The Effect of Addition of Ash from Burning Wood Powder to the Mechanical and Physical Properties of Concrete

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Article Info

ABSTRACT

The wood powder is the waste from woods industry that further used as a mixture of plant soil. Scientist have used the powder of wood to make a particle board. This research, We used the ash of wood powder as an additive thing in the concrete mixture. The test is done for physics and mechanics of the concrete. The sample is made from the ingredients 1 cement : 2 sand : 3 pebble. In variation add to ash of the wood powder for cement is 5%, 10%, and 15%. The result of the researching show that the used of the ash of wood powder can build the impact of the concrete is 9.54% from normal concrete with the mixture of the ash of wood powder is 15%. Other side for the physics, the water absorption and porosity with the ash of the wood powder is from 4.94% to 14.35% and from 4.16% to 14.89% higher than the normal concrete.

Keywords:
Chlorophyll; Phytoplankton; Primary Productivity.

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PRELIMINARY

Housing development causes the need for building materials to increase, this is because the construction requires building materials in the form of stone, gravel, sand, clay, lime, cement and others. Such as clay for red stone, lime, or cement for brick, concrete, and others.

Concrete is the main material used in the manufacture of buildings. Concrete is widely used because of its advantages, among others, because it is easy to maintain, easy to form, and easy to get stacking materials. Concrete consists of paste, aggregate, and admixture. In making a concrete with a certain quality, it is necessary to determine the appropriate amount of paste and aggregate. Paste is a mixture of cement and water used to bond the aggregates in concrete. Cement also functions in hardening and forming concrete so that it is solid. The proportions of both the cement and water mixture determine the properties of the formed concrete.

The most important properties of concrete are its mechanical properties, namely compressive strength, flexural strength, and tensile strength. The properties of concrete change because of the nature of the ingredients that make up concrete, namely sand, cement, stone, water and the ratio of the mixture.
To obtain optimum concrete for a typical use, it is necessary to select the appropriate materials and mix them properly. Aggregates such as natural sand, macadam made from fine sandstone, as well as artificial aggregate from blast furnace slug in the form of coarse aggregate and lightweight aggregate. Occupies 65% - 80% of the volume of concrete, so it greatly affects the quality of concrete.

In accordance with technological developments, several researchers continue to improve the properties of concrete, including adding fiber to the mix called fiber concrete, which is concrete made from a mixture of cement with fine aggregate and coarse aggregate with fiber additives. The types of fibers that can be used to improve the poor properties of concrete are steel fibers, plastic fibers, glass fibers, carbon fibers, and natural fibers. Wood is a forest product from natural resources, it is also a raw material that is easily processed to be made into goods in accordance with technological advances. The definition of wood here is a material obtained from the collection of trees in the forest, which are part of the tree, and it is taken into account which part can be used more for a certain purpose. Both in the form of carpentry wood, industrial wood and firewood. Likewise, sawdust is a type of wood particle with a size of 0.25 mm - 2.00 mm, its weight is very light in dry conditions and is easily carried away by the wind. In this study, concrete was made by adding wood dust burning ash. Where the sawdust itself is known as furniture industry waste and the use of this waste is to have added value.

Waste has the meaning as by-products, by-products and residual products that have been and have not been used for certain production, after going through a further process or not.

Utilization of sawdust is a new alternative to obtain carbon fiber concrete obtained from burning sawdust waste. The results of the combustion of sawdust waste will produce charcoal briquettes and activated charcoal containing carbon which is also expected to improve the mechanical properties of concrete which is much better than concrete without added ingredients and can improve the properties of concrete without added ingredients and without reducing quality.

Research objectives 1. Utilize sawdust waste for the manufacture of concrete, in order to reduce environmental pollution from sawdust waste. 2. Characterization of concrete made by utilizing sawdust combustion ash waste. 3. Comparing the strength of concrete made from a mixture of wood sawdust ash with the strength of normal concrete. Research Benefits 1. It is hoped that through the results of this study, we can utilize sawdust waste as a concrete mixture, and can determine the quality of the concrete from its characterization test. 2. As a source of information about the mechanical properties of concrete mixed with waste wood burning powder.

RESEARCH METHODOLOGY

2.1 Tools and Materials
2.1.1 Equipment
The equipment used in this research include:
-Cylindrical mold, with a diameter of 7.5 cm and a height of 20 cm.
-Mold cube size 10 cm x 10 cm
-Scales
-Measuring cup 1000 ml.
-Receptacle
-Paintbrush
-Rock Corner
-Sieve
-Screws
-Spoon cement
-Compressor machine

2.1.2 Ingredients
The materials used in this research are:
-Portland Cement
2.2 Research Methodology

2.2.1 Research flow chart

- Aggregate
  a. Coarse aggregate (gravel)
  b. Fine aggregate (sand).
- Ashes of burning waste wood powder
- Water
- Vaseline

2.2.2 Compressive Strength Test Procedure

2.2.2.1 Procedure for Making Compressive Strength Test Items

The procedures carried out in the compressive strength research are:

1. Preparation of tools and materials
   All equipment and materials are prepared, in order to facilitate the kneading and printing of test objects.
2. Concrete mix planning

Figure 1. Research flow chart

The Effect of Addition of Ash from Burning Wood Powder to the Mechanical and Physical Properties of Concrete (Yusnita Erna)
In this study, a concrete mixture was used based on the table below where research has been carried out on how much concrete composition is used per m³ that is:

| Material Name | Mass/Volume (kg/m³) | Ratio |
|---------------|---------------------|-------|
| Cement        | 367.4               | 1     |
| Sand          | 720.5               | 2     |
| Gravel        | 1127.0              | 3     |
| Water         | 185.0               | 0.5   |

Source: Tri Mulyono, 2005

The volume for 1 cylinder sample is 0.00088313 m³ and to avoid the loss of concrete at the time of casting, the addition of aggregate is carried out without changing the aggregate ratio which is called Safety Factor (SF) as much as 20% or SF = 1.2 so that the volume of 1 piece of sample concrete becomes 0.0010598 m³.

Based on the comparison of the composition of the concrete mix from the table above, the ratio of aggregate (cement: sand: gravel: water: wood dust burning ash) is obtained in each sample. Samples were made by varying the concentration of sawdust combustion: 0%, 5%, 10%, and 15% per sample for compression testing. The addition of sawdust combustion ash is carried out without reducing the cement composition.

| Percentage Sawdust (%) | Water (kg) | Sand (kg) | Gravel (kg) | Cement (kg) | Burning Ash (kg) |
|------------------------|------------|-----------|-------------|-------------|------------------|
| 0% (normal)            | 0.2        | 0.8       | 1.2         | 0.4         | -                |
| 5%                     | 0.2        | 0.8       | 1.2         | 0.4         | 0.02             |
| 10%                    | 0.2        | 0.8       | 1.2         | 0.4         | 0.04             |
| 15%                    | 0.2        | 0.8       | 1.2         | 0.4         | 0.06             |

3. Doughing and Printing
   The manufacture of test objects carried out are as follows:
   1. Providing concrete mix materials, namely cement, sand, gravel and water.
   2. Prepare wood dust burning ashes.
   3. After all the ingredients are provided, then put the ingredients in the mixing bowl, namely sand, gravel, and cement then stir until smooth and add water to the middle of the dough and leave for 2 - 5 minutes so that the mixture binds to each other.
   4. Then stir and mix all the concrete paste until the mixture is completely homogeneous.
   5. After the kneading is complete, the molding is carried out by inserting the concrete paste into a cylindrical mold as high as 1/3 of the height of the mold, then being crushed with an iron rod to ensure the density of the mixture arrangement.
   6. Put back 1/3 of the concrete paste mixture into the mold and then grind it again.
   7. Put the concrete paste back into the mold until it is full and then grind it again.
8. The surface of the mold is leveled with scrap and the test object is placed in the treatment room.
9. After the concrete is 24 hours old, the mold is opened and given a code number on the test object as desired and then placed in the treatment room again.
10. For the addition of wood dust burning ash, the method is the same as normal concrete casting (without wood sawdust burning ash). The difference lies in the addition of sawdust burning ash along with inserting gravel into the kneading place.

2.2.2.2 Testing Procedure for Compressive Strength of Concrete (Compressive Strength)
The compressive strength test of concrete is carried out to determine the crushed compressive strength of the test object. The test object used is a cylinder 7.5cm x 20cm. The compressive strength test was carried out when the concrete was 28 days old. The amount of concrete tested at the age of 28 days, which consists of 3 samples for each mixture

1. The testing procedure is as follows:
   1. Remove the test object after 27 days of age from the immersion bath and place it in the room until the sample is dry and this is done for 24 hours to be precise the test object reaches the age of 28 days.
   2. Before the test object is given a load, each side is re-measured.
   3. The compressive load is given slowly to the test object by operating the pump lever so that the test object collapses.
   4. When the load scale pointer does not increase or increase, the scale indicated by the needle is recorded as the maximum load that can be carried by the test object.
   5. This procedure was carried out for other samples of compressive strength specimens.

2.2.3 Water Absorption Test Procedure

2.2.3.1 Procedure for Making Water Absorption Test Items
The procedures carried out in water absorption research are:
1. Preparation of tools and materials
   All equipment and materials are prepared, in order to facilitate the kneading and printing of test objects.
2. Concrete mix planning
   In this study, the concrete mixture used is based on the table below where research has been carried out on how much concrete composition is used per m3, namely:

| Material Name | Mass/Volume | Ratio |
|---------------|-------------|-------|
| Cement        | 367.4       | 1     |
| Sand          | 720.5       | 2     |
| Gravel        | 1127.0      | 3     |
| Water         | 185.0       | 0.5   |

The volume for 1 cube sample is 0.001 m3 and to avoid the loss of concrete at the time of casting, the addition of aggregate is carried out without changing the aggregate ratio which is called the Safety Factor (SF) as much as 20% or SF = 1.2 so that the volume of 1 sample concrete to 0.0012 m3.

Based on the comparison of the composition of the concrete mix from the table above, the ratio of aggregate (cement: sand: gravel: water: wood dust burning ash) is obtained in each sample.
3. Doughing and Printing
The manufacture of test objects carried out are as follows:
1. Provide concrete mix materials, namely cement, sand, gravel and water.
2. Preparing wood dust burning ash.
3. After all the ingredients are provided, put the ingredients in the mixing bowl, namely sand, gravel, and cement and stir until smooth and add water to the middle of the dough and leave it for 2 – 5 minutes so that the mixture binds to each other.
4. Then stir and mix all the concrete paste until the mixture is completely homogeneous.
5. After the kneading is complete, the molding is carried out by inserting the concrete paste into the cube mold as high as 1/3 of the mold height, and then pounding it with an iron rod to ensure the density of the mixture arrangement.
6. Put back 1/3 of the concrete paste mixture into the mold and then grind it again.
7. Put the concrete paste back into the mold until it is full and then grind it again.
8. The surface of the mold is leveled with scrap and the test object is placed in the treatment room.
9. After the concrete is 24 hours old, the mold is opened and given a code number on the test object as desired and then placed in the treatment room again.
10. For the addition of wood dust burning ash, the method is the same as normal concrete casting (without wood sawdust burning ash). The difference lies in the addition of sawdust burning ash along with inserting gravel into the kneading place.

2.2.3.2 Water Absorption Testing Procedure (Water Absorption)
This test is carried out to determine the amount of water absorbed by the concrete particles after being soaked for a certain period. The water absorption test uses a cube-shaped test object of 10 cm x 10 cm x 10 cm. Concrete absorption is carried out when the concrete is 28 days old, with the number of concrete to be tested is 12 pieces, consisting of 3 samples for each mixture.

The testing procedure is as follows:
1. The test object at the age of 27 days was taken from the room and weighed to take its dry mass (mk).
2. Then the test object was immersed in a treatment bath for 24 hours.
3. After immersing the test object, it is precisely 28 days old, then the test object if necessary, wipe the entire surface of the test object to avoid excessive water.
4. Then the test object is weighed again to obtain the wet mass of the test object (mb).
5. This procedure is carried out for other samples of the test object.

2.2.4 Porosity Testing Procedure
2.2.4.1 Procedure for Making Porosity Test Items
The procedures carried out in the porosity research are:

1. **Preparation of tools and materials.**
   Molds in the form of cubes as many as 12 pieces were prepared, as well as the material for the test object.

2. **Concrete mix planning**
   In this study, a concrete mixture was used based on the table below, where research has been carried out on how much composition is used concrete per m³, namely:

   | Material Name | Mass/Volume (kg) | Ratio |
   |---------------|-----------------|-------|
   | Cement        | 367.4           | 1     |
   | Sand          | 720.5           | 2     |
   | Gravel        | 1127.0          | 3     |
   | Water         | 185.0           | 0.5   |

Source: Tri Mulyono, 2005

The volume for 1 cube sample is 0.001 m³ and to avoid the loss of concrete at the time of casting, the addition of aggregate is carried out without changing the aggregate ratio called the Safety Factor (SF) as much as 20% or SF = 1.2 so that the volume of 1 sample concrete to 0.0012 m³.

Based on the comparison of the composition of the concrete mix in the table above, the ratio of aggregate (cement: sand: gravel: water: wood dust burning ash) is obtained in each sample. Samples were made by varying the composition of wood sawdust ash: 0%, 5%, 10%, and 15% per test sample. The mixture is carried out without reducing the cement composition.

| Percentage Wood Powder Burning Ash (%) | Water (kg) | Sand (kg) | Gravel (kg) | Cement (kg) | Burning Ash sawdust (kg) |
|---------------------------------------|------------|-----------|-------------|-------------|--------------------------|
| 0% (normal)                           | 0.22       | 0.86      | 1.35        | 0.44        | -                        |
| 5%                                    | 0.22       | 0.86      | 1.35        | 0.44        | 0.022                    |
| 10%                                   | 0.22       | 0.86      | 1.35        | 0.44        | 0.044                    |
| 15%                                   | 0.22       | 0.86      | 1.35        | 0.44        | 0.066                    |

3. **Doughing and Printing**

The manufacture of test objects carried out are as follows:

1. Providing concrete mix materials, namely cement, sand, gravel and water.
2. Prepare wood dust burning ashes.
3. After all the ingredients are provided, the ingredients are put in the mixing bowl, namely sand, gravel, and cement and stirred until smooth and given water in the middle of the dough and left for 2 - 5 minutes so that the mixture binds to each other.
4. Then stir and mix all the concrete paste until the mixture is completely homogeneous.
5. After the kneading is complete, the molding is done by inserting the concrete paste into the cube mold as high as 1/3 the height of the mold, then it is pounded with an iron rod to ensure the density of the mixture arrangement.
6. Re-entered 1/3 of the concrete paste mixture into the mold then crushed again.
7. Put the concrete paste back into the mold until it is full and then grind it again.
8. The surface of the mold is leveled with scrap and the test object is placed in the treatment room.
9. After the concrete is 24 hours old, the mold is opened and given a code number on the test object as desired and then placed in the treatment room again.
10. For the addition of sawdust burning ash, the method is the same as normal concrete casting (without wood sawdust burning ash). The difference lies in the addition of sawdust burning ash along with adding gravel to the kneading.

2.2.4.2 Porosity Testing Procedure

The porosity test procedure is carried out to determine the amount of porosity contained in the test object. The more porosity contained in the test object, the lower its strength, and vice versa. Porosity testing uses a cube-shaped test object. The porosity test was carried out on the water absorption test concrete. So that the porosity test can be directly combined with the water absorption test.

The testing procedure is as follows:
1. The test object at the age of 27 days is taken from the room and weighed to take the dry period (mk).
2. Then the test object is immersed in a treatment bath for 24 hours.
3. After immersing the test object, it is precisely 28 days old, then the test object if necessary, wipe the entire surface of the test object to avoid excessive water.
4. Then the test object is weighed again to obtain the wet mass of the test object (mb).
5. This procedure is carried out for other samples of the test object.

2.3 Sample Test

2.3.1 Mechanical Properties

2.3.1.1 Strong Press

The compressive strength of concrete is basically a function of the volume of the pores/cavities of the concrete itself. The compressive strength test of concrete was carried out when the concrete was 28 days old, at 27 days old the specimens were removed from the immersion bath and on the 28th day the specimens were dried in free air. The compressive strength test is carried out using the Universal Testing Machine until the maximum load is obtained. The test was carried out 3 times for each sample in order to obtain the average compressive strength.

The compressive strength of concrete can be obtained by the formula, as follows:

\[
\sigma' = \frac{F}{A}
\]

with:

\( \sigma' \) = Compressive strength (N/cm²)

F = Compressive Force (N)

A = Surface area (cm²)

2.3.2 Physical Properties

2.3.2.1 Water Absorption

This test is intended to determine the amount of water absorbed by the soaked concrete in a certain period. In this test, the concrete that has been aging for 28 days is weighed with the intention of getting the dry mass of the concrete (mk) after that the concrete is soaked for 24 hours to get the wet mass of the concrete (mb), but in this case the concrete is wiped first to make it wet rather than the concrete. not excessive. The amount of water absorption can be obtained by the formula, as follows:

\[
\text{Penetrated Air} (\%) = \frac{m_b - m_k}{m_k} \times 100\%
\]

with:

mb = Wet mass of the test object (gram)
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2.3.2.2 Porosity Test

Porosity testing is carried out on the same test object for water absorption testing, so this test is carried out to obtain dry mass (mk) after the concrete is soaked and wet mass (mb) is obtained before immersion. The porosity of the test object can be obtained using the following formula:

\[
Porosity = \frac{m_b - m_k}{\rho_v \times \frac{V_b}{V_t}} \times 100\%
\]

with:
- \( m_b \) = Wet mass of the test object (grams)
- \( m_k \) = Dry mass of the test object (grams)
- \( V_b \) = Volume of the test object (cm\(^3\))
- \( \rho_v = \) Density of water 1 g/cm\(^3\)

RESULTS AND DISCUSSION

3.1 Data analysis
3.1.1 Concrete Compressive Strength Test

The compressive strength test of concrete is carried out using a Compressor Machine (Compressor Machine). The compressive strength of concrete can be obtained using the formula:

\[
f'_c = \frac{F}{A}
\]

with:
- \( f'_c \) = Compressive strength (N/cm\(^2\))
- \( F \) = Compressive Force (N)
- \( A \) = Surface Area (Cm\(^2\))

Data on the results of testing the compressive strength of concrete mixed with sawdust combustion ash according to the results of the research that has been done, are listed in Table 4.1 below:

| No | Type        | stress (Kg) | press (MPa) | press average (MPa) |
|----|-------------|-------------|-------------|---------------------|
| 1. | Normal concrete | 9200        | 20.418      | 20.124              |
|    |             | 8700        | 19.311      |                     |
|    |             | 9300        | 20.643      |                     |
| 2. | 5% mix      | 6400        | 14.204      |                     |
|    |             | 6200        | 13.760      | 13.760              |
|    |             | 6200        | 13.760      |                     |
| 3. | 10% mix     | 8200        | 18.199      | 19.086              |
|    |             | 7400        | 16.423      |                     |
|    |             | 10,200      | 22.637      |                     |
| 4. | 15% mix     | 10,000      | 22.193      | 22.045              |
|    |             | 10,200      | 22.637      |                     |
|    |             | 9600        | 21.306      |                     |

The compressive strength test of concrete is carried out after the concrete is 28 days after casting. From the data in Table 4.1, the average compressive strength of concrete mixed with sawdust waste combustion ash is 0% (normal concrete), 5%, 10%, and 15%, respectively, which is 201.24...
Kg/cm² (20.124 Mpa), 139.08 Kg/cm² (13.908 Mpa), 190.86 Kg/cm² (19.086 Mpa), and 220.45 Kg/cm² (22.045 Mpa). The use of wood sawdust waste burning ash by 15% was able to increase the compressive strength of concrete by 9.54% from normal concrete and concrete mixed with 5% and 10% sawdust waste combustion ash was not good, because the addition reduced the strength of the concrete, namely respectively by 30.88% and 51.5%. From graph 4.1 this can also be seen clearly.

3.1.2 Water Absorption Test

This test is intended to determine the amount of water absorbed by the concrete after being soaked for a certain period. In this test, the concrete that has been dried (aged) for 28 days is then soaked for 24 hours. The formula for water absorption is as follows:

\[
\text{Penyerapan air (\%)} = \frac{M_1 - M_2}{M_1} \times 100\%
\]

With
\[ M = \text{wet mass (grams) k} \]
\[ M = \text{dry mass (grams)} \]

Data on the results of testing water absorption in concrete mixed with wood burning powder waste in accordance with the results of research that has been carried out, are listed in table 4.2 below.

| No | Type       | Heavy dry (g) | Gross weight (g) | Water absorption (%) | Water absorption average (%) |
|----|------------|---------------|------------------|----------------------|-----------------------------|
| 1. | Normal concrete | 2344          | 2424            | 3.41                 |                             |
|    |            | 2343          | 2422            | 3.37                 | 3.41                        |
|    |            | 2342          | 2425            | 3.54                 |                             |
|    | 5% mix     | 2292          | 2376            | 3.66                 |                             |
|    |            | 2288          | 2376            | 3.84                 | 3.66                        |
|    |            | 2290          | 2370            | 3.49                 |                             |
| 2. | Mixture    | 2334          | 2416            | 3.51                 |                             |
|    | 10%        | 2337          | 2418            | 3.46                 | 3.61                        |
|    |            | 2332          | 2422            | 3.85                 |                             |
| 3. | Mixture    | 2348          | 2442            | 4.00                 |                             |
|    | 15%        | 2350          | 2440            | 3.82                 | 3.94                        |
|    |            | 2354          | 2448            | 3.99                 |                             |

Based on data 4.2, it can be seen that the percentage of water absorption for concrete mixed with sawdust waste is 0% (normal concrete), 5%, 10% and 15%, respectively, which are 3.44%; 3.66%; 3.61%; and 3.94%. The use of wood sawdust waste burning ash by 5%, 10%, and 15% causes an increase in the percentage of water absorption by 6.39%, respectively; 4.94%; and 14.53%. This can also be seen in graph 4.2.

Normal concrete has a smaller average percentage of water absorption compared to a mixture of ash mixed with wood burning waste, which is optimal in the mix of wood that will absorb more water than normal concrete (without the addition of wood dust burning ash).
3.1.3 Porosity Test

Porosity testing is carried out after the concrete has dried for 28 days and then soaked for 24 hours. The formula for determining porosity is as follows;

$$\text{Porosity} = \frac{M_b - M_k}{V_b \times \rho_w} \times 100\%$$

With;
- $M_b$ = Weight of test object in wet condition (gr)
- $M_k$ = Weight of the test object in a dry state (gr)
- $V_b$ = Volume of the test object (cm$^3$)
- $\rho_w$ = Density of water (1 g/cm$^3$)

The data on the results of the porosity testing of concrete mixed with the burning ash of sawdust waste are in accordance with the results of the research that has been carried out, listed in data 4.3 below;

| No | Type       | Heavy dry (g) | Gross weight (g) | Porosity water (%) | Average porosity flat (%) |
|----|------------|---------------|------------------|--------------------|---------------------------|
| 1. | Normal concrete | 2344          | 2424             | 9.05               |                           |
|    |            | 2343          | 2422             | 8.94               | 9.13                      |
|    |            | 2342          | 2425             | 9.39               |                           |
| 2. | 5% mix     | 2292          | 2376             | 9.51               |                           |
|    |            | 2288          | 2376             | 9.96               | 9.51                      |

Figure 4.3 Graphics Water Absorption on Addition of Wood Dust Burning Ash
Based on data 4.3, it can be seen that the percentage of water absorption for concrete mixed with sawdust waste is 0% (normal concrete), 5%, 10% and 15%, respectively, which are 9.13%; 9.51%; 9.55%; and 10.49%. The use of wood sawdust waste burning ash by 5%, 10%, and 15% causes an increase in the percentage of water absorption, respectively, by 4.16%; 4.60%; and 14.89%. This can also be seen in graph 4.2.

Normal concrete has a smaller average percentage of water absorption compared to the optimal mixture of ash mixture of wood burning waste burning waste into the concrete mixture will absorb more water than normal concrete (without the addition of sawdust burning ash). The less water in the concrete, the amount of water absorption will be smaller then automatically the porosity will also be smaller as well.

**CONCLUSION**

1. From the results of research that has been done, the addition of 15% wood sawdust ash into the concrete mixture is able to increase the compressive strength of concrete by 9.54% of the compressive strength of normal concrete. Meanwhile, the addition of 5% and 10% of wood sawdust ash decreased the compressive strength of concrete by 30.88% and 5.15%, respectively.

2. From the results of research that has been done, the addition of 5%, 10% and 15% of sawdust combustion ash into the concrete mixture increased water absorption by 6.39%, 4.94% and 14.53% of normal concrete, respectively.

3. From the results of research that has been done, the addition of 5%, 10% and 15% of sawdust combustion ash into the concrete mixture increases the porosity by 4.16%, 4.60% and 14.89%, respectively, of normal concrete.

4. From the results of research on concrete mixed with sawdust combustion ash, the mechanical properties of concrete, namely compressive strength, are better than normal
concrete at the addition of 15% sawdust burning ash. And physical properties, namely water absorption and porosity of concrete which increases with each addition of sawdust combustion ash to normal concrete

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