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EXPERIMENTAL INVESTIGATION ON IMPROVING THE STRENGTH OF REINFORCED CONCRETE BEAM USING FLAX FIBRE, POND ASH AND EPOXY RESIN UNDER FLEXURAL BEHAVIOUR

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ABSTRACT

Strengthening of existing building is to improve performances under existing loads or to increase the strength of structural components to carry additional loads. This project attempts to utilise the natural fibre that are easily available and cost effective than the artificial fibre. Flax fibres, which are natural fibre having good impact resistance property and environment friendly in nature. Before using the flax fibre, primary treatments have to provide on those fibres to improve their workability. Although in concrete, cement plays a major role in binding property. Due to depletion of cement production, the pond ash is utilised as a partial replacement for fine aggregate. This investigation is to study the Compressive strength, Split tensile strength and Flexural strength for 0%, 5%, 10%, 15% and 20% replacement of pond ash.

This project also experiments the toughness and bending behaviour of strengthened RC beam by using Flax fibre laminated plate.

Keywords : Flax fibres, RC beam, Ductility, Stiffness and Energy absorption.

1. INTRODUCTION

Over the last decade, fibre reinforced polymer composites have received ever increasing attention, both from the academic world and from various industries. In recent years, the use of composite plates also becomes a subject of great interest in the structural community especially for strengthening of deficient structures. Strengthening of existing structure may become necessary because of a required increase in loading capacity, a change in usage of concrete. Poor design or construction, due to aggressive and accident events such as earthquake and wind, or because of detoriation. Externally bonded plates using epoxy adhesive was found to be the most popular techniques for strengthening of RC beam. In the recent years, development of strong epoxy glue has led a technique, which has a great potential in the field of upgrading structures.

2. OBJECTIVES

- To investigate about the chemical and Physical properties of pond ash and comparing it with the fly ash properties.
- To estimate the strength properties of concrete in which the fine aggregate is replaced with pond ash.
- To study about the properties of flax fibres to utilise it as a composite laminate for RC beam.
- To determine the toughness, crack width, ductility in concrete which is strengthened by flax fibre composite laminates.
- To evaluate the flexural strength, ductility factor from the load deflection curve and also ductilitynumber

1.3. SCOPE OF THE PROJECT

- Utilisation of pond ash as a replacement material for fine aggregate will considerably reduce the land pollution.
- Reusing the pond ash can reduce the amount of waste material sent to the land fill.
- Natural fibres have low production cost, low weight, strength, good mechanical properties and resistance tofatigue.
- Instead of using synthetic fibres, natural fibres are easily available.
- Natural fibres are also eco- friendly in nature.

2.2. LITERATURE REVIEW

Hallonet et al (2019) presented the characterization of the mechanical and durability performance of wet lay-up flax/ epoxy composites used for the external strengthening of concrete structures. The glass and flax composites present comparable tensile stress at failure. As expected, the residual properties of the composites are lower after hydrothermal ageing than after climatic ageing. In contrast, the constraint decreases by 15% for flax composites and by 40% for glass composites. The modulus values decrease by 50% for flax composites and by 20% for glass composites.

Mohammad A. Alhassan et al (2019) explained the influence of discontinuous structural synthetic fibres (DSSF) on the bond-slip behaviour between concrete and carbon fibre reinforced polymer (CFRP) composites was investigated using a double-shear pull- off test. The CFRP composites were bonded to the blocks (with and without a CFRP anchoring strip) in three lengths (Lf): 50, 75, and 100 mm. Addition of DSSF at 0.33% and 0.55% by

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volume resulted in increase in the bond strength of about 6% and 10%, respectively with respect to plain concrete. The toughness approximately increases by 50% and 100% when the CFRP sheet is increased by 50% or 100% through increasing Lf or bf.

Abdul Moudood et al (2019) evaluated the durability and mechanical performance (tensile and flexural behaviour) of flax/bio-epoxy composites exposed to different environmental. The tensile strength and modulus is decreased approximately by 9% and 57%, respectively for water saturated (immersed in water until saturation) samples compared to as manufactured samples. On contrary, this reduction rate is only 0.8% and 3%, respectively in case of humidity saturated (exposed to humid environment until saturation) samples.

3. SELECTION OF MATERIALS

Materials used for casting specimen will undergo some initial tests such as initial and final setting time of cement used, specific gravity, Fineness modulus and bulk density of aggregates etc.,

4. TESTING OFSPECIMENS

For structural investigations cube (150 x 150 x 150 mm), Cylinder (150 x 300mm) and prism (100 x 150 x 500 mm) were casted with pond ash content of 0%, 5%, 10%, 15% and 20% replacement with fine aggregate and full scale RC beams with the dimension of 1100 mm x 150 mm x 100 mm for strengthening tests also be casted. The following Mechanical properties of concrete specimen are evaluated.

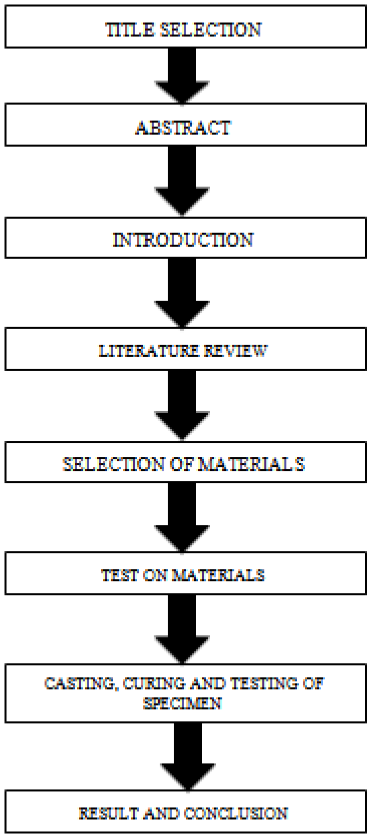

Fig 1: Flow chart

4.1.COMPRESSION STRENGTH TEST

Compression is a major characteristic property of concrete. To test the compressive strength, cube specimens of dimensions 150 x 150 x 150 mm were casted for M25 grade of concrete. After curing of specimen for 28 days, the testing was done with the help of Compressive Testing Machine as shown in figure 2.

Fig 2:Compressive strength test and crack pattern

The load was applied on the specimen till the specimen failed. The failure load was noted. For each test 3 specimens were prepared and tested and their average value is taken as compression strength of the specimens.

4.2. SPLIT TENSILE STRENGTH TEST

After curing the cylinder were tested with the help of compressive testing machine. The failure load was noted. The testing image and the crack pattern for split tensile strength of concrete is given in figure 3.

Fig 3: Split tensile strength test and crack pattern

In each category three cylinders were tested and their average value is found with all the values taken.

4.3.3.FLEXURAL STRENGTH TEST

All prisms were tested using Universal Testing Machine (INSTRON) under two- point loading conditions. As two points load have been considered for testing beams, a distributer was used to split the load. The shear spans of tested beams were 350 mm. Dial gauges were fixed at the mid span of the beam to measure the deflection of beam under monotonic loading. The detailed tests set up of specimens as shown in figure 4.

Fig 4: Flexural strength prism and crack pattern

In that loading frame the load is applied by means of screw jack and proving ring is used to assess the load level. The load at which cracks have been formed is noted down as first cracking load. As the load level is increased further cracks have been propagated and widening of cracking has taken place. The corresponding deflection shows that there is a sudden increase in deflection reading while the loading reaches nearer to the yield loading. The monotonic loading is applied up to ultimate load level and the failure pattern is to be observed.

5. RESULT AND DISCUSSION

5.1. COMPRESSIVE STRENGTH

- The compressive test procedure was carried out according to test method IS 516 – 1959 code of practice. At the age of 28 days, Compressive strength of a concrete is a measure of its ability to resist static load, when the later one tends to crushit.
- TheCompressivestrengthincreasesfor10 %replacementofpondashas16.2%.
- The strength decreases further increasing the amount of pond ash.

The test results graphical representation is given in by table 1.

Table 1: Compressive strength at 28 days

S.No	Mix ID	% of Pond Ash	Compressive strength (MPa)	
			7 Days	28 Days
1	CC	0	19.53	29.08
2	PAC5	5	20.8	32.14
3	PAC10	10	22.34	33.78
4	PAC15	15	20.14	31.4
5	PAC20	20	17.15	27.81

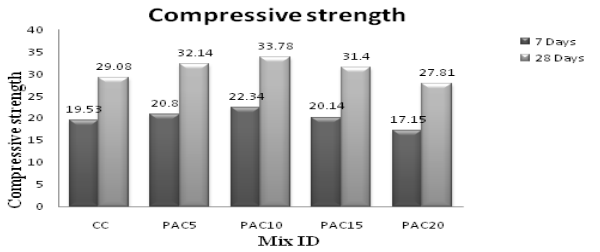

Fig 5: Compressive strength result

5. 2. SPLIT TENSILE STRENGTH

Split tensile test was carried out as per ASTM C496-90. The tensile strength of concrete is one of the basic and important properties which greatly affect the extent and size of cracking in structures. Therefore, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack. For PAC10, 12.5% increase in split tensile strength is observed when compared to conventional specimens. On further increasing the volume fraction of Pond ash, the strength decreases. Hence 10% replacement of pond ash is found to be optimum in case of compressive strength. The Split-tensile strength test results were shown in the Table 2 and graphical representation is given in by Figure 6.

Table 2: Split-tensile Strength at 28 days

S. No	Mix ID	% of Pond Ash	Split tensile strength (MPa)	
			7 Days	28 Days
1	CC	0	2.35	3.53
2	PAC5	5	2.44	3.78
3	PAC10	10	2.63	3.97
4	PAC15	15	2.36	3.69
5	PAC20	20	2.01	3.27

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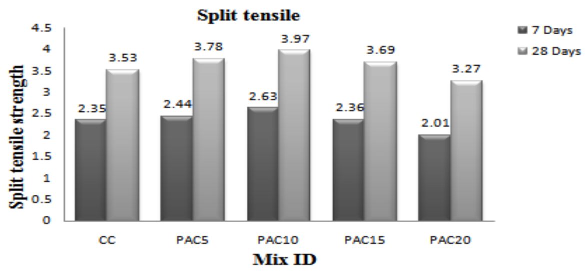

Fig 6: Split tensile strength result

5.3. FLEXURAL STRENGTH

All beams of specimen of 1100x150x100mm size were casted and tested after 28 days curing using Universal Testing Machine under two-point loading conditions as per the IS 516 – 1959. As two points load have been considered for testing beams, a distributer was used to split the load. 5.9% increase in modulus of rupture is observed for PAC10 when compared to CC. The Flexural strength test results were shown in the Table 3 and graphical representation is given in by Figure 7.

Table 3 : Flexural strength at 28 days

S. No	Mix ID	% of Pond Ash	Flexural strength (MPa)	
			7 Days	28 Days
1	CC	0	3.05	3.73
2	PAC5	5	3.12	3.86
3	PAC10	10	3.21	3.95
4	PAC15	15	3.05	3.81
5	PAC20	20	3.31	3.59

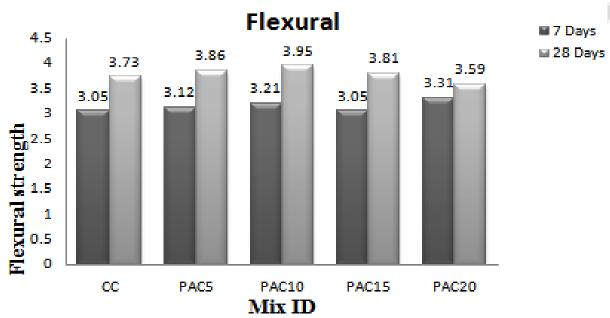

Fig 7: Flexural strength result

5.3. OPTIMIZATION

The results from compressive, Split-tensile and flexural strength test for PAC mixes with varying percentage of pond ash instead of fine aggregate shows that 10% replacement of pond ash gives effective mechanical properties. From this optimization, the pond ash is added 10% by weight of fine aggregate while casting RC beams.

6. CONCLUSION

Based on the conducted experiment and according to the results obtained, it can be concluded that, this study intended to find the effective way to use pond ash along with M-Sand. Analysis of the strength characteristics of concrete containing Pond ash gives following results.

The study includes the various mixing proportion of pond ash in concrete. For improving the workability of concrete the addition of super plasticizer be added. According to the various testing results it is observed that the specimen was tends to various stress and the final results were shown for every individual concrete specimen.

The overall testing results be seen with increase of 5% of pond mixing in every proportion of concrete. The conventional concrete specimen shows the allowable limit of results in specimen. The addition of 5% and 10% of fibre in concrete mixing proportion shows the linearly same results. But the addition of 15% and 25% of fibre in the mixing proportion has some decrease of flexural strength of beam and split tensile strength of cylinder in the concrete. From these results, the Concrete containing 10% replacement of pond ash is found to be optimum.

TheCompressivestrengthincreasesfor10 %replacementofpondashas16.2%.Further increasing the amount of pond ash decreases the strength behaviour of concrete. For PAC10, 12.5% increase in split tensile strength is observed when compared to conventional specimens. 5.89% increase in modulus of rupture is observed for PAC10 when compared to CC. Thus, an optimum percentage of pond ash is partially replaced for fine aggregate to overcome the environmental issues. The strengthening of PAC10 beam which is FFSB develops more deflection to beam against breaking. It gives 43.6 % increase in deflection than the conventional one and 4.5% greater than the PAC10mix. The first crack load for beam of FFSB was 66.6%greater than conventional and 26.6% greater than PAC10 mix. The ultimate value observed from the beam of FFSB was 89% greater than conventional beam and also 28% greater when compared to PAC10 mix.

The stiffness for FFSB was found to be 34.8% greater than conventional beam and 19.8% greater thanPAC10.

The energy absorption capacity observed maximum point for FFSB due to higher deflection with minimum load obtained.

Hence from the results, the flax fibre can give additional support to the beam to resist the load against deflection and also show some promising behaviour in energy carrying capacity.

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