# ANALYSIS OF THE EFFECT OF COMPRESSIVE STRENGTH OFMORTAR USINGCANE WASTE ASH AND LIME

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***Abstract:*** *From the results of research and testing of mortar with a variety of bagasse ash mixtures as a substitute for fine aggregate and limestone, it can be concluded that the compressive strength of normal mortar without bagasse ash waste but using limestone water is 1.90 kg/cm2, the compressive strength of mortarwith Bagasse ash waste is 6% of the weight of cement and limestone is 2.29 kg/cm2 which is the optimum mixture content in this mixture. The compressive strength of mortar with sugarcane bagasse ash waste is 9% of the weight of cement and limestone has a compressive strength of 2.08 kg /cm2, the compressive strength of mortar with bagasse ash waste is 12% of the cement weight, the compressive strength is 2.12 kg/cm2, mortar mixed with bagasse ash and limestone will increase compared to normalmortar.*
***Keywords:*** *Aggregate, Cement, Compressive strength, Limestone, Compressive strength, Mortar, Sugarcane bagasse ash*

## A. Introduction

Bagasse is waste produced from the process of milling sugar cane after the juice is extracted. In the sugar cane milling process, there are 5 grinding processes from the sugar cane stalks until they become bagasse. After the final grinding it produces dry bagasse. The abundant bagasse has been used as fuel forsteam boilers (a machine that produces steam in a certain amount every hour at a certain pressure and temperature) where the energy produced is used as a steam power plant[1].

Cement is an adhesive material that is smooth in shape. If water is added, a hydration reaction will occur and can bind solid materials into one solid mass. The largest percentage of cement content is CaO (calcium oxide) in the range of 60%-65%, SiO2 (silica) in the range of 20%-24% and Al2O3 (aluminumoxide) in the range of 4%-8%[2].

Mortar is a mixture of adhesive (Portland cement), fine aggregate (sand) and water with a certain composition. Mortar as an adhesive for structural construction is used for crushed stone masonry on foundations. Mortar for nonstructural construction is used in masonry for wall filling. The compressive strength of mortar is influenced by several factors, namely density, age of mortar, type of cement, and aggregate properties[3].

Planning high quality mortar requires planning in the form of mortar mix design. The mortar mixturemust be planned as economically as possible with the right composition of ingredients, so that it is easyto work with when the mortar is still wet (not yet formed) and produces good quality when it has hardened(formed). The quality and strength of mortar is greatly influenced by the composition of the mortar mixture and its treatment (curing), water content, the presence of additional materials used for certain purposes and so on[4]. Therefore the author tried an alternative to use sugarcane bagasse ash waste and limestone which was used as a mortarmixture.

## B. Research Methodology

### a. Place and time of research

PeThis research was carried out in the Structures and Materials Laboratory of the Civil Engineering Study Program, Faculty of Engineering, Palembang University and the Construction Materials Laboratory of the Public Works Department of Highways and Spatial Planning of South Sumatra Province with a research period of two months.

***b. Types of Research and Data Sources***

PeThe research carried out was an experimental test, where the conditions were created and regulated by researchers by referring to SNI (Indonesian National Standards) regulations and related literature.

***c. Research Tools and Materials***

a. Scales with an accuracy of 0.1 gram
b. 1000 ml measuring cup
Measuring cup, used to measure the amount of water used.
c. Pycnometer.
d. Sharpened cone
e. Corner rod
f. Aluminum pan
g. Glass plate
h. Cup
i. Oven equipped with temperature control.
j. Density spoons
k. Scales
l. Cylindrical tube
m. Vernier calipers are used to measure all dimensions of the test object.
n. Paintbrush
o. Plastic bucket
p. Cube mold measuring (5 x 5 x 5) cm
q. Cement spoon
r. Universal Testing Machine (Tokyo Testing Machine Inc.) capacity 1000 kN
s. Sieve, Pass sieve No. 200 (fine aggregate composition according to standards)
t. Wet cloth.

***d. Material***

The materials used in this research are:

a. Seme brand Type I Portland cementn Baturaja
b. Fine aggregate
c. PDAM water
d. Sugarcane bagasse ash.
e. Limestone

Before buying these materials, you should first estimate how much is needed. For sand: It is best to increase the amount of sand, so that the aggregate inspection does not happen again, considering that the characteristics of the aggregate will not be the same for each purchase. Cementshould be purchased as the day of printing approaches, because storing cement for too long will reduce the quality, if improper storage can cause the cement to harden and clots occur.

***e. Procedure for Making Mortar Test Materials***

a. Mixing
Materials such as cement, sand and water needed for 3 pieces of mortar are weighed in the ratio according to SNI 03-6825-2002, namely 250 gr : 687.5 : 121 ml and bagasse ash as muchas 0%, 10%, 15%, and 20% of the sand weight.
b. Kneading
After all the ingredients are mixed, water is added to the middle of the mixture and left for 60seconds so that the mixture binds together, then the mixture is stirred until the mixture is completely homogeneous.
c. Printing
After the kneading is complete, molding is carried out by inserting the mortar paste into a cubemold that has been smeared with Vaseline first by:

- Insert the paste as high as 1/3 of the height of the mold, then the mixture is shaken at least 25times to ensure the density of the mixture.
- Put 1/3 of the mortar paste back into the mold then shake it again.
- Put the mortar paste back into the mold until it is full then shake it again.
- The surface of the mold is leveled and then covered with a wet cloth for ± 24 hours.

***f. Mix Planning and Mortar Quality Test ProceduresMortar Mix Planning***

Mortar mixtures are guided by Standard ASTM C109-93, namely:

- Cube mold 5 x 5 x 5 cm
- Samples can be made with material details are:

Table 1. Three samples

| | ***3 samples*** |
|---|---|
| Cement | 250 grams |
| Sand | 687.5 grams |
| Water | 121 ml |

Source: ASTM C109-93

***Mortar Compressive Strength Testing Procedure***

Mortar pressure strength testing is carried out to determine the crushing compressive strength of the test object. The test object used is a cube with side dimensions of (5 x 5 x 5) cm. Mortar pressure strength testing was carried out when the mortar was 28 days old. The amount of mortar tested consisted of 3 samples for each mixture.

Work procedures for testing compressive strength on mortar test specimens include:

a. Remove the test object after it reaches the planned age from the soaking tub, then dry it with a clothand leave it for 24 hours.
b. The test object is placed on the pressing machine.
c. A compressive load is applied slowly to the test object by operating the pump lever so that the testobject collapses and is destroyed.
d. When the needle on the load scale no longer moves or increases, the scale indicated by the needleis recorded as the maximum load that can be carried by the test object.
e. This procedure is repeated for other compressive strength test specimens.

Compressive strength can be obtained using the following formula:

$$fc^{I} = \frac{F}{A}$$

With :

FCI = Compressive strengthtest object (kg/cm2)
F =Maximum compressive load (kg)
A = Field areasurface (cm2)

## C. Results and Discussion

### a. Fine Aggregate Inspection

The fine aggregate (sand) used was Musi river sand. This test was carried out at the Civil Materials & Structure Test Laboratory, Faculty of Engineering, Palembang University and the Construction Materials Laboratory of the Public Works Department of Highways and Spatial Planning, South Sumatra Province. Tests carried out for fine aggregate include loose and solid density, sieve analysis, specific gravity and absorption, mud content and water content. From the results of the examination thathas been carried out, the following data were obtained:

Table 2. Loose weight Content Fine Aggregate (sand)

| No | Information | I | II |
|---|---|---|---|
| 1 | Weight of place + test object (kg) | 5,620 | 5,624 |
| 2 | Place weight (kg) | 1,887 | 1,887 |
| 3 | Test object weight (kg) | 3,733 | 3,737 |
| 4 | Fill the container (litres) | 2,722 | 2,722 |
| 5 | Weight of test object (kg/liter) | 1,371 | 1,373 |
| 6 | Average weight of test object (kg/liter) | | 1,372 |

Source: Test Results

Table 3. Solid weight Content fine aggregate (sand)

| No | Information | I | II |
|---|---|---|---|
| 1 | Weight of place + test object (kg) | 5,975 | 5,970 |
| 2 | Place weight (kg) | 1,887 | 1,887 |
| 3 | Test object weight (kg) | 4,088 | 4,083 |
| 4 | Fill the container (litres) | 2,722 | 2,722 |
| 5 | Weight of test object (kg/liter) | 1,501 | 1,500 |
| 6 | Average weight of the test object (kg/liter) | | 1,501 |

Source: Test Results

Table 4. Fine Aggregate Water Content

| Activity | | Weight (grams) | |
|---|---|---|---|
| | | I | II |
| A E<br>CD | Aggregate WeightCup Weight<br>Weight of Cup+aggregate before washing (dry)<br>Weight of Cup+aggregate before washing (in theoven) | 815<br>3000<br>3815<br>3616 | 824.50<br>3000<br>3824.50<br>3624.50 |
| | $\frac{(C - A) - (D - A)}{(D - A)}$ Sludge levels : | 7.11% | 7.14% |
| Average water content = 7.13% | | | |

Table 5. Hasil Fine Aggregate Testing

| No. | Checking type | Test result |
|---|---|---|
| 1 | Weight of loose contents | 1.372 kg/liter |
| 2 | Solid Content Weight | 1,501 kg/liter |
| 3 | SSD specific gravity | 2.53 |
| 4 | Dry specific gravity | 2.48 |
| 5 | Absorption | 1.85 % |
| 6 | Organic Impurities | No. 2 |
| 7 | Granule Gradation | Zone 4 |
| 8 | Fineness Modulus | 2.53 |

Source: Test Results

***b. Mortar Mix Design***

The mortar mixture composition for the 3 test objects was made according to SNI 03-6825-2002standards. The ratio of dry ingredients used is 1 part by weight of cement, 2.75 parts by weight of sandand the cement water factor is 0.484 for all types of portland cement.

a. Normal Mortar (MN)

The ratio of cement, sand, water and bagasse ash waste required is:Cement : 250 gr
Sand : 687.5 gr
Water : 121 ml

b. *Mortar*by using 6% bagasse ash waste and limestone (MA6%K) The ratio of cement, sand, water and bagasse ash waste required is:Cement : 250 gr – 15 gr = 235 gr
Sand : 687.5 gr
Water : 121 ml
Sugarcane bagasse ash waste 6% of cement weight = 15 gr

c. *Mortar*by using 9% bagasse ash waste and limestone (MA9%K)

The ratio of cement, sand, water and bagasse ash waste needed for 3 pieces is:Cement : 250 gr – 22.5 gr = 227.5 gr
Sand : 687.5 gr
Water : 121 ml
Sugarcane bagasse ash waste 9% of cement weight = 22.5 gr

d. *Mortar*by using 12% bagasse ash waste and limestone (MA12%K)

The ratio of cement, sand, water and bagasse ash waste needed for 3 pieces is:Cement : 250 gr – 30 gr = 220 gr
Sand : 687.5 gr
Water : 121 ml
Sugarcane bagasse ash waste 12% of cement weight = 30 gr

Table 6. Composition of a mixture of Normal Mortar (MN) and Mortar with bagasse ash waste andlimestone (MA K).

| Description | M N | (MA6%K) | (MA9%K) | (MA12%K) |
|---|---|---|---|---|
| Cement (grams) | 250 | 235 | 227.5 | 220 |
| Sand (grams) | 687.5 | 687.5 | 687.5 | 687.5 |
| Water (ml) + limestone | 121 | 121 | 121 | 121 |
| Sugarcane bagasse ash waste | 0 | 15 | 22.5 | 20 |

Source: Calculation ResultsInformation :
M N =*Mortar*Normal
(MA6%K) =*Mortar*with 6% bagasse ash waste and limestone (MA9%K) =*Mortar*with 9% bagasse ash waste and limestone (MA12%K) =*Mortar*with 12% bagasse ash waste and limestone

***c. Mortar Compressive Strength Testing***

Mortar compressive strength testing is carried out using a Compressor Machine. Data on compressive strength testing results for Normal Mortar, and Mortar with 6%, 9%, 12% bagasse ash waste and limestone, the results of the research can be shown in table 7 below:

Table 7. Mortar Compressive Strength Test Results Data at 28 Days

| No | *Mortar* | Compression Area (A) (cm2) | Max Compressive Load Force (F) (kg) | Compressive Strength (fc') (kg/cm2) | Average Compressive Strength (kg/cm2) |
|---|---|---|---|---|---|
| 1 | M N | 25 | 49.9<br>46.5<br>46.2 | 2.00<br>1.86<br>1.85 | 1.90 |
| 2 | MA6%KG | 25 | 60.0<br>58.1<br>53.7 | 2.40<br>2.32<br>2.15 | 2.29 |
| 3 | MA9%KG | 25 | 47.6<br>53.7<br>55.1 | 1.90<br>2.15<br>2.20 | 2.08 |
| 4 | MA12%KG | 25 | 41.0<br>59.3<br>59.1 | 1.64<br>2.37<br>2.36 | 2.12 |

Source: Test results

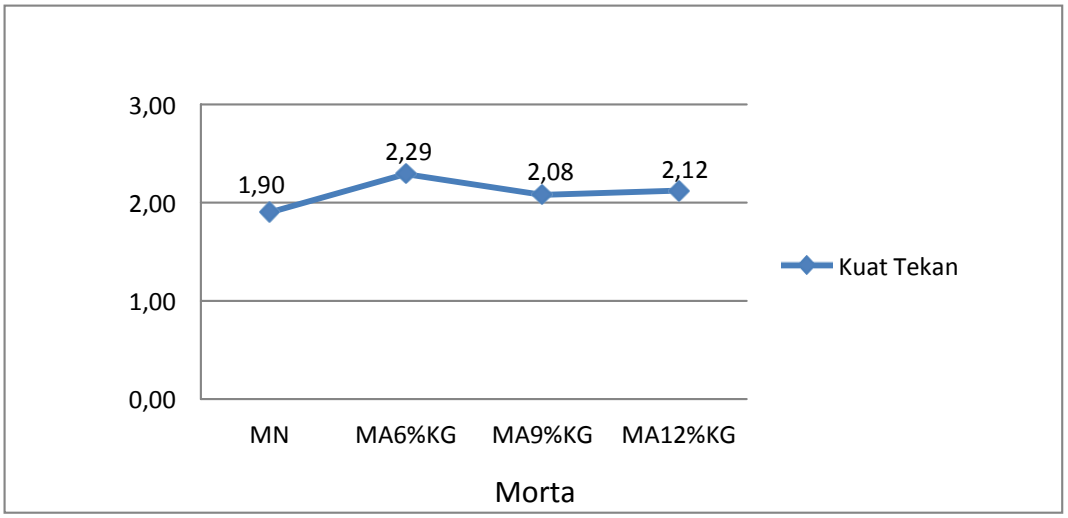


Figure 1. Mortar Compressive Strength Graph at 28 Days

From figure 1. It can be seen that the compressive strength of standard mortar without bagasse ash and lime or normal waste is 1.90 kg/cm2, while the compressive strength of mortar with 6% bagasse ash waste and limestone is 2.29 kg/cm2, and for mortar with 9% bagasse ash waste and lime lime the compressive strength is 2.08 kg/cm2, then for mortar with 12% bagasse ash waste and lime lime the compressive strength is 2.12 kg/cm2.

## D. Conclusions and Recommendations

### a. Conclusion

From the results of research and testing of mortar with various mixtures of bagasse ash as asubstitute for fine aggregate and limestone, it can be concluded that:

a. The compressive strength of normal mortar without bagasse ash waste but using lime water is 1.90 kg/cm2.
b. The compressive strength of mortar with bagasse ash waste 6% of the weight of cement andlimestone is 2.29 kg/cm2 which is the optimum mixture content in this mixture.

c. The compressive strength of mortar with bagasse ash waste 9% of the weight of cement andlimestone has a compressive strength of 2.08 kg/cm2
d. The compressive strength of mortar using bagasse ash waste is 12% of the cement weight, thecompressive strength is 2.12 kg/cm2
e. *Mortar*by mixing bagasse ash and limestone it will increase from normal mortar.

***b. Suggestion***

It is hoped that further research can be carried out using a mixture of bagasse ash with varyingsoaking (treatment) times.

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