GFRP REINFORCEMENT BAR

Structures that have used GFRP
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Structures that have used GFRP

Canada

Beddington Trail Bridge
Calgary, Alberta

- CRJ Composites Research Journal – State-of-the-Art of FRP and SHM Applications in Bridge Structures in Canada
  Aftab A. Mufti, University of Manitoba, Kenneth W. Neale, University of Sherbrooke
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Burnhamthorpe Bridges
Mississauga, ON
Portion of the concrete deck slab of a concrete highway bridge in Headingley, Manitoba, Canada: part of the barrier wall will also be reinforced by GFRP reinforcements. The deck slab was reinforced by 10 mm diameter indented Lead line bars similar to the reinforcement used for pre-stressing. (GFRP) reinforcement bars of 12.5 mm diameter.

Hydroelectric Chambers for Hydro-Quebec
Montreal, Quebec
The concrete chambers house special devices used for electrical transmission lines.

Joffre Bridge
Installed 1997, Sherbrooke City, Quebec, Canada
A vehicular bridge spanning the St. Francois River, opened in 1997. The deck of this bridge is partially constructed with GFRP rebar like the Taylor Bridge, the Joffre Bridge has embedded fiber optic sensors monitoring the bridge and its structural components. The data compiled from these sensors show the bridge continuing to meet performance expectations. In December, 2009, eight cores were extracted from the bridge to monitor the condition of the reinforcement. After 12 years in a harsh, corrosion-promoting environment (high alkalinity, freeze-thaw cycles), the GFRP rebar in the samples is visually perfect. These cores will be used in upcoming durability studies.

Laurier-Taché Parking Garage
Public Works and Government Services Canada (PWGSC) is currently undertaking the reconstruction of the interior structural slabs of the Laurier-Taché parking garage in Ottawa/Hull. GFRP-composite bar technology is incorporated into the project and will be monitored over an extended period of time.

Manitoba Floodway Bridges
Winnipeg, Manitoba
Noden Causeway
The Ministry of Transportation NW Region of Ontario has been a leader in the use of GFRP composite reinforcement in a number of cast-in-place, pre-cast and wood structures. The original structure opened in 1965 is 4.8km long including approaches, but was in need of some rehabilitation. The MTO opted with pre-cast panels, and the project was divided into 3 phases, with Phase 1 installed on site the summer of 2008. The pre-cast deck panels mainly used #5 (16m) and #6 (19m) bar while #4 Carbon rods were used for pre-stressing the panels.

North Perimeter Highway Red River Bridge
Winnipeg, Manitoba

O’Reilly Bridge
Canada

Portage Creek Bridge
British Columbia
Strengthening Against Earthquakes & Field Assessment

Saint Étienne-de-Bolton
This landmark restoration project was completed in a mere three weeks. Twelve out of eighteen circular columns were experiencing severe deterioration because the steel rebar was in an advanced state of corrosion. Nine of the damaged columns were repaired using fiber reinforced polymers (five with carbon FRP and four with GFRP) while the remaining three were repaired using conventional materials and methods. For each column, one layer was first installed with the fibers aligned vertically. A second layer was applied with fibers placed circumferentially.

In a successful effort to validate this method of repair, fiber optic sensors were installed on four of the columns to measure reactions to extreme temperature variations, corrosion and loading. This project proved that the significant savings in labor outweigh the increased expense of
FRPs. Because the materials are so light-weight and the installation method so easy to learn and apply, construction time and the size of the work crew are reduced over conventional methods. In addition, no form-work is required and traffic flows as usual

**Salmon River Highway Bridge**
Nova Scotia
The first steel-free deck-slab in Canada was cast on the Salmon River Bridge, part of the Trans Canada 104 highway near Kemptown, Nova Scotia.

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**Taylor Bridge**
Installed 1997, Headingly, Manitoba, Canada
GFRP Rebar was included in the deck of this two-lane, 540 foot bridge spanning the Assiniboine River. The bridge was opened to traffic in the fall of 1997 and was at the time (and may still be) the longest bridge span in the world to be partially constructed using composite materials. An experimental system of fiber optic sensors was embedded in this bridge providing highly detailed monitoring of the bridge and its structural components. The bridge structural integrity is performing to requirements.

Webster Parkade. GFRP and CFRPs were used to rehabilitate and reinforce columns, which had lost their initial capacity over the years due to corroding steel rebar, and to protect column bases exposed to de-icing salts during the winter.

**Wotton**
Quebec Canada

**USA**

In addition to their high strength and light weight, GFRP reinforcing bars offer corrosion resistance, making them a promising alternative to traditional steel rebars in concrete bridge decks. GFRP reinforcement has been used in several bridge decks recently constructed in North America.

The expansive corrosion of steel rebar stands out as a significant factor limiting the life expectancy of reinforced concrete structures. In North America, significant temperature fluctuations and the use of deicing salts exacerbate the phenomenon in parking garages and on bridge decks. Indeed, North America’s freeze–thaw cycles and heavy salt applications subject roads and bridges to quite severe environmental conditions. Furthermore, the expansive corrosion of steel causes cracking and spalling of concrete bridge decks, resulting in major rehabilitation costs and traffic disruption (Yunovich and Thompson 2003). Problems related to expansive corrosion could be resolved by protecting the steel rebar from corrosion-causing
agents or by producing GFRP reinforcement bars made of noncorrosive materials. GFRP is one such alternative, which has been used successfully in many industrial applications and more recently has been used as concrete reinforcement in bridge decks and other structural elements (Rizkalla and Tadros 1994; Saadatmanesh and Ehsani

**Colorado**

**I-225/SH 83 Interchange**
GFRP as temp/shk in precast concrete deck panels pre-stressed with GFRP tendons

**Parker Rd. Interchange at I-225**
Denver, CO
GFRP Rebar was incorporated in the concrete deck of this interchange. In a 2007 bridge inspection, this structure had a sufficiency rating in the high 90’s. A contact in Colorado DOT’s Bridge Asset Management recently said, “Everything is working fine” regarding this structure.

**O’Fallon Park Bridge**
All FRP deck, GFRP in concrete arch

**Florida**

**Heavy Rail – Miami MetroRail – MIA**
22.4 Miles of elevated rail

**I-75- Tampa**
Deck Replacement – NSM Stitching

**Bridge Cantilever – Old Florida Keys Bridge**
Structural Strengthening

**Kentucky**

**Roger’s Creek Bridge**
Installed 1997, Bourbon County, KY
GFRP rebar was placed in a region (measuring about 13m²) of the top reinforcing mat in the Roger’s Creek vehicular bridge deck when the bridge was built. The contractor’s foreman and almost every laborer commented on how much easier GFRP was to install compared to conventional steel rebar, which sped up construction time. Monthly field monitoring was conducted on the bridge for three years and all signs were positive.

**Two-Mile Creek Bridge**
Installed 2002, Clark County, KY
The concrete deck on this 61-foot long by 31-foot wide two-lane vehicular bridge was the first to be reinforced exclusively with GFRP rebar. Recent test results confirm its effectiveness and durability.
Iowa

53rd Ave Bridge
Bettendorf, IA 2001
Center span GFRP top mat

Ohio

Miles Road
All GFRP deck

Pierce St. Bridge
Installed 1999, Lima, OH
This vehicular bridge, located in the hometown of Marshall’s founder, has a span of 94 feet. A recent inspection gave an efficiency rating in the 90’s.

Salem Ave. Bridge
Dayton, OH
The bridge engineer for the county who oversaw the construction of this vehicular bridge, the deck of which is reinforced with GFRP rebar, is enthusiastic about the future of composite rebar and believes transitioning from conventional steel to composite reinforcement is “the way to go.”

Michigan

Bridge Street/Rouge River Bridge

Missouri

Walter Street Bridge
GFRP as shear reinforcement, all GFRP reinforced box culvert

Montana

Walters Street Bridge
Installed 2001, St. James, MO
A vehicular bridge with a deck reinforced with GFRP rebar, constructed in 2001. The span of the bridge is 24-ft and it has a width of 25-ft. A 2008 performance evaluation attests that this bridge deck’s GFRP rebar reinforcement continues to function effectively.

Texas

Sierrita de la Cruz Creek Bridge
Amarillo, TX 2000, USA
Utah

Emma Park Bridge
Pleasant Grove, Utah DOT 2009

Vermont

The Morristown Bridge
Located in Vermont, United States, is a single span steel girder bridge with integral abutments spanning 43.90 m. The deck is a 230 mm thick concrete continuous slab over girders spaced at 2.36 m. The entire concrete deck slab was reinforced with GFRP bars in two identical layers at the top and the bottom. The bridge is well instrumented at critical locations for internal temperature and strain data collection with fiber-optic sensors. The bridge was tested for service performance using standard truck loads. The construction procedure and field test results under actual service conditions revealed that GFRP rebar provides very good and promising performance.

- Designing and Testing of Concrete Bridge Decks Reinforced with Glass FRP Bars
  Brahim Benmokrane¹; Ehab El-Salahawy²; Amr El-Ragaby³; and Thomas Lackey⁴

Virginia

Gills Creek Bridge
GFRP on top mat

West Virginia

Buffalo Creek Bridge (aka McKinleyville Bridge)
Installed 1996, Brooks County, WV
The McKinleyville Bridge was the first vehicular bridge in the U.S. to be constructed with a concrete deck reinforced with composite rebar. The bridge is 177 feet long by 30 feet wide and accommodates two lanes of traffic. After being built, the bridge underwent extensive load testing and is continuing to meet or exceed all expectations.

Dans Run Slab Bridge

Martha Queen’s Bridge
Lewis County, WV

North Acme Bridge
GFRP in deck on box beams
North Kayford Bridge
GFRP in deck on box beams

South Acme Bridge
GFRP in deck on box beams

Wisconsin

U.S. 151 over SH 26
GFRP bi-directional grid augmented by GFRP bars on GFRP deck panel. 2 bridges

China

Continuous Diaphragm Wall
Project in Guanzhou, China
GBAR Rebar Size: 32mm, 28mm, 22mm

Continuous Diaphragm Wall
Project in Shenzhen, China
GBAR Rebar Size: 30mm, 28mm, 20mm, 14mm

Soldier Piles
Project in Hangzhou, China
GBAR Rebar Size: 25mm, 14mm

Continuous Diaphragm Wall
Project in Nanjing, China
GBAR Rebar Size: 38mm, 36mm, 22mm
Continuous Diaphragm Wall  
Project in Dongguan, China  
GBAR Rebar Size: 32mm, 20mm, 16mm

Soldier Piles  
Project in Shenyang, China  
GBAR Rebar Size: 25mm, 14mm

Soldier Piles  
Project in Chendu, China  
GBAR Rebar Size: 25mm, 20mm, 14mm

Soldier Piles  
Project in Shanghai, China  
GBAR Rebar Size: 25mm, 14mm
Soldier Piles
Project in Changsha, China
GBAR Rebar Size: 32mm, 14mm

Soldier Piles
Project in Beijing, China
GBAR Rebar Size: 28mm, 20mm, 16mm

GFRP Applied to Highway foundation

Continuous Diaphragm Wall (for Tunnel across River)
Project in Nanjing, China

Applied to Super Train railway foundation in Huffie
Philippines
Photo by other for project in Manila Apply to Airport Runway

Spain

The FRP Pedestrian Bridge in Lleida (Spain) is the longest arch bridge (http://en.wikipedia.org/wiki/Arch_bridge) made out standard GFRP (http://en.wikipedia.org/wiki/Fiberglass) pultruded profiles.