LA CONGÉLATION __

ARTIFICIAL FREEZING OF SOILS, in CIVIL ENGINEERING

SOIL FREEZING AND MONITORING

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Overview

- Solexerts: 10 years on freezing monitoring experience
- Overview of Solexerts instruments dedicated for freezing control
- Setting up data monitoring
- Knowledge acquired through these projects
Solexerts : 10 years on freezing monitoring experience
The company

- More than 75 years of experience in projects worldwide with geotechnical and hydrogeological instrumentation and field tests.
- Our workshop has its own means of production to manufacture any device quickly and made-to-measure.
International projects

- Amsterdam (NL)
- Zurich (CH)
- Cigar Lake (CA)
- Rastatt (DE)
- Albula (CH)
- Usolski (RU)
- Napoli (IT)
Solexerts : 10 years on freezing monitoring experience

Grand Paris Express

- Porte de Clichy (L14, 2015)
- Puits d’essai Aulnay sous Bois (2016)
- Mairie d’Aubervilliers (L12, 2018)
- Saint Ouen (L14, 2018)
- Lot T2A – Gare du Vert de Maisons (L15, 2021)
- Lot T3A – Gare Issy RER (L15, 2022)
Overview of Solexperts instruments dedicated for freezing control
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3 entities to watch

3D-View of freezing boreholes for cavern and galleries digging at Le Vert de Maisons Station

Source: Soletanche Bachy
Objective: Controlling brine temperature into pipes

- Sensors thin enough to fit in immersion sleeve (6.5 mm ID)
- Wide temperature range (up to -200°C)
- High accuracy (+/- 0.3°C)
- Correctly insulated from outside temperature
- Wire resistant to extreme temperature and ice crushing
Overview of Solexpers instruments dedicated for freezing control

Objective: Estimating ice expansion on the ground

- Temperature sensors connected together
- Waterproof and small diameter (20mm)
- Sensor distribution adaptable according to the zone of interest
- Thermometric chain installed in horizontal or vertical orientation
Overview of Solexperts instruments dedicated for freezing control

Objective: Measuring temperature at ground/diaphragm wall interface

- 1 m drilling through diaphragm wall
- Make sure that sensor goes correctly to the right place
- Same exigences regarding ice crushing
Setting up data monitoring
Setting up data monitoring

Data collecting chain

Interfaces

Data acquisition

To web-visualisation

Setting up data monitoring
Setting up data monitoring

Data acquisition system

- Use of one or multiple automated acquisition computer
- Acquisition interface close to the zone of interest to limit the number of cables on worksite
- Incorporating phasing into production layouts to optimize instrumentation
- Fast acquisition (less than 30 seconds for 200 sensors)
- Consecutive data transfer to web-visualization
Setting up data monitoring

Web Visualisation

- Web portal accessible by the construction company, the project manager and the owner
- Time based or space-based graph
- Gradient map
- Automatic daily export
- Email/SMS alert
Knowledge acquired through these projects
Knowledge acquired through these projects

Always think about:

- What do you want to measure?
- Where is the sensor?
- What is around the sensor?
- /Can the environment change the measurement?
- Is the sensor able to measure what you expect?
- Why the result is different?
Knowledge acquired through these projects

Sensor protection

- Borehole are not waterproof
- Need to had tubes to protect the probes
Conclusion and alternatives
Conclusion and alternatives

- Monitoring is essential to manage ground freezing projects
- Because of harsh conditions, necessity to well protect sensors with a compromise protection/contact with the ground
- A good alternative: Fiber Optic
- Easy to identify small-scale anomalies but with several requirements:
  - Temperature control via reference sensors
  - Meticulous spatial identification
  - Limited adaptability to phasing
Thank You

Questions?