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# Comparison of Compressive Strength and Wood Powder Absorption and Coffee Grade Aggregate With Uniform Grade

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## Abstract

*In Indonesia, there are many industrial wood processing factories that have a lot of waste or sawdust that has not been utilized. One solution to the utilization of sawdust waste is to use it as a construction material. Wood sawdust is waste obtained from the results of wood craftsmen who use machines or manually. Utilization of wood waste is now used as material for making cabinets and gardening. One solution to the utilization of sawdust waste is to use it as a construction building material. Food industry waste can cause problems in handling because it contains carbohydrates, proteins, fats, mineral salts and also chemical residues used in processing and cleaning. Waste that is increasing and piling up will smell and become a source of microbial development which in the end will also cause various kinds of diseases, so that food industry waste needs good handling. Coffee grounds are also food industry waste produced from processing coffee beans. As with other food industry waste, coffee grounds waste has the potential to be used as a substitute material for cement.*

Keywords
compressive strength; sawdust; coffee grounds ash; uniformly graded

## I. Introduction

One of the studies on the comparison of compressive strength and porosity of porous concrete using uniformly graded coarse aggregate with a continuous slope. The compressive strength of porous concrete using uniformly graded aggregate is lower than continuous. The compressive strength of porous concrete using the highest uniform gradation aggregate is 8.92 MPa and continuous gradation is 14.04 MPa. The porosity of porous concrete using uniformly graded aggregate is higher than that of continuous gradation [1].

Another study on the effect of uniformly graded coarse aggregate size on porous concrete. From the results of this study it can be concluded that the larger the size of the aggregate used, the lower the compressive strength of the porous concrete. The compressive strength of porous concrete with a water cement factor of 0.20 is greater than 0.25. The compressive strength of porous concrete with a ratio of cement to aggregate weight of 1: 5 is higher than a ratio of 1: 6. The effect of aggregate size is not significant on the unit weight of porous concrete [2].

Another research on the effect of gradation on the porosity and compressive strength of porous concrete. The compressive strength, porosity, and permeability tests using the falling head water permeability test method were carried out at 28 days of concrete age. From the results of the analysis using qualitative methods, porous concrete with crushed stone gradations 1-2 and 2-3 with FAS 0.45, the highest compressive strength value obtained in the aggregate mixture 1-2 is 10,584 MPa. The highest porosity occurred in the

aggregate 1-2 mixture of 21.758 % (VIM method). The highest horizontal permeability occurred in the aggregate 1-2 mixture of 1.711 cm/sec. The highest vertical permeability occurred in a mixture of 1-2 with a value of 0.448 cm/sec. So from the results of the analysis of porous concrete that is strong and maintained its porosity value is porous concrete with a mixture of 1-2 aggregates [3].

Another study on the compressive strength and permeability of porous concrete with variations in aggregate size. There are 4 (four) variations tested, namely variation 1 with a composition of 55% aggregate that passes the 1/2" sieve but is retained by the 3/8" sieve and 45% of the aggregate passes through sieve number 4 but is retained by sieve number 8, then variation 2 with 55% the aggregate passed the 1/2" sieve but retained 3/8" and 45% of the aggregate passed the 3/8" sieve but retained number 4, variation 3 consists of 100% of the aggregate passing the 1/2" sieve but retained by the 3/8" sieve, and Finally, there is variation 4 which consists of 55% of the aggregate passing the 1/2" sieve but retained by 3/8" and 45% of the aggregate passing the 3/4" sieve but retained by 1/2" [4].

## II. Review of Literature

Another study on the effect of coarse aggregate of uniformly graded crushed stone on the compressive strength of normal concrete. The results of testing the compressive strength of concrete on the use of uniformly graded crushed stone aggregates can reduce the compressive strength of concrete by 12.35% against the use of continuous graded crushed stone aggregates. Decreasing the use of w/c from 0.50 to 0.45 can increase the compressive strength of concrete by 20.15%. The use of coarse aggregate of uniformly graded crushed stone in the concrete mixture affects the workability and compaction of the concrete [5].

Research on experimental studies of the use of coffee grounds as a partial substitute for cement in the manufacture of concrete. The results of the test based on the percentage of coffee grounds ash 5%, 10%, 15%, and 25% to the volume of cement obtained compressive strength of 26,085 MPa, 20,162 MPa, 20,080 MPa, and 15,358 MPa, respectively. Meanwhile, the compressive strength of normal concrete without coffee grounds ash substitution is 25,406 MPa. These results indicate that the partial replacement of coffee grounds ash by 5% to cement can increase the compressive strength by 2.67% from normal concrete. Furthermore, at 10% and 15% substitution, the compressive strength results still meet the design compressive strength (fc′) [6].

Futher research on the compressive strength of concrete containing coffee grounds ash with superplasticizer added. The test results of normal concrete compressive strength at the age of 28 days (BN) is 35.98 MPa. In the reduction of 10% mixing water and the addition of 0.5%, 1% and 2% superplasticizer, the compressive strength values were 42.32 MPa, 43.33 MPa, and 47.83 MPa, an increase of 17% to 33% of the compressive strength. normal concrete. The results also showed that the substitution of 5% coffee grounds ash by weight of cement without superplasticizer gave an increase in compressive strength of 3.78% from normal concrete. At 5% AAK substitution and with the addition of 0.5%, 1% and 2% superplasticizer, the resulting compressive strength was 44.71 MPa, 45.90 MPa and 49.74 MPa, respectively. These three qualities of concrete can be categorized in high quality concrete [7].

Another study on the modification of concrete fc′ 9.8 MPa using coffee grounds. The purpose of this study was to determine the value of the slump test, compressive strength test, and absorption test of the addition of coffee grounds ash on concrete specimens using a cylinder measuring 15cm x 30cm with 5 pieces of concrete quality. K-125 or equivalent

fc′ 9.8 MPa. The slump test results with percentages of 4%, 8%, 12% are 2.5 cm, 0.5 cm and 2.5 cm. The results of the compressive strength test of concrete with a percentage of 4% obtained a compressive strength of fc′ 10.51 MPa or equivalent to K125 with a percentage of 8% producing a compressive strength of fc′ 8.39 and a percentage of 12% producing a compressive strength of fc′ 7.56 MPa equivalent to K100. The results of the water absorption test for 28 days produced an average value of 0.32 kg, 0.25 kg, 0.15 kg, and 33 kg [8].

***Figure 1.*** *The strong test object is weighed before the compressive strength*

Further research on the effect of uniformly graded coarse aggregate size on porous concrete. From the results of this study it can be concluded that the larger the size of the aggregate used, the lower the compressive strength of the porous concrete. The compressive strength of porous concrete with a water cement factor of 0.20 is greater than 0.25. The compressive strength of porous concrete with a ratio of cement to aggregate weight of 1 : 5 is higher than a ratio of 1: 6. The effect of aggregate size is not significant on the unit weight of porous concrete [1].

Next is the experimental study of the use of coffee grounds as a partial substitute for cement in the manufacture of concrete. The results of the test based on the percentage of coffee grounds ash 5%, 10%, 15%, and 25% to the volume of cement obtained compressive strength of 26,085 MPa, 20,162 MPa, 20,080 MPa, and 15,358 MPa, respectively. Meanwhile, the compressive strength of normal concrete without coffee grounds ash substitution is 25,406 MPa. These results indicate that the partial replacement of coffee grounds ash by 5% to cement can increase the compressive strength by 2.67% of normal concrete. Furthermore, at 10% and 15% substitution, the compressive strength results still meet the design compressive strength (fc') [6].

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Then about the modification of concrete fc' 9.8 MPa using coffee grounds ash. The purpose of this study was to determine the value of the slump test, compressive strength test, and absorption test of the addition of coffee grounds ash on concrete specimens using a cylinder measuring 15cm x 30cm with 5 pieces of concrete quality. K-125 or equivalent fc' 9.8 MPa. The slump test results with percentages of 4%, 8%, 12% are 2.5 cm, 0.5 cm and 2.5 cm. The results of the compressive strength test of concrete with a percentage of 4% obtained a compressive strength of fc' 10.51 MPa or equivalent to K125, a percentage of 8% producing a compressive strength of fc' 8.39 and a percentage of 12% producing a compressive strength of fc' 7.56 MPa equivalent to K100. The results of the water absorption test for 28 days produced an average value of 0.32 kg, 0.25 kg, 0.15 kg, and 33 kg [8].

The next research is on the analysis of the compressive strength of concrete with teak wood powder. The sawdust used as fiber was in the form of teak wood powder with a size of less than 2 mm. Variations in the addition of sawdust to the concrete mixture were 10 kg/m3, 20/kg m3, and 30 kg/m3. Water-cement factor 0.5 with a mix design method based on ACI (American Concrete Institute). The addition of 10 kg/m3, 20 kg/m3, and 30 kg/m3 sawdust in the concrete mixture increased the compressive strength of the concrete. The highest compressive strength was achieved by the addition of teak sawdust as much as 20 kg/m3, which achieved a concrete compressive strength of 230.76 kg/cm2, or an increase of 2.23% compared to normal concrete. The slump value in concrete with the addition of sawdust has decreased so that it affects workability but still meets the requirements in the easy-to-work level [9].

Research on the effect of sawdust ash as a substitute for fine aggregate on the tensile strength of concrete using chemicals. In this study, sawdust ash was used with a percentage of 10%, 20% and 30% of the weight of fine aggregate with chemical additions of 0.8% of the weight of cement. The sample used is a cylindrical sample with a size of 15cm x 30cm. The test carried out is the split tensile strength test. Based on the planning of sawdust ash concrete with Sika Viscocrete 3115 N added material on the split tensile strength of the concrete, the average value for each variation is obtained. BN0 with split tensile strength of 4.60 MPa, BA10 of 3.04 MPa, BA20 of 1.98 MPa, and BA30 of 1.41 MPa [10].

In this study the addition and replacement of concrete mixtures in the form of: oil palm shells as a substitute for fine aggregate and the addition of chemical substances in the form of bondcrete. Utilizing palm oil shell waste as a substitution of fine aggregate for concrete and is expected to produce compressive strength adequate concrete. Normal concrete quality with compressive strength between 20 MPa to 35 MPa and bulk density between 2200 kg/m3 up to 2500 kg/m3 [11].

Palm fiber is the result of a lot of palm fronds (Arenga pinnata). found throughout Indonesia. The physical form of the fiber is in the form of strands thread that is black in color and has reddish edges, is stiff and ductile and has sufficient tensile strength. So that fiber can be used as an additive in the mixture concrete [12].

The high or low performance of concrete depends on the characteristics of the material constituents and substitute materials used. The better the interaction chemically, the characteristics of the concrete will be better. Substitute material form varied, including: in the form of fibers, powders, powders, and even liquids with high yields varied are displayed through tests of mechanical, chemical, and thermal characteristics [13].

Concrete is a solid that is formed by mixing coarse aggregate, fine aggregate, and additives (admixture or additive) with a paste made of cement and water. The strength of concrete construction is very affect the quality of cement, type of material used, bond/adhesion between materials, compaction and treatment [14].

The basic concept is to naturally reinforce concrete with fibres randomly distributed into the concrete mix, so as to prevent the occurrence of premature cracking either due to load or due to heat of hydration. Lots once a fiber that can be used to improve the properties of concrete. Fiber Type These include steel fiber, plastic fiber, carbon fiber, natural fiber, and fiberglass glass [15].

## III. Research Methods

The research method used in this research is the experimental method. The experimental method in this study was carried out by comparing the concrete. The two concretes will be tested by testing the compressive strength of the concrete and to determine the durability of the concrete, testing the compressive strength of the concrete is also carried out by immersing the concrete in water. From the results of research observations on experimental concrete, it is expected to know the effect of adding coffee grounds and sawdust with uniform gradation aggregates on the compressive strength of concrete and its absorption.

Technological developments in human life every year always increased. These developments have had both positive and negative impacts on everyday life. The main negative impact is the waste generated from human activities, most of this waste is directly disposed of nature without processing [15].

This research was also carried out from several recent previous thesis from the same supervisor. In their research on the compressive strength of concrete, they used SNI 03-2834-2000, with different mixtures of added ingredients. The use of lime water as a concrete mixture affects the average compressive strength because it produces a lower average compressive strength than the use of fresh water as a concrete mixture [16]. However, normal concrete with 28 days of sulfuric acid immersion resulted in a lower average compressive strength value than normal concrete with 28 days of fresh water immersion [17]. This shows that normal concrete has weak resistance to sulfuric acid solution compared to rice husk ash and viscocrete 3115 N added [18].

## IV. Results and Discussion

Optimum compressive strength results occur in concrete with a mixture of 6% banana stem ash and 0.8% sikacim concrete additive, which is 30.74 MPa [13]. This shows that the concrete produced with sawdust and am 78 concrete additive 0.8% has a higher strength compared to normal concrete, so this mixture of sawdust and am 78 concrete additive 0.8% can be applied to structures. building (Fani Surya et al., 2020). It can be concluded that the compressive strength of normal concrete and the compressive strength of a mixture of palm shell ash and bondcrete decreased in compressive strength, and did not reach the design compressive strength of 25 MPa due to the influence of the percentage of oil palm shell ash and bondcrete addictive substances ([11]. These mineral additives are additives intended to improve the performance of concrete. At this time, this mineral added material is more widely used to improve the compressive performance of concrete, so that this mineral added material tends to be cementitious. Some of these mineral-added ingredients are fly ash, slag, silica fume, coffee grounds ash and sawdust. In this study, coffee grounds and sawdust were added as mineral additives.

Coffee grounds are also food industry waste produced from processing coffee beans. From 0.50 kg of coffee grounds that are ready to use, it produces ± 0.34 kg of coffee grounds. As with other food industry waste, coffee grounds waste has the potential to be

used as a substitute material for cement [6]. Coffee grounds are an economical and environmentally friendly organic fertilizer. Coffee grounds contain 2.28% nitrogen, 0.06% phosphorus and 0.6 potassium. The pH of coffee grounds is slightly acidic, around 6.2 on the pH scale. In addition, coffee grounds contain magnesium, sulfur, and calcium which are useful for plant growth [19].

***Figure 2.*** *Coffee Ground Ash Passes Filter No. 200*

Sawdust is waste obtained from sawing wood using machines or manually [20]. Wood sawdust is an organic additive. In wood sawdust there are levels of cellulose and hemicellulose which when added to a cement mixture, these compounds will be adsorbed on the mineral/particle surface and provide additional bonding strength between particles due to their adhesion and dispersion properties, and inhibit the diffusion of water in the material due to its hydrophobic nature. Thus, stronger and relatively impermeable concrete can be produced, which can be used for special purposes [8].

Sawdust is one type of organic waste material which is the waste found in the sawmill industry or furniture craftsmen whose utilization is not yet optimal. Wood sawdust is sawdust that comes from wood that is cut with a saw. The powder to be used requires processing which is called the mineralization process. This process is used to reduce extractive substances such as sugar, tannin and organic acids from plants so that the adhesive power and hardening of cement are not disturbed. The inspection carried out on sawdust is an examination of the moisture content of the initial sawdust (before the mineralization process). Checking the final moisture content of sawdust (after the mineralization process) and checking the density of loose sawdust. Wood sawdust is an industrial waste that can be used as an absorbent agent [21].

In this case the need to create quality concrete by utilizing natural resources whose utilization is still not optimal. Besides that, you can using waste that is not used and can be reprocessed into additives or fillers in the concrete mix. To achieve concrete quality good, fresh concrete should fill the space quickly so that there is no air in it, if the concrete has voids on its surface then the concrete will experience a decrease in quality[22].

***Figure 3.*** *Wood sawdust.*

Another study on the use of sawdust as a substitute for sabulakoa sand to mortar mixtures. The results showed that the compressive strength and specific gravity of mortar samples for the 5% and 10% compositions were 50.2 kg/cm3 and 25 kg/cm3, respectively, while the 15%, 20% and 25% compositions failed. . And the addition of sawdust in the mortar mixture has quite an effect on the specific gravity of the mortar, for example the composition of 5%, 10%, 15%, 20%, and 25% decreased respectively 5.2%, 13.1%, 16.5% 23 ,7%, 27,0%. This means that the density of sawdust is lighter than the density of sand [21].

The basic concept is to naturally reinforce concrete with fibres randomly distributed into the concrete mix, so as to prevent the occurrence of premature cracking either due to load or due to heat of hydration. Lots once a fiber that can be used to improve the properties of concrete. Fiber Type These include steel fiber, plastic fiber, carbon fiber, natural fiber, and fiberglass glass [23].

**Table 1.** Chemical content of various woods

| Wood Type | Holoselulosa (%) | Hemiselulosa (%) | Alphacellulosa (%) | Lignin (%) | Pentosa (%) |
|---|---|---|---|---|---|
| Salagundi | 66,61 | 34,26 | 41,75 | 26,35 | 17,18 |
| Raru | 75,99 | 29,26 | 37,35 | 22,26 | 17,31 |
| Medang | 73,86 | 31,64 | 42,22 | 27,59 | 15,40 |
| Mobe | 69,90 | 31,91 | 37,99 | 30,28 | 17,41 |
| Sengon | - | 24,10 | 49,40 | 26,50 | 15,60 |

Another study on the effect of sawdust as a partial substitution of cement and 0.6% additives for Bestmittel. The normal compressive strength of concrete within 14 and 28 days is 22.832 MPa and 25.344 MPa, respectively. Meanwhile, within 28 days, Bestmittel's compressive strength with 0.6% rose 2.23% from the normal 25,909 MPa. The highest compressive strength was found in specimens with 0.6% Bestmittel added and 5% sawdust ash cement as partial cement substitution, namely 24,262 MPa and 27,668 MPa. In another variation, with the addition of 0.6% Bestmittel and 10%, 15%, 20% sawdust as a partial cement substitution, the compressive strength decreased by 8.77%; 28.2%; and 40.86% which is 23,131 MPa; 18,198 MPa; and 14.99 MPa. But the addition of Bestmittel can increase the compressive strength of concrete. Replacing some of the cement with sawdust as much as possible increases the compressive strength of the concrete but with a certain amount [8].

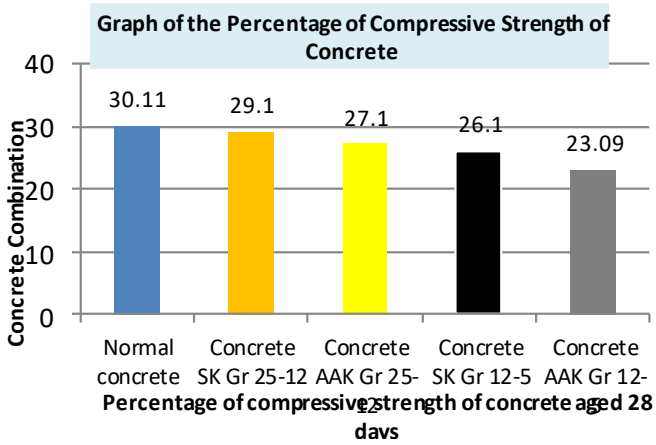


***Figure 4.*** Graph of the percentage of compressive strength of concrete aged 28 days.

From the results of Figure 4., it shows that the addition of wood powder or coffee grounds for 28 days has not been able to exceed the compressive strength of normal concrete. Concrete that is close to the normal compressive strength of concrete occurs in concrete with a mixture of 25-12 graded sawdust with a value of 29.1 MPa. The results of the lowest average compressive strength were obtained in concrete with a mixture of 12-5 graded coffee grounds ash at the age of 28 days with a compressive strength of 23.09 MPa, not meeting the design compressive strength. In a mixture of 12-5 gradation of sawdust at the age of 28 days with a compressive strength of 26.1 MPa. In a mixture of coffee grounds ash, graded 25-12 at the age of 28 days with a compressive strength of 27.1 MPa. In a mixture of 25-12 graded sawdust at the age of 28 days with a compressive strength of 29.1 MPa. The compressive strength value is still below the normal concrete compressive strength value at 28 days of 30.11 MPa. However, this value can be said to exceed the value of the design compressive strength of 24 MPa.

**Table 2.** Absorption test results

| | | | | |
|---|---|---|---|---|
| Normal Concrete | 12394 | 12551 | 157 | |
| | 12506 | 12677 | 171 | 159,6667 |
| | 12479 | 12630 | 151 | |
| Graded Wood Powder Mix Concrete 25-12 | 12426 | 12632 | 206 | |
| | 12323 | 12469 | 146 | 167,3333 |
| | 12166 | 12316 | 150 | |
| Gradient Coffee Groud Ash Mix Concrete 25-12 | 12310 | 12521 | 211 | |
| | 11528 | 11677 | 149 | 163 |
| | 12680 | 12809 | 129 | |
| Graded Wood Powder Mix Concrete 12-5 | 12250 | 12410 | 160 | |
| | 12552 | 12739 | 187 | 173,6667 |
| | 12416 | 12590 | 174 | |
| Gradient Coffee Groud Ash Mix Concrete 12-5 | 12214 | 12505 | 291 | |
| | 12139 | 12285 | 146 | 227 |
| | 12365 | 12609 | 244 | |

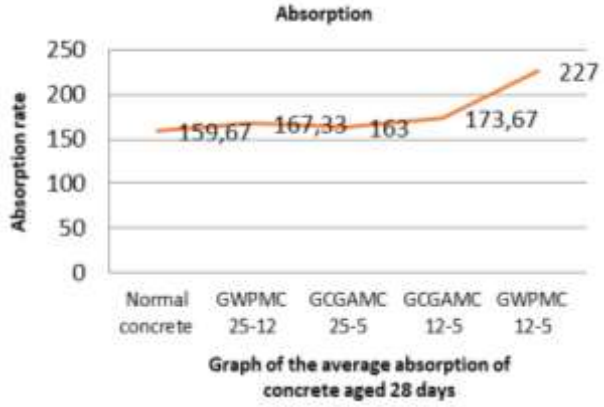


***Figure 5.*** *Graph of the percentage of compressive strength of concrete aged 28 days.*

From the results of Figure 5., it shows that the use of gradation 12-5 has the highest absorption value compared to the use of gradation 25-12. The highest average absorption results were obtained in concrete with a mixture of 12-5 graded coffee grounds ash at the age of 28 days with an absorption of 184.

## V. Conclusion

From the results of research and discussion, several conclusions can be drawn, including the following:

1. The results showed that the addition of 8.5% sawdust and 8.5% coffee grounds in uniform gradations of 25-12 and 12-5 as added ingredients for the concrete mixture did not provide a compressive strength value through normal 28 days fresh water soaked concrete.
2. In this study, the addition of 8.5% sawdust with gradations of 25-12 as a concrete mixture gave the closest compressive strength value to normal 28-day fresh water immersion concrete of 29.1 MPa.
3. Comparison of the compressive strength of normal concrete, the compressive strength of concrete with a mixture of 25-12 gradations of wood powder, a mixture of 25-12 grades of coffee grounds, concrete, 12-5 gradation of wood powder mixture, 12-5 of coffee grounds mixed with concrete. It has an average compressive strength of 30.11 MPa, 29.1 MPa, 27.1 MPa, 26.1 MPa and 23.09 MPa. The average absorption is 116, 123,33, 148,33,169,33 and 184.
4. The results showed the addition of 8.5% coffee grounds ash gradation 12-5 as a concrete mixture gave the lowest compressive strength value in concrete and gave the highest effect on absorption compared to normal 28 days fresh water immersion concrete.
5. Based on the results of research conducted by concrete using a mixture of uniform gradation and added materials, there is a slump, and the highest slump value in normal concrete is 11.9 with a compressive strength of 30.11 MPa and the lowest slump value is in a mixture of uniformly graded sawdust. 12-5 of 8.6 with a compressive strength of 27.1 MPa.
6. In this study, it can be concluded that the use of uniform gradation can reduce the compressive strength and the added material that is mixed has not been able to increase the compressive strength more than normal concrete, but a mixture of 25-12 grade wood powder, and 25-12 grade coffee grounds and graded wood powder. 12-5 has exceeded the compressive strength of the plan, only in the mixture of coffee grounds, graded 12-5, it is not sufficient than the compressive strength of the plan.

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