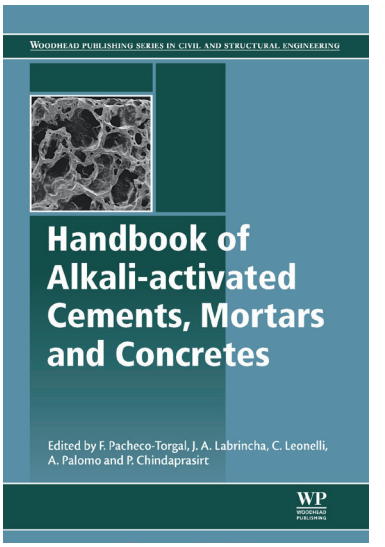
REVIEW OF HANDBOOK OF ALKALI-ACTIVATED CEMENTS, MORTARS AND CONCRETES



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The "Handbook of alkali-activated cements, mortars and concretes" is an excellent first hand read that provides readers with a comprehensive overview of alkali activated cements, covering complete range from their composition, manufacture, mechanical and durability properties, practical applications to life-cycle assessment of the binders. The book has been written and edited by world renowned researchers who have been actively working in the area of alkali activated cements and present to the readers the state-of-the-art in this area.

The book is divided into five key parts. The first part presents the chemistry, mixture design and manufacture of alkali activated cementitious binders (AACB). The second part of the book lists the engineering properties - from the workability, mechanical properties to the pore size distribution of AACBs. The third part covers some of the most important durability aspects such as resistance to corrosion, carbonation, chemical attack and efflorescence and more. The fourth part of the book focuses on the utilization of waste materials to make AACBs more sustainable. The book also discusses the possible applications of AACBs, such as soil stabilization, protective coating to OPC concrete, repair and strengthening of OPC concrete and toxic waste immobilization. The last part of the book very interestingly presents to the readers the life cycle assessment (LCA) and innovative applications of alkali-activated cement and concrete.

Before sharing the review of each of these sections, it is worth sharing some specific qualities of the book. First, the book covers a vast variety of subjects that are important for construction materials. All chapters give a detailed comparison of the properties of AACBs with OPC and provides the readers an objective means to understand the potential of AACBs. Second, each of the chapters is followed by a detailed list of references, demonstrating the width of the literature covered. This list of references is also useful for researchers to understand the evolution of research into the subject. The third important highlight of the book is the brief introduction of the basics provided at the start of each chapter. For example, the introduction of standard fire scenarios, active and passive fire protection given at the start of chapter on fire resistance of AACBs are useful to obtain a preview of the chapter in brief and to understand the context of the chapter in advance. Most chapters also suggest the future research work required on the subjects discussed, making the book much more useful for researchers.

The first part of the book has three chapters focusing on the chemistry and composition of AACBs with important insights for their mix design. This part gives a brief introduction of different raw materials required to produce different types of AACB such as high calcium, low calcium and hybrid AACB, including various types of waste materials. It also presents the reaction mechanism and the micro- and nanostructure of the main reaction products of different AACBs such as C-S-H gel for high calcium AACB and N-A-S-H gel for low calcium AACBs. Then, the two main components of AACBs, cementitious components or solid precursor and alkali activators, are discussed in detail with their main required properties. The most used solid precursors such as blast furnace slag, fly ash and metakaolin are discussed. This part presents the influence of cations and anions of the alkaline activators on the activation mechanism of different types of AACBs. It is shown that the high concentration of OH^- ions is favourable for dissolution and formation of hydrates of silica and alumina and unfavourable for calcium dissolution. It provides a brief review of various combinations of cementitious

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components and alkali activators used in the literature, and their influence on the properties of AACBs. This part also discusses about the use of waste glass for the manufacture of AACB. Interestingly, it is shown that the chemical processing of waste glass in an alkaline solution at 80 °C produces sodium silicate solution, which can potentially be used as an alkaline activator.

The next part of the book, which talks about the engineering properties focuses on the fresh properties, mechanical properties and pore structure of AACBs. The setting time of AACBs containing different prime materials such as slag, metakaolin and fly ash are discussed with brief details on the different factors influencing setting time. A detailed introduction to the forming techniques, basic concepts of rheology of suspensions and various instruments used for measuring the rheological behaviour is provided. Based on the provided basics of rheology, authors discuss the limited data available on the rheology of AACBs and suggest future work required to understand the rheological behaviour of AACBs. This part presents a detailed discussion on the factors that influence the compressive strength and flexural strength of AACB based concretes. Chemical and physical properties of prime materials, synthesis conditions such as type and concentration of activators and curing conditions are mentioned as the main factors. It also talks about the elastic modulus of AACBs at different levels starting from the nano-level of the hydration gel to concrete level, which provides detailed information of elastic modulus at all the levels. One of the chapters in this part presents a neuro-fuzzy approach to model the compressive strength of geopolymers based on the curing time, $Ca(OH)_2$ content, NaOH concentration, mold type, aluminosilicate source and H_2O/Na_2O molar ratio. The pore structure and permeability of AACBs is compared with OPC systems and it is shown that pore size distribution of AACBs in finer than the pore size of OPC. Despite of having limited research on the creep and shrinkage of AACBs, the book briefs on the existing studies and discusses the creep and shrinkage performance of AACBs.

The third part of the book focuses on the durability properties of AACBs such as frost resistance, carbonation and corrosion resistance, etc. It is shown that the frost resistance of AACBs depends on a number of factors like the solid precursor type and the activator type. However, mostly the performance is found to be poorer than OPC. The authors also suggest that new air-entrained admixtures are required for AACBs. The book also suggests that a new methodology to access carbonation resistance for AACBs is required since the existing methods change the microstructure significantly and the same is not found in natural carbonation. The book not only talks about the corrosion in AACBs, it also provides details on the performance of various methods of preventing concrete corrosion such as the use of stainless steel and corrosion inhibitors in AACBs. The discussion about chemical attack on AACBs shows that AACBs have a higher resistance to chemical attack compared to Portland cements.

The book also talks about alkali silica reaction (ASR) in AACBs. The readers may find it useful that affects of ASR have been divided into three categories: slight expansion lower than or similar to that of ordinary Portland cement (OPC), expansion that cannot be neglected but remains lower than in OPC, and significant expansion that is higher than in OPC. A detailed theoretical analysis of various types of alkali activated systems is provided using an existing thermodynamic model. It is shown that alkali activated binders have better fire performance compared to OPC and a protective layer of these binders on concrete can provide excellent fire protection. One of the major durability concerns of AACBs, i.e. efflorescence, is discussed in detail. Authors have also incorporated results from the literature that describe various methods of controlling efflorescence.

The fourth part of the book focuses on the reuse of waste materials for producing AACBs and various applications of AACBs. The potential of using waste generating from various activities such as electricity, mining, ceramics/glass industries, chemical, petrochemical industries, etc. are discussed. It is shown that recycled aggregates, recycled concrete and recycled bricks from construction and demolition waste can be potentially used in AACBs without harmful effects. The possible application of AACBs in soil stabilisation, protective coating to OPC concrete, repair and strengthening of OPC concrete and toxic waste immobilization is discussed in detail. It is shown that for soil stabilisation, by-products based AACBs have potential to be used as sustainable replacement of traditional binders such as lime and cement. Based on a study conducted in Australia, it is shown that the cost of replacing cement binder with AACBs may be higher, especially if the cost of transporting the binder to the treatment site is included. Thus, authors suggest focusing on minimization of overall cost of using AACBs compared to traditional binders. The book also presents alkali activated metakaolin coating as an alternative to traditionally used protective coatings on OPC concrete. The details of an on-site trial of alkali-activated metakaolin (AAM) as a coating on OPC concrete at Shanghai Jinshan coast are provided. For each of the applications discussed, the book lists the most important requirements in detail. The application of AACBs for repair and strengthening of concrete is also explored and the potential of cost effective repairs using AACBs is shown in comparison with commercially available repair materials. It was suggested that further investigation is required for the application of these materials for repair and strengthening of concrete structures. Utilization of geopolymers made from waste materials as masonry units and their required properties such as density, water absorption, unconfined compressive strength and durability properties are also discussed.

The last part of the book brings about the life cycle assessment and innovative applications of alkali activated cement and concrete. This part of the book starts with a brief description of the various LCA methodologies used, their strengths and their limitations. A new approach, which has been argued to be more suitable to concrete, has been presented and existing data in the literature has been analysed using this approach. While noting that there are conflicting reports about the environmental impact of AACBs, it is shown that using the new approach, the global warming potential of AACBs can be lower than that reported in the literature. The book presents strategies for environmentally efficient utilisation of AACBs. Additional benefits in the operational energy of buildings through the production of alkali activated insulating materials are described. The detailed methodology to produce foamed alkali activated concretes, the characteristics of their foam network and the thermal properties of these concretes will be useful both for designers and producers. The photocatalytic behaviour of AACBs for self-cleaning applications have also been discussed in detail. The book ends with describing some innovative applications of alkali activated binders. These applications range from electronics and catalysts to biological applications and drug delivery, to even the storage of hydrogen for energy. Although most of these applications are academic in nature and in the laboratory scale, these laboratory-scale results demonstrate the versatility of the material for many future applications.

To summarise, this book is a complete and detailed resource on alkali activated binders. The book will be useful for teachers, students, researchers, designers and even those who are looking to develop and apply AACB based products. While most subjects are dealt with in detail, every chapter of the book lists resources for further reading. It is important to mention as a rapidly developing field, many developments are making way. So, it is important that readers refer to literature that has been published post publishing of this book. Our view, this book is an excellent resource as the first read.

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