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Research Paper

The Effect of Addition on Pumice and Fiber on Compressive and Fluxural Strength Precast Lightweight Concrete

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Abstract

The use of lightweight concrete is currently increasing along with technological advances, so it is necessary to do research on lightweight concrete by utilizing materials that are around the environment, such as pumice. Several studies have been carried out on lightweight concrete, using plastic or styrofoam, so that further research needs to be done on lightweight concrete by adding fiber to the lightweight concrete to produce precast lightweight concrete. This research was conducted to find out how much influence the use of pumice and and fiber on compressive strength and flexural strength of precast lightweight concrete. The addition of pumice and aggregate is divided into 4 variations, namely 0: 100, 20: 80, 40: 60, 60: 40, with the addition of 0.1% fiber. And then put into a cube and beam mold. Compressive tests were carried out on the cube and flexural tests were carried out on beams. From the test results was obtained that the addition of pumice to the concrete mixture can cause a decrease in compressive strength of the concrete from 202 kg/cm^2 to 129 kg/cm^2 whereas with the addition of fiber there is an increase in flexural strength is 24.48 kg/cm^2. The specific gravity obtained is 1.664 gr/cm^3 so this concrete is included in the "lightweight concrete" classification.

Keywords

Fumice, Fiber, Precast, Lightweight Concrete

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1. INTRODUCTION

Precast concrete is widely used today because of its practicality. Various kinds of precast concrete forms include U girder, Box girder, PC girder, PC pole, pile, pile and pile. To get lightweight precast concrete, of course use lightweight concrete. Several studies have been carried out to obtain lightweight concrete for example by mixing Styrofoam and sawdust in cement (Anugraha and Mustaza, 2010); other research is the use of plastic waste as a substitute for aggregates (Rommel, 2013); and making lightweight concrete with the dreux-corrise mixed design method (R, 2011). In addition to obtaining lightweight concrete, several other studies conducted research on fibrous concrete to obtain the tensile and flexural strength of concrete so that it can be used in structural buildings, including research conducted by (Suamita, 2010; Suhardiman, 2011; Alfansuri and Wardhono, 2017), which uses ori bamboo fiber to increase tensile strength in concrete. Another study was to add oil palm fruit bunches to the flexural strength of concrete (Lydiasari et al., 2017). From the research that has been done, it is necessary to develop new research in support of the development of methods of making lightweight concrete, especially lightweight precast concrete which is currently needed in construction developments in Indonesia.

Innovations in the development of precast lightweight concrete are urgently needed at this time to support the development of development that is being carried out by the government. In previous studies, a separate study was conducted between lightweight concrete and fiber concrete, in which light concrete research was conducted by Anugraha and Mustaza (2010); R (2011); Rommel (2013). While fiber concrete research was conducted by Lydiasari et al. (2017). From this background, further research is carried out by combining lightweight concrete and fiber concrete using pumice and fiber to obtain precast lightweight concrete, which will later be applied to construction projects

2. EXPERIMENTAL SECTION

2.1 Classification method

This research was conducted at the Material Testing Laboratory in the Civil Engineering Department, State Polytechnic of Sriwijaya. Equipment used for aggregate analysis includes: a set of filters, scales, measuring cups/pycnometers, cone sticks to determine the state of SSD, mashers, aluminum pens, plates, ovens equipped with temperature regulators, density spoons, sieve vibrators, spatulas, spindles, tubes cylinders, calipers, brushes, plastic buckets, pressure testing machines, and stirring machines.

A test equipment, consisting of: a scales, a containers, a species spoon, the concrete cube molds with a size of 15 x 15 x 15 cm, the concrete beam molds with a size of 10 x 10 x 50 cm, slump equipment with the bottom diameter 29 cm, the top diameter 10 cm and 30 cm high, compactor sticks with a diameter of 16 mm, length 60 cm, material made of stainless steel, metal plates with a flat and waterproof surface, spoon sunken; and the elbow. While the materials used, namely: portland cement type I, fine aggregate (sand), coarse aggregate (corn corals), PDAM water, pumice, and fiber.

2.2 Analysis method

The stages of this study are testing the physical properties and specific gravity of the aggregate, designing concrete mixtures, making samples (cubes and beams), concrete curing, and testing (compressive and flexural tests) at 28 days.

Whereas the concrete mixture variations consist of: (i) normal concrete without fiber; (ii) normal concrete with fiber (0.1%); (iii) lightweight concrete in the ratio (corn coral: pumice) 0%: 100%; 20% : 80%; 40 % : 60%; and 60% : 40%, where this lightweight concrete uses fiber (0.1%). Overall testing uses the SNI guidelines (SNI03-1974-1990; SNI03-4431-1997).

3. RESULTS AND DISCUSSION

3.1 Material testing

Material testing is carried out on fine aggregates and coarse aggregates which include examining water content, mud content, dry specific gravity, saturated density, absorption, loose bulk density, compact bulk density, and modulus of fineness. The results of examination of fine aggregate and coarse aggregate can be seen in Table 1.

Table 1. Research data of fine aggregate and coarse aggregate

No.	Description	Fine aggregate	Coarse aggregate
1	Water content (%)	5.49	2.77
2	Mud content (%)	3.13	1.21
3	Dry specific gravity	2.51	2.49
4	Saturated density	2.59	2.53
5	Absorption (%)	3.03	1.58
6	Loose bulk density	1.49	1.62
7	Compact bulk density	1.58	1.53
8	Modulus of Fineness	3.72	4.72

3.2 Material requirements design

The fiber added to the concrete mix is 0.1% from concrete volume, while the comparison of the use of coarse aggregates (corn coral: pumice) made in several variations, namely: 0%: 100%; 20% : 80%; 40 % : 60%; and 60% : 40%. As a comparison, normal concrete is

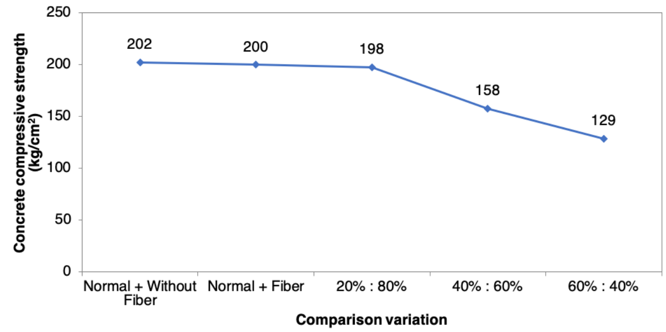

Figure 1. Average Concrete Compressive Strength Value

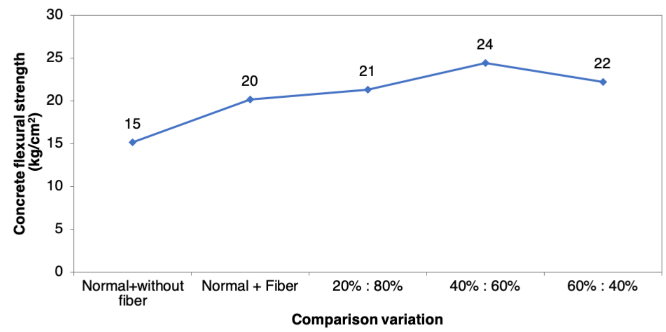

Figure 2. Average Concrete Flexural Strength Value

made without the addition of pumice and fiber so that the effect of the use of pumice and fiber is obtained against lightweight precast concrete. Total weight of material needed can be seen on the Tables 2 and 3.

3.3 Analysis of lightweight concrete compressive strength

Concrete compressive strength test is done by placing the cubes sample on a compressive testing machine centrically. Emphasis is carried out until the cubes sample is wrecked. Concrete compressive strength test results can be seen in Table 4 and Figure 1.

From the compressive strength test results can be seen that the addition of pumice causes a decrease in the compressive strength of concrete, the greater addition of pumice used (60% pumice: 40% corn corals) causes a greater decrease in compressive strength, but when viewed from the value compressive strength of 129 kg/ cm^2 then this concrete can be used as non-structural concrete.

3.4 Analysis of concrete flexural strength

Concrete flexural strength testing is done by placing the beam sample on two pedestals 40 cm apart then pressing the beam. Concrete flexural strength test results can be seen in Table 5 and Figure 2.

From the flexural strength test results it can be seen that an increase in the flexural strength of concrete with the addition of fiber as much as 0.1% of the volume of concrete, the highest

Table 2. Total weight of material for 3 test pieces (cubes)

No	Description	Unit	Normal (without fiber)	Comparison of Pumice: Corn Corals with 0.1% fiber addition 0% : 100%	20% : 80%	40% : 60%	60% : 40%
1	Cement	kg	3.839	3.839	3.839	3.839	3.839
2	Sand	kg	6.694	6.694	6.694	6.694	6.694
3	Coarse Aggregate	kg	14.9	14.9	11.92	8.94	5.96
4	Water	kg	2.067	2.067	2.067	2.067	2.067
5	Fumice	kg	0	0	0.527	1.055	1.582
6	Fiber	kg	0	0.028	0.028	0.028	0.028

Table 3. Total weight of material for 3 test pieces (beams)

No	Description	Unit	Normal (without fiber)	Comparison of Pumice: Corn Corals with 0.1% fiber addition 0% : 100%	20% : 80%	40% : 60%	60% : 40%
1	Cement	kg	5.688	5.688	5.688	5.688	5.688
2	Sand	kg	9.918	9.918	9.918	9.918	9.918
3	Coarse Aggregate	kg	22.075	22.075	17.66	13.245	8.83
4	Water	kg	3.063	3.063	3.063	3.063	3.063
5	Fumice	kg	0	0	0.781	1.563	2.344
6	Fiber	kg	0	0.041	0.041	0.041	0.041

Table 4. Average Concrete Compressive Strength at 28 Days

Comparison of Pumice: Corn Corals with 0.1% fiber addition	Wide (cm^2)	Weight (kg)	Load (kg)	Compressive Strength (kg/cm^2)
Normal (0%:100%) (without fiber)	225	7.49	45,500	202
Normal (0% : 100%) with fiber	225	7.35	45,000	200
(20% : 80%)	225	7.22	44,500	198
(40% : 60%)	225	7.17	35,500	158
(60% : 40%)	225	6.78	29,000	129

Table 5. Average Concrete Flexural Strength at 28 Days

Comparison of Pumice: Corn Corals with 0.1% fiber addition	Wide (cm^2)	Weight (kg)	Load (kg)	Compressive Strength (kg/cm^2)
Normal (0%:100%) (without fiber)	100	10.34	235	15.18
Normal (0% : 100%) with fiber	100	10.64	336	20.16
(20% : 80%)	100	9.88	335	21.3
(40% : 60%)	100	9.02	408	24.48
(60% : 40%)	100	8.32	370	22.2

flexural strength increase in the comparison of pumice with corn corals by 60% : 40%.

3.5 Weight analysis of lightweight concrete contents

The weight value of the light weight concrete is calculated by dividing the weight of the concrete by the volume of the cube or block, where the volume of the cube is 3375 cm^3 (15 cm x 15 cm x 15 cm) and the beam volume is 5000 cm^3 (10 cm x 10 cm x 50 cm). The results of calculating the weight of lightweight concrete can be seen in Tables 6 and 7

Tables 6 and 7 show that the addition of pumice will reduce the weight of the contents of the concrete, both in cube samples and blocks. Concrete is classified into lightweight concrete if it has a specific gravity of less than 1850 kg/ m^3. From the maximum weight of the contents requirement of lightweight concrete, concrete with a mixture of pumice is included in the category of lightweight concrete that can be used as a non-structural construction because it has a compressive strength of

Table 6. Concrete density in cube samples.

Comparison of Pumice: Corn Corals with 0.1% fiber addition	Volume (cm^2)	Weight (kg)	Content Weight (g/cm^3)
Normal (0%:100%) (without fiber)	3375	7,490	2.219
Normal (0% : 100%) with fiber	3375	7,350	2.178
(20% : 80%)	3375	7,220	2.139
(40% : 60%)	3375	7,170	2.124
(60% : 40%)	3375	6,780	2.009

Table 7. Weight of concrete contents in beam samples

Comparison of Pumice: Corn Corals with 0.1% fiber addition	Volume (cm^2)	Weight (kg)	Content Weight (g/cm^3)
Normal (0%:100%) (without fiber)	5000	10,340	2,068
Normal (0% : 100%) with fiber	5000	10,640	2,128
(20% : 80%)	5000	9,880	1,976
(40% : 60%)	5000	9,020	1,804
(60% : 40%)	5000	8,320	1,664

129 kg/cm^2.

Previous studies have shown that lightweight concrete can be produced from lightweight materials such as styrofoam and plastic, but will cause the compressive strength and modulus of elasticity of the concrete to decrease (Anugraha and Mustaza, 2010; Tripriyo et al., 2010; Rommel, 2013). Likewise in this study the use of pumice in lightweight concrete also causes a decrease in the compressive strength of concrete, namely: from 202 kg /cm^2 to 192 kg / cm^2. Even though this lightweight concrete cannot be used for structural buildings, it can still be used as non-structural concrete, such as for practical columns and lean concrete in rigid pavement construction.

4. CONCLUSIONS

Concrete with a mixture of pumice and coral causes a decrease in compressive strength along with increasing use of pumice, the smallest compressive strength value in the percentage of pumice and coral mixture (60%: 40%) is 129 kg/cm^2, while the addition of fiber 0, 1% of the concrete volume causes the flexural strength of the concrete increase i.e. 24.48 kg/cm^2. Concrete with the addition of pumice can be categorized as lightweight concrete because it has the lowest fill weight of 1,664 kg/cm^3.

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