ANALYSIS OF PHYSICAL PROPERTIES OF CONCRETE WITH JUTE FIBRE REINFORCED CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT WITH METAKAOLIN

ISHAN ANAND[1], ATUL VERMA[2], MUKESH KUMAR DUBEY[3], DR VIJAY RAJ[4], SUSANTA KUMAR SETHY[5]

PG Student[1], PG Student[2], Industry Fellow[3], Professor[4], Assistant professor[5]

UNIVERSITY OF PETROLEUM AND ENGINEERING STUDIES, DEHRADUN

ABSTRACT

Natural fibers offer superior mechanical properties, are less expensive, come from renewable resources, and are recyclable. The alkaline matrix is damaging to the fibers in cementitious composites reinforced with natural fibers because the hydration products, primarily calcium hydroxide (CH), move to the fiber walls, producing fiber mineralization. Continuously fiber as reinforcement can be used to create high-performance cement - based materials. The cementitious binder can be used to impregnate unidirectional or bidirectional reinforcing in these composite. This kind of technique has been used in the fabrication of thinwalled components of cement composite assemblies, as well as in repairs and upgrade applications. For a long period of time, the cement industry has used several kinds of pozzolanic ingredients to enhance cement characteristics. Metakaolin is an aluminum silicate that has been dehydroxylated. It's a non-crystallized amorphous substance made up of lamellar particles. Metakaolin is a highly excellent pozzolanic substance, as evidenced by current research studies, and it greatly boosts the strength properties of concrete. Metakaolin also lowers the permeability of cured cement to liquids and gases. As a result, partly substituting Metakaolin for Portland cement reduces carbon dioxide emissions while also extending the life span of structures. In this research concrete is tested with replacement of cement from Metakaolin and addition of jute fiber. The percentage of addition of jute fiber are 0%, 1%, 2%, 3%, 4%, 5% and 6%. Replacement percentages of metakaolin are 0%, 3%, 6%, 9%, 12%, 15% and 18%. After the analysis prepare a new mix with 5% metakaolin and varying % of Jute Fiber. The grade of concrete is M35 that is used in analysis.

Keyword: Jute Fiber Reinforced Concrete, Metakaolin, Compressive Strength, Flexural Strength, Split tensile strength, Water Absorption etc.

1. INTRODUCTION

Concrete is the greatest often utilized construction component. Since 1990, global cement manufacturing has expanded dramatically. The usage of cement in the building sector is expanding with each day, as is the expense of cement, so this analysis attempted to decrease cement consumption by partially replacing it with metakaolin, as cement causes a lot of contamination in the environment. The usage of metakaolin produces green concrete since no co2 is released during the manufacturing process, whereas the manufacturing of cement and clinker produces enormous amounts of carbon dioxide, resulting in greenhouse gas emissions and a 3-5 percent increase in global warming. Many academics have been challenged by resource constraint and the growing concern about global pollution to find and create novel materials based on renewable resources. The use of by-products and waste elements in the construction of buildings is one of them. These are finely ground solid components that are utilized to substitute a part of the cement in a concrete mixing. These additional resources could be indigenous, manufactured, or man-made garbage.

Fiber Reinforced Concrete

Fiber Reinforced Composite Concrete is a composite material made up of fibrous material that adds structural strength, with cement, mortar, or concrete mixed with fibers that are discontinuous, distinct, and scattered. Fibers are commonly used in concrete to prevent cracking caused by shrinkage of the plastic and drying shrinkage. They significantly limit the permeability of concrete, resulting in less water bleeding. Fiber reinforced concrete comes in a variety of varieties and qualities, each with its own set of benefits. Discrete fibers do not include continuous meshes, woven textiles, or lengthy wires or rods. Fiber is a tiny piece of reinforcing material with unique qualities. They come in a variety of shapes and sizes, including round and flat. A useful measure termed "aspect ratio" is frequently used to define the fiber. The length-to-diameter ratio of a fiber is known as its aspect ratio. Aspect ratios often vary from 30 to 150. FRC (fiber-reinforced concrete) is a form of concrete that incorporates fibers to increase structural strength. It's composed up of many smaller, distinct fibers that are uniformly scattered and oriented in a randomized pattern. Steel fibers, glass fibers, synthetic fibers, and natural fibers are examples of fibers. The nature of fiber reinforced concrete differs with varied concretes, fiber materials, geometries, distribution, orientation, and densities within certain diverse fibers. Shotcrete uses fiber-reinforcement the most, although it may also be employed in regular concrete. Fiber-reinforced normal concrete is often used for on-ground floors and pavements, but it may also be utilized for a variety of building sections (beams, pliers, foundations, and so on), either alone or in combination with hand-tied rebars. Concrete reinforced with fibers (often steel, glass, or "plastic") is less costly than hand-tied rebar while boosting tensile strength many times.

Jute Fiber

Engineers must use suitable technology to use natural fibers and local building materials as efficiently, financially, as much as potential in order to generate good performance but low-cost fiber-reinforced cementitious components (FRCCs) for house building and other necessitates in several more developing countries, where natural fibers of different origin are available in abundance. Jute fiber is a three-dimensional composite made up mostly of cellulose, hemicelluloses, and lignin, with tiny quantities of protein and inorganic materials. When compared to other fibers such as sisal, bamboo, coir, and hemp, jute has a high tensile strength. Apart from its tensile strength, jute fiber is also heat resistant. Natural fibers derived from plants are divided into three groups based on the plant component from which they were collected. The first is the so-called fruit fiber (e.g., coir, cotton), which is derived from the plant's fruits. The second type of fiber may be discovered in the plant's stems (e.g., jute, flax, ramie, hemp, etc). Bast fiber is a term for certain types of fibers. The fibers taken from the leaves are the third group (e.g., sisal, date palm, oil palm, etc.).

Metakaolin

Metakaolin is an additive used in HSC to partially replace cement (High Strength Concrete). If the compressive strength of a concrete is greater than 40 MPa, it is considered high strength concrete. Metakaolin is made by calcining kaolin (clay material) at temperatures ranging from 650 to 800 degrees Celsius. Its chemical formula is Al2O3.2SiO2.2H2O, and it possesses Pozzolanic characteristics. It combines with Ca (OH) 2, one of the by-products of the cement hydration reaction, to produce more C-S-H gel, which increases strength. By converting finer particles into discontinuous pores, metakaolin in concrete lowers the size of pores in cement paste. It improves concrete's compressive and flexural strength while also reducing efflorescence. Meta kaolin, a comparatively recent substance in the concrete industry, improves strength, reduces sulphate attacks, and improves the air-void network. By eating the liberated calcium hydroxide (CH) and producing extra calcium silicate hydrate (C-S-H), pozzolanic reactions alter the microstructure of concrete and the chemistry of hydration products, results in higher strength and decreased porosity, and hence enhanced durability.

2. OBJECTIVES

- To incorporate jute fibers to metakaolin concrete to improve its e strength qualities.
- To increase the concrete's fracture resistance to a larger level.
- The purpose of this study was to see if jute fiber could be used as a reinforcing agentin cement concrete.
- Jute fiber length and loading in cement matrix enhancement.
- Chemical and polymer alteration of jute fibers, as well as characterization of changedjute fibers
- Characterization of manufactured cement concrete/mortar in terms of its physical,mechanical, and structural properties.
- Jute fiber longevity in a cement concrete medium.
- To know the properties of metakaolin as a replacement with cement in concrete.
- To enhance the characterization of concrete by metakaolin.

3. METHODOLOGY

In this chapter provide details about mix composition of prepared for testing, detail of test used for cement and concrete. Also tells about source and properties of jute fiber rand Metakaolin. In this research concrete is tested with replacement of cement from Metakaolin and addition of jute fiber. The percentage of addition of jute fiber are 0%, 1%, 2%, 3%, 4%, 5% and 6%. Replacement percentages of metakaolin are 0%, 3%, 6%, 9%, 12%, 15% and 18%. The grade of concrete is M35 that is used in analysis.

Test Performed on Cement

- Initial Setting Time
- Final Setting Time

Test Performed on Concrete

- Slump Test
- Compressive Strength Test
- Flexural Strength Test
- Split Tensile Test

- Water Absorption Test
- Ultra Sonic Pulse Test

Table: 1 Mix Proportions of Samples

Mix	% ofFiber	% of Metakaolin	Jute Fiber (kg)	Metakolin (kg)	Cement(kg)	Sand(kg)	Aggregate(kg)	Water(kg)
Standard	0%	0%	0	0	40.3	67.3	110.6	18.1
SF1M3	1%	3%	0.403	1.2	39.1	67.3	110.6	18.1
SF2M6	2%	6%	0.806	2.5	37.8	67.3	110.6	18.1
SF3M9	3%	9%	1.209	3.7	36.6	67.3	110.6	18.1
SF4M12	4%	12%	1.612	4.9	35.4	67.3	110.6	18.1
SF5M15	5%	15%	2.015	6.1	34.2	67.3	110.6	18.1
SF6M18	6%	18%	2.418	7.3	33.0	67.3	110.6	181

Here,

S=Sample, F1=1% Jute Fiber, F2=2% Jute Fiber, F3=3% Jute Fiber, F4=4% Jute Fiber,F5=5% Jute Fiber; F6=6% Jute Fiber;

M3=3% Metakaolin, M6=6% Metakaolin, M9=9% Metakaolin, M12=12% Metakaolin,M15=15% Metakaolin M18=18% Metakaolin

Table: 2 Mix Proportion with 5% Metakaolin and Varying % of Jute Fiber

Mix	% of Metakaolin	% ofFiber	Cement(kg)	Sand(kg)	Aggregate(kg)	Water(kg)
Standard	0%	0%	40.3	67.3	110.6	181
Mix-1	5%	0.6%	39.1	67.3	110.6	181
Mix-2	5%	1.2%	37.8	67.3	110.6	181
Mix-3	5%	1.8%	36.6	67.3	110.6	181
Mix-4	5%	2.4%	35.4	67.3	110.6	181
Mix-5	5%	3.0%	34.2	67.3	110.6	181

4. RESULT AND DISCUSSION

Tests on Cement

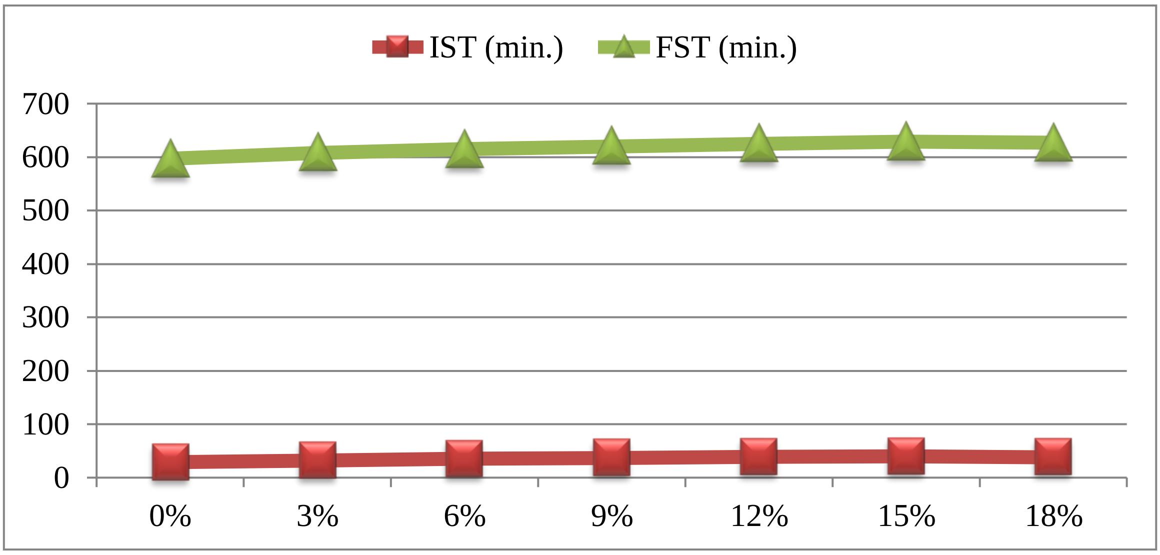

Fig. 1 Initial and Final Setting Time of Cement with Metakaolin as Replacementof Cement

Tests on Concrete

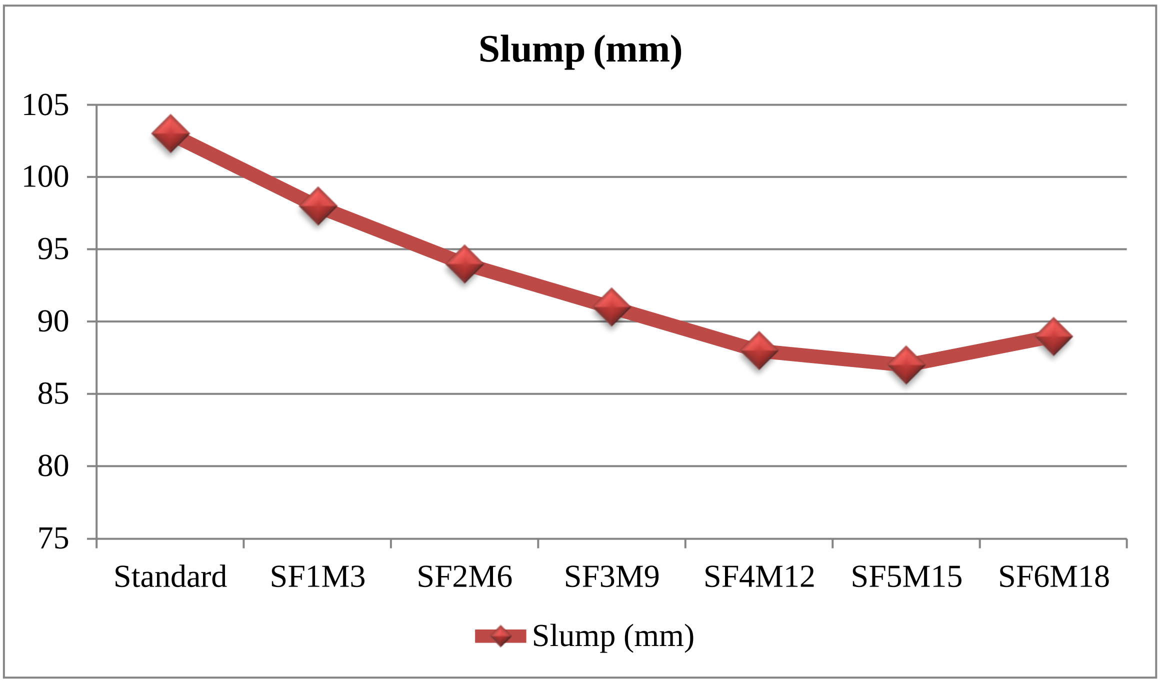

Fig. 2 Slump Test at Addition of varying % of Jute Fiber and Metakaolin asReplacement of Cement

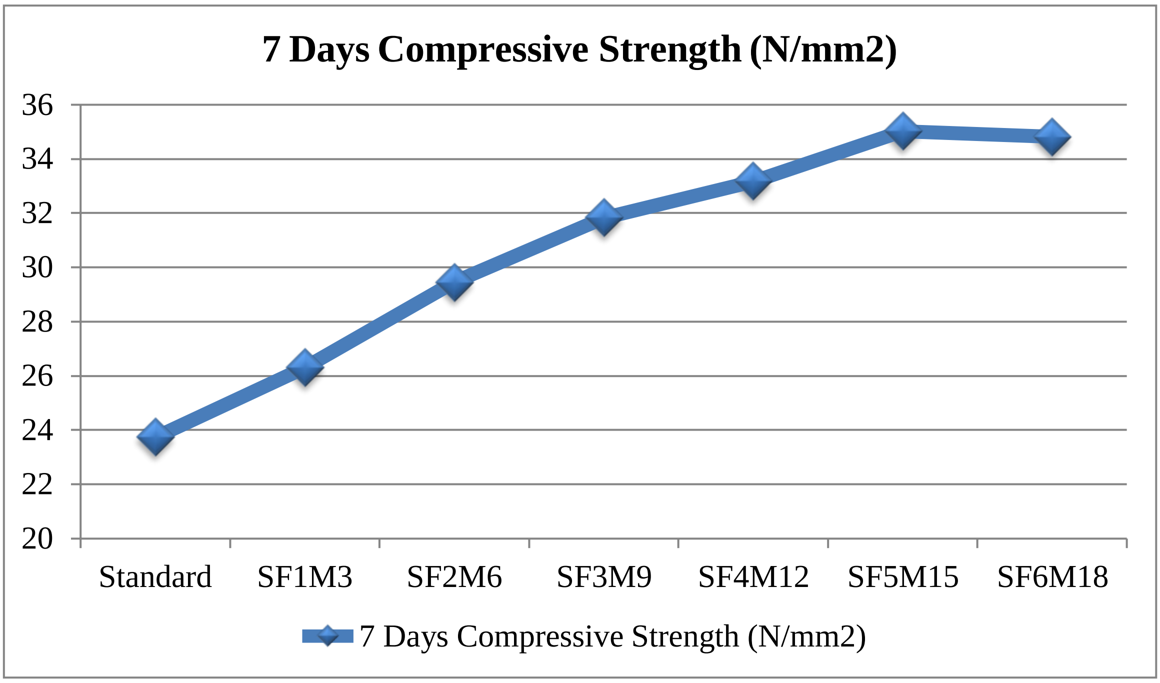

Fig. 3 Compressive Test at 7 Days Addition of varying % of Jute Fiber andMetakaolin as Replacement of Cement

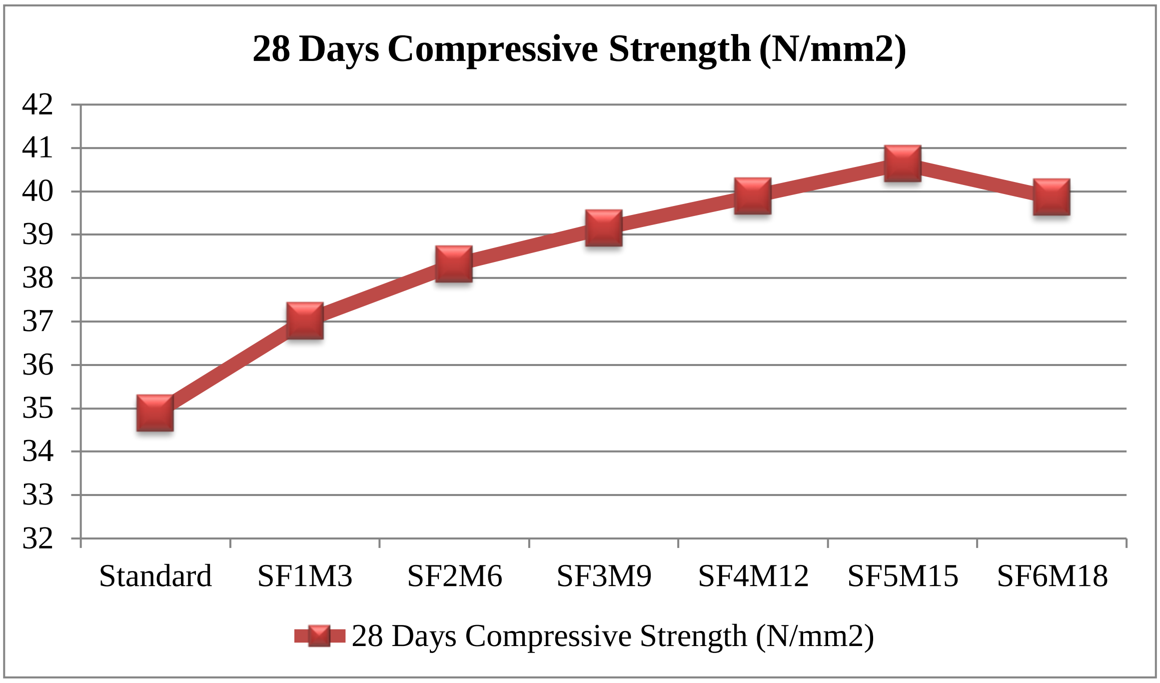

Fig. 4 Compressive Test at 28 Days Addition of varying % of Jute Fiber andMetakaolin as Replacement of Cement

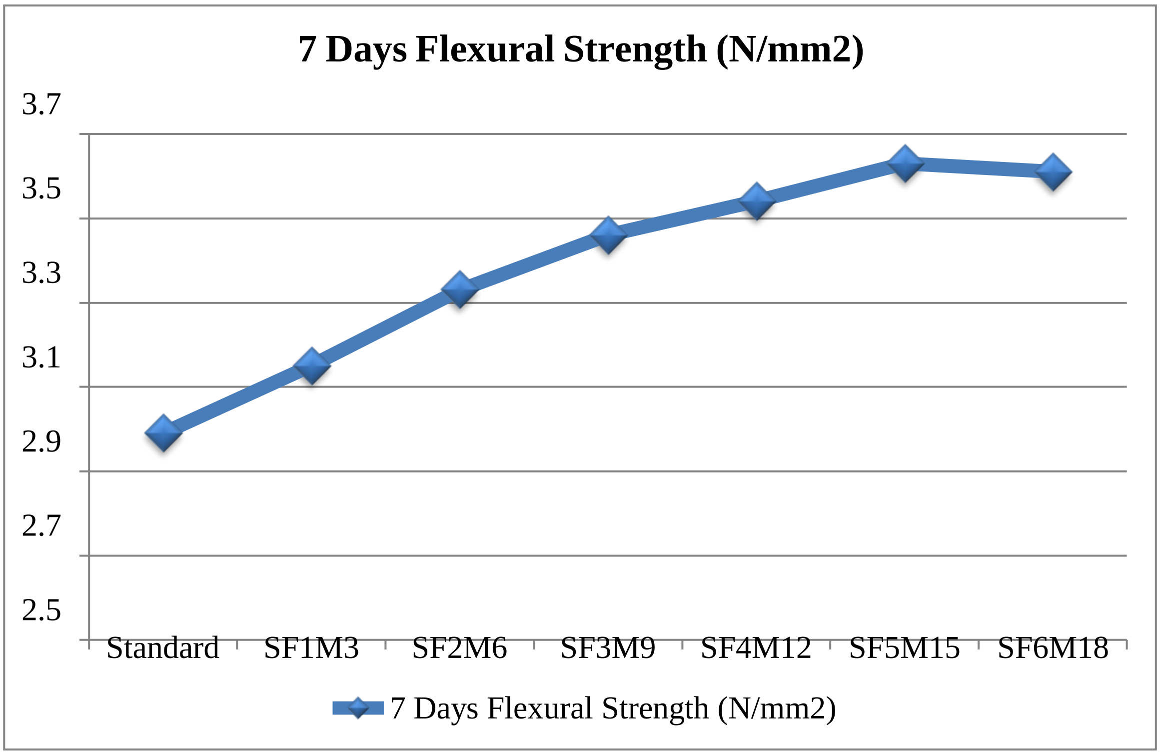

Fig. 5 Flexural Strength at 7 Days Addition of varying % of Jute Fiber andMetakaolin as Replacement of Cement

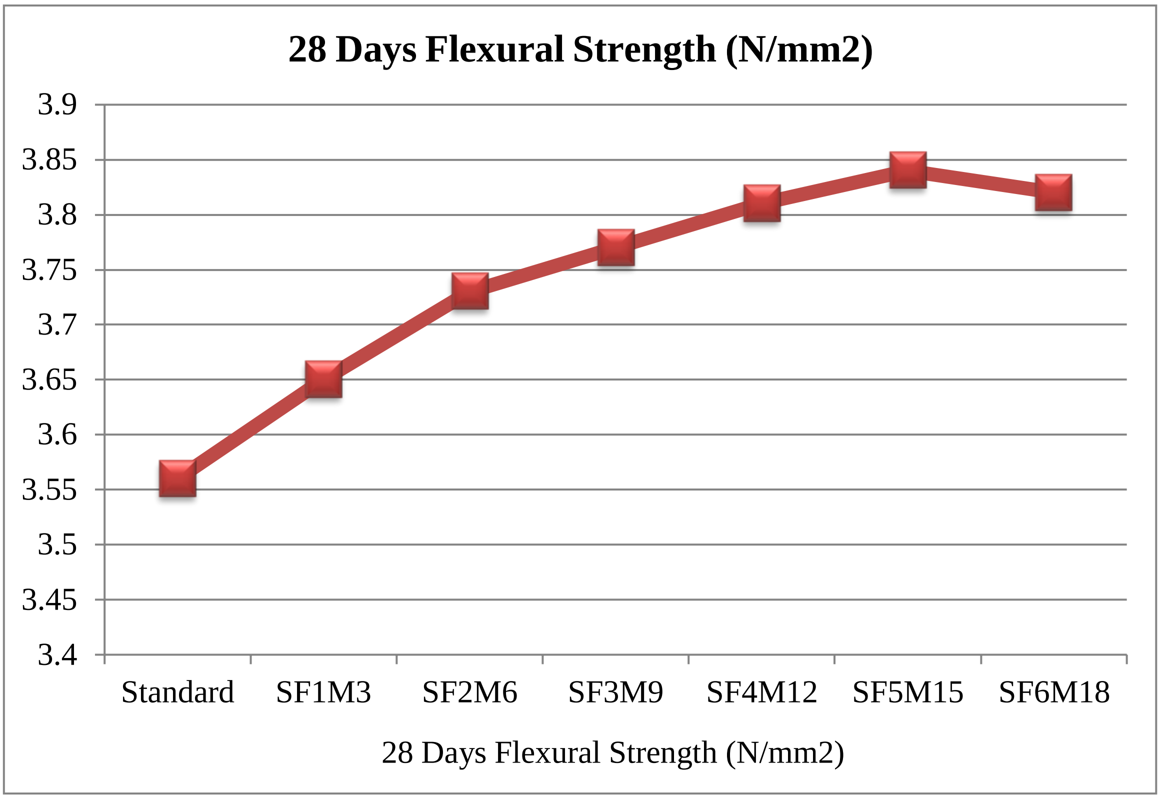

Fig. 6 **Flexural Strength at 28 Days Addition of varying % of Jute Fiber andMetakaolin as Replacement of Cement**

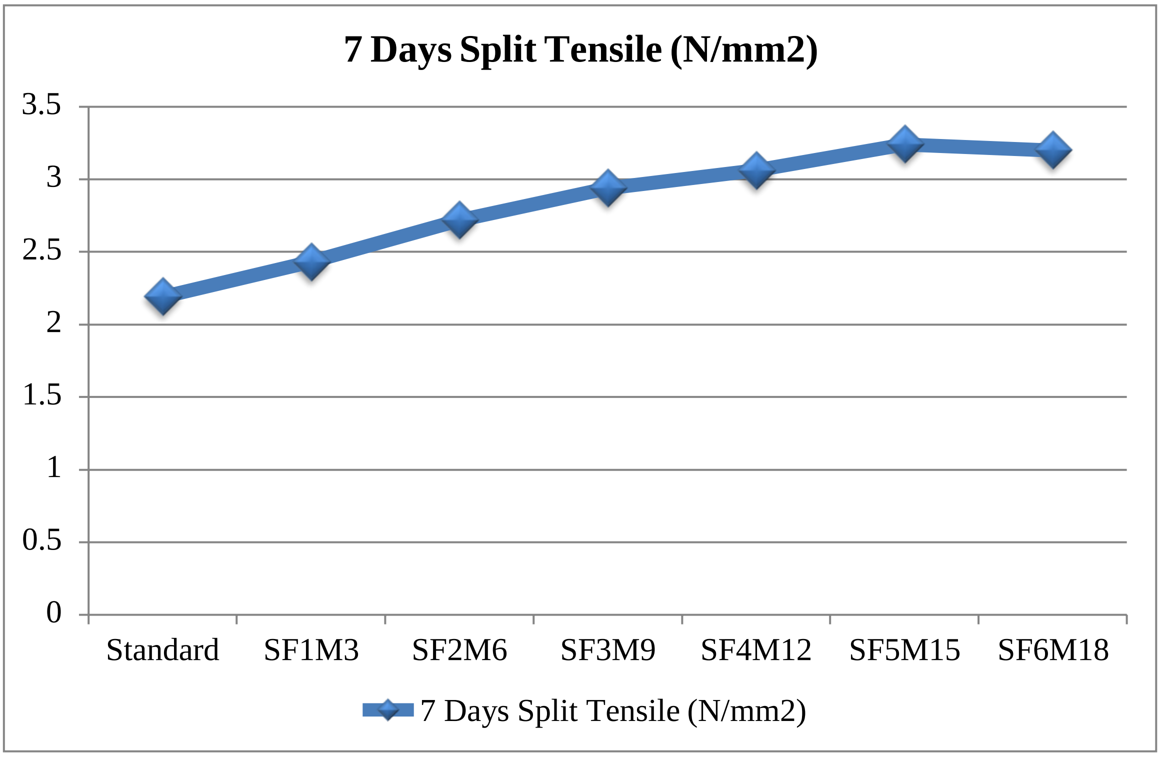

Fig. 7 **Split Tensile at 7 Days Addition of varying % of Jute Fiber andMetakaolin as Replacement of Cement**

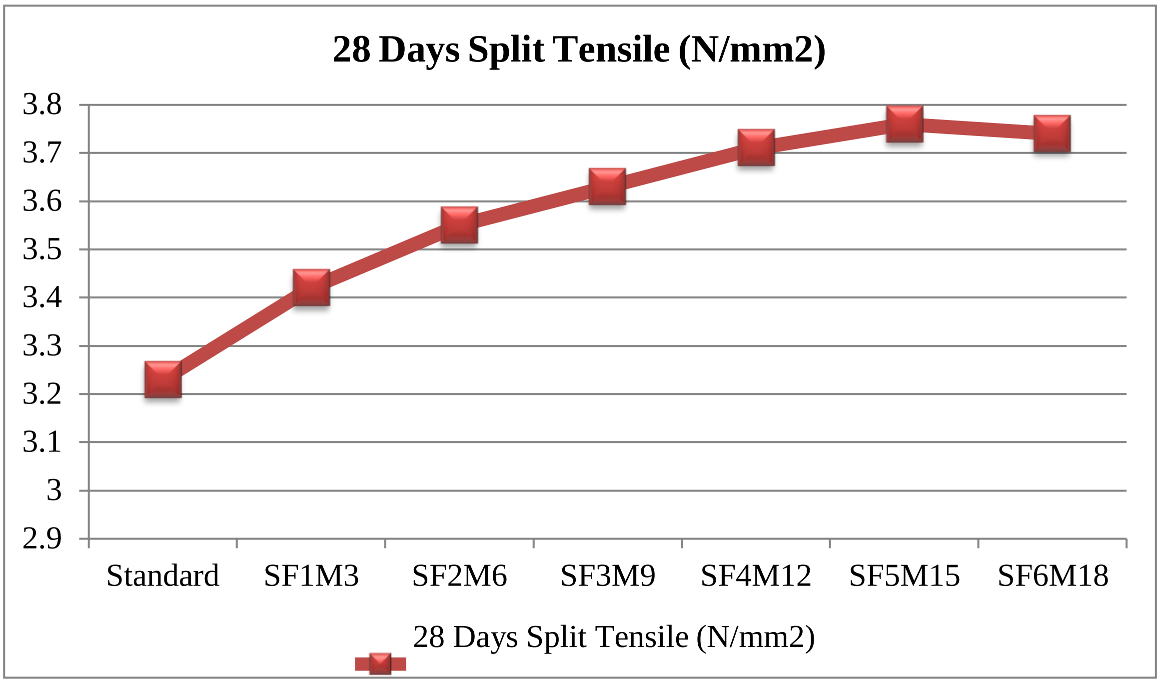

Fig. 8 Split Tensile at 28 Days Addition of varying % of Jute Fiber andMetakaolin as Replacement of Cement

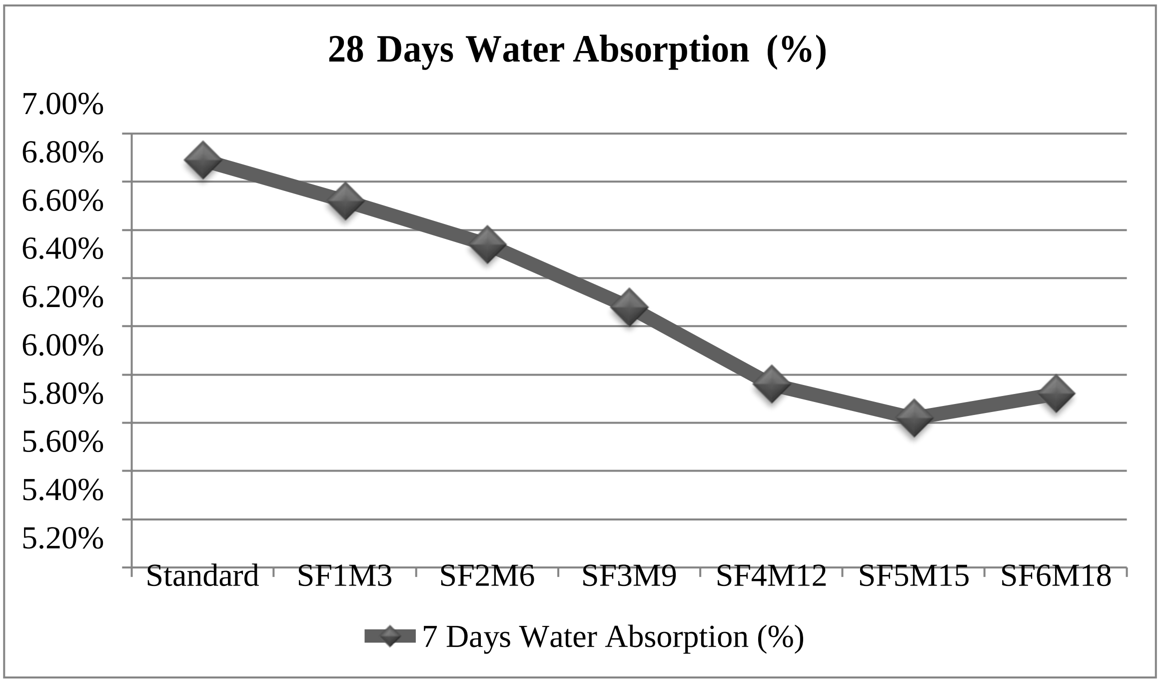

Fig. 9 Water absorption at Addition of varying % of Jute Fiber and Metakaolinas Replacement of Cement

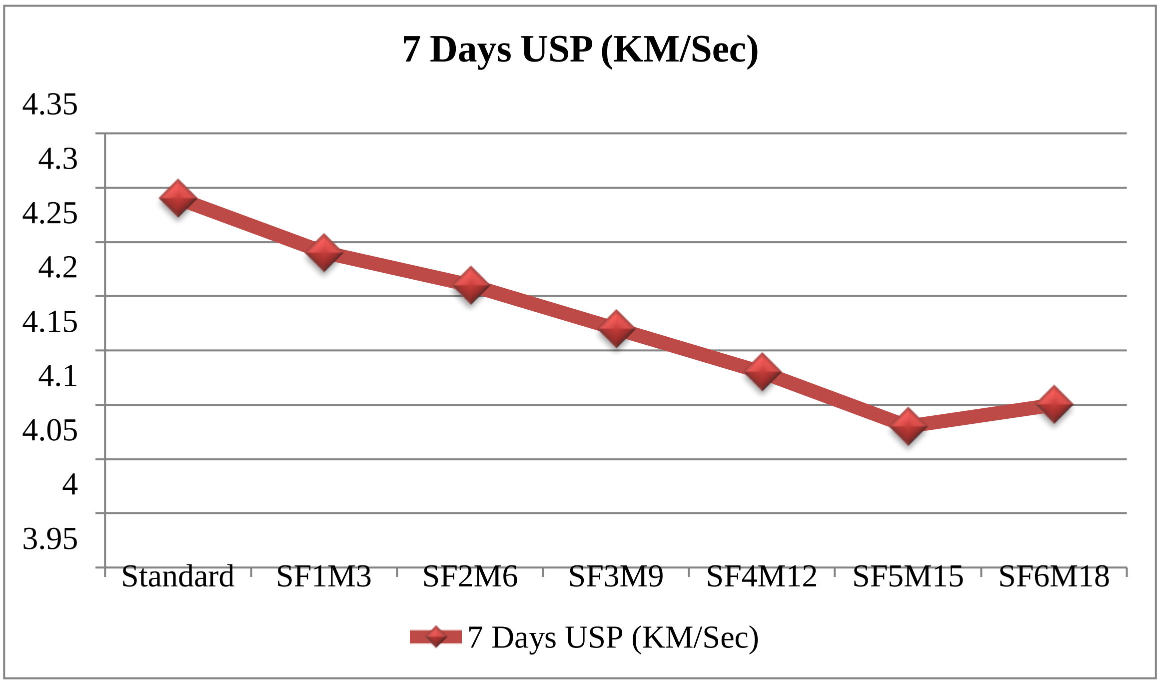

Fig. 10 Ultra Sonic Pulse at Addition of varying % of Jute Fiber and Metakaolinas Replacement of Cement Special Mix of 5% Metakaolin

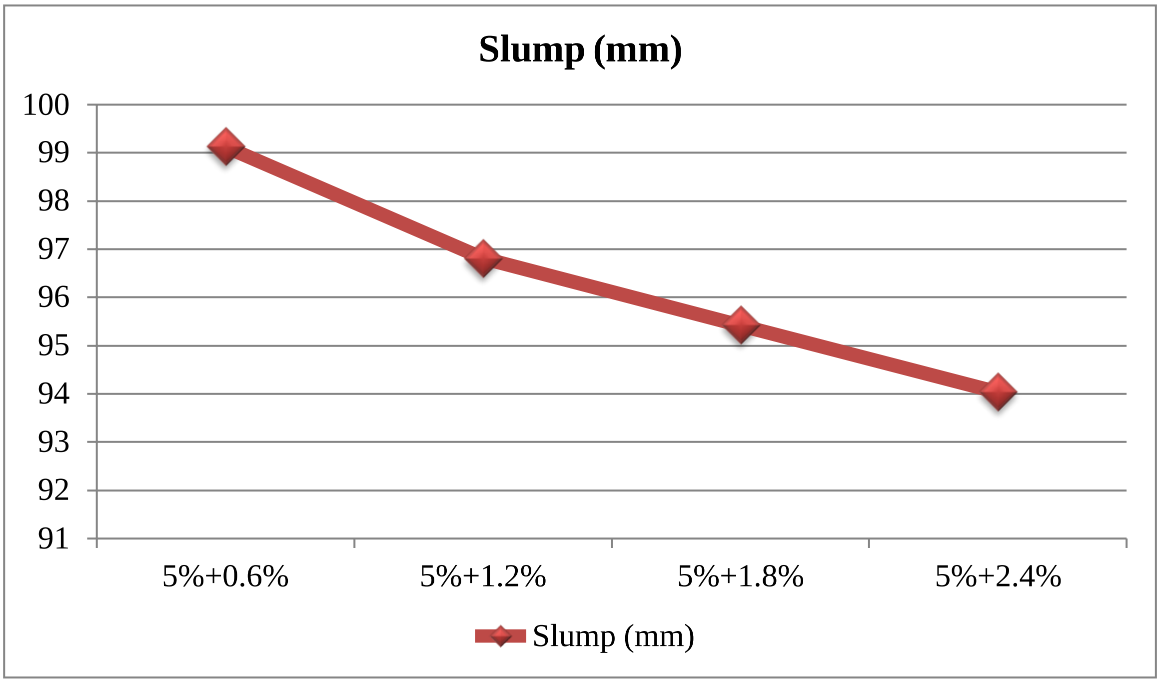

Fig. 11 Slump Test at Addition of varying % of Jute Fiber and 5% Metakaolin asReplacement of Cement

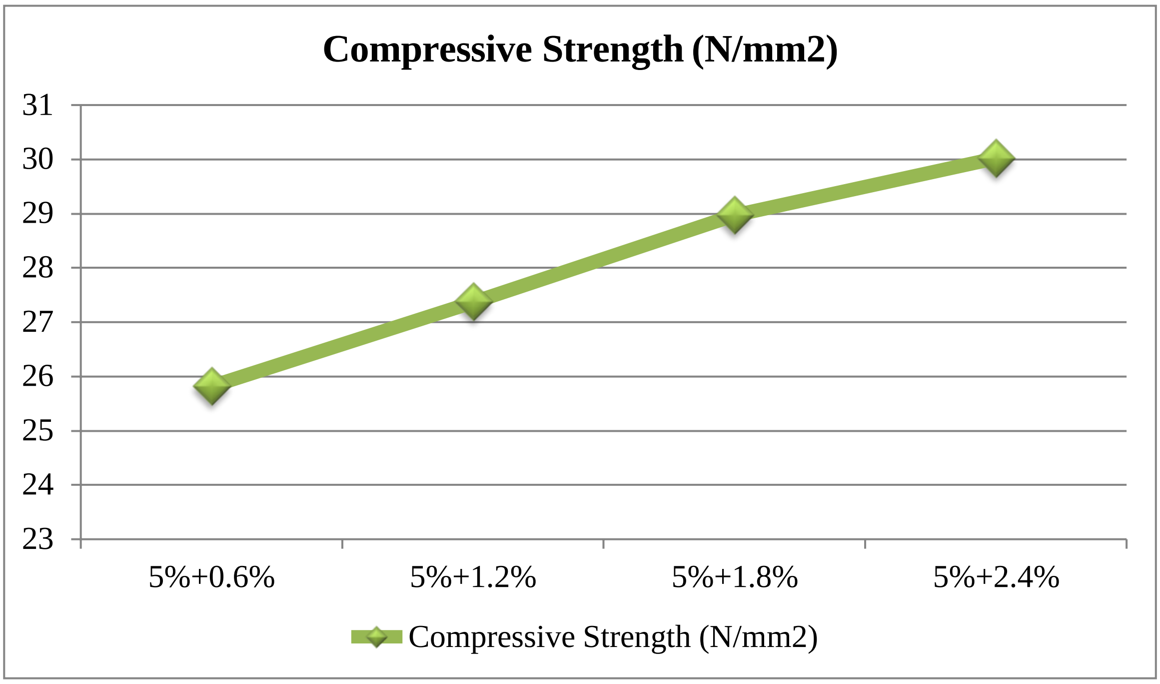

Fig. 12 Compressive Strength at Addition of varying % of Jute Fiber and 5%Metakaolin as Replacement of Cement (At 7days)

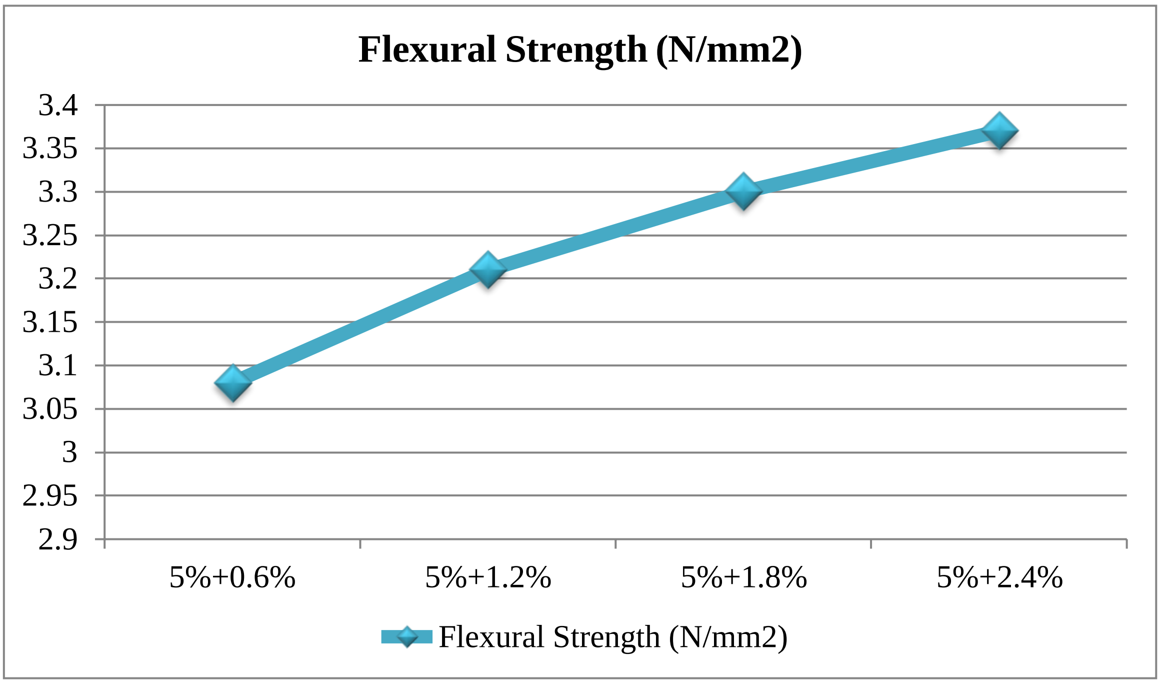

Fig. 13 Flexural Strength at Addition of varying % of Jute Fiber and 5%Metakaolin as Replacement of Cement (At 7days)

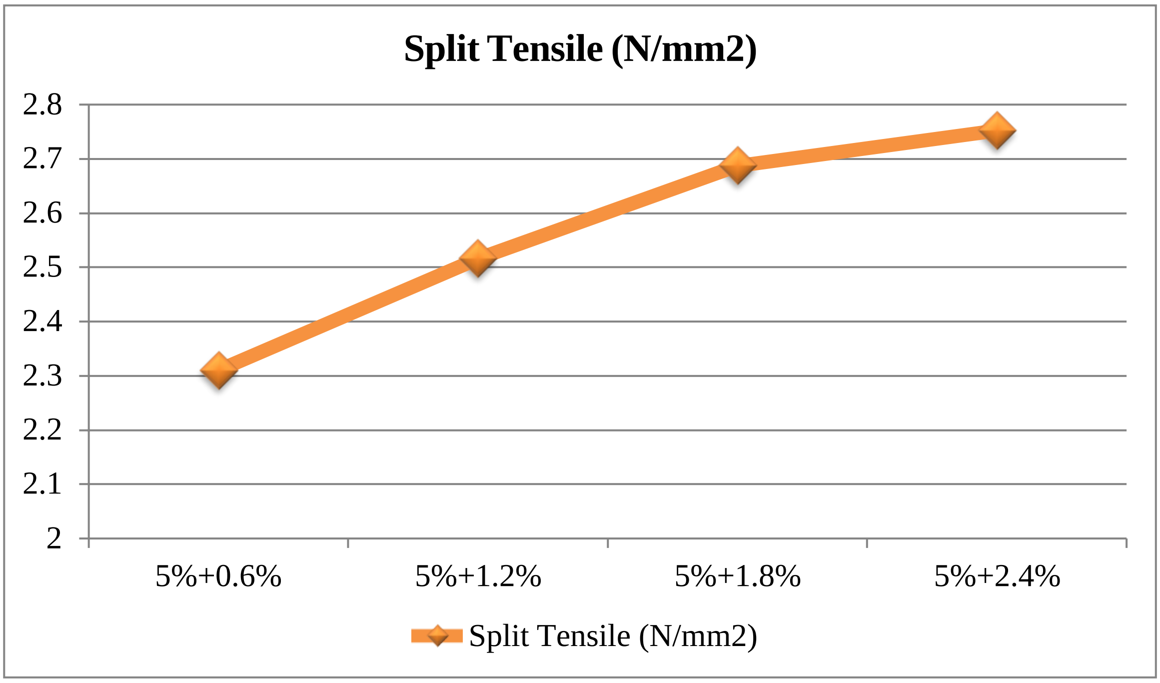

Fig. 14 Split Tensile Strength at Addition of varying % of Jute Fiber and 5%Metakaolin as Replacement of Cement (At 7days)

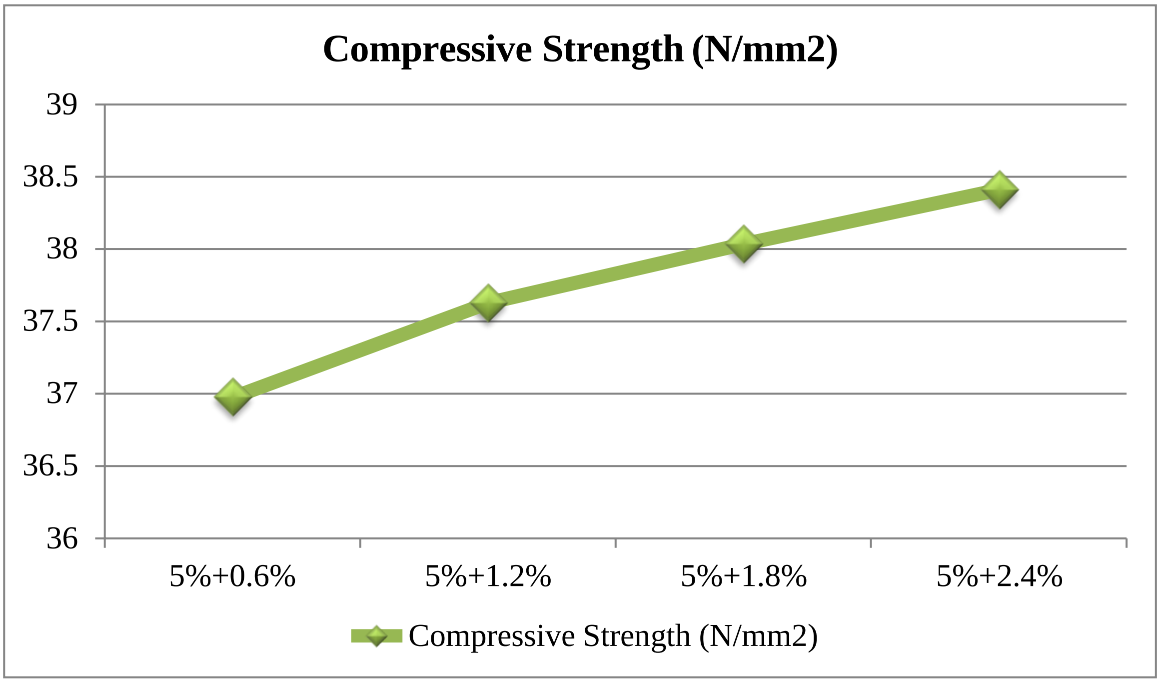

Fig. 15 Compressive Strength at Addition of varying % of Jute Fiber and 5%Metakaolin as Replacement of Cement (At 28days)

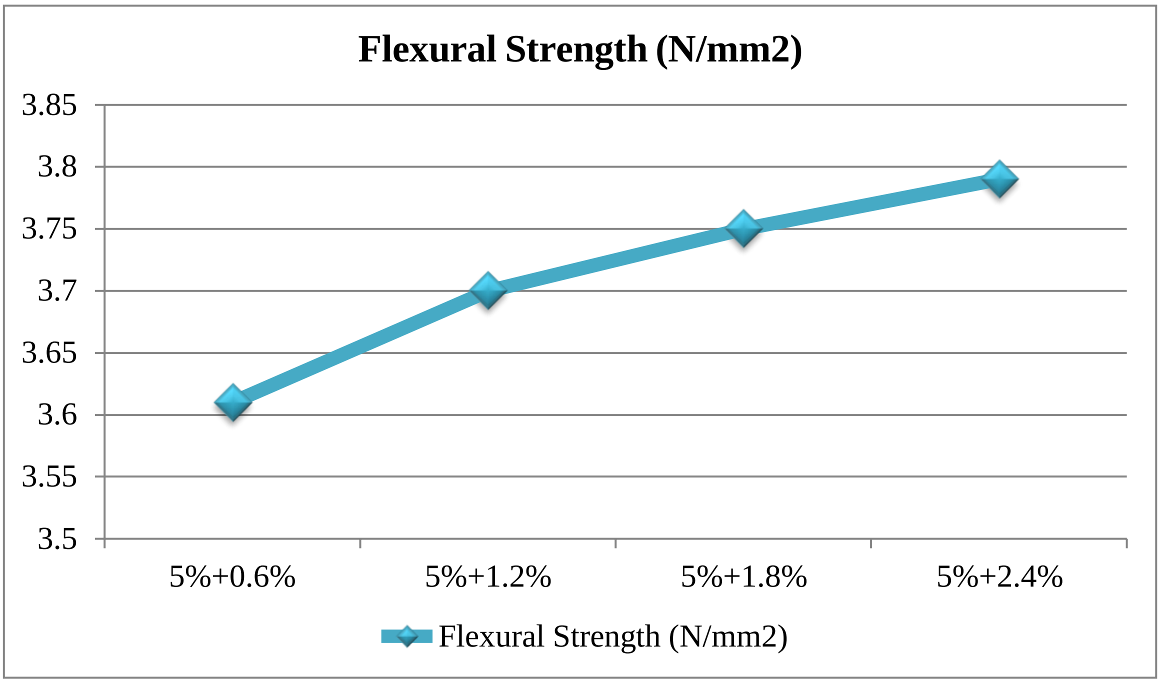

Fig. 16 Flexural Strength at Addition of varying % of Jute Fiber and 5%Metakaolin as Replacement of Cement (At 28days)

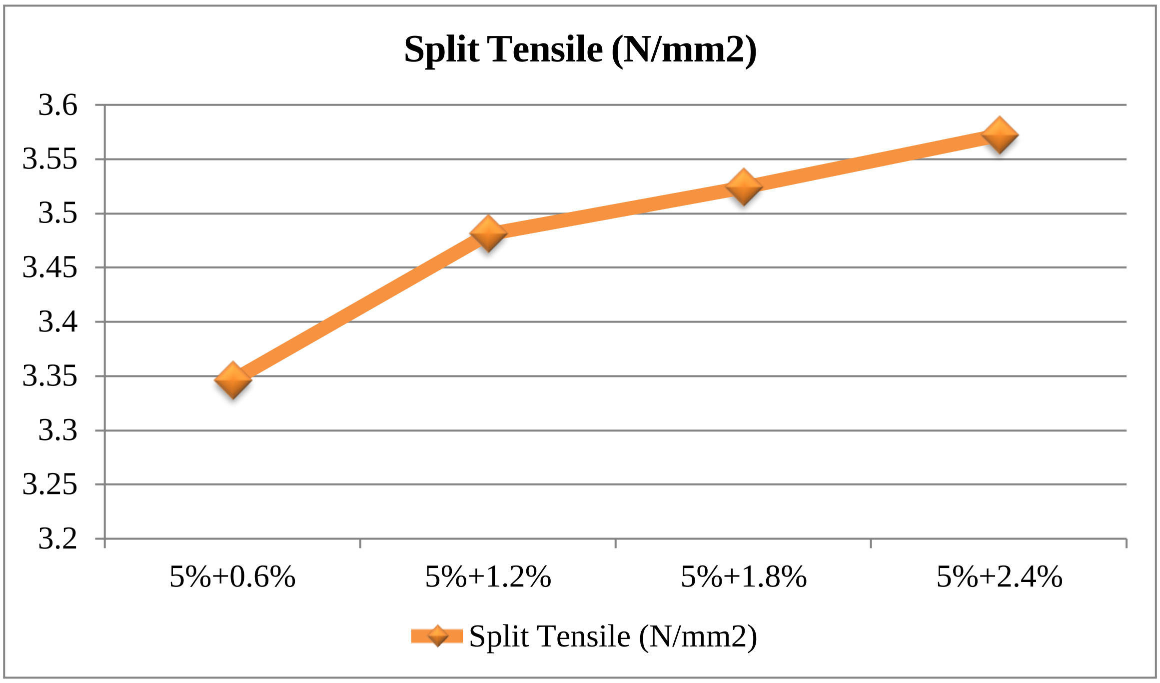

Fig. 17 Split Tensile Strength at Addition of varying % of Jute Fiber and 5%Metakaolin as Replacement of Cement (At 28days)

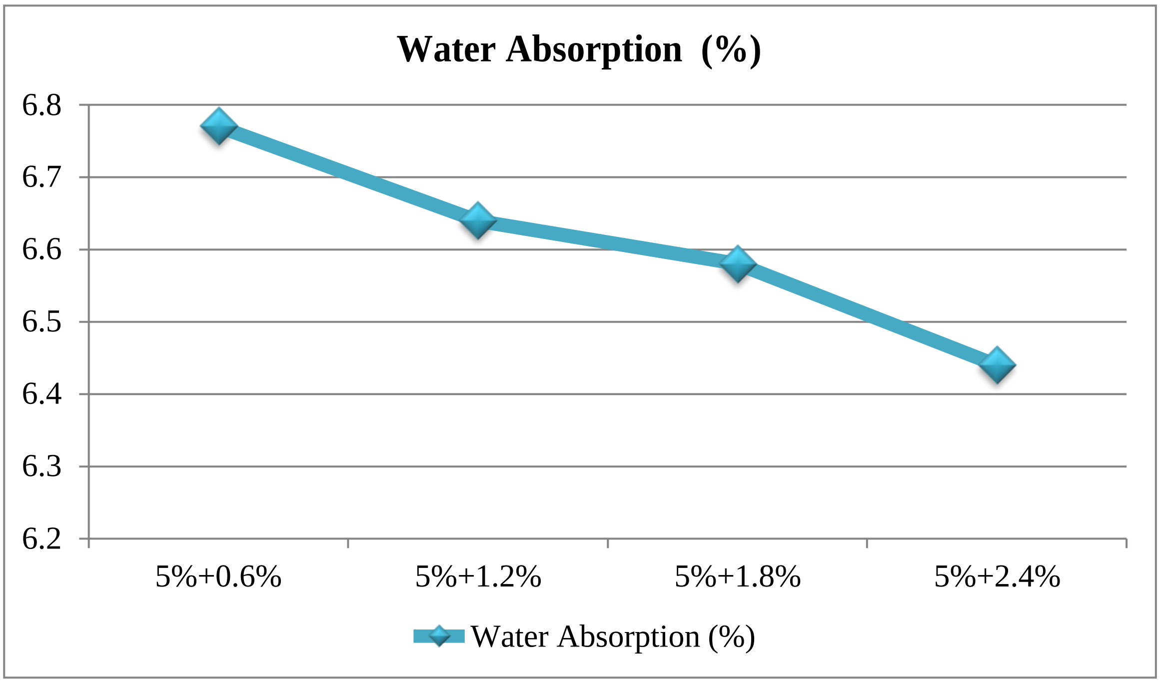

Fig. 18 Water Absorption at Addition of varying % of Jute Fiber and 5%Metakaolin as Replacement of Cement (At 28days)

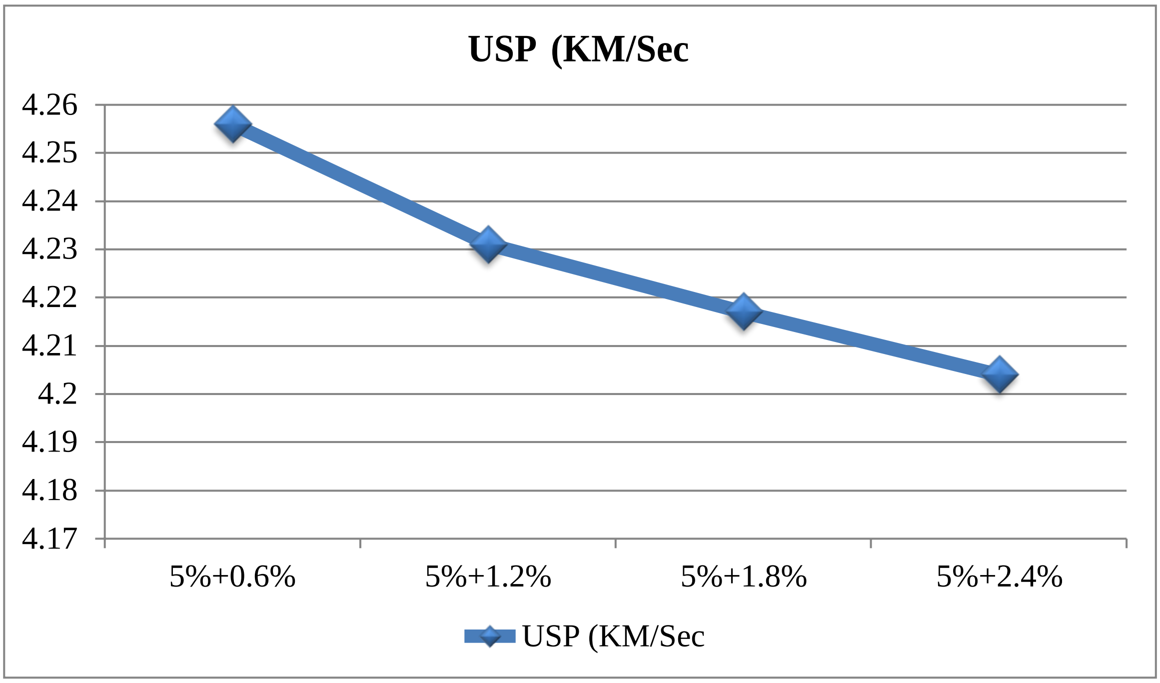

Fig. 19 Water Absorption at Addition of varying % of Jute Fiber and 5%Metakaolin as Replacement of Cement (At 28days)

5. CONCLUSION

Conclusion of Cement and Concrete Results

- Initial Setting Time of Cement with Metakaolin as Replacement of Cement linearly increases with increase in metakaolin till 15% metakaolin after that IST start dropping.
- Final Setting Time of Cement with Metakaolin as Replacement of Cement linearly increases with increase in metakaolin till 15% metakaolin after that FST start dropping.
- Slump value at addition of varying % of Jute Fiber and Metakaolin Replacement of Cement decreases and minimum value slump is 87mm at 15% metakaolin and after that replacement of metakaolin slump value progress in upward.

- At 7 days Compressive strength of at Addition of varying % of Jute Fiber and Metakaolin as Replacement of Cement linearly increases and maximum compressive strength of concrete is 35.02N/mm2 till 15% metakaolin after that compressive strength start dropping.
- At 28 days Compressive strength of at Addition of varying % of Jute Fiber and Metakaolin as Replacement of Cement linearly increases and maximum compressive strength of concrete is 40.63N/mm2 till 15% metakaolin after that compressive strength start dropping.
- At 7 days Flexural Strength of at Addition of varying % of Jute Fiber and Metakaolin as Replacement of Cement linearly increases and maximum flexural strength of concrete is 3.63N/mm2 till 15% metakaolin after that flexural strength start dropping.
- At 28 days Flexural Strength of at Addition of varying % of Jute Fiber and Metakaolin as Replacement of Cement linearly increases and maximum flexural strength of concrete is 3.84N/mm2 till 15% metakaolin after that flexural strength start dropping.
- At 7 days spilt tensile Strength of at Addition of varying % of Jute Fiber and Metakaolin as Replacement of Cement linearly increases and maximum spilt tensile of concrete is 3.24N/mm2 till 15% metakaolin after that tensile strength start dropping.
- At 28 days spilt tensile Strength of at Addition of varying % of Jute Fiber and Metakaolin as Replacement of Cement linearly increases and maximum spilt tensile of concrete is 3.76N/mm2 till 15% metakaolin after that tensile strength start dropping.
- At 28 days water absorption of at Addition of varying % of Jute Fiber and Metakaolin as Replacement of Cement linearly increases and maximum water absorption of concrete is 5.82% till 15% metakaolin after that water absorption value progress in upward.
- At 28 days, USP of at Addition of varying % of Jute Fiber and Metakaolin as Replacement of Cement linearly decreases and minimum USP of concrete is 4.08% till 15% metakaolin after that water absorption value progress in upward.

Test Result for Special Mix

- Slump value at addition of varying % of Jute Fiber and 5% Metakaolin Replacement of Cement decreases and minimum value slump is 94.036mm.
- At 7 days Compressive, strength of at Addition of varying % of Jute Fiber and 5% Metakaolin as Replacement of Cement linearly increases and maximum compressive strength of concrete is 30.02N/mm2.
- At 28 days Compressive strength of at Addition of varying % of Jute Fiber and 5% Metakaolin as Replacement of Cement linearly increases and maximum compressive strength of concrete is 38.410N/mm2.
- At 7 days, Flexural Strength of at Addition of varying % of Jute Fiber and 5% Metakaolin as Replacement of Cement linearly increases and maximum flexural strength of concrete is 3.37N/mm2.
- At 28 days Flexural Strength of at Addition of varying % of Jute Fiber and 5% Metakaolin as Replacement of Cement linearly increases and maximum flexural strength of concrete is 3.79N/mm2.
- At 7 days spilt tensile Strength of at Addition of varying % of Jute Fiber and 5% Metakaolin as Replacement of Cement linearly increases and maximum spilt tensile of concrete is 2.752N/mm2.
- At 28 days spilt tensile Strength of at Addition of varying % of Jute Fiber and 5% Metakaolin as Replacement of Cement linearly increases and maximum spilt tensile of concrete is 3.572N/mm2.
- At 28 days water absorption of at Addition of varying % of Jute Fiber and 5% Metakaolin as Replacement of Cement linearly increases and maximum water absorption of concrete is 6.44%.
- At 28 days USP of at Addition of varying % of Jute Fiber and 5% Metakaolin as Replacement of Cement linearly decreases and minimum USP of concrete is 4.204%.

6. FUTURE SCOPE OF THE WORK

At 14 day and 90 day this study also carried with jute fiber and metakaolin. Horse hairs and coconut fiber that used as reinforcement concrete analysis done. Study done with 10%, 15% 20% and 30% metakaolin as replacement material of cement in concrete.

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