MECHANICAL PROPERTIES OF FIBER- REINFORCED CEMENT-BASED COMPOSITES: EXPERIMENTAL STUDY ON COMPRESSIVE STRENGTH

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Abstract

This study investigates the effect of fiber reinforcement on the compressive strength of cement-based composites. Glass fibers were added at 0%, 1%, 2%, and 3% by weight of cement. Laboratory experiments were conducted to evaluate compressive strength after 28 days of curing. The results revealed that the addition of 1% fiber significantly increased compressive strength by 31% compared to the control specimen. However, higher fiber contents (2–3%) resulted in slightly lower strength values, although they remained higher than the control. The findings highlight the potential of fiber-reinforced composites in construction applications where enhanced strength and crack resistance are required.

Keywords: Composite materials, fiber reinforcement, compressive strength, cement- based composites, construction materials.

МЕХАНИЧЕСКИЕ СВОЙСТВА ЦЕМЕНТНЫХ КОМПОЗИТОВ, АРМИРОВАННЫХ ВОЛОКНАМИ: ЭКСПЕРИМЕНТАЛЬНОЕ ИССЛЕДОВАНИЕ ПРОЧНОСТИ НА СЖАТИЕ

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Аннотация

В данном исследовании изучается влияние армирования волокнами на прочность на сжатие цементных композитов. В качестве армирующего материала использовались стеклянные волокна в количестве 0%, 1%, 2% и 3% по массе цемента. Были проведены лабораторные эксперименты для оценки прочности на сжатие после 28 дней твердения. Результаты показали, что добавление 1% волокон значительно увеличивало прочность на сжатие на 31% по сравнению с контрольным образцом. Однако более высокое содержание волокон (2–3%) привело к немного более низким значениям прочности, хотя они оставались выше контрольного показателя. Полученные данные подчеркивают потенциал композитов, армированных волокнами, для строительных применений, где требуется повышенная прочность и устойчивость к трещинам.

Ключевые слова: Композитные материалы, армирование волокнами, прочность на сжатие, цементные композиты, строительные материалы.

SEMENT KOMPOZITLARINING MEXANIK XUSUSIYATLARI, TOLALAR BILAN MUSTAHKAMLASH: SIQILISH MUSTAHKAMLIGINI EKSPERIMENTAL TADQIQOT

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Annotatsiya

Ushbu tadqiqotda tsement kompozitlarining siqilishdagi mustahkamligiga tolalar bilan mustahkamlashning ta’siri o‘rganildi. Mustahkamlovchi material sifatida tsement massasiga nisbatan 0%, 1%, 2% va 3% miqdorda shisha tolalar ishlatildi. 28 kunlik qotish davridan so‘ng siqilish mustahkamligini baholash uchun laboratoriya tajribalari o‘tkazildi. Natijalar shuni ko‘rsatdiki, 1% tolalar qo‘shilishi nazorat namunasi bilan solishtirganda siqilish mustahkamligini 31% ga oshirdi. Biroq 2–3%

tolalar qo‘shilganda mustahkamlik biroz pasaydi, lekin baribir nazorat namunasi darajasidan yuqori bo‘lib qoldi. Olingan ma’lumotlar tolalar bilan mustahkamlangan kompozitlarning yuqori mustahkamlik va yoriqlarga chidamlilik talab qilinadigan qurilish sohalarida qo‘llash imkoniyatini ta’kidlaydi.

Kalit so‘zlar: kompozit materiallar, tolalar bilan mustahkamlash, siqilish mustahkamligi, tsement kompozitlari, qurilish materiallari.

Introduction

Composite materials are increasingly applied in construction due to their enhanced strength, durability, and resistance to environmental effects. Among these, fiber- reinforced cement-based composites have shown significant improvements in crack resistance and mechanical performance [1–3].

Previous research has demonstrated that the type and dosage of fibers strongly affect the mechanical properties of composites [4–6]. However, the optimal fiber content for achieving maximum compressive strength is still under investigation. This study provides an experimental evaluation of glass fiber reinforcement in cement-based composites.

Materials and Methods.

Materials.

- Cement: Ordinary Portland Cement (CEM I 42.5).
- Aggregates: Natural sand (0–5 mm).
- Fibers: Glass fibers (length 12 mm).
- Water-to-cement ratio: 0.45.

Sample Preparation.

Specimens were cast in 100×100×100 mm molds with fiber dosages of 0%, 1%, 2%, and 3% (by weight of cement). Samples were cured in water at 20 ± 2 °C for 28 days.

Testing.

Compressive strength was measured according to ASTM C109 using a universal testing machine.

Results.

Compressive Strength.

The variation of compressive strength with fiber content is presented in Figure 1.

Fiber content (%)	Compressive strength (MPa)	Change compared to control (%)
0	37.0	-
1	48.5	+31%
2	41.5	+12%
3	43.0	+16%

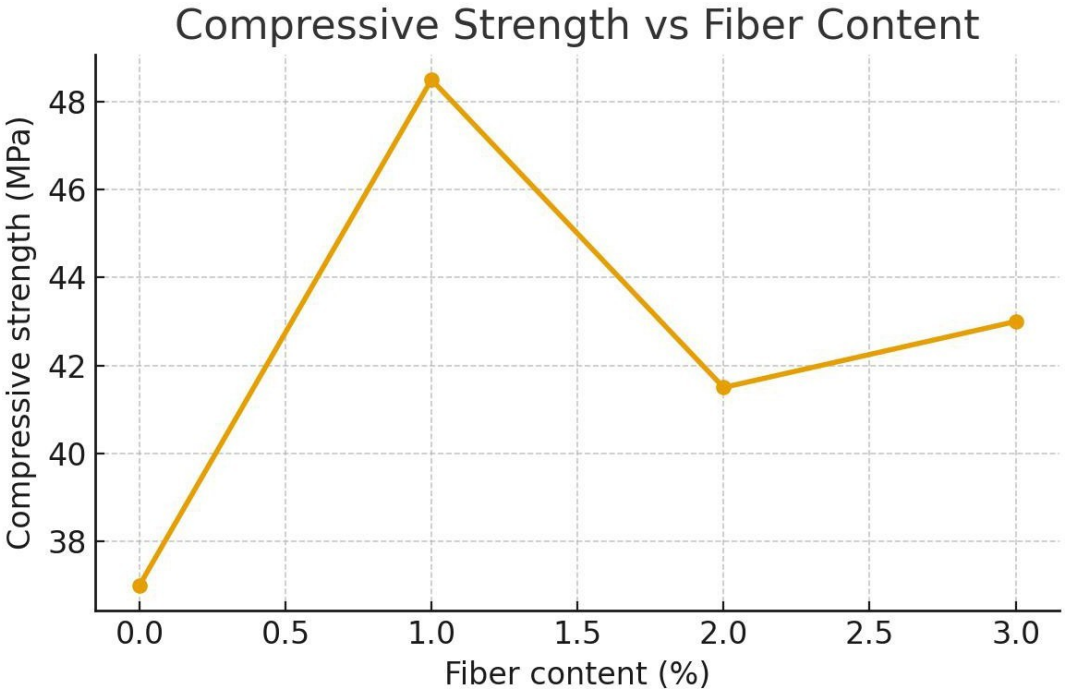

Figure 1. Effect of fiber content on compressive strength of cement-based composites.

Discussion.

The experimental results demonstrate that fiber reinforcement significantly improves compressive strength at low dosages. The optimal performance was

observed at 1% fiber content, where compressive strength increased by 31% compared to the control sample.

At higher fiber dosages (2–3%), strength values decreased slightly due to reduced workability and fiber agglomeration, but remained higher than the control. Similar findings were reported in studies by Li (2003) and Afroughsabet & Ozbakkaloglu (2015), confirming that moderate fiber contents yield the best performance.

Conclusion.

- The addition of glass fibers improved compressive strength of cement composites.

- Optimal dosage was 1%, giving the highest increase (+31%).

- Higher dosages (2–3%) caused minor strength reductions but still outperformed the control mix.

- Fiber-reinforced cement composites are suitable for structural applications requiring enhanced mechanical properties.

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