Bolt Failures on Sea Cliffs

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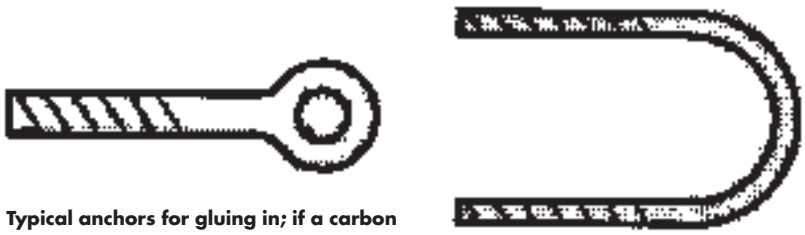
When the UIAA Safety Commission, in the second half of the 80's, worked out the details for the Standard for bolts, UIAA 123, it was aware of the corrosive environment of sea cliffs. The Standard, therefore, specified suitable alloys, which, it was assumed, would cover all terrain.

In the last few years bolt failures in various areas near sea water around the globe have been reported at an alarming rate. No reports of failures have been received from Great Britain, most likely because of their disdain for bolts. Areas in and around the Mediterranean Sea, as far as 20 km inland, have experienced corrosion problems for many years – often within months of placement. Further inland the effects of pollution and acid rain may, however, be the major contributing factors. More recently developed climbing areas in Thailand and Cayman Brac seem particularly affected.

Stainless steel extension bolts consisting of two or more pieces (bolt plus hanger) have repeatedly failed in these two exotic locations. Failures occur usually in the first three years of installation, but have happened in as little as nine months. The bolts typically break under the hanger, flush with the surface of the rock; hangers break where the karabiner rests. Some hangers have been known to shatter like glass with a slight hit of a hammer.

American climbers and metallurgists, investigating Thailand and Cayman Brac, have determined that the failure mechanism is not only simple oxidation or galvanic salt corrosion. The major culprit is apparently Chloride Stress Corrosion Cracking (SCC). The standard expansion bolt and hanger installation does, of course, induce stresses into the bolt as well as the hanger. The process may, however, be exacerbated by the other corrosion mechanisms including chemical corrosion.

In the Mediterranean coastal area of the Calanques (France), this phenomenon has not been observed (possibly because of frequent replacement). Because bolting in this area started a long time ago, many different units have been used and, with time, found wanting. Plain galvanized bolts (whether single glue-in units or with hangers) have long been discarded. The problems have been too thin a zinc coating, low quality steel, the rapid advance of corrosion when hanger and bolts are of dissimilar alloys and the natural trapping of moisture under the hanger.



Typical anchors for gluing in; if a carbon steel and if hot dip galvanized they are very resistant against sea water.

While bolts made to the present UIAA 123 specifications appear to be suitable in mountains and in areas of sport climbing away from the sea, they are definitely not satisfactory in the corrosive environment of sea-side climbing areas. From the above experiences, the suggested solution will most likely contain the following ideal criteria:

1. Single unit glue-in anchor, possible stress relieved,
2. material not susceptible to chemical corrosion, such as oxidation and galvanic (chloride) corrosion,
3. material not susceptible to SCC,
4. material insensitive to temperature,
5. glue is resistant to chloride and chemical attack and is temperature insensitive,
6. installation must separate metal from the surrounding rock (by the glue).

The reality is that corrosion will, nevertheless, eventually cause damage to the bolt but the service life will be greatly extended over most units on the market right now.

American climbers have already pioneered the manufacture of bolts, which satisfy most of these criteria. The outcome has been a titanium bolt, which is now available on the US market. The material is considered superior to stainless steel.

In the Calanques, because of cost implications (8000 bolts placed per year) a single mild steel, hot dipped galvanized eyebolt is used (hot dipping greatly increases the thickness of the zinc coating never less than 24 microns). The experience has been very favorable and the price is very low. The service life of these bolts is expected to be only a little less than that of comparable stainless steel units.

These above developments have provided much information. At the plenary session of the Safety Commission in May this year in Cassis (near Calanques), a working group has been established to further investigate. The culmination of this work should be an addition to the existing bolt Standard covering bolts for use on sea cliffs.

The author Helmut Microys is National Delegate to the UIAA Safety Commission of Canada and the US.