The Soilcrete® – Jet Grouting Process
Small scale underpinning works were the beginnings of an unusual way of jet grouting. To reach today's state of the art, additional development was necessary.

- The process was modified to suit different types of soils.
- The application was developed step by step to provide solutions to a variety of problems.
- Equipment was developed and improved.
- A general licence for Soilcrete was issued by the Institute of Construction Technic in 1986.

This brochure reports on the state of the Soilcrete technique today.
Soilcrete – Jet Grouting Process

The name “Soilcrete” derives from the concept “soil” to “concrete” a form of soil with a concrete consistence, a description that characterises the type of soil stabilisation.

The jet grouting process

The jet grouting process “Soilcrete” is recognised as a cement soil stabilisation. With the aid of high pressure cutting jets of water or cement suspension having a nozzle exit velocity \( \geq 100 \text{ m/sec} \) eventually air-shrouded the soil around the borehole is eroded. The eroded soil is rearranged and mixed with the cement suspension. The cement-sand mix is partly flushed out to the top of the borehole through the annular space between the jet grouting rods and the borehole. Different geometrical configurations of Soilcrete elements can be produced. The erosion distance of the jet varies according to the soil type to be treated, the kind of Soilcrete process and the jetting fluid being used, and may reach up to 2.5 meter.

Applications

In contrast with the conventional ground stabilisation methods Soilcrete may be used for stabilisation and sealing of all kind of soil ranging from loose sediments to clay. This applies also for non homogeneous soil formations and changing soil layers, including organic material. Soft rock formations have also been treated by Keller Grundbau GmbH – for example sandstone with weak grain texture.
The Soilcrete – properties

Soilcrete acts in the ground according to the specification either as a stabilisation or as a sealing structure. A combination of both properties is increasingly required.

The compressive strength of Soilcrete ranges from 2 to 25 N/mm² and is determined by the cement content and the remaining portion of the soil in the Soilcrete mass.

The sealing effect of Soilcrete against water ingress is achieved by selecting a suitable grout suspension and if necessary by the addition of Bentonite. The type and quantity of the injected grout material as well as the kind and volume of the remaining soil particles in the Soilcrete mass guiding the sealing properties.

Depending on the nature of soils, Soilcrete cut-offs are able to reduce the coefficient of permeability by several decimal powers. High quality requirements in respect of the degree of sealing effect necessitate extensive production efforts. For many applications both the strengthening and sealing characteristics of the Soilcrete elements are used. The selected suspensions need to be composited accordingly.
Soilcrete – Process Variations

Soilcrete is produced in three different ways. The method to be used is determined according to the prevailing soil conditions, the geometrical form and the required quality of the Soilcrete elements.

Soilcrete S
(Single direct process) operates with a grout jet of min. 100 m/sec. exit velocity for simultaneous cutting and mixing of the soil without an air shroud.

The Soilcrete S process is used for small to medium sized jet grout columns.

Soilcrete D
(Double direct process) operates with a grout jet of min. 100 m/sec. exit velocity for simultaneous cutting and mixing of the soil.

To increase the erosion capability and the range of the grout jet, air shrouding by means of shaped air jet nozzle is used.

The D process is mainly used for panel walls, underpinning and sealing slabs.

Soilcrete T
(Triple separation process) erodes the soil with an air shrouded water jet of min. 100 m/sec exit velocity. Grout is injected simultaneously through an additional nozzle located below the water jet nozzle. The grout pump pressure ranges above 15 bar.

A variation of this process operates without air shrouding of the water jet.

The T process is used for underpinning works, cut off walls and sealing slabs.
Soilcrete – Construction Forms

The basic geometrical form of Soilcrete elements is created through movements of the drill rods:

- Pulling of the drill rods without rotation resulting in panels – if several jet nozzles are used multiple panels may be produced.
- Pulling and swivelling create segments.
- Pulling and rotating create complete columns.

Soilcrete – Basic forms

The Soilcrete basic forms may be arranged and combined in any way to form each type of element.
Soilcrete site installations consist of storage containers, silos and a compact mixing and pumping unit. Several high pressure hose connections and control cable lines connect the pumping unit with the Soilcrete drilling rig at the installation point. The mast length of the rig varies from 2.00 m in cellars or shafts and up to 35 m in open areas. The borepoints are normally located in small trenches equipped with sludge pumps. From there the excess material, water-cement-soil mixture is pumped to setting ponds or tanks.

1 Drilling
Drill rods equipped with jet nozzle holder and drill bit are used to drill the jet grouting hole down to the required depth. Normally the jet grout mixture is used as drill flushing to stabilize the borehole during the drilling operation. In masonry and concrete, special drilling bits are used.

2 Jetting
The dissolution of the grain texture with a powerful fluid jet starts at the lower end of the Soilcrete element. The excess water soil cement mixture is removed to the surface through the annular space between drill rod and borehole wall. The pre-selected production parameters are constantly monitored.

3 Grouting
For all Soilcrete variations cement suspension is injected under pressure simultaneously with the erosion of the soil. The turbulences caused by the jetting technique results in the uniform mixing of the grout with the soil within the treatment zone. Until the grout in the Soilcrete elements starts setting hydrostatic pressure in the borehole is kept by backfilling grout into the hole from time to time.
**Process Monitoring**

Up to 12 different parameters for the construction of Soilcrete elements may be recorded and used by the engineer-in-charge of supervision and control.

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**4 Extension**

Soilcrete elements of each form may be constructed fresh on fresh as well as fresh against firm and combined and connected in a variety of ways.

The working sequence follows the technical requirements and the conditions of the structure to be treated.

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Optical and manual checking as well as controls and tests according to the requirements laid down in the license issued by the Institute of Construction Technik ensure quality workmanship.
Soilcrete – Applications

Soilcrete for Stabilisation

Underpinning work for adjacent construction pits is one of the main tasks of soil stabilisation – followed by foundation modifications and restoration. Soilcrete opens new ways for tunnel constructions in loose soils.

Underpinning

Underpinning by means of low deformation gravity walls sometimes also used as a ground water seepage barrier, may be safely constructed even from confined working areas.

Tunnel protection

Soilcrete tunnel protection is mainly constructed in loose soils below or close to endangered structures, sometimes with the aim of reducing the groundwater ingress into the tunnel excavation.

Foundation restoration

Historical buildings may be endangered in the event of settlements occurring. Soilcrete provides a safe foundation with the maximum structural protection.

Soilcrete - Horizontal

Horizontal Soilcrete columns protect tunnel drives in loose soil formations. They are constructed from working faces and are horizontal or slightly inclined.

Foundation modification

Changes in utilisations or modifications of buildings often require an enlargement or alteration of the foundation. Soilcrete is an economical and flexible solution for this task.

Shaft supports

Shafts with intersecting Soilcrete columns are constructed if a vibration free installation is required and/or the shafts enter into ground water bearing strata.

Deep foundation

Soilcrete is used for new foundations which require special care in view of nearby existing structures such as historical buildings or computer centres.

Earthpressure relief

Structures exposed to earth pressures, such as historical walls, abutments, avalanche galleries, steep slopes protections or quay walls may be relieved by the addition of or connection to a statically calculated backup Soilcrete body.
**Soilcrete for Sealing**

Building pit walls constructed of deformation and ground water resistant Soilcrete underpinning elements, combined with low permeable Soilcrete slabs enables the execution of deep building pits without the need for large scale ground water lowering.

Environmental safe mineral binder materials are used for Soilcrete.

### Panel walls
Soilcrete panel walls to cut off ground water are used below roads and buildings, for crossing pipelines and to subdivide building pits into different excavation sections. According to the sealing requirements single or multiple panels may be constructed.

### Vault slabs
For small building pits and shafts with reduced width Soilcrete slabs are used as prevention against the water uplift pressure, reducing the required depth of slabs normally required to resist the hydrostatic uplift.

### Column walls
In the event of higher mechanical strain by shearforce, danger of undermining or of a high impermeability requirements, cut off walls of intersecting Soilcrete columns may be constructed.

### Sealing cover
The Soilcrete cover protects the groundwater below buildings against affects from construction activities and old toxic waste deposits.

### Dam sealing
Soilcrete may be used to repair dam cores or enlarge cut-off walls in or below dams.

### Joint sealing
For sealing of joints between piles, sheet piles or other construction parts in the ground the Soilcrete wing-jet is applied.

### Sealing slabs
Soilcrete sealing slabs are constructed by means of overlapping columns within an uplift proof depth. The sealing slabs may be connected to any kind of vertical sealing systems.

### Groundwater exits
Sealing walls are often used as temporary ground water barriers. The reinstatement of the permeability may be reached using the Soilcrete process to wash out the binder material from predetermined sections.