THOMSON REUTERS
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[Kad, 5(7): July 2018]
DOI: 10.5281/zenodo.1316898

ISSN 2348 – 8034
Impact Factor- 4.022

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

INTERNAL CURING OF CONCRETE PARTIALLY REPLACED BY FLY-ASH USING SUPER ABSORBENT POLYMER

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ABSTRACT

Super absorbent polymers (SAP) has numerous valuable consequences for different properties of concrete when SAP is addet 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 addet 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 this study is to test concrete for different quality (compressive, flexural and split tensile) and compare with standard M25 grade concrete. The tests were taken following 7 days, 14 days and 28 days. For corroborative work target strength acquired from regression analysis and accomplished quality after test work were looked at for 7 and 14 days.

Keywords: *Super Absorbent Polymer, Internal Curing, Strength, Regrssion analysis.*

I. INTRODUCTION

Over the latest couple of decades incredible advances in concrete innovation have emerged to a vast degree out of the improvement and utilization of new substance added substance which in spite of the fact that additional to concrete in little amounts can significantly enhance essential properties of concrete in its fresh and hardend state. Water is an essential ingredient in the mixing, curing, and hardening of concrete. Super Absorbent Polymer is a Polymer which can assimilate around 250 time of its volume. We have use SAP as a internal curing material for concrete in which cement is replaced by fly ash (25%). At the point. When SAP added in concrete it assimilates huge measure of water and it brings about swelling of SAP.Utilization of SAP in Concrete likewise influences the workability.

SAP mitigates the crack which occurs when moisture evaporates from the concrete surface and these are called as are known as shrinkage crack. By utilizing Super Absorbent Polymer as new admixture for the adjust concrete makes accessible various new potential 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.Other than a strong diminishment of autogenous shrinkage and delayed drying shrinkage, the SAP expansion can improve the strength of concrete.

Fly Ash is utilized as a supplementary cementitious material to create OPC. When it comes in a contact with water it forms a paste and it additionally adds to the properties of the concrete in hardened state through hydraulic and pozzolanic activity. Generally Fly ash been utilized as a part of cement at levels extending from 15% to 25% by

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mass of the cementitious material. The actual amount in which fly ash is used also depends upon application, properties of fly ash, specification limits and geographic location. By using optimum amount of fly ash in a concrete mixture will increase the technical, environmental and economical benefits of the mixture.

The primary objective of this project was to find the percentage of SAP for which concrete gives results such that amount of (SAP) at which it gives good results of OPC concrete at 28 days and to predict 7,14 and 28 days compressive strength based on percentage of SAP. Once specimens are made to have same strength , strengths can be logically compared.All content should be written in English and should be in 2 column.

II. MATERIAL

A. Cement

Ordinary Portland cement of grade 53 conforming to the specification of IS 12269:1987. The Cement had specific gravity of 3.15

B. Fly ash

Table 1. Chemical Properties Of Fly Ash

Sr. No.	Charactetistics	Requirement as per IS:3812 in %	Test Results
1	SiO2	35.0 Min.	60.21
2	AL2O3	Not Specified	26.08
3	Fe2O3	Not Specified	4.80
4	SiO2+AL2O3+Fe2O3	70.0 Min.	91.09
5	CaO	Not Specified	1.00
6	Cl	0.05 Max	0.002
7	LOI	5.0 Max	1.71

C. Super absorbent polymer

Super absorbent polymers (sap) otherwise 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. In powdered form, they show up as white sugar like hygroscopic material.

Fig 1 - Powdered form of Super Absorbent Polymer – SAP

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.

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D. Water

Water used in this experiment was potable. The test results confirmed to the requirement of IS 456:2000

E. Aggigate

Local sand having a specific gravity 2.61 was used as fine aggregate while crush granite with a nominal maximum size of 20mm with specific gravity of 2.90 was used as coarse aggregate. The fine and coarse aggregates confirmed to the specification of IS 383:1970. Table shows the physical properties of aggregates. The sand was under grading zone I of IS 383.

III. METHODOLOGY

A Mixing tray was used to prepare the concrete. Sand and coarse aggregates were first dry-mixed. Cement and Fly Ash were then 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.

A. Initial Experiments

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. From a strength perspective, the addition of SAPs to concrete has two inverse impact, when the SAP produce voids in the concrete and in this manner decreases strength, the internal water curing provided by the SAP enhances the degree of hydration and thereby increases the strength. Which of these two impacts is prevailing relies upon the watercement ratio (w/c), the maturity of the concrete, and the amount of SAP addition.

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

Table 2. Compressive Strengths

Days	Conventional M25 design	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

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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 3. Split Tensile Strengths

Days	Conventional M25 design	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 4.Flexural Strengths

Days	Conventional M25 design	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

B. Confirmatory Experiments

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

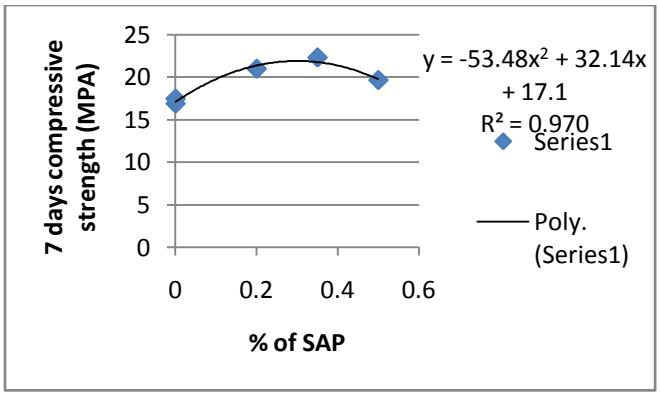

Fig. 2 Regression graph 7days compressive strength Vs % of SAP

A 7 days, C=-53.483x^2 + 32.146x + 17.1…….(a)

ISSN 2348 – 8034
Impact Factor- 4.022

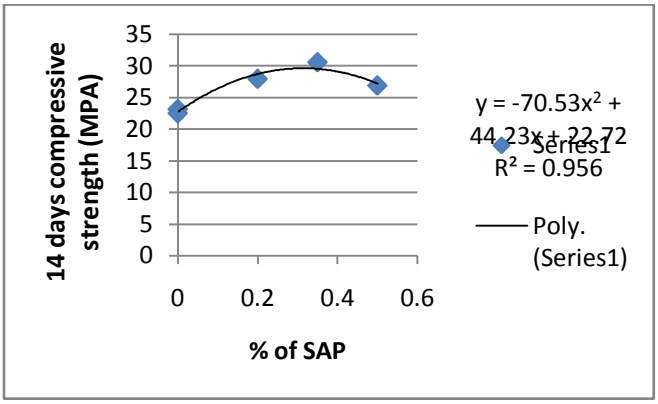

Fig. 3 Regression graph 14days compressive strength Vs % of SAP

A 14 days, C=-70.532x^2 *+ 44.231x + 22.722*…….(b)

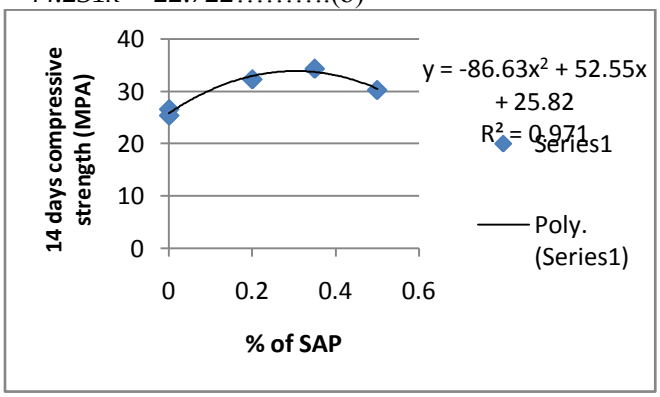

Fig. 4 Regression graph 28days compressive strength Vs % of SAP

A 28 days, C=-86.63x^2 + 52.558x + 25.822 …….(c)

Where,

Y=Compressive strength
x= Percentage of SAP

Table 5. 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

ISSN 2348 – 8034
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TABLE6. 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

IV. .CONCLUSION

From experimental work and testing of specimen following conclusions have been concluded:
After 28 days concrete attains highest compressive strength when 0.35% super absorbent polymer is induced along with 25% replacement of fly ash. After 28 days concrete attains highest tensile strength when 0.35% super absorbent polymer is induced along with 25% replacement of fly ash.

i. After 28 days concrete attains highest flexural strength when 0.20% super absorbent polymer is induced along with 25% replacement of fly ash.
ii. Compressive strength get reduced by 20% when 14 days curing is provided instead of 28 days for optimum content of 0.35% SAP.
iii. Target strength obtained by Regression method is verified by experimental values.

V. ACKNOWLEDGEMENTS

This WORK WAS SUPPORTED BY THE FACULTY OF Department of civil Engineering, Dr.D.Y.Patil S.O.E.T., Pune.

REFERENCES

1. *G. Bhalotia, A. Hulgeri, C. Nakhe, S. Chakrabarti, and S. Sudarshan, "Keyword Searching and Browsing in Databases using BANKS," in Proceedings of the 18th International Conference on Data Engineering, ser. ICDE '02, February 2002, pp. 431–440.*
2. *Jensen, M, "Use Of Superabsorbent Polymer In Concrete", Concrete International, Vol 35, No. 1, January 1, 2013, Pages 48-52.*
3. *Al-Nasra, Moayyad, And Daoud, Mohammad, "Investigating The Use Of Super Absorbent Polymer In Plain Concrete", Ijetae, Vol 3, Issue No. 8, August 2013, Pages 598-603.*
4. *Ekebafe, L. O., Ogbeifun, D.E., And Okieimen, F.E. "Polymer Applications In Agriculture", Biokemistri, Vol 23, No. 2, June 30, 2011, Pages 81-89.*
5. *Jensen, O, And Hensen, "Autogeneous Deformation And Rh-Change In Prospective," Cement And Concrete Research, Vol. 31, No. 12, Dec 2001, Pages 1859-1865*
6. *Al-Nasra, Moayyad, "Optimzing The Use Of Sodium Polyacrylate In Plain Concrete" International Journal Of Engineering Research And Applications (Ijera), Vol. 3, Issue 3, May-June 2013, Pages 1058-1062*
7. *Rilem, Internal Curing Of Concrete – State-Of-The-Art Report Of Rilem Technical Committee 196-Icc. State Of The Art Report, Rilem Publications Sarl, 2007.*
8. *Mechtcherine, Viktor, And Dudziak, Lukasz, And Schulze, Joachim "Internal Curing By Super Absorbent Polymers (Sap) – Effects On Material Properties Of Selfcompacting Fibre-Reinforced High Performance Concrete" Rilem Publications Sarl, Isbn : 2-35158-004-4, Year 2006, Pages 87-96.Author Information*

ISSN 2348 – 8034
Impact Factor- 4.022

9. *Iain A. Smith, " The Design Of Fly Ash Concretes " Paper 6982, Proceedings Institutions Of Civil Engineers, London, Vol 36, 1967.*
10. *Is 10262:2009 Recommended Guidelines For Concrete Mix Design.*
11. *Wikipedia: The Free Encyclopedia.*