CHANGES IN STABILITY TEST USAGE BY SNOWPILOT USERS

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ABSTRACT: Professionals and recreationists utilize stability tests to assess snow stability. Our goal is to determine whether or not people are changing the types of tests they conduct. We utilized the SnowPilot database of over 3,600 snow pits from nine winters, with about 83% of these pits being dug by avalanche professionals. We found a dramatic shift in the tests conducted since 2004. SnowPilot users have moved away from rutschblocks and stuffblocks and moved more toward extended column tests (ECTs) and propagation saw tests (PSTs), while still conducting a large number of compression tests (CTs). ECTs are now the most popular test, being conducted in nearly 80% of all pits. Not surprisingly, this shift toward ECTs and PSTs has coincided with an increasing emphasis on the importance of propagation potential in our stability assessments. As we learn more about snow and the way it fractures, newer and more effective tests might well be advanced. Our results demonstrate that our community will quickly adopt new tests when they are useful and scientifically validated.

1. INTRODUCTION

Professionals and recreationists utilize stability tests as a primary tool for evaluating snow stability on suspect slopes. These tests aim to evaluate avalanche potential by testing small blocks of snow cut out of a snow pit. The development of different tests in recent years has added new tools to our toolbox. The goal of this paper is to determine whether or not people are changing the types of tests they conduct for their stability assessments.

2. METHODS

To do this we utilized the dataset from SnowPilot, a free software program that allows many different users to enter, graph, and database their snow pits at www.snowpilot.org [*Chabot, et al.*, 2004]. These data have been used for several past studies [e.g., *Birkeland and Chabot*, 2006; *Simenhois and Birkeland*, 2009]. The advantage of SnowPilot is that it allows us to collect a great deal of data from diverse sources in all snow climates at a low cost. The data come from all over the U.S. and from several different countries, including Canada, New Zealand, Norway, and Sweden. The disadvantage of SnowPilot is we cannot test whether or not our data are statistically representative of all people doing stability tests. Indeed, there is certainly a bias toward users from the United States, and certain groups or geographic areas within the U.S. are likely over-represented. However, it is still interesting to see the trends that exist in these data. Our study uses over 3,600 snow pits from nine winters, and about 83% of these pits were dug by people who identified themselves as avalanche professionals.

3. RESULTS AND DISCUSSION

There have been some fairly dramatic shifts in the tests preferred by SnowPilot users since 2004 (Figure 1). In the following we summarize the trends for each of the tests:

Compression tests (CTs). Compression tests involve isolating a 30 cm by 30 cm block, placing a shovel on top of it, and tapping the shovel vertically with progressively stronger taps until the weak layer fails [*Greene, et al.*, 2010; *Jamieson*, 1999]. By the time our data start in 2004, CTs were well-established, having been used for over 30 years in some areas. The data clearly show their consistent popularity, with users conducting CTs in about 75% of all pits in 2004. Peak CT use occurred in 2007 (85% of pits), but they continue to be popular today, being used in over 65% of pits.

Rutschblock tests (RBs). Originally developed in Switzerland, Rutschblock tests involve isolating a 2 m by 1.5 m block and having a person on skis progressively load the block [*Föhn*, 1987; *Greene, et al.*, 2010]. Though the test of choice for some U.S. avalanche professionals, RB usage peaked

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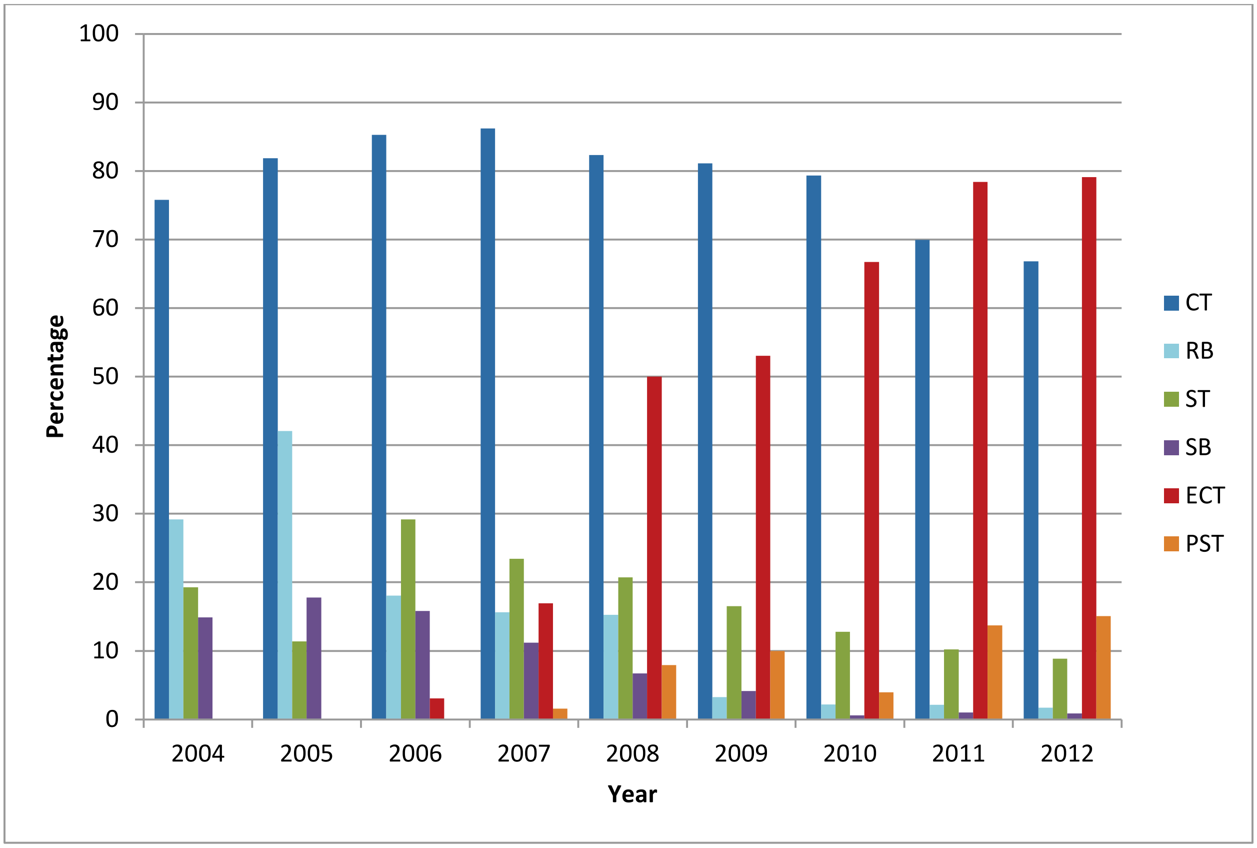

Figure 1: Changes in usage of various stability tests in the SnowPilot database. Percentages represent the percentage of the time a test was used in all the snow pits submitted to SnowPilot during the preceding winter (i.e., 2007 represents the 2006/2007 winter) (CT = compression test, RB = rutschblock test, ST = shovel shear test, SB = stuffblock test, ECT = extended column test, PST = propagation saw test).

in 2005 when they were conducted in a little more than 40% of the SnowPilot pits. Since then RB usage has dropped steadily, and in 2011/2012 they were used in less than 2% of the pits.

Shovel shear tests (STs). Shovel shear tests have been around longer than most of us old grey hairs can remember; they were the test of choice in the U.S. at least as far back as the 1970s and 1980s. STs involve isolating a 30 cm by 30 cm block, inserting your shovel behind, and pulling in a slope parallel direction until the block fails on a weak layer [*Greene, et al.*, 2010]. In our data, ST usage peaked in 2006 when they were used in almost 30% of the pits. Since then their use has declined steadily to less than 10% this past season.

Stuffblock tests (SBs). Stufflocks are a variation of the CT. The same 30 cm by 30 cm block is isolated, but instead of loading the block with taps, a stuff sack filled with snow is dropped from known heights until the weak layer fails [*Birkeland and Johnson*, 1999; *Greene, et al.*, 2010]. The idea is to better standardize the force being applied to the block. SBs gained popularity in some areas of the U.S. in the 1990s, but in our data we can see their steady decline in usage since their peak in 2005, when they were conducted in about 18% of SnowPilot pits. By 2011/12 they were used in less than 1% of the SnowPilot pits.

Extended Column Tests (ECTs). Extended Column Tests aim to test fracture initiation and fracture arrest by isolating a column that is 90 cm wide and 30 cm upslope and then tapping one side of the block [*Greene, et al.*, 2010; *Simenhois and Birkeland*, 2009]. Along with the Propagation Saw Test (see below) the ECT was the first to specifically try to index the propensity of a crack to propagate. The ECT was introduced to the avalanche community at the 2006 International Snow Science Workshop in Telluride, and has been extensively studied and tested in several countries since that time [e.g., *Moner, et al.*, 2008; *Ross and Jamieson*, 2008; *Winkler and Schweizer*, 2009]. The ECT was first implemented in SnowPilot in the 2006/2007 season. The popularity of the ECT has risen steadily since its introduction, and it has become the most popular stability choice in SnowPilot pits in the past two years, being conducted in almost 80% of the pits.

Propagation Saw Tests (PSTs). The propagation saw test involves isolating a block 30 cm wide and varying length (but at least 100 cm) upslope [*Gauthier and Jamieson*, 2008a; 2008b; *Greene, et al.*, 2010]. Along with the ECT, the PST was the first to attempt to index crack propagation propensity, and it was also introduced to the broader avalanche community at the 2006 International Snow Science Workshop in Telluride. It was first implemented in SnowPilot in the 2009/2010 season, but prior to that people put it in the “Notes” section so we have data on it since the 2006/2007 season. In general, the PST has seen steadily increasing usage, and this latest season it was used in 15% of SnowPilot pits, making it the third most popular test behind the ECT and the CT.

4. CONCLUSIONS

Although we cannot show that our data are statistically representative of the larger avalanche community, it is interesting to see trends in stability test usage over time. The last nine seasons have seen a dramatic shift in the tests we use to assess snowpack stability. We have moved away from RBs and SBs and moved more toward ECTs and PSTs, while still maintaining a large number of CTs. Not surprisingly, this shift toward ECTs and PSTs has coincided with an increasing emphasis on the importance of propagation potential in our stability assessments.

The reduced use of SBs makes sense given our broadened view of snow stability. When the SB was developed, the general consensus was that it was important to know just how much force was applied to get weak layer failure. Of course, this is still important. However, research continues to show that the force necessary for crack initiation varies dramatically across slopes [*Birkeland, et al.*, 2010a; *Schweizer, et al.*, 2008]. As such, an exact value has less meaning in stability evaluation and the more approximate values of the CT are typically adequate.

The reduced use of RBs likely comes from the amount of time they take to prepare and conduct in relation to the other tests. They can be used to help determine crack propagation potential, especially when noting the amount of the block that slides (whole block, most of the block, or part of the block [*Greene, et al.*, 2010]). However, with the introduction of faster tests that are more focused on propagation, such a use is not always necessary.

The increased use of tests developed to index propagation is a remarkable shift in the way we assess the snowpack, and a graphic reminder of the importance of propagation in most assessments. In particular, the ECT became the most commonly used test in the SnowPilot dataset only five seasons after it was introduced. Further, despite a more muted acceptance, the PST has become the 3rd most common stability test used. Our results mirror our own experience. We have found the ECT, which provides an index of both crack initiation and crack propagation, to be an excellent (though certainly not perfect!) test to provide information for our stability assessments. Further, the PST has proved useful for some situations, especially with deep slabs over the top of fragile weak layers. The results from both tests have been shown to be mostly independent of slope angle [*Birkeland, et al.*, 2010b; *Gauthier and Jamieson*, 2008b; *Heierli, et al.*, 2011], an extremely valuable characteristic for safely assessing unstable snowpacks. Finally, both the ECT and PST provide a much more graphic view of the current conditions, a quality that is especially important when attempting to communicate avalanche conditions to the public in videos.

We have undoubtedly not seen the last innovations in stability test development. As we learn more about snow and the way it fractures, newer and more effective tests might well be advanced. Our results from this paper demonstrate that when new tests are useful, and are scientifically validated, our community will quickly adopt them.

Acknowledgments

We owe a huge debt of gratitude to Mark Kahrl, the software developer for SnowPilot. Mark has spent countless hours working on and updating the program, and he extracted the data for this short paper. We'd like to thank Ron Simenhois for proof reading the paper. We are also grateful to all the users of SnowPilot, especially those who download their data into the database. If you are a SnowPilot user who does not download their data, please contact us (email Doug at dchabot@bresnan.net (summer) dchabot@fs.fed.us (winter)). We can keep your data private while still being able to use it for studies such as this one.

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