Simulation of Temperature and Stress during and after RCC Dams Construction

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Motivation

The increasing number of Roller Compacted Concrete (RCC) dams being built around the world demands accurate methodologies for the realistic short and long term evaluations of the risk of cracking in these constructions.

Until now, analysis of the thermo-mechanical behavior of RCC dams during the construction phase and the service life have required time consuming 2-D models. The aim of this work is to modify a 1-D model in such a way that it allows to simulate the long term behavior of temperatures and stresses in the core of a dam at low CPU time costs. The numerical simulation considers relevant features of the concrete (hydration, anging, and creep), as well as the evolutionary construction process and ambient conditions.

1-D Strip Model

Due to the large dimensions, vertical heat flux preponderates in the core of a RCC dam during the construction phase. Heat exchange with the environment takes place almost exclusively at the upper face of the last placed lift. Therefore a strip of elements, representing the core of the dam, is sufficient to compute the evolution of temperature during the construction phase. When parts of the dam start to cool down, convection lines, which are placed at both sides of the strip are activated in the model. Once a convection line has been activated, the temperature of the corresponding elements decrease due to horizontal heat flux.

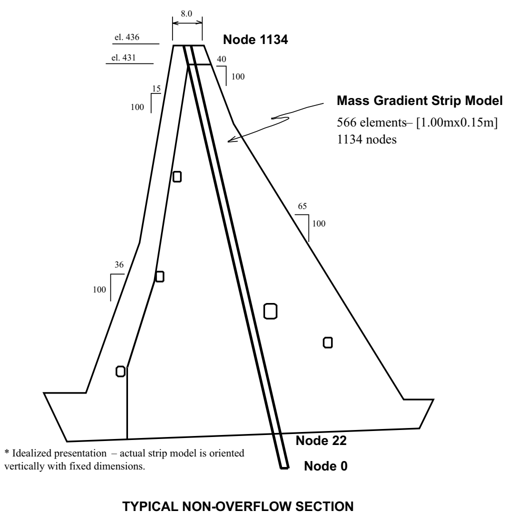

Fig. 1: 1-D Strip Model

Numerical Simulation

Figure 2 shows the long term temperature evolution in the core of Rialb RCC dam(+:measured temperature at Rialb Dam, line: numerical simulation).

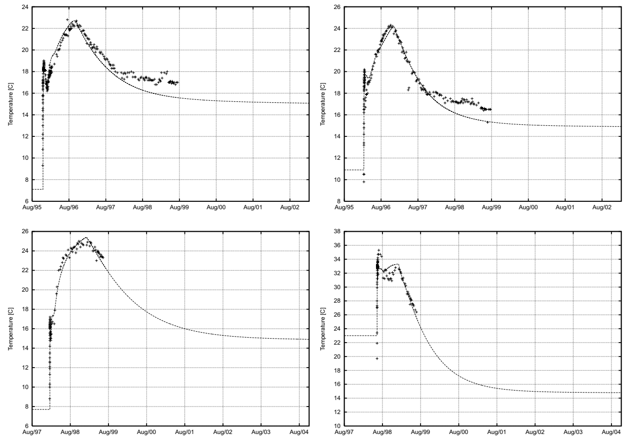

Fig. 2: Long term temperature evolution for different elevations.

Figure 3 shows the long term stress evolution. Note that once the cooling of the core has started the tensile stresses increased quite rapidly.

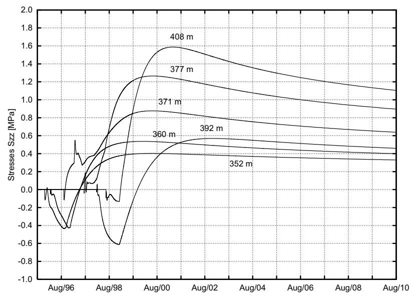

Fig. 3: Long term stress evolution for different elevations.

Conclusion

Vertical 1-D models can predict the vertical distribution of the temperature inside the dam body, although they cannot provide information on the thermal gradients developed near the faces of the dam. The procedure can be applied to perform parametric studies in order to establish the effect of some major variables of the construction process that may influence in the temperature distribution and the evolution of thermally induced stresses: the placing temperature, the starting date, and the placing speed.