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Facultad de Ingeniería -Programa de Magister en Ciencias de la Ingeniería con Mención en Ingeniería Civil

A model for local scour during flood waves

Un modelo para socavación local durante crecidas

Tesis para optar al grado de Magister en Ciencias de la Ingeniería con mención en Ingeniería Civil

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ABSTRACT

The local scour during flood waves is the main cause of bridge collapses all over the world so its study and modeling is of great interest. However, the scour caused by flood waves has been scarcely investigated. The reason is attributed to the complexity in the accurate control of the discharge at laboratory flumes in order to reproduce hydrographs representative of river flows, and to the complexity in representing the scour processes with a model of the time-dependent scour during flood waves. With the aim to improve the estimation of the scour during flood waves the objective of this work is to study the impact of the shape, duration and peak discharge of flood hydrograph on the maximum scour depth and rate under clear-water condition.

For the achievement of the main objective, the local scour during flood waves was modeled and analyzed through experiments that were conducted in a novel installation able to reproduce any hydrograph with high precision in the laboratory flume. Experimental results were used to test different time-dependent scour formulas including a new mathematical model (DFW) based on the hypothesis that there is a unique relationship between the dimensionless, effective flow work W* and the relative scour depth Z*.

Model comparison confirms the reliability and better performance of the dimensionless, effective flow work based, DFW model under both, steady and unsteady hydraulic conditions, corroborating the hypothesis on which it relies. Analyses highlight the impact of different hydrographs on local scour demonstrating the strong control of the hydrograph shape on the temporal evolution of scour depth and scour rate, although final scour after a flood only depends on the total effective flow work exerted by the hydrograph on the sediment bed. Hysteresis between the flow discharge and the scour rate is reported and explained. Flow acceleration is shown to play a secondary role in scouring. The DFW model paves the way for a promising alternative for computation of local scour under unsteady conditions.