EXPERIMENTAL INVESTIGATION OF ARAMID FIBRE REINFORCED CONCRETE USING DURABILITY PROPERITIES

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Abstract

Concrete's resistance to weathering, chemical assault, and other deterioration processes is referred to as durability. The effects of acid, sulphate, and chloride attacks on the calibre and practicality of concrete are also discussed. In order to report on the longevity of synthetic fibres like aramid fibre, an experimental examination was carried out. This article examined the impact of aramid fibre on the durability of concrete for M30 grade by altering the proportion of aramid fibres in concrete. Aramid fibre reinforced concrete samples were subjected to tests for water absorption, sorptivity, RCPT, and chemical resistance (acid, sulphate, and salt). After 28 days of curing, the test samples' tensile strength was assessed. In the experiment, fibre dosages of 0.5%, 1.0%, and 1.5% by volume of concrete were employed for a length of 2.5 cm or less. By submerging these cubes for 30 days in the aforementioned solutions and observing the corresponding changes in compressive strength and weight reduction, we were able to determine the effects of 5% H2SO4, HCl, MgSO4, and NaCl on these concrete mixes. From this, we were able to draw the conclusion that aramid fibre reinforced concrete had better strength and durability properties than conventional aggregate in harsh environments. The experimental investigation's findings indicate that aramid fibre reinforced concrete has higher durable qualities than ordinary cement concrete.

Keywords: Aramid fibre Reinforced Concrete (AFRC), Durability Properties, Strength studies, compressive strength, water absorption, sorptivity test.

1. INTRODUCTION

The most popular building material, concrete, has a variety of desired characteristics, including great compressive strength, stiffness, and durability under typical environmental conditions. Concrete is both brittle and tensionally weak. Plain concrete has two flaws: low tensile strength and low strain at fracture. Concrete reinforcement is frequently utilised to fix these faults. Usually, reinforcement consists of constantly deformed steel bars or prestressing tendons. The advantage of using high tensile steel wires for reinforcement and pre-stressing has helped to overcome concrete's incapacity to withstand tension while maintaining a high level of compressive strength ductility. Fibres ranging from 1.0 percent by volume of concrete are used in numerous current applications of fibre reinforced concrete. Concrete with fibre reinforcement (FRC) is a relatively new material. This composite material has a high tensile strength and is composed of a matrix with a random distribution or dispersion of small, natural or synthetic fibres. Fibres can considerably increase a material's tensile strength and toughness. In reality, fibres act as a bridge between cracks, slowing or stopping their growth while boosting strength, load bearing, and energy absorption. Prior until recently, the majority of uses for fibres in concrete, particularly steel fibres, were restricted to precast components, airport pavements, parking lot pavements, bridge decks, and other locations with high potential for abrasion. Numerous research on the use of steel fibres in concrete have been published; however, when used in high quantities, this type of fibre can lead to issues such agglomeration, accumulation, and a significant loss in workability [1].

[2] In the modern world, extremely complex and difficult civil engineering constructions are being built. Concrete, the most significant and often used material, is frequently required to have extremely powerful and adequate workability qualities. In the area of concrete technology, endeavours are being made to create such concretes with unique properties.

[3] In an effort to improve these qualities, concrete with steel fibres was added in order to explore the durability quality. By altering the quantity of steel fibres in concrete, the influence of steel fibres on the strength of concrete for the M30 grade has been explored in this article.

[4]Consideration is being given to replacing steel strands with aramid fibres. Due to their incredible strength-to-weight ratio and incredible tenacity, aramid fibres are used to control concrete cracking at an early stage.

[5] The effect of various steel fibre dosages on the binding strength between concrete and steel in concrete with reinforcement was examined in the current experiment.

[6] With the advancement of marine equipment, coral aggregates concrete (CAC) has the potential to be used in reef construction. However, coral aggregates' form, surface texture, substantial porosity, and capacity to carry chloride ions produce unique microstructures and have an impact on the mechanical characteristics and toughness of CAC.

[7] Aramid fibre (Kevlar 129) is preferred due to its exceptional qualities, but its uses are constrained by drawbacks including moisture absorption and poor compressive strength. Basalt fibre and epoxy resin are used in hybrid composite construction to get around this.

[8] Twenty-four concrete cylinders that had a notch in the middle were ready. Six of them were covered in double and single layers of fibre-reinforced polymer, while the other six were coated in epoxy resin and served as a control.

[9] Concrete, the most significant and often used material, is frequently required to have exceptionally strong and adequate workability qualities. In the area of concrete technology, efforts are being made to create such concretes with unique properties.

[10] The behaviour of composite materials made of basalt, glass, and carbon under different chemically aggressive circumstances is one of the most crucial areas of research pertaining to their application in the civil construction sector. Fibre-reinforced polymer composites can be exposed to a wide range of pH conditions when utilised as internal and exterior reinforcement in different structural applications.

[11] Utilisation of Polyethylene Terephthalate Plastic (PTP) bottles is necessary and inevitable in modern society. In recent years, it has become difficult to dispose of PTP because improper disposal can have dangerous effects on the environment. In this study, an effort was made to use PTP in concrete in the form of fibre, and the effectiveness in harsh environments was examined.

When replacing metal wires and inorganic fibres, aramid has mechanical properties that are 5–10% better than those of typical synthetic fibres. Used in a range of structural composites that are used to make ropes for offshore oil rigs, armoured vehicles, and aeroplanes. Since Aramid fibres are heat and flame resistant, they not only maintain their properties at high temperatures but also outperform steel and glass in terms of mechanical properties on an equivalent weight basis

[12]. This study aims to identify the ideal percentage of aramid fibre addition to concrete and to explore the durability of aramid fibre reinforced concrete with a fibre mix proportion for M30 grade concrete and compare it to conventional concrete.

2. MATERIALS AND METHODS

2.1 Materials

The components used to manufacture the concrete were gathered, and a number of tests were run to ascertain their physical characteristics in compliance with predetermined standards.

2.1.1 Cement:

This experimental investigation makes use of OPC 53grade (Zuari brand), which complies with IS 12269-2013. According to IS 4031 1988 testing, the physical characteristics of cement are represented in Tables 1 respectively.

Table.1 Physical Characteristics of OPC Grade 53.

SI. No	Physical Properties		Results obtained	Requirements of IS:12269-1987
1	Fineness (%)		3.42	-
2	Initial setting time (min)		105	Minimum 30
	Final setting time (min)		523	Maximum 600
3	Standard Consistency (%)		32	-
4	Soundness by Le-Chatelier (mm)		1.0	Maximum 10
5	Specific gravity		3.15	-
6	Compressive strength (N/mm^2)	7 days	32.5	Not less than 22
		28 days	54.6	Not less than 33

2.1.2 Fine aggregate:

Natural river sand that is readily available in the area and has been put through a 4.75mm screen is used to make fine aggregate (FA). The physical characteristics of FA according to IS: 2386 1968: Part III are displayed in Table 2.

Table.2 Physical Properties of Fine aggregate.

SI.No	Test particulars	Results obtained
1	Specific gravity	2.65
2	Fineness modulus	2.87
3	Water absorption (%)	0.5%
4	Bulk density(kg/m^3)	1443
5	Zone	II

2.1.3 Coarse aggregate:

The study's coarse aggregates (CA) were 20 mm maximum size of aggregate (MSA) crushed stones that were readily available locally. To enhance the performance of concrete binding, CA is typically employed in an angular shape. The results of the IS: 2386–1963 coding test on the coarse aggregate are displayed in Table 3.

Table.3 Physical Properties of Coarse aggregate.

SI.No	Test particulars	Test results
1	Specific gravity	2.70
2	Bulk density(kg/m^3)	1448
3	Aggregate Impact value (%)	22.42
4	Aggregate Crushing value (%)	20.39
5	Fineness modulus	6.51
6	Water absorption (%)	1.0%

2.1.4 Water:

The laboratory has access to potable tap water that is devoid of suspended particles.

2.1.5 Super plasticizers:

The application of super plasticizer enhanced the functionality of concrete. (Table.4) In the current study, sulphated naphthalene polymers were superplasticized using Conplast SP430 superplasticizer, which was acquired from ASTRRA chemicals (India) Pvt. Ltd. The molecular weight of sulphonated napthalene polymers is 1.220. Super Plasticizer complies with the requirements of ASTM-C-494 Type F, Type A, BS: 5075, and IS: 9103-1999.

Table.4 Properties of Super plasticizers.

SI.No	Properties	Results obtained
1	Appearance	Brown liquid
2	Type	Sulphonated naphthalene formaldehyde (CONPLAST SP 430)
3	Specific gravity	1.18 @ 22°C ± 2°C
4	Solid content	40%
5	Compatibility	All type of cement except high alumina cement
6	Compressive strength	Early strength up to 40 – 50%
7	Chloride content	Nil as per IS 456-2000 and IS 5075

2.1.6 Aramid fibre reinforced polymer (AFRP)

In this investigation, the specimens' strength was increased using a bidirectional aramid fibre. As seen in Fig.1 and Table 5, the aramid or synthetic fibre used to make Kevlar fabric has a wide range of uses. Compared to steel, it has five times higher strength. It is made from polyphenylene diamine, which has a carboxylic acetaldehyde group and an amine group. It makes a construction last longer. The Kevlar fabric fibre amine group, that is hydrogen-bonded to carbon, provides toughness to the structure depicted in Fig. 2.

Fig.1 Aramid fibre used in the present study

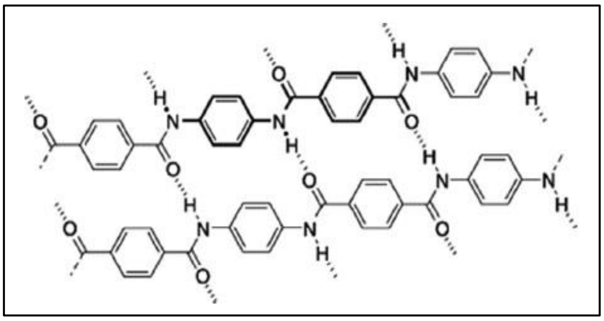

Fig.2 Structure of Aramid fabric fibre

Table.5 Properties of AFRP.

SI.No	Properties of AFRP	Values
1	Color	Yellow
2	Modulus of elasticity (kN/mm^2)	242
3	Tensile strength (N/mm^2)	3887
4	Density (g/cm^3)	1.76
5	Weight (gm/m^2)	480
6	Thickness (mm)	0.33
7	Nominal thickness per layer (mm)	1.0
8	Fibre diameter (μm)	12
9	Elongation at break (%)	3.4

2.2 Mix proportioning:

The M30 concrete grade was created in accordance with IS criteria for regular concrete (i.e., without the addition of fibre). The water-to-binder ratio employed in this investigation was 0.45. To maintain functionality between 50 and 75 mm, super plasticizer is added to all concrete mixtures. CA and FAs were dry stirred in a concrete mixer for fifteen minutes before cement was incorporated and dry stirred for an extra minute. The needed amount of aramid fibre was then added, and the combination was then mixed for a further 120 seconds to ensure that the aramid fibres were dispersed uniformly throughout the mixture. Water that was close by the admixture was incorporated after the mixture had been blended uniformly. Four different mixes were created, the first of which was a control blend with no fibres while the other four each had a volume fraction of aramid fibres. Table.6 displays the mix ratios for fibre-reinforced concrete.

Table.6 Mix proportions of fibre-reinforced Concrete for 1m^3.

SI. No	Material	0.0 % dosage (AF0.0)	0.5 % dosage (AF0.5)	1.0% dosage (AF1.0)	1.5% dosage (AF1.0)
1	Cement (kg/m^3)	413	413	413	413
2	Fine aggregate (kg/m^3)	659	659	659	659
3	Coarse aggregate (kg/m^3)	1155	1155	1155	1155
4	Water (kg/m^3)	186	186	186	186
5	Super plasticizer (kg/m^3)	1.65	2.47	3.30	4.13
6	Aramid fibre (kg/m^3)	0.00	2.06	4.13	6.19
7	Slump (mm)	70	65	60	55

2.3 Durability studies:

On control and aramid FRC specimens, tests for sulphate resistance, acid resistance, water absorption, salt resistance, rapid chloride penetration, and sorptivity were conducted. After 28 days of curing, the test samples' tensile strength was assessed.

2.3.1 Water absorption test:

After 28 days of curing, 150 mm x 150 mm x 150 mm cube samples underwent a water absorption test by being dried in the sun, then submerged in water 24 hours later after cooling to the ambient temperature. At periodic times, the samples were taken out of the water and measured as indicated in Fig.3. The variation between the observed saturated water mass and dry mass, reported as a percentage of mass, is used to compute the amount of water absorbed. This is how the water absorption was determined:

Fig.3 Water Absorption Test Specimen Immersed in Water

2.3.2 Sorptivity test:

Concrete samples that were cylindrical in shape and had 100 mm in diameter and 50 mm in depth underwent sorptivity testing in accordance with ASTM C1585-13. The only equipment needed is a pan of water, a stopwatch, and a ruler. The specimens' sides were coated with ANABOND silicon sealant to prevent water from penetrating, and the bottom area of the sample was allowed to come into contact with the water in the tray. The sample was set in water that was 5 to 10 mm deep, and time was started from the moment the mass was first detected. The specimen's weight was constantly recorded. Surface water was wiped off using a cloth before the sample was measured. The time interval was set to get the value $t^{0.5}$ as a whole number in order to plot the graph. Figures 4 and 5 depict the Sorptivity test setup and the Sorptivity test schematic diagram.

$$i = St^{0.5}$$

Where,

I = Absorbed water per unit area

T = Elapsed time in minute

S = Coefficient of Sorptivity in mm/ $min^{0.5}$

Fig.4 Samples placed in the Sorptivity pan

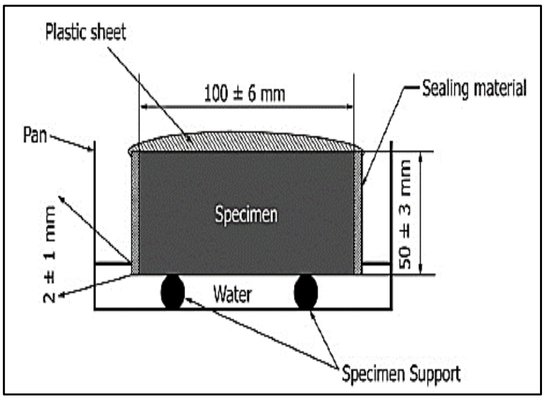

Fig.5 Schematic Diagram of Sorptivity Test

2.3.3 Rapid Chloride penetration test:

In order to ascertain the electrical conductivity of the mixtures of concrete after 28 days of curing, the test was carried out in line with ASTM C1202-2012. Sorptivity samples, a 3.0% NaCl solution as the cathode, and a 0.3 N NaOH solution as the anode were used to construct migration cells. The system was then linked, and an uninterrupted 60 V potential was used for 6 hours to hasten the entrance of chloride. The total charge transferred was measured every half-hour for a maximum of six hours, per the norm. Figures 6 and 7 depict the RCPT test setup and its schematic drawings. Every half-hour, the data logging system examines the voltage supplied and uses that data to determine the present value of each cell. The following equation is then used to determine the total charge that travelled through the sample.

$Q = 900(I_0 + 2\ I_{30} + 2I_{60} + \ldots.. + 2I_{330} + I_{360})$

Where,

Q - Charges in coulomb

I_0 - Current-due to initial voltage applied (ampere)

I_t - Current at‘t’ min after voltage (ampere)

Fig.6 RCPT Test Setup

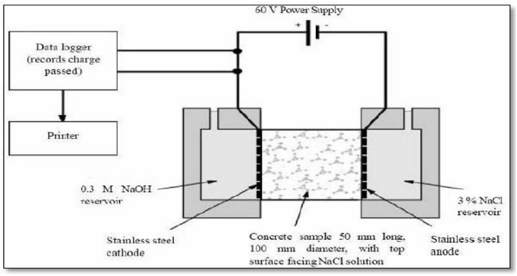

Fig.7 Schematic Diagram of RCPT Test

On the basis of the ASTM C 1202 limits displayed in Table.8, the quality of the concrete can be assessed.

Table.8 Chloride Ion Penetrability Based on Charge Passed.

Charge passed (Coulomb)	Chloride Ion Penetration
More than 4000	High
From 2000 – 4000	Moderate
From 1000 – 2000	Low
From 100 – 1000	Very low
Less than 100	Negligible

Chemical resistance tests:

150mm concrete cube specimens are cast and cured in potable water for 28 days at a standard temperature of 27^oC 2^oC to test the chemical resilience of concrete in challenging situations. The concrete samples were removed after 28 days of water curing and submerged in acids, sulphate, and salt for 30 days. During this time, the mass and durability of the concrete samples were recorded.

2.3.4 Acid resistance test – H2SO4 and HCl

Three 150 mm x 150 mm x 150 mm cube prototypes were cast and allowed to cure for 28 days. After 28 days of curing, the specimens are taken out of the curing tank and given 24 hours to dry. The weights of the cubes are then calculated and utilised as the starting weight. To perform this test, water is diluted with 5% hydrochloric acid (HCL) to a pH of roughly 2. As depicted in Fig.8, the cubes are then submerged in the acid solution for 30 days. The test is performed in accordance with ASTM C 1898 20 specifications. The HCL solution is tested once a week to ensure it stays concentrated. After 30 days, the samples were taken out of the HCL solution, scraped using a wire brush to eliminate any unstable particles that had been leached by the acid, weighed (final mass), and put through a compression test machine. Both the % mass loss and the percentage strength loss were calculated using the compressive strength test. A second batch of concrete samples underwent a 30-day immersion in a 5% sulphuric acid solution (H2SO4). Fig.9 depicts the specimens' damaged surface in an acid solution after 30 days.

Fig.8 Specimens Immersed in H_2S04 Solution

Fig.9 Specimens Immersed in HCl Solution

2.3.5 Sulphate attack test:

To find out how sulphate-resistant concrete cubes were, sulphate resistance analysis was done. Internal strains brought on by a chemical reaction's volume expansion can eventually result in failure by way of internal fractures. To calculate the loss of mass and loss of strength due to sulphate threat, concrete specimen cubes with dimensions of 150 mm x 150 mm x 150 mm were produced.

Fig.10 Specimen Immersed in magnesium Sulphate solution

After 28 days of immersion in 5% magnesium sulphate diluted solutions, the mass of the cube samples was calculated. The pH of the solution was controlled to be between 6.0 and 8.0 each week. After 30 days, the cubes were taken out and their weights could be evaluated as seen in Fig.10. Compressive strength measurements were done in order to calculate the strength decrease as a percentage.

2.3.6 Salt resistance test:

To measure the resistance of concrete cubes to the salt water impact resulting from seawater, a salt resistance test was conducted. Interior strains brought on by salt's volume expansion can result in interior fissures and, eventually, failure. Concrete sample cubes of 150 mm x 150 mm x 150 mm were produced in order to calculate the mass loss and percent of strength loss caused by salt attack. Following a 28-day curing period, the weight of the cube specimens was determined before they were submerged in 5% diluted sodium chloride solutions, as illustrated in Fig. 11.

Fig.11 Specimen Immersed in Sulphuric Chloride solution.

After 30 days of immersion, the cubes were brought out, and weight measurements were made to calculate the amount of mass that had been lost. Compressive strength measurements were done in order to calculate the strength decrease as a percentage.

3. RESULT AND DISCUSSION

3.1 Test results on water absorption test:

As a gauge of water loss, presents the findings of tests on the water absorption of various concrete mixtures.

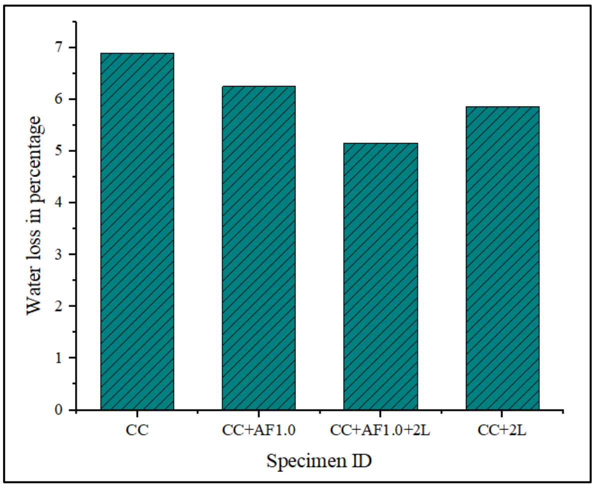

Fig.12 Percentage of water absorption of AFRC Mix

Fig.12 depicts the absorption of water for M30 grade at 28 days with a w/c ratio of 0.45; AFRC mixes of AF0.5 were found to be greater at 6.90%.The test results showed that all AF mixes had lower absorption of water percentages than expected, with AF1.0 mix having the lowest percentage water loss compared to AF0.0 at 5.18%.

3.2 Test results on Sorptivity test:

A porous substance's capacity to absorb and transfer water via capillarity is referred to as sorptivity (S), a material attribute. Sorptivity is determined by calculating the capillary rise rate of absorption on a concrete sample. A mass gain was calculated using the necessary time intervals. An rise in sorptivity value shortens the lifespan of concrete, whereas the effectiveness of sorptivity (S) is used to measure the quality of concrete.

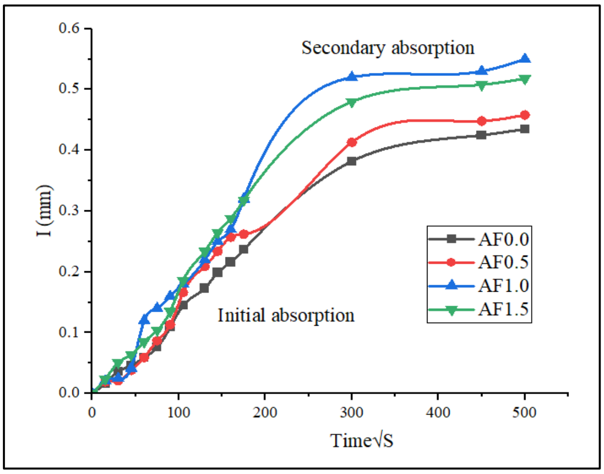

Fig.13 Sorptivity test for AFRC Mix

Initial absorption of the AF1.0 mix was 32.07% lower at 6 hours of observations than the AF0.0 mix. The final absorption of AF1.0 was 21% lower than AF0.0 during 1 day to 3 day observations. Fig.13 clearly shows that the early water absorption was higher in the steeper curve for AF1.0 and AF0.0. Later in the smooth curve for both blends, water absorption was extremely low in relation to time. Because of this, AF1.0 has much less water absorption over time than AF0.0.

3.3 Test results on Rapid Chloride Ion Penetration:

Rapid chloride ion penetration tests on concrete mixes with and without fibre in terms of charge passed in coulombs. The variance in RCPT values for various AFRC mix percentages is depicted in Fig.14. It was discovered that the mix AF1.0 generated a lower RCPT value. The total charges transmitted in the AF0.5, AF1.0, and AF1.5 mixes varied between 1018 to 1670 coulombs, according to the findings of the penetration tests. Aramid fibre clearly reduces the overall charge passes when added. The percentage levels for quick chloride penetration contrasted to AF0.0 were 23.15%, 64.04%, and 39.74%, accordingly, according to the study results. The chloride ion penetration in AF1.0 in the aramid FRC exhibited 1018 low coulombs in compared to the other specimens.

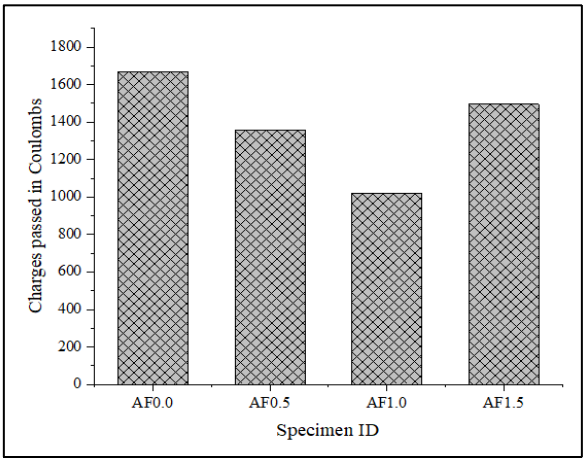

Fig.14 Charge passed in different AFRC Mix

3.4 Test results on Acid resistance:

The findings of testing for sulphuric acid (H2SO4) and hydrochloric acid (HCl) resistance on samples of standard concrete and AF concrete are described below. The acid attack leached away the calcium from the calcareous aggregate and also the calcium-containing components of cement paste created in concrete during the hydration process. Concrete's structural integrity is weakened by acid assault, which also shortens the material's durability and useful life. Figures 15 and 16 for H2SO4 and Figures 17 and 18 for HCl, respectively, display the percentage of loss of mass and durability loss of specimens of concrete that have been cured for 30 days. According to the test results, the AF1.0 blend suffered a minimal amount of strength loss as a result. The use of Aramid fibre greatly increased the concrete's resistance to acid when compared to normal concrete, as shown by the findings of mass loss and strength loss (Figs. 15 and 16).

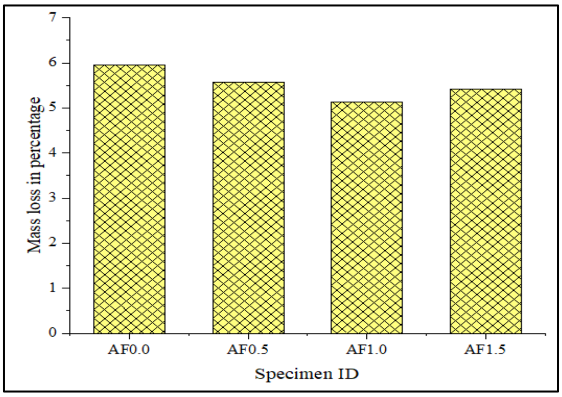

Fig.15 Percentage of Mass Loss on H2S04 Resistance Test

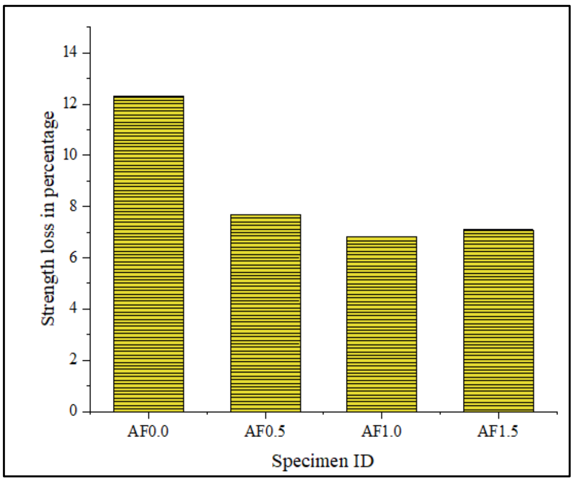

Fig. 16 Percentage of Strength Loss on H2S04 resistance test

Similar to this, the mass loss values for concrete submerged in sulphuric acid were 4.90%, 4.61%, 4.10%, and 4.35% for AF0.0, AF0.5, AF1.0, and AF1.5, respectively. The compressive strength of AF0.0, AF0.5, AF1.0, and AF1.5 was measured both before and after immersion. After 30 days of immersion in 5% diluted sulphuric acid, the strength loss of AF0.0, AF0.5, AF1.0, and AF1.5 was 7.71%, 6.94%, 5.85%, and 6.12%, respectively. With the exception of a relatively low mass loss value of 4.10% that was presented in the mix AF1.0, all mass loss values were lower than AF0.0. In the mix AF1.0, the strength loss was measured at a lower rate of 5.85%. According to the test results, the AF1.0 blend suffered a minimal amount of strength loss as a result. The use of Aramid fibre greatly increased the concrete's acid resistance when compared to conventional concrete, as shown by the findings of mass loss and strength loss (Figs. 17 and 18).

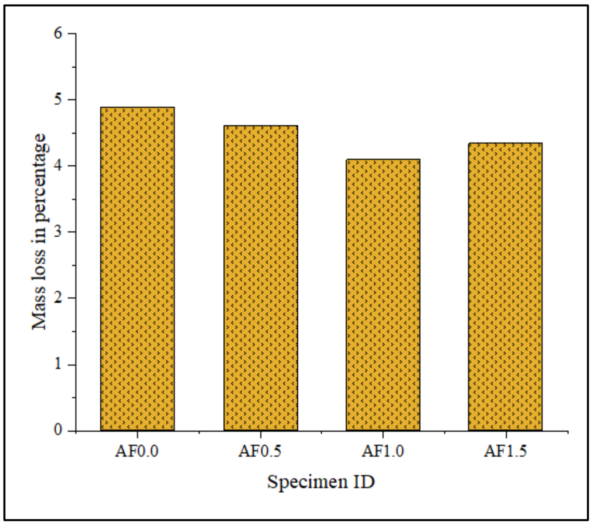

Fig.17 Percentage of Mass Loss on HCl Resistance test

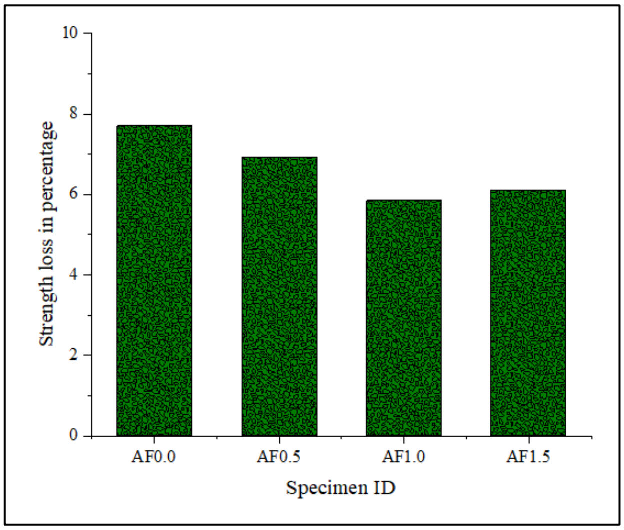

Fig.18 Percentage of Strength Loss on HCl Resistance test

The visual appearance of AF0.0 and AF1.0 specimens submerged in hydrochloric acid and sulphuric acid solution for 30 days is depicted in Figs. 19 and 20. The acid attack caused surface degradation and damage to the AF0.0 specimen. On the AF1.0 specimen, there was, however, no degradation or damage. For concrete immersed in hydrochloric acid at AF0.0, AF0.5, AF1.0, and AF1.5, the mass loss values were 5.96%, 5.57%, 5.14%, and 5.42%, respectively. The compressive strength of AF0.0, AF0.5, AF1.0, and AF1.5 was measured both before and after immersion. After 30 days of immersion in 5% diluted hydrochloric acid, the strength loss of AF0.0, AF0.5, AF1.0, and AF1.5 was 12.29%, 7.69%, 6.82%, and 7.09%, respectively. With the exception of the relatively low mass loss value of 5.14% that was presented in the mix AF1.0, all mass loss values were lower than AF0.0. In the mix AF1.0, the strength loss was measured at a lower rate of 6.82%.

0% Fibre | 1.0% Fibre

Fig.19 After 30 days of immersion in H2SO4 solution the visual appearances of the AF0.0 and AF1.0 specimens

0% Fibre | 1.0% Fibre

Fig.20 After 30 days of immersion in HCl solution the visual appearances of the AF0.0and AF1.0 specimens

3.5 Test results on Sulphate resistance:

In order to defend concrete against sulphate attack from the outside, permeability is crucial. Concrete that has been subjected to sulphate assault may expand, lose compressive strength, and lose weight. For concrete immersed in magnesium sulphate solution at AF0.0, AF0.5, AF1.0, and AF1.5 the mass loss values were 5.74%, 4.06%, 3.77%, and 3.95%, respectively. The combination of all mixes was thus shown to be vulnerable to sulphate assault based on the test findings, with the AF1.0 mix having a lower proportion of mass loss in percentage at 3.77%. The AF1.0 mixture was therefore more resistant to sulphate assault.

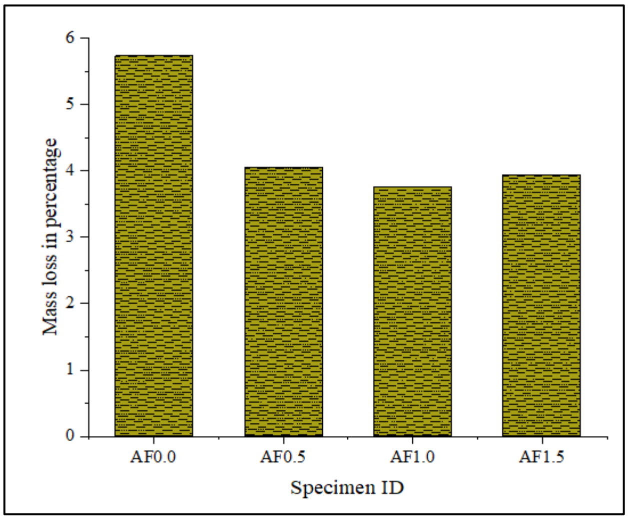

Fig.21 Percentage of Mass Loss on Sulphate Resistance Test

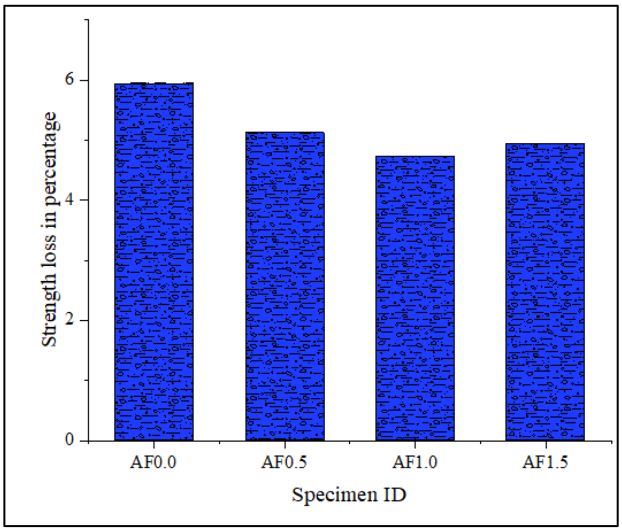

Fig.22 Percentage of Strength Loss on Sulphate Sulphate resistance test

The compressive strength of AF0.0, AF0.5, AF1.0, and AF1.5 was measured both before and after immersion. After being submerged in 5% magnesium sulphate solution for 30 days, the strength loss of AF0.0, AF0.5, AF1.0, and AF1.5 was 5.96%, 5.14%, 4.74%, and 4.96%, respectively. The AF1.0 mixture's strength loss had a lower value of 4.74%. As can be seen in Figs. 21 and 22, the test results showed that, when compared to conventional concrete, the AF1.0 mix had a low percentage of strength loss as well as the outcomes of mass loss and strength loss. The visual appearance of the AF0.0 and AF1.0 specimens submerged in the magnesium sulphate solution for 30 days is depicted in Fig. 23.

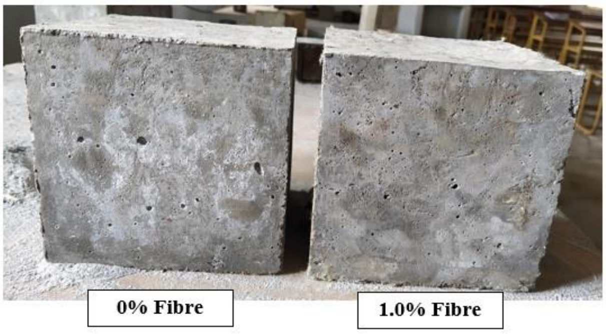

Fig.23 After 30 days of immersion in H2SO4 solution the visual appearances of the AF0.0 and AF1.0 specimens

3.6 Test results on Salt resistance test:

External sources of chlorides are often found in seawater. Sulphate and chlorides disperse in the pore water. When hydrated cement paste interacts with pore water, ionic diffusion happens. Tri-calcium aluminate, a component of cement, can bind chloride ions to create calcium chloro-aluminate in addition to lowering the mobility of chloride ions. The percentage mass loss figures for AF0.0, AF0.5, AF1.0, and AF1.5, respectively, were 8.18%, 4.22%, 3.39%, and 3.92%. In relation to AF0.0, the average mass loss percentages for all combinations ranged from 3.39% to 4.22%. The test findings showed that the combination of all mixes was vulnerable to salt assault, especially the mix AF1.0, which had a low mass loss in percentage at 3.39%. As a result, AF mixes that contained AF1.0 had higher salt resistance. The well-compacted particles were what led to the connectivity of the particles and the reduced grain size. The very low mass loss value in the AF1.0 mix was 3%, and all of the mass loss values were lower than AF0.0. As a result, the AF1.0 mixes showed stronger resistance to salt assault, as shown by a percentage of mass loss, at 3.39%.

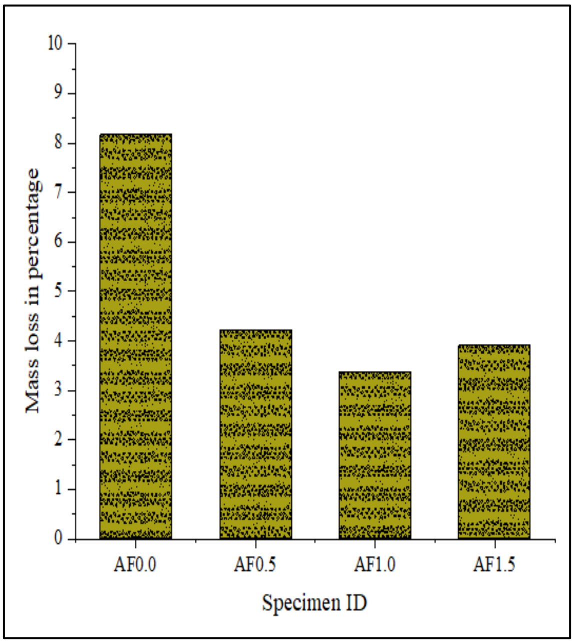

Fig.24 Percentage of Mass Loss on Salt Resistance Test

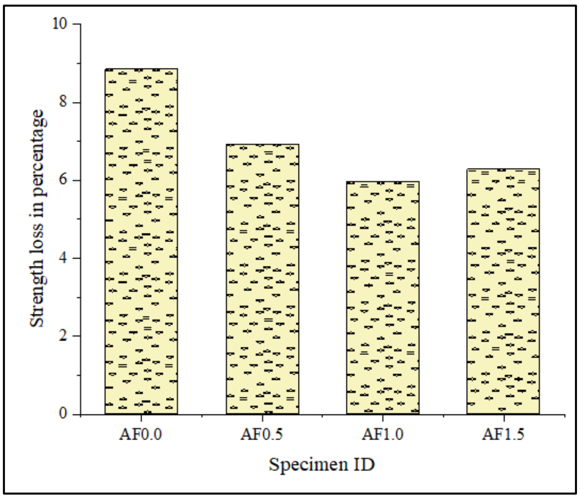

Fig.25 Percentage of Strength Loss on Salt Resistance Test

The compressive strength of AF0.0, AF0.5, AF1.0, and AF1.5 was evaluated both after and before immersion. After 30 days of immersion in a solution of 5% sodium chloride, the compressive strength of AF0.0, AF0.5, AF1.0, and AF1.5 decreased by 8.86%, 6.94%, 5.97%, and 6.30%, respectively. As a result, it was determined from the test results that the AF0.5 mix had a greater value of 6.94% strength loss when compared to standard concrete, as well as the results of loss of mass and loss of strength, as shown in Fig. 24 and Fig. 25. The strength loss in the mix AF1.0 was less than that of standard concrete, coming in at 5.97%. The visual appearance of the AF0.0 and AF1.0 specimens submerged in sodium chloride solution for 30 days is depicted in Fig. 26.

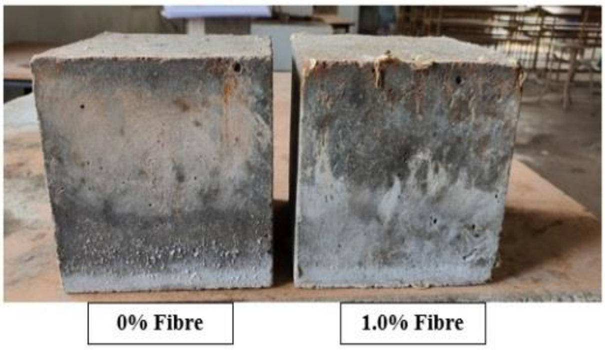

Fig.26 After 30 days of immersion in NaCl solution the visual appearances of the AF0.0 and AF1.0 specimens

4. CONCLUSION:

The findings of this experimental inquiry can be used to draw the following conclusions. Numerous studies on durability traits, including water absorption, Sorptivity, RCPT, acid resistance, sulphate resistance, and salt resistance were performed, were conducted.

- The AF1.0 mix absorbed 5.18% less water than traditional concrete in the water absorption test.
- The sorptivity and water absorption of concrete were both dramatically reduced by the use of Aramid fibre. The specimen with 1.0% AF exhibited the lowest Sorptivity.
- The AFRC mixes performed poorly in the Rapid Chloride Ion Penetration test, especially the mix AF1.0, which had a low penetration value of 64.04% when compared to AF0.0.
- The mix AF1.0 compared to AF0.0 had the least bulk and strength loss in terms of acid resistance.
- For sulphate resistance, the mix AF1.0 showed the lowest mass loss and strength loss compared to AF0.0.

- Lastly, the results of the durability test showed that all of the AFRC mixes performed well, with the mix AF1.0 performing very well in contrast to conventional concrete. The mix AF1.0 had the lowest mass loss and strength loss for salt resistance compared to AF0.0.

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