International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 10 (2017) pp. 2604-2612

A Study on Flow Resistance and Mobility Index at Palu River

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Abstract

Flow Resistance and Mobility Index are theoretical equations derived for nearbed region, in most cases, these equations have been studied using experimental methods. Thus, many consider them as empirical equations. The flow resistance and mobility index were using equations parameters, such as water depth and particle diameter. However, parameters of Flow Resistance and Mobility Index is an index representing bed resistance related to relative roughness and furthermore influences of stream velocity. This research was conducted in the lower reaches of the Palu river, around four research locations.

The aims of this research are to calculate and analyze the mobility index, friction factor, a comparison between the ratio of the shear velocity and current velocity, as well as, , to analize its correlation with the friction factor, and, to arrange the new equation of friction factor, and mobility index.

As a result, it has been confirmed that, there is a decreasing trend of flow resistance and an increasing one of Mobility index due to the increase of water depth. Therefore, in order to correctly predict friction factor as a main parameter of flow resistance and values of mobility index, , it is necessary to use an exponent that reflects bedload transport conditions at the field.

Keywords: Mobility index, flow resistance, Palu river

INTRODUCTION

To predict flow resistance in Palu river with sufficient accuracy is of great interest to hydraulic engineers, researcher, and students who want to study the sediment movement in the alluvial river bed. The problem is that the flow boundary in Palu River is not fixed, but changes continuously in its certain geometric characteristics and dimensions through mutual interaction between the flow and riverbed.

Description of the evolution configurations by changing the flows occurs in the surface of the river bed. Most of the existing resistance relationships do not take into account the role of the all variables affecting the grain and forming the resistance and also the bed configuration formulation. Furthermore, the friction factor equation available in literature has been used widely by hydraulic engineers. The following analysis proposes the friction factor relation in the framework of the Manning's equation, Chezy's Equation, Darcy's formulae and other important flow parameters, sediment characteristics and fluid characteristics with objective of taking advantage of the widespread use with advanced research in alluvial river. Moreover, knowledge of the resistance characteristics of alluvial streams is of great value when dealing with the location of bridges, training works, flood control works, irrigation, channel improvement, backwater purpose due to confluences, mathematical and physical modelling of flow, aggradations and degradation probability to presence of hydraulic structures planner.

Hydraulics has a sub subject call, flow resistance which is an exciting sub-sphere of practical importance and of intriguing fluid mechanics. The complicated physical processes are represented succinctly by resistance coefficients, for practical applications. Despite the success in the past, much can still be done in the future, such as investigating the effects of channelgeometry and flow unsteadiness on the flow resistance, Ben Chieh Yen (2002).

There are a number of approaches used to compute the friction factor, but in this study following eight methods are used to compute the friction factor, and fall velocity as a parameter of mobility Index.

The friction factor equation are : 1) Karim ,(f_2); 2) Wexing and Youhong (f_3), 3)Keulegan's equation (f_4) , Manning Modification (f_1).

The fall velocity equations are: 1) Van Rijn , (ω_{VR}) ; 2) Rubey (ω_R) , 3) Saleh Pallu , (ω_{SP}). In this paper, the evaluation of friction factor and fall velocity, which is encouraging the mobility index values throughvarious approaches and methods has been discussed based on the average size of the particle, current velocity, water depth and their relation in between has been established.

The theory of sediment transport was important to predict incipient motion.

In rough-bed flows, the relative magnitude of z_0 and a representative length scale for the roughness elements are important for the determination of the lower limit of the validity of the log-law, Ell Fereshteh Bagherimiyab and Ulrich Lemmin (2013).

Dynamic is a flow boundary which is the above condition is fulfilled when virtually the whole applied fluid stress to the moving bedload solids.The foregoing statement is restricted to conditions in which the moving bedload solids are sufficiently numerous to interpose an effective flow boundary between the free fluid flow above and the stationary bed below, R.A. Bagnold (1966).

The primary hydrodynamic processes affecting estuarine morphology are river flows, tides and waves, which erode, transport and deposit sediments , Yassir Arafat et.al. (2016) . Erosion and sedimentation process is a complex problem, which is strongly influenced by the flow conditions, and the condition of the river sediment material itself. M. Lukman et al. (2014). According to F. Maricar (2014) the new longitudinal profile were be lower than the original ones, then the degradation were occurred, and if the new profile were above than that original ones than the aggradation were occurred Nenny et al. (2014).

The field data of grain, current velocity and water depth of Palu river has been analyzed in MS Excel and origin software has been used to analyze the data. The various relationships are established between the various parameters as mention below:

1. The correlation between water depth and Friction Factor,
2. The correlation between water depth and Mobility Index,
3. The correlation between ratio v/u_* and friction factor ,
4. The correlation between Friction factor and mobility index
5. The correlation between Ratio h/h_s and v/u_* Ratio.

The data calculations were performed using 102 Varian. The graph was plotted for the above parameters using origin software and results were obtained by statical analysis.

Figure 1. The Four research locations at downstream side of Palu river

RESEARCH METHODS

This researchwas conducted in 4 different locations. The first location was at latitude: -0.8877883, 119.859197, the second was at -0.8924226, 119.8616003, the third was at -0.8980867, 119.8656773, and the fourth at -0.9093291, 119.8690247.

The research was performed in uniform flow conditions. Visually,it appeared there was no sandbars that disrupted the uniformity of flow. Data retrieval was also done in sunny weatherwithout rainfall. The placement of bed load apparatus was done in the spansof the river width, each at a distance of 5 m.

The first and second locations have distance ± 863, 9 m. The second location and a third location ± 766, 66 m. Third and fourth locations within ± 1314, 17 m. While, the total length of Palu River ± 40.000 m.

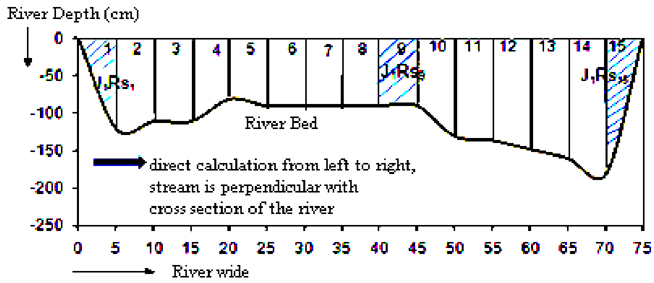

Figure 2. The cross section area and its guide line placed the bed load apparatus and other measurements

Sand and gravel data were taken using a shovel to be studied in the laboratory in order to obtain grain size and density of sand gravel. On other hand, bedload apparatus created specifically to take bed material from the river bed in order to calculate the bedload transport. The depth of the river was measured at the river's cross section area.The current velocity was measured with a current meter. At the first location, it was o,btained 15 variants, the second location 12 variants, the third location 11 variants and a fourth location 13 variants.

Overall, these data were processed to obtain, bedload transport, grain size, and density of sand gravel.

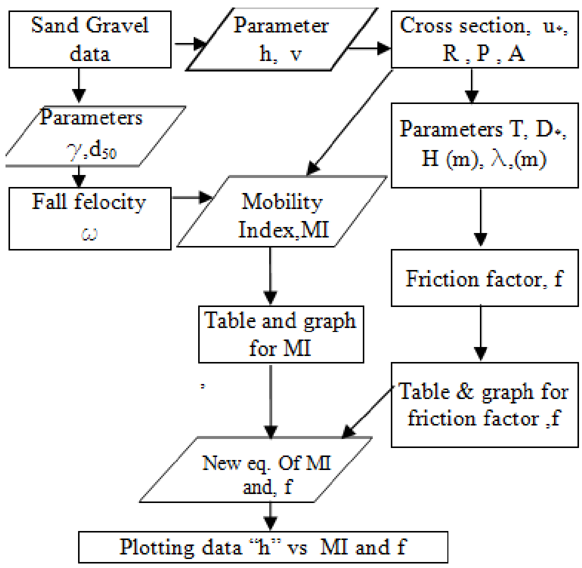

Figure 3. Flow Chart of Data Collection Mechanism, and Calculation

International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 10 (2017) pp. 2604-2612

The calculation process starts from, field data, laboratory data, and equations existing in theory. Overall, this calculation is presented in tabular form. Following the right path, the calculation can yield more accurate results.

The research study usesthe theory that has been formulated by former researchers. Mathematical statistical approach uses a form of data processing in the normal distribution, then, the analysis of tables and graph is conducted.

Mobility Index Calculation

The fall velocity of sediment particles, also called the terminal or settlement or more often settling velocity is one of the most important particle characteristics in sediment transport studies and plays important role for the understanding of suspension, deposition, mixing and other physical as well as chemical and biological exchange processes, M.Zare & M.Koch (2011)

The concept of critical shear stresses and employs an approach similar, or identical to the Shields diagram that was the most commonly applied fundamental method, Efransisco J Simone (2014).

The Value of Mobility Index is the ratio between the shear velocity and particle fall velocity BR. Andharia and BK Samtani (2011):

$$MI = \frac{\text{shear velocity (m/sec)}}{\text{fall velocity (m/sec)}} = u_*/\omega$$

An alternative method that uses the mobility number, defined as the ratio of the shear velocity to the particle's fall velocity. A large measurement of experimental data is used to develop an empirical incipient motion criterion based on the mobility number.It is shown that this approach can provide a simple and accurate method of computing the threshold condition for sediment motion.

This calculation also uses the parameters of particle, and its distribution is d_{50} which is particle diameter. Particle mmobility is influenced by the shear velocity of the particles, calculated shear velocity using below, Muhammad Saleh Pallu (2012).

$$\theta = (u_*)^2/(s-1)\, g\, d_{50} = h\, I/(s-1)\, d_{50}$$

$$(s-1)\, d_{50} (u_*)^2 = (s-1) g\, d_{50} h\, I$$

$$u_* = \sqrt{g\, h\, I}$$

Diameters of particle have different fall velocity value, further, particle fall velocity calculation using equations below [12]: LC Van Rijn (1977)

$$\omega_{VR} = (s-1) g d^2/18\, \nu \qquad \text{for } 1 < d < 100\ \mu m$$

$$\omega_{VR} = 10(\nu/d)[(1 + 0{,}001(s-1) g d^2/18\nu) - 1] \qquad \text{for} 100 < d < 1000\ \mu m$$

$$\omega_{VR} = 1{,}1[((s-1)) g\, d\,] \qquad \text{for } d \geq 1000\ \mu m$$

Where :w_{VR}= particle fall velocity (m/det) , d = particle diameter (m) ν = konematic viscosity (cm^2/det), g = gravitation (m/sec, s = ($\gamma_s - \gamma$) / γ.

Saleh Pallu, considered particle size distribution, specific weight, and porosity are three important parameters in the study of bedload transport and so is the fall velocity as calculated below , S Yang & Hu et all,. (2010) :

$$\omega_{SP} = (1/18)(\gamma_s - \gamma/\gamma)\, g\, (d^2/\nu)$$

Rubey's results of equations to calculate the fall velocity of the particle for larger particles more than 1 mm, as seen below

$$\omega_R = F\, [d_g(\gamma_s - \gamma)/\gamma]^{0{,}5}$$

Where : $F = a - b$, $a = [2/3 + 36\, \nu^2/gd^3(\gamma_s/\gamma - 1)$
$[36\, \nu^2/gd^3(\gamma_s/\gamma - 1)]$

From the researchers above, the variables as the result of calculation can be concluded for fourth variable such as,

1. Mobility Index uses Van Rijn particle fall velocity equation, $MI_{VR} = u_*/w_{VR}$,

2. Mobility Index uses Rubey particle fall velocity equation, $MI_R = u_*/ w_R$,

3. Mobility Index uses Saleh Pallu particle fall velocity equation, $MI_{SP} = u_*/w_{SP}$,

4. Mobility Index uses particle fall velocity betweenw$_{VR}$andw$_{R}$valuesor $MI_{AY} = (\omega_{VR} - \omega_R)/2\}$,

MI_{AY} as fourth equation were founded by this Mobility Index and Flow Resistance research.

Friction Factor Calculation

Friction factor calculation follows the steps, 1) to collect data of grain diameter (d_{50}), the depth of flow (h), the flow velocity 2) calculate and analyze bed form, 3) to calculate the friction factor.

The bed form pattern is described in the table below. LC Van Rijn (1977):

Table 1. River bed form

Transport Regime		Particle diameter (μ m) $1 \le D_* \le 10$	$D_* > 10$
Lower	$0 \le T \le 3$	Mini ripple	dunes
	$3 \le T \le 10$	Mega-ripples and dunes	dunes
	$10 \le T \le 15$	dunes	dunes
Transition	$10 \le T \le 15$	Washed-Out dunes, sand waves	
Upper	$T \ge 15, Fr < 0,8$	(symmerical) sand waves	
	$T \ge 15, Fr \ge 0,8$	Plane bed and or anti dunes	

D* can can be calculated as follows: $T = (\tau_b - \tau_c)/\tau_c$ is the shear stress parameter (dimensionless) and, $D_* = d_{50}[(s-1)g/\upsilon^2]^{1/3}$ is the diameter parameter (dimension- less).

Each bed form has dimensions of length (λ) and dune (H), each using units of meters. Bed form can see below :

Mega ripple :

$$H_{mr} = 0,02\,h\,(1 - e^{-0,1\,T})(10 - T)$$

$$\lambda_{mr} = 0,5h$$

Dunes :

$$H_d = 0,02\,h\,(1 - e^{-0,5\,T})(10 - T)$$

$$\lambda_d = 7,3h$$

Ripples :

$$H_r = 50\ s/d\ 200\ d_{50}$$

$$\lambda_r = 500\ \text{to}\ 1000\ d_{50}$$

Friction factor calculated using first Manning modification :

$$f_{AY} = (e/\kappa)/\left(n\sqrt{g}\ /(R^{1/6} \times \sqrt{8})\right)^2$$

f_{AY} values in Flow Resistance is a value which is an approach to the three previous investigators, they are, Karim, Waxing and Yuhong, and Keulegan. During friction factor calculation, found that equation obtained values which are too large. Is that so, finding a new equation which is taking into account Von Karman constant, κ, and Euler numbers, in order to establish the friction values, made closer to others investigators. Calculated friction factor using Karim equation

$$f_2 = 0.37\, d_{50}^{0,126}\left(1,20 + 8,92(H/h)\right)^{0,465} /^a\, n$$

Where : n = Manning roughness coeficient, A = cross section area, d_{50}= particle diameter (m), H = bed form height (m), h = water depth (m)

Calculated friction factor, f_3, using Wexing dan Yuhong equation

$$f_3 = \sqrt{1/2,21 + 2,033\ \mathrm{Log}(R/\Delta)}$$

Where Δ is a relative roughness, Δ = k_s/R river bed rougness using $2d_{50}$ and R is a hydraulic depth

Friction factor using Keulegan's equation

For the hidraulic smoothness región, Keulegan promotes the equatipon below :

$$\sqrt{8/f_4} = 5,75\log(u_* R/\upsilon) + 3,25$$

RESULTS AND DISCUSSION

The rasio of (v/u*) is the primary data obtained from the research locations. The value u* is the outcome of the calculation using the equation u* = (g h I) 0.5 where, his value from depth measured and the value of I is a ratio of the height and distance of the river or , 40 m / 40.000 m = 0.001.

Result of Mobility Index Calculation

Value of v/u*ratio is a value representing the value directly taken from the study site which were the values of the data on the depth of flow and the average slopeness data of the river. MI_{AY} value found in this research process looks not much different from the value of MI_R and MI_{VR} invitation.

In graph 4, it is obvious that the value MI_{AY} appears to be in between the value MI_{VR} and MI_R, the graph also shows the value MI_{SP} intersect with the largest value MI_{SP} close to MI_{VR} value and the lowest value MI_{SP} approached MI_{AY}. The graph 4 also shows its closeness to MI_{AY} value with the value of M_{IR}.

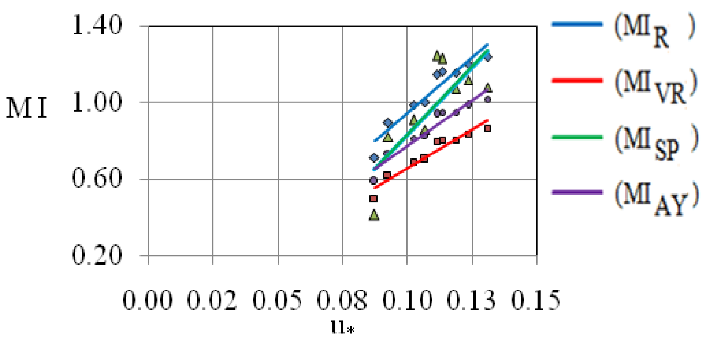

Figure 4. MI vs u* at first research location

Value of MI is the largest obtained from the value of the MI_{SP} reaching 1.75. The smallest value in the MI_{AY} is 0.44. The state of the river at the fourth research site is wider than the third research location and the second research location. Particles of sand and gravels are larger and has flat shape in average, comparing with third research location and second research location.

Kinematic viscosity, density and grain size are important in the calculations. In this first study site, to measure the width of the river at 75 m, having a surface grain riverbed, more elusive. Figure 4 above shows that the higher the shear rate, the higher the value of MI.

Figure 5 below demonstrates that each value of MI increased due to the increasing value of u_*.

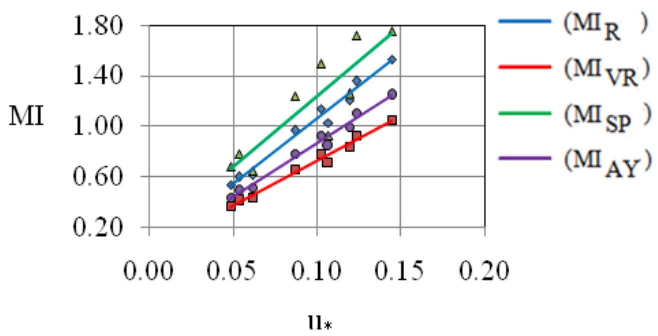

Figure 5. MI vs u_* at second research location

Data obtained from the second research location which has large mobility index reaching 1.75 by MI_{SP}. Values in the table are not much different. M_{AY} value as a new equation accompanying the previous equation has not much different value in the result of mobility index calculation. This indicates that the new equation is feasible to calculate the mobility index of the river.

The data of the second research location is the upstream side of the two previous research locations. Therefore, the flow is fairly fast with sediment grains larger than the previous locations.

The maximum shear velocity obtained 1.214. variations in the value of M_{IR}, MI_{VR}, MI_{SP} and MI_{AY} each follows the order of value-hem sliding speeds. For MI_{AY} value is always in the other MI values. It is caused bythe findings of equations used in this study is within the values of MI_{VR} and of MIR located in the central part of the distance of the x-axis.

This situation also leads to the use of the found equation in calculating equations MI to be used in all types of alluvial river

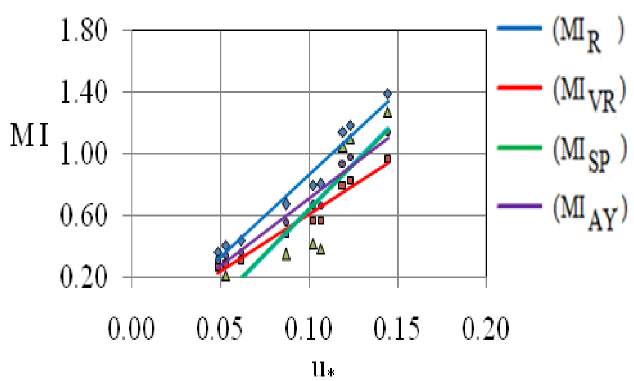

Figure 6. MI vs u_* at third research location

There was a slight deviation, that, MI_{SP} value is lower than the other three values of MI, riverbed particles larger than the average value MI_{SP} rate has a lower value. While the M_{AY}value remains between MI_{VR}value and M_{IR}value.

The values is below 1 in average. The fourth research location has bundled particles which are bigger than the other three research locations. The wet surface of the river wider than the second and the third research locations.

As consideration, the research on thefourth location is at upstream of the three previous surveys. Bedload material like granules have diameters larger than in the previous three research sites.Riverbed degradation occurs, the left and right sides of the river perpendicular to the stream of the river.

This causes the deviation in the flow on the left and the right. However, the degradation is not as deep as those of the previous three research sites.

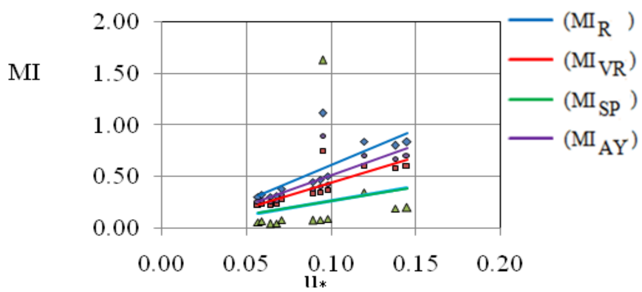

Figure 7. MI vs u_* at fourth research location

In figure 7. Increased trend line followed by increased value of u_*.MI_{AY} value is between MI_{VR} and MI_R values. MI_{AY} equation can be practiced for any rivers. Because of the proximity of its value with the value of calculating MI using a previous equation obtained by the researchers.

Result of Friction Factor

The ratio v/u_* is used as a comparator value to better express what is materializing in the research site with the value of friction factor. Figure 5 describes the correlation between v/u_* and f from different methods of calculation as seen below;

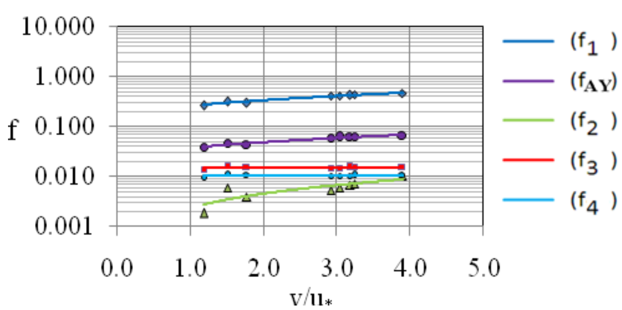

Figure 8. Friction factor vs v/u_* ratio at first research location

In figure 8,f_{AY} value is closer to the value of f_3, f_4 and f_2, which indicates that new equation that computes f_{AY}, came close to three methodsof calculations, which calculate f values as well. While, the value of f_1 is further than others.

Table observations and graphs are quite important because of the variation of the equation used to calculate the friction factor.The f found 0.84 as the largest number, using f_1 equation, while, the smallest value, 0.1 is obtained in f_4 equation.

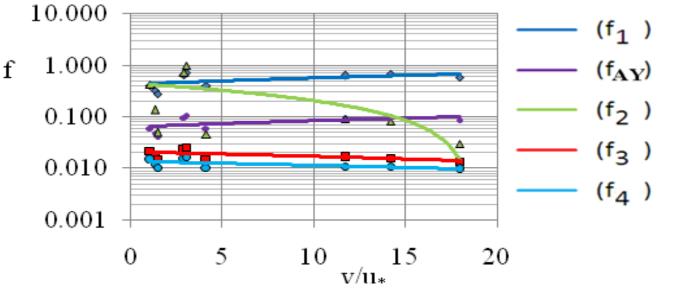

Figure 9. Friction factor vs v/u* ratio at second research location

Figure 9 above, indicates equation to calculate f_{AY}. As one of results in this study to obtain value that is not much different from the other f values. The river observation in this second research location narrower than first research location.Arches happen to the value f_2. F_{AY}value remains between the f_1 and $f_2$values.

As consideration, the particle bedload experiencing surface friction at the second location and having slightly larger grain diameter than that of the grainthan infirstresearch site. The width of the river is also narrower than the first study site.

The friction factor at the second research location is largerin average. This indicates the closeness of values f_3 and f_4 although in different equation. While the value of f_{AY} serves to bring the value of f_1 which is quite far with a value of f_3 and f_4.

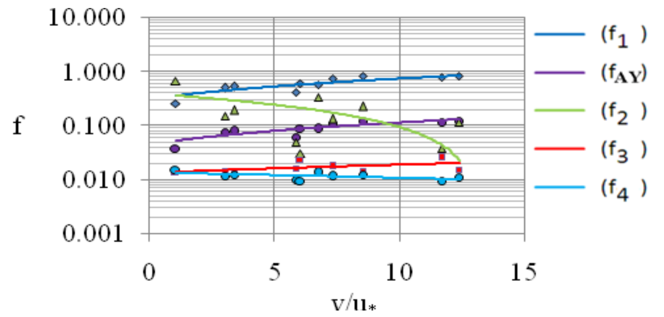

Figure 10. Friction factor vs v/u* ratio at third research location

The third research location has narrower river cross section, comparedto the first and second river cross sections. At this location the water flows faster and has larger bed load particles compared with the research locations before. This situation lead to the rising trendline of f_1, and f_3 and a higher friction factor values. The opposite circumstance can be seen as values of f_2.

At the study site, the value of f_2 seems to decrease. The equation that calculates f_2 with the data obtained from the study site direct condition that the higher the ratio v/u*, the lower the value f_2. Compared with f_2,and f_4,it is not very significant when compared with the value of f_2. While, f_{AY} equation is a modification from f_1 equation, by entering ratio of Von Karman and Euler number. Its new equation turns out between, to f_3 and f_1, means, so, equation feasible to use.

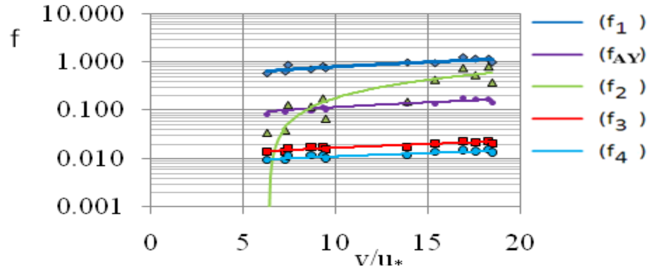

Figure 11. Friction factor vs v/u* ratio at fourth research location

Trend line in figure 8 discribes the flow velocity at the second location faster than first location. The value of f_2 rise up. The ratio of v/u* rises and the value of f_4 lowers. The value f_{AY} rises with others values.

The Correlation between MI and FR

The result of the overall value of MI and f obtained from the study in four different locations expressed in in table 10. The value of "h" is arranged sequentially, whereas, the value of MI and of f follow in the table, on the order of "h".

An overview of the value of MI and FR in every watershed causes sediment transport. River flows in real time judging from the surface of the river can be seen.On the other hand, the displacement of bedload is not visible.

Then, The reaserchers went into the river, walking on the sand gravel, above the riverbed, in a state of flow, in accordance with the actual situation. Two things that can be felt at the time, sand gravel moving and the depth of the river.

Thus, in the actual circumstances, the values of MI and FR, have an indicator, ie the depth of the water, and in this study the situation can be described using a graph.

The correlation between the index and the friction factor mobility which represents flow resistance, can be seen in graph below:

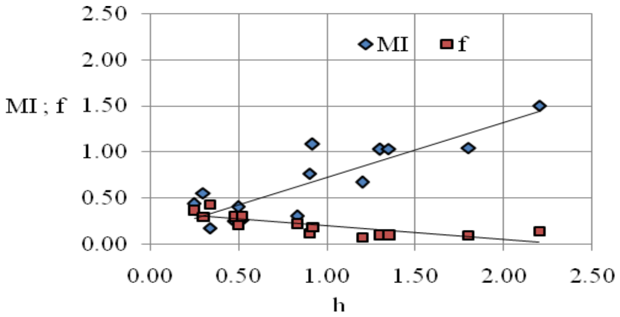

Figure 12. Correlation between h vs MI and h vs f

Whereas, the increase of the value of "h" (which represents the depth of water), was then followed by an increase in the value of the MI representing mobility index. At the same time, the value of "h" increases, followed by a decrease in the value of f (representing flow resistance).

The Correlation between the Two Ratios, h/h_s and v/u_*

Major factors influencing flow resistance, such as flow discharge, bed slope, sediment conditions and relative roughness (h/d_{65}) have been investigated. The divided hydraulic radius approach has been applied for analyzing data[10].

In this Research**,** the h/h_s ratio is the ratio that describes the ratio between the water depth and the depth of the sand in which, sand depth (h_s) is measured from the data below the surface of the riverbed. On the other hand, the water depth (h) is measured from the surface of the water until the surface of the riverbed. The ratio v/u_* describes the correlation betweenthe results of measurements of the average flow velocity (v), and the calculation of the shear velocity (u_*).

The ratio h/h_s is the ratio of the depth of water and depth of riverbed, while, the ratio v/u_*represents the existing flow above the riverbed.This phenomenon is seen directly in the research location visually. At a certain speed (capable of moving riverbed particles), the higher the value of h,the more mobile the sand gravel in the riverbed, which also means, the friction between the water flow and the surface of the riverbed is getting smaller.

Ratio h/h_s is arranged sequentially and the ratio v/u_* follow the sequence. The maximum value of the ratio v/u_* is 3.894 on the value of the ratio h/h_s 0.50. Furthermore,the relations between the two ratios can be examined in the following figure.

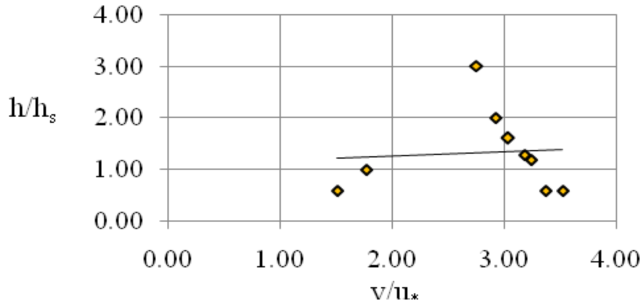

Figure 13. Correlation between h/h_s and v/u_* in the first study site

The figure 13 above reveals the higher the value $v/u_*$the lower ratio the h/d_s ratio decreases. In the first study site bed load particle diameter, d_{50} = 0.00117 m and an average current velocity, v = 0.32 m/s. Both, particle diameter and averagecurrent velocity is taken into consideration in figure 1examination.

Results of research and calculation of correlation between h/ds, and the v/u_*in which the maximum value of the v/u_* is16.3805 and h/ds =1,667is the minimum value of the ratio v/u_* is 1,293.

As a consideration, the ratio of h/h_s represents the depth of the work on the river flow and depth of the work on the material under the watersheds. The ratio of v/u_* is the flow rate of the work, with a speed slide that works on the surface of the riverbed. Both ratios represent the entire movement activity in the river.

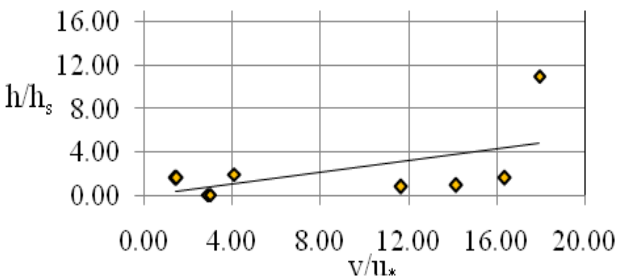

Figure 14. Correlation between h/h_s and v/u_* in the second study site

In Figure 14 above, with the image graph of h/h_s vs v/u_* at the situation of the second study site, the trend line shows the higher the value of the ratio of h/d_s, the higher the value of the ratio of v/u_*. As another consideration, the medianrage value of d_{50} is 0.00096 m and water velocity flow reaches 0.3258 m/s in average.

As a consideration, the third study site has a river's width narrower than other research locations. The location has a third research average value d_{50} = 0.0011 m and the average current velocity, v = 0.32 m/s.

The higher the value of the ratio h/h_s, the higher the value of the ratio v/h_*. This occurs because of the bedload transport above the surface of riverbed.The average current velocity that occurs above the riverbed, has a vertical velocity distribution. Wherein, the current velocity at the surface of the riverbed is slower compared to the current velocity above it.

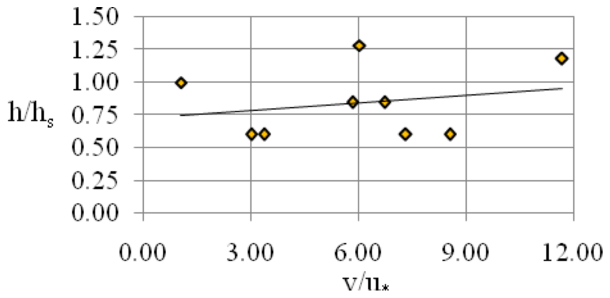

Figure 15. Correlation between h/d_s and v/u_* in the third study site

The figure 15 shows that the ratio v/u_* continue to rise sharply, while, the value of the ratio h/h_s increases gradually.

It can be seen that the trend line in the form of a horizontal line, but when viewed in the table, the line is declining. The higher the value of v/u_* then the trend line looks increasingly horizontal. This indicates that the change in the value of the ratio h/h_s is not balanced in proportion to the value of the ratio u/v_*.

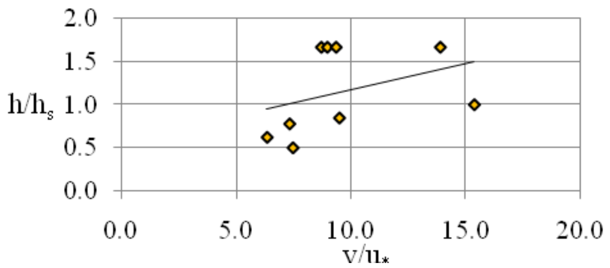

Figure 16. Correlation between h/h_s and v/u_* in the fouth study site

The figure 16 above is plotted on a graph of the correlation ratio h/h_s and the value of the ratio v/u_*. It was found that the value of the ratio h/h_s increases gradually so as to form a straight line. On the other hand, the ratio v/u_* is much more rated, so, the trend line is formed to resemble straight line. As consideration, medianrage value of the flow velocity is v = 0.3284 and an average diameter d_{50} equals 0.003 m.

DISCUSSION

From these results, the value of mobility index and friction factor representing flow resistance, have a common vision.

Whereas, an increasing number of water depth, then, the value of mobility Index increased as well, on the other hand, leading to a decrease in the value of friction factor, which represents the flow resistance.

River depth and the riverbed have unique correlation. Riverbed adjusts the riverbed surface and the surface of the river itself. This depth is to escort the relationship between MI and f. The more varied the surface of the river, the more varied the water surface is. The water is in a state of flow. If there is no flow of the river water level stays flat. However, after the current velocity causing sand gravel moving, then, the effects of shear stress is the water flow becomes slower on the surface of the river bed.

CONCLUSION

Mobility Index is obtained by the ratio of shear velocity and particle fall velocity. It is affected by, depth of flow, grainsize, grain density, gravitational force, and the gradient of the river. The count on the coefficient of friction is based on the value of the flow depth, bed form, size, dune height, dune peak distance, gravity. From the comparison between the ratio of the flow velocity and shear as easily as its correlation with the friction factor can be concluded that, the higher the ratio measuring flow velocity and shear rate, the higher the coefficient of friction.This research holds a new equation for mobility index, which is the ratio between shear velocity and particle fall velocity uses Van Rijn equation and the Rubey equation.A new equation to compute the friction factor was performed by Manning equation modifications multiply by the ratio of Von Karman numbers and Euler numbers.The results indicates the correlation between the ratio h/h_s and v/u_* signifying a balanced increase in these proportions. From the graph, it can be seen that, the higher the value of the ratio h/hs the higher the value of v/u_*. This indicates the sediment transport in the surface of the riverbed. As a consideration, the graphic image correlation configuration h/h_s and u/v_* does not specify the amount of bedload transport that occurred at the sites. In this study, the value of bedload transport is measured using bedload apparatus.

ACKNOWLEDMENT

Thank ful for the funding sources that allowed us to pursue this Doctoral program studies : Provision of Postgraduate Scholarships Program (BPPS) in Indonesian higher education institutions.

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