

## BOLTS AND BOLTING

Csaba Császár  
Hungarian Cave Rescue Service



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## BOLTS

- Reliable bolts and anchors not only increase safety but decrease the negative environmental impact on the caves to the minimum in the same time
- They are inevitable parts of our hardware
- We'll overview the different types and usages



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## Why does an anchor hold in base material?

There are three basic principles which make an anchor hold in base material

- **Friction:** the tensile load is transferred to the base material by friction. An expansion force is necessary.
- **Keying:** the tensile load is in equilibrium with the supporting forces
- **Bonding:** an adhesive bond is produced between the anchor rod and the hole wall by a synteticresin adhesive



Many anchors obtain their holding power from a combination of the above mentioned working principles.

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## Why an anchor does not hold in base material?

- **Pull out**
  - Lowest forces, soft base material, low friction
- **Breaking of substrate**
  - Low strength of substrate, too rigid substrate
  - Small edge distance, too high expansion force
- **Steel failure**
  - Breaking of the anchor, highest force



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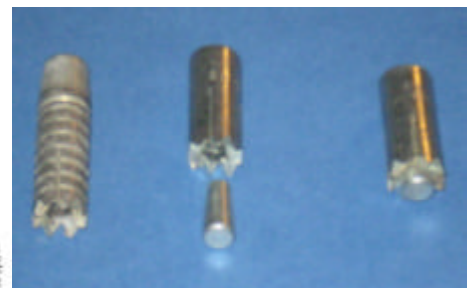
## Anchor types

- Self drilling anchor 'Spit' (The Standard)
- Drop in / Push in / Hammer in Anchor
- Undercut anchors
- Expansion anchors
- Chemical anchors
- Removable anchors



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## SELF DRILLING ANCHOR 'SPIT'



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### Self drilling anchor 'Spit'

- Proven
- Easy to use, no power tool needed
- The best tool to clean the rock surface
- Shallow embedment limits load capacity
- Doesn't fit to all possible rock types
- Limited lifetime (no stainless steel version)
  - High price due to complicated manufacturing
  - Single source (SPIT)



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### DROP IN / HAMMER IN / PUSH IN ANCHOR



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### Drop in / Hammer in / Push in Anchor

- Stainless steel version available
- Internal thread
- Shallow embedment
- High pressure to the rock ( friction! )
- Needs additional setting tool
- Application: in hard rock
  
- Petzl: Long Life, Raumer: Full Time ( Maxi )



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### EXPANSION BOLTS / STUD ANCHOR / WEDGE BOLT



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### Expansion bolts / Stud Anchor / Wedge bolt

- Industry proven
- Stainless steel and tension zone approved types
- Small drill hole diameter ( = thread size )
- Easy manufacturing process, good price
- No special setting tool needed
- Not the best in soft rock
- Hanger removal can be difficult
- The stud can not be removed
  - Mungo Mr2-1 with internal thread
  - Petzl Coeur Goujon
  - Application: allround



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### SLEEVE ANCHOR



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### Sleeve Anchor

- Known as 3 piece bolt as well
- Hole diameter is 2 mm bigger than thread
- Better in soft material than expansion bolts
- May be removed and reused
- Hilti: HLC; Fischerdübel: FSA
- Fixe Triplex
- Application:
  - In soft rock
  - Where removability is important



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### HIGH CAPACITY / SAFETY ANCHORS



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### High capacity / Safety anchors

- Known as 5 piece bolt as well
- Concrete tension zone approved
- High permissible loads and bending torque
- Works fine in soft rock
- Stainless steel versions
- High drill diameter (appr. 1.5Xthread diameter)
- Expensive
- Application:
  - Where high loads are generated (Tyrolean ...)
  - In soft rock



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### UNDERCUT ANCHORS



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### Undercut Anchors

- Highest safety mechanical anchor types
- Need special tooling to install / produce undercut
  - Torque controlled undercut: Liebig Superplus
- High permissible loads
- Low stress / stress free fixing
- Small edge and axle spacing
- Expensive
  - Fischerdübel FZEA
    - Hole and undercut are made with a special drill bit
    - Additional setting tool needed
    - Internally threaded, stainless steel version
    - Application: where safety rules



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### SCREW ANCHOR / CONCRETE SCREW



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### Screw Anchor / Concrete Screw

- The special screw is driven into the hole
- Direct fastening into base material
- Small drill diameter (smaller than thread diameter)
- High quality steel (10.9 and 12.9)
- Some supplier have stainless steel versions
- Removable, reusable
- Small spacings and edge clearance
- Additional adhesive can be used to seal the hole
- Application:
  - Where drill diameter rules
  - Removability is important
  - Artificial step



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### CHEMICAL ANCHORS

- Works in hard and soft rock as well
- Stainless, one piece glue-in-bolts are available
- Stress free fixing
- Small edge and axle spacing
- Sealed hole
- Drill diameter like with the sleeve anchor
- Difficult technology
- Needs time for curing
- For long term installations
- Different systems and chemistries
- Application: long term installations



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### Chemical anchors

- Anchor
  - Bolts, Threaded bars, Ring bolts, Bolt hangers, Tension zone approved adhesive anchors
- Adhesive
  - Resin + Hardener + Filler+ Other additives
- Package of adhesive
  - Capsules
  - Twin Packs ( dispensing gun, static mixer )
  - Separate containers



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### Adhesive packages



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### Adhesive capsules

- Fast curing
- No additional glue gun needed
- Overhead application possible
- Mixing: anchor should be driven into the capsule with hammer drill to gain correct mixing
- Least waste



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### Twin packs

- The glue is dispensed with a glue gun
- The mixing is done in a static mixer
- Different chemistries, different dispense guns
- Fast curing chemistries ? frequent mixer change



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### Separate containers

- Eg.: Epoxies ( Sikadur C31 )
- Epoxies must be mixed well ( Mixing ratio! )
- Lot of waste
- Filling up of the hole has difficulties



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### Glue in Bolts

Designed for rock climbing

- Petzl
- Raumer
- Fixe
- Cassin
- Kong
- Austrialpin / Stubai / Salewa
- Singing Rock



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### Glue in Bolts



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