CHAPTER I

INTRODUCTION

Two or more streams often meet at a junction resulting in flow union which moves through a combined channel. This phenomenon is known as 'Flow Combination'. The situation may arise in numerous fields, namely, irrigation, flood control, power generation, etc. The phenomenon becomes complicated primarily due to presence of turbulent mixing, change in surface profile, separation of flow, formation of cross waves, and air entrainment.

The channel junction behaves like a transition[1]. In the present case, the main channel and the combined channel are aligned in a straight line and both have the same cross-sectional area. When a lateral channel intersects at the junction, the total flow along the transition contracts horizontally over a short distance. In case of subcritical flow, depth of flow along the transition decreases[2,3,4]. As a consequence, this produces a longitudinal surface drop which continues for some distance downstream. Further, inflow of the lateral channel follows a curvilinear path resulting in superelevation[2,4].

Downstream of the junction, separation of flow takes place from walls of the combined channel. This gives rise to a recirculation zone at the inner wall of the curved profile. Also a little distance downstream, an eddying zone forms at the opposite wall. In addition, a staggered pair of positive cross waves develops. Intersection of these waves downstream results in termination of the surface drop and, on the contrary, produces a sudden rise in the water surface through a criss-cross surface discontinuity. For higher discharge and greater angle of intersection, the criss-cross surface discontinuity develops into a quadrangular stationary wave followed by a series of oblique stationary waves gradually diminishing towards downstream.

The problem of flow combination is to determine the depth of flow upstream of the junction, in both the main and lateral channels, when flow parameters in the combined channel, discharge in the main channel, and physical features of all the channels are known. The problem is very complicated due to diversity in the surface profile, development of recirculation and eddying zones, propagation of cross waves, etc. Nevertheless the flow combination which is a regular phenomenon warrants detailed investigation. It gives an indication of how much the side walls or banks are to be raised in order to check over-topping; also in case of mobile bed channels it delineates the area to be protected against possible scouring or silting.

In order to reveal the innate details of the phenomenon, theoretical as well as comprehensive experimental investigations are necessary.

The following conditions further add to the complexity of the problem:

(i) the flow in the junction is affected by backwater characteristics of the combined channel;

(ii) the walls of the channels may not be effective boundaries of the flow;

(iii) in the junction, the flow may be subcritical or supercritical depending on the inflow conditions.

For solution of the problem, various methods based on different concepts are generally used. To name a few are graphical method based on trial and error solution; method of conformal mapping; concept of side weir of zero height; concept of spatially varied flow; and momentum principle. Each method, based on several assumptions, has its own limitation, thereby is applicable only to a particular case. For instance, conformal mapping, based on two dimensional flow of an ideal fluid, does not conform to actual conditions.

So far, the problem of flow combination has been attempted only for rectangular channels. Any solution based on these channels cannot be applied to channels of other cross-sections, namely, triangular, trapezoidal, circular, etc. On the other hand, solution obtained for trapezoidal channels is relatively general. It can be applied to both rectangular and triangular channels by reducing the side slope and base-width respectively to zero. Moreover, in practice most of the channels are trapezoidal.

In the present investigation, attempt has been made to solve the problem, both theoretically and experimentally, for trapezoidal channels. The phenomenon is influenced by a large number of possible variables, namely, base-width, bed slope, side slope, intersection angle, wall friction, turbulence, inflow conditions, etc. An exact analysis involving all these variables appears to be a distant possibility. Thus, a few simplifying assumptions have been made to tackle the problem, which may, however, cause some discrepancy. Nevertheless, the analysis will reveal insight into this complex phenomenon.