

Stream Flow Measurement At Meandering Rivers

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Abstract—The concept of bankfull discharge as a channel forming flow is not appropriate for all channels, such as those with bedrock banks or braided channels or those which are known to be actively degrading or aggrading. It may be applied in some channels without a flood-plain or well-marked bank top by reference to vegetation lines, such as the boundary on a rock bank between the clean or slightly moss-covered rock and perennial grasses and shrubs, which can tolerate only infrequent and brief periods of inundation. Channel cross-section shape and dimensions may vary markedly over short distances. 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.

Index Terms—sediment transport, mathematical model, empirical regime relationship

I. 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 Friedkins' Vicksburg experiments [8] and Inglis' [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 oscillates 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.

1.1 Theory

Geomorphology is the study of the landscape. The landscape system tends toward a dynamic equilibrium state in which the ability of flowing water to erode the land surface or streambed is balanced by the ability of those surfaces to resist erosion.

The qualitative or descriptive attributes of the landscape are the subject of a vast literature, including textbooks such as those by Allen,[1], Ashmore [2], Bagnold [3] and Blanckaert [4]. The extensive research literature on drainage basins and rivers is summarized by Refs.5, 6,7,8,9, 10. The quantitative approach to river and drainage basin morphology is well developed [11, 12] and many indices have been developed to describe landforms; selections are provided in Ref. [13] and in the above-mentioned texts. Some of these indices are duplicative, have been

rarely used, or have little applications for hydrologic purposes. Table 1. Provides examples of the types of relationships which have been developed between hydrologic and geomorphologic variables, using statistical methods. Morphometry of channel cross sections is well understood, particularly with respect to “regime theory “and “hydraulic geometry “[14, 15, 16]. The measurements commonly used are based on standard land surveying techniques or can be obtained from observations made for flow gauging purposes. The shape and size of alluvial channel cross sections are closely related to the flows responsible for forming them. As flow increases in the downstream direction, channel width and mean depth tend to increase, while water surface slope decreases (Fig.1). The rate of change may be broadly similar between rivers, although other factors, particularly the size and quantity of sediment load and the nature and vegetative cover of the banks, are also significant controls. Streamflow indices may be estimated from channel form, which is measured more easily and cheaply than streamflow. Table. 1 gives examples which are applicable only to the locations from which the data were obtained, of regression relationships developed to estimate streamflow from channel measurements.

Channel cross-section shape and dimensions may vary markedly over short distances. This variation may be repeated in a quasi-regular fashion in a channel characterized by meanders, bend, and/or riffles and pools , but in other channels the variation appears to be random. For purposes of quantitative analysis and comparison, it is therefore necessary to ensure that cross- sections intended to be representative of different river reaches are selected in a consistent fashion, e.g. by always choosing a section at the crossover between two bends, or by making measurements at a number of sections in each reach, and calculating the mean and standard deviation of each morphometric variable in that reach. The number of sections depends on the variability displayed and the analyses to be used, but 25 to 30 or more are desirable. The latter approach is becoming more widely used, for instance, in studies of the stream channel environment for fish habitat assessment, because there is a need for information on frequency distributions of morphometric attributes rather than simple average values [14]. The Table 1. Relationships were developed at sites for which streamflow records were already available, for estimating streamflow at nearby locations where records are not available.

Table.1 The observation of sediment transport by meandering channels [14]

Run Number (1)	Width Of Channel B(m) (2)	Size of Bed Material $D \times 10^{-2}$ (3)	Average Bed Slope (4)	Flow rate $Q \times 10^3$ (m ³ /s) (5)	Average Water Depth h (m) (6)	Froude number (7)
10	0.50	0.30	1/75	1.00	0.70	>1
8	0.50	0.30	1/100	1.25	0.80	”
5	0.50	0.30	1/120	1.15	0.69	”
9	0.50	0.30	1/60	1.20	0.75	”
7	0.50	0.30	1/80	1.00	0.70	”
9	0.50	0.30	1/90	1.10	0.73	”
11	0.50	0.30	1/110	1.20	0.75	”
5	0.50	0.30	1/70	1.00	0.70	”
8	0.50	0.30	1/50	1.10	0.74	”

Various indices of streamflow are used, including mean annual flood ($Q_{2.33}$), most probable annual flood ($Q_{1.58}$), which have an average recurrence interval of 2,33, and 1,58 years, respectively, and mean annual discharge (Q). Because channel form is a regionally parameter, in response to sediment characteristics. Furthermore, large, infrequent floods may cause dramatic and longlasting changes to a particular section of channel, so that a particular cross section may not be in equilibrium with these moderate flood

events, occurring once a year or so, which are normally responsible for the long-term average channel form. The concept of bankfull discharge as a channel forming flow is not appropriate for all channels, such as those with bedrock banks or braided channels or those which are known to be actively degrading or aggrading. It may be applied in some channels without a flood-plain or well-marked bank top by reference to vegetation lines, such as the boundary on a rock bank between the clean or slightly

moss-covered rock and perennial grasses and shrubs, which can tolerate only infrequent and brief periods of

inundation. Channel cross-section shape and dimensions may vary markedly over short distances.

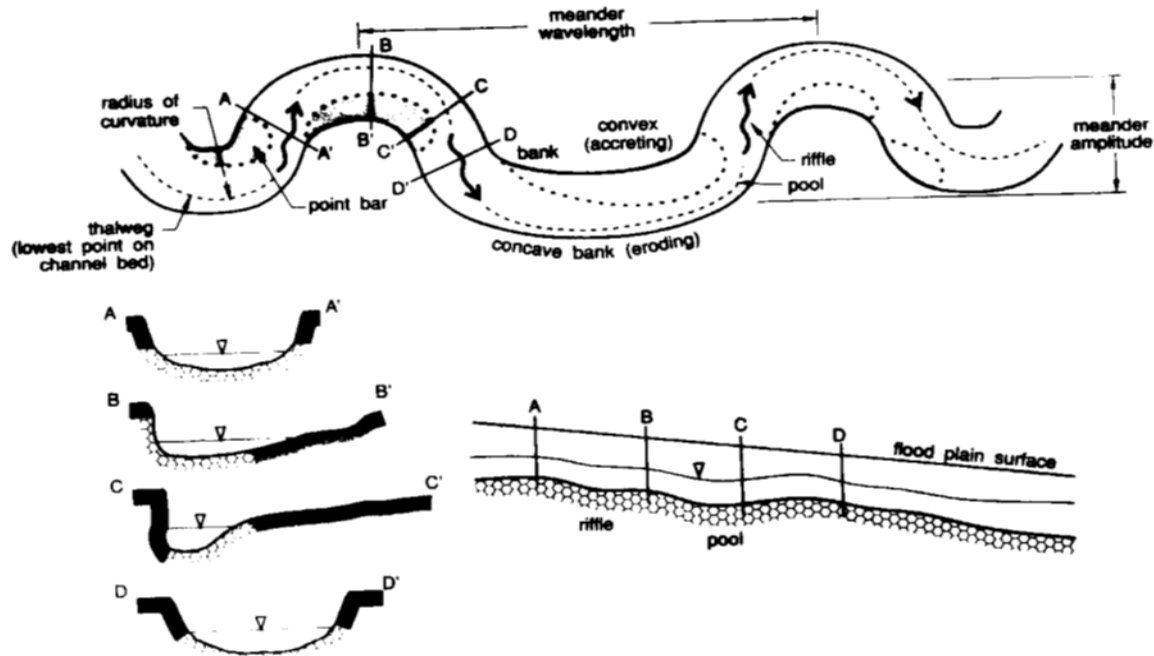


Figure. 1 Definition sketch of the plan geometry of a meandering river [5]

1.2 The Channel Reach

Channel reaches are characterized by their gradient and plan geometry as given in the text [7]. Both are hydrologically significant, for example, channel gradient is a partial determinant of flow velocity, travel time, and sediment transport capacity, and planimetric indices such as meander wavelength are often closely correlated with discharge. Channel gradient may be quite variable over short distances, and a field survey is desirable for detailed studies particularly of streams and small rivers. However for larger rivers, the flood plain gradient may be measured from distances greater than one or two wavelengths of riffles or bends, floodplain gradient becomes a close approximation of water surface or energy gradients, if the measurement is referenced to equivalent points on the repeating patterns of pools and riffles and bars or crossing.

Several classifications of river channel planform or pattern have been proposed. Some of these being based on the relationship between morphology, hydrologic characteristics and sediment load characteristics, are useful in reconnaissance studies in

assisting the hydrologist to make inferences about hydrology from the more readily observed morphometry. However, rivers form a continuum, rather than a series of exclusive classes.

Quantitative measures of channel pattern particularly those descriptive of meander form, have been much investigated. There is a strong relationship between meander wavelength and discharge, although few rivers have meanders which approach the regularity of shape needed to measure wavelength or related variables with great precision. Sinuosity is easily measured from good topographic maps or aerial photographs. It is more strongly related to sediment and topographic characteristics and to the energy of waterway than to indices of streamflow.

II. RESULTS

Studies of the occurrence of meandering channels with suspended sediment laden flow have been made with varying degrees of success. Experimental researches were carried out by Vanoni, Einstein and Chien, Vanoni and Nomicos, Ippen [14]. From these

researches different conclusions for meandering flows with suspended sediments have been given:

The boundary layer roughness factor for the meandering channels decreases as a parameter of flow with suspended sediment. du/dy which is called as the velocity gradient shows an increasing value because of suspended sediment concentration. K , as known the von Karman universal Constant must be smaller than 0,4 which is given as a constant in a pure water flow comparing in flows with sediment transport. As observed the turbulent boundary layer at meandering channels it shows a reduced mixing length because of the occurrence of transportation of suspended sediment particles. Measured mean velocity profiles in the bottom boundary layer of the meandering channels give larger values while comparing with values computed by the velocity defect law. Comparison of the concentrations of sediment particles in the meandering channels with classical empirical equations show a lower value than the experimental results.

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