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INTERNAL CURING OF CONCRETE PARTIALLY REPLACED BY FLYASH USING SUPER ABSORBING POLYMER (SAP)

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ABSTRACT:

In Recent decades great advances in concrete technology have been developed due to adding of new chemical additives. This study focuses on the use of an optimum amount of Sodium Polyacrylate as a Super Absorbent polymer (SAP) in ordinary plain concrete. This paper deals with chemical and mechanical properties of mortars with internal curing by means of water-entrainment with SAP particles. Water has central importance throughout the life of concrete, hence SAP as proved a great opportunity in controlling the water. The main focus of this study would be to test the hardened SAP induced in concrete and to compare them with ordinary M20 grade concrete.

KEYWORDS: Concrete technology, Sodium Polyacrylate, Water-entrainment, Internal Curing.

1. INTRODUCTION:

Concrete is a versatile material made up of cement, coarse aggregate, fine aggregate and water. From past few years, development in concrete technology has put forth a great remark on today's technology. The major problem arising in concrete is formation of cracks during initial period or during any period. There are several factors contributing to cracks in concrete like plastic shrinkage cracks, settlement cracks, delayed curing etc. Different case studies have been reported that 40% failure of structure takes place due to steel reinforcement in concrete leading to corrosion. SAPs are a new type of concrete admixture and introducing these as a new component for production of concrete materials offers various possibilities with respect to water control. Also a positive result on controlling the properties of fresh concrete and hardened concrete. SAPs are polymeric materials that have the ability to absorb large amount of water from the surrounding and retain it within the structure. Standard industrial-quality SAPs typically have water absorption of 100 to 400 g/g dry and produced in any shape and size. In addition SAP enhances the strength and durability of concrete.

2. SUPER ABSOBENT POLYMER:

SAPs are also known as "Smart Materials"- It swells up when exposed to water and reversibly shrinks and releases the entrained water, when subjected to drying. The aim is to investigate the potential of Super Absorbent Polymer (SAP) as an admixture for self-sealing cracks in concrete. But some major problems associated with the use of lightweight aggregate, emerging the difficulties in controlling consistency and significant reduction in strength and elastic modulus. Superabsorbent polymer materials are hydrophilic networks that can absorb and retain huge amount of water or aqueous solution.
SAP is in powdered form like salt as shown in fig1. Low density cross-linked SAPs generally have high absorbent capacity and swell to larger degree.

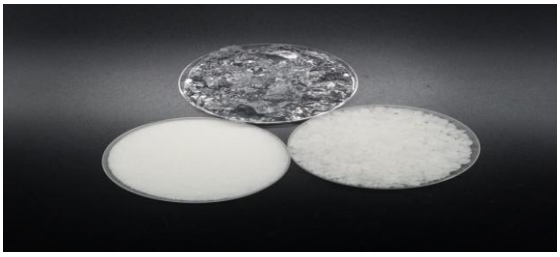

Fig1.1 Powdered form of SAP

Common SAPs are generally white sugar like hygroscopic materials, which are mainly used in disposable diapers and others including agricultural use. SAPs are originally divided into two main classes i.e. Synthetic(Petrochemical-based) and Natural(e.g. ;polysac-charide, and Polypeptide based) Most current superabsorbent are frequently produced from acrylic acid(AA),its salts and acryl amide(AM) via solution or inverse-suspension polymerization techniques. We have used “Sodium Polyacrylate” acid as super absorbent polymer (SAP). Sodium Polyacrylate is also known as “Water lock” .Its chemical formula is

$[-CH_2-CH(COONa)-]_2$ .It has the ability to absorb as much as 200 to 300 times its mass of water.

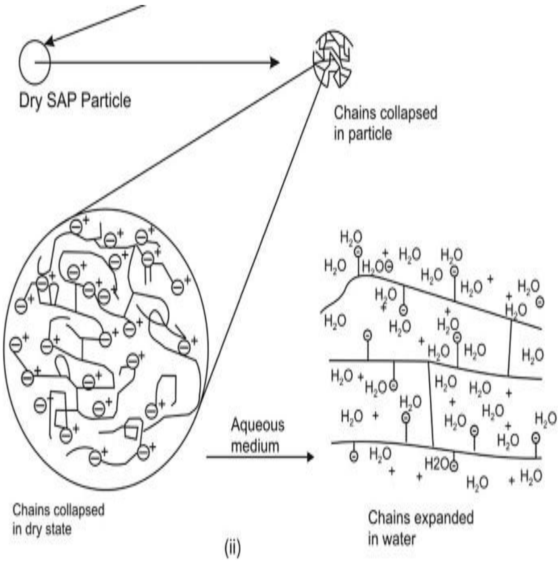

Fig 1.2 Behavior of SAP in Aqueous medium

(SOURCE: Zohuriaan and Kabiri (2008)

2.1 INFLUENCE OF STRENGTH:

When relative humidity inside the cement matrix gradually drops, the absorbent material can slowly release water to supplement the water consumption of cement hydration. While generation of voids takes places in concrete and reduces strength, the internal water curing provided by SAP enhances the degree of hydration and thereby increases the strength, these two effects is dominant depends on the water-cement ratio, maturity of concrete and amount of SAP addition.

2.2 INTERNAL CURING OF CONCRETE:

Internal cured concrete is not a new concept, some might say it's used from ancient period or constructed during Roman Empire. Internal curing was originally defined by the American Concrete Institute (ACI) as "supplying water throughout a freshly placed cementations mixture using reserve oirs, prewetted lightweight aggregates, that readily release water as needed for hydration or to replace moisture lost through evaporation or desiccation". Internal curing reduces early cracking, reduces chloride ingress, improves hydration, improves durability It maintains moisture content and temperature after placing of concrete in order to hydrate the cement particles and produce desire hardened concrete properties. Internal curing does not replace conventional surface curing, but works with it to make it robust. Internal curing is a relatively recent technique that has been developed to prolong cement hydration by providing internal water reservoirs in a concrete mixture.

2.3 FLYASH:

Fly ash is used as a supplementary cementitious material (SCM) in production of Portland cement concrete. The potential for using fly ash as a supplementary cementitious material in concrete has been known since the start of last century (Anon1914), although it wasn't until mid-1900s.The last 50 years has seen the use of Fly ash in concrete grow dramatically with close to 15 million tons used in concrete, concrete products and grouts in the U.S in 2005(ACAA 2006). Historically, fly ash used in concrete at levels ranging from 15% to 25% by mass cementious material component. Higher levels (30% to50%) used in massive structures (dams and foundation) to control temperature rise.

3. EXPERIMENTAL STUDIES:

3.1MATERIAL PROPERTIES

1. Cement- ACC OPC grade 53 was used in this project work. The Specific gravity of cement 3.15.
2. Fly ash: 15% replaced with cement. Specific gravity of fly ash is 2.23.
3. Fine aggregates- Aggregate passing through sieve size (4.75mm) is known fine aggregates. Sand as well as fine aggregate is used in this experimental study.
4. Coarse aggregate- 10mm and 20mm aggregates was used in this study in a proportion of 60% coarse aggregate retaining 10mm sieve and 40% aggregate retaining 20mm sieve respectively.
5. Water- No visible impurities present in water and were verified with IS 456-2000.
6. SAP –Sodium Polyacrylate was used as super absorbent in this project work. 0.25% and 0.15% variations of Sodium Polyacrylate are used.

3.2 TEST CONDUCTED ON MATERIALS:

1. Finess test: In sieve test, the cement weight 100gm is taken and is continuously passed through standard BIS sieve no.9.
2. Standard Consistency Test: The standard consistency of a cement paste is defined as that consistency which will permit the vicat plunger to penetrate to a point 5 to 7mm from the bottom of the vicat mould. The Standard Consistency of the cement is 32.8%.
3. Setting Time: Initial time =38min (>30min) Final setting time =530 min (<600min).

3.2MIX DESIGN

The mix design was carried out as per IS.1206-2009. The mix design was carried out for M20 grade of concrete with FLYASH (15%) as partially replacement of cement and SAP by variation of 0.15% and 0.35%.

Table 1 M20 grade concrete without replacement of Fly ash and SAP.

MATERIALS	0 % replacement of OPC by SAP and Fly ash.(Kg)
Cement	419.53
Fly ash	-
SAP	-
Water	186
Fine Aggregate	652.5
Coarse Aggregate	1139.5

Table2. 0.15% of SAP, OPC is replaced by 15% of Fly ash

MATERIALS	15%FLYASH REPLACEMENT & 0.15 % SAP(Kg)
Cement	13.07
Fine Aggregate	20.25
Coarse Aggregate	35.41
Water	6.01
SAP	0.0196
Fly Ash	1.96

Table3. 0.35% SAP, OPC is replaced by 15% of Fly ash

MATERIALS	0.15%flyash and 0.35% of SAP
Cement	13.07
Fine Aggregate	20.25
Coarse Aggregate	35.41
Water	186
Fly ash	1.96
SAP	0.045

4. Preparation of Test Specimens-

Mixing: The mixing of all the constituents materials are done in a proper manner.

Casting: Cubes are casted for M20 grade with 15% of Fly ash and Percentage of super absorbent polymer is taken as 0.15% and 0.35%.Mixed concrete is poured immediately in the moulds of size 150mmx150mmx150mm concrete is poured in 3layers and tamping is carried out for each layer giving more than 25 blows, in order to obtain fully compacted concrete specimen.

Curing: After 24 hours the moulds are demoulded and were immersed in a water tank for curing. The curing was done far a period of 7days and 14days respectively. Compressive strength test is conducted on hardened concrete after 7days and 14 days.

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Table 4.Total number of cubes.

Period	M20 grade	M20 grade with (15%) fly ash & (0.15%)SAP	M20 grade with(15%) fly ash&(0.35%)SAP
7	3	3	3
14	3	3	3
total	6	6	6

Fig 4.1: Cubes casted are shown in below fig

Fig 4.2 Test on cubes

5. RESULTS AND DISSCUSSIONS

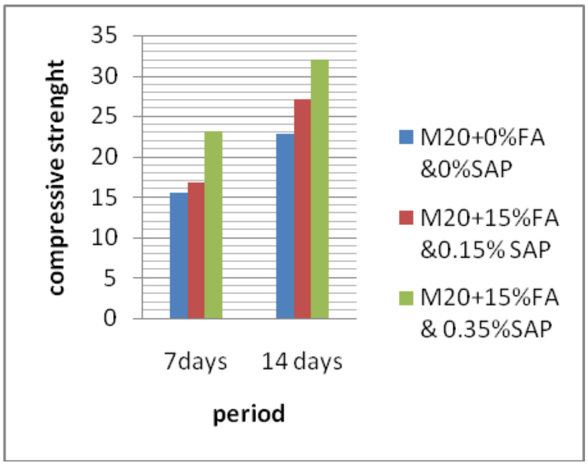
Table 5.1: Compressive strength at 7days of curing.

SR. NO	% of FLYASH	% of SAP	Compressive strength (N/mm²)	Average compressive strength (N/mm²)
1	0	0	1)13.43 2)15.85 3)17.31	15.53
2	15	0.15	1)15.67 2)16.64 3)18.151	16.82
3	15	0.35	1)21.54 2)23.85 3)24.12	23.17

Table 5.2: Compressive strength at 14 days of curing.

SR. NO	% of FLYASH	% of SAP	Compressive strength (N/mm²)	Average compressive strength (N/mm²)
1	0	0	1)20.54 2)23.54 3)24.22	22.76
2	15	0.15	1)25.46 2)27.05 3)28.90	27.13
3	15	0.35	1)31.56 2)31.86 3)32.50	31.97

Fig 5.3: Compressive strength of mix at 7& 14 days in MPA.



Observation:

From fig.5.3. It found that after 7 days the compressive strength of conventional M20 and 15% partially replaced concrete by Fly ash are shown to be close to each other. After 7 and 14 days concrete having 0.15% SAP achieves strength less than 0.35% added SAP. In all the three cases it found that concrete having 0.35% SAP attains highest strength and seems to be an optimum content.

6. CONCLUSION

i. Dry ash absorbs more water while wet ash absorbs less water keeping the water cement ratio intact which in turn also increases the workability of the concrete.

ii. SAP is very useful to prevent water leaks through the concrete mass making it a self-sealing concrete.

iii. It has been observed that increase in the amount of SAP, used in concrete mix decreases the flow rate.

iv. Workability was found to increase with increase in percentage of SAP

v. Adopting SAP as self-curing agent can be advantageous in desert regions to deal with limited avaibility of water.

vi. It has been observed that addition of 0.35% of SAP in OPC gives maximum compressive strength.

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