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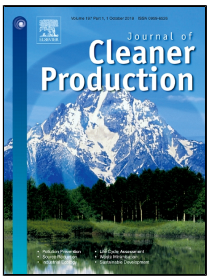


A recycled aggregate concrete high-rise building: structural performance and embodied carbon footprint

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# A recycled aggregate concrete high-rise building: structural performance and embodied carbon footprint

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**Abstract**

Recycled aggregate concrete structures are advocated widely as sustainable structures mainly due to numerous benefits of concrete recycling including reducing the need of natural resources extraction and landfill. Furthermore, the energy and carbon implications of recycled aggregate concrete in material level and low-rise structural level have been investigated. However, little attention has been paid to investigating the effects of adoption of recycled aggregate concrete as structural material on the carbon footprint of high-rise buildings, typical of common structures in megacities such as Shanghai, China. To address this gap, this study investigates the carbon footprint of two identical twin towers, with one tower made of recycled aggregate concrete and the other made of natural aggregate concrete. The structures were designed by following Chinese building codes while optimizing the mix design of recycled aggregate concrete to achieve similar fresh and hardened concrete properties to natural aggregate concrete. The static behaviors and dynamic characteristics of structures were analyzed prior to evaluating the carbon footprint to ensure that both structures had equivalent functions. The global warming potential and cumulative energy demand indicators for the recycled aggregate concrete structure were calculated and compared with those of the same structure made with natural aggregate concrete. The results indicate that adoption of recycled aggregate concrete as structural material in the high-rise structure, in place of natural aggregate concrete, can result in up to about $2.175 \times 10^5$ $kgC_e$ decrease in carbon footprint. The effects of recycling strategy used and the transportation distances on embodied carbon and energy consumption further highlight the environmental benefits of promoting recycled aggregate concrete applications.

**Keywords:** Recycled aggregate concrete (RAC); High-rise building; Dynamic characteristic; Embodied carbon; $CO_2$ emission analysis; Life cycle assessment (LCA).

## 1. Introduction

Construction and building industry is responsible for a significant portion of worldwide

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