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Comments on Using Shear Quality and Fracture Character to Improve Stability Test Interpretation

by

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At the 2004 ISSW in Jackson Hole, a few questions and comments came up regarding shear quality (Birkeland and Johnson, 1999; Johnson and Birkeland, 2002) and fracture character (van Herwijnen and Jamieson, 2003; 2004a; 2004b). Both methods have been used in some form by some practitioners for many years, and both aim to assist in the interpretation of stability tests in the field. I'll try to clarify three issues regarding these two methods: 1) how shear quality and fracture character relate to each other, 2) what specific stability tests have been used for defining these two schemes, and 3) the spatial variability of shear quality and fracture character.

First, after Alec van Herwijnen's nice presentation on the usefulness of fracture character for interpreting stability tests (van Herwijnen and Jamieson, 2004a), a person in the audience asked about the comparability of fracture character and shear quality with the implication that one system might be better than the other. Though it would be great to eventually move toward a common system to make international data exchange easier, I'd just like to emphasize that there is no real competition between these two systems. They are both attempting to characterize the same general things, but fracture character is more specific and provides a little more information, while shear quality is more general. Bruce Jamieson has posted up a table that compares the two systems at: http://www.eng.ucalgary.ca/Civil/Avalanche/Papers/FractCharNotes.pdf. In essence, sudden planar (SP) and sudden collapse (SC) fractures are equivalent to Q1 shear qualities, resistant planar (RP) fractures would rate Q2, and breaks (B) would be Q3. Progressive compression (PC) fractures could be either Q2 or Q3, but would probably often be Q3. On a trip to Canada last season I managed to get in a pit with Bruce and we confirmed his table. While fracture character is slightly more complicated than shear quality, the system may provide some additional useful information for some operations. For example, Jamieson and his group have found the sudden collapse fractures to be more commonly associated with whumpfs than the other fracture types, including sudden planar fractures.

I also overheard someone comment about the inclusion of shear quality in *Snow, Weather and Avalanches: Observational Guidelines for Avalanche Programs in the U.S.* (Greene and others, 2004). This document was intended to reflect what is currently being done in the U.S. Since shear quality has found a reasonable level of acceptance south of the border, it was included in *SWAG*. The exclusion of fracture character was not because the *SWAG* working group made any judgment about its usefulness. Rather, fracture character has yet to find wide acceptance in the U.S. 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*.

Second, I'd like to comment on the stability tests used thus far for shear quality and fracture character research. Fracture character work has focused almost entirely on compression tests (literally thousands of them!) with a limited number of rutschblocks thrown into the mix (Jamieson, pers. comm., 2004). The shear quality work we have done here in southwest Montana also has utilized compression-type tests: the compression test, the stuffblock, and the rutschblock (Johnson and Birkeland, 2002). How well fracture character and shear quality can assist in the interpretation of other types of stability tests has not yet been rigorously studied. On the final day of the ISSW, Jon Andrews presented some interesting work on assessing the stability of faceted layers in the maritime snowpack. In this work he utilized a non-standard shovel shear test whereby the block was isolated to 30 cm above the weak layer, and he emphasized that this test might only be appropriate in maritime areas. When the shovel was pulled, he noted both the effort required to fracture the rest of the slab and to initiate weak layer fracture as well as the shear quality. Because of the test used, his results are not directly comparable to previous shear quality (or fracture character) work. However, his work does suggest that assessing the shear quality in this way might be quite useful in some situations.

Third, I heard several folks asking about the spatial variability of shear quality and fracture character. Ron Johnson and I suggested that the spatial variability of shear quality might be less than for stability test scores based on our experience, but we didn't have any solid data to back up those statements (Johnson and Birkeland, 2002). Other practitioners have also noted the more spatially uniform nature of shear quality, and have found it useful for helping to assess difficult deep slab instabilities (e.g., Savage, pers. comm., 2003). Luckily for us, more rigorous work on the spatial variability of fracture character has been ongoing in Canada. Of 17 arrays of compression tests, Campbell and Jamieson (2003) found that 13 of them had sudden planar fractures (Q1 shears) in every test. Our initial results have been similar, with uniform shear qualities on most days but a few days with more widely scattered values. We still need additional data for more reliable conclusions. Note that shear quality/fracture character are not always completely spatially uniform; sometimes variations exist. For example, on one day with a thin snowpack consisting of a windslab over some depth hoar, we observed Q1, Q2, and Q3 shear qualities all within a couple meters of each other. Further, before we get too excited about the "uniformity" of shear quality, we need to remember that it only has three possible outcomes (Q1, Q2, and Q3), making a uniform spatial distribution more probable. For example, if rutschblocks had only three possible outcomes (e.g., RB1 = fracture during block isolation, RB2 = fracture when approaching or jumping on the block, RB3 = no fracture) we might judge a slope to be "uniform" if all the tests were RB2, but this assessment would not be particularly useful, especially if it was considered separately from other available data.

All said, the general consensus on both sides of the border is that augmenting stability test scores with shear quality and/or fracture character is one way to improve stability assessments. However, like other improvements, we cannot solely rely on stability test results. A holistic approach utilizing a wide variety of data is the best way to minimize our uncertainty in assessing avalanche potential.

For additional information, check out some of the references below. Most are posted on the web. Further, if you have any comments or observations about shear quality (or fracture character) that you would like to share, I'd love to hear them. Feel free to email me at kbirkeland@fs.fed.us.

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