



# EXPERIMENTAL INVESTIGATION ON CONCRETE USING SUPER ABSORBING POLYMER

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## ABSTRACT

*The use of super absorbing polymer (SAP) in concrete is proven to have many positive effect on the properties of concrete in its both stages fresh and harden concrete. The super absorbing polymer is sodium polyacrylate material which is absorb water and convert it into gel, then thus dry/wet polymer add in fresh concrete, after final setting of concrete due to dry periphery of concrete SAP release water and it provides internally curing namely known "self curing concrete" (SCC) in short less or no external curing are required in other way if external curing may causes better heat of hydration. Proper dosage of self curing gels will increase the strength and serviceability of concrete. In this study 0.1%, 0.2%, 0.3% by wt. of cement was varied in M25 grade of concrete and compare with conventional concrete. And thus different dosage is added in concrete in a different form such as gel and powder. Present study involves different strength aspect experiment (only compression strength) on a concrete with curing, without curing and gunny bag curing. Here also studying that what a strength achieve in an actual site condition.*

**Keywords:** *Curing, Compression strength, Gel, Powder, Super Absorbing polymer.*

## INTRODUCTION

Concrete is a mixture of cement, aggregate, water or without suitable admixture. To attain desirable strength and serviceability curing is necessary. Curing is the process of maintaining the proper moisture content to promote cement hydration. Concrete derives its strength by the hydration of cement particles, and thus process continuing for long time. The process of hydration begins when the molecules of the cement and water mixed. Loss of mass in a molecular level, necessarily results in an energy release. In this case the bonding of molecules results in a thermal chemical reaction this is known as heat of hydration. In field work higher water cement ratio is used, since the concrete is open to atmosphere, the water used in the concrete evaporates and the water available in concrete will not be sufficient for effective hydration to take place particularly in the top layer. If the hydration is continue, extra water must be added to refill the loss of water on account of absorption and evaporation under normal condition, once cement and water are mixed the hydration process will begin and concrete will gain strength and serviceability with an passage of time. SAP provides some degree of internally curing to concrete. SAP absorbs water and converts into gel, then releases it slowly with time. From a strength



point of view, the addition of SAP to concrete has to opposite-: while the SAPs generate voids in the concrete and thus reduces strength, the internal water curing provided by SAP enhances the degree of hydration and increases the strength [1]. In particular, at high water cement ratio ( $>0.45$ ) SAP addition has very little effect on hydration and therefore generally reduces compression strength. At low water cement ratio ( $<0.45$ ), SAP addition may increases compressive strength [1]. The concept of super absorbing polymers (SAPs) are Sodium polyacrylate materials that have the ability to absorb a liquid in 170-200 times (as per manufacturer company) of their own weight. After the dried periphery it spread water that time SAP provides internally curing. One point noted this is admixture not a cement replacement. For maintain the slump, amount of SAP may required in gel form. Gel form means sufficient water added in a SAP powder. As per studied and literature there are main focus is to SAP dosage should be added in powder form or gel form? Also there are main question is creates how many quantity should be added in SAP powder. Water quantity is shown in mix design. Here also studying that what a strength achieve in a actual site condition which is proven the help of wet/dry gunny bag.

### **Advantages of using SAP**

- To overcome from deficiencies of external curing generated by both human and hydration. [2]
- It is reduces evaporation, so occasion of cracks are less as well as eliminated shrinkage.
- Provides continue moisture contain for hydration of cement.
- Increase or maintain the strength of concrete if the optimum dosage of self curing is used and this is polymer also use for high strength concrete.
- Some amount SAP appear on surface of concrete, thus advantages for reflect sunrays which makes concrete surface cool, which can resist thermal cracking's.
- Improve resistance to abrasion and compression action of salts and chemical.

## **II. EXPERIMENTAL INVESTIGATION**

### **2.1 Materials**

2.1.1 Cement- Ordinary Portland cement 53 grade are used in this investigation.

2.1.2 Fine aggregate- Locally available river sand.

2.1.3 Coarse aggregate- Locally available crushed stone.

2.1.4 Water- Potable water is use.

2.1.5 Super plasticizer- MC-Zentriment is used to increase workability or reduce frictional property of concrete.

2.1.6 Super absorbing polymer- SAPs are sodium polyacrylate particle where it is contact with water then thus polymer chain will be expand and water held within a structure. Here SAP absorbing 170-200 times of their own weight. It is seen that it totally swell within a 10 min as shown in (fig-2.1 and 2.2). SAP is sodium basis but their no any chemical reaction to concrete and steel.

Table no. 2.1 **Properties of Super Absorbing Polymer**

Chemical formula	$[-CH_2-CH(CO_2Na)-]_n$
Form-dry	Crystalline white powder/granular
Form-wet	Transparent gel
Particle size	125 micron
Water absorbing with distilled water	170-200
pH of absorbing	Neutral
Density	1.08 (g/cm <sup>3</sup> )
Bulk density	0.85 (g/cm <sup>3</sup> )
Hydration/Dehydration	Reversible



Fig.2.1- SAP in Powder Form

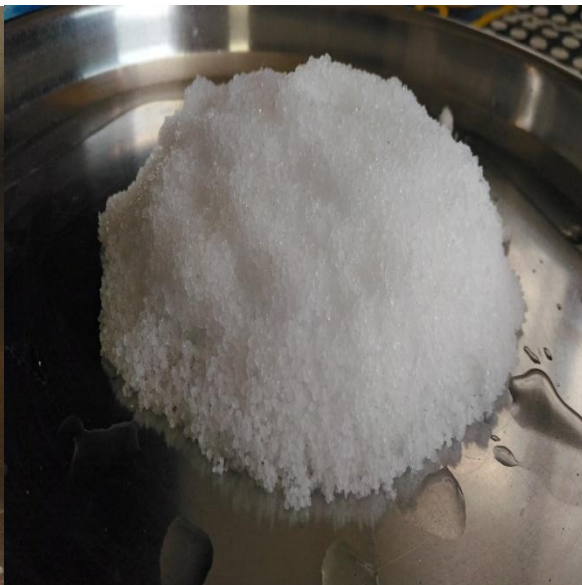


Fig.2.2- SAP in Gel Form

## 2.2. Mix Design

The proportion of ingredient of concrete is governed by the required performance of two states namely; the plastic state and the hardened state. If the plastic concrete is not workable, it cannot be properly placed and compaction. The property of workability becomes important.

The Mix design for concrete was carried out with the guidelines from IS:10262:2009 for M25 grade concrete with the water cement ratio of 0.45

Mc-Zentriment Super plasticizer, water can be reduce 15% and above,

1. Water = 167.45 lit

2. Cement = 372.11

3. W/C ratio= 0.45

4. Aggregate:

Coarse aggregate fraction= 0.63



Fine aggregate fraction= 0.37

5. a) Volume of concrete=  $1 \text{ m}^3$

b) Volume of cement=  $(372.11 / 315) \times (1/1000) = 0.118 \text{ m}^3$

c) Volume of water=  $(167.45/1) \times (1/1000) = 0.167 \text{ m}^3$

d) Volume of aggregates in all=  $1 - 0.118 - 0.167 = 0.715 \text{ m}^3$

e) Coarse aggregate=  $0.715 \times 0.63 \times 2.67 \times 1000 = 1202.7 \text{ kg/m}^3$

f) Fine aggregate=  $0.715 \times 0.37 \times 2.62 \times 1000 = 693.11 \text{ kg/m}^3$

g) Super plasticizer =  $5.58 \text{ kg/m}^3$  (1.5% by wt. of cement)

h) Water quantity for convert SAP powder into gel =  $28.83 \text{ kg/m}^3$  (constant)

Mix proportion:- 0.45: 1: 1.86: 3.23

6) Factor of Safety= 1.2

### 2.3. Test on fresh concrete

As per IS 7320 (1974) the internal surface of the mould is, thoroughly cleaned and applied with a light coat of oil. A 30cm cone filled in 4 layers, each one-fourth of the height of the cone. Each layer tamped 25 times over cross section. At the top layer concrete is truck off by trowel. Remove cone in a vertical direction after 20 sec of tamping and measuring a slump in mm [3].

Table-2

Slump value for SAP in gel form

MIX PROPORTION	SLUMP(MM)
Normal concrete	110
SAP 0.1%	125
SAP 0.2%	130
SAP 0.3%	140

Table-2.1

Slump value for SAP in powder form

MIX PROPORTION	SLUMP(MM)
Normal concrete	110
SAP 0.1%	70
SAP 0.2%	65
SAP 0.3%	50

### 2.4. Test on Harden concrete

#### Compression Test

The test is carried out on 150 X 150 X 150 mm size cubes as per IS 516-1954 firstly tight all screw of the mould then thin coating is applied to inner side of mould. Fill fresh concrete in a 3 layer and each layer should be tamped 35 strokes by MS bar then allow to table vibrator upto 1 min for removing air bubbles. We are casted 42 cubes

and take average of three cubes and tested on universal testing machine (shown in fig no.3). We are adopted various curing method such as without curing, pond curing, gunny bag curing.

Method adopted for curing:

- 1) Pond curing= Cubes are fully immersed in tank.
- 2) Without curing= Cubes are pack in dry gunny bag and keep in room temperature. (Shown in fig.4)
- 3) By Gunny bag= Cubes are packed in wetted bag and securely place in atmospheric temperature and as per site condition allow water daily 2 times on a gunny bag. (Shown in fig.4)



Fig.2.4- Wet/Dry Gunny Bag Curing



Fig.2.3- Universal Testing Machine

### III. RESULT AND DISCUSSION

**Event-3.1** The strength parameters of self cured concrete were compared with cured concrete at 7 days and 28 days as shown in fig no.3.1

- 1) By calculation 350 ml water for 3 cubes should be added for SAP powder convert into gel.
- 2) We are takes constant value of water quantity i.e. 350 ml for 3 cubes and apply and check variation of different to SAP dosage.

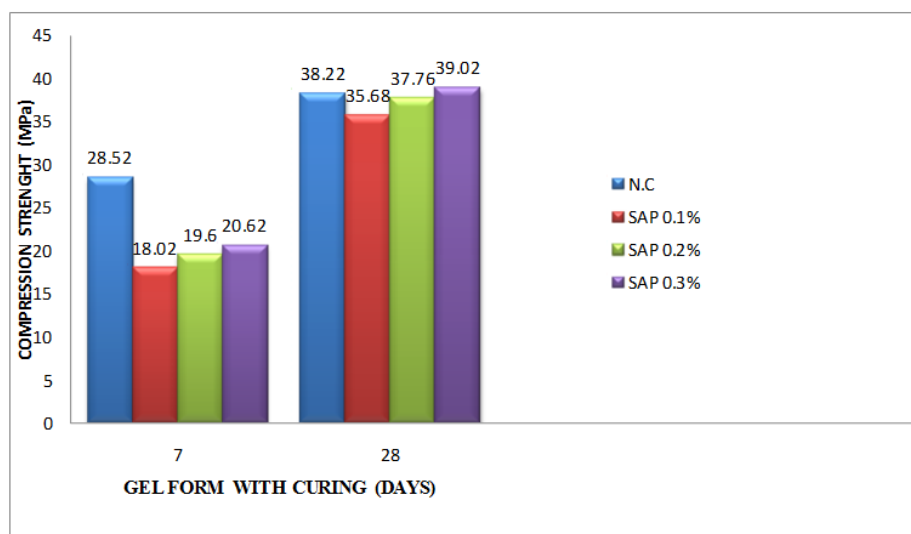


Fig 3.1-Compression Strength for Gel Form Pond Curing



## EVENT 3.2-

- 1) Below graph result shows (fig no.3.2), when SAP adds as powder form (no extra additional water requirement) and applying to pond curing it gives higher strength as compare to gel form pond curing.
- 2) Here also 0.3% gives best result.
- 3) When SAP powder adds in a concrete then the slump will decrease as compare to normal concrete due to lowering water content. But their absorbed water SAP uses for internally curing.

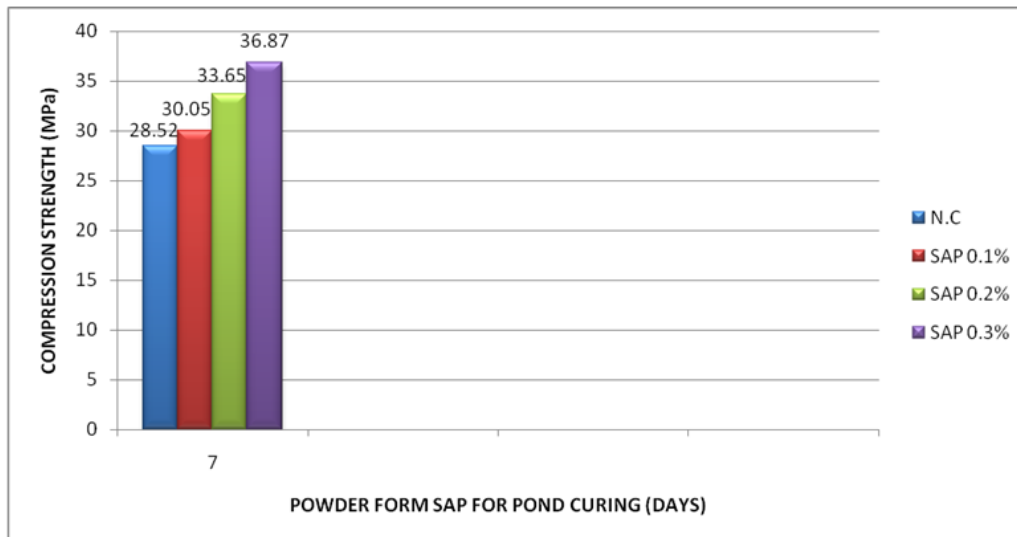


Fig 3.2- Compression Strength for powder Form Curing.

## EVENT 3.3-

- 1) Below graph result shows (fig no.3.3) different curing strength and applying SAP formation i.e. gel or powder.
- 2) Above result shows SAP 0.3% by wt. of cement gives best result as compare to other SAP dosage, so best experience all below event/casting applying to only for SAP 0.3%.

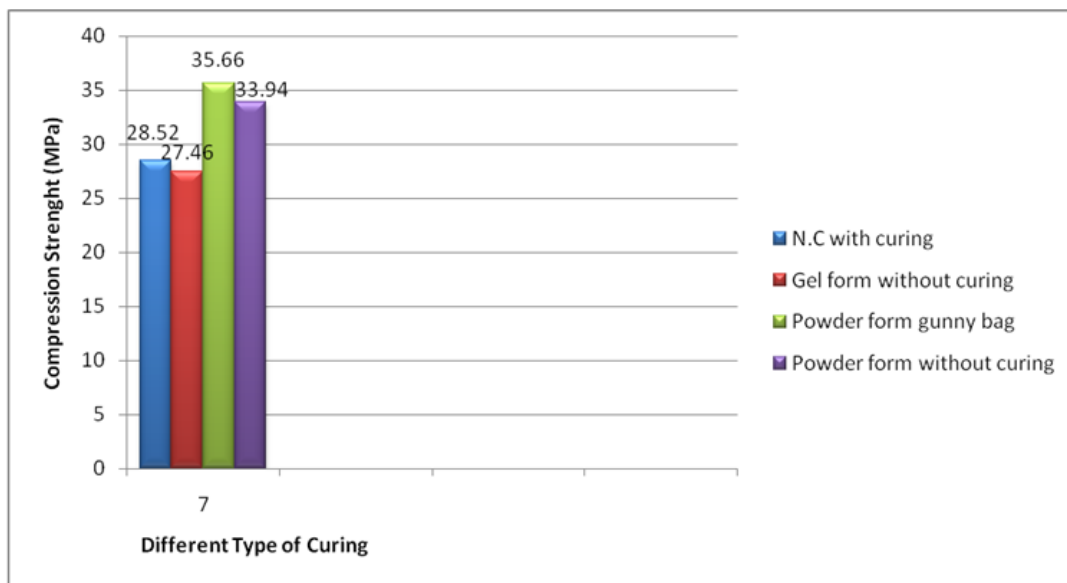


Fig 3.3-Compression Strength for powder Form Curing



#### **IV. CONCLUSIONS**

- 1) The optimum dosage of SAP for internal curing was found out to be 0.3% by weight of cement
- 2) If SAP adds as gel form in concrete, water content is increase and obviously strength of concrete will reduces as compare to powder form.
- 3) Here also seen that SAP add 0.3% as gel form the strength of concrete is reduces in 7 days and it's gradually increase hydration and an achieving in 28 day.
- 4) If SAP adds as powder form in concrete SAP absorbs water then due to lowering water content strength of concrete increases.
- 5) When SAP adds as powder form it touches their 7 days strength to 28 days normal/convention concrete.
- 6) Gunny bag curing strength is touches to powder form pond curing. An actual field/site work gunny bag curing mostly adopted, so thus ideal condition there are suitable.

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