A Degrading Life

Care and maintenance of your metallic equipment

Life moves fast these days. With the increasing popularity of climbing, manufacturers are taking every advantage of the latest advances in materials and technology to make exciting new gear available each year. But one thing never changes, climbing has been and always will be a risk sport, and all the latest equipment in the world will only increase the margin of safety at which you operate. Risk can never be eliminated, so it's absolutely vital to understand the limitations of equipment, and recognise the situations that may cause it to become damaged or even fail.

But how do you know if a certain piece of equipment is damaged? Should you throw a rope away after washing it in detergent? What's a stress fracture? That's where the long anticipated new edition of the BMC's Care & Maintenance Book comes in. This is a concise 60 page full colour guide to caring for your kit, and should be one piece of equipment not to forget. Just one of the important subjects covered is degradation of metallic equipment, so read on if even if you only own a single karabiner, and especially if you've ever dropped it in the sea!

Equipment degradation

Every time you use your gear it is under attack from a variety of sources - UV light, dirt, dust, water, salt – really, the surprise is not that climbing gear sometimes fails, but that it doesn't more often! Here are some of the more common forms of metallic degradation that occur, and some of the ways in which you can combat them:

Seawater corrosion

Seawater and airborne sea spray present a number of corrosion problems of varying severity to all metallic climbing equipment. In all cases the corrosive agent is aqueous chloride ions from the salt in the water, and this generally attacks moving parts such as the gate, springs and latch, or areas of equipment where two different alloys are in contact with each other.

After every use of climbing gear on sea cliffs, and anywhere within the region of sea spray (which may extend well over and around the actual sea cliff in rough weather), it is recommended that the following procedure be carried out:

After finishing climbing for the day - keep the dry gear separate from the wet, and make sure it is kept away from any damp ropes, slings and clothing etc – even to the point of carrying a drybag to store dry equipment. Any wet equipment should be washed thoroughly in tap water or a freshwater stream to remove all traces of salt, then after removal of surface water it should be hung out to dry. This should be done even if the plan is to climb again the following day.

If you are travelling home - do not leave any metal equipment that may be contaminated with salt in a rucksack or other carry bag where it may come into contact with slings or ropes – especially in a warm environment - as this will induce corrosion. If karabiners or camming devices are left like this for, say, a week, they will at the very least become discoloured and suffer surface corrosion. Within a few weeks, they could be so badly affected as to be unfit for further use – a costly mistake!

Sea Cliff climbing can be outstanding - but what's happening to your gear?

As soon as possible after returning home - all equipment that has been contaminated with salt water should be thoroughly washed in tap water, preferably with a little mild detergent. Then remove all surface water and put in a warm, dry airy place (such as a rack in an airing cupboard) to dry off the remaining moisture. With chocks and camming devices, take special care that the wire cables have been thoroughly washed and dried.

When dry - any hinges, movable joints, wires & cables etc. should be treated with a suitable aerosol lubricant, any surplus wiped away, and the movement checked before storage.

Fatigue

Whilst the maximum failure load is a concept central to all engineering applications and their designs, another aspect of equal concern is fatigue. Fatigue is well recognised by professional engineers in nearly all materials, but especially in metallic alloys since it affects the life span of a product. If a load is applied that is lower than the stipulated failure load of a particular piece of equipment, but is done so repeatedly, then the piece may eventually fail. This process is known as fatigue failure. Each load application is known as a cycle, and the less the load, the more cycles are required to cause a failure (if the load is small enough then a failure will never happen) However in reality for climbing equipment, the load level over a sequence of cycles is not

constant, and a sudden big load equalling the failure load will cause the piece to fail.

The importance of fatigue effects implies the need to keep the amount of load to a reasonable level- well below the failure load- and to avoid sudden large loads, thus prolonging the fatigue life of the item. The design of a piece of equipment should take fatigue into account in the following way:

"The usual loads expected should be such that many thousands of cycles are required before fatigue failure, and this should be beyond the expected usable lifetime of the product"

However, if through exceptionally heavy or abnormal use too many cycles have been accumulated and failure is near, then cracks in the highest stressed areas will be forming and growing. Hence, a close examination with a magnifying glass on well-used equipment will be very worthwhile – a common example is cracking at the base of the front points of well-used crampons. In climbing terms, this means that reasonable use should attempt to avoid any chance of fatigue failure by limiting the number and/or severity of the load cycles. Examples of use that go against this are excessive torquing, or repeated hitting of hidden rocks under ice or hard, awkward walking over rocks in crampons. Both secnarios will shorten the useful life of the equipment involved

Wear

Wear is a phenomenon that occurs when metallic surfaces are rubbed by other surfaces under pressure, and local shear stresses arise. Because of these, particles on the surface are eroded, and the physical volume of material locally decreases. The higher the contact pressure and the softer the material, the greater the rate of wear will be. Sharp surface features (like edges and corners) will also erode quicker than smoother parts, because the stresses in those features are higher under a rubbing force. For climbing equipment, any contacting surfaces are liable to wear since most alloys in common use are relatively soft. The most usual high-pressure situation encountered in practice is that of ropes passing through karabiners, abseiling and belay devices etc. Grooves can appear in these items of metallic equipment, and since a noticeable groove represents a new surface geometry with some material removed, the performance of these items will alter over time. This has the further implication that the failure load and other design parameters of the item are changed, and a safe course of action is to retire the piece of equipment once such a groove has become noticeable.

Stress degradation

Any piece of equipment that operates under applied loads becomes subject to the effects of the stresses that result from those loads. Thus, any structure or component used in an engineering application becomes stressed during the normal course of their intended operation, and metallic climbing equipment is no exception to this.

For instance, when a climber falls, the rope takes the climbers weight along with the harness, karabiners, slings and protection placed – all become stressed to a degree. The manufacturers design their equipment to withstand these stresses, but in conjunction with wear & tear and time, continued stressing sometimes leads to a failure. For example (again!), crampon points and ice tools are subjected to continual and sometimes abnormal loading (as in torquing when mixed climbing), which can sometimes be above and beyond the intended design load. In some cases, this load is greater than the equipment can sustain and failure results.

(INSET) A grooved, worn karabiner. This can happen very quickly in the right (wrong!) conditions, and it should be retired from active service.

How long is a lifetime?

Because of all the variables that affect an item of equipment when it is used, it is almost never possible to give a definitive lifetime for equipment in use. In all cases, the owner needs to take into account everything they know regarding:

The history of the equipment – has it been involved in any long falls etc?
The way in which it has been used – e.g. top-rope, lead rope?
The general advice provided in the BMC Care & Maintenance booklet.
The manufacturers advice.
Most importantly, the results of a visual and physical check – which you should always carry out, every time the equipment is used.

This may seem like a complex process, but in reality, much of the calculation is done subconsciously, leading to the old general maxim:

If you think it may be time to replace an item of equipment - then it probably is!

The BMC Technical Committee

For thirty years the BMC Technical Committee has been issuing safety advice and investigating occurrences of failed equipment. Over that time a great body of knowledge has been built up and many members of the committee have been deeply involved with others in generating UIAA and EN standards for mountaineering equipment. This puts the BMC in a unique position to offer members and non-members alike a range of services regarding technical matters:

Regular news regarding equipment testing, design developments and recent failure investigations.

Authoritative advice on care and maintenance of climbing equipment and good practice in its use direct from the office.

Investigations into gear failure. if you have a failure to report, contact Stuart at the BMC office (0161 438 3329, stuart@thebmc.co.uk) or download the report form at www.thebmc.co.uk/safety.htm

Access to the most knowledgeable body of professional volunteers working with climbing equipment in the UK!

An extensive library of reports and documents relating to testing methods and historical failures. See website for catalogue.

A series of advice booklets on specific items of equipment, e.g. Ropes, and Crampons. These detail selection, usage and maintenance.

A yearly conference involving manufacturers, retailers, instructors and the public to discuss matters of current importance. This year's conference is scheduled for November.

In short, the Technical Committee exists to serve the climbing community by gathering accurate and up to date information from all over the globe and making it as easily available as possible. Future developments will include electronic conversion of the existing library, email newsletters and downloadable archives, as well as an increased output of articles and advice booklets.

Cracking

The presence of cracks in any structure that is designed to carry load is potentially dangerous, but obviously so where metallic climbing equipment is involved. Cracks can arise for several reasons:

During manufacture or heat-treatment of the equipment, commonly during welding processes – these are invariably detected at an early stage, or not critical to the intended performance of the equipment.

During a sudden overload when the failure load is exceeded and the item breaks – this is effectively the sudden initiation and catastrophic growth of a crack through the weakest part of the equipment.

Due to corrosion – see previous section.

By fatigue - as previously explained. Such a crack starts at a microscopically small size, growing as the fatigue life progresses until it is big enough to be noticed by the naked eye. In climbing equipment, this usually means that the fatigue life is nearly at an end, and that a failure is imminent. This is the reason for recommending regular inspections of equipment both with the naked eye and with a magnifying glass, and when such a crack is detected to retire the item immediately. Continued use of a cracked item will almost certainly lead rapidly to sudden failure – a very dangerous situation.

Another relevant consideration when considering cracks is the influence of temperature. If the temperature is low enough, the brittleness of a material can increase significantly and any small cracks are liable to sudden and catastrophic breaking, like shattering glass. At higher temperatures, materials exhibit a more ductile characteristic making sudden cracking much less likely. For the alloys used in climbing equipment, the transition temperature between this brittle and ductile behaviour occurs somewhere in the range -50°C to +50°C.

The important factor for climbing equipment is that at cold extremes, it is more liable to brittle fracture, and prolonged use in these conditions increases the likelihood of this occurring (eg. during an expedition). Although a lot of care is taken to consider this during design and material choice, it is prudent to check regularly for cracks in equipment that is used at cold temperatures for extended periods of time.

Find out more

For further information on advice on how to look after all your gear, consult the new edition of Care & Maintenance. Published by the BMC this booklet is only £4 to members and £6 to non-members, available from www.thebmc.co.uk or call 0870 010 4878.

Any technical or equipment related queries, including reports of failures, may be related directly to the BMC's technical assistant Stuart Ingram. Email him at stuart@thebmc.co.uk.