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PhD
Soil mechanics and geotechnical engineering

Project:
BanaVäg i Väst
www.banavag.se

TRAFFIKVERKET
SWEDISH TRANSPORT ADMINISTRATION
Göteborg - Trollhättan

- Length approximately 70 km
- Four-lane highway E45.
- Two track railway (speed 250 km/hr)
- 50 bridges and tunnels
- Cost 1 000 000 000 Euro

Geotechnical challenge
- 0 – 100 m of soft clay
- Settlement of present highway is up to 1,0 m in 40 years
- Geotechnical cost: approx. 100 0000 000 Euro
Important aspects

• Most important = Slope stability – Göta river
• Very soft clay - partly quick clay
• Ongoing settlement 0,5-3 cm/year
• Too high water levels today
• Erosion
• Future climate change
Necessary to build all new highway/railway track on soil improvement or light fill material

Improvement methods used in the Göta river valley

- Embankment piles of wood or precast concrete piles (expensive)
Light weight expanded clay aggregates (LECA)

Note: If located under water uplift stability problems
Lightweight fill material EPS (EPS = expanded polystyrene)

Note: If under water uplift stability problems
Clay stabilisation with lime and cement

- Dry method – Scandinavian countries
- Wet method – Europe

Perfect columns - dry method in medium soft clay

Almost perfect columns - dry method in very soft clay
Pattern for railway: Each circle is one column

Green colour = performed
Red colour = remaining
Lime cement columns facts:
Diameter : 500 – 1000 mm
Depth : max 25 m
Mixture/m: 15kg cement  
+15 kg lime
Raise : 25mm/rotation
Rotation: 160 r/min
Installation of lime-cement columns without temporary road (temporary road is excavated after installation)
With temporary road during construction

- Stability of machines Ok
- Better quality of columns
- Less settlement
Successful installation top of columns after excavation of temporary filling material

What happened?
-the column disappeared
Geotechnical control during construction

- Geotechnical adviser board consisting of professors in geotechnical engineering
- Automatic measurement of movements and porepressures 24 hours (day and night)
- Automatic SMS to responsible geotechnical engineer and site engineer if exceeding threshold value of movements (x,y,z) or porepressures (day and night)
- Always all measurements analysed and reported from contractor to Swedish Transport Administration once a week
- Description of all geotechnical temporary work and calculations must be sent to the client for approval at least 10 days before starting

Example of horizontal movements (mm) with depth
Example of improvement of the shear strength in clay after mixing with lime and cement.

Before:
- Clay with a shear strength of 8-10 kPa (10 kiloPascal=1 ton/m²)

After soil improvement:
- 100-150 kPa
Test embankments 2000-2007

Soil improvement by lime-cement columns
Usually to 15-18 m depth now to 25 m depth (clay to 0-100 m)
Load corresponding to heavy fill 2,5 m

Check:
Stability
Settlement behaviour
Thank You !

New railway
two tracks

Old railway=
Location for
new highway

Old highway =
location for noice
protection barrier
You find a helmet and notice west to borrow in the bus

According to our rules:
When outside of bus at the construction site Helmet and notice west must be used