DEM-based optimal design framework for rockfall protection walls

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ABSTRACT

This study presents a new design framework which can optimize position and size of a rockfall protection walls with the help of numerical simulation. The proposed framework is separated into three stages. In the first stage, rockfall motion is predicted by DEM simulation. Sufficient number of rockfall paths with information of energy are accumulated in this stage, but the interaction between a rock and a protection wall is not considered. In the second stage, two mathematical functions are defined, namely a cost function and a safety function. A protection wall is virtually overlapped on the simulated rockfall paths, and values of the safety function are checked under the different combinations of design parameters. The response surface of the safety function is then approximately constructed by a polynomial function with the help of multiple linear regression analyses. The cost function is modelled to express the penalty in unreasonable situation. After the two functions are obtained, an optimization problem can be formulated in the final stage. The cost function is selected as the objective function, and the constraint condition is defined by the safety condition. Once a safety criterion is given, a feasible domain can be defined on the safety function. The cost is then minimized in the feasible domain. In order to demonstrate the capability of the proposed optimal design framework, a simple numerical example is solved using the framework. Three different types of rockfall protection walls are considered in the numerical example, and the most reasonable rockfall type, size, and position are then determined. The obtained result indicates that the proposed framework has the possibility of developing optimal design of rockfall protection walls.

REFERENCES

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