THESIS

EFFECT OF SUSPENDED SEDIMENT ON FLOW RESISTANCE FOR DIFFERENT CONDITIONS IN AN OPEN CHANNEL

Submitted By:

MUHAMMAD YASEEN
2007-PG-WRE-22

For the Degree of

MASTER OF SCIENCE

IN

WATER RESOURCES ENGINEERING

CENTER OF EXCELLENCE IN WATER RESOURCES ENGINEERING
University of Engineering and Technology Lahore, Pakistan

2009

ABSTRACT

The knowledge of flow resistance for different flow conditions helps for better understanding of water resources problems, such as flood routing, channel enhancement, backwater curve computation, and scouring. Bed material brings up resistance to flow which determines the rate of energy loss along a stream and successively has a strong correlation with channel pattern. Flow resistance is caused by grain surface roughness and form resistance.

This study deals with the effect of suspended sediment on flow resistance for different flow conditions in an open channel. Suspended sediment creates resistance forces that slow down the movement of water in the channel, directly influencing the channel capacity. A representation of suspended sediment effects on flow resistance, in term of parameter describing flow depth, is need to improve numerical accuracy of channel design and modeling technique for surface water flow

The present study aims to investigate whether the flow resistance increases or decreases, determining the inter-relationship of flow velocity and flow discharge on the friction factor (f) and their quantitative relationship and to study the different bed configuration under different flow regimes.

The study was conducted in a rectangular lined channel. The sediment commonly available in rivers of Pakistan was used in the channel under different scenarios. The suspended sediments were introduced by a sand feeding device at the head of the channel and samples were collected by DH 48 sampler at the tail of the channel.

The results showed that the friction factor (f) increases with increasing the concentration of suspended sediment. The flow depth had a direct relation with the

suspended sediment. Typical numerical expressions were derived for these relations signifying the comparative trend of each scenario tested.

Plane type bed-form was produced from 5 to 15 liter/sec discharges and dunes type bed-form was produced from 20-28 liter/sec discharges. The flow resistance decrease with increase in depth of flow (discharge) over the plane bed, but the flow resistance increase with increase in depth of flow (discharge) over the dune bed. All bed forms prediction approaches have the same results and matched with physically observed bed forms. Plane bed was formed at smaller velocity ranging from 0.4 to 0.8 ft/sec and smaller Froude number ranging from 0.14 to 0.23. The friction factor varies from 0.5 to 0.36 over the plane bed. The dune bed was formed when the flow velocity and Froude number exceeded from 0.8 ft/sec and 0.25 respectively. The flow resistance over the dune bed was proportional to stream power. The friction factor (f_0) in clear water decreased with increase of discharge upto 22 liter per second. In this range of discharge a plane bed type was formed due to decrease in flow resistance. For flow of 20 to 30 liter per sec, a dune bed type was formed due to increase in friction factor. For flow of 30 to 40 liter per second the trend of discharge-friction factor relationship was decreased. The results of present study on sediment laden flow in rigid boundary channel revealed that the friction factor increased over the sediment free water value with increase in the dimensionless parameter (CW/US). It was concluded that CW/US<1500 when f/fo $\leq$ 1.0 and CW/US>1500 when f/fo >1.0. The friction factor decreased with increase in velocity. The rate of change in friction factor, (f) with concentration increases at high values of the concentration. The flow resistance decreased with the increase in Reynold number.