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Use of Super Absorbing Polymers (SAP) for Internal Curing of Road Pavement

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Abstract

During the hydration process, the conventional concrete with low w/c ratio experiences a considerable amount autogenously shrinkage deformation lead to an early age cracks and these premature cracks severely reduce the durability of a concrete. External water curing is one of the most conventional and well known applied curing methods to mitigate the autogenously shrinkage however once the capillary pores DE percolate, it will be more difficult to provide adequate external water for curing. Internal curing has proved as an effective method for mitigating the early age chemical shrinkage for the reason that they gradually released the absorbed water and maximize the hydration process. The main objective of this study is to examine the effect of internal curing as a complement to traditional curing in conventional concrete. Internal curing was achieved by super absorbent polymer (SAP) and the experimental parameter was percentage of SAP substitution to regular sand. Experimental results revealed that internal curing water provide by the SAP, effectively reduce the early-age chemical shrinkage and significantly increase the compressive strength of concrete. It has been also found that incorporation of SAP beyond 45% lead to a decrease in the gain of compressive strength.

Keywords – Super Absorbing polymer, Effect on Internal curing, Compressive Strength.

I. INTRODUCTION

In the last few decades great advance in concrete technology have arisen to a large extent, by use of new additives which mix with concrete in very small quantity can increase properties of concrete. Internal curing is one of these great advances in concrete technology. This is very beneficial since the depth that external water can penetrate is limited for any concrete, while internal curing water is dispersed throughout the depth of concrete. Super absorbent polymer (SAP) proves to be good internal curing agent as it absorbs very large quantity of water. SAP proves to be a better element in reducing early age shrinkage and significant increase in compressive strength.

In conventional process time taken for curing is very large, and due to this when we construct the road for curing process road will be closed for some days and that's why there traffic problem is created.

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When we construct the road, for curing process road will be closed for some days and that's why there traffic problem is created. So due to this internal curing process is very beneficial, and we are using super absorbance polymer SAP for internal curing process. Internal curing of concrete has been a topic which has been gathering last couple of years coinciding with the growing demand of high strength of concrete in construction. In high strength concrete the rate of z 3 absorption of water into the concrete micro structure is more than the rate at which water gets absorb into the concrete. This is a problem which prevents conventional methods of curing of water from being successfully implemented in high strength concrete therefore we turn to alternate materials which can absorb, hold and supply water as required which also full fills the role of aggregate such as lightweight aggregate or super absorbent polymers

Fig. 1 Super Absorbent Polymer

Superabsorbent polymers SAP are a new type of concrete admixture is used to supply the hardening concrete with additional water resources for the internal curing. When adding them dry to the mix, they absorb and store much more water than their own weight, within a short time. This absorption of water results in swelling up of SAP and thus an increase in its volume. SAP eventually releases the previously absorbed water thus spreading itself in the cracks formed inside the concrete thus sealing them.

II. RELEVANCE

Generally for normal curing of roads, it will take nearly about 7 to 14 days, so there is various problems generated like heavy traffics etc. and also cracks may developed there in concrete, if proper precautions for curing is not adopted. So to address this problem, super absorbent polymer (SAP) is the material used in different proportion for internal curing of road. So time required for curing is reduced by internal curing by adding SAP in concrete.

Water absorption rate of high strength concrete is more and it takes more time for curing but the

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demand of high strength concrete in construction industry is high, So to address this use of Super Absorbent Polymer should be made to minimize the time for curing. Rapid highway pavement work to avoid traffic problems on road by using SAP in concrete and to make crack-free immediately after construction work.

Fig. 2 Self-Healing Mechanism of Cracks By Using SAP

III. LITERATURE REVIEW

The paper deals with use of SAP in concrete and study the effect of SAP in concrete for internal curing of a road. The super absorbent polymer has ability an absorbed relatively large amount of water; these properties are found to be very useful and effective in plain concrete. There are various tests performed in this paper like test on cement, test on aggregate, and test on concrete, workability of concrete, compressive strength of concrete. It has been observed that super absorbent polymer have been successfully used as internal curing agent and it should be minimize whole curing which necessary for gaining the strength. When 0.1% super absorbent polymer is used in concrete the compressive strength obtained in 7 days is increases by 11.0% as compared to the normal concrete. As the addition of SAP it results very effective in reducing the cracking.[1]

This study tried to focus on the most significant effect of addition of super absorbent polymer to the concrete mixes. However, maximum gain in strength of concrete is found to depend upon the percentage of addition. Super absorbent polymer was added to concrete at varying proportions 0.5%,1%,2% of that of weight of cement at a water cement ratio of 0.5 the desired slump value and compressive strength was obtained for conventional concrete at 0.5 water cement ratio. This study tried to focus on the most significant effect of addition of super absorbent polymer to the concrete mixes. However, maximum gain in strength of concrete is found to depend upon the percentage of addition.[2]

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IV. TEST RESULT AND MATERIAL

1) Coarse aggregate (10mm) passing through 12.5mm, 10mm, 4.75mm, 2.36mm IS sieve and pan.

Table 1; Sieve analysis (Part A)Test Result

Sieve Size	***Wt. in gms Retained***	***Wt. Retained %***	***Cumulative % Wt. Retained***	***% Passing***	***Limit as per IS 383***
12.5mm	0	0.00	0.00	100.00	100
10mm	215	10.75	10.75	89.25	85-100
4.75mm	1318	65.90	76.65	23.35	0-20
2.36mm	158	7.90	84.55	15.45	0-5
Pan	11	0.55	85.10	14.90	
Total	1702	85.10			

2) Coarse aggregate(20mm) passing through 25mm, 20mm, 10mm, 4.75mm IS sieve and pan

Table 2; Sieve analysis (Part B) Test Result

Sieve Size	***Wt. in gms Retained***	***Wt. Retained %***	***Cumulative % Wt. Retained***	***% Passing***	***Limit as per IS 383***
25mm	0	0.00	0.00	100.00	100
20mm	303	15.15	15.15	84.85	85-100
10mm	1690	84.50	99.65	0.35	0-20
4.75mm	30	1.50	101.15	-1.15	0-5
Pan	5	0.25	101.40	-1.40	
Total	2028	101.40			

3) Fine aggregate (Crushed Sand) passing through 10mm, 4.75mm, 2.36mm, 1.18mm, 600micron,300micron 150micron IS sieve and pan.

Table 3; Fine aggregate (Crushed Sand) Test Result

Sieve Size	***Wt. in gms retained***	***Wt. retained %***	***Cumulative % Wt. retained***	***%passing***	***Limit as per IS 383 Zone I***	***Zone II***
10mm	0	0.0	0.00	100.00	100	100
4.75mm	72	6.68	6.68	93.32	90-	90-

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					100	100

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2.36mm	248	23.01	29.68	70.32	60-95	75-100
1.18mm	200	18.55	48.24	51.76	30-70	55-90
600micron	180	16.70	64.94	35.06	15-34	35-59
300micron	150	13.91	78.85	21.15	5-20	8-30
150micron	130	12.06	90.91	9.09	0-20	0-20
Pan	98	9.09	100	0.00		
Total	1078	100				

4) Fineness of cement by dry sieving

Table 4; Fineness of cement Test Result

Sr.No.	***Description***	***Test-1***	***Test-2***
A	Weight of cement	500	200
B	Weight retained on 90 micron sieve	8.00	6.00
C	Fineness of cement (%)R1=(B/A)100	1.60	3.00
	Fineness of cement (%) R0=(R1+R2)/2	Avg. 7.00	

5) Concrete

The concrete mix proportion was designed by IS method to achieve the strength of 40N/mm2, and the designed mix proportion was 1:1.65: 2.92 by weight. The designed water cement ratio was 0.35 and the formulations of various mixtures were listed in Table 5.

Table 5; Mix Proportion

Cement	400kg
Water	160kg
Fine Aggregate	660kg
Coarse Aggregate 20mm	701kg
Coarse Aggregate 10mm	467kg
Admixture 0.6% by wt of cement	2.4kg

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6) Slump Cone test

Internal surface of mold is clean and applied coat of oil then the mold is filled in four layers. Each layer is tamped 25 times by the tamping rod. After the top layer is fully filled the concrete is struck off the trowel. Then the mold is removed from the concrete immediately by raising it in vertical direction. The difference in layer between the height of mold and that of the highest point of the subside concrete is measured. This difference in height in mm is the slump of the concrete.

Fig.3 Slump Cone Test

Table 6; Concrete Mixture Proportions

Mixture	***Control Mixture***	***SAP 45***	***SAP 67.5***	***SAP 90***
W/c Ratio	0.35	0.35	0.35	0.35
Water (kg/m³)	186	186	186	186
Cement (kg/m³)	465	465	465	465
Sand (kg/m³)	603	488.7	431.55	374.54
Course Agg. (kg/m³)	1086	1086	1086	1086
Internal Curing Water (kg/m³)	0	45	67.5	90
SAP (kg/m³)	-	1.05	1.50	2.00

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Table 7; Fresh Concrete Properties

Mixture Designation	***Immediate After Mixing***	***After 30 Minutes***	***After 60 Minutes***
CM	121	85	55
SAP45	92	55	11
SAP67.5	54	21	0
SAP90	35	0	0

V. RESULT AND CALCULATION OF SAP

Table 8; Compressive strength of all mixtures

Mixture Designation	***Compressive strength (N/mm²)***		
	7 Days	28 Days	90 Days
CM	30.14	40.23	41.56
SAP 45	35.33	54.75	57.12
SAP 67.5	32.41	49.38	50.12
SAP 90	31.25	47.88	48.69

Table 9; Split and Flexural Strength of all Mixtures

Mixture Designation	***Split Tensile Strength (N/mm²)***		***Flexural Strength (N/mm²)***	
	7 Days	28 Days	7 Days	28 Days
CM	3.32	4.88	2.60	3.88
SAP 45	4.05	5.34	3.49	5.40
SAP 67.5	3.90	5.26	3.22	4.91
SAP 90	3.59	4.88	3.08	4.55

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VI. CONCLUSION

1) The workability of the concrete was decrease with the increases in the SAP substitution rate and the poor workability was observed for mixture of SAP 67.5 and Sap 90 when compared to the other mixture.

2) In early stage the compressive strength of the mixture containing SAP content are neither close nor little lower than the control mixture and the contribution of SAP can be well identified at later ages.

3) Substitution of SAP significantly mitigates the autogenously shrinkage and the compressive strength of the concrete increased upon aging.

4) Mixtures SAP 45, SAP 67.5, SAP 90 enhanced their compressive strength by 36.10%, 22.74%, and 19.02% when compared to CM.

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