UNDERGROUND STRUCTURES, DEEP FOUNDATION

Lecture #3
D-wall, Caisson & Well foundation
Types of deep foundations

- Deep foundations
  - Pile
  - Diaphragm wall
  - Soil displacement
  - Soil replacement
  - Other
  - Caisson & well foundation
  - Well foundation
  - Caisson fondation
Deep foundation > Diaphragm wall (Slurry wall)

Diaphragm wall (D-wall):
- A wall is created under the ground level

Construction sequences:
- Soil excavation
- Temporary support of trench („panel”) is provided by bentonite slurry
- Placement of reinforcement
- Concreteing

Fields of application:
- Retaining structure of (deep) excavations
- Side wall of underground levels of buildings
- Deep foundation
- (deep groundwater barrier)
Deep foundation > Diaphragm wall > Excavation

- Guide wall is built in advance
- Trench excavation (under bentonite slurry)
- Removal of previous „end stop“
Deep foundation > Diaphragm wall > Concreting

- Inserting „end stop”
- Placement of reinforcement
- Concreting (under Bentonite slurry, using tremie pipe)
- Excavation of subsequent panel
Excavation techniques:

- mecanhical grab (clamshell)
  - cable hung
  - kelly bar
- hydraulic grab (clamshell)
- hydromill or hydrofraise
Deep foundation > Diaphragm wall > Cable hung clam
Deep foundation > Diaphragm wall > Hydraulic grab
Rotary drum cutters excavate the soil (or rock). The cuttings (and slurry) are removed through reverse circulation pumps. The cuttings are removed from the slurry in a desanding plant. Fresh (clean) slurry is added at the top of the trench.
Deep foundation > Diaphragm wall > Excavation

> Hydrofraise
Deep foundation > Diaphragm wall > Excavation

> Hydrofraise

1. Fraiser
2. Pump
3. Desanding
4. Tank
5. Pump
6. Soil
7. Pump
8. Slurry mixer
9. Bentonite
10. Water supply
Deep foundation > Diaphragm wall > Excavation

> Hydrofraise
Deep foundation > Diaphragm wall > Bentonite slurry

Bentonite slurry:
- Mixture of water and bentonite (very fine particles, mostly montmorillonite)
- Density: 1.03-1.12 g/cm³

Role:
- Protection against groundwater inflow
- Trench wall support

\[
\sigma_x = \frac{L \cdot \gamma}{\sin 2\phi} \cdot K_a \cdot (1 - e^{-\frac{\sin 2\phi}{L} \cdot z}) - \frac{c}{\tan \phi} \cdot (1 - K a)
\]
Deep foundation > Diaphragm wall > Reinforcement
Deep foundation > Diaphragm wall
> Connection of panels
Deep foundation > Diaphragm wall
> Advantages - limitations

Advantages:
- flexible geometry
- high bearing capacity
- small settlements
- horizontal + vertical bearing capacity
- can be constructed under groundwater
- minimal dynamic effect
- multiple function (retaining structure during construction + foundation + side wall)

Limitations:
- Very stiff rock
- Very soft soils (trench stability problem; e.g. soft clay, organic material, liquefiable sand)
- Cavities
- Old building remains
- Utilities
Deep foundation > Diaphragm wall
Types of deep foundations

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Deep foundation > **Well foundation**

**WELL FOUNDATION**

- GWL
- Well foundation
- Soft soil layer
- Stiff soil layer
Deep foundation > Well foundation

WELL FOUNDATION

- Superstructure
- Footing beam
- Well foundations
Deep foundation > Well foundation
> construction sequences

Prefabrication  Sinking and excavation  Bottom slab (plug)  Conreteing

Superstructure

Well foundation
Deep foundation > Well foundation – types

CUTTING EDGE TYPES

- Cylindrical
- Cylindrical with enlarged base
- Conical
- Conical with enlarged base

Skin friction reduction

- Reinforced concrete
- With outer steel edge
- Geometry of enlarged base
Deep foundation > Well foundation > Advantages

Advantages:
- large diameter
- similar to piles, but shorter
- if large bearing capacity soil (rock) is between 3-7 m, it can be very effective
- if loads are not too large, but the upper 3-7 m of the soil is not appropriate, can be applied effectively
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Deep foundation > Caisson foundation
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Deep foundation > Caisson foundation
Deep foundation

Caisson foundation
Deep foundation > Caisson foundation

A genfi garázs süllyesztési ütemei, (1) az alsó rész süllyesztése, (2) a felsőrész betonozása, (3) a teljes süllyesztés befejezése, a) talajvízszint, b) kotrógép, c) tixostrópos folyadék besajtolása, d) cementhabarcs injektálása a bentonit kiszorítására.
Deep foundation
> Caisson foundation