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EXPERIMENTAL STUDIES ON TRENGTHENING OF RCC BEAMS BY USING THE FLAX SEEDS AS A PARTIAL REPLACEMENT FOR CEMENT

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ABSTRACT

The role of fibres plays a vital role in modern construction field, the natural form of fibres are said to be the most studied material. The flax seed is the natural forms of fibre possess condescending mechanical properties where the young's modulus rate and tensile strength are in good range and it is eco-friendly. The flax seeds are powdered in a fine manner and it is used as the partial replacement of cement. By adding the flax seeds in the ratio of 0.5%, 1%, 1.5%, and 2% in RCC beams and it is further tested under cyclic loading to determine the flexural strength and stiffness value. Finally the mechanical properties and strengthening capacity of the flax seed beams are compared with conventional RCC beams.

Index terms - Natural fibres, Flax seeds, Eco-friendly, Partial replacement of cement, Cyclic loading, Flexural strength, Stiffness.

INTRODUCTION

Cement is said to be one of the most vital ingredient in the construction field. Day by day the growth of construction is enormous and the usage of cement has been increased at the epitome range [Baley and de Bretagne, 2012]. This huge amount of cement usage affects the environment in a worse manner. The carbon dioxide as which is not environmental friendly has been formed at condescending rate in the manufacture of cement and other greenhouse gases were also emitted. This creates abiotic depletion, global warming, acidification and other hazardous impacts. Hence the replacement for cement is necessary for the current situation. The flax seeds are the natural form of fibre, 147,000 metric tons of flax seeds were produced in India and it is abandoned over here. Hemp and kenaf are also natural form of fibres but they are restricted as they create a harmful impact towards the environment and as well as at the process of cultivation due to pest used and other factors harm the environment. So, we are using flax seeds as the partial replacement on cement [Carrozzini, et al., 2012]. The flax seeds are lustrous, soft and flexible in nature, which possess condescending young's modulus and tensile capacity. The flax seeds are organic in nature and it is environmental friendly.

In this experimental study, the flax seeds are powdered in a fine manner and it is used as the partial replacement of cement of 0.5%, 1%, 1.5% and 2% in RCC beams. This process has been done for M25 and M30 grade of concrete. The RCC beams are cast with corresponding percentage of flax seeds and the curing is done for 28 days. After that, those beams are tested under cyclic loading then flexural strength and stiffness value of RCC beams will be determined. Finally, the flexural strength and stiffness value of the flax seed beam are compared with conventional RCC beams.

II. MATERIALS DESCRIPTION

The cement which is used in this experimental study is Ordinary Portland Cement (OPC) of grade 53 and specific gravity 3.15. The fine aggregate of size 4.75mm and specific gravity of 2.78 is used. The coarse aggregate size of range 20mm to 12mm and specific gravity of 2.98 has also been used. The flax seeds which is said to be natural form of fibre is environmental friendly and produced abandoned in India are obtained in dry form then they are powdered [Singh, et al., 2012] in a fine manner, which is shown in Fig.1 and it is used as the partial replacement on cement. The X-ray Powder Diffraction (XRD) and Field Emission Scanning Electron Microscope (FESEM) tests were done on powdered flax seeds and its results are shown in Fig. 2 (a), Fig.2(b), Fig.2(c) and Fig.2(d).

Fig. 1: Powdered flax seeds

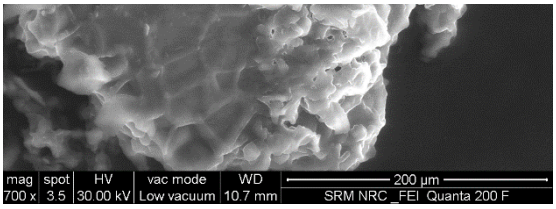

Fig. 2(a): Surface of powdered flax seeds by FESEM

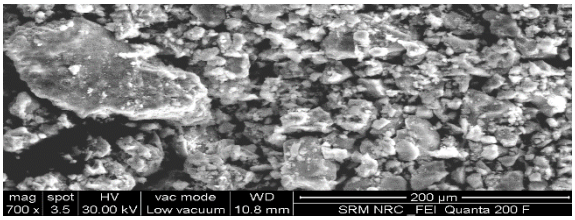

Fig.2(b): Surface of powdered flax seeds with cement, fine aggregate and coarse aggregate by FESEM

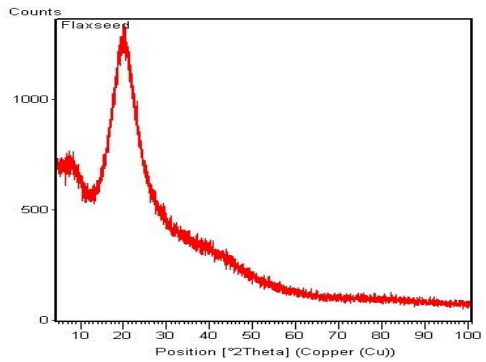

Fig. 2(c): Diffraction pattern in graphical representation of powdered flax seeds by XRD

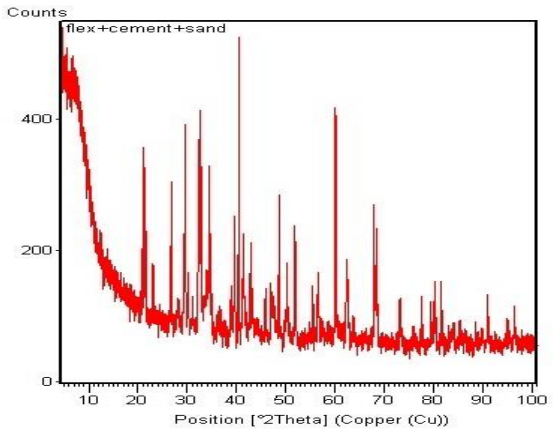

Fig. 2(d): Diffraction pattern in graphical representation of powdered flax seeds, cement, fine aggregated and coarse aggregates by XRD

III.CASTING WORK

The RCC beams are casted on M25 and M30 grades of concrete. The mix design of M25 is 1: 1.54:2.53 and the mix design of M30 is 1: 1.61: 2.81. The doubly reinforcement is designed in as safe manner with the reference of the code book. Now the RCC beams will be casted on partial replacement of cement with flax seeds which is in a powdered manner, of 0%, 0.5%, 1%, 1.5% and 2% on M25 grade and as well as M30 grade. After the process of casting RCC beams, the mould is removed and the curing process is proceeded by covering RCC beams with gunny bags and the moisture is maintained for twenty-eight days. Doubly reinforcement detailing has been made with 20mm and 16mm diameter rods.

IV.EXPERIMENTAL INVESTIGATION

The cyclic loading experiment is done by placing the RCC beam in simply supported manner on the frame and a span is placed over the central portion of the RCC beam then the hydraulic jack is placed on the top of the span. Now, three were plotted at central portion on an equal interval, below the RCC beam [Shri and Thenmozhi, 2014]. At those corresponding three points, the deflectometer must be placed in order to note down the deflections which is formed in the RCC beam. Then the load is applied gradually and deflections were noted according to the load applied. Like this the load is applied till the RCC beam fails and that particular point of load is considered to be the ultimate load, with these data the flexural strength and the stiffness value can be determined. The experimental set up of cyclic loading has been shown in Fig.3(a) and Fig.3(b).

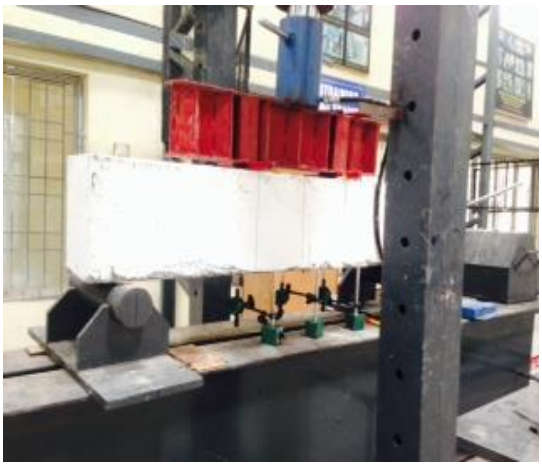

Fig. 3(a): RCC beam under cyclic loading arrangement

Fig.3(b): Cracks formed while testing RCC beam

A. FLEXURAL STRENGTH

The flexural strength or modulus of rupture, is defined to be the material's ability to resist the deformation under load. The unit is N/mm^2.

$$F = \frac{3PL}{2bd^2}$$ Where,

F - Flexural strength
P - Ultimate load
L - Length of RCC beam
b - Breadth of RCC beam
d - Depth of RCC beam

B. STIFFNESS: This is said to be the rigidity of an object and the extent to which it resists deformation in response to an applied force. The unit is KN/mm.

$S = \frac{P}{\delta}$ Where,

S - Stiffness
P - Ultimate load
δ - Unit deflection

V.RESULT AND DISCUSSIONS

A. LOAD AND DEFLECTION GRAPH: The load and deflection which has been observed on the RCC beams of the grades M25 and M30 by cyclic loading test has been plotted in the graph. The x-axis denotes the deflections d_1, d_2 and d_3. d_2 is the deflectomer which is placed at the centre part of the beam, d_1 is the deflectometer which is placed left side of the centre part and d_3 is the deflectometer which is placed right side of the centre part. The y-axis denotes load. The load VS deflection graphs are shown in Fig.4(a), Fig.4(b), Fig.4(c), Fig.4(d), Fig.4(e), Fig.4(f), Fig.4(g), Fig.4(h), Fig.4(i) and Fig.4(j).

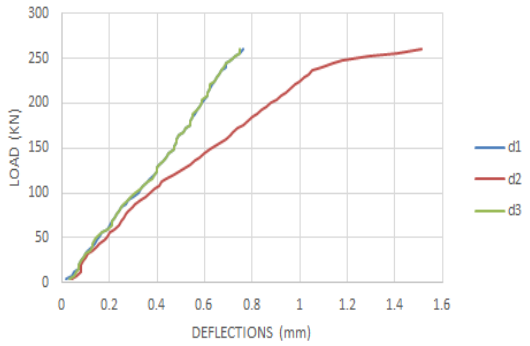

Fig. 4(a): Load VS Deflection graph on 0% flax seeds in M25 grade RCC beam

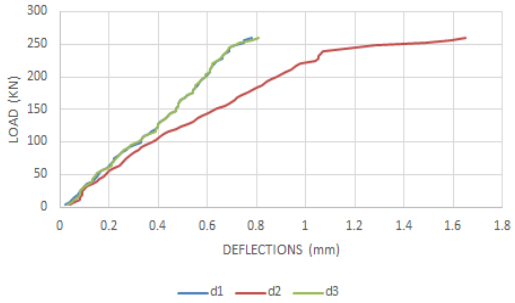

Fig.4(b): Load VS Deflection graph on 0.5% flax seeds in M25 grade RCC beam

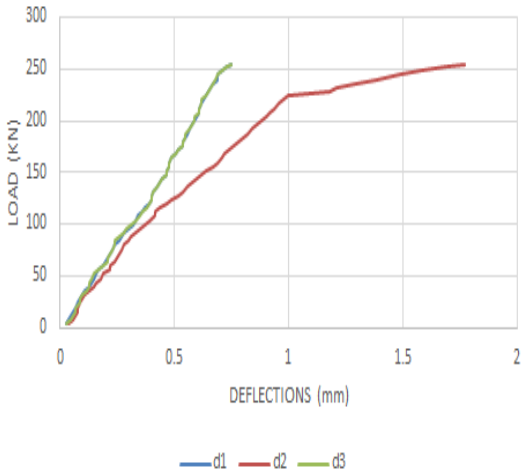

Fig. 4(c): Load VS Deflection graph on 1% flax seeds in M25 grade RCC beam

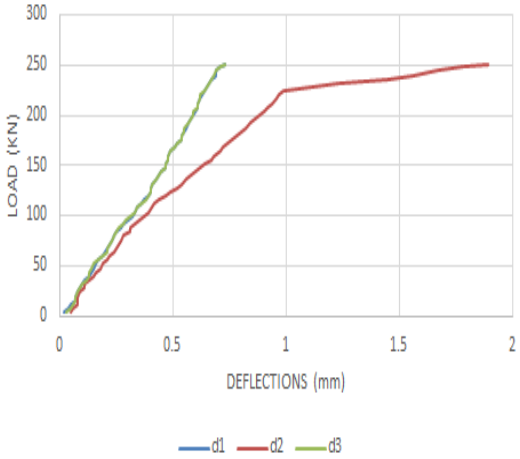

Fig. 4(d): Load VS Deflection graph on 1.5% flax seeds in M25 grade RCC beam

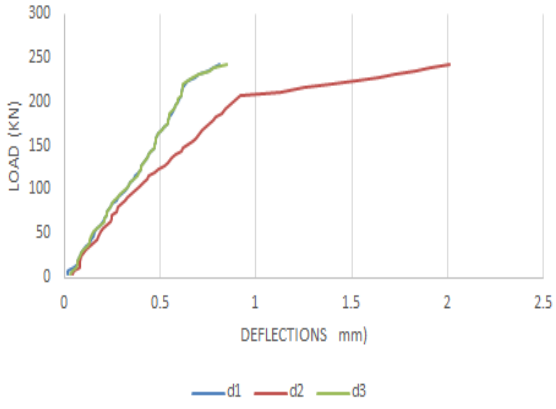

Fig. 4(e): Load VS Deflection graph on 2% flax seeds in M25 grade RCC beam

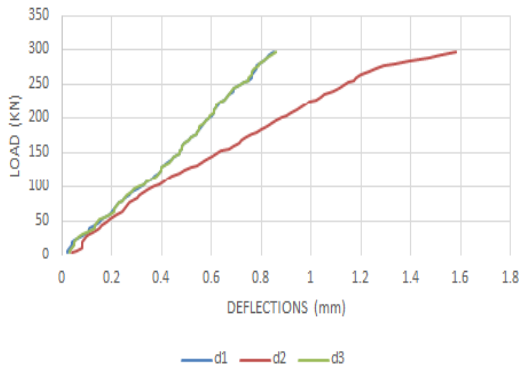

Fig. 4(f): Load VS Deflection graph on 0% flax seeds in M30grade RCC beam.

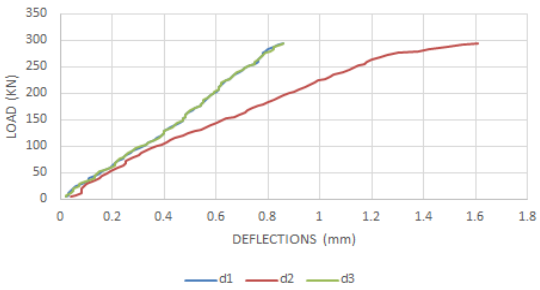

Fig. 4(g): Load VS Deflection graph on 0.5% flax seeds in M30 grade RCC beam

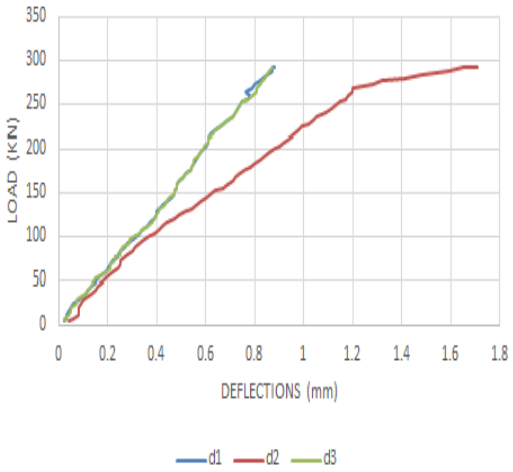

Fig. 4(h): Load VS Deflection graph on 1% flax seeds in M30 grade RCC beam

TABLE 1: Stiffness of RCC beams

FLAX SEED CONTENT	STIFFNESS OF RCC BEAMS kN/mm	
	M25	M30
0%	172.55	187.34
0.50%	158.78	185.09
1%	144.06	171.34
1.50%	132.27	151.83
2%	120.89	133.64

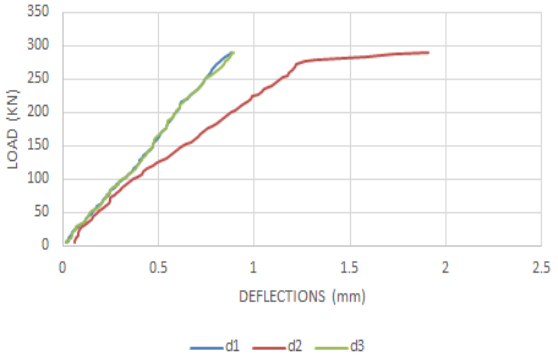

Fig. 4(i): Load VS Deflection graph on 1.5% flax seeds in M30 grade RCC beam

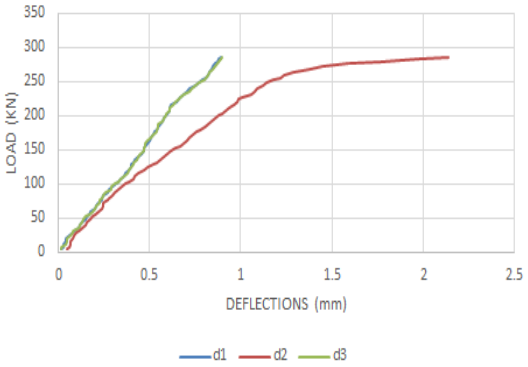

Fig.4(j): Load VS Deflection graph on 2% flax seeds in M30 grade RCC beam

C. STIFFNESS VALUE OF RCC BEAMS: The stiffness value has been calculated for M25 and M30 grade of conventional RCC beams and RCC beams by partial replacement of cement with flax seeds at the range of 0.5%, 1%, 1.5% and 2% and their results are shown in Table. 1.

D. FLEXURAL STRENGTH OF RCC BEAMS: The flexural strength has been calculated for M25 and M30 grade of conventional RCC beams and RCC beams by partial replacement of cement with flax seeds at the range of 0.5%, 1%, 1.5% and 2% and their results are shown in Table. 2.

TABLE 2: Flexural strength of RCC beams

FLAX SEED CONTENT	FLEXURAL STRENGTH OF RCC BEAMS kN/mm^2	
	M25	M30
0%	32.47	36.97
0.50%	32.74	37.23
1%	31.86	36.6
1.50%	31.23	36.22
2%	30.36	35.73

E. COMPARISSION ON LOAD AND DEFLECTION GRAPH IN M25 GRADE RCC BEAMS: The load and deflection graph is made and compared between the conventional RCC beam and the RCC beam with 0.5% of flax seed in M_{25} grade. The x-axis denotes deflections D and D (0.5). D is the deflections in conventional RCC

beam and D (0.5) is the deflections in RCC beams with 0.5% of flax seeds. The y-axis denotes the load. From the Fig.5 we observed that the RCC beam with 0.5% of flax seed has maximum load carrying capacity than the conventional RCC beam.

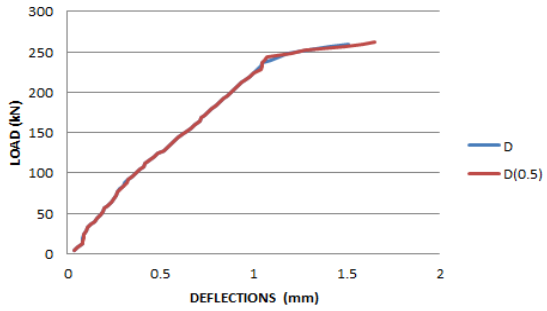

Fig.5.Comparison graph on conventional RCC beam and RCC beam with 0.5% of flax seed in M25 grade.

F. COMPARISSION ON LOAD AND DEFLECTION GRAPH IN M30 GRADE RCC BEAMS: The load and deflection graph is made and compared between the conventional RCC beam and the RCC beam with 0.5% of flax seed in M_{30} grade. The x-axis denotes deflections D and D(0.5). D is the deflections in conventional RCC beam and D(0.5) is the deflections in RCC beams with 0.5% of flax seeds. The y-axis denotes the load. From the Fig.6 we observed that the RCC beam with 0.5% of flax seed has maximum load carrying capacity than the conventional RCC beam.

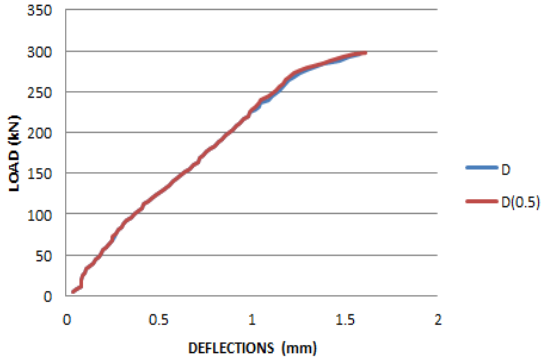

Fig.6.Comparison graph on conventional RCC beam and RCC beam with 0.5% of flax seeds in M30 grade.

VI.CONCLUSION

1. In order to study the resistance of an object against bending deformation, the stiffness has been determined.
2. From the TABLE 1, it is found that RCC beam with flax seeds of 0.5% has more stiffness value than the conventional RCC beam in M25 grade.
3. From the TABLE 1, it is found that RCC beam with flax seeds of 1%, 1.5% and 2% has less stiffness value than the conventional RCC beam in M25 grade.
4. So, the flax seeds of 0.5% in RCC beams are advisable to attain good stiffness value in M25 grade.
5. In order to study the bending strength of an object, the flexural strength has been determined.
6. From the TABLE 2, it is found that RCC beam with flax seeds of 0.5% has more flexural strength than the conventional RCC beam in M30 grade.
7. From the TABLE 2, it is found that RCC beam with flax seeds of 1%, 1.5% and 2% has less flexural strength than the conventional RCC beam in M30 grade.
8. So, the flax seeds of 0.5% in RCC beams are advisable to attain good flexural strength in M30 grade.
9. This partial replacement of flax seeds on cement of 0.5% is said to be effective as it has good stiffness value, flexural strength and eco-friendly, as the usage of cement has been reduced for 0.5%.
10. While constructing the green buildings, we can use flax seeds instead of cement at certain percentage which improves the strength and also it is eco-friendly.

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