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Posterior trajectory analysis of an artificial instrumented boulder

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Despite the advances in simulation techniques actual research in the field of rock falls usually requires corresponding field tests. This includes trajectory experiments as well as the testing of rockfall protection systems where the constructions have to prove to be able to restrain the impacting rockfall energy. For this purpose we now report on the development and testing of an artificial instrumented rock.

Mostly, video records lack of precise resolution in picture size and or time. This prevents a proper resolution of the extremely short-term high acceleration peaks and the still very small displacements within one timestep. Therefore, we decided to use internal accelerometers together with an also internal computer control unit. The total number of eight sensors exceeds the minimum required number corresponding to the boulder's six degrees of freedom. This allows an analysis of imprecision and provides and a certain redundancy.

The instrumented boulder consists of two spherical semi-shells of fiber-reinforced high-performance concrete with a total mass of $825\ kg$. The range of the capacity sensors is $\pm 50\ g$ with a survival load of $1000\ g$. The data are sampled with $2\ kHz$. After triggering, the data are retained in the boulder until downloading is completed.

The posterior trajectory analysis is done using a time integration procedure similar to the central differences method used for finite elements. It gives the velocity and position of the rock from the measured decelerations. The spatial rotation is mathematically described via Euler parameters (Quaternions).

The presentation will show the techniques used for the device development and the trajectory determination. Actual small scale experiments help to quantify the error deviation when applying the time integration algorithm for thousands of time steps.