E.ENG.3

SIMULATION OF POTENTIAL ALKALI AGGREGATE REACTION IN THE VICTORIA DAM

W. J. M. C. S. Bandara, R. M. G. M. Rathnayake, A. P. N. Somaratna

Department of Civil Engineering, Faculty of Engineering, University of Peradeniya

Because of its contribution to hydro-power generation and irrigation, the safety, stability and sustainability of Victoria dam are critical to Sri Lanka's economy. The present study was motivated by reports that its deflection data suggests a slight expansive behaviour of concrete in the dam. This research focused on the numerical simulation of Alkali Aggregate Reaction (AAR) which might be responsible for the slight expansion observed. Comparison of simulation results with actual measurements could help in the determination of whether the dam is in fact suffering from AAR.

AAR is an expansive reaction between alkalis in cement and certain types of reactive mineral aggregates in concrete which takes place in the presence of moisture. This can lead to distress in affected structures. It is a very slow process and usually its effects may be observed only after 10-15 years of construction.

There are several models and methods that have been implemented for simulation of AAR in concrete structures. Some expensive specialized computer software packages also have been developed for this purpose. In the present research a procedure for the use of less expensive general purpose software was used for the simulation. The non-linear AAR process was approximated by a large number of small linear incremental steps. In each step potential expansion due to AAR along the principal stress directions were estimated and mimicked by equivalent thermal expansions. At the beginning of each step the orthotropic co-efficients of thermal expansion and the orientation of material axes in each element had to be updated. A MATLAB program was developed to perform this repetitive task. Finite element computations were performed using the general purpose package SAP2000.

After verifying the accuracy of the procedure using several bench-mark solutions it was used to simulate the behaviour of the Victoria dam if it were subjected to stress-delimited Charlwood type AAR over its entire body. The measured vertical displacements along the dam crest and corresponding results of the finite element simulation showed a striking similarity justifying the simulation procedure. Further refinement of material parameters may produce even better correlations. This type of simulations can be an invaluable tool in the investigations of the observed unusual deformations in the Victoria dam.

Funding: Tokyo Cement Co. (Lanka) Ltd.