An overview of shear quality, fracture character and fracture quality.

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Shear quality, fracture character or fracture quality of a given stability test is something that most of you have probably taken into account for many years. There are even suggestions that the quality of the shear, fracture character, or fracture quality may be more important than the stability test results for evaluating overall stability. In recent years there have been schemes proposed to better enumerate these observations and comments. The purpose of this article is to provide some information on the various schemes developed internationally, and to instigate discussions about which systems are being used in New Zealand and whether we should formally adopt one or more schemes into our observation guidelines. A number of you may already be aware of some of the information presented here, and as such, this should be read as review. For those that are interested, in the references I have also provided the web addresses for the papers that are freely available.

In reviewing the literature, three main schemes come to mind; shear quality, fracture character and fracture quality and type. An outline of these systems is presented below.

Shear quality

The Birkeland and Johnson (1999) and Johnson and Birkeland (2002) scheme for shear quality is shown in Table 1. This system has been applied to compression, rutschblock and stuffblock stability tests. It has also been included in the American Avalanche Association (AAA) Snow, Weather and Avalanches: Observational Guidelines for Avalanche Programs in the US (SWAG) (Greene et al., 2004). These guidelines reflect what is being done in the US and indicate a reasonable level of acceptance by practitioners and researchers alike in this scheme (Birkeland, 2004).

Table 1 Qualitative ratings of shear quality (Johnson and Birkeland, 2002)

Shear quality	Description
Q1	Unusually clean, planar, smooth, and fast shear surface; weak layer may collapse during failure. Slab typically slides easily into the snow pit after weak layer fracture on slopes steeper than 35º, and sometimes on slopes as gentle as 25º. Tests with thick, collapsible weak layers may exhibit a rougher shear surface due to erosion of basal layers as the upper block slides off, but the initial fracture was still planar and fast.
Q2	“Average” shear; shear surface appears mostly smooth, but slab does not slide as readily as Q1. Shear surface may have some small irregularities, but not as irregular as Q3. Shear fracture occurs throughout the whole slab/weak layer interface being tested. The entire slab typically does not slide into snowpit.
Q3	Shear surface is non-planar, uneven, irregular, and rough. Shear fracture typically does not occur through the whole slab/weak layer interface being tested. After the weak layer fractures the slab moves little, or may not move at all, even on slopes steeper than 35º.

Fracture character

The van Herwijnen and Jamieson (2003; 2004a; 2004b) scheme for fracture character is shown in Table 2. This scheme has been applied to both compression and rutschblock stability tests. While this scheme has not been included into any official guidelines, the University of Calgary researchers and several avalanche safety operations in Canada currently use this scheme (van Herwijnen and Jamieson, 2004a).

Table 2 Descriptive classification of fracture character in stability tests (van Herwijnen and Jamieson, 2004a)

Fracture character	Code	Fracture characteristics
Progressive Compression	PC	Fracture usually crosses column with one loading step, followed by gradual compression of the layer with subsequent loading steps
Resistant Planar	RP	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
Sudden Planar	SP	Planar fracture suddenly crosses column with one loading step and the block slides easily* on the weak layer.
Sudden Collapse	SC	Fracture suddenly crosses column with one loading step and causes noticeable slope normal displacement.
Non-planar Break	B	Irregular fracture surface.

*Block slides off column on steep slopes. On low angle slopes, hold sides of block and note resistance to sliding by gently pulling.

Birkeland (2004) notes that fracture character has not been included in the AAA guidelines, not because of a judgement about its usefulness, but rather due to its low usage rate in the US. Birkeland (2004) also suggests that if "*fracture character or any other system becomes used by a reasonable number of U.S. avalanche personnel, it will be included in future versions of SWAG*".

Fracture quality and type

The Schweizer et al. (1995) and Schweizer and Weisinger (2001), scheme for fracture quality and type is shown in Table 3 and Table 4. To my knowledge, this scheme has only been applied to rutschblock stability tests. Kronholm (2004) uses another scheme for stuffblock and rammrutsch (which will not be shown here).

Table 3 Descriptive classification of fracture quality (Schweizer, 2002)

Fracture quality	Description
Planar	A completely planar (even; smooth) fracture surface along the fracture plane.
Rough	Small roughness elements are present along the fracture plane, but the fracture plane is well defined.
Irregular	The fracture plane is not well defined but has a very irregular appearance. This often happens by the collapse of thick layers

Table 4 Descriptive classification of fracture type (Schweizer, 2002)

Fracture type	Description
Whole block	The complete block slid along the weak layer.
Part of the block	Only a part of the block, typically below the operators' skies, slid along the weak layer or weak interface.
Only an edge	Only a corner or an edge of the block broke off

This scheme of fracture quality and type is currently used in Switzerland by the avalanche forecasters and researchers at the Swiss Federal Institute for Snow and Avalanche Research. Interestingly, Schweizer and Weisinger (2001) have shown that when avalanche forecasters in Switzerland rank the relative importance of several variables used for the interpretation of rutschblock results, the highest ranked variables included quality and type of failure, both of which ranked higher than the actual rutschblock score.

Summary

The three schemes outlined show many similarities. Van Herwijnen and Jamieson (2003) have made this clear through aligning the fracture character types alongside typical shear quality. I have extended this by including the approximate Schweizer and Weisinger (2001) fracture quality alongside, see Table 5.

Table 5 Shear quality, fracture character, fracture quality (Adapted from van Herwijnen and Jamieson, 2003)

Fracture character (van Herwijnen and Jamieson, 2003)	**Typical shear quality** (Johnson and Birkeland, 2002)	**Likely fracture quality** (Schweizer and Weisinger, 2001)
Progressive Compression	Q2	Rough
Resistant Planar	Q2	Planar or Rough
Sudden Planar	Q1	Planar
Non-planar Break	Q3	Irregular
Sudden Collapse	Q1	Planar

The international literature and anecdotal evidence from numerous practitioners and researchers alike suggests that some measure of shear quality, fracture character or fracture quality is of crucial importance in obtaining a better understanding of snow stability / instability. There is also talk about the shear quality being significantly less spatially variable than stability test results (some of this is due to the number of outcomes for shear quality, thereby raising the probability of lower spatial variability).

I am not suggesting that one scheme is superior to another, only providing information on the systems available. However, regardless of which of these qualitative schemes we are using in New Zealand and chose to use in the future, of utmost importance is the standardisation of such a scheme. As with all such qualitative schemes, consistency and comparability is essential. Regular training events or detailed documentation and imagery should become available to ensure that one persons' Q2, PC or Rough is the same as someone else's, both within New Zealand and Overseas. As people depart for the other hemisphere, maybe now is the time to start thinking about trying to standardise our understanding of shear quality, fracture character or fracture quality. Maybe this can then be shared and discussed at out next NZ Avalanche Conference to find out what people are using, and if we are using the same system, to ensure that we are all on the same page.

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