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# Experimental Evaluation of Concrete Properties Reinforced with Untreated Jute Fibres Based on Compressive Strength

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**Abstract: In this study, effect of varying untreated jute-fiber (JF) length and dosage on 28-day compressive strength in concrete has been studied. It examined three fiber lengths (10 mm, 15 mm and 20 mm) and three dosages (0.25%, 0.50 % and 1.00 % of cement mass) in addition to a control mixture. The manuscript logs 420 cylinders (150 ×300 mm), vertical volumetric mix ratio of 1:1.5:3 (Cement, fine aggregate and coarse aggregate) and a water–cement ratio of 0.55. This achievement is even more remarkable with 10-, 15- and 20-mm fibers as reported compressive-strength gains over the control (28.61 MPa) were only 1.32%, 1/58% and 0.60% for these respective fiber lengths at a JF of just 0.25%. Consequently, the maximum mean strength among the combinations tested was arrived at with 15 mm fibers at 0.25% dosage. Higher doses were, for the most part, associated with decreased strength relative to control. We further fitted a regression relationship between strength, fiber length and dosage; nonetheless, independent validation and statistical significance of the small strength differences have not been established. Note: These findings are limited to the materials, mixture and 28-day testing conditions studied.**

***Keywords:*** *Jute Fiber; Fiber Reinforced Concrete; Fiber Length; Fiber Content; Compressive Strength.*

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## I. INTRODUCTION

Concrete is among the most consumed and simple materials in construction, known from its strength, availability and cost-effectiveness up to a certain level (Krauss & Paret, 2014). But concrete is brittle in nature, has high compressive strength and low ductility and tensile strength [1]. To overcome this, many reinforcement materials have been used over the years, such as synthetic fibers (polyvinyl alcohol, polyvinyl chloride, polyethylene terephthalate, nylon etc.) and natural fibers (kenaf, hemp, coir fiber, sisal, jute fiber). Of these, natural fibers such as kenaf, hemp, coir fiber, sisal and jute fiber are found to possess significant potential of enhancing the mechanical properties of concrete [2-3]. These fibres also have a large contribution to the reduction of environmental risks [4].

The jute fiber (JF) is natural fiber of the Corchorus plant, which is most widely used agricultural by-product is a biodegradable and renewable raw material for concrete [5-6]). It has recently been applied in various applications, such as tunnel lining, blast resistant buildings, concrete overlays, high strength and high-performance concrete, pozzolanic concrete and rigid pavement system. Low cost and availability of the jute in Bangladesh (the second largest producer of jute in the world, producing 1.38 million tons or about 33% of the world's production) is mainly responsible for this. The addition of JF in concrete is not only used for enhancing the compressive strength of the concrete produced, but also as a tool for the reduction of problems in the environment. This is in line with the initiatives that are taking place throughout the world to improve sustainability [8]. It is, however, the reality of life that a number of problems occur

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on introducing JF into a mixture, such as bulkiness, surface blemishes, fiber clumping and balling during mixing. These problems can cause segregation of the matrix, pores and even honeycombing which decreases the strength.

Different types of researchers have utilized Jute fibres (JF) to be incorporated into concrete and its influence on the mechanical behavior of the concrete is studied by the researchers [9-13] but only compressive strength of the concrete is analyzed. A investigation of Jute-fiber-reinforced concrete (JFRC) with 9 mm-length jute fibers has exhibited that compressive power of chance fell obtainable with the addition of fiber material. In another study 20 mm long jute fibre was used and it found that 0.50 %fibre increased compressive strength by 37% after28days [12]. A further research process analyzed the impact of various percentages of jute-fiber compared to volume of concrete and discovered that with the fiber content, the compressive strength is also improved related to those without jute-fiber [10].

Although previous researches have considered mechanical performance of jute–fibre concrete, the outcomes reported do vary by a fibre properties and mass dosage definitions; b mixtures proportions; c testing methods. The current study considers the combined effect of fiber length (10–20 mm) and dosage (0.25–1.00% by cement weight) on compressive strength at 28 days for a nominal volumetric ratio of 1:1.5:3 together with up to a water-cement ratio of 0.55 It also examines an empirical regression relationship. The study does not demonstrate long-term durability, cost effectiveness or performance beyond the ranges studied.

## II. MATERIALS AND METHODS

➢ *Raw Materials*

For performing the experiment, coarse aggregate (≤19 mm) was collected from the Sylhet region, Bangladesh, and sieved into a gradation. River sand, which was available in the area, was also collected and utilized as a fine aggregate. For reinforcement, jute fibers of three different lengths (10 mm, 15 mm and 20 mm) were procured from the local market and added in the mix in the form of % of Ordinary Portland Cement (OPC) which was used as the binder without any chemical treatment. The potable water was provided by the laboratory and used for both mixing and curing of the concrete.

➢ *Tests on Raw Materials*

The ASTM procedures were reported for tests of the constituent materials, and the results are summarized in Tables 1 and 2. Literature data for jute-fiber diameter and density should not be considered as a measurement of the actual fibres used. There was a lack of documentation pertaining to actual fiber diameter, density, moisture content, absorption and tensile properties, which restricts the ability to reproduce the results and compare them to other studies.

Table 1 Properties of Materials.

| Properties | | Unit | Test standard | Materials | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Fine aggregate | | Coarse aggregate | | OPC | |
| | | | | Present study | Islam and Shahjalal (2021) | Present study | Sarker et al. (2017) | Present study | ASTM C150 (2021) |
| Fineness modulus | | – | ASTM C136 (2001) | 3.28 | 2.56 | 7.33 | 6.75–8.0 | – | – |
| Unit weight | | kg/m$^3$ | ASTM C29 (1997) | 1461 | – | 1563 | 1525 | 1440 | – |
| Specific gravity (dry) | | – | ASTM C127/128 (2001) | 2.6 | 2.37 | 2.65 | 2.68 | – | – |
| Water absorption | | % | ASTM C127/128 (2001) | 0.82 | 3.4 | 0.66 | 0.10–3.0 | – | – |
| Moisture content | | % | ASTM C566 (2013) | 0.6 | – | 1.63 | – | – | – |
| Normal consistency | | % | ASTM C187 (1998) | – | – | – | – | 27 | 28–32 |
| Setting time | Initial | min | ASTM C191 (2001) | – | – | – | – | 150 | ≥ 45 |
| | Final | | | – | – | – | – | 300 | ≤ 375 |
| Compressive strength | 3 d | MPa | ASTM C109 (2007) | – | – | – | – | 22.14 | 12 |
| | 7 d | | | – | – | – | – | 25.24 | 28 |

Table 2 Properties of Jute Fiber

| Fiber length (mm) | Diameter (µm) | Aspect ratio (l/d) | Density (kg/m$^3$) | Water absorption (%) | Reference |
|---|---|---|---|---|---|
| 10, 15, and 20 | 42.8 | 233.64 | 1300 | 302.7 | Current study |
| 10 and 20 | 100 | 100 | 1450 | 160 | Islam and Ahmed (2018) |

➢ *Preparation and Mixing of Materials*

It is reported that the coarse and fine aggregate was wet batch prior to mixing. The jute fibre of 10mm, 15mm and 20mm length were used at 0.25%, 0.50% and 1.00% of cement mass, respectively and also a control without any fibre. The nominal volumetric ratio was 1:1.5:3 and the nominal water–cement ratio was 0.55. The initial report mentions a drum mixing time of about 2–3 minutes and the nominal quantities are listed in Table 3. There were inadequate surface-moisture corrections, moisture condition of fibers, effective mixing water, workability measurements, and controls of the dispersion of the fibers, so that these cannot be evaluated separately from the available report.

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Table 3 Mix Design for 1 $m^3$ of Concrete Incorporating JF

| Mix Designation | Coarse aggregate (kg) | Fine aggregate (kg) | OPC (kg) | JF (kg) | Water (kg) |
|---|---|---|---|---|---|
| JFRC0 (control) | 1278.82 | 597.68 | 392.73 | 0.00 | 216.00 |
| JFRC0.25 | 1278.82 | 597.68 | 392.73 | 0.98 | 216.00 |
| JFRC0.50 | 1278.82 | 597.68 | 392.73 | 1.96 | 216.00 |
| JFRC1.00 | 1278.82 | 597.68 | 392.73 | 3.93 | 216.00 |

➢ *Preparation and Mixing of Materials*

The steel cylindrical molds (150 mm × 300 mm) were brushed, cleaned, and fastened using nut–bolts. For easy demolding, the inner sides of the molds were coated with oil. After unloading the fresh concrete from the mixture, the molds were filled according to [14]. These poured molds were kept undisturbed for 24 hours on a flat surface in the laboratory at a moist laboratory temperature. After that, the hardened samples were demolded, marked, and cured in the laboratory curing tank for 28 days.

➢ *Test on Hardened Concrete*

The manuscript reports the average of 3 specimens having similar C/S composition and tested after 28 days with a 1000 kN compressive testing machine (for more details, refer to reference [15]) Distribution of 420 specimens within the mixtures, cast batches and replicates is not provided. A number of statistically independent observations can only be derived if the experimental record is reconciled beforehand. No standard deviations, confidence intervals or hypothesis-test results are reported in the manuscript.

## III. RESULT AND DISCUSSION

➢ *Compressive Strength ( $f'_c$ )*

The 30-day compressive strengths are reported for the three fiber lengths and three fiber dosages shown in figure 1. The compression strength of the control was 28.61 MPa. At 0.25% dosage, the reported increases relative to control were 1.32% (10 mm), 1.58% (15 mm) and 0.60% (20 mm), corresponding to approximately 28.99, 29.06 and 28.78 MPa, respectively. The highest reported mean for these tested conditions was for the 15 mm × 0.25% combinations. The within group variation is not disclosed so it is not possible to make judgements about whether these small differences are statistically significant. The strengths in Figure 2 are normalized and should be compared to the actual numerical data.

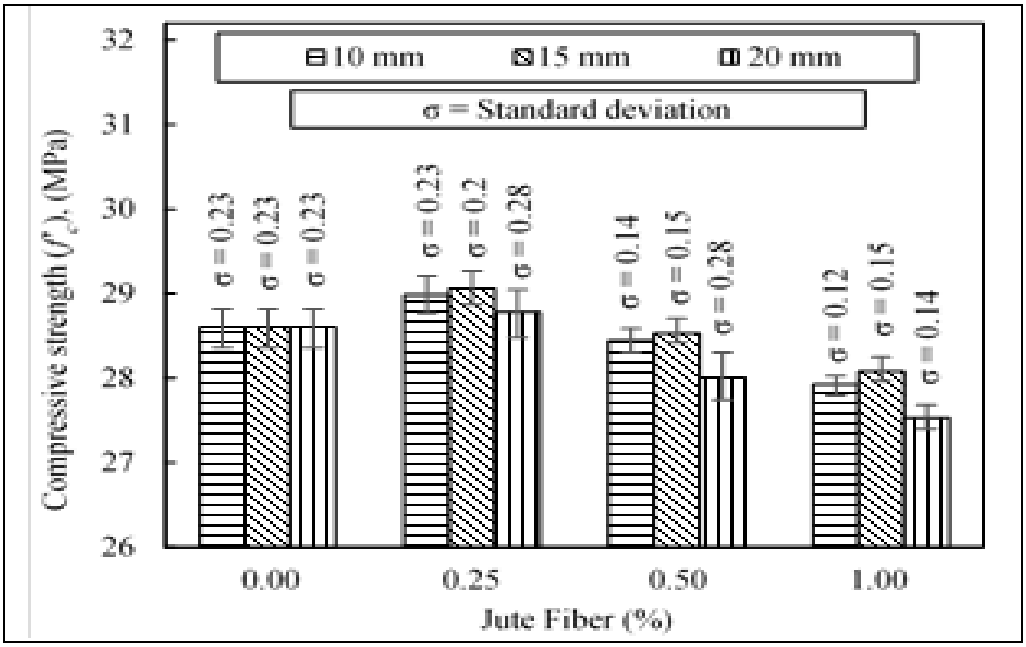



Fig 1 Compressive Strength of JFRC

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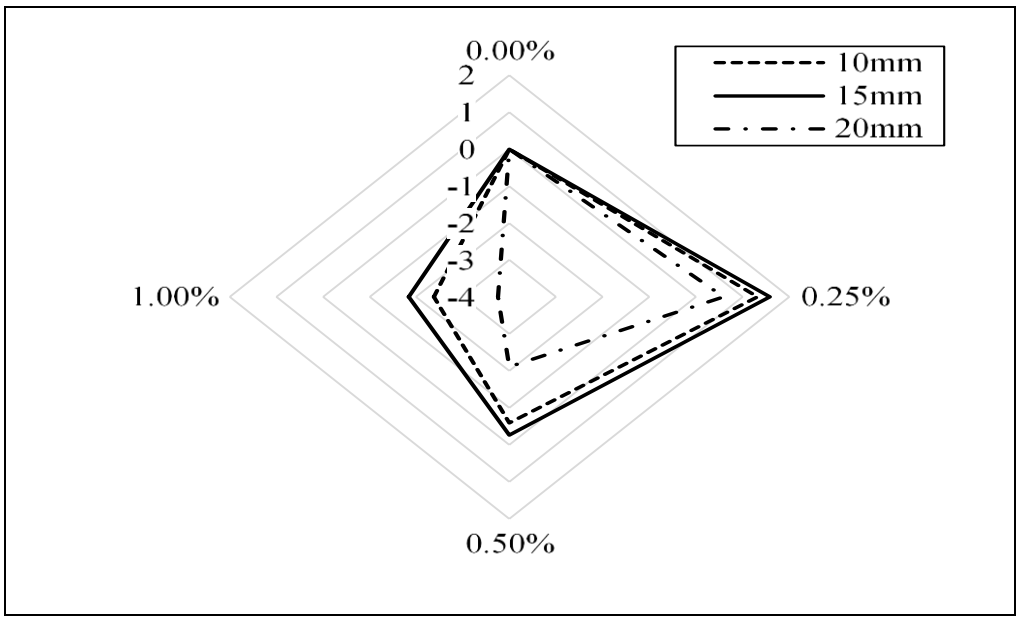



Fig 2 Normalized Compressive Strength of JFRC.

At dosages above 0.25%, the manuscript reports reductions relative to control: for 10 mm fibers, 0.59% and 2.37% at 0.50% and 1.00%; for 15 mm fibers, 0.26% and 1.85%; and for 20 mm fibers, 2.11% and 3.76%, respectively. These observations are in line with the hypothesis that fiber agglomeration and trapped voids or workability reduction were responsible for strength reduction, but were not measured directly. Based on the mean response observed the preferred fibre dosage and fibre combination is 15 mm at a dosage of 0.25 %. There is no evidence yet to confirm an optimum fibre dosage and fibre combination, statistically.

- *Relationships Among $f'_c$, JF Content, and Fiber Lengths*

The fitted correlation for 28-day compressive strength, jute-fiber dosage and fiber length is shown in Fig. 3 This regression is only an empirical fit within the ranges explored. Verify your answer to the original equation, which must be provided in a supplementary file, along with the dataset. Do not call a given surface a hyperbolic paraboloid without checking its algebraic form.

$$f'_c = -0.91JF^2 - 0.01JFL^2 + 0.23JFL + 27.4 \quad (1)$$

28 days compressive strength (MPa), Jute fiber content (%) and Jute fiber length (mm) signify the curing of compressive strength after 28 days, jute fiber contents in percentage, and jute fiber length respectively. Equations 1 (developed by coefficients at the 95% confidence bound) can be used to predict the compressive strength of JFRC. As shown in the Eq. (1) and Fig 3, the regression model has a nonlinear relationship with fiber parameters JF and JFL. This indicates that strength is a at first can increase with increases in fiber length, however when the fiber material contents or extreme lengths are used these can both lead to decreases in duromers fibers. For this reason, it is necessary to know the optimal ranges for both variables in order to obtain the greatest possible strength.

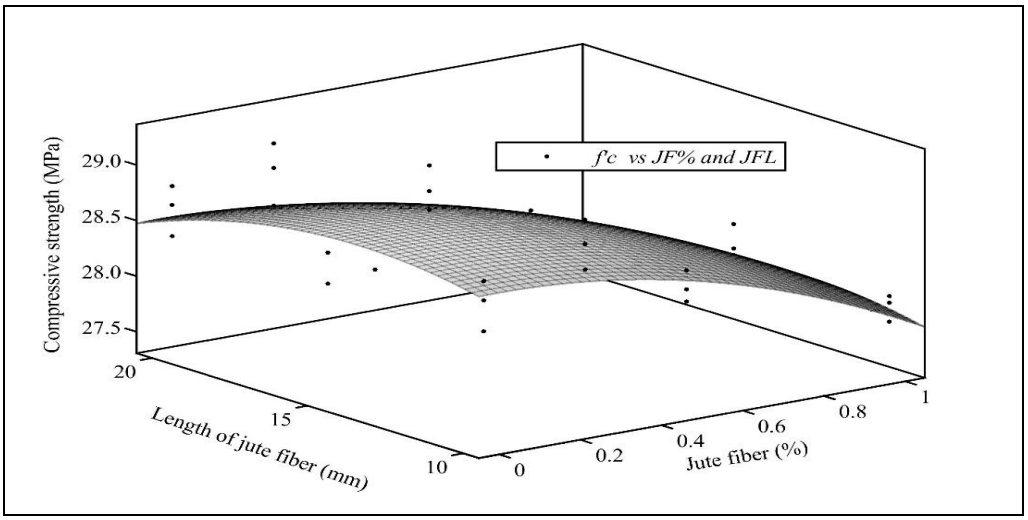



Fig 3 Relationships Among $f'_c$, JF Content, and Fiber Lengths.

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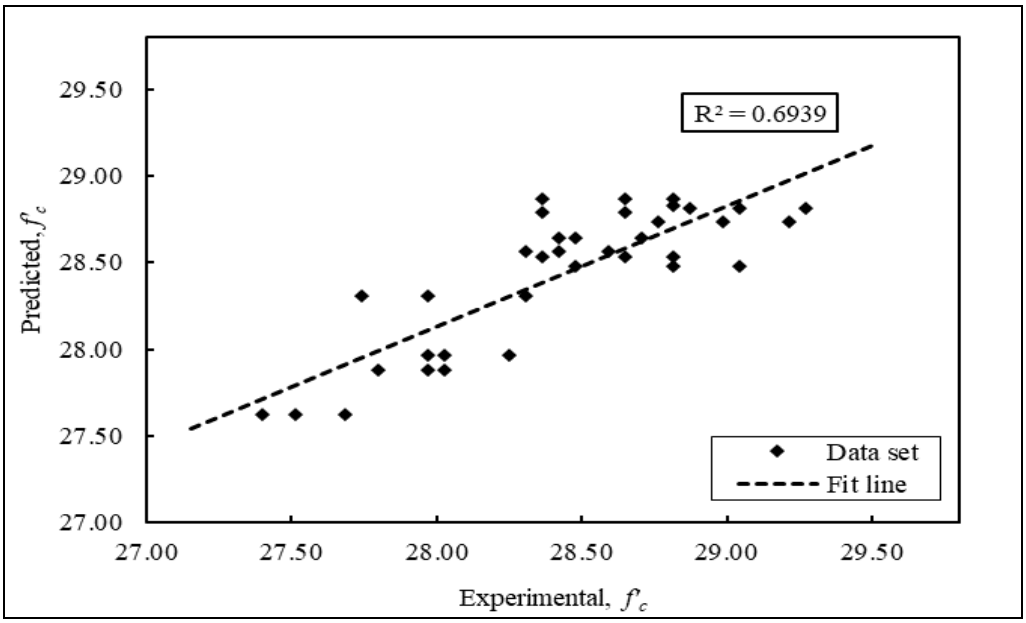


Fig 4 The Plot of the Regression Fit.

Table 4 reports the in-sample model statistics (r = 0.83, $R^2$ = 0.70, adjusted $R^2$ = 0.67, SSE = 2.40, SE = 0.27, RMSE = 0.26, MAPE = 0.70 and MAE = 0.20). These describe agreement with the observations used for model assessment, but do not establish predictive performance on independent data. The number of fitting observations, residual plots, parameter confidence intervals, and independent or cross-validated prediction errors are not provided. Consequently, predictive reliability and extrapolation beyond the tested conditions cannot be claimed.

Table 4 Model Performance Indices.

| Parmeters | Symbol | Value |
|---|---|---|
| Correlation coefficient | r | 0.83 |
| Coefficient of determination | $R^2$ | 0.70 |
| Adusted R-square | - | 0.67 |
| Sum of squared error | SSE | 2.40 |
| Standard error | SE | 0.27 |
| Root mean squared error | RMSE | 0.26 |
| Mean absolute percentage | MAPE | 0.70 |
| Mean absolute error | MAE | 0.20 |

## IV. CONCLUSION AND RECOMMENDATION

An improvement of 0.60% – 1.58% in the compressive strength of concrete was observed with jute fiber, in comparison to control concrete, being prominent at 15 mm fibre (maximum performance) where it was increased by 1.58%. It can be interpreted from the above that more fibre content leads to decrease in compressive strength i.e. optimum fibre content and length was found to be 15 mm fibre and 0.25 %. The regression model that has been developed ($R^2$ = 0.70) provides a good fit of the experimental data however further testing is needed to confirm it as a valid predictor.

Based on the experiments, the following suggestions are proposed:

- Since 15 mm jute fibre at 0.25% by weight of cement is the most beneficial mix to strengthen the compressive strength of mixes in range fibres used, so, further investigation can be performed using its full potential as well as increase the length if feasible due to lack of experimental research carried out on fractional fibre length.
- More experimental experiments with enough replication and statistical testing are needed to validate the strength enhancements and reproducibility of results.
- Experimental studies checking on cementatious property/ O glue injury strength, bending strength, workability up of water absorption and utilization legislation of concrete

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with jute-fibre needs to be more evaluated before usefulness of your promotion.

- prior to recommending the proposed regression model for further practical use in engineering practice, it should be verified by an independent data set of experimental results and some concrete mixes.

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## REFERENCES

[1]. Chandramouli, K., Rao, P.S.R.S., Narayanan, P., Tirumala,S.S. and Sravana,P(2010). Glass fiber concrete — Strength properties. ARPN Journal of Engineering and Applied Sciences, 5(4).

[2]. N. Bheel, T. Tafsirojjaman, Y. Liu, P. Awoyera, A. Kumar and M.A. Experimental Investigation on Cement Concrete Reinforced with Nylon and Jute Fibres. Buildings, 11(10), Article 454.

[3]. L. Yan, N. Chouw, L. Huang and B. Kasal (2016) Alkali treatment on microstructure and mechanical properties of coir fibres, coir fibre reinforced-polymer composites and reinforced-cementitious composites Construction and Building Materials, 112, pp. 168–182.

[4]. Silva, G. Kim, S., Bertolotti, B. Nakamatsu,J. and Aguilar,R.(2020). November 2019: Characterisation of Natural Fibers Reinforced Geopolymer Composite with Construction Wastes outcome, In International Journal of Renewable Energy Research vol.

[5]. Kundu, S.P.; Chakraborty, S.; Roy, A.; Adhikari, B. and Majumder, S.B. (2012) Improving the mechanical properties of Non-pressure (NP) concrete pipes reinforced with chemically modified jute fibre Construction and Building Materials, 37, pp.841–850

[6]. Mansur, M.A. and Aziz, M.A., (1982). 1.Investigated jute fibre reinforced cement composites IJAO : International Journal of Aluminium On January 14, 2001 the Society for Advanced Materials and Process Engineering was formed as an international organization comprised of five constituent societies: The American Ceramics Society, The Association of Metal Finishers of Lochaber Inc., The Electrochemicals Society, The Swedish Corrosion Institute, and the Western Canada Material Handling Conference.

[7]. Food and Agriculture Organization of the United Nations (FAO), 2025. STATISTICAL BULLETIN: FIBRES OF JUTE, KENAF, SISAL, ABACA, COIR AND ALLIED FIBRES 2024 Rome: FAO. Accessed: 10 June 2025.

[8]. Ubayi S S; Ahmad D E; Abubakar D B S et al (2024) Abstract — A Review on Effect of jute Fiber Reinforcement On Properties Of Composite Material Edited by: Editorial Board, International Journal in Engineering Sciences.

[9]. Bheel, N., Tafsirojjaman, T., Liu, Y., Awoyera, P., Kumar A. and Keerio M.A (2021). Experimentalinvestigations on engineering properties of cement concrete incorporating nylon and jute fibres. Buildings, 11(10), Article 454.

[10]. Islam, M.S. and Ahmed, S.J. Effect of Jute Fiber on Properties of Concrete. The material comprising of a polymethyl methacrylate (PMMA) shell with an in-built antibiotic, Nature Publishing Group.

[11]. Kim, J.S., Lee, H.J. and Choi,Y.(2013). Natural fibre-reinforced normal strength and high-fluidity concretes: Mechanical properties. In: Computers and Concrete, v. 11, no. 6, p. 531-539

[12]. Razmi, A., Mirsayar, M.M., 2017. The mixed mode I/II fracture properties of jute fiber-reinforced concrete Construction and Building Materials, 148, pp. 512–520

[13]. Yan, L., Chouw, N. and Huang, L. and Kasal, B. (2016). Alkali treatment in some type such as Sodium hydroxide (NaOH) and more on the microstructure and mechanical properties of coir fibres, coir fibre reinforced-polymer composites and reinforced-cementitious composites. Construction and building materials, 112, pp. 168–182/

[14]. ASTM International (2003). ASTM C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens. West Conshohocken, PA: ASTM International.

[15]. ASTM C31 (2003). Standard Practice for Making and Curing Concrete Test Specimens in the Field 1 76 ASTM International, West Conshohocken, PA 19428-2959..