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Analysis of Metal Fiber Testing with Pondidaha Coarse Aggregate and Konawe Fine Aggregate Against Flexural Strength (Beams)

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Abstract

The territory of Indonesia is a high level of earthquake risk among several earthquake areas around the world. One way to reduce the occurrence of potential damage to building construction is to utilize waste and metal as added material from coarse and fine aggregate to the flexural strength of beams that have equivalent flexural strength. The equivalent flexural strength value tends to increase with the addition of metal fibers. This study aims to determine the effect of adding metal fibers to the flexural strength of the beam and the pattern of cracks and collapse mechanisms that occur in the beam when the object is tested. This research is a type of quantitative research with physical laboratory experimental methods. The data collection method used is a preliminary study, The selection of the type of aggregate and metal fiber and secondary data were then carried out laboratory tests for the gradation of fine aggregate and coarse aggregate. The data analysis technique is linear regression analysis in the Ms. program. Excell to determine the effect of metal fibers as additives on the flexural strength of the mixing of coarse and fine aggregates.

Keywords: Metal Fibers, Fine and Coarse Aggregates, Flexural Strength Beams.

INTRODUCTION

Concrete consists of a mixture of fine aggregate, coarse aggregate, cement, and water. The use of concrete in construction work is urgently needed at this time, concrete is easy to shape as desired, resistant to high temperatures, able to bear compressive loads, and relatively small maintenance. itself is determined by the proportion of the mixture or the specifications of the material to be used.

In terms of achieving the quality of concrete work, there are several factors that affect the results of concrete work, for these factors are grouped into internal factors and external factors. Internal factors include the quality of the concrete mix materials, while external factors include the implementation process, the occurrence of disputes, repetition work, and repair work that is very detrimental to all parties involved. In some developed countries such as America and England, it has been developed by adding fiber to the concrete mix. The basic concept is to naturally reinforce concrete with fibers that are randomly distributed into the concrete mix, so that it can prevent the occurrence of cracks that are too fast either due to the load or due to the heat of hydration received in the concrete itself.

Meanwhile, at this time waste containing metal is still a fairly actual problem in people's daily lives, especially for industry or in terms of construction construction that uses metal materials such as roofs with spandex types and others, where the rest of these materials only becomes waste. If waste containing metals is disposed of continuously without maximum treatment, it can cause balance disturbances, thereby causing the environment to not function as before in terms of health, welfare and biological safety. Metal waste that is buried in the soil will be very difficult to decompose, thus triggering the occurrence of corrosive or rust. Waste containing this corrosive metal which can later be carried into groundwater,

Many ways can be done to improve the quality of concrete, one of which is by adding fiber, which functions as micro reinforcement that protects the concrete from cracking, and

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increases the compressive and tensile strength, as well as the flexural strength of the concrete. In addition, the presence of fiber will not harm the concrete hardening process in the short and long term.

Seeing the above facts, at this time, one side of the human need for housing is increasing and the other side is increasingly expensive building prices, while the large housing industry waste has not been fully utilized, the researchers are motivated to raise it in the form of a thesis with the title: "Analysis Metal Fiber Testing with Pondidaha Coarse Aggregate and Konawe Fine Aggregate Against Flexural Strength (Beams)"

LITERATURE REVIEW

Concrete

According to SNI 03-2834-2000, concrete is a mixture of Portland cement or other hydraulic cement, fine aggregate, coarse aggregate and water with or without added materials forming a solid mass. Concrete is a structural element which is a mixture of cement, fine aggregate, Coarse aggregate, and as a basic building material must be glued together with water, with or without other additives.

Fiber Concrete Properties

One of the important properties of concrete is ductility. Ductility is the ability of a structure or its components to carry out repeated alternating inelastic deformations beyond the first yield point, while maintaining a large amount of load-bearing capacity (SNI 03-1729-2002). One of the reasons for adding fiber to concrete is to increase the energy absorption capacity of the mixed matrix, which means increasing the ductility of the concrete.

Fiber concrete has advantages over normal concrete in several structural properties, including ductility, fatigue life, tensile and flexural strength, resistance to shrinkage, impact resistance, and resistance to wear (abrasion). According to As'ad (2008), fiber concrete provides many advantages, including:

1. Increases the resistance of concrete to formation and crack formation.
2. Improved deformation behavior such as resistance to impact, greater ductility, flexural strength, and better torsional capacity.
3. Increasing the spalling and cracking resistance of the concrete cover will help prevent the corrosion of reinforcing steel from being attacked by potentially corrosive environmental conditions.

Previous Research on Fiber Concrete

Figure 1.1 Graph of the relationship between flexural strength and fiber content
(Source e-Jurnal MATRIX CIVIL ENGINEERING Vol. 2 No. 2/July 2014/109)

From Figure 1.1 the research results of Purnawan Gunawan, Agus Setiya Budi, Kunto Dwi Wicaksono with the title "Bending Strength, Tougnes, and Stiffness in Lightweight Concrete with Foam Technology with Aluminum Fiber Added Materials" it can be seen how much is affected by variations in addition of fiber to the flexural strength of concrete. At the addition of 0.50% fiber there is an increase in flexural strength of 55.004%, this occurs due to the binding of the fibers to one another when loading is carried out, so that the beam can receive a larger deflection than a normal beam and is also the most optimum increase in This experiment, because with the addition of 0.50% fiber can withstand greater tensile stress than other fiber content. This is in contrast to the addition of fiber 0,

Another study on metal fiber concrete, namely by Dhia Karima, The Effect of Fraction Variations from Canned Fiber on the Amount of Concrete Characteristics (2018 thesis) in his research, concrete mixed with used beverage cans fiber with a fraction variation of 10%; 15% ; and 20% of the volume of cylindrical concrete, with the test object of this research is cylindrical concrete with a size of 15cm x 30 cm, resulting in the maximum compressive strength value obtained by a fraction of 10% with a value of f'c = 23,803 MPa (an increase of 6.922% from normal concrete.

As for the quality of concrete and its use, it is divided into 3 parts, namely:

1. **High quality fc'> 45**, Generally used for prestressed concrete such as concrete piles, concrete girders, prestressed concrete slabs, prestressed diaphragms, and the like.
2. **Medium quality 20<fc'< 45**, Generally used for reinforced concrete such as bridge floor slabs, reinforced concrete girders, precast concrete kerebs, reinforced concrete culverts, bridge substructures, cement concrete pavements.
3. **Low quality 15 <fc'< 20**, Generally used for unreinforced concrete structures such as concrete cyclops, and sidewalks. While fc'< 15 is used as a work floor, backfilling with concrete.

Mechanical properties of concrete

In the manufacture of concrete always pay attention to the properties of the concrete we want. The main and general properties we want are the mechanical properties of concrete, this affects us in the calculation and manufacture of concrete mixtures. conditions in which the concrete has hardened.

In the state of fresh concrete, there are several mechanical properties and phenomena that we must pay attention to, including:

- Fresh concrete workability
- Concrete temperature
- Segregation
- *Blending*
- *Pumability*
- Air content
- Tie time

Meanwhile, when the concrete has hardened, the following mechanical properties must be considered:

- Durability or resistance of concrete, especially heating cooling, alkaline reaction and fire hazard

- The strength of concrete, especially compressive strength, flexural strength, split tensile strength
- *Shirinkage*(shrink)
- *Creep*(crawl)
- elastic modulus
- Friction of the concrete surface
- Thermal characteristics
- Concrete volume stability

Bending Strength of Concrete

Flexural strength is the ability of the material to withstand deformation under load, which is given to it until the test object breaks which is expressed in Mega Pascal (Mpa) force per unit area, which is the highest stress experienced in the material at the moment of rupture. According to SNI, the flexural strength of concrete is the ability of a concrete beam placed on two supports to withstand a force perpendicular to the axis of the test object given to it, until the test object breaks.

The long axis of the test object is a line that passes through the center of gravity of the test object in the direction of its length. The cross section of the test object is the cross section of the test object when it is cut in a direction perpendicular to the long axis. The placement of the test object is two supports/support blocks or cylindrical supports made of steel that can rotate at a certain distance to place the test object. Load point is a point (one or two points depending on the loading system used) at a certain distance where the load is applied.

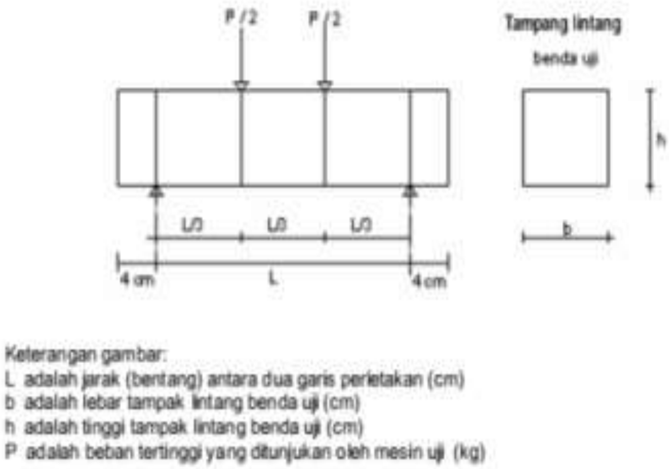

Figure 1.2 Flexural strength test
(Source: SNI 4431:2011)

RESEARCH METHODS

Research sites

In this study, concrete samples using Pondidaha coarse aggregate and Konawe sand with the addition of metal fibers made from scrap metal waste to form fibers. As for the location of the test, it was carried out at the Laboratory of the Public Works and Public Housing (PUPR) Office of Konawe Regency.

Research methods

The research was started after obtaining permission from the Head of the Civil Engineering Study Program at the University of Lakidende and then conducting a literature study, such as looking for reference journals, the content in the added materials used, and the methods used in conducting research. After looking for information about the research to be carried out, then basic examinations such as mud content, filter analysis, water content, specific gravity and bulk density are carried out in order to obtain supporting data obtained in the laboratory.

Next, look for a mix design to find out the proportion of the mixture for the test object to be made. After obtaining the proportion of the concrete mixture, then cutting the spandex (metal fiber) with dimensions of 2 X 50 mm². After the required materials are ready to use, the next step is to manufacture the test object. normal as 0%, 2.5%, 3.0 %, 3.5% with the number of samples as many as 8 pieces.

The next step is to make the concrete dough and check the slump value of the concrete, after doing the slump test, then put the concrete mixture into the 15 X 15 X 50 mm (ASTM) mold. Then the test object is allowed to stand and released from the mold after ± 48 hours. test for 28 days.

After reaching the age of 28 days, the test object is lifted from the immersion place and then the flexural strength test of the concrete is carried out.

Data Type

a. Primary data

That is data obtained directly from the data source, the primary data in question is the result of testing based on the results of laboratory examinations with reference to specifications.

b. Secondary Data

Secondary data is data obtained from several books and literature studies related to concrete and direct consultation with supervisors at the University of Lakidende. Technical data on Indonesian National Standards and books or literature as support to strengthen research conducted.

Materials and Equipment

Concrete-forming materials are:

a. Cement.

The cement used is cement with the Bossowa brand.

b. Fine aggregate.

Fine aggregate is aggregate that passes filter no. 4. The fine aggregate used comes from Konawe District.

c. Coarse aggregate.

Coarse aggregate used in the form of crushed stone with a maximum size of 20mm. Coarse aggregate used comes from Pondidaha District.

d. Water. `

The water used in this study came from the Laboratory of the Department of Public Works and Spatial Planning, Konawe Regency.

e. Metal fiber.

Metal fibers are taken from spandex waste and cut in several parts to form fibers.

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The equipment used to make concrete is:
a. A set of fine aggregate sieve
b. A set of coarse aggregate sieve
c. Oven
d. Digital scales
e. Financial scales
f. Concrete Mixer (Mixer)
g. Measuring cup
h. Mold (Mold)
i. Abrams Cone
j. Flexural strength testing machine.

Preparation and Testing of Concrete Mixtures

In general, the implementation of this research consists of several steps of work. Beginning with determining the composition of the mixture, material preparation, material inspection, manufacture of test objects, maintenance, and testing of test objects. Some of the material inspection steps are only limited to characteristic checks, because they are considered important in the calculation of the composition of the mixture. The materials needed in this test are as follows:

a. Cement

The cement used in this study was Portland cement type I with the Bossowa brand.

b. Fine Aggregate

Fine Aggregate taken from Konawe District, is natural sand as a result of natural disintegration of stone or sand produced from the Konaweeha river. Fine aggregate tests are carried out in accordance with:

1. specific gravity and absorption.
2. Filter analysis.
3. Water content.
4. Sludge levels.

c. Coarse Aggregate

Coarse aggregate taken from Konawe District, is gravel as a natural disintegration of stone or in the form of crushed stone obtained from the stone crushing industry and has a grain size between 5 mm - 40 mm. Coarse aggregate tests are carried out in accordance with:

1. Specific gravity and absorption.
2. Filter analysis.
3. Water content.
4. Mud content.
5. Aggregate wear.

d. Water

The water used comes from the Laboratory of the Public Works and Spatial Planning Office of Konawe Regency. The water in the mix is needed to react with the cement and lubricate the aggregate grains so that they are easy to work with and compact. Basically, the amount of water needed for the hydration process is only about 25% of the weight of the cement. Increasing the amount of water will reduce the strength after hardening (Winarto, 2017).

e. Metal fiber

In this study, metal fibers were obtained from spandex waste or roofing types containing metal which were then cut into pieces with a size of 1x50 mm2 with a percentage of metal fiber addition of 0%, 2.5%, 3.0%, 3.5% of cement weight. The metal fibers in this study were not tested for materials, only the preparation of the fibers which would later be mixed in the concrete mixture during the manufacture of the test object was sufficient.

RESEARCH RESULT

Material Inspection Results

The research materials in question are coarse aggregate (broken stone) pondidaha, fine aggregate (sand) konawe. The results of the examination of these materials will be described below.

Crushed Stone and Sand

Examination of the content of crushed stone and sand includes checking the gradation of coarse and fine aggregates, specific gravity of coarse and fine aggregates, unit weight, water content of crushed stone and sand, examination of coarse and fine aggregate mud content.

Coarse and fine aggregate sieve analysis

The gradation check or determination of the percentage by weight of the aggregate grains that pass by using a set of sieves (ASTM) is carried out on crushed stone and sand in a dry state or the weight of each aggregate in a constant weight state after cleaning or washing from dust or organic substances that attached to each aggregate, by drying using an oven at a temperature of (± 105°C) or by drying in direct sunlight to get the desired dryness. More data can be seen in the attachment.

Table 4.1 The cumulative average passing the coarse aggregate sieve analysis

NO	LUBANG AYAKAN	KOMULATIF LOLOS %		
		SAMPEL 1	SAMPEL 2	RATA-RATA
1	1 1/2"	100,00	100,00	100,00
2	3/4"	97,16	98,88	98,02
3	3/8''	17,70	12,87	15,29
4	NO. 4	1,51	0,80	1,16
5	NO. 8	0,58	0,34	0,46
6	NO. 16	0,48	0,27	0,38
7	NO. 30	0,44	0,23	0,34
8	NO. 50	0,38	0,19	0,29
9	NO. 100	0,17	0,10	0,14

(source: 2022 test results)

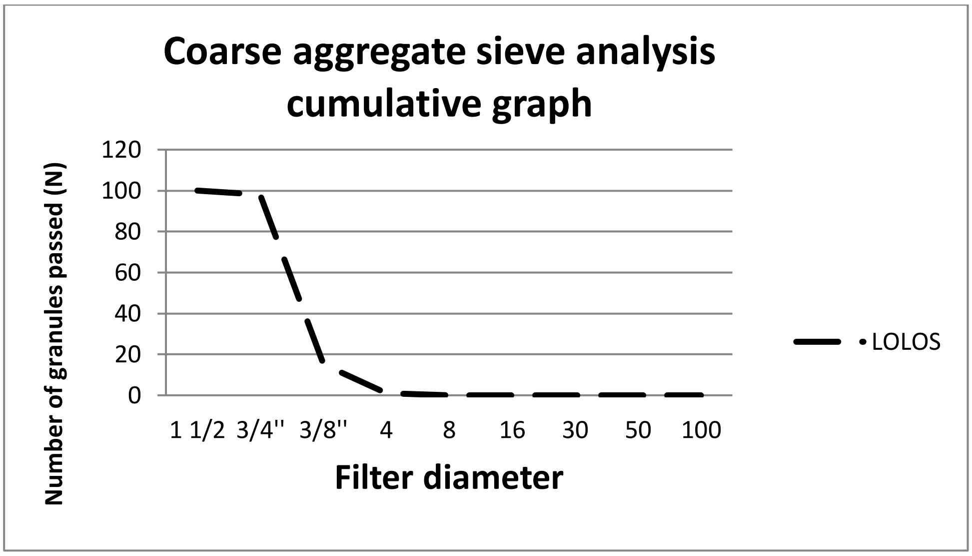

Figure 1.13 Cumulative graph of coarse aggregate sieve analysis

Table. 4.2. The cumulative average passes the fine aggregate sieve analysis

NO	LUBANG AYAKAN	KOMULATIF LOLOS %		
		SAMPEL 1	SAMPEL 2	RATA-RATA
1	1 1/2"	100.00	100.00	100.00
2	3/4"	100.00	100.00	100.00
3	3/8''	100.00	100.00	100.00
4	NO. 4	100.00	100.00	100.00
5	NO. 8	93.34	93.80	93.57
6	NO. 16	86.57	86.39	86.48
7	NO. 30	79.87	79.62	79.75
8	NO. 50	41.79	43.21	42.50
9	NO. 100	3.60	4.07	3.84

(source: 2022 test results)

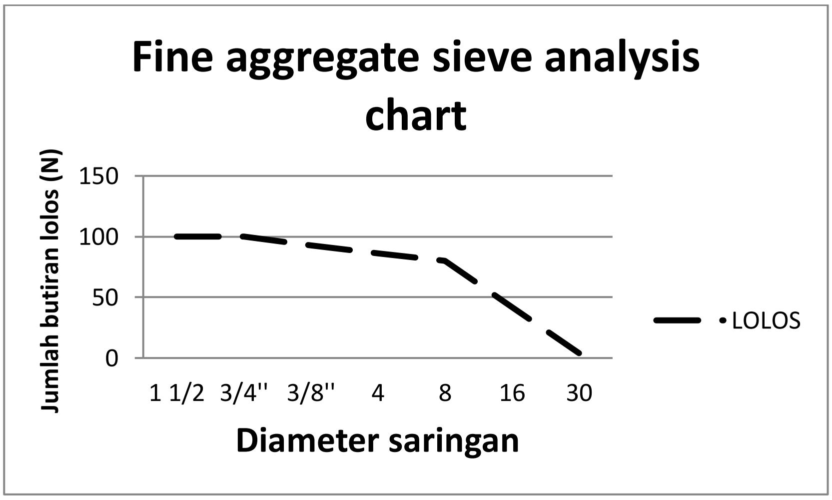

Figure 1.14 Graph of fine aggregate sieve analysis

Coarse and fine aggregate grading test

The test is carried out in an analytical way, with the aim of knowing the gradation of the mixture so that it can be used as a mix design with the required gradation specifications so that a percentage is obtained.

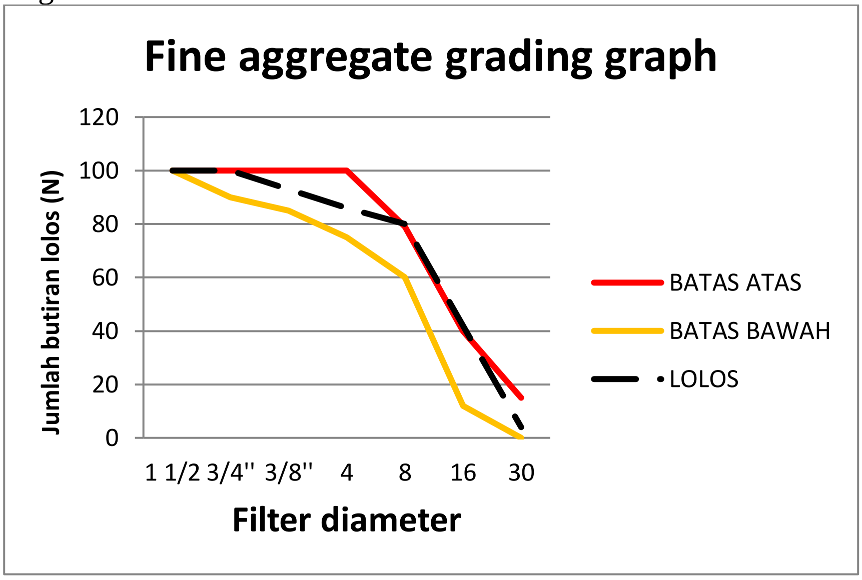

Figure 1.15 Fine aggregate gradation graph

From Figure 1.15, a fine aggregate gradation graph shows that the 1 1/2" sieve to sieve 4 is on the line between the minimum and maximum limits, meaning that the aggregate is suitable for mixing. And for sieve No. 8, No. 16, No. 30, No. 50, No. 100, which is outside the minimum and maximum limits, which means it is not feasible to mix.

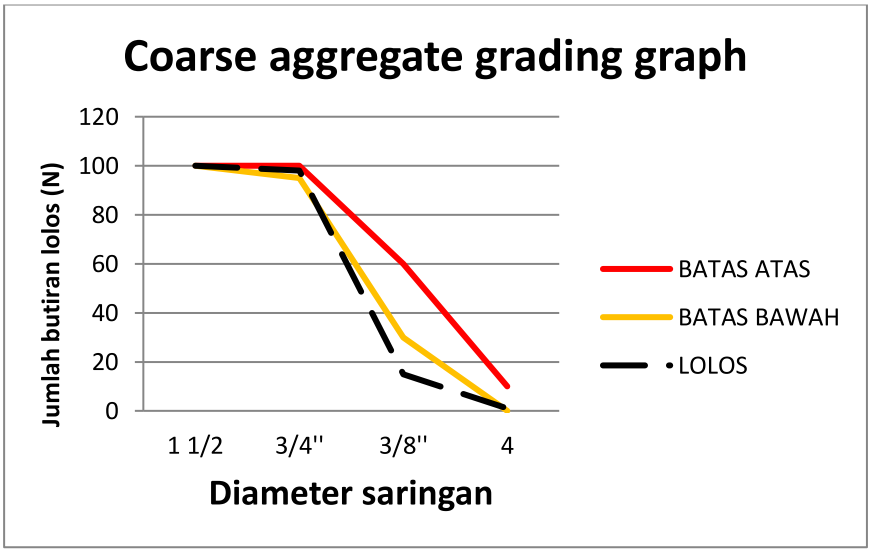

Figure 1.16 Graph of coarse aggregate gradation

From Figure 1.16, a graph of coarse aggregate gradation shows that the 1 1/2" to 3/4" sieve is on the line between the minimum and maximum limits, meaning that the aggregate is suitable for mixing. And for No. 3/8, No. 4 sieves. No. 8, No. 16, No. 30, No. 50, No. 100, which is outside the minimum and maximum limits, which means it is not feasible to mix.

Specific gravity and water absorption of coarse and fine aggregate

Inspection of specific gravity and water absorption on average was carried out twice, namely sample 1 and sample II. For the specific gravity of coarse aggregate, it is done by taking an average dry sample weighing 2500.0 grams (Apparent Specific Gravity), the next stage the material is washed with running water (Bulk Specific Gravity on Dry Basik), after that the sample is left to stand until a sample is obtained. in a state that is not dry and not wet (Bulk Specific Gravity on SSD Basik) after that the sample is weighed, the next step is to put the sample into the water to get the weight of the test object in the water. More details can be seen in the attachment.

For the specific gravity of fine aggregate, it is done by weighing the weight of the pycno, after that the sample is taken weighing 5000.0 grams, the fine aggregate is taken and put into the pycno and then weighed, the next stage of the pycno which contains the sample is put water as needed and weighed, pykno containing the sample and water and then in the oven (± 105°C) to dry and then weighed again (Prosentage Water Absorption). For more details, see the attachment.

Table 4.3 Average density and absorption of coarse and fine aggregates

PARAMETER	AVERAGE GRAVITY AND ABSORPTION	
	FINE AGGREGATE	RUDE AGGREGATE
Apparent Specific Grafity	2.65	3.04
Bulk Specific Gravity on Dry Basic	2.60	2.93
Bulk Specific Gravity on SSD Basic	2.62	2.96
PercentageWaterAbsorbtion	0.76	1.26

(Source: 2022 test results)

Information:

Apparent Specific Gravity =apparent density
Bulk Specific Gravity on Dry Basik =bulk density
Bulk Specific Gravity on SSD Basik =bJ saturated surface dry
Percentage Water Absorption =absorption

Coarse and fine aggregate slurry content.

From the results of the examination of the levels of sand mud (fine aggregate) obtained mud content of 14.6 grams to 14.7 grams in 2 samples with an average weight of 607.7 grams to 658.4 grams in a state before washing, and examination of the levels of crushed stone mud (aggregate) coarse) 12.3 grams to 13.4 grams in the state of the sample before washing with a weight of 200.0 to 2000.9 grams of each sample. while the organic matter content in both aggregates is slightly less than the maximum required amount. The complete results of inspection and testing of crushed stone and sand mud levels can be seen in the appendix.

Density of fine aggregate (sand) and coarse aggregate (crushed stone)

This inspection is carried out in 2 stages, namely the loose state and the solid state at this stage, three tests are carried out, the process carried out is weighing the mold (mold), then for samples that are in a loose state the material is only inserted and weighed, while the sample is in a solid state. 3 layers were inserted in each layer, they were hit 25 times, then weighed. The results of the inspection are in the appendix.

Coarse and Fine Aggregate Moisture Content

The inspection of the moisture content of these two types of aggregates each has a standard (ASTM) of water content. For standard coarse aggregate, the water content is 0.5% - 2.0%, while for fine aggregate the standard moisture content is 3% - 5%. With the process of the cup, the weight must be known then the cup that has been weighed is filled with the sample according to the desired needs, after that it is weighed and put into the oven until it is dry as desired and reweighed in a dry state, each test is carried out 2 times. The results of the inspection of the contents of the two aggregates can be seen in full in the appendix.

Coarse aggregate wear using the LosAngles machine

To determine the strength of coarse aggregate or the value of the wear limit of coarse aggregate using the Los Angeles machine. From this test, the average wear value of coarse aggregate is 12.34%. The results of the complete content inspection can be seen in the appendix.

Slump Concrete

Slump of concrete is carried out when mixing the entire material, where some of the finished material mixture is taken and tested, and the average value obtained is ±7 cm below the pounder.

Concrete Flexural Strength Test Results

The flexural strength test was carried out when the concrete was 28 days old, with 8 specimens, each specimen having a different percentage of metal fiber and an average of 2 specimens for each. The flexural strength test of the beam is carried out using tools such as a compression tension machine with the force gauge brand.

Table 4.4 Flexural strength test value

%	SAMPLE	SAMPLE WEIGHT	FLEXIBLE STRENGTH VALUE
0%	1	29,601 kg	20
	2	29,173 kg	25
2.5%	1	29,751 kg	30
	2	29,331 kg	25
3.0 %	1	30,150 kg	25
	2	30,100 kg	28
3.5 %	1	29,030 kg	23
	2	28,776 kg	20

(Source: 2022 test results)

CLOSING

Conclusion

1. The addition of metal fibers that increased the flexural strength was 2.5% and 3.0% from 0%, while the addition of 3.5% decreased. However, the highest flexural strength value is at 2.5% resulting in a high flexural strength of concrete of 3.85 Mpa Kg/cm³.
2. In concrete testing there is a vertical fracture which means that the load applied to the beam is received directly, but there is a difference in fracture between the two types of concrete where the fiber-free concrete collapses suddenly or breaks overall and the crack pattern that occurs is straight, while for concrete with additional fiber, it slowly collapsed and did not break completely during the test and the crack pattern that occurred was a winding line which means that the fiber added to the concrete affects the flexural strength of the concrete from fracture when the object is tested.

Suggestion

a. There is a need for further research on metal fibers, whether in the form of materials, types of sizes and the percentage value of the metal fibers.
b. It is necessary to find a way or method in metal processing so that it is easy to form into the desired fiber.

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