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Numerical modelling of new rockfall interception nets

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The design and certification of effective rockfall protection barriers is mainly achieved through 1:1 prototype testing. In order to reduce development costs of a prototype it is recommended that pre-studies using numerical simulations are performed. A large component to modelling rockfall protection systems is the numerical simulation of the nets. To date there exist several approaches to model the different mesh types such as ring nets or diagonal meshes (Nicot 1999, Cazzani et al. 2002, Volkwein 2004). However, the consideration of chain link meshes has not yet been realised. Chain link meshes are normally found as standard fence structures. However, they also exist in setups using high-strength steel and wire bundles. These variants show an enormous capacity to retain loads e.g. rockfalls, and at the same time are very efficient due to their low demand of steel material. The increasing application of chain link mesh in barrier systems requires an accurate model is available to complete prototype studies.

A new approach now aims to perform a Finite Element simulation of such chain link meshes. The main challenge herein is to achieve the net deformation behaviour that is observed in field tests also in the simulation. A simulation using simple truss elements would not work since it neglects the out-of-plane-height of the mesh construction providing important reserves for local and global high deformations. Thus addressing this, a specially developed Discrete Element is able to reconstruct the mechanical behaviour of the single chain wire (bundles). As input parameters it utilises typical properties such as longitudinal and transversal mesh widths, and break loads resulting from in-plane-tension tests and steel strength. The single chain elements then can be combined to a complete mesh (e.g. $130\ x\ 65\ mm$, $3\ -\ 4\ mm$ wire with a strength of $1770\ N/mm^2$). Combining these elements with a supporting structure consisting of posts, ropes and energy absorbers, enables the simulation of protection barriers used for natural hazards such as rockfalls or even landslides.

The contribution explains the mechanical behaviour of the chain mesh, the calibration procedures and their application in flexible rockfall protection systems. The investigated meshes are built using three or four millimeter wire with a minimum yield strength of $1770\ N/mm^2$: The maximal load in longitudinal mesh direction ranges about $130 - 380\,kN/m$ and transversal $50 - 170\,kN/m$. The mesh size varies from $83 \times 143\,mm$ to $292 \times 500\,mm$.

References

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