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Extreme pressures and risk of cavitation in steeply sloping stepped spillways of large dams

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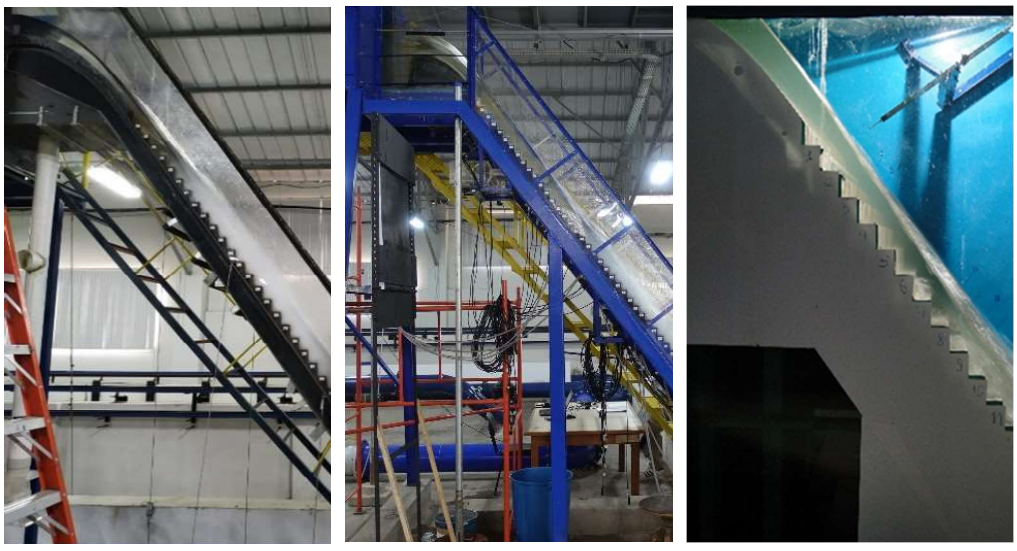
Summary

This thesis proposes the statistical analysis of extreme pressures acting near the outer corners of spillway steps (vertical and horizontal faces), through the analysis of measurements made in three physical models and the comparison with results obtained by different authors in different laboratory experiments. A new approach was developed to predict the longitudinal distribution of extreme pressures and their location in the spillways steps. Having verified that the minimum extreme pressures are more critical in the vertical face and the maximum extreme in the horizontal, three positions of interest were characterized for the estimation of the extreme pressures in the vertical face and two positions of interest for the estimation of the maximum extreme pressures in the horizontal face. This allowed for the analysis and establishment of criteria for verifying the possibility of a cavitation tendency on the steps along the chute (location and specific flow limits). The methodology used consisted of making a statistical analysis of the longitudinal distribution of the minimum and maximum extreme pressures in the vicinity of the steps outer corners along the spillway with natural aeration from the data collected in three different physical models (LOH I, LOH II and LAHE).

Pressure with an estimated non-exceedance of 0.1% was used as the minimum extreme pressure and pressure with an estimated non-exceedance of 99.9% as the maximum extreme pressure. The physical models used have 6 cm and 9 cm step heights and different ogive heights. The results were compared with the data obtained by different authors. It was verified that the data diverge, possibly due to the different characteristics of the models and laboratory effects. However, it was possible to observe that the results of the present thesis were in favor of safety, that is, indicating lower values for the minimum extreme pressures in the vertical face and higher for the extreme maximum, in comparison with the results of the other researchers. A case study was carried out using the proposed approach where it was identified that the flow rates that could risk cavitation are above 22 m3 /s/m. The extension of the chute subject to risk of damage due to cavitation was also identified.

Keywords

Step spillway, extreme pressures, hydrodynamic efforts, start of aeration, risk of damage, cavitation.



(a) (b) (c)

Experimental installations of flood spillways in operation: (a) Laboratory of Hydraulic Works LOH I (IPH-UFRGS); (b) Laboratory of Hydraulic Works LOH II (IPH-UFRGS); (c) LAHE Experimental Hydraulics Laboratory (FURNAS).