ACI 447.1R-18

Report on the Modeling Techniques Used in Finite Element Simulations of Concrete Structures Strengthened Using Fiber-Reinforced Polymer (FRP) Materials

Reported by Joint ACI-ASCE Committee 447

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First Printing
August 2018
ISBN: 978-1-64195-026-8

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American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331
Phone: +1.248.848.3700
Fax: +1.248.848.3701

www.concrete.org

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Ganesh Thiagarajan, Chair

Jian Zhao, Secretar

Riadh S. Al-Mahaidi*
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Gilles Pijaudier-Cabot

Syed Mizanur Rahman
Victor E. Saouma
Frank J. Vecchio
Kaspar J. Willam

*Primary author.

The committee acknowledges R. Kalfat for contributing to this report.

The strengthening of reinforced concrete (RC) members using fiber-reinforced polymers (FRPs) as externally bonded reinforcement has been widely used to enhance the flexural, shear, and axial capacity, or any combination thereof, of structural elements. Although experimental testing has been used predominantly as the sole method of investigation, numerical techniques such as the finite element (FE) method have also been gradually developed to provide predictive models for structural characterization. Well-calibrated FE models have the potential to expand the range of experimental data, provide information on important parameters difficult to measure using experimental instrumentation, and aid in the design of systems requiring complex FRP strengthening where testing may not be possible. This report provides a state-of-the-art review in the area of modeling of FRP-strengthened RC members and provides general guidelines on the best modeling practices that capture the complex phenomenon of concrete cracking and crushing, concrete shear retention, concrete fracture energy, steel-to-concrete bond behavior, FRP-to-concrete interface, FRP debonding failure modes, and FE mesh dependency.

Keywords: bond; fiber-reinforced polymer; finite element modeling; fracture energy; interface; reinforced concrete; shear retention.

ACI 447.1R-18 was adopted and published August 2018.