Regime behavior for alluvial stable Egyptian canals

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Abstract. The design of stable alluvial canals in Egypt is based on regime formulas. These formulas are valid for conditions prevailing before the construction of the High Aswan Dam (HAD), in which the solid suspension was more than 3500 p.p.m. As the regime of Egyptian canals has changed after the construction of HAD (Suspension solid became less than 100 p.p.m.), the design adopted by old regime equations is not satisfactory and a new design concept for the new regime is necessary.

In 1982, investigations were carried out in Egypt based on field study on a group of stable alluvial irrigation channels and other collected data from Irrigation Districts and others, from which a series of design formulas for stable canals has been deduced.

In this paper a continuation of regime studies have been emphasized by analyzing currently the available field data measurements on thirty alluvial stable channels in Egypt. A more useful relationships have been achieved which may give an approach for a better solution in the scope of stable canal design in Egypt.

An investigation of regime theory verifies that the regime formulas of Egyptian Canals are only valid for the limited range of conditions upon which they are based.

Introduction

The stability of alluvial channels is of considerable importance to civil engineers engaged on irrigation schemes, river improvements and similar hydraulic projects. The hydraulic computation of flow in open channels often assume a uniform steady flow as a first approximation. In practice, however, this condition is never entirely met.

Thus, flow in most Channels is rapidly varied or gradually varied, nonuniform motion. The interrelation between the sediment and flow also complicates the problem to a great extent. Therefore, it would appear to be inaccurate to assume that Chezy's equation, or any other uniform flow equation, could be used to describe such flow condition. Nevertheless, lacking a better solution, it is common practice to derive formulas based on natural self adjusting variables to express such kind of flow. Therefore, to find a reasonable solution data should be carefully collected and analyzed from real stable channels over a long period of time.
Early in 1921, Buckley collected data of many Egyptian carrying canals of fairly large capacity for the purpose of designing non-silting irrigation channels. From these data, he derived the following empirical formula that gives reasonable proportions of widths to water depths for hydraulic gradients exceeding 0.000065:

\[ y = 0.10 \left[ \left( \frac{s}{2} \right) + 4 \right] b^{1/2} \]  

where \( y \) is the mean depth of flow in meters, \( s \) is the hydraulic gradient and \( b \) is the bed width in meters.

A.M. El-Banna (1963), proposed a diagram for design of trapezoidal non-silting canals in Egypt with side slope 1:1 and Manning's roughness coefficient \( n = 0.025 \), based on an empirical equation:

\[ v = 0.15 + 0.15y \]  

Konsoh (1963) also proposed the following formulas for the ratio of the average width \( W \) and the average constructed canal depth \( D \) based on the boundary materials as:

\[ \frac{W}{D} = 7.1 Q^{0.139} \]  

for Sand bed and cohesive material, and

\[ \frac{W}{D} = 13.59 Q^{0.139} \]  

for coarse non-cohesive material.

Observation on thirteen canals in different parts of Egypt by K. Ghaleb (1930) produced the empirical equation with suspended material about 3500 p.p.m. with an average of about 1600 p.p.m.

\[ v_0 = 0.284 y^{0.727} \]  

in which \( v_0 \) and \( y \) are maximum allowable velocity (m/s) and average water depth (m).

All of the above formulas are based on the examination of a large number of stable Egyptian canals with suspended solid of more than 3500 p.p.m., before the construction of the High Aswan Dam (HAD).

Because the regime of canal systems in Egypt has changed after the construction of the HAD, the above equations may not be valid and a new design concept for the present regime is needed.