure.

Credit: USACE

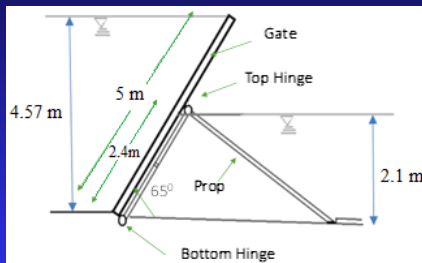
## Recess Panels at Willow Island Locks and Dam, Ohio



Finished panels to be installed Spring 2016.

Credit: USACE

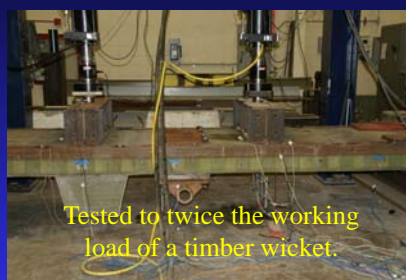
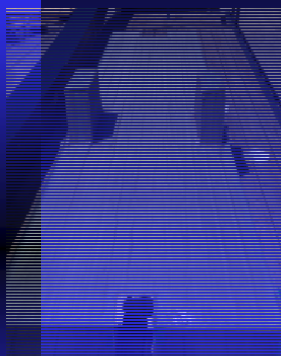
## FRP Composite Wicket Gates to Replace Timber Wicket Gates



Traditional timber wickets showing severe deterioration

Credit: USACE

## Fabrication, Evaluation and Field Installation of Composite Wicket Gates



Tested to twice the working load of a timber wicket.



Credit: USACE

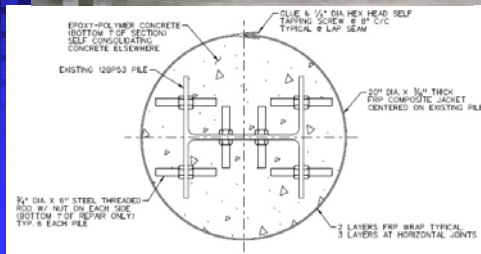


Composite wickets installed on Illinois River, Rock Island District in August 2015

## Rehab of Corroded Steel H-Piles with Composites, East Fork Bridge, Huntington, WV



Bring load capacity back to original at 25% of traditional repair cost, with use of composite shell, wrapped, and then filled with SCC



## Comprehensive Composite Approach



## Transforming Corroded Steel Piles with Composites



## FRP Sheet Piles and Pipe Piles



Long Beach, New York  
Hurricane Sandy Repair and  
Protection (2013)

Credit: Creative Pultrusion





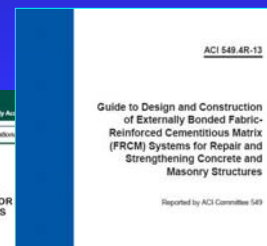
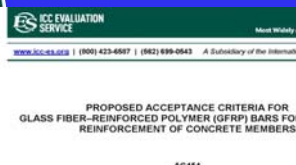
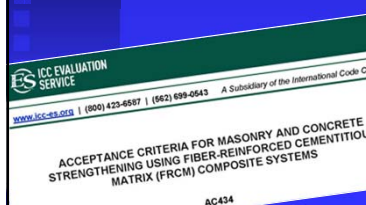
## Composite Anti-Collision Bumper System for Bridge Protection



Credit : Nanjing Tech University and Bohom

## Codes, Specifications and Guidance

- Construction industry relies on design codes, specifications and standards in order for any material to be used, for example, ACI 440.1R.03 & AASHTO LRFD Bridge Design Guide; ICC-ES AC434; AC454 and ACI 549.4R-13
- New design code entitled, “Pre-standard for Load and Resistance Factor Design (LRFD) of Pultruded Fiber Reinforced Polymer (FRP) Structures” by ACMA-ASCE
- These codes will allow architects and structural engineers to incorporate FRPs to build stronger, safer and better structures



## Conclusions

- Academia in cooperation with government and industry has made major strides in developing FRPs for infrastructure applications, including structures for highway and waterway, utility poles, wind turbine blades, and pipelines.
- With recent launching of new design codes, FRP composite materials will become an integral part of civil infrastructure including extensive use for rehabilitating aging infrastructure at 15-30% of conventional repair costs.
- Society will benefit from the increased use of reliable and durable composite materials in terms of high strength, corrosion resistance, cost effectiveness and reduced user inconveniences due to ease of installation, low maintenance, longer service life, and greener products.