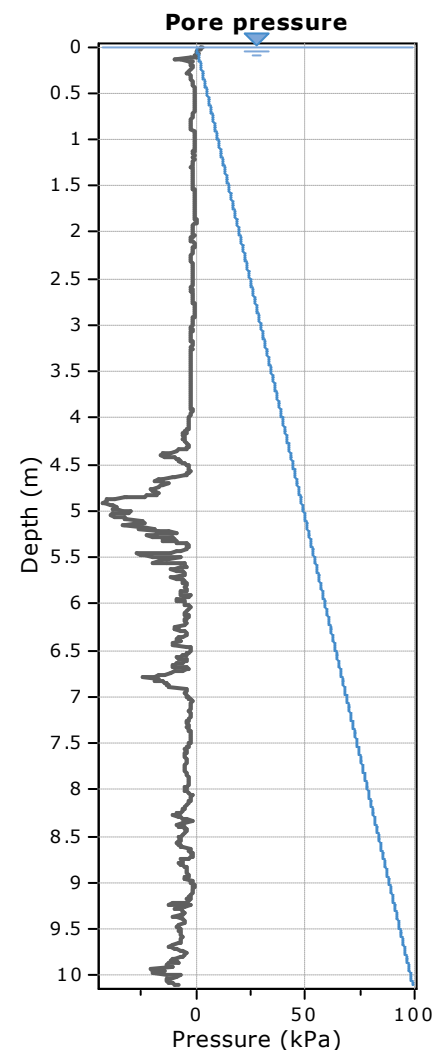
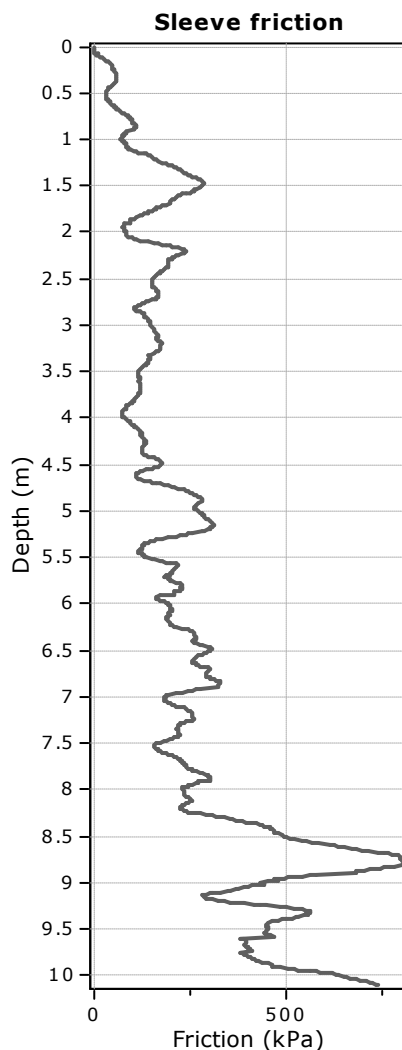
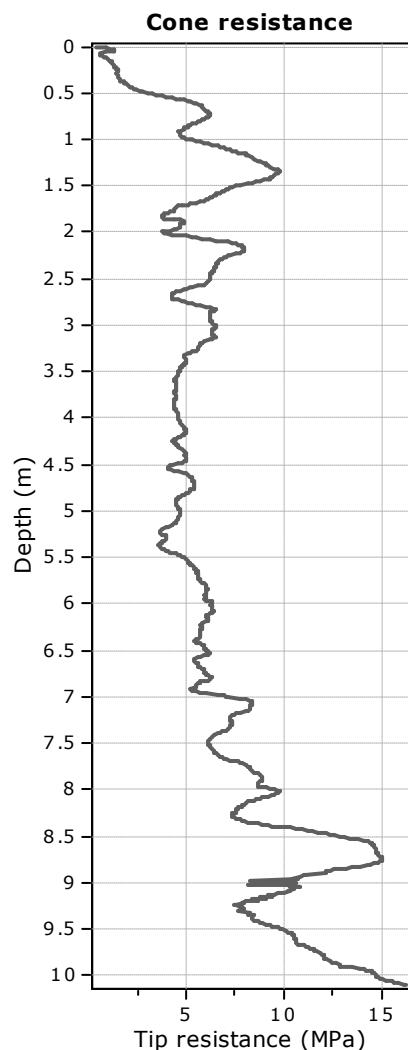
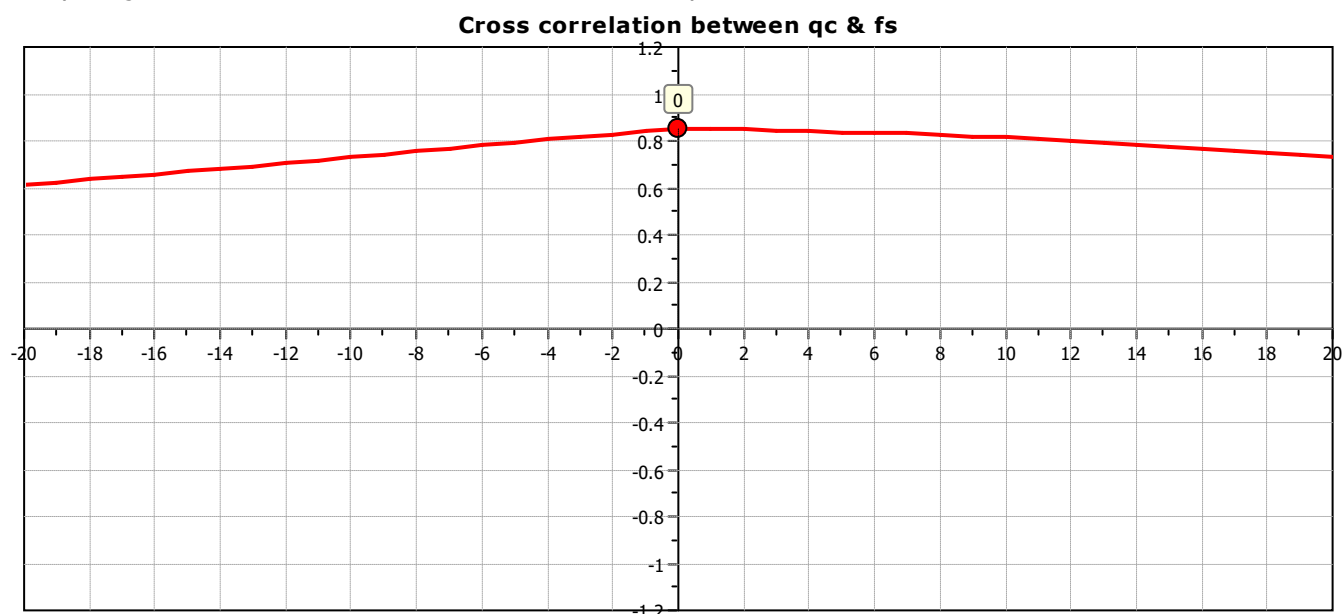


Project:

Location:



The plot below presents the cross correlation coefficient between the raw q_c and f_s values (as measured on the field). X axes presents the lag distance (one lag is the distance between two successive CPT measurements).



Project:

Location:

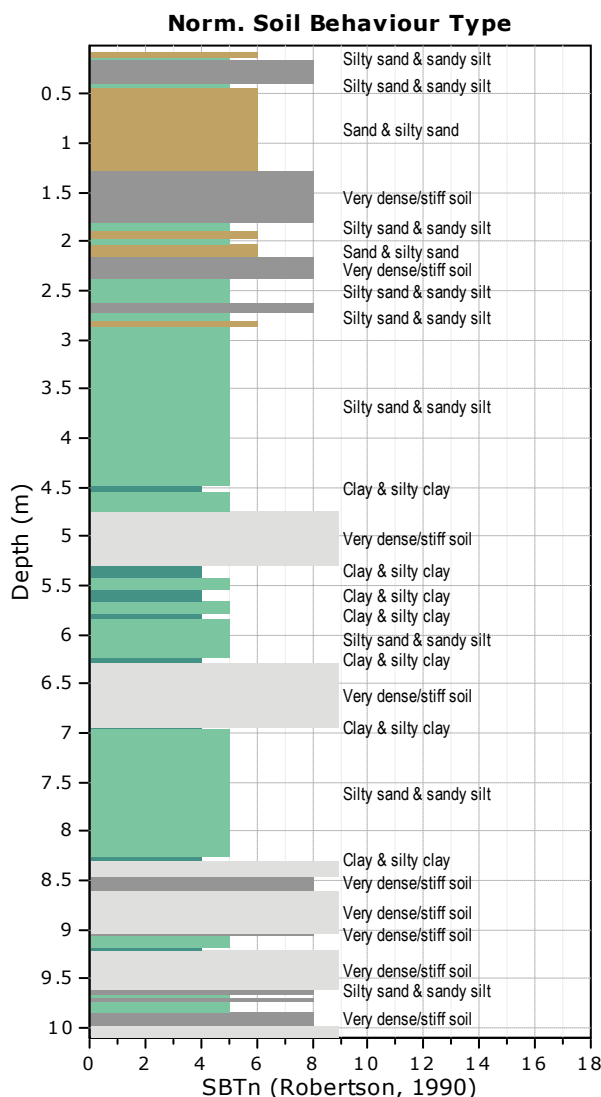
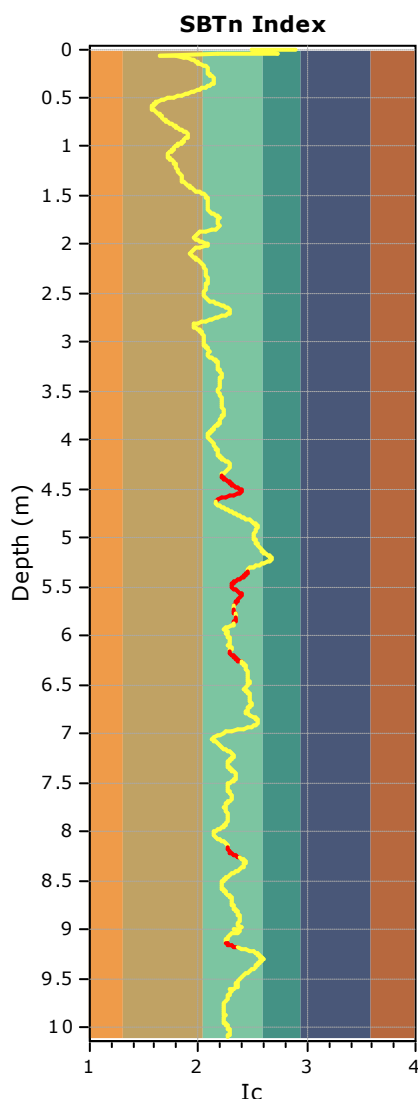
TRANSITION LAYER DETECTION ALGORITHM REPORT

Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vice-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c . Transitions typically occur when the rate of change of I_c is fast (i.e. ΔI_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



Transition layer algorithm properties

I_c minimum check value: 1.70
 I_c maximum check value: 3.00
 I_c change ratio value: 0.0010
 Minimum number of points in layer: 4

General statistics

Total points in CPT file: 1010
 Total points excluded: 108
 Exclusion percentage: 10.69%
 Number of layers detected: 10

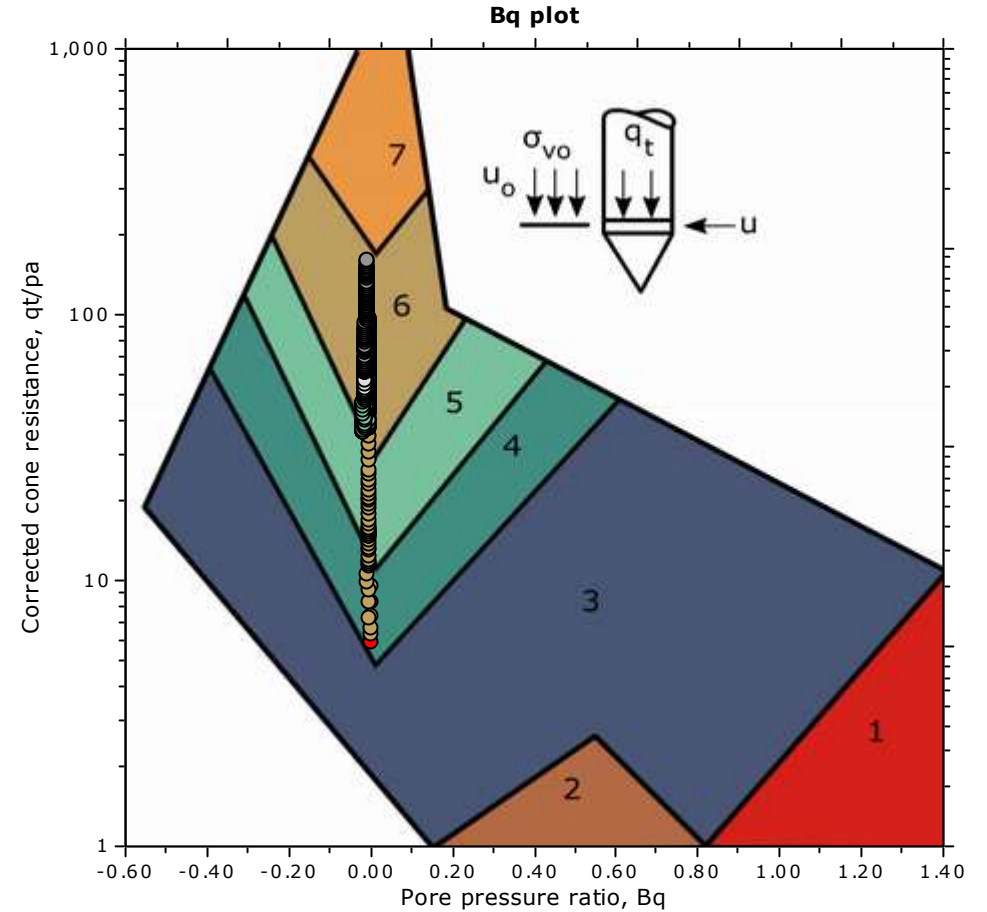
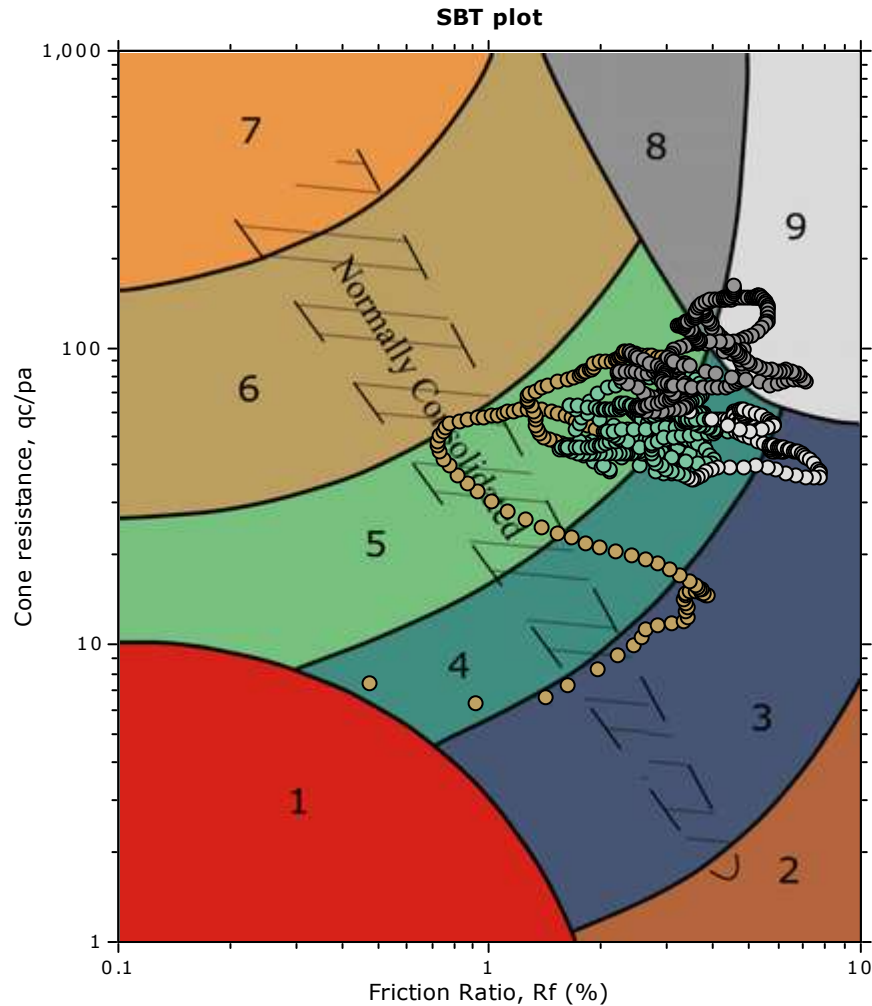
Transition layer No	Number of points	Depth	SBT _n number	SBT _n description
Transition layer 1	16	Start depth: 4.37 (m)	5	Silty sand & sandy silt
		End depth: 4.52 (m)	4	Clay & silty clay
Transition layer 2	12	Start depth: 4.52 (m)	4	Clay & silty clay
		End depth: 4.63 (m)	5	Silty sand & sandy silt
Transition layer 3	14	Start depth: 5.36 (m)	4	Clay & silty clay
		End depth: 5.49 (m)	5	Silty sand & sandy silt
Transition layer 4	10	Start depth: 5.49 (m)	5	Silty sand & sandy silt
		End depth: 5.58 (m)	4	Clay & silty clay
Transition layer 5	13	Start depth: 5.58 (m)	4	Clay & silty clay
		End depth: 5.70 (m)	5	Silty sand & sandy silt
Transition layer 6	5	Start depth: 5.74 (m)	5	Silty sand & sandy silt
		End depth: 5.78 (m)	4	Clay & silty clay
Transition layer 7	6	Start depth: 5.83 (m)	4	Clay & silty clay
		End depth: 5.88 (m)	5	Silty sand & sandy silt
Transition layer 8	12	Start depth: 6.17 (m)	5	Silty sand & sandy silt
		End depth: 6.28 (m)	4	Clay & silty clay
Transition layer 9	13	Start depth: 8.16 (m)	5	Silty sand & sandy silt
		End depth: 8.28 (m)	4	Clay & silty clay
Transition layer 10	7	Start depth: 9.14 (m)	5	Silty sand & sandy silt
		End depth: 9.20 (m)	4	Clay & silty clay

Start depth: Depth where the transition layer begins

End depth: Depth where the transition layer ends

Project:
Location:

SBT - Bq plots



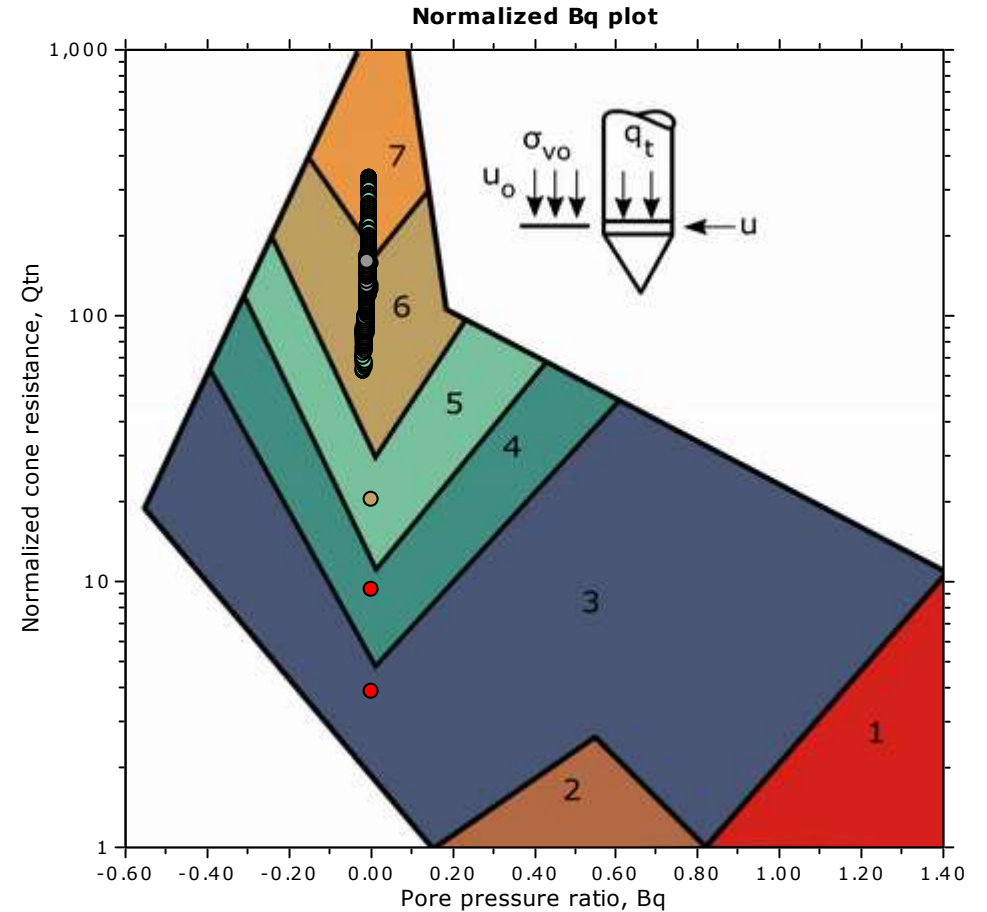
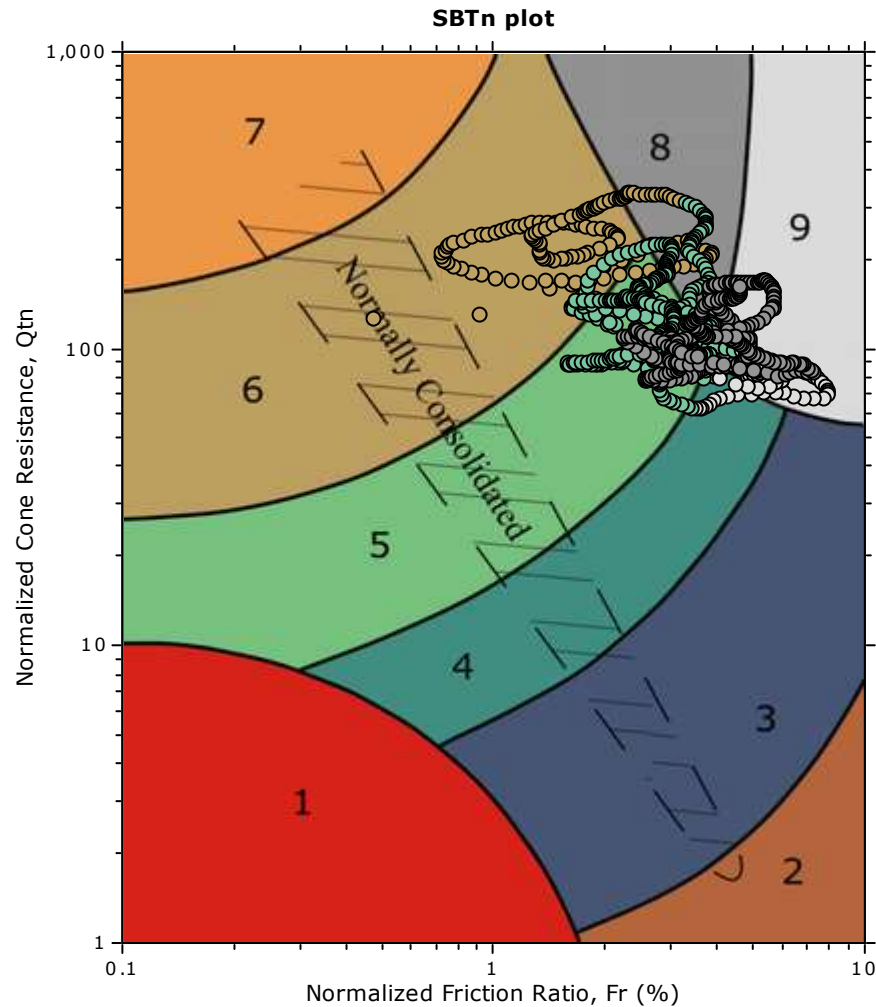
SBT legend

- | | | |
|---------------------------|------------------------------|-----------------------------------|
| 1. Sensitive fine grained | 4. Clayey silt to silty clay | 7. Gravelly sand to sand |
| 2. Organic material | 5. Silty sand to sandy silt | 8. Very stiff sand to clayey sand |
| 3. Clay to silty clay | 6. Clean sand to silty sand | 9. Very stiff fine grained |

Project:

Location:

SBT - Bq plots (normalized)



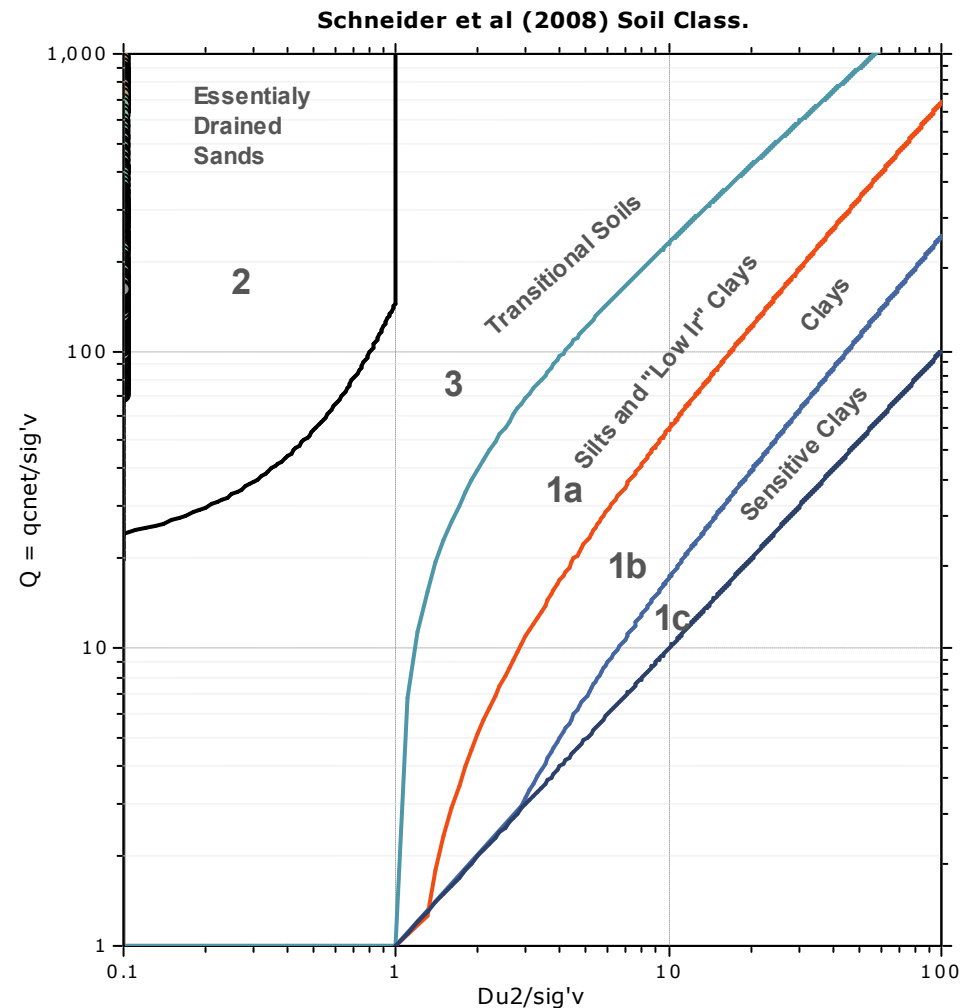
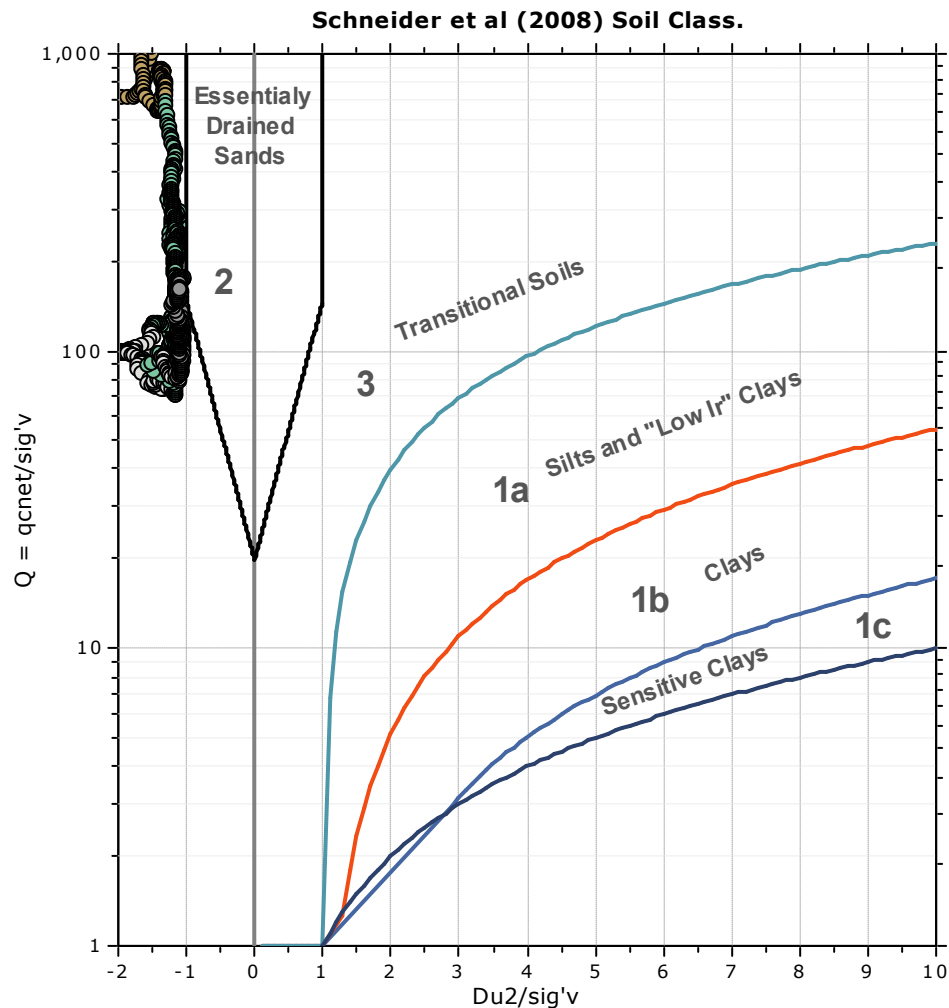
SBTn legend

- | | | |
|---------------------------|------------------------------|-----------------------------------|
| 1. Sensitive fine grained | 4. Clayey silt to silty clay | 7. Gravelly sand to sand |
| 2. Organic material | 5. Silty sand to sandy silt | 8. Very stiff sand to clayey sand |
| 3. Clay to silty clay | 6. Clean sand to silty sand | 9. Very stiff fine grained |

Project:

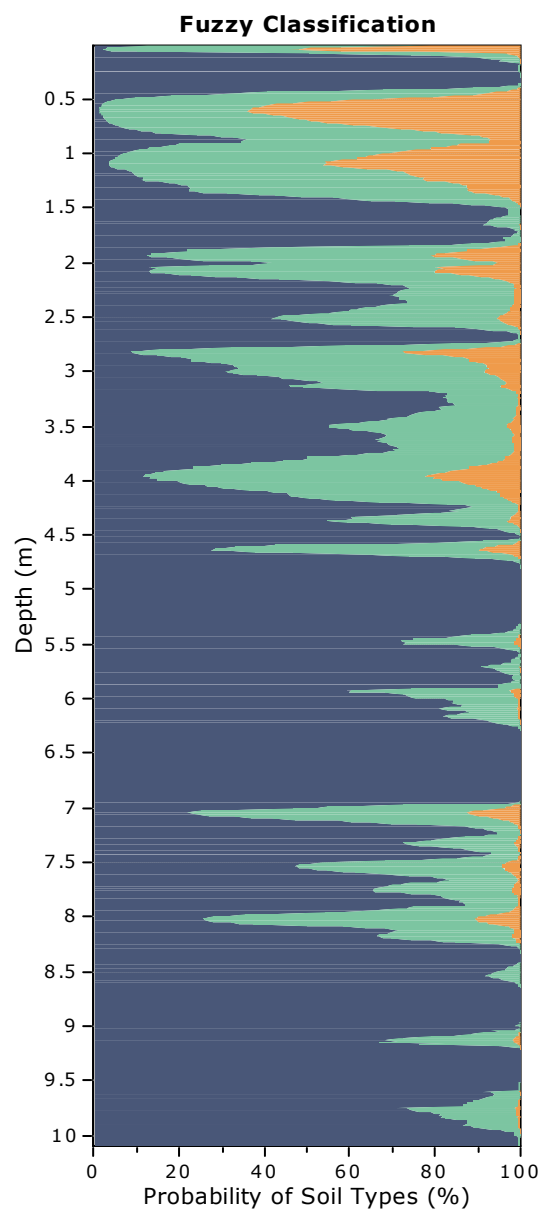
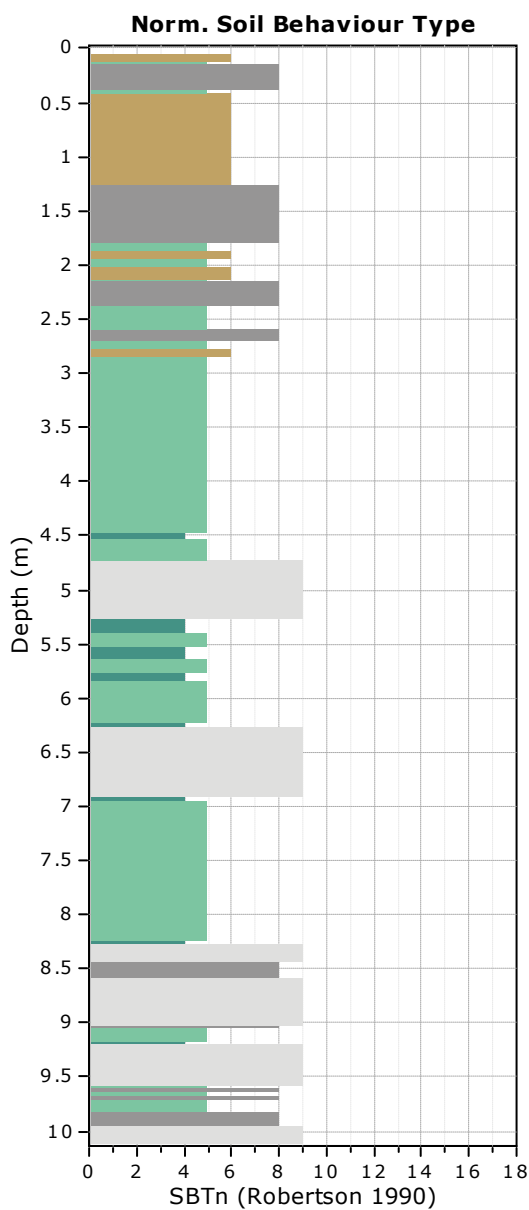
Location:

Bq plots (Schneider)

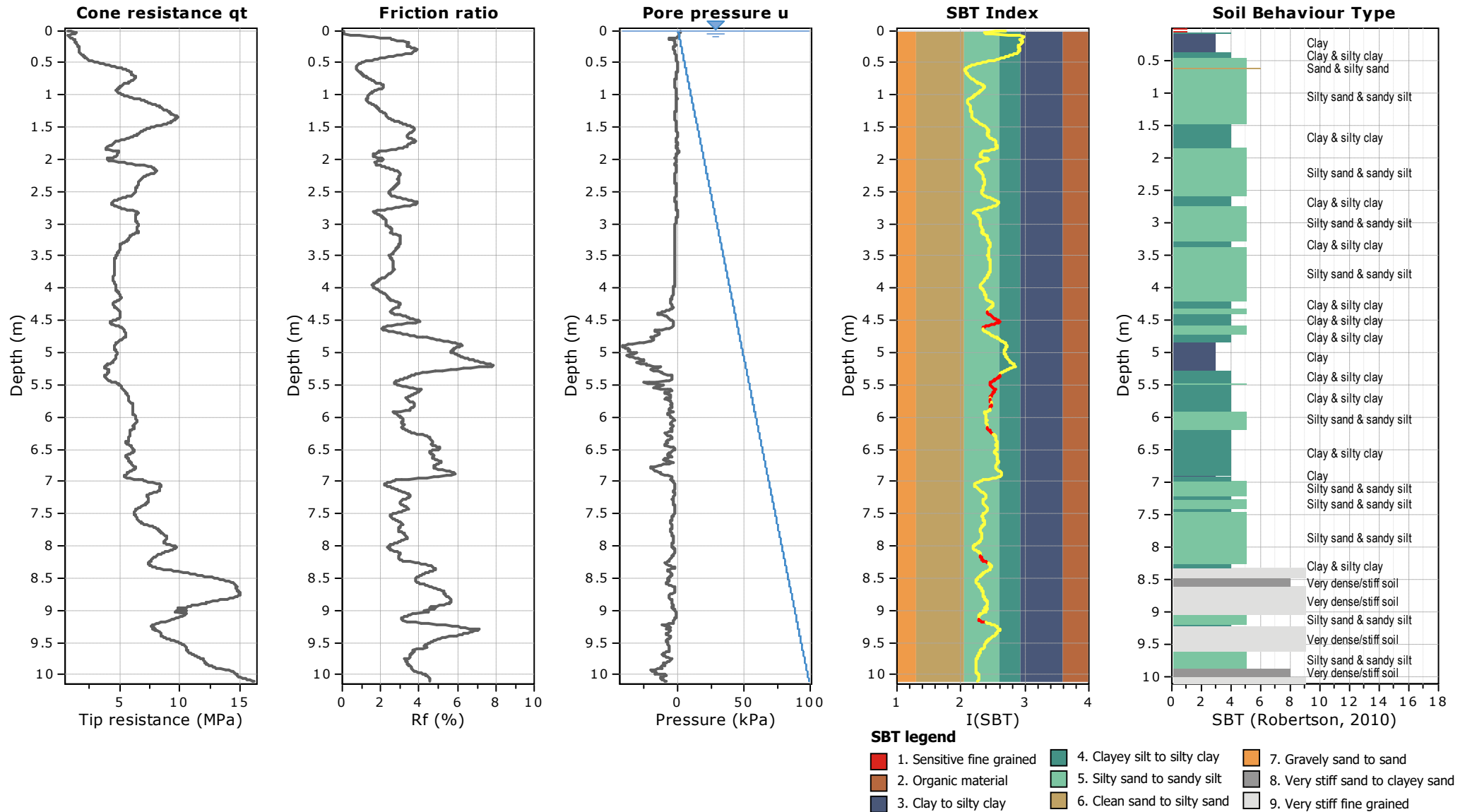


Project:

Location:

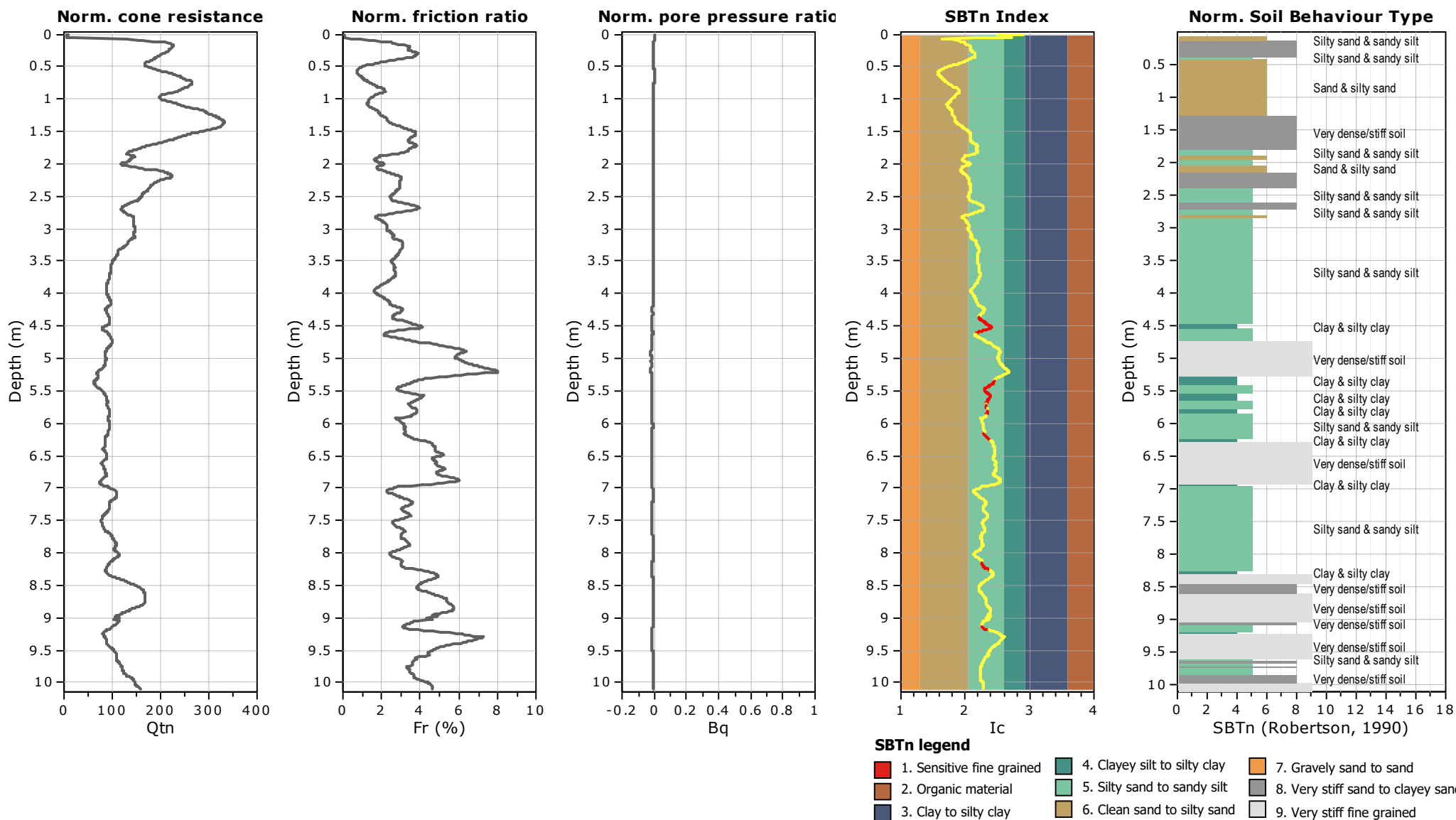


Project:
Location:

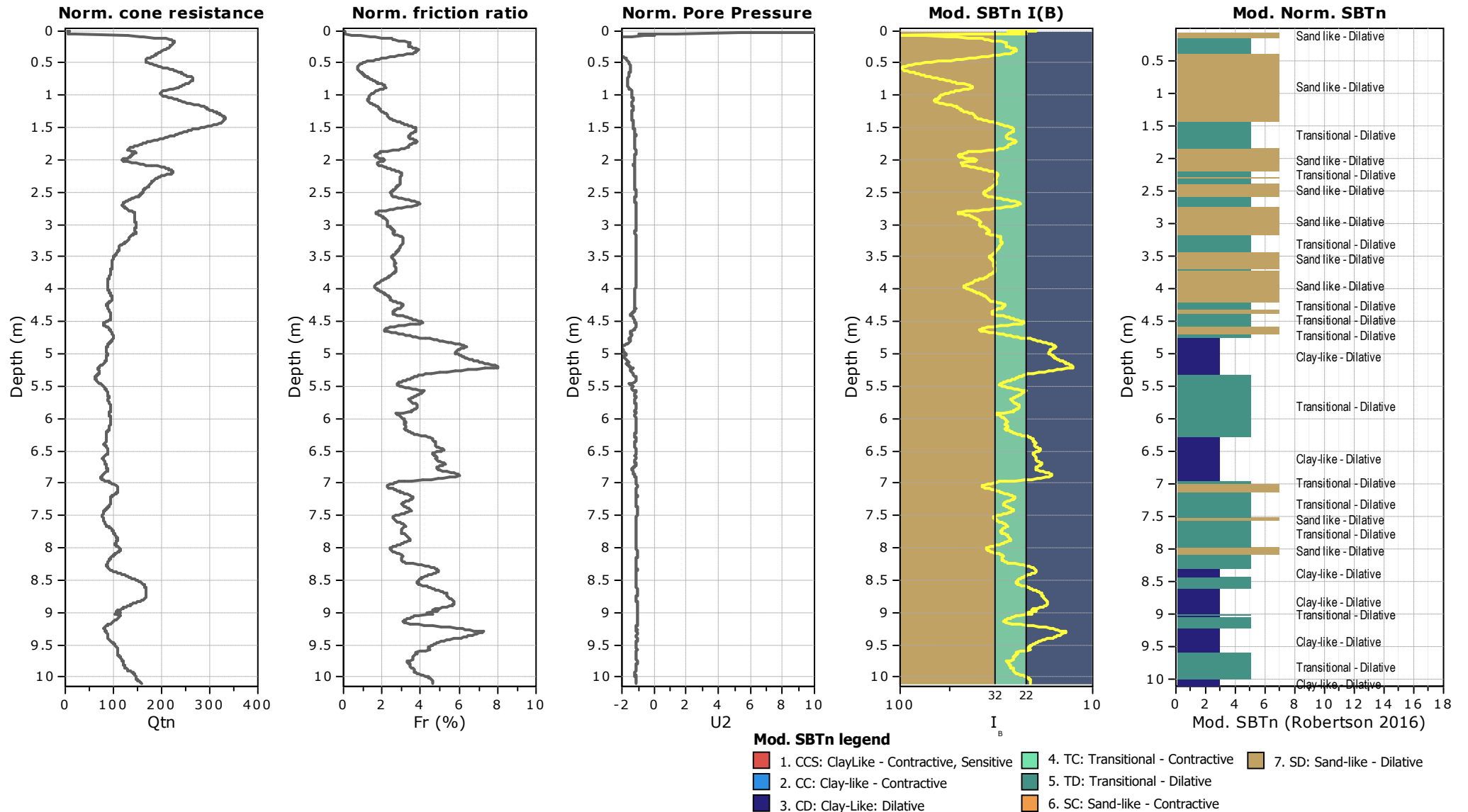


Project:

Location:



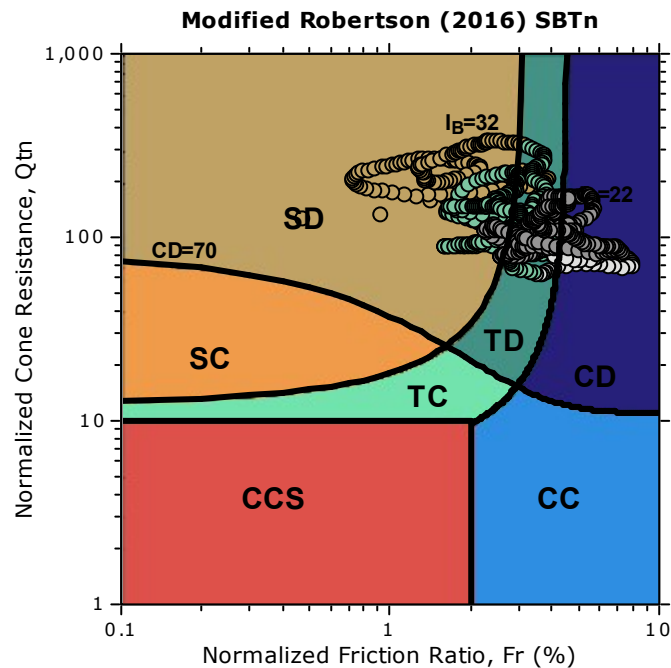
Project:
Location:



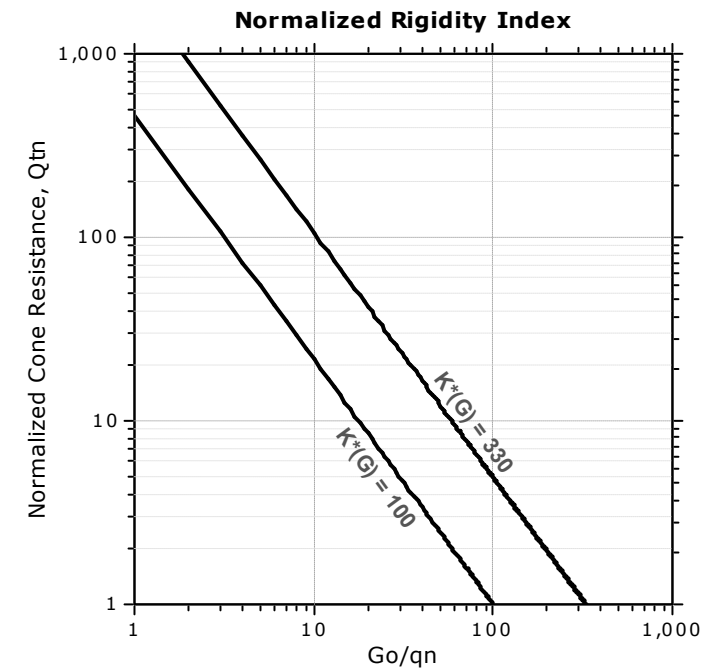
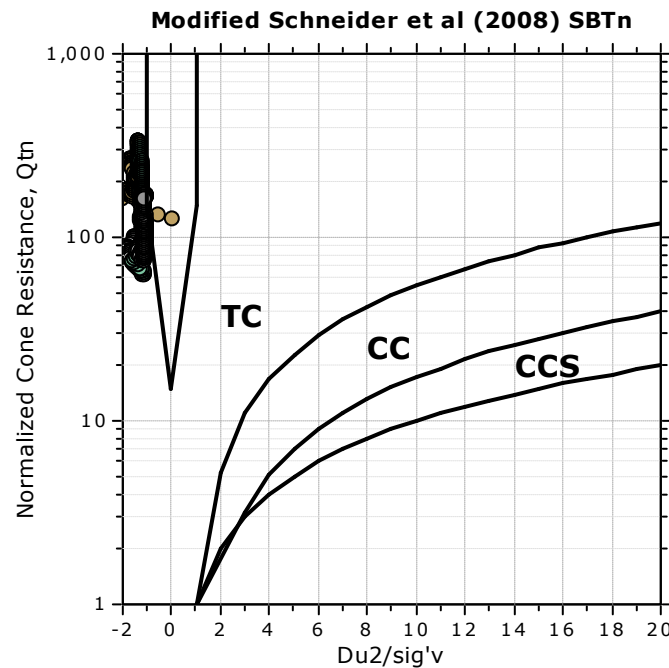
Project:

Location:

Updated SBTn plots



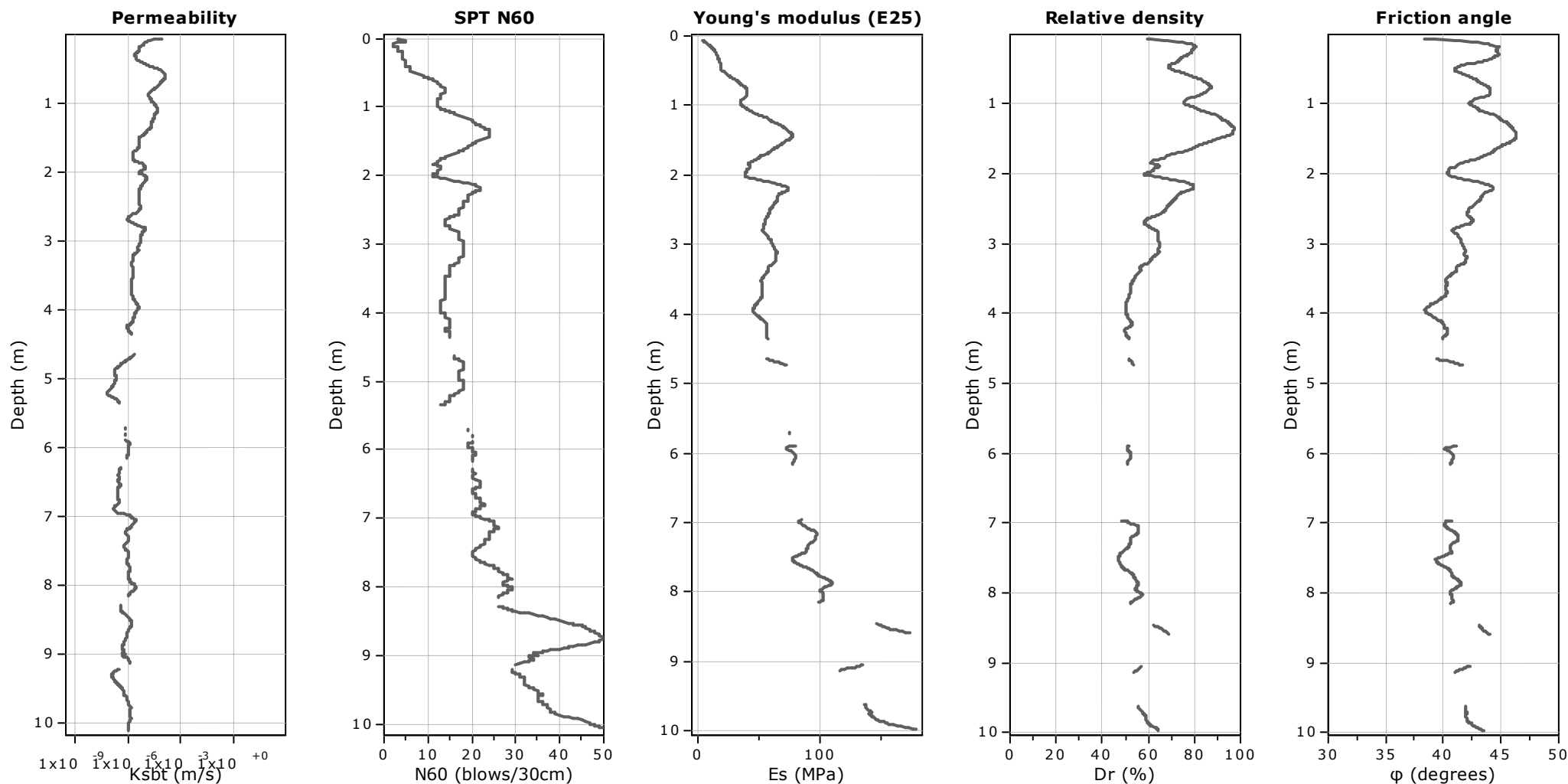
CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative



$K(G) > 330$: Soils with significant microstructure
(e.g. age/cementation)

Project:

Location:



Calculation parameters

Permeability: Based on SBT_n

SPT N_{60} : Based on I_c and q_t

Young's modulus: Based on variable alpha using I_c (Robertson, 2009)

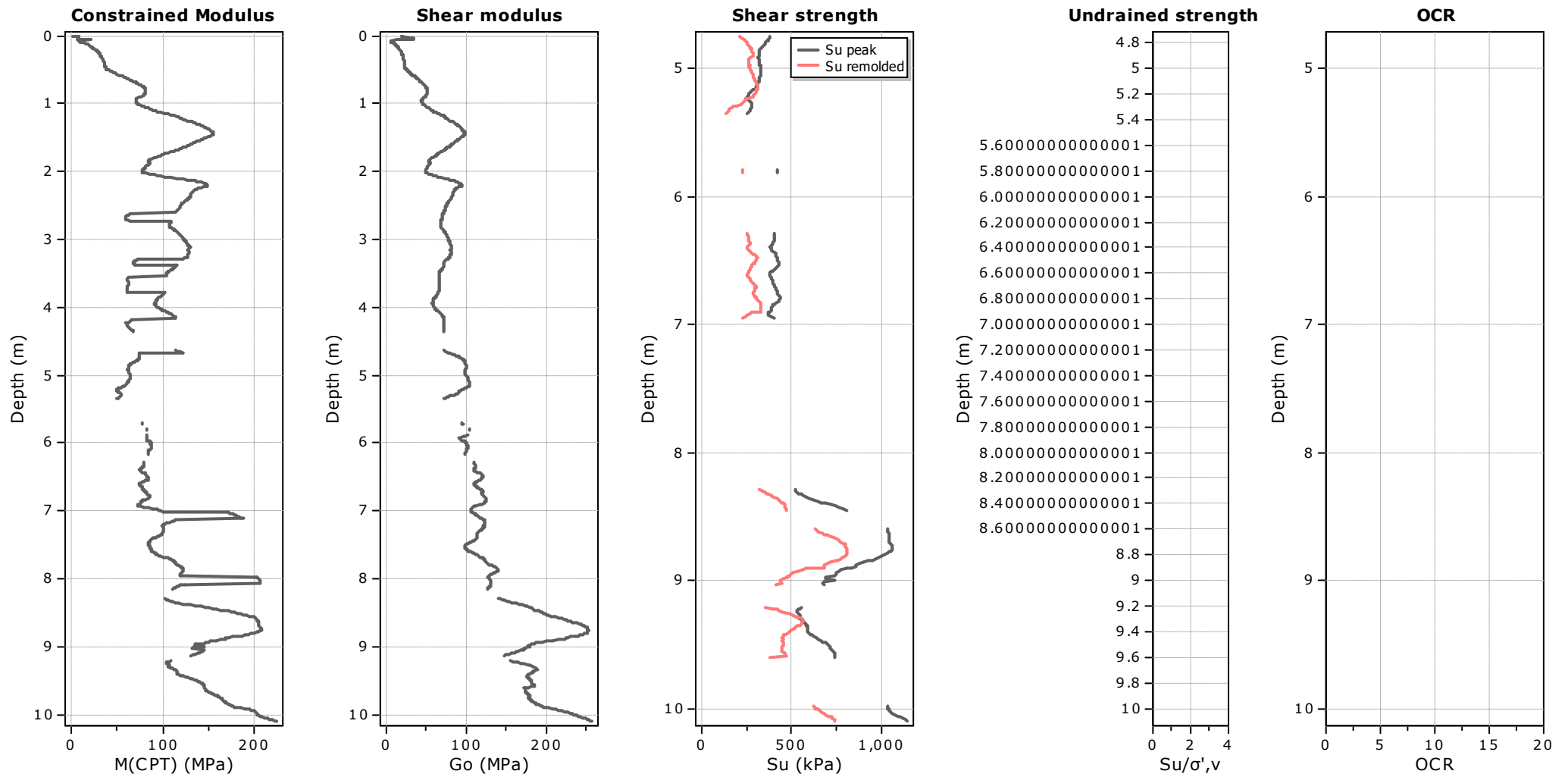
Relative density constant, C_{Dr} : 350.0

Phi: Based on Kulhawy & Mayne (1990)

—●— User defined estimation data

Project:

Location:



Calculation parameters

Constrained modulus: Based on variable α using I_c and Q_{in} (Robertson, 2009)

G_o : Based on variable α using I_c (Robertson, 2009)

Undrained shear strength cone factor for clays, N_{kt} : 14

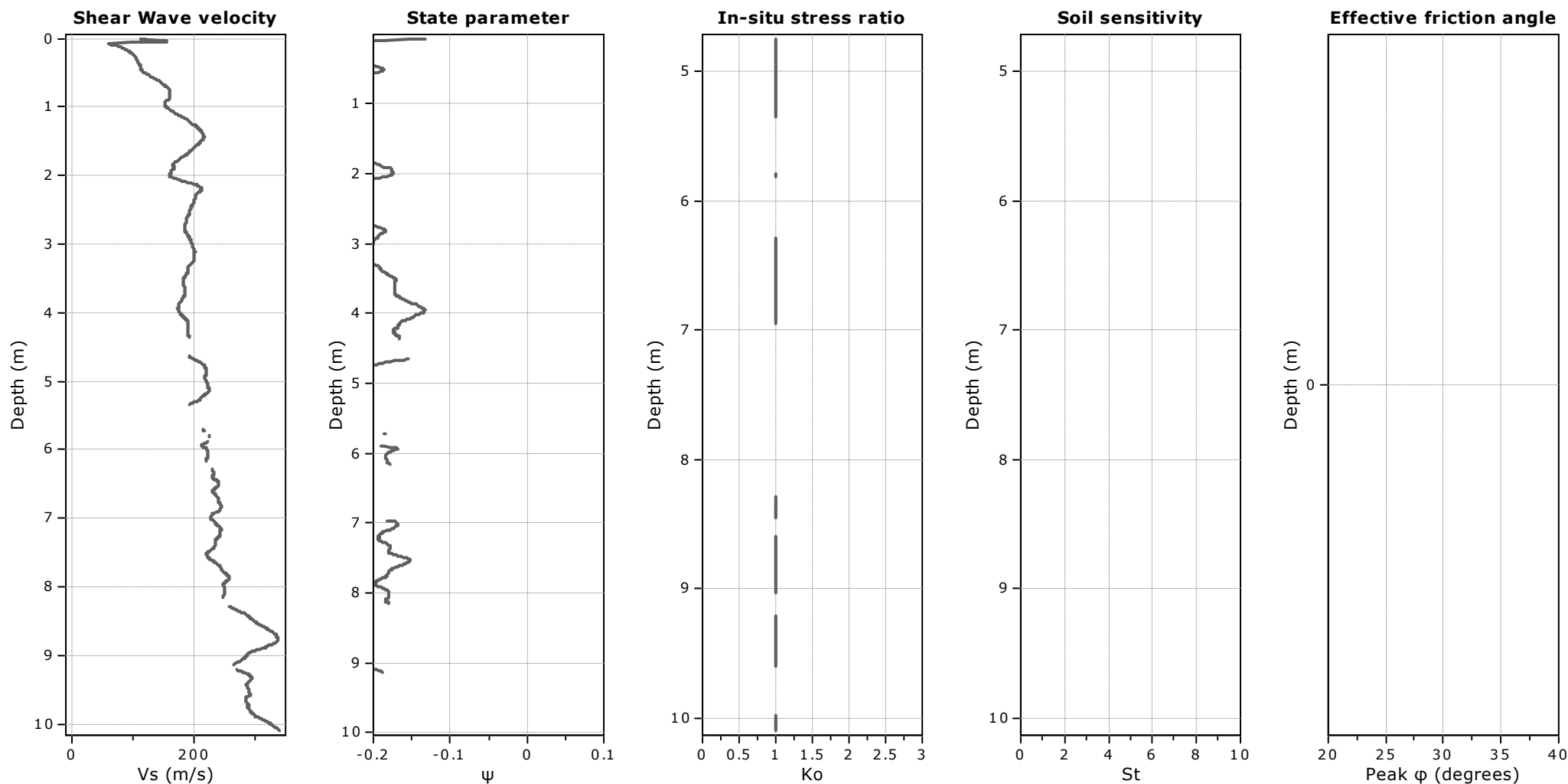
OCR factor for clays, N_{kt} : Auto

● User defined estimation data

● Flat Dilatometer Test data

Project:

Location:



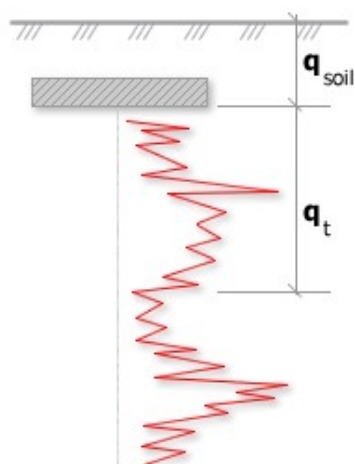
Calculation parameters

Soil Sensitivity factor, N_s : 350.00

—●— User defined estimation data

Project:

Location:



Bearing Capacity calculation is performed based on the formula:

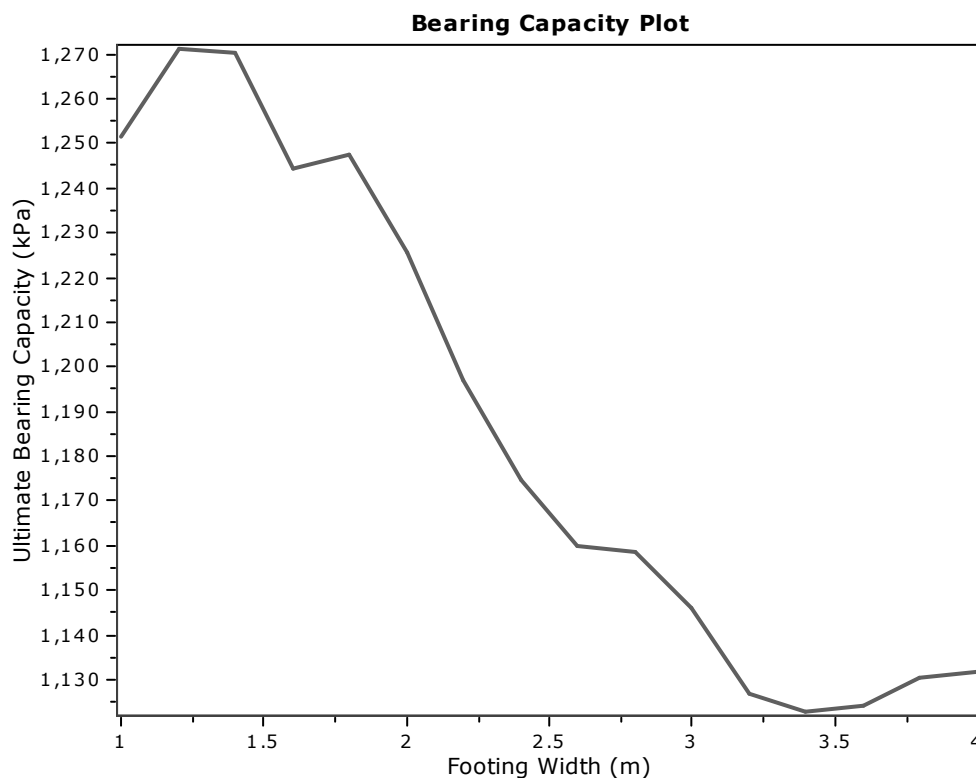
$$Q_{ult} = R_k \times q_t + q_{soil}$$

where:

R_k : Bearing capacity factor

q_t : Average corrected cone resistance over calculation depth

q_{soil} : Pressure applied by soil above footing



:: Tabular results ::

No	B (m)	Start Depth (m)	End Depth (m)	Ave. q_t (MPa)	R_k	Soil Press. (kPa)	Ult. bearing cap. (kPa)
1	1.00	0.50	2.00	6.21	0.20	9.50	1251.36
2	1.20	0.50	2.30	6.31	0.20	9.50	1271.19
3	1.40	0.50	2.60	6.30	0.20	9.50	1270.21
4	1.60	0.50	2.90	6.17	0.20	9.50	1244.40
5	1.80	0.50	3.20	6.19	0.20	9.50	1247.30
6	2.00	0.50	3.50	6.08	0.20	9.50	1225.76
7	2.20	0.50	3.80	5.94	0.20	9.50	1196.98
8	2.40	0.50	4.10	5.83	0.20	9.50	1174.55
9	2.60	0.50	4.40	5.75	0.20	9.50	1159.82
10	2.80	0.50	4.70	5.75	0.20	9.50	1158.56
11	3.00	0.50	5.00	5.68	0.20	9.50	1145.92
12	3.20	0.50	5.30	5.59	0.20	9.50	1126.67
13	3.40	0.50	5.60	5.57	0.20	9.50	1122.85
14	3.60	0.50	5.90	5.57	0.20	9.50	1124.14
15	3.80	0.50	6.20	5.61	0.20	9.50	1130.67
16	4.00	0.50	6.50	5.61	0.20	9.50	1131.88

Project:

Location:

CPT: CPTU

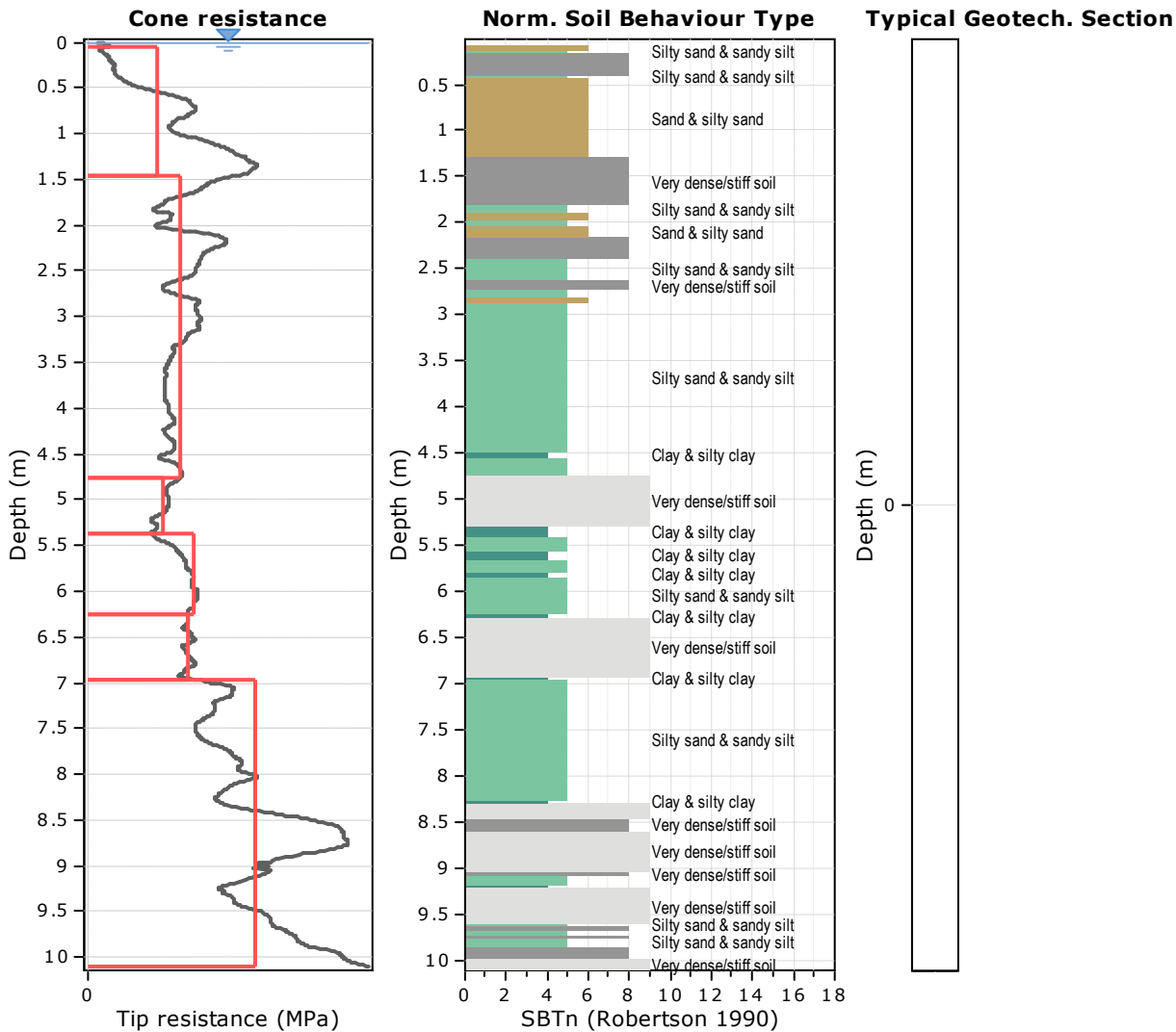
Total depth: 10.10 m, Date: 11/05/2020

Surface Elevation: 0.00 m

Coords: X:46.29, Y:27.59

Cone Type: Mkj588

Cone Operator: ing. Lupusoru Cornel



Tabular results

::: Layer No: 1 :::

Code: Layer_1 **Start depth:** 0.05 (m), **End depth:** 1.45 (m)

Description: Sand & silty sand

Basic results

Total cone resistance: 3.96 ±3.05 MPa

Sleeve friction: 67.11 ±73.73 kPa

Ic: 1.85 ±0.17

SBT_n: 6

SBTn description: Sand & silty sand

Estimation results

Permeability: 2.14E-05 ±3.88E-05 m/s

N₆₀: 9.78 ±7.15 blows

Es: 30.06 ±21.25 MPa

Dr (%): 81.38 ±8.66

φ (degrees): 43.61 ±1.55 °

Unit weight: 18.38 ±1.25 kN/m³

Constrained Mod.: 58.77 ±42.94 MPa

Go: 37.38 ±26.61 MPa

Su: 0.00 ±0.00 kPa

Su ratio: 0.00 ±0.00

O.C.R.: 0.00 ±0.00

:: Layer No: 2 ::**Code:** Layer_2 **Start depth:** 1.45 (m), **End depth:** 4.77 (m)**Description:** Silty sand & sandy silt**Basic results**

Total cone resistance: 5.37 ±1.08 MPa

Sleeve friction: 139.33 ±47.80 kPa

Ic: 2.13 ±0.09

SBT_n: 5SBT_n description: Silty sand & sandy silt**Estimation results**

Permeability: 3.02E-06 ±2.62E-06 m/s

N₆₀: 15.71 ±2.62 blows

Es: 56.33 ±8.32 MPa

Dr (%): 61.37 ±10.36

φ (degrees): 41.54 ±1.78 °

Unit weight: 19.31 ±0.42 kN/m³

Constrained Mod.: 98.72 ±26.81 MPa

Go: 70.80 ±10.61 MPa

Su: 0.00 ±0.00 kPa

Su ratio: 0.00 ±0.00

O.C.R.: 0.00 ±0.00

:: Layer No: 3 ::**Code:** Layer_3 **Start depth:** 4.77 (m), **End depth:** 5.38 (m)**Description:** Very dense/stiff soil**Basic results**

Total cone resistance: 4.37 ±0.43 MPa

Sleeve friction: 256.04 ±44.69 kPa

Ic: 2.54 ±0.07

SBT_n: 9SBT_n description: Very dense/stiff soil**Estimation results**

Permeability: 1.74E-07 ±9.70E-08 m/s

N₆₀: 16.69 ±1.39 blows

Es: 0.00 ±0.00 MPa

Dr (%): 0.00 ±0.00

φ (degrees): 0.00 ±0.00 °

Unit weight: 19.93 ±0.25 kN/m³

Constrained Mod.: 59.89 ±6.02 MPa

Go: 95.58 ±7.85 MPa

Su: 305.55 ±30.69 kPa

Su ratio: 5.78 ±0.67

O.C.R.: 43.10 ±6.63

:: Layer No: 4 ::**Code:** Layer_4 **Start depth:** 5.38 (m), **End depth:** 6.26 (m)**Description:** Silty sand & sandy silt**Basic results**

Total cone resistance: 6.12 ±0.20 MPa

Sleeve friction: 192.76 ±17.96 kPa

Ic: 2.29 ±0.03

SBT_n: 5SBT_n description: Silty sand & sandy silt**Estimation results**

Permeability: 9.81E-07 ±1.89E-07 m/s

N₆₀: 19.88 ±0.63 blows

Es: 77.72 ±2.59 MPa

Dr (%): 51.40 ±0.60

φ (degrees): 40.66 ±0.25 °

Unit weight: 19.74 ±0.10 kN/m³

Constrained Mod.: 84.01 ±2.74 MPa

Go: 98.09 ±3.63 MPa

Su: 0.00 ±0.00 kPa

Su ratio: 0.00 ±0.00

O.C.R.: 0.00 ±0.00

:: Layer No: 5 ::**Code:** Layer_5 **Start depth:** 6.26 (m), **End depth:** 6.96 (m)**Description:** Very dense/stiff soil**Basic results**

Total cone resistance: 5.77 ±0.26 MPa

Sleeve friction: 280.09 ±25.85 kPa

Ic: 2.46 ±0.04

SBT_n: 9SBT_n description: Very dense/stiff soil**Estimation results**

Permeability: 2.88E-07 ±7.19E-08 m/s

N₆₀: 21.07 ±0.93 blows

Es: 0.00 ±0.00 MPa

Dr (%): 0.00 ±0.00

φ (degrees): 0.00 ±0.00 °

Unit weight: 20.14 ±0.11 kN/m³

Constrained Mod.: 79.04 ±3.59 MPa

Go: 115.21 ±5.30 MPa

Su: 402.89 ±18.20 kPa

Su ratio: 5.93 ±0.29

O.C.R.: 46.52 ±3.17

:: Layer No: 6 ::**Code:** Layer_6 **Start depth:** 6.96 (m), **End depth:** 10.10 (m)**Description:** Very dense/stiff soil**Basic results**

Total cone resistance: 9.63 ±2.75 MPa

Sleeve friction: 361.83 ±183.15 kPa

Ic: 2.30 ±0.09

SBT_n: 8SBT_n description: Very dense/stiff soil**Estimation results**

Permeability: 8.93E-07 ±5.97E-07 m/s

N₆₀: 31.62 ±8.79 blows

Es: 109.19 ±27.80 MPa

Dr (%): 54.83 ±5.03

φ (degrees): 41.23 ±1.05 °

Unit weight: 20.63 ±0.60 kN/m³

Constrained Mod.: 136.84 ±40.74 MPa

Go: 157.35 ±44.92 MPa

Su: 0.00 ±0.00 kPa

Su ratio: 0.00 ±0.00

O.C.R.: 0.00 ±0.00

Project:
Location:
Summary table of mean values

From depth To depth (m)	Thickness (m)	Permeability (m/s)	SPT _{N60} (blows/30cm)	E _s (MPa)	D _r (%)	Friction angle	Constrained modulus, M (MPa)	Shear modulus, G ₀ (MPa)	Undrained strength, S _u (kPa)	Undrained strength ratio	OCR	Unit weight (kN/m ³)
0.05	1.40	2.14E-05	9.8	30.1	81.4	43.6	58.8	37.4	0.0	0.0	0.0	18.4
1.45		(±3.88E-05)	(±7.2)	(±21.2)	(±8.7)	(±1.6)	(±42.9)	(±26.6)	(±0.0)	(±0.0)	(±0.0)	(±1.3)
1.45	3.32	3.02E-06	15.7	56.3	61.4	41.5	98.7	70.8	0.0	0.0	0.0	19.3
4.77		(±2.62E-06)	(±2.6)	(±8.3)	(±10.4)	(±1.8)	(±26.8)	(±10.6)	(±0.0)	(±0.0)	(±0.0)	(±0.4)
4.77	0.61	1.74E-07	16.7	0.0	0.0	0.0	59.9	95.6	305.5	5.8	43.1	19.9
5.38		(±9.70E-08)	(±1.4)	(±0.0)	(±0.0)	(±0.0)	(±6.0)	(±7.8)	(±30.7)	(±0.7)	(±6.6)	(±0.2)
5.38	0.88	9.81E-07	19.9	77.7	51.4	40.7	84.0	98.1	0.0	0.0	0.0	19.7
6.26		(±1.89E-07)	(±0.6)	(±2.6)	(±0.6)	(±0.3)	(±2.7)	(±3.6)	(±0.0)	(±0.0)	(±0.0)	(±0.1)
6.26	0.70	2.88E-07	21.1	0.0	0.0	0.0	79.0	115.2	402.9	5.9	46.5	20.1
6.96		(±7.19E-08)	(±0.9)	(±0.0)	(±0.0)	(±0.0)	(±3.6)	(±5.3)	(±18.2)	(±0.3)	(±3.2)	(±0.1)
6.96	3.14	8.93E-07	31.6	109.2	54.8	41.2	136.8	157.3	0.0	0.0	0.0	20.6
10.10		(±5.97E-07)	(±8.8)	(±27.8)	(±5.0)	(±1.1)	(±40.7)	(±44.9)	(±0.0)	(±0.0)	(±0.0)	(±0.6)

Depth values presented in this table are measured from free ground surface

Presented below is a list of formulas used for the estimation of various soil properties. The formulas are presented in SI unit system and assume that all components are expressed in the same units.

:: Unit Weight, g (kN/m³) ::

$$g = g_w \cdot \left(0.27 \cdot \log(R_f) + 0.36 \cdot \log\left(\frac{q_t}{p_a}\right) + 1.236 \right)$$

where g_w = water unit weight

:: Permeability, k (m/s) ::

$$I_c < 3.27 \text{ and } I_c > 1.00 \text{ then } k = 10^{0.952 - 3.04 \cdot I_c}$$

$$I_c \leq 4.00 \text{ and } I_c > 3.27 \text{ then } k = 10^{-4.52 - 1.37 \cdot I_c}$$

:: N_{SPT} (blows per 30 cm) ::

$$N_{60} = \left(\frac{q_c}{p_a} \right) \cdot \frac{1}{10^{1.1268 - 0.2817 \cdot I_c}}$$

$$N_{1(60)} = Q_{tn} \cdot \frac{1}{10^{1.1268 - 0.2817 \cdot I_c}}$$

:: Young's Modulus, E_s (MPa) ::

$$(q_t - \sigma_v) \cdot 0.015 \cdot 10^{0.55 \cdot I_c + 1.68}$$

(applicable only to $I_c < I_{c_cutoff}$)

:: Relative Density, Dr (%) ::

$$100 \cdot \sqrt{\frac{Q_{tn}}{k_{DR}}} \quad \text{(applicable only to SBT}_n\text{: 5, 6, 7 and 8 or } I_c < I_{c_cutoff}\text{)}$$

:: State Parameter, ψ ::

$$\psi = 0.56 - 0.33 \cdot \log(Q_{tn,cs})$$

:: Drained Friction Angle, ϕ (°) ::

$$\phi = \phi'_{cv} + 15.94 \cdot \log(Q_{tn,cs}) - 26.88$$

(applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c_cutoff}$)

:: 1-D constrained modulus, M (MPa) ::

If $I_c > 2.20$

$\alpha = 14$ for $Q_{tn} > 14$

$\alpha = Q_{tn}$ for $Q_{tn} \leq 14$

$M_{CPT} = \alpha \cdot (q_t - \sigma_v)$

If $I_c \geq 2.20$

$$M_{CPT} = 0.03 \cdot (q_t - \sigma_v) \cdot 10^{0.55 \cdot I_c + 1.68}$$

:: Small strain shear Modulus, G_0 (MPa) ::

$$G_0 = (q_t - \sigma_v) \cdot 0.0188 \cdot 10^{0.55 \cdot I_c + 1.68}$$

:: Shear Wave Velocity, V_s (m/s) ::

$$V_s = \left(\frac{G_0}{\rho} \right)^{0.50}$$

:: Undrained peak shear strength, S_u (kPa) ::

$$N_{kt} = 10.50 + 7 \cdot \log(F_r) \text{ or user defined}$$

$$S_u = \frac{(q_t - \sigma_v)}{N_{kt}}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c_cutoff}$)

:: Remolded undrained shear strength, $S_u(rem)$ (kPa) ::

$$S_{u(rem)} = f_s \quad \text{(applicable only to SBT}_n\text{: 1, 2, 3, 4 and 9 or } I_c > I_{c_cutoff}\text{)}$$

:: Overconsolidation Ratio, OCR ::

$$k_{OCR} = \left[\frac{Q_{tn}^{0.20}}{0.25 \cdot (10.50 + 7 \cdot \log(F_r))} \right]^{1.25} \text{ or user defined}$$

$$OCR = k_{OCR} \cdot Q_{tn}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c_cutoff}$)

:: In situ Stress Ratio, K_0 ::

$$K_0 = (1 - \sin \phi') \cdot OCR^{\sin \phi'}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c_cutoff}$)

:: Soil Sensitivity, S_t ::

$$S_t = \frac{N_s}{F_r}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c_cutoff}$)

:: Peak Friction Angle, ϕ' (°) ::

$$\phi' = 29.5^\circ \cdot B_q^{0.121} \cdot (0.256 + 0.336 \cdot B_q + \log Q_t)$$

(applicable for $0.10 < B_q < 1.00$)

References

- Robertson, P.K., Cabal K.L., Guide to Cone Penetration Testing for Geotechnical Engineering, Gregg Drilling & Testing, Inc., 5th Edition, November 2012
- Robertson, P.K., Interpretation of Cone Penetration Tests - a unified approach., Can. Geotech. J. 46(11): 1337–1355 (2009)