Cold Regions Science and Technology 85 (2013) 175–182

Contents lists available at SciVerse ScienceDirect

Cold Regions Science and Technology

journal homepage: www.elsevier.com/locate/coldregions

A new experimental snow avalanche test site at Seehore peak in Aosta Valley (NW Italian Alps)—part I: Conception and logistics

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ARTICLE INFO

Article history:
Received 29 March 2012
Accepted 4 September 2012

Keywords:
Avalanche dynamics
Small and medium avalanches
Experimental site
NW Italian Alps

ABSTRACT

Experimental test sites are important to understand the physical flow processes occurring within an avalanche. They can be at different scale: laboratory or real scale. In Europe, a dozen of real-scale test sites have been realized, though at present only a few of them are still operative. The primary goal is to measure avalanche dynamical variables under controlled conditions. Not all the observed phenomena have been fully understood yet and more work is needed especially regarding small to medium avalanches.

The aim of this paper is to present a new experimental test site at a real scale in order to study specific topics: the dynamics of small and medium avalanches, the avalanche release processes and the interaction between avalanche flows and obstacles.

The test site, called Seehore, is located in Aosta Valley in the North-western Italian Alps. The slope, with an elevation difference of about 300 m (from 2300 to 2570 m asl), has a mean slope angle of about 28°. Avalanches are artificially released on a routine basis to secure the ski-runs, as the site is located within a ski resort (Monterosa Ski); they are usually dense slab avalanches of small or medium size, but also a powder cloud may occasionally form. The site is instrumented with a steel obstacle, described in details in a companion paper, which measures the effects of avalanches impacting on it. Before, during and after each artificial release physical properties of the snow in the avalanche release, track and deposition zones are recorded; front velocity, erosion and deposition mass are estimated by field surveys or by videogrammetry and terrestrial laser-scan measurements.

1. Introduction

Measurements and observations from experimental test sites have improved our understanding of avalanche flow. Experimental test sites can be at different scales: at laboratory scale or real scale.

One of the first well documented avalanche test sites at laboratory scale was the snow chute placed in 1956 alongside the Swiss Federal Institute for Snow and Avalanche Research at the Weissfluhjoch in Davos. The chute was constructed to facilitate the practical study of dynamic processes. Experiments with the snow chute illuminated the flow behavior of snow over short distances, the compression forces that arise upon collision with rigid obstacles, and the retardation effect of flexible obstacles (Salm, 1964).

At laboratory scale, the easiness of following the “ideal avalanche flow” allows the researcher to measure, under controlled situations, specific variables, such as flow velocity profiles, flow heights and densities, basal friction, impact pressures on obstacles of different shape (e.g. Barbolini et al., 2005; Faug et al., 2002; Hauksson et al., 2007; Tiefenbacher and Kern, 2004). However, in those experimental sites the scale factor has to be taken into account when transferring the results to the real scale (Lang and Dent, 1980).

The experimental sites at real scale, instead, allow the measurements of real avalanche events, but have the disadvantage of more complex logistics and more expensive engineering. Sommerhalder (1967) describes the first mechanical velocity measurements of a real avalanche flow taken in the 1960s at the Mettlenruns test site in Switzerland.

After those first measurements, in Europe other experimental test sites have been equipped to study avalanche dynamics. Jóhannesson et al. (2006) describe the eleven different experimental avalanche test sites at real scale present in Europe at the time of publication: Col du Lautaret and Taconnaz in France, Núria in Spain, Ryggfonn in Norway, Vallée de la Sionne, Val Medel and Mettlenruns in Switzerland, Monte Pizzac in Italy, Grosser Gröben and Schnannerbach in Austria, Flateyri in Island. At present, only few of them are still operative, where either spontaneous or artificially triggered avalanches are studied.

All data recorded in the experimental sites are first used to understand the physical processes within an avalanche flow and then to

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http://dx.doi.org/10.1016/j.coldregions.2012.09.006

calibrate dynamic models that describe the flow behavior through equations. One of the first attempts to formulate a theory of avalanche motion was made by Voellmy (1955), and his theory is still widely used. Empirical procedures including statistical and comparative models for runout distance computations, as well as dynamics models for avalanche motion simulations, are now in existence. However, no general model has so far been developed. The limited amount of data available from real events makes it hard to evaluate or calibrate existing models. Several models with different physical descriptions of the avalanche movement can be used to replicate the information contained in the available recorded observations (Barbolini et al., 2007).

Therefore, the continuous implementation of the existing test sites and the development of new tests addressing specific research questions are necessary to go deeply into the avalanche dynamics and to understand all the physical processes not yet completely understood (i.e. erosion and deposition processes along the path, release processes, powder avalanche formation).

A new experimental test site at a real scale has been developed in Aosta Valley in the North-western Italian Alps in order to address specific research topics:

- dynamics of small and medium avalanches (EAWS, 2003);
- avalanche release processes;
- interaction between avalanche flows and obstacles.

The new test site is managed in order to study artificially released small and medium avalanches, while the majority of the existing sites refer to large avalanches.

This paper describes the new test site, starting from its location, morphology, snow and climate conditions, to the logistics of an avalanche experiment and it supplemented by a companion one from the same research team, which describes in details the instrumented obstacle placed in the avalanche track, in order to measure the effects of the avalanche impact on it (Barbero et al., submitted for publication).

2. Description of the site

The table in the Annex 1 summarizes the characteristics of the Seehore test site, following the layout used in Jóhannesson et al. (2006) for the other European test sites, allowing an easier comparison.

The test site belongs to the authority Regione Autonoma Valle d'Aosta and is operative since winter 2009–2010, whereas the instrumented obstacle is operating from the winter season 2010–2011.

2.1. Location

Seehore test site (45°51′05″N; 07°50′34″E) is located at the head of the Lys Valley, near the village of Gressoney-La-Trinité in the Aosta Valley, on the Monte Rosa Massif in the North-western Italian Alps. The test site is included in the Monterosa Ski resort and it is one of the slopes where avalanches occur naturally and may reach the ski-run that crosses the bottom of the slope (Fig. 1). Therefore, it is a routine to artificially release the avalanches after critical new snow amount has been reached and/or snow drift occurred in order to guarantee the safety of the ski-runs.

2.2. Morphology

The slope, with an elevation difference of about 300 m (from 2300 to 2570 m asl), has a mean slope angle of about 28° and a NNW aspect

Fig. 1. Winter view of Seehore peak from North-East. The test site is the slope in the shadow where an avalanche, reaching the ski run, is well visible (photo: A. Welf). The insert shows the geographical location of the test site.