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SIMPLE SNOW STABILITY TESTS

by Bruce Tremper

Everyone who has ever watched any of those old avalanche disaster movies knows that, if nothing else, avalanches are mysterious and unpredictable. Don't they just come roaring down out of the heavens when you talk too loud or shoot a gun? Isn't that how they work?

But old myths seem to last forever, and many of us avalanche professionals spend a great deal of time trying to bring the public up to date on this matter. "It's not that avalanches are mysterious," I'm always telling them, "It's just that they're invisible."

We, as avalanche professionals, spend most of our careers never getting a good look at the one important parameter-the buried weaklayer. Why? Because it's buried, of course. We have invented all kinds of tricks to make the stability of the snow reveal itself. Counting all the usual tests, the unusual ones, and their variations, I have heard of 101 ways to test snow stability.

No, I won't list 101 of them here but just the few which fit my own special criteria. Because of my job as a backcountry avalanche hazard forecaster, I have to travel light and fast and dig lots of snowpits. First, it has to actually work. Second, it has to be quick-three minutes maximum-because I hate getting cold feet. And third, it must be very simple and lightweight. Here they are, listed in order of how much time each takes.

SKI POLE TEST (1-5 SECONDS)

Simply push your ski pole into the snow feeling the unseen layers below. Most avalanche professionals do this hundreds of times per day. With hard snow, use the handle-end of the ski pole.

Advantage:
You can do it hundreds of times per day.
Works well with depth hoar especially in shallow snowpacks.
Works well for density inversions within the new snow.

Disadvantage:
Doesn't work with surface hoar.
Doesn't work well for deeper weak-layers.
People think you have a nervous tick, always poking the snow.

HAND SHEAR TEST (5-20 SECONDS)

Saw out a small square of snow with your mitten and pull on it. Also, a popular test with the Japanese is to cut out a cylinder of snow, wrap your arms around it and pull. Either way, it's a quick way to test how well the surface snow is bonded to the underlying snow.

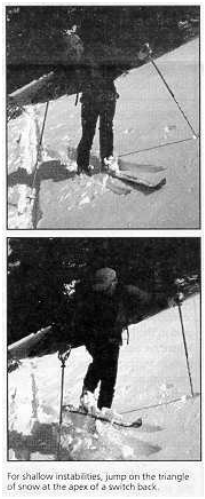

HAND SHEAR TEST— For shallow instabilities. Saw out a small block of snow with your mitten or handle end of a ski pole. Pull on the block to see how well the surface slab is bonded.

Advantage:
You can do dozens of tests in a day.
Works well with new-snow instabilities.
Works well with shallow weak-layers.

Disadvantage:
Only good for shallow weak-layers.

STEPPING ABOVE THE SKI TRACK (5-20 SECONDS)

When following a diagonal or horizontal ski track, simply step above the trail and try and kick some surface snow onto the trail below. Or, you can kick the snow at the apex of each switchback.


For shallow instabilities, jump on the triangle of snow at the apex of a switch back.

Advantage:
Can perform dozens of tests per day.

Disadvantage:
Only works on shallow weak-layers.

SKI CUTS (5-20 SECONDS)

Although some squeemish types and lay people think ski cuts sound dangerous, they have been a standard technique among ski patrollers and helicopter ski guides for decades. The idea is that if you are going to trigger an avalanche, you want to do it on your terms, and minimize the odds of getting caught. Instead of just jumping in and skiing a slope, start at the top of the slope in a point of safety and pick out another point of safety

across and down the slope. Then keep your speed up and cut across the avalanche starting zone, all the while weighting on your skis and trying to start an avalanche. In theory, your momentum should carry you off of the moving slab and into the island of safety if an avalanche breaks. You should ski cut the slope several times as you descend and at each breakover you encounter.

Experienced avalanche professionals will do this instinctively on any slope they plan on descending. When learning ski cut techniques, or on slopes with dangerous consequences of a slide, always wear a belay rope.

Advantages:
Quick.
Good for soft new snow with shallow weak layers.

Disadvantages:
Almost totally ineffective on hard slabs or deep weak-layers.
Dangerous if done improperly or on nasty slidepaths without a belay rope.

TEST SLOPES: (5 - 30 SECONDS)

This is my favorite backcountry test. Find a small, steep slope where the consequences of a slide are small, such as a road cut, the side of a big stump, a mine dump, or a small breakover in the slope. Then simply jump on the slope to see how it responds. You can find test slopes nearly anywhere. Experienced avalanche professionals seldom pass test slopes by without jumping on them. Remember that even on small slopes, it's possible to get buried. Always have your partner watch from a safe spot.

Advantages:
Easy to interpret results.
Safe.
Quick.

Disadvantage:
Dangerous if done on slopes with dangerous consequences.
Not a good test of deep weak-layers, especially ones overlain by hard slabs because of the compressive support from the bottom.

TILT BOARD (20-60 SECONDS)

This has long been a standard test for new snow instability at study plots. Simply cut out a square of new snow the same dimensions as the blade of your shovel. Slide the shovel blade under the block and pick it up. Tilt the shovel blade on edge progressively steeper and steeper while tapping lightly on the bottom of the shovel until the snow fails. The steeper the tilt, the more stable the snow.

Advantage:
Quantifyable (you can put a number on it)
Works well with new snow instabilities.

Disadvantage:
Doesn't work well for deeper weak-layers.

CORNICE TESTS (5 SEC. - 3 MINUTES)

Once again, squeemish folks or lay-people might think cornice tests are dangerous but they have been standard techniques among ski patrollers, helicopter ski guides and especially climbers for decades. Cornices are the bombs of the backcountry. Simply find a cornice which weighs significantly more than a person and knock it down the slope. A cornice the size of a refrigerator or a small car bouncing down a slope provides an excellent statility test. The smaller the cornice, the less effective the test. You can kick the cornice, shovel it or best of all, saw it with one of those new snow saws which mounts on the end of a ski pole. With larger cornices you can use a parachute cord with knots tied in it every foot or so which act like teeth on a saw. Throw the cord over the cornice or push it over the edge with an avalanche probe. You can saw off a fairly large cornice in under 5 minutes. Best to work with small, fresh cornices and not the large, old and hard ones. Always use a belay if the consequences of a slide are high. Cornices have a nasty habit of breaking farther back than you think they should. You can also trundle heavy rocks down the slope which work just as well as cornices and they're safer. This is also a great way to create a safe descent route during very unstable conditions. Make an avalanche and use the slidepath to descend.


Cornice Test — Cornices are the bombs of the backcountry. A refrigerator-sized cornice block bouncing down a slope makes an excellent stability test. You can stomp them, shovel them or use a snow saw mounted on the end on a ski pole.

Advantages:
Probably the best test of a slope besides using bombs.
Easy to interpret.

Disadvantage:
Very dangerous if done improperly.
Small cornices don't stress the slope enough for a reliable test.
Cornices aren't always available.

SNOWPIT TESTS

Most of the time you can gather an incredible amount of information about the snowpack without ever taking out your shovel. But sometimes the only way to get good information about deeper weak-layers is to do the time-honored snowpit. Contrary to popular belief, it doesn't have to take a lot of time. I almost never spend more than 10 minutes in a snowpit. Often you can dig the hole without even taking off your skis, but it usually helps to at least take off the uphill ski. Also, the steeper the slope and the softer the snow, the easier the shoveling. For almost all of these snowpit tests you need to be on a slope of at least 30 degrees in steepness. The optimum steepness is 38 degrees since that's the most dangerous slope steepness for slab avalanches.

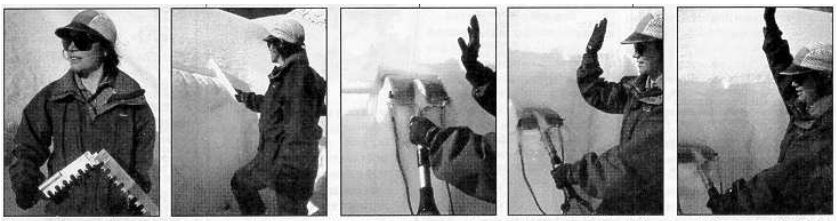
Where to dig a snowpit is just as important as how to dig one. The trick is to dig one in a slope most representative of the slope you are interested in but without puting yourself in danger. Often you can find a small test slope which faces the same direction and the same steepness. Or, you can sneak into the slope in question through thick trees or on a shallow spur ridge. Work your way into it. If one snowpit gives you a green light, then move onto more hazardous terrain. Never dive into the middle of a dangerous avalanche path without first gathering lots of additional data about

the stability of the slope. One of the worst places to dig a snowpit is along ridgelines where the wind has affected the snow. Although the crown face may break right up to the ridge, the place where you will most likely trigger the avalanche is 100 or more feet down off the ridge. Avoid thick trees because conditions are often quite different than on open slopes. However many cagy avalanche professional have developed the habit of digging their snowpit just above a tree so they can grab it if the slope does slide. Better yet, tie a belay rope onto that tree. 1 almost always carry a lightweight belay rope and use it on regular basis. Most important, dig lots of snowpits in lots of different areas because the snow can vary quite a bit from place to place. Look for the pattern of instability.

The times listed for these snowpit tests don't include the time of digging the hole. Most snowpits in reasonably soft snow, with a good shovel and on a steep slope take only a minute or two. For very hard snow it may take twice that time. So you can add a couple minutes to the times listed for digging a hole. When doing these various snowpit techniques, I'm assumuing that you're using a snow saw, which makes all these test go much faster, but you can get by without one in a pinch.

COMPRESSION TEST (10-30 SECONDS)

I love this test. It's quick, easy to interpret and works for most kinds of weak layers. Start by isolating a column about the same size as the blade of your shovel, in other words, about one foot by one foot. Be sure to completely isolate the column. Then take the blade of the shovel and lay it flat on top. Finally start tapping progressively harder on the shovel blade until the column fails. Start with taps by articulating from your wrist, then by articulating from your elbow, then from your shoulder using the full weight of your arm. In this way, the test is quantifiable. In other words it doesn't depend on feel or the opinion of the tester, but it has a reproducible number which is the same for most people and can easily be communicated to others. For instance, it failed on an easy tap from the elbow, or it failed on a moderate tap from the elbow or perhaps a hard tap from the shoulder. Since snow stability is dependent on the size of the trigger required to make it fail, this test is especially easy to interpret.



Compression Test — Using a lightweight saw, make vertical cuts in the back snowpit wall about the same width your shovel blade. Then cut the back of the column with the snow saw so the column is completely isolated. Lay the shovel blade on top of the column and tap gently articulating from the wrist. Then tap progressively harder articulating form the elbow, then finally very hard articulating from the shoulder. Do several of these tests to get a representative sample.

VARIATIONS:

The Swiss have been developing a similar test but-typical of the Swiss-they use a standardized flat plate in lieu of the shovel blade, and in lieu of a hand, they drop a onekilogram weight from progressively greater heights until the column fails.

Depending on your point of view, Americans are either too smart or too lazy to carry all that extra weight. So Ron Johnson of the Southwest Montana Avalanche Center has developed what he calls the "stuffblock test." He caries an extra stuff sack which he fills with snow and a small, lightweight scale to weigh the stuff sack. He then drops the stuff sack onto the column from progressively greater heights until it fails. In other words, it accomplishes the same quantifiable result as the Swiss test but with appropriate technology and lighter weight.

The Bruce Tremper sub-variation is to drop my pack onto the column. It's always about the same weight, so it's quantifiable like the other methods.

Advantages:
Quick.
Easy to interpret.
Quantifiable.
Works for any type of weak-layer, especially effective with faced snow.
What more could you ask for?

Disadvantages:
Small sample size. You need to do several tests for consistent results.
Doesn't work on flat slopes.

SHOVEL SHEAR TEST(10-30 SECONDS)

The good-old shovel shear test has been taught in most every avalanche class since time imortal but unfortunately, it is often the only test that it taught. Even the inventors of the shovel shear test agree that it may be a good test for finding and identifyng weak layers, but it's not a very good test for determining the stability of the snowpack because of: (1) the small sample size, (2) difficulty in interpreting the results and (3) the subjective nature of the test.

First, make vertical cuts with the snow saw in the snowpit wall about the same width as your shovel. Then cut behind the column with the snow saw-not the whole column (a common mistake) but only about a foot or two down. Then, insert the shovel behind the column and pull. Don't lever on the shovel, but pull straight out. Then cut another foot or two down, and pull again, and so on until you reach the bottom of the column. Pay attention only to the smooth, straight shears which pop out easily, and rank the shears as easy, moderate, hard, and so on. Turn each block upside down to see what weak-layer was involved.

The test is hard to interpret because you are removing the overlying snow before you test each layer. Therefore, you will naturally find that the deeper the weak-layer, the stronger it tends to be because it must support the load of overlying snow. It's difficult to take this factor into account. In my experience, most students using this test tend to think
the snow is much more unstable than it actually is. Finally, because of the small sample size, you need to do many tests to get a true feel for the stability of the snow.

But the shovel shear test is a great test for two things: first, testing the snow on a flat slope where most other snowpit tests don't work. Second, it's the only way t know to find and identify surface hoar-one of the main culprits in human triggered avalanches especially by avalanche professionals. That's the only reason why I continue to use the test.

Advantages:
Works on a flat slope.

One of the only tests which finds and identifies surface hoar.

Disadvantages:
Hard to interpret.
Subjective.
Small sample size (must do many tests for consistent results).
Snow seems more unstable than it actually is.

SKI SHEAR TEST (10-30 SECONDS)

This is basically the same as the shovel shear but you completely isolate the column, then insert a ski behind the column and pull on the ski. Doug Fesler and]ill Fredston of the Alaska Avalanche School feel it gives more consistent results. This test, however, suffers from the afore mentioned disadvantages of the o shovel shear test.

Advantages:
Works on a flat slope.
Can identify surface hoar.

Disadvantages:
Hard to interpret.
Subjective.
Small sample size (must do many tests for consistent results).

LOADED COLUMN (30-60 SECONDS)

This is mostly an avalanche forecaster's snowpit test which can estimate how much additional snow will make a slope avalanche. The test is also quantifiable (you can put a number on it)

First on a slope of at least 30 degrees, completly isolate a column, it doesn't matter how big. Then cut blocks of snow the same size as the top of the column and carefully stack them on top of the column until it fails. The test basically duplicates what happens on a slope during a storm. The more stable the snowpack, the more weight required to make it fail. By estimating the density of the added snow it's quantifiable. The test doesn't suffer from any of the difficulties in interpretation like the shovel shear test, but it does take more time.

Advantages:
Good forecasting tool-how much snow will make it slide?
Easy to interpret.
Duplicates what happens in during a storm (but faster).
Works best with faceted snow.
Quantifiable.

Disadvantages:
Takes more time.
Small sample size (must do many tests for consistent results).
Must estimate the density of the snow blocks added.

BURP THE BABY TEST (30-60 SEC.)

One of Doug Fesler's favorite tests, especially for teaching students. Once again, completely isolate a column. Then tip the column toward you, rest it against your shoulder and pat the back of the column with your hand like burping a baby. The farther you have to tip it over and the harder you have to tap it, the more stable the snow. It's a great test for developing a feel for the snow but for the same reasons it takes time to develop a feel for how to interpret the results. It's a good teaching tool for students so they can develop a feel for the mechanics of how snow fails.

Advantages:
Good teaching tool.
Works with any kind of weak-layer including surface hoar.
Good way to develop a feel for the snow.

Disadvantages
Takes experience to interpret results.
Small sample size (must do many tests for consistent results).

RUTSCHBLOCK TEST (1-2 MINUTES)

The Rutschblock test (shear block) and it's cousin the Rutschkiel test (pronounced Rootch-kyle) have rapidly become the standard snowpit test of choice for avalanche professional who do a lot of snowpits. The main advantage is that they work with a larger sample size which tends to smooth out any local variations in the snow. Second, the test is quantifiable and very easy to interpret. Finally, it duplicates what happens when a person skis the slope.

First, on a slope of at least 30 degrees, isolate a block of snow about a ski length across, and a ski pole length up the slope (2 meters wide by 1.5 meters upslope). If you use a snow saw which mounts on the end of an avalanche probe ski pole you can cut the block in under a minute. With two people working together with snow saws the job takes about 30 seconds. You can also use the tail of a ski to saw out the block but it takes longer. Finally, you can shovel out the block which takes a very long time especially in hard snow. Some people insert two probe poles at the upper corners and use a parachute cord to saw out the block but that also takes quite a bit of time. But the best way is a snow saw mounted on the end of a ski pole. It's very quick and lightweight and you can saw cornices with it-definitely standard equipment for anyone venturing into avalanche terrain.

Rutschblock Test — Using a snow saw which mounts on the end of a ski pole allows you to cut out a Rutschblock very quickly. Isolate a column about 2 meters by 1.5 meters. Then with your skis on, jump progressively harder on the column until it fails.

Some people don't cut the back of the column but in my opinion that's a dangerous mistake. You are then testing the strength of the slab along with the strength of the weak-layer, like mixing apples and oranges. Keep it simple. Slabs don't cause avalanches, weak-layers do. If you don't cut the back of the column you can't call it a Rutschblock. Name the test after yourself if you want, but don't call it a Rutschblock because the results you report don't mean the same thing.

The Rutschkiel test is exactly the same as the Rutschblock except it's a triangle of snow (with the point uphill) instead of a square block. Again, you can cut with the snow saw on the end of the ski pole or insert a probe pole at the upper apex of the triangle and saw with a parachute cord.

Next, simply step onto the block with your skis or snowboard on and jump progressively harder until the block fails. Most people rank the test on a scale of one through seven.

1 Fails while isolating the block
2 Fails while stepping onto the block
3 Fails with an easy weighting of the skis
4 Fails with one easy jump
5 Fails with one hard jump
6 Fails with several hard jumps
7 Doesn't fail

Advantages:
Large sample size makes test more reliable
Duplicates what happens with a skier on the slope
Easy to interpret
Quantifiable

Disadvantage:
Takes more time but with the proper snow saw not much more time

SUMMARY OF STABILITY TESTS

Best Snowpit Tests for Deep Slab Instabilities (ranked in order of reliability)
1 Rutschblock
2 Rutschkiel
3 Compression Test
4 Loaded Column
5 Ski shear, burp the baby
6 Shovel shear

Best Active Tests for Deep Slab Instability

1 Cornice test (as long as it's a large cornice)
No other active tests are effective on deep
slab instability

Best Active Tests for New Snow Instabilities (ranked in order)

1 Cornice Test
2 Test slopes
3 Ski cuts
4 Tilt board
5 Hand shear
6 Ski pole test

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