Functionally Graded Concrete for the Civil Infrastructure
– A Multifunctional Material System Approach

Kyounsoo Park, Glaucio H. Paulino and Jeffery R. Roesler
Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign, U.S.A.

Motivation
- Functionally Graded Concrete to achieve multi-objectives
- Layers of specific material properties placed at optimal location and thickness to enhance overall performance
- Achieving high performance rigid pavement system

Fibers: provide toughening mechanisms in concrete

Research Objectives
- Constitutive modeling for fracture mechanisms of fiber reinforced concrete (FRC) through cohesive zone model
- Study the placement and thickness of concrete materials in order to optimize the fracture resistance and behavior

Experimental & Computational Setup

Test Program
- Plain concrete
- Fiber reinforced concrete
- FRC layer at the top
- FRC layer at the bottom

Material Properties

Elastic modulus, \( E = 30 \) (GPa), \( f_t' = 3.9 \) (MPa), \( G_1 = 38.1 \) (N/m), \( G_2 = 145 \) (N/m), \( G_{\text{FRC}} = 2562 \) (N/m), \( \psi_{\text{FRC}} = 0.0157 \) (mm), \( I = 40 \) (mm)

Finite Element Modeling

Effect of Material Thickness Variation

Cost Benefit Analysis

Conclusions
- Proposed softening model captures fracture behavior of PCC, FRC, and layered FRC
- Fracture process zone is divided into aggregate bridging zone and fiber bridging zone
- This investigation can lead to optimal thickness and position of materials in concrete pavements increasing cracking resistance while minimizing costs

Acknowledgement
- National Science Foundation (NSF) under Research Grant Number CMMI 0800805

References