CHAPTER 53

STABLE CHANNELS*

A. E. Bretting
Professor of Hydraulics
Technical University of Denmark
Copenhagen, Denmark

ABSTRACT

The form and size of a channel in cohesionless material, stable against erosion for a definite discharge, Q, is studied.

The angle of internal friction ϕ and the limiting tractive force τ_{max} are taken as known. Distribution of shearing stresses τ is assumed to be such that they are proportional to the distance between bottom and water surface, measured at right angles to the bottom. In addition to the action of gravity and shearing stress τ the grains are acted upon by a hydro-dynamic lift force, proving to be proportional to τ. The differential equation of the bottom form is established and integrated numerically; the form depends on ϕ.

Based on the logarithmic law of velocity distribution and the assumed distribution of shearing stresses, the velocities in all parts of the cross section can be found, and the total discharge is found by numerical integration.

A profile consisting of a curved bank-part of the above mentioned cross section and a middle part of indefinite width and a constant depth y_{max} would be stable for the same tractive force. On the assumption, however, that nature will produce that cross section which has a minimum of area, only one definite solution, viz. the equilibrium profile, is found. The dimensions depend not on ϕ alone but also on the relative roughness of the bottom k/y_{max}. Provided that the hydraulic roughness k is assumed to be in conformity with that of natural watercourses, it is found that the area of the equilibrium profile varies slowly with ϕ and must be proportional to $(Q/\sqrt{\tau_{max}})^{0.9}$.

The above assumptions are checked by calculation of a complete set of isovels.

Three model tests, carried out in Vienna in 1916 are studied and compared with profiles calculated according to this theory. The values of ϕ vary from 14° to 20°.

On the same basis a study is finally made of the relation between mean and maximum velocities v_m/v_{max}, resulting in a simple diagram giving v_m/v_{max} as a function of H, the "degree of fullness" of the profile, and also as a function of y_{max}/k, the reciprocal relative roughness. Methods for estimating k are given.

---

* To be published separately by the Coastal Engineering Laboratory, University of Florida, Gainesville, Florida.