General comments:

There is an intense debate in the avalanche community about shear vs. mixed-mode collapse. This article is a nice contribution to this debate, but its conclusions oversimplify what is likely happening at the slope scale. In previous studies, there is a disconnect between observations of local failures (those directly under a load) and those which self-propagate (failures larger than the loaded area). For instance, Compression Test scores have negative correlation with slope angle (Jamieson, 1999) while Extended Column Tests that propagate have scores with little or positive correlation with slope angle (Heierli et al., 2011; Bair et al., 2012). This article supports Jamieson (1999) and finds that sample strength decreases with slope angle. This finding seems valid for local failure, but invalid for self-propagation.

The authors may only be drawing conclusions about crack initiation, but they do so implicitly. Statements in the conclusion (p. 1914, 4-9) make unsupported leaps that weak layers generally fail in shear. If collapse comes after shear, then how do the authors explain remote triggering from flat ground? The authors should explicitly state the limitations of their sample sizes, which have a maximum length of 20 cm. Propagation Saw Tests, shear models (McClung, 2011), and mixed-mode collapse models (Heierli et al., 2008) indicate that critical lengths are often greater than 20 cm. The authors should state that they were unable to observe critical (i.e. self-propagating) cracks, or provide evidence to the contrary.

The energy of an anticrack nucleus V_m is assumed to be insensitive to slope angle (Heierli et al., 2008, Eq. 1):

$$V_m(r) \propto -r^2(\tau^2 + \sigma^2)$$

where r is crack length, τ is shear stress and σ is compressive stress. I suggest that the results in this article directly refute this assumption.

The particle tracking methodology needs further explanation. It is not clear what particles are being tracked. Are they individual grains or clusters of grains? How does the fragmentation of these particles during failure affect the particle tracking? What is the uncertainty in displacement?

I'd like the second author to specifically cite and explain how this work does not contradict his previous studies (e.g. Sigrist and Schweizer, 2007; van Herwijnen et al., 2010; Schweizer et al., 2011) that assume avalanches fail in a mixed-mode collapse wave.

Specifics:

Fig. 2 – How did you measure strength for a sample that did not fracture? I do not see how the colors show order of magnitude. I suggest you drop the colors, they only clutter the figure.

Bair, E.H., Simenhois, R., Birkeland, K. and Dozier, J., 2012. A field study on failure of storm snow slab avalanches. Cold Regions Science and Technology, 79-80: 20-28, doi: 10.1016/j.coldregions.2012.02.007.

Heierli, J., Birkeland, K.W., Simenhois, R. and Gumbsch, P., 2011. Anticrack model for skier triggering of slab avalanches. Cold Regions Science and Technology, 65(3): 372-381, doi: 10.1016/j.coldregions.2010.10.008.

Heierli, J., Gumbsch, P. and Zaiser, M., 2008. Anticrack nucleation as triggering mechanism for snow slab avalanches. Science, 321(5886): 240-243, doi: 10.1126/science.1153948.

Jamieson, J.B., 1999. The compression test – after 25 years. The Avalanche Review, 18(1): 10-12.

McClung, D.M., 2011. The critical size of macroscopic imperfections in dry snow slab avalanche initiation. Journal of Geophysical Research, 116: F03003, doi: 10.1029/2010jf001866.

Schweizer, J., van Herwijnen, A. and Reuter, B., 2011. Measurements of weak layer fracture energy. Cold Regions Science and Technology, doi: 10.1016/j.coldregions.2011.06.004.

Sigrist, C. and Schweizer, J., 2007. Critical energy release rates of weak snowpack layers determined in field experiments. Geophysical Research Letters, 34(3): L03502, doi: 10.1029/2006gl028576.

van Herwijnen, A., Schweizer, J. and Heierli, J., 2010. Measurement of the deformation field associated with fracture propagation in weak snowpack layers. Journal of Geophysical Research, 115: F03042, doi: 10.1029/2009jf001515.