ELSEVIER

Cement & Concrete Composites 23 (2001) iii

Cement & Concrete Composites

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Guest Editorial

Metakaolin and calcined clays

Metakaolin is a pozzolanic material and its use dates back to 1962 when it was incorporated in concrete for Jupia Dam in Brazil. It is obtained by calcination of kaolinitic clay at a temperature of between 650°C and 800°C.

The behavior of clay minerals on heating depends on their structure, crystal size and degree of crystallinity. After the removal of adsorbed water at just over 100°C, kaolinite decomposes above about 500°C, losing its hydroxyl groups as water. The precise nature of the product of dehydration, however, has been a matter of dispute. Formerly believed to be a mixture of amorphous alumina and silica, the residue has now been shown to possess some definite structural features, some of the original kaolinite structure persisting. Accordingly, it has become current practice to refer to this product as metakaolin.

At higher temperatures (>900°C), the metakaolin undergoes further reactions to form crystalline compounds, the end-products being free silica and mullite.

Metakaolin consumes calcium hydroxide very rapidly and, in the 1980s, a lot of research was carried out about its incorporation in cement matrices to preserve glass-fibers in fiber-reinforced composites.

In the 1990s, its use was extended to concrete. A range of concrete property improvements have been recorded, including improved sulfate resistance, effectiveness in the suppression of ASR expansion and elimination of efflorescences in colored concrete.

This Special Issue contains papers by some of the most active researchers in the field of metakaolin and calcined clays. There are eight papers in this issue. The first one is a review of the research carried out on the use of metakaolin as pozzolanic partial cement replacement for mortar and concrete and in applications of containment of hazardous wastes and other pollutants.

The second and third papers, focus on the hydration reactions in cement pastes with different levels of metakaolin replacement. In the second paper, differential scanning calorimetry is used to follow the hydration process and a theoretical approach using reaction stoichiometry is proposed. In the third paper, the influence of some cement parameters, i.e., total sulfate content, nature of sulfates and portlandite content, is investigated.

The fourth, fifth and sixth papers deal with the durability of concrete and mortar. In the fourth paper, a Vietnamese metakaolin is investigated and can replace up to 20% cement without affecting the properties of concrete and mortar. The fifth paper deals with the properties of high-reactivity metakaolin, produced by calcining a purified kaolinitic clay. Its use significantly lowers the chloride ion diffusion coefficient of concrete and the pore solution alkalinity without suppressing steel passivation. The sixth paper studies the influence of silica fume and high-reactivity metakaolin on the chemistry of alkali-silica reaction products.

The last two papers investigate two new areas. The seventh one studies the effect of metakaolin on the creep and shrinkage of concrete and shows that both shrinkage and creep are reduced at high metakaolin replacement level (15%). The last paper shows that it is possible to limit the rebound of shotcrete by using a blend of silica fume and high-reactivity metakaolin.

Collectively, these papers are a snapshot of contemporary research activity in this field and provide useful scientific and technical information. In the future, research has to be carried out in order to reduce the cost of metakaolin, with restrains its extended use in the concrete industry.

I would like to express my deep appreciation to all the authors for their useful contributions and the reviewers, for their time and advice. Finally, my sincere gratitude to Professor Swamy for giving me this opportunity.

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