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Comparison of methods for determination of load-bearing capacity of I-73 and KA-73 precast concrete bridge beams

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Abstract

A comprehensive procedure to determine a load-bearing capacity I-73 and KA-73 precast concrete bridge beams using the advanced methods of statistical analysis based on simulation technique of Monte Carlo type in combination with nonlinear finite element method analysis is presented in the paper. Degradation processes over time caused by carbonation of concrete and chloride ingress together with consequent corrosion of prestressing tendons are taken into account. Mathematical modelling of these phenomena is based on information about the current state of the investigated bridges obtained from diagnostic surveys, including the degree to which building materials have deteriorated. Results of probabilistic approach are compared with those obtained using a global safety factor method according to the Eurocode 2 and the fib Model Code 2010 method called Estimate of Coefficient of Variation. Shortcomings and advantages of all utilized design/assessment methods are discussed.

Keywords: reliability assessment; bridges; I-73 beams; KA-73 beams; uncertainties; load-bearing capacity; lifetime assessment; reliability index.

1 Introduction

The safety formats and rules that are usually employed in the codes are tailored for classical assessment procedures based on beam models, linear analysis and local section checks. The nonlinear analysis is by its nature always a global type of assessment, in which all structural parts interact. Therefore, the safety format suitable for design of reinforced concrete structures using nonlinear analysis requires a global approach in which nonlinear computation is combined with efficient statistical simulation.

According to current standards several methods can be used, but well-recognized a partial safety method is not suitable approach for nonlinear problems, it works consistently only for linear tasks [1]. Therefore, fully probabilistic approach is suitable and recommended. Alternative techniques aiming to save computational effort are the global safety factor method (GSF) according to the Eurocode 2 [2] and the *fib* Model Code 2010 method [3] called Estimate of Coefficient of Variation (ECoV). Both methods are based on global resistance and therefore suitable for nonlinear analysis of analysed bridges. On the other hand, only the probabilistic approach provides quantitative information about safety level. Such probabilistic analysis takes into account all uncertainties due to random variation in material properties, dimensions, loading, and others.

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