Experimental Investigation On Behavior Of R.C.C Beams Retrofitted With Sisal Fibre Sheet And Cement Composite Mortar

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Abstract *- In this study flexural strength of beams retrofitted with sisal fibre sheet and cement composite mortar was studied. The cement composite mortar was made using conbond, cement, sand, water, glass fibres. For this study, fourty two beams of cross section 150x150mm and overall length of 700mm are casted. Six beams were served as control beams. Four wrapping pattern were adopted for the experiment work i.e U-wrap, Strip wrap, Bottom wrap and Double Bottom wrap. Thus it shows that sisal fibre due to its various environmental benefits being natural fibre could be used for flexural strengthening of beams effectively.*

Keywords - Sisal Fibre, Flexural Strength, R.C.C Beam, Strengthening, Conbond.

I. INTRODUCTION

Due to poor maintenance , corrosion or impact of natural forces i.e. earthquake , Repair and Rehabilitation of old and existing structures is of great interest for extending their service life suitably as well as for their restoration because of new standards and incorporating better factor of safety. Cracks in R.C.C Members generally occurs due to craking and spalling of concrete. It may occur in both plastic state as well as in hardened state. Inadeqaute performance of any type of structure is a major concern in today's time. Thus it has become evident to restore the original structural shape and strength of the members. Over the years many retrofitting techniques have been adopted for strengthing purpose such as concrete jacketing , steel jacketing , shotcrete etc. Out of which concrete jacketing and steel jacketing were the two common methods adopted for strengthing the deficient reinforced concrete beam which results in substantial increase in the cross-sectional area and the self weight of the structure. It is labour intensive and has poor resistance against weather attacks. A new technique has emerged which uses fibre sheets to strengthen the beams. From the durability point of view , fibre reinforced polymer has been adopted which is available in many forms such as sheets , bars and plates. But mostly fibre sheets are used because of high flexibility,ease to install , immunity to corrosion and high strength. Artificial fibres such as Carbon fibres and Glass fibres are most commonly used for the retrofitting of the structures but recent development has shown that use of natural fibres can also be effective for retrofitting purpose. Natural fibres have many advantages such as lower in density , higher toughness , acceptable specific strength properties , good thermal properties , low emboided energy , reduced tool wear , bio-degrable etc. Large numbers of various natural fibres such as sisal , jute , knaf , ramie , coir and various others yarns are among those reinforced composites which are of great interest. Also large environmental benefits are associated with fibres. These fibres requires only a low degree of industralization for their processing as well as low energy is required for their production. Cost of fabrication is also low for these fibres. Thus more emphasis should be given for the use of natural fibres in the field of structural retrofitting and strengthing purpose. An attempt has been made to use sisal fibre sheets and cement composite mortar for strengthening of beams for the research work.

II. MATERIALS

Cement

Ordinary Portland Cement of 53 Grade manufactured by siddhi cement company was used in concrete mixes. The specific gravity of cement is 3.15.

Aggregate

The coarse aggregates of two grades are used one retained on 10 mm size sieve and another grade contained aggregates retained on 20 mm size sieve. The maximum size of coarse aggregate was 20mm and is having specific gravity of 2.85 grading confirming to IS: 383-1970.

Water

Clean water free from impurities is used. It helps in providing strength to cement gel. Quality of water affects the strength of concrete.

Reinforcement

HYSD 500 steel bars of 10mm and 8mm are used for the design of beams. 10mm bars are used as longitudinal bars for both compression and tension zone of the beams while 8mm bars are used for strirrups.

Sisal Fibre

Sisal is a hard fibre extracted from the leaves of sisal plants which are perennial succulents that grow best in hot and dry areas. Sisal is an environmentally friendly fibre as it is biodegradable and almost no pesticides or fertilizers are used in its cultivation. World production is about 300,000 tonnes.

The properties of Sisal Fibre are given below:

- Density(g/cm3) : 1.33
- Tensile strength(Mpa) : 600-700
- Elongation at Failure(%) : 2-3
- Moisture Content(%) : 11

Epoxy

Epoxy resin is one of the types of adhesives which is used to stick fibre to concrete surface. It has components, component A as resin and component B as hardener which have to be mixed thoroughly in the ratio 2:1 by weight.

Conbond

Conbond is a single component polymer based compound used for repairing eroded concrete structures. Its application on old surfaces like R.C.C., brick, ceramic tiles etc. provides new concrete or rendering a dependable 100% monolithic bond. Because of its plasticity; it forms a resilient bond, which will not break under the strain caused by thermal movements. It eliminates shrinkage cracks that usually appear around the repair patches & is not affected by alkalinity of cement.

III. EXPERIMENTAL PROGRAM

To cast the beams of 150mmx150mm dimension aluminium moulds are prepared. With the grade of M-20 and M-25 and reinforcement of HYSD 500 steel bars, 42 beams of dimension 150mmx150mm and a span of 700mm are casted. All the beams are reinforced with 2 bars of 10mm in the tension zone(bottom) zone and 2 bars in the compression(top) zone. Shear reinforcement is provided at 150mm c/c. All the beams are cured for 28 days. Detail description of the beams is shown in table 1 & 2.

Table 1. Beam Description For M-20

Names	Beam description
C-20	Control beams
SF1-20	Beams retrofitted with U-wrapping
SF2-20	Beams retrofitted with 2 layers of Sisal Fibre Sheet
SF3-20	Beams retrofitted with 1 layer of Sisal Fibre Sheet
SF4-20	Beams retrofitted with 80mm width strip wrapping
CCM-20	Beams retrofitted with cement composite mortar

Table 2. Beam Description for M-25

Names	Beam description
C-25	Control beams
SF1-25	Beams retrofitted with U-wrapping
SF2-25	Beams retrofitted with 2 layers of Sisal Fibre Sheet
SF3-25	Beams retrofitted with 1 layer of Sisal Fibre Sheet
SF4-25	Beams retrofitted with 80mm width strip wrapping
CCM-25	Beams retrofitted with cement composite mortar

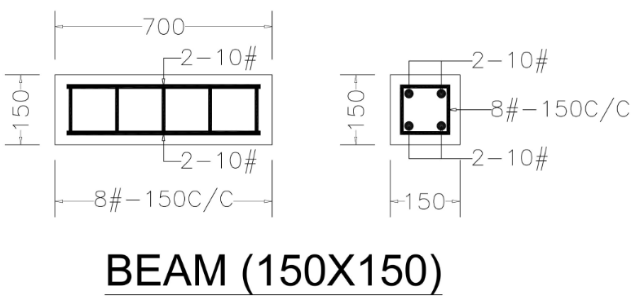

Fig 1. Reinforcement detailing

Fig 1. Shows the deatiling of beams for both M-20 and M-25 .Experimental investigations are carried out on beams to determine the flexural capacity under UTM. Controlled and Retrofitted beams are tested under UTM. Test setup is shown in the Fig 2. Strengthening of beams was done in the flexure zone after 28 days of curing. Average ultimate load(KN) for controlled beams for M-20 was found to be 63.45 KN, while average load for controlled beams for M-25 was found be 98.3 KN. The beams surface is made rough to remove any form of dirt. Epoxy resin in the ratio 2:1 is prepared and applied on the surface of the beams for providing bonding with the fibre. Cement composite mortar was prepared using conbond, water, cement, sand, and glass fibres.

Fig. 2 Test Setup

IV. RESULTS AND DISCUSSION

The average ultimate loads of beams of grade M-20 and M-25 are shown in the table below along with the percentage increase in the ultimate load carrying capacity of beams. Graphs are also plotted for M-20 and M-25.

Table 3. Beam Results For M-20

Beam description	Average ultimate load (KN)	Percentage increase in the ultimate load carrying capacity(%)
C-20	63.4	0
SF1-20	93	46.4
SF2-20	84.3	32.96
SF3-20	81.5	28.34
SF4-20	72	13.38
CCM-20	82	29.33

Table 4. Beam Results For M-25

Beam description	Average ultimate load (KN)	Percentage increase in the ultimate load carrying capacity(%)
C-25	98.3	0
SF1-25	144.79	47.29
SF2-25	131.3	33.6
SF3-25	127.198	29.5
SF4-25	112	14
CCM-25	127.66	30

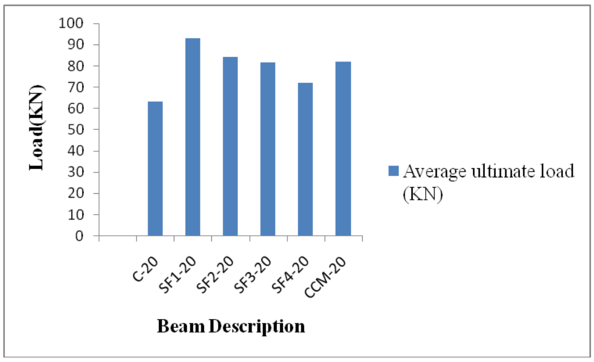

Fig 3. Average Ultimate Loads For M-20

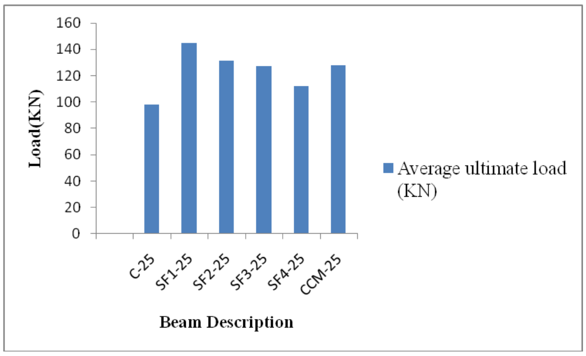

Fig 4. Average Ultimate Loads For M-25

V. CONCLUSION

- From the experiment it was found that U-wrap was the most effective pattern for both M-20 and M-25 .
- The beams retrofitted with U-wrap shows an increase in load carrying capacity by 46.4% and 47.29% for M-20 and M-25 respectively compared to control beams.
- The beams retrofitted with two layers of sisal fibre sheet , one layer of sisal fibre sheet, 80mm width strip wrapping shows an increase in load carrying capacity by 32.96%, 28.34%, 13.38% and 33.6%, 29.5%, 14% for M-20 and M-25 respectively as compared to control beams.
- With use of cement composite mortar beams shows an increase in load carrying capacity by 29.33% and 30% for M-20 and M-25 rescpectively as compared to control beams.
- Cement composite mortar does not emits toxic fumes like epoxy.
- Sisal fibre sheet can be regarded as a suitable strengthening material for R.C.C. members considering environmental aspects.

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