Experimental Investigation and Modelling of Concrete Exposed to Chlorides

P. Konecny[1], M. Hornakova[1], P. Lehner[1]

[1] *VSB – Technical University of Ostrava, Faculty of Civil Engineering, L. Podéště 1875, Ostrava-Poruba 708 00, Czech Republic*

1. Introduction

The aim of the contribution is to summarize selected experimental methods and numerical tools available at VŠB-TUO with respect to prediction and monitoring the deterioration of the concrete bridges. The durability of concrete bridge components may be affected by many negative factors. Corrosion of rein-forcing steel caused by chloride ingress and carbonation are the most significant type of distress. Therefore, by accurately predicting and monitoring the deterioration of the concrete, engineers can manage structural systems in higher quality in order to resist degradation caused by long-term environmental and structural loads.

In this regard, the combination of experimental investigation and numerical modeling is important. For example, the reliability analysis of the remaining service life of a structure can be estimated based on nonlinear modeling of concrete stress-strain state including crack formation and feasible models of corrosion initiation and propagation. The numerical assessment of concrete behavior might be conducted in the ATENA Science software [1] that includes both chloride ingress as well as non-linear fracture models. The ATENA software contains the mechanical models based on finite element analysis with the utilization of nonlinear constitutive law of concrete and smeared crack band approach.

Also, in-house Matlab-based codes can be used for 1D/2D Chloride ingress [2, 3] and corrosion propagation analysis [3] (Korozeeneck). The penetration of chlorides into bridge structures is typically modeled as a diffusion process where the computation is based on the Second Fick's Law. The diffusion coefficient is a governing parameter describing the resistance of chloride penetration into the concrete. Diffusion coefficient might be obtained by the approximation of chloride profile from destructive penetration tests [4] or using the more advanced electrochemical tests such as electrical resistivity [5]. The approach implemented in the open source Korozeeneck software estimates time of the corrosion propagation according to Vidal et al. [6]. The model [6] is complemented with the initiation time period and an estimation of the corrosion current density developed by Morris et al. [7] based on the concrete resistivity values.

Not only the above-mentioned methods of analysis and experimental investigation but also other procedures may lead to the common goal of efficiently administrating existing structures and preparing new ones.

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References

[1] **V. Cervenka, L. Jendele, J. Cervenka**, *ATENA Program Documentation – Part 1: Theory.* Prague (CZ): Cervenka Consulting, 2007.

[2] **P. Konecny and P. Lehner.** (2017). *Effect of cracking and randomness of inputs on corrosion initiation of rein-forced concrete bridge decks exposed to chlorides*. Frattura ed Integrità Strutturale. 11(39), pp. 29-37. Available: 10.3221/IGF-ESIS.39.04

[3] **J. Brozovsky, P. Konecny, P. Ghosh.** (2011). *Evaluation of Chloride Influence on the Cracking in Reinforced Concrete Using Korozeeneck Software*. Transactions of the VŠB – Technical University of Ostrava No.1. Vol.XI, Civil Engineering Series paper #6. Available: 10.2478/v10160-011-0006-y

[4] **AASHTO TP95-11**, **Standard Method of Test for Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration**. Washington, DC, USA: American Association of State and Highway Transportation Officials, 2011.

[5] **NT BUILD 443**, **Concrete, hardened: Accelerated chloride penetration.** Espoo, Finland: Nordtest, 1995.

[6] **T. Vidal, A. Castel, and R. Francois.** (2004). *Analyzing Crack Width to Predict Corrosion in Reinforced Con-crete.* Cement and Concrete Research. Vol. 34, pp.165-174. Available: 10.1016/S0008-8846(03)00246-1

[7] **W. Morris, A. Vico, M. Vanquez, and S.R. Sanchez.** (2002). *Corrosion of Reinforcing Steel Evaluated by Means of Concrete Resistivity Measurements*. Corrosion Science. Vol. 44, pp. 81-99. Available: 10.1016/S0010-938X(01)00033-6