# Effect of Variations in Treatment Using an Autoclave on Mortar Made from Rice Husk Ash and Fly Ash

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**Abstract.** Mortar is a mixture of cement, fine aggregate and water which is generally used in non-structural work. In this research, in addition to using normal mortar to determine the compressive strength value that occurred, an innovation was made to the mortar mixture by adding fly ash and rice husk ash with a mixture percentage variation of 20% of the cement weight, as well as varying the percentage of aluminium powder as an additional ingredient to lighten the weight of the mortar by 0.2%. Apart from innovations in mortar mixtures, innovations were also carried out in the treatment of mortar test specimens using an autoclave at temperature pressures of 1 bar, 2 bar, 3 bar, 4 bar and 5 bar. From this research, it was found that the highest density value for normal mortar with a pressure of 2 bar was 2.20 gr/cm³ and the lowest density value for mortar PC80% : Psr100% : AS20% : AP0.2% with a pressure of 3 bar was 1.78 gr/cm³. Meanwhile, the highest compressive strength value for normal mortar with a pressure of 5 bar was 24.16 MPa and the lowest compressive strength was for the mortar mixture PC80% : Psr100% : AS20% : AP0.2% with a pressure of 3 was of 3.96 MPa. The research results show that the temperature pressure of mortar treatment using an autoclave can influence the compressive strength value of the mortar and the weight value of the mortar content.

**Keywords:** Autoclave, Fly ash, Rice husk ash, Compressive of mortar.

## 1 Introduction

Mortar is a mixture of cement, fine aggregate and water which is generally used in non-structural work. Based on data from Indoanaisis Indonesian Industry Research Company, Indonesia's cement production capacity reached 76.1 million tons at the end of 2019 for both domestic consumption and exports. This capacity increased by 1.2%. To reduce the amount of cement production, it is necessary to innovate the mortar mixture by adding husk ash and fly ash as a cement substitute. A maintenance method was also carried out using an autoclave to determine the effect of the compressive strength and weight of the mortar. increase, so working satisfaction increase as well, and performance either.


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# 2 Literature Reviews

## 2.1 A Subsection Sample

Lightweight Concrete: According to SNI 2847:2013, lightweight concrete is concrete that contains lightweight aggregate or a mixture of lightweight coarse aggregate and natural sand as a substitute for lightweight fine aggregate with a balance volume as determined by ASTM C567, between 1140-1850 kg/m³. Mortar: According to SNI 03-6825-2002, mortar is defined as a mixture of materials consisting of fine aggregate (sand), adhesive (clay, lime, Portland cement) and water with a certain composition. Portland Cement: Portland cement is a hydraulic cement that is produced by grinding Portland cement slag, which mainly consists of calcium silicate which is hydraulic in nature and is ground together with additional materials in the form of one or more crystalline forms of calcium sulfate compounds and may be added with other additional materials (SNI 15- 2049, 2004). Fine Aggregate: Fine aggregate is natural sand as a result of the natural disintegration of rock or sand produced by the stone crushing industry and has the largest grain size of 5.00 mm (SNI 03-2847-2002). Fly ash: Fly ash is solid waste resulting from the combustion process in the furnace at a PLTU which is then carried out by the combustion residue and captured using an electrostatic precipitator. Rice husk ash: Rice husk ash is a waste material from the burning of rice husks as residue from burning bricks and roof tiles. Rice husk ash has a reactive silica content of around 85-90% (Wahyuni A.S., et al, 2015). Alumunium powder: Aluminum powder as a developing agent in making lightweight concrete. Aluminum is added usually around 0.2% to 0.5% per dry weight of cement for mixing materials (Amin, M.S., et al, 2020).

Previous research: Research "Utilization of Fly Ash and Rice Husk Ash Waste in Making Lightweight Bricks to Support Construction Materials in Banyuwangi" (Amin, M.S., et al, 2020). The compressive strength value of the mortar when treated using an autoclave has the highest quality, namely 9.64 MPa. This value is greater than mortar treated by immersion in water which has a quality of 5.12 MPa. Research "Study of the Effect of Adding Rice Husk Ash on the Compressive Strength of Concrete" (Samsudin, and Hartanto, S.D., 2017). The compressive strength of normal concrete aged 28 days was found to be 226.47 kg/m² and the lowest compressive strength was found when adding 12% rice husk ash aged 28 days, namely 129.41 kg/m². Research "The Effect of Variations in Adding Aluminum Powder on the Compressive Strength of Non-Sand Concrete with Added Gypsum Powder" (Kusuma, C.W., 2017). The compressive strength test results showed that there was an increase in maximum compressive strength at 28 days, namely 7.61 MPa, 7.53 MPa, 7.45 MPa, 7.43 MPa. The volume weight of non-sand concrete ranges from 1.61 until 1.65 gr/cm³.

## 3 Methodology

The initial behavior is to prepare the materials and tools used. As for the material, testing is also carried out first. The research that will be carried out is by making test objects at Civil Engineering Materials Testing Laboratory in Politeknik Negeri Banyuwangi, starting with material preparation in the form of sand, cement, water, fly ash, husk ash and aluminum powder. Then tests were carried out on the fine aggregate, specific gravity, infiltration water, water content, sieve analysis, mud content, and volume weight adjusted to ASTM C-128. The composition of the mixture used is the replacement of part of the weight of cement using two types of waste and the use of aluminum powder as an additive, the composition of the waste used as a replacement for part of the weight of cement and the use of aluminum powder.

**Table 1.** Normal mortar mix composition

| Materials | Unit | Needs | Total needs for 5 sample |
|---|---|---|---|
| Cement | kg | 0.415 | 2.075 |
| Fine aggregat | kg | 1.145 | 5.725 |
| Water | ml | 201 | 1007.5 |
| Fly Ash | kg | - | - |
| Rice husk ash | kg | - | - |
| Aluminium Powder | kg | - | - |

**Table 2.** Composition $PC_{99,8\%}: Psr_{100\%}: AP_{0,2\%}$

| Materials | Unit | Needs | Total needs for 5 sample |
|---|---|---|---|
| Cement | kg | 0.414 | 2.075 |
| Fine aggregat | kg | 1.145 | 5.725 |
| Water | ml | 201 | 1007.5 |
| Fly Ash | kg | - | - |
| Rice husk ash | kg | - | - |
| Aluminium Powder | kg | - | - |

**Table 3.** Composition $PC_{80\%}: Psr_{100\%}: FA_{20\%}: AP_{0,2\%}$

| Materials | Unit | Needs | Total needs for 5 sample |
|---|---|---|---|
| Cement | kg | 0.331 | 1.655 |
| Fine aggregat | kg | 1.145 | 5.725 |
| Water | ml | 201 | 1007.5 |
| Fly Ash | kg | 0.83 | 0.415 |

| | | | |
|---|---|---|---|
| Rice husk ash | kg | - | - |
| Aluminium Powder | kg | 0.00083 | 0.000415 |

**Table 4.** Composition $PC_{80\%}: Psr_{100\%}: FA_{20\%}: AP_{0,2\%}$

| Materials | Unit | Needs | Total needs for 5 sample |
|---|---|---|---|
| Cement | kg | 0.331 | 1.655 |
| Fine aggregat | kg | 1.145 | 5.725 |
| Water | ml | 201 | 1007.5 |
| Fly Ash | kg | 0.83 | 0.415 |
| Rice husk ash | kg | - | - |
| Aluminium Powder | kg | 0.00083 | 0.000415 |

## 4 Result and Discussion

The results of testing materials for making mortar, namely fine aggregate in the form of fly ash and rice husk ash, showed that the specific gravity for fly ash was 2.61 gr/cm³ and the specific gravity for husk ash was 1.47 gr/cm³. Meanwhile, for cement, this research used portland cement type 1. The mixing stage is carried out using a molen machine with mix the specified materials into the molen. Each mixture variation will be mixed according to the specified aggregate and material mixture variations. The mixture of ingredients and mortar is ready for testing (as shown in Fig. 1.

**Fig. 1.** Mortar

### 4.1 Mortar Treatment Process Using an Autoclave

An autoclave is a vessel that can be closed, which is filled with hot steam at high pressure. This treatment is usually used with the aim of obtaining high initial strength (Amin, M.S., et al, 2020). The autoclave tool that will be used can be seen in Fig. 2.

**Fig. 2.** Autoclave

### 4.2 Mortar Compressive Strength Testing

Mortar compressive strength is the amount of load per unit area that causes the specimen to crumble because it is loaded with the axial compressive force produced by the load. The compressive strength of concrete can be calculated according to SNI 1974-2011.

$$f'c = \frac{P}{A}$$

From each mortar mixture that had been treated in the autoclave, the results were obtained:

**Table 5.** Recapitulation of mortar compressive strength test results

| Composition | Average result of compressive test (MPa) | | | | |
|---|---|---|---|---|---|
| | 1 bar | 2 bar | 3 bar | 4 bar | 5 bar |
| Normal | 17.44 | 17.50 | 22.57 | 23.10 | 24.16 |
| $PC_{99,8\%} : Psr_{100\%} : AP_{0,2\%}$ | 15.41 | 13.70 | 16.48 | 17.74 | 15.68 |
| $PC_{79,8\%} : Psr_{100\%} : FA_{20\%} : AP_{0,2\%}$ | 11.93 | 12.92 | 13.75 | 13.56 | 13.72 |
| $PC_{79,8\%} : Psr_{100\%} : AS_{20\%} : AP_{0,2\%}$ | 6,38 | 5.23 | 3.96 | 6.62 | 7.41 |

The volume weight of the mortar from the test results was obtained in Table 6.

**Table 6.** Composition $PC_{80\%}$: $Psr_{100\%}$: $FA_{20\%}$: $AP_{0,2\%}$

| Composition | Average result of volume weight (gr/cm$^3$) | | | | |
|---|---|---|---|---|---|
| | 1 bar | 2 bar | 3 bar | 4 bar | 5 bar |
| Normal | 2.08 | 2.20 | 2.15 | 2.03 | 1.99 |
| $PC_{99,8\%}$ : $Psr_{100\%}$ : $AP_{0,2\%}$ | 2.05 | 2.01 | 1.96 | 1.91 | 2.16 |
| $PC_{79,8\%}$ : $Psr_{100\%}$ : $FA_{20\%}$ : $AP_{0,2\%}$ | 2.04 | 2.06 | 2.01 | 2.02 | 2.04 |
| $PC_{79,8\%}$ : $Psr_{100\%}$ : $AS_{20\%}$ : $AP_{0,2\%}$ | 1.82 | 1.82 | 1.78 | 1.81 | 1.80 |

If outlined in the graph it is as follows

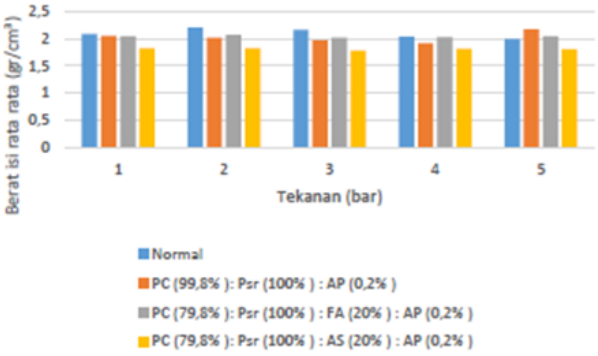


**Fig. 3.** Mortar content weight

## 5 Conclusion

The conclusion of this research was that the highest density value was found in normal mortar with a pressure of 2 bar of 2.20 MPa and the lowest density value was in mortar PC_(80%):Psr_(100%): 〖AS_(20%):AP〗 _(0,2%) with a pressure of 3 bar was 1.78 MPa. Meanwhile, the highest compressive strength value for normal mortar with a pressure of 5 bar was 24.16 MPa and the lowest compressive strength was for the mortar mixture PC_(80%):Psr_(100%): 〖AS_(20%):AP〗 _(0,2%)with a pressure of 3 bar of 3.96 MPa. The research results show that the temperature pressure of mortar treatment using an autoclave can influence the compressive strength value of the mortar and the weight value of the mortar content.

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