Numerical study of weather condition effect on thermal behavior of a gravity dam

Abstract

The assessment of structural dams safety is an essential operation to detect anomalies and avoid human and material damage. Although the temperature of concrete is an index that gives an idea about the state of concrete dams, the prediction of thermal behavior under the effect of various external heat sources requires mathematical models. This thesis aims to analyze the thermomechanical behavior of a concrete dam during the exploitation phase using the finite element method as well as statistical models. The study takes into account solar radiation, shading, night and evaporative cooling, convection with air and long wave radiative exchange which are considered as climatic variables that can affect the temperature of concrete. A recent methodology is adopted to quantify heat fluxes. Tichy Haf's arch weight dam thermocouple data is used to calibrate the thermal models. An approach based on random forest technique to predict dam displacement has been developed. The random forest method is a non-parametric statistical technique that can deal with non-linearities and does not need assumptions about the relationship between the predictors. The results provided by the numerical model show that the temperature of the concrete varies only in the areas close to dam faces. The values of stresses generated by thermal gradients present on downstream face are more or less high during the winter. However, they remain moderate and did not reach the tensile strength value. The model proposed by the random forest method appears as a powerful tool for dam deformations analysis with a rigorous evaluation of thermal loads.

Keywords:

Learning machine; Dam; Concrete; Stresses; Deformations; Finite elements; Gradient; Temperature; Solar radiation