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Self-Cured Concrete Using Water Retaining Agents

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Abstract: — This paper discusses the materials used as water retaining agents, the self-curing mechanism, significance, benefits, and drawbacks, as well as the properties of concrete when subjected to the self-curing method. Concrete is the most commonly used material in the construction industry, but it also requires a lot of water for its production, so there is an urgent need for research to minimise the use of water to produce concrete. Objectives, gap identification, problem identification, and their resolutions, as well as the project's future scope. Different water-retentive materials, including porous lightweight aggregates, chemical admixtures, polymers, natural fibres, and pozzolanic, have been used by numerous researchers in a variety of methods. These materials can withstand large amounts of water. These water retaining agents used as replacement with aggregates and cement in terms of their percentage. Results indicate that by adopting water retaining agents to produce self-cured concrete,properties of concrete were improved. It happened rare that two self-curing agents are used simultaneously. Materials used are Superabsorbent polymer (SAP) and Light-weight expanded clay aggregate (LECA) both. Methodology is done M20 Grade of concrete, which is again have rarely used by researchers for experiment, but this grade is most commonly used in commercial buildings as well as in normal houses. Experiments and Results have taken out for conventionally cured concrete and self-cured concrete for 7, 14 & 28 days. Conclusion express that self-cured concrete give more strength and improved properties than conventionally cured concrete.

Keywords— Self-cured concrete(scc); Two self-curing agents simultaneously; Effective use of water; M20 grade; Increased strength.

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I. INTRODUCTION

A.Self-curing technology:

It is the process in which hydration of cement takes place internally, no external source of water is required for the purpose of external-curing.That is why, Self-curing also called as "Internal-curing" in which hydration of cement occurs internally with the help of water retaining agents.the water used for internal curing is the absorbed water by water retaining agents,which is not a part of water added while mixing of concrete.

B.Self-cured concrete:

Cement, mixing water, water retention agents, coarse aggregates, and fine aggregates are the main ingredients that go into making self-curing concrete.The concept of self-cured concrete is that porous materials are used to supply water internally, these porous materials have higher water retention abilities which helps in curing the concrete structure internally. Additionally, it boosts concrete's ability to retain water and decreases surface water evaporation.

[1]The need for the research includes the characterization of the super absorbent polymer that will be used in self-cured concrete. Self-cured method is also used in mixtures of low water-cement ratio to take care of the workability of concrete and to improve properties of the high-performance concrete as well as to enhance early-age behaviour of concrete structure. A limited number of tests were carried out to determine the compressive strength, split tensile strength, and flexural strength of concrete containing Super Absorbent Polymer (SAP) at a range of 0.1%, 0.2%, 0.3%, and 0.4% of cement and to compare those results with those of cured concrete. The concrete grade employed was M40.[2] With the aid of SAP, the water migration process during internal curing was examined. By adding SAP, it is possible to provide water curing in low water-to-cement ratio (w/c) mixtures. The SAP are intended to be distributed uniformly throughout the concrete structure and act as water reservoirs inside the concrete, which absorb water during concrete mixing and throw out to the surrounding cement paste for hydration.[3] Conventional aggregates are partially replaced with pre-wetted lightweight aggregates to create self-cured high performance concrete, which causes the concrete to internally cure for the hydration of the cement. When compared to traditional weight aggregate concrete, it was found that self-cured concrete had a 25% increase in strength over the course of a year. At the same storage situation, normal weight aggregate concrete is less strong. Concrete's faulty curing owing to shoddy construction can be solved by partially substituting light weight aggregate with normal weight aggregate..[4] explains how SAP is used to avoid water desiccation during the hardening of cement-based materials. The SAP is a substance that traps water inside of it and also creates macro inclusions that cause water to be entrained, forming water-filled macro pore inclusions in newly-poured concrete. In order to prevent self-desiccation, pore structure is deliberately designed.[5] self-cured concrete was studied. The water retention agent was a very absorbent polymer. M40 grade conventional concrete is being used for the research. According to weight decrease over time. The mechanical strength is significantly increased when SAP is injected at the recommended dosage of 0.3%. Additionally, self-cured concrete with an O.3% SAP dosage has a better compressive strength than concrete that has been water-cured. The self-cured

concrete's split tensile strength, which is increased by 0.3% SAP dose, is chosen. On the basis of this investigation, an experiment was run. Conclusion states that when compared to water-cured concrete, self-cured concrete employing SAP has a higher capacity to retain water. Flexural strength of self-cured concrete is reduced at 0.3% SAP dosage compared to water-cured concrete. The mix proportions, namely the water-cement ratio and cement content, will have an impact on how well the water retention agents perform. The dosage strength was gradually increased from 0.1% to 0.2% to 0.3%, and then it was gradually decreased to 0.4%. Concrete that is self-cured using SAP turns out to be more cost-effective than concrete that is treated traditionally. In this work, cubes were cast and maintained at room temperature between 250 and 300 oC to test the viability of self-cured members in hot climates. The efficacy of self-cured concrete utilising SAP is highest when 45 kg/m3 water is added using 1 kg/m3 SAP.[6] carried out work on self-cured concrete using PEG400. The optimal PEG400 dose was stated in the conclusion to be 0.5% for M40-grade concrete and 1% for M20-grade concrete. The slump value for both grades—M20 and M40—increases as the percentage of PEG400 does.

C. Mechanism of internal curing:

Since the liquid and vapour phases have different chemical potentials (free energy), moisture continuously evaporates from an exposed surface (Figure1). In order to lower the chemical potential of the molecules and form hydrogen bonds with the water molecules, the polymers are added to the mixture. This lowers the vapour pressure and slows the rate of surface evaporation. [6,7].

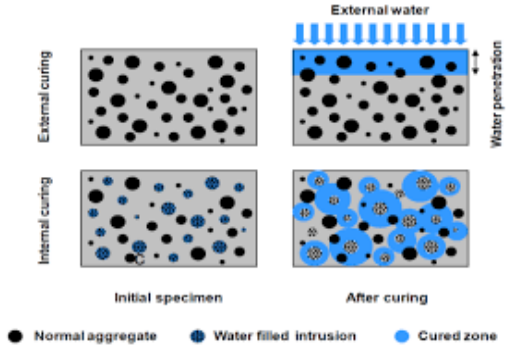


Figure:1

D. Significance of self–curing:

The demand for curing water (internal or external) when the mineral admixtures entirely react in a blended cement system may be significantly higher than in a typical ordinary Portland cement concrete. When this water is difficult to access, significant autogenous deformation and (early-age) cracking may happen. Because of the chemical shrinkage that occurs during cement hydration, which lowers the relative humidity inside the substance and induces shrinkage that could result in early-age cracking, the cement paste develops empty holes.

E. Problem identification:

a) In self-curing concrete, the amount of an individual self-curing agent can be used upto some extent only (it can be 10%, 15%, 20% or anything).
b) Once you exceed that amount (percentage), it may give you more workability, but the slope of strength starts decreasing.
c) Using M30, M40 grade of concrete with self-curing agent may results to be costlier.

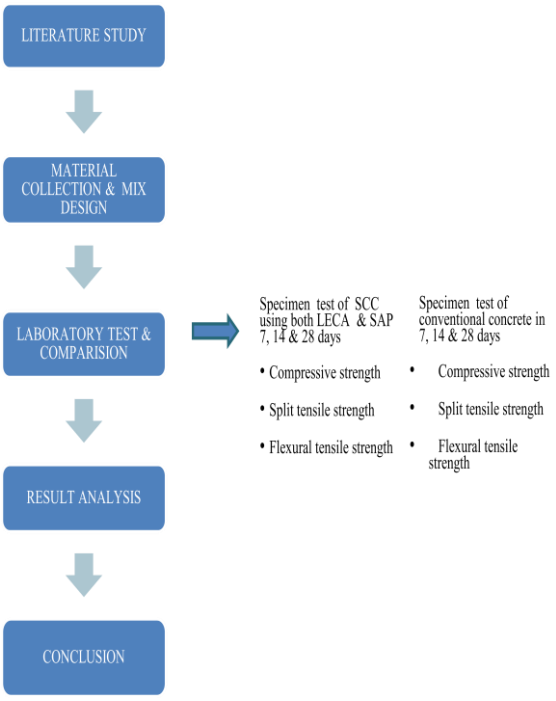
F. Gap identification:

a) Most of the researchers have used M25, M30 or M40 grade of concrete. Experiment in M20 grade of concrete is much required as it is most widely used in domestic as well as in commercial buildings.
b) Most of the researchers have used self-curing agents individually with different grades of concrete, very less it happened that they have used more than one self curing agent simultaneously.

II. OBJECTIVES

a) To add a self-curing chemical to the concrete mixture to increase the water content's effectiveness.
b) To experiment with different percentages of water retaining agents to test the properties of self-cured concrete, such as compressive strength, spliting tensile strength and flexural strength.
c) To contrast the strength of self-cured concrete with traditional concrete.

III. METHODOLOGY



A.Experimental Programme:

Two self-curing agents, Super absorbent polymer (SAP)@0.1%, 0.2%, and 0.3%, and 20% LECA (Lightweight Expanded Clay Aggregate) by Weight of Cement and by weight of aggregate respectively, were added to the concrete as part of an experimental programme to test the strength of internally cured concrete. Aiming to better understand concrete's compressive, splitting, and flexural strengths, the experimental programme was designed to test these properties. Internally cured normal strength concrete and conventionally cured

concrete's cube compressive strength were examined in this study. Mixtures of M20 Grade are taken into consideration for this experimental programme.

B. Material Characteristics

a) Fine Aggregate (In accordance with IS: 2386 1963)

Table.1:Physical properties of fine aggregate

S.no.	Properties	Value
1	Silt content	0.71 %
2	Specific gravity	2.65
3	Bulking of sand	16.05 %
4	Moisture content	0.647 %
5	Fineness modulus	3.28

b) Coarse Aggregate (confirming to IS: 2386 Part 1963):

Table.2 :Physical properties of coarse aggregate

S.no.	Properties	Value
1	Impact value	15.47 %
2	Crushing value	24.5 %
3	Specific gravity	2.70
4	Moisture content	0.12 %

c)Cement (conforming to IS: 12269-1987):

Cement of ordinary Portland grade 53 was utilised.

Table.3: Cement's physical characteristics

S.no.	Property	Value
1	Normal Consistency	25 %
2	(IST)Initial setting time in min.	37
3	(FST)Final setting time in min.	268
4	Fineness(percentage)	9.03%
5	Specific gravity	3.15

d) Lightweight expanded clay aggregate (LECA)

Table.4: physical properties of LECA

S.no.	property	value
1.	pH value	9.5
2.	Water absorption	30%
3.	Permeability(k)	2.53cm/s
4.	Maximum dry density	0.357g/cm3

e) Superabsorbent polymer(SAP):

Table 4:Physical properties of SAP

S.no.	Types of test	SAP
1.	Size of particles	1mm(avg.)
2.	Water retention	1g of SAP retains 150g
3.	pH of water retained	Neutral
4.	Density	1.079g/cc
5.	Hydration/Dehydration	convertible
6.	Bulk Density	0.85
7.	Decomposition in sunlight	6 months
8.	Water available	95%

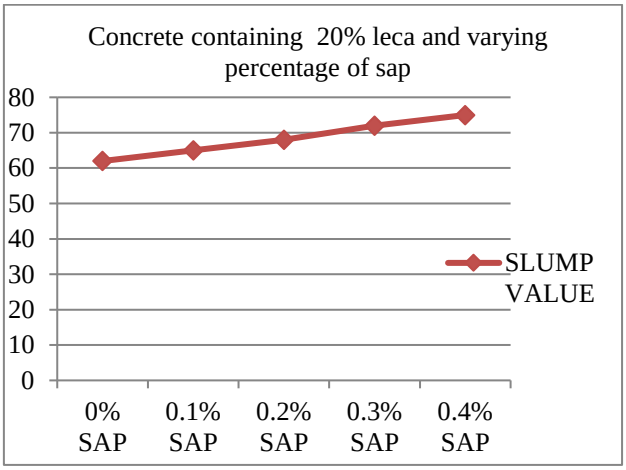
C. Casting details:

a) A set of iron cube moulds were used for casting.
b) Each cube is 150 x 150 mm in dimension.
c) For the M20 GRADE, 12 of each sort of cube were produced.
d) All of the conventional concrete mix cubes were stored for curing and evaluated at 7, 14, and 28 days in accordance with IS.
e) While every Non-Conventional type of mix, or internally cured concrete, was immediately held under dry conditions after being removed from the moulds and tested in accordance with IS at 7, 14, and 28 days, respectively.

IV. RESULTS & DISCUSSION

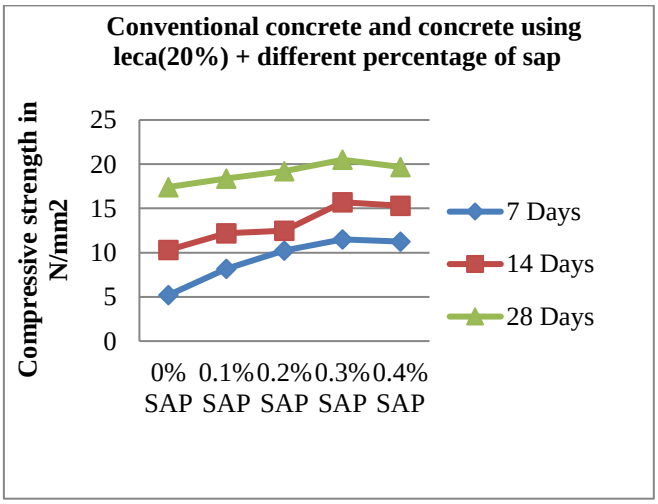
A. Slump test:

The slump values of self-cured concrete containing 20% LECA, for various percentages (0%, 0.1%, 0.2%, 0.3% and 0.4%) of SAP are shown in the graph given below. It was found that as the percentage of super absorbent polymer increases, the slump increases, hence the workability increases. Here 0%SAP indicates, conventionally cured concrete.



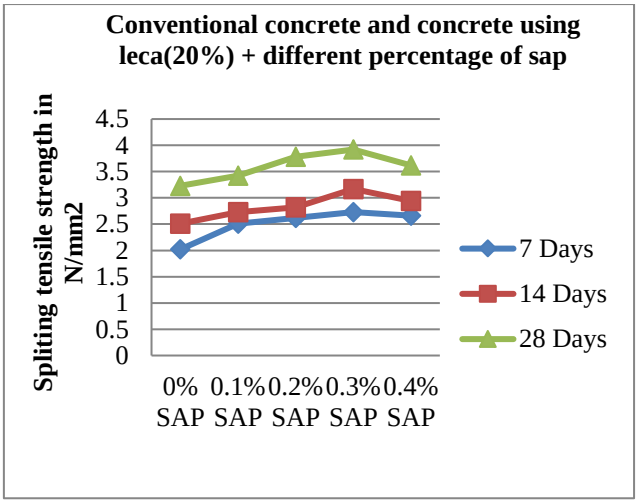
B. Compressive strength of SCC:

The results of determining the compressive strength of conventional (0% SAP) and self-cured concrete at ages 7, 14, and 28 days are presented below. The self-cured concrete contained varying amounts of SAP and 20% LECA. It is obvious that strength grows stronger with age. The strength rises along with the SAP percentage, reaches its peak at the ideal percentage (i.e., 0.3%), and then begins to fall.



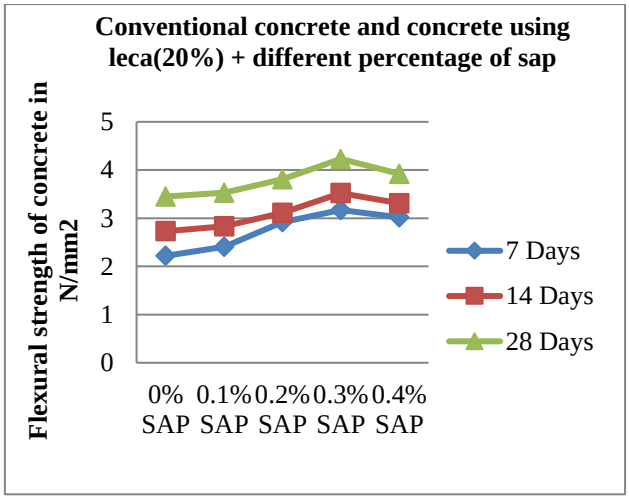
C. Split tensile strength of SCC:

Below is a comparison of the variations in split tensile strength between conventional and self-cured concrete. It can be shown that the split tensile strength rise increases with percentage of SAP in self-cured concrete containing LECA (20%), reaches a maximum at 0.3% of SAP, and then begins to decline.



D. Flexural strength of SCC:

The variance in flexural strength for different mixtures with various SAPs is depicted below. It is evident that 0.3% SAP plus 20% LECA provides the concrete mixer with its maximal strength. Similar to compressive strength, flexural strength follows a similar trend.



V. CONCLUSION

- In self-cured concrete, as the percentage of SAP increases, slump value also increases which indicates that the workability of concrete is also increased at the same water-cement ratio. Hence the water content used to make the concrete is utilized more effectively.
- Compressive strength of concrete for 28 days:
  - Conventionally cured concrete - 17.42 N/mm2
  - 0.3% SAP + 20% LECA - 20.50 N/m
- The extra cost of SAP and LECA is balanced by reduction in cement and aggregate.
- Density of concrete was reduced from 24.42 N/mm2 to 23.55 N/mm2.
- As a result, we may draw the conclusion that concrete can be internally cured to reach a higher strength than traditionally cured concrete by applying the recommended dosage of water retaining agents (0.3% SAP+20% LECA).
- Hence, self-cured concrete is suitable where water is not sufficiently available for curing of concrete.

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