

Strength and Durability Properties of Synthetic Macro Fiber with Recycled Aggregate

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Abstract: This paper deals with the study the properties of fresh and hardened concrete. Due to the low tensile strength concrete may undergo brittle failure. These failure modes can be minimized by adding fiber in concrete and more recently synthetic macro fiber are used. This material can increased the strength, ductility and durability have led to interest in performance of fiber reinforced concrete .The fibers reduce the crack, contribute to tensile strength and improve the other mechanical properties. The natural coarse aggregate was replaced by recycled aggregate and it was treated with HCL acid and the fiber were used in the recycled aggregate concrete 0.5%,1%,1.5%,2% by volume fraction .The result shows that the fiber increase the strength with recycled coarse aggregate.

Keywords: HCL acid.

I. INTRODUCTION

1.1 General

Concrete is nature a brittle material that performs well in Compression but is considerably less effective when in tension. Reinforced concrete is used to absorb this tensile force so that all high Strength does not weaken the structure. Latest development concrete Technology now include in the form of fibers [1]. Like metallic and Synthetic fibers in metallic fiber ,steel fibers of hook end and crimped Round .In synthetic fiber polyester, polypropylene like this fibers are Used in reinforced concrete is predominately used for crack control in The structure .Synthetic chips can be converted into fiber/filament by Tradition melt spinning through the operation parameters need to be Adjusted on the final product span bonded and melt blown process are Also very important fiber producing techniques for non woven [2]. The cracks present in the reinforced concrete are main reason to adding the fiber in concrete to avoid the cracks. Natural coarse aggregates were replaced by recycled aggregate and they are treated with HCL.

1.2 Research Significance

The materials will be Eco friendly, it not harmful to human. Now way days demolished of buildings are increased and it cause global warming to avoid this recycled aggregate are used in concrete technology and addition of fiber. The present study focuses on the compressive strength split tensile

strength and durability test various volume of fiber mix with concrete.

II. METHODOLOGY

2.1 METHODOLOGY

Mix proportion arrived for M40 concrete was 1:1.77:2.66 with W/C ratio 0.40. Total of 24 cube specimens (100 mm x 100 mm x 100 mm) were cast for checking the compressive strength at 7 and 28 days of moist curing. Prior to curing the cubes were tested till failure Compression Testing Machine (CTM) of 3000 kN capacity.



Fig 1 Compressive strength

III. MATERIALS USED

3. Materials and Methods

Ordinary Portland cement of grade 53, Potable water, M-sand, recycled coarse aggregates and fiber with different volume fraction

Ordinary Portland cement (Dalmia) of grade 53 procured from local suppliers was used for the investigation. The cement being a binder material helps to bind the fine and recycled coarse aggregate. Cement had a specific gravity of 3.1 with consistency 31% and setting time as 32 minutes [6].

3.2 Fine aggregate

M-sand has been used as fine aggregate. The fineness modulus and specific gravity are 4 and 2.65 respectively confirming to zone-II as per IS: 383-1970. [7]

3.3 Recycled Coarse aggregate

Recycled coarse aggregate of size 20mm was obtained from demolished building wastes .The waste material was crushed in crusher and made as 20 mm aggregate. The specific gravity of recycled aggregate was 2.53

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3.4 SYNTHETIC MACRO FIBRE

In Synthetic macro fiber one of the type of polyester fiber is used

Table 1 Properties of synthetic Macro fiber

| PROPERTIES | POLYESTER | UNITS |
|--------------------|-----------|---------|
| Length | 24 | mm |
| Effective diameter | 20-40 | Microns |
| Specific gravity | 1.34-1.39 | |
| Melting point | 250-265 | Deg. C |
| Tensile strength | 480-730 | MPa |
| Elongation | 60-90 | % |
| Young's modulus | >5000 | GPa |

3.5 Super plasticizer

Conplast SP430 is utilized where a high level of workability and its maintenance are required. It encourage generation of excellent cement

IV. EXPERIMENT AND TEST RESULTS

4. Results and Discussion

Conventional recycled coarse aggregate with a fiber of different volume fraction were used in concrete structures. The compressive, split tensile strength and durability of concrete were tested and the values are compared.

4.1 Hardened concrete properties

The strength properties like compressive strength for each mix was carried out for conventional mix , mix1-0.5%, mix 2-1%, mix 3-1.5% and mix 4-2% from the above result optimum percentages has been taken.

4.2.1 Compressive strengths

Average compressive test results of the specimens are as shown in fig.1 Even though the replacement resulted in decrease in target strength, the values are nearing 40 MPa. More than 2% of fibre decrease the value

Table 2 Compressive strength

| Design | 7 days | 28 days |
|------------------|--------|---------|
| Conventional mix | 20.1 | 47.6 |
| Mix 1-0.5% | 21.9 | 49.3 |
| Mix 2-1% | 22.6 | 50.9 |
| Mix 3-1.5% | 24.5 | 53.6 |
| Mix 4-2% | 22.2 | 48.9 |

From the above chart it is clearly shown that percentage of each and every materials increase in strength of fibre with different volume fraction mix 3- 1.5% from this we are getting the optimum value mix concrete.

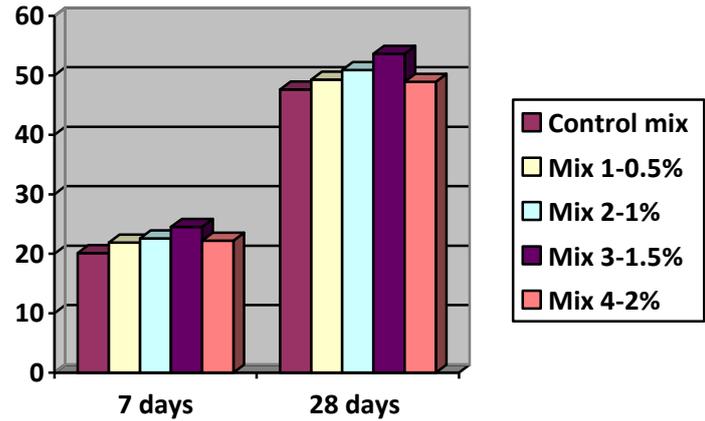


Fig. 2 Compressive strength

4.2.2 Split tensile strength.

The split tensile strength test result is present in graph. Cylinders of dimension 100mm x 200mm are casted. The cylinder is arranged in such a way that the load is applied on the longer length direction when it is loaded we observe that concrete.



Fig 3 split tensile strength

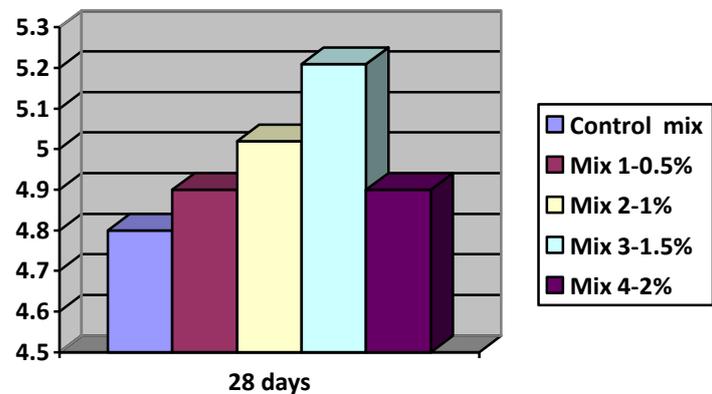


Fig 4 Split tensile strength at 28 days

4.3 Durability Test

4.3.1 SEM Analysis

Scanning electron microscopy (SEM) was used as a surface analysis tool to investigate the synthetic macro fibre in the mortar and the mix state. The bond between the fibre and their corresponding mortar mix has been improvised and they are mentioned in SEM. The specimen size of SEM is 1 cm x 1 x cm.

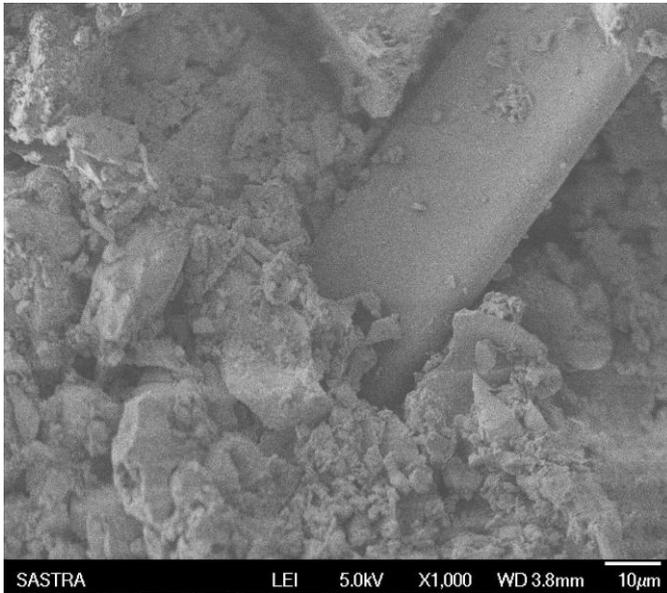


Fig 5. SEM Analysis at 0% of NS

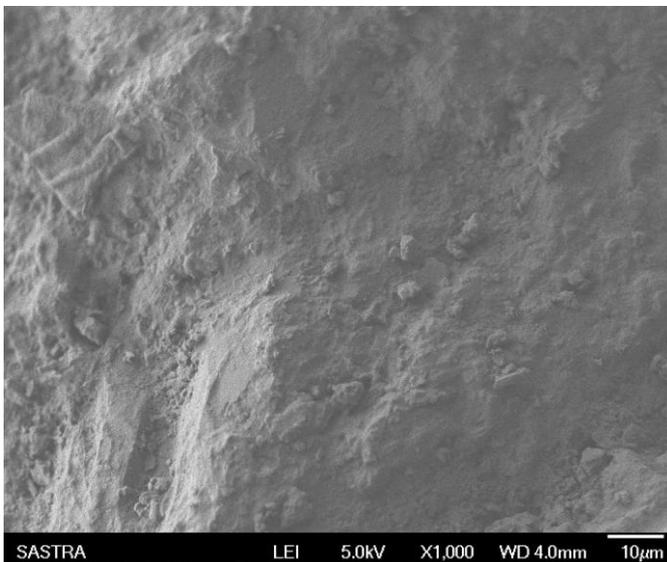


Fig 6. SEM Analysis at 1.5 of NS

4.3.2. Acid Attack Test

Portland Cement OPC with pH values above 12.5 was highly alkaline and they are used for casting concrete. These highly alkaline concrete were not easily attacked by acidic solution. The components of the cement paste break down during contact with acids.

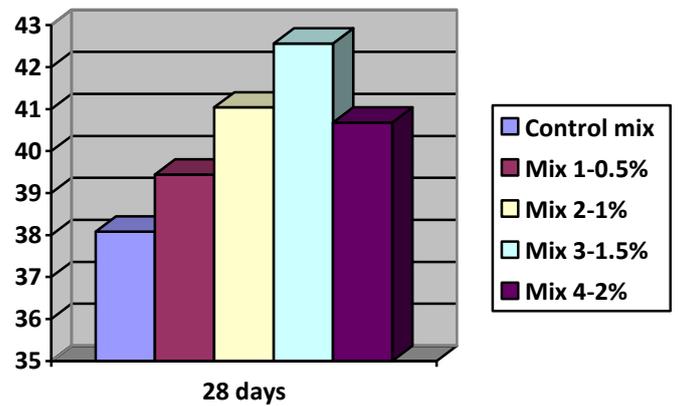


Fig 7 Acid Attack at 28 days

4.3.3 Sorptivity

The cylinder specimen size of 100mm x 50mm height was cast and cured.



Fig 8. Sorptivity specimen

Cured specimen were kept in a water tub with water level not more than 5 mm above the base of specimen and the flow from the peripheral surface was prevented by sealing it properly with non absorbent coating [10]. The quantity of water absorbed in time period 30 min was measured by weighting the specimen on a top pan balance weighting up to 0.1 mg. Surface water on the specimen was wiped off with a dampened tissue and each weighting operation was completed within 30 sec.

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Table. 3 Sorptivity Test result for Sorptivity

| Disc specimen | Control mix | Mix 1 | Mix 2 | Mix 3 | Mix 4 |
|---------------|-------------|-------|-------|-------|-------|
| Dry weight | 910 | 921 | 932 | 943 | 945 |
| Sealed weight | 912 | 923 | 934 | 945 | 947 |
| 5 min | 919 | 927 | 935 | 947 | 947 |
| 10 min | 922 | 929 | 935 | 948 | 947 |
| 20 min | 923 | 930 | 936 | 949 | 947 |
| 30 min | 924 | 932 | 938 | 951 | 949 |
| 1 hr | 928 | 935 | 939 | 953 | 951 |
| 5 hr | 930 | 938 | 940 | 954 | 952 |
| 24 hr | 935 | 941 | 943 | 957 | 955 |

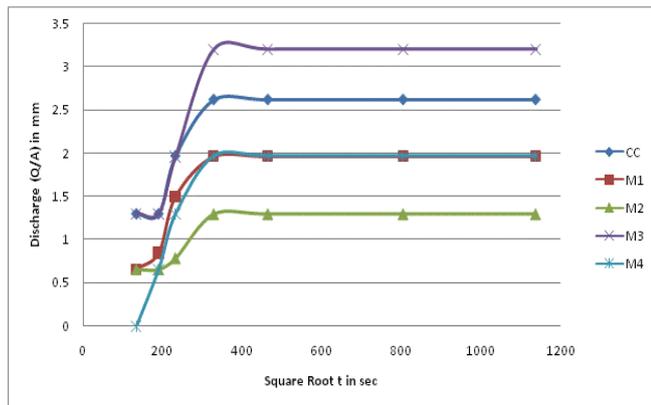


Fig. 9 Sorptivity result

Hence an increase in water penetration of SMFRC can be seen with the increase fiber content. The stop watch was started as soon as the sample touched the water and the reading was noted down by removing the sample from the container after the interval of 1,5,10,20,30,60 min and each hour up to 6 hr from the start to the testing time.

V. CONCLUSION

From the above research the following conclusion were arrived

- The results obtained from the compressive and split tensile strength with recycled coarse aggregate and addition of synthetic macro fiber Mix 3-1.5% get the optimum value from comparing the result. More the 2% of fiber cannot be added if it exist the result will decreases .
- Cracks are formed in reinforced concrete without addition of synthetic macro fiber .Presence of fiber can control the cracked areas and width openings because concrete is bonded with fiber to avoid the cracks
- Result confirmed that the incorporation synthetic macro fiber with recycled coarse aggregate fraction produce 56-days compressive cube strength which exceeds the characteristics and target mean compressive cube strength of the

control mix which are 40 MPa and 53.1 MPa for M40 grade respectively

- The employed fibers insignificantly affected the peak load and its net deflection of specimens under flexural test. The post cracking behavior and toughness of specimens were significantly governed by incorporation of PO fibers, have a negligible effect on these characteristics.
- The paper concludes that fibrillated synthetic macro fiber have little effect on workability of concrete. Since this fibers are non-absorbent, concrete is workable at addition higher percentage of fibers. Therefore we can achieve desired value with this type of fibers.

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