

Application of FEM for the assessment of the load-bearing capacity of reinforced concrete and prestressed structures at risk of corrosion

T. Krykowski

Faculty of Civil Engineering, Silesian University of Technology, Gliwice, Poland
e-mail: tomasz.krykowski@polsl.pl

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The problem of reinforcement degradation is a key issue in assessing the durability of reinforced and prestressed concrete structures. The term corrosion here refers to the combined effects of various mechanisms, including electrochemical and stress corrosion, as well as, in some cases, the influence of aggressive substances that contribute to the degradation of both steel and concrete (e.g., ammonium ions). An example illustrating the importance and complexity of corrosion-induced damage is the collapse of the prestressed Carola Bridge in Dresden in 2024 [1].

This paper concerns the generalization and application of a thermomechanical model formulated in [2] to an elastic–plastic medium with diffusion (a non-electrically neutral model). The study focuses on applying the model to various material descriptions of steel (e.g., J2 and Chaboche models with different hardening rules), concrete (e.g., Menétrey–Willam and microplane models), degradation of the contact zone, and different types of reinforcement corrosion (e.g., stress corrosion and the effects of ammonium ions). The calculations were performed using ANSYS software and the APDL scripting language.

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- [2] T. Krykowski, Application of the theory of diffusion-elastic-plastic medium to evaluate the load-bearing capacity of structural elements subject to corrosion, no. 4, 2026 (accepted to print).