

2018 FTBA Construction Conference

February 8 & 9, 2018

Orlando, FL



Guide Specifications for GFRP Reinforcing

Part 1: AASHTO Guide 2nd Ed.

Antonio Nanni, PhD, PE

University of Miami

Structures Session 2: 3:30 PM-5:00 PM, Thursday 2/8/2018

1. GFRP Rebar Cage Fabrication Case Study (15 min)

- Mikhail Vorobiev, Owens Corning & Contractor (TBA).

2. Bakers Hallover Cut Bulkhead Rehabilitation (15 min)

- Jake Perez, Bolton, Perez & Assoc. JPerez@BPAMiami.com

3. Skyway Rest Area Rehabilitation (15 min)

- Andra Diggs, FDOT D1, Andra.Diggs@dot.state.fl.us

4. Halls River Bridge Update (15 min)

- Antonio Nanni, University of Miami, nanni@miami.edu

5. CFCC Recent Projects and PT developments. (15 min)

- Jen Tankel, TokyoRope USA, jen.tankel@tokyoropeusa.com

6. Guide Specifications for GFRP Reinforcing (15 min)

- Antonio Nanni, University of Miami nanni@miami.edu
- Brahim Benmokrane, University of Sherbrooke, Brahim.Benmokrane@USherbrooke.ca

FRP for New Construction



Task Force for AASHTO Guide 2nd Ed.

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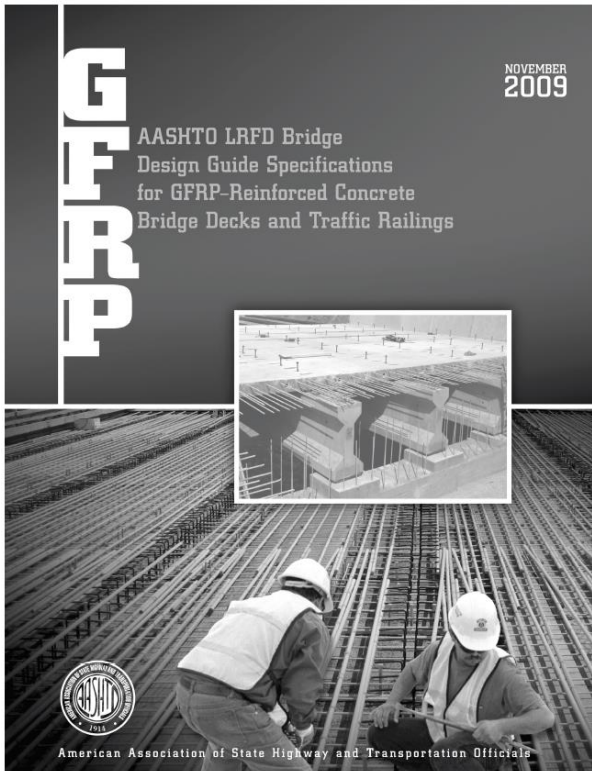
Approach and Relevance

- **Harmonize** with national (ACI, ASTM and AASHTO-BDS) and international (CSA) specifications. **Outcomes:** ease material certification, enlarge market and ease design/deployment
- **Update** existing provisions of 1st Ed. to reflect better materials and manufacturing. **Outcome:** make design more efficient and economical
- **Expand** previous edition to include all elements of a bridge. **Outcome:** allow the design of a bridge entirely reinforced with GFRP



Deliverable

- From 1st Ed. on decks and railings to complete **Bridge Design Specifications (GFRP-BDS)**
- Submitted (**01/16/2018**) to AASHTO Committee T6 for ballot



AASHTO LRFD **2018** BRIDGE DESIGN GUIDE SPECIFICATIONS FOR GFRP REINFORCED CONCRETE – 2ND EDITION

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2nd Ed. Table of Content (**comparison**)

Chapter/Section	AASHTO-18 Ed. 2	AASHTO-09 Ed. 1	ACI 440-15	CSA-14
2. Concrete Structures				
• Flexural elements	X	X	X	X
• Compression elements	X			
• Shear	X	X	X	X
• Torsion	X			
3. Decks	X	X		X
4. Substructures	X			
5. Railings	X	X		X
6. Material & Construction	X	X	X	X



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Critical Design Parameters

	AASHTO -18 2 nd Ed.	AASHTO -09 1 st Ed.	ACI 440. 1R-15	CSA-14	
f_{fu}^*	0.27%	0.27%	0.27%	5.0%	Grnt. strength
Φ_C	0.75	0.65	0.65	0.75	SF concr. failure
Φ_T	0.55	0.55	0.55	0.55	SF FRP. failure
Φ_S	0.75	0.75	0.75	0.75	SF shear failure
C_E	0.70	0.70	0.70	1.0	<i>Env. knock-down</i>
C_C	0.25	0.20	0.20	0.25	<i>Creep knock-down</i>
C_f	0.25	0.20	0.20	0.25	<i>Fatigue knock-down</i>
k_b	1.2	1.4	1.4	1.0	<i>Bond coeff.</i>
w	0.028	0.020	0.028	0.020	Crack width
$C_{C, stirrups}$ [in.]	1.5	1.5	2.0*	1.5	<i>Clear cover</i>
$C_{C, primary}$ [in.]	2.0	2.0	2.5*	1.5	<i>Clear cover</i>
$C_{C, slab}$ [in.]	1.0	0.75	2.0*	1.5	<i>Clear cover</i>

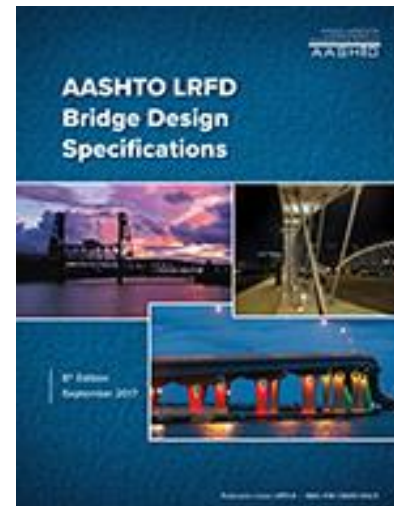
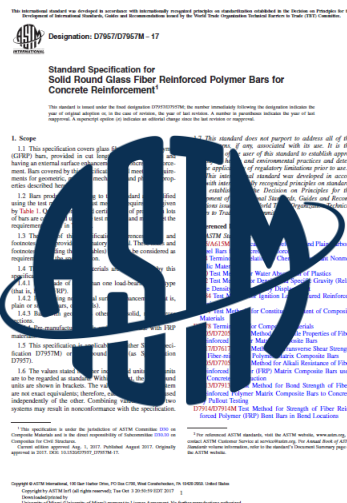
* ACI 440.5-08 Table 3.1



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Harmonize: **ASTM & BDS Docs**

- Material specification as per **ASTM D7957-17**. Only vinyl ester/epoxy glass FRP round bars allowed
- Design of GFRP-RC bridge elements follows structure of **AASHTO BDS-17 (8th)**. Same language used and integration
 - Chapter 2 “GFRP-RC Structures” in 2nd Ed. mimics AASHTO BDS-17 (8th) Chapter 5 “Concrete Structures”



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Harmonize: ACI & CSA docs

➤ Inputs from existing guidelines/codes:

- **ACI 440.1R-15** “Guide for the Design and Construction of Structural Concrete Reinforced with Fiber Reinforced Polymer Bars”
- **CSA S6-14 Section 16** “Canadian Highway Bridge Design Code: Fibre-Reinforced Structures”

➤ Coordination with next-edition codes (where possible):

- **ACI 440-19** “Building Code Requirements for Structural Concrete Reinforced with Glass Fiber Reinforced Polymer Bars” (*under dev.*)
- **CSA S6-19 Section 16** “Canadian Highway Bridge Design Code: Fibre Reinforced Structures” (*for pub.*)



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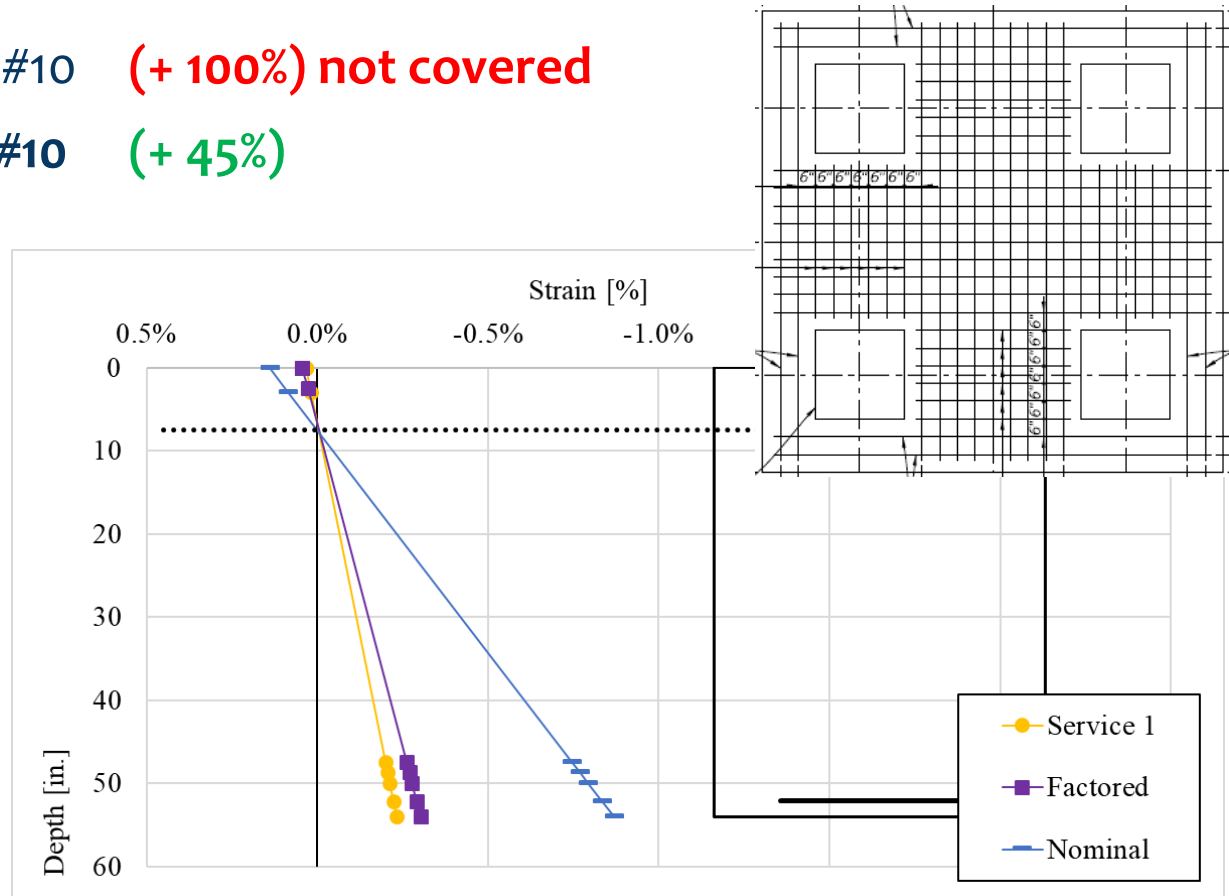
Expand: GFRP-RC Footings

➤ Reference Project: **Old Burnt Mill Creek Bridge Replacement**

➤ Steel-RC 13 #10

➤ GFRP-RC-09 26 #10 **(+ 100%) not covered**

➤ **GFRP-RC-18** 19 #10 **(+ 45%)**



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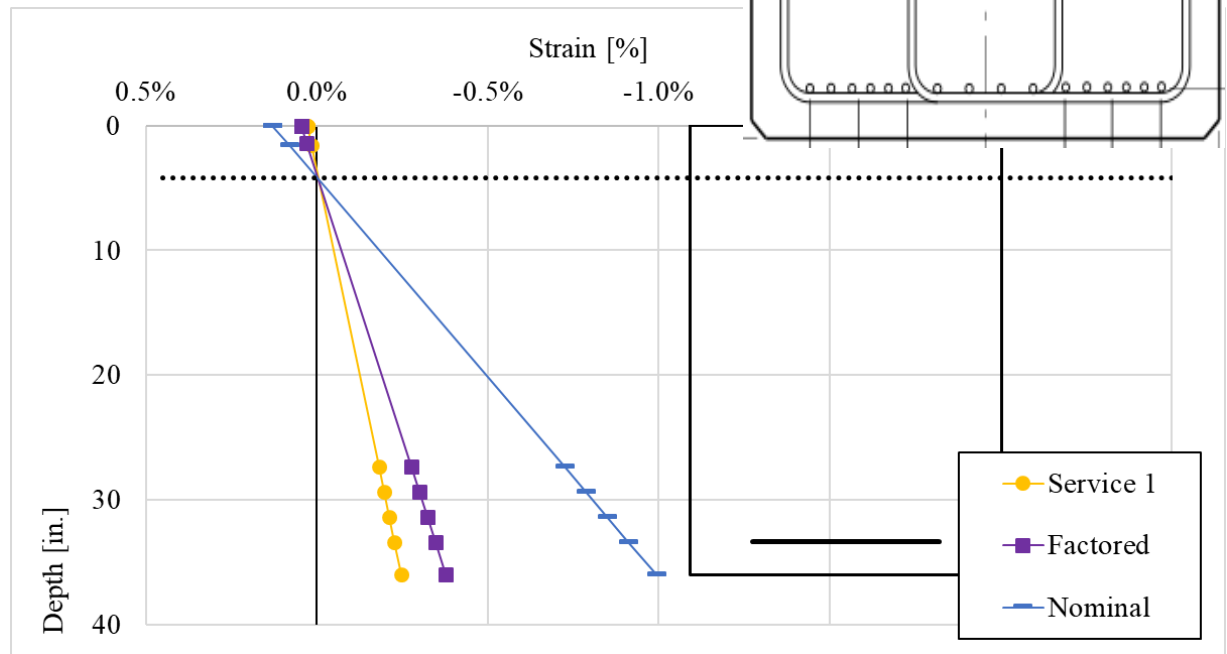
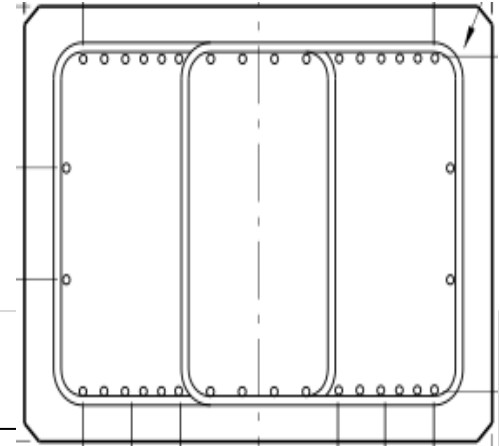
Expand: GFRP-RC Bent Caps

➤ Reference Project: *Halls River Bridge Replacement*

➤ Steel-RC 6 #8

➤ GFRP-RC-09 16 #8 **(+ 166%) not covered**

➤ **GFRP-RC-18** 9 #8 **(+ 50%)**



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Conclusions

- New generation of FRP spec
- Less reinforcement required
- Fully integrated with BDS
- Covers all RC elements in a bridge

Dreaming is nice, but...

**We need adoption
to make it real!!!**



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