

Effect of Super Absorbent Polymer (SAP) As Curing Agent in Concrete

Shruthi H G¹, Alen Joe Fletcher², Deekshith V V³, Mohammed Saqibulla⁴, Pavithra H C⁵

Assistant Professor, Department of Civil Engineering, ATME College of Engineering, Mysuru, Karnataka, India¹

U.G. Student, Department of Civil Engineering, ATME College of Engineering, Mysuru, Karnataka, India^{2,3,4,5}

ABSTRACT: Concrete is the 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. Some of the concrete mixes are added mixes based on the characteristic requirement such as increase the performance of concrete. Concrete needs congenial atmosphere by providing moisture for a minimum period of 28 days for good hydration and to attain desired strength. The problems can occur in not practicing of proper curing techniques which can effect in 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. In the present study, the effect of admixture Super Absorbent Polymer (SAP) is studied with proportions of 0 - 0.4% in M₂₅ grade of concrete. The comparison work of concrete mixes to normal conventional concrete with respective to their strength characteristics is done.

KEYWORDS: Curing, Self-curing concrete, Super Absorbent Polymer (SAP), Compressive Strength

I. INTRODUCTION

Concrete is the most appropriate production material used broadly the world over in all methods of construction engineering works, it plays an essential role in shaping our surroundings and sustainability of production industry. Efforts to enhance the residences of concrete are continuously being made with the aid of researchers. In the final decade, the trouble of curing has led to the drastic reduction inside the power and sturdiness of concrete. When cement is introduced to water, hydration response occurs and this hydration system is essential for hardening of concrete. Curing is the method to keep away from moisture content deficiency from concrete all through the process of hydration. Effect from curing has a strong impact on the characteristics of hardened concrete such because it will increase the sturdiness or durability, quantity stability, abrasion resistance, strength, impermeability and resistance to freezing and thawing. If water isn't provided then shrinkage of concrete takes vicinity which leads to cracking. This has made researches the want of internal curing which eliminates the ill outcomes of manmade outside curing.

Internal curing provides a modern twist on good curing practice by providing water to the cementitious matrix after setting. Internal curing improves the performance of concrete by increasing the reaction of the cementitious materials. Internal curing refers to the system by way of which the hydration of cement occurs because of the provision of extra inner water that isn't always a part of the combination water. This can be achieved by adding certain admixtures to the concrete. Use of self-curing admixtures may be very useful from the factor of view that water assets are becoming valuable each day. It is not possible to provide curing by external supply of water from top surface at the rate required to satisfy the ongoing chemical shrinkage. 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. Internal curing is especially beneficial for mixtures containing high volumes of supplementary cementitious materials that may require longer times to hydrate. In normal methods, the process of curing concrete occurs such that the water is applied on the outside of the concrete and water moves to the inside internal of concrete. In case of the self-curing concrete the process is that curing occurs from the inside towards the outside of the concrete.

II. RELATED WORK

Internal curing agents substantially help in the conservation of water in concrete, by bringing down the evaporation during the hydration of Concrete. The present study focuses on the impact of internal curing agent of Super Absorbent Polymer (SAP) on the concrete mix. **Dayalan J [1]** investigated on-Compressive Strength and Durability of Self Curing Concrete, the objective was to determine the weight loss and physical properties of self-curing concrete and to determine the compressive, split tensile and flexural strength of SCC. The results are use of SAP (0.48% by the weight

of cement) as self-curing agent Provides higher compressive, tensile as well as flexural strength than the strength of conventional mix. **V. Karthikeyan** [2], investigated on- Self-Curing Concrete by using Super Absorbent Polymer. The result of the investigation was the optimum dosage of SAP for addition for maximum strengths was found to be 0.3% for M₃₀ grade of concrete. **Kaustuv Sarkar, Bishwajit Bhattacharjee** [3], investigated on-Application of SAP and PEG as curing agents for ordinary cement-based systems, the use of SAP and PEG as curing agents for ordinary cement-based system with water-to cement ratio of 0.4 and above has been investigated. The results are doses of SAP distinctly improve water retention. Higher SAP and PEG dosages improve the degree of hydration of cement.

III. METHODOLOGY

3.1. Materials and Their Properties

The following are the materials used,

3.1.1 Cement

The cement used was OPC-53 grade cement which conforms to the specifications of IS: 12269-1987. The properties of the cement is shown in Table.3.1.1.

Table.3.1.1 Properties of Cement

Sl.No	Tests performed	Results
1	Specific Gravity	3.13
2	Initial Setting Time	35 minutes
3	Final Setting time	275 minutes
4	Consistency	31%

3.1.2 Fine Aggregate

The fine aggregate used was manufactured sand (m-sand). The fine aggregate confirming to zones is IS: 383-1970. The properties of the Fine Aggregate is shown in Table.3.1.2

Table.3.1.2 Properties of Fine Aggregate

Sl.No	Tests performed	Results
1	Specific Gravity	2.65
2	Fineness Modulus	3.60
3	Moisture Content	1%

3.1.3 Coarse aggregate

Crushed stone was used as Coarse Aggregate confirming to IS: 383-1970. Maximum coarse aggregate size used was between 10-20mm. The properties of the coarse aggregate is shown in Table.3.1.3

Table.3.1.3 Properties of Coarse Aggregate

Sl.No	Tests performed	Results
1	Specific Gravity	2.8
2	Moisture Content	0.1%
3	Impact Value	14.1%
4	Crushing Strength	25%

3.2. Admixtures

3.2.1. Super Absorbent Polymer

Super Absorbent Polymers are the polymers that can absorb and retain extremely large amounts of a liquid relative to their own mass. The SAPs are the polymers that are covalently cross-linked. The polymers can be are Acryl amide or acrylic acid copolymers. One type of SAPs are suspension polymerized, spherical particles with an average particle size of approximately 200 mm and 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. Normally the SAP polymers absorb more than half of the capacity of the water to be absorbed on the few minutes in addition with the mix.

Table 3.2.1 Properties of Admixture

SAP-Super Absorbent Polymer
Acrylic acid co-polymers
Odourless
pH :- 7

3.3 Experimental Investigations

The experiment consists of the process of design the concrete mix as per the Indian Standards (S: 10262-2009). After the process of designing the mix proportions, then was the addition of the self-curing admixture in certain proportion to the concrete mix. SAP was added in the proportions of 0.1%, 0.2%, 0.3%, and 0.4%. The below table represents the mix design for the M₂₅ grade concrete and mix proportions of SAP. The materials for the concrete that is cement, fine aggregate, coarse aggregate and the self-curing agents were mixed at the dry state before addition of the water. Then the calculated amount of water was added to it and thoroughly mixed to have a homogenous mix. The slump factor test was conducted as per the Indian Standards for the concrete mixes in order to know the workability of the concrete mix. Then in order to find the strength characteristics the specimen were casted to the respective Indian Standards. For the compressive test procedure the specimens were casted to the size of 150x150x150mm typical size cubes. For the split tensile test the specimens were casted in the size of cylinders of 150mm in diameter and 300mm in height. All the specimens were tested in the same testing machine.

The mix design was designed for M₂₅ grade concrete done according to the IS 10262:2009 design method to obtain the optimum mix. Since the mix design for the optimum mix was determined. It was used to produce concrete with varying percentage of admixtures that was to be added to the concrete mix. The percentages were that of 0.1-0.4% Super Absorbent Polymer (with the increase of 0.1%) in the concrete mixes. The weight of the admixtures added is the percentage dosages to the weight of cement in concrete mixes. The mix properties are kept constant for all the varying dosages of 0.1, 0.2, 0.3, and 0.4% of SAP into the mixes.

Table 3.3 Mix Proportions for Super Absorbent Polymer

Mixes	CC	Mix-1	Mix-2	Mix-3	Mix-4
SAP- % of Cement	0	0.1	0.2	0.3	0.4
Cement	394	394	394	394	394
Fine aggregate	790.55	790.55	790.55	790.55	790.55
Coarse aggregate	1063.1	1063.1	1063.1	1063.1	1063.1
Water	197.16	197.16	197.16	197.16	197.16

IV. EXPERIMENTAL RESULTS

The test results show that a very small increase in compressive strengths and spilt tensile strengths were observed with the addition of SAP in different percentages. Though the increase in strengths were very small, it was observed that the admixtures involves complete internal curing of the concrete and helps to achieve a strength very nearer to the full strength of conventional normal concrete as the reference mix. The observation was that the maximum value of the strength was obtained at the optimum dosages of 0.3% of SAP.

Table.4.1 compressive strength values for mixes with SAP

MIX-TYPE	SAP (%)	COMPRESSIVE STRENGTH(N/mm ²)	
		7 days	28 days
NC	0	21.85	32.625
MIX - 1	0.1	22.52	33.43
MIX - 2	0.2	23.38	34.27
MIX - 3	0.3	24.8	34.89
MIX - 4	0.4	21.22	32.12

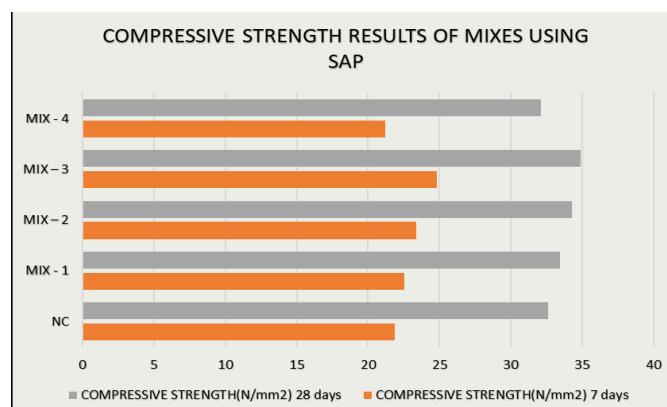


Chart -4.1: Mixes With Super Absorbent Polymer

The observation from chart-4.1 was that the maximum value of the compressive strength was obtained at the optimum dosages of 0.3% of SAP.

The split tensile strength test was conducted in accordance with the IS standards on the cylindrical specimens of 150mm diameter and 300mm in height. These tests are conducted for the ages of 7 and 28 days.

Table.4.2 Tensile Strength Values For Mixes with SAP

MIX-TYPE	SAP (%)	TENSILE STRENGTH (N/mm ²)	
		7 days	28 days
NC	0	1.63	2.36
MIX - 1	0.1	1.78	2.64
MIX - 2	0.2	2.06	3.11
MIX - 3	0.3	2.35	3.49
MIX - 4	0.4	1.52	2.22

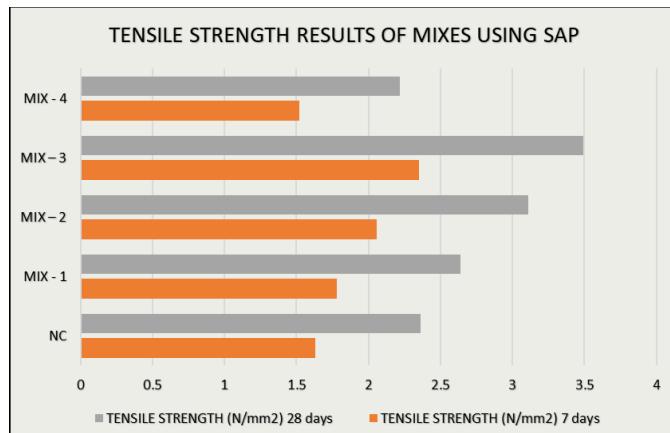


Chart -4.2: Mixes With Super Absorbent polymer

The observation from chart-4.2 is that the maximum value of the strength was obtained at the optimum dosage of 0.3% of SAP.

V. CONCLUSION

The examination explored the practicality of executing SAP as restoring admixtures for normal cementitious mixes, in view of the exploratory perceptions,

- The self-curing admixture SAP in the concrete mixes helps to increase the properties of the concrete of which due to good water retention.
- The optimum dosage of SAP (expressed in percentage by weight of cement) for M25 grade concrete was to be at 1% and 0.3% respectively.
- The further increase in the dosages with the concrete mixes tends to the depletion of the strength of the concrete mixes.
- There is a significant increase(at optimum dosages) in the compressive, split-tensile strength properties self-curing concrete mixes at all ages of curing when compared to normal externally cured concrete mixes.

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