

BOOK REVIEWS

Handbook of Fiber-Reinforced Concrete

Reviewed by Paul Klieger, Consultant, Concrete & Concrete Materials, Northbrook, Illinois

REFERENCE: Beaudoin, James J., *Handbook of Fiber-Reinforced Concrete*, National Research Council of Canada, 1990. Building Materials Science Series, Noyes Publications, New Jersey. ISBN 0-8155-1236-8.

Dr. Beaudoin has produced a book which is a much-needed update of the technology of fiber-reinforced concrete. It is more than a handbook, as the title states. It is a textbook that provides a distillation of the vast amount of research and development work that has been performed by many investigators, particularly in the past 25 or 30 years.

As the author notes in the Preface, "The use of fibers to reinforce brittle materials can be traced to biblical times when straw was used in brick manufacture (Exodus 5:7)." Steel fibers in hydraulic cement systems were used in the early 1900s. As Dr. Beaudoin points out, the development of a rigorous approach to the prediction of cement composite properties has evolved only in the last 30 years. Accompanying this has been a considerable amount of research which has pointed out the importance of matrix and interface microstructure and their influence on the composite's mechanical properties and durability in our often aggressive environment. These developments should promote a significant appreciation of the capability of fiber reinforcement to enhance the performance of hydraulic cement-based systems and extend their use in and beyond conventional construction techniques. Dr. Beaudoin's books should aid such an effort materially.

The book begins with a review and discussion of the principles governing the performance of fibers, both discontinuous and continuous, in cement matrices. These include stress transfer, fiber-fiber interaction, critical fiber volume, mechanical properties, fiber-matrix bond, load-deformation of composite systems, fracture toughness and models, and the use of practical toughness descriptors. This chapter is very heavy on theory and obviously directed to the serious researcher. Following this opening chapter is an excellent discussion of the microstructure of fiber-reinforced cement systems, with a particularly pertinent description of the hydrated cement matrix and the fiber-reinforced matrix. Attention is directed to modifications to the microstructure of the matrix when fibers are added and the microstructure of the fiber-matrix interface, the latter playing a very significant role in the performance of the fiber-reinforced composite. The high concentration of calcium hydroxide crystals in the interface zone appears to be an important parameter with respect to both mechanical performance properties and durability.

Following these two opening chapters are chapters dealing with steel fibers, glass fibers, polypropylene fibers, and natural and mineral fibers. These chapters are replete with presentations of the latest information on the influence of these fibers on mechanical properties such as flexural and tensile strength, compressive strength, toughness (probably one of the more attractive aspects of fiber-reinforced cement systems), creep and shrinkage,

fatigue, and durability of the final product. Mica flakes seem particularly attractive in improving mechanical properties and insensitivity to chemical attack and moisture changes. Included is information on the impact of these fibers on properties of the freshly mixed system, such as workability, bleeding, and pumpability. All of this discussion is supported by an ample quantity of well-prepared graphs of relationships and tables of data to illustrate and support the conclusions of various investigators. This reviewer believes these chapters would have benefited from the use of photographs to illustrate the use and applications of these fibers, in addition to the many scanning electron micrographs of the fiber-cement matrix interfaces.

The next to the last chapter presents information on new developments in fiber-reinforced cement systems. These include a large amount of information on carbon fibers, costly but effective, followed by information on polyvinyl alcohol, polyamide, and polyethylene fibers. There is a brief mention of alumina filaments and the role they can play as fibers. This is followed by a short final chapter describing the use of fiber-reinforced polymer and polymer-modified cement systems. These formulations lend themselves to the production of various products for aggressive environments and rapid patching and repair applications. Benefits accrue from the use of fibers in polymer cement systems (PC) and in polymer-impregnated concretes or mortars containing fibers (PIC).

This book is well organized. Illustrations are many and presented in a clear fashion. Tabular data is not overwhelming. References are many and appear quite complete: The book would be a useful addition to the library of most concrete technologists, whether involved in research and development activities or in the design and use of concrete for many different applications.

Alkali-Activated Slag

Reviewed by G. M. Idorn, Ramball & Hanneman A/S, Denmark

REFERENCE: Anderson, Ronny, Gram, Hans-Erik, Malolepszy, Jan, and Deja, Jan, *Alkali-Activated Slag*, Swedish Cement and Concrete Research Institute, Stockholm, 104 pages, 1988. ISSN 0346-6906.

This book describes a research program for the determination of properties of alkali-activated slag (granulated, finely ground blast furnace slag) and a supplementary program to study the influence of curing conditions on the mechanical properties of alkali-activated slag binders. The first program, Part I of the book, was carried out by the Swedish Cement and Concrete Research Institute, the second, Part II, by the University of Mining and Metallurgy, Crakow, Poland.

The book thus represents substantial public research investments and international cooperation with the aim to clarify essential properties and behavior of alkali-activated slag. It also contains an apparently complete historic bibliography on published papers with 45 entries of USSR studies, hereof 14 in W. European languages, and also refers to the Finnish F cement development in the early 1980s.

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The book presents detailed descriptions of the research methodologies and accomplishments in the manner usually done by public research institutes as records of how the funding has been spent. The research results are thus well documented, and the concluding interpretations seem valid within the constraints given by the chosen conditions and methods of experimental testing.

Mineralogical analyses of the cement and slag used are absent as are theoretical reflections regarding the packing and rheology of the fresh paste and the hydration reactions and reaction products obtained with the different paste compositions and curing regimes. The influence of the variety of parameters which have been tested is therefore inevitably substantiated only under the given experimental circumstances. For high-temperature curing conditions, for instance, the external temperature has been recorded, but not the actual heat development and dissemination, while in concrete practice there is a hydration course given by

the temperature increase representing heat of hydration plus external heat supply, followed by a cooling phase.

The studies can therefore not be used for comparison of results with those of other researchers let alone for any application of the findings in engineering practice.

A series of photomicrographs shows different slag mortars with microcracking characterized by an index of 1–3, suggesting higher crack intensity of slag mortars with 7% $\text{Na}(\text{OH})_2$ as activator, and also with 8% waterglass as activator, than with ordinary portland cement paste. The validity of such simplistic semiquantification of observations by microscopic thin section examination is not substantiated in the paper or by other published studies.

NOTE: A small: 100,- on the back cover probably announces the sales price for the report to be one hundred Swedish kroner.