TO DEVELOP HIGH PERFORMANCE CONCRETE USING JUTE AND COIR FIBERS

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ABSTRACT

Since construction industries are under pressure to achieve increased growth and sustainable development, the demand for standard construction materials is growing by the day. As a result, developers are looking for new materials that can be used as an alternative in construction. Natural fibres, such as jute and coir fibre, were chosen to enhance the properties of the concrete in this study. The aim of this research is to evaluate the addition of jute & coir fibers with GGBS & metakaolin on fresh & hardened properties of concrete. Locally made jute & coir fibers are blended with plain concrete in percentages of 0.25 %, 0.50 %, 0.75 %, and 1.00 % by weight and 15 mm range, with optimum percent of GGBS and metakaolin replacing cement. In this research I will check workability, strength and durability parameters such as slump test, compressive strength, flexural strength, split tensile strength and acid attack with different percentages of natural fibers & mineral Admixture.

Keyword : - *High Performance Concrete, Jute Fiber, Coir Fiber, GGBS, Metakaolin*

1. Introduction :

1.1 High Performance Concrete :

The innovation of high performance concrete has a major impact on concrete technology. Strength, long-term durability, serviceability, and other characteristics of HPCs are important. High performance concrete with different chemical and mineral admixtures, mechanical properties, and long-term properties like sorptivity, acid attack, and so on are all being studied. Cement is the most common used construction material on earth. Its use in various industries has increased gradually since its invention in the Roman period. This is due to its superior strength, durability, and cost-effectiveness as compared to other forms of construction materials.

1.2 Natural Fibers (Jute & Coir) :

Natural fibres are obtained from naturally available resources such as the coconut tree, banana tree, cotton, and jute, and are biodegradable, inexpensive, green, and accessible. To investigate the extent of growth, researchers have performed a number of studies on the effect of natural fibres on the mechanical and physical properties of concrete. Natural fibres in fibre reinforced concrete composites (FRCC) have been extensively studied in terms of strength, energy efficiency, and impact resistance. Natural fibres are increasingly being used to produce high-quality, low-cost sustainable FRCC for housing and other necessities.

Jute is a low-cost, most durable natural fibre that is commonly available in India among the various types of fibre. Jute, as a natural fibre, has a number of advantages over other types of fibre, including high tensile strength, moderate fire resistance, biodegradability, renewability, recyclability, and eco friendliness. The incorporation effects of untreated and treated jute fibres in concrete have been studied in a few different ways. The hardened properties of concrete were found to improve for only lower percentages of fibre in treated fibres in these studies.

The addition of coconut fibre in concrete improves various engineering properties of concrete. Coconut fibre is treated as natural fiber before using in concrete. Coconut fibre, which is the most ductile of all natural fibres, has the ability to be used as a concrete reinforcement material. This is also a way to dispose of waste fibres from coir-based manufacturing plants that are used to make high-strength materials.

2. Materials :

2.1 Cement :

In general, cement is an adhesive material of all types, but in a narrower sense, a binding substance used in building and construction of civil engineering. Cement is seldom used on its own, but rather to bind sand and aggregate together. For this study Ordinary Portland cement (53 grades) of Ultratech is used.

Properties	
Specific gravity	3.15
Fineness	2.78%
Consistency	32%
Initial setting time	135 min
Final setting time	212 min
Compressive Strength	3 day = 32.49 MPA 7 day = 43.55 MPA 21 day = 60.44 MPA

2.2 Sand :

Sand is a granular mixture of finely divided rock and mineral particles that occurs naturally. It is defined by size, being finer than gravel and coarser than silt. Sand may also refer to a type of soil or a textural category of soil, soil containing more than 85 percent sand-sized particles by mass.

Physical Properties		
Zone of Sand	II	--
Fineness Modulus of sand	2.747	--
Water Absorption (%)	1.2%	Max - 2 %
Sp. Gravity of Sand	2.65	2.6 - 2.7

2.3 Coarse Aggregate :

Aggregate is a broad category of coarse to medium grained particulate material used in construction, including sand, gravel, crushed stone, slag, recycled concrete and geo synthetic aggregates. Aggregates are a component of composite materials such as concrete and asphalt concrete; the aggregate serves as reinforcement to add strength to the overall composite material. aggregates are used as a stable foundation or road/rail base with predictable, uniform properties (e.g. to help prevent differential settling under the road or building), or as a low-cost extender that binds with more expensive cement or asphalt to form concrete.

Physical Properties		
Fineness Modulus	3.12	--
Water Absorption (%)	1.12 %	Max - 2 %
Spacific Gravity	2.82	2.6 - 2.9
Aggregate Impact Value	12.5 %	Max - 45 %
Aggregate Crushing Value	13.2 %	Max - 45 %
Max. Aggregate Size	20 mm	--

2.4 Jute Fiber :

Jute fiber is long, soft and shiny with 90 microns in diameter. Jute fibers consists mainly of cellulose and lignin, which are plants materials. The chemical composition of jute fiber includes cellulose (64.4 %), hemicellulose (12 %), pectin (0.2 %), lignin (11.8 %), water soluble (1.1 %), wax (0.5 %) and water (10 %). Jute has high specific properties, low density, less abrasive behavior to processing equipment, good dimensional stability. Despite the negligible reduction in compressive strength with a higher content of jute fiber, there is an increase in ductility after concrete cracking.

2.5 Coconut(coir) fiber:

Coconut fiber is a natural fiber derived from the husk of coconut, obtained from unripe coconut. It is steeped in hot sea water and thereafter, the fibers are separated from the shell by combing and crushing, same process as jute fiber. Two kinds of coconut fiber are available, brown fiber extracted from matured coconuts and white fiber extracted from immature coconuts. Brown fibers are compact, strong and have high resistance to abrasion. The white fibers are thinner and smoother, but also weaker.

Physical Properties	Jute Fiber	Coir Fiber
Length (mm)	15	15
Diameter (µm)	90	156
Cellulose content (%)	62	35
Hemi-Cellulose content (%)	18	12
Specific Gravity	1.42	1.18
Tensile Strength (Mpa)	415	156
Young Modulus (Mpa)	21300	29800
Elongation at break	1.27	27.57

2.6 GGBS :

Ground-granulated blast-furnace slag is collected from a blast furnace in water or steam by quenching molten iron slag, to crate a glassy, granular material that is then dried and ground into a fine powder. It is suitable for applications requiring low hydration heat in the marine area, mass concreting and sulfate environment, water retaining structure, cellars and other structures.

2.7 Metakaolin :

Metakaolin is a dehydroxylated type of the earth mineral kaolinite. It is a pozzolan, probably the most effective pozzolanic material for use in concrete. Stone that are wealthy in kaolinite are known as china dirt or kaolin, customarily utilized in the assembling of porcelain. The molecule size of metakaolin is littler than bond particles, yet not as fine as silica seethe.

3. Mix Design :

Mix design for M40 concrete was completed after collecting and preparing the materials. For all concrete mixes and pastes, use 53 grade of ordinary Portland cement. Fine aggregate of zone II and coarse aggregate are 4.75 mm and 20 mm respectively, and are used in concrete with jute and coir fibers. To achieve high concrete strength, mineral admixtures such as metakaolin and GGBS were used in replace to cement.

Sr. No.	Name of Sample	Grade of Concrete	% of Jute Fiber	% of Coir Fiber	% of GGBS	% of Metakaolin
1	M1	M40	0	0	0	0
2	M2	M40	0.25	-	10	10
3	M3	M40	0.50	-	10	10
4	M4	M40	0.75	-	10	10
5	M5	M40	1.00	-	10	10
6	M6	M40	0.25	-	15	15
7	M7	M40	0.50	-	15	15
8	M8	M40	0.75	-	15	15
9	M9	M40	1.00	-	15	15
10	M10	M40	-	0.25	10	10
11	M11	M40	-	0.50	10	10
12	M12	M40	-	0.75	10	10
13	M13	M40	-	1.00	10	10
14	M14	M40	-	0.25	15	15
15	M15	M40	-	0.50	15	15
16	M16	M40	-	0.75	15	15
17	M17	M40	-	1.00	15	15

4. Concrete Tests :

4.1 Slump Test :

Workability of concrete can be measured by slump cone test as per IS standards. In the test mould, new concrete is poured in three layers. The temping rod should be used to compact each layer by 25 stokes. This procurer gives detailed workability results. The property of fresh concrete is determined by measuring the slump. Concrete slump denotes the true worth of slump.

4.2 Compressive Strength Test :

According to IS 516, a 150mm cube specimen is prepared to test the compressive strength of concrete. Concrete mix design characteristics are proper or not it can be found by testing of cube specimen. To determine the compressive strength of concrete, five 150mm cube specimens must be checked. The proportion of each ingredient used in concrete will improve or reduce the strength of concrete, so choosing the right w/c ratio for the right environment is important.

4.3 Flexural Strength Test :

To evaluate the concrete's tensile strength A flexural strength test will be carried out. The bending capacity of concrete is measured by making a beam specimen according to Indian standard code guidelines. There are two methods for conducting the test: one point method and two point method. The distance between the application load and the centre can vary based on the test method used.

4.4 Split Tensile Strength Test :

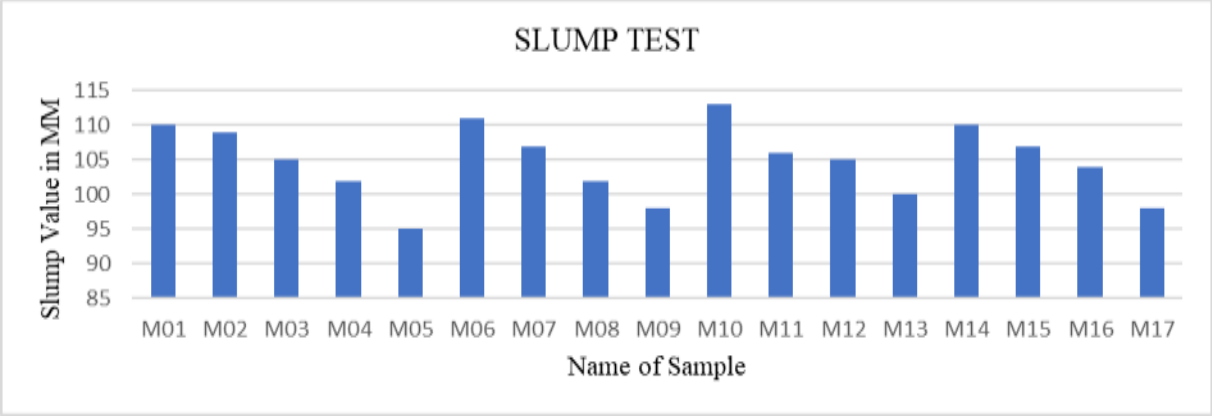
Concrete's tensile strength is very poor as compared to its compressive strength. The Split Cylinder Test is used to measure the tensile strength of concrete since it is difficult to apply uniaxial stress to a concrete specimen. Because of its brittle nature, concrete is very weak in tension and is not expected to resist direct tension. Cracks appear as tensile forces are applied to concrete. As a result, the tensile strength of concrete must be measured in order to determine the load at which the concrete members will crack.

4.5 Acid Attack Test :

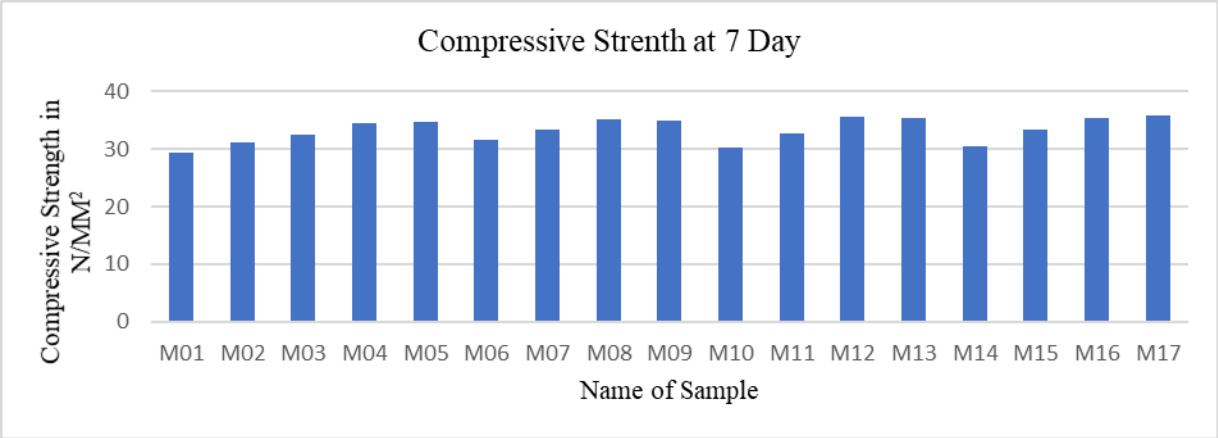
For 28 days, concrete cube specimens were immersed in water containing a 5% HCL solution. After 28 days, the cube specimens were tested in a concrete testing machine, and the results were evaluated as a loss of strength when compared to the strength after 28 days of normal water curing.

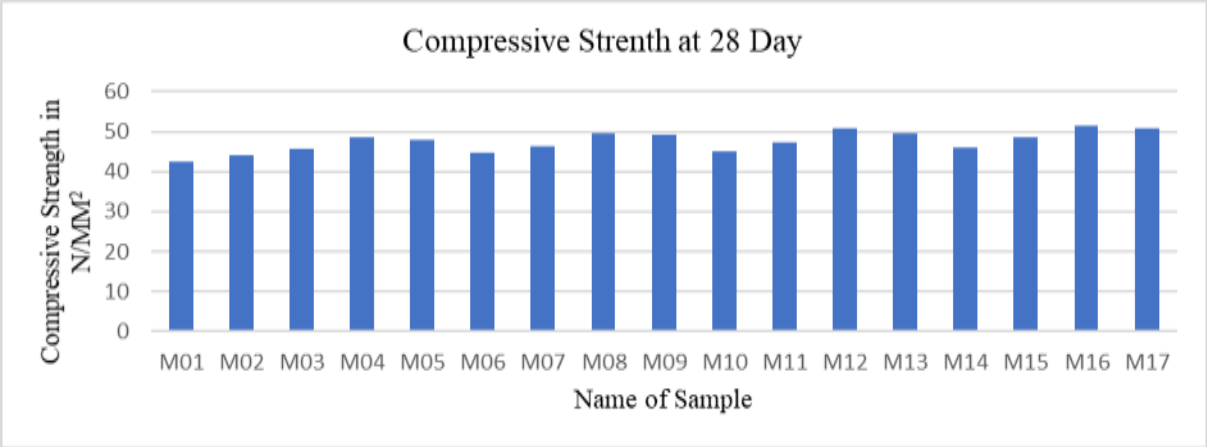
5. Results Chart :

5.1 Slump Test Result :

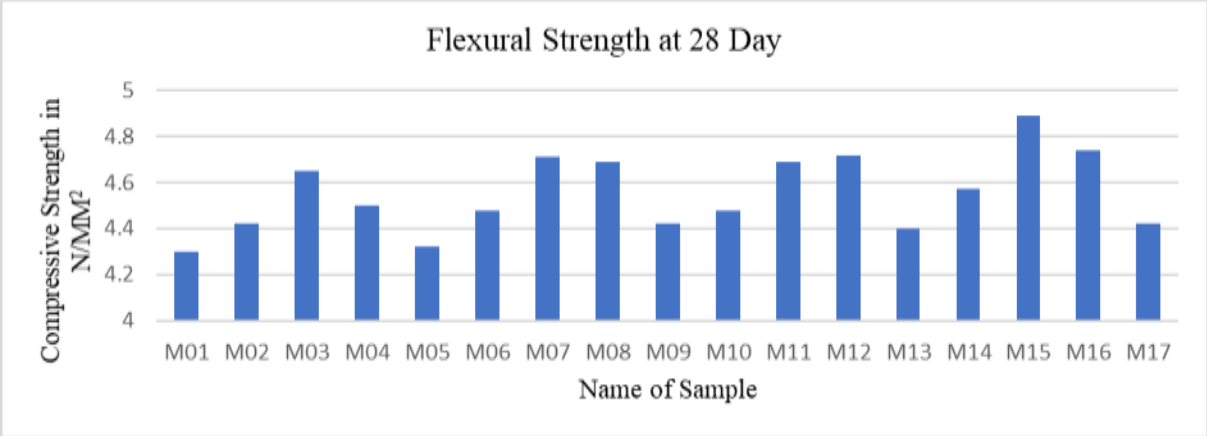


5.2 Compressive Strength Result :

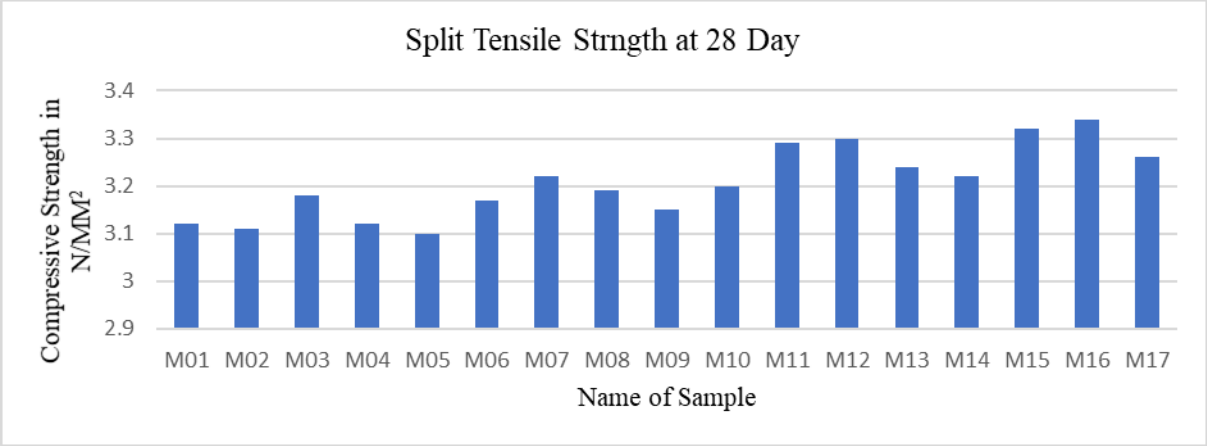




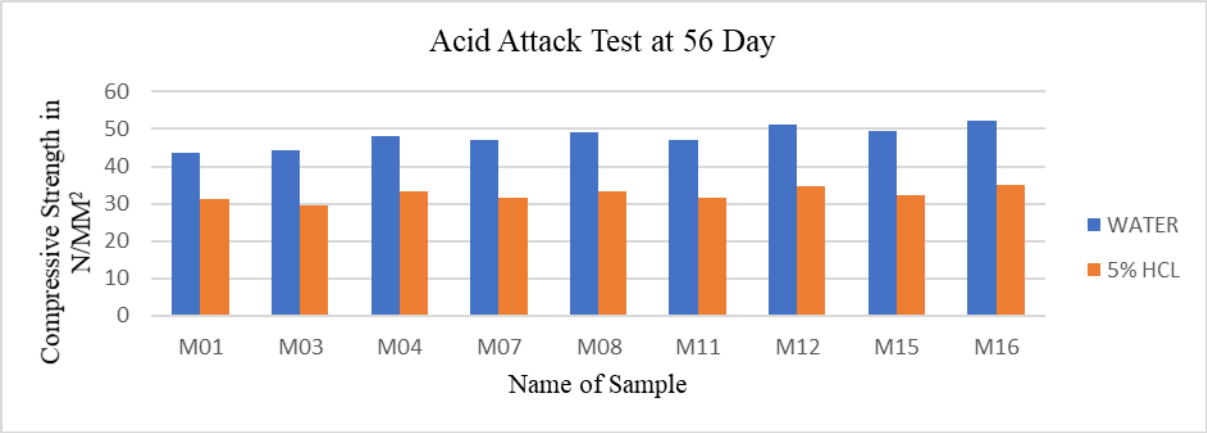
5.3 Flexural Strength Result :



5.4 Split Tensile Strength Result :



5.5 Acid Attack Test Result :



6. Conclusion :

Increased jute and coir fiber content in concrete reduced the slump of fresh concrete. In comparison to coir fiber, the concrete mixtures made with jute fibers had a greater reduction in slump.

In the first 7 days and 28 days, compressive strength increases with 0.25 percent, 0.50 percent, and 0.75 percent jute and coir fiber with various percentages of mineral admixture like GGBS and Metakaolin. When the proportion of jute and coir fiber increases to 1.00 percent, the compressive strength decreases when compared to the control sample.

Jute fibers had no impact on the split tensile strength of concrete after 28 days. The tensile strength of concrete was marginally higher for lower contents (0.25 percent and 0.50 percent) of jute & coir fiber than for specimens prepared with no fiber or a higher volume (1.00 percent) of jute & coir fiber.

The maximum and minimum increases in flexural strength were achieved with 0.5 percent and 0.25 percent jute & coir fiber, respectively, while the maximum volume (1.00 percent) of jute & fiber resulted in a decrease in flexural strength.

Fiber bonding to cementious material has been observed. Fiber can be resist the development of micro cracks. There was a strong bond between the fiber and the cementious paste. The mechanical properties of concrete are improved by strong interfacial bonding between fiber and cement matrix.

Durability showed good performance while adding fiber mainly at 0.5% & 0.75%, the mechanical properties improved than that of control mix and the durability study include acid attack also showed better performance.
From the all research it can be said that we can use natural cellulose fiber like as jute & coir fiber with optimum content of GGBS & Metakaolin in concrete mix.

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