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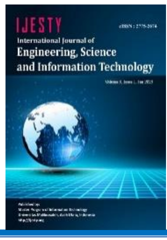

Influence of Groundnut Shell Powder on Normal Concrete's Split Tensile Strength

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Abstract

Groundnut shell powder contains significant amounts of the chemical silica (SiO) to be utilized as construction materials. Through the use of groundnut shell powder, this study seeks to determine the split tensile strength of concrete (GSP). With a compressive strength design of f'c =21.7 MPa, the concrete mixture adheres to ACI 2I1.1-91. The aggregate of crushed stone with a maximum diameter of 19.1 mm. Portland cement type I is the type of cement utilized. With a variation of 0%, 5%, 7,5%, 10%, and 12.5%, additional material (GSP) substitutes cement in part. At 14 and 28 days old, concrete is tested for its tensile strength. For each modification, there are three cylindrical test objects, each measuring 30 cm in length and 15 cm in diameter. The split tensile strength of concrete was tested using 14-day-old peanut shell powder, and the results were 1,699 MPa, 1,840 MPa, 1,581 MPa, and 1,510 MPa, respectively. The findings demonstrated that concrete's split tensile strength (f'ct) was 28 days with a fluctuation of 0%; 5%; 7,5%; 10%; and the sequential 12.5% was 1,934; 2,170; 2.265; 1,958; and 1,887 Mpa. Following the findings, the ideal tensile strength value was at a variation of 7.5%, or 2,265 MPa, greater than 0% (1,934 MPa) of 17.11%. The age of 28 days was 7.5% higher than the age of 14 days (1,840 MPa) of 23.10% for the variation's maximum tensile strength. Compared to standard compressive strength test findings, the Split tensile strength value of concrete utilizing GSP is 6.83%.

Keywords: Groundnut shell powder; normal concrete; split tensile strength.

1. Introduction

Concrete is among the most widely used building materials worldwide. Cement manufacture, which is a necessary component of concrete, is a large contributor to greenhouse gas emissions. Researchers have been examining the use of supplemental cementitious materials (SCMs) recently as a way to lessen the negative effects of concrete manufacturing on the environment while simultaneously enhancing its performance. Groundnut shell powder (GSP), a byproduct of the groundnut industry, is one possible SCM that has attracted interest. [1][2][3].

Groundnut shell powder is obtained from grinding the shells of groundnuts, also known as peanuts. GSP is rich in silica and has been shown to have pozzolanic properties, which indicates that it can react to create new cementing compounds when combined with the calcium hydroxide created during the hydration of cement. GSP has been investigated as a partial replacement for cement in concrete, with research showing that it can improve the properties of concrete, such as increasing its compressive strength and decreasing its permeability. Additionally, GSP is abundant and widely available, making it a potentially cost-effective and sustainable alternative to traditional cement [4][5] [6].

A relatively novel material, split-strength concrete with a groundnut shell, has been the focus of current building research. According to studies, adding groundnut shell ash to concrete can greatly boost the material's strength and durability. All three papers found that groundnut shell ash can be used as a cement substitution material to increase the compressive strength of concrete. When used as a cement replacement, groundnut shell ash drastically increases the compressive strength of concrete. [7][8][9].

In this study, the impact of using groundnut shell powder as a partial cement substitute on the tensile strength of concrete is investigated in order to determine the optimal amount of groundnut shell powder to use to enhance concrete's split tensile strength. Groundnut shells will be used as a partial substitute to prepare concrete samples, which will then have their split tensile strength tested. The results will be studied to determine how utilizing groundnut shell powder affected the concrete's split tensile strength and compare the usage of groundnut shell powder with traditional concrete in terms of split tensile strength [10].

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2. Literature Review

This literature review explains some material definitions and concepts, the existing research development, and the research's novelty.

2.1. Definition Concrete

These papers suggest that the concrete ingredients are cement, water, fine aggregate, and coarse aggregate. Neville found that water is an essential ingredient in concrete manufacture, but there is a lack of research data and standards on the properties of water for making concrete [11]. According to Farzadnia, there are four primary components of concrete: cement, water, fine aggregate, and coarse aggregate. [12]. Jonkers found that modern concrete is based on Portland cement, a hydraulic cement made from calcium, silicon, aluminum, and iron[13]. Nagrockienė 2017 found that adding mineral additives up to 10% increases the compressive strength of concrete[13].

2.2. Groundnut Shells For Construction

Chemical components found in groundnut shell powder include sulfite (SO_3) 6.3%, aluminum oxide (Al_2O_3) 6%, potassium oxide (K_2O), magnesium oxide (MgO), sodium oxide (Na_2O), and silica (SiO)), sodium oxide (Na_2O) 16.3%. As a result, peanut shells can be utilized as a partial replacement for traditional research materials and as a building material for concrete construction. Because of its silica content [14], it is thought that peanut shells may someday be used as a substitute for cement in some areas.

These papers suggest that groundnut shells can be used in construction. Groundnut shells can be utilized in light concrete panels as a partial or full substitute for fine aggregate, according to Kimeng 2015. [15]. Groundnut shells can be utilized in place of fine aggregate at different degrees, according to Sada 2013. [16]. Duc 2019 found that groundnut shells can be modified into various bio-products, which can be used in construction. These papers suggest that groundnut shells can be used in construction [17].

2.3. Previous Research On Split Tensile Strength Of Concrete Using Groundnut Shells

The Split tensile strength of concrete is important in resisting cracking due to changes in water content, temperature and loading. The bond Among the cement paste and coarse aggregate strongly influences the tensile strength of concrete. Tensile strength properties are affected by the quality of the concrete. Every effort to improve the quality of concrete for compressive strength is only accompanied by a small increase in its tensile strength. In the SI (International Unit) the association between tensile strength and compressive strength (f'c) is determined to be $0.5\sqrt{f'c}$ - $0.6\sqrt{f'c}$ [18]

These papers have mixed findings on the split tensile strength of concrete using groundnut shells. Two of these papers suggest that groundnut shells may increase the split tensile strength of concrete: Concrete's compressive and tensile strengths are increased by groundnut shell ash (GSA), according to Samsunan 2021 [8], and Raheem 2013 found that concrete modified with groundnut shell ash (GSA) had increased compressive and tensile strengths [9]. However, Kimeng 2015 found that groundnut shell replacements in concrete panels had decreased compressive strengths [15], and Prithy 2020 found that concrete with groundnut shell as a fine aggregate had decreased compressive strengths [19]. Overall, these papers suggest that groundnut shell is not suitable for concrete production. Kimeng 2015 and Prithy 2020 found that groundnut shell replacements in concrete panels had decreased compressive strengths, suggesting that groundnut shell is not suitable for concrete production [19][15]. Groundnut shell ash (GSA) has been found by Samsunan 2021 and Raheem 2013 to boost the compressive and tensile strengths of concrete, indicating that it may be a potential material for the manufacture of concrete. [8][9] [20].

3. Methods

This research with the preparation of the materials, the setup of the equipment, the processing of the peanut shells, the analysis of the physical properties of the aggregates, the design of the concrete mix, the mixing of the concrete, the testing of fresh concrete (slump test), the creation of test objects, their maintenance, and their testing.

3.1. Research Location

The Civil Engineering Laboratory at Teuku Umar University researched and tested test objects. Coarse aggregate (gravel) was obtained from the Wira Tako stone processing factory, Nagan Raya Regency, and fine aggregate (sand) was obtained from Krueng Meureuebo, Meureuebo District, West Aceh Regency. Groundnut Shells was obtained from a peanut shelling factory in Singo Sari Village, Pante Ceureumen District, West Aceh Regency. The water used for mixing concrete and its treatment comes from clean water.

3.2. Material

The compresive concrete strength used was 21.7 MPa with a cement water factor (FAS) of 0.56. The following table 1. shows the ingredients in groundnut shell powder:

Table 1. Composition of groundnut shell powder

No	Ingredient	Percentages (%)
1	Iron oxide (FeO_2)	0,07
2	Aluminum oxide (Al_2O_3)	1.67
3	Magnesium oxide (MgO)	0.18
4	Calsium oxide (CaO)	6.23
5	Sodium oxide (Na_2O)	0.18
6	Silica (SiO_2)	0.87
7	Potassium oxide (K_2O)	0.92

The mix design used can be seen in the table below:

Table 2. Mix Design Concrete

No	Material	The amount of material used (Kg)				
		Percentages (%) GSP				
		0%	**5%**	**7.5%**	**10%**	**12.5%**
1	Cement (Kg)	362,889	359,260	357,446	355,631	353,817
2	Groundnut Shell Powder (GSP) (Kg)	0,000	3,629	5,443	7,258	9,072
3	Water (L)	167,896	167,896	167,896	167,896	167,896
4	Fine aggregate (Kg)	602,362	602,362	602,362	602,362	602,362
5	Coarse aggregate (Kg)	1212,253	1212,253	1212,253	1212,253	1212,253
Total		2345,401	2345,401	2345,401	2345,401	2345,401

3.2. Research Procedure

The preparation and acquisition of materials, processing of peanut shells, assessment of the equipment used, designing the concrete mix design, work on the concrete mix, creation of specimens, curing of concrete, and testing of specimens are all stages of this study technique. Groundnut Shell Powder are processed by cleaning from other waste, drying to make it easier when grinding, and then filtered with a no.200 pass sieve. Examination of the physical properties of aggregates includes Specific Gravity and Absorption, Bulk Density, and Sieve Analysis. The planning of the concrete mixture used is concrete with a quality of 21.7 Mpa, the shape of the cylindrical test object is 15/30 cm, the cement water factor is 0.56, with a slump value of 75-100 mm, and the coarse aggregate used has a maximum diameter of 19.1 mm. The percentage of Groundnut shell powder used is 2.5%, 5%, 7.5%, 10%, and 12.5%. Table 1 below shows how many design elements there are:

Table 1. Design of the test object

concrete age (day)	Percentage of Groundnut Shell powder					Total
	0%	5%	7,5%	10%	12,5%	
14	3	3	3	3	3	15
28	3	3	3	3	3	15
Total	6	6	6	6	6	30

The test object testing is carried out with a procedure following the concrete tensile strength testing standards with a tool setting plan as shown below:

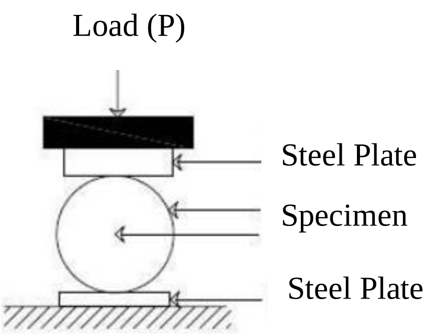

Fig 1. experimental setting

Fig 2. experimental testing

4. Results and Discussion

The following steps would typically be involved in the procedure for the research on the impact of groundnut shell powder (GSP) on the split tensile strength of concrete; Sample preparation: Groundnut shell powder would be collected and processed to a desired particle size. The concrete samples would be prepared by replacing a certain percentage of fine aggregate (sand) with the groundnut shell powder. Mixing: The cement, coarse aggregate, GSP and water would be mixed together in a concrete mixer to produce a homogeneous mixture. Casting: The mixed concrete would be cast into cylindrical or cubic moulds of a standard size. Curing: The concrete samples would be cured in a controlled environment for a specific period of time, typically 7 or 28 days. Testing: The split tensile strength of the concrete samples would be determined by using a universal testing machine. Data analysis: The data collected from the test would be analyzed to determine the effect of GSP on the split tensile strength of concrete.
According to test results on 14-day-old concrete, ground peanut shell powder usage impacted the concrete's tensile strength, which was reduced as the amount of ground powder increased. This resulted in less concrete splitting under tension. The tensile strength of the 14-day-old optimum is 1,840 MPa at 7.5%, whereas 1,510 MPa was attained at 12.5%. The split's tensile strength increased most at age 28 days when it changed by 7.5% of 2,265 MPa, and least when it changed by 12.5% of 1,887 MPa. The results of comparing the split tensile strength of concrete at ages 14 and 28 days are shown in Figure 2 below:

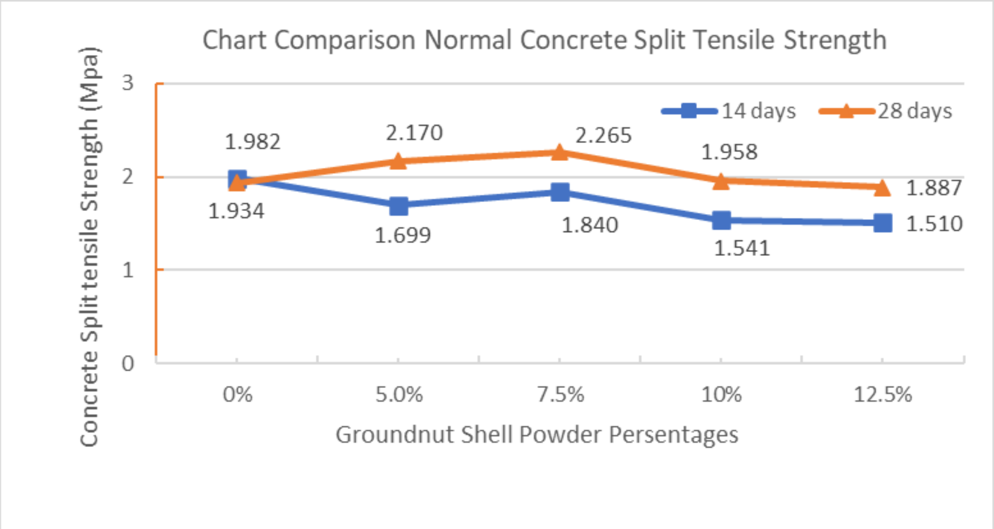

Fig 3. Chart comparison normal concrete split tensile strength

Testing the concrete's split tensile strength after 28 days have passed, the cylindrical test object is mated 15 cm, and 30 cm high with variations of peanut shell powder used is 5%, 7.5%, 10%, and 12.5% substitute part of the weight of cement and 0% as comparison concrete. The findings of the split tensile strength of concrete at the age of 28 days have improved; the optimal rise is in the 7.5% variation, which is 2.265 MPa or 17.1%, and the optimal decline is in the 12.5% variation, which is 1.887 MPa. The age of the concrete affects the growth in split tensile strength because the value of the split tensile strength of the concrete increases with age and because the percentage of groundnut shell powder added also plays a role. Concrete using Groundnut shell powder needs to be carried out further research combining with other materials to increase the tensile strength of the split.

5. Conclusion

The study's findings indicate that the tensile strength of concrete (f'ct) aged 28 days with variations of 0%, 5%, 7,5%, and 10%, and the subsequent 12.5%, was 1,934; 2,170; 2.265; 1,958; and 1,887 Mpa. the optimum tensile strength value of 28 days of age was at a variation of 7.5% at 2.265 MPa, higher than 0% (1,934 MPa) of 17.11%. The optimum tensile strength variation of 7.5% at age 28 days (2,265 MPa) is higher than at age 14 days (1,840 MPa) by 23.10%. The inclusion of peanut shell powder resulted in an improvement in the tensile strength of concrete utilizing GSP, which is 6.83% of the findings of the compressive strength test.

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