

# **Nanomechanics and Multiscale Modeling of Sustainable Concrete**

Vahid Zanjani Zadeh, Christopher P. Bobko

North Carolina State University, Civil, Construction and Environmental Engineering, Campus Box 7098, Raleigh, NC 27695, U.S.A.

The main objective of this research is multiscale modeling of four kinds of sustainable concrete from nano to macroscale level, and the immediate objective is to predict and determine the effects of the different admixtures on concrete microstructure. In this research, intrinsic nanoscale mechanical properties of four types of sustainable concrete (concrete with kenaf, lightweight aggregate and containing fly ash/slag) are determined by nanoindentation technique followed by statistical analysis. Afterward, a multiscale modeling framework was developed to upscale the results from nano to macro. With this information in hand, the methodology may help to assess different mixtures and finally optimize the performance of concrete and its components. Thereby, it can benefit both minimizing cement consumption and developing durability based design codes based on sustainability.

So far it was found that C-S-H phases in cement paste formed by ordinary Portland cement and cements blended with fly ash, blast furnace slag and kenaf fibers are virtually identical. The only variance is volume fraction of hydration products. Considerable porous phase was observed in the concrete bulk; also ITZ around aggregates in concrete containing fly ash and slag was denser than conventional concrete. In addition, microstructure of the cement paste around the kenaf was different than bulk because of internal curing effect of fibers.