Online Monitoring System for Concrete Structures Affected by Alkali-Silica Reaction (ASR)

PI: Jinying Zhu
The University of Nebraska Lincoln (UNL)

Program: RC-5
Information, Instrumentation And Controls

Collaborators:
Paul Ziehl: The University of South Carolina (USC)
Eric Giannini: The University of Alabama (UA)
Ying Zhang : Georgia Institute of Technology (GT)
Vivek Agarwal: Idaho National Laboratory (INL)

ABSTRACT:

Alkali-silica reaction (ASR) is a chemical reaction in concrete between certain siliceous minerals and alkali hydroxides in the pore solution that can lead to expansion and cracking of concrete structures. ASR has resulted in deterioration and loss of serviceability of numerous concrete infrastructures, including transportation, hydraulic, and nuclear power plants (NPP) structures. Although considerable success has been obtained on minimizing the risk of ASR in new construction, diagnosis and evaluation of the extent of damage along with prognosis of the long-term performance of existing structures remain challenging topics in research and practice.

To support long-term operational and maintenance decision making, structural health monitoring (SHM) is required to provide information regarding material degradation and structural integrity. The goal of this project is to develop a dual-mode online SHM system that integrates active and passive sensor networks with advanced signal processing algorithms to monitor ASR induced degradation in reinforced concrete structures. To achieve this goal, the following specific objectives are proposed:

- Design and fabricate concrete specimens that represent ASR damage found in existing NPP structures;
- Develop a highly-sensitive active sensing technique using diffuse ultrasonic waves to monitor ASR initiation and development in concrete
- Develop a passive sensing technique using acoustic emission for ASR monitoring and crack mapping
- Establish the relationship between SHM information and ASR damage
- Extract useful information from ultrasonic and acoustic emission signals, to enable the development of diagnostic models
- Validate the developed dual-mode SHM system on large-scale, realistically reinforced specimens that will be fabricated under the direction of Oak Ridge National Laboratory

This project brings together a multidisciplinary research team with expertise in ultrasonic NDE, acoustic emission/online SHM, concrete materials science, and signal processing. All investigators are proven experts in their specific task areas, and have access to state-of-art facilities to be successful. This collaborative project will provide support to a probabilistic SHM framework under development at Idaho National Laboratory (INL). The proposed SHM system will enable health diagnosis and prognosis of aging NPP concrete structures, to enable risk management based decision making by plant operators.