# DISTINGUISHED SEMINAR SERIES

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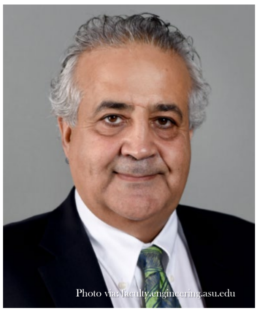
# Flexural Modeling and Design of FRC, TRC, and UHPC Cement Composites

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**Monday October 25, 2021**
12PM - 1PM EST
**Churchill 101**

*Please arrive early to prevent disruptions.*

**ABSTRACT:** An overview of the experimental and modeling work on the structural testing, simulation, and design of Fiber and Textile reinforced Concrete (FRC, TRC) and Ultra-High-Performance Concrete (UHPC) materials are presented. The significant ductility and tensile capacity of these materials make them candidates for structural load-bearing properties where tensile and flexural stresses dominate. During the first part of the presentation, an overview of the potential use of these new three classes of composites in structural design is presented. A series of mechanical testing using uniaxial tension, high-speed tension, flexural and structural tests of full-scale tunnel lining, and slabs are used to define the importance of these materials in the serviceability-based design domain. Using digital image correlation and closed-loop testing methods the post-cracking ductility is addressed through the characterization of stress crack-width relationship and the role of fibers in the toughening and crack distribution.

The main design parameters consist of the mechanical properties of the materials in terms of the piecewise linear strain-hardening or softening composite response. Using the homogenization from a microstructural level to the macro level, the modes that contribute to the ductility under varying loading combinations relate the reinforcement and matrix's interaction and the role of reinforcing mechanisms on ductility through distributed cracking and crack distribution.

Development of the design tools is based on the generation of closed-form solutions for the moment-curvature response of a section of arbitrary shape with different tensile and compression constitutive law, and reinforcement position and properties. The design equations are developed by the calculation of stress distribution, deflection, curvature, with the parametric composite model utilizing the nonlinear response in the strain hardening and softening. These derivations are evaluated to point out the effect of uniform and varying strain fields, interface mechanics, flexural toughening and movement of the neutral axis, as well as imposing shear failure criteria. Using a simplified moment-curvature response, the load-deflection distribution along the length of a beam can also be obtained. Guidelines for the development of tools for specialized applications for hybrid reinforced concrete systems, TRC, UHPC, and sandwich composites are presented and applied to classic reinforced concrete sections. Specialized cases of bridge deck slabs and girders, water retaining structural panels, light-rail track slabs, and segmental tunnel linings are simulated and compared with the experimental data. The generalized models address the flexural design using parameters such as maximum allowable curvature, crack width, deflection, or any other serviceability-based criteria through the parameterized moment-curvature relationship. A variety of sustainable design guidelines for new applications and hybrid systems, minimum reinforcement, maximum crack width limits, as well as stiffness, and deflection-based criteria are possible.

**BIO:** Dr, Mobasher is a professor of civil and environmental engineering at Arizona State University, where he joined in 1991. His research expertise lies in theoretical and experimental mechanics of solids, focusing on new construction materials.