NEUTRON
VOLUME 22 | NUMBER 01 | JULY 2022
https://ejournal.worldconference.id/index.php/neutron
E-ISSN: 2685-3272 | P-ISSN 1412-0860

The Effect of Adding Fly Ash and Glass Powder on the Compression Strength of Concrete

Agung Sumarno, Sandi Indratama, Syafwandi, Agyanata Tua Munthe
Faculty of Engineering, University Mercu Buana Jakarta, Indonesia
agung_sumarmo@mercubuana.ac.id, massandiindratama02@gmail.com,
agyanata.umb@gmail.com, h.syafwandi13@gmail.com

Abstract

The purpose of this study was to determine the effect of the use of fly ash waste and glass powder on the compressive strength of concrete. 17.5% at the age of 3 days, 7 days, 14 days, and 28 days. for the specimens used measuring with a diameter of 10 cm and a height of 20 cm as many as 36 test samples by making variations of the day as many as 3 samples of the test object, After testing the compressive strength of concrete, the compressive strength of the characteristic concrete with the addition of 7% fly ash and glass powder 5%, the maximum compressive strength at the age of 7 days was 23.35 Mpa, the age of 14 days was 28.93 Mpa, and the age of 28 days was 33.85 Mpa. These results exceed the value of the compressive strength of normal concrete characteristics and indicate that fly ash and glass powder increase the compressive strength of concrete. There is a strong influence from the addition of fly ash and glass powder with variations in the addition and certain age of concrete

Keywords:
Compressive Strength, Concrete, Fly Ash Waste, Glass, Alternative.

1. Preliminary

1.1. Background

In the current era, the increasing number of glass industrial plants also results in a large amount of glass waste from production residues. Some glass waste from production waste will usually be made of new glass and other waste is disposed of directly on the ground or in the river without being used properly this can cause environmental pollution. Many studies have been carried out to utilize the glass waste into something more useful, namely as a mixture of concrete mixtures, where the glass can be processed into glass powder. The use of glass powder waste as a concrete mix is expected to reduce unused glass waste. Concrete is a mixture of portland cement or other hydraulic cement, coarse aggregate, fine aggregate, and water with or without additives that form a solid mass (SNI-03-2847,

Glass is an amorphous material made by dry silica and basic oxides. The hardness of glass provides abrasion resistance to concrete. Glass was chosen as an additional material for the concrete mixture, because it can increase the compressive strength of concrete.

Glass powder or fritz is glass flakes that are crushed and can be made into ceramic mixtures in ceramic factories. This glass powder is a fine grain measuring 0.075mm – 0.12mm, non-porous and pozzolanic. Glass powder can be expected to increase the compressive strength of concrete because the grains are very small and are able to fill the pores in the concrete.

Fly Ash(fly ash) is one of the residues produced in combustion and consists of fine particles from the combustion of coal. Fineness of fly ash

This has the potential to cause air pollution. In addition, fly ash handlers are currently limited on stockpiling in vacant land the use of fly ash as a concrete-forming material has a positive impact from an environtmental point of view.

As a concrete mixture, it shows that the value of the compressive strength of concrete at the age of 28 days with fly ash content of 7%, 9& and variations in glass powder content of 7%, 5% obtained the optimum compressive strength value at a variation of 7% glass powder content.

In this study, the author tried to add a mixture of concrete with glass powder 7%, 5% and fly ash variation levels of 7%, 9% to find out the maximum limit of the percentage of fly ash that is good for the compressive strength of concrete.

Based on this background triggered a research entitled "Effect of Addition of Fly Ash and Glass Powder on Compressive Strength of Concrete” utilizing fly ash and glass waste materials to reduce the use of cement as the main material for making concrete against compressive strength.

1.2. Formulation of the problem

Based on the background above, the formulation in this study is as follows:

1. How does the addition of fly ash and glass powder affect the compressive strength of normal concrete?
2. What is the optimum content of fly ash and glass powder added to achieve the design compressive strength?

3. On how many days variation of concrete with fly ash and glass powder variations can have the best results in how long?

1.3. Research Aims and Objectives

The aims and objectives of this research are as follows:

1. Knowing the effect of adding fly ash and glass powder to the compressive strength of normal concrete?
2. Knowing what is the optimum level of fly ash added to achieve the design compressive strength?
3. Knowing the compressive strength of concrete from the 14th, 21st, and 28th days

1.4. Restrictions and Scope of the Problem

Limitations of the problem in this study need to be made so that this research can be controlled and studied properly. Limitations of the problem in this study are:

1. The use of fly ash and glass powder as additives in the manufacture of concrete.
2. The water used is fresh water available at the Civil Engineering Laboratory, Mercu Buana University Campus D Kranggan.
3. The cement used is type 1 portland cement.
4. The fine aggregate used is sand.
5. Coarse aggregate used is crushed stone (split) with a maximum size of 25 mm.
6. Mix design using the calculation of SNI 03 28 24 2000 with a design compressive strength of 30 MPa and a w/c ratio of 0.33.
7. The tests carried out include; gradation of aggregate grains, specific gravity of aggregates, water content of aggregates, water absorption of aggregates, slump test of concrete, weight of test samples, and compressive strength tests of concrete using a compression machine.
8. Variations in the use of fly ash and glass powder as additives were 7%, 9% and 7% and 5% glass powder content.
9. The sample of the test object used was a cylindrical test object measuring 15 cm x 10 cm as many as 48 pieces.
10. The age of the specimens to be tested for the compressive strength of concrete is 14 days, 21 days and 28 days.

2. Literature Review

2.1. Definition of Concrete

Concrete (concerete) is a mixture of Portland cement or other hydraulic cement, fine aggregate, coarse aggregate, and water, with or without admixture. Along with increasing age, the concrete will harden and will reach the design strength (f'c) at the age of 28 days.

Concrete is formed by mixing rock material which is bound with an adhesive in the form of cement. The rock materials used to make concrete are generally divided into two types, namely, coarse aggregate (gravel/pecas/split) and fine aggregate (sand). Fine aggregate and coarse aggregate are referred to as mixed composite materials and are the main components of concrete. In general, the use of aggregate in concrete mixes reaches 70%-75% of all concrete (Aji & Purwono, 2010).

2.2. Concrete Forming Material

2.2.1. Portland Cement

Portland cement is the most common type of cement used generally throughout the world as a base material for non-specialized concrete, mortar, plaster and mortar. It was developed from other types of hydraulic lime in Great Britain in the mid-19th century, and is usually derived from limestone. This cement is a fine powder produced by heating limestone and clay minerals in a kiln to form clinker, grinding the clinker, and adding small amounts of other materials. Several types of Portland cement are available, the most common being called ordinary Portland cement OPC , is gray, but white Portland cement is also available.Portland cement as hydraulic cement cement which not only hardens by reacting with water but also forms a water-resistant product produced by crushing clinker consisting essentially of hydraulic calcium silicates, usually containing one or more forms of calcium sulfate as an inter-soil addition. Portland cement is hydraulic material consisting of at least two-thirds of the mass of calcium silicate, 3 CaOSiO2, and 2 CaOSiO2, the remainder consisting of an aluminum and iron-containing clinker phase and other compounds.the remainder consists of an aluminum- and iron-containing clinker phase and other compounds.the remainder consists of an aluminum- and iron-containing clinker phase and other compounds.

1. Type I (Ordinary Portland Cement)
2. Type II (Modified Portland Cement)
3. Type III (Rapid – Hardening Portland Cement)
4. Type IV (Low – Heat Portland Cement)
5. Type V (Sulphate – Resisting Portland Cement)

2.2.2. Aggregate

Aggregate is a material used as a filler for concrete. Aggregates are formed from volcanic eruptions, deposits, rock fragments or are produced unnaturally such as broken bricks, burning slag, and other synthetic materials. Aggregate is

main constituent of concrete to reduce shrinkage and lower production costs. Almost 70%-80% of the volume of concrete is aggregate (Duggal, 2008).

Aggregate is like a skeleton on concrete. The level of viscosity and the value of cohesion in freshly made concrete is influenced by the amount, type, surface texture, and size gradation of the aggregate used. In hardened concrete, aggregate greatly affects the value of stiffness, unit weight, strength, thermal properties, bonding, and wear resistance of concrete (Li, 2011).

2.2.3. Coarse Aggregate

Coarse aggregate is aggregate that does not pass through the No. 4 (4.75 mm) sieve. In general, the size of the coarse aggregate ranges from 5 mm to 150 mm. In normal concrete for structural elements such as beams and columns, the maximum size of coarse aggregate is 25 mm. In large concrete buildings such as dams and deep foundations, the coarse aggregate used can reach 150 mm (Li, 2011). Types of coarse aggregate are generally natural crushed stone, natural gravel, artificial coarse aggregate such as slag or shale, and aggregates for nuclear protection and heavy weights such as crushed steel, barite, magnetite andlimonite (Nawy, 1998).

2.2.4. Fine Aggregate

Fine aggregate is the aggregate that passes the No. 4 (4.75 mm) sieve and is retained on the No. 200 (75 m) sieve. River sand is the most commonly used type of fine aggregate. (zongli) Generally sand has a minimum size of 0.07 mm (0.003 in.). Materials measuring 0.06 mm (0.002 in.) to 0.02 mm (0.0008 in.) are classified as silt, and other smaller particles are classified as clay (Neville & Brooks, 2010).

2.2.5. Water

Water is a vital component in the manufacture of concrete. The amount of water used in the concrete manufacturing process greatly affects the resulting concrete. If the amount of water is too much, the cement will be lifted up with the water through capillary action and form a thin layer on the top surface of the concrete which is called laitance and weakens the bond in the concrete. In addition, too much water will cause the concrete to become hollow and porous when the water has been removed from the concrete. Meanwhile, when the amount of water is too little it will reduce workability and make fresh concrete difficult to use and consequently make the mixture of constituent materials spread. uneven concrete so that it reduces the strength of the concrete (Duggal, 2008).

2.2.6. Fly Ash

In the process of burning coal, two residual materials are produced. One material that comes out of the chimney of the furnace in the form of very fine dust is called fly ash. While the other material in the form of coarse dust at the bottom of the furnace is called bottom ash. has a high cement content and has pozzolanic properties. According to Neville & Brooks, (2010) pozzolanic properties are the properties of materials containing silica and alumina compounds. Fly ash content according to Santoso et al., (2004) contains Silica SiO_2, Iron Oxide Fe_2O_3, Aluminum Oxide Al_2O_3, Potassium Oxide CaO, Magnesium Oxide MgO, and Sulfate SO_4.

2.2.7. Glass Powder

Glass is one of the products of the chemical industry that is most familiar to our daily lives. From a physics point of view, glass is a very cold liquid. This occurs due to a very fast cooling process, so that the silica particles do not have time to arrange themselves in an orderly manner. From a chemical point of view, glass is a combination of various inorganic non-volatile oxides, which are produced from the decomposition and smelting of alkaline and alkaline earth compounds, sand and various other constituents.The characteristic properties of glass are influenced by the uniqueness of silica SiO_2 and the process of its formation.Glass is a material made by dry silica with a basic oxide.The roughness of glass gives concrete a resistance to abrasion that can only be achieved by a few natural aggregate stones. Glass has distinctive properties compared to other ceramic groups. The reactions that occur in the manufacture of glass are summarized in equation 2-1 dian, 2011 Na_2CO_3 a.SiO_2 Na_2O.a.SiO_2 CO_2 $CaCO_3$ b.SiO_2 CaO.b.

2.2.8. Concrete slump test

The concrete slump test measures the consistency of fresh concrete before use. The test is used to test the workability of fresh concrete and the ease with which fresh concrete can flow (Gambhir, 2004). The slump test of concrete is carried out by decreasing the height at the center of the top surface of the concrete which is measured immediately after the slump test mold is lifted. Concrete with a slump value of 15 mm may not be plastic enough and concrete having a slump of 230 mm may not be sufficiently cohesive for this test.

2.2.9. Compressive Strength of Concrete

The compressive strength of concrete is the magnitude of the load per unit area, which causes the concrete test object to crumble when it is loaded with a certain compressive force generated by the press machine. The compressive strength of concrete is the most important property in the quality of concrete compared to other properties. The compressive strength of concrete is determined by the setting of the ratio of cement, coarse and fine aggregate, water. The ratio of water to cement, the higher the compressive strength. A certain amount of water is required to provide a chemical action in hardening concrete, excess water increases workability but decreases strength (Wang & Salmon, 1990).

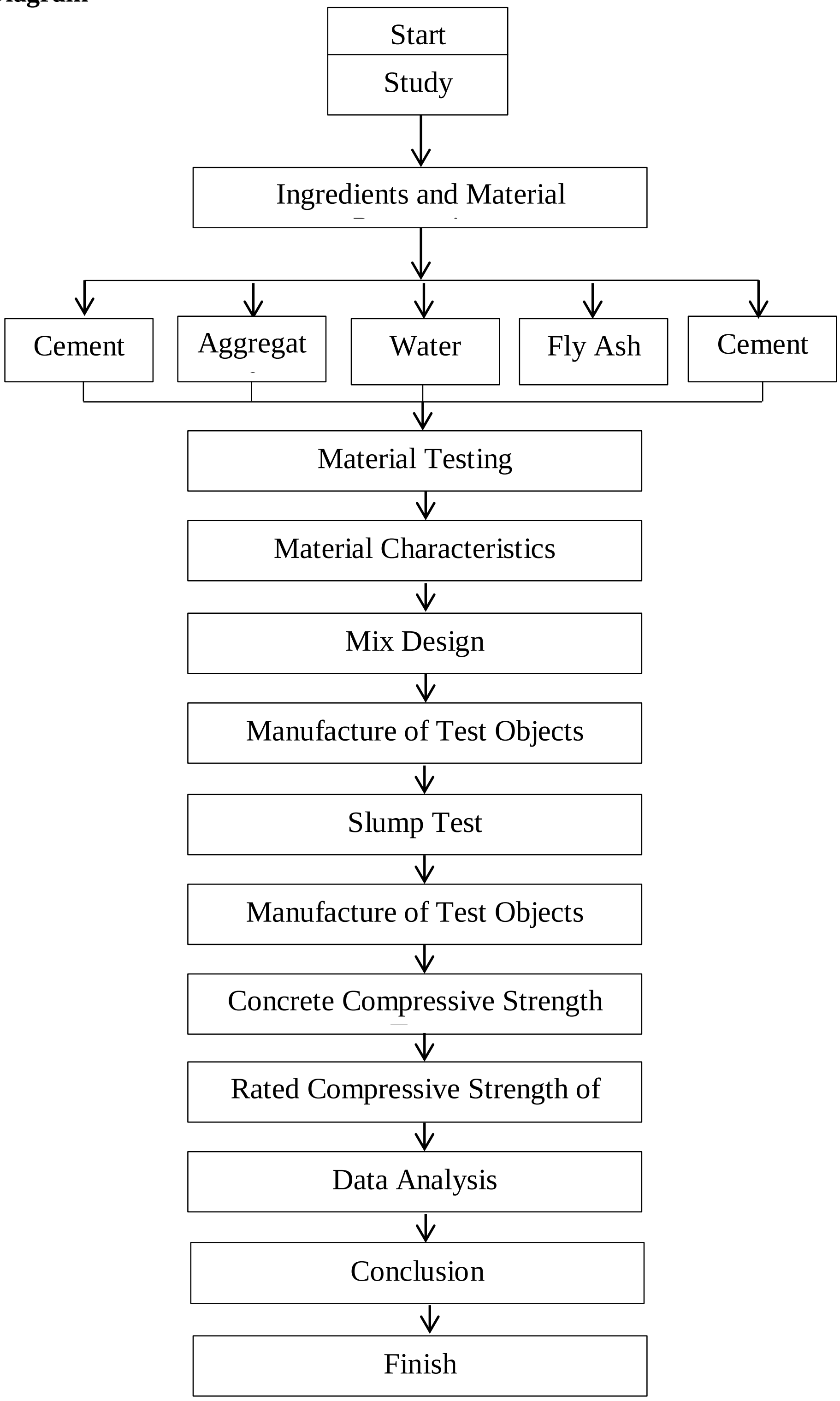
3. Research Methods

3.1. General Description

The research method used is the experimental method. The experimental method is a method to determine whether the cause of the independent variable affects the effect of the dependent variable. Hermawan, (2006) the independent variable to be used is the variation in the percentage of fine aggregate substitution using sawdust and pretreatment.

In this study, researchers will use a 10x20 cm cylinder. Researchers used Fly ash cement with a concentration of 5%, 9% and variations in the content of glass powder 7%, 5% researchers conducted a concrete compressive test on days 7, 14, 28, after the treatment process.

3.2. Flow Diagram



Flowchart 1. Flow Diagram

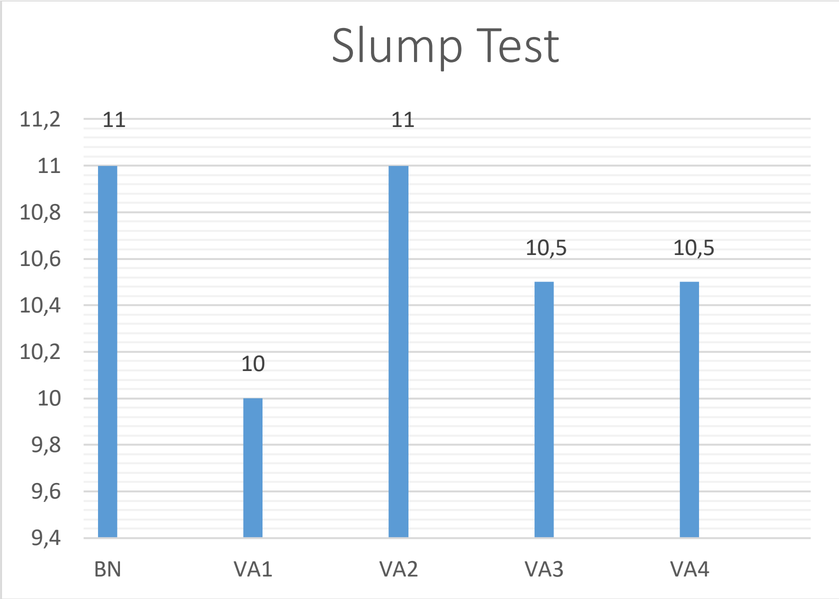
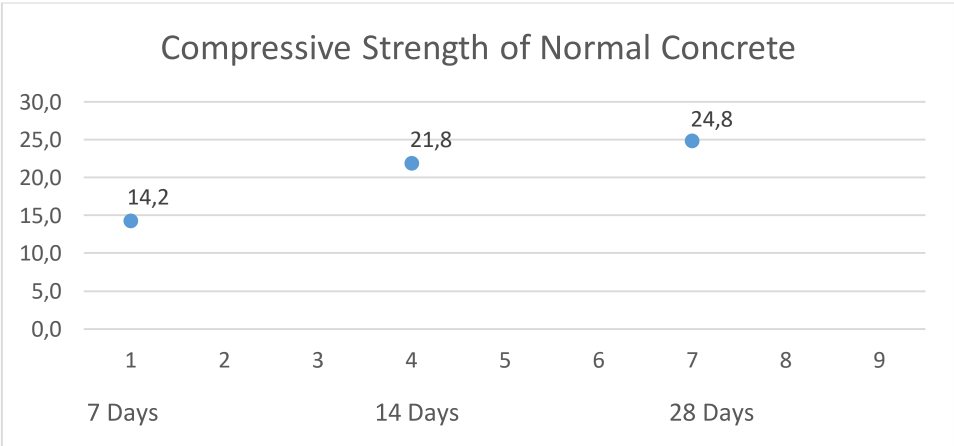


Figure 1. Slump Test Diagram

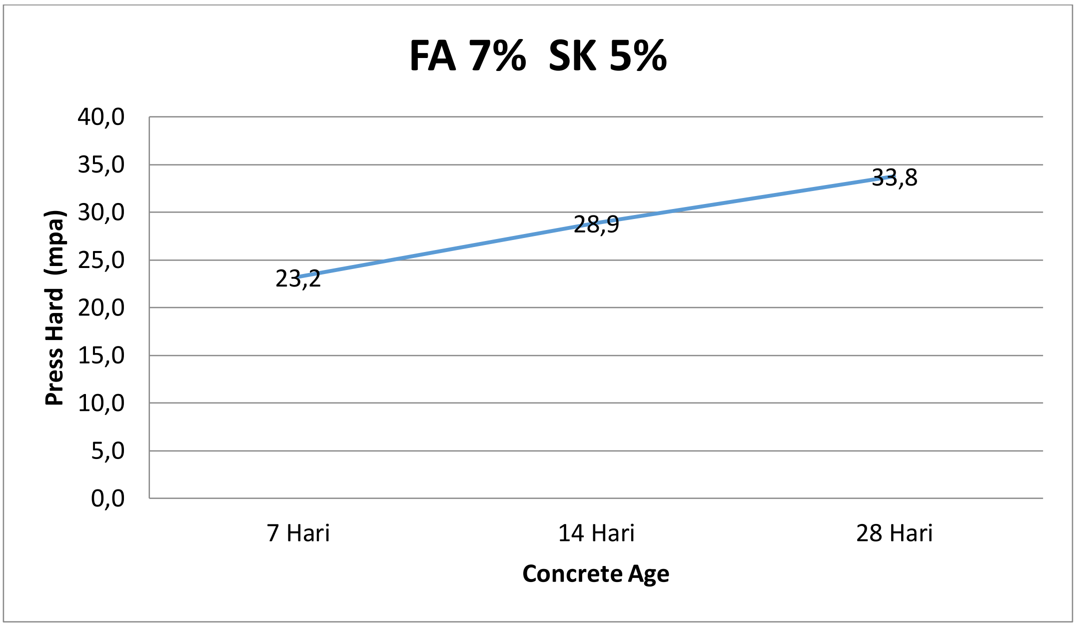
From the slump data, it is obtained when viewed from the overall test object BN, VA1, VA2, VA3, VA4, namely 11, 10.5, 9, and 11 have met the slump standard. So it can be concluded that the higher the percentage of addition of fly ash and glass powder, the smaller the slump obtained, this is due to the nature of fly ash and glass powder that easily absorbs water in the concrete mix so that the concrete mixture is getting thicker.



Source: Research Data

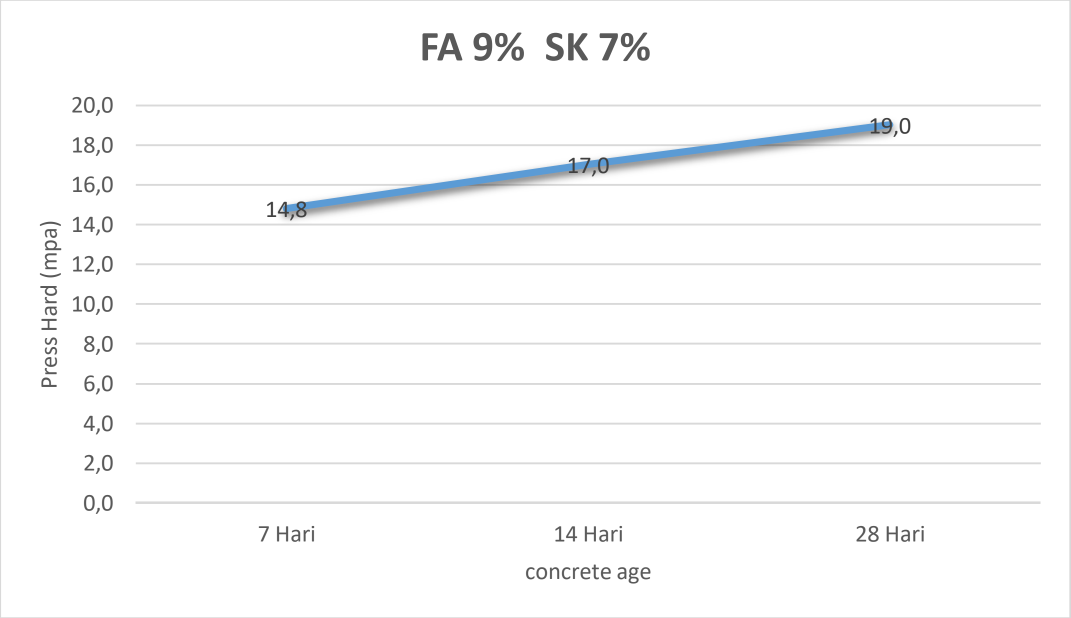
Figure 2. Graph of Normal Concrete Test Results

From the table above, it is known that the normal compressive strength of concrete on day 7 is 14.20 MPa on day 14, which is 21.80 MPa on day 28, which is 24.80 MPa. This can also be seen in the graph that the increase continues to occur until the age of 28 days.



Source: Research Data

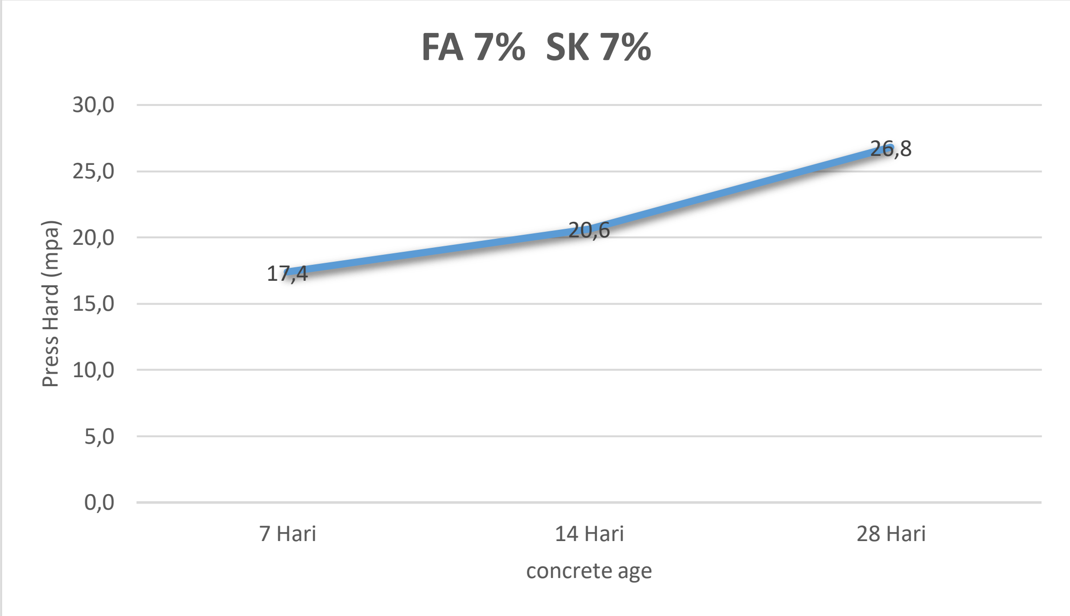
Figure 3. Graph of FA 7% Concrete Test Results and 5% SK



Source: Research Data

Figure 4. Graph of FA 9% and SK 7% Concrete Test Results

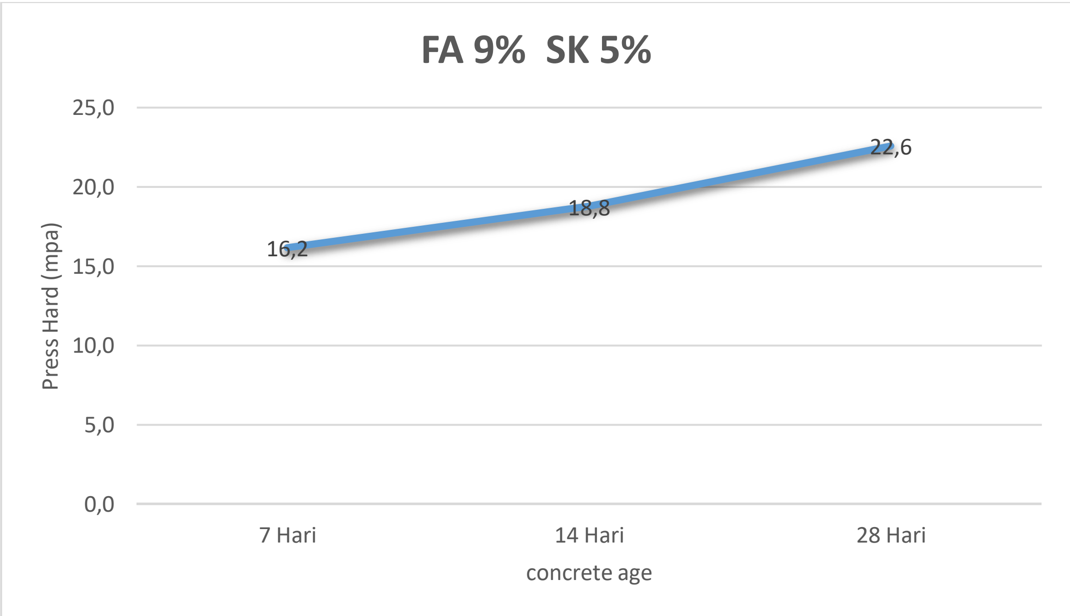
From the table above, it is known that the compressive strength of concrete with the addition of 9% fly ash and 7% glass powder on the 7th day is 14.8 MPa, the 14th day is 17.0 MPa and the 28th day is 19.0 MPa. It can also be seen in the graph that the increase continued to occur at the age of 28 days. With the addition of 9% fly ash and 7% glass powder, the concrete at the age of 28 days reached the K-300 quality, where the concrete entered the class II concrete quality, namely the quality of concrete for structural construction.



Source: Research Data

Figure 5. Graph of FA 7% and SK 7% Concrete Test Results

From the table above, it is known that the compressive strength of concrete with the addition of 7% fly ash and 7% glass powder on the 7th day is 17.4 MPa, the 14th day is 20.6 MPa and the 28th day is 26.8 MPa. It can also be seen in the graph that the increase continued to occur at the age of 28 days. With the addition of 7% fly ash and 7% glass powder, the concrete at the age of 28 days reached the K-300 quality, where the concrete entered the class II concrete quality, namely the quality of concrete for structural construction.



Source: Research Data

Figure 6. Graph of FA 9% and SK 5% Concrete Test Results

From the table above, it is known that the compressive strength of concrete with the addition of 9% fly ash and 5% glass powder on the 7th day is 16.2 MPa, the 14th day is 18.8 MPa and the 28th day is 22.6 MPa. It can also be seen in the graph that the increase continued to occur at the age of 28 days. With the addition of 7% fly ash and 5% glass powder, the concrete at the age of 28 days reached the K-300 quality, where the concrete entered the class II concrete quality, namely the quality of concrete for structural construction.

3.3.Comparison of Compressive Strength of 7 Days Aged Composite Concrete

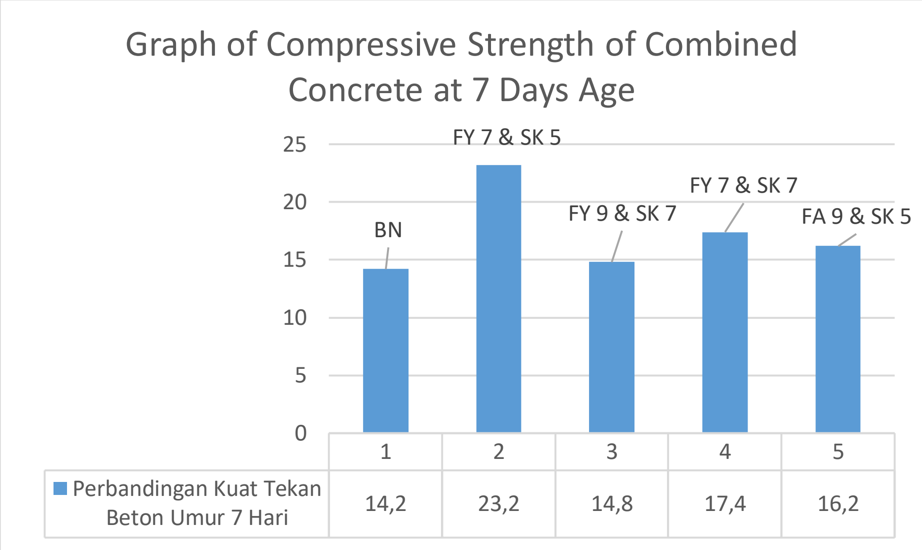


Figure 7. Graph of Compressive Strength of Combined Concrete at 7 Days Age

In the histogram above, it can be seen that the greatest compressive strength of concrete with the addition of fly ash and glass powder at the age of 7 days FA 7% and SK 5% is 23.2 MPa and the smallest concrete compressive strength is FA 9% and 7% which is 14.8 MPa

3.4.Comparison of Compressive Strength of 14 Days Combined Concrete

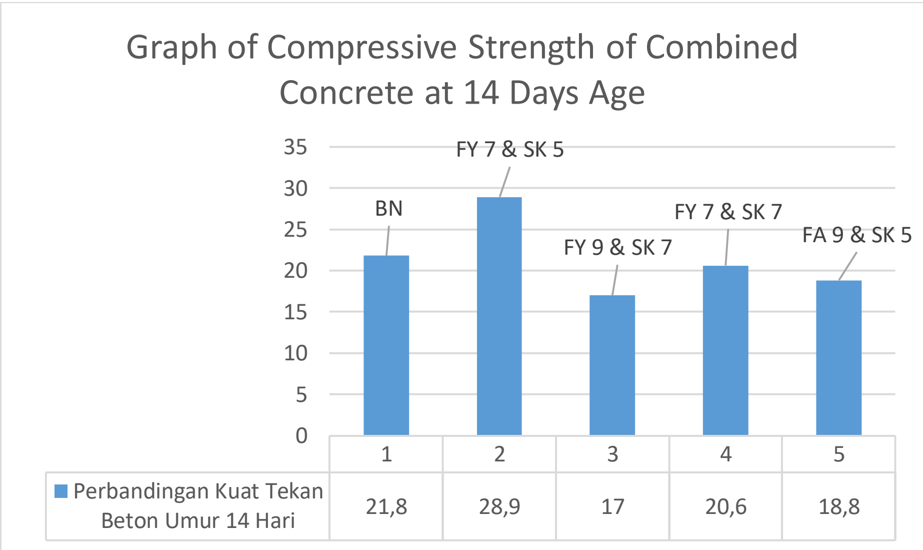


Figure 8. Graph of Compressive Strength of Combined Concrete at 14 Days Age

In the histogram above, it can be seen that the greatest compressive strength of concrete with the addition of fly ash and glass powder at the age of 28 days FA 7% and SK 5% is 28.9 MPa and the smallest concrete compressive strength is FA 9% and 7% which is 17.0 MPa

3.5.Comparison of Compressive Strength of 28 Days Aged Composite Concrete

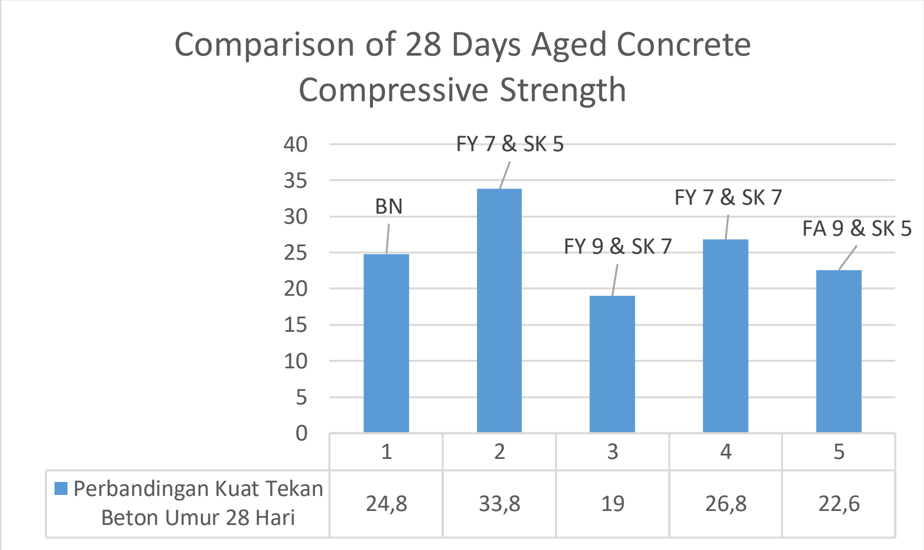


Figure 9. Comparison of 28 Days Aged Concrete Compressive Strength

In the histogram above, it can be seen that the greatest compressive strength of concrete with the addition of fly ash and glass powder at the age of 28 days FA 7% and SK 5% is 33.8 MPa and the smallest concrete compressive strength is FA 9% and 7% which is 19.0 MPa

3.6.Histogram of Compressive Strength of Combined Concrete at Each Test Age

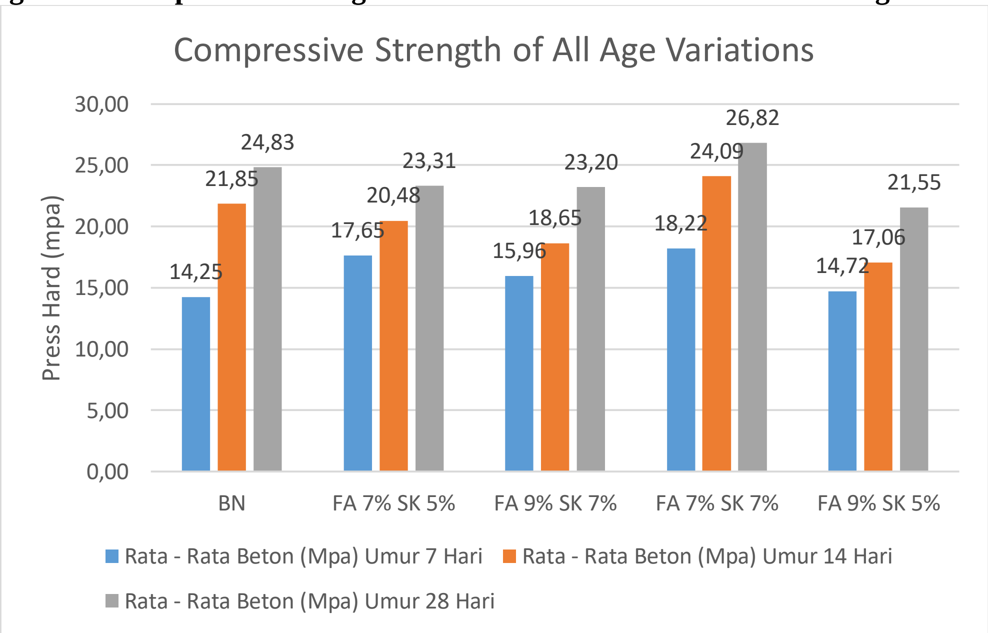


Figure 10. Compressive Strength of All Age Variations

4. Conclusion

1. Based on the Slump value, with BN the slump value is 11 cm, the variation of the mixture of Fly Ash and Glass Powder is in the range of 10 - 14 cm. small so that the level of workability is low.
2. The research proves that Fly Ash and Glass Powder have a great effect on the compressive strength of concrete. Concrete with a mixture of Fly Ash 7% Glass Powder 5% waste obtained a compressive strength at the age of 28 days of 33.82 Mpa. Variation of Normal Concrete sample has a compressive strength of 24.80 MPa at the age of 28 days.

References

Aji, P., & Purwono, R. (2010). Pengendalian Mutu Beton Sesuai SNI, ACI, dan ASTM (Seri 1). ITS Press.

Duggal, S. K. (2008). Building Materials . In New Age International (3rd ed., Vol. 66). New Age International. https://www.worldcat.org/title/611145869

Gambhir, M. L. (2004). Concrete Technology. Tata McGraw-Hill. https://books.google.com/books/about/Concrete_Technology.html?hl=id&id=brO7ltRSA4wC

Hermawan, A. (2006). Penelitian Bisnis Paradigma Kuantitatif. Grasindo. https://onesearch.id/Record/IOS13428.JATEN-02110000000240

Li, Z. (2011). Advanced Concrete Technology. In Advanced Concrete Technology. John Wiley and Sons. https://doi.org/10.1002/9780470950067

Nawy, D. E. G. (1998). Beton Bertulang Suatu Pendekatan Dasar (T. Surjaman (ed.); Cetakan Kedua). Pt. Refika Aditama.

Neville, A. M., & Brooks, J. J. (2010). Concrete Technology (Second Edition). Pearson Education Limited.

Santoso, I., Patrick, P., Andarias, A., & Roy, S. K. (2004). Pengaruh Penggunaan Bottom Ash Terhadap Karakteristik Campuran Aspal Beton. CED: Journal Of Civil Engineering Science And Application. https://doi.org/https://doi.org/10.9744/ced.5.2.pp.%2075-81

Wang, C.-K., & Salmon, C. G. (1990). Disain Beton Bertulang (B. Hariandja (ed.); Cetakan kedua). Erlangga. https://www.scribd.com/document/370010992/334452701-Chu-Kia-Wang-Disain-Beton-Bertulang-Jilid-1-2-pdf#