Volume 4 || Special Issue 5 || ICCEME 2019-2020 || ISSN (Online) 2456-0774
INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH AND ENGINEERING TRENDS

THE POTENTIAL USE OF SUPERABSORBENT POLYMER IN CONCRETE

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Abstract- As Superabsorbent polymers (SAPs) are materials that have the ability to absorb and retain large volumes of water and aqueous solutions. This makes them ideal for use in water absorbing applications such as baby nappies and adults incontinence pads to absorbent medical dressings and controlled release medium. Superabsorbent polymers (SAP) are cross-linked polymers that absorb, swell and retain a large amount of liquid from their surroundings without dissolving. Concrete added with superabsorbent polymers for internal curing and healing, the various tests carried out by researchers on the durability, flexural and shrinkage behavior of concrete specimens added with superabsorbent polymers. The prominent areas covered in the present literature of reviewed are studies related to concept, model, system, functions, experimental tests and IS code recommendations, specifications, guidelines for detailed analysis and design of coldformed steel structures and connections. Indian and international studies are studied.

KEYWORDS: *Superabsorbent Polymer, Analysis of Materials, Modification of Concrete Mix, Performance of Concrete, Sap Mix*

I INTRODUCTION

There are several causes of cracks in concrete. Cracks caused before hardening are due to constructional movement, settlement shrinkage and setting shrinkage. Cracks caused after hardening are due to chemical reactions, physical movement, thermal changes, stress concentrations, structural design, and accidents. Concrete is a kind of porous, multiphase at all scales, and heterogeneous complex system. The durability, strength and high performance during the life cycle of the concrete structure generally depends on the curing of concrete and it is crucial from the initial setting hours. Therefore, an effective curing method is required in order to increase the hydration of cementitious material and minimize the cracking problems due to drying shrinkage. When the mixing water is in contact with the cementitious materials, the hydration starts. 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.

The degree of hydration of cement plays a decisive role in the strength and compactness of concrete. During hydration some part of the mixing water becomes chemically bonded to the hydration products, some other adsorbed at the surface of the hydration products, and the rest remains in solution at the capillary pores formed during hydration. Cementitious materials get the water from the capillary pores to promote hydration, which generates surface tensions that result in volumetric reductions known as autogenous shrinkage. In case the free autogenous shrinkage of a concrete structure is not prevented, internal tensile stresses can be introduced at early ages, which can exceed the tensile strength of the concrete. As a result, premature cracks can be created, making the concrete more vulnerable to the ingress of potentially aggressive species and thus severely reducing the durability of the concrete. One of the most conventional and well known applied curing methods is external water curing to mitigate the autogenous shrinkage of small size concrete elements. However, once the capillary pores depercolate, it will be more difficult to provide adequate external water curing.

The internal curing method has been studied for some years which may be an effective way to ensure the hydration process in concrete. Water is introduced into the concrete in advance by absorbent material like superabsorbent polymer (SAP), so that some of the water acts as internal curing water from the inside out, in order to achieve the effect of internal curing in the hydration process of the cementitious material. When the relative humidity inside the cement matrix gradually drops, the absorbent material can slowly release water to supplement the water consumption of cement hydration. The hydration process continued to generate hydration products to fill the pores of cement paste, reduce the micro cracks in cement matrix, and relieve the autogenous shrinkage and drying shrinkage. Then the strength and durability of the concrete can be improved. Superabsorbent Polymer (SAP) is a common water absorbent material with excellent water absorption and desorption capacity. It is also called as slush powder and can absorb and retain extremely large amounts of a liquid relative to its own mass. It is a material which can absorb up to 300 times their weight in aqueous fluids. SAP with the absorption and desorption properties can change the water distribution in concrete. So that the process of cement hydration is promoted, the microstructure of cement matrix is improved.

II LITERATURE REVIEW

The basic objective of this chapter is to get inside into the previous findings so that it will help to know the gap in earlier studies and to justify the research problem selected by me for the study purpose. The literature is reviewed on concrete added with superabsorbent polymers for internal curing and healing, the various tests carried out by researchers on the durability, flexural and shrinkage behavior of concrete specimens added with superabsorbent polymers.

J. Justs et al, employed superabsorbent polymers (SAP) for internal curing to limit self-desiccation and autogenous shrinkage that may lead to early-age cracking of ultra-high performance concrete (UHPC). Cement pastes and UHPC with water-to-cement ratio below 0.25, with or without SAP, were studied.

C. Chella Gifta et al, explores the use of Super Absorbent Polymers (SAP) and Light Weight fine Aggregates (LWA) as internal curing material. Mix M2 is achieved by adding SAP at 0.3% weight of cement and in mix M3 is obtained by replacing 25% weight of LWA to fine aggregates.

Juntao Dang et al, studied the influences of the volume, particle size and ways of entrained water of SAP on the workability, compressive strength, shrinkage, carbonation resistance and chloride penetration resistance of concrete through the macroscopic and microscopic test.

Bart Craeye et al, performed several thermal and mechanical tests and finite element calculations to evaluate the effect of internal curing on the high-performance concrete properties and cracking behaviour.

Piotr P. Woyciechowski et al, examines the influence of dosing method and material characteristic of superabsorbent polymers (SAP) used for internal curing, on the selected concrete properties.

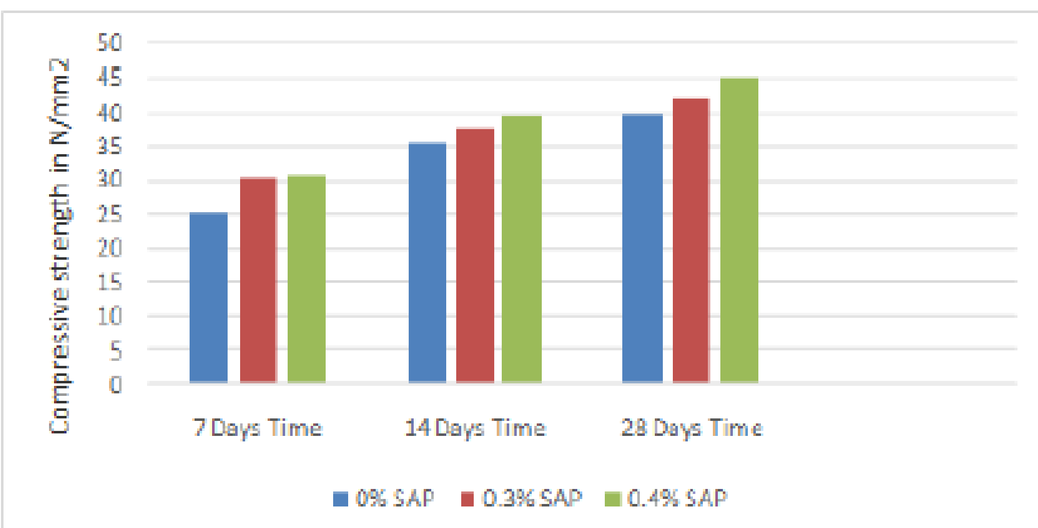
K. Letcham et al, examined the effect of internal curing as a complement to traditional curing in conventional concrete. Internal curing was achieved by super absorbent polymer (SAP) and the experimental parameter was percentage of SAP substitution to regular sand. Experimental results revealed that internal curing water provide by the SAP, effectively reduce the early-age chemical shrinkage and significantly increase the compressive strength of concrete.

Kenneth Sequeira et al, studied work done on SAP by various authors and found out Some of the advantages found in internal curing of concrete are that it reduces autogenous cracking, reduces permeability, largely eliminates autogenous shrinkage, protects reinforcing steel, increases mortar strength, increases early age strength sufficient to withstand strain, provides greater durability, higher early age (say 3 day) flexural strength, higher early age (say 3 day) compressive strength, lower turnaround time, improved rheology, greater utilization of cement, lower maintenance, use of higher levels of fly ash, higher modulus of elasticity, or through mixture designs, sharper edges, greater curing predictability, higher performance, improves contact zone, does not adversely affect finish ability, does not adversely affect pump ability, reduces effect of insufficient external curing.

S.Naga Bhargavi et al, performed experimental investigation in which 0.3% and 0.4% of Pre-soaked SAP was added to M40 concrete mix and compressive strength tests were conducted to standard cubes at 7,14&28 days.

Compressive Strength values

Days	0% SAP	0.3% SAP	0.4% SAP
7	25.46 N/mm2	30.76 N/mm2	31.10 N/mm2
14	35.83 N/mm2	38.07 N/mm2	39.52 N/mm2
28	39.98 N/mm2	42.30 N/mm2	45.56 N/mm2



Dugane S. et al, presents potential practical applications of SAP in concrete construction in this work. 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.

Compressive Strength Results presented by the

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

Ravindra D. Warkhadeet al,

Author Focuses on effect of SAP on mechanical properties of concrete. The dosage of SAP varies from 0.1% to 0.7% at an interval of 0.2%.The results indicate that SAP addition of 0.1 to 0.3% with w/c ratio 0.45 gives good strength of concrete.

II METHODOLOGY

Materials and Methods

Superabsorbent Polymer: This materials that have the ability to absorb and retain large volumes of water and aqueous solutions.

SAP type and proportions

Super absorbent polymer as a cross-linked potassium salt polyacrylate.

SAP Proportions

- Concrete sample with 0% of SAP
- Concrete sample with 0.5% of SAP
- Concrete sample with 1% of SAP

Concrete mix

Mix design for M30 grade concrete and concrete exposed to moderate exposure conditions.

Stipulation for Proportioning Concrete Ingredients

- Characteristic compressive strength required in the field at 28 days grade designation M 30
- Type of Cement: OPC 53 Grade confirming to IS 12269
- Maximum Nominal size of aggregate: 20 mm

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- Shape of CA: Angular
- Workability required at site: 100 mm (slump)
- Type of exposure the structure will be subjected to (as defined in IS: 456): Moderate
- Method of concrete placing: pump able concrete

Test data of material

The following materials are to be tested in the laboratory and results are to be ascertained for the design mix

(a) Cement Used: OPC 53 Grades Confirming to IS 12269

(b) Specific Gravity of Cement: 3.15

(c) Chemical admixture: Super plasticizer confirming to IS 9103

(d) Specific gravity

Specific gravity of Fine Aggregate (sand): 2.70

Specific gravity of Coarse Aggregate: 2.80

(e) Water Absorption

Coarse Aggregate: 0.4%

Fine Aggregate: 1.0%

(f) Free (surface) moisture

Coarse Aggregate: Nil

Fine Aggregate: Nil

Concrete Mix Proportions

Cement = 394 kg/m3

Water = 197 kg/m3

Fine aggregates = 732 kg/m3

Coarse aggregate = 1139 kg/m3

Water-cement ratio = 0.50

Mechanical properties of concrete

Tests for compressive strength, tensile strength shall be performed on concrete specimen with and without SAP. Number of specimens for these tests is shown below in table.

Table 3 Number of specimens

Specifications of specimen	**No. of specimens**
Without SAP	3
With O.5% of SAP	3
With 1% of SAP	3

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III CONCLUSION

With the advantages of SAP in concrete it brings in extreme weather conditions as well as its reduction in water usage on sites, this makes Internal curing a topic which will garner more attention as water usage shoots upwards in the construction industry. The performance of concrete with the addition of SAP will be tested and its advantages with conventional concrete will be justified

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