# MSE SEMINAR

**Materials Science and Engineering**
**Michigan Technological University**

Tuesday, February 11, 2014
11:00 am – 12:00 pm
Room 610, M&M Building

## Concrete: The First – and Last – Engineered Material?

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### Abstract

Concrete has been used by mankind for thousands of years and was originally produced from combinations of natural materials, including volcanic ash as the primary cementitious material. In 1824, portland cement was patented and its use as the key cementitious material became widespread to produce modern portland cement concrete (PCC). As a construction material, PCC is desired for its durability and its relative ease of production. In spite of its long history of use, PCC, is not a well understood material and significant challenges exist. These can be broadly grouped into issues related to performance (i.e., durability) and issues related to PCC production (i.e., sustainability). With respect to durability, PCC performance suffers from a) a lack of quality control in production including appropriate test methods, b) complex interactions between the various constituents of PCC, and c) an increased susceptibility to the environment partially affected by a) and b). Examples of materials interactions include alkali silica reactivity (ASR), which occurs between the aggregates in concrete and the high-pH portland cement based binder, and improper air entrainment leading to physical deterioration by cyclic freeze-thaw exposure. Both of these durability challenges are understood, but not to the point where a fundamental change in PCC mixtures can be recommended. From a sustainability perspective, PCC is largely impacted by the production of portland cement, which accounts for well over 90% of the embodied energy and green house gas (GHG) production associated with PCC. To address the sustainability issues, new non-portland cement binder systems are being developed that in many ways take us back to the starting point of using natural materials as a cementitious binder system. The most prevalent example is geopolymeric materials, which are not hydraulic in nature (i.e., do not harden in the presence of water) but rapidly harden and gain strength when exposed to highly alkaline solutions. Geopolymer cements constitute a growing area of research and offer to be a potential replacement for portland cement, but much additional research is needed.

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