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Analysis of Effect of Internal Curing with Super Absorbent Polymer (SAP)

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Abstract: *Superabsorbent polymers (SAP) are new, very promising multipurpose chemical admixtures for concrete. They make available a number of new possibilities with respect to the control of free water in the mixture. In turn they contribute to the control of the rheological properties of fresh concrete and to the mitigation of autogenously and plastic shrinkage through internal curing. Furthermore, pore systems built up as a result of SAP addition seem to remain stable regardless of the consistency of the concrete, the addition of superplasticizers, or the method of placement and compacting. Thus, SAP can be used as an alternative to air-entrainment agents. This article presents these and other potential practical applications of SAP in concrete construction.*

Keywords: *Super Absorbent Polymer, Plasticizer, internal curing*

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I. Introduction

This study deals with all the aspects of the use of SAP in concrete, that is, the effects of adding SAP on concrete's rheological behaviour, shrinkage, strength, durability, and other properties as well as mechanisms of SAP action on various concrete characteristics.

In recent decades great advances in concrete technology have been made, to a large extent due to the development and use of new chemical additives. These additives, although added to concrete in very small quantities, can dramatically improve crucial characteristics of concrete in its fresh and/or hardened state. Curing is the name given to the techniques utilized for advancing the hydration of the bond, and comprises of a control of temperature and of dampness development from and in to the concrete. Curing permits constant hydration of bond and hence ceaseless increase in quality.

In the production of most superabsorbent polymer there are two courses that can be taken. The balance phase of the procedure can be done in the monomer arrangement before the polymerization (pre-neutralization) or on the polyacrylic acid gel (post-neutralization). Pre-neutralization – This is the most effortless from a specialized outlook on the grounds that the balance of the monomer can happen in the fluid stage (generally with sodium or hydroxide arrangement). The solvency of some writes of cross-linker is influenced by the pH of the monomer arrangement, so this is an imperative element to consider while selecting the sort of procedure to produce superabsorbent.

This paper aims to study the physical and mechanical properties of SAP concrete by conducting durability tests under normal conditions and tests conducted on the beams for flexure. The Compressive and Tensile Strength were analyzed as per IS standards on 7th, 14th and 28th day of curing.

II. Literature Review

Marianne Tange Hasholt, et al. [1] studied the effect of superabsorbent polymer on the mechanical strength of concrete by optimizing the dosage and internal water added. The authors arrived at the conclusion that "Addition of SAP does not lead to decrease in mechanical strength and while one has to be very patient and careful, it is possible to not only retain the same strength but also to increase it while preventing self-dessication.

C. Chella Gifta, et al. studied the effect of superabsorbent polymer on concrete and compared it to internally cured concrete which used superabsorbent polymer and lightweight aggregate. The researcher observed the advantages superabsorbent polymer has in durability against both lightweight aggregate and conventional concrete in this regard.

Bart Craeye, et al. tested high performance concrete at various dosages of superabsorbent polymer to determine the optimum dosage of superabsorbent polymer which provides the maximum autogenous shrinkage reduction as well as the minimum strength reduction. They also studied thermal stress development due to heat of hydration and the chances of early age cracking are determined using finite element analysis and calculation.M. Manoj Kumar, D. Maruthachalam:-Studied the effects of addition of using different ratios of

superabsorbent polymer on the various mechanical properties of concrete, like Compressive Strength, Splitting Tensile Strength and Flexural Strength and compared them to conventional concrete.

Marianne Tange Hasholt Studied the effect of superabsorbent polymer on the mechanical strength of concrete by optimizing the dosage and internal water added.

Mohammad J. Zohuriaan-Mehr and Kourosh Kabiri He said on this topic Several papers have been published to review SAP hydrogel materials, each with own individual outlook. As a general framework, synthetic methods and properties of hydrogel networks were reviewed. Synthetic, semi-synthetic and biopolymeric hydrogels.

Bart Craeye, Matthew Geirnaert, Geert De Schutter. Tested high performance concrete at various dosages of superabsorbent polymer to determine the optimum dosage of superabsorbent polymer which provides the maximum autogenous shrinkage reduction as well as the minimum strength reduction.

O. Mejlhede Jensen Tried superabsorbent polymer as a chemical and its effect on concrete with additional silica fume. The author also outlines the many advantages it brings to concrete such as shrinkage reduction.

K.Mahendra1, P. Bala Krishna2, International Research Journal of Engineering and Technology (IRJET) , Volume: 05 Issue: 03 | (Mar-2018) In this current effort the Shrinkage Reducing Admixture of PEG-4000 and Super Absorbent Polymer (Sodium poly acrylate) make use of the self-curing agent at dissimilar ranges of 1.5% and 3%& 0.1% to 0.5% by the weight of cement in concrete which assistances in self-curing and in better hydration in addition to it, it gives good compressive strength

III. Experimental Investigation

When the mineral admixtures fully react in a blended cement system, the curing water required (external or internal) can be much higher than that which is needed in conventional ordinary Portland cement concrete. When this water is not available, due to de-percolation through the capillary porosity, it leads to significant autogenous deformation and (early-age) cracking. Due to the chemical shrinkage occurring during cement hydration, voids are created within the cement paste, leading to a reduction in its internal relative humidity as well as shrinkage which causes early-age cracking. The Physical and Chemical properties of SAP are shown in Table 1.

Table 1: Properties of Super Absorbent Polymer

Properties	**Value**
Apperance/odour	White Granular Powder, No odour
Ph	5.5-6.5 (1% in water)
Specific Gravity (bulk density)	0.4-0.7 g/ml
Vapour Pressure	<10 mm Hg
Vapour Density	NE
Melting Point	>390 F
Freezing Point	NA
Boiling Point	NA
Solubility in water	Insoluble
Evaporation Rate (%)	<1.0

Super Absorbent Polymer was added to concrete at varying proportions (0.5%, 1%, 2% of that of weight of cement) at a water cement ratio of 0.5 The desired slump value and compressive strength was obtained for conventional concrete at 0.5 water cement ratio. However, when SAP is added to the mix low workability was observed. Hence super-plasticizer was added at different proportions of cement to get a concrete mix of suitable workability. The result of slump test & compressive strength of conventional & with SAP variation concrete are shown in Table 2

Table2: Compressive Strength Results

Specimen	**% Variation of SAP**	**Slump Value (mm)**	**7day strength (N/mm2)**	**Average**	**28day strength (N/mm2)**	**Average**
A	0%	120	14	14.2	24.88	25.03
B			14.4		25.1	
C			14.2		25.1	
D	0.5%	117	14.5	14.6	25.5	25.5
E			14.5		25	
F			14.7		25.55	
G	1%	113	14.7	15.7	27.7	28.08
H			16.3		28.00	

I			16.1		28.54	
J	2%	104	14.6	14.96	26.3	26.20
K			15.3		26.3	
L			15		25.99	

Flexural strength tests were conducted on standard beams of dimension 15cm x 15cm x 40cm.From the results of compressive strength on cubes for SAP proportion of 0.5%, 1% and 2%, it is observed that 1 % addition of polymer gives better result for 7 days as well as 28 days. Hence from economic point of view flexural test was conducted for 1% addition SAP on beam and shown in Table 3.

Table3: Flexure Strength Results

Specimen	**% Variation of SAP**	**Slump Value (mm)**	**7day strength (N/mm2)**	**Average**	**28day strength (N/mm2)**	**Average**
A	0%	120	3.5	3.67	7.1	7.55
B			3.75		7.65	
C			3.75		7.9	
D	1%	105	4.16	4.53	9.12	9.2
E			4.83		9.05	
F			4.6		9.44	

IV. Conclusion

This review study tried to focus on the most significant effects of addition of Super Absorbent Polymer to the concrete mixes.In general, the significant improvement in various strengths is observed with the inclusion of SAP in the plain concrete. However, maximum gain in strength of concrete is found to depend upon the percentage of addition. There was a gradual increase in the strength for dosage of 0.5% to 1%SAP and then later gradually decreases for remaining dosage. Similarly the flexural strength of carbon fiber reinforced concrete also increased

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