VITAL LINK

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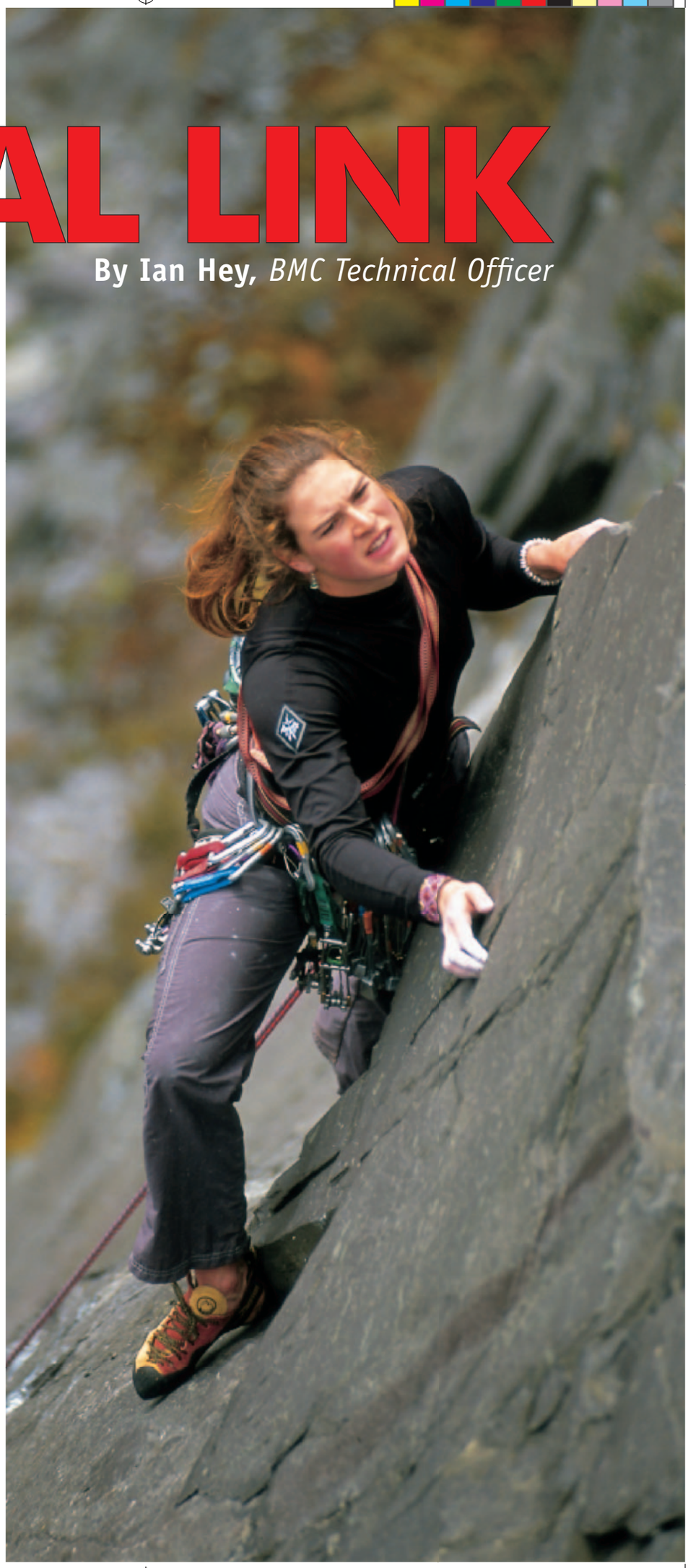


The humble karabiner has a hard life. Slowly tortured against rock, abandoned alone on routes, stuffed thoughtlessly into bags.

Like all things that usually work, they are taken for granted.

Until they fail.

Karabiners may be stronger and more reliable than ever before, but despite tougher safety standards, advances in design and stricter quality control systems, they can and do sometimes snap.

And it doesn't take a dramatic incident for this to happen, it's all down to that bugbear of climbing equipment - forces. Karabiners are designed to be loaded in a certain way, and if the load is incorrectly applied they can fail from the forces easily generated in common fall situations. If you fall when the gate is open, or with the karabiner loaded over an edge, then you could be in for a nasty shock!

DESIGN

Karabiners are designed to take the force down their major axis, the spine. When loaded this way, snapgates should withstand a minimum of 20kN according to the European Standard for karabiners (EN12275). This drops to 7kN if the gate is open and the load is along the spine, or the load is across the minor axis with the gate closed.

So no problems surely? As discussed in Summit 33, when the fall factor is 0.5 or above, with the belayer making a considerable effort to hold the fall, the force on the top runner is likely to be between 6 and 7kN. Well, that may be OK if the gate is open, but only if the load is still down the spine.

If the gate is open and the load is moved away from the major axis towards the nose of the karabiner, then the increased leverage applied will drastically decrease the force required to cause failure. The BMC Technical Committee has done tests to determine figures, and these reveal that when the nose in loaded in this way, forces as low as 2.5 to 3.5kN can be sufficient to cause failure. Depending upon the climber's weight and the belay's dynamics these forces can be easily achieved during a fall of just a few metres.

(LEFT) Audrey Seguy on Pull My Daisy (E2 5c), Rainbow Slab, Llanberis. Credit: Alex Messenger.

OPEN AND SHUT

But surely the chances of falling on a karabiner with it's gate open, and loaded on the nose are pretty small? Well, perhaps, but as a number of recently investigated incidents of broken karabiners will testify, the risk is very real.

Think about it for a second. If you clip any piece of equipment badly, such as a nut wire, a bolt hanger, a sling, or even the rope itself, and leave it caught or hanging in the karabiner's nose, the system is all set for potential failure.

A similar though less serious situation can still arise if the equipment is clipped properly and the karabiner is knocked somehow leaving a wire hung up in the nose behind the gate. This is hard to spot, especially with certain wiregate models, and results in a failure mode similar to loading across the minor axis, i.e. at a minimum of 7kN

The possibility of low failure loads due to loading away from the major axis has been known for some time and mention of it is made in the Standard. Manufacturers are required to ensure that if a rope or sling is positioned near the nose at loading, the design should ensure that the rope or sling simply slips along the karabiner arm into a position against the spine. However it 's not been possible to design a satisfactory repeatable test to check this quality, and as such some karabiners are more prone than others to cause slings and wires to snag up near the nose.

The critical thing here is the shape and size of the karabiner's nose when the gate is closed, and some of the earlier designs of wiregate karabiners fare most badly. In some cases this is because manufacturers simply took standard karabiners and substituted the normal gate for a wiregate without any further modifications to the shape of the nose.

The considerably lower volume of the wiregate leaves much more space in the nose for a wire or sling to hang up. A problem compounded by other developments such as modern narrow spectra slings of 12mm and now even 10mm, more than capable of worming their way into any gap.

STAYING ALIVE

The best way to avoid making the types of mistakes mentioned here is to anticipate any problems and always take a moment to check that you've done things correctly. The last three incidents of failed karabiners investigated by the Technical Committee were almost certainly due to nose loading, yet all climbers were sure that they had clipped the equipment properly.

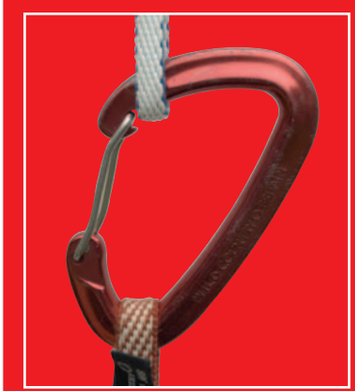
One of the incidents was at a wall, at the rope end of the quickdraw. The other two outside, both at the nut end. In one of these cases the climber involved was able to retrieve both parts of the broken karabiner for analysis, and close examination of the inside of the nose clearly shows deep scratch

Beware:

Have you clipped your krab correctly?

If fallen on when clipped like this, the karabiner will be loaded gate open and could fail completely with a fall of only a few feet.

Due to design, certain karabiners have increased space at the nose and are more prone to slings and nuts getting hung up. It's easy to see that some wiregate models such as the one above are vulnerable.



The new narrow spectra slings can compound this problem. Here at least the gate is completely closed, but this may not always be the case.

Take time to check your gear!

Strange but true:

HMS screwgate karabiners have been known to be levered open by a figure of eight descender.

Few examples are seen, but this scenario is known to have caused at least one fatality and led to serious injury in another incident. It's caused by a very particular alignment between the figure of eight and the screwgate karabiner used to attach it to the harness. In the right configuration the forces are sufficient to force the krab open by damaging the sleeve of the screwgate (see right), with potentially fatal consequences But how would this happen?

1. Having attached the rope through the figure of eight, the climber attaches it to their harness with a screwgate in the normal manner.

2. If tension is not maintained between the figure of eight and the screwgate, there is a tendency for the figure of eight to turn over and take up an abnormal configuration in relation to the karabiner.

3. If the rope is then weighted again the figure of eight can both load the karabiner axially and apply leverage to the gate. The size of loads generated in abseiling and belaying when coupled with this leverage can be sufficient to damage the sleeve of the screwgate.

4. Once this happens the load forces the gate open at which point the figure of eight becomes detached from the karabiner. Bad news.

Tests on one particular type of karabiner showed that loads of just 1kN would be enough to damage the gate and force the karabiner open. Depending on the weight of the climber this equates to not much more than body weight and can easily be achieved by the extra leverage of the figure of eight or by any shock loading of the system.

Take the example of a climber who weighs 80kg. Their gravitational force is 80x9.81 (9.81 is the Earth's gravitational force) = 784 Newtons or 0.78kN. The leverage produce by the figure of eight is of the order of 3 to 1 so the force on the sleeve of the karabiner is 3 x 0.78 = 2.34kN in a static situation. Any shock loading of the system could easily double this resulting in a force of 4.68kN - more than enough to break the sleeve on many karabiners.

The abnormal configuration of the figure of eight and karabiner required for this to happen is very close to instability. That is, when loaded the natural inclination is to straighten itself out and align correctly, but certain combinations of a figure of eight and karabiner are less likely to realign and are more prone to this problem. It's also worth pointing out that this failure can equally happen when using a figure of eight to belay with.

LOOK OUT

When about to commit to an abseil most climbers go through some sort of check to ensure all the components are correct. But how many people continue to watch their abseil device as the load comes on to it to ensure it is aligned correctly? Figure of eight's may be much less common in this country now, but they are still heavily used by centres and on the Continent. So next time you come into contact with one, remember to keep an eye on it.

SOLUTIONS

For a number of years DMM have produced their Belay Master karabiner, designed to prevent this very failure. It incorporates a plastic catch that when put in place prevents the karabiner from moving and being cross loaded. The catch cannot be closed until the gate is done up, a useful visual aid in an instructional setting.

The strength of the screwgate sleeve is another factor. Plastic sleeves tend to be the weakest and the bronze and steel sleeves the strongest. There is a proposal for an amendment to the karabiner standard to test the sleeve strength, and whilst this would not eliminate the problem entirely, it would require some karabiners currently on the market to have stronger sleeves fitted.

marks in the metal. When tests were carried out on a similar karabiner with the wire of a nut hung up in the nose, identical marks were found to those on the karabiner submitted.

As more and more climbers migrate over to using quickdraws with identical wiregates at either end it's also worth remembering that you should always use one end of the quickdraw for clipping gear such as bolts and pegs, while the other end is only ever used for the rope.

When you take falls on a karabiner clipped to a bolt or peg it can lead to small grooves being gouged on the inside of the karabiner. These don't noticeably weaken the strength of the karabiner but they will affect the life of a rope, especially when fallen on.

With bent and straight gate karabiners it used to be simple; bent gates are designed for easier rope clipping, so no confusion there. But if someone handed you a rack of wiregates, there's just no way of knowing which end goes where.

To avoid this most companies produce their wiregates in at least two different colours. Make sure that you always use one colour for the bolt and one for the rope, and don't forget to ask if borrowing someone else's!

THE FUTURE

It's already been shown that the design of a karabiner can play a significant part in making sure that it is loaded where it is strongest. A number of manufacturers are now producing karabiners with no nose hook to snag unwary gear. DMM, Wild Country, Petzl, Black Diamond, and Austrialpin all have at least one model in this category. This is good news, and it immediately removes the possibility of equipment getting caught in the nose when clipping. Other improvements to the nose can also make it less likely for slings or wires to hang up near the nose when the gate is closed. ||