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DURABILITY OF FIBER REINFORCED CONCRETE WITH ARTIFICIAL SAND

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ABSTRACT

Concrete is the combination of cement, natural sand or artificial sand and aggregate which are used in civil engineering works such as township project and infrastructure work .

The present research work shows the study of cement concrete with varying percentage of fibers which are namely 0.10%, 0.20%, 0.30% ,0.40% & 0.50%. M20 grade concrete was adopted. Sizes of cube (15*15*15 cm) were used for testing. Compressive test of cubes was carried out with different types of fibers namely AFRC and NFRC with natural sand and artificial sand.

The aim of this research is to use of different fiber as reinforcement in concrete for a greater durability, workability and reduction in crack. The present work is concerned with the compressive strength of FRC specimens (132 cubes) with 90 days of normal water curing and 90 days curing in sulphate & chloride.

The method of mixing play an important character in FRC in which stress is determined by the fiber orientation. FRC controls micro cracking and deformation under load much better than plain concrete.

About 43.8 N/mm^2 extreme compressive strength found with N.S at 0.4% fiber concentration when cubes samples were cured in plain water (AFRC) & about 44.1 N/mm^2 extreme compressive strength found with natural sand at 0.4% fiber concentration when cube samples were cured in NaCl & $MgSO_4$ mixed water (AFRC) and about 35.8 N/mm^2 compressive strength found with artificial sand at 0.4% fiber concentration when cubes samples were cured in plain water (AFRC) & about 39.9 N/mm^2 compressive strength found with artificial sand at 0.4% fiber concentration when cube samples were cured in NaCl & $MgSO_4$ mixed water (AFRC).

KEYWORDS: Fiber Reinforced Concrete (FRC), Natural Fiber Reinforced Concrete (JUTE) (NFRC), Natural sand (N.S), Artificial sand(A.S), Chemical curing(C.C), Water curing(W.C), Artificial Fiber Reinforced Concrete (PIPE CHIPS) (AFRC).

INTRODUCTION

Conventionally concrete is construction material which are used in different types of construction work and in which the properties of aggregate affect the durability and workability of concrete, so fine aggregate play an major role in concrete mix design. The generally used fine aggregate is natural sand and artificial sand.

Natural sand and coarse aggregate are near about 75% of total volume of concrete. Therefore, we have to select right type and good quality aggregate for concrete, as the aggregate is the major ingredient of the concrete or mortar and provide strength to the concrete. Concrete is a construction material composed of cement, sand, aggregate, water and admixtures.

The method of using fibers to improve the properties of concrete is very aged process and its early applications such as addition of horse hair, etc for the reinforcement of plaster. Use of fiber reinforcement in concrete mix which enhance strength and ductility, but requires proper placement of fiber with proper skill. Fibers addition to concrete

makes it a more uniform and close to isotropic material. When concrete cracks, then fiber orientation play an important role to arrest crack formation and propagation, and thus improve strength and ductility.

The addition of these fiber into concrete which help to improve the compressive strength of concrete and also improves the, tensile strength, and impact strength of concrete. FRC has found many applications in civil engineering.

In the present work, the two type of fiber have been used that is jute fiber (natural fiber) and plastic pipe chips fiber (artificial fiber) in a concrete along with different percentage of fiber varies from 0.1 to 0.5 % along with 100% natural sand and also with artificial sand. Total 132 cubes were casted in which 66 cubes were placed in normal water curing and remaining 66 placed in mixed NACL and $MgSO_4$ solution for 90 days. After normal curing and chemical curing we had compared the compressive strength and durability of these cubes.

OBJECTIVE

The durability of two categories of fibers (AFRC and NFRC) & comparison between them is to be studied so that its can be used in different type of building or infra work and which are cheap in cost.

- To analyze and compare durability of AFRC specimens with natural sand or artificial sand when it is cured for 90 days in normal water & 90 days in chemical mix ($NaCl+MgSO_4$) water.
- To analyze and compare durability of NFRC specimens with natural sand or artificial sand when it is cured for 90 days in normal water & 90 days in chemical mix ($NaCl+MgSO_4$) water.

SCOPE OF WORK

- To overcome or minimize the hair cracking, micro cracks & chemical effect of concrete by addition of small quantity of fibers.
- To provide applications, use of different types of fibers on a single place and also their comparison between them, so that the best one can be chosen which fulfills the requirement of work

There are many types of fibers with different properties and that type of fibers are use in concrete such as artificial fiber, natural fiber also like Jute, Sisal, rice husk etc Fibers are usually used in concrete to control micro crack due to plastic shrinkage of concrete and also drying shrinkage of concrete. They also reduce the permeability of concrete and due to which its control the concrete bleeding and Some fibers produce heavy impact–, abrasion–, and shatter–resistance in concrete The durability and strength of concrete can be changed by making changes in its material like cement, sand such as natural sand or artificial sand , aggregate and water and by adding some special admixtures.

The micro cracks and void decrease the strength of concrete and this drawback can be removed by inclusion of fibers in the mix due to which its improve the strength and also overcome the other major problem. There are several types of fibers, such as those used as in composite materials have been introduced into the concrete mix due to which it increase the toughness of concrete or ability to resist the micro crack growth. The fibers help to distribute loads along the internal cracks and these type of concrete is called fiber-reinforced concrete (FRC).

The definition of Fiber Reinforced Concrete (FRC) can be express such a way that a concrete which consist of mix cement, sand and aggregate mixtures in which fibers are uniformly spread on it and properly mixed with concrete . The fibers which are used in FRC may be of various materials like plastic form polymer, carbon, asbestos, glass,polypropylene, jute etc. The addition of fibers in a concrete mass which enhance the compressive strength of concrete and also enhance the Impact strength and FRC has found many advantages in civil engineering which help to improve its properties.

EFFECT OF FIBER IN CONCRETE

Fiber play an important role to control the permeability of concrete and due to which concrete is free from bleeding and also fibers are used in concrete to control the two type of shrinkage cracks such as drying shrinkage cracking of concrete and plastic shrinkage cracking of concrete. The strength of fiber and its capacity to bond with concrete particles play an important role which depend upon the aspect ratio of fiber that is length by diameter of fiber.(L/D) and Some types of fibers produce greater impact and abrasion resistance in concrete and the concrete strength are also

improve by fiber addition to the concrete. The appropriate use of fiber in concrete its control the problems of concrete such as cracks, bleeding etc. and also very help full for the construction .

Fiber Types

- **Artificial (plastic pipe chips) Fibers**- nylon and polyester. Diameter varied from 0.02 to 0.38 mm and here we have to use plastic pipe chips as fiber of Thickness varied from 0.04 to 0.5 mm
- **Natural (jute) Fibers-** jute**,** wood, asbestos, cotton, coir, bamboo, and rock-wool. These had wide range of sizes.

Aspect Ratio

Aspect Ratio is the **ratio of length of the fiber to the diameter of its cross-section.** Typical aspect ratio ranged between **20 to 150.**

Aspect Ratio = Length (L) / Diameter (D)

Aspect Ratio

Artificial Fiber

In this project we have to use Polyvinyl Chloride Pipe (PVC) as a Artificial fibers (plastic pipe chips) are made up raw materials as Polyvinyl Chloride based chemicals and they are generally manufactured from raw PVC materials that have capacity to withstand in long alkaline or chemical environment of concrete 15]. PVC comes in two basic forms: rigid type and other one is flexible type . The construction pipe is generally made by rigid type which are used in construction site for electrification and in profile applications such as doors of houses. It is also used for making plastic bottle and ATM cards as). It is highly flexible and softer with plasticizers addition. and Pure poly (PVC) is a white in color, and having brittle solid characteristic. PVC is impossible to solve in alcohol but slightly dissolved in tetra-hydro-furan .These PVC materials are polymerized into a long, linear chemical that bond to nearest atoms. Artificial fibers use in concrete because they add little or more strength and That's why some builders add artificial fiber such as plastic fiber to concrete as 2nd reinforcement. Unlike structural reinforcement, synthetic fiber provides a benefit while concrete is still plastic.

Water = 200 liters (approx.)	**$MgSO_4$ = 5 kg, NaCl = 5 kg**

Chemicals for Durability

METHOD OF WORKING AND PROCEDURE

For manufacturing of **M20** Grade of Concrete, following methods are generally adopted:-

Batching: The definition of batching is defined as measurement of the material for making concrete is called as batching. There are two types of batching such as Volume Batching and Weight batching and In this project i have to use weight batching for making Fiber Reinforced. Concrete. Weight batching is better method of measuring materials for important concrete

Cement	Sand	Aggregate
1 kg	1.5 kg	3 kg

Proportion Adoption

Mixing: The cement, sand and aggregate of different size are consistently mixes along with fibers so that it can form the consistently concrete and Mixing should ensure that the concrete becomes homogenous and concrete should have workability.

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Calculation: The calculation for M_{20} (1:1.5:3) concrete:-

- Size of cube **0.15 * 0.15 * 0.15 m**.
- Volume of cube: **0.0033 mm^3**
- Concrete required of 1-cube is **23 kg**
- Concrete required for **132 cubes** **2252 kg.**
- Water cement ratio = **0.45**
- Total water for **132 cubes** **164 liters.**

Item	Weight (kg.)
Cement	**364**
Natural Sand	**756**
Artificial Sand	**756**
Aggregate (metal 1)	**566**
Aggregate (metal 2)	**566**

Quantity Of Material Used

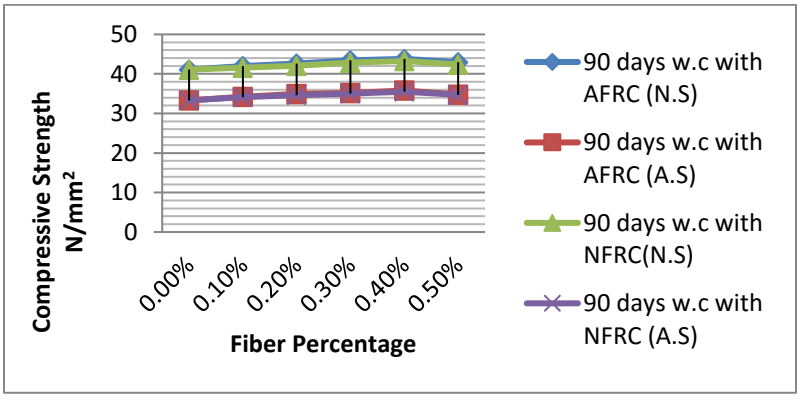
RESULTS

The FRC cubes sample cured in plain water for 90 days, compressive test are following:

	AFRC WITH N.S			**NFRC WITH N.S**			**AFRC WITH A.S**			**NFRC WITH A.S**		
Fiber content (%)	**Compressive strength (N/mm^2)**			**Compressive strength (N/mm^2)**			**Compressive strength (N/mm^2)**			**Compressive strength (N/mm^2)**		
0.0%	42.2	41.1	40.0	42.2	41.1	40.0	32.0	34.2	33.8	32.0	34.2	33.8
	41.1			41.1			33.3			33.3		
0.1%	41.1	41.3	43.3	42.9	41.5	40.2	36.7	34.4	31.5	36.7	34.2	31.5
	41.95			41.5			34.2			34.1		
0.2%	41.5	43.5	42.7	40.7	42.0	43.5	36.0	33.5	*35.1*	34.0	36.0	33.8
	42.60			42.1			34.9			34.6		
0.3%	43.7	43.5	42.9	42.0	43.5	43.1	32.7	36.0	36.7	32.4	37.1	35.5
	43.4			42.9			= 35.1			35.0		
	44.2	44.2	42.9	43.5	43.8	42.4	35.3	35.7	36.2	36.9	32.4	41.5

0.4%												
	43.80			43.2			35.8			35.5		
0.5%	43.3	43.5	41.8	42.0	41.3	44.0	36.2	33.3	34.9	33.3	35.1	35.8
	42.9			42.4			= 34.8			34.7		

Compressive stress (N/mm^2) after 90 days cured in plain water with A.S and N.S

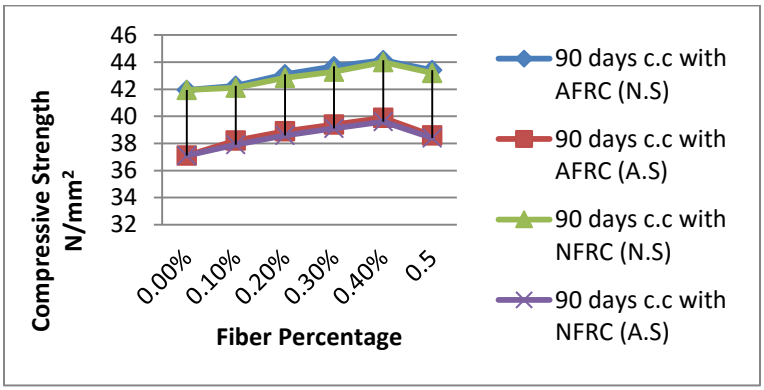


90 days water cured compressive strength of AFRC with natural sand and artificial sand, NFRC with natural sand and artificial sand (scattered chat)

	AFRC WITH N.S			**NFRC WITH N.S**			**AFRC WITH A.S**			**NFRC WITH A.S**		
Fiber content (%)	**Compressive strength (N/mm^2)**			**Compressive strength (N/mm^2)**			**Compressive strength (N/mm^2)**			**Compressive strength (N/mm^2)**		
0.0%	41.5	41.8	42.4	41.5	41.8	42.4	40.4	34.0	36.9	40.4	34.0	36.9
	41.9			41.9			37.1			37.1		
0.1%	41.5	43.1	42.0	41.5	43.5	41.3	39.3	36.2	39.1	39.3	35.5	38.9
	42.2			42.1			38.2			37.9		
0.2%	43.3	44.0	42.0	42.0	43.8	42.7	38.0	38.2	40.4	39.8	38.4	37.8
	43.1			42.8			38.9			38.6		
0.3%	44.0	44.0	43.1	44.0	43.5	42.2	39.5	41.1	42.0	39.1	40.0	38.2
	43.7			43.3			39.4			39.1		
0.4%	44.2	44.0	44.2	44.2	43.8	44.0	39.8	39.1	40.9	40.2	39.1	39.5
	44.1			44.0			39.9			39.6		

0.5%	44.0	43.3	42.9	42.9	43.5	43.1	38.9	38.2	38.7	36.4	38.9	40.0
	43.4			43.2			38.6			38.4		

Compressive stress (N/mm ^{2})after 90 days cured in chloride and sulphate mixed water with A.S nd N.S



90 days chemical cured compressive strength of AFRC with natural sand and artificial sand, NFRC with natural sand and artificial sand (scattered chat)

CONCLUSION

The fiber orientation plays an important role to determine the compressive strength, which depends on the mixing. FRC controls the micro cracking, shrinkage and deformation under load much better than plain concrete. About 43.8 N/mm^2 compressive strength found with natural sand at 0.4% fiber concentration when cubes samples were cured in plain water (AFRC) & about 44.1 N/mm^2 compressive strength found with natural sand at 0.4% fiber concentration when cube samples were cured in NaCl & $MgSO_4$ mixed water AFRC and On the other hand 35.8 N/mm^2 compressive strength found with artificial sand at 0.4% fiber concentration when cubes samples were cured in plain water (AFRC) & about 39.9 N/mm^2 compressive strength found with artificial sand at 0.4% fiber concentration when cube samples were cured in NaCl & $MgSO_4$ mixed water.(AFRC).

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