Anchoring

Ground anchors are elements used to transfer the compressive strength load from structures or other units into the ground around or below that which is being built.

Some of the various types of anchors are:

- standard grouted anchors;
- rock and soil nails;
- driven steel piles;
- driven reinforced concrete piles;
- injected grout piles;
- drilled piles.

Anchors can be used in numerous ways:

- retaining walls for excavation pits;
- to secure shorelines and river banks;
- to prevent buoyancy;
- to secure underpinning;
- for tensioning purposes;
- to secure embankments and rock walls;
- to prevent tipping and sliding of structures;
- to secure and excavate cave-like structures.
Standard Grouted Anchors

The BBV standard ground anchors consist of tension elements made up of 2 to 9 strands, grade ST 1570/1770, that are installed in cased or uncased drilled boreholes. The individual strands are wedged into the anchor head and are, therefore, firmly connected to the element that is to be anchored. The anchor transfers its load through adhesive stress to the pressure-grouted body. This, in turn, transfers the load into the ground through suspended friction.

The length of the pressure-grouted body, known as the bonded length, varies depending on the type of soil, the diameter of the pressure-grouted body and the amount of tension.

The free anchor length is the area between the anchor head and the pressure-grouted body. It extends from the anchor head to the beginning of the anchorage length. The length of the grouted anchor is a result of the static computation (evidence of the sliding joint depth, weight of the ground unit).

Depending on the service life of the anchor, there is a distinction between temporary anchors and permanent anchors.

Temporary anchors, according to European Standard EN 1537, can be used for 2 years and are provided with a single corrosion protection. This protection is made up of cement grout in the anchorage area and, in the exposed anchoring area, of plastic pipes.

Permanent anchors have to carry their load over the lifetime of the structure. For this reason, corrosion protection plays a very important role. The double corrosion protection system consists in the anchorage area of a corrugated tube grouted with cement mortar. In the exposed area, the smooth tube is filled with grease.
Anchor Production – Drilling Method

Boreholes for the anchor installation are drilled as cased, uncased or partially cased borings.

Uncased or partially cased borings can only be done in solid ground or sound rock. Examples of relevant drilling methods are: Auger drill that mechanically conveys the dug out ground over the auger's spiral or a rotary drill that uses an air flushing system.

A cased boring has to be used in soft ground. Depending on the type of ground, the pipes can either be driven or drilled. In the driving method, the ground is displaced to the side; and in the drilling method, it is conveyed to the surface by compressed air or with the help of a flushing stream of compressed air and/or water.

Drilling equipment mounted on caterpillar tracks is primarily used for driving and drilling works.

After the hole has been bored, the anchor tension elements are fed into the anchor and then, in the case of cased drillings, the casing is withdrawn and a cement suspension is simultaneously injected under high pressure. This causes the suspension in the area of the pressure-grouted body to be pressed against the ground and meshes with it. In the case of uncased drilling, this effect is attained only through post grouting.

The strands can be prestressed and wedged after the pressure-grouted body has hardened and the anchor head has been installed.

When permanent anchors are used, in order to protect against corrosion, the anchor head is then covered with a protective cap and sealed with a corrosion preventing paste.
Anchoring to Protect Against Pressurized Water

When retaining walls are being built to retain pressurized water, no water or soil is allowed to flow through the anchor borehole into the construction pit during the anchor installation. Implenia Spezialtiefbau GmbH has developed a special anchoring system for this purpose. Anchor production is done in all phases within a watertight head construction.

Increasing the Anchor’s Load Bearing Strength with Postgrouting

The maximum bearing strength of grouted anchors can be increased by improving the suspended friction between the ground and the pressure-grouted body. This improvement of the suspended friction can be attained by post-grouting. For this purpose, and depending on the post-grouting system, one or more post-grouting lances will be installed with the anchor during the production phase. These lances serve the purpose of feeding water into the pressure-grouted body so that it bursts and then a cement suspension can be injected into it. This cement suspension increases the size of the pressure-grouted body as well as the load bearing capacity. The fissures that result in the pressure-grout body are filled in by the cement grout.

BBV System’s Removable Pressure-Grout Anchor System

When construction pit retaining walls are anchored in inner urban areas, anchors very often protrude into the ground of the neighboring property, if the neighbor allows it, and, after the construction project is completed, these anchors remain in the ground. This sometimes entails high costs per anchor. Implenia Spezialtiefbau GmbH has developed a device that is installed with the anchor and allows the complete steel tension element to be removed.
Soil Nailing

Soil nailing turns naturally occurring soil into an artificial gravity wall. This is achieved with the aid of soil nails which are anchored into a reinforced shotcrete shell. Tension and shearing strength of the soil is increased by soil nailing so that the nailed precipitate can be regarded and certified as a monolithic block. The maximum distance between nails is 1.5 meters both horizontally and vertically and can only be exceeded if the space has been proven to be stable. The bore holes are to be drilled with a minimum horizontal pitch of 10°.

Producing the bore holes is the same as for grouted anchors. In compliance with generally approved building regulations "Soil Nailing System BBV", the soil nails are made up of regulated ribbed concrete steel BSt 500 S-GEWI (IV S GEWI) with thread grooves of the following diameters: 18 mm, 20 mm, 25 mm, 28 mm, 32 mm, 40 mm and 50 mm. The soil nails will be anchored on the exposed side by GEWI-anchors that meet with building regulations approval.

Just like with standard grouted anchors, there is a difference between temporary soil nails (to be used for less than 2 years) and permanent soil nails. Corrosion protection for permanent soil nails is to be applied during the manufacturing phase.

The main applications for soil nailing are for temporary or permanent securing of fissured ground such as in construction pit retaining walls and embankments; the securing of existing sloped banks; and the stabilization of the ground during underpinning work. In the process, the pitch of the wall can be chosen freely.
**Micropiles**

Micropiles are small diameter grouted piles with a load bearing part made of reinforced steel bars with BSt 500 S thread grooves and a nominal diameter of 28 mm, 40 mm and 50 mm or of iron bars with S 555/700 thread grooves and a nominal diameter of 63.5 mm. According to European Standard EN 14199 (formerly DIN 4128), the tension and pressure load on these piles should only be done axially. They are also ideally used as anchoring elements such as anchor piles. The same drilling and grouting techniques used for standard grouted anchors are also used to produce these micropiles. There is also a difference as to whether these piles are to be used for temporary purposes (less than 2 years) or for long-term purposes. The difference has to do with corrosion protection, including a hydrated cement cover. Post-grouting is done in compliance with the “Generally Approved Building Regulations” for BBV grouted piles and BBV micropiles which are only allowed when they are done through grouting lances or grouting valves.

Unlike high-strength pre-stressed grout anchors that have to be pre-stressed with the correct amount of tension in order to limit deformation when used, micropiles are more advantageous because they do not need to be pre-stressed. The load-bearing steel part can be buffered with bushings. This allows the production of micropiles to also be done in tight conditions.

The principal area where micropiles can be utilized as anchoring elements is to secure against buoyancy in underwater concrete and jet grouted inverts as well as for the anchoring of bulkheads and underpinnings.