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Large-scale experiments for the vulnerability analysis of buildings impacted and intruded by fluviatile torrential hazard processes

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In European mountain regions, losses due to torrential hazards are still considerable high despite the ongoing debate on an overall increasing or decreasing trend. Recent events in Austria severely revealed that due to technical and economic reasons, an overall protection of settlements in the alpine environment against torrential hazards is not feasible. On the side of the hazard process, events with unpredictable intensities may represent overload scenarios for existent protection structures in the torrent catchments. They bear a particular risk of significant losses in the living space.

Although the importance of vulnerability is widely recognised, there is still a research gap concerning its assessment. Currently, potential losses at buildings due to torrential hazards and their comparison with reinstatement costs are determined by the use of empirical functions. Hence, relations of process intensities and the extent of losses, gathered by the analysis of historic hazard events and the information of object-specific restoration values, are used. This approach does not represent a physics-based and integral concept since relevant and often crucial processes, as the intrusion of the fluid-sediment-mixture into elements at risk, are not considered.

Based on these findings, our work is targeted at extending these findings and models of present risk research in the context of an integral, more physics-based vulnerability analysis concept. Fluviatile torrential hazard processes and their impacts on the building envelope are experimentally modelled. Material intrusion processes are thereby explicitly considered. Dynamic impacts are gathered quantitatively and spatially distributed by the use of a large set of force transducers. The experimental tests are accomplished with artificial, vertical and skewed plates, including also openings for material intrusion. Further, the impacts on specific buildings within the test site of the work, the fan apex of the Schnannerbach torrent in Tyrol (Austria), are analysed in detail. A couple of buildings are entirely reconstructed within the physical scale model at the scale 1:30. They include basement and first floor and thereby all relevant openings on the building envelopes.

The results from experimental modelling represent the data basis for further physics-based vulnerability analysis. Hence, the applied vulnerability analysis concept significantly extends the methods presently used in flood risk assessment. The results of the study are of basic importance for practical application, as they provide extensive information to support hazard zone mapping and management, as well as the planning of local technical protection measures.