

## Guest Editorial

## Cement and concrete research in Greece

This volume is devoted to cement and concrete research in Greece. The purpose of this introduction is to provide some information concerning the domestic cement industry and relative research centers in Greece as well as a brief description of the presented papers.

Construction works is a major activity in Greece. As a result, cement and concrete industry has been largely developed in Greece, both in quantity and quality. In the year 2000, 14.5 million tons of cement were produced in Greece and 6.3 million tons from the domestic production were exported. Based on these data, Greece was the fifth top country of the European Union in cement production (Spain is the top country with 39.1 million tons annually). Greece is the first European country in cement exports and one of the top exporting countries in the world (Indonesia is the top country with 15 million tons annually). In 1999, Greece produced 5.3% of the total European cement production and 0.9% of the world one. The per capita consumption amount of cement in Greece is 870 kg, being one of the highest in the world. The main reasons for this, is the high growth rate in Greece accompanied by the Olympic Games projects and the high activity levels in private construction. For the next years a further cement consumption increase in Greece is forecasted.

The cement production companies in Greece are: Halyps Building Materials S.A., Heracles G.C. Co. S.A. and Titan Cement Company S.A. producing 4.2%, 56.4% and 39.4% of the total domestic production, respectively. All these companies control ready-mix concrete companies for the production and disposal of concrete. Titan is the only Greek-owned cement maker, while Heracles is a member of Lafarge group and Halyps is a member of Italcementi group. It must be noted, that Titan owns several cement production units abroad and specifically at Kosjeric (Serbia), Skopje (FYROM), Pleven (Bulgaria), Beni Suef (Egypt) and Roanoke (Virginia, USA). A great variety of cement types CEM I, CEM II and CEM IV, according to European Standard EN 197–1, are currently produced in Greece, using either materials available domestically (natural pozzolana, fly ash, limestone) or imported ones (ground granulated blast furnace slag).

The presence of the national dynamic cement industry has led to the development of a remarkable research activity concerning the science and technology of cement and concrete. Research is carried out mainly at university laboratories and at the R&D departments of the cement companies. The main research centers in Greece are:

- The School of Chemical Engineering, National Technical University of Athens.
- The School of Civil Engineering, National Technical University of Athens.
- The Department of Civil Engineering, Aristotle University of Thessaloniki.
- The Department of Civil Engineering, Democritus University of Thrace.
- The Department of R&D and Quality, Titan Cement Company S.A.
- The Hellenic Cement Research Center Ltd., Heracles G.C. Co. S.A.

This issue contains 22 papers investigating a variety of subjects including the cement raw mix sintering, the cement hydration, the development and properties of blended cements, the concrete performance, the corrosion and protection of steel reinforcement, the restoration of historic buildings etc.

The first two papers deal with the introduction of minor elements in clinker and their effect on the burnability of cement raw mix and the structure and properties of clinker. The aim of the 1st paper is to investigate the possibility of introducing small amounts of minerals, containing selected elements, into the cement raw mix. In the 2nd paper, the structure of clinkers, modified by the introduction of foreign elements in the raw mix, is examined.

The 3rd and 4th papers investigate two subjects concerning the hydration process of cement. In the 3rd paper, cement and high calcium fly ash mixtures are examined and the effect of the reactive silica content of fly ash on the hydration rate and the mechanical properties of the mixtures are discussed. In the 4th paper the use of calcium sulfate bearing materials as alternative setting retarders is examined.

The next three papers focus on the development and the properties of composite cements using materials available in Greece. The 5th paper deals with the comparison of Portland limestone cements with other composite cements containing natural pozzolana or fly ash. The 6th paper investigates the exploitation of poor Greek kaolins for the production of metakaolin and its use as a cement constituent. In the 7th paper, a mineral (diatomaceous earth) is tested for potential utilization as cement constituent.

The next two papers focus on the properties of concrete and specifically on the effect of the concrete composition and the use of superplasticizers, on the concrete performance. The 8th paper presents a laboratory study concerning the effect of cement paste volume on strength and water absorption of concrete. In the 9th paper, three types of superplasticizers are tested in relation to the aggregate type and size and the cement quantity.

In the 10th and 11th papers, various types of supplementary cementing materials, produced in Greece, are investigated as concrete constituents. The former paper examines and compares the effectiveness of fly ash, slag and natural pozzolana as concrete constituents. The latter one focus on the use of fly ash in concrete and particularly on the case study of a big dam where fly ash was used as the fourth ingredient in concrete mix.

The next three papers deal with the performance of concrete at elevated temperatures. In the 12th paper the effect of various pozzolanic materials and the type of aggregate on the properties of thermal treated concrete is discussed. The 13th paper focus on the performance of high volume fly ash concrete at elevated temperature, while the 14th paper presents the microstructural investigation of a fire damaged concrete.

The next three papers focus on the corrosion of steel reinforcement. The 15th paper investigates the effect of organic coatings on the durability of lightweight mor-

tars exposed to corrosive environment. The 16th examines the performance of various types of steel and their protection against atmospheric corrosion. In the 17th paper, the effect of a corrosion inhibitor on the steel corrosion and concrete properties is studied.

The 18th and 19th papers deal with ancient as well as restoration mortars. The 18th paper presents a study on the chemical and mechanical properties of several restoration mortars. In the 19th paper the physico-chemical and mechanical characteristics of the most typical mortars encountered in ancient structures around the Mediterranean Basin are discussed.

Finally, the last three papers examine three interesting specific subjects: the stabilization of soil using cement–fly ash mixtures, the recycle of concrete aggregates and the pozzolanic activity of glass cullet.

Collectively, these papers provide a snapshot of contemporary research activities on cement and concrete issues in Greece and give interesting scientific and technical information.

### Acknowledgements

We would like to express our deep appreciation to all the authors for their contribution and the reviewers for their time and advice. Finally, we express our sincere gratitude to Professor R.N. Swamy for giving us this opportunity.

S. Tsivilis  
G. Kakali

*National Technical University of Athens  
School of Chemical Engineering  
Lab of Inorganic and Analytical Chemistry  
9 Heroon Polytechniou St., 15773 Athens, Greece  
Tel.: +30-210-772-3262; fax: +30-210-772-3188  
E-mail addresses: stsiv@central.ntua.gr (S. Tsivilis)  
kakali@central.ntua.gr (G. Kakali)*