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Mechanical Properties of Polypropylene Fiber Reinforced Self Curing Concrete

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Abstract

Today concrete is most widely used construction material due to its good compressive strength and durability. Depending upon the nature of work the cement, fine aggregate, coarse aggregate and water are mixed in specific proportions to produce plain concrete. Plain concrete needs congenial atmosphere by providing moisture for a minimum period of 28 days for good hydration and to attain desired strength. Any laxity in curing will badly affect the strength and durability of concrete. Self-curing concrete is one of the special concretes in mitigating insufficient curing due to human negligence paucity of water in arid areas, inaccessibility of structures in difficult terrains and in areas where the presence of fluorides in water will badly affect the characteristics of concrete. The present study involves the use of shrinkage reducing admixture polyethylene glycol (PEG 400) in concrete which helps in self curing and helps in better hydration and hence strength. In the present study, the affect of admixture (PEG 400) on compressive strength, split tensile strength and modulus of rupture by varying the percentage of PEG by weight of cement from 0% ,0.5%,0.75%,1%,1.25%,1.5% were studied M25 mix. It is also studied with 0.35% of polypropylene fiber. It was found that PEG 400 could help in self curing by giving strength on par with conventional curing. It was also found that 0.75% of PEG 400 for weight of cement was optimum for M25 grade concrete with and without polypropylene fiber for achieving

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maximum strength without compromising workability. It is also found that polypropylene fiber gives more strength than conventional concrete.

Keywords: *Polypropylene fiber, Glycol, Self Curing concrete*

I. INTRODUCTION

Proper curing of concrete structures is important to meet performance and durability requirements. In conventional curing this is achieved by external curing applied after mixing, placing and finishing. In this curing is done from 'outside to inside' Self-curing or internal curing is a technique in which moist condition is maintained in concrete for this process of curing is done from 'inside to outside'. There are three types of self curing they are explained as follows, the first method uses saturated porous lightweight aggregate (LWA) in order to supply an internal source of water, which can replace the water consumed by chemical shrinkage during cement hydration. The second method uses poly-ethylene glycol (PEG) which is a shrinkage reducing admixture (SRA), reduces the evaporation of water from the surface of concrete and also helps in water retention. The third method is use of super absorbent polymer (SAP) which is a polymeric material which is able to absorb a significant amount of liquid from the surroundings and to retain the liquid within its structure without dissolving and cures the concrete. Continuous evaporation of moisture takes place from an exposed surface due to the difference in chemical potentials (free energy) between the vapour and liquid phases. The polymers added in the mix mainly form hydrogen bonds with water molecules and reduce the chemical potential of the molecules which in turn reduces the vapour pressure, thus reducing the rate of evaporation from the surface. When the mineral admixtures react completely in a blended cement system, their demand for curing water can be much greater than that in a conventional ordinary Portland cement concrete. When this water is not readily available, significant auto- genous deformation and cracking may result. Due to the chemical shrinkage occurring during cement hydration, empty pores are created within the cement paste, leading to a reduction in its internal relative humidity and also to shrinkage which may cause early-age cracking. Internal curing (IC) is a method to provide the water to hydrate all the cement, accomplishing what the mixing water

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alone cannot do. Also, it provides water to keep the relative humidity (RH) high keeping self-desiccation from occurring. Maintains the strengths of mortar/concrete at the early age (12 to72 hrs) above the level where internally & externally induced strains can cause cracking. Can make up for some of the deficiencies of external curing, both human related (critical period when curing is required in the first 12 to 72 hours) and hydration. Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula H(OCH2CH2)n OH, where n is the average number of repeating oxy-ethylene groups typically from 4 to about 180. The abbreviation (PEG) is termed in combination with a numeric suffix which indicates the average molecular weights. One common feature of PEG appears to be the water-soluble nature. Polyethylene glycol is non-toxic, odourless, neutral, lubricating, non-volatile and non-irritating and is used in a variety of pharmaceuticals.

II. MATERIALS AND METHODS

The objective is to study the mechanical characteristics of concrete such as compressive strength, splitting tensile strength and modulus of rupture for percentage of PEG 400 such as 0%,0.5%,0.75%,1%,1.25%,1.5% of weight of cement for both M25 grade concrete with and without polypropylene fiber. The experimental program was designed to investigate the strength of self curing concrete by adding poly ethylene glycol PEG400 @ 0.5%, 0.75%, 1%, 1.25% and 1.5% by weight of cement to the concrete. Also it is studied by adding polypropylene fiber. The experimental program was aimed to study the workability, compressive strength, split tensile strength and modulus of rupture. To study the above properties mix M25 were considered. The scheme of experimental program is given in Table1.

Cement used in the investigation was 53 grade ordinary Portland cement confirming IS: 12269: 1987. The fine aggregate used was obtained from a nearby river source. The fine aggregate conforming to zone III according to IS: 383-1970 was used. Crushed granite was used as coarse aggregate. The coarse aggregate according to IS: 383-1970 was used. Maximum coarse aggregate size used is 20 mm. Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula H(OCH2CH2)n OH, The abbreviation (PEG) is termed in combination with a numeric suffix which indicates the average molecular weight. One common

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feature of PEG appears to be the water-soluble nature. The PEG-400 use in the investigation have Molecular Weight 400, Appearance Clear liquid, pH 5-7, Specific Gravity 1.126 . Polypropylene fiber is a synthetic fiber. There are various size of polypropylene fiber here we have used 20 mm fiber. The molecular formula is (C3H6)n. Here we have used 0.35% of weight of cement. The plain samples of cubes, cylinders and prisms were cured for 28 days in water pond and the specimens with PEG400 were cured for 28 days at room temperature by placing them in shade.

III. RESULTS AND DISCUSSION

The compacting factor test is designed primarily for use in the laboratory but it can also be used in the field. From this we can check the workability also. Compression test is done on specimen for 7, 14, 28 days. It is done in the machine capacity of 2000 KN. The axis of the specimen is carefully aligned with the centre of thrust of the spherically seated plate. The spherically seated block is brought to bear on the specimen and the load is applied without shock and continuously at a rate approximately 140 kg/cm2/min until failure of the specimen. The maximum load applied to the specimen until failure is recorded. Splitting tensile test is done on specimen for 7, 14, 28 days. It is done in the machine capacity of 500 KN. The cylinder is placed in such a way that the load is applied on the circumference area of the cylinder. Flexural test is done on specimen for 7, 14, 28 days. It is done in universal testing machine. The loading is, two point loading system as mentioned in IS 516,which creates a pure bending zone with constant bending moment in the middle third span and thus the modulus of rupture obtained is not affected by shear, as in the case of a single concentrated load acting on the specimen. It is loaded on a span of 300 mm. The compressive strength obtained at 0.75% of PEG 400 without fiber is 29.33 N/mm2 which is 7.04% more than controlled concrete and with fiber is 30.3 N/mm2 which is 10.58% more than controlled concrete. The splitting tensile strength obtained at 0.75% of PEG 400 without fiber is 4.02 N/mm2 which is 17.88% more than controlled concrete and with fiber is 4.11 N/mm2 which is 20.52% more than controlled concrete. Flexural strength obtained at 0.75% of PEG 400 without fiber is 3.79 N/mm2 which is 5.86% more than controlled concrete and with fiber is 3.845 N/mm2 which is 7.4% more than controlled concrete.

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Fig.1. Compression test of specimen



Fig.2. Split tensile test of specimen



Fig.3. Flexural strength of the specimen

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Table.2. Mechanical Properties of self curing concrete

S.No	NATURE	F_c (N/mm^2)		F_{split} (N/mm^2)		F_{prism}(N/mm^2)	
		Without Fiber	With fiber	Without fiber	With fiber	Without fiber	With fiber
1	Plain(0%)	27.4	27.86	3.41	3.62	3.58	3.7
2	0.5%	28.13	28.2	3.79	3.9	3.715	3.725
3	0.75%	29.33	30.3	4.02	4.11	3.79	3.845
4	1%	28.26	29.4	3.94	4	3.72	3.8
5	1.25%	27.73	28.4	3.69	3.96	3.68	3.74
6	1.5%	27.54	28.06	3.45	3.79	3.625	3.705

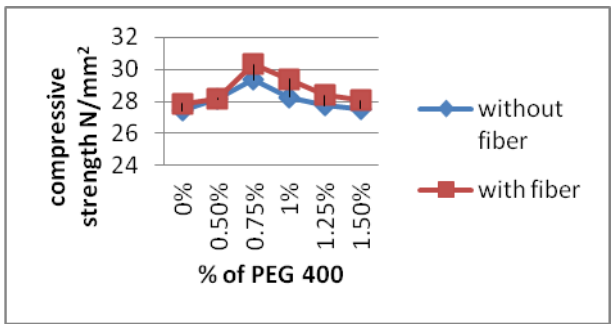


Fig.4. Variation in flexural strength of concrete

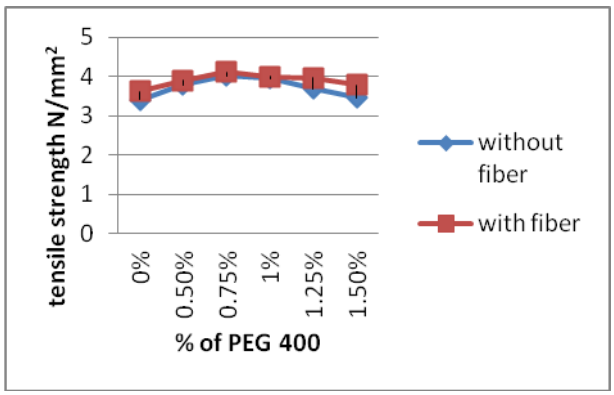


Fig.5. Variation in Split tensile strength of concrete

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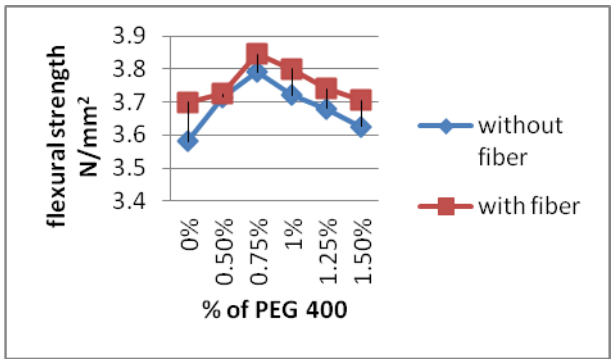


Fig.6. Variation in Flexural strength of concrete

IV. CONCLUSION

From the experimental results the optimal dosage of PEG 400 is 0.75% of weight of cement. It is also found that compressive strength, splitting tensile strength, flexural strength of self curing concrete is better than conventional concrete. It was found that PEG 400 could help in self curing by giving strength on par with conventional curing. It was also found that 0.75% of PEG 400 for weight of cement was optimum for M25 grade concrete with and without polypropylene fiber for achieving maximum strength without compromising workability. It is also found that polypropylene fiber gives more strength than conventional concrete.

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