

## **Fuzzy multi body systems and fuzzy probabilistic multi body systems and their application for numerical simulation of controlled demolitions of structures**

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The controlled demolition of structures at the end of their lifetime is of increasing importance. The objective of such blasting operations is to shatter a building in such a way that the remaining debris can be removed easily. When blasting operations are carried out in urban areas, the surrounding properties should not be affected by debris or accompanying ground vibrations. The planning and design of a controlled demolition depend on a variety of uncertain information. Uncertainty may be of objective or subjective nature. Objective uncertainty appears in connection with uncertain observations and measurements, whereas subjective uncertainty results from information deficits, opinions, and estimations. A realistic and reliable numerical simulation of blasting processes requires adequate computational models that are capable of taking into account data and model uncertainty. A reliable prediction of the collapse process and its effects with consideration of uncertainty is the objective of the current research. In this presentation a special fuzzy probabilistic multi body system for the numerical simulation of collapse processes is discussed.

The local blasting leads to stiffness reductions and structural member failure. The static system is turned into a dynamic one. Several parts of the structure lose their member bindings partly or completely during the collapse. Physical effects like collision, friction, and disconnection of bindings has to take into account by the chosen numerical model. For the deterministic fundamental solution a partially flexible multi body system is applied. Flexible bodies represent potential failure zones undergoing major damages or destructions during the collapse. This mechanical behavior is modeled by nonlinear load-displacement-relations that describe crack development, articulation, and failure.

Physical parameters describing a blasting process are generally not deterministic; they are uncertain. Commonly this applies to geometric and material parameters. In the stochastic sense each blasting operation is an individual event that is generally characterized by limited data and distinctive data uncertainty. The mathematical description of data uncertainty is realized on the basis of fuzzy randomness [1]. Fuzzy randomness is a generalized uncertainty model that includes fuzziness and randomness as special cases. In fuzzy probabilistic structural analysis [1] the uncertain input parameters modeled by fuzzy randomness are mapped to fuzzy random results. In the case of blasting the multi body system algorithm as described above is applied as mapping model. The fuzzy stochastic analysis of blasting is demonstrated by way of examples. The authors gratefully acknowledge the support of the German Research Foundation (DFG).

### References

- [1] B. Möller and M. Beer. *Fuzzy Randomness - Uncertainty in Civil Engineering and Computational Mechanics*. Springer Verlag Berlin, 2004.