

Compaction Grouting



AARSLEFF

PURPOSE

Compaction grouting is a process employed for increasing the density of the soil by injecting a stiff, mortar-like grout under high pressure through cased boreholes. The grouting is usually carried out bottom-up, in successive stages of about 1m.

As the grout is pumped in, it gradually forms a bulb which pushes the surrounding soil to the side, thereby increasing the relative density of the soil. The degree of densification depends on the type of soil treated and the grid pattern selected for the injection points. Injection rates generally vary from 4 to 6m³ per hour, reducing to 2m³ per hour in particularly sensitive conditions. Injection pressure is generally in the range of 1 to 4MPa.

Compaction grouting is used for treating a wide variety of loose soils, with relatively good drainage. Compaction grouting can be performed at depths ranging from 2m, right down to several tens of meters. Grouting works are carried out from the surface, from an existing basement or locations with limited headroom. It is also possible to drill through hard material to gain access for treatment of low strength strata beneath.

The key parameters for compaction grouting are the grid pattern, the injection pressure and the grout take.

METHOD

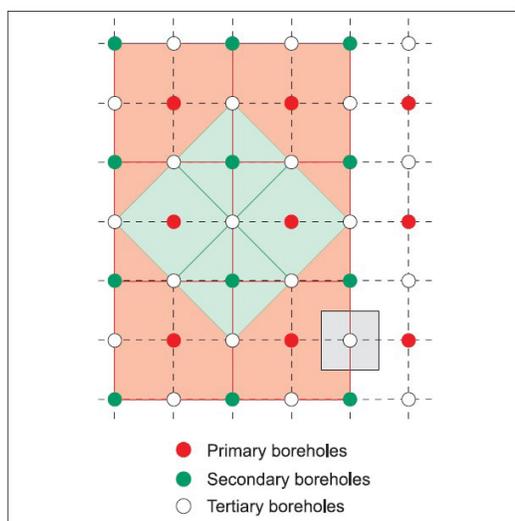
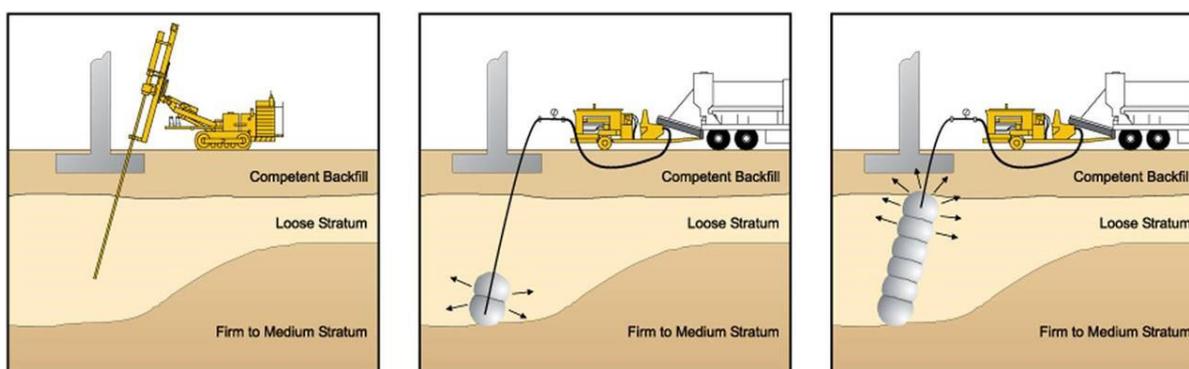
- The grid pattern is devised such that each drill hole nominally treats a given area in plan. The grid can be square or triangular and generally makes the distinction between primary and secondary (and sometimes tertiary) holes. The grid is determined by the type of treatment required (localized or en masse) and the radius of influence (Ri).
- The radius of influence is the distance from the centre of the drill hole to the furthest point at which there is a change of void ratio as a result of the treatment.
- The injection pressure is dependent on the specific site conditions: presence of buildings, civil engineering structures, open site, treatment depths, etc. Pressure is prescribed by depth in stages at 1 bar (100KkPa) per meter of depth measured from the bottom of the stage.
- Most compaction grouting is performed using grid patterns of 4 to 9m² with grout take varying from 2 to 6%. In the particular case of sinkholes, grout takes are highly variable and have been known to be as high as 14%.

THE GROUT MATERIAL

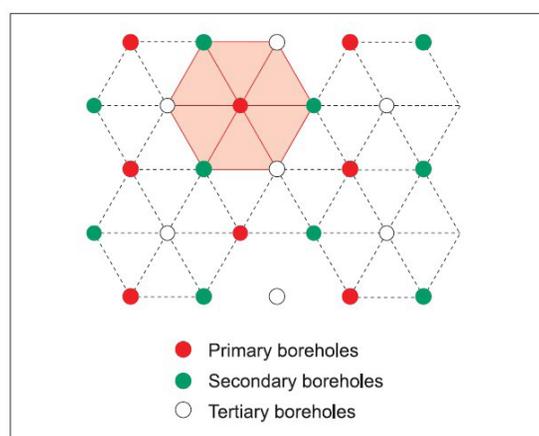
The mortar must meet the following requirements:

- it must be pumpable
- it must not cause soil fracturing
- it must not “bind up” leading to refusal of grout before the injection process is complete.

The grout must therefore have an appropriate slump and grading. The main constituent is a sandy material, often with added fines (cement, fillers, etc.). The usual slump value is circa 100mm.



Square grid pattern



Triangular grid pattern

Figure. 1. The process of compaction grouting: firstly the drilling, secondly the pressure injection of the grout. As the grout is injected it forms a bulb, of which the drill is lifted to create further bulbs.

Figure. 2. / 3. An example of a square and triangular drilling grid pattern including Tertiary boreholes.