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Experimental Study On Vettriver Fiber As Strengthening Agent In Concrete

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Abstract: ***Chrysopogon zizanioides, commonly known as Votive, is a naturally available material that is cultivated and exported at highest rate at Cuddalore, Tamil Nadu. As there is huge demand for high strength concrete, government is sponsoring researchers for researching onmaterials that can increase the strength of concrete. Due to the shortage of conventional fibers, need for an alternative material has been raised.In this paper, an experimental investigation has been conducted with natural vetiver (0%,0.2%,0.4%,0.6%,0.8%). In order to use naturally available resource, votive fibers (Chrysopogon zizanioides)with aspect ratio 90 are used. In addition to this, super plasticizer (Conplast SP430) has been used to reduce the water content and to improve the workability. Cubes with size 150mm X 150mm X 150mm were cast to get the compressive strength and beams of size 1200mmX150mmX200mm for getting flexural strength and cylinders of size 150X300mm to get the split tensile strength were cast. The compressive strength of the concrete neared a maximum at 0.4% vetiver addition, being a 40.53% increase over the CC. The split tensile strength and flexural strength of the concrete neared on increasing the volume fraction %, achieving 29.28% and 75.22% increase, respectively, at 0.4% vetiver fiber. Due to the shortage of natural aggregates, need for an alternative material has been raised. Using regression analysis, the compressive strength, flexural strength and split tensile strength equation of recycled aggregates has also been found. By this experimental investigation, Vetiver is found to be the cheap and an effective material to increase the strength of concrete in all aspects.***

Keywords: vetiver fiber, conventional concrete, vetiver concrete, Superplasticizer.

I. INTRODUCTION

Concrete is the extensively used material in construction and it is the primary component used for infrastructure. Due to the advanced development in construction, the use of admixtures has become intense and need for strengthening agent has become an issue which should be addressed immediately in order to cope up with advancement in structural designs.[1]For the suitability and adaptability, due to the changing atmosphere, the concrete must be such that it can preserve resources, safeguard the environment, economize and lead to appropriate deployment of energy.[2]

Addition of natural fiber increases the toughness, ductility and tensile strength of concrete. In order to preserve the nature and environment and to reduce its manufactured fibers, vetiver can be used as strengthening agent.[3].The use of vetiver as strengthening agent in construction industry will be environmental friendly and economical. At present, many researches indicate that natural fiber from agricultural wastes can be used be dumped in ground. [4]. However, a good quality concreteto be used for structural purposes can be made using concrete with addition of naturalfiber [5]. The properties of fiber manipulate the strength of the concrete, so it is essential to analyze the characteristics of natural fiber obtained from local market [6].Vetiver can be bought from local vetiver export dealers.Natural fibers are usually used in concrete to control cracking due to both plastic shrinkage and drying shrinkage. They also lessen the permeability of concrete and thus reduce bleeding of water[7].

The purpose of addition ofsuper plasticizeris to improve theworkability of concrete. Super plasticizers can enhance the strength of concrete by substantial reduction in water resulting in high early strength and low permeability [8]. They also giveclose texture and denser concrete with reduced porosity and more durability. It also prevents the risk of segregation and bleeding and thereby helps in pumping the concrete[9].

II. METHODOLOGY

Number of 120 specimens has been casted to compare the behavior of concrete with Vetiveras a fiber. The Vetiverfiber wasadded in percentages (0%, 0.2%, 0.4%, 0.6% and 0.8%) by Cement. Super plasticizer (SP) was added to increase the strength. The sand and

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cement were kept constant throughout the mix. The specific gravity and water absorption of aggregates were used to calculate mix design. The mix proportioning of M25 grade concrete has been calculated as per IS 10262 are: cement = 425kg/m^3, fine aggregate= 683.30kg/m^3, coarse aggregate = 1188.93kg/m^3 and admixture = 0.54kg/m^3. W/C ratio has been found as 0.45. The methodology adopted in the study is shown in Figure 1.

III. MATERIALS

The materials used for this experimental work are cement, river sand, natural coarse aggregate, recycled aggregate, water, steel fibers, and super plasticizer.

Cement:The cement used for this study is Ordinary Portland Cement conforming to IS 12269 – 1987 of grade 53. Table 1 shows the physical properties of cement.

Fine Aggregate: Locally available sand zone II with specific gravity 2.70, water absorption 2.46% and fineness modulus 3.14, conforming to I.S. – 383-1970.

Coarse aggregate: Crushed granite stones of 20 mm size having specific gravity of 2.80, fineness modulus of 8.04, impact value of 33% and water absorption of 0.75 conforming to IS 383-1970 have been used

Water: Potable water was used for the experimentation.

Super plasticizer: To impart additional workability a super plasticizer (Conplast SP430) 2% by weight of cement was used. It is based on sulphonated naphthalene polymers with following properties as per I.S. – 9103-1999.

Fibers: Steel Fibers: - In these experimentation Natural fibers (Vetiver)with aspect ratio90 has been used.The length and diameter of steel fiber is90mm and1mm respectively.

IV. RESULTS AND DISCUSSION

A. Compressive strength

Compressive strength gives the overall picture of quality of concrete and it is considered as the most important properties of concrete. From the table, it can be seen that the compressive strength increases when coarse aggregate is replaced with recycled aggregates. It can be found that highest compressive strength has been obtained with 0.4% vetiver. So this can be seen as the optimum replacement percentage. Beyond which any replacement is observed to have detrimental effects on the compressive strength. Table 3 shows the average compressive strength of various additions for 28 days age.Using the results of compressive strength, the regression analysis has been carried out and the equation of best fit has been found for finding the compressive strength of recycled aggregates. It is expressed as shown in equation (1)

$$f_cVA = f_c - 3.7434V_a + 6.036_{Vf} \quad (1)$$

Where f_cVA is the compressive strength of concrete with Vetiver fiber

f_c is the compressive strength of conventional concrete.

V_a andV_f are the volume of conventional aggregates and Vetiver fibre respectively.

B. Split tensile strength

To measure the split tensile strength, cylinders were cast. From Table 4, it can be seen that the split tensile strength of concrete with 0.4 % addition has the highest split tensile strength. This indicates that the 0.4 % addition is the optimum content even for split tensile strength as it was for compressive strength. The results obtained in split tensile test of cylinders are shown in the table 4 for various percentages of Vetiver Fiber.

Based on regression analysis, the equation of best fit for split tensile strength of recycled aggregates can be found using the eqution (2)

$$f_{splt}VA = f_{splt} - 0.5019\ V_a + 0.9468\ V_f \quad (2)$$

Where $f_{splt}VA$ and f_{splt} are the split tensile strength of recycled aggregates and conventional concrete respectively.

V_a andV_f are the volume of conventional aggregates and Vetiver fibre respectively.

C. Flexural strength

It is measured by testing beams under 2 point loading (also called 4 point loading including the reactions). Beam Dimensions: 1.2 m length × 0.15 m breadth x 0.2 m height. Figure 2 shows the loading position of the beams.Table 5 shows the flexural strength

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obtained for concrete and different percentage of Vetiver fibers. When the percentage of Vetiver fiber is increased from 0.2 % to 0.6%, high flexural strength has been obtained at 0.4% Vetiver addition.

Based on regression analysis , the flexural strength of Vetiver Fiber Concrete can be found using the equation (3)

$f_{flx}VA = f_{flx} - 9.8132\ V_a + 16.5975\ V_f$ (3)

where $f_{flx}VA$ and f_{flx} are the flexural strength of recycled aggregates and conventional concrete respectively.

D. Load Vs Deflection

The load vs. deflection behavior of different specimen can be seen in Figure 3. Greater energy absorption capacity along with ductile failure mode makes the Vetiver fiber suitable for use in structural components and also for applications involving earthquake and blast load. It can be seen that 0.4 % addition Vetiver fibers have lesser displacement than the rest of the beams. The stiffness is also more for 0.4% of Vetiver Fiber.

E. Crack Pattern

Regarding the crack pattern diagonal tension failure is noted in all the specimens. The diagonal crack starts from the last flexural crack and turns gradually into a crack more and more inclined under the shear loading as noted in Figure 4.This crack does not cause failure immediately, although in some of the longer shear spans either this seems to be the case or an entirely new and flatter diagonal crack suddenly causes failure.

V. CONCLUSION

This experimental study on Vetiver fiber as strengthening agent in Concrete has given an idea on using natural fiber in concrete. Based on the results, the following conclusion has been made.

A. On comparison, compressive strength of concrete with Vetiver fiber is better than conventional concrete with optimum replacement percentage as 0.4%. It is increased by about 40.53 %.

B. When the percentage of Vetiver fiber is increased from 0.2 % to 0.6%, high flexural strength has been obtained for 0.4%Vetiver fiber.

C. The 0.4% vetiver fiber has less displacement compared to conventional concrete showing that it is stiffer.

D. Concrete made up of Vetiver fiber in addition with Super plasticizer can be used for structural elements also.

E. The split tensile strength and flexural strength of concrete increased with percentage of fibers showing an improvement of about 29.28 % and 75.22 % respectively at 0.4%vetiver fiber.

TABLES

TABLE.1 PHYSICAL PROPERTIES OF CEMENT

Property	Value
Initial setting time (min)	32
Fineness modulus (%)	3.25
Specific gravity	3.10

TABLE.2 PHYSICAL PROPERTIES OF VETIVER FIBER

Property	Value
Specific gravity	0.45
Water Absorption (%)	0.05

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TABLE.3 COMPRESSIVE STRENGTH OF CONCRETE

Sl. No	Batch	Cube strength (MPa) for 28 days
1	Conventional specimen	30.25
2	0.2% Vetiver Fiber	36.38
3	0.4% Vetiver Fiber	39.11
4	0.6% Vetiver Fiber	28.67
5	0.8% Vetiver Fiber	13.78

TABLE.4 SPLIT TENSILE STRENGTH OF CONCRETE

Sl. No	Batch	Cylinder strength (MPa) 28 days
1	Conventional specimen	2.26
2	0.2% Vetiver Fiber	3.54
3	0.4% Vetiver Fiber	3.96
4	0.6% Vetiver Fiber	2.83
5	0.8% Vetiver Fiber	1.56

TABLE.5 FLEXURAL STRENGTH OF CONCRETE

Sl. No	Batch	Flexural strength (MPa) 28 days
1	Conventional specimen	25.51
2	0.2% Vetiver Fiber	27.38
3	0.4% Vetiver Fiber	29.87
4	0.6% Vetiver Fiber	24.58
5	0.8% Vetiver Fiber	19.29

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FIGURES

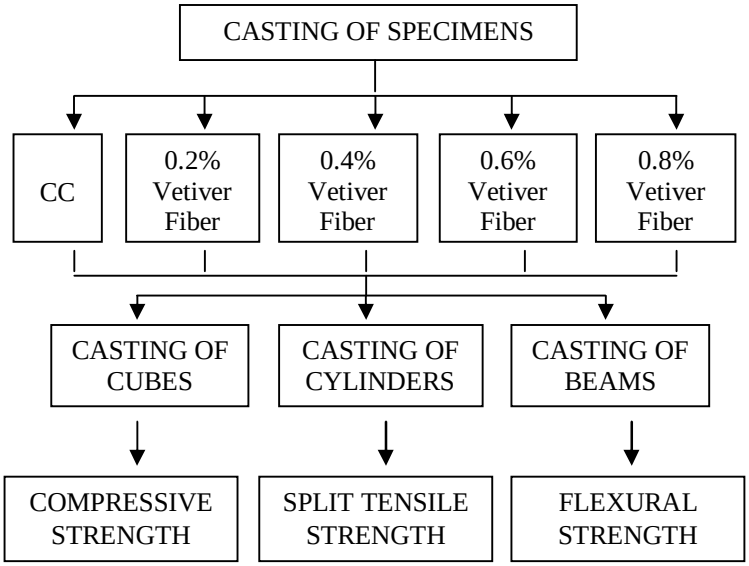


Fig.1 Methodology adopted

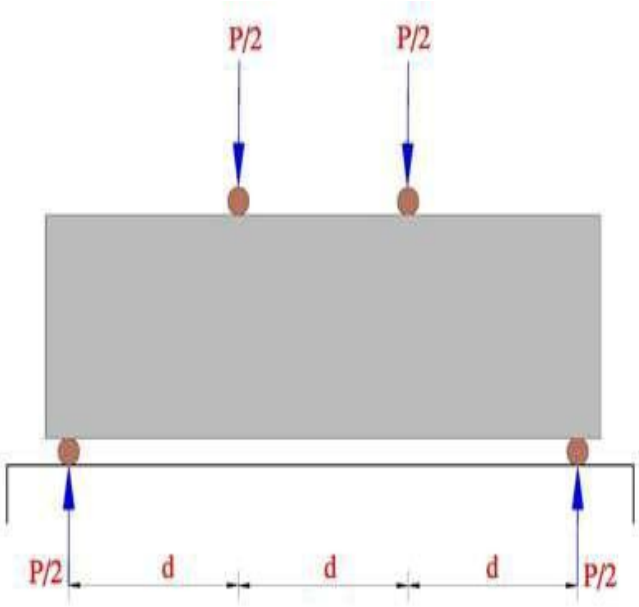


Fig.2 Loading position on beams

Where

F = the load applied to a sample of test length L, width b, and thickness d.

L= centre to centre distance of the supports.

Li= inner span.

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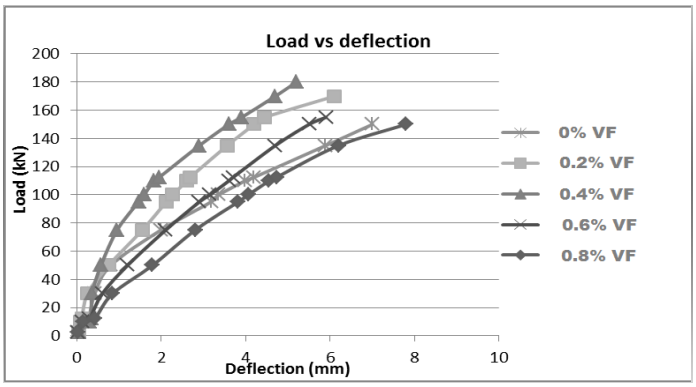


Fig.3 Load vs deflection diagram

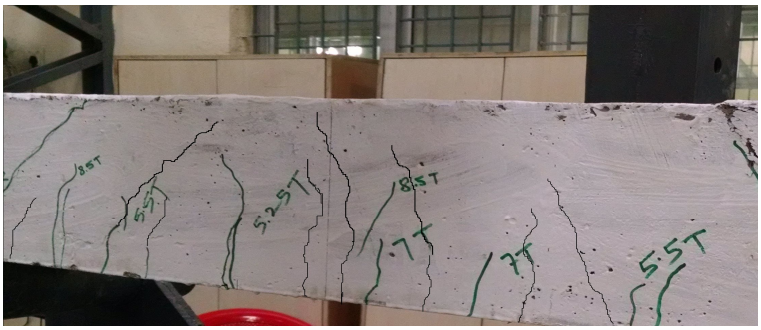


Fig.4 Crack Pattern of beam

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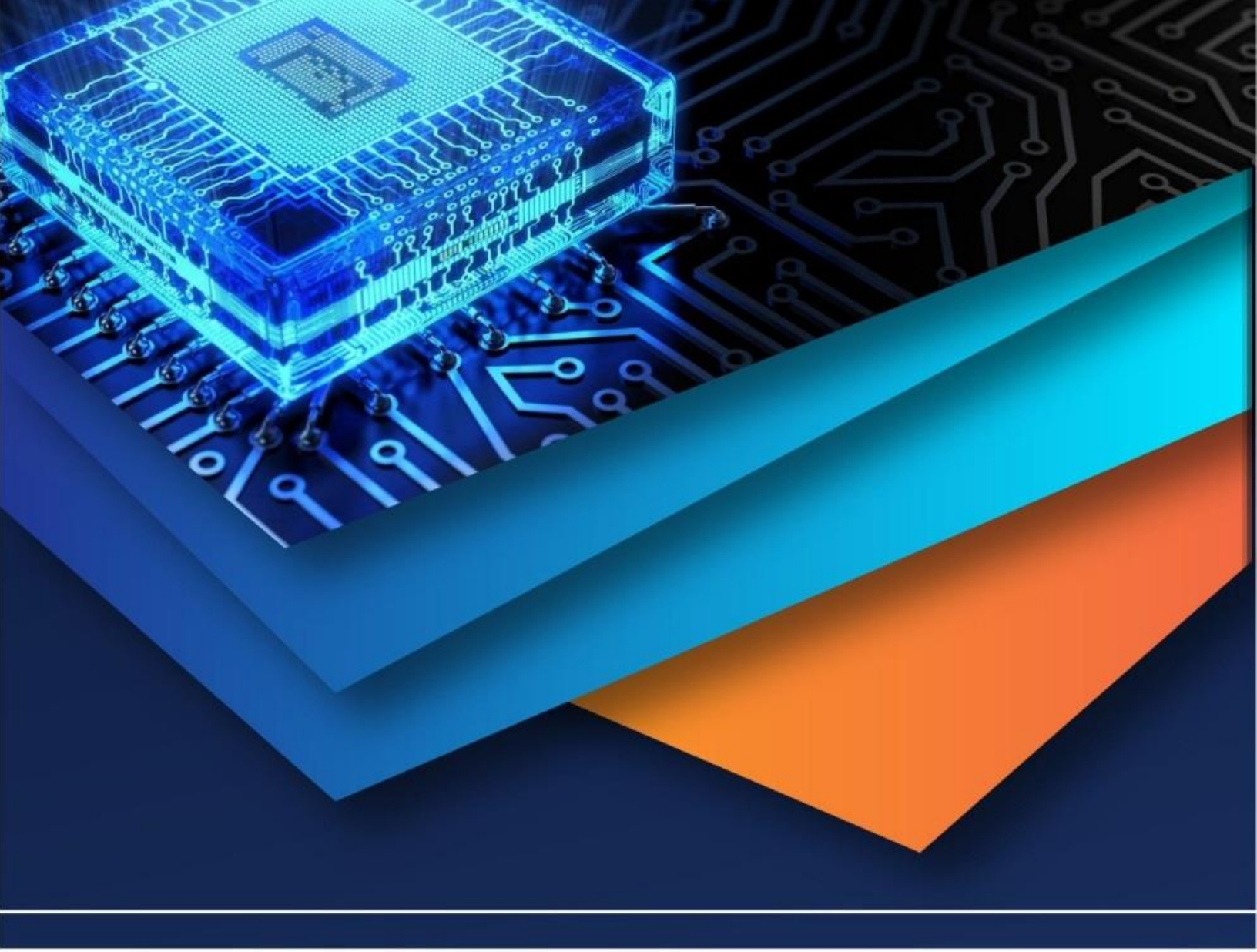
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