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Recycled concrete in structural applications for sustainable construction practices in Australia

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Abstract

As the construction industry drives towards sustainability, recycling construction and demolition waste has become paramount. Furthermore, new construction material composed from recycled construction and demolition waste have added to these sustainable practices. The use of recycled aggregate has been explored to lead to a sustainable future as it provides an alternative to traditional natural concrete. Experimental investigations showed that concrete using recycled aggregate compared to natural aggregate have lower strength. For the construction industry to be sustainable, recycled aggregate must be widely used and even replace natural aggregate. However, research into recycled aggregate discovered the shortcomings of this material and the limiting factors to its utilisation due to its low strength. Several research studies attempt to improve the quality of recycled aggregate by either adding various additives or changing its production methods. However, the industry is still behind in the wider use of recycled aggregate using such research findings. Hence, a research question was formulated as ‘what enablers and barriers affect utilisation of recycled aggregate concrete as a structural material?’. Qualitative interviews were conducted in the Australian construction industry to answer this research question, which provided useful enablers and barriers for promoting recycled aggregate as a structural material. Thereby, a “soft” analysis was conducted to motivate of building industry for using RAC. It is hoped that these findings will be useful for researchers, practitioners and policymakers who are responsible for creating a sustainable construction industry.

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1. Introduction

Nomenclature

RA	Recycled Aggregate
RAC	Recycled Aggregate Concrete
NA	Natural Aggregate
NAC	Natural Aggregate Concrete
C&D	Construction and Demolition

The need to become sustainable in construction has become apparent with the construction industry being a large consumer of natural resources. In particular, the need for recycling construction and demolition (C&D) waste has become crucial. With concrete constituting the main C&D waste produced, and with aggregate being the main by-product of recycled aggregate concrete (RAC), the wider use of recycled aggregate (RA) has been explored so that more sustainable construction practices could be introduced. This paper offers an analysis on different ways of improving the strength of RA, so that it could be widely used in the industry. The paper first presents the literature findings and reports on the case in Australia based on several interviews conducted with builders, designers/architect and engineers operating in the Sydney region in Australia. This consists of part of a research study undertaken at the Western Sydney University involving all the authors.

2. Key literature findings

This section is structured in three sub-sections. First, the need for sustainability practices in construction with concrete recycling for RA production is presented. Second, current RA applications and barriers for wider applications of RA are explored. Finally, the ways to improve RA for wider construction applications based on current research are discussed.

2.1. Need for sustainable construction practices and concrete recycling

Sustainability in terms of the environment implies a natural resource balance [1]. Sustainability is described as a “meeting the needs of the current generation without compromising the ability of future generation to meet their needs” which implies a precautionary approach to those activities that effect the environment to prevent irreparable damage [2]. For this reason, various research is becoming apparent into sustainable construction practices [1]. Studies conducted across the globe have shown C&D waste to have a large impact on the environment, which need urgent attention [3-6]. With C&D waste being disposed of, landfill space is quickly being depleted [7]. Besides depleting landfill space, harm is also placed on natural resources. Natural resources are being consumed at an alarming rate for the production of new construction materials, rather than recycling and reusing existing materials [8]. Therefore, the need for recycling C&D waste has become crucial for the sustainability of the construction industry.

The Australian Environment Protection Authority of New South Wales Conducted an analysis of C&D waste and their effects on landfills over a 6-year period [9]. It was discovered that concrete was the third highest landfill material, with 220,000 tonnes disposed of each year. With concrete constituting one of the main C&D waste produced, and with aggregate being the main by-product of RAC, the use of recycled aggregate (RA) has been explored to lead to a more sustainable future [7, 8].

Concrete recycling provides three benefits; lessen the need for new natural resources; reduce transportation and production cost; and, utilise C&D waste that would otherwise be discarded in landfills [7]. Recycling of concrete also lowers damages on the environment via improper disposal techniques of concrete waste [10]. However, inertia towards common waste disposal practices hinders the recycling of C&D waste. Tam [10] highlighted that only 57% of Australia’s C&D waste are recycled compared to Japan’s rate of 98%. Australia’s low percentage is owed to four main factors: i) the initial cost of equipment needed for recycling concrete, ii) lack of training and management

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