

Assistance in Parameter Determination

in ZSoil v2014



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Contents

- ❑ **Introduction**
- ❑ Parameter selection with the aid of
Parameter Determination Toolbox v2014

Motivation for developing a parameter selection assistance

Client Request

- Realistic simulation of soil-structure interaction

Requirement

- FEM
- Advanced constitutive models

Getting stacked

- Large number of parameters
- Missing data for parameter identification
- Uncertainty in parameter selection

ZSoil solution

- **PARAMETER IDENTIFICATION TOOLBOX**
 - automatic parameter selection
 - user-engaged parameter selection
 - assistance in decision for ranges of parameters
 - automated analysis of laboratory experimental data

Characterization of soils for engineering purposes

❑ Field tests

- Estimation of small strain stiffness characteristics based on undisturbed soil structure (geophysical tests, SDMT, SCPTU)
- Soil characterization at *in situ* stress conditions (DMT, CPTU)
- Qualitative soil description

❑ Laboratory tests

- Basic characterization (macroscopic soil description, grain size distribution, physical properties)
- Full stress-strain relationship (mechanical $\equiv$ model properties)

Characterization by means of field tests

❑ Geophysical test, SCPT, DMT

Small strain stiffness: V_s G_0

❑ **DMT** (empirical correlations) E_{ur} E_{oed} K_0 OCR ϕ

❑ **CPT** (empirical correlations) V_s G_0 E_{50} E_{oed} K_0 OCR ϕ
liquefaction potential

❑ **SPT** (empirical correlations)

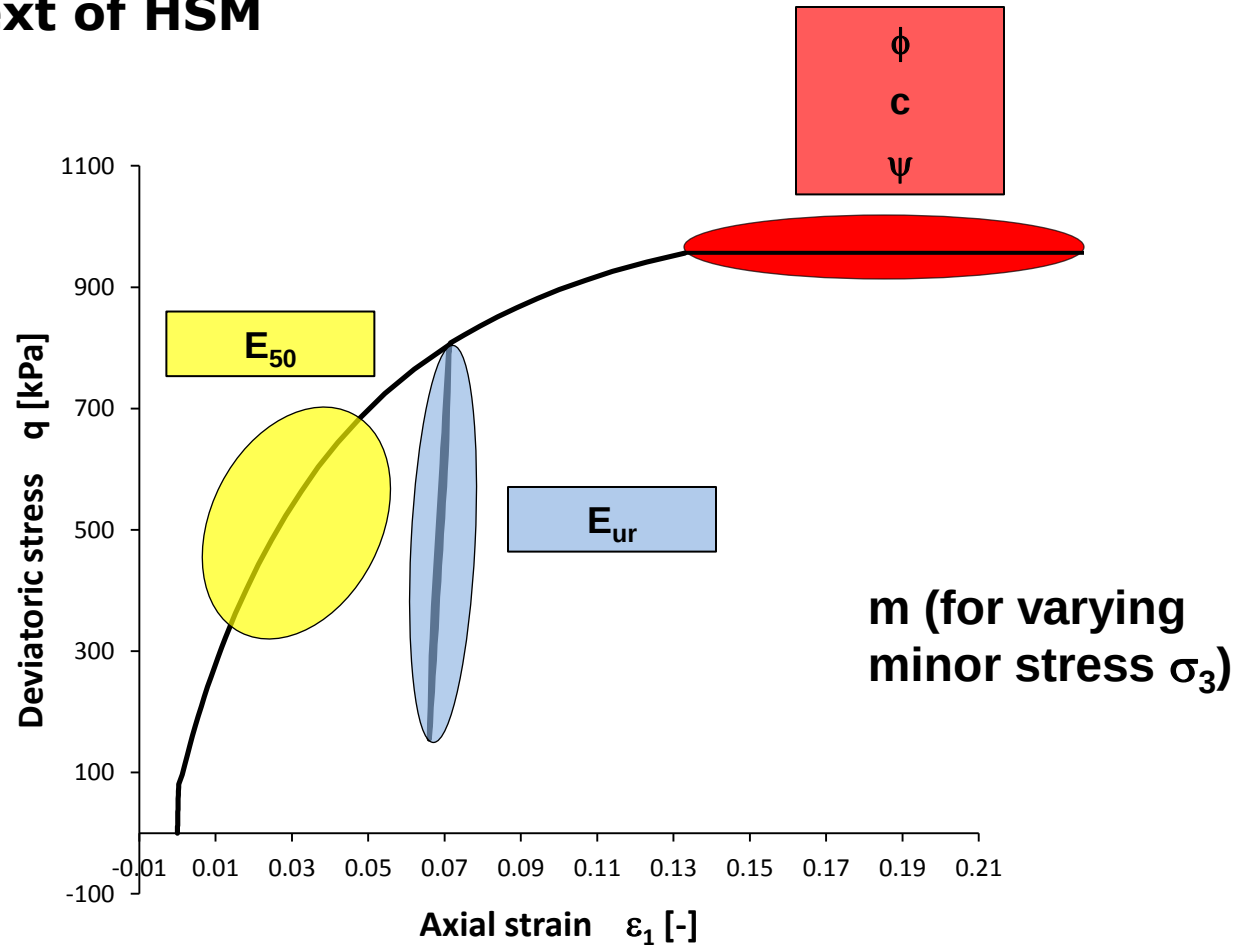
Small strain stiffness V_s

Strength characteristics ϕ

Liquefaction potential

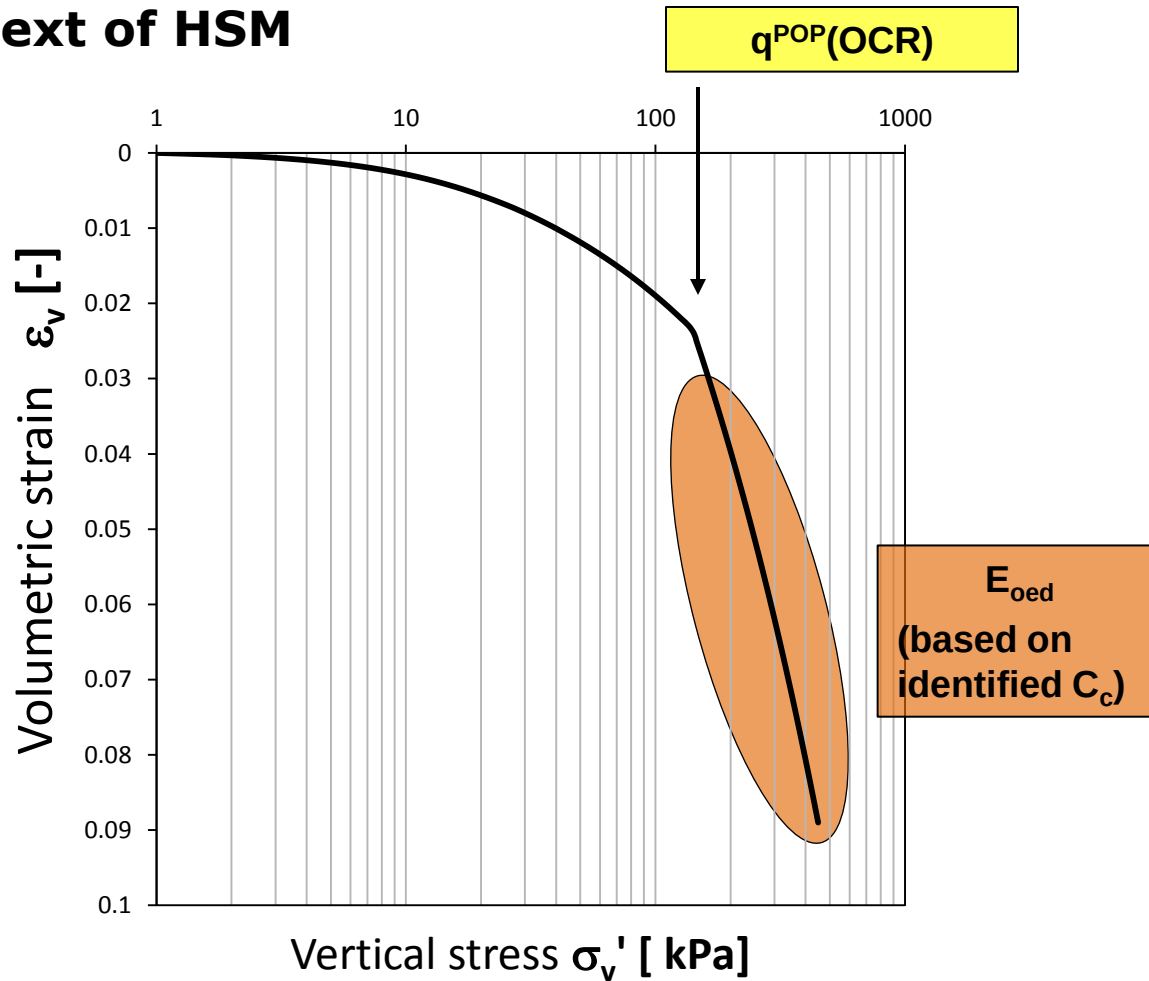
Characterization by means of laboratory tests

... in the context of HSM

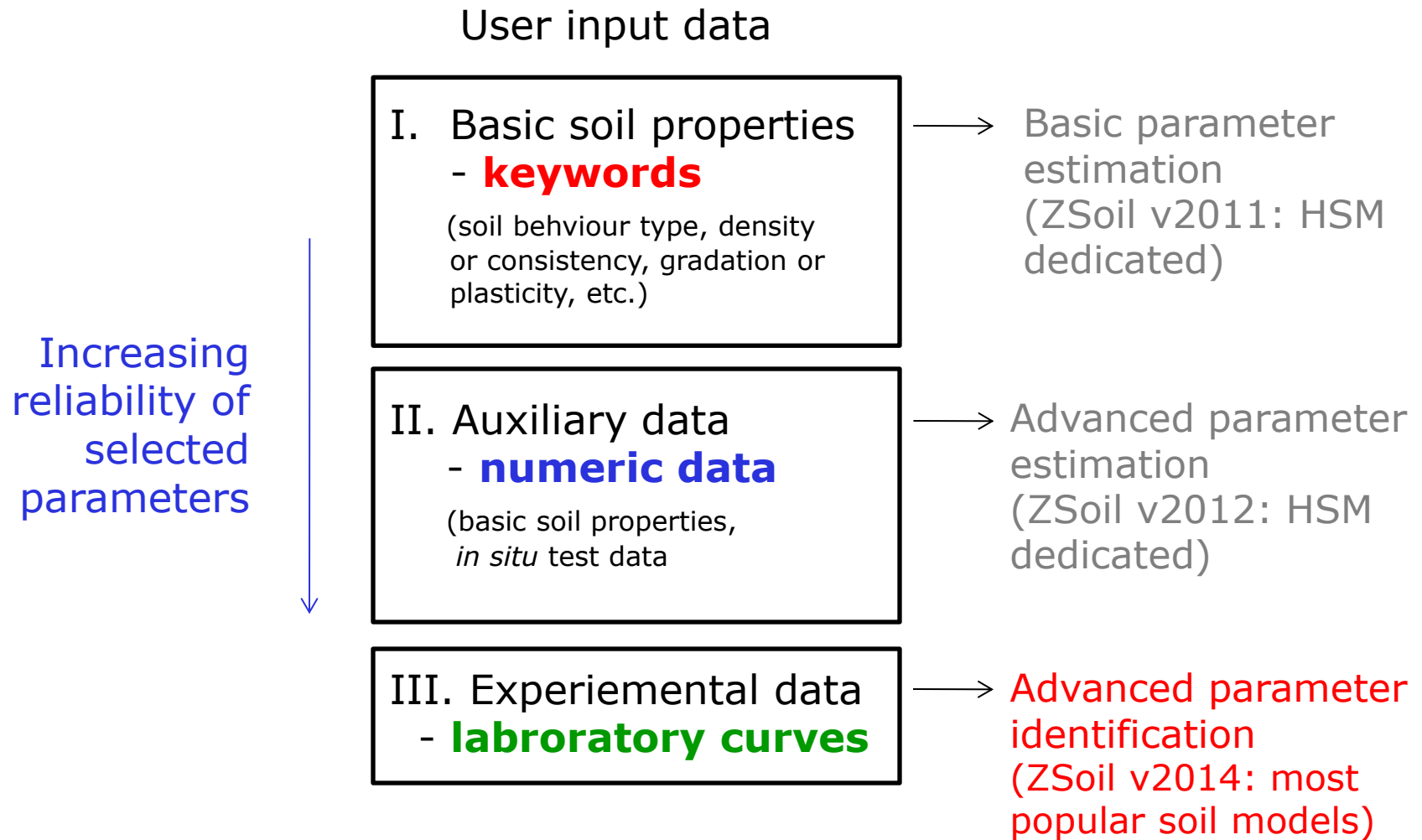


Characterization by means of laboratory tests

... in the context of HSM



Parameter selection assistance in ZSoil 2014



Parameter Determination Toolbox

An interactive tool providing an **assistance for parameter selection** for incomplete or complete experimental results

[Help](#) → [Reports](#)

PARAMETER DETERMINATION TOOLBOX

Z_Soil.PC 120201 report
revised 31.09.2014

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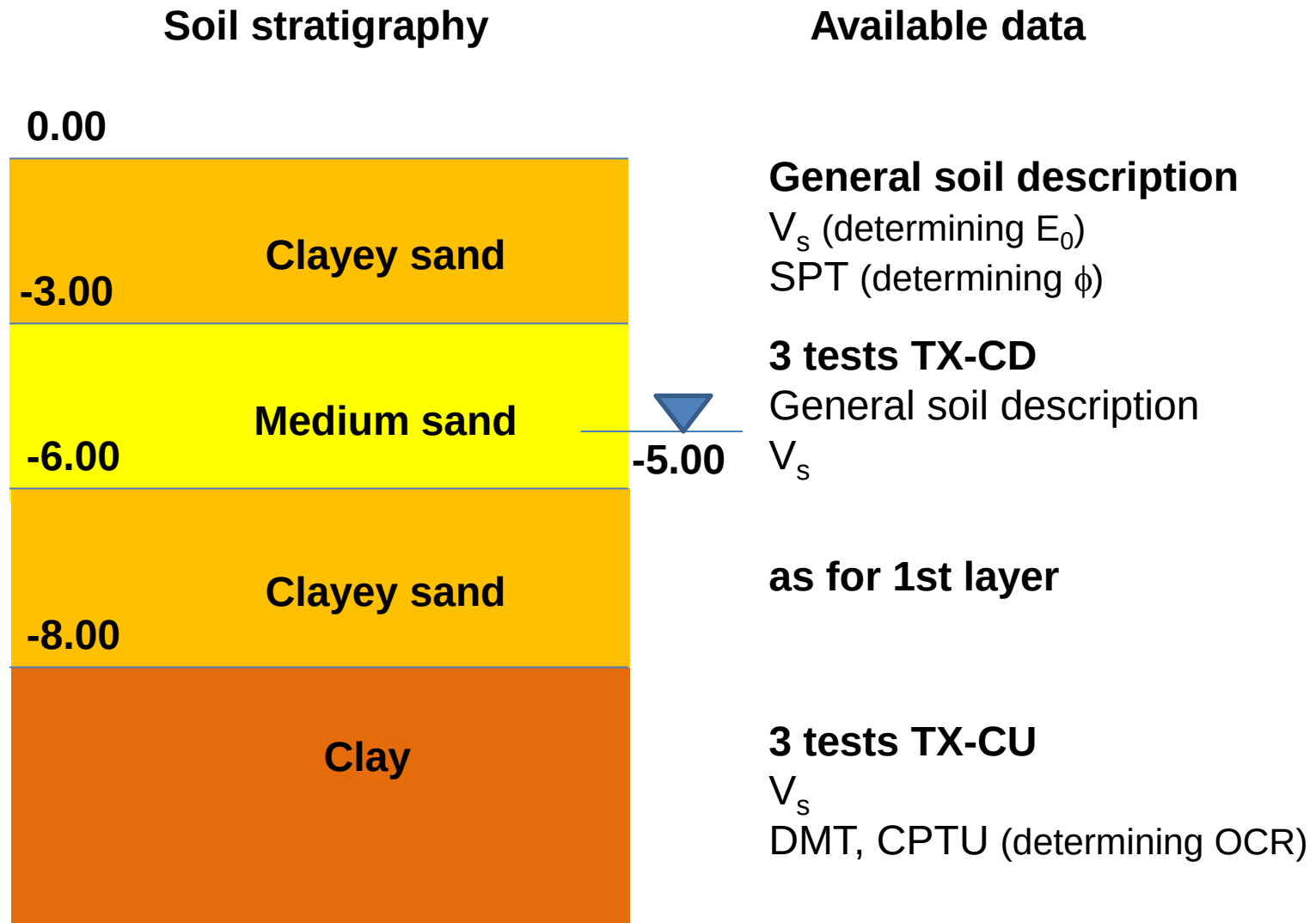


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Contents

- ❑ Introduction
- ❑ **Parameter identification with the aid of
Parameter Determination Toolbox v2014**

Exercise 2 – Parameter identification



Exercise 2 – Tool for parameter identification

Materials

Material definition

Add Modify Delete

List of defined materials

Name	Cont./Struct. type	Material formulation
1: Sand Medium	Continuum	HS-small strain stiffness
2: Clayey Sand	Continuum	HS-small strain stiffness
3: Clay	Continuum	HS-small strain stiffness
4: Seepage	Seepage	Seepage

Determine parameters

☒ Elastic Open

☒ Unit weights Open

☒ Flow Open

☒ Non linear Open

☒ Initial Ko State Open

☐ Heat

☐ Humidity

☐ Stability

☐ Damping

Add selected material to database Import material from *.INP

Help for current model

☒ Advanced Help Cancel OK

1. Select Clayey Sand

2. Press Determine parameters

Toolbox available for:

- Mohr-Coulomb
- Cap
- Cam-Clay
- HSM

Clayey sand – data:

General soil description
(estimation based on
incomplete data)

V_s (determining E_0)

SPT (determining ϕ)

Assistance in parameter selection in ZSoil 2014

DEFINING BASIC PROPERTIES OF MATERIAL

SELECTING CONSTITUTIVE MODEL

PARAMETER IDENTIFICATION METHODS

POST-PROCESSING OF ESTIMATED PARAMETERS

Parameter Determination Toolbox v14.03.09 - C:\ProgramData\ZSoil v2014\FULL\ZTMP\Untitled6.inp - ZSoil

File Options View Help

Material Data

Material label:

Material type:

Select Material Behavior Type

- Gravel
- Sand
- Silt
- Clay**
 - Normally consolidated
 - Lightly overconsolidated
 - Overconsolidated**
 - Heavily overconsolidated

Material Formulation

☒ Assistance in model preselection

Suggested constitutive model formulations:

- HS-small strain stiffness**
- Cap Model

Parameter Determination

Determination methods:

- via literature database and correlations including in situ test data
- via laboratory test data

Parameter Summary **Laboratory Test Simulation**

Parameter Selection

Export user's selection to:

Parameter	Symbol	Unit	User's selection	Automatic	Interactive	TX-CD
Unit weights						
Unit weight	γ	[kN/m ³]	0	18.1	18.1	
Unit weight of fluid	γ_F	[kN/m ³]	10			
Initial void ratio	e_0	[]	0	0.814	0.814	
Unit weight of dry soil	γ_D	[kN/m ³]	0	15	15	
Elastic						
Ref. un-/reload. modulus	E_{ur}^{ref}	[kN/m ²]	80000	20000	20000	
Un-/reloading Poisson's ratio	ν_{ur}	[]	0.2		0.2	
Stiffness exponent	m	[]	0.5	0.563	0.563	
Reference stress	σ_{ref}	[kN/m ²]	100	217	100	
☐ Small strain stiff. active						
Ref. initial stiff. modulus	E_0^{ref}	[kN/m ²]	240000	48554	48554	
Small strain threshold	$\gamma_{0.7}$	[]	0.0002	0.000172	0.000172	
Nonlinear						
Failure friction angle	ϕ_f	[deg]	26	25.8	25.8	
Dilatancy angle	ψ	[deg]	0	0	0	
Failure cohesion	c_f	[kN/m ²]	20		0	
Ref. sec. modulus at 50% of q	E_{50}^{ref}	[kN/m ²]	25000	4000	4000	
☒ Auto. eval. of M and H	Compute M,H		1			
Ko coeff. for NC soil	K_0^{NC}	[]	0.5	0.565	0.565	
Reference oedometric stress	σ_{oed}^{ref}	[kN/m ²]	200	177	177	
Ref. oedometric modulus	E_{oed}^{ref}	[kN/m ²]	25000	4000	4000	
☐ Preoverburden pressure	q^{POP}	[kN/m ²]	0		0	
☒ Overconsolidation ratio	OCR ^{HS}	[]	1	1.1	1.1	
Stress reversal Ko coeff.	K_0^{SR}	[]	0.5		0.565	

Exercise 2 – Parameter estimation for Clayey sand

Parameter estimation from incomplete data

Material label: Sand
Material type: Soil

Select Material Behavior Type

- Gravel
- Sand**
 - Normally consolidated
 - Lightly overconsolidated**
 - Overconsolidated
 - Heavily overconsolidated
- Silt
- Clay

Set basic material properties
Set in situ test data

Material Formulation

☐ Assistance in model preselection

Available constitutive model formulations:

HS-small strain stiffness

Help for current model

Parameter Determination

Determination methods:

1 Automatic and Interactive Selection via literature database and correlations including in situ test data

Identification via laboratory test data

Parameter Selection

Export user's selection to: Test simulation Export

Preview content: Basic

User's selection << Checked or drag-and-drop to assign user-selected values

Parameter	Symbol	Unit	User's selection	Automatic	Interactive	TX-CD
Unit weights						
Unit weight	γ	[kN/m ³]	0			
Unit weight of fluid	γ_f	[kN/m ³]	10			
Initial void ratio	e_0	[]	0			
Unit weight of dry soil	γ_D	[kN/m ³]	0			
Elastic						
Ref. un-/reload. modulus	E_{ur}^{ref}	[kN/m ²]	80000			
Un-/reloading Poisson's ratio	ν_{ur}	[]	0.2			
Stiffness exponent	m	[]	0.5			
Reference stress	σ_{ref}	[kN/m ²]	100			
☐ Small strain stiff. active						
Ref. initial stiff. modulus	E_0^{ref}	[kN/m ²]	240000			
Small strain threshold	$\gamma_{0.7}$	[]	0.0002			
Nonlinear						
Failure friction angle	ϕ_f	[deg]	30			
Dilatancy angle	ψ	[deg]	0			
Failure cohesion	c_f	[kN/m ²]	20			
Ref. sec. modulus at 50% of q_f	E_{50}^{ref}	[kN/m ²]	25000			
☒ Auto. eval. of M and H	Compute M,H		1			
Ko coeff. for NC soil	KoNC	[]	0.5			
Reference oedometric stress	σ_{oed}^{ref}	[kN/m ²]	200			
Ref. oedometric modulus	E_{oed}^{ref}	[kN/m ²]	25000			
☐ Preoverburden pressure	q^{POP}	[kN/m ²]	0			
Consolidation ratio	OCR ^{HS}	[]	1			
Initial Ko coeff.	K_0^{SR}	[]	0.5			
Initial KoNC						
Initial isotropic						

1. Select the determination method
„Automatic and Interactive Selection“

Exercise 2 – Introducing available data

1

Basic soil setup

Soil Behaviour Type:

- Unknown
- Gravel
- Sand**
- Silt
- Clay

Stress History:

- Unknown
- Normally consolidated
- Lightly consolidated**
- Overconsolidated
- Heavily overconsolidated

Soil Density:

- Unknown
- Very loose
- Loose
- Medium**
- Dense
- Very dense

Gradation:

- Unknown
- Well-graded
- Poorly-graded
- Silty
- Clayey**

Particle shape:

- Unknown
- Angular
- Subangular
- Subrounded**
- Rounded

State:

- Dry (S=0%)
- Humid (S=1-25%)
- Damp (S=26-50%)
- Moist (S=51-75%)
- Wet (S=76-99%)
- Saturated (S=100%)**

Run basic parameter selection

Reset All Data

5

2

Known soil properties

NB. If specified, the values of basic soil properties

Material name: Piasek gliniasty

Elastic modulus E [kPa]

Weight / unit volume γ [kN/m³]

Friction angle ϕ [deg]

Cohesion c [kPa]

Vert. eff. stress at characterization or in the middle of soil layer σ'_{v0} [kPa]

Overconsolidation ratio OCR 1.5 [-]

Initial void ratio e_0 0.6 [-]

Unit weight setup

☒ Weight of dry soil γ_D 16.5 [kN/m³]

☐ Weight of saturated soil γ_{SAT} 20.3 [kN/m³]

2

3

In situ test results

Standard Penetration Test (SPT)

Number of blows N_{60} 25

Vertical effective in situ stress σ'_{v0} 125 [kPa]

Overburden correction factor C_N 0.894 [-]

3

4

Seismic tests (SDMT / SCPT / Other geophysical test)

Shear wave velocity V_s 100 [m/s]

Soil density ρ 2.1 [g/cm³]

Vertical effective in situ stress σ'_{v0} 100 [kPa]

4

1. Define general soil description
2. Introduce known values of soil properties
3. Introduce available results from SPT
4. Introduce the results obtained from shear wave velocity measurements
5. Run basic parameter selection

Exercise 2 – Post-processing of results

Basic soil setup

Material name:	No name	Gradation:	Clayey
Soil Behaviour Type:	Sand	Stress History:	Lightly consolidated
Soil Density:	Medium	Particle shape:	Subrounded

Summary of Advanced Parameter Selection - interactive estimation

Standard HS model setup

Young modulus unload./reload. at reference stress	Help	E_{ur}^{ref}	16000 [kN/m ²]
Reference stress for Young modulus		σ_{ref}	100 [kN/m ²]
Poisson ratio unloading/reloading		ν_{ur}	0.2
Exponent for power law		m	0.563
Lower bound stiffness cut-off at stress		σ_L	10 [kN/m ²]

Small strain extension

☒ Active

Initial Young modulus at reference stress	Help	E_0^{ref}	66327 [kN/m ²]
		$\gamma_{0.7}$	1.70E-04

	E_{50}^{ref}	4000 [kN/m ²]
	σ_{ref}	100 [kN/m ²]

ϕ	34.5 [deg]
ψ	5.25 [deg]
c	0

Cohesion Help

Parameters obtained with the aid of automatic parameter selection will be stored in the column **Interactive estimation. These values can be modified next during interactive browsing of different available correlations (**Advanced Parameter Selection**)**

Basic Parameter Selection - automatic estimation

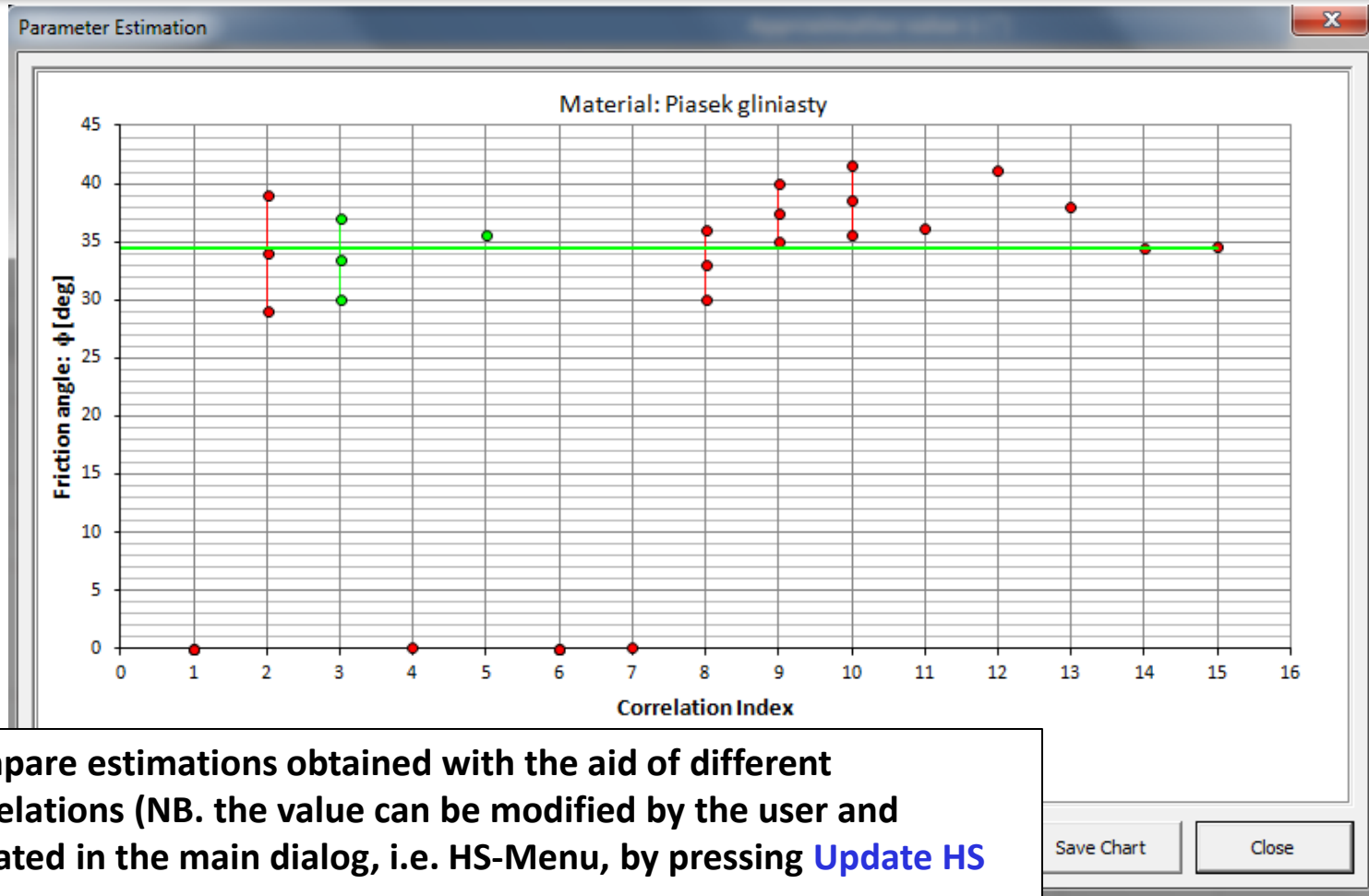
Range of values				Advanced Parameter Selection
Min	Mean	Max	Std Dev.	
12000	16000	20000	4000	E ☒
	100			
0.40	0.56	0.75	0.02	E ☒
66327	66327	66327	0	E ☒
1.03E-04	1.70E-04	3.09E-04	5.00E-05	E ☒
2182	4000	8000	1786	E ☒
30.00	34.50	37.00	1.41	E ☒
4.88	5.25	5.63	0.38	E ☒
	0.00			

Exercise 2 – Interactive control of applied correlations

Friction angle ϕ		Approximative value ϕ [°]			
Correlation Type	Soil Type	Auxiliary data	Min	Average	Max
☐ 1 Typical values	Select soil type ...	Dense	N/A	N/A	N/A
☐ 2 Typical values	SC Clayey sands, sandy-clay mix		29.0	34.0	39.0
☒ 3 Typical values	Medium Dr: 36-65%		30	33.5	37
☐ 4 Typical values	Fine Grained Select gradation ...	Dr: 60%		N/A	
☒ 5 Empirical	Relative density	D_r [%]: 50		35.5	
Test type	Measurement or transformed measurement	Value	Min	Average	Max
☐ 6 Marchetti's dilatometer DMT	Horizontal stress index K_D [-]:	not specified	N/A	N/A	N/A
☐ 7 Cone penetration test CPT	Cone resistance q_t [kPa]:	not specified		N/A	
	Effective vert. in situ stress σ'_{v0} [kPa]:	not specified			
☐ 8 Standard penetration test SPT	Number of blows per 0.3m	10-30 Medium sand	30	33	36
☐ 9 Standard penetration test SPT			35	37.5	40
☐ 10 Standard penetration test SPT	Number of blows per 0.3m N_{60} :	25	35.6	38.6	41.6
	Effective vert. in situ stress σ'_{v0} [kPa]:	125			
	☒ Use overburden correction factor C_N [-]:	0.894			
☐ 11 Standard penetration test SPT				36.1	
☐ 12 Standard penetration test SPT				41.0	
☐ 13 Standard penetration test SPT				38.0	
☐ 14 Standard penetration test SPT				34.4	
				34.6	
Min/Mean/Max			30.00	34.50	37.00
Standard Deviation				1.4	
1			Plot		
Selected Value			34.5 Update HS Menu		

1. Press **Plot** to run a graphical summary of estimations obtained from different correlations that have been applied during automatic parameter selection, and estimations based on SPT results

Exercise 2 – Interactive control of applied correlations



1. Compare estimations obtained with the aid of different correlations (NB. the value can be modified by the user and updated in the main dialog, i.e. HS-Menu, by pressing **Update HS Menu**)
2. Return to the main dialog by pressing **HS-Menu button** or **click right mouse button** to see the context menu

Exercise 2 – Final selection & exporting parameters for simulating TXCD

Parameter Selection

Export user's selection to: Test simulation Export 3 2 Preview content: Basic

User's selection << Checked or drag-and-drop to assign user-selected values

Parameter	Symbol	Unit	User's selection	Automatic	Interactive	TX-CD
Elastic						
Ref. un-/reload. modulus	E_{ur}^{ref}	[kN/m ²]	16000	☐ 16000	☒ 16000	
Un-/reloading Poisson's ratio	ν_{ur}		0.2	☐ 0.2	☒ 0.2	
Stiffness exponent	m		0.563	☐ 0.563	☒ 0.563	
Reference stress	σ_{ref}	[kN/m ²]	100	☐ 100	☒ 100	
☐ Small strain stiff. active						
Ref. initial stiff. modulus	E_0^{ref}	[kN/m ²]	110716	☐ 110716	☒ 110716	
Small strain threshold	$\gamma_{0.7}$		0.00017	☐ 0.00017	☒ 0.00017	
Nonlinear						
Failure friction angle	ϕ_f	[deg]	34.5	☐ 34.5	☒ 34.5	
Dilatancy angle	ψ	[deg]	5.25	☐ 5.25	☒ 5.25	
Failure cohesion	c_f	[kN/m ²]	0	☐ 0	☒ 0	
Ref. sec. modulus at 50% of q_f	E_{50}^{ref}	[kN/m ²]	4000	☐ 4000	☒ 4000	
☒ Auto. eval. of M and H	Compute M,H		1			
Ko coeff. for NC soil	KoNC		0.434	☐ 0.434	☒ 0.434	
Reference oedometric stress	σ_{ocd}^{ref}	[kN/m ²]	230	☐ 230	☒ 230	
Ref. oedometric modulus	E_{ocd}^{ref}	[kN/m ²]	4000	☐ 4000	☒ 4000	
☐ Preoverburden pressure	q^{POP}	[kN/m ²]	0		☒ 0	
☒ Overconsolidation ratio	OCR ^{HS}		1.5	☐ 1.85	☒ 1.5	
Stress reversal Ko coeff.	K_0^{SR}		0.434		☒ 0.434	
☐ Consolidation KoNC						
☐ Consolidation isotropic						
☐ Consolidation anisotropic						
Initial Ko State						
Coeff. Ko in X direction	$K_{0,x}$		0.546	☐ 0.614	☒ 0.546	
Coeff. Ko in Z direction	$K_{0,y}$		0.546	☐ 0.614	☒ 0.546	
Flow						

1

0. Leave the dialog for automatic and interactive parameter estimation
- **Update and Exit**

1. Mark all parameters from column **Interactive**

2. Move marked values using **Copy checked to user's selection**

3. In order to verify effectiveness of parameter identification, **Export** user's selection to **Test simulation**; you will be asked whether you'd like to automatically move to **Laboratory Test Simulation**

Exercise 2 – Simulation of a drained triaxial test

1. Define **initial state variables** for simulation of the drained triaxial test. **Loading program** can be modified.
2. Run simulation of the triaxial test by pressing **Simulate selected test**
3. Browse the results

Parameter Summary
Laboratory Test Simulation

Test preselection

TX-CD

☐ Use real test data

Lab. Tests

TX-CD-1elem simul

Test type

TX-CD

Input data for test simulation

Initial state variables

Parameter	Symbol	Value	Unit
Initial void ratio	e_0	0.5	[]
Confining pressure	σ_c	100	[kN/m ²]
Initial Ko coeff.	K_0^{test}	0.5	[]

1

Loading program

	Init. ϵ_1 []	Incr. $\Delta\epsilon_1$ []	Multiplier	No. of steps
1	0	1e-06	1	10
2	1e-05	1e-05	1	9
3	0.0001	0.0001	1	9
4	0.001	0.001	1	19
5	0.02	-0.0002	1	10
6	0.018	0.0002	1	10

Model parameters

☐ Show advanced parameters

Parameter	Symbol	Unit	Value	Last spe
Ref. sec. modulus at 50...	E_{50}^{ref}	[kN/m ²]	4000	4000
☒ Auto. eval. of M an...	Compute M,H		1	1
Ko coeff. for NC soil	KoNC	[]	0.434	0.434
Reference oedometric s...	σ_{oed}^{ref}	[kN/m ²]	230	230
Ref. oedometric modulus	E_{oed}^{ref}	[kN/m ²]	4000	4000
☐ Preoverburden pres...	q^{POP}	[kN/m ²]	0	0
☒ Overconsolidation r...	OCR ^{HS}	[]	1.5	1.5
Stress reversal Ko coeff.	K_0^{SR}	[]	0.434	0.434
☒ Consolidation KoNC				
☐ Consolidation isotr...				
☐ Consolidation oisr...				

Simulate selected test

2

Graphical interpretation

Content preview: $\epsilon_1 - q$

3

Axis Manager

TX-CD-1elem simul

Deviatoric Stress q [kN/m²]

Axial Strain ϵ_1 []

Legend

Model: HS-small strain

Simulation status: COMPUTED, CONVERGED

Save Chart

View Log

Exercise 2 – Exit from Parameter Determination Toolbox

1

Parameter determination project is about closing.

Configure data saving before the exit.

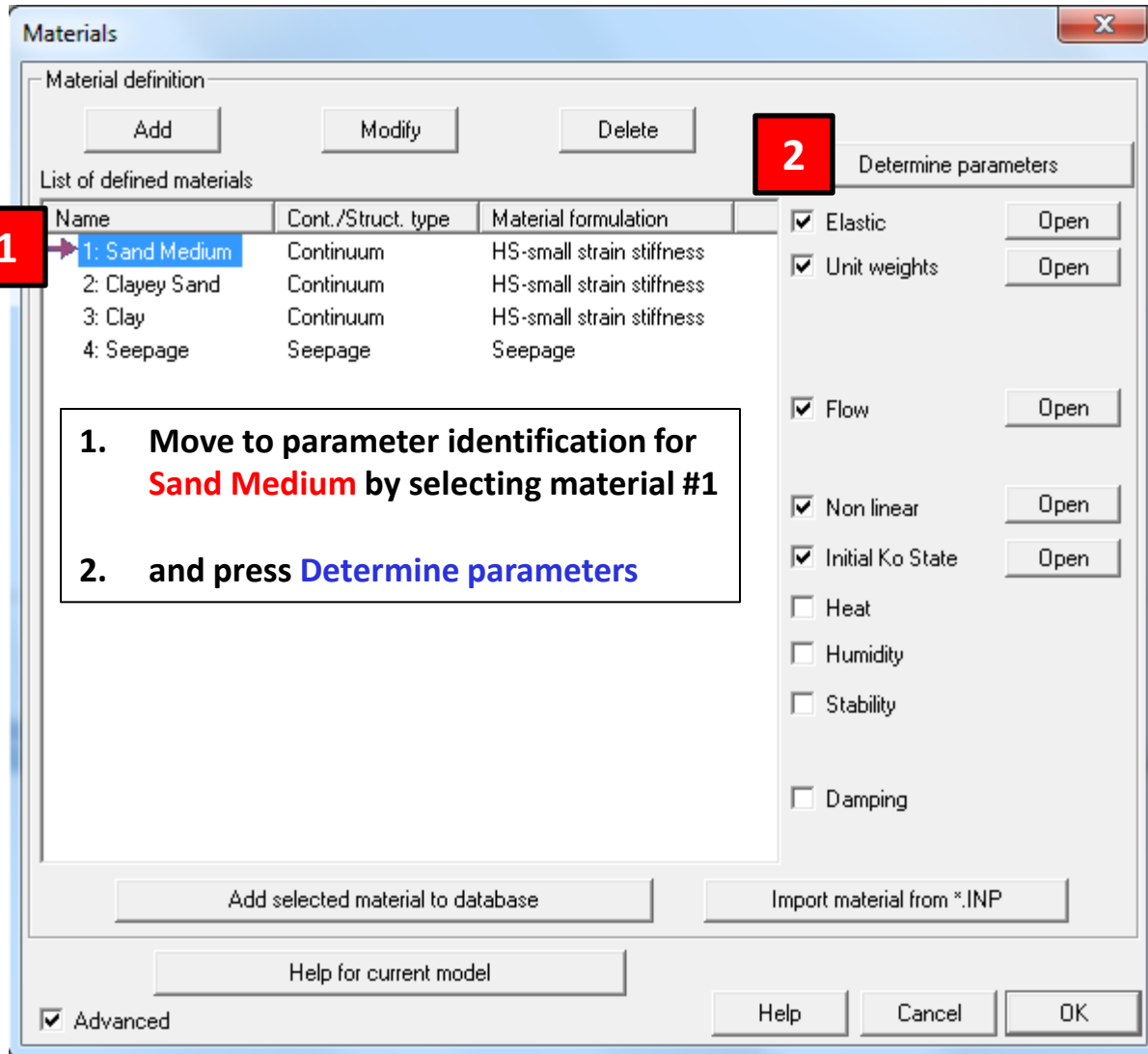
- ☒ Save this parameter determination project
- ☒ Update parameter values in material dialog

OK Cancel

Parameter	Symbol	Value	Unit
Initial void ratio	e_0	0.5	[-]
Confining pressure	σ_c	100	[kN/m ²]
Initial Ko coeff.	K_0^{test}	0.5	[-]

1. **Exit** Parameter Determination Toolbox
2. Accept saving the parameter determination project and updating parameter values in material dialog

Exercise 2 – Parameter identification for **Medium Sand**



Sand medium – dane:

3 drained triaxial tests

General soil description
(parameter estimation from
incomplete data)

V_s (determining E_0)

SPT (determining ϕ)

Exercise 2 – Initializing the identification from laboratory data

File Options View Tools Help

Material Data

Material label:

Material type:

Select Material Behavior Type

Gravel
Sand
Silt
Clay

Set basic material properties

Set in situ test data

Material Formulation

☐ Assistance in model preselection

Available constitutive model formulations:

HS-small strain stiffness

Help for current model

Parameter Determination

Determination methods:

Automatic and Interactive Selection

via literature database and correlations including in situ test data

1 Identification

via laboratory test data

Opens a dialog for an automated interpretation of laboratory test results.

Parameter Summary Laboratory Test Simulation

Parameter Selection

Export user's selection to: Export

Preview content:

User's selection << Checked or drag-and-drop to assign user-selected values

Parameter	Symbol	Unit	User's selection	Automatic	Interactive	TX-CD
Unit weights						
Unit weight	γ	[kN/m ³]	0			
Unit weight of fluid	γ_f	[kN/m ³]	10			
Initial void ratio	e_0	[]	0.6			
Unit weight of dry soil	γ_D	[kN/m ³]	16.5			
Elastic						
Ref. un-/reload. modulus	E_{ur}^{ref}	[kN/m ²]	80000			
Un-/reloading Poisson's ratio	ν_{ur}	[]	0.2			
Stiffness exponent	m	[]	0.5			
Reference stress	σ_{ref}	[kN/m ²]	100			
☐ Small strain stiff. active						
Ref. initial stiff. modulus	E_0^{ref}	[kN/m ²]	240000			
Small strain threshold	$\gamma_{0.7}$	[]	0.0002			
Nonlinear						
Failure friction angle	ϕ_f	[deg]	30			
Dilatancy angle	ψ	[deg]	0			
Failure cohesion	c_f	[kN/m ²]	20			
Ref. sec. modulus at 50% of q_f	E_{50}^{ref}	[kN/m ²]	25000			
☒ Auto. eval. of M and H						
Ko coeff. for NC soil	Compute M,H		1			
	KoNC	[]	0.5			
Reference oedometric stress	σ_{oed}^{ref}	[kN/m ²]	200			
Ref. oedometric modulus	E_{oed}^{ref}	[kN/m ²]	25000			
	q^{POP}	[kN/m ²]	0			
	OCR ^{HS}	[]	1			
	K_0^{SR}	[]	0.5			
☒ Overconsolidation ratio						
☒ Consolidation KoNC						
☐ Consolidation isotropic						

1. Select the determination method: **Identification**

Exercise 2 – Import experimental test data

Test Data Input | **Data Interpretation**

Assembly of tests

TX-CD [Add] **1**

Lab. Tests

- PiasekSredni-txcd-sig25kPa TX-CD
- PiasekSredni-txcd-sig50kPa TX-CD
- PiasekSredni-txcd-sig75kPa TX-CD
- untitled test 4 TX-CD

Test type

TX-CD **2**

Specimen data

Test label: untitled test 4

Specimen and test data

Parameter	Symbol	Value
Initial void ratio	e_0	0.5
Confining pressure	σ_c	100
In situ vert. eff. stress	σ'_{v0}	100
vert. precons. pressure	σ'_{vc}	100
Overconsolidation ratio	OCR	1
Initial K_0 coeff.	K_0^{test}	1

Import experimental data **3**

Import wizard for experimental data

This import wizard allows setting the delimiters the data contains.

Delimiters

☐ Comma ☒ Semicolon ☐ Tab

☐ Space ☐ Other:

☐ Treat consecutive delimiters as one

Text qualifier {None}

The data preview allows to specify the columns which correspond to expected variables.

☒ First row is header

Preview 6 rows

Data Preview

	ϵ_1	σ_1' [kN/m ²]	ϵ_v
1	0.000000E+00	5.000000E+01	0.000000E+00
2	5.000000E-04	6.168721E+01	3.894413E+00
3	1.000000E-03	6.962162E+01	6.539192E+00
4	1.500000E-03	7.531380E+01	8.436687E+00
5	2.000000E-03	7.958536E+01	9.860709E+00

3

OK **Cancel**

Import experimental test data **3**

In order to define a new laboratory test:

1. Preselect the type of test and press **Add**
2. Give a **label** to the test and define initial state variables
3. Import test results from an ASCII file by pressing **Import experimental data**, selecting the file, and assigning variables to corresponding columns

Exercise 2 – Import experimental test data

Identification from Laboratory Tests

Test Data Input | Data Interpretation

Assembly of tests

TX-CD [Add]

Lab. Tests [Test type]

- PiasekSredni-txcd-sig25kPa TX-CD
- PiasekSredni-txcd-sig50kPa TX-CD
- PiasekSredni-txcd-sig75kPa TX-CD

Add Test
Remove Test
Import experimental data
Load Test
Save Test

Specimen data

Test label: PiasekSredni-txcd-sig75kPa

Test type: TX-CD [Detailed Specimen Record]

Specimen and test data

Parameter	Symbol	Value	Unit
Initial void ratio	e_0	0.5	
Confining pressure	σ_c	75	[kN/m ²]
In situ vert. eff. stress	σ'_{v0}	100	[kN/m ²]
Vert. precons. pressure	σ'_{vc}	200	[kN/m ²]
Overconsolidation ratio	OCR	2	
Initial Ko coeff.	K_0^{inst}	1	

Experimental measurements

	ϵ_1 []	σ_1' [kN/m ²]	ϵ_v []	ϵ_3 []
1	0	75	0	0
2	0.001	112	0.00036	-0.00032
3	0.002	140	0.000632	-0.000684
4	0.003	162	0.000844	-0.001078
5	0.004	179	0.00101	-0.001495
6	0.005	194	0.00115	-0.001925
7	0.006	206	0.00127	-0.002365
8	0.007	216	0.00137	-0.002815

NB. Compression and contractancy must be positive

Verify consistency of data [Import experimental test data]

Verification status: Not verified

Options

1B

Import prepared data files:

SandMedium-txcd-sig25kPa.pit

SandMedium-txcd-sig50kPa.pit

SandMedium-txcd-sig75kPa.pit

1A. In order to import prepared in advance and saved experimental data for three triaxial tests, click right button and select **Load test(s)**

1B. Select files and open them

2. Browse imported results by selecting each test separately in **Assembly of tests**

Exercise 2 – Parameter identification **Clayey Sand**

1

1

2

3

1

2. Run parameter identification algorithm by pressing **Interpret Selected**

3. Configure identification algorithm; in this case, define the identification of stiffness power law exponent m based on the values of modulus E_{ur} derived from unloading-reloading cycle

Exercise 2 – Post-processing of results

Identification from Laboratory Tests

Test Data Input | Data Interpretation

Assembly of tests
TX-CD

Lab. Tests | Test type
☒ PiasekSredni-txcd... TX-CD
☒ PiasekSredni-txcd... TX-CD
☒ PiasekSredni-txcd... TX-CD

Data interpretation
 Preview for retrieved variables: HS-small strain parameters
 Tests interpretation for model:

	Symbol	Unit	Average	Sredni
Deformation				
Ref. sec. modulus at 50% of q	E_{50}^{ref}	[kN/m ²]	24319.4	
Stiffness exponent	m	[]	0.545674	
Reference stress	σ_{ref}	[kN/m ²]	100	
Un-/reloading Poisson's ratio	ν_{ur}	[]	0.2	
Ref. un-/reload. modulus	E_{ur}^{ref}	[kN/m ²]	72657	
Strength				
Failure cohesion	c_f	[kN/m ²]	1.32901	
Failure ratio	R_f	[]	0.897988	
Failure friction angle	ϕ_f	[deg]	37.754	
Dilatancy				
Dilatancy angle	ψ	[deg]	7.49472	
Maximal void ratio	e_{max}	[]	0.533672	
Initial state				
Ko coeff. for NC soil	K_0^{NC}	[]	0.387727	

Graphical interpretation
 Content preview: p' - q
 Axis Manager

Deviatoric Stress q [kN/m²]
 Effective Mean Stress p' [kN/m²]

Legend
☒ PiasekSredni-txcd-sig25kPa
☒ PiasekSredni-txcd-sig50kPa
☒ PiasekSredni-txcd-sig75kPa

Save Chart

Options

Interpret selected

OK Cancel

- Browse values of parameters identified for the chosen constitutive law, i.e. HS model, and other identified variables
- Leave the identification tool by clicking OK

Exercise 2 – Post-processing of results

File Options View Tools Help

Material Data

Material label:

Material type:

Select Material Behavior Type

Gravel
Sand
Silt
Clay

Material Formulation

☐ Assistance in model preselection

Available constitutive model formulations:

Parameter Determination

Determination methods:

☐ Automatic and Interactive Selection via literature database and correlations including in situ test data

☐ Identification via laboratory test data

Parameter Summary **Laboratory Test Simulation**

Parameter Selection

Export user's selection to:

Preview content:

User's selection << Checked or drag-and-drop to assign user-selected values

meter	Symbol	Unit	User's selection	Automatic	Interactive	TX-CD
Unit weights						
Unit weight	γ	[kN/m ³]	0			
Unit weight of fluid	γ_f	[kN/m ³]	10			
Initial void ratio	e_0	[]	0.6			☐ 0.5
Unit weight of dry soil	γ_D	[kN/m ³]	16.5			
Elastic						
Ref. un-/reload. modulus	E_{ur}^{ref}	[kN/m ²]	80000			☐ 72657
Un-/reloading Poisson's ratio	ν_{ur}	[]	0.2			☐ 0.2
Stiffness exponent	m	[]	0.5			☐ 0.545674
Reference stress	σ_{ref}	[kN/m ²]	100			☐ 100
☐ Small strain stiff. active						
Ref. initial stiff. modulus	E_0^{ref}	[kN/m ²]	240000			
Small strain threshold	$\gamma_{0.7}$	[]	0.0002			
Nonlinear						
Failure friction angle	ϕ_f	[deg]	30			☐ 37.754
Dilatancy angle	ψ	[deg]	0			☐ 7.49472
Failure cohesion	c_f	[kN/m ²]	20			☐ 1.32901
Ref. sec. modulus at 50% of q_f	E_{50}^{ref}	[kN/m ²]	25000			☐ 24319.4
☒ Auto. eval. of M and H	Compute M,H		1			
Ko coeff. for NC soil	KoNC	[]	0.5			☐ 0.387727
Reference oedometric stress	σ_{oed}^{ref}	[kN/m ²]	200			
Ref. oedometric modulus	E_{oed}^{ref}	[kN/m ²]	25000			

1. Column TX-CD has been updated
2. Press **Automatic and Interactive Selection** to determine the remaining parameters

Exercise 2 – Estimation based on available data

1

✕ Basic soil setup

Soil Behaviour Type:

Unknown
Gravel
Sand
Silt
Clay

Stress History:

Unknown
Normally consolidated
Lightly consolidated
Overconsolidated
Heavily overconsolidated

Soil Density:

Unknown
Very loose
Loose
Medium
Dense
Very dense

Gradation:

Unknown
Well-graded
Poorly-graded
Silty
Clayey

Particle shape:

Unknown
Angular
Subangular
Subrounded
Rounded

State:

Dry (S=0%)
Humid (S=1-25%)
Damp (S=26-50%)
Moist (S=51-75%)
Wet (S=76-99%)
Saturated (S=100%)

✕ **Run basic parameter selection**

Reset All Data

4

✕ ☒ **Known soil properties**

NB. If specified, the values of basic soil properties have supremacy over 'Basic soil setup'

Material name		No name	
Elastic modulus	E		[kPa]
Weight / unit volume	γ		[kN/m ³]
Friction angle	ϕ	37	[deg]
Cohesion	c	1.3	[kPa]
Vert. eff. stress at characterization or in the middle of soil layer	σ'_{v0}		[kPa]
Overconsolidation ratio	OCR		[-]
Initial void ratio	e_0		[-]

Unit weight setup

☒ Weight of dry soil

☐ Weight of saturated soil

γ_D

 γ_{SAT}

[kN/m³]
[kN/m³]

2

✕ ☐ **Physical soil properties**

✕ ☐ **Soil type specific properties**

✕ ☒ **In situ test results**

Standard Penetration Test (SPT)

Number of blows	N_{60}		
Vertical effective in situ stress	σ'_{v0}		[kPa]
Overburden correction factor	C_N		[-]

Seismic tests (SDMT / SCPT / Other geophysical test)

Shear wave velocity	V_s	175	[m/s]
Soil density	ρ	2.05	[g/cm ³]
Vertical effective in situ stress	σ'_{v0}	80	[kPa]

3

✕ ☐ **Physical soil properties**

✕ ☐ **Soil type specific properties**

✕ ☒ **In situ test results**

1. Define general soil description
2. Introduce known values of soil properties (also those identified from laboratory test)
3. Introduce the results obtained from shear wave velocity measurements
4. Run basic parameter selection

Exercise 2 – Final selection & exporting parameters for simulating TXCD

Parameter Summary Laboratory Test Simulation

Parameter Selection

Export user's selection to: Test simulation Export **4** Preview content: Basic

User's selection << Checked **3** d-drop to assign user-selected values

Symbol	Unit	User's selection	Automatic	Interactive	TX-CD	TX-CU	TX-C
E_{ur}^{ref}	[kN/m ²]	72657	☐ 40000	☐ 40000	☒ 72657		
v_{ur}	[]	0.2		☐ 0.2	☒ 0.2		
m	[]	0.545674	☐ 0.563	☐ 0.563	☒ 0.545674		
σ_{ref}	[kN/m ²]	100	☐ 100	☐ 100	☒ 100		
E_0^{ref}	[kN/m ²]	230287	☐ 230287	☒ 230287			
$\gamma_{0.7}$	[]	0.00017	☐ 0.00017	☒ 0.00017			
ϕ_f	[deg]	37.754	☐ 34.5	☐ 37	☒ 37.754		
ψ	[deg]	7.49472	☐ 5.25	☐ 5.25	☒ 7.49472		
c_f	[kN/m ²]	1.32901	☐ 1.3	☐ 1.3	☒ 1.32901		
E_{90}^{ref}	[kN/m ²]	24319.4	☐ 10000	☐ 10000	☒ 24319.4		
Compute M,H		1					
KoNC	[]	0.387727	☐ 0.434	☐ 0.398	☒ 0.387727		
σ_{oed}^{ref}	[kN/m ²]	251	☐ 251	☒ 251			
E_{oed}^{ref}	[kN/m ²]	10000	☐ 10000	☒ 10000			
q^{POP}	[kN/m ²]	0		☐ 0			
OCR ^{HS}	[]	1	☐ 1.85	☐ 1.85			
K_0^{SR}	[]	0.387727		☐ 0.398			
$K_{0,x}$	[]	0.577	☐ 0.614	☒ 0.577			
$K_{0,y}$	[]	0.577	☐ 0.614	☒ 0.577			

1

2

0. Leave the dialog for automatic and interactive parameter estimation - **Update and Exit**

1. Mark all parameters from column **TX-CD** ...

2. ... and selected values in column **Interactive**

3. Move marked values using **Copy checked to user's selection**

4. In order to verify effectiveness of parameter identification, export user's selection to **Test simulation**; you will be asked whether you'd like to automatically move to **Laboratory Test Simulation**

Exercise 2 – Reproducing results derived from drained test

1 Laboratory Test Simulation

Test preselection

TX-CD

2 ☒ Use real test data

3 Tests

Test	Test type
☒ PiasekSredni-txcd-sig25kPa	TX-CD
☒ PiasekSredni-txcd-sig50kPa	TX-CD
☒ PiasekSredni-txcd-sig75kPa	TX-CD

Allows selecting the tests to be simulated.

4 Simulate selected test

data for test simulation

Initial state variables

Parameter	Symbol	Value	Unit
Initial void ratio	e_0	0.5	[-]
Confining pressure	σ_c	75	[kN/m ²]
In situ vert. eff. stress	σ'_{v0}	100	[kN/m ²]
Vert. precons. pressure	σ'_{vc}	200	[kN/m ²]
		2	[-]
Initial Ko coeff.	K_0^{init}	1	[-]

Model parameters

☐ Show advanced parameters

Parameter	Symbol	Unit	Value	Last spe
☐ Small strain stiff. act...				
Ref. initial stiff. modulus	E_0^{ref}	[kN/m ²]	230287	230287
Small strain threshold	$\gamma_{0.7}$	[-]	0.00017	0.00017
Nonlinear				
Failure friction angle	ϕ_f	[deg]	37.754	37.754
Dilatancy angle	ψ	[deg]	7.49472	7.49472
Failure cohesion	c_f	[kN/m ²]	1.32901	1.32901
Ref. sec. modulus at 50...	E_{50}^{ref}	[kN/m ²]	24319.4	24319.4
☒ Auto. eval. of M an...	Compute M,H		1	1
Ko coeff. for NC soil	KoNC	[-]	0.387727	0.387727
Reference oedometric s...	σ_{oed}^{ref}	[kN/m ²]	251	251
Ref. oedometric modulus	E_{oed}^{ref}	[kN/m ²]	10000	10000
☐ Preoverburden pres...	q^{POP}	[kN/m ²]	0	0
☒ Overconsolidation r...	OCR ^{HIS}	[-]	1	2.6
Stress reversal Ko coeff.	K_0^{SR}	[-]	1	1
☐ Consolidation KoNC				
☒ Consolidation isotr...				
☐ Consolidation aniso...				

Graphical interpretation

Content preview: $\epsilon_1 - \sigma_1$

Axis Manager

PiasekSredni-txcd-sig75kPa

5

1. In order to verify effectiveness of parameter identification move to **Laboratory Test Simulation**
2. Select drained test in the test preselection (**TX-CD**) and enable **Use real test data** to simulate the tests used for parameter identification (notice that the initial state variables and loading program have been already defined).
3. Select one of tests
4. Press **Simulate selected test**
5. Compare model responses with laboratory curves

Exercise 2 – Parameter identification for Clay

Materials

Material definition

Add Modify Delete

List of defined materials

Name	Cont./Struct. type	Material formulation
1: Sand Medium	Continuum	HS-small strain stiffness
2: Clayey Sand	Continuum	HS-small strain stiffness
→ 3: Clay	Continuum	HS-small strain stiffness
4: Seepage	Seepage	Seepage

1

2 Determine parameters

☒ Elastic Open

☒ Unit weights Open

☒ Flow Open

☒ Non linear Open

☒ Initial Ko State Open

☐ Heat

☐ Humidity

☐ Stability

☐ Damping

Add selected material to database Import material from *.INP

Help for current model

☒ Advanced Help Cancel OK

1. Select Clay (material #3)

2. Press Determine parameters

Clay – data:

3 undrained triaxial tests

General soil description
(parameter estimation from
incomplete data)

V_s (determining E_0)

DMT, CPTU
(determining OCR)

Exercise 2 – Import experimental data (undrained tests)

1A

2

Test label: Glina-txcu-sig200kPa
Test type: TX-CU

Specimen and test data

Parameter	Symbol	Value	Unit
Initial void ratio	e_0	0.8	
Confining pressure	σ_c	200	[kN/m ²]
Initial pore pressure	u_0	0	[kN/m ²]
Vertical eff. stress	σ'_{v0}	125	[kN/m ²]
Excess pore pressure	σ'_{vc}	625	[kN/m ²]
Overconsolidation ratio	OCR	5	
Initial K_0 coeff.	K_0^{test}	1	

Experimental measurements

	ϵ_1 []	σ_1 [kN/m ²]	u [kN/m ²]	σ'_1 [kN/m ²]
1	0	200	0	200
2	0.0005	228.039	9.34567	218.693
3	0.001	250.249	16.7486	233.501
4	0.0015	268.124	22.7067	245.417
5	0.002	282.742	27.5796	255.162
6	0.0025	294.88	31.6254	263.255
7	0.003	305.095	35.0306	270.064
8	0.0035	313.799	37.932	275.867

NB. Compression and contractancy must be positive

Verify consistency of data Import experimental test data

Verification status: Not verified

3 Interpret selected

1B

Load test from files:

Clay-txcu-sig50kPa.pit

Clay-txcu-sig100kPa.pit

Clay-txcu-sig200kPa.pit

3

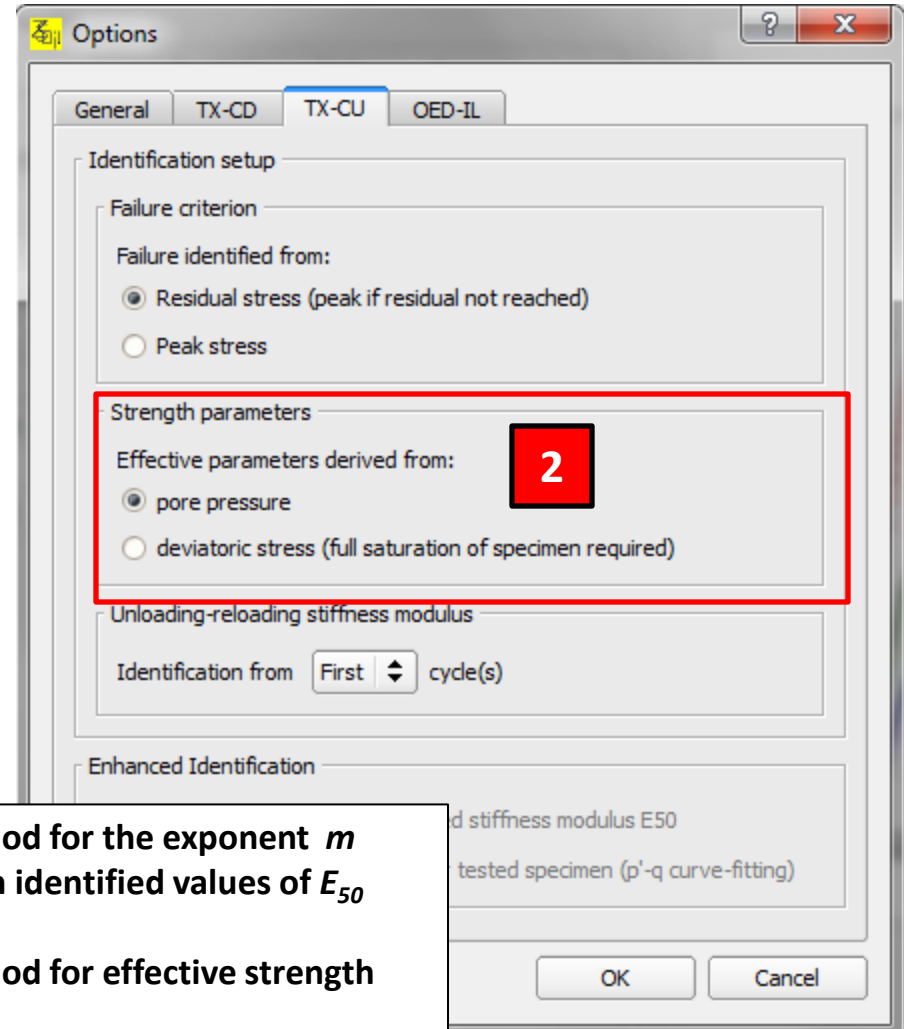
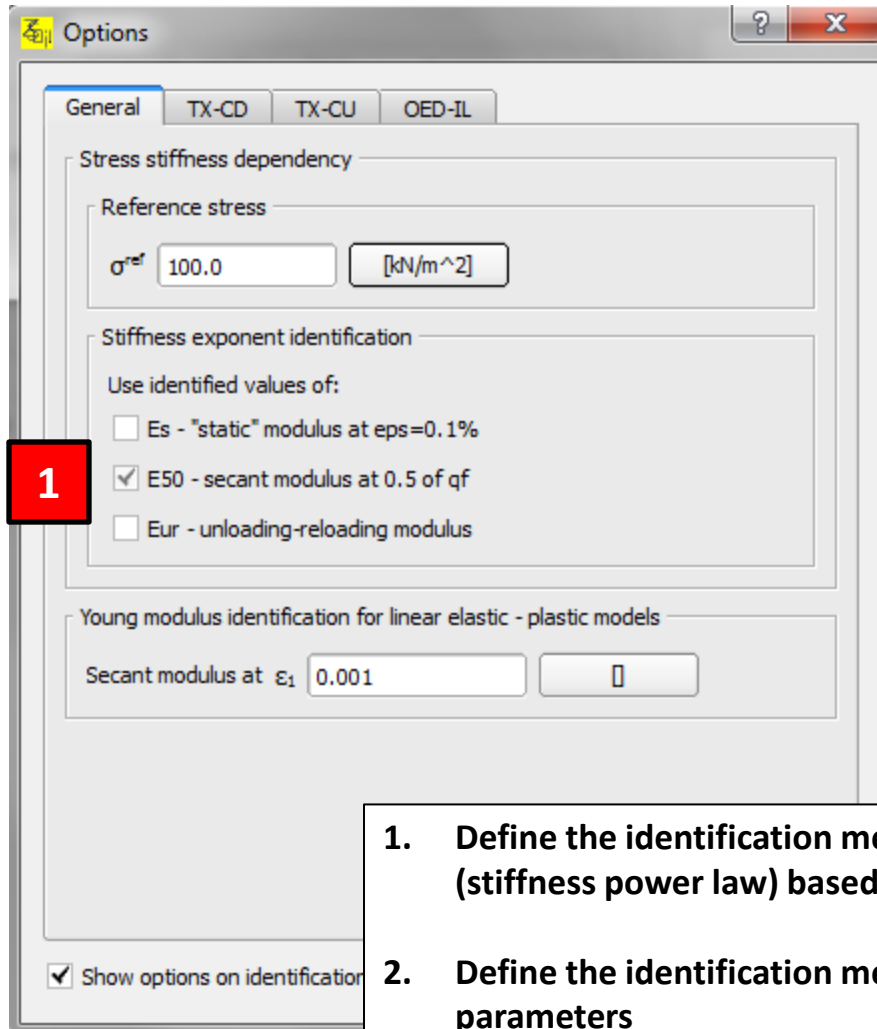
1A. Import prepared in advance and saved experimental data for three undrained triaxial tests, click right button and select **Load test(s)**

1B. Select files and open them

2. Move to **Data interpretation** tab widget

3. Run interpretation of laboratory curves by pressing **Interpret selected**

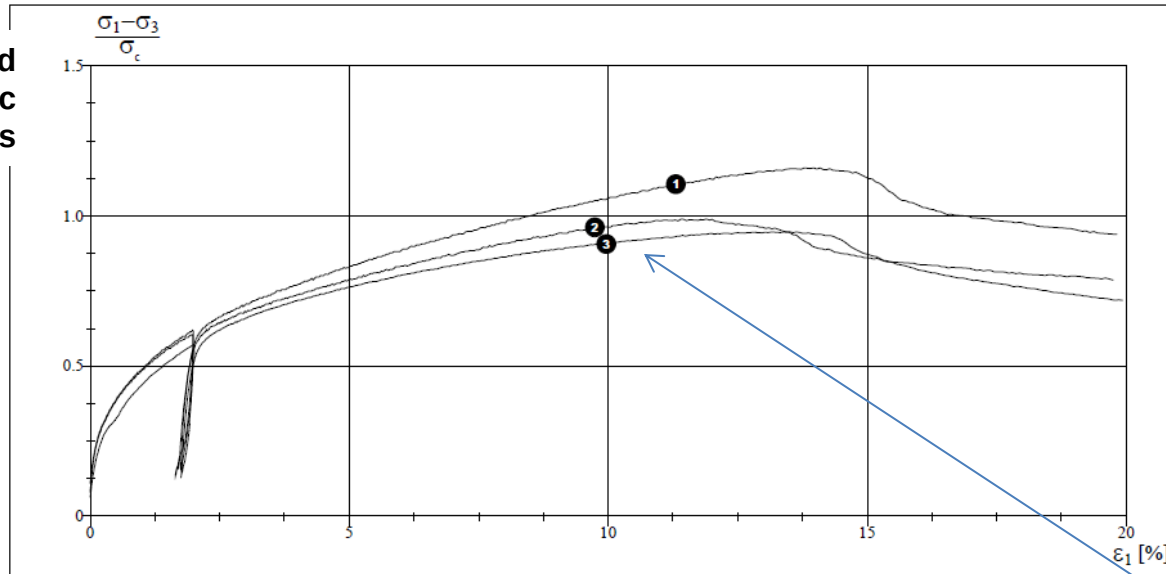
Exercise 2 – Setting options for identification



1. Define the identification method for the exponent m (stiffness power law) based on identified values of E_{50}
2. Define the identification method for effective strength parameters

NB. Effective strength parameters from undrained triaxial tests

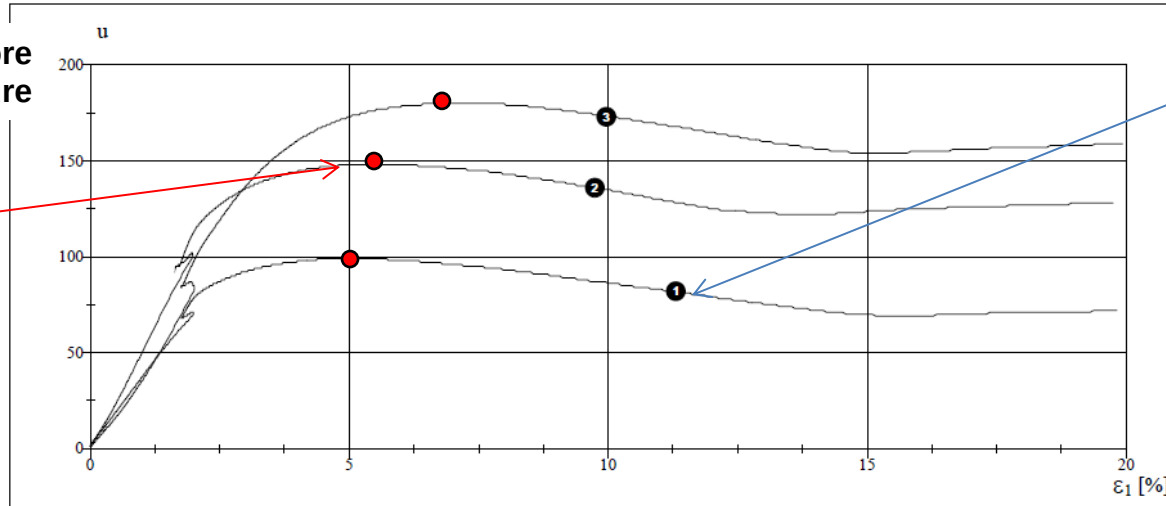
Normalized deviatoric stress



According to the report the degree of saturation in specimens:

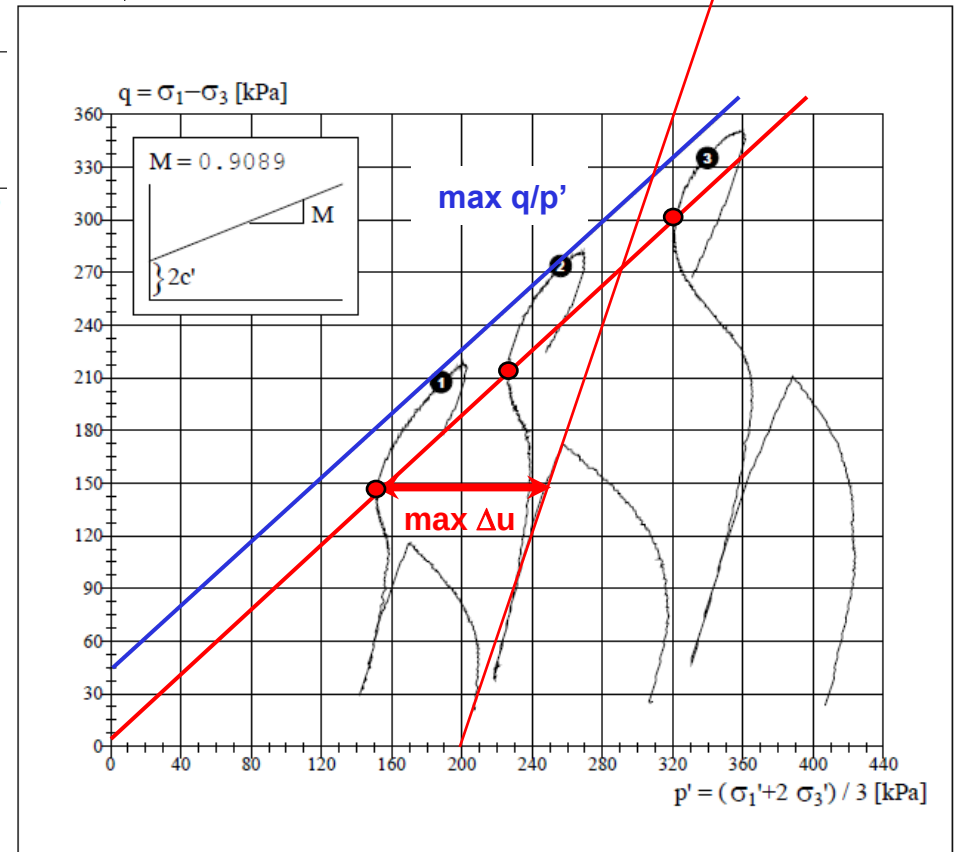
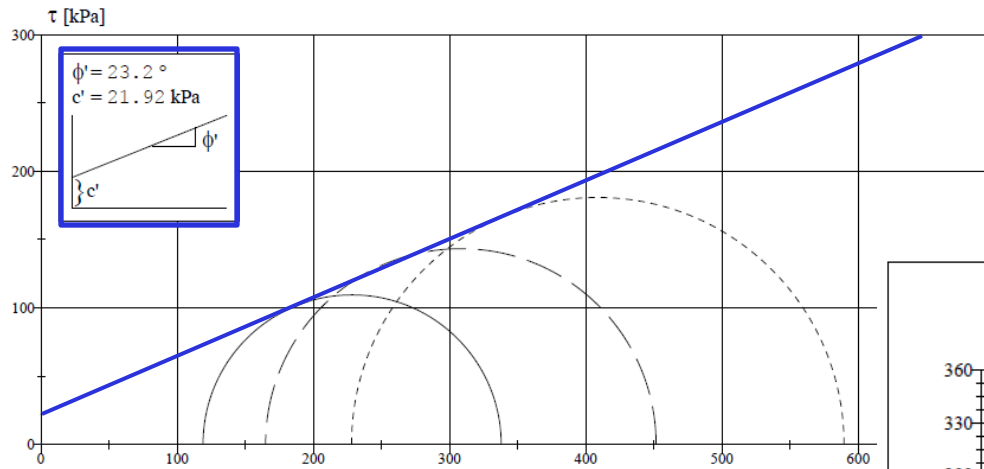
100%, 100%, 96%

Pore pressure



Ultimate state based on maximal q/p' criterion according to interpretation by the testing laboratory

NB. Effective strength parameters from undrained triaxial tests



Exercise 2 – Post-processing of results

Material Data

Material label:

Material type:

Select Material Behavior Type

- Gravel
- Sand
- Silt
- Clay

Material Formulation

☐ Assistance in model preselection

Available constitutive model formulations:

Parameter Determination

Determination methods:

via literature database and correlations including in situ test data

via laboratory test data

Parameter Summary Laboratory Test Simulation

Parameter Selection

Export user's selection to:

Preview content:

User's selection << Checked or drag-and-drop to assign user-selected values

Symbol	Unit	User's selection	Automatic	Interactive	TX-CD	TX-CU	TX-C
γ	[kN/m ³]	0					
γ_f	[kN/m ³]	10					
e_0	[]	0.8					
γ_D	[kN/m ³]	16.5					
E_{ur}^{ref}	[kN/m ²]	80000				☐ 86021.5	
v_{ur}	[]	0.2				☐ 0.69101	
m	[]	0.5				☐ 100	
σ_{ref}	[kN/m ²]	100					
E_0^{ref}	[kN/m ²]	240000					
$\gamma_{0.7}$	[]	0.0002					
ϕ_f	[deg]	30				☐ 26.4978	
ψ	[deg]	0					
c_f	[kN/m ²]	20				☐ 0.785824	
E_{50}^{ref}	[kN/m ²]	25000				☐ 19898.9	
Compute M,H		1					
KoNC	[]	0.5				☐ 0.553836	
σ_{ocd}^{ref}	[kN/m ²]	200					
E_{ocd}^{ref}	[kN/m ²]	25000					
q^{POP}	[kN/m ²]	0					
OCR^{HS}	[]	1					
K_0^{SR}	[]	0.5					

1

1. Column **TX-CD** has been updated
2. Press **Automatic and Interactive Selection** to estimate the remaining parameters

Exercise 2 – Estimation based on available data

Basic soil setup

Soil Behaviour Type: Unknown, Gravel, Sand, Silt, Clay (selected)

Stress History: Unknown, Normally consolidated, Lightly consolidated, Overconsolidated (selected), Heavily overconsolidated

Soil Consistency: Unknown, Very Soft, Soft, Medium, Stiff, Very Stiff (selected), Hard

Plasticity: Unknown, Low plasticity, Medium plasticity (selected), High plasticity

Organics Content: Unknown, Inorganic (selected), Organic

State: Dry ($S=0\%$), Humid ($S=1-25\%$), Damp ($S=26-50\%$), Moist ($S=51-75\%$), Wet ($S=76-99\%$), Saturated ($S=100\%$) (selected)

☒ **Known soil properties** NB. If specified, the values of basic soil properties have supremacy over 'Basic soil setup'

Material name: No name

Elastic modulus: E [kPa]

Weight / unit volume: γ [kN/m³]

Friction angle: ϕ 26.5 [deg]

Cohesion: c 1 [kPa]

Vert. eff. stress at characterization or in the middle of soil layer: σ'_{v0} [kPa]

Overconsolidation ratio: OCR [-]

Initial void ratio: e_0 0.8 [-]

Unit weight setup

☒ Weight of dry soil γ_D 16.5 [kN/m³]

☐ Weight of saturated soil γ_{SAT} 20.9 [kN/m³]

☐ **Physical soil properties**

☒ **Soil type specific properties**

Coarse-grained soils

Coefficient of uniformity: C_u [-]

Coefficient of curvature: C_k [-]

Content of fine particles: f_p [%]

Relative density: D_r [%]

Fine-grained soils

Plasticity index: PI 30 [%]

Liquid limit: w_L [%]

Unconfined compressive strength: q_u [kPa]

Undrained shear strength: S_u [kPa]

Effective vertical stress for S_u : σ'_{v0} [kPa]

Compression index: C_c [-]

1

2

3

4

1. Define soil properties
2. Introduce parameters determined from triaxial tests
3. Introduce other known parameters
4. Insert the value of plasticity index being used for identification of $\gamma_{0.7}$

Exercise 2 – Introducing data from field testing

☒ In situ test results			
Standard Penetration Test (SPT)			
Number of blows	N_{60}		
Vertical effective in situ stress	σ'_{v0}		[kPa]
Overburden correction factor	C_N		[-]
Marchetti Dilatometer Test (DMT)			
First DMT reading	p_0	952	[kPa]
Second DMT reading	p_1	1149	[kPa]
Hydrostatic pore pressure	u_0	50	[kPa]
Effective <i>in situ</i> vertical stress	σ'_{v0}	140	[kPa]
Material index	I_D	0.218	[-]
Horizontal stress index	K_D	6.44	[-]
Dilatometer modulus	E_D	6836	[kPa]
Dimensionless unit weight	γ_{DMT}/γ_w	2.05	[-]
Soil Behaviour Type:		Clay	
Seismic tests (SDMT / SCPT / Other geophysical test)			
Shear wave velocity	V_s	255	[m/s]
Soil density	ρ	1.9	[g/cm ³]
Vertical effective in situ stress	σ'_{v0}	140	[kPa]
Cone Penetration Test (CPT/CPTU)			
Corrected cone resistance	q_t	2120	[kPa]
Pore pressure behind the cone	u_2	860	[kPa]
Friction sleeve resistance	f_s	115	[kPa]
Total vertical stress	σ_{v0}	190	[kPa]
Hydrostatic pore pressure	u_0	50	[kPa]
Effective vertical stress	σ'_{v0}	140	[kPa]
Dimensionless unit weight	γ_{CPT}/γ_w	1.91	[-]
Normalized cone resistance	Q_t	13.8	[-]
Pore pressure parameter	B_q	0.42	[-]
Normalized friction ratio	F_r	0.0596	[-]

1. Introduce the results of shear wave velocity measurement
2. Introduce representative results obtained for this soil layer from the dilatometric test
3. Introduce representative results obtained for this soil layer from CPTU
4. Run **Basic Parameter Selection**

Exercise 2 – Automatic Selection: post-processing of results

Shear mechanism

Friction angle

Help

ϕ

26.5 [deg]

Dilatancy angle

Help

ψ

8.5 [deg]

Cohesion

Help

c

1

Failure ratio

R_f

0.9

☐ Tensile cut-off

Tensile strength

f_t

0 [kN/m²]

☐ Dilatancy cut-off

Dilatancy cut-off

Help

e_{max}

1.8

Multiplier for Rowe's dilatancy law in contractant domain

D

0.25

Cap volumetric mechanism

Hardening parameter

H

60000 [kN/m²]

Hardening parameter

M

0.7

M,H calculator based on oedometric test

Given:

Oedometric tangent modulus

E_{oed}

5250.0 [kN/m²]

Reference vertical stress

σ_{oed}^{ref}

181.0 [kN/m²]

Ko coefficient

Apply Jaky's formula

K_0^{NC}

0.55

Setting initial state variables with respect to the initial stress state

☒ Through overconsolidation ratio

Help

OCR

7.25

☐ Through preoverburden pressure

Help

q^{POP}

0 [kN/m²]

19.00	25.50	31.00	5.64	E	✗
6.33	8.50	10.30	4.25	E	✗
	1.00				
	0.90				
1.80	1.80	1.80	0.78	E	✗
3750	5250	8750	2566	E	✗
	181				
0.67	0.57	0.49	0.10	E	✗
4.50	7.25	10.00		E	✗

1

1. Move to interactive estimation of the overconsolidation ratio OCR from DMT and CPTU results

Exercise 2 – Interactive selection: OCR

1

☒	Overconsolidation ratio	OCR	Approximative value OCR [-]		
	Correlation Type	Soil Type or Other Auxiliary Data	Min	Average	Max
☐	1 Geotechnical convention	Heavily overconsolidated	4.5	7.3	10.0
☐	2 Empirical	Undrained shear strength s_u [kPa]: not specified	N/A	N/A	N/A
		Effective vertical stress for S_u σ'_{v0} [kPa]: 0			
		Specify consolidation mode ...			

	Test Type	Measurement or transformed measurement	Value	Min	Average	Max
☒	3 Marchetti's dilatometer DMT	Horizontal stress index	K_D [-]: 6.44		6.20	
☒	4 Marchetti's dilatometer DMT				4.87	
☒	5 Marchetti's dilatometer DMT	Medium plasticity soils		N/A	3.75	N/A
☒	6 Piezocone test CPTU	Site-specific empirical coefficient	k_t [-]: 0.3		4.14	
		Total <i>in situ</i> vertical stress σ_{v0} [kPa]: 190				
		Effective <i>in situ</i> vertical stress σ'_{v0} [kPa]: 140				
☒	7 Piezocone test CPTU	Corrected cone resistance	q_t [kPa]: 2120		4.95	
		Site-specific empirical coefficient k_e [-]: 0.55				
		Pore pressure measured behind cone u_2 [-]: 860				

Material: Glinia

Overconsolidation ratio: OCR [-]

Correlation Index

Min/Mean/Max	3.75	4.43	4.95
Standard Deviation		0.58	

3

Selected Value 4.5

4

5

Exercise 2 – Final selection & exporting parameters for simulating TXCU

Parameter Selection

Export user's selection to: Test simulation Export 3 2 Preview content: Basic

User's selection << Checked or drag-and-drop to assign user-selected value

Symbol	Unit	User's selection	Automatic	Interactive	TX-CD	TX-CU	TX-C
E_{ur}^{ref}	[kN/m ²]	86021.5	☐ 21000	☐ 80000		☒ 86021.5	
v_{ur}		0.2		☐ 0.2			
m		0.69101	☐ 0.656	☐ 0.5		☒ 0.69101	
σ_{ref}	[kN/m ²]	100	☐ 100	☐ 100		☒ 100	
E_0^{ref}	[kN/m ²]	240000	☐ 238666	☐ 240000			
$\gamma_{0.7}$		0.0002	☐ 0.000324	☐ 0.0002			
ϕ_f	[deg]	26.4978	☐ 25.5	☐ 30		☒ 26.4978	
ψ	[deg]	0	☐ 8.5	☐ 0			
c_f	[kN/m ²]	0.785824	☐ 1	☐ 20		☒ 0.785824	
E_{50}^{ref}	[kN/m ²]	19898.9	☐ 5250	☐ 25000		☒ 19898.9	
Compute M,H		1					
KoNC		0.553836	☐ 0.569	☐ 0.5		☒ 0.553836	
σ_{ocd}^{ref}	[kN/m ²]	173		☐ 200			
E_{ocd}^{ref}	[kN/m ²]	20000		☐ 25000			
q^{POP}	[kN/m ²]	0		☐ 0			
OCR ^{HS}		4.5	☐ 7.25	☒ 4.5			
K_0^{SR}		0.553836		☐ 0.5			
$K_{0,x}$		0.75	☐ 1.34	☐ 0.5			
$K_{0,y}$		0.75	☐ 1.34	☐ 0.5			

1A

1B

1C

0. Leave the dialog for automatic and interactive parameter estimation - **Update and Exit**
1. Mark all parameters from column „TX-CU” and OCR value from column **Interactive**
2. Move marked values using **Copy checked to user's selection**
3. In order to verify effectiveness of parameter identification, export user's selection to **Test simulation**; you will be asked whether you'd like to automatically move to **Laboratory Test Simulation**

Exercise 2 – Reproducing results derived from undrained test

1

2

3

1. In order to verify effectiveness of parameter identification move to **Laboratory Test Simulation**
2. Select undrained test in the test preselection (**TX-CU**)
3. Enable **Use real test data** to simulate the tests used for parameter identification (notice that the initial state variables and loading program have been already defined).
4. Press **Simulate all checked**
5. Compare model responses with laboratory curves

4

Parameter Summary Laboratory Test Simulation

Test preselection

TX-CU

☒ Use real test data

Lab. Tests	Test type
☒ Glna-txcu-sig50kPa	TX-CU
☒ Glna-txcu-sig100kPa	TX-CU
☒ Glna-txcu-sig200kPa	TX-CU

Input data for test simulation

Initial state variables

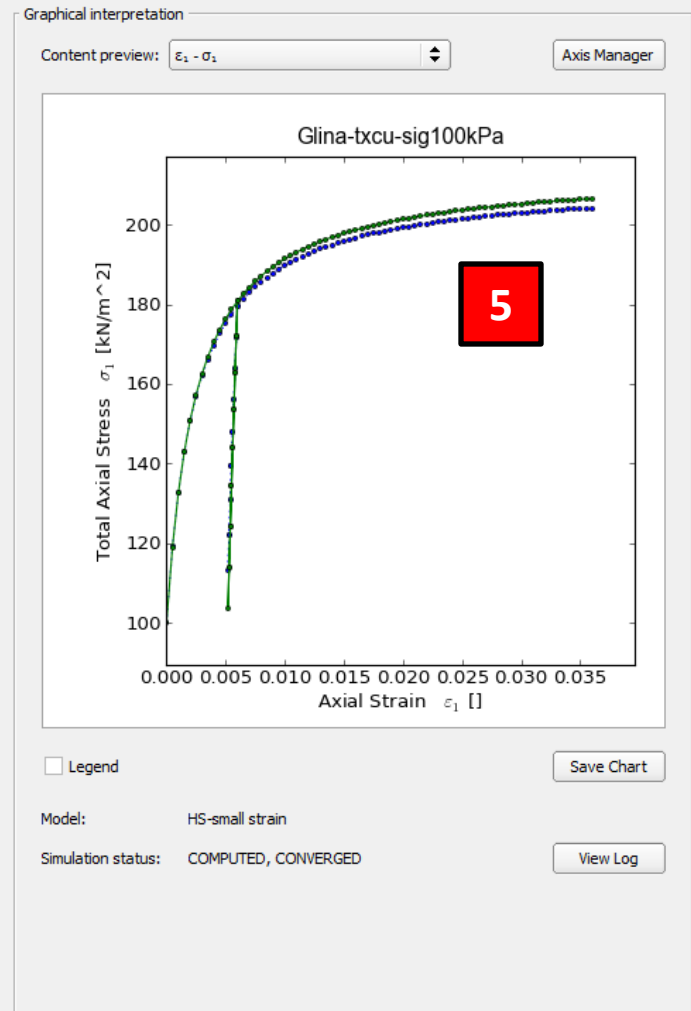
Parameter	Symbol	Value	Unit
Initial void ratio	e_0	0.8	[-]
Confining pressure	σ_c	100	[kN/m ²]
Initial pore pressure	u_0	0	[kN/m ²]
In situ vert. eff. stress	σ'_{v0}	125	[kN/m ²]
Precons. pressure	σ'_{vc}	625	[kN/m ²]
Consolidation ratio	OCR	5	[-]
Initial K_0 coeff.	K_0^{test}	1	[-]

Parameters

☐ Show advanced parameters

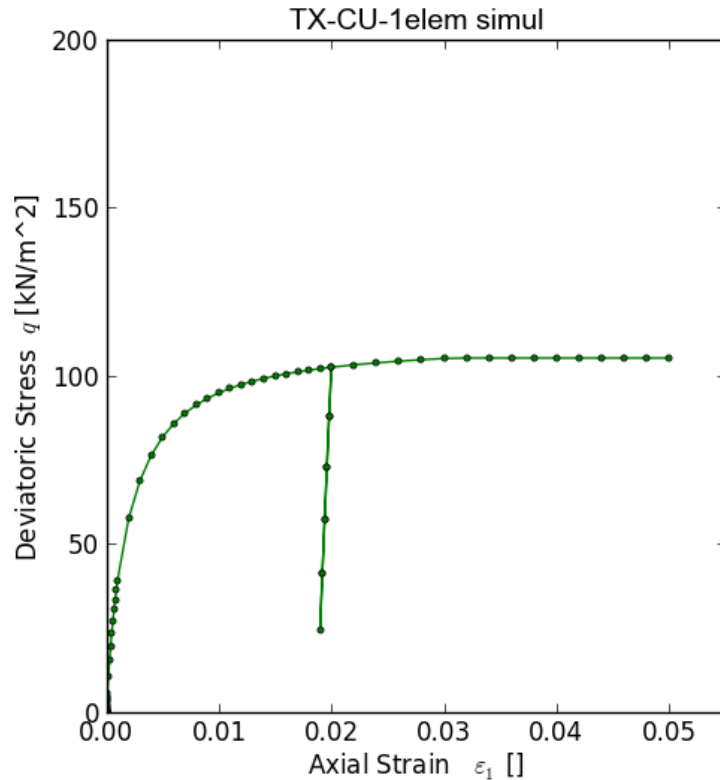
Parameter	Symbol	Unit	Value	Last spe
Small strain stiff. act...				
Ref. initial stiff. modulus	E_0^{ref}	[kN/m ²]	240000	240000
Small strain threshold	$\gamma_{0.7}$	[-]	0.0002	0.0002
Failure friction angle	ϕ_f	[deg]	26.4978	26.4978
Dilatancy angle	ψ	[deg]	0	0
Failure cohesion	C_f	[kN/m ²]	0.785824	0.785824
Ref. sec. modulus at 50...	E_{90}^{ref}	[kN/m ²]	19898.9	19898.9
☒ Auto. eval. of M an...	Compute M,H		1	1
K_0 coeff. for NC soil	KoNC	[-]	0.553836	0.553836
Reference oedometric s...	σ_{oed}^{ref}	[kN/m ²]	173	173
Ref. oedometric modulus	E_{oed}^{ref}	[kN/m ²]	20000	20000
☐ Preoverburden pres...	q^{POP}	[kN/m ²]	0	0
☐ Overconsolidation r...	OCR ^{HS}	[-]	4.5	4.5
Stress reversal K_0 coeff.	K_0^{SR}	[-]	1	1
☐ Consolidation KoNC				
☐ Consolidation isotr...				
☐ Consolidation aniso...				

Simulate selected test Simulate all checked

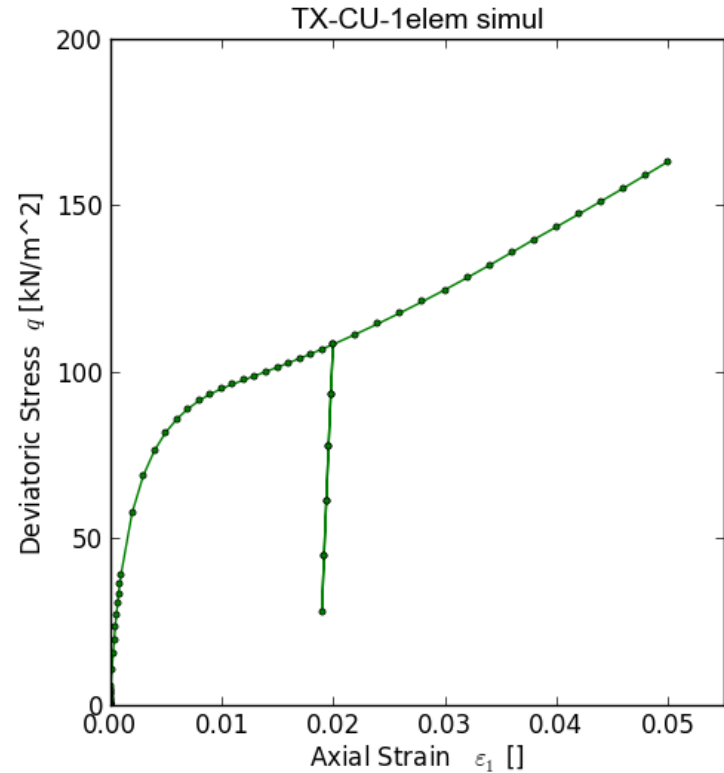


Modeling undrained behavior using the HS model

$$\psi = 0^\circ$$



$$\psi = 3^\circ$$



$\psi > 0$ shouldn't be used to simulate undrained behavior of cohesive soils !!!