CHAPTER - I

INTRODUCTION

1.1 General:

River characteristics are important to every one dealing with water resources and it is therefore quite natural that investigations of river behaviour have been conducted since the beginning of time. On alluvial plains rivers seldom run straight but tend to meander. Why should a river deviate from its direct course ? There are many opinions expressed though until now no definite answer is available. However, it would perhaps be interesting to quote ideas of some leading men on the profession. Leliavsky (1) summarises his ideas in his outstanding book on fluvial hydraulics :

'The centrifugal effect (which causes the superelevation) may possibly be visualised as the fundamental principle of the meandering theory, for it represents the main cause of the helicoidal cross-currents which removes the soil from the concave banks, transports the eroded material across the channel, and deposits it on the convex banks, thus intensifying the tendency towards meandering. It follows therefore that the slightest accidental irregularity in channel formation, turning, as it does, the stream lines from their straight course, may, under certain circumstances, constitute the focal point for the erosion process which leads ultimately to meander'.

Friedkin (2) considers

'Meandering results primarily from local bank erosion and consequent local overloading and deposition by the river of the heavy sediments which move along the bed. Meandering is essentially a natural trading process of sediments from banks to bars, ... '

Inglis (3) says :

'Where however, banks are not tough enough to withstand the excess turbulent energy developed during floods, the banks erode and the river widens , ...

In channels with widely fluctuating discharges and silt charges, there is a tendency for silts to deposit at one bank and for the river to move to the other bank. This is the origin of meandering, ... '.

Langbein and Leopold (4) state :

'Meanders are the results of erosion-deposition processes tending toward the most stable form in which the variability of certain essential properties is minimized. This minimization involves the adjustment of the planimetric geometry and the hydraulic factors of depth, velocity and local slope. The planimetric geometry of a meander is that of a random walk whose most frequent form minimizes the sum of the squares of the changes in direction in each successive unit length .... '.

Einstein and Li (5) propose that secondary currents develop in a straight rectangular channel with or without sediment motion. This leads to the development of alternate scour holes in the straight channel and ultimately causes the river to meander.

Thus rivers may meander for different reasons and meandering is difficult to understand as because many of the above mentioned factors often act on a particular river at the same time.

Meandering of streams often poses a serious problem to the hydraulic engineers as it has often been responsible for unpredictable damage to adjoining properties and by-passing of costly irrigation structures. It has thus become a problem of economic importance throughout the world as the amount of valuable land destroyed by bank erosion steadily increases. Besides, in large navigable streams meandering must be corrected and controlled by costly dredging and by construction of revetment. The devastating effects as well as the economic consequences of meandering have simulated extensive research in the field. These investigations have helped in better understanding of the distribution of erosive forces and in developing methods to stabilise the stream.

The problem of river control is however all the more serious in case of meander channel with flood plain as they are almost invariably encountered at those places where the flood action is of concern. The conventional uniform flow formulas cannot be directly applied for the discharge computation of such over bank flows, as consideration of single channel leads to abrupt changes in hydraulic characteristics at just above the bankfull stage. The general practice has therefore been the use of separate channel method. But the presence of a channel with flood plain introduces the complication of secondary currents associated with the exchange of flow between the channel and flood plain. And as the later method fails to take care of this characteristic phenomenon, the computed value of discharge by this method also may not be a reliable one. A correct understanding of the mixing process for such river geometry is therefore very much essential for any systematic study. In flood routing computations also it is necessary to select approximate values of empirical constants in order to obtain information about the capacity of the floodway as a function of stage for a particular geometry. Moreover, the growing necessity for soil and water conservation demands a thorough knowledge of the internal flow characteristics of meander channel with flood plain and a knowledge of the flow distribution between meandering channels and adjoining flood plains would thus be essential for river management problems.

It often happens that the dimensions of the flood plain continuously changes along the length of the river. Again because of geological features or bank protection schemes, the flood plain in a meander channel is sometimes located on only one side of it. The flow process through such a complex meander flood plain geometry can be understood only through a programme of systematic study.

Straight channels comprising of a deep section and flood plain on both sides or on only one side have been the subject matter of many recent investigations as discussed in the subsequent chapters. Observations on meandering channel with flood plain on both sides have also been reported by Toebes and Sooky (6) and Ghosh and Kar (7). The study undertaken in the present case relates to a meander channel with flood plain on only one side, a geometry which has so far received little attention.

1.2 Comments on the Current Investigation:

Recently there has been a great interest to know more about the fluid flow resistance and boundary shear stress distribution in channels with irregular geometry and varying roughness distribution. In actual practice fluid flow in natural courses do not confine itself to simple geometrical boundary nor does it take place over boundaries having identical roughness distribution. Most of the flow in a river takes place in a moveable bed and nonlinear interaction between flow and granular media takes place both in space and time. In such cases the flow rates and flow boundaries are time dependent with the time scale varying from a few days to several years. Such flow situations are thus very complex and can be effectively solved only through hydraulic model study.

Though, of late, there has been some work on the mechanics of flow in meander channel, it appears, that not much informations are available on the distribution of shear stress and resistance relationship in complex meander channels. The need for detailed boundary shear stress distribution becomes apparent in a large number of problems associated with scour, bed and bank protection and design of hydraulic structures. A channel running in alluvial material may erode its banks, may remain stable or may silt up its section depending upon whether or not the shear stress at the boundary is sufficient to cause the material to move. The selection of riprap sizes for the protection of guide banks and aprons should also be based on the knowledge of local shear stress values. Thus the information regarding the distribution of shear stress in such composite channels is very much needed for various water resources engineering projects.

The laboratory model used in the present investigation is an idealised one with a fixed bed sinusoidal channel with a flood plain on one side. The study has been initiated to evaluate the effect of geometry and roughness on the flow resistance inclusive of interaction loss and variation of boundary shear stress distribution across the flow sections. Relevant observations and conclusions for inbank flow are also incorporated in the study as and when found necessary for a thorough understanding of the problem. The investigation reported herein is a further extension of the work of Engelund (8), Toebes and Sooky (6) and Ghosh and Kar (7) and provides a reasonable insight into the effects of interaction on channel discharge and boundary shear. Finally it may be remarked here that the investigation is primarily directed towards understanding of the underlying mechanism of flow resistance rather than simulating a prototype situation. The channel dimensions adopted are quite small because of space and other limitations and hence appropriate study of scale effects has to be undertaken before any use can be made of the results for prototype situations.