Hazard managing in Austrian ski areas

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ABSTRACT

The first decree concerning avalanche protection of cableways in Austria was published in 1975. Based on experiences and the continuous development of artificial avalanche releases, avalanche forecasting and avalanche warning, an updated Avalanche Decree was put in force 2011.

Even through the implementation of permanent technical avalanche protection measures, absolute safety cannot be achieved. The residual risk after the implementation of the permanent technical protective measures must be taken into account when planning the safety measures. The remaining residual risk must be minimized through temporary measures such as closing the ski slope or cableway shutdown. For each individual ropeway a specific assessment must be developed, and measures to minimize the residual risk in the best possible way must be provided. The Avalanche Decree regulates not only the safety for the system components but also the operational safety, guaranteeing the use and the access of a cableway under avalanche safe conditions. The regulations of the Avalanche Decree and their implementation in Austrian ski resorts will be explained in more detail using the example of the Raintal ropeway in Kitzbühel.

1. INTRODUCTION

After several serious avalanche accidents in the area of cableways, the Federal Ministry of Transport, Innovation and Technology created an Avalanche Decree for the first time in 1975 to maximise avalanche protection. According to this decree, the construction of new cableways was only permitted on sites safe from avalanches or protected by permanent protective measures. The same applied to at least one ski slope associated to the cableway (Fritz, 2011).

The avalanche expertise gained, the improvements and further developments of artificial avalanche release as well as avalanche forecasting and avalanche warning created the base for a new regulation of avalanche protection for cableways in the Avalanche Decree 2011. As experience shows absolute safety cannot be achieved with permanent avalanche structures, it is now an issue of minimising any residual risks as far as possible by implementing temporary measures (BMVIT, 2011). Therefore closures or artificial avalanche releases can be used to secure the associated ski slope, station access areas, station exit areas and rescue access. The aim is a measure or a combination of measures that minimise the residual risk as far as possible and optimise the avalanche protection. For this purpose each individual ropeway project has to be evaluated separately. Such an assessment has to be done in analogy to the hazard zone planning according to the Austrian Forestry Law 1975. This offers the advantage that experts from the Austrian Federal Service for Torrent and Avalanche Control can use a well proven assessment method for the evaluation (Fritz, 2011).

2. METHODS

Before a new cableway can be constructed, a safety analysis with regard to natural hazards has to be carried out as part of the permit procedure. If the planned cableway or the associated ski slope is not inherently avalanche safe, the applicant must prepare a so-called **avalanche protection concept** in cooperation with the local avalanche commission. This concept refers to the facilities and operational safety in the context of the Avalanche Decree. The suggested avalanche protection measures (permanent and/or temporary) are described and assessed in terms of their effectiveness. During the approval procedure the suitability of the planned protective measures requires an avalanche expert assessment by the department of the Austrian Federal Service for Torrent and Avalanche Control (BMVIT, 2011).

The **facility safety** required in the Avalanche Decree includes the structures and components of the cableway itself (mountain and valley stations, pylons, ropes). These components are not allowed to suffer any damage up to an event with a 150-year return level. This also applies outside operational times. The stations have to be installed primarily on inherently avalanche safe sites. If this is impossible the risk situation of a red avalanche hazard zone must be reduced to that of a yellow avalanche hazard zone by implementing permanent technical protective measures (BMVIT, 2011). A pressure of 10 kN/m² was defined as the limit between yellow and red avalanche zones (BMLFUW, 2016). The remaining residual hazard (corresponding to the yellow hazard zone) must be eliminated by applying additional object protection measures (e.g. reinforced side walls). The pylons must be dimensioned to resist the calculated avalanche and snow pressures. The rope guide has to be designed in such a way to prevent the rope from being dropped as a result of an avalanche (BMVIT, 2011).

Operational safety refers to the safety to be ensured for persons (passengers and staff) when operating the cableway or using the direct station entrance and exit areas. In addition, rescue operation for blocked systems have to be possible under avalanche safe conditions. It also must be possible for skiers to use the cableways ski slope under avalanche safe conditions. To ensure this operational safety, temporary safety measures can be used in addition to permanent safety measures (BMVIT, 2011). According to the Avalanche Decree guidelines, the sole blocking of the ski slope as a safety measure is not permitted for frequent avalanches with a 30-year return level (BMLFUW, 2011).

For replacement or modification of already existing ropeways, it is possible to invoke a specific **exceptional procedure** (not further discussed in this paper).

3. RESULTS

In the following section, you will find a practical example for the application of the Avalanche Decrees regulations. For this purpose the new construction of the 10 EUB Raintal by Bergbahn AG Kitzbühel was selected. The new Raintal ropeway will replace the old chairlift "Raintal". The lifts location and length have been redefined.

3.1. Facility safety according to Avalanche Decree

3.1.1 Stations

The planned **mountain station** will be built on the ridge of the Kitzbühler Horn. According to the Avalanche Decree terms this site is classified as inherently avalanche safe, so no measures are required.

Above (north of) the planned **valley station** there is a 170 m high, south-facing slope with an inclination between 30 and 34 degrees. Avalanche simulations with the numerical model RAMMS show the planned valley station being overflowed by avalanches from the largest release area AG 03 (Figure 1). The avalanche pressures in this area represent an endangerment in the form of a red hazard zone with a pressure of more than 10 kN/m² (Figure 2).

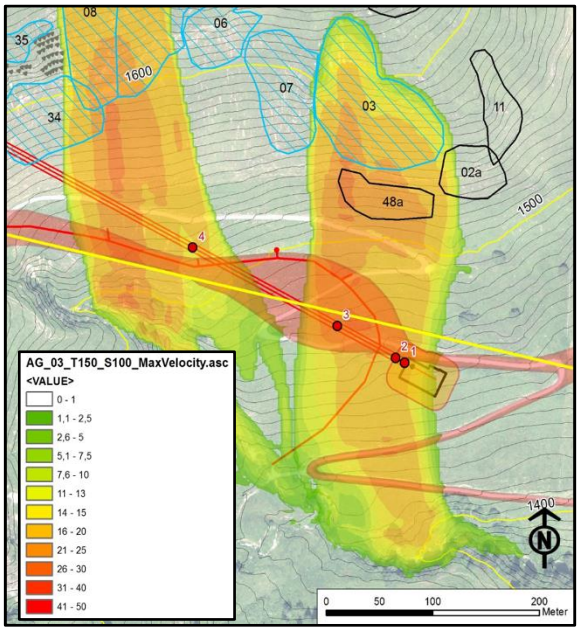

Figure 1: Maximum flow velocity for release area AG 03 (blue polygon) modelled with RAMMS. Release areas for snow glides are marked in black. The new Raintal ropeway, its valley station and the according ski slope is marked in red. The yellow line shows the old chairlift "Raintal" (Illmer, 2018).

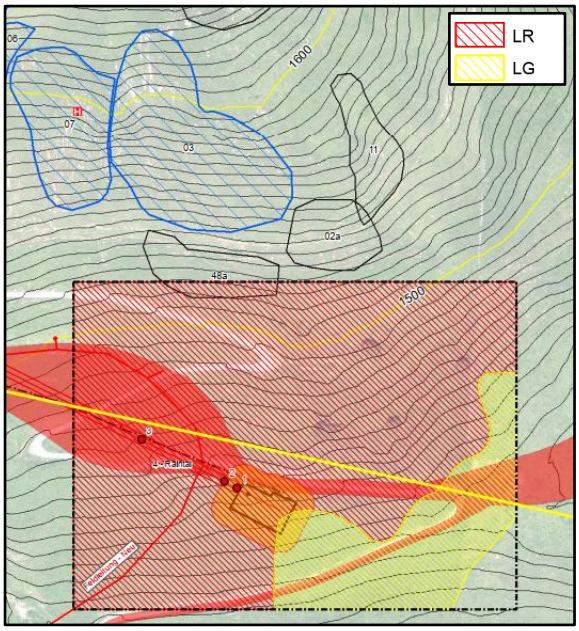

Figure 2: Hazard zone map for the valley station including the red (pressure ≥ 10 kN/m²) and yellow avalanche hazard zones (Illmer, 2018).

In order to protect the planned valley station, release area AG 03 was secured through permanent avalanche barriers (Figure 3). From the smaller release areas (AG 48a and AG 02a) local snow slides still occur in warm weather conditions. The danger level can be minimized by a terrain modification next to the valley station.

3.1.2 Pylons

As the new cableway line diagonally crosses the slope, snow pressure from sliding and creeping movements act on the planned pylons. The forces were calculated for each individual pylon according to the specifications of the Austrian Standards Institute (ONR) 24805 (2010). Detailed avalanche simulations were performed and evaluated for pylons affected by avalanches (analogous to Figure 1). Based on dense flow avalanche intensities and the position of the pylons in the avalanche path, pressures and impact heights of powdered snow were calculated in accordance to ONR 24805 (2010).

Figure 3: Support structure to protect the valley station built in the release area AG 03 (KitzSki, 2019)

Figure 4: Elevated and wedge-shaped foundations to protect the pylons against flow avalanches (KitzSki, 2019)

These snow and avalanche pressures had to be considered as separate load cases in the pylons structural analysis. For those pylons with high impact pressures from the dense flow avalanche, the foundations were elevated and built wedge-shaped towards the avalanche impact direction (Figure 4). This way the largest pressures can be transferred directly to the foundation.

3.1.3 Rope guide

Since no rope shedding may occur as a result of an avalanche up to the size of the design event, the powder snow heights and pressures from the powdered layer along the rope line was calculated in accordance to ONR 24805 (2010) and to the Avalanche Decree guidelines. If the rope line (height of the rope) is reached by a powder snow avalanche, the pressure has to be considered by the cableway manufacturer. In our case, powder snow avalanches only reach the height of the rope guide in the area of pylon number four. This effect was considered by the manufacturer during planning.

3.2. Operational safety according to Avalanche Decree

3.2.1. Access of the new ropeway

The planned ropeway is located in the developed ski area and is safely accessed via the inherently avalanche safe mountain station, therefore no further measures were required.

3.2.2. Station entry and exit areas

The mountain station entrance and exit area is inherently safe from avalanches. The valley station is now secured by supporting structures. However, a yellow hazard zone at the northern side remains due to the two snow slide areas. This residual risk is covered by temporary measures such as the preparation of a snow wall with grooming equipment.

3.2.3. Rescue in the case of an immovable system

As a requirement for any rescue the systems avalanche safety must be guaranteed. The assessment of avalanche safety has to be carried out by the local avalanche commission. If necessary, this commission recommends appropriate measures to be taken by the lift operator. The safety required to rescue the Raintal ropeway is ensured by artificial avalanche release

(temporary measures). Therefore, two avalanche blasting masts have been installed to be used in combination with the helicopter-based "Daisy Bell" system.

3.2.4. Associated ski slope

The ski slope from the mountain station to the valley station is endangered by avalanches in several areas. The slope is secured with temporary avalanche protection measures, e.g. helicopter blasting, manual blasting or rolling with a groomer. Also the already existing avalanche blasting cableway will be used further on.

4. CONCLUSIONS

The avalanche safety of a new cableway and at least one associated ski slope is an essential requirement for a cableway license or permit. The applicant has to prepare a so-called avalanche protection concept, if the planned cableway or the associated ski slope is not inherently avalanche safe. The involvement of the local avalanche commission in the development of the avalanche protection concept is an important part. In the context of the avalanche decree the facility and the operational safety must be assessed in detail. Furthermore appropriate avalanche protection measures (permanent and/or temporary) have to be planned and evaluated in terms of their effectiveness. A very central part of the license procedure is the suitability assessment of the proposed avalanche protection measures. This is done by the Austrian Federal Service for Torrent and Avalanche Control. Such an assessment has to be done in analogy to the hazard zone planning according to the Austrian Forestry Law 1975. Due to consistent compliance to the strict regulations of the Avalanche Decree 2011, a very high level of avalanche safety has been achieved in Austria’s ski resorts.

REFERENCES

BMLFUW, 2011: Leitfaden für die Anwendung durch die Lawinensachverständigen des Forsttechnischen Dienstes für Wildbach- und Lawinenverbauung. Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, Stubenring 1, 1010 Wien

BMLFUW, 2016: Richtlinie für die Gefahrenzonenplanung in der Wildbach- und Lawinenverbauung. Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, Stubenring 1, 1010 Wien

BMVIT, 2011: ERLASS des Bundesministers für Verkehr, Innovation und Technologie betreffend den Lawinenschutz im Bereich von Seilbahnen (Lawinenerlass 2011). BMVIT – IV/SCH3 (Oberste Seilbahnbehörde), Radetzkystraße 2, 1000 Wien

Fritz S., 2011: Lawinenschutz neu geregelt. Neuer Erlass des bmvit betreffend den Lawinenschutz im Bereich von Seilbahnen (Lawinenerlass 2011). Bundesministerium für Verkehr, Innovation und Technologie, Radetzkystraße 2, 1030 Wien

Illmer D., 2018: Lawinenschutzkonzept gem. Lawinenerlass 2011 für die 10 EUB Raintal inklusive zugehöriger Pisten, Industriegelände Zone C 11, A-6166 Fulpmes

KitzSki, 2019: Bautagebuch in Bildern. Bergbahn Aktiengesellschaft Kitzbühel Hahnenkammstraße 1a, 6370 Kitzbühel, www.kitzski.at

ONR 24805, 2010: Permanenter technischer Lawinenschutz - Benennungen und Definitionen sowie statische und dynamische Einwirkungen. Austrian Standards Institute, Heinestraße 38, 1020 Wien