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STUDY OF THE EFFECT OF COCONUT SHELL MIXTURE AS A SUBSTITUTIONAL MATERIAL FOR COARSE AGGREGATE ON THE COMPRESSIVE STRENGTH OF CONCRETE f'c 20 MPA (COCONUT SHELL EX. PASAR KEMAKMURAN)

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ABSTRACT

Coconut shell is a hard layer consisting of lignin and cellulose which has a low water content, the hard structure of coconut shell is caused by silicate which is quite high in content, silicate can increase the compressive strength of concrete, the shape of coconut shell has a hard layer and texture rough surface so that the bond with the cement paste will be stronger. Therefore, if coconut shell can be technically proven as an ingredient or aggregate for concrete mixtures, it is hoped that it can reduce the impact of environmental pollution. In this study, coconut shells were crushed to a maximum size of 20 mm x 20 mm and used as a substitute for coarse aggregate. The percentages of coconut shells used in this study were 0%, 2.5% and 5 %. Printed in a cylindrical shape measuring 15x30 cm. The aim of the research is to analyze the characteristics of concrete f'c 20 MPa with the addition of coconut fiber and obtain effective mixture variations through compressive strength tests at 14 and 28 days. From the research results, it can be seen that the difference in compressive strength of normal concrete and with 2.5% and 5% coconut shell substitution at 14 days experienced a decrease in strength of 3.752% and 18.85%. The compressive strength at 28 days with 2.5% and 5% coconut shell substitution experienced a decrease of 3.752% and 9.413%.

Keyword: *Coconut shell, compressive strength, concrete.*

1. INTRODUCTION

Coconut shell is a hard layer made up of lignin and cellulose which has a low water content, the hard structure of coconut shell is caused by silicate (SiO2) which is quite high, silicate itself is known to increase the compressive strength of concrete, the shape of coconut shell has a hard layer and a rough surface texture so that the bond with cement paste will be stronger.[1]
Therefore, if coconut shell can be technically proven as a material or aggregate for concrete mixes, it is expected to reduce the impact of environmental pollution. In this research, different variations of the coconut shell mixture were used as coarse aggregate substitutes of 0%, 2.5% and 5%. The design concrete quality is *f'c* 20 MPa, which is carried out at the age of 14 and 28 days of concrete. Because the author wants to know the strength of concrete by substituting the coconut shell and add insight to the author and readers so that it can be used as a reference for the next. The purpose of this research is to determine the compressive strength of concrete with a variation of coconut shell mixture of 0%, 2.5% and 5% at the age of 14 and 28 days of concrete.

2. RESEARCH METHOD

Application of Coconut Shell on The Compressive Strength of K-100 Concrete. Department of Civil Engineering, Pasir Pengaraian University. The study aims to analyze the characteristics of K-100 concrete with the addition of coconut shell, and to obtain an efficient mixture variation through the

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compressive strength test at the age of 7 days. From the results of the study, it can be seen that the highest compressive strength of concrete is obtained in concrete using a 5% coconut shell mixture of 16.5 tonnes or 73.33 Kg/cm2 with a predicted 28-day compressive strength of 112.82 Kg/cm2 while the lowest compressive strength is found in concrete using a 15% mixture of 4.5 tonnes or 20 Kg/cm2 with a predicted 28-day compressive strength of 30.77 Kg/cm2 . The addition of coconut shell to the concrete mix increases the compressive strength of the concrete for the addition of 5% coconut shell by weight of coarse aggregate.[1]

The Effect of Using Coconut Shells as Coarse Aggregate Additive for Concrete Quality of F'c 17 Mpa on the Concrete Compressive Strength. Department of Civil Engineering, Medan Area University. In this research, the author used coconut shells to be used as an additional ingredient in conventional concrete mixtures. Different percentages in the addition of the mixture aim to determine differences in compressive strength results. The variations used are 0%, 10%, 20% and 30%. and the concrete compressive strength results obtained were 54.72 tons, 28.75 tons, 28.59 tons, and 22.96 tons[2]

The addition of other materials to a concrete mix or mortar should not change the composition of the other ingredients, because the use of these additives tends to be a replacement or substitution of the concrete mix itself, so that the tendency of changes in composition in weight or volume is not directly felt compared to the initial composition of concrete without the addition of other materials[3]

Coconuts, or nyiur trees, usually grow in coastal areas. The coconut (*Cocos nucifera*) is the only member of the *Cocos* genus of the *Arecaceae* family. Coconuts grow naturally on beaches and the tree can reach a height of 30 m. It originated on the coast of the Indian Ocean but has now spread throughout the tropics. The plant can grow up to an altitude of 1,000 m above sea level, but its growth slows down with increasing altitude.

In this study, the authors used coconut shell as an additive or additional material. The coconut shell was obtained from Kemakmuran Market, Kotabaru Regency. Coconut shells, which are only used as firewood, are obtained from household or industrial waste. According to [4] glass can be used as a fibre material in concrete mixes. Visually, both glass and coconut shell do not differ much when melted, namely in the form of hard flakes. So the properties are expected to be the same. Therefore, it is logical that coconut husk, when used as a fibre material, will have the same or better performance than glass. This is due to several factors, such as:

1. The strength and ductility of coconut shell is higher than glass (glass is more fragile than coconut shell). High strength and ductility generally result in a high modulus of elasticity, which results in concrete with a high modulus of elasticity.
2. Compared to glass, the surface of the coconut shell is rougher, because the coconut shell contains coconut fiber residue which will make the bond with the cement paste stronger.

3. RESULTS OF ANALYSIS AND DISCUSSION

3.1 Mix Design Planning

The composition of the concrete quality of f'c 20 MPa in this study refers to the JMF (Job Mix Formula) for the Major Market Rehabilitation Project Block B/F, Kemakmuran Market Complex, Kotabaru Regency, which is as follows: cement 442.00 kg, sand 681.79 kg, gravel 1065.72 kg, water 215.00 litres[3]

3.2 Equipment Used

The equipment used is as follows:

1. Cylindrical mold measuring 15 cm x 30 cm.
2. The compactor stick with 16 mm in diameter, 600 mm long, with a rounded end made of stainless steel.
3. A metal plate with a solid, flat and waterproof surface.
4. Waterproof concave spoon.
5. Scales with an accuracy of 0.3% of the sample weight.
6. And other additional equipment.

P-ISSN : 2598-1277
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3.3 Curing Process

Apart from achieving maximum compressive strength, concrete treatment also aims to improve the quality of concrete durability, water resistance, wear resistance and structural dimensional stability. Good curing is intended to harden the concrete, thus avoiding the appearance of cracks on the surface of the concrete due to the rapid loss of water when the concrete is still in a plastic state, and ensures that the desired compressive strength is achieved in this research after the sample is removed from the mould and then cured by soaking it in water for 7 days. After curing for the specified time, the concrete sample is removed from the water basin before the test is carried out, the way to dry the sample is to drain it with the sample tilted so that the sample can dry at the top and bottom.

3.4 Concrete Compressive Strength Testing

The test is carried out to determine how much concrete compressive strength is produced by the sample. The testing machine used has passed the calibration test, which can be seen on the information panel of the compressive strength machine, calibration is carried out to get accurate readings from the compressive strength machine.

4. RESULT OF THE STUDY

4.1. Material Requirenment Calculation

Slump test is used to measure the height of the concrete mix slump after it has been removed from the slump tool. This test is used to determine the amount of concrete viscosity of a mixture, the slump test results are obtained as shown in Table 1 below:

Table 4. 1 Material Requirement Calculation Results

Number of samples	Test Material	Percentage of Subtitution (Kg)			Ammount (Kg)
		0%	2,5%	5%	
22	Cement	23.426	14.0556	14.0556	51.5372
	Sand	36.135	21.681	21.681	79.497
	Coarse Aggregate	56.483	33.0426	32.1953	121.7209
	Water	11.395	6.837	6.837	25.069
	Coconut Shell	-	0.8472	1.6945	2.5417

4.2. Concrete Compressive Strength Testing Results

The test is carried out to determine how much concrete compressive strength is produced by the sample, whether or not the required compressive strength value is achieved. The test was conducted at Kotabaru Polytechnic Laboratory. The compressive strength is obtained using the following equation:

$$\sigma b = P/A \quad (1)$$

Where,
P = Maximum Load (kg)
A = Cross-sectional area of the samples (cm^2)

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σb = Concrete Compressive Strength (kg/cm^2)

Based on the results of the tests carried out, the compressive strength of the concrete at the age of 28 days was obtained, as tabulated in the following table.

Table 4. 2 Compressive strength test results for 14-day-old concrete

Sample Age	**Concrete Type**	**Sample No.**	**Concrete Compressive Strength (MPa)**	**Average Compressive Strength (MPa)**	**Targeted Quality (MPa)**	**Percentage %**
1	**2**		**3**	**4**	**5**	**6 = (4-5) / (5) × (100)**
14 Days	Normal Concrete	1	22,081	20,326	20	1,628
		2	18,684			
		3	20,948			
		4	20,099			
		5	19,816			
	2.5% Coconut Shell Substituted Concrete	1	20,948	19,250		-3,752
		2	19,816			
		3	16,985			
	5% Coconut Shell Substituted Concrete	1	18,117	16,230		-18,85
		2	16,419			
		3	14,154			

Table 4. 3 Compressive strength test results for 28-day-old concrete

Sample Age	Concrete Type	Sample No.	Concrete Compressive Strength (Mpa)	Average Compressive Strength (MPa)	Targeted Quality(MPa)	Percentage %
1	2		3	4	5	6 = (4-5) / (5) × (100)
28 Days	Nomal Conrete	1	24.912	22.194	20	10.970
		2	23.213			
		3	21.515			
		4	20.099			
		5	21.231			
	2.5% Coconut Shell Substituted Concrete	1	20.948	19.250		-3.752
		2	19.816			
		3	16.985			
	5% Coconut Shell Substituted Concrete	1	18.684	18.117		-9.413
		2	18.117			
		3	17.551			

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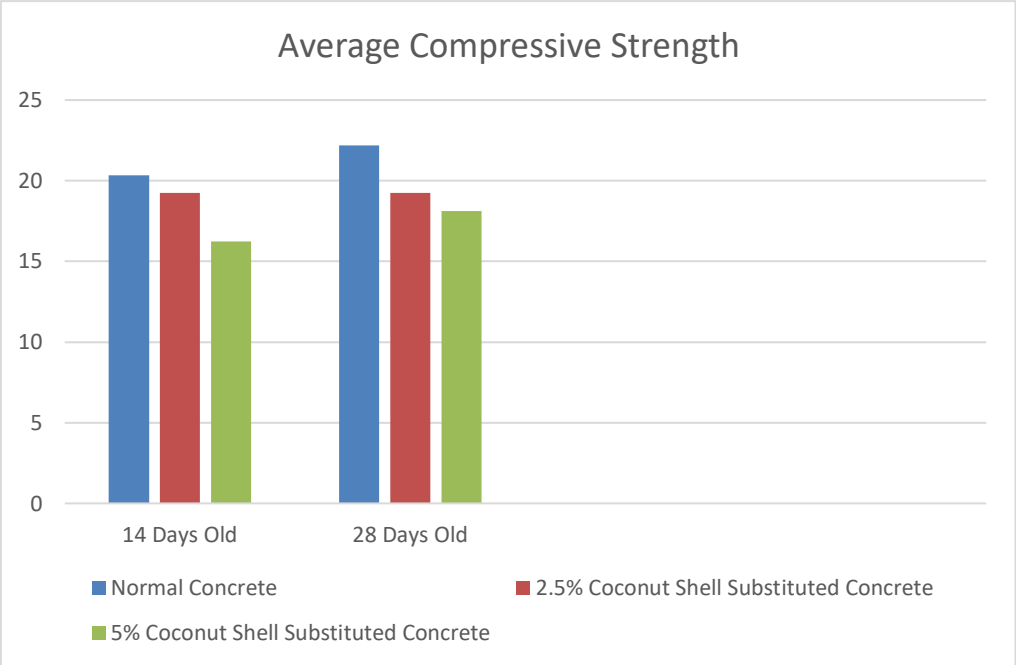

Figure 4.1 Comparison Chart of Compressive Strength Testing of Normal Concrete and Concrete with Coconut Shell Substitution.

The following is a summary of the test results for normal concrete and concrete with added materials.

5. CONCLUSIONS AND RECCOMENDATIONS

5.1 Conclusion

The results of concrete compressive strength testing on 10 normal concrete samples and 12 concrete samples with 2.5% and 5% coconut shell substitution are as follows:

a. The compressive strength for 5 normal concrete samples aged 14 days was 22.081 Mpa, 18.684 Mpa, 20.948 Mpa, 20.099 Mpa, 19.816 Mpa and for 5 normal concrete samples aged 28 days was 24.912 Mpa, 23.213 Mpa, 21.515 Mpa, 20.099 Mpa, and 21.231 Mpa respectively.
b. The The compressive strength for 3 samples of 2.5% coconut shell substitution concrete aged 14 days was 20.948 Mpa, 19.816 Mpa, 16.985 Mpa respectively and for 3 samples of 2.5% coconut shell substitution concrete aged 28 days was 20.948 Mpa, 19.816 Mpa, and 16.985 Mpa respectively.
c. The compressive strength for 3 samples of 5% coconut shell substitution concrete aged 14 days was 18.117 Mpa, 16.419 Mpa, 14.154 Mpa respectively and for 3 samples of 5% coconut shell substitution concrete aged 28 days was 18.684 Mpa, 18.117 Mpa, and 17.551 Mpa respectively.

From the *Job Mix Formula* used by the author, it is concluded that the compressive strength of concrete is influenced by the amount of coconut shell used in the concrete mix. The more coconut shell is used in the mix, the lower the compressive strength and the lighter the weight of the concrete. So, concrete samples using coconut shell of 2.5% and 5% can reduce the compressive strength of concrete, while samples that do not use coconut shell, The quality of the concrete design that we plan is in accordance with the results of the compressive strength of the concrete.

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