

Optimizing Performance-Engineered Concrete using Thermodynamics

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ABSTRACT

Portland Cement-based Concrete is a multiphase, multiscale, and multiphysics material. It is the second most used material by humankind after water, while simultaneously being one of the least understood materials at the micro- and nano-scale. In this talk we will introduce concrete as a building material, reason the multiscale nature of the material, and elucidate some of the approaches in history used to model such a complex material. Cement and concrete manufacture account for 8% of global CO₂ emissions, and thus developing sustainable concrete is the need of the hour. One such modelling framework based in thermodynamic modelling is presented, which can be used to predict the reaction products. A pore partitioning model is then used to predict the pore volumes at the nano- and micro-scale, which is then scaled up to predict concrete performance using structure-property relationships. We will also present tools used to characterize the raw materials used in modern cements, which are inputs to the modelling framework. We will present applications of the developed framework to develop and optimize concrete mixtures for least cost or carbon emissions or some combination of the two, and some ongoing research on the performance of low-carbon concrete exposed to fire.

ABOUT THE SPEAKER



Dr. Keshav Bharadwaj is an Assistant Professor at IISc in the Civil Engineering Department. He was previously an Assistant Professor at IIT Delhi. He has earned his B.Tech. in Civil Engineering and M.Tech. in Applied Mechanics from IIT Madras and Ph.D. in Civil Engineering from Oregon State University. His research focusses on developing sustainable, durable, performance-engineered concrete and he currently works on Durability of concrete from a microstructure to engineering perspective, Multi-blended sustainable binders, Thermodynamic and service life modeling, and, Developing sustainable performance-engineered concrete. Dr. Keshav Bharadwaj received the Wason Medal for Materials Research from American Concrete Institute, an Honorable mention for the Innovandi Nanocem Best Ph.D for research in the areas of pozzolanic reactivity and concrete durability, and is an Infosys Young Investigator at IISc. He is also currently the RILEM Youth Council representative for the South Asia region, and is the associate editor for Journal of Materials in Civil Engineering and the Journal CEMENT.

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