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Towards Carbon Neutrality in Steel Construction: Cradle-to-Cradle Carbon Management through Life-Cycle Assessment

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Extended Abstract:

As global imperatives shift toward sustainability and carbon neutrality, the construction industry faces an urgent need to address its environmental impact, particularly within steel construction. Despite the increasing adoption of sustainable practices, a detailed understanding of the entire lifecycle emissions of structural steel, especially within the rapidly evolving Chinese market, remains a significant gap. This study introduces a comprehensive life-cycle assessment (LCA) approach to map the carbon footprint of structural steel construction, with a focus on Chinese structural steel as a case study. By adopting a cradle-to-cradle perspective, the research aims to highlight and address the environmental impact across the entire lifecycle of steel used in construction. Specifically, this study will 1) develop a detailed LCA model that encapsulates the environmental impacts of structural steel from production, use, and recycling phases, 2) dentify and analyze carbon hotspots and inefficiencies within the lifecycle of Chinese structural steel, and 3) evaluate and suggest strategies for stakeholders to minimize carbon emissions, moving towards carbon-neutral steel construction.

Leveraging a process-based LCA framework, this study captures the material, energy, and emissions flows associated with the lifecycle of structural steel, including steel production, fabrication, transportation, construction, and recycling, in the context of Chinese construction practices. The model is enriched with data from current Chinese steel construction projects, ensuring its accuracy and applicability. Through systematic analysis, the study pinpoints critical phases where carbon emissions can be significantly reduced. Preliminary Results show significant carbon emission sources within the production, fabrication, and transportation phases of Chinese structural steel. These insights are crucial for devising targeted reduction strategies, such as improving production and fabrication efficiency, optimizing logistics, and enhancing material recyclability.

The anticipated impact of this research is multi-faceted: providing a robust framework for assessing and managing the carbon footprint of steel construction, guiding industry and policy-makers towards sustainable practices, and setting a precedent for carbon management in steel construction worldwide. This research marks a significant step towards achieving carbon neutrality in steel construction, with a particular focus on Chinese structural steel. Through a comprehensive LCA model, this study offers a deep dive into the lifecycle emissions of steel construction, paving the way for actionable strategies to reduce the environmental impact, contributing to the global endeavor towards carbon-neutral construction.

Keywords: Carbon Neutrality, Structural Steel, Life Cycle Assessment, Cradle-to-Cradle, Sustainable Construction