Wave Drag Forces Contributing to Log Movement Within Streams: A Flume Experiment

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Abstract. It is now recognized that large woody debris (LWD) in streams and rivers can provide important benefits to aquatic and riparian ecology and habitat while locally controlling hydraulic grade. Consequently, river engineers are considering the use of LWD as an integral component of stream stabilization techniques, and river restoration programs. The complex interaction of multiple logs among themselves and with the stream environs determines in the end the overall behaviour of LWDs. However, unravelling the dynamics of that interaction must start with a correct specification of the forces acting on individual logs.

This paper reports on drag forces measured in a series of flume experiments conducted into the hydraulic and geomorphic impacts of individual logs. In the course of this study it became necessary to determine the coefficient of drag for logs with varying length to diameter ratios submerged in relatively shallow open channel flows. The log dimensions tested were determined for a study using a Froude-scaled mobile-boundary physical model of a prototype reach on Abiaca Creek, northern Mississippi, where extensive field surveys of LWD jams had been conducted.

Drag forces exerted on cylindrical simulated logs by flowing water were measured in a laboratory flume, and drag coefficient values were calculated for a range of log submergence and slenderness values. Drag coefficients for large submergence values are consistent with those previously published. However, at submergence values less than eight log diameters, the observed drag coefficients are consistently higher than those previously published. This discrepancy is due to the additional drag created by stationary surface waves that causes the drag coefficient to increase considerably when a log is positioned near the free surface. This phenomenon, which has not been accounted for in previous studies on LWD dynamics, is shown to depend on log slenderness, submergence, and Froude number.

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