Improving the availability of mountain roads - solutions and challenges: the example of the Furka road between Hospental and Realp (Switzerland)

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INTRODUCTION

The Furka road between Hospental and Realp is situated in the Urseren Valley in Uri, Switzerland. A railway line also runs through the valley parallel to the road, connecting the Urseren Valley to the upper Rhone valley by the Furka tunnel. In winter the road is only open as far as Realp and car shuttle trains transport the vehicles through the tunnel. The average winter traffic is 1400 cars per day. The 5 km road section between Hospental and Realp is endangered by more than 25 major avalanche paths (Fig. 1). There are no structural mitigation measures. In the past the road was closed on average 4.2 days each winter because of avalanche danger. During the exceptionally snow rich winter 1999 the road was closed for 29 days. Realp, a village with 160 inhabitants, is no longer accessible if road and railway line are closed. 61 inhabitants who commute to work cannot reach their work places if the village is cut off. The residents of Realp have therefore requested for improvements in the availability of the road to the village in winter by means of several political interpellations.

AVALANCHE SITUATION AND THE PRESENT SAFETY CONCEPT

In the last 40 years more than 170 avalanches hit the Furka road - most frequently the Böschen avalanche, which hit the road 50 times. This avalanche endangers the road over a total length of 1 km. The avalanche path consists of upper and lower release areas which are separated by a flatter terrain terrace. The total drop height of the avalanche path is 500 m. The lower release area extends to the roadside. Even small snow slides hit the road. Approximately 35% of the total avalanche risk on the road between Hospental and Realp is caused by the Böschen avalanche. At present, the road safety service evaluates the weather situation and avalanche danger daily and closes the road if necessary. In addition, the release areas of the Böschen avalanche are occasionally controlled by dropping explosives from a helicopter. The analysis of the present control procedures and the risk situation shows that improvement of the availability of the road can only be achieved if the avalanche risk can be reduced.

PLANNING OF MITIGATION MEASURES IN THE BÖSCHEN AVALANCHE PATH

The Böschen avalanche represents the largest single risk to the road. First, the construction of a 850 m long snow shed was evaluated. The costs were estimated to be CHF 30 Mio. The main advantage of a snow shed is that the residual risk is negligible, but the costs are very high. A risk reduction of 84% would result, yet the effect on the road availability was estimated to be smaller than 40%. Secondly, an improvement of the artificial avalanche release concept was studied. In recent winters, helicopter blasting was operated on a more regular basis, in order to obtain more information on the effect of the artificial release of avalanches and to optimize shot placement. During winter 2012-2013, 22 avalanches were triggered artificially, thus demonstrating that avalanche control by explosives can be successful in the Böschen avalanche path. Today the most common and state of the art solution to trigger avalanches effectively is the use of fixed blasting systems. In the upper avalanche release zone four detonation points and in the lower one six points were proposed, with estimated costs of CHF 1.4 Mio. The main problem of fixed installed blasting systems is that large avalanches from the upper release zone, such as were observed in winter 2012-2013, may cause high impact pressures (>100 kN/m²) in the lower release zone. Special reinforcement of the blasting towers would be necessary for them withstand such powerful avalanches. In addition, a combination of fixed blasting systems with an avalancheur, a long-range...
gas pressure cannon, was studied. The cost was estimated to be CHF 0.65 Mio. The main challenges regarding the operation of an avalancheur are the need for a safe launching position on the one hand, and the accuracy in case of strong winds on the other. Improving the procedure for the artificial release of avalanches might reduce the risk by up to 80%, in particular for the road maintenance crew. However, the influence on road availability was estimated to be smaller than 20%. The main reasons are that the road has to be closed during the control operation and that the risk from other avalanche paths becomes decisive.

OUTLOOK
The construction of a snow shed and the installation of fixed blasting systems in the Böschen avalanche path were not considered to be economically efficient. The risk would be significantly reduced, yet the availability of the road could only slightly be improved because the remaining avalanche paths would still be uncontrolled. To improve road availability, additional snow sheds or the use of artificial release methods in more avalanche paths of the Urseren Valley would be required. The government of canton Uri decided to continue the present mitigation approach with temporary road closures in combination with helicopter bombing in the Böschen avalanche path. The presented example demonstrates that the availability of mountain roads is becoming increasingly important as residents commute to work and tourists travel to winter sport destinations. However, there is no accepted procedure at present to evaluate the economic loss caused by road closures in a benefit-cost-analysis approach. Finally, it is also a political question as to how much money can be invested in the availability of transportation lines in relatively remote mountainous areas.

LITERATURE

Figure 1. View of the Urseren valley with avalanche paths and transportation lines. The Böschen avalanche path is situated on the right close to Hospental.

KEYWORDS
case study, risk analysis, snow shed, artificial release of avalanches, availability

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