# State and development of earthquake risk mitigation In Switzerland

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#### SUMMARY: (10 pt)

In the last 10 years earthquake risk mitigation in Switzerland has seen some progress, especially in the domains of building codes, technical guidelines and the systematic integration of seismic safety in public building projects. In the private sector much remains to be done in order to achieve a consistent and homogeneous integration of the seismic safety in building projects. In that respect regional and communal building authorities, which have a high autonomy in the Swiss federal system, have an important role to play and should become more proactive. To that end, the federal coordination center for earthquake risk mitigation has developed different strategies and procedures that building authorities could and should implement in their building permit procedures. As an absolute minimum a so called declaration of earthquake safety should be requested by the building authorities. In such a declaration, the building owner, the architect and the structural engineer confirm through their signature that they have or will respect the earthquake provisions of the building codes. The aim of this procedure is to force the owner, architect and engineer to talk about and integrate the seismic safety early on in their project, which is a very important contributor leading to an integrated, efficient and cost effective seismic design.

Another critical step towards an integrated earthquake risk management is the coverage of the financial losses to buildings and their content. In Switzerland, the seismic risk is the only risk from natural hazards that is not covered in the mandatory building insurance. Also 2 voluntary Pools from the cantonal building insurances with a capacity of 3 billion swiss francs exist, the risk is largely under covered. The project of a solidarity based earthquake insurance has been worked out by the insurances between 2005 and 2010 but has been frozen in June 2010 because of an insufficient political support and the disinterest or refusal of building owners associations for such a solution. Interestingly, a poll from 2011 showed that a majority of building owners think they are covered by their building insurance for earthquake damage, also they are not. A politically driven thorough discussion about the risk sharing between owners, insurances and the state will be necessary in order to achieve a sufficient and balanced financial risk coverage so that the necessary capital for reconstruction can be efficiently and quickly mobilized. In march 2012 the principle of introducing a mandatory earthquake insurance has been accepted by the national Parliament. The federal council is de facto mandated to propose applicable solutions in the near future.

Keywords: Earthquake, Risk, Mitigation, Prevention, Switzerland

# 1 DEVELOPMENT OF EARTHQUAKE RISK MITIGATION IN SWITZERLAND

The following list shows the principal milestones in the development of earthquake risk mitigation in Switzerland.

- 1855 : Damaging earthquake in the Valais
- 1856 : First earthquake catalogue of Switzerland
- 1878: Establishment of the Swiss Earthquake Commission (academy of sciences).
- 1911: Installation of the first seismograph (Zürich).
- 1913: Establishment of the swiss seismological service

- 1946: Damaging magnitude 6.1 earthquake in Sierre (canton of Valais).
- 1950: until 1970 construction of most swiss dams (first applications of seismic design inland).
- 1969: until 1984, four nuclear power plants enter service (design according to actual the of the art).
- **1970:** First building code with rudimentary seismic provisions (largely ignored).

**1975 :** installation of the swiss network of seismic stations.

- 1978: First earthquake hazard map of Switzerland (in intensity scale).
- 1978: Founding of the Swiss Pool for Earthquake Coverage (voluntary pool of cantonal insurances).
- 1982: Founding of the Swiss Society for Earthquake Engineering and Structural Dynamics (SGEB).
- 1985: until 1993: seismic retrofit of nuclear power plants Beznau and Mühleberg.
- 1989: First modern seismic prescriptions in modern building codes (largely ignored).
- 1991: until 1993: construction of a Strong Motion Network.
- **1993:** First canton (Basel-city) begins to evaluate the seismic safety of its critical infrastructures.

1994 : First seismic retrofit of a building in Switzerland

- 1995: Katanos study lists earthquakes as being a major risk related to natural hazards for Switzerland.
- 1998: SGEB-publication "Need for action for authorities, universities, industry and private persons,..".
- 1998: Motion Epiney: "call for the establishment of a clear legal basis for seismic risk mitigation".
- 1999: A concept for a risk mitigation program is addressed to the federal council.
- 2000: Federal council decision : earthquake risk mitigation program at the federal level.
- **2001:** First canton (Basel-city) modifies its construction law and starts to control the seismic safety of private construction projects.
- 2002: New guidelines for seismic requalification of dams (controls mandated until end of 2012).
- 2003: New seismic hazard map of Switzerland is published.
- 2003: Newest generation of building codes with actualized seismic prescriptions.
- 2003: The constitutional modification to establish a clear legal basis for earthquake risk mitigation is rejected by a subcomission of the parliament. The federal government cannot issue national prerogatives regarding earthquake safety.
- 2004: The canton of Valais modifies its construction law and starts to control the seismic safety private construction projects.
- 2004: First building code for the seismic verification of existing buildings (SIA, 2004).
- 2005: The insurance industry launches a project for a national mandatory earthquake insurance.
- 2005: First conference "Seismic risk mitigation: what can the cantons do" (organized by the Confederation)
- 2005: The canton of Nidwalden is the third canton (out of 26) to introduce seismic specific demands in the building permit procedures for private buildings.
- 2005: First continuing education course on earthquake engineering.
- 2009 : Start of the renewal of the swiss strong motion network (2009-2017).
- 2010 : Project for a mandatory earthquake insurance is frozen for lack of political support.
- 2010: The canton of Jura introduces seismic specific demands in the building permit procedures for private buildings.
- 2010: The canton of Aargau introduces seismic specific demands in the building permit procedures for private buildings.

# 2012: The national parliament accepts a motion that mandates the federal council to prepare a solution for the introduction of a mandatory earthquake insurance.

2012: Tri-national exercise SEISMO12 in the region of Basel-City.

It is clear from this list of milestones that the first real earthquake risk mitigation measures only started in the mid 90's. The triggering of these measures were largely due to the observation of the consequences of devastating earthquakes in foreign developed countries (Loma-Prieta 1989, Northridge 1994, Kobe, 1995).

Regarding the control of the seismic safety of buildings, the first control procedures of private buildings were enforced in 2001. At this day only a minority of the cantons (5 out of 26) have specific earthquake related demands in the building permit procedures.

From the establishment of the Swiss Earthquake Commission to the first earthquake hazard map 100 years have passed. From the first earthquake hazard map to the first building code with adequate earthquake safety provisions, 20 years have passed. From the publication of these building codes to the introduction of the first seismic safety control procedures, another 10 years have passed. How many more years will be needed until a coherent and adequate prevention is actually lived is unknown, but Switzerland is on its way and efforts are accelerating.

# 2 ASSESSMENT OF THE ACTUAL SITUATION

# 2.1 Legal basis

The Federal Constitution gives the federal government no general strategic competence in the field of earthquake mitigation. The prevention in the sense of constructive measures falls under cantonal building legislation. According to the actual building laws in the cantons, structures have to be built according to the state of the art, which according to a dominant view amongst jurists implicitly means that building codes of the Swiss society for engineers and architects are mandatory (earthquake provisions included). A few cantonal construction laws are more explicit in the sense that the buildings codes of SIA are explicitly mentioned as legally binding. In that sense, the construction legislation in Switzerland is seen as sufficient although a systematic precision regarding the legally binding aspect of building codes of SIA would be desired for clarity.

#### 2.2 Technical and normative basis

In the field of modern buildings and bridges, the necessary technical normative basis is available. Practical guidelines and standardized solutions are missing predominantly for the following problems:

- seismic safety of non structural components and equipments;
- evaluation and retrofit of older buildings made of masonry and flexible floors;
- performance based criteria for infrastructure elements.

#### 2.3 Constructive measures and control procedures by building authorities

Most cantons and the federal state have developed earthquake mitigation strategies for their own building stocks but do not interfere with private construction projects. The cantons leave the responsibility of a correct and complete building code application to the construction professionals and building owners.

Only 5 out of 26 cantons have specific demands regarding the earthquake safety in the building permit procedures. These demands range from a simple declaration from the building owner, architect and engineer that the earthquake provisions of the building codes will be respected (cantons of Nidwalden, Jura and Aargau) to the control of the engineer's design calculations (cantons of Basel-City and Valais). This situation is unsatisfactory as it is observed that the seismic provisions of the buildings codes are still often ignored or misused by building professionals. More pressure from building authorities would surely help to solve this problem.

# 2.4 State of knowledge and education of building professionals

The state of knowledge in earthquake engineering amongst civil engineers has been improving in the last 10 years, although it remains on average relatively basic. The main problem remains the state of knowledge of architects regarding basic seismic conceptual design and more importantly their responsibility regarding the integration of safety against natural hazards in building projects.

Courses in earthquake engineering are given in most engineering schools, although sometimes in a very rudimentary form. On the contrary most student architects are not confronted with seismic conceptual design during their studies. Engineering and Architecture schools should put an effort to ensure that a minimal level of education in this field is provided. To try to start and support the necessary effort, the federal office for the environment (FOEN) in collaboration with earthquake engineering specialists has elaborated in 2010 introductory courses for engineers and architects that professors can use as a starting basis. On request FOEN also provides qualified personnel for the introduction of these courses during 2 years so that professors can get comfortable with the content of the courses. As of 2012 a majority of engineering schools have used this offer, but only a minority of architecture schools did.

# 2.5 Coverage of earthquake financial losses

The reinsurance industry has estimated the costs of a repeat of the Basel-earthquake of 1356 between 50 and 100 billion swiss francs. This event is a very rare event with an estimated return period of around 2'000 to 3'000 years. For more frequent events such as the earthquake of Visp in the Valais with a return period of about a 100 years, the expected losses are 2 to 5 billion swiss francs. In both cases many building owners would face financial ruin.

In 19 out of the 26 cantons buildings are insured through a cantonal insurance. In the 7 other cantons, buildings are mandatorily insured through private insurances. In the canton of Zurich, the cantonal insurance covers earthquake damages to buildings up to 1 billion swiss francs per event (maximum 2 events in a calendar year). The deductible is 10% of the insured value. For the other 18 cantons with a cantonal building insurance, there exists a voluntary Pool for earthquake damage with a capacity of 2 billion swiss francs per event (max. 2 events per calendar year). The deductible is also 10% of the building value. In the 7 cantons with private insurances, no voluntary fund exists for earthquake damages. Private earthquake insurances exist but they are expensive and do not have a large market penetration. In the actual situation a private earthquake insurance policy costs roughly as much as the mandatory insurance policy covering all the other natural hazards and fire.

The project of a solidarity based earthquake insurance has been worked out by the insurances between 2005 and 2010 but has been frozen in June 2010 because of an insufficient political support and the disinterest or refusal of building owners associations for such a solution. Interestingly, a poll from 2011 showed that a majority of building owners think they are covered by their building insurance for earthquake damage, also they are not. A politically driven thorough discussion about the risk sharing

between owners, insurances and the state will be necessary in order to achieve a sufficient and balanced financial risk coverage so that the necessary capital for reconstruction can be efficiently and quickly mobilized. In march 2012 the principle of introducing a mandatory earthquake insurance has been accepted by the national Parliament. The federal council is de facto mandated to propose a concrete solution in the near future.

# **2.6 Preparadeness**

In Switzerland, cantons have the operational lead in case of natural catastrophes. The Confederation has to support the effort of the cantons and eventually take the lead if requested by the cantons (principle of subsidiarity).

The Confederation has elaborated its own preparedness plan in order to support the cantons at best and is organizing exercises to train the cantonal crisis management organizations as well as its own personnel. In 2012 a trinational exercise with France and Germany has been organized to train the reaction and the cooperation of crisis management organizations for a repeat of the Basel earthquake of 1356 (estimated magnitude of 6.6).

One very big recognized deficit following this exercise is the preparedness for post earthquake evaluation of buildings that has not been institutionalized in Switzerland yet. Although a methodology has been published by the federal office for the protection of population in 2010, the procedures and the resources have not been planned by the cantons yet. The first canton that is preparing the formation of a pool of engineers for this task is the canton of Valais. In the coming years, efforts will have to be achieve an adequate preparation for this crucial task after an event.

# **3 DISCUSSION**

# 3.1 What should building authorities do?

As an absolute minimum a so called declaration of earthquake safety should be requested by the building authorities. In such a declaration, the building owner, the architect and the structural engineer confirm through their signature that they have or will respect the earthquake provisions of the building codes. The aim of this procedure is to force the owner, architect and engineer to talk about and integrate the seismic safety early on in their project, which is the main factor leading to a simple, efficient and cost effective seismic design. This concept is easily implementable by communes that usually don't have the technical knowledge and resources to perform an actual control of the seismic design. This solution also leaves the responsibility for a correct application of the building codes by the engineers, which is the normal procedure in Switzerland at least for buildings. Cantons and communes would then be free to define if they want a more in depth control for more important projects.

The federal office for the environment has prepared and published in 2011 online documents that cantonal and communal authorities can readily integrate in their building permit procedures if they decide to do so. Already in September 2011, the canton of Aargau has adopted these procedures in the framework of a revision of its construction law. It is hoped that most of the other cantons will follow in the coming years.

#### 3.2 What insurance to cover damage to private buildings?

The earthquake financial risk is largely under covered in Switzerland. In case of a large event numerous building owners may face financial ruin. Building owners are not very aware of this risk and think that they are covered through their building insurance, although they are not. When confronted with the fact that they are not insured, most of them don't feel the necessity to conclude a private insurance or the need for an extension of the mandatory insurance against natural hazards to cover earthquake damages. This seems paradoxal but is typical for an event that is perceived as very unlikely.

Politics through the national parliament has given a clear signal in march 2012 that this situation is not acceptable anymore and that the effort to find a consensus for a mandatory earthquake insurance should be pursued and led by the federal council with a clear political mandate. This turning point came as a surprise as this question was already debated and refused several times in the past through various political initiatives at the national parliament level. Again the perception of consequences of recent earthquakes in foreign developed countries (L'Aquila, 2009; Christchurch, 2011; Tohoku earthquake, Japan ,2011) may have triggered this change.

#### 3.3 How can the collaboration between building professionals be improved ?

The building owner is responsible for the safety of its building. The conception, design and construction of a building code conform and earthquake safe building belong to the tasks of the architect <u>and</u> the civil engineer. This tasks involves the necessity of a dialogue between these three actors.

What needs to be improved first is a mutual comprehension between architect and civil engineer of each other's role and responsibilities. The architect as a general planer has a central role and has the responsibility that the question of earthquake safety will be explicitly discussed in a project. This should have as a result that the objectives and requirements regarding earthquake safety as well as the seismic conceptual design will be handled early on in the project. Interviewed architects are often of the opinion that earthquake safety is strictly a "problem" of the engineer and that no active role from their part is necessary. On the other hand, the civil engineer expects that this specific issue will be coordinated by the architect. From another perspective, the building owner don't really know who should do what regarding this issue.

From this situation it is evident that firstly the buildings codes should be more explicit regarding the respective responsibilities and tasks of architects and engineers. Secondly, instruments that favor a dialogue and a mutual understanding of the problem should be readily available for the building professionals and the building owners. FOEN and the foundation for structural dynamics and earthquake engineering are working actively in this field.

# 4 CONCLUSIONS

Earthquake risk mitigation has started in the mid 90's in Switzerland. Since then, several important steps towards a more systematic implementation of preventive measures have been made. The decision of cantonal authorities to become more proactive in putting pressure on private building projects through building permit procedures will be a critical success factor to improve the earthquake performance of the building stock. The finding of a consensus for an adequate coverage of the financial losses through a mandatory earthquake insurance would also be a major milestone towards an integrated earthquake risk management.

For more information in German and French, the reader is referred to the website of the coordination center for earthquake risk mitigation of the federal office for the environment at www.bafu.admin.ch/erdbeben