



GRADATION ANALYSIS OF FINE AGGREGATE WITH COMPARISON OF CIMANGKOK SAND, JEBROK SAND, CIPELANG SAND, PELABUHAN RATU SAND IN SUKABUMI

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ABSTRACT

This research report presents a gradation analysis of fine aggregates, a comparison of Cimangkok Sand, Jebrog Sand, River Sand, and Sea Sand in Sukabumi. Fine aggregate gradation analysis is essential in concrete mix design and other construction applications. The purpose of this study was to understand the gradation characteristics and compare the quality of different types of fine aggregates for use in construction. The methodology involves collecting sand samples from various locations in Sukabumi, to ensure a representative sample for each type of sand to be analyzed. Qualitative analysis was conducted to assess cleanliness. The results of qualitative analysis showed that all sand samples met hygiene standards and suitability for fine aggregates. However, there may be variations in physical characteristics depending on the source of sand. Gradation analysis produces a gradation curve for each type of sand. The findings of this study provide information showing that the specific gravity of fine aggregates is within the normal range (2.475 to 2.718), which is in line with the standard for fine aggregates in construction. The fill weight of fine aggregate also meets the requirements, being in the range of 1.416 to 1.740, according to normal concrete standards. However, mud content in sand shows significant variation, with Pelabuhan Ratu Sand having the lowest mud content (2.6%) and Jebrog Sand having the highest mud content (21.8%). This condition corresponds to the requirement that fine aggregate must have a sludge content of less than 5%. The results of the sieve analysis showed that Cimangkok Sand and Jebrog Sand were included in zone 1 (coarse sand) with greater particle distribution variations. Pelabuhan Ratu Sand is included in Zone 4 (fine sand), and Cipelang Sand is also included in Zone 1 (coarse sand). This research provides insight into the characteristics of fine aggregates from different types of sand in Sukabumi and how these characteristics can affect the quality of construction materials. The results of this study are expected to help construction professionals in selecting suitable sand for various types of construction projects, including concrete, asphalt, and others.

Keywords— Gradation Analysis, Fine Aggregate, Cimangkok sand, Jebrog sand, Cipelang sand, Pelabuhan Ratu sand.

I. INTRODUCTION

Fine aggregates are natural mineral grains that function as fillers in mixtures or concrete. The aggregate used in the concrete mixture can be either natural aggregate or artificial aggregate in that the gradation characteristics of fine aggregate have an important role in determining the mechanical and functional properties of concrete. Therefore, research on fine aggregate gradation becomes very relevant to understanding the quality of construction materials[1]. Sand has a crucial role in the construction industry, used to mix materials such as concrete, asphalt, and mortar. One important factor in determining the quality of construction materials is the gradation of sand, that is, the particle size distribution in it[2]. Therefore, research on fine aggregate gradation becomes very relevant to understanding its impact on the quality of construction materials.

In the Sukabumi region, there are several natural sand sources that are commonly used in construction, such as Cimangkok Sand, Jebrog Sand, Cipelang Sand, and Pelabuhan Ratu Sand. By comparing the gradation differences of different sand sources, we can identify variants that might affect the strength, durability, and overall performance of concrete [3]. The quality of this material is greatly influenced by sand gradation, that is, the particle size distribution in the sand itself. Each sand mining site has different gradation characteristics, even within the same area. In analyzing the gradation of fine aggregates of different types of sand from different locations to understand variations in sand characteristics. Therefore, this study aims to comprehensively analyze the gradation of fine aggregate from Cimangkok Sand, Jebrog sand, Cipelang sand, and Pelabuhan Ratu sand in Sukabumi[4]. According to previous research, it has been shown that aggregate gradation characteristics have a significant influence on the performance of the asphalt concrete mixture. The study confirms that optimal aggregate gradation plays an important role in determining the properties of asphalt concrete mixtures, such as

strength and resistance to pressure and use. Therefore, the selection of fine aggregate with appropriate gradation is key in designing a high-quality asphalt concrete mixture[5].

In the context of this study, understanding the characteristics of sand from various sources in Sukabumi will provide a solid foundation for choosing the most suitable sand for making concrete which in turn will affect mechanical properties(6). Thus, this research will provide valuable guidance for construction professionals in selecting sand that suits the needs of their construction projects[7]. This research will more specifically answer a number of important questions that are the main focus. First, we will analyze the gradation characteristics of fine aggregate from Cimangkok sand, Jebrog sand, Cipelang sand, and Pelabuhan Ratu sand. because the gradation characteristics of sand affect the material properties of construction, including concrete and asphalt mixture[8].

Then, the study will also look for differences in particle size distribution between each of the existing sand types. This will provide insight into the variations that may exist between the various sand sources in Sukabumi. This variability has a significant impact on the selection of the most appropriate type of sand for a particular construction project. In addition, differences in particle size distribution can also affect properties such as workability and compressive strength of concrete[9]. Thus, this study will provide valuable guidance for construction professionals in the selection of sand aggregates that suit their project needs. in this study will focus on each type of fine aggregate (sand) that will be used to make concrete and take the title of gradation analysis of fine aggregate with the ratio of cimangkok sand, jebrog sand, ceiling sand river sand, The sand of Pelabuhan Ratu is loved[10].

II. RESEARCH METHODS

A. Literature Study

The fine aggregates used in this study came from different locations, namely Cimangkok sand, Jebrog sand, Pelabuhan Ratu sand, and Cipelang sand all came from Sukabumi. Inspections carried out on fine aggregates include specific gravity and water absorption tests of fine aggregates, fine aggregate sieve analysis tests, fine aggregate content weight tests and filter no.200 pass tests (sludge content test in sand)[11].

B. Research Design

The research design is a plan for the study of test objects with a comparison of different types of fine exaggeration (sand). There are 4 types of fine aggregate (sand) used, namely Cimangkok Sand, Jebrog Sand, Cipelang River Sand, and Pelabuhan Ratu Sand. The research used is testing the specific gravity and water absorption of fine aggregates, testing the weight of fine aggregate content, testing sludge content, and testing filter analysis.

C. Preparation of Tools and Materials

The preparation of this test is to prepare the materials and tools that will be used for research. The preparation of the tools used is a tool from the Concrete Laboratory of Nusaputra University.

The equipment to be used in this research includes:

- 1) ASTM Sieve
A set of ASTM sieves is used to measure gravel distribution/gradation and fly ash filtration.
- 2) Analytical balances
A 2600 gr analytical balance is used to determine the weight of materials (cement, fine aggregate, coarse aggregate) during materials testing
- 3) Vibrating device (sieve shaker)

A sieve shaker is used to vibrate the fine aggregate inside the ASTM sieve. This tool makes work easier than manual vibration.

- 4) Pycnometer 100 cc
Used as a place for fine aggregate dosing when material testing. A 100 cc pycnometer is used during sand-specific gravity testing.
- 5) Oven
The oven is used to dry the fine aggregate used in material testing, so that the fine aggregate does not contain water. Ovens are used in testing humidity, infiltration water, and aggregate cleanliness against sludge in a dry way.
- 6) Pan
Used as a place for fine aggregate at the time of weighing and ovening in tests.
- 7) Decapitated Cone
Used as a place for fine aggregate dosing when material testing. A 100 cc pycnometer is used during sand-specific gravity testing.
- 8) Temperature measurement with reading accuracy of 1°C
- 9) Greetings
- 10) Shovel
Shovels are used as a tool for picking up fine aggregates.

The preparation of materials used in this study includes:

- 1) Fine Argegat (Sand)
In this study, fine argeate was used there were 4 different types of sand.
 - a) Cimangkok Sand
 - b) Jebrog Sand
 - c) Cipelang River Sand
 - a) Pelabuhan Ratu Sand
- 2) Water
The water used in the study was taken from a clean water network from the Laboratory of the Department of Civil Engineering, Nusaputra University.

D. Fine Aggregate Testing

1. Specific Gravity and Water Absorption Testing of Fine Aggregates
This test is carried out to determine the weight of fine aggregate under conditions of dry bulk, apparent bulk, and surface dry. The dry state of the surface can be seen by lifting the cone stuck, if it collapses but is still imprinted then the aggregate can be known to be surface dry. This test refers to SNI1970:2008 on Specific Gravity and Water Absorption Testing of Fine Aggregates.
2. Fine Aggregate Fill Weight Testing
Weight testing of fine aggregate content in this study was carried out to determine the proportions of fine aggregate used.
3. Sludge Testing
Testing of fine aggregate sludge content in this study was carried out to find out that the sludge content was not more than 5%. This test refers to SNI 03-4142 1996 concerning Testing the Amount of Material in Aggregates that Pass Sieve No. 200 (0.075 mm). Mud is a mixture of water or semiliquid between water and soil. "Mud" occurs when the soil is wet. Geologically, mud is a mixture of water silt, and clay deposits. The past deposits hardened over some time into sedimentary rock. According to the standard of SK SNI S-04-1998-F, fine aggregate for building materials should not contain a sludge content of more than 5%.
4. Sieve Analysis Testing
Fine aggregate sieve analysis testing in this study was carried out to determine the gradation of materials in the

form of aggregates and meet the particle distribution size in accordance with the requirements of usable specifications. This test refers to SNI 03-1968 1990 concerning Sieve Analysis Testing of Fine and Coarse Aggregates.

III. RESULTS AND DISCUSSION

A. Fine Argegat Research Analysis

The fine aggregates used in this study came from different locations, namely Cimangkok sand, jebrog sand, Pelabuhan Ratu sand, and Cipelang sand all came from Sukabumi. Inspections carried out on fine aggregates include specific gravity and water absorption tests of fine aggregates, fine aggregate sieve analysis tests, fine aggregate content weight tests and filter no.200 pass tests (sludge content test in sand).

1. Specific Gravity and Absorbency Testing of Fine Aggregate
Specific gravity and water absorption tests of fine aggregates were carried out and analyzed based on SNI 03-1970-1990. The test results can be seen in Table 1 as follows.

Table 1. Specific Gravity and Absorbency Test Results of Fine Aggregate

descripti on	result 1				average			
	cim ang kok san d	jeb ro sa nd	sand pelab uhan ratu	cip ela ng san d	cim ang kok san d	jeb ro sa nd	sand pelab uhan ratu	cip ela ng san d
dry sand weight (S)	500	500	500	500	500	500	500	500
pycnometer weight+ water (B)	690	690	690	690	690	690	690	690
pycnometer+weight+water +sand (C)	988	1003	1004	1000	1003	1003	1006	1000
specific gravity of sand (SSD)	2.475	2.674	2.688	2.632	2.475	2.674	2.718	2.632

The results of the specific gravity and water absorption test in table 1 can be seen the specific gravity value of sand (SSD) of 2,475 Cimangkok Sand, 2,674 Jebrog Sand, 2,718 Pelabuhan Ratu Sand and 2,632 Cipelang Sand of all types of sand that has the greatest specific gravity is Pelabuhan Ratu Sand of 2,718. According to Tjokrodimaljo (1992) a normal aggregate specific gravity is between 2.5-2.7 so the fine aggregate used in the study included the normal aggregate specific gravity.

2. Fine Aggregate Fill Weight Testing
Implementation of weight testing of fine aggregate contents using SNI 03-4804-1998 method. The results of the content weight test can be seen in Table 2.

Table 2. Fine Argegat Content Weight Test Results

No	Types of Sand	Sand Weight (S)	Weight of Dry Sand Oven (A)	Water Absorption
		gram (g)	gram (g)	((S-A)/A)x100%
1	Cimangkok Sand	500	484	3,306
2	Jebrog Sand	500	488	2,459
3	Pelabuhan Ratu Sand	500	500	0,000
4	Pasir Cipelang	500	492	1,626

The results of the content weight test in Table 4.2 can be seen in the value of the weight of the sand content of 1,740 for Pasir Cimangkok, 1,540 for Pasir Jebrog, 1,680 for Pasir Pelabuhan Ratu and 1,416 for Pasir Cipelang. Of all the types of sand, the largest weight is the Cimangkok Sand of 1,740. The fill weight on fine aggregate required in normal concrete ranges from 1.5 to 1.8. So that the weight of the fine aggregate content used has met the requirements.

3. Testing Passes Filter No. 200 (Test of Mud Content in Sand)
The test passed filter no.200 (mud content test in sand) and was carried out using the method from SNI 03-4142-1996. The test results of passing filter no. 200 can be seen in Table 3.

Table 3. Test Results Pass Filter

No	Types of Sand	Original Sand Weight (B1)	Sand Weight After Washing (B2)	Sludge content
		gram (g)	gram (g)	(B1-B2)/B1 × 100%
1	Sand bowl	500	406	18,8
2	Jebrog sand	500	391	21,8
3	Queen port sand	500	487	2,6
4	Cipelang sand	500	435	13

Based on the test results of passing filter no.200, an average mud content value of 18.8% for Pasir Cimangkok, 21.8% for Pasir Jebrog, 2.6 for Pasir Pelabuhan Ratu, 13% for Pasir Cipelang. According to SNI 03-4428-1997 fine aggregate can be used for building materials that have a mud content of not more than 5%, so that it meets the sand that meets the requirements, namely Pelabuhan Ratu Sand of 2.6%.

4. Fine Argegat Sieve Testing
In the British Standard (BS) a gradation condition is given for sand where the roughness of sand is divided into four zones according to its gradation, namely coarse sand (zone 1), slightly coarse (zone 2), slightly fine (zone 3), and fine (zone 4). In SK SNI S-04-1989-F it is stated that fine aggregates have a large variety of grains (gradation) good, so that the cavity is small and has a fineness modulus between 1.5 to 3.8 and when sifted with the sieve arrangement that is continued, must enter one of the grain arrangement areas according to zones 1, 2, 3, or 4 as in Table 4.

Table 4. Table of Gradation of Fine Aggregates According to SNI

Diameter	Rough (Zone 1)		medium (zone 2)		rather smooth (zone 3)		smooth (zone 4)	
	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit
(mm)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
9,5	100	100	100	100	100	100	100	100
4,75	100	90	100	90	100	90	100	95
2,38	95	60	100	75	100	80	100	95
1,19	70	30	90	55	100	75	100	90
0,59	34	15	59	35	79	60	100	80
0,297	20	5	30	8	40	12	50	15
0,149	10	0	10	0	10	0	15	0

Sieve analysis testing on this fine aggregate uses cimangkok sand, jebrog sand, Pelabuhan ratu sand, and cipelang sand.

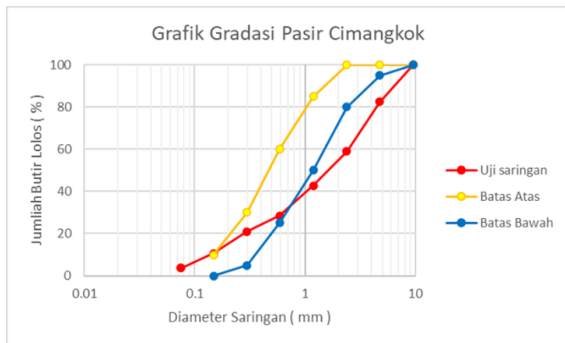


Figure 1. Analysis of Cimangkok Sand Filter

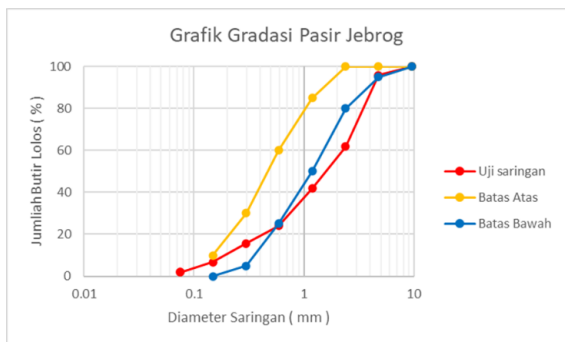


Figure 2. Jebrog Sand Sieve Analysis

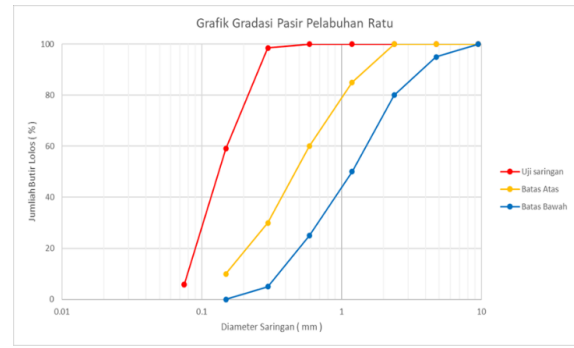


Figure 3. Pelabuhan Ratu Sand Filter Analysis

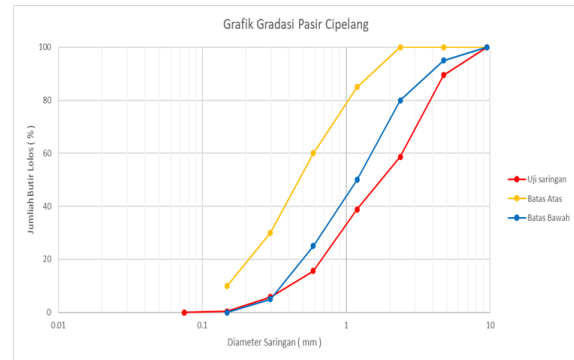


Figure 4. Analysis of the Sand Filter of Cipelang Port

Based on the graphic image above which is a fine aggregate sieve analysis graph, the percent escape from the fine aggregate is already between the maximum and minimum gradation boundary lines, so that curves with various gradations starting from Cimangkok Sand can be seen Figure 4.1 with the percentage of cumulative pass of the filter 4.75 mm = 82.5%, filter 2.36 mm = 58.9%, filter 1.19 mm = 42.8%, 0.60 mm filter = 28.5%, 0.30 mm filter = 20.9%, 0.15 mm filter = 10.6% and 0.08 mm filter = 3.7%. The results of fine aggregate gradation show that cimangkok sand is included in zone 1, namely coarse sand.

Jebrog sand can be seen in Figure 4.2 with the percentage of cumulative pass of sieve 9.5 mm = 100%, sieve 4.75 mm = 96%, sieve 2.36 mm = 61.8%, sieve 1.19 mm = 41.8%, sieve 0.60 mm = 24%, sieve 0.30 mm = 15.7%, sieve 0.15 mm = 6.7% and sieve 0.08 mm = 1.9%. The results of fine aggregate gradation show that cimangkok sand is included in zone 1, namely coarse sand.

Pelabuhan Ratu sand can be seen in Figure 4.3 with the percentage of cumulative pass sieve 9.5 mm = 100%, filter 4.75 mm = 100%, filter 2.36 mm = 100%, sieve 1.19 mm = 100%, sieve 0.60 mm = 100%, sieve 0.30 mm = 98.5%, filter 0.15 mm = 59.1% and filter 0.08 mm = 5.9%. The results of fine aggregate gradation show that cimangkok sand is included in zone 4, namely fine sand.

Cipelang sand can be seen in Figure 4.4 with the percentage of cumulative pass of 9.5 mm = 100% sieve, 4.75 mm filter = 89.5%, 2.36 mm filter = 58.7%, 1.19 mm filter = 38.8%, 0.60 mm filter = 15.6%, 0.30 mm filter = 5.8%, 0.15 mm filter = 0.4% and 0.08 mm filter = 0%. The results of fine aggregate gradation show that cimangkok sand is included in zone 1, namely coarse sand.

B. Gradation Characteristics of Fine Aggregate

Deep In this section, the gradation characteristics of fine aggregates from Cimangkok sand, Jebrog sand, River sand, and Sea sand in Sukabumi will be discussed. Data from particle size distribution measurements will be presented in the form of graphs

and tables. Each type of sand will be analyzed separately. Based on the table and figure above from the test results we can find out the characteristics of all types of sand that we have tested.

1. Cimangkok Sand



Figure 5. Cimangkok Sand

It can be seen in picture 5 of Pasir Cimangkok which has a slightly grayish color or can be slightly black. For the distribution of Cimangkok sand particle size, we can see in Figure 1 which shows the results of the Cimangkok sand gradation analysis showing that the majority of particles are in the size range of 0.3 to 1 mm. There is slight variation in particle size, and note that this sand may be more suitable for certain construction applications.

2. Jebrog Sand



Figure 6. Jebrog Sand

For Jebrog sand can be seen in Figure 6 from the color can also look different from brownish edit it from Cimangkok sand. For the garfik distribution of Jebrog sand particle size, we can see in Figure 2 which shows the results of the Jebrog sand gradation analysis, maybe the garfik results are no different from Cimangkok sand, the majority of particles are in the size range of 0.3 to 1 mm. There is slight variation in particle size, and note that this sand may be more suitable for certain construction applications.

3. Pelabuhan Ratu Sand



Figure 7. Pelabuhan Ratu Sand

Pelabuhan Ratu sand is the sand of Pelabuhan Ratu Beach or called sea sand, we can see in figure 7, which is a picture of Pelabuhan Ratu sand. For the garfik distribution of the particle size of Pelabuhan Ratu sand, we can see in figure 3 which shows the majority of particles in the size range of 0.08 to 0.3 mm is very different from Cimangkok sand and Jebrog sand because sea sand is formed due to rock erosion

caused by erosion of sea waves, while land sand comes from volcanic rock fragments in addition, Sea sand also has a uniform gradation or size.

4. Cipelang Sand



Figure 8. Cipelang Sand

Cipelang sand is sand found in almost all rivers in Sukabumi but most people in Sukabumi mostly use Cimangkok sand or Jebrog sand rather than Cipelang sand, perhaps because the effect obtained is faster. We can see in picture 8 that Cipelang sand for a brownish color than Jebrog sand. To. For the garlic particle size distribution of Cipelang sand, we can see in Figure 4 which shows the results of the Cipelang sand gradation analysis, maybe the Grafik results are no different from Cimangkok sand and Jebrog sand, the majority of particles are in the size range of 0.3 to 1 mm. There is slight variation in particle size, and note that this sand may be more suitable for certain construction applications

C. Fine Argegat Gradation Zone

The results of the gradation analysis show the gradation zone of each type of sand:

1. Cimangkok Sand: This sand is included in zone 1 (coarse sand) with a percentage of escape in a 0.08 mm sieve of about 3.7%. This indicates that this sand has relatively large and coarse grains.
2. Jebrog Sand: Like Cimangkok Sand, Jebrog Sand is also included in zone 1 (coarse sand) with a pass percentage on a 0.08 mm sieve of about 1.9%. The gradation characteristics of Jebrog sand are similar to Cimangkok sand.
3. Pelabuhan Ratu Sand: This sand has different characteristics, belonging to zone 4 (fine sand), with a pass percentage in a 0.08 mm sieve of about 5.9%. This indicates that this sand has finer grains compared to Pasir Cimangkok and Pasir Jebrog.
4. Cipelang Sand: Although Cipelang Sand has coarse characteristics, it does not meet the 0.08 mm sieve requirement, so it cannot be given a clear gradation zone.

D. Specific Gravity and Fill Weight

The specific gravity and fill weight test results of fine aggregates indicate the following:

1. The specific gravity of fine aggregates of all types of sand is within the specific gravity range of normal aggregates (2.5-2.7), indicating that fine aggregates of all types of sand belong to the category of normal aggregates.
2. The content weight of fine aggregates of all kinds of sand is in the range of 1.5-1.8, which meets the requirements for normal concrete. However, it should be noted that Pasir Cimangkok has the highest fill weight of 1,740.

E. Mud Content in Sand

The sludge content in the sand is also an important factor in the assessment of the quality of fine aggregates:

- a. Cimangkok sand has a mud content of about 18.8%.
- b. Jebrog sand has a mud content of about 21.8%.
- c. Pelabuhan Ratu sand has a mud content of about 2.6%.
- d. Cipelang sand has a mud content of about 13%.

According to SNI 03-4428-1997, fine aggregates that can be used for building materials should have a sludge content of no more than 5%. Thus, only Pelabuhan Ratu Sand meets this requirement.

Conclusion

In this study, we have analyzed and evaluated the gradation characteristics of fine aggregates from four types of sand originating from Sukabumi, namely Cimangkok Sand, Jebrog Sand, Pelabuhan Ratu Sand, and Cipelang Sand. Based on the analysis that has been carried out, we reach several important conclusions:

1. Fine aggregate gradation characteristics:
 - a. Based on the sieve analysis, we determined that Cimangkok Sand and Jebrog Sand are included in Zone 1 (coarse sand), Pelabuhan Ratu Sand is included in Zone 4 (fine sand), and Cipelang Sand is included in Zone 1 (coarse sand) according to SNI standards.
 - b. The results of the sieve analysis show that each type of sand has a different particle size distribution.
2. Fine Aggregate Quality:
 - a. The specific gravity of fine aggregates of all types of sand is within the range corresponding to normal aggregates, which is between 2.5 to 2.7.
 - b. The weight of fine aggregate content of all types of sand meets the requirements of normal concrete, ranging from 1.5 to 1.8.
 - c. The mud content in fine aggregate varies between types of sand. Only Pasir Pelabuhan Ratu meets SNI requirements with a mud content of less than 5%.
3. Sand selection recommendations:
 1. The selection of sand types must be in accordance with the requirements of a particular project. Pelabuhan Ratu sand is a good choice if the project has strict requirements related to the mud content in fine aggregates.
 2. For projects with specific roughness requirements, Cimangkok Sand and Jebrog Sand can be suitable choices.

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