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Use of Super Absorbent Polymer (SAP) and flyash in Concrete

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Abstract - *Super absorbent polymers (SAP) has numerous valuable consequences for different properties of concrete when SAP is added to concrete. Because of water assimilation property of Super Absorbent Polymer, the concrete is cured inside. Because of this sort of curing, there is a huge effect on the strength of concrete. Super absorbent polymers (SAP) has many beneficial effects on various properties of concrete when SAP is added to concrete. Due to water absorption property of Super Absorbent Polymer, the concrete is cured internally. Due to this type of curing, there is a significant influence on the strength on concrete. SAP likewise helps seal a crack created inside the concrete because of hydration process. Alongside great applications it has a few confinements, if an excess of amount of SAP is included the concrete, it might prompt extra void development in the concrete mass which negatively affect the concrete. This impact of SAP on solid prompts change in usefulness and placing of concrete. In this study we supplanted concrete by 25% Fly Ash which pozzolana, a substance which contain aluminous and sliliceous material that becomes cementations material when it interacts with water. The fundamental focal point of outcomes as for water control and accordingly to the control over the rheological properties of creep concrete cement, what's more water assimilation and water discharge in either new or harder concrete. At the point when SAP is included the concrete then they assimilate and store significantly more water than their own weight, inside a brief timeframe. At the point when concrete permits to set, during the hydration process, the saturated SAPs supply the surrounding cement matrix with extra water. When SAP dried out, voids are formed of size (100 to 600 µm diameter), acting correspondingly as pores created via air-entraining specialists.*

1.1 Early Investigation

Per Freiesleben Hansen started another arrangement of curing innovation idea in 1997. They called this innovation "water entrainment" in view of likenesses with air entrainment. Jensen again utilized SAP in concrete in 2013. He expressed that water entrainment is a new technique for incorporation of create, air-filled cavities in concrete. Clear and free of huge downsides, water entrainment can be prompted with fine SAP particles as a concrete admixture. These included rheology modification, frost protection.

L. O. Ekebafe, d.e. Ogbeifun, f.e.okieimen express that the utilization of polymer is increasing increasingly notoriety in the field of polymer science and farming. Super absorbent polymers (sap) help in limiting different agrarian issues in the present life by expanding area and water efficiency without debilitating the environment. This is done because sap impact the soil structure, density, permeability etc. Sap helps in builds the productivity of pesticides, permitting lower measurements to be utilized because of its water entrainment property. This property of SAP influenced different scientists to trust that fuse of SAP in cement would be beneficial from multiple points of view.

Moayyad Al-Nasra And Mohammad Daoud utilized SAP in cement and testing of examples demonstrated an indistinguishable outcome from that of Jensen's in 2013. The utilization of Super absorbent polymer in concrete influences distinctive properties of cement in its fresh stage and hardened stage. Despite the fact that the measure of Super spongy absorbent utilized as a part of concrete fluctuated for them, they were successful in copying the aftereffects of jensen's exploration. They were likewise fruitful in playing out the soundness test on sap incited crisp concrete.

1.2 Internal Curing

Internally cured concrete is certifiably not another idea some may even say it is old since it can be considered to go back to concrete developed amid the Roman Empire. Internal curing gives something that concrete needs and regular curing can't give, extra internal water avoid early age shrinkage (reducing early age cracking) and enhance hydration of cementitious materials throughout the concrete. At the point when concrete sets, hydration makes incompletely filled pores in the concrete which causes stress that outcomes in shrinkage. IC gives quickly available additional water all through the solid, so hydration can proceed while a greater amount of the pores in the concrete stay immersed. This decreases cracking, early age curling/warping, shrinkage, increases strength and decreases the permeability of the concrete, making it more impenetrable to chloride penetration. Internal curing does not supplant traditional surface curing, but instead works with it to make strong all the more intense. Internal curing can likewise help adjust for less than ideal weather conditions and poor conventional curing that is often seen in the real world. ACI characterizes internal curing (IC) as a procedure by which the hydration of bond proceeds with as a result of the accessibility of interior water that isn't a piece of the blending water. The even course of extra water sources inside the concrete will incite to more noteworthy consistency of dampness all through the thickness of the member, and in this manner decreased interior worries

because of differential drying. While drying shrinkage may not be completely neutralized in the long haul, deferring it will enable the concrete to pick up strength and be better ready to oppose the associated stresses.

2. EXPERIMENTAL PROGRAM

The present study aims at casing and testing of concrete specimens for compressive strength, tensile strength and flexural strength that consists of three dosage of SAP 0.2%,0.35% and 0.5%. M25 grade concrete was designed and to that cement was replaced with 25% by Fly ash. The effect of Super absorbent Polymer on concrete the fresh & hardened concrete properties like the slump was also studied in study.

Regression Analysis is carried from experimental values which is obtained from testing of specimens. Which is casted and tested in initial set of experiment. Regression model is obtained for 7,14and 28 days. After this analytical work we predict the strength of concrete for 7,14 and 28 days with the different dosage of concrete. To validate this analytical work confirmatory work is done in this set of experiment cube is casted to achieve target strength and then test for compressive strength.

2.1 Material specifications

Super absorbent polymers (sap) also called slush powder this is polymers which with respect to their own particular mass, can absorb and hold incredibly a lot of fluid. Water absorbing polymers, through holding amongst hydrogen and water particles ingest fluid arrangements. A SAP may absorb 450-500 times its weight (from 40 to 60 times its own particular volume) and can progress toward becoming up to 99.99% fluid, yet when put into a 0.9% saline arrangement, the absorption drops to conceivably 40-50 times its weight. The essential utilization of sap is found under horticulture. It is also utilized as a part of dispensable child sterile items because of its water holding property.

Fig 1 - Powdered form of Super Absorbent Polymer – SAP

In powdered form, they show up as white sugar like hygroscopic material. Sap is believed to be a keen material, it swells up when it is in contact of water and it reversibly psychologists and release the entrained water, when subjected to drying. This article manages the impacts of sap on various properties of cement due its own particular water entraining property.

2.3 Casting of Specimens

A Mixing tray was used to prepare the concrete. Sand and coarse aggregates were first dry-mixed. Then Cement and Fly Ash were added along with appropriately 70% of the design water. After few minutes of mixing, SAP in a gel form was added to the remaining 30% of the water and use in the mix. Table vibrator was used to vibrate the moulds for full compaction. Cubical specimens of 150 mm side, Beam specimen of 100 x 100x 500, Cylinder specimen of size 150 x 300 were used for compressive strength, flexural strength and split tensile strength test respectively. Test was done at 7, 14 day and 28 days for respected strength for all set of experiment. The specimens in the moulds were removed after 24 hours and then cured in open water tank at ambient condition until the testing day. Individual variation of the test results was within IS 456:2000 limit.

2.4 Initial Experiment

In the first set of experiment, For this, the w/b ratio used were 0.55 while SAP percentage were 0%, 0.20, 0.35, 0.50% of the total cementitious material and 25% of total cementitious material Fly Ash is used. In first set of experiments cubes, beams and cylinder were casted to test these specimens for respected strength. The compressive strength of concrete was plotted against the percentage of Super Absorbent Polymer. The graph were represented by curved line.

A Super Absorbent polymer can ensure very effective internal water curing, said by O. Mejlhede Jensen "consolidation of a curing agent servingin as an inside supply of water, slowly discharging it as the concrete dries out." Internal water curing has been utilized for a considerable length of time to advance hydration of cement and to control the shrinkage of concrete during hardening. Which of these two impacts is prevailing relies upon the water cement ratio (w/c), the maturity of the concrete, and the amount of SAP addition.

After the curing at required intervals has done, we chose to test the different qualities of hardened concrete which includes compressive, split tensile and flexural strength. Reasonable types of equipment's and testing machines were utilized to test different strength of concrete.

TABLE I

COMPRESSIVE STRENGTHS

Days	M25	25% FA 0% SAP	25% FA + 0.20% SAP	25% FA + 0.35% SAP	25% FA + 0.5% SAP
7	16.87	17.44	20.96	22.29	19.63
14	23.15	22.51	27.91	30.52	26.87
28	26.5	25.3	32.26	34.3	30.2

During the testing period of these results, the water/cement ratio was kept constant at 0.55 and then they were cured externally for a period of 7, 14 and 28 days respectively as shown in the table. Along with the compressive strength, split tensile strength was also tested with the help of Cylinders of dimension 15 x 30 centimeters and the average Tensile strength achieved are displayed below.

TABLE II

SPLIT TENSILE STRENGTHS

Days	M25	25% FA 0% SAP	25% FA + 0.20% SAP	25% FA + 0.35% SAP	25% FA + 0.5% SAP
7	1.83	2.20	2.04	2.30	1.89
14	2.51	3.01	2.80	3.15	2.59
28	2.83	3.39	3.15	3.54	2.92

Simultaneously, Beams of dimension 10 x 10 x 50 cm for testing flexural strength of hardened concrete was also casted and then tested for flexural strength. The average Flexural strengths achieved in 7, 14 and 28 days for ordinary M25 concrete and SAP induced concrete are as given below.

TABLE III

FLEXURAL STRENGTHS

Day	M25	25% FA 0% SAP	25% FA + 0.20% SAP	25% FA + 0.35% SAP	25% FA + 0.5% SAP
7	3.53	4.12	4.45	3.87	4.03
14	4.84	5.65	6.09	5.30	5.51
28	5.44	6.35	6.85	5.96	6.20

2.5 Confirmatory Experiments

To validate the experimental value regression analysis is done and the formulas we get are given below, in confirmatory experiments first we decide target strength and then casting of respected specimens are done. Test these specimens for compressive strength at the age of 7, 14 and 28 days and compare the target and experimentally achieved strength.

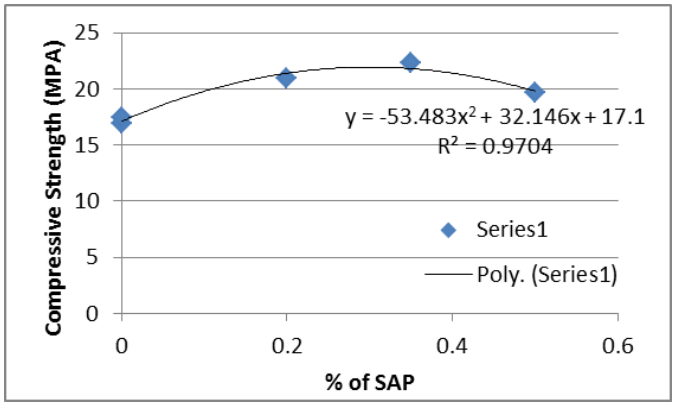

Fig – 2: Regression graph 7days compressive strength Vs % of SAP

A 7 days, C= -53.483x² + 32.146x + 17.1.....(a)

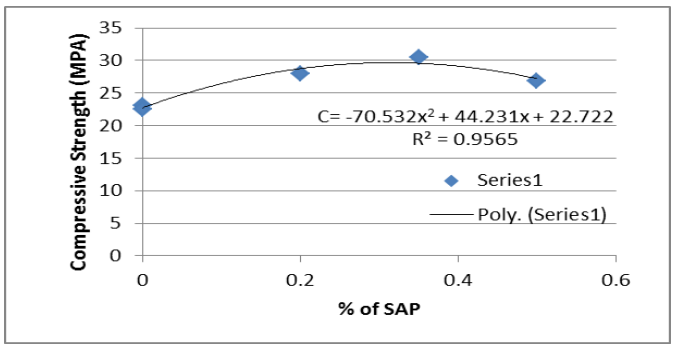

Fig – 3: Regression graph 14days compressive strength Vs % of SAP

A 14 days, C= -70.532x² + 44.231x + 22.722.....(b)

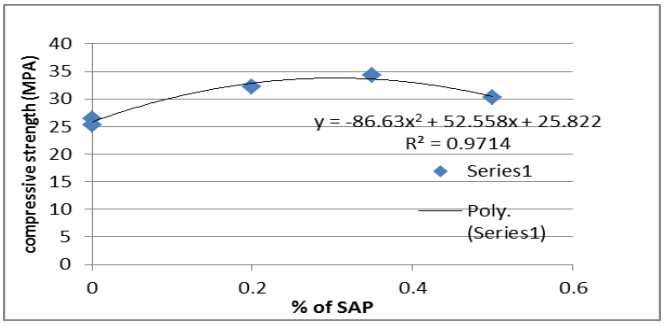

Fig - 4: Regression graph 28days compressive strength Vs % of SAP

A 28 days, C=-86.63x² + 52.558x + 25.822 …….(c)

Where, Y=Compressive strength

x= Percentage of SAP

TABLE IV

Comparison of target strength and achieved strength after 7 Days

Percentage of SAP	Target strength	Achieved strength	% variation
0.2	21.389	22.481	5.10
		21.264	0.58
		22.143	-3.52
0.4	21.401	21.191	-0.98
		22.043	3
		22.583	5..52
0.6	17.133	18.451	7.69
		16.122	-5.9
		17.5	2.14

TABLE V

Comparison of target strength and achieved strength after 14 Days

Percentage of SAP	Target strength	Achieved strength	% variation
0.2	28.746	27.687	-3.86
		28.455	-1.01
		28.671	-0.26
0.4	29.129	28.903	-0.77
		29.474	1.18
		29.322	0.66
0.6	23.869	24.103	0.98
		24.276	1.70
		23.755	-0.47

TABLE VI

Comparison of target strength and achieved strength after 28 Days

Percentage of SAP	Target strength	Achieved strength	% variation
0.2	32.8684	31.86	-3.06799
		33.2	1.008872
		32.1	-2.33781
0.4	32.9844	32.4	-1.77175
		33.6	1.866337
		33	0.047295
0.6	26.17	23.9	-8.67405
		25.3	-3.32442
		25	-4.47077

3. CONCLUSIONS

From experimental work and testing of specimen following conclusions have been concluded:

i. After 28 days concrete attains highest compressive strength when 0.35% super absorbent polymer is induced along with 25% replacement of fly ash.
ii. After 28 days concrete attains highest tensile strength when 0.35% super absorbent polymer is induced along with 25% replacement of fly ash.
iii. .After 28 days concrete attains highest flexural strength when 0.20% super absorbent polymer is induced along with 25% replacement of fly ash.
iv. Compressive strength and Split tensile test is increased by 22 & 20 % Respectively with respect to M25 concrete for 0.35% of SAP Dosage.
v. For the given interval of SAP compressive strength increases from 4% to 22% and the optimum contain is at 0.35%.

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