EMERGING PROFESSIONALS

Geopolymers: Alternatives for Sustainable Development
Behzad Majidi, Laval University

In 2013, world cement production was approximately 4 billion metric tons. The process is highly material and energy consuming, with CO₂ emissions attributed to Portland cement production alone comprising roughly 8% of global emissions. Thus, high energy usage and CO₂ emissions combined with high consumption of limestone-based raw materials make Portland cement production unsustainable.

Geopolymers present a promising alternative. In the 1950s, Victor Glukhovsky first introduced alkali-activated cements, which were then developed, formulated, and named geopolymers by Joseph Davidovits in the 1970s. Total CO₂ emissions for the production of geopolymer cements is estimated to be only one-sixth that of Portland cement.

A wide range of natural clays and industrial residues, such as Tungsten mine residue, red mud, and blast furnace slag, have been successfully used in the production of geopolymers. It is important to note that annual global production of red mud exceeds 70 million metric tons and it is considered one of the most important industrial waste disposal problems. Use of these materials in the production of geopolymers provides a convenient and economical way to dispose of these industrial byproducts. In addition to fewer environmental issues, superior properties of geopolymers such as high compressive strength, short setting time, fire resistance, and high resistance to chemical attacks make them serious alternatives to Portland cement. Several applications of geopolymer composites have been reported in the aerospace industry.

A critical question is, “Why does the industry, in particular the construction industry, have such an inertia to shift to geopolymer alternatives?” The answer seems to be that Portland cement has been in widespread use over the last two centuries and, therefore, strong knowledge and experience have been developed about its properties and long-term behavior. On the contrary, geopolymer technology is new and a conservative view to new materials exists in industry.

How many more years can Portland cement sustain production? Is now the right time to invest in geopolymers? In any case, a turning point will arrive soon in the industry—a time to go green and switch to a sustainable solution.