

OPTIMIZATION ON THE CHARACTERISTICS OF FOAM BASED ACOUSTIC PANEL UNDER DIFFERENT CURING REGIME

Anuja N¹, Dhanalakshmi A², Athibaranan S³

¹Assistant Professor (Senior Grade), Department of Civil Engineering, Mepco Schlenk Engineering College, Sivakasi, Virudhunagar District, Tamil Nadu, India.

²Assistant Professor, Department of Civil Engineering, P.S. R. Engineering College, Sivakasi, Virudhunagar District, Tamil Nadu, India.

³Assistant Professor, Department of Civil Engineering, GMR Institute of Technology, Srikakulam, Andhra Pradesh, India.

Abstract

The paper describes a Development of foam based lightweight insulated panel and the relative performance of foam produce with two different synthetic based foam agent Alpha Olefin Sulfonate (AOS) and Sodium Lauryl Ether Sulphate (SLES) for use in foam concrete. In additional, the Optimization of foaming agent through trial-and-error process using the different curing methods Like Ambient Curing, Steam Curing, Water Curing and Hot air oven curing. Various taken in the two Foaming agent 0.1, 0.2, 0.3, 0.4, 0.5 and take the one percentage of best less density (not less than 1800kg/m^3) and high strength. In this research work, Compressive Strength, and Acoustic Insulation tests were performed in Foam Based Concrete. The acoustic insulation being the main factor of interest, as the primary objectives of the mentioned research in the development of foam concrete. In the composition of cement, water, aggregate, and foam concrete. Urban sustainability issues in buildings have become more prominent in noise control studies. This work aimed to produce and characterize the composition of SLES & AOS foam agent wooden board Panel sheet cores for acoustic absorption.

Keywords: Acoustic, Insulation, Foam, Panel, Curing, Optimization

1. Introduction

Normal concrete, while widely used in construction, is not provide good sound insulation properties. The primary problem with normal concrete in terms of sound insulation is its density and lack of sound-absorbing properties. When sound waves hit a solid material like concrete, they tend to transmit through it rather than being absorbed or reflected. This transmission can result in significant sound transfer from one side of the concrete structure to the other. In contrast, sound insulation concrete, also known as acoustical concrete or acoustic blocks, is specifically designed to mitigate sound transmission. This type of concrete incorporates various additives or structures to improve its sound-absorbing and sound-blocking properties. These additives might include materials like rubber, cork, or foam, or the concrete may be designed with specific air pockets or voids to disrupt the transmission of sound waves.

By enhancing the sound-absorbing and sound-blocking capabilities, sound insulation concrete can significantly reduce noise transfer between different areas or rooms within a building. This makes it particularly useful in environments where noise control and privacy are important considerations, such as residential buildings, offices, hotels, and entertainment venues. Foam-based lightweight insulated panels represent a significant advancement in construction material, various application Foam concrete is a ranging from a residential to commercial and industrial buildings for fire resistant, and its thermal and acoustic insulation properties make it ideal for a wide range of purposes, from insulating floors and roofs, to void filling. These panels are engineered to provide exceptional thermal insulation properties while being lightweight, durable and easy to install. The relative performance of foam produces with two different synthetic based foam agent Alpha Olefin Sulfonate (AOS) and sodium lauryl ether sulphate (SLES) for use in foam concrete. The foam based light weight insulated

panels, including improved energy efficiency, enhanced indoor comfort, faster construction times, reduce the material waste, and potential cost saving.

2. Materials and Methods

Foam concrete are prepared using Portland Cement. The desired composition in the terms of cement, water, aggregate, and foam concrete. The two different synthetic based foam agent Alpha Olefin Sulfonate (AOS) Powder and Sodium Lauryl Ether Sulphate (SLES) liquid this two are chemical based material. The target density is not less than 800kg/m³ and not more than 200kg/m³ and using fine aggregate either is partially with lightweight aggregates. The foam is lightweight concrete block is cementations material are performed on the cubic specimens of 7.1m. The first step to prepare foam concrete is take the various percentage of taken in two foaming agent 0.1,0.2,0.3,0.4,0.5 and take one percentage of best less density and high strength. The Identification of better curing condition based on time period, density and strength.

3. Foaming Agents Used

Adhesive sealant to fix, fill and insulate against noise, cold - good insulation properties as effective at dampening sound. Used to bond insulation panels and insulating system components on top of each other due to excellent adhesive properties and fast curing ability. Table 1 indicates the chemical composition of two different foams.

Table 1: Chemical Composition

CHEMICAL NAME	Alpha Olefin Sulphonate	Sodium Lauryl Ethyl Sulfate
FORM	Powder	Liquid
BASE	Chemical	Chemical
COLOUR	White	Colourless
FOAM (%)	0.1, 0.2, 0.3, 0.4, 0.5	0.1, 0.2, 0.3, 0.4, 0.5

3.1 Alpha Olefin Sulphonate

Alpha olefin Sulfonate (AOS) has high Foaming agent and strong emulsifying character. The main advantages is it is a concrete density modifier, fire fighting foam and wetting agent. it has excellent cleaning properties and biodegradability. Fig 1 indicates the foam Alpha Olefin Sulphonate.



Fig 1 Alpha Olefin Sulphonate

3.2 Sodium Lauryl Ethyl Sulphate

SLES is a synthetic based foam is very effective foaming agent and it is also very inexpensive. And its used to produce stable foam for foam concrete production. It creates less density. In concretes also provide higher compressive strength compare to other foaming agent. Fig 2 indicates the foam Sodium Lauryl Ethyl Sulphate.



Fig 2 Sodium Lauryl Ethyl Sulphate

4. Results and Discussion

The main results of this study are the different subsection of the better curing based on the time period, dry density and compressive strength value.

4.1. Strategy 1 : Control Mix Density and Strength

The Control Mix concrete is various type of concrete that has be the exact proportions of the concrete and the all ingredients as per the mix design and the used other reference sample for the testing and the quality of concrete. The Mix is designed based on the performance is give the high strength, durability. Table 2 and Fig 2 represents the results of density and compressive strength

Table 2 : Results of Density and Compressive strength

SPECIMEN	WET DENSITY (kg/m ³)	DRY DENSITY (kg/m ³)	COMPRESSIVE STRENGTH (N/mm ²)
S1 (7days)	2216.56	2273.40	21.0
S2 (14days)	2273.40	2216.56	26.5
S3 (21days)	2159.73	2330.23	30.5
S4 (28days)	2330.23	2330.23	35.5

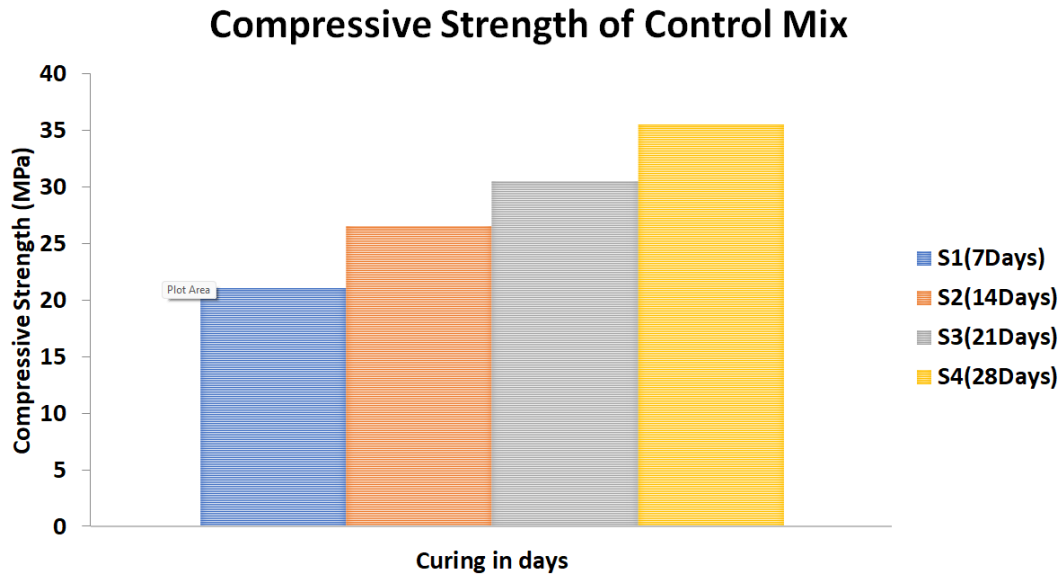


Fig 2: Results of Density and Compressive strength

5.2.Strategy 2: Different Curing Method

Horizontal type Steam Sterilizer (Autoclave)

Autoclave steam curing is also known as autoclaving, a steam curing sterilizer refers to a method used in the curing process of concrete. Steam curing is a technique employed to accelerate the hydration process of concrete, which enhances its strength development and reduces curing time. In steam curing, moist heat is applied to the concrete surface by introducing steam into a chamber or enclosure where the concrete is placed. This elevated temperature and humidity environment speeds up the chemical reactions involved in the hydration of cement, leading to faster curing and increased strength gain. . Fig 3 indicates Steam Chamber Curing.



Fig 3 Steam Chamber Curing

Hot Air Oven – Hot air oven curing in concrete is a method used to accelerate the curing process by exposing concrete specimens to elevated temperatures in a controlled environment. It involves placing the freshly cast concrete specimens in an oven-like chamber where hot air is circulated to promote hydration and strengthen the concrete. The oven is heated to the desired temperature, typically ranging from 40°C to 90°C (104°F to 194°F). Fig 4 shows the hot air oven curing.



Fig 4 Hot air oven curing

Ambient Curing – Ambient curing in concrete refers to the process of allowing freshly cast concrete to cure naturally under ambient environmental conditions, without the application of additional heat or moisture control. This method relies on the surrounding temperature, humidity, and air circulation to facilitate the hydration process and achieve the desired strength and durability of the concrete. Fig 5 shows the Ambient curing.



Fig 5 shows the Ambient curing.

Water Curing – Water curing in concrete is a traditional method used to promote hydration and achieve proper curing by continuously keeping the concrete surface wet for an extended period after casting. It involves applying water to the concrete surface to prevent moisture loss and maintain a saturated condition, which is crucial for the hydration of cement particles and the development of strength and durability in the concrete. Fig 6 shows the Water Curing.



Fig 6 shows the Water Curing.

5.3.Strategy 3:Alpha Olefin Sulphonate (Different curing method of strength and density

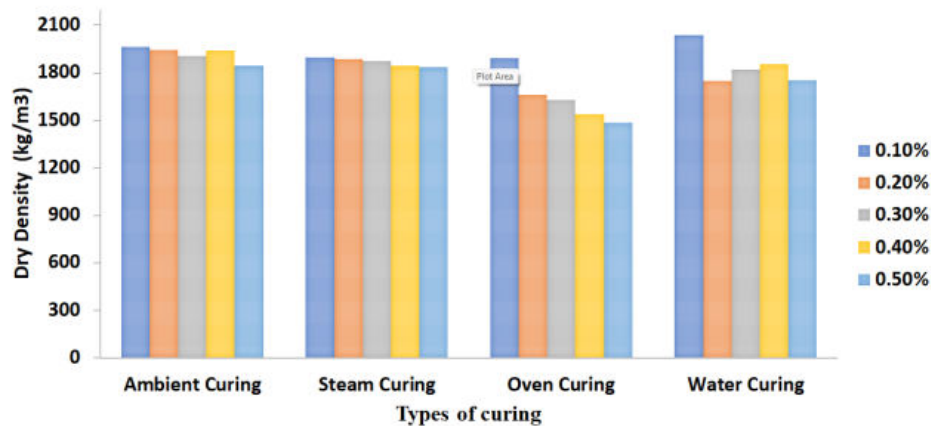
Different curing conditions are utilized for concrete to assist it hold dampness and avoid it from drying out some time recently coming to its most extreme equality. Curing can too offer assistance progress the concrete's solidness and anticipate shrinkage splits.

ALPHA OLEFIN SULPHONATE(AOS) FOAM

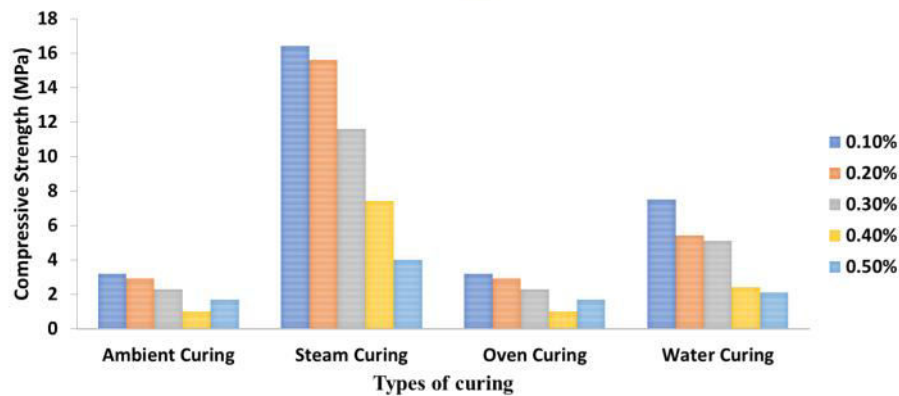
Curing Type	% of foam to be added	Dry Density (Kg/m ³)	Compressive strength(MPa)
OVEN CURING	0.1	1892.60	3.2
	0.2	1662.42	2.9
	0.3	1628.32	2.3
	0.4	1534.54	1.0
	0.5	1484.08	1.7
WATER CURING	0.1	1845.69	7.5
	0.2	1747.67	5.4
	0.3	1821.56	5.1
	0.4	1852.82	2.4
	0.5	1752.89	2.1

Curing Type	% of foam to be added	Dry Density (Kg/m ³)	Compressive Strength(MPa)
AMBIENT CURING	0.1	1963.65	3.2
	0.2	1943.75	2.9
	0.3	1907.89	2.3
	0.4	1942.53	1.0
	0.5	1843.07	1.7
STEAM CURING	0.1	1895.25	16.4
	0.2	1889.76	15.6
	0.3	1872.71	11.6
	0.4	1844.29	7.4
	0.5	1835.77	4.0

Dry Density of ALPHA Based Foam concrete at various curing condition



Compressive strength of ALPHA Based Foam concrete at various curing condition



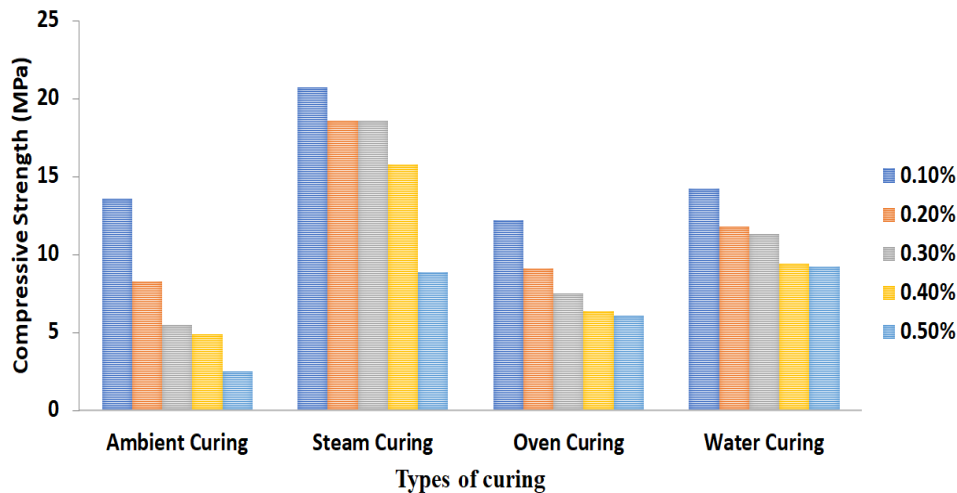
5.4.Strategy 4:*Sodium Lauryl Ethyl Sulphate*(Different curing method of strength and density)

SODIUM LAURYL ETHYL SULFATE(SLES) FOAM

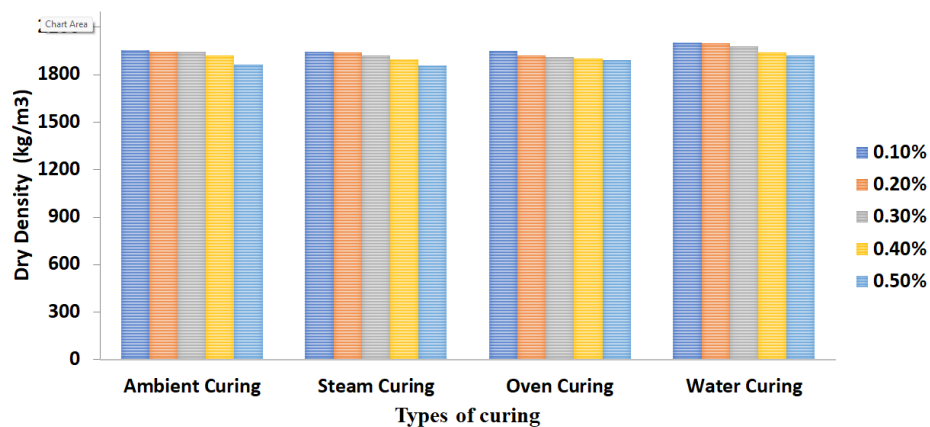
Curing Type	% of foam to be added	Dry Density (Kg/m ³)	Compressive Strength(MPa)
AMBIENT CURING	0.1	1955.12	13.6
	0.2	1946.5	8.3
	0.3	1946.5	5.5
	0.4	1921.02	4.9
	0.5	1861.34	2.5
STEAM CURING	0.1	1943.75	20.7
	0.2	1940.91	18.6
	0.3	1921.02	18.6
	0.4	1898.2	15.8
	0.5	1858.5	8.9

Curing Type	% of foam to be added	Dry Density (Kg/m ³)	Compressive Strength(MPa)
OVEN CURING	0.1	1949.44	12.2
	0.2	1921.02	9.1
	0.3	1909.65	7.5
	0.4	1901.13	6.4
	0.5	1892.60	6.1
WATER CURING	0.1	2003.4	14.2
	0.2	1999.75	11.8
	0.3	1977.85	11.3
	0.4	1940.41	9.4
	0.5	1921.02	9.2

Compressive strength of Sodium Based Foam concrete at various curing condition



Dry Density of Sodium Based Foam concrete at various curing condition



5. Conclusion

In conclusion, the research successfully investigated the development of foam-based lightweight insulated panels using Alpha Olefin Sulfonate (AOS) and Sodium Lauryl Ether Sulphate (SLES) as synthetic-based foam agents for foam concrete. Through a systematic optimization process

involving different curing methods and varying percentages of foaming agents, the study identified the optimal composition that balances low density (not less than 1800 kg/m³) and high strength. The evaluation of compressive strength and acoustic insulation performance highlighted the significance of acoustic properties in the context of urban sustainability and noise control in buildings. The research aimed to address these challenges by producing wooden board panel sheet cores with enhanced acoustic absorption capabilities. Overall, the study contributes to the advancement of materials for building construction, particularly in urban environments, where noise pollution is a growing concern. By focusing on the development of foam-based panels with improved acoustic properties, the research offers potential solutions for creating more sustainable and comfortable living spaces in densely populated areas.

References

1. Falliano, D., De Domenico, D., Ricciardi, G., Gugliandolo, E., 2018a. Experimental investigation on the compressive strength of foamed concrete: Effect of curing conditions, cement type, foaming agent and dry density. *Construction and Building Materials*; 165: 735-749.
2. Falliano, D., Gugliandolo, E., De Domenico, D., Ricciardi, G., 2019a. Experimental Investigation on the Mechanical Strength and Thermal Conductivity of Extrudable Foamed Concrete and Preliminary Views on Its Potential Application in 3D Printed Multilayer Insulating Panels. In: *First RILEM International Conference on Concrete and Digital Fabrication – Digital Concrete 2018*, Springer, Cham, pp. 277-286, DOI: 10.1007/978-3-319-99519-9_26.
3. Baiardo, M., Frisoni, G., Scandola, M., Rimelen, M., Lips, D., Ruffieux, K., Wintermantel, E., 2003. Thermal and mechanical properties of plasticized poly(L-lactic acid). *J. Appl. Polym. Sci.* 90, 1731–1738.
4. Baldwin, D.F., Park, C.B., Suh, N.P., 1996a. A microcellular processing study of poly(ethylene terephthalate) in the amorphous and semi-crystalline states. Part I: Microcell nucleation. *Polym. Eng. Sci.* 36, 1437–1445.
5. Panel Miss Mera, et.al, 2020 “Development of a strength model for foam concrete based on water-cement ratio” in *Materials Today: Proceedings*, vol.32, part 4, pp.923-927
6. Junjie Huang, et.al, 2020 “Experimental and Numerical analysis of lightweight foamed concrete is filler for widening embankment” in *Construction and Building Materials*, vol.250, no.118897, pp.1-6.
7. Tzar Sheng Tie, et.al, 2020 “Sound absorption performance of modified concrete” in the *Journal of Building Engineering*, vol.30, no.101219, pp. 7-10.
8. Vinith Kumar, et.al, 2020 “Experimental study on Mechanical and Thermal behavior of Foamed concrete” in *Materials Today: Proceedings*, vol.5, part 3, pp.8753-8760.
9. Amrith Raj, et.al, 2021 “Physical and functional characteristics of foam concrete” in *Construction and Building Materials*, vol.221, pp.787-799.
10. Metindavraz, et.al, 2022 “Investigation of the effect of autoclaving on foam concrete properties” in the *Journal of Radiation Research and Applied Sciences*, vol.16, no.100722, part 4, pp. 10-19.
11. DevidFalliano, et.al, 2022 “Increase the fracture energy of foamed concrete: two possible solutions” in *Procedia Structural Integrity*, vol.39, pp.229-235.
12. Vinith Kumar, et.al, 2022 “Strategies to increase the compressive strength of ultra-lightweight foamed concrete” in *Procedia Structural Integrity*, vol.28, part.3, pp.1673-1678.
13. Baris Arslan, et.al, 2023 “Investigation of aggregate size effect on the compressive behavior of concrete by electromechanical and mechanical impedance spectroscopy” in *Procedia Structural Integrity*, vol.5, pp.171-178.
14. Mastrogriannis, et.al, 2023 “Investigation of acoustic emission and pressure stimulated currents detected during bending of restored marble epistyles within the frame of log-periodic power-law models” in *Procedia Structural Integrity*, vol.10, pp.319-325.