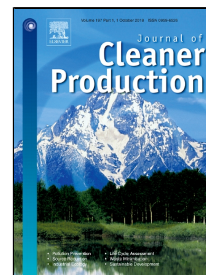


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A recycled aggregate concrete high-rise building: structural performance and embodied carbon footprint



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

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7

8 **Abstract**

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

29
30 **Keywords:** Recycled aggregate concrete (RAC); High-rise building; Dynamic characteristic;
31 Embodied carbon; CO₂ emission analysis; Life cycle assessment (LCA).

32 **1. Introduction**

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

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