AN EMPIRICAL STUDY ON THE SELF-CURING PROPERTIES OF CONCRETE UTILIZING NATURAL ADDITIVES

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Abstract - *The research extensively explores transforming concrete characteristics through the experimental examination of Aloevera gel and Large Caltrops gel. The primary components utilized in this investigation comprise of premium-grade Portland Pozzolana Cement (43 grade), M-sand, and 20-mm coarse aggregate. Aloevera gel and Large Caltrops gel are added to the concrete compositions in different ratios, ranging from 0% to 6%, all mixed with water. This study emphasizes the critical significance of conducting a thorough assessment of mechanical properties, with a specific focus on compressive strength, split tensile strength, and flexural strength. The primary aim of this study is to ascertain the most effective combination ratio based on the findings and analysis of the data. Aloe vera gel and a caltrops gel concentration of 6% are identified as the most promising formulations without any ambiguity. This research analysis centers on global initiatives aimed at mitigating the environmental impact of the construction sector by analyzing the reduction of chemical admixture consumption as a means to decrease the environmental footprint. The primary objective of this study is to investigate the capacity of concrete to withstand dry shrinkage, its environmental sustainability, water conservation, and cost efficiency.*

Keywords: *Concrete, Aloe Vera Gel, Large Caltrops Gel, Compressive Strength, Workability etc*

1.INTRODUCTION

Conventional methods of concrete curing frequently require significant amounts of water and time-consuming external interventions, resulting in practical difficulties and environmental considerations. The incorporation of natural chemicals into self-curing concrete offers a potentially fruitful route for innovation in addressing these concerns. The objective of this study is to investigate the potential synergistic effects of self-curing mechanisms and the incorporation of natural additives on the performance, mechanical qualities, and overall sustainability of the material. This work seeks to analyze the complex interactions inside the self-curing concrete matrix that has been enhanced with natural additives, using careful experiments. Through a meticulous examination of the hydration kinetics, pore structure, and mechanical strengths, our aim is to offer a full comprehension of the manner in which these amalgamated components contribute to the resilience and enduring durability of the material. In addition, the scope of the inquiry goes beyond the confines of the laboratory, as it explores the economic viability and ecological consequences associated with the implementation of self-curing concrete using natural additives in practical construction situations. By providing the results of this experimental endeavor, we expect to provide significant contributions to the wider academic conversation surrounding concrete technology. The objective of this study is to provide valuable insights to industry experts, researchers, and policymakers, facilitating a more comprehensive comprehension of the possible advantages and obstacles linked to the incorporation of natural additives into self-curing concrete systems.

Aloe vera gel has been investigated for its potential as a bio-additive in concrete due to its unique properties, including high water retention capacity and viscosity. Research suggests that incorporating aloe vera gel into concrete mixes can improve workability and reduce water demand, resulting in enhanced hydration and strength development of the concrete (Saravanan et al., 2017). Additionally, aloe vera gel contains polysaccharides and other organic compounds that may contribute to the overall performance of concrete (Saravanan et al., 2017)

Large Caltrops, also known as Tribulus terrestris, is a plant commonly found in arid regions. Recent studies have explored its potential as a natural bio-additive in concrete due to its fibrous nature and chemical composition. Large Caltrops fibers possess high tensile strength and can act as reinforcement within the concrete matrix, improving its crack resistance and ductility (Kaur et al., 2020). Moreover, chemical constituents present in Large Caltrops, such as saponins and flavonoids, may also contribute to the hydration process and overall performance of concrete mixes (Kaur et al., 2020).

Neupane et al. (2019) This review highlights the increasing interest in using eco-friendly additives in concrete production. Natural additives offer the potential to enhance certain properties of concrete while reducing environmental impact. Patil, et al. (2019) Research indicates that aloe vera gel can potentially be used as a partial replacement for cement in concrete mixtures. Its presence may contribute to improved workability and possibly enhanced durability of concrete.
Nambiar et al (2007) The incorporation of natural additives in concrete can influence its mechanical properties. Proper assessment of these additives is necessary to understand their effects on concrete's strength, durability, and other performance characteristics.

Silva et al. (2015) Utilizing natural additives in concrete aligns with the broader goal of environmental sustainability in construction. By reducing reliance on traditional cementitious materials and incorporating renewable resources, concrete production can become more environmentally friendly.

2 MATERIALS

CEMENT

The Cement used in this research is Portland Pozzolana Cement (PPC) 43 Grade is a construction material recognized by the Bureau of Indian Standards (BIS) as per IS 1489 (Part 1 & Part 2): 2015. This cement offers a sustainable alternative to Ordinary Portland Cement (OPC) 43 Grade while meeting strength requirements. PPC 43 grade exhibits superior workability, mitigating challenges associated with handling and placing concrete. Its reduced heat of hydration is particularly advantageous in large-scale projects, minimizing the risk of thermal cracking during curing. During the experimental work in the laboratory the following composition of Chemical was incorporated in the Portland Pozzolana cement which is accustomed in Table 1.

Table 1 Chemical compositions of PPC 43 Grade

Oxides	Weight in %
$CaSO_4.2H_2O$	75
CaO	67
SiO_2(Fly Ash Content)	60
Al_2O_3(Fly Ash Content)	30
SiO_2	25
Fe_2O_3(Fly Ash Content)	15
Al_2O_3	9
Fe_2O_3	5
MgO	5

AGGREGATES

Aggregates was selected and prepared according to IS 383:2016 particle proportion was lugged out.

FIE AGGREGATE:

The Fine Aggregate used in this research is Manufactured sand, commonly referred to as M-sand, is an alternative to natural river sand used in construction applications. M-sand is produced by crushing rocks, quarry stones, or larger aggregates to the required size and shape, typically within the range of 0.075mm to 4.75mm. It is characterized by its uniform particle size distribution, angular shape, and clean texture, which make it suitable for various construction purposes. The Specific Gravity of Fine Aggregate in this research is 2.91.

COARSE AGGREGATE:

The size of Coarse Aggregate used in this research is 20mm. Coarse aggregate is a key component in concrete mixtures, providing strength, stability, and durability to the final product. It typically consists of larger particles ranging from 4.75mm to 75mm in size, derived from natural sources such as crushed stone, gravel. Coarse aggregate is primarily responsible for providing bulk to the concrete mix, filling the voids between fine aggregates and cement paste. Its properties including shape, size, and surface texture, influence the workability, strength, and durability of concrete. The Specific Gravity of Coarse Aggregate in this research is 2.71.

WATER:

Portable Water is used in this research collected from laboratory with pH value 6.9 to 9.0. Water initiates the hydration process in concrete by reacting with cement particles. This chemical reaction forms a gel-like substance known as cement paste, which binds the aggregates together. The water-to-cement ratio is a critical factor, influencing the degree of hydration. Achieving an optimal ratio is vital for ensuring proper strength development without excess water, which can lead to weakened concrete.

ALOE VERA GEL:

Aloe vera (*Aloe barbadensis miller*) is a succulent plant species of the genus Aloe. An ever green perennial, it originates from the arbian peninsula but grows around the world. Aloe vera is a short stem plant that has almost 98% of water in its leaves. Each leaf is full of a slimy tissues which possesses water. This slimy water is called as “Gel”. It is good for making readily mix concrete that is more flowing as compared to conventional concrete. It also helps in the compressive strength and flexural strength of concrete.

Figure 1 Extraction of aloe Vera gel

Table2. Chemical compositions of Aloe Vera gel

CHEMICAL COMPOSITIONS	VALUES (g/100g)
Moisture	97±0.17
Fat	0.02±0.01
Protein	0.12±0.00
Crude Fiber	0.13±0.00
Carbohydrate	0.60±0.02
Ash	0.16±0.09
Acidity	0.43±0.023
Reducing Sugar	0.99±0.003
Non-Reducing Sugar	1.01±0.018
Energy(kcal)	4.37±0.22

LARGE CALTROPS:

Pedalium murex, usually referred to as Large Caltrops, is a plant species. The genus Pedalium belongs to the Pedaliaceae family and consists of a single species, Pedalium murex. It is found in tropical regions of Africa, the Indian subcontinent, and Southeast Asia. This gel, which is obtained from the medicinal plant Pedalium Murex, shows great potential as a self-curing agent, thereby introducing a new era of construction materials that are both ecologically conscious and long-lasting. The gel derived from Pedalium Murex has a high concentration of naturally occurring chemicals, hence enhancing its capacity to retain water. The intrinsic characteristic of Pedalium Murex gel makes it a very suitable option for effectively preserving the correct moisture levels inside the concrete matrix throughout the critical curing process. The inherent advantages of Pedalium Murex gel in the context of self-curing concrete are apparent. In addition to its ability to hold water, Pedalium Murex gel may provide other benefits such as enhanced mechanical characteristics, environmental friendliness, and versatility in various *construction situations.*

Figure 2 Large Caltrops Gel Extraction

Table3 Chemical compositions of Large Caltrops Gel

CHEMICAL COMPOSITIONS	MOLECULAR wt.(g/mol)
Flavonoids	316.26
Saponens/Steroids	576.85
Terpenoids	472.7
Alkaloids	147.13
Hydrocarbons	537.0
Phenols	152.15
Amino Acids	119.12

2.1 METHODOLOGY

By using Aloe Vera Gel and Large Caltrops Gel as a water reducing agent we have checked fresh and hardened properties of concrete. Inorder to check fresh property of concrete we conducted workability test, mix design of concrete at the proportion of (1:2.392:2.915) at water cement ratio of (0.53) where Aloe Vera Gel and Large Caltrops Gel which are added in the proportion of 0%, 2%, 4% & 6% to the weight of cement was made and slump cone test was done for workability. Table 4 depicts the mix proportion.

Table 4. Mix proportion

Cement	Fine Aggregate	Coarse Aggregate	Water/Cement Ratio
1	2.392	2.915	0.53

3. RESULTS AND DISCUSSIONS

3.1WORKABILITY ON CONCRETE:

The graph shows the slump values of all concrete mixes. Workability increases with increases in Aloe Vera Gel and Large Caltrops Gel dosage. The Reason behind the increase in workability is that it is water containing material and contain high qualified properties in Aloe Vera Gel and Large Caltrops Gel. This chemical has certain properties to enhance the workability of concrete. The Maximum slump was recorded 80mm at the dosage of 6% of Aloe Vera Gel and Large Caltrops Gel.

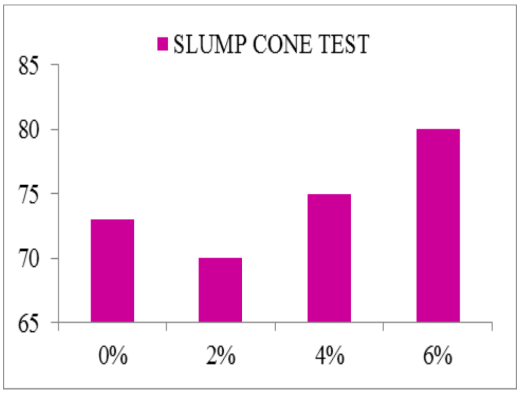

Figure 3 Slump test

3.2 COMPRESSIVE STRENGTH

Table 5 and Figure 4 present the compressive strength values for different natural additives at varying curing periods. The normal concrete reached a strength of 25.50MPa after 28 days, but the aloe Vera and caltrops gel (2%, 4%, and 6%) achieved strengths of 23.13MPa, 25.20MPa, and 26.60MPa, respectively. The highest compressive strength was achieved by 6% of aloe Vera and Caltrops gel mixed concrete.

Table 5 summary of test results on compressive strength

DESCRIPTION	COMPRESSIVE STRENGTH (MPA)		
	7 DAYS	14 DAYS	28 DAYS
Conventional Concrete	19.56	21.78	25.50
Aloe Vera Gel and Large Caltrops Gel 2%	18.8	21.88	23.13
Aloe Vera Gel and Large Caltrops Gel 4%	19.85	23	25.20
Aloe Vera Gel and Large Caltrops Gel 6%	20	23.3	26.6

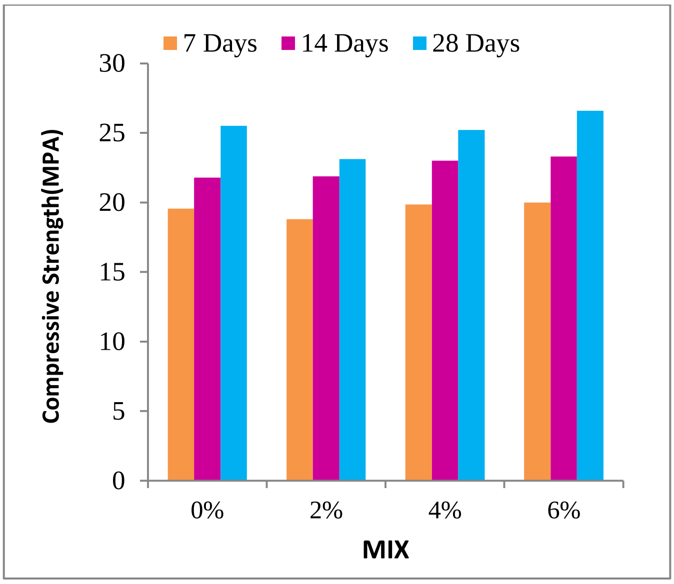

Figure 4 Compressive Strength variations

3.3 SPLIT TENSILE STRENGTH

The test findings pertaining to the split tensile strength of different specimens at 14 and 28 days are illustrated in Figure 5. The concrete mixture containing 6% aloe Vera and Caltrops gel exhibited the highest split tensile strength. Conventional concrete exhibits strength of 3.5 MPa, however the incorporation of aloe Vera and caltrops gel at concentrations of 2%, 4%, and 6% resulted in strengths of 3.35 MPa, 3.94 MPa, and 4.15 MPa, respectively.

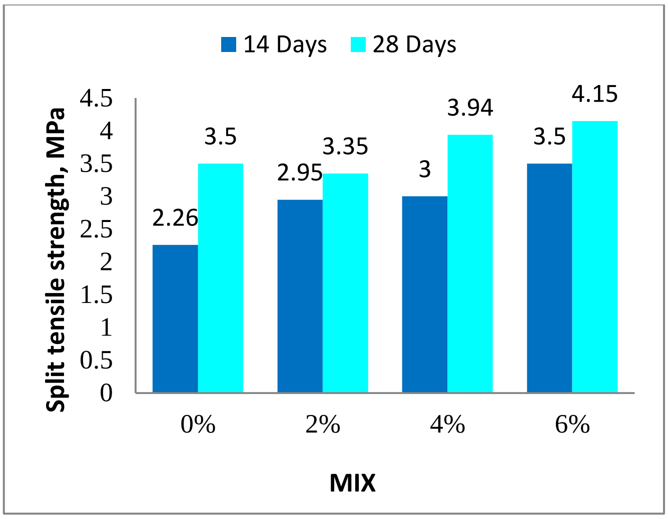

Figure 5 Split tensile strength variation

3.4 FLEXURAL STRENGTH

The flexural strength test results for different specimens are illustrated in Figure 6. The standard mix reached a compressive strength of 3.2 Mpa after 28 days. The aloe

Vera and caltrops gel, with concentrations of 2%, 4%, and 6%, exhibited compressive strengths of 3.18MPa, 3.93MPa, and 4.28MPa, respectively. The concrete mixture using a combination of aloe Vera and Caltrops gel exhibited the maximum flexural strength.

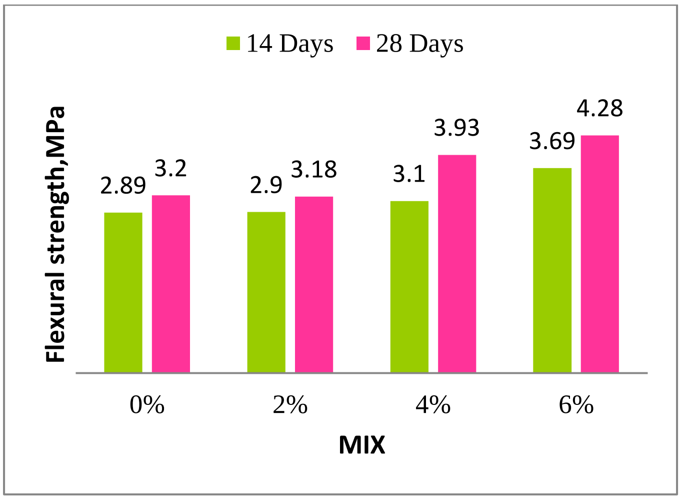

Figure 6 Flexural Strength variations

3. CONCLUSIONS

- This study focuses on the effects of Aloe Vera Gel and Large Caltrops Gel on the workability, compressive strength, split tensile strength, and flexural strength of concrete. The following conclusion indicates that positive research has been achieved in this age of the topic.
- • The addition of Aloe Vera Gel and Large Caltrops Gel to concrete has been found to enhance its workability and compaction factor. The maximum workability of 80mm and the compaction factor rate of 0.78 are attained when using the maximum dosage of Aloe Vera Gel and Large Caltrops Gel 6%.
- Based on the analysis of the hardened characteristics of concrete, it has been determined that the compression strength, split tensile strength, and flexural strength of concrete specimens are minimally influenced when 2% of Aloe Vera Gel and Large Caltrops Gel are added. At greater dosages of Aloe Vera Gel and Large Caltrops Gel 4% and 6%, the compressive strength of the concrete specimen is slightly higher. However, the split tensile strength and flexural strength are also increased.
- The utilization of Aloe Vera Gel and Large Caltrops Gel in congested reinforcement structures is limited to a maximum dosage of 6%. The compressive strength, split tensile strength, and flexural strength can be increased by approximately 10% when using a maximum dosage of 6% Aloe Vera Gel with Large Caltrops Gel.
- The experimental findings indicate that using Aloe Vera Gel and Large Caltrops Gel by weight of cement in concrete can effectively mitigate honeycombing in structures. Consequently, these materials have the potential to be utilized globally as a means to enhance workability in large-scale construction projects.
- The material is readily accessible within the local area at a reasonable cost.

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