Concrete at High Temperatures: Material Properties and Mathematical Models

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Although concrete engineering is over one hundred years old, it continues to diversify and become ever more sophisticated as new applications are discovered, new structural forms are conceived and the requisite theories are formulated. One important diversification has been the application of concrete in various high temperature environments, for example, those encountered in the chemical industry, nuclear reactor structures and fire protection. These applications necessitate a good knowledge of concrete properties at high temperatures and their mathematical modelling. In response to these needs, intense researches have been conducted, especially during the last two decades, and a large new body of knowledge has emerged. However, the research results have been scattered over a wide range of periodicals, proceedings volumes and chapters of various books of broader scope. There has been a gap with regard to a systematic and focused coverage. It is our hope that the present monograph will fill this gap.

This book aims to provide a systematic review of the properties and mathematical modelling of concrete at high temperatures. It is intended for university researchers and graduate students in civil engineering and materials science, engineers in research laboratories as well as practising engineers occupied with fire resistance, chemical technology vessels or nuclear reactor structures. Part I of the book, written mostly by the second author, deals with material properties and behaviour in a descriptive non-mathematical manner. It calls for a background at the B.Sc. level in civil engineering or materials science, including the basic courses in mechanics, in concrete technology and design, and in material properties. Some portions of Part II, devoted to mathematical modelling, can be understood on the basis of the same background; however, much of Part II, written by the first author, requires a deeper erudition in mathematics, mechanics and physics, at least to the M.Sc. level. Although this is not a textbook, it can be used as a reference for courses on the properties and mechanics of concrete.

The idea of writing the present monograph was conceived in the autumn of 1984, during the first author’s Visiting Professor appointment at the University of Cape Town. However, except for a gradual accumulation of materials and preparation of extensive notes, a concentrated writing effort was not begun until 1990. In August 1991, at the culmination of this effort, came the untimely death of the second author, just after he had completed a draft of Part I. Even though his tragic departure prevented interactive integration of both parts of the book, the initial goals of this writing project have essentially been met.
Concrete at High Temperatures

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Zdeněk P. Bažant
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