The Effect of Flow Capacity on The Geometry of The Meander of River

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Abstract. Musi River in Bailangu Village, Banyuasin Regency, has 3 (three) landslide locations and needs careful repairs due to some parameters related to cliff landslide on the meandering river. The influence of the river hydraulic parameter is the discharge flow (Q) toward the magnitude of the erosion depth (de) at the bend of Musi River. Besides, the influence of discharge flow (Q) does not affect the erosion depth (de) based on the certain experiment time. With the modeling method of the meander river in the laboratory, it is found the result that the discharge flow (Q) is very influential on the magnitude of the scour depth (de), which is shown from the determination value (R2) at the experiment time for 10 minutes, 15 minutes, 20 minutes and 30 minutes with each value of 98.7%, 99.1%, 99.1%, and 85.6%. Then, at the experiment for 25 minutes, the discharge flow (Q) does not affect the erosion depth (de) with the determination value (R2) only at 49.7%, of which it shows that there is no significant influence of the magnitude of the discharge flow on the erosion depth (de).

Keywords: discharge, meander, river geometry, sediment, flow speed

INTRODUCTION

In South Sumatra Province, there is the Musi River where most of its cliffs often occur, especially in areas outside the bend of the river adjacent to the main road. Bailangu Village is one of the villages located in Sekayu District, Kab. Musi Banyuasin, South Sumatra Province. The coordinates of Bailangu village are 1.3° - 4° South Latitude, 103° - 105° East Longitude. The condition of the road that passes through Bailangu Village is on the edge of the Musi river with the existence of the road being on the side of the Musi river. This will result in landslides / terbis on the road body due to the scouring of the Musi river.[11]

The Musi River in Bailangu Village has 3 landslide locations and needs careful repair due to several parameters related to cliff landslides on meandering rivers. At this time, structural repairs have been carried out at the point of the landslide, but researchers are more likely to conduct research related to the movement of flow on the riverbed. In meandered areas, erosion usually occurs at outer bends, this is due to the flow of energy that seems to hit a cliff because the flow will naturally find a straight path so that some of the riverbank material will be carried away. Whereas in deep turns due to lack of energy to carry the entire flow of water together with suspended sediment transport, some of it will settle in the area.[10]

River channel shift is a process in the river associated with erosion on one bank and riverbed on the one hand accompanied by silting on the other. Discharge fluctuations that occur throughout the year cause changes in subgrade and riverbanks, changes in discharge fluctuations may also cause rapid movement of river flows.[12]

Natural conditions shape the flow of the river with geometry in accordance with the demands of the discharge that occurs and the existing topography so that it is impossible for the river to look perfectly straight. This misalignment of the river causes a helical current to accelerate the bends and bends of the river. In this meandered river channel, the threat to the safety of river structures becomes more real, it can be seen that the movement of the meandered river channel is faster than that which occurs in a relatively straight channel.[12]

River flow discharge or flow capacity is the flow rate of a liquid per unit time. Discharge is also defined as the product of velocity and cross-sectional area. The greater the speed and the cross-sectional area, the greater the discharge generated. Speed itself is the amount of distance traveled per unit time. We often encounter the phenomenon of bedforms in rivers in river morphology. This basic form occurs due to flow (flow induced) and the influence of basic roughness (roughness). As a result of changes in the volume of river transport can cause the shape of the riverbed to change. The bottom sediment transport (bed load) is influenced by flow conditions including flow rate (Q), channel bottom slope (S), and variations in bottom sediment composition.[6]

SITE OVERVIEW AND METHODOLOGY

Research sites

This research was carried out at the location of the cliff landslide point in Bailangu Village, Sekayu District, Musi Banyuasin Regency. There are two approaches to be implemented empirically and to make a scalable model of the prototype as shown in Figure 1.

FIGURE 1. Location of research

Research materials and tools used in this study are as shown in table 1.

TABLE 1. List of materials and tools used in research

No.	Tools Name	Amount	Utility
1	River scale model	1 set	River model simulation tool in the laboratory. This model is made based on the available river topography measurements
2	Pump	1 set	Assists the movement of flow in the model. The water in the reservoir is then sucked up and flowed into the model scale

3	River bed materials	+/- 10 kg	Sediment base material for river model.Sediment base material is overlaid in the model
4	Water	Customized	Flow simulation. Media for flowing sediment in the model
5	Measuring scour depth (erosion)	1 unit	Get erosion and sedimentation values. The moving or transporting material is then measured to gain erosion and sediment values

Research Parameters

The parameters related in this study are as follows in the mathematical formulation.[3]

$$ds = f(Q, A, t, So, x, \rho w, b, h) \quad (1)$$

where :

Q = Flow Discharge (m3/sec)
V = River Flow Velocity (m/sec)
A = River Wet Cross-sectional Area (m2)
t = Time (seconds)
So = Riverbed Slope
x = View point distance in the river (m)
ds = Diameter of Riverbed Grain (mm)
ρw = Mass Density of Water (kg/m2)
b = River Width (m)
h = River Height/Depth (m)

Q (flow discharge) in the river in this study is the dependent variable, and V, A, x, t, ds, b, and h are independent variables. While w includes other variables.
Furthermore, the dimensionless parameter analysis of some of the variables mentioned above will be carried out using the Langhaar method. This method is used to see the relationship between related parameters without dimension.

Langhaar Method

If the hydraulic phenomenon/event 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 the dimensionless numbers that can be derived number (n-m). For hydraulic engineering purposes, there are usually 3 main elements, namely: mass (M), length (L), and time (T).

$\pi j = P1^{k1}.\ P2^{k2}.\ P3^{K3} \ldots\ldots\ P$, where

πj_{nkn} = product of dimensionless numbers with j = 1, 2, 3

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

$$\pi = (M^{\alpha 1} L^{\beta 1} T^{\tau 1})^{k1} * (M^{\alpha 2} L^{\beta 2} T^{\tau 2})^{k2} * \ldots\ldots\ldots\ (M^{\alpha n} L^{\beta n} T^{\tau n})^{kn}$$

$$\pi = [M^{(\alpha 1k1+ \alpha 2k2 +\ldots\ldots +\alpha nkn)}]*[L^{\beta 1k1 + \beta 2k2+\ldots\ldots +\beta nkn}]*[T^{\tau 1k1+ \tau 2 k2 +\ldots\ldots +\tau n kn}]$$

π is a dimensionless number if :

$\alpha 1\ k1+ \alpha 2\ k2 +\ldots\ldots+ \alpha\ n\ kn = 0$

$\beta 1\ k1 +\beta\ 2\ k2+\ldots\ldots + \beta n\ kn = 0$

$\tau 1\ k1 + \tau 2\ k2 +\ldots\ldots+ \tau n\ kn = 0$

The coefficients αi, βi and τi can be known from the related Pi parameters.[3]

Dimension Analysis

The data generated from the various experiments that have been carried out are analyzed using the Langhaar theorem which is one of the dimensions in the analysis. Langhaar's theorem is considered more in line with current conditions and in accordance with research because the parameters are relatively few.[6] The results of the determination of dimensionless numbers are as in table 2 below :

TABLE 2. Parameters of dimensionless numbers

ki	**k1**	**k2**	**k3**	**k4**	**k5**	**k6**
Parameter	**de**	**x**	**Q**	**t**	**ρ_w**	**g**
$\pi 1$	1	0	0	-1	0	0
$\pi 2$	0	1	0	-1	0	0
$\pi 3$	0	0	1	-1	0	0
$\pi 4$	0	0	0	1	0	0,5

(de/t) = f (x/t) and (Q/t) we get the following two equations:
(de/t) vs (Q/t) and (de/t) vs (x/t)

RESULTS AND DISCUSSION

Based on the results of dimensional analysis, the results obtained in the form of images and graphs of the relationship between related variables in the form of the relationship between the parameters of discharge (Q), scouring depth or erosion) (de), sedimentation or deposition (dd), distance (x), and time (t) as well as parameters Others are gravity (g) and flow density (ρw). The results of the study are as shown in the image below:

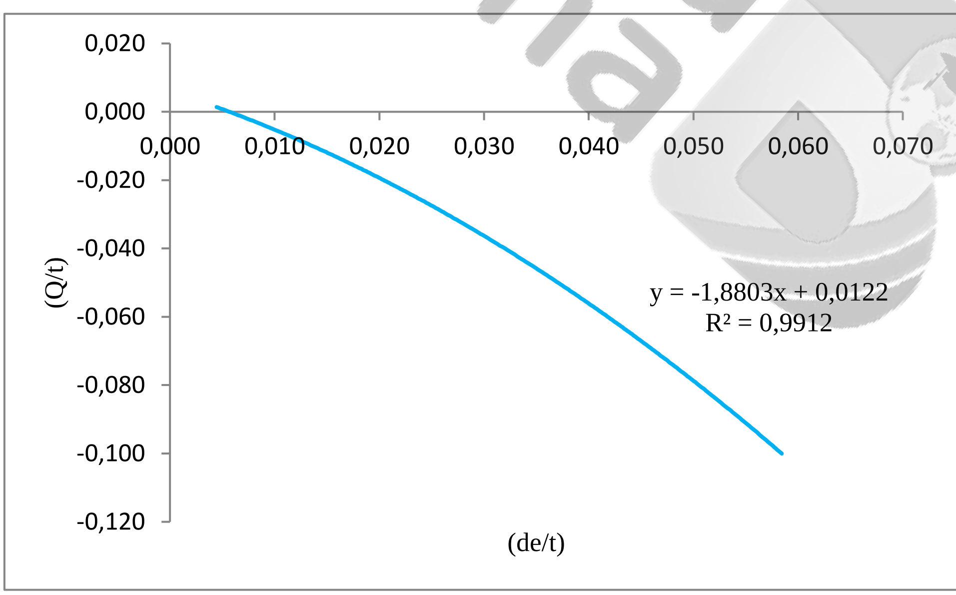

FIGURE 2. Graph of the relationship between (Q/t) and (de/t) for 15 minutes trial

In figure 2. it can be seen that the maximum relative erosion $(de/t)_{max}$ in the river occurs at the maximum discharge (Q/t)max = 0.1, which is 0.058. This means that within 15 minutes of the experiment, there was 0.87 cm of river erosion in the model with R^2 = 0.991 or R = 0.98. This means that there is a very significant relationship between the erosion that occurs and the flow rate in the river. there is a very relevant relationship between flow rate and erosion in the river bed

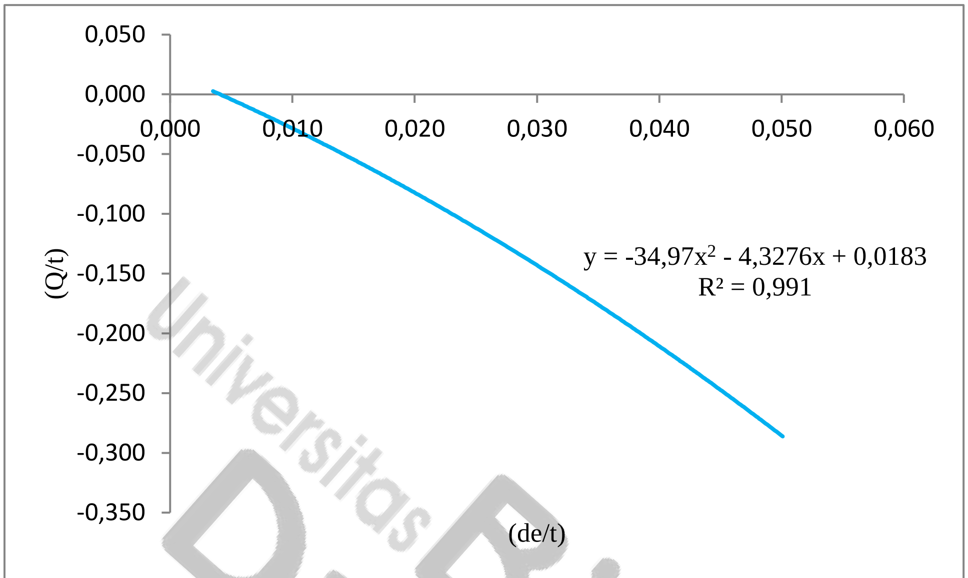

FIGURE 3. Graph of the relationship between (Q/t) and (de/t) for 20 minutes trial

In figure 3. it can be seen that the maximum relative erosion (de/t)max in the river occurs at the maximum discharge (Q/t)max = 0.286, which is 0.050. This means that within 20 minutes of the experiment, there was 1.00 cm of river erosion in the model with R^2 = 0.991 or R = 0.98. This means that there is a very significant relationship between the erosion that occurs and the flow rate in the river.

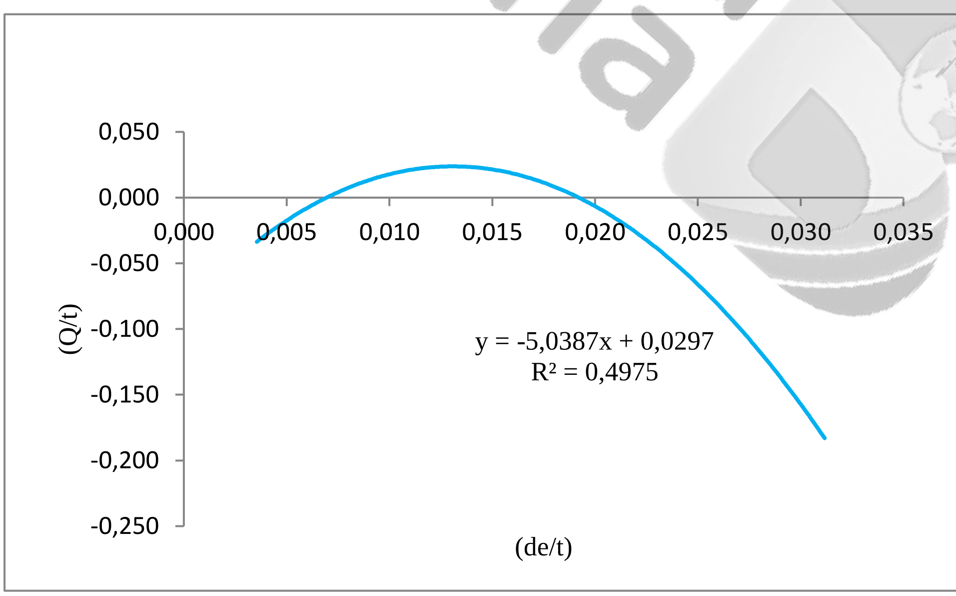

FIGURE 4. Graph of the relationship between (Q/t) and (de/t) for 25 minute trial

In figure 4. it can be seen that the maximum relative erosion (de/t)max in the river occurs at the maximum discharge (Q/t)max = 0.158, which is 0.030. This means that within 25 minutes of the experiment, there was 0.325 cm of river erosion in the model with R^2 = 0.497 or R = 0.247. This means that there is no significant relationship between the erosion that occurs and the flow rate in the river, this is because the determination value is only 0,247.

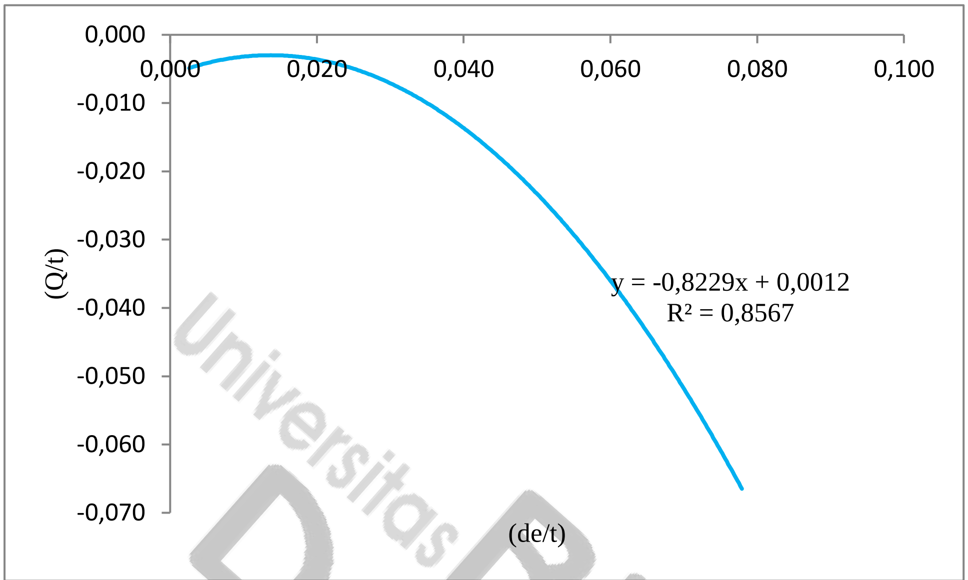

FIGURE 5. Graph of the relationship between (Q/t) and (de/t) for 30 minutes trial

In figure 5. it can be seen that the maximum relative erosion (de/t)max in the river occurs at the maximum discharge (Q/t)max = 0.068, which is 0.078. This means that within 30 minutes of the experiment, there was 2.34 cm of river erosion in the model with R^2 = 0.856 or R = 0.732. This means that there is a significant relationship of 73.2 percent between the erosion that occurs and the flow rate in the river.

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CONCLUSION

This research can be concluded as follows :

1. The discharge flow (Q) greatly influences the magnitude of the scour depth (de), this can be seen from the determination value (R2) when the trial time is at intervals of 10 minutes, 15 minutes, 20 minutes and 30 minutes where each value of R2 is 98, 7%, 99.1%, 99.1%, and 85.6%)
2. When the experiment is for 25 minutes, the flow rate (Q) does not affect the depth of erosion (de) where the determination value (R2) is only 49.7% which shows that there is no significant impact on the magnitude of the discharge rate on the erosion depth (de)

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