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Summary of the dissertation entitled:

"Modelling of reinforced concrete elements degradation due to reinforcement corrosion"

Construction structures are exposed to environmental factors that negatively affect their durability and can in extreme situations even lead to a disaster of the structure. Particularly dangerous for elements of reinforced concrete structures are impurities caused by the influence of the environment containing compounds and chemicals such as chloride salts, acids or sulphates directly affecting the concrete surface and causing a gradual decrease in its protective properties. The resulting damage due to the development of corrosion reinforcement processes is strongly related to the cost of maintenance of construction works and the need for periodic repairs during their exploitation. Aspects related to the safety of the structure, the economy of maintenance and the esthetics of the structure justify the need to undertake studies on the durability of reinforced concrete structures and to analyse the propagation of damage due to electrode processes occurring during reinforcement corrosion. The work focused solely on the degradation of concrete reinforcement as a result of the continuous increase in corrosion products.

The work has 119 pages and consists of six chapters preceded by a list of major symbols, placed at the end of an appendix specifying certain formal issues and a reference list.

The first chapter of the work provides an introduction to the subject matter, describes the background of the work and clarifies the objectives and scope of work.

Chapter two focuses on the conditions and problems of corrosion of reinforcing steel in concrete. The mechanisms for initiating corrosive processes due to the influence of an

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aggressive external environment are presented. The issues of electrode polarization, overcapacity, passive state and depassivation of reinforcing steel are discussed. The last point referred to the problem of accelerating the reinforcement corrosion process with DC, which is crucial for describing the research issues considered in this work.

Chapter three deals with the thermomechanics of multi-component media and the formulation of equations for modelling the reinforcement corrosion process. In this part of the work, a general equation was formulated to describe the issues of the destruction of the cover in the accelerated corrosion test, as well as the material models used in computer analysis for concrete, steel and the model to capture steel-concrete contact issues. Chapter three also formulates a tensor of the rate of change in volumetric deformation, which depends on the corrosive current intensity, the phase of the reinforcement corrosion process and the effective electrochemical value of the steel equivalent and λ parameter that measures the effects of transferring corrosion products directly into the solution (all effects associated with perturbations in reinforcement corrosion process).

Chapter four presents the experimental studies and their results. The chapter focuses, inter alia, on the description of the method of carrying out the tests, the determination of the computational electrochemical steel equivalent and the critical time t_{cr} by using the method, the idea of which is formulated in Chapter 2 and which is one of the original elements presented in the work. This chapter presents experimental studies and their results. The chapter consists of two parts. The first part describes how reinforced concrete samples are prepared for testing, together with a description of the concrete material parameters obtained and a description of the test bench for the accelerated reinforcement corrosion process in concrete. Part two focuses on the determination of the effective electrochemical steel equivalent, the assessment of the weight loss of the rod, as well as the assessment of the effectiveness of the effects of corrosion products on the concrete of the cover.

Chapter five presents the results of the calculations obtained using the computer model set out in Chapters 2 and 3. In order to verify the correctness of the model in the Matlab environment, a computer program was written, allowing to determine the rate tensor of corrosive volumetric strains rates $\dot{\varepsilon}^V$, which is the result of the corrosion process of reinforcement. In order to evaluate the time of propagation of damage, a finite element model in ATENA-GID program of the mechanical process of propagation of damage in test elements was build. The results of computer simulation calculations were compared with those obtained from experimental tests of samples subjected to accelerated reinforcement corrosion tests. In addition, computer simulations using the Monte Carlo method were performed to evaluate the

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model's sensitivity to possible material parameter divergence, assuming that the material parameters are random variables with a uniform distribution. The results of the tests were the limit times for damage of the concrete covers.

The sixth and final part of the work summarizes the entire work. In this part of the work, conclusions and proposals for further research topics are formulated. In addition, certain concepts and symbols used in the theoretical description of the work were detailed in the following Annexes.

Original work features include:

- Development of a theoretical description of reinforcement corrosion problems that allows analysis of so-called accelerated reinforcement corrosion processes by introducing the rate of change of the tensor of volumetric deformation, which coordinates change depending on the phase of the reinforcement corrosion process, the effective electrochemical equivalent of reinforcing steel and the parameter λ allowing to take into account the wash-out of reinforcement corrosion products. The effect of the gradual increase in the effect of corrosion products on the concrete of the cover was taken into account by applying a linear function of the intensity of the effects of reinforcement corrosion products depending on the time of filling the porous spaces t_0 and the critical time of the reinforcement corrosion process t_{cr} (the analytical linear form of the function was adopted on the basis of literature).
- Establishing of the experimental method of determination of critical time t_{cr} using simple linear regression and optical measurement of sample deformation due to reinforcement corrosion.
- Performed experimental verification of the computer model and model parameters using, inter alia, optical measurement methods.

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