INTEGRAL ROCK FALL PROTECTION IN ADELBODEN (BERNESE OBERLAND)

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INTRODUCTION

Since 2003 the well-know summer and winter health resort Adelboden in the Bernese Oberland is in possession of a hazard map for processes of natural hazards. This map shows that parts of the village among other things are also threatened by rock fall. The corresponding hot spots lie primarily in the distinctive rock walls, which are formed by massive and highly fissured malm limestone and from which occasionally smaller and rarely also larger rocks break out. In 1964 a boulder of about 20 m^3 fell out of a rock wall, crossed the protection forest and rolled past the houses downhill, but without causing greater damage.

According to the hazard map around 60 resident houses and about 20 holiday houses are inside zones with threat level red and blue, meaning in prohibited or restricted areas. According to federal guidelines in these zones damages – personal injury or building damage – are to avoid through appropriate preventive measures. Without such preventive measures no building permits are currently issued.

The aim of the local authorities of Adelboden is to improve the threat level with an integrated protection from rock fall. This is primarily to avoid personal and building damage. Furthermore the building development – be it in the section of renovations and building extensions or new buildings in existing building zones – will improve.

PRELIMINARY INVESTIGATIONS AND RISK ANALYSIS

As a basis for the design of protective measures a 3D rock fall simulation was performed throughout the hazard area on a detailed digital terrain model. The results allow precise information about the range of the falling objects, their energy as well as their relative jump heights. Due to the geological surveys and the event cadastral (historical events) the falling rocks from the earlier mentioned rock walls have e size between ¼ m^3 at a 30 year and around 2 m^3 at a 100 respectively 300 year event. The results of the model were included in the risk assessment. Decisive is the individual death risk, meaning the probability that a person in a hazard zone dies from a falling rock. If this (involuntary) risk is > than 10^{-5} per year, protection measures are necessary according to the stipulations of federal and cantonal authorities. At a risk between 1 x 10^{-5} to 1 x 10^{-6} per year such protection measures are desirable. The calculations show that such protection measures are necessary for 30 buildings and desirable for 19 houses. As protection of people is first priority according to the instructions of the authorities, the upper village of Adelboden has a proven protection deficit.

PLANNING OF PROTECTION MEASURES

The areal performed 3D simulation also allows a precise determination of protective measures relatively a differentiated variant study. The relatively steep terrain allows, as comparisons have shown, only rock fall protection barriers.

While planning the rock fall protection barriers, in addition to sizing parameters of 3D simulation (energies, jumping heights) also economic criteria are taken into account: To receive the federal and cantonal subsidies, protective measures must be as cost-effective as possible, that is, the benefit-cost ratio must be in the range of 1 or more. This factor is calculated from the relationship between a

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monetized risk reduction of the collective death risk and the yearly costs of a rock fall protection barrier, derived from the investment costs with the involvement of maintenance and lifespan. These calculations were made with the tools named “EconoMe”, which were created by the Swiss Federal Office of the Environment.
Furthermore an agreement had to be made with the municipality of Adelboden and the private landowners concerning the location of the individual rock fall protection barriers in the area. Questions had to be answered about landscape protection, land use or also about the protective effect under conditions of poor cost-effectiveness. The results of these investigations was that compromise solutions had to be sought in different areas. This difficult task finally resulted in a workable compromise solution, which now provides rock fall protection barriers with a total length of about 1000 m. These rock fall protection barriers have, depending on the situation, a height of between 3 and 4 m and an energy absorption capacity between 500 and 1500 kJ. Thanks to this compromise solution the project with total costs of about CHF 3.3 million was granted with a large majority in the fall of 2010 by a popular vote of the municipality of Adelboden.

REALIZATION OF THE PROTECTION MEASURES

The barriers are to be created from spring 2012. After implementation of the measures, the red and blue hazard areas in the protection of the rock fall barriers are converted into an area with so-called residual hazard. This means that the risk of rock fall cannot be ruled out entirely, leaving a residual risk. This residual risk may exist for example in large-volume fall events or consecutive strikes of several large blocks on one single rock fall protection barriers. To reduce this risk, several measurement stations have been installed in the rock walls above the village, where any movement, either on the ground by hand or from the distance periodically by laser, can be detected. Moreover the protection forest, which is very important for the village of Adelboden, will continue to be maintained to preserve the protecting function against rock fall and other natural hazards.

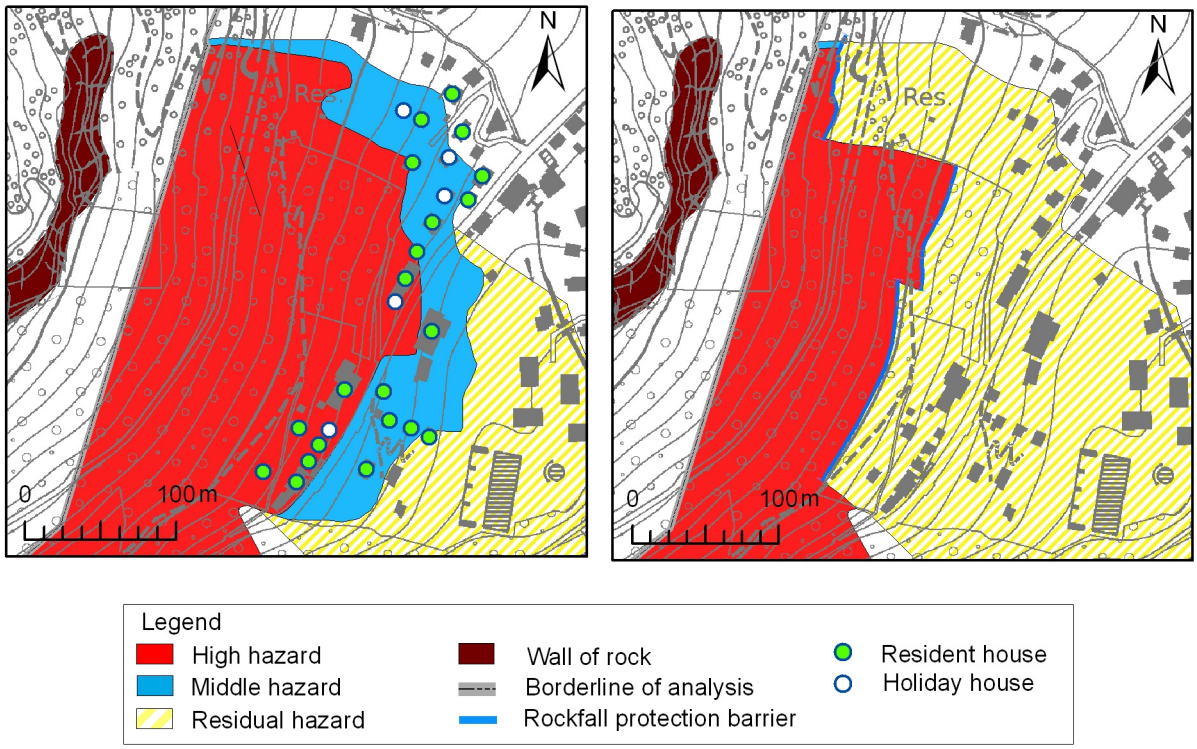

Fig. 1 Rock fall hazard map of a part of the village of Adelboden (left) and hazard map after the realization of rock fall protection barriers (right)

Keywords: rock fall, 3D simulation, natural hazard map, risk analysis