International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 10 Issue: 01 | Jan - 2026 SJIF Rating: 8.586 ISSN: 2582-3930

A Review on Mechanical and Durability Properties of Jute Fiber Reinforced Fly Ash Concrete

SOUVIK DATTA[1], SOUVIK SHARMA[2],Prof. (Dr.) BIMAN MUKHERJEE[3]

[1]***Souvik Datta,*** *M.Tech student of Narula Institute of Technology, West Bengal, India.*

[2]***Souvik Sharma,*** *Assistant Professor, Dept. Of Civil Engineering, Narula Institute of Technology, West Bengal, India.*

[3]***Prof.(Dr). Biman Mukherjee****, Professor & Former HOD, Dept. of Civil Engineering, Narula Institute of Technology, West Bengal, India.*

Abstract - The growing demand for sustainable and eco-friendly construction materials has led to increased interest in the use of natural fibers and industrial by-products in concrete. Jute fiber and fly ash are two such materials that offer significant environmental and technical benefits. This review paper presents a comprehensive analysis of research studies on jute fiber–reinforced fly ash concrete, focusing on its fresh, mechanical, durability, and microstructural properties. Fly ash, a by-product of coal combustion, partially replaces cement, reducing carbon emissions while improving workability and long-term strength. Jute fiber, a renewable and biodegradable natural fiber, enhances crack resistance, tensile strength, and ductility of concrete. The paper reviews the effects of fiber content, fiber treatment, fly ash replacement levels, and curing conditions on concrete performance. Challenges related to fiber dispersion, water absorption, and durability in alkaline environments are also discussed, along with possible treatment and mix-design solutions. Overall, the review highlights the potential of jute fiber fly ash concrete as a sustainable alternative to conventional concrete and identifies research gaps for future investigation.

Key Words**: Jute fiber, Fly ash, Sustainable concrete, Natural fiber concrete, Green construction.**

1. INTRODUCTION

Concrete is the most widely used construction material, but its production contributes significantly to CO_2 emissions, mainly due to cement manufacturing. Fly ash has been extensively used as a partial cement replacement to improve workability, long-term strength, and durability while reducing environmental impact.

Natural fibers such as jute have gained attention as eco-friendly alternatives to synthetic fibers. Jute fibers are low-cost, abundantly available, and possess good tensile strength. The combination of jute fiber and fly ash in concrete offers a promising approach to producing sustainable and performance-enhanced construction materials.

2. Methodology

This review investigates advancements in self-healing concrete technologies by systematically analyzing existing literature and experimental studies. The methodology involves the following steps:

3. Properties of Jute Fiber and Fly Ash

3.1 Jute Fiber

Jute fiber is obtained from the stem of the *Corchorus* plant. It has moderate tensile strength, low density, and good crack-bridging ability. However, its hydrophilic nature and durability in alkaline environments are major concerns.

a. Advantages:

- Renewable and biodegradable
- Low cost and low density
- Improves ductility and crack resistance

b. Limitations:

- High water absorption
- Degradation in alkaline cement matrix

c. Fly Ash:

Fly ash is classified into Class F and Class C based on chemical composition. It improves workability, reduces heat of hydration, and enhances long-term strength and durability.

3.2 Fresh Properties of Jute Fiber Fly Ash Concrete

Studies indicate that the inclusion of jute fiber generally reduces workability due to fiber interlocking and water absorption. However, fly ash helps compensate for this loss by improving flowability. Proper mix design and use of superplasticizers are often required.

3.3 Mechanical Properties

a. Compressive Strength

- Fly ash concrete shows lower early-age strength but improved later-age strength.
- Jute fibers have a marginal effect on compressive strength but help control microcracking.

b. Tensile and Flexural Strength

- Significant improvement in split tensile and flexural strength is observed due to fiber bridging.
- Optimal jute fiber content is generally found between **0.5% and 1.0% by volume**.

c. Impact and Toughness

Jute fibers enhance energy absorption capacity and post-cracking behavior, improving toughness and impact resistance.

3.4 Durability Characteristics

Fly ash improves resistance to sulfate attack, chloride penetration, and alkali–silica reaction. However, durability of jute fibers in alkaline concrete remains a challenge. Surface treatments such as alkali treatment, bitumen coating, or polymer impregnation have been suggested to improve fiber durability.

3.5 Environmental and Sustainability Benefits

- Reduction in cement consumption and CO_2 emissions
- Utilization of industrial waste (fly ash)
- Biodegradable and renewable reinforcement Life-cycle assessments indicate that jute fiber fly ash concrete has a lower environmental footprint compared to conventional concrete.

3.6 Challenges and Research Gaps

- Long-term durability of jute fibers
- Standardization of fiber treatment methods
- Lack of large-scale field applications
- Limited studies on structural behavior

3.7 Future Scope

Future research should focus on fiber surface treatments, hybrid fiber systems, optimization of fly ash content, and structural-level investigations to promote real-world applications.

4. Conclusion

Jute fiber–reinforced fly ash concrete presents a sustainable alternative to conventional concrete with improved tensile behavior, crack resistance, and environmental benefits. While challenges related to durability and workability remain, ongoing research indicates strong potential for its use in low-cost and eco-friendly construction.

References

1. Hossain, M. A., Datta, S. D., Akid, A. S. M., Sobuz, M. H. R., & Islam, M. S. (2023). *Exploring the synergistic effect of fly ash and jute fiber on the fresh, mechanical, and non-destructive characteristics of sustainable concrete.* Heliyon, 9(11), e21708. ScienceDirect
2. Varshney, K., Dev, D., Ralli, R., & Ram, S. (2024). *Study the Effects of Using Jute Fiber and Fly Ash as Partial Replacement of Cement in M25 Grade Concrete Properties.* Indian Journal of Structure Engineering, 4(2), 9–13. Lattice Science Publications
3. Shrestha, R. K., Alagirisamy, M., & Giri, O. P. et al. (2024). *Incorporation of Jute Fiber in Concrete: A Literature Review.* IJRASET. IJRASET
4. Mahi, S. H., Hossain, M. S., Khayruzzaman, M., & Ridoy, T. A. (2025). *Jute Fiber in Concrete: Comprehensive Review of Workability and Strength Characteristics.* International Journal of Structural Analysis and Advanced Construction Techniques. MAT Journals
5. Akhtar, J. N., Ahmad, T., Akhtar, M. N., & Abbas, H. (2014). *Influence of Fibers and Fly Ash on Mechanical Properties of Concrete.* American Journal of Civil Engineering and Architecture, 2(2), 64–69. Sciepub
6. Joseph Reffin, A., Karuppasamy, M., Manikandakumar, S., & Baskar Singh, G. (2021). *An Experimental Study of Jute Fiber and Partially Added Fly Ash with OPC in Concrete.* IRJET, 8(3). IRJET
7. Singh, G., Priyadarshi, S., & Singh, A. (2021). *Fly Ash Concrete – A Review of Literature.* International Journal of Research in Engineering, Science and Management. IJRESM
8. Choudhary, N. P., Sakale, R., & Singh, H. P. (2025). *A Review on Strength Characteristics of Concrete Using Fly Ash and Steel Fiber under Alkaline Attack.* Int. J. Sci. Res. Civil Engg., 9(4). IJSRCE
9. Performance of concrete reinforced with jute fibers (Natural fibers). *SAGE Journals.* (2022). (Study on improved durability and decreased fluidity with jute fibers). SAGE Journals
10. Effects of Jute Fiber on Fresh and Hardened Characteristics of Concrete — MDPI. (2023). (Analysis on environmental impact and optimized fiber content). MDPI
11. *Comparative Studies of Fibres in Concrete* (2025). IJERT. (Comparison of various fibres including natural ones). IJERT

12. Salla, S., Pitroda, J., & Shah, B. K. (2013). *Comparative Study on Jute Fibre and Banana Fibre in Fly Ash Bricks.* IJETT, 4(4). Seventh Sense Research Group®
13. *A Review of the Impact of Jute Fiber Reinforcement on Mechanical Properties of Concrete.* IJES Journal. (2024). (Broad review on jute fiber effects). IJES Journal
14. *Fly Ash-Based Jute Fiber Reinforced Concrete: A Go Green Approach.* Taylor & Francis. (2022). Focus on chemical and mechanical characterization. Taylor & Francis
15. Mohammed, A. D. A. A., Ronghui, W., & Huseien, G. F. (2024). *Mechanical Properties of Natural Jute Fiber-Reinforced Geopolymer Concrete.* Journal of Composites Science, 8(11), 450. MDPI
16. *Fly Ash as Sustainable Reinforcement in Composite Materials: Review on Mechanical Properties.* Discover Materials (2025). (Comprehensive review on fly ash composites). Springer Link
17. *An Experimental Investigation of Fiber and Fly Ash Effect on Concrete* — Singh et al. (2018). IJARIIT Journal (Examines fiber + fly ash mechanical behavior). IJARIIT
18. *Influence of Fly Ash Fineness on Mechanical Properties of Concrete.* Construction and Building Materials (2011). (Classic reference on fly ash effects). IJSRCE
19. Chindaprasirt, P., Kanchanda, P., & Sathonsaowaphak, A. (2007). *Sulfate resistance of blended cements containing fly ash and other pozzolans.* Construction and Building Materials. (Good for durability section). Veterinaria
20. Nair, D. G., Fraaij, A., & Klaassen, A. A. K. (2008). *Structural Investigation Relating to the Pozzolanic Activity of Rice Husk Ash.* Cement and Concrete Research. (Useful for comparative pozzolanic behavior with fly ash). Veterinaria