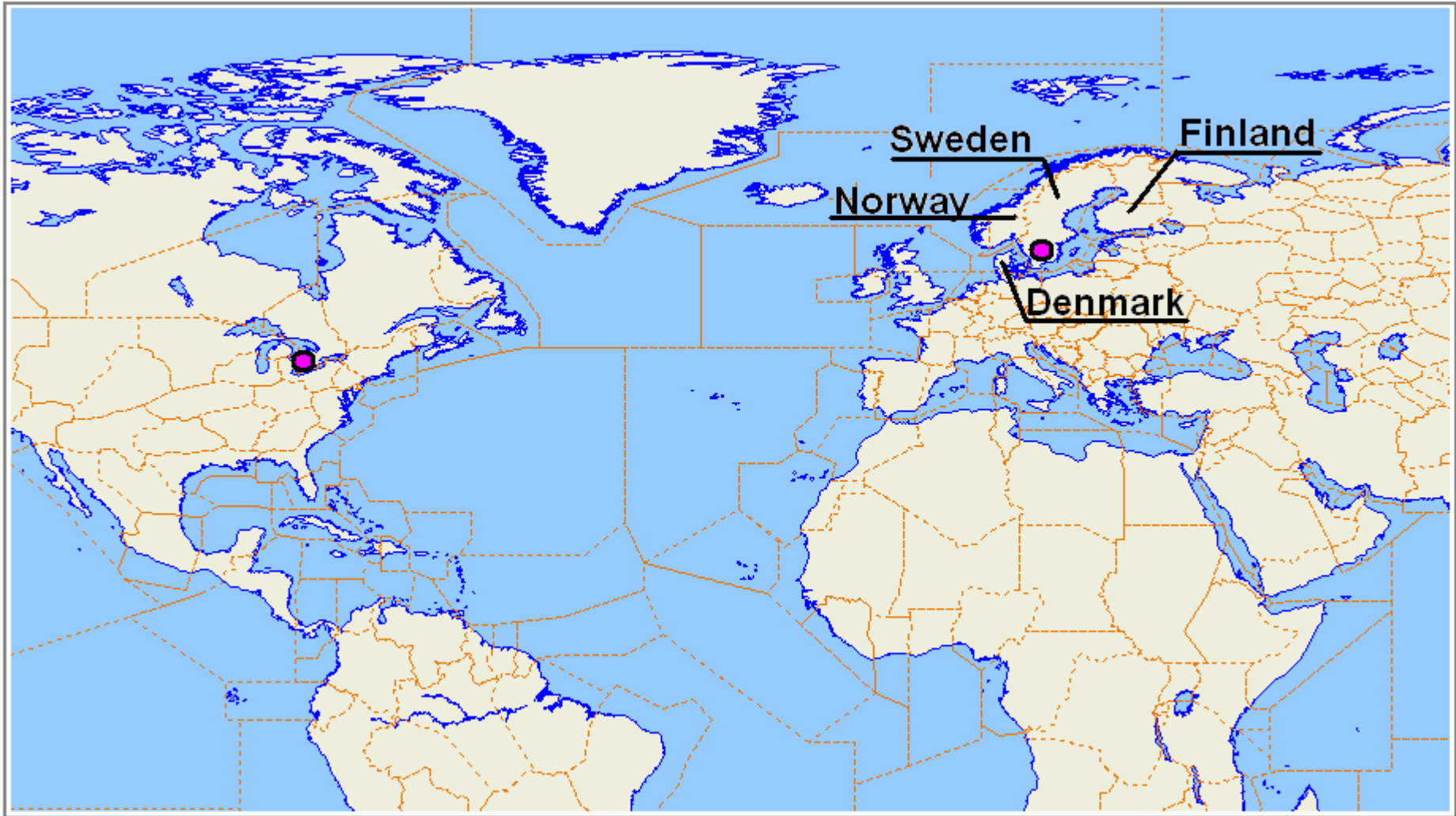


# **Drilled MicroPile Walls**

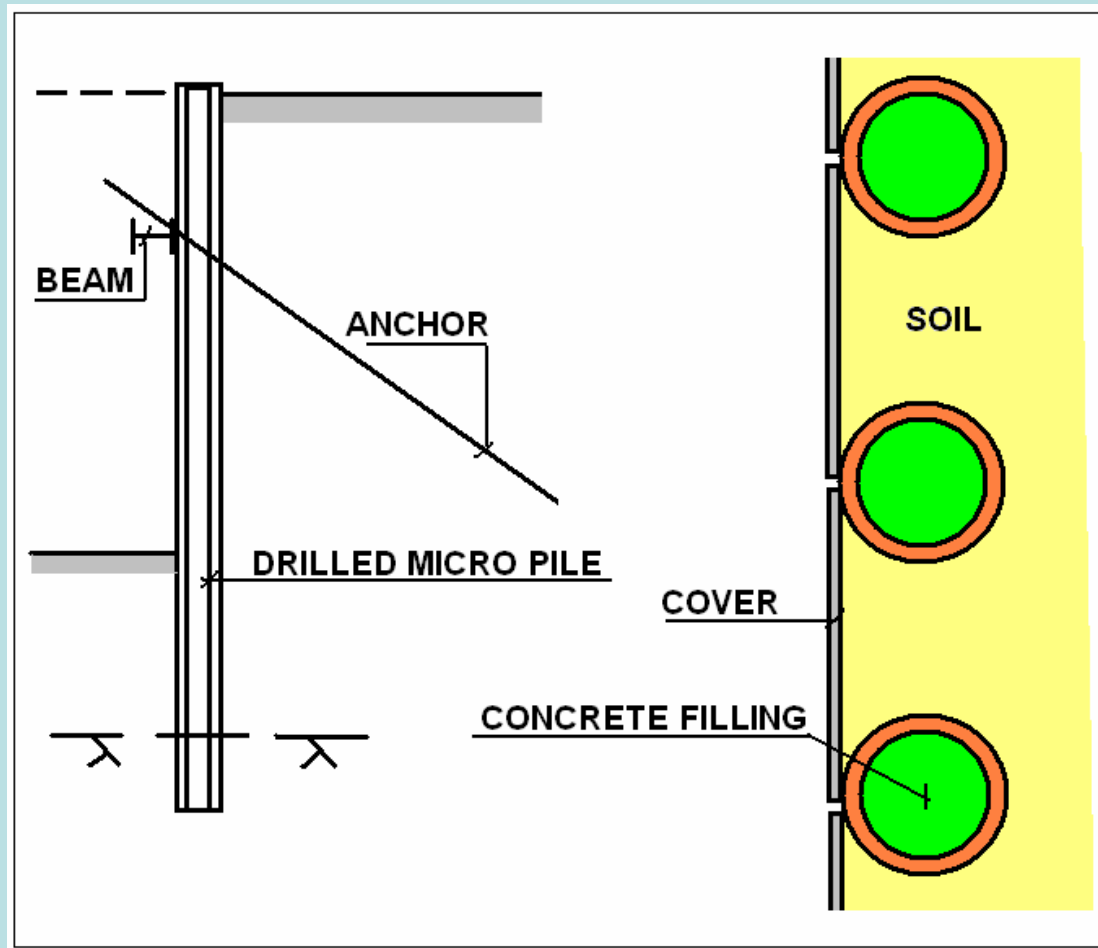
**- Use of Drilled MicroPile Walls in Scandinavia**

**Håkan Bredenberg**

# Scandinavia ... ?



# Drilled MicroPile Walls ...



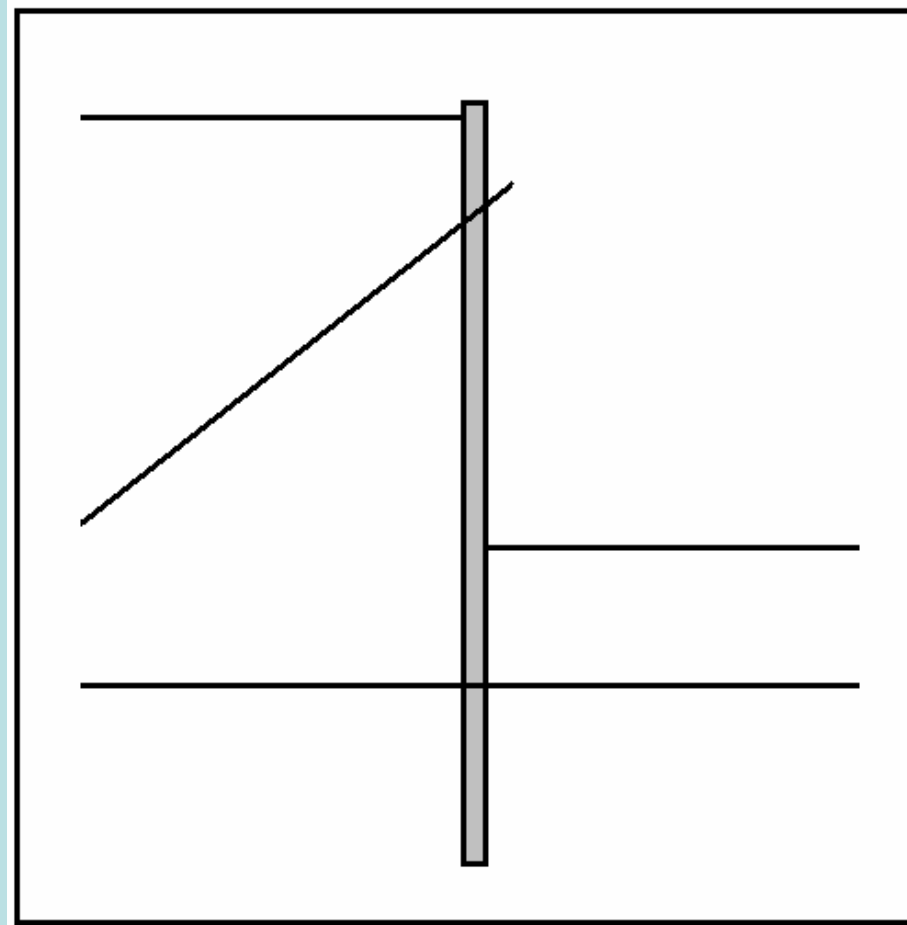
# Index

- applications & examples
- drilled MicroPile wall elements
- supports
- cover
- costs
- equipment
- design

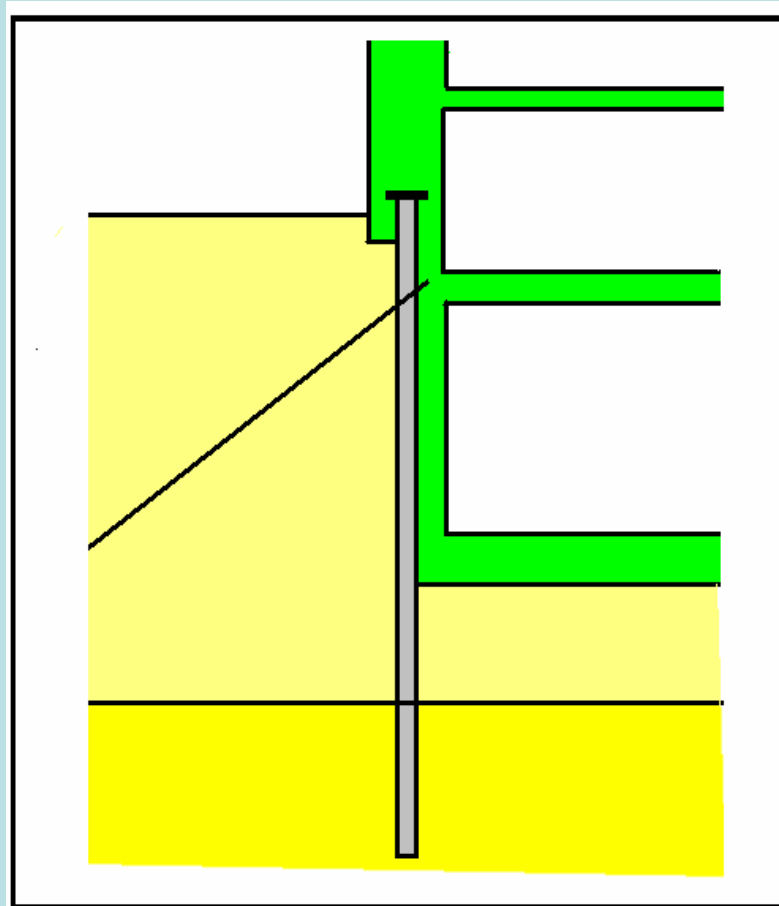
# Applications

- excavation temporary cut off walls
- same, also serving as permanent support
- bridge support /foundation

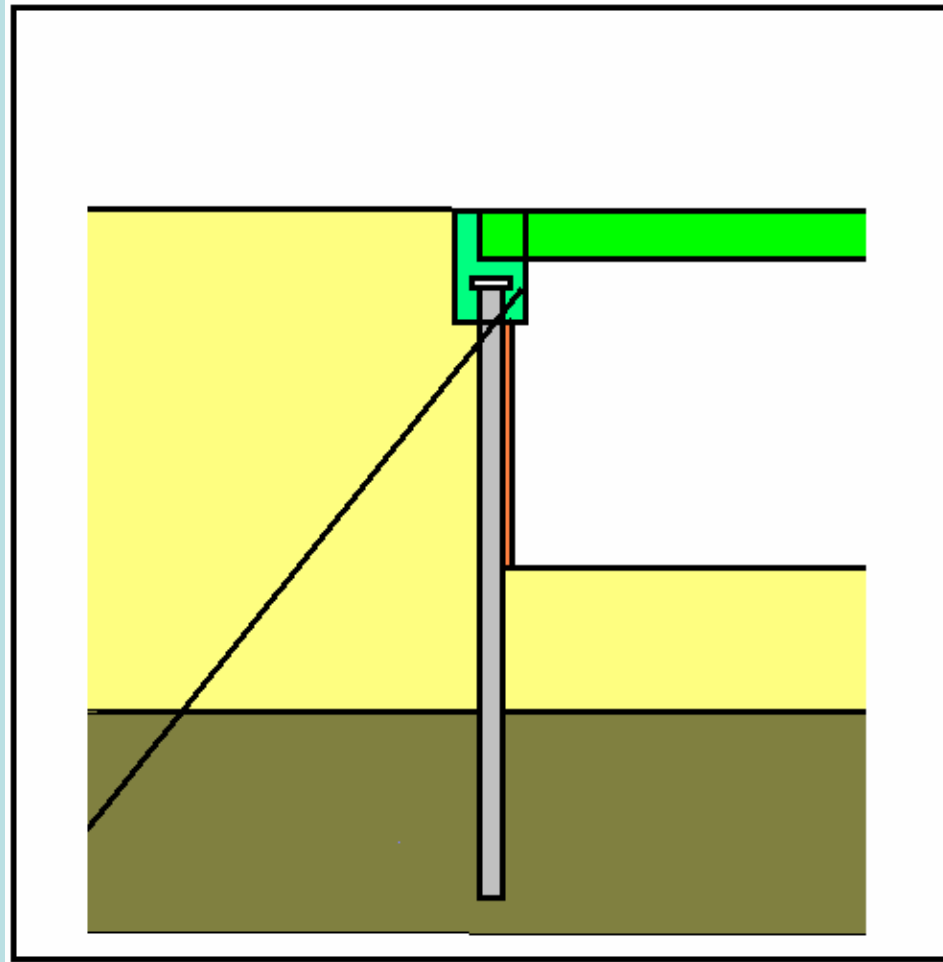
# Excavation cut off wall



# Temporary wall & permanent support

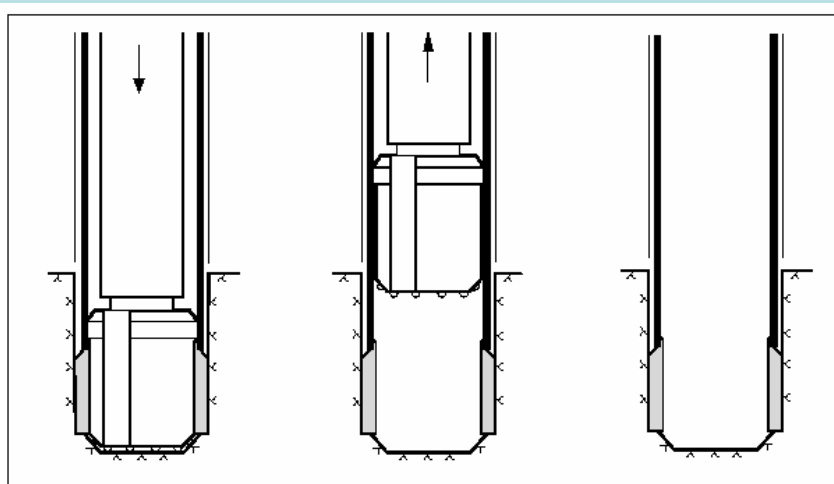
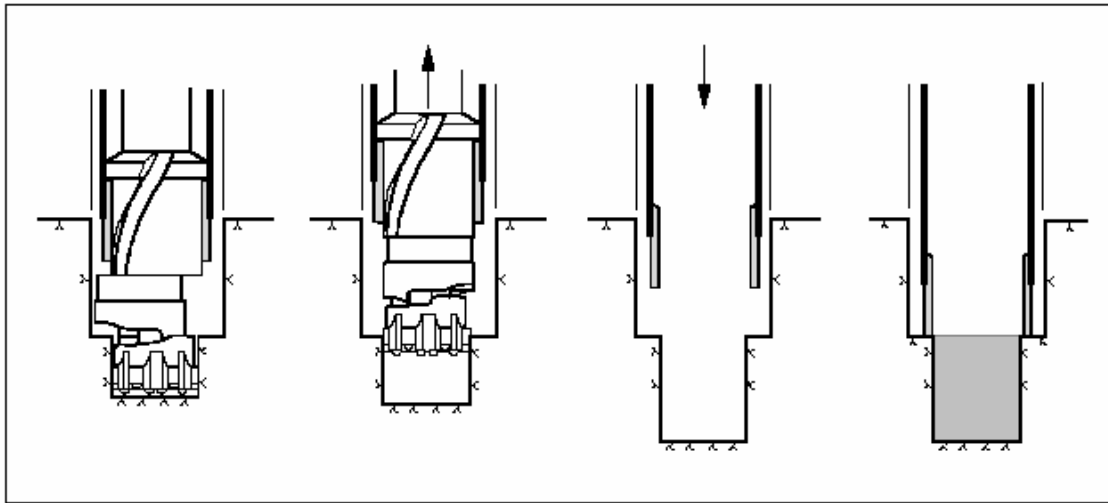


# Temporary wall & permanent bridge support





# Drilled MicroPile Walls, usual Drilling methods



## Drilled MicroPile Walls – the Klemm 806



# Drilled MicroPile Walls - equipment

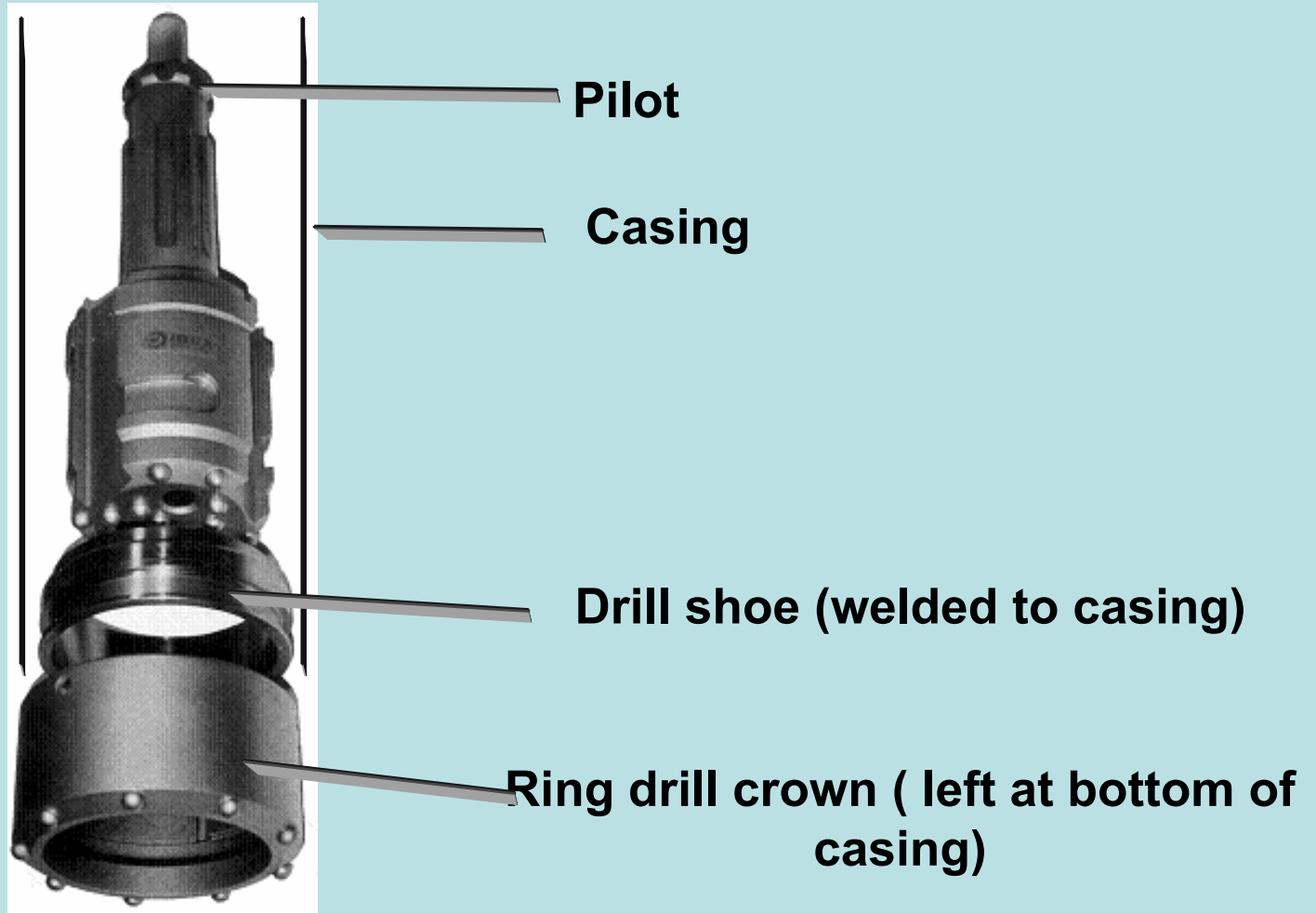


**” The Basement Mouse”**

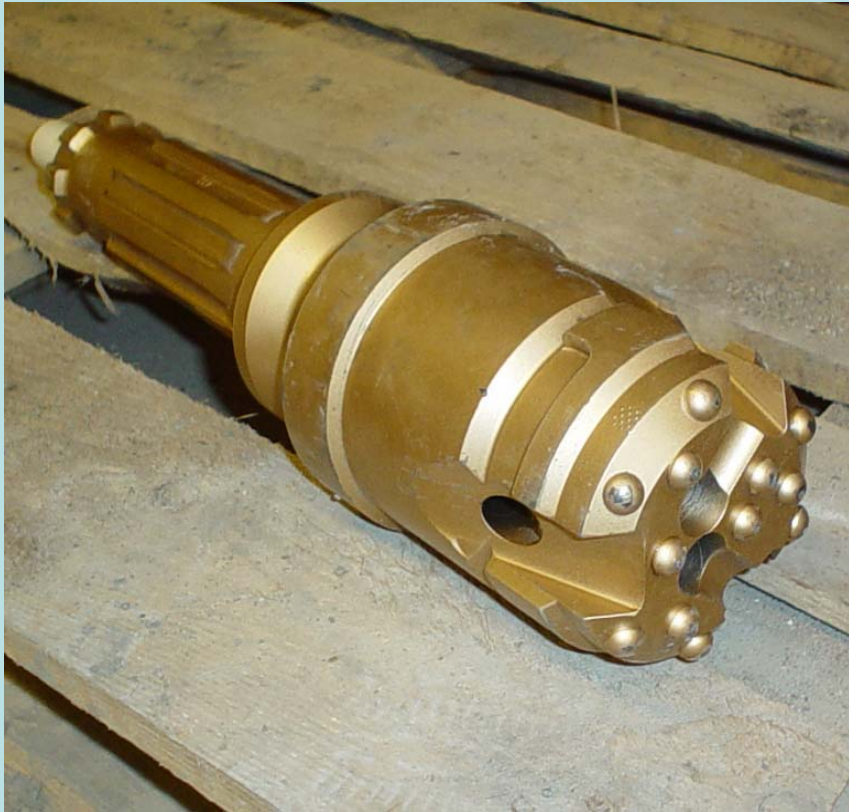
# Drilled (micro) Pile Walls – equipment, drilling rigs



# Drilled MicroPile Walls – equipment for drilling



# Drilled MicroPile Walls – Equipment at tube front



**Pilot (recovered)**



**Ring crown – welded to tube, left at tip**

## Drilled pile walls – drill bit for 600 mm tubes

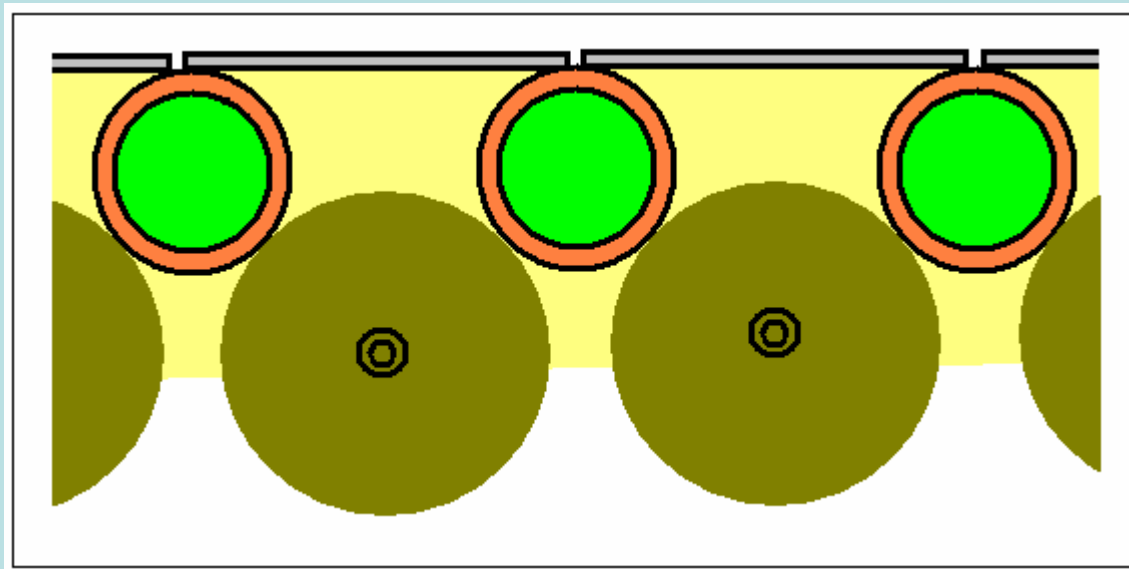


# Excavation

- How to keep soil in place between space between tubes ?
- Which spacing between tubes ?
- If ground water level above excavation bottom ?
- Which material for cover ? Wood, steel, shotcrete ?



# Jet grouting to prevent soil inflow



# Drilled MicroPile Wall – extending into rock



# Drilled MicroPile Wall during construction



# Drilled MicroPile Wall in rock fill



# Excavation before cover



# 5 mm steel sheet cover beeing spot welded to drilled soldier beams



5 mm steel cover plates being cut to size (from 2 x 1 m)



# Drilled MicroPile Wall sealed with shotcrete





After excavation to final level ...  
some case pictures from 2007.

## Drilled & driven Pile Wall, finalized (?), rock anchors



# Drilled MicroPile Wall, Limmared



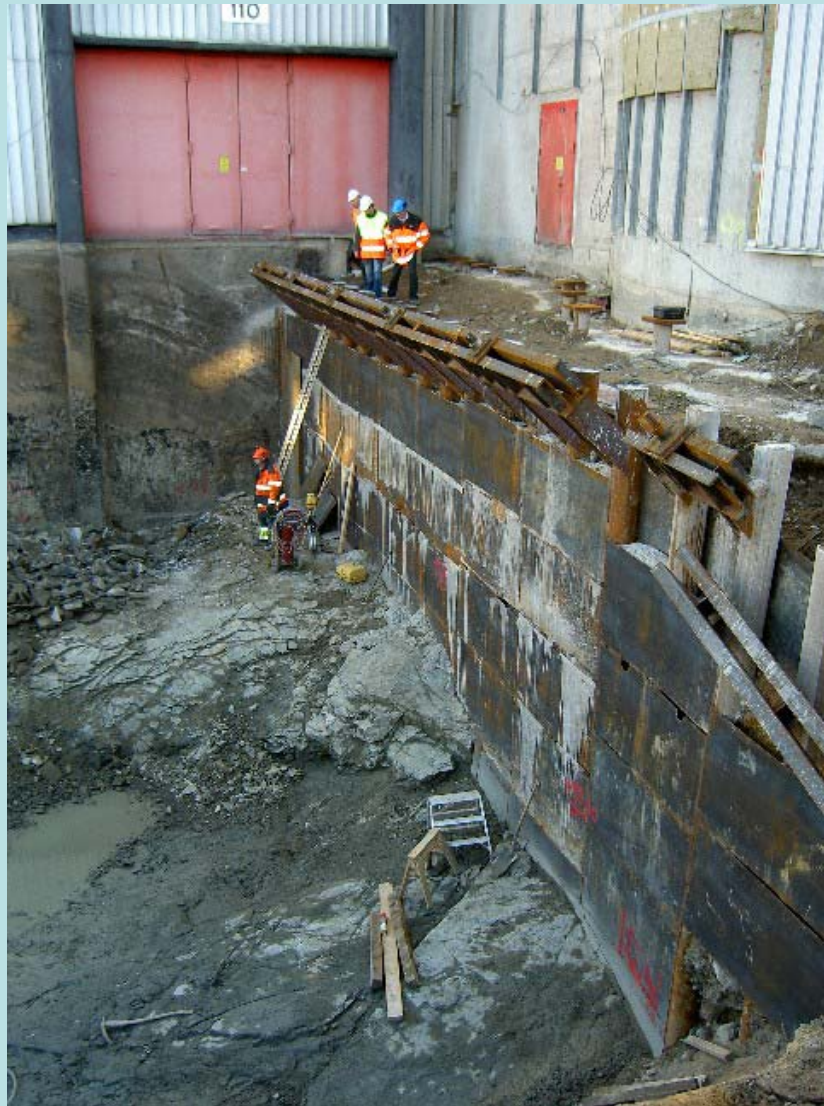
## Liljeholmen, drilled MicroPile wall for new subway station



# Drilled MicroPile Wall at Ringhals nuclear power plant



# MicroPile Wall was drilled into rock



# Drilled MicroPile Wall for new theatre building, Norrköping, Sweden



# Drilled MicroPile Wall – shotcreted – note boulders.





# Drilled MicroPile Wall – under & close to existing building



# Drilled MicroPile Wall finalized



# Drilled MicroPile Wall used as formwork



# Drilled MicroPiles for temporary column support



# Drilled MicroPile Wall support

- soil / rock anchors
- beam struts
- tie-backs
- ... others

# Drilled MicroPile Wall – supported by drilled soil anchors



# Corner supported by H-beams



# Anchor rod fixed to slab

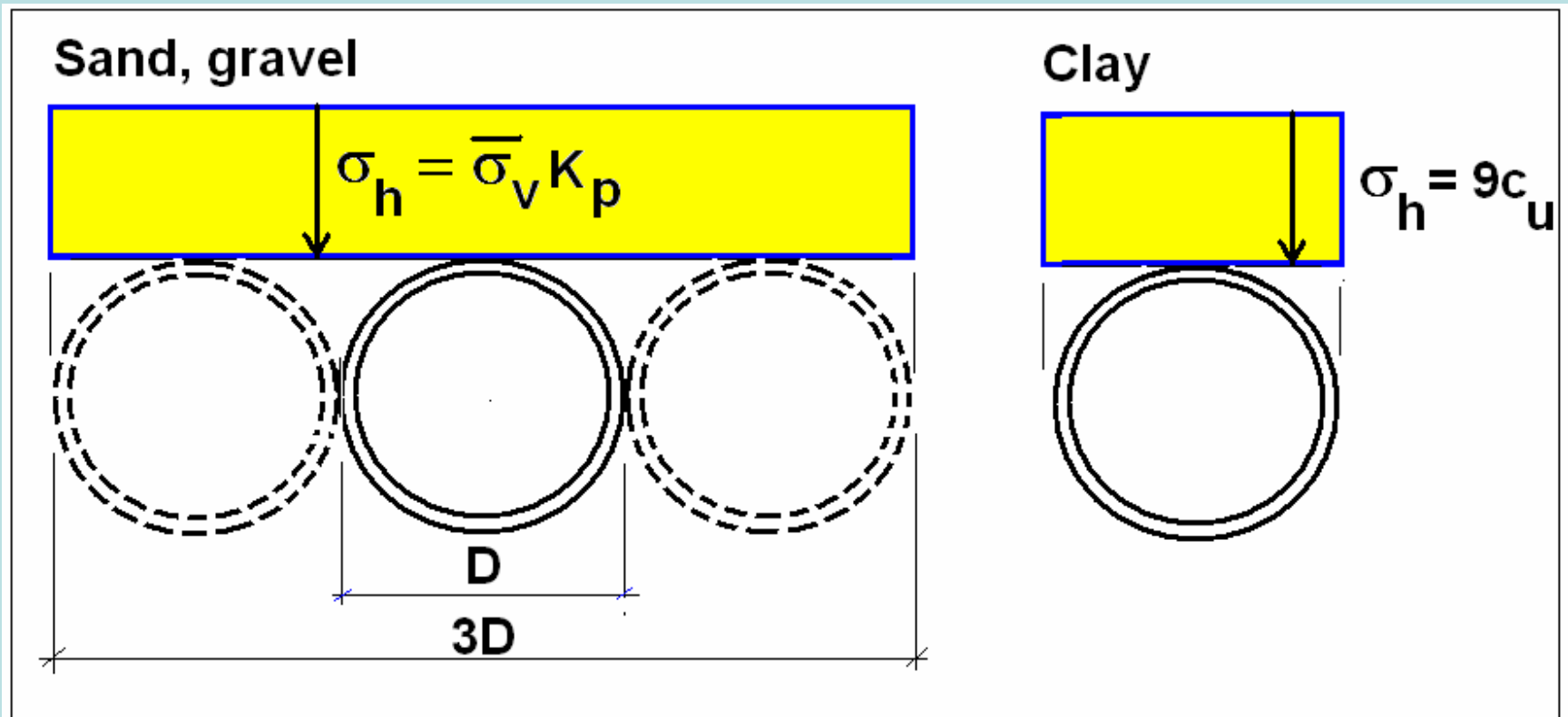




# Design of drilled MicroPile walls

- Soil pressure active/passive
- Forces, bending moments
- Section analysis :
  - Axial capacity
  - Bending capacity
  - Buckling
  - Local buckling (thin wall structures)
- Deflection, soil movements

# Soil – tube interaction



# Bending moment capacity

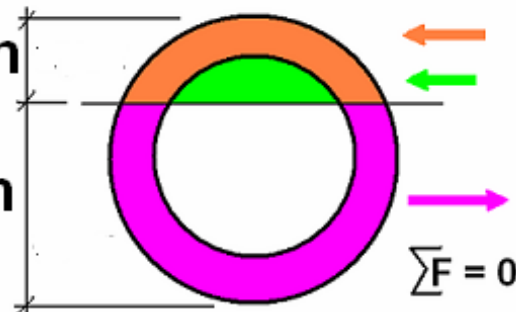
**Elastic** :  $M_e = W_{el} \cdot f_{yd}$

**Plastic** :  $M_{pl} = W_{pl} \cdot f_{yd}$



**Compression**

**Tension**



# Drilled MicroPile Wall – bending capacity

**RörMedBalk 2005-09-25 - Bredenberg Geoteknik**

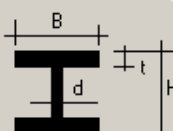
**INDATA**

Ytter-diameter (mm) : 323.90  
 Inner-diameter (mm) : 298.90  
 fyd rör (MPa) : 296.00  
 fyd balk (MPa) : 296.00  
 fcc (MPa) : 17.00

alfa-start (grader) : 1.00  
 alfa-steg (grader) : 0.001000

**Balkdata**

Höjd H (mm) : 200.00  
 Bredd B (mm) : 200.00  
 Fläns t (mm) : 12.50  
 Liv d (mm) : 25.00



**BETECKNINGAR**

Abtg = btgarea över neutrala lagret (NL) ■  
 ebtg= TP-avstånd för Abtg från NL  
 Fbtg= tryckkraft i betongsegmentet

A2 = tryckt stålarea över NL ■  
 e2= TP-avstånd för A2 från NL  
 Fst = tryckkraft i A2

A1 = dragen stålarea under NL ■  
 e1= TP-avstånd för A1 från NL  
 Fsd = dragkraft i A1

Ytterdiameter (mm) = 323.90  
 Innerdiameter (mm) = 298.90  
 fyd (MPa) = 296.00  
 fydBalk (MPa) = 296.00  
 fcc (MPa) = 17.00

**RESULTAT**

=====

alfa (grader) = 83.396  
 ey (mm) = 17.188  
 Abtg (cm2) = 299.58  
 ebtg (cm) = 5.56  
 Fbtg (kN) = 509.29  
 A2 (cm2) = 56.84  
 e2 (cm) = 8.88  
 Fst (kN) = 1682.39  
 A1 (cm2) = 65.45  
 e1 (cm) = 10.93  
 Fsd (kN) = 1937.29

**Balken**

=====

Tryckt Livarea (cm2) = 17.58  
 Dragen Livarea (cm2) = 26.17  
 Tryckt Flänsarea (cm2) = 25.00  
 Dragen Flänsarea (cm2) = 25.00

=====

Summa tryck-kraft = 3451.99  
 Summa drag-kraft = 3451.98  
 DIFF = SummaTryck - SummaDrag = 0.01163  
 MomentKapacitet Rör (kNm) = 389.50  
 MomentKapacitet Balk (kNm) = 197.59  
 MomentKapacitet Btg (kNm) = 28.33  
 MomentKapacitet Balk+Rör+Btg (kNm) = 615.42

Enbart Rör =====

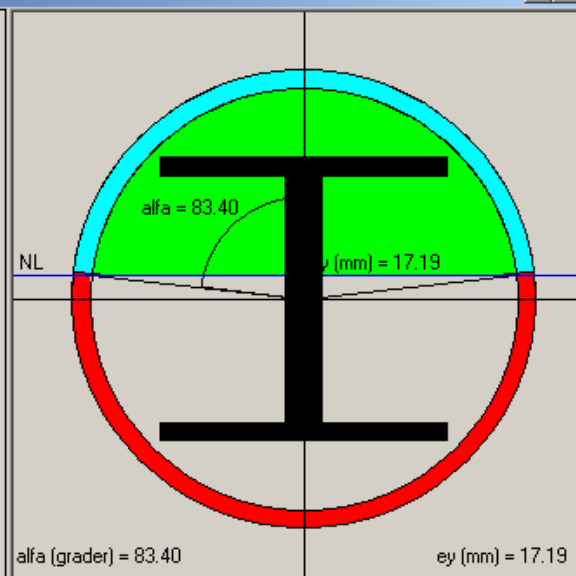
Wel (cm3) = 916.74  
 Mel (kNm) = 271.35

Wpl (cm3) = 1212.78  
 Mpl (kNm) = 358.98

Wpl/Wel = 1.32

Enbart Balken =====

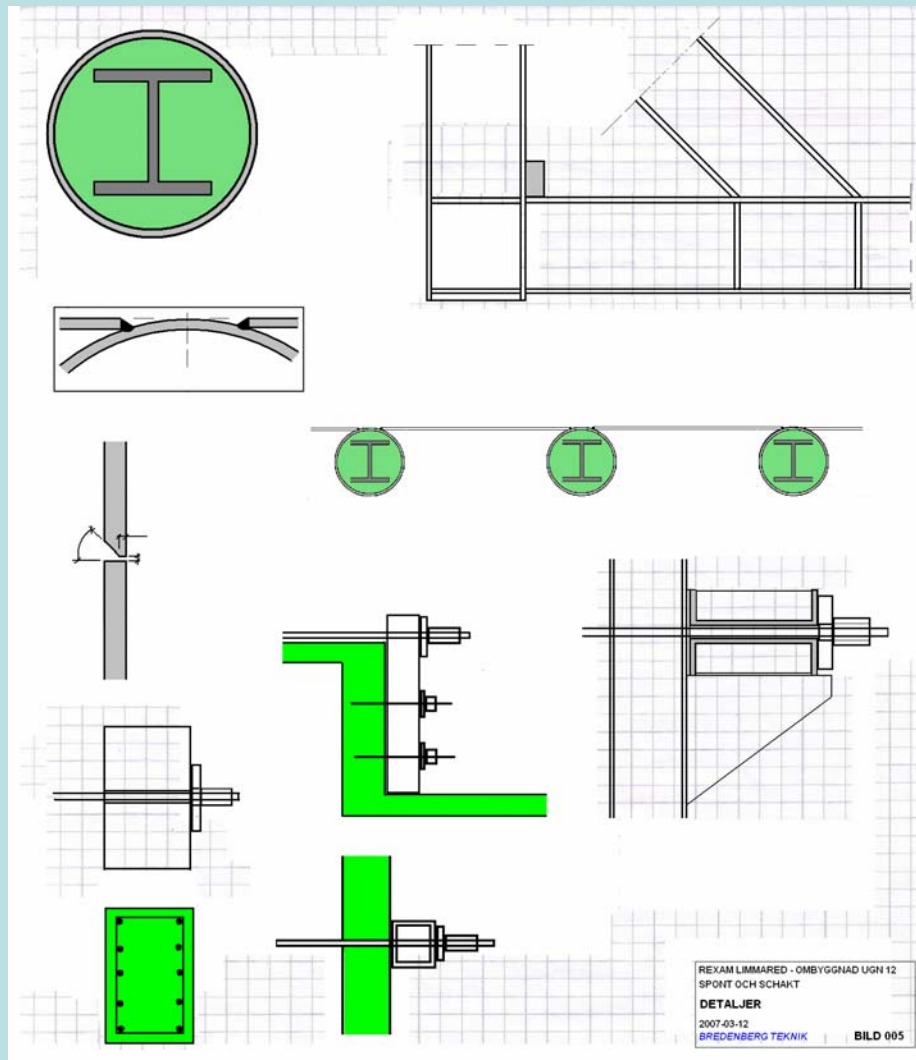
Wel (cm3) = 570.52  
 Mel (kNm) = 168.87  
 Wpl (cm3) = 371.09  
 Mpl (kNm) = 259.62  
 Wpl/Wel (kNm) = 1.54



alfa (grader) = 83.40  
 ey (mm) = 17.19

status : ■ Iteration Exit

# Design details



# Conclusions

- **Consider to use Drilled MicroPile walls when:**
  - **Obstacles in soil prevents sheet piling**
  - **Small equipment required at site**
  - **Time schedule of critical importance**
  - **Temporary piles can be used for permanent use**
  
  - **If below ground water level, lowering is required**
  - **If soil flow use jet grouting/small excavation steps**
  
  - **Thats all for now ...drill carefully out there !**