# Preface

In the introduction of his book *The Substance of Civilization: Materials and Human History from the Stone Age to the Age of Silicon*, Stephen L. Sass indicates: “Materials not only affect the destinies of nations but define the periods within which they rise and fall. Materials and the story of human civilization are intertwined, as the naming of eras after materials – the Stone age, the Bronze age, the Iron age – remind us.”

Indeed, we can say that we are in the Concrete age, considering how concrete is the most widely known man-made material in the world, with annual consumption estimated at between 21 and 31 billion tons. Next to the fact that worldwide infrastructure is mainly composed of concrete and reinforced concrete, this man-made material is omnipresent in the everyday life – people use it, rely on it, and live on or in it. Concrete is a moldable composite material in which natural gravel stones of well-graded sizes are bound together by a cement matrix, which provides concrete strength. Although this principle of building materials fabrication can be traced back to at least the Roman Empire, it was later neglected for centuries. Concrete regained importance in the 1800s, when methods for large-scale production of modern cement were developed; since then, its use has expanded tremendously.

Concrete is a durable and sustainable material, widely used for both buildings and infrastructure. When properly designed and constructed, it can resist severe storms and earthquakes, as well as aggressive environments; nonetheless, concrete is a brittle material. Reinforced with steel bars (reinforced concrete) or with prestressed steel tendons (prestressed concrete), its applicability greatly expands. However, reinforced concrete is also prone to various degradation mechanisms, primarily corrosion of the steel reinforcement, which impacts durability and service life. This leads to a strong financial, environmental, and safety concerns. This creates an increasing scientific and engineering focus to extend the service life of reinforced concrete structures. Novel solutions for new cement blends, composite coatings, nanomaterials, self-healing approaches, etc., are more recently studied solutions and show great potential. Nevertheless, these methods often target the quality of the cement-based material only, or solely enhanced steel corrosion resistance, rather than considering the overall complexity of "reinforced concrete" as a composite system. To this end, novel, feasible, and sustainable solutions, originating from entirely different scientific backgrounds, are of scientific interest and are being explored for practical applications.

The importance of reinforced concrete as a building material is due to its structural, physical, and chemical properties, and its cost-efficiency and effectiveness. In one's hands, concrete is a sentient entity, capable of creating amazing forms while providing resistant structures. It is a material that has been able to endure modern demands. To craft good concrete, one needs to study hard, get out to the field, get dirt in one's shoes, and treat it with affection and respect; this is the only language that this unique material understands.

This uniqueness of concrete may make it appear to be an awkward material in light of today's scientific advances. In fact, all concrete may seem the same. Certainly, the basic product has remained unchanged since its invention. Nonetheless, concrete properties depend largely on the exploration conditions (e.g., environment) and the quantity and quality of its components, including Portland cement. The selection, use, and constituents of components are important to design appropriately, and as economically as possible, the desired characteristics of any particular type of concrete.

This book disseminates new knowledge on concrete durability for the field of civil engineering. It collects recent studies on cementitious materials, including reinforced concrete properties, behavior, and corrosion resistance. Biodegradation of concrete structures is discussed, as well as the utilization of wastes to control such degradation mechanisms. The major durability-related challenge for reinforced concrete structures, i.e., chloride-induced steel corrosion, is presented in view of recent studies on sensors and sensor technology for early corrosion detection, but also with regard to novel methods for corrosion control, such as the application of hybrid nanomaterials. Furthermore, the rather seldom reported in the present state of the art, stray current-induced corrosion is discussed with regard to both steel reinforcement and bulk matrix properties and performance. This book aims at contributing to the present knowledge on the subject, raising awareness on the complex and challenging aspects of materials' behavior within service life of reinforced concrete structures. It targets dissemination of fundamentally substantiated mechanisms and verification of innovative applications, in view of bringing confidence for industrial utilization of novel solutions and practices in civil engineering.

The research contributions in every chapter of this book highlight new technologies to reverse the trend in the weathering, decaying concrete infrastructure, and will be of interest to academics, engineers, and professionals involved in concrete and concrete infrastructure.

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