



EFFECT OF SUPER ABSORBENT POLYMER ON STRENGTH OF CONCRETE

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Abstract: SAP (Super Absorbent polymer) is one of the smart materials with a great scope in civil engineering. SAP can effect the concrete in various ways and aspects like crack, shrinkage, tensile strength and compressive strength. In this study we are going to study the effect of SAP on the strength of concrete mainly and other aspects too. The name of the SAP we will be studying about is Sodium Polyacrylate. The main function of SAP is that it acts as an internal water source which also can be called as internal curing agent plays vital role in the after final setting time of the cement .SAP also imparts some extra voids as it forms gel with water and decreases the strength of concrete . It replaces super plasticizers and also works as a plasticizer to some extent itself. In this study we will concentrate on the effect of SAP on fresh as well as hardened concrete to determine its strength when it is subjected to various loading conditions.

Index Terms – concrete strength, curing, gel, super absorbent polymer

I. INTRODUCTION

Water being an essential agents not only increases workability but also used for curing of concrete in fresh state as well as early stage of hardened state of concrete but can not be used after that is noticeable .SAP on the other hand when mixed with water forms gel which is released slowly over a long period of time, thus curing can be done internally and smartly by SAP for a long period time Excessive amount of water added in the concrete increases workability but increases the drying shrinkage of the hardened concrete over a period of time which is not desirable. Different type of admixtures used to reduce the amount of water known as plasticizers and super plasticizers. SAP on the other hand provides lubrication to the hardened concrete mass. workability and stability both are enhanced. in a research which was focused on the strength and shrinkage of concrete, it was found that the water was lost both in plastic stage and hardened stage which led to cracks , it happened due to the loss of surrounding water , further in a research autogenous phenomenon of HPC was studied, it was found out that SAP is also helpful in countering of cracking in high performance concretes also because of its slow release of water . super absorbent polymer is related to the corresponding increase in the internal relative humidity of the cement paste. Due to the use of super absorbent polymer stress concentration phenomenon was also taken care of in high strength concretes. Every benefit of SAP has a limitation in terms of its amount. Al-Nasra (2013) studied the use of super absorbent polymer i.e. Sodium Polycarylate. He concluded that the optimum amount of the SAP was 0.11% of the concrete by weight.

In concrete when the hydration process is in continuation, the SAP shrinks to leave behind the voids in which the water can expand on freezing which can be harmful for concrete as it has the capacity to generate high pressure which leads to the cracking of concrete Same as when air voids are created in it and the hydraulic pressure with stress concentration increases. This cycle is known as freezing thawing cycle of the environment. This is because of continuous cooling and thawing effect, due to this phenomenon on the use of SAP the concrete is protected from the frost. The expansion of water is about ten percent by its volume in the absence of SAP.

A very similar phenomenon of osmotic pressure happens in the concrete. Osmosis is the process of movement of particles from high concentration to low concentration. In case of concrete the salts are the responsible for this phenomenon, due to this difference in salt concentration osmotic pressure is created and this process is prevented with the help of deicer by putting it on the surface of the concrete. Snoek et al(2012) studied the SAP as the crack sealing and also as a crack healing mechanism in cementitious materials it was studied by hindering the fluid flow by swelling up of the SAP. This sealing capacity was measured by the water permeability test water was passed through the concrete and its passing through the concrete was seen. Researchers concluded that use of SAP is able to seal cracks and decrease in permeability was noticed.

Proper curing can improve durability, tensile and compressive strengths and reduce cracking. Concrete has been cured traditionally externally by applying moisture from outside and and by sealed curing. Water can also be bonded directly on the concrete by using different method like forging near the surface to stop evaporation. Internal curing can be done in two ways, first is internal curing

agent can store water during mixing which is uniformly released through hydration, and the second one is internal sealing which is very similar to external sealing.

II. LITERATURE REVIEW

K Nithya et al analysed the strength variations in the concrete by using super absorbent polymer and polyvinyl alcohol as shrinkage reducing admixtures. SAP has very high compressive strength which makes it very suitable for the construction works of concrete. The compressive tensile and flexural strength of concrete was enhanced. in this test the compressive strength were found on 7, 14 and 28 days and was compared with traditional design of concrete. According to another research the SAP was varied form 0.1% to 0.4% by cement weight as an internal curing agent with the steel reinforcement of 2%. another research explained that t compressive tensile and flexural strength variation at 0.5%,1%,1.5%2% PEG and at 0.1%,0.2%,0.3% and 0.4% of SAP. 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 concrete.

Kenneth Sequeira et al. this paper explained that the compressive strength of the concrete was reduced with the increase of SAP. But with the 0.15% of SAP and 30kg/cubic m internally cured water it has maximum strength this test was carried out at 3,7,28 days. Its is found that the compressive strength of the sample with optimum dosage of SAP is found to be greater than that without SAP if only marginally

Rajiv Chandak et al. In the present study, the effect of super absorbent polymer on compressive strength by varying the percentage of SAP by weight of cement from 0.2%, 0.3% and 0.4% were studied for both mixes M20 and M30 and it is compare with same grade of concrete which is made by conventional method. It was found that sap could help in self-curing by giving strength on par with conventional curing. These SAP are added at the rate of 0.2,0.3%,0.4% by wt of cement. It was proved to be economical than other research

Fazhou Wang et al. in this paper the application of SAP was studied as the internal curing agent in high strength concrete. This work will offer a fresh look on the application of SAP in highstrength concrete. the conclusion of this paer water entrained by SAP is almost exhausted within hydration of cement paste for 7 days numerous pores will be left during the water-release process of SAP and the pre structure is influenced by SAP dosage and the entrained water

B.vijaya rangan examined the SAP based concrete is much better than the conventional concrete and geopolymer concrete in term of all the aspects like compressive strength tensile strength and as well as economically.

III. MATERIALS

1: Super Absorbent polymer:

SAPs are the combination of many polymers basically the cross linked electrolytes, these are used for the prevention of self desiccation . SAP is able to attract the liquid around it to form a gel like viscous fluid which is insolvable mainly in the concrete so it can retain liquid in the structure itself. They are linked by the covalent bond. All of the polymers are acrylic acids . generally they are added in 0-0.6% of cement by weight. They have the property of swelling due to which it can be used as sealing agent for concrete. Chemically they are non-toxic and non-corrosive materials, they can absorb water about 280 times of their own weight and their properties are as follows

2: Coarse aggregates:

As per IS 383-1970 their coarse aggregates are formed from the locally available granites. After sieving the particles passed from 20mm sieve and retained over 4.75 mm. now after they are crushed in saturated surface dry condition we obtain the SAPs which have following

Table 1

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 Super Absorbent Polymer



Figure 2 Coarse Aggregates

3. Fine Aggregates:

Fine aggregates are always found on the banks of river. In this research the locally available sand was used. Screening was done in order to remove deleterious material as per IS 383-1970



Figure 3 Fine Aggregate

IV. EXPERIMENTAL PROCEDURE

The concrete constituents are taken as follows based on mix design of B.V. Rangan

Table 2

Materials	Water	Fine Aggregate(kg/m ³)	Coarse Aggregate(kg/m ³)
Quantity	430	768.65	1025.48
Ratio	0.45	1.78	2.42

1: Casting of specimen:

Before casting of specimen the bolts were tightened properly and lubricated.

2: Batching

The quantity of various constituents were determined like fly ash coarse aggregates and fine aggregates by weight and all chemical constituents by volume

3: Mixing:

Dry mixing

The fly ash ,coarse aggregate and fine aggregate were mixed together .

Wet Mixing:

The chemical constituents like like sodium silicate and sodium hydroxide were mixed with Dry constituents for 3 minutes water can be added if necessary(about 2%).

3: Moulding compaction and surface :

Once the mixing is done moulding is done by two methods

Compaction of SAP was done in mould of three layers with 25 manual strokes in three layers and each layer is compacted by tamping with tamping rod



4: Concrete curing of specimen:

After demoulding that is after 24 hours the specimen were kept in curing condition

In which it is made sure that loss off moisture doesnt not take place with maintaining a satisfactory temperature regime



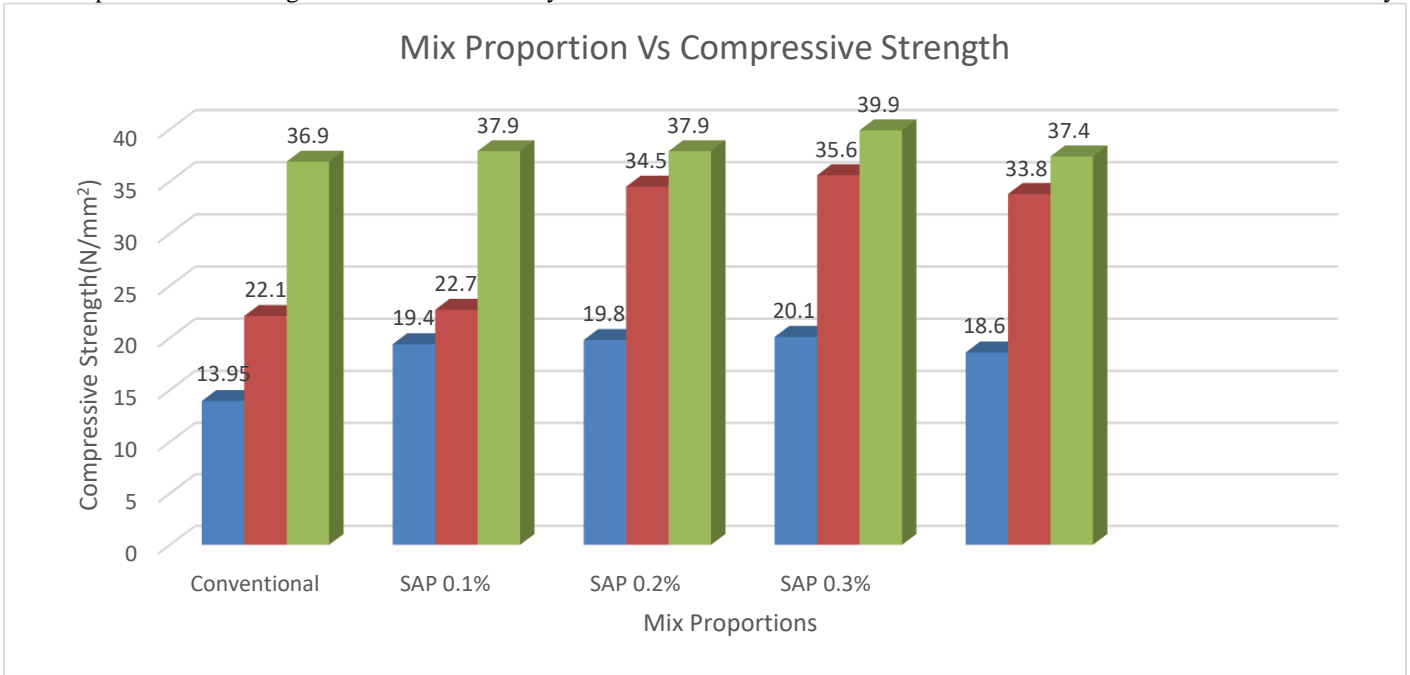
Figure 4 Curing

V. Test conducted:

The tests which were conducted are as follows

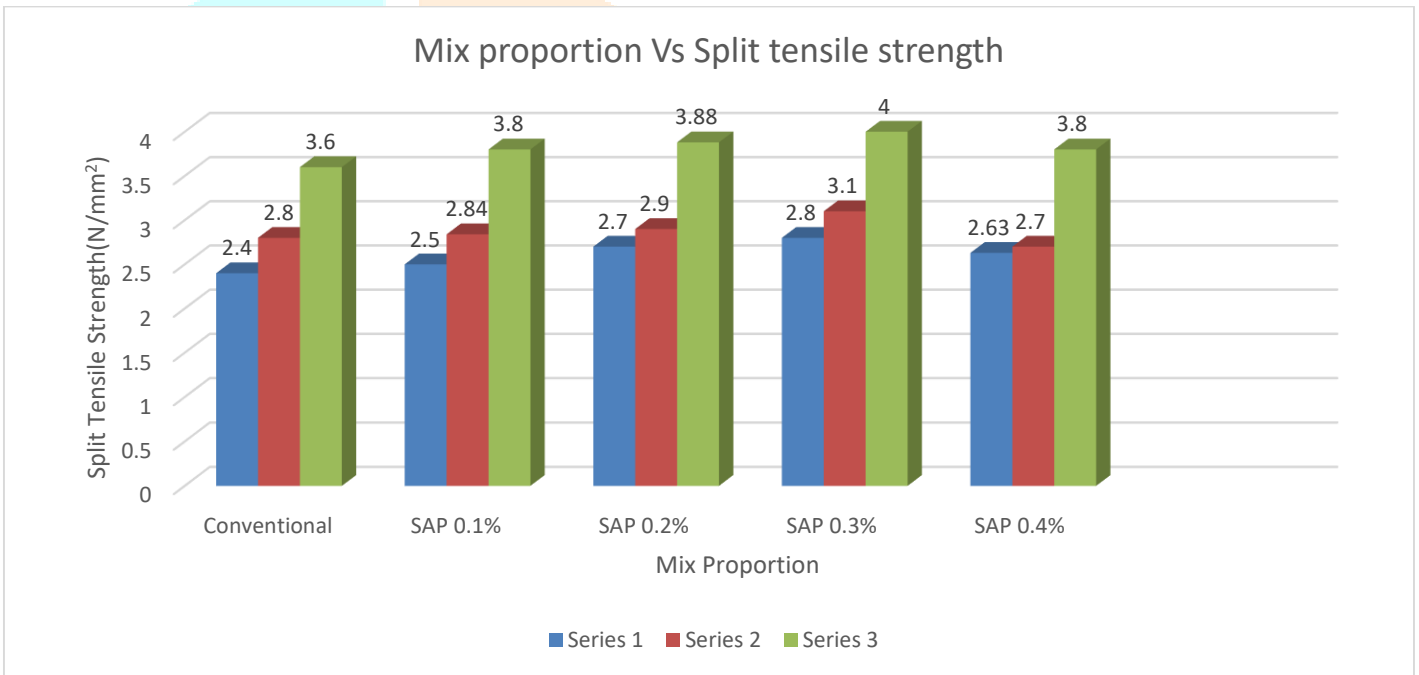
- 1: compressive strength test for 7,14 and on 28 days
 - 2: split tensile test for 28 days
 - 3: flexural strength test
- 1: Compressive strength test:

Compressive strength at 28 days for control mix is 39.9 MPa at 28th day



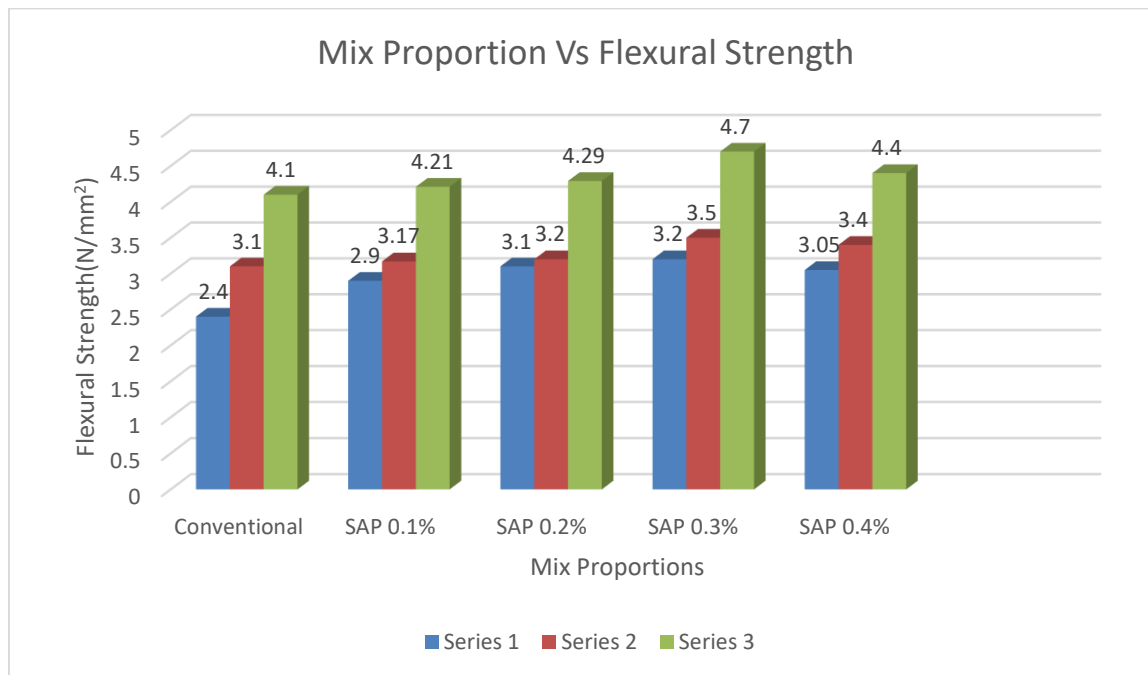
2: Split tensile test:

Split tensile test was carried out for control mix and optimum percentage for the age of 28 days



3: Flexural Strength Test:

A Flexural strength test was carried out for control mix and optimum percentage for the age of 28 days.



VI. CONCLUSION:

1. The optimum dosage of SAP for M30 concrete is 0.3% for maximum Strength of concrete.
2. due to addition of SAP there is a significant increase in Compressive, tensile and flexure strengths.
3. The self-cured concrete in which SAP was used proved to be more economical than conventionally cured concrete.
4. Self-curing concrete is reducing the improper curing problems.

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