Experimental Investigation on Vetiver as Fibre in Conventional Concrete

Anand M
Assistant Professor
Dept. Civil Engineering
CK College of Engg.
Cuddalore

Kumaraguru R*
UG Student
Dept. Civil Engineering
CK College of Engg.
Cuddalore

Santhoshkumar S
UG Student
Dept. Civil Engineering
CK College of Engg.
Cuddalore

Kuralamuthan S
UG Student
Dept. Civil Engineering
CK College of Engg.
Cuddalore

Abstract: **Vetiveria zizanioides, commonly known as Vetiver, 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 on materials that can increase the strength of concrete. Due to the shortage of conventional fibres, 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 increase the strength and ductility of the concrete, vetiver fibres (Vetiveria zizanioides) with aspect ratio 90 are used. In addition to this, super plasticizer (Conplast SP430) has been used to improve the workability. Cubes of size 150mm X 150mm X 150mm to check the compressive strength and beams of size 1200mmX150mmX200mm for checking flexural strength and cylinders of size 150X300mm to check the split tensile strength were cast. The compressive strength of the concrete reached a maximum at 0.4% vetiver addition, being a 40.53% improvement over the CC. The split tensile strength and flexural strength of the concrete improved with increasing the volume fraction, achieving 29.28% and 75.22% improvements, respectively, at 0.4% vetiver fibre. 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. Due to the shortage of natural aggregates, need for an alternative material has been raised.**

***Keywords:* Vetiver Fibre, Conventional Concrete, Vetiver Concrete, Super Plasticizer**

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 fibre increases the toughness, ductility and tensile strength of concrete. In order to preserve the nature and environment and to reduce its manufactured fibres, 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 fibre from agricultural wastes can be used be dumped in ground. [4]. However, a good quality concrete to be used for structural purposes can be made using concrete with addition of natural fibre [5]. The properties of fibre manipulate the strength of the concrete, so it is essential to analyze the characteristics of natural fibre obtained from local market [6]. Vetiver can be bought from local vetiver export dealers. Natural fibres 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 of super plasticizer is to improve the workability 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 give close 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

A total of 120 specimens have been casted to compare the characteristics of concrete with Vetiver fibre. The Vetiver fibre were added in percentages (0%, 0.2%, 0.4%, 0.6% and 0.8%) by Cement. Super plasticizer (SP) were added to increase the strength. The sand and 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, vetiver fibres.

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.

Fibres: Vetiver Fibres: - In these experimentation Natural fibres (Vetiver) with aspect ratio 90 has been used. The length and diameter of vetiver fibre is 90mm and 1mm respectively. (Fig.2)

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)

$$f_cVA= f_c – 3.7434V_a + 6.036 V_f \qquad (1)$$

Where f_cVA is the compressive strength of concrete with Vetiver fibre

f_c is the compressive strength of conventional concrete.

V_a and V_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 Fibre.

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

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

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

V_a and V_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 obtained for concrete and different percentage of Vetiver fibres. When the percentage of Vetiver fibre 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 Fibre Concrete can be found using the equation (3)

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

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 fibre suitable for use in structural components and also for applications involving earthquake and blast load. It can be seen that 0.4 % addition Vetiver fibres have lesser displacement than the rest of the beams. The stiffness is also more for 0.4% of Vetiver Fibre.

E. Crack Pattern

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 study deals with experimental study on Vetiver fibre as strengthening agent in Concrete. Based on the results, the following conclusion has been arrived.

a) On comparison, compressive strength of concrete with Vetiver fibre 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 fibre is increased from 0.2 % to 0.6%, high flexural strength has been obtained for 0.4% Vetiver fibre.
c) The 0.4% vetiver fibre has less displacement compared to conventional concrete showing that it is stiffer.
d) Concrete made up of Vetiver fibre 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 fibres showing an improvement of about 29.28 % and 75.22 % respectively at 0.4% vetiver fibre.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 04, April-2017

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 FIBRE

Property	Value
Specific gravity	0.45
Water Absorption (%)	0.05

TABLE.3 COMPRESSIVE STRENGTH OF CONCRETE

Sl. No	Batch	Cube strength (MPa) for 28 days
1	Conventional specimen	30.25
2	0.2% Vetiver Fibre	36.38
3	0.4% Vetiver Fibre	39.11
4	0.6% Vetiver Fibre	28.67
5	0.8% Vetiver Fibre	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 Fibre	3.54
3	0.4% Vetiver Fibre	3.96
4	0.6% Vetiver Fibre	2.83
5	0.8% Vetiver Fibre	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 Fibre	27.38
3	0.4% Vetiver Fibre	29.87
4	0.6% Vetiver Fibre	24.58
5	0.8% Vetiver Fibre	19.29

Figures

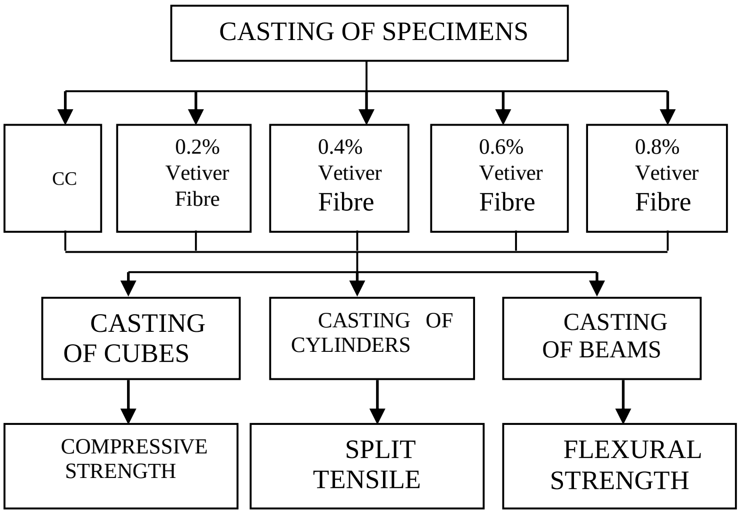

Fig.1 Methodology used

Fig.2 Vetiver fibre

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.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 04, April-2017

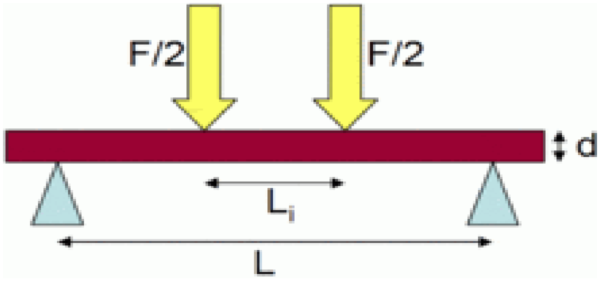

Fig.3 Loading position on beam

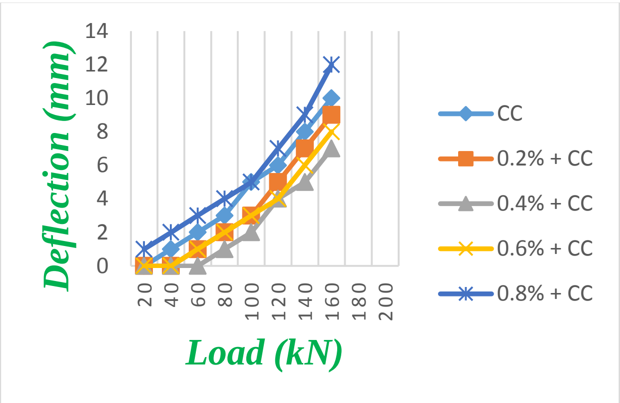

Fig.4 Load vs deflection diagram

Fig.5 Crack Pattern of beam

REFERENCES

[1] C. J. Zega; Y. A. Villagrán-Zaccardi; A. A. Di Maio: "Effect of natural coarse aggregate type on the physical and mechanical properties of recycled coarse aggregates", Materials and Structures, Vol.43, Issue 1-2, pp. 195-202, Springer (2010).

[2] Song a,P.S; Hwang ,S: "Mechanical properties of high-strength steel Strength fibre reinforced concrete", Construction and Building Materials, pp. 669-673. Elsevier (2004).

[3] Yalley; Kavan: "Use of Coconut fibre as Enhancement of Concrete", Online Research Cardiff, (2009).

[4] Noor MD; Hasan; "The Use of Coconut Fibre in the Production of Structural Lightweight Concrete", Journal of Applied Science, Issue 10, pp. 831-839, (2012).

[5] Jianzhuang Xiaoa; Long Li; Luming Shen; Chi Sun Poon: "Compressive behaviour of recycled aggregate concrete under impact loading", Cement and Concrete Research, Vol.71, pp. 46-55, Elsevier (2015).

[6] M. Etxeberria; E. Vázquez, A. Marí; M. Barra: "Influence of amount of recycled coarse aggregates and production process on properties of recycled aggregate concrete", Cement and Concrete Research, Vol 37, Issue 5. Pp. 735-742 Elsevier (May 2007),

[7] R.V. Silva; J. de Brito; R.K. Dhir: "Properties and composition of recycled aggregates from construction and demolition waste suitable for concrete production", Construction and Building Materials, vol. 65, pp 201-217, Elsevier (2014).

[8] S. P. Singh; Y. Mohammadi; S. K. Madan: "Flexural fatigue strength of steel fibrous concrete containing mixed steel fibres", Journal of Zhejiang University SCIENCE A, vol. 7, Issue 8, pp 1329-1335 Springer (2006).

[9] M. Pająk; T. Ponikiewski: "Flexural behavior of self-compacting concrete reinforced with different types of steel fibres", Construction and Building Materials, vol. 47, pp 397-40, Elsevier (2013).