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DURABILITY OF HYBRID FIBRE REINFORCED CONCRETE

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ABSTRACT

In Hybrid fiber reinforced concrete, hybrid fibers (steel fibers and polypropylene fibers) along with admixture like Alccofine-1203 will be used. The hybrid fiber will help to reduce the cracks due to shrinkage, creep and early age cracking along with an increase in ductility, toughness and fatigue resistance. The mineral admixture (Alccofine-1203) will help to increase the strength of concrete, modulus of elasticity along with workability, durability, and reduction in segregation. Both the mineral admixture (Alccofine) and hybrid fibers (Steel fiber and polypropylene fiber) will be beneficial to HFRC to achieve better structural performance. They also reduce the permeability of concrete and thus reduce bleeding of water. Experiments will be conducted to study the effect of steel fiber and polypropylene fiber in different proportion in hardened concrete. we are conducting Tests like Compressive strength test, Flexural strength test and durability tests like Water permeability test, Acid attack test, Water absorption test and Fire resistance will be conducted on hybrid fiber reinforced concrete using Steel Fiber, Polypropylene fiber, and Alccofine-1203.

KEYWORDS: Durability, Hybrid fiber reinforced concrete, Alccofine-1203, Polypropylene Fiber, Steel fiber.

I. INTRODUCTION

The definition of concrete is the mixture of cement, water, coarse aggregates, sand, or sometimes super-plasticizers. The most important part of concrete is cement. At the production of cement, it's raw material produces a lot of gases one of them is CO_2. The most effective way to decrease the CO_2 emission of cement industry is to substitute a proportion of cement with other materials.

The durability of cement concrete is defined as its ability to resist weathering action i.e. physical, chemical or any other type of attack to the process of deterioration. Durable concrete will retain its original form strength, quality, and serviceability when exposed to the environment. There are many reasons for deterioration of concrete one of the main reasons for the deterioration of concrete in the past is that concrete compressive strength rather than on the performance criteria. The deterioration of reinforced concrete structures usually involves from the surrounding environment followed by physical and chemical actions happens in internal structure. The transport of aggressive gases or liquids into concrete depends on its permeation characteristics. As the permeation of concrete decreases its durability performance, in terms of degradation, increases.

Using Hybrid Fiber Reinforced Concrete (HFRC) one of the important properties of it is its superior resistance to cracking and crack propagation. Many experiments are taking globally for improving the strength of concrete suggests that cement replacement materials along with Mineral and chemical admixtures can improve the ability and durability characteristics of concrete. We introduce Alccofine, Steel fiber, and polypropylene fiber these materials that can be used to produce high strength as well as highly durable concrete composites, they also improve the compressive strength, workability, and fluidity of the mix. It also shows segregation resistance and durability of the concrete structures.

II. LITERATURE REVIEW

The researcher Saurav and Ashok Kumar Gupta in this paper researcher presented a comparison between cubical strength and cylindrical strength of normal concrete and with partial replacement of cement with ultrafine slag (Alccofine). The researcher subdivided into 8 groups Control concrete without alccofine, Control

concrete with 3% ,5%,7%,10%,13%,15% and 18%. They are tested for 3,7 and 28 days. After testing researcher concluded that 1) Hardened properties of concrete with alccofine are enhanced. 2) The optimum alccofine percentage which enhances the hardened properties of a cube and cylindrical concrete is 13%. 3) After 10% replacement of alccofine there is a very nominal change in the strength of conventional concrete. 4) The cylindrical strength of concrete increases after addition of alccofine but always less than its cubical counterpart.
The other researchers Selina Ruby G., Geethanjali C., Jaison Varghese, and P. Muthu Priya in this paper researcher presented, The usefulness of hybrid fiber reinforced concrete in various Civil Engineering applications. This study explores the feasibility of hybrid fiber reinforced concrete. The concrete manufactured by using cement, fine aggregate, coarse aggregate, steel fiber, polypropylene fiber. Fiber Reinforced Concrete is concrete containing fibrous material which increases its structural integrity. The result indicated that it is beneficial to manufacture the fiber reinforced concrete with fiber proportion S0.75P0.25, i.e., 75% steel fiber and 25% polypropylene fiber. This combination of fiber gives better results in terms of compressive strength and spilt tensile strength. The maximum compressive strength reaches in the hybrid fiber reinforced concrete using combination S0.75P0.25, i.e., 75% steel fiber, and 25% polypropylene fiber because of the high elastic modulus of steel fiber and the low elastic modulus of polypropylene fiber work in perfect combination. The spilt tensile strength of fiber percentage with S0.75P0.25 shows a slight increase in strength. Improved tensile strength can be achieved by increasing the percentage of steel fiber.

III. RESEARCH OBJECT

1. To study the durability of hybrid fiber reinforced concrete.
2. To study the effects of mineral admixture Alccofine-1203 with Hybrid Fiber Reinforced Concrete (HFRC).
3. To study the performance of high strength concrete mainly compressive strength, flexural strength, water absorption test and permeability test etc using alccofine.
4. Comparison between with and without using alccofine and fiber.
5. To find out parameters like durability

IV. EXPERMINTEL DETAILS

- **Materials**

1. Cement

Ordinary Portland cement (OPC) of 53 grades 12269-1987 was used for the experimental work that was locally available with the brand name "BIRLA SUPER SHAKTI" Cement.

2. Coarse Aggregate

Broken granite stones were used as a coarse aggregate in concrete. The size of the coarse aggregate used in the investigation was 10 -20 mm. The specific gravity of the coarse aggregate was found to be 2.87.

3. Fine Aggregate

In the current study, the high-performance concrete mixes were prepared using locally available river sand. Fineness modulus and specific gravity of the crushed sand were found to be 3.76 and 2.71 respectively. Similarly, Fineness modulus and specific gravity of the river sand were found to be 2.00 and 2.56 respectively

4. Water

Water is an important ingredient of the concrete as it actually participates in the chemical reaction with cement. In general, water fit for drinking is suitable for mixing concrete. Impurities in the water may affect setting time, strength, shrinkage of concrete or promote corrosion of reinforcement. Locally available drinking water was used in the present work.

5. Steel fiber

Steel fibers are thin filaments of wires, deformed and cut to length, for reinforcement of concrete, mortar and other composite materials. It is a coldly drawn wire fiber with corrugated and flatted shape. Steel fibers mixed into the concrete can provide an alternative to the provision of conventional steel bar or welded fabric in some application

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6. Polypropylene fibers

Typically they may be added to concrete at a rate about 0.9 kg/cum. Their main role is to improve the properties of the fresh concrete. They increase the homogeneity of the mix, stabilizing the movement of solid particles and blocking bleed blocking bleed water channels. This reduces the bleed capacity of the concrete and slows down the bleed rate, helping to reduce plastic settlement. Polypropylene fibers have a limited effect on the properties of the hardened concrete. They do not provide any significant post first crack ductility.

7Alccofine 1203

Alccofine 1203 is proprietary of low calcium silicate-based mineral additive. Controlled granulation process results from in unique particle size distribution. Its latent hydraulic property and pozzolanic reactivity results in enhanced hydration process. The addition of Alccofine 1203 improves the packing density of paste component. This results in lowering water demand, admixture dosage and hence improving strength and durability parameters of concrete at all ages.

8. Super-plasticizer

Super-plasticizer was used to improve the workability of concrete. As per Indian standards, the dosage of super plasticizer should not exceed 2% by weight of the cement. A higher dosage of super plasticizer may delay the hardening process. After trials, the optimal dosage of the super plasticizer was found to be 1% to produce slump of 15 mm.

- **Mix proportion**

Several specimens were cast for different tests accordingly. HFRC Specimens of grade M60 was cast by ACI method.

These are subdivided into four groups as follows

1. Plain concrete (P)
2. Plain concrete with alccofine (PA)
3 Plain concrete with fiber (PF)
4. Plain concrete with alccofine and with fiber (PAF)

Specimens were tested at age of 28 days compressive strength.

- **Mixing, Demoulding, and Curing**

Thorough mixing and adequate curing are most essential for achieving a good concrete. In the laboratory, the concrete was mixed in a mechanical and hand mixing. The mixing time was kept to about 3–4 min for normal concrete. Generally, the demoulding was done 24 hr of casting. Potable water was used for curing all the concretes. All the concretes were kept in the moist environment immediately after the initial set and before the demoulding.

Table1. Mix proportion (Kg/m3) for grade M60 (w/c 0.33)

Sr. No.	Material	Specifications	Estimated Quantity
1.	Cement	OPC 53 Birla super	160KG
2.	Fine Aggregate Coarse Aggregate	River sand 10mm 20mm	182KG 109KG 164KG
3.	Water	Tap water	54KG
4.	Super-plasticizer		1.00KG
5.	Additive	Ambuja Alccofine1203	12.0KG
6.	Fibers Polypro-pylene Steel	Dolphine Strongcrete 3-5mm length Dramix 0.55mm dia.	1.8KG 7.4KG

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Alccofine- 7.5% of cement volume
Fiber Content- 1.5% of total volume (In 1.5% of vol. it is taken in 80% and 20%)
Steel fiber- 80%
Polypropylene fiber- 20%

V. EXPERIMENTAL PROCEDURE

1. Compressive Strength

The compressive loading tests on concrete were carried out on a compression testing machine (CTM) of capacity 2000 kN. For the compressive strength test, a loading rate of 2.5 kN/s was applied as per IS: 516–1959. The entire specimens used were 150 mm cube. The Test was performed at 28 days. The specimens were tested immediately after taking the cubes from curing tank in surface dry condition. Three test specimens were cast and used to measure the compressive strength for each grade by both methods and an average value was considere

Figure 1 Compression testing machine

2. Water Absorption Test

The study of the water absorption, which is closely related to durability of concrete, is very important because deterioration of porous materials like concrete is affected by migration of water. The absorption test was conducted using 150 mm cubes that were cured for 28 days. The specimens were weighed at oven dry condition **and wet condition and thus the water absorption were determined.**

$$\% \text{ water absorption} = \frac{W2 - W1}{W1} \times 100 \quad \ldots\ldots (2)$$

Where, W_1 = Oven dry weight of specimen in grams.
W_2 = wet weight of specimen in grams

VI. RESULTS AND DISCUSSION

1Compression of Compressive Strength

The Compression of compressive Strength of M60 grade concrete for different mixtures are presented in table 1and illustrated in fig.1 The data presented shows that the compressive strength of all specimens by ACI Method

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Table.2. Compressive Strength

Mixture	Block No.	Compressive Strength	Average strength
Plain Concrete (P)	1	62.66	61.77
	2	59.33	
	3	63.33	
Plain Concrete + Alccofine (PA)	1	69.7	68.36
	2	70.44	
	3	64.88	
Plain Concrete + Fibre (PF)	1	66.66	63.11
	2	64.44	
	3	58.22	
Plain Concrete + Alccofine + Fibre (PAF)	1	65.33	70.11
	2	67.11	
	3	80	

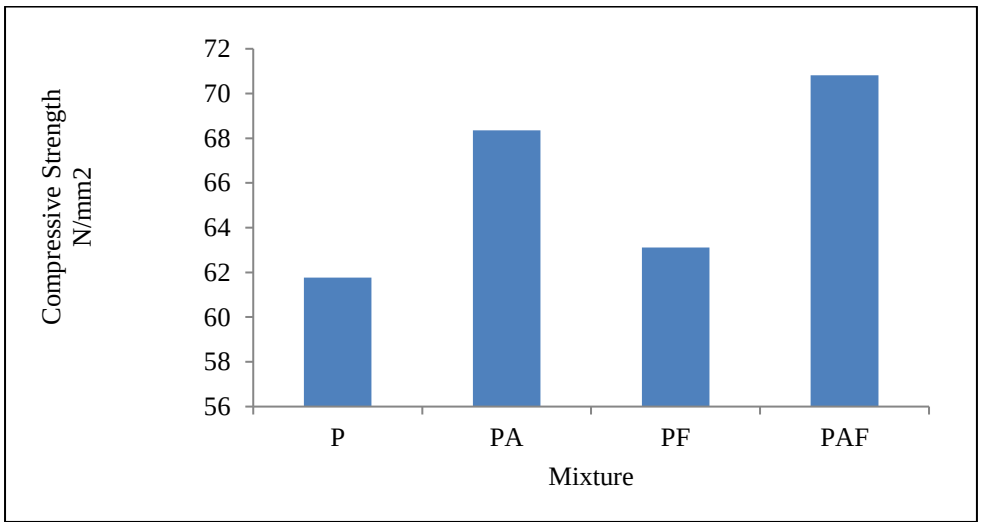

Figure 2 Compressive strength comparison

2. Water Absorption Test

In general, water absorption in the concrete causes serious problems, which may affect the strength of the concrete. In the experimental investigation, the measurements of difference in weight in the cubes were performed at. The test results of absorption are presented in Tables 2. The absorption of the cube 150 mm containing fiber together with admixtures are lower than that of alccofine for the tested age.

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Table 3.Water absorption in ACI method

Mixture	Block No.	Weight Before	Weight After Oven	Percentage Absorption	Average Percentage
Plain Concrete (P)	1	8.40	7.88	6.60	7.08
	2	8.30	7.70	7.79	
	3	8.72	8.16	6.86	
PlainConcrete + Alccofine	1	8.46	8.08	4.70	4.53
	2	8.38	7.96	5.28	
	3	8.62	8.32	3.61	
Plain Concrete + Fibre (PF)	1	8.50	8.00	6.25	6.33
	2	8.40	7.90	6.33	
	3	8.64	8.12	6.40	
Plain Concrete + Alccofine +	1	8.54	8.20	4.15	4.29
	2	8.28	7.94	4.28	
	3	8.44	8.08	4.46	

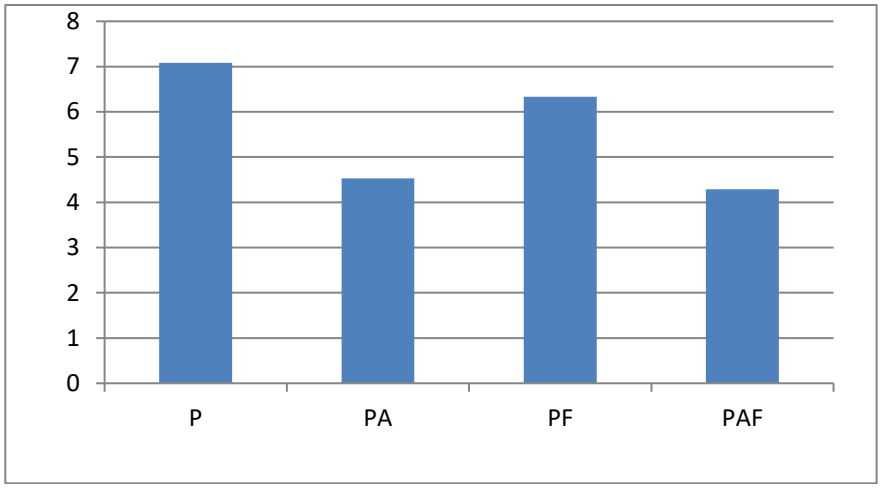

Figure 3 Water absorption comparison

An experimental study on the high performance concrete made with HFRC and partial replacement of cement with alccofine subjected to water curing is conducted for finding the mechanical properties such as compressive strength and water absorption characteristics of concrete mixtures. Concrete specimens were prepared with M60 grade concrete mix.

Following conclusions can be drawn from the study.

1. In Compressive Strength result shows HFRC + alccofine give exceptionally high compressive strength as compare to plain concrete.
2. In water adsorption test addition of HFRC + alccofine gives lower water absorption while addition of only fiber increases the percentage.
3. The material which has less water absorption which shows high strength means that is more durable.

VII. RESULTS AND DISCUSSION

An experimental study on the high performance concrete made with HFRC and partial replacement of cement with alccofine subjected to water curing is conducted for finding the mechanical properties such as compressive strength and water absorption characteristics of concrete mixtures. Concrete specimens were prepared with M60 grade concrete mix.

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