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Effect of Mineral Admixture on Physical and Mechanical Properties Pf Reative Powder Concrete (RPC)

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ABSTRACT

The most popular building material today is concrete. Concrete is used for buildings, industrial structures, bridges, railroad sleepers, roads, dams and more. Along with the development of concrete technology is increasingly developing and innovative so as to achieve better characteristics, cheaper prices and environmentally friendly. In the early days of the development of concrete it is explained to us about the origin from ancient times to civilization to the present century of its development.

In current developments, concrete already has a very high compressive strength up to 200-800 MPa, this is also called Ultra High Concrete (UHC). It is developed by the Reactive Powder concrete (RPC) method. Where in the research conducted, the manufacture of reactive material, namely Reactive Powder concrete (RPC) was given with a compressive strength of up to 42.8 MPa. The components for the RPC mixture consist of cement, fine aggregate, chemical admixture, mineral admixture, coconut shell charcoal and water. To produce a compressive strength above 60 MPa, the composition of the mixture uses the research that has been done previously. Detailed RPC concrete mix proportions are given in this study. Preparation and testing of materials is made in the laboratory of the Faculty of Civil Engineering at Untan. The results that will be obtained are the physical and mechanical properties of RPC Concrete.

As previously explained, the manufacture of RPC concrete requires basic ingredients that include cement, fine aggregate, chemical admixture, mineral admixture, coconut shell charcoal and water mixed together. Of course, with basic ingredients with good and correct composition, the physical and mechanical properties of RPC concrete will reach the planned quality. So far, the mineral admixture used in the manufacture of RPC is silica fume, because the price is expensive and difficult to obtain. Therefore, researchers provide a solution by using materials that are readily available in West Kalimantan in the form of coconut shell charcoal.

From the research conducted, the average compressive strength for the age of 28 days is between 50.930-60.352 MPa. From the results obtained the greatest compressive strength is variation 1 using a mixture of coconut shell charcoal by 5%, while the lowest is variation 3 using a mixture of 20% coconut shell charcoal. And from the results obtained, it turns out that only variation 1 reaches a design strength of 60 MPa. The hypothesis which states that there is an effect of a mixture of coconut shell charcoal on the physical and mechanical properties of RPC concrete is proven from the results obtained. The result of the best (optimum) charcoal mixture was variation 1 in terms of physical and mechanical properties and reached a design compressive strength of 60 MPa.

Keywords: *Concrete, Reactive Powder concrete, Cement, Physical and Mechanical properties, Coconut Shell Charcoal*

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I. INTRODUCTION

RPC concrete is made of material in the form of powder (powder) so that they interact with one another. With a perfect reaction will produce concrete that has the best physical and mechanical properties and in accordance with the plan.

Mineral admixture as one of the basic ingredients for making RPC concrete is a material that binds powder materials into one solid. Mineral admixture in concrete in its development, such as sugarcane pulp ash (AAT), rice husk ash, *Styrofoam* and polymers.

The strength, durability and properties of concrete depend on the properties of the basic ingredients, the value of the comparison of the ingredients, the way of mixing and the way of working during the pouring of the concrete mixture, the method of compaction and the way of treatment during the hardening process (*Tjokrodimuljo, 2007*).

In addition, if the use of coconut waste can be proven technically as an admixture material for concrete mixtures, it is also expected to reduce the impact of environmental pollution and have added economic value for the community.

Based on technological developments, research has been carried out to improve concrete properties and concrete performance at a low cost without reducing its quality by utilizing waste such as palm fiber, coconut fiber, nylon fiber, rice husk ash, bagasse, wood residue, sawn waste, ash. palm shells, fly ash (*fly as*), *silica fume*, candlenut shells, shells and others. The waste used is coconut shell charcoal.

The reason for taking this alternative is because the ash content of coconut shell charcoal shows similarities to *fly ash*, coconut shell charcoal is also quite abundant in certain areas. In this study, coconut shell charcoal was used as a mineral admixture in the manufacture of RPC concrete with the percentage of coconut shell charcoal mixture 5%, 10%, 20%, 35%, and 50% and by weight of selica fume. With variations of coconut shell charcoal as an admixture material, it is certain that the physical and mechanical properties of RPC concrete will change.

II. METHOD

This study will examine the RPC concrete with the ratio of the percentage of coconut shell charcoal, then the percentage of coconut shell charcoal is the best and in accordance with the final goal of this study, namely to produce the best RPC concrete and in accordance with the compressive strength plan.

2.1 Analysis of Materials and Tools

2.1.1 Ingredient

The materials to be used in the RPC concrete mix should be analyzed first. This analysis is carried out to determine the properties of these materials, such as water content, specific gravity, volume weight and other materials, which can affect the setting time, because these properties can affect the design calculations *(mix design* of RPC concrete later. The materials used in this research are as follows:

1. The cement used is the chord brand PCC.
2. The sand to be used is quartz sand that passes filter no 50
3. The water used is PDAM water with a PH of 6-7.
4. Superplasticizer with the trademark Sikamen LN issued by PT Sika
5. The Sika fume used is Sikacim from PT Sika
6. The planned compressive strength is 60 MPa.
7. W/C used 0.28
8. Coconut Shell Charcoal Flour passes filter no 50
9. The composition of the mixture will be based on previous journals and research

2.1.2 Tool

Some of the equipment used in this research are as follows:

1. MBT brand compression *testing machine* with a capacity of 2000 kN and an accuracy of 5 KN, this tool is used for testing compressive strength and testing split tensile strength with the help of *bearing blocks* and *bearing strips* .
2. *Bearing block* is a tool for testing split tensile strength which functions as a holder for cylindrical test objects when testing split tensile strength.
3. The MBT brand Cylindrical Mold is a cylindrical mold that is used to shape the test object into a cylinder with a diameter of 10 cm and a height of 20 cm, and a diameter of 15 cm and a height of 30 cm which were used in this test as many as 15 pieces.
4. The sieve vibrating machine (*Shave Seeker Machine*) of the Marui brand is a set with a sieve pan which is used in gradation analysis for both fine and coarse aggregates .
5. The Memmert brand oven material is used for testing the specific gravity of fine and coarse aggregates to remove water content.
6. Exellent brand electric scales with a capacity of 30 kg with an accuracy of 1 gram were used to weigh cylindrical specimens.
7. Vibra brand electric scales with a capacity of 10 kg with an accuracy of 1 g are used in testing the analysis of fine aggregates and coarse aggregates.
8. The MBT brand *slump* tool is a set for *slump flow testing* and the manufacture of concrete test objects consisting of one Abrams cone, one round stick with a diameter of 16 mm and a length of 600 mm, one 30 cm ruler, one cement spoon and one wire brush. .
9. Exellent brand electric scales with a capacity of 150 kg and an accuracy of 0.01 kg for the process of weighing materials and testing the weight of *the volume of* Aggregate .

10. A mixer or Molten (Concrete Mixer) with a capacity of 500 liters, a stirring capacity of 400 liters is used during the concrete manufacturing process.
11. Measuring cup, this tool is used in several fine aggregate tests.
12. Organic *Plate* is a color standard for organic content in fine aggregate , this tool has five color standards.
13. Los Angeles test for crushing coconut shell charcoal.

2.2. Research Place

This research was carried out at the Structure and Materials Laboratory, Faculty of Engineering, Untan

2.3. Population and Sample

The population is all objects to be studied in this study, namely the shape of a cylinder with the following sizes:
1. Cylinder with a diameter of 150 mm, and a height of 300 mm
2. Cylinder with a diameter of 100 mm, and a height of 200 mm

No	SAMPLE	Cylindrical Test Object						
		Number of Test Items					Pull Up	Modulus of Elasticity
		DAYS TO-					DAYS TO	DAYS TO-
		3	7	14	21	28	28	28
1	V1 (5% Charcoal)	5	5	5	5	5	3	3
2	V2 (10% Charcoal)	5	5	5	5	5	3	3
3	V3 (20% Charcoal)	5	5	5	5	5	3	3
4	V4 (35% Charcoal)	5	5	5	5	5	3	3
5	V5 (50% Charcoal)	5	5	5	5	5	3	3
TOTAL		125					30	

Table 1 List of Test Object Samples

2.4. Material Inspection

Inspection of materials as follows:

2.4.1. Cement

This inspection is carried out visually on the cement used, namely PCC chord cement which has met the Indonesian National Standard (*SNI 15-0302-2004*).

2.4.2. Fine Aggregate (Quartz Sand)

For sand inspection includes:
1. Examination of Organic Content in Sand Aggregate
2. Checking Sludge Aggregate Levels of sand
3. Sand Aggregate Moisture Check
4. Sand Aggregate Gradation Inspection
5. Specific Gravity and Water Absorption Sand Aggregate
6. Check Weight Volume Fine Aggregate Sand

2.4.3. Water

The water used is taken from the PDAM on Perdana street no 257 where the lightweight foam concrete brick is made. However, in this study, the chemical content of water was not investigated.

2.4.4. Superplasticizer

This inspection is carried out visually and by examining the composition of the brochure, which is planned to use the LN type.

2.4.5. Silica Fume

This inspection is carried out visually and by reviewing the composition of the existing brochure. With a composition based on previous research.

2.4.6. Coconut Shell Charcoal

This examination is carried out visually and with a study of the chemical elements contained based on previous research. As for the size using a filter no 50.

2.5. RPC Concrete Testing

Tests carried out for Reactive Powder concrete (RPC) include:
1. Slump Test

2. Volume Weight Test
3. Compressive Strength Test
4. Tensile and Split Test
5. Elasticity Modulus Test

NO	TESTING TYPE	TESTING TIME (DAYS) AND NUMBER OF TESTING OBJECTS				
		CYLINDER				
		3	7	14	21	28
1	Volume Weight	5	5	5	5	5
2	Tensile and split test					3
3	Compressive Strength	5	5	5	5	5
4	Modulus of Elasticity					3

Table 2 Table of Time and Number of Test Objects for 1 Sample Variation

2.6. Mixed Design

Because RPC concrete does not yet have international and Indonesian standards, the mix design uses a journal where a mix design has been made from research that has been done.

2.6.1. Mix Variation Plan

The mix variation plan to be made is presented in Table 3:

No	Ingredient	Amount/M3					Unit
		V1	V2	V3	V4	V5	
1	Coconut Shell Charcoal	7.01	14.03	28.05	49.09	70.13	kg
2	Silica Fume	133.24	126.23	112,20	91.16	70.13	kg
3	Cement	935.00					kg
4	Sand	1135,70					kg
5	Superplasticizer	17.77					kg
6	Water (w/(c+p)=0.34)	319,18					kg

Table 3 Table of Sample Base Material Composition

III. THE RESULT AND DISCUSSIONS

3.1. Material Inspection Results

1. Gradation of fine aggregate in the form of quartz sand obtained fineness modulus for quartz sand including zone IV and fine quartz sand 1.744. The quartz sand gradation falls into the upper and lower intervals for zone IV with a max size of 1.18 mm. The specific gravity of the quartz sand used is between 2,576 Kg/m3. The absorption of quartz sand used is between 0.361%. The average volume weight of the quartz sand is 1,543 kg/m ^{3} and the organic content contained in the quartz sand does not exceed the tolerance (standard color No. 3). The silt content contained in the quartz sand is less than 5%, the water content of the quartz sand for the RPC concrete mix is 5.985%. So it can be concluded that quartz sand aggregate can be used as a mixture in the manufacture of RPC concrete because its physical properties have met the standard as fine aggregate.
2. The results of the quartz sand analysis can be seen in the table below:

No	Tests	Results
1	Absorption (absorption) %	0.361
2	Apparent Density kg/m ^{3}	2,600
3	Volume weight kg/m ^{3}	1,543.33
4	water content %	5,985
5	Fine Modulus of Grain (MHB)	1,744
6	Organic Substance Content	3

7	Mud Content %	1.351
8	Gradation of details	Fine Sand

Table 4 Results of Examination of Fine Aggregate

3. In PCC cement, the largest elements are calcium oxide (CaO) or lime, silicon dioxide (SiO_2), aluminum oxide (Al_2O_3) and ferric oxide (Fe_2O_3). The cement used includes cement type I and III, which have high-early-strength-Portland-cement. This type gains great strength in a short time, so it can be used for the manufacture of RPC concrete.
4. The water used is PDAM water with a PH of 6 -7 and clean conditions because the water can be used for drinking water, thus the water has met the standards and can be used for mixing in the manufacture of RPC concrete.
5. In this study, Sikamen LN was used as a chemical admixture to reduce the use of water, formulated for the precast concrete element industry, to increase the initial strength of the concrete so that the formwork can be released quickly and can be used as much as possible so that the time used can be used faster. Where Sikamen LN is a type F chemical admixture with high initial strength and water reduction, making it suitable for the manufacture of RPC concrete. Its density is 1.22 Â± 0.01 kg/L at 2+20 Â°C. The usage varies for each variation, for variation 1 as much as 7.16 kg, variation 2 as much as 6.78 kg, variation 3 as much as 6.03 kg, variation 4 as much as 4.90 kg, and variation 5 as much as 3.77 kg.
6. In this study, Silica Fume was used as a mineral admixture to provide excellent internal cohesion and water retention in fresh concrete. The concrete becomes highly pliable and the pump ability is substantially improved. In hardened concrete, the later reactive silica fume forms chemical bonds with free lime (CaOH2). The hydration product formation additive resulted in a significantly denser cement matrix . Where Sika Fume is a type F admixture mineral with the following properties:

- High stability
- eco-friendly concrete
- Greatly increased endurance
- Salt Resistant
- Ultimate power increase
- Improved abrasion resistance
- Improved water abrasion resistance
- Increased viscosity of gas
- Reduces chloride penetration
- Silica Fume does not contain chlorides or other corrosion-inducing agents for steel, and therefore can be used without limitation for the construction of prestress concrete

The specific gravity is 0.65 kg/l and the chloride ion is < 0.3 M%. . The use is 28.64 kg, so it is 11.40% by weight of cement. It turned out to exceed the existing brochure 5%-10% of the weight of cement. Because this is based on previous research where the basis is in making high-strength concrete that is used is between 15%-25% of the weight of cement.

7. For coconut shell charcoal, the following data were obtained:

No	Test	Results
1	Color	black
2	Texture	Fine (flour)
3	Condition	Sticky
4	Content	Oil
5	Size	Pass filter no 50
6	Water content	3.42
7	Specific Gravity (kg/m3)	1.550

Table 5 Examination Results of Coconut Shell Charcoal

3.2. Reactive Powder Concrete (RPC) Analysis

RPC concrete is the final subject of this research. RPC concrete research used a cylindrical specimen with dimensions of 100 x 200 mm and 150 x 300 mm. The material composition plan was obtained from previous research, namely from journal materials using water per binder (w/c) of 0.34. The cylindrical concrete mix design uses a variation of coconut shell charcoal. The independent variable used was coconut flour charcoal used.

3.2.1 Slump Test

Slump testing is very important to determine the level of workability and the resulting material. Where the slump test is carried out. The data from the research that has been done obtained the following data :

No	Variations	Slump Test (cm)
1	Variation 1	2.5 . Height
2	Variation 2	9 . Height
3	Variation 3	10 . high
4	Variation 4	4 . high
5	Variation 5	4 . high

Table 6 . Slump Test

From the results of the slump, it can be concluded that based on the plan, the slump is 3-6 cm. Thus for variations 2 and 10 do not meet the requirements of the plan. Thus the resulting RPC concrete will not go according to plan. And also the results will be smaller than the original plan.

Variations 1 to 5 have a low or thick level of workability. Thus, a better quality of RPC concrete will be obtained, because a small slump will produce stronger concrete compared to a large slump. Where required in the manufacture of structural concrete (SNI 2002) the ideal slump is 25-100 mm. For the resulting slump is 2.5 â€“ 10 cm, thus the RPC concrete has met the requirements as concrete for structural construction.

3.2.2 Volume/Fill Weight Test

The results of the average volume/content weight of RPC concrete bricks that have been tested for a sample size of 150 mm x 300 mm from each variation of coconut shell charcoal for each age obtained the following data:

No	Variations	Volume Weight (Kg/m3 / day)				
		3	7	14	21	28
1	Variation 1	2,124	2.116	2.113	2.110	2,094
2	Variation 2	2.121	2.113	2.112	2.104	2.072
3	Variation 3	2.116	2.112	2.107	2.096	2,074
4	Variation 4	2.112	2.109	2.105	2.090	2,053
5	Variation 5	2.108	2.104	2.096	2,084	2.070

Table 7 . Volume/Fill Weight

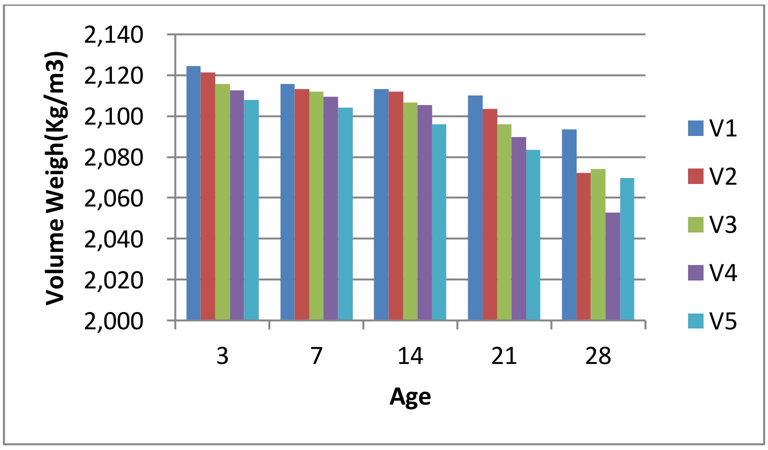

Figure 1 Volume Weight Barchart with Variations

From the table, we can see that the volume weight of RPC concrete at the age of 28 days is 2,070 – 2,094 Kg/m3. So that RPC has a volume weight that is smaller than normal concrete of above 2200 kg/m3. Thus, RPC concrete is included in lightweight concrete.

From the barchart, we can see that for all variations in weight the volume will decrease with increasing age of this RPC concrete. This is due to a reaction in the RPC concrete which causes the water contained in the RPC concrete to evaporate due to the hydration process in the RPC concrete.

4.3.1 Compression Test

The results of the compressive strength test of RPC concrete that have been tested for a sample size of 150 mm x 300 mm from testing 15 samples per each variation for each age obtained the following data:

Variations	**Mixed Average Compressive Strength (Day) (MPa)**				
	3	**7**	**14**	**21**	**28**
Variation 1	17,571	26,993	32,111	56,786	60,352
Variation 2	17,316	25,847	26,339	36,415	52,457
Variation 3	14,388	18,971	22,651	48,510	50,930
Variation 4	7,130	24,873	47,873	42,526	56,786
Variation 5	1,222	10,476	39,852	45,073	54,495

Table 9. Average Compressive Strength of each variation VS Age

From the table it can be seen that the RPC concrete of each variation was taken from 15 samples that had been made, which resulted in an average compressive strength of 28 days between 50.93 - 60.35 MPa. From the results obtained, the greatest compressive strength is variation 1 using a mixture of coconut shell charcoal at 5% by weight of silica fume, while the lowest is variation 3 using a mixture of coconut shell charcoal at 20% by weight of silica fume. From the table we can also see that the compressive strength of RPC concrete from the age of 3 days to 28 days experienced an increase in strength.

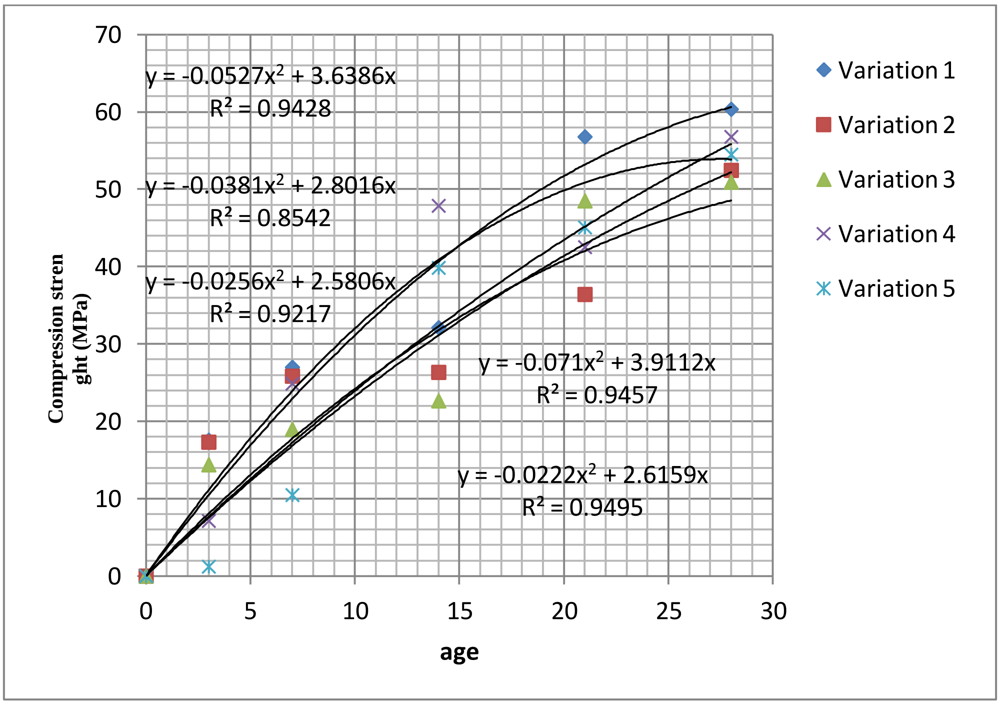

Figure 2 Graphic Compression strength Vs. Age

From the graphs and tables above, it can be concluded that with increasing age of concrete, the resulting compressive strength will increase non-linearly. And from the results obtained, it turns out that only variation 1 reaches a design strength of 60 MPa.

4.3.2 Elasticity Modulus Test

The results of the elastic modulus of RPC concrete that have been tested for a sample size of 150 mm x 300 mm from testing 3 samples per each variation for the age of 28 days obtained the following data:

No	Variations	Average Modulus of Elasticity (Ec) MPa
1	Variation 1	34.119
2	Variation 2	31.750
3	Variation 3	30.267
4	Variation 4	33.798
5	Variation 5	30.811

Table 11 Modulus of elasticity

From the table, it can be seen that the RPC concrete of each variation was taken from the 3 samples that had been made, which resulted in an average modulus of elasticity of 28 days between 30,267 - 34,119 MPa. From the results obtained, the largest modulus of elasticity is variation 1 using a mixture of coconut shell charcoal at 5%, while the lowest is variation 3 using a mixture of coconut shell charcoal at 20%. From the results obtained, it turns out that the modulus of elasticity of RPC concrete is greater than normal.

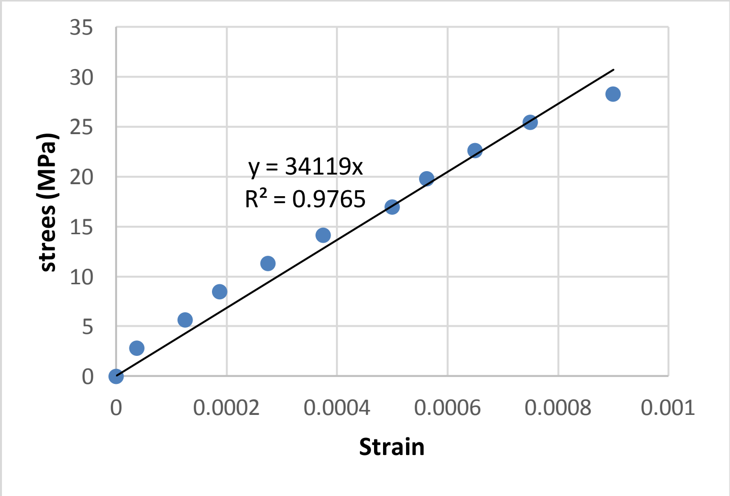

Figure 3 Graphic Strees Vs Strain Variation 1

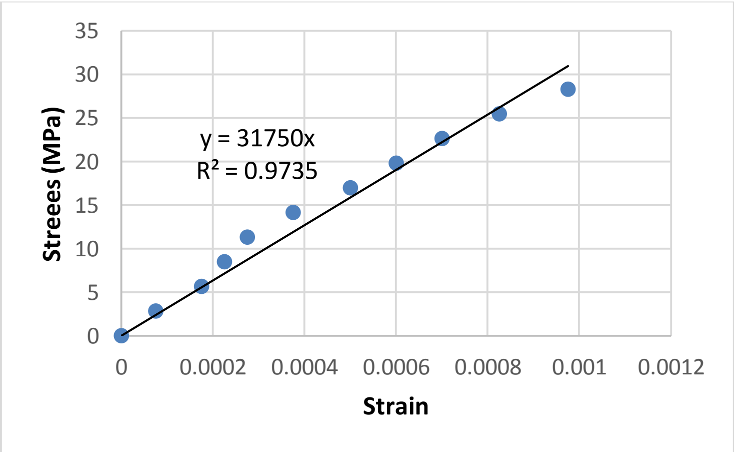

Figure 4 Graphic Strees Vs Strain Variation 2

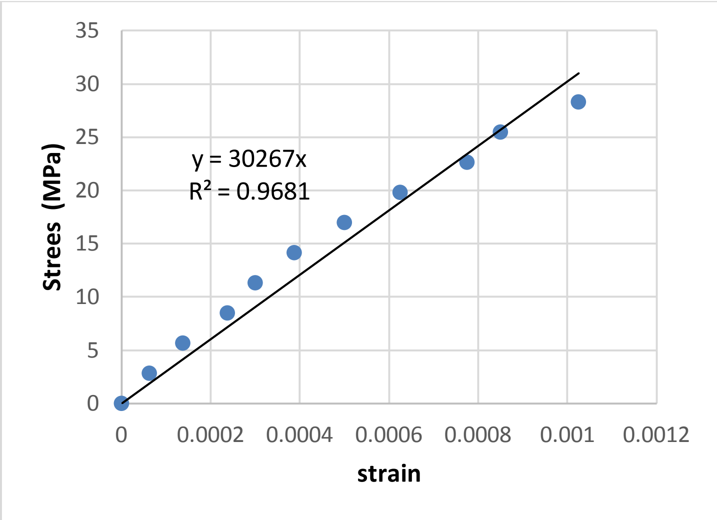

Figure 5 Graphic Strees Vs Strain Variation 3

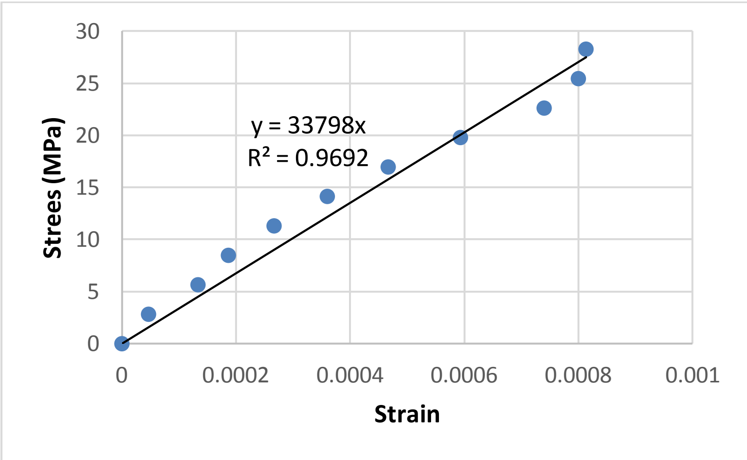

Figure 6 Graphic Strees Vs Strain Variation 4

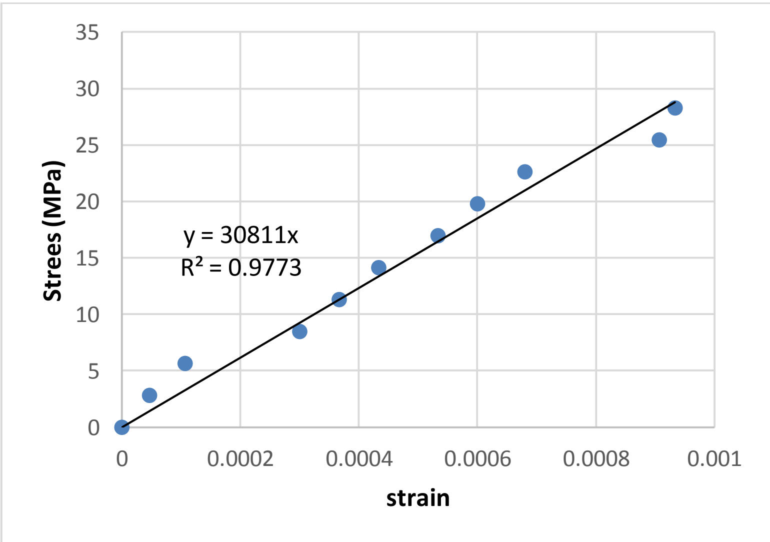

Figure 7 Graphic Strees Vs Strain Variation 5

Meanwhile, if you use the equation issued by ***SNI 2847:2018***:

Ec = $Wc^{1,5}$. 0,043 √fc′ MPa

Where : wc = Weight of Concrete

fc' = Compressive Strength of Concrete

No	Varations	Avarge Modulus of Elasticity (Ec) MPa
1	Variation 1	35.799,33
2	Variation 2	34.558,70
3	Variation 3	30.437,80
4	Variation 4	35.240,50
5	Variation 5	31.027,21

Table 17 Modulus of elasticity based on SNI

From the table, it can be seen that the RPC concrete of each variation produces a modulus of elasticity of 30,437.80 – 35,799.33 MPa. From the results obtained the largest modulus of elasticity is variation 1 using a mixture of coconut shell charcoal 5% of the weight of silica fume, while the lowest is variation 3 using a mixture of coconut shell charcoal 20% of the weight of silica fume

4.3.3 Split Tensile Strength Test

The tensile strength value is obtained by entering the maximum value when the test object is destroyed and split into 2 parts.

NO	Varations	Average Split Tensile Strength (Mpa)
1	Variation 1	10,52
2	Variation 2	9,93
3	Variation 3	9,63
4	Variation 4	9,48
5	Variation 5	7,33

Tabel 18 Average Split Tensile Strength

From the table, it can be seen that the RPC concrete of each variation was taken from the 3 samples that had been made, which resulted in an average split tensile strength of 28 days between 7.33 – 10.52 MPa. From the results obtained, the largest split tensile strength is variation 1 using a mixture of 5% coconut shell charcoal, while the lowest is variation 5 using a 50% coconut shell mixture. If we compare the resulting compressive strength, we will get the percentage reduction of the compressive strength which can be seen in the table below:

NO	Varations	Percentage (%) split tensile strength of compressive strength
1	Variation 1	17,4%
2	Variation 2	18,9%
3	Variation 3	18,9%
4	Variation 4	16,7%
5	Variation 5	13,5%

Table 19 Percentage of Split Tensile Strength Vs Compressive Strength

The split tensile strength of concrete is relatively low, about 10%-15% of the compressive strength of concrete, sometimes reaching 20%. This strength is more difficult to measure and the results vary from one experimental material to another than for pressure cylinders. If we see from the results obtained that the value of % RPC concrete has met the above statement because it is obtained between 13.5% – 18.9%.

IV. CONCLUSION

1. All variations for the slump test were obtained on average above 2.5-10 cm, thus having a low or thick level of workability. So that the quality of RPC concrete will be better, because with a small slump, it will produce stronger concrete compared to a large slump. Where required in the manufacture of structural concrete (SNI 2002) the ideal slump is 25-100 mm.
2. The average volume/content of RPC concrete is between 2,070 – 2094 kg/cm3. The volume weight of RPC concrete in general will be lighter with increasing age of the brick. RPC concrete has a volume weight that is smaller than normal concrete of over 2100 kg/m3. Thus, RPC concrete is included in lightweight concrete.
3. The average compressive strength for the age of 28 days is between 50.930-60.352 MPa. From the results obtained the greatest compressive strength is variation 1 using a mixture of coconut shell charcoal by 5%, while the lowest is variation 3 using a mixture of 20% coconut shell charcoal. The compressive strength of RPC concrete from the age of 3 days to 28 days experienced an increase in its compressive strength along with the age of the RPC concrete. And from the results obtained, it turns out that only variation 1 reaches a design strength of 60 MPa
4. RPC concrete produces an average modulus of elasticity of 28 days between 30,267 - 34,119 MPa. From the results obtained, the largest modulus of elasticity is variation 1 using a mixture of coconut shell charcoal at 5%, while the lowest is variation 3 using a mixture of coconut shell charcoal at 20%. From the results obtained, it turns out that the modulus of elasticity of RPC concrete is greater than normal concrete 2.35.104 – 2.4 104 MPa..
5. RPC concrete produces an average split tensile strength of 28 days between 7.33 – 10.52 MPa. From the results obtained, the largest split tensile strength is variation 1 using a mixture of 5% coconut shell charcoal, while the lowest is variation 5 using a 50% coconut shell charcoal mixture. From the results obtained, it turns out that the split tensile strength of RPC concrete is greater than normal concrete, namely from 13.5% – 18.9% of its compressive strength, while normal concrete is 10%-15% of normal concrete compressive strength.
6. From the conclusions above, the H1B hypothesis which states that there is an effect of a mixture of coconut shell charcoal on the physical and mechanical properties of RPC concrete is evident from the results obtained. This can be seen from the physical and mechanical properties of the resulting concrete.
7. Judging from the results obtained, the best (optimum) charcoal mixture is variation 1 in terms of its physical and mechanical properties.
8. The following is a summary table of RPC concrete test results using a mixture of coconut shell charcoal with several percentages:

Mechanics Test	Variations				
	1	2	3	4	5
Volume Weight (Kg/m3)	2.094	2.072	2.074	2.053	2.070
Compressive Strength (Mpa)	60,352	52,457	50,93	56,786	54,495
Modulus of Elasticity (Mpa)	34.119	31.750	30.267	33.798	30.811
Split Tensile (Mpa)	10,52	9,93	9,63	9,48	7,33

Table 20 RPC Concrete Test Results Recapitulation

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