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Roof Slab Using Organic Pozzolan To Produce Acid Rain Resistant Concrete

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ABSTRACT
Many minimalist houses use reinforced concrete slabs as a roof which is no cover. One phenomenon that is happening now is the emergence of acid rain due to air pollution. Concrete is very vulnerable to damage due to acid. Therefore, this study aims to use organic pozzolan into reinforced concrete slab roofs to increase resistance to acid rain. This study is experimental research in a laboratory. The slab used has three types of thickness of 10 cm, 12 cm, and 15 cm. The organic pozzolan used is rice husk ash which is used 5% by weight of the cement used in the mixture. Acid rain simulation in a laboratory is , by immersed in an acidic solution with a pH of 3. Flexural testing was conducted on the slabs that have been soaked for 28 days, 90 days, and 120 days. The results of this study indicate that organic pozzolan can increase resistance to acid rain. The durability provided by a 12 cm slab is relatively the same as a 15 cm slab. The results of this study provide benefits in determining the thickness of the concrete slab used as a roof slab, especially in areas that experience acid rain.
Keywords – acid rain, organic, pozzolan, roof slab, rice husk ash.

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I. INTRODUCTION

The structure of reinforced concrete flat roofs is already familiar. Whereas in the country of Indonesia in the 1980s also had to use this flat slab structure for offices. Nowadays, with the development of minimalist themed houses, the flat roof is increasingly popular and used.

A common problem that often arises in flat roof designs is leakage due to stagnant water for a long time. Some solutions have been carried out, including making the surface not tilted at least 2 ° or installing roof drain on the surface of the roof, so that rainwater can flow down vertically. Coating the beginning of the slab with a waterproof coating can also anticipate the problem of leakage on the slab.

The direction of research on roofing slabs is how to make durable slabs in use. Several researchers discussed creating a protected roof slab with several waterproofing methods. Researchers [1] investigated the concept of a type of slab known as an inverted roof, which is an insulating layer mounted on top of a waterproofing layer. Researchers [2] examines a multilayer system of inverted roofs that both functions as a roof and as a roof garden.

Conventional roofing slabs that use bitumen and insulating layers have low strength. Researchers [3] dan [4] provides alternative materials that are more resistant in the form of layers of Polyvinyl Chloride, thermoplastic polyolefin, and ethylene propylene diene monomer. Researchers [5] make roofing slabs with an outer layer coated with self-compacting concrete. This layer is proven to have compressive strength, resistance to snow, and high waterproofing.

Several factors must be considered in maintaining the durability of a roof slab. The surface of the roof must be free from obstacles that cause the water not to flow. The use of types and types of waterproofing layers need to pay attention to the weather and the outside environment. The process of maintenance and finishing when making a roof slab needs to be done carefully and thoroughly [6].

Previous researchers have used waste to improve the performance of concrete, such as using fly ash and rice husk ash [7,8,9,10]

While research on rice husk ash (ASP) in concrete mixtures has been carried out, the results of the ASP characterization indicate it is in the amorphous phase. The smoothness and chemical composition of RHA plays an essential role in increasing strength. ASP contains silicon dioxide, which is very high and is a very reactive pozzolan, suitable as an additive [11 and [12].

Researched by [13] illustrates that ASP is an amorphous silica-containing material so that it can be classified into pozzolans. Researcher [14] concluded that the optimal mixture was obtained with a mix of 90% PCC: 10% ASP. Researcher [15] uses synthesis pozzolan (fly ash, bottom ash, and) with a percentage of 20% by weight of cement as pozzolan material in forming blended cement. The result is that the strength of the mixed cement mortar is lower than the control mortar but increases and exceeds the control mortar at a higher age. Researcher [16] found that rice husk ash caused an increase in the standard consistency value and the binding time of the cement paste mixture and husk ash.

This research aimed to obtain the behavior of reinforced concrete roof slab structures using Green Concrete technology based on organic pozzolan with variations in thickness. Furthermore, if a slab that uses organic pozzolan behaves well, it can create a slab that has a green concrete concept.

II. METHODOLOGY

Organic pozzolan (OP) and Portland Composite Cement (PCC) used as binders were examined for their chemical and physical characteristics. This research used rice husk ash as an organic pozzolan. An X-ray diffraction test was carried out to determine the chemical composition of ash. The test specimen used was in the form of a reinforced concrete roof slab. This study uses two independent variables, namely slab thickness (10 cm, 12 cm damn 15 cm) and concrete age (28 days, 90 days and 120 days). While the dependent variable is roof slab flexural strength.

The treatment of acid rain in the laboratory was done by immersed the entire slab in a tub containing an acid solution (pH 3). After that, the slabs were tested for bending at 28 days, 90 days, and 120 days to determine the strength of concrete after being immersed in acid.

Descriptive statistical analysis was carried out to get a clear picture of the relationship between the independent variables and the dependent variable on the results of the test.

III. RESULS

The organic pozzolan used is rice husk ash from the free burning of farmers. This free method causes combustion to be carried out without temperature control and duration of combustion. Therefore, the husk ash produced is tested again for its chemical content. This test is beneficial to ensure the husk ash is still in the amorphous phase. The XRD test results show that rice husk ash contains SiO2 in the form of the Tridymite phase (Fig. 1).

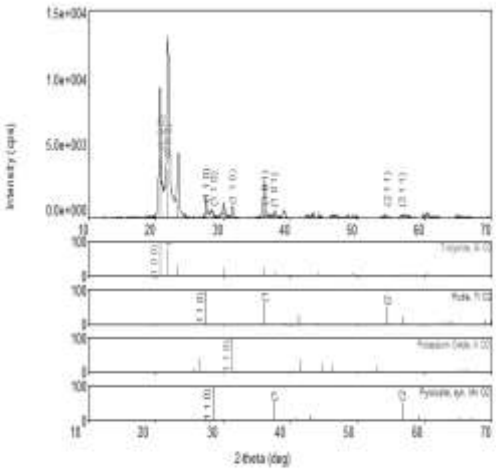

Figure 1 X-ray diffraction test of OP

The results of the microstructure test using XRD obtained the composition of the oxide compound present in rice husk ash as an organic pozzolan in the mixture (Table 1). The percentage of SiO2 compounds from husk ash is 88.9%, which means that it is below 90%. This percentage is below the results of previous studies that use ash with silica oxide content above 90%. However, based on specifications according to the American Society for Testing and Materials (ASTM C618-93), this ash can be categorized as an additional mineral in a concrete mixture. The percentage of SiO2 compounds from husk ash is higher than 70%.

Table 1 Chemical Composition of OP

Oxide Compounds	Chemical Composition (%)
SiO_2	88,9
TiO_2	4,48
K_2O	3,18
MnO_2	3,5

The standard consistency obtained from this study is based on the amount of water needed by the Vicat test results. Table 2 shows the calculation of normal viscosity for regular mixes and those using rice husk ash. The value of normal consistency usually ranges from 26% to 29%. This value shows that the normal consistency for mixtures using rice husk ash is still within the required limits of 28.7%.

Table 2 Normal Consistency

Mixed	Setting Time	
	Initial (min)	Final(min)
0%OP; 100%PCC	63	125
5%OP;95%P CC	78	143

Tests carried out on reinforced concrete slabs is a flexural test. Testing is done after the slab is immersed for 28 days, 90 days, and 120 days. The mixture used is only using rice husk ash. The thickness of the slabs used in this study varied to 10 cm, 12 cm, and 15 cm. The results of the flexural test can be seen in Table 3.

Table 3 Flexural Strength

Condition	Immerse (days)	Flexural Strength (kN)		
		10 cm	12 cm	15 cm
Normal	28	15.3	16.8	18.2
	90	16.2	20.1	21.7
	120	16.8	20.5	22.0
pH 3	28	14.5	16.0	17.4
	90	14.9	18.7	20.3
	120	15.1	18.8	20.3

The behavior of the slab in question is the bending behavior of the slab when tested because of the immersion treatment in acid solution. Fig. 2 shows the relationship between slab thickness and percentage of decrease in flexural strength. This relationship was described for 28 days, 90 days, and 120 days respectively. Decrease in the 10 cm slab by 5% after soaking for 28 days. While the decrease in the slab 12 cm and 15 cm respectively decreased lower, namely by 4.6% and 4.4%.

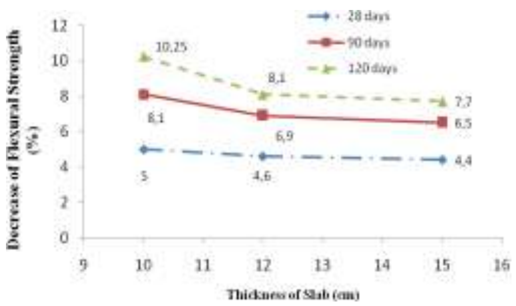

Figure 2 Relationship between thickness of slab and decrease of flexural strength

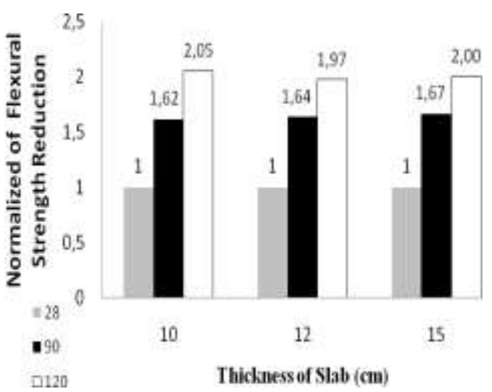

Figure 3 The effect of Immersion Periods

Furthermore, soaking for 90 days and 120 days resulted in a more significant decrease in flexural strength on all types of slab thickness. The downward trend is the same as for 28-day immersion. Namely, the thicker the slab used, the smaller the decrease in bending strength that occurs.
Figure 3 shows the relationship between the duration of immersion and the ratio of decreasing flexural strength. The comparison here means the rate of flexural strength to flexural strength at 28 days immersion for each slab thickness. Decrease in flexural strength for slab thickness of 10 cm after soaking 90 days has increased by 1.62 times compared to after submerged 28 days. Then the same thing happened, that is, after being soaked 120 days, it increased by 2.05 times. The same thing happened for slabs 12 cm and 15 cm, the decrease in flexural strength increased with increasing immersion. However, the magnitude of the increase was not as large as that experienced by the 10 cm slab. The decrease in flexural strength after soaking 90 days for 12 cm and 15 cm slabs only increased by 1.5 and 1.48 times, respectively. Meanwhile, after soaking 120 days, it only increased by 1.76 and 1.75 times.

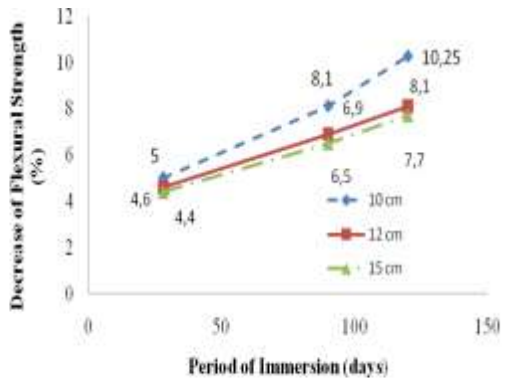

Figure 4 Relationship between period of immersion and decrease of flexural strength

The relationship between the length of immersion and a decrease in flexural strength can be seen in Fig. 4. This relationship is depicted respectively for slab thickness of 10 cm, 12 cm, and 15 cm. The first is that the decrease in flexural strength increases for all types of slab thickness. Secondly, the magnitude of the increase that occurs for a 12 cm slab is almost the same as that for a 15 cm slab. This illustrates that the flexural strength behavior for 12 cm slab and 15 cm slab is relatively the same in an acidic environment.

The results showed that decrease in flexural strength due to acidic conditions for 10 cm slabs by 5% after soaking for 28 days. While the decrease in the slab 12 cm and 15 cm respectively decreased lower, namely by 4.6% and 4.4%. Furthermore, after

90 days, the decline in the 10 cm, 12 cm, and 15 cm slabs was 8.1%, 6.9%, and 6.5%, respectively. Furthermore, after 120 days in a row of 10.25%, 8.1%, and 7.7%.

Next, Fig. 5 shows the influence of slab thickness on the ratio of decrease in flexural strength. The comparison in question is the ratio of flexural strength to flexural strength for slab thickness of 10 cm at each immersion length. The decrease in flexural strength after being immersed 28 days for a 12 cm slab and a 15 cm slab was reduced by 0.92 and 0.88 times compared to a 10 cm slab. Meanwhile, after soaking 90 days for a 12 cm slab and 15 cm slab reduced by 0.85 and 0.80 times. Then the same thing happened, that is, after being soaked for 120 days, it decreased by 0.79 and 0.75 times. This illustrates that slab thickness of 10 cm has the most considerable decrease in flexural strength, especially after being soaked 90 and 120 days. A visible reduction of flexural strength for slab thickness of 12 cm and 15 cm occurs a smaller decrease.

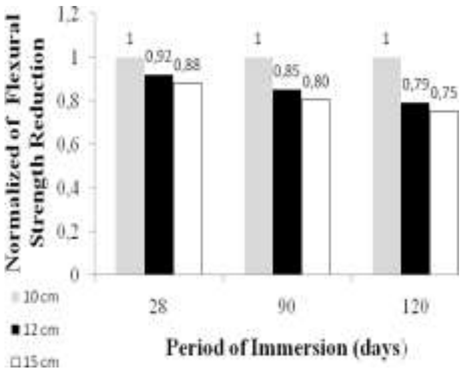

Figure 5. The effect of slab thickness

IV. CONCLUSION

This study concludes that slabs using organic pozzolan have resistance to the acid environment. This study uses slabs with a thickness of 10 cm, 12 cm, and 15 cm. Slabs 12 cm and 15 cm thick provide the same relative resistance to the acid environment. 10 cm thick slabs provide the lowest resistance.

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