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GLASS FIBRE REINFORCED CONCRETE AND ITS PROPERTIES

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ABSTRACT: Many RC constructions start to deteriorate with time and exposure to various hostile conditions. In nearly all cases, the emergence of small fissures and cracks is attributed as the cause of this early degeneration.Beginning with the casting of the structure, cracks begin to form early. Upon loading, these little cracks spread out more, which causes the structure to develop large openings. Many studies are being conducted to try and stop the spread of the early microcracks and stop the degeneration of the structure. This report's primary goal is to

• To research how adding glass fibres to the mix can prevent crack progression.

• Research on how adding fibre to concrete improves its durability.

By loading the concrete blocks to 60% of their compressive strength in order to permit the opening of surface fissures and cracks (which may be formed due to dead weight itself), an attempt is made to replicate the site conditions. The concrete blocks are then tested for alternate drying-wetting cycles. A comparison between plain cement concrete and glass fiber-reinforced concrete (GFRC) is done. Both materials are of the same grade. The improvement brought about by the additional fibres is noted as the comparative findings are plotted.

Keywords: RC structures, Glass fibres

I. INTRODUCTION

In today's world, concrete is the most widely used building material and is mostly used in massive structures like bridges, dams, and roads. Concrete has been used on such a big scale primarily due to its superior durability when compared to other building materials. With routine maintenance, it is anticipated that the majority of these large concrete structures will continue to be safe and useful for at least 50 to 100 years. But many concrete buildings have seen substantial deterioration even after only 20 or 30 years of use.

Concrete with Fibers

Use of fibres in the concrete mix design has gained traction in the construction sector as one of several efforts undertaken to increase the durability of concrete. Fiber-reinforced concrete was shown to significantly increase the durability of concrete by reducing the propagation of the early microcracks.

In plain concrete and other brittle materials, structural cracks (micro cracks) can appear even before the material is loaded, sometimes as a result of drying shrinkage or other volume-changing factors.

These first cracks' widths hardly ever go beyond a few microns, although they could have larger other two dimensions. When under load, microcracks spread and widen, and because of the action of stress concentration, new cracks develop where there are small flaws. Because of different impediments and changes in direction to avoid the more resistant grains in the matrix, structural fissures advance slowly or by little jumps. Inelastic deformations in concrete are mostly caused by the growth of such microcracks.

Small, tightly spaced, uniformly scattered fibres have been known to significantly enhance the static and dynamic properties of concrete by acting as a crack arrestor. Fibre Reinforced Concrete is the name given to this kind of concrete.

Fibers serving as reinforcement is not a novel idea.

In the past, straw and horsehair were both used to make mud bricks.

II. RELATEDWORKS

Since 1967, a variety of fibre kinds and materials have been effectively used into concrete to enhance its durability and physical characteristics. Numerous independent research findings that demonstrate how fibres can enhance the physical qualities and durability of concrete provide substantial evidence for this. The distinctive qualities and restrictions of various fibre kinds vary. Steel, polypropylene, nylon, asbestos, coir, glass, and carbon are a few of the most popular fibres. Whatever its cause, cracking causes concrete to deteriorate and become less durable when it is brought on by mechanical, chemical, or environmental forces. Additionally, the increased permeability brought on by cracking can hasten the effects of freezing and thawing damage and other deterioration processes, making concrete less durable overall.

The formation of cracks in concrete is affected by the presence of fibre reinforcement, which may also increase the surface roughness of individual cracks and increase the chance of multiple cracks and crack branching.

1 Authors: Kumar J.D.

Discussion: In his studies he found that the addition of glass fibres at 0.5 percent , 1 percent , 2 percent and 3 percent \sof cement decreases the cracks under different loading conditions. It has been observed that\sthe workability of the concrete increases at 1 percent with the addition of glass fibre. The increase \sin compressive strength, flexural strength, split tensile strength for M-20 grade of concrete \sat 7 and 28 days are observed to be much at 1 percent . We can likewise make use of the waste\sproduct of glass as fibre.

2 Dr. P. Srinivasa Rao is one of two authors.

Discussion: He has undertaken durability experiments on glass fibre reinforced concrete.

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3 J.D. Chaitanya Kumar, authors (2016)

Discussion: This investigation was conducted using M20 grade concrete, and glass fibre was added in percentages of 0.5, 1, 2, and 3. The concrete is tested for compressive and tensile strength using the specimens that were thrown. In this experiment, the concrete gains strength when 2% of the fibre is added to the concrete, while the strength of the concrete decreases when 3% of the fibre is added.

4 2010 authors are Kannan.

Discussion: By adding AR glass fibre in amounts up to 1% and super plasticizer by weight of the cement, the authors of this research conducted an experimental study on the permeability and compressive strength of superplasticized concrete. With the aid of A.R. glass fibre and super plasticizer, an effort has been made in this paper to create a new concrete with good workability and a better resistance to permeability. The M20 grade GFRC mix design is used in this study, and

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A.R. Glass Fibers are added at concentrations of 0.2, 0.4, 0.6, 0.8, and 1.0 percent by weight of cement to the reference mix. Test specimens are then allowed to cure for 28 days to assess their workability, compressive strength, and permeability.

III. MATERIAL PROPERTIES

- **Cement :-**

By combining Portland cement clinker, gypsum, and granulated blast furnace slag in the proper amounts, and then grinding the mixture to achieve a complete and intimate mixture of the ingredients, Portland Slag Cement is created. The end product is cement, which resembles regular Portland cement in terms of physical characteristics. Additionally, it has a low heat of hydration, is more resistant to chlorides, soils and water that include large amounts of sulphates of alkali metals, alumina, and iron, as well as acidic waters and marine operations. Jaypee Group Portland Slag Cement, made on January 27, 2022, was utilised in the project.

- **Aggregate :-**

Aggregates are crucial components of concrete that give it body, lessen shrinkage, and improve economy.

Since aggregates make up between 70 and 80 percent of the volume of concrete, they significantly affect the material's numerous traits and qualities. Crushed concrete aggregate with a predominance of angular shapes was used as the coarse aggregate in our investigation. In order to get better results, the maximum size of aggregate is limited to 20mm, and a specific ratio between 10mm and 20mm aggregate is maintained in mix design. The fine aggregate utilised in this instance is typical river bed sand, which has a fineness modulus of 6.93 and a specific gravity of 2.63. Its specific gravity was determined to be 2.68 and fineness modulus to be 3.42.

- **Water :-**

Ordinary tap water with a pH between 6 and 8 was used in the attempt to create concrete.

- **Glass Fibres :-**

"Anti-Crack®" HD (High Dispersion) alkali resistant glass fibres that can be easily introduced into conventional concretemix giving millions of dispersed fibres/m3 of concrete providing highly uniform and efficient three dimensional reinforcement throughout the 15 matrix which can effectively reduce the problems prone to plastic shrinkage by controlling the early age plastic shrinkage cracking

Table 3.1 Properties of Glass Fibre

Sno.	PROPERTIES	VALUE/FEATURES
1.	High Tensile Strength (1700 MPa)	3-4 times higherthan steel.
2.	High Elastic Modulus	10 times of propylene
3.	Excellent Corrosion Resistance (Doesnot rust)	Alkali and Acid Resistant
4.	Easy to Incorporate (InstantDispersion)	Does not Protrude
5.	Safe to use, with no health risk	Inorganic, Incombustible
6.	Product form	Monofilament
7.	Number of fibres	>200 million/kg
8.	Aspect Ratio	857:1
9.	Specific Surface Area	105 m^2/kg
10.	Typical addition rate:	0.6 kg/m^3 ofconcrete.
11.	Length	12 mm
12.	Zirconia content	16.7%
13.	Specific Gravity	2.68 g/cm^3
14.	Elastic Modulus	72 GPa
15.	Filament Diameter	14μm

Table 3.2 Ordinary Portland Cement Contents

Table 3.2 Ordinary Portland Cement Contents

(courtesy: OCV REINFORCEMENT)

CaO	SiO2	Al2O3	Fe2O3	MgO	SO3
32-34%	33-35%	18-20%	1.8-2.0%	8-10%	1.5-4.0%

IV. TEST PROCEDURE

The castings were put through a range of tests after being cured in a curing tank for 28 days. Prior to the destructive testing, non-destructive tests were carried out to see if the concrete poured was homogeneous and would develop the necessary strength. These tests can be resorted to for creating reasoning in case any results deviate from the anticipated result, and they are important in interpreting the results generated from the compression tests carried out later.

Two non-destructive tests were conducted, and they are as follows:

1. **Test of Rebound Hammer:**

- The following applications of the rebound hammer method (IS:13311 Part2-1992):
- Using appropriate correlations between the rebound index and compressive strength, one can estimate the likely compressive strength of concrete.
- Evaluating concrete's homogeneity.
- Evaluating the quality of the concrete in reference to industry standards,
- Eevaluating the quality of one concrete component in light of another.

Figure 4.1 Rebound Hammer Test Apparatus

2. **Compression Test:-**

• There were three main groups into which the compression tests were divided:

• Series A, which consists of glass fiber-only FRC mixes with M25 and M20 having two values of fibre volume fractions (1% and 0.5%) by volume of concrete;

• Series B, which consists of FRC mix of M25 with 1% and 0.5 % fibres by volume and 10% cement by weight; and Series C, which consists of PSC mixes.

Standard cubical specimens were created for each blend and tested after 28 days. For each parameter, at least three samples were examined. As 100x100 mm cubes were the standard size for this experiment, 150x150 mm cubes were also made and analysed after one day to show any link between the two sizes.

Figure 4.2 Compression Testing Machine

V. RESULTS:

According to slump experiments, it was discovered that the addition of fibres significantly reduced the workability of concrete. However, it had no impact on how concrete was mixed. As seen in prior experiments employing fibres, the fibres did not form any lumps or balls. Comparing the compressive strengths of various combinations revealed that adding 0.5 percent of fibres significantly increased strength. Although not as significant as the 0.5 percent fibre mix, the addition of 1 percent of fibres increased strength. The PSC gave a full dispersion failure, although the surface of the FRC was intact with cracks on the surface, was different from the pattern of cracks created during the compression stress application.

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5.1 Results of Destructive Tests

By shattering the test specimen under specific weights, the destructive test of concrete aids in understanding behaviour and quality. Casting test specimens from newly formed concrete is the main step of the destructive test. The hardened concrete can be examined using a variety of tests. These are what they are Flexural strength test Compressive strength test Splitting tensile strength test.

TABLE 5.1 DESTRUCTIVE TEST RESULT

Table 4.1 Destructive Test Results

SAMPLE	SLUMP (mm)	FLEXURAL STRENGTH (N/mm2)	COMPRESSIVE STRENGTH (N/mm2)	
			100mm CUBE	150mm CUBE
M25 1.0%	0	1.39	27.7	27.1
M25 0.5%	1 3	1.69	31.7	30.1
M20 1.0%	0	1.14	24.4	23.3
M20 0.5%	2 1	1.39	26.4	25.1
PCC M25	4 5	1.25	28.7	27.8
PCC M20	6 0	0.95	24.4	22.5

5.2 Results of Non-Destructive Testing

TABLE 5.2 NON DESTRUCTIVE TEST RESULTS

SAMPLE	REBOUND HAMMERCOMPRESSIVE STRENGTH(N/mm2)	UPVT (mm/µs)
M25 1.0%	22.34	3.17
M25 0.5%	25.23	3.19
M20 1.0%	22	3.11
M20 0.5%	19	3.42
PCC M25	26.11	3.18
PCC M20	19.45	3.52

Concrete can be tested non-destructively to determine its compressive strength and other qualities from existing constructions. The concrete structure's actual strength and qualities are revealed by this test, along with immediate results.

Testing specimens cast concurrently for compressive, flexural, and tensile strengths is the norm for assessing the quality of concrete in buildings or other structures.

The main drawbacks are that results take time to come about, that concrete specimens may have different curing and compaction conditions than actual constructions, and that a concrete specimen's strength attributes depend on its size and shape.

These non-destructive techniques can be divided into six categories: radioactive testing, dynamic tests, pullout techniques, penetration tests, and maturity concept tests. These rely on the notion that certain concrete physical characteristics can be linked to strength and can be assessed using non-destructive techniques. Hardness, resistance to projectile preparation, rebound capacity, and the capability to transmit ultrasonic pulses, X-rays, and Y-rays are a few of these qualities.

The many techniques for conducting non-destructive tests on concrete are as follows:

1. Penetration Technique

2. Hammer tests with rebound

3.Pull Out Test Technique

4. Using Ultrasonic Pulse Velocity

5.Radioactive Techniques

5.3 Results of Durability Tests

SAMPLE	REBOUND HAMMERCOMPRESSIVE STRENGTH(N/mm2)	UPVT (mm/µs)
M25 1.0%	22.34	3.17
M25 0.5%	25.23	3.19
M20 1.0%	22	3.11
M20 0.5%	19	3.42
PCC M25	26.11	3.18
PCC M20	19.45	3.52

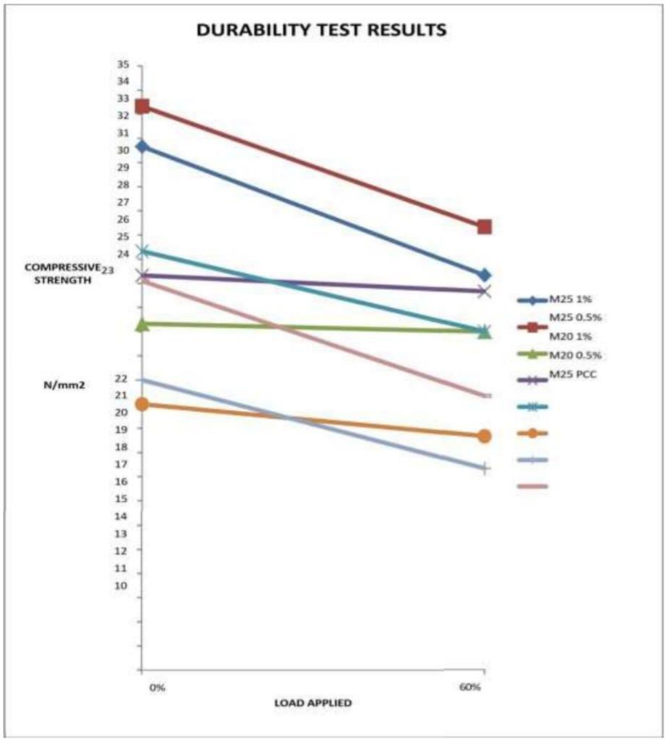

Figure 5.1 Durability Test Results

5.3 28 Days Flexural Strength

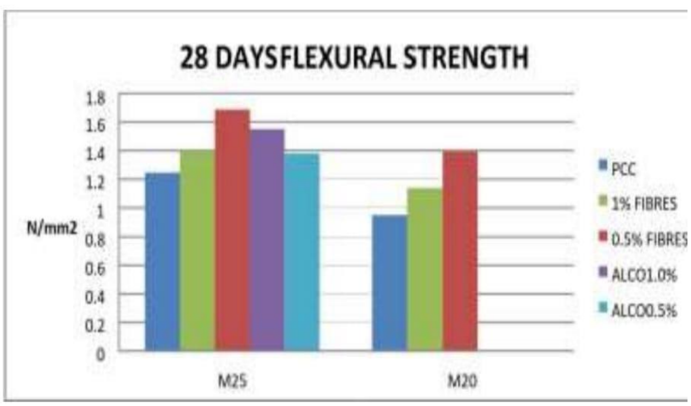

Figure 5.2 28 Days Flexural Strength

5.4 28 Days Compressive Strength (100 mm)

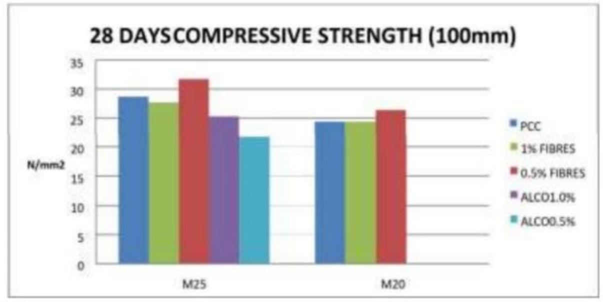

Figure 5.2 28 Days Compressive Strength Strength (100 mm)

5.5 28 Days Compressive Strength (150 mm)

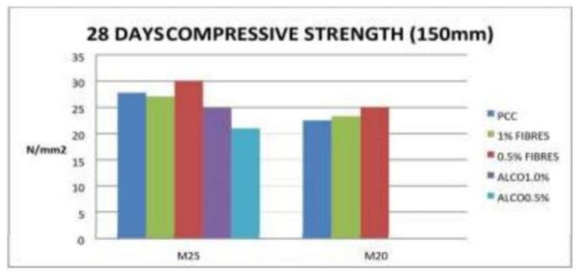

Figure 5.3 28 Days Compressive Strength (150 mm)

VI. CONCLUSION:

It was shown that adding ALCCO Fines to concrete combined with 1 percent glass fibres produced superior outcomes versus concrete that only contained 0.5 percent glass fibres. Due to its smaller particle size than cement, the inclusion of ALCCOFINE decreased the void volume. And because there were fewer voids, more fibres in the concrete became active, boosting its strength.

After dry and wet cycles, samples loaded with 60% of the ultimate compressive strength demonstrated lower compressive strengths than samples loaded with 0% of the ultimate compressive strength, which was as it should have been. To imitate the state of concrete in the field, this was done.

VII. REFERENCES

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