

Safer rock climbing

Climbing a vertical wall, finding the next crack or jut in the rock face, pushing higher with nothing but the body's strength, are part of the thrill of rock climbing. However, without the aid of safety anchors to catch the climber in the event of a mishap, the sport could be deadly. Both experience and study indicate that molybdenum-alloyed stainless steel anchors play an increasingly important role to protect climbers' lives.

"As soon as I found no further place for my toes or fingers, or to set my anchors, it all came in a flash: the sweat, shaking knees and **fear**. Unbelievably, I was only about ten feet up...[this] turned out to be one of the great experiences of my life – **rock climbing**".

Whether it is to master fear, feel an adrenalin rush, or to enjoy technical and esoteric aspects, people are increasingly turning to extreme sports like mountaineering and rock climbing. The term "rock climbing" covers a wide range of activities from low-level bouldering or scaling indoor, artificial climbing walls, to extreme mountaineering in locations and altitudes such as Yosemite's

El Capitan in California and the famous North Face of the Eiger in Switzerland. Here, climbers face challenges that go well beyond the technical difficulty of the rock face. Rock climbing is very popular today because of the increased accessibility to climbing experiences, improved training and support services, and new technologies in equipment. Anchors are a longstanding and critically important part of a climber's gear, but even they are progressing as the sport itself evolves.

Types of rock climbing routes

Traditionally, a climber would scale a 'virgin' route having no previously

established path. He or she would use temporary anchors inserted in and removed from cracks in the face as the climber moves over the rock. Now, climbs over a route established by experts and fitted with permanent climbing anchors, or bolts, are becoming popular. These bolted climbing routes are widespread. Sixty thousand have been built in the U.S. alone since the 1980s. More suited to novices or a hiking expedition, are well-established paths fitted with permanent cables or even ladders, which are called 'via ferratas'.

Devotees often argue about whether the use of permanent anchors and devices is environmentally acceptable or philosophically pure, but all agree that they have opened the sport to many more participants. This increase in participation drives a need for better standards for equipment safety and quality, locally and worldwide.

Climbing sport governance

A variety of local and national sporting and industry groups oversee various aspects of climbing around the world. The global organization concerned with safety, sustainability and sport is UIAA (Union Internationale des Associations d'Alpinisme, or International Climbing and Mountaineering Federation). UIAA is active in a broad spectrum of issues in the sport. For example, it grades rock-climbing routes according to increasing difficulty from I to XI. It also has committees focused on safety standards for helmets, anchors, and other equipment. Individual national clubs contribute in specific areas. ➤



Stainless steel anchors are an important safety device in rock climbing. © iStockphoto/sezer66

For example, the CSMT (Centro Studi Materiali e Tecniche of the Italian Alpine Club) operates a tower used to test equipment and safety measures.

The permanent climbing anchor

The basic permanent anchor consists of a ring attached to a bolt embedded in the rock face. The placement of permanent anchors is usually carried out by experts, who are well aware of the legal and ethical implications of bolting. They are trained to consider the biophysical impacts on fragile soils, vegetation and wild life, aspects studied by UIAA. The anchors are used in 'belays', where a stationary climber protects an ascending or descending partner, with the help of ropes and breaking devices. Climbers attach the ropes with carabiners and other connections to the ring.

Two types of permanent anchors are currently in use. One is a ring, called a 'hanger', attached to a bolt that is mechanically secured in a drilled hole. The other is a one-piece eyebolt inserted and glued in a drilled hole. Anchors were originally made of high carbon steel. However, this material is subject to general corrosion and to galvanic corrosion when in contact with a stainless steel hanger. These older bolts have a life expectancy of only about



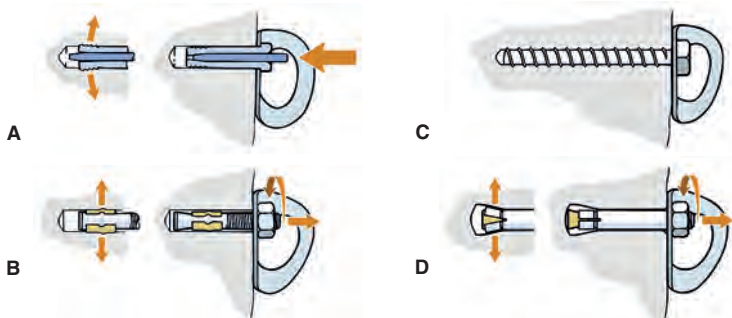
The rope is attached to the anchor with the help of a connection device such as a carabiner. © iStockphoto/Extreme-photographer

twenty years, and sometimes much less, which means that hundreds of thousands of permanent anchors installed in the 1980's and 1990's are due or overdue for replacement.

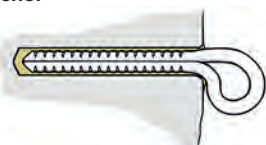
In order to increase the life and depend-

ability of these anchors, molybdenum-free Type 304 stainless steel has become common in North America, while Type 316 stainless steel with 2–3% molybdenum is the material of choice in Europe. As the sport grows, more climbing sites are discovered and developed around the world. Some of the most popular are located in corrosive coastal environments that challenge even these materials. Hence the focus on long-term material performance and climber safety grows stronger.

Mechanical anchors



Adhesive anchor



Anchors can be categorized by the method used to attach to the wall. Adhesive anchors are glued in. Mechanical anchors press against or screw into the rock: **A** expansion anchor, **B** sleeve anchor, **C** tapping screw anchor, **D** wedge anchor. © Georg Sojler

Durability and future of the permanent anchor

This new focus has raised questions about how long a 'permanent' anchor should last and what environmental conditions it should be designed to endure. Late in the last decade, some Type 316 stainless steel anchors failed by chloride stress corrosion cracking. Typically an affected bolt would show little outward sign of distress, before shearing off at the tap of a hammer. ➤



Rock climbers are rappelling into a canyon. © iStockphoto/Extreme-photographer

Climbing sites most susceptible to this failure type are those in warm climates with moist coastal environments, for example in Thailand, the Dominican Republic and Greece. Climbers were rightly concerned about this problem because they literally attach their lives to their anchors.

Following the appearance of the problem, UIAA commissioned a working group to study the issue and develop appropriate standards for anchor materials. In June 2016 the UIAA's Safety Commission Working Group issued a draft of an improved standard for anchor safety at an internal meeting in Bergamo, Italy.

The draft standard considered various geographic-environmental conditions and corrosion mechanisms, and made recommendations based on a desired anchor life expectancy of 50 years. It classifies various alloy groups according to their anticipated performance and suitability for particular environments.

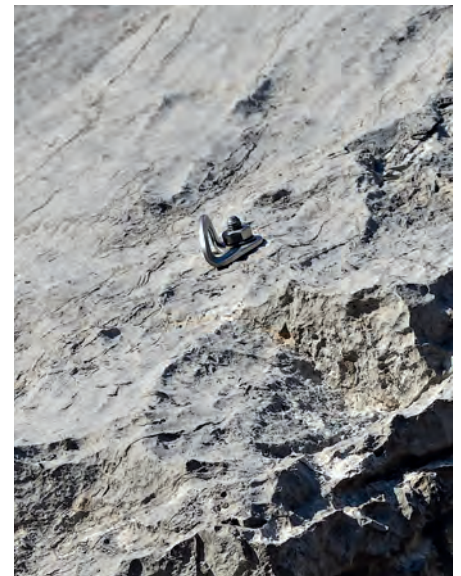
In this draft standard, Type 316 stainless steel is suggested for use in non-coastal European locations. A number of high-molybdenum, highly corrosion-resistant (HCR) stainless steels are considered to be resistant to stress-corrosion cracking and localized corrosion in coastal environments throughout the world. These alloys

include 2205 (UNS S31803) duplex stainless steel with 3% molybdenum and 904L (UNS N80904) austenitic stainless steel with 4% molybdenum. However, for the most severe warm and humid coastal environments titanium Grade 2 is suggested.

Meanwhile UIAA is sponsoring a long-term testing program on anchor materials, and some suppliers are already introducing HCR alloys into their product offerings. Without a doubt, molybdenum-containing Type 316 and HCR alloys will continue to be a mainstay of the anchors that support and provide safety to rock climbers all around the world. (GR)



New high corrosion-resistant (HCR) anchor made of 904L stainless steel. © Petzl



It is important to minimize permanent damage to the rock and visual impact of safety devices. Stainless steel anchors blend in with their surroundings and have a very long service life, so re-drilling of holes will not be necessary for decades. © Gaetano Ronchi