MONITORING OF TACONNAZ AVALANCHE PATH : PRESSURE AND VELOCITY MEASUREMENTS ON BREAKING MOUNDS

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CONTEXT

The Taconnaz avalanche path is located in the Arves valley, close to Mont Blanc in France. During the last century, several large dense and mixed avalanches (dense core covered by a powder layer) occurred on this path, on several occasions reaching the inhabited areas. The immensity of the starting zone is the chief characteristic of the path. The historical records show that the difference between the maximum and minimum runout distances is >1000 m. The avalanche release can be due to serac fall. The Taconnaz path is 7 km long, has a mean slope of 25° and a mean width of 300–400 m. The permanent avalanche survey has been organized by the French Forest Service since the beginning of the 20th century. The collected data contain qualitative and quantitative information (release and runout, altitudes, mean length, mean width and mean thickness of the deposits in the runout zone). Between 1900 and 2000, 75 events were surveyed. In February 1999, a mixed avalanche overflowed the defence system built up in 1991, showing the limits of this defence structure. The local municipalities decided to improve the system. Both dense and powder avalanches have to be considered : the defence structure must retain dense avalanches up to the centennial event and reduce the pressure developed by the powder part. The available historical data were back-analyzed using an avalanche-dynamics numerical model and a 100 year return period event was determined not only in terms of volume but also in term of Froude number F (F is defined as the square root of the ratio between the kinetic and the potential energies). Physical and numerical models of dense avalanches interacting with defense structures are combined in order to design the most effective passive structures able to contain centennial events (mainly new mounds at the entry of the run-out zone instead of deflecting wall and increase (from 14 m to 25 m) of the retention dam (Naaim et al., 2010).

PRESSURE AND VELOCITY MEASUREMENTS ON BREAKING MOUNDS

Such measurements aim at better understanding the dynamics of avalanche flow over and around breaking mounds, estimating the run-out distance reduction, and determining impact forces (particularly dynamic drag coefficients) at large scale for natural avalanches. This measurements are complementary to those conducted on the Lautaret avalanche test site (France / Cemagref) at intermediate scale and on Aosta Valley avalanche test site (Italy, Regione Autonoma Valle d'Aosta) at small scale. The challenge consists in measuring pressure (until 100 tons/m^2) and velocity (until 60 m/s) on three mounds with data synchronization lower than 0.1 s. These values correspond to the centennial event. Sensors and data loggers, which have to resist low temperatures (down to -30°C), are not accessible during winter due to the dangerousness of the path. Moreover, as the avalanches are not artificially released, the path must be monitored during all the winter season and an automatic detection of events, taking into account electronic noise or sensors drift, must be designed. It was done in the framework of the European project DYNAVAL (INTERREG ALCOTRA) with a cofinancing from General Council Haute-Savoie

For the force measurements, we used transducers based on extensometry gauges, which has the advantages of preserving low frequencies and temperature compensation. We determined the optimal sampling frequency by determining stiffness coefficients for the sensors and sizing the bandwidth of

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the expected signals. Two sensors are set up on each mound. For the velocity measurements, we employed a measurement principle widely used in the avalanche research community (Dent et al. 1998), which they implemented in two previous experiments at Col du Lac Blanc and Col du Lautaret. The measurement principle is based on the correlation of two signals produced by infrared reflection sensors aligned in the direction of the flow. These measurements lead to sample at 100 kHz per channel. Two sensors are set up on each mound.
To build a rugged and reliable measurement system able to withstand extreme mountain conditions, we selected three CompactRIO chassis equipped with a controller and NI 9239 and NI 9215 analog input modules. Each CompactRIO chassis is integrated in the console with leak-proof connections. In addition, LabVIEW software controls and synchronizes the data recorders through a digital link distributed by NI 9472 modules. We buried three CompactRIO signal acquisition modules in a protective chamber close to sensors at the foot of three breaking mounds on the avalanche path. The three modules are interconnected by an Ethernet network that is also accessible outside the device in an underground chamber approximately 300 m to away. This remotely-linked point allows us to consult the modules, configure them, and download acquired data. The modules permanently record pressure and velocity signals in a circular memory allowing a data recording for 60 s. During detection of an avalanche event on the pressure sensors, the CompactRIO and LabVIEW system automatically saves the data record 60 s prior to and 120 s after the event. When an event is detected by one of the modules, it makes a request via the Ethernet network to the module on mound five to generate a digital signal via an NI 9472 module. This signal received by the three modules allows the team to resynchronize the specific signals recorded by each module. The automatic triggering system and the sensors have operated satisfactorily during the avalanche event of December 29, 2010.

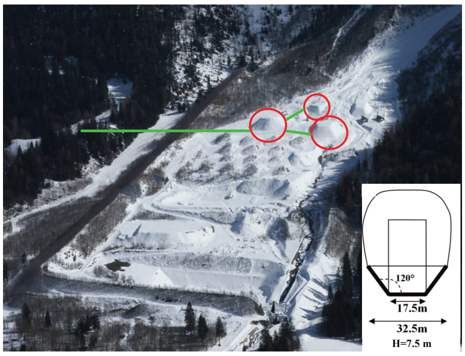

Fig. 1 The three mounds equipped with velocity avalanche and pressure sensor with a schematic view

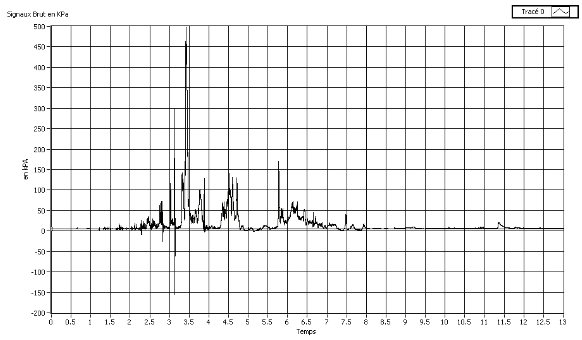

Fig. 2 Example of pressure recorded during the event of December 29, 2010 : first of a of mound

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