Media communiqué

Materials Science & Technology

Duebendorf, St. Gall, Thun, 3rd June 2010

43rd Science Apéro on Earthquake Security in Switzerland

Earthquake-proof buildings – a topic of interest in Switzerland too

Although the risk of a severe earthquake occurring in Switzerland is regarded as being only moderately probable, history shows that the possibility exists. What is more – very few buildings in this country are built in a way that would allow them to survive a severe earthquake without suffering any damage. At the latest Empa Science Apéro experts gave details of what can be done to protect buildings against such a catastrophe.

At least the first information that the audience heard was comforting. “Not every generation in Switzerland will be affected by an earthquake,” commented Donat Faeh of the Swiss Seismological Service on the level of seismic risk in the country. Despite this, severe quakes such as those which struck Basel in 1356 or Visp in 1855, causing enormous damage with strengths of six and almost seven respectively on the Richter scale, could happen again at any time. The reason is the collision of tectonic plates under the country which generates powerful forces deep within the earth’s crust. The areas of Switzerland primarily affected are the region around Basel, along the Alps and in the upper part of Canton Valais. Every day the Swiss Seismological Service records several earthquakes, but these are too small to be noticed by people and are not dangerous. However, according to Faeh, “the next large earthquake is expected in Valais in the next twenty to thirty years.”

The question which naturally interested the two hundred-odd strong audience most of all, of course, was how new buildings (and also existing ones) can be optimally protected against such a disastrous event. “During an earthquake such as the one which hit Visp, the earth’s surface moves some ten centimeters back and forth,” explains Hugo Bachmann, Emeritus Professor of the ETH and President of the Foundation for Structural Dynamics and Earthquake Engineering. “The foundations of a building are forced to move along too.” If the upper part of the structure is not sufficiently earthquake proof, it will collapse. There are two ways of preventing this from happening; either the building must be strengthened, or “softened” – two completely different methods of achieving the same end.

The solution: to strengthen or soften the structure

By strengthening the building, it is forced to follow the movements caused by the quake. To achieve this, the building must be anchored to the foundation, preferably with reinforced concrete walls up to three meters wide which support the structure asymmetrically on all sides from the foundation to the top floor. This gives the building enough stability to prevent it from collapsing if the earth should move, because it is a lack of vertical walls from top to bottom which allows this to happen. So called “soft floors” which support several

higher floors by means of pillars or columns alone are not able to bear the weight of the whole building in the event of an earthquake occurring.

Instead of completely rebuilding such structures, there is also, according to Bachmann, the possibility of "softening" its foundations. To achieve this, the outside walls of the cellar or lowest floor level below ground are cut open horizontally. Soft disks of rubber about 50cm in diameter are then inserted at regular intervals into the cavity which this generates. During an earthquake the horizontal movement of the earth is taken up by the elastic disks so that the upper part of the structure, the actual building itself, remains stable.

Developed by Empa

Another, very promising method of securing existing buildings involves the use of carbon fiber reinforced polymers (CRP). This method, which was developed at Empa, is being used worldwide to protect buildings from collapsing, explained Masoud Motavalli of the Engineering Structures Laboratory. The polymer, in the form of long strips, is fixed around load bearing columns to stabilize them. During an earthquake the columns have to support the weight of the upper floors, something which they are frequently not capable of doing. As a result they can crumble, develop cracks and may fracture. This is prevented by the carbon fiber bands. An internal tension is created within the columns which automatically gives them increased stability and prevents them from collapsing. Complete walls can also be strengthened by this method.

Motavalli's team is also working on other methods of making buildings earthquake resistant. The researchers have high hopes for so-called memory shape alloys, materials which can be bent into any required shape but which, on heating, return to their original form. These can be used for reinforcing load bearing pillars, among many other applications. They can help to guarantee the stability of a building even during a fire – an event which frequently accompanies an earthquake.

And it would be so easy… …

The 43rd Science Apéro made it quite clear: there are various, mostly quite simple techniques already in existence which can be used to counter the threat of the earthquake which, according to Donat Faeh is going to happen sooner or later. Small changes and a minimum amount of effort are enough to prevent a building from collapsing when it does. Despite this situation, by no means is every new building automatically constructed to be earthquake proof today. "The obligation to follow building regulations is not enforced thoroughly and they are not always applied conscientiously," says Hugo Bachmann. Only in Basel and Canton Valais is enforcement stringent. This situation exists even though the additional cost of making a new building earthquake resistant is practically negligible. "The extra cost is small, something between nothing to one percent of the total cost of construction" maintains Bachmann.

Further information

Prof. Masoud Motavalli, Engineering Structures Laboratory, Tel. +41 44 823 41 16,
masoud.motavalli@empa.ch

CRP cables attached to the façade of Empa's Administration Building in 2008 lend reinforcement to prevent earthquake damage.

A view of the entrance hall of the Hotels Azadi in Teheran. To make the 28-floor building earthquake proof the ten meter high supporting pillars of reinforced concrete are wrapped in a layer of woven CRP fiber.

The images in print-quality resolution and the text in electronic form are available from redaktion@empa.ch