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The Effects of Cement Typeson Porous Concrete

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ABSTRACT:The development of developments in Indonesia causes a reduction in green lands. In addition, the public awareness of the environment is a problem that must be considered. Porous concretebecomes one of the solutions in pavement construction, concrete sheet pile, soil retaining walls, which is a product that can be said to be successful in meeting expectations as an environmentally friendly construction. Calculation of the concrete mixture using the ACI 522R-10 Report on Pervious Concrete method with a compressive strength of 16.55 MPa. Cement mix variations are divided into 5 to find the best type of cement for making porous concrete. Test object in the form of a cylinder with Ø15 cm and 30 cm high. Testing of specimens includes tests for volume weight, compressive strength, split tensile strength, modulus of elasticity of concrete, porosity, absorption, and permeability. From the research, it was found that the volume yield of porous concrete weight was 1.807.97 kg / m3 to 1.881.58 kg.m3 where porous concrete was included as lightweight concrete. The average compressive strength value of porous concrete is 9,253 - 13,870 MPa. The tensile strength value of porous concrete is 5,603 MPa to 5,902 MPa. The average value of the modulus of elasticity for the age of 28 days was 10,263.95 - 12,899.72 MPa. The average porosity value was between 8.307 - 13.097%. The average absorption value was between 3,452 - 5,444%. The average permeability value was between 43.54-33.14 liters / sec/m2. From this research, shows that the compressive strength of the plan which is 16 MPa,is not achieved as planned due to the slump in the max 10 cm plan. It turns out to produce a bigger slump where anaverage of 18.6 cm and there is an effect of cement on physical and physical properties. machined from porous concrete.

KEYWORDS: Development, Porous concrete. Physical and Mechanical, variety of cement

I. INTRODUCTION

The development of developments in Indonesia causes the reduction of green land. Coupled with the lack of public awareness of the environment is an issue that must be considered. One of the environmental problems that must be prioritized in Indonesia itself is in water treatment, especially the treatment of waterways. Where the iMPact of the importance of greening and poor water treatment is a flood disaster that very often occurs when the rainy season comes.

Porous concrete becomes one of the solutions in pavement construction, turap concrete, ground retaining, which is a product that can be said to be successful in meeting expectations as an environmentally friendly construction. Porous concrete has a uniqueness when coMPared. The process of making porous concrete does not use fine aggregates as a cavity filling material. However when itis used, fine aggregates is usually only used in small quantities with the aim that the cavities in concrete are not covered.

This research aims to determine the influence of cement type as a porous concrete mixture material against the physical and mechanical properties of the resulting concrete, find the best type of cement for porous concrete mixture as well as the composition of the material used for the porous compressive strength of 16.55 MPa.

II. METHODOLOGY

This research study is a library study and an experimental study of porous concrete. The research site at the Materials and Construction Laboratory of the Faculty of Engineering, Tanjungpura University Pontianak.

1. Material

The materials used in the manufacture of porus concrete are as follows:

1. The cement used is PCC and PPC cement.
2. The water used is PH of 6-7
3. The rough stone aggregate

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4. Superplasticizersikamen LN

2. Equipment

The equipment used in this test is a compressive testing machine, bearing block, Permeability tool, Porosity tool, cylinder mold, shieve sekker machine, material oven, scale, mixer, los engeles machine, slump tool,organic plate and other supporting tools.

3. Stages / Research Procedures

The stages of the implementation of this research are divided into several parts, namely as follows:

1. Material preparation and inspection
a. Collection of theoretical basis, previous research journals that support this research
b. Preparation of materials and testing of materials
2. Mixed planning

Calculation of the concrete mixture using ACI 522R-10 with a design compressive strength of 16.55 MPa. The calculation of the need for the production of the test object consisted of 5 sample variations, five sample variations with different cement brandsthat arePCC TigaRodacement, PPC Gresik cement, PCC Holcim cement, PPC Puger cement, and PCC Conch cement.

3. Casting of test objects

The test object is made in the form of a cylinder with a height of 30 cm and a diameter of 15 cm as many as 75 cylinders for each variation of the sample. Casting of test objects is assisted by a concrete mixer machine.

4. Care of the test object

Treatment of specimens is carried out by immersing them in a tub filled with water at room temperature. Treatment is carried out one day after casting to one day before testing.

5. Volume weight testing

Testing the volume weight of the concrete cylinder using an electric weighing tool with an accuracy of 0.05 kg at the age of concrete 3, 7, 14, 21, 28 days.

6. Compressive strength test

Testing the compressive strength of concrete based on SNI 03-1974-2011, this study is using a MTB brand compressive testing machine with a capacity of 2000 kN and an accuracy of 5 kN at the age of 3, 7, 14, 21, 28 days.

7. Permeability Testing

Permeability testing is carried out to determine and measure the ease with which water can pass concrete. The test is carried out using a permeability tool

8. Tensile strength test

Testing for split tensile strength based on SNI 03-2491-2002, this study is using a bearing block tool and a MTB brand compressive testing machine with a capacity of 2,000 kN and an accuracy of 5 kN at the age of 28 days.

9. Testing the modulus of elasticity

Tensile strength test based on SNI 03-2491-2002, this research is using modulus test equipment and compressive testing machine MTB brand with a capacity of 2,000 kN and accuracy of 5 kN at the age of 28 days.

4. Method of Analysis

Volume weight can be calculated by the formula:

$$W_c = \frac{m}{V} \quad (1)$$

Where :
Wc= volume weight (kg/ m^3)
m = weight of concrete (kg)
V = volume of concrete (m^3)

Compressive strength can be calculated by the formula:

$$f_c = \frac{P}{A} \quad (2)$$

Where
fc= compressive strength (MPa)
P = maximum test load (N)
A = area of contact area (mm^2)

The permeability coefficient can be calculated by the formula:

$$K = \frac{\rho g L Q}{PA} \quad (3)$$

Where :
K = permeability coefficient (cm/s)
ρ = density of water (kg/cm^3)
g = acceleration due to gravity (cm/s^2)
L = length or height of the sample (cm)
Q = flow rate of water (cm^3/sec)
P = pressure of water (kgcm / s^2 / cm^2)
A = cross-sectional area of the sample (cm2)

The split tensile strength can be calculated by the formula:

$$f'_{ct} = \frac{2P}{\pi t D} \quad (4)$$

Where :
f'ct = tensile strength of concrete (N / mm2)
P = current maximum compressive loadconcrete cylinder split / collapse (N)
π = phi (22/7)
t = height / length of concrete cylinder(mm)
d = diameter of concrete cylinder (mm)

Composition of Cement

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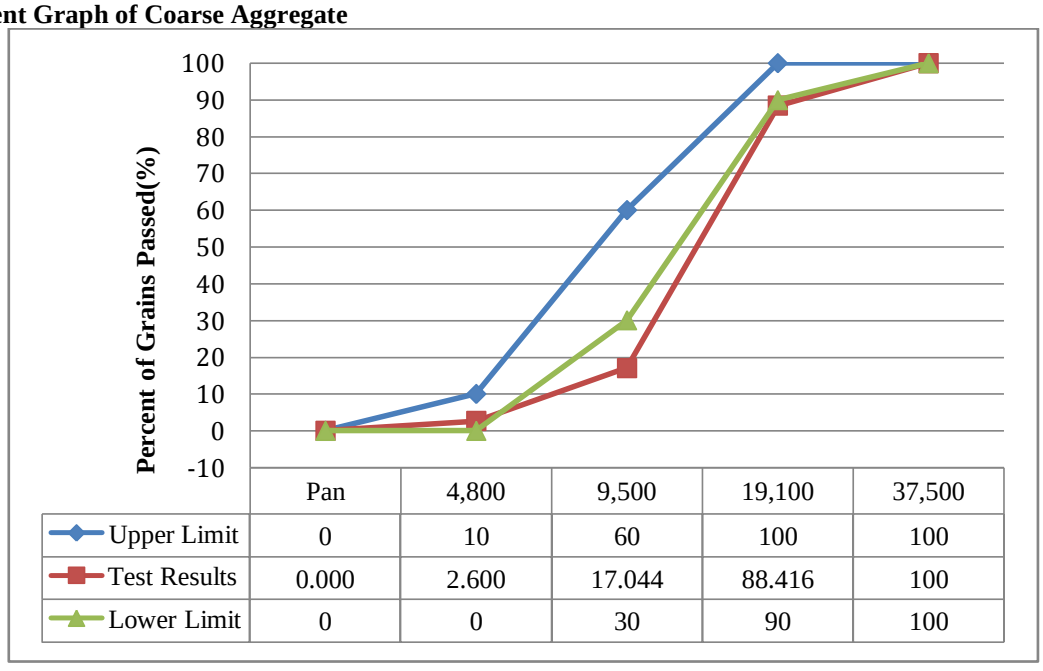
III. RESULTS AND DISCUSSION

1. Material Testing

Material testing methods refer to SNI and ASTM.

Element	Cement				
	PCC Holcim	PCC Tiga Roda	PPC Puger	PPC Gresik	PCC Conch
	%	%	%	%	%
Silicon Dioxide (SiO_2)	23.04	20.75	20.84	22.04	23.64
Aluminium Oxide (Al_2O_3)	7.40	5.11	7.10	5.40	8.40
Ferric Oxide (Fe_2O_3)	3.36	3.17	5.38	3.26	4.36
Calsium Oxide (CaO)	57.38	64.39	60.63	51.38	58.38
Magnesium Oxide (MgO)	1.91	Max 6	0.70	1.91	1.91
Sulphur Trioxide (SO_3)	2.0	-	1.99	2.0	2.0
Loss on Ignition (Lo_1)	3.94	-	3.04	2.94	3.28
Free Lime	0.56	0.76	0.86	0.56	0.56
Insoluble portions	10.96	-	3.19	6.96	8.96
Total Alkaline (Na_2O)	-	0.39	0.52	-	-

Gradient Graph of Coarse Aggregate



From the results of testing, the characteristics of all materials still meet the requirements of SNI and ASTM so that the materials that have been tested are fit for use.

2. Concrete Mix Results

Calculation of the concrete mixture using the ACI 522R-10 Report on Pervious Concrete, here are the results of the concrete mixture

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Composition of Concrete Mixtures

No.	Mix	Volume	Unit
1	Cement Weight	251.748	Kg
2	Water Weight	100.699	Kg
3	Coarse Aggregate Weight	1,542.188	Kg
4	Superplasticizer	1.259	Kg
Total		1,894.636	Kg

3. Slump test

The average slump test is 18.6 cm, this means that the mixture of variations 1 to 5 has a high level of discomfort.

Slump test

No.	Mix	Slump Test (cm)
1	PCC Holcim	18.5
2	PPC Gersik	19.0
3	PCC Conch	17.5
4	PCC Tiga Roda	17.4
5	PPC Puger	18.4

4. Volume Weight

The results of volume weight testing can be seen in the following table:

Volume Weight

No	Sample	Average Volume Weight per day (kg / m^3)				
		3	7	14	21	28
1	PCC Holcim	1,815	1,812	1,810	1.810	1,808
2	PPC Gersik	1,835	1,841	1,843	1.842	1,841
3	PCC Conch	1,819	1,840	1,841	1,841	1,841
4	PCC Tiga Roda	1,885	1,881	1,881	1,881	1,882
5	PPC Puger	1,822	1,833	1,833	1,833	1,833

From the table, it can be seen that for the weight of the volume test, the weight of the porous concrete volume is 1.807.97 kg / m^3 up to 1.881.58 kg.m^3. Where a large volume is porous concrete using three-wheeled cement, this means that the mixture of variations 1 to 5 includes lightweight concrete. It can be seen that the weight of porous concrete is lighter than normal concrete in general and there are also several variations in which the weight of the concrete volume is increasing.

5. Compressive Strength

The results of the concrete compressive strength test can be seen in the following table:

Compressive Strength

No	Sample	Average Compressive Strength(Days)(MPa)				
		3	7	14	21	28
1	PCC Holcim	6.635	9.554	11.943	10.085	11.253
2	PPC Gersik	10.085	9.023	12.739	12.739	12.102
3	PCC Conch	7.696	10.35	12.208	13.535	13.87
4	PCC Tiga Roda	9.554	9.82	12.899	13.21	13.51
5	PPC Puger	8.227	8.554	8.943	9085	9.253

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From the table, it can be seen that the porous concrete of each variation taken from the 15 samples that have been made produces an average compressive strength of 28 days between 9,253 - 13,870 MPa. From the results obtained, the greatest compressive strength is variation 3 using PCC type cement, while the lowest is variation 5 using PPC type cement. From the table we can also see that the compressive strength of porous concrete from the age of 3 days to 28 days has experienced an increase in strength.

6. Tensile Strength

The results of the concrete split tensile strength test at the age of 28 days can be seen in the following table:

Tensile Strength

No	Mix	Average Tensile Strength (MPa)
1	PCC Holcim	5.803
2	PPC Gersik	5.803
3	PCC Conch	5.852
4	PCC Tiga Roda	5.902
5	PPC Puger	5.603

From this table it can be seen that for the tensile strength test, the tensile strength of porous concrete is obtained from 5.603 MPa to 5.902 MPa. Where the large tensile strength is porous concrete using three-wheel cement.

7. Modulus Of Elasticity

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

Modulus Of Elasticity

No	Mix	Mean Modulus of Elasticity (Ec) MPa
1	PCC Holcim	11,088.92
2	PPC Gersik	11,812.54
3	PCC Conch	12,649.91
4	PCC Tiga Roda	12,899.72
5	PPC Puger	10,263.95

From the table, it can be seen that the porous concrete of each variation taken from the 3 samples that have been made results in an average modulus of elasticity of 28 days of age between 10,263.95 - 12,899.72 MPa. From the results obtained, the greatest modulus of elasticity is variation 2 using PCC type cement, while the lowest is variation 5 using PPC type cement. From the results obtained, it turns out that the modulus of elasticity of porous concrete is smaller than normal concrete ($2,35x10^4$ - $2,4x10^4$) MPa.

8. Porosity

Testing the porosity of porous concrete using a small cylinder 15 x 30 cm, the three specimens were weighed in oven dry conditions, in water, and SSD conditions then recorded the results according to the results of weighing. The test results are presented in the following table:

Porosity

No	Mix	Porosity Average (%)
1	PCC Holcim	11.107
2	PPC Gersik	8.307
3	PCC Conch	10.417

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4	PCC Tiga Roda	12.023
5	PPC Puger	13.097

From the table, it can be seen that the porous concrete of each variation taken from 6 cylindrical samples with a diameter of 15 cm and a height of 30 cm has been made, which results in an average porosity of between 8.307 - 13.097%. Where the more porosity of the porous concrete, the lighter the porous concrete. Thus, based on the measure of average porosity, variation 5 is very good for porous concrete mixtures.But with the number of pores, the strength of the concrete will be weaker. Therefore, the best variation is variation 2 with the smallest level of porosity.

9. Absorption

The absorption test uses 15cm x 30cm small cylinder porous concrete. This test is done in order to find out the amount of absorption for each variation, the data is presented as follows:

Absorption

No	Mix	Absorption Rate (%)
1	PCC Holcim	4.486
2	PPC Gersik	3.452
3	PCC Conch	4.203
4	PCC Tiga Roda	4.921
5	PPC Puger	5.444

From the table it can be seen that the porous concrete of each variation taken from 6 cylindrical samples with a diameter of 15 cm and a height of 30 cm that has been made, which results in an average absorption of between 3.452 - 5.444%. Where the greater the absorption of porous concrete results in the porous concrete getting heavier and better at absorbing water. Thus, for a review of the average absorption, a very good variation for porous concrete mixtures is variation 5. However, with the amount of absorption, the strength of the concrete will be weaker. Therefore, the best variation is variation 2 with the smallest absorption rate.

10. Permeability

Due to the presence of holes / pores in porous concrete, it results in permeability. The permeability data from the research that has been done are as follows:

Permeability

No	Mix	Permeability (ltr/sec/m^2)
1	PCC Holcim	38.30
2	PPC Gersik	33.14
3	PCC Conch	36.40
4	PCC Tiga Roda	43.39
5	PPC Puger	43.54

From the table it can be seen that the porous concrete of each variation taken from 6 cylindrical samples of 15 cm diameter 30 cm high has been made, which results in an average permeability between 43.54-33.14 liters / s / m2. The large permeability of the porous concrete causes the porous concrete to get worse. Thus, for the reference of the average permeability, it is very good for a porous mixture is variation 2 because it has a small permeability.

IV. CONCLUSION

From the research and the results obtained, several conclusions can be drawn, as follows:

1. The compressive strength of the plan is 16 MPa, apparently, it does not reach according to the plan due to the plan slump is max 10 cm which actually produces a larger slump where the average is 18.6 cm.
2. From the above discussion, the H1B hypothesis which states that there is an effect of cement type on the physical and mechanical properties

of porous concrete is evident from the above conclusions. This can be seen from the physical and mechanical properties of the resulting porous concrete.

3. Judging from the results obtained, the best (optimum) type of cement is variation 4 (TigaRoda brand) using PCC cement in terms of its physical and mechanical properties.

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SOME OF THE ADVANAGES FROM THE RESULTS ABOVE

1. Physical and mechanical properties of porous concrete
2. The best type of cement for porous concrete mixes

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