

NEx Workshop on Designing Concrete Structures Reinforced with GFRP Bars

Recognizing the importance of developing knowledge sharing, NEx: An ACI Center of Excellence for Nonmetallic Building Materials organized its first workshop on designing with the new ACI CODE-440.11-22, “Building Code Requirements for Structural Concrete Reinforced with Glass Fiber-Reinforced Polymer (GFRP) Bars—Code and Commentary.” Sponsored by Aramco and NEx, the event took place on October 26, 2022, at the ACI Concrete Convention in Dallas, TX, USA.

With growing interest and use of glass fiber-reinforced polymer (GFRP) reinforcing bars in various applications, NEx aimed to expand the knowledge and awareness of the newly developed code. Waleed Al-Otaibi, NEx President and Aramco Nonmetallic Project Management Office (PMO) leader, provided the opening remarks and stressed the importance of using more sustainable and reliable materials in the construction sector. Maria Lopez, Chair of ACI Committee 440, Fiber-Reinforced Polymer Reinforcement, and Jerzy Zemajtis, NEx Executive Director, were the workshop moderators.

The workshop featured presentations by four speakers and lunch with a keynote address by Mohammed Al Mehthel from Aramco. The workshop topics included:

- Part 1: Overview of GFRP Reinforced Concrete, by Carol K. Shield, Professor Emeritus, University of Minnesota, Minneapolis, MN, USA;
- Part 2: Serviceability and Flexural Design, by Vicki L. Brown, Professor, Department of Civil Engineering, Widener University, Chester, PA, USA;
- Part 3: Shear and Torsion Design and Detailing, by Doug Tomlinson, Associate Professor, Department of Civil and Environmental Engineering, University of Alberta, Edmonton, AB, Canada; and
- Part 4: Columns, Fire, and Structural Analysis, by William J. Gold, ACI Senior Engineer, Farmington Hills, MI, USA.



From the right, NEx workshop presenters Vicki Brown, Carol Shield, Doug Tomlinson, and Will Gold, with Jerzy Zemajtis, NEx Executive Director, in the back. From the left, Aparna Deshmukh, NEx Technical Director; Oscar Salazar Vidal, NEx Steering Committee member, Aramco; Gusai AlAithan, NEx Liaison Director, Aramco; Maria Lopez, Chair of ACI Committee 440; and Waleed Al-Otaibi, NEx President and Nonmetallic PMO leader at Aramco

During her presentation, Shield provided a definition for GFRP bars, discussed the mechanical properties and behavior of GFRP bars, and introduced available standards and guides on fiber-reinforced polymer reinforcement. She then compared ACI CODE-440.11-22 with ACI 318-19 and discussed major differences in design with GFRP bars in comparison to design with conventional steel reinforcement. Shield concluded with applications for GFRP reinforcement.

Brown discussed the changes in ACI CODE-440.11-22 from ACI 318-19 in Chapter 9—Beams and Chapter 7—One-way Slabs, followed by an introduction to design properties of GFRP bars. Then, she moved on to the serviceability of GFRP reinforcement, with an example of design for serviceability, and flexural strength of GFRP reinforcement, with an example of a design for flexural strength.

Tomlinson focused on Chapter 22—Sectional Strength (Shear and Torsion) and Chapter 25—GFRP Reinforcement Details, with a discussion on one-way shear strength, beam requirements for shear (Chapter 9), torsional strength, beam reinforcement limits and spacing, and transverse reinforcement detailing, with an example on shear and torsion reinforcement calculations. In the section on detailing, Tomlinson covered bond and development of GFRP reinforcement, reduction for excess reinforcement, and splices, and provided a detailing example.

Gold presented a discussion on Chapter 10—Columns, Chapter 4—Structural System Requirements, and Chapter 6—Structural Analysis. First, Gold introduced column design philosophy and discussed designing GFRP reinforced columns. Then he focused on the structural analysis of GFRP reinforced concrete structures and fire resistance of structural concrete with GFRP bars.

The workshop ended with a wrap-up, questions and answers, and concluding remarks from Antonio Nanni,



Participants of the first NEX workshop at the ACI Concrete Convention in Dallas, TX, USA

NEX Board Director.

Over 80 attendees participated in the workshop. NEX plans on organizing similar workshops at future ACI conventions.

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