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STUDY ON THE PERFORMANCE OF ADMIXTURE AND SYNTHETIC POLYMER FIBER IN CONCRETE

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Abstract:-

This paper inspect on exploring the effects of using fiber and admixture in the mechanical properties of the strength of concrete of different grades. The primary concern of this study is to establish the divergence in the strength properties of M20, M25 and M30 concrete with addition of admixture and polymer fiber. Based on the compressive strength of fifty four tested cylinders, the results show that the addition of admixture and polymer fiber both give higher strengths more than that of the reference concrete which largely can be used to reduce the percentage of cement.

Key Words:-*Admixture, micro fiber, concrete.*

1. INTRODUCTION

Concrete is the most widely used man-made construction material in the world, and is second only to water as the most utilized substance on the planet. It is obtained by mixing cementitious materials, water, aggregate and sometimes admixtures in required proportions. Fresh concrete or plastic concrete when freshly mixed can mould into any shape and on harden state forms a rock like mass known as concrete. (Shah, 2014) It is a composite, consisting of aggregates enclosed in a matrix of cement paste including possible pozzolans, has two major components – cement paste and aggregates (Rashid, 2009) .Concrete plays important role in the construction industry but it has some drawbacks. To overcome these drawbacks the search for durable and sustainable construction materials is the need of time (Shivani R. Bothra, 2015). One of the main tasks of the construction industry is to increase the strength and reliability of structures while reducing construction costs. Due to the high availability, consistency, reliability, and affordability of concrete, however, concrete will likely remain a primary construction material in the future. As a result of the Kyoto Protocol for regulating CO2 emissions and energy consumption in the international community, construction industries all over the world are trying to reduce cement usage, find alternative materials, and use recycled materials for future construction projects (Koo, 2014). Effective use of fiber reinforced concrete is likely to lead to reduction in cement and reinforcement (Shah, 2014). On this background, a study on the contribution of both fiber and admixture on concrete and variation of strength with different mix design proportion is an emerging demand.

Fiber reinforced concrete is cement- based composite material that has been developed in recent years. Fiber Reinforced Concrete can be defined as a composite material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibers (Shah, May 2014). However, polymer fiber may serve as a super plasticizer admixture which may result to concrete's lower rate of water absorption, high-range water reducer, greater strength and excellent in elasticity (Jr, 2013).An admixture, according to the ASTM C-12597a standards, is a material other than water, aggregates or hydraulic cement that is used as an ingredient of concrete or mortar, and is added to the batch immediately before or during mixing (Somayaji, 2001).

2. EXPERIMENTAL PROGRAM

The experimental program was planned to quantify the compressive strength of M20, M25 and M30 concrete using admixer and polymer fiber. This investigation was conducted to observe the effects of different additives on concrete, contributing in the compressive strength at various ages of curing. To attain the aim of present study experimental investigation was carried out on 54 Nos. cylinders; eighteen cylinders each were prepared for M20, M25 and M30 concrete.

2.1. MATERIALS

2.1.1 CEMENT

Thirty six test specimens were prepared using Portland cement of type CEM 2.

TABLE I: PHYSICAL PROPERTIES OF CEMENT

Physical Properties	Results	Requirements as per IS:12269-1987 (RA 2008)
Specific Gravity	3.14	
Consistency	26%	Not specified
Initial setting time	2 hours	Shall not be less than 30 Minutes
Final setting time	3 hours	Shall not be more than 600 Minutes
Compressive strength		
1. 72 ± 1 h (average of three results)	15 MPa	Shall not be less than 27.0 MPa
2. 168 ± 2h (average of three results)	25 MPa	Shall not be less than 37.0 MPa
3. 672 ± 4h (average of three results)	40 MPa	Shall not be less than 53.0 MPa

TABLE II: CHEMICAL PROPERTIES OF CEMENT

Chemical Constituents	Percentage (%)
CaO	63
SiO_2	23
Al_2O_3	6
Fe_2O_3	4.5
MgO	2.6
SO_3	2.2

2.1.2. AGGREGATE

The locally available stone chips were collected and characterized in the laboratory. Table III shows the sieve analysis of aggregate.

TABLE III: SIEVE ANALYSIS OF AGGREGATE

SIEVE SIZE	% PASSING BY WEIGHT
19.0 mm	10
13.5 mm	50
9.51 mm	30
4.76 mm	10

The gradation of aggregate were found out giving more compressive strength to concrete from another investigation conducted in the HBRI laboratory.

2.1.3. ADDITIVES

2.1.3.1. ADMIXTURE

Locally available water reducing super plasticizer DARACEM 100 was used in a view to get high strength mortar which complies with the requirements of ASTM C-494. 1% of admixture of total amount of cement was used.

2.1.3.2. POLYMER MICROFIBER

Polypropylene fibers of 20 mm in length were used. The standard addition rate was chosen as 600 g/m^3 of mortar. Twelve cylinders incorporated with nylon fiber and twelve with polypropylene fiber were prepared.

2.2. PREPARATION OF CONCRETE SAMPLES

The preparation of concrete cylinders included the following steps

-weighing of the materials such as cement, aggregate and the additives;

- hand mixing of dry materials in order to uniformly distribute fibers and admixture into the concrete premix;
- Hydrating the mixture by adding the target quantity of water. Table IV shows the water cement ratios and slump - Mechanical shaking of the mixture at slow speed (for about two minutes) until a homogeneous and workable product of semi-fluid consistency was obtained;
- Casting cylindrical specimens into 100mm×200mm molds and accurately vibrate them.

We removed the specimens from the formworks after 24 h curing at room temperature. Next, we cured the unmolded specimens in water at 23 °C until testing. We examined nine plain mortar specimens and twenty four specimens in correspondence with two different fibers and admixture, thus obtaining a total of 36 cylindrical specimens.

TABLE IV:W/C RATION AND SLUMP

	M20			M25			M30		
	NC	AC	PC	NC	AC	PC	NC	AC	PC
W/C ratio	0.5	0.4	0.5	0.45	0.35	0.45	0.45	0.40	0.45
Slump(mm)	25	20	25	75	100	75	75	80	75

3. RESULTSAND DISCUSSION

3.1. RESULTS OF COMPRESSIVE STRENGTH

Sample	Compressive Strength(MPa) (3rd day)	Compressive Strength(MPa) (7th day)	Compressive Strength (MPa) (28th Day)
Normal Concrete (NC)	20.16	24.55	26.79

Results show that the addition of admixtures And polymer fiber give increase to the strength of mortar. The increase in compressive strength is due to the bonding effect of fiber with matrix.

TABLE V: COMPRESSIVE STRENGTH TEST RESULTS (TARGETED MINIMUM STRENGTH M20)

Admixture Mixed Concrete(AC)	25	26.82	31.14
Polymer Fiber Mixed Concrete(PC)	21	23.63	30.76

FIGURE 1: COMPRESSIVE STRENGTH VS DAYS OF CURING FOR M20

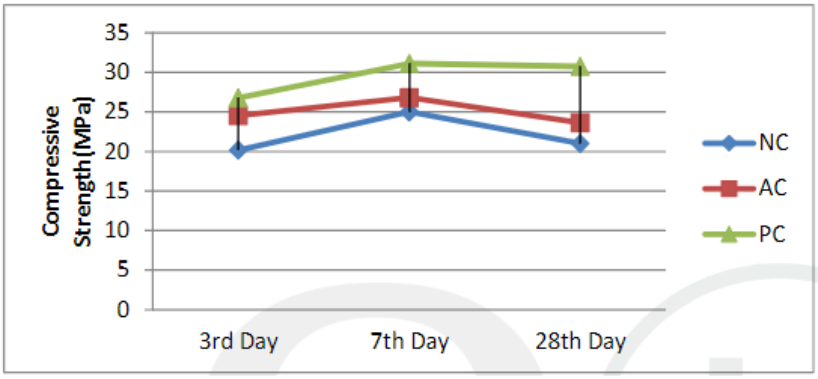
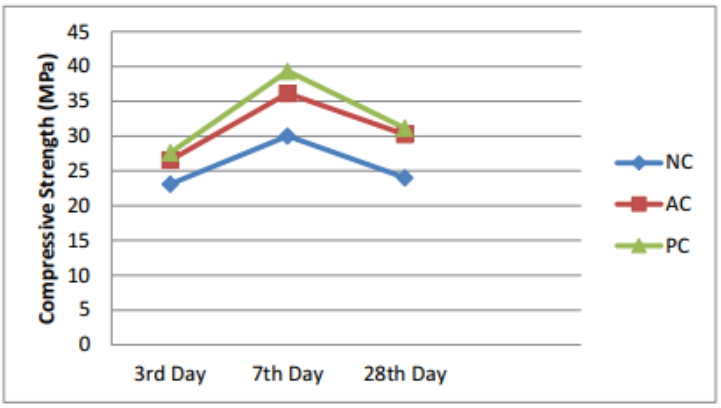


TABLE VI: COMPRESSIVE STRENGTH TEST RESULTS (TARGETED MINIMUM STRENGTH M25)

Sample	Compressive Strength(MPa) (3^{rd} day)	Compressive Strength(MPa) (7^{th} day)	Compressive Strength (MPa) (28^{th} Day)
Normal Concrete (NC)	23.10	26.55	27.60
Admixture Mixed Concrete(AC)	30	36.13	39.33
Polymer Fiber Mixed Concrete(PC)	24	30.23	31.14

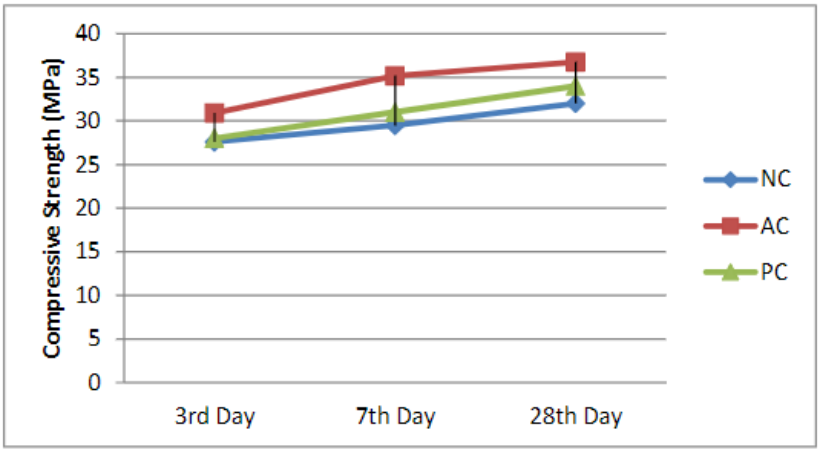
FIGURE 2: COMPRESSIVE STRENGTH VS DAYS OF CURING FOR M25



TABLEVII: COMPRESSIVE STRENGTH TEST RESULTS (TARGETED MINIMUM STRENGTH M30)

Sample	Compressive Strength(MPa) (3^{rd} day)	Compressive Strength(MPa) (7^{th} day)	Compressive Strength (MPa) (28^{th} Day)
Normal Concrete (NC)	27.60	29.49	32
Admixture Mixed Concrete(AC)	30.92	35.16	36.75
Polymer Fiber Mixed Concrete(PC)	28	31	34

FIGURE 3: COMPRESSIVE STRENGTH VS DAYS OF CURING FOR M20



3.2. DISCUSSION

Based on the results, the following conclusion may be drawn:

- Admixture and polymer mixed concrete shows a slight increase in the compressive strength as compared to plain concrete.
- It is observed that polypropylene fibers have not contributed significantly towards compressive strength of concrete.
- Maximum compressive strength was achieved for admixture.

4. CONCLUSION

The study on the introduction of the effect of fiber and admixture can promise for sustainable and long-lasting concrete structures. Lot of research work had been done on fiber reinforced concrete and lot of researchers work significantly over it. According to many researchers, the addition of steel fiber into concrete creates low workable or inadequate workability to the concrete; therefore to solve this problem of super plasticizer without affecting other properties of concrete may introduce (Shah, 2014). An endeavor was prepared to study the effect of use of fiber and admixture in concrete and draw a conclusion with respect to an optimum mix with the balance between the cost and the advantage it offers with respect to the mechanical properties. The general perception of fiber hindering the flow ability of concrete was discussed in detail with the industry experts and also observed during the conduct of field trails. It was inferred that the problem of hindrance in flow ability can be neutralized through nominal enhanced dosage of super plasticizer without compromising on other properties. This will enable a flow able concrete with fiber thereby increasing the tensile of concrete. For an M-60 concrete, use of fiber enhances the 56 day compressive strength up to 77 MPa.

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