On the sustainability and arrest of weak layer fracture in whumpfs and avalanches

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Recent theoretical and practical descriptions of weak layer fracture have focused on the mechanics of achieving a state of propagation, which is assumed to be self-sustaining. Arrest of weak layer fracture has been addressed for shear-based models, but has often been overlooked for collapsing weak layers. Regardless of the failure mode, discrete weak layer crystals must fail in sequence during propagation. This means that the slab is responsible to ‘communicate’ the fracture laterally as part of the propagation process. This communication ability is lost, and weak layer fracture propagation should arrest, if the continuity of the slab is destroyed by a fracture through its thickness. Often this is the case, for example in perimeter slab fractures in whumpfs; however, these perimeter fractures are difficult to explain without considering weak layer collapse, slab bending, and the spatial variability of the slab. In addition, it is unclear how weak layer fracture continues to propagate despite the en-echelon slab fractures sometimes observed during avalanche release. We propose several simple mechanisms by which perimeter fractures in whumpfs may occur, how weak layer fracture may repeatedly advance beyond the en-echelon slab fractures, and how these processes could be linked. We argue that fractures should propagate downward through the slab, and investigate the interaction or competition between the weak layer and slab fractures that may determine the arrest condition. In addition, we propose that a sustainability term is required to properly describe propagation propensity.