



PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile



Regione Emilia-Romagna



CONFERENZA DELLE REGIONI E
DELLE PROVINCE AUTONOME

Attuazione dell'articolo 11 dalla legge 24 giugno 2009, n.77

MICROZONAZIONE SISMICA

Livello 3

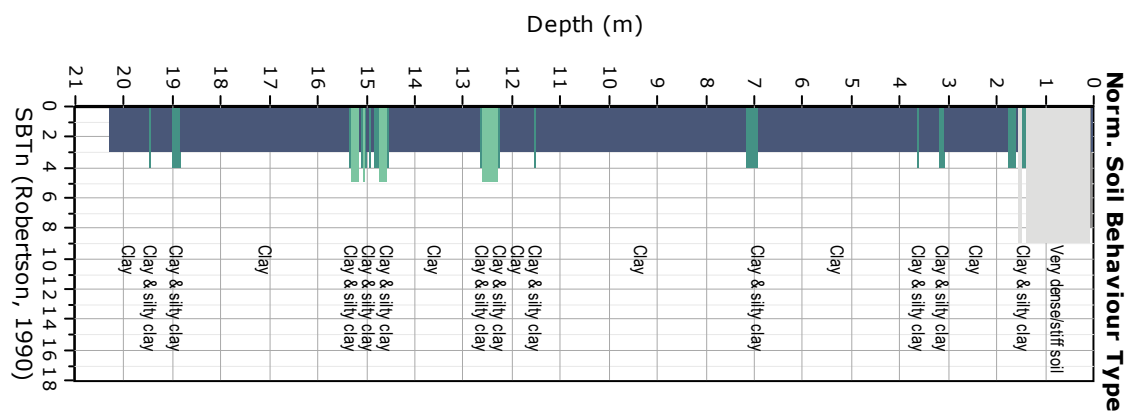
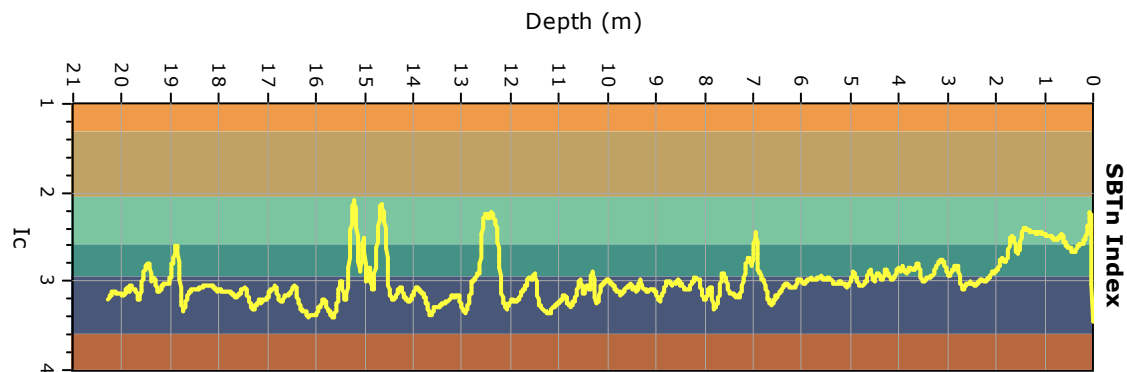
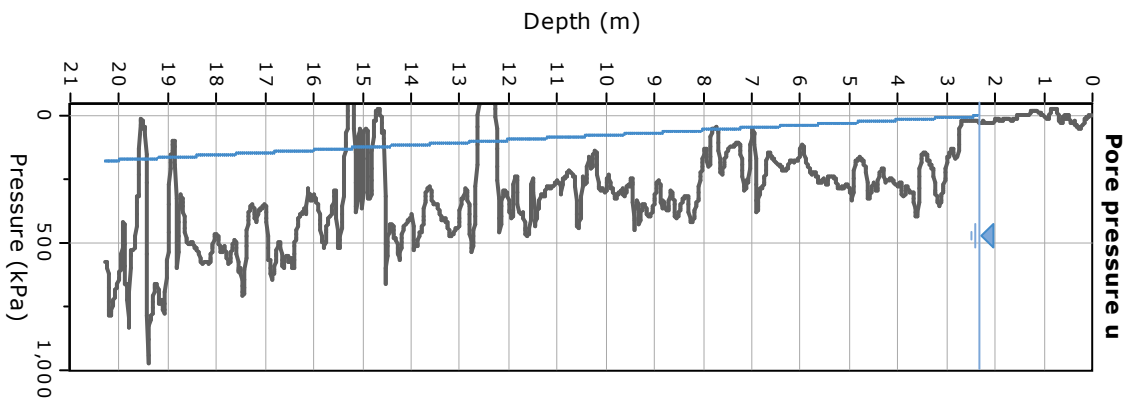
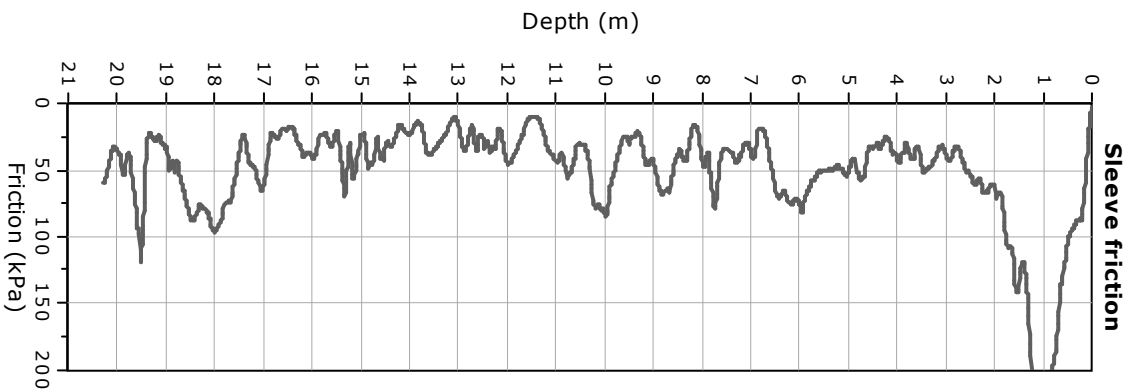
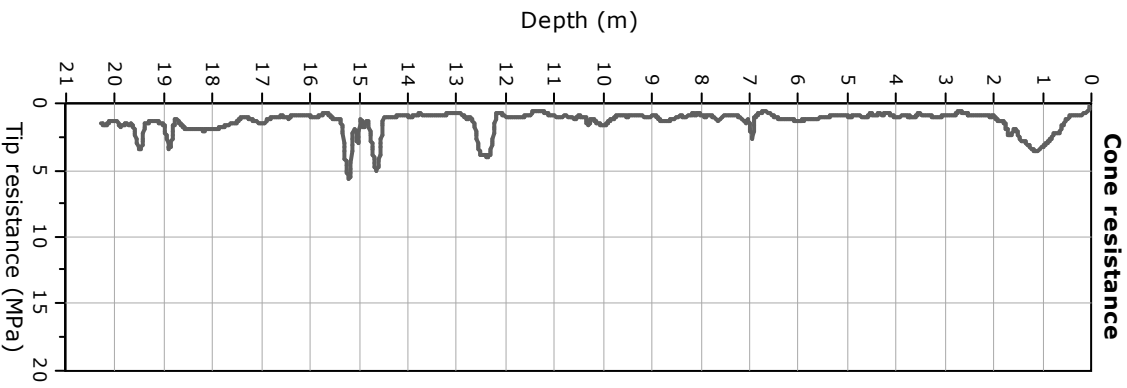
Allegato 2 – Rapporto delle indagini

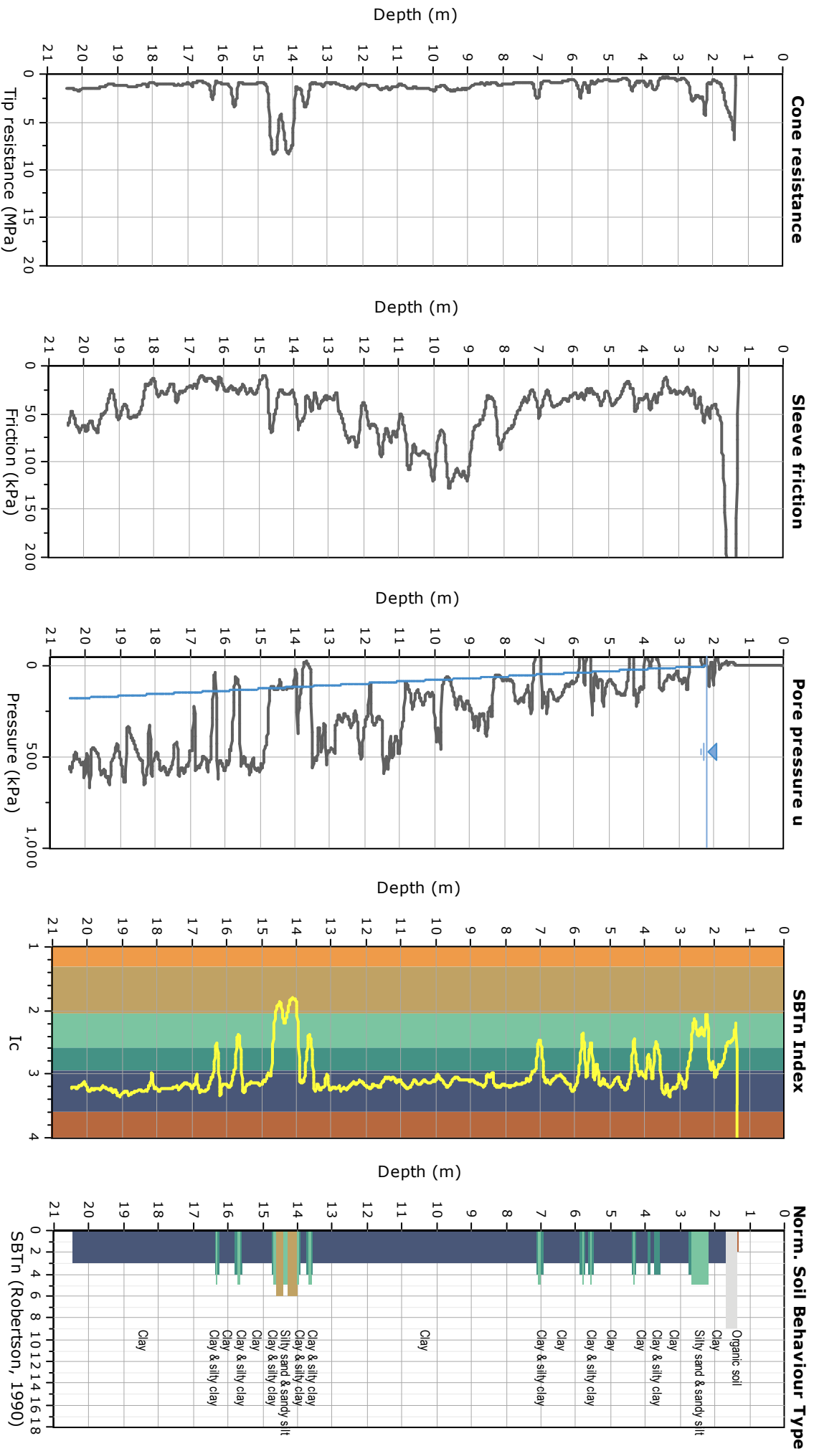
Regione Emilia–Romagna

Comune di Anzola dell'Emilia



Regione	Soggetto realizzatore	Data
EMILIA–ROMAGNA	Raggruppamento temporaneo di imprese e professionisti Capogruppo: dott. geol. Samuel Sangiorgi Mandanti: dott. geol. Tiziano Righini, dott. geol. Antonio Milioto, ing. Marco Soglia	Febbraio 2019





ANZOLA DELL'EMILIA_MS, TR4

037001P60002HVSER59143

Instrument: TRZ-0108/01-10

Start recording: 17/09/18 10:28:23 End recording: 17/09/18 11:28:24

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 1h00'00". Analyzed 98% trace (manual window selection)

Sampling rate: 128 Hz

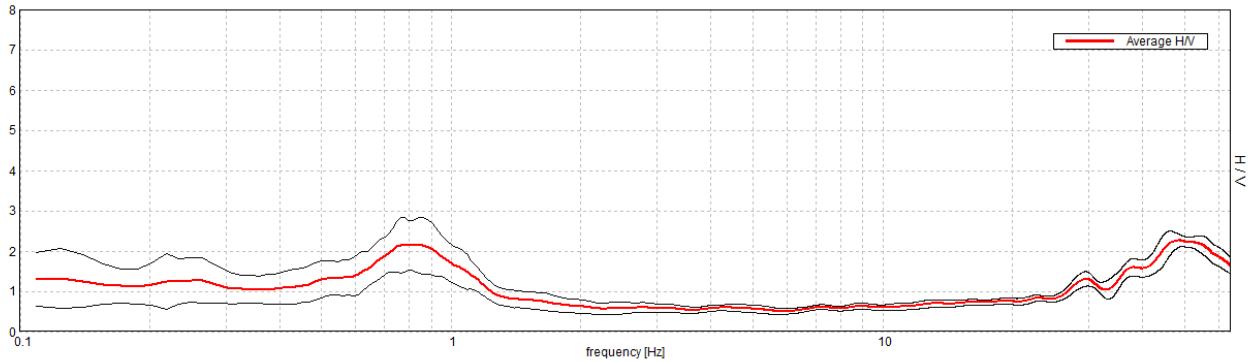
Window size: 60 s

Smoothing type: Triangular window

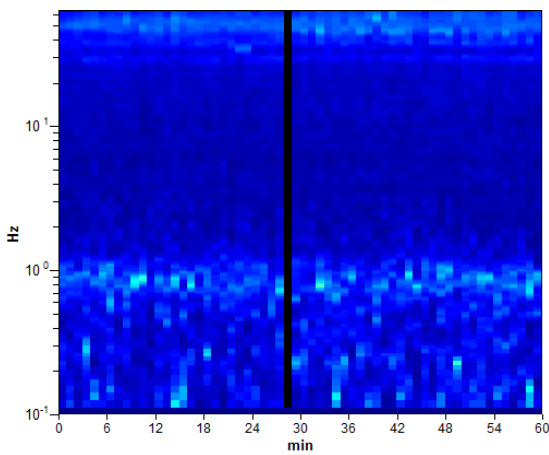
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

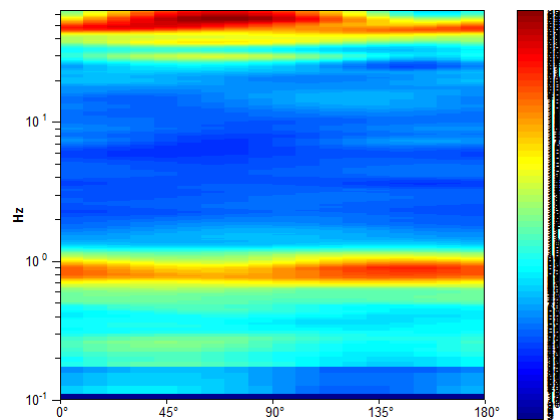
Max. H/V at 0.78 ± 0.02 Hz. (In the range 0.1 - 20.0 Hz).



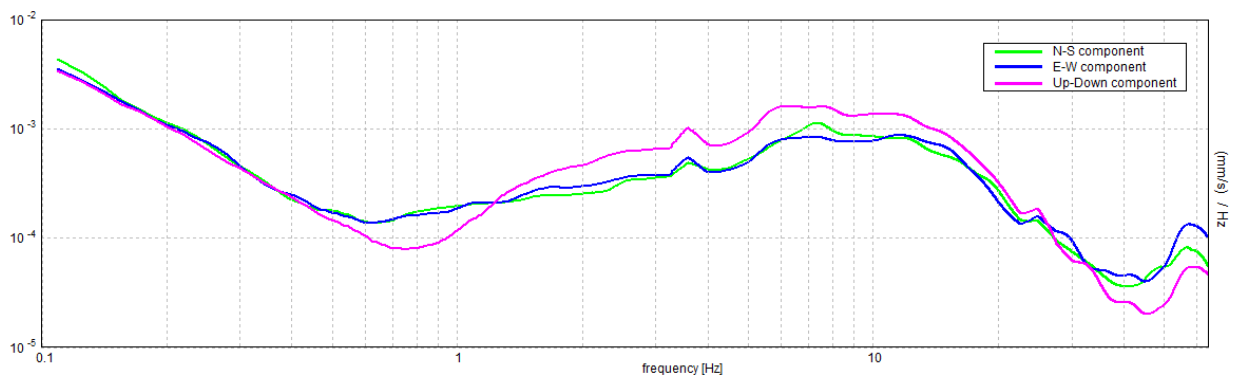
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. Please read carefully the *Grilla* manual before interpreting the following tables.]

Max. H/V at 0.78 ± 0.02 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.78 > 0.17$	OK	
$n_c(f_0) > 200$	$2765.6 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 76 times	OK	

Criteria for a clear H/V peak

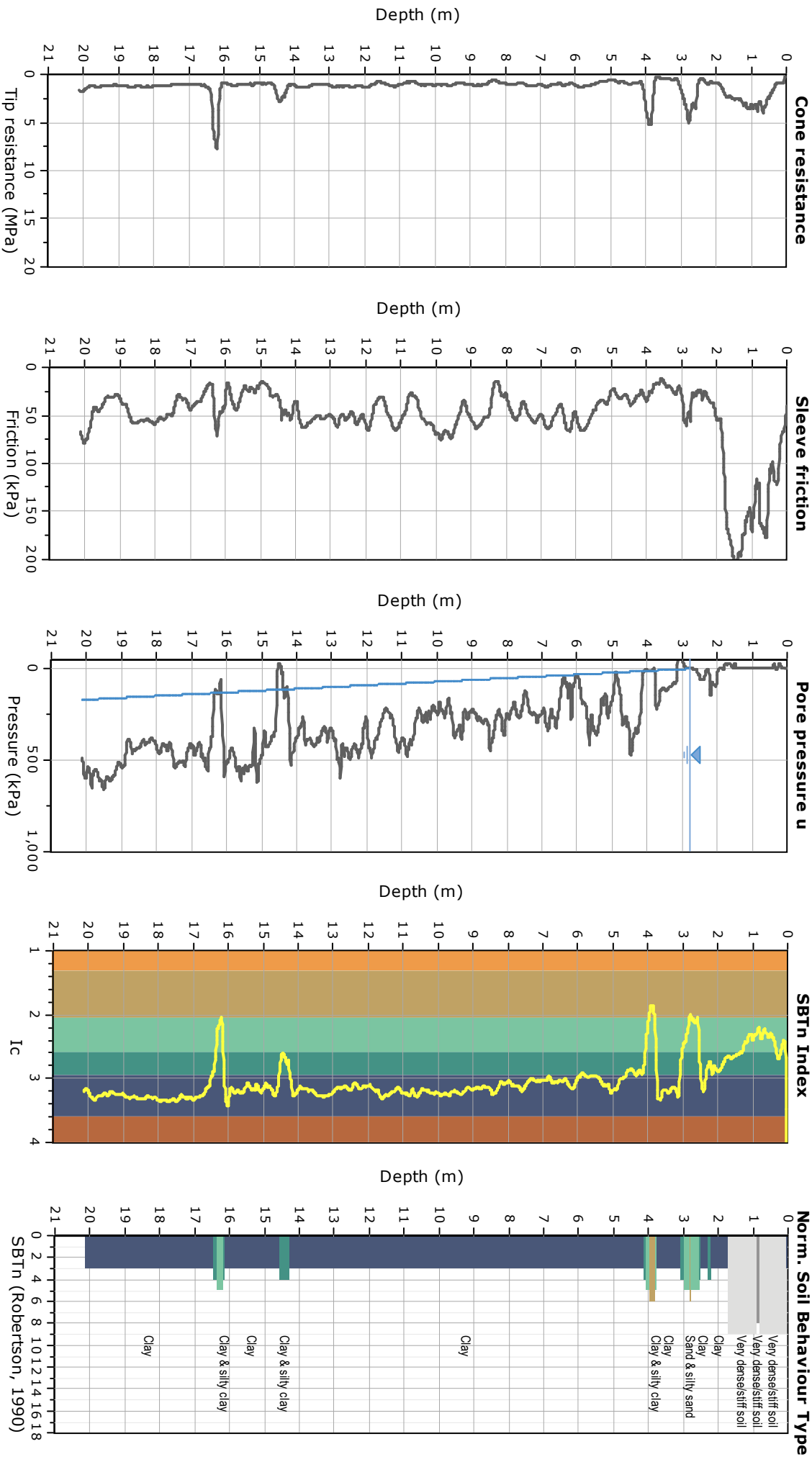
[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$	0.406 Hz	OK	
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.219 Hz	OK	
$A_0 > 2$	$2.16 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01066 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.00833 < 0.11719$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3377 < 2.0$	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{\log H/V}(f)$	standard deviation of $\log A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$

Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20



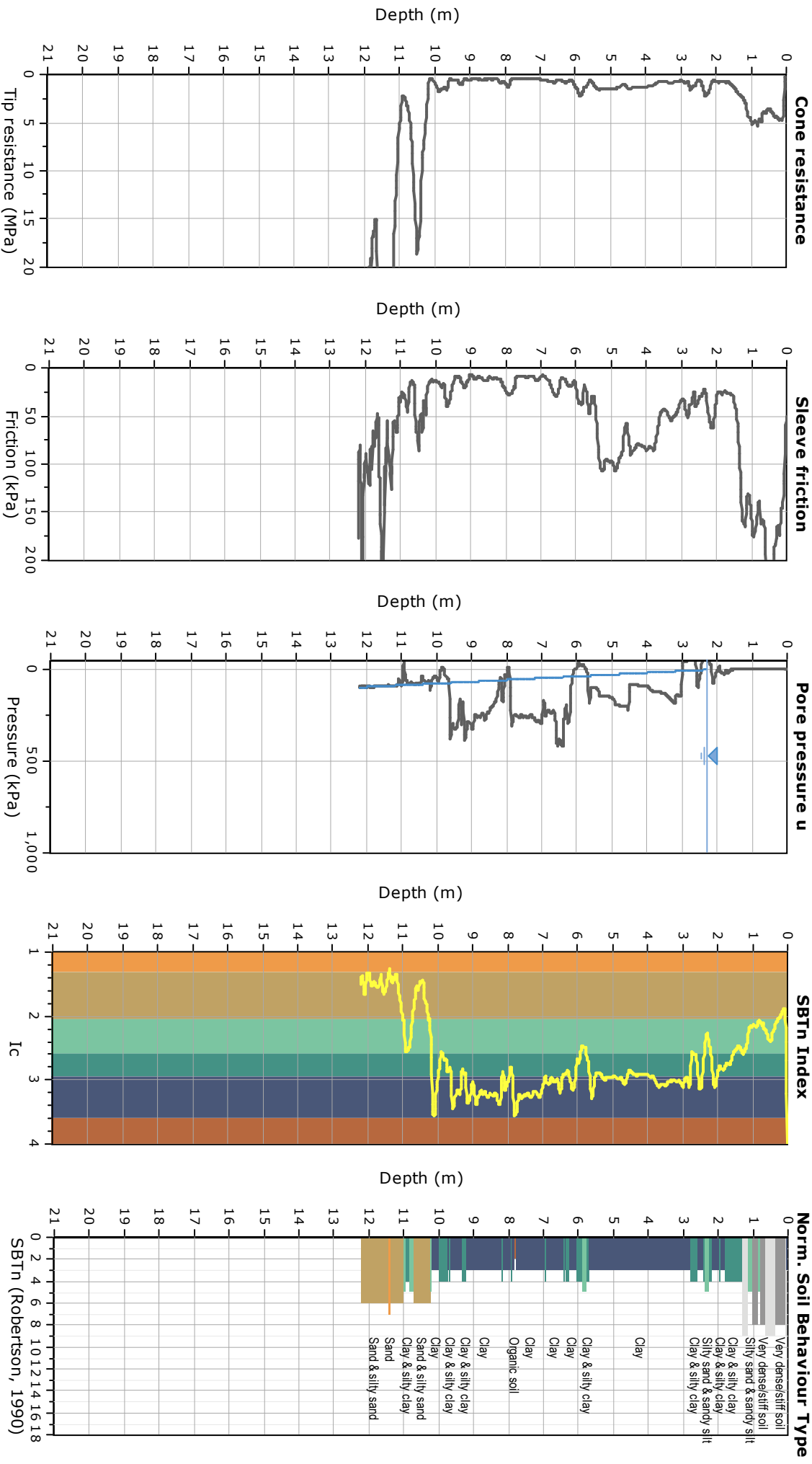


Studio Samuel Sangiorgi
 Via Valsellustra 32, 40060 - Dozza (BO)
 info@studiosamuelsangiorgi.eu
 Tel. 0542-640279

037001P60004CPTU59145

Project: Microzonazione Sismica Anzola dell'Emilia
Location: via IV Novembre - Anzola dell'Emilia

CPT: CPTU4
 Total depth: 12.22 m, Date: 13/09/2018



ANZOLA DELL'EMILIA_MS, TR1

037001P60004HVS59146

Instrument: TRZ-0108/01-10

Start recording: 13/09/18 14:26:57 End recording: 13/09/18 15:26:58

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 1h00'00". Analyzed 92% trace (manual window selection)

Sampling rate: 128 Hz

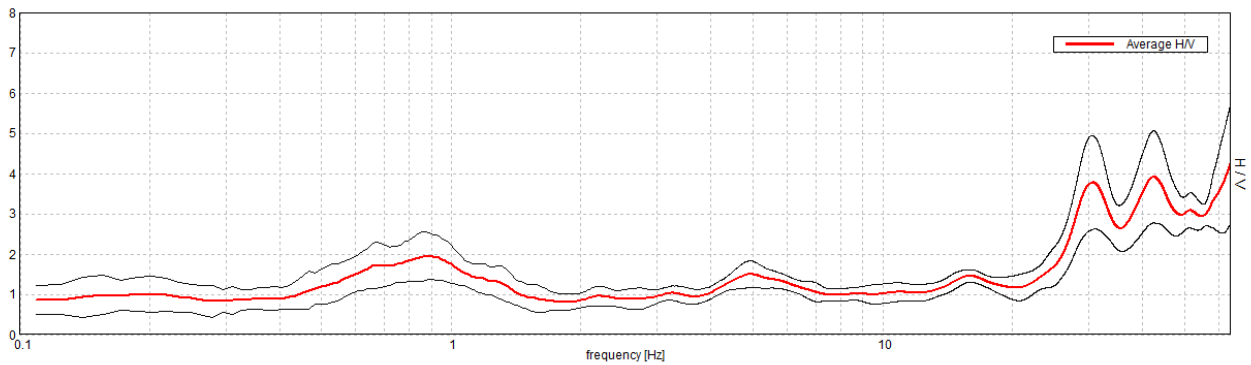
Window size: 60 s

Smoothing type: Triangular window

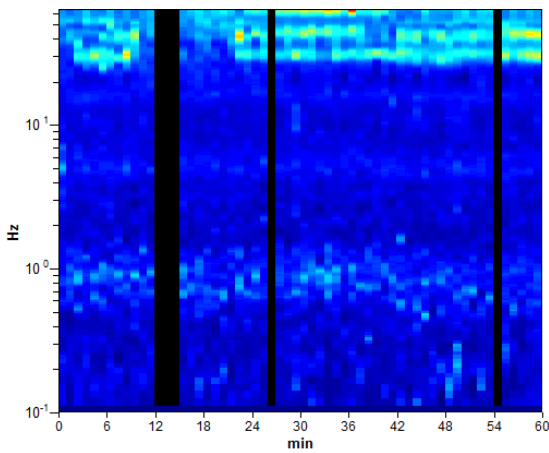
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

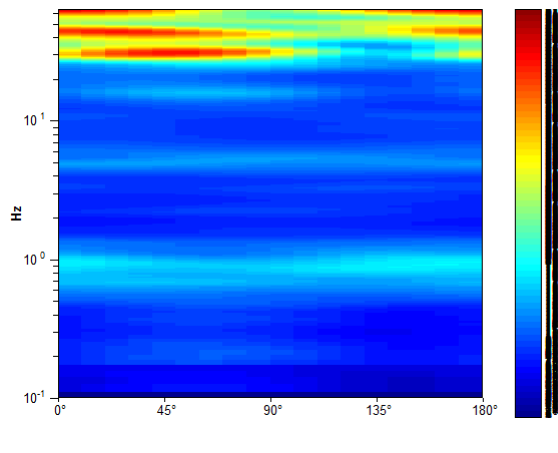
Max. H/V at 0.88 ± 0.21 Hz (in the range 0.1 - 20.0 Hz).



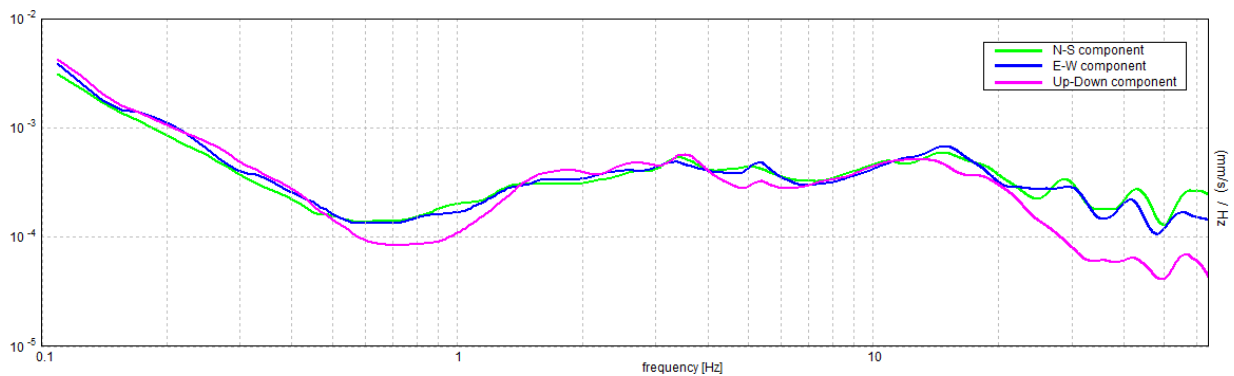
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. Please read carefully the *Grilla* manual before interpreting the following tables.]

Max. H/V at 0.88 ± 0.21 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.88 > 0.17$	OK	
$n_c(f_0) > 200$	$2887.5 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 85 times	OK	

Criteria for a clear H/V peak

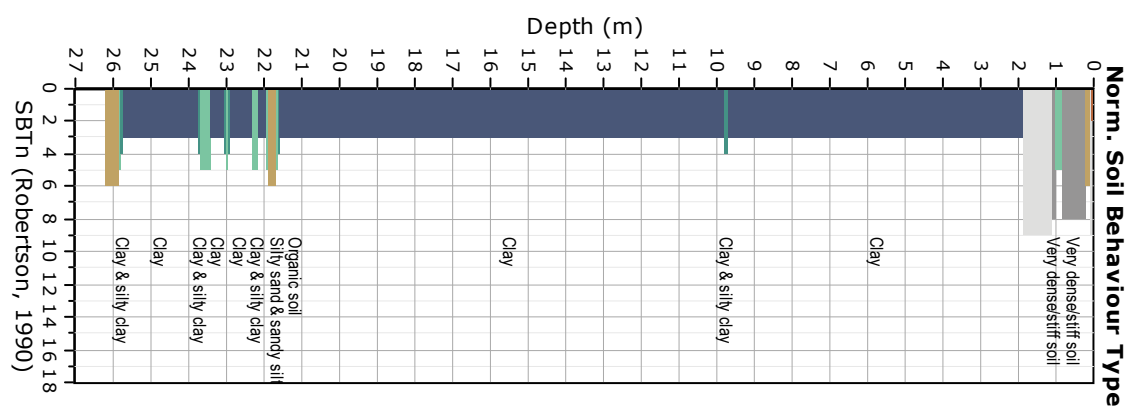
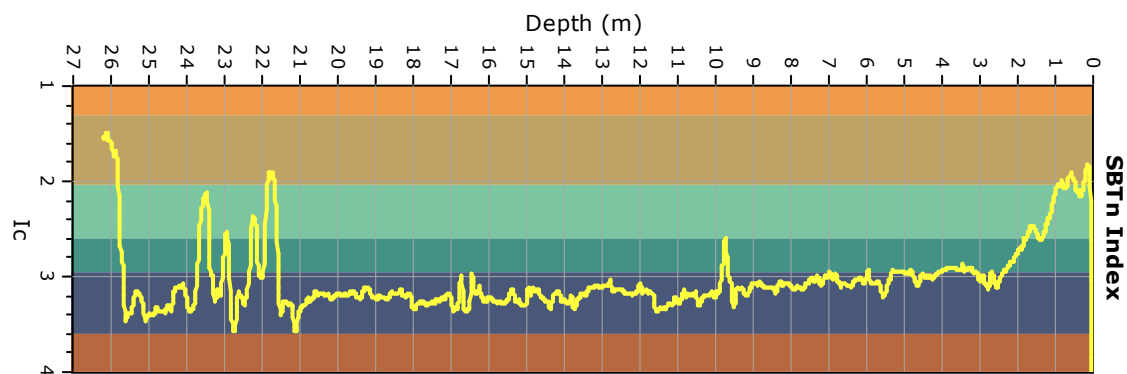
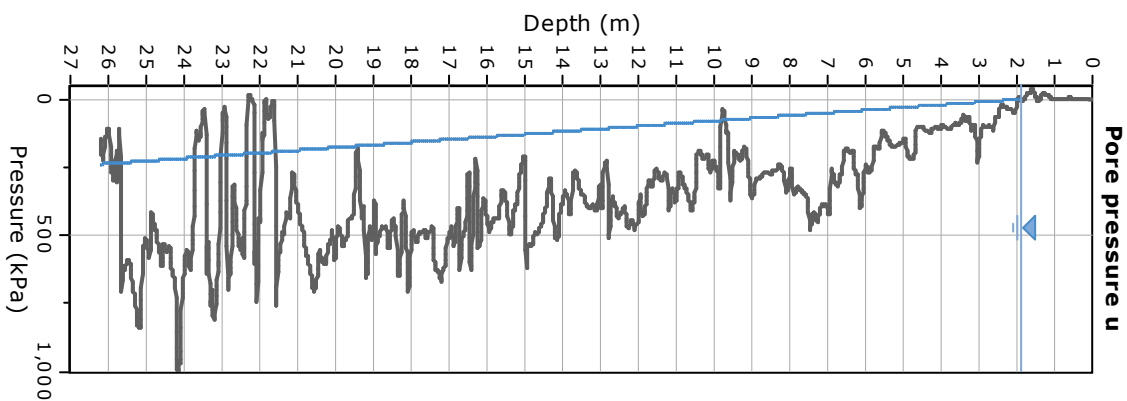
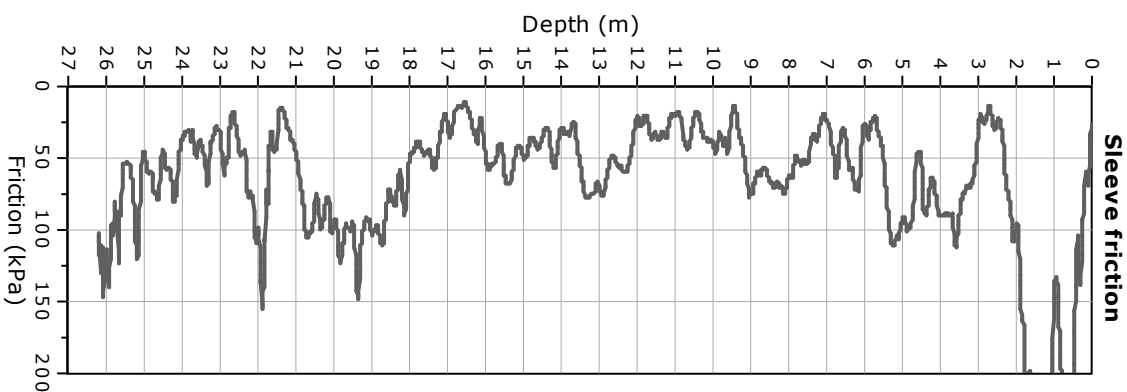
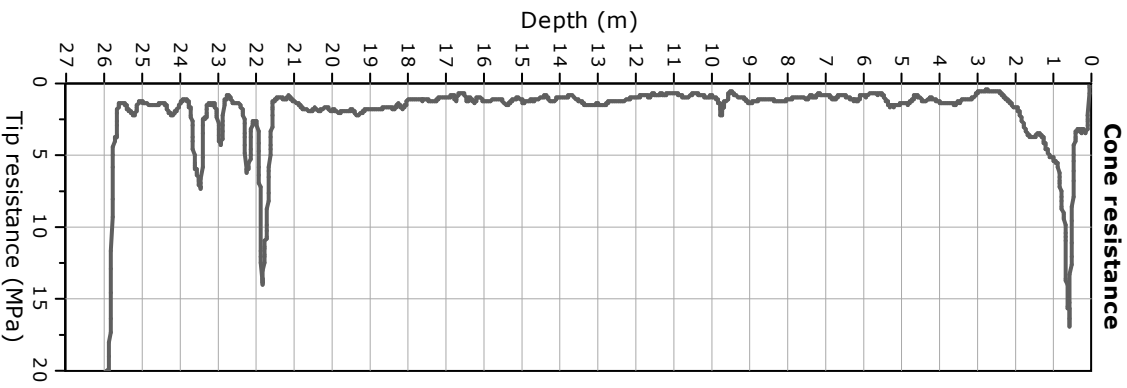
[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$	0.438 Hz	OK	
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.469 Hz	OK	
$A_0 > 2$	$1.95 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.12125 < 0.05$		NO
$\sigma_f < \varepsilon(f_0)$	$0.10609 < 0.13125$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.301 < 2.0$	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{\log H/V}(f)$	standard deviation of $\log A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$

Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20



SONDAGGIO S1 – STRATIGRAFIA

037001P60005SC59148

Pagina 1 di 2

Riferimento: STUDIO DI MZS COMUNE DI ANZOLA DELL'EMILIA

Data: 1 e 2 OTTOBRE 2018

Località: VIA S. PERTINI

Quota p.c.:

Impresa esecutrice: SONGEO SRL

Redattore: GEOL. SAMUEL SANGIORGI

Perforazione: CAROTAGGIO CONTINUO

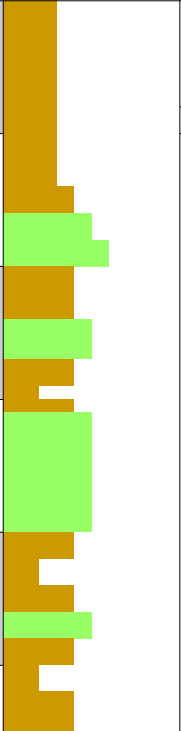
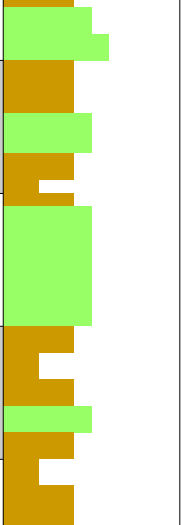
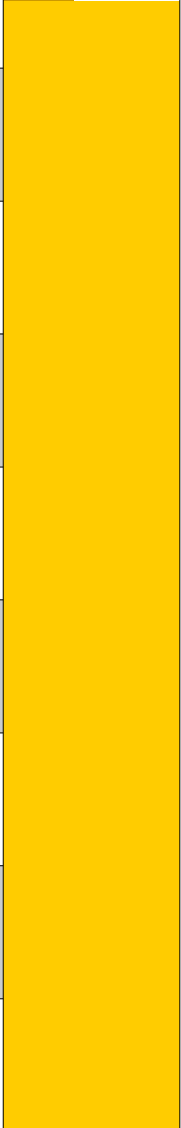
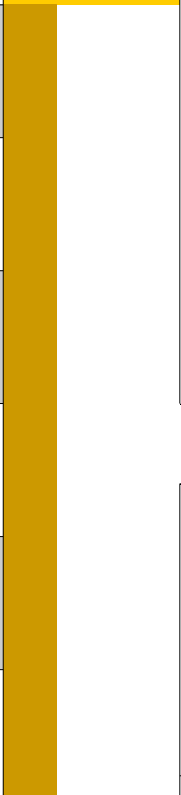
Pz	Progr (m)	LITO	Campioni	RP	VT	Recupero	SPT	Prof (m)	DESCRIZIONE
	-1								
	-2								Limi argillosi sabbiosi di colore nocciola
	-3		Disturbato1 2,4÷2,6 m					-3,5	
	-4		Shelby1 4,0÷4,7 m						Argille limose di colore nocciola con calcinelli
	-5								
	-6							-6,8	
	-7								
	-8								
	-9								
	-10								
	-11		Shelby2 11,0÷11,6 m						
	-12								
	-13								Argille limose plastiche di colore grigio
	-14		Disturbato2 14,0÷14,3 m						
	-15								
	-16								
	-17								
	-18		Shelby3 18,0÷18,6 m						
	-19								
	-20								

SONDAGGIO S1 – STRATIGRAFIA

Riferimento: STUDIO DI MZS COMUNE DI ANZOLA DELL'EMILIA
 Località: VIA S. PERTINI
 Impresa esecutrice: SONGEO SRL
 Perforazione: CAROTAGGIO CONTINUO

Data: 1 e 2 OTTOBRE 2018
 Quota p.c.:

Redattore: GEOL. SAMUEL SANGIORGI

Pz	Progr (m)	LITO	Campioni	RP	VT	Recupero	SPT	Prof (m)	DESCRIZIONE	
	-21		Disturbato3 20,8÷21,0 m					-21,4	Argille limose plastiche di colore grigio	
	-22									
	-23							-25,5	Alternanze di argille di colore grigio e limi sabbiosi con intercalati strati decimetrici torbosi	
	-24									
	-25									
	-26							34,0	Ghiaie con ciottoli di diametro anche >5 cm e con abbondante matrice limoso sabbiosa	
	-27									
	-28									
	-29									
	-30									
	-31									
	-32									
	-33									
	-34									
	-35									
	-36		Shelby4 37,0÷37,6 m						Argille limose plastiche di colore grigio	
	-37									
	-38									
	-39									
	-40		Disturbato2 14,0÷14,3					40,0		

RAPPORTO DI PROVA ACQUISIZIONE ED ELABORAZIONE DI DATI SISMICI CON METODO DOWN - HOLE

COMMITTENTE:	Dott. Geol. Samuel Sangiorgi, Via Valsellustra, 32 - Dozza (BO)		
LOCALITA':	Via S. Pertini, Anzola Dell' Emilia (BO)		
PROVA:	DOWN HOLE		
DATA PROVA:	09/11/2018		
Prot.LAB	xxx	rev.0 del:	xxx
		COMM:	18388/18

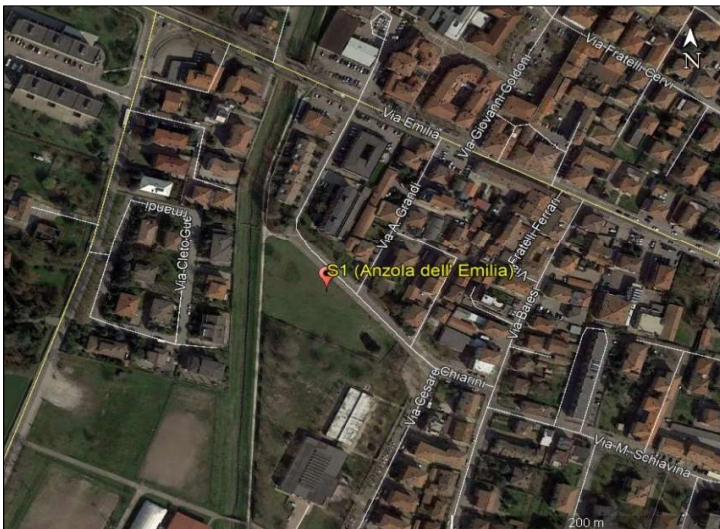
PROVA SISMICA IN FORO DOWN - HOLE ANZOLA DELL'EMILIA

UBICAZIONE

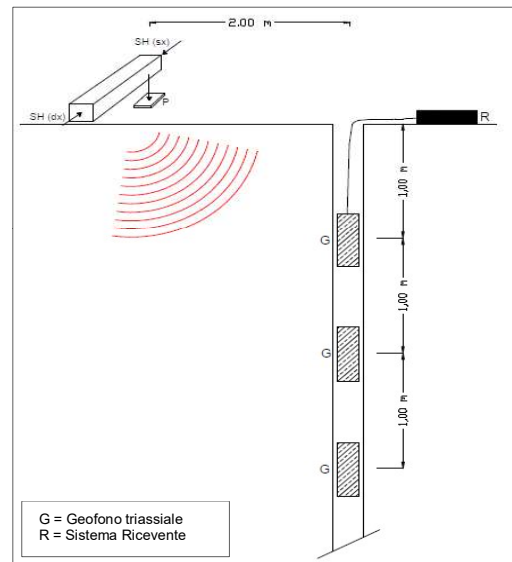
Latitudine :	44.545109° N
Longitudine :	11.191537° E
Profondità foro di sondaggio:	40,00 m
Profondità esecuzione prova:	1,00 m - 40,00 m

SCHEMA DI ACQUISIZIONE

Sismografo (R):	Geometrics geode
Geofono (G):	G1-GEO 3D P
Distanza Intergeofonica:	1,00 m
Offset sorgente:	2,00 m
Intervallo campionamento:	0.125 ms



S1: Foro di sondaggio



DOCUMENTAZIONE FOTOGRAFICA



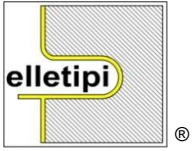
ELABORATO

Dott. Andrea Lombardo

Dott. Antonio Battiato

VERIFICATO

Dott. Fabio Faccia



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Sede legale, operativa, amm.va: via Zucchini, 69 - 44100 FERRARA

P.IVA e Codice Fiscale n.00174600387

sito: www.elletipi.it - email: info@elletipi.it

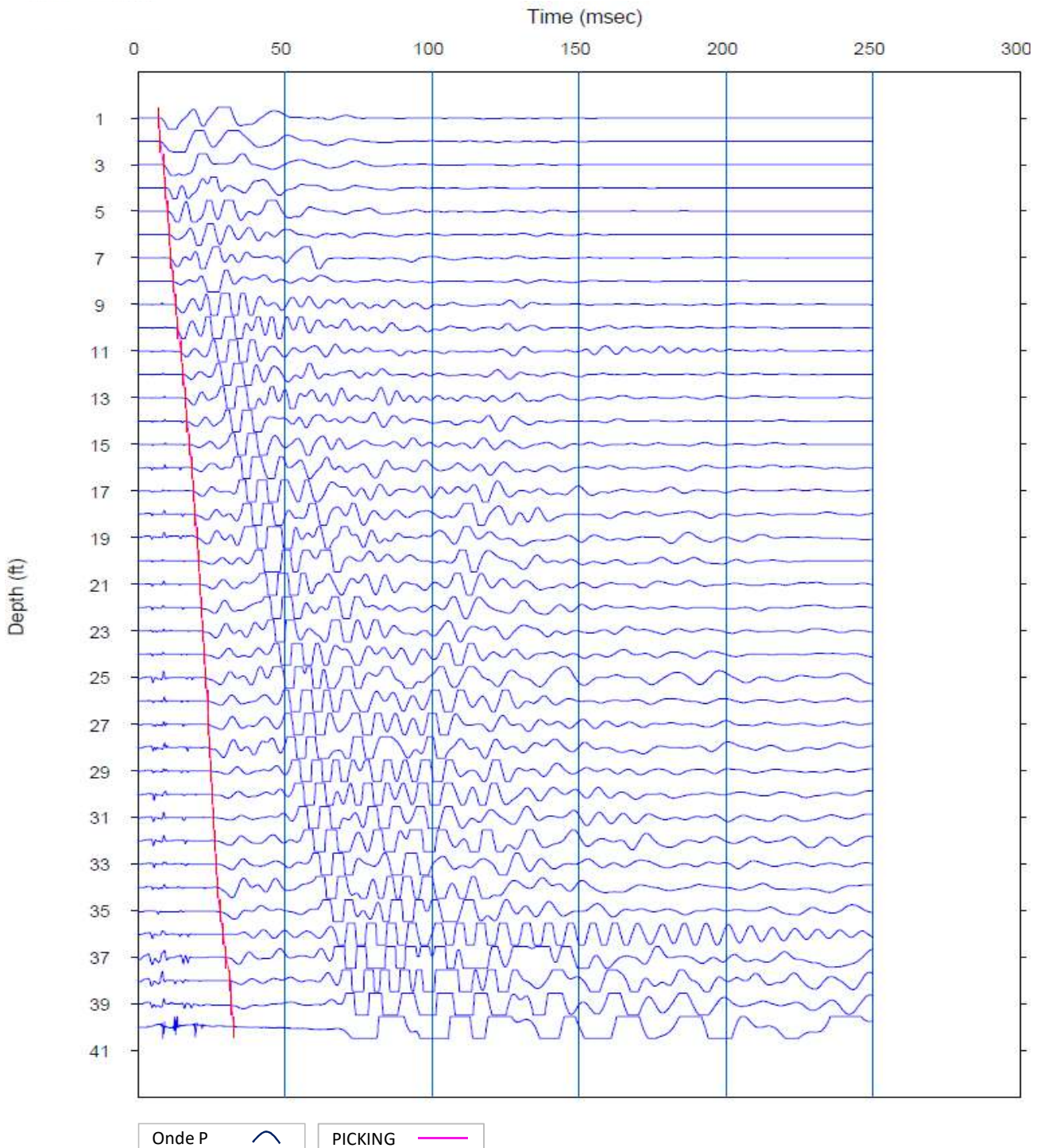


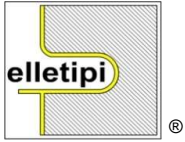
Laboratorio Geotecnico autorizzato con Dec. n. 6572 del 07/10/2014, art. 59 del D.P.R. 380/2001, Circolari Ministeriali 7618/STC

RAPPORTO DI PROVA ACQUISIZIONE ED ELABORAZIONE DI DATI SISMICI CON METODO DOWN - HOLE

COMMITTENTE: **Dott. Geol. Samuel Sangiorgi, Via Valsellustra, 32 - Dozza (BO)**
LOCALITA': **Via S. Pertini, Anzola Dell' Emilia (BO)**
PROVA: **DOWN HOLE**
DATA PROVA: **09/11/2018**
Prot.LAB xxx rev.0 del: xxx COMM: 18388/18

SISMOGRAMMA ONDE P





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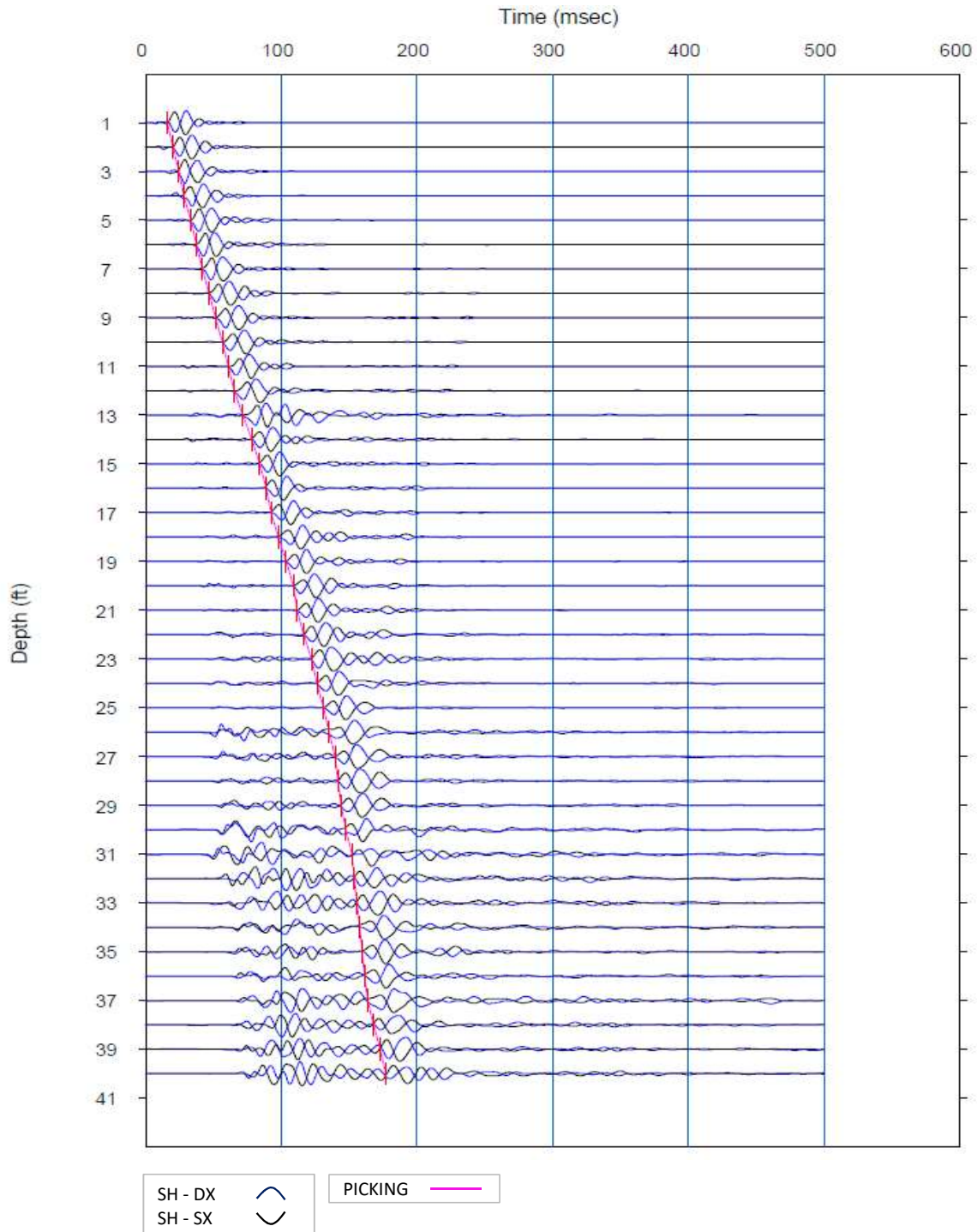


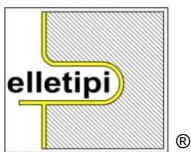
Laboratorio Geotecnico autorizzato con Dec. n. 6572 del 07/10/2014, art. 59 del D.P.R. 380/2001, Circolari Ministeriali 7618/STC

RAPPORTO DI PROVA ACQUISIZIONE ED ELABORAZIONE DI DATI SISMICI CON METODO DOWN - HOLE

COMMITTENTE: **Dott. Geol. Samuel Sangiorgi, Via Valsellustra, 32 - Dozza (BO)**
LOCALITA': **Via S. Pertini, Anzola Dell' Emilia (BO)**
PROVA: **DOWN HOLE**
DATA PROVA: **09/11/2018**
Prot.LAB xxx rev.0 del: xxx COMM: 18388/18

SISMOGRAMMA ONDE SH





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RAPPORTO DI PROVA ACQUISIZIONE ED ELABORAZIONE DI DATI SISMICI CON METODO DOWN - HOLE

COMMITTENTE: Dott. Geol. Samuel Sangiorgi, Via Valsellustra, 32 - Dozza (BO)
LOCALITA': Via S. Pertini, Anzola Dell' Emilia (BO)
PROVA: DOWN HOLE
DATA PROVA: 09/11/2018
Prot.LAB xxx rev.0 del: xxx **COMM:** 18388/18

TABELLA RIASSUNTIVA

Z (m)	Tp (ms)	Ts (ms)	Tp corr (ms)	Ts corr (ms)	Vp (m/s)	Vs (m/s)	μ	Ed (MPa)	G (Mpa)	K (Mpa)	Peso di volume (t/mc)
1	7.24	16.40	3.24	7.33	309	136	0.38	92.96	33.71	127.80	1.81
2	7.90	20.35	5.59	14.39	426	142	0.44	102.68	35.71	274.75	1.78
3	8.82	24.69	7.34	20.54	570	162	0.46	138.09	47.42	521.17	1.80
4	9.48	28.25	8.48	25.26	878	212	0.47	247.36	84.19	1332.98	1.88
5	10.14	33.58	9.41	31.18	1070	169	0.49	151.12	50.81	1968.27	1.78
6	10.80	37.73	10.24	35.79	1205	217	0.48	258.55	87.15	2579.94	1.86
7	11.45	42.07	11.01	40.46	1307	214	0.49	251.59	84.64	3030.05	1.84
8	12.12	47.01	11.75	45.61	1344	194	0.49	201.22	67.55	3150.54	1.79
9	12.85	51.56	12.54	50.33	1265	212	0.49	242.54	81.63	2800.52	1.82
10	13.64	56.49	13.38	55.40	1203	197	0.49	206.41	69.44	2490.38	1.78
11	14.64	61.04	14.40	60.05	972	215	0.47	246.05	83.44	1597.85	1.81
12	15.54	65.58	15.33	64.69	1081	216	0.48	248.41	83.96	1997.96	1.80
13	16.25	71.90	16.06	71.07	1365	157	0.49	123.44	41.33	3077.68	1.68
14	16.95	78.42	16.78	77.63	1392	152	0.49	115.36	38.61	3172.33	1.66
15	17.70	84.35	17.54	83.61	1307	167	0.49	141.66	47.48	2831.78	1.69
16	18.37	88.89	18.23	88.20	1463	218	0.49	251.77	84.56	3712.79	1.79
17	19.13	92.84	19.00	92.20	1297	250	0.48	339.18	114.53	2933.18	1.83
18	19.63	97.98	19.51	97.38	1957	193	0.50	193.89	64.84	6558.08	1.73
19	20.21	103.70	20.10	103.13	1698	174	0.49	152.50	51.01	4807.14	1.69
20	20.71	109.24	20.61	108.69	1967	180	0.50	164.66	55.04	6510.09	1.70
21	21.15	111.80	21.05	111.30	2235	384	0.48	864.66	291.17	9481.90	1.98
22	21.60	116.74	21.51	116.26	2190	201	0.50	210.79	70.46	8232.78	1.74
23	22.20	122.27	22.12	121.81	1652	180	0.49	164.02	54.89	4543.71	1.69
24	22.73	126.62	22.65	126.18	1869	229	0.49	278.03	93.15	6084.32	1.78
25	23.21	131.16	23.14	130.74	2064	219	0.49	252.32	84.43	7371.90	1.76
26	23.75	135.51	23.68	135.11	1838	229	0.49	277.47	92.98	5861.90	1.77
27	24.21	139.65	24.14	139.27	2156	240	0.49	307.44	102.91	8163.78	1.79
28	24.65	142.02	24.59	141.66	2255	418	0.48	1030.14	347.50	9642.02	1.99
29	25.05	144.20	24.99	143.86	2480	456	0.48	1244.56	419.75	11843.92	2.02
30	25.44	147.56	25.38	147.23	2544	296	0.49	487.19	163.15	11798.52	1.86
31	25.80	152.10	25.75	151.78	2756	220	0.50	251.59	84.04	13128.61	1.74
32	26.24	154.07	26.19	153.77	2260	502	0.47	1521.83	516.22	9763.29	2.05
33	26.73	155.65	26.68	155.37	2022	627	0.45	2417.46	835.46	7572.31	2.13
34	27.24	158.02	27.19	157.75	1963	420	0.48	1026.46	347.70	7146.62	1.98
35	28.01	159.60	27.96	159.35	1296	628	0.35	2252.71	836.33	2450.46	2.12
36	29.14	161.45	29.10	161.20	884	539	0.20	1444.00	599.39	814.57	2.06
37	30.12	163.95	30.08	163.71	1019	398	0.41	871.64	309.09	1614.06	1.95
38	30.95	168.10	30.91	167.87	1203	241	0.48	302.03	102.10	2415.04	1.76
39	31.85	173.04	31.81	172.81	1110	202	0.48	205.88	69.42	1997.14	1.70
40	32.78	176.99	32.74	176.77	1074	253	0.47	333.69	113.45	1898.84	1.78

LEGENDA

Tp (ms)	Tempo di primo arrivo P	μ	Coeff. Di Poisson
Ts (ms)	Tempo di primo arrivo S	Ed (Mpa)	Modulo di elasticità
corr	Corretto	G (Mpa)	Modulo di taglio
Vp(m/s)	Velocità onde P	K (Mpa)	Modulo di compressibilità
Vs(m/s)	Velocità onde S		



elletipi s.r.l.

Sede legale, operativa, amm.va: via Zucchini, 69 - 44100 FERRARA

P.IVA e Codice Fiscale n.00174600387

sito: www.elletipi.it - email: info@elletipi.it



Laboratorio Geotecnico autorizzato con Dec. n. 6572 del 07/10/2014, art. 59 del D.P.R. 380/2001, Circolari Ministeriali 7618/STC

RAPPORTO DI PROVA ACQUISIZIONE ED ELABORAZIONE DI DATI SISMICI CON METODO DOWN - HOLE

COMMITTENTE: **Dott. Geol. Samuel Sangiorgi, Via Valsellustra, 32 - Dozza (BO)**

LOCALITA': **Via S. Pertini, Anzola Dell' Emilia (BO)**

PROVA: **DOWN HOLE**

DATA PROVA: **09/11/2018**

Prot.LAB

xxx

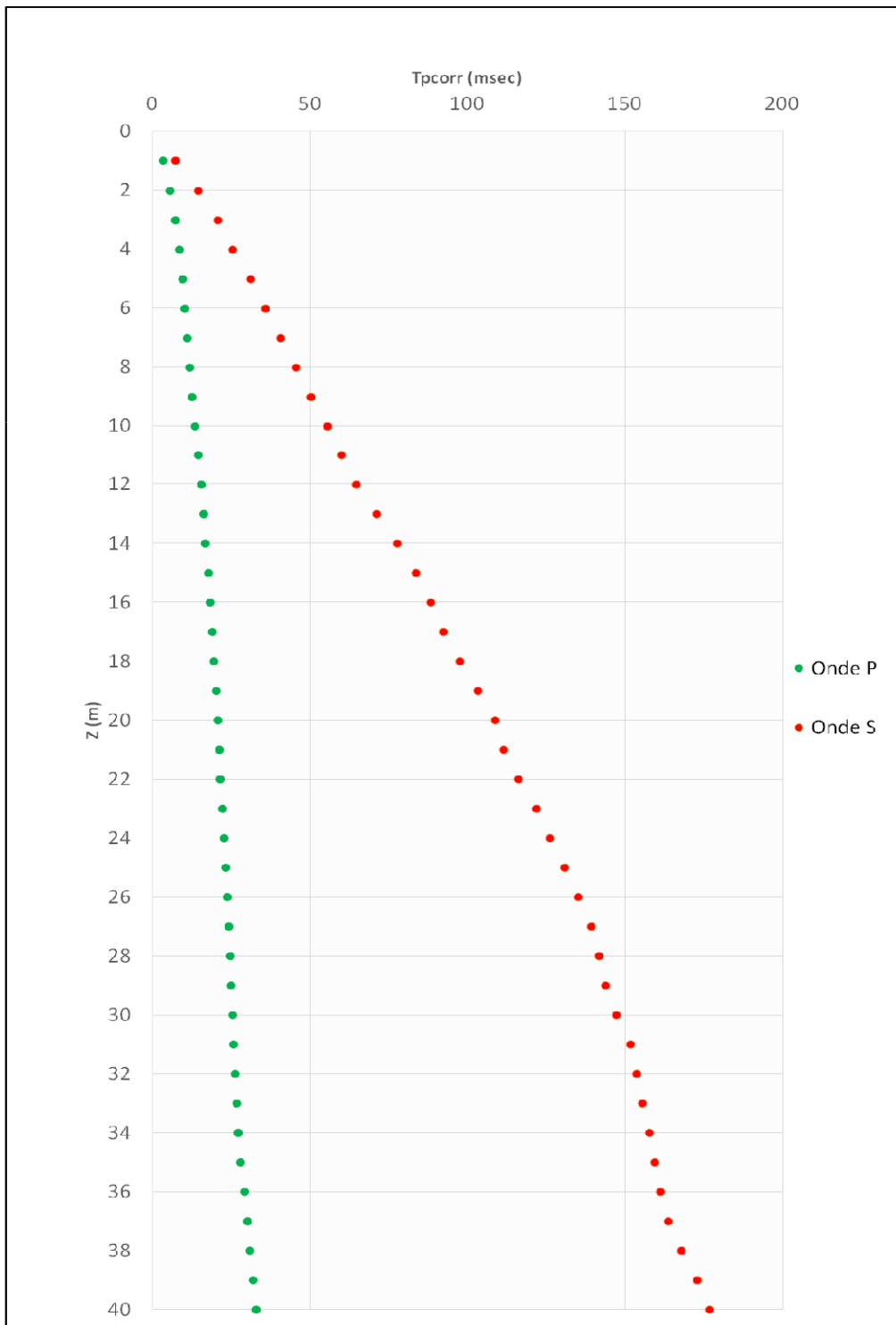
rev.0 del:

xxx

COMM:

18388/18

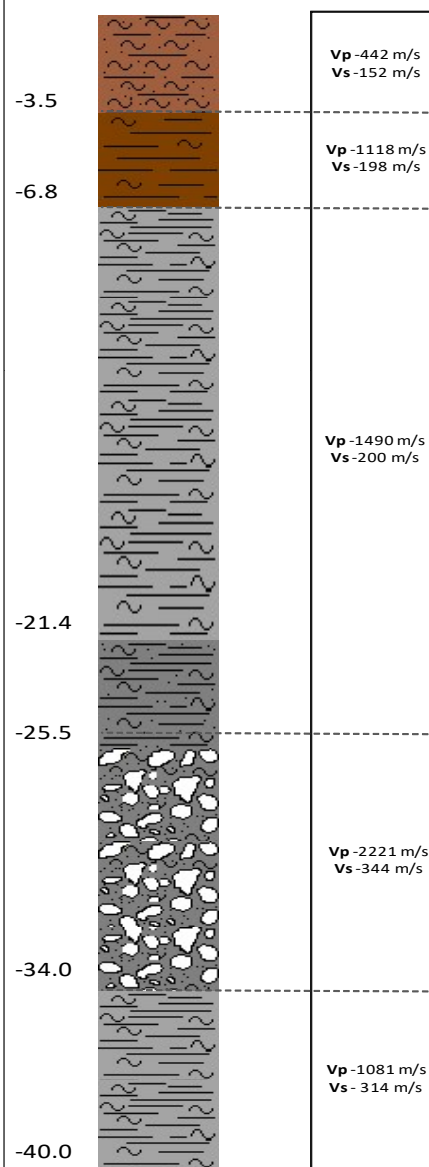
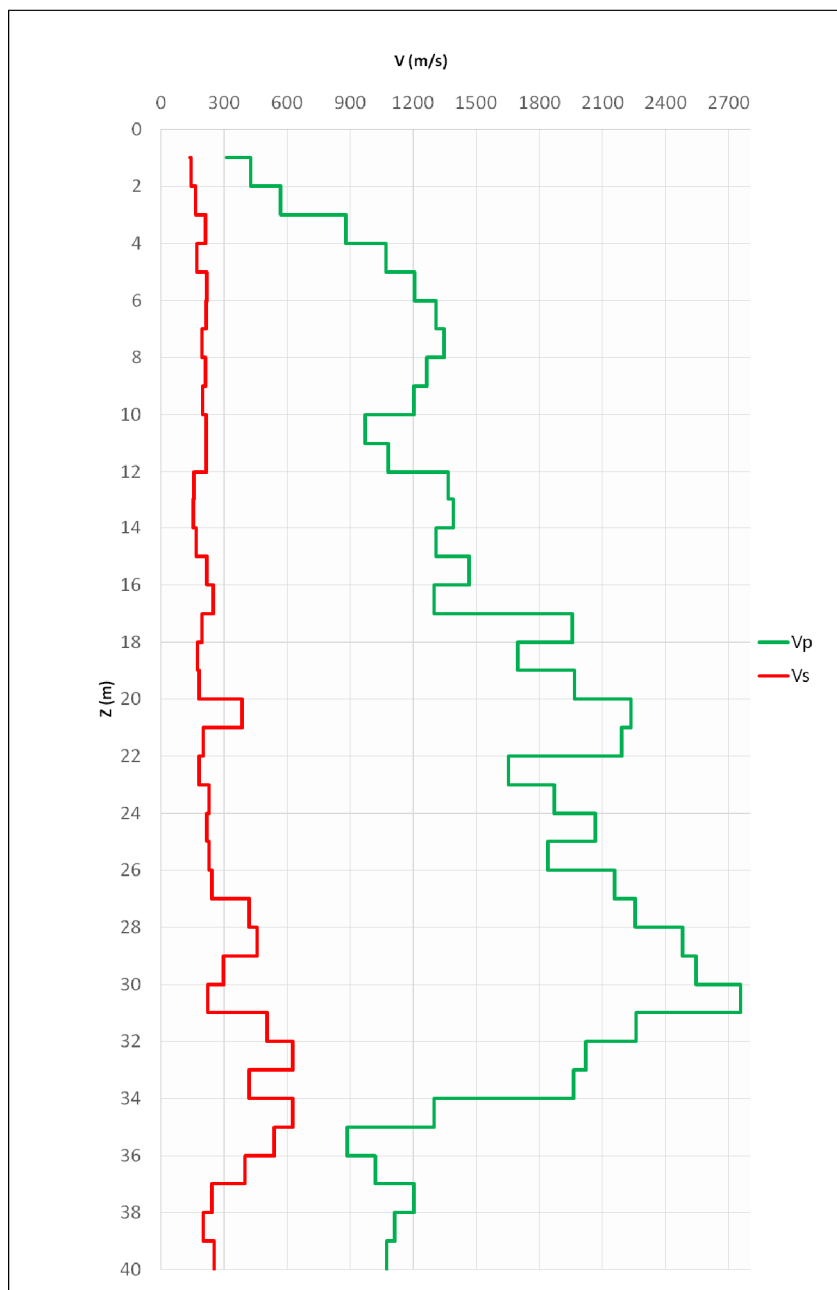
ELABORAZIONE PER DROMOCRONE



RAPPORTO DI PROVA ACQUISIZIONE ED ELABORAZIONE DI DATI SISMICI CON METODO DOWN - HOLE

COMMITTENTE: **Dott. Geol. Samuel Sangiorgi, Via Valsellustra, 32 - Dozza (BO)**
 LOCALITA': **Via S. Pertini, Anzola Dell' Emilia (BO)**
 PROVA: **DOWN HOLE**
 DATA PROVA: **09/11/2018**
 Prot.LAB: xxx rev.0 del: xxx COMM: 18388/18

RISULTATI



Vp medio (m/s)	Vs medio (m/s)	g medio (kN/mc)	ni medio	G medio (MPa)	Ed medio (MPa)	E medio (MPa)	Ev medio (MPa)
442.48	152.77	17.69	0.43	42.1	353.2	120.61	297.06
1118.64	198.68	18.8	0.48	75.66	2398.64	224.52	2297.76
1490.04	200.19	17.3	0.49	70.72	3917.63	210.85	3823.35
2221.65	344.66	20.02	0.49	242.56	10078.08	721.69	9754.67
1088.07	314.92	20	0.45	202.25	2414.32	588.26	2144.66

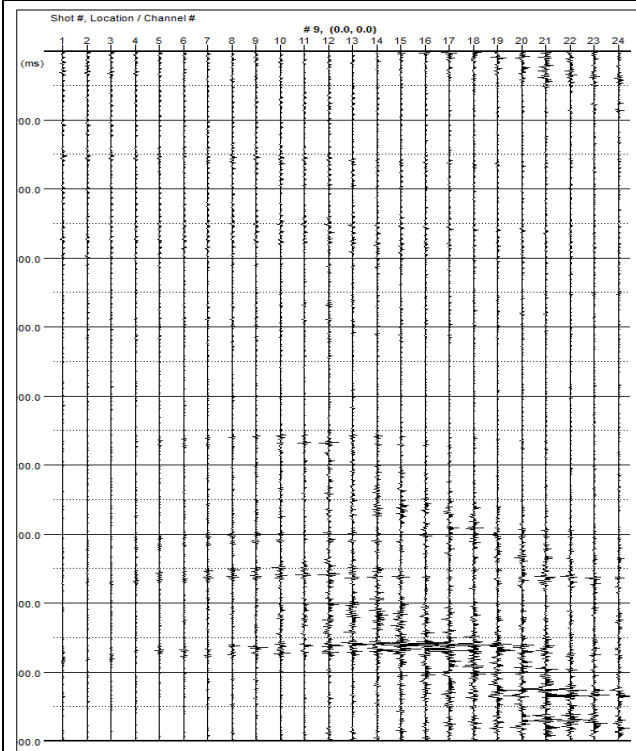
*VS ₃₀ = 202 m/s	*VS ₄₀ = 226 m/s
CATEGORIA SUOLO (NTC-18): C	

PROSPEZIONE SISMICA CON METODOLOGIA ESAC

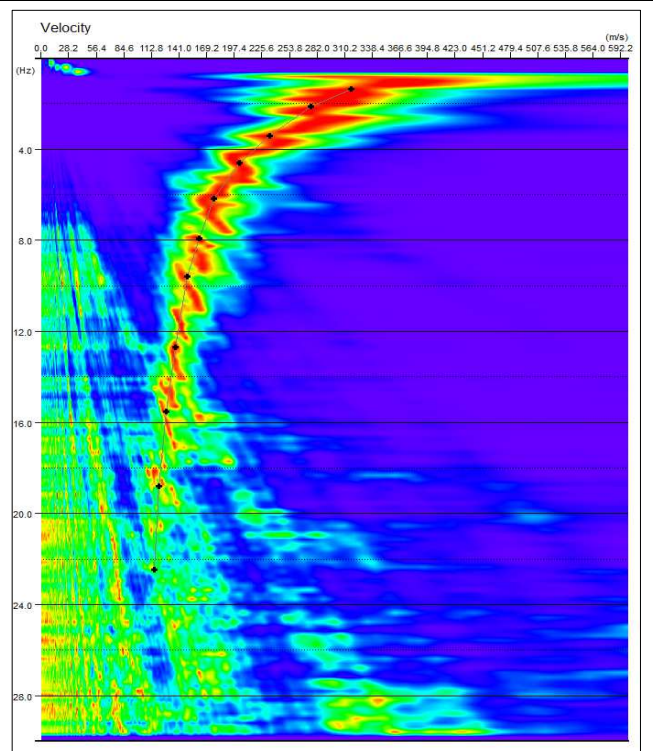
Via S. Pertini, Comune di Anzola dell'Emilia (BO) - 037001P60005ESAC_SPAC59150

n° tracce	Δt (ms)	T (s)
25	2,0	32,0

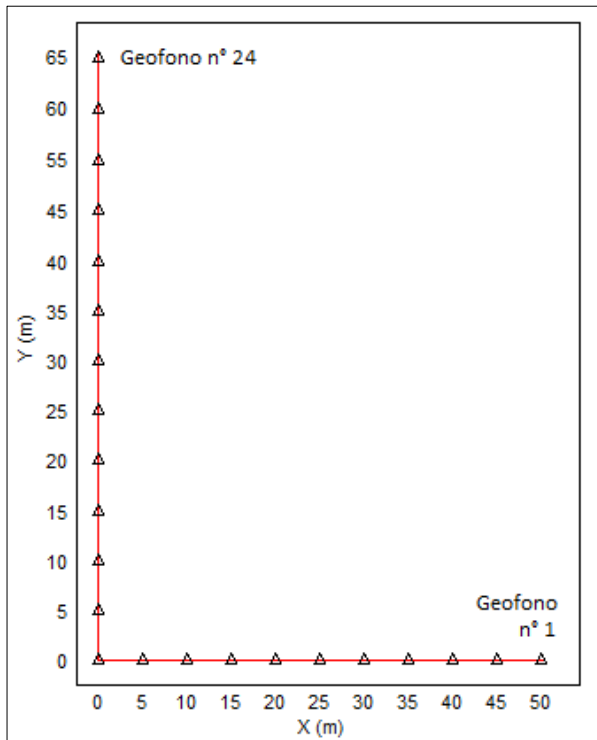
Δt : passo di campionamento; T: durata registrazione.



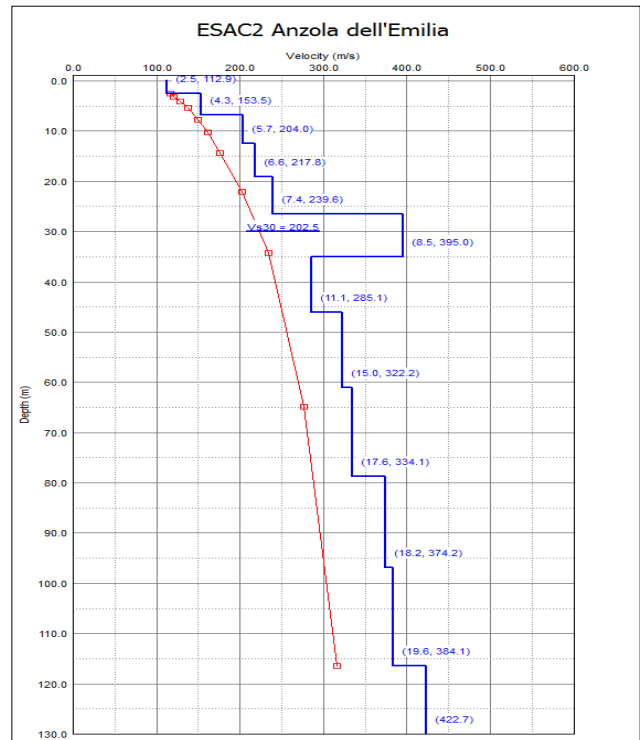
Sismogramma registrato durante le acquisizioni di microtremore sismico. In ascissa il numero dei geofoni, in ordinata il tempo (ms).



Spettro di potenza nel dominio $f-v$ e Picking della curva sperimentale delle onde R (croci nere).



Geometria dello stendimento sismico bidimensionale.



Modello di sottosuolo (1D) descritti in termini di V_s e spessore dei sismostrati (spezzata blu) e curva di dispersione sperimentale delle onde R (curva rossa).

Tabella di sintesi

n. Strato	Profondità letto (m dal p.c.)	Spessore (m)	V _s (m/s)
1	2.5	2.5	112.9
2	6.8	4.3	153.5
3	12.5	5.7	204.0
4	19.1	6.6	217.8
5	26.5	7.4	239.6
6	35.0	8.5	395.0
7	46.1	11.1	285.1
8	61.1	15.0	322.2
9	78.7	17.6	334.1
10	96.9	18.2	374.2
11	116.5	19.6	384.1
12	∞	∞	422.7

$$V_{s30} = 202.5 \pm 10\% \text{ [m/s]}$$

Sintesi dei parametri del modello di sottosuolo ottenuto e Valore di Vs30 calcolato.

ANZOLA DELL'EMILIA_MS, TR7

037001P60005HVSR59151

Instrument: TRZ-0108/01-10

Start recording: 04/10/18 11:17:43 End recording: 04/10/18 12:17:43

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 1h00'00". Analyzed 80% trace (manual window selection)

Sampling rate: 128 Hz

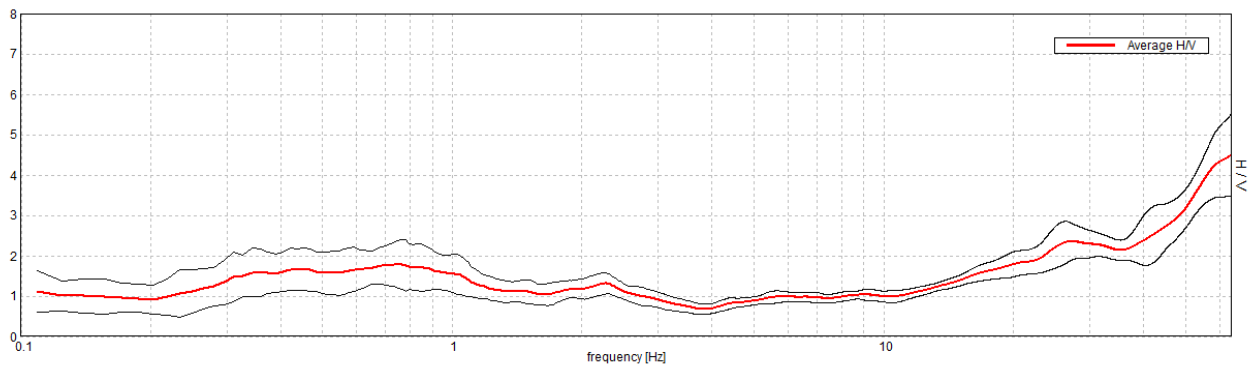
Window size: 60 s

Smoothing type: Triangular window

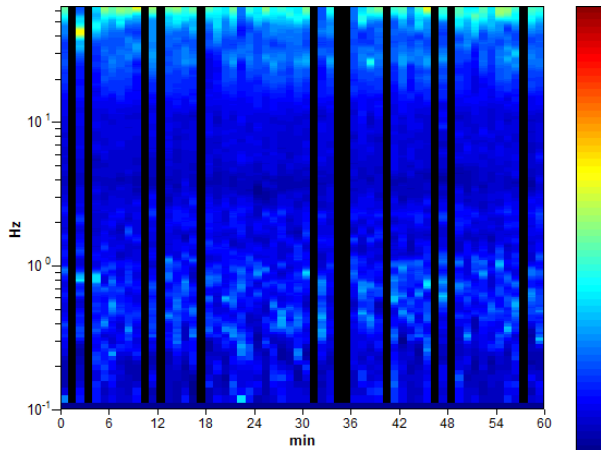
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

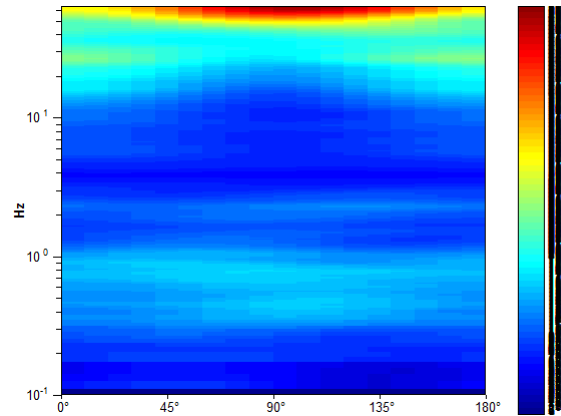
Max. H/V at 0.75 ± 0.03 Hz. (In the range 0.1 - 10.0 Hz).



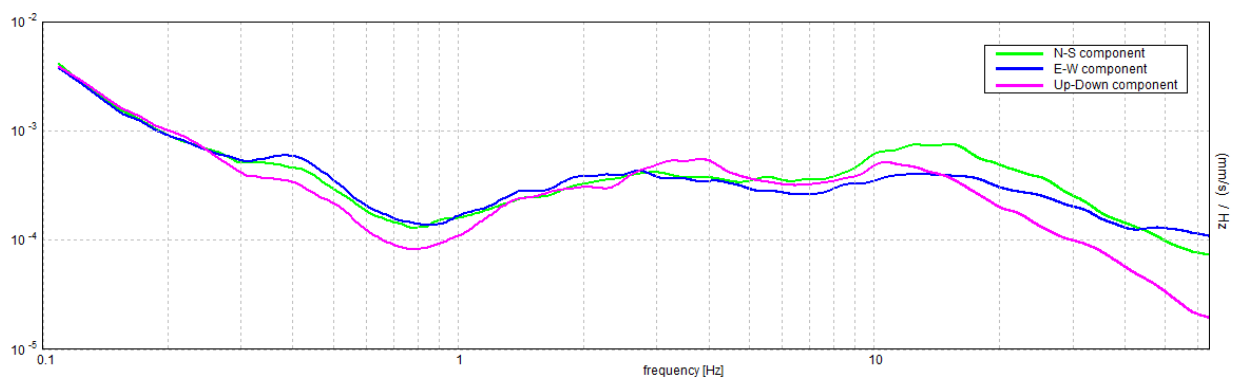
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. Please read carefully the *Grilla* manual before interpreting the following tables.]

Max. H/V at 0.75 ± 0.03 Hz (in the range 0.1 - 10.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.75 > 0.17$	OK	
$n_c(f_0) > 200$	$2160.0 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 73 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0]$ $A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$			NO
$A_0 > 2$	$1.78 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01835 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01376 < 0.1125$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.2905 < 2.0$	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{\log H/V}(f)$	standard deviation of $\log A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$

Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20



Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A, B e C

rev.	data emiss.	sperimentatore	direttore
0	10/12/2018	Angeloni	Saccenti

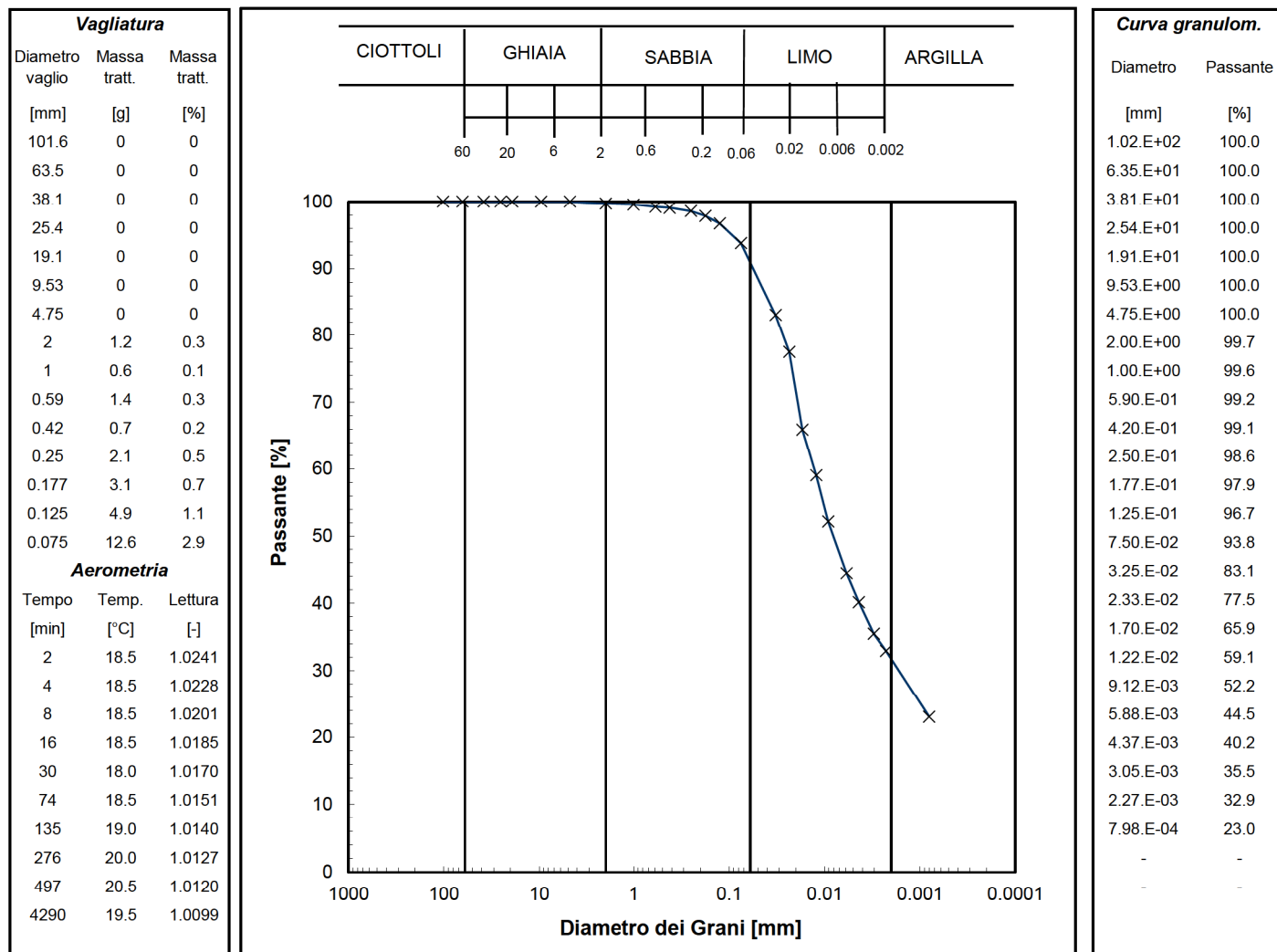
Normativa di riferimento: ASTM D422/07

Classificazione di riferimento: AGI 1977

N° certificato di prova:

N° verbale di accettazione: 044/2018

Committente: DOTT.GEOL. SANGIORGI
Cantiere: ANZOLA DELL'EMILIA
Sondaggio: S1
Campione: CR1
Profondità prelievo [m]: 2.4 - 2.6
Prova: Gr 1
Data prova: 03/12/2018



Prova	Simbolo	Profondità		Massa secca materiale [g]	Metodo preparazione materiale	% < 0.075mm	% CIOTTOLI	% GHIAIA	% SABBIA	% LIMO	% ARGILLA	Massa materiale aerometria [g]	L max [mm]	D ₆₀ [mm]	D ₅₀ [mm]
		da m	a m												
Gr 1	x	2.40	2.60	429.3	VIA UMIDA	94	-	0	9	59	32	35	-	1.3.E-02	8.0.E-03

NOTE:

GS= 2.700

La soluzione disperdente è stata preparata il 14/05/18



Concessione Ministeriale Decreto n°55126 del 12 luglio 2006 - Settori A, B e C

Sperimentatore:	Diaby
Direttore:	Saccenti
Data emissione:	11/12/2018
Rev.	0

Committente:	DOTT.GEOL. SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	CR1
Profondità prova [m]:	2.40 - 2.60
Prova:	LLP1
Data prova:	30/11/2018

Normativa di riferimento: ASTM D4318

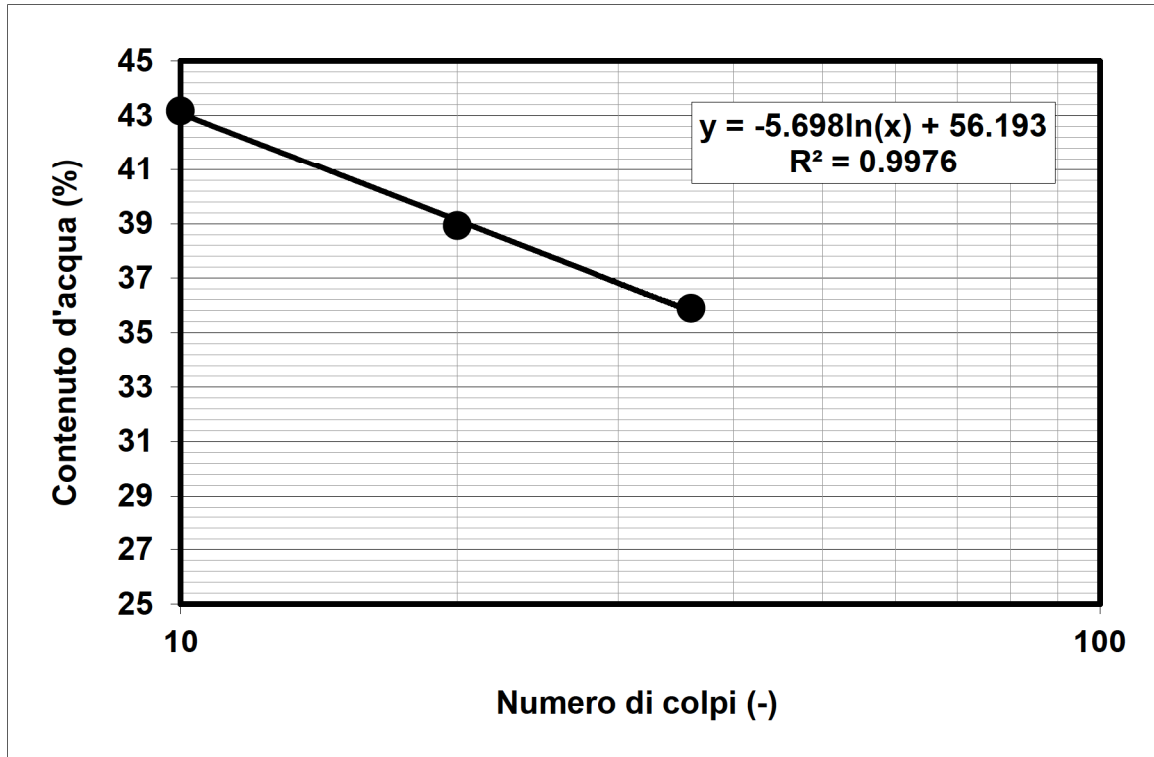
N° certificato di prova:

N° verbale di accettazione: 044/2018

Limite Liquido			
	prova 1	prova 2	prova 3
numero colpi	36	20	10
massa tara (g)	20.95	22.12	22.22
massa umido + tara (g)	69.38	77.09	80.79
massa secco + tara (g)	56.59	61.69	63.13
umidità (%)	35.89	38.92	43.17

Limite Plastico		
massa tara (g)	22.2	22.24
massa umido + tara (g)	38.04	38.27
massa secco + tara (g)	35.34	35.58
umidità (%)	20.55	20.16

Limite Liquido LL (%)	37.9
Limite Plastico LP (%)	20.4
Indice Plastico IP(%)	17.5



Note:



Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A, B e C

rev.	data emiss.	sperimentatore	direttore
0	10/12/2018	Angeloni	Saccenti

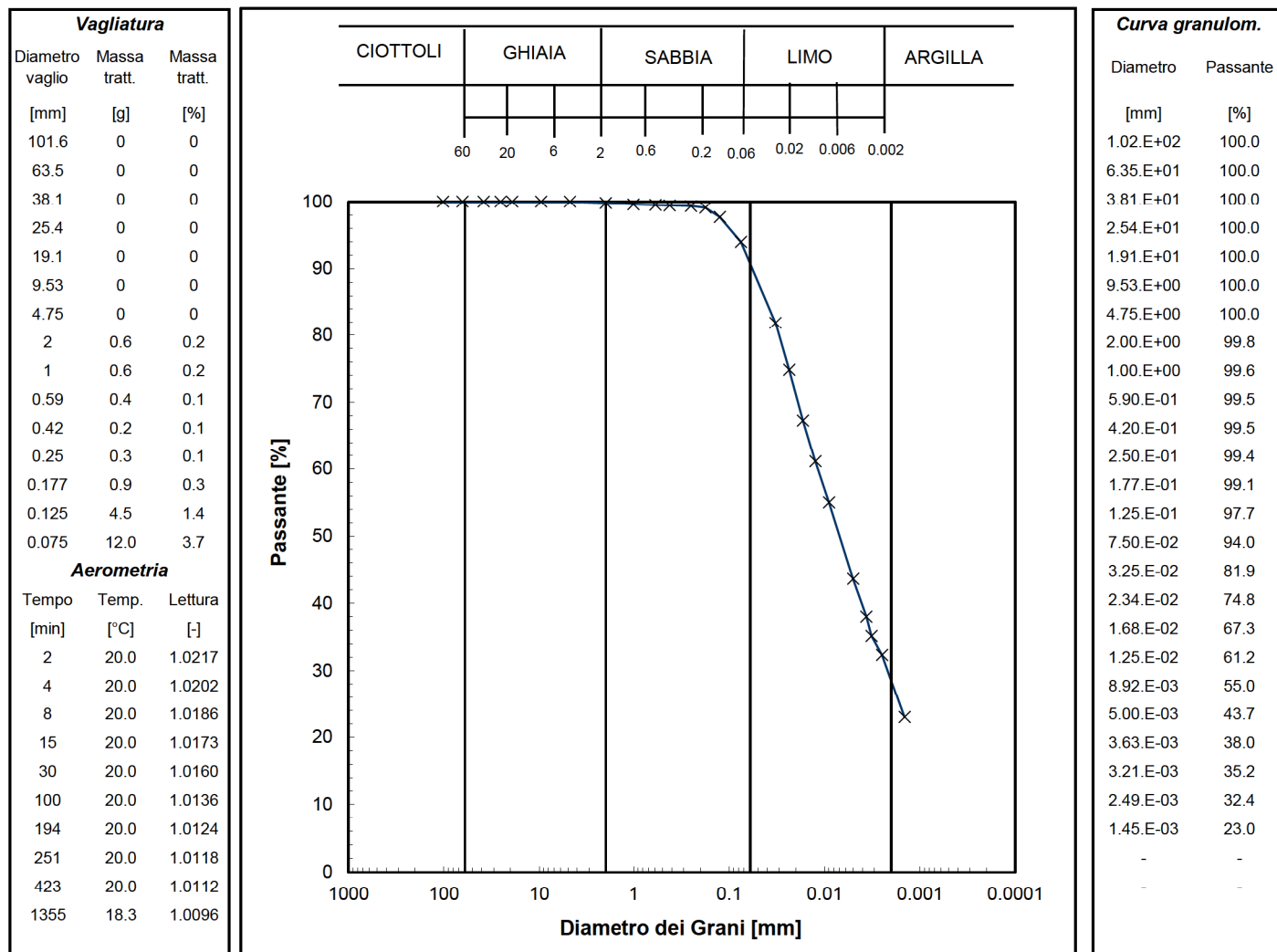
Normativa di riferimento: ASTM D422/07

Classificazione di riferimento: AGI 1977

N° certificato di prova:

N° verbale di accettazione: 044/2018

Committente:	DOTT. GEOL. SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	CI1
Profondità prelievo [m]:	4.13 - 4.23
Prova:	Gr 1
Data prova:	22/11/2018



Prova	Simbolo	Profondità		Massa secca materiale [g]	Metodo preparazione materiale	% < 0.075mm	% CIOTTOLI	% GHIAIA	% SABBIA	% LIMO	% ARGILLA	Massa materiale aerometria [g]	L max [mm]	D ₆₀ [mm]	D ₅₀ [mm]
		da m	a m												
Gr 1	x	4.13	4.23	321.0	VIA UMIDA	94	-	0	9	62	29	32	7	1.2.E-02	6.9.E-03

NOTE:



Concessione Ministeriale Decreto n°55126 del 12 luglio 2006 - Settori A, B e C

Sperimentatore:	Diaby
Direttore:	Saccenti
Data emissione:	10/12/2018
Rev.	0

Committente:	DOTT.GEOL. SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	CI1
Profondità prova [m]:	4.13 - 4.23
Prova:	LLP1
Data prova:	21/11/18

Normativa di riferimento: ASTM D4318

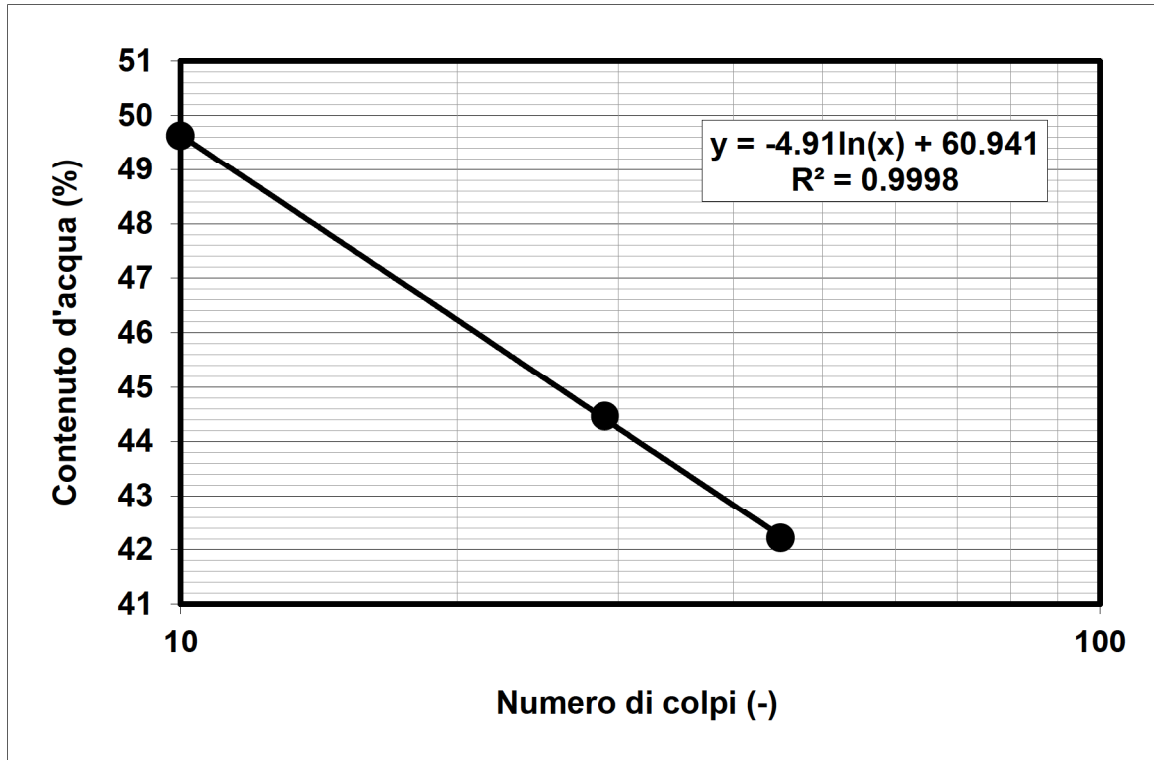
N° certificato di prova:

N° verbale di accettazione: 044/2018

Limite Liquido			
	prova 1	prova 2	prova 3
numero colpi	45	29	10
massa tara (g)	22.33	22.2	22.43
massa umido + tara (g)	60.23	70.19	77.64
massa secco + tara (g)	48.98	55.42	59.33
umidità (%)	42.21	44.46	49.62

Limite Plastico		
massa tara (g)	22.45	22.22
massa umido + tara (g)	44.28	45.98
massa secco + tara (g)	40.05	40.58
umidità (%)	24.03	29.41

Limite Liquido LL (%)	45.1
Limite Plastico LP (%)	26.7
Indice Plastico IP(%)	18.4



Note:



Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A, B e C

rev.	data emiss.	sperimentatore	direttore
0	10/12/2018	Angeloni	Saccenti

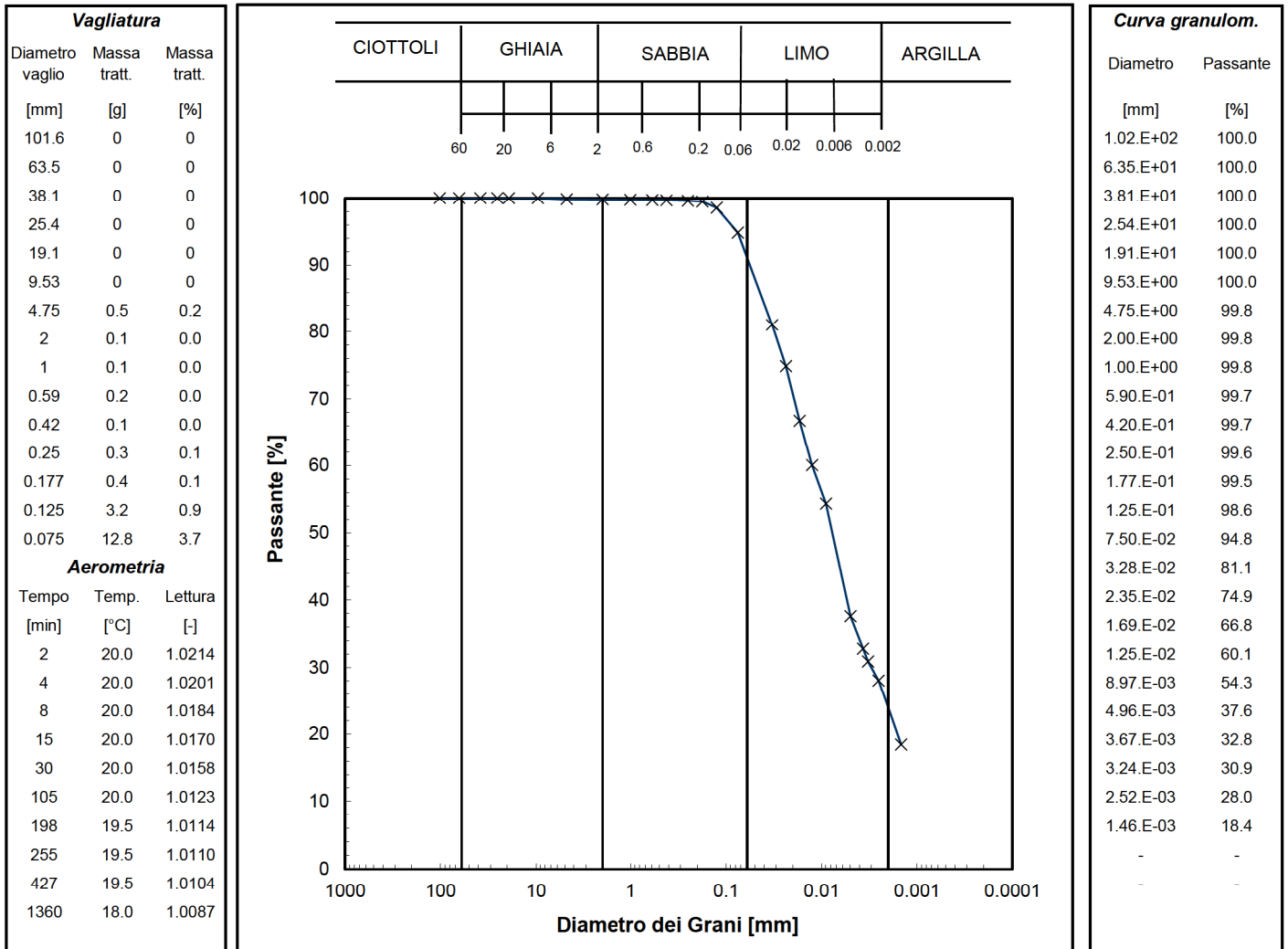
Normativa di riferimento: ASTM D422/07

Classificazione di riferimento: AGI 1977

N° certificato di prova:

N° verbale di accettazione: 044/2018

Committente:	DOTT.GEOL. SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	CI2
Profondità prelievo [m]:	11.06 - 11.16
Prova:	Gr 1
Data prova:	22/11/2018



Prova	Simbolo	Profondità		Massa secca materiale [g]	Metodo preparazione materiale	% < 0.075mm	% CIOTTOLI	% GHIAIA	% SABBIA	% LIMO	% ARGILLA	Massa materiale aerometria [g]	L max [mm]	D ₆₀ [mm]	D ₅₀ [mm]
		da m	a m												
Gr 1	x	11.06	11.16	344.5	VIA UMIDA	95	-	0	9	67	24	32	12	1.2.E-02	7.7.E-03

NOTE:



Concessione Ministeriale Decreto n°55126 del 12 luglio 2006 - Settori A, B e C

Sperimentatore:	Diaby
Direttore:	Saccenti
Data emissione:	10/12/2018
Rev.	0

Committente:	DOTT.GEOL. SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	CI2
Profondità prova [m]:	11.06 - 11.16
Prova:	LLP1
Data prova:	21/11/2018

Normativa di riferimento: ASTM D4318

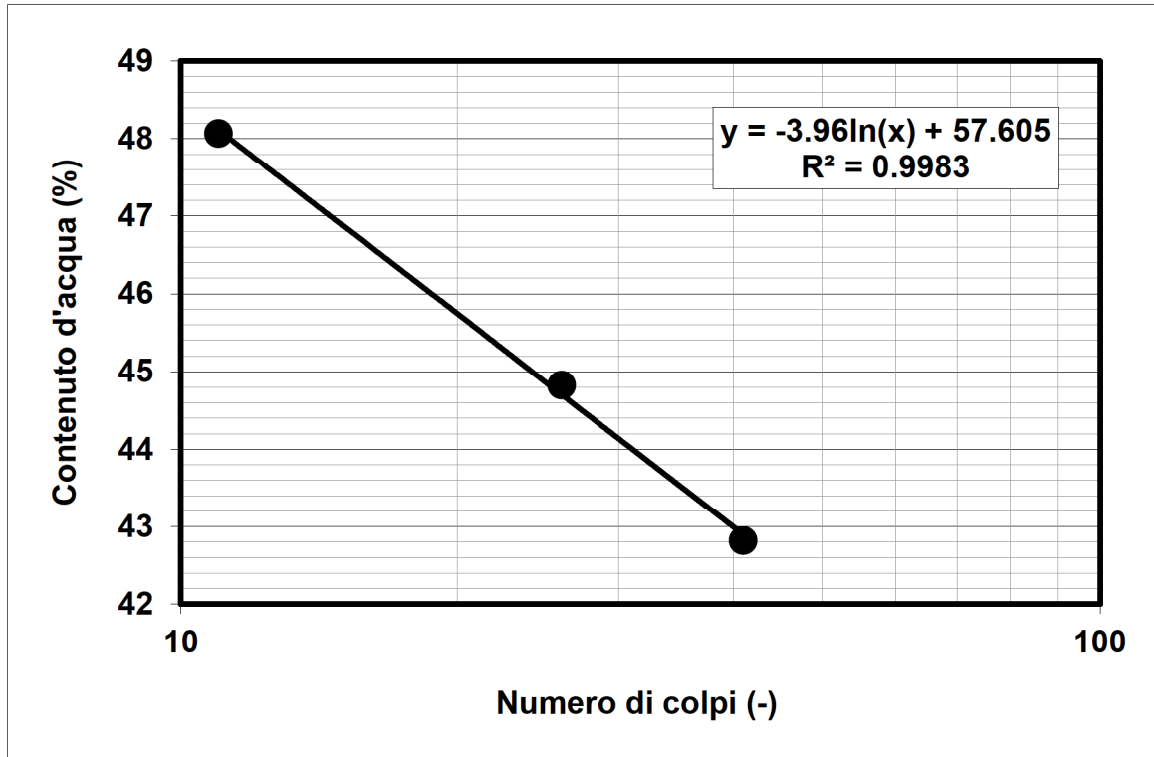
N° certificato di prova:

N° verbale di accettazione: 044/2018

Limite Liquido			
	prova 1	prova 2	prova 3
numero colpi	41	26	11
massa tara (g)	22.34	22.49	22.23
massa umido + tara (g)	72.94	73.44	78.11
massa secco + tara (g)	57.77	57.67	59.97
umidità (%)	42.82	44.83	48.07

Limite Plastico		
massa tara (g)	22.31	21.64
massa umido + tara (g)	35.08	34.39
massa secco + tara (g)	32.66	31.99
umidità (%)	23.38	23.19

Limite Liquido LL (%)	44.9
Limite Plastico LP (%)	23.3
Indice Plastico IP(%)	21.6



Note:



Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A, B e C

rev.	data emiss.	sperimentatore	direttore
0	10/12/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

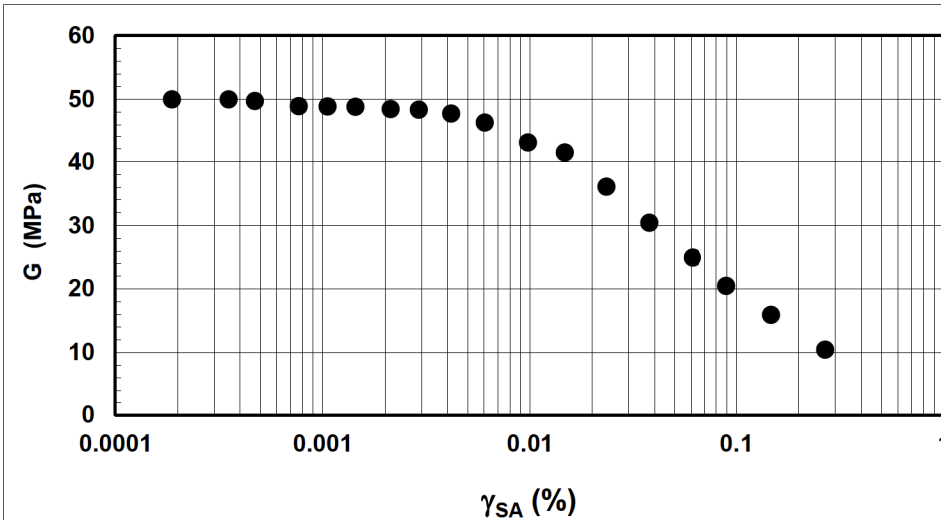
N° certificato di prova:

N° verbale di accettazione: 044/2018

Committente:	SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	C12
Profondità prova [m]:	11.40 - 11.50
Prova:	RC
Provino:	1
Data prova:	05/12/2018

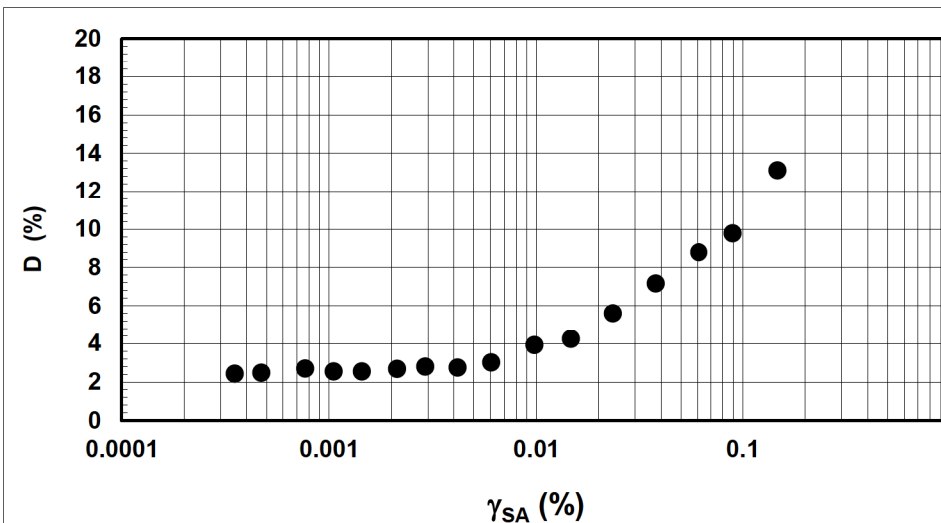
Dati generali dei provini

Dati iniziali					Dati a fine consolidazione										Informazioni generali		
Φ	H	γ_w	w	e	σ'_a	σ'_r	K	B.P.	B	D	H	γ_w	w	e	S	tipo di provino	
mm	mm	kN/m ³	%	-	kPa	kPa	-	kPa	-	mm	mm	kN/m ³	%	-	%	metodo di preparazione	
50.00	101.00	18.25	34.7	0.954	120	120	1.0	300.0	0.95	49.7	100.4	18.46	33.9	0.922	99	INDISTURBATO	
																FUSTELLAZIONE	
																PIETRA POROSA	
																TORSIONALE	
																peso specifico (-)	2.700



Legenda:

- Φ = diametro del provino
- H = altezza del provino
- γ_w = peso di volume umido
- w = contenuto d'acqua
- e = indice dei vuoti
- σ' = tensioni efficaci
- K = σ'_r / σ'_a
- B.P. = back pressure
- B = coefficiente di Skempton
- G = Modulo di taglio
- γ_{SA} = def. di taglio in singola ampiezza
- D = Rapporto di smorzamento di taglio
- Subscritto 'a' = assiale
- Subscritto 'r' = radiale
- S = grado di saturazione



Note:

rev.	data emiss.	sperimentatore	direttore
0	10/12/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

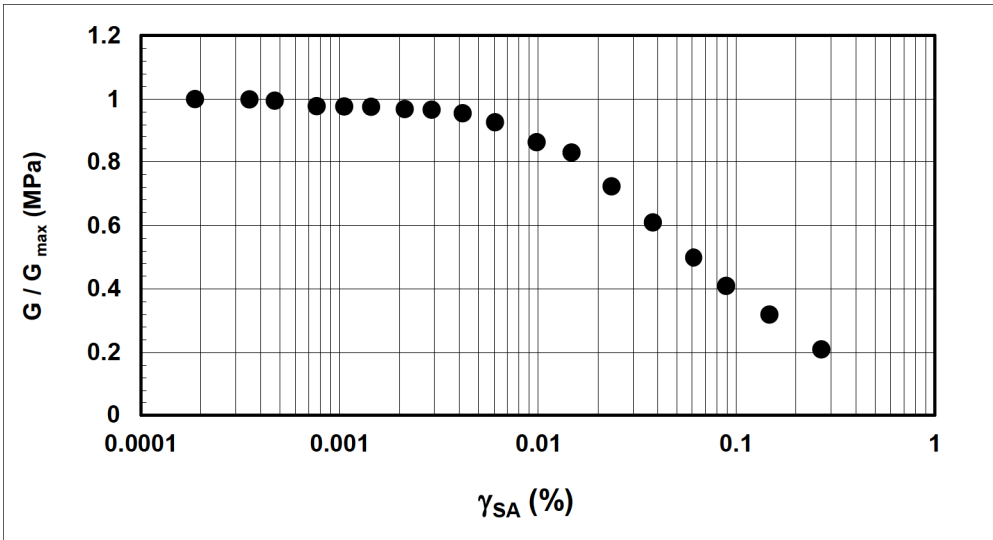
N° certificato di prova:

N° verbale di accettazione: 044/2018

Committente:	SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	CI2
Profondità prova [m]:	11.40 - 11.50
Prova:	RC
Provino:	1
Data prova:	05/12/2018

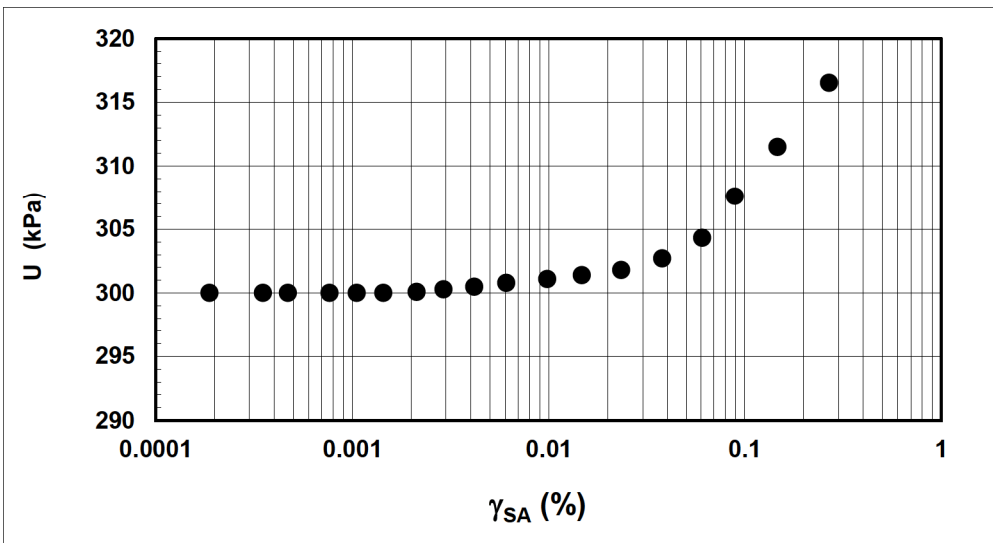
Dati generali dei provini

Dati iniziali					Dati a fine consolidazione										Informazioni generali		
Φ	H	γ_w	w	e	σ'_a	σ'_r	K	B.P.	B	D	H	γ_w	w	e	S	tipo di provino	
mm	mm	kN/m ³	%	-	kPa	kPa	-	kPa	-	mm	mm	kN/m ³	%	-	%	metodo di preparazione	
50.00	101.00	18.25	34.7	0.954	120	120	1.0	300.0	0.95	49.7	100.4	18.46	33.9	0.9	99	INDISTURBATO	
																FUSTELLAZIONE	
																PIETRA POROSA	
																TORSIONALE	
																peso specifico	2.700



Legenda:

- Φ = diametro del provino
- H = altezza del provino
- γ_w = peso di volume umido
- w = contenuto d'acqua
- e = indice dei vuoti
- σ' = tensioni efficaci
- K = σ'_r / σ'_a
- B.P. = back pressure
- B = coefficiente di Skempton
- G = Modulo di taglio
- γ_{SA} = def. di taglio in singola ampiezza
- D = Rapporto di smorzamento di taglio
- Subscritto 'a' = assiale
- Subscritto 'r' = radiale
- S = grado di saturazione



Note:	
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Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A, B e C

rev.	data emiss.	sperimentatore	direttore
0	10/12/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

N° certificato di prova:

N° verbale di accettazione: 044/2018

Committente:	SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	CI2
Profondità prova [m]:	11.40 - 11.50
Prova:	RC
Provino:	1
Data prova:	05/12/2018

Dati generali dei provini

Dati iniziali					Dati di prova										Informazioni generali	
Φ	H	γ_w	w	e	σ'_a	σ'_r	K	B.P.	B	D	H	γ_w	w	e	tipo di provino	
mm	mm	kN/m ³	%	-	kPa	kPa	-	kPa	-	mm	mm	kN/m ³	%	-	metodo di preparazione	
50.00	101.00	18.25	34.7	0.954	120	120	1.0	300.0	0.95	49.7	100.4	18.46	33.9	0.922	superficie di appoggio	INDISTURBATO
															eccitazione	PIETRA POROSA
																TORSIONALE

Valori numerici

G	G/G _{MAX}	γ	D	U
(MPa)	(-)	(%)	(%)	(kPa)
49.97	1.000	0.00019		300.0
49.95	1.000	0.00035	2.43	300.0
49.73	0.995	0.00047	2.46	300.0
48.89	0.978	0.00077	2.69	300.0
48.83	0.977	0.00106	2.54	300.0
48.79	0.976	0.00144	2.54	300.0
48.44	0.969	0.00213	2.67	300.1
48.34	0.967	0.00291	2.79	300.3
47.77	0.956	0.00417	2.73	300.5
46.33	0.927	0.00607	3.00	300.8
43.01	0.861	0.00980	3.92	301.1
41.40	0.829	0.01471	4.23	301.4
36.09	0.722	0.02337	5.61	301.8
30.43	0.609	0.03772	7.17	302.7
24.94	0.499	0.06104	8.79	304.3
20.45	0.409	0.08936	9.77	307.6
15.92	0.319	0.14716	13.11	311.5
10.47	0.209	0.26861	0.00	316.5

Legenda:

Φ = diametro del provino

H = altezza del provino

γ_w = peso di volume umido

w = contenuto d'acqua

e = indice dei vuoti

σ' = tensioni efficaci

K = σ_r / σ_a

B.P. = back pressure

B = coefficiente di Skempton

G = Modulo di taglio

γ_{SA} = def.di taglio in singola ampiezza

D = Rapporto di smorzamento di taglio

Subscritto 'a' = assiale

Subscritto 'r' = radiale

Note:



Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A, B e C

rev.	data emiss.	sperimentatore	direttore
0	10/12/2018	Angeloni	Saccenti

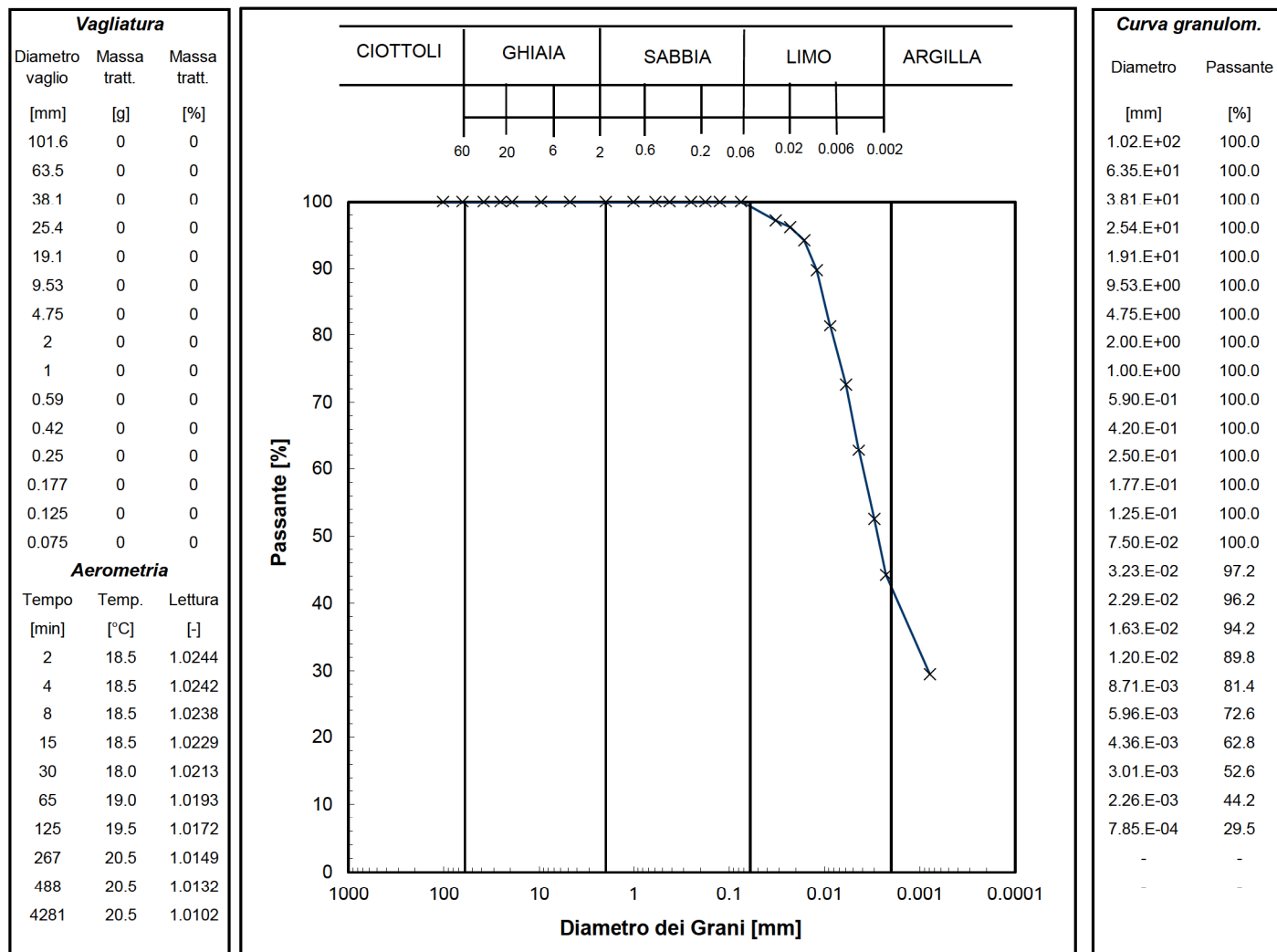
Normativa di riferimento: ASTM D422/07

Classificazione di riferimento: AGI 1977

N° certificato di prova:

N° verbale di accettazione: 044/2018

Committente:	DOTT.GEOL. SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	CR2
Profondità prelievo [m]:	4 - 4.3
Prova:	Gr 1
Data prova:	03/12/2018



Prova	Simbolo	Profondità		Massa secca materiale [g]	Metodo preparazione materiale	% < 0.075mm	% CIOTTOLI	% GHIAIA	% SABBIA	% LIMO	% ARGILLA	Massa materiale aerometria [g]	L max [mm]	D ₆₀ [mm]	D ₅₀ [mm]
		da m	a m												
Gr 1	x	4.00	4.30	311.8	VIA UMIDA	100	-	-	1	57	43	32	-	3.9.E-03	2.8.E-03

NOTE:

GS= 2.700

La soluzione disperdente è stata preparata il 14/05/18



Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A, B e C

rev.	data emiss.	sperimentatore	direttore
0	10/12/2018	Angeloni	Saccenti

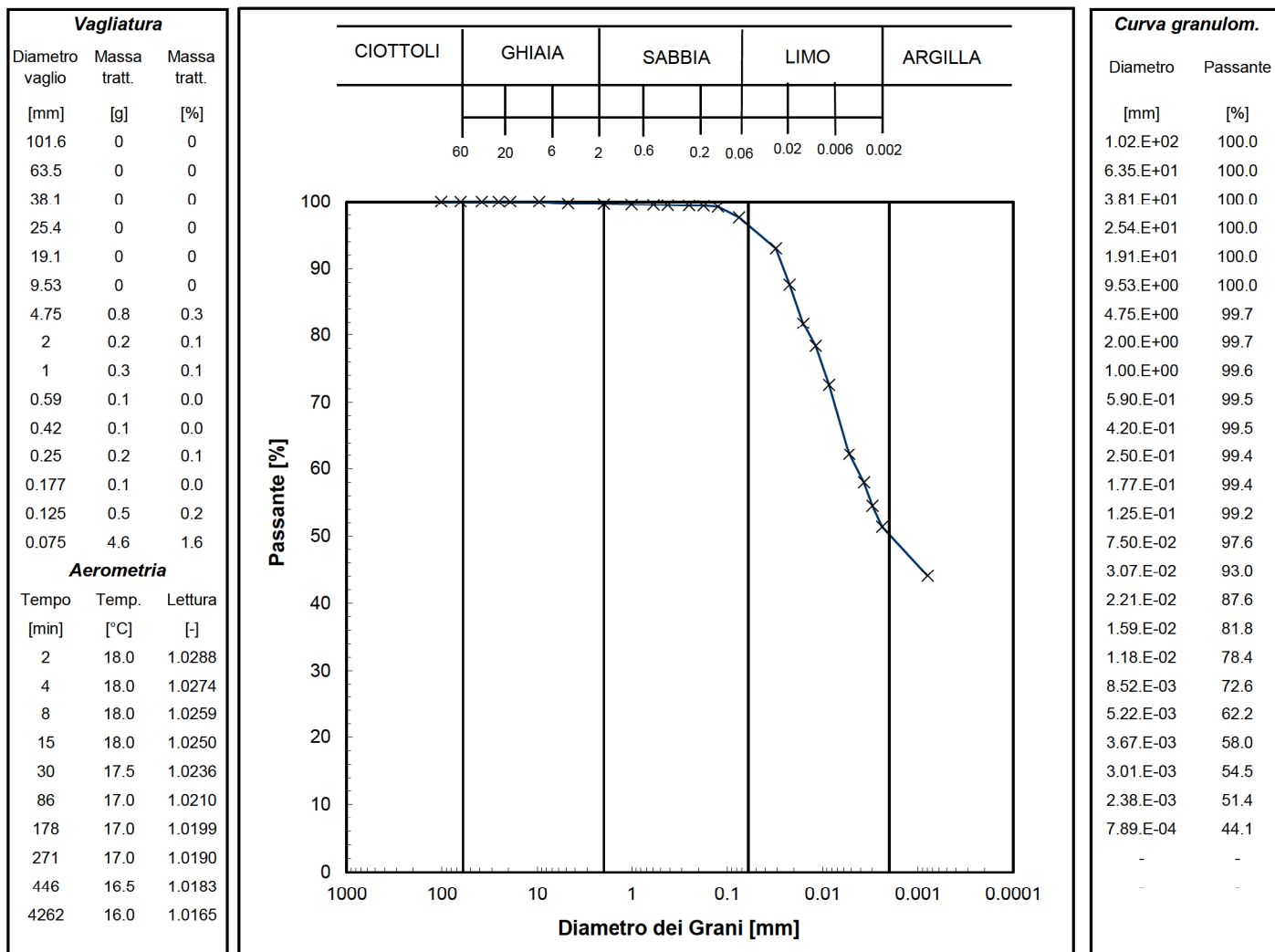
Normativa di riferimento: ASTM D422/07

Classificazione di riferimento: AGI 1977

N° certificato di prova:

N° verbale di accettazione: 044/2018

Committente:	DOTT.GEOL. SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	CI3
Profondità prelievo [m]:	18.15 - 18.25
Prova:	Gr 1
Data prova:	27/11/2018



Prova	Simbolo	Profondità		Massa secca materiale [g]	Metodo preparazione materiale	% < 0.075mm	% CIOTTOLI	% GHIAIA	% SABBIA	% LIMO	% ARGILLA	Massa materiale aerometria [g]	L max [mm]	D ₆₀ [mm]	D ₅₀ [mm]
		da m	a m												
Gr 1	x	18.15	18.25	286.6	VIA UMIDA	98	-	0	3	46	50	40	-	4.3.E-03	1.9.E-03

NOTE:

La soluzione disperdente è stata preparata il 14/05/18

GS= 2.700



Concessione Ministeriale Decreto n°55126 del 12 luglio 2006 - Settori A, B e C

Sperimentatore:	Diaby
Direttore:	Saccenti
Data emissione:	10/12/2018
Rev.	0

Committente:	DOTT.GEOL. SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	CI3
Profondità prova [m]:	18.15 - 18.25
Prova:	LLP1
Data prova:	26/11/2018

Normativa di riferimento: ASTM D4318

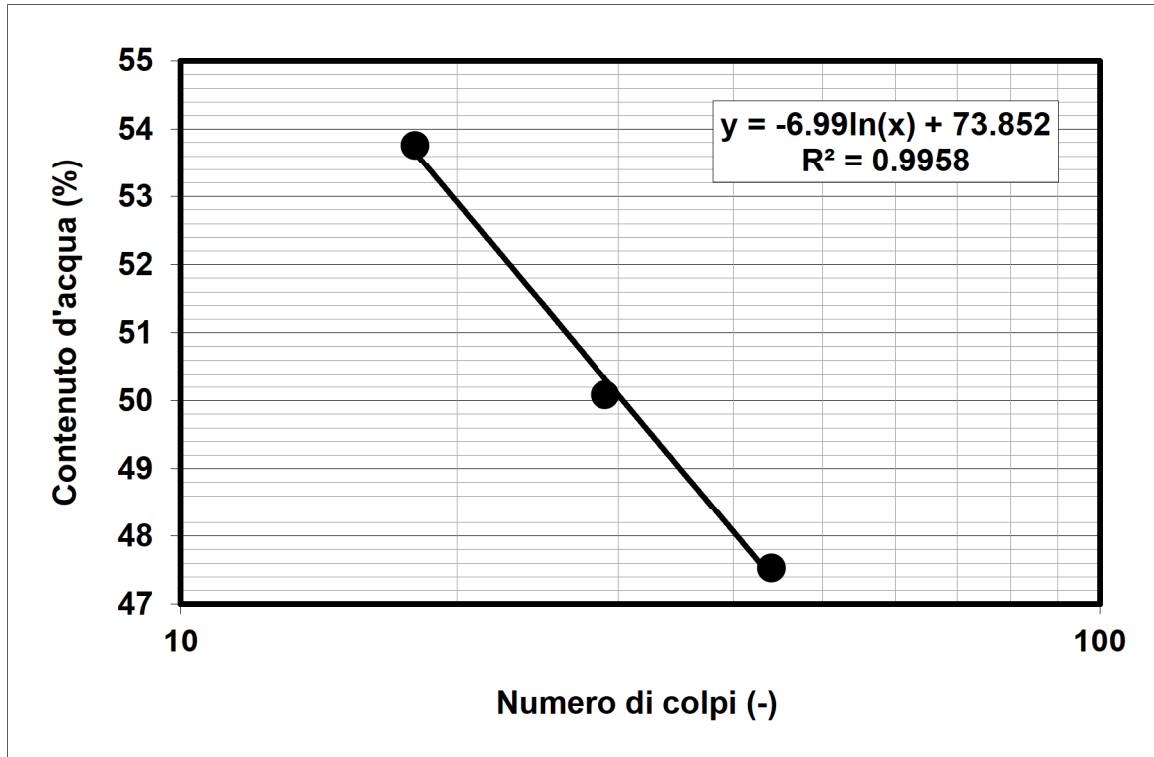
N° certificato di prova:

N° verbale di accettazione: 044/2018

Limite Liquido			
	prova 1	prova 2	prova 3
numero colpi	44	29	18
massa tara (g)	22.47	22.48	22.2
massa umido + tara (g)	76.11	88.11	79.29
massa secco + tara (g)	58.83	66.21	59.33
umidità (%)	47.52	50.08	53.76

Limite Plastico		
massa tara (g)	22.3	22.26
massa umido + tara (g)	40.37	39.97
massa secco + tara (g)	36.96	36.63
umidità (%)	23.26	23.24

Limite Liquido LL (%)	51.4
Limite Plastico LP (%)	23.3
Indice Plastico IP(%)	28.1



Note:



Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A, B e C

rev.	data emiss.	sperimentatore	direttore
0	10/12/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

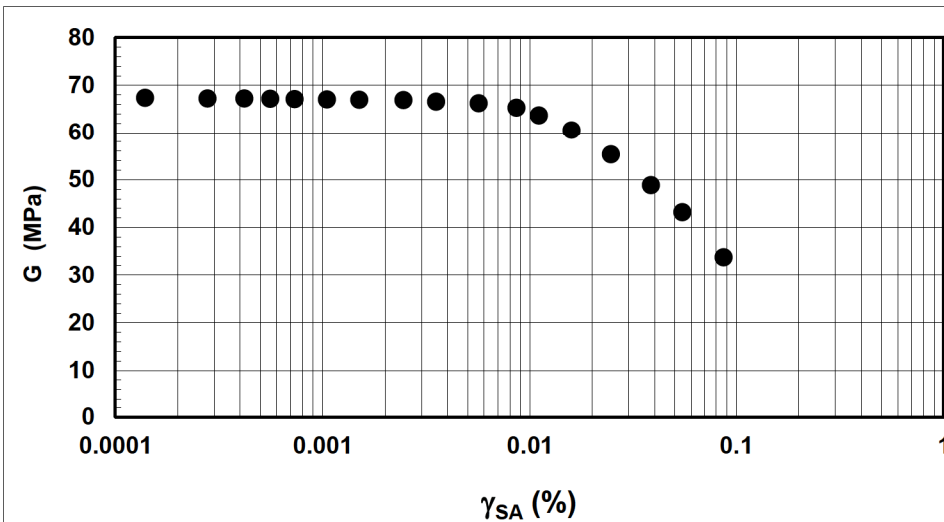
N° certificato di prova:

N° verbale di accettazione: 044/2018

Committente:	SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	C13
Profondità prova [m]:	18.45 - 18.55
Prova:	RC
Provino:	1
Data prova:	04/12/2018

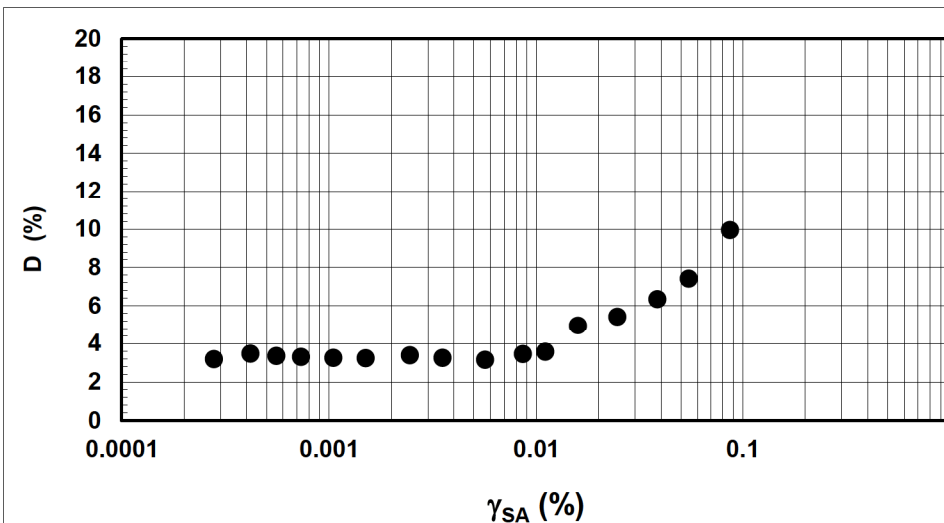
Dati generali dei provini

Dati iniziali					Dati a fine consolidazione										Informazioni generali		
Φ	H	γ_w	w	e	σ'_a	σ'_r	K	B.P.	B	D	H	γ_w	w	e	S	tipo di provino	
mm	mm	kN/m ³	%	-	kPa	kPa	-	kPa	-	mm	mm	kN/m ³	%	-	%	metodo di preparazione	
50.00	97.60	18.96	29.9	0.816	190	190	1.0	300.0	0.95	49.7	96.9	19.29	29.8	0.782	103	INDISTURBATO	
																FUSTELLAZIONE	
																PIETRA POROSA	
																TORSIONALE	
																peso specifico (-)	2.700



Legenda:

- Φ = diametro del provino
- H = altezza del provino
- γ_w = peso di volume umido
- w = contenuto d'acqua
- e = indice dei vuoti
- σ' = tensioni efficaci
- $K = \sigma'_r / \sigma'_a$
- B.P. = back pressure
- B = coefficiente di Skempton
- G = Modulo di taglio
- γ_{SA} = def. di taglio in singola ampiezza
- D = Rapporto di smorzamento di taglio
- Subscritto 'a' = assiale
- Subscritto 'r' = radiale
- S = grado di saturazione



Note:

Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A, B e C

rev.	data emiss.	sperimentatore	direttore
0	10/12/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

N° certificato di prova:

N° verbale di accettazione: 044/2018

Committente:	SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	CI3
Profondità prova [m]:	18.45 - 18.55
Prova:	RC
Provino:	1
Data prova:	04/12/2018

Dati generali dei provini

Dati iniziali					Dati di prova										Informazioni generali	
Φ	H	γ_w	w	e	σ'_a	σ'_r	K	B.P.	B	D	H	γ_w	w	e	tipo di provino	
mm	mm	kN/m ³	%	-	kPa	kPa	-	kPa	-	mm	mm	kN/m ³	%	-	metodo di preparazione	
50.00	97.60	18.96	29.9	0.816	190	190	1.0	300.0	0.95	49.7	96.9	19.29	29.8	0.782	superficie di appoggio	INDISTURBATO
															eccitazione	FUSTELLAZIONE
																PIETRA POROSA
																TORSIONALE

Valori numerici

G	G/G _{MAX}	γ	D	U
(MPa)	(-)	(%)	(%)	(kPa)
67.35	1.000	0.00014		300.0
67.25	0.999	0.00028	3.18	300.0
67.21	0.998	0.00042	3.46	300.0
67.16	0.997	0.00056	3.33	300.0
67.09	0.996	0.00073	3.29	300.0
67.00	0.995	0.00105	3.25	300.0
66.98	0.995	0.00150	3.23	300.0
66.87	0.993	0.00245	3.37	300.1
66.53	0.988	0.00352	3.24	300.2
66.23	0.983	0.00566	3.14	300.3
65.26	0.969	0.00862	3.44	300.4
63.62	0.945	0.01105	3.55	300.5
60.48	0.898	0.01589	4.96	300.7
55.31	0.821	0.02458	5.42	301.1
48.81	0.725	0.03842	6.34	302.0
43.14	0.641	0.05434	7.40	304.0
33.77	0.501	0.08677	9.95	307.9

Legenda:

Φ = diametro del provino

H = altezza del provino

γ_w = peso di volume umido

w = contenuto d'acqua

e = indice dei vuoti

σ' = tensioni efficaci

K = σ_r / σ_a

B.P. = back pressure

B = coefficiente di Skempton

G = Modulo di taglio

γ_{SA} = def.di taglio in singola ampiezza

D = Rapporto di smorzamento di taglio

Subscritto 'a' = assiale

Subscritto 'r' = radiale

Note:



Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A, B e C

rev.	data emiss.	sperimentatore	direttore
0	10/12/2018	Angeloni	Saccenti

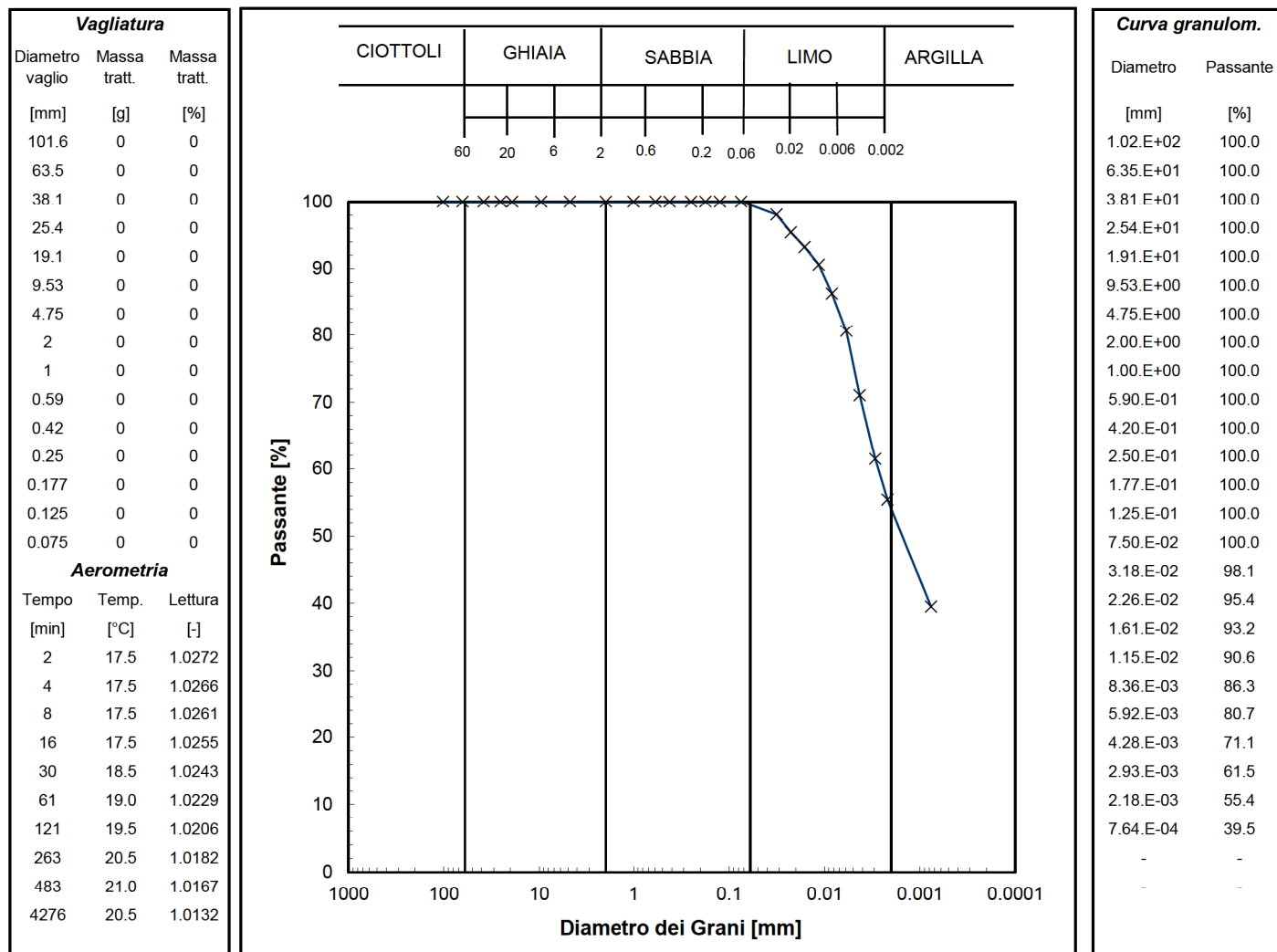
Normativa di riferimento: ASTM D422/07

Classificazione di riferimento: AGI 1977

N° certificato di prova:

N° verbale di accettazione: 044/2018

Committente:	DOTT.GEOL. SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	CR3
Profondità prelievo [m]:	20.8 - 21
Prova:	Gr 1
Data prova:	03/12/2018



Prova	Simbolo	Profondità		Massa secca materiale [g]	Metodo preparazione materiale	% < 0.075mm	% CIOTTOLI	% GHIAIA	% SABBIA	% LIMO	% ARGILLA	Massa materiale aerometria [g]	L max [mm]	D ₆₀ [mm]	D ₅₀ [mm]
		da m	a m												
Gr 1	x	20.80	21.00	253.8	VIA UMIDA	100	-	-	1	45	54	36	-	2.7.E-03	1.5.E-03

NOTE:

GS= 2.700

La soluzione disperdente è stata preparata il 14/05/18



Concessione Ministeriale Decreto n°55126 del 12 luglio 2006 - Settori A, B e C

Sperimentatore:	Diaby
Direttore:	Saccenti
Data emissione:	11/12/2018
Rev.	0

Committente:	DOTT.GEOL. SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	CR3
Profondità prova [m]:	20.80 - 21.00
Prova:	LLP1
Data prova:	30/11/2018

Normativa di riferimento: ASTM D4318

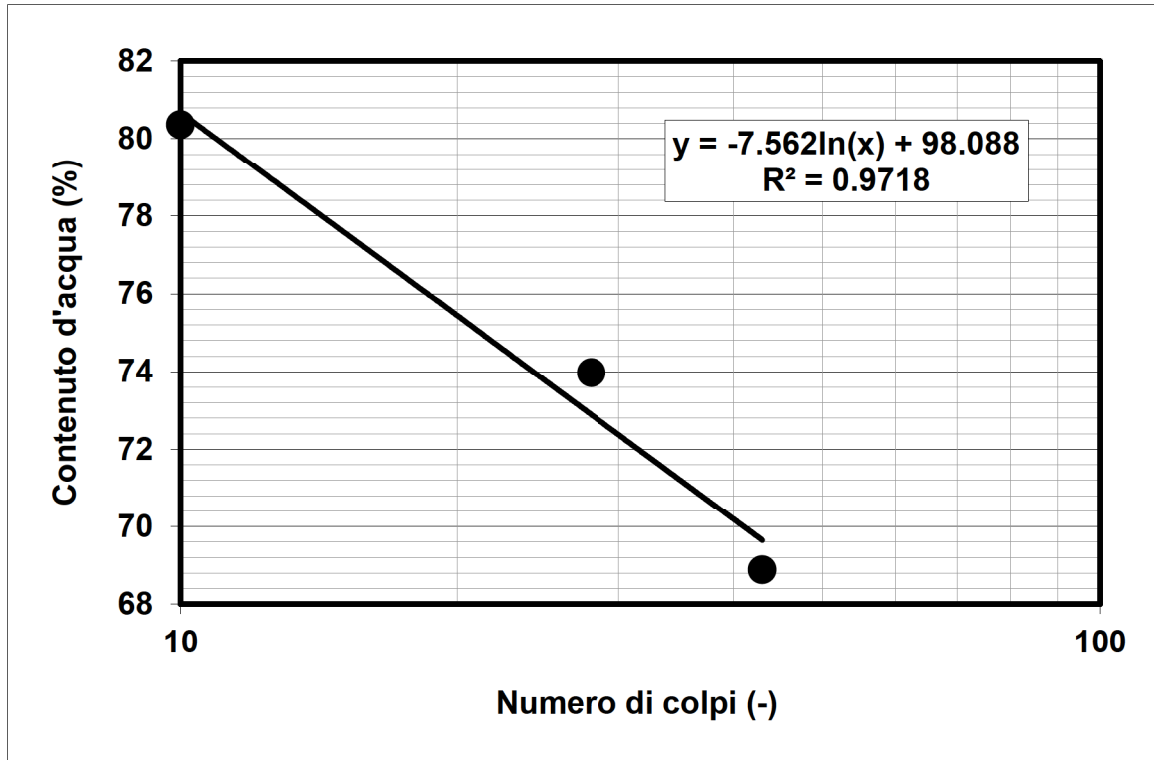
N° certificato di prova:

N° verbale di accettazione: 044/2018

Limite Liquido			
	prova 1	prova 2	prova 3
numero colpi	43	28	10
massa tara (g)	22.11	22.39	21.94
massa umido + tara (g)	74.21	79.68	73.36
massa secco + tara (g)	52.96	55.32	50.45
umidità (%)	68.88	73.98	80.36

Limite Plastico		
massa tara (g)	22.18	22.16
massa umido + tara (g)	35.66	36.73
massa secco + tara (g)	32.7	33.51
umidità (%)	28.14	28.37

Limite Liquido LL (%)	73.7
Limite Plastico LP (%)	28.3
Indice Plastico IP(%)	45.5



Note:



Concessione Ministeriale Decreto n°55126 del 12 luglio 2006 - Settori A, B e C

Sperimentatore:	Diaby
Direttore:	Saccenti
Data emissione:	10/12/2018
Rev.	0

Committente:	DOTT.GEOL. SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	CI4
Profondità prova [m]:	37.26 - 37.35
Prova:	LLP1
Data prova:	26/11/2018

Normativa di riferimento: ASTM D4318

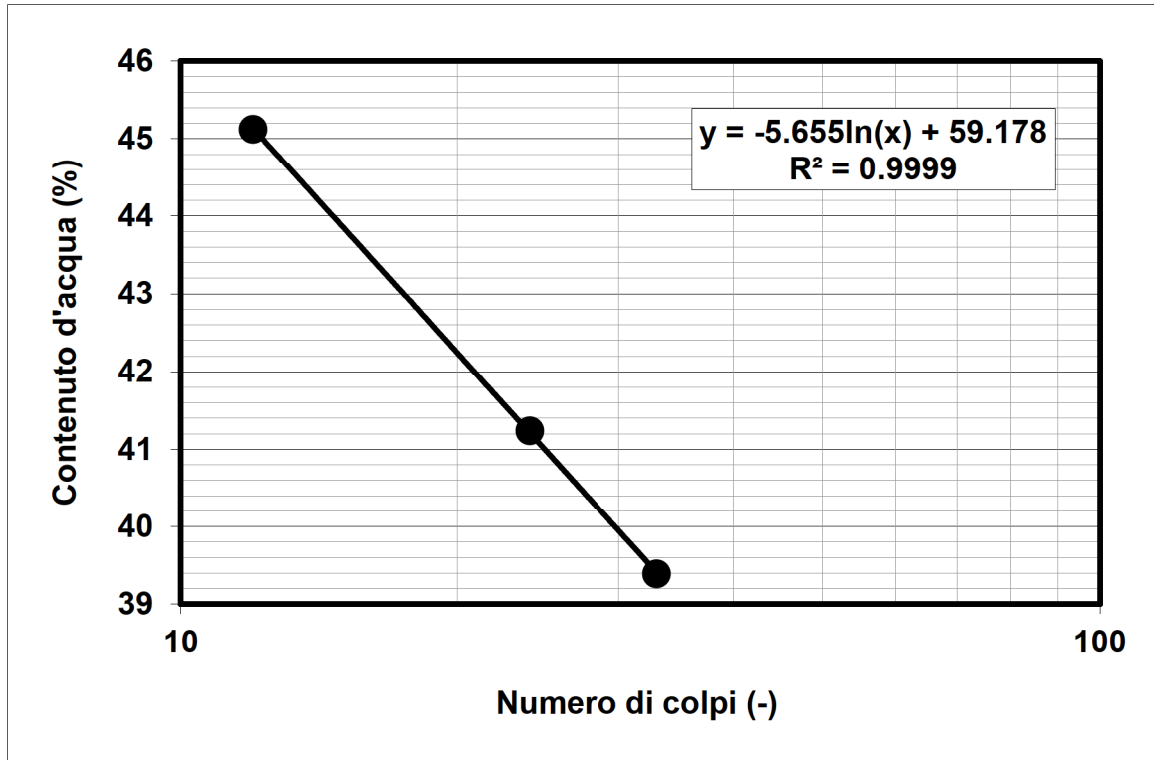
N° certificato di prova:

N° verbale di accettazione: 044/2018

Limite Liquido			
	prova 1	prova 2	prova 3
numero colpi	33	24	12
massa tara (g)	22.2	22.43	22.15
massa umido + tara (g)	79.99	83.5	82.49
massa secco + tara (g)	63.66	65.67	63.73
umidità (%)	39.39	41.23	45.12

Limite Plastico		
massa tara (g)	22.23	22.53
massa umido + tara (g)	43.71	42.7
massa secco + tara (g)	39.68	38.88
umidità (%)	23.09	23.36

Limite Liquido LL (%)	41.0
Limite Plastico LP (%)	23.2
Indice Plastico IP(%)	17.7



Note:



Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A, B e C

rev.	data emiss.	sperimentatore	direttore
0	10/12/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

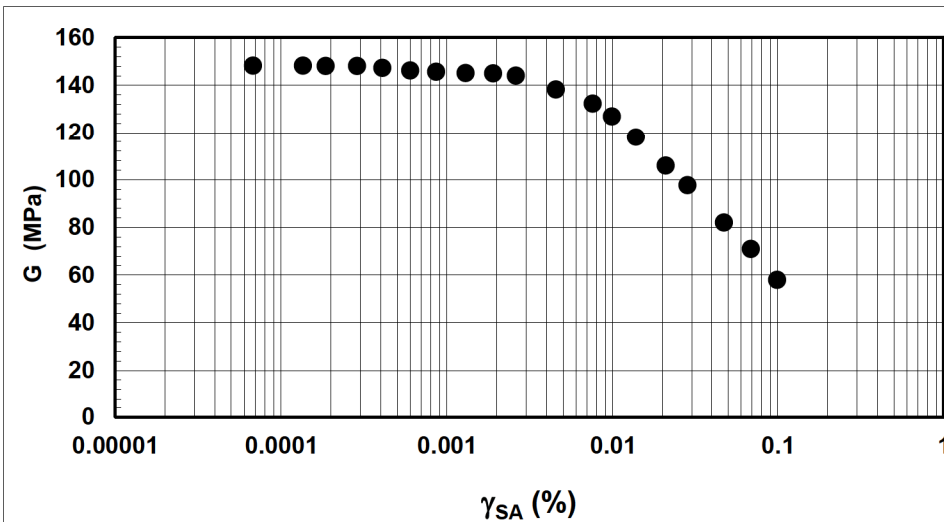
N° certificato di prova:

N° verbale di accettazione: 044/2018

Committente:	SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	C14
Profondità prova [m]:	37.45 - 37.55
Prova:	RC
Provino:	1
Data prova:	05/12/2018

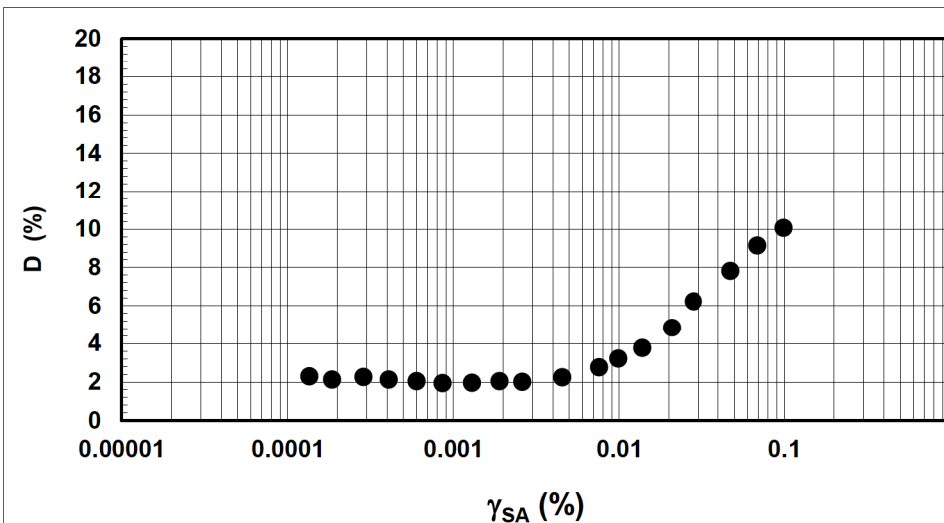
Dati generali dei provini

Dati iniziali					Dati a fine consolidazione										Informazioni generali		
Φ	H	γ_w	w	e	σ'_a	σ'_r	K	B.P.	B	D	H	γ_w	w	e	S	tipo di provino	
mm	mm	kN/m ³	%	-	kPa	kPa	-	kPa	-	mm	mm	kN/m ³	%	-	%	metodo di preparazione	
50.00	96.60	19.51	27.1	0.725	390	390	1.0	300.0	0.95	49.4	95.5	19.99	25.4	0.662	104	INDISTURBATO	
																FUSTELLAZIONE	
																PIETRA POROSA	
																TORSIONALE	
																peso specifico (-)	2.700



Legenda:

- Φ = diametro del provino
- H = altezza del provino
- γ_w = peso di volume umido
- w = contenuto d'acqua
- e = indice dei vuoti
- σ' = tensioni efficaci
- $K = \sigma'_r / \sigma'_a$
- B.P. = back pressure
- B = coefficiente di Skempton
- G = Modulo di taglio
- γ_{SA} = def. di taglio in singola ampiezza
- D = Rapporto di smorzamento di taglio
- Subscritto 'a' = assiale
- Subscritto 'r' = radiale
- S = grado di saturazione



Note:

rev.	data emiss.	sperimentatore	direttore
0	10/12/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

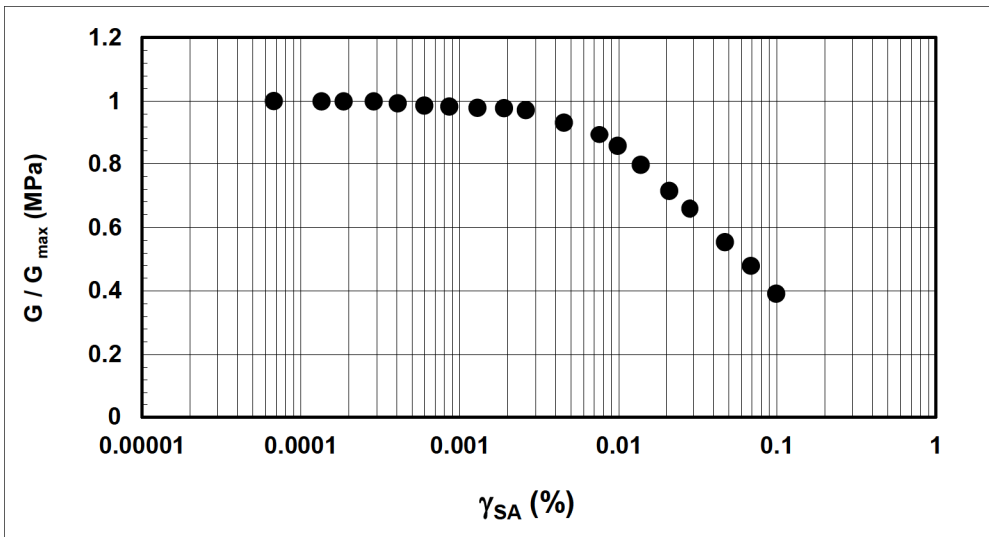
N° certificato di prova:

N° verbale di accettazione: 044/2018

Committente:	SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	CI4
Profondità prova [m]:	37.45 - 37.55
Prova:	RC
Provino:	1
Data prova:	05/12/2018

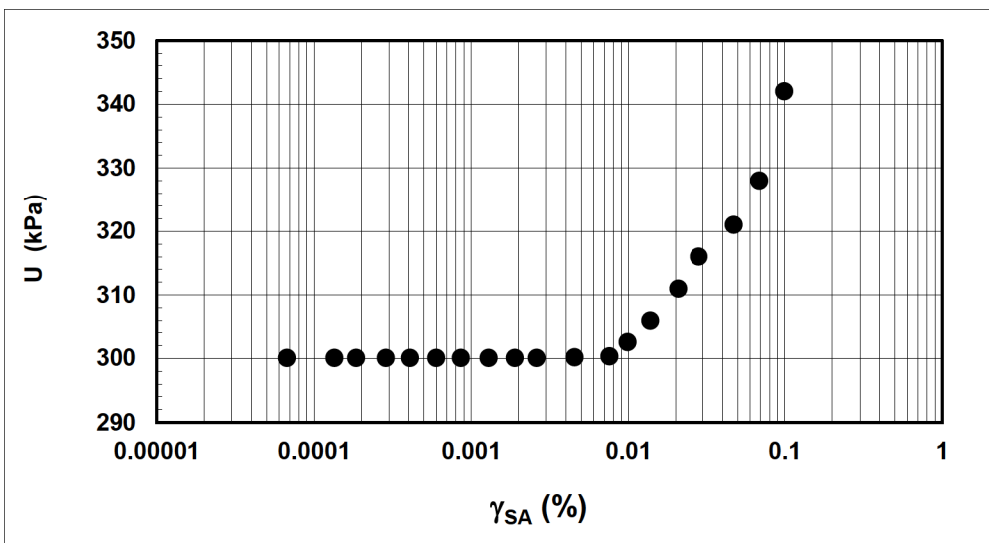
Dati generali dei provini

Dati iniziali					Dati a fine consolidazione										Informazioni generali		
Φ	H	γ _w	w	e	σ' _a	σ' _r	K	B.P.	B	D	H	γ _w	w	e	S	tipo di provino	
mm	mm	kN/m ³	%	-	kPa	kPa	-	kPa	-	mm	mm	kN/m ³	%	-	%	metodo di preparazione	
50.00	96.60	19.51	27.1	0.725	390	390	1.0	300.0	0.95	49.4	95.5	19.99	25.4	0.7	104	INDISTURBATO	
																FUSTELLAZIONE	
																PIETRA POROSA	
																TORSIONALE	
																peso specifico	2.700



Legenda:

- Φ = diametro del provino
- H = altezza del provino
- γ_w = peso di volume umido
- w = contenuto d'acqua
- e = indice dei vuoti
- σ' = tensioni efficaci
- K = σ_r / σ_a
- B.P. = back pressure
- B = coefficiente di Skempton
- G = Modulo di taglio
- γ_{SA} = def. di taglio in singola ampiezza
- D = Rapporto di smorzamento di taglio
- Subscritto 'a' = assiale
- Subscritto 'r' = radiale
- S = grado di saturazione



Note:	
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Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A, B e C

rev.	data emiss.	sperimentatore	direttore
0	10/12/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

N° certificato di prova:

N° verbale di accettazione: 044/2018

Committente:	SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	CI4
Profondità prova [m]:	37.45 - 37.55
Prova:	RC
Provino:	1
Data prova:	05/12/2018

Dati generali dei provini

Dati iniziali					Dati di prova										Informazioni generali	
Φ	H	γ_w	w	e	σ'_a	σ'_r	K	B.P.	B	D	H	γ_w	w	e	tipo di provino	
mm	mm	kN/m ³	%	-	kPa	kPa	-	kPa	-	mm	mm	kN/m ³	%	-	metodo di preparazione	
50.00	96.60	19.51	27.1	0.725	390	390	1.0	300.0	0.95	49.4	95.5	19.99	25.4	0.662	superficie di appoggio	INDISTURBATO
															eccitazione	FUSTELLAZIONE
																PIETRA POROSA
																TORSIONALE

Valori numerici

G	G/G _{MAX}	γ	D	U
(MPa)	(-)	(%)	(%)	(kPa)
148.22	1.000	0.00007		300.0
148.15	1.000	0.00014	2.29	300.0
148.11	0.999	0.00019	2.12	300.0
148.04	0.999	0.00029	2.26	300.0
147.27	0.994	0.00041	2.13	300.0
146.16	0.986	0.00060	2.04	300.0
145.64	0.983	0.00086	1.94	300.0
145.05	0.979	0.00129	1.96	300.0
145.02	0.978	0.00190	2.04	300.0
144.02	0.972	0.00261	2.00	300.0
138.26	0.933	0.00453	2.24	300.1
132.35	0.893	0.00756	2.75	300.3
126.89	0.856	0.00986	3.21	302.5
118.04	0.796	0.01378	3.77	306.0
105.86	0.714	0.02080	4.84	311.0
97.67	0.659	0.02818	6.22	316.0
82.00	0.553	0.04731	7.81	321.0
70.96	0.479	0.06877	9.14	328.0
57.96	0.391	0.09931	10.06	342.0

Legenda:

Φ = diametro del provino

H = altezza del provino

γ_w = peso di volume umido

w = contenuto d'acqua

e = indice dei vuoti

σ' = tensioni efficaci

K = σ_r / σ_a

B.P. = back pressure

B = coefficiente di Skempton

G = Modulo di taglio

γ_{SA} = def.di taglio in singola ampiezza

D = Rapporto di smorzamento di taglio

Subscritto 'a' = assiale

Subscritto 'r' = radiale

Note:



Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A, B e C

rev.	data emiss.	sperimentatore	direttore
0	10/12/2018	Angeloni	Saccenti

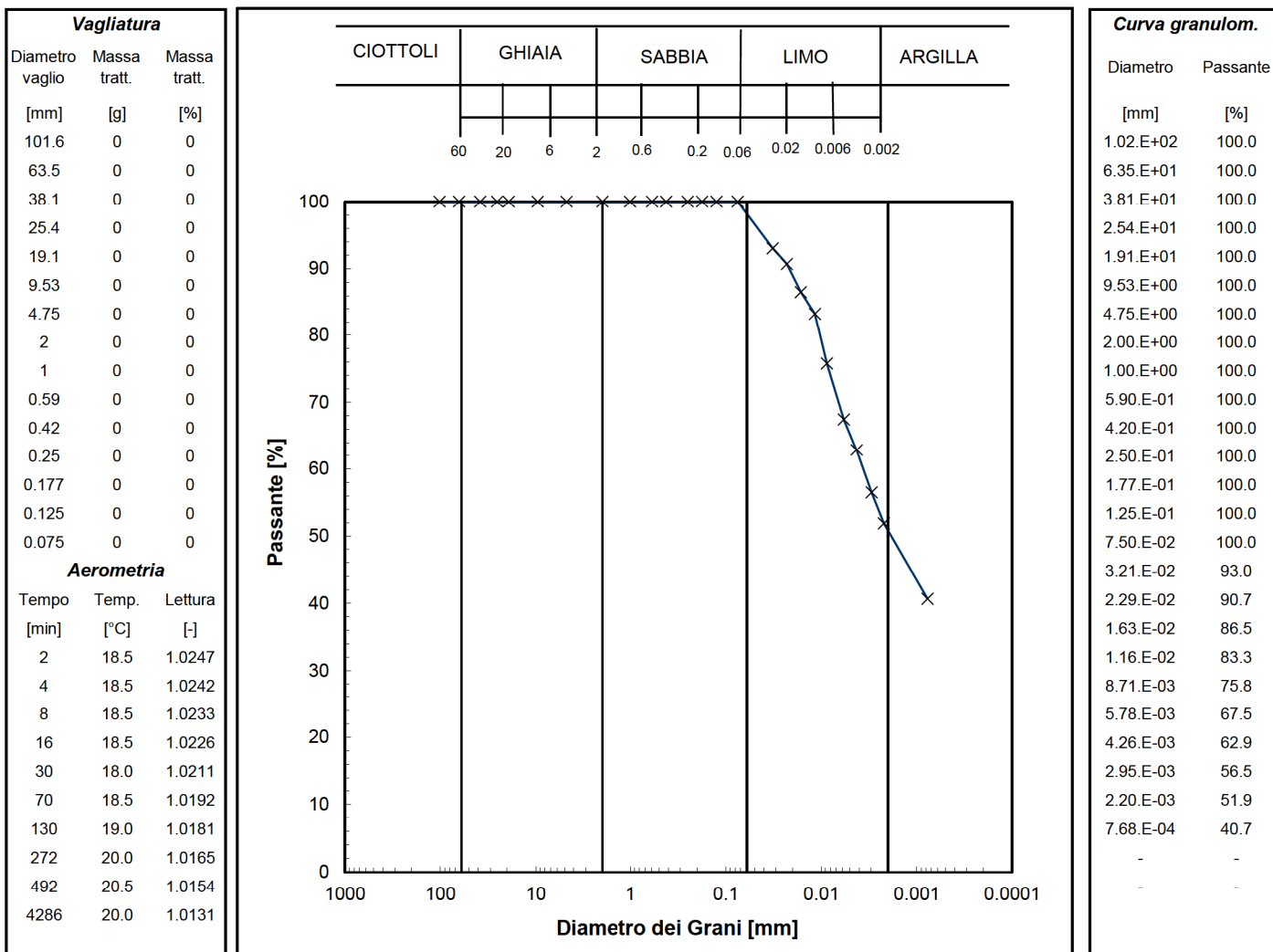
Normativa di riferimento: ASTM D422/07

Classificazione di riferimento: AGI 1977

N° certificato di prova:

N° verbale di accettazione: 044/2018

Committente:	DOTT.GEOL. SANGIORGI
Cantiere:	ANZOLA DELL'EMILIA
Sondaggio:	S1
Campione:	CR4
Profondità prelievo [m]:	39.8 - 40
Prova:	Gr 1
Data prova:	03/12/2018

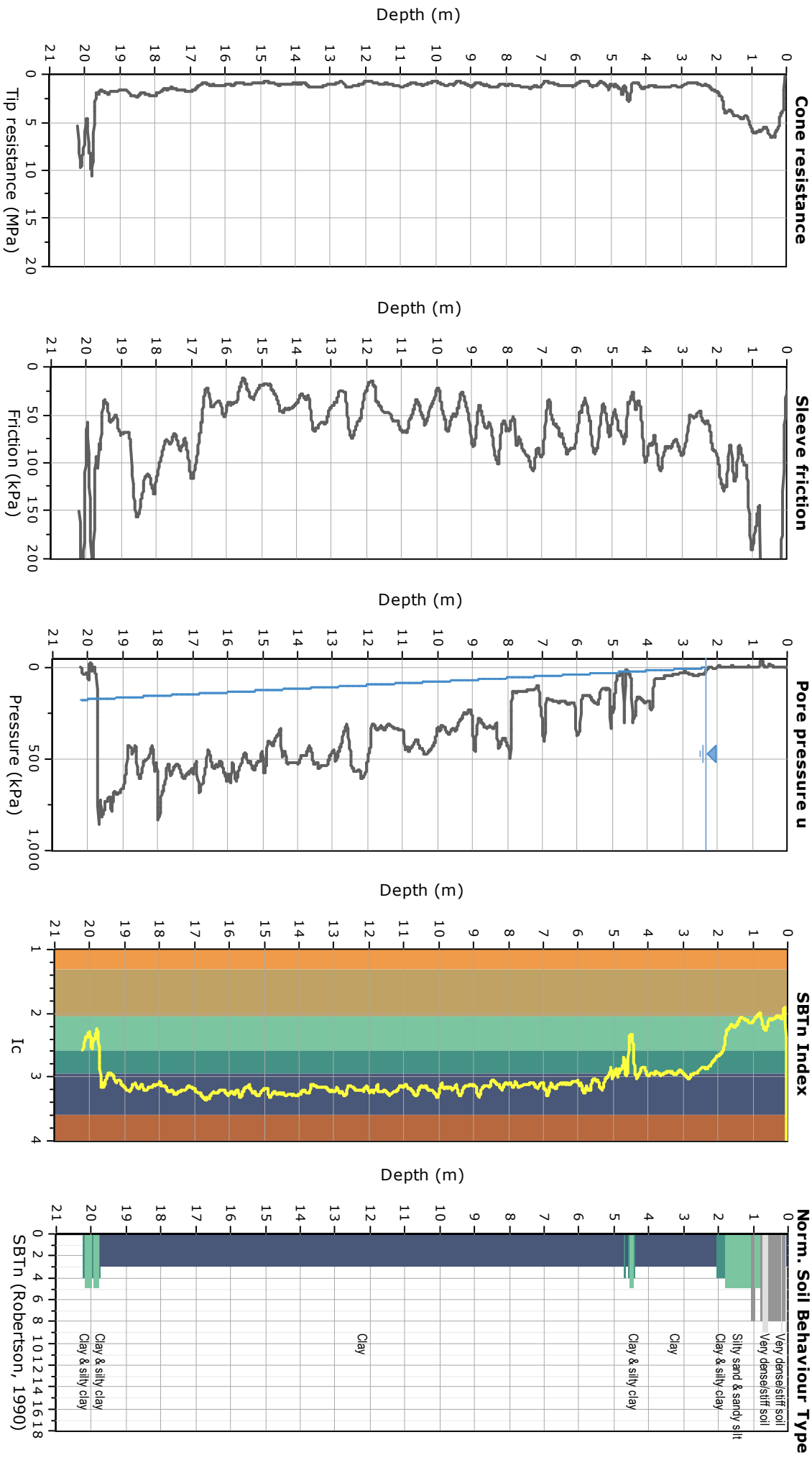


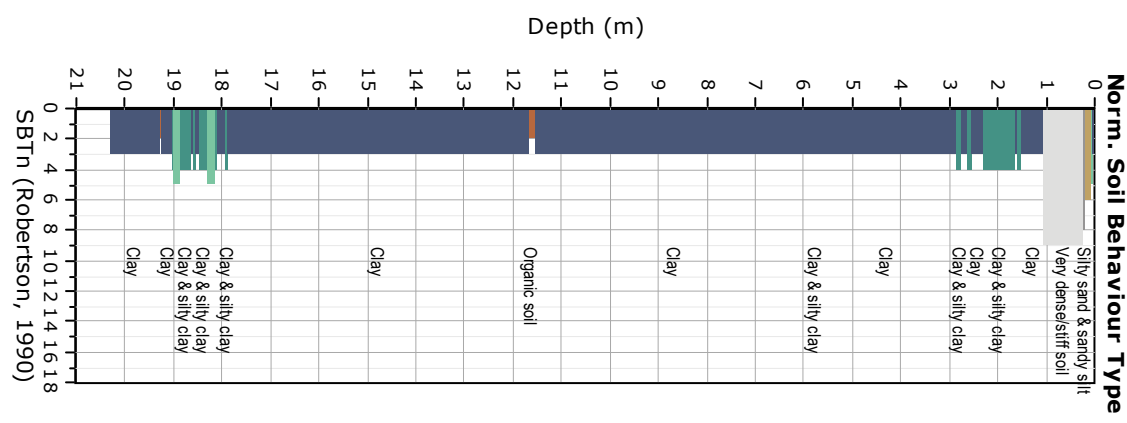
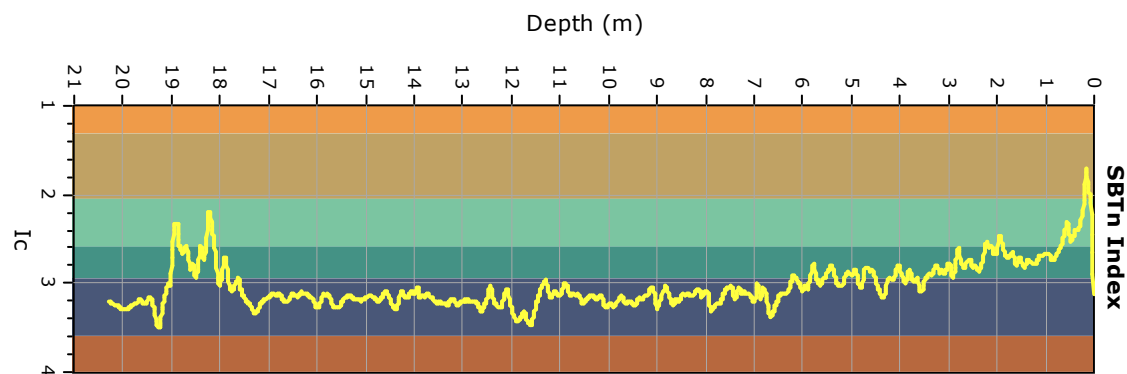
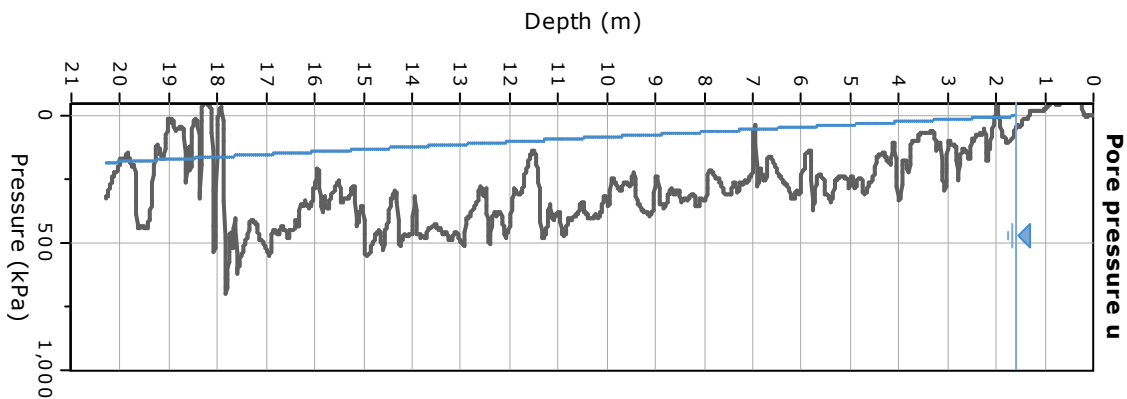
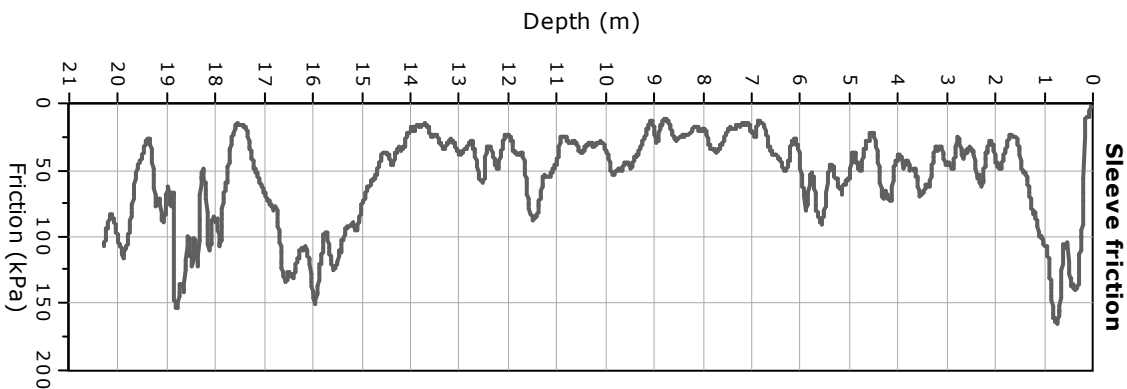
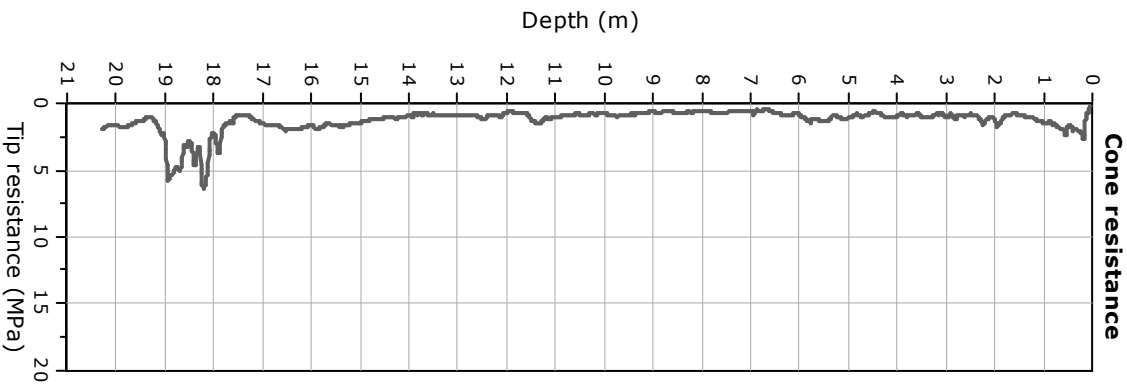
Prova	Simbolo	Profondità		Massa secca materiale [g]	Metodo preparazione materiale	% < 0.075mm	% CIOTTOLI	% GHIAIA	% SABBIA	% LIMO	% ARGILLA	Massa materiale aerometria [g]	L max [mm]	D ₆₀ [mm]	D ₅₀ [mm]
		da m	a m												
Gr 1	x	39.80	40.00	351.1	VIA UMIDA	100	-	-	2	47	51	34	-	3.6.E-03	1.8.E-03

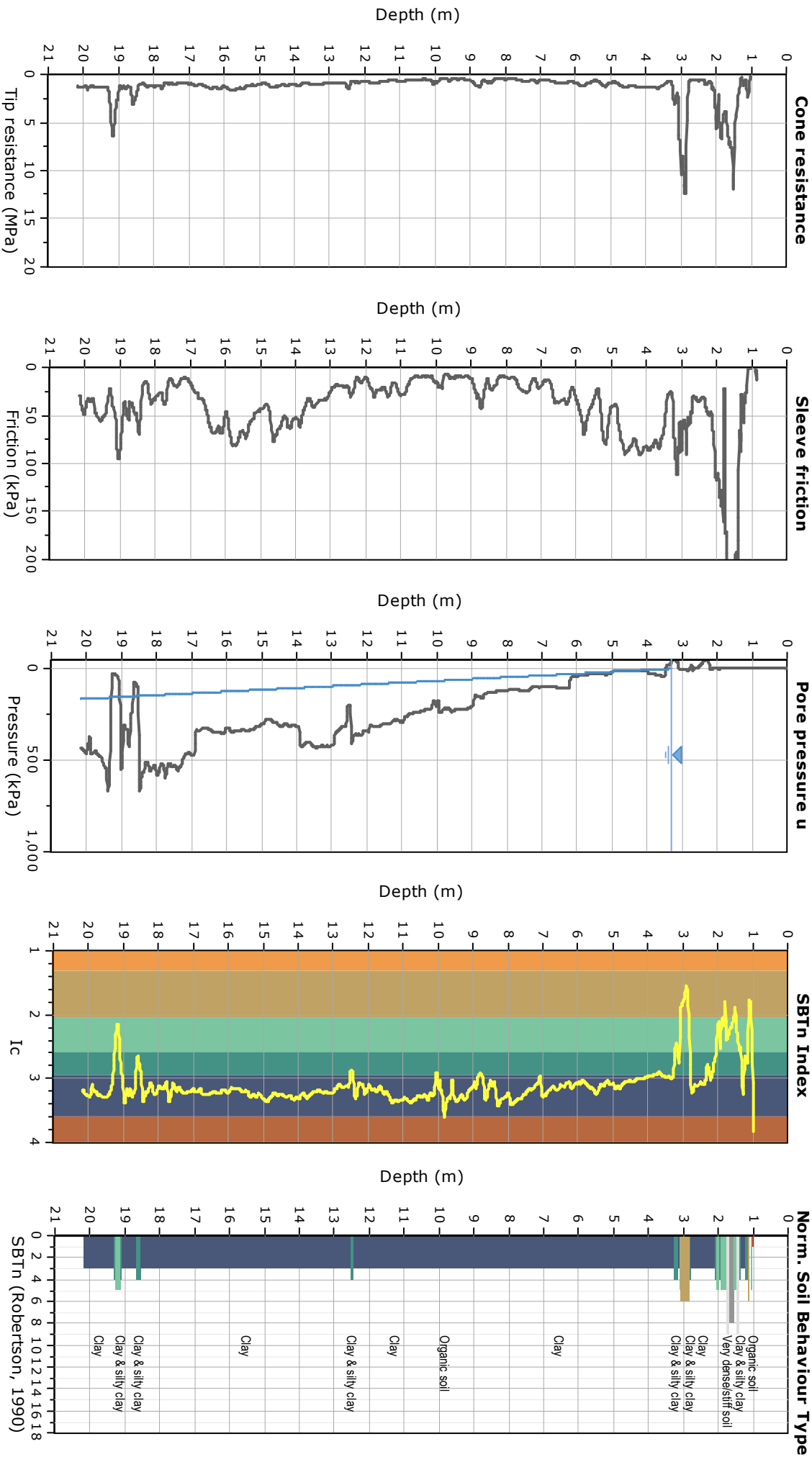
NOTE:

GS= 2.700

La soluzione disperdente è stata preparata il 14/05/18







ANZOLA DELL'EMILIA_MS, TR2

037001P60008HVSR59166

Instrument: TRZ-0108/01-10

Start recording: 14/09/18 09:17:18 End recording: 14/09/18 10:17:18

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 1h00'00". Analyzed 92% trace (manual window selection)

Sampling rate: 128 Hz

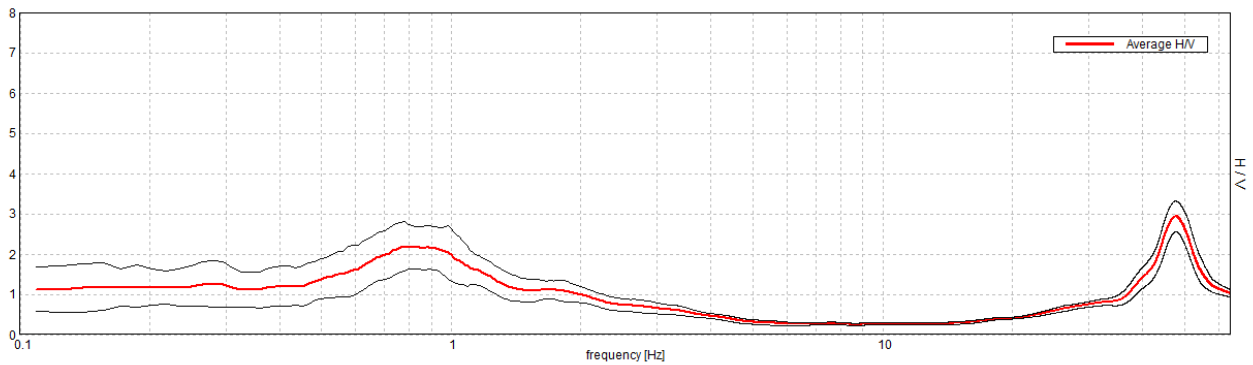
Window size: 60 s

Smoothing type: Triangular window

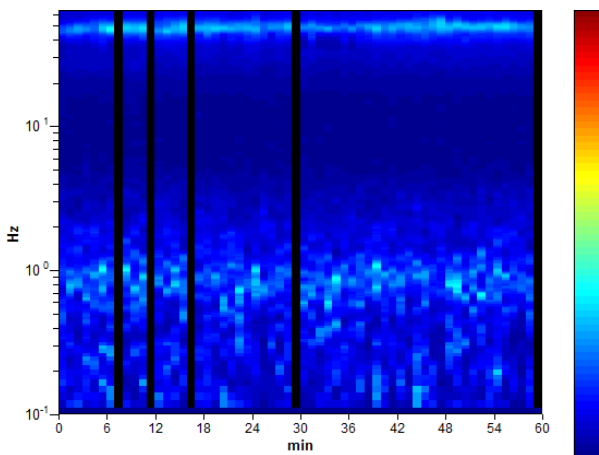
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

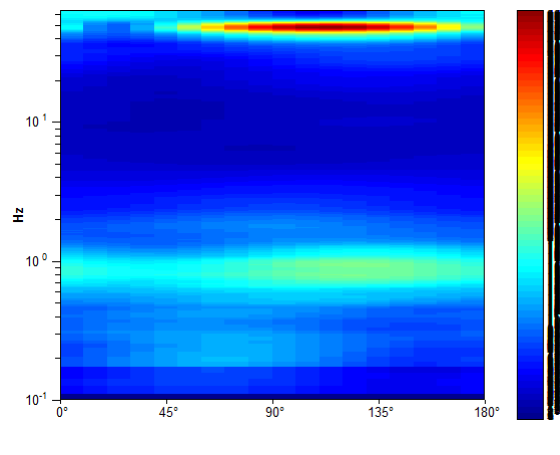
Max. H/V at 0.78 ± 0.02 Hz. (In the range 0.1 - 20.0 Hz).



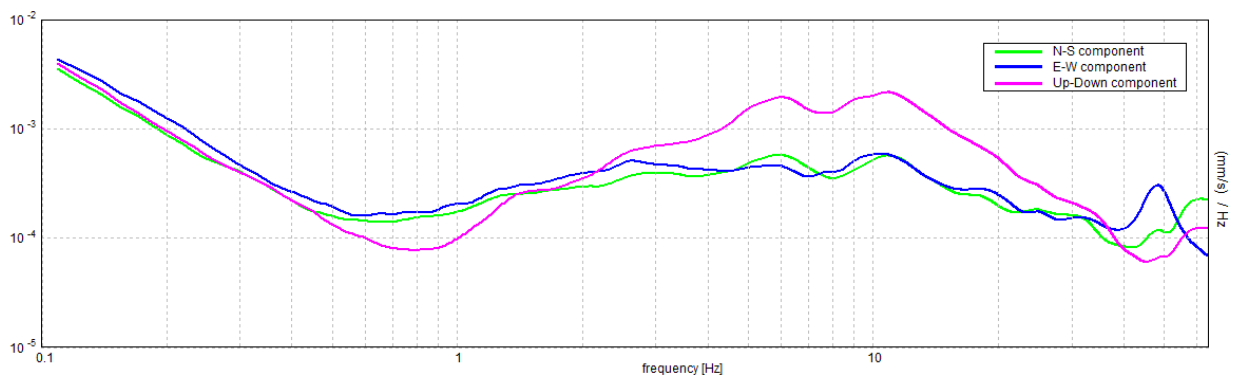
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. Please read carefully the *Grilla* manual before interpreting the following tables.]

Max. H/V at 0.78 ± 0.02 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.78 > 0.17$	OK	
$n_c(f_0) > 200$	$2578.1 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 76 times	OK	

Criteria for a clear H/V peak

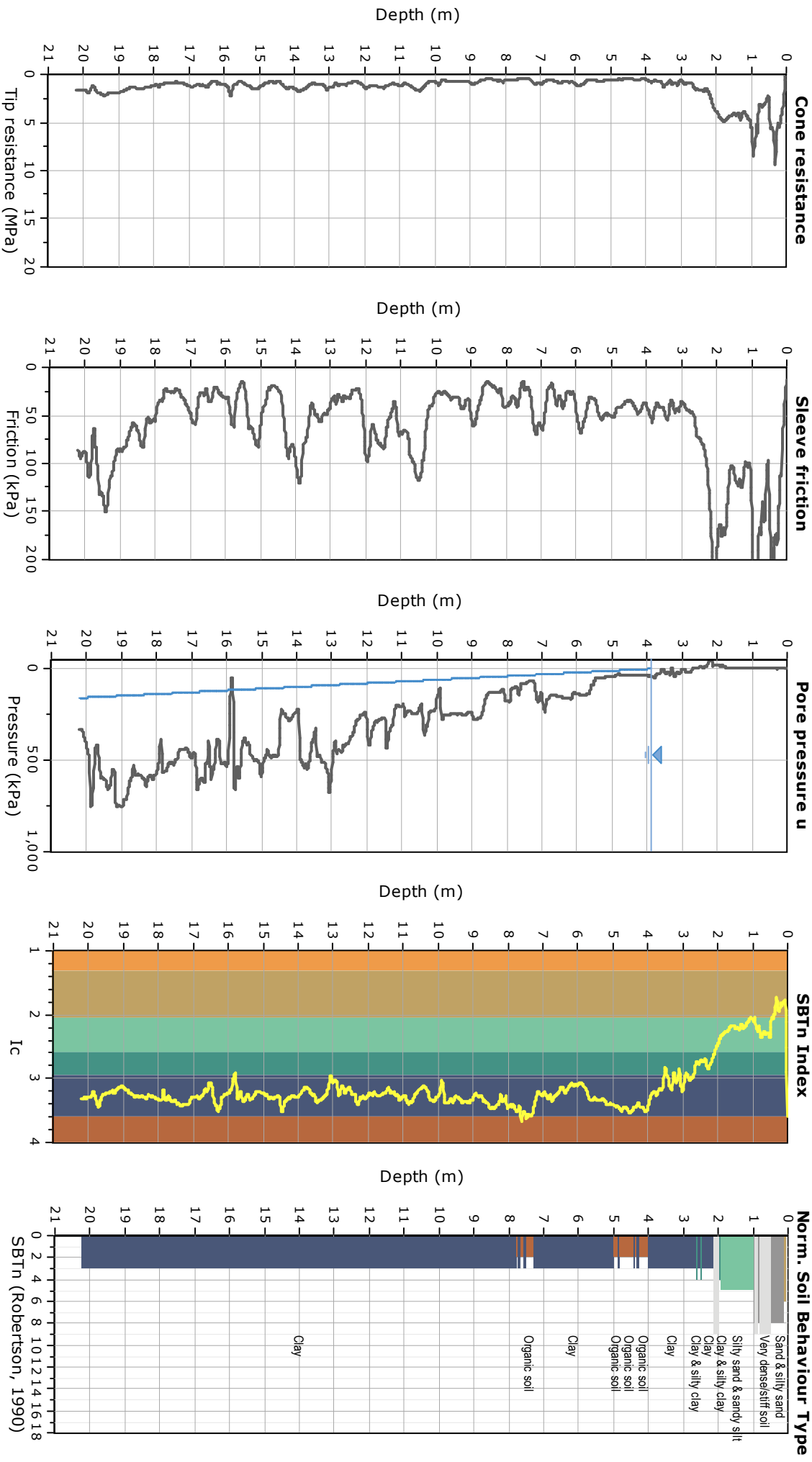
[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.531 Hz	OK	
$A_0 > 2$	$2.19 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01479 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01155 < 0.11719$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3037 < 2.0$	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{\log H/V}(f)$	standard deviation of $\log A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$

Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

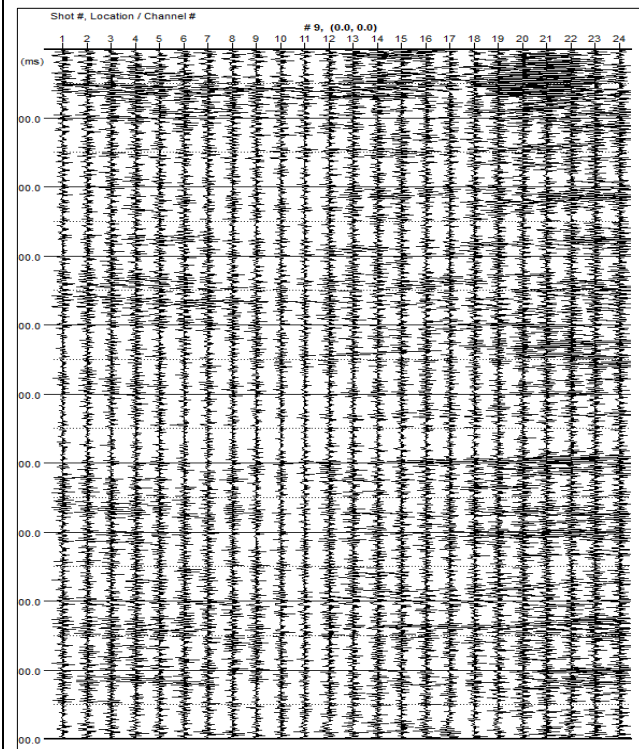


PROSPEZIONE SISMICA CON METODOLOGIA ESAC

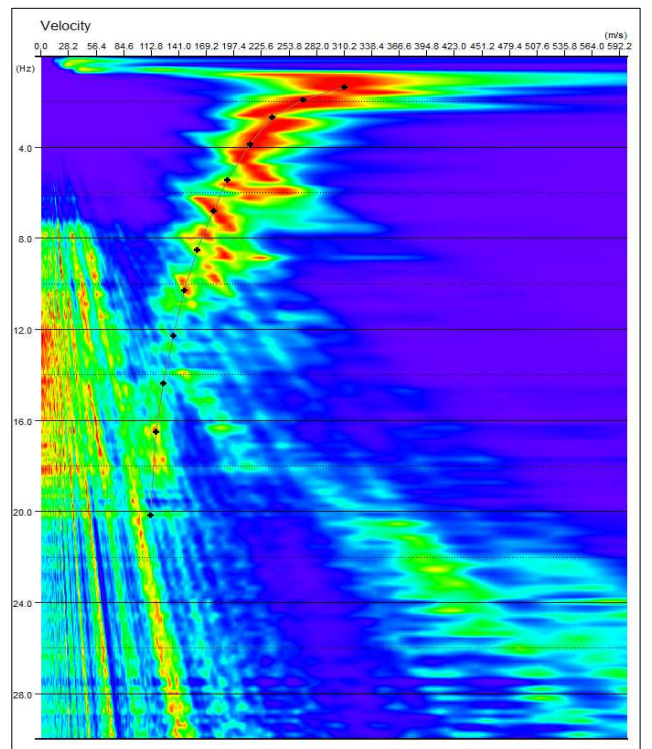
Ponte Samoggia, Comune di Anzola dell'Emilia (BO) - 037001P60009ESAC_SPAC59168

n° tracce	Δt (ms)	T (s)
25	2,0	32,0

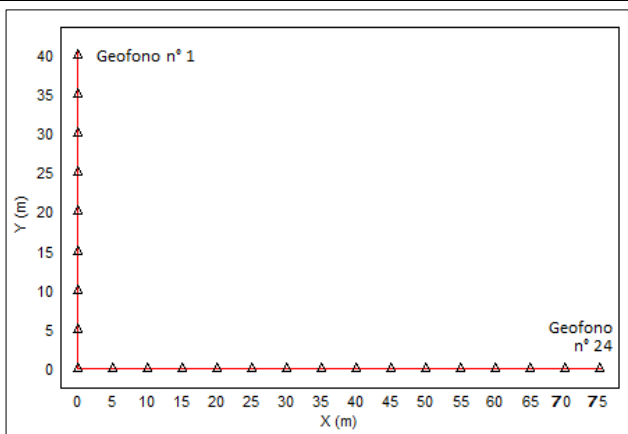
Δt : passo di campionamento; T: durata registrazione.



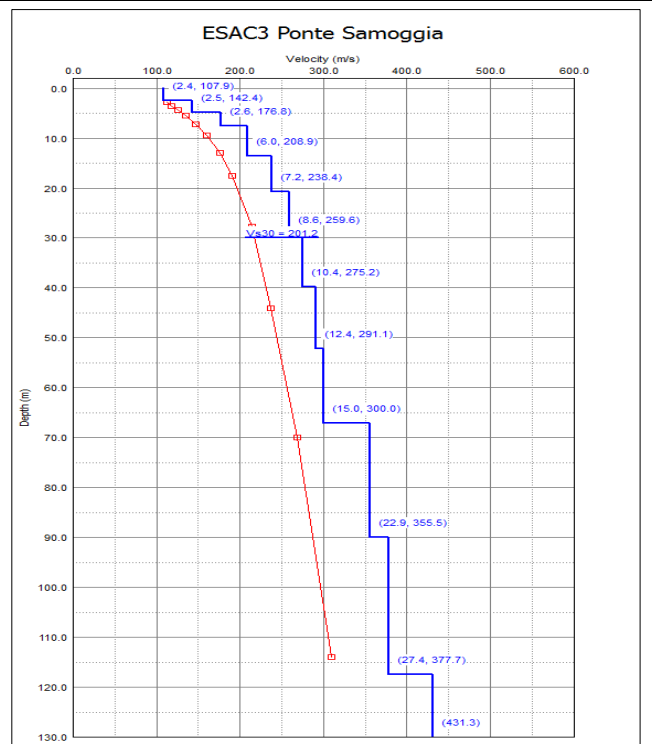
Sismogramma registrato durante le acquisizioni di microtremore sismico. In ascissa il numero dei geofoni, in ordinata il tempo (ms).



Spettro di potenza nel dominio $f-v$ e Picking della curva sperimentale delle onde R (croci nere).



Geometria dello stendimento sismico bidimensionale.



Modello di sottosuolo (1D) descritti in termini di V_s e spessore dei sismostrati (spezzata blu) e curva di dispersione sperimentale delle onde R (curva rossa).

Tabella di sintesi

n. Strato	Profondità letto (m dal p.c.)	Spessore (m)	V _s (m/s)
1	2.4	2.4	107.9
2	4.9	2.5	142.4
3	7.5	2.6	176.8
4	14.1	6.6	208.9
5	21.3	7.2	238.4
6	29.9	8.6	259.6
7	40.3	10.4	275.2
8	52.7	12.4	291.1
9	67.7	15.0	300.0
10	90.6	22.9	355.5
11	118.0	27.4	377.7
12	∞	∞	431.3

$$V_{s30} = 201.2 \pm 10\% \text{ [m/s]}$$

Sintesi dei parametri del modello di sottosuolo ottenuto e Valore di Vs30 calcolato.

ANZOLA DELL'EMILIA_MS, TR8

037001P60009HVSR59169

Instrument: TRZ-0108/01-10

Start recording: 04/10/18 13:58:52 End recording: 04/10/18 14:58:53

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 1h00'00". Analyzed 85% trace (manual window selection)

Sampling rate: 128 Hz

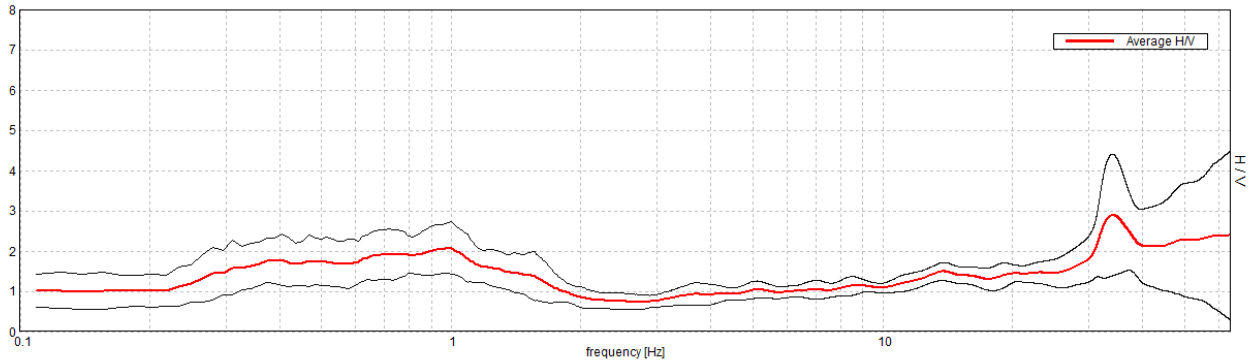
Window size: 60 s

Smoothing type: Triangular window

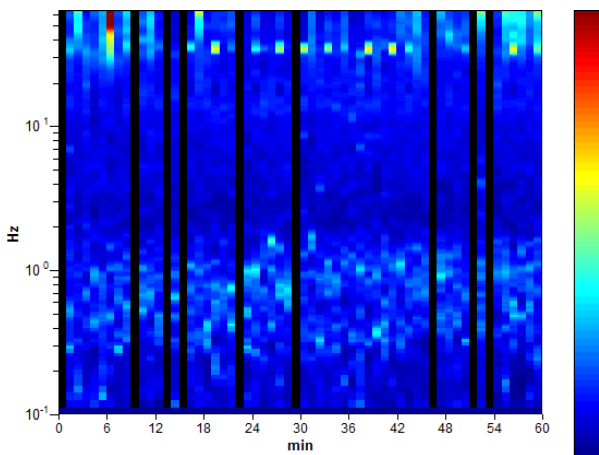
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

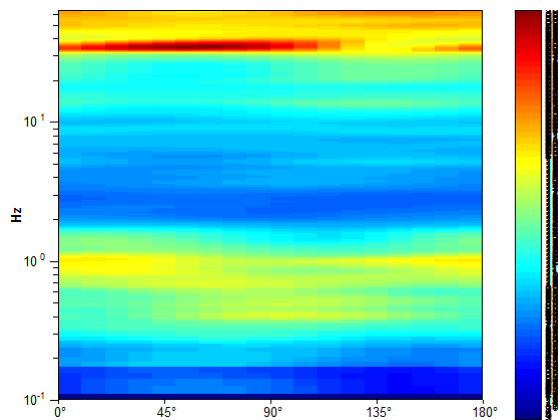
Max. H/V at 0.98 ± 0.1 Hz. (In the range 0.1 - 20.0 Hz).



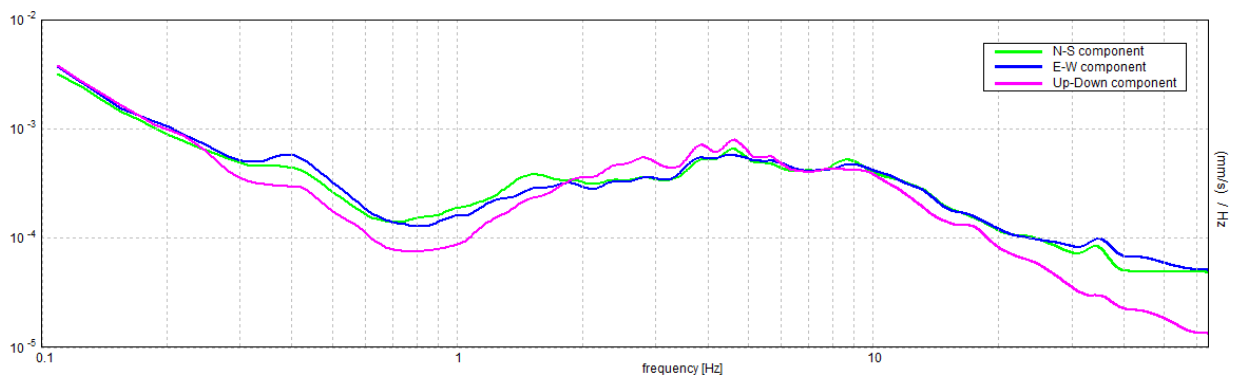
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. Please read carefully the *Grilla* manual before interpreting the following tables.]

Max. H/V at 0.98 ± 0.1 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.98 > 0.17$	OK	
$n_c(f_0) > 200$	$3012.2 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 96 times	OK	

Criteria for a clear H/V peak

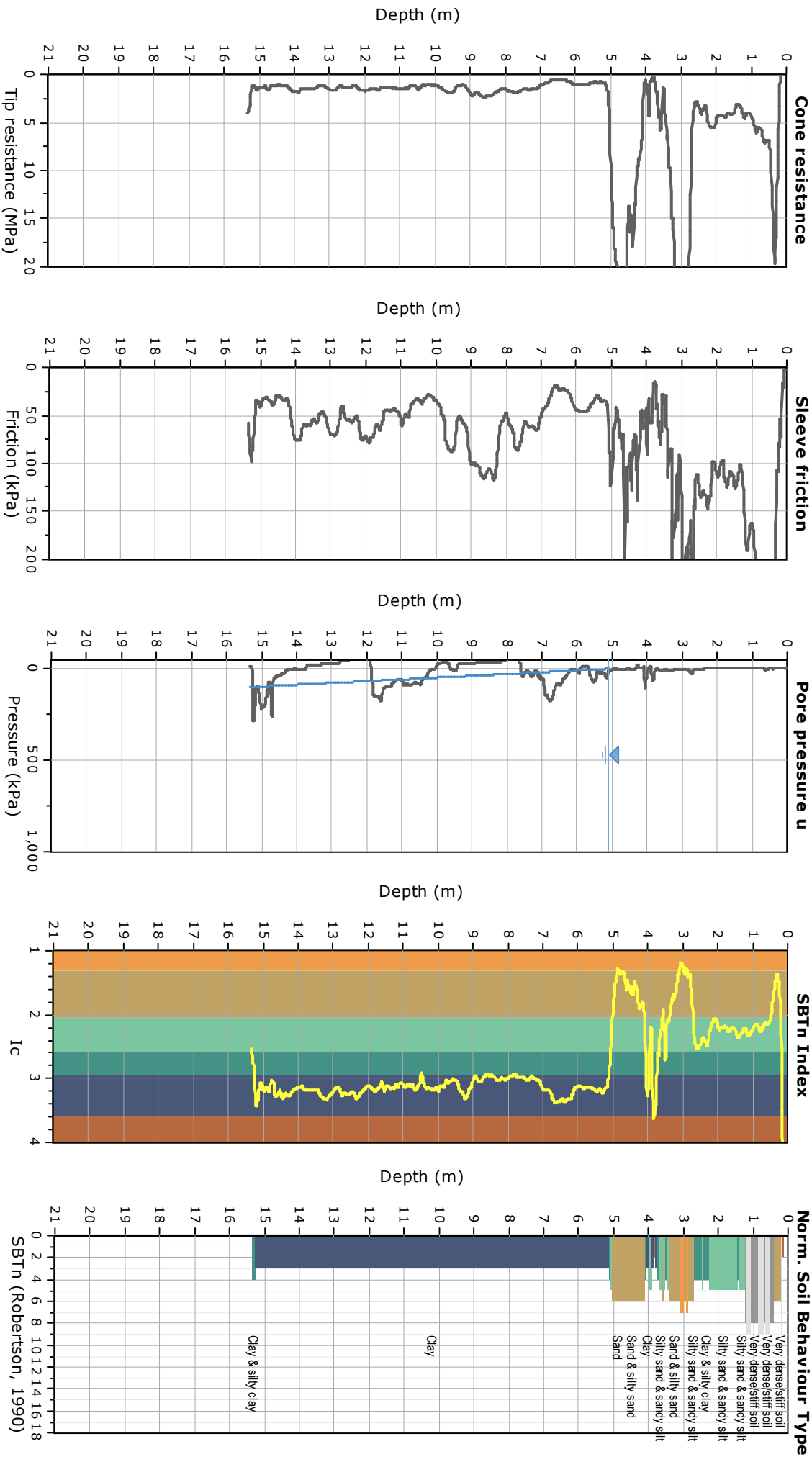
[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0]$ $A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	1.797 Hz	OK	
$A_0 > 2$	$2.08 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.05012 < 0.05$		NO
$\sigma_f < \varepsilon(f_0)$	$0.04933 < 0.14766$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3146 < 2.0$	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{\log H/V}(f)$	standard deviation of $\log A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$

Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20



ANZOLA DELL'EMILIA_MS, TR5

037001P60010HVSR59171

Instrument: TRZ-0108/01-10

Start recording: 17/09/18 12:51:07 End recording: 17/09/18 13:51:08

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 1h00'00". Analyzed 88% trace (manual window selection)

Sampling rate: 128 Hz

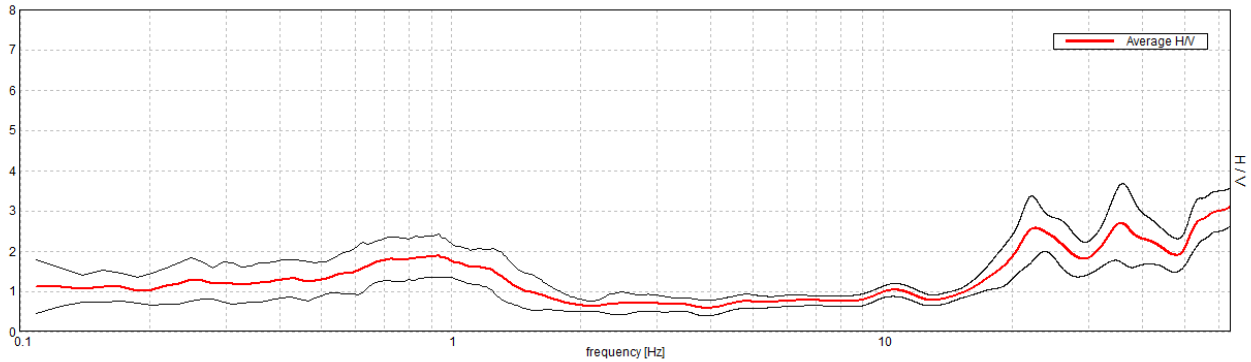
Window size: 60 s

Smoothing type: Triangular window

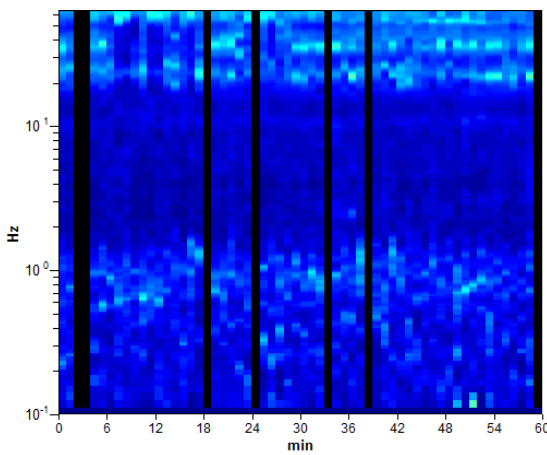
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

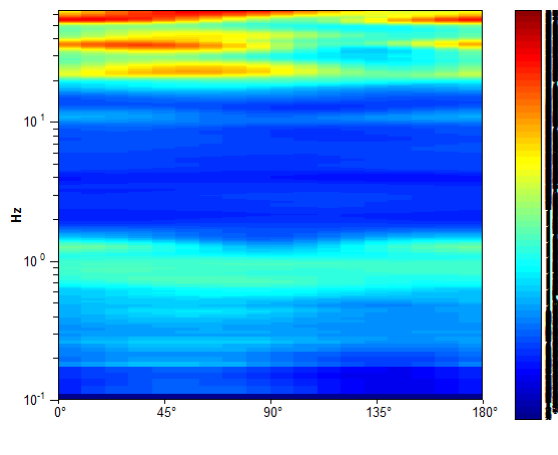
Max. H/V at 0.94 ± 0.73 Hz. (In the range 0.1 - 20.0 Hz).



H/V TIME HISTORY

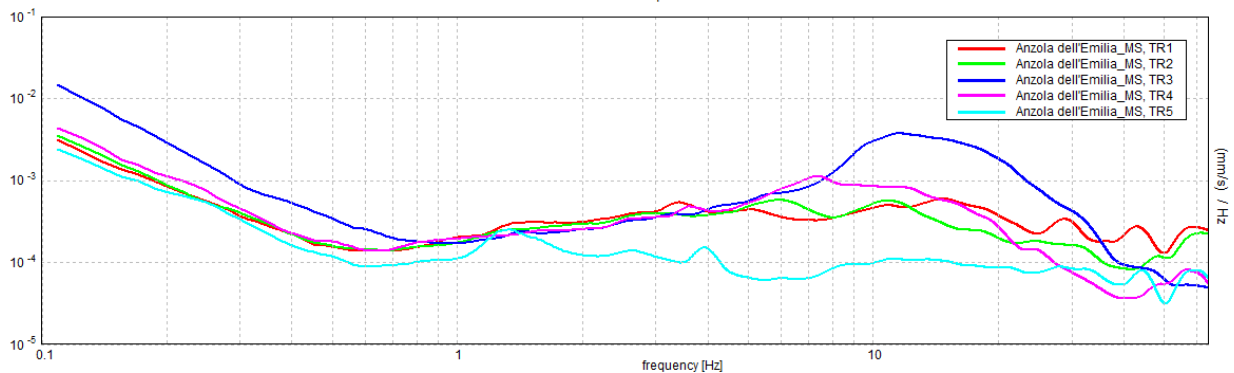


DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA

North-South component



[According to the SESAME, 2005 guidelines. Please read carefully the *Grilla* manual before interpreting the following tables.]

Max. H/V at 0.94 ± 0.73 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.94 > 0.17$	OK	
$n_c(f_0) > 200$	$2981.3 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 91 times	OK	

Criteria for a clear H/V peak

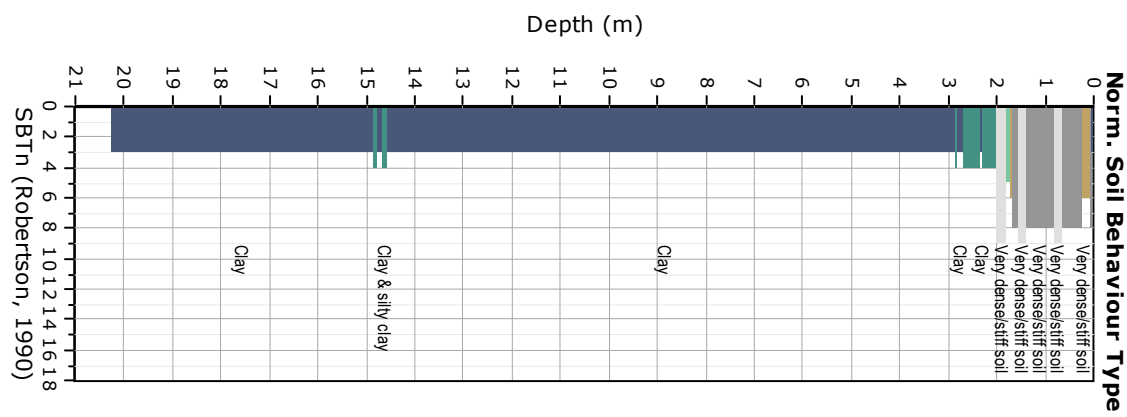
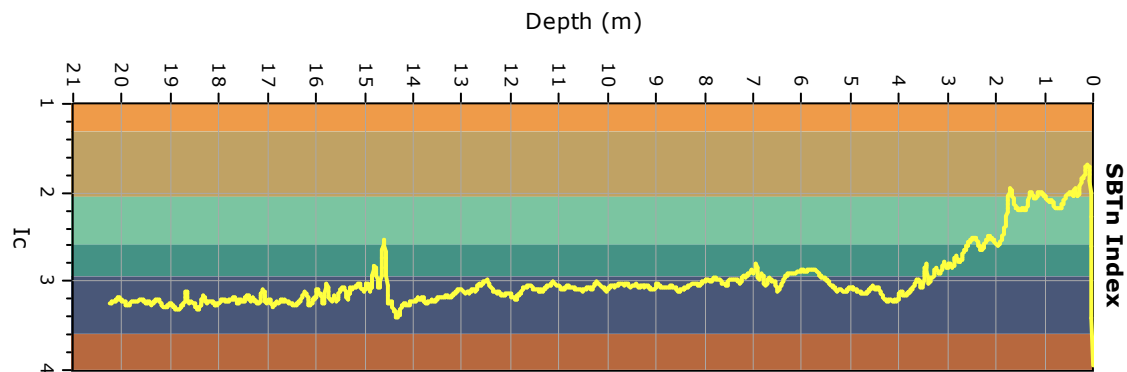
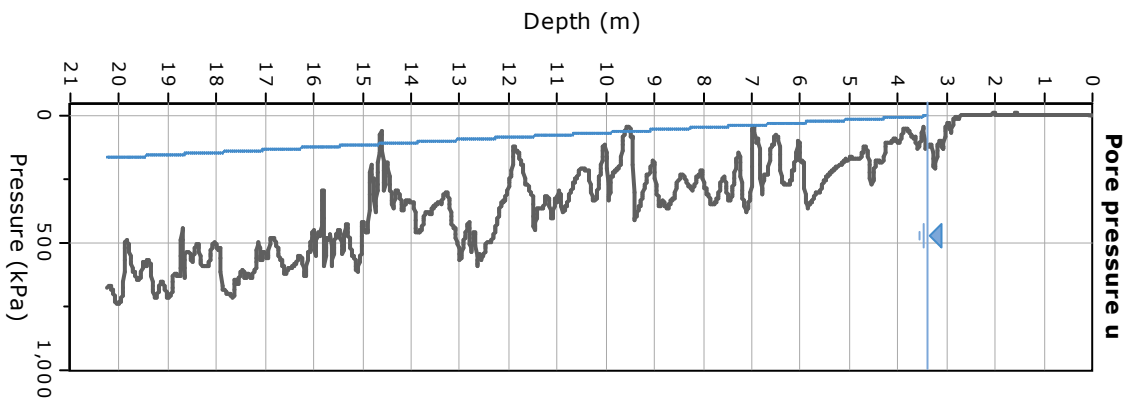
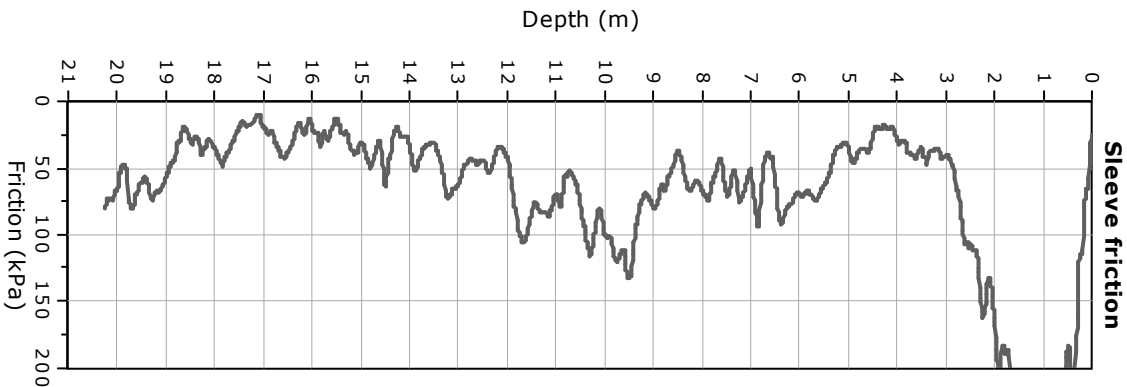
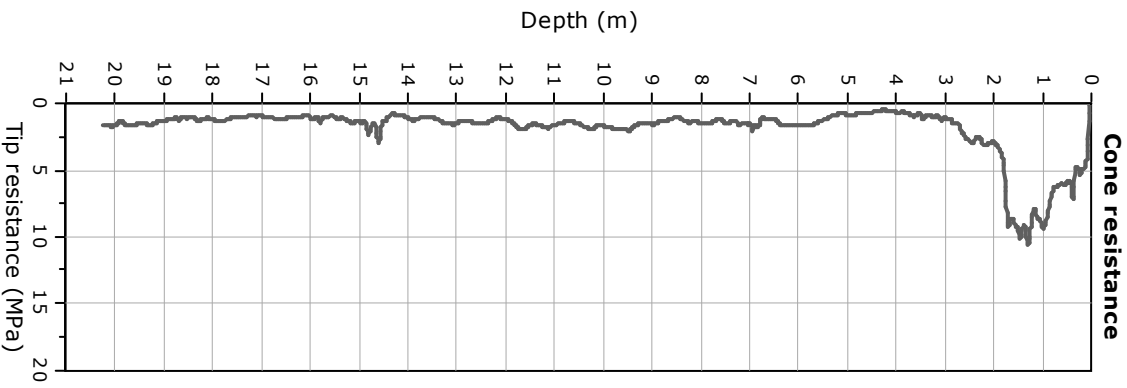
[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.594 Hz	OK	
$A_0 > 2$	$1.88 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.38463 < 0.05$		NO
$\sigma_f < \varepsilon(f_0)$	$0.36059 < 0.14063$		NO
$\sigma_A(f_0) < \theta(f_0)$	$0.2699 < 2.0$	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{\log H/V}(f)$	standard deviation of $\log A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$

Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20



ANZOLA DELL'EMILIA_MS, TR10

037001P60011HVSR59173

Instrument: TRZ-0108/01-10

Start recording: 10/10/18 10:52:26 End recording: 10/10/18 11:52:26

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 1h00'00". Analyzed 93% trace (manual window selection)

Sampling rate: 128 Hz

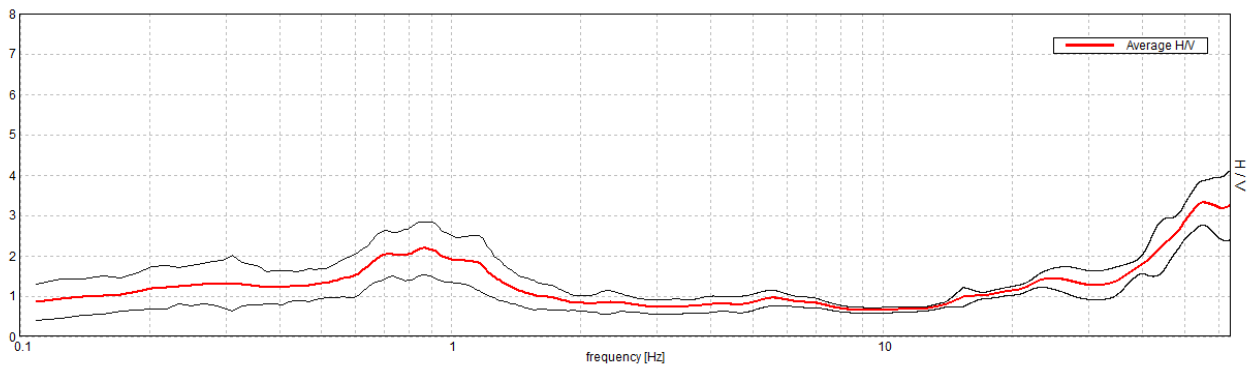
Window size: 60 s

Smoothing type: Triangular window

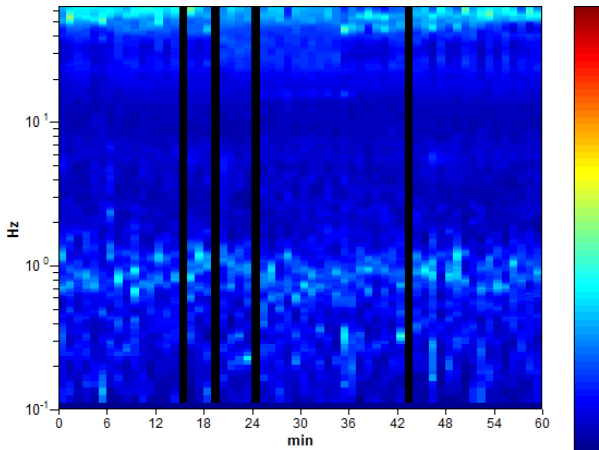
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

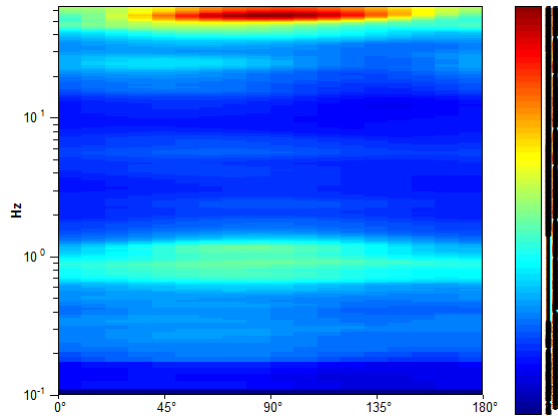
Max. H/V at 0.86 ± 0.03 Hz. (In the range 0.1 - 20.0 Hz).



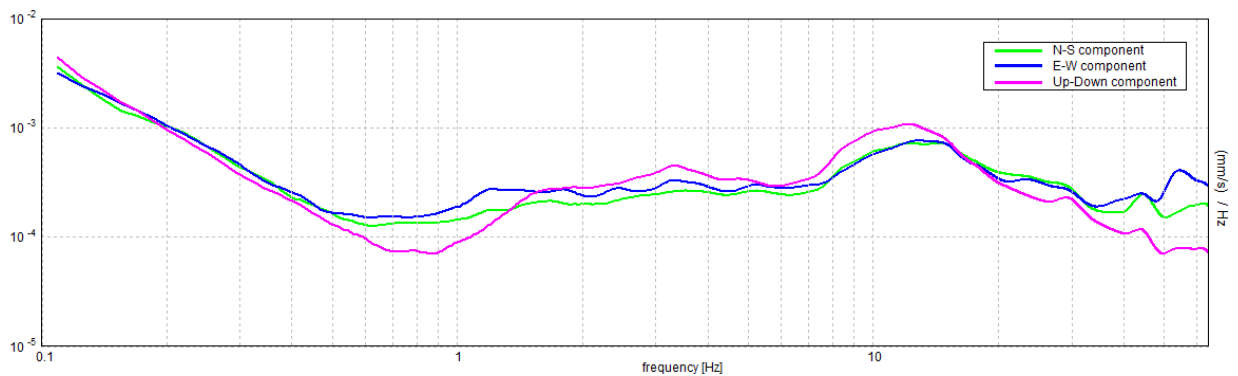
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. Please read carefully the *Grilla* manual before interpreting the following tables.]

Max. H/V at 0.86 ± 0.03 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.86 > 0.17$	OK	
$n_c(f_0) > 200$	$2887.5 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 84 times	OK	

Criteria for a clear H/V peak

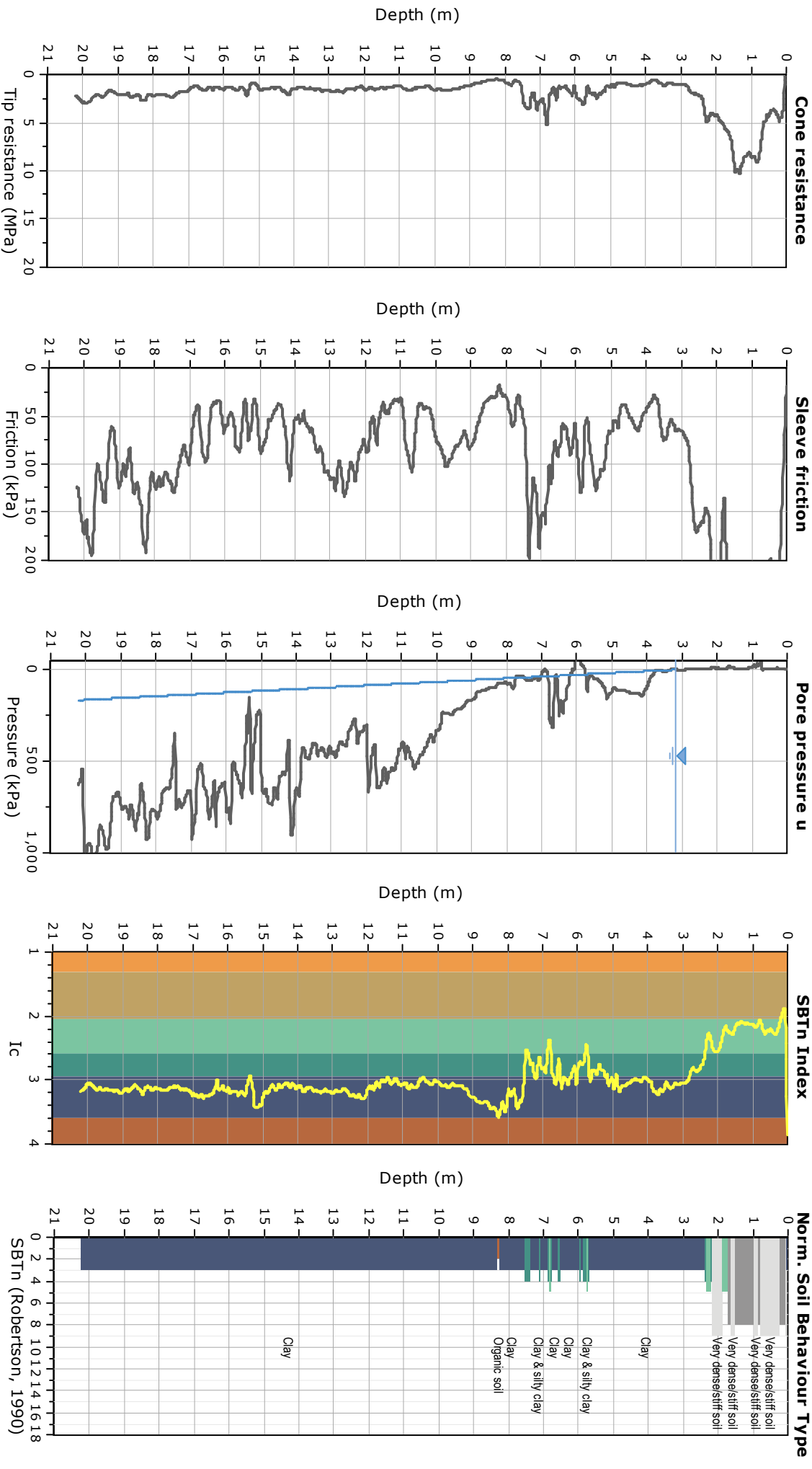
[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.484 Hz	OK	
$A_0 > 2$	$2.18 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01591 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01367 < 0.12891$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3273 < 2.0$	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{\log H/V}(f)$	standard deviation of $\log A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$

Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20



ANZOLA DELL'EMILIA_MS, TR3

037001P60012HVSR59175

Instrument: TRZ-0108/01-10

Start recording: 14/09/18 14:44:54 End recording: 14/09/18 15:44:55

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 1h00'00". Analyzed 92% trace (manual window selection)

Sampling rate: 128 Hz

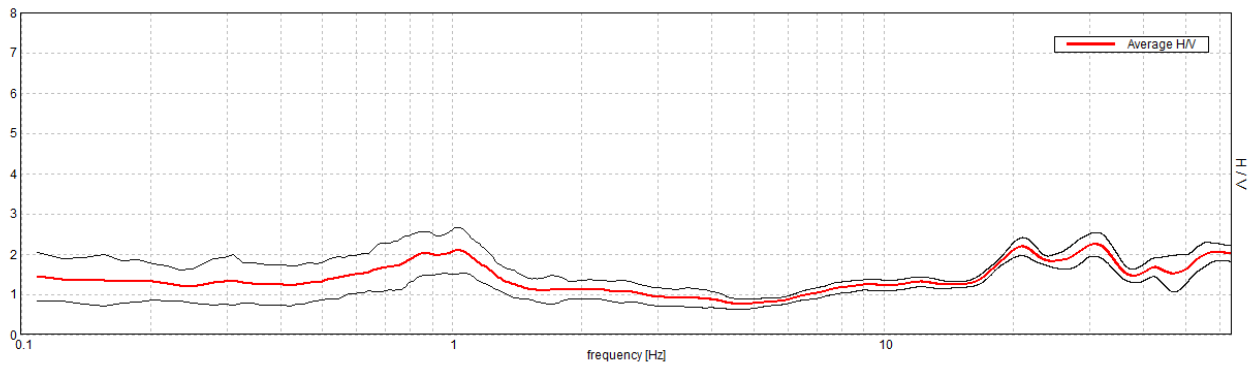
Window size: 60 s

Smoothing type: Triangular window

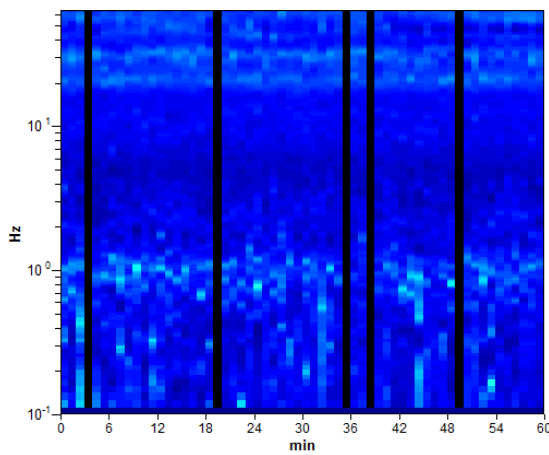
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

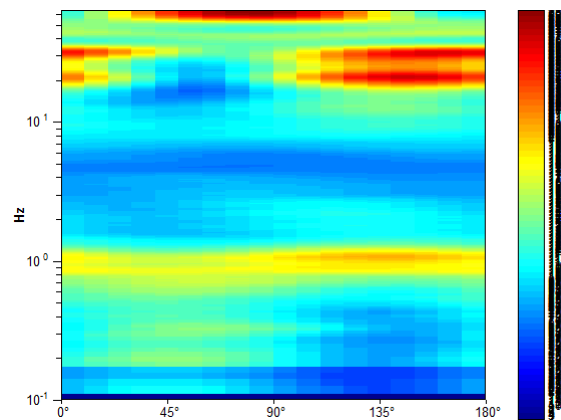
Max. H/V at 19.98 ± 4.59 Hz. (In the range 0.1 - 20.0 Hz).



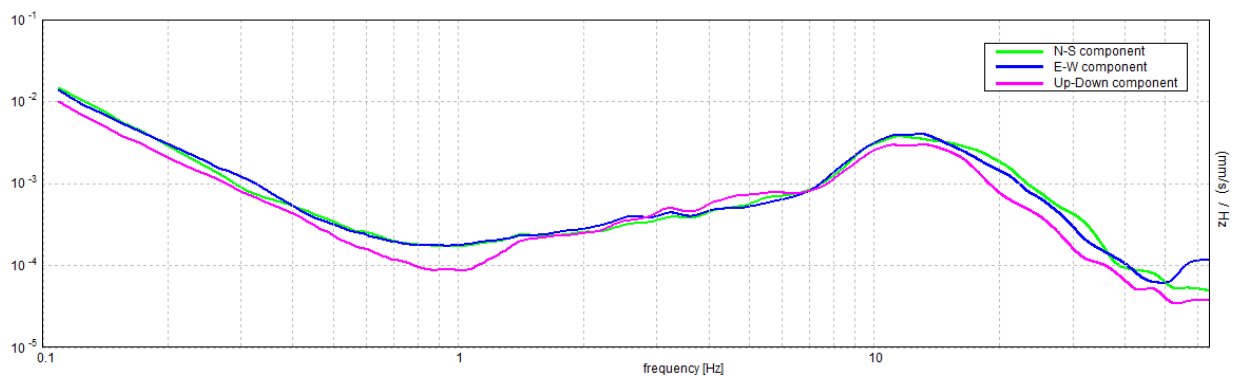
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. Please read carefully the *Grilla* manual before interpreting the following tables.]

Max. H/V at 19.98 ± 4.59 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	19.98 > 0.17	OK	
$n_c(f_0) > 200$	65948.4 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 1920 times	OK	

Criteria for a clear H/V peak

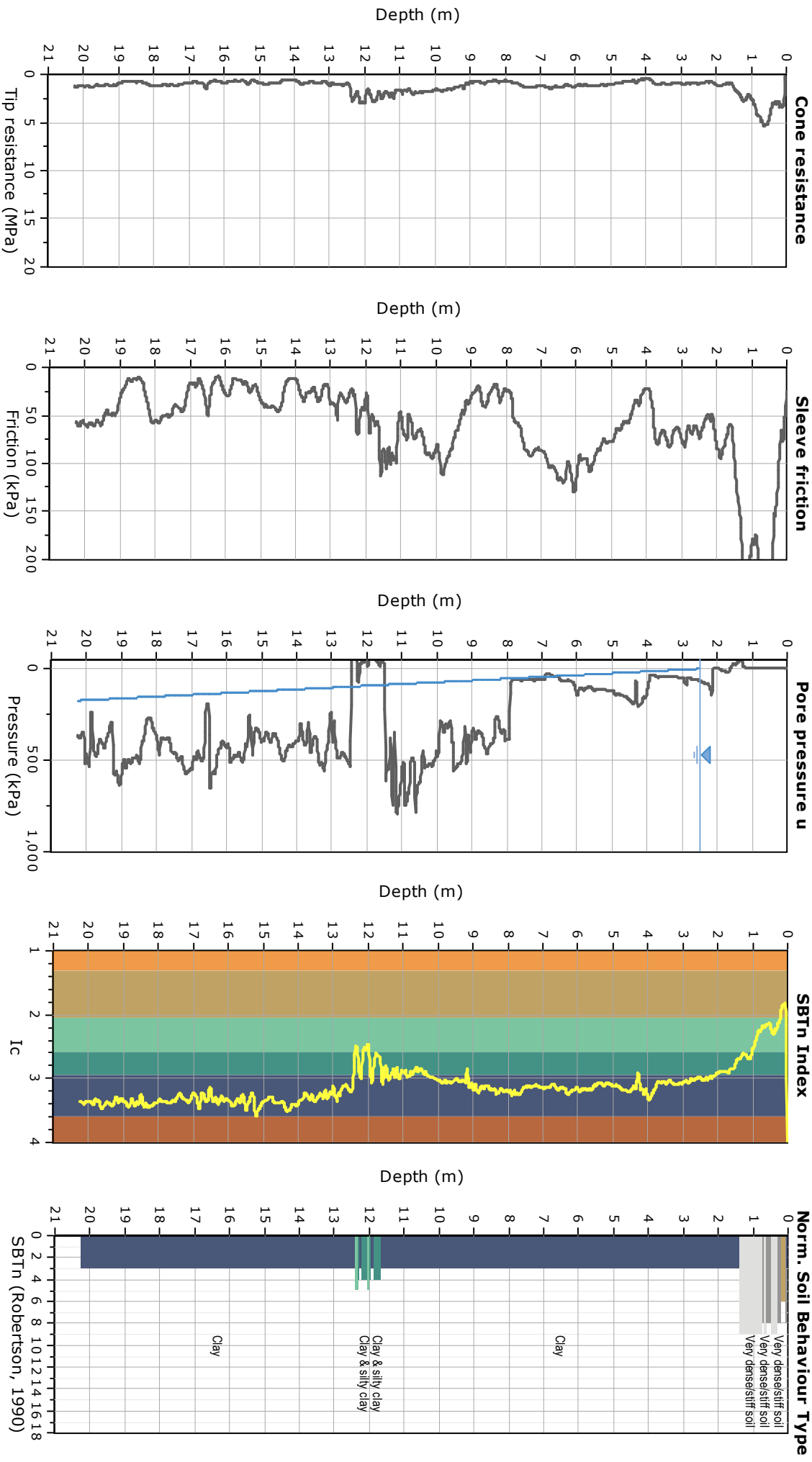
[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0]$ $A_{H/V}(f^-) < A_0 / 2$	7.125 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$			NO
$A_0 > 2$	2.09 > 2	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.11344 < 0.05$		NO
$\sigma_f < \varepsilon(f_0)$	2.26693 < 0.99922		NO
$\sigma_A(f_0) < \theta(f_0)$	0.0925 < 1.58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{\log H/V}(f)$	standard deviation of $\log A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$

Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

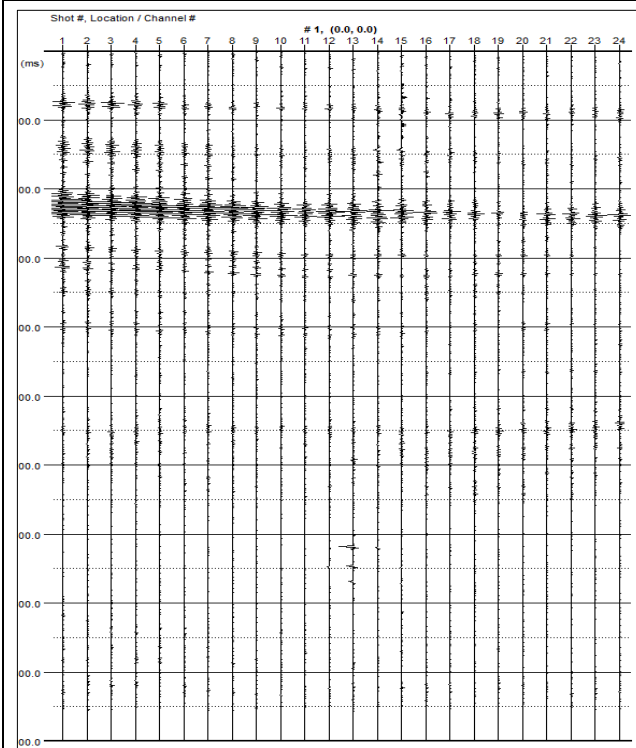


PROSPEZIONE SISMICA CON METODOLOGIA ESAC

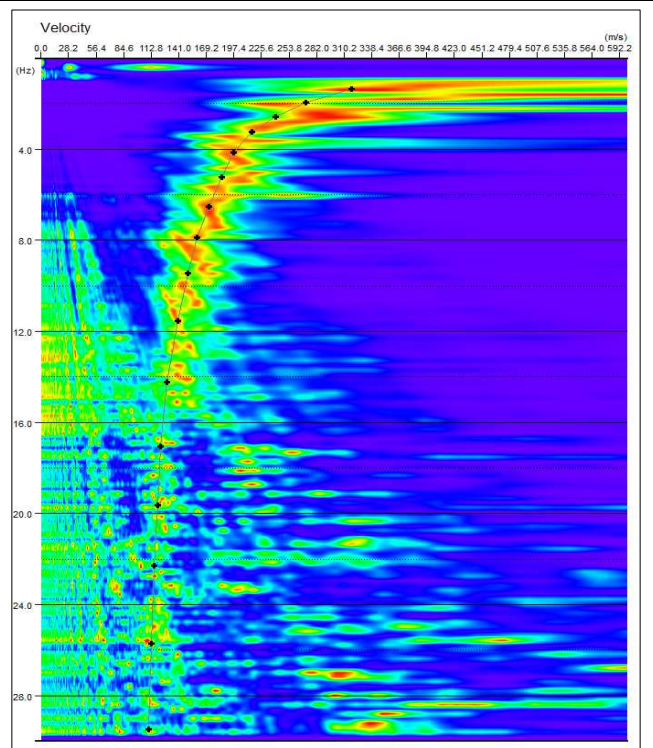
Lavino di Mezzo, Comune di Anzola dell'Emilia (BO) - 037001P60014ESAC_SPAC59177

n° tracce	Δt (ms)	T (s)
25	2,0	32,0

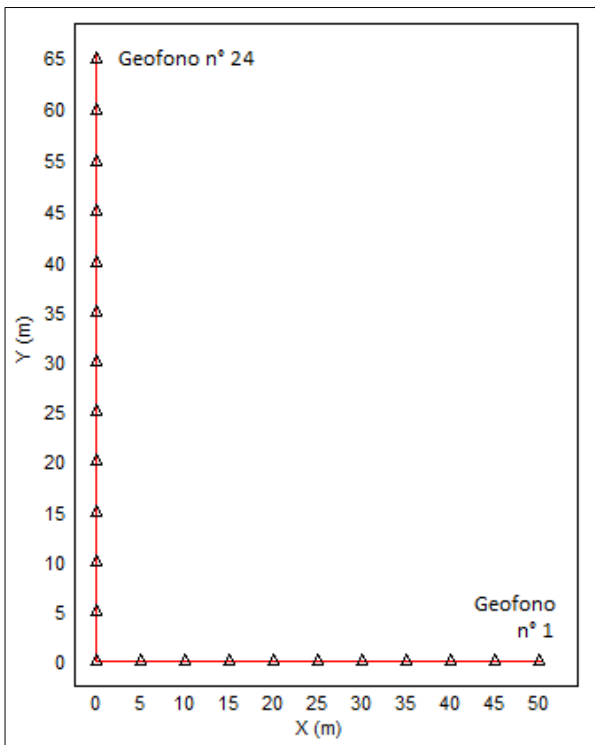
Δt : passo di campionamento; T: durata registrazione.



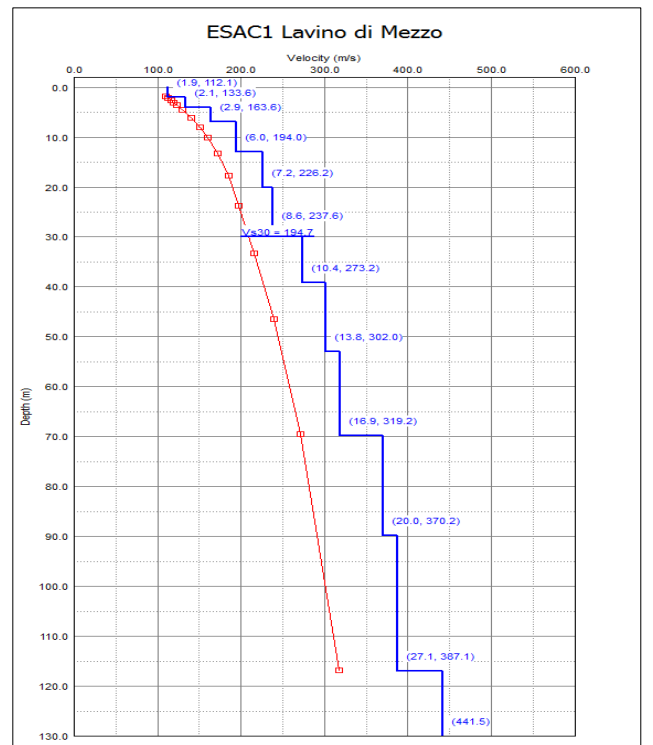
Sismogramma registrato durante le acquisizioni di microtremore sismico. In ascissa il numero dei geofoni, in ordinata il tempo (ms).



Spettro di potenza nel dominio $f-v$ e Picking della curva sperimentale delle onde R (croci nere).



Geometria dello stendimento sismico bidimensionale.



Modello di sottosuolo (1D) descritti in termini di V_s e spessore dei sismostrati (spezzata blu) e curva di dispersione sperimentale delle onde R (curva rossa).

Tabella di sintesi

n. Strato	Profondità letto (m dal p.c.)	Spessore (m)	V _s (m/s)
1	1.9	1.9	112.1
2	4.0	2.1	133.6
3	6.9	2.9	163.6
4	12.9	6.0	194.0
5	20.1	7.2	226.2
6	28.7	8.6	237.6
7	39.1	10.4	273.2
8	52.9	13.8	302.0
9	69.8	16.9	319.2
10	89.8	20.0	370.2
11	116.9	27.1	387.1
12	∞	∞	441.5

$$V_{s30} = 194.7 \pm 10\% \text{ [m/s]}$$

Sintesi dei parametri del modello di sottosuolo ottenuto e Valore di Vs30 calcolato.

ANZOLA DELL'EMILIA_MS, TR6

037001P60014HVSR59178

Instrument: TRZ-0108/01-10

Start recording: 04/10/18 10:03:21 End recording: 04/10/18 11:03:22

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 1h00'00". Analyzed 98% trace (manual window selection)

Sampling rate: 128 Hz

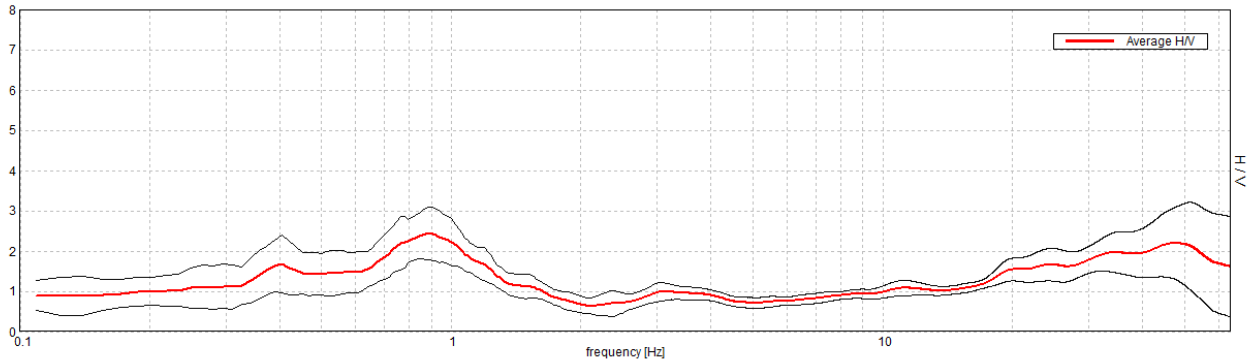
Window size: 60 s

Smoothing type: Triangular window

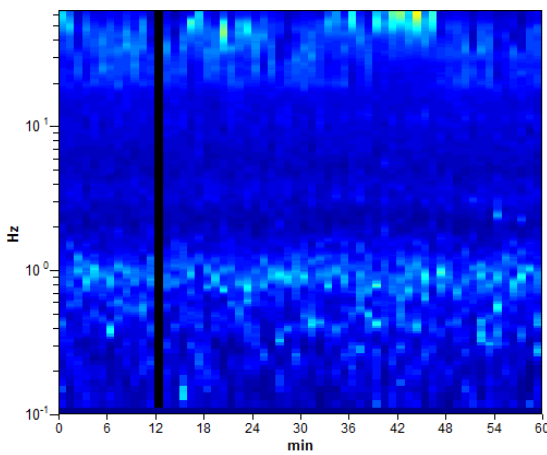
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

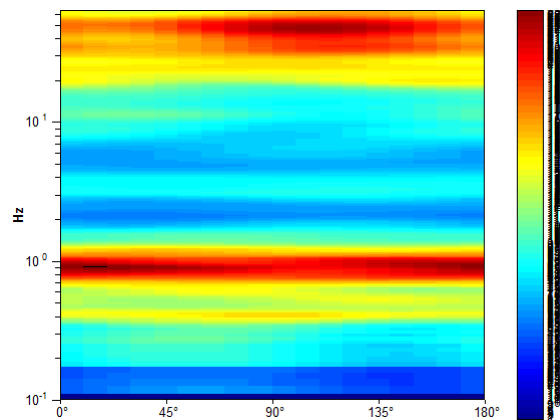
Max. H/V at 0.89 ± 0.02 Hz. (In the range 0.1 - 20.0 Hz).



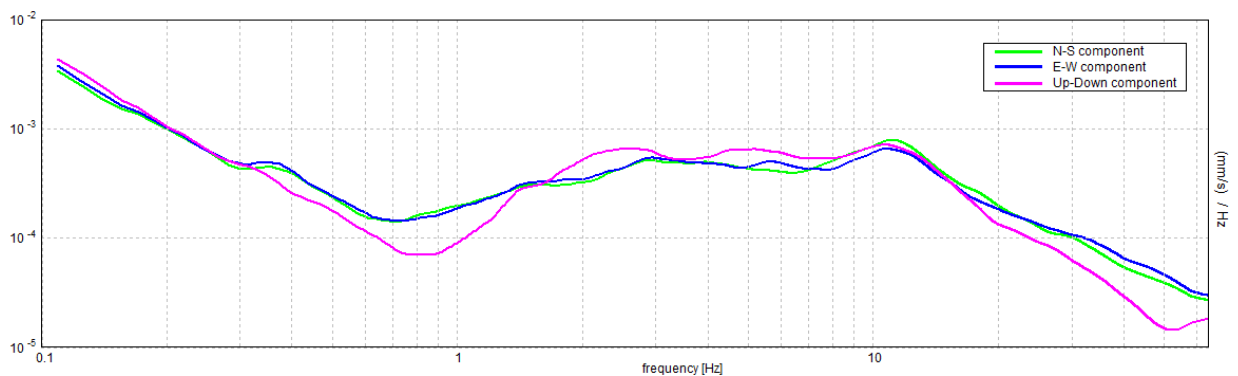
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. Please read carefully the *Grilla* manual before interpreting the following tables.]

Max. H/V at 0.89 ± 0.02 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.89 > 0.17$	OK	
$n_c(f_0) > 200$	$3152.8 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 86 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$	0.328 Hz	OK	
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.344 Hz	OK	
$A_0 > 2$	$2.44 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01117 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.00995 < 0.13359$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3281 < 2.0$	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{\log H/V}(f)$	standard deviation of $\log A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$

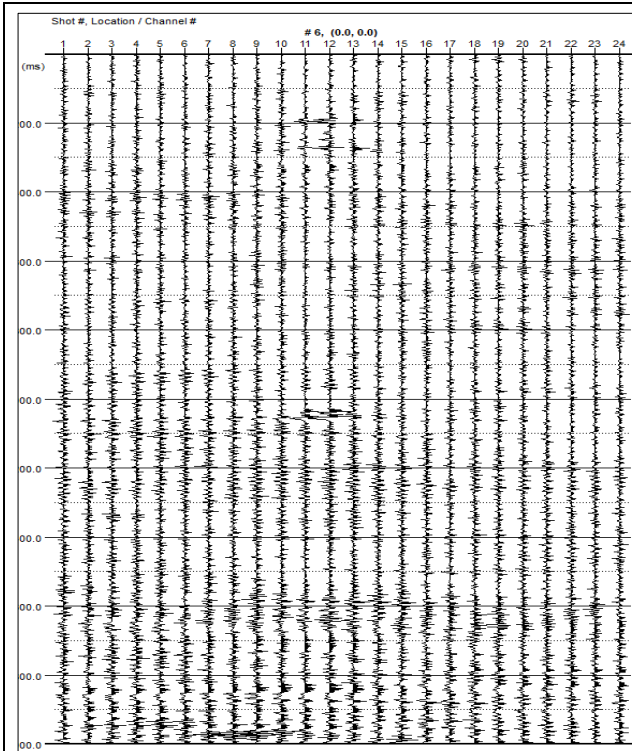
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

PROSPERAZIONE SISMICA CON METODOLOGIA ESAC

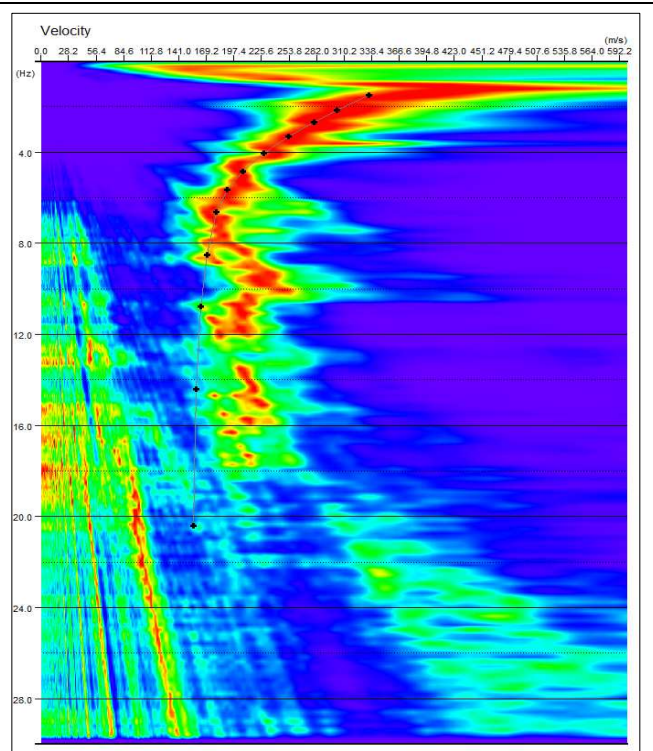
S. Giacomo del Martignone, Comune di Anzola dell'Emilia (BO) - 037001P60015ESAC_SPAC59179

n° tracce	Δt (ms)	T (s)
25	2,0	32,0

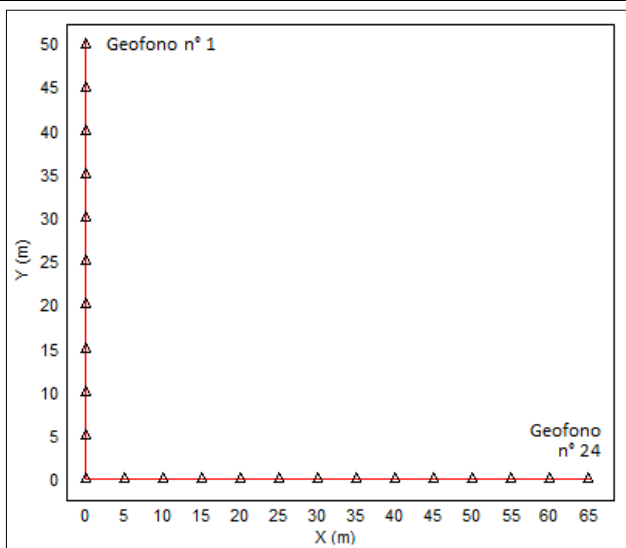
Δt : passo di campionamento; T: durata registrazione.



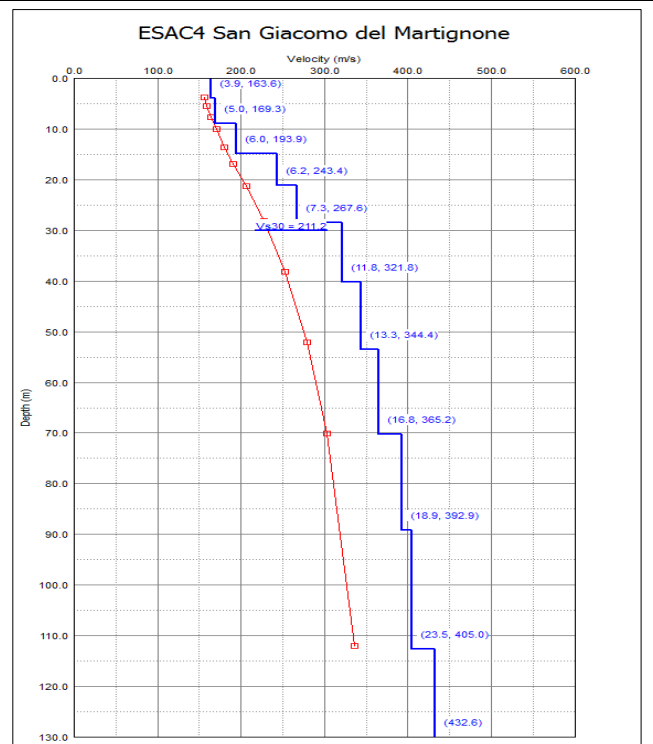
Sismogramma registrato durante le acquisizioni di microtremore sismico. In ascissa il numero dei geofoni, in ordinata il tempo (ms).



Spettro di potenza nel dominio $f-v$ e Picking della curva sperimentale delle onde R (croci nere).



Geometria dello stendimento sismico bidimensionale.



Modello di sottosuolo (1D) descritti in termini di V_s e spessore dei sismostrati (spezzata blu) e curva di dispersione sperimentale delle onde R (curva rossa).

Tabella di sintesi

n. Strato	Profondità letto (m dal p.c.)	Spessore (m)	V _s (m/s)
1	3.9	3.9	163.6
2	8.9	5.0	169.3
3	14.9	6.0	193.9
4	21.1	6.2	243.4
5	28.4	7.3	267.6
6	40.2	11.8	321.8
7	53.5	13.3	344.4
8	70.3	16.8	365.2
9	89.2	18.9	392.9
10	112.7	23.5	405.0
11	∞	∞	432.6

$$V_{S30} = 211.2 \pm 10\% \text{ [m/s]}$$

Sintesi dei parametri del modello di sottosuolo ottenuto e Valore di Vs30 calcolato.

ANZOLA DELL'EMILIA_MS, TR9

037001P60015HVSR59180

Instrument: TRZ-0108/01-10

Start recording: 04/10/18 15:20:58 End recording: 04/10/18 16:20:58

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 1h00'00". Analyzed 85% trace (manual window selection)

Sampling rate: 128 Hz

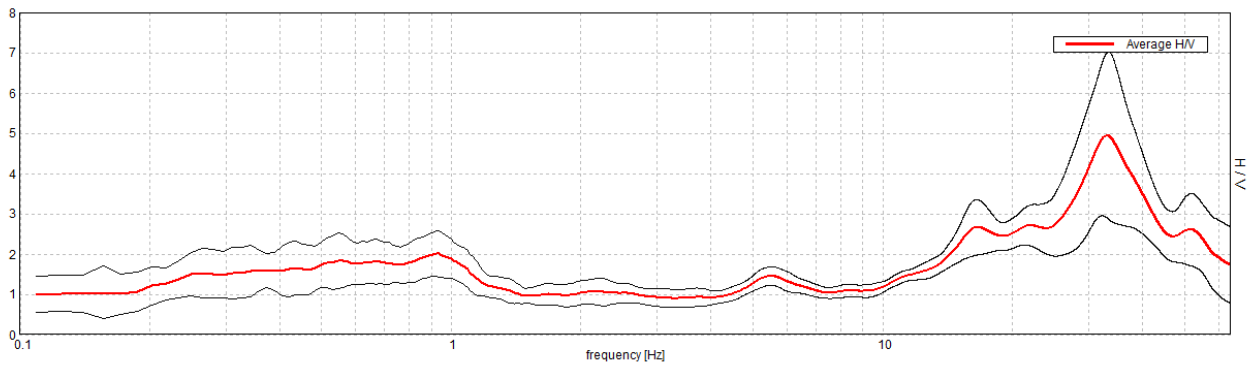
Window size: 60 s

Smoothing type: Triangular window

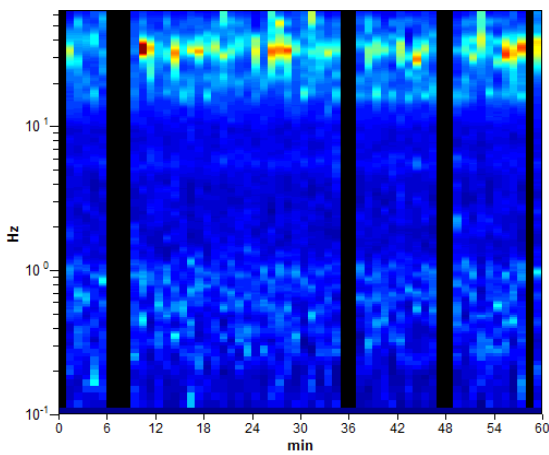
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

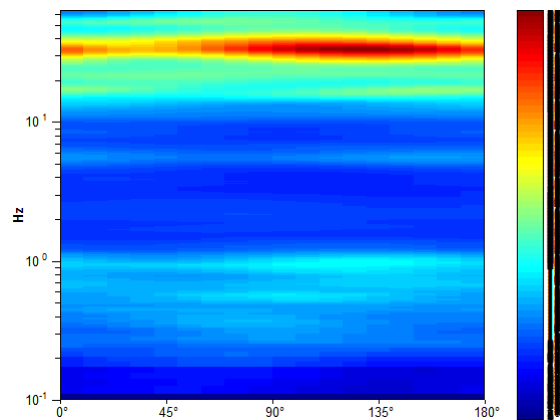
Max. H/V at 16.64 ± 1.4 Hz. (In the range 0.1 - 20.0 Hz).



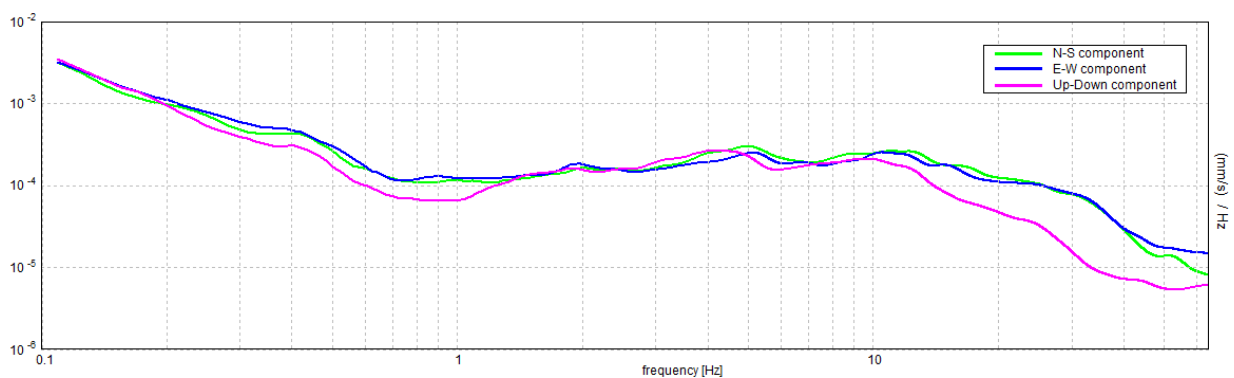
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the SESAME, 2005 guidelines. Please read carefully the *Grilla* manual before interpreting the following tables.]

Max. H/V at 16.64 ± 1.4 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	16.64 > 0.17	OK	
$n_c(f_0) > 200$	50920.3 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 34 out of 1598 times		NO

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$	10.609 Hz	OK	
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$			NO
$A_0 > 2$	2.66 > 2	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.04134 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.68793 < 0.83203$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3358 < 1.58$	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{\log H/V}(f)$	standard deviation of $\log A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$

Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20