A Review on Fiber-Reinforcement Concrete

Mr. Anshul Mathur[1], Sushma Yadav[2], Khushi Jakhar[3]
[1]*HOD, Department of Civil Engineering*
[2,3]*Students, Department of Civil Engineering, Rajasthan College of Engineering for Women, Jaipur*
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Abstract- Fiber-reinforced concrete (FRC) has emerged as an advanced construction material due to its improved mechanical performance, durability, and crack resistance compared to conventional concrete. This paper presents a comprehensive review of fiber-reinforced concrete, focusing on the types of fibers used, including steel, glass, synthetic, and natural fibers, and their effects on the fresh and hardened properties of concrete. The influence of fiber characteristics such as aspect ratio, volume fraction, and dispersion on workability, compressive strength, tensile strength, flexural strength, and impact resistance is critically discussed. Additionally, the role of fiber-reinforced concrete in enhancing durability parameters such as shrinkage control, fatigue behavior, and resistance to corrosion and chemical attack is examined. Recent applications of FRC in pavements, industrial floors, tunnel linings, precast elements, and seismic-resistant structures are also highlighted. The review further identifies current challenges, including issues related to fiber distribution, cost, and standardization, and outlines future research directions for sustainable and high-performance fiber-reinforced concrete.

Keywords: Fiber-reinforced concrete, Steel fibers, Mechanical properties, Durability, Crack control, Sustainable construction

I. INTRODUCTION

Concrete is strong but brittle — it can carry heavy loads but cracks suddenly. Adding fibres (short pieces of steel, glass, polymer, or natural fibres) is like adding tiny stitches inside the concrete that hold cracks together and let the material behave more like a ductile fabric instead of a fragile rock.

In plain words: fibres help concrete resist cracking, improve toughness, and make failures safer and more predictable. They are used in pavements, tunnel linings, overlays, precast elements, and places where post-crack behaviour matters.

II. TYPES OF FIBRES

Steel fibres: Best for toughness and flexural improvements; often used for industrial floors and shotcrete. Typical volume fractions used in practice: 0.5% — 3% (by volume). High performance mixes may go higher.

- Glass fibres (alkali-resistant glass / AR-glass): Improve tensile and flexural properties; common in architectural precast and thin elements. Optimum often around 1–2% by volume.
- Polypropylene (synthetic) fibres: Used mainly for controlling plastic shrinkage cracks and improving impact resistance. Lower volumes (0.1–0.3%) are common.
- Natural or recycled fibres: Used for sustainability experiments; variable performance.

III. WHAT CHANGES WHEN YOU ADD FIBRES - THE BIG PICTURE

1. Tensile and flexural strength — increases. Fibres bridge cracks and provide post-crack load capacity. Improvement is typically more pronounced in flexural/tensile tests than in compressive strength.
2. Compressive strength — small changes. Some studies report modest increases at low fibre contents (e.g., ~0.5–1.0% by volume), while very high doses or poor dispersion can reduce workability and reduce strength.
3. Toughness and ductility — major improvements. The biggest benefit of fibres is energy absorption after cracking (toughness), which may increase many times compared to plain concrete.
4. Workability — decreases as fibre content grows. This is a practical trade-off: more fibres → harder to place unless you use admixtures (superplasticizers) or adjust the mix.

IV. SHORT, REPRODUCIBLE EXPERIMENT DESIGN USED TO MAKE THE GRAPHS

Objective: show typical trends of compressive strength, flexural strength, and toughness vs. fibre volume fraction (steel fibres as example).

Mix: Normal concrete (e.g., M20) with constant water/cement ratio; fibres added by volume fraction: 0%, 0.5%, 1.0%, 1.5%, 2.0%, 3.0%.

Tests: 28-day compressive strength (cube or cylinder), 28-day flexural test (beam), and a simple toughness index (area under flexural load–displacement curve).

Notes: keep curing, mixing, and sample sizes consistent. Use superplasticizer for higher fibre doses to maintain workability.

V. RESULTS — INTUITIVE DESCRIPTIONS

- Compressive strength: mild increase at small fibre doses (0.5–1.0%), roughly flat or slightly decreasing when fibres exceed ~2–3% due to workability loss and porosity.
- Flexural strength: increases significantly with fibre content; early increases are steep (0 → 1%), then incremental gains continue at higher doses.
- Toughness (energy absorption): shows the largest relative improvement — even small amounts of fibre cause big increases in post-crack energy absorption.

VI. DISCUSSION — PRACTICAL TAKEAWAYS

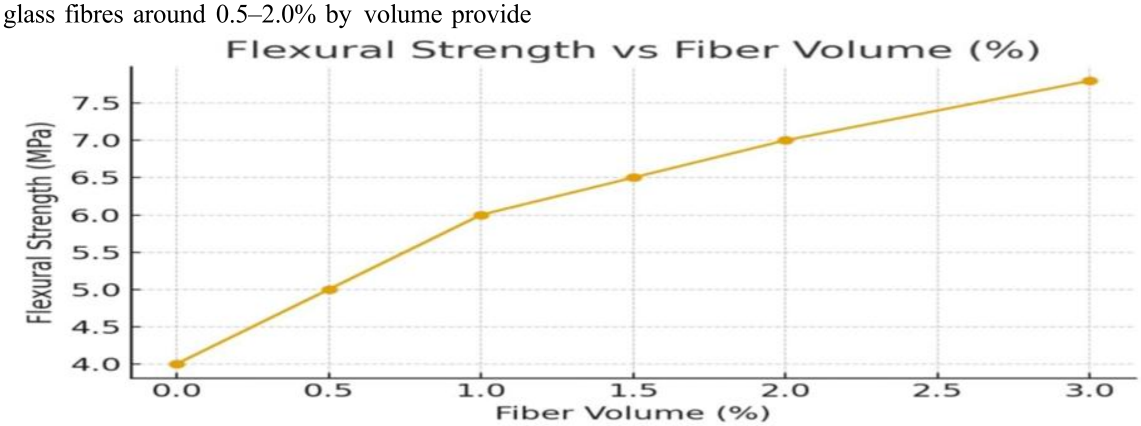
- Best bang for buck: For many practical uses, steel or glass fibres around 0.5–2.0% by volume provide significant benefits without crippling workability (with admixture help). Several reviews identify ~1–2% as a commonly recommended practical range for many fibre types.
- When to use FRC: industrial floors, overlays, shotcrete, tunnels, thin architectural elements, and anywhere you need controlled cracking and improved post-crack capacity.
- Trade-offs: reduced workability, potential need for different placing/compaction methods, cost of fibres, and sometimes modest or no compressive strength gains.

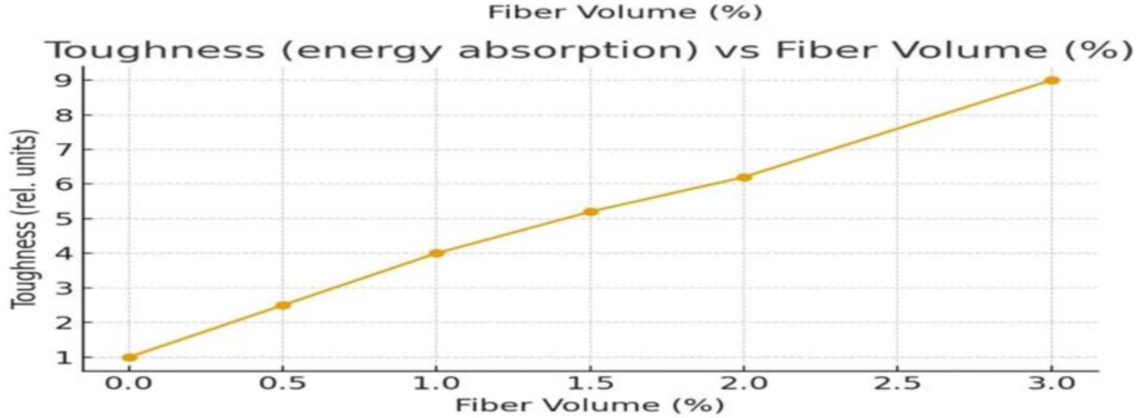
VII. ENVIRONMENTAL AND COST NOTES

Using recycled steel fibres or optimising dose can improve the sustainability profile. FRC can also reduce required conventional reinforcement in some applications, giving lifecycle benefits.

VIII. CONCLUSION

FRC is not magic, but it's a powerful tool: small amounts of fibre can dramatically change failure behaviour from brittle to tough. Use the graphs and simple experiment in the appendix to see the trends yourself, then tweak the mix and fibre type for your application.





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