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Study of The Physical Model of Flow in Down Stream of Sluice Gate of the Jakabaring Sport City Main Channel

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***Abstract*— The city drainage system which always experiences flooding in the city of Palembang every year is the Jakabaring River Basin. The Jabaring watershed is one of 33 points of frequent flood areas in Palembang City. This is because, until now, the Jakabaring River Basin (DAS) area does not yet have pumping facilities. So that it often becomes a customer for flooding.**

For that we need physical model research in the laboratory, namely with a standard flume with various variations in speed, time and sediment material in the form of sand.

The results showed that the greatest depth of erosion that occurred after the JSC main channel sluice building was 1.75 cm in the model with an experimental time of 25 minutes. In the first 5 minutes of the experiment, 10 minutes and 15 times no erosion occurred. At the time of the experiment for 30 minutes, there was a decrease in erosion, namely 0.15 cm in the model. Meanwhile, the largest sedimentation (dd) was 1.20 cm in the model during the experiment time of 30 minutes. Continued to experience a decrease in sedimentation (dd) both at the time of the experiment for 5 minutes, 10 minutes, then there was an increase in erosion for 15 minutes, and then it fell back down to 30 minutes.

***Keywords*— The Jakabaring Watershed; Langhaar Method; Erosion Rete; Sedimentation Rate.**

I. INTRODUCTION

River or open channel is a channel where water flows freely. In open channels, such as rivers (natural channels), the flow variables are very irregular with respect to space and time. These variables are channel cross-section, roughness, base slope, flow discharge turns and so on (Triatmodjo, 2003). River is a long channel above the earth's surface where water flows from rain and is always touched by water flow and is formed naturally (Sosrodarsono, 1994).

The complexity of the river system can be seen from the various components that make up the river, for example the shape of river channels and branching, river bed form, river morphology, and river ecosystem. The branching of the river will resemble a river tree starting from the first-order river to the n-order river. The riverbed formation when examined at a glance is very difficult to identify and characterize.

The shape of the meander groove is influenced by the longitudinal slope of the landscape, the type of riverbed material, and the vegetation in the area concerned (Maryono, 2007). The greatest benefit of a river is for agricultural irrigation, raw material for drinking water, as a drainage channel for rainwater and waste water, in fact it has the potential to become a river tourist attraction. In Indonesia, there are currently 5,950 watersheds (DAS).

Palembang city itself has 108 tributaries. There are 4 major rivers that cross the city of Palembang, namely the Musi River, Komering River, Ogan River, and Keramasan River. Of the 4 major rivers above the Musi River is the largest river with an average width of 504 meters and a maximum width of 1,350 meters around Kemaro Island. (Syarifudin, A, et al, 2018; Achmad Syarifudin, 2022)

Based on the division of river areas, there are 21 sub-watersheds, but only 18 sub-watersheds in the city of Palembang which empties directly into the Musi river in the city of Palembang, namely the Rengas Lacak, Gandus, Lambidaro, Boang, Sekanak, Weir, Lawang Kidul, Buah, Juaro, Batang, Sei Lively, Keramasan, Kertapati, Kedukan Ulu, Aur, Sriguna, Jakabaring and Plaju. (Department of PUPR of Palembang city, 2018)

The city drainage system which always experiences flooding in the city of Palembang every year, among others, is the Jakabaring watershed. Jabaring watershed is one of 33 flood-prone areas in Palembang City. This is because, until now, the Jakabaring Watershed (DAS) does not yet have pumping facilities. So it often becomes a flood subscription. (Sripo, 24 November 2020)

Simulation using physical modeling based on model scale from prototype to model in the laboratory with the same conditions in the prototype, namely existing conditions, normalization of river channels, drains, retention ponds, combined with pump systems and embankment construction, shows that in the existing conditions there are seven areas that flooded. (Achmad Syarifudin, 2022).

II. Research Methods

The research was carried out using the Hydraulics and Rivers laboratory at Bina Darma University with a laboratory scale (scale model) as shown in Figure 1.

Fig. 1. Research model in the laboratoy

2.1. Materials and tools

In this study the materials used:

- The material is sand from the Buah river with a diameter of 0.025 mm to 2.36 mm. Before being used as experimental material, a sieve analysis was carried out to obtain a uniform grain diameter.
- The flow in the channel is water as well as to move sediment grains,
- The tools are specifications of as follows:
    - Flexiglass for standard flume
    - Length of the channels: 4.00 m
    - Width: 0.15 m
    - Depth: 0.20 m

- The instrument meter used for scouring depth value.
- Photo camera to take pictures when doing the experiment.
- Video recorder to record experiment implementation.

2.2. Preparation of channel models in Research

This research was conducted using a laboratory approach method with various variations in the flow rate, flow rate and time. The standard channel (flume standard), most of its components are made of glass and have important parts, namely:

The research approach is carried out with physical models in the laboratory with various variations of discharge, velocity and flow time. The standard flume is mostly made of glass and has the following important parts:

a. 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.

b. A reservoir that serves to accommodate water that will flow into the channel or out,

c. 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,

d. 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,

e. 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 maximum positive bed slope + 3.0 % and maximum negative bed slope - 1.0 %.

III. Results and Discussion

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 of the relatively few parameters. The results of the determination of dimensionless numbers are shown in table 1 below:

TABLE I. DIMENSIONLESS NUMBER

ki	**k1**	**k2**	**k3**	**k4**	**k5**	**k6**
Parameter	**x (cm)**	**d_s (mm)**	**h (cm)**	**t (minute)**	**P (kg/cm^3)**	**g ($kg\ m/sec^2$)**
$\pi 1$	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

$f(x/t\ ;\ ds/t;\ v) = 0\ ;\ (v \approx 0)$

$(x/t) = f(d_d/t)$ focus on sedimentation rate

$(x/t) = f(d_e/t)$ focus on erosion rate

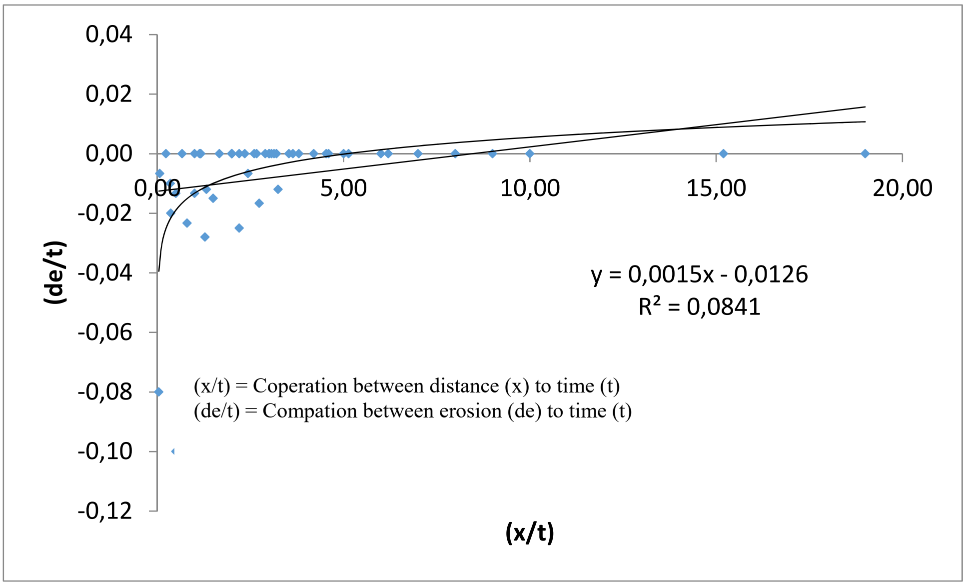

Fig 3. Comparison graph between (x/t) and (de/t) for 30 minute

Figure 3. is a graph showing that after the floodgates in the JSC channel there was a relative erosion (de/t) of 0.02 then sedimentation occurred at a relative distance (x/t) of 10. This means that for 30 minutes there was an erosion of 0.6 cm in models. If a scale of 1:100 is taken, it means that there is an erosion depth of 60 cm in the field. $R^2 = 0.084$ within 30 minutes, means that statistically the value obtained is not significant, invalid and cannot be used of the site.

During the first 5 minutes, there was a maximum relative erosion (de/t)max as shown in figure 4. below:

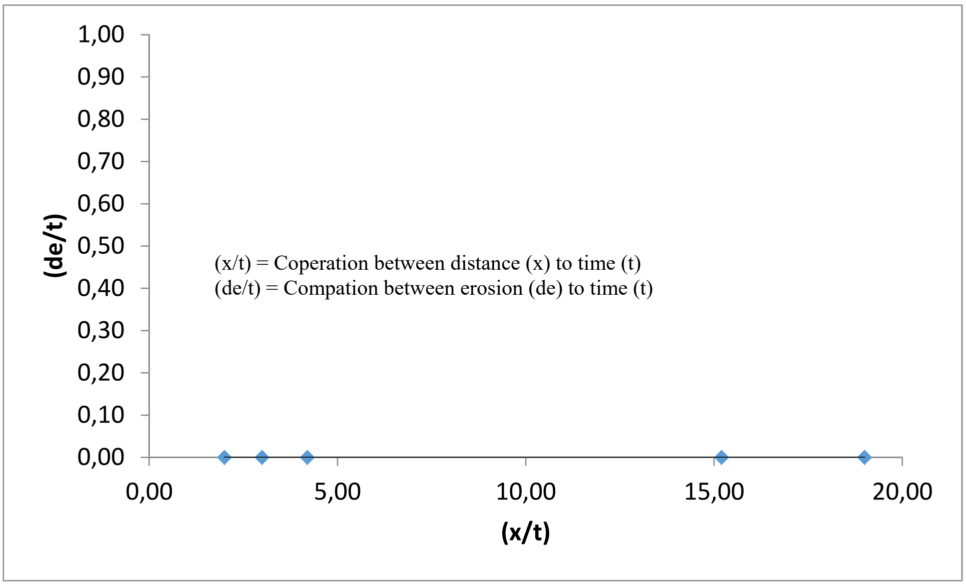

Fig 4. Comparison graph between (x/t) and (de/t) for 5 minutes

In figure 4. it can be seen that there was no erosion at all that occurred in front of the JSC main channel water gate, as well as at 10 minutes and 15 minutes no erosion occurred. $R^2 = 0.000$ within 5 minutes, means that statistically the value obtained is not significant, invalid and cannot be used of the site.

At the time of 20 minutes there was a maximum relative erosion (de/t)max as shown in Figure 5. below:

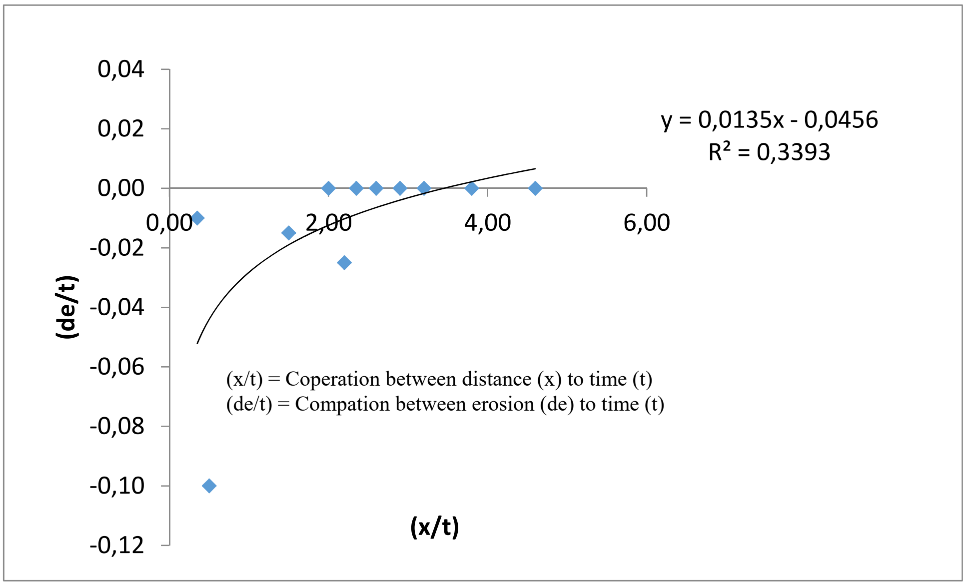

Fig 5. Comparison graph between (x/t) and (de/t) for 20 minutes

In Figure 5. it can be seen that the relative erosion (de/t) of 0.05 occurred in the main JSC channel for 20 minutes after the floodgate. This means that the depth of erosion that occurs is 1.00 cm in the model. R^2 = 0.339 within 5 minutes, means that statistically the value obtained is not significant, invalid and cannot be used of the site.

At the 25 minutes, there was a maximum relative erosion $(de/t)_{max}$ as shown in Figure 6. below:

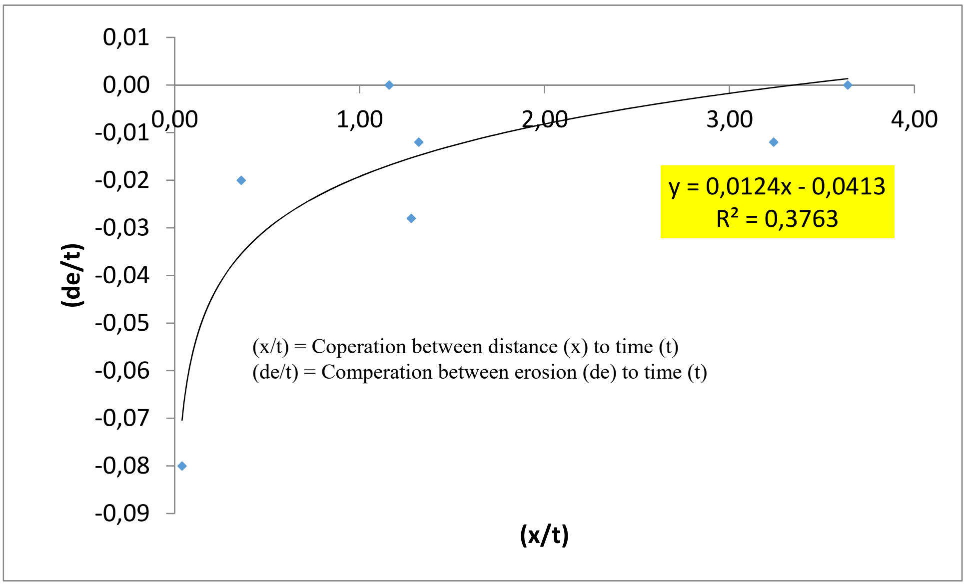

Fig 6. Comparison graph between (x/t) and (de/t) for 25 minutes

In Figure 6. it can be seen that the maximum relative erosion (d_e/t)max occurred right after the sluice building, which was 0.07 in 25 minutes, meaning that the erosion that occurred in front of the JSC main channel sluice was 1.75 cm in the model. R^2 = 0.376 within 5 minutes, means that statistically the value obtained is not significant, invalid and cannot be used of the site.

At the 30 minutes, there was a maximum relative sedimentation $(d_d/t)_{max}$ as shown in figure 7 below:

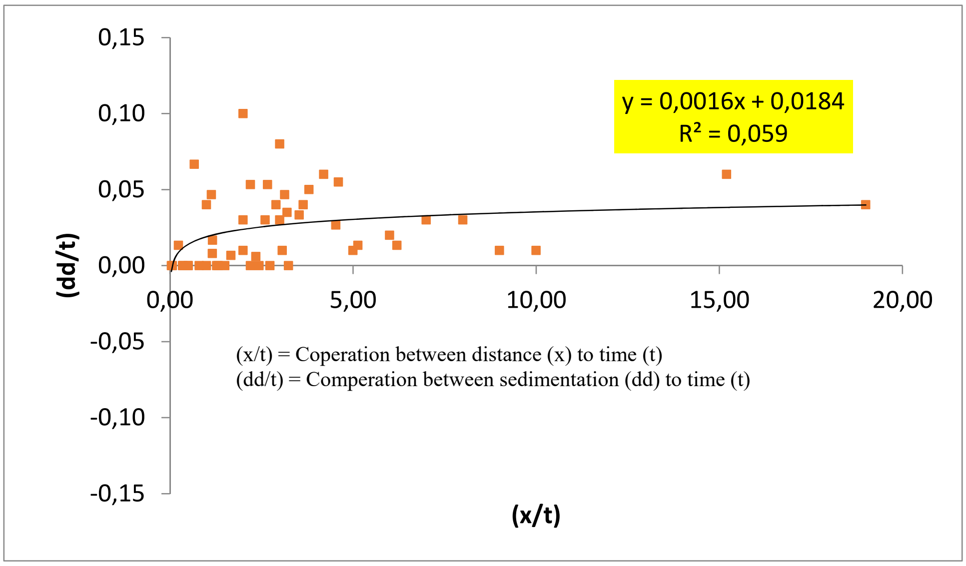

Fig 7. Graph of the relationship between (x/t) and (dd/t) for 30 minute

In Figure 7. it can be seen that the maximum relative sedimentation (d_d/t)max after the JSC main channel floodgate was 0.04 for 30 minutes, meaning that the sedimentation that occurred was 1.2 cm in the model. $R^2 = 0.059$ within 5 minutes, means that statistically the value obtained is not significant, invalid and cannot be used of the site.

At the 5 minutes, there was a maximum relative sedimentation $(d_d/t)_{max}$ as shown in Figure 8 below:

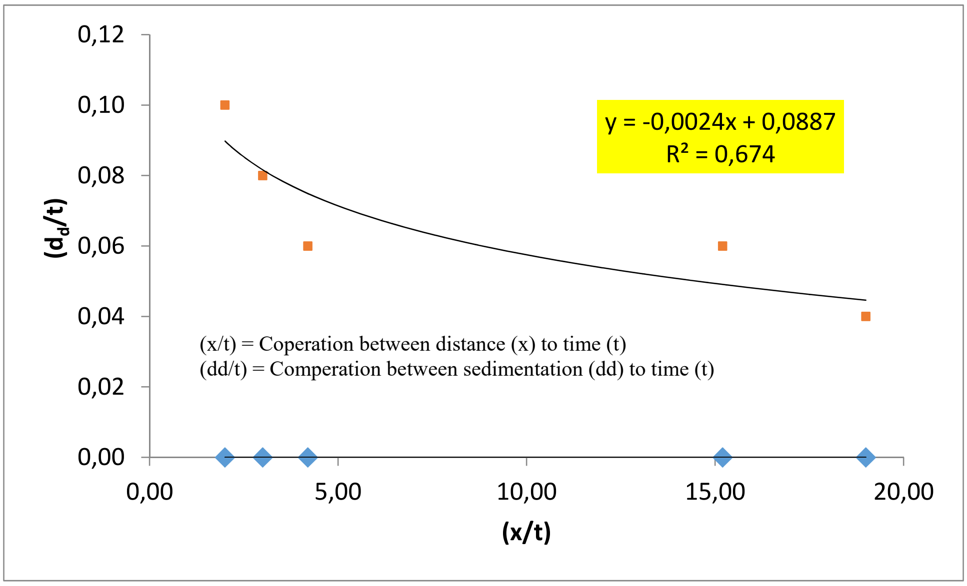

Fig 8. Graph of the relationship between (x/t) and (dd/t) for 5 minute

In Figure 8. it can be seen that the maximum relative sedimentation (d_d/t)max after the JSC main channel sluice was 0.09 for 5 minutes, meaning that there was 0.45 cm sedimentation in the model. $R^2 = 0.059$ within 5 minutes, means that statistically the value obtained is not significant, invalid and cannot be used of the site.

At the 10 minutes, there was a maximum relative sedimentation $(d_d/t)_{max}$ as shown in figure 9 below:

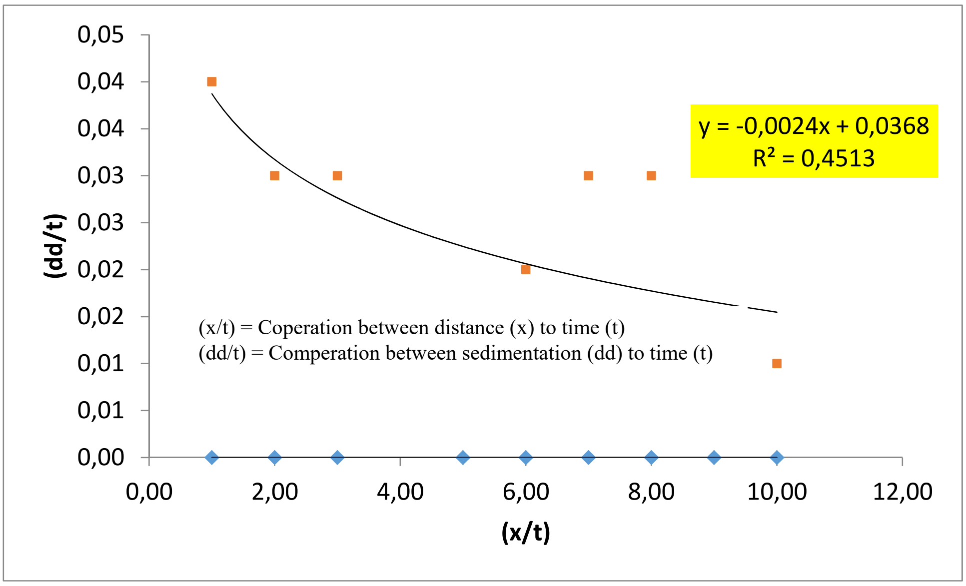

Fig 9. Comparison graph between (x/t) and (dd/t) for 10 minutes

In Figure 10, it can be seen that the maximum relative sedimentation (d_d/t)max after the JSC main canal floodgate was 0.04 for 10 minutes, meaning that sedimentation in front of the JSC main channel floodgate was 0.4 cm in the model. $R^2 = 0.451$ within 10 minutes, means that statistically the value obtained is not significant, invalid and cannot be used of the site.

At the 15 minutes, there was a maximum relative sedimentation $(d_d/t)_{max}$ as shown in figure 10 below:

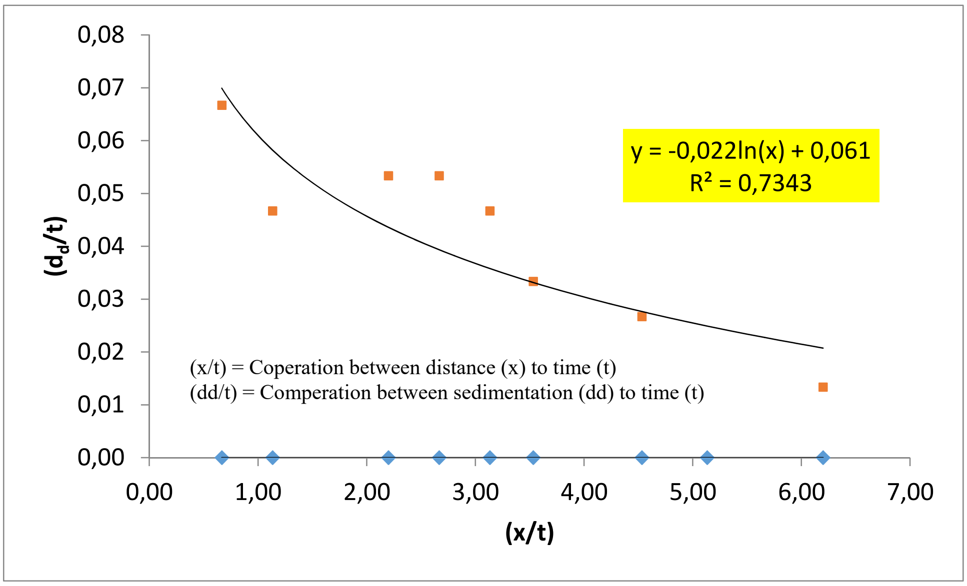

Fig 10. Comparison graph between (x/t) and (dd/t) for 15 minutes

In Figure 10. it can be seen that the maximum relative sedimentation (dd/t)max after the JSC main channel sluice gate was 0.07 for 15 minutes, meaning that there was a sedimentation of 1.05 cm in the model. $R^2 = 0.734$ within 15 minutes, means that statistically the value obtained is significant, valid and can be used of the site.

At the 20 minutes, there was a maximum relative sedimentation $(d_d/t)_{max}$ as shown in Figure 11 below:

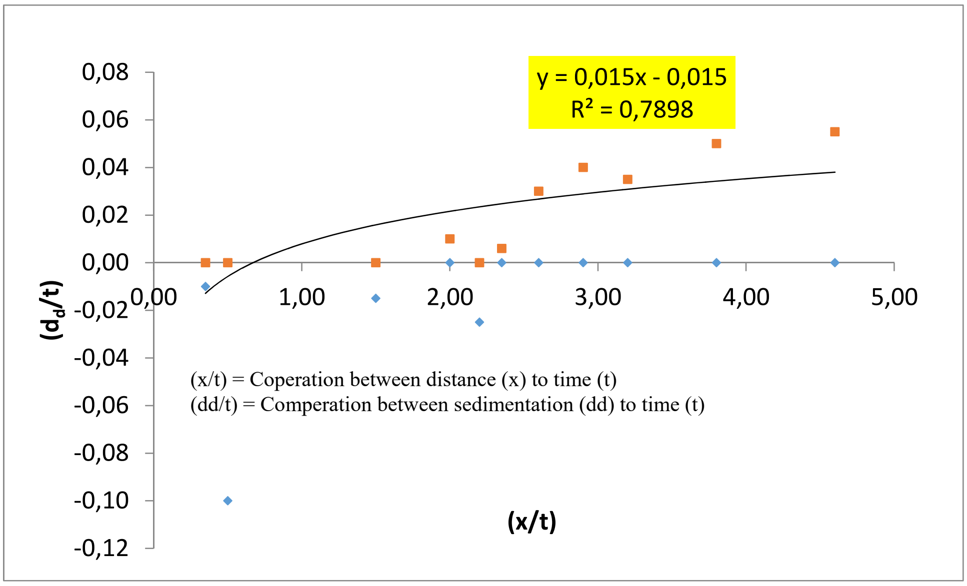

Fig 11. Graph of the relationship between (x/t) and (dd/t) for 20 minute

In Figure 11, it can be seen that the relative sedimentation (d_d/t) that occurred was only very little, namely 0.04 then erosion occurred in front of the water gate of the JSC main channel. During 20 minutes there was a sedimentation of 0.8 cm in the model. R^2 = 0.734 within 15 minutes, means that statistically the value obtained is significant, valid and can be used of the site.

At the 25 minutes, there was a maximum relative sedimentation $(d_d/t)_{max}$ as shown in Figure 12:

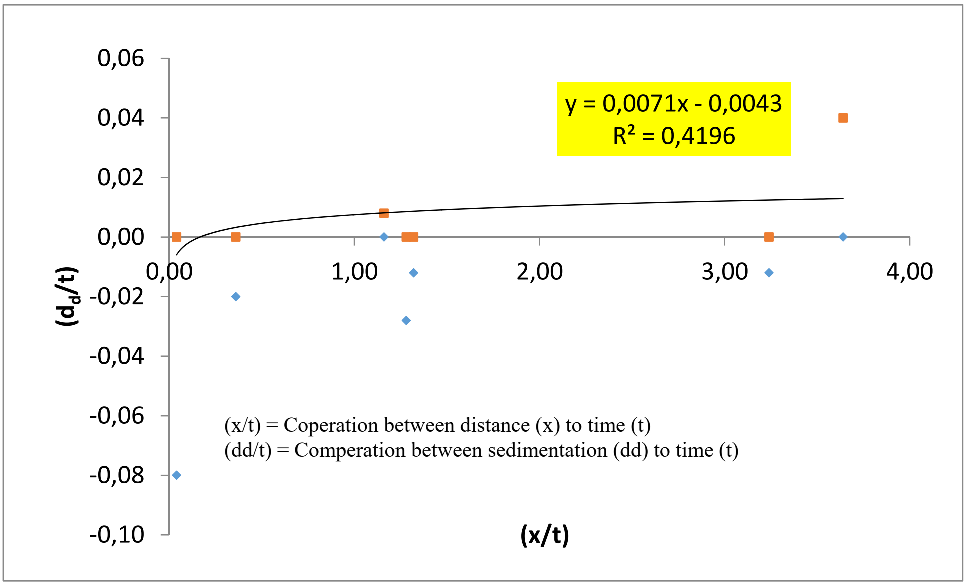

Fig 12. Graph of the relationship between (x/t) and (dd/t) for 25 minutes

Figure 12. shows the relative sedimentation (d_d/t) which is only 0.015 so that for 25 minutes there is a sedimentation of 0.375 cm in the model. R^2 = 0.419 within 25 minutes, means that statistically the value obtained is not significant, not valid and can not be used of the site.

IV. Conclusion

The greatest depth of erosion (de) that occurred after the JSC main channel sluice gate was 1.75 cm in the model with an experimental time of 25 minutes. In the first 5 minutes of the experiment, 10 minutes and 15 times no erosion occurred. At the time of the experiment for 30 minutes there was a decrease in erosion of 0.15 cm in the model.

Meanwhile, the largest sedimentation (d_d) was 1.20 cm in the model during the 30 minute experiment. Continued to experience a decrease in sedimentation (d_d) both at the time of the experiment for 5 minutes, 10 minutes, then there was an increase in erosion (de) again for 15 minutes, and then it went down again for 30 minutes.

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