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Enhancement of Mechanical Behaviour of Self Curing Concrete with Partial Replacement of Fine Aggregate by using Quarry Dust

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Abstract : 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 with partial replacement of conventional fine aggregate with light weight fine aggregate and to optimise the quantity of polyethylene glycol. Flexural Behaviour of Self-curing concrete of M30 grade is casted by replacing optimum % of natural fine aggregate with lightweight fine aggregate & optimum % of Polyethylene Glycol by weight of cement.

The fine aggregate partially replaced by 25% of Quarry dust. From the optimum % of light weight fine aggregate replacement, Optimum % of polyethylene glycol -400 was found out by varying the percentage of PEG 0%, 0.5%, 1% and 1.5% by weight of cement for M30 grade of concrete. In this study, compressive strength, split tensile strength, and flexural strength of self-curing concrete with varying quantity of polyethylene glycol is evaluated and compared with the conventional concrete specimen.

Keywords : Self Curing, Super Absorbents Polymer (SAP), Special Concrete, Quarry Dust, Poly Ethylene Glycol.

1.0 Introduction

Proper curing of concrete structures is very much essential to ensure their meet 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 more effective hydration of cement and reduced self-desiccation[1,2,3]. Internal curing implies the introduction of a curing agent into concrete that will act as an internal source of water in the concrete structures.

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 hydration of cement. 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 hydration of cement [4,5].

For optimum performance, the internal curing agent should possess high water absorption capacity and high water desorption rates.

2.0 Self Curing Concrete

2.1 Scope

The main objective of the work is to develop self-curing concrete using self-curing agent and with partial replacement of natural fine aggregate with lightweight fine aggregate (quarry dust) and subjecting the concrete to indoor curing.

2.2 Objective of work

The objective of this project is to study the mechanical characteristics of concrete such as compressive strength, split tensile strength and also to study the flexural strength by replacing optimum percentage of natural fine aggregate with lightweight fine aggregate and optimum % of Polyethylene Glycol by weight of cement. Optimum % of polyethylene glycol -400 will found out by varying the percentage of 0%, 0.5%, 1% and 1.5%, by weight of cement for M30 grade of concrete pay ethylene glycol.

Two concrete mixes were considered for this study. Ppolyethylene glycol with molecular weight of 400 is used as a self-curing agent. The concrete mixes with and without self-curing agent is subjected to indoor curing and conventional concrete specimens are cured by normal water using curing respectively to study the above mentioned parameters.

2.3 Mechanism of Internal Curing

Self-curing concrete is that concrete in which there is no need for external curing. Self curing is also known as internal curing. Internal curing (IC) is a technique that can provide additional moisture in concrete for more effective hydration of cement and reduced self-desiccation[6]. Internal curing implies the introduction of a curing agent into concrete that will act as an internal source of water Continuous evaporation of moisture takes place from an exposed surface of concrete 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 water molecules, which in turn reduces the vapour pressure, thus reducing the rate of evaporation from the concrete surface.

2.4 Quarry Dust

Light Weight Aggregate Concrete (LWAC) is not a new invention in concrete technology. It has been known since ancient times, so it is possible to find a good number of references in connection with the use of LWAC. It was made using natural aggregates of volcanic origin such as pumice, scoria, etc. Concrete is mostly known as a grey material with good mechanical strength.It is generally understood that concrete is not necessarily just heavy, sharp-edged grey blocks. It can acquire any shape, colour, density, and strength. The low density of pumice aggregates results in weight reduction of the structures and the foundations, and also provides considerable saving in regarding thermal insulation[7,8]. Low density of the material results in high thermal insulation for buildings. The density is mostly controlled by the type of aggregate used. The strength is also partially dependent upon the type of aggregates used for making the concrete.

2.5 Poly Ethylyne Glycol (PEG)

Polyethylene glycol is a condensation polymers of ethylene oxide and water with the general formula of $H(OCH_2CH_2)_n OH$, where n is the average number of repeating oxyethylene groups typically from 4 to about 180. The low molecular weight members varying from n=2 to n=4 are diethylene glycol, triethylene glycol and tetra ethylene glycol respectively, which are produced as pure compounds. The low molecular weight compounds up to 700 are colourless, odourless viscous liquids with a freezing point from -10□C (di-ethylene glycol), while polymerized compounds with higher molecular weight than 1,000 are wax like solids with melting point up to 67□ C for n is 180.

3.0 Experimental investigations

The preliminary tests were conducted for various material properties, and using these properties, IS method was adopted for M30 grade concrete for computing control mix ratio. The mechanical characteristics of concrete such as compressive strength, split tensile strength and modulus of rupture and the flexural behavior of reinforced concrete beams of self curing concrete were studied. The optimum percentage of light weight aggregate will be found by various literatures the optimum percentage of quarry dust is25%[9]. The optimum percentage of polyethylene glycol will be found by varying the percentage of polyethylene glycol from 0%, 0.5%, 1%, and 1.5%, by weight of cement for the optimum percentage of lightweight fine aggregate. As per IS method, mix design for M_{30} grade concrete is carried out by conforming IS10262:2009 and the mix proportions are shown in the table 1

Table 1 Mix Proportions

Cement	Fine aggregate	Coarse aggregate	w/c
425.7	665	1062	192
1	1.56	2.50	0.45

3.1 Compressive Strength

The compressive strength test for cubes was conducted in compression testing machine as per IS 516: 1964. The cubes were tested in compressive testing machine at the rate of 140 kg/cm^2/min and the ultimate loads were recorded.

Figure 1 Compressive Strength of Specimens

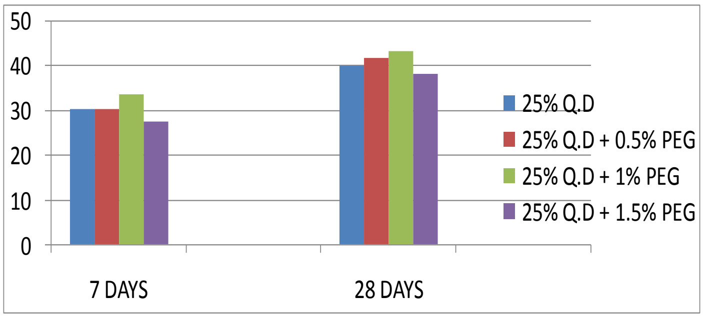

Figure 2. Comparisons of Compressive Strength

3.2 Split Tensile Strength

The split tensile strength test for cylinders was carried out as per IS 516 : 1964. This test was carried out by placing a cylinder specimen horizontally between the loading surfaces of a universal testing machine and the load was applied until failure of the cylinder along the vertical diameter. When the load was applied along the generatrixan element on the vertical diameter, the cylinder is subjected to a horizontal stress. Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds.

Figure 3 Split Tensile Strength of Specimen

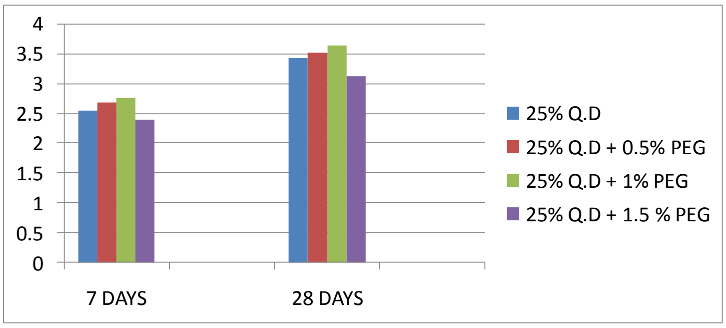

Figure 4. Comparisons of Split Tensile Strength

3.3 Flexural Strength

The Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. After the curing period the specimen is taken out from the curing tank and wipes it clean. The dimensions of the specimen and the weight of the specimen were noted down with accuracy. The testing machine should be provided with two rollers of 38mm diameter on which the specimen are placed and the rollers are spaced that the between two rollers

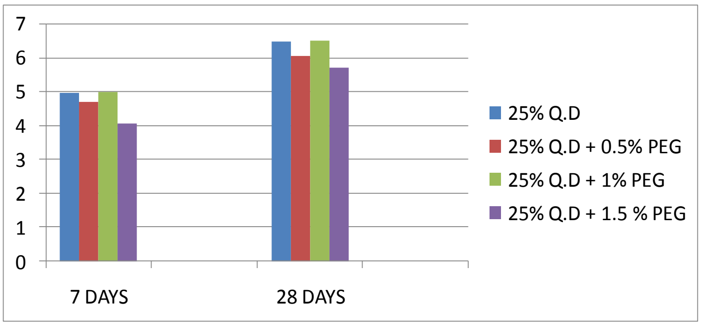

Figure 5 Flexural Strength of Specimen **Figure 6. Comparisons of Flexural Strength**

3.4 Summary

In this project, the mix design for control concrete grade of M30 has been designed. Self-curing concrete is useful in water scarce areas and in places where good quality water is not available. The self-curing concrete required had been arrived from the control concrete by optimizing the percentage of lightweight aggregate and polyethylene glycol. From the experimental work carried out it is observed that 1.0% of PEG-400 is optimum for obtaining desirable strength properties under self curing.

The addition of quarry dust as a replacement for fine aggregate and is effectively increase the strength when compared to the conventional concrete specimen and it has been used as effective alternate for fine aggregate without modifying the strength.

3.5 Conclusions

From the test results observed, the following conclusion had been drawn:

1. The optimum percentage of lightweight aggregate for maximum strengths (compressive, split-tensile and modulus of rupture) was found to be 25% for M30 grade of concrete.
2. As the percentage of lightweight aggregate increased, the slump value decreased.
3. The optimum dosage of PEG400 with 25% lightweight aggregate for maximum strengths (compressive, tensile and modulus of rupture) was found to be 1% for M30 grade of concrete.
4. As percentage of PEG400 increased, slump increased for M30 grade of concrete.
5. The flexural behaviour of self curing concrete was same as the conventional concrete.
6. Self curing concrete is the answer to many problems faced due to lack of proper curing.

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