Leendert de Boerspolder

Design and evidence of the failure: suggestions for the discussion

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“Clay dyke on peat”

Choice of the experimental sites

Standard site investigation

Laboratory testing

TXCU, DSS, K0-CRS, CRS, IL

In situ stress and OCR

Effect of overburden stress and OCR on deformational behaviour

Crest: sample A contractant

Toe: sample B dilatant

Polder: sample C dilatant

Effect of void ratio and organic content on the permeability

Organic clay: thick interface transition between peat and silty clay

Designing the test

- Testing in extreme wet conditions
- Avoiding failure of the outer slope
- Forcing the failure surface in the peat layer
- Controlled failure
- Collecting as much information as possible from pre-failure stages

Designing the test

Wetting – staged excavation and pumping

TU Delft

Deltares

Excavation 1: 28/09/2015

Pumping 1: 30/09/2015

Excavation 2: 05/10/2015

Pumping 2: 07/10/2015

Excavation 3: 12/10/2015

Pumping 3: 14/10/2015

Monitoring the test

Inclinometers, Extensometers, Piezometers

Designing the test

Inclinometers – Extensometers

- Follow the change in horizontal and vertical deformation during the stress stages approaching failure
- Describe the failure mechanism as well as possible
- Back-analyse the deformation response during the stress tests before failure and check for material models

Designing the test

Piezometers

- Follow the change in pore pressures during wetting
- Analysing the response to initial excavation and pumping stages to update the failure design
- Back-analyse the pore water pressure changes during the stress tests and at failure (Permeability? Drained, undrained?)

Strategy for the design

The design of the failure was made by using effective strength parameters but NOT assuming DRAINED CONDITIONS. Instead, an hypothesis on pore water pressure was made assuming PARTIALLY DRAINED conditions observed during the previous pumping stage (pumping II) --- > reduction of pore pressures around 20% with respect to undrained conditions

Soil strength parameters

Layer	c' [kPa]	ϕ' [deg]	γ_{sat} [kN/m^3]
D.M.	5	33	18
Peat	2,5	28,8	10
Organic Clay	4,4	29,5	15

Peak or 5% axial strain

Contribution to strength: Sensitivity analysis

Influence of the pore water pressure assumption: LEM - failure

Model 1-A: undrained behaviour, unique phreatic line

Influence of the pore water pressure assumption: LEM - failure

Model 1-B: drained behaviour at toe, unique phreatic line

Influence of the pore water pressure assumption: LEM - failure

Model 2-B: drained behaviour at toe, high phreatic line for DM

Influence of the pore water pressure assumption: LEM - failure

Model 3-B: partial drainage of peat, three different phreatic lines

Layer	Pl
D.M.	2
Peat	3
O. C.	1

Influence of the pore water pressure assumption: LEM - failure

LEM vs FEM

Second excavation and pumping

Time dependent coupled FEM

Sensitivity to the hydraulic conductivity

The prediction (Bishop min FoS)

FoS = 1.22

FoS (-1.25) = 0.85

FoS (-1.50) = 0.79

Numerical analysis: LEM & FEM

Gianluca Cavallo, internship 2016

Preliminary evaluation of the 3D effect

Excavation II & Pumping

Excavation

FoS 2D/FoS 3D =0.85

Pumping

FoS 2D/FoS 3D =0.88

Pumping 2: pre-failure mechanism section mid-toe

Inclinometer

Pumping 2: pre-failure mechanism section south-toe

Inclinometer

Failure: mechanism evolution

Failure : mechanism evolution

Failure : mechanism evolution

Failure : mechanism evolution