Hydraulic analysis of dam spillways with the particle finite element method (PFEM)

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ABSTRACT

Hydraulic analysis of dam spillways has been traditionally performed by means of experimental testing. In the last decades, numerical modelling is increasingly used to tackle certain design aspects, mainly limited to 2D analysis and evaluation of the discharge capacity [1]. However, the verification of supercritical flows in spillway chutes with clear 3D behaviour remains as a challenge for researchers and practitioners. The flow in these structures features high velocity and irregular shape of the free surface, as well as large computational domains. All these characteristics represent obstacles for conventional numerical schemes.

The capability of the particle finite element method (PFEM) for computing free flow problems with high variations in the free surface, both in time and space, make it appropriate to handle this problem. Moreover, recent advances towards computation efficiency allow considering real-scale domains of large structures. Examples of application have been published in the field of harbour [2], geo-mechanical [3] or marine engineering [4], among others. In dam engineering, it was used to verify the aeration system in bottom outlets [5].

In this contribution, the hydraulic analysis of several dam spillways with the PFEM at full scale is presented. The results show that local phenomena such as shockwaves or rooster tails can be correctly captured. As a result, numerical modelling with the PFEM can be useful for the design of new spillways, as well as in refurbishing projects of existing structures.

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