Need for action in earthquake mitigation of nonstructural elements in Switzerland – Regulations, responsibilities & implementation

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15 WCEE
LISBOA 2012

SUMMARY:
Switzerland is a country of moderate seismicity and the therefore typical problems among the project responsible people: a low awareness of the seismic hazard and a strong underestimation of the seismic risk. Seismic design of the building structure according to the Swiss building codes could be widely implemented among Swiss engineers. The seismic design of nonstructural elements on the other hand is still widely ignored. The situation is complex because responsibilities are not clear and expected safety levels are not fixed. An intense dialogue and decision making are needed from all project people responsible: owner, architect, specialisede planning consultants and building contractor.

Keywords: nonstructural, mitigation, moderate seismicity, Switzerland,

1. MOTIVATION

Despite of the requirements for seismic design of nonstructural elements in the actual Swiss Building Codes SIA until this day there are no basics for the realization and control of nonstructural elements and building equipment in Switzerland. Therefore generally no analysis of the earthquake resistance of nonstructural elements takes place even though these elements exist in every building type – residential or office building, shopping centre department or industrial halls.

Beside the obscure responsibilities and the missing promotion among project people responsible another major part of the problem are indifference, convenience or conscious ignorance. The seismic risk is needlessly increased on a constant base.

Analyzing the actual situation the coordination central at FOEN decided to work on a publication to fill the gaps: basics for the project practitioner focusing on useful approaches and procedures, clearer knowledge about responsibilities and a huge catalogue of demonstrative examples of fastening details.

The publication was developed inside a accompanying group of experts and specialized practitioners from different technical backgrounds. The document will be published through FOEN by the end of the year.

2. SEISMIC HAZARD IN SWITZERLAND

Seismic hazard in Switzerland can be classified as moderate. Therefore strong earthquakes may occur but considerably less frequently than in highly threatened zones, like Turkey or Italy. Oot of the national angle there is a greater hazard level in the Valais, the Basel Region, in Central Switzerland, in the Engadin und in the Upper Rhine Valley.

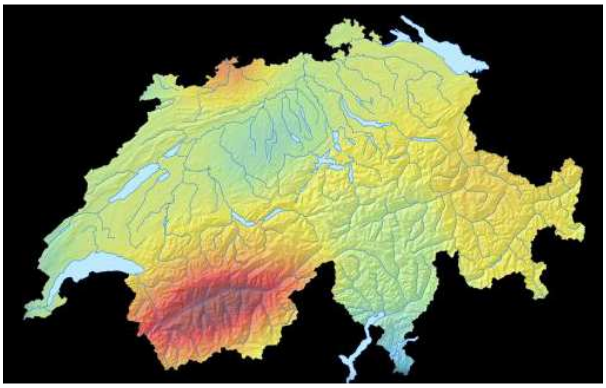

Figure 1. Seismic hazard zones of Switzerland according to Code SIA 261 (2003)

In Switzerland, an earthquake of magnitude 5 on the Richter scale and causing damage on a local scale may be expected every 10 years or so. An earthquake of magnitude 6 causing damage on a regional scale may be expected every 100 years or so. A supraregional destructive earthquake of magnitude 7 – like the Quake of Basel in 1356 - may be expected every 1,000 years. In fact the majority of earthquakes attain magnitude $M < 3$. On average 10 earthquakes are registered every year that are felt by the population, hence with a magnitude $M > 4$. Serious building damage – structural damage at vulnerable buildings - occurs starting from magnitude $M > 5$. A strong earthquake with a magnitude $M > 6$ starts seriously damaging structures of robust building.

Damage to nonstructural elements already occurs at much lower magnitudes. Starting from magnitude $M > 4.5$ considerable damage may occur depending on the depth and the location of the epicentre of the earthquake and the settlement and infrastructure of the affected region. Nearly no attention goes towards the potential of damage of small earthquakes. Small earthquakes can not only have catastrophic impact, they are also much more frequent. Such kind of earthquakes are likely to occur even in the lower and the weakly seismic zones of Switzeraland. The extent of damage of a smaller earthquake in Switzerland will massivly depend on the detailing of the nonstructural elements.

3. SEISMIC RISK IN SWITZERLAND

Seismic risk in Switzerland has to be considered quite high and is – in oposition to the seismic hazard zones – more evenly distributed over the country. High values-at-risk appear in the agglomerations of Berne, Zürich or Sion. Reasons therfore are at first the big density in settlement, then the high asset values and after all the vulnerable infrastructure. Due to this earthquakes have the highstes damage potential among naturals hazards in Switzeralnd.

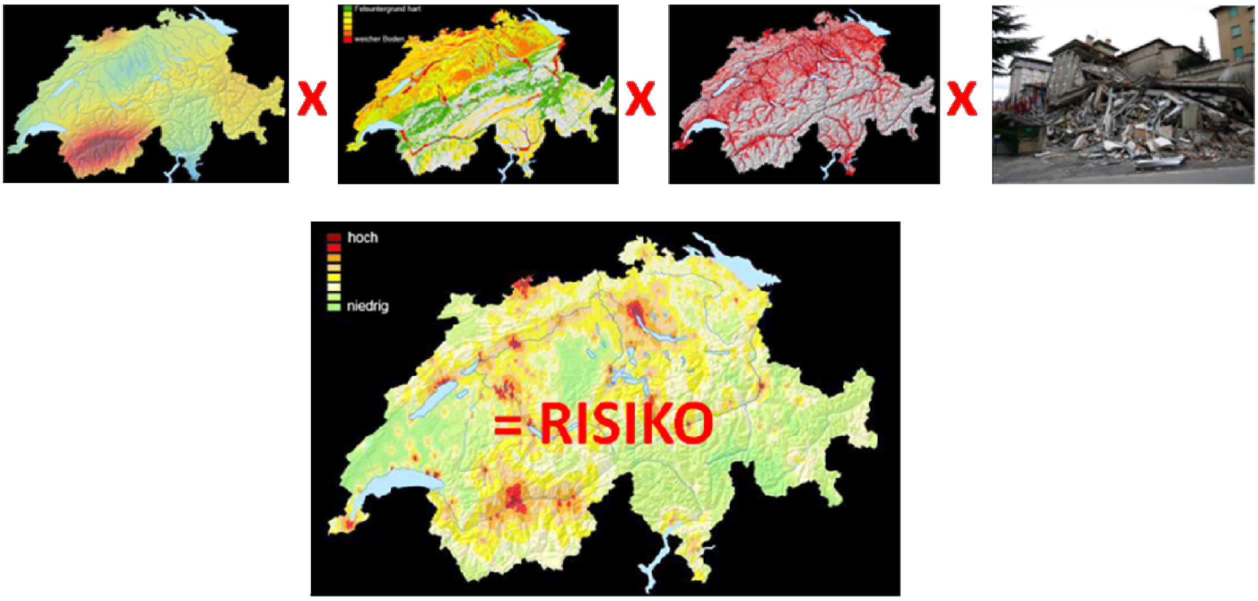

Figure 2. Seismic risk in Switzerland and factors of influence (Source: SED)

In fact the parameter capable of being influenced in the risk equation is the vulnerability of the Swiss building stock.
95 % of the buildings were built before 2003, hence before the introduction of the actual Swiss building codes. Because of high quality in construction and wind design old buildings that weren't designed to resist earthquakes show a certain fondamental seismic safety. But it must be assumed that a lot of the existing buildings especially the ones with typical seismic "weaknesses" don't fullfill the actual code requirements. Additionally among new construction it is to be doubted that code requirements are kept. Reasons are the underestimation of the seismic risk and insufficient legal obligations.

Paper length is to be not longer than 10 pages including summary, main text, all figures, tables and references

4. OBJECTIVE

Beyond controversy the main goal of seismic design and construction of structures is avoiding casualties through building collapses caused by over-strengthening the structure.

But buildings do not only consist of the structure. Next to the structural elements a number of nonstructural elements of the interior fitting, the HVACR, the building exterior and the furnishing are directly or indirectly connected to the structure.

Therefore, also beyond controversy, the secondary goal must be the avoidance of property damage that can already occur at small earthquakes and damage nonstructural elements to a considerable financial extent.

Figure 3. Typical nonstructural damage (Source: FEMA)

The problem of earthquake safety of nonstructural elements is barely considered among project people responsible. The earthquake damages of nonstructural elements and the complexity of the problems is not very well known in Switzerland and mainly underestimated. Therefore the necessity of seismic fixations is rarely executed.

According to Swiss Code SIA 261, Section 16.7 “nonstructural elements that in case of collapse have a potential to endanger people, damage the structure or influence the operation of important facilities” have to be designed considering this impact including their fixation or anchorage.

When the real behavior of nonstructural elements in an earthquake has to be reviewed, the expected level of performance of every single element during and after the event has to be analyzed and discussed. Of course these requirements directly depend on the building requirements:

Best behavior	Fully operational
	Immediate occupancy
	Damage control
	Life saftey
	Risk reduction
Worst behavior	No requirements

It is often misjugded that the seimic detailing of nonstructural elements is massivly responsible for the maintenance of the functionality or the oparation of the building. In most of the cases a small investment causes an enormious increase in the performance of the nonstructural elements and a massiv gain of safety.

5. DELIMITATION

In general all buildings have to comply with the seismic requirements of the actual Swiss SIA buildings codes – structural and nonstructural elements.

The publication will treat the most important groups of nonstructural elements (archtectural, HVACR, interior). Most of the elements, p.e. partition walls, exist to a large extent in every builing type.

Nonstructural elements cannot be considered independant of the building. Depending on type and function of the building the damage requirements towards the same element can be totally different. a The consequences of a destroyed water pipe in an earthquake can be taken as an example: one time thenpipe is in a hospital and one time in a residential building.

6. PUBLICATION

To raise awareness of the topic the introducing chapters will define the systematic of nonstructural elements and their major difference in behavior.

The origin and consequences of the influence of the seismic phenomenon on nonstructural elements will be also explained.

A procedure to approach the evaluation of the accepted damage level and the possible damage behavior of nonstructural elements is presented.

The main part of the publication are examples of seismic detailing of nonstructural elements and their fixation and anchorage.

The primary target audience are the non-engineer project people responsible: building owners, architects, specialized planning consultants and building contractors. The goal was to produce a nontechnical documentation that focuses

Knowing how unaware the engineers also are of the problem, the publication is considered as the first more superior sensitization in that topic in the construction world in Switzerland.

AKCNOWLEDGEMENT
Acknowledgement goes to the assigned structural engineer that worked out the document according to the comments of the accompanying group. The engineer is a Swiss earthquake expert.
Acknowledgement goes also to all the members of the accompanying group that supported the project and gave helpful input to all the parts of the documentation.

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