
Metamodel enforced Bayesian interface-based calibration of a novel rockfall protection structure and an inverse analysis tool to access structural performance

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Résumé

Reliability in the performance of rockfall protection structures in relation to the impact response is vital for the safety of the concerned area and the durability of the structure. A new type of such structure is proposed by Géolithe which is made of piled-up concrete blocks interconnected via metallic components whose dynamics response under projectile impact is examined via real-scale experiments (1). The corresponding numerical model is developed in a Python-based open-source software SICONOS (2) which implements the Non-Smooth Contact Dynamics (NSCD) method (3). The NSCD model is reported to be highly computationally efficient in comparison to a traditional FE model. A combination of meta-modelling techniques and a Bayesian interface in the framework of UQlab (4) are used to highlight the sensitivity of model parameters and to successfully calibrate the numerical model as per the real-scale on-site experiments (5). Further, the generalised impact response of the numerical model wall is examined and the sensitivity of the input impact parameters is highlighted. The Bayesian interface-based inverse analysis is successfully conducted as an effort to retrieve the impact conditions of future recorded events and to provide aid in warning-based decision-making. Here, the real-time measurements serve as a warning pertinent to the wall’s displacement reaching a safety limit and the damage to the constitutive blocks, predicted with a root mean square error (RMSE) of 16 cm and 80 kJ respectively. Similarly, the inverse analysis of the post-impact conformation of the wall predicted the energy imparted to the wall with RMSE of 70 kJ and the position along the wall length with RMSE of 30cm. The proposed approach appeared efficient and further improvement requires finding and implementing the methods (*{e.g.}*, adaptive surrogates and customised likelihood functions) enabling the effective implementation of a continuous system of equations for a non-continuous physical phenomenon. Further, the uncertainty quantification towards the trajectory analysis of the falling rock blocks is inspired for further study.

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Mots-Clés: Rockfall, Impact, NSCD modelling, Metamodelling, Bayesian interface, Sensitivity analysis