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The Effect of Sediment Movement on the Capacity of the Aur River Retention Pond

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Abstract— The conditions on the slopes of Komering river have a soft soil layer (back fill) and less strong soil reinforcement with a depth ranging from 20 m to 25 m, with the presence of a soil layer like this, plus a soil reinforcement that is less supportive to withstand the loads that are above it, so if there is a disturbance or the maximum load occurs on the slope soil surface, it will cause landslides.This study aims to draw and produce how much erosion and sedimentation that occurs in the river bends with sheet-pile with a physical model approach in the laboratory and dimensional analysis using the Langhaar method.The results of the study, the depth of erosion around the sheet-pile building with a relative erosion (ds/t) of 0.068. This means that there is an increase in the depth of erosion within 15 minutes of 1.02 cm in the model or with a scale in the field of 1:100, there is an erosion depth of 1.02 m. When the experiment lasted for 30 minutes, it was seen that the maximal relative sedimentation (ds/t) of 0.02 occurred at a relative speed (v/t) of 0.0012. This means that the sediment accumulation that occurs around the sheet-pile building in the model within 30 minutes is 0.6 cm or on a 1:100 scale in the prototype there will be sedimentation of 0.6 m..

Keywords: River Cliffs, Dimensional Analysis, Langhaar Method, Erosion And Sedimentation

I. INTRODUCTION

The city of Palembang as the capital city of South Sumatra Province, is located at a position of 1040 37' – 1040 52' east longitude and 20 52' - 30 05 south latitude which is currently developing very rapidly, but in the midst of its development, it is often faced with emerging challenges (floods). . The southern part of the city of Palembang has a land elevation that tends to be flat, while the higher location is in the northern part of the city of Palembang.

Due to the relatively flat condition of the city of Palembang, in certain locations it often occurs due to air (floods) caused by air flow that cannot be accommodated by the channel. In addition, at certain locations, water (flood) is also caused by runoff from the Musi River.

Rivers with flood water level are the elevation of the water level at a station above the datum line (normal height). Sometimes the normal water level is taken equal to the average sea level, but more often it is taken slightly below the zero point of river flow (Yandi Hermawan, 1996).

In current conditions, along with the development of urban areas, there are more and more questions that not only have a good effect but also have a bad influence on natural conditions and the environment. The river is one of the aquatic ecosystems that is influenced by many factors, both in natural activities and human activities in the watershed (DAS). In the management of a watershed, one must pay attention to the water body of a watershed because incorrect watershed management will have an impact on the survival of the river, namely very high fluctuations in water discharge and riverbed sediment and reduced river capacity. (Paimin et al, 2012)

This study aims to determine in depth the effect of flow in the river on the air balance in the retention pond of the Aur river, so that real conditions in the field can be seen whether there is an imbalance (water imbalance).

II. Material And Methods

2.1 Research material

The materials used in this study include:

- Sand with a diameter of 0.075 mm to 2.36 mm, is considered a sedimentary material which was previously carried out by sieve analysis to obtain a uniform grain diameter (ds) originating from the Aur river material.
- Water, as a medium for moving sedimentary material flows in the channel,

The equipment used in this research is a hydraulics laboratory facility, Master of Civil Engineering, Postgraduate Program at Bina Darma University.

The specifications of the tool are as follows:

- Standard channel (standard flume):

  Wall material: glass (flexiglass)

  Effective length: 400 cm

  Width: 15 cm

  Depth: 20 cm
- Measuring depth of scour
- Meter, to measure the location of scour
- Photo camera to take pictures during experiments
- Video recorder to record the execution of the experiment.

2.2 Research Steps

Broadly speaking, the research steps are divided into two stages, namely:

- Physical research, which is carried out in laboratory experiments to observe and record existing phenomena.
- Hypothetical and analytical research, which was conducted to find the relationship and the variables that influence it.

2.3 Research Prepation

This research was conducted using a laboratory approach with various variations in flowrate, velocity and time. The standard flume is mostly made of glass and has the following important parts:

- Aqueduct, the main place in this experiment, to drain water. In the form of a water flume with a size of 400 x 20 x 15 cm. This channel has transparent walls for easy viewing.
- A reservoir that serves to accommodate water that will flow into the channel or out,
- Water pump, serves to pump water so that it can be distributed along the gutters. This pump is equipped with an automatic on/off switch for 220/240 V, 50 Hz,

- Discharge faucet, is a faucet that functions to regulate the size of the discharge coming out of the pump. Has a discharge opening scale of 6-9 range,
- Slope adjustment wheel, located upstream and downstream of the channel that can be turned manually to adjust the desired bed slope. This bed slope control wheel has a scale for a maximum positive bed slope of + 3.0 % and a maximum negative bed slope of -1.0%.

Figure 1. 2-Dimensional channel model (Syarifudin, A, 2018)

2.4 Stage in Research

The Stage of research are divided into:

- The first stage is to collect references from journals, books, and other secondary data sources such as the BBWSS-VIII office, PU Pengairan of South Sumatra Province and PUPR of Palembang city as well as from other relevant agencies.
- The second stage, conducting a field orientation survey to obtain the current (existing) field conditions, taking photos of the field (site) so that they can be used as initial research data.
- The third stage, taking riverbed material, survey data and measuring channel topography to be input data for conducting model simulations in the laboratory.
- The fourth stage, conducting experimental simulations with various variations of discharge, velocity and flow tiThe fifth stage, to obtain experimental results, namely, the location and amount of sedimentation at the bottom of the river (bed load) of the Aur river and the possibility of erosion (scouring) that occurs with various discharges, flow rates and times.
- The sixth stage, analyze the simulation results and conduct discussions- The seventh stage, making research conclusions and providing suggestions for further research by other studies.

2.5 Langhaar Methods Dimentional analysis

Hydraulic phenomena or events can be explained by n parameters Pi with i = 1,2, 3, ... , n and if the parameter is composed of m principal elements, then the product of dimensionless numbers that can be derived is (n-m). For hydraulic engineering purposes there are usually 3 main elements, namely: mass (M), length (L), and time (T).

j = P1k1 . P2k2 . P3k3 . . . . P, where

jnkn = product of dimensionless numbers with j = 1, 2, 3

If Pi has dimension M, then the dimensions can be written as follows:

= (Mα1 Lβ1 Tτ1)k1 * (Mα2 Lβ2 Tτ2)k2 * .... (Mαn Lβn Tτn)kn

= [M (α1k1+ α2k2 +........ +αnkn)]*[Lβ1k1 + β2k2+....... +βnkn]*[Tτ1k1+ 2 k2 +......... +τn kn]

is a dimensionless number if:

1 k1+ 2 k2 +........+ n kn = 0

1 k1 + 2 k2+....... + n kn = 0

1 k1 + 2 k2 +........+ n kn = 0

coefficients i, i and i can be known from the related parameters Pi.

III. Research Result And Discussion

3.1. Dimension Analysis

Dimensional analysis in this study uses Langhaar's theorem, this theorem is considered more in line with current conditions and in accordance with research because the parameters are relatively few. The dimensional analysis steps are as follows:

1. In the formulation of the problem, it is stated that the parameters that affect the erosion around the sluice gate include water depth (h), flow velocity (v), location of erosion or distance (x), acceleration of gravity (g), water mass density (ρw) and time (t).

2. The parameters are grouped into:

a. Dependent parameter: x

b. Parameters changed during the experiment: ds, h, v and t

c. Other parameters: g and w

3. The prices for 1, 1 and 1 are determined by tabulation as follows:

Table 1. Pricing 1, 1 and 1

Grup	1		2		3		Ket
Parameter	ds	q	h	t	ρ	g	
M	0	0	0	0	1	0	α1
L	1	1	1	0	-3	1	β1
T	0	0	0	1	0	-2	γ1
	k1	k2	k3	k4	k5	k6	ki

Equations related to parameters

k6 = 0

k1 + k2 +k3+k4 -3k6 + k7 = 0

-k4 + k5 – 2k7 = 0 ; k7 = 0.5k4 –0.5k5

k5 elimination

k6 = 0

k1 + k2 + k3 + 1.5k4 – 0.5k5 = 0

k7 = 0.5k4 – 0.5k5

The determination of the dimensionless number is as shown in table 2. Below

ki	k1	k2	k3	k4	k5	k6
Parameter	ds	q	h	t	ρ	g
π1	1	0	0	-1	0	0
π2	0	1	0	-1	0	0
π3	0	0	1	0	0	2
π4	0	0	0	1	0	0,5

π1 = ds/t

π2 = q/t

π3 = 2g * t

π4= x*1/2g

f (dd/t; de/t; q/t; v) = 0 where v ≈ 0

There are two equations with each function, namely:

(dd/t) = f (q/t) focus on sedimentation in rivers

(de/t) = f (q/t) focus on river erosion

3.2. Simulation Results and Discussion

3.2.1. Analysis of discharge per unit width (Q/b); q(m2/s)

After doing a dimensional analysis to determine the relationship between dimensionless parameters, the results of which are in the form of a graph of the relationship between dimensionless parameters, table 3 below is the calculation of the flood discharge in the Aur river which affects the capacity balance in the Aur river retention pond.

Table 3. Flood discharge per unit width of the Aur . river

No	t (menit)	b (cm)	h (cm)	So	A (cm2)	n	P (cm)	R (cm)	V (cm/det)	Q (cm3/det)	(Q/b) (m2/det)
1	5	15	20	0.005	300	0.03	55	5.455	23.375	7012.629	0,584
2	10	15	20	0.005	300	0.03	55	5.455	23.375	7012.629	0,584
3	15	15	20	0.005	300	0.03	55	5.455	23.375	7012.629	0,584
4	20	15	20	0.005	300	0.03	55	5.455	23.375	7012.629	0,584
5	25	15	20	0.005	300	0.03	55	5.455	23.375	7012.629	0,584
6	30	15	20	0.005	300	0.03	55	5.455	23.375	7012.629	0,584

Source: Analysis results, 2021

3.2.2. 3.2.2. Analysis of the test results of dimensionless parameters between (de/t) and (q/t)

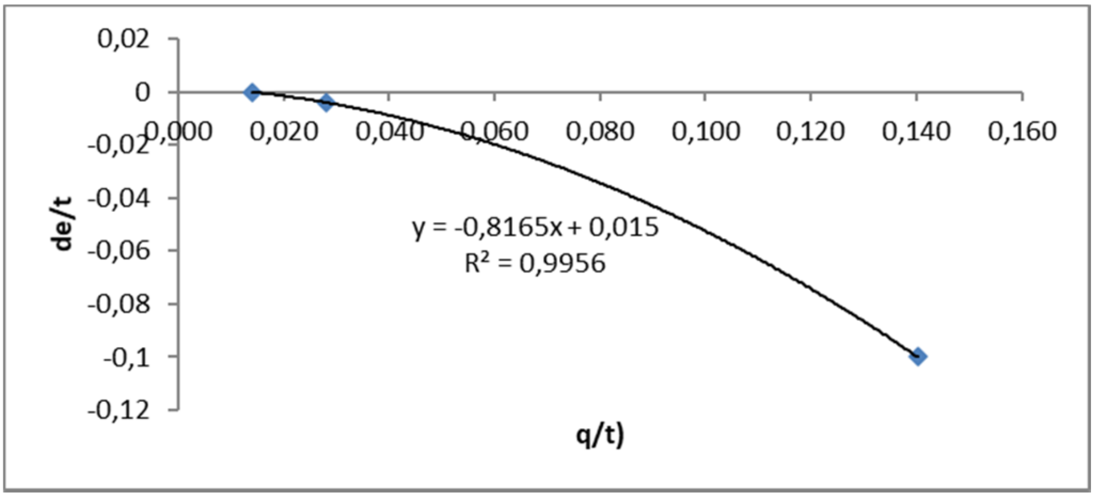

Figure 2. Graph of dimensional analysis results between (de/t) vs (q/t)

Based on the results of the analysis as shown in Figure 2. it can be said that at the starting point in the Aur river there is a maximum relative erosion (de/t)max of 0.11 cm (in the model) or 0.55 cm in the prototype with a scale of 1:100.

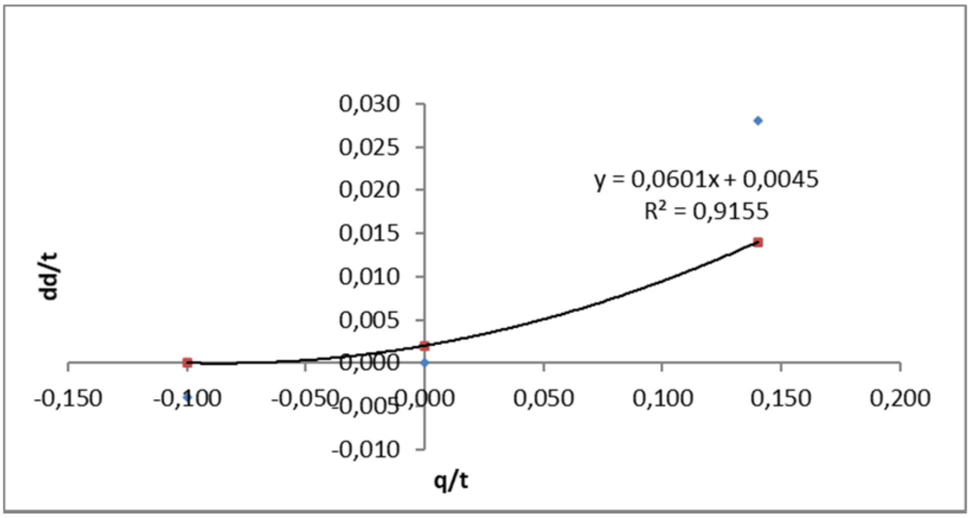

Figure 3. Graph of dimensional analysis results between (dd/t) vs (q/t)

In Figure 3. there is a significant increase in sedimentation resulting in a maximum relative sedimentation (dd/t) of 0.015, so it can be said that in the model there is a maximum sedimentation of 0.15 cm and in the prototype (field) there is a maximum sedimentation of 0.15 m (scale 1:100).

IV. CONCLUSIONS

At the mouth of the Aur river there is a maximum relative erosion (de/t) of 0.11 cm (model) or 0.55 cm in the prototype (field), meaning that in the Aur river there is an erosion of 0.55 m while the maximum relative sedimentation (dd /t)max 0.015 so it can be said that there is a maximum sedimentation of 0.015 cm (model) and in the prototype (field) a maximum sedimentation of 0.15 m occurs in the prototype with a scale of 1:100.

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