

Effect of compaction grouting in loosely packed sand on density

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PROBLEM

The shield tunnel of Randstandrail (Rotterdam, The Netherlands) crosses the railway Rotterdam-Gouda

The railway embankment consists of anthropogenic saturated very loose sand

Identified geotechnical risks during the tunneling are:

- liquefaction of loose sand due to monotonic loading (small deformations during passage TBM)
- densification loose sand during tunneling
- cyclic liquefaction loose sand

Different mitigation measures have been considered, one of them being compaction grouting.

BUT: is compaction grouting effective in this situation?

PRINCIPLES COMPACTION GROUTING

Compaction grouting is defined as a displacement grouting method, aimed at compaction of the soil without fracturing.

During compaction grouting:

- an expanding cavity is created within the soil
- a complex system of radial and tangential stresses develop
- significant displacement shearing and plastic deformation occur

MODEL TEST

Aim of the test:

- gain insight in the mechanisms of compaction grouting
- test effectiveness of compaction grouting

Test set-up:

- cylinder filled with loose sand
- use of a balloon in order to contain injected volume (prevent occurrence of fracturing)
- no surcharge loading
- measurement of
 - injected volume
 - void ratio
 - cone resistance (with a penetrometer)

CONCLUSIONS FROM THE TEST

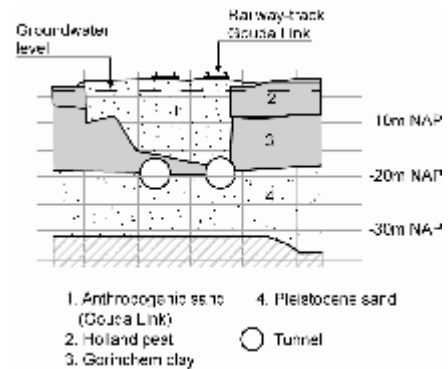
- contrary to general believe in this case no compaction but loosening
- increase in cone resistance
- increase in horizontal stresses expected
- increase in cone resistance does not prove increase in density

With soft soil next to the treated sand body it is feared that the increase in horizontal stress decreases with time due to relaxation. For this project the option of compaction grouting has been abandoned.



Partly excavated grout body after the test

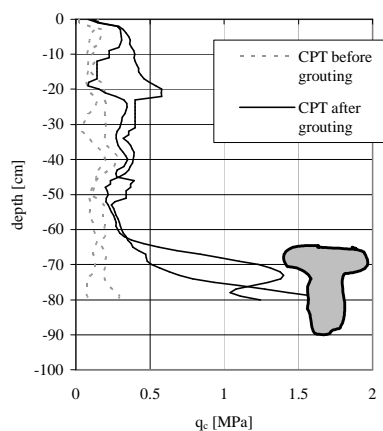
Logo GW-Rotterdam, GeoDelft en Jan Maertens



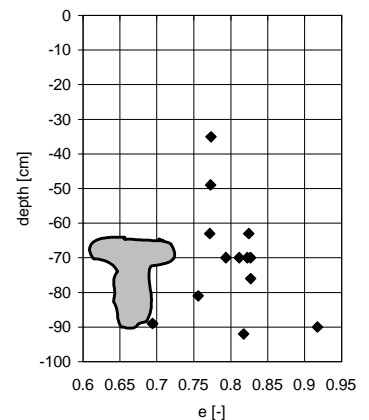
Cross section railway embankment with tunnel



Execution model test



Measured cone resistance before and after the test



Measured void ratio after the test, initial void ratio $e = 0.77$