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## Embedded-smart PZT sensors for combined local and distributed monitoring of concrete structures

Hydration process of concrete begins when concrete is mixed with water. Development of the early age properties of concrete are important in determining the load carrying capacity of concrete structures during construction and service. Early age monitoring of concrete is difficult due to the presence of moisture and the highly alkaline environment inside concrete. In-situ monitoring large volume of concrete in structures requires a large number of robust sensors. In this study, an embedded PZT sensor, which can be placed inside concrete and has protection from alkaline and moist environment of concrete is developed. An array of PZT sensors are placed inside a concrete structure at the time of casting for monitoring changes in the material over a 28-day period. The PZT sensors are used in localized and distributed sensing modes. The localized sensing is based on monitoring the changes in the electrical impedance (EI) of an embedded PZT sensor. Changes in EI measurements are shown to sensitively reflect the changes in hydrating concrete as it transforms from a fluid to a solid state and during the strength gain of the solid material. In the distributed measurement, PZT sensors are used as actuator-receiver (AR) pairs for global monitoring of concrete. The changes in the stress-waves propagating through the concrete produced by changes in the material medium are monitored. The changes in the hydrating concrete along the stress wave travelling path are sensitively reflected in AR measurements. The EI and the AR measurements techniques are combined to develop an effective methodology for monitoring the early age changes in large volumes of concrete with less number of PZT sensors. The EI measurements are used to assess the changes in vicinity of sensor and the AR measurements are used to assess the changes in bulk of concrete.

### Biography

Kolluru V L Subramaniam is currently a Professor in the Department of Civil Engineering at Indian Institute of Technology Hyderabad (IITH). Prior to joining IITH, he was the Catell Fellow and Professor of Civil Engineering at the Grove School of Engineering, City College of New York. He received the James Instrument Award from the American Concrete Institute (ACI) in 1999 for his research on nondestructive evaluation of concrete. He is the recipient of the Early CAREER award from the National Science Foundation of U.S.A. for research on nondestructive evaluation of microstructure development in hydrating cement. He was the Chairman, committee 215 on Fatigue of Concrete of the ACI. In 2009, he was elected as a Fellow of the American Concrete Institute. He is an Associate Editor of the Journal of Materials in Civil Engineering (ASCE).

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