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CHARACTERIZATION ANALYSIS FOR SEDIMENT MANAGEMENT IN GROGOL RIVER

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Abstract

This study analyzed the grain size distribution and physical characteristics of the Grogol River bed sediment, Grogol Petamburan District, West Jakarta. This river plays an important role in the urban drainage system, but sediment accumulation causes siltation and a decrease in its capacity, thus increasing the risk of flooding during the rainy season. This study aims to provide technical data for sedimentation control. The method used is quantitative with laboratory tests, including grain size analysis (sieve analysis), specific gravity test, and water absorption. Sediment samples were taken from the river bed at certain points, then dried, sieved, and weighed. The analysis refers to SNI 03-1968-1990 and ASTM C-33. The results showed that 45% of the sediment material passed the No. 200 sieve (0.075 mm), classified as Clayey Sand (SC) according to the Unified Soil Classification System (USCS). The grain size distribution is classified as poorly graded, indicating an uneven and homogeneous size distribution, thus accelerating sedimentation. The fine fraction exceeds the ASTM limit which allows a maximum of 3% to pass the No. 200 sieve for fine aggregate. The bulk specific gravity value of 2.353 gr/cc, bulk SSD specific gravity of 2.415 gr/cc, apparent specific gravity of 2.510 gr/cc, and absorption of 2.7% indicate moderate porosity. These characteristics affect sediment stability and movement, especially when the flow rate changes. Overall, the Grogol River sediment has the potential to accelerate sedimentation, worsen siltation, and reduce the river's hydraulic capacity. These findings form the basis for planning mitigation strategies such as normalization, routine dredging, settling ponds, and adaptive drainage management according to local sediment characteristics.
Keywords: river sedimentation, sieve analysis, grain gradation, clayey sand, specific gravity, Grogol River

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1. Introduction

A river is a natural or artificial water channel or reservoir in the form of a water control network that limits the flow of water from its source to the estuary on its left and right borders..Rainwater flows into reservoirs such as rivers and lakes, then into the sea.(Hidayati et al., 2021).

A river is a network of naturally occurring channels on the earth's surface, consisting of small streams upstream and larger streams downstream. Most of the rainwater that falls on the earth's surface evaporates, and most of it flows in the form of small streams, then becomes medium-sized streams before collecting into large or main streams. Therefore, rivers function to collect rainfall and drain it to the sea. (Wardhana, 2015.

River shape, flow, sediment transport, and water bed roughness are all influenced by reciprocal interactions.(Humairah Annisa et al., 2021).

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Some parts of the river start at a spring and flow into tributaries. Some tributaries join to form the main stream.(Hidayati et al., 2021). Catching and retaining rainwater from upstream and downstream is how rivers function to transport water to the estuary. Furthermore, rivers also transport erosion from the land surface and from the river itself. This occurs when surface rainfall flows into the river.(Rusdi et al., 2023).

The Grogol River flows through the Grogol Petamburan District in West Jakarta. It is a significant contributor to flooding. In these conditions, the river is very flat, and its capacity is insufficient to handle the flow of water during heavy rainfall.

The Grogol River in Jakarta plays an important role in the city's drainage system, but also faces major challenges related to flooding and pollution.(Apriyanti & Arbaningrum, 2024).

Due to the influence of rainwater and surface water, soil particles dissolve and are carried to lowland areas, where they enter rivers and streams, where they are called sediment. As sediment is transported from uplands to downstream areas, it can shallow reservoirs, rivers, and irrigation canals and form new land on riverbanks and river deltas.(Mauliddiyah, 2021). Important factors for maintaining water flow and channel cross-section stability from various flow conditions and sediment transport because it is a basic parameter that causes morphological changes.(Ananda, 2022).

An analysis of the problems occurring in the Grogol River, located in Grogol Petamburan, West Jakarta, revealed that when rainfall and river flow reach high levels, water overflows and spills onto surrounding streets. Sediment accumulation in the river has a substantial impact on reducing water storage volume, ultimately triggering flooding risks in the surrounding areas.

Sediment is the result of erosion processes, whether surface erosion, gully erosion, or other types of soil erosion. Sediment generally settles at the bottom of hillsides, in floodplain areas, in waterways, rivers, and reservoirs. Sediment yield is the amount of sediment originating from erosion that occurs in a water catchment area measured over a certain period of time and place. The erosion process consists of three parts, namely, detachment, transportation, and sedimentation (Asdak, 2014).

Sedimentation is the deposition of rock material that has been transported by water or wind power. When erosion occurs, water carries rocks flowing into rivers, lakes, and eventually reaches the sea. When the transporting power decreases or is exhausted, the rocks are deposited in water flow areas (Anwas, 1994).

Therefore, analysis of the physical characteristics and particle size distribution of sediment is a crucial aspect in technical studies of river management. Sediment transported and deposited on the riverbed not only affects flow capacity but also alters channel

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morphology and accelerates silting, which can lead to flooding. Sediment particle size distribution is strongly influenced by flow velocity, channel cross-sectional shape, and the source of material from upstream areas. In urban river systems like the Grogol River, human activities such as construction, domestic waste, and reduced catchment areas contribute to increased sediment input to the river body.

To identify sediment types and sedimentation trends, appropriate analytical methods are required. One method commonly used in geotechnics and soil science is sieve analysis. This method can classify sediment grains based on particle size and provide an overview of the sediment gradation carried by the flow. Through grain size distribution data, we can interpret the physical characteristics of the sediment, whether it is coarse, medium, or fine, and determine the level of particle size uniformity (well-graded or poorly-graded), which determines the material's tendency to settle on the riverbed.

Furthermore, specific gravity and water absorption tests also contribute to understanding the natural density and porosity of sediment. High specific gravity indicates a dense and heavy mineral composition, while water absorption capacity reflects the sediment's porosity and stability to moisture changes. This information is crucial for river planners and managers in determining technical strategies, such as sediment trap design, routine dredging schedules, and upstream conservation measures.

Thus, this study specifically aims to analyze the distribution of sediment grain size and the physical characteristics of fine aggregates in the Grogol River, as a scientific basis for understanding the sedimentation process and designing appropriate sedimentation mitigation measures. This study is expected to make a significant contribution to water resource management and flood control in urban areas, particularly West Jakarta.

Sample analysis involves observing and identifying the sediment to determine its texture. Grain size analysis is then performed to determine the type of particles within the sediment. Samples are oven-dried and weighed on an analytical balance to calculate the settling rate from the sample weight.

a) Sieve Analysis

River sedimentation characteristics can be observed at this stage of the research. Sieve tests to determine the size of rock grains based on samples taken in the field are essential. Sediment samples are oven-dried, soil chunks are crushed, and the soil samples are shaken and then passed through a series of sieves. The debris remaining on each sieve is weighed and the percentage of debris remaining on each sieve is calculated. Sieve analysis uses a D50 sieve for the study.

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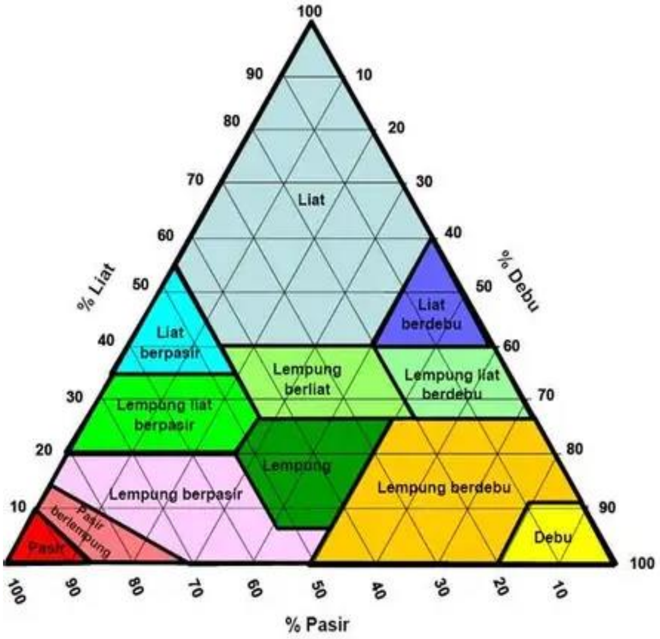

Figure 1 Classification of sedimentary materials based on sieve passing
(Source:Lestari et al., 2024)

The image shows a classification of fine sedimentary material. The result is the distribution of particle sizes in a sediment sample. The following is a general classification of sedimentary material based on particle size:

1. Gravel
   (a) Size: > 64 mm
   (b) Medium: 32 - 64 mm
   (c) Small: 2 - 32 mm
2. Sand
   (a) Size: 0.5 - 2 mm
   (b) Medium: 0.25 - 0.5 mm
   (c) Small: 0.0625 - 0.25 mm
3. Silt
   Particle size: 0.004 - 0.0625 mm
4. Clay
   Particle size: < 0.004 mm

Table1Fine Aggregate Size Classification

Sieve Number	Opening Size (mm)
4	25.4
6	19.1
8	12.7
12	9.52
16	4.75
20	2.36
30	1.18
40	0.6

50	0.3
100	0.15
200	0.075

Source:(Lestari et al., 2024)

The table is a size classification of fine aggregate itself, which is an aggregate particle that passes through sieve No. 4 or has a size of 4.75 mm. Fine material sieves include sieves with diameters of 37.5 mm (3”); 63.5 mm (2.5”); 50.8 mm (2”); 19.1 mm (¾”); 12.5 mm (½”); 9.5 mm (⅜”); No. 4 (4.75 mm); No. 8 (2.36 mm); No. 16 (1.18 mm); No. 30 (0.600 mm); No. 50 (0.300 mm); No. 100 (0.150 mm); No. 200 (0.075 mm)

b. TestingSpecific Gravity and Water Absorption

Water absorption is the weight of water that can be absorbed by dry aggregate, expressed as a percentage. Specific gravity provides information about the density of sedimentary material, which helps understand the mineral composition and physical properties of the sediment. Specific gravity can affect how sediment moves and is deposited along a river. Sediments with higher specific gravity may settle more quickly than those with lower specific gravity.(Virlayani et al., 2024).

2. Method

The research employed a quantitative methodology, focusing on systematically processed numerical data. Data were obtained from sediment sampling in the field. The data were processed in the Soil Mechanics Laboratory using sieve analysis and density testing to determine the sedimentation characteristics of the Grogol River.

The flow of this research can be seen in the following flowchart:

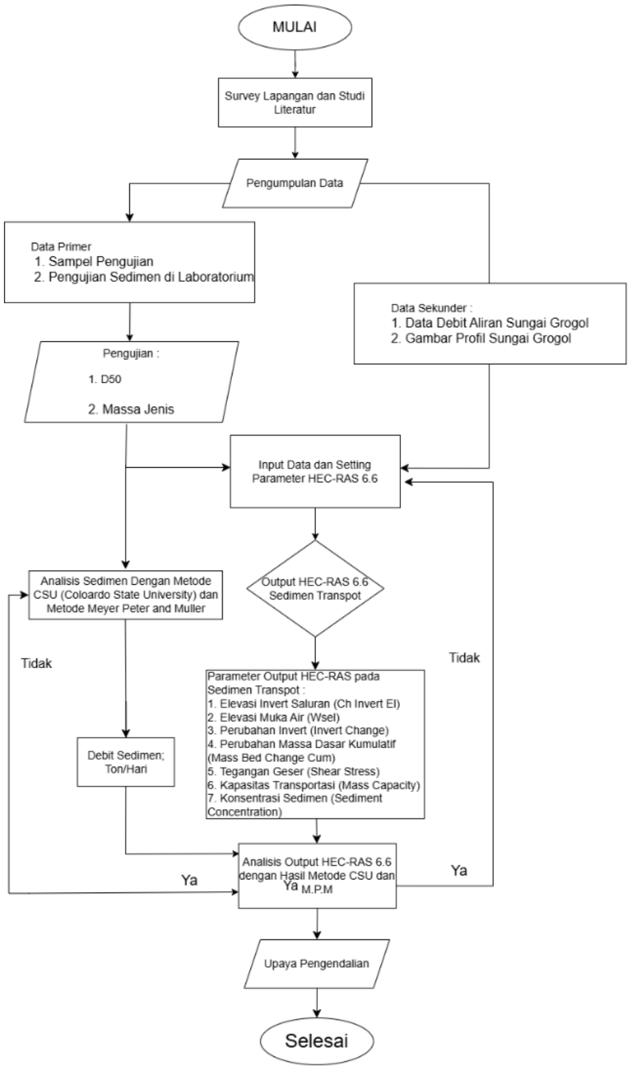

Figure 2. Research flowchart

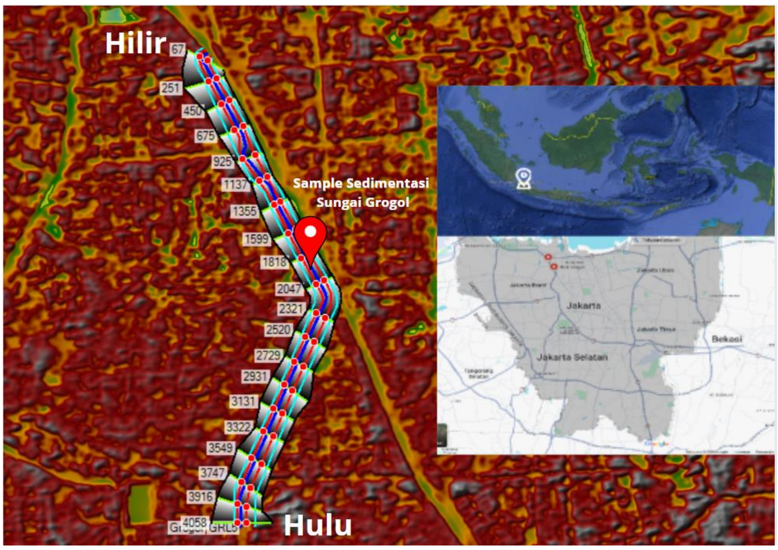

Figure 3. Research location

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The research was conducted for 6 (six) months, namely from January 2025 to June 2025. In the first and second months, administrative processing was carried out, in the third month, literature studies and data collection were carried out, then in the fourth and fifth months, data analysis was carried out, and in the sixth month, the research completion process was carried out.

The research location was carried out on the Grogol River channel at coordinates 6°10'8.33"S 106°47'16.41"E - 6° 8'11.81"S 106°47'6.93"E, Grogol Petamburan District.as in Figure 2.

Data collection technique

The data used in this study include:

1. Primary data in the form ofSediment material sampling in the Grogol River field at STA 4.00 to STA 0.00. The test objects were sampled based on the predetermined research location points. Sieve analysis and specific gravity tests were carried out in the laboratory to obtain the value of rock grains based on the classification of grains passing the sieve analysis with a gradation percentage of 50% so that researchers can determine sediment transport.
2. Secondary data in the form of; Grogol River flow discharge data, and Grogol River profile images.

3. Results and Discussion

Sediment Characteristics Testing

Implementation of Sediment Characteristics Testing Sieves

a. Sediment sampling on the river bed (Bed Load) was carried out at the planned point using 1000 grams at point 1, and using a 2 inch diameter PVC pipe in the river which was inserted into the river bed to a depth of 50 cm.
b. Sampling was carried out with an even flow distribution so that the sediment taken remained constant and there was no circular flow.
c. The sediment samples taken were then transferred to cup 1 and cup 2 to differentiate the samples taken.
d. Put the sample into the oven at a temperature of (110 ± 5) ºC to obtain a constant sample weight.
e. Prepare a material sieve with sieve sizes arranged from large diameter sieves to small diameter sieves. The sieves are shaken by hand or by a shaking machine for 15 minutes.
f. Separate the sediment material that passes through the sieve with a separate cup.

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g. Make data on the percentage of the results of the sieve for each material passing through the sieve to the total weight of the sediment after being sieved.

h. After that, make a cumulative graph.

i. Determine the fineness modulus (the standard is 1.5-3.8)

j. Equality :

If Wi is the weight of the soil retained on the i-th sieve (from the top of the sieve arrangement) and W is the total weight of the soil, then the percentage of the weight retained is shown in the following formula equation.

% weight retained on sieve $= \frac{Wi}{W}\ x\ 100\%$ .... (3.20)

Information:

Wi = retained weight (gr)

W = weighttotal retained (gr)

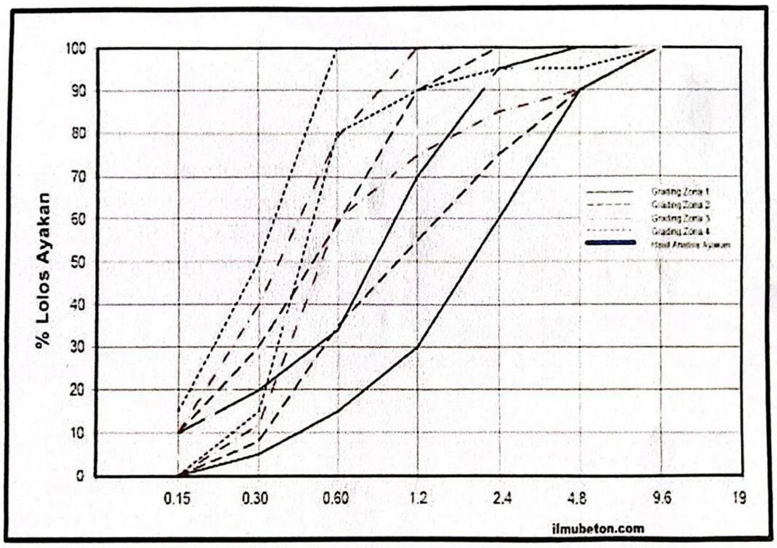

Figure 4 Aggregate Gradation Zone Division Graph

(Source: Concrete Practical Laboratory, 2025)

Information: based on (Burangkeng Civil Laboratory, 2025) Sieve size indicates the mesh dimensions used for particle separation. Retained mass indicates the weight of aggregate retained on each sieve. Cumulative % Retained is the percentage of aggregate retained on each sieve in sequence. % Passing indicates the percentage of aggregate that passes through the sieve.

Specific Gravity and Water Absorption Testing

How to Conduct Testing

a. Dry the object and tray in an oven at 110 °C ± 5 °C (230 °F ± 9 °F) until the mass is constant.

b. Soak the test object in water for ±24 hours.

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c. Carefully discard the soaking water, making sure no grains are lost or thrown away.
d. Spread the aggregate into the tray.
e. Dry in hot air by turning the test object over until it reaches SSD (surface dry) condition.
f. To check the condition of the SSD, insert the test object into a sharpened cone, compact it with a pounding rod 25 times, then lift the cone. The SSD state is reached if the test object collapses but is still in the printed state.
g. After the SSD test specimen, place 500 grams of the specimen into the pycnometer and fill it with distilled water until it reaches 90% of the volume. Then, rotate and shake it until no bubbles are visible. This can also be done by boiling the pycnometer.
h. Immerse the pycnometer in water and measure the water temperature to adjust the calculation at the standard temperature of 25˚C.
i. Add water until it reaches the mark.
j. Weigh the pycnometer containing water and test object (Bt)
k. Remove the test specimen, dry it in an oven at 110 °C ± 5 °C (230 °F ± 9 °F) until constant mass, then cool it in a desiccator.
l. After the test object has cooled, weigh it (Bk).
m. Determine the weight of the pycnometer filled with water up to the limit mark and measure the water temperature to adjust it to the standard temperature of 25˚C, and weigh it (B).
n. Equality

Heavy bulk type (bulk dry specific gravity): $\frac{BK}{(B+500-Bt)}$ ....(3.21)

Surface dry specific gravity (saturater surface dry): $\frac{500}{(B+500-Bt)}$ ....(3.22)

Apparent specific gravity: $\frac{BK}{(B+Bk-Bt)}$ ....(3.23)

AbsorptionWater: $\frac{(500-Bk)}{Bk}\ x\ 100\%$ .... (3.24)

Information :

Bk : weight of oven-dried test object (grams) B = weight of pycnometer containing water (grams)
Bt : weight of the pycnometer containing the test object and water (grams)
500 : weight of the test object in a saturated surface dry state (grams)
The calculation results are reported in two decimal places.

Laboratory test results

1. Sieve analysis (sieve analysis)

From this test, the amount and distribution of sediment size were obtained using a filter that was appropriate toSNI 03-1968-1990.

Filter		Weight retained	Accumulative retained	Accumulative retained	Passing
Inch	mm	gr	gr	%	%
2"	50				
1/12"	37.5				
1"	25				
3/4"	19				

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1/2"	12.5				
3/8"	9.5	0.0	0.0	0.0	100.00
1/4"	6.3	0.0	0.0	0.0	100.00
# 4	4.75	169.8	169.8	11.3	88.68
# 8	2.36	304.4	474.2	31.6	68.39
# 16	1.18	107.2	581.4	38.8	61.24
# 30	0.6	104.7	686.1	45.7	54.26
# 50	0.3	44.3	730.4	48.7	51.31
# 100	0.15	53.9	784.3	52.3	47.71
# 200	0.075	27.6	811.9	54.1	45.87
Pan	-	688.1	1,500.0	100.0	0.00

Table 2 Sieve Analysis of Fine Aggregate

(Source: Author, 2025)

Based on Table 2, the analyzed soil samples show characteristics that comply with the soil classification based on the SNI 03-1968-1990 standard. Based on the test results, the sample that passed the No. 200 sieve (0.075 mm) reached 45%, so this sample has a significant proportion of very fine particles. The fraction obtained passing the No. 200 sieve is quite high and the soil has plastic clay characteristics, so it is included in the SC (Clayey Sand) category.

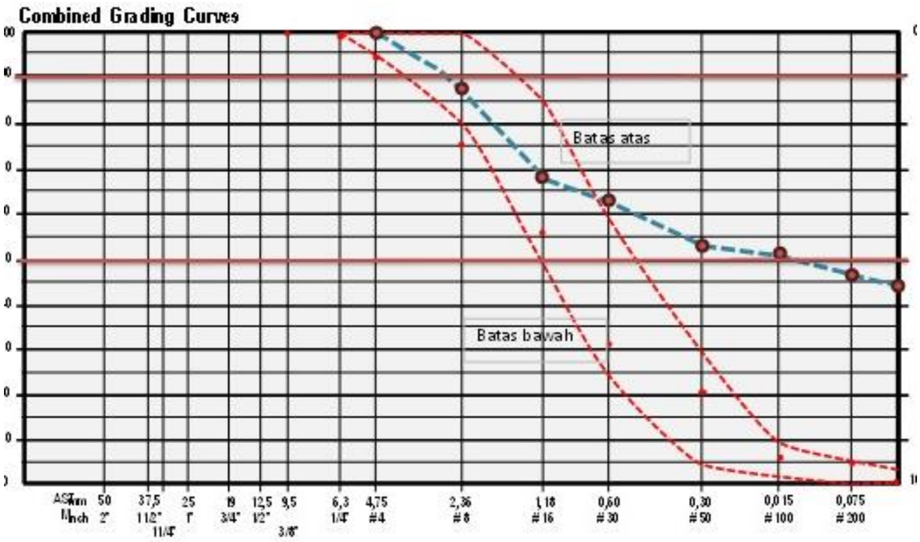

Figure 5 Grading Curve of Fine Aggregate

(Source: Author, 2025)

From the results of grading curve sieve analysis on sediment samples from the Grogol River, it can be seen that the percentage of material passing through sieves No. 30 to No. 200 is quite high and exceeds the upper limit. With 54% passing No. 30, 51% passing No. 50, 48% passing No. 100, and 46% passing No. 200, this indicates that the

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sample contains excessive fine particle dominance. Sediment content that is too fine is risky.

Increase sediment transport in water flow, which can accelerate the sedimentation process at the river mouth. If fine particles dominate, there is a high probability of reduced water infiltration into the river bed, which can affect flow capacity. ASTM C-33, 117, and 138 stipulate that the amount of material passing the No. 200 sieve should not exceed3% for fine aggregate.

2. Specific gravity and water absorption testing

In this test, we used a sample sieve (sieve) No. 30 fine aggregate grains. The weight of the test object was 50 grams SSD.(Saturated Surface Dry) is a condition where the sample is saturated with water in its pores but the surface is no longer wet. Water absorption is usually expressed as a percentage (%).

Description			*Test*
Weight of SSD condition		gr	50
Weight of dry sample in air	A	gr	48.7
Weight of pyc+water	B	gr	156.1
Wt of pyc+spl+water	C	gr	185.4
Bulk Sp.Grafity	$\frac{A}{B+50+C}$	gr/cc	2,353
Description			*Test*
Bulk Sp.Grafity ssd basic	$\frac{\mathbf{50}}{\mathbf{B+50+C}}$	gr/cc	*2,415*
Apparent Sp. Gravity	$\frac{\mathbf{A}}{\mathbf{B+A+C}}$	gr/cc	*2,510*
Absorption	$\frac{\mathbf{50-A}}{\mathbf{A}}\ \mathbf{x\ 100\%}$	%	*2.7*

Table 3 **Specific Gravity and Absorption of Fine Aggregate**

(Source: Author, 2025)

Based on the test results table, the test specimen has an absorption value of 2.7%, which means the material is able to absorb 2.7% of its dry weight of water after being soaked. Absorption of 2.7% indicates that the test specimen has moderate porosity, meaning there are still empty spaces in the material structure that allow water to enter. The higher the absorption value, the more water can be absorbed. Materials with absorption in the range of 2–3% are generally still considered quite good in maintaining stability against moisture, even though they absorb a little water. When compared to standards such as SNI 03-1969 and ASTM C-127 based on the provisions used at the

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Burangkeng Civil Laboratory, this value is still within reasonable limits for fine aggregates.

4. Conclusions and Suggestions

Based on the results of field research, laboratory testing, and analysis of the distribution of sediment grain sizes in the Grogol River using the sieve analysis method and gradation diagram, several important conclusions were obtained as follows:

1. Physical characteristics of Grogol River sedimentsshows that the sediment found on the riverbed is dominated by fine to very fine grains. From the results of laboratory testing on the sediment samples taken, it was found that 45% of the sediment particles passed the No. 200 sieve (0.075 mm). This indicates that the sediment is classified as sandy clay (Clayey Sand / SC) according to the USCS soil classification system and SNI 03-1968-1990. This high content of fine particles indicates a high level of sediment cohesion and has the potential to cause faster sedimentation on the riverbed, especially when the flow rate decreases.
2. Sediment gradation distributionshows a non-uniform pattern or is classified as poorly graded. Based on the gradation curve obtained from sieve analysis data, it is known that more than 50% of the grains pass through sieves No. 30 to No. 200. This high content of passing particles indicates that the sediment in the Grogol River is not only dominated by fine sand, but also contains silt and clay fractions. This is an indicator that the river is susceptible to rapid sedimentation of sediment material, especially in areas experiencing changes in flow velocity or river cross-sectional shape.
3. Compared to the ASTM C-33 standard limit, which requires a maximum of 3% fine aggregate passing through the No. 200 sieve, the 45% content found in the Grogol River sediment exceeds the safe limit. This reinforces the conclusion that the sediment in the Grogol River has a tendency to accelerate the silting process of waterways, reducing flow capacity, and ultimately increasing the risk of inundation or flooding in the surrounding area, especially during the rainy season.
4. Specific gravity and water absorption testingprovides an overview of the density and ability of sediment pores to absorb water. A bulk specific gravity of 2.353 gr/cc and an absorption of 2.7% indicate that the analyzed fine aggregate has moderate porosity. This porosity indicates that although the sediment particles are relatively dense, they are still able to absorb moisture, which can affect the mechanical stability of the riverbed, especially when flow volume changes drastically (for example, during floods or droughts).

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5. Based on the results and analysis above, it can be concluded that the Grogol River is experiencing sediment accumulation with a significant predominance of fine fractions. If not addressed immediately through a normalization program, periodic dredging, sediment trap construction, or other technical measures, this condition has the potential to exacerbate the city's drainage problems, accelerate the degradation of river capacity, and increase the potential for damage to surrounding infrastructure due to flooding.
6. These findings also provide baseline data for comprehensive sediment management planning in the Grogol River. Furthermore, this study demonstrates the usefulness of the sieve analysis and gradation graph approaches for identifying sediment distribution characteristics, which can be used in civil engineering planning, river conservation, and flood mitigation in urban areas.

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