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Flexural Behavior of Self-Curing Concrete Using Different Curing Agents

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Abstract - In this research, the strength parameters of M20 grade self-curing concrete is compared with that of conventional concrete. Curing of concrete is the process used to maintain the moisture inside the body of the concrete during its earlier days, in order to develop the desired properties in terms of strength and durability. Due to the scarcity of potable water increases day by day, use of self-curing concrete is widely increased. Concept of self-curing is used to reduce the evaporation of water from concrete and increases the water retaining capacity to compensate the loss of water due to the heat of hydration by using different self-curing agents. Sodium Polyacrylate (SPA) and Paraffin wax are used as self-curing agents at desired range of 0.4% (SPA) to the weight of cement. Paraffin wax applied externally after the casting of concrete. River sand is used as fine aggregate. Coarse aggregate with 20mm size are used. The experiment focuses on testing the mechanical properties of the self-curing concrete prepared using different methods and compare the results with that of conventional concrete.

Key Words: *Self-curing; Sodium Polyacrylate; Paraffin wax*

1. INTRODUCTION

Moisture plays a vital role in the curing of concrete. Curing is the procedure used for the hydration of cement. It involves the control of temperature and moisture in the concrete. This is done to ensure continuous hydration of cement and consequently aids in proper gain in strength. The strength gain in concrete stops when curing is stopped. In conventional concrete, curing is done by the application of water after mixing, placing and finishing. In self- curing, this need for external application of water is neglected. Instead, admixtures or membranes are added to prevent the evaporation of moisture from the concrete. The admixtures added also aid in absorption of moisture from the environment. In this paper, two agents are used for promoting self- curing. The materials used are Sodium Polyacrylate and Paraffin wax. Sodium Polyacrylate is a Super Absorbent Polymer(SAP). It has the capacity to hold water manifold to its original volume. This water is dissipated into the concrete when the moisture in the concrete is getting evaporated due to heat of hydration. Paraffin wax is a membrane coating that is applied over the concrete after it has been casted and demoulded. The wax acts as a sealant for the moisture present inside the concrete. Hence, requirement for the further application of water for curing is neglected. The primary objective of this research is to compare the test results of the mechanical properties of self curing concrete produced using the above mentioned two methods with that of conventional methods.

2. OBJECTIVES

- To study the strength parameters of self curing concrete by conducting hardened concrete test.
- To conduct compressive, split tensile strength and flexural strength tests on Sodium Polyacrylate concrete sample and Paraffin waxed concrete sample and compare the test results with that of conventional concrete.

3. MATERIALS USED

3.1. CEMENT

The cement used is PPC confirming to IS 1489- 1 was used. Various tests were performed on the cement. The specific gravity of this cement was found to be 3.15. The initial setting time is 30 minutes. The final setting time was found to be 600 minutes.

3.2. FINE AGGREGATE

The fine aggregate used is river sand. The sand was washed and screened in order to remove delirious materials. The specific gravity of the sand was found to be 2.54.

3.3. COARSE AGGREGATE

The coarse aggregate used is gravel of size 20mm. The specific gravity of the gravel used was found to be 2.60. The water absorption was found to be 0.396.

3.4. SODIUM POLYACRYLATE

Sodium Polyacrylate is a Super Absorbent Polymer (SAP). They have a covalently cross linked structure. SAP has a capacity to hold water 250-300 times its own weight. It is non- toxic and non- corrosive .It has a crystalline structure when dry but forms a transparent gel when it absorbs water. It has a density of 1.22 g/cm^3. The specific gravity of sodium polyacrylate used in the experiment is 1.2. SAP is used as an addition at the rate of 0.4% to the weight of cement.

3.5. PARAFFIN WAX

Paraffin wax is used as a membrane coating in the experiment. It is used as a sealant to prevent the loss of water from the concrete. The specific gravity of the wax used is 1.077. It has a density of 1.1258 g/cm^3.

3.6. WATER

Water is used for mixing and curing in the experiment. The water used must be potable. It must not have any acidic or alkaline substances, salt compounds, organic materials or sugar compounds or any other material that may cause harmfulness or damage to the concrete. The water used must have a neutral pH level.

4. MIX DESIGN

Table -1: Mix Design

CEMENT (kg/m^3)	FINE AGGREGATE (kg/m^3)	COARSE AGGREGATE (kg/m^3)	WATER (litres)
434	593.85	1128.92	195.30

5. FRESH CONCRETE TEST

5.1. SLUMP CONE TEST

The concrete slump test is an empirical test that measures the workability of fresh concrete. The test is performed to check the consistency of freshly mixed concrete in a specific batch. Consistency refers to the ease and homogeneity with which the concrete can be mixed, placed, compacted and finished.

5.2. COMPACTION FACTOR TEST

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS: 1199 – 1959. This test is used to find the degree of compaction of concrete.

6. MIXING AND CASTING

Mixing of concrete was done by hand. It was compacted using a table vibrator. The dry mix was first mixed thoroughly before the addition of water. After water was added, it was mixed swiftly and casted in cubes and cylinders. The size of the cube used is 150mm X 150mm X 150mm. The cylinders used are of 150 mm in diameter and 300 mm in height. The moulds after filling are placed in a table vibrator so as to compact it thoroughly. The moulds are removed after 24 hours. The self curing specimen is kept outside in normal environment for curing. The conventional concrete is placed in a curing tank with water.

7. HARDENED CONCRETE TEST

7.1. COMPRESSION STRENGTH TEST

Compressive strength is one of the most important properties of hardened concrete. It is tested using a concrete cube of size 150mmX 150mm X150mm. The specimen is placed in a compression testing machine of 2000KN capacity and the load is applied till the failure is reached. In this experiment, compression test is done on samples after 7 days, 14 days and 28 days.

Fig -1: Compression Strength Test

Table -2: Compression Strength Test

COMPRESSIVE STRENGTH TEST (N/mm^2)			
DAYS	**7 DAYS**	**14 DAYS**	**28 DAYS**
Conventional	14.05	17.20	22.50
Paraffin Wax	10.20	18.02	19.20
Sodium Polyacrylate	13.02	17.50	23.20

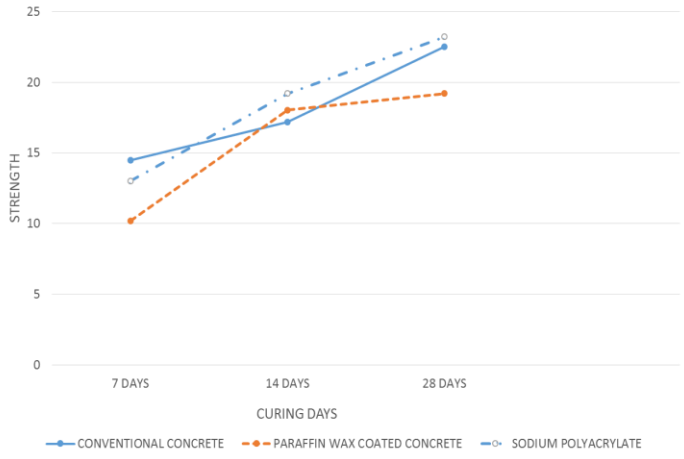

Chart -1: Compression Strength Test Result Comparison

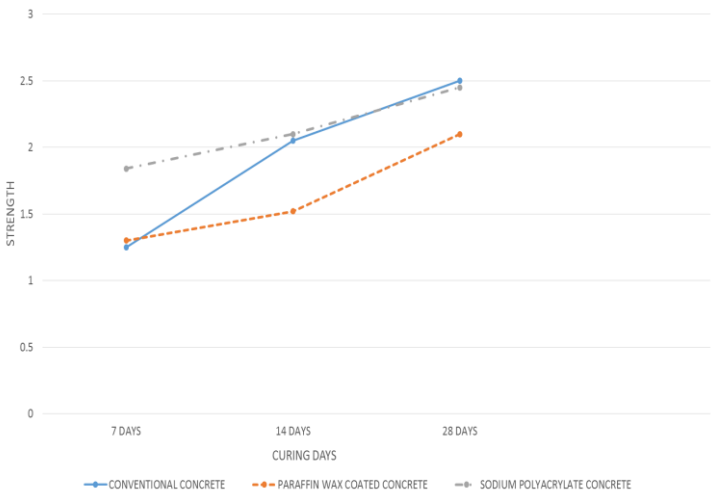

Chart -2: Split Tensile Strength Test Result Comparison

7.2. SPLIT TENSILE STRENGTH

Split tensile strength is used to determine the tensile strength of the concrete indirectly. It is done using a cylinder specimen of diameter 150mm and height 300mm. The specimen is placed horizontally in the compression testing machine and loaded. The test is performed for 7 days, 14 days and 28 days.

Fig -2: Split Tensile Strength Test

Table -3: Split Tensile Strength Test

SPLIT TENSILE STRENGTH TEST (N/mm²)			
DAYS	**7 DAYS**	**14 DAYS**	**28 DAYS**
Conventional	1.25	2.05	2.50
Paraffin Wax	1.30	1.52	2.10
Sodium Polyacrylate	1.84	2.10	2.45

7.3 FLEXURAL STRENGTH TEST

Flexure strength test were carried out on beams of size 100×150×1600mm on loading frame of capacity 500KN. All the beams were tested under Centre single point load condition. The beams are tested as simply supported beam. The beam designed as a under reinforced beam having 8mm dia bar used as a tension reinforcement and 6mm dia bar used as a compression reinforcement. Two legged 8mm stirrups used as a shear reinforcement spacing of 160mm c/c. The deflectometer was set the bottom of the beam. Proving ring as placed the beam. While the load was applied from hydraulic jack the deflectometer in the proving ring indicates the load applied on the beam

Fig -3: Flexural Strength Test

Table -4: Flexural Strength Test

SL.NO	DIVISION	LOAD (KN)	DEFLECTION (mm)		
			CONVENTIONAL CONCRETE	WAX COATED CONCRETE	SODIUM POLYACRYLATE CONCRETE
1	3	4.29	0.13	0.21	0.09
2	6	8.58	0.24	0.38	0.29
3	9	12.87	0.37	0.66	0.51
4	12	17.96	0.60	0.94	0.66
5	15	21.45	0.85	1.13	0.89
6	18	25.74	1.06	1.40	1.05
7	21	30.03	1.27	1.56	1.30
8	24	34.32	1.50	1.82	1.53
9	27	38.61	1.62	2.05	1.74
10	30	42.10	1.72	2.22	1.93
11	33	47.19	1.84	2.40	2.20
12	36	51.48	1.96	2.51	2.36
13	39	55.77	2.06	2.73	2.88

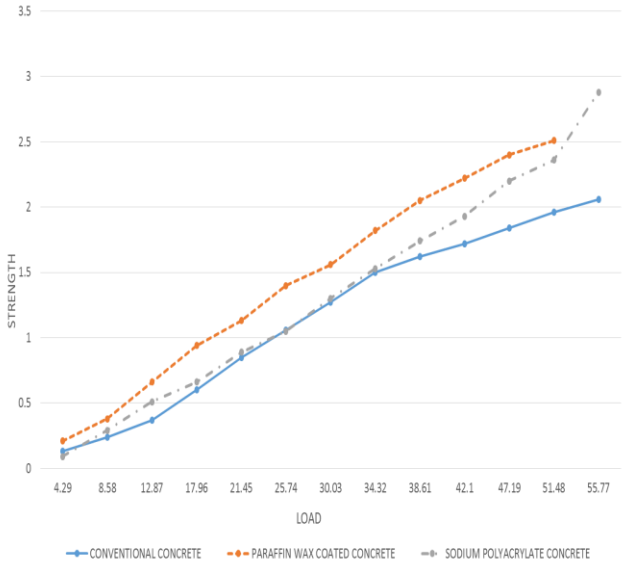

Chart -3: Flexural Strength Test Result Comparison

8. CONCLUSIONS

An experimental study on self- curing concrete was done using Paraffin wax and Sodium Polyacrylate and the following conclusions were drawn by conducting compressive strength and split tensile strength tests and flexural strength tests.

• The concrete with sodium polyacrylate showed 1.7% more compressive strength than conventional concrete at 14 days and 3% more compressive strength at 28 days.
• The sodium polyacrylate concrete showed 11% lesser compressive strength than conventional concrete at 7 days.
• Paraffin wax coated concrete had 29% and 21% lesser compressive strength than conventional concrete and sodium polyacrylate concrete at 7 days.
• Paraffin wax coated concrete had less split tensile strength than conventional concrete at 28 days.
• Flexural capacity of self-curing concrete (Sodium polyacrylate) beam shows better results.
• The ultimate load and ultimate deflection for Sodium polyacrylate beam was increased 39% when compared to conventional concrete.
• The usage of Sodium Polyacrylate as a self-curing agent is more functional than Paraffin wax coating. This is because, although the strength of sodium polyacrylate concrete was lesser than that of conventional concrete, it gained the grade strength, whereas, wax coated concrete failed to achieve the grade strength.

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