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Editorial: Low carbon emissions, carbonation fixation and high energy efficiency in building related materials

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Editorial on the Research Topic
Low carbon emissions, carbonation fixation and high energy efficiency in building related materials

In recent years, the problem of carbon dioxide emissions has become increasingly prominent on a global scale, which has led to increasing attention to carbon emissions. In the construction industry, CO_2 emissions from the production and use of traditional building materials are of particular concern, such as cement and concrete. They consume a lot of energy in the production process and release a lot of carbon dioxide, resulting in serious impact on the environment. In recent decades, there has been an urgent need to reduce carbon footprint of these materials and to seek more environmentally friendly alternatives. It is in this context that environmentally friendly recycled building materials demonstrate rubust environment friendly advantages and promising industrial application potentials. These materials, such as recycled cement and recycled concrete, are collectively referred to as sustainable building materials, and their emergence undoubtedly opens up new possibilities for the construction industry. Compared to traditional building materials, these sustainable materials produce significantly lower CO_2 emissions during production and use, and even have a carbon sequestration function, as evidenced by Wang et al. This means that instead of causing damage to the environment, they help to improve it.

Xu et al. have made remarkable research achievements in the field of recycled cement. They deeply explored the activation method of recycled cement and found the optimal activation temperature, which provided an important theoretical basis for the industrial production of recycled cement. At the same time, Xu et al. also conducted detailed study on the hydration mechanisms of different types of regeneration, revealed the microscopic mechanisms of the hardening process of recycled cement, and laid foundation for further improving its performance. Wang et al. focused on the carbon emissions of recycled cement and proposed a series of energy-saving and emission reduction measures. By optimizing

the production process, reducing energy consumption, and improving the utilization rate of recycled materials, they have effectively reduced carbon emissions in the production process of recycled cement, and made positive contributions to the cause of environmental protection. In addition, Wang et al. studied potential green additives for cement-based materials that could significantly improve the performance of cementitious materials while reducing their environmental impact. These research results provide strong technical support for the greening and low-carbon development of cement-based materials.

Rong et al. investigated the impact of varying sodium alginate concentrations and dosing techniques on the characteristics of microbial repair materials, encompassing $CaCO_3$ content, mechanical strength, water absorption capacity, and heating shrinkage rate, and their study explored how these factors influenced the mortar repair outcomes, specifically in terms of macroscopic appearance and surface water absorption rate. Feng et al. fabricated and studied *in-situ* samples of previous concrete pavement and reported the field results of effect of deicing salts and other additives on the freezing and thawing resistivity of concrete. A comprehensive study was conducted by He et al. to explore the intricate relationship between the particle size distribution characteristics of ground granulated blast furnace slag (GGBFS) and its mortar properties. Their research revealed that, in the absence of polycarboxylate superplasticizers (PCE), the aggregation of GGBFS had notable adverse effect on both the fluidity and hardened paste strength of the mortar. However, with the inclusion of PCE, the mortar's properties were primarily influenced by two key factors: the specific surface area of the GGBFS and the disparities in De and n values between the GGBFS and Portland cement.

These studies not only provide strong scientific support for the development of green and recycled building materials, but also inject new vitality into the green transformation and sustainable development of the construction industry. In order to achieve low carbon emissions and carbon sequestration, these sustainable building materials are designed and produced with a variety of environmentally friendly technologies and concepts. They focus on the use of renewable resources to minimize dependence on natural resources, as well as reusability and recyclability of materials to extend the life of materials and reduce waste. In addition, they include a large amount of recycled materials in their composition, which not only reduces production costs, but also further reduces the environmental impact. In long term, the environmental cost of these sustainable building materials is significantly lower than that of traditional natural materials. While the initial investment may be high, their overall cost-effectiveness is significant due to their low maintenance costs and low environmental impacts.

However, despite the many advantages of these sustainable building materials, research on them is still limited. In particular, we need to conduct more in-depth research and exploration on how to achieve excellent low carbon emissions and the basic mechanism of carbonation fixation. In addition, the physical and chemical properties of these materials, as well as their performance in industrial applications, require further research and validation. Therefore, future research should pay more attentions to the performance optimization and industrial application fields exploration of these sustainable building materials. We need to delve into their preparation processes to explore more efficient methods of low carbon emissions and carbon sequestration. Meanwhile, more attentions should be paid to their practical applications and performance evaluations in different projects to promote their widespread application in the construction industry.

In short, as new types of building materials, environmentally friendly recycled building materials have great potentials in reducing carbon emissions and protecting the environment. However, to achieve this target, we need to do more in materials research, preparation processes, and practical applications. Only in this way can we truly achieve sustainable development in the construction industry.

Author contributions

JW: Conceptualization, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing–original draft, Writing–review and editing. SW: Project administration, Supervision, Writing–original draft, Writing–review and editing. YW: Investigation, Project administration, Supervision, Writing–original draft, Writing–review and editing. WW: Investigation, Project administration, Supervision, Writing–original draft, Writing–review and editing. CW: Investigation, Project administration, Supervision, Writing–original draft, Writing–review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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