APPLICATIONS OF JET GROUTING TECHNOLOGY IN HONG KONG

SEMINAR ON GROUTING AND DEEP MIXING

Trevi Group ... a qualified presence in the world

Trevi Construction Co., Ltd., Tsim Sha Tsui, Hong Kong
Seminar on Grouting and Deep mixing
Jet Grouting Technology

**Features:**
disaggregation of the soil and its mixing in place with, and partial replacement by, a cement grout mix; the disaggregation is achieved by high energy jet of one or more fluids, one of them being the grout mix itself.

**Applicable soils:** from peaty clays to gravel

**Achievable results:** increasing strength reducing horizontal & vertical permeability (for block treatment)

**Limits:**
- risk of surface movements
- highly experienced personnel
- strict safety rules
- expensive equipment
- large quantity of spoil to be managed
Jet grouting can be used in the largest range of soil types:

- **K:**
  - $10^{-4}$
  - $10^{-5}$
  - $10^{-6}$
  - $10^{-3}$
  - $10^{-2}$

Cement Grouting:
- Microfine

Chemical Grouting:
- Compaction Grouting

Jet Grouting:
- Fracture Grouting

Graph showing the range of sieve sizes and permeability ($k = m/s$) for different soil types (Gravel, Sand, Silty, Clay).
Soil erodibility plays a major role in determining geometry, quality and production. Cohesionless soils are typically more erodible than cohesive soils.
“single fluid”
One fluid (cement grout) for both breaking up the ground and cementing it

“double fluid”
two fluids (cement grout & compressed air) for both breaking up the ground and cementing it
Seminar on Grouting and Deep mixing
Jet Grouting systems

“single fluid”
Typical column’s diameters:
400 - 1200 mm

“double fluid”
Typical column’s diameters:
800 - 2500 mm

cement grout

compressed air
cement grout
compressed air
coaxial nozzle
Density of spoil = 1.6 – 2.0 t/mc

Pressure → kinetic energy

Spoil return shall be maintained at all times, to avoid hydrofracturing of soil.
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Mix type vs permeability & grain size
Permeation Grouting

Features:
Replacing interstitial water or gas of a porous medium with a cement based or chemical grout at injection pressures low enough to prevent uplift.

Applicable soils: silty sands to gravel

Achievable results:
• increasing strength
• reducing horizontal & vertical permeability

Limits:
• experienced personnel
• quite expensive plants
• quite expensive QC systems
• high costs of materials when dealing with fine fissures
Fracture Grouting

Features:
fracturing of a ground by the injection of a grout mix under pressure thick enough to induce excess of local tensile strength and confining pressure”.

Applicable soils: dense sandy formations, stiff cohesive formations, very soft rock (shale etc.)

Achievable results:
• increased load bearing capacity by compressing the soil between the grout lenses
• reduced vertical permeability

Limits:
• risk of heaves at the surface
• experienced personnel
• extensive instrumentation
• no influence on horizontal permeability
Permeability = $10^{-6} \text{ m/s} - 10^{-8} \text{ m/s}$
(lower values associated to cohesive formations).

Final Strength is a function of the original ground and the quantity of cement jetted into the ground itself.
DC/2007/16
Lai Chi Kok Transfer Scheme
Cross-section chainage 545 (TBM maintenance chamber)

Note:
Proposed Pressure Grout mix in CDG sodium silicate + hardner.
Proposed Pressure Grout mix in rock microfine cement and bentonite.

Pressure Grouting later replaced by Jet Grouting
DC/2007/16
Lai Chi Kok Transfer Scheme
TBM Maintenance Chamber at chainage 545

Site: Grout Coring and Permeability Test for the "TBM Maintenance Chamber ch0+545" at Lai Chi Kok
Drill Hole: T2
Depth (m): 0.00 to 39.59
Job No.: J201126e
Box No.: 1 of 3
Photo Date: 3/9/11
DC/2007/16
Lai Chi Kok Transfer Scheme
TBM Maintenance Chamber at chainage 545
DC/2007/16
Lai Chi Kok Transfer Scheme
TBM Maintenance Chamber at chainage 545
DC/2007/16
Lai Chi Kok Transfer Scheme
TBM Maintenance Chamber at chainage 545

Pictures taken inside the chamber from TBM
Setting out of the Jet Grout column in relation to the outfall shaft M2
DC/2007/16
Lai Chi Kok Transfer Scheme

Steel platform erected for the support of the jet grouting rig
DC/2007/16
Lai Chi Kok Transfer Scheme
Grout Column Sample Coring at TBM Shaft
DC/2007/16
Lai Chi Kok Transfer Scheme
Grout Column Sample Coring at TBM Shaft

Site: Lai Chi Kok Transfer Scheme - Grout Column Sample Coring at TBM Shaft
Drill Hole: CH04
Depth (m): 0.00 to 40.30
Box No.: 1 of 2
Photo Date: 31/3/2011
Job No.: J201114e
DC/2007/16
Lai Chi Kok Transfer Scheme
Grout Column Sample Coring at TBM Shaft

Site: Lai Chi Kok Transfer Scheme – Grout Column Sample Coring at TBM Shaft
Drill Hole: CH04
Box No.: 2 of 2
Depth (m): 40.30 to 47.00
Photo Date: 31/3/2011
Job No.: J201114e
Jetting rig SM20 in action at Kowloon (MTR 810A)
Excavated column in Marine Deposit at Kowloon (MTR 810A)
Jetting rig SM14 with horizontal silo (background) where overhead restriction applies (Pier 15)
Mixing plant with vertical silos in Central (Contract 18)
Stans – Tunnel Excavation

THANK YOU FOR LISTENING.