LONG-TERM ANALYSIS OF CONCRETE STRUCTURES

Zbyněk Hora, Bořek Patzák*

For assessment of safety and durability of any large-scale concrete structure, prediction of the behaviour of the structure under various service and extreme conditions is crucial. To perform reliable analysis of the complete structure, a sufficiently realistic but still feasible numerical model must be used, in which the relevant physical phenomena are reflected. Therefore, a constitutive model for concrete including effects of moisture and heat transfer, cement hydration, creep, shrinkage and optionally microcracking of concrete should be chosen.

The present paper focuses on the simulation of the service life of a NPP containment, aiming to determine the material and model parameters to enable reliable prediction of durability and structural behaviour under various conditions. The purpose of the work is to provide a numerical model calibrated using existing measurements to predict the long-term behaviour reliably. Extensive in situ *measurements are used to calibrate the model and to check the validity of model hypotheses. Moreover, the material model parameters are systematically re-calibrated based on continuous monitoring of the structure. The structural integrity test is reanalysed numerically to show the model capability of predicting behaviour of the structure under given loading and climate conditions.*

Key words : *concrete, creep, hydration, material model, microprestress-solidification theory*

1. Material model

The numerical model is based on the description of coupled heat and moisture transport, hydration, creep and shrinkage of concrete [1] and [2]. By incorporating the hydration model, the strains can be predicted starting from the time of cast and the creep model is refined. It also allows to take into account the construction sequence. The analysis of containment long-term behaviour has been performed using a constitutive model based on the microprestress-solidification theory of Bažant and Baweja [7], which includes creep and shrinkage effects. The state and evolution of processes in the material microstructure is described by internal state variables at integration points representing elementary volumes. The model aims to separate the elementary processes in the material, minimising the number of 'external' empirical parameters. The mathematical model neglects the influence of strain on transport properties caused by changes in porosity. Thus, the analysis can be split in two subsequent parts for each solution step – transport and mechanical analysis. In both parts of the computation, hydration is taken into account. The material model has been implemented in a finite element code OOFEM [11], [12]. A 3-dimensional finite element model of the containment structure has been used.

* Z. Hora, B. Patzák, Czech Technical University in Prague, Faculty of Civil Engineering, Department of Structural Mechanics, Thákurova 7, 166 29 Praha 6, Czech Republic