EXPERIMENTAL STUDY ON SELF CURING CONCRETE WITH FLYASH AND QUARRYDUST

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Abstract

Concrete is the most widely used construction material due to its good compressive strength and durability. 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 aim of the investigation is to evaluate the use of water-soluble polyethylene glycol as self-curing agent glycol. Self-curing concrete of M40 grade were cast by replacing fine aggregate with 50% quarry dust and by varying quantity of fly ash by 5%, 10%, 15%, 20%,25%. In this study, compressive strength, split tensile strength, and modulus of rupture of self-curing concrete with optimum result of fly ash is evaluated and compared with the conventional concrete specimens.

Key Words: *Fly ash, Quarry dust, Compressive strength, Self curing concrete, Polyethylene glycol.*

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1. INTRODUCTION

In this experimental study an attempt will be made to find the effect of partial replacement of fine aggregate by quarrydust and cement by fly ash. The innovative use of fly ash partial replacement of cement by fly ash in the range of 5%, 10%, 15%, 20%, 25% fine aggregate by quarry dust 50% polyethylene glycol 0.5% in the weight of cement M-40 grade concrete. The experimental investigation is concern to know the behavior, mechanical properties of concrete.

Proper curing of concrete structures is important to ensure they meet their intended performance and durability requirements. In conventional construction, this is achieved through external curing, applied after mixing, placing, and finishing. Internal curing (IC) is a very promising technique that can provide additional moisture in concrete for a more effective hydration of cement and reduced self-desiccation. Internal curing implies the introduction of a curing agent into concrete that will act as an internal source of water. Currently, there are two major methods available for internal curing of concrete. 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 super-absorbent polymers (SAP), as these particles can absorb a very large quantity of water during concrete mixing and form large inclusions containing free water, that preventing self-desiccation during cement hydration. For optimum performance, the internal curing agent should possess high water absorption capacity and high water desorption rates.

2.OBJECTIVES

The main objectives of this paper were:

a) To study the mechanical properties of self curing concrete using self curing agent, partial replacement of cement by fly ash and fine aggregate by quarry dust.
b) To compare the concrete mixes with and without self curing agent is subjected to indoor curing and conventional curing respectively.

3. EXPERIMENTAL STUDY

The various methods employed in this paper were discussed with the results in the following topics:

3.1 Material used & Methodology

A. *Cement:*
An ordinary Portland cement (OPC 53 grade) was used. Specific gravity is 3.15.

B. *Fly Ash:*
Class F fly ash was used. Specific gravity is 2.2.

C. *Natural sand:*
Natural river sand passing through 4.75mm was used as fine aggregate and was tested following IS: 383-1970. The sand conformed to zone II.
specific gravity=2.74, fineness modulus=3.17, moisture content=1.08%, and water absorption =0.80%.

D. *Aggregate:*
The aggregates were selected based on the limitation of IS 881 and 882 and the aggregate was 20mm. specific gravity=2.74, fineness modulus=3.06, and water absorption=0.25%.

E. *Quarry Dust:*

Quarry dust is collected from local stone crushing units. The physical properties of quarry dust obtained by testing the sample as per IS standard. The sand conformed to zone II.

Specific gravity=2.97, Fineness modulus=2.23,,moisture content=1.5%,water absorption=1.3%.

F. *Polyethylene Glycol-400(PEG-400)* (Used as an internal curing compound)

Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula $H(OCH_2 CH_2)_n OH$, where n is the average number of repeating polyethylene groups typically from 4 to about 180. One common feature of PEG appears to be the water-soluble nature. Polyethylene glycol is non-toxic, odorless, neutral, lubricating, non-volatile and non-irritating and is used in a variety of pharmaceuticals. Thus, it is a shrinkage reducing admixture.

H. *Mix Proportioning:*

The mix design is done according to the IS method.

M40 Grade concrete having mix proportion 1:2.56:3.25 was used with w/c ratio of 0.4.

I. *Concrete Mixes:*

In this study, the early age properties of fresh concrete and mechanical performance and tensile strength of hardened concrete were examined. All tests were conducted using the following sample groups:

1.Conventional concrete.

2.Sand is replaced by quarry dust with 50% and cement is replaced by fly ash 5%, 10%, 15%, 20%, 25%.

3.Each of the above samples was test for compressive strength, split tensile strength, modulus of rupture.

Table 1. Mix proportion of specimens

Sl. No	Quarry Dust content	Fly ash content	PolyEthylene Glycol
M40	Concrete Mix		
Mix1	50%	5%	0.5%
Mix2	50%	10%	0.5%
Mix3	50%	15%	0.5%
Mix4	50%	20%	0.5%
Mix5	50%	25%	0.5%

Table 2. Detail of specimens

Sl. No	Specimen Details (mm)	No. of specimens					
		M40	Percentage of flyash with quarry dust 50% and Polyethylene glycol 0.5%				
			5 %	10 %	15 %	20 %	25 %
1	Cube (150x150x150)	6	6	6	6	6	6
2	Cylinder (Diameter=150 Height=300)	3	3	3	3	3	3
3	Prism (100x100x500)	3	3	3	3	3	3

3. RESULTS & DISCUSSION:

A. *Workability:*

Various mixes of freshly mixed concrete were test for workability by slump value. It was observe that, the workability decreases with increase in Quarry dust content in the mix. The mix with cement as the only binder, the workability was medium. As per the table and figure below it shows that there is an increase in workability with the inclusion of fly ash.

Table 3. Slump cone values

Sl. No	Slump of concrete (mm)
M40	90
Mix1	86
Mix2	79
Mix3	77
Mix4	75
Mix5	73

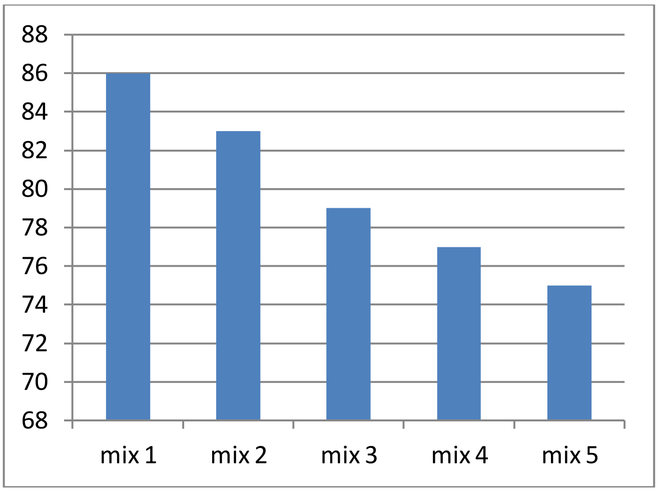

Fig 1. Variation of Slump cone values

Table 4. Compaction factor values

Sl.No.	Compaction factor
M40	0.91
Mix1	0.90
Mix2	0.87
Mix3	0.85
Mix4	0.83
Mix5	0.81

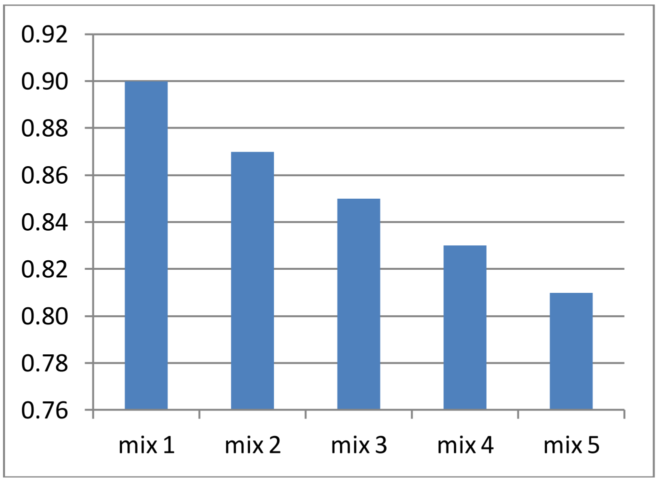

Fig 2. Variation of Compaction Factor values

B. *Compressive strength:*

Various mixes of concrete were tested for compressive test. Maximum compressive strength value at 7 days is obtained at replacement of cement by fly ash 15% is 33.58Mpa. Maximim compressive strength value at 28 days is obtained at replacement of cement by fly ash 15% is 43.44Mpa. The graphical representation of the variation of average compressive strength at 7 days and 28 days is shown in figure [3].

Table 5. Variation of Compressive Strength at 7 and 28 days

Sl.No.	7 Days Compressive Strength (N/mm^2)	28 Days Compressive Strength (N/mm^2)
M40	32.00	42.41
Mix1	30.04	40.03
Mix2	30.91	40.78
Mix3	**33.58**	**43.44**
Mix4	32.28	42.64
Mix5	30.24	40.43

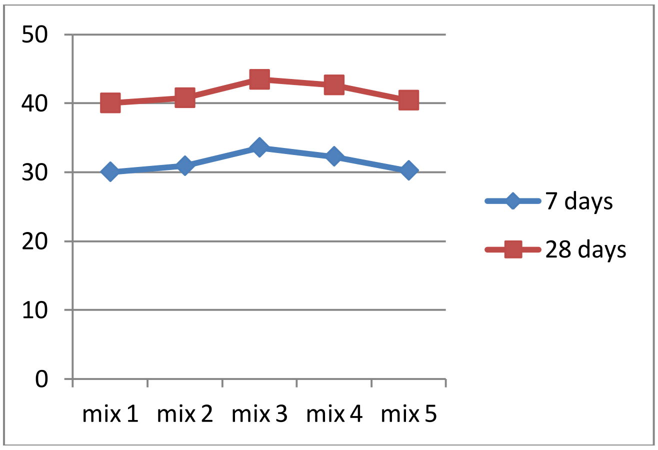

Fig3. Variation of Compressive Strength at 7and 28 days

C. *Split tensile strength:*

Average split-tensile strength at 28 days increased with increase in percentage of Fly Ash up to 15% and then decreased for 20% and 25%. The graphical representation of the variation of average split-tensile strength at 28 days is shown in figure[4].

Table 6. Variation of Split tensile strength 28 days

Sl.No.	Split tensile strength=(2P//πLD) (N/mm^2)
M40	2.47
Mix1	2.00
Mix2	2.25
Mix3	**2.50**
Mix4	2.42
Mix5	2.31

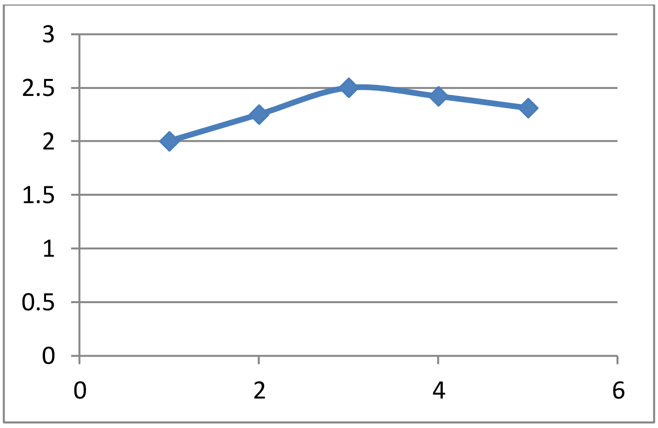

Fig 4. Variation of Split tensile strength 28 days

C. *Modulus of Rupture:*

Average modulus of rupture at 28 days increased with increase in percentage of fly ash up to 15% and then decreased for 20% and 25%. The graphical representation of the variation of average modulus of rupture at 28 days is shown in figure[5].

Table 7. Variation of Modulus of rupture 28 days

Sl.No.	Modulus of Rupture=PL/bd^2 (N/mm^2)
M40	5.37
Mix1	5.18
Mix2	5.20
Mix3	**5.36**
Mix4	5.24
Mix5	5.14

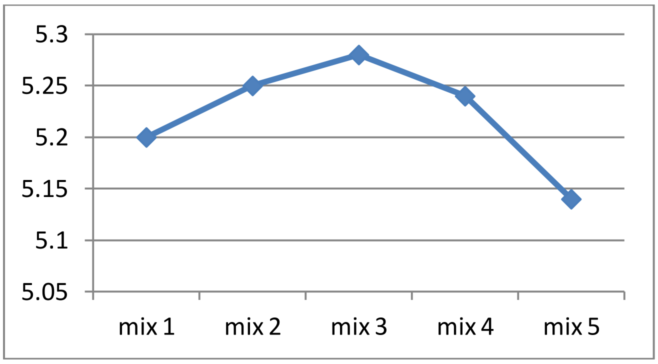

Fig5. Variation of Modulus of rupture 28 days

4. CONCLUSION

The use of fly ash, quarry dust and polyethylene glycol in self-curing concrete and their effects had been throughly studied from reputed journals. The preliminary investigations were done for basic ingredients of both self-curing concrete and controlled concrete. From the material property results, mix proportions arrived for controlled concrete of M40. The results were obtained for the maximum compressive strength, split tensile strength, and flexural strength was found to be obtained for **Mix 3**.

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