Experimental Study On The Effect Of Jute Fiber And Nylon Fiber Reinforced Concrete

1Subhamay Nag, 2Dr. Biman Mukherjee
1Student, 2Professor
1Narula Institute of Technology (NIT),
2Narula Institute of Technology (NIT)

Abstract - **All over the world concrete plays an important role in the construction industry. There are some boundaries on the use of concrete as a binding material for certain deficiencies such as low durability, low ductility, fatigue, brittleness and poor resistance, and poor tensile strength on impact strength. In this current situation waste materials collected from various industries are added to the concrete mix with admixture. Fiber-reinforced concrete (FRC) has been widely used as a non-corrosion material as well as high strength and lightweight materials. Fiber-reinforced concrete helps to improve structural strengthening both economically and efficiently. In terms of bearing capacity, ductility, and durability, fiber reinforced concrete helps to create an exciting structure for prominent improvement. In steel-reinforced concrete corrosion may be unsafe for structure. FRC helps to decrease the permeability of concrete by using glass, steel, and polymer fibers. As a result of using steel, FRC helps to improve yield strength, glass fiber helps to increase flexural strength and polymer fiber increases high corrosion resistance but reduces fire resistance capacity. Fiber-reinforced concrete can be used as economical cementitious material which also helps in sustainable construction. In this research paper, researchers will conduct a test on M30 grade concrete mix and will do a compression test, tensile test, and flexural test. After that, the result of fiber-reinforced concrete will be compared with traditional structures. This research paper significantly focuses on nylon fiber and jute fiber.**

keywords - **Concrete, Fiber-reinforced concrete, Jute fiber, Nylon fiber.**

1. Introduction

Concrete is widely known as a versatile and cost-effective construction material but concrete also has a huge no. of drawbacks in inherent composition. For any country's infrastructure development concrete is a primary element. Besides all properties in concrete, compressive strength is considered a useful quality. Though for a long time concrete performance changed into durability. For any concrete mixture, durability shows a significant amount without any substantial damage (Naser, Hawileh, and Abdalla, 2019). Fiber reinforcement is one of the best methods to ensure durable structure for a long time. Concrete materials with fly ash and silica fume reduce permeability. This problem only occurs when the concrete is in the curing stage.

Various types of fiber-reinforced concrete are used all over the world. On fiber-reinforced versatile performance, many studies are already done. Nylon is an easily available material that can be used in fiber reinforced concrete as a "Nylon fiber". Nylon is a material that helps to resist chemical attack in concrete and provide high abrasion resistance in concrete. Nylon is also considered a non-reactive material. Jute fiber is also considered natural fiber. An increase of fiber materials in concrete helps to improve chemical properties in the concrete. Concrete cannot bear cracks and tension which occurs in tensile areas (Mahmood, *et al.,* 2021). In this tension area fiber such as nylon, jute, steel, and other fiber materials can be used to prevent cracks in that particular tension zone.

In this review paper research will focus on a combination of jute fiber and nylon fiber. This paper fill the gap and investigate the influence of jute and nylon fiber with combined with reinforcement. This also consist with various engineering properties of concrete such as elastic modules, compressive strength, workability, shrinkage and tensile strength of concrete.

2. Aims and objective

Fiber-reinforced concrete helps to increase concrete strength at low cost in addition it also provides tensile reinforcement of the structure in all directions (Qi, Wang and Ma, 2018). FRC also helps to reduce the requirement of steel reinforcement.

- To improve the strength of the structure
- To reduce the requirements of steel structure
- To improve impact, abrasion, and resistance
- To improve ductility and reduce crack
- To minimize the damage to the structure

3. Literature Review

3.1 Introduction

Fiber Reinforced Concrete can be considered as a composite material which consist of mixtures of cement, mortar, or suitable fibers. Fiber-reinforced concrete has different types and it provides many advantages. Fiber is a small piece of reinforcing

material which help to possess certain characteristic properties (Zhao, *et al*., 2018). Fiber-reinforced concrete (FRC) is containing with fibrous material which increases its structural stability and integrity. Fibers include steel fibers, glass fibers, synthetic fibers, and natural fibers. Fiber-reinforcement significantly used in shotcrete, but can also be used in normal concrete. Fiber-reinforced concrete is commonly used for pavements and ground floors, but it can be used as wide range of construction parts such as beams, pliers, foundations, etc. The shape, length and dimension of fiber is important.

3.2 Advantage and disadvantages

Fiber reinforce concrete has various types of advantages, these are-

- Fiber helps to increase fatigue strength in reinforcing concrete.
- Fiber helps to reduce the growth of the crack in the structure besides that it helps to increase the impact strength of the structure.
- Fiber helps to increase the durability of concrete.
- As compared with non-fiber reinforced concrete, FRC has more tensile strength (Ishtiaq, 2019).
- Fiber also improves the resistance power of concrete which resists freezing.

Besides of various advantages of fiber reinforced concrete, there are some disadvantages, these are-

- Due to heavy rain fiber may be exposed from the structure (Affan, 2019).
- Randomly orientation of fiber in concrete may result in poor quality of concrete if fiber is not distributed uniformly.

3.3 Effect of fiber in concrete

Fibers are generally used to control dry shrinkage crack and plastic shrinkage crack. Fiber also lowers the permeability of concrete which helps to reduce water bleeding. Some specific fiber has a huge impact on concrete such as shatter and aberration resistance. Technically, fibers cannot increase the flexural strength of concrete so they cannot replace moment resistance in structural steel. Some of the fiber may reduce the strength of concrete. When mass fiber is added into the concrete mixture to measure the percentage of the total volume of composite material of fibers and concrete which are considered as the volume fraction of the fiber (Tiwari, Sahu and Pathak, 2020). For the calculation of aspect ratio non-circular cross-section is used as equivalent diameter. As compared to longer fiber microfiber has a better impact on resistance.

3.4 The necessity of fiber reinforced concrete

Reinforce cement concrete is considered a composite material. Therefore the use of fiber in RCC helps the structure a lot to increase the strength. In concrete fiber provides excellent resistance creep towards the structure. Fiber also performs as tendons/rebars in concrete. In addition fibers in concrete works as a crack arrester and significantly improve the dynamic and static properties of the structure (Bilal, 2020). Besides of that, there are some necessary parameter of fiber, these are-

- Fiber increases the durability power of the concrete.
- Fiber helps to reduce voids such as air and water inside of concrete.
- Fiber helps to increase the tensile strength of the concrete.

3.5 Affecting properties of fiber reinforced concrete

Fiber-reinforced is a composite material which consists of fiber in a cement mixture in an orderly distributed manner. For better performance of fiber in the concrete mixture, it required efficient transfer of stress in between fiber and matrix (Hsie, Tu and Song, 2008). Besides of that, it depends of some factors these are-

1. Stiffness
2. Volume of fiber
3. Orientation of fiber
4. Workability
5. Size of coarse aggregate
6. Mixing

3.6 Types of fiber reinforced concrete

There are various types of fiber although the following types of fibers are generally used in the construction industry. These are-

- Steel fiber
- Natural fiber
- Glass fiber
- Nylon fiber
- Carbon fiber
- Organic fiber

4. Research methodology

Research methodology is a significant way to get specific techniques and identify specific procedures on this research topic. In this research paper, the research methodology section allows all readers to critically evaluate the overall study on fiber reinforced concrete. This entire research will be done in a primary data collection method, and the researcher will do lab tests.

4.1 Materials

For this research materials required raw jute fiber which is available locally and nylon fiber. For this research jute and nylon will be used in various volumetric percentages in the concrete mixture. In this research, the author will use ordinary portland cement as a binding material, sand is also used as fine aggregate.

4.2 Concrete mix

Concrete mix design consists of some coarse aggregate, fine aggregate such as sand and cement as a binding material. For this study researchers should know the targeted strength and water cement ratio. In this research mix design study will help to

know the targeted strength of the mixture. In concrete mix examination jute and nylon fiber volumetric content and cut length will be applied in the concrete mix proportion.

4.3 Experimental program

This research study consists of determining tensile strength, compressive strength, and flexural strength on concrete composite with nylon and jute fiber. Universal Testing Machine will be used to determine tensile strength and an Automatic Compression Testing Machine helps to determine compression and flexural strength.

5. Conclusion

This review paper investigates the effect of jute fiber and nylon fiber. This paper also considers that FRC provide high capacity to tensile stress, bending moment and shear stress. Fiber reinforced concrete provides very high durability to the structure but its workability is low. We can use fiber reinforced concrete to reduce dept of the beam without any kind of loss in bearing capacity of the structure. In fiber content modulus of elasticity gradually increased. In some of the situation we can use steel fiber as a replacement material of steel bar.

6. Reference

Journal

Naser, M.Z., Hawileh, R.A. and Abdalla, J.A., 2019. Fiber-reinforced polymer composites in strengthening reinforced concrete structures: A critical review. *Engineering Structures*, *198*, p.109542.

Mahmood, A., Noman, M.T., Pechočiaková, M., Amor, N., Petrů, M., Abdelkader, M., Militký, J., Sozcu, S. and Hassan, S.Z.U., 2021. Geopolymers and Fiber-Reinforced Concrete Composites in Civil Engineering. *Polymers*, *13*(13), p.2099.

Lee, J.H., Cho, B. and Choi, E., 2017. Flexural capacity of fiber reinforced concrete with a consideration of concrete strength and fiber content. *Construction and Building Materials*, *138*, pp.222-231.

Thomas, J. and Ramaswamy, A., 2007. Mechanical properties of steel fiber-reinforced concrete. *Journal of materials in civil engineering*, *19*(5), pp.385-392.

Zhao, J., Liang, J., Chu, L. and Shen, F., 2018. Experimental study on shear behavior of steel fiber reinforced concrete beams with high-strength reinforcement. *Materials*, *11*(9), p.1682.

Qi, J., Wang, J. and Ma, Z.J., 2018. Flexural response of high-strength steel-ultra-high-performance fiber reinforced concrete beams based on a mesoscale constitutive model: Experiment and theory. *Structural Concrete*, *19*(3), pp.719-734.

Marcalikova, Z., Cajka, R., Bilek, V., Bujdos, D. and Sucharda, O., 2020. Determination of mechanical characteristics for fiber-reinforced concrete with straight and hooked fibers. *Crystals*, *10*(6), p.545.

Ramya, D., Ramesh, G., Prakash, A.R., Ramya, D., Ramesh, G. and Prakash, A.R., 2021. Shear Behavior of Hybrid Fiber Reinforced Concrete. *Concrete", International*, *7*(02), pp.79-82.

Xargay, H., Folino, P., Nuñez, N., Gómez, M., Caggiano, A. and Martinelli, E., 2018. Acoustic emission behavior of thermally damaged self-compacting high strength fiber reinforced concrete. *Construction and Building Materials*, *187*, pp.519-530.

Xargay, H., Folino, P., Sambataro, L. and Etse, G., 2018. Temperature effects on failure behavior of self-compacting high strength plain and fiber reinforced concrete. *Construction and Building Materials*, *165*, pp.723-734.

Luccioni, B., Isla, F., Codina, R., Ambrosini, D., Zerbino, R., Giaccio, G. and Torrijos, M.C., 2018. Experimental and numerical analysis of blast response of High Strength Fiber Reinforced Concrete slabs. *Engineering structures*, *175*, pp.113-122.

Ahmad, J., Zaid, O., Aslam, F., Shahzaib, M., Ullah, R., Alabduljabbar, H. and Khedher, K.M., 2021. A Study on the Mechanical Characteristics of Glass and Nylon Fiber Reinforced Peach Shell Lightweight Concrete. *Materials*, *14*(16), p.4488.

Orasutthikul, S., Unno, D. and Yokota, H., 2017. Effectiveness of recycled nylon fiber from waste fishing net with respect to fiber reinforced mortar. *Construction and building materials*, *146*, pp.594-602.

Ishtiaq, M., 2019. *Experimental Evaluation of Nylon Fiber Reinforced Concrete (NFRC) for Shear Strength Enhancement of Deep Beams* (Doctoral dissertation, CAPITAL UNIVERSITY).

Dayananda, N., Gowda, B.K. and Prasad, G.E., 2018, June. A study on compressive strength attributes of jute fiber reinforced cement concrete composites. In *IOP Conference Series: Materials Science and Engineering* (Vol. 376, No. 1, p. 012069). IOP Publishing.

Affan, M., 2019. *Effect of Freeze-Thaw Cycles on Mechanical Properties of Jute Fiber Reinforced Concrete for Pavement* (Doctoral dissertation, CAPITAL UNIVERSITY).

Tiwari, S., Sahu, A.K. and Pathak, R.P., 2020, November. Mechanical Properties and Durability Study of Jute Fiber Reinforced Concrete. In *IOP Conference Series: Materials Science and Engineering* (Vol. 961, No. 1, p. 012009). IOP Publishing.

Rahman, S. and Azad, M.A.K., 2018. Investigation on mechanical strength of jute fiber reinforced concrete JFRC compared to plain concrete. *Int. J. Sci. Eng. Res*, *9*, pp.560-564.

Yuhazri, M.Y., Zulfikar, A.J. and Ginting, A., 2020, December. Fiber Reinforced Polymer Composite as a Strengthening of Concrete Structures: A Review. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1003, No. 1, p. 012135). IOP Publishing.

Bilal, M., 2020. *Investigation of Jute Fiber Reinforced Concrete Having GFRP Rebars in Slabs Under Impact Loading* (Doctoral dissertation, CAPITAL UNIVERSITY).

Wang, Q., Zhu, H., Zhang, B., Tong, Y., Teng, F. and Su, W., 2020. Anchorage systems for reinforced concrete structures strengthened with fiber-reinforced polymer composites: State-of-the-art review. *Journal of Reinforced Plastics and Composites*, *39*(9-10), pp.327-344.

Hsie, M., Tu, C. and Song, P.S., 2008. Mechanical properties of polypropylene hybrid fiber-reinforced concrete. *Materials Science and Engineering: A*, *494*(1-2), pp.153-157.
Lee, J.H., Cho, B. and Choi, E., 2017. Flexural capacity of fiber reinforced concrete with a consideration of concrete strength and fiber content. *Construction and Building Materials*, *138*, pp.222-231.
Zhao, J., Liang, J., Chu, L. and Shen, F., 2018. Experimental study on shear behavior of steel fiber reinforced concrete beams with high-strength reinforcement. *Materials*, *11*(9), p.1682.
Khalid, F.S., Irwan, J.M., Ibrahim, M.W., Othman, N. and Shahidan, S., 2018. Performance of plastic wastes in fiber-reinforced concrete beams. *Construction and Building Materials*, *183*, pp.451-464.