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SCOUR DOWNSTREAM IRRIGATION STRUCTURES

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LIST OF SYMBOLS

D_{10} = Diameter of grain at passage of 10% of sieved material.

D_{50} = Mean sediment diameter.

D_{60} = Diameter of grain at passage of 60% of sieved material.

d_s = Maximum depth of scour.

d_o = Characteristic depth of scour .

F_1 = Froude number at vena contract.

G = Gate opening.

H = Water depth upstream the gate.

h_o = The crest level of notch.

h_n = The water surface reading.

h = Difference between h_n & h_o.

L = Length of solid apron , downstream the gate.

R_n = Reynold's number .

L_h = Whole length of scour.

q = Discharge passing / unit width of the channel.

Q = Discharge.

T = Time.

T_o = The time taken for maximum scour depth to attain a value of d_o .

V = Velocity of flow.

X_i, Y_i = Co-ordinates of point on scour hole.

Y_1, Y_2, Y_3 = Water depths at three sections on solid apron.

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ρ_s = Sediment density.

σ_g = Geometric distribution of sediment diameter about the mean.

ρ = Fluid density.

ν = Fluid kinematic viscosity.

γ_s^1 = Submerged weight of soil .

R = Coeffecient of correlation .

L_s = The distance between the end of solid apron and the location of the maximum depth of scour .

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I- INTRODUCTION

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I- INTRODUCTION

Heading up works , such as weirs and regulators are the most water structures exposed to many of hydraulic actions resulting from water pressure forces . The most important action is scour action . The effect of scour action is very serious as it affects the stability of water structures directly causing failure with time .

Many types of energy dissipators are used to dissipate the amount of energy such as the hydraulic jump which can be formed only when a stream flowing with supercritical velocity is transformed to a subcritical flow. This operation followed by reduction of the velocity from $V > V_c$ down to $V < V_c$ where V_c is the critical velocity . During the velocity reduction , the stream looses a considerable amount of energy. This energy which is dissipated helps to decrease the amount of scour .

The formation of the hydraulic jump depends on the relationship between the existing tail water depth and the depth required to form it . Therefore, specially in a wide irrigation channel the depth of water required to form a hydraulic jump on the solid apron (down-

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stream irregation works) takes a considerable time to reach the required depth from the adverse flow . During this time a sheet flow of supercritical velocity is formed , and no energy dissipates on the apron .The veloci-ties are very high in this case causing scour and erosion of the bed soil . The scour and erosion on soil leads to failure of some irrigation structures.

The case of sheet flow is the case where the flow is super-critical , velocities are very high and local scour and soil erosion are very dangerous . The study of the local scour and erosion on soil downstream irrigation structure and their effects on the stability of these structures are the aim of this work .

The scour process depends on many variables, mainly the velocity of approach flow . This process depends on the value of the velocity or in other expression on Froude number, whereas the velocity itself depends on the depth of flow.

From this view , the goal is studying of the scour process and its changes with time . As a plan for this study a one-vent regulator model representing an Egyptian irrigation

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practice was chosen to clarify the scour effect on bed of two model channels. The aim of this research is to study the following main points :

1- Study of scour hole parameters .

2- Study of the changes of the scour hole parameters with respect to the time .

3-Develop the relationship between the dimensionless terms of scour hole relative to head of water upstream the gate .

4- Comparison between this case of sheet flow on the scour (super critical flow) and the scour occuring after the existence of hydraulic jump on the apron .

5- Comparative study of the scour on two different channel sections in downstream(models A and B).

This research work is divided into two parts, namely a theoretical study and an experimental study. In the theoretical study a dimensional analysis approach is used to develop the relation between all variables affected the scour . Also, it helps in understanding the behavior of the scour phenomenon .

In the experimental study two models are used , model A and model B . The two models are identically similar. Except the downstream channels, for model A it is trapezoidal in cross-section . While, for model B it is a rectangular in cross-section .

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For model A the following experimental investigations were conducted under different flow conditions. The gate opening ranges from 1 to 2.5 cm.(4 different opennings) three different heads of water upstream the gate ranges from 12 to 24 cm., tweleve discharges ranges from 2.4636 to 8.7123 liter/sec., constant length of floor downstream the gate . One type of soil conformed the bed of model channel, Froude number ranging from 4.3 to 9.4 and five different times (5 - 90 min.) .

The same experimental investigations were conducted for model B but for three different gate opennings (1 , 1.5 , 2 cm.) and for one head upstream the gate.

The water depth at different sections on the solid apron and the depthes of scour were measured, and velocities of flow were calculated . Also , a contour map was prepared for the scour hole for each test.

The statistical analysis is used to analyse the experimental data and to prepare the necessary charts for the characteristics of scour .

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