EXPERIMENTAL STUDY OF POROUS CONCRETE WITH VARIOUS ADDITON OF RICE HUSK ASH

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Focus from this study is porous concrete. To improve the mechanic properties's porous concrete, one of which is with addition of fiber. The Fiber material used in this study is ash of rice husk. Dimension's for cylinder sample is 15 x 30 cm, as much 84 samples with addition of fiber 0%, 0.5%, 1% and 1.5% from weight of cement. Result of porous concrete testing, with addition of fiber showed the largest pore volume is 22.081%. While porous concrete without addition of fiber, the largest percentage of pore volume is 23.533%. Weight of volume with addition fiber, the largest percentage is 1894.737 kg/m3 and without addition fiber is 1963.883 kg/m3. Value of compressive strength testing with addition fiber is 13.48 MPa and split tensile strength is obtained 1.94 MPa, while value of compressive strength without addition fiber is 12.03 MPa and split tensile strength is obtained 1.77 MPa. Value of flexural testing and modulus elastic of porous concrete with addition of fiber, respectively the value's 1.946 MPa and 342.85 MPa, while value of flexural testing and modulus elasticity of porous concrete without addition of fiber, respectively the value's 1.58 MPa and 360 MPa.

Keywords: Porous concrete, rice husk ash, compressive strength, split strength, flexural strength, modulus of elasticity.

PRELIMINARY

Pervious concrete, also known as porous concrete, is a type of concrete that has a cavity in its structure, allowing the fluid to multiply through the cavities contained in the concrete. According to the ACI 522R-10 Report on Pervious Concrete, porous concrete can be described as concrete formed from portland cement, coarse aggregate, slightly fine or nonexistent aggregate, and water.According to the function of porous concrete that is concrete pavement that is easy to pass by water there is a need for pores in the concrete, where the pore volume to be achieved is between 25 ± 5% of the volume of concrete so that it is easily passed by water (Neville et al., 1987). The process of making porous concrete is the same as the making of concrete in general, that is the material after mixed according to its composition and added water according to the water comparison factor to the cement (fas). The water factor of cement on non-sand concrete is around 0.36 and 0.46 while the factor value optimum cement water about 0.40. In non-sand concrete it is necessary to add admixture to add workability. With the optimum cement factor value, it can also produce maximum compressive strength of a non-sand concrete (Tjokrodimulyo, 1992). Porous concrete is not a type of concrete commonly used in a construction due to its pore nature. The pore nature of porous concrete makes this type of concrete has a lower compressive strength than the commonly used concrete type, thus making porous concrete more suitable when used for applications that do not require high compressive strength values.

RESEARCH METHODOLOGY

In this study, the specimen uses a cylinder with a diameter of 15 cm and a height of 30 cm. Test specimens for porous concrete without addition of fiber (BRN) of 12 samples, porous concrete with the addition of fiber husk fiber variation 0,5%, 1,0%, and 1,5% 54 samples and 9 samples for beam element, porous concrete with the addition of fiber fibers (BRSK) variations of 0.1%, 0.2%, and 0.3%. The compressive strength test comprised 60 samples for 3,7,14,21,28 days, and 12 samples for 28 days concrete tensile strength test and 12 beam samples for flexural test and modulus of elasticity. This research was conducted in Structural and Materials Laboratory, Civil Engineering Study Program, Faculty of Engineering, Christian University of Indonesia Paulus Makassar. The testing equipment used for compressive strength and tensile strength is the Universal Testing Machine 2000 KN capacity as shown in figures 1 and 2 as well as the flexural strength apparatus shown in figure 3.

Figure 1. Compression Strength Testing

Figure 2. Split Tensile Testing

Figure 3. Flexural Strength Testing

This research begins with collecting data characteristic of materials porous concrete are obtained from laboratory test, then design process of mixed composition, implementaion, maintenance and testing of specimen based on parameters determining porous concrete characteristics. Then analyze the data that have been obtained from the test results of laboratory test. Test data were analyzed to determine pore volume, volume weight, compressive strength and tensile strength as well as flexural strength, elastic modulus of porous concrete with various addition of rice husk ash. The research flow chart is shown in figure 4.

Figure 4. Flowchart of research

Pore volume to be achieved is range from 15-30% of the volume of concrete so easy to pass by water. The percentage of pore is calculated by the following formula:

$$V_p = \frac{(V_s - V_{po})}{V_s} \quad (1)$$

With,

V_p = percentage of pore volume (%)

V_s = cylinder volume (liters)

V_{po} = pore volume (liters)

And to calculate pore volume (V_{po})is used following formula,

$$V_{po} = \frac{(W_a - W_w)}{\gamma_w} \quad (2)$$

With,

W_a = dry air weight of cylinder (Kg)

W_w = weight in water of cylinder (Kg)

γw = volume weight of water (1 Kg/liter)

The weight of concrete or specific gravity of concrete is the ratio between the weight of the air cylinder volume of the concrete and the cylindrical volume expressed in kg / m3. The volume-weight is calculated by the following formula:

$$W_c = \frac{W_a}{V_s} (3)$$

With,

W_c = volume weight of concrete (kg/m^3)

W_a = dry air weight of cylinder (kg)

V_s = cylinder volume (m^3)

The value of concrete compressive strength can be calculated by the equation as follows

$$f'_c = \frac{P}{A} \quad (4)$$

With,

$f'c$ = compressive strength of cylinder [MPa]

P = maximum load [N]

A = sectional area of cylinder [mm^2]

The value of compressive strength and tensile strength of concrete are not proportional straight, each improvement of compressive strength is accompanied by a small increase in the value of its tensile strength. According to ASTM C496-86 standards the value of the approach obtained from the test results repeatedly reaches a strength of 0.5 - 0.6 times $\sqrt{f'_c}$, so that for normal concrete is used $0.57\sqrt{f'_c}$. So that vertical stress of can be calculated with

$$f_{spv} = \frac{2P}{\pi LD}\left[\frac{D^2}{r(D-r)}\right]-1 \qquad (5)$$

Horizontal stress can be calculated with:

$$f_{sp} = \frac{2P}{\pi LD} \qquad (6)$$

With,

f_{sp} = split stress of cylinder [MPa]

P = maksimum load [N]

L = height of cylinder [mm]

D = diameter of cylinder [mm]

r = space from load to compression area [mm]

To know the flexural strength of a block can be tested to specimen of concrete beam by means of central point loading. Flexural strenght of beam (modulus of rupture) if the collapse occurs in the middle of the span, calculated by the following equation,

$$R = \frac{PL}{bd^2} \qquad (7)$$

With,

R = modulus of rupture (MPa).

P = maximum load (KN).

L = long span (cm).

b = width of specimen (cm).

d = height of specimen (cm).

The test of elastic modulus uses the standard ASTM C 469 - 87a (6) "Standard Test Method for Static Modulus of Elasticity and Poisson 's Ratio in Compression", in which the modulus of elasticity is analyzed based on the value of stress occurring on concrete beams in the event of loading and value of extension the beam span after being loaded with the length of the initial beam.

Modulus of elasticity can be calculated by the following equation

$$E = \frac{P/A}{\Delta L/L} \qquad (8)$$

With,

E = modulus of elasticity (MPa).

P = maximum loads (N).

A = section area (mm^2).

L = span length (mm).

ΔL = increase of span length (mm).

RESULTS AND DISCUSSION

The data of the aggregate test results shown in Table 1 shows that the rough aggregate under study meets the interval of the standard used so that it can be used for research.

Table 1 Recapitulation of examination of aggregate characteristics

No.	Characteristic Material	Result	ASTM Interval	Explanation
1	Water content	0.592	0.5% - 2.0%	Qualified
2	Sludge content	0.52	0.2% - 1.0%	Qualified
3	Weight volume-heavy	1.46	1.40 – 1.90 kg/liters	Qualified
4	Weight volume-loose	1.432	1.40 – 1.90 kg/liters	Qualified
5	Specific gravity, SSD	2.558	1.60 – 3.20	Qualified

6	Absorption	1.576	0.2% - 2%	Qualified

For porous concrete, pore volume values from the results of the test data analysis can be seen in table 2.

Table 2. Results of the percentage of average pore volume

Variation code	Percentage of pore volume
SN (0%)	23.533
SB1 (0.5%)	23.238
SB2 (1.0%)	22.979
SB3 (1.5%)	22.081

Volume-weight of concrete or specific gravity of concrete is the ratio between volume-weight of concrete cylinder in air and the volume of cylinder. For values of porous concrete volumes can be seen in table 3

Table 3. Average weight-volume of porous concrete

Variation code	Volume-weight (kg/m^3)
SN (0%)	23.533
SB1 (0.5%)	23.238
SB2 (1.0%)	22.979
SB3 (1.5%)	22.081

The value of compressive strength of concrete from each specimen at age 28 days in table 4. Normal porous concrete (without addition of rice husk ash), compressive strength value of 12.53 Mpa, while the highest value of porous concrete compressive strength with the addition of rice husk ash in the variation 0.5% is 13.48 Mpa and the smallest compressive strength value in porous concrete with the addition of rice husk ash in the variation 1.5% is 8.21 MPa.

Table 4. Results of compressive strength of the average age of 28 days

Variation code	Compression strength (MPa)	Average
SN1 28	12.59	12.53
SN1 28	12.46	
SN1 28	12.54	
SB1 28 A1	13.76	13.48
SB1 28 A2	13.19	
SB1 28 A3	13.49	
SB2 28 A1	9.06	9.63
SB2 28 A2	10.19	
SB2 28 A3	9.64	
SB3 28 A1	7.93	8.21
SB3 28 A2	8.49	
SB3 28 A3	8.22	

Figure 5 shows that the value of compressive strength at 28 days has increased by 7.58% of normal porous concrete to the variation of 0.5% increase in rice husk ash. For porous concrete the addition of rice husk ash with variation of 1.5% there was a decrease of compressive strength value equal to 65,52%.

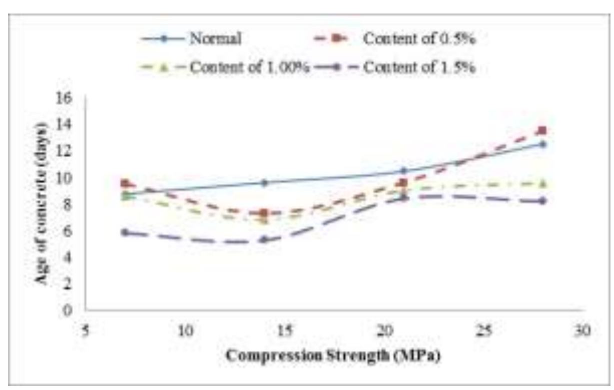

Figure 5 curve of compressive strength and age of concrete

The result of porous concrete tensile strength value at 28 days showed that in normal porous concrete without the addition of rice husk ash the value of tensile strength was 1.77 Mpa, while the highest tensile strength value of porous concrete with the addition of rice husk ash 0.5% is 1.95 Mpa and porous concrete with 1.5% ash of rice husks ash 1.29 Mpa. The value of tensile strength of concrete from each specimen can be seen in table 5.

Table 5. Average of split strength in 28 days

Variation code	Split strength (MPa)	Average
SN1 28	1.84	1.77
SN1 28	1.7	
SN1 28	1.78	
SB1 28	1.97	1.95
SB1 28	1.92	
SB1 28	1.96	
SB2 28	1.63	1.65
SB2 28	1.67	
SB2 28	1.66	
SB3 28	1.43	1.29
SB3 28	1.145	
SB3 28	1.30	

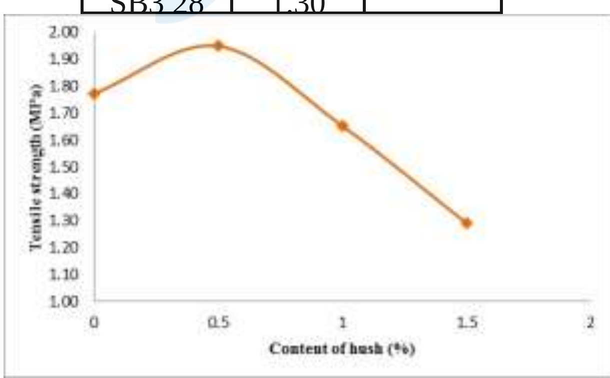

Figure 6. curve of hush content with split strength

Figure 6 shows that the strength of the cage at 28 days increased by 39.03% of the normal porous concrete at 0.5% increase of rice husk ash. And decrease value of tensile strength of porous concrete in addition of rice husk ash 1.5% equal to 72,59%.

The flexural strength of porous concrete at 28 days showed that in normal porous concrete, the flexural strength value is 1.158 MPa. For the highest flexural strength of porous concrete on 1.5% ash of rice husk ash is 1,946 MPa and the smallest bending strength value in normal porous concrete is without the addition of rice husk ash of 1,156 MPa.

Flexural strength values of each specimen at age 28 days can be seen in table 6.

Table 6. Results of flexural strength in 28 days

Variation	f'_{lt} in 28 days (MPa)	Average
BN (0%)	1.067	1.158
BN (0%)	1.248	
BN (0%)	1.159	
BB1(0.5%)	1.667	1.610
BB1(0.5%)	1.552	
BB1(0.5%)	1.610	
BB2 (1.0%)	1.800	1.807
BB2 (1.0%)	1.813	
BB2 (1.0%)	1.808	
BB3 (1.5%)	1.933	1.946
BB3 (1.5%)	1.957	
BB3 (1.5%)	1.947	

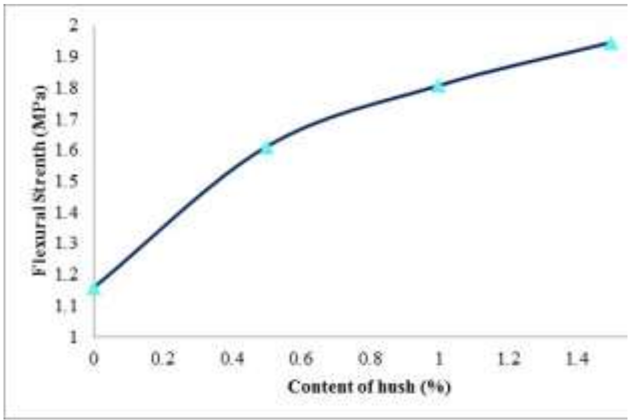

Figure 7. curve of hush content with flexural strength

Figure 7 shows that the flexural value of porous concrete beam at 28 days has increased by 68.05%. of normal porous concrete for a variation of 1.5%.

The result of elastic modulus value of porous concrete at 28 days showed that in normal porous concrete without the addition of rice husk ash the value of tensile strength was 364 Mpa, while the highest elastic modulus of porous concrete with the addition of rice husk ash 1.5% of 333 Mpa. The modulus of elasticity value of concrete from each specimen can be seen in table 7.

Table 7. result of average modulus of elasticity at 28 days

Variation	Load (N)	Section area (mm^2)	Long of span (mm)	Deflection (mm)	Modulus of elasticity (MPa)
BN (0%)	2733	10000	400	0.3	364
BN (0%)			400		
BN (0%)			400		
BB1(0.5%)	6100	10000	400	0.7	349
BB1(0.5%)			400		
BB1(0.5%)			400		
BB2 (1.0%)	8500	10000	400	1	340
BB2 (1.0%)			400		
BB2 (1.0%)			400		
BB3 (1.5%)	10000	10000	400	1.2	333
BB3 (1.5%)			400		
BB3 (1.5%)			400		

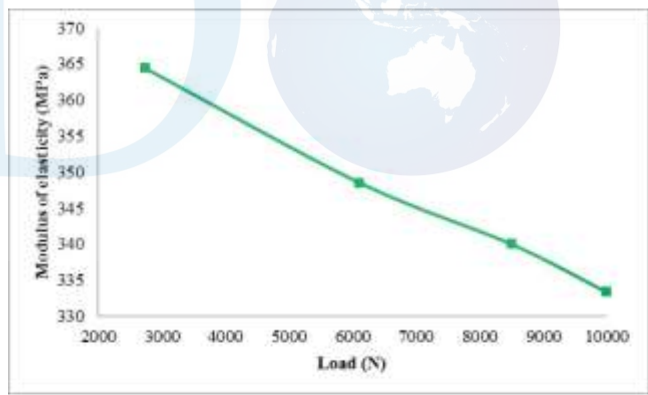

Figure 8. curve of load with modulus of elasticity

Figure 8 shows that the value of tensile strength at 28 days decreased by 8.52% of normal porous concrete in a 1.5% variation of rice husk ash.

CONCLUSION

From the test results, it can be concluded that porous concrete with the addition of ash husk rice fiber, the pore volume value is reduced from normal porous concrete. The more grains of rice husk ash the smaller the pore volume of porous concrete. Likewise with volume-weight of concrete, the more addition of fiber is smaller volume-weight of concrete. For the value of compressive strength, the more the addition of fiber the resulting compressive strength is smaller. Different things happen in the tensile strength where in the concrete with the addition of rice husks fiber increase tensile strength along with the addition of rice husk ash variation. Similarly, in porous concrete with the addition of rice husk ash, the value of tensile strength increases. While for elastic modulus of concrete using rice husk ash material has a small value compared with porous concrete without the addition of rice husk ash as well as the largest flexural strength is in porous concrete with the highest ash of husk ash which is 1.5%.

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