Influence of fine aggregate types for the achievement of concrete quality

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Abstract. Fine aggregates in the form of sand are granulated materials, which generally measure between 0.0625 to 2 millimeters. Sand as a fine aggregate mixed with cement and water becomes a concrete mixture that has a role in the strength of construction. This study aims to determine how much influence the fine aggregates or sand of four different mining sites have on the compressive strength of concrete. The method used is an experiment, based on the results of laboratory tests of compressive strength tests at the age of concrete 7, 14 and 28 days for fc'25 or 25 MPa quality concrete with a mix of designs for fine aggregates from Leles sand, Kuyamut sand, Cikamiri sand, and Cilopang sand, Garut Regency West Java Province Indonesia. The aggregates tested include moisture content, sludge content, organic content, dry saturation, waand ter absorption affects the quality of concrete and improves quality strength with the same treatment for laboratory testing. The results of the analysis with 28 days of concrete compressive strength testing obtained the achievement of the highest concrete strength, namely with Cilopang sand 27 MPa, allowed by Kuyamut sand 26 Mpa, Leles sand 25 MPa and Cikamiri sand 23 MPa. Based on the results of concrete strength testing for up to 28 days, there are three sources of fine aggregates that can reach a minimum of fc' 25, and there is one sand source that has a compressive strength value of concrete.

1 Introduction

Concrete is a mixture formed in a solid mass, consisting of fine and coarse aggregates, portland cement, and water with or without added materials [1]. The use of aggregates must be by the requirements to achieve better concrete quality because the aggregate composition reaches 65-75% of the total volume of concrete [2]. The role of aggregates in the manufacture and quality of concrete is very influential [3], with the property of having the strength of disintegration and resistance to impact to affect the bond between the cement paste, porosity, and water absorption characteristics [4,5]. It is influenced also by the type or source of aggregates used [6].

The sludge content can affect the compressive strength of concrete, where the less mud content in concrete, the greater the specific gravity and the maximum compressive strength of concrete [7]. Aggregate material has sludge content, moisture content, organic content, hardness index, water absorption, and face dry saturation that will affect the strength of

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concrete [8]. Fine aggregates function to fill the pores between coarse aggregates to minimize the air content in the concrete mixture so as not to reduce the strength of concrete due to the gradation and uniformity of the aggregate.

Concrete with excess sludge content results in reduced binding strength and not maximum construction strength [9]. Sludge has direct contact with water through the pores of concrete when the concrete hardens it will expand or shrink in the concrete and over a long-time result in the concrete becoming weak. Incompatibility of organic levels can reduce the strength of concrete and excess organic content will damage the strength of concrete [10–12], especially organic content in fine aggregate materials or sand. The addition of water affects porosity and absorption in concrete [4,13] so as not to degrade the strength of concrete [14].

The compressive strength of concrete is the magnitude of the load per unit area loaded on the concrete with a certain compressive force until the concrete test object is destroyed using a press machine [15,16]. As the age increases, the concrete hardens and its strength increases until it reaches the strength of the plan [17,18]. The influence of aggregate and concrete life largely determines the strength of the quality of concrete [19]. Research on the influence of fine aggregates as concrete mixture materials in several sand mining in Garut Regency, West Java Province has not been carried out, so it is necessary to determine how influential fine aggregates from several aggregate sources are so that the quality of concrete is as expected.

2 Methods

Laboratory research conducted includes material tests on coarse aggregate concrete materials and fine aggregates. Fine aggregates use Leles sand, Kuyamut sand, Cikamiri river sand, and Cilopang sand. In the test, a mix design of the initial concrete design with quality fc'25 MPa was made with concrete test objects guided by the SK. SNI-03-2847-2002.

The test objects were made of 15 cylindrical samples with a height of 30 cm and a diameter of 15 cm for each sand mine. A total of 60 test objects were made. Furthermore, compressive strength tests were carried out at the age of concrete 7, 14, and 28 days after treatment by soaking water according to the age of the plan.

Background the research Aggregate is a material affecting the strength of concrete, so the content contained in the aggregate must be by the requirements. Study Objectives to know the fact known affects the quality of concrete quality of fine aggregate materials and how much they affect the strength of concrete with 4 different mining sites. Guidelines and standards used include SNI-03-2847-2002, SNI-03-1972-1990, ASTM-C127, SNI-03-2834-2000, ASTM-C-117, ASTM-C-40, SNI-03-1974-1990, ASTM-C-128, ASTM-C33-90, SNI-02-1968-1990, ASTM-C-556, and ASTM-C29

The analysis was performed on mix concrete design, fresh concrete slump value, the proportion of the mixture weight of fresh concrete contents, and concrete quality. Results to be achieved about the strength of concrete are influenced by the quality of the material, including fine aggregates related to sludge content, moisture content, organic content, absorption, facial dry saturation, hardness, and reactive alkali must be up to standard to achieve the increase in strength to be achieved.

3 Results

Laboratory testing for the examination of coarse aggregate materials and fine aggregates that meet the specifications is made as concrete mixture materials. The results of the laboratory examination of aggregate materials can be seen in Table 1.

Table 1. Aggregate laboratory test results.

Types of Tests	Test Results Aggregates					Standard Testing	
	Gravel	**Sand Kuyamut**	**Sand Leles**	**Sand Cilopang**	**Sand Cikamiri**	**Gravel**	**Sand**
Dropsy Volume Weight (kg/ltr)	1,32	1,48	1,53	1,29	1,23	1,6-1,9	1,4-1,9
Solid Volume Weight (kg/ltr)	1,81	1,92	1,94	1,88	1,52		
Moisture Content (%)	3,23	5,49	4,34	5,10	6,85	0,5-2,0	3-5
Bulk Specific Gravity	2,2	2,38	2,33	2,44	2,13		2,4
Infiltration (%)	3,1	10	8	10	18	0,2-4,0	0,2-2,0
Sludge Content (%)		8,4	6,8	2,8	2,3		0,2-6
Organic Levels (color)		No.3	No.3	No.2	No.4		< No.3

Aggregate gradation implementation was tested on fine aggregates and coarse aggregates with sieve analysis as aggregate gradation distribution data in concrete mixture planning. Based on ASTM C33-90, the condition of the cumulative pass test percentage is to be between the upper limit standard and the lower limit of the cumulative percentage of passing the sieve. The graph of the results of the analysis of coarse aggregate sieves is made in gradation curves, which can be seen in Figure 1.

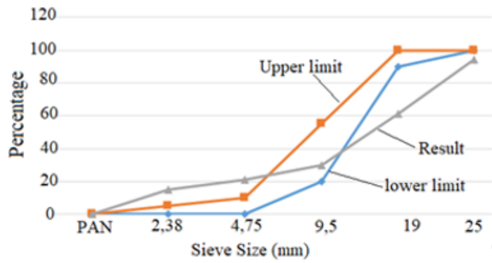

Fig. 1. Coarse aggregate gradation curve.

The graph of the results of the fine aggregate sieve analysis of Cilopang Sand, Cikamiri Sand, Leles Sand, and Kuyamut Sand made in a gradation curve, can be seen in Figure 2.

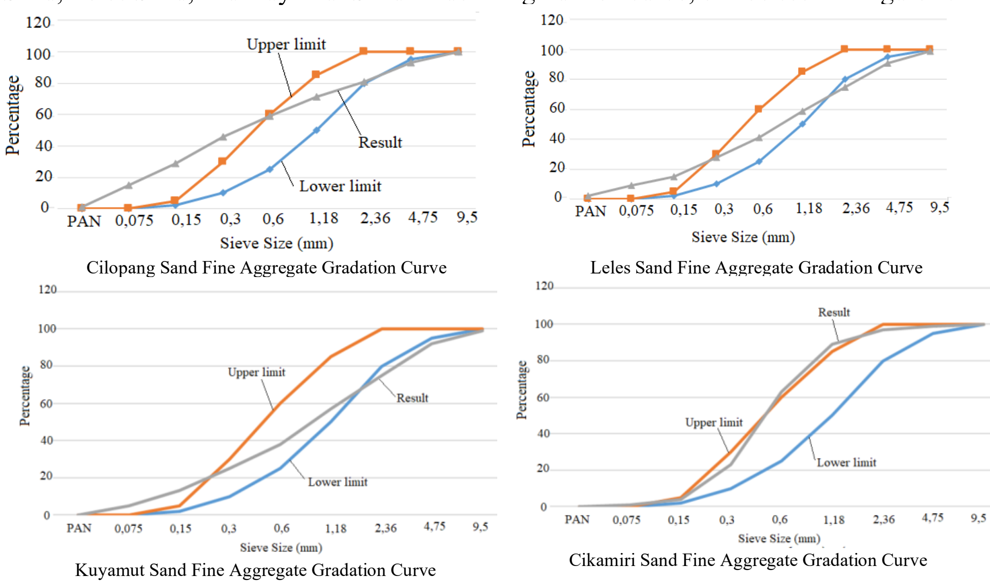

Fig. 2. Smooth aggregate gradation curve.

Figure 2, shows the standards or percentage requirements of the upper limit and lower limit to meet the cumulative pass test of ASTM C33-90. The test was carried out for coarse aggregates that passed sieve number: 100 and retained in sieve number: 200 taken from the test results of 5 kg of coarse aggregate in the laboratory.

A slump value of between 7.5-15 cm is set for structural needs on slabs, beams, and wall columns at FAS 0.55 for outdoor planned concrete needs and a state unprotected from rain and direct sun, at a mixed aggregate specific gravity of 2.302 and a concrete specific gravity of 2.290 kg/m^3. The results of planning the fc'25 MPa concrete mix can be seen in Table 2.

Table 2. Mix concrete design Fc'25 Mpa.

Materials	Necessity	Percentage (%)	Comparison Ratio	Proportion of 1 Test Piece (kg)
Cement	372,73 kg/m^3	17,04	1	1,98
Fine Aggregates	683,94 kg/m^3	31,27	1,83	3,62
Coarse Aggregates	925,33 kg/m^3	42,31	2,48	4,9
Water	205 liter	9,38	0,55	1,09

Testing the strength of hard concrete in determining the mechanical properties of concrete that have been planned with a reference to the quality of concrete 25 MPa, is carried out at the age of 7, 14, and 28 days. The results of the compressive strength of the test object can be seen in Figure 3.

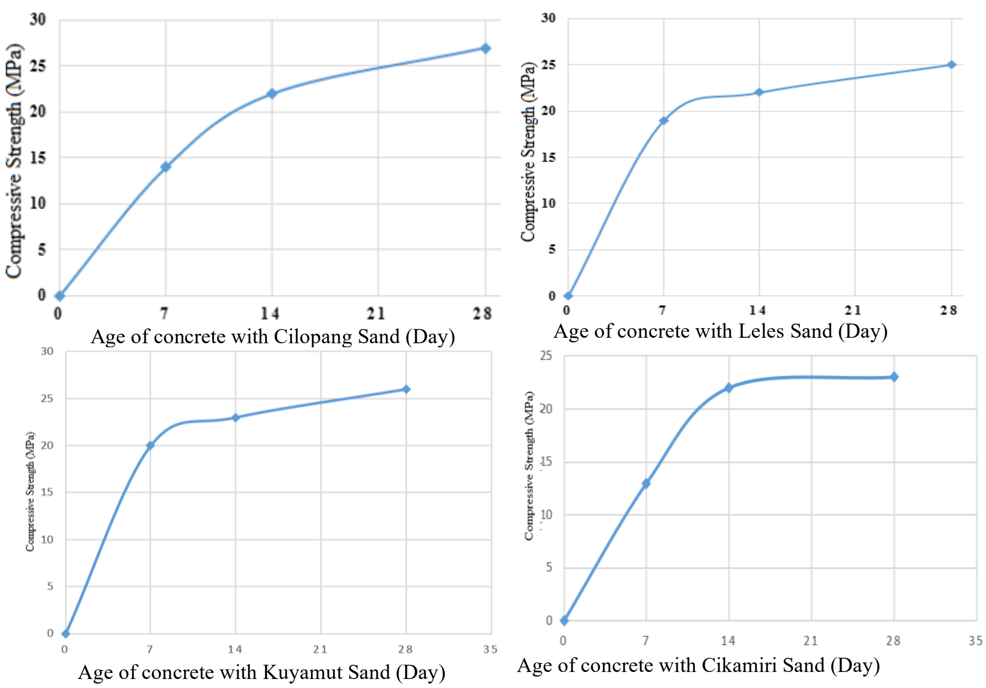

Fig. 3. Graph average compressive strength of concrete.

Figure 3 shows the results of concrete compressive testing in reaching fc'25 MPa based on a certain period. Cikamiri Sand testing in the first week (7 days) obtained an average compressive strength of 13 MPa which is 51% of the desired compressive strength of concrete, in the second week (14 days) an average compressive strength of 20 MPa was produced, which is 78% of the desired compressive strength of concrete and in the fourth week (28 days) an average compressive strength of 23 MPa was produced, which is 92% of the desired compressive strength.

Kuyamut sand first week of the sample had an average compressive strength of 20 MPa which is 81% of the desired compressive strength of concrete, in the second week an average compressive strength of 23 MPa was produced which is 91% of the desired compressive strength of concrete and in the fourth week an average compressive strength of 26 MPa was produced which is 103% of the desired compressive strength. The test results at 28 days have exceeded the achievement of compressive strength by 3% so that Kuyamut sand meets the desired compressive strength of 25 MPa.

4 Discussion

The strength of concrete is greatly influenced by the ratio of the mixed material of concrete. The type of cement material, fine aggregate, coarse aggregate, water, and treatment method as long as the concrete hardens will give its characteristics to the properties and strength of the concrete. In addition, the state of humidity and temperature that occurs during the concrete process is cast until the concrete hardens will affect the strength of the concrete. Therefore, it is necessary to inspect concrete materials, plan concrete mixtures, make test objects, and maintain test objects up to 28 days old. Testing of concrete test objects against compressive strength is carried out according to the stages of the inspection life of 7 days, 14 days, and 28 days.

The aggregate characteristics of the test results for fine and coarse aggregates were obtained below the SNI standard. This is caused by the spread of the aggregate size not according to the criteria so the resulting concrete will have a poor density because there are many empty cavities between the aggregates as filters due to poor aggregate gradation. Poor gradation in fresh concrete affects workability, because it will be more difficult to stir, lift, pour, and compact. With a reduced density, concrete with non-optimal strength will be produced. Cikamiri sand does not meet the desired compressive strength of 25 MPa because at the age of 28 days it has not reached 100%.

Leles sand the first week of the sample had an average compressive strength of 19 MPa i.e. 77% of the desired compressive strength of concrete, in the second week an average compressive strength of 22 MPa was produced which is 88% of the desired compressive strength of concrete and in the fourth week, an average compressive strength of 25 MPa was produced i.e. 100% of the desired compressive strength. The results of the compressive test at the age of 28 days reached 100% so the Leles Sand met the desired compressive strength of 25 MPa.

Cilopang sand in the first week of the sample had an average compressive strength of 14 MPa which is 57% of the desired compressive strength of concrete, in the second week an average compressive strength of 22 MPa was produced, which is 86% of the desired compressive strength of concrete and in the fourth week an average compressive strength of 27 MPa was produced, which is 107% of the desired compressive strength. The test results at 28 days have exceeded the achievement of compressive strength by 7% so that Cilopang Sand meets the desired compressive strength of 25 MPa.

Concrete with Kuyamut sand and Leles sand can achieve strength faster than concrete with Cilopang sand and Cikamiri sand. At the age of 7 days Kuyamut sand and Leles sand can reach a high percentage at 81% and 73% compared to Cilopang sand at 57%, and Cikamiri sand at 51%. This achievement is indicated to be influenced by the moisture content, dry saturation of the face in the SSD state contained in the sand is lower. Thus, the value contained is still far below the maximum requirement.

Different conditions of better gradation variation will allow for a faster increase in quality since the density of concrete is reached faster until the age of 7 days, although after the age of day 7 the increase is relatively the same up to 24 days. The composition of Cilopang Sand and Kuyamut Sand as a whole is qualified except for infiltration at 10%, then on day 24, there is still a significant increase in strength. In another case, Leles Sand and Cikamiri Sand with a composition of several elements that do not meet the specifications occur in water content, infiltration, and organic content, especially from the influence of too much organic content resulting in a reaction between chemicals and certain components of the cement paste that have hardened so that the strength obtained after the concrete hardens becomes slower in achieving the strength of the plan.

The test results of coarse aggregate materials and fine aggregates for Cilopang Sand, Kuyamut Sand, and Leles Sand are feasible to be used as normal concrete mixture materials even though the aggregate size spread is not by the requirements, but to achieve maximum results, the Leles Sand condition needs to be washed by ASTM C-117. Only Cilopang sand that meets all the requirements of the Indonesian National Standard is used as a reference in the design mix.

The use of Cikamiri Sand does not fall within the limits of the plan. The time difference in achieving increased strength is due to the spread of sieve pass aggregates on parts smaller than 0.3 mm to PAN and lower overcharge than other types of sand. However, because the organic content in fine aggregates is quite high, the compressive strength of concrete can increase in rhythm with the increase in concrete hardening which is disturbed due to the reaction of chemical substances with certain components of the hardened cement paste.

5 Conclusion

The test results of coarse aggregate materials and fine aggregates for Cilopang Sand, Kuyamut Sand, and Leles Sand are feasible to be used as normal concrete mixture materials even though the aggregate size spread is not by the requirements, but to achieve maximum results, the Leles Sand condition needs to be washed by ASTM C-117. Only Cilopang sand that meets all the requirements of the Indonesian National Standard is used as a reference in the design mix.

The factors affecting the concrete strength of the aggregate are the spread of aggregate size, maximum sludge content 6%, maximum moisture content 5%, maximum water absorption 2%, organic content should not be too dark under color number 3, hardness index 2.2%, and dry saturated face 2.4. The results of testing the compressive strength of concrete in 28 days with Cilopang Sand reaching 27 MPa, Kuyamut Sand reaching 26 Mpa, Leles Sand reaching 25 Mpa, and Cikamiri Sand 23 MPa.

The use of Cikamiri Sand does not fall within the limits of the plan. The time difference in achieving increased strength is due to the spread of sieve pass aggregates on parts smaller than 0.3 mm to PAN and lower overcharge than other types of sand. However, because the organic content in fine aggregates is quite high, the compressive strength of concrete can increase in rhythm with the increase in concrete hardening which is disturbed due to the reaction of chemical substances with certain components of the hardened cement paste.

Research can be developed by making design mixes according to each aggregate source, where the composition is based on needs. In addition, comparisons can also be analyzed related to the increase in concrete quality strength that occurs per certain period and known factors that affect it.

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