EL **NASLOVNA STRAN Z OSNOVNIMI PODATKI O ELABORATU**

NAČRT

E –geološko – geomehansko poročilo

NAROČNIK

Občina Braslovče, Braslovče 22, 3314 Braslovče

OBJEKT

plaz pod cesto

VRSTA PROJEKTNE DOKUMENTACIJE:

PZI

ZA GRADNJO

rekonstrukcija

LOKACIJA CESTNEGA ODSEKA:

LC 490261 od km 0+690 do km 1+440

IZDELOVALEC:

GHC-Projekt, projektiranje in inženiring d.o.o., Pristova 8, 3204 Dobrna

Odgovorna oseba izdelovalca:

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ODGOVORNI IZDELOVALEC:

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ŠTEVILKA, KRAJ IN DATUM IZDELAVE ELABORATA:

GG 26/1/24, Dobrna 27.3.2024

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S.3 KAZALO GRAFIK

G.1 Situacija z lokacijo meritev

G.2 Geološko geotehnični karakteristični profil PR1

T. TEHNIČNI DEL

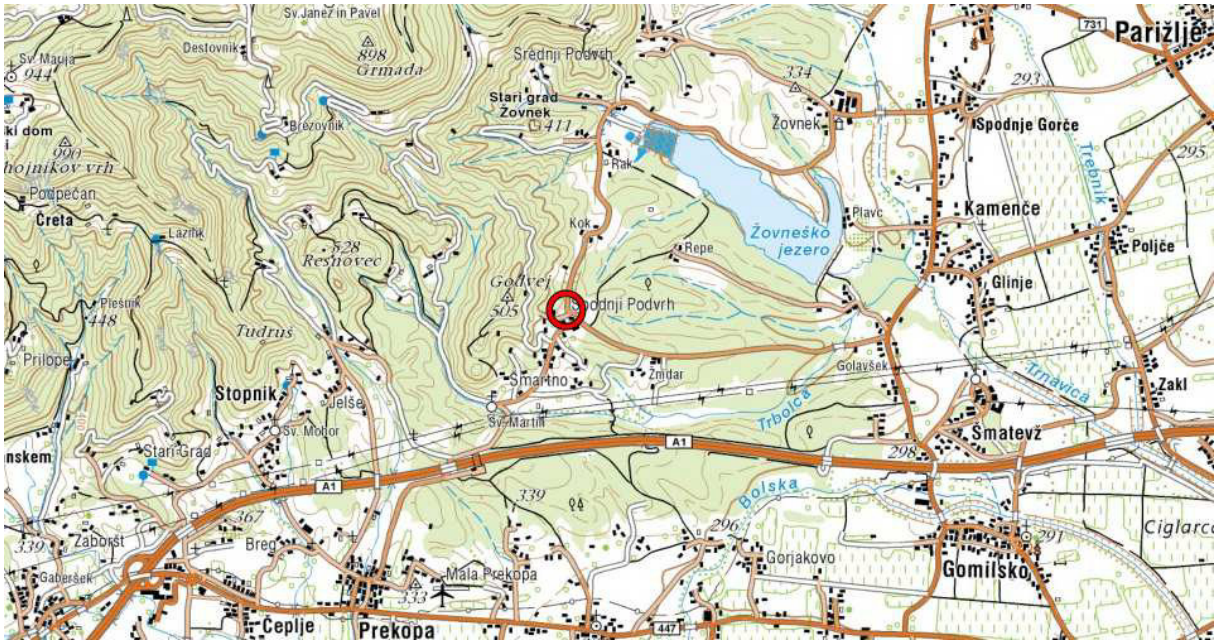
T.1. SPLOŠNO

Naročnik geološko geotehničnega poročila želi na lokalni cesti LC 490261 od km 0+690 do km 1+440, pridobiti informacije o pogojih za sanacijo ceste.

Osnova za izdelavo tega poročila je terenski pregled območja, predhodne raziskave na obravnavanem območju in izvedene terenske meritve ter interpretacija pridobljenih podatkov.

T.1.1. Lokacija in opis

Cestni odsek se nahaja na lokalni cesti LC 490261 od km 0+690 do km 1+440. Celotna trasa je po neurju 4.8.2023 v slabem stanju. Vozišče je močno razpokano, robovi cest so nalomljeni in posedeni. Cestni elementi za odvodnjavanje so uničeni. Na stacionaži od km 1,0+59 do km 1,0+75 je plaz uničil del ceste. Zgornji odlomni rob plazu poteka po voziščni konstrukciji v dolžini 16 m. Zemljina leze v smeri neimenovanega vodotoka, ki teče 20m pod cesto.



Slika 1 – Lokacija parcele



Slika 2 – fotografija splazene brežine pod odlomom na cesti

T.2. OSNOVE ZA PROJEKTIRANJE

T.2.1. Geološke osnove

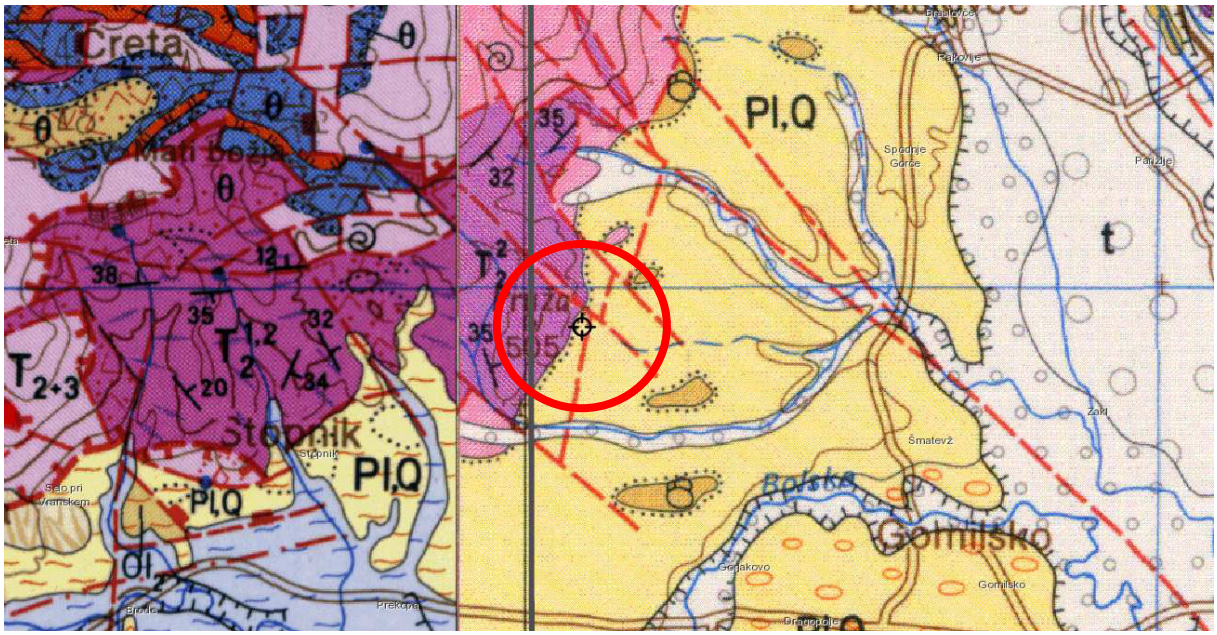
Na obravnavanem območju nahajamo plasti ladinijske stopnje. Te plasti leže normalno na anizijskih skladih.

Na Dobroveljski planoti in pri Žovneku blizu Braslovč nahajamo močno silificirane zelenkaste tufe, ki se menjavajo s pogostnimi plastmi roženca, vmes pa dobimo še črne ploščaste apnence in kalkarenite. Te plasti je Teller (1898c) izdvojil na geološki karti kot skrilavce in peščenjake Šenturške gore in Dobrovelj.

(tolmač za list Celje, L 33 – 67, Beograd 1979)

[T_2^2] - Apnenec in dolomit z roženci, lapor, skrilavec, tuf in tufit

[Pl,Q] – Glina, podrejeno kisli prod in pesek



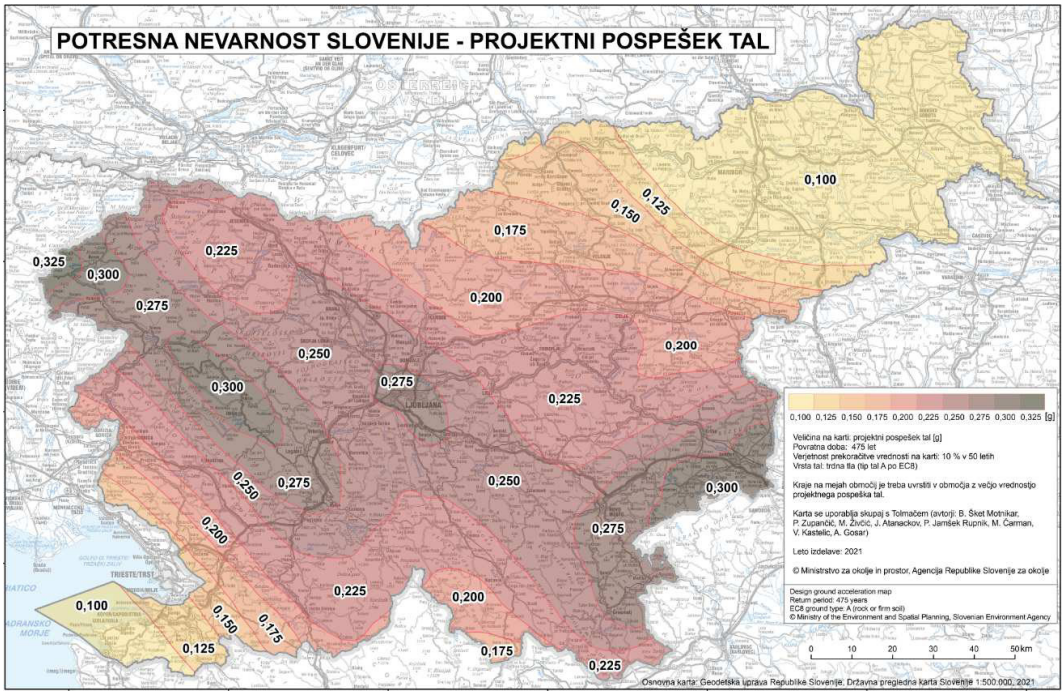
Slika 3 – izsek iz geološke karte (list:Celje)

T.2.2. Seizmičnost terena

Podatke o seizmičnosti terena smo povzeli po karti »POTRESNA NEVARNOST SLOVENIJE – PROJEKTNI POSPEŠEK TAL« za povratno dobo 475 let.

Projektni pospešek tal: 0,2 g

A – Skala ali druga skali podobna geološka formacija, na kateri je največ 5 m slabšega površinskega materiala.

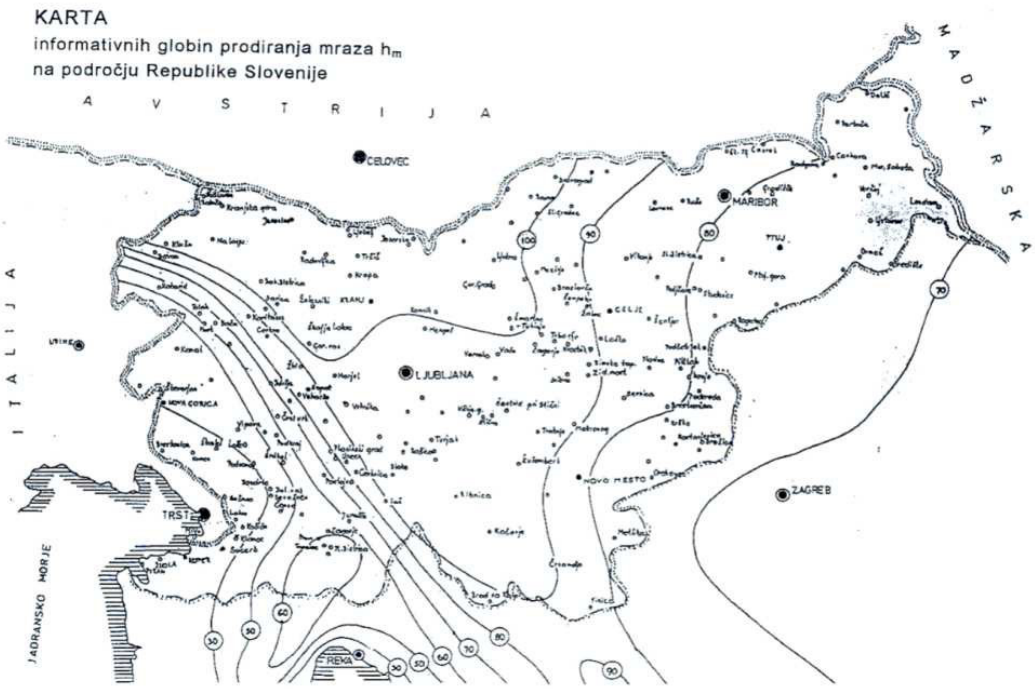


Slika 4 - Karta projektnega pospeška tal s povratno dobo 475 let (2021)

T.2.3. Zmrzlinska cona

Podatke o zmrzlinskih conah smo povzeli po TSC 6.512:2003 iz priloge 1: Karta informativnih globin prodiranja mraza h_m na področju Republike Slovenije.

Globina prodiranja mraza h_m = 100 cm.



Slika 5 - Karta informativnih globin prodiranja mraza h_m

T.3. TERENSKE PREISKAVE

T.3.1. Splošno

Geološko sestavo in mehanske lastnosti smo ugotavljali z meritvami z dinamičnim penetrometrom PR.13 (DPSH – dynamic penetrometer super heavy). Aparature in postopek merjenja sta skladna s standardom (DIN) EN ISO 22476-2. Izvedba penetracijskega sondiranja nam omogoča pridobiti informacije o geotehničnih karakteristikah zemljine kakor o globinah posameznih slojev.

Preiskave s statičnim konusnim penetrometrom so bile izvedene z opremo, ki je skladna z standardi SIST EN 1997-2:2007 ter EN ISO 22476- 1:2005.

	korelacija
od globine	
do globine	
nedrenirana strižna trdnost	Terzaghi-Peck
Qc (CPT odpor konice)	Robertson (1983)
Oedometrični modul elast. Eed	Trofimenkov (1974), Mitchell e Gardner
Youngov modul elastičnosti Ey	Apollonia
specifična teža	Meyerhof
hitrost strižnega valovanja	Ohta & Goto (1978) Low plasticity clays and silty clays

	enota	DPSH 1		DPSH 2		DPSH 3		DPSH 4	
od globine	m	0.4	3.0	0.0	3.2	0.0	2.8	0.6	3.0
do globine	m	3.0	6.6	3.2	5.6	2.8	5.2	3.0	6.0
nedrenirana strižna trdnost	kPa	37.66	258.21	36.38	364.22	37.46	191.62	17.75	253.6
Qc (CPT odpor konice)	MPa	1.2	7.65	1.16	10.79	1.2	5.68	0.57	7.51
Oedometrični modul elast. Eed	MPa	6.32	39.19	6.11	55.21	6.3	29.13	3.07	38.49
Youngov modul elastičnosti Ey	MPa	6.02	38.26	5.82	53.96	6	28.39	2.83	37.57
specifična teža	kN/m3	17.85	24.22	17.75	24.52	17.85	21.08	15.98	23.83
hitrost strižnega valovanja	m/s	103.74	174.53	101.92	182.15	99.87	160.02	92.07	171.83

T.3.2. Izvleček rezultatov meritev vlažnosti

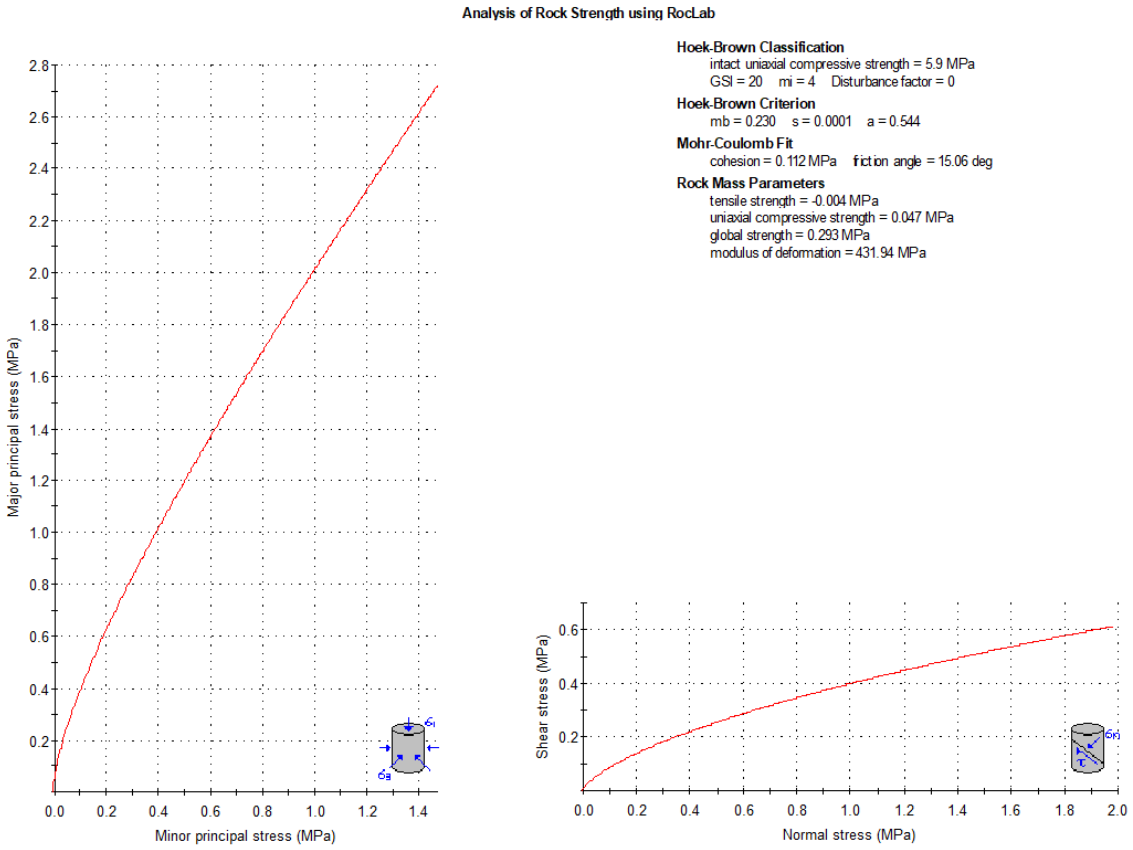
V laboratoriju smo določili relativno vlažnost tako da smo izmerili maso vzorca naravne vlažnosti in maso suhega vzorca.

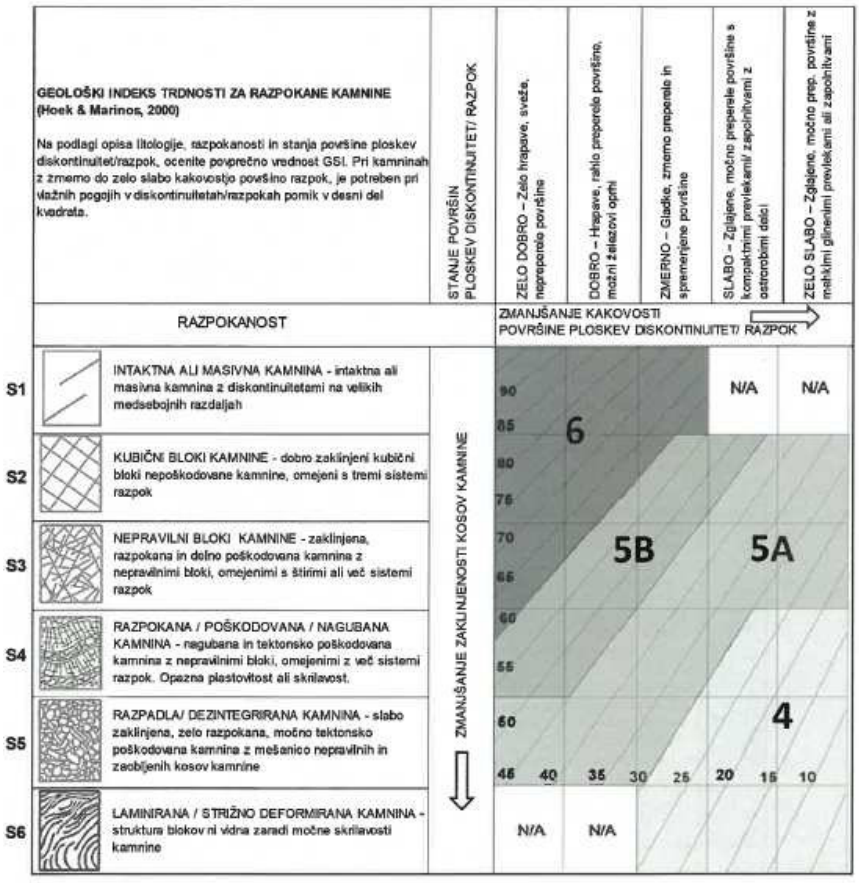
vrtina	globina [m]	naravna masa [g]	suha masa [g]	w - relativna vlažnost [%]
V1	0,4	252	217	13,89%
	1,3	287,5	244,5	14,96%
	2,2	346	284,5	17,77%
	3,1	320,5	257,5	19,66%
	4,0	315	259	17,78%
	4,9	326	270	17,18%

$w=W_w/(W_w+W_s)\times 100$ (%) W_w - teža vode W_s – teža trde snovi

T.3.3. Določitev strižnih parametrov hribine

Po Hoekov Brownovem porušitvenem kriteriju smo določili strižne karakteristike hribine. Tlačna trdnost preperine je bila določena z dinamično penetracijo v hribinsko preperino in je znašala 5,9 MPa. GSI smo prevzeli 20, mi 4 D=0. Strižne trdnosti za hribino se lahko prevzamejo manj kot c = 112 kPa in $\phi = 15{,}1^{o}$.





Slika 6 – Tabela za določitev GSI

T.3.4. Računski parametri

Iz preiskav in izkustveno smo določili računske parametre, ki jih predlagamo, da se uporabljajo pri analizah.

sloj	kohezija [kPa]	strižni kot [^{o}]	Modul stisljivosti [MPa]	gostota [kN/m^3]
glina židke do lahko gnetne konsistence	1	20	1	16
glina srednje gnetne konsistence	10	25	10	20
preperina laporja	20	35	100	22

T.4. ANALIZA STABILNOSTI

Za analizo smo obravnavali profil – PR.1. s Povretno analizo smo določili Mohr-Coulombove karakteristike materialov. Pri analizi stabilnosti smo upoštevali tandemsko variablino obremenitev prometa 9kN/m^2 in 2x točkovni obremenitvi 65kN. V Sloveniji se z po nacionalnem dodatku Evrokoda 7 za globalno stabilnost uporablja projektni pristop 3 (PP3).

T.4.1. Uporabljene karakteristike materialov v analizah

gruščnata glina židke do srednje gnetne konsistence (grCl) :

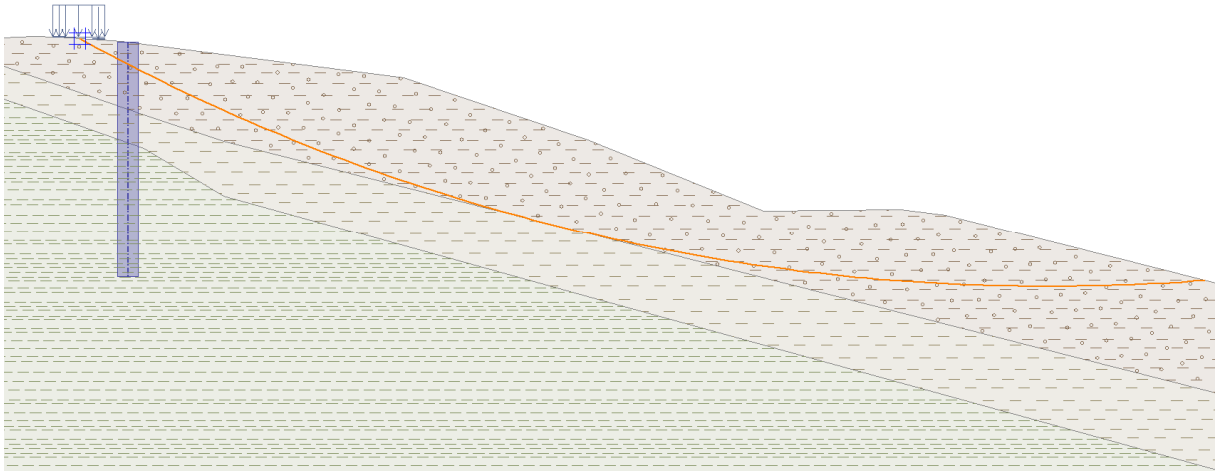
C = 1 kPa - kohezija
φ = 12^o - strižni kot
γ = 16 kN/m^3 - prostorninska teža

glina poltrdne do trdne konsistence (Cl):

C = 10 kPa - kohezija
φ = 25^o - strižni kot
γ = 19 kN/m^3 - prostorninska teža

preperina laporja :

C = 20 kPa - kohezija
φ = 35^o - strižni kot
γ = 22 kN/m^3 - prostorninska teža



Slika 7 –Prečni prerez

T.4.2. Analiza v PR.1

REZULTAT ANALIZE STABILNOSTI

Profil PR1	Izkoriščenost
Trenutno stanje brez prometa	124,6 %
Sanirano stanje z obtežbo prometa	47,9 %

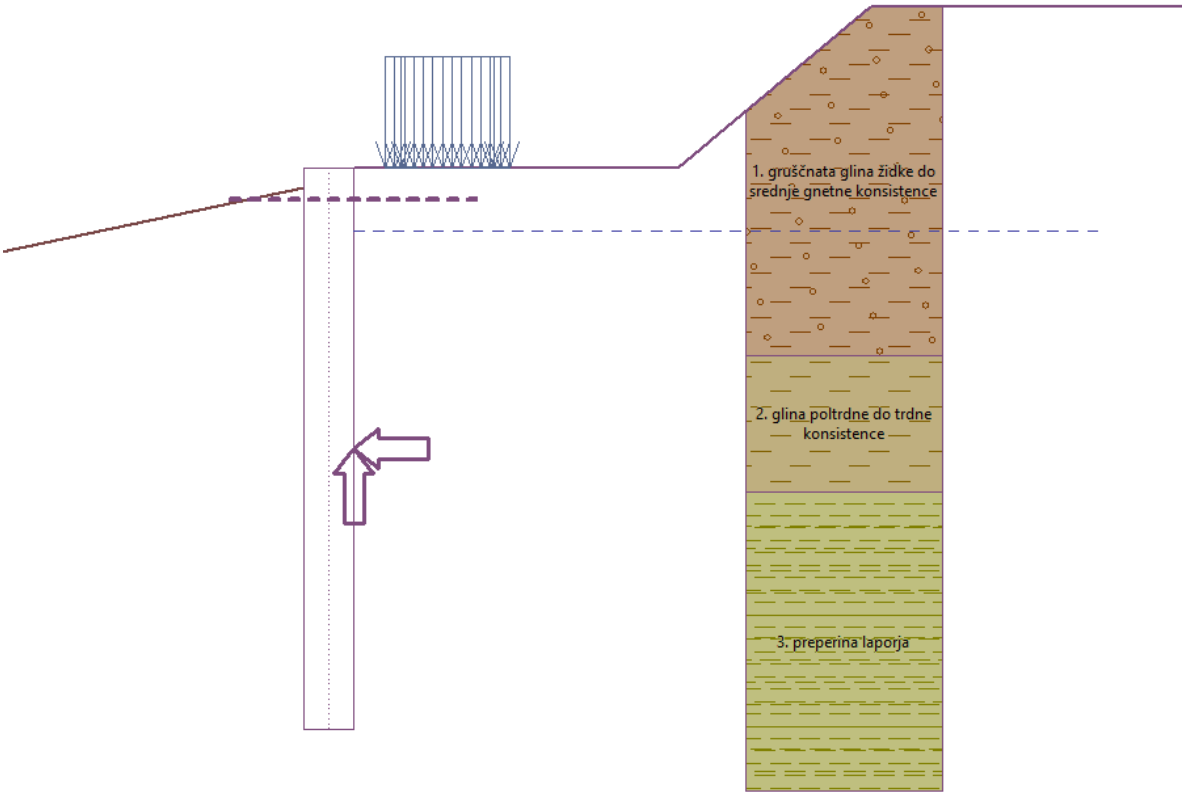
Stabilnost zemljine pod vozišču konstrukcijo ceste je labilno.

Predlagamo da se podpre vozišču konstrukcijo s pilotno steno.

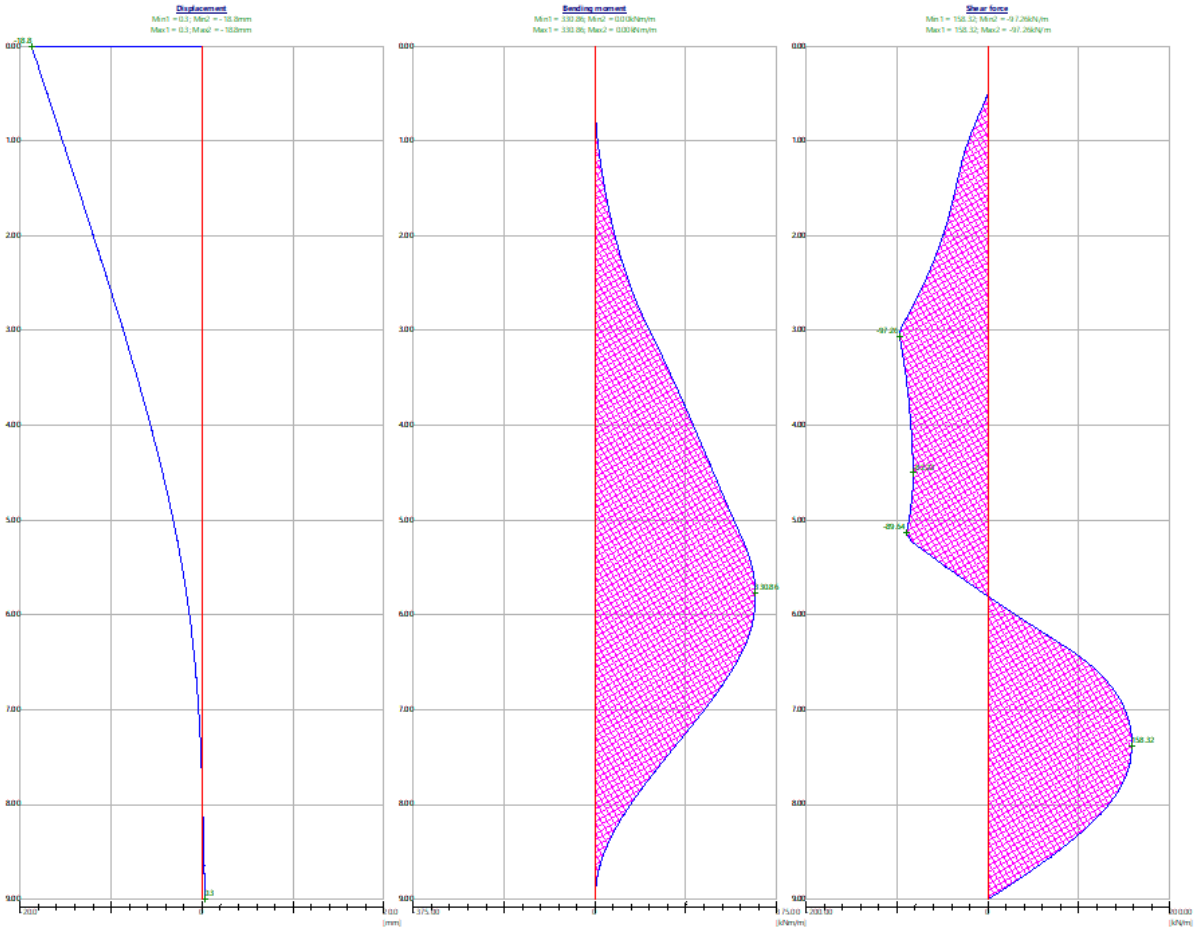
T.5. ANALIZA PILOTNE STENE

S programom GEO5 Anti-Slide Pile smo izračunali napetosti in pomike v pilotni steni. Prav tako smo izračunali potrebno armaturo v pilotih.

Za analizo smo uporabili Mohr-Coulombove karakteristike materialov uporabljene v prejšnjem poglavju.

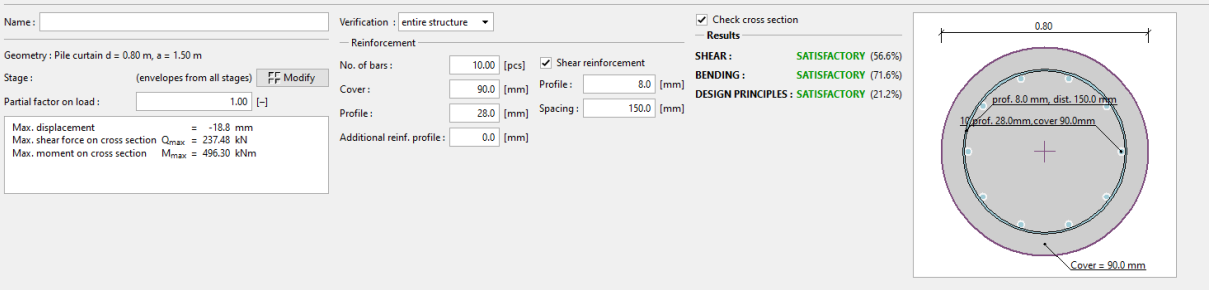


Slika 8 –Prečni prerez



Slika 9 –diagram pomikov in napetosti v pilotih

opis	vrednost
strig	[-97,26;158,32] kNm/m
upogibni moment	[0,0;330,86] kNm/m
pomik	[-18,8; 0,0] mm



Potrebna armatura v pilotih je:

- Vzdolžna armatura 10xϕ28
- Prečna armatura ϕ8/15

T.6. PREDLOG UREDITVE VOZIŠČNE KONSTRUKCIJE

Dimenzioniranje vozišče konstrukcije ceste je izvedeno skladno s Tehničnimi specifikacijami za javne ceste Republike Slovenije, izdala Direkcija Republike Slovenije za ceste, TSC 06.520: 2009, PROJEKTIRANJE, DIMENZIONIRANJE NOVIH ASFALTNIH VOZIŠČNIH KONSTRUKCIJ.

Na obravnavanem odseku ceste je bila izvedena vizualna ocena stanja obstoječih vozišč. Kot vsota zmnožkov obsega in jakosti posameznih vrst poškodb (razpoke, udarne jame, obraba, krpe) je izraženo stanje vozne površine.

Obstoječa asfaltna konstrukcija je v slabem stanju. Krovna plast je lokalno razpokana in deformirana.

Temeljna tla sestavljajo materiali, ki jih uvrščamo v razred neodpornih proti učinkom zmrzovanja in odtajevanja. Hidrološki pogoji po ureditvi ceste bodo ugodni. Potrebna debelina vozišče konstrukcije hmin je 70 % globine prodiranja mraza hm, kar znaša 63 cm.

Prevzeli smo lažjo prometno obremenitev.

Predlog izvedbe novogradnje in zamenjave vozišče konstrukcije na lokalni cesti

- 4 cm bitumenskega betona AC 11 surf B70/100, A4
- 6 cm bituminiziranega drobljenca AC 22 base B70/100, A4
- 21 cm tamponski drobljenec TD32
- 45 cm zmrzlinsko odpornega kamnitega materiala D63 (posteljica)
- geotekstil (površinska masa ≥180 g/m2, natezna trdnost ≥ 13,5 kN/m

86 cm skupaj

Izvedba:

V predlogu dimenzioniranja je predvidena izgradnja nove voziščne konstrukcije na nasip iz zmrzlinsko odpornega kamnitega materiala.
Pri izvedbi rekonstrukcije lokalne ceste se izkop izvede do planuma temeljnih tal, ki je **na globini 63 cm** pod projektirano koto vozišča. Na izravnan in utrjen planum temeljnih tal se za povečanje nosilnosti, vgradi geotekstil, na to pa plast **zmrzlinsko odpornega kamnitega materiala v debelini 45 cm** in utrdi. Na planumu zmrzlinsko odpornega materiala mora biti zagotovljena nosilnost CBR ≥ 10%. Na planum spodnjega ustroja se vgradi **21 cm tamponskega drobljenca TD32** in utrdi, zagotovljena mora biti nosilnost E_{V2} ≥ 100MPa in E_{V2}/E_{V1} ≤ 2,2. Asfaltna utrditev se izvede z vgradnjo bituminiziranega drobljenca **AC 22 base B70/100, A4 v debelini 6 cm** in bitumenskega betona **AC 11 surf B70/100, A4 v debelini 4 cm**.

Dobrna, marec 2024

Sestavil:

Martin Škoflek

Pregledal:

PI Vid Štukovnik, dipl.inž.grad.

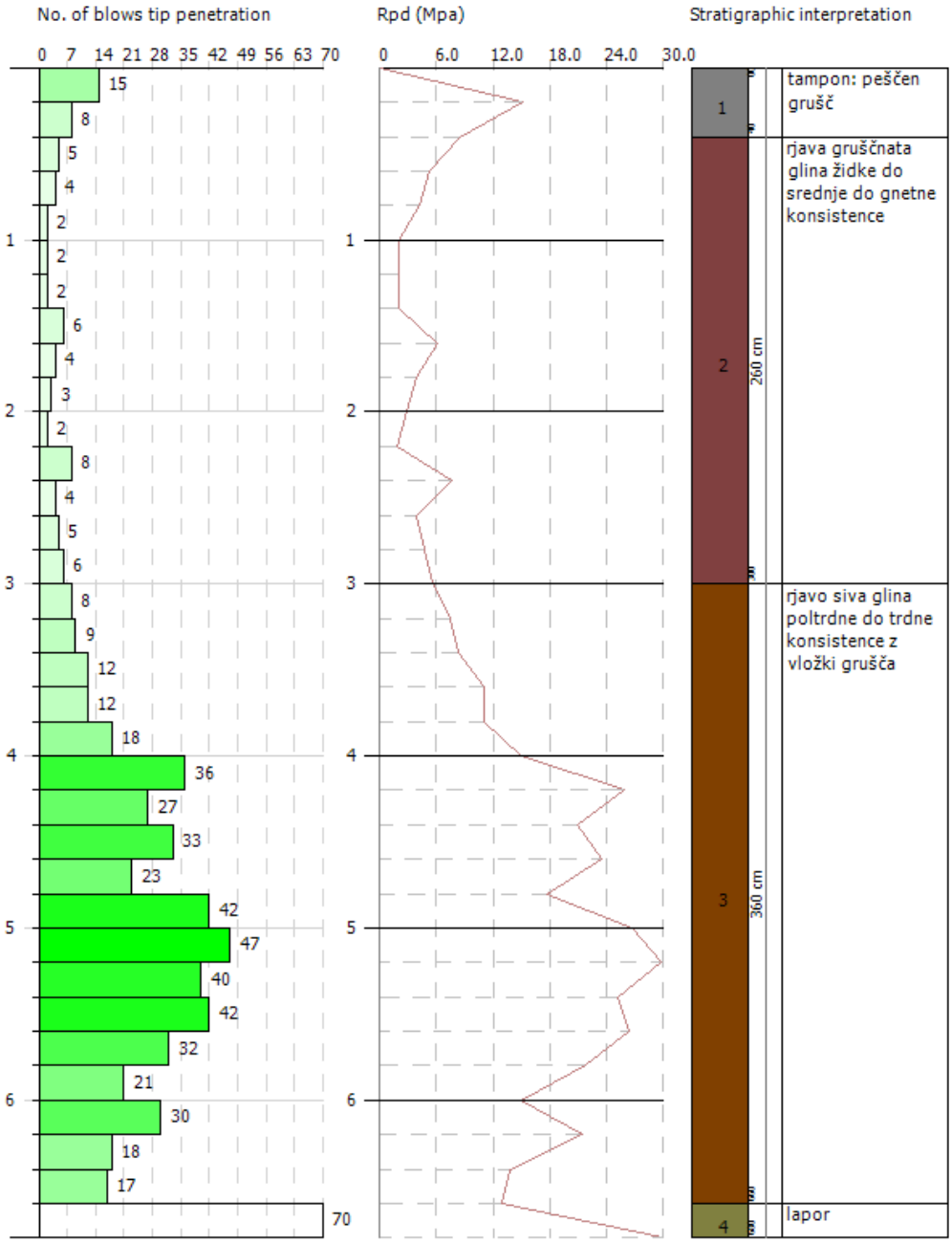
R. RAČUNSKI DEL

R.1. REZULTATI MERITEV Z LAHKIM DINAMIČNIM PENETROMETROM

R.1.1. DPSH 1

Podatki o meritvi:

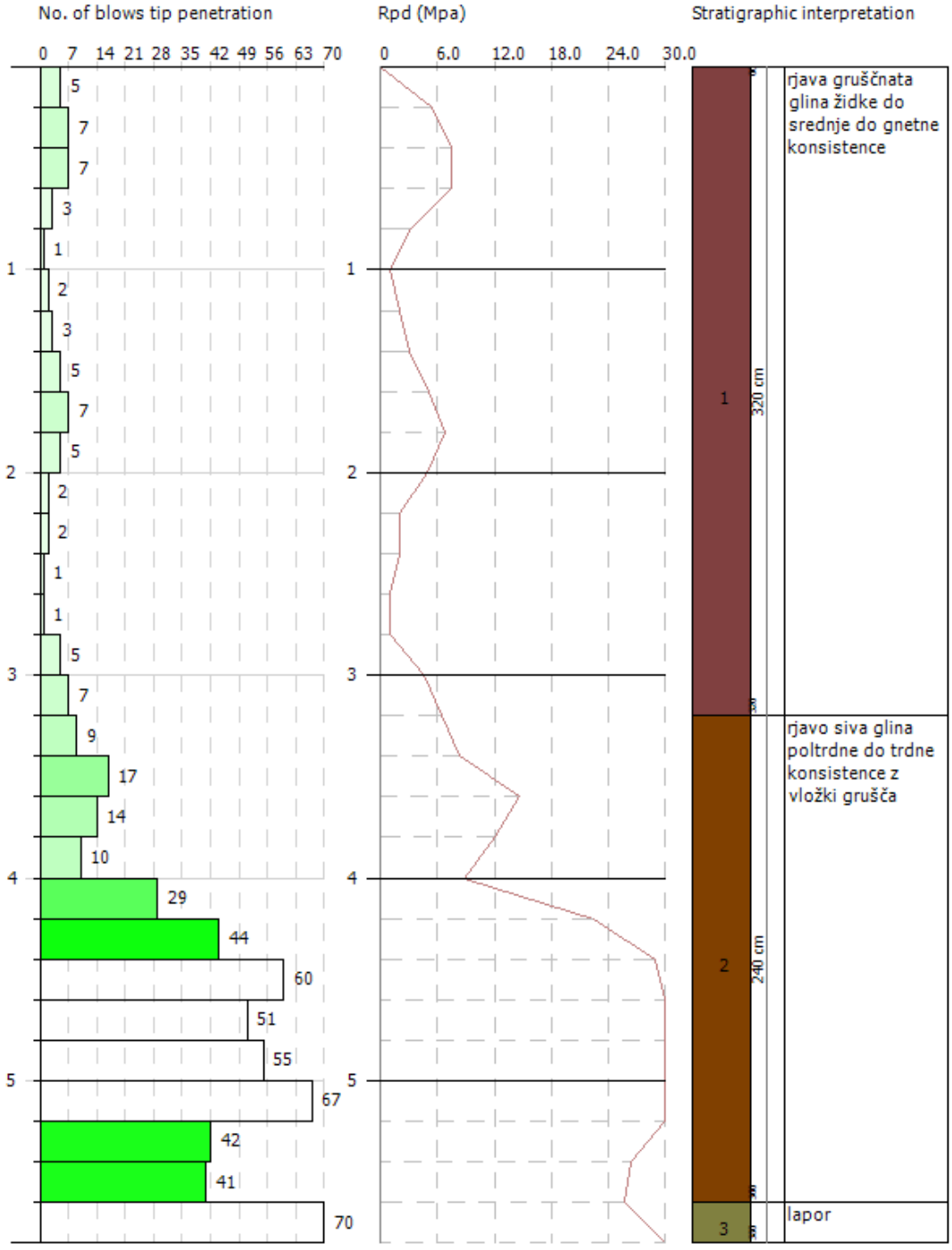
Oznaka meritve:	DPSH 1
Tip meritve/naprava:	DPSH
Koordinate (D96/TM)	e:500518.25; n:125202.87
Investitor:	Občina Braslovče
Datum:	6.2.2024
Vreme:	suho, 10 °C
Nivo podtalne vode:	/
Meritve izvajal:	Peter Zobec
Globina meritve:	6,4 m



R.1.2. DPSH 2

Podatki o meritvi:

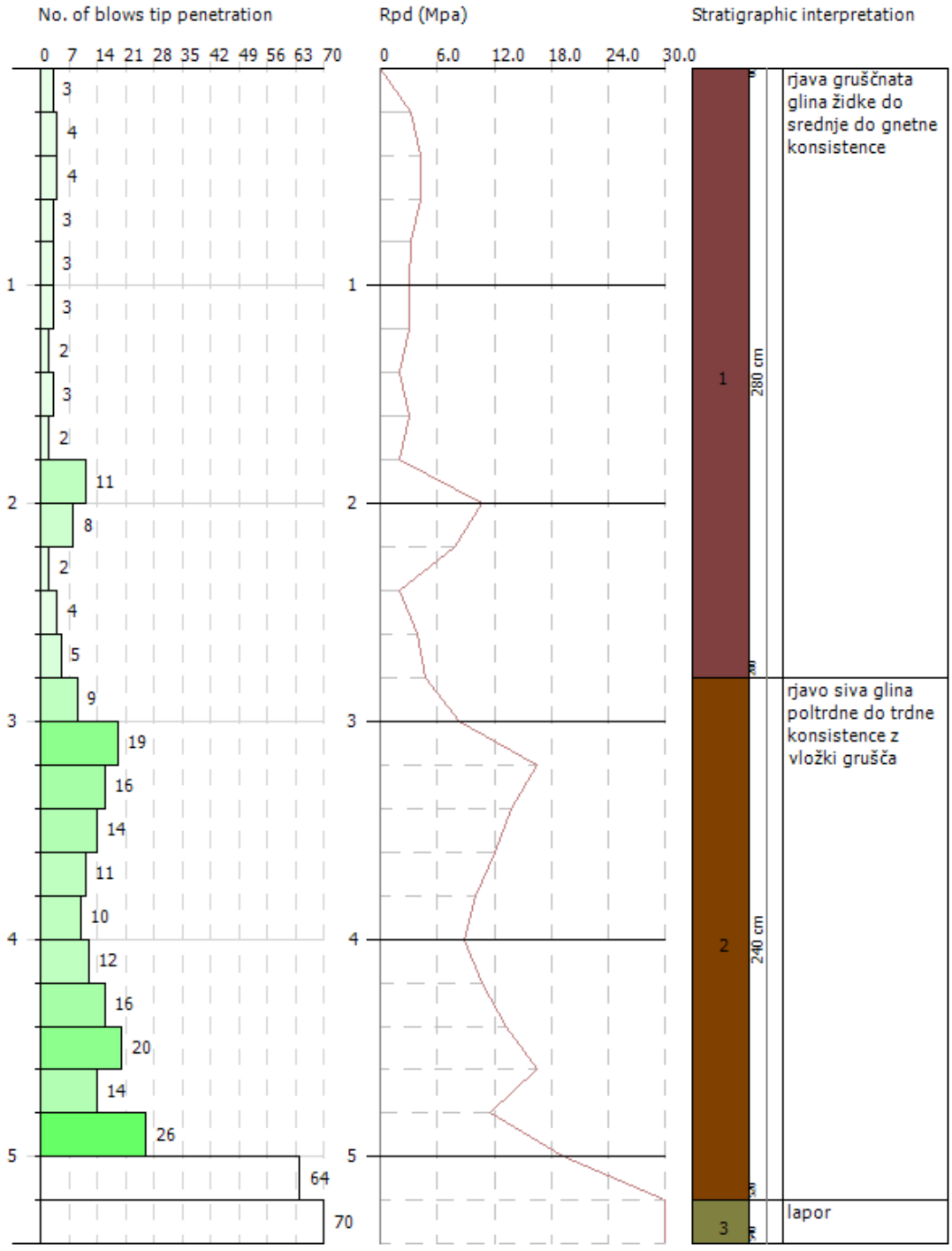
Oznaka meritve:	DPSH 2
Tip meritve/naprava:	DPSH
Koordinate (D96/TM)	e:500516.83; n:125195.31
Investitor:	Občina Braslovče
Datum:	6.2.2024
Vreme:	suho, 10 °C
Nivo podtalne vode:	/
Meritve izvajal:	Peter Zobec
Globina meritve:	5,8 m



R.1.3. DPSH 3

Podatki o meritvi:

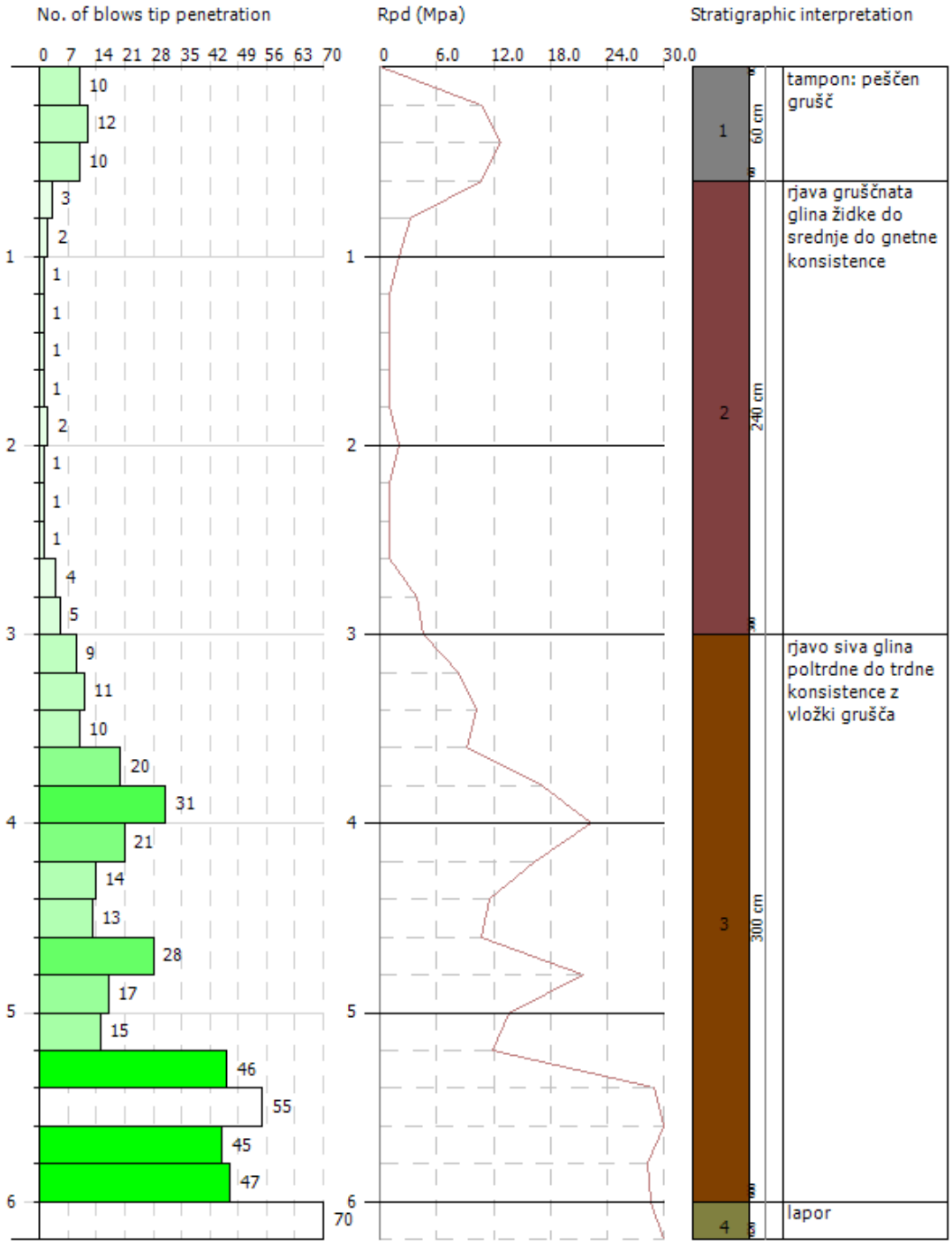
Oznaka meritve:	DPSH 3
Tip meritve/naprava:	DPSH
Koordinate (D96/TM)	e:500515.50; n:125189.78
Investitor:	Občina Braslovče
Datum:	6.2.2024
Vreme:	suho, 10 °C
Nivo podtalne vode:	/
Meritve izvajal:	Peter Zobec
Globina meritve:	5,4 m



R.1.4. DPSH 4

Podatki o meritvi:

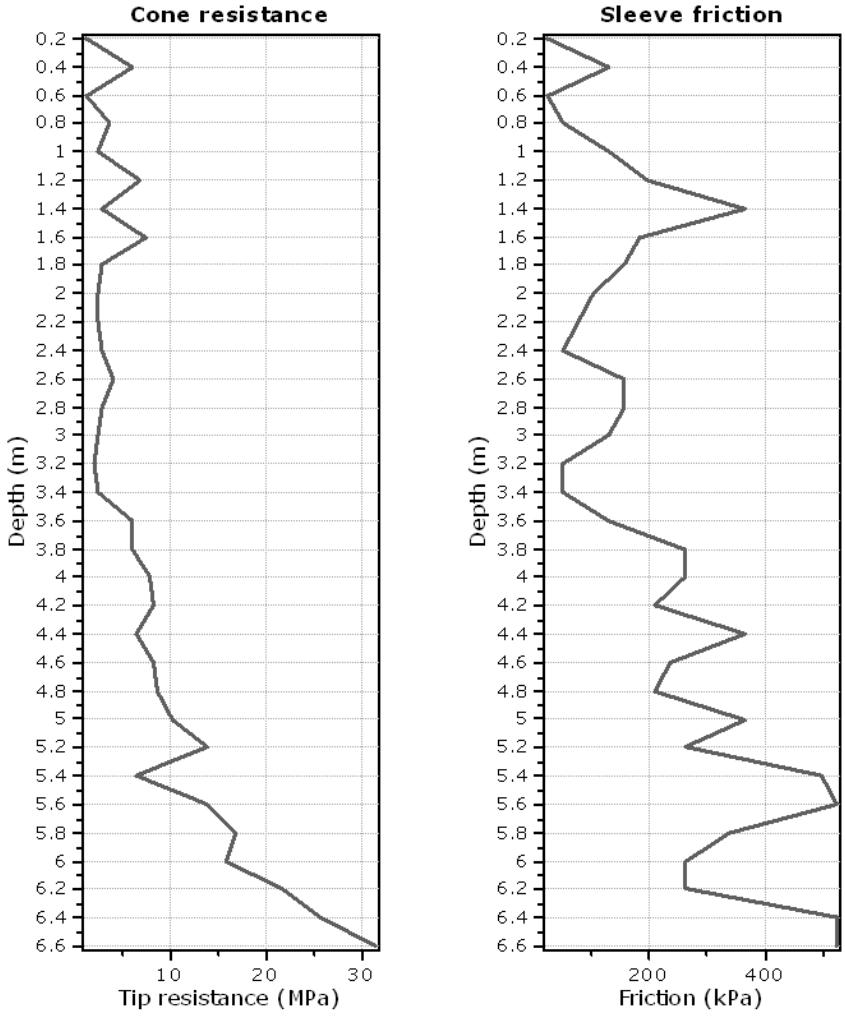
Oznaka meritve:	DPSH 4
Tip meritve/naprava:	DPSH
Koordinate (D96/TM)	e:500514.31; n:125183.88
Investitor:	Občina Braslovče
Datum:	6.2.2024
Vreme:	suho, 10 °C
Nivo podtalne vode:	/
Meritve izvajal:	Peter Zobec
Globina meritve:	6,2 m



R.1.5. CPT 1

Podatki o meritvi:

Oznaka meritve:	CPT 1
Tip meritve/naprava:	CPT
Koordinate (D96/TM)	e: 500519.78; n: 125194.25
Investitor:	Občina Braslovče
Datum:	6.2.2024
Vreme:	suho, 10 °C
Nivo podtalne vode:	/
Meritve izvajal:	Peter Zobec
Globina meritve:	6,6 m



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/m³)
0.00	1.80	3.04E-06	11.9	36.1	60.7	41.4	49.8	58.8	0.0	0.0	0.0	19.0
1.80		(±3.28E-06)	(±3.8)	(±13.0)	(±8.7)	(±0.9)	(±16.6)	(±23.6)	(±0.0)	(±0.0)	(±0.0)	(±0.0)
1.80	1.60	2.71E-07	11.0	0.0	0.0	0.0	40.2	62.7	187.2	3.5	15.9	19.0
3.40		(±2.26E-07)	(±1.7)	(±0.0)	(±0.0)	(±0.0)	(±8.7)	(±7.4)	(±26.5)	(±0.6)	(±3.0)	(±0.0)
3.40	2.00	8.66E-07	25.7	103.5	49.5	40.5	108.2	132.0	0.0	0.0	0.0	19.0
5.40		(±5.24E-07)	(±7.4)	(±29.0)	(±6.0)	(±1.2)	(±33.8)	(±35.0)	(±0.0)	(±0.0)	(±0.0)	(±0.0)
5.40	1.00	1.09E-05	47.0	158.0	66.6	42.2	188.9	201.3	0.0	0.0	0.0	19.0
6.40		(±1.04E-05)	(±9.4)	(±15.7)	(±9.6)	(±0.8)	(±27.5)	(±20.0)	(±0.0)	(±0.0)	(±0.0)	(±0.0)

R.2. LITOLOŠKI STOLPEC

GHC PROJEKT

GHC–Projekt, d.o.o.
Pristova 8,
3204 Dobrna

Naročnik: Občina Braslovče
Izvajalec vrtanja: GHC–Projekt d.o.o.
Datum izvedbe: 6.2.2024
Globina: 3,8m Merilo: 1:50
koordinate (D96/TM) e:500520 n:125194 z:354,50

V–1

Projekt: GG 26/1/24
Lokacija: Občina Braslovče

GLOBINA n.m.v.	GLOBINA m.	LITOLOŠKI STOLPEC	Klasifikacija SIST EN ISO 14688-2	GEOLOŠKO – GEOTEHNIČNI OPIS	NIVO. VODE	ROČ. PENO.	KRIL. SONDA	SPT (ud/30)	OPOMBE
0.0			saGr	tampon: peščen grušč					
-0.5			grCl	rjava gruščnata glina židke do srednje gnetne konsistence		50 kPa 40 kPa 40 kPa 30 kPa 90 kPa 120 kPa 120 kPa 50 kPa 40 kPa 180 kPa			
-1.0									
-1.5									
-2.0									
-2.5									
-3.0									
-3.5			Cl	rjavo siva glina poltrdne do trdne konsistence z vložki grušča		250 kPa 360 kPa 350 kPa 340 kPa 330 kPa 330 kPa			
-4.0									
-4.5									
-5.0									
-5.5				preperina laporja					
-6.0									
-6.5									
-7.0									
-7.5									
-8.0									
-8.5									
-9.0									
-9.5									
-10.0									

Opombe:
Obdelal: Martin Škoflek Pregledal: Vid Štukovnik 1/1

R.2.1. Slike vrtine



0m-0,8m 0,8m-1,7m 1,7m-2,6m 2,6m-3,5m 3,5m-4,4m 4,4m-5,3m

R.3. OPREMA IN INTERPRETACIJA

R.3.1. Dinamični penetrometer super heavy

DPSH - (DIN) EN ISO 22476-2

Masa uteži: (63,5kg)

Višina padca: 750mm

Jeklene palice Ø (51mm); L 1000 mm

Krona Ø (42,3mm); B 90°; A (20 cm²)



Slika 10 - dinamični penetrometer super heavy

Energija prenešena skozi drogovje je preračunana kot:

$$F(t)=A_a * E_a * \varepsilon_m(t)$$

Kjer je:

A_a Prerez drogovja

E_a Modul elastičnosti drogovja

$\varepsilon_m(t)$ Merjena deformacija drogovja ob času t

Razmerje med teoretično energijo in dejansko energijo preneseno skozi drogovje do krone je za vsak penetrometer definirano posebej kot:

$$E_r = \frac{EM}{ET}$$

Kjer je:

$$EM = \frac{1}{n}\sum_{1}^{n} E$$ dejanska prenešena energija skozi drogovje do krone

$$ET = m * g * h$$ teoretična – potencialna energija

$$E_r = 0{,}6$$

Odpornost tal je preračunana kot:

$$q_d = \left(\frac{m}{m+m'}\right) * r_d \qquad r_d = \frac{EM}{A * e} \qquad \delta_{dop} = \frac{r_d}{25}$$

Kjer je:

m	masa kladiva
m’	skupna masa aparature z drogovje,
g	zemeljski pospešek
h	višina padca kladiva
A	Površina krone
E	povprečen prodor krone

R.3.2. Penetracija s statičnim konusnim penetrometrom - CPT

OPREMA IN POSTOPEK MERITEV

Preiskave s statičnim konusnim penetrometrom so bile izvedene z opremo, ki je skladna s standardi SIST EN 1997-2:2007 ter EN ISO 22476- 1:2005.

Za preiskavo smo uporabili stroj za vtiskanje (penetrometer) GD 150KN. Drogovje je opremljeno s merilno konico površine 10 cm^2. Merilno konico se vtiska v tla s povprečno hitrostjo 2,0 ± 0,5 cm/s.



Slika 11 - fotografija uporabljene opreme

MERJENE VREDNOSTI

S statičnim konusnim penetrometrom smo na terenu pridobili izmerjene vrednosti prikazane v spodnji tabeli 1.

ID	parameter	oznaka	enota
1	Odpor na konico	Qc	MPa
2	Trenje po plašču drogovja	fs	KPa/MPa

NORMALIZIRANI ODPOR NA KONICO qt

Vrednosti odpora pod konico smo korigirali zaradi vpliva dinamienih pornih tlakov. Korigirana oziroma normalizirana vrednost odpora na konico tako znasa :

$$q_t = q_c + u_2 \cdot (1 - a)$$

$$q_{tn} = \frac{(q_t - \sigma)}{\sigma_{ef}}$$

Qt – totalni odpor na konico (MPa)

Qtn – normaliizrani odpor na konico (kPa) glede na težo zemljine

u2 - dinamicni (merjeni) porni tlak

σ – primarna napetost v tleh

a – razmerje med površino konice na katero deluje sila odpora zemljine ter efektivnim merskim prerezom (0,58 v našem primeru)

NORMALIZIRANO TRENJE PO PLAŠČU – Fr

Trenje po plašču smo prav tako normalizirali zaradi vplivov dinamičnih pornih tlakov. Tako je normalizirano trenje po plašču drogovja.

$$F_r = \left(\frac{f_s}{q_t} \right) \cdot 100$$

kjer je:

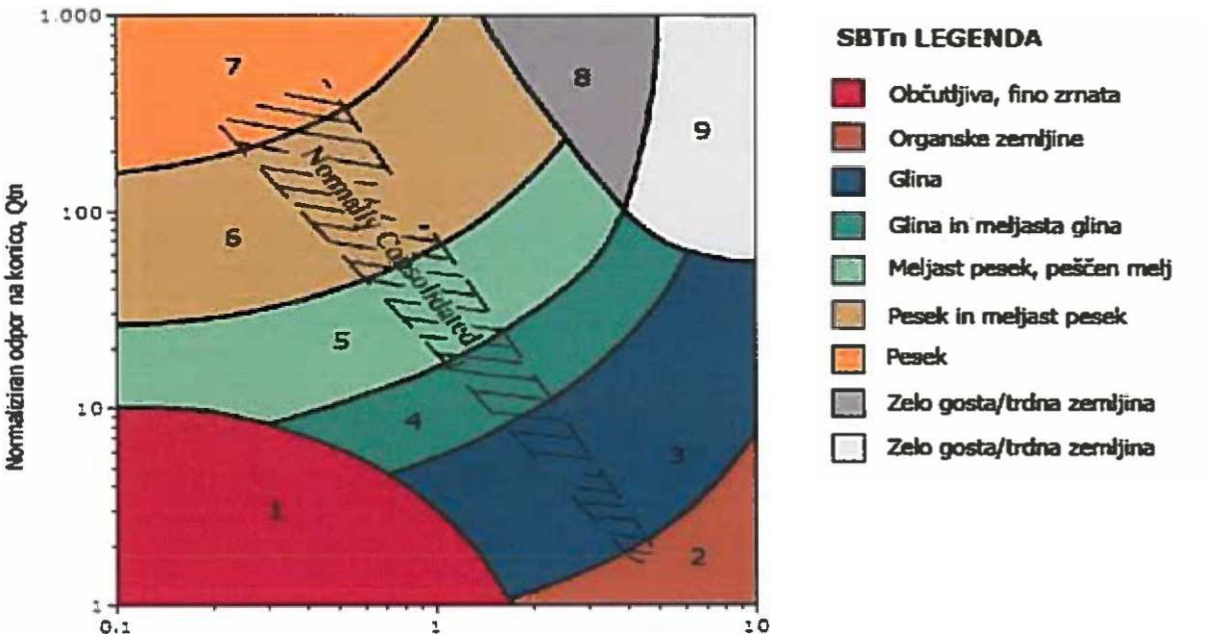
fr - normalizirano trenje po plašču drogovja

fs – merjeno trenje po plašču drogovja

qt- normaliziran odpor na konici

SBTn diagram – NORMALIZIRAN DIAGRAM TIPA OBNAŠANJA ZEMLJIN

SBTn diagram (Lunne et al.,1997) je diagram tipa obnašanja zemljin glede na izmerjene parametre. Na podlagi tega diagrama se klasificira zemljine, kar je eden glavnih prednosti preiskave s statičnim konusnim penetrometrom. Tako razvrščanje zemljin na podlagi SBTn diagramov je zgolj orientacijsko in služi kot opora za nekatere nadaljnje izračune, saj nekateri od njih temeljijo na predpostavki ali zemljini predpišemo koherentne oziroma nekoherentne lastnosti.



SBTn indeks - Ic

Indeks tipa obnašanja zemljin smo izračunali po sledeči enačbi

$$I_c = \left[\left[3{,}47 - \log(q_{tn}) \right]^2 + \left(\log(F_r) + 1{,}22 \right)^2 \right]^{0{,}5}$$

Kjer je:

Ic – SBTn indeks

Qtn – normaliziran opdor na konico

Fr –normalizirano trenje po plašču drogovja

Na podlagi SBTn indeksa lahko izračunamo koficient prepustnosti – k.

IZRAČUN OCENJENIH VREDNOSTI GEOTEHNIČNIH PARAMATREOV

Koeficient prepustnoti - k_{SBT}

SBTn tip	Koeficient prepustnosti (m/s)
1	$1x10^{-8}$
2	$1x10^{-7}$
3	$3x10^{-10}$
4	$1x10^{-8}$
5	$1x10^{-6}$
6	$1x10^{-4}$
7	$1x10^{-2}$
8	$1x10^{-6}$
9	$3x10^{-9}$

Tabela: Korelacija med koeficinetom prepustnosti ter normaliziranim tipom obnašanja zemljin

Korelacija z SPT testom –N_{60}

Korelacija med podatki iz CPT preiskav ter številom udarcev pri standardnem penetracijskem testu je podana kot odvisnost od klasifikacije posameznega zemljinskega intervala in odpora na konico, kot je prikazano v s spodnji tabeli

območje	Tip zemljine	(qc/pa)/N_{60}
1	Občutljivo, fino zrnata zemljina	2
2	Organski material	1
3	glina	1
4	Meljasta glina do glina	1.5
5	Glinast melj do meljasta glina	2
6	Peščen melj do glinast melj	2.5
7	Mejast pesek do peščen pesek	3
8	Pesek do meljast pesek	4

9	pesek	5
10	Prodnat pesek do pesek	6
11	Zelo gosto, fino zrnata zemljina	1
12	Pesek do glinast pesek	2

Tabela: korelacija SBTn ter N60

Izračun N60 je izveden po spodnji enačbi

$$\frac{\left(q_c / p_q\right)}{N_{60}} = 8{,}5 \cdot \left(1 - \frac{I_c}{4{,}6}\right)$$

Kjer je:

qc – merjen odpor na konico

pa – referenčni tlak (100kPa)

N60 – število udarcev

Ic – SBTn indeks

Youngov modul elastičnosti – Es

Modul elastičnosti je izračunan po spodnji enačbi

$$E_s = \alpha_E \cdot (q_t - \sigma)$$

$\alpha_E = 0{,}015 \cdot \left[10^{(0{,}55 \cdot I_c + 1{,}68)}\right]$ pri $I_c > 2{,}6$

Kjer je:

Es – ocenjen Youngov modul elastičnosti

α tn – konstatna, ki je odvisna od tipa zemljine

Ic- SBTn indeks tipa obnašanja zemljin

Youngov modul elastičnosti se izračuna pri Ic>2,6 (lunne et al, 1997)

Relativna gostota – Dr

Izračun relativne gostote se izvaja samo za 5,6,7 in 8 normaliziran tip obnašanja zemljin (Lunne et al, 1997) in sicer po spodnji enačbi

$$D_r = \sqrt{\frac{q_{tn}}{C_{Dr}}}$$

Kjer je

D_r – relativna gostota v %

q_{tn} – nornmaliziran odpor na konico

C_{Dr} – konstanta tipa zemljine

Strižni kot – φ

Izračun strižnega kota je izveden po spodnji enačbi za 5,6,7 in 8 normaliziran tip obnašanja zemljine (Lunne et al, 1997)

$$\phi = 17{,}6 + 11 \cdot \log(q_t)$$

Kjer je

Φ ocenjen strižni kot

qt – odpor na konico

Modul stislljivsoti – oedometrski – M

Modul stisljivosti je izračunan po spodnji enačbi za vse tipe zemljin (Lunne et al, 1997) in sicer po spodnji enačbi

$$M = \alpha_M \cdot (q_t - \sigma)$$

Pri nekoherentnih zemljinah α_M

$$M = \alpha_M \cdot (q_t - \sigma)$$

Pri koherentnih zemljinah pa za α_M vzamemo:

$$\alpha_M = 0{,}0188\,[10^{(0.55 \cdot I_c + 1{,}68)}]$$

Kjer je:

M – modul stisljivosti

α_M – korekcijski faktor glede na SBTn indeks

Strižni modul – G_0

Strižni modul je ocenjen po sledeči enačbi (www.geologismiki.gr, CpeT-IT user`s manual, 2008)

$$G_0 = \alpha_M \cdot (q_t - \sigma)$$

$$\alpha_M = 0{,}0188\,[10^{(0.55 \cdot I_c + 1{,}68)}]$$

kjer je:

G0 - strižni modul

α_M – korekcijski faktor glede na SBTn indeks

Nedrenirana strižna trdnost – Su

Za vsak interval koherentne zemljine smo določili nedrenirano strižno trdnost Su (Meigh 1987), kjer smo upoštavali relacijo:

$$s_u = \frac{(q_t - \sigma)}{N_{kt}}$$

kjer je:

Su – nedrenirana strižna trdnost

Qt – odpor na konico

σ – primarna napetost v tleh

Nkt – emeprični faktor odvisen od tipa konice, OCR, stopnje cementacije. Tipična vrednost

Nkt= 10 – 20. V prekonsolidiranih zemljinah je Nkt večji kot pri normalno konsolidiranih. Izračun se izvedeni samo za SBTn tipe 1, 2, 3, 4 in 9

Koeficient prekonsolidacije – OCR

Koeficient prekonsolidacije koherentnih zemljin OCR smo izračunali po enačbi (Mayne, 1991)

$$OCR = k_{OCR} \cdot \frac{(q_t - \sigma)}{\sigma_{ef}}$$

kjer je:

OCR – koeficient prekonsolidacije

Kocr – konstanta glede na zemljino (pri izračunih smo uproabili vrednost 0.33, ki je predlagana v literaturi)

σ – primarna napetost v tleh

σ_{ef} – efektivna napetost

OPOMBA

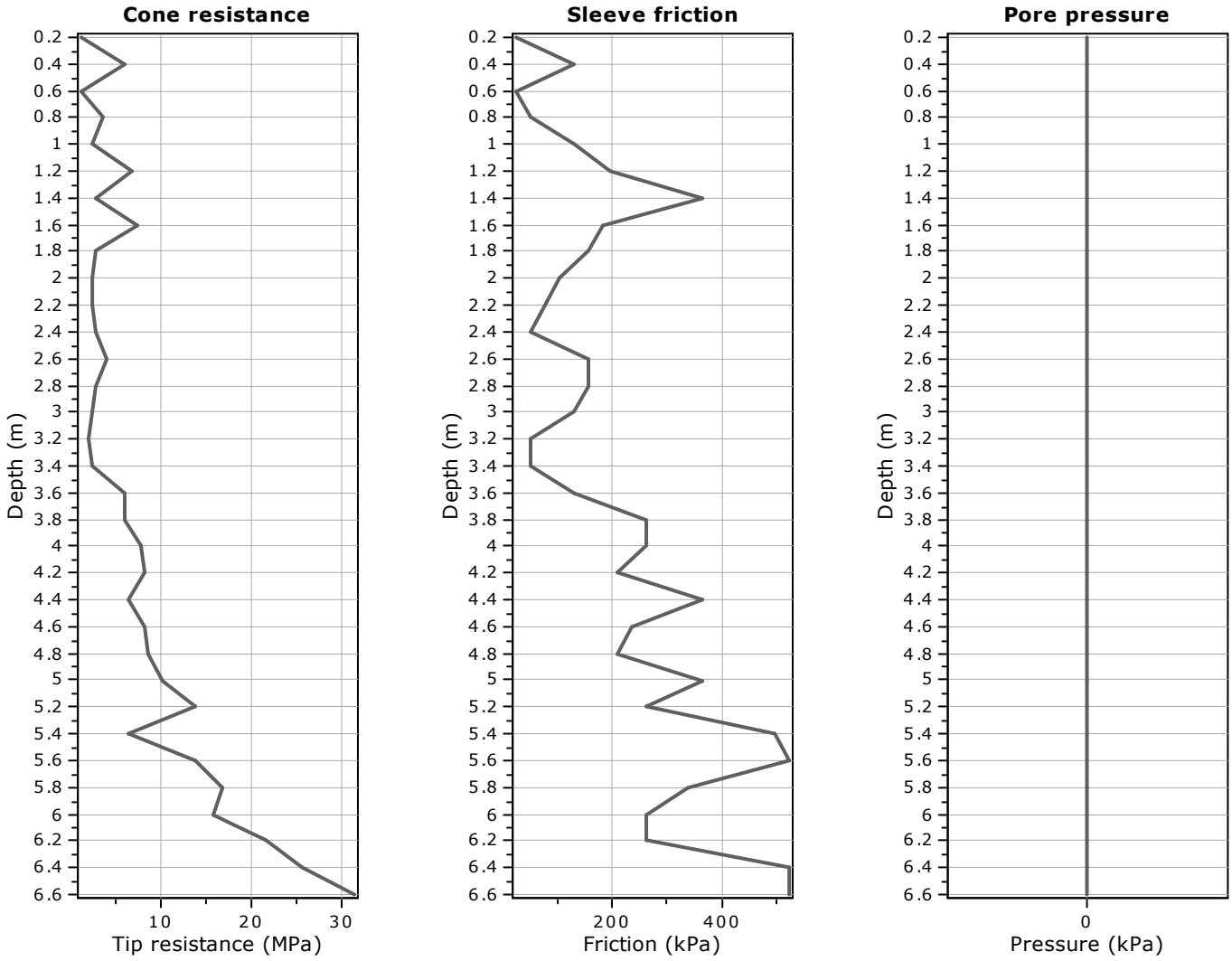
Za ustrezno interpretacijo dobljenih rezultatov je potrebno rezultate meritev preveriti in uskaditi z ostalimi geotehničnimi preiskavami na obravani lokaciji.

R.4. IZPIS REZULTATOV CPeT-IT

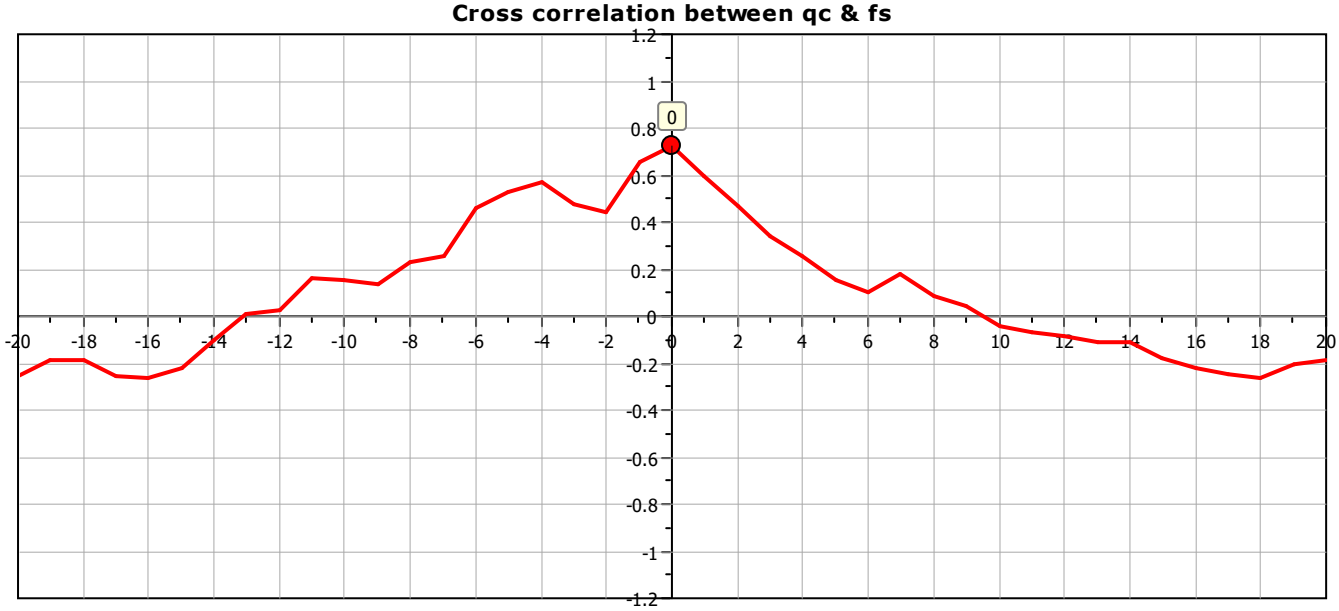
GHC-Projekt d.o.o.
Pristova 8
3204 Dobrna

CPT: CPT 1
Total depth: 6.60 m, Date: 27. 03. 2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project:
Location:



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).

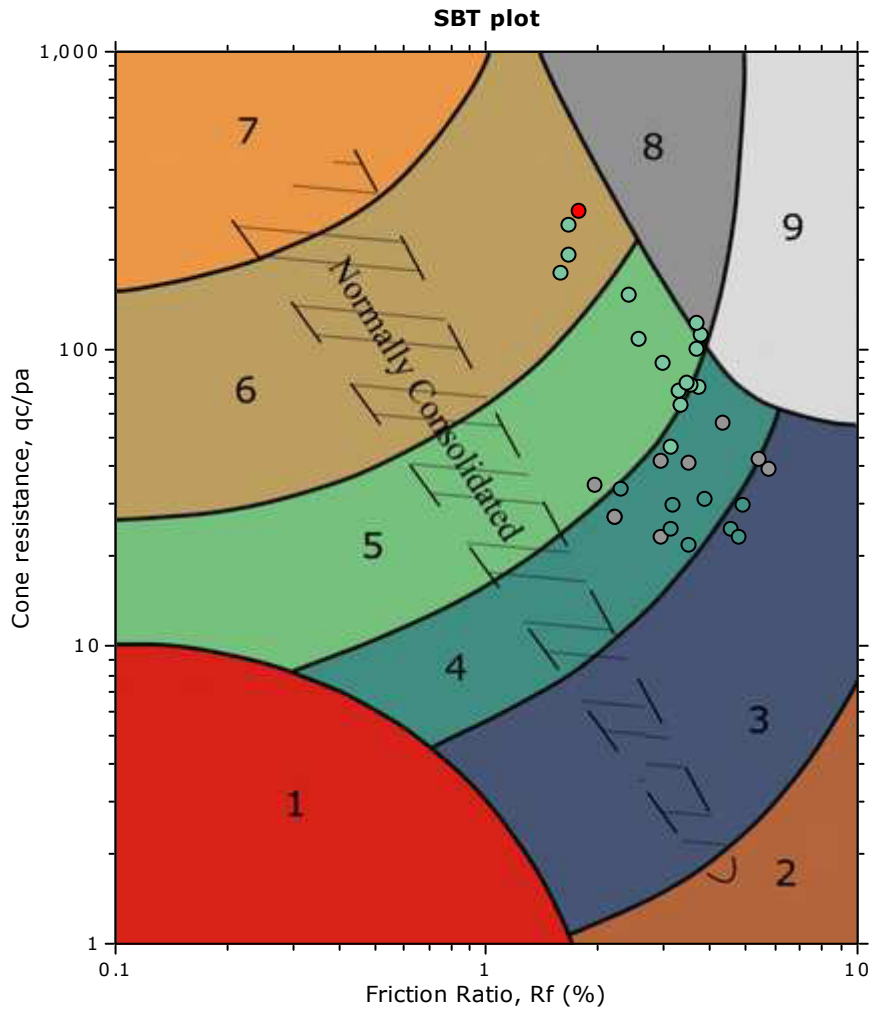


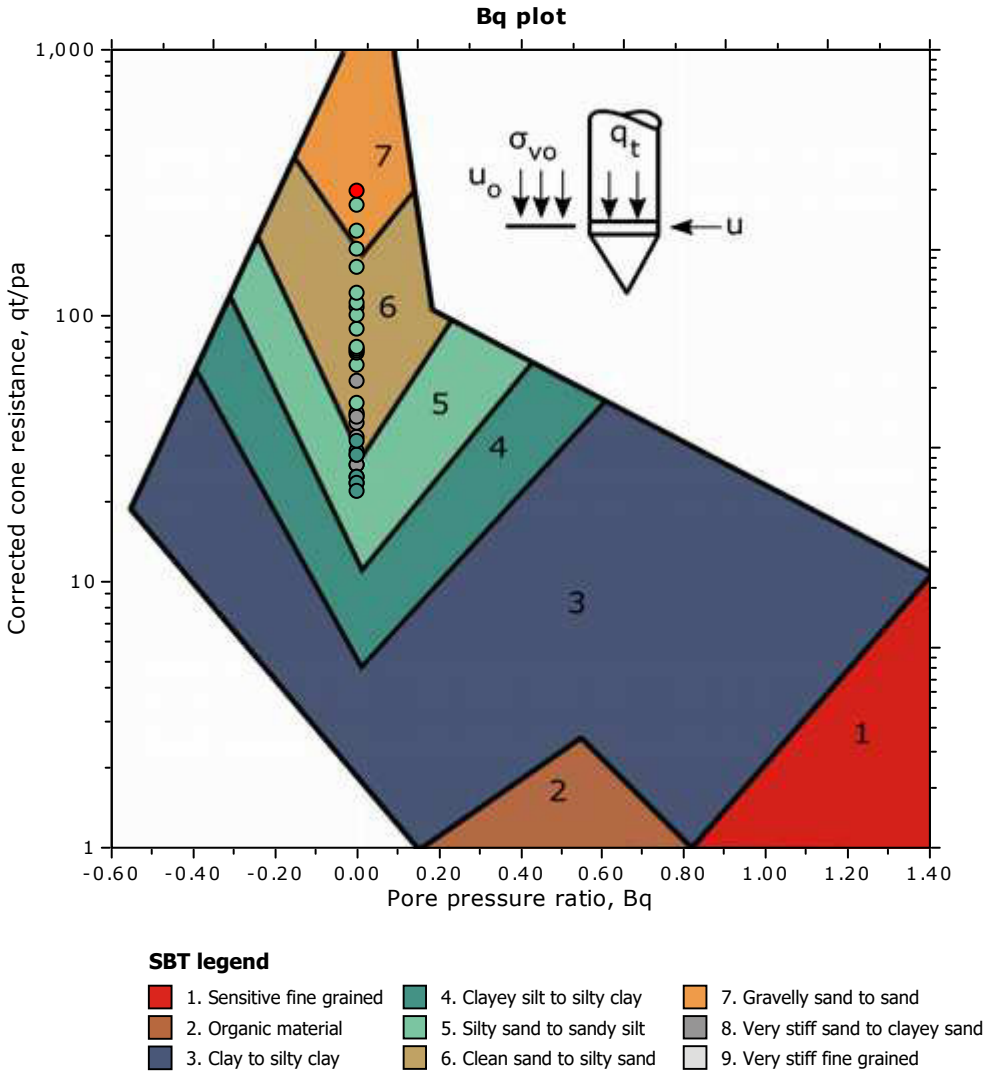
GHC-Projekt d.o.o.
Pristova 8
3204 Dobrna

Project:
Location:

CPT: CPT 1
Total depth: 6.60 m, Date: 27. 03. 2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots



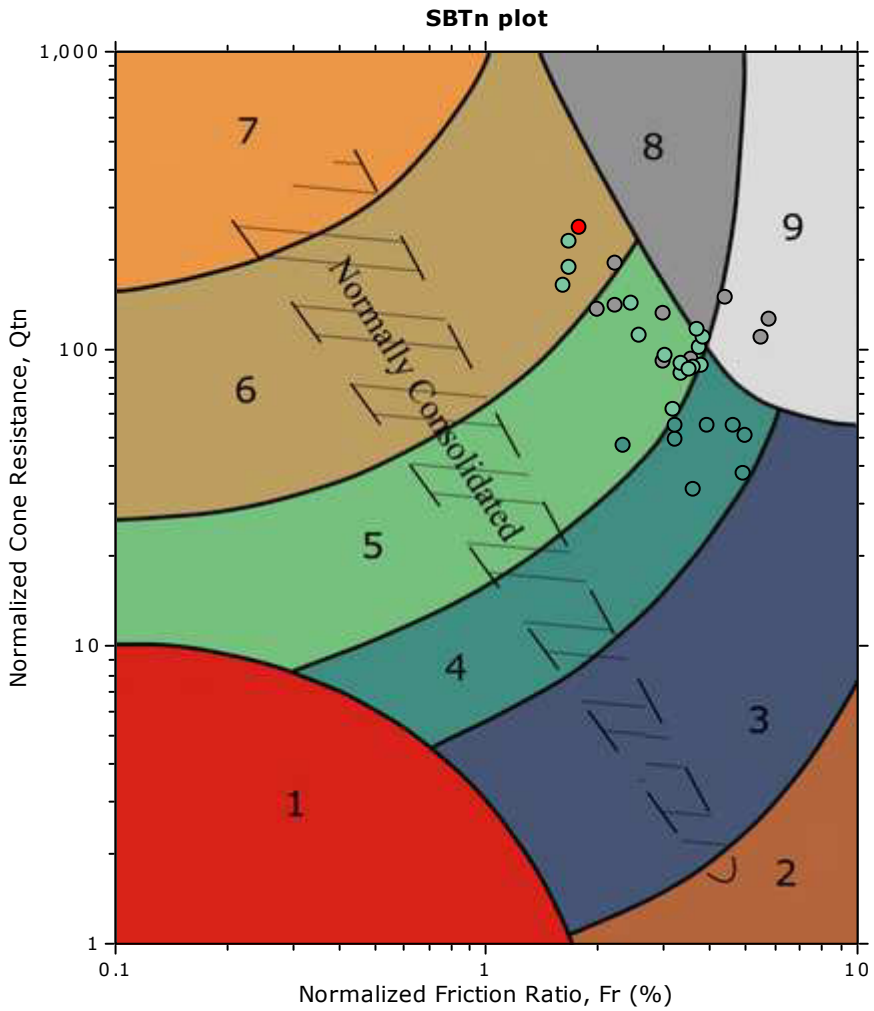


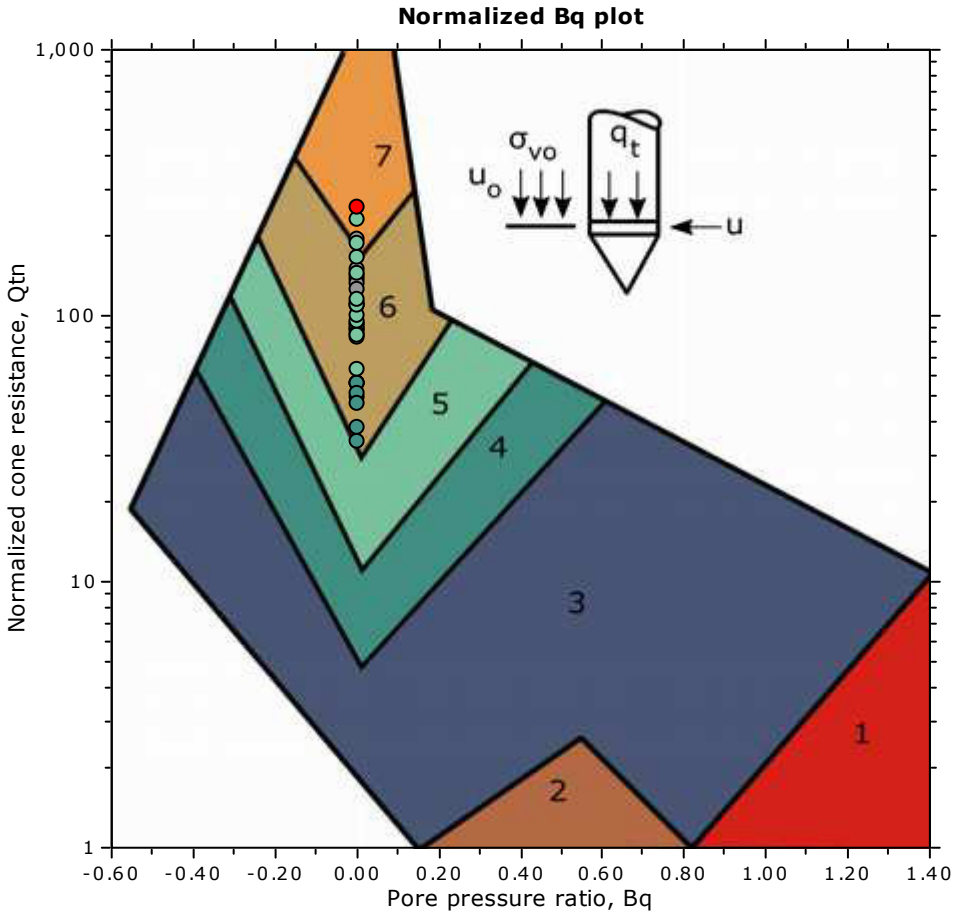
GHC-Projekt d.o.o.
Pristova 8
3204 Dobrna

Project:
Location:

CPT: CPT 1
Total depth: 6.60 m, Date: 27. 03. 2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

SBT - Bq plots (normalized)





SBTn legend

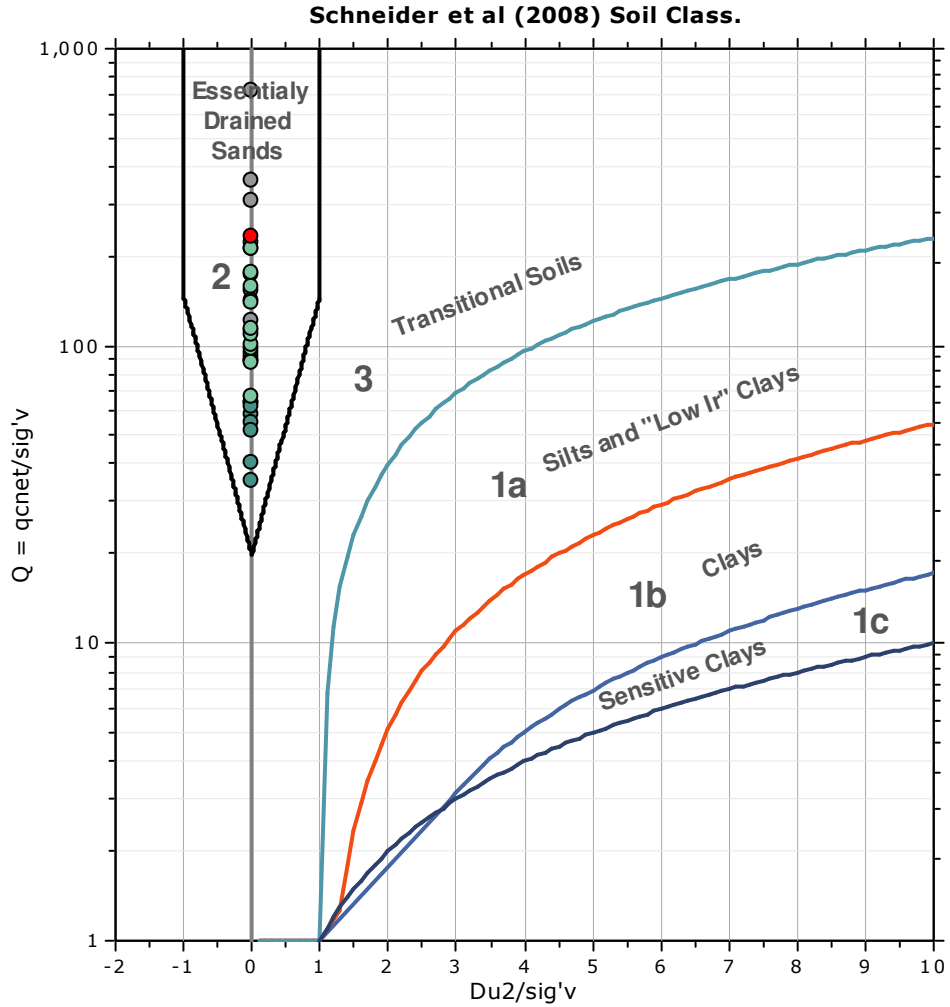
1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravelly sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to clayey sand
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

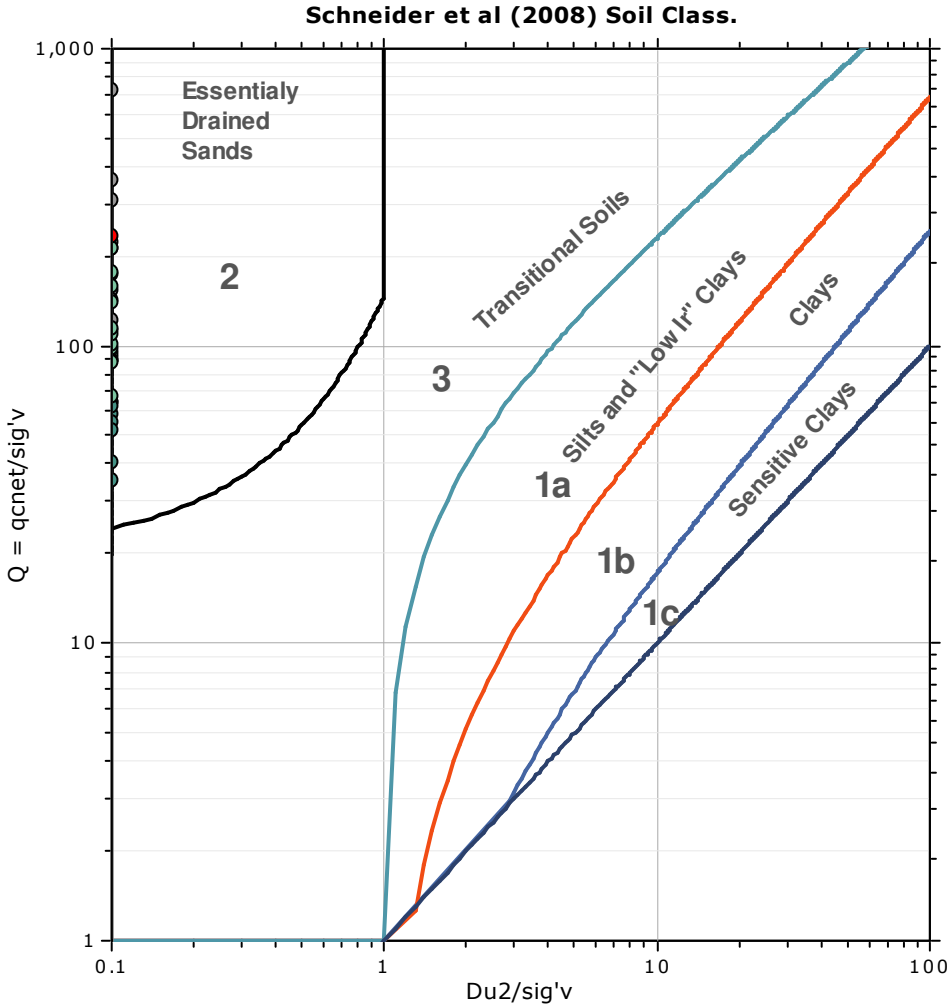
GHC-Projekt d.o.o.
Pristova 8
3204 Dobrna

Project:
Location:

CPT: CPT 1
Total depth: 6.60 m, Date: 27. 03. 2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Bq plots (Schneider)

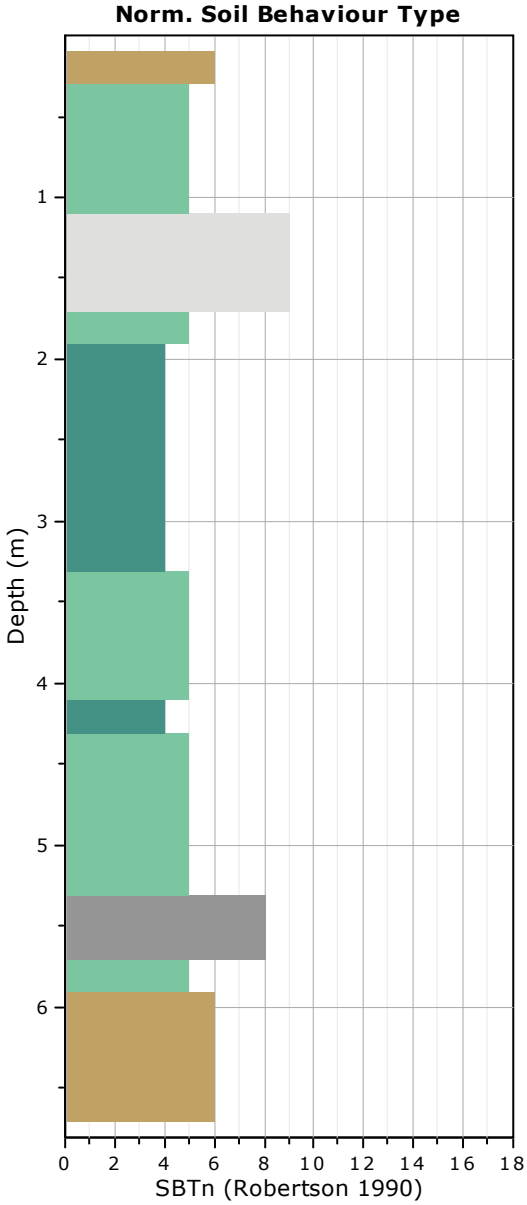


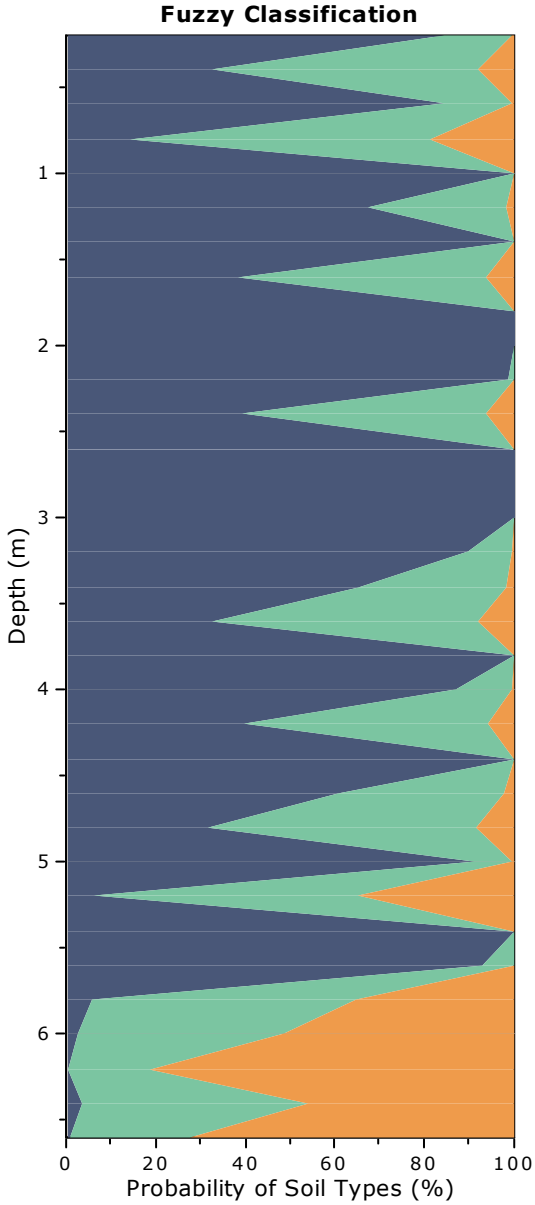


GHC-Projekt d.o.o.
Pristova 8
3204 Dobrna

CPT: CPT 1
Total depth: 6.60 m, Date: 27. 03. 2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project:
Location:

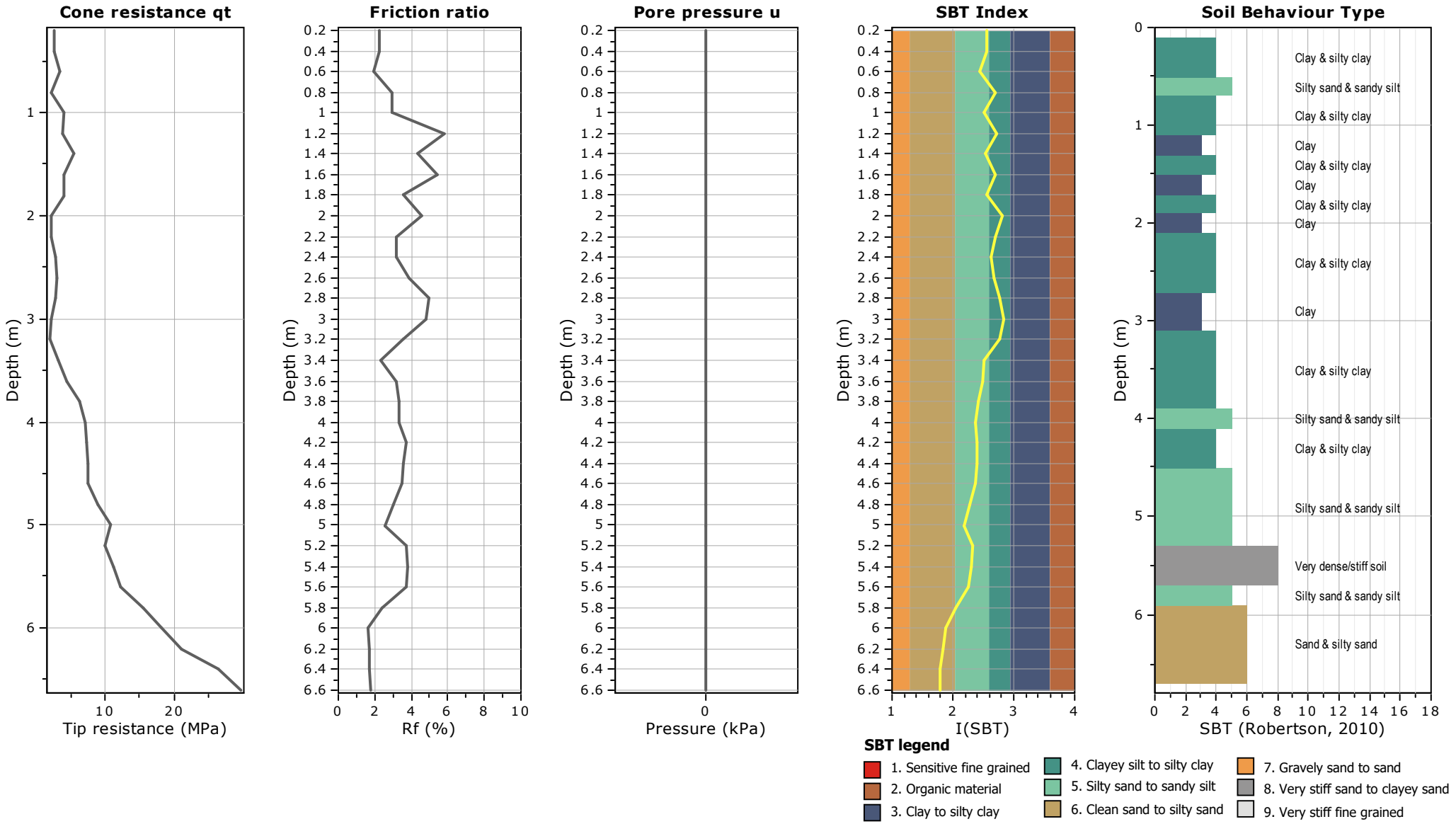




GHC-Projekt d.o.o.
Pristova 8
3204 Dobrna

CPT: CPT 1
Total depth: 6.60 m, Date: 27. 03. 2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

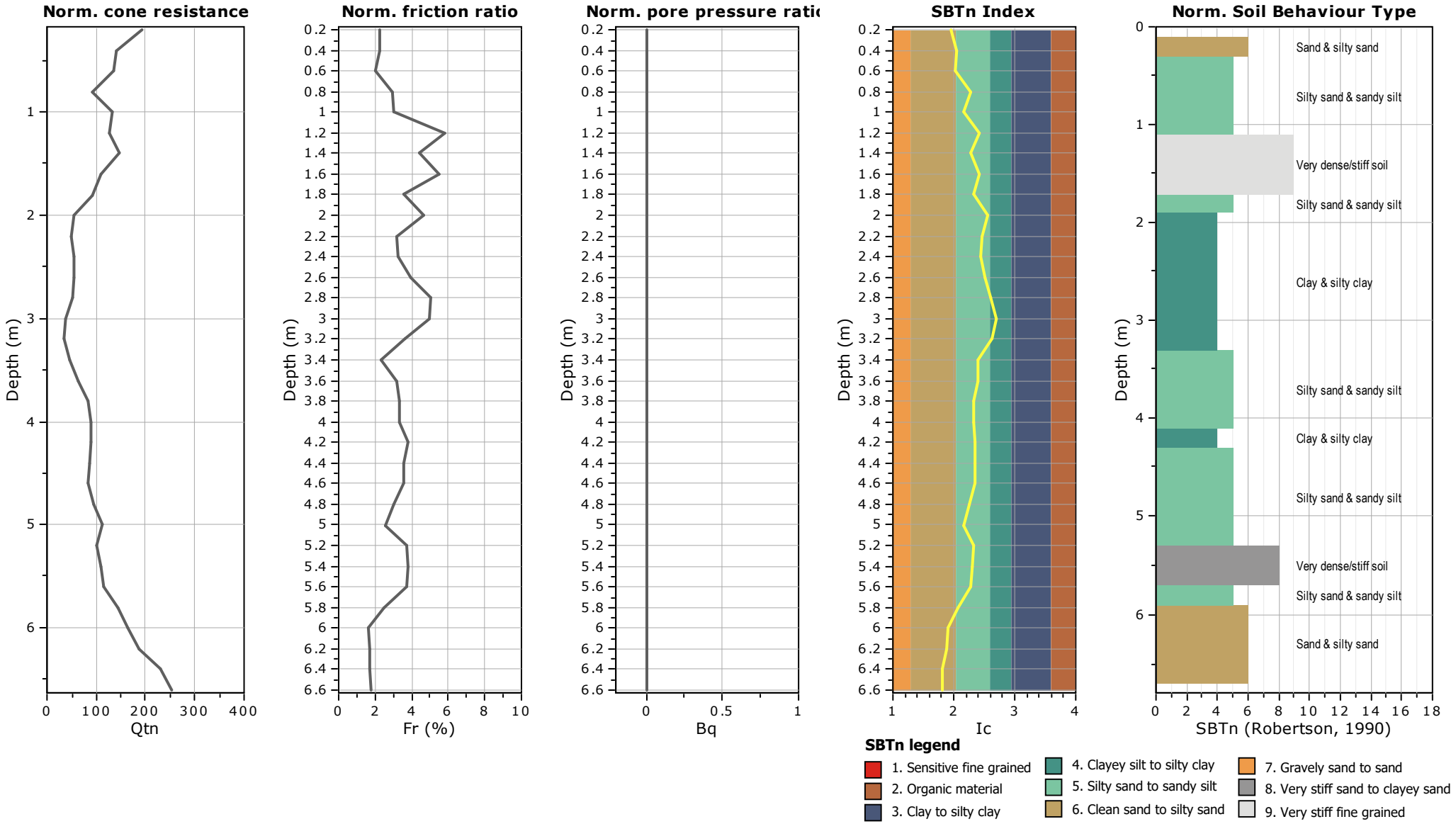
Project:
Location:



GHC-Projekt d.o.o.
Pristova 8
3204 Dobrna

CPT: CPT 1
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Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

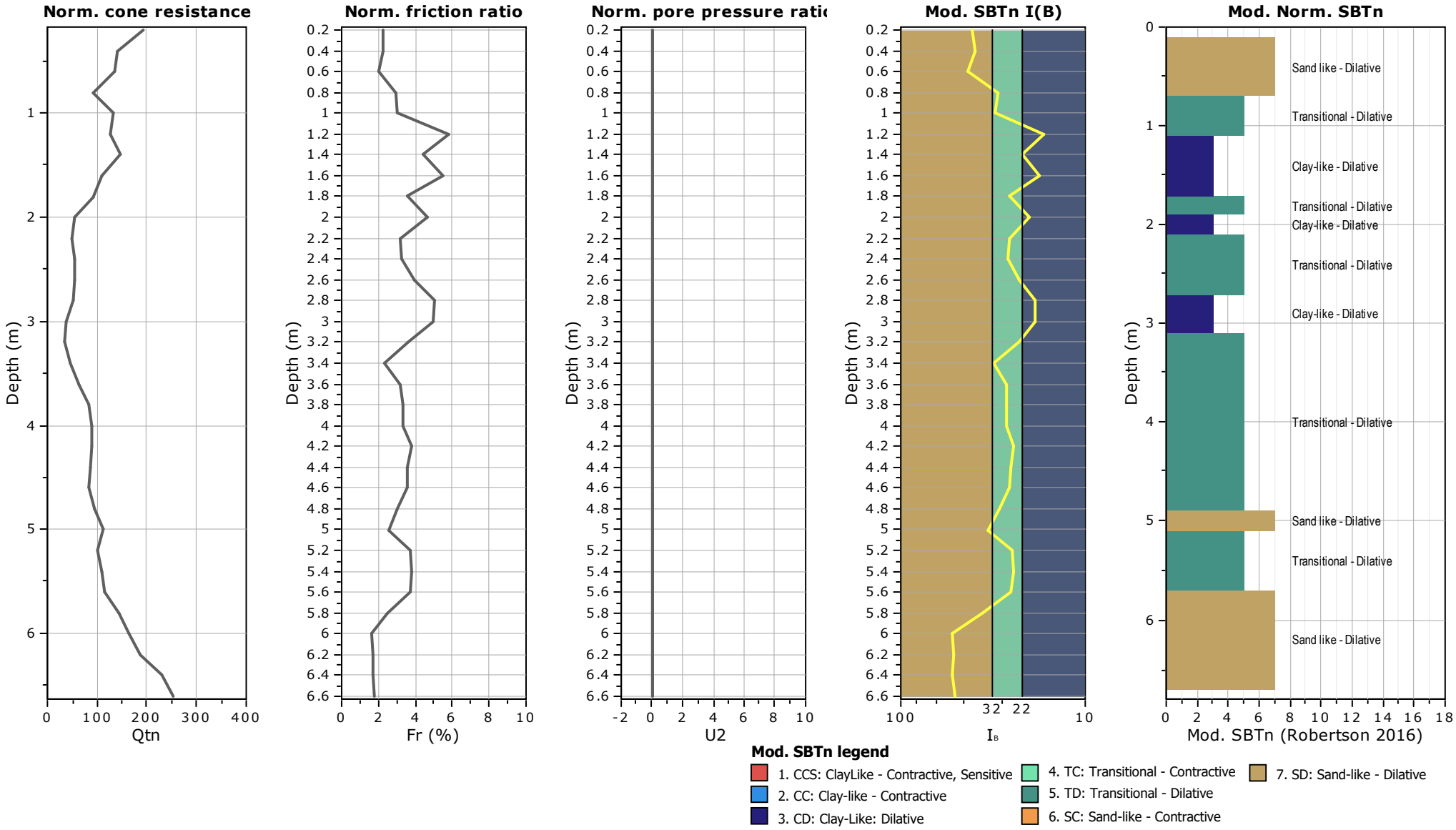
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Location:



GHC-Projekt d.o.o.
Pristova 8
3204 Dobrna

CPT: CPT 1
Total depth: 6.60 m, Date: 27. 03. 2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project:
Location:

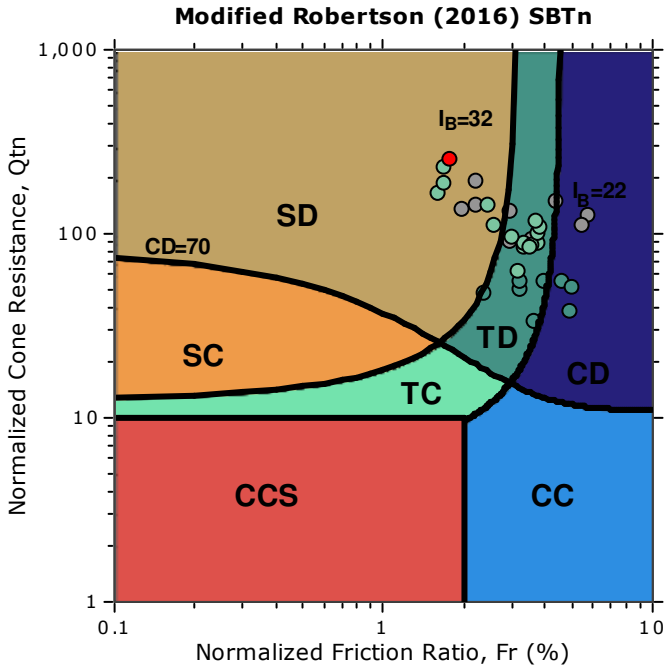


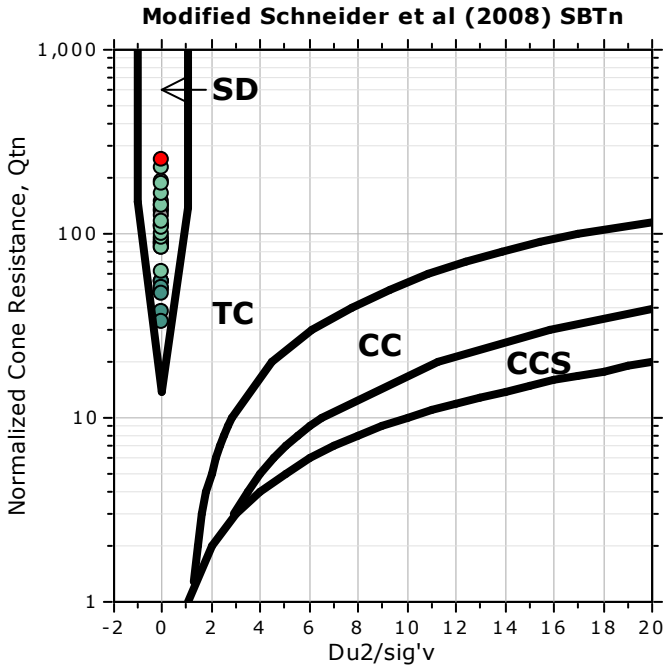
GHC-Projekt d.o.o.
Pristova 8
3204 Dobrna

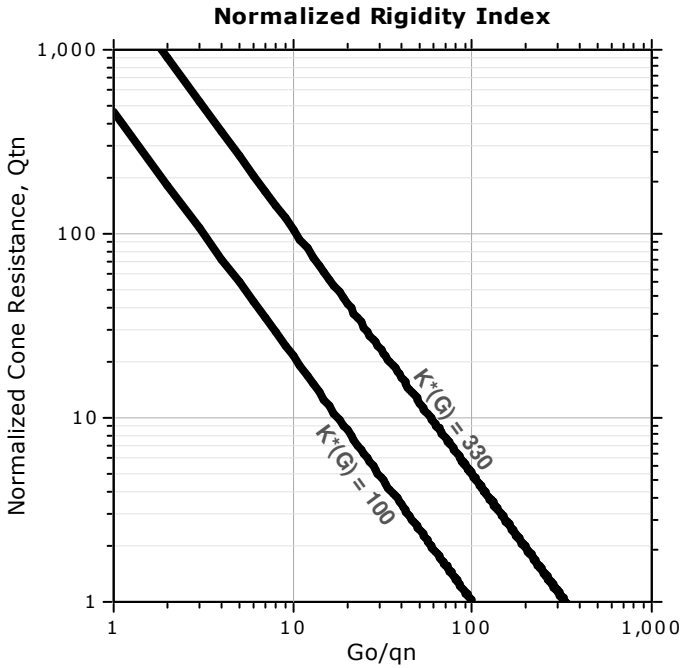
Project:
Location:

CPT: CPT 1
Total depth: 6.60 m, Date: 27. 03. 2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Updated SBTn plots







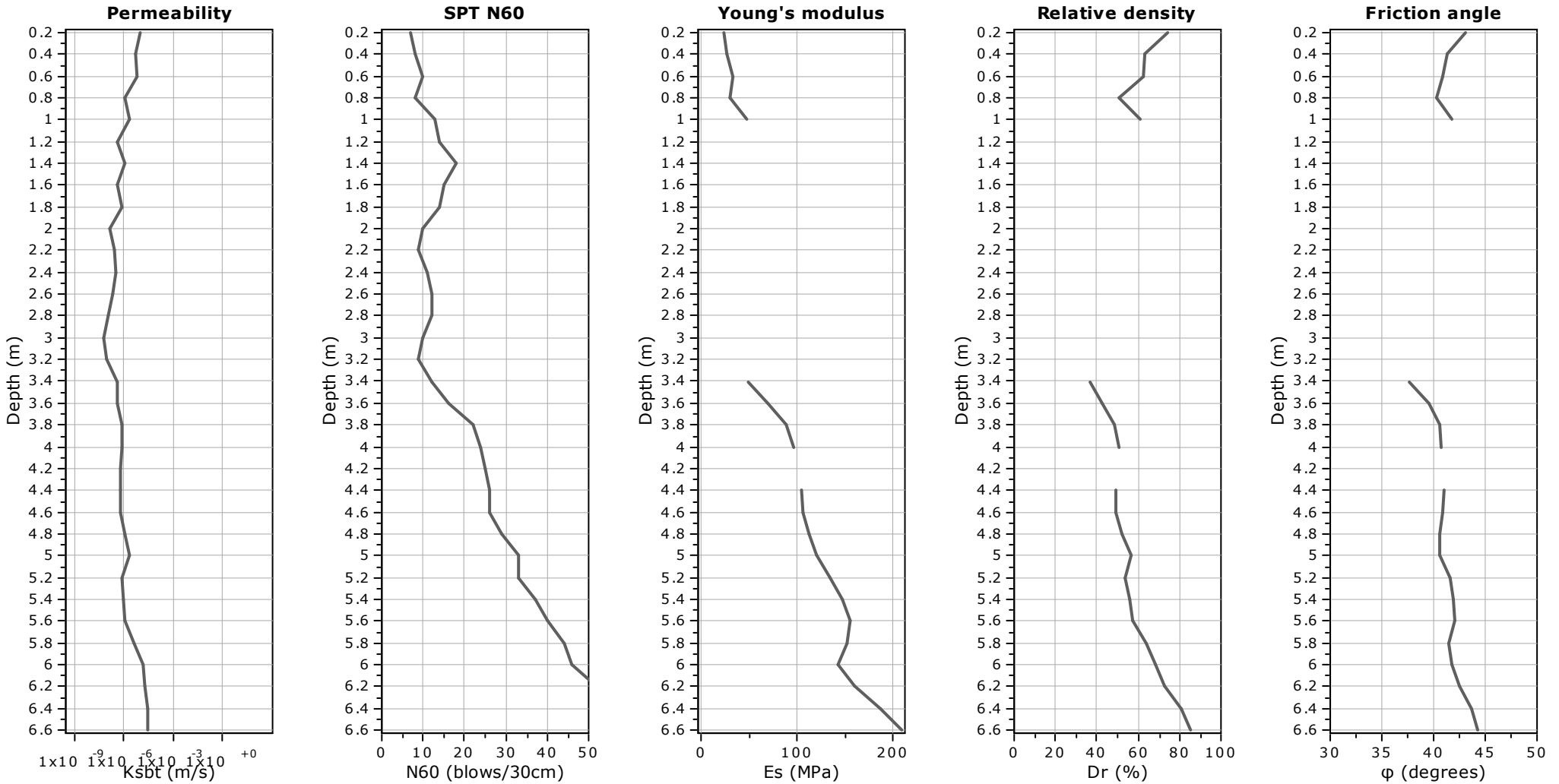
CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

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

GHC-Projekt d.o.o.
Pristova 8
3204 Dobrna

CPT: CPT 1
Total depth: 6.60 m, Date: 27. 03. 2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project:
Location:



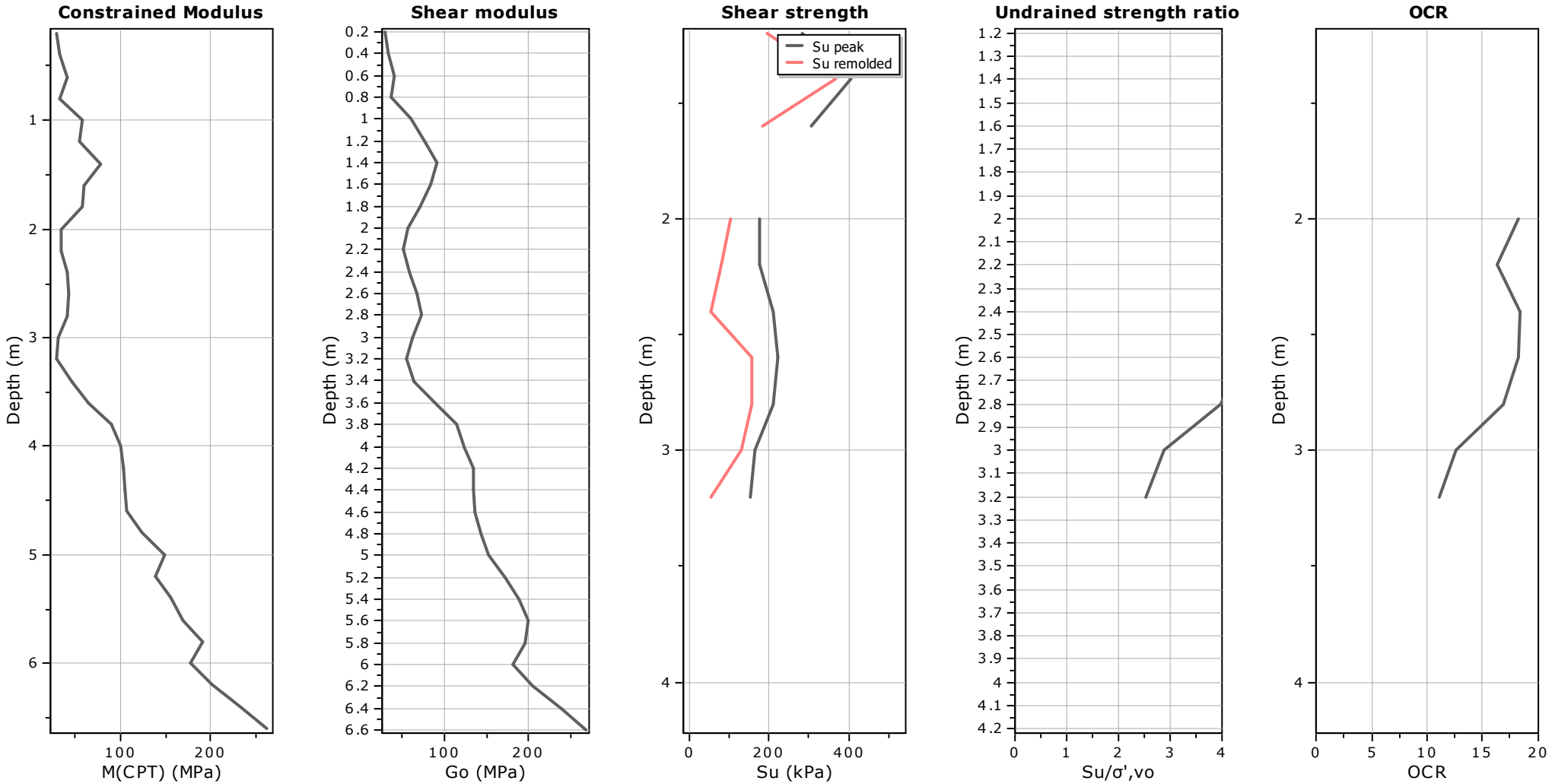
Calculation parameters

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)

GHC-Projekt d.o.o.
Pristova 8
3204 Dobrna

CPT: CPT 1
Total depth: 6.60 m, Date: 27. 03. 2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project:
Location:



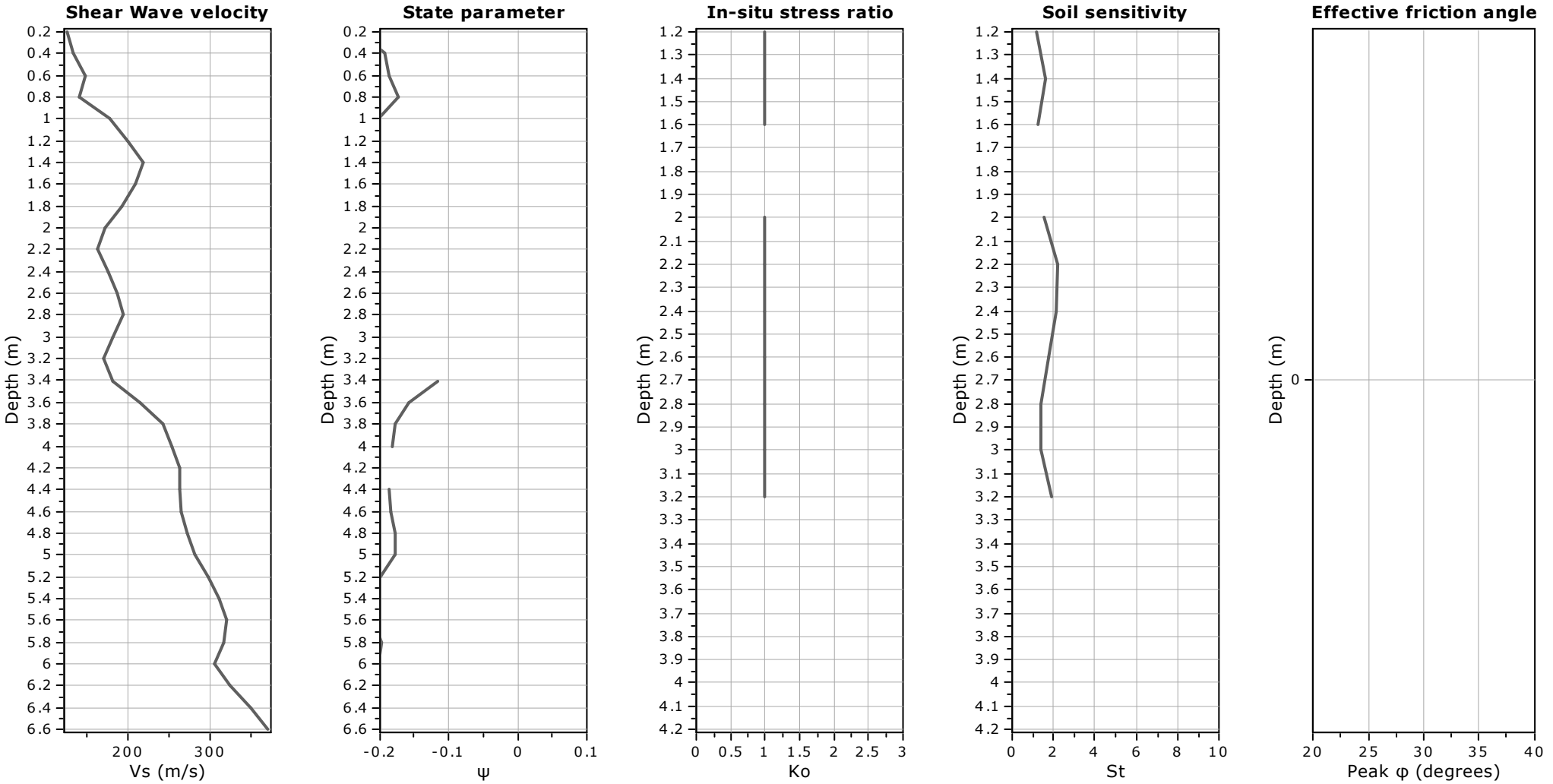
Calculation parameters

Constrained modulus: Based on variable *alpha* using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable *alpha* using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14
OCR factor for clays, N_{kt}: 0.33
Flat Dilatometer Test data

GHC-Projekt d.o.o.
Pristova 8
3204 Dobrna

CPT: CPT 1
Total depth: 6.60 m, Date: 27. 03. 2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project:
Location:



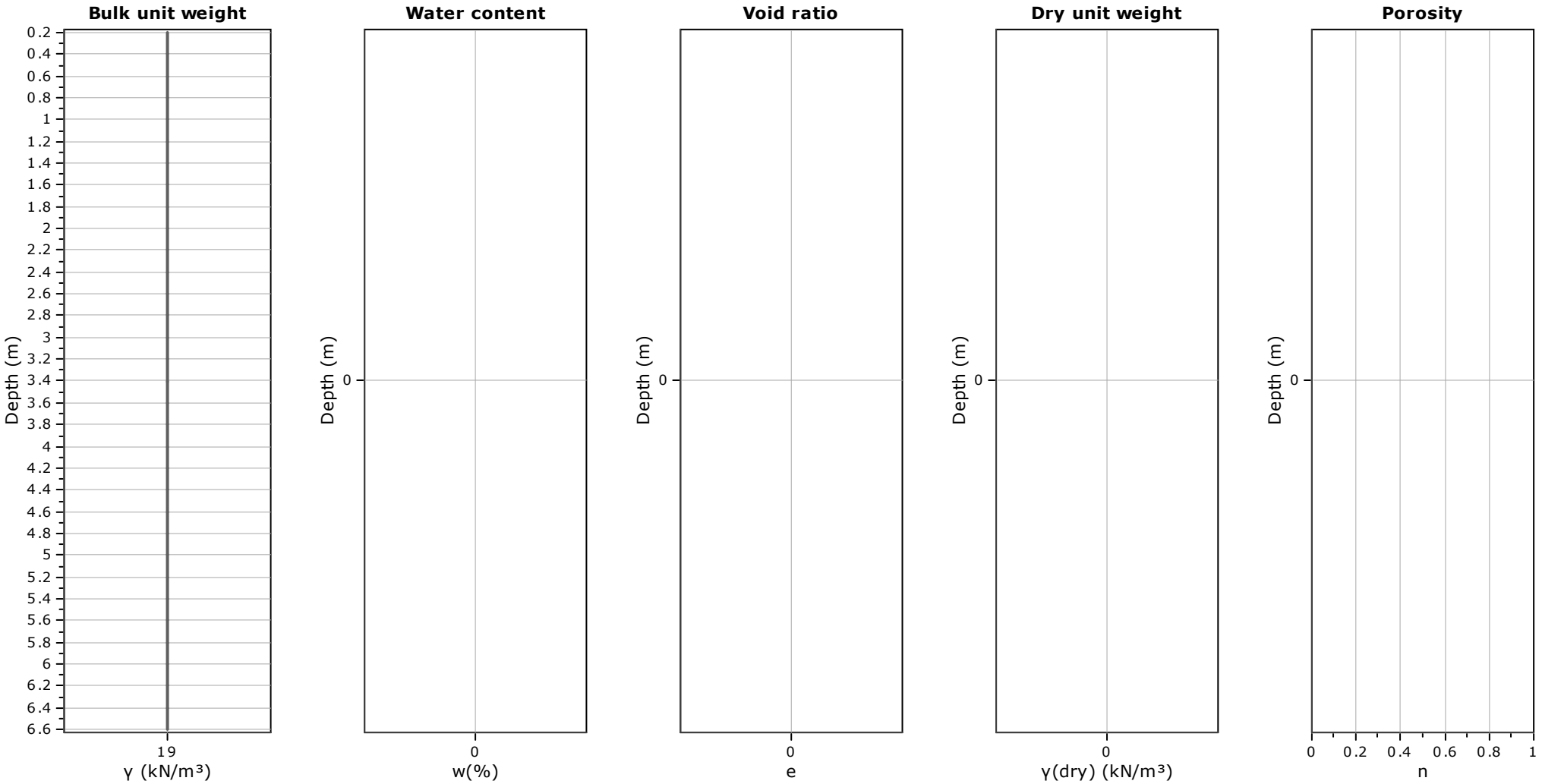
Calculation parameters

Soil Sensitivity factor, N_S: 7.00

GHC-Projekt d.o.o.
Pristova 8
3204 Dobrna

CPT: CPT 1
Total depth: 6.60 m, Date: 27. 03. 2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

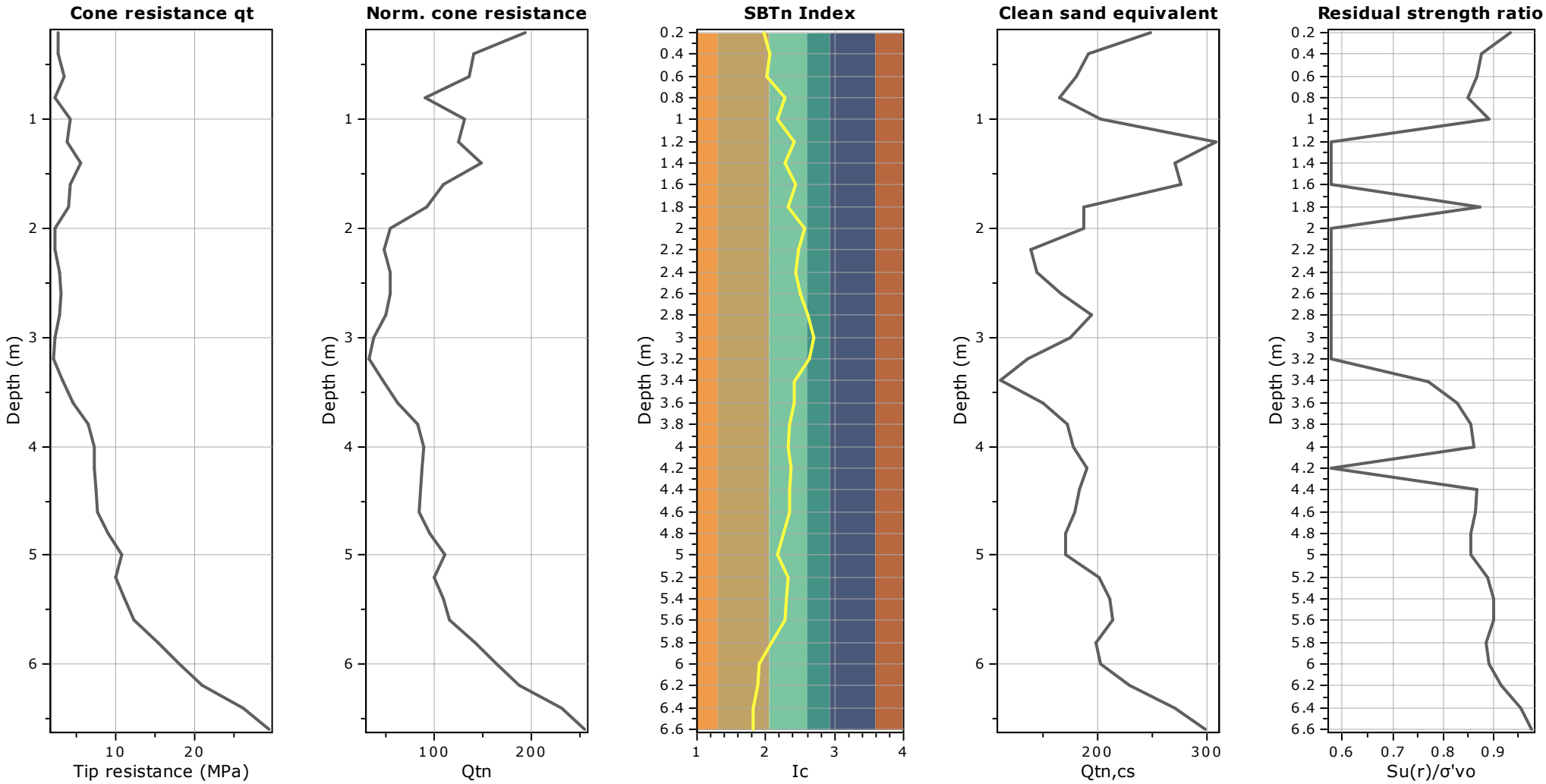
Project:
Location:

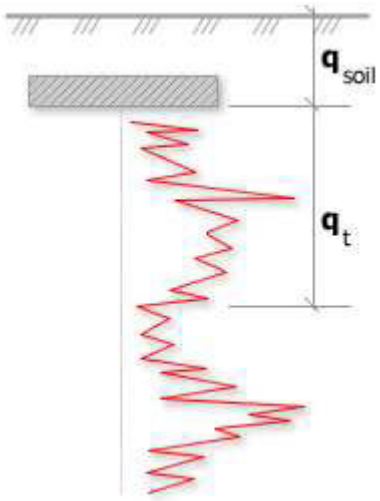


GHC-Projekt d.o.o.
Pristova 8
3204 Dobrna

CPT: CPT 1
Total depth: 6.60 m, Date: 27. 03. 2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project:
Location:

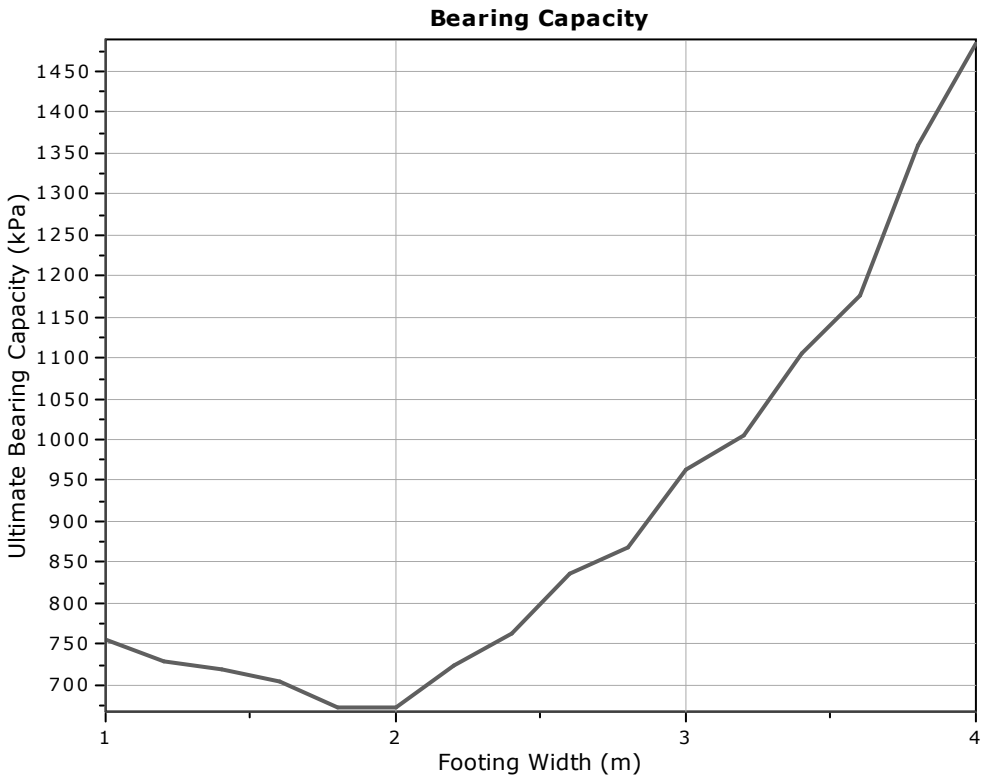




Bearing Capacity calculation is perfromed based on the formula:

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

where:
R_k: Bearing capacity factor
q_t: Average corrected cone resistance over calculation depth
q_{soil}: Pressure applied by soil above footing



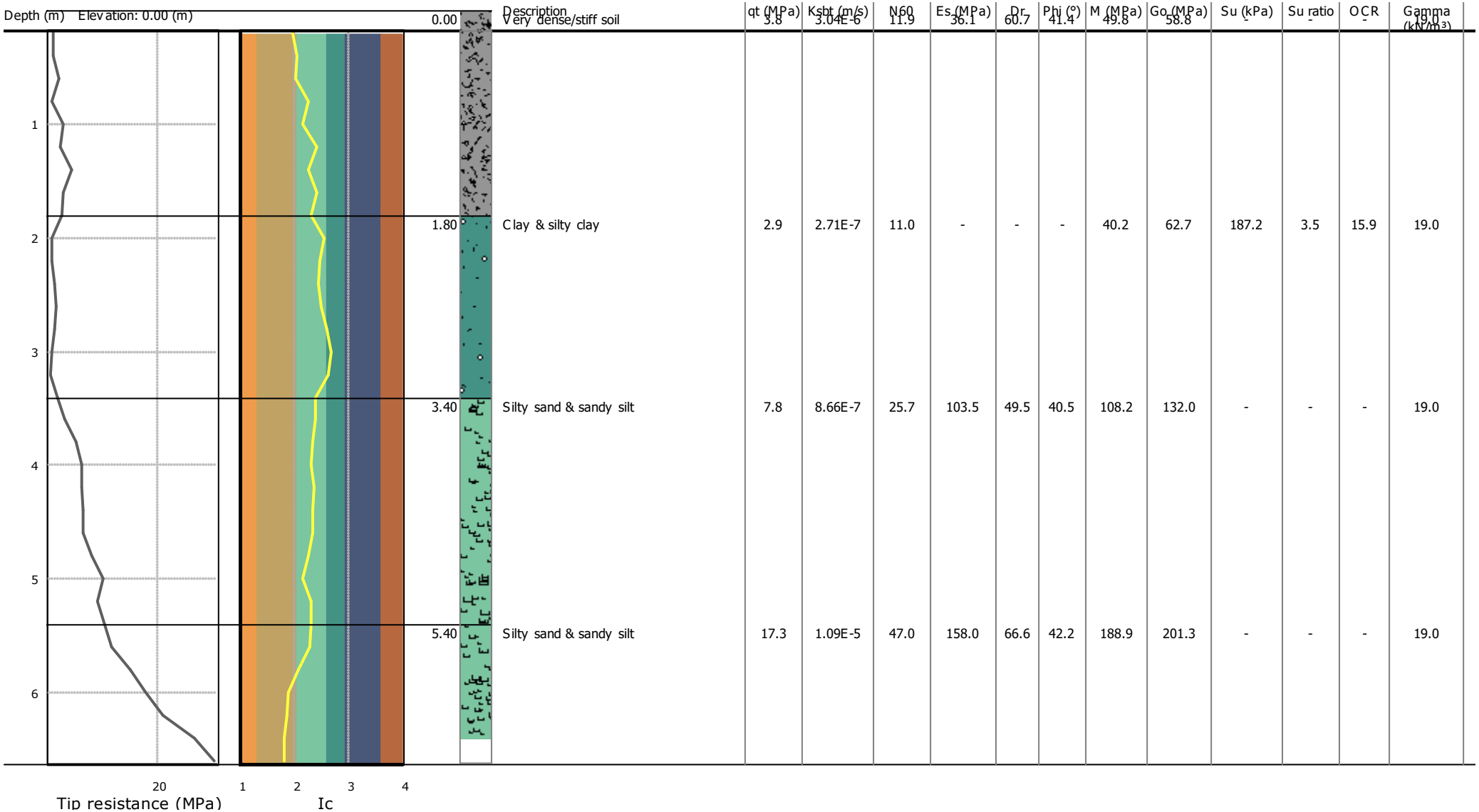
:: Tabular results ::

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	3.73	0.20	9.50	754.69
2	1.20	0.50	2.30	3.60	0.20	9.50	729.83
3	1.40	0.50	2.60	3.55	0.20	9.50	719.02
4	1.60	0.50	2.90	3.47	0.20	9.50	704.42
5	1.80	0.50	3.20	3.32	0.20	9.50	672.74
6	2.00	0.50	3.50	3.32	0.20	9.50	673.75
7	2.20	0.50	3.80	3.58	0.20	9.50	724.83
8	2.40	0.50	4.10	3.77	0.20	9.50	764.27
9	2.60	0.50	4.40	4.13	0.20	9.50	835.66
10	2.80	0.50	4.70	4.29	0.20	9.50	868.26
11	3.00	0.50	5.00	4.76	0.20	9.50	962.33
12	3.20	0.50	5.30	4.98	0.20	9.50	1004.78
13	3.40	0.50	5.60	5.48	0.20	9.50	1105.43
14	3.60	0.50	5.90	5.83	0.20	9.50	1176.50
15	3.80	0.50	6.20	6.74	0.20	9.50	1358.46
16	4.00	0.50	6.50	7.37	0.20	9.50	1483.65

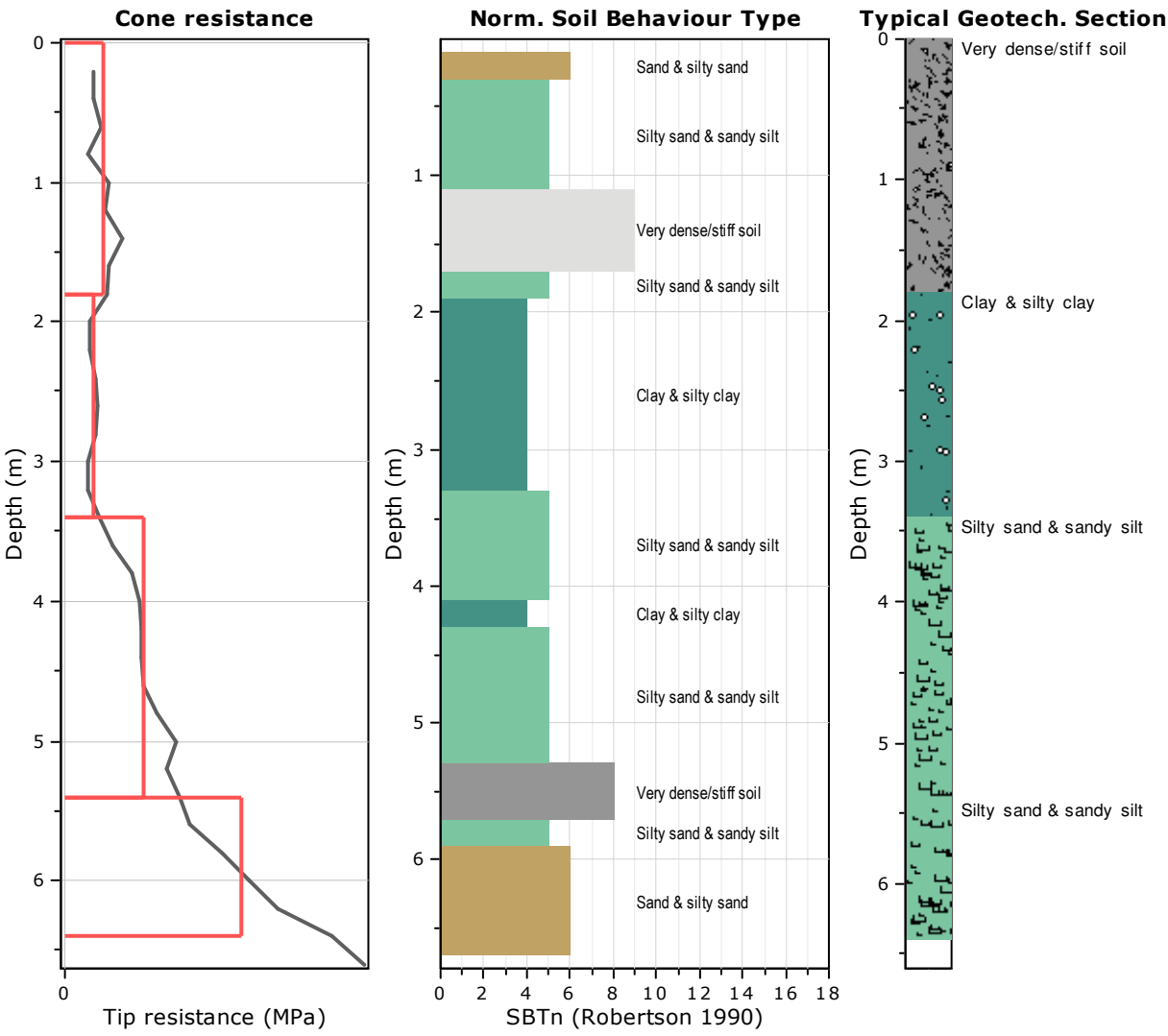
GHC-Projekt d.o.o.
Pristova 8
3204 Dobrna

CPT: CPT 1
Total depth: 6.60 m, Date: 27. 03. 2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project:
Location:



Depth (m)	Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
0.00	Very dense/stiff soil	3.8	3.04E-6	11.9	36.1	60.7	41.4	49.8	58.8	-	-	-	19.0
1.80	Clay & silty clay	2.9	2.71E-7	11.0	-	-	-	40.2	62.7	187.2	3.5	15.9	19.0
3.40	Silty sand & sandy silt	7.8	8.66E-7	25.7	103.5	49.5	40.5	108.2	132.0	-	-	-	19.0
5.40	Silty sand & sandy silt	17.3	1.09E-5	47.0	158.0	66.6	42.2	188.9	201.3	-	-	-	19.0



Tabular results

.:: Layer No: 1 ::.

Code: 1 **Start depth:** 0.00 (m), **End depth:** 1.80 (m)

Description: Very dense/stiff soil

Basic results	Estimation results	
Total cone resistance: 3.76 ±1.04 MPa	Permeability: 3.04E-06 ±3.28E-06 m/s	Constrained Mod.: 49.83 ±16.64 MPa
Sleeve friction: 140.93 ±106.18 kPa	N_{60}: 11.89 ±3.79 blows	Go: 58.82 ±23.63 MPa
Ic: 2.21 ±0.17	Es: 36.05 ±12.99 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 8	Dr (%): 60.66 ±8.67	Su ratio: 0.00 ±0.00
SBTn description: Very dense/stiff soil	φ (degrees): 41.40 ±0.93 °	O.C.R.: 0.00 ±0.00
	Unit weight: 19.00 ±0.00 kN/m³	

.:: Layer No: 2 ::.

Code: 2 **Start depth:** 1.80 (m), **End depth:** 3.40 (m)

Description: Clay & silty clay

Basic results	**Estimation results**	
Total cone resistance: 2.92 ±0.62 MPa	Permeability: 2.71E-07 ±2.26E-07 m/s	Constrained Mod.: 40.18 ±8.73 MPa
Sleeve friction: 104.60 ±47.15 kPa	N_{60}: 11.00 ±1.66 blows	Go: 62.67 ±7.43 MPa
Ic: 2.52 ±0.12	Es: 0.00 ±0.00 MPa	Su: 187.22 ±26.54 kPa
SBT_n: 4	Dr (%): 0.00 ±0.00	Su ratio: 3.45 ±0.64
SBTn description: Clay & silty clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 15.94 ±2.95
	Unit weight: 19.00 ±0.00 kN/m³	

.:: Layer No: 3 ::.

Code: 3 **Start depth:** 3.40 (m), **End depth:** 5.40 (m)

Description: Silty sand & sandy silt

Basic results	**Estimation results**	
Total cone resistance: 7.81 ±2.43 MPa	Permeability: 8.66E-07 ±5.24E-07 m/s	Constrained Mod.: 108.17 ±33.78 MPa
Sleeve friction: 259.13 ±120.10 kPa	N_{60}: 25.73 ±7.38 blows	Go: 132.04 ±35.05 MPa
Ic: 2.32 ±0.07	Es: 103.49 ±28.99 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 5	Dr (%): 49.49 ±6.04	Su ratio: 0.00 ±0.00
SBTn description: Silty sand & sandy silt	φ (degrees): 40.50 ±1.20 °	O.C.R.: 0.00 ±0.00
	Unit weight: 19.00 ±0.00 kN/m³	

.:: Layer No: 4 ::.

Code: 4 **Start depth:** 5.40 (m), **End depth:** 6.40 (m)

Description: Silty sand & sandy silt

Basic results	**Estimation results**	
Total cone resistance: 17.35 ±5.61 MPa	Permeability: 1.09E-05 ±1.04E-05 m/s	Constrained Mod.: 188.88 ±27.54 MPa
Sleeve friction: 400.98 ±127.76 kPa	N_{60}: 47.00 ±9.38 blows	Go: 201.32 ±20.04 MPa
Ic: 2.04 ±0.21	Es: 157.98 ±15.73 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 5	Dr (%): 66.64 ±9.61	Su ratio: 0.00 ±0.00
SBTn description: Silty sand & sandy silt	φ (degrees): 42.23 ±0.77 °	O.C.R.: 0.00 ±0.00
	Unit weight: 19.00 ±0.00 kN/m³	

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_O (MPa)	Undrained strength, S_U (kPa)	Undrained strength ratio	OCR	Unit weight (kN/m³)
0.00	1.80	3.04E-06	11.9	36.1	60.7	41.4	49.8	58.8	0.0	0.0	0.0	19.0
1.80		(±3.28E-06)	(±3.8)	(±13.0)	(±8.7)	(±0.9)	(±16.6)	(±23.6)	(±0.0)	(±0.0)	(±0.0)	(±0.0)
1.80	1.60	2.71E-07	11.0	0.0	0.0	0.0	40.2	62.7	187.2	3.5	15.9	19.0
3.40		(±2.26E-07)	(±1.7)	(±0.0)	(±0.0)	(±0.0)	(±8.7)	(±7.4)	(±26.5)	(±0.6)	(±3.0)	(±0.0)
3.40	2.00	8.66E-07	25.7	103.5	49.5	40.5	108.2	132.0	0.0	0.0	0.0	19.0
5.40		(±5.24E-07)	(±7.4)	(±29.0)	(±6.0)	(±1.2)	(±33.8)	(±35.0)	(±0.0)	(±0.0)	(±0.0)	(±0.0)
5.40	1.00	1.09E-05	47.0	158.0	66.6	42.2	188.9	201.3	0.0	0.0	0.0	19.0
6.40		(±1.04E-05)	(±9.4)	(±15.7)	(±9.6)	(±0.8)	(±27.5)	(±20.0)	(±0.0)	(±0.0)	(±0.0)	(±0.0)

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) ::

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

where g_w = water unit weight

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

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

$I_c \leq 4.00$ and $I_c > 3.27$ 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, Es (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 (%) ::

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

:: State Parameter, ψ ::

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

:: Drained Friction Angle, φ (°) ::

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

(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, Go (MPa) ::

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

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

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

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

$N_{kt} = 10.50 + 7 \cdot \log(F_r)$ 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, Su(rem) (kPa) ::

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

:: Overconsolidation Ratio, OCR ::

$$k_{OCR} = \left[\frac{Q_{tn}^{0.20}}{0.25 \cdot (10.50 \cdot +7 \cdot \log(F_r))} \right]^{1.25}$$ 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, Ko ::

$K_O = (1 - \sin\varphi') \cdot OCR^{\sin\varphi'}$

(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' (°) ::

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

(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)

• N Barounis, J Philpot, Estimation of in-situ water content, void ratio, dry unit weight and porosity using CPT for saturated sands, Proc. 20th NZGS Geotechnical Symposium

R.5. ANALIZA STABILNOSTI

Slope stability analysis

Input data

Project

Task : Analiza stabilnosti
Customer : Občina Braslovče
Author : Martin Škoflek
Date : 27. 03. 2024
Project ID : GG 26-1-24

Settings

Slovenia - EN 1997

Stability analysis

Earthquake analysis : Standard
Verification methodology : according to EN 1997
Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

Partial factors on actions (A)

Permanent design situation

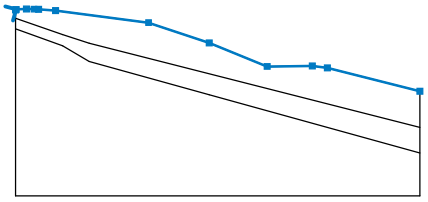
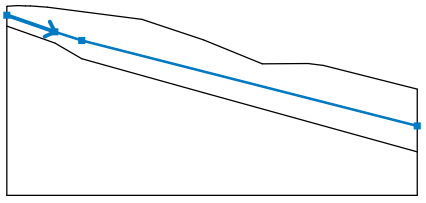
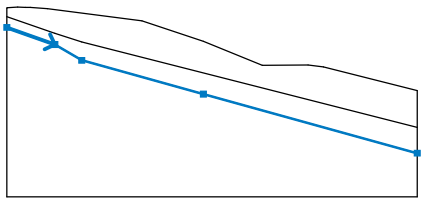
		State STR				State GEO			
		Unfavourable		Favourable		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.00	[–]	1.00	[–]	1.00	[–]	1.00	[–]
Variable actions :	γ_Q =	1.50	[–]	0.00	[–]	1.30	[–]	0.00	[–]
Water load :	γ_w =					1.00	[–]		

Partial factors for soil parameters (M)

Permanent design situation

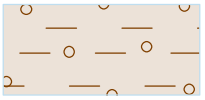
Partial factor on internal friction :	γ_ϕ =	1.25	[–]
Partial factor on effective cohesion :	γ_c =	1.25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1.40	[–]

Interface

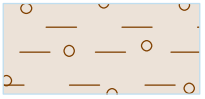
No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		16.50	10.80	16.59	10.85	17.77	10.91
		18.65	10.89	19.18	10.86	21.16	10.72
		31.97	9.32	39.02	6.97	45.77	4.22
		51.02	4.28	52.77	4.06	63.52	1.33
2		16.50	9.82	22.00	7.91	25.08	6.91
		63.52	-2.88				
3		16.50	8.58	22.00	6.62	25.08	4.81
		39.02	0.93	63.52	-5.83		

[GEO5 - Slope Stability | version 5.2017.79.0 | hardware key 9183 / 2 | GHC-projekt d.o.o. | Copyright © 2019 Fine spol. s r.o. All Rights Reserved | www.finesoftware.eu]
[Geoportal d.o.o. | | info@geoportal.si| http://www.geoportal.si]

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
1	gruščnata glina židke do srednje gnetne konsistence		12.00	1.00	16.00
2	glina poltrdne do trdne konsistence		25.00	10.00	20.00
3	preperina laporja		35.00	20.00	22.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	n [–]
1	gruščnata glina židke do srednje gnetne konsistence		17.00		
2	glina poltrdne do trdne konsistence		20.50		
3	preperina laporja		22.00		

Soil parameters

gruščnata glina židke do srednje gnetne konsistence

Unit weight : γ = 16.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 12.00 °
Cohesion of soil : c_{ef} = 1.00 kPa
Saturated unit weight : γ_{sat} = 17.00 kN/m^3

glina poltrdne do trdne konsistence

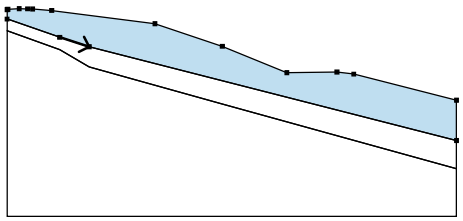
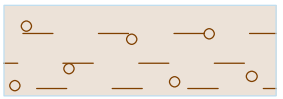
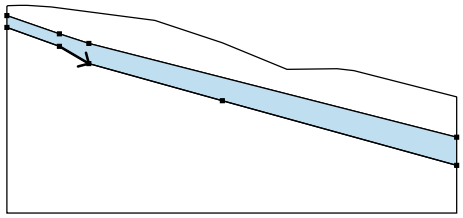
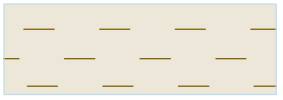
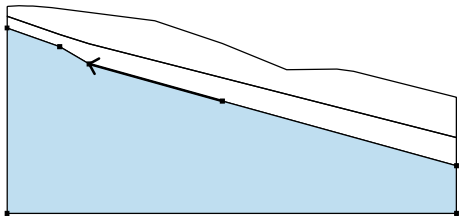
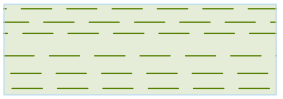
Unit weight : γ = 20.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Saturated unit weight : γ_{sat} = 20.50 kN/m^3

preperina laporja

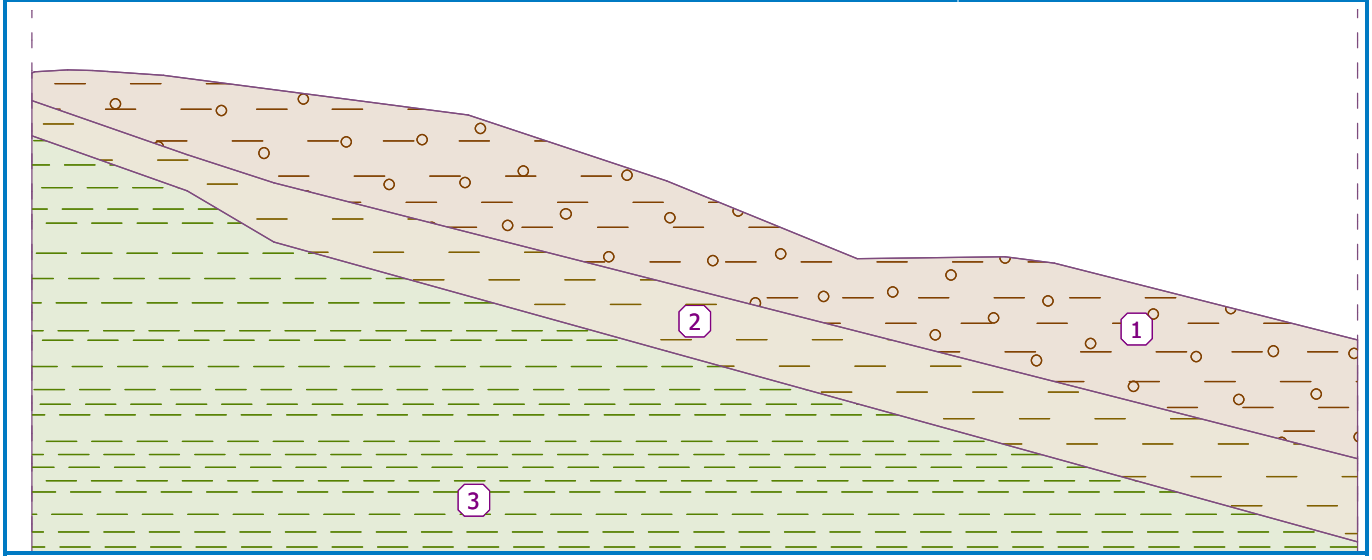
Unit weight : γ = 22.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 35.00 °
Cohesion of soil : c_{ef} = 20.00 kPa
Saturated unit weight : γ_{sat} = 22.00 kN/m^3

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Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		22.00	7.91	25.08	6.91	gruščnata glina židke do srednje gnetne konsistence
		63.52	-2.88	63.52	1.33	
		52.77	4.06	51.02	4.28	
		45.77	4.22	39.02	6.97	
		31.97	9.32	21.16	10.72	
		19.18	10.86	18.65	10.89	
		17.77	10.91	16.59	10.85	
		16.50	10.80	16.50	9.82	
2		22.00	6.62	25.08	4.81	glina poltrdne do trdne konsistence
		39.02	0.93	63.52	-5.83	
		63.52	-2.88	25.08	6.91	
		22.00	7.91	16.50	9.82	
		16.50	8.58			
3		39.02	0.93	25.08	4.81	preperina laporja
		22.00	6.62	16.50	8.58	
		16.50	-10.83	63.52	-10.83	
		63.52	-5.83			

Name : Soils and assignment | **Stage : 1**



Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

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Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1 (stage 1)

Circular slip surface

Slip surface parameters							
Center :	x =	44.37	[m]	Angles :	α_1 =	-29.98	[°]
	z =	53.76	[m]		α_2 =	1.63	[°]
Radius :	R =	49.56	[m]				
The slip surface after optimization.							

The restrictions of points of circular slip surface

Keep the left end point of the slip surface

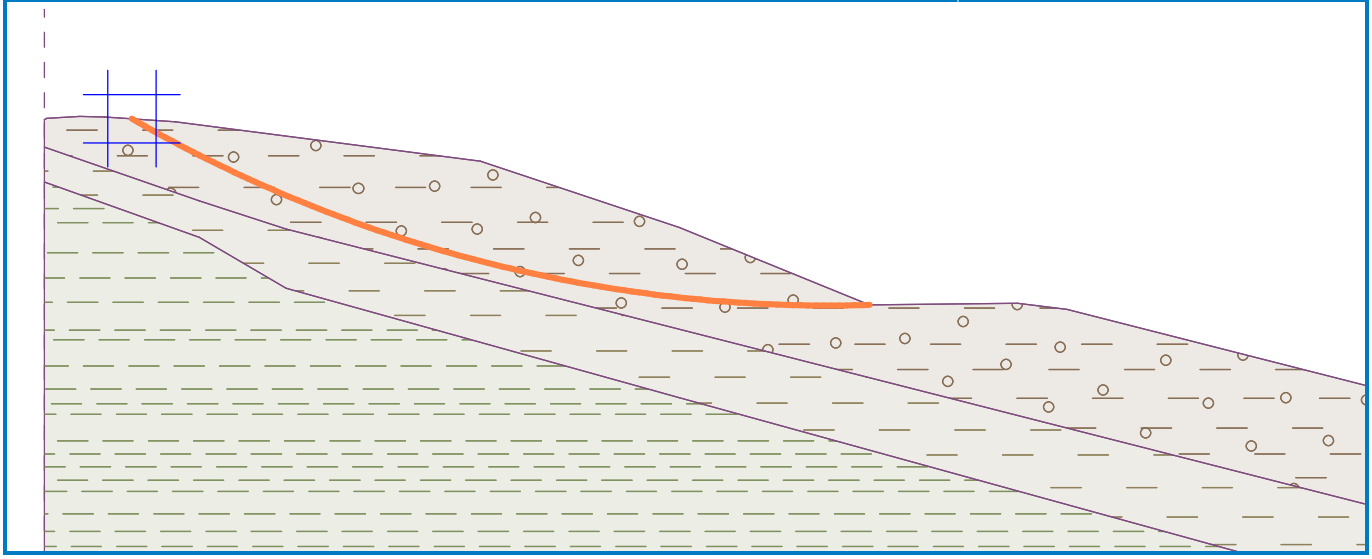
Slope stability verification (Bishop)

Sum of active forces : F_a = 216.56 kN/m
Sum of passive forces : F_p = 173.80 kN/m

Sliding moment : M_a = 10732.66 kNm/m
Resisting moment : M_p = 8613.32 kNm/m
Utilization : 124.6 %

Slope stability NOT ACCEPTABLE

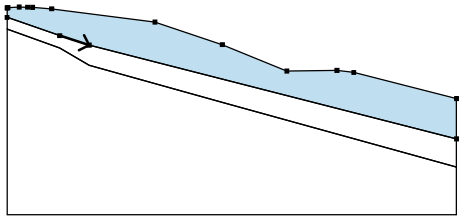
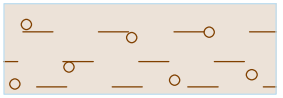
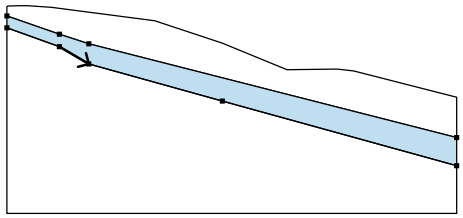
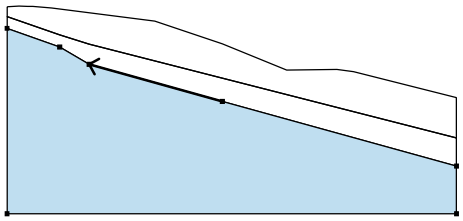
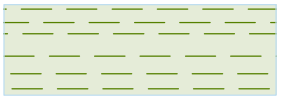
Name : Analysis	Stage - analysis : 1 - 1



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Input data (Stage of construction 2)

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
1		22.00	7.91	25.08	6.91	gruščnata glina židke do srednje gnetne konsistence
		63.52	-2.88	63.52	1.33	
		52.77	4.06	51.02	4.28	
		45.77	4.22	39.02	6.97	
		31.97	9.32	21.16	10.72	
		19.18	10.86	18.65	10.89	
		17.77	10.91	16.59	10.85	
		16.50	10.80	16.50	9.82	
2		22.00	6.62	25.08	4.81	glina poltrdne do trdne konsistence
		39.02	0.93	63.52	-5.83	
		63.52	-2.88	25.08	6.91	
		22.00	7.91	16.50	9.82	
		16.50	8.58			
3		39.02	0.93	25.08	4.81	preperina laporja
		22.00	6.62	16.50	8.58	
		16.50	-10.83	63.52	-10.83	
		63.52	-5.83			

Anti-Slide piles

No.	Anti-Slide pile new	Point x [m]	z [m]	Length l [m]	Pile spacing b [m]	Cross-section [m]	Pile bearing capacity Distribution along the pile	Max. bearing capacity V_u [kN]	Gradient K [–]	Passive force direction
1	Yes	21.40	10.69	9.00	1.50	d = 0.80	linear	1000.00	1.00	perpendicular to pile

Surcharge

No.	Surcharge new	change	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q_1, f, F	q_2	unit
1	Yes		strip	variable	on terrain	x = 18.50	l = 2.00		0.00	9.00		kN/m^2
2	Yes		concentrated	variable	on terrain	x = 18.50	l = 0.50	b = 0.32		65.00		kN
3	Yes		concentrated	variable	on terrain	x = 20.00	l = 0.50	b = 0.32		65.00		kN

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

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Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 2)

Analysis 1 (stage 2)

Circular slip surface

Slip surface parameters							
Center :	x =	56.72	[m]	Angles :	α_1 =	-28.74	[°]
	z =	78.61	[m]		α_2 =	4.43	[°]
Radius :	R =	77.30	[m]				
The slip surface after optimization.							

The restrictions of points of circular slip surface

Keep the left end point of the slip surface

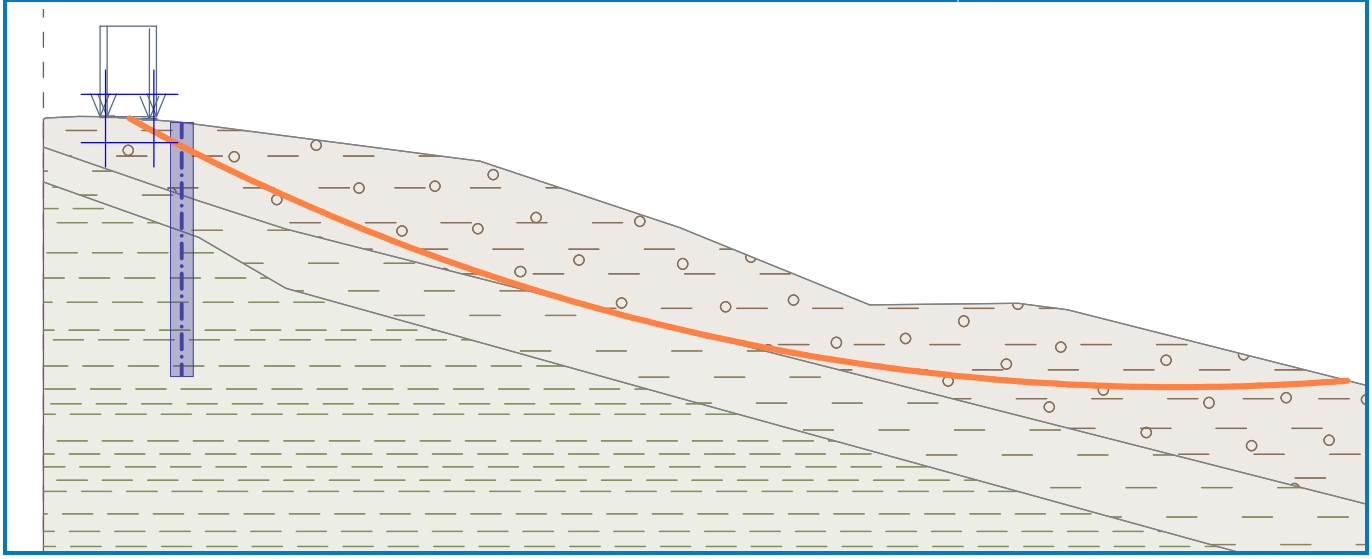
Slope stability verification (Bishop)

Sum of active forces : F_a = 425.19 kN/m
Sum of passive forces : F_p = 886.83 kN/m

Sliding moment : M_a = 32867.05 kNm/m
Resisting moment : M_p = 68552.20 kNm/m
Utilization : 47.9 %

Slope stability ACCEPTABLE

Name : Analysis	Stage - analysis : 2 - 1



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Slope stability analysis

Input data

Project

Task : Povratna analiza
Customer : Občina Braslovče
Author : Martin Škoflek
Date : 27. 03. 2024
Project ID : GG 26-1-24

Settings

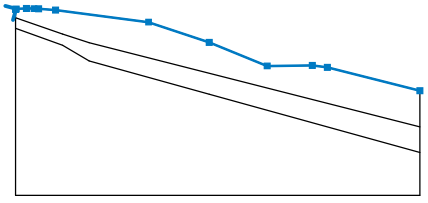
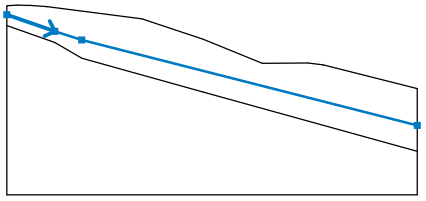
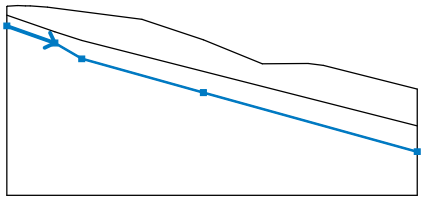
Standard - no reduction of parameters

Stability analysis

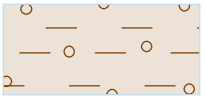
Earthquake analysis : Standard
Verification methodology : Limit states (LSD)

Reduction coeff. of soil parameters			
Permanent design situation			
Reduction coeff. of internal friction :	$\gamma_{m\varphi}$ =	1.00	[–]
Reduction coeff. of cohesion :	γ_{mc} =	1.00	[–]
Reduction coeff. of overall stability of construction :	γ_s =	1.00	[–]

Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		16.50	10.80	16.59	10.85	17.77	10.91
		18.65	10.89	19.18	10.86	21.16	10.72
		31.97	9.32	39.02	6.97	45.77	4.22
		51.02	4.28	52.77	4.06	63.52	1.33
2		16.50	9.82	22.00	7.91	25.08	6.91
		63.52	-2.88				
3		16.50	8.58	22.00	6.62	25.08	4.81
		39.02	0.93	63.52	-5.83		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
1	gruščnata glina židke do srednje gnetne konsistence		12.00	1.00	16.00

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No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
2	glina poltrdne do trdne konsistence		25.00	10.00	20.00
3	preperina laporja		35.00	20.00	22.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	n [–]
1	gruščnata glina židke do srednje gnetne konsistence		17.00		
2	glina poltrdne do trdne konsistence		20.50		
3	preperina laporja		22.00		

Soil parameters

gruščnata glina židke do srednje gnetne konsistence

Unit weight : γ = 16.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 12.00 °
Cohesion of soil : c_{ef} = 1.00 kPa
Saturated unit weight : γ_{sat} = 17.00 kN/m^3

glina poltrdne do trdne konsistence

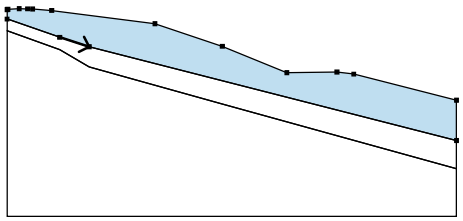
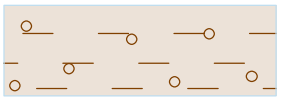
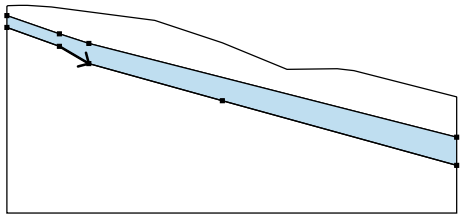
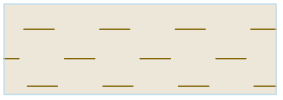
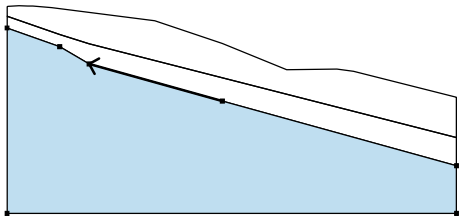
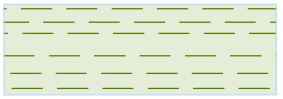
Unit weight : γ = 20.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Saturated unit weight : γ_{sat} = 20.50 kN/m^3

preperina laporja

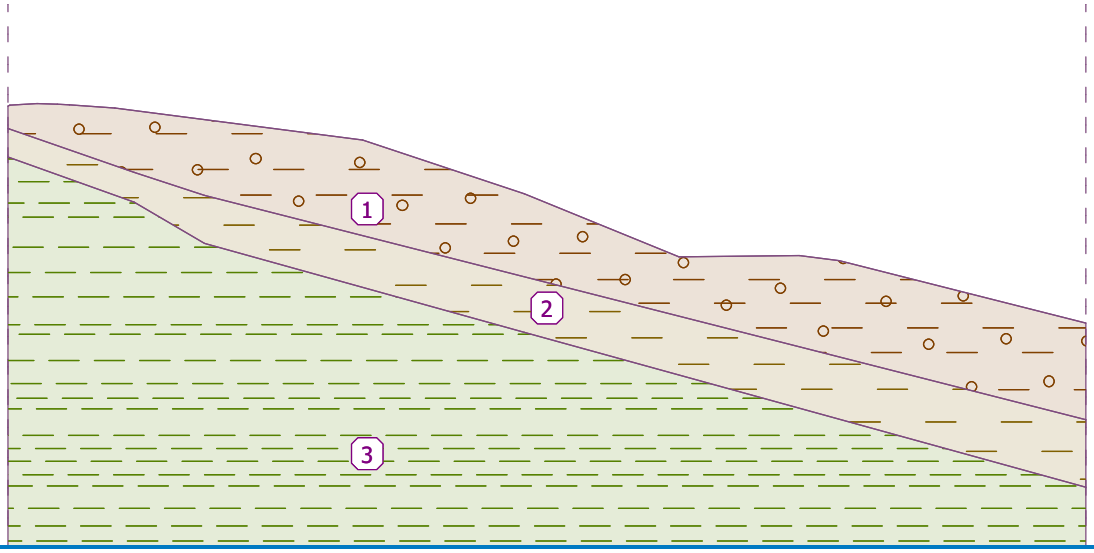
Unit weight : γ = 22.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 35.00 °
Cohesion of soil : c_{ef} = 20.00 kPa
Saturated unit weight : γ_{sat} = 22.00 kN/m^3

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Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		22.00	7.91	25.08	6.91	gruščnata glina židke do srednje gnetne konsistence
		63.52	-2.88	63.52	1.33	
		52.77	4.06	51.02	4.28	
		45.77	4.22	39.02	6.97	
		31.97	9.32	21.16	10.72	
		19.18	10.86	18.65	10.89	
		17.77	10.91	16.59	10.85	
		16.50	10.80	16.50	9.82	
2		22.00	6.62	25.08	4.81	glina poltrdne do trdne konsistence
		39.02	0.93	63.52	-5.83	
		63.52	-2.88	25.08	6.91	
		22.00	7.91	16.50	9.82	
		16.50	8.58			
3		39.02	0.93	25.08	4.81	preperina laporja
		22.00	6.62	16.50	8.58	
		16.50	-10.83	63.52	-10.83	
		63.52	-5.83			

Name : Soils and assignment | **Stage : 1**



Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

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Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	44.37	[m]	Angles :	α_1 =	-29.98	[°]
	z =	53.76	[m]		α_2 =	1.63	[°]
Radius :	R =	49.56	[m]				
The slip surface after optimization.							

The restrictions of points of circular slip surface

Keep the left end point of the slip surface

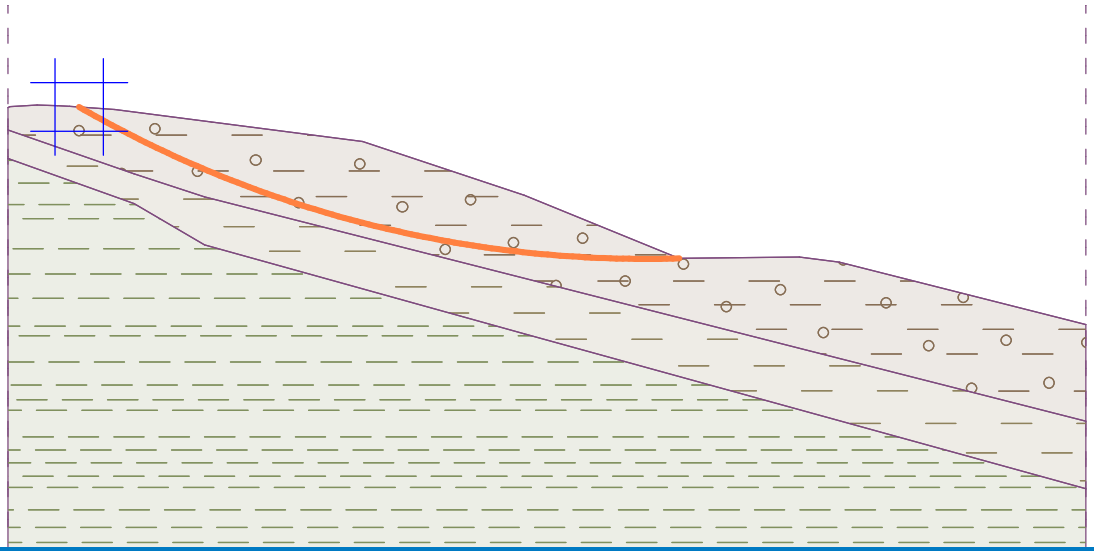
Slope stability verification (Bishop)

Sum of active forces : F_a = 216.56 kN/m
Sum of passive forces : F_p = 217.24 kN/m

Sliding moment : M_a = 10732.66 kNm/m
Resisting moment : M_p = 10766.63 kNm/m
Utilization : 99.7 %

Slope stability ACCEPTABLE

Name : Analysis	Stage - analysis : 1 - 1



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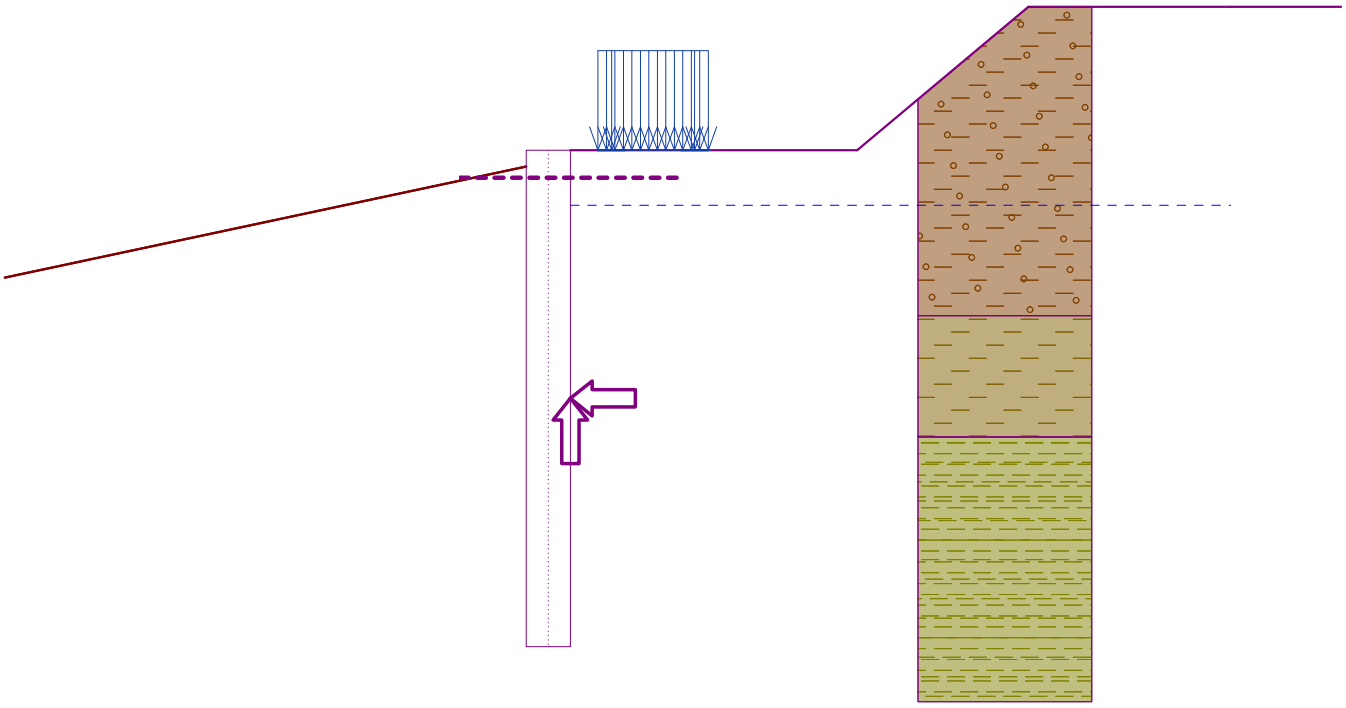
R.6. ANALIZA PILOTNE STENE

Analysis of anti-slide pile

Input data

Task : Analiza pilotne stene
Customer : Občina Braslovče
Author : Martin Škoflek
Date : 27. 03. 2024
Project ID : GG 26-1-24

Name : Project	Stage - analysis : 1 - 0



Settings

Slovenia - EN 1997

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : γ_{M0} = 1.00

Pressure analysis

Verification methodology : according to EN 1997
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Caquot-Kerisel
Earthquake analysis : Mononobe-Okabe
Modulus of subsoil reaction : standard
Consider reduction of the modulus of subsoil reaction for a braced sheeting
Pressures below the slip surface : standard
Design approach : 2 - reduction of actions and resistances

Partial factors on actions (A)					
Permanent design situation					
		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.35	[–]	1.00	[–]

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Partial factors on actions (A)					
Permanent design situation					
Variable actions :	γ_Q =	1.50	[–]	0.00	[–]
Water load :	γ_w =	1.35	[–]		

Partial factors for resistances (R)			
Permanent design situation			
Partial factor on earth resistance :	γ_{Re} =	1.40	[–]

Anchors

Verification methodology : Limit states (LSD)

Reduction coefficients			
Reduction. coeff of steel strength :	γ_s =	1.35	[–]
Reduction coefficient of pull out resistance (soil) :	γ_e =	1.35	[–]
Reduction coefficient of pull out resistance (grouting) :	γ_c =	1.35	[–]

Geometry of structure

Structure length = 9.00 m

Cross-section name : Pile curtain d = 0.80 m, a = 1.50 m
Material of pile : concrete
Computed coefficient of pressure reduction below the ditch = 1.00
Area of cross-section A = 3.35E-01 m^2/m
Moment of inertia I = 1.34E-02 m^4/m

Forces above the slip surface

Depth of slip surface h_{s1} = 0.50 m
Input of active horizontal force : residual active force
Input of passive horizontal force : residual passive force

Active horizontal force T = 0.00 kN/m
Passive horizontal force P = 0.00 kN/m

Distribution of active force : triangle
Distribution of passive force : triangle

Material of structure

Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete: C 20/25

Cylinder compressive strength	f_{ck} =	20.00	MPa
Tensile strength	f_{ctm} =	2.20	MPa
Elasticity modulus	E_{cm} =	30000.00	MPa
Shear modulus	G =	12500.00	MPa

Longitudinal steel: B500B
Yield strength f_{yk} = 500.00 MPa

Transverse steel: B500B
Yield strength f_{yk} = 500.00 MPa

Modulus of reaction

Modulus of subsoil reaction is computed by method Schmitt.

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Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]	γ_{su} [kN/m³]	δ [°]
1	gruščnata glina židke do srednje gnetne konsistence		12.00	1.00	16.00	7.00	5.00
2	glina poltrdne do trdne konsistence		20.00	10.00	20.00	10.50	10.00
3	preperina laporja		35.00	20.00	22.00	12.00	0.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	φ_{ef} [°]	v [–]	OCR [–]	K_r [–]
1	gruščnata glina židke do srednje gnetne konsistence		cohesive	-	0.40	-	-
2	glina poltrdne do trdne konsistence		cohesive	-	0.35	-	-
3	preperina laporja		cohesive	-	0.30	-	-

Parameters of soils to compute modulus of subsoil reaction (Schmitt)

No.	Name	Pattern	v [–]	E_{oed} [MPa]	E_{def} [MPa]
1	gruščnata glina židke do srednje gnetne konsistence		0.40	-	1.00
2	glina poltrdne do trdne konsistence		0.35	-	10.00
3	preperina laporja		0.30	-	100.00

Soil parameters

gruščnata glina židke do srednje gnetne konsistence

Unit weight : $\gamma = 16.00$ kN/m³
Stress-state : effective
Angle of internal friction : $\varphi_{ef} = 12.00$ °
Cohesion of soil : $c_{ef} = 1.00$ kPa
Angle of friction struc.-soil : $\delta = 5.00$ °
Soil : cohesive
Poisson's ratio : $v = 0.40$
Deformation modulus : $E_{def} = 1.00$ MPa
Poisson's ratio : $v = 0.40$
Saturated unit weight : $\gamma_{sat} = 17.00$ kN/m³

glina poltrdne do trdne konsistence

Unit weight : $\gamma = 20.00$ kN/m³
Stress-state : effective
Angle of internal friction : $\varphi_{ef} = 20.00$ °
Cohesion of soil : $c_{ef} = 10.00$ kPa
Angle of friction struc.-soil : $\delta = 10.00$ °
Soil : cohesive
Poisson's ratio : $v = 0.35$
Deformation modulus : $E_{def} = 10.00$ MPa
Poisson's ratio : $v = 0.35$

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Saturated unit weight : γ_{sat} = 20.50 kN/m^3

preperina laporja

Unit weight :	γ =	22.00 kN/m^3
Stress-state :	effective	
Angle of internal friction :	φ_{ef} =	35.00 °
Cohesion of soil :	c_{ef} =	20.00 kPa
Angle of friction struc.-soil :	δ =	0.00 °
Soil :	cohesive	
Poisson's ratio :	v =	0.30
Deformation modulus :	E_{def} =	100.00 MPa
Poisson's ratio :	v =	0.30
Saturated unit weight :	γ_{sat} =	22.00 kN/m^3

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	3.00	0.00 .. 3.00	gruščnata glina židke do srednje gnetne konsistence	
2	2.20	3.00 .. 5.20	glina poltrdne do trdne konsistence	
3	-	5.20 .. ∞	preperina laporja	

Excavation

Soil in front of wall is excavated to a depth of 0.30 m.
Soil slope in front of structure β = -12.00 °

Terrain profile

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	5.20	0.00
3	8.30	-2.60
4	9.30	-2.60

Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

Water influence

GWT behind the structure lies at a depth of 1.00 m

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m^2]	Mag.2 [kN/m^2]	Ord.x x [m]	Length l [m]	Depth z [m]
1	Yes		variable	9.00		0.50	2.00	on terrain

Input concentrated surcharges

No.	Surcharge new	Surcharge change	Action	Magnitude [kN]	Ord.x x [m]	Length l [m]	Width b[m]	Depth z [m]
1	Yes		variable	65.00	0.50	0.50	0.32	on terrain
2	Yes		variable	65.00	2.00	0.50	0.32	on terrain

Earthquake

Factor of horizontal acceleration K_h = 0.0300

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Factor of vertical acceleration $K_v = 0.0300$

Water below the GWT is restricted.

Global settings

Number of FEs to discretize wall = 100
Analysis of depending pressures : reduce according to analysis settings
Minimum pressure is considered as $\sigma_{a,min} = 0.20\sigma_z$

Settings of the stage of construction

Design situation : permanent

Analysis results

Pressure above the slip surface

Depth [m]	Passive pressure [kPa]	Active pressure [kPa]
0	0.00	0.00
0.30	0.00	0.00
0.30	0.00	0.00
0.50	0.00	0.00

Distribution of pressures acting on the structure (in front and behind the wall) - below the slip surface

Depth [m]	Ta,p [kPa]	Tk,p [kPa]	Tp,p [kPa]	Ta,z [kPa]	Tk,z [kPa]	Tp,z [kPa]
0.50	-0.54	-1.86	-3.64	41.74	41.74	41.74
0.51	-1.91	-1.91	-3.70	44.19	44.19	44.19
0.60	-2.82	-2.82	-4.79	42.77	42.77	42.77
0.60	-2.82	-2.82	-4.79	54.48	54.48	54.48
0.95	-6.02	-6.02	-8.63	47.39	47.39	47.39
1.00	-6.51	-6.51	-9.21	46.31	46.31	46.31
1.00	-6.51	-6.51	-9.21	50.10	50.10	50.10
1.11	-7.49	-7.49	-10.39	48.58	48.58	48.58
1.11	-7.50	-7.50	-10.40	48.55	48.55	48.55
1.14	-7.80	-7.80	-10.77	48.07	48.07	48.07
1.14	-7.80	-7.80	-10.77	34.99	34.99	34.99
1.42	-10.42	-10.42	-13.91	38.30	38.30	38.30
1.63	-12.36	-12.36	-16.23	40.75	40.75	40.75
1.63	-12.36	-12.36	-16.23	40.74	40.74	40.74
1.78	-13.80	-13.80	-17.96	46.73	46.73	46.73
1.89	-14.82	-14.82	-19.19	50.98	50.98	50.98
2.37	-19.23	-19.23	-24.47	69.27	69.27	69.27
2.51	-20.58	-20.58	-26.09	74.89	74.89	74.89
2.79	-23.13	-23.13	-29.14	87.15	87.15	87.15
2.79	-23.13	-23.13	-29.14	82.15	82.15	82.15
2.84	-23.63	-23.63	-29.75	84.63	84.63	84.63
2.86	-23.80	-23.80	-29.95	85.47	85.47	85.47
3.00	-25.10	-25.10	-31.51	89.49	89.49	89.49
3.00	-9.60	-20.48	-57.16	37.11	39.67	84.61
3.32	-12.74	-23.47	-64.47	48.47	48.47	93.27
3.79	-17.44	-27.96	-75.43	65.52	65.52	106.25
4.13	-20.84	-31.20	-83.35	77.83	77.83	115.63
4.26	-22.15	-32.45	-86.39	80.36	80.36	119.23
4.37	-23.24	-33.49	-88.92	82.47	82.47	122.24

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Depth [m]	Ta,p [kPa]	Tk,p [kPa]	Tp,p [kPa]	Ta,z [kPa]	Tk,z [kPa]	Tp,z [kPa]
4.74	-26.85	-36.94	-97.35	89.48	89.48	136.04
5.20	-31.45	-41.33	-108.06	98.40	98.40	153.60
5.21	-4.98	-33.88	-195.59	58.21	67.24	331.60
5.28	-5.54	-34.50	-198.46	59.16	68.54	334.46
5.68	-8.35	-37.92	-214.39	64.43	75.81	350.41
6.16	-11.66	-41.96	-233.18	70.66	84.40	369.22
6.60	-14.72	-45.70	-250.59	76.42	92.39	386.64
6.63	-14.96	-46.00	-251.98	76.88	93.02	388.03
6.75	-15.78	-46.99	-256.60	78.41	95.15	392.65
7.11	-18.27	-50.03	-270.77	84.21	101.66	406.84
7.18	-18.78	-50.66	-273.67	85.39	102.99	409.74
7.58	-21.58	-54.07	-289.57	93.65	110.31	425.65
8.05	-24.89	-58.11	-308.36	103.42	118.96	444.46
8.53	-28.20	-62.15	-327.15	113.18	127.63	463.27
9.00	-31.51	-66.19	-345.95	122.94	136.30	482.08

Distributions of the modulus of subsoil reaction and internal forces on the structure

Depth [m]	kh,p [MN/m3]	kh,z [MN/m3]	Displacement [mm]	Pressure [kPa]	Shear Force [kN/m]	Moment [kNm/m]
0.00	0.00	0.00	-18.76	0.00	0.00	-0.00
0.27	0.00	0.00	-17.83	0.00	0.00	-0.00
0.27	0.00	0.00	-17.83	0.00	0.00	-0.00
0.30	0.00	0.00	-17.75	0.00	0.00	-0.00
0.30	0.00	0.00	-17.72	0.00	0.00	0.00
0.45	0.00	0.00	-17.22	0.00	0.00	-0.00
0.50	0.00	0.00	-17.06	0.00	0.00	-0.00
0.50	0.00	0.00	-17.04	40.52	-0.16	0.00
0.90	0.00	0.00	-15.69	40.27	-17.61	3.53
1.35	0.00	0.00	-14.15	24.35	-31.75	15.00
1.80	0.00	0.00	-12.63	29.19	-43.17	31.78
2.25	0.00	0.00	-11.12	41.55	-59.09	54.58
2.70	0.00	0.00	-9.64	55.05	-80.67	85.80
3.15	0.00	0.00	-8.20	-18.13	-95.57	126.97
3.60	0.00	0.00	-6.83	-12.34	-88.72	168.34
4.05	0.00	0.00	-5.54	-6.56	-84.46	207.21
4.50	11.52	0.00	-4.35	0.11	-82.22	244.58
4.95	11.52	0.00	-3.29	16.73	-86.06	282.16
5.40	0.00	0.00	-2.37	-142.41	-59.32	318.94
5.85	0.00	0.00	-1.61	-154.35	7.46	330.81
6.30	0.00	0.00	-1.02	-166.30	79.60	311.43
6.75	196.29	0.00	-0.58	-81.79	135.48	261.31
7.20	196.29	0.00	-0.27	-17.71	157.03	194.41
7.65	196.29	196.29	-0.06	34.18	153.82	123.65
8.10	196.29	196.29	0.09	96.66	123.71	60.15
8.55	0.00	196.29	0.21	140.30	69.05	15.98
9.00	0.00	196.29	0.31	166.51	-0.00	0.00

Maximum shear force = 158.32 kN/m

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Maximum moment = 330.86 kNm/m
Maximum displacement = 18.8 mm
Displacement in the depth of slip surface = 17.1 mm

Name : Analysis | **Stage - analysis : 1 - -1**



Dimensioning No. 1

Distribution of forces on construction

	Disp. min [mm]	Disp. max [mm]	Shear force min. [kN/m]	Shear force max [kN/m]	Moment min. [kNm/m]	Moment max. [kNm/m]
0.00	-18.76	-18.76	0.00	0.00	-0.00	-0.00
0.27	-17.83	-17.83	0.00	0.00	-0.00	-0.00
0.27	-17.83	-17.83	0.00	0.00	-0.00	-0.00
0.30	-17.75	-17.75	0.00	0.00	-0.00	-0.00
0.30	-17.75	-17.75	-0.00	-0.00	-0.00	-0.00
0.30	-17.72	-17.72	-0.00	-0.00	0.00	0.00
0.30	-17.72	-17.72	0.00	0.00	0.00	0.00
0.45	-17.22	-17.22	0.00	0.00	-0.00	-0.00
0.50	-17.06	-17.06	0.00	0.00	-0.00	-0.00
0.50	-17.06	-17.06	0.00	0.00	-0.00	-0.00
0.50	-17.04	-17.04	-0.16	-0.16	0.00	0.00
0.50	-17.04	-17.04	-0.16	-0.16	0.00	0.00

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	Disp. min [mm]	Disp. max [mm]	Shear force min. [kN/m]	Shear force max [kN/m]	Moment min. [kNm/m]	Moment max. [kNm/m]
0.90	-15.69	-15.69	-17.61	-17.61	3.53	3.53
1.35	-14.15	-14.15	-31.75	-31.75	15.00	15.00
1.80	-12.63	-12.63	-43.17	-43.17	31.78	31.78
2.25	-11.12	-11.12	-59.09	-59.09	54.58	54.58
2.70	-9.64	-9.64	-80.67	-80.67	85.80	85.80
3.15	-8.20	-8.20	-95.57	-95.57	126.97	126.97
3.60	-6.83	-6.83	-88.72	-88.72	168.34	168.34
4.05	-5.54	-5.54	-84.46	-84.46	207.21	207.21
4.50	-4.35	-4.35	-82.22	-82.22	244.58	244.58
4.95	-3.29	-3.29	-86.06	-86.06	282.16	282.16
5.40	-2.37	-2.37	-59.32	-59.32	318.94	318.94
5.85	-1.61	-1.61	7.46	7.46	330.81	330.81
6.30	-1.02	-1.02	79.60	79.60	311.43	311.43
6.75	-0.58	-0.58	135.48	135.48	261.31	261.31
7.20	-0.27	-0.27	157.03	157.03	194.41	194.41
7.65	-0.06	-0.06	153.82	153.82	123.65	123.65
8.10	0.09	0.09	123.71	123.71	60.15	60.15
8.55	0.21	0.21	69.05	69.05	15.98	15.98
9.00	0.31	0.31	-0.00	-0.00	0.00	0.00

Maximum values of internal forces

Maximum displacement = -18.8 mm
Minimum displacement = 0.3 mm
Maximum bending moment = 330.86 kNm/m
Minimum bending moment = 0.00 kNm/m
Maximum shear force = 158.32 kN/m

Verification of RC cross section (Pile curtain d = 0.80 m, a = 1.50 m)

All construction stages are taken into the analysis.
Partial factor on load = 1.00

Verification of cross section in bending:

Reinforcement - 10 pc bars 28.0 mm; cover 90.0 mm
Type of structure (reinforcement ratio) : beam
Reinforcement ratio $\rho = 0.612\ \% > 0.130\ \% = \rho_{min}$
Load : $M_{Ed} = 496.30$ kNm
Bearing capacity : $M_{Rd} = 693.29$ kNm

Designed pile reinforcement is SATISFACTORY

Verification of cross section in shear:

Shear reinf. - profile 8.0 mm; spacing 150.0 mm
$A_{sw} = 2 \times 335.1 = 670.2\ mm^2$
Ultimate shear force: $V_{Rd} = 419.61$ kN > 237.48 kN = V_{Ed}

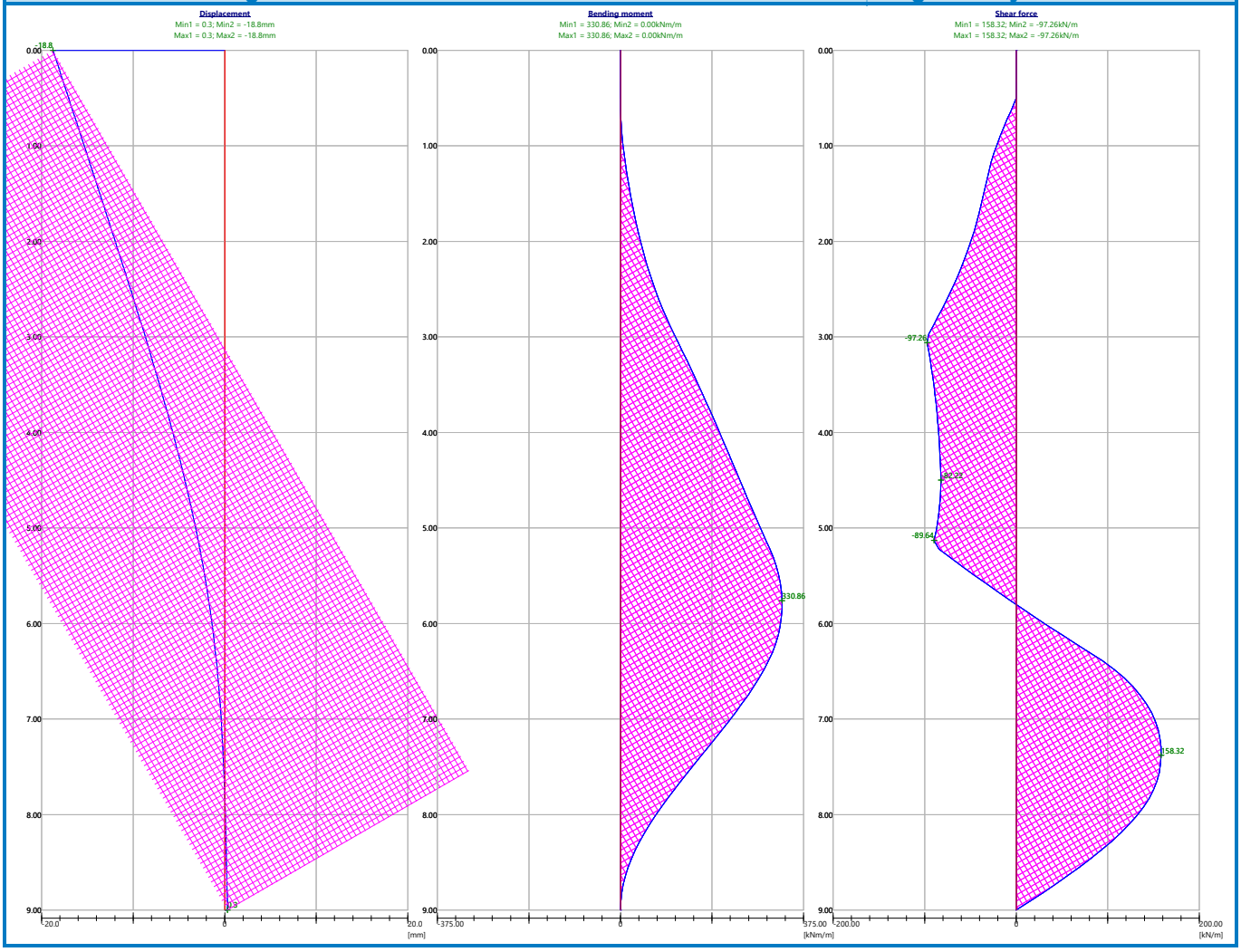
Cross-section is SATISFACTORY.

Overall verification: Cross-section is SATISFACTORY

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Name : Dimensioning

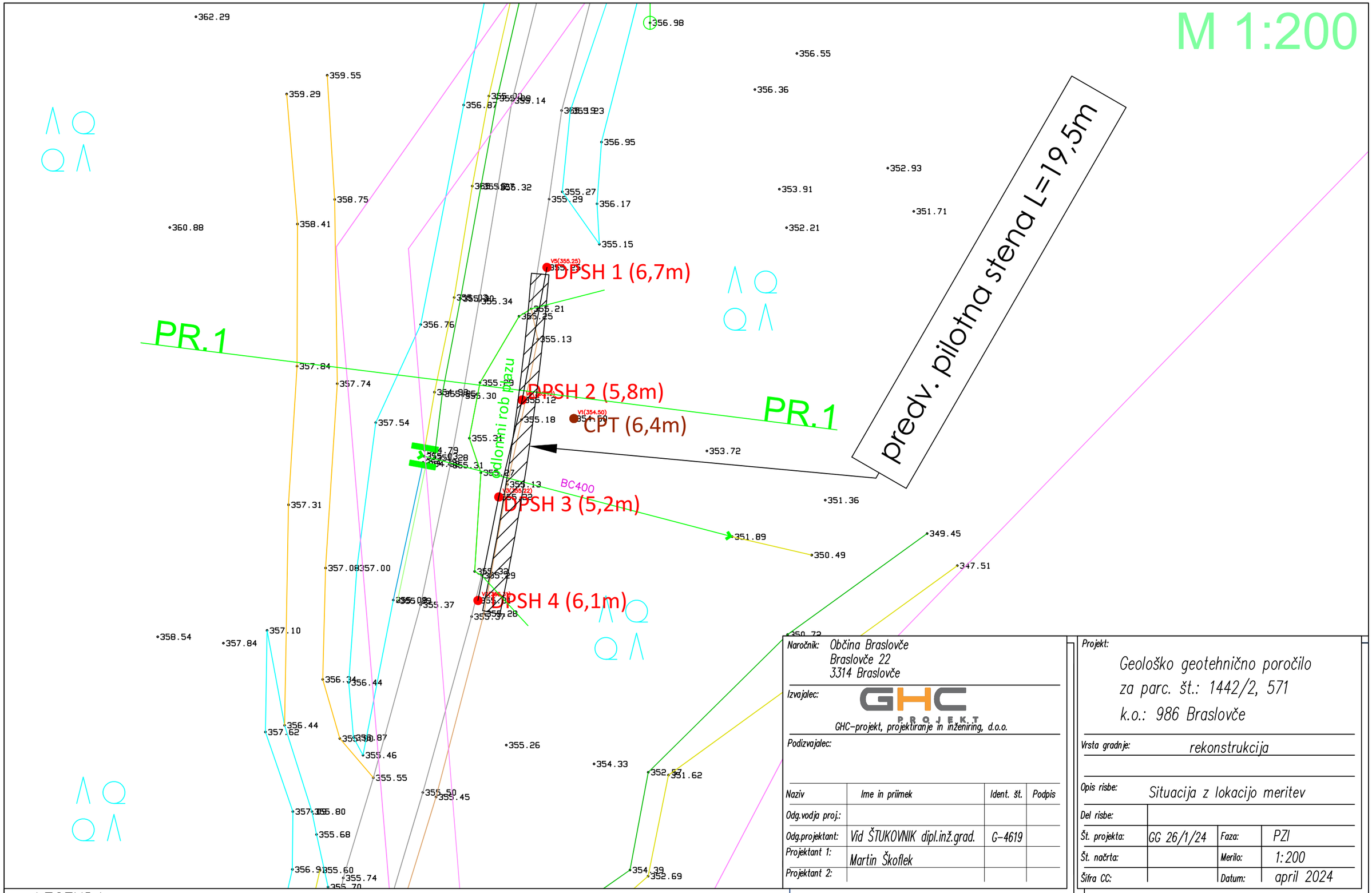
Stage - analysis : 1 - 1



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G. GRAFIKE

M 1:200



LEGENDA:

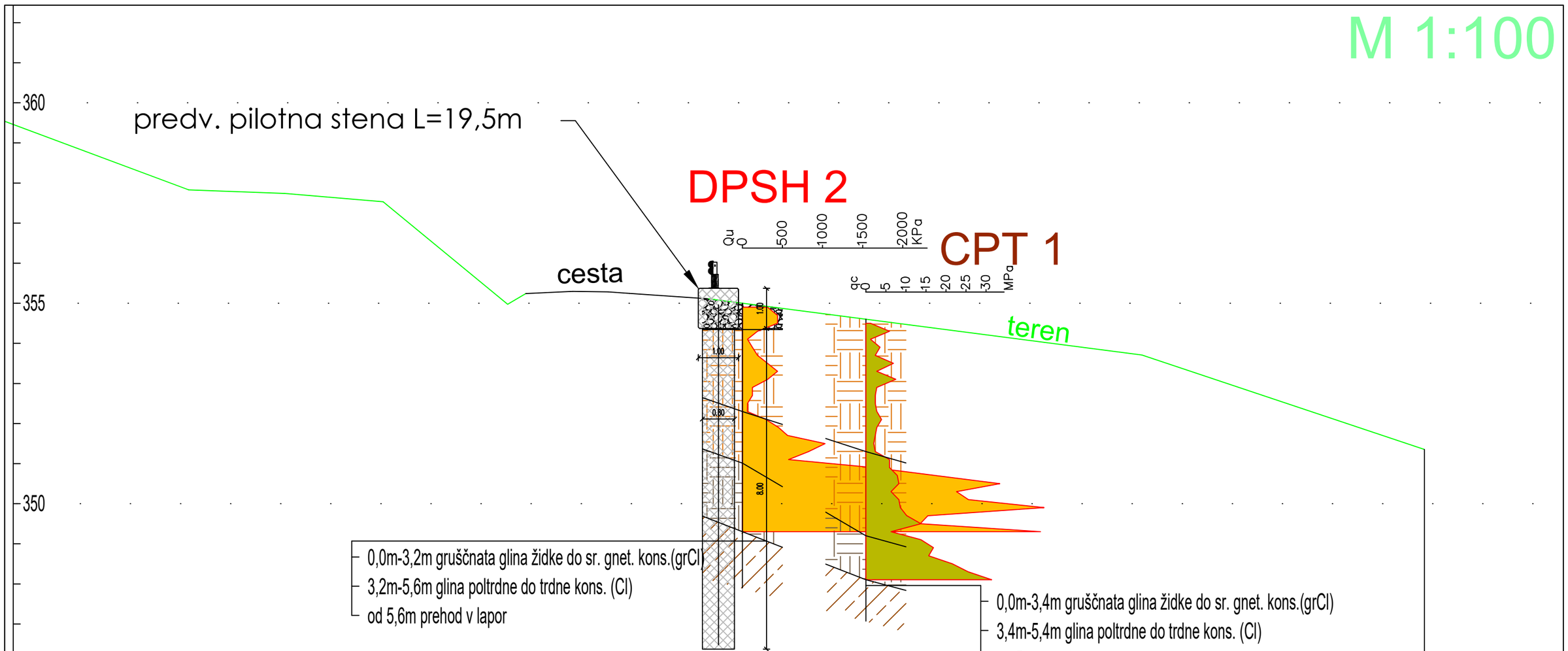
DP – LOKACIJE MERITEV Z DINAMIČNIM PENETROMETROM
CPT – LOKACIJE MERITEV S STATIČNIM PENETROMETROM

Naročnik:	Občina Braslovče Braslovče 22 3314 Braslovče		
Izvajalec:	GHC-projekt, projektiranje in inženiring, d.o.o.		
Podizvajalec:			
Naziv	Ime in priimek	Ident. št.	Podpis
Odg.vodja proj.:			
Odg.projektant:	Vid ŠTUKOVNIK dipl.inž.grad.	G-4619	
Projektant 1:	Martin Škoflek		
Projektant 2:			

Projekt:	Geološko geotehnično poročilo za parc. št.: 1442/2, 571 k.o.: 986 Braslovče		
Vrsta gradnje:	rekonstrukcija		
Opis risbe:	Situacija z lokacijo meritev		
Del risbe:			
Št. projekta:	GG 26/1/24	Faza:	PZI
Št. načrta:		Merilo:	1:200
Šifra CC:		Datum:	april 2024

Št. odseka:	Arhivska št.:	Faza/Objekt:	Šifra risbe:
Št. priloge:	G.1	Avtor risbe:	GHC-projekt, projektiranje in inženiring, d.o.o.
		Ident. št. risbe:	

M 1:100



LEGENDA:

DP – Qu – LOKACIJE MERITVE Z DINAMIČNIM PENETROMETROM

CPT – qc – LOKACIJE MERITVE S STATIČNIM PENETROMETROM

Naročnik:	Občina Braslovče Braslovče 22 3314 Braslovče
Izvajalec:	GHC PROJEKT GHC–projekt, projektiranje in inženiring, d.o.o.
Podizvajalec:	

Naziv	Ime in priimek	Ident. št.	Podpis
Odg.vodja proj.:			
Odg.projektant:	Vid ŠTUKOVNIK dipl.inž.grad.	G–4619	
Projektant 1:	Martin Škoflek		
Projektant 2:			

Projekt:	Geološko geotehnično poročilo za parc. št.: 1442/2, 571 k.o.: 986 Braslovče
Vrsta gradnje:	rekonstrukcija
Opis risbe:	Geološko geotehnični profil PR.1
Del risbe:	
Št. projekta:	GG 26/1/24
Faza:	PZI
Št. načrta:	
Merilo:	1:100
Šifra CC:	
Datum:	april 2024

Št. odseka:	Arhivska št.:	Faza/Objekt:	Šifra risbe:

Št. priloge:	G.2	Avtor risbe:	GHC–projekt, projektiranje in inženiring, d.o.o.
		Ident. št. risbe:	