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EXPERIMENTAL STUDY ON HYDROPHOBIC CONCRETE USING STEARIC ACID POWDER AND ETHANOL

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ABSTRACT

Concrete is one of the most widely used construction materials; however, its porous structure allows water penetration, which can adversely affect its strength, durability, and service life. The present study focuses on developing hydrophobic concrete using stearic acid and ethanol to improve its water-repellent properties. Stearic acid, a long-chain fatty acid, is selected as the hydrophobic agent, while ethanol is used as a solvent or carrier to facilitate its preparation and distribution. Cement, fine aggregate, coarse aggregate, and water are used to prepare the concrete mixtures with different proportions of stearic acid. The study aims to investigate the influence of stearic acid and ethanol on the physical, mechanical, and water-resistance properties of concrete. The performance of the modified concrete is evaluated by conducting tests such as compressive strength, water absorption, and by comparing the results with conventional concrete. The optimum percentage of stearic acid is to be determined based on the balance between water-repellent performance and Previous research has demonstrated that stearic-acid-based modifications can reduce water absorption, although excessive dosages may adversely affect compressive strength.

Keywords: Hydrophobic Concrete, Stearic Acid, Ethanol, Compressive Strength, Water Absorption, Concrete Durability.

I. INTRODUCTION

Concrete is one of the most widely used construction materials because of its high compressive strength, durability, and versatility. However, its porous structure allows water and other liquids to penetrate into the concrete, which can lead to moisture-related deterioration, corrosion of reinforcement, cracking, and reduced service life. Therefore, developing hydrophobic concrete, which resists water absorption and penetration, is an important approach for improving concrete durability.

Stearic acid is a long-chain fatty acid that can be used as a hydrophobic agent for concrete. When incorporated into concrete, stearic acid can interact with the cementitious matrix and impart water-repellent properties to the pore surfaces. Ethanol can be used as a solvent or

dispersing medium to help dissolve and distribute stearic acid more uniformly before its incorporation into the concrete mixture. The resulting modification can reduce the affinity of the concrete surface and internal pores toward water, thereby lowering water absorption and improving resistance to moisture ingress.

The development of hydrophobic concrete using stearic acid and ethanol provides a relatively simple method of modifying conventional concrete to enhance its water-repellent characteristics. This study focuses on evaluating the effect of stearic acid, with ethanol as a solvent, on the physical and durability properties of concrete, particularly its water absorption, permeability, surface hydrophobicity, and overall durability. The findings can contribute to the development of more moisture-resistant concrete suitable for applications where protection against water penetration is important. An important advantage of surface and internal hydrophobic modification is the potential to minimize the movement of water through the capillary pores of concrete. By reducing moisture ingress, such treatment may also help limit the transport of dissolved salts and harmful chemicals into the concrete matrix. Stearic acid is particularly interesting because its long hydrocarbon chain has a low affinity for water, which can contribute to the formation of a water-repellent layer within or around the pore structure. The use of ethanol can further support the preparation of the treatment by improving the dispersion of stearic acid and facilitating its application. The effectiveness of this approach depends on factors such as the concentration of stearic acid, ethanol-to-stearic-acid ratio, method of application, curing conditions, and characteristics of the concrete mix. Therefore, optimizing these parameters is essential to achieve hydrophobicity without adversely affecting the strength and other engineering properties of concrete. Ethanol has an additional role in this system because it can act as a carrier for stearic acid during the preparation of the hydrophobic treatment. The use of a suitable solvent can improve the handling and application of the fatty acid and may help in obtaining a more consistent treatment. After application, ethanol can evaporate, leaving the hydrophobic component available to interact with the concrete surface. This makes the combination of stearic acid and ethanol an interesting system for investigating water-repellent concrete.

II. RESEARCH GAP AND NOVELTY

Research Gap

Although previous studies have investigated hydrophobic concrete using different water-repellent materials, further investigation is required to understand the combined effect of stearic acid powder and ethanol on concrete properties. Limited experimental data are available in the present project regarding the relationship between different stearic acid dosages, water absorption and compressive strength. Therefore, this study evaluates the performance of concrete modified with stearic acid powder and ethanol to identify the balance between improved water resistance and compressive strength.

Proposed Novelity

The novelty of this study lies in the experimental evaluation of hydrophobic concrete using stearic acid powder dispersed in ethanol at a reported ratio of 1:2. Different additive dosages are investigated to compare their effects on 28-day compressive strength and water absorption. The study examines the trade-off between reducing water absorption and maintaining concrete strength, providing a basis for further optimization of hydrophobic concrete for potential construction applications.

III. OBJECTIVES

- To prepare concrete mixes containing stearic acid powder with ethanol as a dispersing medium.
- To evaluate the 28-day compressive strength of control and modified concrete cubes.
- To determine water absorption for each reported stearic acid dosage.
- To compare the balance between compressive strength and water absorption.
- To identify a promising dosage for further verification, without treating it as a final optimum until repeat tests are completed.

IV. MATERIALS AND EXPERIMENTAL METHODOLOGY

Materials

The project report identifies the following materials:

Material	Role in the study
Portland Pozzolana Cement (PPC)	Primary binding material in the concrete matrix.
Fine aggregate (sand)	Fills voids between coarse aggregate particles and contributes to workability.
Coarse aggregate	Provides the granular skeleton and contributes to concrete strength.
Stearic acid powder ($C_{18}H_{36}O_2$)	Hydrophobic additive investigated for reducing water uptake.
Ethanol	Used as a dispersing medium; the report specifies a stearic acid:ethanol ratio of 1:2.
Water	Used for concrete mixing and curing.

Methodology

-Clean the cube moulds properly and apply a thin layer of mould-release oil on the inner surfaces.

-Weigh the required quantities of cement, fine aggregate and coarse aggregate according to the designed mix proportion.

-Prepare the stearic acid solution by dissolving the required quantity of stearic acid in ethanol with continuous stirring until a uniform solution is obtained.

-Mix the cement, fine aggregate and coarse aggregate in a dry condition until a uniform mixture is obtained.
-Add the required quantity of stearic acid–ethanol solution along with the mixing water and mix thoroughly to obtain a uniform concrete mix.
-Fill the concrete into the cube moulds in three approximately equal layers.
-Compact each layer properly using a tamping rod or vibrating table to remove entrapped air.
-Level and finish the top surface of the cubes using a trowel.
-Mark the cubes with the required identification and mix details.
-Keep the moulds undisturbed for approximately 24 hours.
-Remove the cubes from the moulds carefully and place them in clean water for curing for the specified period, normally 7 or 28 days.
-After curing, remove the cubes from the water and allow them to reach the required test condition before conducting the compressive strength or water absorption test.

Preparation and casting

A control mix was prepared without the hydrophobic additive. For modified mixes, the required stearic acid powder was measured and combined with ethanol using the reported 1:2 ratio. The prepared chemical mixture was introduced into the concrete mix, followed by mixing to distribute the ingredients. Fresh concrete was placed into clean, oiled 150 mm cube moulds and compacted to reduce entrapped air. After the initial setting period, specimens were demoulded and water-cured before testing. The project report describes testing the cubes at 28 days.

Reported additive dosages

Mix designation	Reported stearic acid quantity	Reported ethanol quantity
Control	0 g	0
0.5%	35 g	75 g
1.0%	70 g	140 g
1.5%	100 g	200 g
2.0%	150 g	350 g

The quantities above reproduce the values recorded in the project report. Some listed ethanol quantities do not equal exactly twice the corresponding stearic acid mass, and the stated percentages should be checked against the cement mass used for each batch. Accordingly, the dosage labels are treated here as reported mix designations rather than independently verified cement-weight percentages.

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Testing procedures and calculations

Compressive strength test

After 28 days of curing, the surface water was wiped from each cube and the specimen was placed centrally in a Compression Testing Machine. The load was applied until failure, and compressive strength was calculated from the maximum load divided by the loaded area.

Compressive strength (MPa) = Failure load (N) / Loaded area (mm^2)

Water absorption test

The dry mass and saturated mass of each specimen were recorded. Water absorption was calculated from the increase in mass relative to the dry mass.

Water absorption (%) = [(Wwet − Wdry) / Wdry] × 100

Where Wwet is the saturated/wet mass and Wdry is the dry mass of the specimen.

V. RESULTS AND DISCUSSION

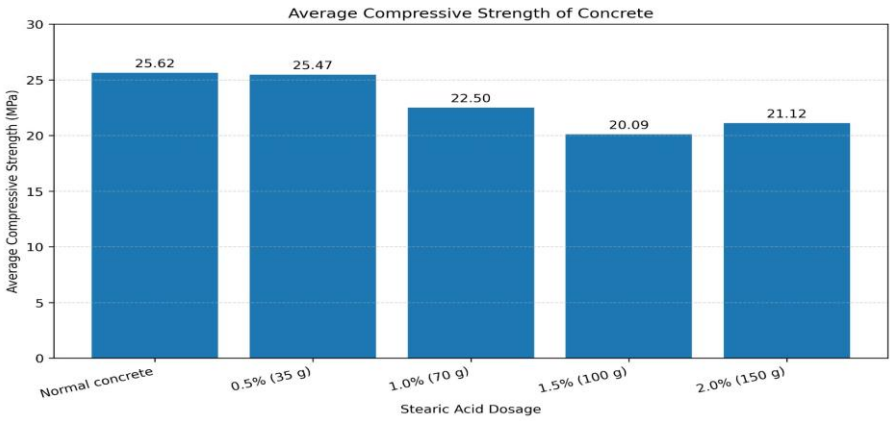
Compressive strength

The average 28-day compressive strengths recorded in the project report. The control concrete achieved 25.62 MPa. The 0.5% mix recorded 25.47 MPa, which is close to the control value. At the 1.0% and 1.5% reported dosages, the average strength decreased to 22.50 and 20.09 MPa. The 2.0% mix recorded 21.12 MPa, showing a small increase compared with the 1.5% mix but remaining below the control value.

Sr.No	Sample	Load (KN)	Compressive Strength(N\mm^2)	Avg. Compressive Strength(N\mm^2)
1.	Normal cube	550	24.44	25.62
		600	26.66	
		580	25.77	
2.	35gm (0.5%)	550	24.44	25.47
		590	26.22	
		580	25.77	
3.	70gm (1%)	520	23.40	23.50
		530	23.50	
		531	23.60	
4.	100 gm (1.5%)	470	21.00	21.09
		480	21.10	
		480	21.17	
5.	150 gm (2%)	470	21.00	21.12
		470	21.10	

		480	21.12	

Reported average 28-day compressive strength



Water absorption

The recorded water absorption decreased as the reported stearic acid dosage increased. The control mix had a water absorption of 4.00%, while the 0.5%, 1.0%, 1.5% and 2.0% mixes recorded 2.95%, 2.61%, 2.16% and 1.72%, respectively. Relative to the control, these values correspond to reductions of 26.25%, 34.75%, 46.00% and 57.00%. Within the available dataset, the 2.0% mix showed the lowest water absorption.

Stearic acid (%)	Dry wt.(kg)	Saturated wt.(kg)	Water absorption(%)
0.0	8.750	9.100	4.00
0.5 %	8.800	9.060	2.95
1.0%	8.820	9.050	2.61
1.5%	8.780	8.970	2.16
2.0%	8.700	8.850	1.72

Reported water-absorption results and calculated reduction

Combined interpretation

The results show a clear trade-off in the supplied dataset: the modified mixes absorbed less water, but their reported compressive strengths were generally lower than that of the control mix. The 0.5% mix retained strength close to the control (a reported decrease of about 0.59%) and reduced water absorption by 26.25%. The 2.0% mix provided the greatest recorded reduction in water absorption (57.00%) but had a 17.56% lower average compressive strength than the control. Thus, the 0.5% mix may be considered a candidate for further testing where retaining strength is important, while the 2.0% mix may be investigated further where lower water absorption is the main target. Neither should be declared the optimum without repeated testing and verified dosage calculations. The slight rise in compressive strength from 20.09 MPa at 1.5% to 21.12 MPa at 2.0% also indicates that the strength trend is not strictly

monotonic. The available report does not provide uncertainty analysis or enough detail about replicate variability to determine whether this difference is statistically meaningful.

VI. LIMITATIONS OF THE PRESENT STUDY

- The paper uses the experimental values available in the supplied project report; raw laboratory records were not independently re-measured.
- The report's dosage labels, ethanol quantities and batch cement mass are not fully consistent and should be verified before submission.
- The mix-design section contains grade/mix-proportion details that should be reconciled with the intended concrete grade.
- Contact angle, permeability, chloride penetration, microstructure and long-term durability were not reported.
- The number of specimens and statistical variation are not sufficient in the available summary to support broad generalization.

VII. CONCLUSIONS

This experimental study investigated concrete containing stearic acid powder dispersed using ethanol and evaluated compressive strength and water absorption using the values recorded in the project report. The control mix showed an average 28-day compressive strength of 25.62 MPa and water absorption of 4.00%. The modified mixes recorded lower water absorption, declining from 2.95% at the reported 0.5% dosage to 1.72% at the reported 2.0% dosage. The lowest water absorption represented a 57% reduction relative to the control.

Compressive strength was 25.47 MPa for the 0.5% mix, 22.50 MPa for 1.0%, 20.09 MPa for 1.5%, and 21.12 MPa for 2.0%. These results suggest that stearic acid treatment may improve water resistance while potentially reducing compressive strength, and that dosage selection requires balancing both properties. The 0.5% mix is a useful candidate for additional trials because its reported strength was close to the control while water absorption was lower. However, all dosage and mix calculations should be checked, and additional replicate testing is necessary before identifying a definitive optimum or recommending structural use.

VIII. FUTURE SCOPE

Future work should verify the batch quantities and additive percentages, test more dosage levels, and include replicate specimens with statistical analysis. Further tests may include contact-angle measurement, water permeability, sorptivity, split tensile strength, flexural strength, chloride resistance, freeze–thaw durability and microstructural analysis such as SEM. Trials using different concrete grades and field-scale specimens would help assess practical suitability for water-related structures.

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REFERENCES

1. [1] J. Luo et al., "Research on the Performance of Superhydrophobic Cement-Based Materials Based on Composite Hydrophobic Agents." Full publication details should be added from the original source.
2. [2] Z. Zhao et al., "Development of a Superhydrophobic Protection Mechanism and Coating Materials for Cement Concrete Surfaces," Materials, vol. 17, no. 17, p. 4390, Sep. 2024, doi: 10.3390/ma17174390.
3. [3] Y. Zhao, L. Lei, Q. Wang, and X. Li, "Study of superhydrophobic concrete with integral superhydrophobicity and anti-corrosion property," Case Studies in Construction Materials, vol. 18, p. e01899, Jul. 2023, doi: 10.1016/j.cscm.2023.e01899.
4. [4] D. Abdrassilov, A. Aniskin, Z. Shakhmov, and R. Lukpanov, "Hydrophobic Modification of Concrete Using a Hydrophobizing Admixture," Construction Materials, vol. 6, no. 1, p. 3, Jan. 2026, doi: 10.3390/constrmater6010003.
5. [5] N. Sharma and P. Sharma, "Effect of hydrophobic agent in cement and concrete: Review," IOP Conference Series: Materials Science and Engineering, vol. 1116, no. 1, p. 012175, Apr. 2021, doi: 10.1088/1757-899X/1116/1/012175.
6. [6] J. Sidhu, P. Kumar, R. Bharadwaj, and V. Kumar, "Experimental Investigation on Hydrophobic Treatment of Cement Concrete with Organosilane Based Compound," Journal of Civil Engineering and Materials Application, vol. 6, no. 3, Sep. 2022, doi: 10.22034/jcema.2022.353918.1091.
7. [7] Q. Wang, Y. Li, X. Zheng, R. Zhang, and N. Wang, "Strategies for Developing Superhydrophobic Surfaces on Cement-Based Materials Using Stearic Acid: A Review," Engineering Reports, vol. 7, no. 7, p. e70260, Jul. 2025, doi: 10.1002/eng2.70260.
8. [8] M. N. Balakrishna, M. M. Rahman, D. A. Chamberlain, F. Mohammad, and R. Evans, "Interpretation of Hydrophobicity in Concrete by Impregnation," 2013.