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Study of strength of concrete using areca fiber and tile powder as additives

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Abstract – *Waste management is one of the major concerns in the modern world. This paper is intended for the utilization of waste materials such as areca fiber and ceramic tile powder in concrete inorder to modify the strength properties. Nowadays, 15% to 30% production of ceramic tile goes as waste in tile industry. Areca fiber is one of the natural fiber which is abundantly produced as a waste material in many parts of South India, which is not properly utilized. Here we are utilizing tile powder as the partial replacement of cement by 30% of its weight. Areca fiber is added as a partial replacement of cement accordingly in the range of 0%, 1%, 2% and 3%by weight for M20 grade concrete. Various tests such as compressive strength, split tensile strength and flexural strength for 28 days were conducted. The test result shows that the compressive strength, flexural strength and split tensile strength of concrete increases with the increase in addition of areca fiber at different percentages.*

Key Words: **Concrete, Areca fiber, Tile powder, Waste management, Cost effective**

1. INTRODUCTION

Concrete, as a constructing material has been used in construction industry for about two centuries. Concrete is a composite material composed of fine aggregate and coarse aggregate bonded together with fluid cement that hardens over time. When aggregate is mixed together with ordinary Portland cement and water, the mixture forms fluid slurry that can be easily poured and moulded into shape. Often, additives like super plasticizers are included in the mixture to improve the physical properties of the wet mix or the finished material. As concrete dries it acquires a stone like consistency that renders it deal for constructing roads, bridges, water supply and sewage systems, factories, airports, rail roads, water ways, mass transit systems and other structures. Rapid industrial development causes serious problems all over the world such as depletion of natural aggregate and creates enormous amount of waste materials from construction and demolition activities.

Doing research about using modern technologies in production of concrete is of great importance. One of the most critical problems of the world has been related to remove the wastage and reusing of it. One such waste is ceramic tile. The global production of ceramic tiles in the world is about 8500 millions square meters. The ceramic waste from ceramic and construction industries is a major contribute to construction and demolition waste , representing a serious environment technical and economic problem of society now a days . It has been estimated that about 30% of the daily production in the ceramic industry goes to waste. Ceramic waste is durable, hard and highly resistant to biological chemical and physical degradation forces. As the ceramic waste is piling up every day there is a pressure on the ceramic industries to find a solution for its disposal. The hard physical structure of these materials and also their chemical structure make them a good and suitable choice to be used in a concrete. Ceramic can be used in concrete as partial replacement of cement, sand as well as coarse aggregate. The use of ceramic wastage as partial replacement can increase compressive strength and also durability of concrete.

Natural Fibers composites are considered to have potential use as reinforcing material in concrete because of their good strength and stiffness .These are eco-friendly material that can give high performance at low cost. They are lightweight materials having superior strength. They are non-toxic and non-hazardous in nature, naturally recyclable, available in abundance, flexible in usage, and less expensive. These fiber exhibits the property of hydrophilicity. Most of these are hydrophilic (exhibit high moisture absorption) in nature because of hydroxyl and other polar groups in their constituents. One such fiber is areca fiber. It is extracted from the areca nut. Slenderness ratio is the ratio of the length of fiber to the diameter of the fiber. This is derived value from the dimensions of the fiber. Fiber length and fiber diameter are among the important parameters to determine the strength of natural fiber.

2. EXPERIMENTAL STUDY

The experimental study aims at modification of concrete by using locally available waste materials. The objective of this experiment is to observe the effect of the combination of areca fiber and tile powder in concrete. Compressive, split tensile and flexural tests were conducted with the standard curing duration of 28 days. Areca fiber, which is an agricultural waste found abundantly in Kerala was collected from nearby local areas for our study. Tile, which is a globally available construction and demolition waste material which is only used in landfills, was also collected for our study from nearby demolition sites.

3. EXPERIMENTAL MATERIALS

3.1. Cement

Ordinary Portland cement of grade 53 confirming to IS 8112:1989 was used for the study. The basic tests like specific gravity, fineness test, initial and final setting time were conducted.

Table-1 Test results of cement

TEST	RESULT
Specific gravity	3.15
Fineness modulus	9%
Initial setting time	35 min
Final setting time	620 min

3.2. Tile Powder

The tile was obtained from a nearby demolition site and was grinded to powder form.

Table-2 Test result of tile powder

TEST	RESULT
Specific gravity	2.63
Fineness modulus	7.3%

3.3. Fine Aggregate

M-Sand was collected from nearby stone crusher confirming to zone-II of IS 383:1970 has been used for the study.

Table-3 Test result of fine aggregate

TEST	RESULT
Specific Gravity	2.65
Fineness modulus	5.27%
Bulk density	1.8 g/cc

3.4. Coarse Aggregate

The coarse aggregate used here was 20 mm sized aggregate .

Table -4 Test result of coarse aggregate

TEST	RESULT
Specific gravity	2.7
Fineness modulus	6.09

3.5. Areca Fiber

It is a naturally occurring and locally available fiber material. Areca nut is soaked in water for 7 days and the fiber is extracted from it. The extracted finer is cut into 3 parts. The aspect ratio of fiber is taken as 70 with a length of 35 mm and thickness of 0.5 mm for each fiber.

Fig -1 : Areca fiber

3.6. Water

It is one of the important ingredients of concrete, because it participates in chemical reaction with cement. It helps to form the strength giving cement gel, therefore it is necessary to accurately determine the quantity and quality of water.

3.7 Super plasticizer

Auramix 400 is used as the admixture. It has low viscosity and high elastic modulus; it has better resistance to carbonation and lower permeability with increased durability.

4. DESIGN MIX

As per IS 10262:2009 a mix for M20 grade was designed and was used to prepare the test samples. The quantity required for casting 12 cubes, 12 cylinders and 12 beams were computed as per mix design. The design proportions are tabulated below in table 5.Apart from the control specimen, the remaining 27 specimens were casted with varying percentages of areca fiber and with 30% tile powder. After 28 days curing period the specimens were tested for compression, split tensile and flexural strength.

Table – 5 Design mix proportion for M20 mix

	W(l)	C (Kg/m^3)	FA (Kg/m^3)	CA (Kg/m^3)
By weight (Kg)	148.5	330	821.7	1150.2
By volume (m^3)	0.45	1	2.49	3.48

W= Water, C= Cement, FA= Fine aggregate, CA= Coarse aggregate.

5. EXPERIMENTAL METHODOLOGY

Here in this study the control specimen were casted without any addition of tile powder and areca fiber and with an addition of 0.6% super plasticizer by weight of cement. Three beams three cubes and three cylinders were casted with 1%, 2%, and 3% of areca fiber and with 30% tile powder in each. After 24 hours the specimens were set out for curing. After 28 days these specimens are taken out for compression, split tensile and flexural strength test strength and the test results were compared.

Fig -2: compression testing machine, flexural strength testing machine and split tensile strength testing machine

6. RESULT ANALYSIS AND DISCUSSIONS

Compressive strength, split tensile strength and flexural strength test were conducted at the end of 28 days on concrete specimens. The result shows that there is a gradual increase in compressive strength, split tensile strength and flexural strength. The test results and corresponding graphs are shown below:

Table - 6 Compressive strength of M20 grade concrete after 28 days

Specimen	0% Areca fiber	1% Areca fiber & 30% tile powder	2% Areca fiber & 30% tile powder	3% Areca fiber & 30% tile powder
Cube (compressive strength N/mm²)	22.44	25.99	27.33	29.44

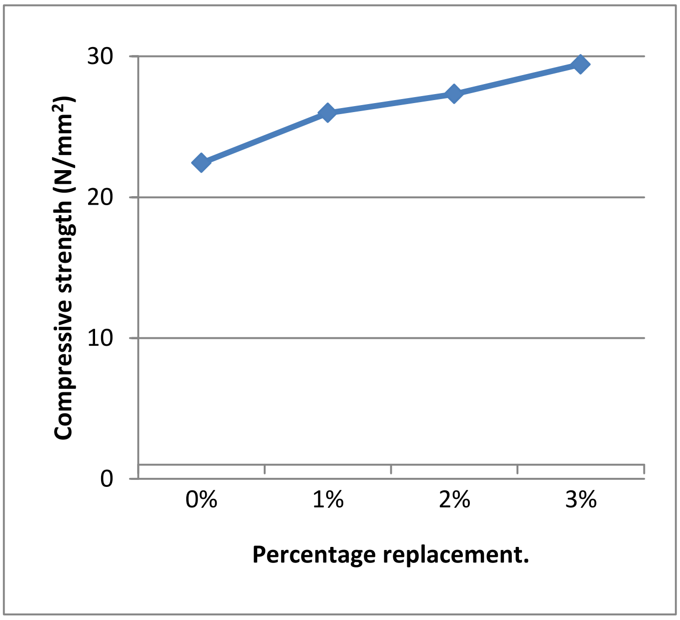

Chart -1 Percentage variation of areca fiber with 30% tile powder V/S compressive strength

Table- 7 split tensile strength of M20 grade concrete after 28 day

Specimen	0% Areca fiber	1% Areca fiber & 30% tile powder	2% Areca fiber & 30% tile powder	3% Areca fiber & 30% tile powder
Cylinder (Split tensile strength N/mm²)	2.61	2.86	3.39	3.56

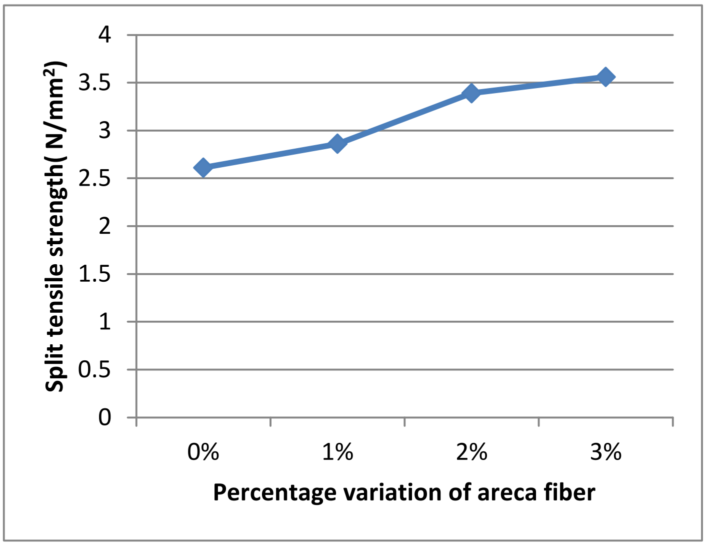

Chart –2 Percentage variation of areca fiber with 30% tile powder V/S split tensile strength

Table – 8 Flexural strength of M20 grade concrete after 28 days

Specimen	0% Areca fiber	1% Areca fiber & 30% tile powder	2 % Areca fiber & 30% tile powder	3 % Areca fiber & 30% tile powder
Beam (flexural strength N/mm^2)	6.03	6.18	6.562	6.9

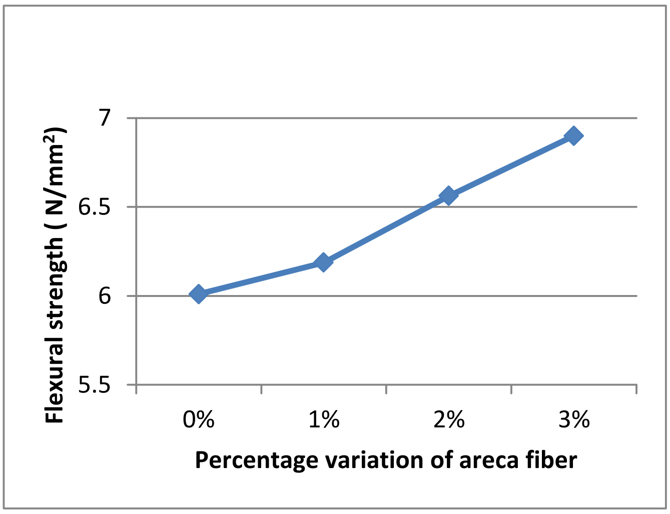

Chart -3 Percentage variation of areca fiber with 30% tile powder V/S flexural strength

7. CONCLUSIONS

From this experimental study it is noted that the mechanical properties like compressive strength, split tensile strength, flexural strength, creep and modulus of elasticity increases. Based on the obtained result we have arrived to the following conclusions:

1. As fiber dosage increases, workability decreases
2. The compressive strength split tensile strength and flexural strength of concrete increases as percentage dosage of areca fiber increases.
3. By adding waste tile powder to concrete the problem of waste disposal crisis can be reduced.
4. It is noted that the durability of concrete has increased with the addition of tile powder.

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