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Utilization of advanced calibration techniques in stochastic rock fall analysis of quarry slopes

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In order to study rock fall dynamics, a research project was conducted by the Vienna University of Technology and the Austrian Central Labour Inspectorate (Federal Ministry of Labour, Social Affairs and Consumer Protection). A part of this project included 277 full-scale drop tests at three different quarries in Austria and recording key parameters of the rock fall trajectories. The tests involved a total of 277 boulders ranging from 0.18 to 1.8 m in diameter and from 0.009 to 8.1 Mg in mass. The geology of these sites included strong rock belonging to igneous, metamorphic and volcanic types. In this paper the results of the tests are used for calibration and validation a new stochastic computer model. It is demonstrated that the error of the model (i.e. the difference between observed and simulated results) has a lognormal distribution. Selecting two parameters, advanced calibration techniques including Markov Chain Monte Carlo Technique, Maximum Likelihood and Root Mean Square Error (RMSE) are utilized to minimize the error. Validation of the model based on the cross validation technique reveals that in general, reasonable stochastic approximations of the rock fall trajectories are obtained in all dimensions, including runout, bounce heights and velocities. The approximations are compared to the measured data in terms of median, 95% and maximum values. The results of the comparisons indicate that approximate [U+FB01]rst-order predictions, using a single set of input parameters, are possible and can be used to aid practical hazard and risk assessment.