A method to analyse and calculate concentration profiles of different types of ions in the pore solution of porous materials such as concrete subjected to external wetting and drying is described. The equations in use have a solid theoretical meaning and are derived from a porous media technique, which is a special branch of the more general mixture theory. The effect of chemical action is ignored making the presented model suitable to be implemented into codes dealing solely with chemical equilibrium. The coupled set of equations for diffusion of ionic species, the internal electrical potential and the moisture content are solved simultaneously using an implicit finite element technique, in order to avoid numerical oscillations. Important verified material behaviours are included in the model, such as the convective flow of ionic species due to moisture flow, the effect of the moisture content on the ionic diffusion resistance in the pore solution of the porous material. The Gauss' law is included in the model in order to be able to calculate the electrical potential which develops due to small deviations from total charge neutrality among the ionic species in the pore solution. The correctness of the model should be judged from the assumptions made when developing the balance laws and the constitutive equations and the assumptions made in obtaining a working numerical calculation scheme.