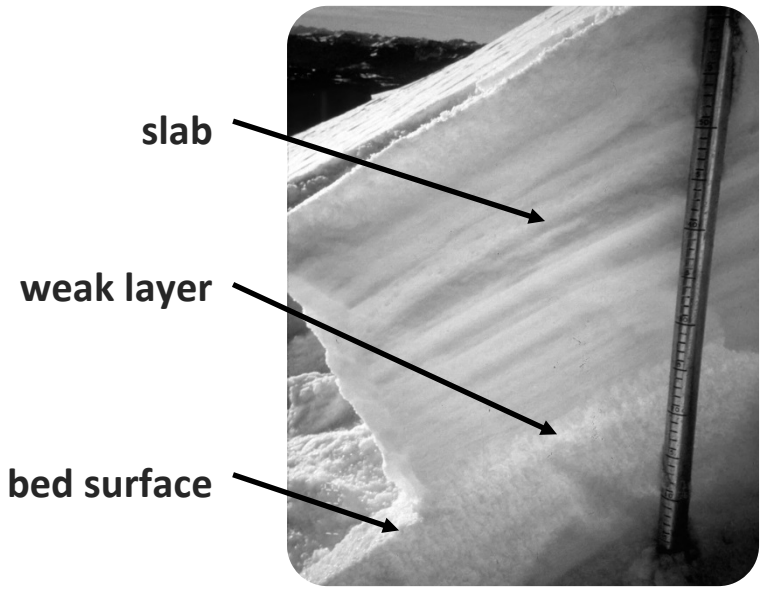
RECIPE FOR AN AVALANCHE

Recipe for a slab avalanche:

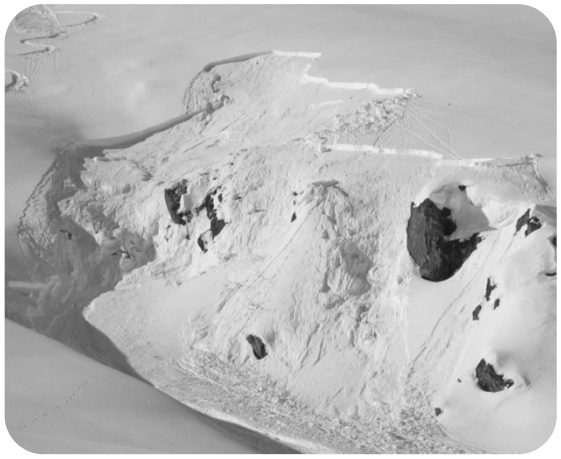


PLUS:
A slope that is steep enough to avalanche and a trigger

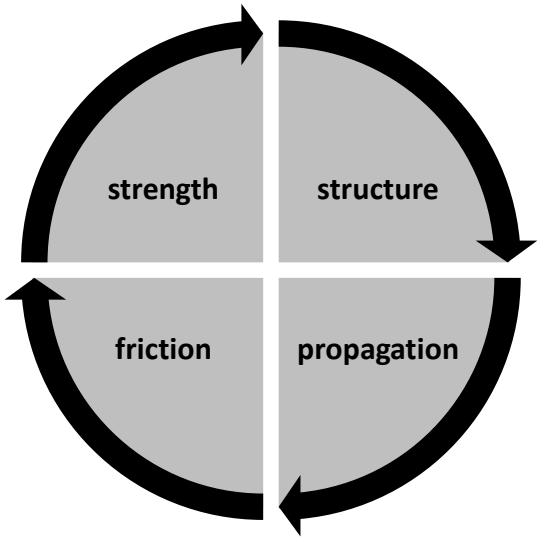
AVALANCHE RELEASE

What Happens When an Avalanche Releases:

Initiation
↓
Propagation
↓
Fracture of Slab
↓
Overcoming Friction



STABILITY WHEEL



Structure

Derived from lemons.

The 5 Lemons are:

- ➔ **Weak Layer within one meter of the surface.**
- ➔ **Weak layer thickness of 10 centimeters or less.**
- ➔ **Hardness difference of one step or more between adjacent layer.**
- ➔ **Persistent grain type (facets, depth hoar, and surface hoar).**
- ➔ **Grain size difference of one millimeter or more between adjacent layers.**

4-5 Lemons indicate a poor structure which may be a path of least resistance for a failure to travel along.

Initiating Failure in a Weak Layer

- *There is a component of shear failure in weak layer failure initiation*
- *Anti-crack accounts for the component of compression in weak layer failure initiation and propagation*
- *Elastic properties of slab determine whether the slab bends and propagates the failure or fractures and ends propagation.*

Step by Step: Stress overcomes strength. Fracture initiates and weak layer is disrupted. Crack opens. Slab drops above crack opening.

Propagation Propensity

Derived from ECT & PST

Propagation or no propagation

Self-Sustaining Propagation:

Relies on the "right" physical properties of a slab COMBINED WITH the "right" physical properties of the weak layer.

Energy is created through strain, in this case through the bending of a slab. This can create a collapse wave.

In order to achieve self-sustaining propagation, the initial crack must achieve a critical crack length. This length depends on the relationship between the slab and the weak layer. Propagation Saw Test is our field test for exploring critical crack length and propagation.

Steps to Achieve Mechanical Release

- ➔ Crack initiation (anti-crack)
- ➔ Crack reaches Critical Crack Length
- ➔ Self-sustaining propagation
- ➔ Overcome friction

<u>A few things to keep in mind:</u>
Collapse is required
Slab properties are important
Slab properties are dynamic
Persistent weak layers evolve slowly over time

Propagation from Thin to Thick vs. Thick to Thin

Propagation from thin to thick is more likely than propagation from thick to thin.

In other words: one is more likely to trigger an avalanche from a thin spot than a thick spot.

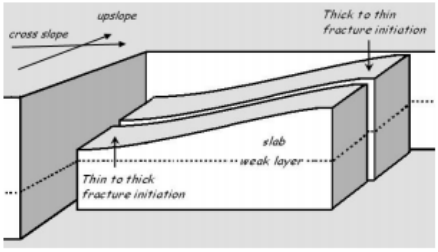


Figure 1: Schematic illustration of side-by-side extended column tests. Fractures are initiated under thin and thick parts of the slab by placing and tapping on a shovel on the thin side in one test and on the thick side in the second test.

Graphic: Ron Simenhois

Friction

Derived from fracture character or shear quality

Residual Friction is also referred to as the crack face friction. This is the friction created between the slab, the disrupted weak layer, and the bed surface.

Friction is influenced by:

- *Bed surface smoothness*
- *Weak layer type*
- *Slab hardness*
- *Slope angle*

Fracture Character

Sudden Planar Planar fracture suddenly crosses column with one loading step and the block slides easily on the weak layer.

Sudden Collapse
Fracture suddenly crosses column with one loading step and causes noticeable slope normal displacement.

Resistant Planar
Planar or mostly planar fracture that requires more than one loading step to cross column and/or block does not slide easily on weak layer.

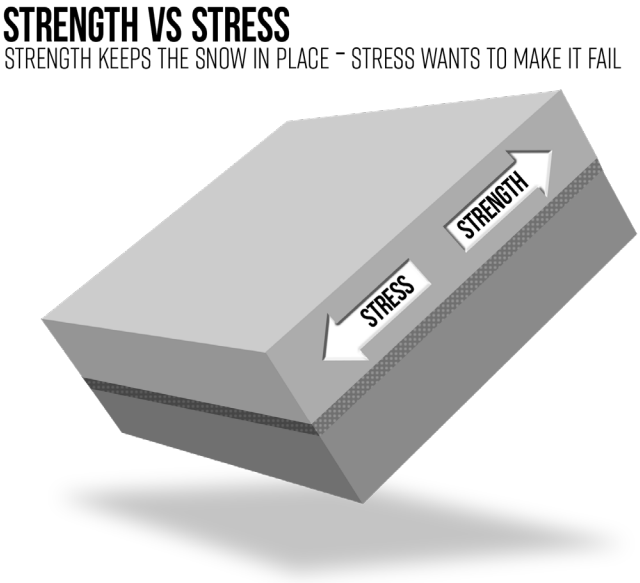
Progressive Compression
Fracture usually crosses column with one loading step, followed by gradual compression of the layer with subsequent loading steps.

Non-planar Break (B)

Irregular fracture surface.

Strength

Derived from stability tests.



Things that weaken a snowpack:

- **Ra**pid warming
- Rapid loading
- Temperature gradients

Things that weaken a snowpack:

- Consistent mild temperatures
- Time (more than less)
- Settlement

Continuity

Spatial Variability or Spatial Uniformity of the slab, weak layer, bed surface

Slab – thickness, extent, hardness
Weak Layer – size, extent, hardness
Bed Surface – roughness, extent, hardness

Greater continuity could lead to larger/wider avalanches.