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Experimental Study On Self-Curing Concrete Using LECA And Sodium Acrylate

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Abstract

Water is a source of life. In the upcoming era, society faces dramatic issues on water scarcity. Construction without water is practically impossible. In the manufacturing of concrete, Curing requires a large quantity of water. New advancement in Science and technology to ensure undisturbed hydration with replenishment of water loss and to maintain temperature for the process of hydration as in [9]. This will intend the development of strength and durability of concrete. Curing decreases the permeability of the hardened concrete, thereby reducing the crack formation. . In this experimental study, the conventional concrete is compared internally cured with Lightweight. Expanded Clay Aggregate (LECA) and Sodium Polyacrylate (SP). Conventional concrete is compared with self-curing concrete. All the testing procedures are formulated as per Indian Standards.

Keywords: *Internal curing, Lightweight Expanded Clay Aggregate (LECA), Sodium Polyacrylate (SP), Self-curing, Superabsorbent Polymer.*

INTRODUCTION

Building Construction without water is unimaginable. Since the water needs are huge, the buildings are a necessity to switch over alternatives such that water usage can be reduced as in [1]. Thus, self-curing systemizes are the new emerging trend for conservation of water in the construction industry. To promote a sustainable environment, we have to switch over alternatives as in [2].
Curing of concrete is done to maintain optimum moisture content, to prevent the loss of water required for hydration of the cement as in [3], to avoid shrinkage cracks and premature stressing or disturbance in concrete, as in [4].
According to ACI, a process by which hydration of cement continues because of the availability of internal water is not part of the mixing water. Curing often happens “from outside to inside.” In contrast, internal curing happens “from inside to outside” through internal reservoirs like super absorbent polymer and lightweight clay aggregate as in [2].
To achieve the designated self-curing concrete properties, water evaporation at the surface has to be avoided in addition to supplying water from the exterior. Mineral admixtures are now used in partial replacement with cement to reduce the pollution caused by the manufacturing of cement; these admixtures as like cement, don’t completely blend with the components of cement as in [5]. Hence these conventional methods require high demand for curing as compared to ordinary Portland cement. When water for the curing is unavailable, due to depercolation of the capillary porous nature, early age cracking is quite usual as in [6-]. On the other hand, the early development of crack is due to shrinkages during hydration. Usually, shrinkages would be due to either dryin8g, thermal or carbonated shrinkage as in [9-11]. Chemical shrinkage is an internal volume reduction due to the absolute volume of hydration as in [12]. The alternative source for these aspects of limitations is sustainable building with a newly emerging field of advancement as in [13,14].
In this experimental study,

- Presoaked LECA of 10%, 20%, 30%, and 40%are partially replaced with normal weight aggregate as a source of additional water.
- SP is added to concrete of 0.2, 0.25, 0.3, 0.4, and 0.5% of cement.
- Compressive and tensile strength tests are done on this internally cured concrete.

MATERIALS USED

- Ordinary Portland cement (OPC)
- M_{30} grade of Concrete (1:1.65:2.24)
- Coarse aggregate (20mm)
- Fine aggregate (passing through 4.75mm sieve)
- 20mm LECA
- Sodium Polyacrylate (SP)

LIGHTWEIGHT EXPANDED CLAY AGGREGATE (LECA)

Lightweight expanded clay aggregate (LECA) is obtained by heating clay at 1200 C in a rotary kiln; the gases yielded expands the clay by thousands of small bubbles forming a honeycomb structure.

Physical Properties
Table 1

PROPERTY	VALUE
Specific Gravity	0.9
Water Absorption	16%

Fig1. LECA

Fig. 2 Available sizes of LECA

SODIUM POLYACRYLATE

Sodium Polyacrylate is a super absorbent polymer (SAP), as in [1], which possesses a good water holding capacity. It can absorb 200 to 300 times in mass of its weight. It forms like a gel structure to retain water.

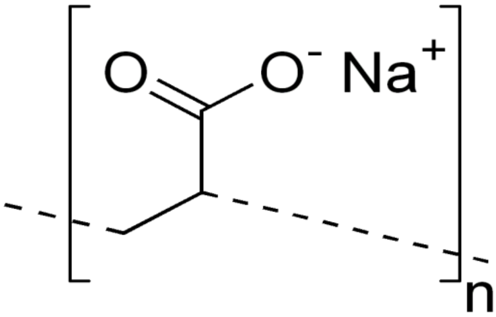


Fig. 3 Chemical structure

Fig. 4 Sodium Polyacrylate

ORDINARY PORTLAND CEMENT (OPC)

The combination of Calcareous and argillaceous material is the major constituent of OPC.OPC is available in three grades, 33, 43, and 53.

Physical Properties

Table 2

PROPERTY	VALUE
Specific Gravity	3.14
Fineness	1.3%

Fig. 5 Cement

FINE AGGREGATE

Fine aggregate is a granular material used as a filler material that densifies the concrete. Fine aggregate passing through IS sieve 4.75mm is used.

Physical Properties

Table 3

PROPERTY	VALUE
Specific Gravity	2.81
Fineness	2.85%
Water Absorption	0.81%

Fig.6 Sand

COARSE AGGREGATE

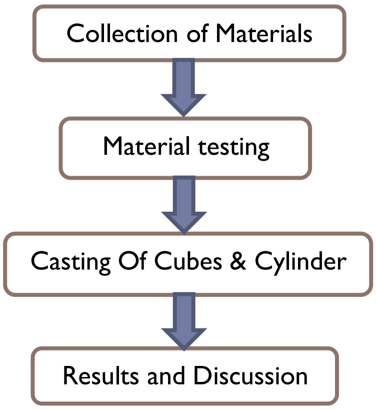
Coarse aggregates are gravels that are generally sized greater than 4.75mm are used.20mm aggregates are used.

Physical Properties
Table 3

PROPERTY	VALUE
Specific Gravity	2.6
Crushing	15.8
Impact	16.35
Water Absorption	1.3%

Fig. 7 Aggregate

Methodology



Mix Design

According to IS 10262: 2009, the mix ratio has arrived.M30 Grade of concrete is used. For conventional concrete, the mentioned mix design is used.

Table4-Mix Ratio for Materials

	H_2O	Cement	Sand	Aggregate
Ratio	W/c-0.4	1	1.65	2.24
Quantity	186 (lit/m^3)	465 (kg/m^3)	766 (kg/m^3)	1040 (kg/m^3)

Casting of cubes

The number of cubes and cylinders cast.

Table 5

	Conventional Concrete	SP	LECA
Cube	3nos	15 nos	12 nos
Cylinder	3 nos	15 nos	12 nos

Testing of specimens

Cubes are tested for compressive strength test, for all proportions mentioned for LECA and SP, M30 grade of concrete is used, and the ratio of 1:1.65:2.24 is adopted. Ordinary Portland cement is used. The fine aggregate of size passing through 4.75 sieves is used. A coarse aggregate of 20mm sized aggregate is used. LECA material of 20 mm is replaced for aggregate. SP is used as required for curing. Cubes are cast, and results are obtained for the 7th and 28th day as in [7]. Cube Specimens are tested in a compressive testing machine for the compressive strength value.

Result and Discussion

Respective results for conventional concrete, SP, and LECA are compared and studied graphically.

The compressive strength results for SP and LECA are summarized below.

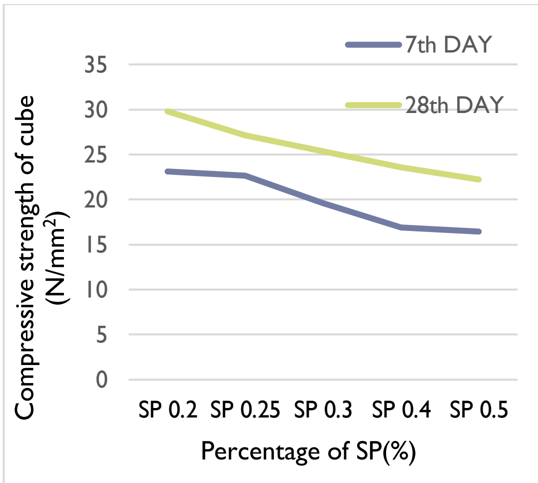


Fig.8 Compressive strength of SP cube

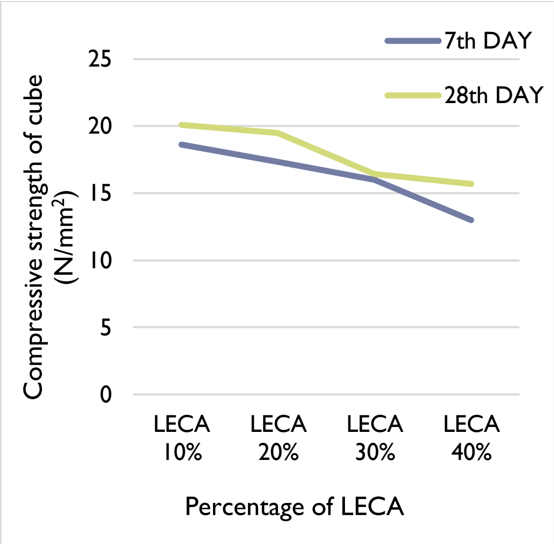


Fig.9 Compressive strength of LECA cube

The Split tensile results for SP and LECA are summarized below.

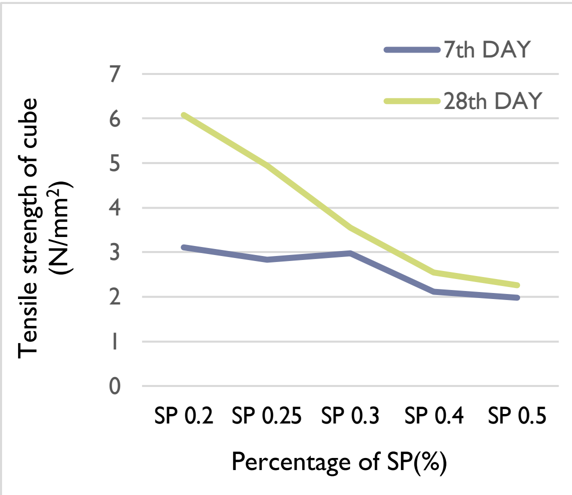


Fig.10 Split tensile strength of SP cylinder

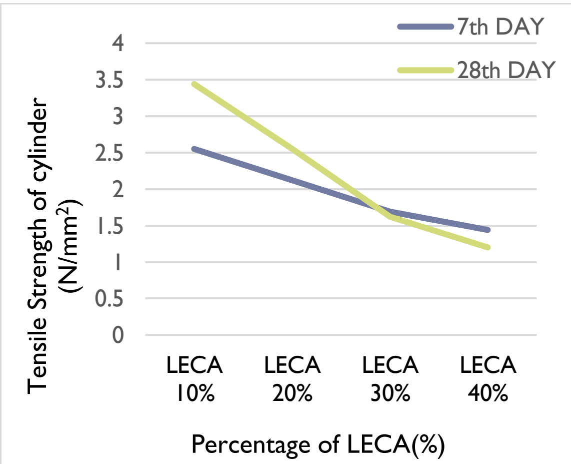


Fig.11 Split tensile strength of LECA cylinder

The utilization of SP and LECA will experimentally give out the following results. From the Experimental study and various test results

- LECA as 10% gives more strength compared to other proportions in LECA
- SP as 0.2% gives more strength compared to various proportions in SP
- Using SP as a self-curing agent gives high compressive & tensile strength when compared to LECA
- SP as 0.2% gives strength nearly equal to the strength of conventional concrete
- Further studies can be done using SP as a self-curing agent in concreting to reduce the water content
- LECA can also be used as a self-curing agent in non-load-bearing structures.

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