AN INTEGRATED MULTI-COMPONENT MODEL TO INVESTIGATE THE PERFORMANCE OF A ROCKFALL BARRIER SUBJECTED TO DIFFERENT LOADING CONDITIONS

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OBJECTIVES

Current design approaches for flexible rockfall barriers evaluate system performance through standardized full-scale tests, which only represent a limited subset of possible impact conditions. A generalized multi-component analytical model has recently been developed to simulate the mechanical response of these barriers under arbitrary impact scenarios, accounting for the contribution and interaction of all mechanical components [1]. However, this model has so far considered only impacts on the intercepting structure. To address the rare but potentially critical case of block impacts on the posts, this study introduces an empirical metamodel derived from a parametric numerical investigation calibrated against dedicated tests performed by Geobrugg. The analyses show that the impact on the steel profile alters the trajectory of the block and reduces its kinetic energy, allowing it to subsequently impact against the intercepting structure. The metamodel is incorporated as an additional dissipative mechanism within the existing analytical framework, enabling the multi component model to quantify barrier performance regardless of the relative position of the impact. An example illustrates the architecture of the integrated model and its predicted energy dissipation pathways.

MATERIALS AND METHODS

- A multi-component analytical model has been developed to quantify barrier performance when the block collides with the intercepting structure, regardless of its location.
- Geobrugg performed full-scale impacts on barrier posts, measured the resulting permanent deformations, and used these data to calibrate an Abaqus finite element model of the impacted post.
- A parametric simulation campaign varying impact conditions and post geometry quantified the kinetic energy dissipated by the whole system during block–post interaction.
- The resulting empirical law was formulated as a metamodel and integrated into the existing multi-component analytical model for system-wide performance assessment.

MAIN RESULTS AND CONCLUSIONS

- The impact on the post and its permanent deformation reduces the kinetic energy of the block.
- The kinetic energy dissipation is affected by the reciprocal position between the axis of the steel profile and the centre of gravity of the block, and by the eventual presence of bypass ropes.
- The residual kinetic energy not dissipated at the post is absorbed by the intercepting structure, primarily through the net and the energy dissipating devices.
- Integrating the metamodel into the analytical framework allows the multi-component model to quantify performance for any impact location, including rare impacts on sustaining components.
- The multi-component analytical model is proved to be an effective tool for barrier design.

REFERENCES

[1] Pimpinella, F., Marchelli, M., & De Biagi, V. (2025). A generalized multi-component analytical method to study the performance of a rockfall barrier under a generic impact condition. Computers and Geotechnics, 188, 107602.