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Analysis of the Effect of Adding Fly Ash and Bio Enzyme (Bio Conc) on Concrete Compressive Strength

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ABSTRACT: This research is concrete research using fly ash and bio enzyme (bio conc) as additional ingredients in concrete mixture. The purpose of this research is to obtain information on how these two additives can affect the characteristics of concrete, especially on concrete compressive strength and specific gravity. As well as to obtain the most optimal composition of the use of fly ash and bio enzymes (bio conc) in concrete. This study uses the experimental method of this study using concrete with a concrete quality of *f*`c 25 Mpa and using fly ash with a percentage of 7.5%; 9%; 10.5%; 12%; 13.5%; and 15% and bio enzymes (bio conc) as much as 500 ml / m³, For the age of concrete used in this concrete compressive strength test is 28 days old concrete with 24 samples. In the addition of bio conc and fly ash 7.5% - 15% continue to get a higher percentage increase in compressive strength value than just using bio conc alone which has the highest increase in the addition of bio conc and fly ash 15% by 32% which has a compressive strength value of 36.046 Mpa at 28 days of concrete age.

KEYWORDS: bio enzyme (bio conc), Fly ash, Concrete, Compressive Strength

1. INTRODUCTION

Concrete is one of the most commonly used construction materials worldwide because it has high strength and its ability to adapt to various forms of structure. In modern times, global warming and climate change have become the main content throughout the world, Cement which is one of the most important materials for making concrete is one of the most important materials in making concrete is one of the largest contributors of carbon dioxide (CO_2) in the world, Therefore, it is necessary to find alternatives for substitute materials or reduce the use of cement that is more environmentally friendly. For example, such as fly ash and bio enzymes (bio conc) which can be used as a substitute material for some cement in making concrete and also fly ash and bio enzymes (bio conc) can improve the characteristics of concrete, for example in the compressive strength of concrete.

Fly ash is an industrial waste produced from coal combustion. As a by-product of the energy industry, fly ash produces significant carbon emissions from its production process, which contributes to global warming. Effective and efficient management of fly ash waste is still a major challenge considering its nature which has the potential to contain heavy metals and other hazardous substances. However, fly ash can also be used as a reducing agent for cement use or can also be used as an additive in concrete mixtures because fly ash contains silica (SiO_2) and aluminum oxide (AI_2O_3) which can react with calcium hydroxide ($Ca\ (OH)_2$). Which is produced during cement hydration which forms compounds that can increase the strength and durability of concrete.

Bio Enzyme or bio conc is an enzyme-based additive that can improve the process of hydration and chemical interaction in concrete mixtures. This enzyme functions as a catalyst that accelerates chemical reactions between the components of the concrete composition so that it can improve the microstructure so that it can increase the compressive strength of the concrete.

The purpose of this study itself is to find out the effect of adding fly ash and bio enzyme (bio conc) on the compressive strength of concrete and to find out the most optimal composition of adding fly ash and bio enzyme (bio conc) on the compressive strength of concrete.

Meanwhile, the purpose of this research is to obtain information on how these two additional materials can affect the characteristics of concrete, especially on the compressive strength of concrete. And to obtain the most optimal composition of the use of fly ash and bio enzyme (bio conc) in concrete.

The problem to be discussed in this study is how the addition of fly ash and bio enzyme (bio conc) affects the concrete mixture with a strength of Fc` = 25Mpa. The number of samples to be used later is 24, with the percentage of fly ash addition of 7.5%; 9%; 10.5%; 12%; 13.5%; and 15% and bio enzyme (bio conc) of 500 ml/m³. The age of the concrete to be tested later is 28-day-old concrete. The concrete that will be the test object used later is in the form of a cylinder measuring 15x30 cm.

Concrete consists of essential ingredients, including cement, fine and coarse aggregates, water, and necessary additives, all mixed in a predetermined ratio. According to (Badan Standarisasi Nasional, 2847-2019) concrete is a mixture made of coarse aggregate, fine aggregate, hydraulic cement or other portland cement and also water, which can be added with additional components (admixtures) or also without using additional materials, thus creating a solid object.

The concrete composition itself is the result of a combination of mechanical and chemical properties between the materials used as its composition. The materials for the composition of concrete itself consist of cement, water, fine aggregate, coarse aggregate, air and additional materials or other additives (if necessary).

1. Cement

Cement is a hydraulic binder that has a clinker form (this material itself has a content of hydrolyzable calcium silicates) and is then made smooth by adding gypsum. The material for making cement according to SNI itself consists of limestone, clay, silica sand, silica limestone, iron sand, gypsum. The use of cement is for a binder between fine grains and coarse grains and functions to form a solid mass and fill the air space between the aggregate grains.

2. Aggregate

Aggregates themselves have several functions, for example as fillers in mixtures that provide structural strength to concrete or mortar. In addition, aggregates also help reduce the volume of cement paste in the mixture, thereby reducing contraction during drying and increasing strength and resistance to pressure. Strong and hard aggregates can increase the resistance to deformation and pressure on concrete or mortar. The composition of the aggregate itself in the concrete mixture is around +/- 70% of the composition of concrete or mortar. According to (SNI 03-2834-2000), aggregates consist of fine aggregates (sand) and coarse aggregates (gravel). Fine aggregates are materials that pass a 4.8 mm sieve, while coarse aggregates are materials that remain on a 4.8 mm sieve. To produce high-quality concrete, aggregates must meet certain requirements such as water content must be less than 2%, water absorption must not exceed 5%, and aggregate unit weight must not exceed 2.5 g/cm..

3. Water

Water in the concrete mixture functions as a trigger for chemical reactions that allow the adhesion of materials in the concrete, so that the concrete hardening process can occur. In addition, water also acts as a lubricant between aggregate grains in the concrete mixture, which facilitates compaction when the concrete is poured into a mold or casting media. Water requirements according to (Tjokrodimuljo, 2007) :

a. The sludge content should not exceed 2 grams per liter.
b. The salt content, including organic substances, acids and similar substances should not exceed 15 grams per liter
c. Chloride levels (CI) are not permitted to exceed 0.5 grams/liter.
d. Sulfate levels are not permitted to exceed 1 gram/liter

4. Additives

According to (Mulyono, 2004) the additive itself is a material added to the concrete mixture to improve certain characteristics, both when the concrete is still fresh and after it has hardened. The use of this additive aims to optimize concrete performance, such as increasing strength, accelerating or slowing down the hardening time, and increasing resistance to environmental factors. This material can function to strengthen concrete, increase resistance to weather conditions, increase durability, or regulate the hardening time of concrete (to accelerate or slow it down). Additives in concrete are generally categorized into two main groups, namely chemical additives and mineral additives. The following are examples of additives:

1. Mineral additive

These mineral additives are used to improve the performance of concrete. Usually, these additives are used to increase the compressive strength of concrete, so that it has properties that resemble cement. Some examples of these mineral additives are pozzolan, fly ash, slag, and silica fume

2. Chemical admixture.

a) Type A "Water Reducing Admixture"
This additive serves to reduce the amount of water in the concrete mixture, so that it can achieve the desired consistency. Water reducing admixture is used to maintain cement content and slump value without significant changes, allowing the production of concrete with a reduced water-cement ratio (WCR).

b) Type B "Retarding Admixture"
Retarding admixture helps delay the hardening time of concrete. Its use is to maintain the time of concrete bonding (setting time),

c) Type C "Accelerating Admixture"
accelerating admixture has a function to accelerate the concrete binding process and increase strength at an early age. The use of this material helps accelerate the hydration process and accelerate the achievement of concrete strength.

d) Type D "Water Reducing and Retarding Admixture"
This water reducing and retarding admixture has two uses, namely it can reduce water requirements to achieve the desired concrete consistency and can also slow down the bonding process time of the concrete.

e) Type E "Water Reducing and Accelerating Admixture"
This water reducing and accelerating admixture has two uses, namely being able to reduce the water content in the concrete mixture so that it can achieve

a certain desired consistency and also being able to accelerate the concrete binding process.

f) Type F "Water Reducing, High Range Admixture"
This water reducing, high range admixture is designed to reduce the water content in the concrete mixture by up to 12% or more, thereby increasing the workability of the concrete.

g) Type G " Water Reducing, High Range and Retarding Admixture"
This water reducing, high range and retarding admixture is useful for reducing water content by more than 12% in order to achieve the desired concrete consistency and can slow down the concrete binding process.

Fly Ash

Fly ash is the remaining fine particles resulting from coal combustion in companies that use coal as their main fuel and in steam-powered power plants (PLTU). According to (SNI 03-2460-1991), Fly ash comes from the combustion of anthracite coal at a temperature of around 1560 ˚C. Fly ash is known to have pozzolanic properties, namely the ability to react with calcium hydroxide in wet conditions to form a binding compound, so it is often used as an additional material for concrete to increase the durability and strength of concrete. According to (Standar Nasional Indonesia ,S-15-1990-F) The pozzolanic properties themselves are the properties of natural or synthetic materials that contain fine silicates or aluminates that can react with water and are similar to the properties of cement when mixed and harden at room temperature (24˚C – 27˚C).

According to (SNI 03-2460-1991) Fly ash is classified into several categories based on its silica and calcium oxide content. This classification is important because it affects how fly ash is used in various types of applications. Here is the classification of fly ash based on its class:

a) Class F
Class F fly ash has a high silica content and less calcium oxide so it is very good when used as an additional material in concrete.

b) Class C
Class C fly ash has a higher silica and calcium oxide content than class F so it can be used as a cement substitute in concrete.

Bio Enzyme (Bio Conc)

Bio enzyme (bio conc) is a biotechnology product that has a liquid form made from natural or organic materials, protein denaturation, surfactant biopolymers, and organic minerals that undergo a fermentation process by microbes. Bio enzyme (bio conc) can improve the mechanical properties of concrete. Bio enzyme (bio conc) itself has several advantages, including reducing cement use, reducing shrinkage cracks and also increasing the compressive strength of concrete. Here are some of the main properties and characteristics of bio enzyme (bio conc) among others are as follows:

a) Biodegradable
Bio conc is made from organic materials that can decompose naturally so it is environmentally friendly.

b) Increased strength
The use of bio conc in concrete mixtures can maximize its strength, this is because the enzymatic reaction that occurs is able to improve the bonds between particles in concrete.

c) As cement reduction
By adding bio conc, the cement requirement in the concrete mixture can be reduced by up to 35% (depending on the quality of the concrete) without reducing the strength of the concrete, which means it can have a positive impact on reducing carbon dioxide emissions from cement production.

d) Increasing density
Bio conc can help to improve particle distribution and increase material density which can reduce porosity and increase water resistance.

e) Long term effects
The use of bio conc can provide long-term stability and durability to the applied material because bio conc can help create a denser microcrystalline structure.

2. METHODOLOGY

In making cylindrical concrete with dimensions of 15x30 cm under normal conditions, and with the addition of fly ash and bio enzymes (bio conc), it is necessary to test the materials that will be used in making the concrete later, this aims to ensure that the planned compressive strength can be achieved. The following are the steps taken to carry out the research.

1. Material Testing
   a) Testing of fine aggregate material (sand).
   b) Testing of coarse aggregate material (coral/split).

2. Making Test Objects
   This study will use 24 cylindrical test object samples using 8 variations, namely:
   a) Normal concrete (without additional fly ash and bio enzyme (bio conc).
   b) Normal concrete + Bio enzyme (Bio Conc) 500 ml/m³.
   c) Normal concrete + Fly ash 7.5% + Bio Enzyme (Bio Conc) 500 ml/m³.
   d) Normal concrete + Fly ash 9% + Bio Enzyme (Bio Conc) 500 ml/m³.
   e) Normal concrete + Fly ash 10.5% + Bio Enzyme (Bio Conc) 500 ml/m³.
   f) Normal concrete + Fly ash 12% + Bio Enzyme (Bio Conc) 500 ml/m³.
   g) Normal concrete + Fly ash 13.5% + Bio Enzyme (Bio Conc) 500 ml/m³.
   h) Normal concrete + Fly ash 15% + Bio Enzyme (Bio Conc) 500 ml/m³.

Each sample is made of 3 test objects and the compressive strength test will be carried out when the concrete is 28 days old.

3. RESULTS AND DISCUSSION

From the results of the concrete compressive strength test carried out on 28-day-old concrete, it was then processed to obtain data on the concrete compressive strength results for each variation. The results of the characteristic compressive strength were obtained as in the table below.

Table 1. Concrete Compressive Strength Characteristics at 28 days old

Mixing Variations `	Average Compressive Strength (Mpa)	Characteristic Compressive Strength (Mpa)
Normal concrete	25,65	24,833
Normal concrete + Bio enzyme (Bio Conc) 500 ml/m³.	27,63	27,366
Normal concrete + Fly ash 7.5% + Bio Enzyme (Bio Conc) 500 ml/m³.	29,05	28,786
Normal concrete + Fly ash 9% + Bio Enzyme (Bio Conc) 500 ml/m³.	30,37	30,096
Normal concrete + Fly ash 10.5% + Bio Enzyme (Bio Conc) 500 ml/m³.	31,22	30,946
Normal concrete + Fly ash 12% + Bio Enzyme (Bio Conc) 500 ml/m³.	32,63	32,366
Normal concrete + Fly ash 13.5% + Bio Enzyme (Bio Conc) 500 ml/m³.	34,42	34,156
Normal concrete + Fly ash 15% + Bio Enzyme (Bio Conc) 500 ml/m³.	36,31	36,046

Based on table 1, a graph of the compressive strength of concrete at the age of 28 days and a graph of the percentage increase in the compressive strength of normal concrete + bio enzyme (bio conc) with normal concrete + fly ash + bio enzyme (bio conc) are made, as shown in the image below

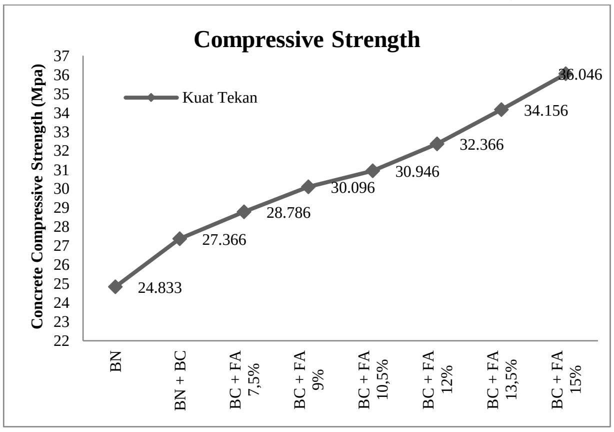

Figure 1. Concrete Compressive Strength Graph Characteristics of Concrete Aged 28 Days

Tabel 2. Recapitulation of Percentage of Strength Increase of Normal Concrete + Bio Enzyme (Bio Conc) with Normal Concrete + Fly Ash + Bio Enzyme (Bio Conc).

Mixing Variation	Strength Increase (%) Sample Age 28 Days old
Normal concrete + Bio enzyme (Bio Conc) 500 ml/m³.	0
Normal concrete + Fly ash 7.5% + Bio Enzyme (Bio Conc) 500 ml/m³.	5
Normal concrete + Fly ash 9% + Bio Enzyme (Bio Conc) 500 ml/m³.	10
Normal concrete + Fly ash 10.5% + Bio Enzyme (Bio Conc) 500 ml/m³.	13
Normal concrete + Fly ash 12% + Bio Enzyme (Bio Conc) 500 ml/m³.	18
Normal concrete + Fly ash 13.5% + Bio Enzyme (Bio Conc) 500 ml/m³.	25
Normal concrete + Fly ash 15% + Bio Enzyme (Bio Conc) 500 ml/m³.	32

Based on table 2, a graph is made of the percentage increase between the compressive strength of normal concrete + bio enzyme (bio conc) and normal concrete + fly ash + bio enzyme (bio conc), as shown in the image below :

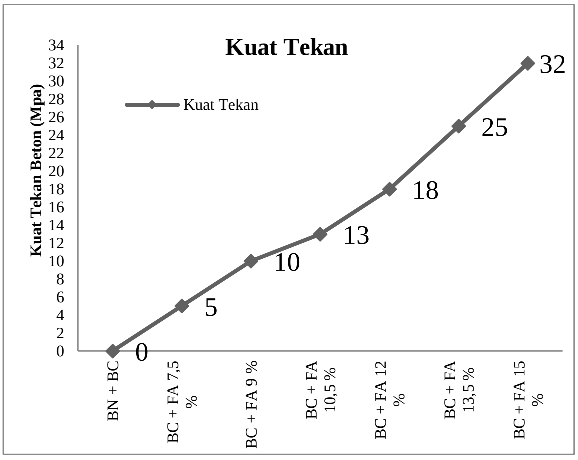

Figure 2. Graph of Percentage Increase in Compressive Strength Between Normal Concrete + Bio Enzyme (Bio Conc) and Normal Concrete + Fly Ash + Bio Enzyme (Bio Conc) in 28-day-old Concrete.

4. CONCLUSION

Based on the results of the discussion and research on the addition of fly ash and bio conc that has been carried out, the following conclusions were obtained:

1. In the variation of concrete mixture with the addition of bio conc and fly ash 7.5% - 15%, the compressive strength value continues to increase compared to the addition of bio conc alone.
2. The addition of bio conc and fly ash 7.5% - 15% continues to get a higher percentage increase in compressive strength value compared to using only bio conc, which has the highest increase is the addition of bio conc and fly ash 15% of 32% with a compressive strength value of 36.046 Mpa, and the lowest increase is in the addition of bio conc and fly ash 7.5% of 5% with a compressive strength value of 28.786 Mpa, which when compared to the addition of bio conc alone has a compressive strength value of 27.366 Mpa at the age of 28 days.

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