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Characterization and performance evaluation of coconut shell concrete with alccofine supplements

ABSTRACT

The development of a country's infrastructure relies heavily on the use of cement concrete as the major building material. The aggregate represents a substantial amount of the total volume of concrete. However, the continuous exploitation of granite rock to obtain coarse aggregate adds to the growing demand for natural resources among future generations. The cement industry significantly contributes to global warming due to its substantial carbon dioxide (CO2) emissions. Reducing the consumption of cement in concrete, while maintaining its essential features, might lead to a more cost-effective and environmentally friendly advancement of the construction sector. This study explores the use of agricultural waste coconut shell as a replacement for traditional aggregate in concrete, resulting in the creation of lightweight coconut shell concrete. The alccofine- 1101 consists of ultrafine particles that have a unique composition, which improves the pozzolanic and hydration processes in concrete. Cement was supplemented with Alccofine substitutes, which varied in proportion from 5% to 15%. The findings indicated that substituting 10% of alccofine improved the workability and strength characteristics of the lightweight coconut shell concrete. Utilizing a blend of coconut shell and alccofine in concrete would represent the most ecologically conscientious choice within the construction sector.
Keywords: *Alccofine; Coconut shell aggregate; Eco-friendly; Sustainability; Water absorption*

1. INTRODUCTION

Concrete is well recognized as the predominant construction material in most parts of the world. Concrete is a widely utilized substance worldwide, second only to water [1]. The manufacturing process involves the extensive use of significant quantities of natural resources. Mehta and Monteiro [2] state that a significant amount of waste materials can be used as replacements for aggregate or binder in concrete. According to Alexander and Mindess [3], approximately 78% of the volume of concrete consists of aggregates. The use of natural coarse aggregates encounters substantial sustainability issues, leading to numerous ecological concerns [4]. Waste and by-product materials offer the most viable substitute for natural materials in order to achieve sustainable development in concrete production.

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Crushed coconut shell is a suitable material for producing concrete. Coconut shells are prevalent in numerous coconut-producing regions worldwide, such as India. According to the official data from the Indian Ministry of Agriculture and Farmer's Welfare, India produced a total of 20,736 million units of nuts in 2021 [5]. The incorporation of coconut shell as a replacement for coarse aggregate in concrete has numerous benefits, including the reduction of environmental impact and cost savings in production. Olanipekun et al. [6] have calculated that by replacing coarse aggregate with coconut shell in concrete, it is possible to achieve a cost reduction of 30%. The utilization of coconut shell reduces the dependence of concrete on natural resources. Moreover, the utilization and distribution of coconut shell waste in concrete offer clear benefits and simplicity. Therefore, it is a highly efficient and environmentally beneficial substance for constructing concrete. Basri et al. [7] state that when wood-based materials are added to a concrete matrix, their organic nature does not result in the production of harmful chemicals through contamination. The compatibility between coconut shell aggregate and cement composite has been discovered to be excellent, since it does not require any pretreatment and has minor inhibitory effects. According to Gunasekaran et al. [8], the durability characteristics of coconut shell concrete are similar to those of traditional lightweight concretes. Coconut shell, being a lightweight aggregate, lowers the density of concrete, resulting in a decrease in the dead load of the construction. The endurance of lightweight concretes is enhanced in adverse environments due to their decreased stiffness and the even dispersion of microcracks [9]. Utilizing coconut shell coarse aggregate enhances the sound absorption coefficient of lightweight concrete in comparison to regular-weight concrete [10].

Cement manufacture is a major contributor to environmental pollution due to the significant release of carbon dioxide into the atmosphere by cement production plants. Utilizing supplemental cementitious materials (SCMs) as a partial or full substitute for cement allows for a significant reduction in the usage of large amounts of cement during concrete manufacturing. Some examples of supplementary cementitious materials (SCMs) are fly ash, ground granulated blast furnace slag (GGBS), silica fume, pond ash, limestone particles, rice husk ash, and metakaolin.

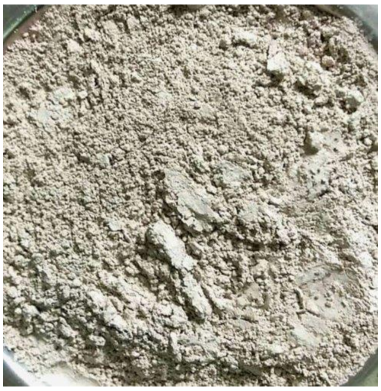
Alccofine-1101 is a microfine material made from low calcium silicate and is environmentally benign. It contains a significant amount of glass content and has a high reactivity. Alccofine-1101 is a refined substance derived from GGBS, which is the byproduct of the iron ore factories in India. Therefore, the production volume of alccofine is contingent upon the iron ore production in India, which is projected to reach 255 million tons in the fiscal year 2022/2023. India's top cement makers are also making the alccofine ingredient.Due to the customized particle size distribution, it provides unique characteristics that enhance the performance of concrete in both its fresh and hardened states. By partially substituting alccofine for cement in concrete, the consumption of cement is reduced, resulting in a decrease in CO_2 emissions associated with cement manufacturing. Due to the controlled granulation process, alccofine-1101 contains ultra-fine particles with a fineness of 12,000 cm^2/gm and a distinctive chemistry [11-14]. The use of alcofine-1101 in the production of concrete not only enhances the concrete's compressive strength but also its flowability and workability [15-20]. Alcofine-1101 material particles are significantly finer than those of cement, GGBS, silica, fly ash, etc. The incorporation of alccofine-1101, can therefore be used to fill the cavities that formed between the cement particles. Alccofine-1101 outperforms all other mineral admixtures due to the presence of CaO (lime). Because of its high glass content, the XRD pattern of alcofine-1101 is nearly amorphous [16].

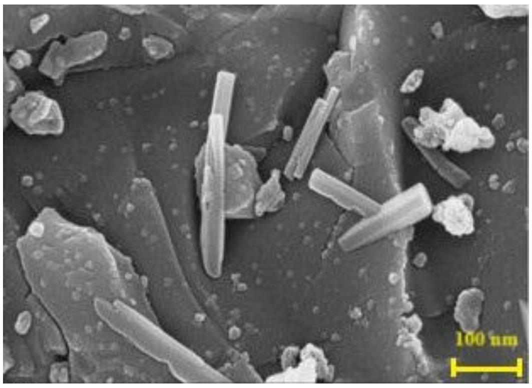
The present study aimed to examine the impact of alccofine, used as a substitute for cement, on the mechanical properties of lightweight concrete (LWC) produced using coconut shell aggregate. Specifically, the study focused on evaluating the effects on compressive strength, split tensile strength, flexural strength, elastic modulus, and impact resistance. There is a wealth of material available on the investigation of alccofine in standard concrete. However, there is a lack of comprehensive literature on the investigation of alccofine in coconut shell concrete. This study will examine the impact of alccofine, at weight percentages of 5%, 10%, and 15%, as a partial replacement for cement on the characteristics of coconut shell lightweight concrete.

2. EXPERIMENTAL PART

Conventional Portland cement (Grade 53), compatible with IS:12269-1987, with a specific surface area of 3,350 cm^2/g and a specific density of 3.13. The cement takes 65 minutes for the first setting and 140 minutes for the last setting. As an additional cementitious material, alccofine with a specific surface area and density of 12,500 cm2/g and 900 kg/m3 was used. Sand from the Cauvery River that complied with Zone II requirements was used as fine aggregate. The fineness modulus was 2.91 and the specific gravity was 2.36. The alccofine sample, and SEM image are depicted in Figures 1a, and 1b, respectively. Table 1 lists the chemical properties of cement and alccofine.

The coconut shell was obtained from a nearby copra processing yard. The CS sample was subjected to sieving after undergoing the processes of hammering and crushing, resulting in the formation of minuscule pieces. Coarse aggregates were used in the form of crushed CS samples, with particle sizes ranging from 12.5 to 4.75 mm. Subsequently, the pre-treated CS aggregate was washed with fresh water and let to dry in the sun. Due to their remarkable moisture retention capacity, CS aggregates need to be immersed in water for a duration of 24 hours. Prior to their use in concrete, the saturated CS aggregates were dried to eliminate any surface water, ensuring that they were in a saturated surface dry (SSD) state. When the CS aggregate is in a solid-state drive (SSD) condition, it does not absorb any more water from the concrete, thus ensuring that the workability of the concrete is unaffected.

 a)



b)

Figure 1. a) Alccofine sample b) SEM image

The piled CS waste in the copra preparation yard may be observed in Figure 2a. The garbage from computer science was gathered and crushed into aggregates (Fig. 2b). Table 2 and 3 provide a comprehensive summary of the physical and engineering properties of CS aggregate. The water-reducing additive Conplast SP430 was utilized, and the college's readily available bore well water was employed for the purpose of concrete mixing.

Table 1. Chemical properties of cement and alccofine

Chemical composition	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O	K_2O	LOI
Cement	21.10	4.65	3.5	64.9	1.1	2.8	0.35	0.73	0.72
Alccofine 1101	34.8	22.0	2.2	33.2	7.4	0.4	0.03	0.60	0.55

Table 2. CS aggregate-Physical properties

Physical Properties	Max. and min. size (mm)	Thick. (mm)	Water absorption (%)	Sp.gr.	Fineness modulus	Bulk density (g/cm^3)	Void ratio	Moisture content (%)
Values	12.5 and 4.75	4-7	22	1.2	6.3	0.67	0.61	3.5

Table 3. Engineering properties of CS aggregate

Mechanical Properties	Crushing value (%)	Abrasion value (%)	Impact value (%)
Values	2.6	2.1	7.2

 a)

 b)

Figure 2 (a) Waste Coconut shell, (b) Coconut shell aggregate

2.1. Concrete Mix Proportions

The experimental mixes were prepared following the guidelines specified in ACI 211.2-98. Consequently, the mixture that demonstrated greater performance was chosen for further examination in this study. Alccofine1101 was used as a replacement for cement in different amounts, specifically 10%, 20%, and 30% by weight. The combinations were labeled as CSA5, CSA10, and CSA15, respectively. The ratio of binder to water in all of the combinations was continuously maintained at 0.33. In order to achieve the appropriate level of workability in the concrete, a high-range water-reducing agent called Conplast SP430 was added at a dosage of 1.2% in relation to the weight of the binder. The concrete mix proportions for all the mixes created in this investigation are outlined in Table 4.The mixing method entailed the amalgamation of CS aggregate and M-sand in a rotary drum mixer for a duration of roughly three minutes. Afterwards, cement and alccofine were introduced and agitated for an extra six minutes. Afterwards, water and superplasticizer were added to the drum, and the mixing process continued for an additional 8 minutes. Afterwards, the mixture was placed into moulds and compressed. The specimens were extracted from the moulds after 24 hours and then underwent a procedure of water curing until the scheduled testing day.

Table 4. Mix proportions of various concrete mixes designed in this study

Mix ID	Alccofine (%)	Cement (kg/m3)	Fine aggregate (kg/m3)	Coconut Shell Aggregate	w/b	Super plasticizer % (by weight of cement)
CSA	0	500	750	332	0.35	1.0
CSA5	5	450	750	332	0.35	1.0
CSA10	10	400	750	332	0.35	1.0
CSA15	15	350	750	332	0.35	1.0

2.2. Testing methods

The slump test was performed in accordance with the ASTM C143/C143M-12 standard. The compressive strength of 100 mm cube specimens was measured according to the parameters provided in IS 456:2000. For the evaluation of split tensile strength and flexural strength, a total of three cylindrical specimens measuring 100 mm x 200 mm and three prismatic specimens measuring 100 mm x 100 mm x 500 mm were used. The specimens were cured for a period of 28 days. The experiment employed a compression testing apparatus with a maximum capacity of 2,000 kN and a loading rate of 2.3 kN/s. The concrete specimens were subjected to water absorption and sorptivity testing, in accordance with the requirements outlined in ASTM C1585.The Rapid Chloride Permeability Test (RCPT) was performed in accordance with the instructions outlined in ASTM C 1202.

3. RESULTS AND DISCUSSION

3.1. Slump

The quality of the concrete structure is determined by the workability of the fresh concrete during transportation, placement, and compaction, as well as the quality of its constituent materials. The lighter-weight particles separate from the denser cementitious matrix as a result of the substantial slump of lightweight concrete (LWC). Substandard compaction and inadequate finishing will be the consequences of this separation. In order to achieve a suitable level of finishing and compaction, the ACI 213R-87 standard restricts the slump of lightweight concrete (LWC) to a maximum of 100 mm [2]. According to [2], a decrease of 50-75% was considered enough for LWC to achieve effective compaction and finishing.

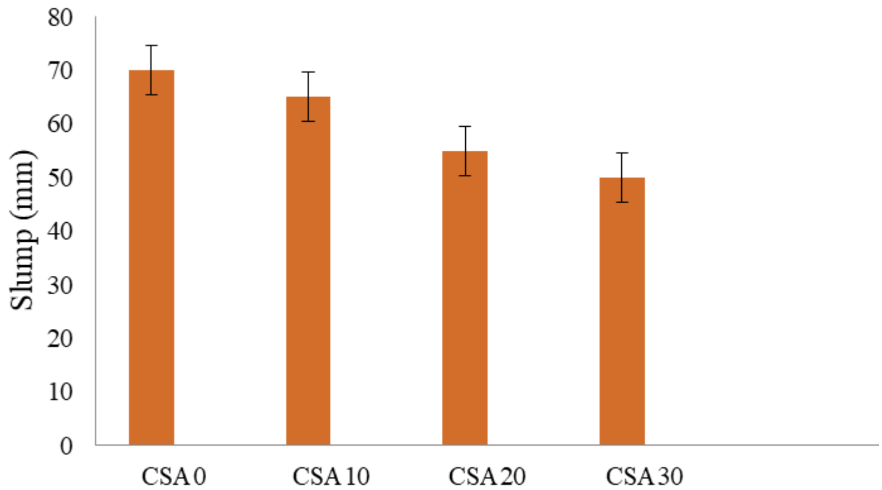


Figure 3. Influence of Alccofine content on slump of CS concrete

Hossain [17] argued that because to the significantly reduced labor performed by lightweight aggregate by gravity, a large slump was not required to achieve satisfactory finishing and compaction of lightweight concrete (LWC). Despite the fact that CS aggregate typically has a high water absorption rate, it was employed in the current investigation under saturated surface dry conditions, which prevented it from absorbing water during the mixing process. As a result, the mix's capacity to work may not be impacted. The amounts of water and superplasticizer in this study's mixes were kept constant. Fig. 3 demonstrates how lightweight concrete made from coconut shells was replaced by the slump of alccofine. The slump was reduced by 7%, 21%, and 28%, respectively, with the addition of 5%, 10%, and 15% alcofine. A higher alccofine content tends to absorb more water. This characteristic results from the alcofine's larger particle size, which has a greater surface area and can absorb more water.

3.2. Density

According to Newman and Choo [18], structural LWC has a density in the range of 1600–2000 kg/m^3. Notably, when the amount of alccofine increases, concrete density marginally increases. This increase in density is the result of alcofine particles being packed more tightly between cement particle spaces. All the mixes had densities below 2000 kg/m^3, which meet LWC's requirements for density. The density of the alccofine-replaced CS concrete is shown in Fig. 4. The addition of 10% alccofine was observed to result in a maximum 3% density increase. Alccofine does make light weight concrete made from coconut shells denser, but the difference is negligible, therefore the structure's overall weight will not be affected.

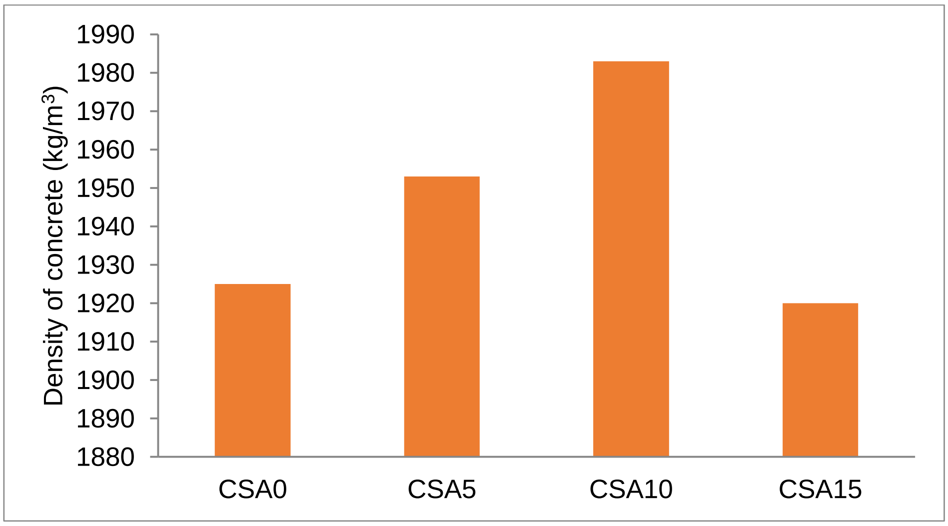


Figure 4. Influence of alccofine content on density of CS concrete

3.3. Compressive Strength

The compressive strength of concrete is a fundamental property that plays a crucial role in determining the structural integrity and durability of concrete structures. It is a measure of the concrete's ability to withstand axial loads or forces that tend to squeeze or crush the material. Sagar and Sivakumar [19] observed a maximal 17% improvement in compressive strength in conventional concrete. Pawar and Saoji [14] discovered that SCC containing 10% alccofine-1101 had superior workability and compressive strength. Kavitha and Felix Kala [20] discovered that replacing cement with 10% alccofine-1101 and 30% GGBS results in the highest compressive and split tensile strengths for SCC, compared to the other replacement levels of alccofine-1101. Kavyateja et al. [21] determined that a proportion of 25% fly ash and 10% alccofine-1101 is optimal for partially replacing cement in SCC with superior tensile properties. Table 4 displays the compressive strength values at 28 for various CS concrete mixtures. In this study, the addition of alccofine increased compressive strength by up to 10%, after which it decreased. Among the various alccofine addition percentages, the mixture containing 10% alccofine had the highest compressive strength. At 28 days, the compressive strength increased by 20% compared to the control CS concrete mix. The result is comparable with that of compressive strength improvement in conventional concrete found by past researchers. With the incorporation of ultra-fine particles of alccofine-1101, the particle density of the binder mass has increased, resulting in the concrete's gain of high strength. The addition of lime (CaO) enhances and facilitates the formation of secondary hydrated C-S-H gel products, leading to increased early-age strength development and reduced heat generation throughout the hydration process. The observed reduction in compressive strength in concrete mixes containing 15% alccofine can be attributed to the instability of the binder caused by an increase in the presence of free lime (CaO), alumina (Al_2O_3), and magnesia (MgO). These compounds, when hydrated, result in excessive expansion and the formation of micro-cracks within the concrete. Consequently, the concrete exhibits diminished resistance to compressive loads.

Table 4. Compressive strength alccofine supplemented CS concrete

Mix ID	Compressive strength,(MPa)
CSA0	30.8
CSA5	33.3
CSA10	36.9
CSA15	30.2

3.4. Split tensile strength

The property of tensile strength holds significant importance in the context of concrete, primarily because concrete elements are prone to cracking when subjected to tensile loads, such as the weight of the structure itself. Overall, lightweight concrete (LWC) exhibits a low level of tensile strength. Hence, the incorporation of supplementary cementitious materials (SCM) presents a viable approach to address the inherent weakness in the strength characteristics of concrete including crushed sand (CS), specifically in terms of split tensile strength, while ensuring that the density limit for lightweight concrete (LWC) is not surpassed. Sagar and Sivakumar [19] observed a maximal 22% improvement in split tensile strength in conventional concrete. In their study, Kavitha and Felix Kala [20] observed that the incorporation of 10% alccofine-1101 and 30% GGBS as substitutes for cement yielded the highest split tensile strengths in self-compacting concrete (SCC) when compared to alternative degrees of alccofine-1101 replacement. The mechanical properties of self-compacting concrete (SCC) were investigated by Kavyateja et al. [21]. This investigation focused on the effects of partially replacing cement with blends of fly ash and alccofine-1101. The specimens, which consisted of 25% fly ash and 10% alccofine-1101, demonstrated the highest split tensile strengths.

Table 5 presents the split tensile strength values of CS concrete reinforced with sisal fibres. In a general context, the incorporation of alccofine resulted in an improvement in the split tensile strength of calcium silicate (CS) concrete. At the 28-day mark, the CSA10 mixture exhibited a maximum increase of 12% in split tensile strength, reaching a value of 3.46 MPa. This increase equates to about 9.8% of the compressive strength of the equivalent mixture. The result is comparable with that of split tensile strength improvement in conventional concrete found by past researchers. As per the specifications outlined in ASTM C330, the utilization of lightweight concrete (LWC) in structural applications necessitates a minimum split tensile strength of 2.0 MPa. Hence, it is plausible to utilize all combinations of experimental mixtures as structural lightweight concrete (LWC).

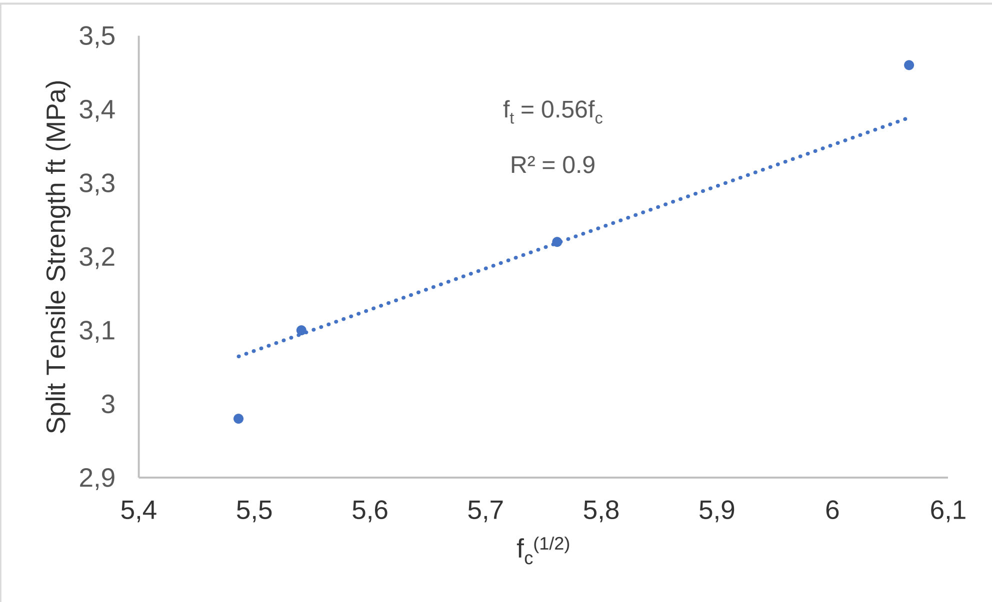


Figure 5. Correlation between compressive strength and Split tensile strength of sisal fibre-reinforced CS concrete

This work aimed to demonstrate empirical relationships between split tensile strength and compressive strength by the utilization of regression analysis, as depicted in Figure 5. The correlation between split tensile strength and compressive strength can be established by regression analysis, utilizing equation (1).

$$f_t = 0.5586\sqrt{f_c} \quad (1)$$

Figure 6 presents a comparison between the experimental and theoretical outcomes according to the split tensile strength. Evidently, the experimental findings closely align with the anticipated theoretical outcomes derived from Equation 3.

Table 5. Split tensile strengthof sisal fibre-reinforced CS concrete

Mixture ID	Split tensile strength (MPa)
CSC	3.12
CSA5	3.24
CSA10	3.48
CSC15	2.99

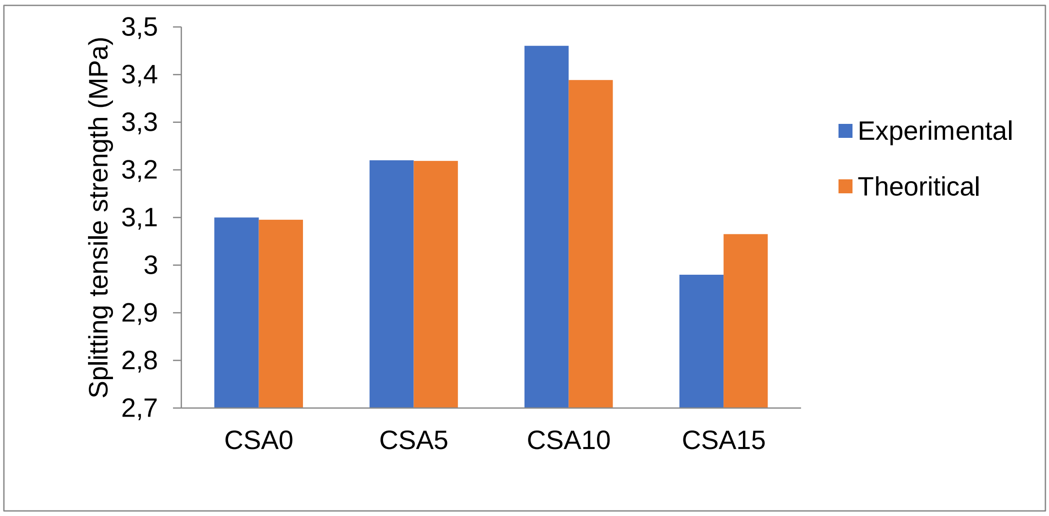


Figure 6. Experimental and theoretical split tensile strengthof sisal fibre-reinforced CS concrete

3.5. Flexural strength

Table 6 presents the data pertaining to the flexural strength of CS concrete. The flexural strength of the control concrete specimen was measured to be 4.95 MPa, which corresponds to approximately 14.5 percent of its compressive strength. During this study, it was seen that the incorporation of alccofine into CS LWC resulted in a notable enhancement in the flexural strength of the concrete. In a study conducted by Khating et al. [21], it was observed that the incorporation of 15% alccofine into steel fibre-reinforced self-compacting concrete (SCC) resulted in a notable enhancement in flexural strength. In a study conducted by Sanjeev Kumar et al. [22], it was observed that the use of alccofine in lightweight concrete led to a substantial enhancement in its flexural strength. In their study, Reddy and Ramadoss [23] employed a proportion of 8% alccofine in the composition of high performance concrete. Their findings revealed a significant improvement in the flexural strength of the material.

The present study demonstrates that the incorporation of alccofine into CS concrete resulted in a notable improvement in its flexural strength, with enhancements of up to 20% seen. The incorporation of alccofine at concentrations of 5% and 10% resulted in respective enhancements of 8% and 18% in the flexural strength of CS concrete. Nevertheless, the incorporation of a 15% alccofine admixture resulted in a marginal decrease in the flexural strength of the calcium silicate (CS) concrete.

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$$f_r = 0.514 f_c^{2/3} \qquad (2)$$

Table 6. Flexural strength

Mixture ID	Flexural strength (MPa)
CSA0	4.97
CSA5	5.33
CSA10	5.86
CSA15	4.93

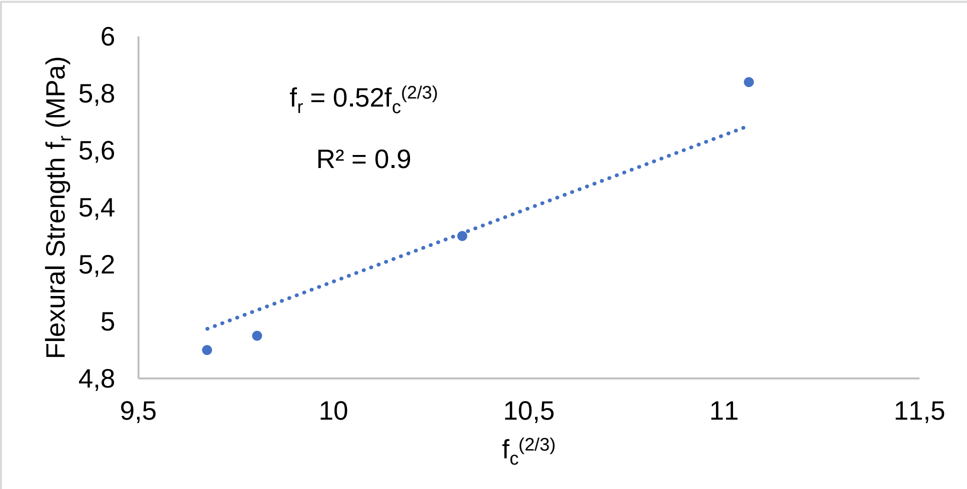

Figure 7. Correlation between compressive strength and flexural strengthof sisal fibre-reinforced CS concrete

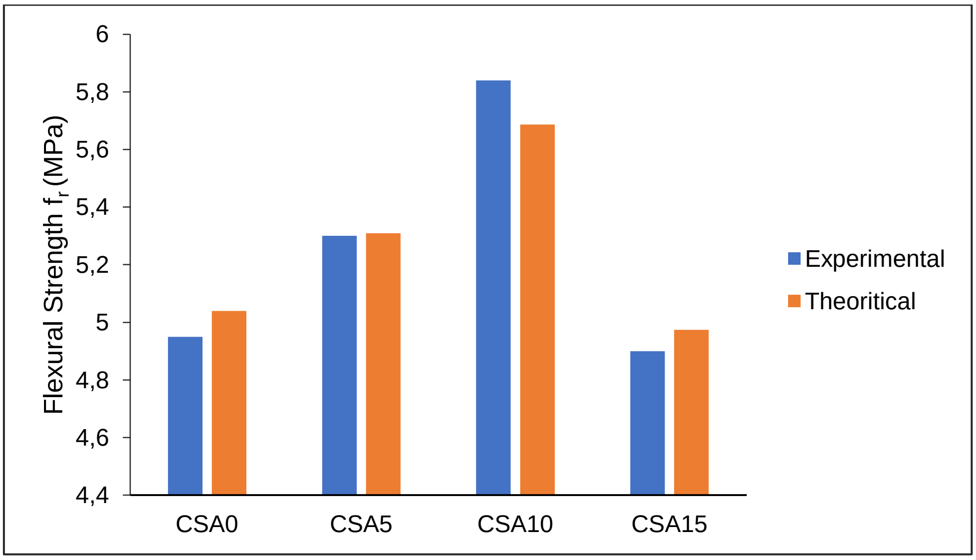

Figure 8 Experimental and theoretical flexural strengthof sisal fibre-reinforced CS concrete

3.6. Water absorption

The determination of concrete's durability can be achieved by the analysis of its absorption characteristic. The phenomenon under considera-tion can be characterized as the movement of fluids within permeable substances as a result of the capillary action exerted by surface tension [24]. The open pore volume of specimens can be determined by measuring their absorption in water [25]. Studies proved that, the addition of alccofine in concrete reduced water absorption and thus increased to durability [26]. Vivek et al [27] found that the alccofine admixed fibre reinforced SCC mix has less water absorption that the control concrete. Figure 9 illustrates the water absorption characteristics of all the mixtures. In the control mixture, the water absorption rate was determined to be 10.7% after 28 days. This rate decreased to 8.3%, 7.2%, and 5.7% when fly ash was used as a replacement for 5%, 10%, and 15% of the mixture, respectively. This outcome could potentially be attributed to the total evaporation of water from the CS aggregate, which was retained by CS during the process of concrete immersion. Subsequently, it was shown that the water absorption of mixtures containing alccofine was lower than that of the control mixture. The water absorption of the mixture increased when a smaller quantity of alccofine was added, and conversely, decreased when a larger quantity of alccofine was added. The inclusion of alccofine in the concrete resulted in a reduction in pore size, owing to its fine particle size. The relationship between alccofine and water absorption is inversely proportional, resulting in a decrease in the available area for water storage within the specimen.

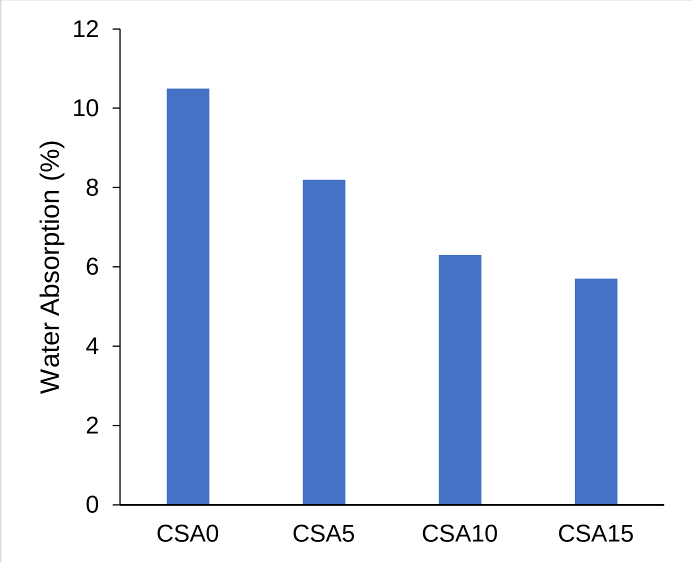

Figure 9. Water absorption

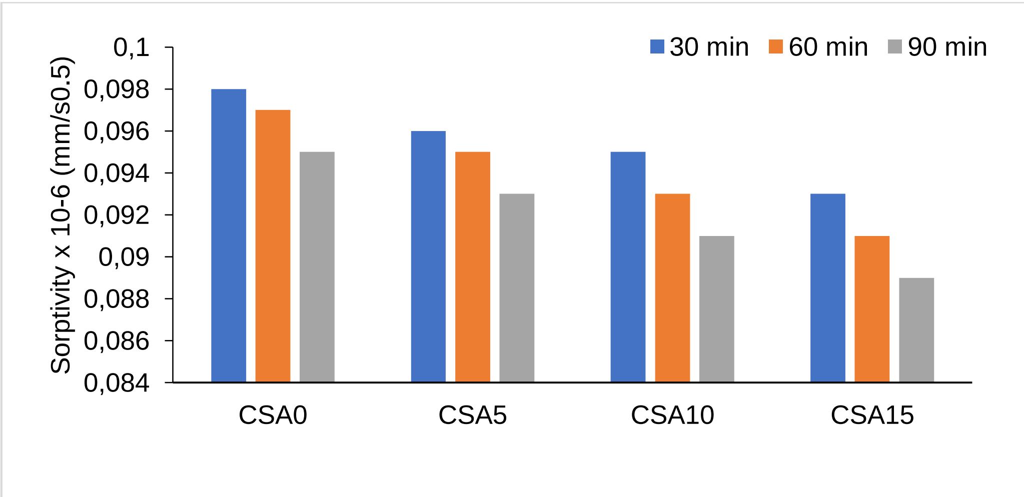

Figure 10. Sorptivity

3.7. Sorptivity

The measurement of sorptivity offers valuable insights into the permeability characteristics of concrete [25]. Low sorptivity levels are indicative of a high level of resistance to the absorption of water. In general, concrete is deemed to possess a high grade if its sorptivity value falls below 0.1 mm/min0.5 [8]. Researchers found that, the alccofine in concrete decrease the sorptivity coefficient and thus increased to durability [26]. It was found that the alccofine admixed fibre reinforced SCC mix has less sorptivity value that the control concrete [27]. Figure 10 displays the sorptivity values of concrete mix including alccofine with the addition of CS. The sorptivity of the CSA0 mixture at the age of 28 days was measured to be in the range of 0.095 to 0.098 mm/min^0.5. The inclusion of alccofine resulted in a further decrease in these values. This can be attributed to the high specific surface area of alccofine, which is a result of its fine particle size. The presence of alccofine lowered the transition zone between the aggregates. The sorptivity values for the alccofine replacement at 15% were determined to be within the range of 0.089-0.093mm/min0.5, indicating the lowest levels of sorptivity. The sorptivity values observed in this study are consistent with previous research conducted on various types of lightweight concretes, such as sintered pulverized fuel ash and expanded shale. These materials have been found to exhibit sorptivity values of 0.06 mm/min0.5 and 0.03 mm/min0.5, respectively.

3.8. Rapid chloride penetrability test (RCPT)

Chloride ingress is a significant environmental threat to concrete, causing the corrosion of rebar and leading to a reduction in the structural capacity and serviceability of the structural element. The aforementioned outcome has the potential to lead to premature degradation and necessitate structural member repair. The primary method employed to mitigate rebar corrosion involves the prevention of chloride infiltration into the concrete, or at the very least, limiting its penetration to the vicinity of the steel reinforcement. This method can be realized by the construction of a concrete structure that exhibits a relatively high level of impermeability. Determining the extent of chloride penetration into concrete is essential for both quality control and design purposes. Nevertheless, the direct determination of chloride penetrability within a specific time range is not feasible. Therefore, it is imperative to develop a methodology that expedites the assessment of chloride penetration, enabling the determination of diffusion coefficients within a feasible timeframe. Figure 11 displays the results of the Rapid Chloride Penetration Test (RCPT) conducted on concrete mixtures with varying levels of alccofine substitution. The CSA0's RCPT value was measured to be 793.7 at the age of 28 days. In addition, the concrete mixes containing various amounts of CS (i.e. CSA5, CSA10, and CSA15) exhibited a drop in the charge passed, which was further lowered as the alccofine concentration increased. The observed outcome can be attributed to the alkali binding properties and reduced permeability of voids in concrete that has been integrated with alccofine. According to the literature, it has been observed that the values of RCPT (Rapid Chloride Penetration Test) for expanded clay lightweight aggregate concrete range from 2115 to 3336 coulombs [28]. Patankar and Sandeep [29] revealed that the 10 % alccofine supplements in conventional concrete decreased the chloride penetration upto 285 coulumbs. The result obtained from this study agreed with that of conventional concrete studied by past researchers.

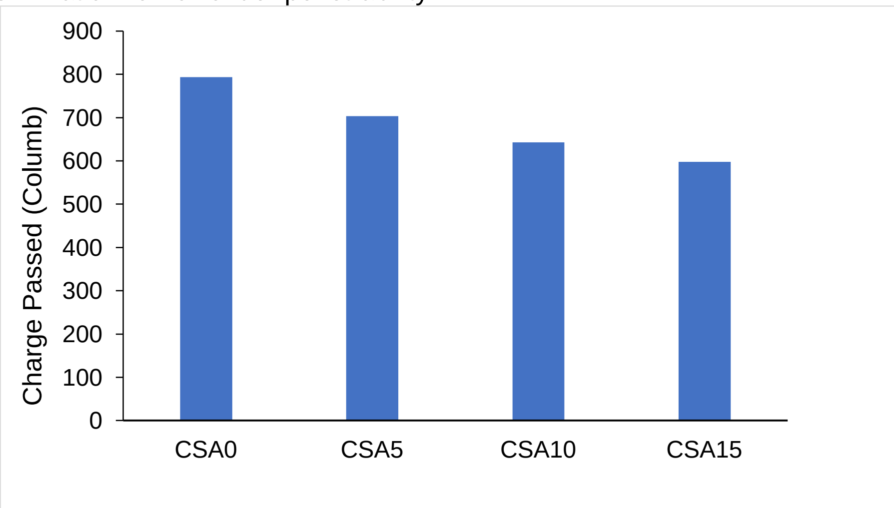

Figure 11. Charge passed

4. CONCLUSION

A structural lightweight concrete was produced by incorporating coconut shell, an agricultural waste, as a partial replacement for cement, along with the addition of alccofine. The addition of alccofine significantly improved the strength and durability attributes of concrete, while also reducing the amount of cement used. As a result, the use of alccofine in concrete manufacturing promotes eco-friendliness. The investigation yielded the following specific conclusions.

(i)Increasing content of alccofine results in linear decreasing trend on slump. The density have not been shown a significant changes

(ii) The enhancement of hardened concrete properties is observed with the increase in alccofine content. The specimen that incorporated 10% alccofine replacement exhibited the highest values for mechanical properties.

(iii) Incorporating fly ash into the CS concrete mixes led to a substantial decrease in water absorption. The decrease in concrete pores can be due to the presence of fine particles of fly ash, which leads to an enhanced generation of hydration products.

(iv) The use of alccofine in the CS concrete resulted in reduced chloride permeability

(v) The sorptivity of CS concrete was decreased by using fly ash, resulting in an improvement in the interfacial transition zone between the low-strength aggregate and CS lightweight concrete.

The findings suggest that incorporating coconut shell, an agricultural byproduct, as coarse aggregate, in combination with alccofine, a supplementary cementitious material (SCM), as a partial replacement for cement, is a feasible method for producing cost-effective and environmentally sustainable concrete. Moreover, this specific blend of concrete has the capability to be used in structural purposes.

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IZVOD

KARAKTERIZACIJA I PROCENA PERFORMANSI BETONA OD KOKOSOVE LJUSKE SA DODACIMA ALKOFINA

Razvoj infrastrukture jedne zemlje u velikoj meri se oslanja na upotrebu cementnog betona kao glavnog građevinskog materijala. Agregat predstavlja znatnu količinu ukupne zapremine betona. Međutim, kontinuirana eksploatacija granitnih stena za dobijanje krupnog agregata doprinosi rastućoj potražnji za prirodnim resursima među budućim generacijama. Industrija cementa značajno doprinosi globalnom zagrevanju zbog značajne emisije ugljen-dioksida (CO_2). Smanjenje potrošnje cementa u betonu, uz zadržavanje njegovih osnovnih karakteristika, moglo bi dovesti do isplativijeg i ekološki prihvatljivijeg napretka građevinskog sektora. Ova studija istražuje upotrebu otpadne kokosove ljuske iz poljoprivrede kao zamene za tradicionalni agregat u betonu, što rezultira stvaranjem laganog betona od kokosove ljuske. Alkofin-1101 se sastoji od ultrafinih čestica jedinstvenog sastava, koji poboljšava pucolanske i hidratacione procese u betonu. Cement je dopunjen zamenama Alkofina, koje su varirale u proporcijama od 5% do 15%. Nalazi su pokazali da je zamena 10% alkofina poboljšala obradivost i karakteristike čvrstoće laganog betona od kokosove ljuske. Korišćenje mešavine kokosove ljuske i alkofina u betonu predstavljalo bi ekološki najsavesniji izbor u građevinskom sektoru.

Ključne reči: *Alccofin, Agregat kokosove ljuske, ekologija, održivost, upijanje vode*

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