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The Effect of Asbestos Waste as an Additive to Concrete Mixtures

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ABSTRACT

The purpose of this study was to determine the material characteristics of coarse aggregate, fine aggregate and asbestos waste and to determine the strength value of concrete. The choice of using concrete construction takes into account the availability of materials in the area, the price is relatively cheap, has strength and is resistant to environmental conditions. In the current technological era, mixing materials to make a concrete structure can be done by looking for substitute materials or additional materials to produce a strong and resistant concrete mix by utilizing waste materials found in the surrounding environment. One of the wastes that can be utilized is asbestos waste, this is because there are quite a lot of asbestos wastes available and there are several waste storage areas. To produce good concrete, a concrete strength test must be carried out so that it produces the desired material in accordance with the Indonesian National Standard (SNI). The results showed that the material characteristics of the sand were black and 0.55–2.5 mm in size, tended to have poor adhesion and high chloride content, while the characteristics of crushed stone varied in size and high hardness. and black and gray, the compressive strength test of asbestos added concrete for 3 days was 42.2 kg/cm2, 7 days 62.1 kg/cm2 and 28 days 75.5 kg/cm2.

Keywords: *Crushed stone material, sand, asbestos waste*

1. Introduction

Concrete is a structural material that is generally used in construction and its use increases every year along with the development of a region. The choice of using concrete construction takes into account the availability of materials in the area, the price is relatively cheap, has strength and is resistant to environmental conditions. In the current technological era, mixing materials to make a concrete structure can be done by looking for substitute materials or additional materials to produce a strong and resistant concrete mixture by utilizing waste materials found in the surrounding environment. Waste material as a mixture or substitute for coarse or fine concrete mixtures.

To produce good concrete, concrete strength tests must be carried out to produce the desired material in accordance with Indonesian national standards (SNI). Concrete according to SNI-03-2847-2002 is a mixture of Portland cement or hydraulic cement, fine aggregate, coarse aggregate and water, with or without additional ingredients that form a solid mass. The hardening process in concrete occurs due to a chemical reaction between water and cement which continues over time. Increasing the age of the concrete will make the concrete harden further and will reach design strength (fc') at the age of 28 days (Tjokrodimuljo, 1996). Concrete in the field of roads and bridges can be used to make roads, bridges and culverts. Concrete is used in almost all construction (Limbong, 2014). Research carried out by Hendra Alexander and Mukhlis (2011) used coconut fiber ash waste as a substitute or additional material.

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The research results show that the addition of coconut fiber ash with certain optimal levels to the concrete mixture can produce higher compressive strength. In general, according to the Indonesian national standard (SNI-03-2847-2002), the components of concrete material consist of cement, sand (fine aggregate), gravel/crushed stone (coarse aggregate) and water. The size and technical specifications of orggregate as a building material for concrete must comply with the provisions in SNI-03-2847-2002.

One of the wastes that can be used is asbestos waste, this is because there is quite a lot of asbestos waste available and several rubbish storage sites have been found and one of the impacts of this asbestos waste is that it is very dangerous for health. Based on the background above, the aim of this research is to determine the material characteristics of coarse aggregate, fine aggregate and asbestos waste and determine the strength value of concrete.

2. Methods

This research uses a quantitative method, namely experimental research which aims to find a causal relationship (causal relationship) between two factors that were deliberately created by the researcher by eliminating or reducing or setting aside other factors that interfere with Arikunto (2006). The type of data that will be used in this research is primary data obtained from the results of checking the aggregate characteristics of the concrete mixture and the results of concrete strength tests in the laboratory which were carried out in various stages as follows:

Material Preparation

Before the implementation begins, the first thing to do is prepare the materials, the main materials that will be used in research in the laboratory. To make concrete, with the original ingredients, namely: cement, water, gravel aggregate, sand aggregate and asbestos waste as additional ingredients for coarse aggregate.

1. Cement: what will be used is Tonasa cement
2. Clean water in the Civil Engineering laboratory at Muhammadiyah University of Buton
3. Gravel aggregate: what will be used is taken from Wakoko
4. Sand aggregate: what will be used is sand taken from Wakoko
5. Asbestos waste: collected directly from the Siontapina area

Equipment Preparation

The equipment used for making test objects and examining materials in research consists of:

1. Mold the cylindrical test object measuring 15cm x 30cm.
2. Concrete mixer, which functions to mix aggregates or concrete-forming materials.
3. Sieve, particulate separator based on particle size.
4. Digital scales, with an accuracy of 0.1 gram.
5. Pycnometer
6. Collider
7. Drying oven, temperature 220 c
8. Additional equipment: bucket, shovel, spoon, meter and level.
9. Compression machine for testing concrete compressive strength.

Mixture Composition

The research carried out was by making samples of concrete specimens measuring 15cm x 30cm. The materials used in making concrete consisted of Portland cement type 1 (PC) brand "Tonasa", sand, gravel and asbestos waste. The concrete made in this study consisted of 3 samples, the composition of the aggregate planning mixture for making concrete for each sample was 180 liters of water, 310 kg cement, 1-260 kg sand, and 1010 kg gravel. The quality of concrete used is K200. Based on SNI, quality K200 is a concrete construction that can be used to accept compressive loads of up to 200kg/m3.

Table 1. Mix Design Plan

Concrete Material	Heavy/M³ Concrete (Kg)	Ratio to the amount of cement	Weight for 1 sample (Kg)	Weight for 5 sample (Kg)
Water	215,00	0,66	1,14	6,84
Cement	371,00	0,66	1,97	11,80
Sand	731,00	0,66	3,88	23,25
Gravel	1031,00	0,66	5,47	32,79

Source: SNI DT-91-2007 (Department of Public Works)

Mixing Process

The mixing process in making concrete uses 1/2 dry mix. This means that after the mixture is homogeneous (even), then sprinkle water while stirring. If the mixture in the ball is no longer messy / the ambrolberart can be used, the mixture is ready to be molded.

Printing Process

Once the dough is ready to be molded, prepare a cylindrical mold, then start filling it with the dough that has been prepared little by little and while compacting it using an iron plate as a compactor/pressing tool, once it is solid, add more dough while compacting it until the mold is completely formed. full and even.

Mold Removal Process

Once the mold is full, even and really solid, first tap every corner and top with a hammer, so that the mixture with the mold doesn't stick, then slowly lift the mold from the concrete.

Concrete Compressive Strength Testing

Method for determining the compressive strength of concrete using cylindrical test objects. To carry out a compressive strength test on concrete, the following steps must be followed:

1. Weigh and record the weight of the concrete sample
2. Place the test object on the pressing machine
3. Apply the load until the test object is destroyed and record the maximum load that occurs.
4. Calculate the compressive strength of the test object using the formula:

Compressive strength of concrete (fc') = $\frac{P}{A}$

With understanding;

fc = Concrete Cross-Section Stress

P = Compressive Axial Load

A = Cross-sectional area carrying the load

Table 2. Test objects

Mix Test Object Design	Age (Days)			Number of Samples
	3 Days	7 Days	28 Days	
Concrete uses asbestos waste additives	5	5	5	15
Normal concrete	5	5	5	15
Total number of test objects				**30**

Source: Processed laboratory data

3. Findings and Discussions

Fine Aggregate

Several testing procedures are carried out after testing fine aggregate, including mud content, organic content, water content, absorption volume, specific gravity, and fineness modulus. The test results can be seen in table 3 below.

Table 3. Examination of the Characteristics of Fine Aggregate (Sand)

Aggregate Characteristics	Interval	Observation result	Information
Sludge levels	Max 5 %	10.29%	Not Fulfilling
Organic content	< NO. 3	--	--
Water content	2 % - 5 %	6.90%	Not Fulfilling
Volume weight			
a. Loose condition	1,4 - 1,9 kg/liter	1.05	Not Fulfilling
b. Solid condition	1,4 - 1,9 kg/liter	1.39	Not Fulfilling
Absorpsi	Max 2 %	5.68%	Not Fulfilling
Specific gravity			
a. Bj. real	1,6 - 3,3	2.60	Fulfilling
b. Bj. dry basis	1,6 - 3,3	2.26	Fulfilling
c. Bj. dry surface	1,6 - 3,3	2.39	Fulfilling
Fineness modulus	1,50 - 3,80	1.97	Fulfilling

Source: Results of laboratory data analysis

Based on the data in the table above, it can be seen that the value of the fine aggregate inspection results for Wakoko sand is with a mud content of 10.29%, a water content of 6.90%, with a loose condition that does not meet the observation results of 1.05, while the solid condition is 1.39, which does not meet the standard, according to with the SNI that has been determined, namely 5% water content and 5% mud content so that in this study it is not suitable and does not meet the requirements as a concrete material.

Table 4. Examination of Fine Aggregate (sand) Sieve Analysis

Filter Number	Suspended Weight	Percent Retained	Persen Kum. Stuck	Persen Kum. Get away
Mm	gram	%	%	%
1	0.00	0.00	0.00	100.00

¾	0.00	0.00	0.00	100.00
½	0.00	0.00	0.00	100.00
3/8	0.00	0.00	0.00	100.00
4	25.00	1.67	1.67	98.33
8	295.00	19.67	21.33	78.67
16	774.00	51.60	72.93	27.07
30	262.00	17.47	90.40	9.60
50	79.00	5.27	95.67	4.33
100	60.00	4.00	99.67	0.33
PAN	5.00	0.33	100.00	0.00
Amount	1500.00	100.00	481.67	
Fine Modulus			4.82	

Source: Results of laboratory data analysis

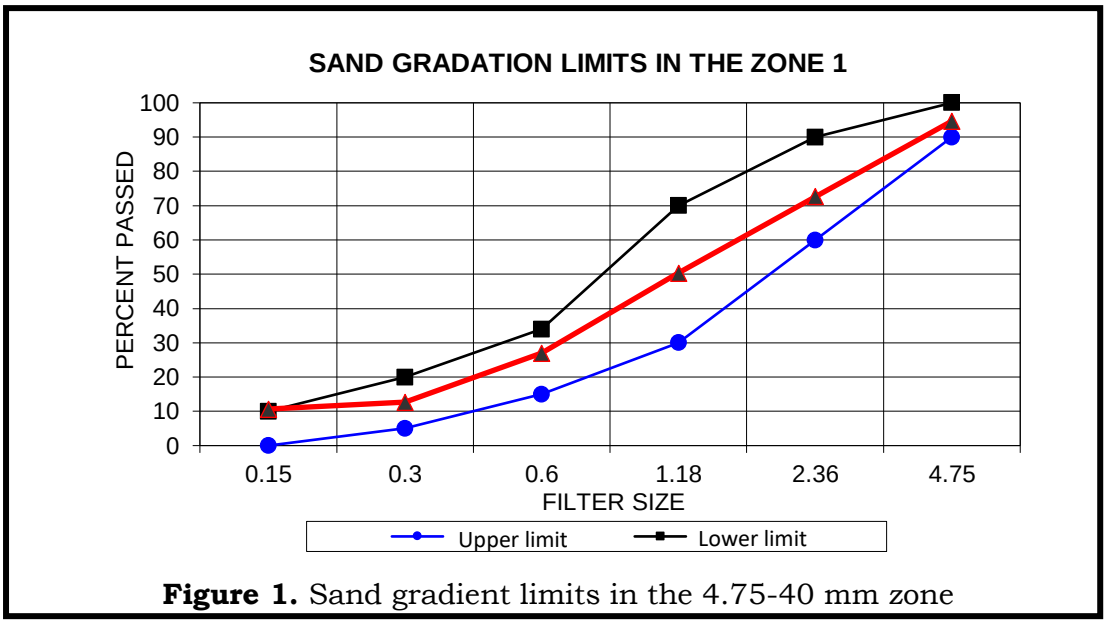

Figure 1. Sand gradient limits in the 4.75-40 mm zone

Based on the data in the table above, namely the results of the Wakoko sand fine aggregate sieve analysis in the inspection process using a set of sieves by looking at sieve holes number 1, 3/4, 1/2, 3/8, 4, 8, 16, 30, 50, 100, and PAN. The average retained weight (gr) with sieve hole number 1 is 0.00 gram, sieve hole number 3/4 is 0.00, sieve hole number 1/2 is 0.00, sieve hole number 3/8 is 0, 00, sieve hole number 4 is 25.00 grams, sieve hole number 8 is 29.00 grams, sieve hole number 16 is 774.00 grams, sieve hole number 30 is 262.00 grams, sieve hole number 50 is 79.00, sieve hole number 100 is 60.00, PAN which is 5.00 grams. The fine aggregate material that is sifted is retained as much as 1500.00 grams of the sieve norm and is known as the weight retained, the cumulative weight retained and the cumulative weight passed through the fine aggregate sieve.

Coarse Aggregate

The results of the examination of the Wakoko coarse aggregate/gravel used in this research can be seen in table 5 below:

Table 5. Examination Of The Characteristics Coarse Aggregate (Crushed Stone)

Aggregate Characteristics	Interval	Observation result	Information
Sludge levels	Maks 1 %	3.62%	Not Fulfilling
Wear and tear	Maks 50 %	-	-
Water content	0,5 % - 2 %	5.17%	Not Fulfilling

Volume weight			
a. Loose condition	1,6 - 1,9 kg/liter	1.65%	Fulfilling
b. Solid condition	1,6 - 1,9 kg/liter	2.29%	Not Fulfilling
Absorption	Maks 4 %	1.63%	Fulfilling
Specific gravity			
a. Bj. real	1,6 - 3,3	2.53	Fulfilling
b. Bj. dry basis	1,6 - 3,3	2.43	Fulfilling
c. Bj. dry surface	1,6 - 3,3	2.47	Fulfilling
Roughness modulus	6,0 - 7,1	6.94	Fulfilling

Source: Results of laboratory data analysis

Based on the data in the table above, you can see the results of the examination of the coarse aggregate of crushed stone in the Wakoko sub-district, namely with a mud content of 3.62%, water content of 5.17%, loose condition of 1.65, solid condition of 2.29%, adsorption of 1.63%, bj. Real 2.53%, bj. dry basis 2.47%, bj. Surface dryness is 2.47%, with a roughness modulus of 6.94%. In accordance with the SNI that has been determined, namely a water content of 0.5% - 2% in this research, which meets the requirements as a concrete material.

Table 6. Examination of Coarse Aggregate Sieve Analysis (Crushed Stone)

Filter Number	Suspended Weight	Percent Retained	Persen Kum. Stuck	Persen Kum. Get away
Mm	**gram**	**%**	**%**	**%**
1 ½”	0,00	0,00	0,00	100,00
1"	95,00	3,96	3,96	96,04
¾	800,00	33,33	37,29	62,71
1/2"	875,00	36,46	73,75	26,25
3/8"	340,00	14,17	87,92	12,08
4	235,00	9,79	97,71	2,29
8	55,00	2,29	100,00	0,00
16	0,00	0,00	100,00	0,00
30	0,00	0,00	100,00	0,00
50	0,00	0,00	100,00	0,00
PAN	0,00	0,00	100,00	0,00

Source: results of laboratory data analysis

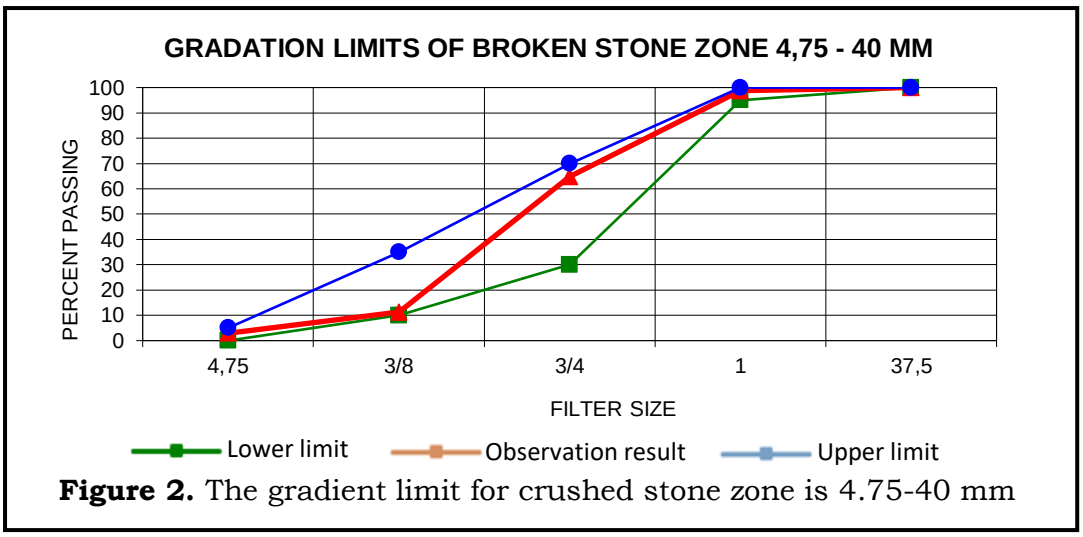

Figure 2. The gradient limit for crushed stone zone is 4.75-40 mm

Based on the table above, the results of the sieve analysis examination of the coarse aggregate (crushed stone from Wakoko Village) fall into the standard aggregate gradation area with a maximum grain of 44mm. results of the coarse aggregate sieve analysis inspection in the inspection process using a sieve that has sieve holes numbered 11/2, 1'', ¾, ½, 3/8, 4, 8, 16, 30, 50, and PAN. Average retained weight (gr) with sieve hole number 1, namely 95.00, and ¾ sieve hole, namely 800.00, and 1/2 sieve hole, namely 875.00, 3/8 sieve hole, namely 340.00, hole sieve 4, namely 235.00, sieve hole number 8, namely 55.00. The coarse aggregate material that is sifted is retained as much as 2400.00 grams from the sieve hole number on the sieve and is known as the weight retained, the cumulative weight retained, and the cumulative weight that passes through the coarse aggregate sieve.

Water

The water used in the laboratory is colorless, odorless, and does not have a particular taste. So it is very good for use in mixing concrete.

Cement

The cement used in this research is cement that is commonly used for concrete construction and is widely available on the market, namely Portland Type I (PCC) Tonasa cement which is produced by the Tonasa cement factory.

Mix Design Results

Table 7. Standards K200 mix design according to SNI

Concrete Material	Heavy/M³ Concrete (Kg)	Ratio to the amount of cement	Weight for 1 sample (Kg)	Weight for 5 sample (Kg)
Water	215,00	0,66	1,14	6,84
Cement	371,00	0,66	1,97	11,80
Sand	731,00	0,66	3,88	23,25
Gravel	1031,00	0,66	5,47	32,79

Source: SNI-03-2847-2002

Based on the table above, you can plan how many kg of water to use, how many kg of cement, how many kg of sand and how many kg of coarse aggregate. Based on the mix design planning, the cement water factor of 0.5 is the weight for each of the 5 samples, namely for water 6.84 kg, cement 11.80 kg, sand 23.25 kg, and coarse aggregate 32.79 kg.

Concrete Slump Value Test Results

Table 8. Slump value of concrete mix

Casting	Point			Average Slump Value (Cm)
	1	2	3	
I	14,00	13,00	12,20	13,07
II	14,30	12,25	13,50	13,35
III	13,00	14,50	13,00	13,67
Average Slump Value				13,36

Source: Results of laboratory data analysis

Compressive Strength Testing

Concrete compression testing is designed to determine the compressive strength of concrete that has been soaked in the laboratory for 3, 7, 28 days. The

test is carried out on one type of FAS, each with four test objects. The cylindrical test object has a diameter of 150 mm and a height of 300 mm. The load is placed on the testing tool until the test object is destroyed and is no longer able to withstand the specified load (pointer stops), this will give the maximum load that the test object can withstand.

Table 9. Test results for concrete compressive strength for 3 days

Age (Days)	Heavy (Kg)	Compressive Strength Reading (Kg)	Wide (cm^2)	FCU (Kg/cm^2)	FCU Average (Kg/cm^2)
3	11,75	13922.272	176,625	78.8	
3	11,60	13310.752	176,625	75.4	
3	11,72	13392.288	176,625	75.8	74,6
3	11,53	12811.344	176,625	72.5	
3	11,50	12413.856	176,625	70.3	

Source: Results of laboratory data analysis

From the table and graph above, it is explained that the compressive strength of concrete at 3 days old with 5 samples averages 74.6 kg/cm^2 and the weight of each sample is 11.75 kg, 11.60 kg, 11.72 kg, 11.35 kg and 11.50 kg. has a concrete compressive strength of 78.8 kg/cm^2, 75.4 kg/cm^2, 75.8 kg/cm^2, 72.5 kg/cm^2, 70, kg/cm^2. And has an average value of 74.6kg/cm^2.

Table 10. Test results for concrete compressive strength for 7 days

Age (Days)	Heavy (Kg)	Compressive Strength Reading (Kg)	Wide (cm^2)	FCU (Kg/cm^2)	FCU Average (Kg/cm^2)
7	11,70	13392.288	176,625	75.8	
7	11,67	13331.136	176,625	75.5	
7	11,73	13830.544	176,625	78.3	75,7
7	11,70	12281.36	176,625	69.5	
7	11,64	14044.576	176,625	79.5	

Source: Results of laboratory data analysis

From the table and graph above, it is clear that the compressive strength of concrete can be seen at the age of 7 days with an average sample of 75.7 kg/cm^2, and the weight of each sample is 11.70 kg, 11.67 kg, 11.73 kg, 11 .70 kg, 11.64 kg, and has a concrete compressive strength of 75.8 kg/cm^2, 75.5 kg/cm^2, 78.3 kg/cm^2, 69.5 $kg/cm^2$79.5 kg/cm^2 and has an average concrete compressive strength value average of 75.7 kg/cm^2.

Table 11. Test results for concrete compressive strength for 28 days

Age (Days)	Heavy (Kg)	Compressive Strength Reading (Kg)	Wide (cm^2)	FCU (Kg/cm^2)	FCU Average (Kg/cm^2)
28	12.25	19252.688	176,625	109.0	
28	12.01	17917.536	176,625	101.4	
28	12.13	16541.616	176,625	93.7	101,2
28	12.04	17214.288	176,625	97.5	
28	11.83	18416.944	176,625	104.3	

Source: Results of laboratory data analysis

From the table and graphic data above, the compressive strength of concrete aged 28 days with 5 samples shows an average of 101.2 kg/cm^2, and the weight of each sample is 12.25kg, 12.01 kg, 12.13 kg, 12.04 kg, 11.83 kg, has a concrete compressive strength of 109.0 kg/cm^2, 101.4 kg/cm^2, 93.7 kg/cm2, 97.5 kg/cm^2, 104.3 kg/cm^2, and has a concrete compressive strength value the average is 101.2 kg/cm^2.

Table 12. Test results for compressive strength of concrete with added asbestos materials for 3 days

Age (Days)	Heavy (Kg)	Compressive Strength Reading (Kg)	Wide (cm^2)	FCU (Kg/cm^2)	FCU Average (Kg/cm^2)
3	10.87	7735.728	176,625	43.8	42,2
3	11.67	7164.976	176,625	40.6	
3	11.73	7919.184	176,625	44.8	
3	11.70	7348.432	176,625	41.6	
3	11.64	7114.016	176,625	40.3	

Source: Laboratory analysis results

From the table above, it is clear that the compressive strength of concrete with added asbestos aged 3 days with 5 samples averages 42.2 kg/cm^2. And the weight of each sample is 10.87 kg, 11.67 kg, 11.73 kg, 11.70 kg, 11.64 kg. has a concrete compressive strength of 43.8 kg/cm^2, 40.6 kg/cm^2, 44.8 kg/cm^2, 41.6kg/cm^2, and 40.3 kg/cm^2, and has an average compressive strength value of 42, 2kg/cm^2.

Table 13. Test results for compressive strength of concrete with added asbestos materials for 7 days

Age (Days)	Heavy (Kg)	Compressive Strength Reading (Kg)	Wide (cm^2)	FCU (Kg/cm^2)	FCU Average (Kg/cm^2)
7	11.41	11578.112	176,625	65.6	62,1
7	11.60	10232.768	176,625	57.9	
7	11.72	10426.416	176,625	59.0	
7	11.53	11231.584	176,625	63.6	
7	11.50	11364.08	176,625	64.3	

Source: Laboratory analysis results

From the table above, it can be seen that the average compressive strength test for concrete with asbestos added at 7 days is 62.1 kg/cm^2. Having sample weights of 11.41 kg, 11.60 kg, 11.72 kg, 11.53 kg, 11.50 kg, respectively. With concrete compressive strengths of 65.6 kg/cm^2, 57.9 kg respectively /cm^2, 59.0 kg/cm^2, 63.6 kg/cm^2, and 64.3 kg/cm^2.

Table 14. Test results for compressive strength of concrete with added asbestos materials for 28 days

Age (Days)	Heavy (Kg)	Compressive Strength Reading (Kg)	Wide (cm^2)	FCU (Kg/cm^2)	FCU Average (Kg/cm^2)
28	11.73	13045.76	176,625	73.9	72,5
28	11.39	14217.84	176,625	80.5	

28	11.60	11955.216	176,625	67.7
28	12.01	12475.008	176,625	70.6
28	11.72	12311.936	176,625	69.7

Source: Laboratory analysis results

From the table above, it can be seen that the average compressive strength test for concrete with added asbestos at 28 days is 72.5 kg/cm^2. Each sample weighs 11.73 kg, 11.39 kg, 11.60 kg, 12.01 kg, 11.72 kg, with concrete compressive strength of 73.9 kg/cm^2, 80.5 kg/ cm^2, 67.7 kg/cm^2, 70.6 kg/cm^2, 69.7 kg/cm^2.

Table 15. Average compressive strength test results for asbestos-added concrete

Compressive Strength of Asbestos Concrete		
3 Days Asbestos	7 Days of Asbestos	28 Asbestos Day
42.2	62.1	72.5

Based on the results of concrete tests using 1.5% asbestos additives, the compressive strength value at 3 days was 42.2kg/cm^2, at 7 days was 62.1kg/cm^2, and at 28 days was 72.5kg/cm^2. Looking at the graphic above, it can be concluded that concrete that uses asbestos waste additives cannot reach the quality of concrete based on SNI.

4. Conclusion

Based on the results of examining the characteristics of concrete materials and compressive strength tests of concrete using asbestos additives, the following conclusions were obtained:

1. The characteristics of the sand material are black in color and have a size of 0.55–2.5 mm, adhesion tends to be poor and the chloride content is quite high, while the characteristics of crushed stone vary in size, high level of hardness and are black and gray in color.
2. Compressive strength of concrete with asbestos added 3 days 42.2 kg/cm^2, 7 days 62.1 kg/cm^2 and 28 days 75.5 kg/cm^2.

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