(HTTP://WWW.MEC.CA/MAIN/HOME.JSP)

SNOWPACK ANALYSIS

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Good decisions require good information. Snowpack observations can improve our risk perception, and thereby help us achieve a level of avalanche risk that is personally acceptable – considering the benefits of mountain recreation.

TO DIG OR NOT TO DIG?

In recent years, the value of snowpack observations by recreationists has been debated, especially in Europe. Because the results of popular tests such as the rutschblock or compression tests observed a few metres apart can vary substantially, why bother with such imprecise indications of instability?

In Canada some forecast areas are much larger than the entire Swiss Alps. Within these areas there are important changes, such as the presence or absence of particular weak layers. At the very least, snowpack tests observed where the snowpack is not particularly variable can help you recognize if the area of our day trip is comparable to the snowpack described in the public bulletin. In other words, snowpack observations on a small scale, a single valley or drainage, can complement the large-scale public bulletin. Also, the appearance of fractures in stability tests and recently developed structural stability indices are indicators of instability, and more consistent over terrain than the numerical scores derived from stability tests.

THE RECIPE FOR A HUMAN-TRIGGERED SLAB AVALANCHE

For a person to trigger a slab avalanche, two conditions must be met in or near the start zone of an avalanche path:

1. The person must start a fracture in a weak layer, and usually this is due to dynamic stress below the person exceeding the strength of the weak layer.
2. The weak layer and the overlying cohesive slab must be able to propagate the fracture along the weak layer beyond the trigger point – over a distance usually greater than ten metres.

No snowpack test or observation is an ideal indicator of both conditions, as the following examples illustrate:

(/AST/ContentPrimary/Learn/Snowsports/AvalancheSafety/SnowpackTests.jsp)

Watch the videos (/AST/ContentPrimary/Learn/Snowsports/AvalancheSafety/SnowpackTests.jsp)

Tests demonstrated in these videos should be used in conjunction with other snowpack observation information.

(/AST/ContentPrimary/Learn/Snowsports/AvalancheSafety/SnowpackTests.jsp)

RUTSCHBLOCK TEST

Rutschblock Test

For a rutschblock test, a person on skis, snowshoes, or a snowboard, moves gently onto, then loads in stages, a block of the snowpack that is two metres across the slope and one and half metres upslope. The rutschblock test is not foolproof, but is quite good at identifying weak layers under a cohesive slab (condition 1, described above). Weak layers identified by the test are generally in the upper 80cm of the snowpack and can be triggered by a person (condition 2). The test also indicates whether conditions are favourable to propagation (condition 3) but only within the area of the block.

The limitations of the rutschblock test relate mostly to spatial variability. A careful rutschblock test might not detect a weak layer, say, 120cm below the surface, and that same weak layer might be weaker and only 60cm below the surface at a potential trigger point somewhere on the same or nearby slope. Also, the snowpack might not be favourable for propagation within the block but might be favourable elsewhere on the same or nearby slopes. The rutschblock test is also relatively slow, is best done with two or more people, and requires a slope of at least 25°. The good news is that Swiss and Canadian studies have shown that avalanches are likely when rutschblock scores are 3 or less, and unlikely when scores are 6 or 7 (the maximum score). Scores of 4 or 5 are harder to interpret, but I recommend cautious interpretation, especially when the weak layer consists of surface hoar, faceted crystals or depth hoar. A Swiss study showed that even with scores of 6 or 7, about 10-15% of the adjacent slopes were human triggered, so we should not rely too much on any point observation of the snowpack.

Snow Stability Resources (http://www.avalanche.ca/caa/resources/avalanche-related-resources/snow-stability)

COMPRESSION TEST

This test involves tapping on a shovel on top of a 30 x 30cm column of the snowpack. The tapping force is increased after 10 and again after 20 taps, to a maximum of 30 taps. A recent evaluation of the compression test has shown that even when 25 to 30 taps were required to cause fracture in a weak layer (the upper part of the hard range) about 17% of the adjacent slopes were human triggered! So, although the test is faster than the rutschblock and can be done on level or gentle terrain, it overestimates stability more often. This is likely due to the small cross section of the column. While the number of taps is an index of the likelihood of skier initiating fractures in weak layers (condition 1), the column is too narrow to interpret the score (number of taps) in terms of propagation potential (condition 2). The limitations of the compression test are partly addressed by observing and interpreting the fracture of the weak layers.

POPS, DROPS AND OTHER FRACTURES

Various descriptions of the fractures in snowpack tests have been used for decades, and recently, systematic descriptions such as "fracture character" and "shear quality" have been developed. Studies in Canada and the US suggest (but have not proved) that these fracture descriptions are indicative of propagation potential and more consistent over the terrain that the scores from snowpack tests.

About 15 years ago, some staff at Canadian parks started classifying fractures as "pops" (sudden planar fractures), and "drops" (sudden collapses) due to collapse of a thick weak layer. A recent analysis showed that pops and drops were common near human-triggered avalanches, but other types of fractures were infrequent near such avalanches. This is likely because pops and drops indicate that slab and weak layer properties are favourable to fracture propagation (condition 2 above), which is the information missing from small column tests such as the compression and stuffblock tests. The pops and drops classification is a better predictor than compression test score, but the best interpretation results from the score combined with the fracture classification.

STRUCTURAL STABILITY INDICES

There are various recent developments in objective profile interpretation that, like fracture descriptions such as pops and drops, are likely indicative of propagation potential. These schemes involve placing checkmarks beside each layer boundary according to six conditions. The most practical one is usually called "lemons". Other schemes are also being developed – please refer to links below for further details.

SUMMARY

There are many snowpack tests that can improve our perception of the potential for human triggering of slab avalanches. These tests are better indicators of instability than stability. None are suitable - by themselves - for making decisions in avalanche terrain. Although it is slow and requires a slope, the rutschblock test results correlate better than other test results with skier triggering. Tests of small columns such as the compression tests or stuffblock test are best interpreted with observations of the fractures, such as pops and drops. Although they require a profile of the snowpack layers, profile stability indices such as lemons are promising additions to currently popular snowpack tests.

FURTHER DETAILS

For further information on the information contained in this article, please refer to following papers:

The Compression Test – after 25 years (http://www.eng.ucalgary.ca/Civil/Avalanche/Papers/CT_25y.pdf)

Comments on Shear Quality and Fracture Character… (http://www.fsavalanche.org/NAC/techPages/articles/04_TAR_shearquality.pdf)

Fracture Character in Compression Tests (http://www.eng.ucalgary.ca/Civil/Avalanche/Papers/FracCharCtIssw04.pdf)

Integrating Shear Quality into Stability Test Results (http://www.fsavalanche.org/NAC/techPages/articles/02_ISSW_shear_quality.pdf)

A Field Method for Identifying Structural Weaknesses in the Snowpack (http://www.snowpit.com/articles/lemons%20reprint%20copy.pdf)

Interpreting Rutschblocks in Avalanche Start Zones (http://www.eng.ucalgary.ca/Civil/Avalanche/Papers/RBinStartZones.pdf)

The Stuffblock Snow Stability Test (http://www.fsavalanche.org/NAC/techPages/articles/96_stuffblock_report.pdf)

Be consistent and be cautious. I really think that's the way we can keep coming back to the mountains year after year and enjoying them.

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