# The Compressive Strength of Fly Ash and Stone Dush in Concrete

Dewi Sulistyoini*, Dimas Langga Chandra Galuh, Mafazi Azizan

*Civil Engineering, Engineering Faculty, Universitas Sarjanawiyata Tamansiswa, Yogyakarta, Indonesia*
**Corresponding author: dewi.sulistyorini@ustjogja.ac.id*

**ABSTRACT**

Concrete is one of the most used in construction materials because it is easy to shape. In other condition, the material that form the concrete is decreasing, so innovation of concrete materials is needed. One of them uses fly ash and stone dust as a cement substitution. Fly ash is a by product from burning pulverized coal in electric power generating plants, than stone dust is waste material obtained from crusher plants. Both of these materials are widely produced but have not been optimally utilized in concrete materials.

In the present investigation, an experimental program was carried out to study the workability and compressive strength of concrete made using fly ash type C and stone dust as partial replacement of cement in the variation of fly ash is 0%, 5%, 10%, 20% and 30%, than the variation of stone dust is 0% and 10 %. The compressive strength planned is 25 MPa in 28 days curing. The research uses 15 specimen cylindrical test.

The result of the slump test BN, BFA-5, BFA-10, BFA-20, BFA-30 are 10 mm, 10 mm, 9 mm, 8.8 mm, and 8.2 mm. Result of compressive test BN, BFA-5, BFA-10, BFA-20, BFA – 30 are 27.46 MPa. Result showed that by replacing of cement with 10% fly ash and 10% stone dust (BFA-10) of optimum compressive strength.

***Keywords**: Fly Ash, Stone Dust, Compressive Strength*

## 1. INTRODUCTION

Construction in Indonesia is increasing rapidly and this in in line with the demand of community to get the expected facilities. In addition to strong and quality materials, the consumer must look for low prices, one of which is concrete. Concrete is one of construction materials that consist of cements, fine aggregate, coarse aggregate and water. Those materials are standard and there is strength, even thought the strength is adjusted by planning [1]. One of the main elements in concrete is portland cement. A cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement [2] is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Concrete is the most widely used material in existence and is behind only water as the planet's most-consumed resource. (Wikipedia). The use of fly ash [3] and stone [4]dust as a cement substitution to reduce cement in concrete. Fly ash is a by product from burning pulverized coal in electric power generating plants, than stone dust is waste material obtained from crusher plants. Both of these materials are widely produced but have not been optimally utilized in concrete materials.

Based on Fitra, [5] research, the use of stone dust as a filler in the self compacting concrete can increase the compressive strength by 3.5%, with the addition of stone dust at a rate of 25% by cement weight [6].

Fly ash can be obtained in the territory of Indonesia such as in steam power plants. The production of fly ash in Indonesia is increases in proportion from year to year. The use of fly ash is still limited between 10-35% of the cement weight. This research was to investigation workability and compressive strength of concrete when used fly ash and stone dust.

## 2. MATERIAL AND METHOD

a. Fly Ash
Fly ash used in this research is type C, where contain of CaO above 10% which is produced from burning lignite or sub bituminous coal (light coal). Te total content of $SiO_2$, $Al_2O_3$, $Fe_2O_3$ is greater than 50%. CaO level reached 10%.


Figure 1. Fly Ash
(https://www.rumahmaterial.com/2018/03/pilih-mana-beton-readymix-fa- atau-nfa.html)

b. Stone Dust
Stone dust is waste material obtained from crusher plants. Stone dust contains a lot of silica, alumina, alkali, iron and lime compounds in low levels. The use of stone dust can save of cement. Stone dust contains very fine silica that are amorphous so they can harden when mixed the cement. The compound that occurs between amorphous silica and lime is a calcium compound that is difficult to dissolve in water. (Wikipedia)

Figure 2. Stone Dust
(httpsasiacon.co.idblogmanfaat-pengertian-abu-batu-pavingblock)

c. Portland Cement
Portland Cement used is type I. This type is used for general construction that does not require special requirements for height hydration and initial compressive strength. The uses of Portland cement type I include construction for residential houses, high rise building and highways. The characteristics of Portland cement type I are suitable for use on construction sites in areas far from the coast dan low sulfate.

d. Fine Aggregate
Fine aggregate used Brosot Sand from Kulon Progo regency, Yogyakarta, Indonesia.

e. Coarse Aggregate
Coarse aggregate from stone crusher in Muntilan regency, Magelang, Central Java, Indonesia

Figure 3. Coarse Aggregate

This experimental research to investigate workability, unit weight and compressive strength. The sample is 15 concrete cylinders with 150 mm diameter and 300 mm height. Fly ash and stone dust as a partial replacement of cement. Table 1 shows the sample variation. Table 2 shows the proportion of concrete mix with a plan f'c 25 MPa, factor air cement 0.47 and 28 days curing. Mix design used Indonesia Standard or SNI 7656:2012.

Table 1. Sample Variation

| No | Sample | Cement | Fly ash | Stone Dust | Number of samples |
|---|---|---|---|---|---|
| 1 | BN | 100 % | 0 % | 0 % | 3 |
| 2 | BFA-5 | 85 % | 5 % | 10 % | 3 |
| 3 | BFA-10 | 80 % | 10 % | 10 % | 3 |
| 4 | BFA - 20 | 70 % | 20 % | 10 % | 3 |
| 5 | BFA - 30 | 60 % | 30 % | 10 % | 3 |

Table 2. Proportion for one cylinder

| No | Sample | Cement (Kg) | Fly ash (Kg) | Stone Dust (Kg) | Fine aggregate (Kg) | Coarse Aggregate (Kg) | Water (Kg) |
|---|---|---|---|---|---|---|---|
| 1 | BN | 2.209 | 0 | 0 | 3.775 | 5.738 | 1.003 |
| 2 | BFA-5 | 1.877 | 0.110 | 0.221 | 3.775 | 5.738 | 1.003 |
| 3 | BFA-10 | 1.767 | 0.221 | 0.221 | 3.775 | 5.738 | 1.003 |
| 4 | BFA - 20 | 1.546 | 0.448 | 0.221 | 3.775 | 5.738 | 1.003 |
| 5 | BFA - 30 | 1.325 | 0.664 | 0.221 | 3.775 | 5.738 | 1.003 |

## 3. RESULT AND DISCUSSION

The result of fine aggregate test as shown in table 3 below.

**Table 3. Properties of Fine aggregate**

| Properties | unit | Result value | Standard |
|---|---|---|---|
| Specific Gravity (SSD) | | 2.442 | 2.2 – 2.7 |
| Water Absorbtion | % | 3.872 | < 3 % |
| Unit Weight | $Kg/m^3$ | 1302 | Min 1200 |
| Water content | % | 4.3 | |
| Silt content | % | 3.4 | Max 5% |
| Fines Modulus | | 2.8 | 1.5 – 3.8 |
| Grading zone | | Zone 2 | Zone 1,2,3,4 |

**Table 4. Properties of course agreggate**

| Properties | unit | Result value | Standard |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Specific Gravity (SSD) | | 2.6 | 2.2 – 2.7 |
| Water Absorbtion | % | 0.975 | < 3 % |
| Unit Weight | $Gr/cm^3$ | 1.457 | Min 1.2 |
| Water content | % | 0.787 | |
| Silt content | % | 0.75 | Max 1% |
| Fines Modulus | | 2.43 | 5 – 8 |
| Grading zone | mm | 20 | 20 – 40 |

**Table 5. Properties of cement and fly ash**

| **Properties** | **unit** | **Result value** | | **Standard** |
|---|---|---|---|---|
| | | **Cement** | **Fly Ash** | |
| Specific Gravity | | 3.19 | 3.15 | 3.1 – 3.3 |
| Weight Unit | $Kg/m^3$ | 1080 | 1150 | 1250 |

**Table 6. Compression Test**

| **No** | **Sample** | **Slump Test** | **Unit Weight** | **Compression Test** |
|---|---|---|---|---|
| | | **cm** | **$Kg/m^3$** | **MPa** |
| 1 | BN | 10 | 2380 | 27.46 |
| 2 | BFA-5 | 10 | 2365 | 24.07 |
| 3 | BFA-10 | 9 | 2354 | 25.67 |
| 4 | BFA - 20 | 8.8 | 2348 | 22.83 |
| 5 | BFA - 30 | 8.2 | 2361 | 21.04 |

Based on table 6 the addition of fly ash and stone dust reduces workability, unit weight and compressive strength. The results at the fly ash 10% and stone dust 10 % or sample BFA-10 are the optimum compressive strength.

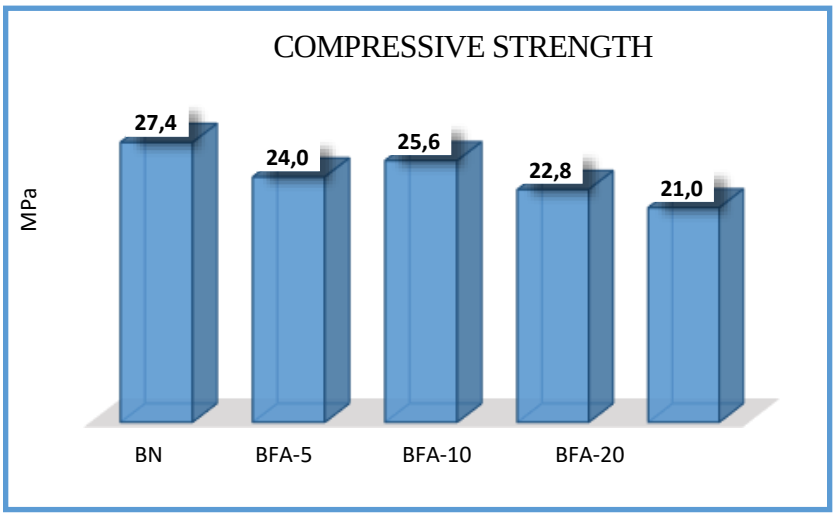


Figure 4. Variation of compressive Strength with gradual increase fly ash

The percentage of compressive strength decrease of BN to BFA-5 is 12.37%, BN to BFA-10 is 6.52%, BN to BFA-20 is 16.86%, BN to BFA-30 is 23.38%.

## 4. CONCLUSION

Based on the result during the experimental investigation, the conclusions are drawn :

a. The fly ash and stone dust as a partial replacement of cement reduce workability.
b. The results at the fly ash 10% and stone dust 10 % or sample BFA-10 are the optimum compressive strength.
c. Fly ash and stone dust can be used as substitute for cement in the right proportions.

## REFERENCES

[1] Achmad.B, "Bahan Tambah Pada Campuran Beton. Department of Civil Engineering," 2012.
[2] "Cement," *Wikipedia*. .
[3] "Fly Ash." .
[4] "Stone Dust." (httpsasiacon.co.idblogmanfaat-pengertian-abu-batu-pavingblock).
[5] F. H, "Manfaat Limbah Abu Batu Sebagai Bahan Tambah Material Bahan Bangunan," ULM, 2019.
[6] V. C. A. Amit K S, Vikas S., "Stone Dust in Concrete : Effect on Compressive Strength," *Int. J. Eng. Tech. Res.*, vol. 3, 2015.