

The 12th International Congress on the Chemistry of Cement

The 12th International Congress on the Chemistry of Cement (co-organized by the National Research Council of Canada and the Cement Association of Canada) was held in Montreal Canada, July 08–13, 2007. The theme of the Congress was, *Cement Systems—a Knowledge-based Approach*. About 660 delegates and exhibitors from more than 60 countries participated. The program comprised more than 400 oral and poster presentations with eight parallel sessions.

The Opening Ceremonies featured Dr. J. Francis Young as keynote speaker. He spoke about the heritage of cement chemistry and provided an informed view of the scientific highlights from past Congresses. Future research directions were seen as: sustainability and durability issues utilizing sophisticated model-based approaches; reduction of greenhouse gases through the use of modified Portland or non-Portland cements; controlled *in situ* production of concrete using field computers.

Plenary lectures on each of the eight sub-themes were delivered by internationally recognized researchers in the field of cement and concrete science. There were two lecturers for each sub-theme with the exception of the lecture on standards where there was one. These lectures provide the content for this special issue. A brief description of each contribution follows.

J. Lukasik and J. Damtoft addressed the subject of sustainable development and climate change initiatives. An informed perspective on the cement industry involvement including strategies for positively affecting climate change was presented. Key performance indicators for sustainability as well as principal routes for progress were described. The importance of research and development for bringing innovation into concrete construction technology was stressed.

K. L. Scrivener and R. J. Kirkpatrick spoke to innovations in cement and concrete science. Understanding the micro and nanoscale physical processes underlying macroscopic performance was considered invaluable. Sustainability was viewed as a major driver for innovation. The application of atomic and molecular scale computational methods was advanced by Kirkpatrick as a means to provide the basic knowledge for innovation in cementitious materials. The computational methods were seen as enabling the connection between the atomic and macroscopic length and time scales.

R.D. Hooton presented his views on bridging the gap between research and standards with a concentration on North American standards. He provided an informed perspective on the transition from prescriptive to performance-based specifications and the lag of standards behind new developments. Historical and recent developments in standards relating to cementitious materials were addressed and insights on future directions given.

I. Richardson and H. Van Damme spoke to hydration chemistry and the structure of cement systems. Richardson reviewed existing models for the nanostructure of C-S-H. Hal Taylor's contribution to resolving the structure of both jennite and metajennite was highlighted. Discussion of the nanostructure of C-S-H present in cement pastes was facilitated by Richardson's viewpoints on the applicability of the tobermorite–jennite and tobermorite–'solid-solution' calcium hydroxide structure.

Van Damme discussed the nature of the C-S-H structure using analogies based on the physical chemistry of clays. References were made to earlier work by T.C. Powers and the surprising accuracy of his predictions.

S. Hanehara and D. Bentz reviewed the state-of-the-art on rheology and early age properties of cement. Hanehara addressed the rheology issues. He conducted an in-depth review of rheology principles and test methods. Recent developments with chemical admixtures were highlighted including the development of multifunctional superplasticizers. Mechanisms of dispersion, adsorption and compatibility issues with various cements were discussed.

Bentz focused on the major physical and chemical processes occurring at early ages. The versatility of the X-ray adsorption technique for monitoring the effects of drying and moisture transport was demonstrated. Effects of environmental factors such as chemical shrinkage, self-desiccation and internal relative humidity were described.

C. Hall and J. Skibsted presented an appraisal of modern characterization techniques with Skibsted focusing on NMR methods. It was noted that the combined use of X-ray diffraction and NMR methods remains as valuable today as in the past. The emergence of Rietveld analysis of cements and synchrotron advances were discussed. Other techniques

covered included X-ray absorption spectroscopy, high resolution MAS NMR, ^1H relaxation NMR, Raman spectroscopy. It was emphasized that experimental techniques must provide chemical and structural information at all approximate scales and throughout transformation processes.

F. Glasser and J. Marchand spoke to the durability and degradation of cement systems. Glasser focused on the underlying chemical principles and Marchand on numerical modeling. Mechanisms that govern the transport of ions, moisture and gas and their deleterious interactions are described. The lack of rigor (relating to physical and chemical processes occurring in aggressive environments) with empirical testing protocols is emphasized. A combination of targeted experiments coupled with numerical modeling is recommended for the best results.

A. Bentur and D. Mitchell provide an excellent assessment of concrete materials performance based on field experience. The practice of specifying and monitoring concrete quality on the basis of strength was questioned by Bentur. The need for

modelling tools to predict cracking and corrosion of reinforcement was underlined. Minimizing the risk of cracking during construction by reducing thermal and shrinkage stresses was advocated. Standards based on a performance approach to concrete design were endorsed.

The plenary papers published in this special edition of *Cement and Concrete Research* present a broad but integrated view of the Congress theme. They reflect the significant progress since the previous Congress and the spirit of cooperation between researchers in industries, universities and public sector institutions. The emergence of numerical modelling as a tool for sustainable innovation is recognized.

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