CERIS : Civil Engineering Research and Innovation for Sustainability

Development of models for effects separation using hybrid HSVT-FEM formulation to analyse the observed bahaviour of concrete dams

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Period
2016-2018
2020-2024

Funding
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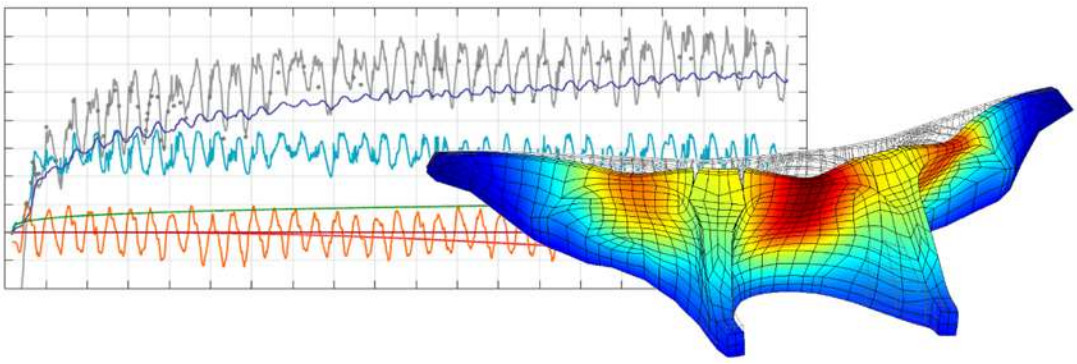
Summary

The safety control of large dams is based on the comparison between numerical models results and observation data. To analyse dam's behaviour, it is important to understand the separate effect of each action. Finite Elements (FE) models are numerical models able to simulate the behaviour of a concrete dam to the separate effect of each action. Hydrostatic Seasonal Time (HST) models are statistical models able to estimate the contribution of each action to the overall observed behaviour. Operating dams constructed more than two decades ago are structures prone to develop internal concrete swelling reactions over time. This type of pathological dam behaviour can lead to structural damage. Therefore, to identify and understand the swelling pathological effect, it is proposed a Hydrostatic Seasonal Viscoelastic Time (HSVT) type of model that can separate viscoelastic from elastic behaviour and consequently estimate a time dependent effect such as the swelling reactions effect. These proposed models are capable of analysing observed displacements and estimate their swelling reactions component. This component is then comparable with the one resulting from a reference numerical model. These models are also capable of analysing observed strains, convert them to stresses, taking into the account the tensor character of these physical quantities, and estimate a stress component derived from the swelling reactions effect, which can also be compared with the one resulting from a reference numerical model.

The HSVT models can be hybrid, because they can use FE models results to calculate the hydrostatic pressure and self-weight elastic effects. To process all the observation and simulation data, to apply the proposed HSVT models and to compare its results with the ones obtained from numerical models, DamSafe4 is introduced as dam behaviour analysis software. Aguieira, Cabril and Cahora Bassa large concrete dams were considered as case studies. By applying the proposed methodology with DamSafe4 to the case studies, it was possible to quantitatively estimate the swelling reactions effect evolution in terms of displacements and stresses. The results were validated by their approximation to the ones obtained by the reference FE models.

Keywords

Large concrete dams, HSVT-FE hybrid models, swelling effects, hydrostatic pressure effects, seasonal effects, creep effects, relaxation effects, displacement histories analysis, strains to stresses conversion, stresses histories analysis.



HSVT separation of effects results and finite elements model results.