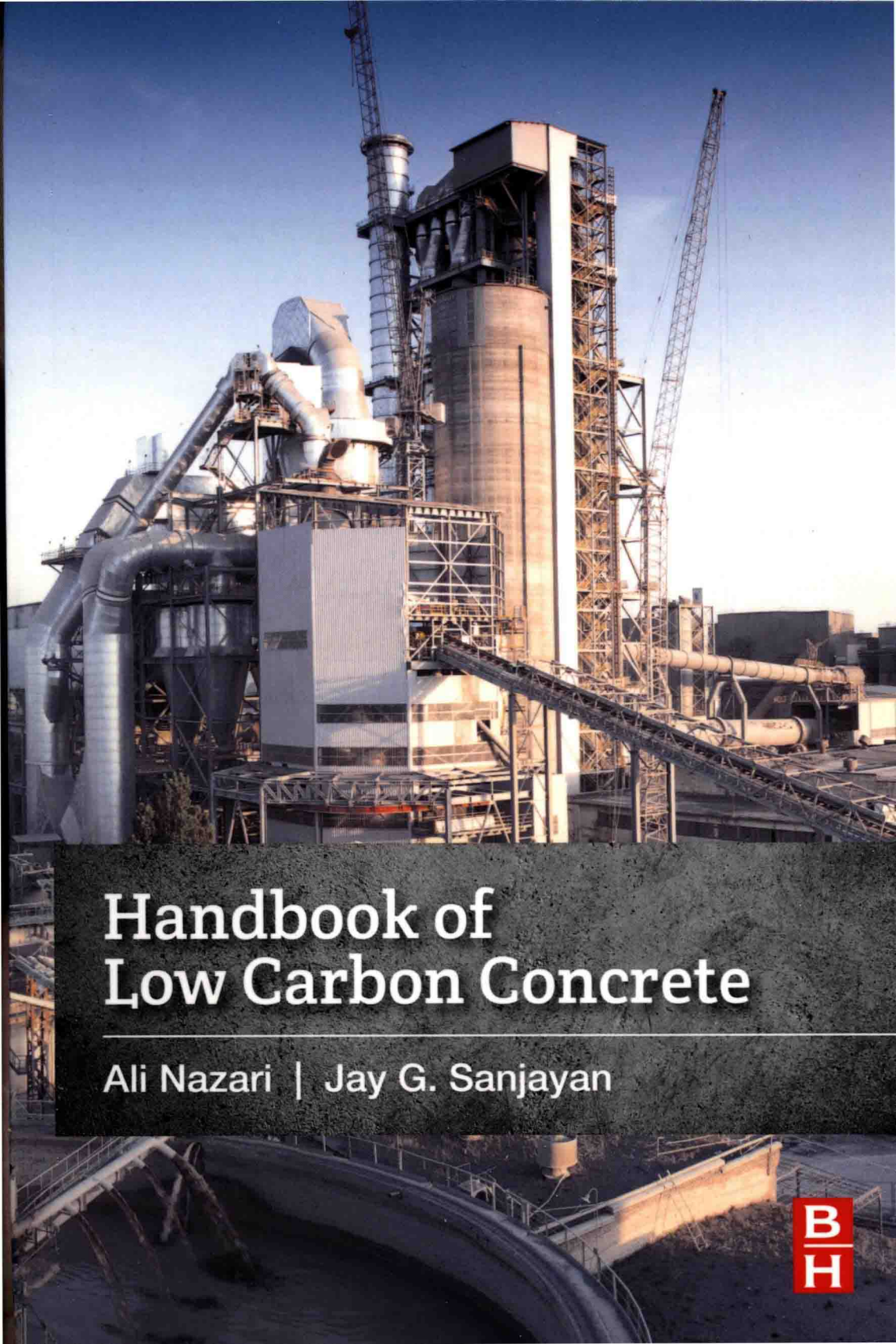

# Handbook of Low Carbon Concrete

Ali Nazari | Jay G. Sanjayan

B/H

# HANDBOOK OF LOW CARBON CONCRETE

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# PREFACE

Manufacture of ordinary Portland cement (OPC) requires the mining of limestone and releasing of carbon dioxide. For each ton of limestone mined, one-third is released as carbon dioxide that has been locked beneath the surface of the earth for millions of years. Emissions of greenhouse gases through industrial activities have a major impact on global warming and it is believed that at least 5–7% of $CO_2$ released to the atmosphere is due to the production of OPC. This has led to significant research on eco-friendly construction materials such as geopolymers and binary- and ternary-blended OPC concretes. *Handbook of Low-Carbon Concrete* is a collection of high-quality technical papers to provide the reader a comprehensive understanding of the ways in which carbon reductions can be achieved by careful choices of construction materials.

The demand for worldwide cement production is increasing by approximately 30% per decade as of 2016. The need for new infrastructure construction in developing nations is projected to force the demand up for cement in the coming years.

Manufacture of Portland cement is the fourth largest contributor to worldwide carbon emissions and is only behind petroleum, coal, and natural gas in releasing carbon dioxide that has been locked beneath the earth's surface for millions of years. The new cement factories that are being built mostly in developing nations to meet this forthcoming demand are unsustainable in the long term for the following reasons:

1. *Capital Intensive*: Cement factories are extremely capital-intensive developments. Once the capital is invested, the investor is committed to cement-production tonnages to recoup their capital investments. Cement manufacturers are notoriously well connected in the construction industry and are resistant to any new low-carbon technologies to protect their investments. Once capital investments are locked into new cement factories, there is little incentive for the cement manufacturers to embrace low-carbon technologies. For example, according to a Lafarge report, a new dry process cement line producing 1 million tons annually can cost up to $240 million.
2. *Low Employment/Capital Dollars Invested*: Cement manufacture is largely automated with low labor intensity. Despite large capital

investments, it offers very few employment opportunities. A modern plant usually employs less than 150 people.

3. *Energy Intensive*: Each ton of cement produced requires 60–130 kg of fuel oil or its equivalent, depending on the cement variety and the process used, and about 110 kWh of electricity.

Alternative low-carbon technologies utilize fly ash, slag, and other materials instead of calcination of limestone. Worldwide, there are 780 million tons of fly ash, only half of which is utilized in some form. The worldwide production of blast furnace slag is about 400 million tons per year and steel slag is about 350 million tons per year. In Australia, for example, there are 14 million tons of fly ash and about 3 million tons of slag produced per annum in comparison with the 9 million tons of cement demand per annum.

There is a serious case for the construction industry to utilize low-carbon concrete to meet the additional demand rather than investing in new cement factories.

This book has collected some of the most recent advances in low-carbon concrete technologies. The first six chapters are related to low-carbon OPC concretes, where other reactive cementitious materials are substituted for OPC. The last nine chapters are related to geopolymer concrete, eco-friendly materials with much lower $CO_2$ emissions that are produced from industrial byproducts such as fly ash, slag, or metakaolin, which are considered as the main possible low-carbon alternatives to Portland cement concrete.

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