Compaction grouting

Increasing the bearing capacity of non-cohesive soils

Geotechnical solutions for the construction industry

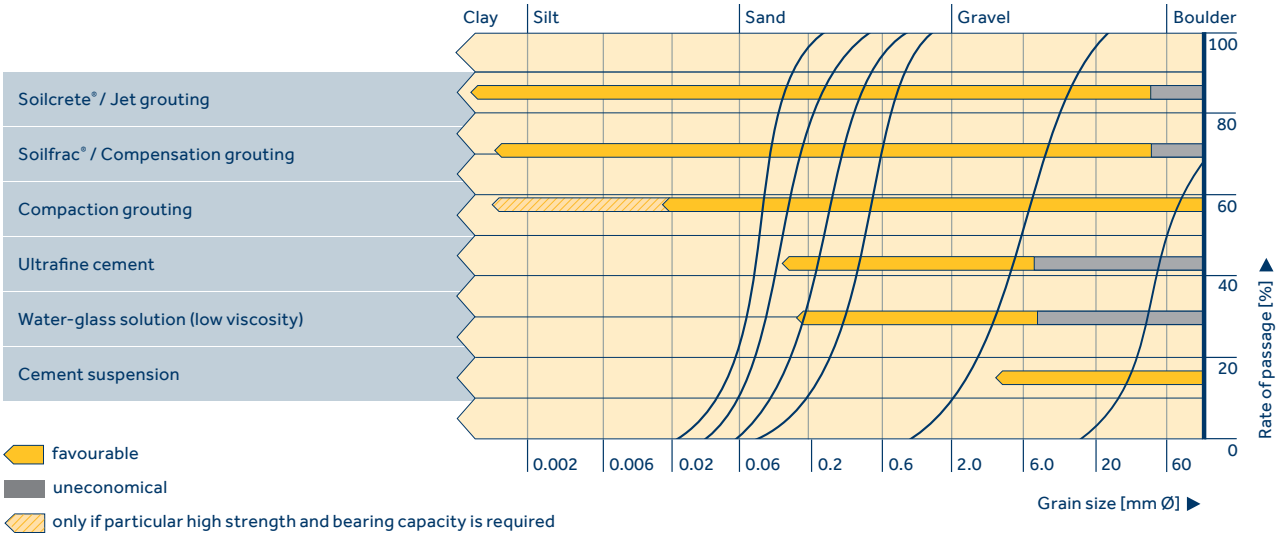
Various ground improvement and remedial applications

Compaction grouting improves ground conditions mainly by displacement. A very viscous (low-mobility) aggregate grout is injected or pumped in stages to displace and densify the surrounding soils.

An injection pipe is inserted typically to the maximum treatment depth. The grout is then injected as the pipe is slowly removed in lifts, creating a column of overlapping grout bulbs.

The effectiveness of the improvement can be increased by sequencing the compaction grouting work from primary to secondary to tertiary locations as appropriate.

Applying grouting techniques in specific soil types



Applications

Compaction grouting was originally developed as a remedial measure to correct building settlement. Over time it has increasingly been used for a variety of ground improvement and remedial applications and is often a more efficient alternative to other techniques.

It is particularly suitable for:

- Poorly placed fills
- Loosened or collapsible soils
- Sinkhole sites or karst conditions
- Liquefiable soils

Ground improvement

Improvement of ground conditions with insufficient bearing capacity by increasing the density of the soils. This may be as an alternative to pile foundations or stone columns.

Stabilising foundations and correcting settlement

Various influences and processes can affect subsoil conditions, reducing bearing capacity or increasing displacement of foundations. Structural modifications of existing buildings also often require work to increase the bearing capacity of foundations.

Compaction grouting can be applied to stop or correct settlement and deformation or to increase the bearing capacity of an existing foundation. It is also an excellent technique for underpinning in sensitive or non-homogeneous soil conditions or if the cause of settlement can't be determined.

Cavity grouting

Scarce land for development and increasing land costs mean it's often necessary to build in areas previously considered unsuitable for construction because of the poor ground conditions. In former mining regions, for example, mining tailing backfills are sold cheaply after a rest period and frequently used for the construction of industrial and commercial buildings.

The direct interaction between soil and grout material makes compaction grouting particularly suitable where there's a risk of unforeseen non-homogeneities or cavities during construction. The same applies to karstic underground conditions.

Liquefaction mitigation

If an earthquake occurs, sandy soils may liquefy leading to large deformations or structural collapse. Densifying soils using compaction grouting has proved to be one of the most efficient ways to prevent this.

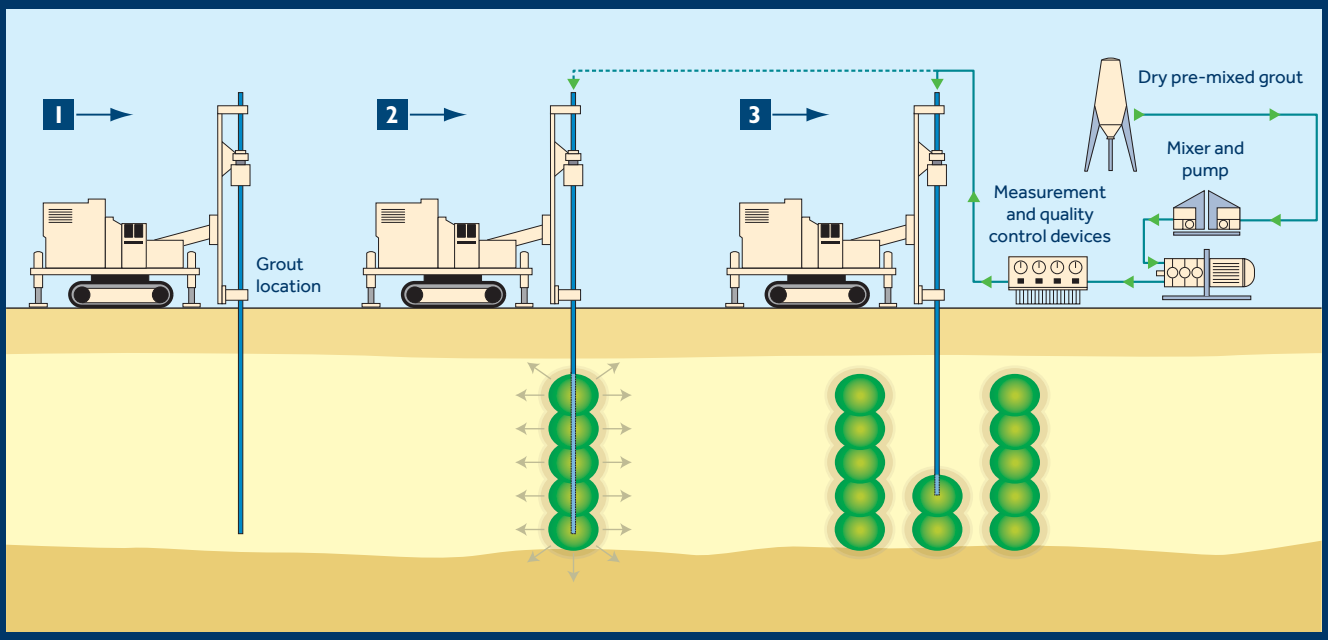
An ideal method for improving non-cohesive soils

During compaction grouting, a low-mobility grout is injected into the soil under pressure. It expands to form compaction grouting elements that displace and compact the surrounding soil. Unlike with other grouting techniques, the grout material doesn't penetrate the voids of the soil or cause cracking.

During the process, we constantly monitor pressure, grout quantity, and deformations. Depending on design requirements, we stop grouting when we reach maximum pressure or grout volume, achieve the desired uplift of the structure, or grout material starts to flow out on the site surface.

Advantages

- Ideal for the improvement of non-cohesive soils
- Can be done where access or space is limited and underneath existing buildings
- Quick installation
- Can offer an economic advantage over conventional approaches such as removal and replacement, or piling



1 Installation of the Grout Pipe

Depending on the soil and the treatment requirements, the grout pipe is either installed using a drill rig or vibro hammer.

2 Mixing and Grouting

Grout is prepared in the mixing plant and pumped into the soil using a custom-built grout pump. While gradually pulling the grout pipes, individual overlapping grout bulbs are formed to create a column.

3 Staged Compaction

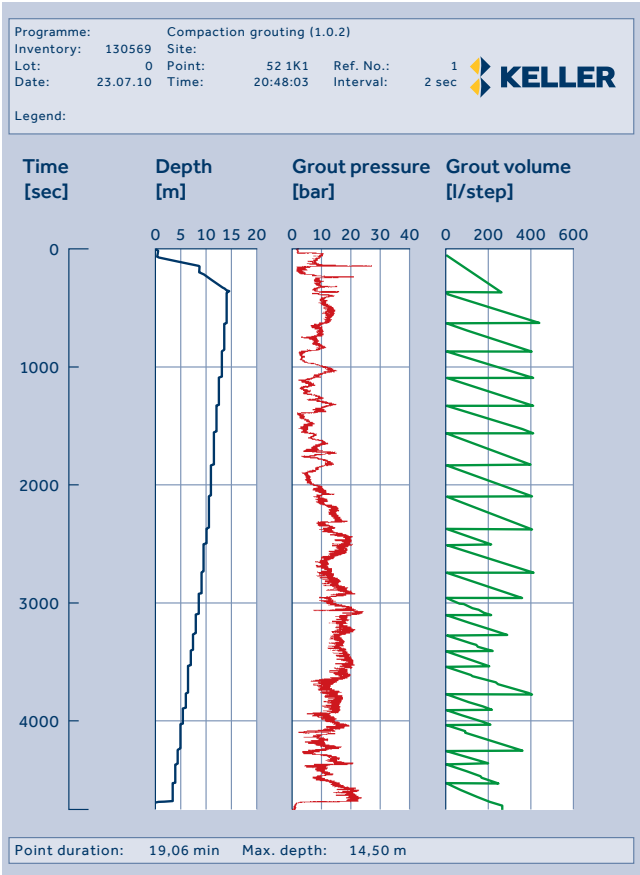
To achieve uniform compaction of the soil, the injections are executed in a primary grid and maybe compacted further using a secondary or tertiary grid.

Assured quality based on continuous evaluation

The degree of compaction can be controlled by the following parameters, depending on requirements:

- Evaluation of the automatically-recorded process parameters using Keller in-house software
- Deformation measurements at site surface or structures
- Cone penetration test, standard penetration test and dynamic probing completed before and after the compaction grouting process

Quality, as well as the suitability of the fresh grout, is continually checked by measuring its slump.



M5 - print out: depth, pressure and grout volume are continuously recorded and shown on a time axis. Alternatively, recordings can be drawn on a depth axis.

Example Compaction Grouting

ICE Frankfurt – Cologne, Germany

Between Frankfurt and Cologne, the ICE German high-speed train reaches more than 300km/h, so the track foundation plays a vital role in passenger safety. The soil around the small German city of Neuwied is particularly challenging, so Keller was commissioned to solidify track foundations here using compaction grouting technology.

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