Griffith UNIVERSITY

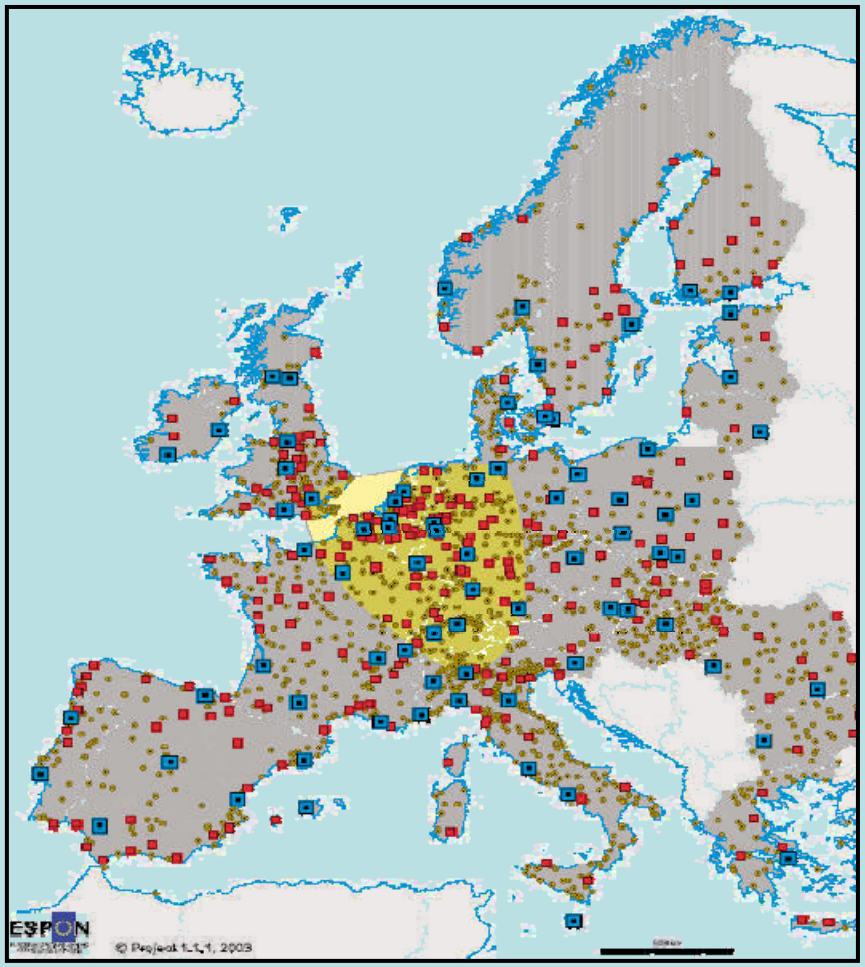
LECTURE SERIES AND WORKSHOPS ON
GEOTECHNICAL ENGINEERING IN PRACTICE

European Experience of Deep Mixing Method

K. Rainer Massarsch, Sweden

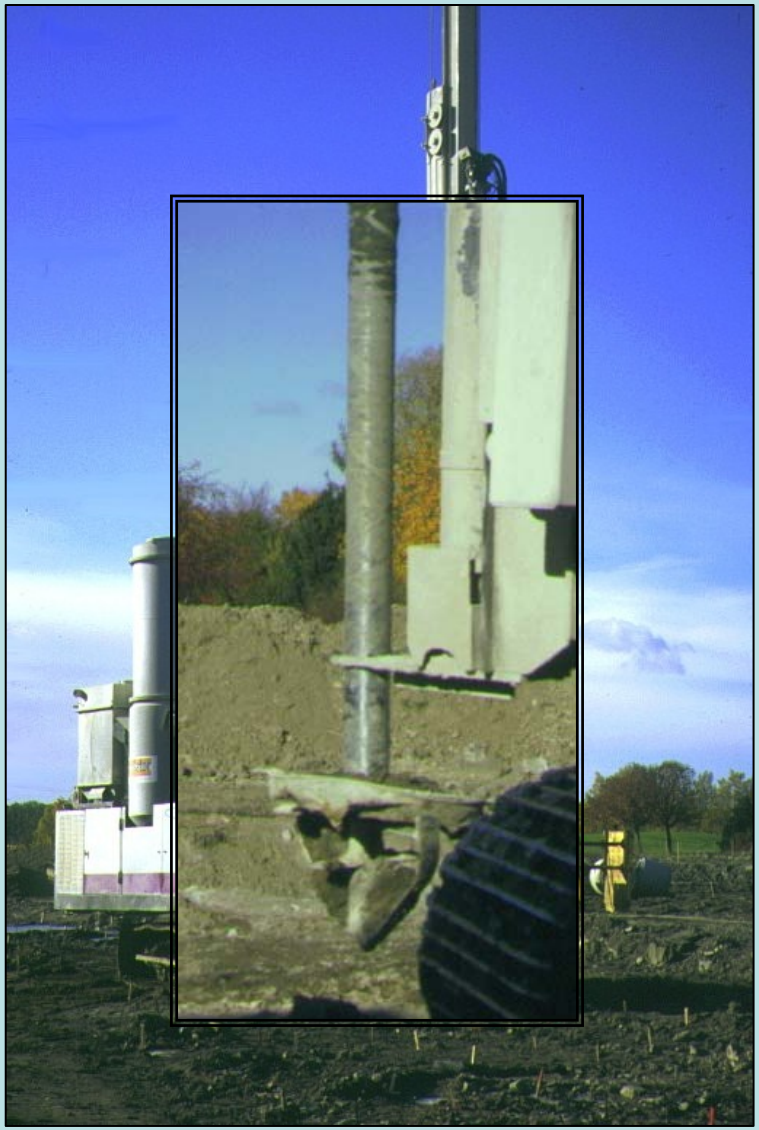
Michał Topolnicki, Poland

The European Setting



Geological and Geotechnical Conditions

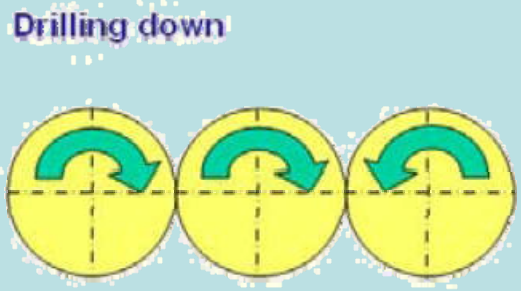
Soil Mixing Methods

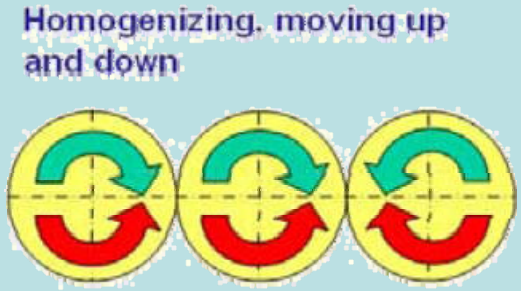


Dry Mixing – Nordic Method

Soil Mixing Methods

Wet Mixing – Central European Methods





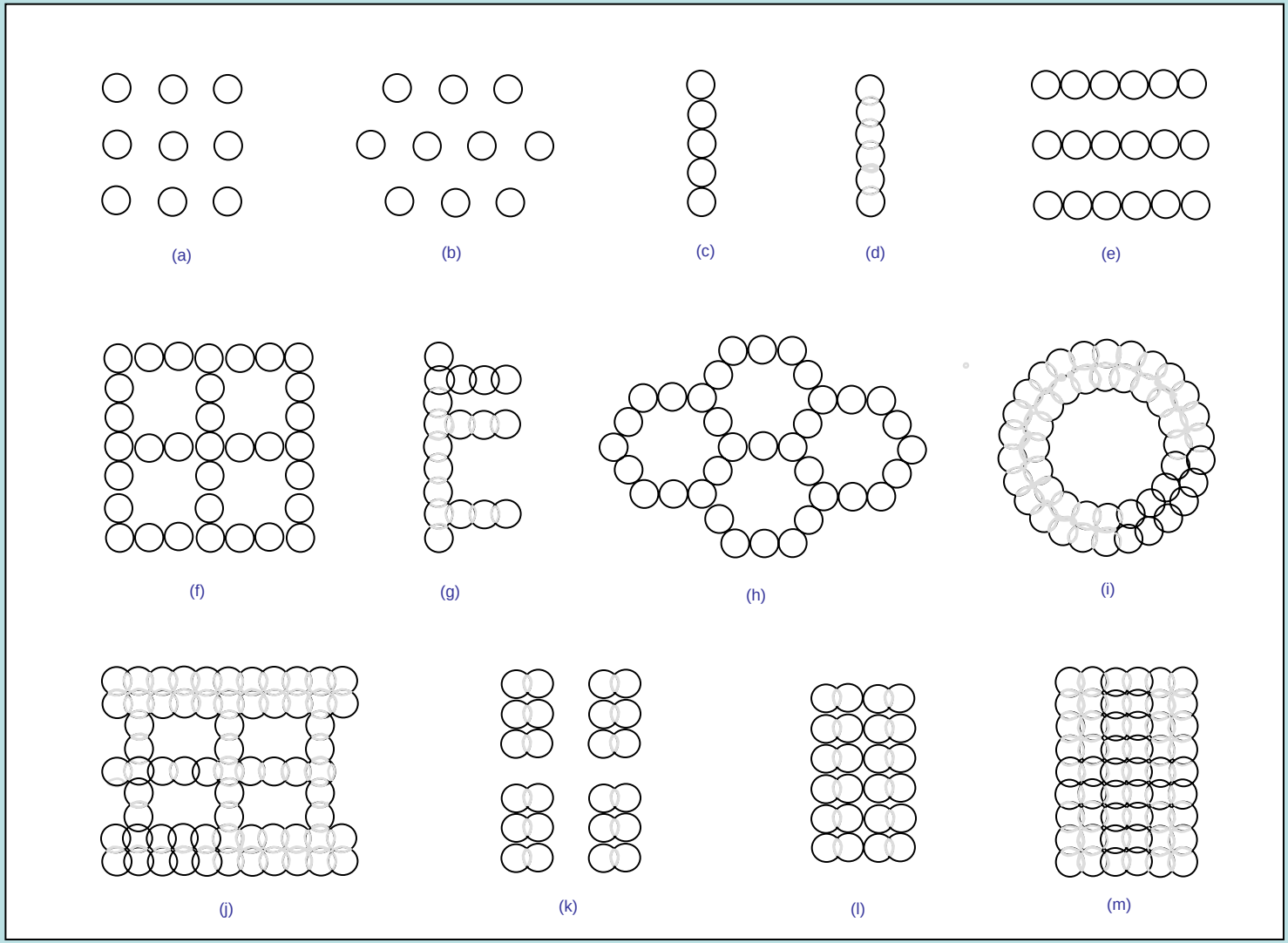
Soil Mixing Methods

Wet Mixing – Central European Method

Soil Mixing Methods

Recently developed wet Mixing Methods

Installation Patterns



Important EU-regulations & Activities

- **European Standard on Deep Mixing, (EN14679 - 2005) prepared by EFFC & CEN.**
- **European Spatial Planning Observatory Network (ESPON).**
- **Swedish Deep Stabilization Research Centre (SD).**
- **Stabilisation/Solidification Treatment and Remediation Network (StarNet).**
- **European Water Framework Directive (EWFD).**
- **Landfill Directive (LFD).**

Areas of application and major users

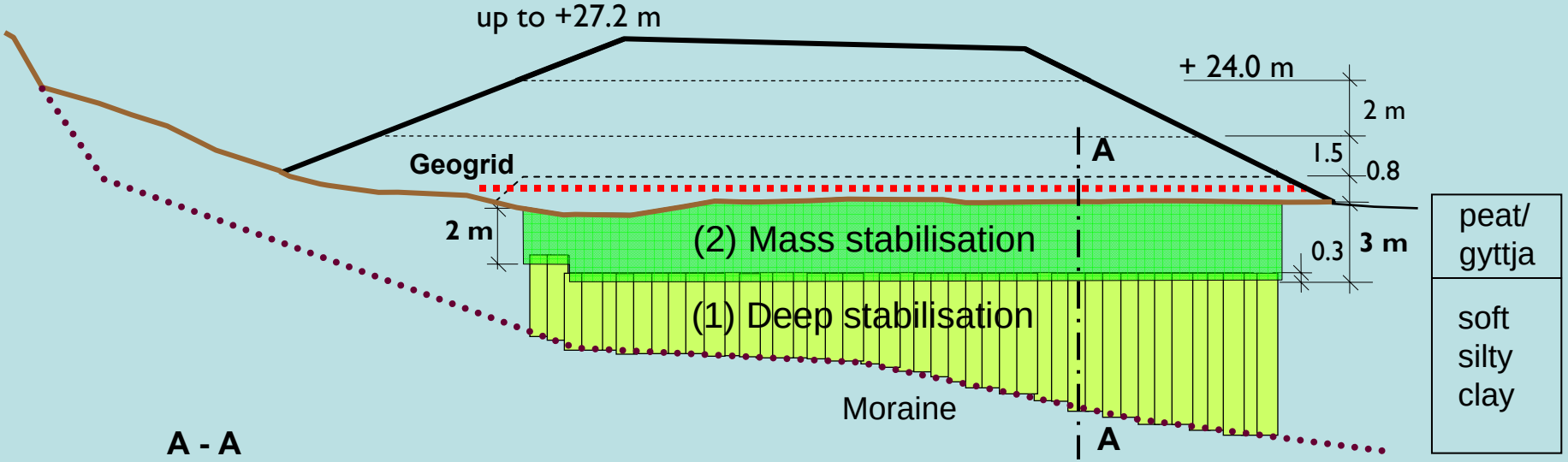
- Foundation Support (Poland, Germany)
- Retention systems, slope stab. (Germany, Scand.)
- Ground Improvement (Scandinavia)
- Hydraulic Cut-off Walls (Germany, Poland)
- Environmental Remediation, Active/Passive barriers (UK)

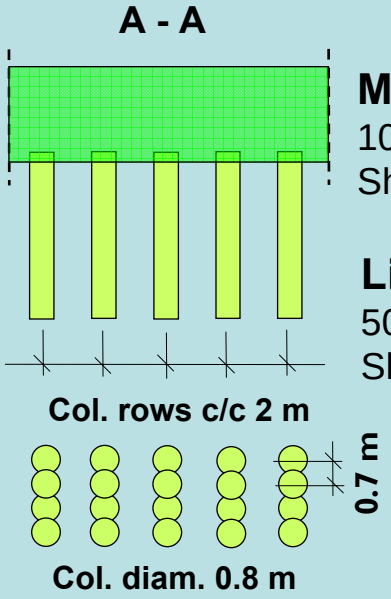
Use of mixing processes

- Dry mixing (Scandinavia, Poland, UK)
- Wet mixing (Germany, Poland, UK, Italy)

Road embankment Södertälje/Nynäshamn, Sweden

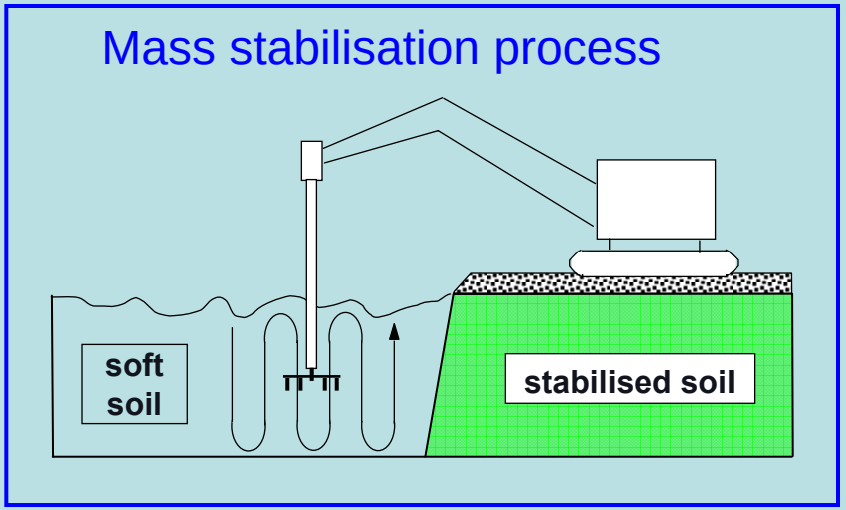
Dry mixing





Mass stabilisation:
100% Cement,175 kg/m^3,
Shear strength 50 kPa

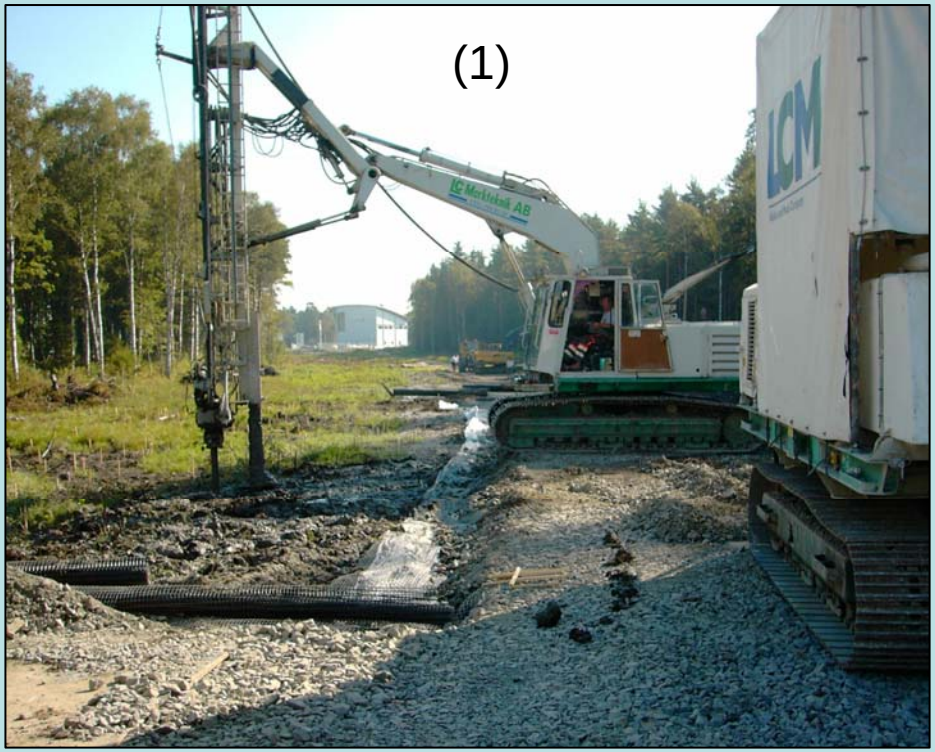
Lime/Cement columns:
50%/50%, 80 kg/m^3,
Shear strength 200 kPa

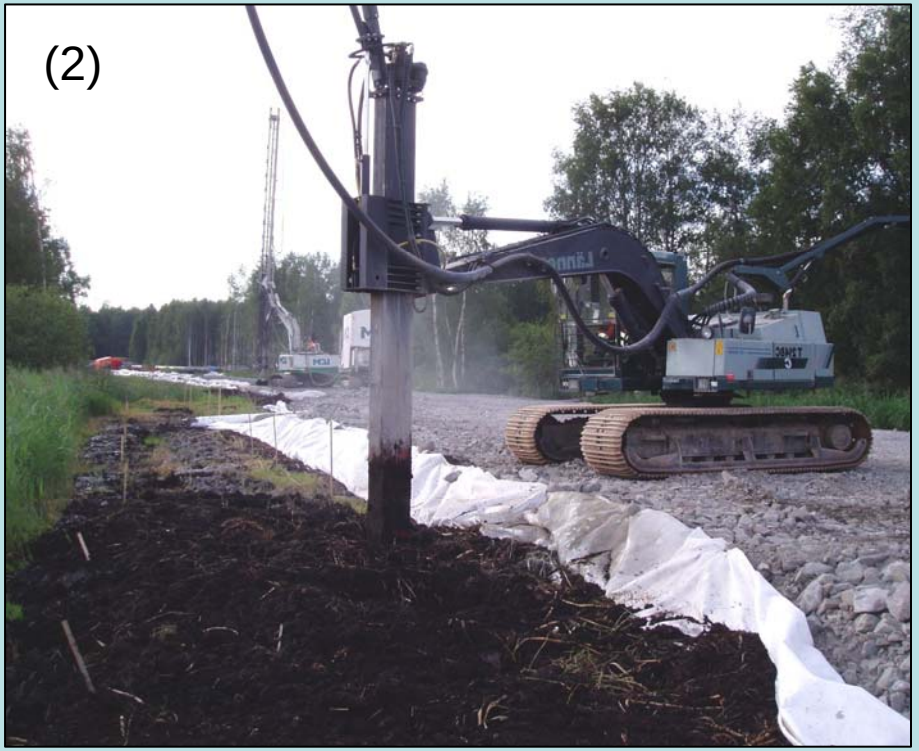


Courtesy of LCM

Dry mixing

Road embankment, Sweden

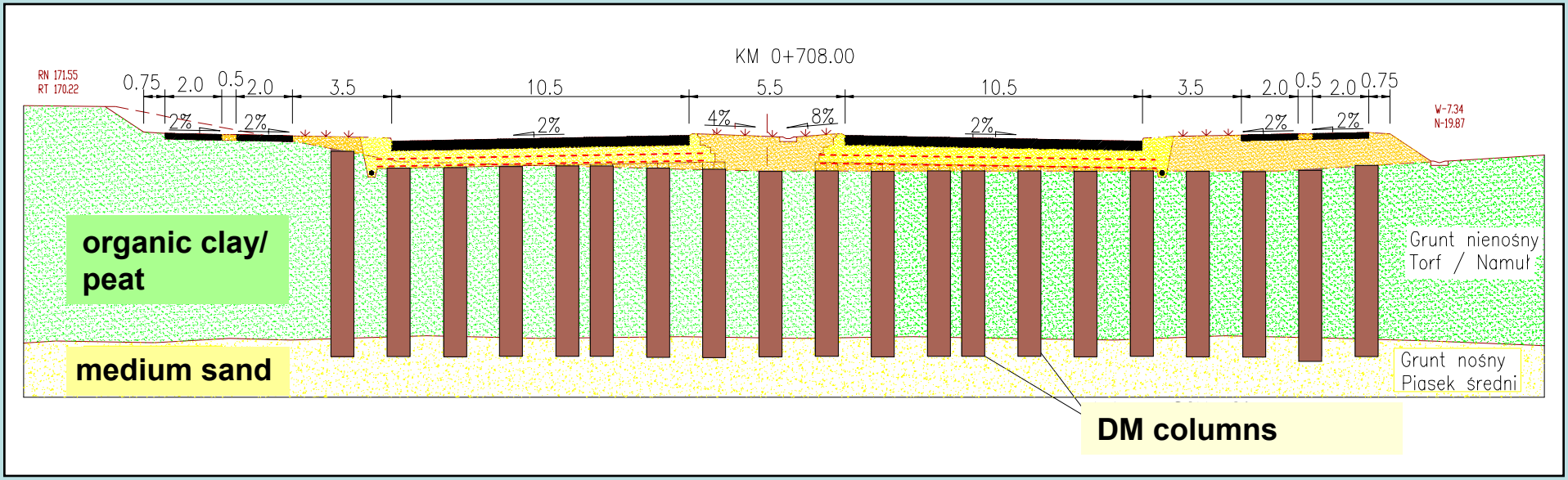


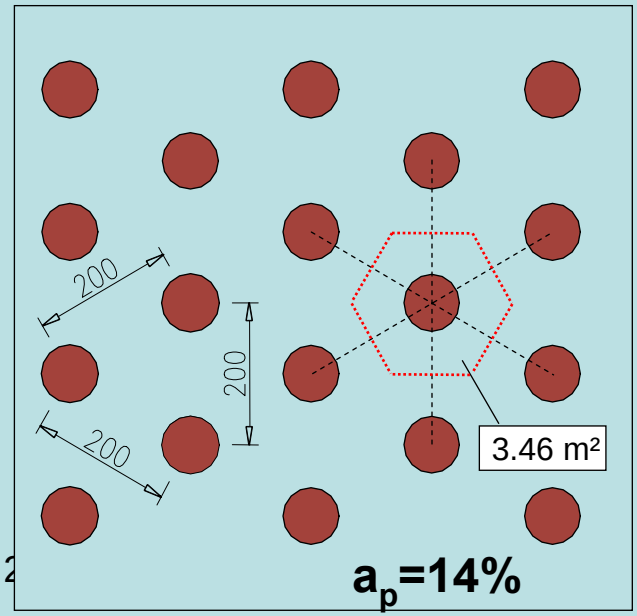


Courtesy of LCM

Wet mixing

Trasa Zielona in Lublin, Poland





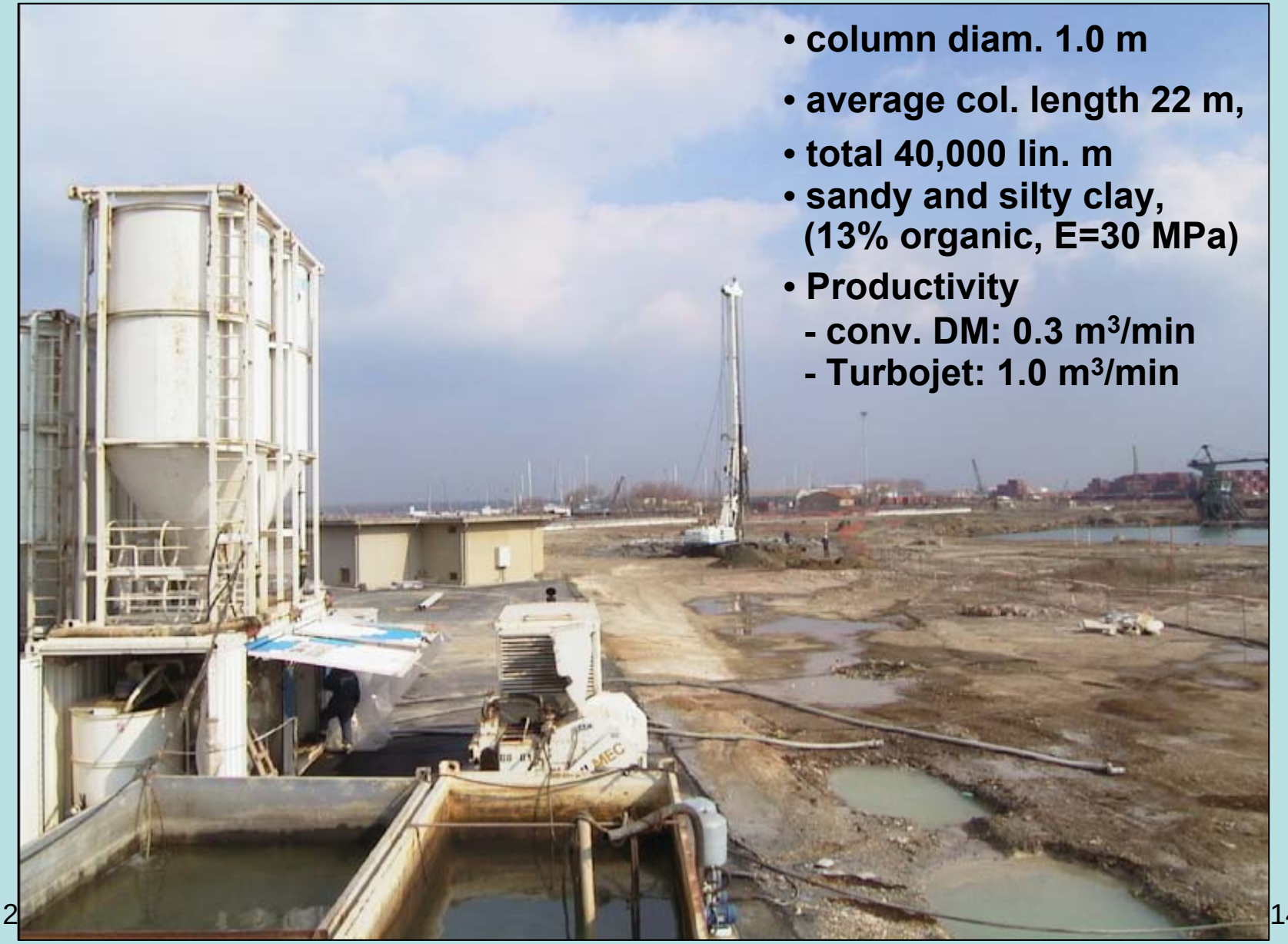
Load Transfer Platform design:

- 2402 columns, diameter 0.8 m
- average column length 6,5m, total 15,538 lin. m
- area improvement ratio 14%
- column load 185 to 260 kN
- design compressive strength 480-670 kPa, (for reduced column diameter of 0.7 m)

Courtesy of Keller Polska

Wet mixing

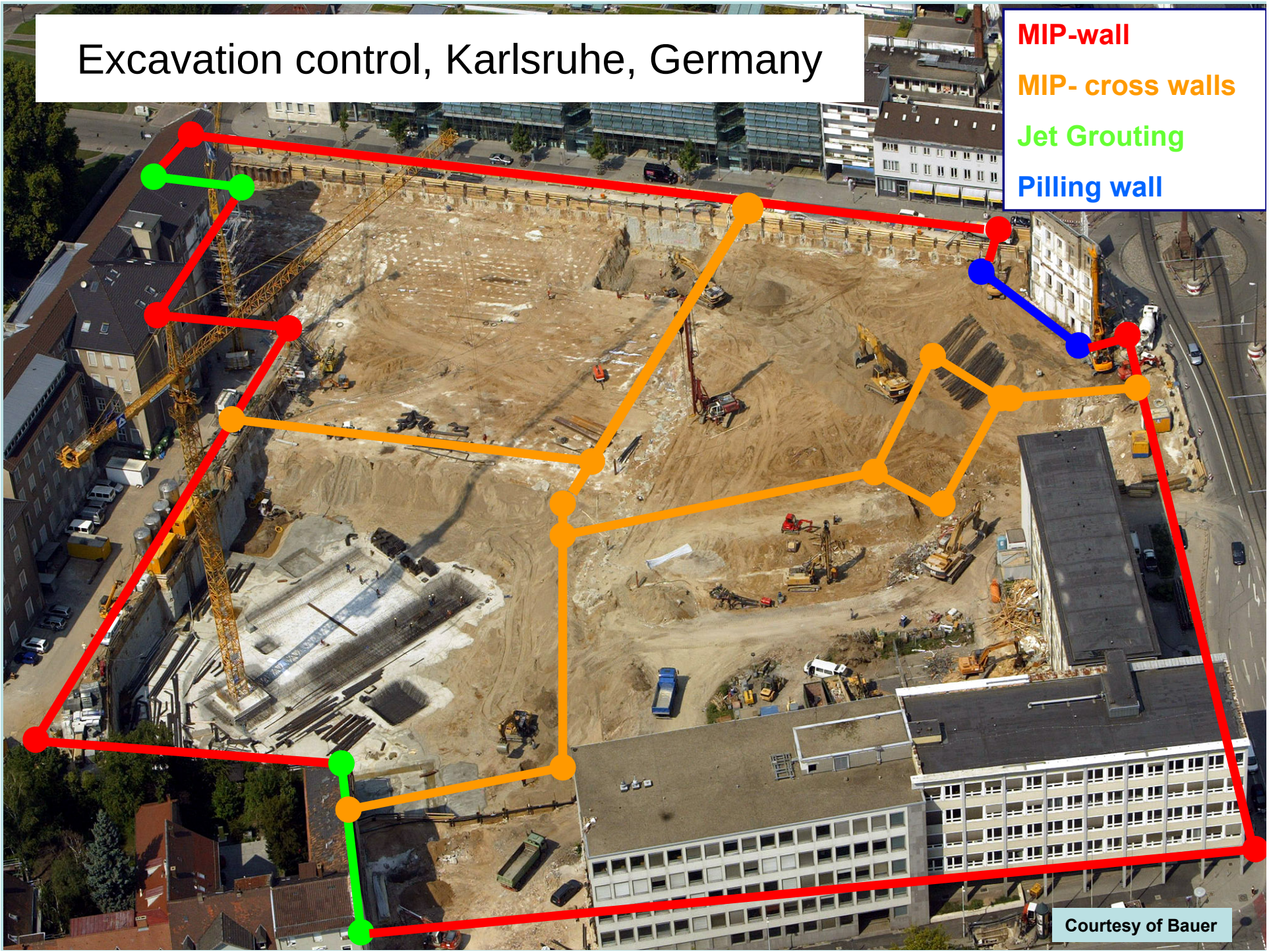
Fiumicino Airport Highway, Rome, Italy



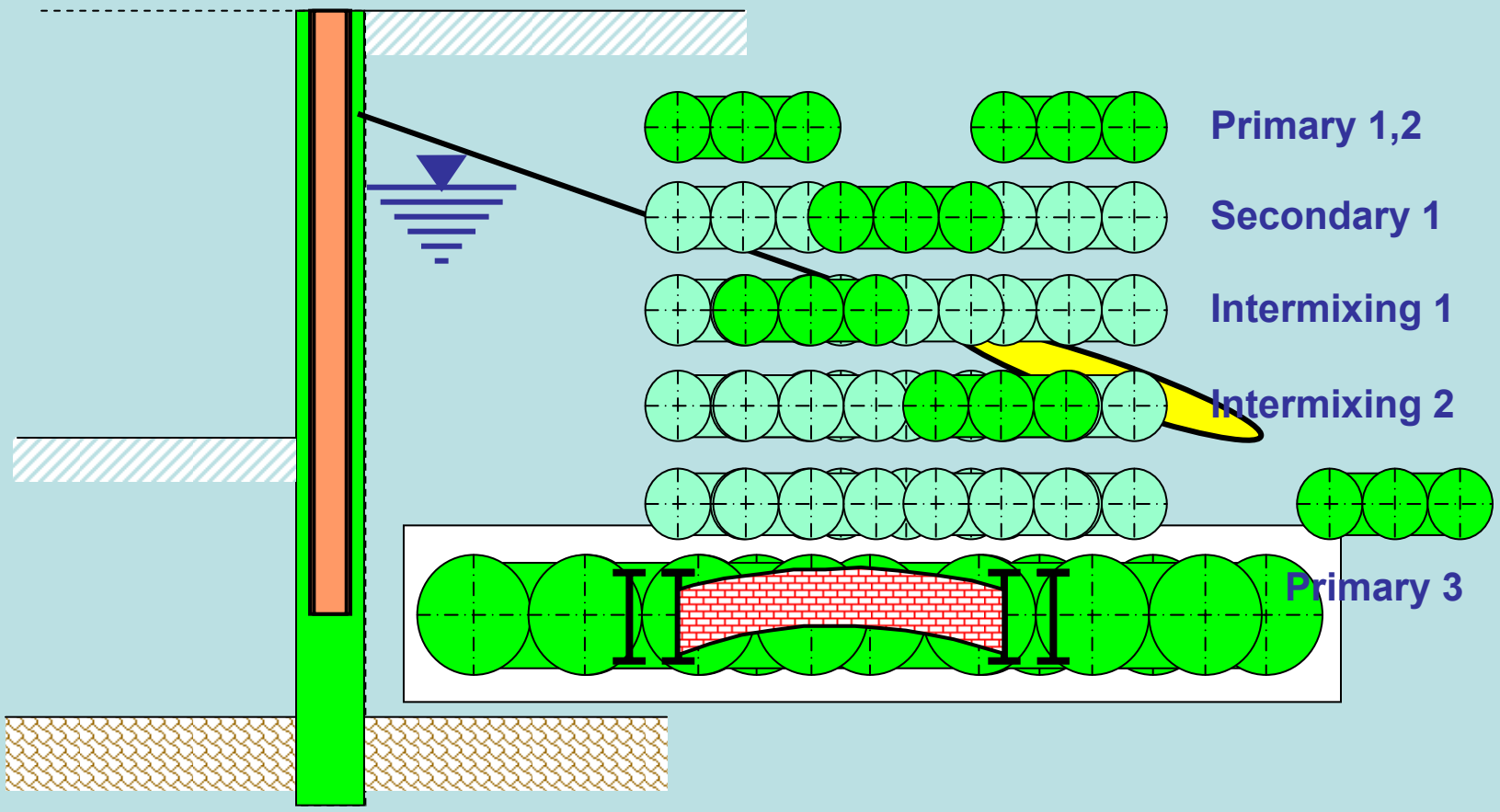
- **column diam. 1.0 m**
- **average col. length 22 m,**
- **total 40,000 lin. m**
- **sandy and silty clay, (13% organic, E=30 MPa)**
- **Productivity**
  - **conv. DM: 0.3 m^3/min**
  - **Turbojet: 1.0 m^3/min**

Courtesy of Trevi

Excavation control, Karlsruhe, Germany



Excavation control: Execution and Design Principle



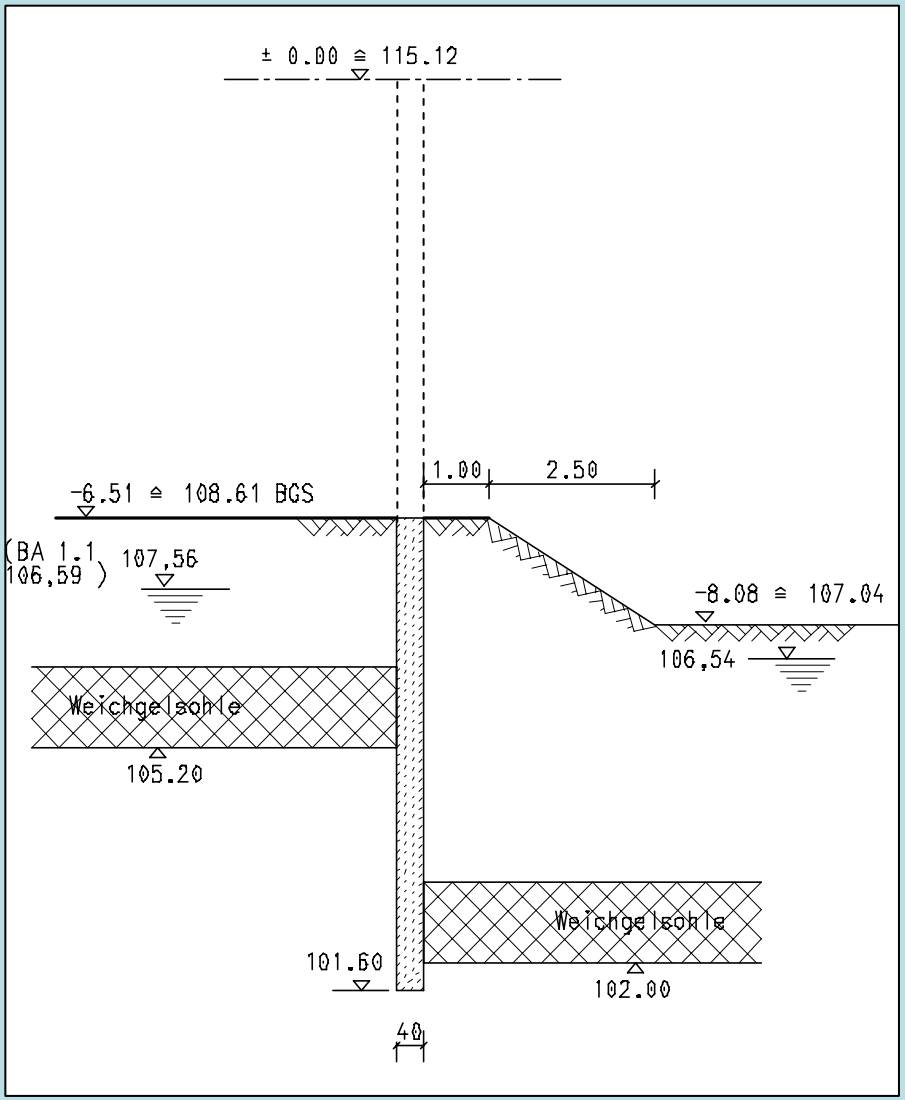
MIP- wall, Karlsruhe

Wet mixing

Courtesy of Bauer

Wet mixing

MIP- cross wall, Karlsruhe

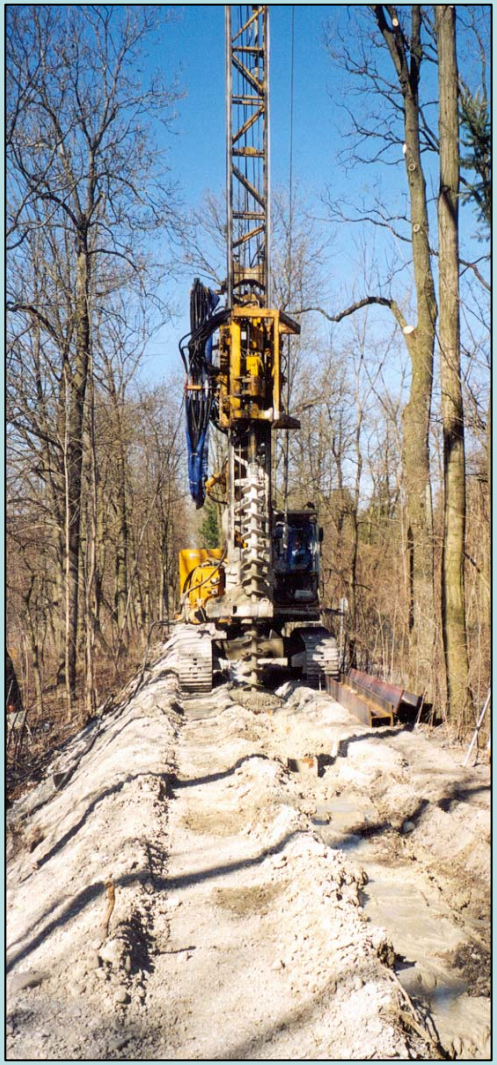


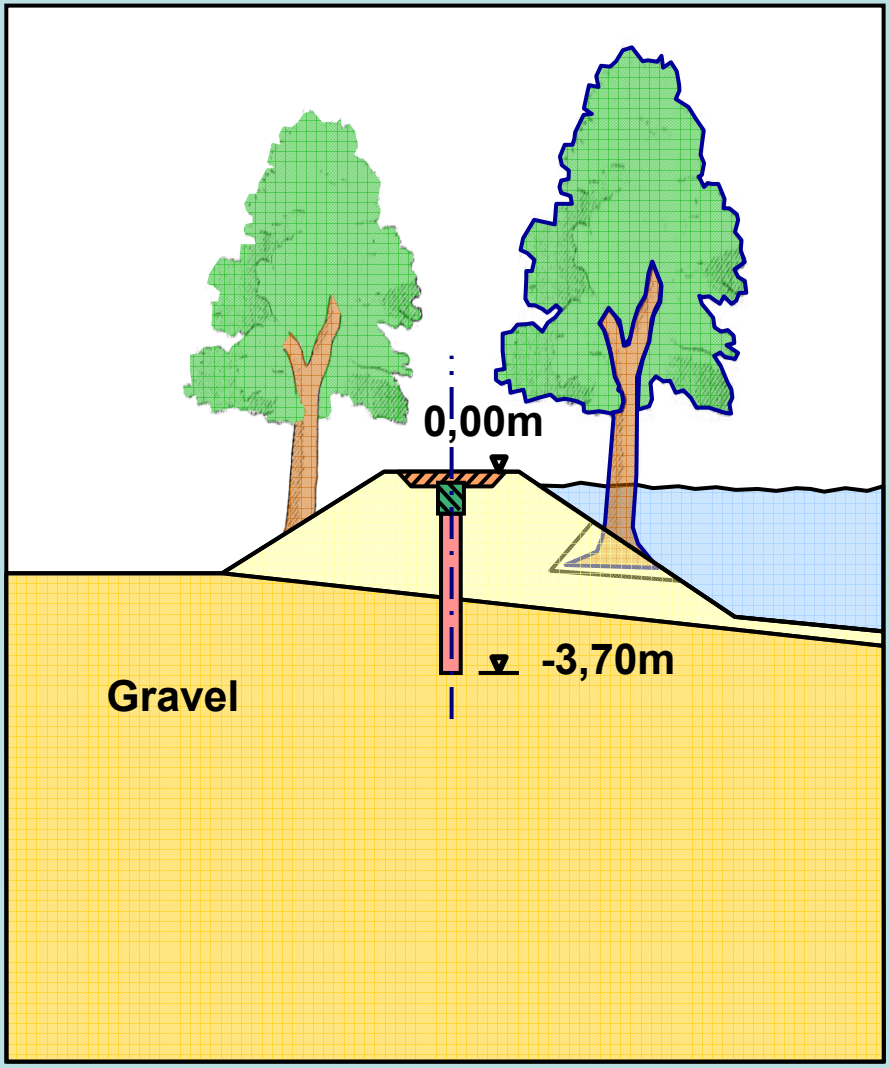
wall thickness 0.4 m

Courtesy of Bauer

Wet mixing

Cut-off walls, Germany





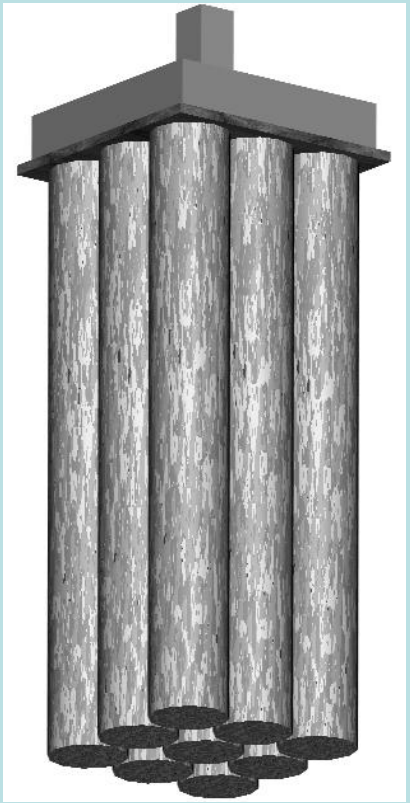
Courtesy of Bauer

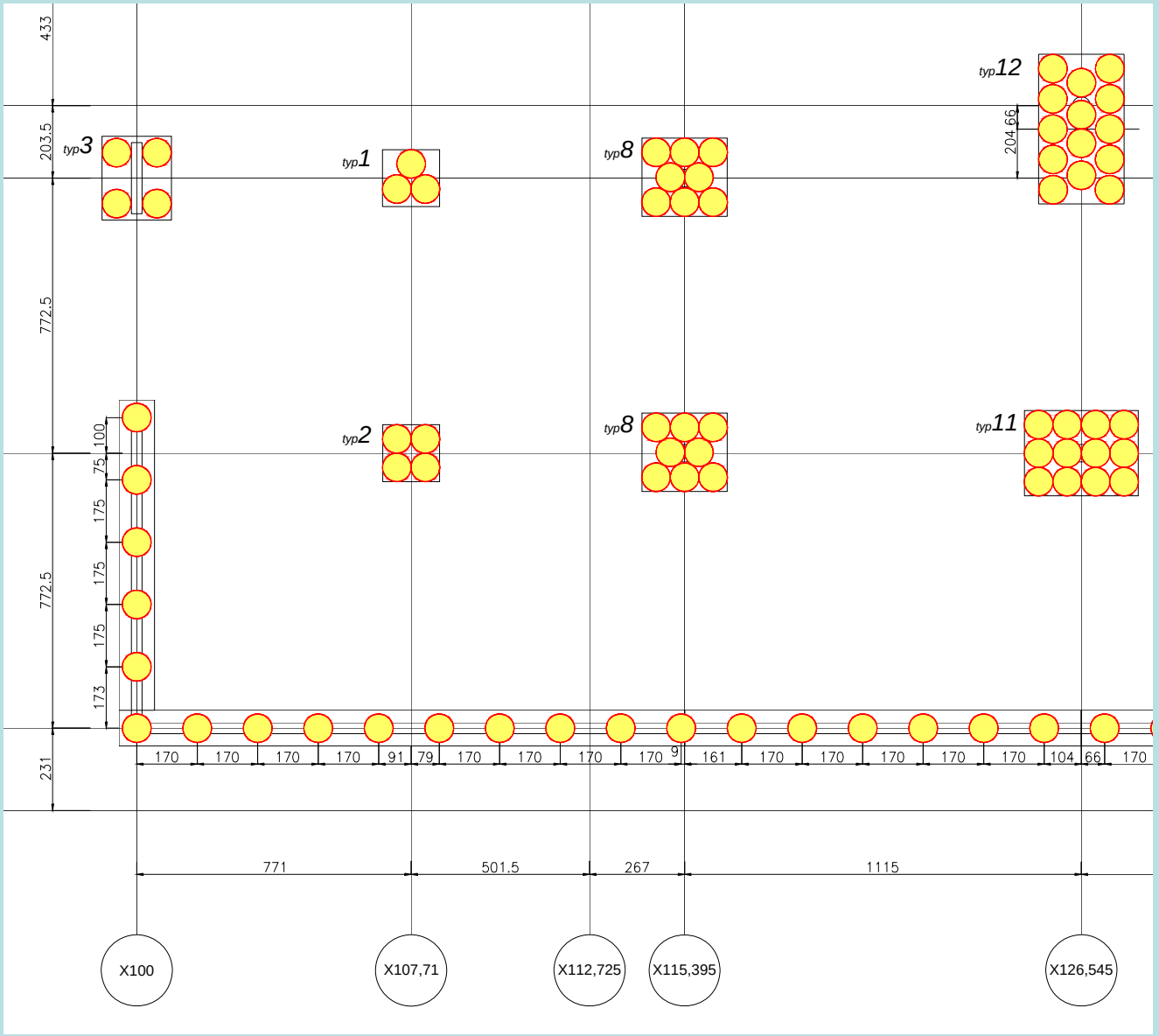
Wet mixing

Cut-off walls, Germany

Courtesy of Bauer

Foundation support: MEGAPLEX, Katowice, Poland





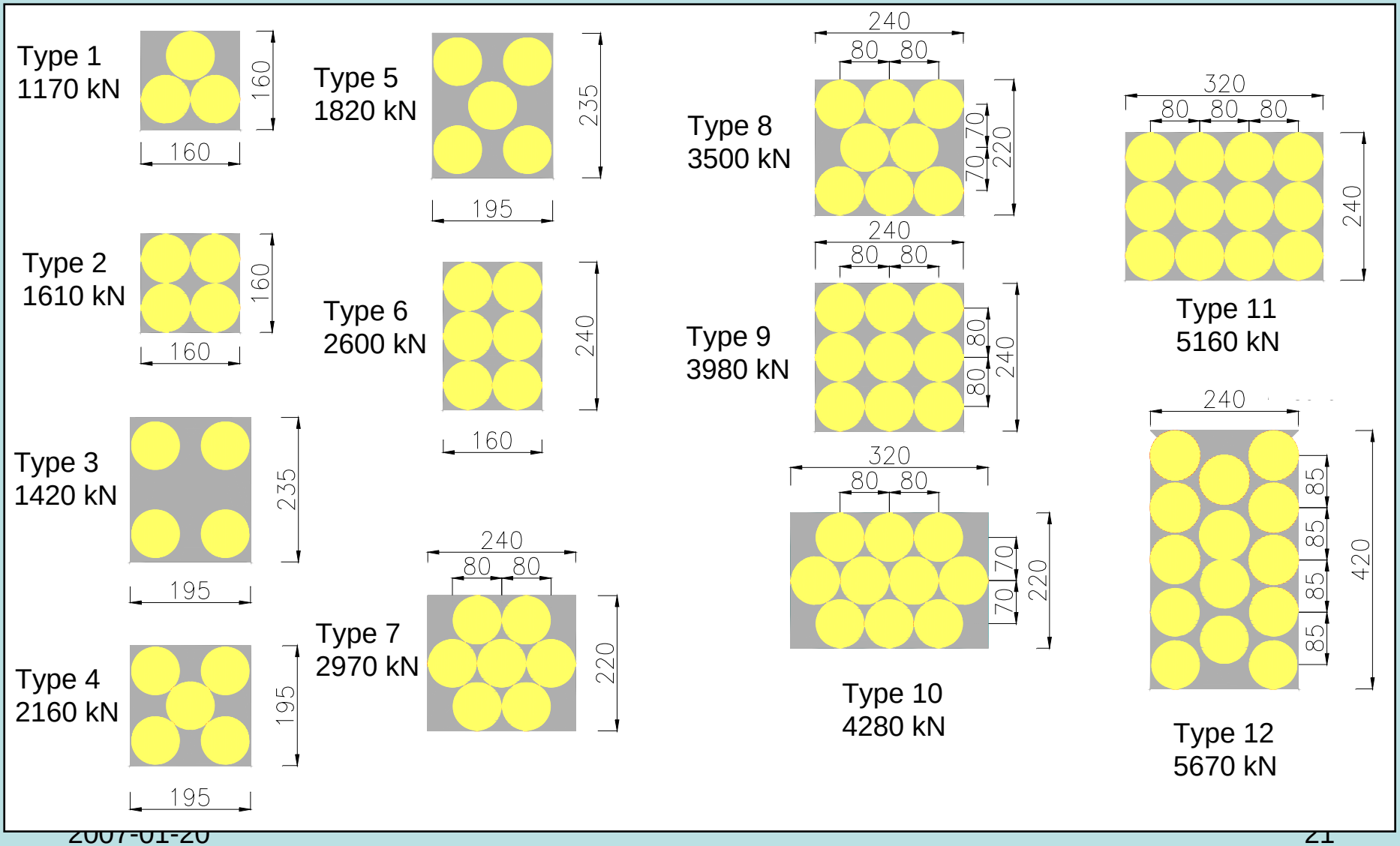
Wet mixing

2007-01-20

Courtesy of Keller Polska

Wet mixing

MEGAPLEX, Poland



Courtesy of Keller Polska

Wet mixing

MEGAPLEX - Exposed columns

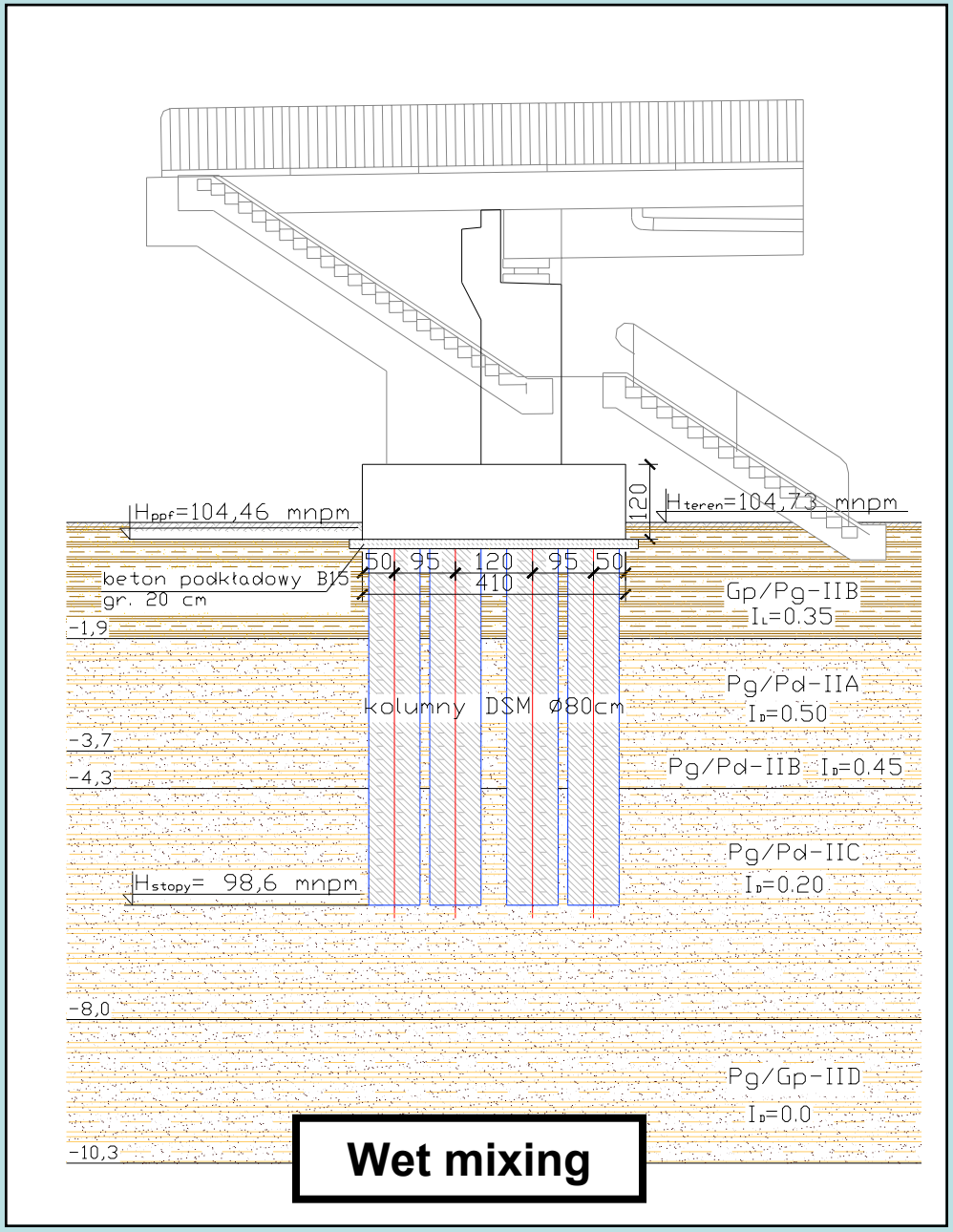
Courtesy of Keller Polska

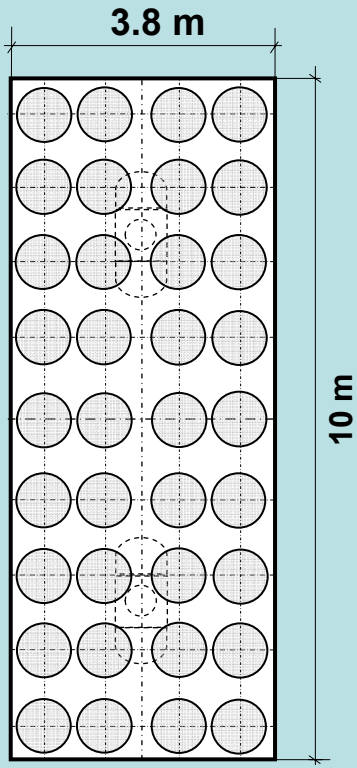
Wet mixing

MEGAPLEX, Poland

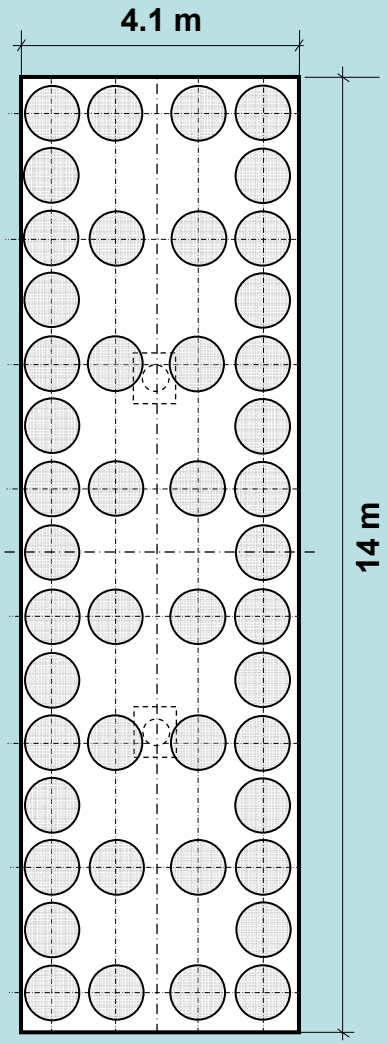
Courtesy of Keller Polska

Bridge supports on DM columns – A2, Poland (ca 80 bridges)





Supports:
P2, P3, P4,
on 36 columns

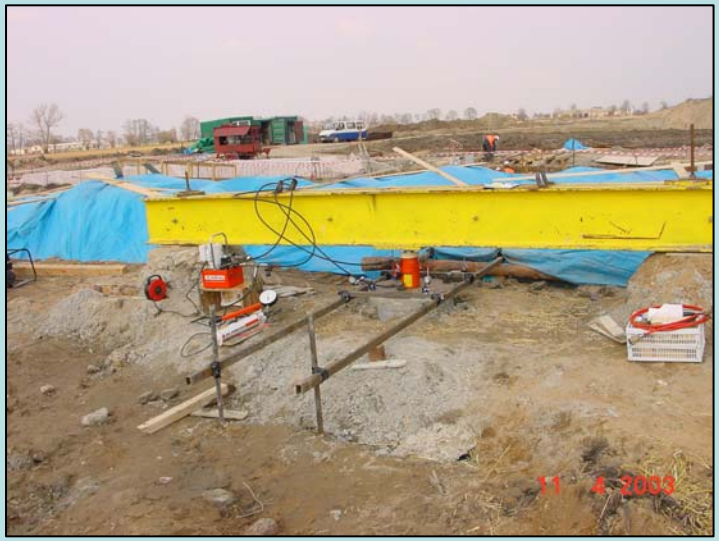


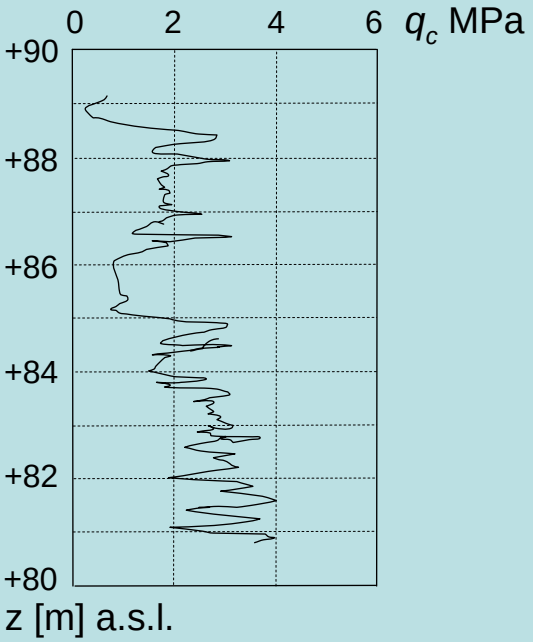
Supports:
P1, P5,
on 46 columns

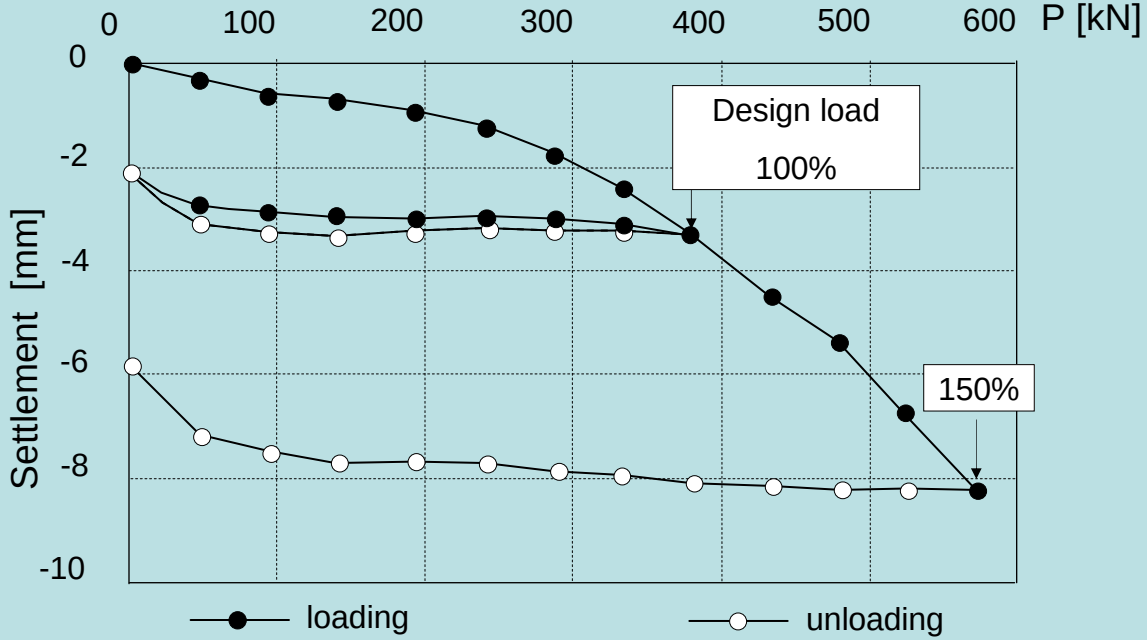
Courtesy of Keller Polska

Wet mixing

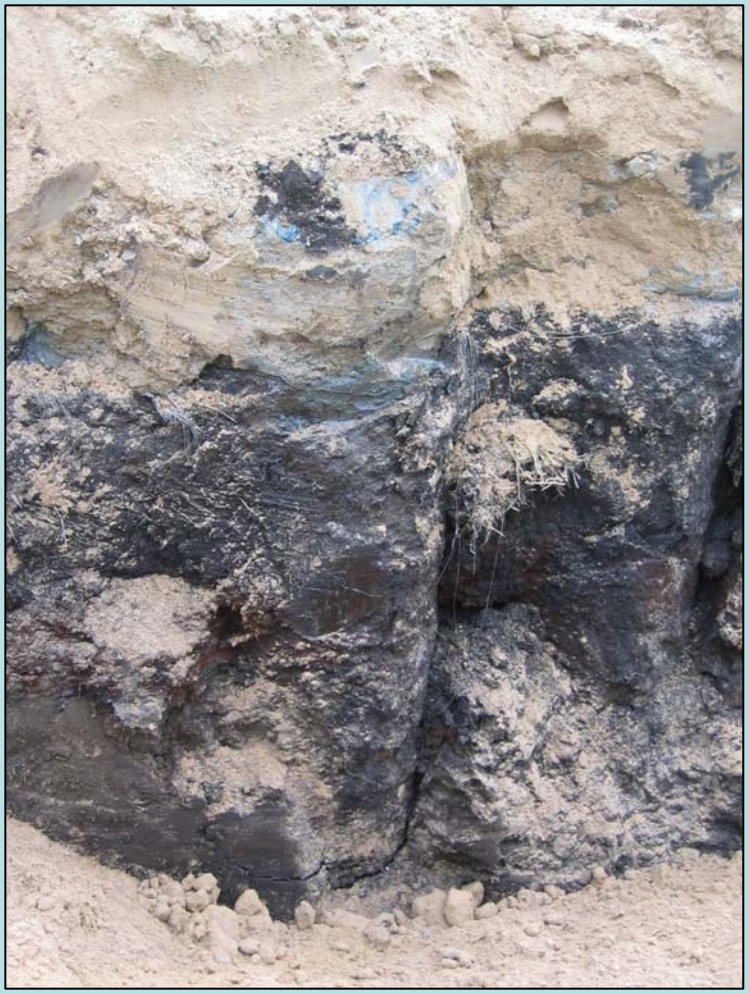
A2: Loading test of a single DM column







Problematic applications

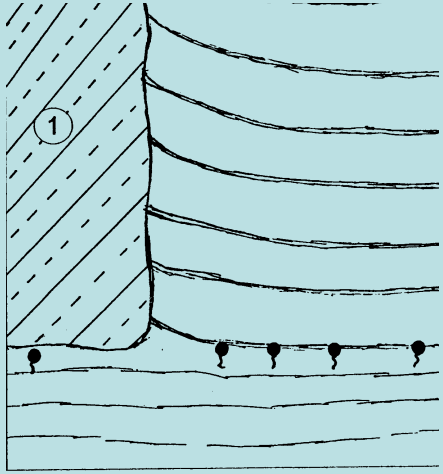


Dry mixing

Problematic applications

Wet mixing

Problematic applications



Wet mixing

Conclusions

- **Growing interest for Soil Mixing in Europe**
- **Noticeable development in equipment and QC**
- **Ongoing research activity**
- **Progress in standardisation**
- **Troubleshooting QA hamper wider SM acceptance**
- **Need for sufficiently flexible QA control programs to respond to variable characteristics of soil mix and different design requirements**