

# Mechanical Properties of Super Absorbent Polymers (SAP) Modified Concrete

<sup>[1]</sup>Shaikh Mohd Zubair, <sup>[2]</sup>R.R.Sonawane, <sup>[3]</sup>R.K. Sonawane, <sup>[4]</sup>D.G.Deore <sup>[5]</sup>A.D.Waikar

<sup>[1]</sup>Assistant Professor , Deogiri Institute of Engineering and Management Studies, Aurangabad 431005,

<sup>[2]</sup> U.G. Students, Deogiri Institute of Engineering and Management Studies, Aurangabad.

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**Abstract:**— since few years great advances in concrete technology have been increasing, now a days the development and the use of new chemical additives which added to concrete in very small quantities can dramatically improve mechanical properties of concrete in its fresh and hardened states. This paper presents an experimental investigation on the mechanical properties of concrete produced by incorporating Super Absorbent Polymers in varied percentage. Test result indicates that the mechanical properties of concrete can be improved through the optimum use of Super Absorbent Polymers (SAP).

**Index Terms** :-- Super Absorbent Polymers (SAP), w/c ratio, Compressive Strength, Split tensile Strength, Workability.

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## I. INTRODUCTION

Super Absorbent Polymers are one of the most fascinating materials in modern polymer technology. This polymers are able to absorb up to 1000 gram of water per gram of SAP. Concrete production by using Portland cement is probably the most widely used material made by man and the worldwide production of cement is tremendously increasing. [1]. Moreover, construction industry performed a continuous modifications and improvements in order to successfully comply with the requirements of sustainable development. It is expected to develop more durable, less labor and service intensive materials at a competitive price. To meet these demands various types of additives, admixtures and supplementary cementitious materials are more commonly incorporated into cement matrices. This however necessitates thorough analysis of their individual reactions with clinker and between each other. [2]. A promising and relatively new technology to achieve the latter is the application of superabsorbent polymers (SAP) to facilitate internal curing. SAP has been found to successfully improve the microstructure of high strength concrete. [3]. Little information is available on the use of SAP to improve the microstructure and durability-related properties of mortars of normal strength made with supplementary cementitious materials. With regards to strength properties, the use of SAP in concrete can have the effect of reducing strength due to the creation of additional voids in the hardened cement matrix. However, this effect is partly offset due to the generally improved microstructure achieved due to internal curing. The overall effect depends on factors such as w/b ratio, maturity and amount of SAP addition [3,4]. The effects of SAP on tensile strength development may not be of the

same magnitude as that of compressive strength. Since tensile strength depends specifically on the micro-cracks occurrence resulting from self-desiccation, prevention of this process may actually improve tensile properties.[2].

The main focus of the experimental work was to study the general effect of SAP addition on the mechanical properties of the fresh and hardened concrete produce by use of SAP .

## II. EXPERIMENTAL PROGRAMME

### 2.1 Materials

Ordinary Portland cement (53 Grade) conforming to IS: 12269-1987 [5]. Natural river sand passing through 4.75 mm IS sieve conforming to grading zone II as per IS-383 1970 [6] with fineness modulus 2.9 and was of specific gravity 2.81. Coarse aggregate maximum size of 20 mm as well as graded crushed granite stone with a specific gravity of 2.87 having moisture content 1.95% was used. Fly ash Pozzocrete P-60 grade of reputed company used as mineral admixtures. The naphthalene based super plasticizer was used to obtain the required workability.

### 2.2 Mix proportioning

The experimental stage of this study was designed such that the mechanical properties of concrete made by adding Super Absorbent Polymers could be determined. For that experimental program was design based on a reference concrete mix containing 0 % sap addition. on the basis of literature survey the percentage addition of Super Absorbent Polymers 0.15%, 0.2% and 0.25% were fixed for the present study. This research involves the use of mineral admixture Fly Ash as a replacement of cementitious material by weight of cement, at definite proportions to enhance the compressive

strength of concrete. It consists of casting concrete mixes, dosage of superplasticizer and workability of concrete was kept constant. water cementitious material ratio (w/c) of 0.31 decided and implemented for casting. after the test on material and its properties, the proportioning of concrete mix was carried out in accordance to IS 10262:2009 [7]. Mix proportioning for per cubic meter of concrete is shown in [Table-1].

**Table - 1 : Material for per cubic meter of concrete mixtures.**

Sr. No	Mix Designation	W/C	Cement (Kg)	SAP (Kg)	Fly Ash (Kg)	Water (kg)	Aggregate (Kg)		Chemical Admixture (kg)
							C.A. 12.5 mm	F.A.	
1	Mix-01-R	0.31	290.82	58.17	38.78	159.36	1167.68	740.18	3.89
2	Mix-02	0.31	407.16	81.44	54.28	157.46	1073.58	683.01	5.43
3	Mix-03	0.31	339.3	67.83	45.24	158.64	1132.05	718.54	4.53
4	Mix-04	0.31	488.59	115.36	74.65	155.74	988.33	631.22	6.79

### III. TESTING OF CONCRETE

Concrete cube of size 150x150x150 mm were tested for compressive strength at the age of 7days, 21days and 28 days as per the IS 516:1959 [8]. To obtained the split tensile strength, cylindrical specimen of size 150 mm diameter and 300mm length were tested as per the provision laid in IS 5816: 1999. The workability of concrete was measured by means of conventional slump test.

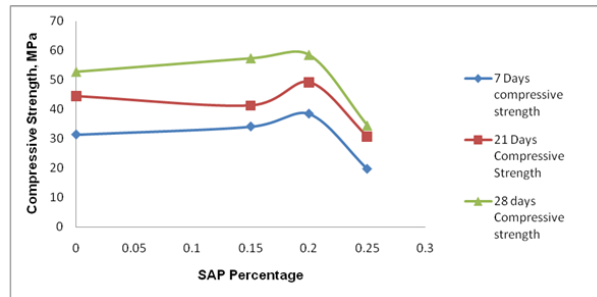
### IV. RESULTS AND DISCUSSION

#### Compressive Strength Test Results

The mix designations and percentage addition of SAP along with test results of each mix are presented in Table 2. Column No 2 shows designation of the mixes, while w/cm ratio by mass, percentage addition of SAP is shown in Column No 3 and 4 respectively for each mix. In Table 2, Column No 5,6 and 7 gives the overall results of 7days, 21days and 28 days compressive strength of concrete produced by using varied percentage addition of SAP. The variations of compressive strength at the age of 7days, 21days and 28days at different percentage addition of SAP can be depicted in the form of graph as shown in Figure- 1. Compared to the compressive strength of reference mix concrete (0 % of SAP) and concrete mix having 0.15 % of SAP gives higher compressive strength. the results shown in column 5,6 and 7 indicated that the optimum amount of SAP which gives maximum compressive strength is 0.2%. the mix having SAP content 0.25% shows less compressive strength compared to reference mix. results reveal that the rate of gain of strength developments is increased with increase in SAP contents up to 0.2% and after this compressive strength get reduced even less than reference mix concrete.

**Table - 2: Compressive Strength results with varied percentage addition of SAP.**

Sr. No	Mix Designation	W/C	SAP (%)	Compressive Strength, N/mm <sup>2</sup>		
				7 Days	21 Days	28 Days
01	02	03	04	05	06	07
1	Mix-01-R	0.31	0	33.19	44.48	52.73
2	Mix-02	0.31	0.15	35.33	41.33	57.33
3	Mix-03	0.31	0.2	38.49	49.22	58.48
4	Mix-04	0.31	0.3	23.68	30.71	39.4



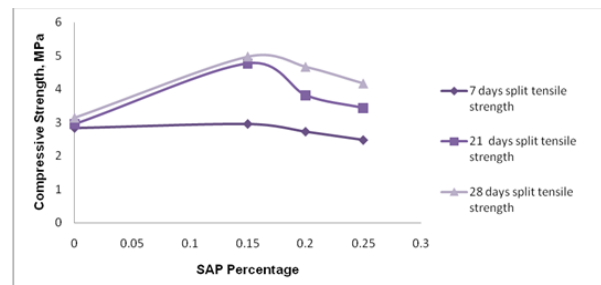
**Figure-1. Variation of compressive strength of concrete with different percentage of SAP.**

#### Split Tensile Strength Test Results

Table- 3 gives the overall results of split tensile strength of concrete produced by using varied percentage addition of SAP. The variations of Split tensile strength at the age of 7days, 21days and 28days at different percentage addition of SAP can be depicted in the form of graph as shown in Figure- 2. Comparing the split tensile strength of reference mix and rest of the mixes, the mix having varied percentage addition of SAP shows higher split tensile strength and its obtained strength values are represented in column no 5,6 and 7 respectively in Table- 3.

**Table - 3: Split Tensile strength results with varied percentage addition of SAP.**

Sr. No	Mix Designation	W/C	SAP (%)	Split Tensile Strength, N/mm <sup>2</sup>		
				7 Days	21 Days	28 Days
01	02	03	04	05	06	07
1	Mix-01-R	0.31	0	2.84	2.96	3.14
2	Mix-02	0.31	0.15	2.96	4.775	4.98
3	Mix-03	0.31	0.2	2.73	3.82	4.67
4	Mix-04	0.31	0.3	2.48	3.44	4.17



## V. CONCLUSIONS

Following Conclusions may be drawn in the present study based on the results:

- (1) The results indicated that the rate of gain of strength developments is increased with increase in SAP contents up to 0.2% and after this both compressive strength as well as split tensile strength get reduced even less than reference mix concrete.
- (2) The experimental results reveals that compared to the compressive strength of reference mix concrete (0 % of SAP) and concrete mix having 0.15 % of SAP gives higher compressive strength.
- (3) The results shows that the optimum amount of SAP which gives maximum compressive strength is 0.2%. The gain of strength of SAP may be attributed to its water holding properties which may increase the internal curing of concrete.
- (4) The results shows that the percentage addition of SAP more than 0.2% reduces the workability, which indicated more water content demand to achieve required degree of workability.

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