



GeoFuture II – muligheter og løsninger for geoteknikere

Trimble brukermøte 2019

Steffen Giese, Multiconsult, prosjektleder GeoFuture II

BIA Foundations for tomorrow's infrastructure



BIA Fundamentering av fremtidens infrastruktur

Prosjektpartnere og Budsjett

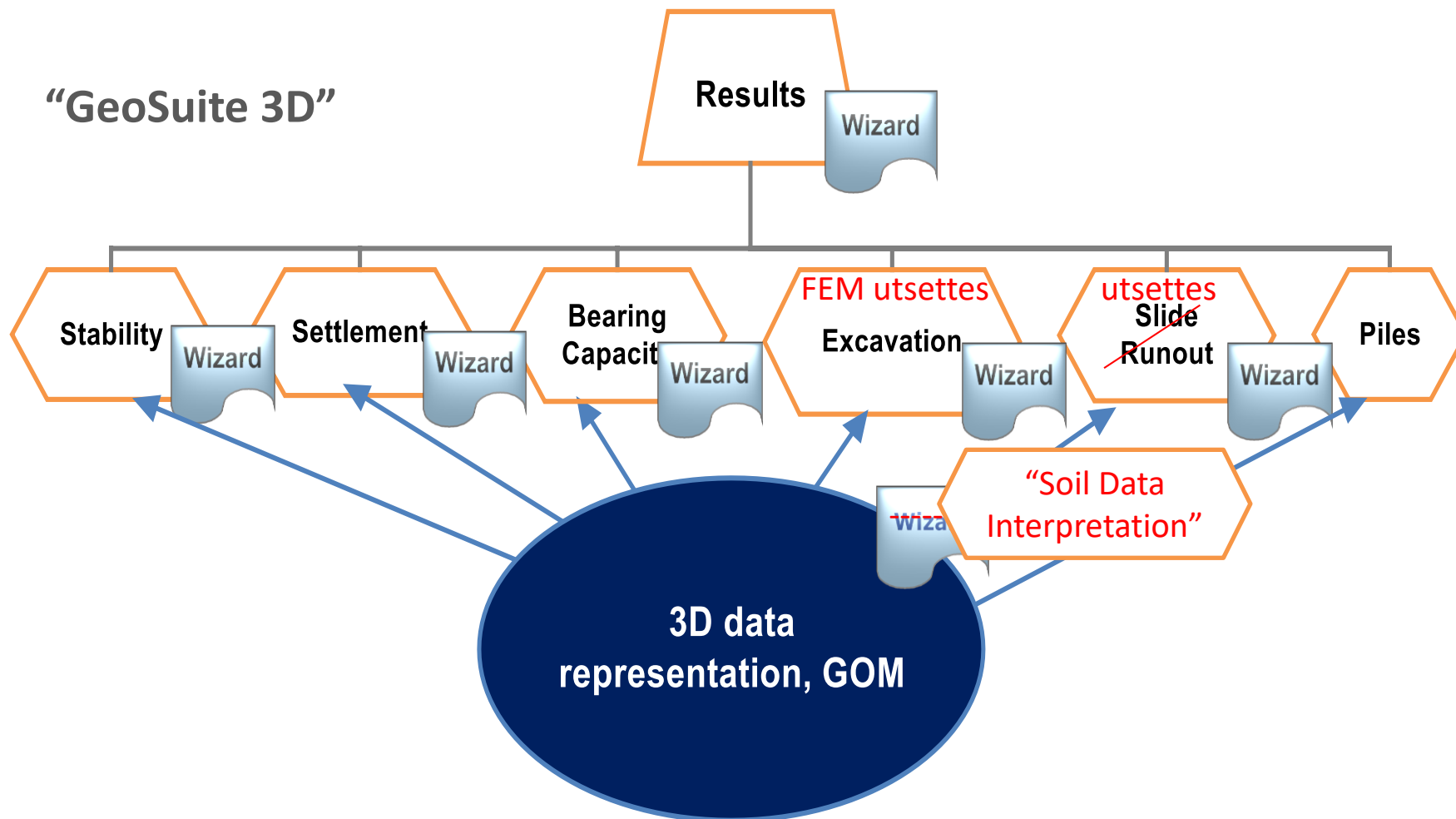


Rådgivere / industripartnere	FoU	Offentlige
Multiconsult	Norges Geotekniske Institutt	Statens Vegvesen
Norconsult	SINTEF	Bane NOR
Geovita	NTNU	
Sweco		
Rambøll		
Cowi		
Trimble Solutions Sandvika		
AGEF		
Trimble Solutions Stockholm		

- Budsjett 2015-2019: 31.5 mNOK

Visjon og revidert målsetning

“GeoSuite 3D”



Utviklingstrinn



3D FEM

Generell 3D FEM
som dimensjoneringsverktøy

3D FEM - forenklet

2D FEM

Deformasjoner
Uregelmessige bruddmoder

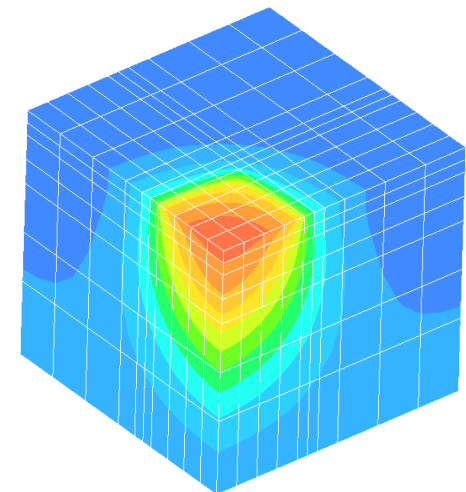
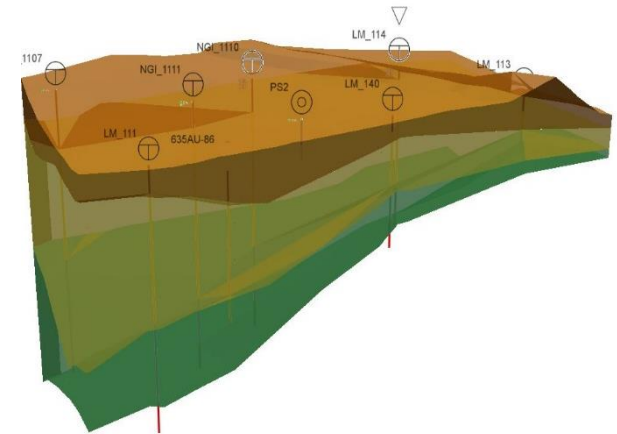
LEM

2D (Stability)
3D (Piles)

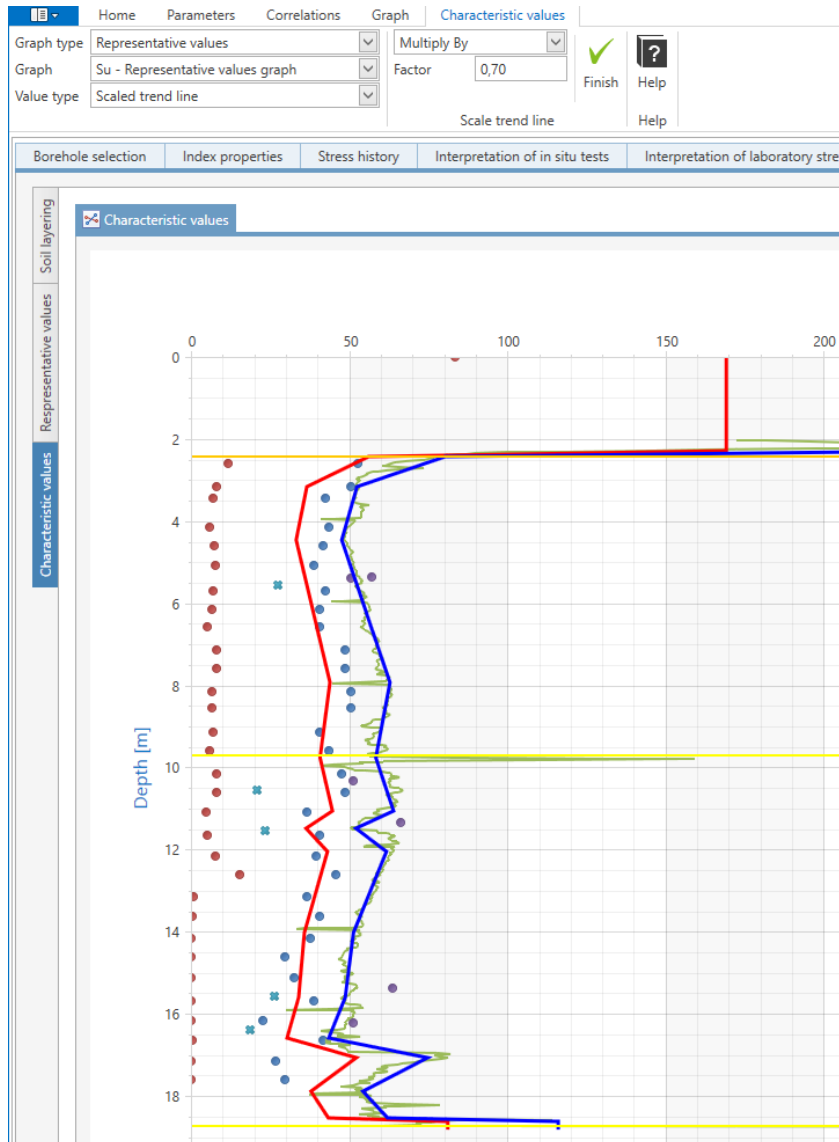
Ground Observation Model (GOM)



- Plassere grunnundersøkelser på kartgrunnlag
- Velge boringer og sonderinger til videre tolkning vha. Soil Data Interpretation
- Visualisere grunnforhold og lagdeling i 3D
- Lage 2D snitt som grunnlag for beregninger
- Visualisere beregningsresultater i 3D

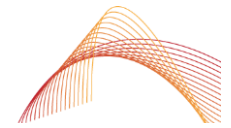


Soil Data Interpretation



- Verktøy og veileder for tolkning av geotekniske designparametere
- CPTu, vingebor, div. sonderinger
- Indeks, treaks, DSS, ødometer
- Fokus på parametere for leire
 - Indeks
 - Skjærstyrke
 - Stivhet
 - Permeabilitet
- Wizard fullt integrert

Soil Data Interpretation



Model2 - Soil Data Interpretation

Home Parameters Correlations Graph CPT/CPTU

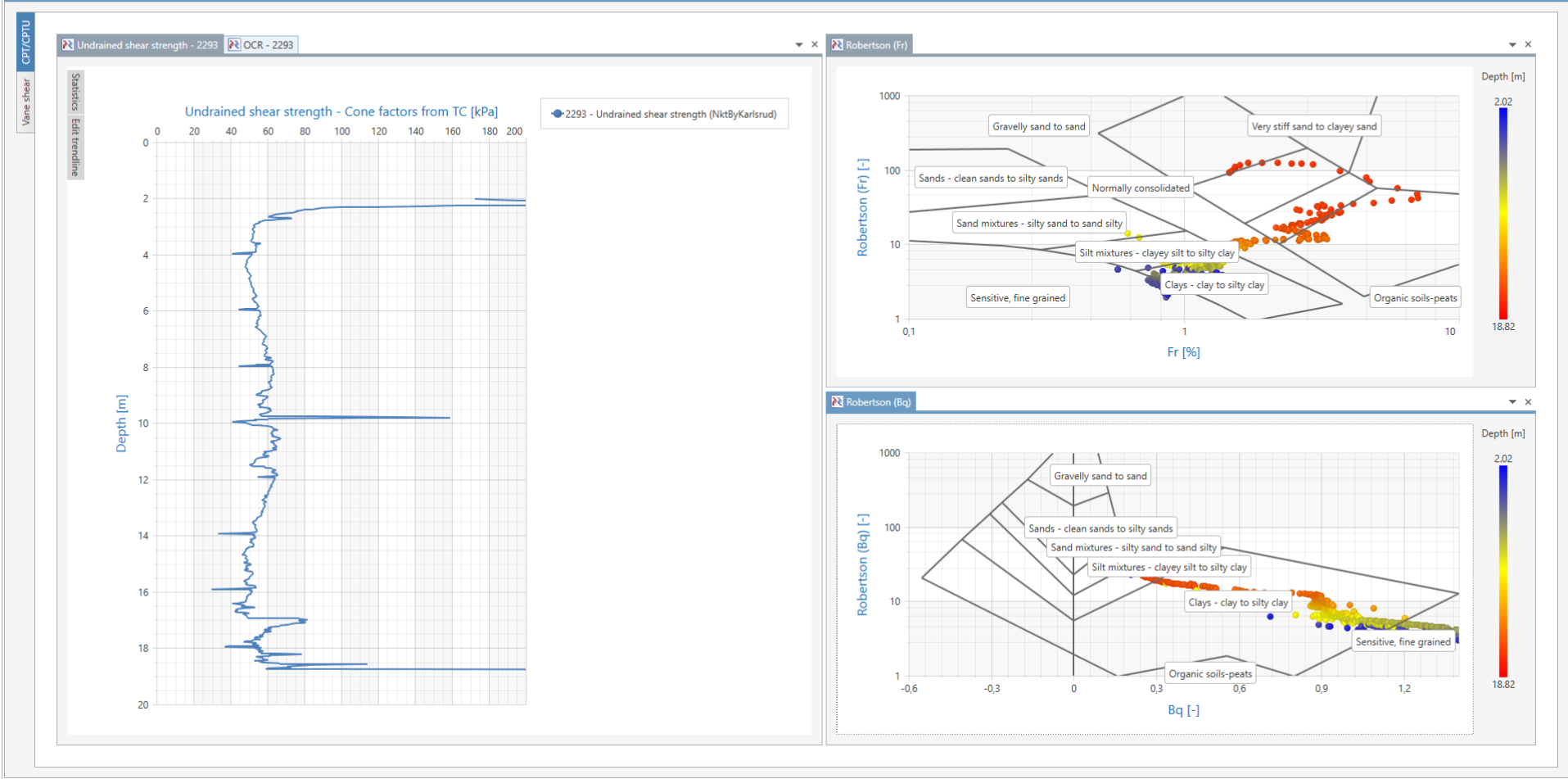
Calculation Type: Undrained shear strength
Calculation method: Nkt (Karlsruud et al 2005)

Finish Raw data Select borehole(s) Comparison of boreholes

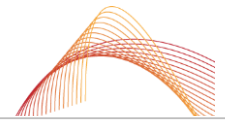
Show calculated curve: No
Factor to be multiplied by σ'_0

Calculate View charts Comparison of boreholes Calculated undrained strength curve Help

Borehole selection Index properties Stress history Interpretation of in situ tests Interpretation of laboratory strength tests Soil profile View & Edit Graphs



Soil Data Interpretation



Borehole selection Index properties **Stress history** Interpretation of in situ tests Interpretation of laboratory strength tests Soil profile View & Edit Graphs

GW/PP

In Situ Stress

Oedometer interpretation

σ'_c

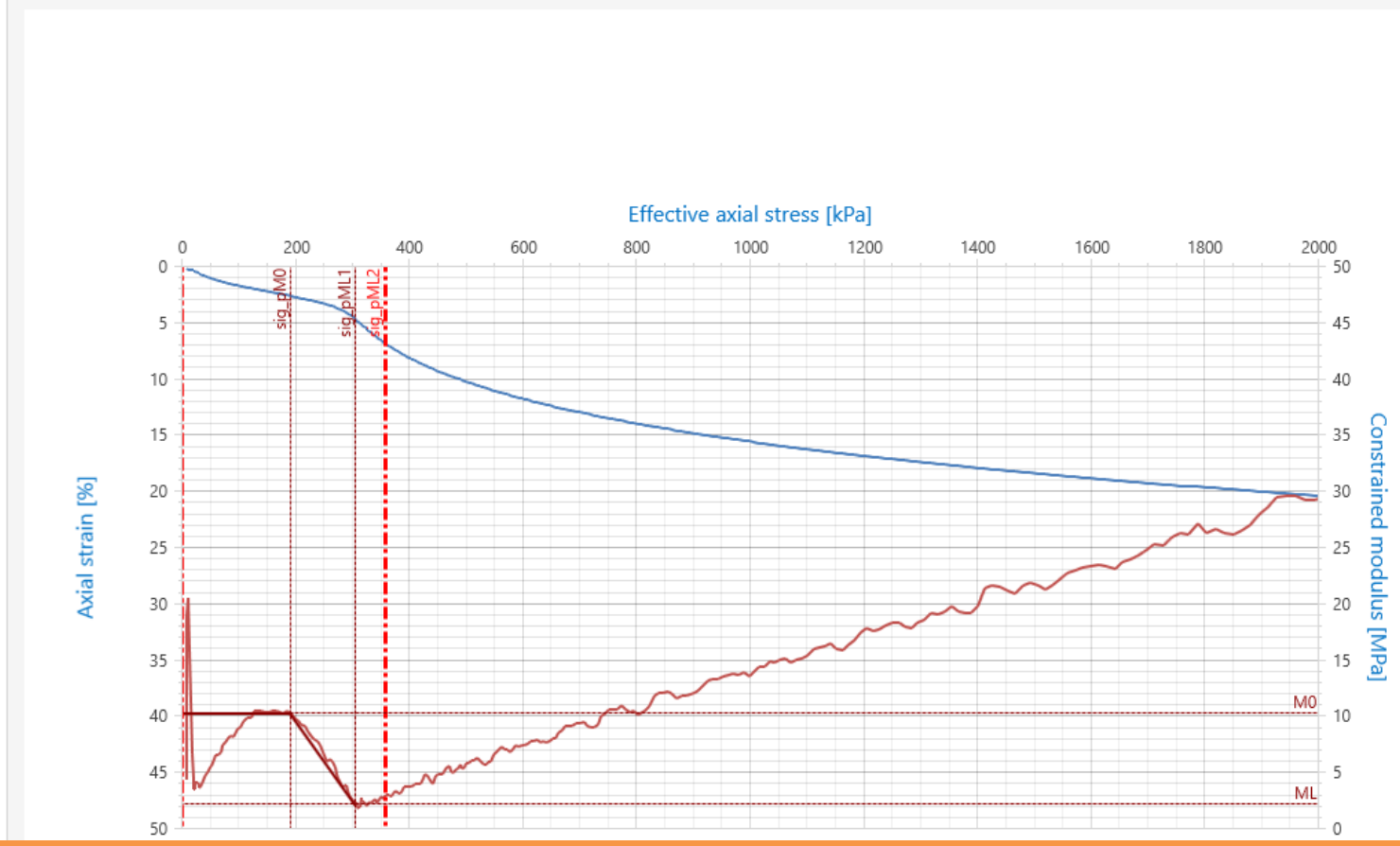
OCR

Stress History

Depth [m]	Oedom...	Quality...	Casagra...	Energy...	Sällfors...	Tangent...	Tangent method (Karlsrud 2012)				Note
			σ'_c [kPa]	σ'_c [kPa]	σ'_c [kPa]	σ'_c [kPa]	σ'_c [kPa]	M_0 [MPa]	M_L [MPa]	m	
2,00	CRS						10,3	2,2			

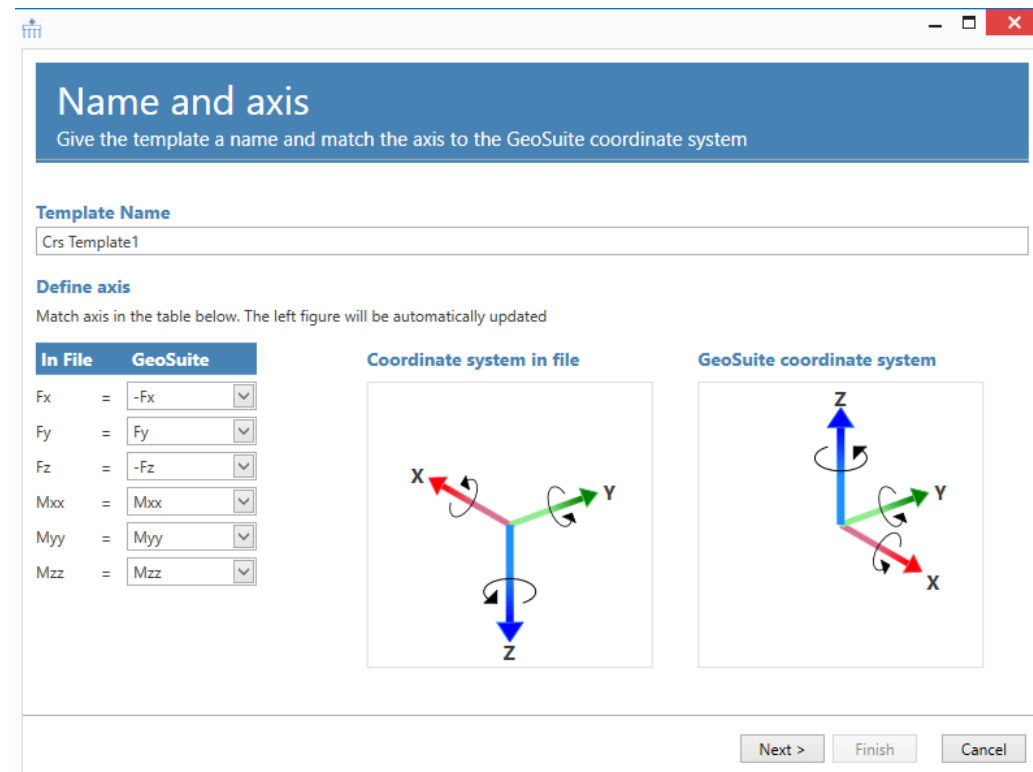
Type B - Depth 2,00 [m] Type C - Depth 2,00 [m]

Type A - Depth 2,00 [m]

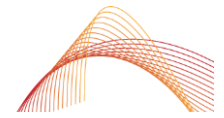


Piles

- Full 3D funksjonalitet fra før
- «state of the art» regnemotor
- Oppdatert med anerkjente modeller for
 - Bæreevne
 - Pel-jord samvirke
- Fokus på brukervennlighet
 - Tidsriktig brukergrensesnitt
 - Utvide muligheter for uttak av stivhetsmatriser
 - Forbedret brukerstøtte til dimensjonering
 - Nytt oppsett for datainput



Piles



calculation1.pjjson - GeoSuite PileGroup

File | Soil | **Piles** | Loads | Advanced loads | Settings | Calculation | Results | Replace pile segment from database

Geometric pile center X: 0,000 Y: 0,000 Z: 0,000
 Pile center X: Y:
 View: Plan | Section X-axis | Section Y-axis | Section Azimuth | Moment force curve

Soil | **Piles** | Loads | Advanced loads | Settings | Calculation

Piles																					
Pile no	Label	Connected to...	Type	Wall material	Tip code	Tip code z-lev...	x [m]	y [m]	z [m]	Vertical	Slope, n	Azimuth [degr...]	Tip at soil profil...	Length [m]	Local scour [m]	Global scour [m]	P-Y p-factor	T-Z t-factor	Q-Z q-factor		
1	001	Soil profile 1	Circular	Steel	Free	N/A	2,000	2,000	0,000	<input type="checkbox"/>	2,00	0,00	<input type="checkbox"/>	15,00	0,00	0,00	1,0	1,0	1,0		
2	002	Soil profile 1	Circular	Steel	Free	N/A	2,000	-2,000	0,000	<input checked="" type="checkbox"/>	N/A	0,00	<input checked="" type="checkbox"/>	20,00	0,00	0,00	1,0	1,0	1,0		
3	003	Soil profile 1	Circular	Steel	Free	N/A	-2,000	2,000	0,000	<input checked="" type="checkbox"/>	N/A	180,00	<input checked="" type="checkbox"/>	20,00	0,00	0,00	1,0	1,0	1,0		
4	004	Soil profile 1	Circular	Steel	Free	N/A	-2,000	-2,000	0,000	<input checked="" type="checkbox"/>	N/A	180,00	<input checked="" type="checkbox"/>	20,00	0,00	0,00	1,0	1,0	1,0		

Pile segments - Pile 3 "003"																
Segmen...	Length [m]	Type	Segment part	Cross section t...	Weight [kN/m3]	Diameter [m]	Thickness [m]	Yield str. [kPa]	Temp. str [1/deg C]	Weight fluid/soil [kN/m3]	Eccentr. [m]	E [kPa]	Override EI and EA	EI [kNm2]	EA [kN]	
1	20,00	Constant	Whole	Single	67,00	0,500	0,100	3,550E+000	1,200E-005	0,00	0,000		<input type="checkbox"/>	0,1	0,1	
2	0,00	Constant	Whole	Single	67,00	0,500	0,100	3,550E+000	1,200E-005	0,00	0,000		<input type="checkbox"/>	0,1	0,1	

Plan

Section X-axis

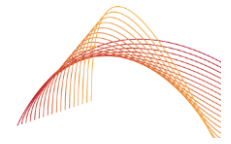
Section Y-axis

Section Azimuth

Moment force curve

MN-diagram for pile: 003, segment no: 2

Piles



calculation1.pgjson - GeoSuite PileGroup

File | Soil | Piles | Loads | Advanced loads | Settings | Calculation | Results

Current profile: Soil profile 1
Color: LightBlue

Soil profiles | Soil layers | Help

Properties | Create | Delete | Add | Divide | Delete | Help

Soil | Piles | Loads | Advanced loads | Settings | Calculation

Soil Profile Properties

General

Name: Soil profile 1
Color: LightBlue

Modelling

Model: API
Layer sub division: Automatic
Skin friction and tip resista...: API-93

Ground z-level

Ground z-level: 0,00
Ground Water z-level: 0,00

Soil properties in profile

Soil weight, γ

Data Source: GeoSuite Soil Data Interpretat...
Model File: Model2.spjson
Curve: 2293 - IndexPropertiesTotalUn...

Undrained shear strength

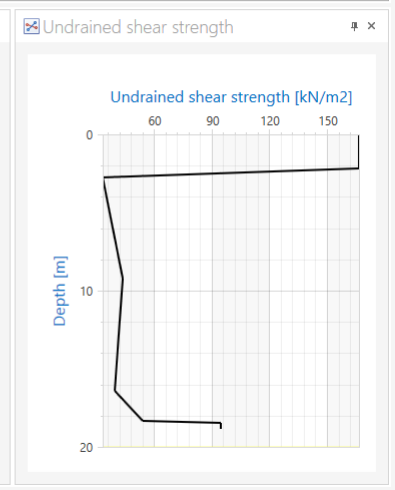
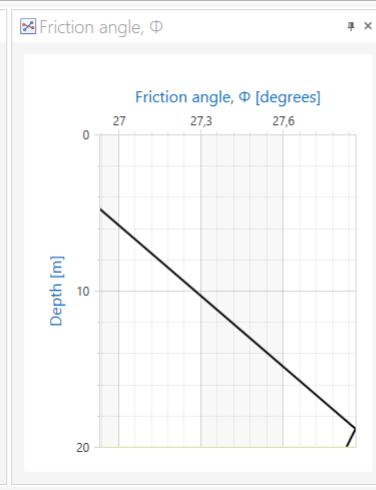
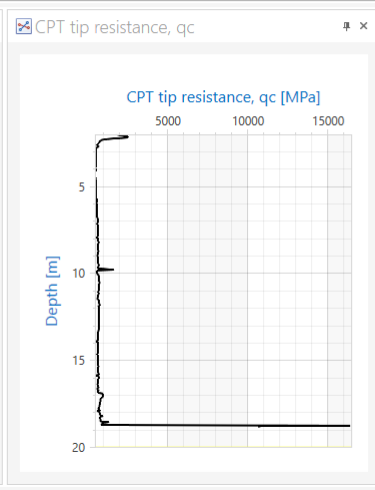
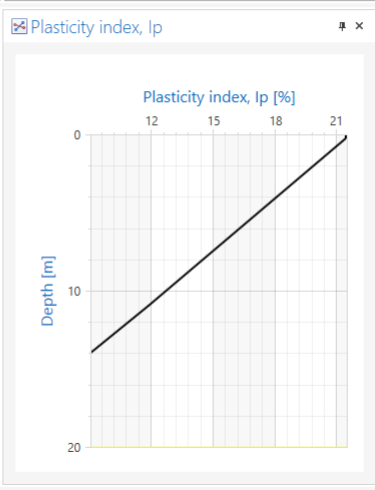
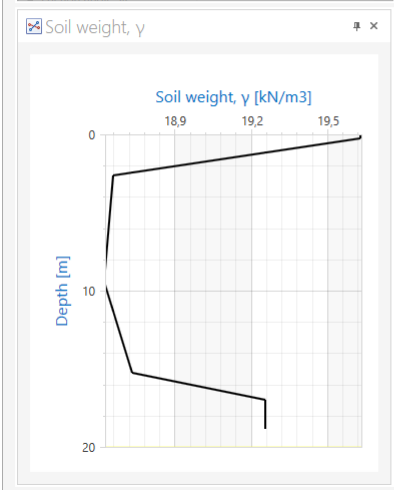
Data Source: GeoSuite Soil Data Interpretat...
Model File: Model2.spjson
Curve: Su - Characteristic values graph

Soil Layer

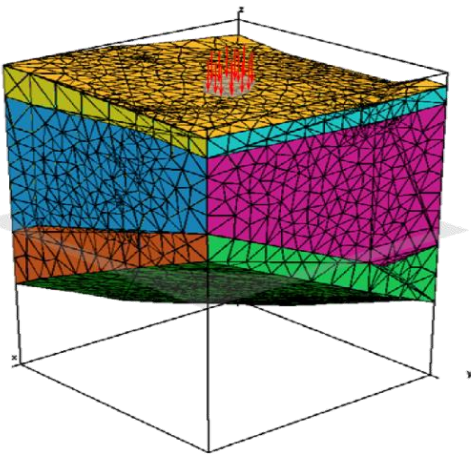
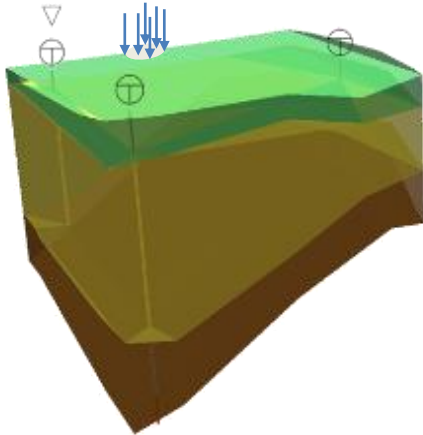
Placement	Depth	Soil weig...	Undraine...	Friction a...	Strain, ϵ_{50}	API-J	Side fricti...	Side fricti...	Factor, f_{res}	Ratio, t_{res}	Tip capacity	CPT tip resis	Relative der	Plasticity in
Name: 0,00														
Top of layer	0													
Bottom o...	20													

Övrigt

Name: Clay
Color: Yellow
Top depth [m]: 0,00
Bottom depth [m]: 20,00
Thickness: 20,00
Number of sub layers: Automatic
Lateral model: API 1987
Axial model: API 1993
Axial tip model: API 1993



3D regnemotor



- Generell 3D FE formulering
 - Deformasjoner
 - Poretrykk/konsolidering
 - Bruddanalyser

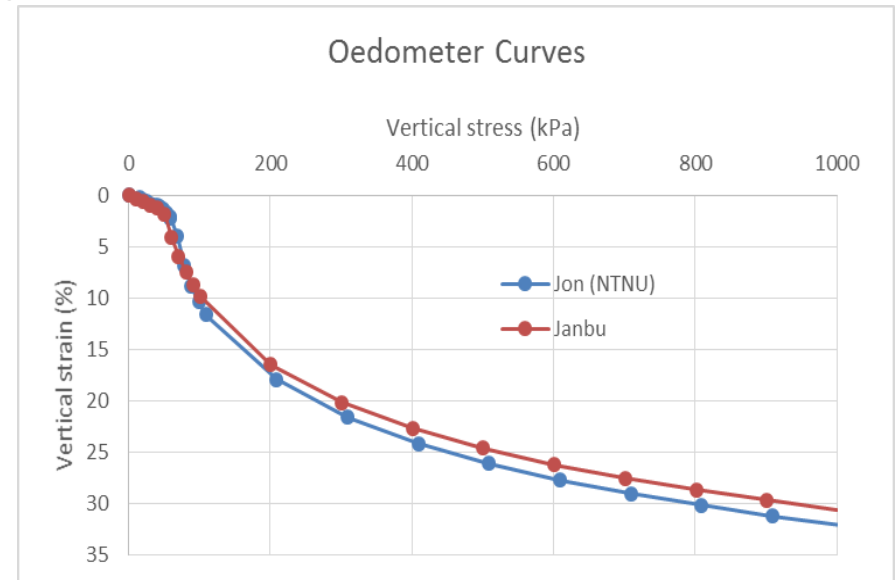
- 3D materialmodeller
 - Udrenert og drenert:
NGI-ADP og E-ADP

- Generelle 3D elementmodeller

- utfordringer:
 - Brukergrensesnitt (geometri)
 - Diskretisering
 - Regnetid

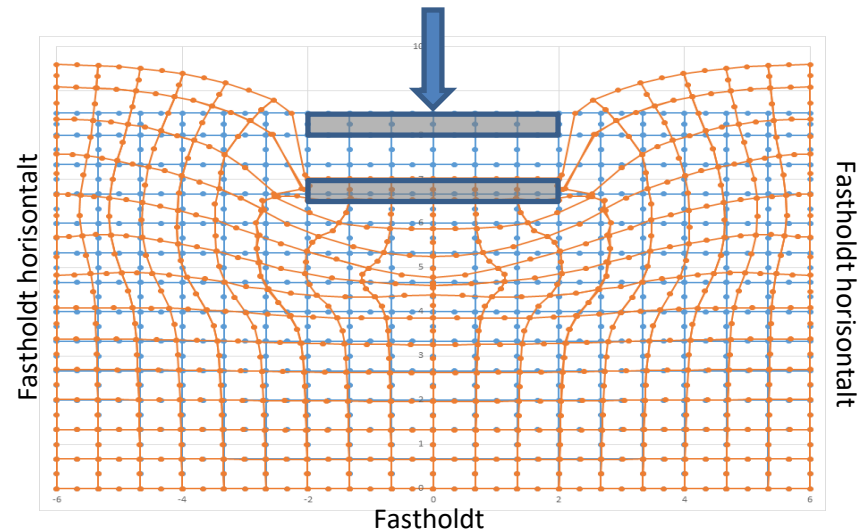
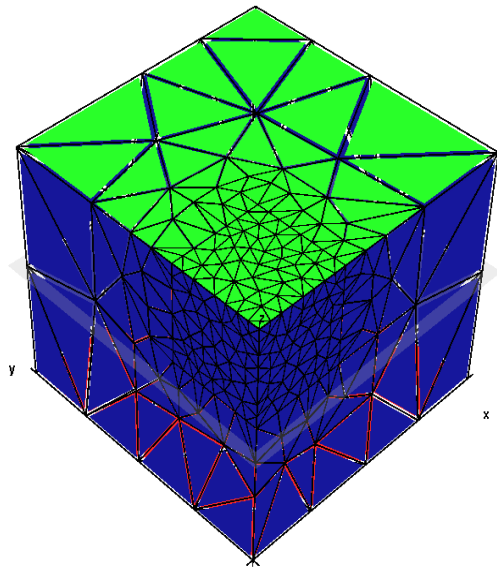
LabTest Simulator

- 3D FE-modell
- Visualisering av materialoppførsel for valgte designparametere
- Sammenligning med lab-resultater
- Spennings- eller tøyningsstyrt
- Ødometer
 - CRS / IL
 - Inkl. avlastning
- Triax og DSS
 - Spenningsstier
 - Tøyninger

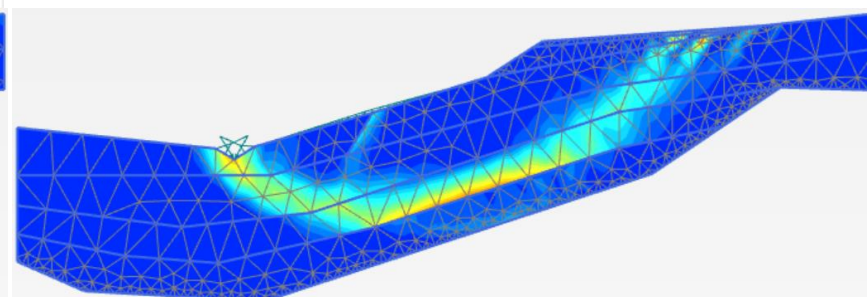
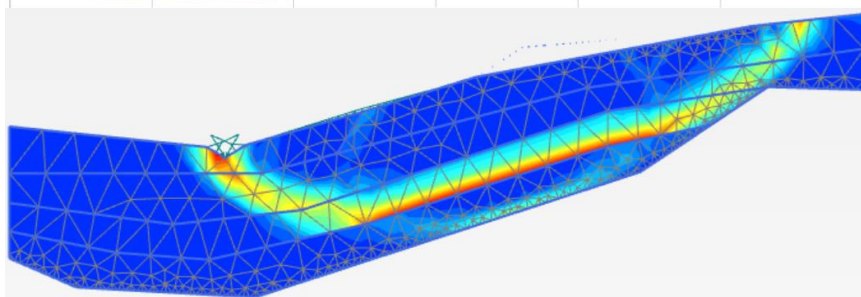
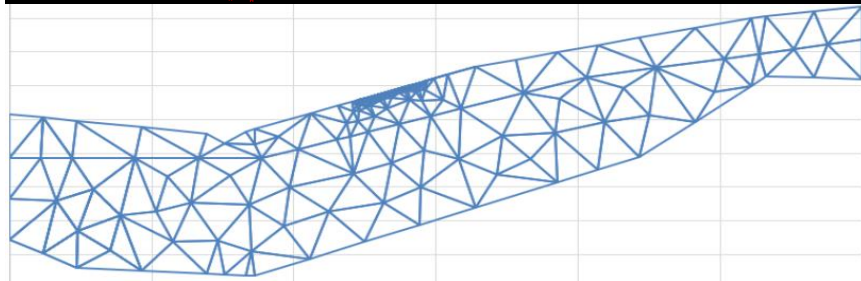
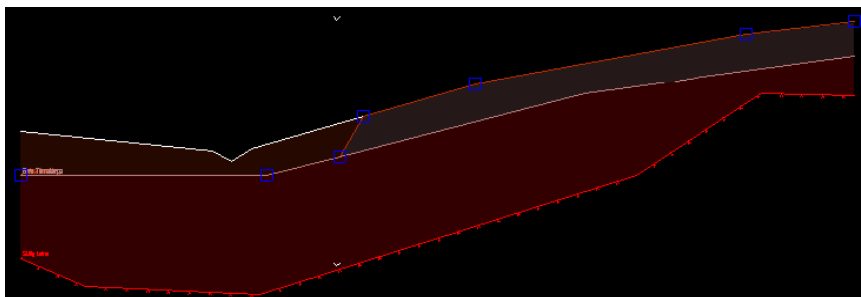
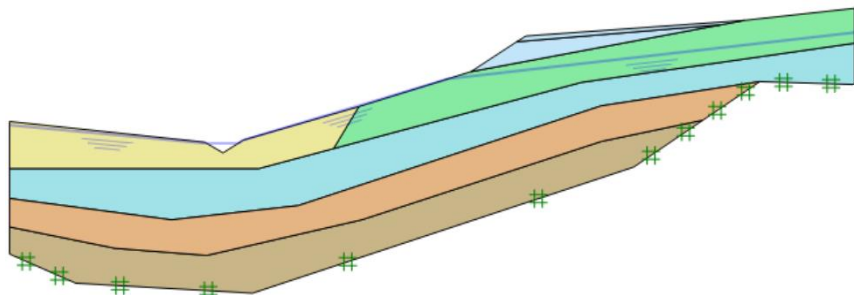


Settlements / Bearing Capacity

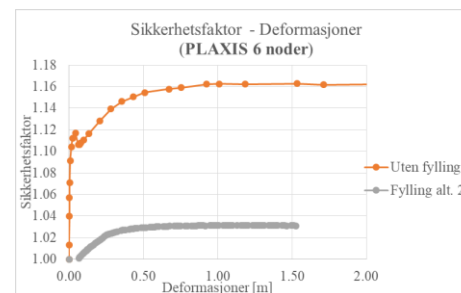
- 3D FE beregninger
- Begrenset helning på lagdelinger
- Benytter seg av eksisterende brukergrensesnitt
- Foreløpig ikke integrert mot GOM og Soil Data Interpretation
- Visualisering av resultater og bruddmoder som heatmap og 2D snitt



Stability

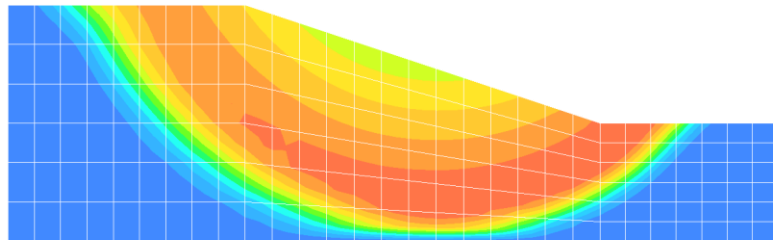
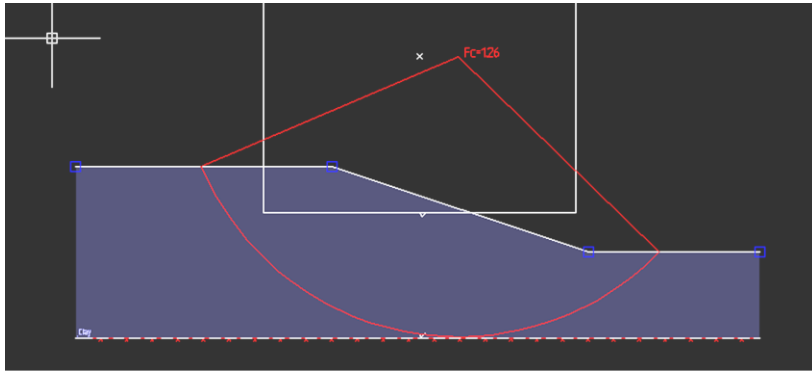


- 3D FE beregning
- Ikke-sirkulære bruddmoder
- Modellgrunnlag fra 2D snitt i GOM
- Varsel ved dårlig mesh-kvalitet
- Eksisterende brukergrensesnitt

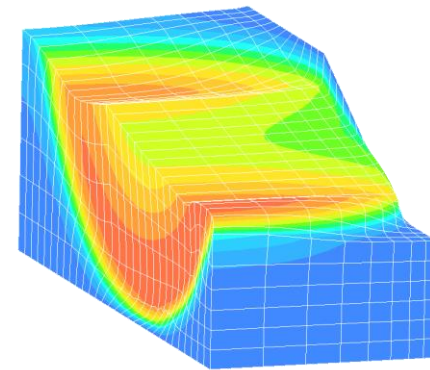


Stability

- Forenklet 3D modell ved å definere begrenset dybde i planen
- Visualisering av resultater og bruddmoder som heatmap og 2D snitt

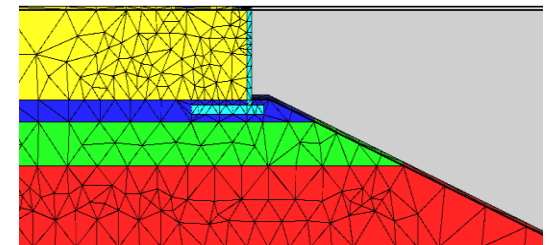


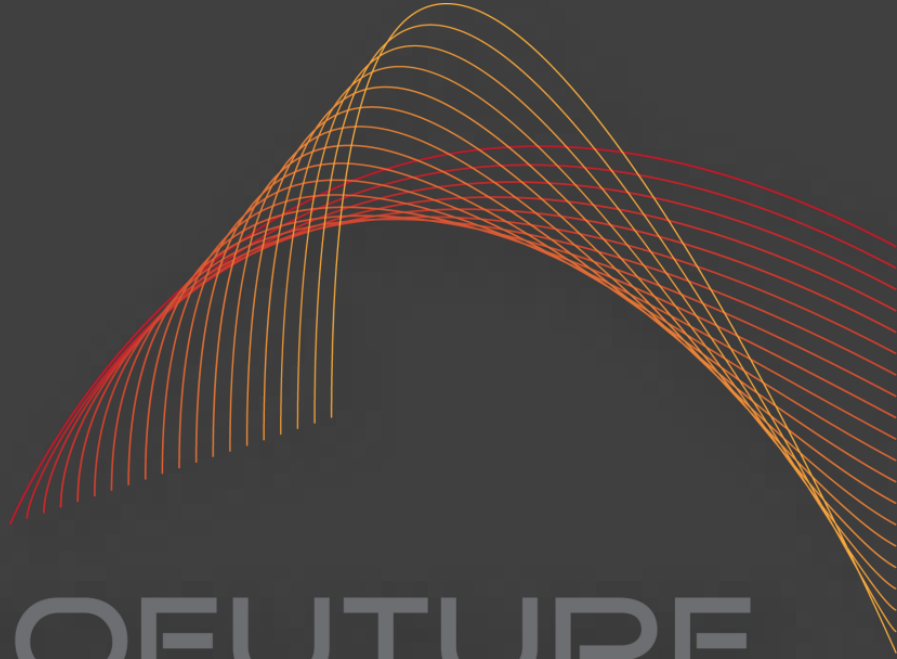
```
Model: 0510  
Deformation: 1  
STEP: Analysis of a simpl  
Step: 24 TIME: 0  
Model: 0510051005  
Max: 5.00 Min: 0
```



Excavation

- Dagens løsning beholdes i første omgang
 - Kjøpt dimensjoneringsverktøy for støttekonstruksjoner
- 3D FEM regnemotor forberedes for senere implementering, inkl.
 - Heldende terreng
 - Trekantelementer
 - Ankerement





GEOFUTURE