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A conceptual model of the hydraulics of check dam for gully control

C. Castillo (1), R. Pérez (1), and J.A. Gómez (2)

(1) University of Cordoba, Rural Engineering Department, Spain (ccastillo@uco.es), (2) Institute for Sustainable Agriculture. CSIC. Apartado 4084. 14080 Cordoba, Spain.

Check dams have been long recognized as useful structures to minimize concentrated flow erosion by reducing the original gradient of the gully channel and, consequently, the erosive power of run-off (FAO, 1986). Careful attention must be paid to the design of the structures in order to avoid negative effects such as bypassing or scouring that might lead to the parcial or total collapse of the structure (Nyssen,2004).

This study attempts to offer a conceptual model to explain the fundamental hydraulics of the flow regime modifications produced by these structures on rectagular-shaped gullies, before and after the filling by sediment of the small volume created by the check dam. The factors affecting the characteristics (location and amount of dissipated energy) of the hydraulic jump and the role played by the steepness of the gully on the hydraulic influence are discussed through a geometric and energetic approach. The shear stress reduction efficiency of the structure is evaluated against flow conditions (subcritical and supercritical), steepness factor, effective height and check dam spacing. HEC RAS 4.0 model (U.S. Army Corps of Engineers, 2008) has been used for validation purposes. In addition, apron protection measures (riprap stone and gabions) have been discussed in order to determine the limits of the discharge and drop height to prevent scouring.

The model presented a good performance on the prediction of hydraulic variables, and especially estimating shear stress reduction by the check dam structure. Steepness factor is the key parameter defining the hydraulic influence and ultimate slope and, therefore, the efficiency of the structure. The effective control of the flow erosivity requires the selection of a steepness factor value close to or higher than 1, showing similarities with natural stabilised channels as step-pools morphologies (Abrahams, 1995). The requirements for an efficient reduction of the shear stress and for assuring the stability of the hydraulic jump, define a relatively narrow interval of design (within the scour limits) for the optimal steepness factor, the check dam spacing and the effective height.

References

Abrahams, A.D., Atkinson J.F. 1995. Step-pool streams: adjustment to maximum flow resistance. Water resources research Vol. 31, 10, 2593-2602.
Food and Agricultural Organization for the United Nations. 1986. FAO watershed management field manual: Gully control.
Nyssen, J., Veyret-Picot, M., Poesen, J., Moeyersons, J., Haile,M., Deckers, J., Govers,G. 2004. The effectivenes of loose rock check dams for gully control in Tigray, northern Ehipia. Soil use and management 20, 55-64.
U.S. Army Corps of Engineers. 2008. HEC RAS River Analysis system, version 4.0.