The Remote Monitoring of Avalanche Activity

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ABSTRACT

Observing and recording avalanche activity is one of the most important factors when assessing snow stability and preparing a forecast. This information is critical for the optimum timing of road closures, explosives control and reopening of avalanche zones. Observing this avalanche activity can be a problem as it requires manpower and time. In remote areas or operations with numerous avalanche paths, this can be impractical if not impossible. Poor visibility or darkness can also hinder the accurate assessment of avalanche control results.

The following paper outlines a two year project aimed at developing a remote system of avalanche detection which will provide down avalanche information in real time.

INTRODUCTION

The Trans Canada Highway is the main artery for vehicle traffic through the Western Canadian mountains. Forty kilometers of this road travels through Rogers Pass, where 134 separate avalanche paths with multiple starting zones affect the route. Temporary road closures are frequent here during the winter months, each one affecting the commerce of several provinces. It has been estimated that a typical two hour closure will result in $50 000 of direct costs to stopped vehicles alone (Morrall, 1992).

The need for a remote telemetry system indicating down avalanches and hopefully streamlining the timing of road closures was expressed in 1994 by the Snow Research Avalanche Warning Section (SRAWS) in Rogers Pass, BC. Over the winters 1994/95 and 95/96, the authors undertook a project to develop a technology which would give real time indication of avalanche activity, be durable enough to withstand impact forces, would reset itself to monitor multiple cyclic events throughout the season and require minimal maintenance.

The system was built by Mountain Watch Inc. and named the Avalanche Track Monitoring System (ATMS). The ATMS was installed in Cougar Corner #6 (CC#6) at Rogers Pass, an indicator path where conditions are considered to be representative of the snow stability in surrounding terrain. The information obtained was then used in combination with other standard forecasting parameters to produce stability evaluations and forecasts.

- Working on contract to Mountain Watch Inc.

METHODOLOGY

The sensor was located high in the track of the avalanche path. It was suspended by a cable which hung from an aerial line tensioned 10 meters high between mature trees on either side of the track. This suspension cable could be raised or lowered to account for the potential buildup of avalanche debris. A two strand signal wire was intertwined with the 1/8 inch steel suspension cable, connecting the sensor with a Campbell Scientific CR10 datalogger and a radio located safely to the side of the track.

The sensor was a PVC encased one piece mechanical accelerometer with a weighted 1.5 meter PVC type 1 wand attached underneath. The accelerometer measured snow movements by the deflections of angle off vertical of the suspended wand. Avalanches striking the wand would deflect the sensor beyond a predetermined angle, thus triggering an alarm. The signal was generated as a dry contact closure and sent to the datalogger/radio via the signal wire. The alarm was a 15 second tone transmission on a radio frequency and a time/date print within the datalogger.

Deflections were monitored in the downslope axis only. An adjustable switch was used to set the optimum angle of trigger for that particular site. Options were 30, 60 or 90 degrees off vertical, which would prevent site dependent variables such as wind gusts from triggering the alarm.

A signal conditioner module was located at the datalogger/radio site. This functioned in detecting the switch closure at the sensor, flagging this event within the datalogger and then powering up the radio transmitter to send an alarm tone. The datalogger was used only for research purposes to confirm exact avalanche times. The sensor and signal conditioner required no power of their own to operate in the sleep mode. The entire system derived it's excitation power from the load carried in the datalogger/radio to flag avalanche events. This was a 12v battery and was continuously available to the signal conditioner since an event may happen at any time.

RESULTS

The first installation of this sensor occurred on January 21, 1995. The angle of deflection was set at 60 degrees and the base of the wand was approximately 2 meters above the ground. During the next avalanche cycle CC#6 produced two avalanches, the second of the two being the largest. The sensor indicated only the larger avalanche. Subsequent to this, the angle of deflection was changed to 30 degrees and the wand height lowered to 1.5 meters above the ground in the hopes of not missing the smaller, but equally important events.

Two more significant avalanche cycles occurred that season, with CC#6 producing a total of 6 more avalanches, ranging from size 1 to 3. The sensor indicated each event, and in one instance awoke the Forecaster during the night who was anticipating the cycle and had set various closure parameters before going home.

Based on the successful results of the first season, CC#6 was again instrumented for the 1995/96 winter season. Results from this winter were variable, with several problems being identified and corrected. Durability was an issue as a large avalanche early in the season snapped the PVC wand in half and ripped apart one of the connectors in the signal wire. This was repaired, but soon after the radio began transmitting a continuous tone which rendered the ATMS inoperable. Another field trip revealed a stuck switch within the sensor which was easily repaired, however this continuous transmission had drained the radio batteries which needed replacement.

After these repairs were made, the sensor successfully detected several avalanches before the season came to a close. It became apparent this season that repairs to the sensor mid winter were quite serious, requiring a climb directly up the avalanche path and working directly under the starting zone for several hours.

CONCLUSION

The original objective of developing a remote sensor which gives real time indication of avalanche activity and automatically resets to monitor multiple cyclic events was successful. Further development remains in the areas of durability and low maintenance throughout the winter.

Future plans are to eliminate all PVC components and replace them with high strength aluminum. Exterior connections on the signal wire between sensor and datalogger will be eliminated and housed within the sensor. Finally, a non working radio frequency should be used during the testing of the device to eliminate the possibility of disrupting the workplace should a malfunction occur.

The potential of this device is wide ranging, from monitoring a single avalanche path on a remote stretch of highway to an array of sensors throughout a single operation, linked with telemetry to a central computerized alarm system. Future development of this device will allow it to reach it's full potential of remotely indicating down avalanches.

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