Failure Probability for Extreme Load Cases evaluated by FE-calculations – A Case Study for the Rockfall Protection Gallery Rieinertobel

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Abstract

The safety level evaluation of an existing reinforced concrete rockfall protection gallery for a specific load case is investigated by estimating the failure probability based on the results of dynamic impact response analyses. The three-dimensional elasto-plastic finite element model contains four main parameters with large influence on the impact resistance. Ten FE-simulations with different combinations for the gallery parameters are carried out. A failure criteria is defined by the elastic recovery ratio and used as damage index of the roof slab. A regression function between the elastic recovery and model parameters is obtained from the FE-results and used to establish a surrogate model of the elastic recovery ratio. From it, the probability of failure is assessed by a Monte Carlo simulation. This methodology to predict the failure probability of a structure for a given extreme load case considering the model uncertainties can be applied independently from the model and can be used to compare the safety level with the requirements from the structural codes.

Keywords: Rockfall protection gallery; Impact response analysis; Elastic recovery ratio; Failure probability.

1 Introduction

Current regulations for the design or evaluation of reinforced concrete protective structures against rockfall are proposing a static equivalent force. Different models exist for considering the structural impact behaviour dynamically [1], but whenever structural safety has to be evaluated, there are difficulties on how to apply safety factors or how to insure an acceptable safety level which corresponds to the requirements in the structural codes. Experience shows that acceptable damage levels are obtained from advanced dynamic analyses for cases, where ultimate limit state is not fulfilled by the current structural codes using a static calculation [2]. A

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