A PRACTITIONER'S TOOL FOR ASSESSING GLIDE CRACK ACTIVITY

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Glide cracks can result in full-depth glide avalanche release. Avalanches from glide cracks are notoriously difficult to forecast, but are a reoccurring problem in a number of different avalanche forecasting programs across a range of snow climates. Despite this, there is no consensus for how to best manage, mitigate, or even observe glide cracks and the potential resultant avalanche activity. It is thought that an increase in the rate of snow gliding occurs prior to full-depth avalanche activity, so frequent measuring of glide crack movement provides an index of instability. Therefore, a comprehensive avalanche program with glide crack avalanche activity, should at the least, undertake some form of direct monitoring of glide crack movement.

In this paper we present a simple, cheap and repeatable method to track glide crack activity using a series of stakes, reflectors and a laser rangefinder (LaserTech TruPulse360B) linked to a GPS (Trimble Geo XH). We tested the methodology in April 2010, on a glide crack above the Going to the Sun Road in Glacier National Park, Montana, USA. This study suggests a new method to better track the development and movement of glide cracks. It is hoped that by introducing a workable method to easily record glide crack movement, avalanche forecasters will improve their understanding of when, or if, avalanche activity will ensue. Our initial results suggest that these new observations, when combined with local micro-meteorological data will result in improved process understanding and forecasting of these phenomena.

1. BACKGROUND AND PREVIOUS METHODS

Glide avalanches are difficult to predict and yet seem to be a reoccurring problem for many operations (e.g. Reardon et al., 2006; Simenhois and Birkeland. 2010). Previous work has indicated that there are some typical preconditions:

- Smooth surface at the bottom of snowpack
- Temperature at the bottom of snowpack must be at 0ºC
- Free water exists at the bottom of the snowpack
- Slope angle at least 15º for typical alpine ground surface

The rate of gliding is sensitive to the amount of water at the interface. Rainfall or heavy snowmelt increases glide activity by reducing friction at the interface. Increased rate of snow gliding is thought to occur prior to full-depth avalanche activity (Clarke and McClung, 1999). Therefore, measurement of the rate of gliding should help in forecasting these events.

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Previous work has tried a range of methods to measure creep and glide, with the most popular being tension or strain gauges / recording potentiometers (Clarke and McClung, 1999) or acoustic sensors (McClung and Schaerer, 2006) . Previous work has shown that the acoustic signal is very strong prior to release of full depth avalanche activity by gliding

2. OUR METHODS

Our method used a laser rangefinder which enabled measurement of the glide cracks from a distant location. The laser rangefinder is a small, portable device that sends out a laser to a reflective surface and returns the vertical distance, horizontal distance and azimuth. The manufacture specified accuracy in the measured metrics are: Range ± 0.3 m, Compass accuracy ± 1.0 degree, Inclination accuracy ± 0.25 degrees, and a maximum range of 1000m under typical conditions and 2000m to a reflective target. The laser range finder is linked wirelessly (Bluetooth compatible) to a Trimble Geo XH GPS unit with sub-meter accuracy.

The following is a simple experimental methodology that permitted measurement and tracking of glide cracks (Figure 1):

- Found safe location to view glide crack
- Measured initial crack dimensions
- Installed stakes with reflectors above and below crack
- Measured distance using range finder in X, Y, and Z
- Linked observations to GPS

We measured Z to allow measurements from different locations which, in turn, allowed for more flexible repeat observations. To reduce the error in the measurement of the stakes, we attempted to stay as close to the target as possible without standing on the slope of interest. However, observations were also made from positions further away (e.g. the road below).

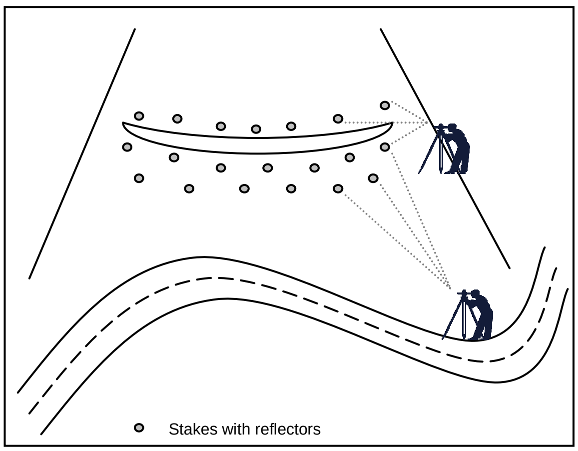

Figure 1: Schematic of the methodology showing the slope with a glide crack, the stakes with reflectors and the potential different measurement locations.

3. RESULTS

This methodology has great promise to provide further insight into glide crack behavior. The laser rangefinder was compact, portable and easy to use in the field. The direct wireless link into the GPS was convenient and allowed for the observer to measure the glide crack from different observation locations.

Tests on the range finder and GPS indicated that the GPS is generally the limiting factor for sub decimeter accuracy. Other limitations of the method included the need for adequately sized reflectors on the stakes and an operating range of approx 500m with the size reflectors we used.

Unfortunately, due to limited glide crack activity this season because of glide cracks melting in situ, insufficient observations were made to truly assess the robustness of the proposed methods. However, we believe the method has potential and we will attempt to repeat the experiments in the 2010/11 winter and spring.

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DISCLAIMER

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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