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To Investigate the Mechanical Properties of Concrete by Partial Replacement of Cement with Ceramic Tiles Waste Powder and Addition of Jute Fiber

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Abstract: The need for natural and non-renewable resources has grown as a result of the continuing development of society and human endeavours. As a result, the amount of industrial solid waste products kept growing. The most widely used man-made material in the world, concrete, has generated a lot of interest as a potential method for recycling solid waste. About the same amount of CO_2 is produced during the manufacture of 1 tonne of Portland cement. The cement sector is thought to be responsible for 5% to 8% of yearly global greenhouse gas emissions. The use of waste materials in our current concrete can lessen the environmental pollution. Put the scenario in a critical state employing alternate approaches and come up with a better material recycling solution. As additional cementitious materials, a variety of by-products, including fly ash, slag, and silica fume, are successfully used every day in the manufacturing of concrete (SCM). According to the research it has been found that about 150 million tons of ceramic have been produced per year. From that total production, around 25% to 35% has become waste material without recycling from the ceramic industry at present. The ceramic powder has various advantages such as cost - saving, energy Saving and reduces the hazards materials to the environment. Ceramic waste can be used in concrete to increase the compressive strength and physical and chemical properties of concrete. It has been established that the addition of evenly distributed, tightly spaced Fibers to concrete will significantly enhance its static and dynamic properties and act as a crack arrester. Concrete that has been reinforced with fibrous material, or fiber-reinforced concrete (FRC), has a higher structural stability. It is important to note that jute is sometimes referred to as the golden fibre owing to its high cash value and its colour. It improves the shear and punching resistance of concrete, aid in recovering post-cracking strength losses, increases the toughness and become an effective way for reinforcement. In this experimental work, partial replacement of cement by ceramic tiles waste powder by percentages of 0%, 15%, 20%, 25% and 30% with expansion of Jute Fiber at different rate as 0%, 0.25%, 0.50%, 0.75% and 1.0% are done to make sustainable concrete. All specimens were cured for 7days and 28 days before testing. From the study it has been observed that the test results shows optimum proportion for concrete mix and are within acceptable limits.

Keywords: Ceramic Tiles Waste Powder, Jute Fiber, Compression strength, Tensile Strength, Flexural Strength, Slump Test, Concrete mix.

I. INTRODUCTION

The need for natural and non-renewable resources has grown as a result of the continuing development of society and human endeavours. As a result, the amount of industrial solid waste products kept growing. The most widely used man-made material in the world, concrete, has generated a lot of interest as a potential method for recycling solid waste. About the same amount of CO_2 is produced during the manufacture of 1 tonne of Portland cement. The cement sector is thought to be responsible for 5% to 8% of yearly global greenhouse gas emissions. The use of waste materials in our current concrete can lessen the environmental pollution. Put the scenario in a critical state employing alternate approaches and come up with a better material recycling solution. As additional cementitious materials, a variety of by-products, including fly ash, slag, and silica fume, are successfully used every day in the manufacturing of concrete (SCM). Waste like ceramic wastes, plastics waste PPE waste, etc, In this way, we can contribute to solving this environmental problem. The ceramic powder has various advantages such as cost - saving, energy Saving and reduces the hazards materials to the environment. Ceramic waste can be used in concrete to increase the compressive strength and physical and chemical properties of concrete.

Concrete has undesirable characteristics as well, such as low tensile strength, quasi-brittle failures, limited resistance to wind and seismic loads, increased self-weight, and/or density, in addition to these advantageous qualities. The addition of fibres to the concrete matrix not only makes the concrete body more durable but also prevents cracks from forming. Numerous studies have looked into the impact of fibres.

A. Ceramic Tiles Waste Powder

In the ceramics business, 15% to 30% of the overall production is wasted. Currently, there is no recycling of this garbage in any way. The ceramic waste is tough, resilient, and highly resistant to forces of biological, chemical, and physical deterioration. Utilizing such trash has a number of benefits in addition to aiding in environmental protection, such as reducing the need for other raw materials and promoting a natural resource economy.

Advantages of Ceramic Tiles Waste Powder

1) Ceramic waste can be used in concrete to improve its strength and other durability factors.
2) Ceramic waste can be used as a partial replacement of cement to achieve different properties of concrete.
3) It reduces permeability which prevents from ground water recharge.
4) If ceramic waste has been utilized in the concrete than it is environment and eco-friendly to our eco system.

B. Jute Fiber

Jute fibres are typically categorised as bast fibres, which are plant fibres that can be extracted from the phloem or bast that surrounds the plant's stem. Other well-known examples of fibres made from the phloem or bast of the plants that produce them are kenaf, industrial hemp, and linen (made from the bast of the flax plant) (also known as Java jute and Deccan hemp). It should be noted that jute fibres typically range in colour from brown to off-white.

Advantages of Jute fiber

1) They are easy to obtain with low energy demands and CO_2 emissions.
2) The fibers in the mixture of concrete also improve the shear and punching resistance of concrete and aid in recovering post-cracking strength losses.
3) The fibers in the concrete matrix increases the toughness of the concrete.
4) The use of jute fibers in concrete could become an effective way for reinforcement.

II. LITERATURE REVIEW

Prince et.al (2017) In their exploration concentrate on the concrete has been supplanted by clay squander powder appropriately in the scope of 0%, 10%, 20%, 30% 40%, and half by weight for M-25 grade concrete and furthermore concrete is likewise supplanted by 10%-half of GGBFS. The outcome shows center compressive strength accomplished up to 20% substitution of fired squander powder without influencing the trademark strength of M25.

KeerthiGowda B S et.al.(2018) make Study on Compressive Strength Attributes of Jute Fiber Reinforced Cement Concrete Composites. The investigation helps to explore more on the variation of properties of concrete with jute fibers, its effective usage and to reduce the usage of polymer fibers which interns an environmental harm. In the present study, raw jute fibers cut to 10 mm were used with the proportionate mix of cement, coarse aggregate and sand with the watercement ratio of 0.45. The mixed specimens are casted for different volume content of jute fibers (0.2%, 0.4%, 0.6%, 0.8%, 1%, 1.2%, 1.4%, 1.6% and 1.8%) and cured for 3, 7 and 28 days. The maximum compressive strength is obtained for a concrete coupon of fiber content 0.4%. As the fiber content increased from 0.4 % the compressive strength get reduced, causing poor workability of concrete.

S.M. Leela Bharathi et.al.(2019) chipped away at the flexural conduct of Natural Fiber Reinforced concrete with halfway substitution of Flyash and GGBFS. It is seen that Jute Fiber Reinforced Cement Concrete (JFRCC) blend in with 30% GGBFS has greatest compressive strength which is 8.8% higher than ordinary concrete and 15.8% higher than JFRCC with 30% Flyash.

Pramodini Sahu et al. (2020) proposed concentrate on impact of jute Fiber direction and rate on strength of jute Fiber built up concrete. In this examination, the analyses connected with jute Fiber supported concrete are finished by taking different Fiber rate and the compressive strength and modulus of break esteem noticed. This work inferred that with jute Fiber the compressive strength esteem pretty much different as for Plain concrete cement.

Naraindas Bheel (2021) proposed an experimental study on the technical properties of cement concrete reinforced with nylon and jute fibers. The current study investigates the technical properties of cementitious concrete co-reinforced with nylon and jute fibers. Therefore, the combined effects of nylon and jute fibers on the workability, density, water absorption, compression, tensile, flexural strength and drying shrinkage of concrete were studied. The results show that the concrete containing 1% by volume fraction of nylon and jute fibers together had compressive, split tensile and flexural strengths of 11.71%, 14.10% and 11.04% respectively compared to the control concrete mix. showed the greatest improvement of %. 90 days later. However, the water absorption of concrete increased with increasing content of nylon and jute fibers. Drying shrinkage of concrete decreased when nylon and jute fibers were added together after 90 days.

III. MATERIALS USED

A. Water

Fresh and hardened properties of concrete like workability, compressive strengths, water tightness, permeability, weathering, durability, drying shrinkage and potential for cracking are generally controlled by the quantity of water used.

B. Cement

Cement is the binder material used to bind coarse aggregate & fine aggregate in concrete & after solidification makes concrete. Cement when mixed with water starts an exothermic reaction & releases heat of hydration.

C. Fine Aggregates

Fine aggregates are essentially any natural sand particles won from the land through the mining process. Fine aggregate (Sand) Fills voids between aggregates. It forms the bulk and makes mortar or concrete economical. It provides resistance against shrinking and cracking.

D. Coarse Aggregates

Materials that are larger to be retained on 4.75 mm sieve size are called coarse aggregate, and their maximum size can be up to 63 mm. Locally available coarse aggregate having average size of 20 mm was used in this study confirming to IS: 383-1970.

E. Ceramic Tiles Waste Powder (CWP)

CWP represents an important subject to master in terms of its environmental impact. It can cause soil, water and air contamination. On the other hand, if it can be used to make concrete, it could be a great opportunity to use it as an alternative raw material for concrete. Ceramic tile waste powder (CWP) is uniformly hand pounded into a powder of approximately cement size and sieved to 90 microns. The chemical composition of ceramic tile waste powder is shown in Table 3.1.

Table 3.1: Chemical Composition of Ceramic Tiles Waste Powder
Source: (Paper) Amitkumar D. Raval1 , International Journal of Engineering Trends and Technology (IJETT) - Volume4 Issue6- June 2013

Sr. No	Characterstics	Value
1	Silica(SiO_2)	63.29
2	Alumina(Al_2O_3)	18.29
3	Fe_2O_3	4.32
4	Lime(CaO)	4.46
5	P_2O_5	0.16
6	Potassium(K_2O)	2.18
7	Magnesia(MgO)	0.72

Figure 3.1: Ceramic Tiles Waste and CWP

F. Jute Fiber

Jute fiber has strength, low cost, durability, and versatility. Jute has a low carbon footprint and is biodegradable. Raw jute fibers cut to 10 mm length are used in this study. Jute fiber content is determined in relation to cement weight.

Figure 3.2 Jute fibers

IV. RESULTS AND DISCUSSIONS

A. Slump Test

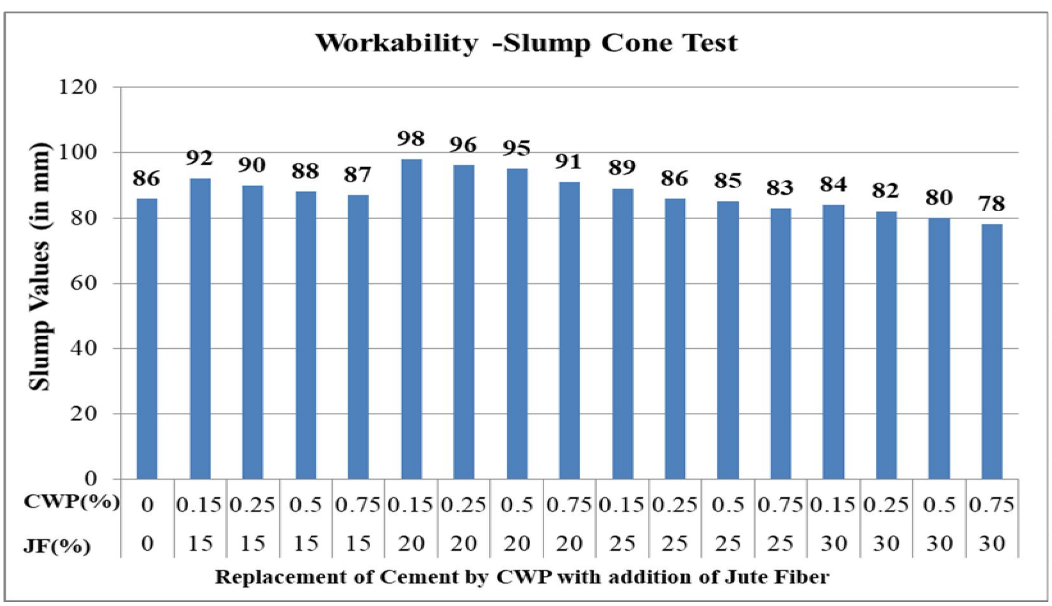

Figure 4.1: Slump Test

B. Compression Test

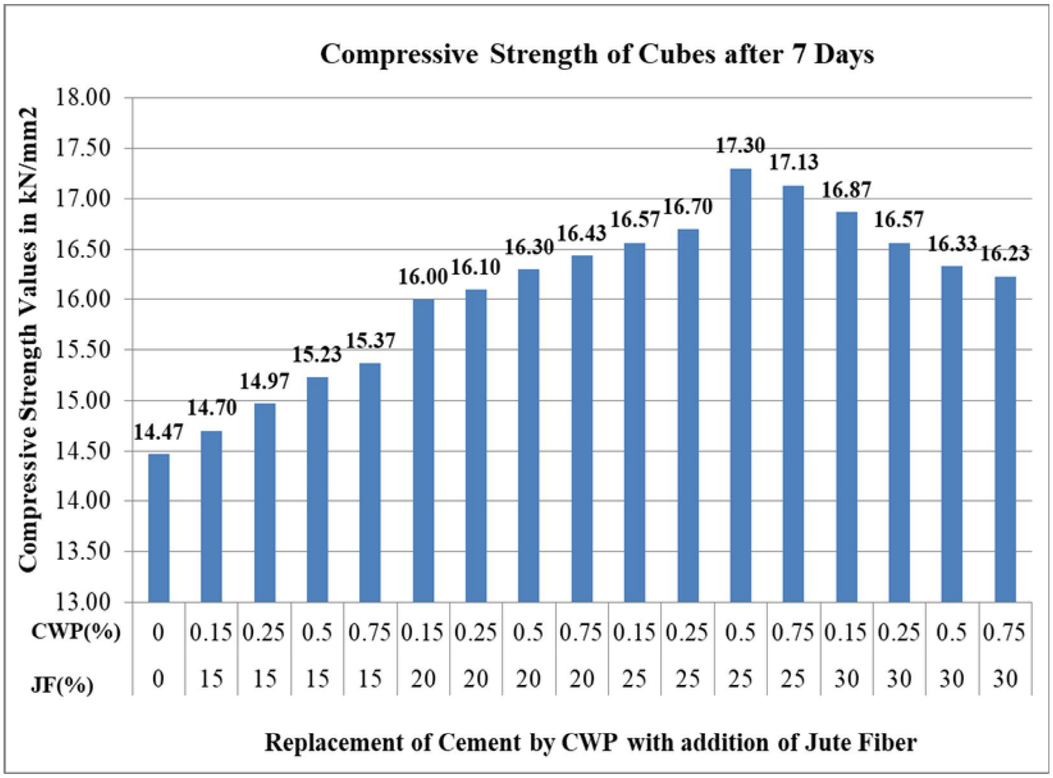

Figure 4.2: Compression Test results after 7 days

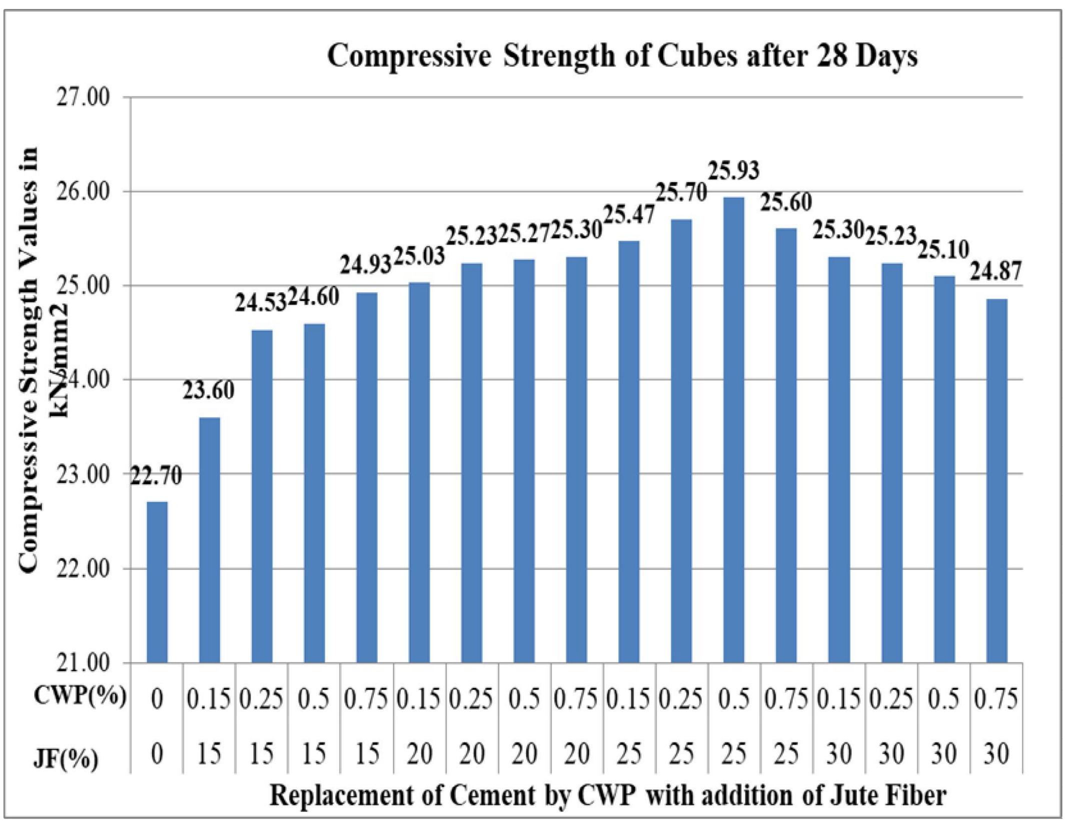

Figure 4.3: Compression test results after 28 days

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C. Split Tensile test

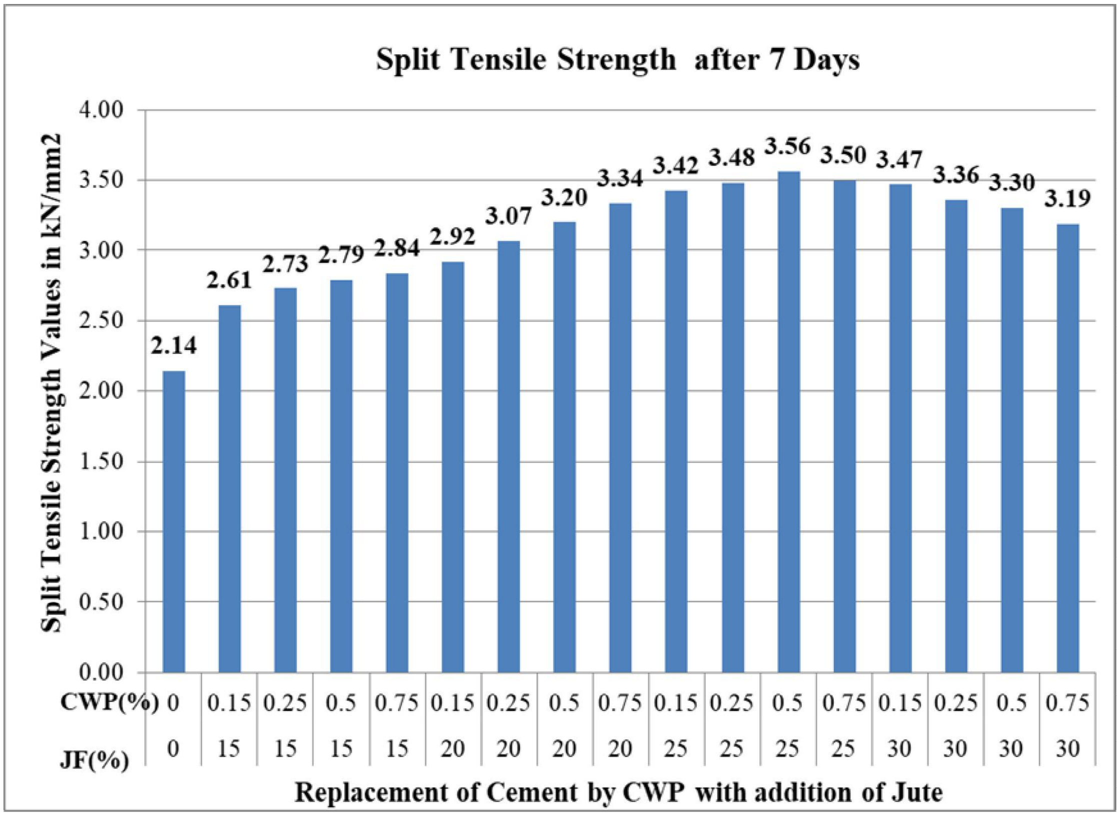

Figure 4.4: Split Tensile test results after 7 days

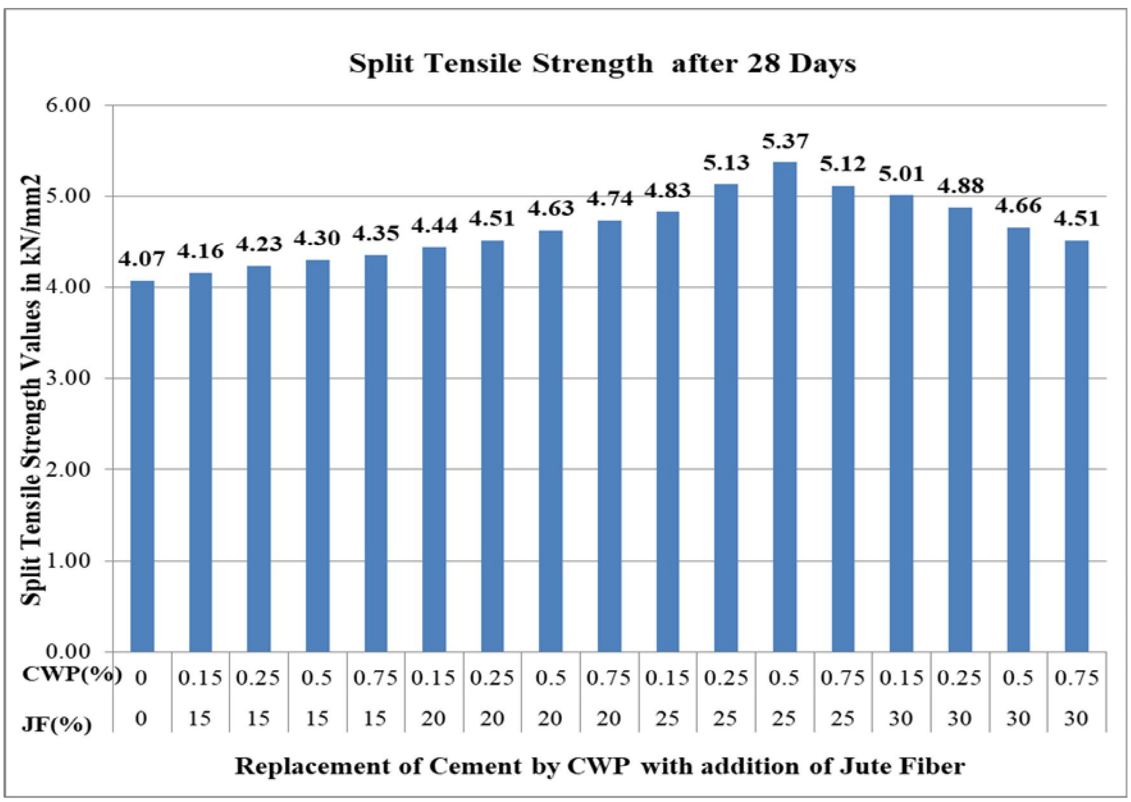

Figure 4.5: Split Tensile Test results after 28 days

D. *Flexural Test*

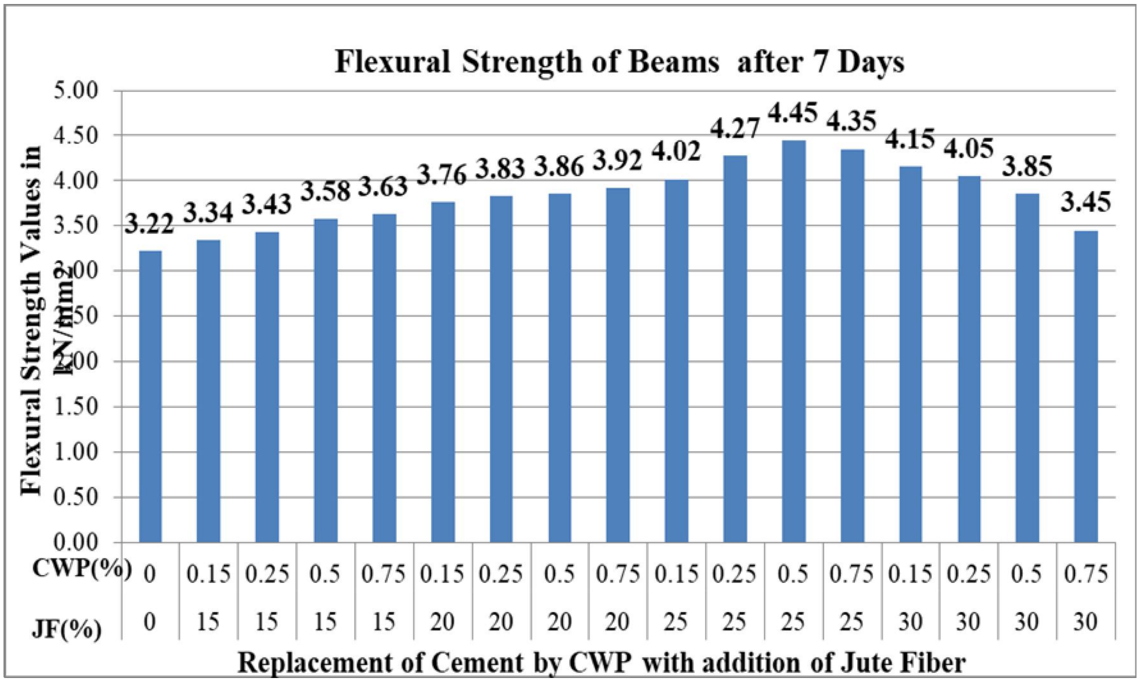

Figure 4.6: Flexural Test results after 7 days

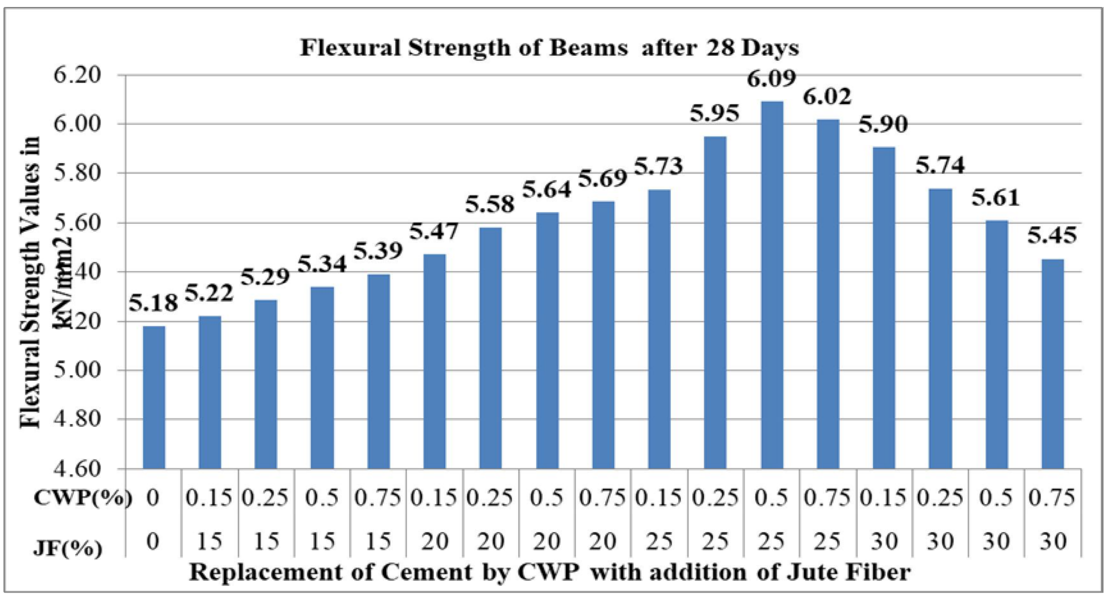

Figure 4.7: Flexural Test results after 28 days

V. CONCLUSIONS

1) The findings of the compressive strength test indicate that the compressive strength is increased by partially substituting the powdered waste from ceramic tiles with cement and jute fibre.
2) CWP25%JF0.5% is an appropriate substitution percentage for Jute Fiber and Ceramic Tile Waste Powder in terms of strength and affordability. At the ideal % substitution, the compression strength is measured at 25.93MPa.
3) The split tensile strength and the flexural strength or rupture modulus showed similar characteristics to compressive strength or toughness strength.
4) The partial substitution of cement and jute fibre for ceramic tile waste powder has demonstrated a positive influence on split tensile strength up to CWP25%JF0.5% substitution.

5) The maximum tensile strength measurement, 5.37MPa, was made at CWP25%JF0.5% replacement.
6) Additionally, the strongest flexure was observed when CWP25%JF0.5%. is being partially replaced by replacing the waste powder from ceramic tiles with cement and jute fibre, increasing the strength to 6.09 MPa after 28 days. Both aid in boosting power during low volume replacement.

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