Fly ash, silica fume, slag and natural pozzolans in concrete

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These two volumes are proceedings of an international conference organized by the Canada Centre for Mineral and Energy Technology, held in Trondheim in June 1989. The conference was the third one on the same topic since 1983, and one naturally asks what is the purpose of 1714 pages of papers (plus a supplementary volume of 902 pages)? Is it presentation of research? Is it the state of the art? Is it a distillation of new knowledge? Or is it an outlet for the pressure of publication? The answer is probably a mixture, but for the reader who wants an update on the various topics the book is very useful.

It is impossible to review 83 individual papers, and anyway this would be of little value for the purpose of reaching a decision whether or not to buy the set of proceedings. What is of more value is to describe fairly fully the contents and scope of the books.

The proceedings start with a good review of various aspects of concrete containing pozzolanic and cementitious materials so that someone who has not hitherto used them can readily find what influence they have on various properties of concrete. This of course is important in order to avoid conferring some benefit on concrete at the expense of other harmful consequences.

The papers which follow cover, not surprisingly in view of their number, a very wide range of topics. The three materials considered are fly ash (in British parlance, pulverized fuel ash or PFA), silica fume and slag (ground granulated blast furnace slag or GGBS).

In the field of fly ash, there are papers on chemistry, hydration, effects of fineness, mechanical properties, behaviour in a hot and humid climate, the influence of curing on porosity, permeability and carbonation, and the related protection of reinforcement from corrosion and resistance to de-icer scaling. There are also several papers on the role of fly ash in alkali–aggregate reactions.

There are some papers on the beneficiation of fly ash by separation of fine particles when coal from various sources is burnt in a single power station. This is an interesting practical topic as more coal may shortly cross old national frontiers, and the economics of classification have to be based on the technical value of beneficiation. In the field of silica fume there are papers on its influence on creep, shrinkage and durability, especially with respect to protection of the reinforcement and erosion resistance in hydraulic structures; other papers deal with chemical resistance and performance under cryogenic conditions, as well as the more usual freezing and thawing, and scaling. Performance at elevated temperatures and fire resistance are also discussed.

In the field of slag, there are papers on characterization and microstructure, on the interface between aggregate and the cement paste, on the effects of curing and temperature, and on carbonation and permeability and the related chloride ion penetration. Elastic properties, shrinkage and creep are also considered. There are also five papers on alkali-activated slag.

The above is of course not a comprehensive list but it is a good indication of the wide range of topics covered.

So much for the topics. As far as the nature of the papers in these books is concerned, some deal with new developments. Probably the most significant paper in that category is that by Sivasundaram, Carette and Malhotra on concrete made with a high content of fly ash and a low content of Portland cement (corresponding to a fly ash 'replacement' of nearly 60%) and a very low water/cementitious material ratio (about 0·3), using, of course, a superplasticizer. The properties of the resulting concrete are excellent in many respects, including resistance to freezing and thawing and to chloride ion penetration.

It seems that, although fly ash has been used for many years, its full potential had not been sufficiently investigated for use under a wide range of conditions. Perhaps the reason for this is that fly ash was considered to be a replacement material and mixes containing it were judged against a control concrete with Portland cement only. This point of view may have been due to the resistance of cement manufacturers to the use of what they saw as a competition. In reality of course fly ash extends the range of the applicability of concrete, and it is possible to design many concrete mixes with desirable properties at an economic price. To have established this beyond any doubt is a great value of the proceedings.

Some other papers are directed at chemists; they range from the chemistry of silica fume to chemical modelling of blended cement systems. The paper on the latter topic is actually of considerable general significance as it attempts to predict long-term physicochemical properties of cement systems with a view to assessing the behaviour of concrete used in the containment of radioactive waste in repositories.

Another group of papers deals with the traditional engineering studies of various properties of concrete made with different supplementary materials or under different conditions of exposure. Not surprisingly,

much attention is given to carbonation and permeability of concrete and to its behaviour with respect to the protection of reinforcement from corrosion. There are reports of tests using chloride ion diffusion by the steady state method and also by the fashionable (probably because it is rapid) AASHTO T277 test for this important but elusive property of concrete. It is tempting to comment that it is time someone proved that the results of this test correlate with a meaningful and relevant property of concrete in service with respect to the protection of steel.

There are some case histories of the use of very high strength concrete with fly ash in high-rise buildings, and more generally on the use of silica fume; this includes bridge girders, offshore structures, high strength concrete in general, grouts for prestressed concrete, and repair work.

The papers are grouped as logically as possible but the reader is inevitably confronted with the fact that some papers deal with a particular property of mixes containing different supplementary materials while others deal with various properties of concrete containing a single material in addition to Portland cement.

The volume of supplementary papers, 902 pages of them, is a mixed bag. Some papers are of the same quality as those in the two volumes of the proceedings, but others are poorer. They may contain gems of information but are more appropriate for a local journal of ephemeral existence than for a book with its permanence on a shelf. But then, perhaps conference papers are a mammoth journal rather than a true book. However, a review is not the place to consider this question. What is important is that the two volumes of proceedings of the Trondheim conference are well worth buying, or borrowing, for anyone who uses concrete so that the full range of possibilities of using fly ash, silica fume and slag can be exploited.

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Cement data book, Volume 3
Raw material for cement production

H. Duda

Bauverlag GmbH, Wiesbaden and Berlin, 1988. 210 mm × 297 mm. 188 pp. Text in English and German, illustrated, hardback. ISBN 3 7625 2286 3. DM 148·00, $90·00.

This book represents the third and latest component of a well respected treatise covering the various aspects of cement manufacture. The initial concept was to contain these in a single volume but it is understood that constraints of space meant that a number of items had to be omitted. Thus the original work has now been reclassified as Volume 1 and deals with "International Process Engineering in the Cement Industry". A second volume has been produced covering electrical engineering, automation, storage, transportation and despatch.

The title of Volume 3 may be somewhat misleading since a considerable proportion of Volume 1 remains devoted to raw materials. The reader should not, therefore, expect to find in Volume 3 information on chemical composition, the manner in which they are combined to produce a suitable feedstock to the process, or the types of equipment used to transform them into the correct physical form or to dry them. Fuels and water are also raw materials and appear in Volumes 1 and 2 respectively. With this in mind, it may have been more appropriate to have entitled Volume 3, 'Quarry operations associated with cement manufacture'.

Before discussing the contents in detail, it is important to be clear as to what this treatise sets out to achieve. Principally it is "To provide a concise, versatile description of production processes and arrangements as well as of machinery at this time internationally applied in the Cement Industry". We are also advised that "An evaluation of the processes was not intended since this was quite impossible when looked at from an international point of view". Thus, the three volumes of the treatise provide a useful review of the machinery and processes available without attempting any critical assessment thereof.

Volume 3 begins with some pictorial and descriptive information on the types of raw materials which are extracted for cement making, and devotes 20 pages to some of the computerized techniques now available to assist geologists in assessing and optimizing the working and the cost of the materials available to them. It is here that some criticism of the jargon used may be in order: the sentence "Geological deposits of Raw Materials for Cement Manufacture are almost always anisotropic heterogeneous formations whose tectonic– stratigraphic constitution must be taken into account", may not mean a great deal to most cement