Geophysical Research Abstracts,
Vol. 10, EGU2008-A-07035, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-07035
EGU General Assembly 2008

Structural response and vulnerability assessment of buildings in front of the rockfall impact

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The performance of the Quantitative Risk Assessment is becoming a fundamental tool for an appropriate management of the rockfall hazard. To assess risk in villages and urban settlements it is indispensable to identify the exposed elements and to quantify their vulnerability. Despite the significant progress made during the last years in the assessment of the components of the risk equation, the vulnerability is still poorly treated in the QRA studies. In this paper we present a methodology for the evaluation of both the structural response and the vulnerability of buildings subjected to rockfall impacts.

The assessment of the vulnerability of a building is performed for different intensity values of the block impact, which is expressed in terms of the boulder kinetic energy. The structural vulnerability is then determined by analyzing the response of the building to the block impact by means of a finite element model. The impact force is simulated according to Eurocode 8's suggestions for accidental actions. The spatial probability of a block impacting on a certain structural or non structural element of the building is considered by taking into account the boulder size and the geometry of the exposed façade. The resultant damage level (structural and non-structural) is based on a stress and strain analysis and it is expressed in quantitative terms. The risk for a structure due to a rockfall impact is calculated, as the product of the spatial probability of the rock hitting a certain building element, multiplied by the structural

vulnerability, corresponding to this impact.

In order to illustrate the application of the methodology, three representative structural typologies of buildings in Andorra are investigated: a reinforced concrete structure, with column and beam frames; a reinforced concrete structure with additional reinforced concrete walls on the exposed façade and a bearing brick masonry. The peculiarities of each structural type are taken into account for the development of the three finite element models and the parameters of the analysis. Adequate quantitative damage indices, for reinforced concrete and masonry structures, representing local and global structural performance, are defined and calculated, for each rockfall intensity value. The damage level is quantitatively expressed, for all the afore-mentioned cases. Conclusions are derived, on the effect of the rockfall event, for each impact intensity and structural typology.