English language translation of the press release of 24 Oct, 2012 by the Austrian Mountain Safety Council and the alpine clubs of South Tirol, Austria, Germany, and Switzerland based on several accidents provided by Dave Custer, UIAA Safety Commission.

Danger of rope failure due to worn, fixed quick-draws

Climbing ropes can sever under certain circumstances—for example when they run over sharp edges. Such edges are not limited to the sharp rock on the cliff; a worn carabiner that has developed a sharp edge can damage the rope's sheath and even sever the rope completely.

The accidents

- In April of 2008 at a climbing gym in Prague (Czech Republic), a lead climber took a fall from above the first quick-draw and severed the rope.

- In September of 2010, a climber at Red River Gorge (USA) fell after clipping the rope into the fixed quick-draw attached to the first bolt; the rope severed, resulting in ground-fall and severe injury.

- In September 2012 at the Magletsch crag in Switzerland, a rope severed at a fixed quick-draw high on a climb, resulting in fatal injuries.

In addition to these three documented accidents, there are more reports of rope sheaths that have been severed due to falls on fixed quick-draws—quick draws that are not placed by the leader but instead are found equipping the route.

The accident cause

The factual details of the Swiss accident have not been fully collected, and the official investigation is ongoing. Nonetheless, because this recent accident fits the pattern of the previous two and because the likely cause of the rope failure in these three accidents is not well known to the climbing community, we offer this warning:

In steep, overhanging sport routes in the upper levels of difficulty, it is customary to equip the route with fixed quick-draws. Depending on many factors (how the rope runs, how often the route is attempted, the carabiner alloy and finish) such carabiners become worn with use, resulting in a slot becoming worn into the carabiner through which the rope runs. This wearing process is especially effective when the forces are high and the rope is abrasive, for instance during lowering with a sandy rope.

Climbers are familiar with such worn slots as they are commonly observed in anchors at the tops of climbs (Fig 1b, left carabiner). A remarkable fact is that the worn carabiners can remain remarkably strong, even when the metal has been worn half-way through. {*Translator's note: Do not rely on the increased strength of a worn carabiner. Although the worn slot can constrain the rope to*

run close to the carabiner's spine and the resulting reduction of torque on the spine might increase carabiner strength, such wear eventually results in a severely weakened carabiner that will fail under body weight.}

But from the point of view of severing a rope, there can be a subtle but significant difference between a worn anchor carabiner and a worn carabiner on a fixed quick-draw below the anchor:

- For the anchor carabiner, the load of the lowering climber is the load that abrades the carabiner, so the abrasion smoothes the path of rope as it runs over the carabiner while the climber is being lowered (Fig 1, left image and the left carabiner in the right image). This action does create an edge of sorts (Fig 1, the left carabiner in the right image), but geometry dictates that the edge will not be particularly sharp and that the rope will run alongside rather than over this edge during lowering.

- In contrast, the fixed quick-draw carabiner is abraded as the climber is lowered from the anchors above to create sharp edges across the path where the rope would run in the event of fall arrest or in the event that the climber lowers directly from the fixed quick-draw. Essentially, the quick-draw wear occurs when the rope is contacting the carabiner at an obtuse angle, but during fall arrest the rope contacts the carabiner over an acute angle that exposes the rope directly to the sharpened edge (Figs 1, 2, and 3).

Thus, it is possible over time for the abrasion of a fixed quick-draw carabiner to produce a metal edge over which the rope will be constrained in the event of a fall. A fall under this circumstance can easily damage or sever even a new rope.

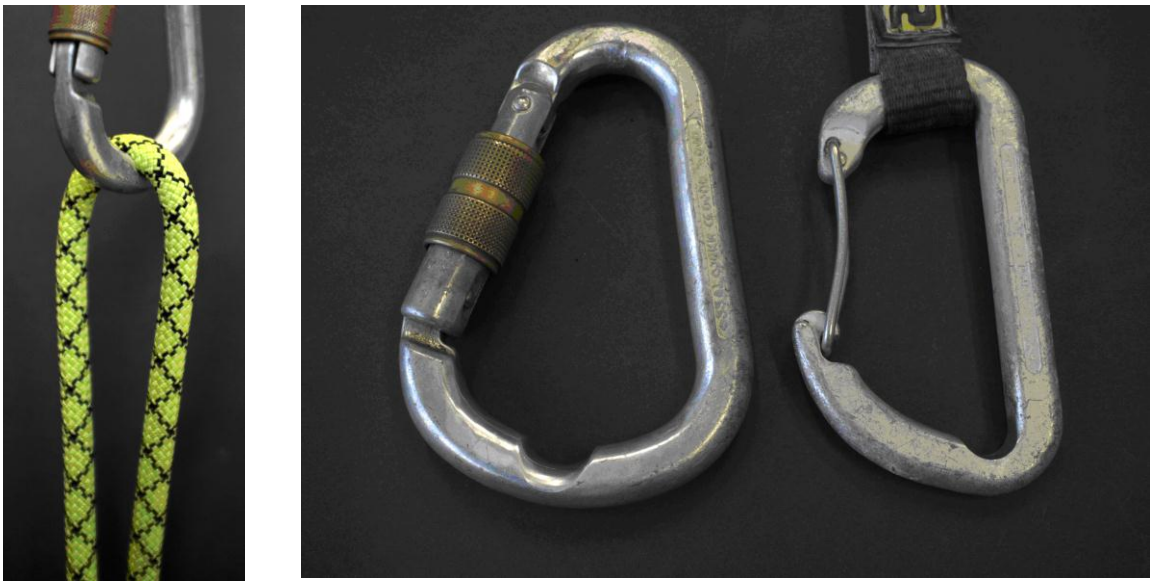

Figure 1 Anchor carabiner compared to fixed quick-draw During lowering, the rope always loads the carabiner in the same way, contacting the carabiner over an acute angle (left figure), so the abrasion smoothes the carabiner where the rope runs (left carabiner in the right figure); although a sharp edge is

produced, the edge is never (only in highly unusual circumstances) exposed to the rope in a configuration that leads to failure. In contrast, a fixed quick-draw can be abraded to produce sharp edges that can damage a rope during fall arrest (right carabiner in the right figure).

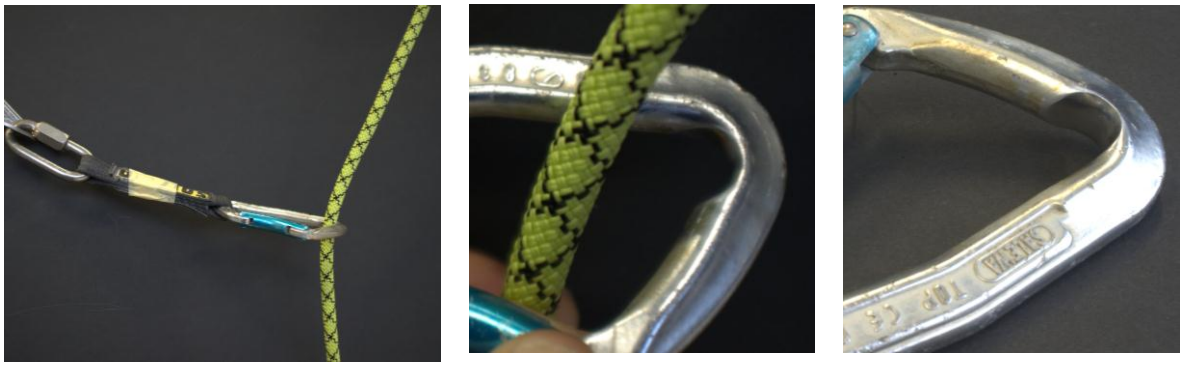

Fig 2 Fixed quick-draws Fixed quick-draws are subject to abrasion during lowering from the anchors above during which the rope makes an obtuse angle as it contacts the carabiner (left image). The abrasion from lowering produces a sharp edge that can cause rope failure when the rope is loaded during fall arrest; in the fall situation, the rope contacts the carabiner over an acute angle and loads the carabiner directly across the sharp edge (middle and right images).

Abrasion due to obtuse rope/carabiner contact angle can be particularly intense at the first bolt if the belayer is not standing directly under the first bolt during lowering. Such increased abrasion would explain why this failure mode is prevalent at the first fixed draw.

Although the potential danger of worn carabiners on fixed quick draws is not new (in 2009, Black Diamond tested such scenario and the German Alpine Club did some field research), until recently it has not been a problem. To our knowledge, this failure mode has not been covered in German language climbing literature thus is not taken seriously.

The Austrian Mountain Safety Council and the alpine clubs of South Tirol, Austria, Germany, and Switzerland are investigating this failure mode further and will report findings in the next issue of the *Berg und Steigen*, the journal for risk management in mountain sports

Consequences for sound practices

In general:

The cliff is not a climbing gym. In the gym, the integrity of the bolts, slings, and carabiners is the responsibility of the owner; at the cliff, each individual climber is responsible for evaluating the integrity of the equipment. When in doubt, swap in your own draws or choose not to climb the route. If you have doubts in the gym, let the management know about the state of the equipment.

In specific—routes with fixed quick-draws:

- Inspect each quick-draw (both the carabiners and the sling); replace any suspect draws with your own. (Also, the quality of the bolt itself deserves to be evaluated.)

- To minimize rope drag and its resulting abrasion, extend the length of quick-draws with runners.

- The first fixed quick-draw appears to be particularly susceptible to abrasion. Positioning the belayer directly below the first quick-draw can reduce the abrasion and the sharp edge it produces.

Some thoughts for those who install fixed quick-draws:

- Please, only equip routes with fixed quick-draws when it makes sense to do so.

- Steel carabiners resist abrasion significantly better than do aluminum carabiners; thus, steel carbiners are recommended for fixed quick-draws.

- Consider leaving the first bolt unequipped so that individual climbers can provide their own quick-draw for the ascent.

- Arrange the fixed draws to minimize abrasion during lowering.

- The carabiner on the bolt side of the quick-draw can also be the cause of accidents; please use appropriate equipment and practices on this side of the quick-draw.

Figure 3 Fixed quick-draws from the Veil Falls sport crag (Klettergarten Schleier Wasserfall) in Tirol The abraded notches on fixed quick-draw carabiners—the various sharp edges are easily recognizable. Photos: Peter Plattner