Discussion of
"RIVERBED DEGRADATION BELOW LARGE CAPACITY RESERVOIRS"

by M. Gamal Mostafa
(Proc. Paper 788)

M. L ALBERTSON,* M. ASCE and H. K. LIU**.—The subject of riberbed degradation downstream from reservoirs is one with which engineers throughout the world will be concerned increasingly as more and more flow-regulating structures are built. Therefore, the author is to be thanked for presenting to the profession the results of his study on this timely subject.

Logic and observation in the field and in the laboratory have shown that scour and degradation will occur in any alluvial channel if the flow is not saturated with bed material. Therefore, for a given discharge and channel width, scour will occur until equilibrium is reached either by increasing the resistance of the bed to scour (i.e., increasing the size of the exposed bed material), or by decreasing the carrying capacity (i.e., decreasing the slope), or by a combination of both of these. In either case degradation occurs until a stable channel is reached.

In the first case the development of a stable channel is dependent upon the availability of coarse material in the bed, so that as selective sorting takes place the bed gradually becomes covered or plated with coarser material which can withstand the forces of scour. The necessary size of this material can be determined to some extent by the use of the stable channel theories of Lane(1) and Blench.(2)

On the one hand, if the necessary size of coarse material is readily available in the bed, the amount of degradation will be small and equilibrium will be reached quickly. On the other hand, if coarse material of the necessary size is not available in the bed, then degradation must continue until the slope is decreased to the point where the channel is stable for the coarser fractions of bed material. This ultimate slope also can be predicted by use of the stable channel theories.

In view of the foregoing comments, it is quite possible that the application of the stable channel theories to the problem of riverbed degradation would be helpful.

The writers would like to point out that, in a given alluvial channel having steady, uniform flow, the various dependent variables DV are functions of certain independent variables as follows:

---

*Prof. of Civ. Eng., Head of Fluid Mechanics Research, Colorado Agri. and Mech. College, Fort Collins, Colo.

**Dept. of Civ. Eng., Colorado Agri. and Mech. College, Fort Collins, Colo.

1. Lane, E. W., "Design of Stable Channels," Trans. ASCE, Vol. 120 (1955), pp 1234-1279.
2. Blench, T., "Regime Theory for Self-formed Sediment-bearing Channels." Trans. ASCE, Vol. 117, (1952), pp 383-408.

$$DV = \phi \left[\text{discharge, slope, } \begin{matrix}\text{characteristics}\\ \text{of the water}\end{matrix}, \begin{matrix}\text{characteristics}\\ \text{of the bed and}\\ \text{bank materials}\end{matrix} \right] \qquad \text{(a)}$$

The dependent variables include such factors as the Chezy resistance coefficient, the concentration and distribution of the total load and the suspended load of sediment, the shape of the channel cross section, and the depth of flow.

In most developments of Eq (a) for turbulent flow by either analytical methods or by dimensional analysis, or by a combination of both, the velocity of flow is found to vary with the square root of the slope. This is contrary to Eq 5 by the author. Therefore, the writers would like to suggest that consideration be given to the following equation which follows from Eq (a):

$$C/\sqrt{g} = \phi\,(Re,\ d/R) \qquad \text{(b)}$$

wherein C is the Chezy resistance coefficient $C/\sqrt{g} = \frac{u}{\sqrt{gHS}}$, Re is the Reynolds number $Re = \frac{uR}{\nu}$, d is the characteristic size of the bed material, u is the mean velocity, R is the hydraulic radius, and ν is the kinematic viscosity of the water. The writers have found a significant correlation between Eq (b) and the data available from both laboratory and field experiments. Furthermore, these data show very clearly that beyond a certain value of Re the roughness decreases and the concentration increases with increasing Re.[3,4] This conclusion is in accordance with the author's comment. However, the results of the writers show that for certain ranges of Reynolds numbers and relative roughness the opposite effect is also found.

Since the process of degradation is from upstream (starting at the toe of the dam) to downstream, it seems logical to begin the computation of degradation by the successive increament method at the toe of the dam, rather than some distance downstream such as a_1 in Fig. 3.

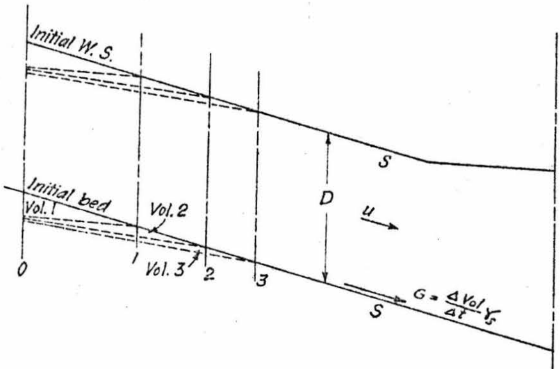

Fig. A

3. Ali, S., "Some Aspects of Roughness of Alluvial Channels," M. S. Thesis, Aug. 1953, Colorado A and M College, Fort Collins, Colo.
4. Albertson, M. L. "Roughness in Alluvial Channels," Research Report, Civil Engineering Dept., Colorado A and M College, Fort Collins, Colo. 1953.

For a given discharge, slope of stream, size of sediment, and temperature of water, the stream has a certain capacity to carry sediment. If such a capacity is reached by eroding upstream reaches, the downstream bed will be unaffected initially. However, once the bed within a reach is eroded, see 0-1 in Fig. A for example, the slope will decrease, the capacity of erosion will decrease, and the erosion process will shift downstream to pick up more sediment in order to satisfy the capacity of the stream. The rate of erosion between Section 1 and 2 in the second time interval will not be as high as the first time interval between Section 0 and 1. However, the total sediment volume Vol_2 will be the same as Vol_1 (assuming no change in the composition of the sediment).

In order to estimate the rate of degradation more accurately, it is necessary to study the mechanics of degradation more thoroughly. Since the phenomenon of degradation is a condition of non-equilibrium and unsteady flow, the present knowledge of the mechanics of sediment transport is much too limited to enable accurate solution of the problem. The ideas presented in the paper and in this discussion are over-simplified as far as degradation in a natural stream is concerned. Nonetheless, it is only through a simplified beginning that a more exact (and perhaps more complex) solution may eventually be found.