ACI ACTIVITIES RELATED TO FRP

by

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1. **ACI International**

   The American Concrete Institute (ACI International) was established in 1905 and chartered with a goal of guiding and assisting its members and the general public by disseminating information on concrete. ACI International's motto describes this interaction flawlessly...progress through knowledge. Members of ACI International may take part in the development of design codes, standards and practices that affect construction world wide. ACI International's publications include Concrete International, ACI Structural Journal, ACI Material Journal and more than 400 technical documents. Also included are publications such as ACI 318 Building Code Requirements for Structural Concrete and the five-part ACI Manual of Concrete Practice known as the “encyclopedia of the concrete world”.

2. **ACI Committee 440 - FRP Reinforcements**

   At the Spring 1991 Convention in Boston, Massachusetts, USA, an exploratory meeting was held with the intent to form a new technical committee with the mission of studying and reporting on research, development and uses of fiber reinforce polymer (FRP) reinforcing bars and prestressing tendons and of developing guiding documents for the use of these materials in reinforced concrete. The meeting, attended by 17 people, resulted with the official formation of such a committee.

   After eight years of existence, ACI Committee 440 has 54 voting members, 62 associate members and 11 consulting members. Presently, the technical, educational and management activities of the committee are handled by the following subcommittees: (A) Membership, (B) Title and Mission, (C) State-of-the-Art Report, (D) Research, (E) Professional Education, (F) Repair, (G) Student Education, (H) Reinforced Concrete, (I) Prestressed Concrete, (J) Stay-in-Place Formwork and (K) Material Characteristics. The major tasks under completion are design and construction documents (in the form of guidelines or provisional codes) for RC and PC structure and repair.

   ACI Committee 440 organized the First International Symposium on FRP Reinforcement for Concrete Structures in Vancouver, British Columbia, Canada, during the Spring 1993 Convention (see ACI Special Publication 138 for the symposium proceedings). This event has
continued and is held every two years. After Belgium in 1995 and Japan in 1997, the fourth symposium will be held again in North America (Baltimore, Fall 1999 Convention).

In the spring of 1996, ACI Committee 440 published the State-of-the-Art Report on FRP Reinforcement available as publication ACI 440R-96.

3. Fourth International Symposium on FRP

The Fourth International Symposium on FRP Reinforcements for Concrete Structures (FRPRCS-4) will be held during the ACI Fall Convention, October 31 to November 6, 1999, in Baltimore, Maryland, USA. The symposium themes are classified as follows:

- Properties of FRP Reinforcements
- Manufacturing and Quality Control of FRP Reinforcements
- Performance of Concrete Structures Using FRP Reinforcements
- FRP Repair/Strengthening Systems
- Use of FRP in Masonry Structures
- Bond, Durability and Compatibility of FRP Reinforcements in Concrete Structures
- Case Studies of FRP Reinforcements, Design and Implementation
- Code and Standards Development of FRP Reinforcements

4. ACI Special Publication

ACI Committee 440 produced a “State-of-the-Art Report on Fibre Reinforced Plastic Reinforcements for Concrete Structures” (Special Publication ACI 440R-96). The report summarizes the state of knowledge on these materials up to 1996. The report includes:

- Introduction and History
- FRP Composites: An Overview of Constituent Materials
- Mechanical Properties and Test Methods
- Design Guidelines
- Behaviour of Structural Elements
- Prestressed Concrete Elements
- External Reinforcement
- Field Application
- Research Needs
- References

5. Guidelines for Selection, Design and Installation Systems for External Strengthening of Concrete Structures

In 1995, ACI Subcommittee 440-F, chaired by R. McCullough, was charted by ACI Committee 440 to write a pre-code guidelines loosely modeled after ACI 318. After significant debate, the following format was agreed to in the fall of 1996. The document is currently in its final draft stage and is expected to be balloted by the ACI Committee 440 at the ACI Spring Convention in Chicago, Illinois, March 14 to 19, 1999. The current outline, subject to approval of the committee
and final approval by the ACI Technical Activities Committee, are:

- Chapter 1: Introduction
- Chapter 2: General Requirements and Considerations
- Chapter 3: Properties of Materials
- Chapter 4: Evaluation of Existing Structures
- Chapter 5: General Considerations for Use of FRP Systems
- Chapter 6: Structural Design and Repairs
- Chapter 7: Shipping, Storage and Handling
- Chapter 8: Preparation of Concrete Substrate for FRP Application
- Chapter 9: Installation
- Chapter 10: Quality Control and Quality Assurance
- Chapter 11: Maintenance and Repair of Strengthening Systems
- Appendix A: Glossary

6. **Provisional Design Recommendation for Concrete Reinforced with FRP Bars**

ACI Subcommittee 440-H, co-chaired by S. Faza and A. Nanni, submitted a draft of the above-noted document to be voted on by ACI Committee 440 at the ACI Spring Convention in Chicago, Illinois, March 14 to 19, 1999. The document consists of the following five sections:

- **Section I: Design of Concrete Reinforced with FRP Bars**
  - Chapter 1: Introduction
  - Chapter 2: Terminology
  - Chapter 3: Notation
  - Chapter 4: Historical Development of FRP Reinforcements
  - Chapter 5: Material Characteristics for Design
  - Chapter 6: Flexural Strength and Design Procedures
- **Section II: Recommendation for Code Modifications**
- **Section III: Design Examples**
- **Section IV: Construction Recommendations for Concrete Reinforced with FRP**
- **Section V: Manufacturers’ Specification Data**

Based on the approval of ACI Committee 440, the document will then be reviewed by the ACI Technical Activities Committee for final approval and publication.

7. **Standard Test Methods for FRP Rods and Sheets**

The second draft of the above-noted document is being prepared by ACI Subcommittee 440-K, co-chaired by S. Faza and B. Benmokrane. The document is expected to be voted on by ACI Committee 440 at the ACI Spring Convention in Chicago, Illinois, March 14 to 19, 1999. The document is divided into two parts as follows:

- **Part I: Standard Test Methods for FRP Rod**
  - Standard Test Method for Cross-sectional Area of FRP Rod
  - Standard Test Method for Tensile Strength and Modulus of FRP Rod
Standard Test Method for Creep of FRP Rod
Standard Test Method for Long-term Relaxation of FRP Rod
Standard Test Method for Tensile Fatigue of FRP Rod
Standard Test Method for Coefficient of Thermal Expansion of FRP Rod
Standard Test Method for Performance of Anchorage of FRP Rod
Standard Test Method for Performance of Couplers of FRP Rod
Standard Test Method for Performance of Anchoring Section of FRP Rod
Standard Test Method for Bond Strength of FRP Rod
Standard Test Method for Shear Properties of FRP Rod
Recommended Anchor for Testing FRP Specimen under Monotonic, Sustained and Cyclic Tension
Bent Strength of FRP Rod

Part II: Standard Test Method for FRP Sheet
Standard Test Method for Direct Tension Pull-off Test
Standard Test Method for Tension Test of Flat Specimen
Standard Test Method for Overlap Splice Tension Test

8. **Student Competition**

ACI Subcommittee 440-G, currently chaired by V. Brown, organizes an annual international student competition at each ACI Spring Convention and the winners are presented with a certificate, a cash prize, subscriptions to Concrete International and CDA magazine, and free admission to the annual Composite Institute Conference and Expo. At last spring’s convention, 14 teams out of 21 submissions were selected to compete in the FRP beam competition. The competition, conducted at the University of California, included two types of glass fibre polymer rebars. The competition included design and construction of 5.5" X 2.5" concrete beams reinforced with FRP bars to a span of three feet. The beam was then subjected to concentrated loads at mid-span and tested to failure. Six prizes were awarded based on the highest ultimate load capacity of the beam and the most accurate prediction of the load. Funding was made available to students to help defray some of the travel expenses associated with attendance at the competition. Complete competition rules and details are published each year in Concrete International magazine.

9. **Other Documents in Progress**

Other technical subcommittees are working on the following documents:

- Subcommittee 440-I, chaired by C. Dolan, “Provisional Design Recommendations for Concrete Prestressed with FRP”.
- Subcommittee 440-D, chaired by M. Porter, white paper on “Research Needs”.
- Subcommittee 440-E, chaired by C. Goodspeed, is developing a course package for training consultants, educators, government agencies and highway engineers on the use of FRP in structures. The course will consist of slides with associated narrative using PowerPoint.