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EXPERIMENTAL STUDY ON BEHAVIOUR OF CONCRETE USING SELF CURING AGENTS

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ABSTRACT

Concrete is most widely used construction material due to its good compressive strength and durability. Depending upon the nature of work, the constituent materials; cement, fine aggregate, coarse aggregate and water are mixed in specific proportions to produce concrete. 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 and inaccessibility of structures in difficult terrains. It increases water retention capacity of mix. Many studies are done about the usage of Self curing concrete. In the present study, the effect of admixture, Poly Ethylene Glycol (PEG) & Super Absorbent Polymer (SAP) are studied with proportions of PEG 0 -2% and SAP 0-0.4% in M25 grade of concrete. Comparing both types of concrete with conventional concrete,the compressive, split tensile and flexural strength are found and optimum percentage of curing agent is determined.

KEYWORDS: Internal Curing, Moisture Preservation , Water Retention, Super Absorbent Polymer

INTRODUCTION

Concrete is the premier construction material used widely across the world in all types of engineering works, it plays an important role in shaping our environment and sustainability of construction industry. Efforts to improve the properties of concrete are continuously being made by researchers.In the last decade,the problem of curing has led to the drastic reduction in the strength and durability of concrete. This has made researches the need of internal curing which eliminates the ill effects of manmade external curing.Internal curing refers to the process by which the hydration of cement occurs because of the availability of additional internal water that is not part of the mixing water. The additional internal water is typically supplied by using relatively small amounts of saturated, light weight, fine aggregates or super absorbent polymer particles in the concrete. Benefits of internal curing include increased hydration and strength development, reduced autogenous shrinkage and cracking, reduced permeability and increased durability. The impact of internal curing begins immediately with the initial hydration of the cement. Interest is being shown to incorporate internal curing as a tool to reduce cracking, especially in pavements. Internal curing distributes extra water throughout the entire microstructure, thus maintaining saturation of the cement paste during hydration.Curing of concrete is for maintaining satisfactory moisture content in concrete during its early stages in order to develop the desired properties. However, good curing is not always practical and often neglected in many cases. Therefore, the need to develop self-curing agents attracted several researchers. The concept of self-curing agents is to reduce the water evaporation from concrete and hence increase the water retention capacity of the concrete compared to conventional concrete. It was found that water soluble alcohols can be used as self curing agents in concrete. The use of self-curing admixtures is very important from the point of view that water resources are getting valuable every day. Self-curing or internal curing is a technique that can be used to provide additional moisture in concrete for more effective hydration of cement and reduced self-desiccation.Conventionally, curing concrete means creating conditions such that water is not lost from the surface i.e., curing is taken to happen „from the outside to inside‟. In contrast, „internal curing‟ is allowing for curing „from the inside to outside‟ through the internal reservoirs.

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The benefit of self-curing admixtures is more significant in desert areas (e.g. Rajasthan) where water is not adequately available.It eliminates largely autogenous shrinkage and maintains the strengths of concrete at the early age (12 to 72 hrs.) above the level where internally & externally induced strains can cause cracking. The following materials can provide internal water reservoirs:Lightweight Aggregate (natural and synthetic, expanded shale),)SRA(Shrinkage Reducing Admixture) (propylene glycol type i.e., polyethylene-glycol),Wood powder, SAP(Super Absorbent Polymer)

Concrete deficiencies that IC can address

- Cracking of concrete provides passageways resulting in deterioration of reinforcing steel
- Low early-age strength is a problemPermeability or durability must be improved
- Rheology of concrete mixture, modulus of elasticity of the finished product or durability of high fly-ash concretes are considerations.
- Need for reduced construction time, quicker turnaround time in precast plants, lower maintenance cost, greater performance and predictability.

EXPERIMENTAL INVESTIGATIONS

The strength [flexural, split tensile and compressive] and workability [slump factor]were studied on concrete with self curing admixtures in certain proportions of weight of cement. PEG was added in terms of 0.5%,1%,1.5%,2%.SAP was added in terms of 0.1%,0.2%,0.3%,0.4%. Table 5 and 6 presents the M25 grade concrete mix design . All of the experiments were performed in normal room temperature. The concrete ingredients namely cement, coarse aggregate, fineaggregate, and self curing agents were first mixed in drystate, then calculated amount of water was added and mix it thoroughly to get a homogeneous concrete mix. Workability of fresh concrete was determined by the slump factor test according to Indian standers. The typical size of cube 150mm ×150mm ×150mm was used to determine the Compressive strength. Split tensile strength was carried out on the cylinder with 150mm diameter and 300mm height. To calculate the flexural strength, prisms of 150mm x 150mm x 700mm was casted. These were tested at 7 and 28day's period and the engineering properties of the Self Curing Concrete were compared to those of the reference concrete.

MATERIALS

Cement

Ordinary Portland Cement (OPC) is factory- made in the formula of different grades. Grade-53, Grade-43 and Grade-33 are extensively consuming grades in India. The grade43 is licensed with IS 8112:198 .Grade43 is in great requirement in India. Today OPC43 is most widely available in all the regions of India through an extensive distribute on network.In this paper, OPC43 grade cement is used.

Fine aggregate

Fineaggregate is obtained from locally available river sand, which is passed through 4.75 mm sieve. According to IS383:1970, the FA is being classified into four different zones, that is Zone-I, Zone-II, Zone-III, Zone-IV.The fine aggregate used in this study is under zone II.

Coarse aggregate

Coarse aggregate was obtained from locally available crushed stone aggregate quarry. Maximum of 20mm size aggregate has been used throughout the experiment.

Water

Potable water conforming to IS:3025-1964[6] is used for mixing. Water is a chief constituent of concrete as it essentially play a part in the chemical response with cement. As it supports to form the strength providing gel, the measure and eminence of water are mandatory to be observed into very cautiously and the pH of water was 7.

Polyethylene Glycol

Poly ethylene glycols (PEGs) are family of water-soluble linear polymers formed by the additional reaction of ethylene oxide(EO) With mono ethylene glycols (MEG) or diethylene glycol. The generalized formula for polyethylene glycol is: $H(OCH2CH2)\ n\ OH$, n: Average number of repeating ethylene oxide groups. There are many grades of PEGs that represents them by theirs average molecular weight. For example, PEG 600 consists of a distribution of polymers of varying molecular weights with an average of 600.Polyethylene glycols are available in average molecular weight ranging from 200 to 8000; this wide range of products provides flexibility in choosing properties to meet the requirements of many different applications.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.

Super Absorbent Polymer

super absorbent polymers(also called slush powder) are polymers that can absorb and retain extremely large amounts of a liquid relative to their own mass. The common SAPs are added at rate of 0 – 0.6 wt % of cement. The SAPs are covalently cross-linked. They are Acryl amide/acrylic acid copolymers. One type of SAPs are suspension polymerized, spherical particles with an average particle size of approximately 200 mm; another type of SAP is solution polymerized and then crushed and sieved to particle sizes in the range of 125–250 mm. The size of the swollen SAP particles in the cement pastes and mortars is about three times larger due to pore fluid absorption. The swelling time depends especially on the particle size distribution of the SAP. It is seen that more than 50% swelling occurs within the first 5 min after water addition.

Mixdesign

The mix design for M25 grade concrete is done according to the IS design method to obtain the optimum mix. Once the optimum mix is determined,it is used to produce concrete with 0.5%, 1%, 1.5%, 2% PEG and 0.1%,0.2%,0.3% and 0.4% SAP.

RESULTS AND DISCUSSION

Workability

Increasing the percentage of admixtures(both PEG and SAP),the slump value is found to increase and the value is more than that compared with conventional concrete as shown in Table 7

Compressive strength

Compressive strength testing was performed in general accordance with Indian Standard Test Method. For the compressive strength, tests were conducted at the ages of 7 and 28 days.It has been observed that the compressive strength is maximum at 1%PEG and 0.3% SAP.

Split tensile Strength

The split tensile strength of concrete is carried on cylindrical specimen of diameter 150mm and length 300 mm. The specimen was loaded until it fails. The test is done at the age of 7 and 28 days. The machine used was the same UTM that used for compression test. It has been observed that the split tensile strength is maximum at 1%PEG and 0.3% SAP.

Flexural strength test

The flexural strength test of concrete is carried on prisms of 150mmX150mmX700mm. The specimen was loaded until it fails. The test is done at the age of 7 and 28 days. It has been observed that the flexural strength is maximum at 1%PEG and 0.3% SAP.

Tables:

Table 1:Physical properties of Cement

PROPERTY	VALUE
Specific Gravity	3.15
Standard Consistency	36%
Initial Setting Time	30 minutes
Fineness	5%

Table 2: Physical property of Fine Aggregate

PROPERTY	VALUE
Specific Gravity	2.64
Fineness Modulus	2.44

Table 3 : Physical property of Coarse Aggregate

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PROPERTY	VALUE
Specific Gravity	2.8
Fineness Modulus	2.7

Table 4:Physical properties of IC agents

PEG -Poly Ethylene Glycol	SAP-Super Absorbent Polymer
• Carbon compound containing Ethylene Oxide group	• Acrylic acid co polymers
• Colourless & odourless	• Odourless
• pH: 5 to 7	• pH: 7

Table 5:Concrete mix design proportions (M25) using PEG (Mix I)

Sl no	PEG- % of cement	Cement (kg/m^3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)	Water (lit/m^3)
Cc	0	413	632	1243	186
Mix-1	0.5	413	632	1243	186
Mix-2	1.0	413	632	1243	186
Mix-3	1.5	413	632	1243	186
Mix-4	2.0	413	632	1243	186

Table 6:Concrete mix design proportions (M25) using SAP (Mix II)

Sl no	SAP- % of cement	Cement (kg/m^3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)	Water (lit/m^3)
Cc	0	413	632	1243	186
Mix-1	0.1	413	632	1243	186
Mix-2	0.2	413	632	1243	186
Mix-3	0.3	413	632	1243	186
Mix-4	0.4	413	632	1243	186

Table 7:Slump value(mm)

Type	Mix I	Mix II
Cc	52	52
Mix 1	61	64
Mix 2	73	75
Mix 3	85	87
Mix 4	94	92

Table 8: Mechanical Properties of mix I

Mix Type	PEG	f_{comp} (N/mm^2)		f_{split}(N/mm^2)		f_{flex}(N/mm^2)
I	%	7 days	28 days	7 days	28 days	28 days
1	0	21.85	32.625	1.63	2.36	4.31
2	0.5	22.76	35.01	1.74	2.49	4.78
3	1.0	23.07	35.71	1.84	2.63	5.36
4	1.5	22.08	30.66	1.62	2.42	4.67
5	2.0	20.26	29.59	1.60	2.29	4.55

Table 9: Mechanical Properties of mix II

Mix Type	SAP	f_{comp} (N/mm^2)		f_{split}(N/mm^2)		f_{flex}(N/mm^2)
II	%	7 days	28 days	7 days	28 days	28 days
1	0	21.85	32.625	1.63	2.36	4.31
2	0.1	22.89	33.65	18	2.69	4.69
3	0.2	23.95	34.7	2.08	3.19	5.7
4	0.3	25.5	36.68	2.58	3.66	6.65
5	0.4	20.95	32.23	1.48	2.15	5.12

Figures

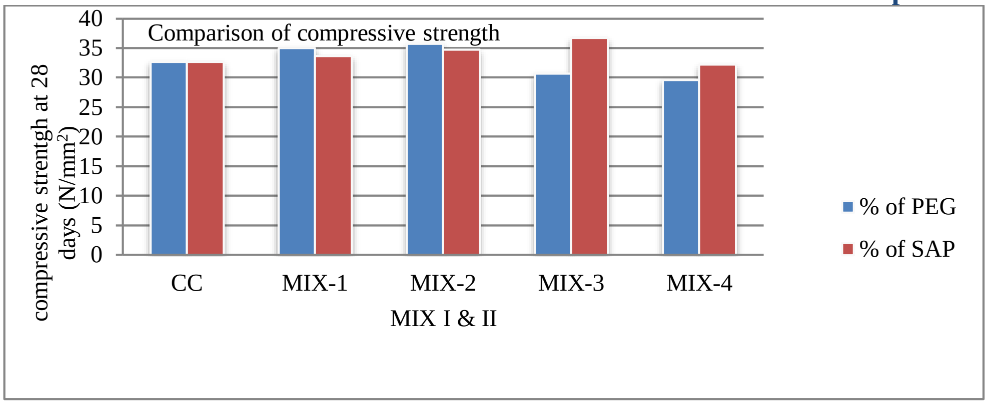

Fig 1:Comparison of Compressive Strength of Cubes in Mix I and Mix II

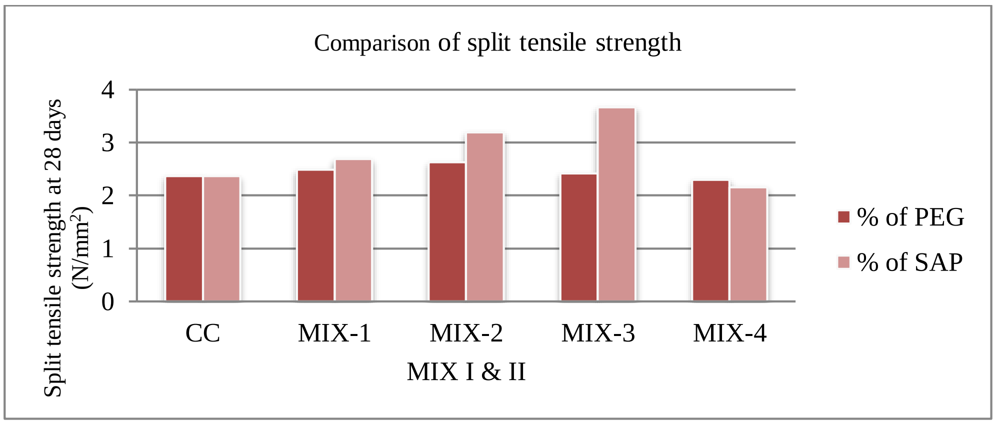

Fig 2:Comparison of Split Tensile Strength of Cylinders in Mix I and Mix II

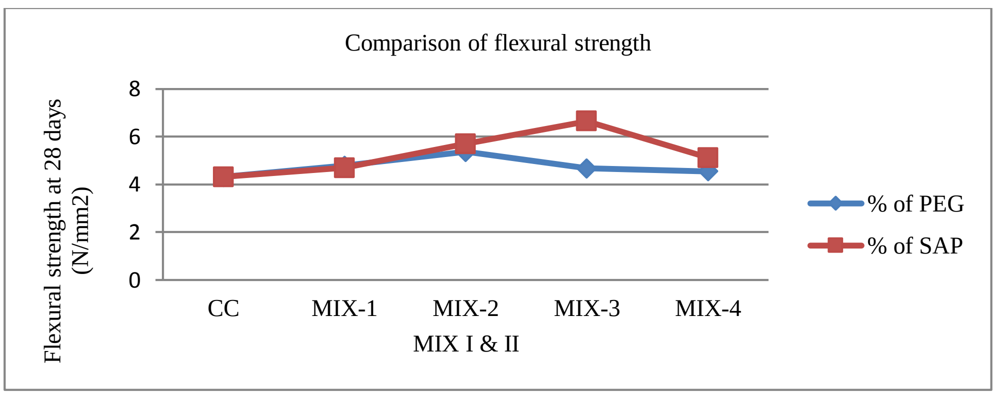

Fig 3:Comparison of Flexural Strength of Prisms in Mix I and Mix II

CONCLUSION

1. PEG&SAP can be used as additives for producing Self Curing Concrete.
2. The optimum dosage of PEG for maximum strengths (compressive, tensile and flexural strength) was found to be 1% for M25 grade of concrete.
3. The optimum dosage of SAP for maximum strengths was found to be 0.3% for M25 grade of concrete.
4. SAP gives better results than PEG. Its more economical than PEG.

5. Self curing concrete is the answer to many problems faced due to lack of proper curing.

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