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Modeling seismic capacity of stalagmites

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The need to model seismic capacity of stalagmites derives from the objective of speleoseismology to study long term seismic hazard [1], [2], [3]. Assessment of the seismic capacity of stalagmites is done in terms of peak ground acceleration, which would break the stalagmite. The problem is not easy for many reasons: (1) the shape and internal structure is neither uniform nor isotropic, (2) it is well known from seismic engineering that to model breaking of a vertical cantilever may require knowledge of a full time history of accelerations (PGA, duration, spectral content) and (3) that one may also need to consider multicomponent seismic effects (e.g. including rocking component [4], [5]).

So far the seismic models of stalagmites are modeled as beams with intervals of constant cross-sections (e.g. [2]). In order to develop more sophisticated Finite Element Models (FEM), including also their random properties, one may require to calibrate the models by breaking some real stalagmites which, for obvious reasons is not possible. However, some short pieces of broken stalagmites can be found in the caves and used in the breaking experiments. The real stalagmites often represent the slenderness ratio (λ = height/width) of the order of 40 or more. It is well known that modes of failure of such slender objects are different than the failure modes of short, stocky beam.

Thus, before any experimental validations of the FEM models of the stalagmites are undertaken, numerical modeling of bending and shear seismic capacities of short and slender beams must be compared and respective breaking parameters should be determined.

The purpose of the lecture proposed for session NH4.2/SM3 is to present results of numerical analyses of 3D FEM models of short (λ = about 10) and long beams (λ = about 40). Results of such numerical simulations will help to design proper breaking experiment on the pieces of stalagmites and help calibrate future FEM models consisting of many thousands of finite elements including random, nonuniform structure of tested stalagmites.

References

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