



THE INFLUENCE OF AUTOMATIC FLAP GATE ON EROSION IN TIDAL SWAMP AREA

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ABSTRACT: This research aims to examine the problem of erosion and sedimentation in canals in swampy areas in South Sumatra, namely the P8-13S scheme of the canal (SPD) Telang I, Banyuasin regency with the influence of flap gate. The research method used is to perform simulations in the laboratory using a scale model and related parameters, such as velocity (v), depth of erosion (de), sedimentation (ds), water density (ρ_w), gravitation (g), time (t) and distance (x). Dimensional analysis to determine the related parameters that produce a dimensionless parameter relationship model is carried out using the Langhaar method. The result of the study was that the maximum relative erosion $(de/t)_{max}$ occurred at the canals estuary near the flap gate, which was 0.255 during simulation times of 5 minutes. While the maximum relative sedimentation $(dd/t)_{max}$ also occurred at the estuary of the secondary canals (SPD) of 0.05 for 5 minutes. So, the sediment transport process in the secondary canal (SPD) is generally influenced by flow velocity and the presence of a flap gate in the canal to regulate sediment transport.

KEYWORDS: *SPD Channels, Sluice-gate, Langhaar Method, Sediment Transport.*

1. INTRODUCTION

In river management, it will be related to sediment transport, which will take into account the magnitude of the dominant discharge. The definition of dominant discharge is discharged that drains most of the suspended sediment in a cross-section river to reach its equilibrium condition [1]. Sediment discharge will be related to river discharge in the form of a discharge-duration curve between the water discharge and the suspended sediment discharge. In contrast, the sediment settlement is directly proportional to the suspension discharge [2], [3].

The flow of water flowing in rivers is not fixed but constantly changes according to a function of time. So the river flow is not permanent (non-steady flow). The sediment intensity will also change according to changes in the discharge, so the amount of total sediment transport is the integration of sediment transport over a certain time [4]. The best approach to forecasting the transport intensity is to use statistical analysis of the flow data [5].

The erosion and sedimentation process greatly affect the balance of the riverbed configuration [4]. The factors forming the configuration of the riverbed are strongly influenced by the speed, duration of flow and depth of flow [6]. Observing the basic material and flow conditions can predict the possibility of sedimentation and erosion/scouring at the riverbed at certain locations in the river channel [7]–[9].

Fig. 1. Research location



Fig. 2. Two-dimension standard flume

The materials used in this study consisted of:

- Sand with a diameter of 0.025 mm to 2.36 mm is considered sedimentary grain material that was previously carried out by sieve analysis to obtain a uniform grain diameter (ds).
- Water flows in the channel as a medium for moving sedimentary material.

Based on Fig. 2, the specifications of the flume: Wall material is glass (Plexiglas); Effective length of 4 m; Width of 0.15 m; Depth of 0.2 m, And automatic valve door. The research model is made by making a scalable model in the laboratory with various flow rate variations, flow rate, and time. The standard flume is mainly made of glass and has the following parts:

- Standard channel is the main part to drain water. In the form of a rectangular channel with 400 cm x 20 cm 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 to be distributed along the channel. This pump is also equipped with an automatic on and off switch for 220/240 V, 50 Hz;
- The discharge control valve is a faucet that regulates the amount of discharge that comes out of the pump. Has a discharge opening scale of 6-9 range;
- Slope adjustment wheel, located upstream and downstream of the channel, 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%.

The dimensions of the variables contained in the field of hydraulic engineering, the MLT system is usually used, namely the writing of dimensions using 3 main elements of the dimensions Mass (M), length (L) and Time (T).

The model is usually done to reduce the various variables by giving a scale (n) on each of these variables. Meanwhile, the scale of the various variables or parameters can be determined based on the relationship between the parameters expressed in dimensionless numbers, such as Reynolds number, Froude number, etc.



In addition to determining the relationship between scales, this dimensionless number can also be used to describe research results thus the results of these studies can be generalized to determine the dimensionless number can be done by dimensional analysis. Dimensional analysis to determine the dimensionless number has several ways: Basic echelon matrix; Buckingham (phi. theorem); Rayleigh; Stepwise; and Langhaar.

If the hydraulic phenomenon/event can be explained by n parameters Π_i with $i = 1, 2, 3, \dots, n$ and if the parameter is composed of m principal elements, then the product of dimensionless numbers can be derived number (n-m). For hydraulic engineering purposes, there are usually 3 main elements, namely: mass (M), length (L), and time (T).

$$\pi_j = P_1^{k_1} \cdot P_2^{k_2} \cdot P_3^{k_3} \dots P \quad (1)$$

where π is a product of dimensionless number.

When Π_i has dimension M, then the dimensions can be written as follows:

$$\pi = (M^{\alpha_1} \cdot L^{\beta_1} \cdot T^{\tau_1})^{k_1} \cdot (M^{\alpha_2} \cdot L^{\beta_2} \cdot T^{\tau_2})^{k_2} \cdot (M^{\alpha_n} \cdot L^{\beta_n} \cdot T^{\tau_n})^{k_n} \quad (2)$$

$$\pi = [M^{(\alpha_1 k_1 + \alpha_2 k_2 + \alpha_n k_n)}] \cdot [L^{(\beta_1 k_1 + \beta_2 k_2 + \beta_n k_n)}] \cdot [T^{(\tau_1 k_1 + \tau_2 k_2 + \tau_n k_n)}] \quad (3)$$

π is a dimensionless number if

$$0 = \alpha_1 k_1 + \alpha_2 k_2 + \alpha_n k_n$$

$$0 = \beta_1 k_1 + \beta_2 k_2 + \beta_n k_n \quad (4)$$

$$0 = \tau_1 k_1 + \tau_2 k_2 + \tau_n k_n$$

Coefficients α_i , β_i and τ_i can be known from Π_i 's related parameters.

In this research, the dimensional analysis used the Langhaar method because there are few parameters involved. The relationship between the related parameters and the results is in the form of dimensionless parameters.

3. RESULTS AND DISCUSSION

From Fig. 3, the maximum relative erosion depth $(d_e/t)_{\max}$ of 0.255 occurs at the mouth of the channel, then up to a relative distance (x/t) of 80, the erosion value (d_e/t) is 0.05. with a coefficient of determination R^2 of 0.663 or an R-value of 81.24%, it means that distance (x) and time (t) simultaneously have a significant effect on the depth of erosion (d_e) that occurs.

From Fig. 4, the maximum relative erosion depth $(d_e/t)_{\max}$ of 0.10 occurred at the estuary of the secondary channel (SPD) to a relative distance (x/t) of 25, neither erosion nor sedimentation occurred. This condition is called the balance condition in the channel or "equilibrium". With a coefficient of determination R^2 of 0.666 or an R-value of 81.60%, it means that distance (x) and time (t) simultaneously have a significant effect on the depth of erosion (d_e) that occurs.

From Fig. 5, the maximum relative erosion depth $(d_e/t)_{\max}$ of 0.07 occurs at the mouth of the secondary channel (SPD), and a relative distance (x/t) between 10-20 sedimentation occurs in the secondary channel. Then, another relative erosion (d_e/t) of 0.04 at a relative distance (x/t) of 26. with a coefficient of determination R^2 of 0.611 or an R-value of 78.16%, it means that distance (x) and time (t) simultaneously have a significant effect on the depth of erosion (d_e) that occurs.

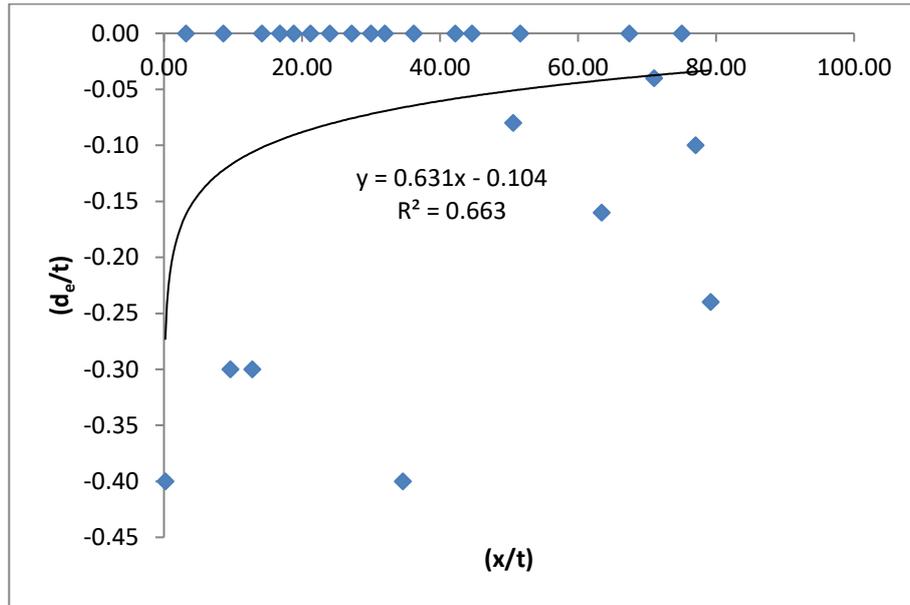


Fig. 3. Test 1 - the relationship between (d_e/t) and (x/t) during the 5 minute experiment

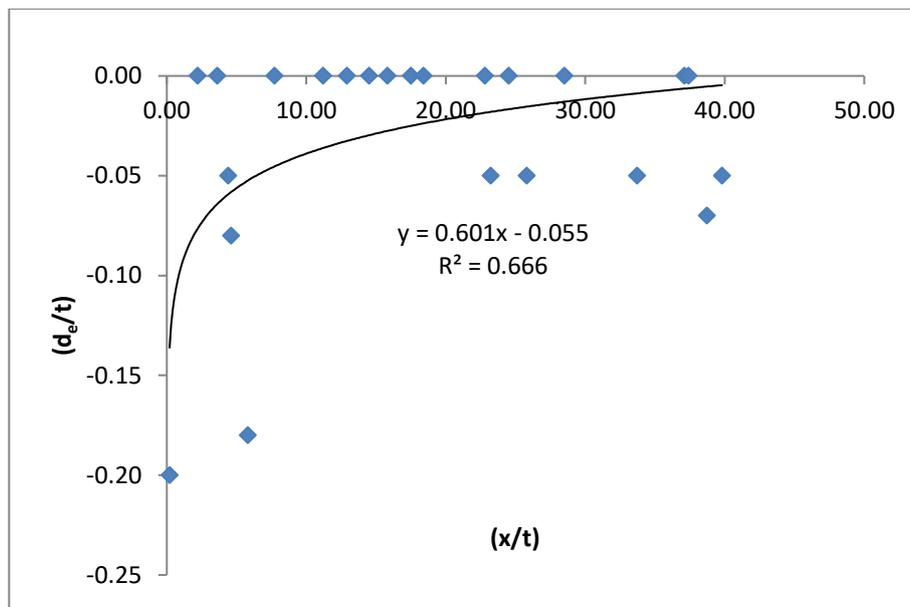


Fig. 4. Test 2 - the relationship between (d_e/t) and (x/t) during the 5 minutes experiment

From Fig. 6, it looks almost the same as the simulation time of 15 minutes, where the maximum relative erosion depth $(d_e/t)_{max}$ of 0.06 occurs at the estuary of the secondary channel (SPD) and a relative distance (x/t) between 10-15 sedimentation occurs in the secondary channel. Then, another relative erosion (d_e/t) of 0.04 at a relative distance (x/t) of 20. with a coefficient of determination R^2 of 0.628 or an R-value of 79.24%, it means that distance (x) and time (t) simultaneously have a significant effect on the depth of erosion (d_e) that occurs.

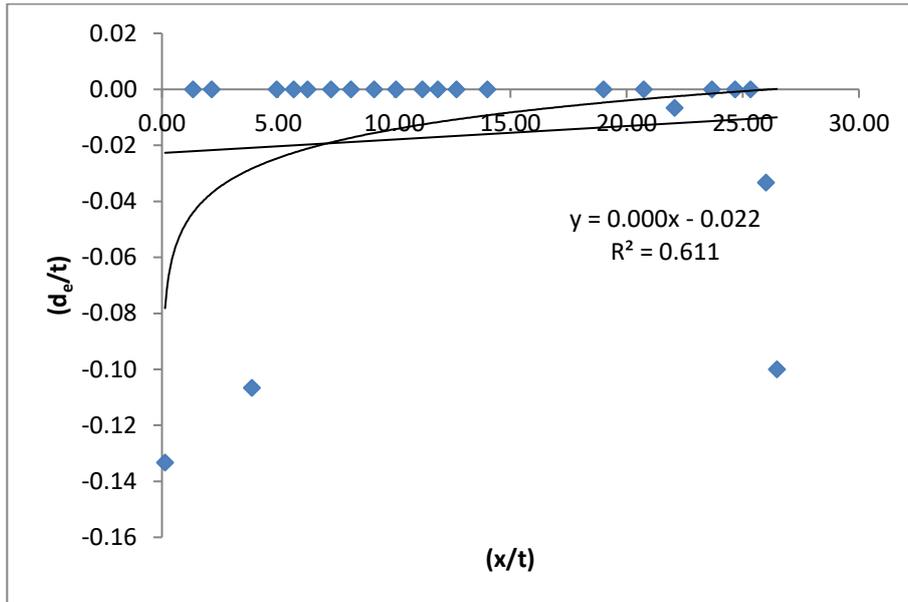


Fig. 5. Test 3 - the relationship between (d_e/t) and (x/t) during the 5 minutes experiment

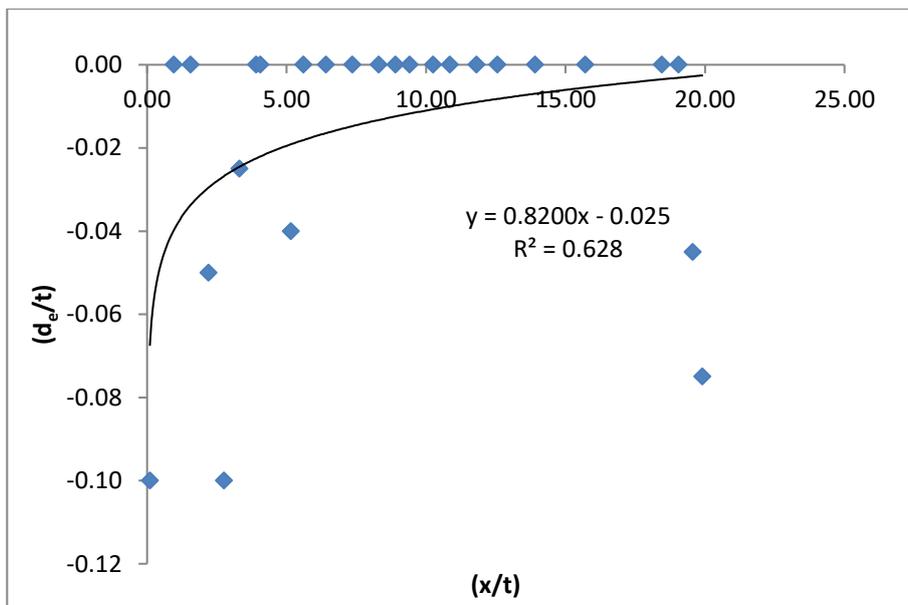


Fig. 6. Test 4 - the relationship between (d_e/t) and (x/t) during the 5 minutes experiment

4. CONCLUSION

The maximum relative erosion depth $(d_e/t)_{max}$ of 0.255 occurs at the mouth of the channel, then up to a relative distance (x/t) of 80, the erosion value (d_e/t) is 0.05. with a coefficient of determination R^2 of 0.663 or an R-value of 81.24%, it means that distance (x) and time (t) simultaneously have a significant effect on the depth of erosion (d_e) that occurs.

The maximum relative erosion depth $(d_e/t)_{max}$ of 0.10 occurred at the estuary of the secondary channel (SPD) to a relative distance (x/t) of 25; neither erosion nor sedimentation occurred. This condition is called the balance condition in the channel or "equilibrium". With a coefficient of determination R^2 of 0.666 or an R-value of 81.60%, it means that distance (x) and time (t) simultaneously have a significant effect on the depth of erosion (d_e) that occurs.



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