An Experimental Investigation on Properties of Glass Fibre Reinforced Mortar

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Abstract- **Concrete mortar posses very low tensile strength, limited ductility and little resistance to cracking. Addition of small closely spaced, uniformly distributed fibres act as crack arrester, Substantially increase static & dynamic properties With increasing water content bleeding , plastic shrinkage, reduction in strength will occur. With decreasing water content hydration process is incomplete, increase in gel/space ratio will happens. By adding plasticisers and other chemicals for workability & to achieve strength will act temporarily. To come across these two problems by the addition of small amount of fibres effectively control early age plastic shrinkage & cracking.**

In the present work two types of fibres Poly propylene fibre STEALTHe3, Alkali resistant fibre CEM- FIL was used. PPfibre act mechanically in the cement mortar & act as crack arrester with increased Flexural, Compressive, Split tensile strength properties. AR fibre act chemically with the cement mortar by the formation of Zr O2 & Si O2 .These two oxidants act with the C-S-H gel & CaOH2 which are by products of hydration , by increasing alkali content in the cement mortar, and durability properties and are shown in my work. Both fibres have increased mechanical & durability properties when compared to control mix. In water absorption test both fibres have no effect because fibre will evaporate at the temp. of 1100C. When compared to HCl ,H2SO4 shows more loss of weight because of the action of sulphates on the cement mortar and as time is going on byproduct CaOH2 leached away from the mortar. Finally as result we conclude that addition of small amount of fibres will increase 5 to 15 % in strength and durability properties of cement mortar.

Index Terms-**Plasticizers, Poly propylene fibre STEALTHe3, resistant fibre CEM- FIL, Zr O2 & Si O2, C-S-H gel & CaOH2**

I. INTRODUCTION

plain concrete posses a very low tensile strength, limited ductility , and little resistance to cracking By the addition of small , closely spaced and uniformly dispersed fibres to concrete would act as crack arrester and substantially increase static and dynamic properties. Each type of fibre has its own characteristic properties and limitations.

So far, a very limited quantity of research work has been done on the application of fibres in structural concrete. Hence, the present research would lead to a stronger and durable Fibre Reinforced mortar, which can be recommended for applications like construction of special building and shelters, slab panels, wall planes etc.

Conventional concrete mixes are usually prone to plastic shrinkage during the curing phase and often lead to crazing and cracking. The addition of relatively small amounts of fibres can effectively eliminate this problem by controlling this early – age plastic shrinkage cracking. Not only the fibre concrete is easy and cost effective to use, but also enables to produce a hardened concrete, which has improved surface quality and greater impact resistance.

In the present experimental investigation, attempts are made to study on the various strength properties like compressive strength, split tensile strength, flexural strength and also durability properties like water absorption, Acid and Sulphate attack on both ordinary cement mortar and by adding poly propylene Fibre and alkali resistant Glass fibre, at stipulated ages With different percentages of fibres separately. Studies were made on residual compressive strength, weight loss and Acid attack at specified ages.

II. POLY PROPYLENE FIBRE STEALTHe3



1.Application Rate: The application rate for Stealth® e3 fibers is 1 lb. per cubic yard.

2. Mix Designs: Stealth e3 micro reinforcing is a mechanical, not chemical, process. The addition of Stealth e3 fibers does not require any additional water nor other mix design changes at normal application rates.

3. Mixing procedures: Stealth e3 fibers are added to the mixer before, during or after batching the other concrete materials. Mixing time and speed are specified in ASTM C-94.

4. Finishability: Stealth e3 micro-reinforced concrete can be finished by any finishing technique. Exposed aggregate , broomed and tined surfaces are no problem.

5.Compatibility: Making Good Concrete Better Stealth e3 fibers are compatible with all concrete admixtures and performance enhancing chemicals , but requires no admixtures to work.

6.Guidelines: Stealth e3 fibers should not be used to replace structural, load bearing reinforcement. Stealth e3 fibers should not be used as a means of using thinner concrete sections than original design. Stealth e3 fibers should not be used to increase joint spacing past those dimensions suggested by PCA and ACI industry standard guidelines.

7.Packaging: Stealth e3 fibers are available in a variety of packaging options. Special packaging is available for full truckload addition. Stealth e3 fibers are packaged, packed in to cartons, shrink up, wrapped and palletized for protection during shipping.

8.Mini-Specification: Use only 100 percent virgin graded multifilament polypropylene fibers containing no reprocessed olefin materials and specifically engineered and manufactured in an ISO 9002 certified facility for use as concrete secondary reinforcement (Stealth® e3™). Application per cubic yard shall equal a minimum of 1 pound per cubic yard. Fibers are for the control of cracking due to drying shrinkage and thermal expansion/ contraction , lowered water migration , increased impact, abrasion and shatter resistance. Fiber manufacturer must document evidence of 5 year satisfactory performance history, compliance with applicable building codes

III . AR GLASS FIBRE CEM – FIL

CEM-FIL Alkali Resistant Glass fibres were first developed by the Building Research Establishment in the UK more since 1970, and were later manufactured under license in Japan and the USA.They have the longest service history, and have been used in more than 80 countries worldwide to create some of the world's most stunning architecture.

CEM-FIL□GRC products can be produced by one of many manufacturing processes. The most common are the spray and vibration-cast premix, but products may also be spun, filament wound, laminated on a moving conveyor, pressed, vacuum formed ,extruded, etc.

As the manufacturing processes have evolved, so have the fibres. A large range of fibres has been developed to satisfy the needs of the markets, and to provide optimum processing efficiency and performance in the chosen manufacturing methods. In addition to the manufacturing processes, guidelines and techniques for moulding, achieving different surface finishes, and enhanced mechanical properties have also been developed

IMPORTANT CHARACTERISTICS

- 37 years in-service use worldwide
- Proven durability and performance
- Comprehensive product range
- Excellent processing characteristics
- High tensile strength and elastic modulus

- Manufactured under ISO9001 approved Quality Management System

IV. PROCESS OF GFC

1. Spray process:

Sprayed-up GFC is produced by using spray gun which sprays mortar fed from a “mortar” pump and “glass fibres” cut in the spray gun from roving. Compacting of sprayed GFC is done by roller. Sprayed GFC required spray gun, mixer, mortar pumps and air compressor. A briefing of the process is given below.

2. Premix process:

Premix GFC is produced by using just a mixer where mortar (cement, sand and water) and chopped strands are mixed. Mixed GFC mortar is cast into a mould, vibrated and eventually pressed.

What are AR-Glass fibres? AR-Glass fibres are high-quality alkali-resistant glass fibres which are designed to reinforce cementitious and other alkaline matrixes. NRG ARG fibre has non-combustibility characteristics, corrosion resistance, and also has high tensile strength like a piano wire.

V. PREPARATION OF SPECIMEN AND MIX PROPORTION

1. FIBRES USED:

POLY PROPYLENE FIBRE STEALTH e3:

Specific gravity	Aspect ratio	Diameter-micron	Length-mm
0.91	1200	10	12

GLASS FIBRE CEM – FIL:

Specific gravity	Aspect ratio	Diameter-micron	Length-mm
2.68	857.1	14	12

28 – Day values for AR-GFRC

Modulus of Rupture	2.7 to 17.25 Mpa
Ultimate Tensile strength	7.0 to 11.0 Mpa
Shear Strength	2.76 to 5.5 Mpa
Impact Strength	0.4 to 1.0 Mpa
Dry Density	19.2 to 22.4 KN/m3

2. PREPARATION OF SPECIMENS: In this investigation, IS 4031-1968(33) prescribed simple prism mould of size 40x40x160mm. By using these prisms as specimens consumption of materials for preparation of specimens is much less. To do different mechanical properties studies in Compressive testing machine dyes made with steel plates of thickness 10 mm and springs to maintain gap for placing the specimens as shown in fig(1).

To test mechanical and durability properties of cement mortar with different percentages of poly propylene fibre ,Alkali resistant glass fibre were investigated. Instead of casting separate specimens for carrying out tests for flexural strength , compressive strength ,and split tensile strength only one set of specimens, prism specimen of size 40 x40 x 160 mm were cast as shown in fig. (2) and used to carry out all the three different strength tests.

VI. TEST METHODS

1 FLEXURAL STRENGTH TEST: Two point load was applied to find out the modulus of rupture of mortar specimens as per IS: 4031-1968(33) Fig.(3) shows the line diagram of flexural strength test set up and Fig.(4, 5) shows the test set up before and after the testing the sample. . Modulus of rupture was calculated using formula

Flexural Strength ($\sigma_{t)}$ = p L / b d^2 (N/mm2)

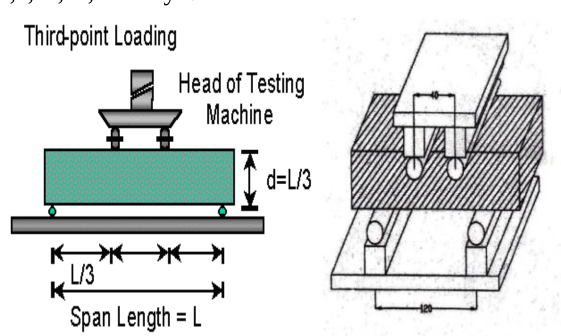
Where P = Applied load in (Newton)

L = Span of the beam in (mm)

b = Breadth of the beam in (mm)

d = Depth of the beam in (mm)

Nine identical specimens were used for flexural test for all the known mixtures at all ages of 3,7,14,28,56 days.



2. COMPRESSIVE STRENGTH TEST : As stated earlier that compressive strength of mortar specimens was found out by using the broken specimens obtained from flexural strength test as per IS 4031 – 1968 (33) . Two steel plates of 40 mm width and 10 mm thickness were kept at

bottom and top of the broken specimen in the same line and load applied.

Compressive strength was calculated using formula P/A. Nine identical specimens are used for all tests. Tests were conducted for all the known mixtures at the ages of 3,7,14,28, and 56 days. Fig. (6) shows the line diagram of compressive strength test set up and Fig. (7,8) shows the test set up before and after testing the specimen.

Compressive strength = P/A (N/mm^2)

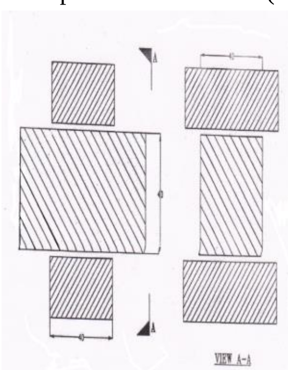
P = Applied load in Newton (N)

A = Surface area in (mm2) = (bxL)

b = Breadth of the specimen in (mm)

d = Depth of the specimen in (mm)

L = Span of the beam in (mm)



VII. TEST RESULTS

1 FLEXURAL STRENGTH: Fig. 6.1 shows development of Flexural strength of control mix and mortar mixtures with 0.5, 1 % PP Fibre by weight of cement and sand. At all ages of testing, mortar mixtures with PP Fibre shows increase in flexural strength when compared to control mixture.

Flexural Strength (σ_t) = $p L / b d^2$ (N/mm^2)

Flexural strength of cement mortar with poly propylene e3 fibre Two point loading , in MPa

MIX	At 3 days	At 7 days	At14 days	At 28 days	At 56 days
0%	1.5	2.15	2.312	2.46	2.52
0.5%	1.6	2.34	2.62	2.8	2.924
1 %	1.65	2.45	2.79	2.94	3.02

Percentage increase in Flexural strength of PP Fibre mortar compared to Control mortar

Mix	3 days	7 days	14 days	28 days	56 days
0.5%	6.66	8.83	13.32	13.82	16.03
1%	10	13.95	20.67	19.51	19.84

2 COMPRESSIVE STRENGTH: development of compressive strength of control m/weight of cement and sand. At all ages of testing , mortar mixtures with PP Fibre shows increase in compressive strength when compared to control mixture.

Compressive strength = P/A (N/mm^2)

Compressive strength of cement mortar with poly propylene e3 fibre :

Mix	At3 days	At7 days	At14 days	At28 days	At56 days
0%	10.0	15.0	16.45	19.687	20.15
0.5%	11.56	17.45	18.95	20.565	21.075
1 %	11.78	18.12	19.75	21.165	21.95

Percentage increase in compressive strength of PP Fibre mortar compared to Control mortar

Mix	3 days	7 days	14 days	28days	56days
0.5%	15.6	16.33	15.19	4.45	4.59
1%	17.8	20.8	20.06	7.50	8.93

VIII. CONCLUSION

The Following Conclusions are drawn from the Experimental investigation:

1. Reduction in bleeding is observed by addition of PP fibre in the Control mix when compared AR fibre.
2. Reduction in bleeding improves the surface integrity of concrete, improves its homogeneity, and reduces the probability of cracks.
3. The percentage difference in flexural strength by the addition of PP fibres increases by 16 % for 0.5 % mixing, 19.8 % for 1 % mixing.
4. The percentage difference in flexural strength by the addition of AR fibres increases by 17.4 % for 0.5 % mixing, 23 % for 1 % mixing.
5. When compared to PP, AR fibres AR fibre shows 1.4 % to 3.2 % more Flexural strength for 0.5 %, 1 % mixing.
6. The percentage difference in compressive strength by the addition of PP fibres increases by 4.5 % for 0.5 % mixing, 8.9 % for 1 % mixing.
7. The percentage difference in compressive strength by the addition of AR fibres increases by 10.6 % for 0.5 % mixing , 14.7 % for 1 % mixing.
8. When compared to PP, AR fibres AR fibre shows 6.1 % to 5.8 % more Compressive strength for 0.5 %, 1 % mixing.

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