CIVED Journal of Civil Engineering and Vocational Education

EISSN: 2622-6774
Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

Experimental Study of Compressive Strength and Tensile Strength of Foam Mortar with the Addition of Polyethylene Fibers

Rio Marpen[1*], Amiruddin[2], Efrilia Rahmadona[3], Indah Islamiati[4], Yusni Septiani Labais[5]
[1,2,3,4,5] Civil Engineering, Politeknik Negeri Sriwijaya, Indonesia
*Corresponding author e-mail: riomarpen@polsri.ac.id

Received 17th Feb 2024; Revision 21th March 2024; Accepted 31th March 2024

ABSTRACT

Mortar is a building material of sand, cement, and water that is stirred until homogeneous. So that a light mortar can be obtained, this can be done by mixing the mortar with a foaming agent. Adding polyethylene fiber increases the compressive strength, tensile strength, modulus of elasticity, and brittleness of lightweight mortar. The percentage of added fiber is 0%, 0.25%, 0.5%, 0.75% and 1%. The average density of lightweight mortar added with polyethylene fiber is 895.316 kg/m3. The optimal compressive strength with a fiber ratio of 0.5% polyethylene fiber is 3461.429 kPa, an increase of 172.906% compared to 0% polyethylene fiber. The optimal tensile strength of 0.5% polyethylene fiber is 1218.384 kPa, an increase of 364.917% compared to 0% polyethylene fiber. Based on the results of foam mortar experiments using a foam agent with polyethylene fiber, this is classified as type O mortar, not recommended for interior and exterior walls that do not support structural loads.

Keywords: *Foam Mortar, Compressive Strength, Split Tensile Strength.*

INTRODUCTION

Technological developments have given rise to many innovations in the construction sector to reduce the weight of concrete used in buildings, apart from that, innovations have also developed not only to reduce the weight of concrete but also to minimize environmental impacts. Plastic waste is a problem that is difficult to overcome due to the complexity that occurs, the amount of plastic waste on earth is estimated to be more than 500 million plastic bags that are difficult to decompose and used by the world's population every year [1]. This certainly complicates the problem of overcoming the problem of plastic waste because it takes 100 to 500 years for plastic to decompose completely. There are many innovations in the world of construction, one of which is substituting the use of cement to reduce the environmental impact, by using other alternative materials [2]. Therefore, concrete innovation with the addition of plastic waste (polyethylene), where so far polyethylene fiber is known as the raw material of plastic products with the final product in the form of plastic bags [3], the use of polyethylene fiber is the beginning of the utilization of plastic waste to reduce the environmental impact caused by plastic waste. Not only utilizing plastic waste to increase the compressive strength of concrete, innovation efforts to produce concrete products are carried out with research to reduce the weight of concrete, one of which is foam mortar, foam mortar is a mixture of cement, water, aggregate, and additives [4], which is lightweight in the form of concrete and can even float in water, by Therefore, by utilizing foam bubbles to create hollow

CIVED Journal of Civil Engineering and Vocational Education
EISSN: 2622-6774
Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

spaces in the structure, research can be carried out on foam mortar to find out to what extent foam mortar can be used as an alternative building material [5]

This research will test the compressive strength, which shows the ability of concrete to withstand the compressive force of unity area, this compressive strength determines the quality of the structure (6) In addition, split tensile strength testing is one of the parameters of concrete strength (7), which aims to evaluate the shear resistance of structural components made of concrete made from lightweight aggregate split tensile strength and to determine the value of the modulus of elasticity of lightweight mortar after being added with foam agent and polyethylene fiber, so it is hoped that this research will obtain a lightweight mortar that has high durability, and is able to withstand compressive and tensile forces high.

MATERIALS AND METHOD

This research was carried out at the Material Testing Laboratory of the Civil Engineering Department of Sriwijaya Polytechnic, where the method used in this research was experimental (testing in the laboratory). In this research, cylindrical test objects measuring 10 cm x 20 cm with fiber variations of 0%, and 0 were used. 0.25%; 0.5%; 0.75%; and 1%, each variation was made from 3 mortar samples aged 14, 21, and 28 days before being tested, the data was processed statically using Microsoft Excel. From the test results data, it can be seen how much influence the compressive strength, splitting tensile strength, and modulus of elasticity of the mortar have and will be analyzed according to the research results.

Material

Materials used sand, cement, water, polyethylene fiber and foam agent

Figure 1. Foam Agent and polyethylene fiber

Compressive Strength

Compressive strength can be calculated based on Equation 1 [6]

$$f'c = \frac{P}{A} \quad \text{..... (1)}$$

Where:
f'c = Compressive Strength (N/mm)
P = Load (Ton)
A = Cross-sectional area of the test object (mm^2)

Split Tensile Strength

Split tensile strength testing aims to evaluate the shear resistance of structural components made from lightweight aggregate-based concrete [7]. The method for testing split tensile strength is based on SNI-03-2491-2002, namely that the test object is placed horizontally

EISSN: 2622-6774
Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

parallel to the surface of the pressing table to measure the split tensile strength. The tensile strength value of the test object can be obtained by multiplying the maximum tensile load (N) and dividing it by the length and diameter of the test object. [8]

Split tensile strength can be calculated based on equation 2.

$$ft = \frac{2P}{\pi L D} \quad \text{.....} \quad (2)$$

Where:
ft = Cylinder split tensile strength (kg/cm^2);
P = maximum/crushing test load (N);
L = length of the test object (cm);
D = diameter of the test object (cm).

Testing Specifications for Research Materials
This test is carried out on fine aggregate and the test is carried out according to ASTM and SK SNI standards.
1. Testing density and water absorption of fine aggregate [9]
2. Aggregate water content testing [10]
3. Testing the weight of solid and loose contents in aggregate [11]
4. Testing the compressive strength of cement mortar [12]
5. Mortar specifications for masonry unit work mortar for masonry unit work [13]

Stages and Procedures for Making Fibrous Foam Mortar
The procedure for making fibrous foam mortar is as follows:

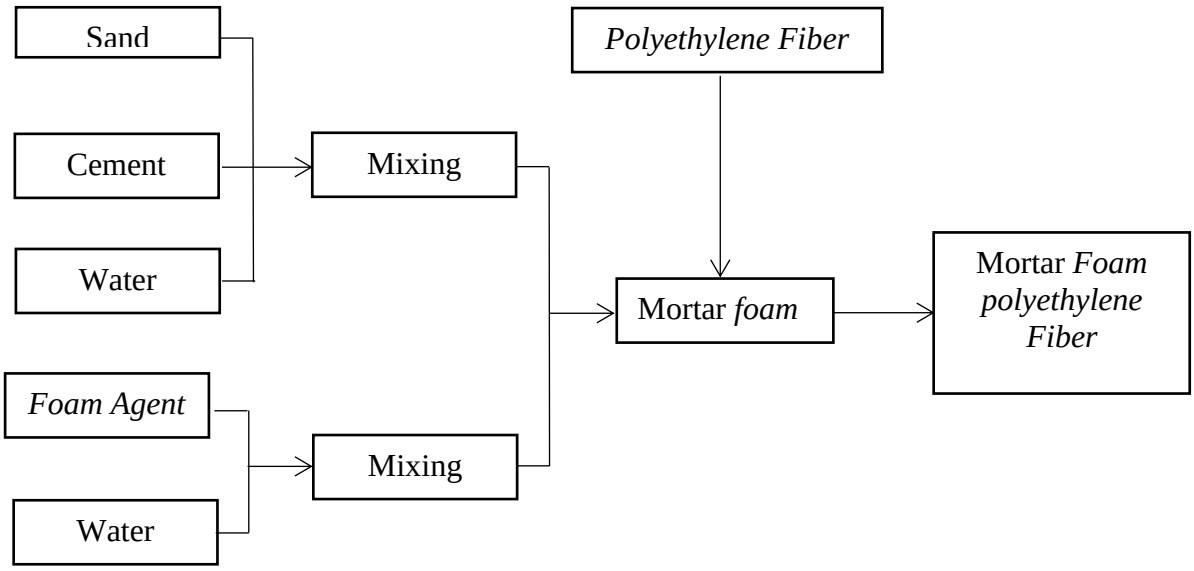

Figure 2. Flow diagram for making polyethylene fiber foam mortar

RESULTS AND DISCUSSION

CIVED Journal of Civil Engineering and Vocational Education
EISSN: 2622-6774
Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

Design Calculation Results of Mortar Mixture

The mortar mix design calculation is based on the design of the center for 800 kPa mortar, from the calculations obtained the material requirements per 1 m^3 will be presented in Table 1.

Table 1. Material needs of fibrous foam mortar for 1 m^3

Test Object Code	Cement (Kg)	Water (Kg/liter)	Fine Agregat (Kg)	*Foam Agent* (Kg/liter)	*Polyethylene Fiber* (gram)
MBSP 0	1,296	0,739	1,000	3,078	0
MBSP 0,25	1,296	0,739	1,000	3,078	3,240
MBSP 0,5	1,296	0,739	1,000	3,078	6,480
MBSP 0,75	1,296	0,739	1,000	3,078	9,719
MBSP 1	1,296	0,739	1,000	3,078	12,959

Test Results for Density of Fiber Foam Mortar

Tests were carried out on the density of fibrous foam mortar with variations in the polyethylene fiber mixture, where each fiber variation had 3 samples to be tested. The density test results can be seen in Table 2 as follows.

Table 2. Testing Results for Density of Fibrous Foam Mortar

Test Object Code	Mortar Age (Day)	Mortar Weight (Kg)	Volume (m^3)	Mortar Density (Kg/m^3)	Mortar density average (Kg/m^3)
MBSP 0	14	1.58740	0.00157	1010.57023	984.27783
	21	1.56140		994.01811	
	28	1.48950		948.24515	
MBSP 0.25	14	1.50750	0.00157	959.70431	946.78093
	21	1.48990		948.49980	
	28	1.46420		932.13867	
MBSP 0.5	14	1.42310	0.00157	905.97360	881.59106
	21	1.40390		893.75050	
	28	1.32740		845.04909	
MBSP 0.75	14	1.36440	0.00157	868.60402	867.20345
	21	1.36240		867.33078	
	28	1.35980		865.67557	
MBSP 1	14	1.25820	0.00157	800.99500	796.72965
	21	1.25680		800.10373	
	28	1.23950		789.09021	
Density Mortar					895.31658

The density data above shows that the average density value of polyethylene fiber foam mortar is 895.316 kg/m3, so it is considered a light mortar. According to SNI, concrete contains light

Journal of Civil Engineering and Vocational Education
EISSN: 2622-6774
Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

aggregate and has a unit weight with a density of 1900 kg/m3.

Compressive Strength Testing Results of Fibrous Foam Mortar

After testing the compressive strength of the polyethylene fiber foam mortar, the results obtained can be seen in Figure 2.

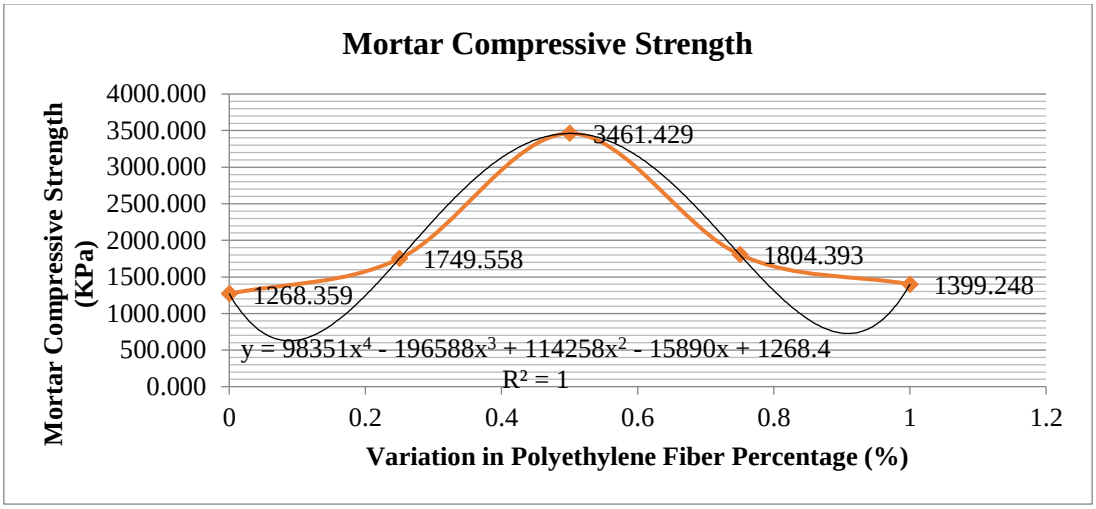

Figure 3. Graph of the relationship between compressive strength and polyethylene fiber content

This increase in compressive strength is caused by the contribution of fiber to increasing the density of the mortar mixture. On the other hand, this decrease was caused by replacing the mortar mixture with an increased volume of polyethylene fiber, thereby reducing the bond strength between the mortar mixtures.

Splitting Tensile Strength Test Results of Fibrous Foam Mortar

After testing the split tensile strength of the polyethylene fiber foam mortar, the results obtained can be seen in Figure 3.

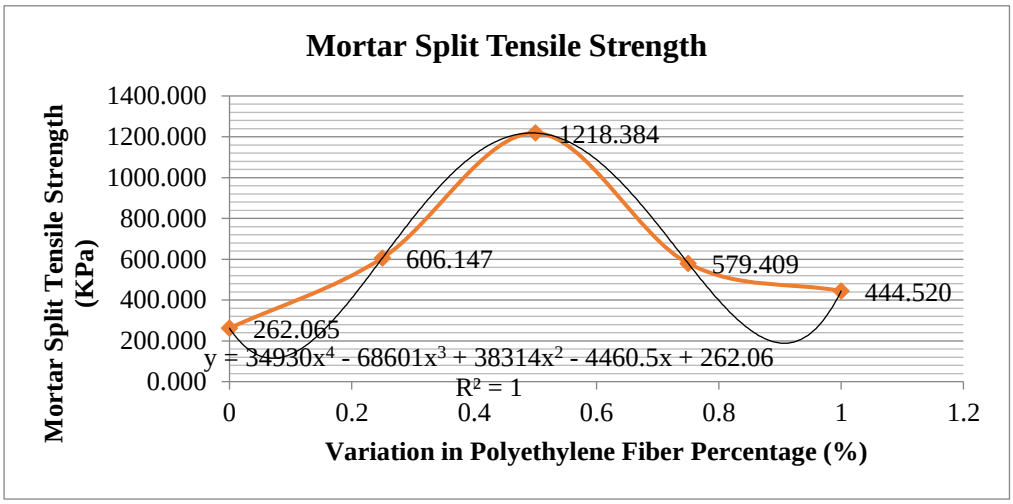

Figure 4. Graph of the relationship between split tensile strength and polyethylene fiber

The increase in split tensile strength occurs due to adding polyethylene fiber, the split tensile

EISSN: 2622-6774
Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

strength is increased and a good adhesion effect, namely a higher adhesive tension is obtained. The decrease in splitting tensile strength occurs because the volume of the polyethylene mixture that binds the mortar is too high, thereby reducing the bond stress that occurs between the lightweight concrete and the resulting polyethylene fibers.

CONCLUSION

Based on the research results, it can be concluded that the compressive strength of foam mortar added with polyethylene fiber at the age of 28 days reached the ideal compressive strength value of 3461.429 kPa with a variation in the percentage of added fiber of 0.5%. The average density test results of 895.316 kg/m3 also show that the compressive strength of foam mortar added with polyethylene fiber reaches the ideal compressive strength value of 3461.429 kPa. According to the results of this research, mortar is included in type O, where this type cannot be recommended for interior or exterior walls that are unable to withstand structural loads.

REFERENCE

[1] E. Rommel, "Preparation of lightweight concrete from plastic-based artificial aggregates," J. Gamma, vol. 9, no. 1, pp. 137-147, 2013.

[2] E. Rahmadona, K. R. Amalia, L. Ulfah, and N. Praditya, "Analysis of Concrete Compressive Strength with Utilization of Silica Fume and Fly Ash as Partial Cement Replacement," Talenta, vol. 7, no. 1, pp. 217-223, 2024, doi: 10.33087/talentasipil.v7i1.451.

[3] Warsino, "Effect of Polyethylene Fiber Addition in Gas Technology Lightweight Concrete on Compressive Strength, Split Tensile Strength, and Modulus of Elasticity," J. Tek. Civil, pp. 680-686, 2015.

[4] P. Oktaviani, A. Abrar, and W. Fadli, "Experimental Study of Making Lightweight Bricks by Using Additive Foam Agent," Pros. 2nd Andalas Civ. Eng. Natl. Conf., pp. 139-145, 2015.

[5] A. Susilowati and F. Nabhan, "Effect of Variation of Cement Water Factor on Foam Mortar," J. Appl. Civ. Environ. Eng., vol. 1, no. 2, pp. 9, 2021, doi: 10.31963/jacee.v2i1.2797.

[6] T. Mulyono, Concrete Technology. Yogyakarta: CV. Andi Offset.

[7] D. Mandala Putra and D. Widjaja, "Relationship between split tensile strength and compressive strength of lightweight concrete with crumb rubber and broken roof tiles," Civil Engineering, vol. 4, no. 2, pp. 76-88, 2015.

[8] Kardiyono Tjokrodimuljo, Concrete Technology. Yogyakarta: Civil Engineering Publishing Bureau of Civil and Environmental Engineering Student Family UGM, 2007.

[9] S. Farlianti and S. Sapta, "A study of the flexural strength of concrete against the compressive strength of concrete (fc'=25 MPa) using MUSI SUNGAI SAND," Tech.

J. Tech., vol. 6, no. 1, pp. 79, 2019, doi: 10.35449/teknika.v6i1.106.

[10] S. 03-1971-1990, Test Method for Aggregate Moisture Content. Decree of the Minister of Public Works 1990.

[11] SNI 03-4804-1998, "SNI 03-4804-1998 (Aggregate Content Weight)," Sni 03-4804-1998, pp. 1-6, 1998.

[12] SNI 03-6825-2002, Test Method for Compressive Strength of Cement Mortar. Decree of the Minister of Public Works, 2002.

[13] SNI 03-6882-2014, Specification for Mortar for Pair Unit Work Mortar for Pair Unit Work. National Standardization Agency, 2014.