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The Effect of Using Master Rheobuild 6 Towards Compressive Strength and Porosity of Concrete

Juli Ardita Pribadi[1*], Muhammad Gala Garcya[1], Dedi Enda[1*]

[1]Bengkalis State Polytechnic,
Bathin Alam, Desa Sungai Alam, Kecamatan Bengkalis, Bengkalis, 28711, INDONESIA

*Corresponding Author

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Abstract: Bengkalis Regency is an island where almost all of its land is peat soil. Peat is a soil layer rich in organic matter. The organic matter that makes up the soil is formed from the remains of dead and weathered plants. This area is also located in the middle of the ocean and the absence of rivers and mountains in the area so construction materials were imported from Tanjung Balai Karimun. Coarse and fine aggregates in the area are exposed to high salt content also no fresh water meets the basic specifications of concrete design. This research uses additives to improve the quality of concrete named Master Rheobuild 6. This study used cylindrical concrete measuring 105 x 210 mm and as many as 27 samples for testing compressive strength and porosity with a treatment period of 14 and 28 days. based on the results of compressive strength, the addition of 1.5% additive by weight of cement resulted in compressive strength of up to 35.39 MPa compared to normal concrete which only reached 32.71 MPa. Meanwhile, for the porosity test with the addition of 1.5% additive, the porosity value was 4.75% compared to normal concrete, which was 10.45%. This study highly recommends the use of this additive in concrete work so that based on the tests carried out, the quality of the concrete is high and the porosity is relatively small so it is not easy for water to enter the concrete which has an impact on the performance of the concrete material itself.

Keywords: Additive, portland, seawater, low-quality materials

1. Introduction

Bengkalis Regency is one of the regions in Riau Province, located in the middle of the ocean. Bengkalis Regency is directly adjacent to the Malacca Strait and Malaysia, as shown in Figure 1 below. This case impacts all types of mobilization, material and anything that must pass through the sea. Due to the absence of rivers and mountains, construction materials must be imported from Tanjung Balai Karimun. Tanjung Balai Karimun is located southeast of Bengkalis Island, surrounded by the ocean. So the area exposes coarse and fine aggregates with high salt content, which affects the quality of it, potentially reducing the quality of the concrete that will be designed (Zhang et al, 2013). In terms of water in the Bengkalis Island area, no fresh water meets the basic specifications of concrete design.

*Corresponding author:juliarditapribadi@gmail.com

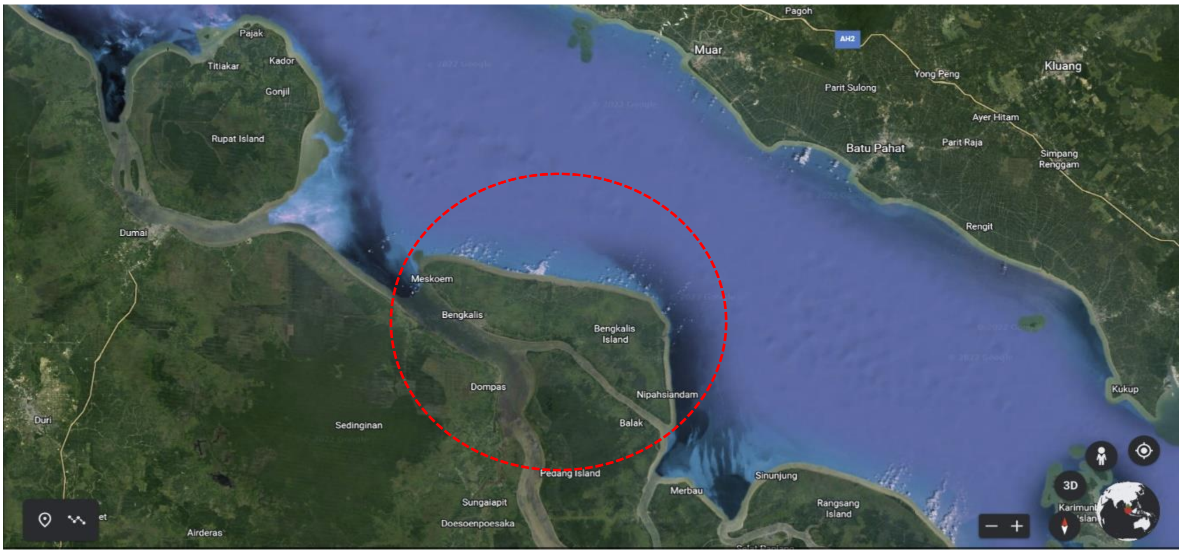

Fig. 1 - Bengkalis distric geographical area (google map, 2022)

Bengkalis Regency is an island where almost all of its land is peat soil. Peat is a soil layer rich in organic matter. The organic matter that makes up the ground is formed from the remains of dead and weathered plants (BB Litbang SDLP, 2011). The results showed that the distribution of peat soils in the Bengkalis district reached 82,129.73 hectares (Nasrul, 2010). This peat soil tends to be acidic, so indirectly, this acid has the potential to damage the outer structure of the concrete material.

Additionally, because the Bengkalis district is located on the shore, the structural material is constantly exposed to seawater with high chloride. Seawater is the leading cause of corrosion in concrete reinforcement. In addition, materials made of metal also tend to rust easily due to rainwater in the area, so it is better to plan for concrete with high durability so that the material in the site is not easily damaged due to increasing material age. The wet-dry cycle can increase the degree of concrete deterioration (Attiogbe & Rizkalla, 1988).

Based on these two things, it is crucial to make high-strength concrete with better durability to withstand an aggressive environment like Bengkalis District. But it's to make high-strength concrete that is difficult to achieve given the quality of the material and the value of low workability (Mittal et al., 2013). Rheobuild is an additive that has the potential to increase workability and compressive strength better than ordinary concrete. So with this research, it is hoped that this Rheobuild can be a solution that this additive can overcome problems in making high-quality concrete, especially in areas where the quality of the material is not good, especially in this Bengkalis district. In some research, an additive can increase compactness and strength (Dogra & Bhardwaj, 2014).

2. Methodology

2.1 Research Material

Concrete comprises cement, additives (if needed), water, and coarse and fine aggregates. PCC cement is cement produced by Semen Padang Company and is commonly used for concrete binders because it contains pozzolanic materials (Olivia et al., 2019). This study's coarse and fine aggregates came from Tanjung Balai Karimun, Riau Islands. The additive used is Master Rheobuild 6. The additives used are set from 1 to 1.5% of the cement weight. The appearance of the research materials used can be seen in Figure 2 below.

Fig. 2 - Research materials

*a= Fresh water; b=Coarse Aggregate; c=Fine Aggregate; d = Cement; e = Rheobuild Additive

2.2 Specimens

In this study, 18 (eighteen) specimens were used as a cylinder with a diameter of 105 mm and a height of 210 mm to test for compressive strength. As for the porosity test, 9 (nine) cylinders have a diameter of 105 mm and a height of 210 mm. So the total number of samples in this study was 27 (twenty-seven). For a more detailed sample number, see Table 1 below.

Table 1 - Sample of this research

Testing Methods	0% MR		1,0% MR		1,5% MR	
	Curing Age					
	14 Days	28 Days	14 Days	28 Days	14 Days	28 Days
Compressive	3	3	3	3	3	3
Porosity	-	3	-	3	-	3
	Total				27 Sample	

Based on Table 1 above, it can be seen that for compressive strength testing, 6 (Six) specimens for MR 0% concrete cylinders, 6 (Six) specimens for 1.0% MR concrete cylinders, and 6 (Six) specimens for 1.5% MR concrete cylinders with treatment periods of 14 and 28 days. So testing the compressive strength of concrete requires 18 cylindrical concrete samples measuring 210 x 105 mm. Testing the porosity of concrete requires 9 (nine) cylindrical concrete measuring 210 x 105 mm for the three fractions with treatment periods of 28 days.

2.3 Composition

The composition used in 1 m3 consists of the composition of cement, water, coarse aggregate, fine aggregate, and additives in units of Kg with 3 (three) different fractions, namely for MR 0%, MR 1.0%, and MR 1.5%. The determination of this use refers to (Osmani, 2017) because the increasing use of superplasticizers produces better concrete characteristics. For more details, it can be seen in the following Table 2.

Table 2 - Composition in 1 m^3 sample

Additive Composition	Cement (Kg)	Water (Kg)	Coarse Aggregate (Kg)	Fine Aggregate (Kg)	MR (Kg)
MR 0%	352,23	205	995,30	792,47	0
MR 1,0%	352,23	205	995,30	792,47	3,52
MR 1,5%	352,23	205	995,30	792,47	5,28

2.3 Compressive Testing

The strength of the concrete against the compressive force is one of the parameters to determine the power of the concrete to receive the maximum load in the unit area. The value of this compressive strength defines how capable the concrete can withstand the applied force in one unit area.

$$\text{Compressive Strength (MPa)} = \frac{\text{Force (N)}}{\text{Area (mm}^2\text{)}} \qquad (1)$$

When loading is carried out, there is a reaction between the compressive load given by the compression test tool and the concrete surface until it collapses slowly. When the concrete has reached its maximum limit, the reading value on the device will not increase again, and the concrete is already in a state of collapse (crushed). For the setup of the compression test tool, it can be seen in Figure 3 below

Fig. 3 - Compressive testing machine

2.4 Porosity Testing

Porosity is the percentage of pores or space in the concrete to the volume of concrete. Large particles of concrete constituents can cause porosity, so the density is not optimal (Pah et al., 2020). The formula used to calculate the porosity is:

$$\text{Porosity (\%)} = \frac{W_{SSD} - W_{dry}}{W_{SSD} - W_{inwater}} \times 100\% \qquad (2)$$

3. Result and Conclusion

3.1 Compressive Strength

The compressive strength of concrete dramatically affects the way the concrete is worked during moulding. The properties of the research base materials and the job mix design significantly affect the concrete's quality. Concrete has a higher compressive strength than steel material, so the value of this concrete's compressive strength significantly affects the concrete's quality in resisting the designed load.

The concrete compressive strength test was carried out when the specimens were 14 and 28 days old, with variations in the use of MR additives of 0%, 1.0%, and 1.5%. Based on the testing of these three mixtures, they produced different values. When the concrete was 14 days old, this value increased linearly with the addition of MR. When the concrete reaches the age of 14 days, it can be seen that the value of the compressive strength of concrete with the addition of 1.5% MR is significantly increased compared to concrete without MR mixture (MR 0%). The results of testing the compressive strength of concrete aged 14 days can be seen in Figure 4 and Table 3 below.

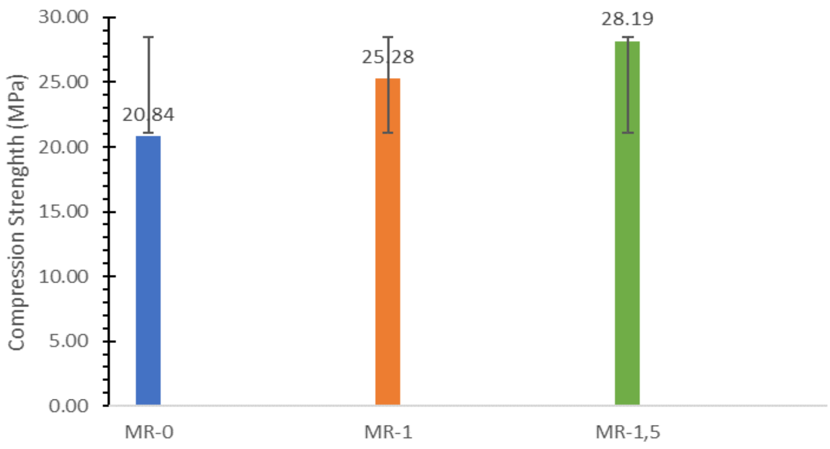

Fig. 4 - 14 days curing compression testing concrete

As seen in Figure 4 above, with the addition of Master Rheobuild 6, the value achieved is also increasing. Using 0%, MR showed a compressive strength value of 20,84 MPa at 14 days of age. Concrete with the use of 1.0% MR offers a significant compressive strength value, reaching 25,28 MPa at 14 days of age, and the use of 1.5% MR shows the compressive strength of concrete comes to 28,19 MPa. More detailed results can be seen in Table 3 below.

Table 3 - Detailed 14 days curing compression testing concrete

Sample	Diameter	Height	Area	Compress Strength	Mean Compress Strength
	(mm)	(mm)	(mm2)	MPa	MPa
	105	210	8659.015	20.42	
MR-0	105	210	8659.015	20.57	20.84
	105	210	8659.015	21.53	
	105	210	8659.015	24.81	
MR-1	105	210	8659.015	25.31	25.28
	105	210	8659.015	25.73	
	105	210	8659.015	26.43	
MR-1,5	105	210	8659.015	27.50	28.19
	105	210	8659.015	30.64	

Meanwhile, according to the compressive strength test, the 28-day-old concrete of these three mixtures resulted in different values from the 14-day-old concrete. When the concrete is 14 days old, this value increases linearly with the addition of MR use. In comparison, when the concrete reaches the age of 28 days, there is a decrease when the concrete is mixed with 1.0% MR from the weight of cement also increases when it adds 1.5% from cement weight. This case can happen when doing the slump test. The concrete undergoes an initial setting process which results in the hydration process of the concrete being disturbed. The results of testing the compressive strength of concrete aged 28 days can be seen in Figure 5 and Table 4 below.

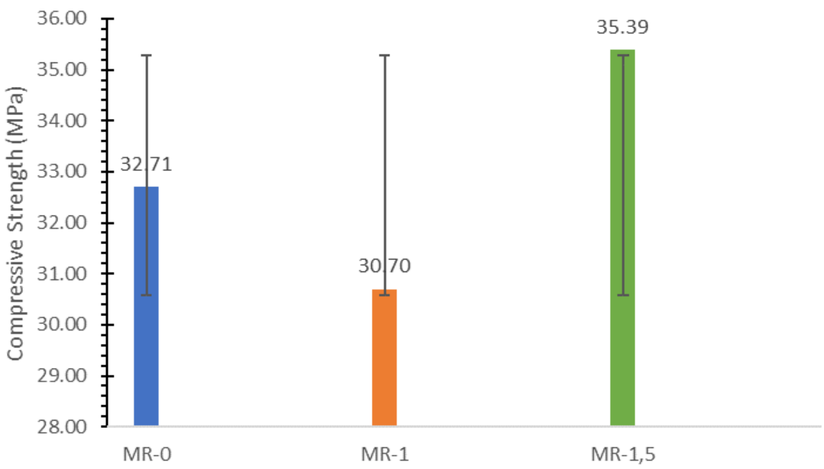

Fig. 5 - 28 days curing compression testing concrete

As seen in Figure 5 above, with the addition of Master Rheobuild 6, the value achieved is also increasing. Using 0%, MR showed a compressive strength value of 32,71 MPa at 28 days of age. Concrete with 1.0% MR showed a decreased compressive strength value of 30,70 MPa at 28 days of age. This case can be caused by several external factors, which can be further investigated in the subsequent study. And the use of 1.5% MR shows the compressive strength of concrete reaches 35,39 MPa. More detailed results can be seen in Table 4 below.

Table 4 - Detailed 28 days curing compression testing concrete

Sample	Diameter	Height	Area	Compress Strength	Mean Compress Strength
	(mm)	(mm)	(mm2)	MPa	MPa
	105	210	8659.015	33.06	
MR-0	105	210	8659.015	32.14	32.71
	105	210	8659.015	32.91	
	105	210	8659.015	30.22	
MR-1	105	210	8659.015	30.83	30.70
	105	210	8659.015	31.04	
	105	210	8659.015	35.07	
MR-1,5	105	210	8659.015	34.94	35.39
	105	210	8659.015	36.15	

3.2 Porosity

Concrete porosity testing also needs to be done to see how big the pores are in the concrete, which calculates how much water percentage enters the concrete mixture. This research was conducted when the specimens were 28 days old with MR substitution variations of 0%, 1.0%, and 1.5%. Based on the test results, it can be seen that with the addition of MR. The concrete tends to have a much better bond than ordinary concrete because the value of the ability of the concrete itself to absorb water seems to reach 4.75% with the addition of 1.5% MR of the cement weight compared to without the addition MR. The porosity test results can be seen in Figure 6 and Table 5 below.

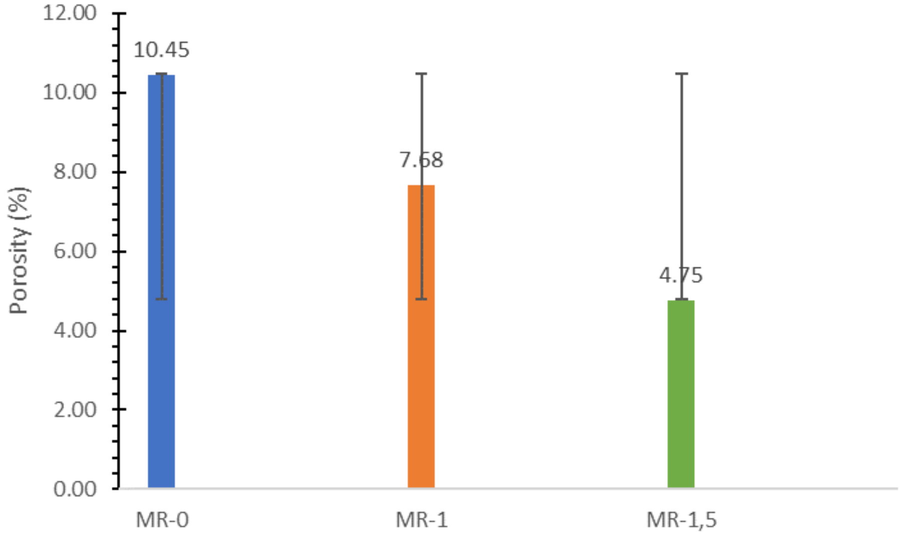

Fig. 6 - 28 days curing porosity of concrete

Table 5 - Detailed 28 days curing compression testing concrete

Sample	Diameter (mm)	Height (mm)	Area (mm2)	Weight (gram)	Dry Weight (Gram)	SSD Weight (Gram)	In Water Weight (Gram)	Porosity (%)	Mean porosity (%)
	105	210	8659.01	4510	4338	4483	2555	7.52	
MR-0	105	210	8659.01	4370	4229	4501	2537	13.85	10.45
	105	210	8659.01	4260	4196	4384	2502	9.99	
	105	210	8659.01	4380	4213	4345	2469	7.04	
MR-1	105	210	8659.01	4400	4419	4536	2587	6.00	7.68
	105	210	8659.01	4380	4323	4516	2584	9.99	
	105	210	8659.01	4340	4233	4330	2449	5.16	
MR-1,5	105	210	8659.01	4320	4439	4526	2567	4.44	4.75
	105	210	8659.01	4420	4343	4430	2564	4.66	

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