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Study of Sediment Characteristics in the Jeneberang River's Upstream

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Abstract. This study aims to determine the characteristics of sediments found in the Jeneberang River specifically in the upstream part. The data required includes the results of sieve analysis, grain diameter of the sediment and the density of the sediment. The study was conducted by taking samples from the segments around Sabo 7-1. The data obtained indicate that the gradation of sediment particles consists of fine sand, medium sand, coarse sand, fine gravel and coarse gravel with a median diameter (D50) of 0.5-13.10 mm and specific gravity values ranging from 2.659-2.682 gr/ cm.

Key words : Sediment characteristics, sediment disaster, Jeneberang River

1. Introduction

Jeneberang River is one of the rivers that disgorge on Mount Bawakaraeng. The collapse of Mount Bawakaraeng on March 26, 2004, resulted in the deaths of 32 people, 635 cows missing, the destruction of several houses and an elementary school building, and the buried area of 1,500 hectares of agricultural land. The volume of debris is estimated at 200 - 300 million m3. Mountain material flows in the Jeneberang river and results in very large sedimentation of the Bili-Bili Reservoir. Subsequent disasters due to debris flow in January 2006 caused the Daraha Bridge to be washed away.

The collapse of the caldera wall of Mount Bawakaraeng in March 2004, followed by flash floods that killed and injured dozens of people, and the destruction of dozens of houses have created a continuing threat of disaster for local residents. This was proven when flash floods hit the same area again in February 2007 which caused the isolation of thousands of residents.

The biggest threat is the deposit of debris from the landslide in March 2004 which disrupts the preservation of the function of the Bili-Bili reservoir downstream of Mount Bawakaraeng as a source of water for local residents. This problem is getting worse when this loose and unstable debris material with a very large volume can at any time move into a flash flood/landslide disaster if heavy rains occur. This then becomes a secondary sediment disaster or what is also often called cold lava.

The movement of sediment mass can be grouped into several types, including landslides, debris flow, transitional flow between debris flow and individual flow (bedload), which is called hyper concentration flow. [1]

Debris flow is a mass flow in the form of a mixture of water and sediment with a very high concentration. Once this flow starts (because the static equilibrium between the shear forces generated is greater than the shear forces that resist), then the amount of mass that flows, its height, and its velocity will always increase (has an acceleration). At a certain level, due to local boundary conditions, for example, changes in slope that become gentle, reduced water mass, changes in sediment character and so on. This debris flow process will experience a slowdown, the amount of mass flowing is reduced, then a certain amount of mass will be deposited. The initial criteria for the occurrence of moving debris flow due to the surface at the bottom of the groove formed by loose-grained deposits modeled by Takahashi.

In general, debris flow is caused by high rainfall intensity and lasts a long time in the upstream area of the watershed. The beginning of the occurrence of debris flow can be divided into three types including, first, landslides on cliffs that turn into debris flows, second is the collapse of natural dams due to sediment buildup upstream, and the third is sediment flows that move sequentially following a steep channel bottom [2].

According to Zaini (2005), in his understanding, Sabo is a technical terminology derived from the Japanese "Sa" and "Bo" which in a broad sense means erosion and sediment control works. The term Sabo means sand and gravel management which is essentially an effort to prevent mountainous land from being damaged by erosion, protecting people and downstream infrastructure against the threat of disasters due to erosion and sediment. [3]

The target of the sabo work is all sand, gravel and stones of various sizes that are upstream, both those in riverbeds, river cliffs and hills that are expected to landslide or collapse or are called sediment production source areas (Cahyono, 2010). 2000). [4] Sediment production areas are areas located on upstream slopes with a slope of > 6”. Countermeasures for cold lava flooding in sediment production can be anticipated by constructing sediment retaining structures, consolidation dams and flow control dams.

To identify and determine the river fluctuation and advice the best position of proposed sabo facilities along the main river course especially at the upstream, it is necessary to study the characteristics of sediments found in the Jeneberang River. These sediment characteristics include sediment density, sediment diameter size and sediment grain size analysis

2. Research Method

2.1. Research Design

This research was conducted in the upstream Jeneberang River and this type of research used a descriptive approach to determine the characteristics of sediments that could be used as a basis for determining the type and location of the right sabo facility as a form of sediment disaster mitigation.

2.2. Research Site

The research location was determined at the upper reaches of the Jeneberang River (Figure 1). This upstream part was chosen because the existing sabo facility suffered a lot of damage, so it was deemed necessary to review the design by reviewing the characteristics of the sediment first.

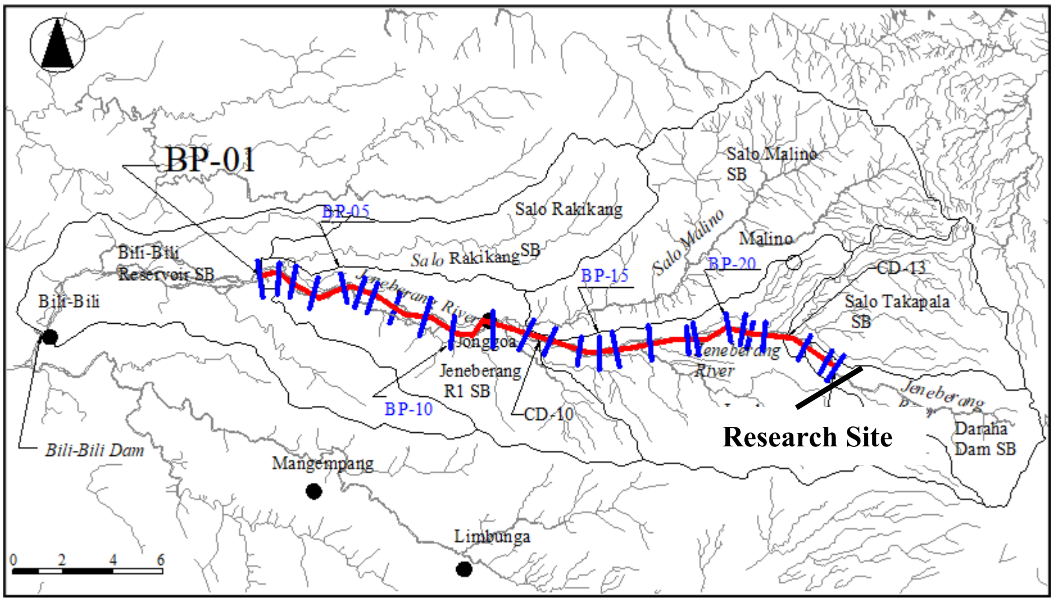

Figure 1 Research Site

2.3. *Field Activities*

The data collection method was carried out by taking samples in the upperstream of the Jeneberang River for the segments before Sabo 7-1 and after Sabo 7-1. In each segment, at least 2 different types of samples are taken. This segment difference is taken as a comparison and supporting data to see the performance of the existing Sabo Series 7 facilities. The location of the segment in question is shown in Figure 2.

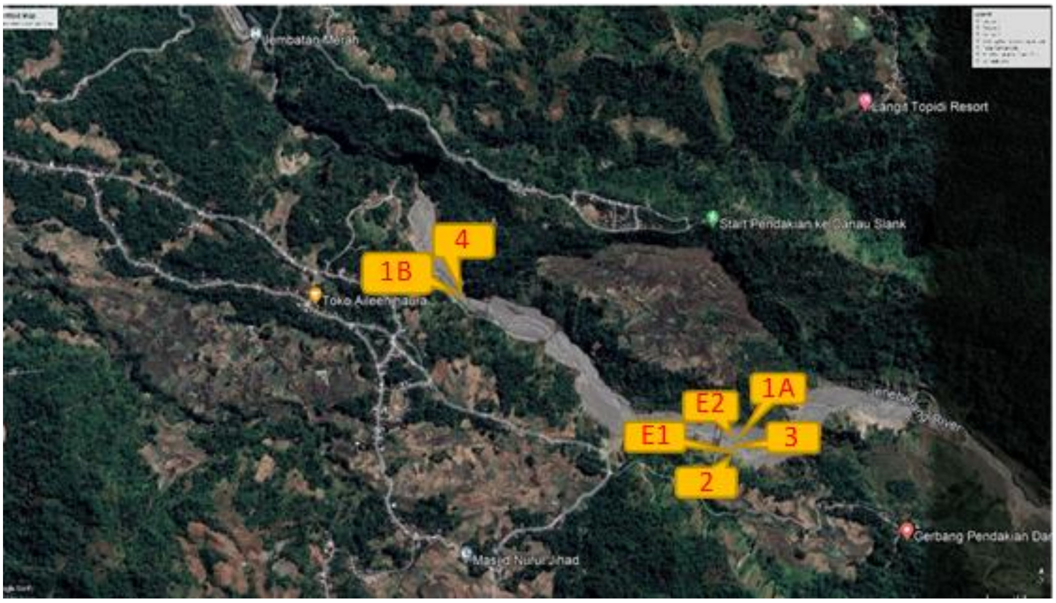

Figure 2. Location of Segments

2.4. *Data Analysis*

The data presented has been clearly and systematically arranged, for further analysis. The data obtained from laboratory and field results are sieve analysis and specific gravity testing. The entire data is presented in an easy-to-understand form, namely in the form of test results tables and graphs. The data obtained in this study is primary data.

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3. Result and Interpretation

3.1. Sediment Specific Gravity

From the results of the examination and calculations, the values of sediment density (Gs) are obtained which are presented in Table 1:

Table 1. Specific Gravity Test Results

Sample Depth & Inclination	m	2		E1		3		E2		1a		1b		4	
Number of Volumetric Flask	-	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Weight of Vol. Flask + Soil (W2)	Gram	45.8	53.0	45.7	47.2	46.7	54.1	49.6	53.3	82.78	82.26	81.58	80.86	81.82	83.52
Weight of Vol. Flask (W1)	Gram	20.75	28.02	20.65	22.21	21.72	29.12	24.58	28.32	32.78	32.26	31.58	30.86	31.82	33.52
Weight of Dry Soil (Ws=W2-W1)	Gram	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	50.00	50.00	50.00	50.00	50.00	50.00
Temperature, T (oC)	Degree	28	28	28	28	28	28	28	28	25	25	25	25	25	25
Weight of Vol. Flask+Water at T (W4)	Gram	68.90	77.63	68.56	76.53	68.79	76.83	68.91	77.65	129.40	131.32	128.43	134.13	127.94	135.26
Weight of Vol. Flask+Water+Soil (W3)	Gram	84.58	93.22	84.22	92.15	84.38	92.50	84.51	93.28	160.64	162.61	159.59	165.41	159.24	166.71
Unit Weight of Water at T, g_T	Gram/Cm^3	0.9963	0.9963	0.9963	0.9963	0.9963	0.9963	0.9963	0.9963	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971
Temp. Corr. Coefficient, $a=g_T/g_{20}{}^0C$	-	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9988	0.9988	0.9988	0.9988	0.9988	0.9988
Weight of Soil (Wu=(Ws+W4-W3))	Gram	9.3	9.4	9.3	9.4	9.4	9.3	9.4	9.4	18.76	18.71	18.84	18.72	18.70	18.55
Specific Gravity of Soil (Gs=a*Ws/Wu)	-	2.677	2.652	2.671	2.660	2.652	2.674	2.654	2.663	2.662	2.669	2.651	2.668	2.671	2.692
Average of Gs	-	2.664		2.666		2.663		2.659		2.666		2.659		2.682	
Remarks:				Unit Weight of Water,		$g_{w,20}{}^0C=$ 0.99823									

The density of sediment is generally around 2.65 g/cm^3 except in the form of heavy metals (Hambali et al., 2016). The density of the bottom sediment in the Jeneberang River ranged from 2.659-2.682 g/cm^3 with an average of 2.665 g/cm^3 (see Table 2). The distribution pattern of sediment density tends to be regular.

Table 2 Recapitulation of Riverbed Sediment Density (g/cm^3)

No	Sample Code	Sediment Density
1	2	2,664
2	E1	2,666
3	3	2,663
4	E2	2,659
5	1A	2,666
6	1B	2,659
7	4	2,682

3.2. Sediment Diameter Test Results

Determination of sediment diameter in this case is through sieve analysis experiments conducted in the laboratory, so that from the results of these experiments can be obtained a uniform grain diameter value or d50 of the sediment. The value of the diameter of the sediment grains (d50) obtained is presented in table 3 below.

Table 3 Value of d_{50}

No	Sample Code	d_{50} (mm)
1	2	5,21
2	E1	6,06
3	3	9,03
4	E2	13,10
5	1A	10,92
6	1B	3,15
7	4	0,50

3.3. Results of Sediment Grain Size Analysis

The results of the recapitulation of sieve analysis for each sample are presented in the table of sieve analysis test results in Table 4. Figure 3 shows a graph of the recapitulation of the gradation of sediment grains in each sample tested.

Table 4 Recapitulation of Percent Results Passing the Sieve Analysis Test

Sieve Number	**Sieve Diameter**	**Percent Passing (%)**						
	Sample Code	**2**	**E1**	**3**	**E2**	**1A**	**1B**	**4**
3"	75.00	99.2	99	98.68	98.44	99.48	100	100
2"	50.00	99.2	99	89.6	98.04	98.04	100	100
11/2"	37.50	97.48	94.6	84.16	97.44	92.8	98.36	100
1"	25.00	93.56	87.08	77.36	88.24	81.8	94.56	100
3/4"	19.00	90.08	80.4	72.08	81.8	61.88	86.64	100
3/8"	9.500	78.68	66.64	51.04	38.32	47.92	77.08	99.6
4	4.750	46.44	43.6	28.96	22.8	31.12	59.08	98.8
10	2.000	25.36	24	12.2	12.2	21.88	43.44	79.56
20	0.840	12.6	12.2	5.12	5.88	14.64	30.2	61.92
40	0.425	6.24	6.24	2.68	2.68	8.68	19.04	47.16
60	0.250	2.12	4.28	2.12	1.8	5.8	7.8	28.2
100	0.150	0.52	2.48	1.6	0.72	2.16	3.36	4.16
200	0.075	0.24	0.72	0.72	0.16	0.6	1.4	1.8
Pan	-	0	0	0	0	0	0	0

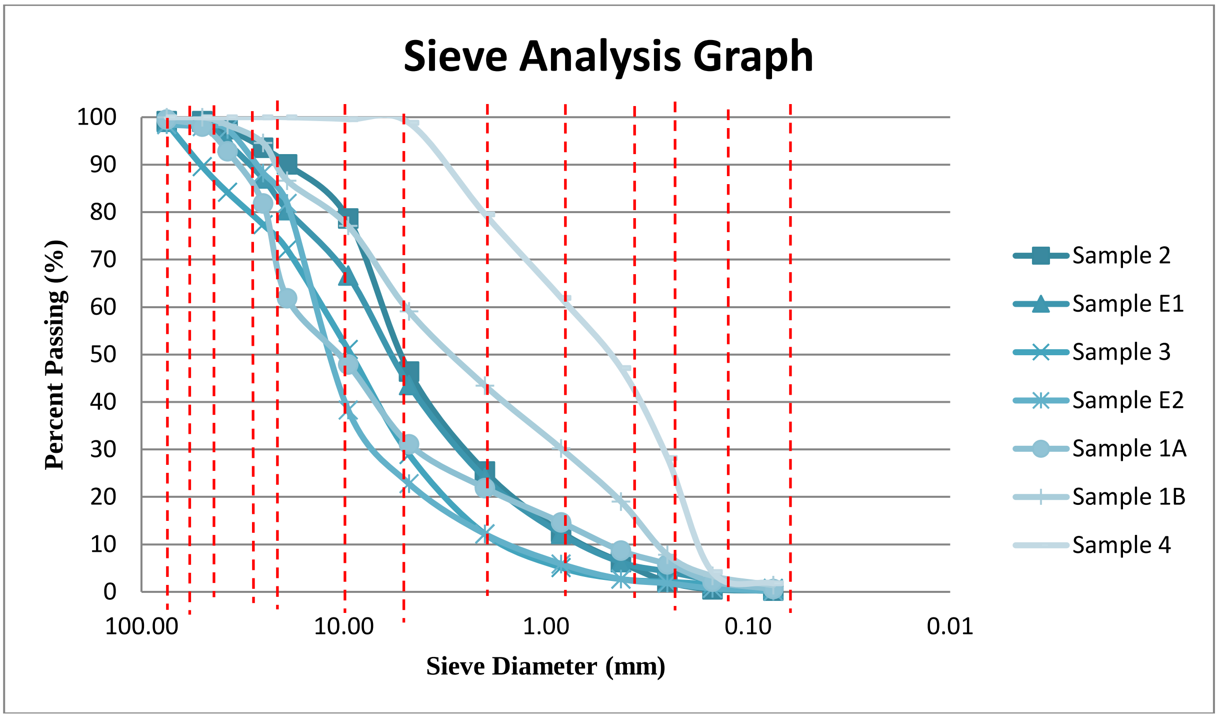

Figure 3 Graph of the Recapitulation of Sieve Analysis Results

4. Conclusion

Based on the data and discussion of the research, it can be concluded that the gradation of sediment particles consists of fine sand, medium sand, coarse sand, fine gravel and coarse gravel with a median diameter (D50) of 0.5-13.10 mm and the specific gravity values range from ranged from 2.659-2.682 g/cm. These data could be use to determine the best sabo plan for upstream area; include for the right structure, the right position etc.

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