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Numerical Method Approach of Water Level Changes in Main Channel Jakabaring Sport City (JSC) Palembang, Indonesia

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Abstract — **This research was conducted to identify the main water level rise in the main channel Jakabaring Sport City (JSC) located at the Jakabaring watershed with a channel length of 600 m using the HEC-RAS ver.4.1.0 program with the initial conditions and boundary conditions as well as the planned discharge from the results of hydrological analysis.**

Palembang City 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. Musi river is a largest river with an average width of 504 meters and a maximum width of 1,350 meters is located around Kemaro Island. So one of the channels that needs to be researched is the main channel of Jakabaring Sport City (JSC).

The results showed that the pattern of water flow movement in the main channel of JSC, both in the return period (R_2, R_5, R_{10}, R_{20} and R_{50}), overflow occurred at Sta. 0+000 (P_{14}) of 1.50 m. Overflow for Sta. 0+100 - Sta. 0+500 or the P_{15}-P_{19} line ranges from 0.50 m to 1.00 m. While at Sta. 0+600 or P_{20} either the return period R_2, R_5, R_{10}, R_{20} and R_{50} does not overflow.

Keywords* — *JSC Main Channel; Bedload; Scale Models; Erosion Depht.

I. INTRODUCTION

The condition of the Palembang city area is relatively flat, so at certain locations it often experiences puddles (floods) caused by the flow of rainwater (run-off) which cannot be accommodated by the channel. In addition, at certain locations, puddles (floods) are also caused by the runoff of the Musi River. Floods that occurred in the city of Palembang caused problems for the Government to evaluate the existing drainage channels. The rainwater drainage channels have been built but need to be reviewed and evaluated to function properly. (Syarifudin A, 2018).

Areas prone to inundation (floods) that have been recorded are in the Sekanak, Sriguna, Buah, Lawang Kidul, Lambidaro, Gandus, Jaka Baring, Aur, and Kedukan sub-watersheds where there are several inundation locations which are a priority for handling by the Palembang city government.

One channel that has an important role in the city of Palembang is the Jakabaring Sport City (JSC) Main River which is located in a built area. In recent years, the Main river Jakabaring Sport City (JSC) is no longer able to accommodate the capacity (discharge) of water flow during the rainy season, not to mention a lot of water hyacinth in the channel.

Various efforts have been made, but these efforts have not been optimal in overcoming the problem of puddles (floods). These efforts are in the form of maintaining city drainage channels, cleaning river channels that cross the city. Likewise, studies related to flood control in urban areas, construction of flood control facilities have been made and several policies and regulations have been issued for flood control. These efforts turned out to be outpaced by the development of the city. (Syarifudin, A, 2018). For this reason, it is necessary to conduct a study on changes in water level rise or water overflow in the JSC main channel, especially in segment 3.

The complexity of the river system can be seen from the various components of the river, for example the shape of the river flow and branching, river bed form, river morphology, and river ecosystem. The river branch will resemble a river tree starting from the first order to the nth order river. The river bed 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 river bed material, and the vegetation in the area (Maryono, 2007).

The 19 sub-watersheds of drainage network system of the city of Palembang is divided into Jakabaring watershed, Gandus, Gasing, Lambidaro, Borang, Sekanak, Weir, Lawang Kidul, Buah, Juaro, Batang, Selincah, Nyiur, Sriguna, Aur, Kedukan, , Kertapati and Cleanliness. (PUPR of Palembang city, 2018).

A river or open channel is a channel where water flows with a free water level. In an open channel, for example a river (natural channel), the flow variable is very irregular with respect to time and space. These variables are the cross section of the channel, roughness, bottom slope, curvature of the flow rate and so on (Triatmodjo, 2003).

II. Research Methods

The research was carried out using an numerical combined with empirical approach, including hydrological analysis and hydraulics analysis, then simulation was carried out using the HEC-RAS program. Hydrological analysis to determine the design rain with a certain return period and get a picture of the Intensity Duration Frequency (IDF) curve as well as channel hydraulics analysis to calculate flood discharge and then a simulation is carried out with the help of the HEC-RAS program.

In the hydraulic analysis, the water level profile is calculated using data like a the design flood discharge and drainage channels in the Jakabaring Sport City (JSC) main channel to obtain a water level profile. In this analysis also used the application program HEC-RAS 4.1.0. After getting the direct runoff discharge, the results of the calculations on the existing channel are simulated using HEC-RAS 4.1.0. as shown in Figure 1.

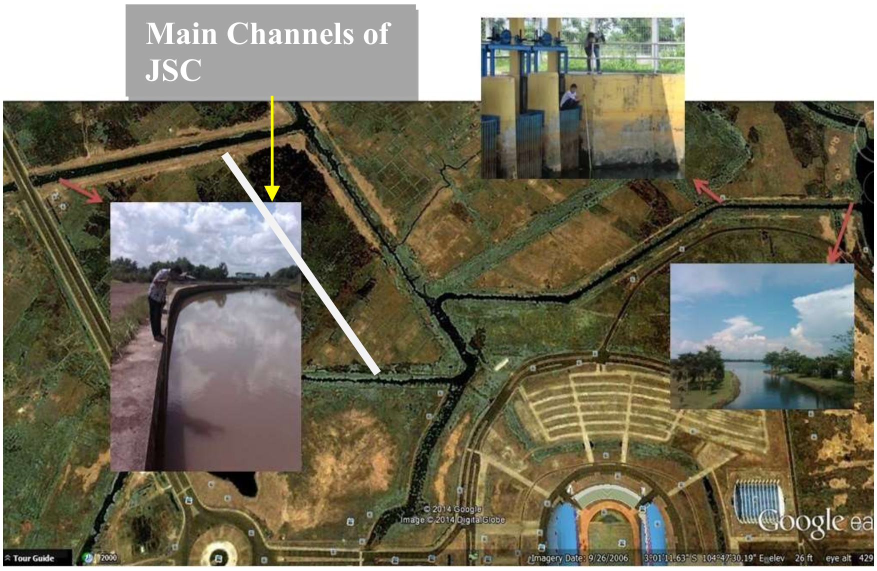

Fig. 1. Research location

2.1. Materials and tools

The materials used in this study include:

- Sand with a diameter of 0.025 mm to 2.36 mm is considered to be a sedimentary material that previously carried out sieve analysis to obtain a uniform grain diameter (ds) originating from the Buah river material.

- Water, as a medium for moving the sedimentary material flow in the channel,
- The instrument used in this research is a laboratory facility for the Masters in Civil Engineering Hydraulics at the Postgraduate Program at Bina Darma University. The specifications of the tool are as follows:
  - Standard channel (standard flume): flexiglass
  - Effective length: 400 cm
  - Width: 15 cm
  - Depth: 20 cm
  - Scour depth measuring instrument meter, to measure the location of the scour.
  - Photo camera to take pictures when doing the experiment.
  - Video recorder to record experiment implementation.

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2.2. Research preparation

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:

a. The aqueduct, the main place in this experiment, to drain the water. In the form of water flume with a size of 400 x 20 x 15 cm. This channel has transparent walls for easy observation,

b. A reservoir that functions to accommodate water that will be flowed into the channel or out,

c. Water pump, functions to pump water so that it can be distributed along the gutter. The pump is equipped with an automatic on / off switch for a 220/240 V, 50 Hz supply of electricity,

d. Discharge faucet, is a faucet that functions to regulate the size of the discharge that comes out of the pump. Has a discharge scale of 6-9 range,

e. The tilt adjustment wheel, located upstream and downstream of the channel, can be manually turned to adjust the desired bed slope. This bed slope adjustment wheel has a scale for maximum positive bed slope + 3.0% and maximum negative bed slope - 1.0%.

2.3. Research Step

The steps of this research are divided into:

- The first, collecting references from journals, books, and other secondary data sources such as the BBWSS-VIII office, PU Pengairan, South Sumatra Province and PUPR Palembang city as well as from other related agencies.
- The seconds, conducting a field orientation survey to obtain the current conditions (existing) in the field, taking photos of the field (site) so that they can be used as initial research data.
- The third is to collect the river bed material, survey data and measure the topography of the channel to be used as input data in simulating the model in the laboratory.
- The fourth, performs experimental simulations with various variations of flowrate, velocity and flow time.
- The fifth, obtaining the experimental results, namely, the location and magnitude of the erosion (scour) that occurs with various flows, velocities and times of flow.
- The sixth, analyzes the simulation results and conducts discussions
- The seventh, makes research conclusions and provides suggestions for further research by other research.

III. RESULTS AND DISCUSSION

The dimensional analysis in this study uses the Langhaar theorem, this theorem is seen as more appropriate to current conditions and in accordance with research because it has relatively few parameters. The results of determining the dimensionless numbers are as in table 1 below:

TABLE I. THE RESULT OF DETERMINING OF DIMENSIONALESS NUMBER PARAMETER

ki	**k1**	**k2**	**k3**	**k4**	**k5**	**k6**
Parameter	**de**	**x**	**h**	**t**	**ρ**	**g**
π1	1	0	0	-1	0	0
π2	0	1	0	-1	0	0
π3	0	0	1	-1	0	0
π4	0	0	0	1	0	0.5

f (de/t ; x/t; v) = 0 (v ≈ 0)

(de/t) = f (x/t)

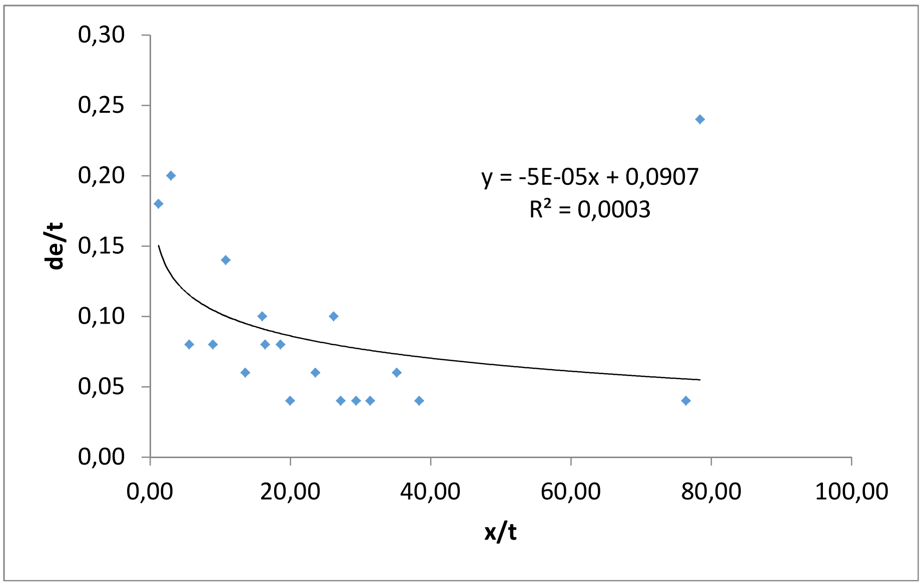

Fig. 2. Plotting The Results of The Dimensionless Analysis Between (de/t) versus (x/t) For 5 minute experiment

Based on the results of the analysis as shown in Figure 2. it can be said that at the starting point in the Buah river within 5 minutes, there is a relative erosion depth of 0.15 cm (in the model) then the trend decreases at a relative distance (x/t) of 80 cm with erosion of 0.04 cm.

With a coefficient of determination R^2 of 0.00 or an R value of 0%, it means that the speed (v) and time (t) simultaneously do not affect the depth of erosion (de) that occurs.

This is because the farther in the river, the greater the relative depth of erosion or the maximum relative depth of erosion depending on [2]the flow velocity in the river.

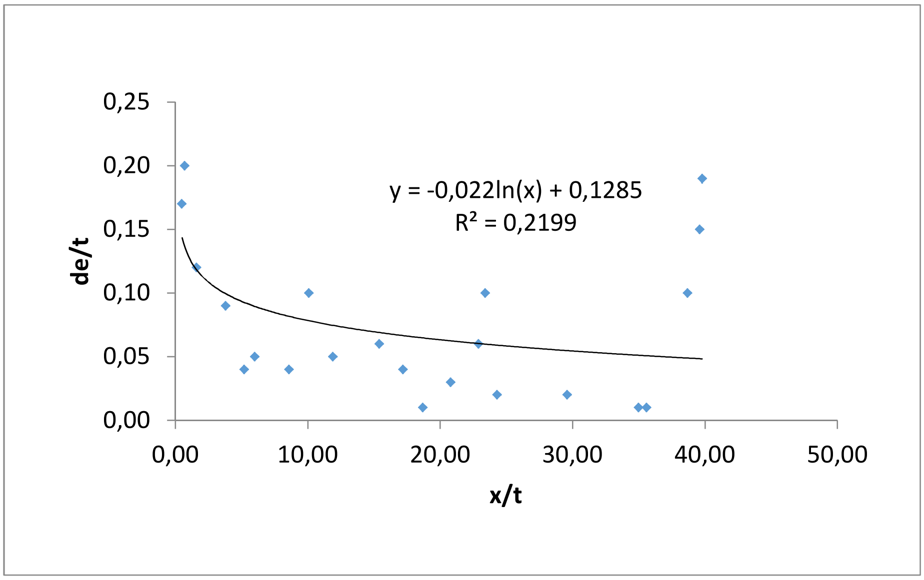

Fig. 3. Plotting The Results of The Dimensionless Analysis Between (de/t) versus (x/t) For 10 minutes

Based on the results of the analysis as shown in Figure 3. It can be said that at the initial point in the Buah river within 10 minutes, there is a relative erosion depth of 0.14 cm (in the model) then the trend decreases at a relative distance (x/t) of 40 cm with an erosion of 0.05 cm.

With a coefficient of determination R^2 of 0.219 or an R value of 46.79%, it means that speed (v) and time (t) simultaneously have no effect on the depth of erosion (de) that occurs at the mouth of the Buah river.

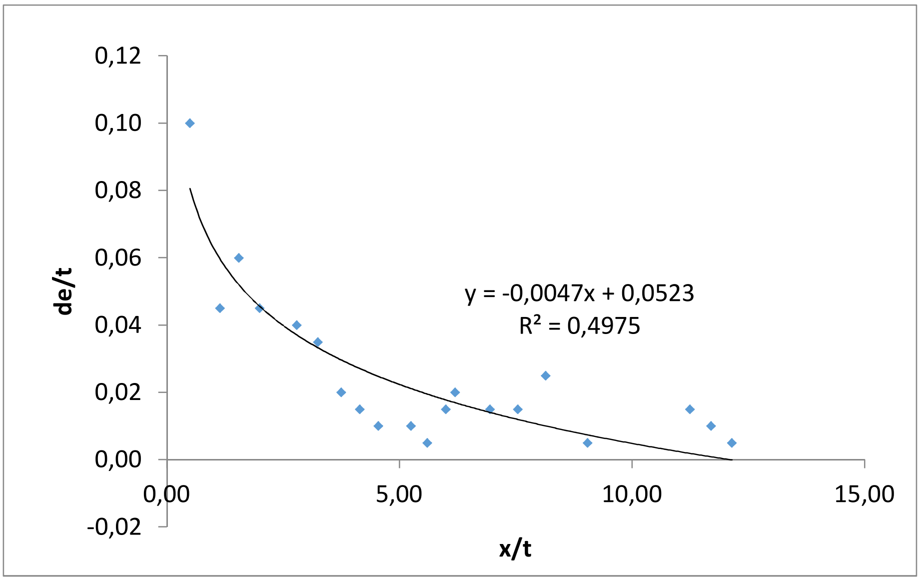

Fig. 4. Plotting The Results of The Dimensionless Analysis Between (de/t) versus (x/t) For 15 minutes

Based on the results of the analysis as shown in Figure 4. it can be said that at the starting point in the Buah river within 15 minutes, there is a relative erosion depth of 0.14 cm (in the model) then the trend decreases at a relative distance (x/t) of 40 cm with erosion of 0.05 cm.

With a coefficient of determination R^2 of 0.497 or an R value of 46.79%, it means that velocity (v) and time (t) simultaneously have no effect on the depth of erosion (de) that occurs at the mouth of the Buah river.

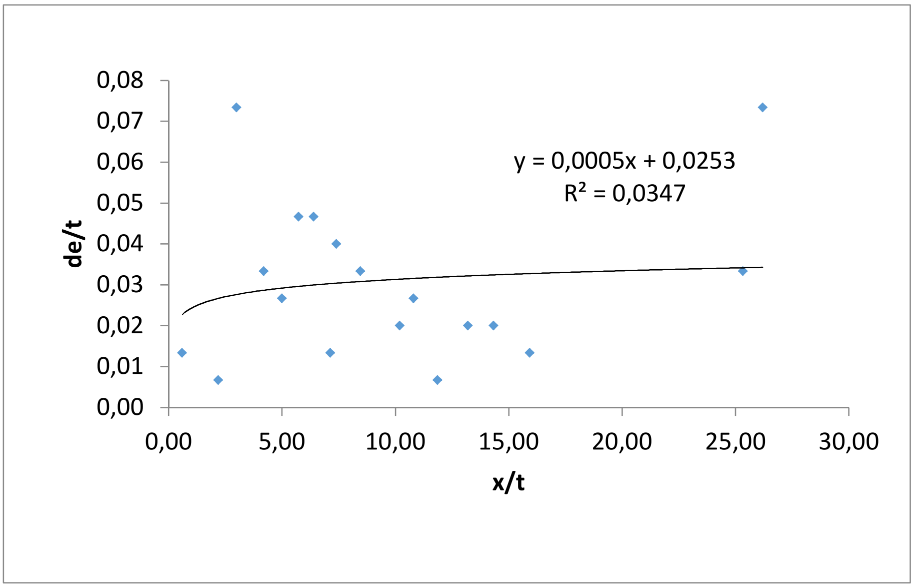

Fig. 5. Plotting The Results of The Dimensionless Analysis Between (de/t) versus (x/t) For 20 minutes

Based on the results of the analysis as shown in Figure 5. It can be said that the relative erosion depth (de/t) increases starting at the relative distance (x/t) 26 and the maximum erosion depth (de) is 0.035 cm (in the model).

With a coefficient of determination R^2 of 0.034 or an R value of 18.43%, it means that speed (v) and time (t) simultaneously have no effect on the depth of erosion (de) that occurs at the mouth of the Buah river.

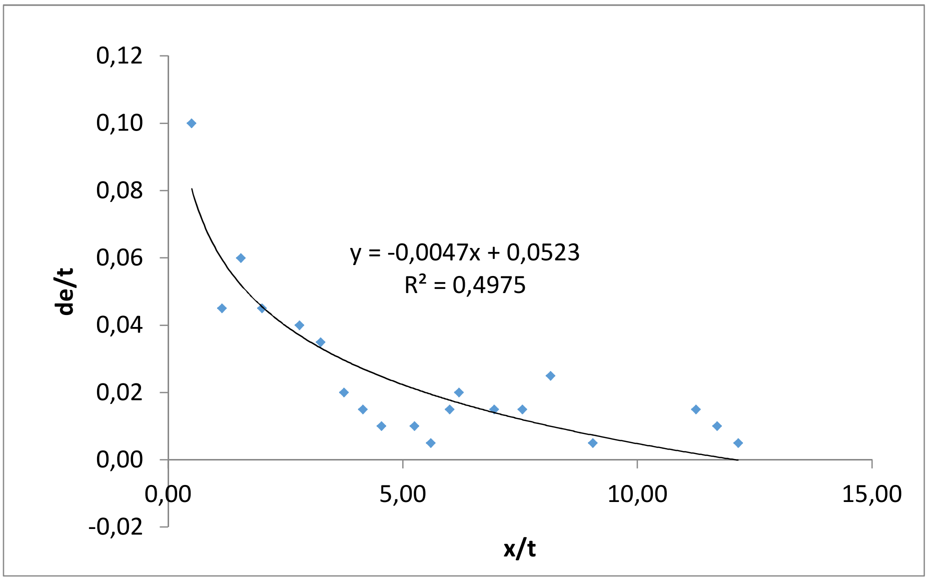

Fig. 6. Plotting The Results of The Dimensionless Analysis Between (de/t) versus (x/t) For 25 minutes experiment

Based on the results of the analysis as shown in Figure 4.5. it can be said that at the initial point in the Buah river within 25 minutes, there was a maximum relative erosion depth (de/t) of 0.08 in the experiment for 20 minutes, meaning that at 20 minutes there was an erosion depth of 1.56 cm in the model. This is the optimum erosion in the channel.

With a coefficient of determination R2 of 0.497 or an R value of 70.49%, it means that the speed (v) and time (t) simultaneously have quite an effect on the depth of erosion (de) that occurs at the mouth of the Buah river.

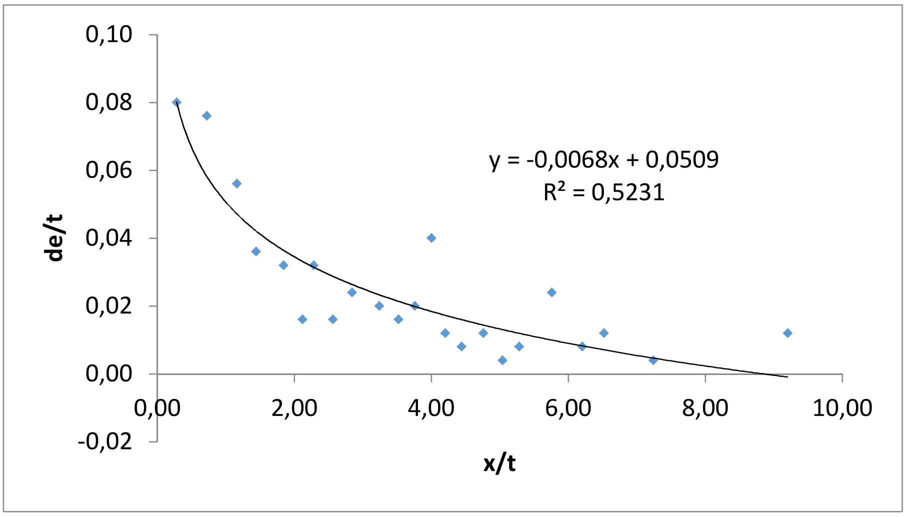

Fig. 7. Plotting The Results of The Dimensionless Analysis Between (de/t) versus (x/t) For 25 minutes experiment

During the 25-minute experiment as shown in Figure 7 above, there was a decrease in erosion at the beginning of the channel/river with a relative erosion value (de/t) of 0.08, meaning that the magnitude of erosion in the river was 2 cm in the model. The result is significant with R^2 = 5.23 or R = 72.3% significant. The results can be used in the field (prototype).

With a coefficient of determination R^2 of 0.523 or an R value of 72.31%, it means that speed (v) and time (t) simultaneously have quite an effect on the depth of erosion (de) that occurs at the mouth of the Buah river.

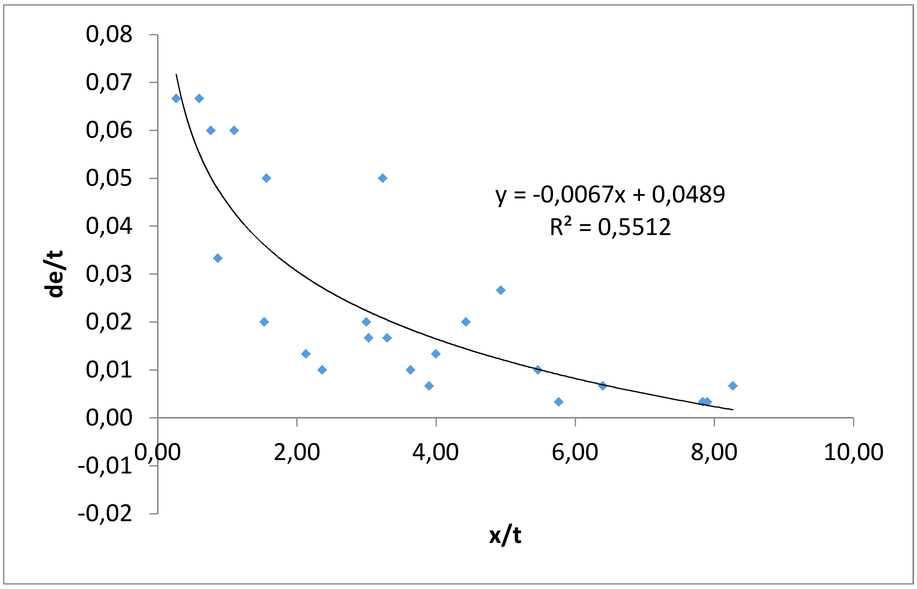

Fig. 8. Plotting The Results of The Dimensionless Analysis Between (de/t) versus (x/t) For 30 minutes experiment

During the 30-minute experiment as shown in Figure 8 above, there was a decrease in erosion at the beginning of the channel/river with a relative erosion value (de/t) of 0.072, meaning that the magnitude of erosion in the river was 2.16 cm in the model. In the prototype (actually) with a scale of 1: 100, the bottom erosion in the Buah river will be 2.16 m.

With a coefficient of determination R^2 of 0.551 or an R value of 74.22%, it means that the speed (v) and time (t) simultaneously have quite an effect on the depth of erosion (de) that occurs at the mouth of the Buah river.

IV. CONCLUSION

The relative erosion depth (de/t) on the riverbed precisely at the mouth of the Buah river is 2.16 cm in the model with a significant level of R of 74.22% or 0.7422. This means that the speed (v) and time (t) simultaneously have quite an effect on the depth of erosion (de) that occurs at the mouth of the Buah river.

Other factors that influence the magnitude of the depth of bottom erosion (bed load) at the mouth of the Buah river as the dominant variables are flow velocity (v), grain diameter (d), and changes in water level (h).

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