

Experimental Study on Mechanical Properties of Sisal Fiber Reinforced Concrete with Addition of Cow Dung Ash

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ABSTRACT: The concrete industry is looking for supplementary cementitious material with the objective of reducing the carbon dioxide emission which is harmful to environment. The effective way of reducing CO₂ emission from the cement industry is to use the industrial by products or use of supplementary cementing material. In this present experimental work an attempt is made to replace cement by Cow dung ash (CDA). The cement has been replaced by CDA in the range of 6%, 8%, 10% and 12% by weight of cement for M25 grade mix. The present investigation has shown that an addition of 1.5% sisal fiber to concrete makes it stronger and more durable. The concrete was tested for compressive strength and split tensile strength at the age of 7, 14 and 28 days and compared with those of conventional concrete.

KEYWORDS: Cow Dung Ash (CDA), Sisal fiber, Compression strength test, Tensile strength test.

I. INTRODUCTION

Cow dung is the undigested residue of plant matter which has passed through the animals (cow) gut. It has been reported that the faecal material is rich in nitrogen, calcium, carbon, potassium and phosphorus. A full grown well fed cow produces between 10-15kg of cow dung per day which contains about 28% water in its fresh state and 34% ash when calcined. The world cattle population is estimated at 1.4 billion. India has an estimated cow population of 299.6 million and is expected to produce an estimated 3,745,000 tons of cow dung per day. In many parts of the world, cow dung is predominantly used as green manure for farming. It is also used with adobe in brick production, insect repellent and more recently used to produce biogas for electricity and heat generation. It can be noted that despite its application in the aforementioned areas, its production outweighs the usage. The cow dung is exposed to sunlight to dry in order to have dung cakes which is then subjected to burning after it is dried to have the cow dung ash which is obtained in black colour.

Sisal Fiber is one of the most widely used natural fiber and is very easily cultivated. It is obtained from sisal plant. The plant, known formally as *Agave sisalana*. Sisal is a long, soft, shiny plant fiber that can be spun into coarse, strong threads. It is one of the cheapest natural fibers, and is second only to cotton in amount produced and variety of uses. The fibers are extracted using extraction machine. The extracted fibers are sun-dried which whitens the fiber once dried the fibers are ready for knotting. A bunch of fibers are mounted or clamped on a stick to facilitate segregation. Each fiber is separated according to fiber sizes and grouped accordingly. To knot the fiber, each is separated and knotted to the end of another fiber manually. The separation a knotting is repeated until bunches of unknotted fibers are finished. Sisal fiber is often reported to offer better mechanical properties and a more economical, environmental friendly manufacturing process.

II. CONSTITUENT MATERIALS AND ITS PROPERTIES

1. **Fine aggregate:** The particles of granular materials are so fine that they pass through a 4.75mm sieve. It is essential material in concrete consist of natural sand. It was screened to remove deleterious materials and tested as per procedure given in IS: 2386-1963. Specific gravity of fine aggregate is 2.34, Grading zone - Zone II, Water absorption-0.5%, Bulk density-1.60 g/cc, and Moisture content-nil.
2. **Coarse aggregate:** Aggregate, which retained in 4.75 mm sieve, is known to be coarse aggregate. Locally available coarse aggregate having the maximum size of 10mm were used in this experiment. Testing of

coarse aggregate was done as per IS: 383-1970. Specific gravity of coarse aggregate is 2.70, water absorption-0.3%, Impact value-20% and crushing value-18%.

3. **Ordinary Portland cement:** Cement in concrete acts as a binding material that addition of water. It plays an important role construction sector. In this study the Ordinary Portland Cement (OPC) of 53 grade conforming to IS: 12269-2013 is used. Various tests were performed on cement they are: Consistency 32%, Specific gravity-3.15, Fineness-4% Initial and Final setting time 50 minutes & 360 Minutes.
4. **Cow Dung Ash:**
The cow dung is exposed to sunlight to dry in order to have dung cakes which is subjected to burning to obtain the cow dung ash. The resultant ash was sieved through a sieve of 300 μ m.
 - a) **Physical Properties:** Color -Grey to black color. Specific Gravity- 2.55. Moisture - 6.5%. Fineness - 9%
 - b) **Chemical Properties:** Cow dung ash have high content of nitrogen, calcium, carbon, potassium, and phosphorus. The pH value of CDA is 8.5. CDA is neither Acidic (pH<7.0) nor alkaline (pH>11) but neutral (pH in between 7-9).
5. **Sisal fiber:**
Sisal fiber is one of the most widely used natural fiber and is very easily cultivated. Sisal fiber is a hard fiber extracted from the leaves of the sisal plant (*Agave sisalana*).
Physical Properties: Color- It is white in color. Diameter - It is in different diameter like 0.25mm - 0.5 mm. Moisture - 6.5%. Tensile Strength - 385 – 728 Mpa. Density - density of sisal fiber is 1.58g/cm³. Young Modulus- 9-22 Gpa.
6. **Water:** Potable tap water available in the laboratory with PH value 6 to 8 and conforming to the requirement of IS: 456-200 is used for mixing concrete and curing the specimens.



Fig 1. Cow Dung Ash



Fig 2. Sisal Fiber

III. EXPERIMENTAL INVESTIGATION

The experimental investigation on concrete is done to know the effect of CDA and Sisal fiber on its mechanical property. The following tests were conducted on the Basalt fiber reinforced concrete specimens are

1. **Compression test (conforming to IS 516):** This test was performed on 150 mm x 150 mm x 150 mm sized CDA added sisal fiber concrete cubes casted for M25 grade to determine the compressive strength of the mix. The compression test on cube specimens was performed in the compression testing machine.
2. **Split tensile test (conforming to IS 5816-1999):** To determine the tensile strength of CDA added sisal fiber concrete mix for M25 grade, split tensile test was done on the cylindrical test specimens of 150mm x 300mm using the compression testing machine. This method consists of applying a diametric compressive force along the length of a cylindrical specimen.

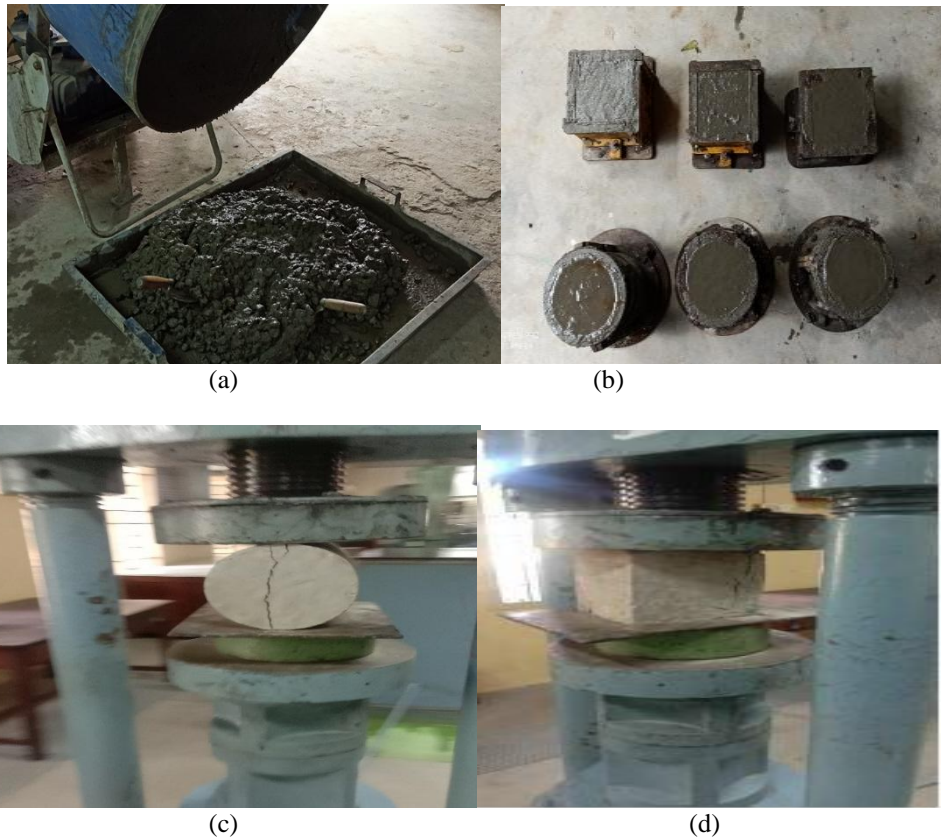


Fig 3. Testing of mechanical properties and casting of specimens (a) Batching (b) Cube and cylindrical specimens(c) Split tensile strength test (d) Compression strength test

IV. EXPERIMENTAL RESULTS

COMPRESSIVE TEST

A test result is the average of at least three standard cured strength specimens made from the same concrete sample and tested at the same age. In most cases strength requirements for concrete are at an age of 28 days of curing. The concrete cubes, after 28 days were tested for their compressive strength in the following manner. After cleaning of bearing surface of compression testing machine, the axis of the specimen was carefully aligned with the center of thrust of the plate. No packing was used between faces of the test specimen and of testing machine. The load was applied without shock and increased continuously at a rate approximately 140 Kg/cm²/min until the resistance of the specimen to the increasing load broke down and no greater load could be sustained. The compressive stress calculated in N/mm² from the maximum load sustained by the cube before failure.

Table 1. Compressive strength test results

S. No	Grade	CDA %	Sisal Fiber %	Compressive Strength N/mm ²		
				7 days	14 days	28 days
1	M25	0	0	17.86	25.35	29.38
2	M25	6	1.5	18.73	26.91	29.26
3	M25	8		20.27	28.77	32.73
4	M25	10		17.64	24.38	28.52
5	M25	12		16.05	22.42	27.06

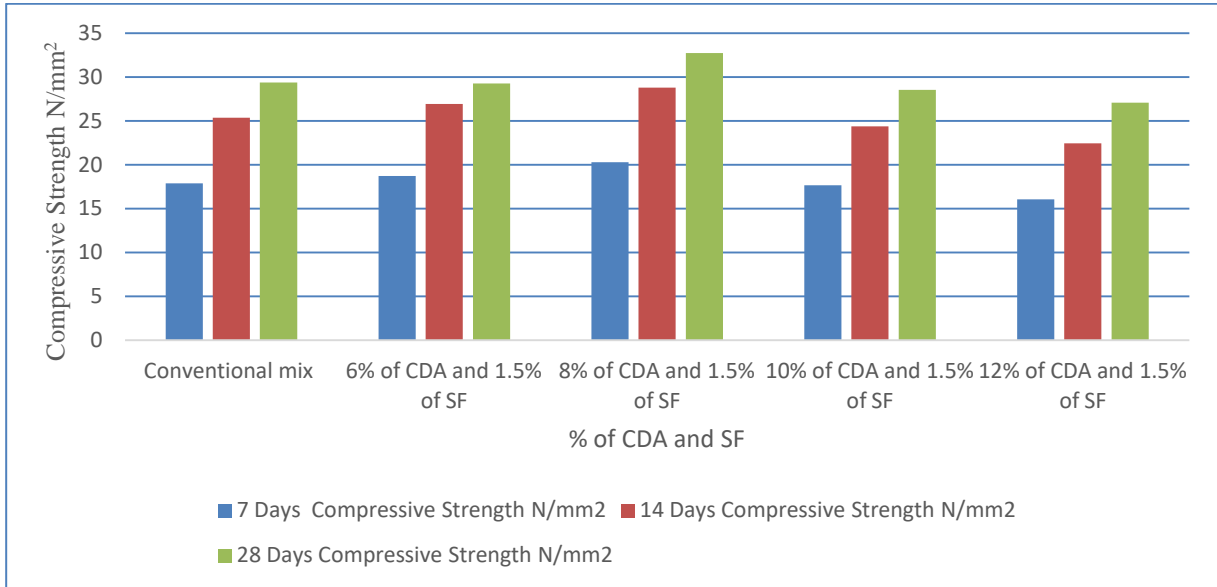


Fig 4. Graph of compressive strength test

SPLIT TENSILE TEST:

This method consists of applying a diametric compressive force along the length of a cylindrical specimen. This loading induces tensile stresses on the plane containing the applied load. Tensile failure occurs rather than compressive failure. Plywood strips are used so that the load is applied uniformly along the length of the cylinder. The maximum load is divided by appropriate geometrical factors to obtain the splitting tensile strength. A diametric compressive load is applied along the length of the cylinder until it fails. The cylinder will typically fail due to horizontal tension and not vertical compression.

Table 2. Split tensile strength test results

S. No	Grade	CDA %	Sisal Fiber %	Split Tensile Strength N/mm ²		
				7 days	14 days	28 days
1	M25	0	0	2.41	2.75	3.02
2	M25	6	1.5	2.76	2.84	3.15
3	M25	8		2.94	3.18	3.36
4	M25	10		2.22	2.61	2.94
5	M25	12		2.06	2.33	2.58

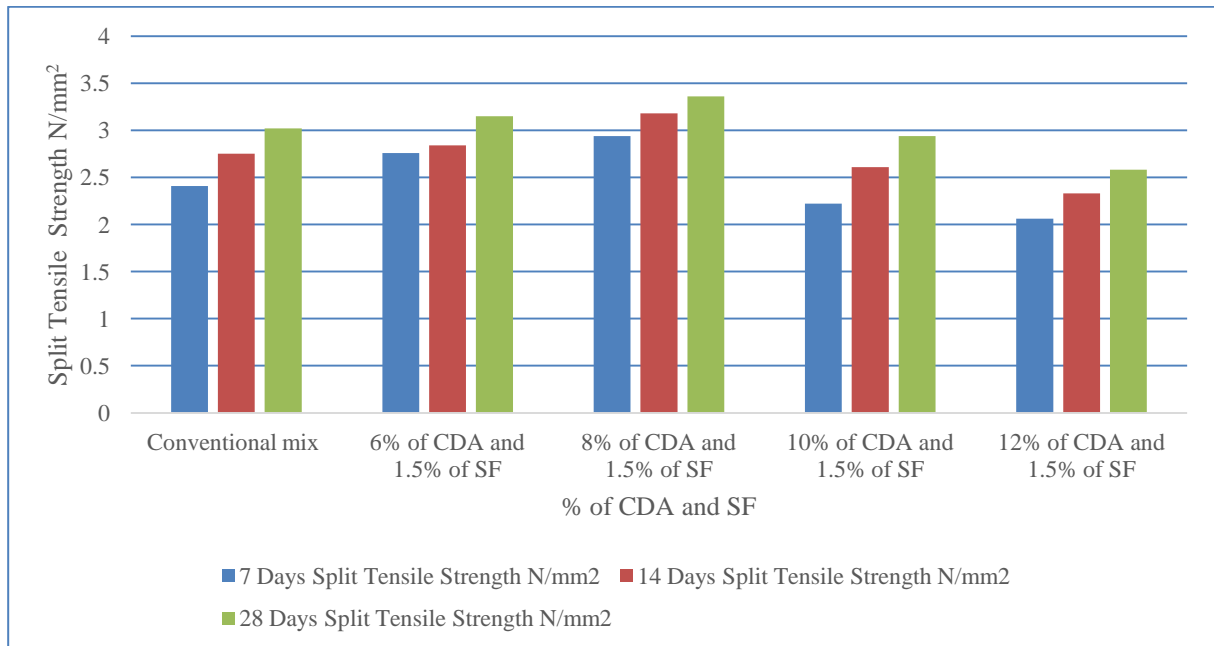


Fig 5. Graph of split tensile strength test

V. CONCLUSION

Based in experimental investigation carried out in this work the following conclusion was obtained:

1. Maximum compressive strength is attained at 8% CDA and 1.5% of Sisal fiber, after that strength starts decreasing, thus the optimum content is 8% for compression.
2. Addition of 8% of CDA and 1.5% of Sisal fiber results in increase of 28 days compressive strength by 11.40%.
3. Also maximum split tensile strength is attained at 8% CDA and 1.5% of Sisal fiber, after that strength starts decreasing, thus the optimum content is 8% for split tensile strength.
4. Addition of 8% of CDA and 1.5% of Sisal fiber results in increase of 28 days split tensile strength by 11.26%.
5. As we increase the content of Cow Dung Ash, density of concrete decreases.

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