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Experimental investigation on strength aspects of internal curing concrete using super absorbent polymer

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Abstract: Proper Curing of concrete is maintaining moisture in the concrete during early ages specifically within 28 days of placing concrete, to develop desired properties. Curing concrete plays a major role in developing the concrete microstructure and pore structure. Concept of self curing is to reduce the water evaporation from concrete and hence increase the water retention capacity of the concrete compared to conventional concrete. Improper curing can easily reduce the strength of concrete. It is found that water soluble polymers used as admixtures in concrete influences the strength properties of concrete curing of concrete plays a major role in developing the concrete micro structure and hence improves its durability and performance. Self-curing concrete is one of the special concretes in mitigating insufficient curing due to human negligence paucity of water in arid areas, inaccessibility of structures in difficult terrains.

Superabsorbent polymer (SAP) is used as internal curing agent .SAP is a group of polymeric material that have the ability to absorb and retain a significant amount of water from their surrounding and to retain the water with their structure without dissolving. In this study 0.2, 0.25, 0.3, 0.35 and 0.4 percentages of SAP are used to produce different mixes of self curing concrete. The optimum dosage for M50 grade concrete can be determined.

Keywords: *Internal Curing, Super Absorbent Polymer, Compressive Strength, Split Tensile Strength, Flexural Strength*

1. Introduction:

1.1 General:

The ACI-308 code states that "internal curing refers to the process by which the hydration of cement occurs because of the availability of additional internal water that is not part of the mixing water." The 'internal curing' is allowing for curing 'from inside to outside' through the internal reservoirs Created. Internal curing is often also referred as 'self-curing'.

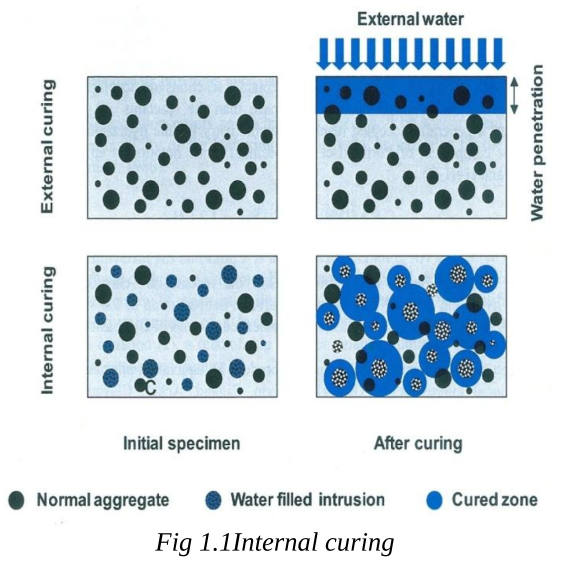

Fig 1.1Internal curing

The figure shows the differences between external and internal curing. While external curing water can penetrate just a few millimetres from the exposed surface due to depercolation (pores disconnection that normally occurs in low *w/c* mixtures), internal curing provides water throughout the matrix.

2. Experimental Investigation:

2.1 Materials Used:

The following materials were used in the study.

Cement: Ordinary Portland cement, 53 Grade conforming to IS 12269 – 1987.

Super Absorbent Polymer: It has good expansion properties, sealing features, and resistance to the changes of weather and age and the existence of chemical erosion.

Fine aggregate: Locally available river sand conforming to Grading zone II of IS 383 –1970.

Coarse aggregate: Crushed granite aggregate with specific gravity of 2.6 and passing through 20 mm sieve and retained on 12.5 mm was used for casting all the specimens.

Super plasticizer: A commercially available sulphonated naphthalene formaldehyde based super plasticizer (CONPLAST SP 430) was used as chemical admixture to enhance the workability of the concrete.

Water: Potable water.

2.2 Mix Design:

The mix composition was chosen to satisfy all performance criteria for the concrete in both the fresh and hardened states. Proportioning of concrete mixes can be regarded as a procedure set to proportion the most economical concrete mix for specified durability and grade for required site conditions.

The mix design has been adopted as per IS: 10262-2009.The concrete used in this study was proportioned to attain strength of 50 MPa. i.e. M50.

2.3 Preparation, Casting and Testing of Specimens:

The 150 mm cubes were cast for compressive strength, 150mm X 300mm cylinders for split tensile strength and 100mm X 100mm X 500mm beams for flexural strength. All the test specimens were stored at room temperature and demoulded after 24 hours and kept in room temperature. The 150mm concrete cubes were tested for compressive strength and 150 X 300 mm cylinders for split tensile and 100mm X 100mm X 500mm beams for flexural strength at 3, 7, 14 and28 days.

2.4 Mix Design:

The control mix was proportioned by IS 10262 : 2009 to obtain compressive strength of 50 MPa. The mixes 1, 2, 3, 4, 5 and 6 were obtained by adding SAP content 0%, 0.2%, 0.25%, 0.3%, 0.35% and 0.4% of weight of cement. Additional water added to the mix depends upon the amount of SAP added (for 1 kg SAP add 45 litre water). Super plasticizer Conplast SP430 is added 2% to the weight of binder.

3. Results and Discussion:

The experimental investigations were carried out to study the strength of internal curing concrete. The basic strength properties namely compressive strength, split tensile strength and flexural strength were studied.

3.1 Slump Cone Test:

Table 3.1 Slump cone result

MIX	Type	Slump (mm)
MIX1	Non-self curing concrete	122
MIX2	Self curing concrete SAP-0.2% of cement	105
MIX3	Self curing concrete SAP-0.25% of cement	112
MIX4	Self curing concrete SAP-0.3% of cement	117
MIX5	Self curing concrete SAP-0.35% of cement	124
MIX6	Self curing concrete SAP-0.4% of cement	116

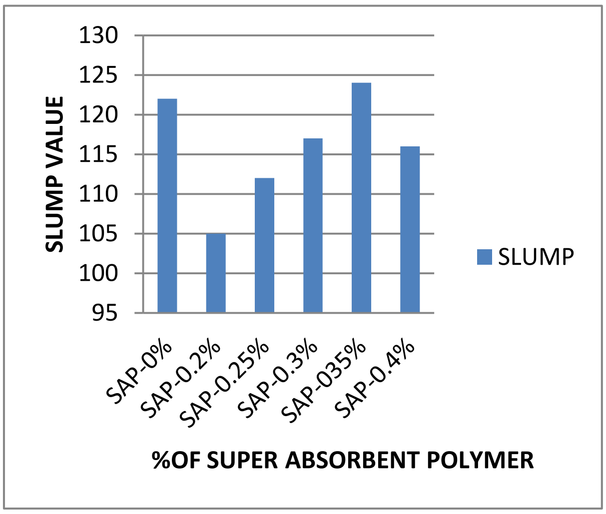

Fig 3.1 Slump cone test

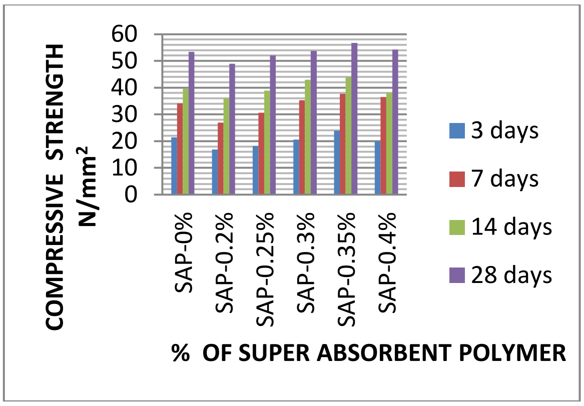

Fig 3.2 Compressive strength graph

3.2 Experimental Results of Compressive Strength Test:

Table 3.2 Compressive strength test results

Type	3 days N/mm^2	7 days N/mm^2	14 days N/mm^2	28 days N/mm^2
Non-self curing concrete	21.46	34.05	39.62	53.33
Self curing concrete SAP-0.2% of cement	16.9	26.9	36.06	48.88
Self curing concrete SAP-0.25% of cement	18.15	30.6	38.9	52.05
Self curing concrete SAP-0.3% of cement	20.54	35.35	42.9	53.77
Self curing concrete SAP-0.35% of cement	23.95	37.65	43.9	56.77
Self curing concrete SAP-0.4% of cement	19.85	36.45	38.05	54.22

The graph shows that by adding SAP 0.35% of cement obtain the maximum compressive strength. Compressive strength obtained for self curing concrete is more than that of the non self curing concrete by adding the SAP content 0.35% of cement.

3.3 Experimental Results-Split Tensile Test:

Table 3.3 Split tensile strength results

TYPE	3 days N/mm^2	7 days N/mm^2	14 days N/mm^2	28 days N/mm^2
Non-self curing concrete	1.95	3.401	4.3	5.4
Self curing concrete SAP-0.2% of cement	1.60	2.9	3.94	4.9
Self curing concrete SAP-0.25% of cement	1.74	3.19	4.01	5.35
Self curing concrete SAP-0.3% of cement	1.85	3.48	4.31	5.504
Self curing concrete SAP-0.35% of cement	2.01	3.69	4.65	5.69
Self curing concrete SAP-0.4% of cement	1.79	3.35	4.02	5.3

The graph shows that by adding SAP 0.35% of cement obtain the slightly increases in flexural strength. Strength obtained for self curing concrete is more than that of the non self curing concrete by adding the SAP content 0.35% of cement.

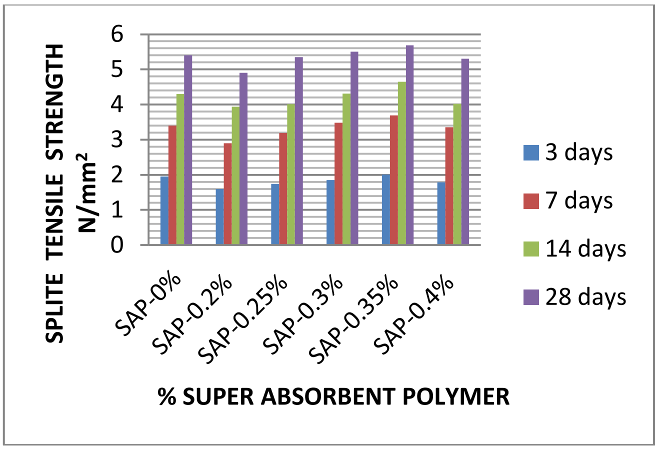

Fig 3.3 Split tensile strength graph

3.4 Experimental results - Flextural Strength Test

Table 3.4 Flexural strength result

TYPE	3 days N/mm^2	7 days N/mm^2	14 days N/mm^2	28 days N/mm^2
Non-self curing concrete	1.7	2.25	4.06	5.98
Self curing concrete SAP-0.2% of cement	1.45	1.9	3.5	5.45
Self curing concrete SAP-0.25% of cement	1.59	2.04	3.84	5.6
Self curing concrete SAP-0.3% of cement	1.69	2.19	3.91	5.84
Self curing concrete SAP-0.35% of cement	1.78	2.38	4.20	6.05
Self curing concrete SAP-0.4% of cement	1.61	2.11	3.62	5.79

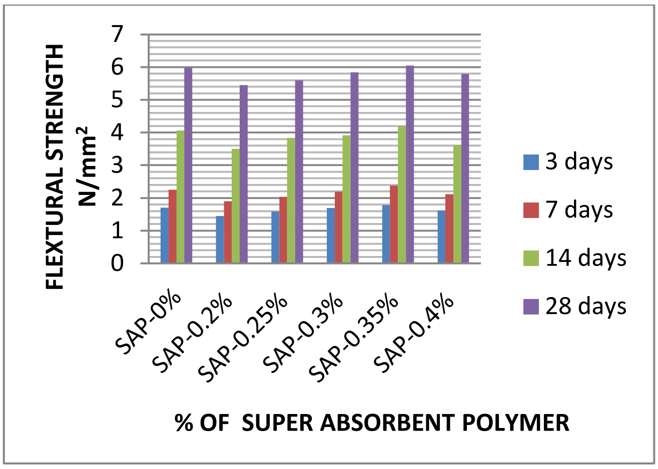

Fig 3.4 Flexural strength graph

The graph shows that by adding SAP 0.35% of cement obtain the slightly increases in flexural strength. Strength obtained for self curing concrete is more than that of the non self curing concrete by adding the SAP content 0.35% of cement .other percentage of adding the strength will decrease.

4. Conclusion:

Concrete mix M50 has been designed based on the experimental investigation. The concrete with various percentages of super absorbent polymer is used and the test results have been evaluated. The following conclusions are arrived at based on the experimental results of the study.

1. Workability test shows that the increase in up to 0.35% super absorbent polymer provides better workability.
2. The Maximum compressive strength develop in M-50 grade self curing concrete by adding SAP 0.35% of cement
3. The split tensile strength has improved with addition super absorbent polymer of at various percentages. The concrete specimen with 0.35 super absorbent polymer has showed slighter increase in strength than other percentage
4. Flexural strength test with 0.35 percentage of SAP shows increase in strength. Concrete specimens with other percentage SAP showed decreased flexural strength.
5. Comparison of experimental values for compressive strength, split tensile strength and flexural strength were done. The compressive strength will increase greater value were found.

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