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ARTICLE

Discussion at Maximum Sediment Discharge Theory

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ABSTRACT

It is observed the gravel river sediment discharge with existing empirical regime relationships. The aim of the research is to give a mathematical model about the stable cross-section geometry and to determine a model for the stable slope of an alluvial channel which is in nature seldom stable. In an alluvial channel to reach an equilibrium condition, it changes its plane geometry until to have a stable condition in plane configuration. There are three different parameters in plan configuration about river behavior: width, depth and slope.

1. Introduction

The research for equilibrium state in an alluvial channel the analytical methods are investigated. For this reason, the evidence of laboratory studies and information about the sediment data is studied. The behavior distribution of meanders in nature is reviewed which has a good performance of a laboratory sand-bed channel evolution. The observation of experimental set-up is very similar with observations of a natural gravel-bed river evolution [1,7].

The meander formation is a function of the dominant discharge, grain size and sediment transport content. The Friedkin's Vicksburg experiments [8] and Inglis's [8] analysis of Indian Data are important references for understanding of alluvial flow behavior. In the last decades important research has been prepared in analytical methods. Meander migration is a significant river engineering problem [2,3].

Meander flow takes place in one single channel which ossilates more or less regularly with amplitudes that tend to increase with time. Interaction between the flow and maximum sediment transport produces channel pattern which are classified as meandering or braided.

The research deals with a solution about analytical method. In the river boundary layer two different parameters, the suspended sediment and the friction at the inner boundary layer are evaluated and found mathematical model for the evolution. Till today several researchers determined the analytical models which gave the equation for bank instability because of sedimentation [1]. Another research was about the variation of minimum stream power or about the explanation about stream power in unit discharge where a variation about basic principle is given for the channel shape. It is observed that the boundary layer changes its width, depth and slope during maximum sediment transport. The first derivatives about geometrical approaches are the shape of channel bed which boundary layer shows an acceptable equilibrium since its maximum

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sedimentation occurs with some assumptions. For these assumptions another hypothesis become aware by Ramette [6] where there are some new principles. This work gives new relations without any comparison by sensibility analysis on different environmental data. Ramette's (1979) research has analytical conditions in minimum stream power approach [2].

The proposed mathematical model shows the similarity between Ackers and White's relationships for sedimentation in the river boundary layer and for resistance parameter of flow in the river bed by White, Paris and Bettes relationships [7]. Using these equations it is proposed having new parameters about geometric and hydraulic characteristics for a not moving boundary layer in river section. The results have been compared with practice. It is suitable while comparing the results with other river data in nature and show good approximation by using regime equations. These new inventions about river behavior on an alluvial interface show excess applications in spite using limited regime properties.

2. Formulation of Method

There are six different parameters which easily shapes the channel deformation on an alluvial boundary layer. These parameters are:

(1)The average depth,d;

(2) The slope, S;

(3) The average water velocity, V;

(4) The discharge, Q;

(5) Sediment concentration, X and

(6) The channel width.

The formulation of these variables, it is used,

(1) The continuity equation

(2) Formulas for sediment transport

(3) Formulas for flow resistance

(4) Formulation of the stream condition, that if the stream power should be minimized where maximum sediment discharge takes place in the channel boundary layer.

3. Sediment Transport

Different equations are given in the scope of the continuity equation of water flow and sedimentation, flow boundary layer resistance formula, different kind of sediment transport relationships and the rule where stream power should be minimized when the power of sediment transport must be maximized [7].

The parameters V, d, X and B are given for determination of discharge and slope of the channel where it is assumed that the flow is steady and uniform for a non cohesive boundary layer material. It is invented some equations for determining the sediment transport concentration. This mobility at the boundary layer takes place with different kind of parameters in three values without dimension. These are :

(1) Particle size D_{gr} without dimension,

(2) Content of Sediment G_{gr} and

(3) The particle property which is not stabil and constant, F_{gr}.

This particle property is defined as the ratio of immersed weight and the ratio of shear forces which is a river boundary layer occurrence while the water flowing as a function of bed resistance.

In the river boundary layer it is given that the light sediment particles continue to flow from upstream to the downstream direction [2]. These particles show a mobility as a suspended load in sedimentation with turbulent behavior. By flowing of water the turbulence intensity is very high to carry all the particles which are finer with help of total boundary layer shear stress. It is given as the definition for particle movement [2]:

$$F_{gr} = \frac{V_*^n}{\sqrt{gD(s-1)}} \left(\frac{V}{\sqrt{32 \log\left(\frac{10d}{D}\right)}} \right)^{1-n} \tag{1}$$

For fine sediments, n=1, and n = 0 for coarse property of the sediment particles. For mean value of sediment particles n is described as a value between 0 and 1 in the transition zone, which is dependent to the parameter $D_{gr.}$

$$D_{gr} = D\left[\frac{g(s-1)}{\nu}\right]^{1/3} \tag{2}$$

where g is the gravitational constant and, ν is the kinematic viscosity of the continuum medium, s is the density of coarse sediment.

$D_{gr} > 59$ gives the condition of the flume data for coarse sediments. For fine sediments the result for computation $D_{gr} < 1$. Between these values there is transition zone from fine to coarse sediments.

The cube root is identified as the ratio of immersed weight of sediment particles to viscous boundary layer forces. There is also a sensitivity analysis for different flow data for $D_{gr} > 59$ and $D_{gr} < 1$, for different kind of coarse and fine sediment particles, respectively. The transition zone takes place between above given limits. There is also a stream power definition by sedimentation process where it is combined with a mobility number of particles at the river boundary layer with a continuity parameter of sedimentation [2],

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$$G_{gr} = \frac{Xd}{sD}\left(\frac{V_*}{V}\right)^n \tag{3}$$

where a general model for a particle discharge is given as, [2]

$$G_{gr} = C\left(\frac{F_{gr}}{A} - 1\right)^m \tag{4}$$

in which C and m are different constants for D_{gr} function, and X is the parameter for initial movement of the particles. The given threshold for changing the location of particles in the boundary layer is given with the above parameter of $F_{gr.}$ For the paramerters n, m, G_{gr} and A is defined by transitional zones of D_{gr} between 1 and 61 [7].

$$n = 1.0 - 0.56 \log D_{gr} \tag{5}$$

$$m = (9.66/D_{gr}) + 1.34 \tag{6}$$

$$\log C = 2.86 \log D_{gr} - \log^2 D_{gr} - 3.53 \tag{7}$$

$$A = \frac{0.23}{\sqrt{D_{gr}}} + 0.14 \tag{8}$$

where for transition zone of coarse sediments, $D_{gr}>61$ is given as [7]:

$$n = 0.11 \tag{9}$$

$$m = 1.51 \tag{10}$$

$$C = 0.026 \tag{11}$$

$$A = 0.18 \tag{12}$$

4. Frictional Characteristics

Including the Ackers sedimentation theory [1] there is another linear relationship between sediment transport and the total shear stress,

F_{fg}, is given as

$$F_{fg} = \frac{V_*}{\sqrt{gD(s-1)}} \tag{13}$$

and the mobility, related to the effective shear stress, F_{gr}, existed with coefficients depending on D_{gr}. An extensive correlation exercise for a wide range of sediment sizes (0.05 mm to 11 mm) gave the equation

$$\frac{F_{gr} - A}{F_{fg} - A} = 1.0 - 0.76\left[1 - \frac{1}{\exp(\log D_{gr})^{1.7}}\right] \tag{14}$$

There is traditional methods which can easily matches with data of sediment sizes between 0,04 mm to 69 mm[5].

5. Variation Principle

For solving the problem another attempt had been made with maximum or minimum parameters in the boundary layer which is given for different sediment sizes. The new hypothesis is given in the conditions of special discharge for fluvial slope where during maximum sedimentation the width of the bed boundary layer is changed till it is stable. Using stream power at the channel boundary layer if the stream power is minimum, sufficient equilibrium condition for alluvial boundary layer can be observed. The other researchers give the same observation with different analytical approaches [3,4] where the channel width is given and remains fixed during the minimization of stream power. These attempts relate the principles of minimum unit stream discharge while the occurrence of energy dissipation with minimum sediment rate. It can easily observed the same results by maximizing sedimentation and obtained a minimum slope for channel bed [5,6]. During comparison methods it is given that the maximum sediment concentration for a constant water discharge and slope, many sedimentation theories and friction relationships for bed boundary layer identifies the same parameters. It is given different diagrams for slope and sediment concentration as a function of channel width. By observations in nature both extremes occur at a width of 43 m. Since the two principles of maximizing transport rate and minimizing slope are equivalent, the work relating minimizing stream power to minimizing the rate of energy dissipation which can be used for the method of maximum sedimentation at the boundary layer. If there is not maximum transport rate conditions on the boundary layer without adjusted the alluvial fluvial bed slope with discharge. There are different solutions to the different parameters of concentration, velocity and depth. The new approaches give the solutions about different parameters which have sedimentation discharge under the maximum rates and width under the extreme values. There are another constrains with parameters of bank and bed erosion. It gives a solution about erosion parameter where the banks have more erosion property than the bed boundary layer, observed new bed deformation on alluvium with more larger curvature. This research gives the conditions about uniform flow properties without subjected the development of river plan behabiour. Only new concept about maximum sedimentation can easily determine river behavior in plan section. It is observed that only in the meandering channel development it is observed the comparison with straight channel formation where river discharge transport larger sedimentation with smaller energy. It is concluded that the plan geometry of alluvial plan behavior of meander needs maximum sediment transport rate. The comparison between theoretical study and observations in praxis has the same results. In the meandering plan geometry the uniform flow conditions produce also the same characteristic behavior.

6. Computational Procedure

There are different artificial computer intelligence software for satisfying geometric values about sedimentation density, about the size of different bed boundary layer material and about temperature conditions. These are inputs in computer software and as output the meandering boundary layer depth, water depth, mean velocity and slope for inner boundary layer which can be computed. The results have as for the sensibility analysis only 1 % deviation from observations [7]. The other researchers observed in laboratory channel a rectangular sand cross section [2,3], where it has the same computational procedure about the hydraulic radius, referring the wetted area divided into the wetted perimeter as R is the hydraulic radius, g acceleration gradient and S is the alluvial boundary layer slope, determined by the equation

$$V_* = \sqrt{gRS} \tag{15}$$

For trapezoidal cross-sections in laboratory channel conditions the flow plan section shows an equilibrium condition for shaping its width and shape, if the cross-section slope z (defining where z is horizontal to 1 vertical) is computed for below conditions: [4]

$$z=0.5 \text{ if } Q<1 \text{ m}^3/\text{s} \tag{16}$$

$$z=0.5Q^{1/4} \text{ if } Q>1 \text{ m}^3/\text{s} \tag{17}$$

7. Evaluation of Method

By using sensitivity analysis of observations with analytical model of discharge and slope the parameters of sedimentation density, plan width and water depth were predicted. For different data another computer model is developed to determine the laboratory model discharge, Q, and sedimentation density, from which it is taken for computational procedure the different parameters as water width, water depth and boundary layer slope.

For the same data distribution there are some parameters about sediment granulometry of D_{35} size on sediment distribution curves [5], where the bank full discharge is chosen as a constrained factor. For this reason there are different data collections for evaluation about sandy boundary layer of alluvium and the gravel-bed rivers .By comparison of the results for sand channels existing regime channel relationships are compared with new approaches. It is observed that two approaches overlap in different relationships. Predictions show that the boundary layer slope is a function of sedimentation [6]. If there are deviation in the curve data of sedimentation it is given because of observation errors. Observed and calculated values may readily be compared by considering the discrepancy ratio, the ratio of the predicted to the observed value in the each data set. The mean discrepancy ratio for the slope is 2.20 with a standard deviation of 1.9. From the observed values of the discharge density in the alluvial river boundary it is given the calculation procedure for channel width determination. It showed a good agreement in the range 1> B (m)< 20 between calculated and observed values. The standard deviation is given as 0,33 with the mean discrepancy ratio of 0,96.

The results for gravel rivers in present computations are given for comparing with another scientific data [6]. The sedimentation changes between 10-50 ppm and a sediment size of 100 mm with different diagrams in cartesian coordinate systems [1]. The sensitivity analysis is not appropriate for D_{35} size and there are empirical formulas for D_{50}, D_{65} and D_{90} sizes of sedimentation with overlapping property.

The last examples for sedimentation research were taken from surface boundary layer of alluvial rivers. In gravel-bed rivers, there are different sizes in formulas except D_{35} and D_{50} which are under mean values. The other observations are obviously for computing of different properties like slope, and water depth, water boundary layer thickness with width. The prediction of slope shows a good agreement with empirical formulas. If there are not heavy sedimentation the results of formulas give more overlapping properties with observations and computation. The new methods show the tendency to under predict in low sedimentation. The deviation shows an increasing character with increasing particle property and decreased at the high sedimentation. The standard discrepancy is given as 1,1 where its deviation shows a value of 0,54. As stated earlier, the sedimentation discharge is most important factor in gravel-bed flumes. In addition, D_{35} size of material property with D_{50}, D_{65} and D_{90} is chosen for estimation of different properties.

Because of granulometry curve the computational

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method shows a weak relationship in affecting the bank instability, where there exists no one relationship between size distribution of sedimentation and surface boundary layer geometry. The results for width distribution in gravel-bed flumes are not satisfactorily while the complicated procedure of computation.

The sensitivity analysis for widths does not show good agreement at the gravel boundary layer brcause of the lack of laboratory experimentation where

(1) To specify the different grain sizes at the boundary layer,

(2) To specify bed performance at the gravel bed boundary layer,

(3) It is difficult to give all parameters for a flood which is observed in the nature in exact values.

(4) There are some constraints because of the gravel-bed formations and also channel bank formations.

8. Conclusions

(1) The approaching procedure for prediction of boundary layers in a flume movement is derivation by minimum discharge parameters the maximum rates for sedimentation. This method can easily predict the unknown parameters for sand and gravel-bed flumes.

(2) The maximization method is investigated in scope of determining the minimum channel slope the sediment transport at the river valley which shows moving character in plan configuration.

(3) From comparisons with available data it has been shown that: ① Predictions of slopes show scatter when compared with observations. This is not necessarily a deficiency in the method. There is a slight tendency to overestimate slopes; ② predictions of widths are excellent except for very large sand channels and for meandering laboratory channels where there is a tendency to underpredict.

References

[1] Ackers, P.. Experiments on small streams in alluvium. Journal of the Hydraulics Division, ASCE, 1964, 90(HY4): 1-38.

[2] Ackers, P.. Use of sediment transport concepts in stable channel design. International Workshop on Alluvial River Problems, Roorkee, India, March, 1980.

[3] Bray, D. I.. Regime Equations for gravel bed rivers. Proceedings of the International workshop on engineering Problems in the Management of Gravel Bed Rivers, Newtown, Powys, United Kingdom, 1980.

[4] Kennedy, R. G.. On the Prevention of Silting in irrigation channels. Proceedings, Institution of Civil Engineering, 1895, 119.

[5] Lacey, G.. Stable channels in alluvium. Proceedings, Institution of Civil Engineers, 1930, 229: 259-384.

[6] Ramette, M.. A Theoretical Approach on Fluvial Processes. International Symposium on River Sedimentation, Beijing, China, 1980.

[7] Yilmaz, L.. On the problem of the meander development in alluvial channels. Bulletin of the Technical University of Istanbul, 1990, 43(4): 553-365.

[8] Yilmaz, L.. Meanderbildung, Beitrag in Türkisches Wissenschafts - Technologiezentrum e.V. Berlin [IWAWI]. Technische Universitaet Berlin, West Germany, 1989.

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ARTICLE

Empirical Studies in Alluvial Streams

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ABSTRACT

Meander flow takes place in one single channel which oscillates more or less regularly with amplitudes that tend to increase with time. Meanders are found in beds of fine sediments with gentle slopes. In this study, effort will be made to investigate meanders' turbulent boundary layer and to improve the present knowledge about the river meandering phenomena. It is assumed that the development of the perturbations which develop into meanders or braids, is longer than the width of the channel. Interaction between the flow and mobile boundaries produces channel patterns which are classified as meandering or braided. It is therefore long compared with the ripples or dunes which cover the bed of such a channel and whose wavelength is shorter than the width of the channel. The variation of resistance to flow and rate of transport of bed material with velocity are discussed briefly and taken into account. Meander flow and meander shear stress distribution of the channel are described. The basis is a steady, two-dimensional model of flow in an alluvial channel with variable curvature. The meander development is described by forcing a travelling, small-amplitude channel alignment wave on the system, and determining the growth characteristics of the wave. Laboratory data are used to verify the formulas.

1. Introduction

The alluvium and boundary layer of channel occurrences are distinguished while these events can be controlled at the laboratory by the scientists. Any parameter which is selected as an independent variable is classified as long-term and short-term in the field. It is given as three different following classifications: 1. Steady time, 2. Graded time,and 3. Geologic time that it is divided into short - term, long – term, and very long-term time spans, respectively [1].

The first time period is given in days, the graded time is in the value of a few hundred years, and the geologic time may have a value of millions years. It is dependent to the size of the drainage area on alluvium. Here is the most important events which have different properties can be shown as cause or as effect depending on time scales. The sediment discharge is an important parameter in the steady time duration which can be transmitted as a water velocity function in empirical relationships [1].

In the last observation the water velocity is given as the reason and the sedimentation is the result. This is usually correct for the short-term evaluation but not so for the long-term graded time duration equilibrium conditions where flow inflow and sedimentation are searched on the drainage boundary layer as independent parameters for the flume [2]. These amounts of drainage area are flowing

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from upstream and from the tributaries which are observed at the upstream and tributary entrances to the basin. During the long –term period of river flow the different parameters like transport capacity and the inflow amount must show an equilibrium condition on the river valley. In the empirical relationships channel migration rate is given as the function of width, depth and slope in the alluvium like the relative curvature r_m/B and definition of r_m [12]. If there is no aggradation braided channel formations occur in quasi-equilibrium conditions.

The primary reasons at the channel alluvium may be given the braided channel formations [12]. The results of primary occurrences are:

(1) Over-sedimentation because of heavy sediment transportation from the upstream boundary layer

(2) Because of steep horizontal slopes

Analysis of braided river conditions is out of scope of this paper.

2. River Types

River types with point bars in nonsinuous patterns can be met at heavy bed-material and low silt-clay mixture on horizontal steep valley slopes. Flumes with these properties have mean values of lateral curvature at the valley route where one of the multiple tributaries moves against the inner bank boundary layer. The differences between sinous flumes and nonsinuous braided rivers are given with two contrast in width-depth ratio, slope, channel and bank stability and other properties. It seems to be contrasted in:

(1) Blockage of a main channel by ice blocks in northern hemisphere,

(2) Different topographical properties of river boundary layers

(3) Geological reasons such as alluviums or different soil aspects

By different researchers the reason for meandering channels is given as the soil properties of the river valley environment which shows the quasi-equilibrium condition. Anabranches rivers have more steeper borders than the undivided river patterns where they have low sediment transport rate and the meanders have high sedimentation for having equilibrium conditions on the river reaches.

3. Threshold in River Morphology

The relationships for river morphology cannot continue undefinitely because of the auter effects of the natural disasters like earthquake, flood conditons and drought conditions where there is observed different thresholds and discontinuities. The length along the meandering patterns is given as

$$M = 2 \pi B \qquad (1)$$

where B is the width of the channel curvature illustrating diffent frequency distributions. The properties for 8 alluvial and 5 bedstone armour streams are reported [11]. The other approach is given for different river pattern curvature where the transverse oscillation of the water velocity takes place against the river bank degradation. Meandering river pattern shows good agreement with the evaluation of river plan formations. In a bedrock environment the meander formation about gooseneck is shown [12] (Figure 1).

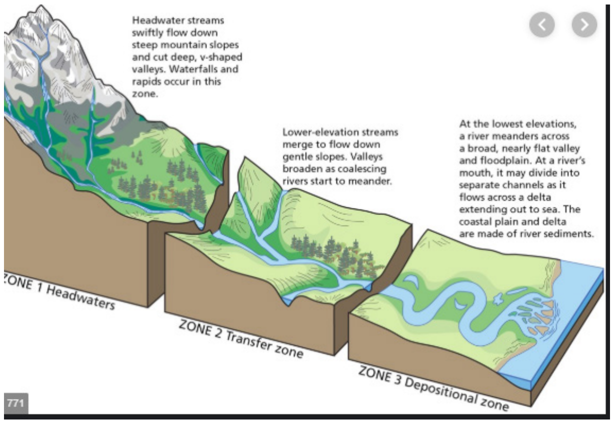

Figure 1. Gooseneck river meander

The oscillation of boundary layer in river meanders is dependent on the sedimentation amount from upstream reach. There is another damping constant which is dependent on the water velocity with different reverse components. It is invented new relationships about discharge and wavelength using the formula [6-9],

$$\frac{\lambda}{AB^{1/2}} = 72FB^{0,52} \qquad (2)$$

$$\lambda = 39\ Q^{0,41} \qquad (3)$$

where A is the cross-sectional area and B is the width , F Froude number and λ is the river oscillation wave-length (Figure 2).

Figure 2. Sedimentary Deposition Environment

The above relationships have statistically character by collecting different laboratory and natural data. There are also distributed in different 60 constant discharge laboratory evaluation. At the lower discharge condition the alternate bars occur at the river boundary layer with different characteristics. In several researchesar the alternate bar conditions can be seen with controlled discharge and bank stabilization near alternate sides of the river boundary layer. At higher stages of flow conditions alternate bars dissappeared. It is the reason of higher velocities in the channel. There is directly connection between alternate bar formation and curvature migration in the boundary layer. In the erosion condition of meandering rivers alternate bars change their forms quickly in free developing curves. In different conditions where water depth has fifth percent of width is observed alternate bars occurs at the river axis scour. Alternate bars at the meandering conditions are significant effect on river geology and river ecosystem. It is also concluded in this condition meander length $\lambda / A^{1/2}$ changes into Froude number with 0,5 exponent and their wavelength changes with the discharge of 0,4 exponent. Different researchers give the same idea that the laboratory observations are not the same as the natural phenomena because of different impacts of the river shoreline.

4. Results

River types with point bars in nonsinuous patterns can be met at heavy bed-material and low silt-clay mixture on horizontal steep valley slopes. Flumes with these properties have mean values of lateral curvature at the valley route where one of the multiple tributaries moves against the inner bank boundary layer. The differences between sinous flumes and nonsinuous braided rivers are given with two contrast in width-depth ratio, slope, channel and bank stability and other properties. It seems to be contrasted in [5-7]

(1) Blockage of a main channel by ice blocks in northern hemisphere,

(2) Different topographical properties of river boundary layers

(3) Geological reasons such as alluviums or different soil aspects

References

[1] Yilmaz, L.. Meanderbildung, Beitrag in türkisches Wissenschafts-Technologiezentrum e.V. Berlin[IWA-WI]. Technische Universitaet Berlin, 1989.

[2] Holtorff, G.. The formation of Bed Waves in Alluvial Channels, Proc. III International Symposium on river sedimentation, Jackson, Miss., USA, 1986.

[3] Vollmers, Pernecker. Beginn des Feststoff-Transportes für feinkörnige Materialien in einer richtunskonstanten Strömung. Wasserwirtschaft, Heft. 1967, 6: 236-241.

[4] Eckelmann, H.. The structure of the viscous sublayer and the adjacent wall region in a turbulent channel flow. J. Fluid Mech., 1974: 439-459.

[5] Hanratty, T.J., J. A. Campbell. Measurement of wall shear stress, in fluid mechanics measurements. Edited by R.J. Goldstein, Hemisphere, Washington, D.C. 1983: 559-615.

[6] Odgaard, A.J.. River Meander Model. I. Development. J. of Hydraulic Engineering, 1989, 115(11): 1433-1451.

[7] Odgaard, A.J.. River Meander Model. II. Applications. J. of Hydraulic Engineering, 1989, 115(11): 1451-1465.

[8] Miller, S., Chaudhry, M. H., Dam. Break Flows in Curved Channel. J. of Hydraulic Engineering, 1989, 115(11): 1465-1479.

[9] Dammuller, D. C., Bhallamudi, S. M., Chaudhry, M. H.. Modeling of Unsteady Flow in Curved Channel. J. of Hydraulic Engineering, 1989, 115(11): 1479-1496.

[10] Rahuel, J.L., Holly, F.M., Chollet, J.P., Belleudy, P.J., G. Yang. Modeling of Riverbed Evolution for Bedload Sediment Mixtures. J. of Hydraulic Engineering, 1989, 115(11): 1521-1543.

[11] Zimmermann, C., Kennedy, J. F.. Transverse bed slopes in curved alluvial streams. J. of Hydraulic Engineering, 1978, 104(1): 33-48.

[12] Yilmaz, L.. Laboratory Channel Meander, (unpublished material) Nisantasi University, Engineering Faculty, Hydraulic Division, 2020.

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ARTICLE

Sediment Distribution of the River Boundary Layer

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ABSTRACT

The movement of particles on the river boundary layer is a complex phenomena which can be never solved by a deterministic approach. The unsteady non uniform conditions in flow boundary layer show the result of water surface and bed stream changing with time and location of particles. To determine the movement of boundary layer particles other new theories about stochastic processes using the theory of probability and statistics in river alluvial channels will give better results.

1. Introduction

To determine several formulas for sediment transport discharge are useless which can be given as discharge of sediment as a function of flow properties because of its complexity. As a result, it was no universal formula determination foe sediment discharge. Different theories of probability have great potential in problem solution which are playing an important role for determination of particle movement duration on the alluvial river boundary layer [1]. In this aspect the laboratory observations can be used for verifying of the stochastic results.

Einstein [2] searched this phenomena using the probability density formulas solving the sediment transport length and rest of duration which are given as exponential functions. The travelling total distance of the particle is given as [1],

$$f(x,t) = k_1 . e^{-k1x - k2t} \Sigma_{n=1}^{\sim} [(k_1.x)^{n-1} / \Gamma(n)] . [(k_2.t)^{n} / \Gamma(n+1)] \ldots\ldots x>0 \quad (1)$$

in which f (x,t) = gamma function

k_1, k_2 = constants of the mean step length and rest period, respectively.

Equation (1) is proportional to the sediment particle concentration with respect to longitudinal position of x as a function of time duration. It is derived two-dimensional model of stochastic interpretation of the bed-sediment particle layer height where the particles deposited.

In the model application, the function for probability density at the rest period is calculated in the deposition elevation as f x_D (x), the function for probability density function is given as $f_{T\backslash YD}$ (t\y) which is given as the rest period at the elevation deposition .

Using cluster techniques of tracer particles [1], the statistics for the lengths and duration periods can be easily

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calculated. Here $k_1$and k_2 parameters are found from longitudinal concentration distribution curves [4]. It is reported that the theoretical and laboratory applications are overlapped. Model parameter estimations from different laboratory observations are difficult. Another experimental study is given by another research [3].

Different laboratory flume with two bed-material sizes were conducted by experiments were as bed configurations can be seen ripples and dunes. The step lengths and the rest can be determined by using single radioactive tracer movements where step lengths and the rest periods were measured directly. It is observed that the gamma distribution overlap with step lengths and the rest periods to be approximately exponentially distributed [1]. The bed elevation as a function of time records, it is given that the conditional probability density function of the rest periods can be observed by the exponential function [3],

$$f_{T/YD}\ (t/y) = k_y(y)\ e^{-k3\ (y)t} \quad (2)$$

in which $k_3(y)$ = the constant of the conditional mean rest period at elevation y. If significant further results is to be expected new solutions must be determined for estimating the probability distributions. The purpose of these experiments is to give the observations of different laboratory studies about flumes in which different data are collected.

2. Experiments about Flume Boundary Layer

In alluvial boundary layers the most expected bed forms are dunes. The shape of a dune is approximately triangular in long section with gentle upstream slope and a steep downstream slope. The upstream flow conditions determine the shape of a dune whereas the slope on dune is more dependent on the angle of repose of the bed material. The movement of dunes downstream gives the observation about erosion from the stoss or upstream side and deposition on the downstream face. Sediments particles of a dune at the upstream side must make a step in the downstream direction before being rest on the slip side. After deposition they rest until the dune has moved to another place whose sequence continues at the flume boundary layer. Particles show movement by erosion and rest on the bed boundary layer where its step length depends only on the height of bed slope from which it has moved. The number of dune crests shows deposition and shape and scale during the time of the erosion. If the number of particles per unit volume of the bed Ω is constant the accumulation is assumed in statistical sense stationary, both erosion and deposition cannot be observed at the same point and at the same time. The rest length of the particle is given from the stochastic equation as $y_x(t)$ values. The value of sediment particles per unit area within the class intervals ($\eta_{j,}\ \eta_{j41}$) in step duration, given by $N_d\ (y_j)$ as [1],

$$N_d\ (y_j) = \Omega\Sigma_{x=1}{}^{m}\ \Delta y_{j,\pi} \qquad j = 1,2,\ldots\ldots,n \quad (3)$$

where π = the value of class intervals for having of Y_D value;

$\Delta\ y_{j,\ k}$ = the elevation height of the bed in every class interval associated with y_j for the k^{th} deposition period and m_j = the maximum value of bed forms contained in the $y_x(t)$ step and which also have some deposition in the class interval, having with y_1 for the k^{th} deposition period.

The total value of sedimentation per unit boundary layer area rests over all intervals which is deposited by N_d and is obtained by summing them [1].

$$N_d = \ \Sigma_{j=1}{}^{n}\ N_d\ (y_j) = \Omega\Sigma_{j=1}{}^{n}\Sigma_{k=1}{}^{mj}\ \Delta y_{j,k} \quad (4)$$

This equation was approximated by us of the sample probability mass function, given as

$$P\ Y_D\ (y_i) = P\ [\eta_j < Y_D < \ \eta_{j+1}\ ] = N_d\ (y_i)\ /\ N_d \ \text{ for a large m} \quad (5)$$

The particle probability of erosion within a particular class interval can be observed in the same time where the erosion periods instead of the deposition periods must be taken. The probability function will be given to either deposition periods or erosion periods, the bed height probability function in deposition and erosion must be identical [4].

3. Probability of Particle Rest Periods

The particle rest duration is given as the rest time between the deposition and erosion at the flume boundary layer where the $y_x(t)$ value defines the probability estimation of particle density function at duration on the height of bed elevation. This probability is given by [3]. Measurement the time difference between a down crossing and the previous up crossing values ($t_{j,k\ ;}$ j= 1,2,….., n and k = 1,2, ,,,,, m_n) for a relative frequency analysis of the statistic ($t_{i,k}$) is given for a sample conditional probability mass function of the rest period definition [3].

$$P_{T,YD}(\ t_\alpha|y_j) = P\ [\ \tau_\alpha < \tau < \tau_{\alpha+1}\ /\ \ \eta_j < \ \ Y_D < \eta_{j+1}\ ] \quad j=1,2,..,n \qquad \alpha = 1, 2,\ldots\ldots r \quad (6)$$

where τ = the random variable describing the rest periods, t_α, and y_i = the class properties for τ and Y_D.

τ_α and $\tau_{\alpha+1}$ = the lower and upper class limits of τ_α, and r = the number of class intervals for τ.

This function of probability is used to determine the mass function for the sediment deposition durations

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$$P\tau_n (t\alpha) = P [\tau_\alpha < \tau < \tau_{\alpha+1}] = \Sigma_{p=1}^{n} P_\tau \ ; Y_D (t_\alpha | y_i) P_{YD} (y_t)$$
α= 1,2,..r (7)

The duration of probability function for the deposition of sedimentation on the flume boundary layer can be collected by distribution of bed height value at a fixed location with time interval. Other observations can be given as [3]:

(1) Noting that both sediment transport at the bed boundary layer with the other word erosion and rest of particles (deposition) do not see at the same time interval,

(2) The sedimentation at the bed height is assumed stationary in view of statistics where its results must show the same application in the field and at the experimental-set-up.

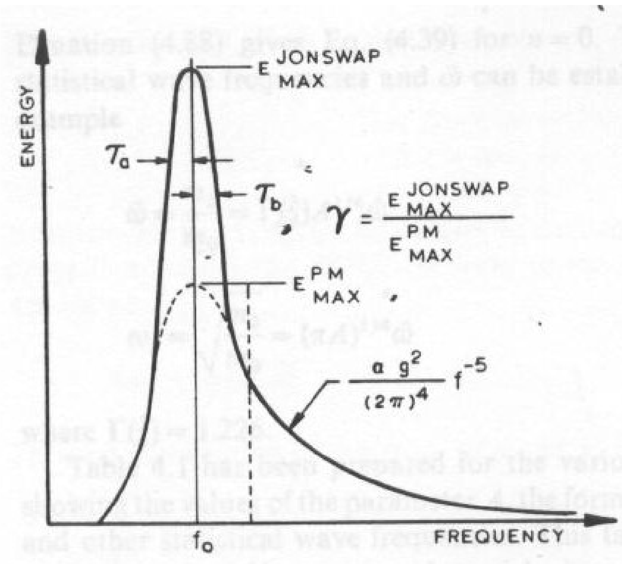

Figure 1. Comparison of the JONSWAP and Pierson-Moskowitz Normal Distributions at particle movement energy [5]

4. Step Length Determination with Probability Distributions

For step length distribution first we must assume that a particle has also energy by deposition and erosion in view of bed load distribution on the river boundary layer [5]. Using Model theory we can easily have the same experimental-set-up on the laboratory. The suspended bed load is given as that material which is transported from upstream and deposited on the downstream part of the bed material formation like a dune from which it shows a movement. The suspended bed material must be that sediment material which is not deposited on the downstream part of the same bed formation. If we observe the bed load as previously defined the distance between the transporting at elevation y_1, and the transportation to the bed height y_1 of the k-th bed formation in the $y_t(x)$ location. This observation is a definition of the step distance of a sediment particle which is transported from the bed elevation y_i and is resting on the bed height y_i on the same bed form. The frequency analysis of the observations (x, β) determines a sample conditional probability mass function which is defined as:

$$P_{x|YE,\ YD} (X_{i\beta} | Y_t, Y_j) = \quad (8)$$

in which X = the random step length value,

$$P_{x|YE,\ YD} (X_{i\beta} | Y_t, Y_j) = P [\lambda_\beta < X < \lambda_{\beta+1}] [\eta_i < Y_E < \eta_{i+1} , \eta_j < Y_D < \eta_{\beta+1}] \quad (9)$$

β = 1,2,….., s and i,j = 1,2,….., n

X_β = the class property for the observation of $X_i\lambda_\beta$, and $\lambda_{\beta+1}$ the lower and upper class limits of X_β , and s = the number of class intervals for the realizations of X variable.

If Y_E and Y_D are assuming independent for a uniformly sized boundary layer sedimentation, it defines that a particle passing a bed form crest has no memory of the height of its movement where the sample mass function of the rest length given that a particle is lying at elevation y_j, defined as [3]

$$P_{x|YD} (X_\beta | Y_i) = P [\lambda_\beta < X < \lambda_{\beta+1} \mid \eta_j < Y_D < \eta_{j+1}] \quad (10)$$

The step length function of the bed load sedimentation can be determined by combining the observations taken in the y_x (t) and $y_t(x)$ measurements. The other conditions are given as [5]:

(1) No accumulation can be observed on the upstream sides of dunes and no sediment transportation occurs on the downstream parts of the bed forms.

(2) The height of accumulation, Y_E and the elevation of particle deposits, Y_D, are independent.

(3) The flow is in Froude number as transition part [6]. The first assumptions may not be strictly true due to flow separation, in the dune environment where both deposition and erosion may occur at the same point. For dune flow conditions, laboratory observations show that such an area is small. The second assumption seems to be reasonable because as a sediment particle passes a dune crest it is likely to lose any memory of where it came from. Bed load is defined as that portion of the total load which passes only one dune crest per step

5. Sediment Discharge Definition

The transport rate of sedimentation at elevation $y_p v_B$ (j) is given as,

$$vB(j) = \frac{E\left[X \middle| YD = Yj\right]}{E\left[\tau \middle| YD = yp\right]} \tag{11}$$

in which $E[X|Y_D=y_j]$ = th mean step length of the sample, given that the height of deposition is at y_p, and $E[\tau|Y_D=y_p]$ = the mean rest period of the sample given the elevation of deposition is at y_p. This transport rate can be determined at each zone of the bed contributes to the total bed-load.

Using the continuity equation the total bed-load distribution is given as [6]

$$Q_B = \gamma_B (1- \theta) \Sigma_{i=1}^{n} v_n (j)\xi_j \Delta y_p \tag{12}$$

where $Q_{B=}$ the bed-load discharge in weight per unit time and width,

γ_B = the specific weight of the bed particles,

θ = the porosity of the bed material,

Δy_p = the class width which remarks at the bed elevation, y_j

In the bed discharge formula, the bed-material particles must have identical transport properties. We can change the above expression as

$$Q_B = \gamma_B (1- \theta) h\, v_B \tag{13}$$

where h= the mean depth of the layer in which bed-load particles transported

v_B = the average transport velocity of a bed-load transportation.

6. Analysis of Experimental Evaluation

Different experiments were observed in a recirculating flume of rectangular cross-section [6]. The bed transportation observed in the experiments, was a uniformly sized river accumulation with uniform distribution. After an uniform discharge was observed, the y_x (t) and y_t(x) values, the bed material discharge, and the hydraulic units were evaluated. The methods and procedures of evaluation have been given [7].

The y_t (x) evaluation were given by mounting a sonic depth sounder on an instrument carriage such that the ultra sounder was over the center line of the flume and then moving the sounder and carriage in the upstream direction. The evaluation time was approximately 5 min., the y_t(x) evaluation is continuously.

The y_x (t) evaluation was held by putting a sonic depth sounder at the canal centerline, downstream of the instrumentation. Both the y_t(x) and y_x(t) evaluations were digitized with an analog-to-digital converter at the lag intervals [8]. The lag interval on the y_t(x) evaluations was not constant because the speed of the carriage was somewhat different for each lag.

The probability mass function samples were obtained by the given above formulas by accumulation height of sedimentation at the flume boundary layer and sediment transport [8].

The y_x(t) evaluation of each run was standardized so that the class intervals y_t, measures the heights of deposition or erosion in terms of the standard deviation about the mean bed height.

The class width of 0,4 standard deviations was used for all class evaluations. The histograms of frequency for accumulation and sediment transport are given [1]. The Gaussian density function obtained from data evaluation shows to fit the values for different experimental-set-ups very well. For flume stationary condition continuity needs that the probability of erosion from any bed height is equal to the accumulation probability. Therefore, the density functions for the height of accumulation, and sediment transport must be identically distributed. The mean and variance of evaluation data histograms are also given. The total number of points are available for analysis, Σm_j. In the low sedimentation processes the slow transport rates give the limited number of occurrences. The deposition periods were computed by determining the difference between the sediment transport from the bed formations and the time of deposited which have defined as each observed event as m_{ti} . Also given in this figure the overlapping of occurrence into the two-parameter gamma probability density function.

7. Summary and Results

(1) For deposition or sediment transport at the flow boundary layer evaluation by the sediment probability density function it has the shape of standard normal density function with +- 2.4 standard deviations.

(2) The observation of mean rest period of sedimentation shows with decreasing bed height an increase. The property of mean deposition duration seems to be not a function of upstream continuum mechanics

(3) Noting that both sediment transport at the bed boundary layer with the other word erosion and rest of particles (deposition) do not see at the same time interval,

(4) The mean deposit period depends on accumulation of boundary layer properties which can be larger than the mean deposition duration of particles at the boundary layer height.

(5)The exponential density function overlaps with the measured deposition duration distributions reasonably well.

(6) The mean step length of a sedimentation particle increases nearly linearly with a decrease in the boundary

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layer height. The mean step length of a sedimentation particle seems nearly 45 % of the mea bed form length for different experimentation procedure.

(7) The Gamma Density Function fits the measured deposition length distribution reasonably well.

References

[1] Lee, K. Baum. Stochastic Analysis of Dune bed Profiles, ASCE, Journal of the hydraulics Division, HY7,10557, 1974: 849-857.

[2] Einstein,H. A.. The Bedload Movement as a Probability Problem. Mitteilung der Versuchsanstalt fur Wasserbau, an der EidgenossischeTechnischeHochschule in Zurich, VerlagRascher and Co., Zurich, Switzerland, 1937.

[3] Hubbell, D.W., Sayre, W.W.. Closure in "Sand Transport Studies with Radioactive Tracers". Journal of the Hydraulics Division, ASCE, Proc. Paper 4464, 1965, 91(HY5): 139-149.

[4] Sediment. Transportation Mechanics: Introduction and properties of Sediment. by the Task Committee on preparation of Sedimentation, Manual of the Committee on Sedimentation, Vita A. Vanoni. Journal of the Hydraulics Division, ASCE, Proc. Paper 3194, 1962, 88(Hy 4): 77-107.

[5] Yilmaz, L.. Stochastic Sedimentation Process Distribution at Particle Energy. Nisantasi University, 1453, Neocampus, Istanbul, Turkey, (unpublished research) 2019.

[6] Shen, H. W., Todorovic, P.N.. A General Stochastic Model for the Transport of Sediment Bed Material. Proceedings, 1st International Symposium on Stochastic Hydraulics, Chao – Lin Chiu ed., Pittsburg, Pa.,1971: 426-448.

[7] Williams , G.P.. Aids in designing Laboratory Flumes. Open-File report, United States Geological Survey, 1971.

[8] Lee, B. K.. Laboratory Study of an alluvial stream at one Foot Depth. Thesis presented to Colorado State University, at Fort Collins, Colo., in partial fulfillment of the requirements for the degree of Master of Science, 1969.

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ARTICLE

Development of River Meander Model

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ABSTRACT

In the studies of open-channel flow with suspended sediments, used a constant of Von Karman κ in a model for velocity profile. The augmentation parameters have been added by various researchers in more recent development of the boundary-layer theory of meander development. In this research new parameters will be included because of the existence of the turbulent flow region in meandering channels because of boundary-layer theory.

1. Introduction

A functional relationship was attempt for the lower flow regime discharge to which the sediment rate may be related as [1]:

$$U/U_*'' = F(\psi') \tag{1}$$

where U is the mean velocity and U_*'' is the shear velocity and ψ' is the intensity of shear on representative particles and is given by [1]

$$\psi'_{35} = \frac{(\rho s - \rho) d35}{\rho R's}. \tag{2}$$

where ψ'_{35} is the intensity of shear on the particle with a diameter 35 mm. sieve probe,

ρs = Sediment density and

ρ = Water density

R' = Hydraulic radius of meandering boundary layer

S = Slope of the meandering boundary layer which is given in the Form resistance relationship of the 2nd equation.

2. Method

Another research works with the divided slope approach by assuming that the skin friction is due primarily to expansion losses associated with flow separation downstream of dune crest in meandering boundary layer [1].

The magnitude of the expansion head loss H'' may be estimated from the formula [1],

$$\Delta H'' = \alpha \frac{(U1 - U2)**2}{2g} \tag{3}$$

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where α is the loss coefficient, U_1 is the mean velocity above the crest, and U_2 is the mean velocity over the trough. If the bed form height is given as h and the mean depth is given as D, then the 3rd relationship becomes [1]

$$\Delta H'' = \frac{\alpha}{2g}[\frac{q}{D-\left(\frac{1}{2}\right)h} - \frac{q}{D+\left(\frac{1}{2}\right)h}]A^2 \cong \frac{U^2}{2g}[\frac{h}{D}]A^2 \quad (4)$$

where q is the discharge per unit channel width and U = q/D is the mean velocity and A =unit.

The energy gradient S'' is the head loss H'' divided by the distance of one wavelength at the bed formation in meandering channels [1],

$$S'' = \frac{\Delta H''}{\lambda} = \frac{\alpha}{2}\frac{h1^2}{\lambda D}F1^2 \quad (5)$$

and substituting the above equation into Eq. 5 yields [1],

$$S = S' + S'' \quad (6)$$

where the depth D is replaced by the hydraulic radius R.

Multiplying both sides by $\gamma R(\gamma_s - \gamma)$ gives,

$$\frac{\gamma RS}{(\gamma s-\gamma)d} = \frac{\gamma RS'}{(\gamma s-\gamma)d} + \frac{\alpha}{2}\frac{\gamma h1^2}{(\gamma s-\gamma)\lambda d} \quad (7)$$

3. Mathematical Model

In research of this model the vertical component of velocity is negligible, and the pressure is assumed as hydrostatic. The two-dimensional equations for water depth and depth-averaged velocities is given accoding to [14].

$$\frac{\delta(uh)}{\delta s} + \frac{1}{r}\frac{\delta(rvh)}{\delta n} = 0 \quad (8)$$

$$\frac{\delta u}{\delta s}u + \frac{\delta u}{\delta n}v + \frac{uv}{r} = -\frac{1}{\rho}\frac{\delta p}{\delta s} - \frac{\tau 1_s}{\rho h} + 2\frac{\delta}{\delta s}[\in \frac{\delta u}{\delta s}] + \frac{\delta}{\delta n}[\in \frac{\delta u}{\delta n}] \quad (9)$$

$$\frac{\delta u}{\delta s}u + \frac{\delta u}{\delta n}v - \frac{u1^2}{r} = -\frac{1}{\rho}\frac{\delta p}{\delta s} - \frac{\tau n_s}{\rho h} + 2\frac{\delta}{\delta n}[\in \frac{\delta v}{\delta n}] + \frac{\delta}{\delta s}[\in \frac{\delta v}{\delta s}] \quad (10)$$

where u, v, is the s- and n- components of the depth-averaged flow velocity, respectively, is the depth of water, r is the radius of curvature of meandering boundary layer at (s,n); ρ is the specific density of fluid; p = ρ g (h+z); z = bed elevation; τ_s ; τ_n = s- and n- components of bed shear stress; respectively; and ϵ = Diffusion coefficient.

In the model prediction the continuity equation for two-dimensional bed-load sedimentation equation is predicted [14],

$$\frac{\delta z}{\delta t} + \frac{1}{1-\lambda}[\frac{\delta q1_{BS}}{\delta s} + \frac{1}{r}\frac{\delta(rq1_{Bn})}{\delta n}] = 0 \quad (11)$$

where t is the duration; λ is the porosity of bed material, and q_{Bs}, q_{Bn} = s- and n- components of the volume rate of bed-load transport per unit width of the bed, respectively. For calculation of bed-load transport equation the Meyer-Peter-Müller Formula is used [1].

4. Equations with Empirical Background

Meander expansion is a significant sediment transport problem in river navigation which is well-researched by [2]. Many investigations have been made for the so-called regime theory [3-7], which are given for empirical relationships. They are used for primarily designing the stable, straight channels. All the theories generally are given for predicting the value of meander formation that the channel width must be less than six-to-ten times depth in order for the channel remaining unchanged. Most river meanders have a width-depth ratio larger than six to ten, and their planform is variable. It consists of meanders that usually expanded by both downstream translation and lateral expansion. Most empirical equations cannot give rate and direction of expansion. Some expansion equations are given in the form of measured correlations between rates of bank retreat and width or width-radius ratio [8-12].

Another theory is obtained by perturbation theory of river meandering boundary layer [13]. Perturbations are permitted into the system of observing the discharge which shows variation on channel planform migration by calculating the rate of growth of the oscillation at the boundary layer. The gain for river planform protection is that the perturbation – stability analysis enables river discharge characteristics in future basic flow conditions at the boundary layer. One –dimensional, straight-channel resistance formulas are given by [14,15] where the perturbation analyses generally give some new models including those of sedimentation, and the description of flow and boundary layer formation in the channel in two different conditions. Two different stability formulations are given as:

(1) Bend formation theory which gives expansion of meandering features,

(2) Bar formation theory which gives alternating bar formation in straight channel.

New bend formation theories are given by[15]. It gives theories about river erosion conditions with centrifugally induced secondary flow rates which influenced the river boundary layer topography and primary flow distributions. It is assumed that the bank erosion rate is proportional to the secondary current phase [15]. It is assumed that the transverse bed slope has negligible impact on river boundary layer stability [15]. In other research the secondary circulation is influenced by an external stress conditions which is controlled by different basic flow conditions.

5. Meandering Boundary Layers

A mandering flow model is searched to predict the symmetric and asymmetric meander loops. Results overlapping with experiments are given. Observations of the prediction to the development of meso-scale bed configuration in straight channels are also shown. The model predictions are conducted for three types of bed formations: alternating bars, braided bars, and no bars, according to the regime criteria of meso-scale bed formations [14]. The migration velocity of bars in expanding boundary layers is also predicted.

In river management, it is the first condition to predict water surface height, water path and erosion and deposition of alluvial channels with sedimentation under different regime theories. Mathematical and physical models can be used in designing or planning for navigation use of river channels and hydraulic structures. Several researches have been conducted to evaluate flow and bed variation in expanding channels in nature [1,4]. In meandering boundary layers the erosion and the deposition also shorthly bed variation is computed by the continuity equation for sedimentation and discharge. Typical boundary layer formations and discharge with alternating bars and braided bars are predicted firstly in straight channels, and thus the formation and migration of bars are enabling prediction the boundary layer formations quantitatively.

6. Conclusions

Through an iteration process by prediction new finite difference method on a computational grid a result for steady-state condition is determined [1]. The relationsips for discharge are given implicitly, while the continuity equation is given explicitly. The ratio of mean discharge is given as the square root of the mean energy gradient which is given by Manning [1].

$$\frac{Q+\Delta Q}{Q} \approx [\frac{Ie+\Delta Ie}{Ie}]1^{1/2} \approx \frac{1}{2}\frac{\Delta Ie}{Ie} \qquad (12)$$

in which Q = the discharge; and Ie=energy slope is equal to the cross-sectional averge water surface gradient. If v =0 and a slip velocity u_w is emphasized as,

$$\frac{\tau 1_w}{\rho} = \in \frac{du}{dn} = C1_d u1_{w1^2} \qquad (13)$$

where τ_w is the shear stres at the boundary layer and C_d is the friction coefficient at boundary. The coefficient ϵ of the diffusion gives permission to compute the slip velocity u where v=0 and z is the location at the upstream end. If the flow is superctitical, the boundary conditions are given as p at the upstrea end and u,v are given at the downstream end.

7. Results

The results of model observations were carried out fort he same conditions as the mathemtical model at the Technical University of Berlin, Institute of Water Constructions and Water Resources, continued with a boundary layer without any gradient at contiuous discharge conditions. Then the boundary layers were solidified, and precise measurement of the boundary layer formations and the new velocity conditions were attempted. It is observed [14]:

(1) The depth-averaged computational precise investigation was used to show equilibrium with natural observations at the symmetrical and asymmetrical meander loops.

(2) The simulation with experimentation models and prototypes show good overlapping with this model.

(3) The objective was to investigate a simple numerical relationship for prediction the variation of bed topography in prototypes.

In alluvial planforms, the relationships between hydraulic behaviour and plan geometries result in various of boundary layer formations which are dependent on migration bars and meandering river dunes.

Selected Readings

Hey, R.D., Bathurst, J.C., Thorne, C.R.. Gravel Bed Rivers. John Wiley, new York, 1982.

References

[1] Yilmaz, L.. Meandering River Sediment Distribution Determination. Nisantasi University, 1453 Neocampus, Maslak, Istanbul, Turkey, 2019. (unpublished source).

[2] U.S. Army Corps of Engineers. The Streambank Erosion Control Evaluation and Demonstration. Act of 1974, section 32, Public Law 93-251. Final report to Congress, Waterways Experiment Station, Vicksburg, Miss, 1981.

[3] Yen, B. C.. Spiral motion of developed flow in wide

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curved open channels. Sedimentation, H. W. Shen, ed., Fort Collins, Colo., 1972, 22.
[4] Zimmermann, C., Kennedy, J.F.. Transverse bed slopes in curved alluvial streams, J. Hydr. Div., ASCE, 1978, 104 (1): 33-48.
[5] Odgaard, A. J.. Meander flow model. I: Development, J. Hydr. Div., ASCE, 1986a, 112(12): 1117-1136.
[6] Odgaard, A. J.. Meander flow model. II: Applications, J. Hydr. Div., ASCE, 1986b, 112(12): 1137-1150.
[7] Odgaard, A. J.. Streambank erosion along two rivers in Iowa. Water Resources Research, 1987, 23(7): 1225-1236.
[8] Odgaard, A. J.. River-Meander model. II: Applications, J. Hydr. Engrg. Div., ASCE, 1989, 115(11): 1451-1464.
[9] Odgaard, A. J., Bergs, M. A.. Flow processes in a curved alluvial channel. Water Resources Research, 1988, 24 (1): 45-56.
[10] Parker, G., Andrews, E.D.. Sorting of bed load sediment by flow in meander bends. Water Resources Research, 1985, 21 (9): 1361-1373.
[11] Rozovskii, I. L.. Flow of water in bends of open channels. Academy of Sciences of the Ukrainian SSR, Kiev, USSR (in Russian),1957. (English Translation, Israel Program for Scientific Translation, Jerusalem, Israel, 1961).
[12] Simons, D.B., Senturk, F.. Sediment transport technology, Water Resources Publications, Fort Collins, Colo., 1977.
[13] Zeller, J.. Meandering channels in Switzerland, International Association of Scientific Hydrology, Symp. On River Morphology, Bern, Switzerland, 1967, 75: 174-186.
[14] Yilmaz, L.. Sedimentation in different rough boundary layers, Nisantasi University, 1453 Neocampus, Maslak, Istanbul, Turkey, 2019. (unpublished resource).
[15] Yilmaz L.. Irrigation and Drainage Management Studium Press.P.O. Box 772200, HOUSTON.TEXAS 77072 USA, 2012.

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ARTICLE

Applications in New River-meander Model

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ABSTRACT

If the sediment transport behaves as bed-load, the sediment surface at meandering channel will deform into transverse waves. This investigation is a new model for prediction of river-meander models in nature. The aim of this research is to give a precise method whose bed forms can have a variety of scales ranging from ripples through small dunes to fully developed dunes or sandwaves. Its mathematical model will be investigated.

1. Introduction

Using momentum equation and continuity equation in previous researches an important model for evaluation of meandering models was developed. From a stability criterion for sediment particles on the stream bed another mathematical model is used to predict the damped oscillating system at the meandering boundary layer. The stability of the system is predicted by forcing upon it a traveling, small-amplitude alignment wave. The changing rate of the amplitude is predicted by observing the bottom wave and the change in channel bottom through a bank-moving similarity. The depth and velocity distributions are determined fort he change of migration in meandering width with a certain lag, which corresponds $\gamma L/2\pi$ for velocity and $\Phi L/2\pi$ for depth where γ and Φ are corresponding phase angles. It is assumed that the bank sediment transport depends on the same phase like velocity where the wavelength in boundary layer formations λ has nearly the same value as the L. In new model it is predicted [1]:

(1) Channel migration direction and migration expenditure value,

(2) Dominant meander wavelength and phase shift,

(3) Depth and velocity distribution of discharge in meandering boundary layer.

Values for input corresponds [2]:

boundary layer slope S,

width b,

centerline depth d,

median grain size D,

friction factor f,

meander wave-length λ which was taken as twice the distance from crossover to crossover, and bank-erosion

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constants.

2. Model

There are some research for model verification of field data and of the formulas and graphs where the computing of dominant migration wavelength and phase shift enables [3]. In this model the erosion rate and boundary layer accumulation is depending to the change in curvature with a certain shift, which gives $\gamma L / 2\pi$ for erosion rate and $\Phi L/2\pi$ for boundary layer height where γ and Φ are the corresponding phase angles [2]. In the new boundary layer model it is assumed that boundary layer erosion is given with the same overlapping as velocity where the ODG model gives that the bank sediment transport phenomena can be seen with the same lag as depth. In this model the meander wave-length λ is given twice the distance from crossover to crossover. It is given the suggested wavelength as [2],

$$\Lambda = 2\pi B \quad (1)$$

where Yalin (1971) proposed that channel migration could be given with the law of the spatial correlation among perturbations in mixing length of channel flow [4]. There are also observed macroturbulent eddies, presumably secondary flow cells which produce some roughness frictions against the flow accumulation. In a normal curvature which means that the channel has a constant curvature radius and has the straight boundary layer, it is more simple to calculate the velocity and depth values [6,7].

3. Verification

In the previous literature it is very difficult to verify field data for testing of the different relationships and graphs which enables to predict migration wavelength and phase shift. There are many data observations on river meandering phenomena, however, as was observed also by Blondeaux and Seminara (1985), most of the data are incomplete because of insufficient evaluation about migration phenomena conditions where there is no information about channel slope and discharge [3]. Computed migration wavelengths λ are given against dominant wavelengths, λd [4]. Parameters are:

m = power law exponent,

$\kappa(8/f)^{0.5}$ = it is given as power law,

κ = von Karman's constant (= 0.4)

F_{Dc}= Froude number of particle densimetry, is given as $Umean_c/(\Delta gD)^{0.5}$,

$Umean_c$= centerline-depth averaged flow rate,

Δ = specific weight of submerged sediment = $(\rho_s - \rho) / \rho$,

ρ and ρ_s = density of fluid and sediment,

g = acceleration of gravity

The value of B approximated nearly to six unless a larger number is obtained by evaluating B using some parameters [8,9]:

(1) A largest possible transverse bed slope of two times average boundary layer height which is divided by width

(2) Needs some evaluation about sinuosity, width, depth, flow rate, and grain size.

By observing the graph for data plotting $\alpha = 0.4$ is noted which is given as transverse-mass flux constant. As a result the scatter of the data graphs gives agreement with the other evaluated data [10,11]. It is given that the distribution of the evaluation observed points shown in the line of enabling agreement is approaching but less than that given by the observations of Ikeda et al. (1981) which shows good agreement [12]. This approaching has only one reason which is given as in the earlier studies as observations that fixed values of B without considering whether the flow depth in the channel was enough to accommodate the corresponding transverse bed slope [13]. The evaluated observations is taken in this research from protoypes in natural rivers. The data are complete in the condition that channel-forming flow conditions are choosen. Details of the data - evaluation conditions are proofed in an previous chapter [14]. The distribution conditions of meander wavelength which is taken as twice the distance from crossover to crossover in plan-section, is observed to change from roughly six times the width to nearly 31 times the width, with a mean of the order of 13 [15]. By using transverse bed gradient and mixing length of B = 6 and $\alpha = 0.4$, and the overall-average bankfull discharge evaluation of b/d = 20, F_{Dc} =13 and m = 5, the dominant and most seen wavelength which is observed by this assumption if the ODG bank-erosion model is given as proof [16] where the IKEDA model conditions are also added [16]. The group distribution of wavelengths of channel migrations are in changing from less than 6b to more than 31 b. By using B = 7, $\alpha = 0.4$, and the boundary layer's average discharge values of $b/d_c = 41$ and $F_{Dc} = 8$, and m = 2.92, the most predicted wavelength shows the same property as the observed average distance of wavelength in boundary layer [17].

Different conditions in occurrence of migration rates is dependent by a comparable distribution in length from crossover at s = 0.1 to first outer - bank erosion condition s_e [17]. The distance in the migration bends ranges from about 0.10 to about 0.47 times the meander migration length. The model distance is shorter than the one-quarter of a wavelength. If bank sedimentation rate is dependent by different discharge rates and here the parameters should be in a close relationship between s_e and phase shift

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between either curvature and boundary layer topography Φ and migration and discharge γ [17] which shows good agreement with the mechanism of controlling bank sedimentation. This bank erosion cannot be the same of s_e, the phase shift is a good proof for outer-bank sedimentation which can be observed firstly at the downstream from a given migration plan point. The distance s_e fort he most observed meander migration rate would then be estimated by the Φ_d and γ_d distributions [16] as,

$$(s_e)_d = \gamma_d L_d / 2\pi \qquad \text{(IKEDA MODEL)} \qquad (2)$$

or

$$(s_e)_d = \Phi_d L_d/2\pi \qquad \text{(ODG MODEL)} \qquad (3)$$

where the indis d = a variable of the most observed migration rate [16]. By putting as before, B = 7, α = 0,4 , b/d = 20, F_{Dc} = 14 , and m = 13, the evaluated $(s_e)_d$ is 0.13, $L_d \approx 0.15 L1_d$, which is smaller than the computed model distance of 0.3 L_d. The given length is maybe correct [16].

4. Discussion

In observing the meander migration lengths the phase lag between the meander form and discharge rate is realistic that has small importance in the collection of data by meandering occurrences of individual meandering formation.

5. Conclusion

The outer-bank sedimentation rate can be plotted as a function of migration rate which is computed as twice the length from crossover to crossover of planform meander occurrences. Here the lenghts are without dimension by dividing in plot through the migration distance L, which is computed along the boundary layer symmetry axis. It is observed that migration plan forms with a large λ/b ratio show length to first outer-bank sedimentation location phenomena of less than 0.27 L.

The new equations for prediction of γ [16]:

$$\Gamma = \arctan \Gamma = \arctan\left(\frac{e1}{e2}\right) \qquad (4)$$

and

$$\Phi = \Upsilon - \arctan\left(\frac{bk}{a1}\right) \qquad (5)$$

where k = 2π/λ, e1 and e2, a1 are constants which are dependent on the boundary layer sediment material (Figure 1).

6. Result

The point of the bend migration locations gives the correct phase shift associated with boundary layer disturbances which is a proof fort the outer boundary layer sedimentation in the prototype of a flume which shows a good agreement with the phase difference with discharge rate at least as long as a transverse boundary layer gradient factor of greater than 7 if it is used. A comparison is given between measured and computed discharge rates of meander bend. The computed discharge velocity are predicted as the mean amplitude growth velocity and the n-component of the wave ditribution at crossover.

References

[1] Sediment. Transportation Mechanics: Introduction and properties of Sediment. Task Committee on preparation of Sedimentation, Manual of the Committee on Sedimentation, Vita A. Vanoni, Journal of the Hydraulics Division, ASCE, Paper 3194, 1962, 88(Hy 4): 77-107.

[2] Yilmaz, L.. Stochastic Sedimentation Process Distribution at Particle Energy. Nisantasi University, 1453, Neocampus, Istanbul, Turkey, (unpublished research) 2019.

[3] Blondeaux, P., Seminara, G.. A unified bar-bend theory of river meanders. J. Fluid Mech., 1985, 157: 449-470.

[4] Chitale, S. V.. River channel patterns. J.Hydr.Div., ASCE, 1970, 96(1): 201-222.

[5] Dietrich, W.E., Smith, J. D.. Influence of the point bar on flow through curved channels. Water Resour. Res., 1983, 19(5): 1173-1192.

[6] Ikeda, S.. Prediction of alternate bar wavelength and height. J. Hydr. Engrg., ASCE, 1984, 110(4): 371-386.

[7] Ikeda, S., Parker, G., Sawai, K.. Bend theory of river meanders. Part 1. Linear development. J. Fluid Mech., 1981, 112: 363 - 377.

[8] Kitanidis, P. K., Kennedy, J.F.. Secondary current and river-meander formation. J. Fluid Mech., 1984, 114: 217-229.

[9] Odgaard, A. J.. Bank erosion contribution to stream sediment load. IIHR Report No. 280, Iowa Inst. of Hydr. Res., The Univ. of Iowa, Iowa City, Iowa, 1984.

[10] Odgaard, A. J.. Meander flow model. I: Development. J. Hydr. Engrg., ASCE, 1986a, 112(12): 1117-1136.

[11] Odgaard, A. J.. Meander flow model. II: Applications. J. Hydr. Engrg., ASCE, 1986b, 112(12): 1137-1150.

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[12] Odgaard, A. J.. Streambank erosion along two rivers in Iowa. Water Resour. Res., 1987, 23(7): 1225-1236.
[13] Odgaard, A. J.. River Meander model. I: Development. J. Hydr. Engrg., ASCE, 1989, 115(11): 1433-1450.
[14] Osman, A. M. , Thorne, C.R.. Riverbank stability analysis. I: Theory. J. Hydr. Engrg., ASCE, 1988, 114(2): 134-150.
[15] Thorne, C.R., Osman, A.M.. Riverbank stability analysis. II: Applications. J. Hydr. Engrg., ASCE, 1988, 114(2): 151-172.
[16] Yilmaz, L.. Irrigation and Drainage Management, Chapter 11. Hydraulic Geometry: Ramette's Work Maximum Sediment Discharge and Froude Number Hypothesis, Studium Press, P.O. Box 722200, Houston, Texas 77072, USA, 2012: 142-154.
[17] U.S. Army Corps of Engineers.. The Streambank Erosion Control Evaluation and Demonstration Act of 1974. Section 32, Public Law 93-251. Final report to the U.S. Congress, Waterways Experiment Station, Vicksburg, Miss, 1981.

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