AGENDA
ACI Committee 345
Bridge Construction, Maintenance, and Repair
Spring 2012 Convention
Dallas, TX
Sanger B
Sunday, March 18, 2012, 1:30 pm to 3:30 pm

1. Introductions

2. Approval of Cincinnati Fall 2011 minutes

3. Membership
   Jimmy Kim – status changed to Chair
   Michael Brown – status changed to voting member
   Chris Carroll – status changed to voting member
   Ronald Vaughn – status changed to voting member
   Claudia Pulido – status changed to associate member
   Jeffrey Bazzo – new associate member

4. Technical Sessions/Symposium Publications:
   Fall 2011 – Cincinnati, OH – joint session with 302/223
   "Technical Session in Honor of Robert Gulyas"
   Moderators – Fred Goodwin, Aimee Pergalsky
   Spring 2013 – Minneapolis, MN – two sessions
   "Advanced Materials and Sensors towards Smart Concrete Bridges: Performance, Evaluation, and Repair"

5. Liaison reports from other committees (TAC, 342, 343, others)

6. Status of Documents

   a. <u>345.1R – Maintenance of Concrete Bridge Elements</u>, published July 2006. Present Document Status – Due for revision/re-approval in 2014. No action at present.

   b. <u>345.XR – Guide for Concrete Bridge Deck Repair and Rehabilitation</u>

      Chapter 1 – Brown to draft after other chapters

      Chapter 2 – Brown to draft after other chapters

      Chapter 3 – send to 342 as the basis for their new document on Bridge Superstructure Condition Assessment. Overview (brief synopsis) from Jeff Smith/Larry Olson – by April 15, 2012

      Chapter 4 – Weyers to draft – Brown to check status by Oct 31, 2011

      Chapter 5 – to be balloted in October (Brown to post by Oct 31, 2011)

      Chapter 6 – Needs additional sections drafted (St. John/Kim/Williams) by Feb 28, 2012 (see Chapter 6 attached to agenda, thanks, Jimmy)

      Chapter 7 – Sprinkel to draft – by Feb 15, 2012

      Chapter 8 – Brown to draft – by Feb 28, 2012

Chapter 9 – Akbari – Chair received no response from Akbari – subsections reassigned

9.1– Sidewalks – Andy Foden – by May 31, 2012
9.2 –Parapets – Andy Foden – by Feb 28, 2012
9.3 – Joints – Chris Carroll – by Feb 28, 2012
9.4 – Approach slabs – Mark Williams/Devin Harris – by Feb 28, 2012

b. 345.2R – Guide for Widening of Highway Bridges, updated and approved in 1998, reapproved in 2005. Present Document Status – Conditional approval by TAC; final ballot prior to publication. *Thanks for the efforts of Jimmy Kim and Mark Williams in getting this document ready for the final ballot of response to TAC comments which closed on October 15, 2011.*

7. Other Business

a. Strategic Development Council's TMC Technology Review of Waterproof Concrete – Hycrete

Chapter 6. Repair methods

6.1. Repair with advanced composite materials

Materials: Repair of deteriorated bridge decks may be conducted with advanced composite materials such as fiber reinforced polymer (FRP) composites. FRP materials are widely used for aerospace and automotive industries, whereas it has been introduced to structural engineering applications since the 1980's. FRP composites consist of high-strength fibers embedded in a matrix resin. The fibers provide strength of the composite, while the resin bind the fibers and transfer stresses between fibers. For structural engineering applications, three types of FRP composites are widely used: glass FRP (GFRP), aramid FRP (AFRP), and carbon FRP (CFRP). GFRP material shows a tensile strength ranging from 3,000 MPa [435 ksi] to 4,000 MPa [580 ksi] with a density of 2.5 g/cm^3 [0.1 lb/in^3]. AFRP shows a tensile strength of approximately 3,500 MPa [510 ksi] and a density of 1.5 g/cm^3 [0.05 lb/in^3]. The tensile strength of CFRP ranges between 2,500 MPa [360 ksi] and 5,500 MPa [800 ksi] with a similar density to AFRP. The tensile moduli of these composite materials vary from 70 GPa [10,150 ksi] to 350 GPa [50,700 ksi], depending upon the type of fibers. The benefits of using FRP composites include favorable strength and stiffness to weight ratios, non-corrosive characteristics, excellent durability, reduced long-term maintenance costs, low labor expenses, and prompt implementation on site (Neale 2000, Bakis et al. 2002, Teng et al. 2003). FRP materials exhibit excellent fatigue resistance that is necessary for bridge applications (Kim and Heffernan 2008). Typical fatigue damage to FRP composites occurs in a resin matrix and is transferred along the fibers. An emerging composite material called steel reinforced polymer (SRP) is also available for repair of concrete members (Huang et al. 2005, Kim et al. 2005). SRP composites consist of high-strength steel fibers coated with micro-fine brass to improve durability performance. SRP composites may be bonded to concrete surface with epoxy resins as in the case of FRP applications. Further details on FRP composites are available in ACI-440.R-07 (ACI 2007).

Applications: FRP materials may be bonded on tensile soffit of bridge decks using adhesives to increase load-carrying capacity. Two-part epoxy adhesives are widely used for such applications, consisting of resin and hardener. Externally-bonded FRP sheets are the most widely used method for strengthening bridge decks (Fig. 6.1a), whereas near-surface mounted (NSM) FRPs are increasingly used (Fig. 6.1b). NSM FRP applications are conducted in a way that a narrow groove is cut on bridge decks in which FRP strips are inserted and bonded with adhesives. A noticeable benefit of the NSM application is that it will improve the bond performance of FRP composites. Bond is a critical consideration for FRP-strengthening, provided that the effects of strengthening are significantly reducing when bond becomes inadequate. Considerable amounts of research has been reported to examine bond of FRP composites (Taljsten 1997, Bizindavyi and Neale 1999, Smith and Teng 2001, Harries and Aidoo 2006, Lu et al. 2007). Typical bond failure of externally bonded FRP composites occurs i) near flexural critical regions such as midspan of simply-supported beams due to flexural cracks and ii) near the cut-off points of FRPs. Fatigue durability and environmental effects have been studied to evaluate the performance of bonded FRPs (Green et al. 2000, Bizindavyi et al. 2003). Freezing-and-thawing can cause bond deterioration of FRP-concrete interface and two types of failure has been reported such as cohesion failure near the surface of concrete and adhesion failure at the level of adhesives (Green et al. 2000).

Site implementation: Alkhrdaji et al. (1999) reported a case study of strengthening a reinforced concrete deck bridge with NSM CFRP rods and externally-bonded CFRP sheets. The bridge included three spans of simply-supported decks (7.6 m [25 ft] wide and 7.9 m [26 ft.] long). The strengthening design aimed at increasing load-carrying capacity of the deck by 30% when compared to the unstrengthened state. The CFRP rods had a tensile strength of 992 MPa [144 ksi] with a modulus of 119 GPa [17,200 ksi], whereas the CFRP sheets had a tensile strength of 3,800 MPa [550 ksi] with a tensile modulus of 228 GPa [33,000 ksi]. The CFRP sheets were used to strengthen the middle deck of the bridge (Fig. 6.1a).

The concrete surface was sand blasted to improve bond of the CFRP sheets and a primer was applied. The CFRP sheets were then bonded with an adhesive. After curing of the CFRP sheets, a pull-off test was conducted to evaluate the on-site bond property of the CFRP sheets. Another bridge deck was precut to have a groove size of 14 mm [0.55 in.] and NSM CFRP rods (11 mm [0.43 in.] diameter) were inserted into the groove and then bonded with an epoxy adhesive (Fig. 6.1b).

(a) (b)

Fig. 6.1. FRP applications for deck slab (courtesy of Tarek Alkhrdaji): (a) externally bonded FRP sheets; (b) near-surface mounted FRP strips

References

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Teng, J.G, Chen, J.F., Smith, S.T., and Lam, L. 2003. Behavior and strength of FRP-strengthened RC structures: a state-of-the-art review, Structures and Buildings, ICE, 156(1), 51-62.

Future Conventions

	Spring 2012 — The Art of Concrete March 18-22, Hyatt Regency Dallas, Dallas, TX
	Fall 2012 — Forming Our Future October 21-25, Sheraton Centre, Toronto, ON, Canada

8. Announcements:

1	2011 PCI Annual Convention and Exhibition and National Bridge Conference http://www.pci.org/news/index.cfm	October 22-25, 2011	Salt Lake City, UT
2	NRMCA Handling Concrete Specifications, Low Strength Problems	Oct. 26, 2011	Austin, TX
3	ASBI 23rd Annual Convention http://www.asbi-assoc.org/index.cfm/events/events	November 7-8, 2011	Washington, DC
4	Transportation Research Board Annual Meeting	January 22-26, 2012	Washington, DC
5	National Conference on Transportation Asset Management	April 16-18, 2012	San Diego, CA
6	29th Annual International Bridge Conference at the David L. Lawrence Convention Center	June 10th-13th, 2012	Pittsburgh, PA
7	IABMAS 2012	July 2012	Lake Como, Italy