# Uplift Pressure and Flow Through Joints and Cracks in Spillway Chutes

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The failure of the spillway chute at Oroville Dam in 2017 was a dramatic example of hydraulic jacking, a phenomenon that can affect many hydraulic structures, including spillways, drop structures, and canal wasteways. High pressure water forced into an open joint or crack can undermine a concrete slab to the point of collapse, or lift it up into the flow, initiating a catastrophic failure sequence. The first line of defense in modern structures is the inclusion of waterstops in concrete joints, but when waterstops fail, slab anchorage and foundation drainage are needed to prevent failure of the structure. New testing in a high-speed open-channel flume is providing information for estimating uplift pressures and flow through open joints and cracks to provide information needed to design anchorage and drainage features.

Measured uplift pressures have been related to flow conditions in the boundary layer and to the geometry of the open joint. Empirical relations to the depth-averaged mean channel velocity are also being sought to simplify application. Flow rates through joints are shown to be modeled effectively by the orifice equation, with a variable discharge coefficient strongly influenced by the flow conditions in the chute.