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Textile fibers and biomass reinforced concrete: A sustainable construction material

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ABSTRACT
Concrete is one of the most important and most widely used materials for construction activities around the world. However, it has inherent deficiencies, e.g., brittleness, low impact resistance, low tensile strength, low fire resistance, low durability, and lower resistance to crack formation. Fibers and waste materials of different types are added as partial replacement of cement and aggregates in concrete to improve performance properties and reduce environmental pollution. Industry construction is shifting towards sustainable and high-performance materials to bring environmental concerns and enhance structural integrity. Traditional concrete, despite its widespread use, has limitations in terms of energy consumption, carbon footprint, and long-term durability. The growing awareness of the building sector about environmental impacts, which is 39% responsible for carbon emissions globally, with 11% stemming from embodied carbon in construction processes and materials. Innovation can integrate environmental sustainability of natural fibers and polymeric composites in concrete structures. Natural fibers, such as those derived from waste of agriculture, are gaining attention due to their affordability, sustainability, and mechanical properties. Natural fiber for Reinforced Concrete not only helps reduce waste but also offer enhanced mechanical performance, particularly in critical structural elements. In the present study, a thorough research on the use of various types of fibers with high and low elastic moduli in concrete to improve mechanical performance and reduce environmental pollution issues has been conducted. This research also provides comprehensive information on the different types of waste materials, e.g., biodegradable and non-biodegradable, which are used in concrete. The use of waste materials in concrete reduces the amount of waste sent to landfill and, in addition, improves some mechanical properties of concrete. This review is aimed at evaluating and understanding the strengths and weaknesses of fiber-reinforced concrete by using SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis. Moreover, this study also concluded that carbon fiber-reinforced concrete proves to be stronger and more durable but more expensive than other fibers. An ideal percentage of natural origin fibers used in concrete can greatly improve the mechanical performance. This study also discussed that waste from polymeric materials can be used in concrete as a partial replacement of cement and other components, e.g., coarse aggregates. It can be inferred that the optimum content of fibers that gives effective results is about 1%, and the reinforcement of concrete with different varieties of wastes as a replacement for fine aggregates should not be more than 2%. Parametric optimization of fiber content will be necessary for the best possible combination of performance properties.