An Experimental Study on Floating Concrete

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Abstract:- Archimedes Principle (Law of Buoyancy) to support the structure at a moderate and convenient depth. The solid body of a floating concrete construction is composed of lightweight components. Due to its low density and moderate range of compressive strengths, concrete is suitable for a variety of tests, including water buoyancy, spilt tensile strength, slump test, flow properties, and others. This project focuses on the creation of mix design for these tests; it is applicable to non- structural application. Applications of floating concrete are Marine construction, Infrastructure, Architectural. In this work, components with lower specific gravities than traditional concrete were used to create floating concrete in varying quantities. On the seventh, fourteenth, and twenty-eighth days after casting, testing is conducted.

Keywords:- *Floating Concrete, Light Weight Concrete, Mix Design, Law Of Buoyancy.*

I. INTRODUCTION

The use of Lightweight concrete (LWC) has been an integral component of the constructionindustry for centuries, offering versatility and advantageous properties. As with many construction materials, the expectations for LWC have evolved over time, with a growing demand for consistency, reliability, and predictable characteristics. Among the various typesof lightweight concrete, lightweight aggregate concrete stands out, often produced using materials like Perlite, shown in Fig.1 an amorphous volcanic glass.

Fig 1: Perlite Aggregate

Floating concrete represents a pioneering approach to construction that harnesses thebuoyant properties of concrete to create structures that literally float on water surfaces. Unlike conventional concrete structures that rely on weight and gravity for stability, floatingconcrete structures achieve buoyancy through careful design and material selection, opening up a wealth of possibilities for innovative applications in marine and waterfront environments.

In conclusion, Perlite aggregate represents a cornerstone of contemporary construction practices, offering a blend of durability, insulation, and versatility. Its extensive use demonstrates how well it works to meet the challenges of modern building projects, fromresidential developments to commercial structures. As the construction industry continues to evolve, Perlite's role as a key component of lightweight concrete is poised to expand, shaping the future of sustainable, high-performance construction.

➢ *Characteristics of Floating Concrete*

- **Low Density**: Floating concrete is significantly lighter than traditional concrete due to the inclusion of lightweight aggregates such as expanded clay, shale, or slate aggregates.This low density makes it buoyant and suitable for applications where weight is a concern, such as floating structures or lightweight fill.
- **High Porosity**: Its cellular structure, formed by entrained air or gas bubbles within theconcrete mix, gives it high porosity. This Porosity is a factor in its low density while also potentially enhancing insulation properties, depending on the application.
- **Reduced Structural Weight**: The lower concrete's floating density reduces the overall structural weight of a building or a floating structure. This characteristic can be beneficial for minimizing foundation requirements, reducing construction costs, and facilitating ease of transportation and installation.
- **Environmental Benefits**: The use of light weight aggregates in floating concrete can contribute to sustainability through lowering the amount of natural resources used and energyrequired for production, as well as decreasing transportation-related emissions due to lighter weight.
- **Compressive Strength**: Despite its low density, floating concrete can exhibit adequate compressive strength for structural applications. The strength can differ based on elements like the type and proportion of lightweight aggregates, cement content, curing conditions, and mix design.
- **Durability**: Floating concrete can offer good durability when properly designed, mixed,placed, and cured. Factors such as resistance to freeze-thaw cycles, chemical attack, andabrasion can be enhanced through appropriate mix designs and admixtures.

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II. LITERATURE REVIEW

Different lightweight concrete blends were formulated using EPS andlightweight aggregate, achieving satisfactory quality. Aggregate size and ratio affect unit weight and compressive strength. EPS usage produced lightweight concrete. However, lightweight aggregate reduced strength but decreased dead load. Unsuitable for load- bearing structures, it's appropriate for dividing walls. [1]

The partial substitution of conventional aggregates with expanded polystyrene (EPS) beads renders concrete lighter compared to traditional compositions. This substitution showcases a promising alternative application in construction materials. While utilizing lightweight aggregates reduces the dead load, it may compromise concrete strength. Ingredients for floating concrete must be carefully chosen to ensure their specific weight is less than the typical concrete components. Additionally, this approach presents an efficient method for repurposing EPS waste. [2]

Experimental floating concrete, with a density below 1000kg/m³, surpasses that of water, utilizing For coarse aggregates, use Light Expanded Clay Aggregates (LECA); for fine aggregates, use Pumice Powder; and for foaming, use Sodium Lauryl Ether Sulphate. Compressive strength tests reveal peak performance with 10% foaming agent, yielding a maximum average of 21.45 N/mm². Similarly, split tensile strength tests exhibit optimal results with the same foaming agent concentration,registering a maximum average of 1.22 N/mm². [3]

Floating Concrete with Thermocol. Using expanded polystyrene (EPS) beads as a partial replacement for aggregates in concrete creates a lighter material than traditional concrete. This positive application serves as an alternative building material, minimizing dead load without compromising strength. [4]

III. SCOPE & RESEARCH OBJECTIVES

Investigate various materials suitable for floating concrete, considering factors such as buoyancy, durability, and environmental impact. Assess the feasibility of incorporatinglightweight aggregates like Perlite or expanded polystyrene (EPS) into the mixture of concrete to achieve the desired buoyant properties.

Explore different mix designs and proportions to achieve optimal buoyancy while maintaining structural integrity and durability. Conduct laboratory experiments and computational simulations to analyze the effects of varying material compositions, water-cement ratios, and admixtures regarding the execution of floating concrete.

Evaluate the floating concrete's mechanical characteristics, such as its tensile strength, compressive strength, and flexural strength. Investigate how the buoyancy of the concrete affects its load-bearing capacity and resilience to external forces such as waves, wind, and impact.

Assess the long-term durability of floating concrete structures in marine environments, considering exposure to saltwater, corrosion, and biological degradation. Study the impact of environmental factors on the buoyancy and stability of floating concrete overtime, including changes in water level, temperature fluctuations, and wave action.

Investigate the structural design considerations for floating concrete structures, including shape, size, and configuration. Analyze the behavior of floating concrete under different loading conditions, such as static loads, dynamic loads, and seismic events, toensure structural stability and safety.

The main object the goal of this research is to investigate the ideal floating concrete design through experimentation, considering its compressive strength and density.

IV. METHODOLOGY

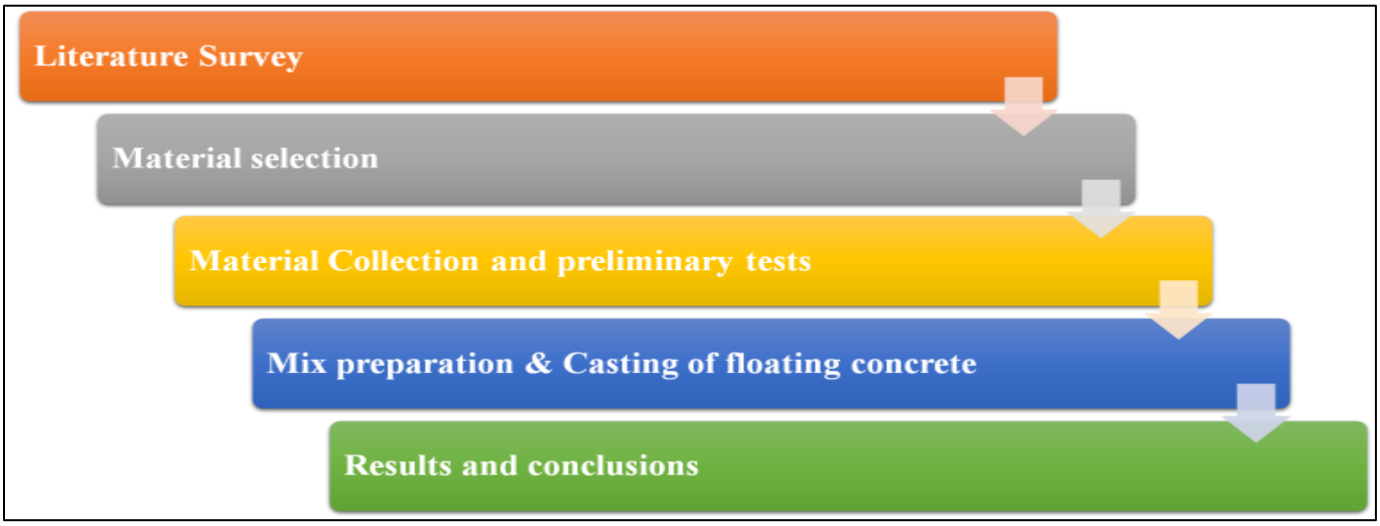

Fig 2: Methodology

V. PRELIMINARY TESTS ON MATERIALS

- **Cement:** The cement that was utilised in this experimental investigation is ordinary Portland Cement of 53 grade confirming to IS:12269 : 1987.
- **Fine Aggregate:** In the present investigations fine aggregate is natural sand obtained from near river is used.
- **Coarse Aggregate:** This expansion process also creates one of perlite's most distinguishing characteristics were shown in Table:1.

Table 1: Physical Characteristics of Perlite

Color	White
G.E. Luminosity %	70-79
Index of Refractivenes	1.44
Specific Gravity	2.2-2.4
Visible Density	40-170 KG/M3
Wet Density	80-320 kg/m3
pH	neutral
MOHS Hardness	5.4
Water Adsorption	240-570 % by weight
Oil Adsorption	60-90 grms oil/gms of perlite
Softening Point	1790 F or 970 ºC
Moisture %	< 1.0 %
Loss of Ignition (1700 F)	1.2% maximum

- **Water:** To mix concrete, potable tap water that complied with IS: 456 - 2000 standards and had a pH value of 7.0±1 was available in the lab.
- **Fly Ash:** The fly ash (Class F) used in this investigation was obtained from S.I.E.L. located at Muthukuru, SPSR Nellore, Andhra pradesh.

Preliminary tests are conducted for all the materials used for concrete composition. Physical tests were conducted on Cement of OPC 53 grade, Flyash according to IS 4031 (Part 5) – 1988. Fine aggregate and coarse aggregates (perlite) physical tests were conducted to exhibit their properties.

From the preliminary tests conducted to concrete composition fresh concrete property tests were conducted to know the workability of perlite and fly ash-infused concrete which will be used for Mix design of concrete of M25 quality

VI. FLOATING CONCRETE MIX DESIGN

Concrete mixes were designed for M25 with perlite aggregate to study the destructive tests at different w/c ratios. The w/c ratios of 0.30 were adopted. Fly ash (class F) content were varied as 0%, 5%, 10% and 15% by cement weight. The cementitious material was taken as 450 kg/m3 and Sand content was 650kg/m3. The quantity of perlite aggregate was calculated by allowing 2% air entrainment. All the materials are weighted as per mix proportion of 1:0.78:2.25. Concrete with perlite aggregate and different content of fly ash infused was studied at different ages, namely days 7, 14 and 28. Destructive tests were conducted to cube and cylindrical specimens to test achieve maximum strength value shown in Fig 3.

Fig 3: Destructive Tests of Floating concrete

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VII. RESULTS AND DISCUSSIONS

A. Results of Preliminary Tests for Floating Concrete Composition

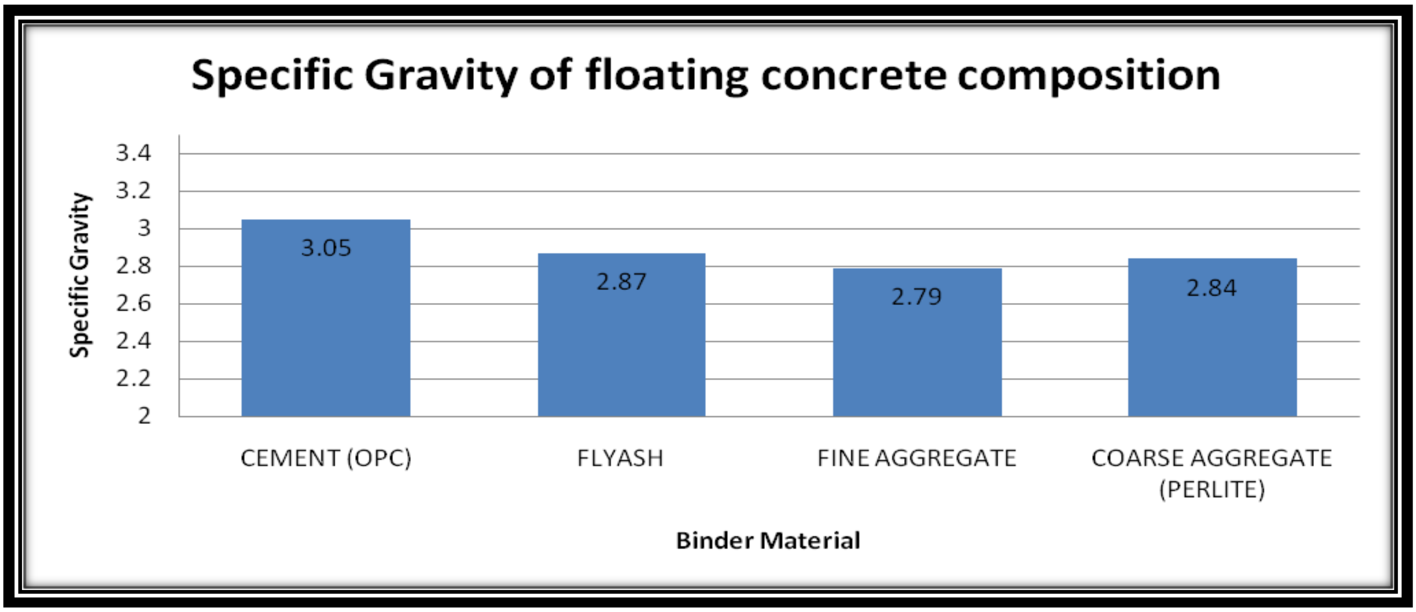

Fig 4: Specific Gravity Test of the Composition of Floating Concrete

Fig.4 displayed Specific gravity test carried out on cement, Flyash, Fine aggregate, coarse aggregate (perlite). Specific gravity test conducted for cement is similar to be tested for flyash with specific gravity bottle according to IS2720- Part3. The Specific gravity values of perlite exhibits higher compared to conventional coarse aggregate according to IS 2386 Part3 -1963.

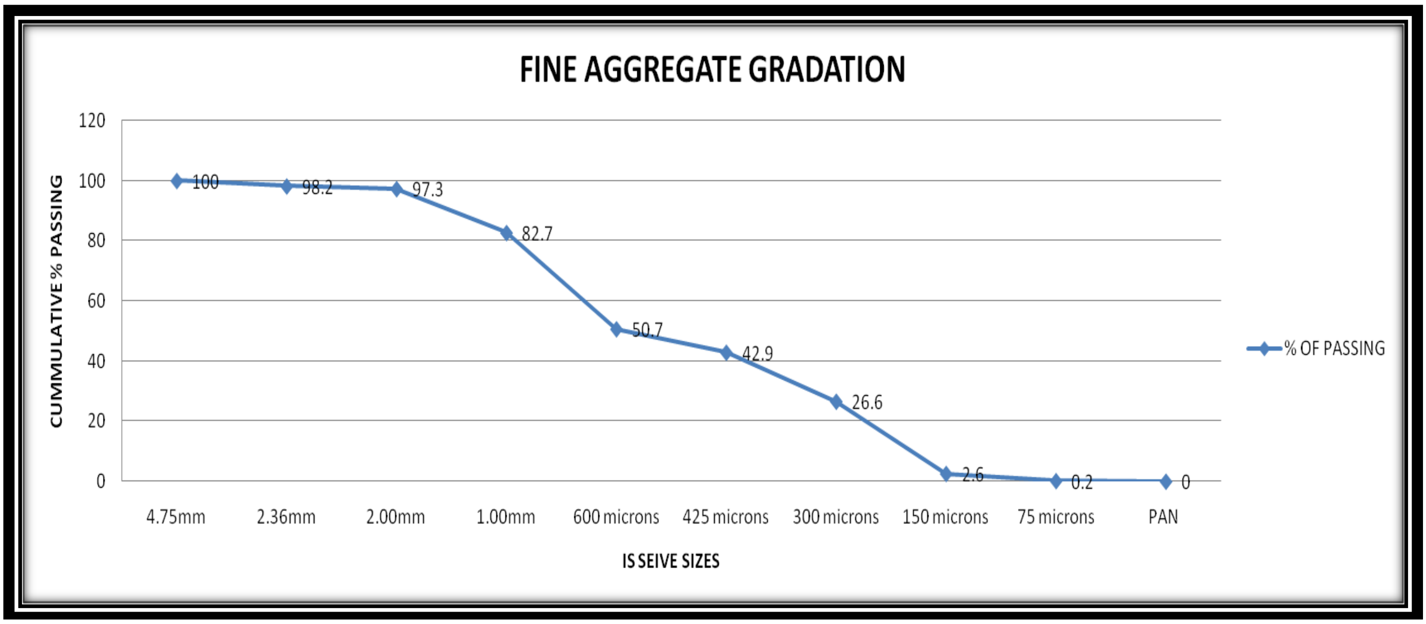

Fig 5: Gradation of Fine Aggregate

Fig 5 exhibits gradation of fine aggregate which passes standard sieves to designates the zone of fine aggregate which is employed in concrete mix design. From above graph gradation of fine aggregate utilised in this research falls under zone II.
zone-II.

B. Results of Fresh Concrete Properties

In our study Workability of concrete is tested for conventional concrete with partial replacing of fly ash in 5%, 10% and 15%,. From Table 2 we can conclude that high slump value is obtained by replacing 10% of flyash concrete with perlite aggregate.

Table 2: Fresh Concrete Properties

Binder	W/C Ratio	Slump (mm)	Compaction Factor	Vee-Bee (Sec)
OPC53Cement	0.35	90	0.86	8
(97.5% OC53)+ (P5% FA)		95	0.90	6
(95% OPC53)+ (10% FA)		98	0.92	6
(92.5% OPC53)+ (15% FA)		100	0.94	5

C. Results of Hardened Concrete Properties

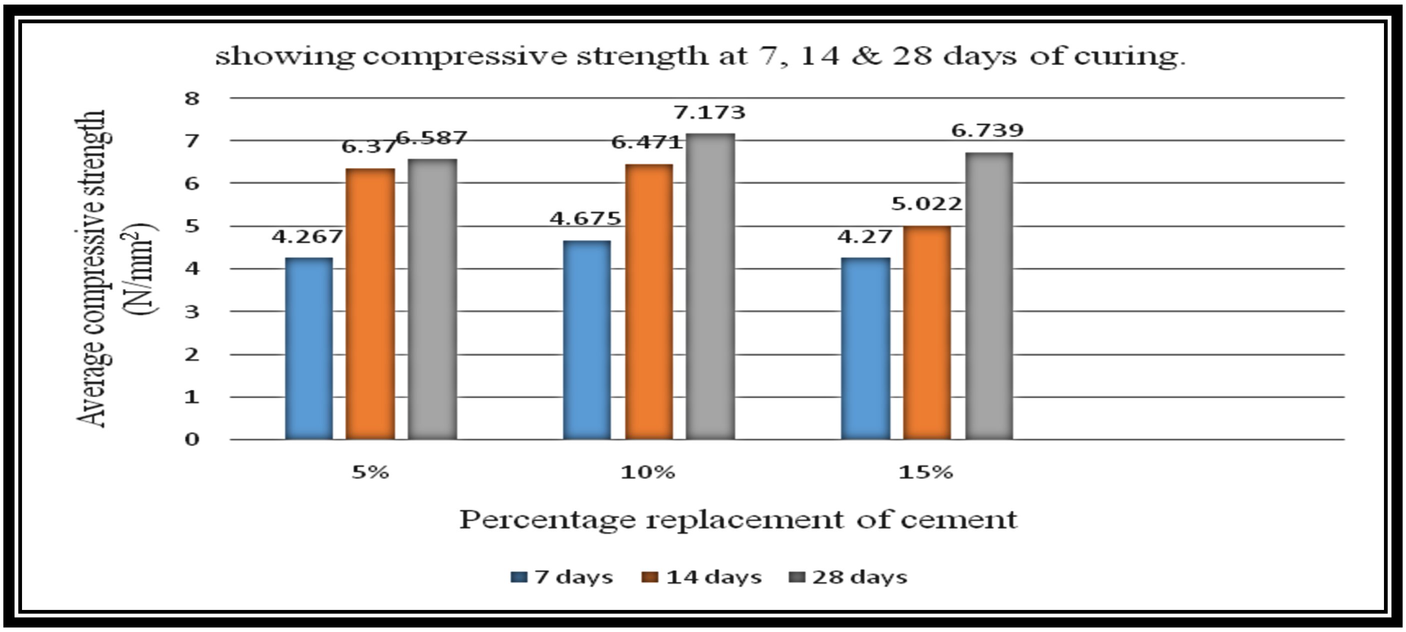

Fig 6: Concrete Mixes Compressive Strength of Days 7, 14 and 28

Hardened concrete property test were conducted by destructive Compressive strength testing and split tensile strength tests with age of days 7,14 and 28 of concrete mixes in replacing of Flyash 5%, 10%, and 15%. From Fig 6 &7 it is observed that 7, 14 & 28 days strength of concrete of M25 quality is achieves maximum strength in compression and tensile at 10% of Flyash replacement with perlite aggregate.

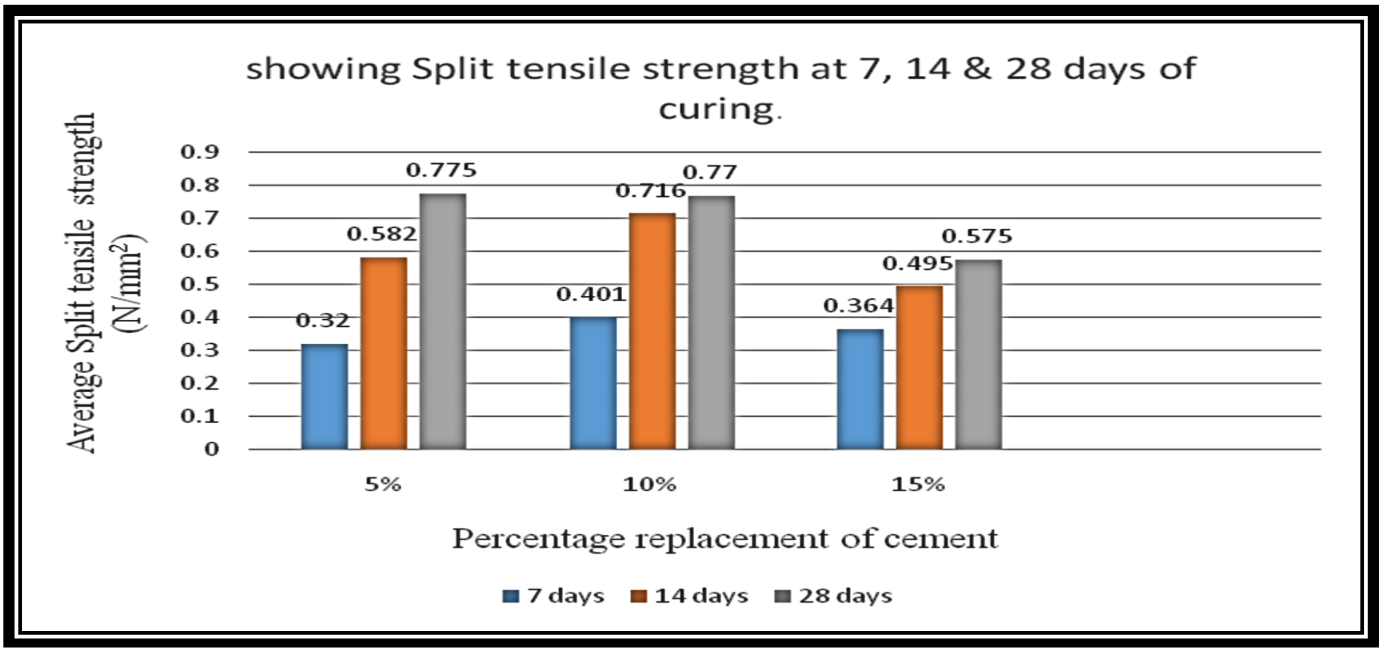

Fig 7: Concrete Mixes Split Tensile Strength of Days 7,14 and 28

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VIII. CONCLUSIONS

In conclusion, as the perlite content increases, perlite concrete's compressive strength will decline. As the amount of fine aggregate in perlite concrete increases, so will its compressive strength.

The maximum compressive strength value is achieved for the ratio 1:0.78:2.25 i.e. trial mix. Perlite is a lightweight volcanic rock that significantly reduces the overall density of concrete 1.273 kN/m3.

This translates to better buoyancy, making perlite concrete suitable for floating structures. Perlite concrete typically has lower compressive strength compared to standard concrete.This needs to be factored into the design of floating structures to ensure they can handleintended loads without compromising stability.

Due of perlite's high water absorption rate of 0.2% to 0.4%, the design of the concrete mix may need to be adjusted in order to preserve workability throughout construction. Particle sizes have a major impact on how much water a perlite particle can absorb.

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