VOL. 10, NO. 14, AUGUST 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

FLEXURAL BEHAVIOUR OF HEMP FIBER REINFORCED CONCRETE BEAMS

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ABSTRACT

In this research work, an attempt was made to obtain low cost building materials using natural fibres. Fibers are usually used in concrete to control cracking due to both plastic shrinkage and drying shrinkage and bridge across the cracks that develop in concrete. Hemp fibres were used in this work to exploit the enormous potentials of renewable resources in the non-food areas of natural fibers. The fibres in volumetric ratios of 0.25%, 0.5%, 0.75% and 1% fibers were used. It was attempted to determine the optimum percentage of Hemp fiber in concrete that is found to bring about an appreciable increase in the mechanical properties of concrete. Reinforced concrete beams of grade M25 were cast and tested under two-point loading. The test results were found to be appreciable for RC beams with hemp fibres.

Keywords: hemp fibre, aspect ratio, RC beam, two-point load.

1. INTRODUCTION

To evaluate and quantify advantages of fibre reinforced concrete, extensive research is currently going on. Various types of fibres like steel, carbon, glass, polypropylene, polyolefin The use of plant fibers like hemp as a cost and performance effective reinforcement was largely developed in Europe in the early 1990's and has been embraced by North American car makers at the end of the 1990's. Hemp fiber is of interest to automotive and other applications due to the following features: (1) Cost effective, (2) High tensile strength and stiffness, (3) Ideally suited for needle punched non-woven products, (4) Effective replacement for glass fiber, (5) Reduces molding time, (6) Weight reduction in finished part, (7) Easy to process and recycle, (8)Can be customized to meet a variety of specifications and different manufacturing systems and (9)Consistent quality and availability of supply is possible.

2. MATERIALS USED

A. Materials used for concrete

Ordinary Portland Cement (OPC) of grade 43 was used. The specific gravity was found to be 3.15. The initial setting time and fineness of the OPC were found to be 45 minutes and 5% respectively.

River sand of zone III and specific gravity 2.66 was used. Coarse aggregates of size 20 mm and specific gravity 2.69 was used. Potable water confirming to the requirements of IS: 456 - 2000 is used.

B. Hemp fibres

Hemp [Deccan Hemp/ Pulichaikeerai] is a type of natural fiber extracted from blast of hemp stalk is from the Hibiscus family. The fibers were obtained from markets of Vellore district of Tamil Nadu. They were soaked in sodium hydroxide solution (NaOH) at 6% by weight for 48 hours. After soaking they were washed with water and left to dry. The fibres were then cut into required aspect ratio of 75. The hemp fibre stalks before and after cutting is shown in Figures 1 and 2.

Figure-1. Hemp fibre stalks.

Figure-2. Hemp fibres.

3. EXPERIMENTAL PROGRAMME

A. Concrete mix design

Concrete of grade M25 was design ed as per IS 10262:2009. A mix proportion of 1:1.5:2.75 (Cement:Fine

aggregate: Coarse aggregate)was obtained. A water cement ratio of 0.45 was adopted.

B. Procedure for mixing

The coarse aggregate and fine aggregate were initially poured into the concrete mixture and allowed to mix thoroughly

i The fibers are randomly dispersed into the mixer and allowed to mix with the aggregates
ii Then Cement and half of the water is poured into the mixer
iii As mixer is allowed to rotate, gradually the remaining water is added into the mixer.
iv The mixing time is kept from 4 to 4.5 minutes from the time when all these mix ingredients had been charged into the mixer
v After this, the concrete that is ready for use is allowed to pour into a tub to be used for casting the specimens.

C. Casting of beam specimen

Four numbers of structural beams of size 1m x 0.15m x 0.18m with 0%, 0.25%, 0.5% and 0.75% of hemp fibers were cast and tested on 28th day. The fibres were mixed to the concrete at random orientation. The beam specimen was provided with main rreinforcement of 4 numbers of 10 mm diameter rods and shear rreinforcement of 8 mm diameter rods at 120 mm center to center. The reinforcement details are shown in Figure-3.

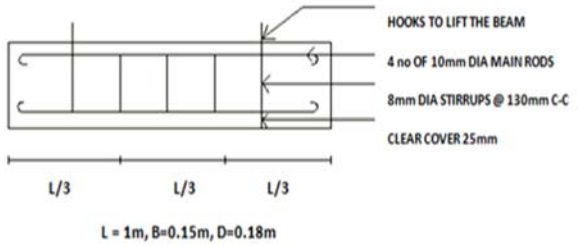

Figure-3. Reinforcement details of beam.

D. Testing of beam specimen

The beam specimens were cured in water for 28 days and tested for flexural behaviour. Two-point loading was applied to the beams until failure occurs. The test results of the hemp fibre reinforced concrete beams were compared with those of the beam specimen without hemp fibres. The test set up is shown in Figure-4.

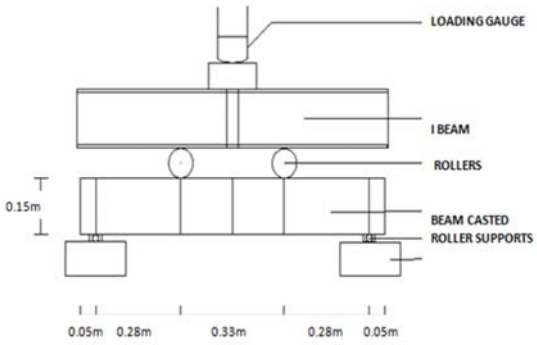

Figure-4. Test set up for beam.

The cast beam specimens are shown in Figure-5.

Figure-5. Casted beam specimens for tesing.

The ultimate load and the first crack load were obtained for all the beams and the flexural strength was calculated. A keen observation on the appearance and propagation of cracks was studied and the deflections corresponding to load applied was noted down.

The tested beam specimens are shown in Figure-6.

Figure-6. Tested beam specimens.

4. RESULTS AND DISCUSSIONS

The beams were kept in simple supports and two-point load was applied through load cells. The mode of failure, first crack load, ultimate load and deflection were recorded for control beam and beams with hemp fibres of dosages 0.25%, 0.50% and 0.75%.

Table-1. Test results of beams with and without hemp fibres.

Type of beam and dosage of fibres	**First crack load** (kN)	**Ultimate load** (kN)	**Deflection** (mm)
Control beam	900	2000	5.5
0.25% HEMP	1106	2340	5.4
0.5% HEMP	1300	2500	4.8
0.75% HEMP	1100	2116	5.0

CONCLUSIONS

Based on the study of the results obtained from the experimental investigations made, the following conclusions were made:

a) It was observed that the load capacity of hemp fibre reinforced concrete beam was increased by increase in percentage of hemp fibres. An increase of 25% in load capacity for beam with 0.5% hemp fibres was observed.

b) Therefore 0.5% shall be considered as the optimum percentage of fibers that shows appreciable increase in strength.

c) Thus thse non- food areas of the natural hemp fiber can be effectively used in the design of economical constructions

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