Enhancing Flexural Strength and Sustainability in Concrete through Hemp Fiber Reinforcement: Mechanical Properties and Environmental Impact

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1. INTRODUCTION & OBJECTIVE

This research explores the potential of hemp fiber-reinforced concrete (HFRC) as a sustainable construction material aimed at enhancing flexural strength and reducing the environmental impact of traditional concrete. Conventional concrete, while strong and durable, faces challenges such as brittleness and susceptibility to cracking under tensile and flexural stresses. Hemp fibers, derived from the stalks of Cannabis sativa, offer a renewable, biodegradable alternative with high tensile strength and low density, making them suitable for reinforcing concrete. This study investigates the effects of incorporating varying percentages of untreated and NaOH-treated hemp fibers into concrete mixes and their impact on mechanical properties such as compressive strength, split tensile strength, and flexural strength. The alkali treatment with NaOH improves the bond between fibers and the cement matrix, enhancing the overall performance of HFRC. Experimental tests, including compressive strength tests, split tensile tests, flexural strength tests, sorptivity tests, and impact tests, will be conducted to evaluate the material's structural performance. The research will also examine the effect of fiber treatment on water absorption and durability, contributing to the development of high-performance, eco-friendly concrete. By comparing the outcomes of treated and untreated fibers, this study aims to optimize the use of HFRC for sustainable building applications, reducing concrete's carbon footprint while improving its mechanical properties.

hemp fibers have gained attention due to their high tensile strength, low density, and renewable nature. Hemp fibers are particularly suitable for concrete reinforcement as they enhance crack resistance and improve tensile and flexural strength without significantly increasing the material's weight (Ferrari et al., 2020; Li et al., 2021). Studies have shown that incorporating hemp fibers into concrete improves its tensile and flexural properties. Fibers help to bridge cracks and distribute stress more evenly across the concrete matrix, thereby reducing the propagation of cracks and enhancing durability. For instance, research by Stevulova et al. (2012) demonstrated that hemp fiber-reinforced concrete exhibited improved mechanical properties, especially in terms of flexural strength. However, the performance of HFRC can be influenced by the fiber content, length, and the treatment methods used to modify the fibers (Ali et al., 2020). Research has demonstrated that NaOH-treated fibers perform better than untreated fibers in concrete, leading to improved strength, durability, and moisture resistance (Sedan et al., 2008; Rahim et al., 2017). In conclusion, existing literature highlights the significant potential of hemp fibers in enhancing the mechanical properties of concrete, particularly in improving flexural strength and crack resistance. However, the effectiveness of hemp fiber-reinforced concrete depends on factors such as fiber content, treatment, and the type of concrete matrix used. Further research, including experimental validation, is needed to optimize the performance of HFRC for practical, large-scale applications in sustainable construction.

2. RESULTS & HIGHLIGHTS OF IMPORTANT POINTS

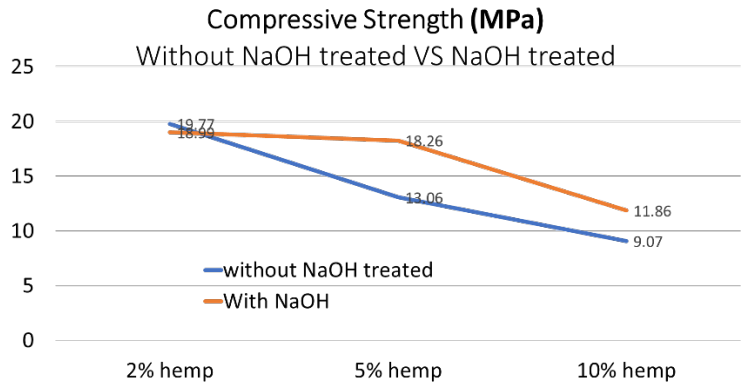

Table 1. Compressive strength of Hemp fiber cement mortar for various fiber percentage.

Table 1. Change in compressive strength of hemp fiber cement mortar due to NaOH treatment.

S.No.	Fibre Percentage	NaOH Treatment(Mpa)	Without Treatment(Mpa)	Percentage Improvement
1	2	18.99	19.77	-3.95%
2	5	18.26	13.03	40.14%
3	10	11.86	9.07	30.76%

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