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COMPRESSIVE AND FLEXURAL BEHAVIOR OF FERROCEMENT AND FERRO-GEOPOLYMER USING VARIOUS NUMBER OF WIRE MESH LAYERS

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ABSTRACT

Infrastructure is the driving force of development and economic growth in a developing country such as Indonesia. This increased infrastructure need is in line with the increasing need for reinforced concrete. Ferrocement technology is a composite material consisting of mortar and wire mesh as reinforcement. The use of cement can provide greenhouse gas emissions that can increase global warming. Geopolymers are environmentally friendly innovations (eco-green construction) using fly ash as a binder to minimize the use of cement. To reduce environmental pollution and infrastructure needs, innovations such as ferro-geopolymers are needed, where the matrix is forms a geopolymer mortar and wire mesh as reinforcement.

This study aims to find out the strength of the flexural of ferrocement slab and ferro-geopolymer slab 750×150×35 mm and compressive strength of cement mortar and geopolymer mortar 50×50×50 mm. The various ferrocement slab and ferro-geopolymer slab consists of the number of wire mesh layers that are without wire mesh, one layer wire mesh, and two layers of wire mesh with curing, i.e., wet PDAM water, wet-dry PDAM water, and swamp water. Cement mortar is based on SNI 03-6825-2002, while geopolymer mortar mix planning is based on weight comparison with additional superplasticizer plastiment-VZ 2% of fly ash weight.

The results showed that the increasing number of wire mesh layers used could increase the bending strength with ranges of 5.98-12.67% and 81.33-128.18% in ferrocement and increases with ranges of 2.92-16.86% and 135.23-166.76% in ferro-geopolymers in a row against the addition of one layer wire mesh and two layers wire mesh. Based on curing, it showed that samples with wet PDAM water curing produce flexural and compressive strength higher than wet-dry water PDAM curing and swamp water curing.

Keywords: *Fly Ash, Ferrocement, Ferro-Geopolymer, Wire Mesh*

1. INTRODUCTION

Background

Infrastructure is the driving force of development and economic growth in a developing country such as Indonesia. Proper infrastructure is needed and an important part of the community service system. Therefore, it is necessary to increase infrastructure development to improve the economic standard of the community. The increasing need for infrastructure is in line with the increase in reinforced concrete. Therefore, the production of cement as a binder for concrete increases as well.

According to Sreevidya (2012), the global cement industry contributes about 1.35 billion tons of greenhouse gas emissions every year, or about 7% of the total artificial greenhouse gas emissions into the earth's atmosphere. Various efforts have been made to minimize cement as a binder in concrete production. One of the pozzolanic materials that have been introduced in the construction industry is fly ash (FA) which is a by-product of coal-fired power plants and steam generation (Demie et al., 2011). The geopolymer technology developed by Davidovits offers a solution to this problem.

Ferrocement technology is a composite material, where the matrix (mortar made of cement and sand) is reinforced with wire mesh throughout, resulting in a material with better performance. This ferrocement was first discovered by Joseph Louis Lombat in 1884. Then it was developed into a ferro-geopolymer. The ferro-geopolymer is a composite consisting of geopolymer mortar as a matrix and wire mesh as reinforcement. The term ferro-geopolymer comes from introducing geopolymer mortars into ancient ferrocement technology (Vipin et al., 2021).

Research

The objectives of this study aim to determine the effect of the number of wire mesh layers on the flexural strength of ferrocement and ferro-geopolymer plates and to determine the effect of the curing method on the compressive strength of the mortar and the flexural strength of the plate.

Limitation of the Problem

The limitation of the problem in this study are as follows:

1. Dimensions of mortar specimens 50×50×50 mm and plate specimens 750×150×35 mm.
2. Geopolymer mortar forming material:
   a. Fly ash from PLTU Asam-Asam is filtered on sieve no. 200.
   b. The alkaline solution combines Na_2SiO_3 and 8M NaOH with a ratio of 2.5:1.
   c. The ratio of fly ash to the alkaline solution used is 65:35.
   d. The ratio of fine aggregate to the binder used is 60:40.
   e. Using superplasticizer plastiment -VZ 2% by weight of fly ash.

3. Cement mortar design using SNI-6825-2002.
4. The study did not discuss the chemical reactions in the geopolymer mortar.

Benefits of Research

Through this research, it is hoped that the research results can be a source of information for the manufacture of ferro-geopolymers based on fly ash and reduce the volume of fly ash waste at PLTU Asam-Asam and reduce the use of cement.

2. THEORETICAL STUDY

Geopolymer

A Combination of sodium silicate (Na_2SiO_3) or potassium silicate (K_2SiO_3) and sodium hydroxide (NaOH) or potassium hydroxide (KOH) has been widely used as an alkaline activator is added to the fly ash to form geopolymer (Abdullah et al., 2011). Geopolymer is an innovative green material that is environmentally friendly for sustainable development with enhanced strength properties. This material does not emit high amounts of carbon dioxide gas as in the manufacture of conventional concrete (Muthukumar & Mohana, 2019).

Ferrocement

Ferrocement is a form of reinforced concrete, which exhibits different behavior from conventional concrete in strength performance and application potential. This is because the uniform distribution of reinforcement in the matrix offers improvements in many engineering properties of the material, such as tensile and flexural strength, toughness, fracture, crack control, yield resistance, and impact resistance, while also providing advantages in fabrication. In developing countries, raw materials for ferrocement construction are readily available and can also be constructed in complex forms. The skills required are low level and have superior strength properties than conventional reinforced concrete (Sreevidya et al., 2012).

Ferro-Geopolymer

Ferro-geopolymer is a composite consisting of geopolymer mortar as matrix and wire mesh as reinforcement. The term ferro-geopolymer comes by introducing geopolymer mortars into ancient ferrocement technology. What is meant by ferrocement is a composite material, where the matrix (mortar made of cement and sand) is reinforced with wire mesh throughout, resulting in a material with better performance. This ferrocement was first discovered by Joseph Louis Lombat in 1884 (Vipin et al., 2021).

Portland Cement

The most widely available portland types of cement in the market today are portland composite cement (PCC) and portland pozzolan cement (PPC)

Fly ash

Fly ash is industrial waste, one of which is an electric steam power plant (PLTU). Based on SNI 2460:2014 fly ash Asam-Asam are classified as type C fly ash.

Alkaline Solution

The alkaline solution is a combination of sodium silicate (Na_2SiO_3), which functions as a catalyst, and sodium hydroxide (NaOH), which functions to react aluminum and silica elements in fly ash into a strong polymeric bond.

Wire Mesh

According to Mune dan Patil (2018), the ferrocement wire mesh is also called reinforcing mesh, which functions as a reinforcement to hold the mortar.

Plastiment-VZ

Plastiment-VZ is a plasticizer and water reducing agent for concrete mixtures in the form of a liquid and has the effect of slowing down the setting time (set retarder) by ASTM C494-99 type D.

Curing

A standard treatment method commonly used is concrete treatment by immersing water (wet), which functions to prevent the loss of concrete moisture and is effective at maintaining the temperature in the concrete. Meanwhile, wet-dry curing is a cycle that undergoes repeated wetting and drying by water, the material will experience wet conditions because it is submerged in water and dry conditions due to exposure to sunlight (Pratama et al., 2019).

Compressive Strength Test

Compressive strength test using cube mortar with dimensions of 50×50×50 mm aims to determine the value of compressive strength of mortar quality at a certain age. The compressive strength equation is calculated by dividing the load per unit area as follows:

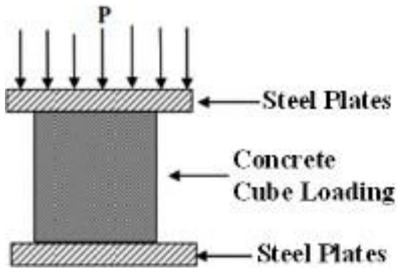


Figure 1 Compressive Strength Test

$$f_c' = \frac{P_{maks}}{A} \quad \text{...} 1$$

Where:

f_c' = Compressive strength of mortar, MPa

P_{maks} = Maximum compressive force, N

A = Cross-sectional area of the specimen, mm^2

= 2500 mm^2 (Side length 50 mm)

Flexural Strength Test

The flexural strength test using a slab with dimensions of 750× 150×35 mm aims to determine the ability of plates placed on two supports to withstand forces in a direction perpendicular to the axis of the test object. The flexural strength equation is as follows:

$$f_b = \frac{P \cdot L}{b \cdot h^2} \quad \text{...} 2$$

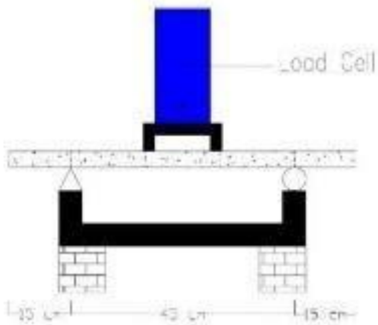


Figure 2 Flexural Strength Test

Where:

f_b = flexural strength of the test object, MPa

P = the highest load read on the load indicator, N

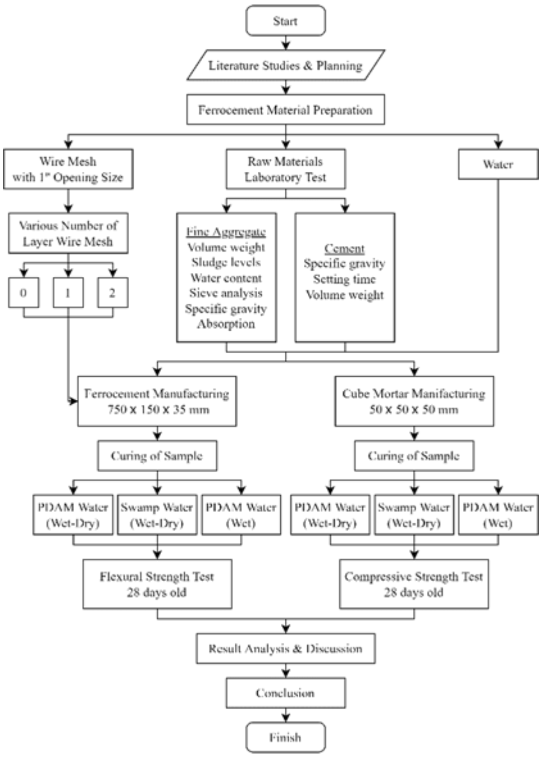
L = the distance between two placements, mm

b = the width of the fracture cross-section in the horizontal direction, mm

h = the width of the fracture cross-section in the vertical direction, mm

3. METHOD

In this study, there were two stages carried out, namely ferrocement and ferro-geopolymer, which can be seen in Figure 3 and Figure 4.



Gambar 3 Diagram Alir Ferrosemen

Gambar 4 Diagram Alir Ferro-Geopolimer

4. RESULT AND DISCUSSION

Examination of Fine Aggregate and Fly Ash

Examination laboratory results of the fine aggregate of Barito sand and fly ash Asam-Asam can be seen in Table 1 and Table 2.

Table 1 Examination of Barito Sand

No.	Examination Type	Result
1.	Water Content	1.30 %
2.	Sludge Levels	1.55 %
3.	Organic Content	Tea
4.	Sieve Analysis	Zone 2
5.	Volume Weight	
	a. Release Condition	1.50 gr/cm^3
	b. Shake Condition	1.60 gr/cm^3
	c. Compaction Condition	1.60 gr/cm^3
6.	Specific Gravity	
	a. Apparent Specific Gravity	2.64 gr/cm^3
	b. Bulk Specific Gravity on Dry Basic	2.62 gr/cm^3
	c. Bulk Specific Gravity on SSD Basic	2.63 gr/cm^3
7.	Water Absorption Percentage	0.28 %

Table 2 Examination of Fly Ash Asam-Asam

No.	Examination Type	Result
1.	Water Content	1.30 %
2.	Sludge Levels	1.55 %
3.	Organic Content	Tea
4.	Sieve Analysis	Zone 2
5.	Volume Weight	
	a. Release Condition	1.50 gr/cm^3
	b. Shake Condition	1.60 gr/cm^3
	c. Compaction Condition	1.60 gr/cm^3
6.	Specific Gravity	
	a. Apparent Specific Gravity	2.64 gr/cm^3
	b. Bulk Specific Gravity on Dry Basic	2.62 gr/cm^3
	c. Bulk Specific Gravity on SSD Basic	2.63 gr/cm^3
7.	Water Absorption Percentage	0.28 %

Examination of Cement and Setting Time

Examination laboratory results of PCC cement and setting time can be seen in Table 3, Table 4, and Figure 5.

Table 3 Examination of PCC Cement

No.	Examination Type	Result
1.	Volume Weight	
	a. Release Condition	1.00 gr/cm^3
	b. Shake Condition	1.05 gr/cm^3
	c. Compaction Condition	1.20 gr/cm^3
2.	Specific Gravity	3.16 gr/cm^3

Table 4 Examination of Setting Time

No.	Paste	Initial	Final
1.	Cement	108 Minute	195 Minute
2.	Geopolymer	81 Minute	135 Minute

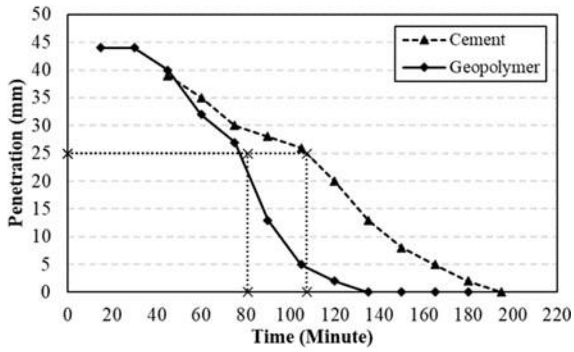


Figure 5 Examination of Setting Time

Influence of Number of Wire Mesh Layers on Flexural Strength of Ferrocement

The results of calculating the flexural strength of the 28-day-old ferrocement plate can be seen in Figure 7 – Figure 9.

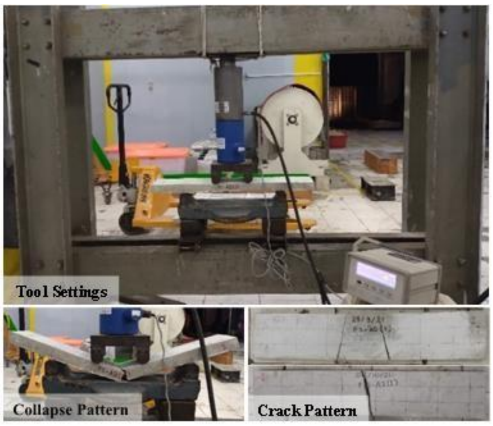


Figure 6 Flexural Strength Test of Ferrocement

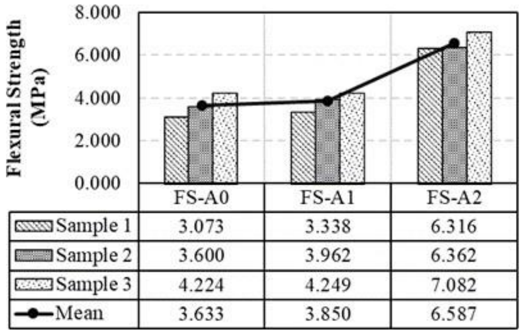


Figure 7 Flexural Strength of PDAM Water Wet Curing Ferrocement (FS-A)

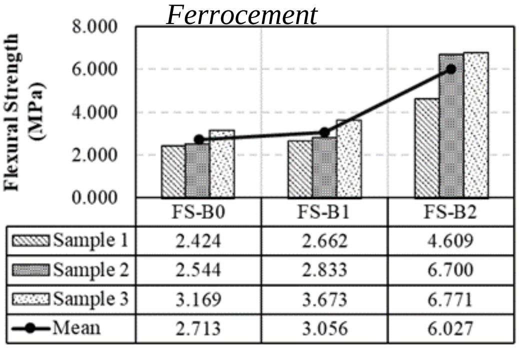


Figure 7 Flexural Strength of PDAM Water Wet-Dry Curing Ferrocement (FS-B)

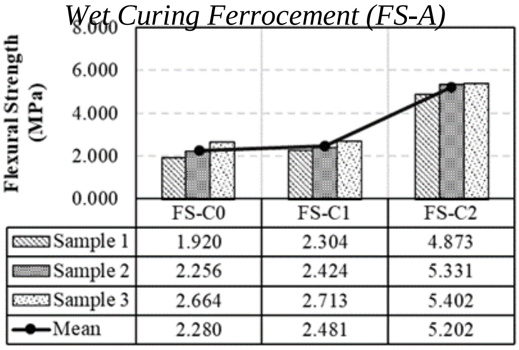


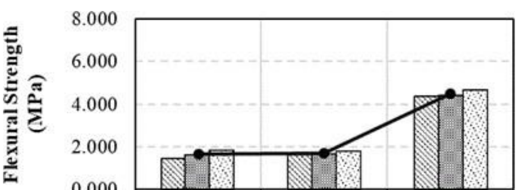
Figure 9 Flexural Strength of Swamp Water Wet-Dry Curing Ferrocement (FS-C)

Based on Figure 7 – Figure 9, the flexural strength of ferrocement in all curing methods has increased with the increase in the number of wire mesh layers used. From Figure 7, the average increase in flexural strength is 5.98% and 81.33%, respectively, in ferrocement with the addition of single and double layers of wire mesh. From Figure 8, the increase in the average flexural strength is 12.67% and 122.18%, respectively, in ferrocement with the addition of single and double layers of wire mesh. From Figure 9, the average increase in flexural strength is 8.81% and 128.18%, respectively, in ferrocement with the addition of single and double layers of wire mesh. This result is in line with the research of Sabale (2016), which states that increasing the number of wire mesh layers increases the flexural strength of ferrocement plates due to an increase in the percentage of reinforcement in ferrocement.

Influence of Number of Wire Mesh Layers on Flexural Strength of Ferro-Geopolymer

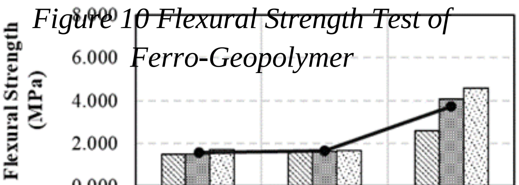
The results of calculating the flexural strength of the 28-day-old ferro-geopolymer plate can be seen in Figure 11 – Figure 13.

Figure 10 Flexural Strength Test of Ferro-Geopolymer



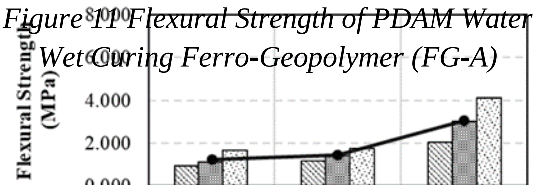
	FG-A0	FG-A1	FG-A2
Sample 1	1.464	1.665	4.369
Sample 2	1.680	1.697	4.393
Sample 3	1.896	1.824	4.682
Mean	1.680	1.729	4.482

Figure 11 Flexural Strength of PDAM Water Wet Curing Ferro-Geopolymer (FG-A)



	FG-B0	FG-B1	FG-B2
Sample 1	1.489	1.656	2.589
Sample 2	1.536	1.680	4.082
Sample 3	1.751	1.719	4.562
Mean	1.592	1.685	3.744

Figure 12 Flexural Strength of PDAM Water Wet-Dry Curing Ferro-Geopolymer (FG-B)



	FG-C0	FG-C1	FG-C2
Sample 1	0.936	1.188	2.040
Sample 2	1.151	1.442	3.024
Sample 3	1.704	1.800	4.129
Mean	1.264	1.477	3.064

Figure 13 Flexural Strength of PDAM Water Wet-Dry Curing Ferro-Geopolymer (FG-B)

Based on Figure 11 – Figure 13, the flexural strength of ferro-geopolymer in all curing methods has increased with the increase in the number of wire mesh layers used. From Figure 11, the average increase in flexural strength is 2.92% and 166.76%, respectively, in ferro-geopolymer with the addition of single and double layers of wire mesh. From Figure 12, the increase in the average flexural strength is 5.85% and 135.23%, respectively, in ferro-geopolymer with the addition of single and double layers of wire mesh. From Figure 13 the average increase in flexural strength is 16.86% and 142.51%, respectively, in ferro-geopolymer with the addition of single and double layers of wire mesh. This result is in line with the research of Sreevidya (2014), which states that an increase in the number of wire mesh layers gives an increase in the flexural strength of ferro-geopolymer plates, due to an increase in the percentage of reinforcement in the ferro-geopolymer.

Flexural Strength Comparison of Ferrocement and Ferro-Geopolymer to Number of Wire Mesh Layers

Flexural strength comparison of 28-days-old ferrocement and ferro-geopolymer on any number of wire mesh layers can be seen in Figure 14 – Figure 16.

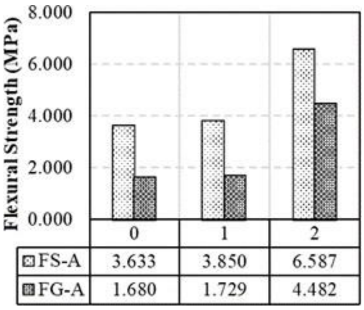


Figure 14 Comparison of the Average Flexural Strength of PDAM Water Wet Curing

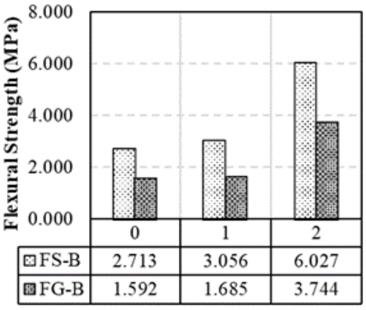


Figure 15 Comparison of the Average Flexural Strength of PDAM Water Wet-Dry Curing

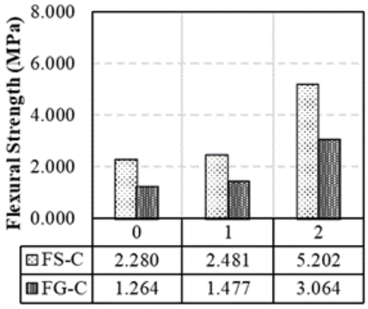


Figure 16 Comparison of the Average Flexural Strength of Swamp Water Wet-Dry Curing

Based on Figure 14 – Figure 16, the average flexural strength of ferrocement in all variations of the number of wire mesh layers has a greater value than the average flexural strength of ferro-geopolymer. From Figure 14, there is a decrease in the average flexural strength of ferro-geopolymer by 53.75%, 55.09%, and 31.96%, respectively, without wire mesh, single layer wire mesh, and double layers wire mesh to the average flexural strength of ferrocement in each layer wire mesh. From Figure 15, there is a decrease in the average flexural strength of ferro-geopolymer by 41.32%, 44.87%, and 37.87%, respectively, without wire mesh, single layer wire mesh, and double layers wire mesh to the average flexural strength of ferrocement in each layer wire mesh. From Figure 16, there is a decrease in the average flexural strength of ferro-geopolymer by 44.58%, 40.47%, and 41.10%, respectively, without wire mesh, single layer wire mesh, and double layers wire mesh to the average flexural strength of ferrocement in each layer wire mesh.

Influence of Curing Methods on Flexural Strength of Ferrocement

The results of calculating the flexural strength of the 28-day-old ferrocement plate can be seen in Figure 18 – Figure 20.

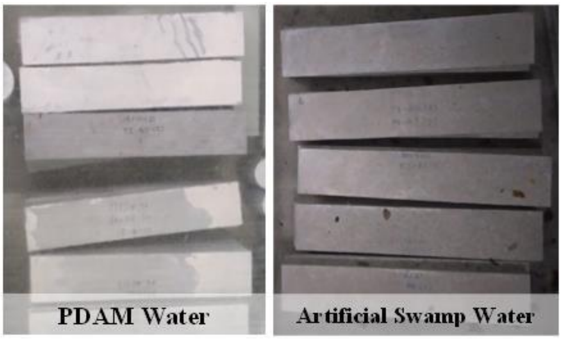
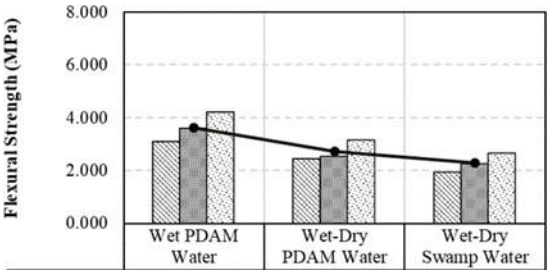
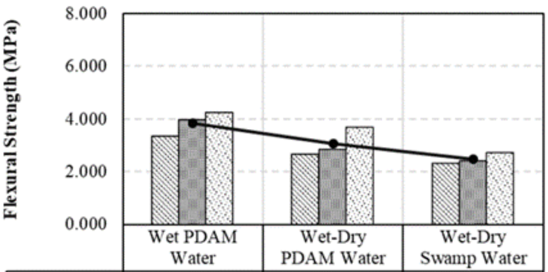


Figure 17 Curing Methods of Ferrocement



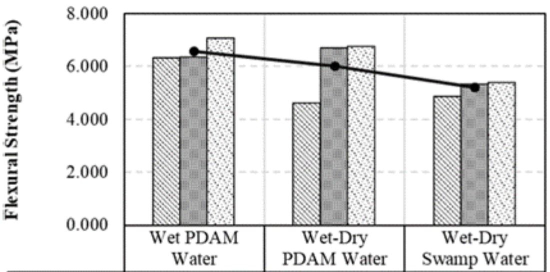
	Wet PDAM Water	Wet-Dry PDAM Water	Wet-Dry Swamp Water
Sample 1	3.073	2.424	1.920
Sample 2	3.600	2.544	2.256
Sample 3	4.224	3.169	2.664
Mean	3.633	2.713	2.280

Figure 18 Flexural Strength of Ferrocement without Wire Mesh



	Wet PDAM Water	Wet-Dry PDAM Water	Wet-Dry Swamp Water
Sample 1	3.338	2.662	2.304
Sample 2	3.962	2.833	2.424
Sample 3	4.249	3.673	2.713
Mean	3.850	3.056	2.481

Figure 19 Flexural Strength of Ferrocement with Single Layer Wire Mesh



	Wet PDAM Water	Wet-Dry PDAM Water	Wet-Dry Swamp Water
Sample 1	6.316	4.609	4.873
Sample 2	6.362	6.700	5.331
Sample 3	7.082	6.771	5.402
Mean	6.587	6.027	5.202

Figure 20 Flexural Strength of Ferrcement with Double Layer Wire Mesh

Based on Figure 18 - Figure 20, the results of flexural strength test of ferrocement with PDAM water wet curing method has a higher value than ferrocement with PDAM water dan swamp water wet-dry curing method on all various number of wire mesh layers. From Figure 18, the decrease in the average flexural strength is 25.33% and 37.24%, respectively, in PDAM water and swamp water wet-dry curing ferrocement against PDAM water wet curing ferrocement. From Figure 19, the decrease in the average flexural strength is 20.16% and 35.56%, respectively, in PDAM water and swamp water wet-dry curing ferrocement against PDAM water wet curing ferrocement. From Figure 20, the decrease in the average flexural strength is 8.50% and 21.02%, respectively, in PDAM water and swamp water wet-dry curing ferrocement against PDAM water wet curing ferrocement.

Influence of Curing Methods on Flexural Strength of Ferro-Geopolymer

The results of calculating the flexural strength of the 28-day-old ferrocement plate can be seen in Figure 22 – Figure 24.

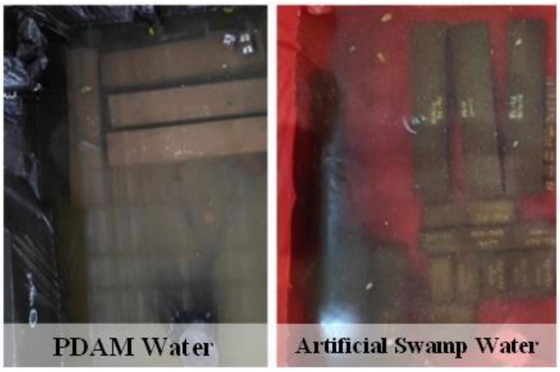


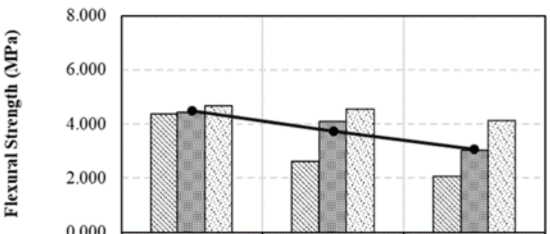
Figure 21 Curing Methods of Ferro-Geopolymer

	Wet PDAM Water	Wet-Dry PDAM Water	Wet-Dry Swamp Water
Sample 1	1.464	1.489	0.936
Sample 2	1.680	1.536	1.151
Sample 3	1.896	1.751	1.704
Mean	1.680	1.592	1.264

Figure 22 Flexural Strength of Ferro-Geopolymer without Wire Mesh

	Wet PDAM Water	Wet-Dry PDAM Water	Wet-Dry Swamp Water
Sample 1	1.665	1.656	1.188
Sample 2	1.697	1.680	1.442
Sample 3	1.824	1.719	1.800
Mean	1.729	1.685	1.477

Figure 23 Flexural Strength of Ferro-Geopolymer with Single Layer Wire Mesh



	Wet PDAM Water	Wet-Dry PDAM Water	Wet-Dry Swamp Water
Sample 1	4.369	2.589	2.040
Sample 2	4.393	4.082	3.024
Sample 3	4.682	4.562	4.129
Mean	4.482	3.744	3.064

Figure 24 Flexural Strength of Ferro-Geopolymer with Double Layers Wire Mesh

Based on Figure 22 - Figure 24, the results of flexural strength test of ferrocement with PDAM water wet curing method has a higher value than ferro-geopolymer with PDAM water dan swamp water wet-dry curing method on all various number of wire mesh layers. From Figure 22, the decrease in the average flexural strength is 5.25% and 24.78%, respectively, in PDAM water and swamp water wet-dry curing ferro-geopolymer against PDAM water wet curing ferro-geopolymer. From Figure 23, the decrease in the average flexural strength is 2.55% and 14.59%, respectively, in PDAM water and swamp water wet-dry curing ferro-geopolymer against PDAM water wet curing ferro-geopolymer. From Figure 24, the decrease in the average flexural strength is 16.45% and 31.62%, respectively, in PDAM water and swamp water wet-dry curing ferrocement against PDAM water wet curing ferrocement.

Flexural Strength Comparison of Ferrocement and Ferro-Geopolymer to Curing Methods

Flexural strength comparison of 28-days-old ferrocement and ferro-geopolymer on any curing methods can be seen in Figure 25 – Figure 27.

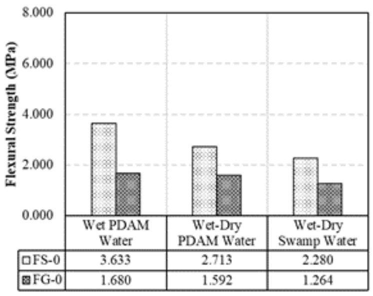


Figure 25 Comparison of the Average Flexural Strength of No Layer Wire Mesh

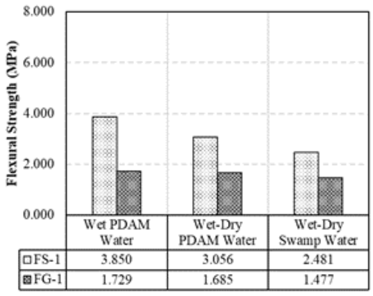


Figure 26 Comparison of the Average Flexural Strength of Single Layer Wire Mesh

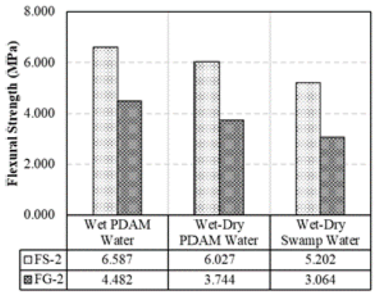
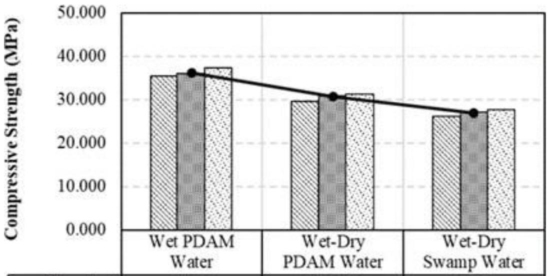


Figure 27 Comparison of the Average Flexural Strength of Double Layer Wire Mesh

Based on Figure 25 – Figure 27, the average flexural strength of ferrocement in all variations of curing methods has a greater value than the average flexural strength of ferro-geopolymer. From Figure 25, there is a decrease in the average flexural strength of ferro-geopolymer by 53.75%, 41.32%, and 44.58%, respectively, in PDAM water wet curing, PDAM water wet-dry curing, and swamp water wet-dry curing to the average flexural strength of ferrocement in each curing methods. From Figure 26, there is a decrease in the average flexural strength of ferro-geopolymer by 55.87%, 44.87%, and 40.47%, respectively, in PDAM water wet curing, PDAM water wet-dry curing, and swamp water wet-dry curing to the average flexural strength of ferrocement in each curing methods. From Figure 27, there is a decrease in the average flexural strength of ferro-geopolymer by 31.96%, 37.87%, and 41.10%, respectively, in PDAM water wet curing, PDAM water wet-dry curing, and swamp water wet-dry curing to the average flexural strength of ferrocement in each curing methods.

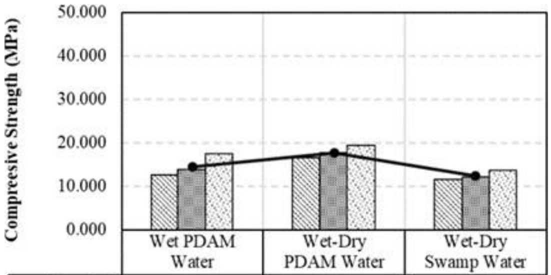
Influence of Curing Methods on Compressive Strength of Cement Mortar and Geopolymer Mortar

The results of calculating the compressive strength of the 28-day-old cement mortar and geopolymer mortar can be seen in Figure 28 and Figure 29.



	Wet PDAM Water	Wet-Dry PDAM Water	Wet-Dry Swamp Water
Sample 1	35.398	29.651	26.160
Sample 2	36.010	30.961	27.035
Sample 3	37.383	31.267	27.764
Mean	36.264	30.627	26.986

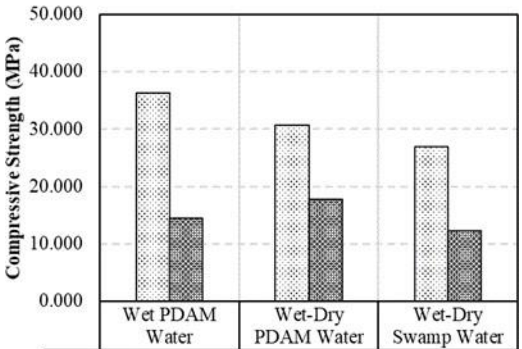
Figure 28 Compressive Strength of Cement Mortar



	Wet PDAM Water	Wet-Dry PDAM Water	Wet-Dry Swamp Water
Sample 1	12.550	16.396	11.532
Sample 2	13.745	17.510	12.007
Sample 3	17.310	19.264	13.462
Mean	14.535	17.724	12.334

Figure 29 Compressive Strength of Geopolymer Mortar

Figure 30 Compressive Strength Test of Mortar



	Wet PDAM Water	Wet-Dry PDAM Water	Wet-Dry Swamp Water
MS	36.264	30.627	26.986
MG	14.535	17.724	12.334

Gambar 31 Comparison of the Average Compressive Strength of Mortar

From Figure 28 the compressive strength of PDAM water wet curing cement mortar has a higher value than PDAM water and swamp water wet-dry curing cement mortar. The average compressive strength of cement mortar decreased by 15.54% and 25.58%, respectively, in PDAM water and swamp water wet-dry curing cement mortar. From Figure 28, the compressive strength of PDAM water wet-dry curing cement mortar has a higher value than PDAM water wet curing and swamp water wet-dry curing cement mortar. The average compressive strength of geopolymer mortar increased by 21.94% in PDAM water wet-dry curing geopolymer mortar and decreased by 15.14% in swamp water wet-dry curing geopolymer mortar.

Based on Figure 31, the average compressive strength of cement mortar in all methods of curing has a greater value than the average compressive strength of geopolymer mortar. The average compressive strength of geopolymer mortar decreased by 59.92%, 42.13%, and 54.30%, respectively, in the PDAM water wet curing, PDAM water wet-dry curing, and swamp water wet-dry curing to the average compressive strength of cement mortar in each curing method.

5. CONCLUSION

Conclusion

From the results of the research conducted, the following conclusions can be drawn:

1. The flexural strength of ferrocement and ferro-geopolymer has increased along with the increase in the number of *wire mesh layers* used in all curing methods
2. The flexural strength of ferrocement and ferro-geopolymer has a maximum value in PDAM water wet curing compared with wet-dry curing in PDAM water and swamp water.
3. The compressive strength of geopolymer mortar has increased in PDAM water wet-dry curing compared with PDAM water wet curing and swamp water wet-dry curing.
4. The wet curing method in PDAM water generates the value of flexural strength and compressive strength is higher when compared with the wet-dry curing method in PDAM water and swamp water.
5. The use of Plastiment-VZ 2% on geopolymer mortar affects the compressive value.

Suggestions

From the results of the research and the changes carried out, several suggestions for further research can be taken as follows:

1. Further research is needed on the percentage of optimum use of plastiment-VZ in geopolymer mortar.
2. It is necessary to pay attention to the quality of the material and the casting process of the sample.
3. It is necessary to conduct further research on curing methods suitable for geopolymers.

4. It is necessary to select the right reinforcement to be used, such as reinforcement in general used and then tied or welded. This is to avoid the unavailability of the reinforcement specifications used.

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