MICROSTRUCTURAL HOMOGENIZATION TO MODEL THE SIGNIFICANCE OF ASR ON MECHANICAL RESPONSE OF CONCRETE

Mahmoud M. REDA TAHA
Department of Civil Engineering, University of New Mexico
Albuquerque, NM, USA, 87131-0001, e-mail: mrtaha@unm.edu

Tai FAN
Department of Civil Engineering, University of New Mexico
Albuquerque, NM, 87131-0001, USA, e-mail: fantai@live.com

Jung J. KIM
Department of Civil and Environmental Engineering, Sejong University
Seoul, South Korea 143-747, e-mail: jungjkim@sejong.ac.kr

ABSTRACT

Alkalis in cement react with reactive silica in aggregate in the presence of water in what is known as alkali-silica reaction (ASR). When ASR takes place, it produces gels that absorb water and expand. Swelling of ASR gels can damage concrete and cause cracking and volume expansion in concrete structure. In this paper, mechanical consequences of ASR on concrete are simulated by a discrete homogenization model. Representative volume element (RVE) of concrete is built as a cluster of cement paste and aggregate particles connected by interfacial transition zone (ITZ), which includes contact and cracking mechanisms to consider particle interaction. The mechanical evolution of concrete subjected to ASR is achieved from microstructural behaviors: volume expansion of reactive elements induces internal stresses and cause debonding and cracking. Stress-strain curve of concrete is attained via the homogenization approach. A case study is used to demonstrate the proposed microstructural homogenization method. The simulated results using the proposed model are in good agreement with the experimental concrete with ASR observations reported in the literature. The effect of continuous cement hydration on concrete deterioration due to ASR is also examined.

Keywords
Homogenization, Alkali-Silica Reaction (ASR), Cracking.