THESIS

ANALYSIS OF FLOW MEASUREMENT BY DEFLECTION OF AN IMMERSED ROD

Submitted BY

MUHAMMAD MASOOD

94-PG-WRE-24

For The Degree of

MASTER OF SCIENCE

IN

WAETR RESOURCES ENGINGEERING

CENTRE OF EXCELLENCE IN WATER RESOURCES ENGINEERING
University Of Engineering and Technology
Lahore, Pakistan

1996

ABSTRACT

ANALYSIS OF FLOW MEASUREMENT BY DEFLECTION OF AN IMMERSED ROD

Generally weirs flumes and orifices are used for flow measurement in small channels. In some techniques flow velocity is determined and discharge is calculated by multiplying the velocity with flow cross-sectional area. However all these arrangements require perfect installation of certain fixtures in the channel before any measurement can be done. In addition these have certain limitations to their use in respect of their suitability, differential head available, channel geometry etc.

A rod immersed in flowing water experience the thrust of velocity current of water. The velocity currents tend to produce deflection under the hydrodynamic force of flowing water. An appropriately hinged rod of suitable dimensions when dipped in the flowing water will be deflected to a new equilibrium state. The rod would attain equilibrium at the deflected position with respect to flow depth and flow velocity. This study was conducted to evaluate both theoretically and by experiment the possible use of the deflection of an immersed rod for determining average flow velocity in a prismatic channel.

At the deflected position the rod is in equilibrium and sum of all the moments about the hinge produced by different forces equal to zero. By comparing the moments at this stage under assumptions that the pressure distribution being hydrostatic, flow being steady uniform and hinge point being frictionless, an equation was developed to relate average flow velocity to deflection of the rod. In this equation all the parameters except flow velocity and deflection in the rod are known. Deflection can be measured easily for any channel flow and the average flow velocity can be then determined.

This equation was verified under laboratory and field conditions for different values of discharges and for different flow depths using rods of different physical properties. It was found that a rod of thickness twice of the width gives reasonable velocity values. A rod of smaller mass underestimates velocity for large flow depths at small discharges. It was noted that the deflection in the rod increases with increase in the velocity and flow depth. The submerged length decreased with increase in velocity against same flow depth and increased with increase in flow depth for a given discharge.

Three rods of different physical properties were used. Each rod was calibrated separately and a coefficient was developed to incorporate the errors due to assumptions. It was found that each rod had it's limit of applicability, and gave

satisfactory results within that limit. One of the rods was used under field conditions and reasonable results were obtained. It is concluded the deflection produced in a rod immersed in flowing water can be used for estimation of flow velocity within the limits of applicability of the rod used.