Methods for evaluating block stability on masonry or jointed spillways

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Many early spillways and weirs in the United Kingdom were constructed or faced with masonry. While some structures have deteriorated and require replacement with reinforced concrete, some remain in good condition. However, the evaluation of these structures presents a particular challenge to the engineer. This paper details the work undertaken to evaluate six masonry spillway structures using computational fluid dynamics, selected physical modelling and site testing. As a number of the spillways were stepped, the CFD models showed high sensitivity to the turbulence model selection and required the use of an LES model to adequately develop the transient turbulence structures that had been observed on the prototype and in physical modelling. A combination of CFD and on-site inspection and testing was employed to evaluate the masonry. The CFD model was used to provide velocity magnitudes close to the bed and joint and uplift pressures were estimated from onsite inspection and known joint pressure and velocity relationships. The uplift pressures were then applied to selected masonry blocks on site using a pull-out test rig. The assessment and testing showed that for masonry spillways in good condition, individual blocks would adequately resist the maximum predicted hydraulic forces and uplift pressures. Where masonry was in poor condition or where foundation conditions were less favourable, pull out tests resulted in early block failure indicating additional work or replacement would be required. As such, the modelling, inspection, and testing regime showed that the maximum potential for pull-out could be assessed with CFD and tested, providing a robust methodology for evaluation and safety assessment of masonry spillways.