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The Impact of Super Absorbent Polymers on Concrete Strength

K. Manoj Kumar[1], M.V.N. Siva Sankar Reddy[2], Ch.Srikanth[3], D. Sundar Kumar[4], and G. Vamsi Krishna

[1,2,3]Assistant Professor, Department of Civil Engineering, Pace Institute of Technology and Sciences, Ongole, Andhra Pradesh, India
[4]M. Tech Scholar, Department of Civil Engineering, Pace Institute of Technology and Sciences, Ongole, Andhra Pradesh, India
[5]B. Tech Scholar, Department of Civil Engineering, Pace Institute of Technology and Sciences, Ongole, Andhra Pradesh, India

Correspondence should be addressed to K. Manoj Kumar; manojkumar_k@pace.ac.in

ABSTRACT- SAP (Super Absorbent Polymer), one of the advanced materials, offers significant promise in the field of civil engineering. SAP may affect concrete in a number of ways, including cracking, shrinkage, tensile strength, and compressive strength. We'll examine at how SAP influences concrete strength in this study, but we'll also look at other aspects. Sodium Polyacrylate will be the focus of our investigation. The fundamental function of SAP is to serve as an internal water supply, also known as an internal curing agent, which is critical during the post-final setting stage of cement. Furthermore, as it weakens concrete by creating a gel with water, SAP introduces some extra voids. SAP, or Super Absorbent Polymer, is a smart material with high absorbency. In addition to replacing super plasticizers, it also serves as a plasticizer in its own right. In this investigation, we will focus on the influence of SAP on both freshly-poured concrete and concrete that has already been hardened in order to determine the strength of concrete over different loading conditions.

KEYWORDS- Concrete Strength, Curing, Gel, Super Absorbent Polymer.

I. INTRODUCTION

Water, as an important agent, not only promotes workability but is also utilised for curing concrete in its fresh condition as well as in the early stages of hardening, but it cannot be used after that point. SAP, on the other hand, when combined with water generates gel that is partially mediated over a lengthy period of time, allowing SAP to cure internally and intelligently over a prolonged amount of time. Excessive water supplied to the concrete improves workability but causes drying shrinkage of the hardened concrete over time, which is undesirable. Plasticizers and superplasticizers are two types of admixtures used to lower the quantity of water. SAP, on the other hand, offers lubricant for hardened concrete mass.

Both workability and stability are improved. In a study of the strength and shrinkage of concrete, it was discovered that water was lost both in the plastic and hardened stages, resulting in cracks. Furthermore, in a study of the autogenous phenomenon of HPC, it was discovered that SAP is also helpful in the prevention of cracking in high performance concretes due to its slow release of water. The use of highly absorbent polymers is connected to an increase in the internal relative humidity of the cement paste. Stress concentration phenomena was also addressed in high strength concretes due to the introduction of super absorbent polymers. Every advantage in terms of quantity, SAP has a limit. Al-Nasra (2013) investigated the usage of Sodium Polycarylate, a hyper absorbent polymer. He concluded that 0.11% of the concrete by weight was the optimal quantity of SAP. When the hydration process in concrete is ongoing, the SAP compresses to leave spaces in which water may expand when frozen, which can be hazardous to concrete since it has the potential to generate high pressure, that results in crack formation, same as when air cavities are generated in it and the hydraulic pressure with stress concentration develops. This is characterized as the atmosphere's freezing-thawing cycle. This is due to the continual cooling and thawing impact; as a result of this phenomena, the concrete is protected from frost when using SAP. In the absence of SAP, water expands by around ten percent by volume. A comparable osmotic pressure phenomena occurs in concrete. Osmosis is the mechanism by which particles travel from a high concentration to a low concentration. In the case of concrete, salts are responsible for this phenomena due to the difference in salt concentration, osmotic pressure is formed, and this process is halted by sprinkling deicer on the concrete's surface. Snoek et al. (2012) investigated the SAP as a fracture sealing and crack healing mechanism in cementitious materials by impeding fluid flow by swelling up the SAP. The water permeability test was used to determine this sealing capability. Water was fed through the concrete and its passage through the concrete was observed. Researchers determined that the usage of SAP can seal fractures and reduce permeability. Curing can increase durability, tensile and compressive strength, and cracking resistance.

Concrete has typically been cured externally by adding moisture from the outside and sealed curing. Water can also be bonded directly on the concrete using various methods such as forging at the surface to prevent evaporation. Internal curing may be accomplished in two ways: the first is that the internal curing agent can hold water during mixing, which is then uniformly released by hydration, and the second is internal sealing, which is very similar to external sealing.

II. LITERATURE REVIEW

The common SAP are added at 0-0.6% rate of weight by cement. The maximum compressive flexural and tensile strength was found out at 1% of PEG and 0.3% of SAP. It certainly gives better result than ploythylene glycol Vinayak vijapur, in this research M30 concrete was studied using SAP as the internal curing agent with addition of 2% steel fibers in this research the SAP was varied from 0.1% to 0.4% by weight of cement. This study concluded that at 0.3% of SAP workability of this concrete is very good and found to be maximum T. Mazur et al.

In this research, the paper presents relationship between compressive strength, modulus of elasticity water and chloride permeability.

The Super plasticizer was used to increase \workability of polymer used concrete mix. Conclusion of this paper is less than 10% or more than 30% replacement by burnt clay chips can be considered as not necessary for internally cured concreteThe ordinary SAP is added at a rate of 0-0.6% by weight by cement. The maximal compressive, flexural, and tensile strength was determined to be 1% PEG and 0.3% SAP. It definitely outperforms ploythylene glycol. Vinayak Vijapur, in this study, M30 concrete was tested using SAP as the internal curing agent and 2% steel fibres. The SAP was changed from 0.1% to 0.4% by weight of cement. This investigation revealed that the workability of this concrete at 0.3% SAP is extremely good and determined to be maximal T.Mazur et al. The report examines the link between compressive strength, modulus of elasticity, water, and chloride permeability in this study. A superplasticizer was utilised to boost the workability of the polymer used in the concrete mix. The conclusion of this article is that replacement by burnt clay chips of less than 10% or more than 30% is not required for internally cured concrete. According to Kenneth Sequeira et al., the compressive strength of concrete decreased as the SAP increased. However, with 0.15% SAP and 30kg/cubic m internally cured water, it has a maximum strength of 3,7,28 days. It is discovered that the compressive strength of the sample with the optimal dosage of SAP is slightly larger than that without SAP. Rajiv Chandak and others The influence of super absorbent polymer on compressive strength was explored in this study by altering the proportion of SAP by weight of cement from 0.2%, 0.3%, and 0.4% for both mixes M20 and M30, and it was compared to the same grade of concrete created by traditional technique. It was discovered that sap might aid in self-curing by providing strength comparable to traditional curing. These SAP are added at 0.2,0.3%,0.4% by weight of cement. It was shown to be more cost effective than other research. Fazhou Wang et al. investigated the use of SAP as an internal curing agent in high strength concrete in this article. This effort will provide a new perspective on the use of SAP in high strength concrete. The water entrained by SAP is nearly exhausted within 7 days of hydration of cement paste, and numerous holes will be left during the water-release process of SAP, and the pre structure is impacted by SAP dose and the entrained water. According to B.vijaya rangan, SAP-based concrete outperforms conventional concrete and geopolymer concrete in all aspects.

III. MATERIALS

- SAPs are a collection of several polymers that are essentially cross-linked electrolytes, and they are employed to avoid self-desiccation. SAP may attract liquid around it to produce a gel-like viscous fluid that is primarily insoluble in concrete, allowing it to retain liquid within the structure itself. The covalent bond connects them. The polymers are all acrylic acids(see figure 1). They are typically mixed into 0-0.6% of the cement by weight. They have the ability to swell, which allows them to be utilised as a concrete sealing agent. Chemically, they are non-toxic and non-corrosive materials that can absorb water 280 times their own weight (table 1).
- Coarse aggregates: According to IS 383-1970, coarse aggregates are made using locally - sourced granites. After filtering the particles through a 20mm screen and retaining above 4.75 mm, they are broken in a saturated surface dry state to produce SAPs with the different properties

Table 1: Test of the Polymer

S.No.	Tests	Super Absorbent polymer
1	Size of particle	0.9mm on an average
2	Water absorption	170g/1g of SAP
3	Water pH	7
4	Density	1.08
5	Type of hydration	Reversible
6	Water available	93%
7	Decomposition in sun	125 days
8	Bulk density	0.849

Figure 1: Polymer meterial

IV. EXPERIMENTAL PROCEDURE

- Casting of specimen: The bolts were appropriately tightened and greased prior to specimen casting.
- 2 Batching The quantities of different constituents, such as fly ash coarse aggregates and fine aggregates by weight, and all chemical contents by volume, were determined (table 2).

Table 2: Different constituent- fly ash coarse aggregates and fine aggregates by weight, and all chemical contents

Materials	Water	Fine Aggregate	Coarse Aggregate (kg/n)
Quantity	430	768.65	1025.48
Ratio	0.45	1.78	2.42

- Mixing Dry blending The fly ash, coarse aggregate, and fine aggregate were combined.
- Wet Mixing For 3 minutes, chemical ingredients such as sodium silicate and sodium hydroxide were combined with dry constituents. Water can be added if necessary (approximately 2%).
- Moulding compaction and surface After the mixture is complete, two methods of moulding are used. SAP was compacted in a three-layer mould with 25 hand strokes in each layer, and each layer was compressed by tamping with a tamping
- Concrete curing of specimen Upon demoulding, or after 24 hours, the specimen was held in a curing environment to ensure that moisture loss did not occur while maintaining a desirable temperature regime.

V. TEST CONDUCTED

The tests which were conducted are as follows (see figure 2,3, and 4)

- compressive strength test for 7,14 and on 28 days
- split tensile test for 28 days
- flexural strength test

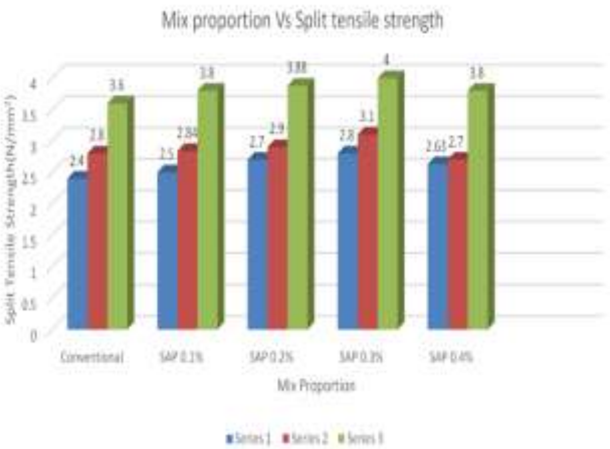

Figure 2: Compressive strength test for 7,14 and on 28 days

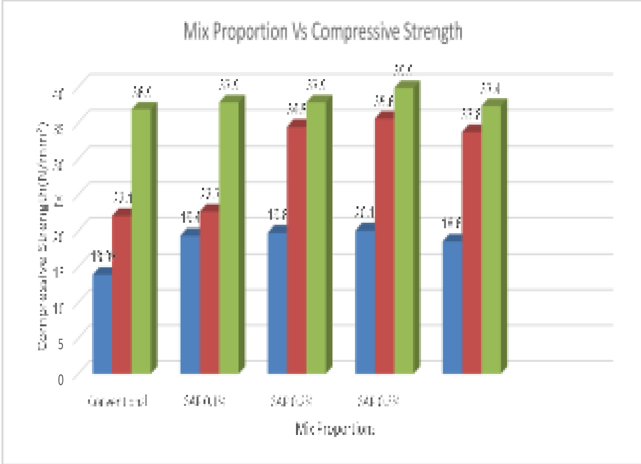

Figure 3: Split tensile test for 28 days

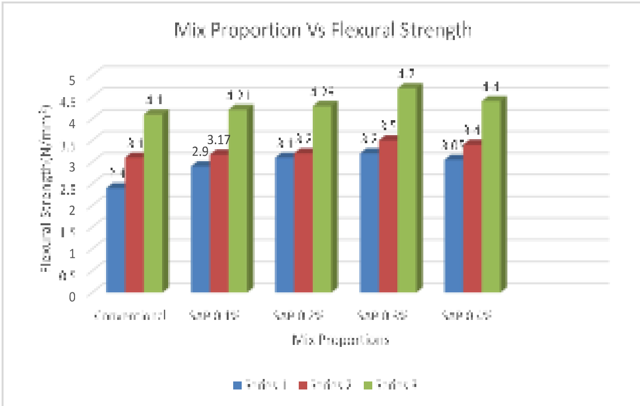

Figure 4: Flexural strength test

VI. CONCLUSION

- For best concrete strength, the recommended SAP dose for M30 concrete is 0.3%.
- The inclusion of SAP increases the compressive, tensile, and flexural strengths significantly.
- The self-cured concrete with SAP showed to be more cost effective than traditionally cured concrete. 4. Self-curing concrete is decreasing the issue of poor curing.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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