THE DÜRNSTEIN ROCKSLIDE (WACHAU, LOWER AUSTRIA)

IMPLEMENTATION OF PROTECTIVE MEASURES WHILE MAINTAINING PUBLIC TRANSPORTATION – A CASE STUDY

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INTRODUCTION

The Wachau-Danube Valley is one of Austria's oldest cultural landscapes. Since long time quarrying has substantial impact on slope morphology and slope stability. At Mt. Vogelberg near Dürnstein, gneiss was mined until early 20th century. The remaining vertical to overhanging walls were unstable which led to two major rock fall events since then. Therefore, during construction of the Wachau Railway Line in 1909, 65.000 m³ unstable rocks were removed from the ridge by blasting. As a consequence the residual rock face was destabilized which culminated in a large rockslide in spring 2009 with a total volume of approximately 15.000 m³. Rail infrastructure was totally destroyed by this event over a distance of more than 100 metres, and some smaller boulders even reached the main road B3.

OBJECTIVES

As both transportation routes crossing the rockfall run-out zone are of transregional importance, (commuter traffic and tourism in the UNESCO world heritage region Wachau), there was heavy local and politically pressure to restore the transport network as quick as possible. Therefore it was decided to structure remediate measures in three major steps: quick safety restoration by means of monitoring and warning measures, infrastructural restoration and long term stabilisation measures.

IMPLEMENTATION

Immediate rock mechanical failure analysis clearly showed that block sliding along failure planes dipping out of the slope was the main failure mode. In that case long-term stable equilibrium are typically achieved by removing potentially unstable falls and by cutting back the rock surface extensively, which means further long-lasting traffic obstructions. As this option was politically and economically difficult to achieve and historic and nature conservation directives limited measure options, a detailed slope stability analysis by means of a joint monitoring system was implemented first to optimize location, design and morphologic impact of slope stabilisation measures. To start restoration action as soon as possible, the joint monitoring system was combined with a warning system. The system consisted of seven fissurometers, measuring the opening width of cracks, 17 3-D prism targets for measurement of surface movement and two geophones. Additionally, a pluviometer was installed to check for periods of heavy rain as a triggering mechanism.

Any rock face deformation, exceeding a defined threshold, triggered the alarm lights, which resulted in road/railway track closure by local safety personnel and pre-defined evacuation action. The railway authorities and the federal government of Lower Austria were alarmed via SMS to coordinate further action. Restoration works could start and the main road B3 was reopened a few days after the rockfall event took place.

As a medium-term measure the Austrian Federal Railways decided to construct a 150-m-long and eight-metres-high protection dam between the hillslope foot and the railway track and additional

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rockfall protection kits were installed. As the dam consisted of deposited rockfall material no construction material had to be transported to or from the site. By creating this absorption bench parallel to the railway line at the foot of the rock face, the endangered runout zone was considerably reduced. During dam construction all construction machines working in the danger-zone were equipped with hazard lights, which were connected to the alarm system, enabling in time evacuation. At the same time restoration of the railway track started and the first train passed the danger-zone three months after the rockfall event took place.

Approximately half a year later a fissurometer logged rock wedge movement of approx. 700 m^3. As joint opening rate increased after each rainfall, it was necessary to remove these unstable rock masses immediately. Security blasting and removal of loose stones were carried out safely behind the dam without lengthy traffic interruption. The energy-absorbing capacity of the dam is limited to an impact of approximately 10.000 kJ. Major rockslides could easily exceed this capacity. Therefore a long-term remedial concept was designed, cutting back all unstable parts of the rock face by blasting. The projected slope design considered the fact that slope geometry is strongly influenced by geological settings, whereby discontinuity properties have the greatest control on slope stability. The overall slope angle is reduced by the inclusion of seven benches. These measures will be finished in summer 2011 with a total cutting volume of 4.500 m^3. The material will be deposited at stockpiles on site. During measure implementation the warning system will ensure safety during construction works.

CONCLUSION

By applying a combined rock monitoring/warning system, the time-span to accomplish relief measures as well as short time stabilisation measures was reduced and it was possible to re-open infrastructural lines within weeks. The combined monitoring/warning system fulfilled all requirements and was easy to implement due to its modular design. Further more the rock monitoring system gave substantial decision support for optimizing long term measures in terms of cost efficiency and accordance with historic and nature conservation directive restrictions.

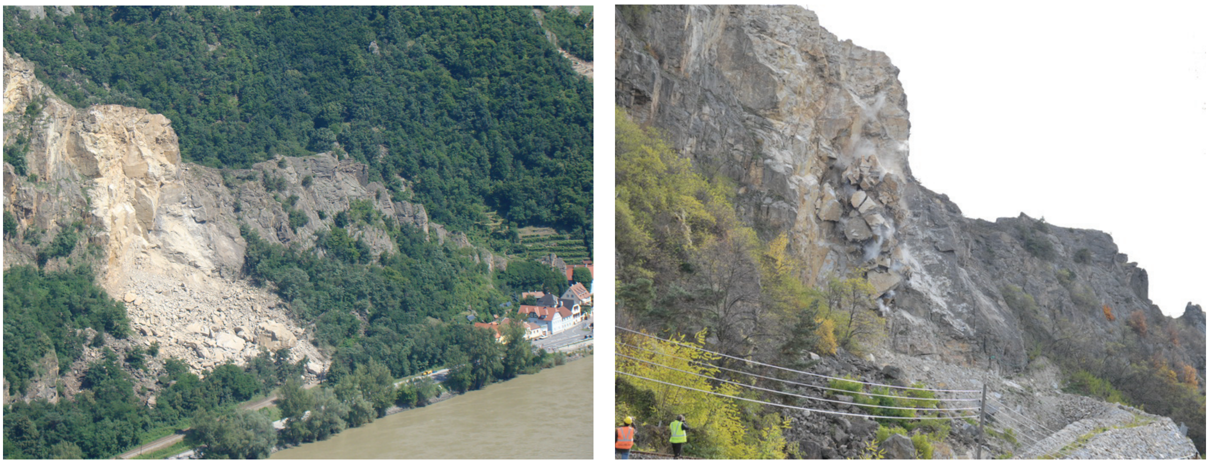

Fig. 1 The 2009 rockslide at Dürnstein (left) and blasting of an unstable rock wedge after dam construction completition (right)

Keywords: rockslide monitoring system, protection dam, security blasting, slope design