# CHAPTER I

## INTRODUCTION

Water is a precious resource to humanity that nobody is free to waste the other man's share of it. Every consumer, either a farmer for irrigation or an industrialist or a domestic user is tempted to use more and more water for no extra gain when supplied unchecked. The rapidly increasing use of all available water resources and the increasing costs of on-farm irrigation development require economical use of irrigation water. Most of the irrigation projects are being mis-utilised by the upper reach farmers leaving the tail-end farmers starve for water. This leads to social unrest and further lowers the net returns from the irrigation projects throwing unbearable burden on the public exchequer. The present-day knowledge on soil-moisture-plant relationships permits efficient design of an irrigation system so that water can be applied in correct quantities at appropriate times. Measuring and regulating devices play an important role in such a system.

Many measuring and regulating devices have been developed by different researchers. Not all of them satisfy the concomitant requirements of simplicity, sturdiness, reasonable accuracy, low head loss, low cost of construction and maintenance and simple operation leaving enough scope for further development particularly in small measuring structures. Presently, these small structures are receiving a very little attention by the individuals and the governments. Yet they play a key role in the entire irrigation system as the water measurements have to be done in order to avoid wastage of water due to over-irrigation. In fact, 80 percent of the worlds' irrigated land is situated in the developing countries and it is expected to be doubled by the year 2000. Since the present rate of development of water resources is not enough to meet the requirements of increasing population, any improvement in the efficiency of utilization of existing water resources acquires greatest importance. Consequently, the development of simple, inexpensive and reasonably accurate small measuring devices for measuring low discharges in open channels is a vital concern.

The techniques available in open channel hydrometry are the use of hydraulic structures, velocity-area methods, dilution techniques and slope-hydraulic radius and area methods. Considering the constraints in the low discharge measurements through open channels, hydraulic structure technique is best suited. Major problems encountered are the need to reshape the channels, the requirement of considerable water surface drops through the devices and the errors in installation and measurement. Most of these problems can be eliminated by creating conditions characteristic of critical flow phenomenon in the measuring devices. Many structures like orifices of different shapes and sizes, sharp crested and broad-crested weirs of different shapes, Parshall flumes, cut-throat flumes have come into existence. Each has its own advantages and disadvantages.

Critical flow flumes may be grouped into two general categories :

a) flumes in which critical flow occurs in a region of curvilinear flow and

b) flumes in which critical flow occurs in a region of parallel or nearly parallel flow.

The first category includes Parshall flumes, cut-throat flumes and even sharp-crested weirs. The difficulty in the analysis of curvilinear critical flow, the complications in fabrication, the errors in installation, the economy and the sensitivity towards submergence have limited the use of

Parshall flumes. The second category of flumes, with crest sections long enough to achieve nearly parallel flow conditions in the region of critical flow, includes modified broad-crested weirs of rectangular and trapezoidal cross sections.

A broad-crested weir is one having a relatively large longitudinal crest in the direction of flow and is being studied as a critical flow flume in the recent years. When the parallel critical flow exists within the throat of the weir, classical hydraulic principles can be applied to determine the head-discharge relationships. The modified broad-crested weirs made by bottom contractions are particularly convenient forms of long-throated flumes. These structures have many advantages over the other types of weirs and flumes. Wide range of discharges can be measured and the head losses are the lowest attainable amongst all free flowing open channel devices. The trapezoidal weirs when compared to triangular and rectangular weirs, exhibit such similar characteristics, allowing for wide range of measurements with acceptable sensitivity at relatively low head loss.

It is realised by many workers that the performance evaluation of a broad-crested weir depends primarily on the knowledge of the location of critical depth and the characteristics of brink depth as a function of the discharge and geometrical properties of the weir. A limited study, however, appears to have been made along these lines for a modified broad-crested weir of trapezoidal cross-section. It is, therefore, felt necessary to study in detail the flow characteristics of modified trapezoidal broad-crested weirs in portable forms for measuring low discharges. Thus, the present study aims at achieving the following objectives :

1. To fabricate a few standard types of modified broad-crested weirs for low discharges with different crest lengths, upstream and downstream ramps.

2. To compare the velocity distribution patterns for typical combinations of weir types and crest lengths under investigation.

3. To study the characteristics of critical depth and brink depth with regard to

   a) location of critical depth
   b) submergence effect on the location of critical depth
   c) relationship between critical depth and brink depth.

4. To investigate the effects of weir type, crest length, outflow Froude number and upstream energy head on the coefficient of discharge.

5. To develop single and multi non-dimensional parametric relationships between coefficient of discharge and other independent variables selected for study.