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Risk Quantification of Urban Areas in Switzerland

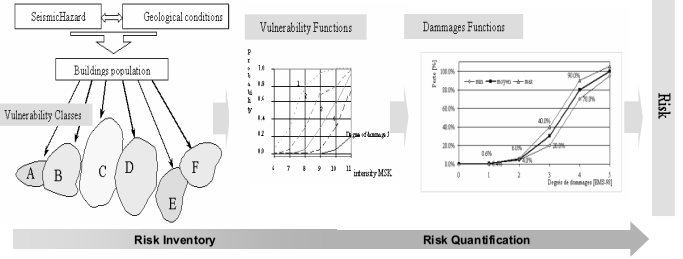
Keywords

- Seismic Risk assessment
- Seismic inventory
- Vulnerability
- Seismic category
- Traditional masonry building
- Built environment

The City

The city of Aigle (Switzerland), situated in the Swiss Alps was chosen for our pilot project. It is located in an area of middle seismicity with estimated return period of about 100 years for an earthquake of MSK intensity of 7 and about 1'000 years for an intensity of 9. Its size (around 1500 buildings and 8'000 Inhabitants) allows a visual analysis of the building population while providing a large variety of buildings. It has a wide range of structural types and is representative of many the building population of many Swiss towns.

Risk Quantification Model



Seismic Based Inventory

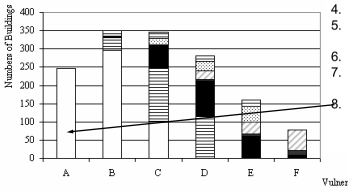
Categories

The seismic categories are based largely on those proposed in European Macorseismic Scale **[EMS-1998]** and are adapted to the building population of Aigle. They are:

1. Traditional Rubble stone masonry buildings
2. Traditional Simple stone masonry buildings
3. Modern masonry buildings
4. Reinforced concrete bearing walls buildings
5. Reinforced concrete frame buildings
6. Steel buildings
7. Timber buildings

Vulnerability Classes

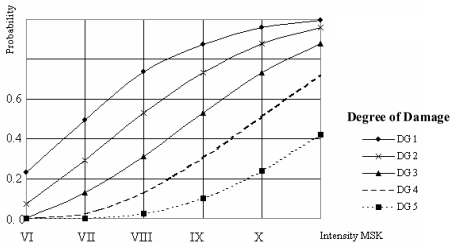
Once seismic categories and vulnerability classes were defined, it was possible to link them. EMS 98 was used as the starting point in this operation. EMS-98 indicates vulnerability classes' distribution for many seismic categories. For example steel structures are most likely to be in vulnerability class E, with the probable range of vulnerability stretching to D and F, and less probable range including C. These indications were interpreted quantitatively and adapted to the characteristics of the Swiss built environment. For most seismic categories, this adaptation was done on the basis of available research results (see below). Much relevant data from theoretical studies as well as post earthquake damage surveys was available for modern construction types. For reinforced concrete buildings, for example, a previous vulnerability study of Swiss buildings was available.



1. Tanks
2. Timber buildings
3. Steel buildings
4. Reinforced concrete frame buildings
5. Reinforced concrete bearing walls buildings
6. Modern masonry buildings
7. Traditional Simple stone masonry buildings
8. Traditional Rubble stone masonry buildings

Vulnerability Curves

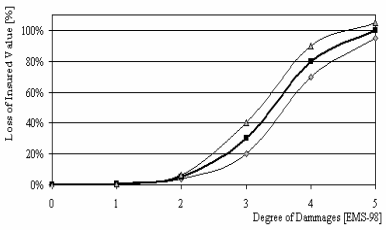
Vulnerability Curves



Damages Curves

Relations

Damages Curves coupling degree of damages of buildings with level of losses were built. Statistical available information and experts process to adapt into the Swiss context were used. We have developed this kind of curves for direct economic losses and human losses.



Risk Quantification

Porbabilistic Approach

According the expected losses, we have coupled the results with the seismic hazard of the studied region. So we have estimated the annual risk for people and buildings. We have used a probabilistic approach to evaluate the average risk (Insurance Premium) and we also have estimated the Maximum Potential Loss Event (Re-insurance).

Risk = Hazard x Consequences

Earthquake & Local Condition

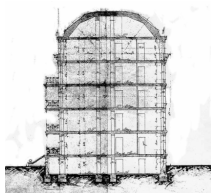
Structural Vulnerability & Value at risk

Vulnerability of traditional masonry buildings

Rubble Stone Masonry

One seismic category was given particular attention. The definition of the vulnerability curve of traditional rubble stone masonry buildings was based on ad hoc detailed seismic assessment of actual buildings of the City of Aigle. In order to improve the basis on which the vulnerability of traditional masonry buildings was quantified, detailed seismic assessment of many representative buildings was conducted. See example to the right.

Five-story building traditional masonry building



Current Developments

Conclusions

In the next phase the Decision Makers (government officials, or plant managers, or insurance industry representatives, or …) must select the strategy which will be implemented. Even if other considerations influence the decision, it can be based on recommendations developed from the findings of the Comparative Evaluation phase. This comparison phase is the current state of this research.

These recommendations must be based on a comparison which is risk-oriented and which accounts for different criteria and point of views. The comparison distinguishes components which are objective (even if uncertain) such as economic losses or loss of life, and aspects which are subjective because dependent on the point of view of those affected (loss of heritage, pollution…).

We want to compare traditional Cost-benefits analysis with outranking methods, which allows taking into consideration different criteria and points of view.

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