5. Avalanche release in four steps

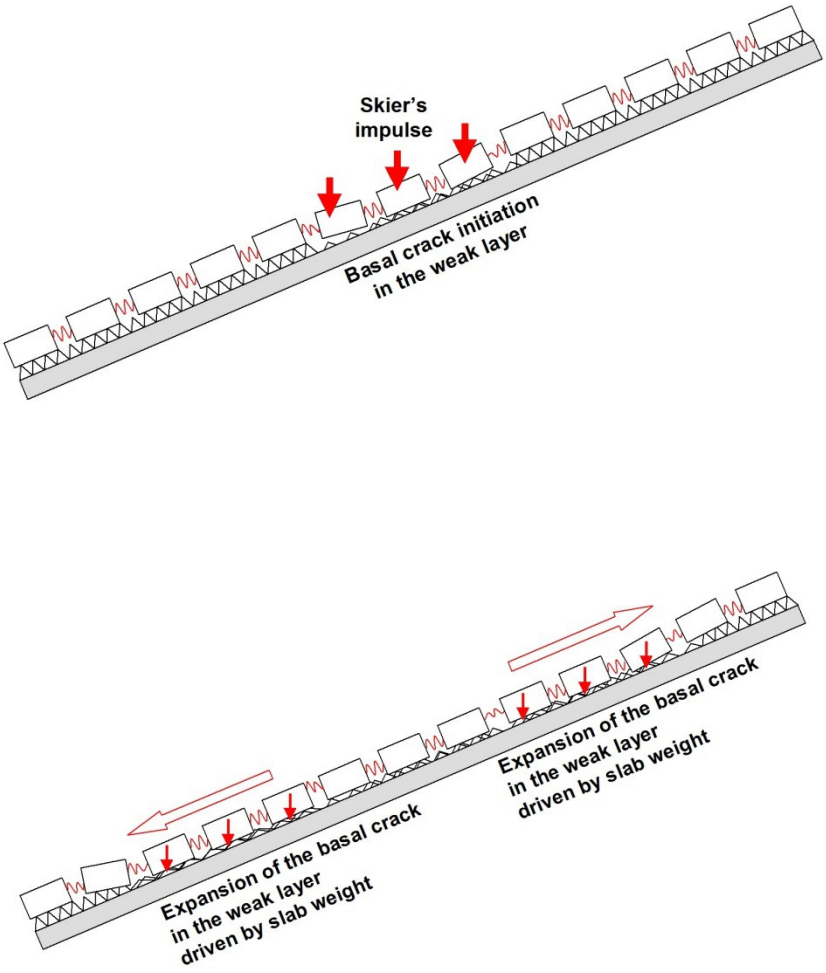
Do you remember this strange feeling that "it" would have released, but it did not? Or when the first skier started crossing the slab very carefully, the 2^{d} as well, that everything seemed to be OK, and suddenly the whole slab failed? The answer to this "mystery" is based on the fact that the triggering process results from various successive steps. If a single one is missing, the whole chain is broken, and nothing happens.

1. The first step is the initiation of the basal crack through a local collapse of the weak layer (WL). It may result from a skier's impulse, or from an explosive burst close to the surface, which is transferred to the WL. In some cases, e.g. if the slab is too thick, or in some cases too stiff, the transmitted impulse would not be able to damage the WL. In the opposite case, the WL usually collapses on a size comparable to ski length, i.e. larger than the critical Griffith's size, usually of the order of a few tens of cm (note #1). The initial crack is thus likely to expand under the slab. The freed part of the slab then starts gliding downslope.

2. The question is now whether or not the initial WL shear rate, related to the initial slab flowing velocity, is large enough to prevent clotting (note #4). If the slab is too light, or the slope too flat, the flowing velocity is too low, and the WL clots. The initial collapse and the incipient expansion would result in a simple whumpf, and probably a slight pang for the skiers. If not, we go to step #3.

3. The "unclotted" crack has now expanded on a large area. The slab is not bonded to the substrate any more, and its weight is hanging at its top. The bigger is the hanging slab, the larger would be the tensile stress at the top. A total release of the avalanche obviously requires the opening of a crown crack, that initiates when the stress exceeds the slab resistance, preferentially at a weak point.

4. But Griffith's criterion (note #1) also applies here: if the incipient crown crack size is smaller than the critical size for crown crack opening, a small stable crown crack would be visible at the top, and nothing else would happen. This is what may occur for instance when the slab rests on a stauchwall at the bottom of the slope, or gets stuck to the substrate at places (note # 4), resulting in a rapid vanishing of the hanging load after crack initiation. This is the last chance to avoid avalanche release. Otherwise, all conditions are met, the crown crack develops rapidly, the slab gets loosed from its anchorings, and the avalanche tumbles down.



Top: a skier's brief local impulse initiates a local collapse in the WL.

Bottom: the slab load expands the basal crack (Louchet & Duclos 2005).

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