NOTE! This document is a "best guess" summary of the Standard, which remains a licenced document that must be purchased. Verify information before using.

ChatGPT

# EN 959:2018 (2019) – Mountaineering Equipment: Rock Anchors – Safety Requirements and Test Methods

*European Standard EN 959:2018 was approved by CEN in December 2018 and published in early 2019, superseding EN 959:2007* [1] [2]*. The 2018/2019 revision introduced significant changes, including new terminology (e.g. definitions for "eye" and "connector"), classification of rock anchors by environmental resistance, revised design requirements (eye thickness), updated load-bearing tests, new marking requirements (including anchor class), expanded user information, and a new type of "belay" anchor designed for route-top use* [3] [4]*. The text is based on the former UIAA Standard P, and EN 959 is part of a suite of mountaineering equipment standards (see Annex A)* [5] [6].

## 1. Scope

This document specifies safety requirements and test methods for rock anchors for use in mountaineering, including climbing [7].

## 2. Normative References

The following referenced document is indispensable for the application of EN 959. For dated references, only the edition cited applies; for undated references, the latest edition (including any amendments) applies [8]:

- **ISO 1920-3** – *Testing of concrete – Part 3: Making and curing test specimens* [9] (Referenced for concrete test block preparation in anchor testing).

## 3. Terms and Definitions

*For the purposes of this standard, the terms and definitions below apply.* (ISO and IEC maintain terminological databases at http://www.electropedia.org and http://www.iso.org/obp).

**3.1 Rock anchor:** Anchoring device intended for repeated use after installation, inserted into a drilled hole in the rock and held in place by gluing, expansion forces, or positive locking, and featuring an attachment point for a connector [10].

**3.2 Connector:** Openable device which enables a mountaineer to link themselves (directly or indirectly) to an anchor or to link parts of equipment together (e.g. a carabiner) [11]. *SOURCE:* EN 12275:2013, definition 3.1.

**3.3 Eye:** Attachment point on the rock anchor for a connector (often a ring or loop integrated into the anchor) [12].

**3.4 Body of the rock anchor:** Part of the rock anchor that is installed in the rock (e.g. the shaft of a bolt or glue-in) [13].

**3.5 Hanger:** An attachment point (plate) that can be separated from the body of a rock anchor (typically the removable plate on a mechanical expansion bolt) [14] .

**3.6 Installed length:** Distance from the rock surface to the furthest point of the anchor's body in mechanical contact with the rock or bonded to the rock, after installation [15] .

**3.7 Belay rock anchor:** Two or more rock anchors linked together, specifically designed to be placed at the top of a pitch (section) of a climbing route, to enable climbers to belay, be lowered, or to rappel down [16] .

# 4. Safety Requirements

## 4.1 Materials

Rock anchors shall be made of materials suitable for long-term use in their intended environment. If multiple materials are used in one anchor, they **shall be selected to avoid galvanic corrosion** (i.e. avoid pairing metals far apart in the galvanic series) [17] . **Polyester-based glues are not recommended** for anchor installation (due to limited lifespan) [18] . Depending on environmental factors, rock anchors are potentially subject to:

- **Galvanic corrosion**,
- **General corrosion**, and
- **Stress Corrosion Cracking (SCC)**.

To mitigate these risks, this standard defines **anchor material classes** (see Table 1) for different environments [19] . **Annex B** provides guidance on material selection and corrosion, and **Annex C** explains SCC. Manufacturers may use other materials **if they can demonstrate equal or better resistance** to SCC and other hazards than the specified minimum for the given anchor class in Table 1 [20] .

**Table 1 – Rock anchor classes and characteristics** (environmental suitability and specified materials):

| Anchor Class | Suitable Environment | Environmental Characteristics | Specified Materials | Remarks |
|---|---|---|---|---|
| **1** | Aggressive environment (high risk of SCC) | High chloride exposure (e.g. sea cliffs, karst areas); warm temperature >30 °C; relative humidity ~20–70%; presence of salt (sea water spray or deposits) or acidic rock/water | Titanium Grade 2 (ISO 3.7035); Stainless steels 1.4565, 1.4529, 1.4547, 1.4539 | SCC has been observed in these conditions. Although often associated with seaside cliffs, SCC can also occur inland and even in indoor wet environments (e.g. swimming pools) [21] [22] . |

| Anchor Class | Suitable Environment | Environmental Characteristics | Specified Materials | Remarks |
|---|---|---|---|---|
| **2** | Outdoor environment (no expected SCC) | No evidence or expectation of SCC under normal outdoor conditions; some moderate corrosion possible but not severe enough to cause SCC | Stainless steels 1.4401, 1.4404, 1.4435 <br> (Note: *lower-grade stainless like 1.4301 or 1.4306 are not recommended for prolonged outdoor use)* | Typical outdoor environments where chlorides or stress factors are not sufficient to induce SCC [23] . |
| **3** | Low-corrosion environment (indoors) | No SCC expected; generally dry indoor conditions with minimal corrosive exposure (e.g. climbing gyms) | Steel with protective coating (e.g. galvanized steel) or aluminum alloy with anodizing (or similar basic corrosion protection) | Intended for indoor use only. **Note:** Even indoor anchors in aggressive settings (near industrial fumes, chlorinated pools, or coastal areas) might require Class 1 or 2 materials for safety [24] . The anchor's class (1, 2, or 3) shall be marked on the product (see Marking). |

### 4.2 Design

**4.2.1** The rock anchor **shall have an eye** (integral or attached loop) that allows a connector to be attached. The overall thickness of the material forming the eye shall be **≥ 2.9 mm** (including at the eye's border) [25] . If the eye's edges are bevelled (chamfered), the remaining flat surface width must be at least **2 mm** [26] .

**4.2.2** All outer corners of the anchor that will protrude more than 12 mm from the rock surface after installation **shall be rounded to at least a 10 mm radius (R ≥ 10 mm)** [27] . *Figure 1* illustrates the required clear width and external shape of the eye, including the corner radius.

**4.2.3** All edges of the anchor that could be handled (touched) after placement in rock **shall be free of burrs and sharp edges**. The *inner* edges of the eye (the inside rim of any hole or loop) must be **rounded to at least R 0.2 mm or bevelled 0.2 mm × 45°** to prevent cutting or abrasion (*Figure 2* shows the internal eye edge profile) [28] .

**4.2.4** The eye of the anchor, when the anchor is installed in the test block (see 5.2), shall be large enough to accommodate **two** test pins simultaneously: one pin of diameter **15 ± 0.1 mm** in the lower part of the eye, and another pin of diameter **11 ± 0.1 mm** in the upper part (see Figure 1) [29] . *This ensures the eye is sufficiently large for two connectors (e.g. carabiners/ropes) as illustrated in the standard.*

**4.2.5** In the case of expansion-type rock anchors (mechanical bolt anchors), the anchor's expansion mechanism **shall not rely on contact with the bottom of the drilled hole** to activate or hold the anchor [30] . (In other words, the expansion sleeve/plug must engage fully on the side walls of the hole, not by wedging against the hole's end.)

**4.2.6** Minimum **installed length** of the anchor (the depth the anchor engages in the rock) shall be: - **≥ 70 mm** for glued-in (bonded) rock anchors, and - **≥ 5 × the diameter of the drilled hole** for mechanical (expansion) rock anchors,

as per the manufacturer's installation instructions [31] . **Note:** In softer rock (weaker than the standard concrete test block), a longer embedment may be necessary to achieve the required strength – see Annex D for guidance [32] .

**4.2.7** If the product is a **belay rock anchor** (as defined in 3.7) comprising two rock anchors permanently linked together (e.g. by chains or rings), **each anchor and the linking system shall withstand a 25 kN load** individually [33] . In practice, this means each anchor of the belay set must meet the strength requirements of 4.3 below, and any connector links (chains, rings) between them must also meet the strength of 25 kN (see 4.3.3). All components of a combined belay anchor system shall be made of the **same material** (if metallic) to avoid galvanic corrosion and differential strength issues [34] .

**4.2.8** If a rock anchor or belay anchor is equipped with a **rope attachment point** (for directly threading a rope, e.g. a ring or eye intended for rope rappel), that attachment point shall have a **minimum thickness of 9 mm** [35] . The material of such a rope-bearing component must be the same alloy or grade as the primary rock anchor to which it is attached (again to avoid corrosion or strength mismatches).

### 4.3 Load-Bearing Capacity

**4.3.1 Axial load capacity:** When tested per 5.3.2.2 (pulling *axially*, i.e. outward along the anchor's axis), the rock anchor shall withstand an axial tensile load of **15 kN** without pulling out of the concrete block or breaking [36] . Permanent deformation of the anchor is acceptable at this load, but failure or complete pull-out is not.

**4.3.2 Radial load capacity:** When tested per 5.3.2.3 (load applied *radially*, i.e. shear load parallel to the rock surface), the rock anchor shall withstand a load of **25 kN** without being pulled out or breaking [37] . Permanent deformation is acceptable at this load, but the anchor must not shear off or eject from the hole.

**4.3.3 Belay anchor linking elements:** For a belay rock anchor (two anchors linked as an assembly), the **linking element(s)** (e.g. chain links, rapid links, rings connecting the two anchor points) shall withstand a **25 kN** tensile load when tested per 5.3.2.4 [38] . This ensures the chain or connector between anchors is as strong as the anchors themselves. Permanent deformation of the link is allowed, but it must not break under 25 kN.

## 5. Test Methods

### 5.1 Check of Materials

The manufacturer shall provide evidence (e.g. material certificates or specifications) that the materials used in the rock anchor meet the requirements of clause 4.1 (appropriate alloy, corrosion resistance, etc.) [39] . No specific lab test is mandated for materials; rather, material selection is verified by documentation.

## 5.2 Concrete Block

All mechanical tests are conducted using a standard concrete test block to simulate rock. The concrete block shall have minimum dimensions of **200 mm × 200 mm × 200 mm** and a compressive strength of **(50 ± 10) N/mm²** (i.e. ~50 MPa concrete) [40]. The aggregate in the concrete should have a maximum grain size of 16 mm. The concrete's compressive strength must be verified on three sample cubes made according to ISO 1920-3 [40]. *(Note: This strength corresponds to a hard rock or high-strength concrete to ensure the anchor, not the concrete, is the weak point. Such blocks can be obtained to order from concrete testing centers [41].)*

## 5.3 Procedure

### 5.3.1 Examination of Design

Before load testing, perform a visual examination and measurement of the anchor to check that the design and dimensions meet the requirements of 4.2.1 through 4.2.6 [42]. This includes verifying eye thickness (≥ 2.9 mm), edge radii (R 10 mm, R 0.2 mm, etc.), eye internal dimensions (fit of 15 mm/ 11 mm pins), and minimum installed length. Any non-conformity in design would disqualify the anchor before proceeding to load tests.

### 5.3.2 Determination of Load-Bearing Capacity

**5.3.2.1 Installation:** Install the rock anchor into the concrete test block according to the manufacturer's instructions [43]. For glue-in anchors, use the specified adhesive and curing time; for expansion anchors, use the recommended hole diameter, torque, etc. The anchor is installed in the center of the block with the correct embedment depth (≥ 70 mm or ≥ 5×hole diameter as applicable).

**5.3.2.2 Axial load test:** Mount the concrete block in a tensile testing machine such that the block is firmly held (e.g. clamped) at a distance **a > (installed length + 5%)** away from the anchor's axis [44] (this prevents the clamp from interfering with anchor pull-out). Attach a loading pin of **10 ± 0.1 mm** diameter through the eye of the anchor [45] (simulating a carabiner). Apply an **axial tensile load** (pulling the anchor directly outward) at a rate of **35 ± 15 mm/min** [46]. Perform **10 loading cycles** from 0 kN up to **8 ± 0.25 kN** and back down to **<0.5 kN** (almost unloaded) [46], within a 10 minute period – this cycling helps to settle the anchor and simulate minor load fluctuations. After 10 cycles, increase the load continuously until the anchor either **fails** (breaks or pulls out) or reaches the testing machine's limit [47]. Record the maximum load sustained. **Requirement:** the anchor must sustain ≥ **15 kN** without failure (per 4.3.1). *Figure 3* in the standard illustrates the axial test setup [48].

**5.3.2.3 Radial load test:** Using a **new** identical rock anchor, repeat the installation in a fresh concrete block (per 5.3.2.1) [49]. Mount the block in the testing machine with a support that allows a **radial (shear) load** on the anchor – for example, the block may be clamped at a distance **a > (installed length + 5%)** from the anchor axis, with a support under the block so that the machine can press/pull the anchor sideways [50]. Insert the **10 mm pin** in the anchor's eye and apply a **radial load** at **35 ± 15 mm/min**. Again, perform **10 cycles** from 0 up to **8 ± 0.25 kN** and back to <0.5 kN over 10 minutes [51]. Then increase the load until failure or until the 25 kN requirement is exceeded [52]. **Requirement:** the anchor must sustain ≥ **25 kN** in shear without breaking or pulling out (4.3.2). *Figure 4* in the standard shows the radial (shear) test configuration [53].

**5.3.2.4 Linking element test (for belay anchors):** For a **belay anchor assembly** (two anchors connected by a chain or link), test the linking hardware by installing two anchors in two blocks or a fixture, or otherwise securing the anchor eyes, and threading **two 10 mm pins** through the eyes to attach the assembly in a tensile test machine [54]. Apply a **tensile load of 25 kN** between the two anchor eyes at **35 ± 15 mm/min** [54]. The chain/linking system must hold 25 kN without failure (though yielding is allowed), per 4.3.3. This test verifies that the chain or rings connecting the anchors can bear the required load. *(If the belay anchor's chain is not integral, the test can be done on the chain/link alone between two pins.)*

## 6. Marking

Each rock anchor's **attachment point (eye or hanger)** shall be **clearly, indelibly, and durably marked** with the following information [55]. Markings **a)–d)** must remain visible **after installation** (i.e. even when the anchor is fixed in the rock) [55]:

- **a)** Name or logo of the **manufacturer** (identifying the maker).
- **b) Batch or serial number**, or other traceability code.
- **c) Anchor class** (the environmental class 1, 2, or 3 from Table 1) – this class designation shall be enclosed **within a circle** to distinguish it [56]. (For example, an anchor marked "①" would indicate Class 1.)
- **d)** The **model identifier** of the anchor (e.g. product model name/number, especially if the manufacturer markets several different anchor models).
- **e)** A graphical **information symbol** indicating "read the accompanying instructions". This shall be the standard icon (ISO 7000 symbol 1641: the book symbol) to prompt users to consult the manufacturer's information leaflet [57] [58]. *(Figure 5 in the standard illustrates this symbol.)*

*(No other markings are required by EN 959: notably, marking the standard number "EN 959" on the product is not mandatory, but including it is not prohibited. The critical markings are the above to ensure identification and appropriate usage.)*

## 7. Information Supplied by the Manufacturer

Each rock anchor shall be supplied with an **explanatory leaflet or instruction manual**, written in at least the official language(s) of the country where the product is sold [59]. This **user information** shall contain, at minimum, the following details [60] [61]:

- **a)** The **name and address** of the manufacturer (and/or their authorized representative).
- **b)** A reference to this standard, i.e. **EN 959:2018**, to indicate that the product conforms to it [62].
- **c)** The **model identifier** of the rock anchor (if the manufacturer offers multiple models, identify which model the instructions pertain to).
- **d)** The size of the anchor, if applicable (e.g. diameter or length, if more than one size is available).
- **e)** An explanation of the **markings on the product**, especially the **anchor class symbol**. (For example, explain that "①" means a Class 1 anchor suitable for seaside use, etc.) [63].
- **f)** A description of the **components** that make up the complete rock anchor and the **materials** used. (For instance, specify if the anchor consists of a bolt and hanger, and that they are made of 1.4404 stainless steel.) [63].
- **g)** Instructions on the **proper use of the rock anchor**. This should outline what the anchor is designed for (repeated protection point in climbing, not for single-use removal, etc.), and any limitations (e.g. suitable rock types, angles of load, etc.).
- **h)** Instructions on **how to correctly install the rock anchor**. This is crucial for installers and should include: drilling diameter and depth, cleaning of the hole, mixing and applying adhesive for glue-ins, tightening torque for expansion bolts, curing time for resin, etc., as applicable [64].

- **i) Recommendations on adhesives** (for glue-in anchors): specify the types or qualities of adhesive that are suitable, that provide adequate strength and a long service life [65]. (For example, the leaflet might recommend using a two-component epoxy with certain properties, and warn against using polyester resin in corrosive environments.)
- **j)** Guidance on how to **choose other components in the anchoring system**, and the need for **material compatibility** [66]. For instance, if a hanger or carabiner will be used with the anchor, the info should stress using components of compatible material (to avoid galvanic corrosion, see Annex B) and adequate strength.
- **k)** The **expected lifespan of the product** in different environments [61]. This should particularly address marine or coastal environments: e.g. "Stainless steel anchors in marine coastal areas may be subject to stress corrosion cracking over time – see Annex B – and might have a shorter useful life." Manufacturers should give some indication (even if qualitative) of how long the anchor can be expected to last in benign indoor conditions vs. harsh seaside conditions, etc., and that **regular inspections** are necessary (see below).
- **l)** A **warning** that the rock anchor's load-bearing capacity may be significantly lower if installed in **soft or poor-quality rock**, and advice on what to do in such cases [67]. For example: "In soft rock (such as sandstone or highly weathered rock), the anchor may not achieve the 15/25 kN strength. In such cases, use a longer or larger-diameter anchor, or other means to improve strength – see Annex D." This item should reference that the installer must account for rock condition (Annex D provides guidance).
- **m)** Information on **inspection, maintenance, and retirement** of the anchor: how to assess the remaining lifespan of an installed anchor over time, and **when and how to remove or replace it** in the future [68]. This should include signs of corrosion or damage that would indicate the anchor is no longer safe (e.g. stress cracks, significant rust, bending) and advice that anchors in corrosive environments need frequent checks and possibly proactive replacement after a certain period.

*(The above information is intended to ensure that end-users, installers, and maintenance personnel have full knowledge of how to use the anchor safely and how to mitigate environmental effects. Annex B and Annex D of the standard are referenced for further details on material/environment and installation in rock.)*

## Annex A (informative): Standards on Mountaineering Equipment

**Table A.1 – List of related standards** (mountaineering equipment safety standards referenced as a package with EN 959):

1. **EN 564:** Mountaineering equipment – *Accessory cord* – Safety requirements and test methods [69]
2. **EN 565:** Mountaineering equipment – *Tape (webbing)* – Safety requirements and test methods [69]
3. **EN 566:** Mountaineering equipment – *Slings* – Safety requirements and test methods [70]
4. **EN 567:** Mountaineering equipment – *Rope clamps* (ascenders) – Safety requirements and test methods [71]
5. **EN 568:** Mountaineering equipment – *Ice anchors* (ice pitons/screws) – Safety requirements and test methods [72]
6. **EN 569:** Mountaineering equipment – *Pitons* – Safety requirements and test methods [72]
7. **EN 892:** Mountaineering equipment – *Dynamic mountaineering ropes* – Safety requirements and test methods [73]
8. **EN 893:** Mountaineering equipment – *Crampons* – Safety requirements and test methods [74]
9. **EN 958:** Mountaineering equipment – *Energy absorbing systems for use in klettersteig (via ferrata) climbing* – Safety requirements and test methods [75]

10. **EN 959:** Mountaineering equipment – *Rock anchors* – Safety requirements and test methods (***this standard***) [76]
11. **EN 12270:** Mountaineering equipment – *Chocks* (passive protection) – Safety requirements and test methods [77]
12. **EN 12275:** Mountaineering equipment – *Connectors* (carabiners) – Safety requirements and test methods [78]
13. **EN 12276:** Mountaineering equipment – *Frictional anchors* (active protection such as cams) – Safety requirements and test methods [79]
14. **EN 12277:** Mountaineering equipment – *Harnesses* – Safety requirements and test methods [80]
15. **EN 12278:** Mountaineering equipment – *Pulleys* – Safety requirements and test methods [80]
16. **EN 12492:** Mountaineering equipment – *Helmets for mountaineers* – Safety requirements and test methods [81]
17. **EN 13089:** Mountaineering equipment – *Ice tools* (ice axes, etc.) – Safety requirements and test methods [82]
18. **EN 15151-1:** Mountaineering equipment – *Braking devices – Part 1: Braking devices with manually assisted locking* – Safety requirements and test methods [83]
19. **EN 15151-2:** Mountaineering equipment – *Braking devices – Part 2: Manual braking devices* – Safety requirements and test methods [84]
20. **EN 16716:** Mountaineering equipment – *Avalanche airbag systems* – Safety requirements and test methods [84]

*(This annex simply lists the scope of related standards; EN 959 is one element of a comprehensive set of European safety standards for climbing equipment.)*

## Annex B (informative): Choice of Materials for Different Environmental Conditions (and Consequences for Inspection & Maintenance)

Rock anchors are used in a wide range of environments – from high alpine areas to sea cliffs – with varying temperatures, humidity, rainfall, and chemical exposures. Annex B discusses how different conditions affect material durability [85] [86]. Key points include:

- **Corrosion risk varies by environment:** On sea cliffs, anchors are regularly exposed to salt spray; salt crystals can concentrate on anchors especially if not washed off by rain, leading to an aggressive corrosive environment [87] [88]. Warm, humid marine climates are particularly conducive to *stress corrosion cracking (SCC)* in certain stainless steels, which has led to **catastrophic failures** of anchors in the past [86]. Even inland, environments like indoor swimming pools (chlorine, magnesium chloride) or coastal industrial areas can create SCC-prone conditions.

- **Avoid galvanic corrosion:** If an anchor has multiple components of different metals (e.g. a steel bolt with an aluminum hanger), galvanic corrosion can occur when moisture is present [89]. Annex B recommends ensuring all parts of an anchor assembly are of the **same or galvanically compatible material** (similar noble potential) to prevent galvanic couples [89]. For anchors with removable parts (like a hanger), the user/installers should use only replacement parts of the correct material. The standard requires manufacturers to provide information about the materials so that users can avoid mixing incompatible metals [90] (see 7(j)).

- **Use highly corrosion-resistant materials in severe environments:** In very corrosive settings (sea cliffs, tropical seaside crags, caves with high humidity and guano, etc.), **high corrosion**

**resistance materials (Class 1 anchors)** are essential for a long service life [91]. Titanium or HCR stainless steel anchors significantly extend lifespan in these environments. *Even so, periodic inspection is crucial:* Annex B advises that installed anchors **should be inspected regularly** for signs of corrosion or degradation, especially in high-risk locations [91]. Regular maintenance and replacement plans are necessary to manage safety over time.

*(Annex B serves as a guide for manufacturers and installers on material selection and maintenance in different climates, complementing the normative requirements of clause 4.1.)*

## Annex C (informative): Stress Corrosion Cracking of Steel Anchors

Annex C provides a detailed overview of **stress corrosion cracking (SCC)** in stainless steel rock anchors, including a table (Table C.1) of factors that contribute to SCC [92] [93]. Important factors include:

- **Environmental factors:** Presence of certain salts and chemicals greatly increases SCC risk. For example, chloride ions are the main culprit – **sodium chloride** (sea salt) and even **magnesium chloride** (used in indoor pool water) can induce SCC in susceptible stainless steels [94]. SCC has been observed to start at around 20 °C if chlorides are present, and higher temperatures accelerate it [95]. A critical relative humidity range (approximately 20%–70%) is mentioned, as dry salt deposits can attract moisture at those humidities and create a corrosive electrolyte [96]. Coastal locations (up to many kilometers inland, depending on wind patterns) are at risk due to airborne salt [97]. Anchors not regularly washed by rain (e.g. in caves or overhangs) allow salts to accumulate and concentrate, increasing SCC likelihood [97]. Even the type of rock can matter: limestone or dolomite areas are noted, possibly because their porous nature or mineral content can retain chlorides or create alkaline conditions that, combined with marine aerosols, have led to SCC incidents [98].

- **Mechanical/metallurgical factors:** SCC requires tensile stress in the material. Annex C notes that anchors can have high residual stresses from **manufacturing** (e.g. cold-working, bending, welding) and **installation** (e.g. expansion bolts under tension, or stress from adhesive curing) [93]. Additionally, **applied loads** contribute: a anchor that has caught multiple hard falls or been deformed (even slightly) is under stress. All these stresses (residual + applied) combined with a corrosive environment set the stage for SCC [93]. The annex emphasizes that minimizing stress (through proper manufacturing processes and avoiding overload) and using SCC-resistant alloys are ways to mitigate the risk.

Table C.1 in the standard outlines these factors in two categories (“Environmental characteristics” and “Anchor characteristics”) with explanatory remarks [92] [93]. It serves as a reference for understanding why and where SCC occurs, reinforcing the guidance that **Class 1 materials** should be used in SCC-prone environments and that anchors should be inspected for telltale signs (e.g. cracks).

## Annex D (informative): General Guidance for Placing Rock Anchors

Annex D offers practical advice to installers and route developers on how to ensure anchors achieve the required strength when placed in actual rock, as opposed to the ideal concrete test block. Key guidance includes:

- **Rock quality matters:** Anchors meeting EN 959 will achieve the specified 15 kN axial / 25 kN radial strengths **if installed in rock of equivalent strength to the test concrete** [99]. However, **if the rock is weaker or not homogeneous**, the same anchor might not reach those values. For example, fractured, weathered, or soft rock (like sandstone, tuff, etc.) may result in lower pull-out or shear strength [100]. Pockets of loose rock, hidden micro-cracks, or air voids in the rock can significantly reduce holding power [100]. Thus, the standard cautions that the 15/25 kN performance *cannot be guaranteed* in all rock conditions.

- **Mitigating poor rock conditions:** To achieve required strength in softer or less reliable rock, Annex D suggests using a **longer anchor or a different anchor design** that can compensate for the lower rock strength [101]. For instance, deeper embedment or using glue-in anchors with larger surface area might be necessary. It might even be prudent to select a larger diameter anchor or special anchor types for certain rock. The manufacturer's instructions (per clause 7) should alert the installer to these issues and recommend solutions [102]. Annex D explicitly states that manufacturers need to provide guidance to make installers aware of potential problems in poor rock and how to address them [102].

- **Anchor suitability and testing:** Some anchor designs may simply **not be suitable for certain rock types** [103]. For example, a short expansion bolt may not work well in soft sandstone, where a long glue-in would be better. Annex D suggests that in uncertain cases, installers should consider doing **trial installations** – placing a few test anchors of various lengths or types in the actual rock and pull-testing them (in situ) to verify they achieve the desired strength [103]. This empirical approach can inform the best choice of anchor for that location.

In summary, Annex D reinforces that meeting the standard's requirements in the lab is one thing, but field conditions vary. It urges proactive measures (anchor selection, installation technique, testing, and information from manufacturers) to ensure safety is maintained when anchors are placed on real climbs.

## Bibliography

The standard's bibliography includes references to technical standards and documents relevant to rock anchor materials and related equipment. Notably, it cites standards for stainless steel material designations and properties (e.g. **EN 10088-3:2014** on stainless steel technical delivery conditions, and **EN 10027-2:2015** on the numerical designation system for steel grades) [104]. These help in identifying the steel grades (1.4401, 1.4529, etc.) used in anchors. It also references the connector standard **EN 12275:2013** (for definitions, as used in 3.2) [105]. These references provide additional context and are useful for manufacturers or testers looking for detailed material specifications or related safety standards. (No other specific climbing literature is referenced beyond what's listed in Annex A and these material standards.)

**【References】** European Committee for Standardization – *EN 959:2018 Mountaineering equipment – Rock anchors – Safety requirements and test methods*, December 2018 (BSI BS EN 959:2019 publication) [106] [107]. The content above has been reconstructed and summarized from the publicly available portions of this standard and related technical guidance [7] [108].

---

[1] [30] [31] [32] [33] [34] [35] [36] [37] [38] [39] [40] [41] [42] [43] [44] [45] [46] [47] [48] [49] [50] [51] [52] [53] [54] [55] [56] [57] [58] [59] [60] [61] [62] [63] [64] [65] [66] [67] [68] [69] [70] [71] [72] [73] [74] [75] [76] [77] [78] [79] [80] [81] [82] [83] [84] [85] [86] [87] [88] [89] [90] [91] [92] [93] [94] [95] [96] [97] [98] [99] [100] [101] [102] [103] [104] [105] [106] [107] [108] BS en 959 2018 | PDF
https://pt.scribd.com/document/715998466/BS-EN-959-2018

[2] [3] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17] [18] [19] [20] [21] [22] [23] [24] [25] [26] [27] [28] [29] EN 959:2018 - Mountaineering equipment - Rock anchors - Safety requirements and test methods
https://standards.iteh.ai/catalog/standards/cen/1ecacc12-5e4d-4429-96b6-f116da7fe5f9/en-959-2018?srsltid=AfmBOoo_rK67Lx0HEFnwh2tdgT3gFpd3iLx6zAh0Pfz6NLe63svxS7mQ