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ANALYSIS OF COMPRESSIVE STRENGTH OF PAVING BLOCKS WITH THE ADDITION OF WOOD POWDER WASTE AND LIQUID LIME (CACO3)

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ABSTRACT

This research was carried out to find out how strong the compressive strength of the Paving Block is to withstand the load above it, by adding sawdust waste and liquid lime (CaCO3). But for Paving Blocks, the effects of adding sawdust waste and liquid lime (CaCO3) are not yet well known. Further research needs to be carried out on the addition of waste sawdust and liquid lime (CaCO3) in making Paving Blocks. The aim of this research is to reduce environmental pollution caused by sawdust waste, and to use this waste as additional construction material technology and to find out how strong the compressive strength of Paving Blocks is so that it can be used as a construction tool. The results of testing the compressive strength of Paving Block aged 7 days in a ratio of 1:5 with the addition of Wood Powder Waste and Liquid Lime (CaCO3), resulted in an average compressive strength of 310.85 Kg/cm2. In a ratio of 1:6 with the addition of Wood Powder Waste and Liquid Lime (CaCO3), an average compressive strength of 241.02 Kg/cm2 was produced. Normal 1:5 Paving Block from 2 samples produces an Average Stress fcr' of 203.62 Kg/cm^2 and normal 1:6 Paving Block from 2 samples produces an Average Stress fcr' of 186.08 Kg/cm^2.

Keywords: *Compressive Strength, Paving Block, Wood Powder Waste and Liquid Lime (CaCO3)*

1. Introduction

Paving Block is a building material composition made from a mixture of Portland cement or similar hydraulic adhesive, water, and aggregate with other additives that do not reduce the quality of the Paving Block. Apart from being a ground surface cover and water absorption, Paving Block is a new alternative as a pavement system. Based on the binding material, ground surface pavement construction can be divided into flexible, rigid, and composite pavement [1].

Based on its quality, Paving Blocks can be used for roads, parking, pedestrians and parks as well as other uses. Several other advantages are that Paving Blocks are better than other types of pavement and are more economical to maintain, do not require heavy equipment to work/install, and can be mass produced. As we know, our country contributes to waste in the world. So the use of waste in updating building materials is highly recommended.

Wood dust waste can be used as a mixture with cement. Wood powder waste has good compressive strength capabilities, so the use of a mixture of wood powder waste is expected to provide the advantages of each material, resulting in good quality. Sawdust waste has ductile properties, can absorb water, and has a good level of durability if it is not in direct contact with the weather, so this material is very good for use as a mixture for making cement. The basic idea in using sawdust waste household materials is to utilize unused materials that cannot be recycled. Therefore, this research tries to utilize sawdust waste inspired by household materials as an additional material in making concrete [2].

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Liquid lime (CaCO3) is physically able to make the paste move more freely to fill the pores of the paving. This results in the porosity of the paving being smaller and the density of the paving increasing so that the strength of the paving block will also increase. The addition of liquid lime (CaCO3) has the effect of maintaining the planned cement water factor but must be adjusted to the recommended dose. If the dose used is excessive, it will cause the paving to set for a long time and can even reduce the strength of the paving itself [3].

2. Material and Methods

According to SNI 03-0691-1996 concerning Specifications for concrete materials including [11]:

1. The granules are hard and sharp
2. Resistant to extreme weather effects
3. Does not contain mud
4. Fine grain modulus according to gradation provisions
5. Especially for highly durable concrete, fine aggregate should not be reactive to alkalis
6. Use of fine aggregate from the chain must be permitted by a recognized inspection agency

2.1. Tools and materials :

1. Portland cement
2. Good quality sand that has been sifted and washed
3. Rock ash
4. Prints (quadrangles, hexagons, etc.)
5. Bat
6. Water

2.2. How to make Paving Block :

1. Mix cement and sand using a ratio of 1:5, or 1:6. The composition of these constituent materials has a major influence on the compressive strength of the resulting paving blocks.
2. Add enough water, make sure the mixture is not too wet. Hold the mixture with your hands, then feel whether it is strong enough.
3. Second mixture, mix enough sand and cement then sprinkle just a little water so that the cement can bind the sand. Stir this mixture until it is completely even and slightly wet. This second mixture serves to wrap the first mixture so that it doesn't stick to the mold.
4. Insert the second mixture into the mold in such a way. After that, spread the first mixture on top. You can add mixed ingredients in the middle of the second layer of mixture to produce paving blocks with certain characteristics.
5. Adjust the position of the mold and make sure everything is arranged in such a way. Use a stick and a hammer to compact the paving block mixture in the mold by hitting it repeatedly until the desired level of density is obtained.
6. Lift the finished prints, then place them in the drying room. This raw paving block must be placed on a plane that has a flat surface.
7. Quality testing by changing the position of the paving blocks that have just been printed to standing. Good quality paving blocks are characterized by their permanent shape and not experiencing change/damage.

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2.3. Data Processing

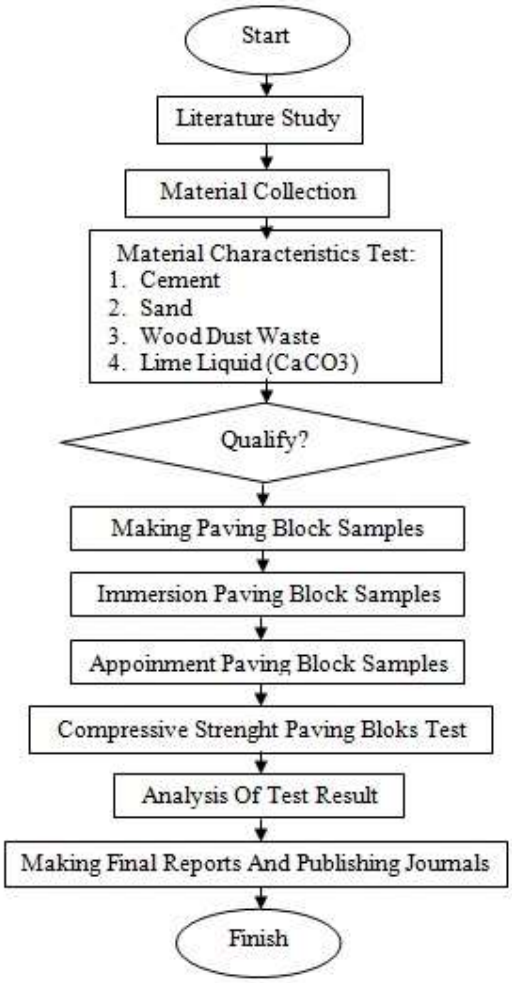

Figure 1. Research Flowchart

3. Results and Discussion

3.1. Paving Blocks

Paving blocks became known in Indonesia in 1976 as a material covering and hardening the soil surface. Paving block (concrete brick) is a composition of building materials made from a mixture portland cement or hydraulic adhesive, water, and aggregate (ash stone/sand) with or without other additives to the composition certain (SNI 03-0691-1996). Paving blocks also have a semi-permeable or permeable surface, allowing water to enter the ground. Paving blocks used as a pavement layer, both inside and outside the building can be colored like the original or given a certain color (SNI 03-0691-1996) [1][2].

Paving blocks are widely used for various purposes, starting from simple needs to demanding uses special specifications. Paving blocks can be used for road pavement in housing complexes or residential areas, beautify sidewalks 6 roads in cities, beautify parks, yards and yards, pavement of parking areas, office areas, factories, parks and yards schools, as well as in hotel and restaurant areas [3][4]. Paving blocks can even be done used in special areas such as container ports, ports air, bus terminal and train station. The advantages of paving blocks in various aspects of their use and

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Its manufacture means that paving block production is now starting to increase engaged in home industry and large industry [5][6]. As for the advantages among others:

a. It is easy to make so it provides good job opportunities widely to society.
b. If there is damage, repairs do not require additional materials which is a lot because paving blocks are a material that can be used returned even though it had been demolished.
c. Resistant to high static, dynamic and shock loads
d. Flexible enough to handle differentials settlement)
e. Has good durability.

Everything that has advantages must have disadvantages or weakness. The weakness of Paving Block is that it is easy wavy if the foundation is not strong and less comfortable for vehicle at high speed.

Figure 2. Paving Blocks

3.2. Test compressive strength

In making paving blocks, tests need to be carried out to produce them paving blocks which can be used as pavement material. Compressive strength is the ability of concrete to accept compressive forces per unit area. Compressive strength identify the quality of a structure. The higher the strength of the structure the desired quality, the higher the quality of the concrete produced. This test is carried out to determine the compressive strength of the test object paving blocks. Testing the compressive strength of paving blocks using a compression tool test [5].

Figure 3. Test Compressive Strenght

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3.3. Fine Aggregate

Fine aggregate is a natural mineral that functions as a filler in concrete mixtures that have a grain size of less than 5 mm or pass sieve no. 4 and stuck to sieve no. 200. Fine aggregate comes from the results natural disintegration of natural rock or artificial sand produced from tools stone crusher. Sand is generally found in large rivers. However It is best to choose the sand used for building materials qualify [7].

Figure 4. Fine Agregate

3.4. Portland Cement

Portland cement is a hydraulic binder. which is produced by grinding clinker consisting of calcium silicate hydraulics, which generally contain one or more forms of calcium sulfate as an additional ingredient that is ground together with the main ingredient. The actual composition of the various compounds present varies from one type of cement to another, for various types 14 cement is added to various types of other raw materials, in accordance with the need for cement use is caused by location conditions and certain conditions required construction implementation [8].

Figure 5. Portland Cement

3.5. Water

Water is an important basic ingredient for making concrete, however the price is the cheapest. Water is needed to react with cement, as well to act as a lubricant between the aggregate granules so that they can be easily lubricated worked and compacted. To react with cement, water is required only about 30% of the weight of cement, if its use occurs 23 excess water, the strength of the resulting concrete will also be low as well as the concrete becomes porous / hollow. This is caused by bleeding events, namely the movement of water to the surface along with cement particles in the mix fresh concrete that has just been poured, where these cement particles are left

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will become empty spaces in the concrete. The water that can be used as a concrete mixture is water that is used in a concrete mixture will produce concrete with a strength of 90% from concrete using distilled water [9].

3.6. Powder Wood

Powder Wood (sawdust) is waste obtained from the result of sawing wood using a machine or manually. Wood sawdust can also be used used as a sound absorber [10]. Quality of soundproofing material is indicated by the value α (material absorption coefficient for sound), The larger α, the better it is used as a sound dampener [11]. Values range from 0 to 1. If α is 0, it means there is no sound absorbed. Meanwhile, if α is 1, it means 100% The incoming sound is absorbed by the material. On in this research, wood waste is used for replacement for some of the fine aggregate used in light brick making mixture. Wood has used as a structural material since first. Wood has tensile and compressive strength, and structurally suitable for the role elements that carry axial compression loads, axial tensile, and bending loads [12].

Figure 6. Powder Wood

3.7. Liquid Lime

Liquid lime is water or a solution containing the compound Calcium Hydroxide. When viewed, the appearance of this compound is like white and colorless crystals or powder [13]. This is due to the reaction between water and potassium oxide (CaCO3). Apart from that, this compound also takes the form of a precipitate resulting from a mixture of Calcium Chloride (CaCl2) and Sodium Hydroxide (NaOH) solutions. This calcium hydroxide compound cannot dissolve completely in water. Especially at a temperature of 25°C. When viewed physically, the water is clear, colorless, has a slight earthy odor and has a bitter taste, due to the manifestation of the Calcium Hydroxide compound [14].

Figure 7. Liquid Lime

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3.8. Paving Compressive Strength Test Results

Compressive Strength Test Results on Paving 1: 5 with a mixture Addition of Wood Powder Waste and Liquid Lime (CaCO3)

Sample 1

Manufacture Date = 23 August 2024
Test Date = 30 August 2024
Sample Age = 7 Days
Sample Weight = 4250 Grams

Area of Test Object = $(\frac{2}{3} \times \sqrt{3}) \times S^2$ (1)
$= (\frac{2}{3} \times \sqrt{3}) \times 12^2$
$= 374\ cm^2$

Dial reading = 780 KN

Compressive Strength = (Dial Reading x 101,987) / Area of Test Object (2)
= (780 x 101,987) / 374
= 212,70 Kg/cm^2

Time Conversion = 0,65

7 Day Compressive Strength fb' = Compressive Strength / Time Conversion (3)
= 212,70 / 0,65
= 328,43 Kg/cm^2

Sample 2

Manufacture Date = 23 August 2024
Test Date = 30 August 2024
Sample Age = 7 Days
Sample Weight = 4200 Grams

Area of Test Object = $(\frac{2}{3} \times \sqrt{3}) \times S^2$ (4)
$= (\frac{2}{3} \times \sqrt{3}) \times 12^2$
$= 374\ cm^2$

Dial reading = 750 KN

Compressive Strength = (Dial Reading x 101,987) / Area of Test Object (5)
= (750 x 101,987) / 374
= 204,52 Kg/cm^2

Time Conversion = 0,65

7 Day Compressive Strength fb' = Compressive Strength / Time Conversion (6)
= 204,52 / 0,65
= 324,64 Kg/cm^2

Average Voltage fcr' = Total Compressive Strength 7 Days fb'/ Number of Samples (7)
= (328,43 + 324,64 + 299,45 + 296,63 + 305,09) / 5
= 1554,24 / 5
= 310,85 Kg/cm^2

Compressive Strength Test Results on Paving 1: 6 with a mixture Addition of Wood Powder Waste and Liquid Lime (CaCO3)

Sample 6

Manufacture Date = 23 August 2024
Test Date = 30 August 2024
Sample Age = 7 Days
Sample Weight = 4300 Grams

Area of Test Object = $(\frac{2}{3} \times \sqrt{3}) \times S^2$ (8)
$= (\frac{2}{3} \times \sqrt{3}) \times 12^2$

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$= 374\ cm^2$

Dial reading = 560 KN

Compressive Strength = (Dial Reading x 101,987) / Area of Test Object (9)

$= (560 \times 101{,}987) / 374$

$= 152{,}71\ Kg/cm^2$

Time Conversion = 0,65

7 Day Compressive Strength fb' = Compressive Strength / Time Conversion (10)

$= 152{,}71 / 0{,}65$

$= 236{,}74\ Kg/cm^2$

Sample 7

Manufacture Date = 23 August 2024

Test Date = 30 August 2024

Sample Age = 7 Days

Sample Weight = 4200 Grams

Area of Test Object = $(\frac{2}{3} \times \sqrt{3}) \times S^2$ (11)

$= (\frac{2}{3} \times \sqrt{3}) \times 12^2$

$= 374\ cm^2$

Dial reading = 590 KN

Compressive Strength = (Dial Reading x 101,987) / Area of Test Object (12)

$= (590 \times 101{,}987) / 374$

$= 160{,}89\ Kg/cm^2$

Time Conversion = 0,65

7 Day Compressive Strength fb' = Compressive Strength / Time Conversion (13)

$= 160{,}89 / 0{,}65$

$= 249{,}55\ Kg/cm^2$

Average Voltage fcr' = Total Compressive Strength 7 Days fb'/ Number of Samples (14)

$= (236{,}74 + 249{,}55 + 247{,}38 + 235{,}72 + 235{,}72) / 5$

$= 1205{,}11 / 5$

$= 241{,}02\ Kg/cm^2$

Compressive Strength Test Results on Paving 1: 5 Normal

Sample 11

Manufacture Date = 23 August 2024

Test Date = 30 August 2024

Sample Age = 7 Days

Sample Weight = 4000 Grams

Area of Test Object = $(\frac{2}{3} \times \sqrt{3}) \times S^2$ (15)

$= (\frac{2}{3} \times \sqrt{3}) \times 12^2$

$= 374\ cm^2$

Dial reading = 480 KN

Compressive Strength = (Dial Reading x 101.987) / Area of Test Object (16)

$= (480 \times 101{,}987) / 374$

$= 130{,}89\ Kg/cm^2$

Time Conversion = 0,65

7 Day Compressive Strength fb' = Compressive Strength / Time Conversion (17)

$= 130{,}89 / 0{,}65$

$= 202{,}57\ Kg/cm^2$

Sample 12

Manufacture Date = 23 August 2024

Test Date = 30 August 2024

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Sample Age = 7 Days
Sample Weight = 4000 Grams
Area of Test Object = $(\frac{2}{3} \text{ x } \sqrt{3}) \text{ x } S^2$ (18)
$= (\frac{2}{3} \text{ x } \sqrt{3}) \text{ x } 12^2$
$= 374 \text{ cm}^2$
Dial reading = 480 KN
Compressive Strength = (Dial Reading x 101.987) / Area of Test Object (19)
= (480 x 101,987) / 374
= 133,62 Kg/cm^2
Time Conversion = 0,65
7 Day Compressive Strength fb' = Compressive Strength / Time Conversion (20)
= 130,89 / 0,65
= 204,67 Kg/cm^2

Average Voltage fcr' = Total Compressive Strength 7 Days fb'/ Number of Samples (21)
= (202,57 + 204,67) / 2
= 407,24 / 2
= 203,62 Kg/cm^2

Compressive Strength Test Results on Paving 1: 6 Normal

Sample 13
Manufacture Date = 23 August 2024
Test Date = 30 August 2024
Sample Age = 7 Days
Sample Weight = 4150 Grams
Area of Test Object = $(\frac{2}{3} \text{ x } \sqrt{3}) \text{ x } S^2$ (22)
$= (\frac{2}{3} \text{ x } \sqrt{3}) \text{ x } 12^2$
$= 374 \text{ cm}^2$
Dial reading = 450 KN
Compressive Strength = (Dial Reading x 101.987) / Area of Test Object (23)
= (450 x 101,987) / 374
= 122,71 Kg/cm^2
Time Conversion = 0,65
7 Day Compressive Strength fb' = Compressive Strength / Time Conversion (24)
= 122,71 / 0,65
= 189,71 Kg/cm^2

Sample 14
Manufacture Date = 23 August 2024
Test Date = 30 August 2024
Sample Age = 7 Days
Sample Weight = 4150 Grams
Area of Test Object = $(\frac{2}{3} \text{ x } \sqrt{3}) \text{ x } S^2$ (25)
$= (\frac{2}{3} \text{ x } \sqrt{3}) \text{ x } 12^2$
$= 374 \text{ cm}^2$
Dial reading = 450 KN
Compressive Strength = (Dial Reading x 101.987) / Area of Test Object (26)
= (450 x 101,987) / 374
= 117,26 Kg/cm^2
Time Conversion = 0,65
7 Day Compressive Strength fb' = Compressive Strength / Time Conversion (27)

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= 122,71 / 0,65
= 182,45 Kg/cm^2

Average Voltage fcr' = Total Compressive Strength 7 Days fb'/ Number of Samples (28)
= (189,71 + 182,45) / 2
= 372,16 / 2
= 186,08 Kg/cm^2

Table 1. Paving Block Compressive Strength Test Results

No	Test Object Name	Sample Weight (gr)	Test Object Area (cm^2)	Dial Reading (KN)	Compressive Strength (fc) (kg/cm^2)	Compressive Strength 7 Days fb' (kg/cm^2)	Average Stress fcr' (Kg/cm^2)
1	1:5 Mix	4250	374	780	212,70	328,43	310,85
2		4200	374	750	204,52	324,64	
3		4000	374	690	188,16	299,45	
4		4150	374	750	190,88	296,63	
5		4000	374	720	196,34	305,09	
6	1:6 Mix	4300	374	560	152,71	236,74	241,02
7		4200	374	590	160,89	249,55	
8		4100	374	580	158,16	247,38	
9		4250	374	550	149,98	235,72	
10		4450	374	550	149,98	235,72	
11	1:5 Normal	4000	374	480	130,89	202,57	203,62
12		4200	374	490	133,62	204,67	
13	1:6 Normal	4150	374	450	122,71	189,71	186,08
14		4000	374	430	117,26	182,45	

Source: Calculation Results, 2024

Table 2. Time Conversion

Concrete Age (Days)	**3**	**7**	**14**	**21**	**28**	**90**
PC Paving Block	0,40	0,65	0,88	0,95	1,00	1,20
PC Concrete	0,55	0,75	0,90	0,95	1,00	1,15

Source: Madura University Civil Engineering Laboratory, 2024

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Figure 8. Sampling After Testing

Figure 9. Paving Block that has been tested

4. Conclusions

Results from testing the compressive strength of Paving Block aged 7 days in a ratio of 1:5 with the addition of Wood Powder Waste and Liquid Lime (CaCO3), sample 1 produced a compressive strength of 328.43 Kg/cm^2, sample 2 produced a compressive strength of 324.64 Kg /cm^2, sample 3 produces a compressive strength of 299.45 Kg/cm^2, sample 4 produces a compressive strength of 296.63 Kg/cm^2, sample 5 produces a compressive strength of 302.06 Kg/cm2, resulting in an average compressive strength of 305.09 Kg/cm^2.

In a ratio of 1:6 with the addition of Wood Powder Waste and Liquid Lime (CaCO3), sample 6 produces a compressive strength of 236.74 Kg/cm^2, sample 7 produces a compressive strength of 249.55 Kg/cm^2, sample 8 produces a compressive strength of 247.38 Kg/cm^2, sample 9 produces a compressive strength of 235.72 Kg/cm2, sample 10 produces a compressive strength of 235.72 Kg/cm^2, resulting in average compressive strength of 237.45 Kg/cm^2.

Normal 1:5 Paving Block from 2 samples produces an Average Stress fcr' of 203.62 Kg/cm^2 and normal 1:6 Paving Block from 2 samples produces an Average Stress fcr' of 186.08 Kg/cm^2.

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