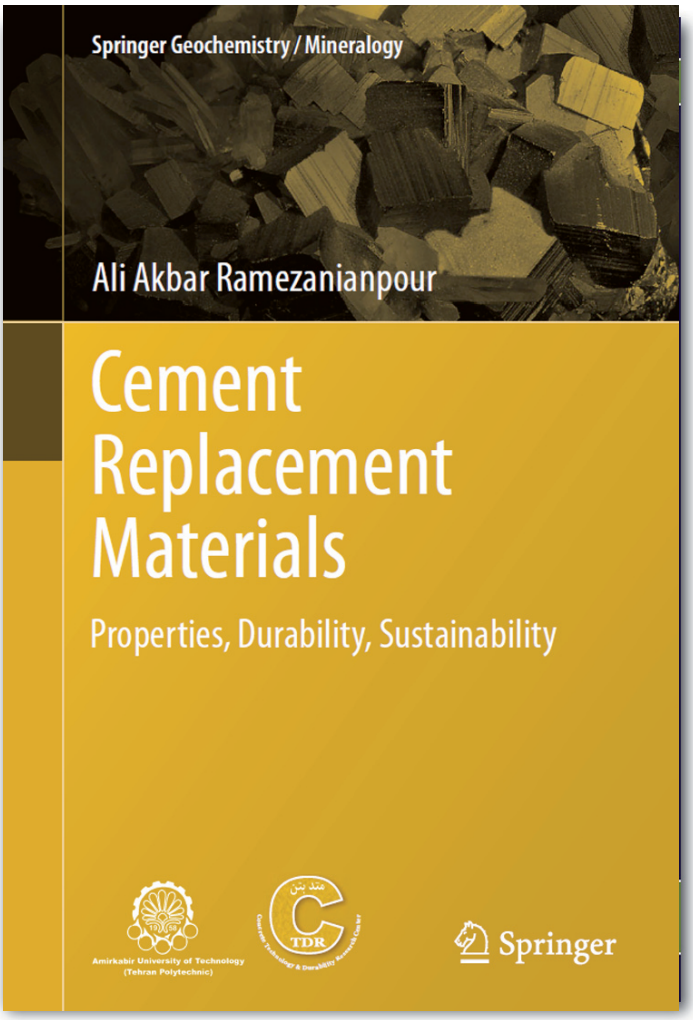
# BOOK REVIEWS

## Cement Replacement Materials

Ali Akbar Ramezanianpour – Springer, 2014

ISBN 978-3-642-36720-5




From the environmental point of view, the construction industry can be considered as an unsustainable industry: it is accounted for up to 30% of carbon dioxide emissions, and a raw materials consuming of about 3000 Mt/year which yields the depletion of large amounts of nonrenewable resources (*Construction and Building Materials, 2011, Volume 25, Issue 2, p. 575*). Particularly, the environmental issues associated with $CO_2$ will play a leading role in the sustainable development of the cement and concrete industry during this century. This is remarkably serious in the current context of climate change and meltdown of the world economy (*N. Stern, Stern review on economics of climate change, 2006, Cambridge University Press*). Due to the increasing demand for urbanization, which is a dramatic development in the emerging countries, the construction industry will grow at a speed and on a scale never before found in human history. For instance, China will need 40 billion square meters of combined residential and commercial floor space over the next 20 years – equivalent to build one new city of the size of New York every 2 years.

In order to achieve a more sustainable construction industry, the European Union recently established that in a medium term raw materials consumption must be reduced by 30% and that waste production in this sector must be cut down by 40%. Therefore, the use of more sustainable construction materials and construction techniques represents not only a major contribution to the eco-efficiency of the construction industry and thus to a more sustainable development, but also an imperative commitment for researchers in the field of building materials.

In the last years an increasing attention has been payed to new kinds of building materials, which can be considered more eco-friendly if compared to concrete and steel. For example, there is an increasing interest for structural composites and for nano-technologies applied in various fields related to the construction industry. In some cases, the advantages of using such materials can be seen only in higher specific performances while costs and durability are often disregarded.

On the other hand, the building technologies based on concrete and steel will indisputably represent the most applied construction techniques also in the future. However, the growing attention for the eco-sustainability is pushing both the research and the industry towards an increasing awareness regarding the use of resources.

Thus, in the recent years, the eco-compatibility and the sustainability of building materials is being related to their durability. The concept of durability cannot be ignored in the evaluation of sustainability of constructions. Durability is the characteristics of those objects or materials that maintain their properties over time. Durability ends when the object or material has to be replaced. A durable material or object is useful for longer. Actually, it is well known that concrete has a high permeability that allow water and other aggressive elements to penetrate, leading to corrosion of steel rebars which is the main reason for infrastructure deterioration. As far as construction is concerned, if we increase the durability of concrete works from 50 to 500 years, their environmental impact would decrease 10 times (*Building and Environment, 2007, vol. 42 pp. 1329–1334)*.

Many efforts have been conducted by researchers to arrive

at some alternatives that are able to significantly reduce energy consumption and environmental impact of cement and concrete.

There is plenty of scientific literature on durability, life cycle assessment and sustainability associated to building materials and in recent years a new concept of concrete has emerged: the green concrete.

Green concrete is defined as a concrete which fulfills various sustainability requirements: it contains more eco-friendly or even waste materials as at least one of its components; its production process does not lead to environmental destruction, and it has high performance, durability and life cycle sustainability.

Actually, some cleaner and more environmental friendly technologies in concrete production are well known, such as substituting relatively high percentage of cement by other sustainable materials for higher performance in terms of strength, stiffness, and durability.

In particular, resources savings can be accomplished by the substitution of part of the cement with fly ashes, natural pozzolans, alkali-activated cement, magnesia cement, and sulfoaluminate cements, and the use of alternative aggregates such as recycled aggregates and vegetal fibers. (*Procedia Engineering, 2014, vol. 95, pp. 305 – 320*).

In other words, besides the use of new technologies and advanced materials, there is another perspective to achieve the eco-sustainability of the concrete industry. Indeed there are quite many opportunities to improve both sustainability and durability of concrete by the use of "Supplementary Cementing Materials" (SCM). Moreover a higher awareness of the importance of mix design for concrete can lead to the enhancement of its durability.

On the basis of the above concerns, the reading of "Cement Replacement Materials: Properties, Durability, Sustainability" may give a new vision of concrete technology.

The book reports in details both the basic information and also more recent findings in the field of the most common natural and artificial materials that can be used as cement substitutions or cement supplementary. In particular, it provides a deep assessment of the properties, the applications and the durability of blended cements.

The eight chapters of the book are settled following a logical thread starting from the most ancient hydraulic cementing aids represented by natural pozzolans, whose durability is well demonstrated since it was used with lime by Greeks and Romans for monuments, which in some cases are still in use.

Subsequently the analysis of the properties of more recent SCM are reported: fly ash, granulated furnace slag, silica fume and metakaolin. The author describes in details in which way these materials affect all the properties of blended concrete, taking into account both the mechanical performances and the transport phenomena of water, gases and chlorides, which strongly affect concrete durability.

A particular attention is paid to Rice Husk Ash (RHA), an artificial pozzolan obtained from the combustion of rice husk. RHA is an agricultural waste, and is classified as "a highly active pozzolan" because it possesses a very high amount of amorphous $SiO_2$ and a large surface area, which can be used to produce high performance concrete.

The last chapter of the handbook describes the role of supplementary cementing materials on sustainable development and takes into account all the issues related to the environmental impact of concrete technology, from the embodied energy to the green-house gas emission.

The book is devised as an in depth manual for technicians, academics and researchers in the fields of cementitious materials. The bibliography is relatively large and allows the reader to get an overview regarding the possible strategies for the realization of concrete structures that are designed with an increasing focus on environmental sustainability.

Therefore, if I should define a motivation to consider the reading of "Cement Replacement Materials: Properties, Durability, Sustainability", I would refer to the roots of Horizon 2020. Hopefully the sustainability concerns of Horizon 2020 (resource efficiency and climate action) will have a strong impact on the future of the European construction industry. Indeed, the influence of resource efficiency on building sector is clearly expressed by the recently issued Draft Horizon 2020 Work Programme 2016-2017:

"The objective of the Societal Challenge 'Climate action, environment, resource efficiency and raw materials' is to achieve a resource – and water – efficient and climate change resilient economy and society, the protection and sustainable management of natural resources and ecosystems, and a sustainable supply and use of raw materials, in order to meet the needs of a growing global population within the limits of the planet's natural resources and eco-systems".

*Luciano Di Maio*
D.I.In.
Department of Industrial Engineering
University of Salerno