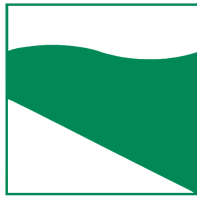




PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile



Regione Emilia Romagna



CONFERENZA DELLE REGIONI E
DELLE PROVINCE AUTONOME

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

MICROZONAZIONE SISMICA

Report delle indagini

Regione Emilia–Romagna

Comune di Castel Maggiore



Regione	Soggetto realizzatore	Data
EMILIA–ROMAGNA	Raggruppamento temporaneo di imprese e professionisti Capogruppo: dott. geol. Samuel Sangiorgi Mandanti: ing. Marco Soglia, ISMGEO s.r.l., Consorzio Futuro in Ricerca, Songeo s.r.l.	Giugno 2018



via A. Ascari 6 - 44019 Gualdo di Voghiera (FE)
tel. 0532 773136-815683 Fax 0532 776455

E mail info@songeo.it - www.songeo.it

Decreto di concessione n° 56718 del 17.09.2007, per il rilascio dei certificati relativi alle prove geotecniche in sito (settore c), ai sensi del D.P.R. 06.06.2001 n° 380 e della Circolare n° 349/STC del 16.12.1999

CERTIFICATO DI PROVA

CERTIFICATO N°	43/17	data	10/04/2017	N° Verbale Accettazione	63/16	data	20/12/2016
----------------	-------	------	------------	-------------------------	-------	------	------------

COMMITTENTE:	Unione Comuni Reno Galliera
LOCALITA':	Castelmaggiore (BO)
CANTIERE:	Centro commerciale Le Piazze
Sondaggio N°:	S1 Castelmaggiore
Specifiche di prova:	ASTM D 2488-90; AGI 1977
Attrezzatura:	Hydra Joy 4
Metodo perforazione:	Carotaggio Continuo; PRO E01; PRO E02; PRO E03; PRO E06; PRO E08; PRO E12
Attrezzi:	Carotiere semplice diam. 101 mm, rivestimenti diam. 127 mm

QUOTA INIZIO	p.c.
PROFONDITA' DEL SONDAGGIO	40,0 m
PROFONDITA' DELLA FALDA	

ANNOTAZIONI:

COROGRAFIA E PLANIMETRIA:



IL PRESENTE CERTIFICATO SI COMPONE DI:

3 Pagine

Sperimentatore

Giulio Boni

Direttore



COMMITTENTE Unione Comuni Reno Galliera

LOCALITA' Castelmaggiore (BO) - Centro Commerciale Le Piazze

TUBO PER DOWN HOLE

Tubo per Down Hole in PVC, diam. 3", profondità 40 m

NOTE

CAMPIONI

- SPT
- CAMPIONI RIMANEGGIATI
- CAMPIONI INDISTURBATI

LIVELLO ACQUA DATA MT. dal P.C.

PROF. FORO

PROF. RIVEST.

ASSISTENTI

R. Sacchetti, A.Fini, L. Malservigi

OPERATORI

G. Rossi

mt.	QUOTA da P.C.	SIMBOLOGIA	CAMPIONI			DESCRIZIONE STRATIGRAFICA	POCKET kg/cm ²	TORVANE kg/cm ²	TUBO PER DOWN HOLE
			TIPO	NUM.	PROF.				
1	0,90					Limo argilloso nocciola con resti di laterizi tra 0,5 m e 0,9 m			Riempimento boiacca cementizia
	1,30					Argilla limosa nocciola con qualche minuto frammento di laterizio	4,5	>2,4	
2	2,10					Limo argilloso a tratti debolmente sabbioso nocciola moderatamente consistente e plastico	1,6	0,6	
						2,4	0,7		
3	3,70		SH1	2,7 3,3		Argilla debolmente limosa nocciola moderatamente consistente e plastica con sfumature ocre e punti bruni	2,2	0,8	
						1,9	0,6		
4	4,30					Sabbia fine limosa nocciola saturata e sciolta	2,0	0,7	
						4,60	Argilla debolmente limosa nocciola e grigia moderatamente consistente e plastica	1,5	
5	5,10					Alternanze di sabbia fine con limo e limo sabbioso nocciola con sfumature grigie ed ocre	0,6	0,2	
						5,10	Limo con argilla nocciola, grigio ed ocre	0,5	
6						Argilla debolmente limosa nocciola e grigia moderatamente consistente e plastica	1,5	0,6	
						1,3	0,6		
7						Argilla grigia con livelletti e livelli di colore nocciola consistente e plastica con concrezioni calcaree	2,5	1,0	
						1,5	0,7		
8			C1	7,5 7,8			2,2	0,9	
						1,9	1,0		
9	9,10						1,6	0,8	
						2,1	1,0		
10	10,30					Limo e limo sabbioso grigio con livelletti di sabbia fine limosa e concrezioni calcaree	1,7	0,8	
						2,0	0,8		
11	11,40		C2	10,7 11,0		Limo con argilla moderatamente consistente e plastico grigio con sfumature verdastre alla base; da 11,00 m passa a limo sabbioso	2,6	1,2	
						0,8	0,2		
12							0,8	0,1	
						0,6	0,1		
13	13,30					Argilla grigia con sfumature verdastre e qualche frustolo, consistente e plastica, con concrezioni calcaree nella parte bassa (da 12,40 m il colore passa a grigio/azzurro)	0,9	0,3	
						0,9	0,3		
14	14,40						0,6	0,2	
						0,4	0,1		
15						Limo argilloso da debolmente sabbioso a sabbioso, a tratti argilla limosa poco consistente e plastica con rade concrezioni calcaree	1,8	0,8	
						2,1	0,9		
16	17,60		SH2	15,5 16,0		Limo e limo argilloso e/o con argilla e argilla limosa grigia chiara da moderatamente consistente (argilla) a poco consistente (limo) e plastica; presente qualche frustolo	1,5	0,6	
						1,9	0,7		
17							2,0	1,0	
						2,4	1,2		
18	18,20					Argilla grigia scura consistente e plastica con qualche frustolo e resti di gusci	2,5	1,2	
						0,5	0,2		
19	18,80						0,5	0,2	
						0,5	0,2		
20						Limo con argilla moderatamente consistente e plastico grigio con sfumature verdastre alla base; da 11,00 m passa a limo sabbioso	0,9	0,3	
						0,9	0,3		
						Argilla grigia con sfumature verdastre e qualche frustolo, consistente e plastica, con concrezioni calcaree nella parte bassa (da 12,40 m il colore passa a grigio/azzurro)	0,9	0,4	
						1,0	0,4		
							0,9	0,3	
						0,6	0,3		
						Argilla grigia consistente con grosse concrezioni calcaree (centimetriche)	0,6	0,3	
						1,1	0,3		
							0,9	0,4	
						1,0	0,4		
						Argilla grigia moderatamente consistente e plastica, debolmente torbosa con resti legnosi parzialmente decomposti e resti di gusci. Talora i resti torbosi hanno struttura laminata. Talora strie grigie chiare e qualche livelletto francamente torboso	1,0	0,4	
						1,0	0,4		
							0,9	0,4	
						0,8	0,4		
							0,6	0,3	
						0,7	0,4		

Certificato n°	43/17	data	10/04/17	N° VERBALE ACCETTAZIONE	63/16	DATA	20/12/2016
Procedure di riferimento	ASTM D 2488-90; AGI 1977						
elaborazione	responsabili	revisione	inizio lavori	1 marzo 2017			
verifica	Dr. Andrea Fini	0	responsabile cantiere	Dott. Geol. Sacchetti Ren			
	Dr. Renato Sacchetti		direzione lavori	Dott. Geol. Sangiorgi San			
SPERIMENTATORE				DIRETTORE			



DATA ESECUZIONE DAL 20/03/17 AL 21/03/17	METODO PERFOR. Carotaggio continuo	SONDAGGIO 1 Castelmaggiore	Pagina 3/3
QUOTA p.c.	ATTREZZI: Carotiere semplice diam. 101 mm Rivestimenti diam. 127 mm		SONDA IDRAULICA Hydra Joy 4
COMMITTENTE Unione Comuni Reno Galliera		TUBO PER DOWN HOLE Tubo per Down Hole in PVC, diam. 3", profondità 40 m	
LOCALITA' Castelmaggiore (BO) - Centro Commerciale Le Piazze		LIVELLO ACQUA DATA	ASSISTENTI R. Sacchetti, A.Fini, L. Malservigi
NOTE		PROF. FORO 40,00 m	OPERATORI G. Rossi
CAMPIONI ● SPT ○ CAMPIONI RIMANEGGIATI ■ CAMPIONI INDISTURBATI		PROF. RIVEST. 37,00 m	

mt.	QUOTA da P.C.	SIMBOLOGIA	CAMPIONI			DESCRIZIONE STRATIGRAFICA	POCKET kg/cm ²	TORVANE kg/cm ²	TUBO PER DOWN HOLE
			TIPO	NUM.	PROF.				
21						0,6 0,5 1,1 1,3 1,4 1,2 1,1 1,3	0,3 0,2 0,4 0,5 0,6 0,6 0,4 0,6	Tubo per down hole	
22									
23	23,10								
24	23,60				Argilla nerastra	1,9 1,9	0,9 1,0		
25			■ SH3	24,5 25,0	Argilla grigia chiara consistente con livelletti di limo argilloso debolmente sabbioso	1,8 2,3 3,0 2,9	0,7 0,8 1,5 1,4		
26	25,70				Argilla grigia moderatamente consistente	1,2 1,3	0,6 0,6		
27					Limo e limo argilloso debolmente sabbioso grigio poco consistente alternato a sabbia fine debolmente limosa e locali livelletti continui argillosi	0,5 0,4 0,7 0,6 0,5 0,8	0,1 0,1 0,2 0,1 0,1 0,4		
28	27,40				Torba nerastra. Verso il basso alternanze di argilla e torba con livelletti di sabbia limosa nocciola	1,3 1,0	0,6 0,9		
29	27,90				Argilla passante ad argilla debolmente limosa grigia consistente e plastica con frustoli	2,3 2,2	1,2 1,1		
30	28,90				Sabbia medio grossa debolmente limosa grigia; da 29,6 m alla base presenza di ghiaia media appiattita con sabbia	1,9 1,5	0,8 0,6		
31	29,90				Argilla da grigia scura a grigia chiara consistente e plastica	2,2 2,5 2,5	1,0 1,3 1,2		
32	30,40				Limo argilloso passante ad argilla grigia chiara consistente con concrezioni calcaree	1,7 2,4	0,8 1,4		
33	31,00				Argilla grigia variegata nocciola verdastra consistente e plastica con qualche concrezione e livello limoso tra 32,7 m e 33,0 m	2,4 2,4 2,5 1,7 2,0 2,0 0,8 1,3 1,8 1,5 1,1	1,4 1,4 1,2 1,6 1,1 1,2 0,6 1,0 1,2 0,7 0,5		
34	34,40				Alternanze di sabbia fine debolmente limosa grigia, limo argilloso e localmente argilla talora di colore grigio scuro/nerastro con qualche frustolo	0,7 1,9 1,0 1,6	0,2 0,8 0,4 0,6		
35	36,10				Argilla grigia scura consistente e poco plastica	3,0 3,6 2,7 3,7 3,5 3,5 3,2	1,3 1,8 1,4 1,8 1,4 1,7 1,6		
36			■ SH4	36,5 37,0					
37									
38			○ C4	38,7 39,0					
39	39,50								
40	40,00				Sabbia medio grossa grigia addensata debolmente limosa				

Certificato n°	43/17	data	10/04/17	N° VERBALE ACCETTAZIONE	63/16	DATA	20/12/2016
Procedure di riferimento	ASTM D 2488-90; AGI 1977						
responsabili	Dr. Andrea Fini	revisione	0	inizio lavori	1 marzo 2017	fine lavori	31 marzo 2017
elaborazione	Dr. Renato Sacchetti	responsabile cantiere		direzione lavori	Dott. Geol. Sangiorgi Santini		
verifica							
SPERIMENTATORE	Giulio Bini			DIRETTORE			





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

rev.	data emiss.	sperimentatore	direttore
0	08/05/2018	Ranzini	Saccenti

N° verbale di accettazione: 009/2017

Dati Generali di Campionamento

Data prelievo: 20/03/2017
 Attrezzatura sondaggio: -
 Attrezzatura prelievo: -
 Modalità prelievo: -

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH1
Profondità prelievo [m]:	2.7-3.3
Prova:	
Data fine descrizione:	08/05/2018

N° certificato di prova:

Dati Generali del Campione

Data arrivo in laboratorio:	22/03/2017	Tipo contenitore:	FUSTELLA ACCIAIO
Data estrusione campione:	22/03/2018	Forma campione:	CILINDRICO
Condizioni contenitore:	BUONE	Dimensioni Campione:	Φ= 8.5 cm L= 55 cm
		Classe del terreno:	CLASSE 4

Descrizione

2.75 m - 3.30 m: Limo con argilla con tracce di sabbia di colore marrone oliva (2.5Y 4/4) con debole reazione all'HCl e tracce di materia organica nerastra, passante a 3.10 m a sabbia limosa con discreta reazione all'HCl.

Schizzo	Penetrometro		Scissometro		Prove eseguite
	+	//	+	//	
	[MPa]	[MPa]	[MPa]	[MPa]	
2.65					LLP1 Gr1
2.70					
2.75					
2.80	0.14				
2.85					
2.90	0.10				
2.95					
3.00	0.10				
3.05					
3.10					
3.15					
3.20					
3.25					
3.30					
3.35					
3.40					
3.45					
3.50					
3.55					
3.60					
3.65					
3.70					
3.75					
3.80					

Richiami

LLP = Limiti di liquidità e plasticità

Gr = Analisi Granulometrica



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

rev.	data emiss.	sperimentatore	direttore
0	08/05/2018	Ranzini	Saccenti

N° verbale di accettazione: 009/2017

Committente: Unione Comuni Reno Galliera
Cantiere: CASTELMAGGIORE
Sondaggio: S1
Campione: SH1
Profondità prelievo [m]: 2.7-3.3
Prova:
Data fine descrizione: 08/05/2018

Prove	Profondità	Risultati prove	Riferimento procedure	N° certificato di prova
LLP1	2.90m - 3m	Limite Liquido = 43 [%] Limite Plastico = 22 [%]	PT-LMT-00020 REV. 1	

Rev	data emiss.	eseguito da	elaborato da
0	11/05/2018	Sirtoli	Sirtoli

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH1
Profondità prelievo [m]:	2.70 – 3.30
Data prova:	



rev.	data emiss.	sperimentatore	direttore
0	09/04/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D422/07

Classificazione di riferimento: AGI 1977

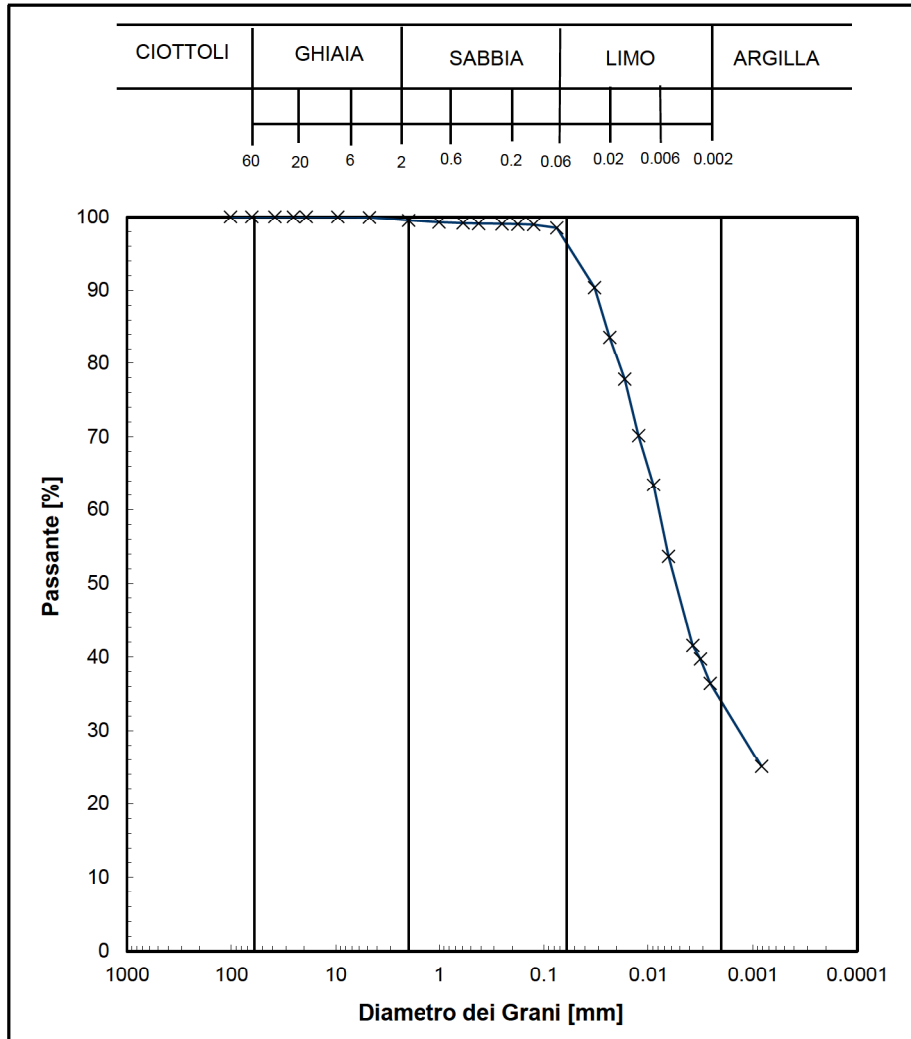
N° certificato di prova:

N° verbale di accettazione: 009/2017

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTEL MAGGIORE
Sondaggio:	S1
Campione:	SH1
Profondità prelievo [m]:	2.9 - 3
Prova:	Gr 1
Data prova:	29/03/2018

Vagliatura		
Diametro vaglio [mm]	Massa tratt. [g]	Massa tratt. [%]
101.6	0	0
63.5	0	0
38.1	0	0
25.4	0	0
19.1	0	0
9.53	0	0
4.75	0.2	0.0
2	1.8	0.4
1	1.1	0.3
0.59	0.6	0.1
0.42	0.3	0.1
0.25	0.2	0.0
0.177	0.2	0.0
0.125	0.3	0.1
0.075	2.0	0.5

Aerometria		
Tempo [min]	Temp. [°C]	Letture [-]
2	19.0	1.0235
4	19.0	1.0221
8	19.0	1.0209
15	19.5	1.0192
30	19.5	1.0178
61	19.0	1.0159
186	19.0	1.0134
258	19.5	1.0129
398	20.0	1.0121
4160	18.5	1.0101



Curva granulom.	
Diametro [mm]	Passante [%]
1.02.E+02	100.0
6.35.E+01	100.0
3.81.E+01	100.0
2.54.E+01	100.0
1.91.E+01	100.0
9.53.E+00	100.0
4.75.E+00	100.0
2.00.E+00	99.5
1.00.E+00	99.3
5.90.E-01	99.1
4.20.E-01	99.1
2.50.E-01	99.0
1.77.E-01	99.0
1.25.E-01	98.9
7.50.E-02	98.5
3.25.E-02	90.4
2.34.E-02	83.6
1.68.E-02	77.8
1.24.E-02	70.2
8.87.E-03	63.4
6.39.E-03	53.7
3.75.E-03	41.6
3.17.E-03	39.7
2.55.E-03	36.4
8.23.E-04	25.1
-	-
-	-

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	2.90	3.00	433.6	VIA UMIDA	98	-	0	3	62	34	32	10	7.9.E-03	5.4.E-03

NOTE:

GS= 2.700

La soluzione disperdente è stata preparata il 21/08/2017



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

Sperimentatore: Diaby
Direttore: Saccenti
Data emissione: 18/04/2018
Rev.

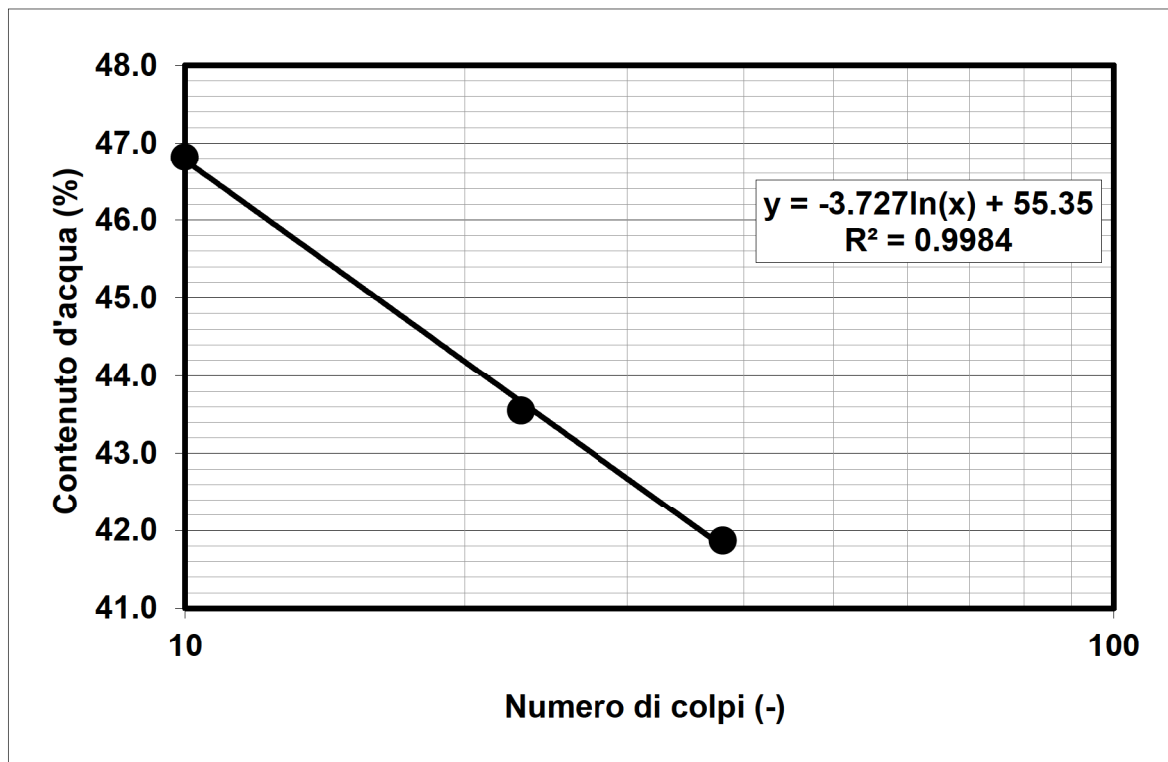
Committente: Unione Comuni Reno Galliera
Cantiere: CASTELMAGGIORE
Sondaggio: S1
Campione: SH1
Profondità prova [m]: 2.90 - 3.00
Prova: LLP1
Data prova: 26/03/2018

Normativa di riferimento: ASTM D4318
N° certificato di prova:
N° verbale di accettazione: 009/2017

Limite Liquido			
	prova 1	prova 2	prova 3
numero colpi	23	10	38
massa tara (g)	22.12	22.20	22.65
massa umido + tara (g)	81.88	76.52	71.38
massa secco + tara (g)	63.75	59.20	57.00
umidità (%)	43.55	46.81	41.86

Limite Plastico		
massa tara (g)	21.93	22.44
massa umido + tara (g)	36.48	38.17
massa secco + tara (g)	33.85	35.31
umidità (%)	22.06	22.22

LL (%)	42.9
LP (%)	22.1
IP (%)	20.8



Note:



Via Pastrengo, 9 - 24068 Seriate (Bg) -
tel. 035 303120 - fax 035 290388 -
Email: ismgeo@ismgeo.it

**DESCRIZIONE CAMPIONE RIMANEGGIATO E
CARATTERISTICHE GENERALI**

037019P244SM319

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

rev.	data emiss.	sperimentatore	direttore
0	23/04/2018	Angeloni	Saccenti

N° verbale accettazione: 009/2017

N° certificato di prova:

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	C1
Profondità prelievo [m]:	7.50 - 7.80
Prova:	Dc
Data fine descrizione:	23/04/2018

Dati Generali del Campione

Tipo contenitore:	Sacchetto PVC
Forma campione	-
Dimensioni Campione:	$\Phi =$ - cm L= - cm
Classe del terreno:	1

Descrizione

(Normativa di riferimento: AGI 1977)

Limo con argilla debolmente sabbioso

Risultati caratteristiche generali

Prova	Risultato della prova	Normativa di riferimento	N° certificato di prova
Limite liquido (%)	49.9	ASTM D4318/95	
Limite plastico (%)	21.4	ASTM D4318/95	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
Gr 1	-	ASTM D422/90	

Note:

-

rev.	data emiss.	sperimentatore	direttore
0	23/04/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D422/07

Classificazione di riferimento: AGI 1977

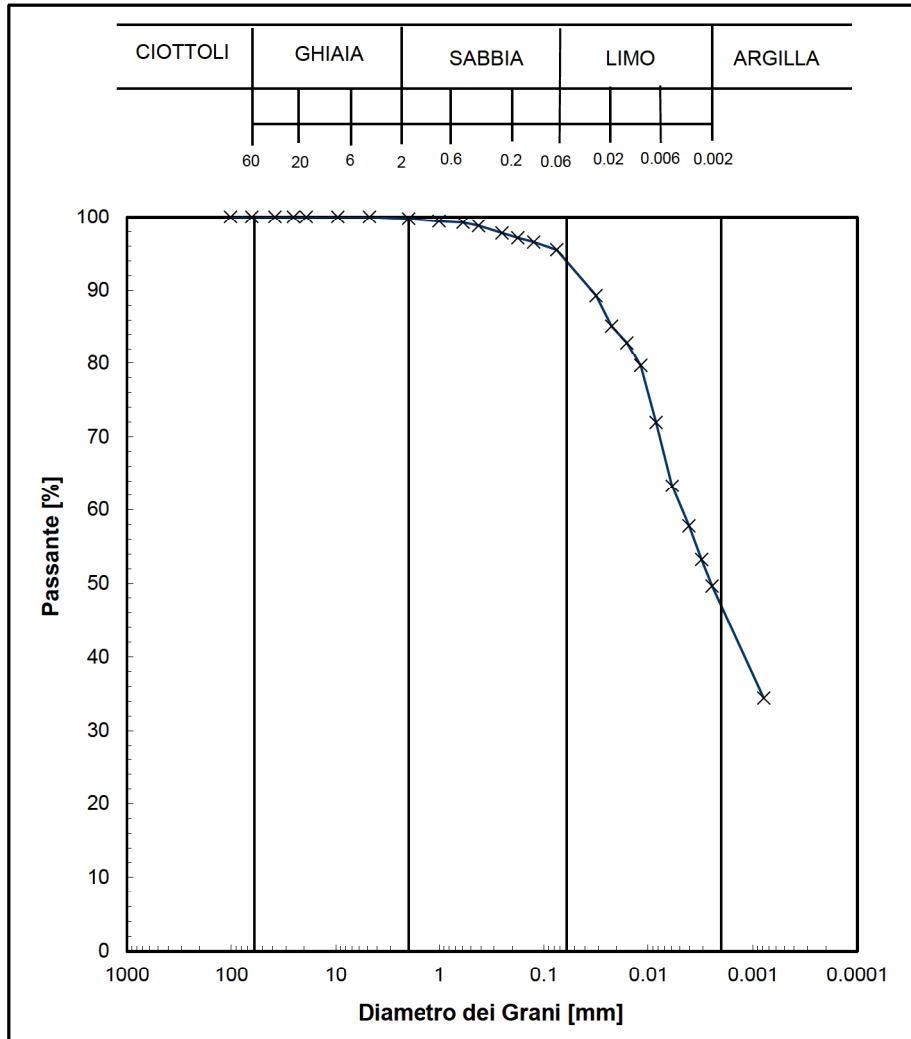
N° certificato di prova:

N° verbale di accettazione: 009/2017

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	C1
Profondità prelievo [m]:	7.5 - 7.8
Prova:	Gr 1
Data prova:	11/04/2018

Vagliatura		
Diametro vaglio [mm]	Massa tratt. [g]	Massa tratt. [%]
101.6	0	0
63.5	0	0
38.1	0	0
25.4	0	0
19.1	0	0
9.53	0	0
4.75	0	0
2	0.7	0.2
1	0.9	0.3
0.59	0.6	0.2
0.42	1.2	0.4
0.25	2.8	1.0
0.177	1.8	0.7
0.125	1.6	0.6
0.075	3.0	1.1

Aerometria		
Tempo [min]	Temp. [°C]	Letture [-]
2	21.0	1.0240
4	21.0	1.0231
8	21.0	1.0226
15	21.0	1.0219
30	21.5	1.0201
64	21.5	1.0182
137	21.5	1.0170
243	21.5	1.0160
389	22.0	1.0151
4116	21.0	1.0120



Curva granulom.	
Diametro [mm]	Passante [%]
1.02.E+02	100.0
6.35.E+01	100.0
3.81.E+01	100.0
2.54.E+01	100.0
1.91.E+01	100.0
9.53.E+00	100.0
4.75.E+00	100.0
2.00.E+00	99.8
1.00.E+00	99.4
5.90.E-01	99.2
4.20.E-01	98.8
2.50.E-01	97.8
1.77.E-01	97.1
1.25.E-01	96.5
7.50.E-02	95.5
3.15.E-02	89.3
2.25.E-02	85.2
1.60.E-02	82.9
1.18.E-02	79.7
8.43.E-03	72.0
5.89.E-03	63.3
4.07.E-03	57.8
3.09.E-03	53.2
2.45.E-03	49.6
7.85.E-04	34.4
-	-
-	-

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	7.50	7.80	278.5	VIA UMIDA	95	-	0	6	47	47	33	8	4.7.E-03	2.5.E-03

NOTE:

GS= 2.700

La soluzione disperdente è stata preparata il 21/08/2017



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

Sperimentatore: Diaby
Direttore: Saccenti
Data emissione: 18/04/2018
Rev.

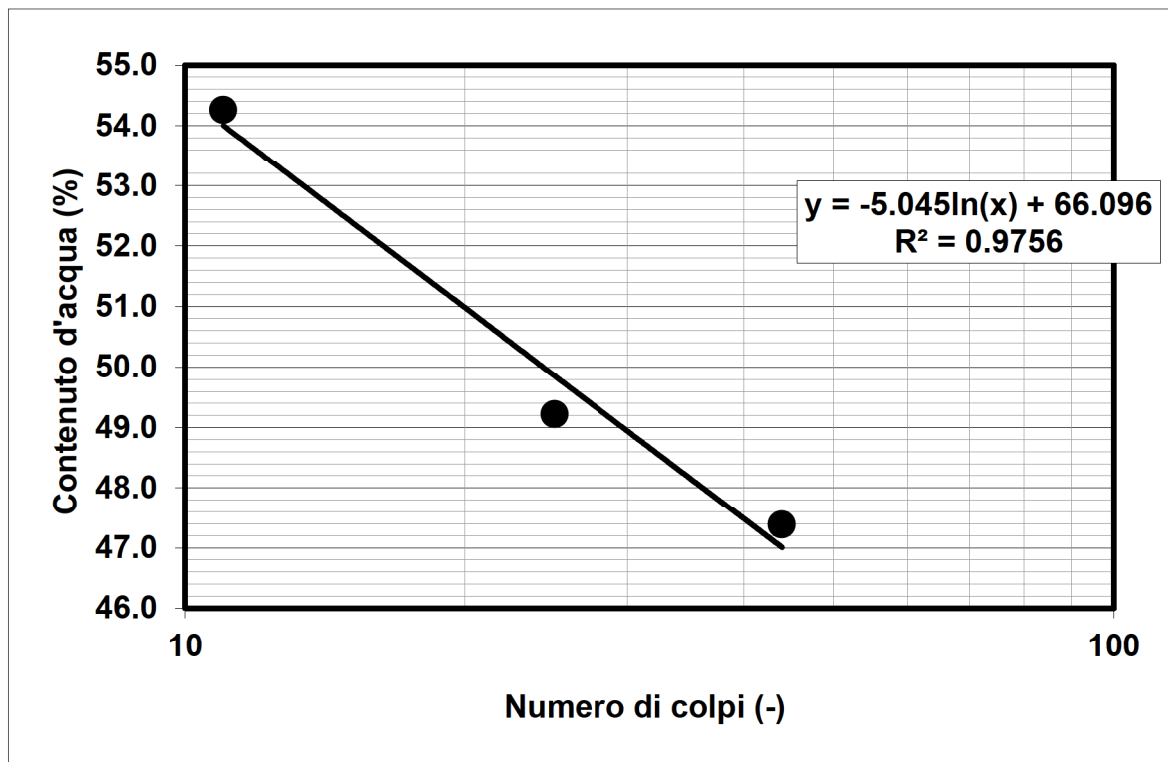
Normativa di riferimento: ASTM D4318
N° certificato di prova:
N° verbale di accettazione: 009/2017

Committente: Unione Comuni Reno Galliera
Cantiere: CASTELMAGGIORE
Sondaggio: S1
Campione: C1
Profondità prova [m]: 7.50 - 7.80
Prova: LLP1
Data prova: 09/04/2018

Limite Liquido			
	prova 1	prova 2	prova 3
numero colpi	11	25	44
massa tara (g)	22.14	22.24	21.94
massa umido + tara (g)	80.99	71.90	77.99
massa secco + tara (g)	60.29	55.52	59.97
umidità (%)	54.26	49.22	47.38

Limite Plastico		
massa tara (g)	22.19	22.52
massa umido + tara (g)	40.09	40.99
massa secco + tara (g)	36.93	37.73
umidità (%)	21.44	21.43

LL (%)	49.9
LP (%)	21.4
IP (%)	28.4



Note:



Via Pastrengo, 9 - 24068 Seriate (Bg) -
tel. 035 303120 - fax 035 290388 -
Email: ismgeo@ismgeo.it

DESCRIZIONE CAMPIONE RIMANEGGIATO E
037019P244SM320 CARATTERISTICHE GENERALI

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

rev.	data emiss.	sperimentatore	direttore
0	24/04/2018	Angeloni	Saccenti

N° verbale accettazione: 009/2017

N° certificato di prova:

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	C2
Profondità prelievo [m]:	10.70 - 11.00
Prova:	Dc
Data fine descrizione:	24/04/2018

Dati Generali del Campione

Tipo contenitore:	Sacchetto PVC
Forma campione	-
Dimensioni Campione:	$\Phi =$ - cm L= - cm
Classe del terreno:	1

Descrizione

(Normativa di riferimento: AGI 1977)

Limo argilloso debolmente sabbioso con tracce di ghiaia

Risultati caratteristiche generali

Prova	Risultato della prova	Normativa di riferimento	N° certificato di prova
Limite liquido (%)	34.7	ASTM D4318/95	
Limite plastico (%)	21.3	ASTM D4318/95	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
Gr 1	-	ASTM D422/90	

Note:

-

rev.	data emiss.	sperimentatore	direttore
0	24/04/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D422/07

Classificazione di riferimento: AGI 1977

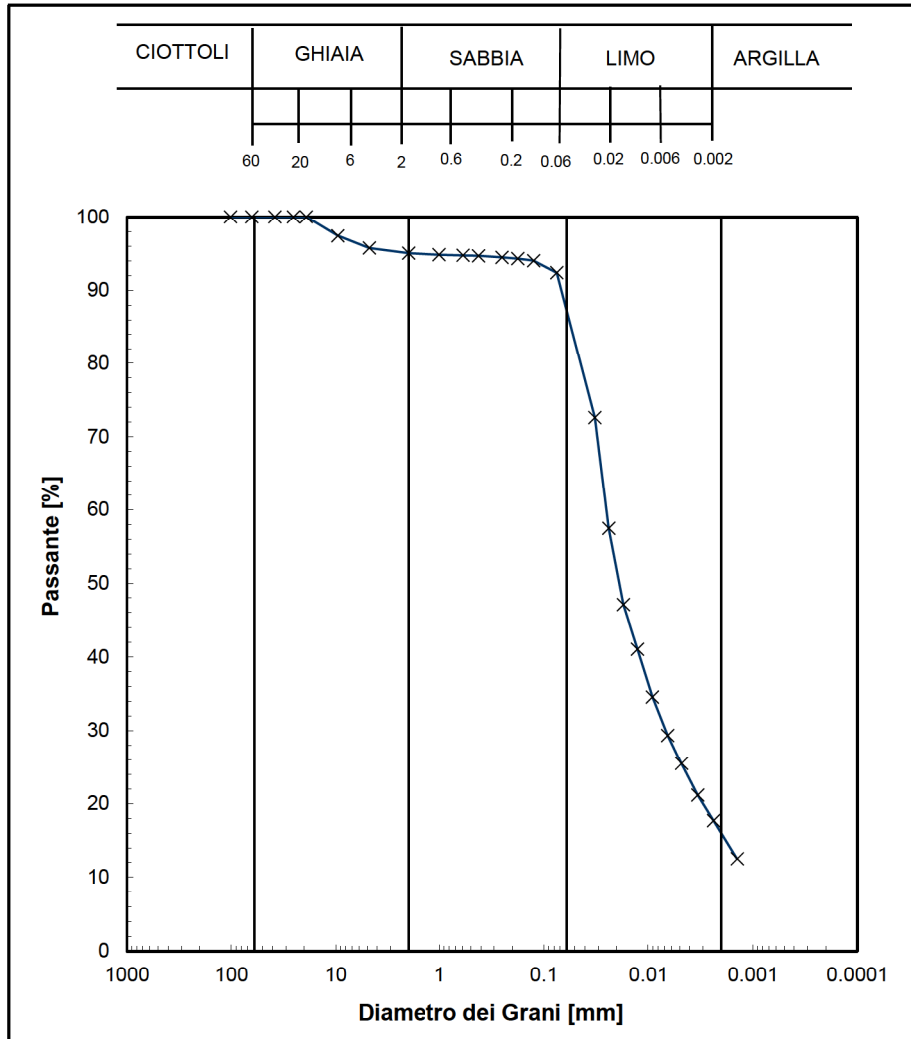
N° certificato di prova:

N° verbale di accettazione: 009/2017

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	C2
Profondità prelievo [m]:	10.7 - 11
Prova:	Gr 1
Data prova:	11/04/2018

Vagliatura		
Diametro vaglio [mm]	Massa tratt. [g]	Massa tratt. [%]
101.6	0	0
63.5	0	0
38.1	0	0
25.4	0	0
19.1	0	0
9.53	10.6	2.6
4.75	7.0	1.7
2	2.9	0.7
1	0.9	0.2
0.59	0.3	0.1
0.42	0.3	0.1
0.25	0.9	0.2
0.177	0.7	0.2
0.125	1.1	0.3
0.075	6.7	1.6

Aerometria		
Tempo [min]	Temp. [°C]	Letture [-]
2	21.0	1.0210
4	21.0	1.0175
8	21.0	1.0151
15	21.5	1.0136
30	21.5	1.0121
60	21.5	1.0109
112	21.5	1.0100
230	22.0	1.0089
465	22.0	1.0081
1367	21.5	1.0070



Curva granulom.	
Diametro [mm]	Passante [%]
1.02.E+02	100.0
6.35.E+01	100.0
3.81.E+01	100.0
2.54.E+01	100.0
1.91.E+01	100.0
9.53.E+00	97.4
4.75.E+00	95.7
2.00.E+00	95.0
1.00.E+00	94.8
5.90.E-01	94.7
4.20.E-01	94.7
2.50.E-01	94.5
1.77.E-01	94.3
1.25.E-01	94.0
7.50.E-02	92.4
3.24.E-02	72.6
2.38.E-02	57.5
1.72.E-02	47.1
1.27.E-02	41.0
9.10.E-03	34.5
6.51.E-03	29.4
4.80.E-03	25.5
3.36.E-03	21.1
2.38.E-03	17.7
1.41.E-03	12.5
-	-
-	-

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	10.70	11.00	412.9	VIA UMIDA	92	-	5	8	71	16	34	33	2.5.E-02	1.9.E-02

NOTE:

GS= 2.700

La soluzione disperdente è stata preparata il 21/08/2017



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

Sperimentatore: Diaby
Direttore: Saccenti
Data emissione: 18/04/2018
Rev.

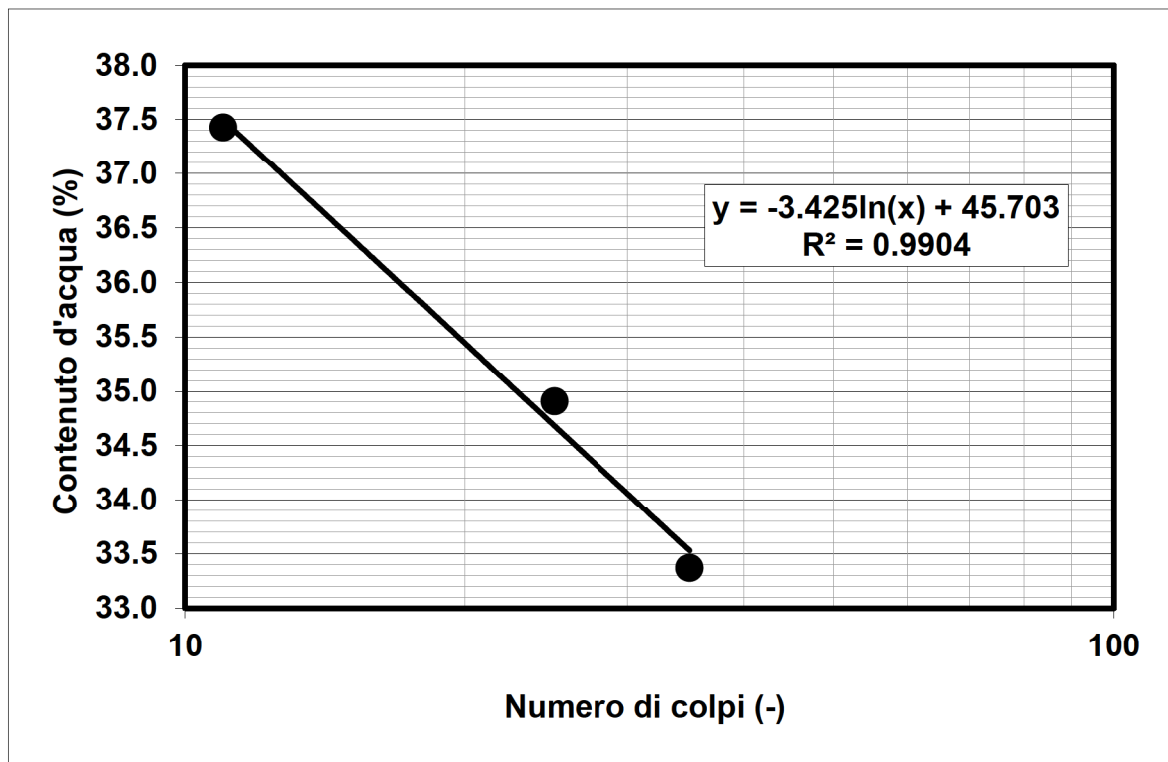
Normativa di riferimento: ASTM D4318
N° certificato di prova:
N° verbale di accettazione: 009/2017

Committente: Unione Comuni Reno Galliera
Cantiere: CASTELMAGGIORE
Sondaggio: S1
Campione: C2
Profondità prova [m]: 10.70 - 11.00
Prova: LLP1
Data prova: 09/04/2018

Limite Liquido			
	prova 1	prova 2	prova 3
numero colpi	11	25	35
massa tara (g)	22.20	22.27	22.27
massa umido + tara (g)	77.72	80.05	74.43
massa secco + tara (g)	62.60	65.10	61.38
umidità (%)	37.43	34.91	33.37

Limite Plastico		
massa tara (g)	22.31	21.63
massa umido + tara (g)	37.31	37.28
massa secco + tara (g)	34.68	34.52
umidità (%)	21.26	21.41

LL (%)	34.7
LP (%)	21.3
IP (%)	13.3



Note:



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

rev.	data emiss.	sperimentatore	direttore
0	08/05/2018	Ranzini	Saccenti

N° verbale di accettazione: 009/2017

Dati Generali di Campionamento

Data prelievo: 20/03/2017
 Attrezzatura sondaggio: -
 Attrezzatura prelievo: -
 Modalità prelievo: -

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH2
Profondità prelievo [m]:	15.5-16
Prova:	
Data fine descrizione:	08/05/2018

N° certificato di prova:

Dati Generali del Campione

Data arrivo in laboratorio:	22/03/2017	Tipo contenitore:	FUSTELLA ACCIAIO
Data estrusione campione:	22/03/2018	Forma campione:	CILINDRICO
Condizioni contenitore:	BUONE	Dimensioni Campione:	Φ= 8.5 cm L= 42 cm
		Classe del terreno:	CLASSE 4

Descrizione

15.58 m - 16.00 m: Limo con argilla con tracce di sabbia di colore grigio scuro (5Y 4/1) con chiazze ossidate color ocra e tracce di reazione all'HCl.

Schizzo	Penetrometro		Scissometro		Prove eseguite
	+	//	+	//	
	[MPa]	[MPa]	[MPa]	[MPa]	
15.45					RC1 γ1 w1 LLP1 Gr1 Gs1
15.49					
15.54					
15.58					
15.62	0.13				
15.67					
15.71	0.15				
15.75					
15.79					
15.84	0.17				
15.88					
15.92	0.15				
15.97					
16.01		0.12			
16.05					
16.10					
16.14					
16.18					
16.22					
16.27					
16.31					
16.35					
16.40					
16.44					

Richiami

RC = Colonna risonante
 γ = Peso di volume
 w = Umidità
 LLP = Limiti di liquidità e plasticità
 Gr = Analisi Granulometrica
 Gs = Peso specifico dei grani



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

rev.	data emiss.	sperimentatore	direttore
0	08/05/2018	Ranzini	Saccenti

N° verbale di accettazione: 009/2017

Committente: Unione Comuni Reno Galliera
Cantiere: CASTELMAGGIORE
Sondaggio: S1
Campione: SH2
Profondità prelievo [m]: 15.5-16
Prova:
Data fine descrizione: 08/05/2018

Prove	Profondità	Risultati prove	Riferimento procedure	N° certificato di prova
γ_1	15.70m - 15.80m	Peso di volume = 0.0 [kN/m ³]	PT-LMT-00021 REV. 1	
w ₁	15.70m - 15.80m	Umidità = 0 [%]	PT-LMT-00016 REV. 0	
LLP1	15.70m - 15.80m	Limite Liquido = 40 [%] Limite Plastico = 22 [%]	PT-LMT-00020 REV. 1	
Gs1	15.70m - 15.80m	Peso specifico dei grani = 2.712 [-]	PT-LMT-00019 REV. 1	

Rev	data emiss.	eseguito da	elaborato da
0	11/05/2018	Sirtoli	Sirtoli

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH2
Profondità prelievo [m]:	15.50 – 16.00
Data prova:	



rev.	data emiss.	sperimentatore	direttore
0	06/04/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D422/07

Classificazione di riferimento: AGI 1977

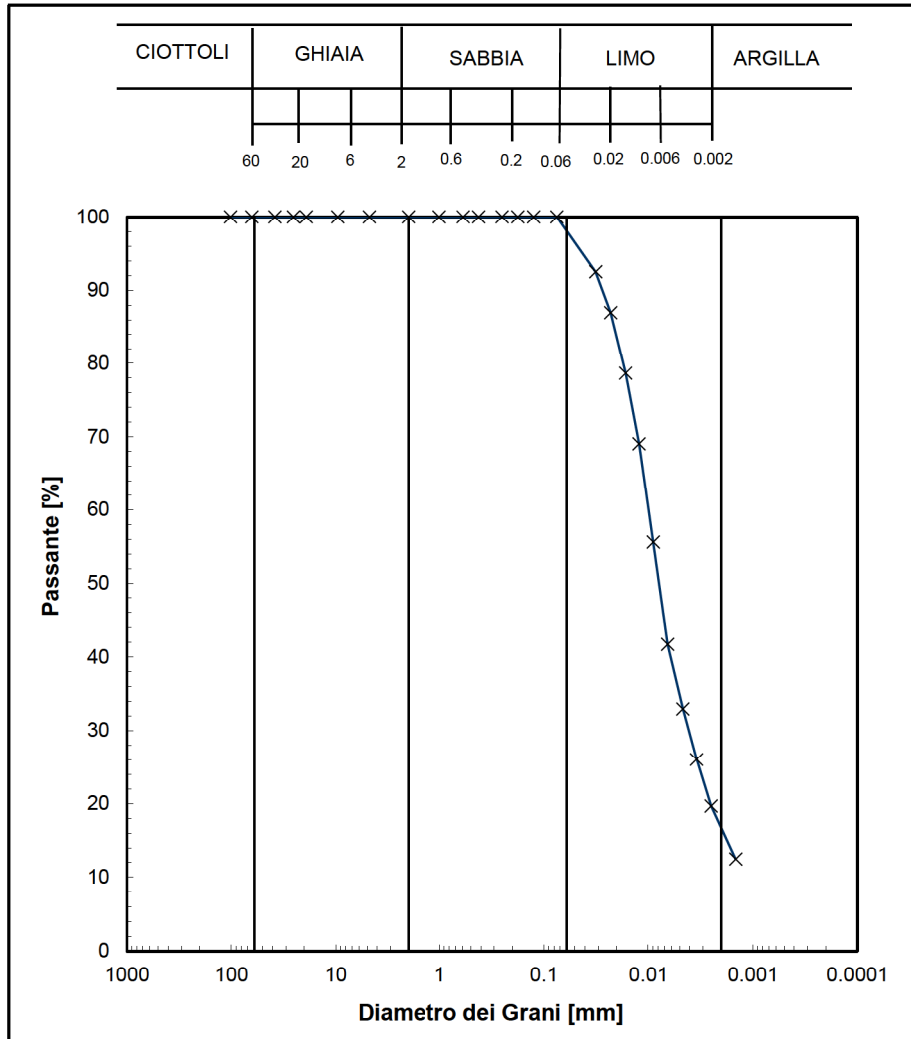
N° certificato di prova:

N° verbale di accettazione: 009/2017

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH2
Profondità prelievo [m]:	15.7 - 15.85
Prova:	Gr 1
Data prova:	29/03/2018

Vagliatura		
Diametro vaglio [mm]	Massa tratt. [g]	Massa tratt. [%]
101.6	0	0
63.5	0	0
38.1	0	0
25.4	0	0
19.1	0	0
9.53	0	0
4.75	0	0
2	0	0
1	0	0
0.59	0	0
0.42	0	0
0.25	0	0
0.177	0	0
0.125	0	0
0.075	0	0

Aerometria		
Tempo [min]	Temp. [°C]	Letture [-]
2	19.5	1.0250
4	19.5	1.0238
8	19.5	1.0220
15	20.0	1.0198
30	19.5	1.0170
60	19.5	1.0140
122	19.5	1.0121
230	19.5	1.0106
442	20.0	1.0091
1383	18.5	1.0079



Curva granulom.	
Diametro [mm]	Passante [%]
1.02.E+02	100.0
6.35.E+01	100.0
3.81.E+01	100.0
2.54.E+01	100.0
1.91.E+01	100.0
9.53.E+00	100.0
4.75.E+00	100.0
2.00.E+00	100.0
1.00.E+00	100.0
5.90.E-01	100.0
4.20.E-01	100.0
2.50.E-01	100.0
1.77.E-01	100.0
1.25.E-01	100.0
7.50.E-02	100.0
3.18.E-02	92.5
2.28.E-02	87.0
1.65.E-02	78.7
1.22.E-02	69.1
8.97.E-03	55.6
6.53.E-03	41.7
4.66.E-03	32.9
3.44.E-03	26.0
2.50.E-03	19.7
1.46.E-03	12.4
-	-
-	-

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	15.70	15.85	333.9	VIA UMIDA	100	-	-	2	81	17	34	-	9.9.E-03	7.9.E-03

NOTE:

GS= 2.700

La soluzione disperdente è stata preparata il 21/08/2017



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

Sperimentatore: Diaby
Direttore: Saccenti
Data emissione: 18/04/2018
Rev.

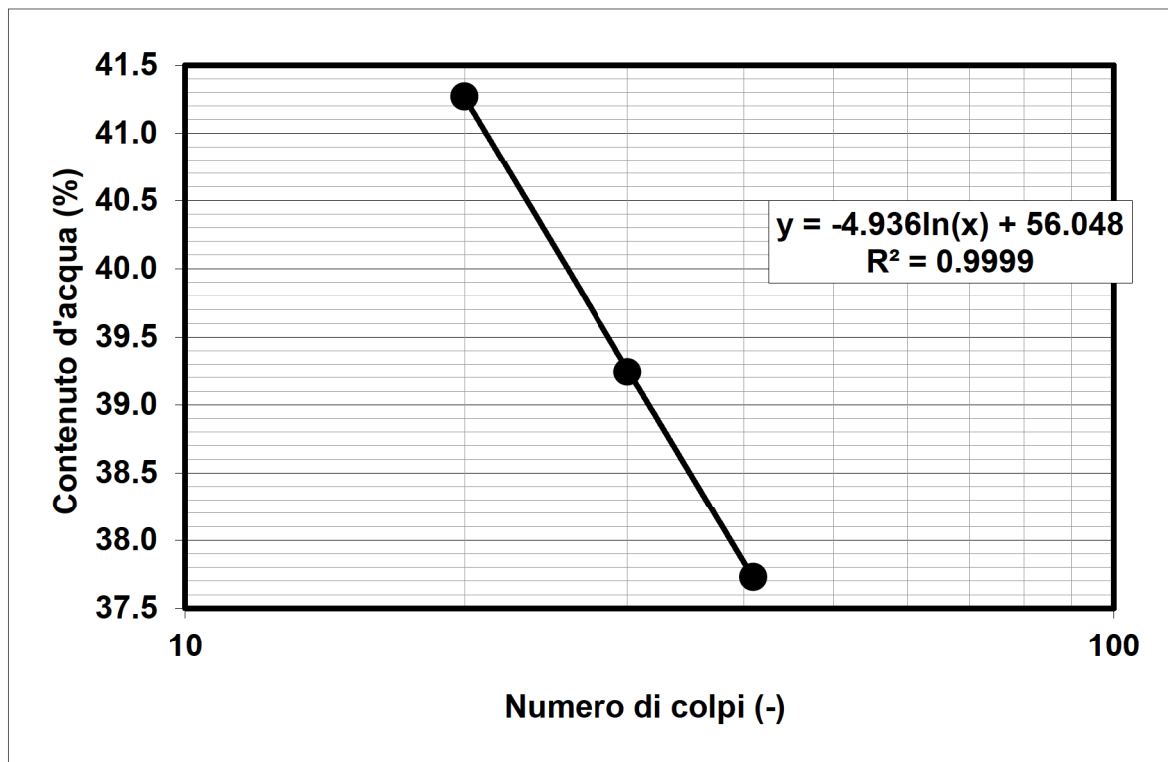
Normativa di riferimento: ASTM D4318
N° certificato di prova:
N° verbale di accettazione: 009/2017

Committente: Unione Comuni Reno Galliera
Cantiere: CASTELMAGGIORE
Sondaggio: S1
Campione: SH2
Profondità prova [m]: 15.70 - 15.80
Prova: LLP1
Data prova: 26/03/2018

Limite Liquido			
	prova 1	prova 2	prova 3
numero colpi	41	20	30
massa tara (g)	22.57	22.62	22.30
massa umido + tara (g)	62.47	80.71	66.69
massa secco + tara (g)	51.54	63.74	54.18
umidità (%)	37.73	41.27	39.24

Limite Plastico		
massa tara (g)	22.30	22.14
massa umido + tara (g)	36.60	37.00
massa secco + tara (g)	34.05	34.33
umidità (%)	21.70	21.90

LL (%)	40.2
LP (%)	21.8
IP (%)	18.4



Note:

rev.	data emiss.	sperimentatore	direttore
0	11/05/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

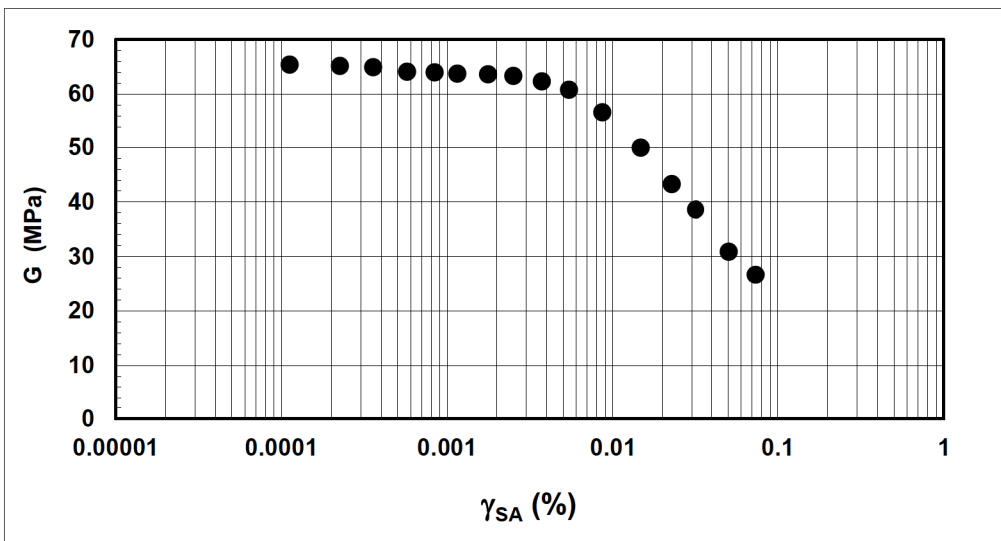
N° certificato di prova:

N° verbale di accettazione: 009/2017

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH2
Profondità prova [m]:	16.70 - 16.80
Prova:	RC
Provino:	1
Data prova:	06/04/2018

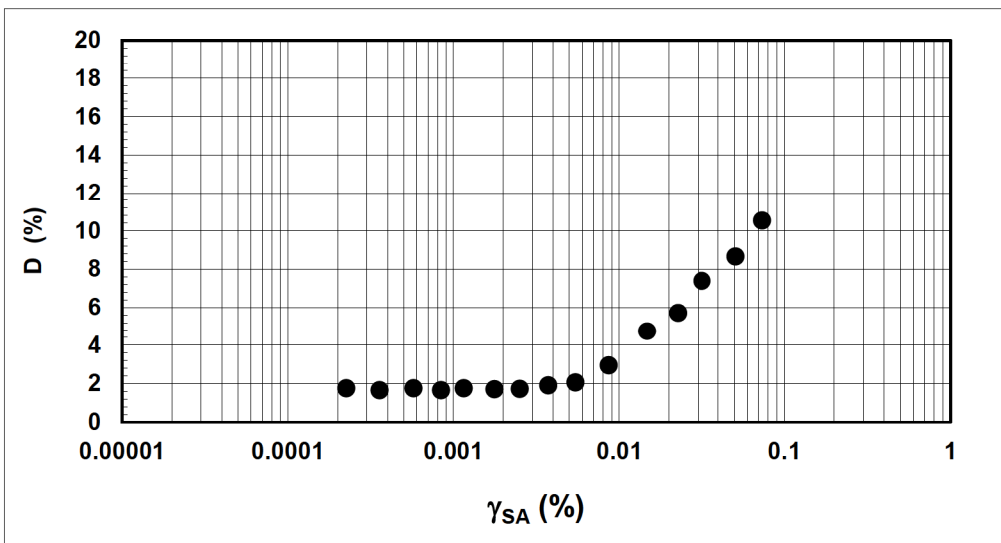
Dati generali dei provini

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	100.20	18.57	31.2	0.872	126	126	1.0	300.0	96.00	49.7	99.7	18.82	30.9	0.842	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	11/05/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

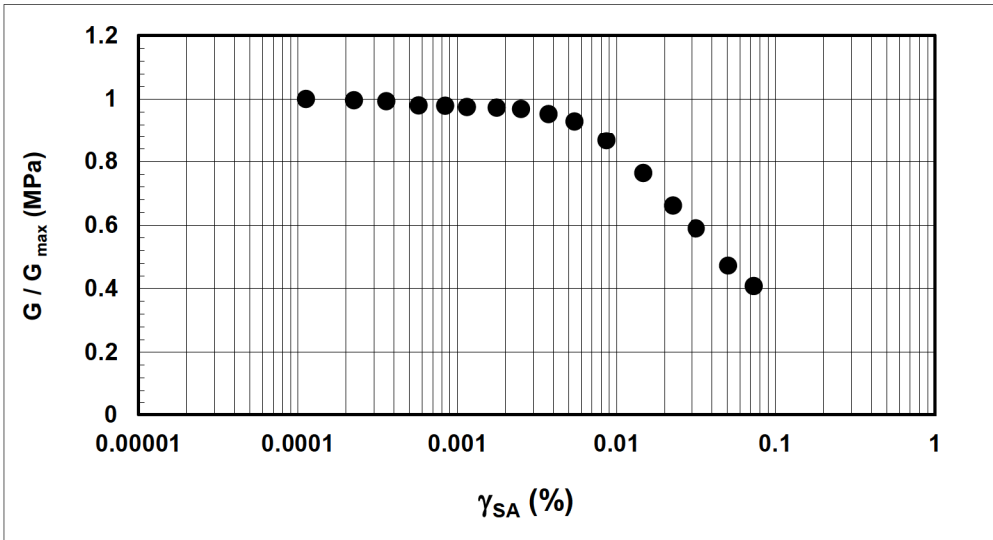
N° certificato di prova:

N° verbale di accettazione: 009/2017

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH2
Profondità prova [m]:	16.70 - 16.80
Prova:	RC
Provino:	1
Data prova:	06/04/2018

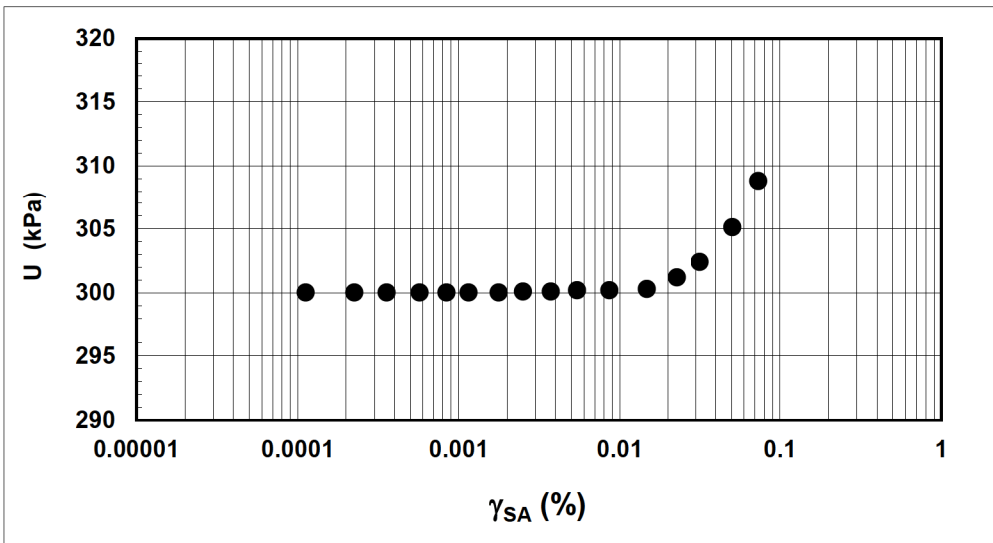
Dati generali dei provini

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		
mm	mm	kN/m ³	%	-	kPa	kPa	-	kPa	-	mm	mm	kN/m ³	%	-	%		
50.00	100.20	18.57	31.2	0.872	126	126	1.0	300.0	96.00	49.7	99.7	18.82	30.9	0.8	99	tipo di provino	INDISTURBATO
																metodo di preparazione	FUSTELLAZIONE
																superficie di appoggio	PIETRA POROSA
																eccitazione	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	11/05/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

N° certificato di prova:

N° verbale di accettazione: 009/2017

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH2
Profondità prova [m]:	16.70 - 16.80
Prova:	RC
Provino:	1
Data prova:	06/04/2018

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	100.20	18.57	31.2	0.872	126	126	1.0	300.0	96.00	49.7	99.7	18.82	30.9	0.842	superficie di appoggio	INDISTURBATO
															eccitazione	PIETRA POROSA
																TORSIONALE

Valori numerici

G	G/G _{MAX}	γ	D	U
(MPa)	(-)	(%)	(%)	(kPa)
65.35	1.000	0.00011		300.0
65.11	0.996	0.00023	1.75	300.0
64.88	0.993	0.00036	1.65	300.0
64.07	0.980	0.00057	1.75	300.0
63.98	0.979	0.00084	1.64	300.0
63.75	0.975	0.00115	1.74	300.0
63.61	0.973	0.00177	1.71	300.0
63.33	0.969	0.00251	1.71	300.1
62.28	0.953	0.00373	1.90	300.1
60.76	0.930	0.00544	2.06	300.2
56.62	0.866	0.00865	2.94	300.2
49.90	0.764	0.01472	4.73	300.3
43.27	0.662	0.02263	5.71	301.2
38.58	0.590	0.03173	7.37	302.4
30.86	0.472	0.05077	8.66	305.1
26.65	0.408	0.07350	10.53	308.8

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:



Via Pastrengo, 9 - 24068 Seriate (Bg) -
tel. 035 303120 - fax 035 290388 -
Email: ismgeo@ismgeo.it

**DESCRIZIONE CAMPIONE RIMANEGGIATO E
CARATTERISTICHE GENERALI**

037019P244SM323

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

rev.	data emiss.	sperimentatore	direttore
0	24/04/2018	Angeloni	Saccenti

N° verbale accettazione: 009/2017

N° certificato di prova:

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	C3
Profondità prelievo [m]:	20.00 - 20.30
Prova:	Dc
Data fine descrizione:	24/04/2018

Dati Generali del Campione

Tipo contenitore:	Sacchetto PVC
Forma campione	-
Dimensioni Campione:	$\Phi =$ - cm L= - cm
Classe del terreno:	1

Descrizione

(Normativa di riferimento: AGI 1977)

Argilla con limo

Risultati caratteristiche generali

Prova	Risultato della prova	Normativa di riferimento	N° certificato di prova
Limite liquido (%)	77.8	ASTM D4318/95	
Limite plastico (%)	31.4	ASTM D4318/95	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
Gr 1	-	ASTM D422/90	

Note:

-

rev.	data emiss.	sperimentatore	direttore
0	24/04/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D422/07

Classificazione di riferimento: AGI 1977

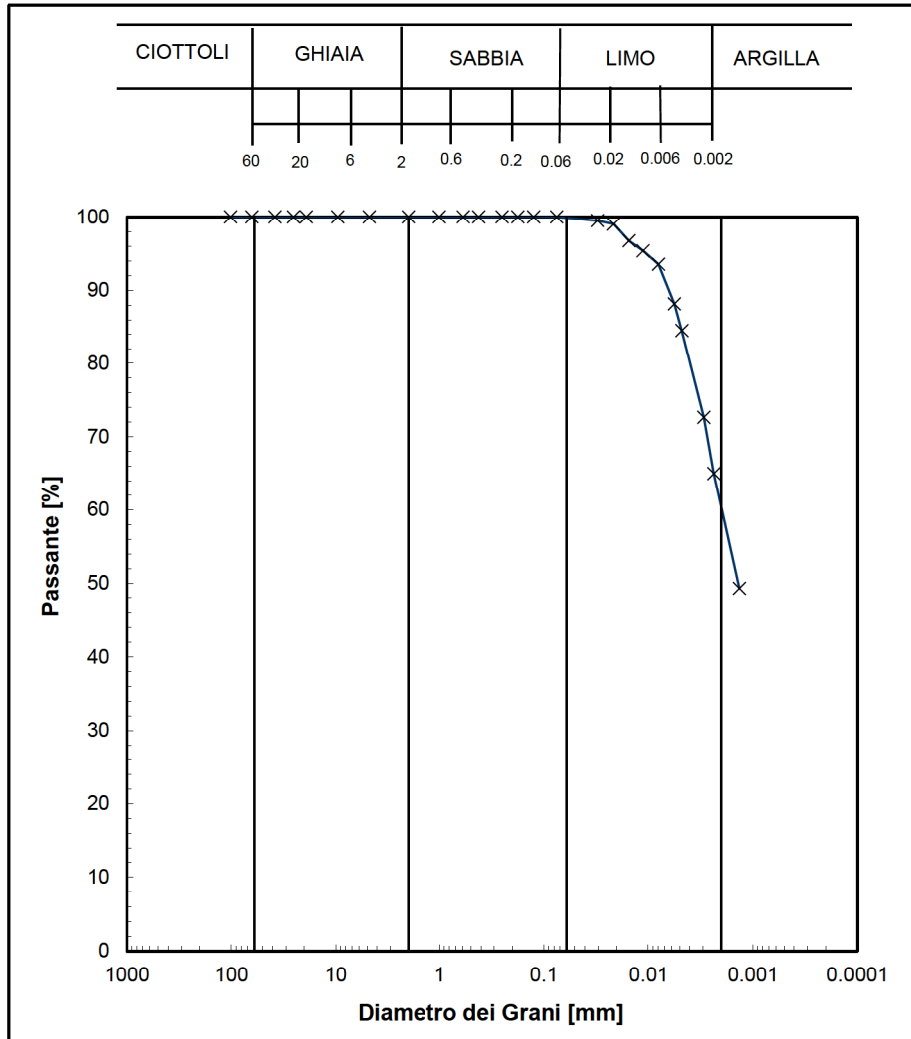
N° certificato di prova:

N° verbale di accettazione: 009/2017

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	C3
Profondità prelievo [m]:	20 - 20.3
Prova:	Gr 1
Data prova:	11/04/2018

Vagliatura		
Diametro vaglio [mm]	Massa tratt. [g]	Massa tratt. [%]
101.6	0	0
63.5	0	0
38.1	0	0
25.4	0	0
19.1	0	0
9.53	0	0
4.75	0	0
2	0	0
1	0	0
0.59	0	0
0.42	0	0
0.25	0	0
0.177	0	0
0.125	0	0
0.075	0	0

Aerometria		
Tempo [min]	Temp. [°C]	Letture [-]
2	21.5	1.0260
4	21.5	1.0259
8	21.5	1.0254
15	21.5	1.0251
30	21.5	1.0247
61	22.0	1.0234
87	22.0	1.0226
242	22.0	1.0200
387	22.5	1.0182
1301	21.5	1.0150



Curva granulom.	
Diametro [mm]	Passante [%]
1.02.E+02	100.0
6.35.E+01	100.0
3.81.E+01	100.0
2.54.E+01	100.0
1.91.E+01	100.0
9.53.E+00	100.0
4.75.E+00	100.0
2.00.E+00	100.0
1.00.E+00	100.0
5.90.E-01	100.0
4.20.E-01	100.0
2.50.E-01	100.0
1.77.E-01	100.0
1.25.E-01	100.0
7.50.E-02	100.0
3.04.E-02	99.5
2.15.E-02	99.0
1.53.E-02	96.8
1.12.E-02	95.4
7.98.E-03	93.6
5.64.E-03	88.2
4.77.E-03	84.5
2.94.E-03	72.6
2.35.E-03	65.0
1.35.E-03	49.3
-	-
-	-

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	20.00	20.30	215.6	VIA UMIDA	100	-	-	0	39	60	35	-	2.0.E-03	1.4.E-03

NOTE:

GS= 2.700

La soluzione disperdente è stata preparata il 21/08/2017



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

Sperimentatore: Diaby
Direttore: Saccenti
Data emissione: 18/04/2018
Rev.

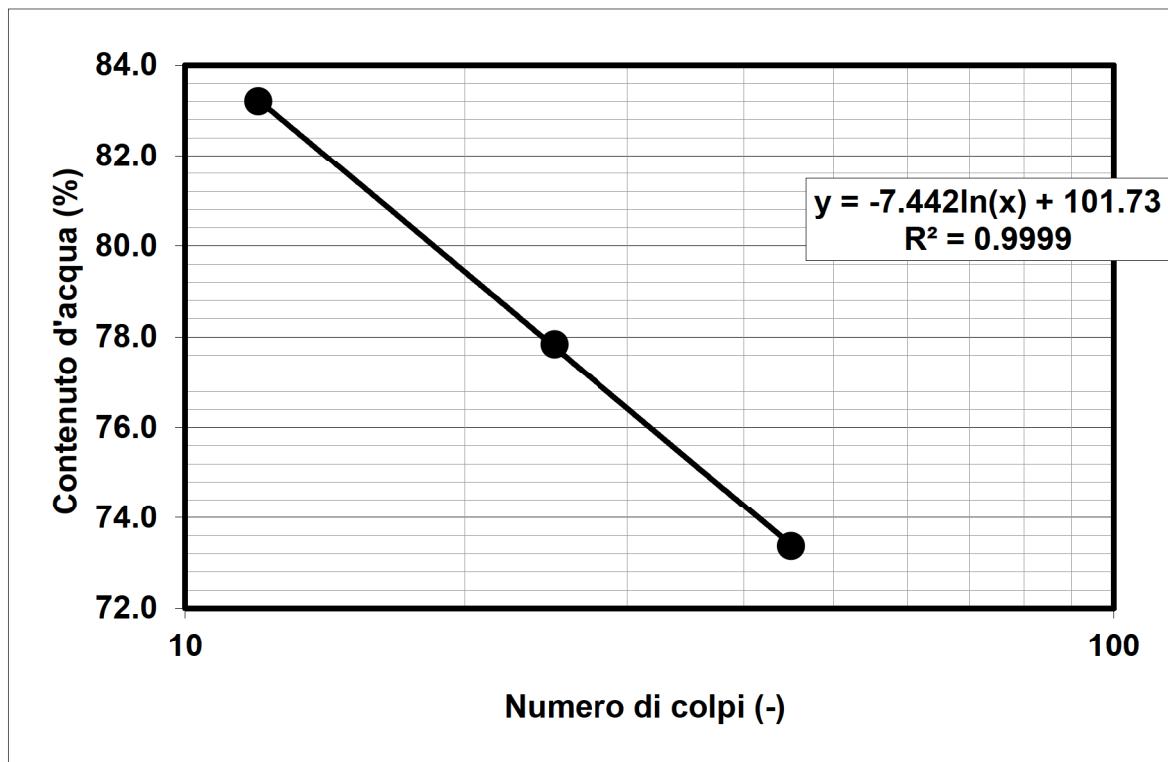
Committente: Unione Comuni Reno Galliera
Cantiere: CASTELMAGGIORE
Sondaggio: S1
Campione: C3
Profondità prova [m]: 20.00 - 20.30
Prova: LLP1
Data prova: 09/04/2018

Normativa di riferimento: ASTM D4318
N° certificato di prova:
N° verbale di accettazione: 009/2017

Limite Liquido			
	prova 1	prova 2	prova 3
numero colpi	12	25	45
massa tara (g)	21.92	22.19	22.13
massa umido + tara (g)	74.39	77.39	74.26
massa secco + tara (g)	50.56	53.23	52.20
umidità (%)	83.21	77.84	73.36

Limite Plastico		
massa tara (g)	22.59	22.10
massa umido + tara (g)	36.28	36.10
massa secco + tara (g)	33.01	32.75
umidità (%)	31.38	31.46

LL (%)	77.8
LP (%)	31.4
IP (%)	46.4



Note:



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

rev.	data emiss.	sperimentatore	direttore
0	08/05/2018	Ranzini	Saccenti

N° verbale di accettazione: 009/2017

Dati Generali di Campionamento

Data prelievo: 20/03/2017
 Attrezzatura sondaggio: -
 Attrezzatura prelievo: -
 Modalità prelievo: -

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH3
Profondità prelievo [m]:	25.5-26
Prova:	
Data fine descrizione:	08/05/2018

N° certificato di prova:

Dati Generali del Campione

Data arrivo in laboratorio:	22/03/2017	Tipo contenitore:	FUSTELLA ACCIAIO
Data estrusione campione:	22/03/2018	Forma campione:	CILINDRICO
Condizioni contenitore:	BUONE	Dimensioni Campione:	Φ= 8.5 cm L= 54 cm
		Classe del terreno:	CLASSE 4

Descrizione

25.46 m - 26.00 m: Argilla con limo di colore grigio (5Y 5/1) con chiazze di ossidazione e debole reazione all'HCl, passante gradualmente a circa 25.80 m a argilla limosa con sabbia fine con discreta reazione all'HCl.

Schizzo	Penetrometro		Scissometro		Prove eseguite
	+	//	+	//	
	[MPa]	[MPa]	[MPa]	[MPa]	
25.35					RC1 γ1 w1 Gs1 Gr1 LLP1
25.40					
25.45					
25.50					
25.55	0.18				
25.60					
25.65	0.18				
25.70					
25.75	0.17				
25.80					
25.85					
25.90					
25.95					
26.00					
26.05					
26.10					
26.15					
26.20					
26.25					
26.30					
26.35					
26.40					
26.45					
26.50					

Richiami

RC = Colonna risonante
 γ = Peso di volume
 w = Umidità
 Gs = Peso specifico dei grani
 Gr = Analisi Granulometrica
 LLP = Limiti di liquidità e plasticità



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

rev.	data emiss.	sperimentatore	direttore
0	08/05/2018	Ranzini	Saccenti

N° verbale di accettazione: 009/2017

Committente: Unione Comuni Reno Galliera
Cantiere: CASTELMAGGIORE
Sondaggio: S1
Campione: SH3
Profondità prelievo [m]: 25.5-26
Prova:
Data fine descrizione: 08/05/2018

Prove	Profondità	Risultati prove	Riferimento procedure	N° certificato di prova
γ_1	25.55m - 25.65m	Peso di volume = 0.0 [kN/m ³]	PT-LMT-00021 REV. 1	
w1	25.55m - 25.65m	Umidità = 0 [%]	PT-LMT-00016 REV. 0	
LLP1	25.55m - 25.70m	Limite Liquido = 58 [%] Limite Plastico = 23 [%]	PT-LMT-00020 REV. 1	
Gs1	25.55m - 25.65m	Peso specifico dei grani = 2.665 [-]	PT-LMT-00019 REV. 1	

Rev	data emiss.	eseguito da	elaborato da
0	11/05/2018	Sirtoli	Sirtoli

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH3
Profondità prelievo [m]:	25.50 – 26.00
Data prova:	





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

Sperimentatore: Diaby
Direttore: Saccenti
Data emissione: 18/04/2018
Rev.

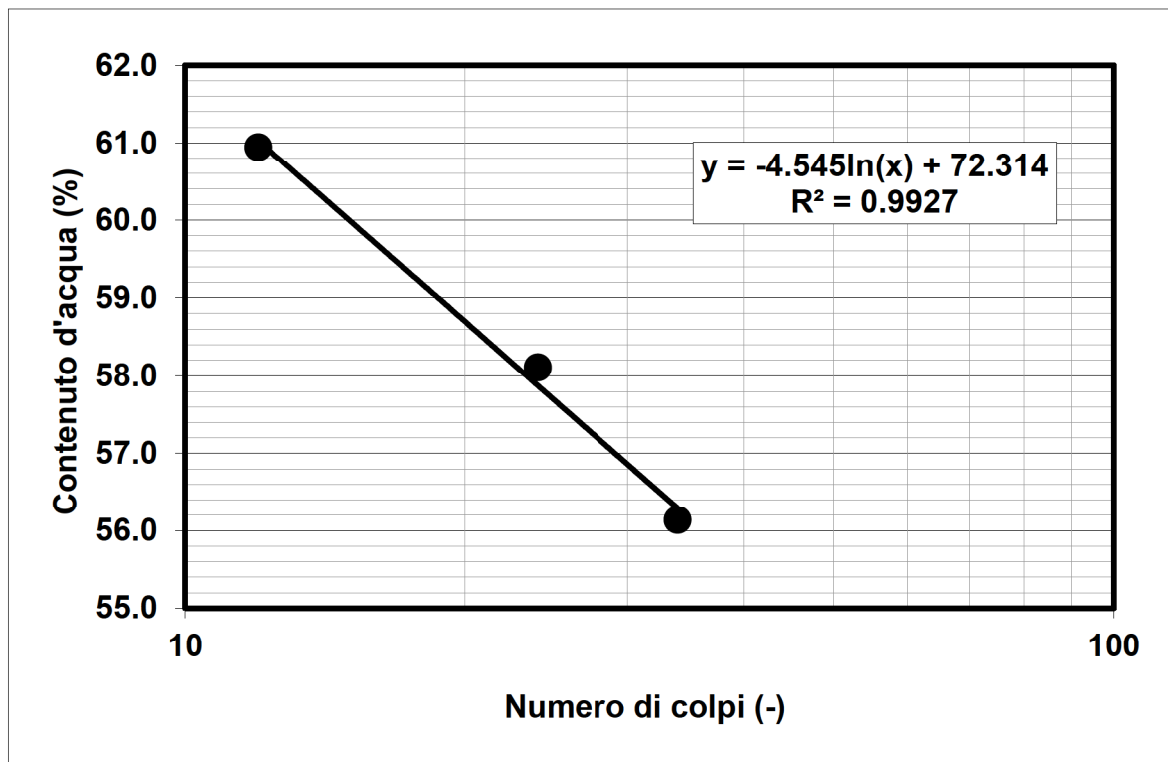
Normativa di riferimento: ASTM D4318
N° certificato di prova:
N° verbale di accettazione: 009/2017

Committente: Unione Comuni Reno Galliera
Cantiere: CASTELMAGGIORE
Sondaggio: S1
Campione: SH3
Profondità prova [m]: 25.55 - 25.70
Prova: LLP1
Data prova: 26/03/2018

Limite Liquido			
	prova 1	prova 2	prova 3
numero colpi	34	24	12
massa tara (g)	22.39	22.25	22.29
massa umido + tara (g)	79.05	75.99	78.33
massa secco + tara (g)	58.68	56.24	57.11
umidità (%)	56.13	58.11	60.94

Limite Plastico		
massa tara (g)	22.55	22.46
massa umido + tara (g)	37.75	36.55
massa secco + tara (g)	34.91	33.92
umidità (%)	22.98	22.95

LL (%) 57.7
LP (%) 23.0
IP (%) 34.7



Note:

rev.	data emiss.	sperimentatore	direttore
0	14/05/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

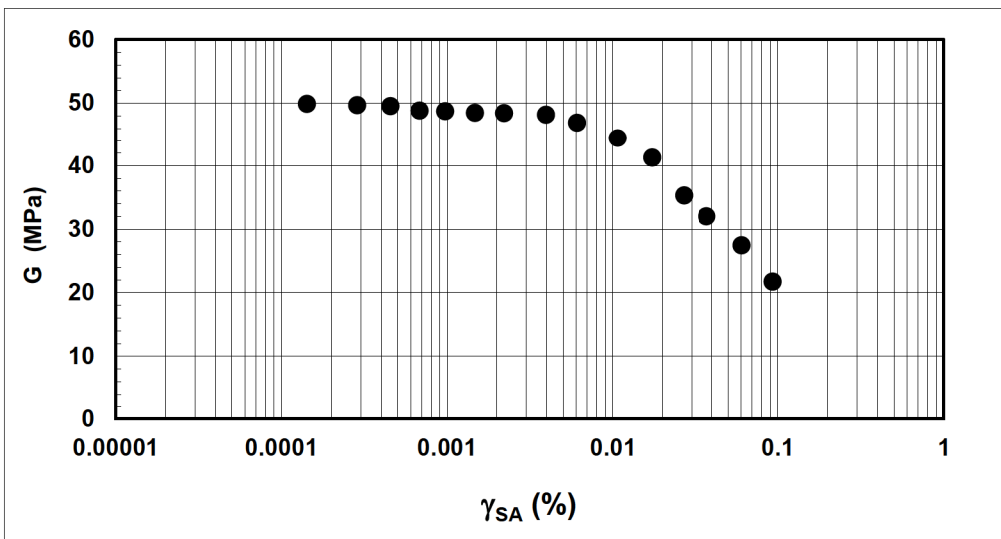
N° certificato di prova:

N° verbale di accettazione: 009/2017

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH3
Profondità prova [m]:	25.55 - 25.65
Prova:	RC
Provino:	1
Data prova:	29/03/2018

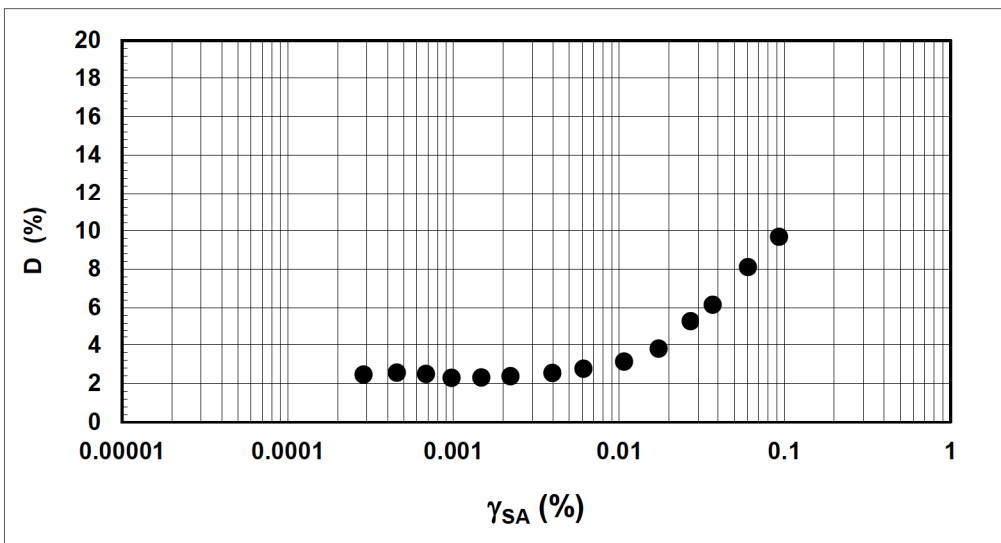
Dati generali dei provini

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	18.52	32.1	0.890	178	178	1.0	300.0	0.98	49.4	100.0	18.96	30.8	0.828	101	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	14/05/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

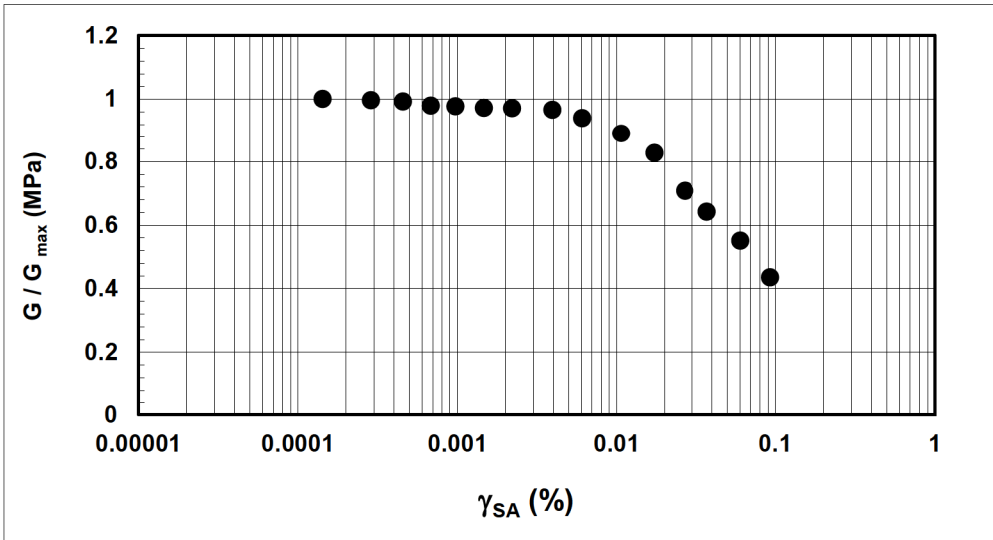
N° certificato di prova:

N° verbale di accettazione: 009/2017

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH3
Profondità prova [m]:	25.55 - 25.65
Prova:	RC
Provino:	1
Data prova:	29/03/2018

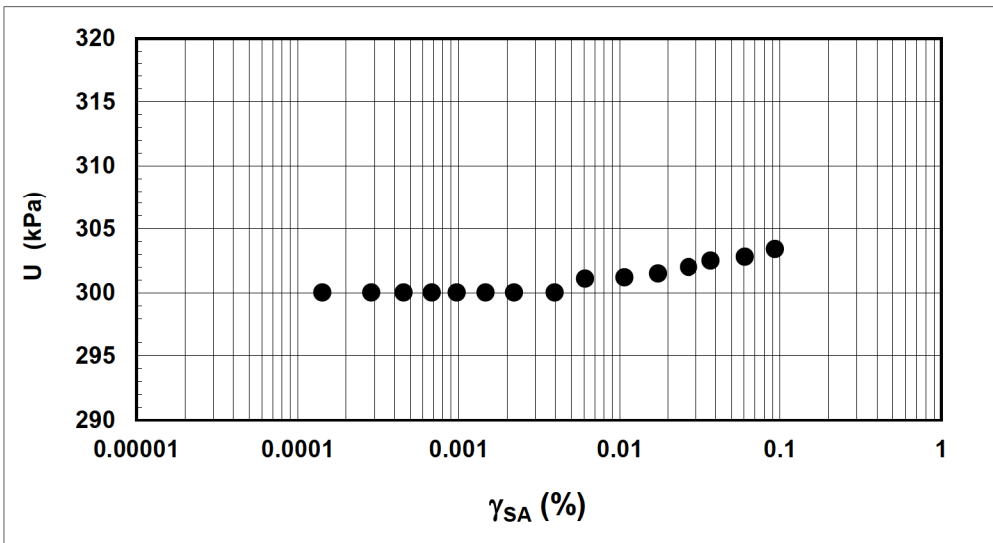
Dati generali dei provini

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		
mm	mm	kN/m ³	%	-	kPa	kPa	-	kPa	-	mm	mm	kN/m ³	%	-	%	tipo di provino	
50.00	101.00	18.52	32.1	0.890	178	178	1.0	300.0	0.98	49.4	100.0	18.96	30.8	0.8	101	INDISTURBATO	
																metodo di preparazione	FUSTELLAZIONE
																superficie di appoggio	PIETRA POROSA
																eccitazione	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:

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

rev.	data emiss.	sperimentatore	direttore
0	14/05/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

N° certificato di prova:

N° verbale di accettazione: 009/2017

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH3
Profondità prova [m]:	25.55 - 25.65
Prova:	RC
Provino:	1
Data prova:	29/03/2018

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	18.52	32.1	0.890	178	178	1.0	300.0	0.98	49.4	100.0	18.96	30.8	0.828	superficie di appoggio	INDISTURBATO
															eccitazione	PIETRA POROSA
																TORSIONALE

Valori numerici

G	G/G _{MAX}	γ	D	U
(MPa)	(-)	(%)	(%)	(kPa)
49.85	1.000	0.00014		300.0
49.65	0.996	0.00029	2.46	300.0
49.49	0.993	0.00046	2.55	300.0
48.79	0.979	0.00068	2.48	300.0
48.71	0.977	0.00098	2.28	300.0
48.45	0.972	0.00147	2.30	300.0
48.41	0.971	0.00221	2.37	300.0
48.17	0.966	0.00395	2.53	300.0
46.87	0.940	0.00609	2.75	301.1
44.39	0.891	0.01071	3.12	301.2
41.27	0.828	0.01728	3.79	301.5
35.29	0.708	0.02694	5.29	302.0
32.01	0.642	0.03713	6.14	302.5
27.47	0.551	0.06056	8.09	302.8
21.70	0.435	0.09312	9.67	303.4

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	08/05/2018	Ranzini	Saccenti

N° verbale di accettazione: 009/2017

Dati Generali di Campionamento

Data prelievo: 20/03/2017
 Attrezzatura sondaggio: -
 Attrezzatura prelievo: -
 Modalità prelievo: -

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH4
Profondità prelievo [m]:	36.5-37
Prova:	
Data fine descrizione:	08/05/2018

N° certificato di prova:

Dati Generali del Campione

Data arrivo in laboratorio:	22/03/2017	Tipo contenitore:	FUSTELLA ACCIAIO
Data estrusione campione:	26/03/2018	Forma campione:	CILINDRICO
Condizioni contenitore:	BUONE	Dimensioni Campione:	Φ= 8.5 cm L= 54 cm
		Classe del terreno:	CLASSE 4

Descrizione

36.46 m - 37.00 m: Argilla con limo di colore grigio scuro (5Y 4/1) con tracce di reazione all'HCl.

Schizzo	Penetrometro		Scissometro		Prove eseguite
	+	//	+	//	
	[MPa]	[MPa]	[MPa]	[MPa]	
36.35					RC1 γ1 w1 Gs1 LLP1 Gr1 Tx CAU local1
36.40					
36.45					
36.50					
36.55					
36.60	0.27				
36.65	0.32				
36.70					
36.75					
36.80	0.30				
36.85					
36.90	0.27				
36.95					
37.00		0.26			
37.05					
37.10					
37.15					
37.20					
37.25					
37.30					
37.35					
37.40					
37.45					
37.50					

Richiami

- LLP = Limiti di liquidità e plasticità
- Gr = Analisi Granulometrica
- Tx CAU local = Triassiale consolidata anisotropica rottura non drenata con misure locali
- RC = Colonna risonante
- γ = Peso di volume
- w = Umidità
- Gs = Peso specifico dei grani



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

rev.	data emiss.	sperimentatore	direttore
0	08/05/2018	Ranzini	Saccenti

N° verbale di accettazione: 009/2017

Committente: Unione Comuni Reno Galliera
Cantiere: CASTELMAGGIORE
Sondaggio: S1
Campione: SH4
Profondità prelievo [m]: 36.5-37
Prova:
Data fine descrizione: 08/05/2018

Prove	Profondità	Risultati prove	Riferimento procedure	N° certificato di prova
γ_1	36.78m - 36.88m	Peso di volume = 0.0 [kN/m ³]	PT-LMT-00021 REV. 1	
w ₁	36.78m - 36.88m	Umidità = 0 [%]	PT-LMT-00016 REV. 0	
LLP1	36.75m - 37m	Limite Liquido = 62 [%] Limite Plastico = 24 [%]	PT-LMT-00020 REV. 1	
Gs1	36.78m - 36.88m	Peso specifico dei grani = 2.719 [-]	PT-LMT-00019 REV. 1	

Rev	data emiss.	eseguito da	elaborato da
0	11/05/2018	Sirtoli	Sirtoli

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH4
Profondità prelievo [m]:	36.50 – 37.00
Data prova:	



rev.	data emiss.	sperimentatore	direttore
0	09/04/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D422/07

Classificazione di riferimento: AGI 1977

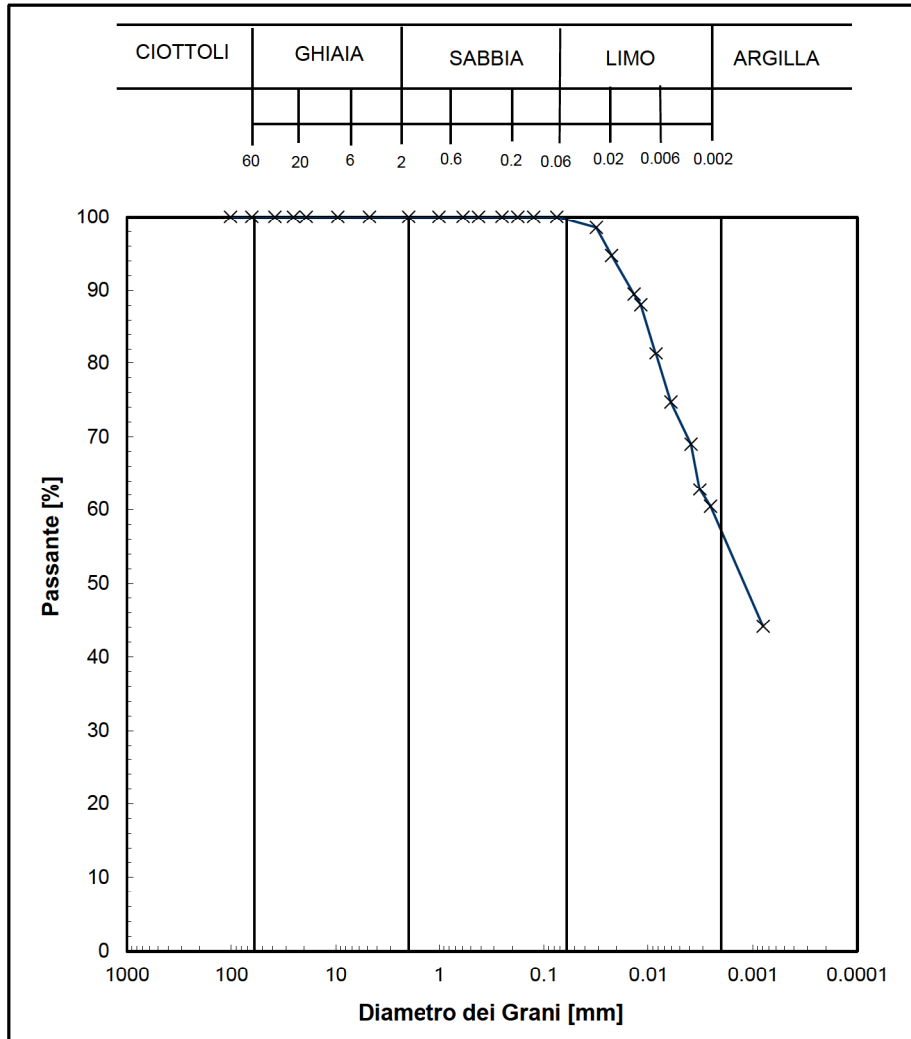
N° certificato di prova:

N° verbale di accettazione: 009/2017

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTEL MAGGIORE
Sondaggio:	S1
Campione:	SH4
Profondità prelievo [m]:	36.75 - 37
Prova:	Gr 1
Data prova:	29/03/2018

Vagliatura		
Diametro vaglio [mm]	Massa tratt. [g]	Massa tratt. [%]
101.6	0	0
63.5	0	0
38.1	0	0
25.4	0	0
19.1	0	0
9.53	0	0
4.75	0	0
2	0	0
1	0	0
0.59	0	0
0.42	0	0
0.25	0	0
0.177	0	0
0.125	0	0
0.075	0	0

Aerometria		
Tempo [min]	Temp. [°C]	Letture [-]
2	20.0	1.0251
4	20.0	1.0243
11	20.0	1.0232
15	20.0	1.0229
30	20.0	1.0215
60	20.0	1.0201
150	20.0	1.0189
225	20.0	1.0176
361	20.5	1.0170
4125	18.5	1.0140



Curva granulom.	
Diametro [mm]	Passante [%]
1.02.E+02	100.0
6.35.E+01	100.0
3.81.E+01	100.0
2.54.E+01	100.0
1.91.E+01	100.0
9.53.E+00	100.0
4.75.E+00	100.0
2.00.E+00	100.0
1.00.E+00	100.0
5.90.E-01	100.0
4.20.E-01	100.0
2.50.E-01	100.0
1.77.E-01	100.0
1.25.E-01	100.0
7.50.E-02	100.0
3.14.E-02	98.5
2.24.E-02	94.7
1.37.E-02	89.5
1.18.E-02	88.1
8.45.E-03	81.4
6.07.E-03	74.7
3.89.E-03	69.0
3.22.E-03	62.8
2.54.E-03	60.4
7.95.E-04	44.2
-	-
-	-

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	36.75	37.00	340.1	VIA UMIDA	100	-	-	0	43	57	33	-	2.5.E-03	1.2.E-03

NOTE:

GS= 2.700

La soluzione disperdente è stata preparata il 21/08/2017



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

Sperimentatore: Diaby
Direttore: Saccenti
Data emissione: 18/04/2018
Rev.

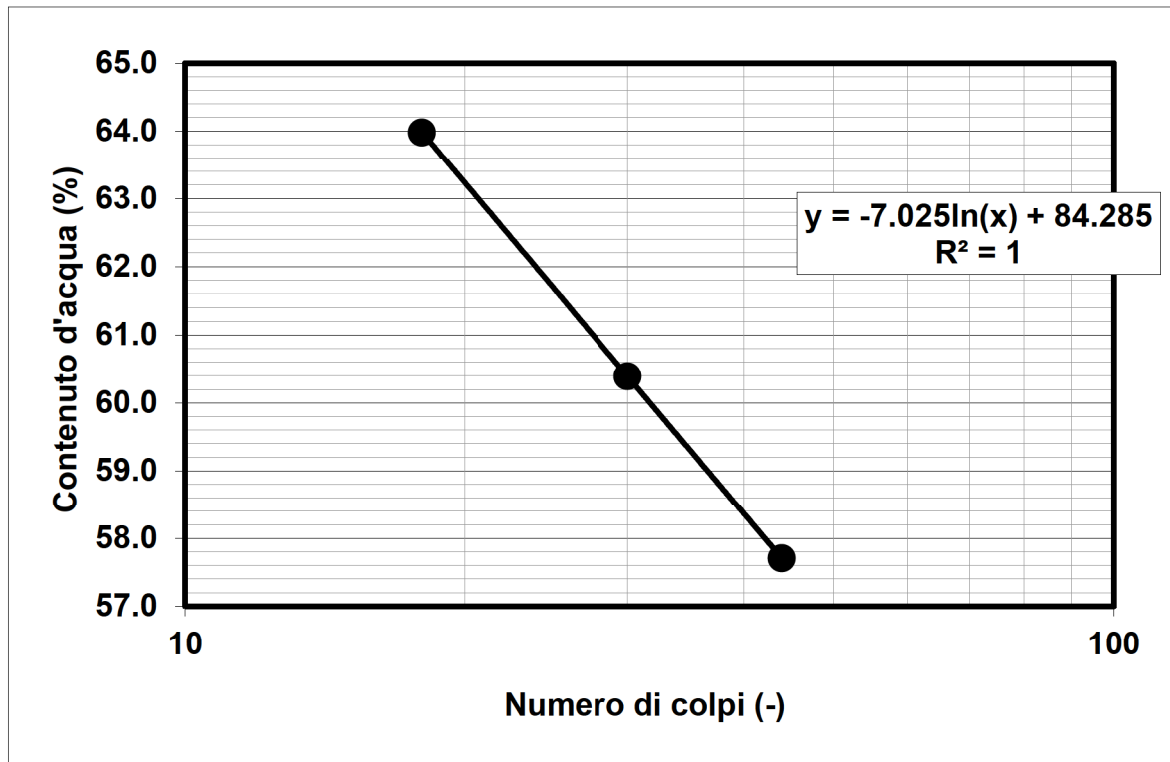
Committente: Unione Comuni Reno Galliera
Cantiere: CASTELMAGGIORE
Sondaggio: S1
Campione: SH4
Profondità prova [m]: 36.75 - 37.00
Prova: LLP1
Data prova: 26/03/2018

Normativa di riferimento: ASTM D4318
N° certificato di prova:
N° verbale di accettazione: 009/2017

Limite Liquido			
	prova 1	prova 2	prova 3
numero colpi	44	30	18
massa tara (g)	22.42	22.13	22.20
massa umido + tara (g)	66.15	76.31	74.46
massa secco + tara (g)	50.15	55.91	54.07
umidità (%)	57.70	60.39	63.98

Limite Plastico		
massa tara (g)	22.51	21.75
massa umido + tara (g)	35.10	33.68
massa secco + tara (g)	32.64	31.36
umidità (%)	24.28	24.14

LL (%)	61.7
LP (%)	24.2
IP (%)	37.5



Note:

rev.	data emiss.	sperimentatore	direttore
0	14/05/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

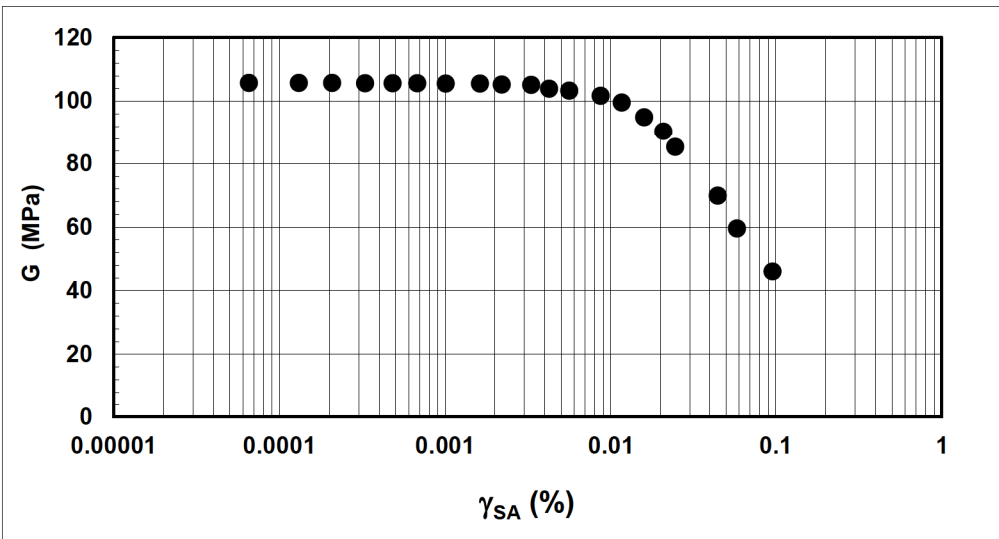
N° certificato di prova:

N° verbale di accettazione: 009/2017

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH4
Profondità prova [m]:	36.78 - 36.89
Prova:	RC
Provino:	1
Data prova:	26/03/2018

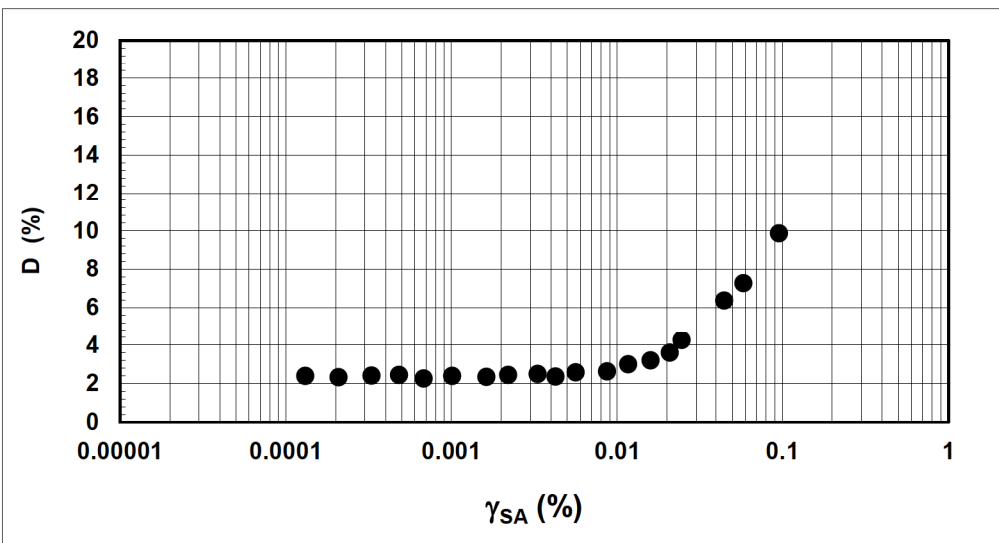
Dati generali dei provini

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	101.50	19.40	26.1	0.722	266	266	1.0	300.0	0.98	49.9	101.3	19.51	25.9	0.709	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	14/05/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

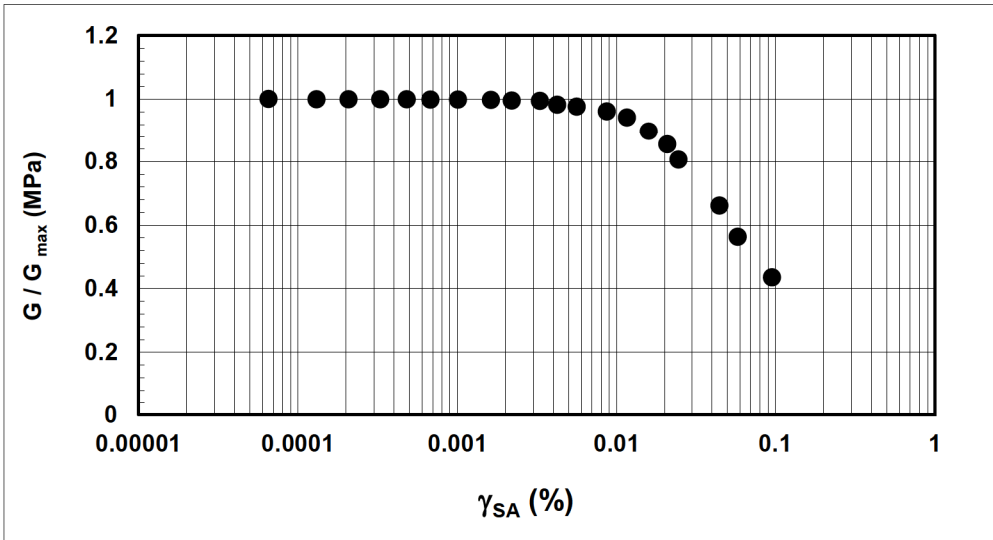
N° certificato di prova:

N° verbale di accettazione: 009/2017

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH4
Profondità prova [m]:	36.78 - 36.89
Prova:	RC
Provino:	1
Data prova:	26/03/2018

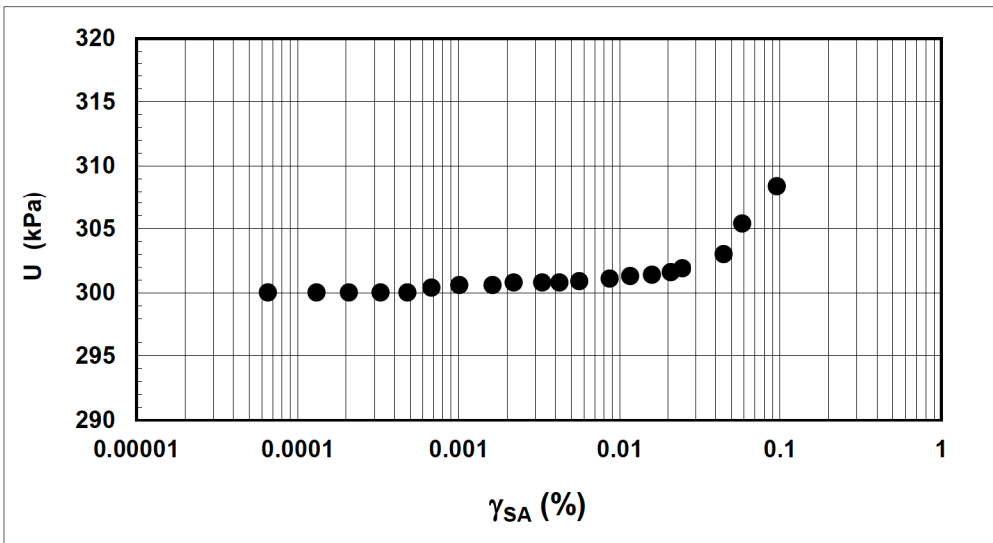
Dati generali dei provini

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		
mm	mm	kN/m ³	%	-	kPa	kPa	-	kPa	-	mm	mm	kN/m ³	%	-	%		
50.00	101.50	19.40	26.1	0.722	266	266	1.0	300.0	0.98	49.9	101.3	19.51	25.9	0.7	99	tipo di provino	INDISTURBATO
																metodo di preparazione	FUSTELLAZIONE
																superficie di appoggio	PIETRA POROSA
																eccitazione	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	14/05/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

N° certificato di prova:

N° verbale di accettazione: 009/2017

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH4
Profondità prova [m]:	36.78 - 36.89
Prova:	RC
Provino:	1
Data prova:	26/03/2018

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	101.50	19.40	26.1	0.722	266	266	1.0	300.0	0.98	49.9	101.3	19.51	25.9	0.709	superficie di appoggio	INDISTURBATO
															eccitazione	PIETRA POROSA
																TORSIONALE

Valori numerici

G	G/G _{MAX}	γ	D	U
(MPa)	(-)	(%)	(%)	(kPa)
105.73	1.000	0.00007		300.0
105.70	1.000	0.00013	2.38	300.0
105.64	0.999	0.00021	2.32	300.0
105.62	0.999	0.00033	2.40	300.0
105.62	0.999	0.00048	2.44	300.0
105.59	0.999	0.00068	2.25	300.4
105.53	0.998	0.00101	2.39	300.6
105.44	0.997	0.00163	2.34	300.6
105.18	0.995	0.00220	2.44	300.8
105.09	0.994	0.00331	2.49	300.8
103.88	0.982	0.00424	2.36	300.8
103.22	0.976	0.00561	2.57	300.9
101.61	0.961	0.00866	2.62	301.1
99.57	0.942	0.01163	2.99	301.3
94.88	0.897	0.01586	3.18	301.4
90.37	0.855	0.02076	3.60	301.6
85.28	0.807	0.02444	4.25	301.9
69.92	0.661	0.04471	6.35	303.0
59.57	0.563	0.05831	7.27	305.4
46.07	0.436	0.09550	9.85	308.4

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:

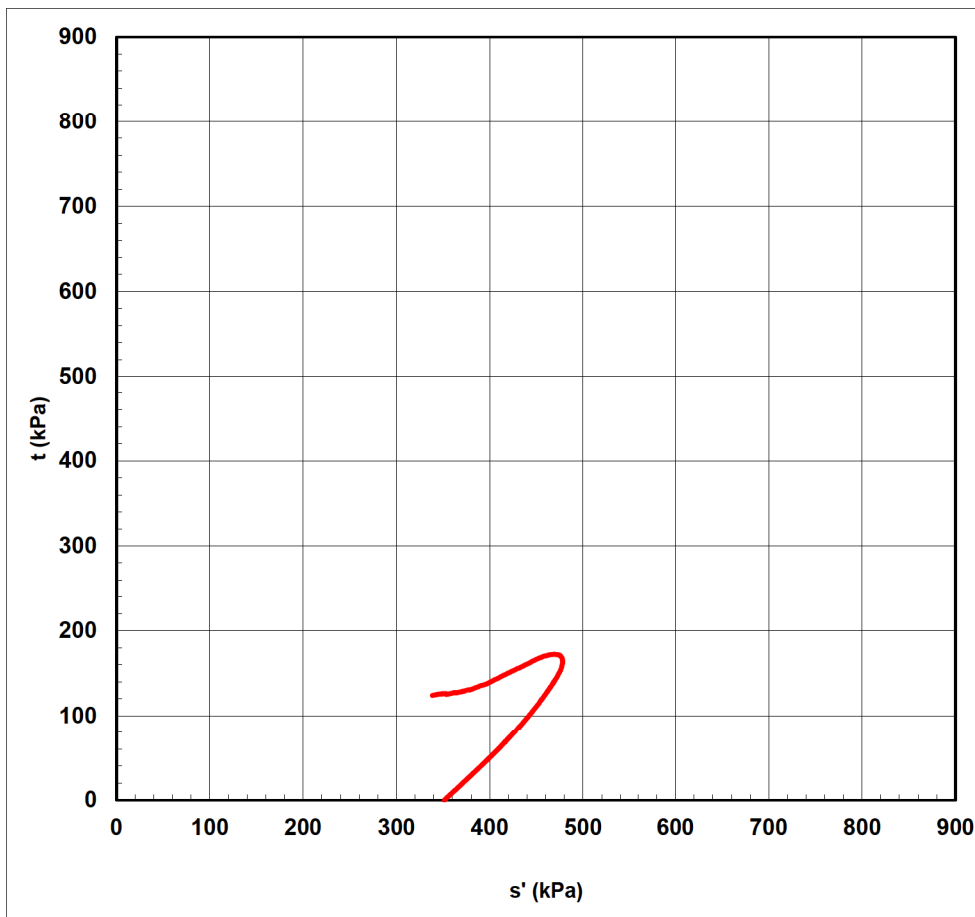
Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A, B e C			
rev.	data emiss.	sperimentatore	direttore
0	13/05/2018	Sirtoli	Saccenti

Committente: Unione Comuni Ren Galliera
Cantiere: CASTELMAGGIORE
Sondaggio: S1
Campione: SH4
Profondità prova [m]: 36.89-36.99
Prova: TxCAU
Provino: 1
Data prova: 12/04/2018

Normativa di riferimento: ASTM D4767/11
 N° certificato di prova:
 N° verbale di accettazione: 009/2017

Dati generali dei provini

Provino	Profondità	Dati iniziali					Dati a fine consolidazione								Tipo di rottura				Metodo di preparazione - tipo di materiale
		D	H	γ	w	e	σ'_a	σ'_r	K	B.P.	B	ϵ_a	ϵ_r	e	v	t	s'	ϵ_a	
-	m	mm	mm	kN/m3	%	-	kPa	kPa	-	kPa	-	%	%	-	mm/m	kPa	kPa	%	
1	36.94	50.0	98.3	18.96	28.0	0.788	352	351	1.00	301	0.97	0.00	0.00	0.788	0.020	172.6	469	4.31	fustellazione
																			indisturbato



- Legenda:**
- D = diametro del provino
 - H = altezza del provino
 - γ = peso di volume umido
 - w = contenuto d'acqua
 - e = indice dei vuoti
 - σ, σ' = tensioni totali ed efficaci
 - $K_0 = \sigma_r / \sigma_a$ a fine consolidazione
 - B.P. = back pressure
 - B = coefficiente di Skempton
 - ϵ = deformazioni
 - $\epsilon_p = (\epsilon_a + 2 \cdot \epsilon_r)$
 - $\epsilon_q = 2/3 (\epsilon_a - \epsilon_r)$
 - $q = (\sigma_a - \sigma_r)$
 - $p' = (\sigma'_a + 2 \cdot \sigma'_r) / 3$
 - E = modulo di Young
 - v = coefficiente di Poisson
 - v = velocità delle pressa
 - Subscritto 'a' = assiale
 - Subscritto 'r' = radiale
 - Subscritto 'v' = volumetrico

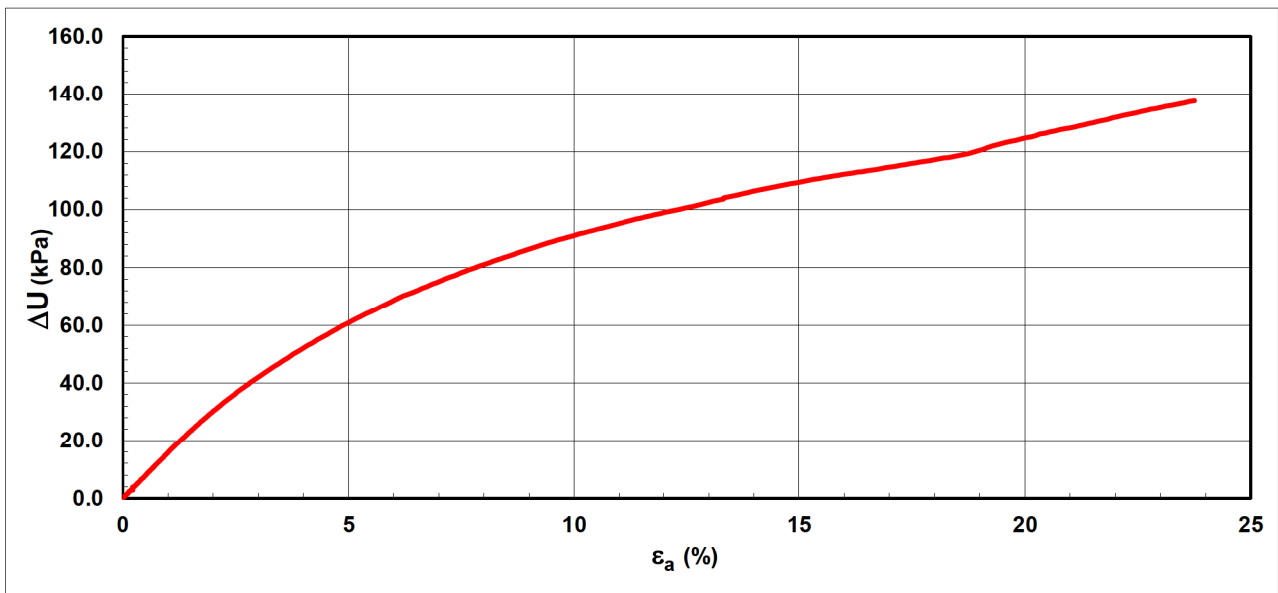
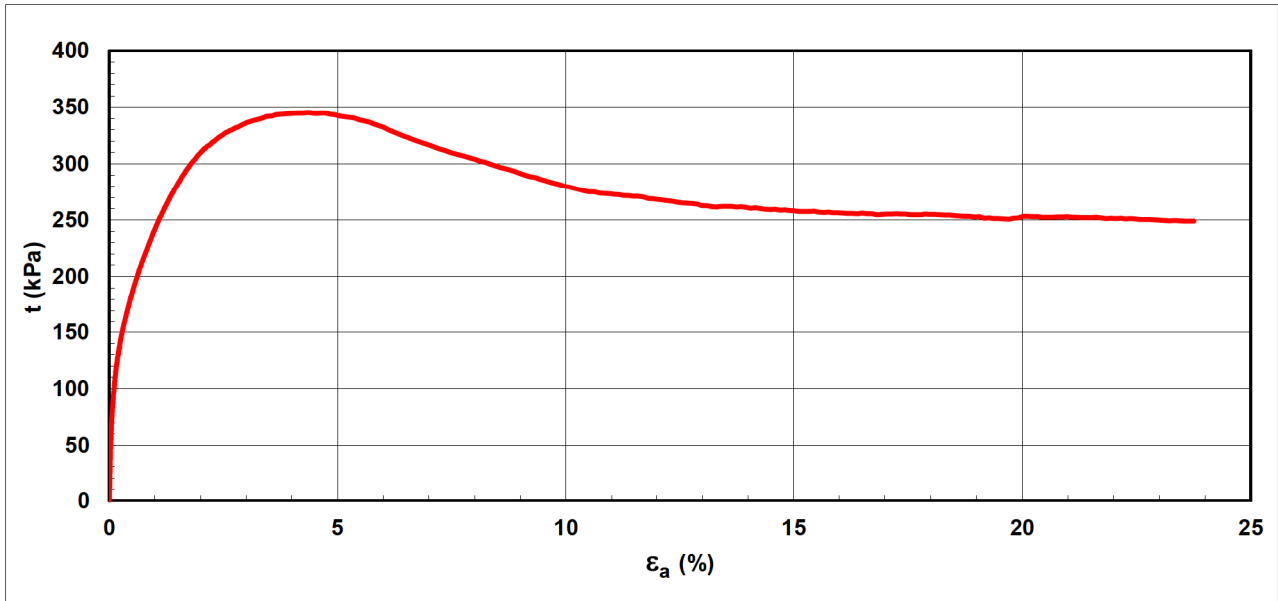
Note:	
--------------	--

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

rev.	data emiss.	sperimentatore	direttore
0	13/05/2018	Sirtoli	Saccenti

Normativa di riferimento: ASTM D4767/11

Committente:	Unione Comuni Ren Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH4
Profondità prova [m]:	36.89-36.99
Prova:	TxCAU
Provino:	1
Data prova:	12/04/2018



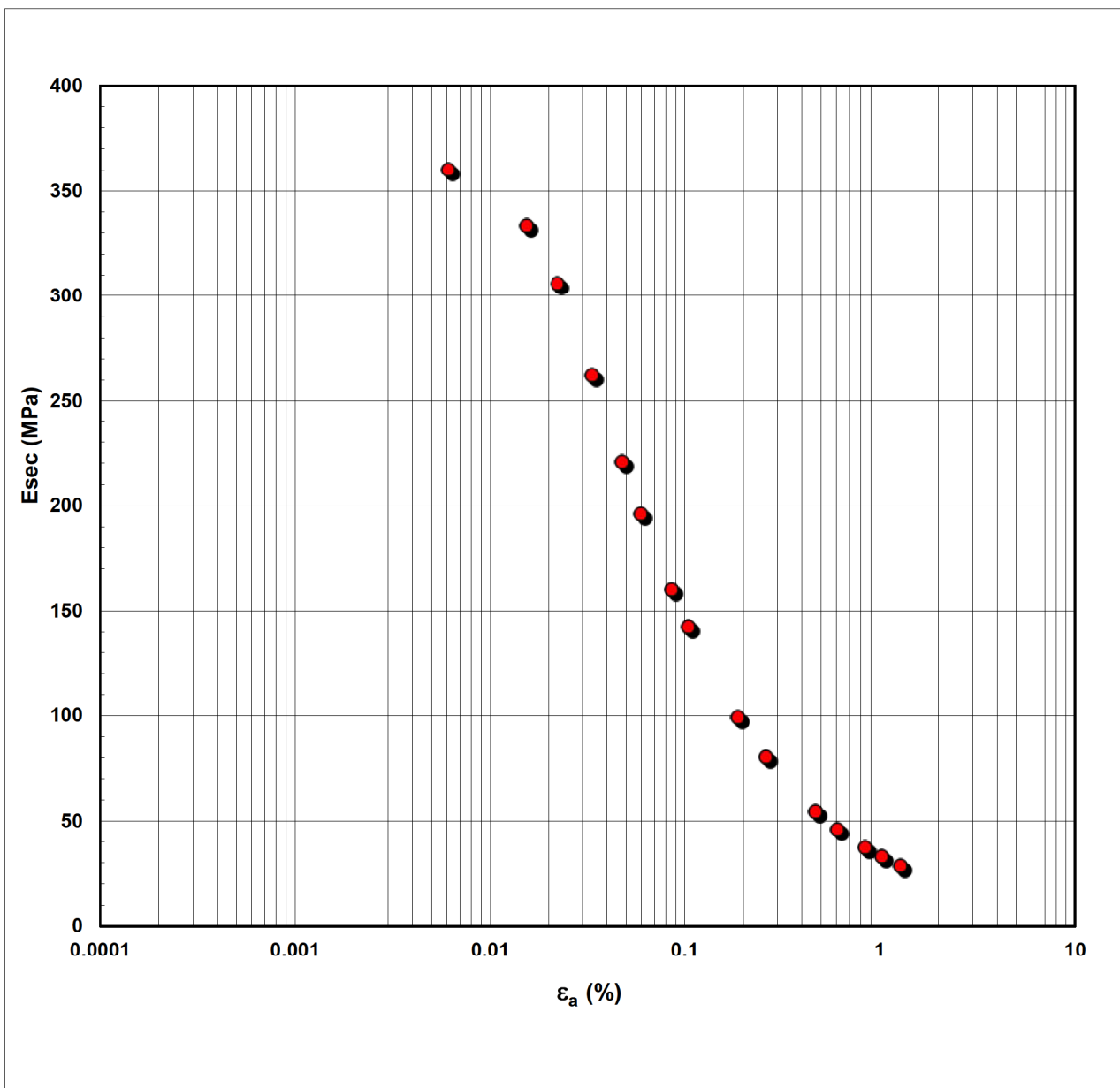
Note:	Deformazioni assiali da misure esterne
--------------	--

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

rev.	data emiss.	sperimentatore	direttore
0	13/05/2018	Sirtoli	Saccenti

Normativa di riferimento: ASTM D4767/11

Committente:	Unione Comuni Ren Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	SH4
Profondità prova [m]:	36.89-36.99
Prova:	TxCAU
Provino:	1
Data prova:	12/04/2018



Note:	<p><i>I valori di modulo sono stati calcolati interpolando gruppi di dati ritenuti significativi.</i></p> <p><i>Deformazione assiale da misure locali interne</i></p>
--------------	---

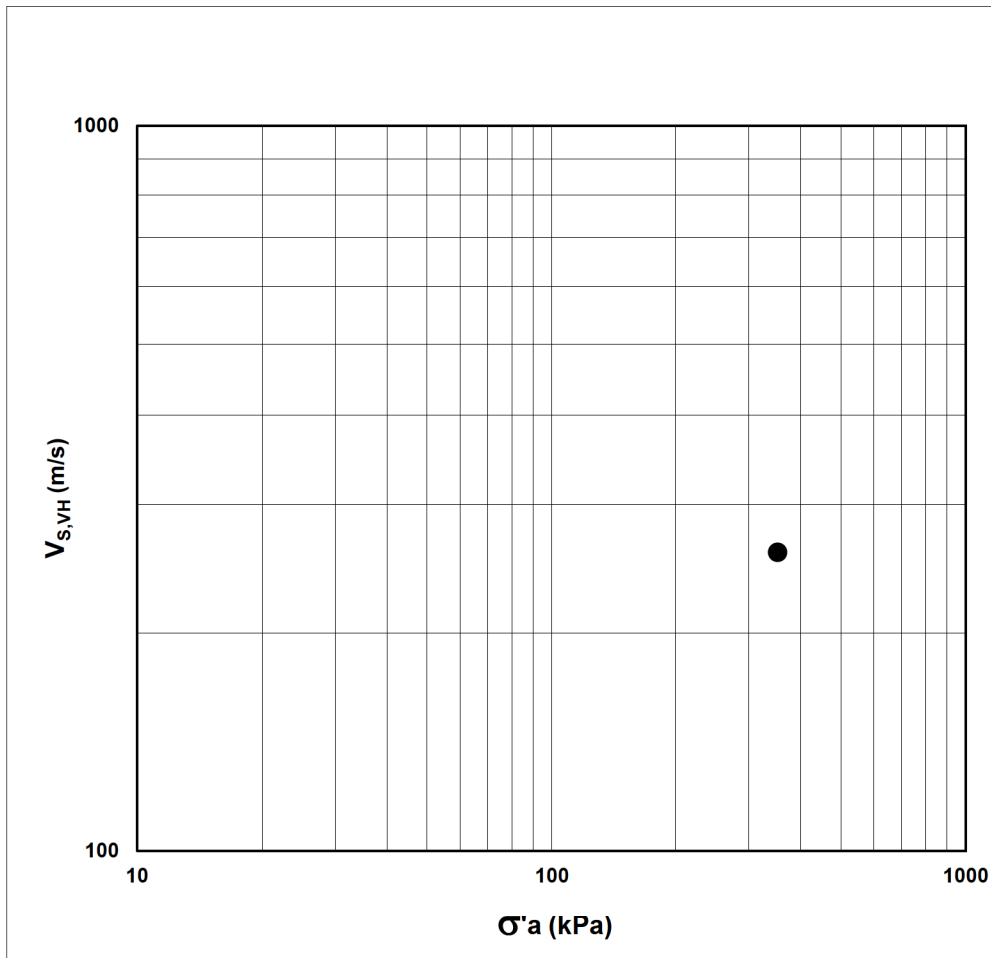


MISURA DELLA VELOCITA' ONDE DI TAGLIO IN PROVINI TRIASSIALI

Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A, B e C			
rev.	data emiss.	Sperimentatore	Direttore
0	05/05/2018	Sirtoli	Saccetti
Procedura di riferimento: PT-LMT-159/01 N° verbale di accettazione: 009/2017 Numero certificato di prova:			
Committente:		Unione Comuni Ren Galliera	
Cantiere:		CASTELMAGGIORE	
Sondaggio:		S1	
Campione:		SH4	
Profondità prova [m]:		36.89-36.99	
Prova:		VTL	
Provino:		1	
Data prova:		12/04/18	

TIPO DI ONDA: SVH (onda di taglio propagata in direzione verticale)

misura	Dati del provino										Dati relativi alla misura				
	σ'_a kPa	σ'_r kPa	t_{rv} min	p' kPa	q kPa	OCR	ρ g/cm ³	w %	e -	f kHz	D mm	t μ s	$V_{S,VH}$ m/s	G_{VH} MPa	
1	352	352	-	352.0	0.0	-	1.951	-	0.788	10.0	98.300	381.0	258.0	129.8	



Legenda:

- σ, σ' = tensioni totali ed efficaci
- $p' = (\sigma'_a + 2 \cdot \sigma'_r) / 3$
- $q = (\sigma_a - \sigma_r)$
- ρ = densità del terreno
- w = umidità del terreno
- e = indice dei vuoti
- f = frequenza onda di eccitazione
- D = distanza del percorso dell'onda
- t = tempo di percorso dell'onda
- V = velocità dell'onda elastica
- G = modulo di taglio
- Subscritto 'a' = assiale
- Subscritto 'r' = radiale
- Subscritto 'S' = onda di taglio (Shear)
- Subscritto 'VH' = onda di taglio propagata in direzione verticale e con movimento delle particelle in direzione orizzontale
- OCR = grado di preconsolidazione
- t_{rv} = tempo trascorso dal raggiungimento del valore di pressione a cui si eseguono le misure

Note:



Via Pastrengo, 9 - 24068 Seriate (Bg) -
tel. 035 303120 - fax 035 290388 -
Email: ismgeo@ismgeo.it

**DESCRIZIONE CAMPIONE RIMANEGGIATO E
CARATTERISTICHE GENERALI**

037019P244SM329

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

rev.	data emiss.	sperimentatore	direttore
0	24/04/2018	Angeloni	Saccenti

N° verbale accettazione: 009/2017

N° certificato di prova:

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	C4
Profondità prelievo [m]:	38.70 - 39.00
Prova:	Dc
Data fine descrizione:	24/04/2018

Dati Generali del Campione

Tipo contenitore:	Sacchetto PVC
Forma campione	-
Dimensioni Campione:	$\Phi =$ - cm L= - cm
Classe del terreno:	1

Descrizione

(Normativa di riferimento: AGI 1977)

Argilla con limo con tracce di sabbia

Risultati caratteristiche generali

Prova	Risultato della prova	Normativa di riferimento	N° certificato di prova
Limite liquido (%)	72.5	ASTM D4318/95	
Limite plastico (%)	27.7	ASTM D4318/95	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
-	-	-	
Gr 1	-	ASTM D422/90	

Note:

-

rev.	data emiss.	sperimentatore	direttore
0	24/04/2018	Angeloni	Saccenti

Normativa di riferimento: ASTM D422/07

Classificazione di riferimento: AGI 1977

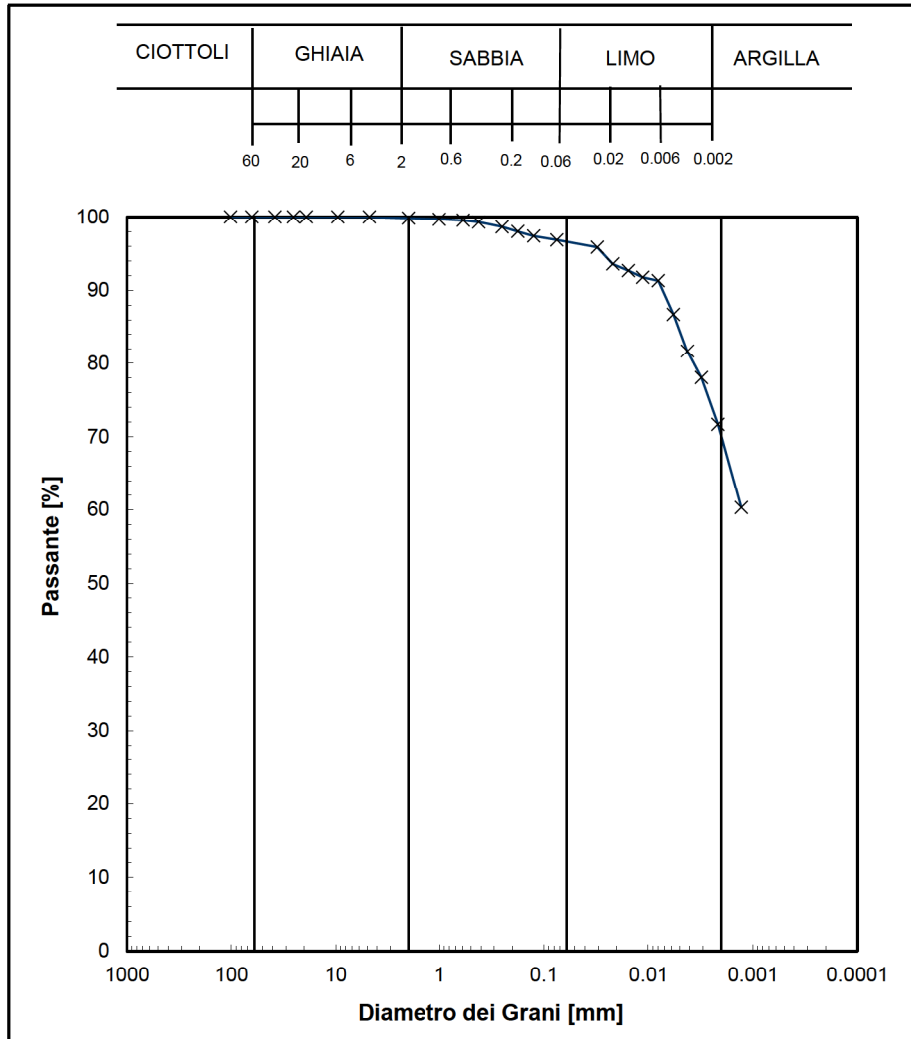
N° certificato di prova:

N° verbale di accettazione: 009/2017

Committente:	Unione Comuni Reno Galliera
Cantiere:	CASTELMAGGIORE
Sondaggio:	S1
Campione:	C4
Profondità prelievo [m]:	38.7 - 39
Prova:	Gr 1
Data prova:	11/04/2018

Vagliatura		
Diametro vaglio [mm]	Massa tratt. [g]	Massa tratt. [%]
101.6	0	0
63.5	0	0
38.1	0	0
25.4	0	0
19.1	0	0
9.53	0	0
4.75	0	0
2	0.6	0.2
1	0.5	0.1
0.59	0.5	0.1
0.42	0.9	0.2
0.25	2.5	0.7
0.177	2.3	0.6
0.125	2.3	0.6
0.075	1.9	0.5

Aerometria		
Tempo [min]	Temp. [°C]	Letture [-]
2	21.5	1.0250
4	21.5	1.0245
8	21.5	1.0243
15	21.5	1.0241
30	21.5	1.0240
60	21.5	1.0230
113	21.5	1.0219
211	22.0	1.0210
446	22.5	1.0195
1348	21.5	1.0172



Curva granulom.	
Diametro [mm]	Passante [%]
1.02.E+02	100.0
6.35.E+01	100.0
3.81.E+01	100.0
2.54.E+01	100.0
1.91.E+01	100.0
9.53.E+00	100.0
4.75.E+00	100.0
2.00.E+00	99.8
1.00.E+00	99.7
5.90.E-01	99.6
4.20.E-01	99.3
2.50.E-01	98.6
1.77.E-01	98.0
1.25.E-01	97.4
7.50.E-02	96.9
3.07.E-02	95.9
2.18.E-02	93.6
1.55.E-02	92.7
1.13.E-02	91.8
8.02.E-03	91.3
5.74.E-03	86.7
4.23.E-03	81.7
3.11.E-03	78.1
2.16.E-03	71.7
1.29.E-03	60.3
-	-
-	-

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	38.70	39.00	372.9	VIA UMIDA	97	-	0	3	27	70	34	-	1.3.E-03	8.1.E-04

NOTE:

GS= 2.700

La soluzione disperdente è stata preparata il 21/08/2017



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

Sperimentatore: Diaby
Direttore: Saccenti
Data emissione: 18/04/2018
Rev.

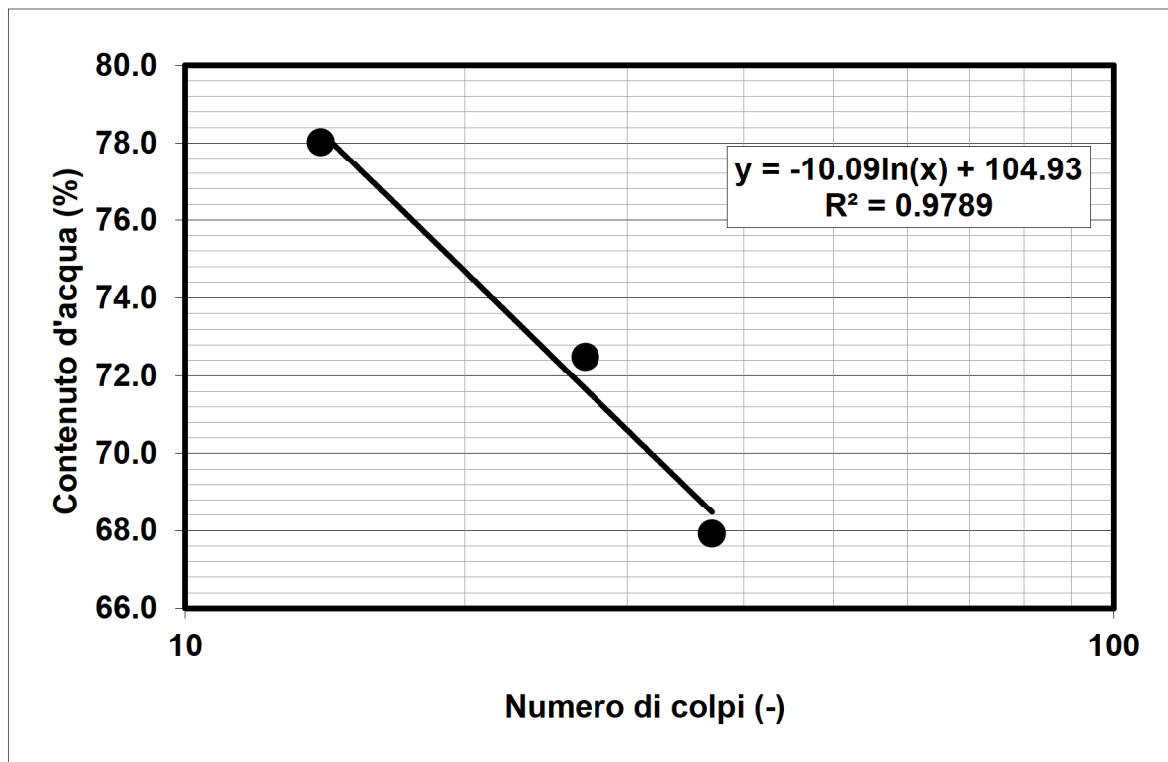
Normativa di riferimento: ASTM D4318
N° certificato di prova:
N° verbale di accettazione: 009/2017

Committente: Unione Comuni Reno Galliera
Cantiere: CASTELMAGGIORE
Sondaggio: S1
Campione: C4
Profondità prova [m]: 38.70 - 39.00
Prova: LLP1
Data prova: 09/04/2018

Limite Liquido			
	prova 1	prova 2	prova 3
numero colpi	37	27	14
massa tara (g)	22.55	22.38	22.19
massa umido + tara (g)	70.12	67.52	67.78
massa secco + tara (g)	50.88	48.55	47.80
umidità (%)	67.91	72.49	78.02

Limite Plastico		
massa tara (g)	22.23	22.29
massa umido + tara (g)	33.81	33.96
massa secco + tara (g)	31.30	31.43
umidità (%)	27.67	27.68

LL (%)	72.5
LP (%)	27.7
IP (%)	44.8



Note:

Tabella tempi di arrivo onde P ed SH della prova DH-02 (comune di Castel Maggiore, BO)

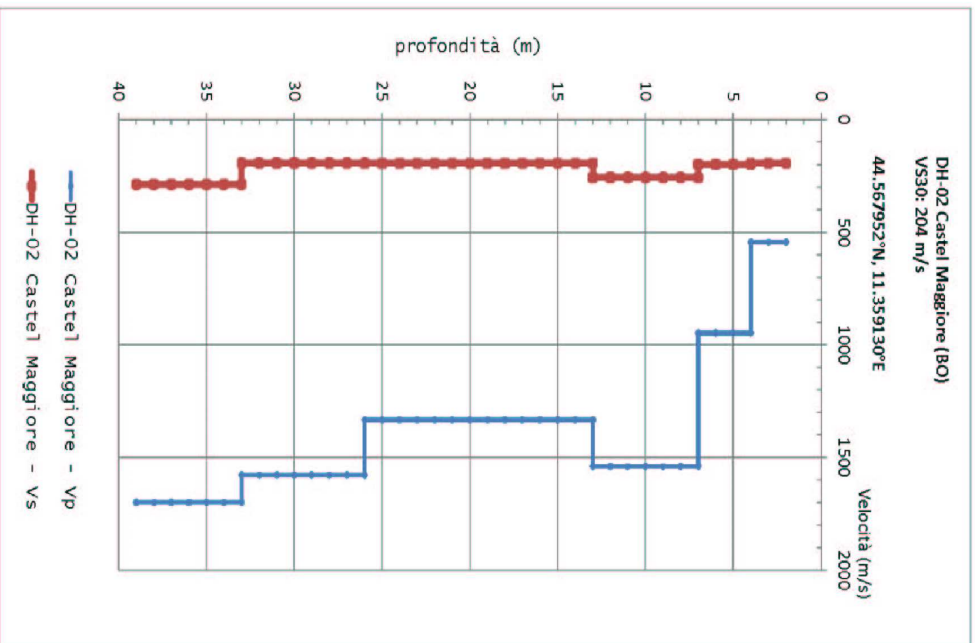
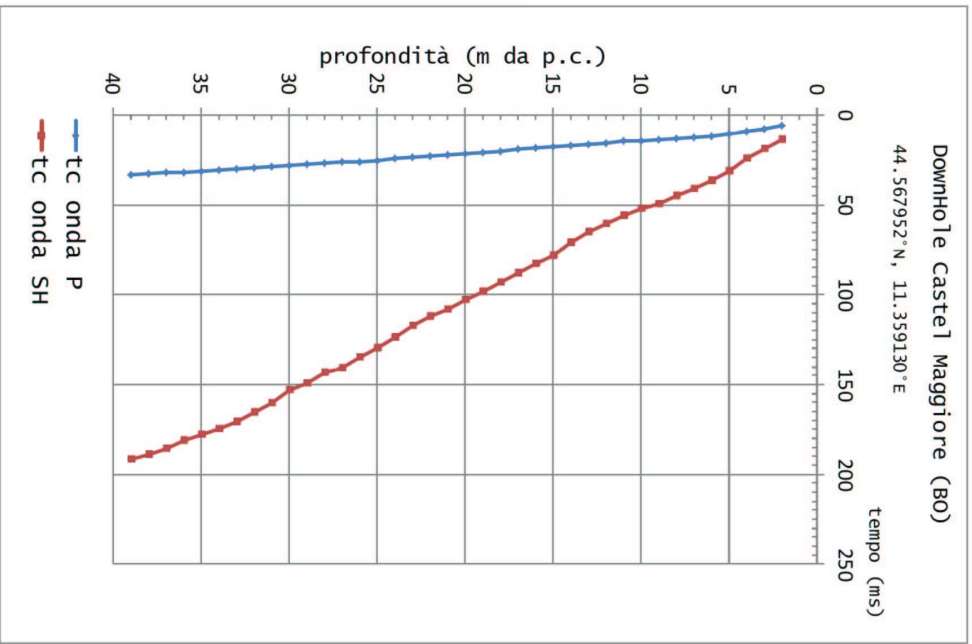
Profondità (dal p.c.) (m)	Tempo (p) in ms	Tempo TSH (in ms)	Tempo (tp0) (p) in ms	Tempo (tSH0) TSH (in ms)
1	-	-	-	-
2	8.16	19.81	5.77	14.01
3	9.27	23.12	7.71	19.24
4	10.58	27.20	9.46	24.33
5	11.18	33.72	10.38	31.31
6	12.39	38.36	11.75	36.39
7	12.99	43.00	12.49	41.35
8	13.40	46.64	13.00	45.25
9	13.87	50.95	13.54	49.74
10	14.43	53.20	14.15	52.17
11	14.95	56.80	14.71	55.88
12	15.65	61.22	15.44	60.39
13	16.49	66.19	16.30	65.42
14	17.20	72.15	17.03	71.42
15	17.83	78.78	17.67	78.09
16	18.47	83.24	18.33	82.60
17	19.21	88.71	19.08	88.10
18	20.15	93.68	20.03	93.11
19	20.85	99.32	20.74	98.77
20	21.50	103.73	21.39	103.22
21	22.20	108.92	22.10	108.43
22	23.00	112.57	22.91	112.11
23	23.80	117.87	23.71	117.43
24	24.50	124.49	24.42	124.06
25	25.30	130.10	25.22	129.69
26	26.00	135.30	25.92	134.90
27	26.40	141.06	26.33	140.67
28	27.14	144.04	27.07	143.67
29	27.63	149.67	27.56	149.32
30	28.28	153.65	28.22	153.31
31	29.00	160.60	28.94	160.27
32	29.66	166.24	29.60	165.92
33	30.16	170.87	30.10	170.56
34	30.60	175.18	30.55	174.88
35	31.20	178.16	31.15	177.87
36	31.84	181.48	31.79	181.20
37	32.39	185.78	32.34	185.51
38	32.90	189.10	32.85	188.84
39	33.58	192.08	33.54	191.83

Modello di velocità del DH-01 (Castel Maggiore, BO)

Sismostrato	profondità (m)	media(Vp) m/s	media (Vs) m/s
1	0 - 4.0	542	194
2	4.0 - 7.0	948	199
3	7.1-13.0	1539	256
4	13.1-26.0	1334	194
5	26.1-33.0	1578	193
6	33.1-39.0	1698	287
VS30=204 m/s			

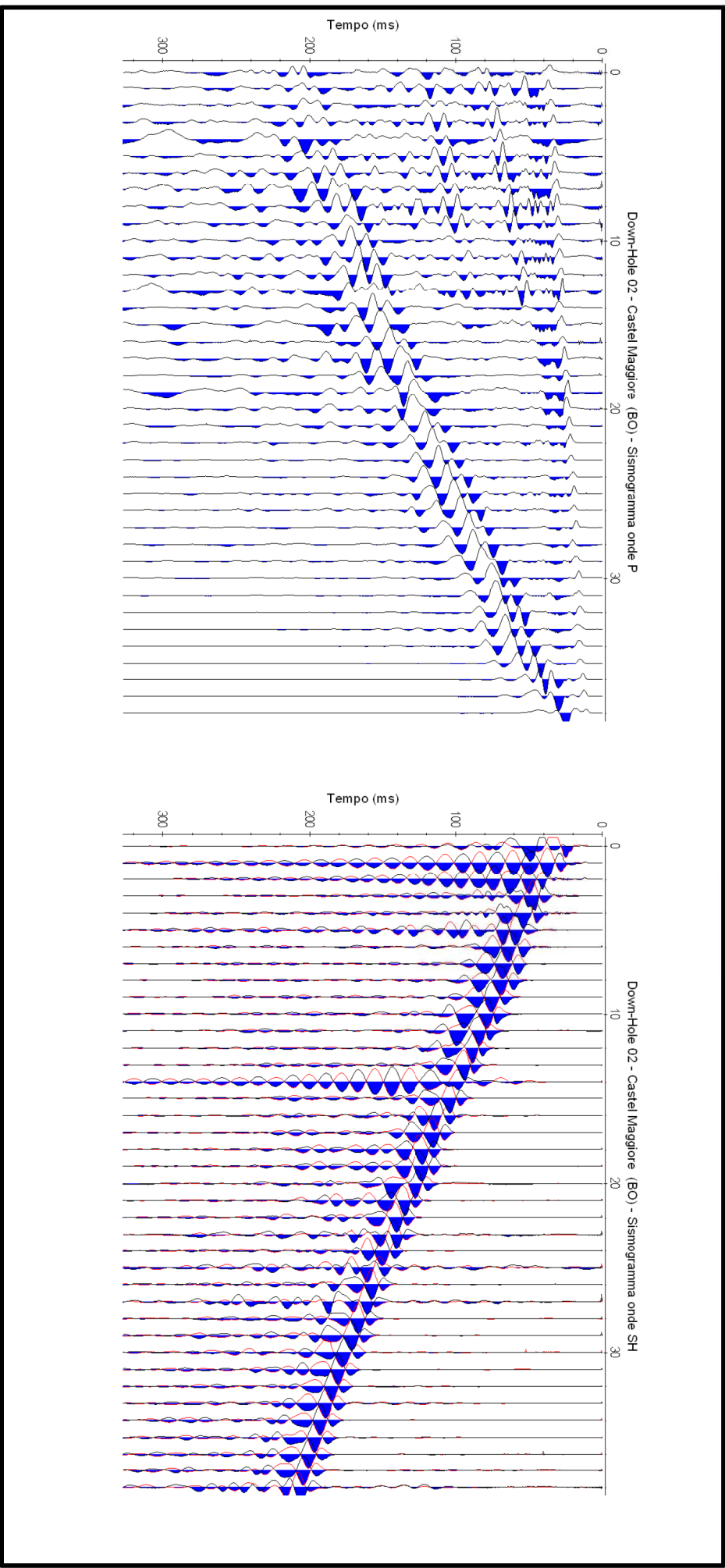
Calcolare i moduli elastici dinamici OK

Sismostrato	Profondità	Media (Vp)	Vs	Vp/Vs	densità (kg/m ³)	Poisson	M. di rigidità G (Gpa)	M. di Lamé (Gpa)	M. di Young E (Gpa)	M. di Incompressibilità K (Gpa)	Lamé/G
1	0 - 4.0	542	194	2,79	1,4561	0,4265	0,0548	0,3182	0,156	0,3547	5,81
2	4.0 - 7.0	948	199	4,76	1,6024	0,4770	0,0635	1,3132	0,187	1,3555	20,69
3	7.1-13.0	1539	256	6,01	1,8000	0,4858	0,1180	4,0274	0,351	4,1060	34,14
4	13.1-26.0	1334	194	6,88	1,7335	0,4892	0,0652	2,9544	0,194	2,9979	45,28
5	26.1-33.0	1578	193	8,18	1,8124	0,4924	0,0675	4,3780	0,202	4,4230	64,85
6	33.1-39.0	1698	287	5,92	1,8500	0,4853	0,1524	5,0293	0,453	5,1309	33,00



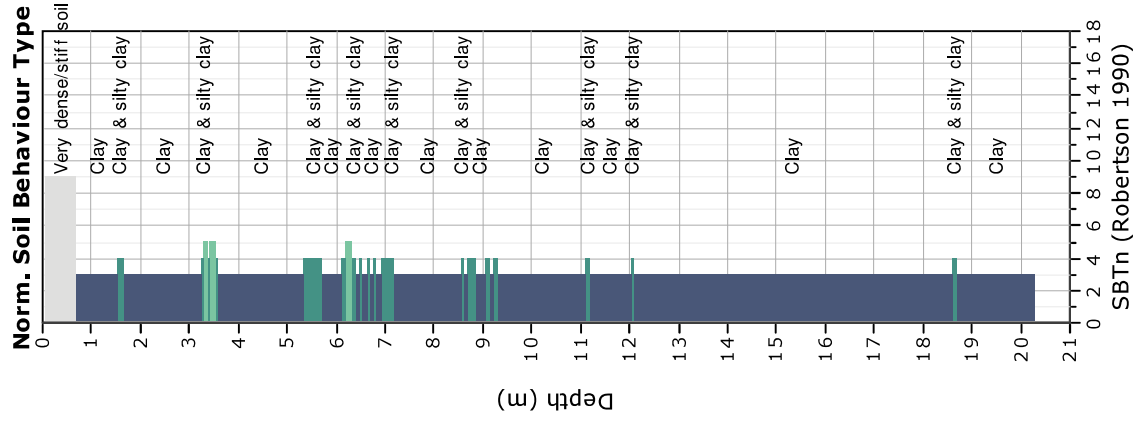
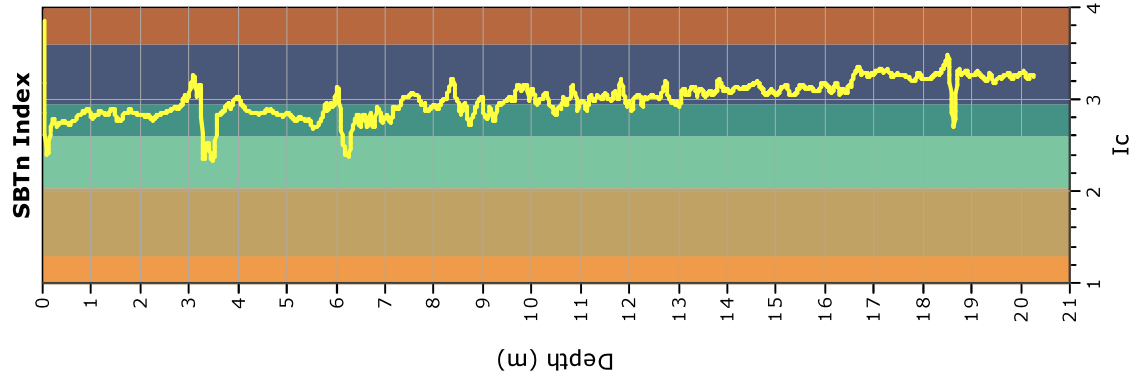
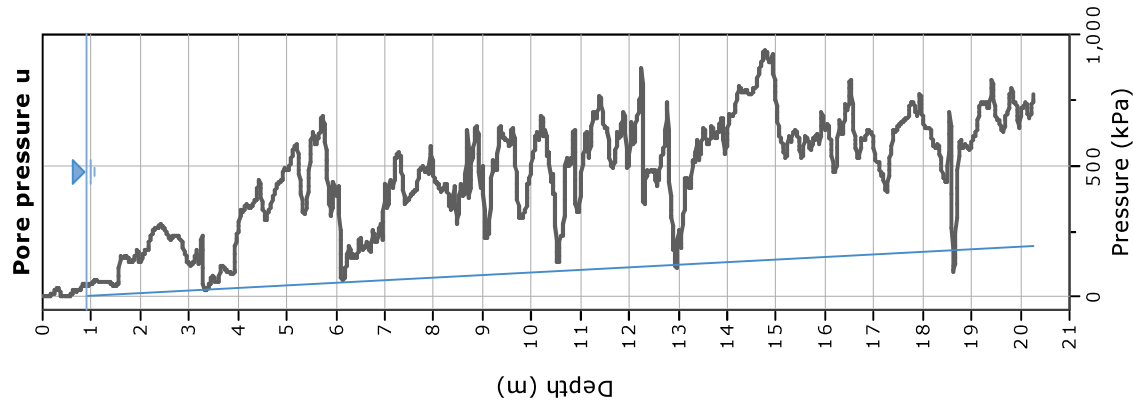
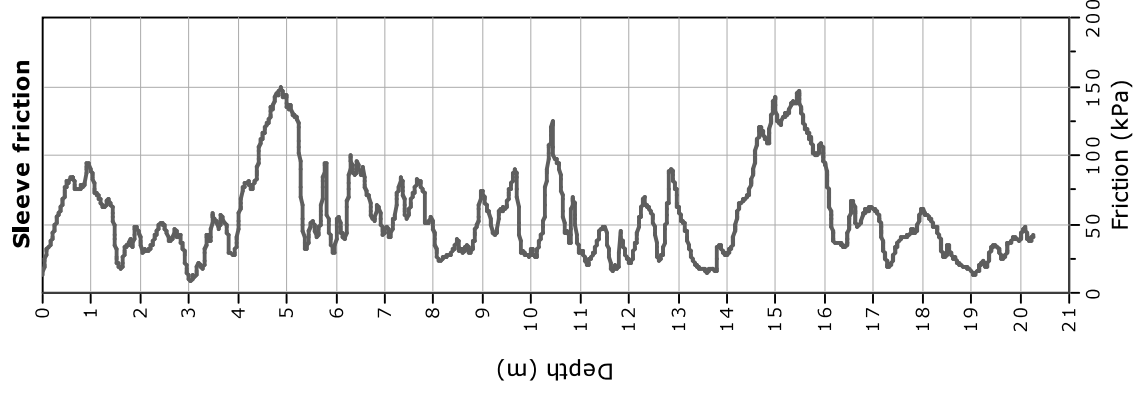
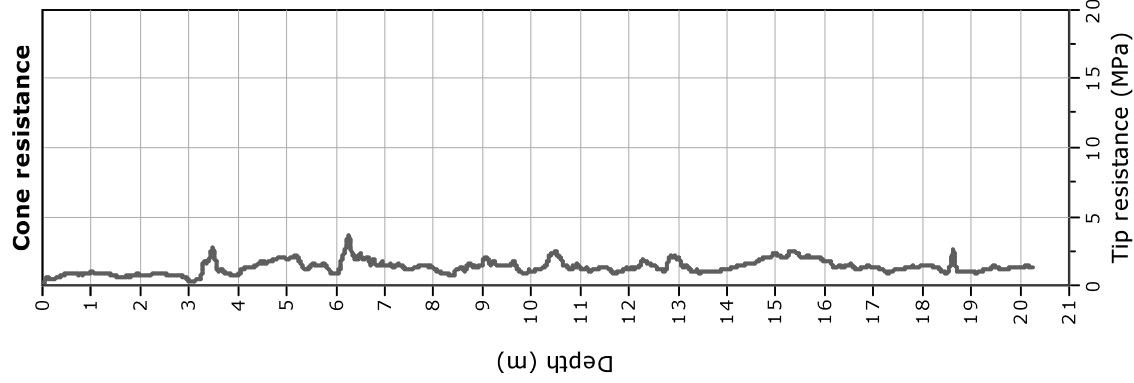
Down-Hole: 02 – Castel Maggiore (BO)

- sismogrammi onde P ed SH



Project: Microzonazione Sismica Castel Maggiore

Location: via Berlinguer - Castel Maggiore (BO)



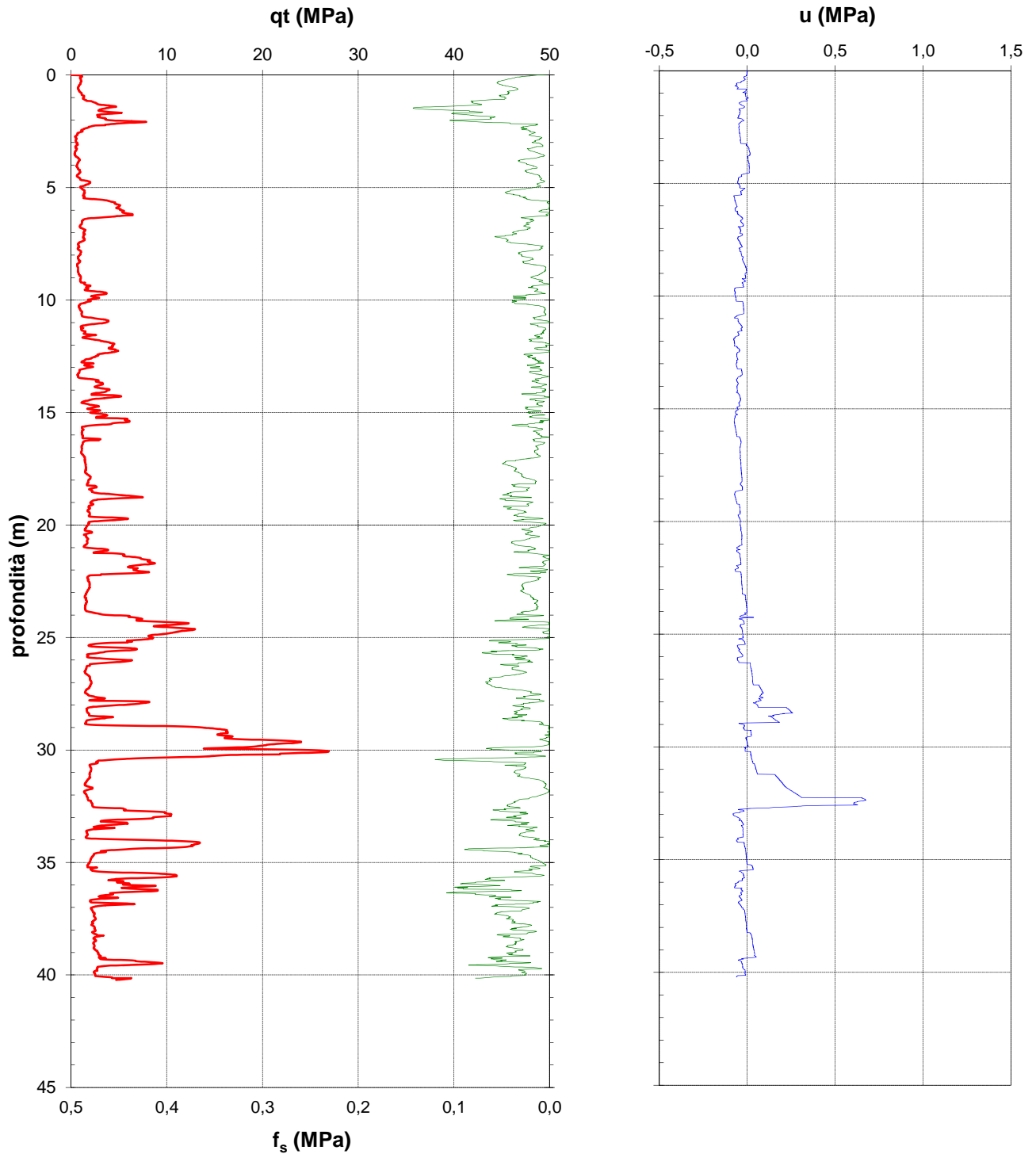
Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A-B-C

Procedura di riferimento: ASTM D 5778 (2000)

Certificato di prova n°:

rev.	data emiss.	Sperimentatore	Direttore
0	30/03/2017	Ranzini	Saccenti

Committente:	Unione Comuni Reno Galliera
Cantiere:	Castel Maggiore
Prova:	SCPTU1
Data prova:	



Coordinate:	X =	Y =	Z =
Quote (m):	inizio prova = piano campagna		fine prova = 40.31 (40.22)

Note: Prova eseguita con piezocono n. 510

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

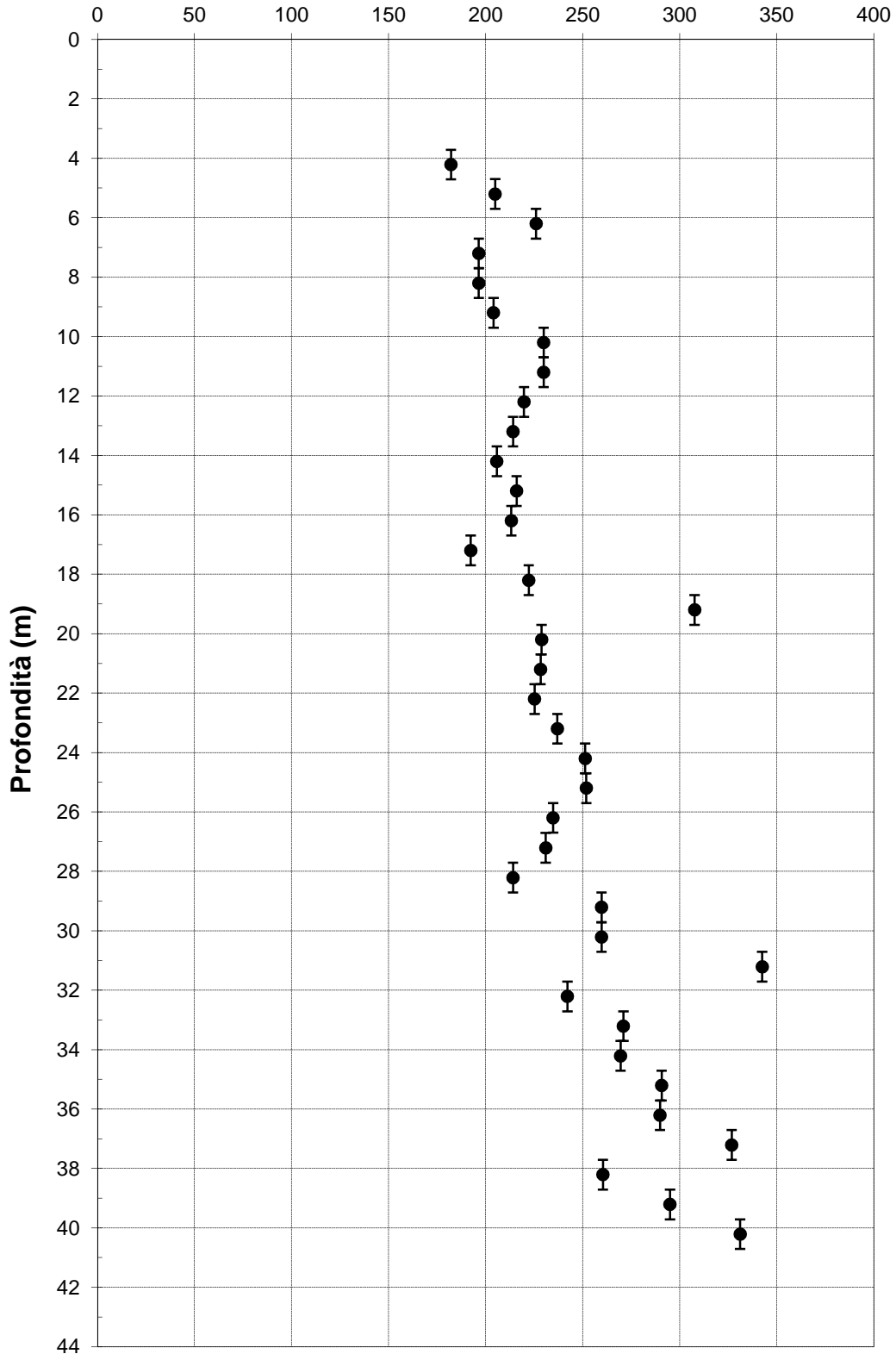
rev.	data emiss.	eseguito da	elaborato da
0	30/03/2017	Ranzini	Saccenti

Procedura di riferimento: PT 162

037019P246SCPT289

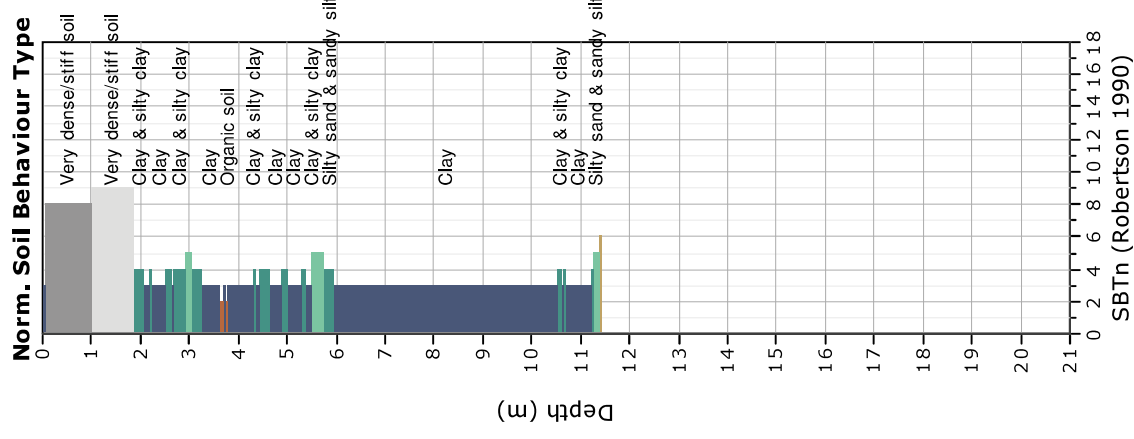
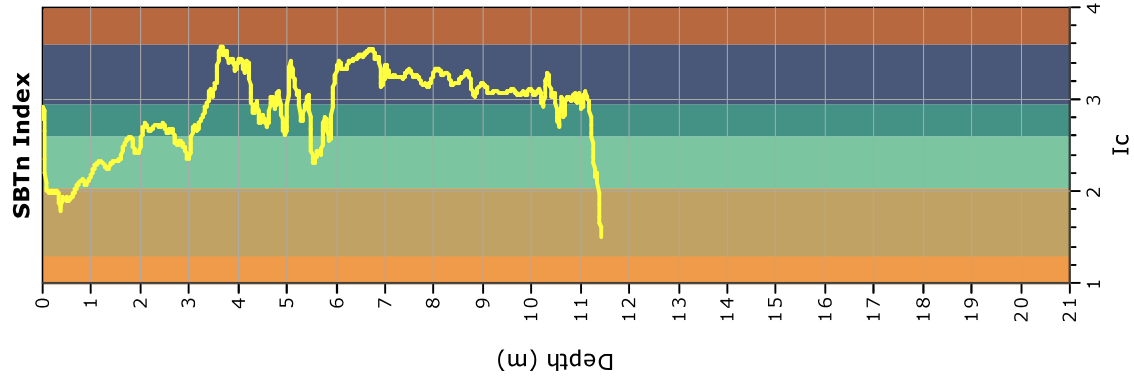
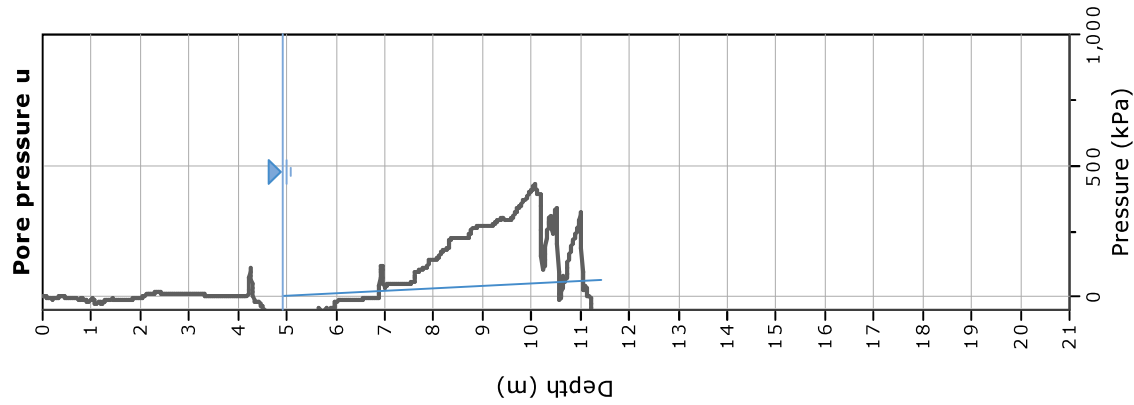
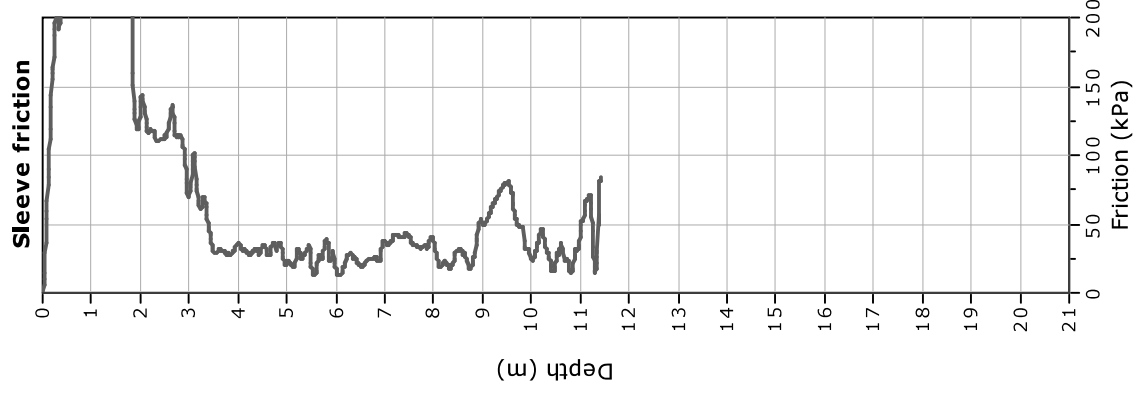
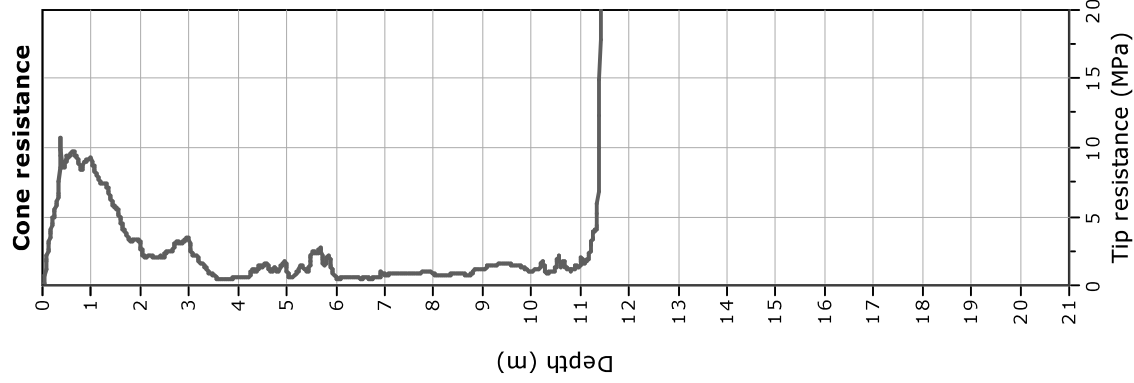
Committente:	Unione Comuni Reno Galliera
Cantiere:	Castel Maggiore
Prova:	DH1
Data prova:	03/03/2017

Velocità onde di taglio V_{SVH} (m/s)



Project: Microzonazione Sismica Castel Maggiore

Location: Trebbo - Castel Maggiore (BO)



CASTEL MAGGIORE_MS, MS 2017 TR2 TREBBO 037019P251HVS295

Strumento: TRZ-0108/01-10

Inizio registrazione: 25/09/17 10:43:15 Fine registrazione: 25/09/17 11:03:16

Nomi canali: NORTH SOUTH; EAST WEST ; UP DOWN

Durata registrazione: 0h20'00". Analizzato 85% tracciato (selezione manuale)

Freq. campionamento: 128 Hz

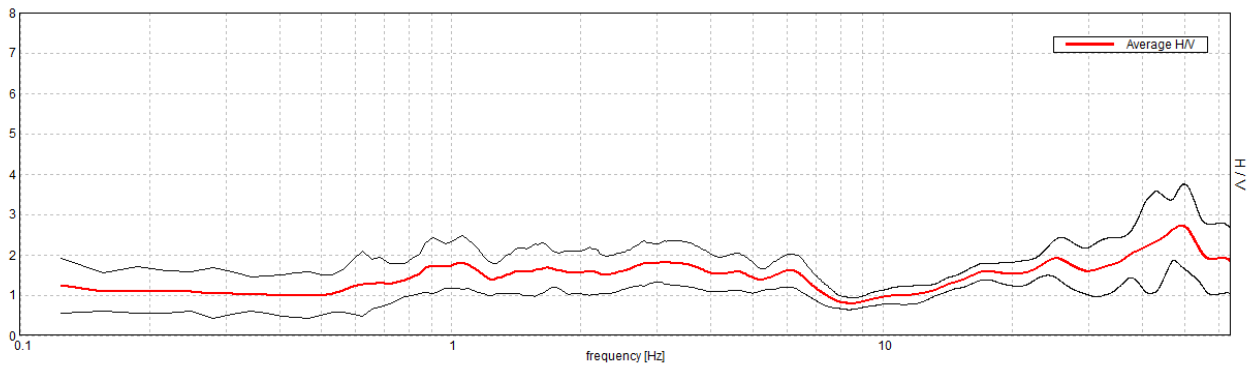
Lunghezza finestre: 20 s

Tipo di lisciamento: Triangular window

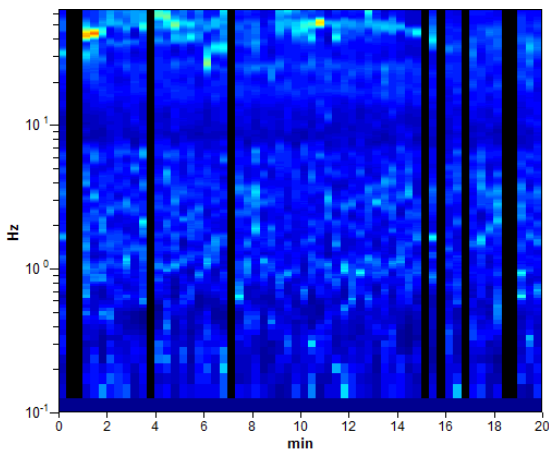
Lisciamento: 10%

RAPPORTO SPETTRALE ORIZZONTALE SU VERTICALE

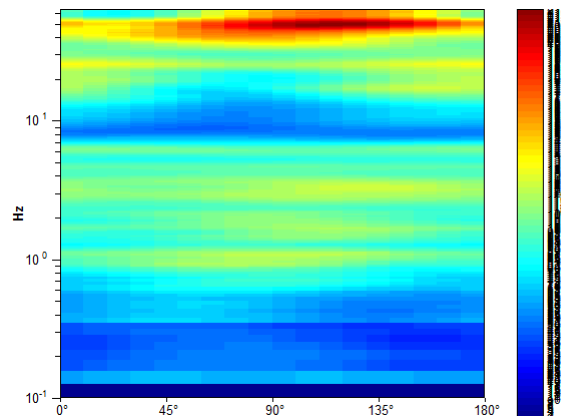
Max. H/V at 3.09 ± 0.56 Hz. (In the range 0.1 - 20.0 Hz).



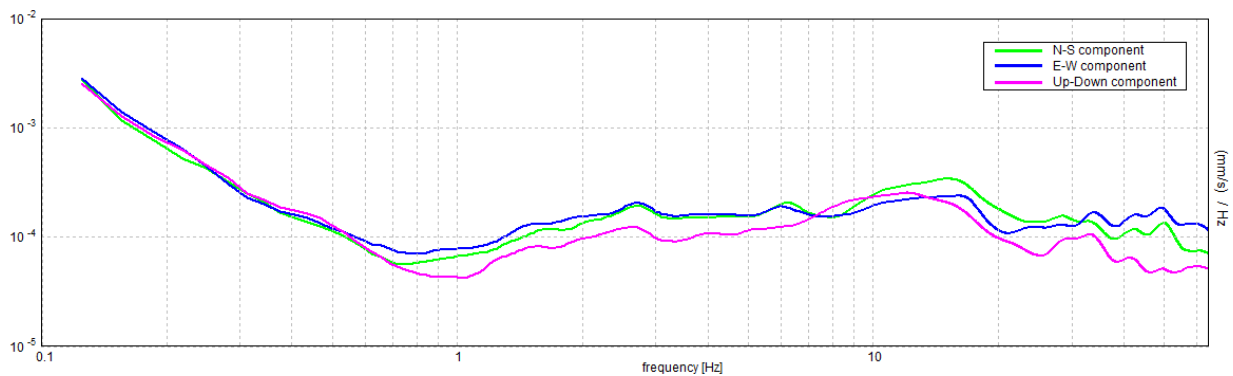
SERIE TEMPORALE H/V



DIREZIONALITA' H/V



SPETTRI DELLE SINGOLE COMPONENTI



[Secondo le linee guida SESAME, 2005. Si raccomanda di leggere attentamente il manuale di Grilla prima di interpretare la tabella seguente].

Picco H/V a 3.09 ± 0.56 Hz (nell'intervallo 0.1 - 20.0 Hz).

Criteri per una curva H/V affidabile

[Tutti 3 dovrebbero risultare soddisfatti]

$f_0 > 10 / L_w$	$3.09 > 0.50$	OK	
$n_c(f_0) > 200$	$3155.6 > 200$	OK	
$\sigma_A(f) < 2$ per $0.5f_0 < f < 2f_0$ se $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ per $0.5f_0 < f < 2f_0$ se $f_0 < 0.5\text{Hz}$	Superato 0 volte su 150	OK	

Criteri per un picco H/V chiaro

[Almeno 5 su 6 dovrebbero essere soddisfatti]

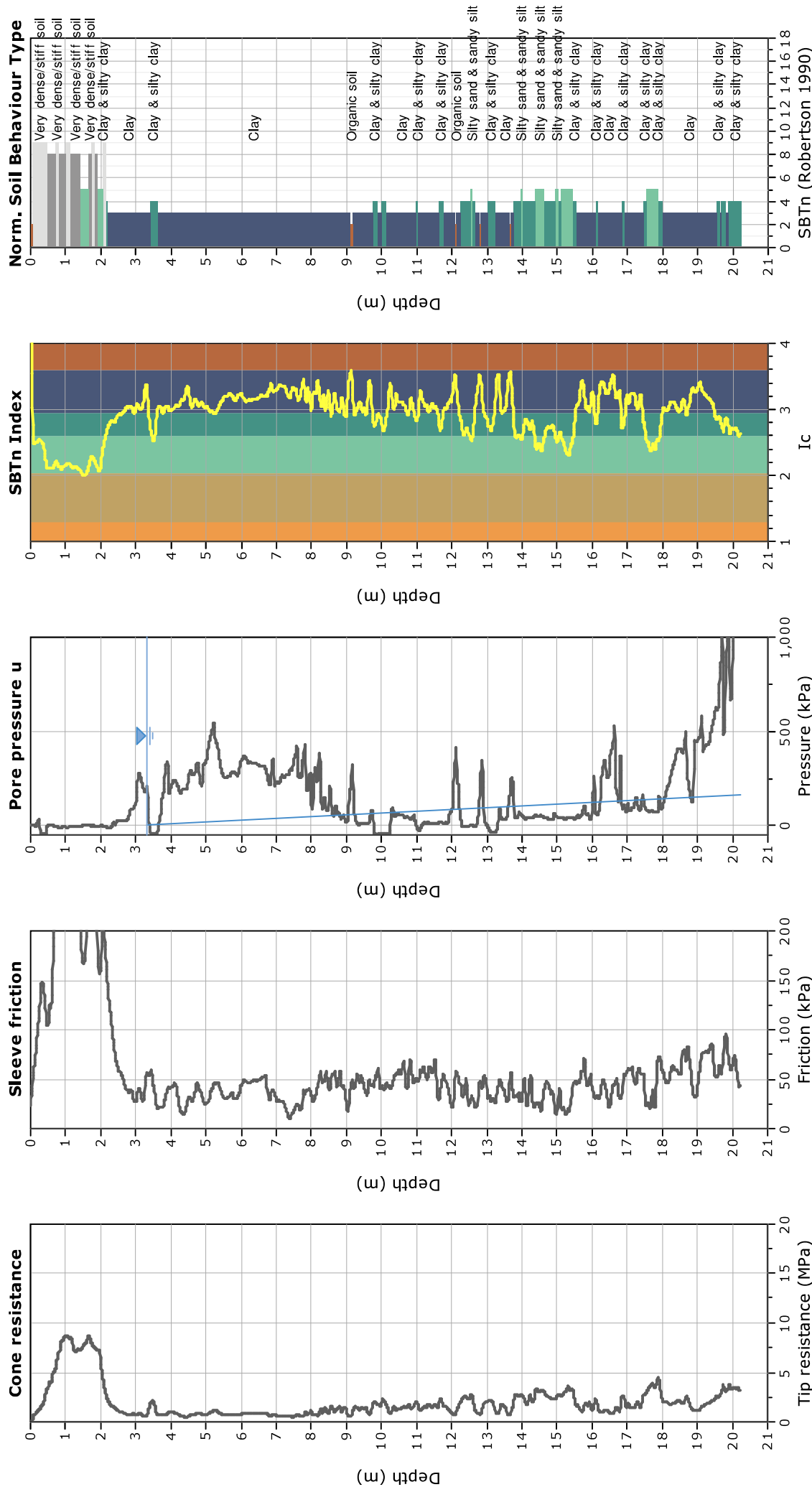
Esiste f^- in $[f_0/4, f_0]$ $A_{H/V}(f^-) < A_0 / 2$			NO
Esiste f^+ in $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	7.656 Hz	OK	
$A_0 > 2$	$1.81 > 2$		NO
$f_{\text{picco}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.08933 < 0.05$		NO
$\sigma_f < \varepsilon(f_0)$	$0.27637 < 0.15469$		NO
$\sigma_A(f_0) < \theta(f_0)$	$0.2534 < 1.58$	OK	

L_w	lunghezza della finestra
n_w	numero di finestre usate nell'analisi
$n_c = L_w n_w f_0$	numero di cicli significativi
f	frequenza attuale
f_0	frequenza del picco H/V
σ_f	deviazione standard della frequenza del picco H/V
$\varepsilon(f_0)$	valore di soglia per la condizione di stabilità $\sigma_f < \varepsilon(f_0)$
A_0	ampiezza della curva H/V alla frequenza f_0
$A_{H/V}(f)$	ampiezza della curva H/V alla frequenza f
f^-	frequenza tra $f_0/4$ e f_0 alla quale $A_{H/V}(f^-) < A_0/2$
f^+	frequenza tra f_0 e $4f_0$ alla quale $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	deviazione standard di $A_{H/V}(f)$, $\sigma_A(f)$ è il fattore per il quale la curva $A_{H/V}(f)$ media deve essere moltiplicata o divisa
$\sigma_{\log H/V}(f)$	deviazione standard della funzione $\log A_{H/V}(f)$
$\theta(f_0)$	valore di soglia per la condizione di stabilità $\sigma_A(f) < \theta(f_0)$

Valori di soglia per σ_f e $\sigma_A(f_0)$

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

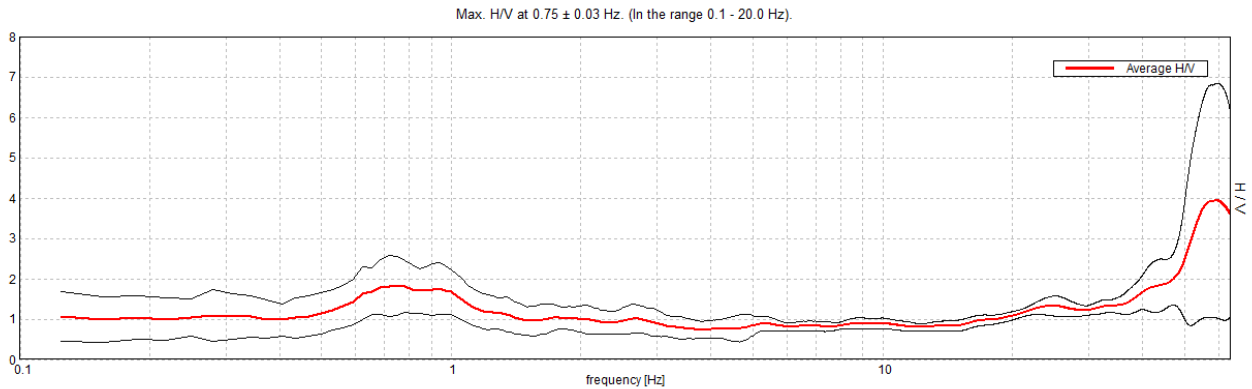
Project: Microzonazione Sismica Castel Maggiore
Location: viale Europa - Castel Maggiore (BO)



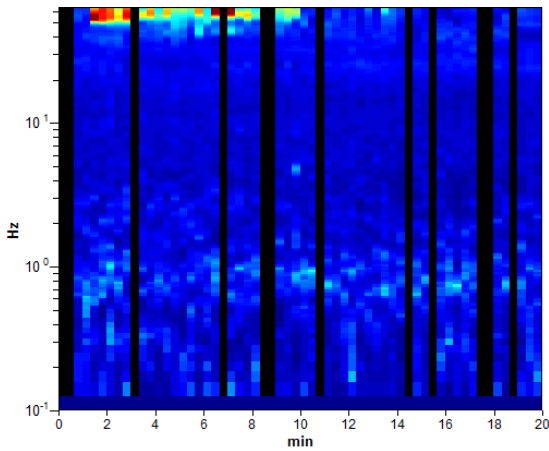
CASTEL MAGGIORE_MS, MS 2017 TR3 VIALE EUROPA 037019P252HVSR297

Strumento: TRZ-0108/01-10
 Inizio registrazione: 25/09/17 12:25:52 Fine registrazione: 25/09/17 12:45:53
 Nomi canali: NORTH SOUTH; EAST WEST ; UP DOWN
 Durata registrazione: 0h20'00". Analizzato 80% tracciato (selezione manuale)
 Freq. campionamento: 128 Hz
 Lunghezza finestre: 20 s
 Tipo di lisciamento: Triangular window
 Lisciamento: 10%

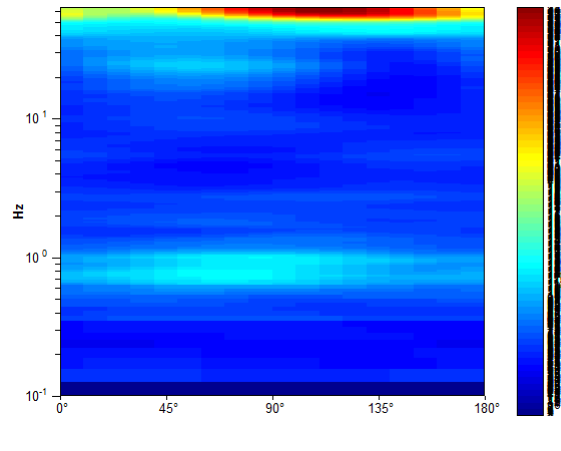
RAPPORTO SPETTRALE ORIZZONTALE SU VERTICALE



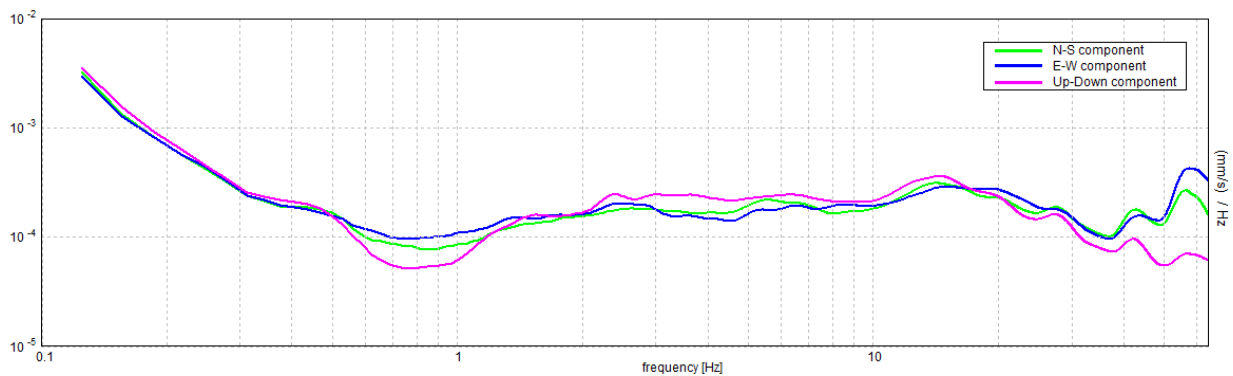
SERIE TEMPORALE H/V



DIREZIONALITA' H/V



SPETTRI DELLE SINGOLE COMPONENTI



[Secondo le linee guida SESAME, 2005. Si raccomanda di leggere attentamente il manuale di Grilla prima di interpretare la tabella seguente].

Picco H/V a 0.75 ± 0.03 Hz (nell'intervallo 0.1 - 20.0 Hz).

Criteri per una curva H/V affidabile

[Tutti 3 dovrebbero risultare soddisfatti]

$f_0 > 10 / L_w$	$0.75 > 0.50$	OK	
$n_c(f_0) > 200$	$720.0 > 200$	OK	
$\sigma_A(f) < 2$ per $0.5f_0 < f < 2f_0$ se $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ per $0.5f_0 < f < 2f_0$ se $f_0 < 0.5\text{Hz}$	Superato 0 volte su 37	OK	

Criteri per un picco H/V chiaro

[Almeno 5 su 6 dovrebbero essere soddisfatti]

Esiste f^- in $[f_0/4, f_0]$ $A_{H/V}(f^-) < A_0 / 2$			NO
Esiste f^+ in $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	2.313 Hz	OK	
$A_0 > 2$	$1.82 > 2$		NO
$f_{\text{picco}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01958 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01469 < 0.1125$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3555 < 2.0$	OK	

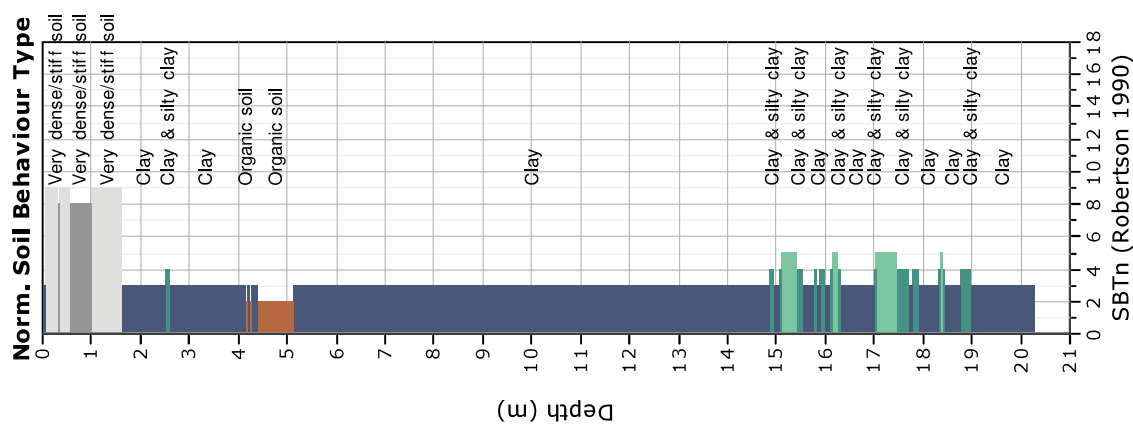
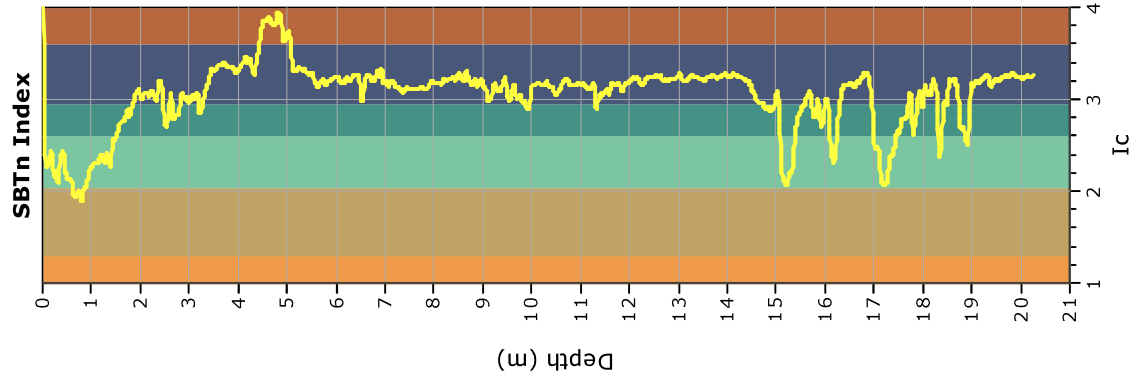
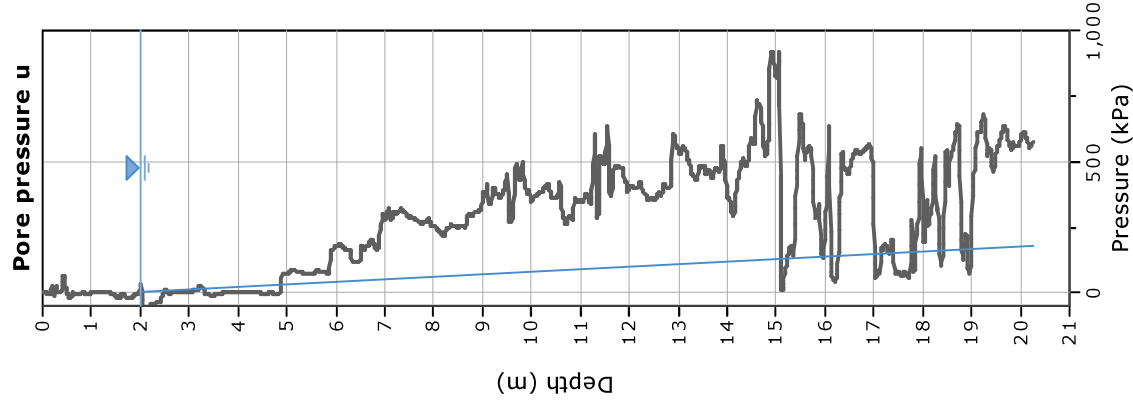
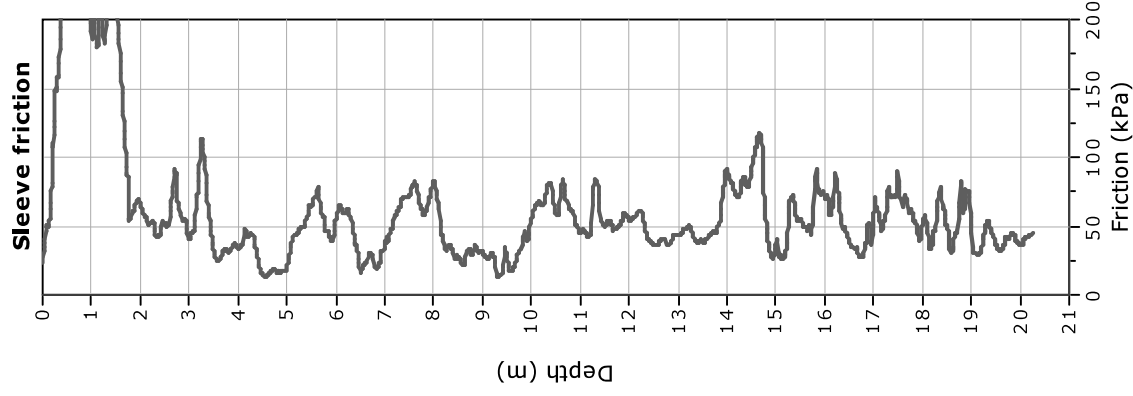
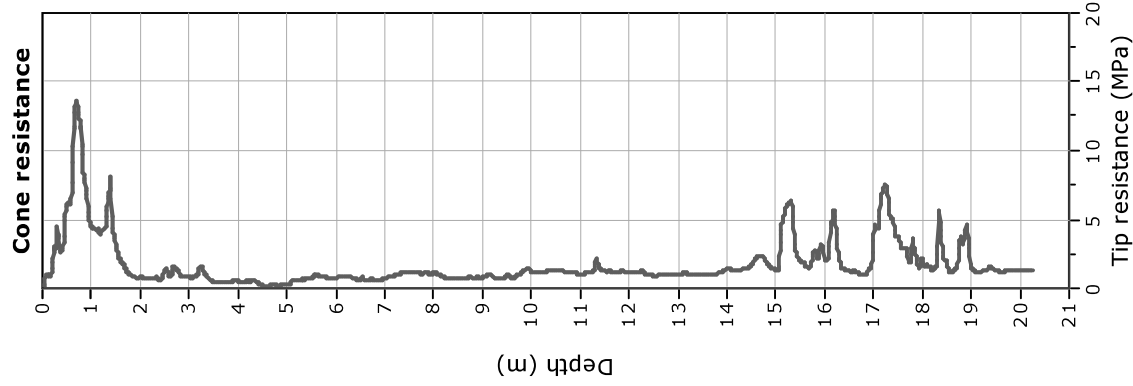
L_w	lunghezza della finestra
n_w	numero di finestre usate nell'analisi
$n_c = L_w n_w f_0$	numero di cicli significativi
f	frequenza attuale
f_0	frequenza del picco H/V
σ_f	deviazione standard della frequenza del picco H/V
$\varepsilon(f_0)$	valore di soglia per la condizione di stabilità $\sigma_f < \varepsilon(f_0)$
A_0	ampiezza della curva H/V alla frequenza f_0
$A_{H/V}(f)$	ampiezza della curva H/V alla frequenza f
f^-	frequenza tra $f_0/4$ e f_0 alla quale $A_{H/V}(f^-) < A_0/2$
f^+	frequenza tra f_0 e $4f_0$ alla quale $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	deviazione standard di $A_{H/V}(f)$, $\sigma_A(f)$ è il fattore per il quale la curva $A_{H/V}(f)$ media deve essere moltiplicata o divisa
$\sigma_{\log H/V}(f)$	deviazione standard della funzione $\log A_{H/V}(f)$
$\theta(f_0)$	valore di soglia per la condizione di stabilità $\sigma_A(f) < \theta(f_0)$

Valori di soglia per σ_f e $\sigma_A(f_0)$

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

Project: Microzonazione Sismica Castel Maggiore

Location: via Albertina - Castel Maggiore (BO)

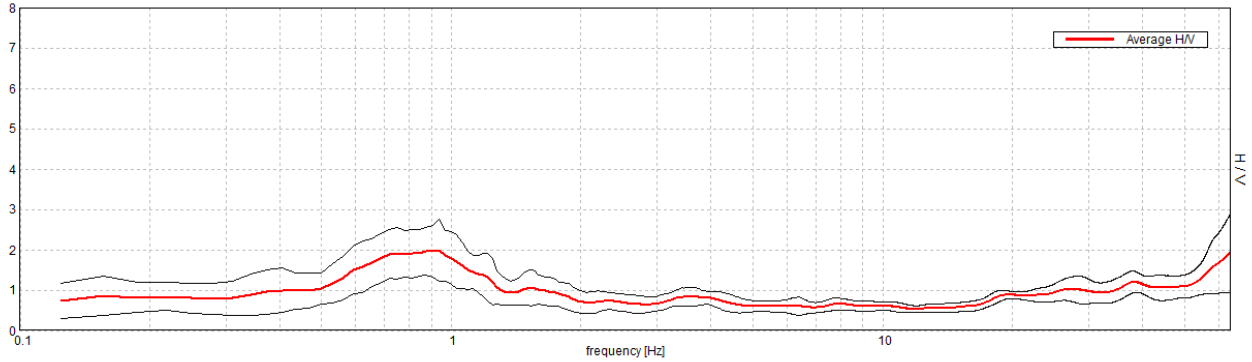


CASTEL MAGGIORE_MS, MS 2017 TR4 VIA ALBERTINA 037019P253HVSR299

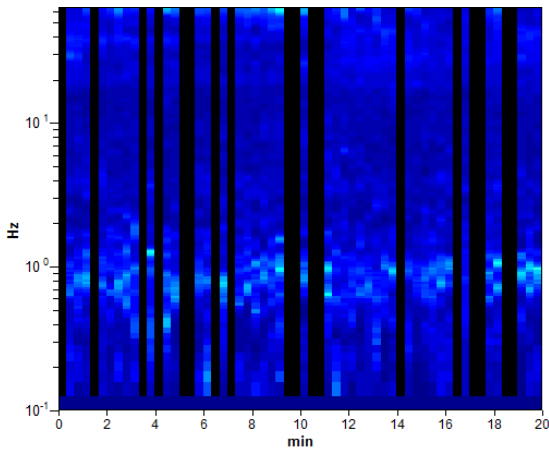
Strumento: TRZ-0108/01-10
 Inizio registrazione: 25/09/17 15:11:44 Fine registrazione: 25/09/17 15:31:45
 Nomi canali: NORTH SOUTH; EAST WEST ; UP DOWN
 Durata registrazione: 0h20'00". Analizzato 70% tracciato (selezione manuale)
 Freq. campionamento: 128 Hz
 Lunghezza finestre: 20 s
 Tipo di lisciamento: Triangular window
 Lisciamento: 10%

RAPPORTO SPETTRALE ORIZZONTALE SU VERTICALE

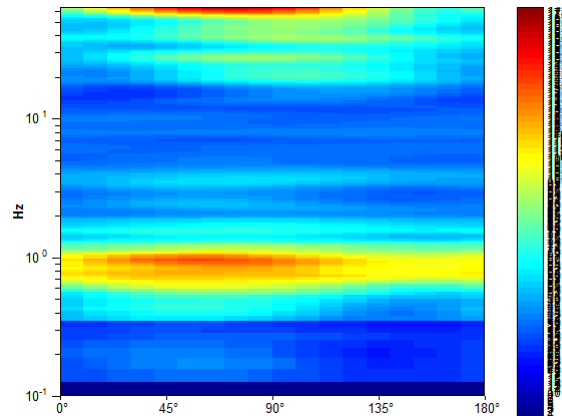
Max. H/V at 0.94 ± 0.06 Hz. (In the range 0.1 - 20.0 Hz).



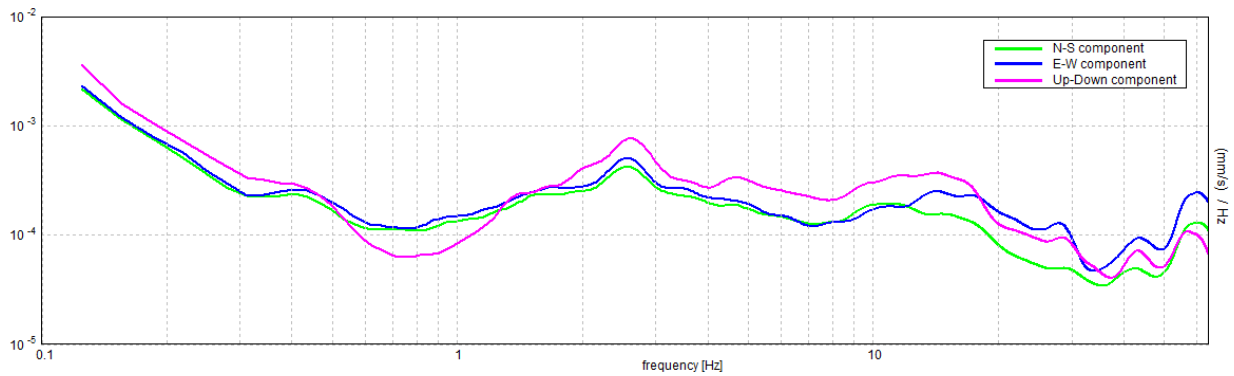
SERIE TEMPORALE H/V



DIREZIONALITA' H/V



SPETTRI DELLE SINGOLE COMPONENTI



[Secondo le linee guida SESAME, 2005. Si raccomanda di leggere attentamente il manuale di Grilla prima di interpretare la tabella seguente].

Picco H/V a 0.94 ± 0.06 Hz (nell'intervallo 0.1 - 20.0 Hz).

Criteri per una curva H/V affidabile

[Tutti 3 dovrebbero risultare soddisfatti]

$f_0 > 10 / L_w$	$0.94 > 0.50$	OK	
$n_c(f_0) > 200$	$787.5 > 200$	OK	
$\sigma_A(f) < 2$ per $0.5f_0 < f < 2f_0$ se $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ per $0.5f_0 < f < 2f_0$ se $f_0 < 0.5\text{Hz}$	Superato 0 volte su 46	OK	

Criteri per un picco H/V chiaro

[Almeno 5 su 6 dovrebbero essere soddisfatti]

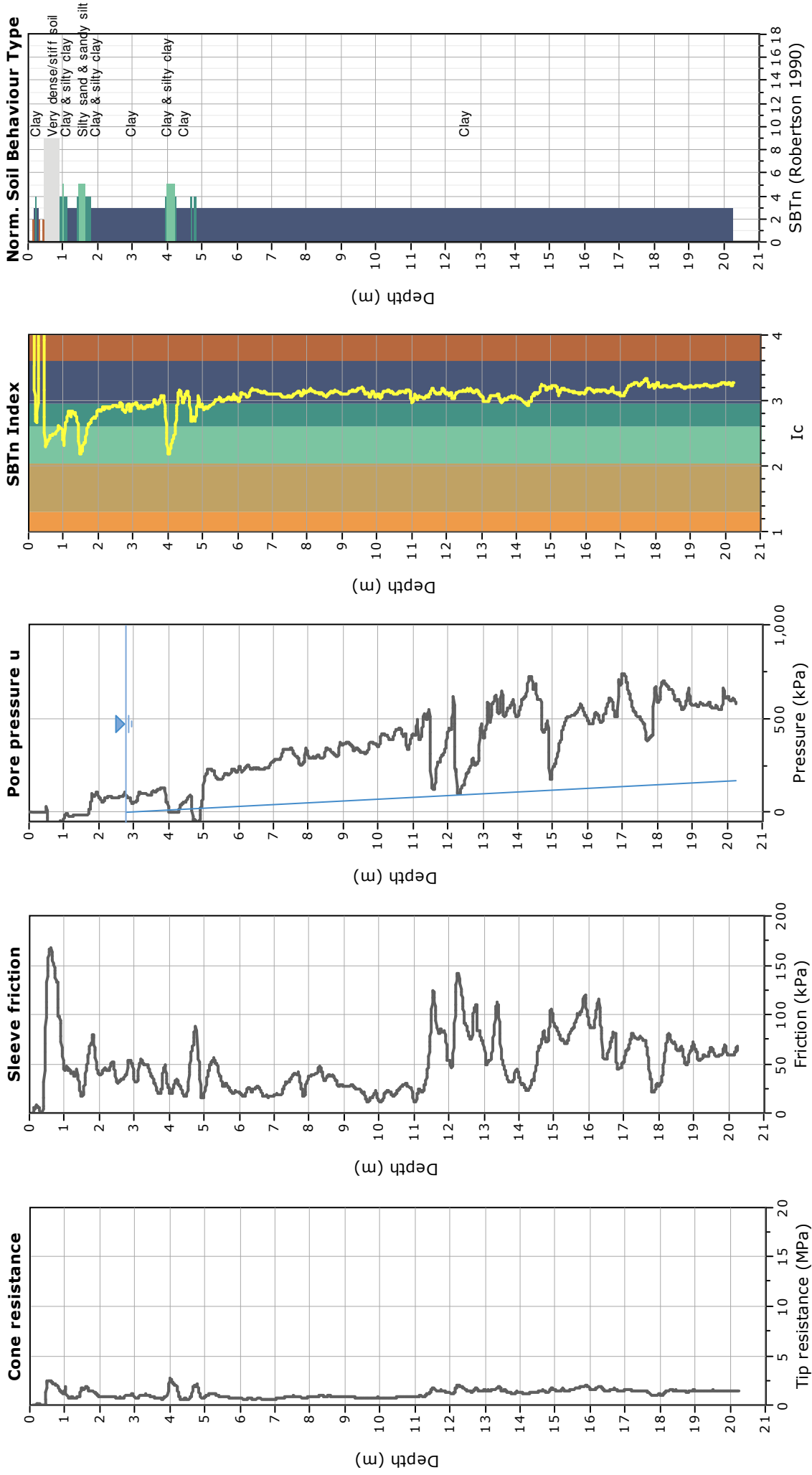
Esiste f^- in $[f_0/4, f_0]$ $A_{H/V}(f^-) < A_0 / 2$	0.469 Hz	OK	
Esiste f^+ in $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	1.344 Hz	OK	
$A_0 > 2$	$1.98 > 2$		NO
$f_{\text{picco}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.03025 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.02836 < 0.14063$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3761 < 2.0$	OK	

L_w	lunghezza della finestra
n_w	numero di finestre usate nell'analisi
$n_c = L_w n_w f_0$	numero di cicli significativi
f	frequenza attuale
f_0	frequenza del picco H/V
σ_f	deviazione standard della frequenza del picco H/V
$\varepsilon(f_0)$	valore di soglia per la condizione di stabilità $\sigma_f < \varepsilon(f_0)$
A_0	ampiezza della curva H/V alla frequenza f_0
$A_{H/V}(f)$	ampiezza della curva H/V alla frequenza f
f^-	frequenza tra $f_0/4$ e f_0 alla quale $A_{H/V}(f^-) < A_0/2$
f^+	frequenza tra f_0 e $4f_0$ alla quale $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	deviazione standard di $A_{H/V}(f)$, $\sigma_A(f)$ è il fattore per il quale la curva $A_{H/V}(f)$ media deve essere moltiplicata o divisa
$\sigma_{\log H/V}(f)$	deviazione standard della funzione $\log A_{H/V}(f)$
$\theta(f_0)$	valore di soglia per la condizione di stabilità $\sigma_A(f) < \theta(f_0)$

Valori di soglia per σ_f e $\sigma_A(f_0)$

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

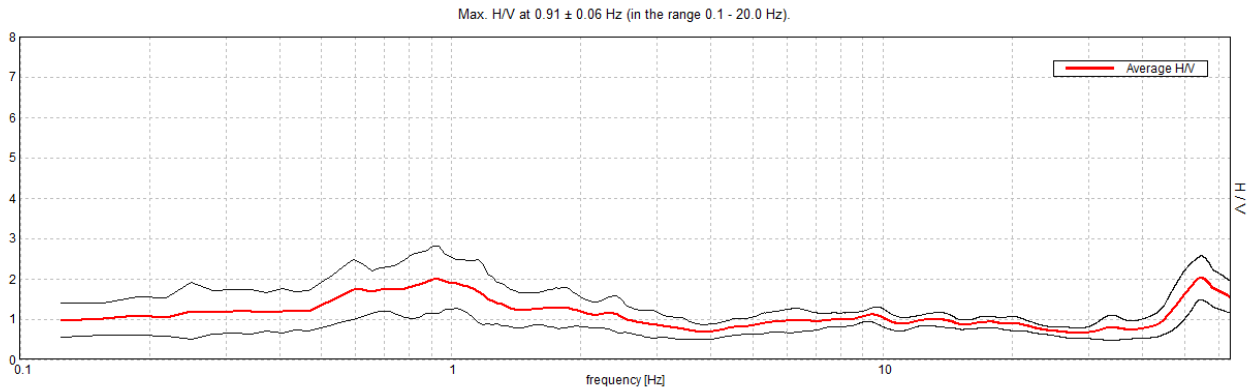
Project: Microzonazione Sismica Castel Maggiore
Location: via Costa - Castel Maggiore (BO)



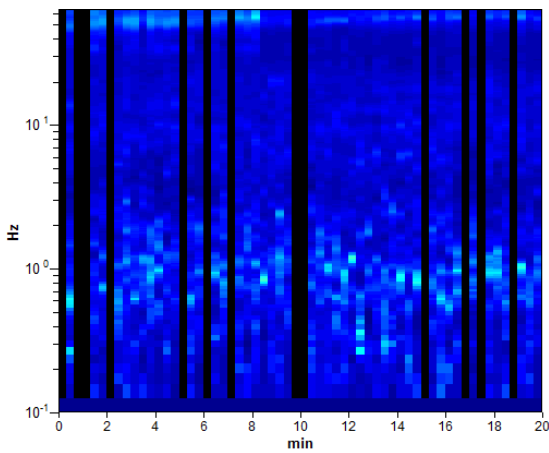
CASTEL MAGGIORE_MS, MS 2017 TR5 VIA COSTA 037019P254HVSR301

Instrument: TRZ-0108/01-10
 Start recording: 16/11/17 14:22:25 End recording: 16/11/17 14:42:26
 Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
 Trace length: 0h20'00". Analyzed 78% trace (manual window selection)
 Sampling rate: 128 Hz
 Window size: 20 s
 Smoothing type: Triangular window
 Smoothing: 10%

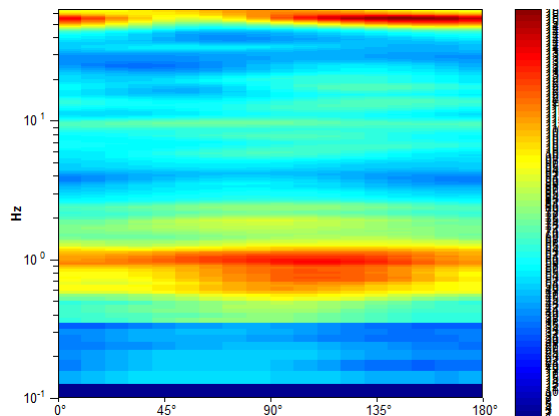
HORIZONTAL TO VERTICAL SPECTRAL RATIO



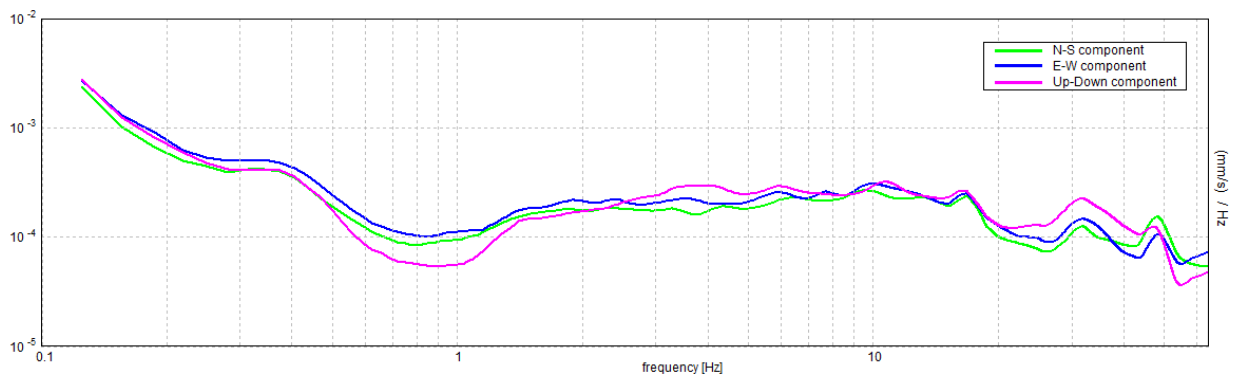
H/V TIME HISTORY



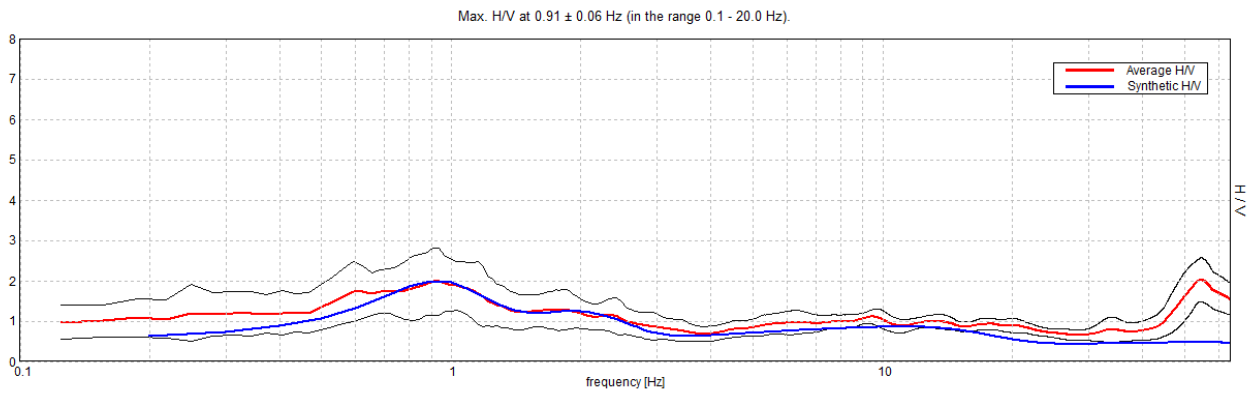
DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA

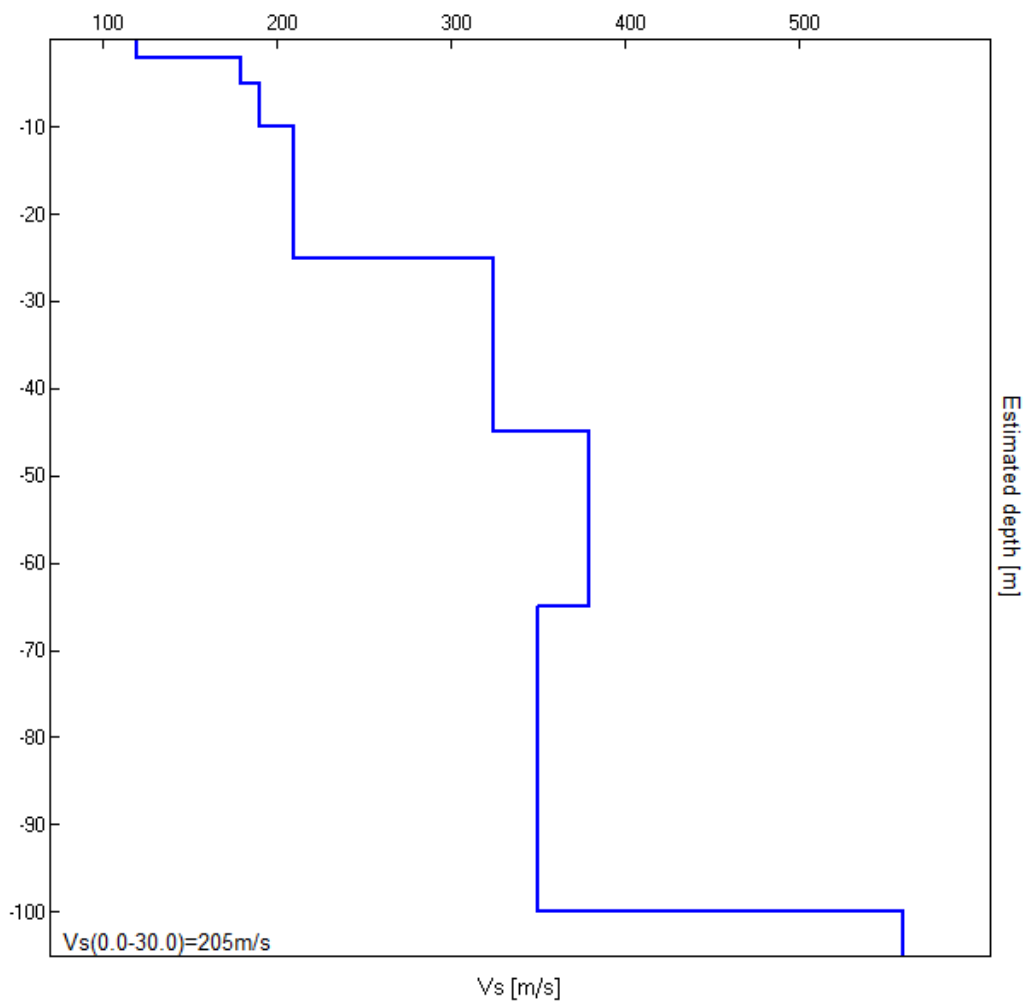


EXPERIMENTAL vs. SYNTHETIC H/V



Depth at the bottom of the layer [m]	Thickness [m]	Vs [m/s]
2.00	2.00	120
5.00	3.00	180
10.00	5.00	190
25.00	15.00	210
45.00	20.00	325
65.00	20.00	380
100.00	35.00	350
inf.	inf.	560

Vs(0.0-30.0)=205m/s



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

Max. H/V at 0.91 ± 0.06 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.91 > 0.50$	OK	
$n_c(f_0) > 200$	$851.9 > 200$	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 44 times	OK	

Criteria for a clear H/V peak

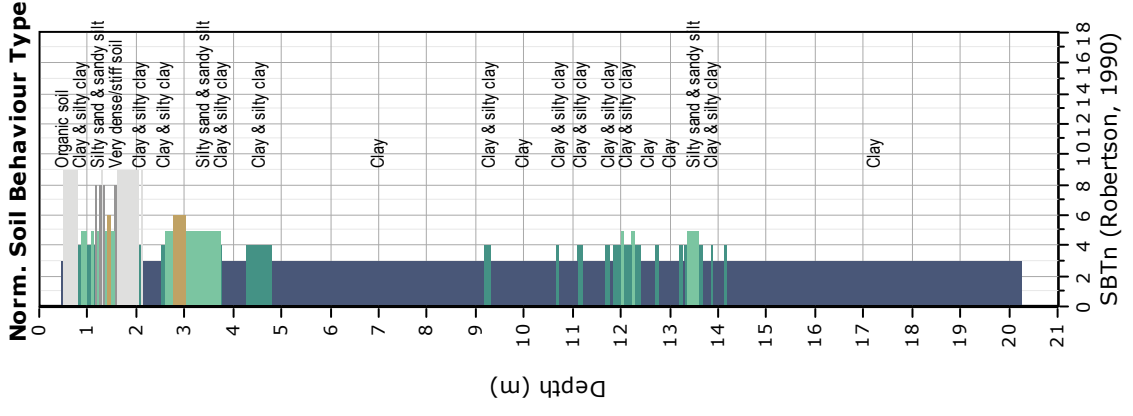
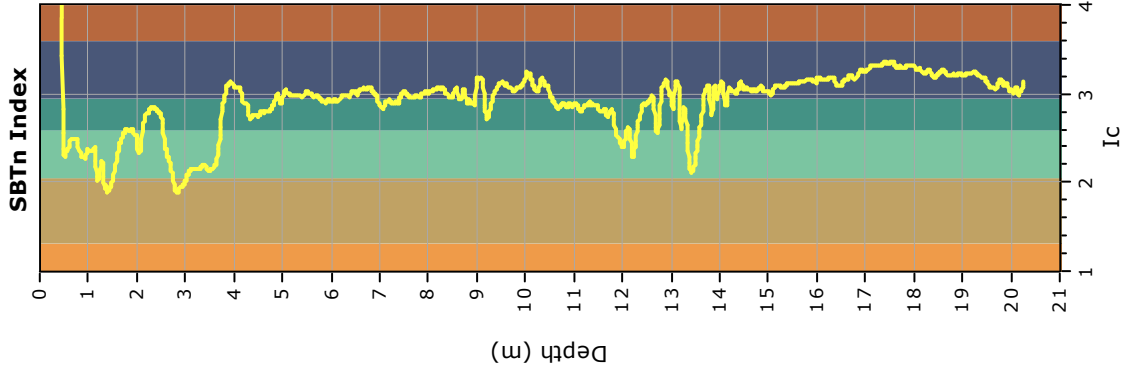
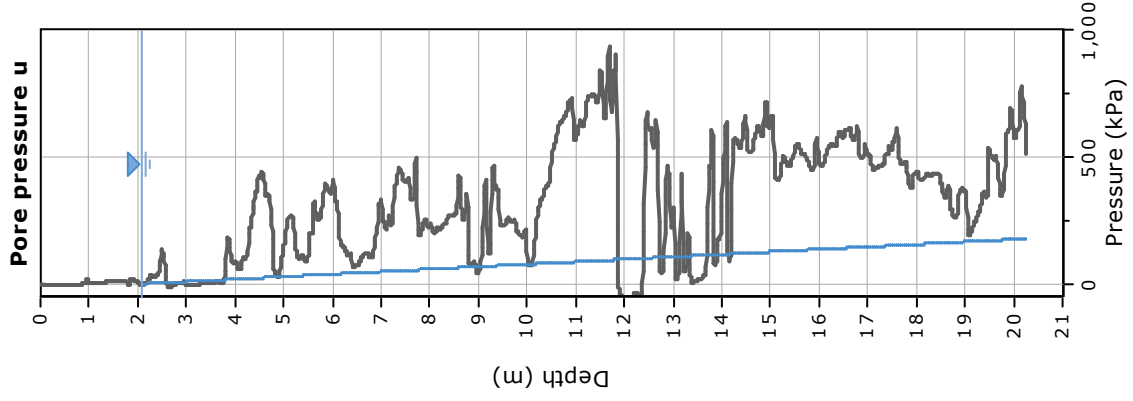
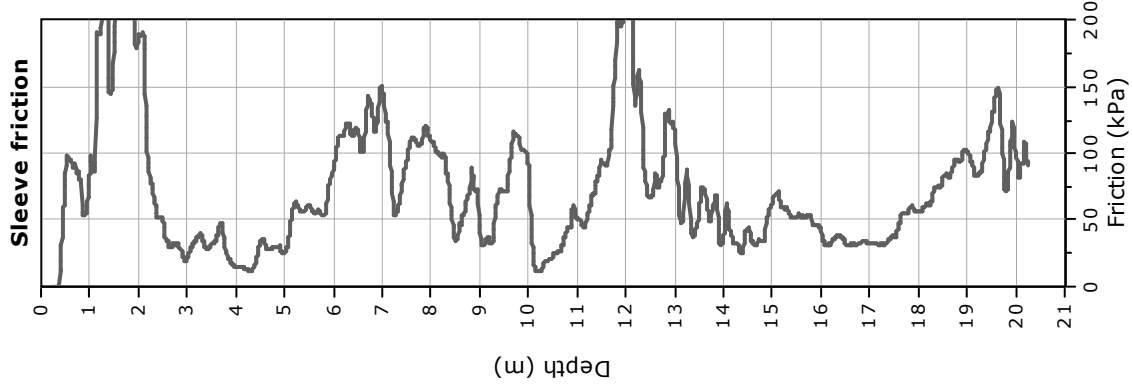
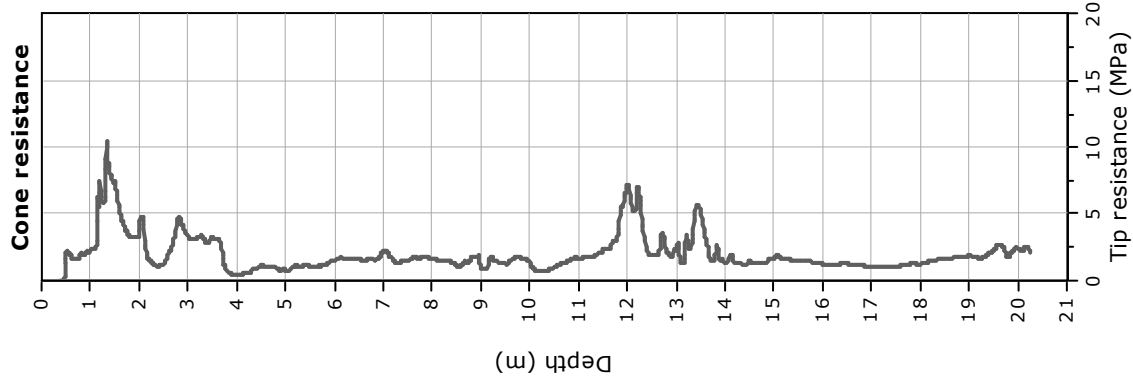
[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	2.594 Hz	OK	
$A_0 > 2$	$1.98 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.03316 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.03005 < 0.13594$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.4065 < 2.0$	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 $\sigma_A(f_0)$

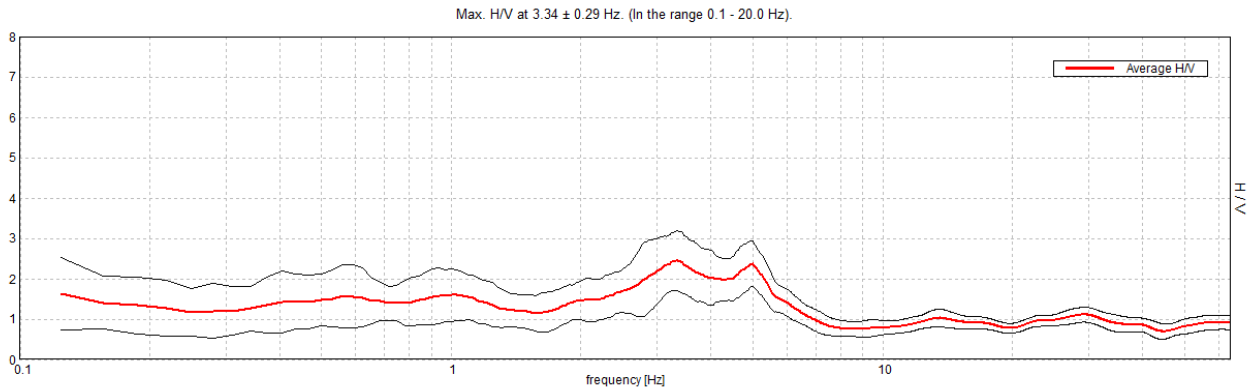
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20



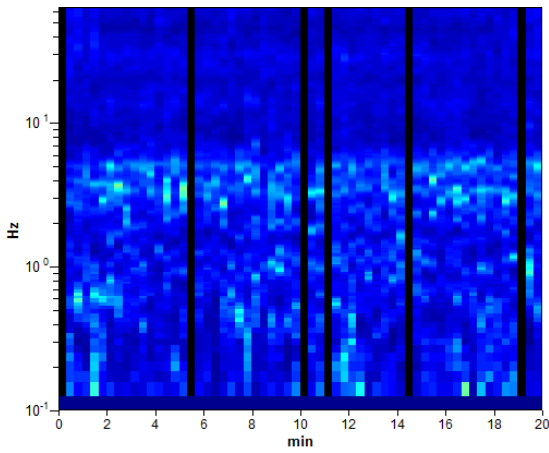
CASTEL MAGGIORE_MS, MS 2017 TR6 037019P256HVSR303

Instrument: TRZ-0108/01-10
 Start recording: 18/12/17 10:15:11 End recording: 18/12/17 10:35:12
 Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
 Trace length: 0h20'00". Analyzed 90% trace (manual window selection)
 Sampling rate: 128 Hz
 Window size: 20 s
 Smoothing type: Triangular window
 Smoothing: 10%

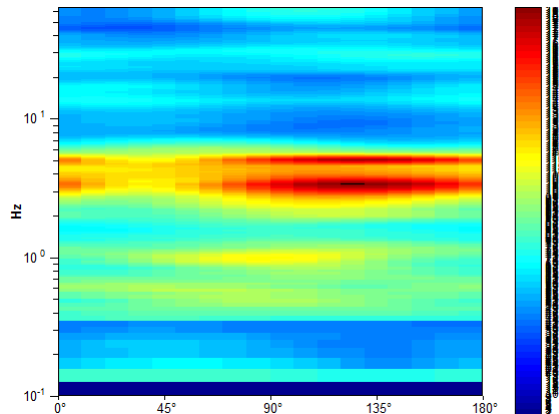
HORIZONTAL TO VERTICAL SPECTRAL RATIO



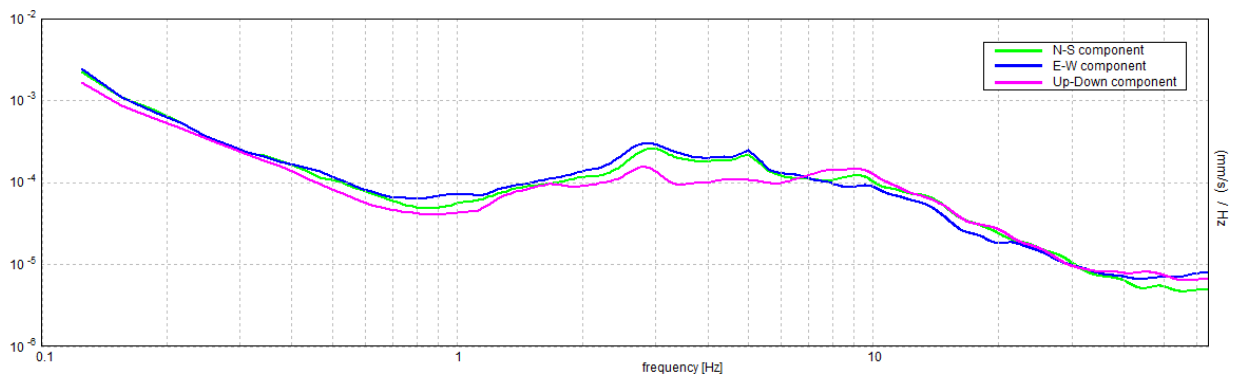
H/V TIME HISTORY



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 3.34 ± 0.29 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$3.34 > 0.50$	OK	
$n_c(f_0) > 200$	$3611.3 > 200$	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 162 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$	1.719 Hz	OK	
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	6.375 Hz	OK	
$A_0 > 2$	$2.44 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.0421 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.14078 < 0.16719$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.365 < 1.58$	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 $\sigma_A(f) < \theta(f_0)$

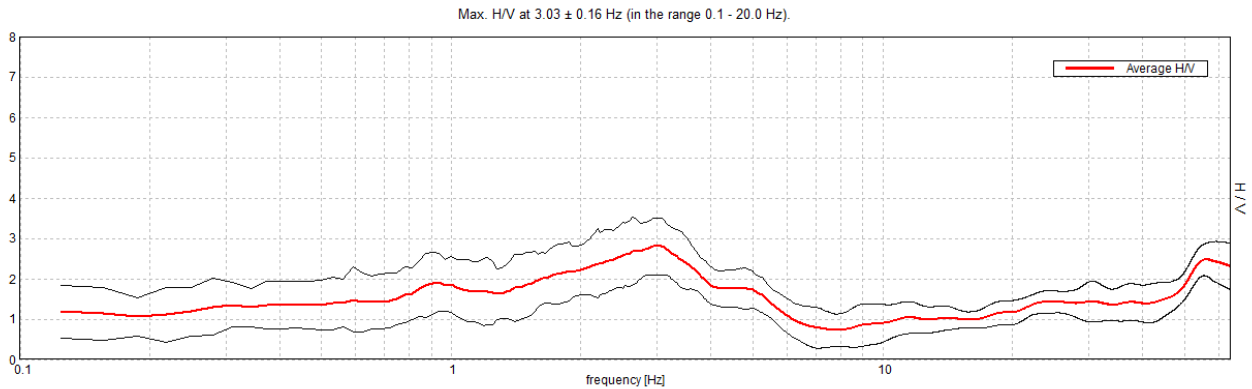
Threshold values for σ_f and $\sigma_A(f_0)$

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

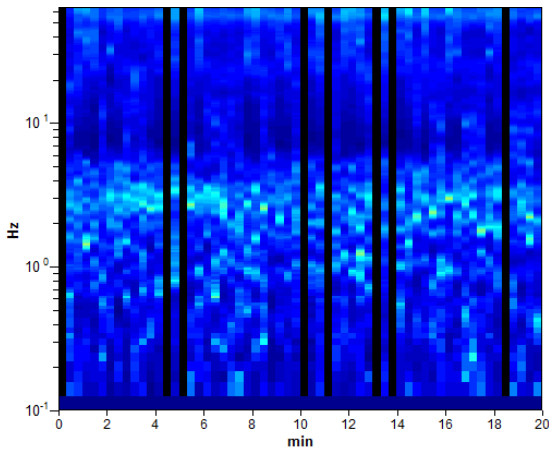
CASTEL MAGGIORE_MS, MS 2017 TR7 037019P257HVSR304

Instrument: TRZ-0108/01-10
 Start recording: 18/12/17 09:44:11 End recording: 18/12/17 10:04:12
 Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
 Trace length: 0h20'00". Analyzed 87% trace (manual window selection)
 Sampling rate: 128 Hz
 Window size: 20 s
 Smoothing type: Triangular window
 Smoothing: 10%

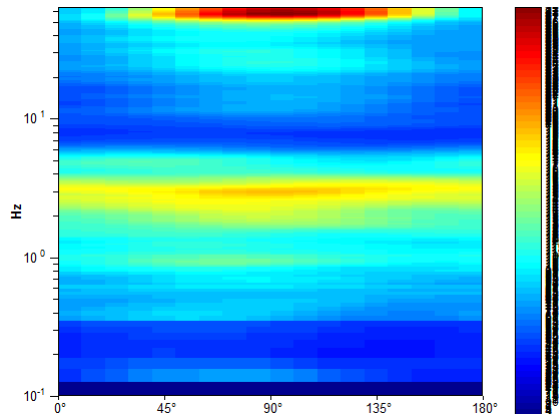
HORIZONTAL TO VERTICAL SPECTRAL RATIO



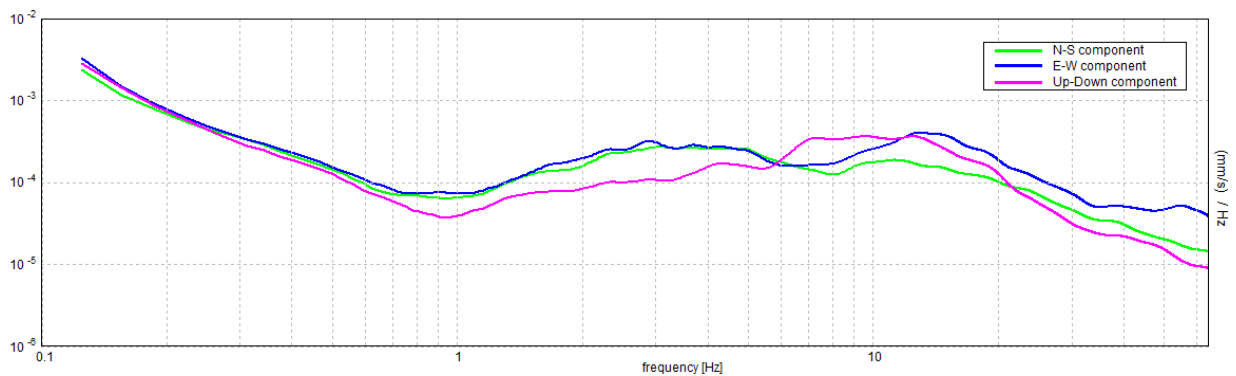
H/V TIME HISTORY



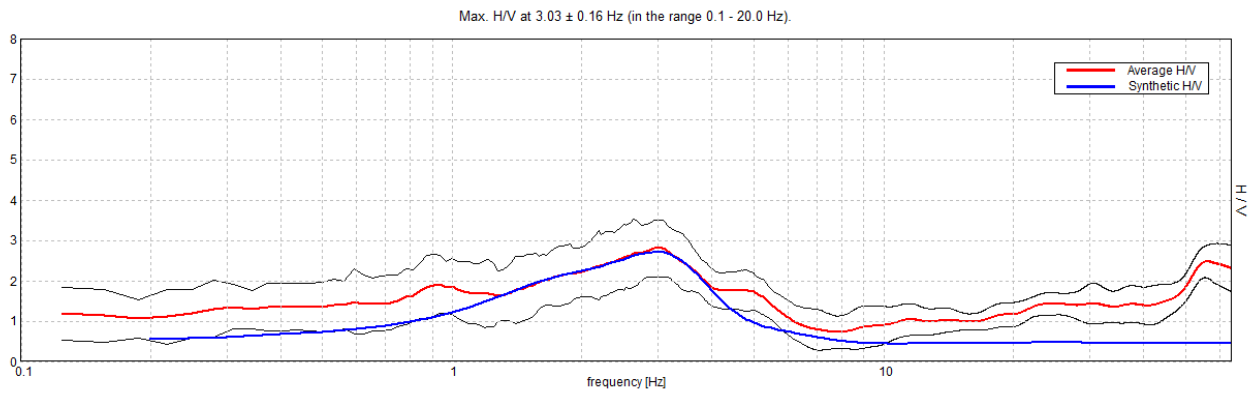
DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA

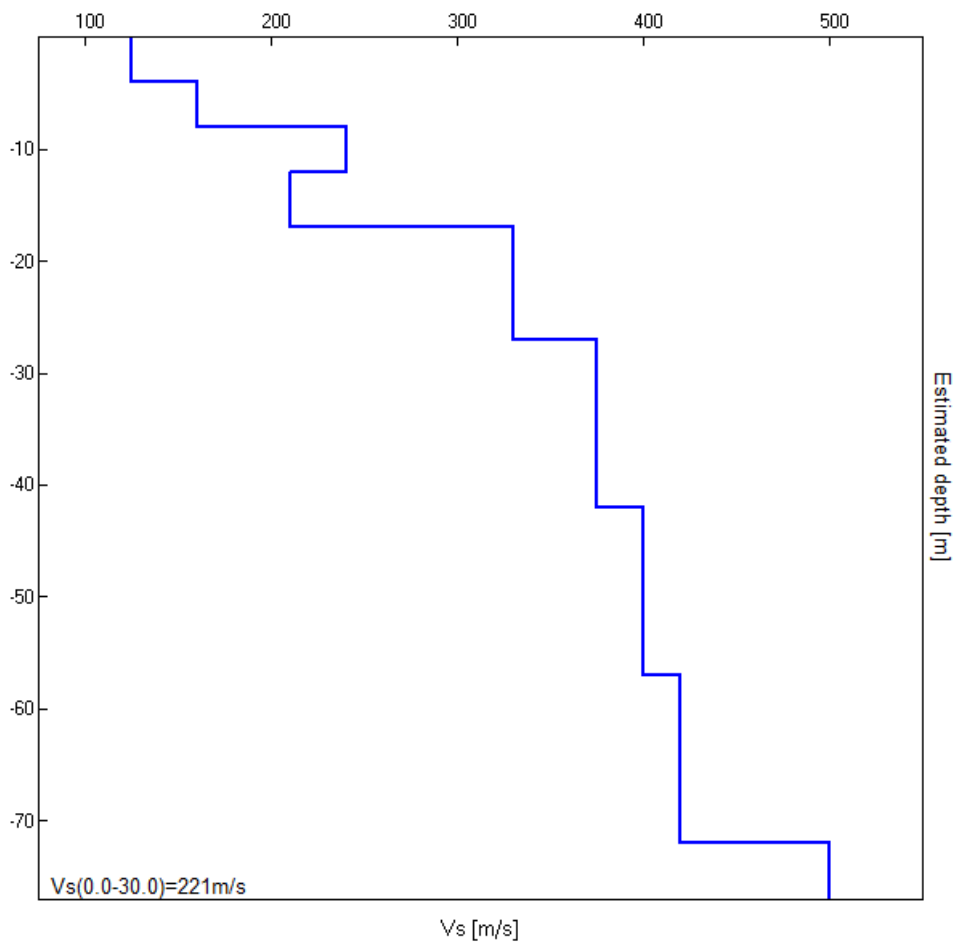


EXPERIMENTAL vs. SYNTHETIC H/V



Depth at the bottom of the layer [m]	Thickness [m]	Vs [m/s]	Poisson ratio
4.00	4.00	125	0.40
8.00	4.00	160	0.35
12.00	4.00	240	0.35
17.00	5.00	210	0.35
27.00	10.00	330	0.35
42.00	15.00	375	0.35
57.00	15.00	400	0.35
72.00	15.00	420	0.35
inf.	inf.	500	0.35

Vs(0.0-30.0)=221m/s



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

Max. H/V at 3.03 ± 0.16 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$3.03 > 0.50$	OK	
$n_c(f_0) > 200$	$3152.5 > 200$	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 146 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 $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	5.531 Hz	OK	
$A_0 > 2$	$2.81 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.02662 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.08068 < 0.15156$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3481 < 1.58$	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 $\sigma_A(f) < \theta(f_0)$

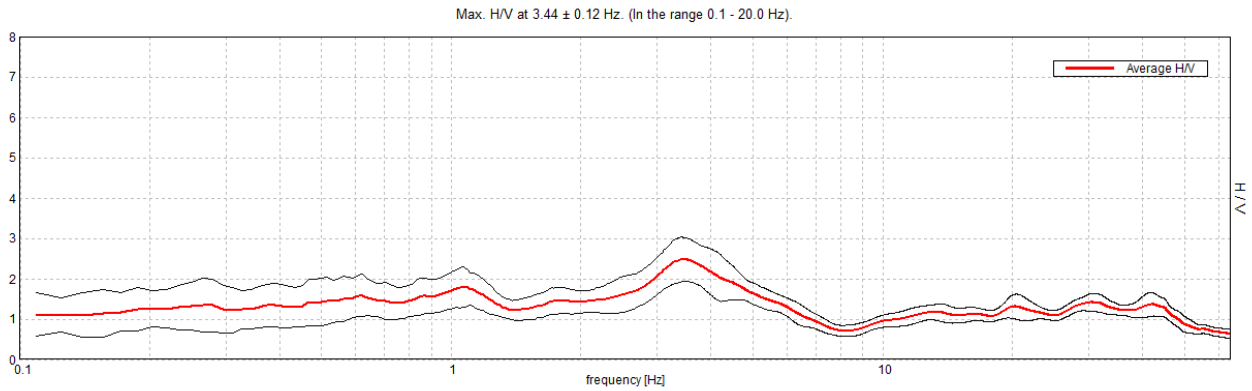
Threshold values for σ_f and $\sigma_A(f_0)$

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

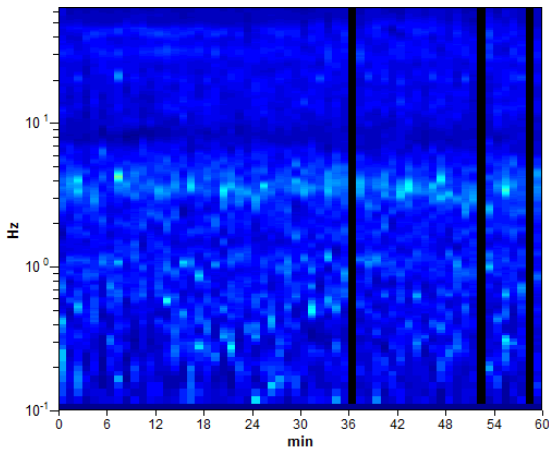
CASTEL MAGGIORE_MS, MS 2017 TR8 037019P258HVSR305

Instrument: TRZ-0108/01-10
Start recording: 18/12/17 10:41:34 End recording: 18/12/17 11:41:35
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
Trace length: 1h00'00". Analyzed 95% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 60 s
Smoothing type: Triangular window
Smoothing: 10%

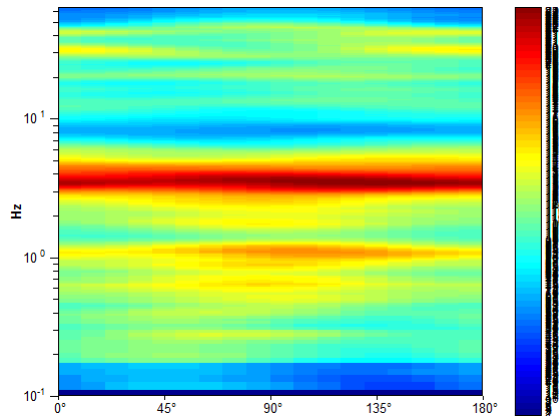
HORIZONTAL TO VERTICAL SPECTRAL RATIO



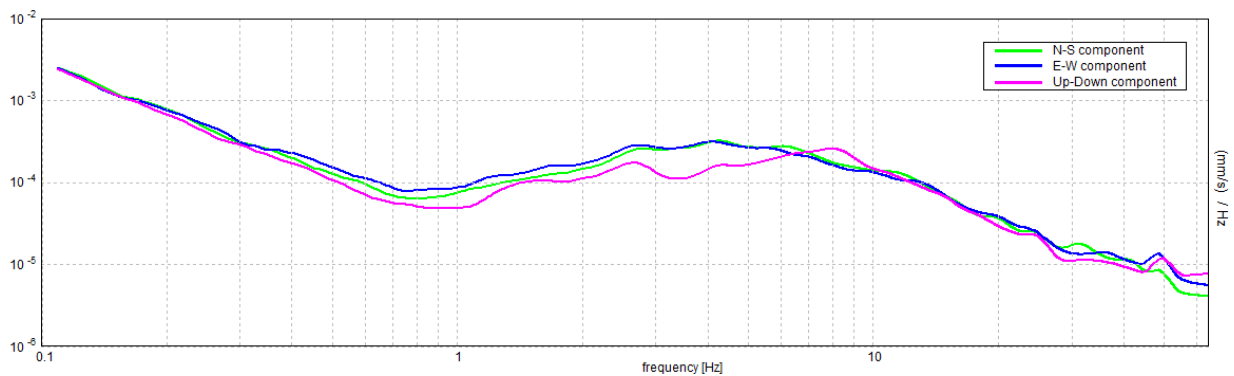
H/V TIME HISTORY



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 3.44 ± 0.12 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$3.44 > 0.17$	OK	
$n_c(f_0) > 200$	$11756.3 > 200$	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 331 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$	1.453 Hz	OK	
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	6.125 Hz	OK	
$A_0 > 2$	$2.48 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01704 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.05859 < 0.17188$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.2719 < 1.58$	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

CASTEL MAGGIORE_MS, MS 2017 TR9

037019P259HVSR306

Instrument: TRZ-0108/01-10

Start recording: 18/12/17 11:52:23 End recording: 18/12/17 12:12:24

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 93% trace (manual window selection)

Sampling rate: 128 Hz

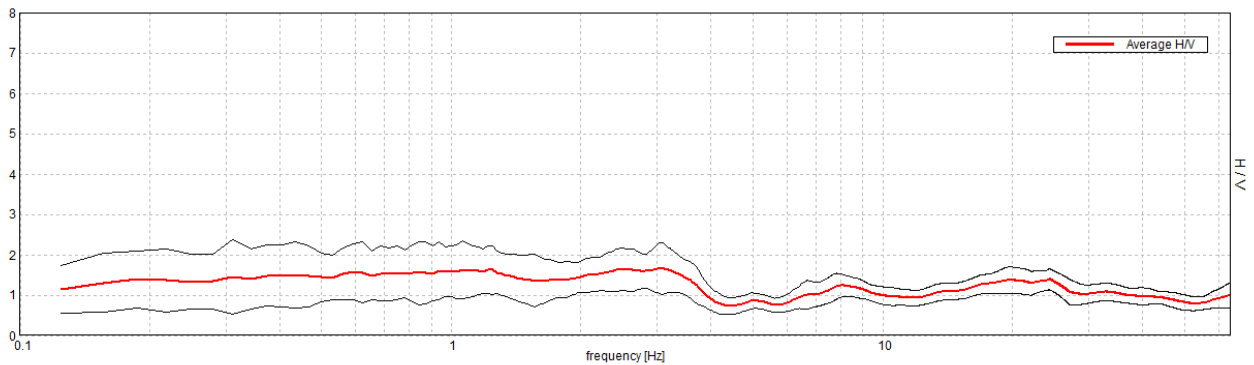
Window size: 20 s

Smoothing type: Triangular window

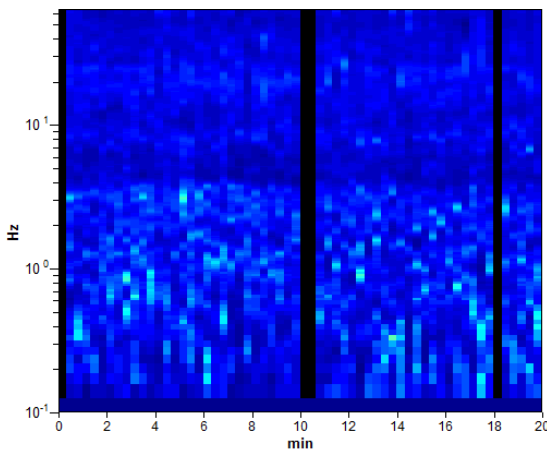
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

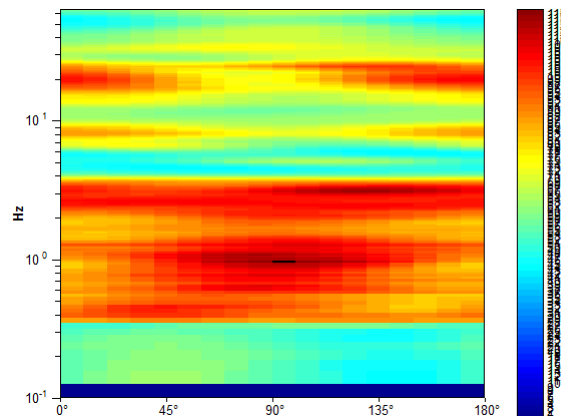
Max. H/V at 3.06 ± 0.15 Hz. (In the range 0.1 - 20.0 Hz).



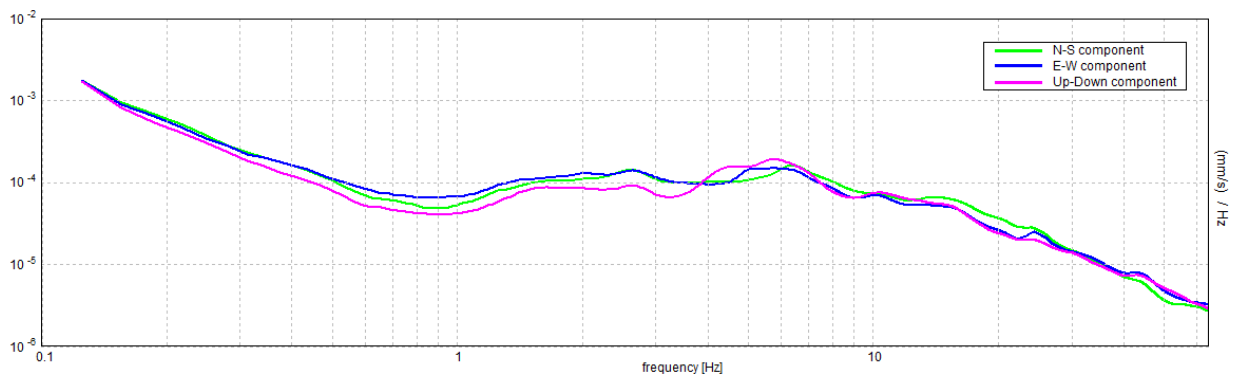
H/V TIME HISTORY



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 3.06 ± 0.15 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$3.06 > 0.50$	OK	
$n_c(f_0) > 200$	$3430.0 > 200$	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 148 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 $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	4.125 Hz	OK	
$A_0 > 2$	$1.66 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.02457 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.07525 < 0.15313$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3172 < 1.58$	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 $\sigma_A(f) < \theta(f_0)$

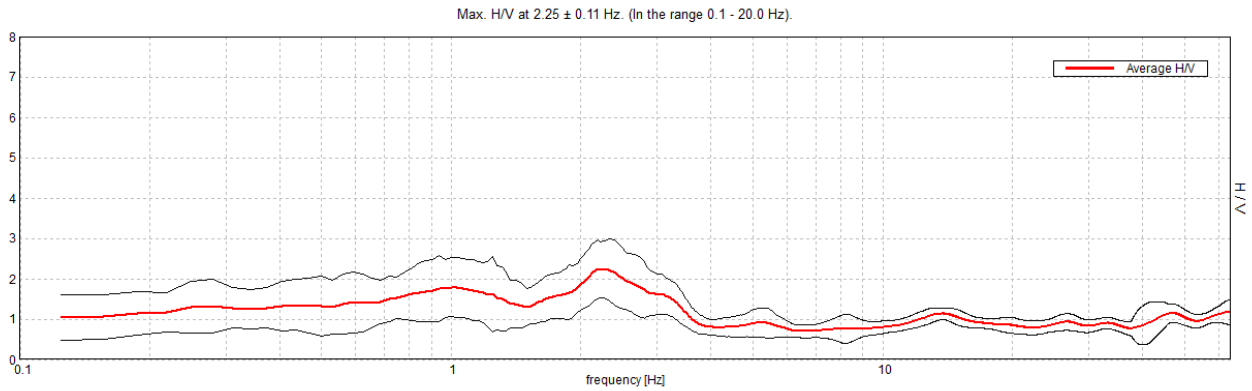
Threshold values for σ_f and $\sigma_A(f_0)$

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

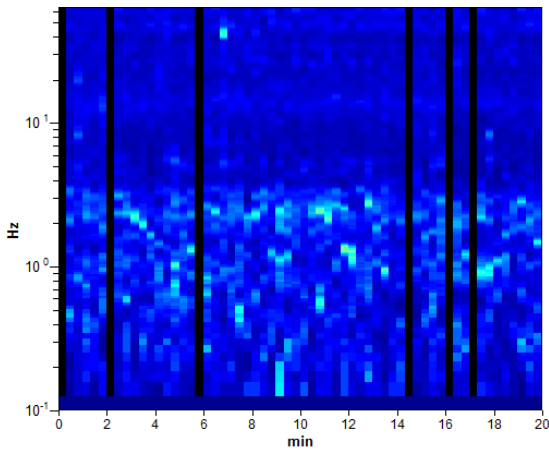
CASTEL MAGGIORE_MS, MS 2017 TR10 037019P260HVSR307

Instrument: TRZ-0108/01-10
 Start recording: 18/12/17 12:22:40 End recording: 18/12/17 12:42:41
 Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
 Trace length: 0h20'00". Analyzed 90% trace (manual window selection)
 Sampling rate: 128 Hz
 Window size: 20 s
 Smoothing type: Triangular window
 Smoothing: 10%

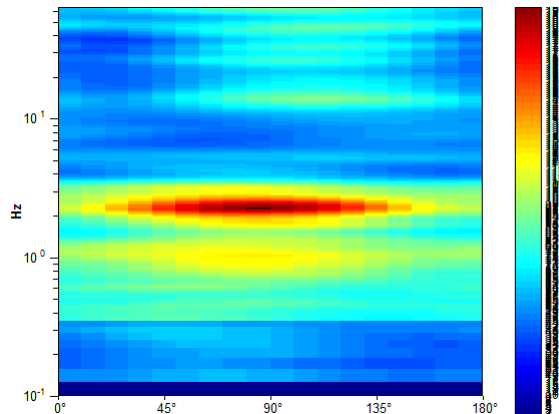
HORIZONTAL TO VERTICAL SPECTRAL RATIO



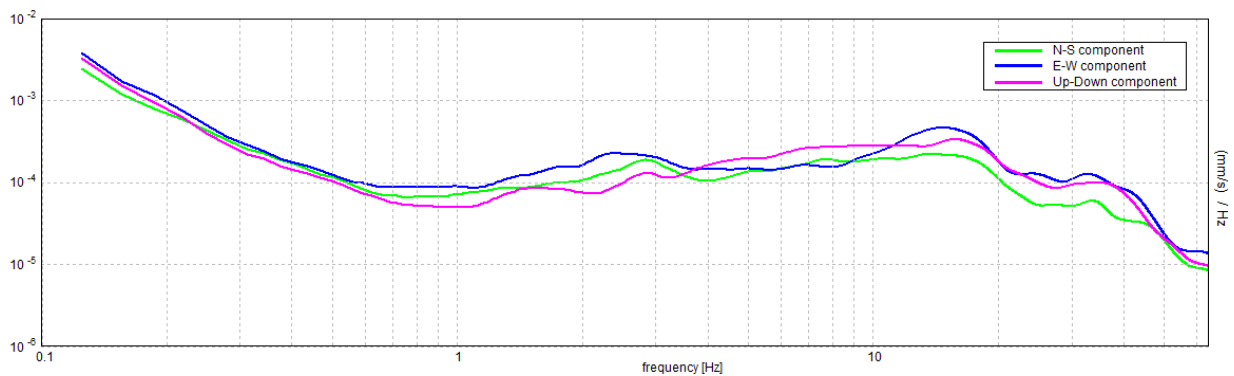
H/V TIME HISTORY



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 2.25 ± 0.11 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$2.25 > 0.50$	OK	
$n_c(f_0) > 200$	$2430.0 > 200$	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 109 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 $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	3.531 Hz	OK	
$A_0 > 2$	$2.24 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.02417 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.05439 < 0.1125$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3472 < 1.58$	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

CASTEL MAGGIORE_MS, MS 2017 TR11

037019P261HVSR308

Instrument: TRZ-0108/01-10

Start recording: 18/12/17 12:55:57 End recording: 18/12/17 13:15:58

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 80% trace (manual window selection)

Sampling rate: 128 Hz

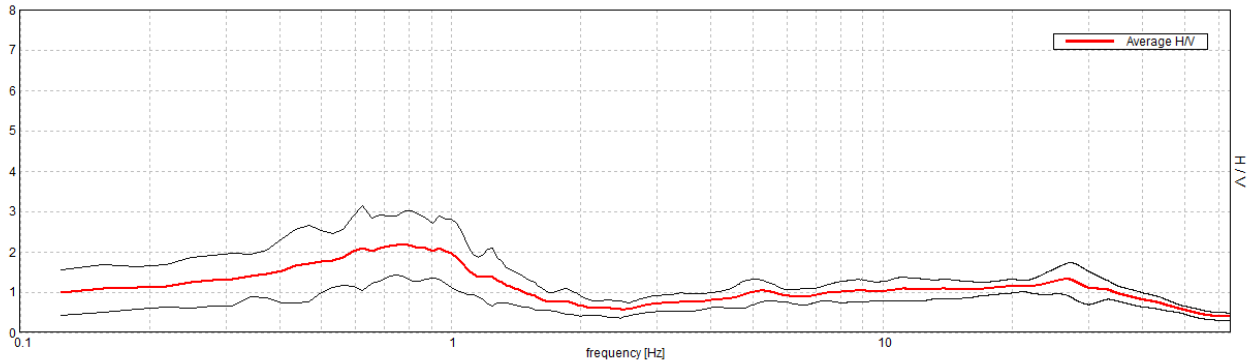
Window size: 20 s

Smoothing type: Triangular window

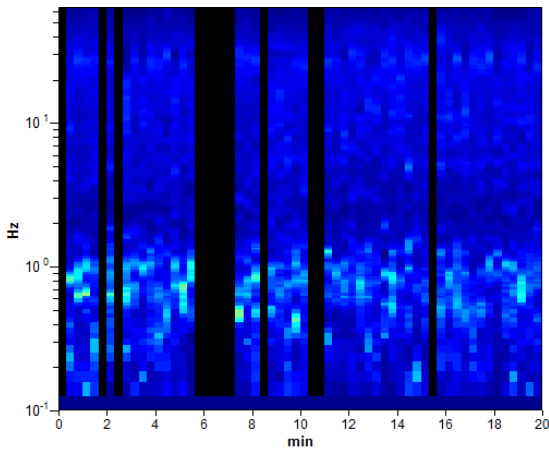
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

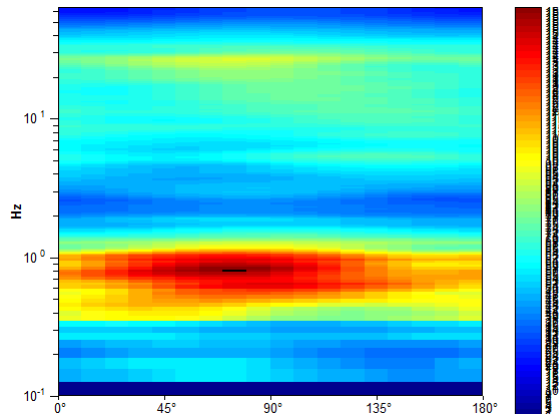
Max. H/V at 0.78 ± 0.03 Hz. (In the range 0.1 - 20.0 Hz).



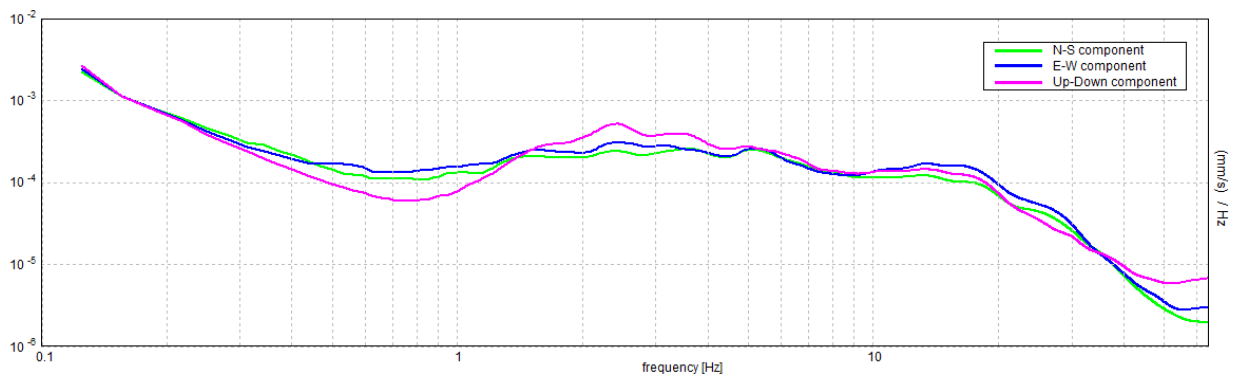
H/V TIME HISTORY



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 0.78 ± 0.03 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.78 > 0.50$	OK	
$n_c(f_0) > 200$	$750.0 > 200$	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 38 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 $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	1.406 Hz	OK	
$A_0 > 2$	$2.18 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.02167 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01693 < 0.11719$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.4034 < 2.0$	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 $\sigma_A(f_0)$

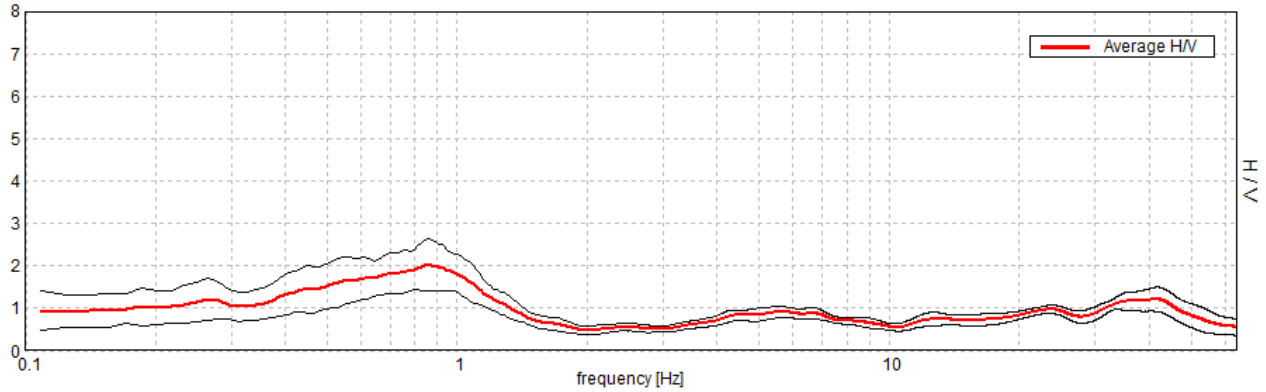
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CASTEL MAGGIORE_MS 2017 TR12 037019P262HVSR309

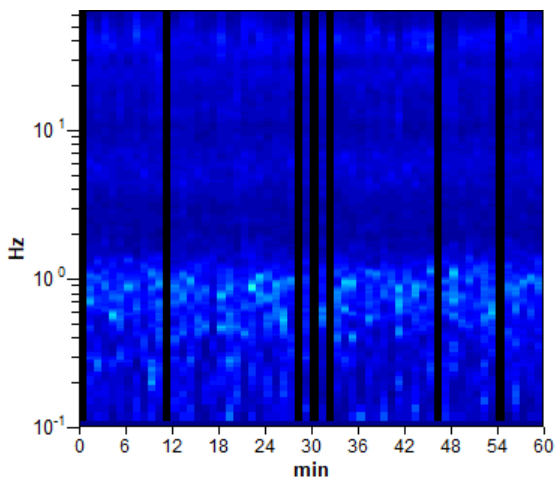
Instrument: TRZ-0108/01-10
 Start recording: 19/12/17 14:14:29 End recording: 19/12/17 15:14:30
 Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
 Trace length: 1h00'00". Analyzed 88% trace (manual window selection)
 Sampling rate: 128 Hz
 Window size: 60 s
 Smoothing type: Triangular window
 Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

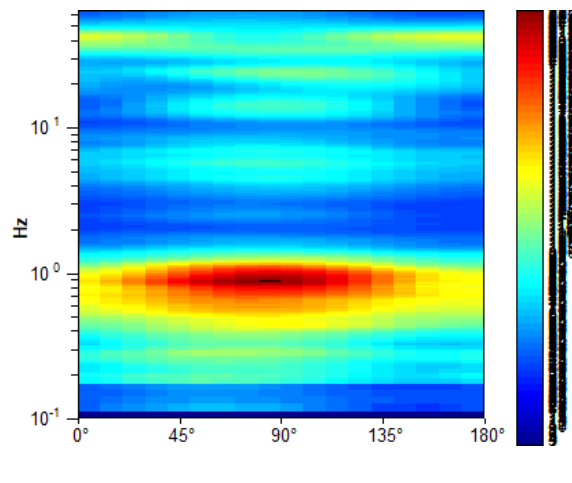
Max. H/V at 0.86 ± 0.01 Hz (in the range 0.2 - 20.0 Hz).



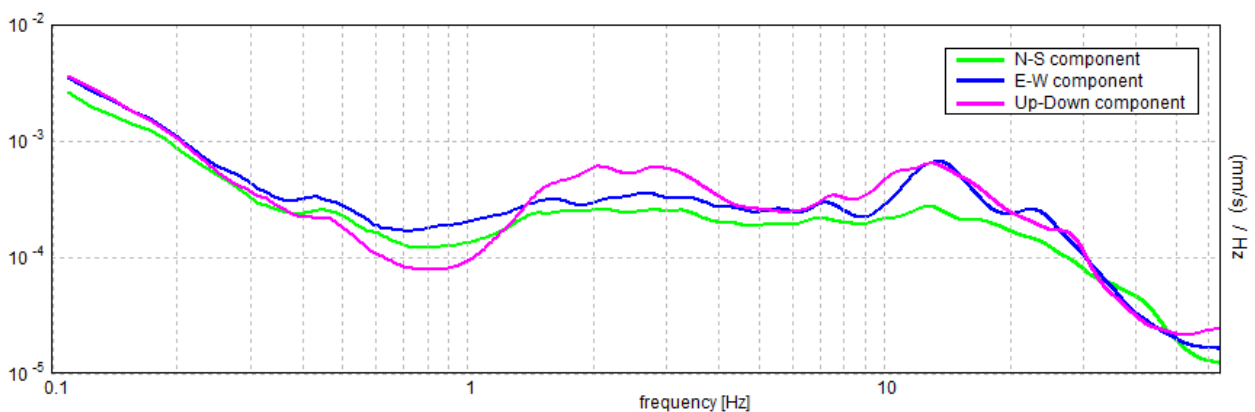
H/V TIME HISTORY



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 ± 0.01 Hz (in the range 0.2 - 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	
$n_c(f_0) > 200$	$2732.8 > 200$	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 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 $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.344 Hz	OK	
$A_0 > 2$	$2.03 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.00773 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.00664 < 0.12891$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3056 < 2.0$	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

CASTEL MAGGIORE_MS 2017 TR13

037019P263HVSR310

Instrument: TRZ-0108/01-10

Start recording: 19/12/17 15:55:30 End recording: 19/12/17 16:55:31

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

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

Sampling rate: 128 Hz

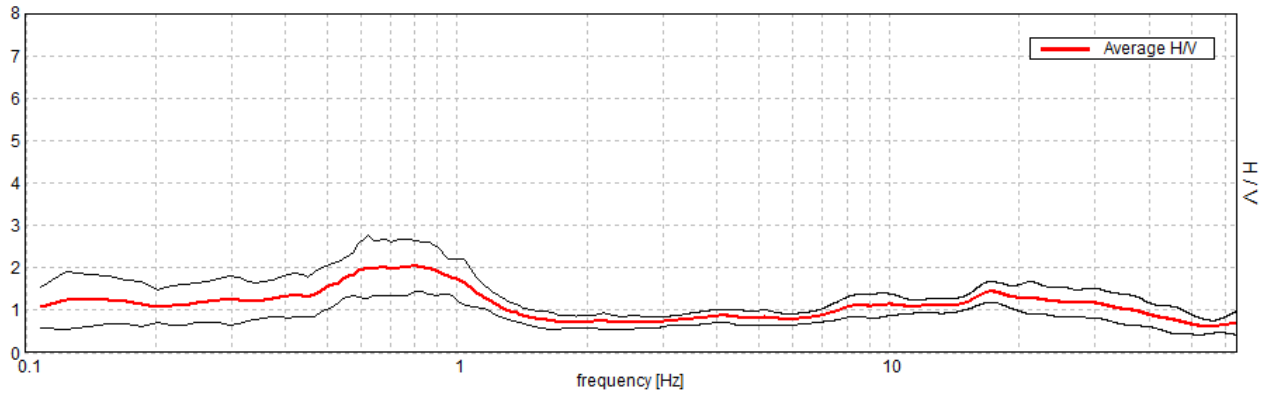
Window size: 60 s

Smoothing type: Triangular window

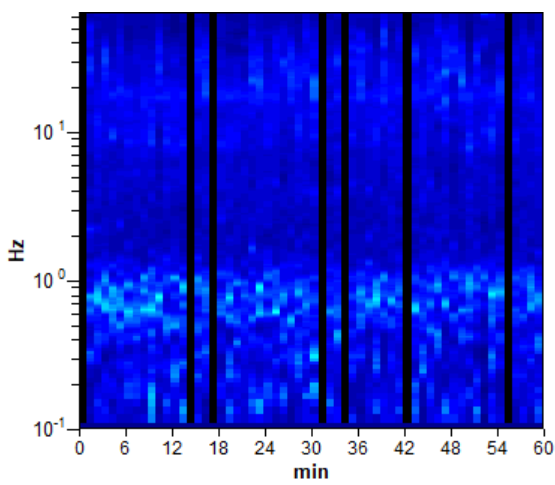
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

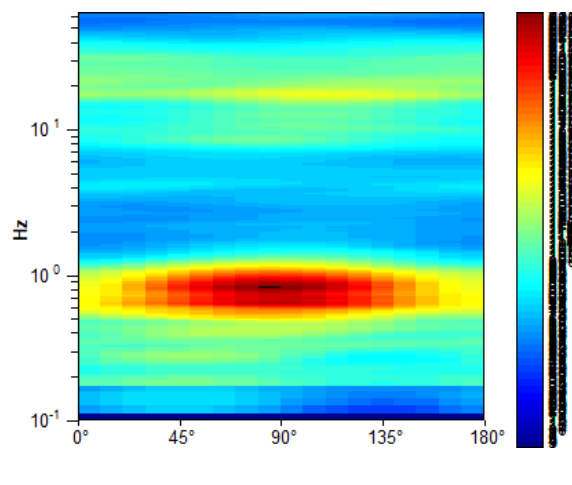
Max. H/V at 0.78 ± 0.04 Hz (in the range 0.0 - 64.0 Hz).



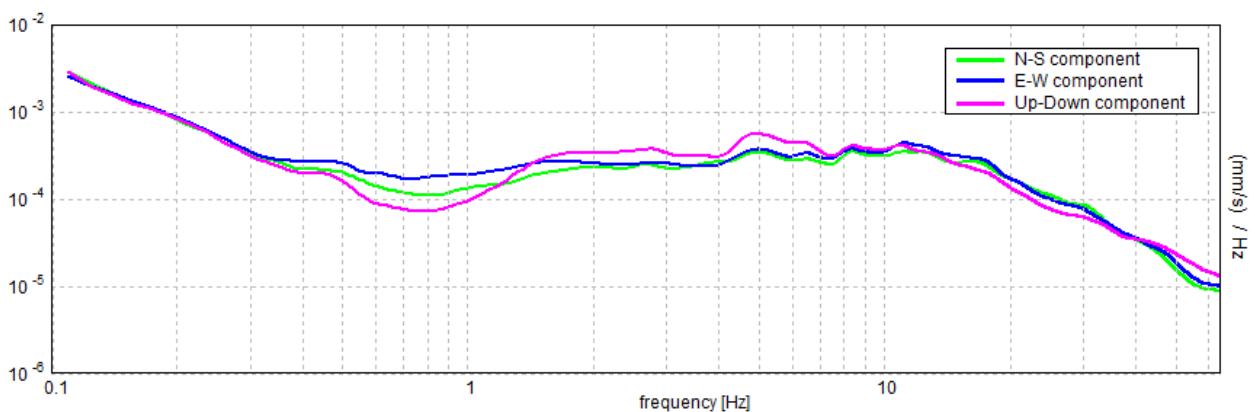
H/V TIME HISTORY



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 ± 0.04 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.78 > 0.17$	OK	
$n_c(f_0) > 200$	$2484.4 > 200$	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 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 $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.297 Hz	OK	
$A_0 > 2$	$2.04 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.02305 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01801 < 0.11719$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3206 < 2.0$	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 $\sigma_A(f_0)$

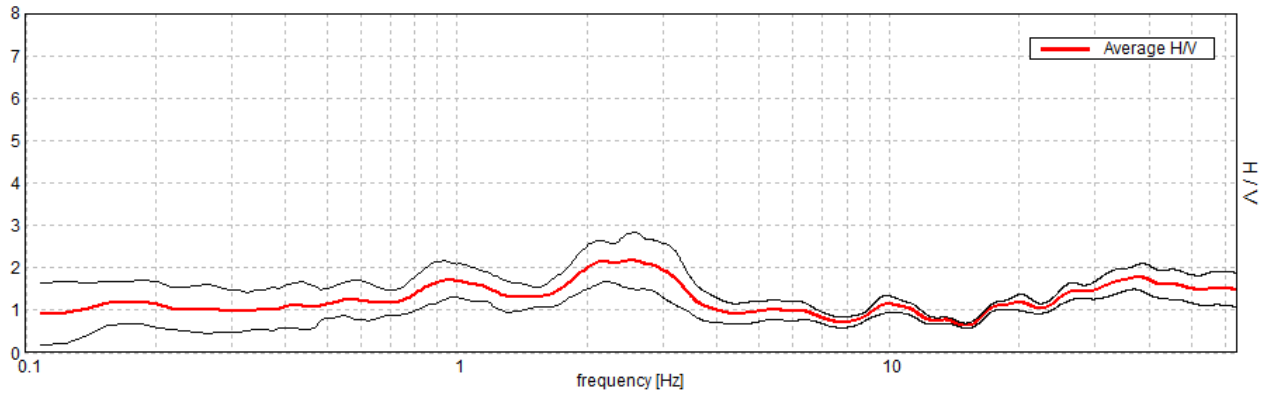
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CASTEL MAGGIORE_MS 2017 TR14 037019P264HVS311

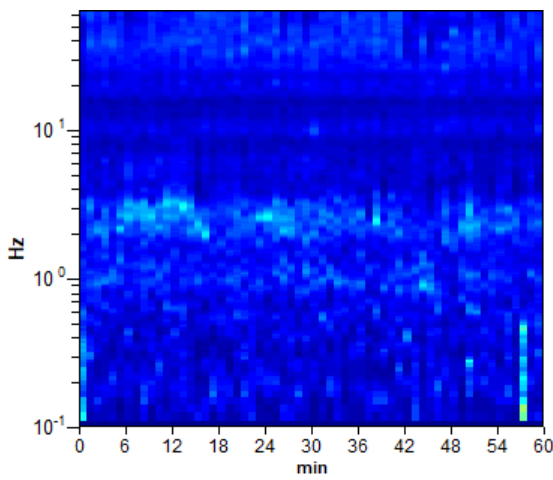
Instrument: TRZ-0108/01-10
Start recording: 20/12/17 10:05:04 End recording: 20/12/17 11:05:05
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
Trace length: 1h00'00". Analysis performed on the entire trace.
Sampling rate: 128 Hz
Window size: 60 s
Smoothing type: Triangular window
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

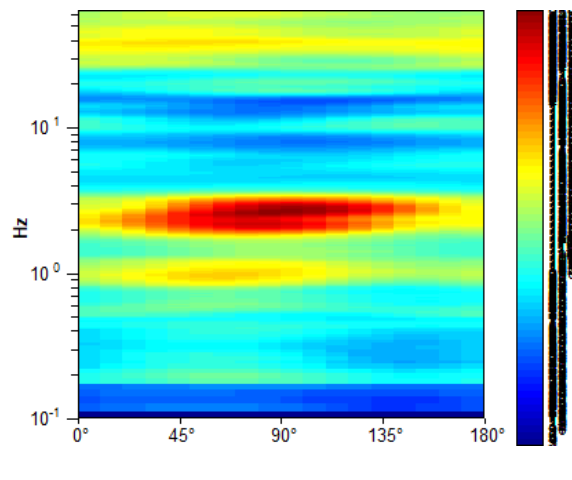
Max. H/V at 2.5 ± 0.13 Hz (in the range 0.0 - 64.0 Hz).



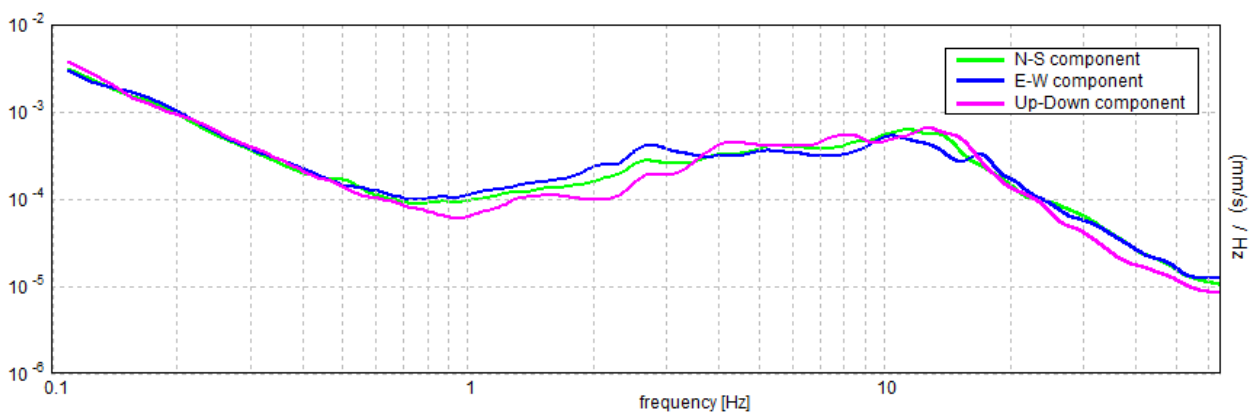
H/V TIME HISTORY



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 2.5 ± 0.13 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$2.50 > 0.17$	OK	
$n_c(f_0) > 200$	$9000.0 > 200$	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 241 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 $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	3.781 Hz	OK	
$A_0 > 2$	$2.17 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.02596 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.0649 < 0.125$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3214 < 1.58$	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

CASTEL MAGGIORE_MS 2017 TR15

037019P265HVSR312

Instrument: TRZ-0108/01-10

Start recording: 20/12/17 11:28:38 End recording: 20/12/17 11:48:39

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 90% trace (manual window selection)

Sampling rate: 128 Hz

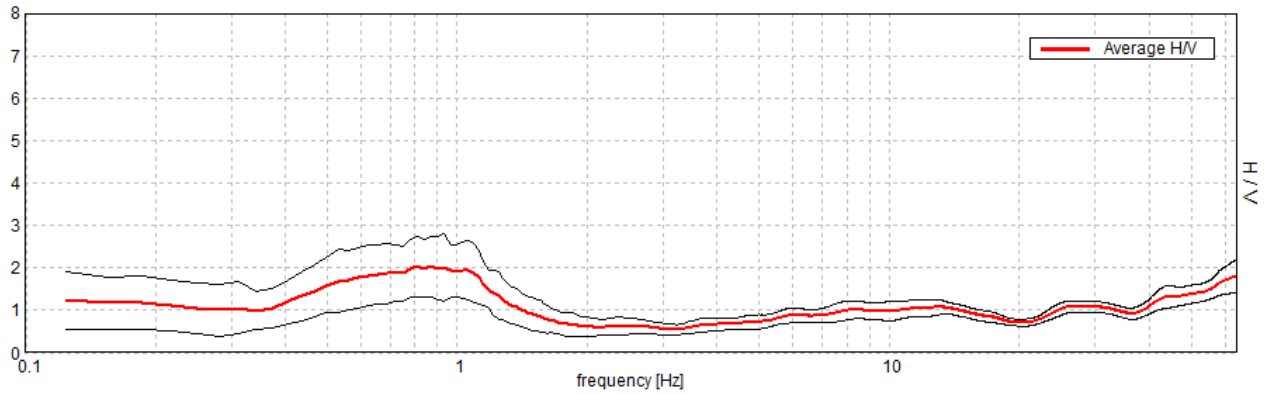
Window size: 20 s

Smoothing type: Triangular window

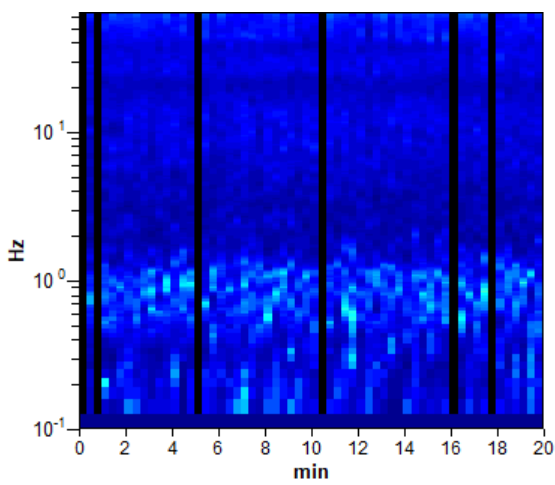
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

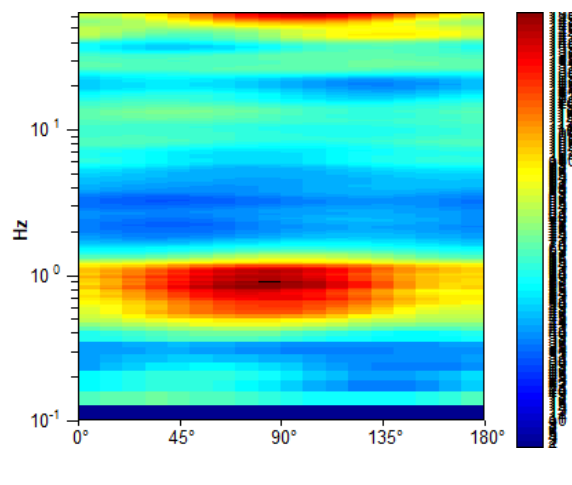
Max. H/V at 0.81 ± 0.02 Hz (in the range 0.0 - 64.0 Hz).



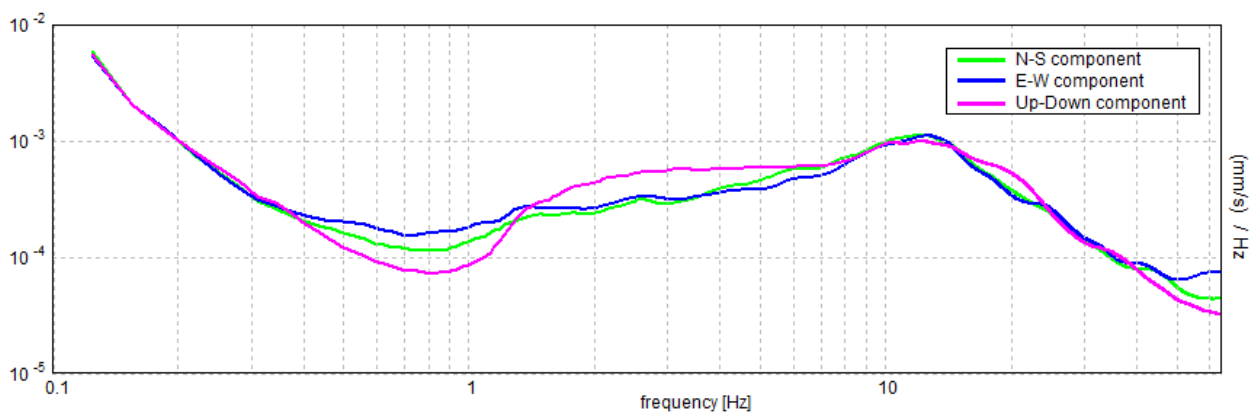
H/V TIME HISTORY



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 0.81 ± 0.02 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.81 > 0.50$	OK	
$n_c(f_0) > 200$	$877.5 > 200$	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 40 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$	0.344 Hz	OK	
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.406 Hz	OK	
$A_0 > 2$	$2.03 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.00953 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.00774 < 0.12188$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3468 < 2.0$	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

CASTEL MAGGIORE_MS, MS 2017 TR16

037019P266HVSR313

Instrument: TRZ-0108/01-10

Start recording: 20/12/17 11:56:46 End recording: 20/12/17 12:16:47

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 78% trace (manual window selection)

Sampling rate: 128 Hz

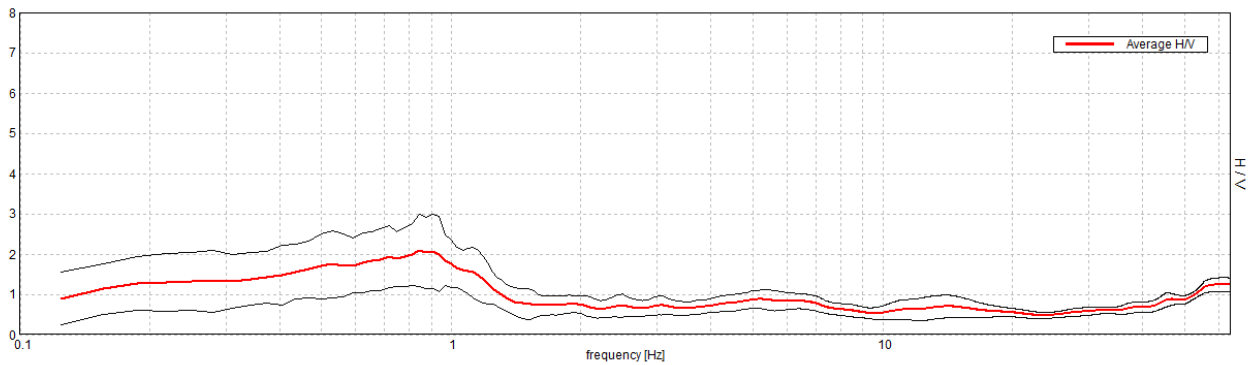
Window size: 20 s

Smoothing type: Triangular window

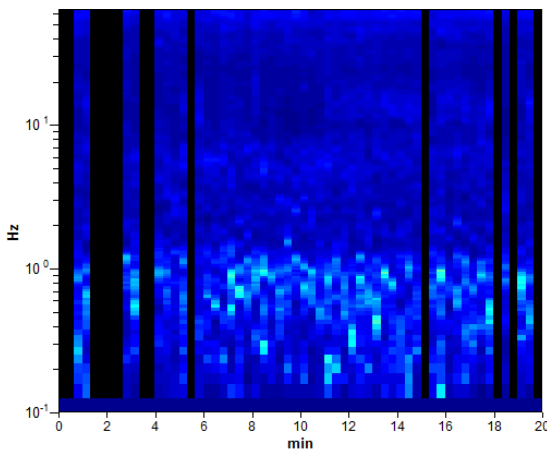
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

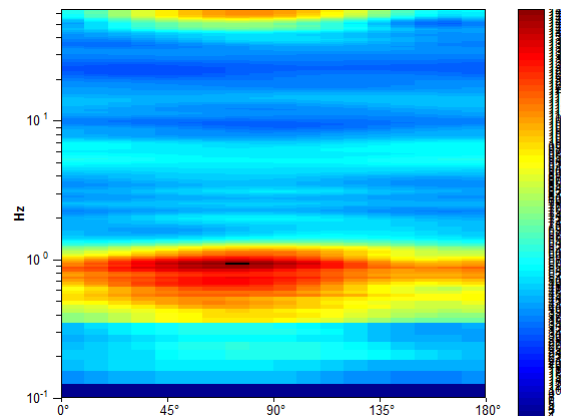
Max. H/V at 0.84 ± 0.04 Hz (in the range 0.1 - 20.0 Hz).



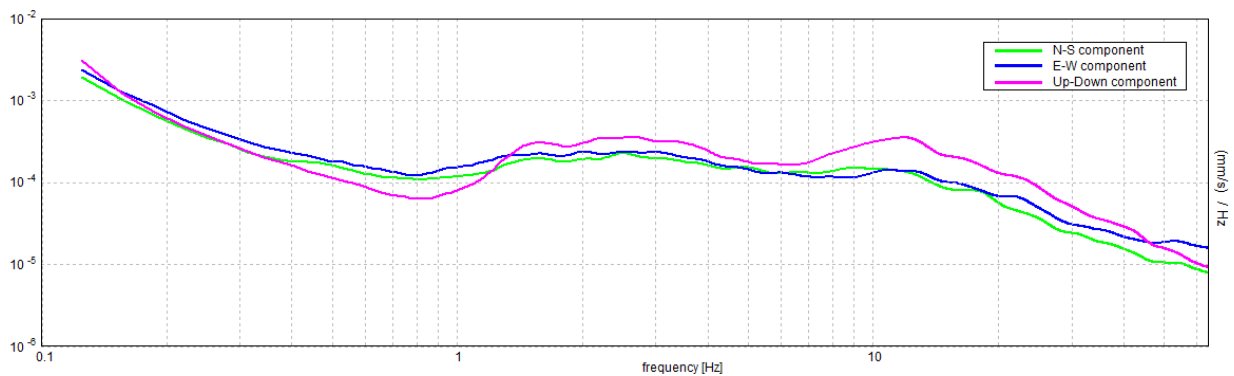
H/V TIME HISTORY



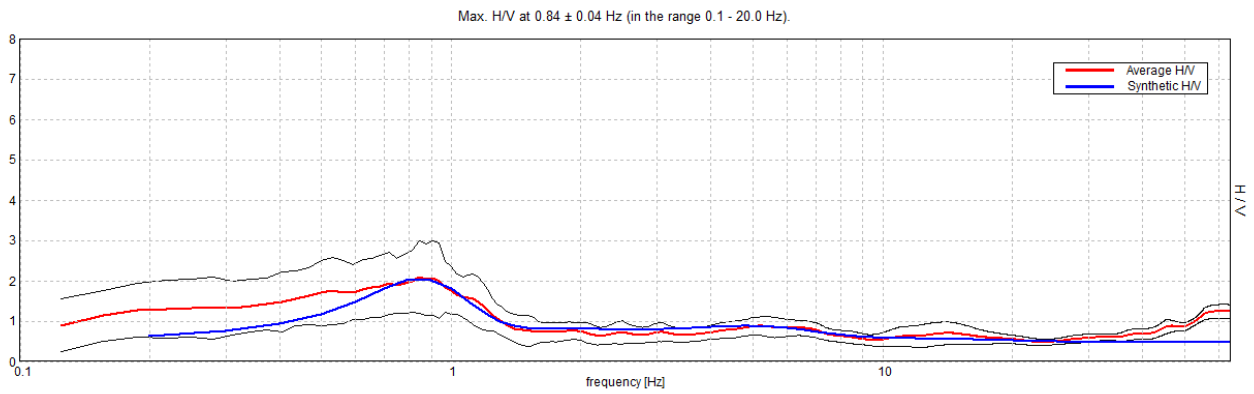
DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA

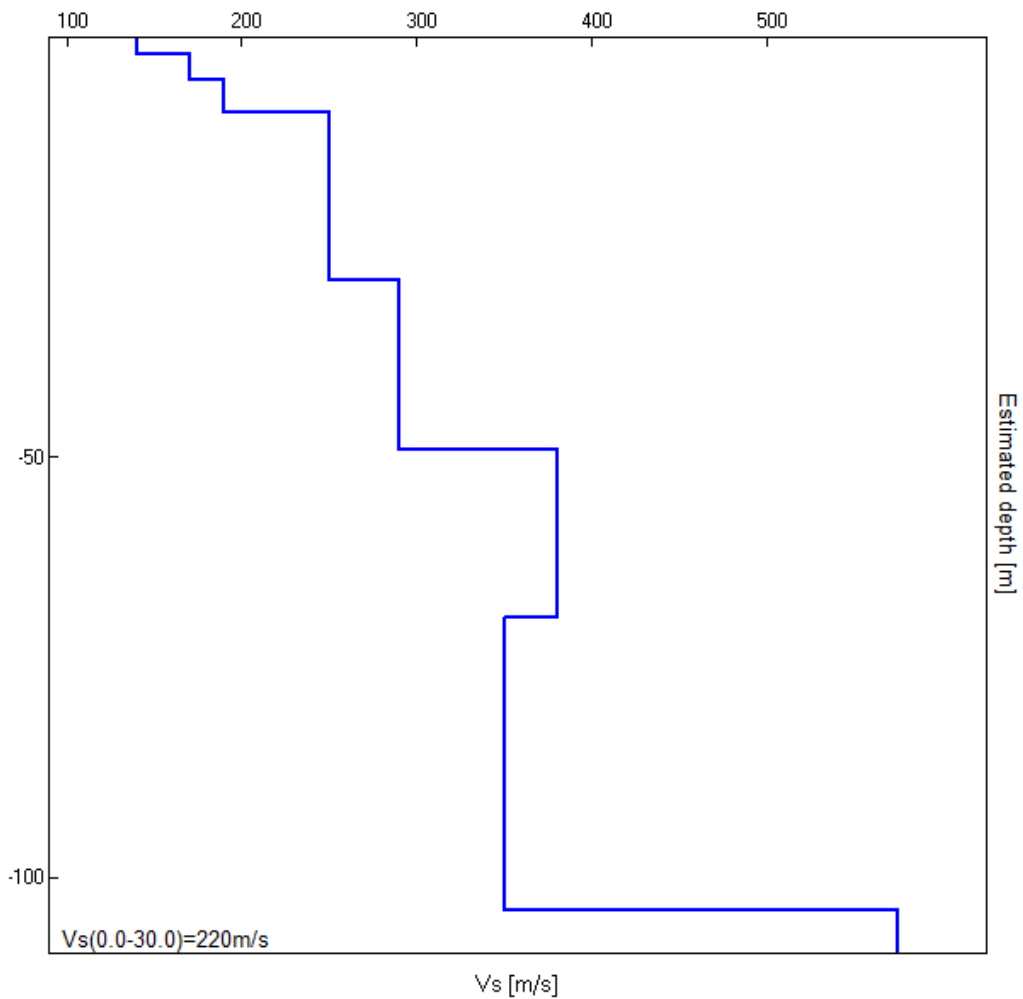


EXPERIMENTAL vs. SYNTHETIC H/V



Depth at the bottom of the layer [m]	Thickness [m]	Vs [m/s]
2.00	2.00	140
5.00	3.00	170
9.00	4.00	190
29.00	20.00	250
49.00	20.00	290
69.00	20.00	380
104.00	35.00	350
inf.	inf.	575

Vs(0.0-30.0)=220m/s



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

Max. H/V at 0.84 ± 0.04 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.84 > 0.50$	OK	
$n_c(f_0) > 200$	$793.1 > 200$	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 42 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 $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.313 Hz	OK	
$A_0 > 2$	$2.09 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.02074 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.0175 < 0.12656$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.4413 < 2.0$	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

CASTEL MAGGIORE_MS 2017 TR17

037019P267HVSR314

Instrument: TRZ-0108/01-10

Start recording: 23/12/17 10:24:14 End recording: 23/12/17 10:44:15

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 75% trace (manual window selection)

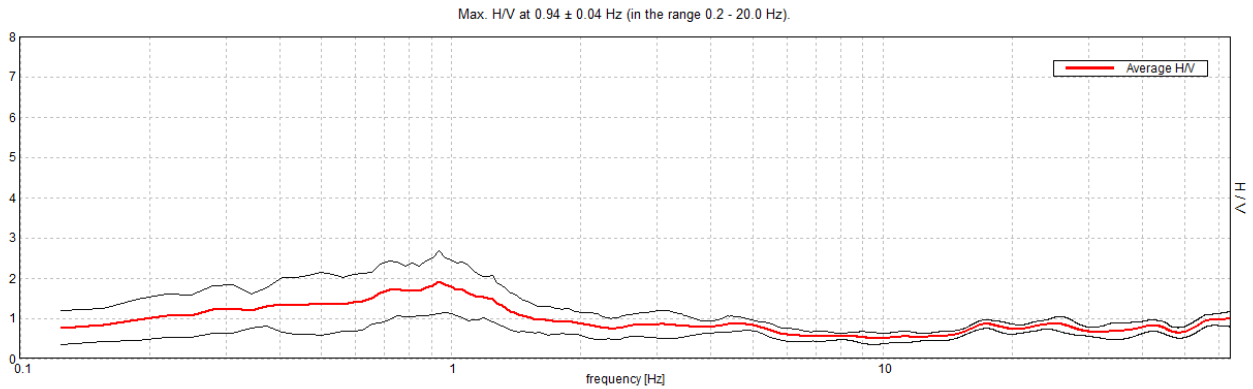
Sampling rate: 128 Hz

Window size: 20 s

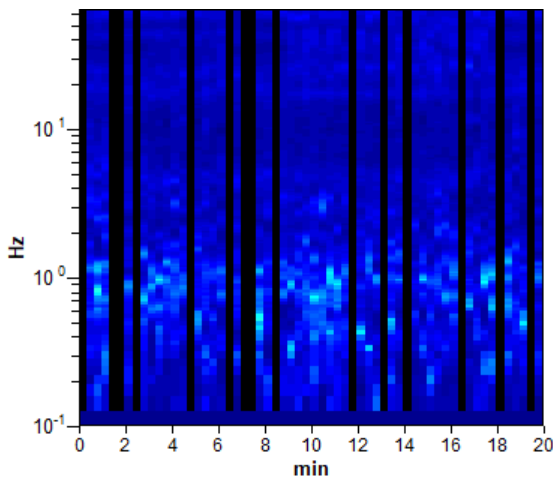
Smoothing type: Triangular window

Smoothing: 10%

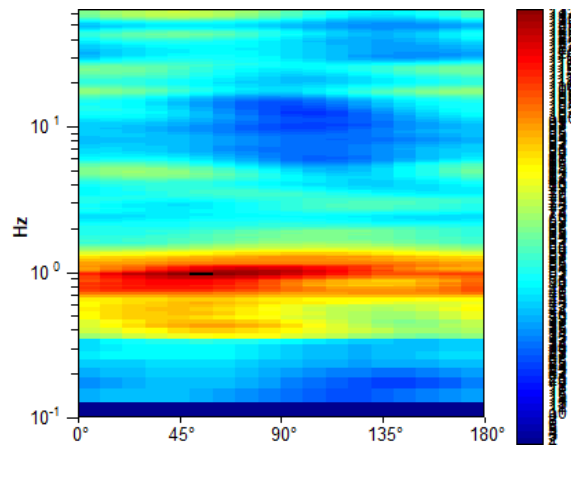
HORIZONTAL TO VERTICAL SPECTRAL RATIO



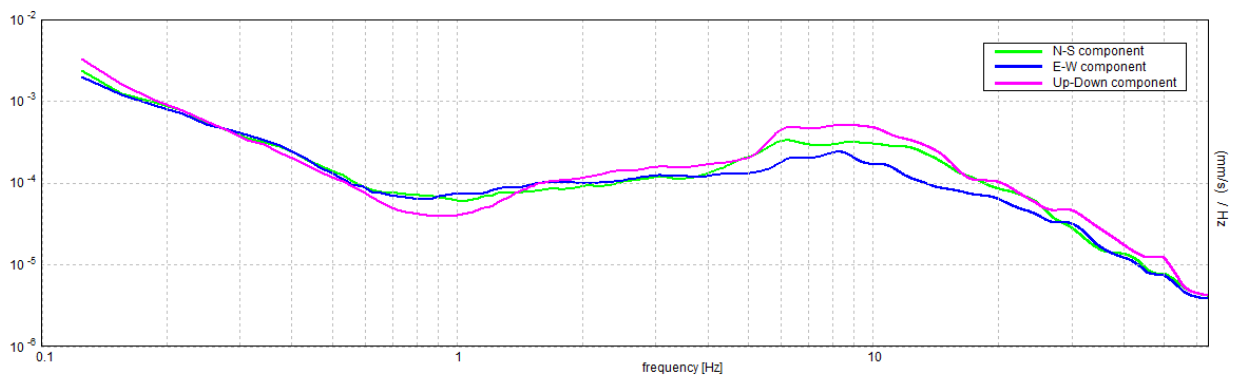
H/V TIME HISTORY



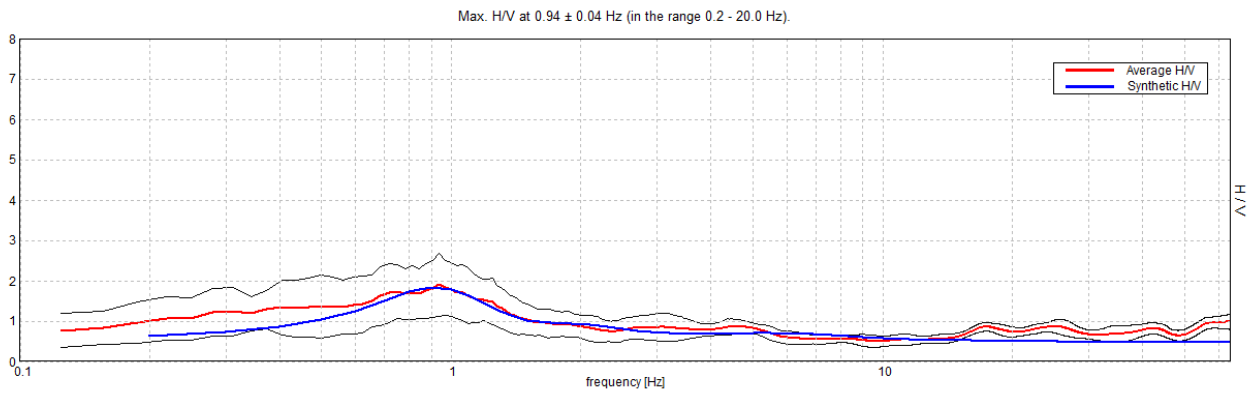
DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA

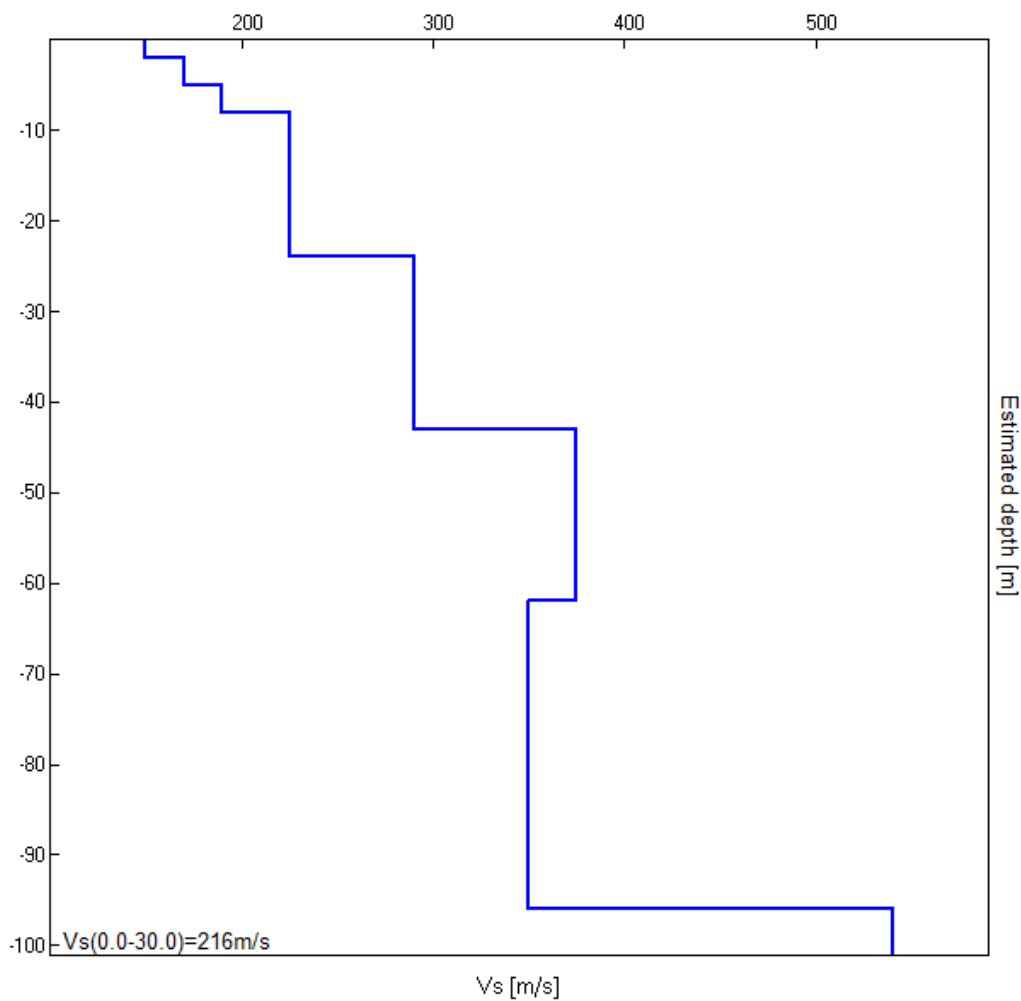


EXPERIMENTAL vs. SYNTHETIC H/V



Depth at the bottom of the layer [m]	Thickness [m]	Vs [m/s]
2.00	2.00	150
5.00	3.00	170
8.00	3.00	190
24.00	16.00	225
43.00	19.00	290
62.00	19.00	375
96.00	34.00	350
inf.	inf.	540

Vs(0.0-30.0)=216m/s



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

Max. H/V at 0.94 ± 0.04 Hz (in the range 0.2 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.94 > 0.50$	OK	
$n_c(f_0) > 200$	$843.8 > 200$	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 46 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 $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	1.688 Hz	OK	
$A_0 > 2$	$1.90 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01874 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01757 < 0.14063$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3864 < 2.0$	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

ESAC09

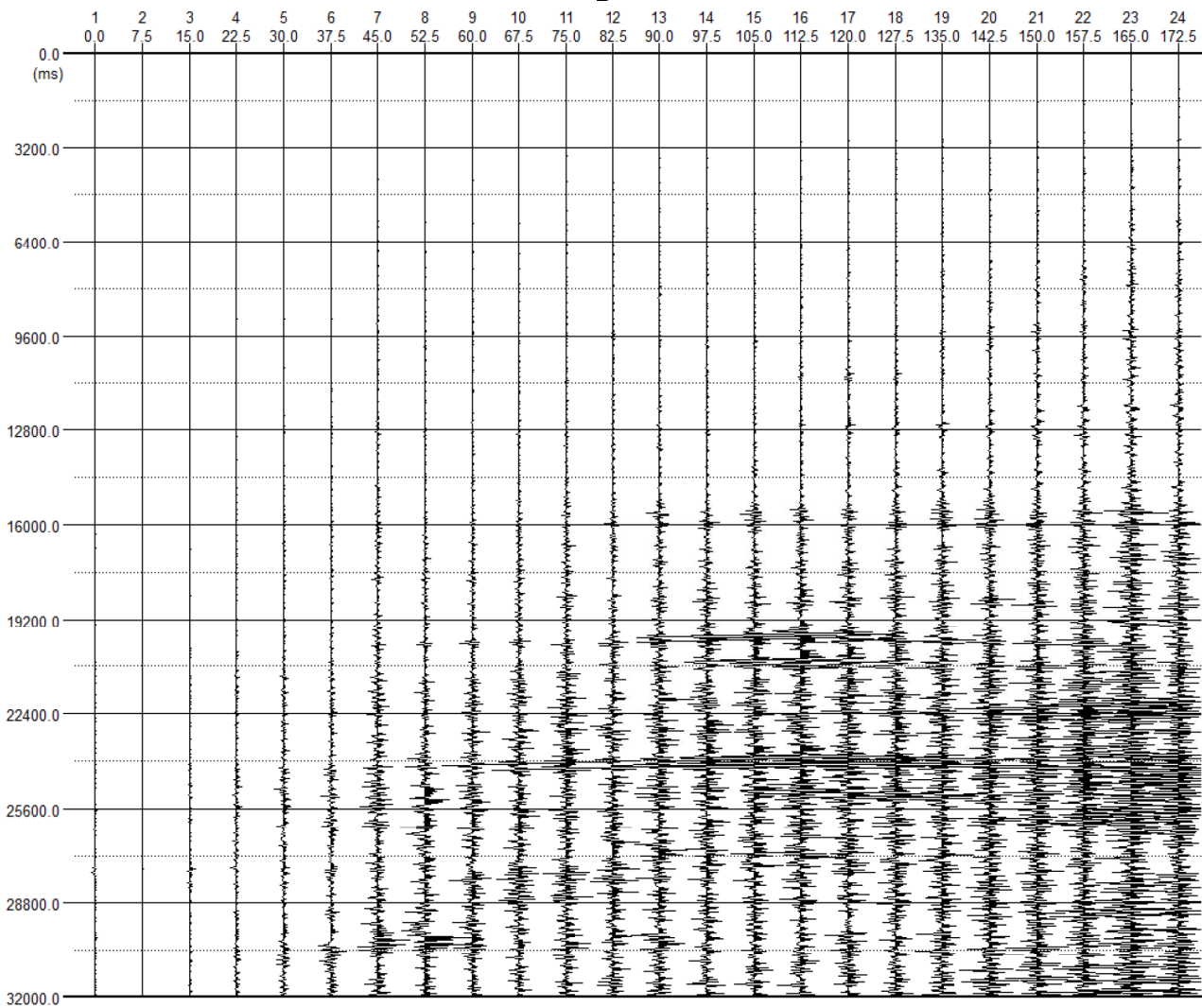
Comune di Castel Maggiore (BO) -

via Angelelli

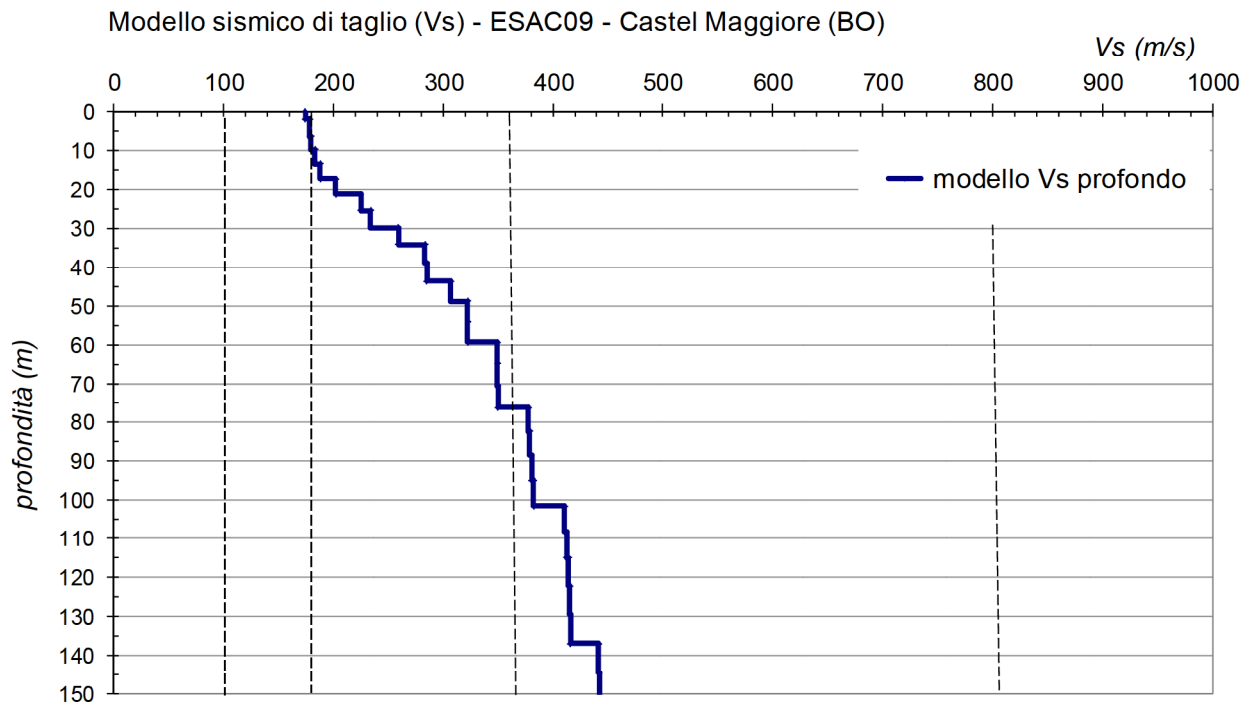
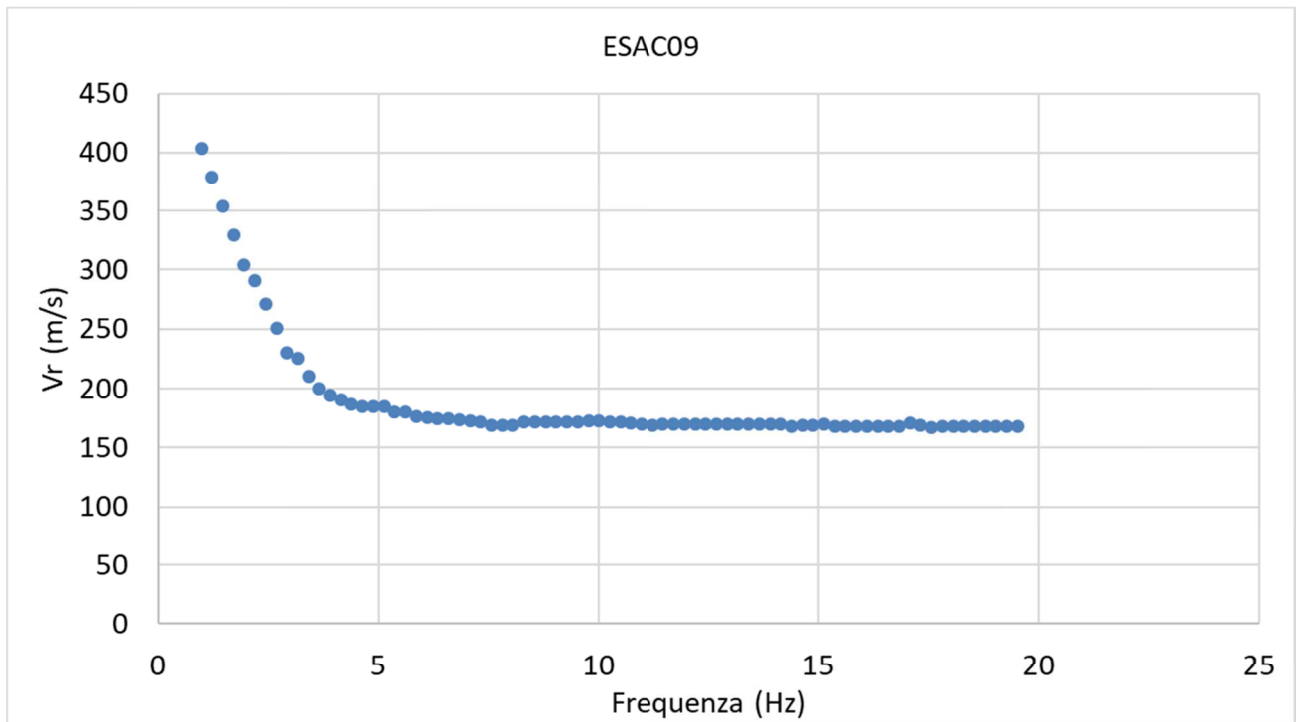
n° tracce	Δx (m)	L tot (m)	Δt (ms)	T (s)
24	7.5	172.5	2	32

Δx : interdistanza geofonica; L tot: lunghezza profilo; Δt : passo di campionamento; T: durata registrazione.

Sismogramma



Curva di dispersione



Modello Vs (1D)

PROFILO sismico fino a 150 metri			
ESAC09			
Vs30= 196 m/s ± 4.0 m/s (1.7 RMS:%)			
Sismo-strato	Profondità letto (m)	Velocità (m/s)	Spessore (m)
1	2.0	174.2	2.0
2	6.4	178.3	4.4
3	9.8	179.3	3.5
4	13.5	183.0	3.6
5	17.3	187.4	3.8
6	21.2	201.5	4.0
7	25.4	224.9	4.1
8	29.7	233.2	4.3
9	34.2	259.0	4.5
10	38.9	282.8	4.7
11	43.7	284.5	4.8
12	48.7	306.7	5.0
13	53.9	321.8	5.2
14	59.2	321.9	5.4
15	64.8	348.7	5.5
16	70.5	348.9	5.7
17	76.3	349.4	5.9
18	82.4	377.2	6.0
19	88.6	378.4	6.2
20	95.0	379.9	6.4
21	101.5	381.6	6.6
22	108.3	410.2	6.7
23	115.2	411.8	6.9
24	122.3	413.3	7.1
25	129.5	414.6	7.3
26	136.9	415.6	7.4
27	144.5	442.0	7.6
28	152.3	442.5	-

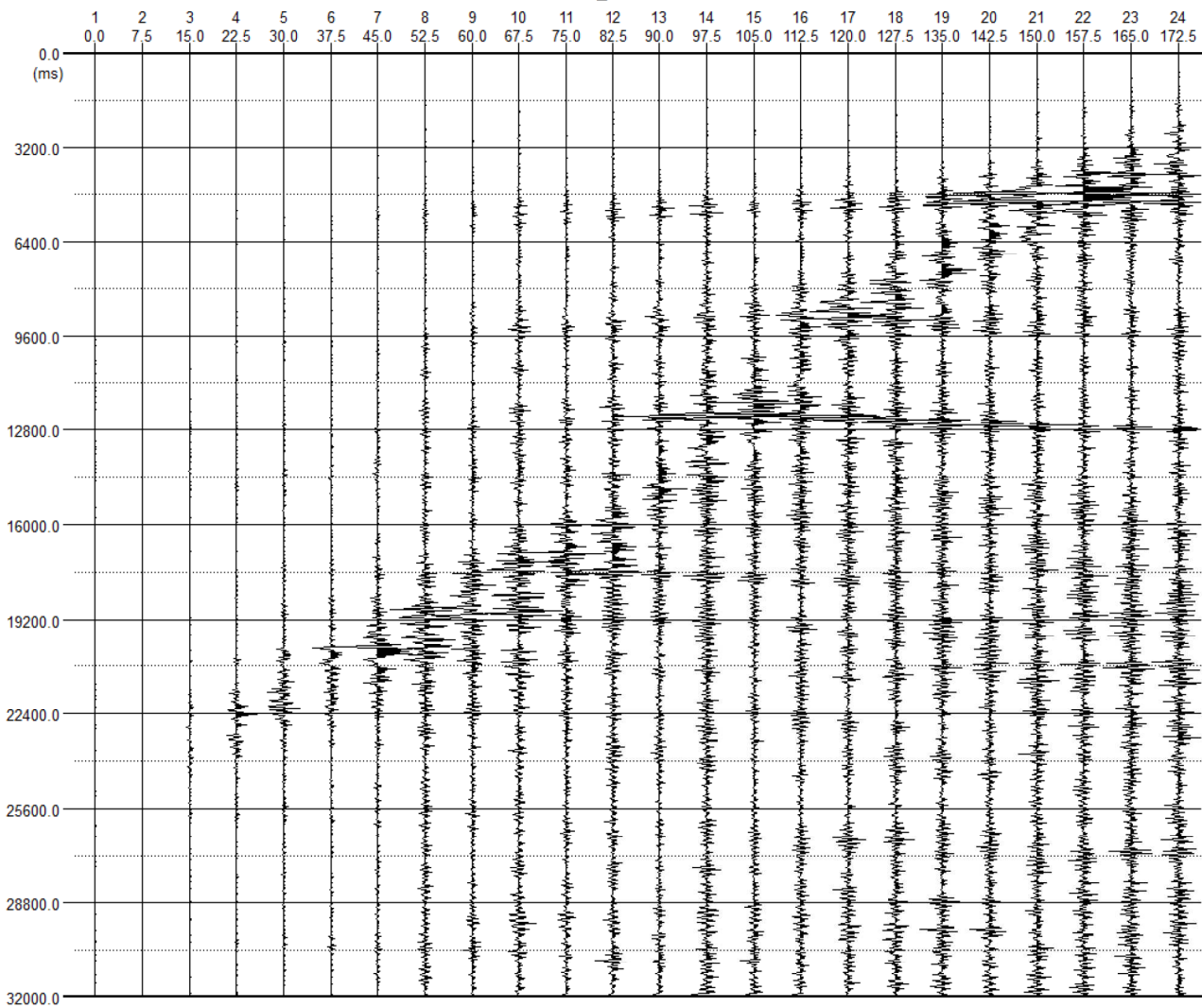
ESAC10

Comune di Castel Maggiore (BO) - Località Trebbo di Reno

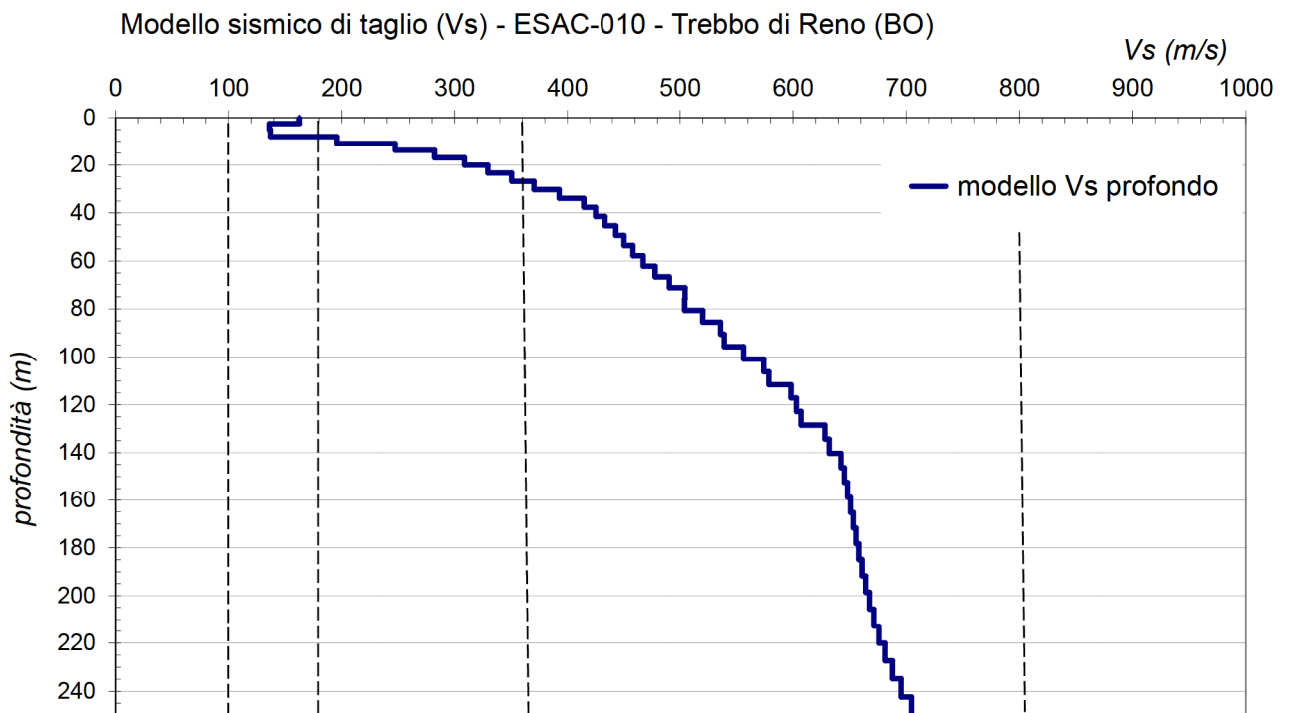
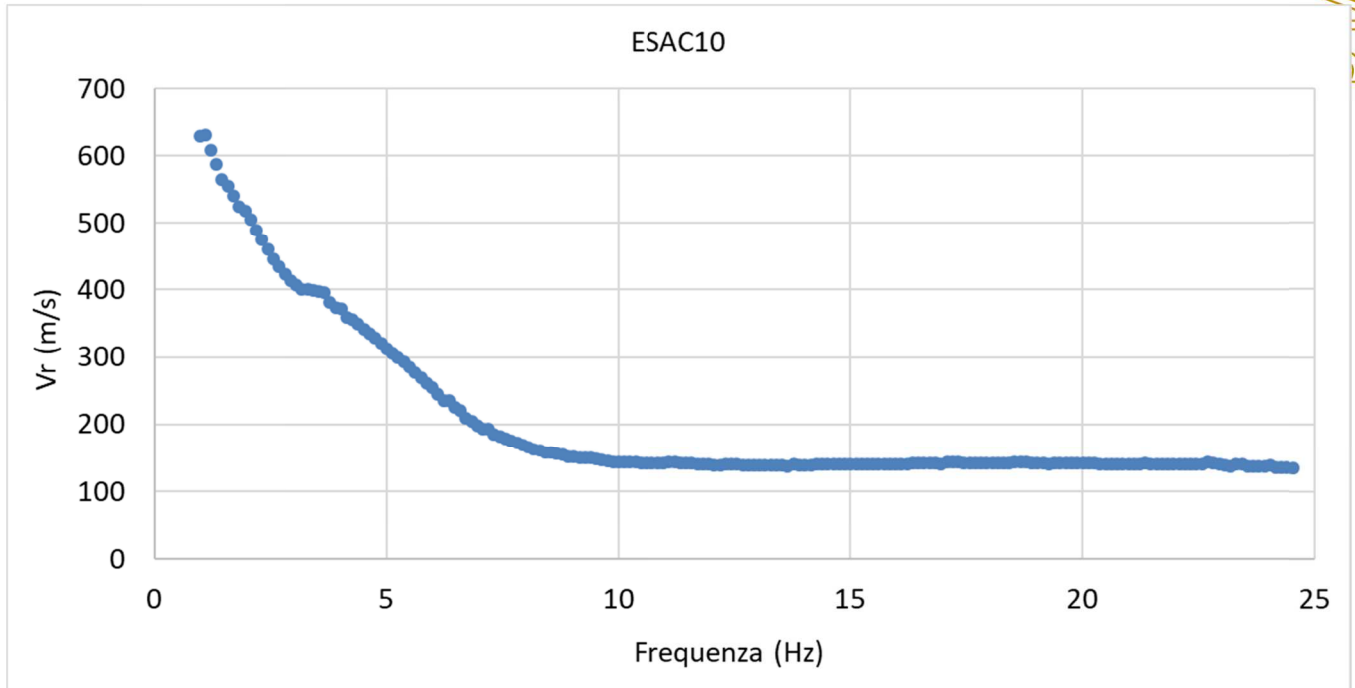
n° tracce	Δx (m)	L tot (m)	Δt (ms)	T (s)
24	7.5	172.5	2	32

Δx : interdistanza geofonica; L tot: lunghezza profilo; Δt : passo di campionamento; T: durata registrazione.

Sismogramma



Curva di dispersione



Modello Vs (1D)

PROFILO sismico fino a 250 metri			
ESAC10			
Vs30= 228 m/s ± 6 m/s (3.7 RMS:%)			
Sismo-strato	Profondità letto (m)	Velocità (m/s)	Spessore (m)
1	2.6	162.7	2.6
2	5.0	136.1	2.4
3	8.0	137.1	3.0
4	10.8	195.7	2.9
5	13.8	247.4	3.0
6	16.9	282.1	3.1
7	20.1	308.8	3.2
8	23.4	329.4	3.3
9	26.8	350.5	3.4
10	30.3	370.4	3.5
11	33.9	392.7	3.6
12	37.6	414.6	3.7
13	41.5	425.0	3.8
14	45.4	433.4	3.9
15	49.4	443.0	4.0
16	53.6	450.3	4.1
17	57.8	458.2	4.3
18	62.2	467.3	4.4
19	66.6	478.0	4.5
20	71.2	490.5	4.6
21	75.9	504.5	4.7
22	80.7	504.1	4.8
23	85.6	520.0	4.9
24	90.6	536.0	5.0
25	95.7	539.1	5.1
26	100.9	556.2	5.2
27	106.2	574.2	5.3
28	111.6	578.7	5.4
29	117.1	598.3	5.5

PROFILO sismico ESAC10 cont.,,

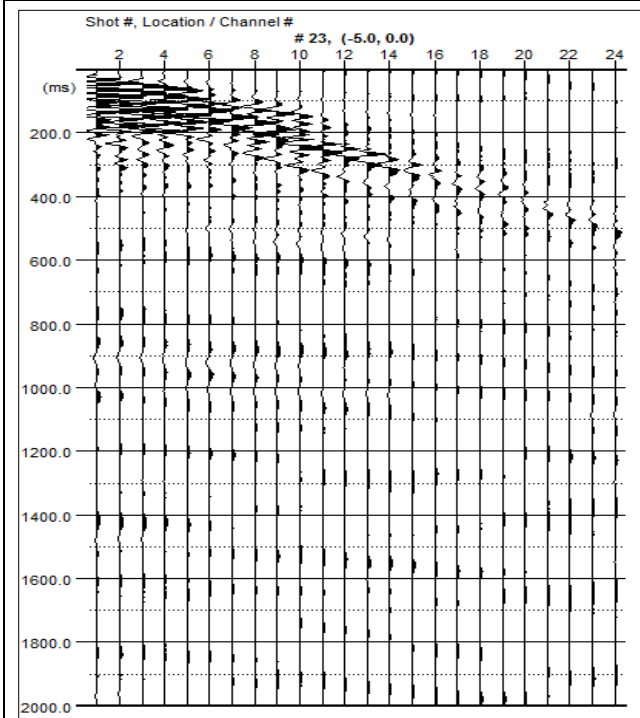
Sismo-strato	Profondità letto (m)	Velocità (m/s)	Spessore (m)
30	122.8	602.9	5.6
31	128.5	607.2	5.7
32	134.4	628.3	5.8
33	140.3	631.9	6.0
34	146.4	642.3	6.1
35	152.5	645.3	6.2
36	158.8	648.1	6.3
37	165.2	650.7	6.4
38	171.7	653.2	6.5
39	178.3	655.7	6.6
40	184.9	658.2	6.7
41	191.8	661.0	6.8
42	198.7	664.1	6.9
43	205.7	667.5	7.0
44	212.8	671.4	7.1
45	220.0	675.9	7.2
46	227.4	681.3	7.3
47	234.8	687.7	7.4
48	242.3	695.4	-

PROSPEZIONE SISMICA CON METODOLOGIA ATTIVA/PASSIVA MASW/Re.Mi.

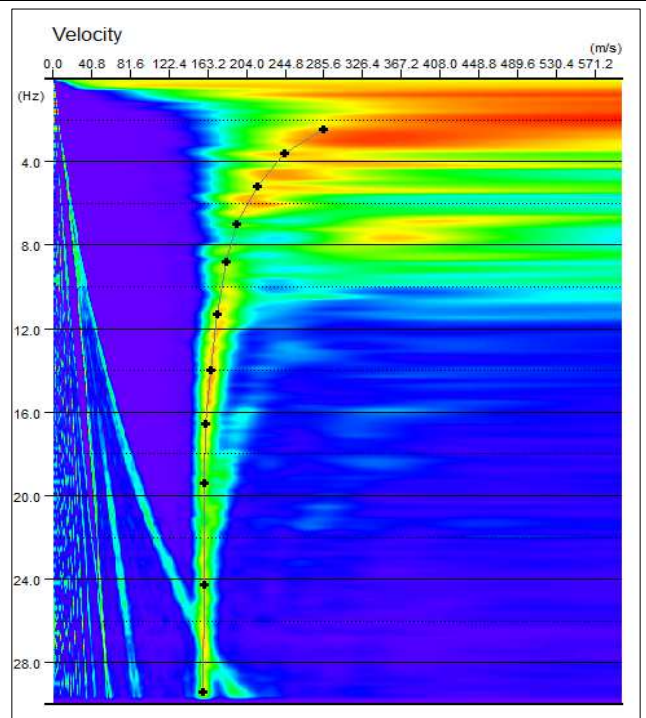
Comune di Castel Maggiore (BO) – Sabbiuono

n° tracce	Δx (m)	L tot (m)	Δt (ms)	T (s)
25	3,0	69,0	0,5/2,0	2,0/32,0

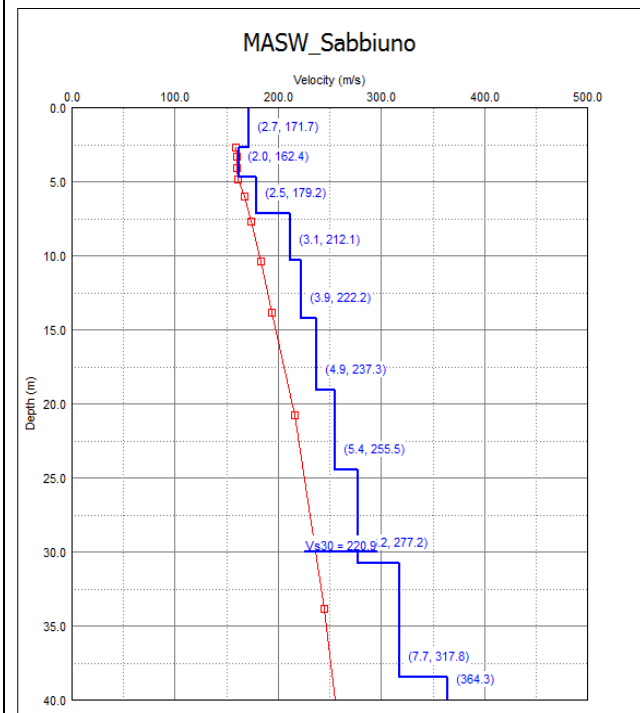
Δx : interdistanza geofonica; L tot: lunghezza profilo; Δt : passo di campionamento; T: durata registrazione.



Sismogramma registrato durante le acquisizioni di microtremore sismico. In ascissa la distanza tra i geofoni (m), in ordinata il tempo (ms).



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



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.	Profondità letto (m dal p.c.)	Spessore (m)	V_s (m/s)
1	2.7	2.7	171.7
2	4.7	2.0	162.4
3	7.2	2.5	179.2
4	10.3	3.1	212.1
5	14.2	3.9	222.2
6	19.1	4.9	237.3
7	24.5	5.4	255.5
8	30.7	6.2	277.2
9	38.4	7.7	317.8
10	∞	∞	364.3

$$V_{s30} = 220.9 \pm 10\% \text{ [m/s]}$$

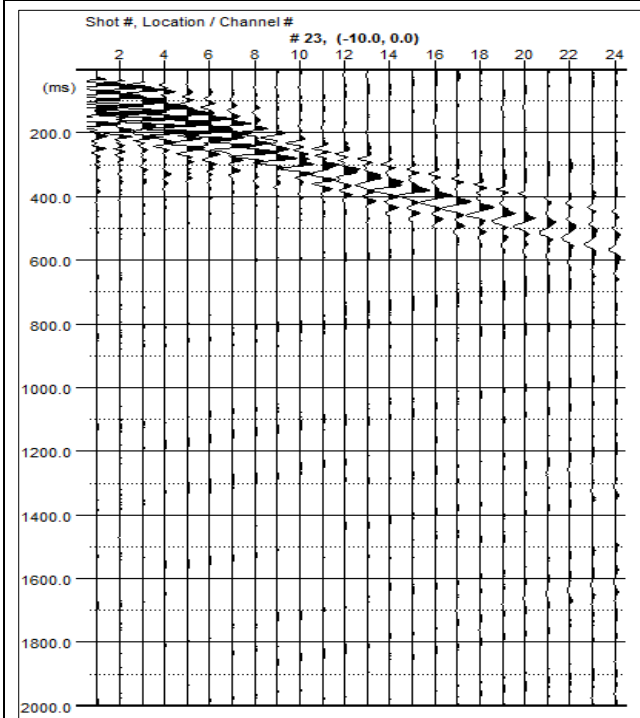
Sintesi dei parametri del modello di sottosuolo ottenuto e Valore di V_{s30} calcolato.

PROSPEZIONE SISMICA CON METODOLOGIA ATTIVA/PASSIVA MASW/Re.Mi.

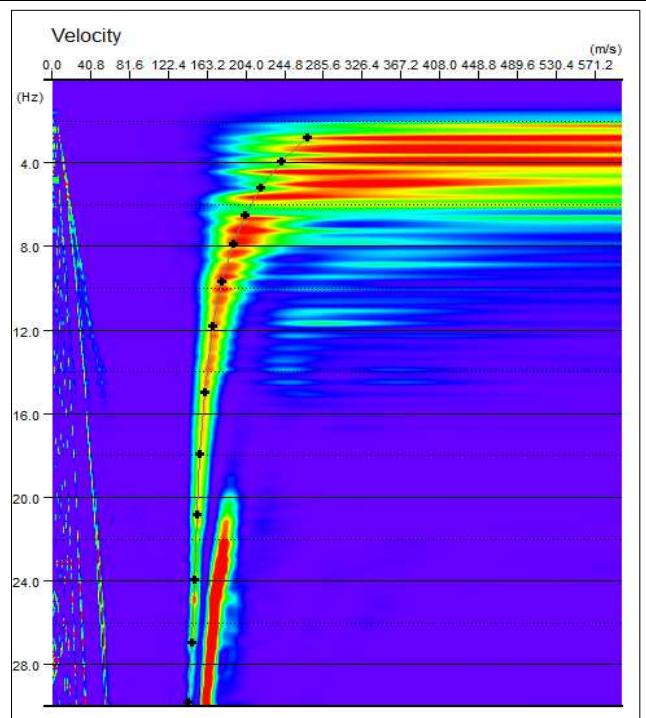
Comune di Castel Maggiore (BO) – Stazione FS

n° tracce	Δx (m)	L tot (m)	Δt (ms)	T (s)
25	3,0	69,0	0,5/2,0	2,0/32,0

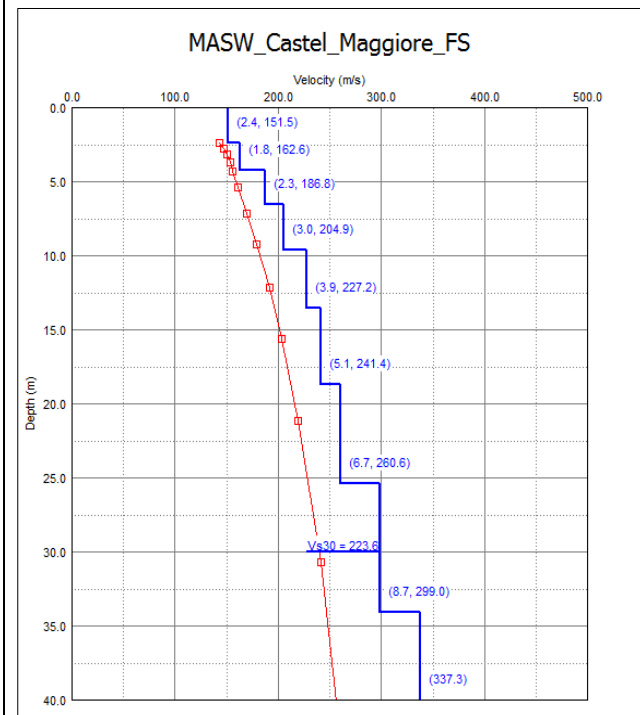
Δx : interdistanza geofonica; L tot: lunghezza profilo; Δt : passo di campionamento; T: durata registrazione.



Sismogramma registrato durante le acquisizioni di microtremore sismico. In ascissa la distanza tra i geofoni (m), in ordinata il tempo (ms).



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



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	151.5
2	4.2	1.8	162.6
3	6.5	2.3	186.8
4	9.5	3.0	204.9
5	13.4	3.9	227.2
6	18.5	5.1	241.4
7	25.2	6.7	260.6
8	33.9	8.7	299.0
9	∞	∞	337.3

$$V_{s30} = 223.6 \pm 10\% \text{ [m/s]}$$

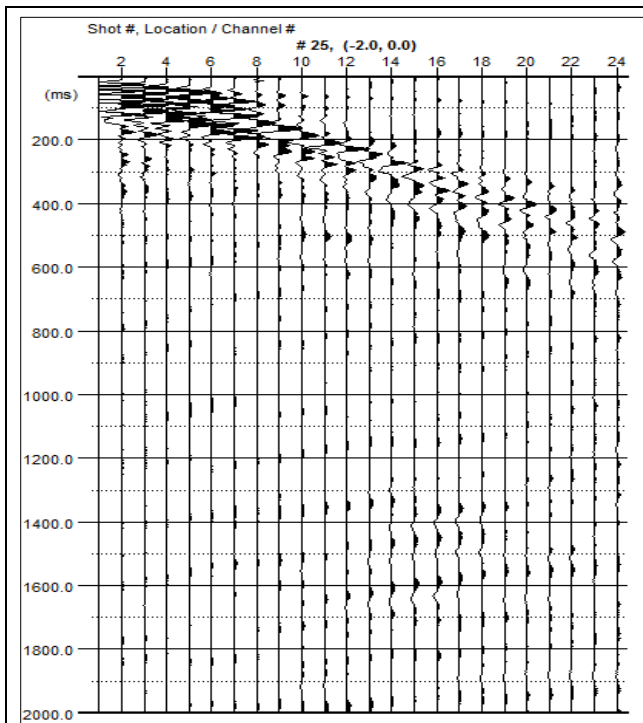
Sintesi dei parametri del modello di sottosuolo ottenuto e Valore di V_{s30} calcolato.

PROSPEZIONE SISMICA CON METODOLOGIA ATTIVA/PASSIVA MASW/Re.Mi.

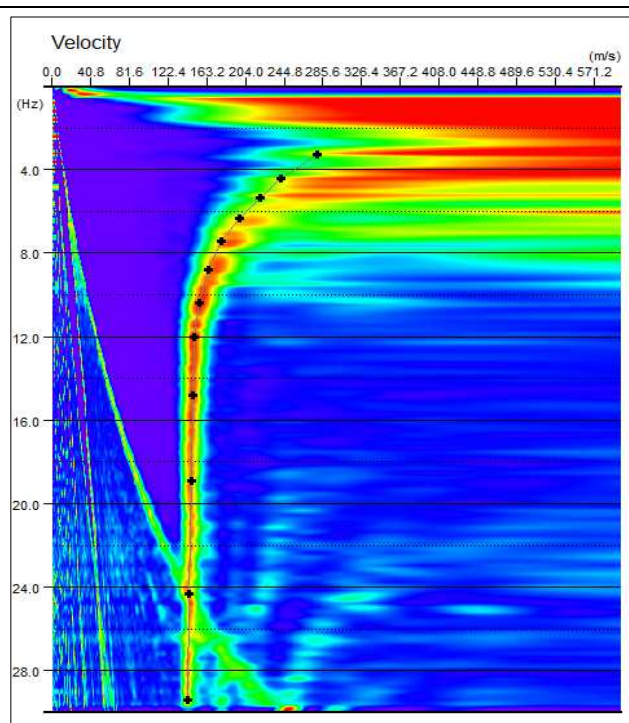
Comune di Castel Maggiore (BO) – Torre Verde

n° tracce	Δx (m)	L tot (m)	Δt (ms)	T (s)
25	3,0	69,0	0,5/2,0	2,0/32,0

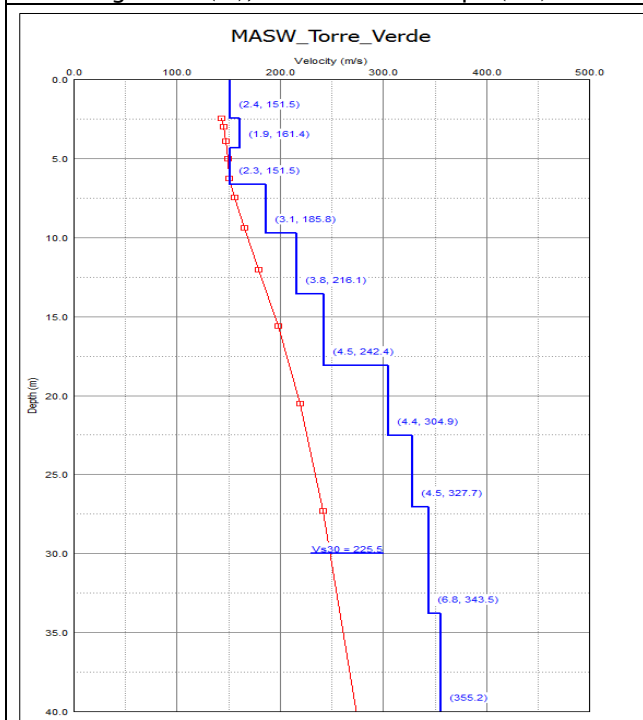
Δx : interdistanza geofonica; L tot: lunghezza profilo; Δt : passo di campionamento; T: durata registrazione.



Sismogramma registrato durante le acquisizioni di microtremore sismico. In ascissa la distanza tra i geofoni (m), in ordinata il tempo (ms).



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



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

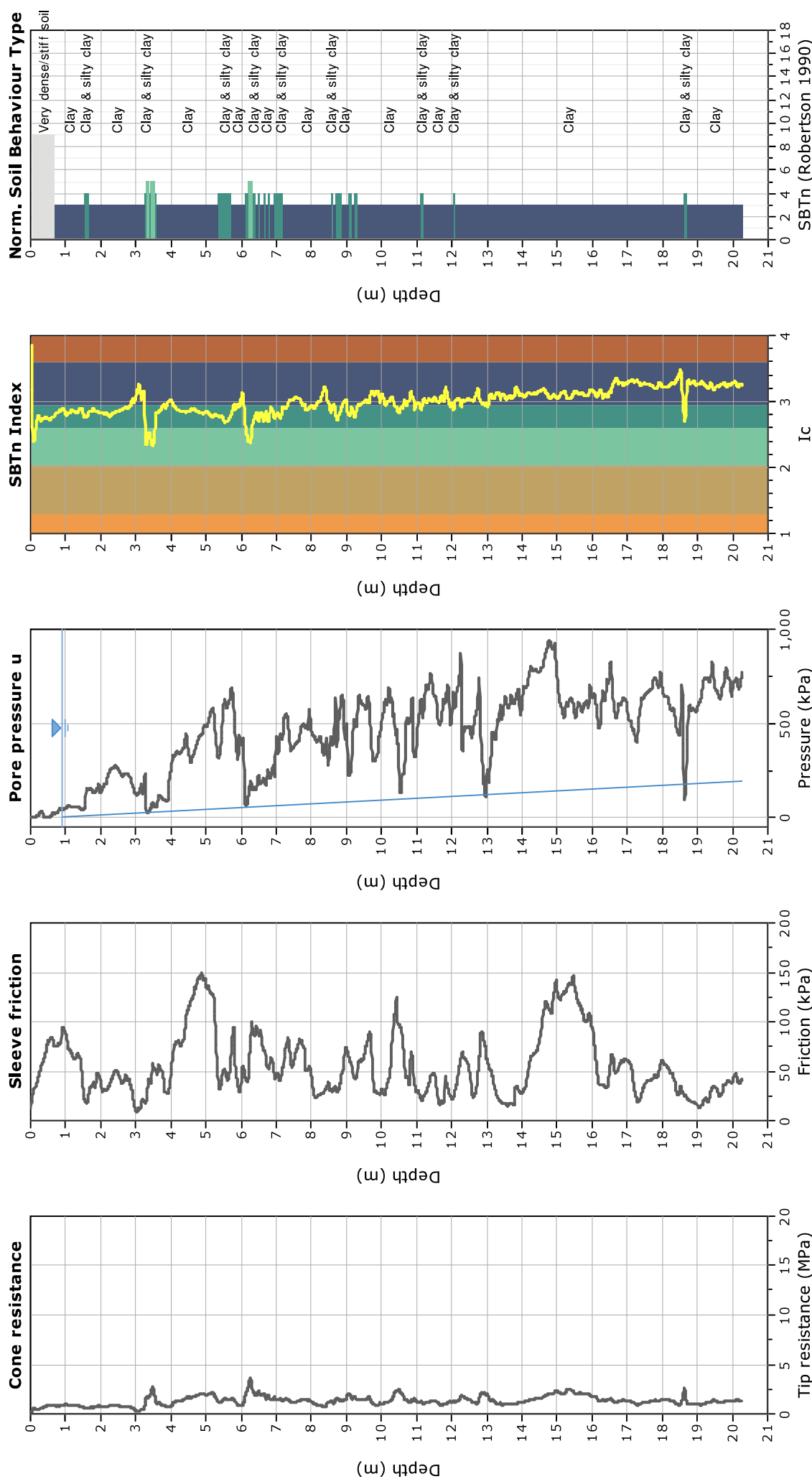
n.	Profondità letto (m dal p.c.)	Spessore (m)	V_s (m/s)
1	2.4	2.4	151.5
2	4.3	1.9	161.4
3	6.5	2.3	151.5
4	9.6	3.1	185.8
5	13.4	3.8	216.1
6	17.9	4.5	242.4
7	22.3	4.4	304.9
8	26.8	4.5	327.7
9	33.6	6.8	343.5
10	∞	∞	355.2

$$V_{s30} = 225.5 \pm 10\% \text{ [m/s]}$$

Sintesi dei parametri del modello di sottosuolo ottenuto e Valore di V_{s30} calcolato.

Project: Microzonazione Sismica Castel Maggiore

Location: via Berlinguer - Castel Maggiore (BO)



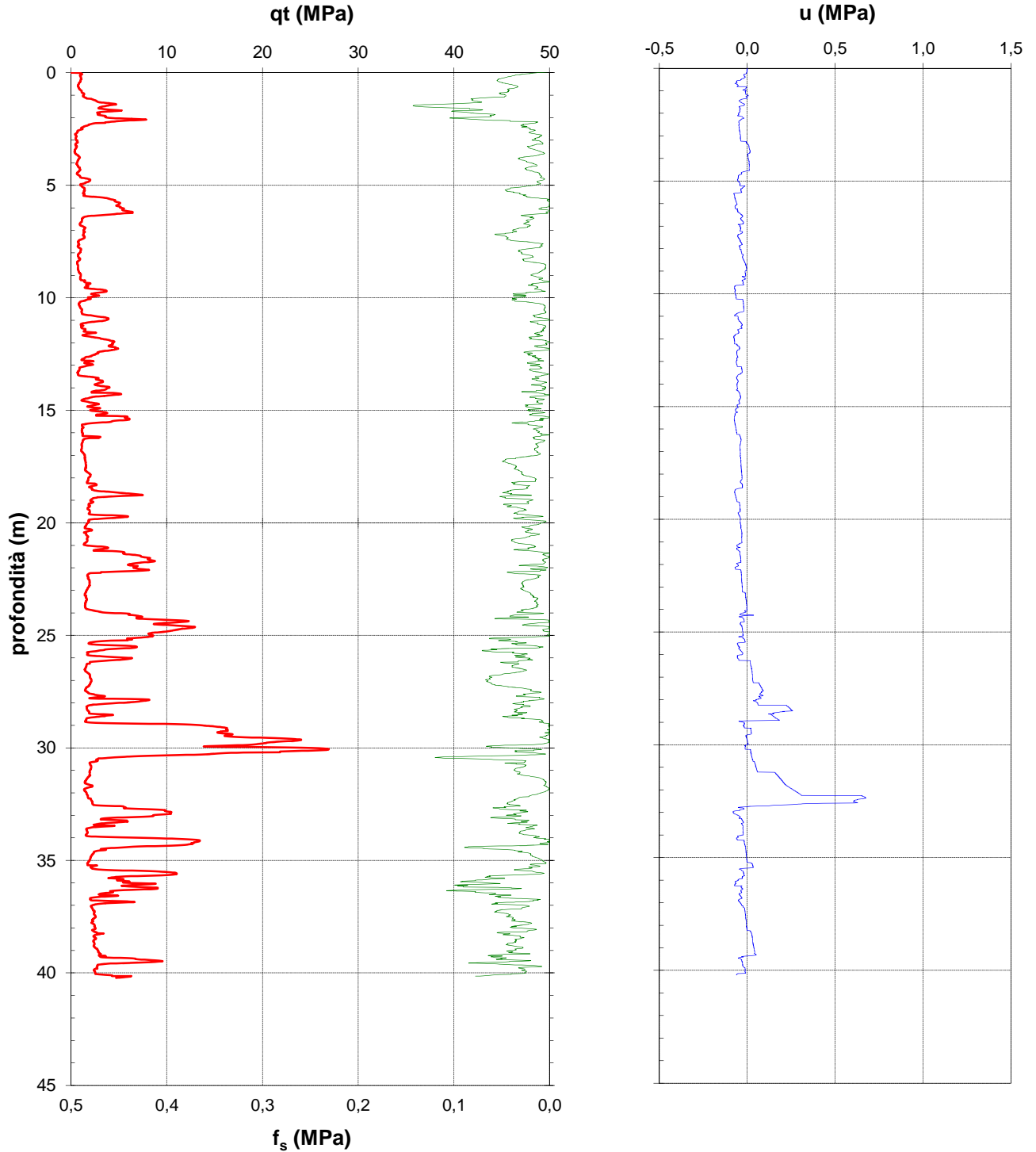
Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A-B-C

Procedura di riferimento: ASTM D 5778 (2000)

Certificato di prova n°:

rev.	data emiss.	Sperimentatore	Direttore
0	30/03/2017	Ranzini	Saccenti

Committente:	Unione Comuni Reno Galliera
Cantiere:	Castel Maggiore
Prova:	SCPTU1
Data prova:	



Coordinate:	X =	Y =	Z =
Quote (m):	inizio prova = piano campagna		fine prova = 40.31 (40.22)

Note: Prova eseguita con piezocono n. 510

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

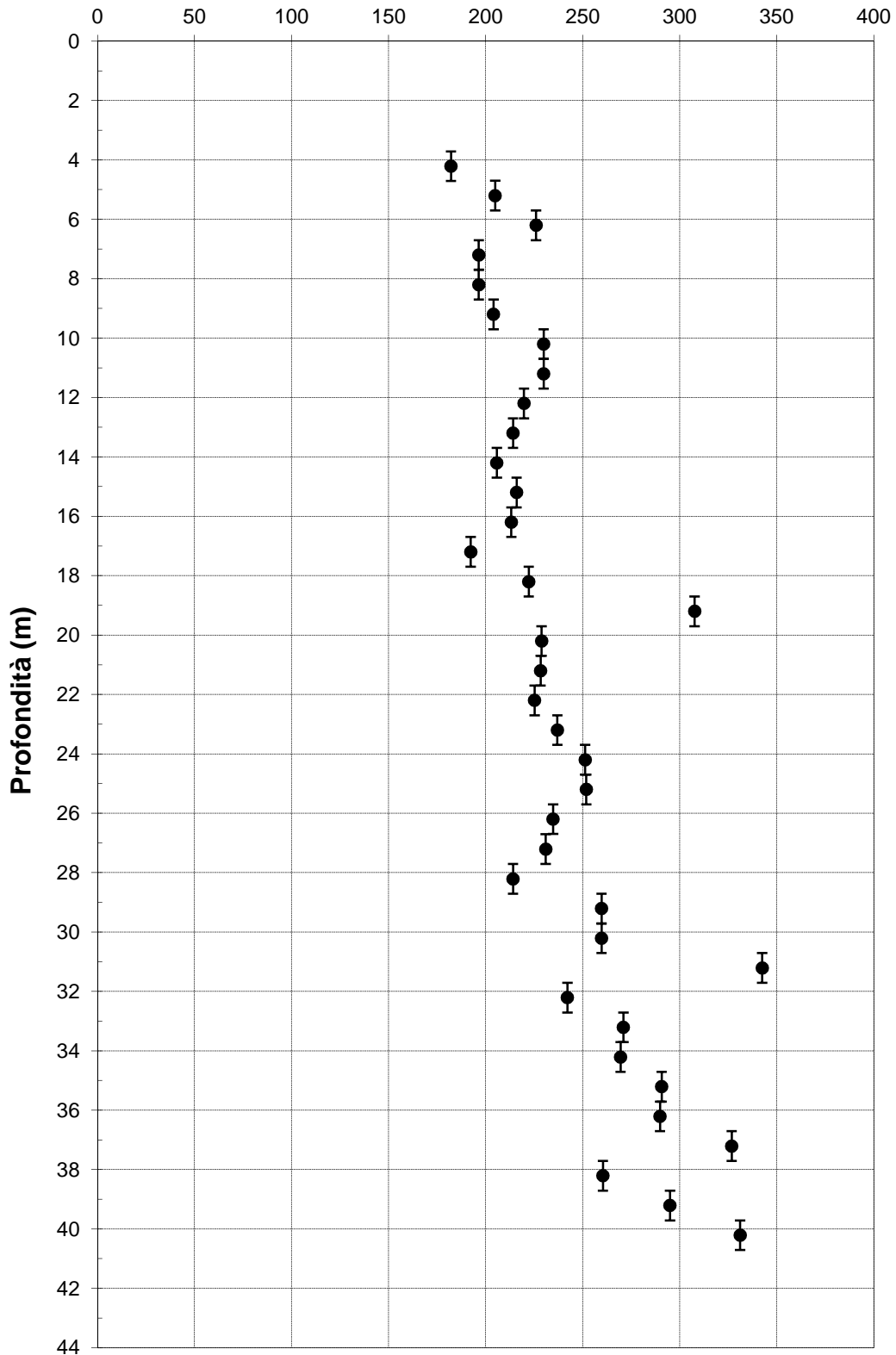
rev.	data emiss.	eseguito da	elaborato da
0	30/03/2017	Ranzini	Saccenti

Procedura di riferimento: PT 162

037019P246SCPT289

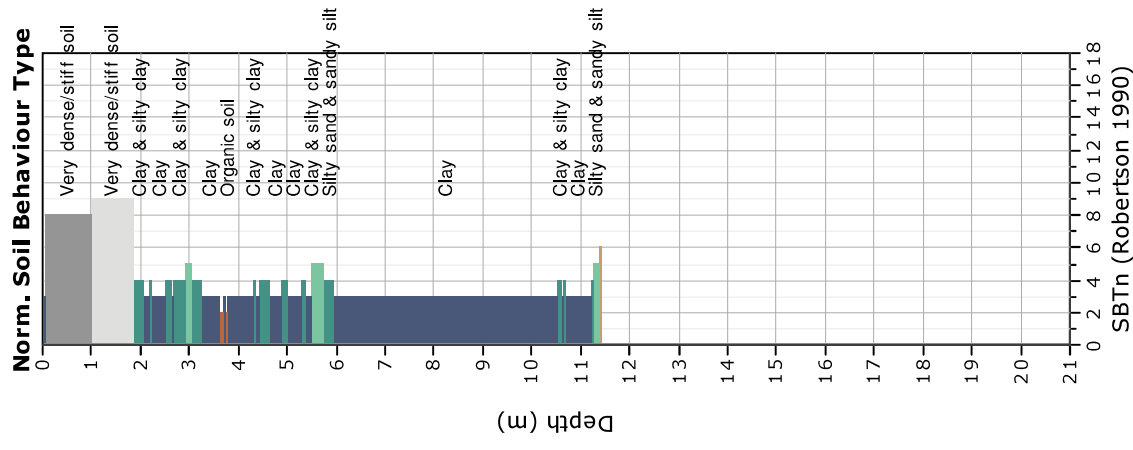
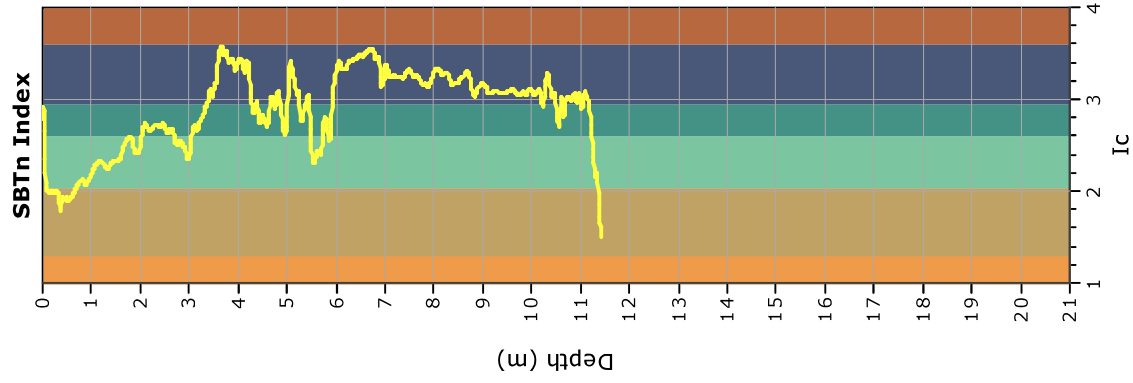
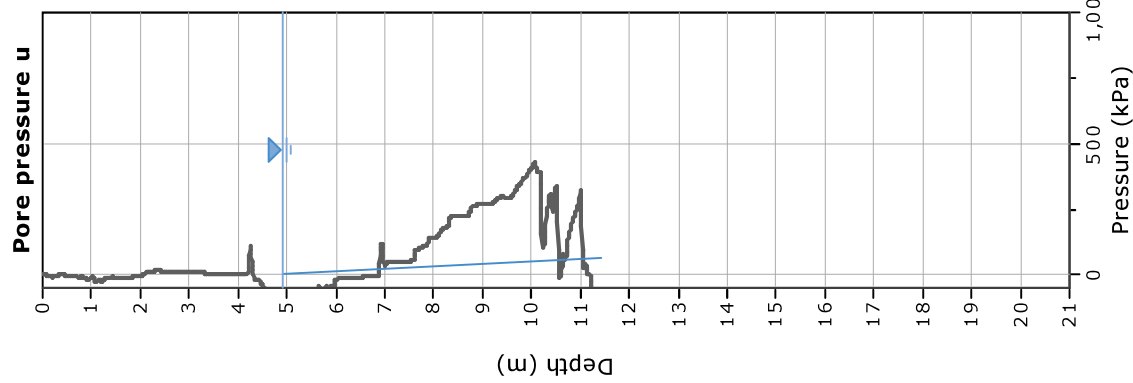
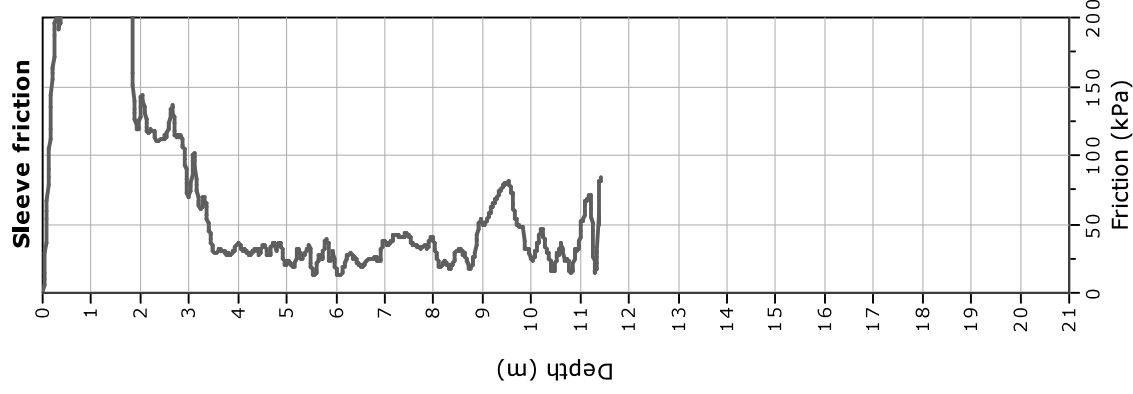
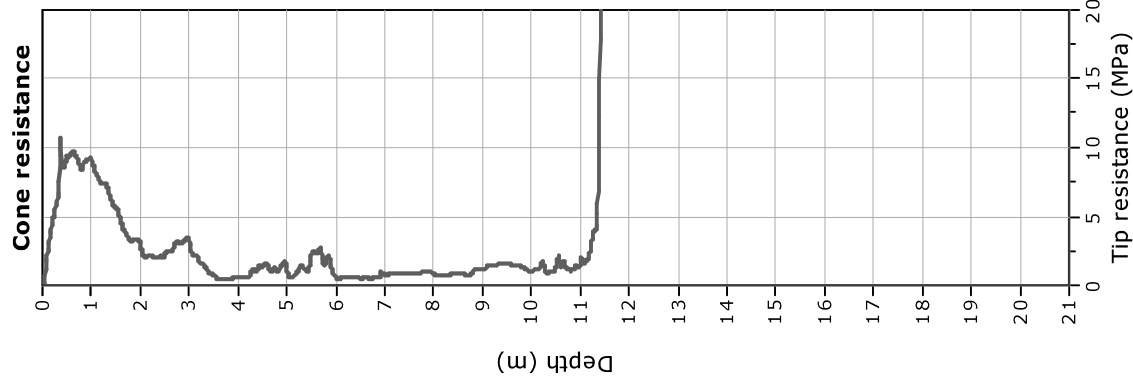
Committente:	Unione Comuni Reno Galliera
Cantiere:	Castel Maggiore
Prova:	DH1
Data prova:	03/03/2017

Velocità onde di taglio V_{SVH} (m/s)



Project: Microzonazione Sismica Castel Maggiore

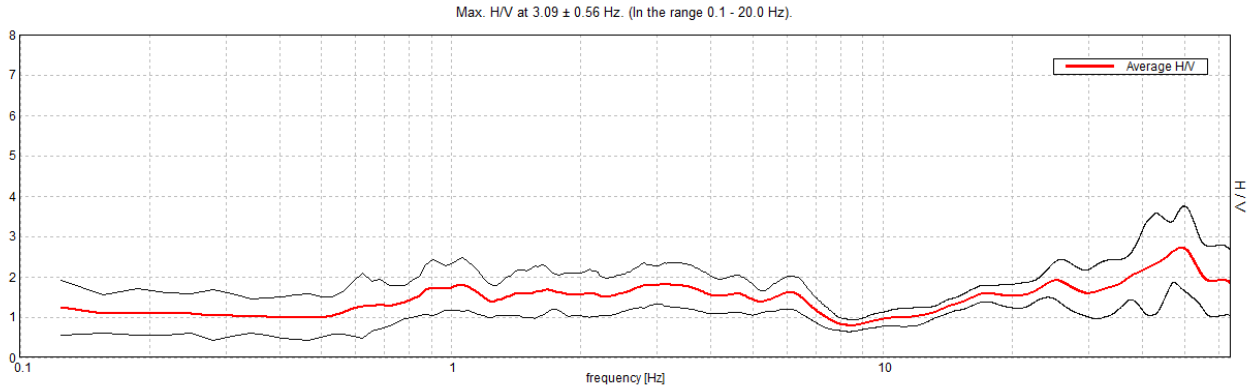
Location: Trebbo - Castel Maggiore (BO)



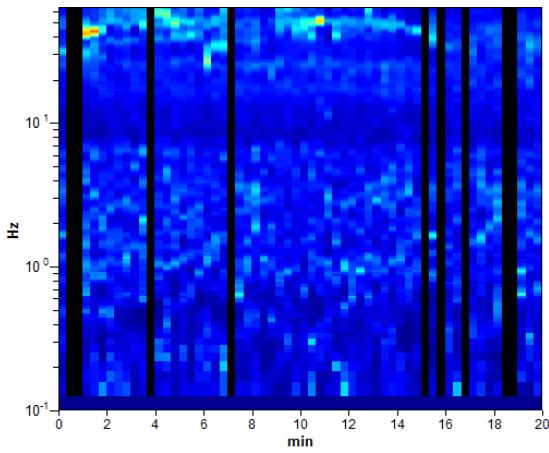
CASTEL MAGGIORE_MS, MS 2017 TR2 TREBBO 037019P251HVS295

Strumento: TRZ-0108/01-10
 Inizio registrazione: 25/09/17 10:43:15 Fine registrazione: 25/09/17 11:03:16
 Nomi canali: NORTH SOUTH; EAST WEST ; UP DOWN
 Durata registrazione: 0h20'00". Analizzato 85% tracciato (selezione manuale)
 Freq. campionamento: 128 Hz
 Lunghezza finestre: 20 s
 Tipo di lisciamento: Triangular window
 Lisciamento: 10%

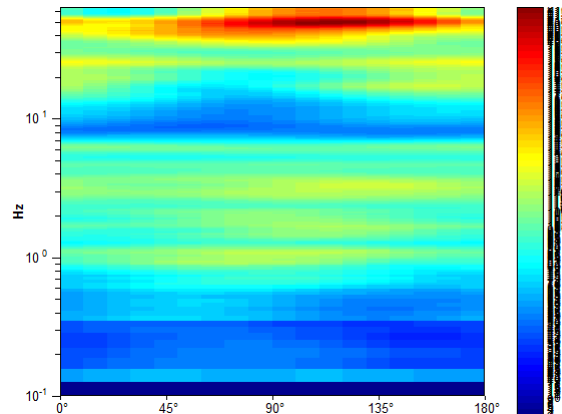
RAPPORTO SPETTRALE ORIZZONTALE SU VERTICALE



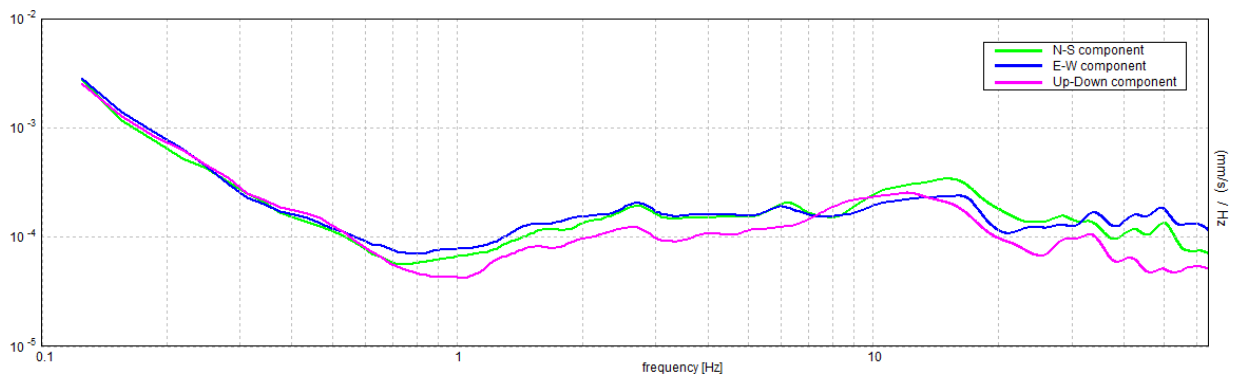
SERIE TEMPORALE H/V



DIREZIONALITA' H/V



SPETTRI DELLE SINGOLE COMPONENTI



[Secondo le linee guida SESAME, 2005. Si raccomanda di leggere attentamente il manuale di Grilla prima di interpretare la tabella seguente].

Picco H/V a 3.09 ± 0.56 Hz (nell'intervallo 0.1 - 20.0 Hz).

Criteri per una curva H/V affidabile

[Tutti 3 dovrebbero risultare soddisfatti]

$f_0 > 10 / L_w$	$3.09 > 0.50$	OK	
$n_c(f_0) > 200$	$3155.6 > 200$	OK	
$\sigma_A(f) < 2$ per $0.5f_0 < f < 2f_0$ se $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ per $0.5f_0 < f < 2f_0$ se $f_0 < 0.5\text{Hz}$	Superato 0 volte su 150	OK	

Criteri per un picco H/V chiaro

[Almeno 5 su 6 dovrebbero essere soddisfatti]

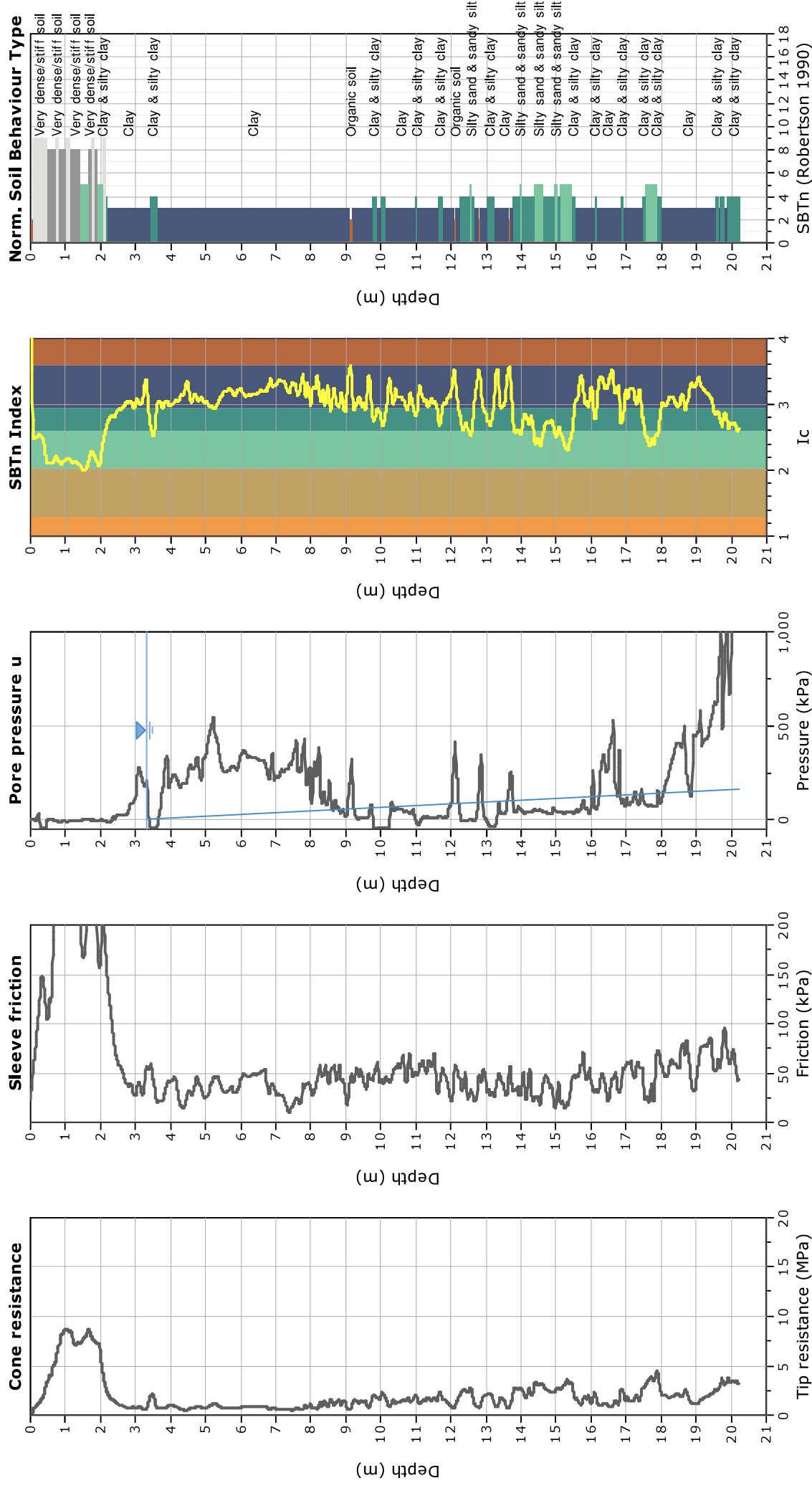
Esiste f^- in $[f_0/4, f_0]$ $A_{H/V}(f^-) < A_0 / 2$			NO
Esiste f^+ in $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	7.656 Hz	OK	
$A_0 > 2$	$1.81 > 2$		NO
$f_{\text{picco}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.08933 < 0.05$		NO
$\sigma_f < \varepsilon(f_0)$	$0.27637 < 0.15469$		NO
$\sigma_A(f_0) < \theta(f_0)$	$0.2534 < 1.58$	OK	

L_w	lunghezza della finestra
n_w	numero di finestre usate nell'analisi
$n_c = L_w n_w f_0$	numero di cicli significativi
f	frequenza attuale
f_0	frequenza del picco H/V
σ_f	deviazione standard della frequenza del picco H/V
$\varepsilon(f_0)$	valore di soglia per la condizione di stabilità $\sigma_f < \varepsilon(f_0)$
A_0	ampiezza della curva H/V alla frequenza f_0
$A_{H/V}(f)$	ampiezza della curva H/V alla frequenza f
f^-	frequenza tra $f_0/4$ e f_0 alla quale $A_{H/V}(f^-) < A_0/2$
f^+	frequenza tra f_0 e $4f_0$ alla quale $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	deviazione standard di $A_{H/V}(f)$, $\sigma_A(f)$ è il fattore per il quale la curva $A_{H/V}(f)$ media deve essere moltiplicata o divisa
$\sigma_{\log H/V}(f)$	deviazione standard della funzione $\log A_{H/V}(f)$
$\theta(f_0)$	valore di soglia per la condizione di stabilità $\sigma_A(f) < \theta(f_0)$

Valori di soglia per σ_f e $\sigma_A(f_0)$

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

Project: Microzonazione Sismica Castel Maggiore
Location: viale Europa - Castel Maggiore (BO)



CASTEL MAGGIORE_MS, MS 2017 TR3 VIALE EUROPA 037019P252HVSR297

Strumento: TRZ-0108/01-10

Inizio registrazione: 25/09/17 12:25:52 Fine registrazione: 25/09/17 12:45:53

Nomi canali: NORTH SOUTH; EAST WEST ; UP DOWN

Durata registrazione: 0h20'00". Analizzato 80% tracciato (selezione manuale)

Freq. campionamento: 128 Hz

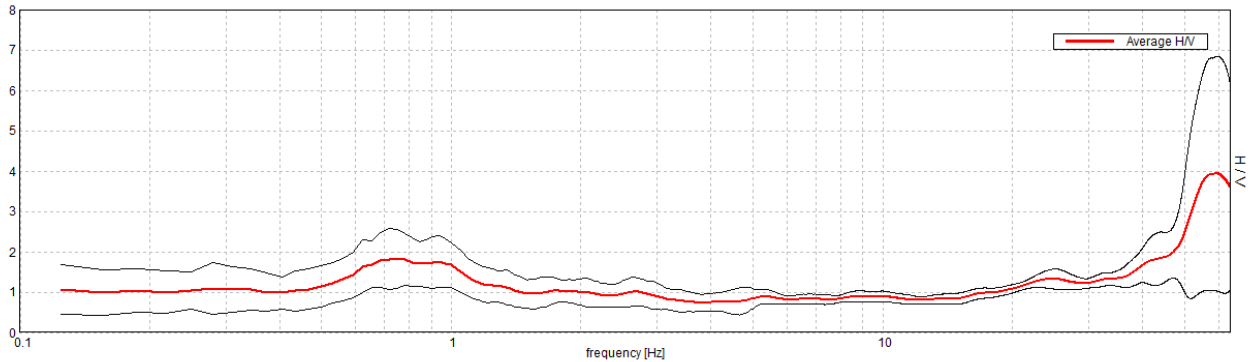
Lunghezza finestre: 20 s

Tipo di lisciamento: Triangular window

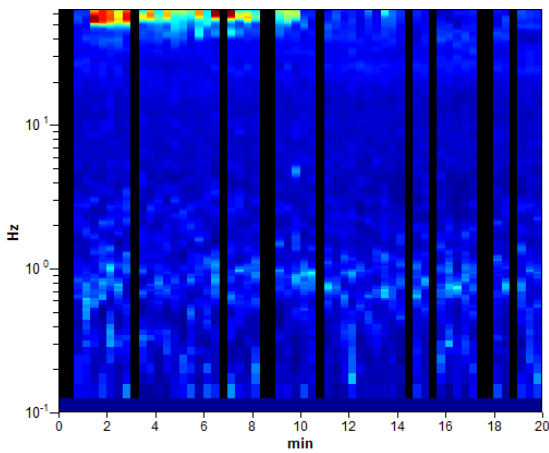
Lisciamento: 10%

RAPPORTO SPETTRALE ORIZZONTALE SU VERTICALE

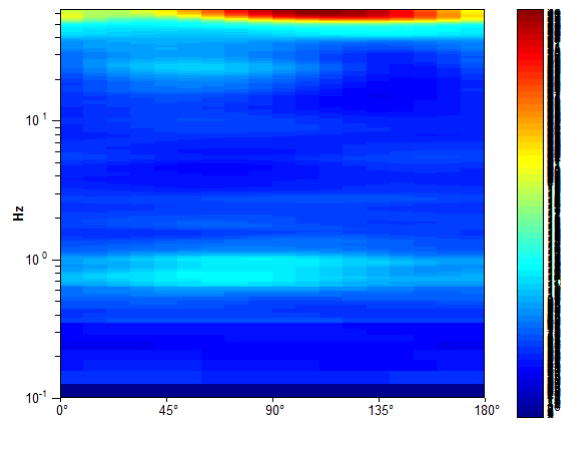
Max. H/V at 0.75 ± 0.03 Hz. (In the range 0.1 - 20.0 Hz).



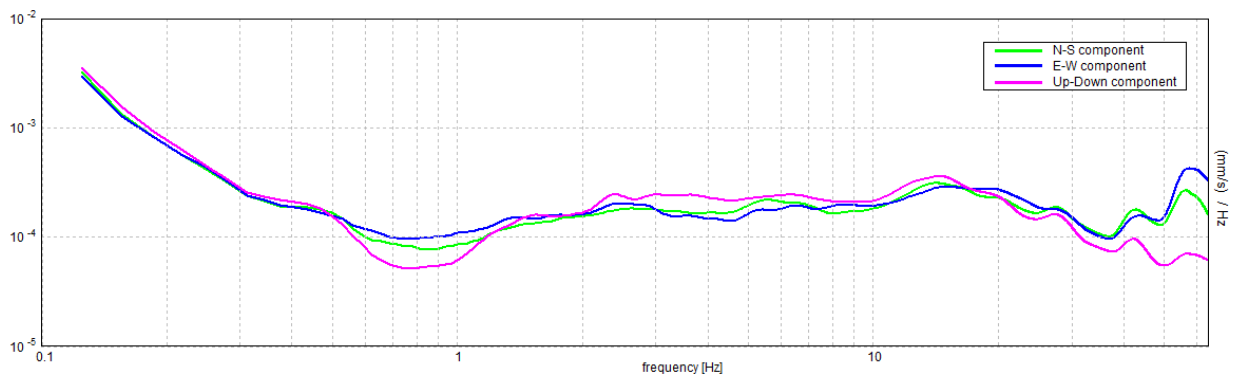
SERIE TEMPORALE H/V



DIREZIONALITA' H/V



SPETTRI DELLE SINGOLE COMPONENTI



[Secondo le linee guida SESAME, 2005. Si raccomanda di leggere attentamente il manuale di Grilla prima di interpretare la tabella seguente].

Picco H/V a 0.75 ± 0.03 Hz (nell'intervallo 0.1 - 20.0 Hz).

Criteri per una curva H/V affidabile

[Tutti 3 dovrebbero risultare soddisfatti]

$f_0 > 10 / L_w$	$0.75 > 0.50$	OK	
$n_c(f_0) > 200$	$720.0 > 200$	OK	
$\sigma_A(f) < 2$ per $0.5f_0 < f < 2f_0$ se $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ per $0.5f_0 < f < 2f_0$ se $f_0 < 0.5\text{Hz}$	Superato 0 volte su 37	OK	

Criteri per un picco H/V chiaro

[Almeno 5 su 6 dovrebbero essere soddisfatti]

Esiste f^- in $[f_0/4, f_0]$ $A_{H/V}(f^-) < A_0 / 2$			NO
Esiste f^+ in $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	2.313 Hz	OK	
$A_0 > 2$	$1.82 > 2$		NO
$f_{\text{picco}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01958 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01469 < 0.1125$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3555 < 2.0$	OK	

L_w	lunghezza della finestra
n_w	numero di finestre usate nell'analisi
$n_c = L_w n_w f_0$	numero di cicli significativi
f	frequenza attuale
f_0	frequenza del picco H/V
σ_f	deviazione standard della frequenza del picco H/V
$\varepsilon(f_0)$	valore di soglia per la condizione di stabilità $\sigma_f < \varepsilon(f_0)$
A_0	ampiezza della curva H/V alla frequenza f_0
$A_{H/V}(f)$	ampiezza della curva H/V alla frequenza f
f^-	frequenza tra $f_0/4$ e f_0 alla quale $A_{H/V}(f^-) < A_0/2$
f^+	frequenza tra f_0 e $4f_0$ alla quale $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	deviazione standard di $A_{H/V}(f)$, $\sigma_A(f)$ è il fattore per il quale la curva $A_{H/V}(f)$ media deve essere moltiplicata o divisa
$\sigma_{\log H/V}(f)$	deviazione standard della funzione $\log A_{H/V}(f)$
$\theta(f_0)$	valore di soglia per la condizione di stabilità $\sigma_A(f) < \theta(f_0)$

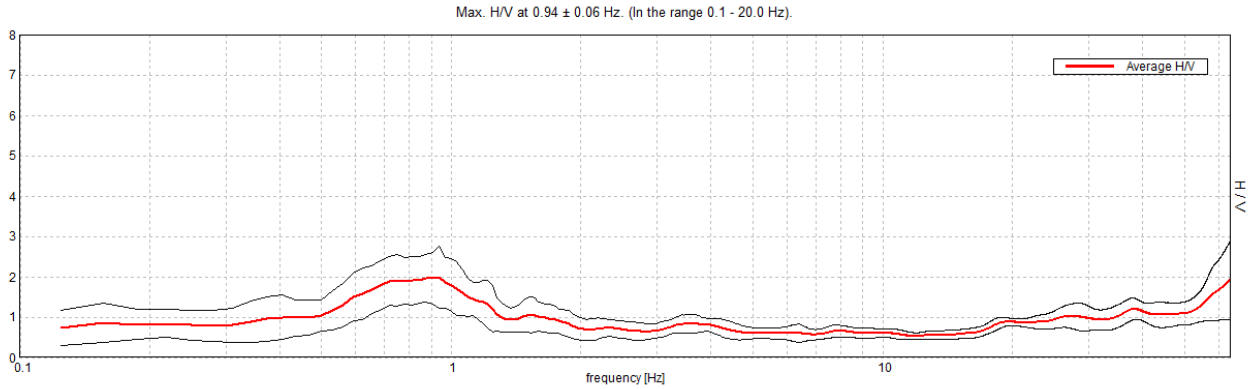
Valori di soglia per σ_f e $\sigma_A(f_0)$

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

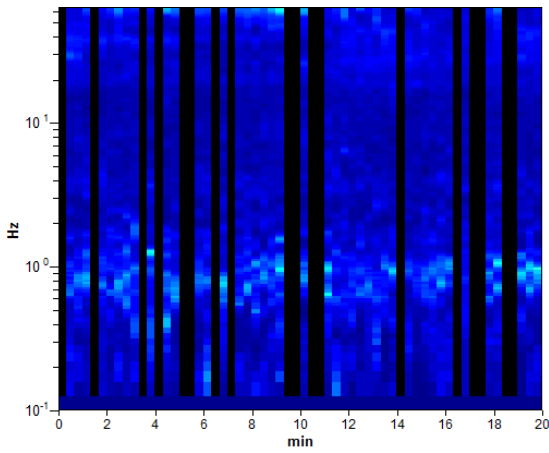
CASTEL MAGGIORE_MS, MS 2017 TR4 VIA ALBERTINA 037019P253HVSR299

Strumento: TRZ-0108/01-10
 Inizio registrazione: 25/09/17 15:11:44 Fine registrazione: 25/09/17 15:31:45
 Nomi canali: NORTH SOUTH; EAST WEST ; UP DOWN
 Durata registrazione: 0h20'00". Analizzato 70% tracciato (selezione manuale)
 Freq. campionamento: 128 Hz
 Lunghezza finestre: 20 s
 Tipo di lisciamento: Triangular window
 Lisciamento: 10%

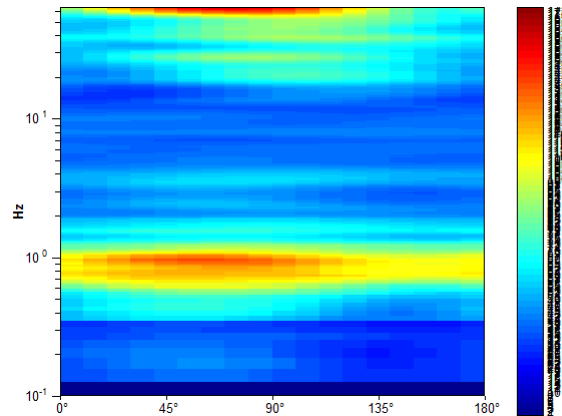
RAPPORTO SPETTRALE ORIZZONTALE SU VERTICALE



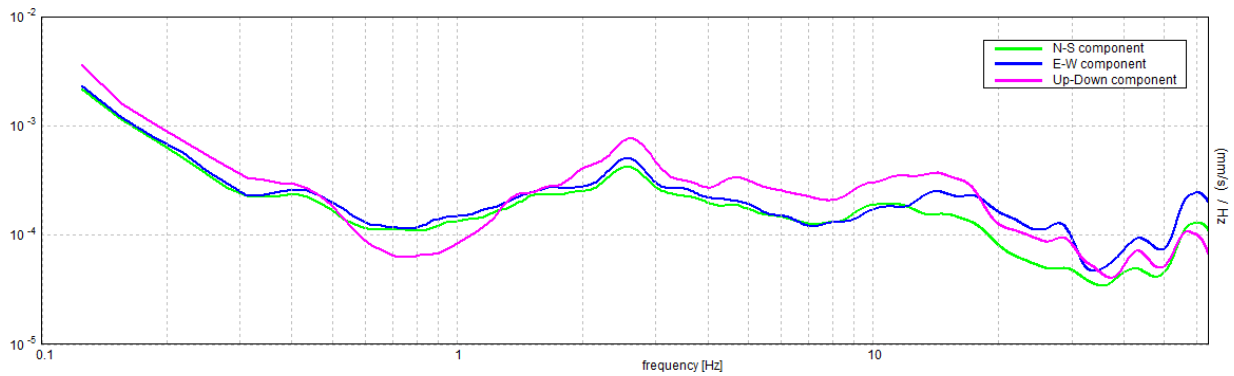
SERIE TEMPORALE H/V



DIREZIONALITA' H/V



SPETTRI DELLE SINGOLE COMPONENTI



[Secondo le linee guida SESAME, 2005. Si raccomanda di leggere attentamente il manuale di Grilla prima di interpretare la tabella seguente].

Picco H/V a 0.94 ± 0.06 Hz (nell'intervallo 0.1 - 20.0 Hz).

Criteri per una curva H/V affidabile

[Tutti 3 dovrebbero risultare soddisfatti]

$f_0 > 10 / L_w$	$0.94 > 0.50$	OK	
$n_c(f_0) > 200$	$787.5 > 200$	OK	
$\sigma_A(f) < 2$ per $0.5f_0 < f < 2f_0$ se $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ per $0.5f_0 < f < 2f_0$ se $f_0 < 0.5\text{Hz}$	Superato 0 volte su 46	OK	

Criteri per un picco H/V chiaro

[Almeno 5 su 6 dovrebbero essere soddisfatti]

Esiste f^- in $[f_0/4, f_0]$ $A_{H/V}(f^-) < A_0 / 2$	0.469 Hz	OK	
Esiste f^+ in $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	1.344 Hz	OK	
$A_0 > 2$	$1.98 > 2$		NO
$f_{\text{picco}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.03025 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.02836 < 0.14063$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3761 < 2.0$	OK	

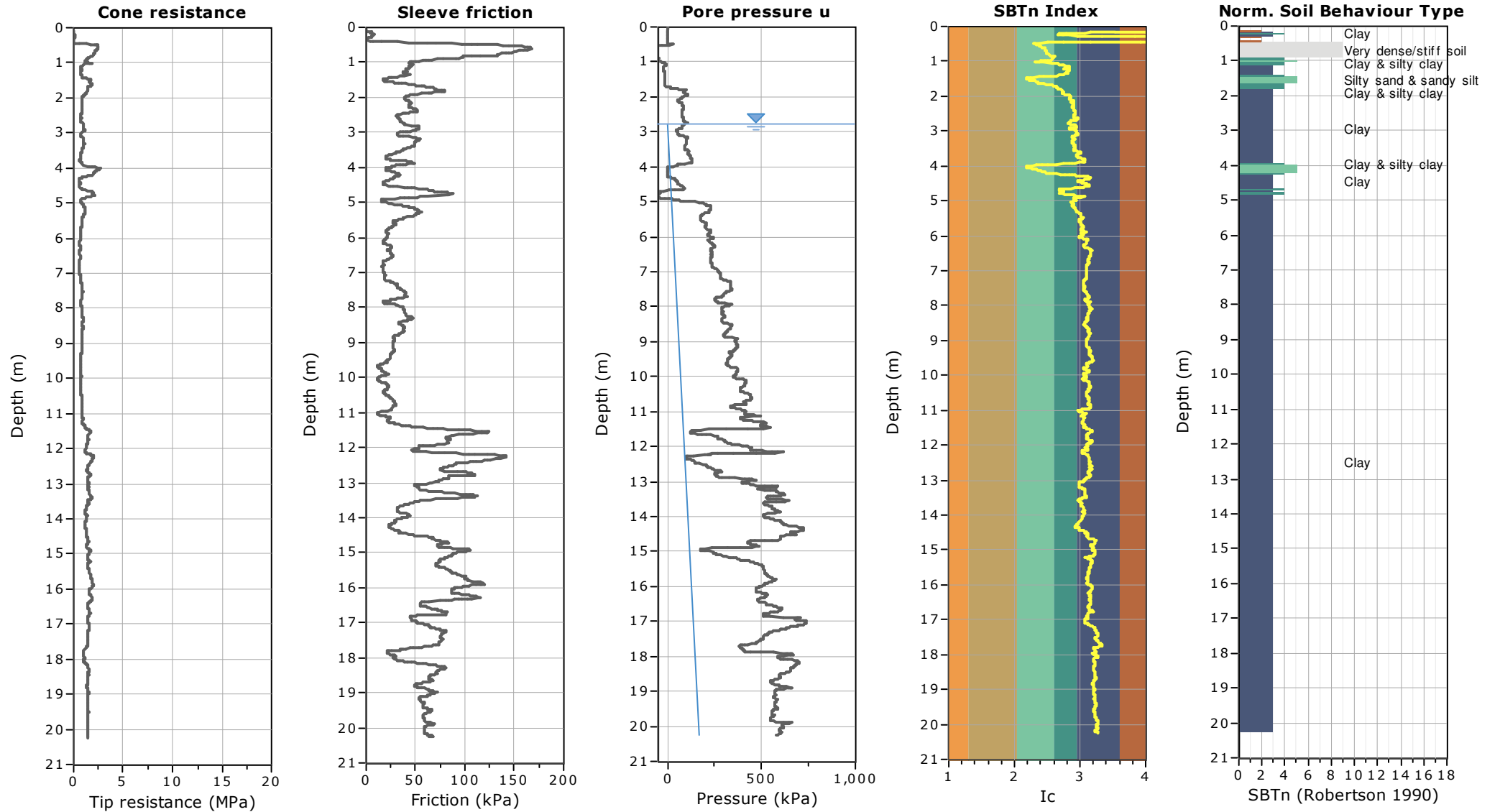
L_w	lunghezza della finestra
n_w	numero di finestre usate nell'analisi
$n_c = L_w n_w f_0$	numero di cicli significativi
f	frequenza attuale
f_0	frequenza del picco H/V
σ_f	deviazione standard della frequenza del picco H/V
$\varepsilon(f_0)$	valore di soglia per la condizione di stabilità $\sigma_f < \varepsilon(f_0)$
A_0	ampiezza della curva H/V alla frequenza f_0
$A_{H/V}(f)$	ampiezza della curva H/V alla frequenza f
f^-	frequenza tra $f_0/4$ e f_0 alla quale $A_{H/V}(f^-) < A_0/2$
f^+	frequenza tra f_0 e $4f_0$ alla quale $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	deviazione standard di $A_{H/V}(f)$, $\sigma_A(f)$ è il fattore per il quale la curva $A_{H/V}(f)$ media deve essere moltiplicata o divisa
$\sigma_{\log H/V}(f)$	deviazione standard della funzione $\log A_{H/V}(f)$
$\theta(f_0)$	valore di soglia per la condizione di stabilità $\sigma_A(f) < \theta(f_0)$

Valori di soglia per σ_f e $\sigma_A(f_0)$

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

Project: Microzonazione Sismica Castel Maggiore

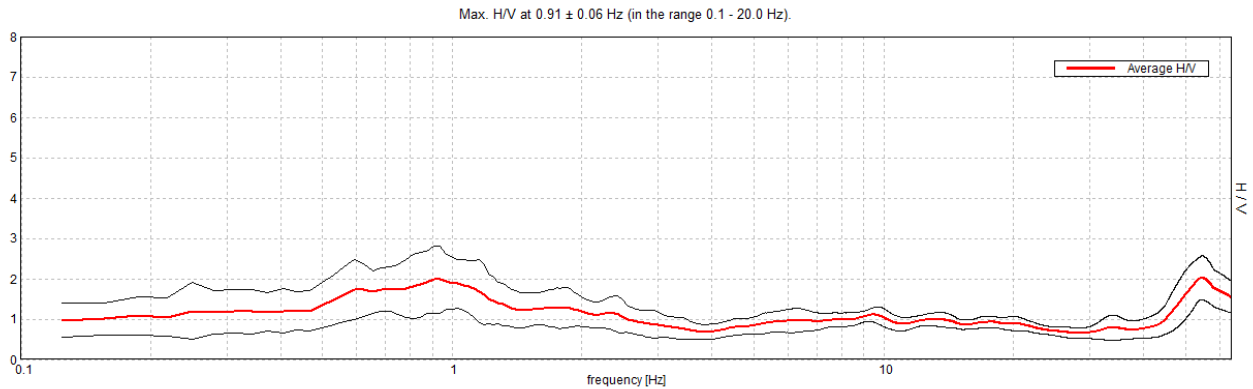
Location: via Costa - Castel Maggiore (BO)



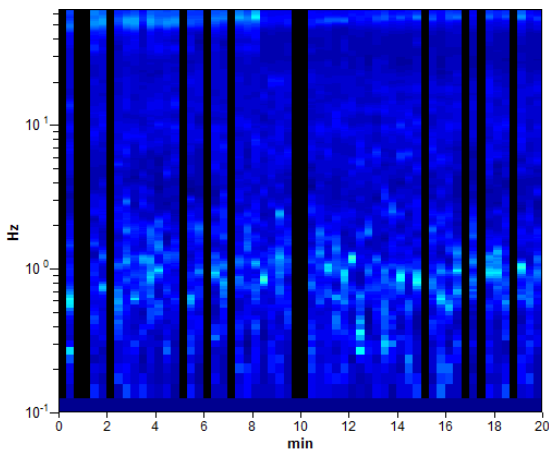
CASTEL MAGGIORE_MS, MS 2017 TR5 VIA COSTA 037019P254HVSR301

Instrument: TRZ-0108/01-10
 Start recording: 16/11/17 14:22:25 End recording: 16/11/17 14:42:26
 Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
 Trace length: 0h20'00". Analyzed 78% trace (manual window selection)
 Sampling rate: 128 Hz
 Window size: 20 s
 Smoothing type: Triangular window
 Smoothing: 10%

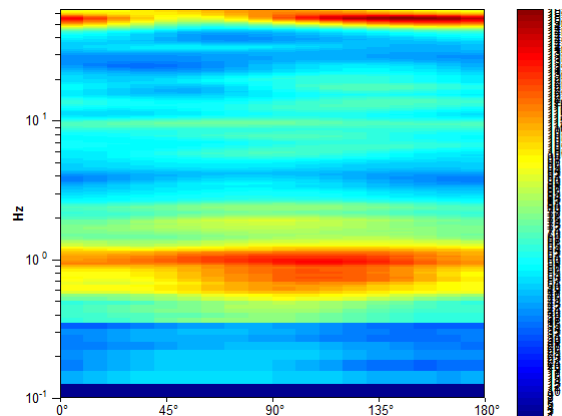
HORIZONTAL TO VERTICAL SPECTRAL RATIO



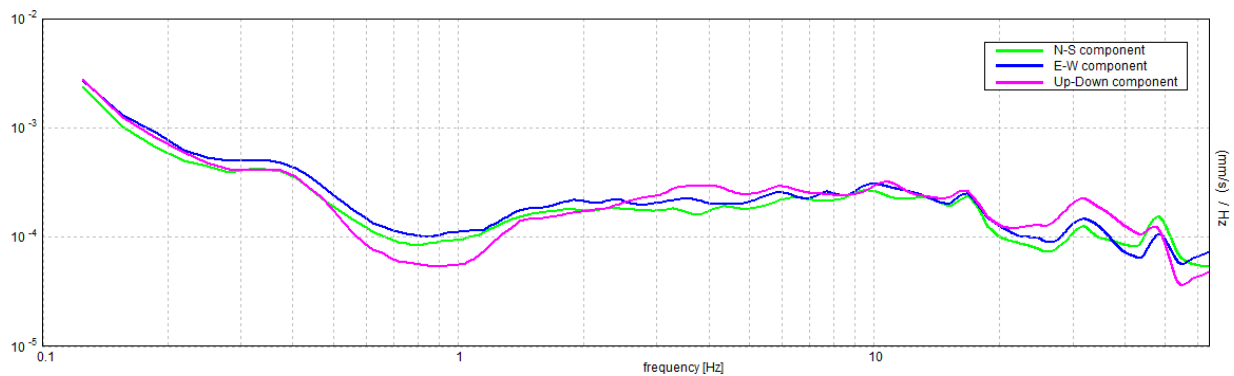
H/V TIME HISTORY



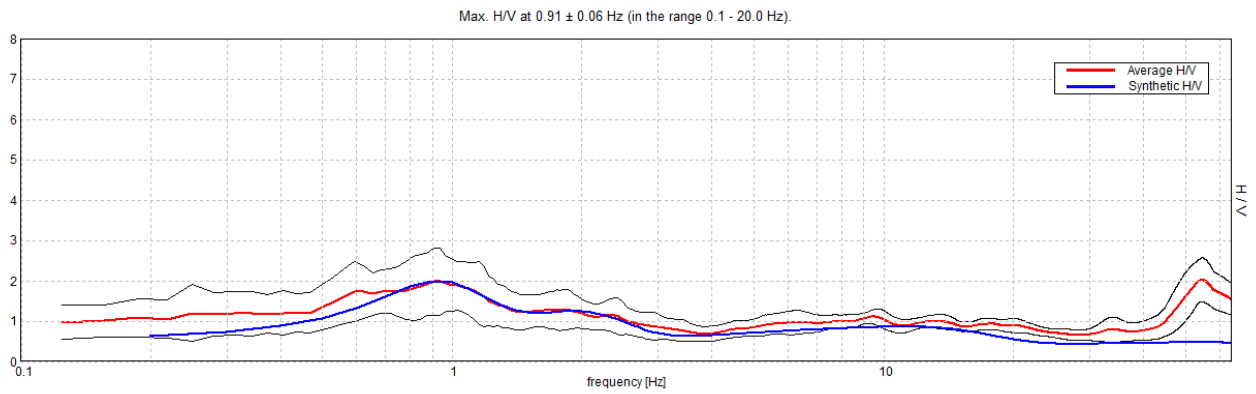
DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA

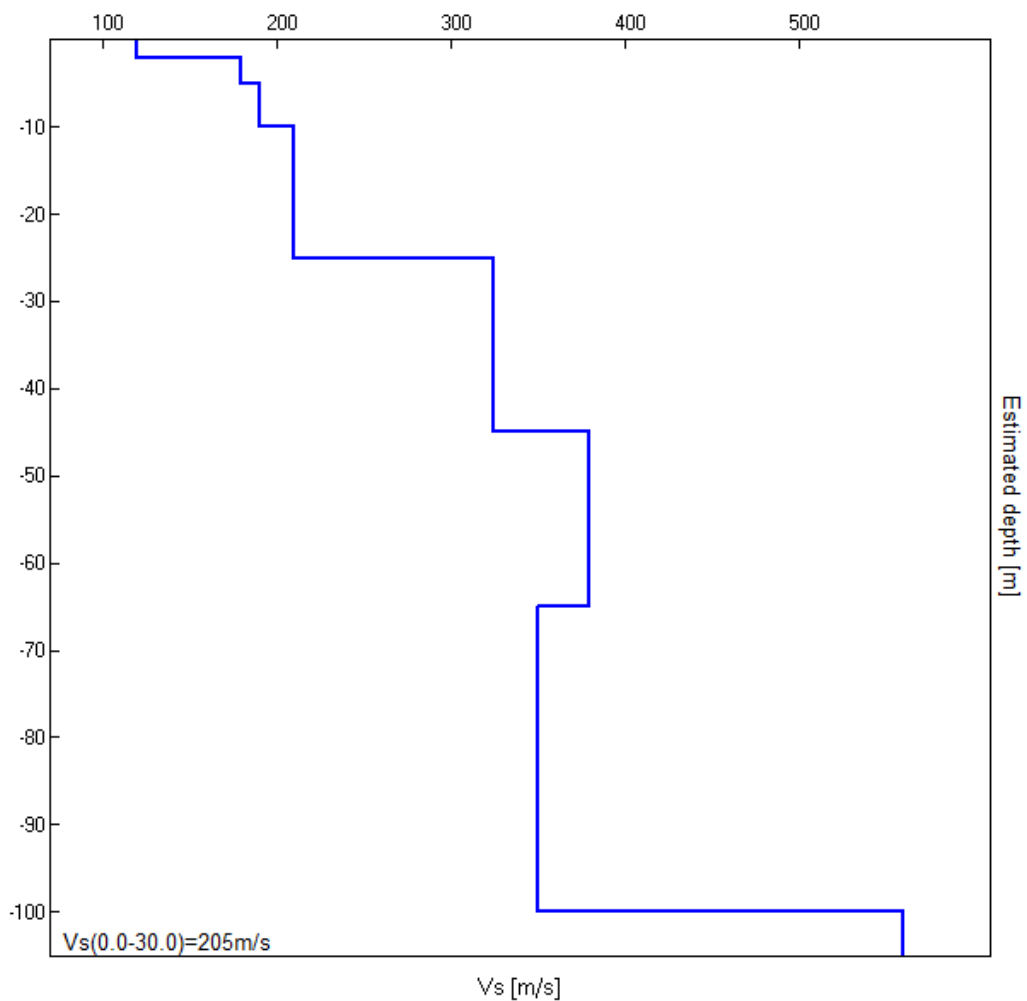


EXPERIMENTAL vs. SYNTHETIC H/V



Depth at the bottom of the layer [m]	Thickness [m]	Vs [m/s]
2.00	2.00	120
5.00	3.00	180
10.00	5.00	190
25.00	15.00	210
45.00	20.00	325
65.00	20.00	380
100.00	35.00	350
inf.	inf.	560

Vs(0.0-30.0)=205m/s



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

Max. H/V at 0.91 ± 0.06 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.91 > 0.50$	OK	
$n_c(f_0) > 200$	$851.9 > 200$	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 44 times	OK	

Criteria for a clear H/V peak

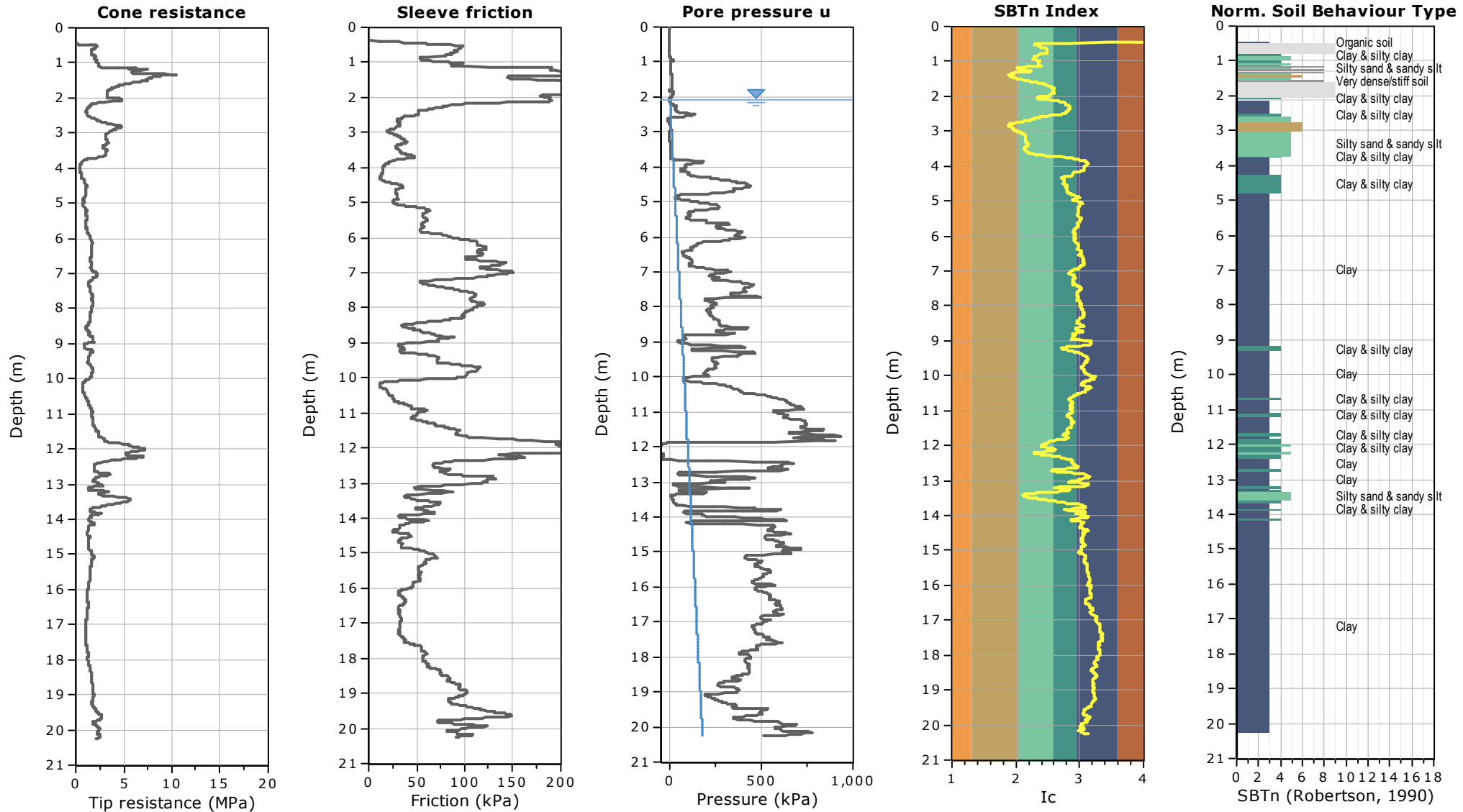
[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	2.594 Hz	OK	
$A_0 > 2$	$1.98 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.03316 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.03005 < 0.13594$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.4065 < 2.0$	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 $\sigma_A(f_0)$

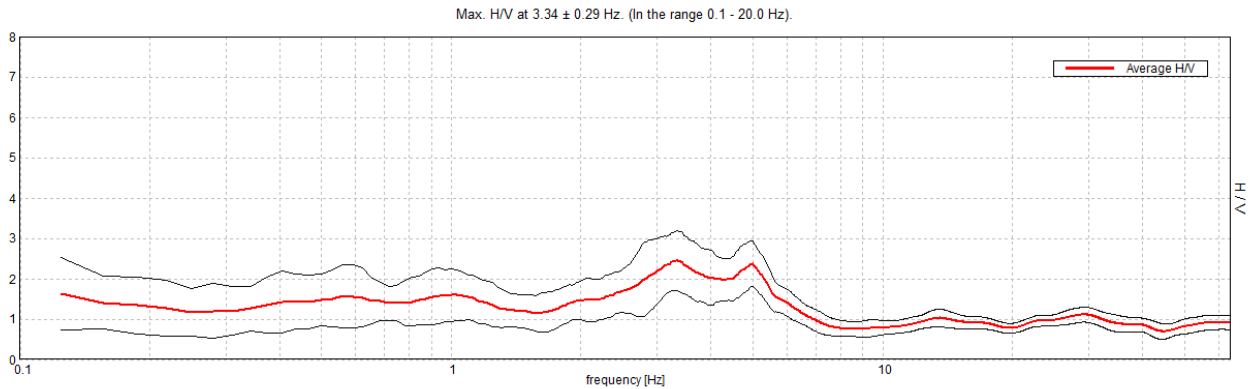
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20



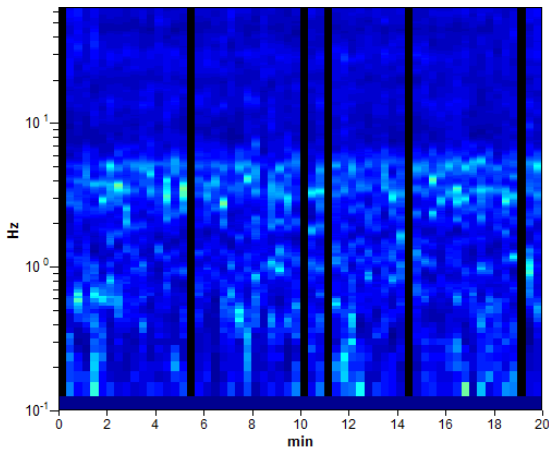
CASTEL MAGGIORE_MS, MS 2017 TR6 037019P256HVSR303

Instrument: TRZ-0108/01-10
 Start recording: 18/12/17 10:15:11 End recording: 18/12/17 10:35:12
 Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
 Trace length: 0h20'00". Analyzed 90% trace (manual window selection)
 Sampling rate: 128 Hz
 Window size: 20 s
 Smoothing type: Triangular window
 Smoothing: 10%

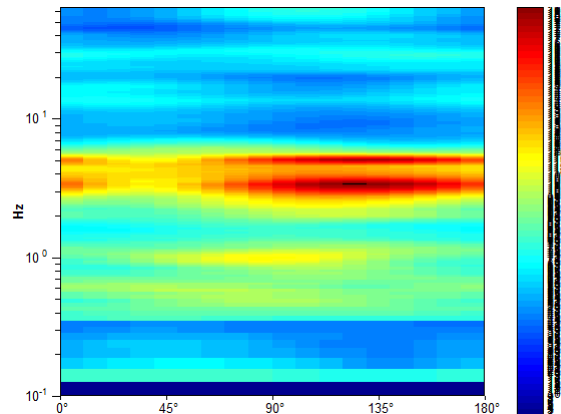
HORIZONTAL TO VERTICAL SPECTRAL RATIO



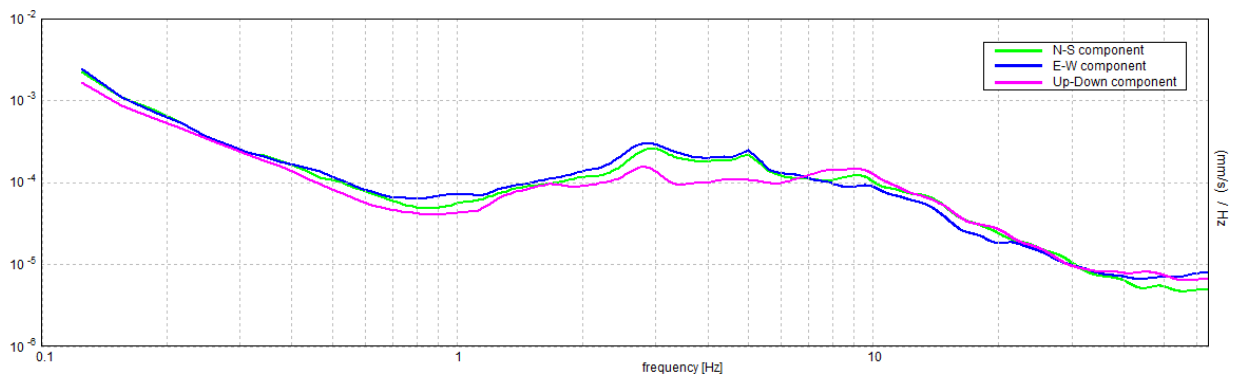
H/V TIME HISTORY



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 3.34 ± 0.29 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$3.34 > 0.50$	OK	
$n_c(f_0) > 200$	$3611.3 > 200$	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 162 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$	1.719 Hz	OK	
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	6.375 Hz	OK	
$A_0 > 2$	$2.44 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.0421 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.14078 < 0.16719$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.365 < 1.58$	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 $\sigma_A(f) < \theta(f_0)$

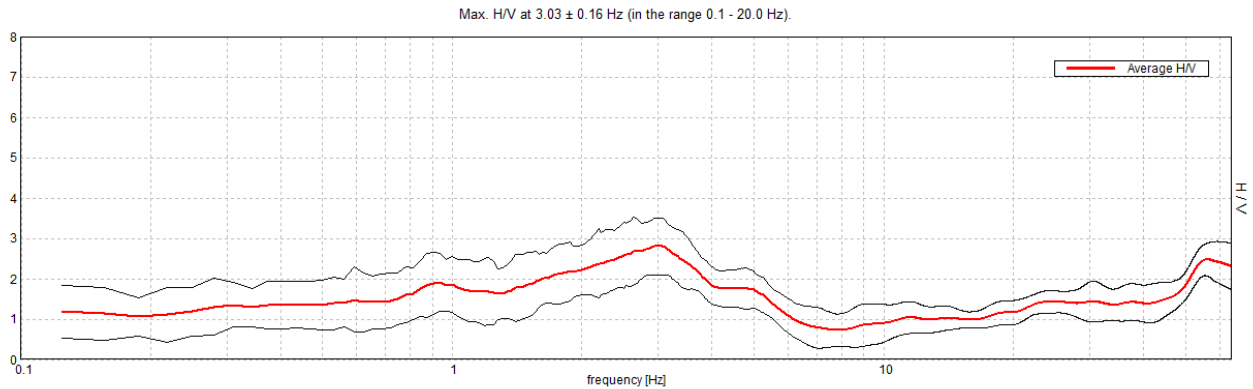
Threshold values for σ_f and $\sigma_A(f_0)$

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

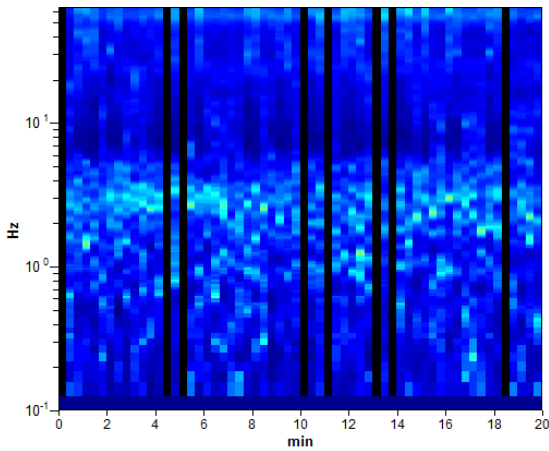
CASTEL MAGGIORE_MS, MS 2017 TR7 037019P257HVSR304

Instrument: TRZ-0108/01-10
 Start recording: 18/12/17 09:44:11 End recording: 18/12/17 10:04:12
 Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
 Trace length: 0h20'00". Analyzed 87% trace (manual window selection)
 Sampling rate: 128 Hz
 Window size: 20 s
 Smoothing type: Triangular window
 Smoothing: 10%

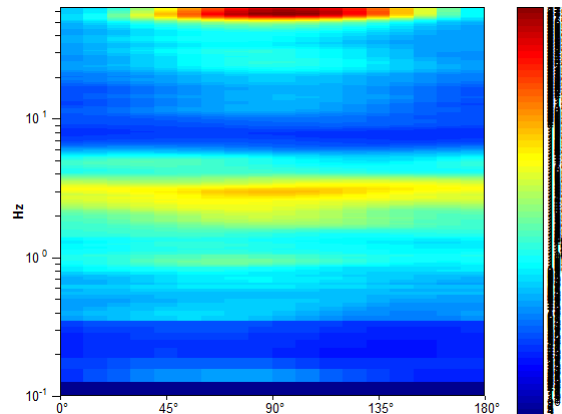
HORIZONTAL TO VERTICAL SPECTRAL RATIO



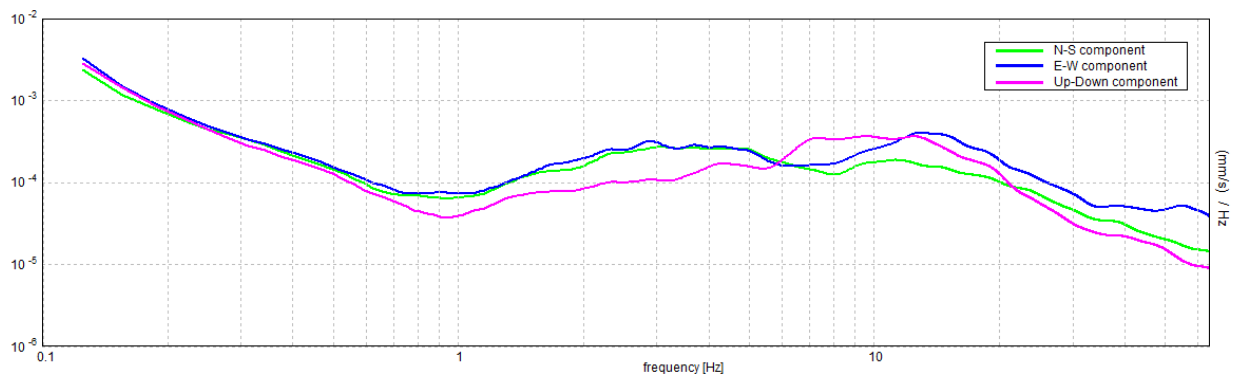
H/V TIME HISTORY



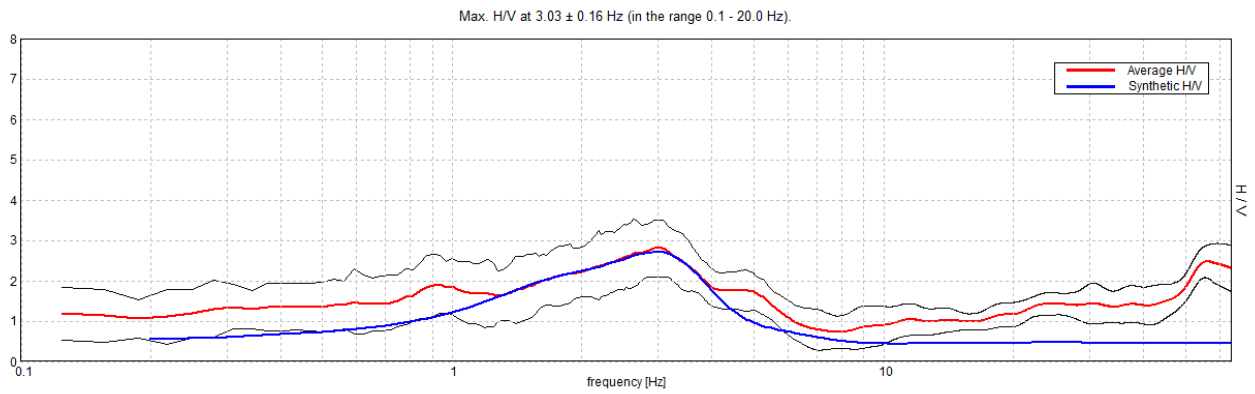
DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA

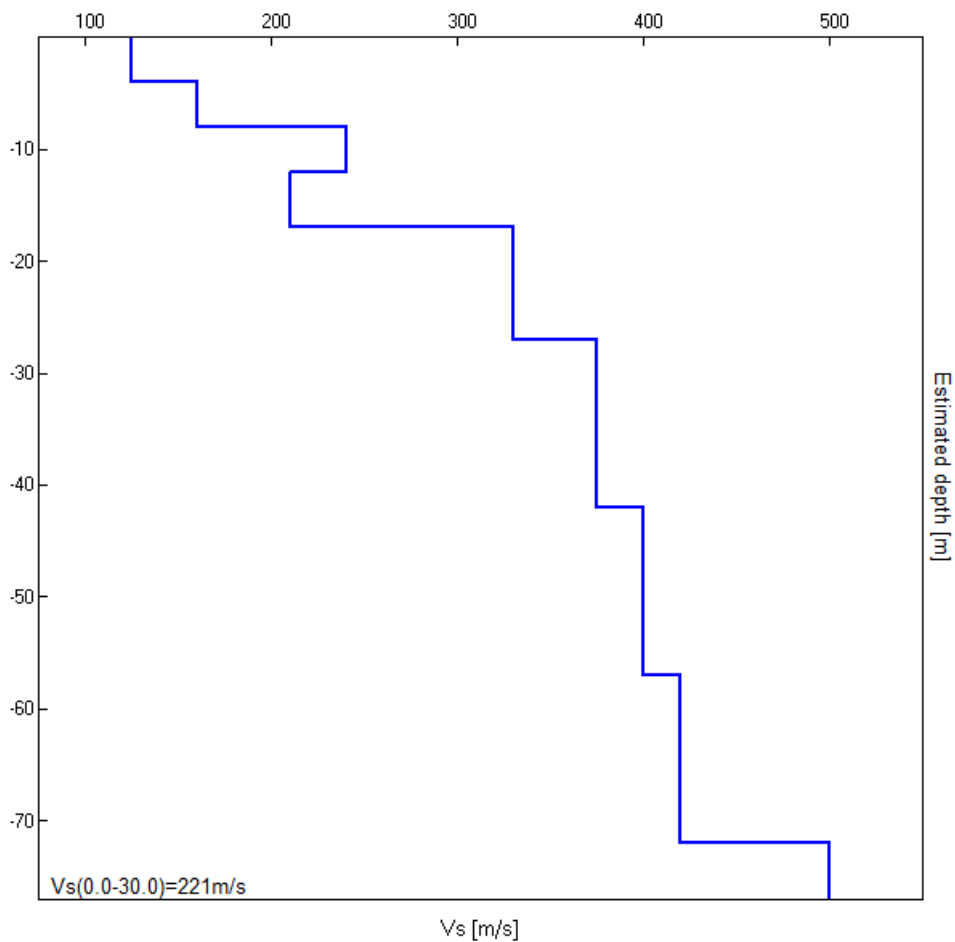


EXPERIMENTAL vs. SYNTHETIC H/V



Depth at the bottom of the layer [m]	Thickness [m]	Vs [m/s]	Poisson ratio
4.00	4.00	125	0.40
8.00	4.00	160	0.35
12.00	4.00	240	0.35
17.00	5.00	210	0.35
27.00	10.00	330	0.35
42.00	15.00	375	0.35
57.00	15.00	400	0.35
72.00	15.00	420	0.35
inf.	inf.	500	0.35

Vs(0.0-30.0)=221m/s



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

Max. H/V at 3.03 ± 0.16 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$3.03 > 0.50$	OK	
$n_c(f_0) > 200$	$3152.5 > 200$	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 146 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 $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	5.531 Hz	OK	
$A_0 > 2$	$2.81 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.02662 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.08068 < 0.15156$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3481 < 1.58$	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 $\sigma_A(f) < \theta(f_0)$

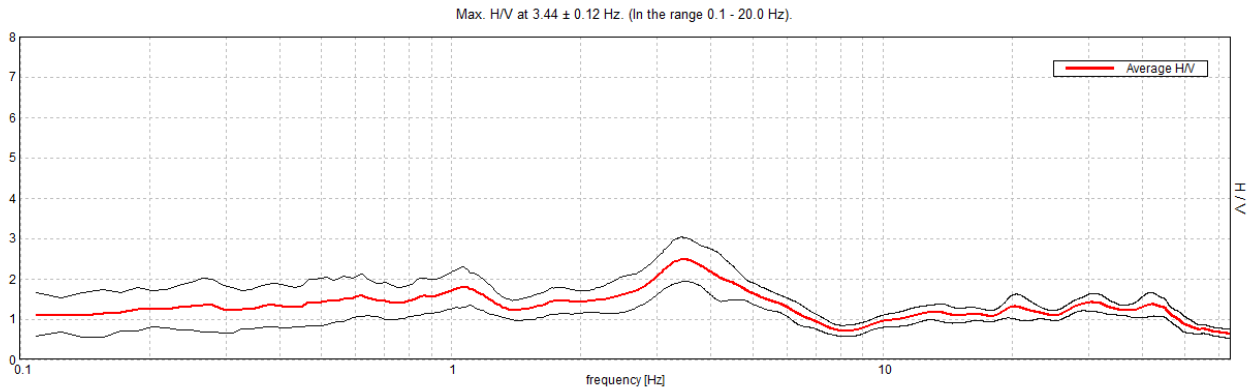
Threshold values for σ_f and $\sigma_A(f_0)$

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

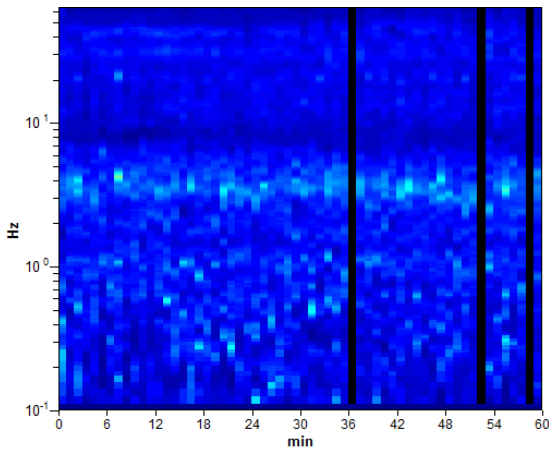
CASTEL MAGGIORE_MS, MS 2017 TR8 037019P258HVSR305

Instrument: TRZ-0108/01-10
Start recording: 18/12/17 10:41:34 End recording: 18/12/17 11:41:35
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
Trace length: 1h00'00". Analyzed 95% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 60 s
Smoothing type: Triangular window
Smoothing: 10%

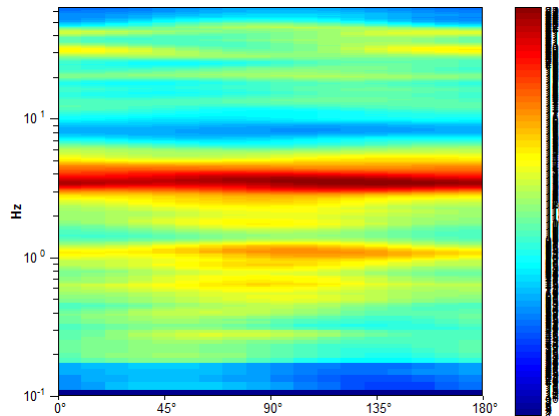
HORIZONTAL TO VERTICAL SPECTRAL RATIO



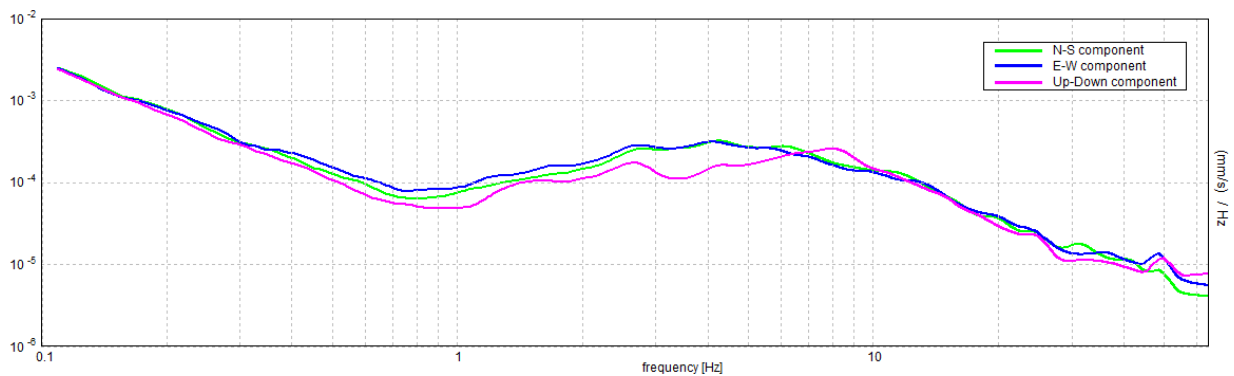
H/V TIME HISTORY



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 3.44 ± 0.12 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$3.44 > 0.17$	OK	
$n_c(f_0) > 200$	$11756.3 > 200$	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 331 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$	1.453 Hz	OK	
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	6.125 Hz	OK	
$A_0 > 2$	$2.48 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01704 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.05859 < 0.17188$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.2719 < 1.58$	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

CASTEL MAGGIORE_MS, MS 2017 TR9

037019P259HVSR306

Instrument: TRZ-0108/01-10

Start recording: 18/12/17 11:52:23 End recording: 18/12/17 12:12:24

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 93% trace (manual window selection)

Sampling rate: 128 Hz

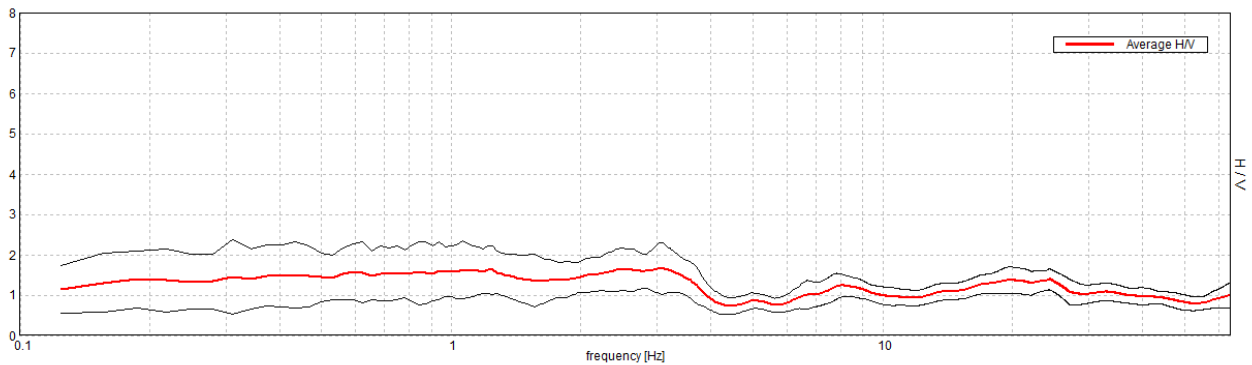
Window size: 20 s

Smoothing type: Triangular window

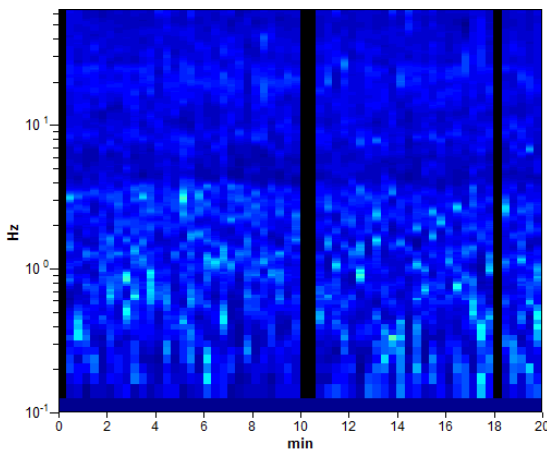
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

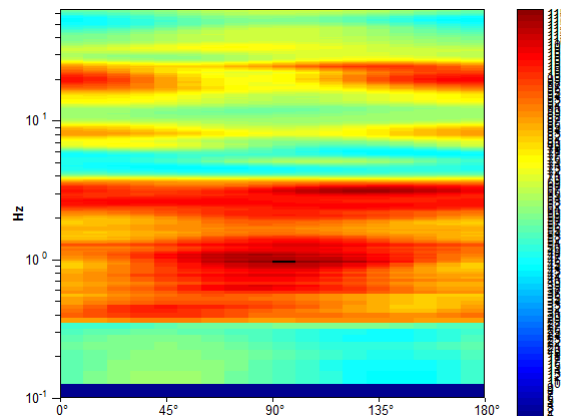
Max. H/V at 3.06 ± 0.15 Hz. (In the range 0.1 - 20.0 Hz).



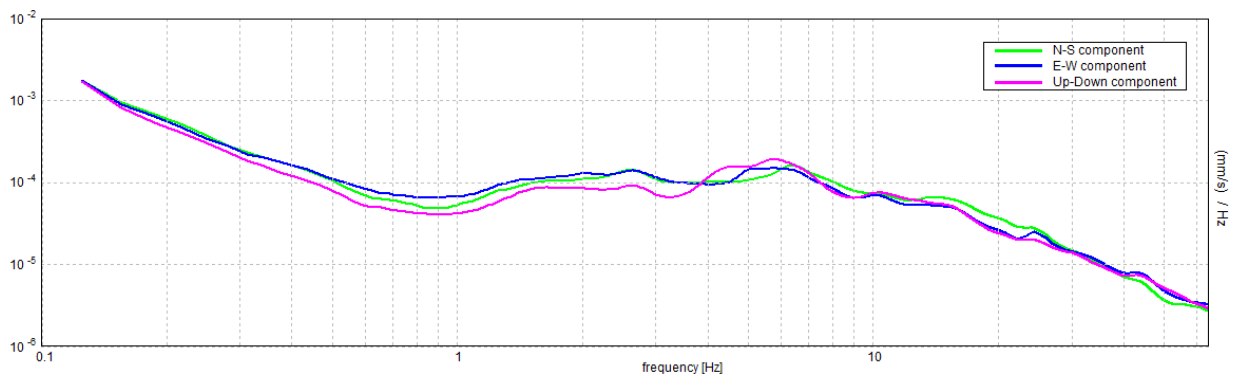
H/V TIME HISTORY



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 3.06 ± 0.15 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$3.06 > 0.50$	OK	
$n_c(f_0) > 200$	$3430.0 > 200$	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 148 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 $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	4.125 Hz	OK	
$A_0 > 2$	$1.66 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.02457 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.07525 < 0.15313$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3172 < 1.58$	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 $\sigma_A(f) < \theta(f_0)$

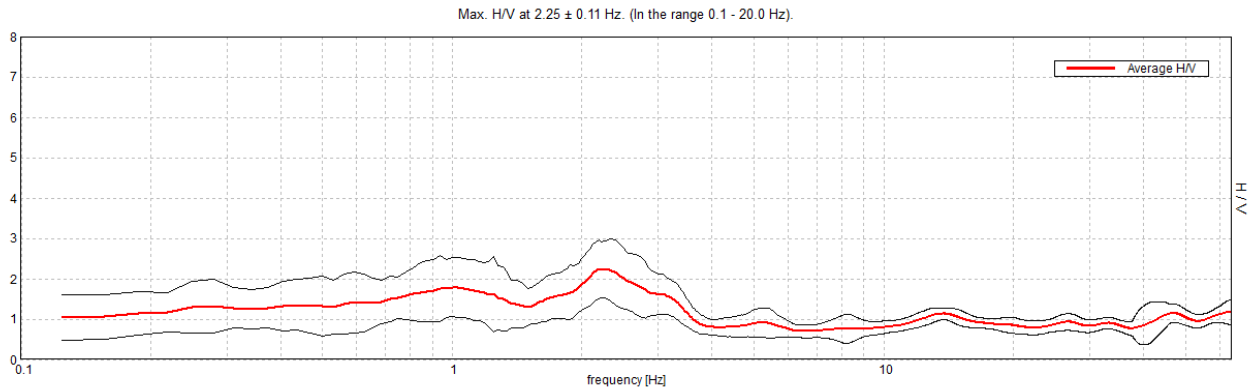
Threshold values for σ_f and $\sigma_A(f_0)$

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

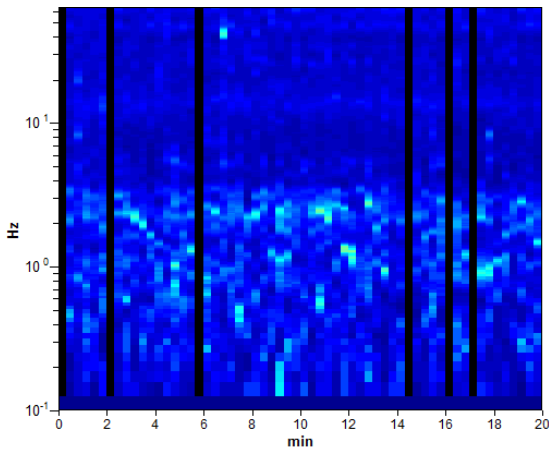
CASTEL MAGGIORE_MS, MS 2017 TR10 037019P260HVSR307

Instrument: TRZ-0108/01-10
 Start recording: 18/12/17 12:22:40 End recording: 18/12/17 12:42:41
 Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
 Trace length: 0h20'00". Analyzed 90% trace (manual window selection)
 Sampling rate: 128 Hz
 Window size: 20 s
 Smoothing type: Triangular window
 Smoothing: 10%

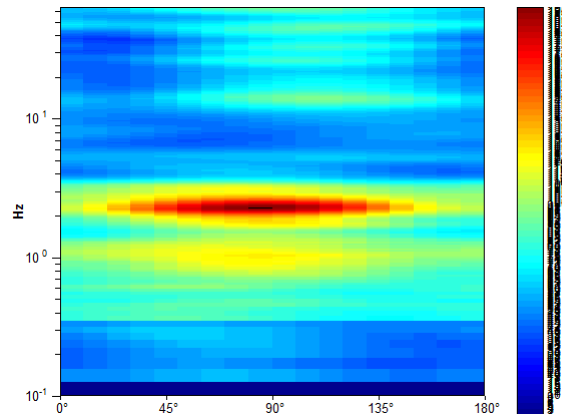
HORIZONTAL TO VERTICAL SPECTRAL RATIO



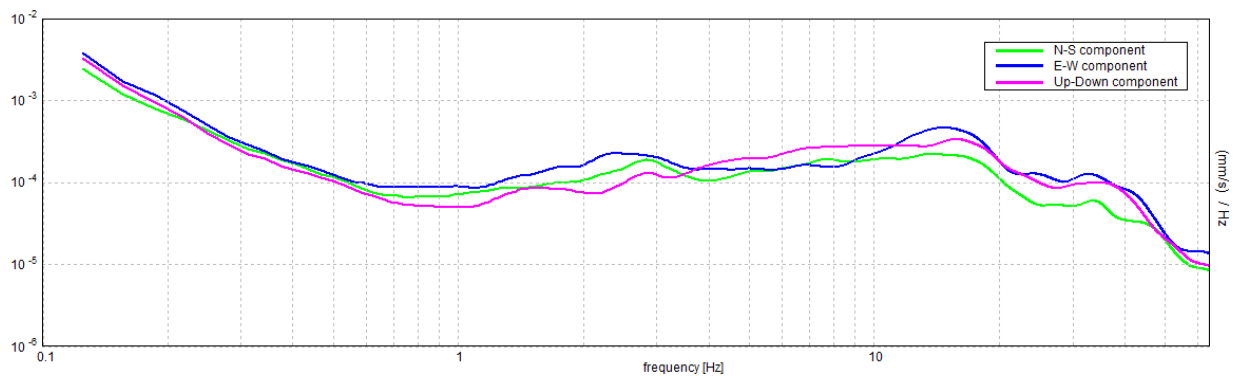
H/V TIME HISTORY



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 2.25 ± 0.11 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$2.25 > 0.50$	OK	
$n_c(f_0) > 200$	$2430.0 > 200$	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 109 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 $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	3.531 Hz	OK	
$A_0 > 2$	$2.24 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.02417 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.05439 < 0.1125$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3472 < 1.58$	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

CASTEL MAGGIORE_MS, MS 2017 TR11

037019P261HVSR308

Instrument: TRZ-0108/01-10

Start recording: 18/12/17 12:55:57 End recording: 18/12/17 13:15:58

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 80% trace (manual window selection)

Sampling rate: 128 Hz

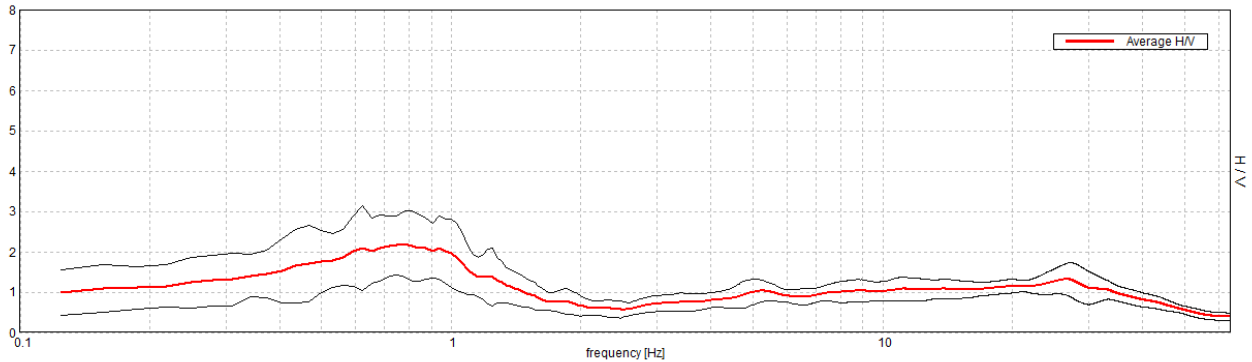
Window size: 20 s

Smoothing type: Triangular window

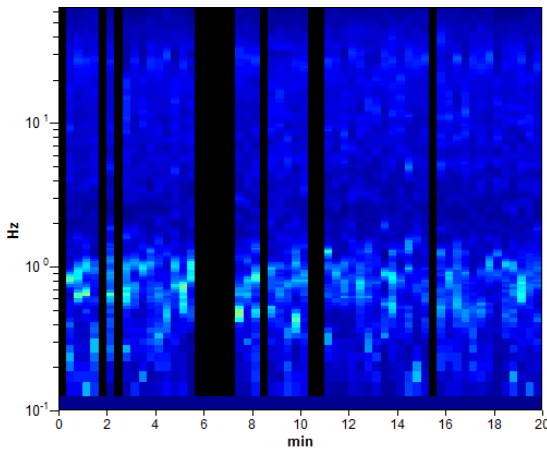
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

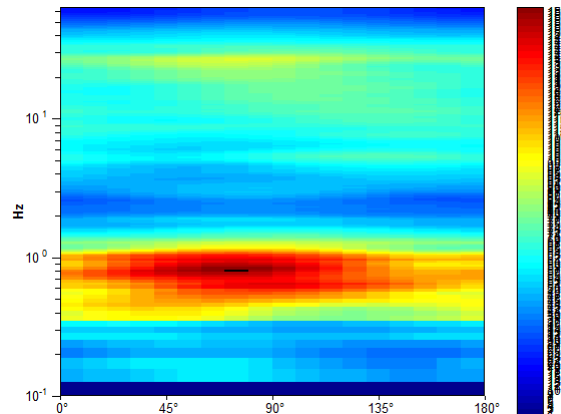
Max. H/V at 0.78 ± 0.03 Hz. (In the range 0.1 - 20.0 Hz).



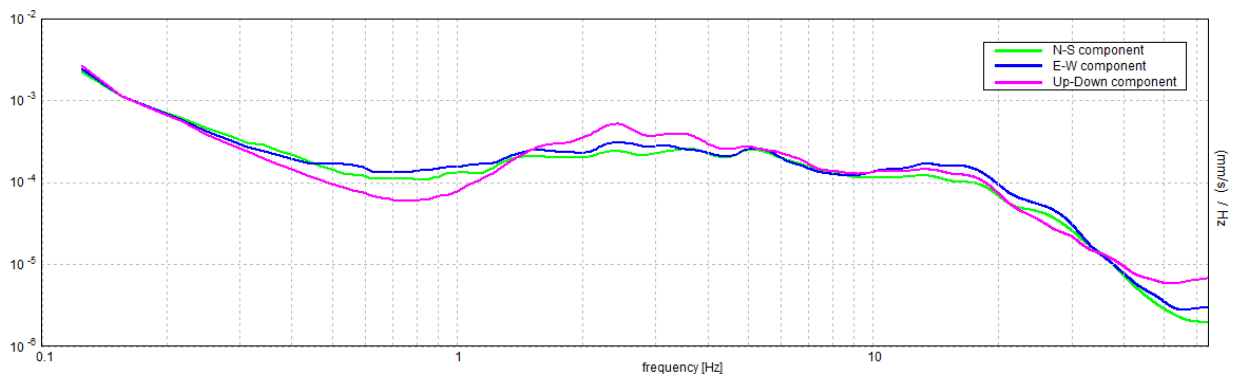
H/V TIME HISTORY



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 0.78 ± 0.03 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.78 > 0.50$	OK	
$n_c(f_0) > 200$	$750.0 > 200$	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 38 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 $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	1.406 Hz	OK	
$A_0 > 2$	$2.18 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.02167 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01693 < 0.11719$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.4034 < 2.0$	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 $\sigma_A(f_0)$

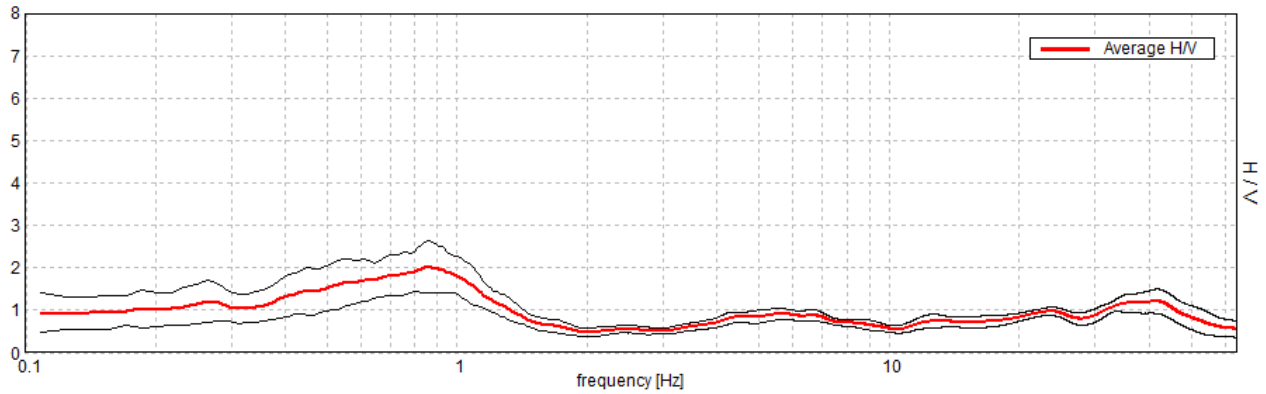
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CASTEL MAGGIORE_MS 2017 TR12 037019P262HVSR309

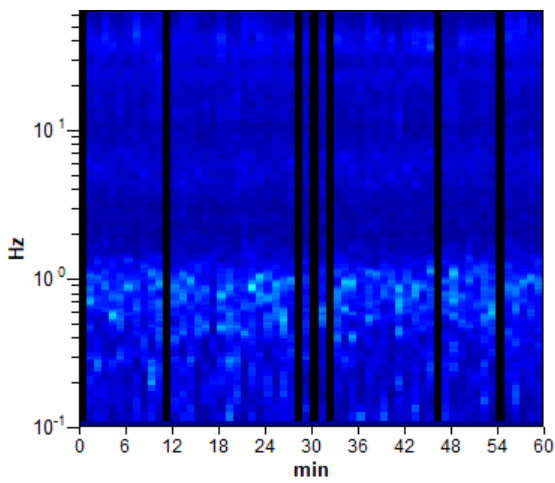
Instrument: TRZ-0108/01-10
 Start recording: 19/12/17 14:14:29 End recording: 19/12/17 15:14:30
 Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
 Trace length: 1h00'00". Analyzed 88% trace (manual window selection)
 Sampling rate: 128 Hz
 Window size: 60 s
 Smoothing type: Triangular window
 Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

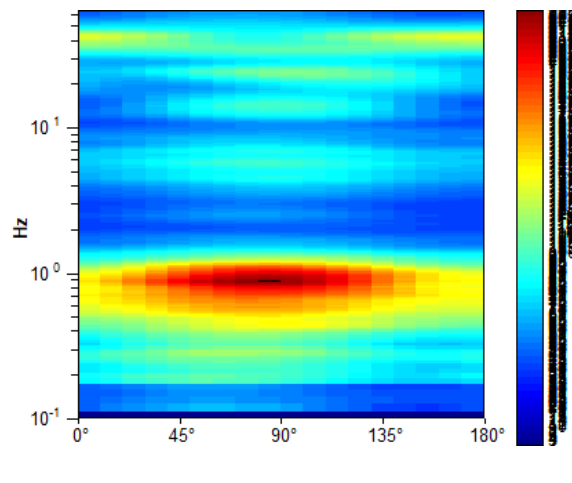
Max. H/V at 0.86 ± 0.01 Hz (in the range 0.2 - 20.0 Hz).



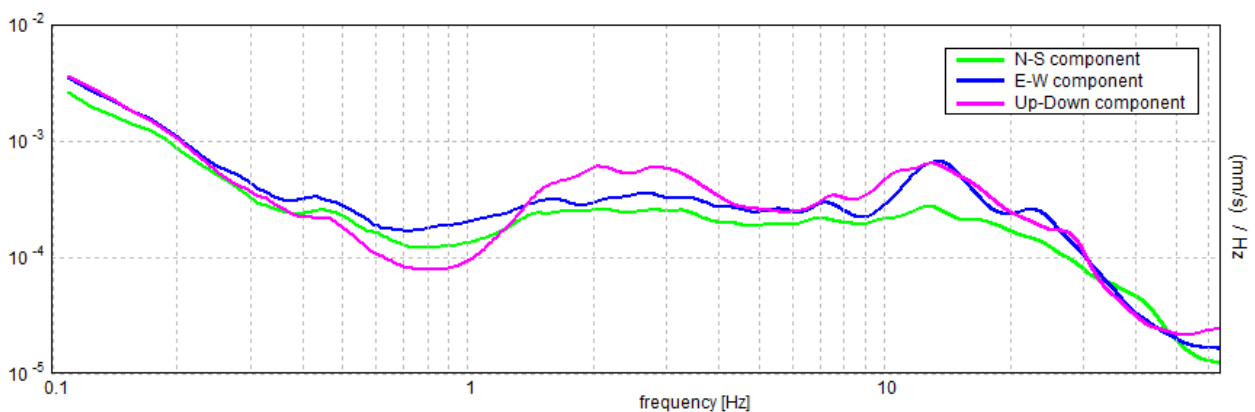
H/V TIME HISTORY



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 ± 0.01 Hz (in the range 0.2 - 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	
$n_c(f_0) > 200$	$2732.8 > 200$	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 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 $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.344 Hz	OK	
$A_0 > 2$	$2.03 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.00773 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.00664 < 0.12891$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3056 < 2.0$	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

CASTEL MAGGIORE_MS 2017 TR13

037019P263HVSR310

Instrument: TRZ-0108/01-10

Start recording: 19/12/17 15:55:30 End recording: 19/12/17 16:55:31

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

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

Sampling rate: 128 Hz

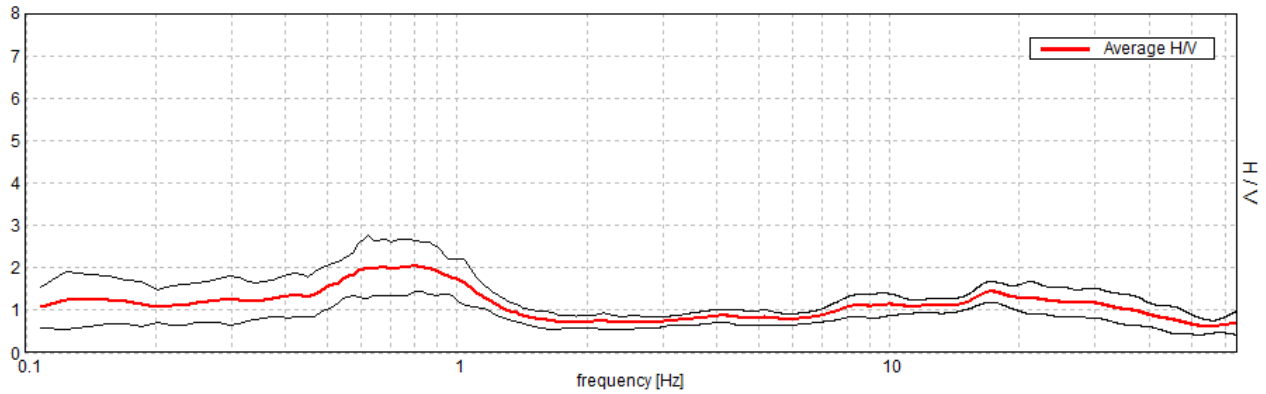
Window size: 60 s

Smoothing type: Triangular window

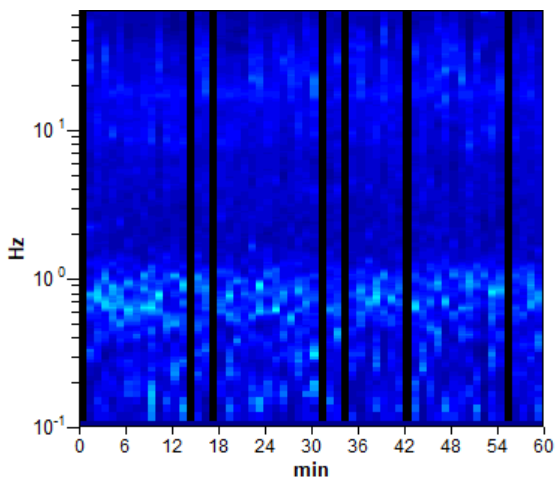
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

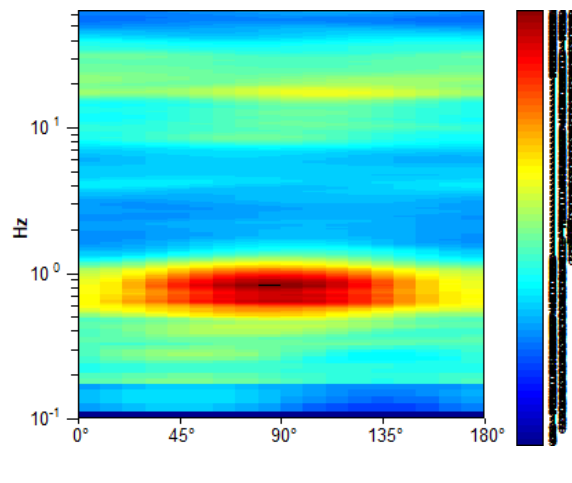
Max. H/V at 0.78 ± 0.04 Hz (in the range 0.0 - 64.0 Hz).



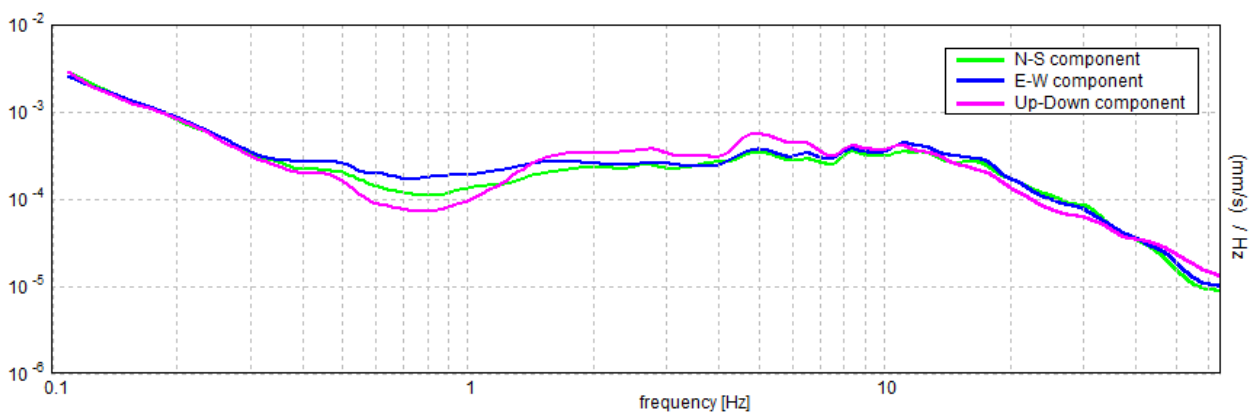
H/V TIME HISTORY



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 ± 0.04 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.78 > 0.17$	OK	
$n_c(f_0) > 200$	$2484.4 > 200$	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 76 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0]$ $A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	1.297 Hz	OK	
$A_0 > 2$	$2.04 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.02305 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01801 < 0.11719$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3206 < 2.0$	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 $\sigma_A(f_0)$

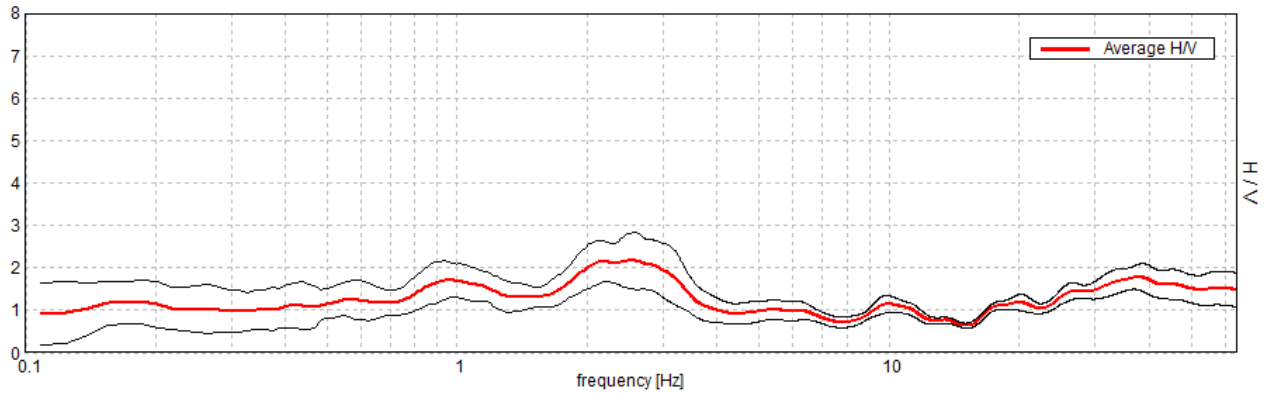
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CASTEL MAGGIORE_MS 2017 TR14 037019P264HVS311

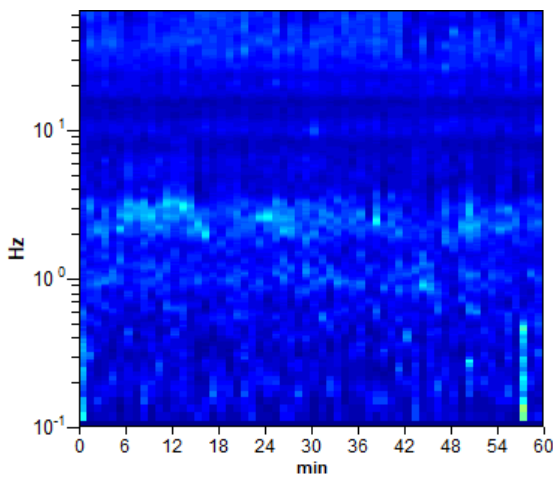
Instrument: TRZ-0108/01-10
Start recording: 20/12/17 10:05:04 End recording: 20/12/17 11:05:05
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
Trace length: 1h00'00". Analysis performed on the entire trace.
Sampling rate: 128 Hz
Window size: 60 s
Smoothing type: Triangular window
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

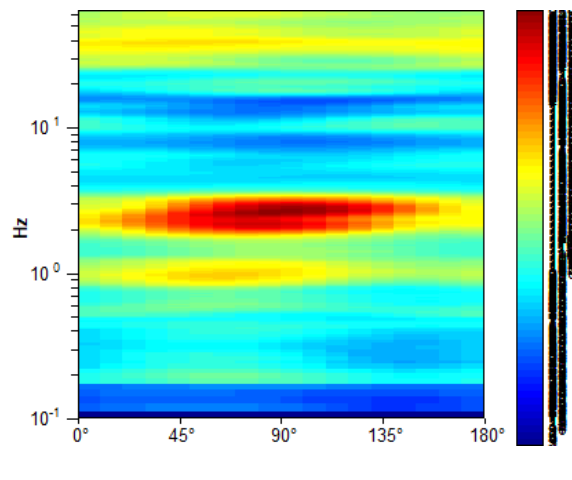
Max. H/V at 2.5 ± 0.13 Hz (in the range 0.0 - 64.0 Hz).



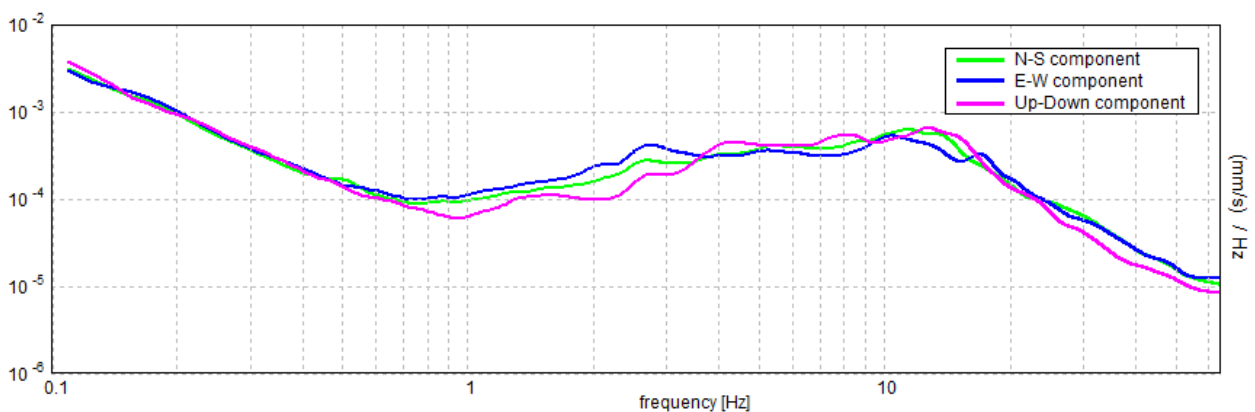
H/V TIME HISTORY



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 2.5 ± 0.13 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$2.50 > 0.17$	OK	
$n_c(f_0) > 200$	$9000.0 > 200$	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 241 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 $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	3.781 Hz	OK	
$A_0 > 2$	$2.17 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.02596 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.0649 < 0.125$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3214 < 1.58$	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

CASTEL MAGGIORE_MS 2017 TR15

037019P265HVSR312

Instrument: TRZ-0108/01-10

Start recording: 20/12/17 11:28:38 End recording: 20/12/17 11:48:39

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 90% trace (manual window selection)

Sampling rate: 128 Hz

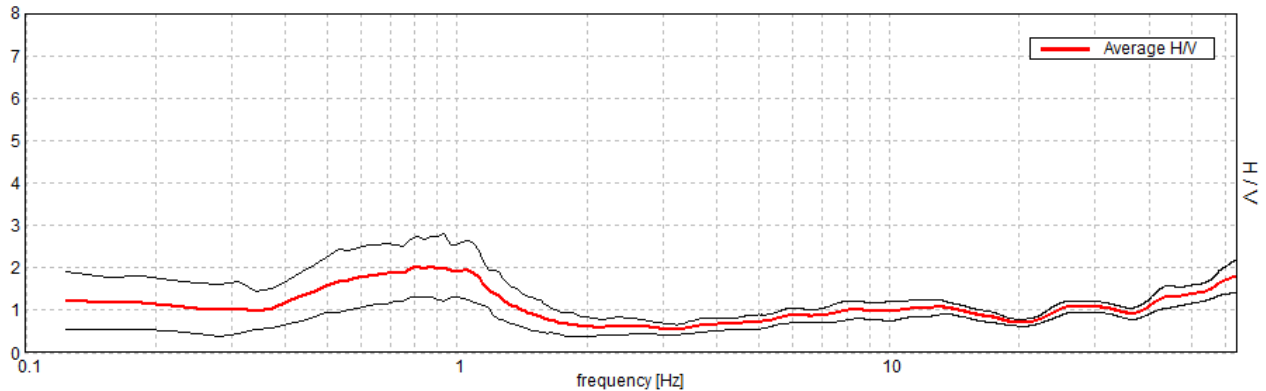
Window size: 20 s

Smoothing type: Triangular window

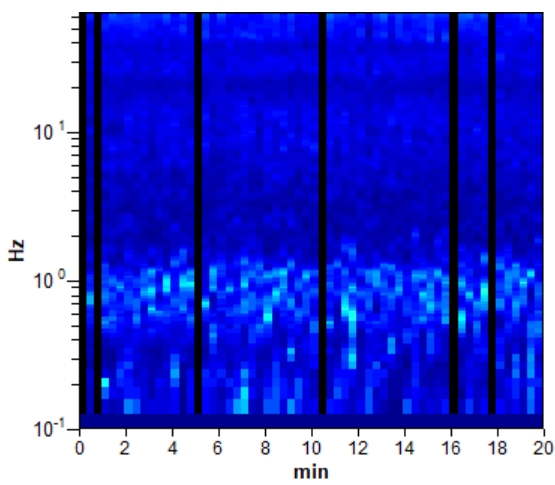
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

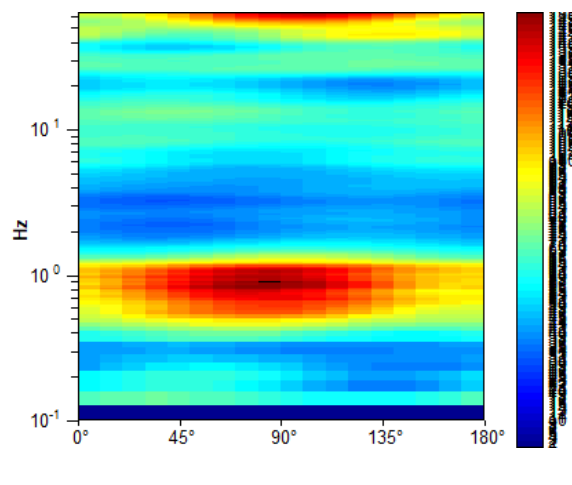
Max. H/V at 0.81 ± 0.02 Hz (in the range 0.0 - 64.0 Hz).



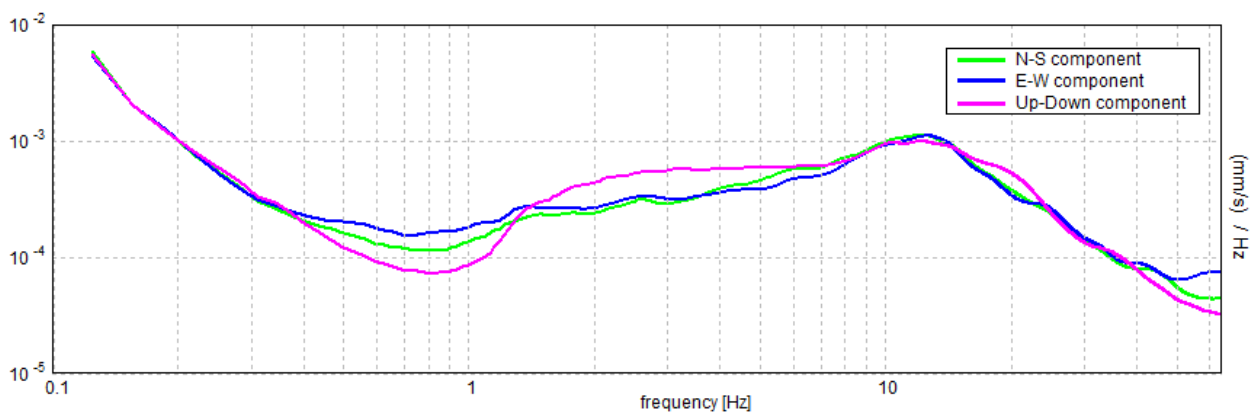
H/V TIME HISTORY



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 0.81 ± 0.02 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.81 > 0.50$	OK	
$n_c(f_0) > 200$	$877.5 > 200$	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 40 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$	0.344 Hz	OK	
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.406 Hz	OK	
$A_0 > 2$	$2.03 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.00953 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.00774 < 0.12188$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3468 < 2.0$	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 $\sigma_A(f_0)$

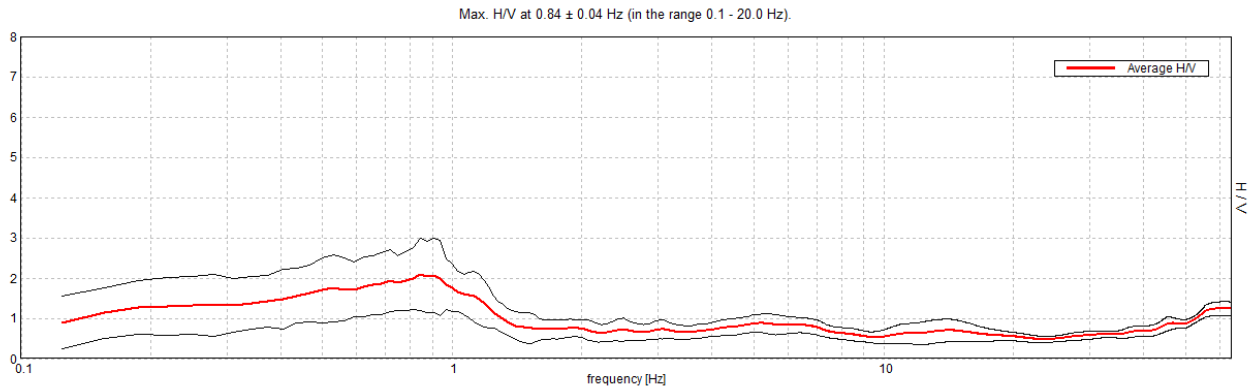
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CASTEL MAGGIORE_MS, MS 2017 TR16

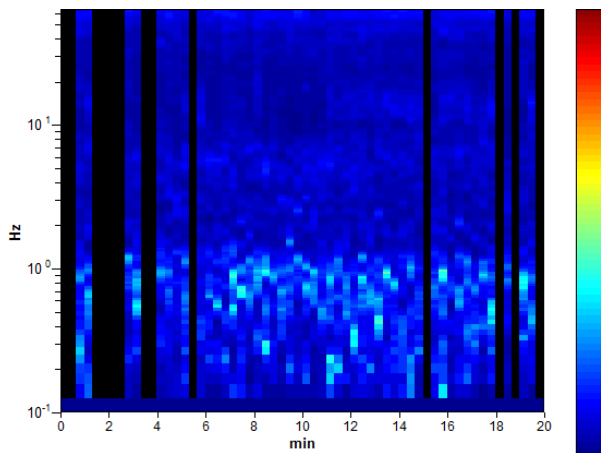
037019P266HVSR313

Instrument: TRZ-0108/01-10
 Start recording: 20/12/17 11:56:46 End recording: 20/12/17 12:16:47
 Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
 Trace length: 0h20'00". Analyzed 78% trace (manual window selection)
 Sampling rate: 128 Hz
 Window size: 20 s
 Smoothing type: Triangular window
 Smoothing: 10%

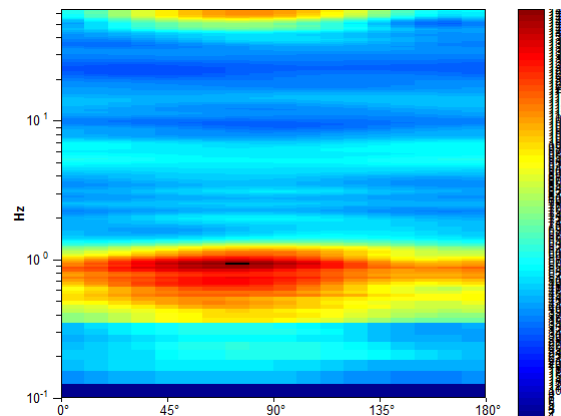
HORIZONTAL TO VERTICAL SPECTRAL RATIO



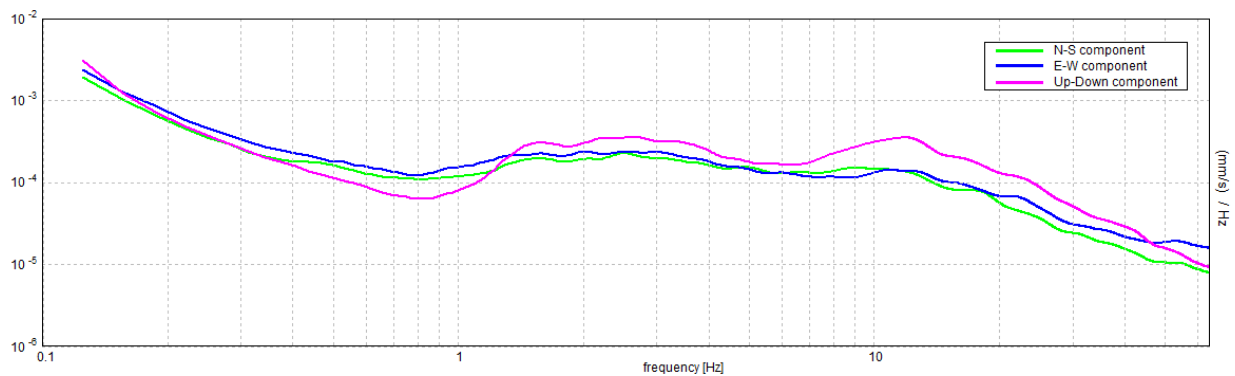
H/V TIME HISTORY



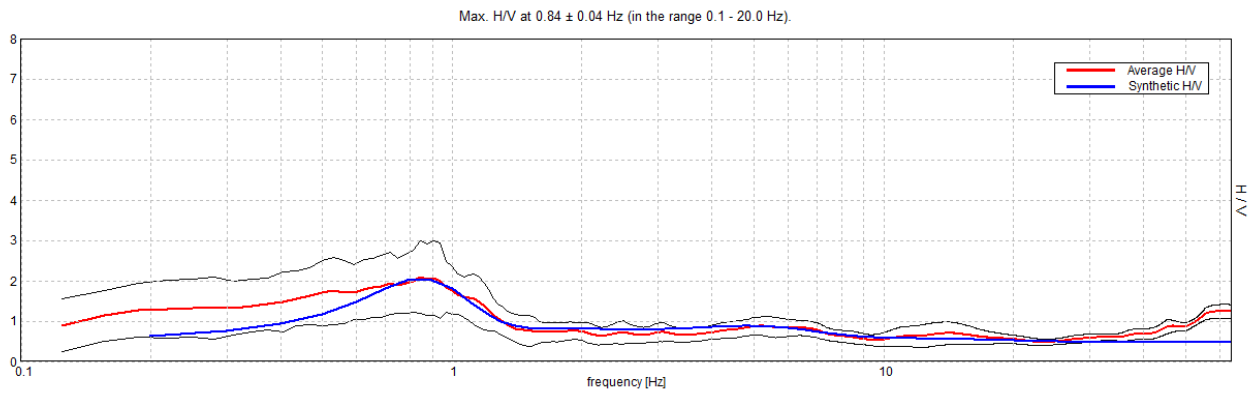
DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA

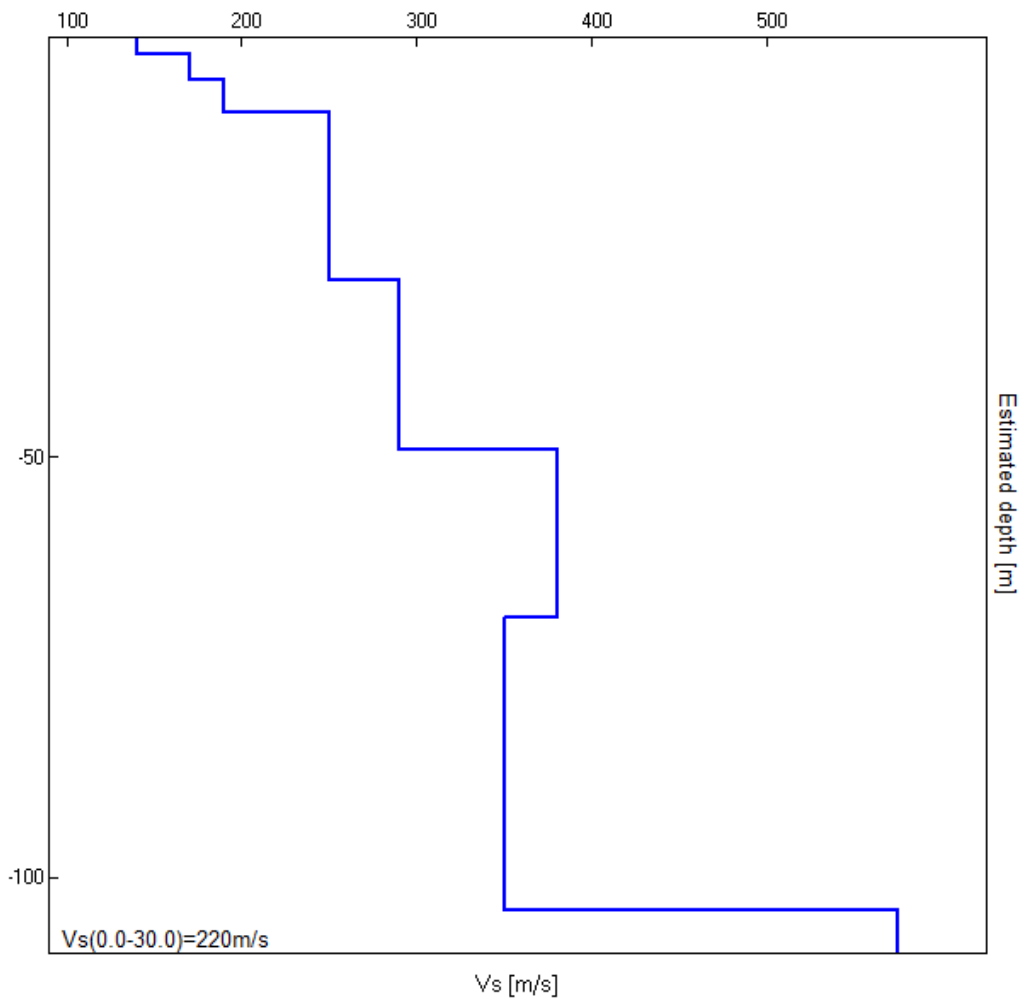


EXPERIMENTAL vs. SYNTHETIC H/V



Depth at the bottom of the layer [m]	Thickness [m]	Vs [m/s]
2.00	2.00	140
5.00	3.00	170
9.00	4.00	190
29.00	20.00	250
49.00	20.00	290
69.00	20.00	380
104.00	35.00	350
inf.	inf.	575

Vs(0.0-30.0)=220m/s



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

Max. H/V at 0.84 ± 0.04 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.84 > 0.50$	OK	
$n_c(f_0) > 200$	$793.1 > 200$	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 42 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 $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.313 Hz	OK	
$A_0 > 2$	$2.09 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.02074 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.0175 < 0.12656$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.4413 < 2.0$	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

CASTEL MAGGIORE_MS 2017 TR17

037019P267HVSR314

Instrument: TRZ-0108/01-10

Start recording: 23/12/17 10:24:14 End recording: 23/12/17 10:44:15

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 75% trace (manual window selection)

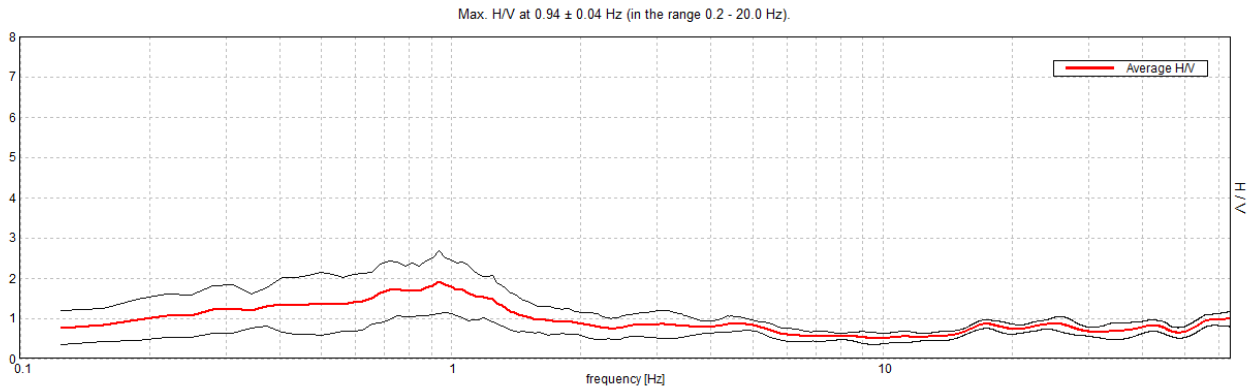
Sampling rate: 128 Hz

Window size: 20 s

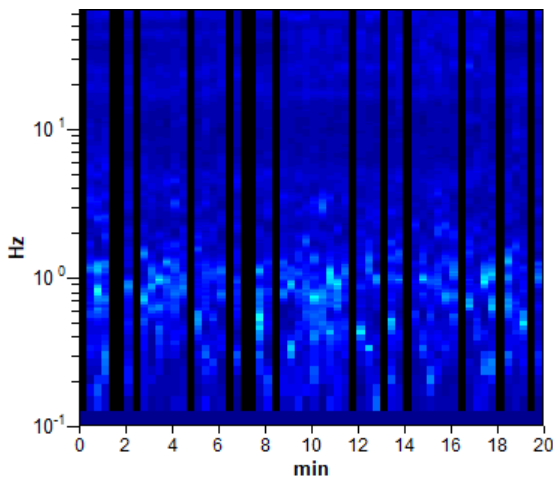
Smoothing type: Triangular window

Smoothing: 10%

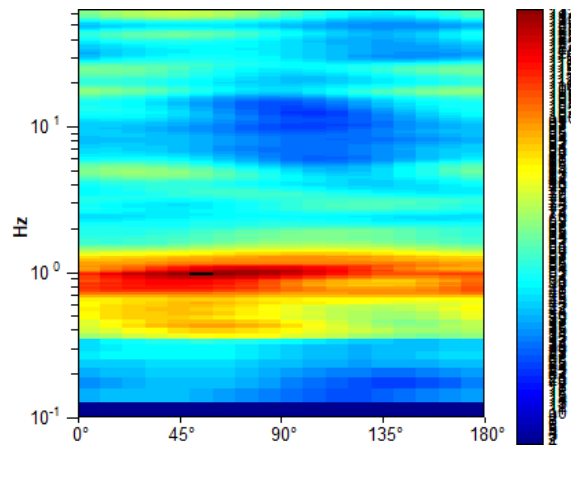
HORIZONTAL TO VERTICAL SPECTRAL RATIO



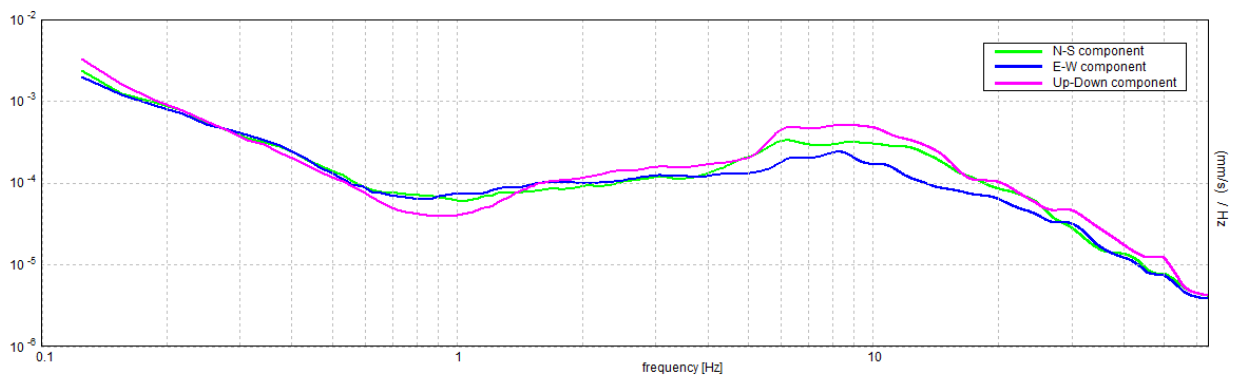
H/V TIME HISTORY



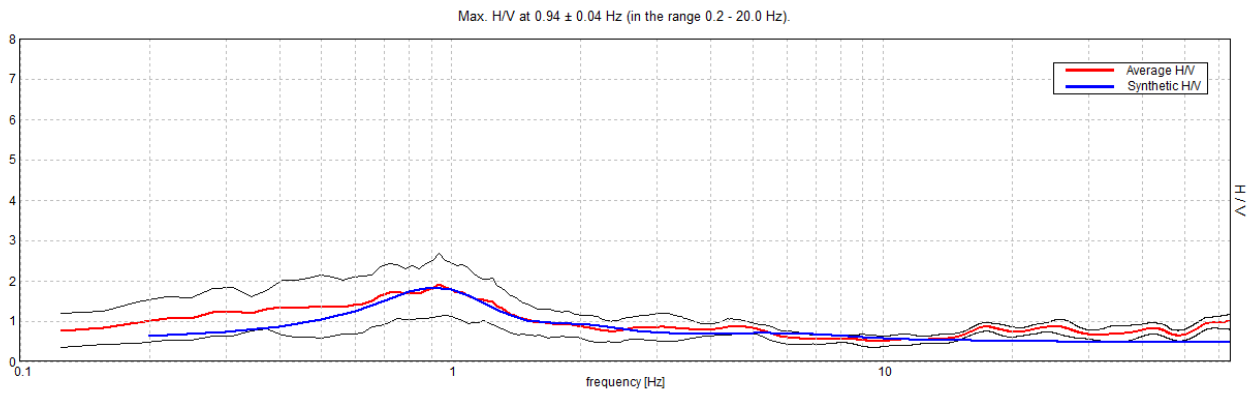
DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA

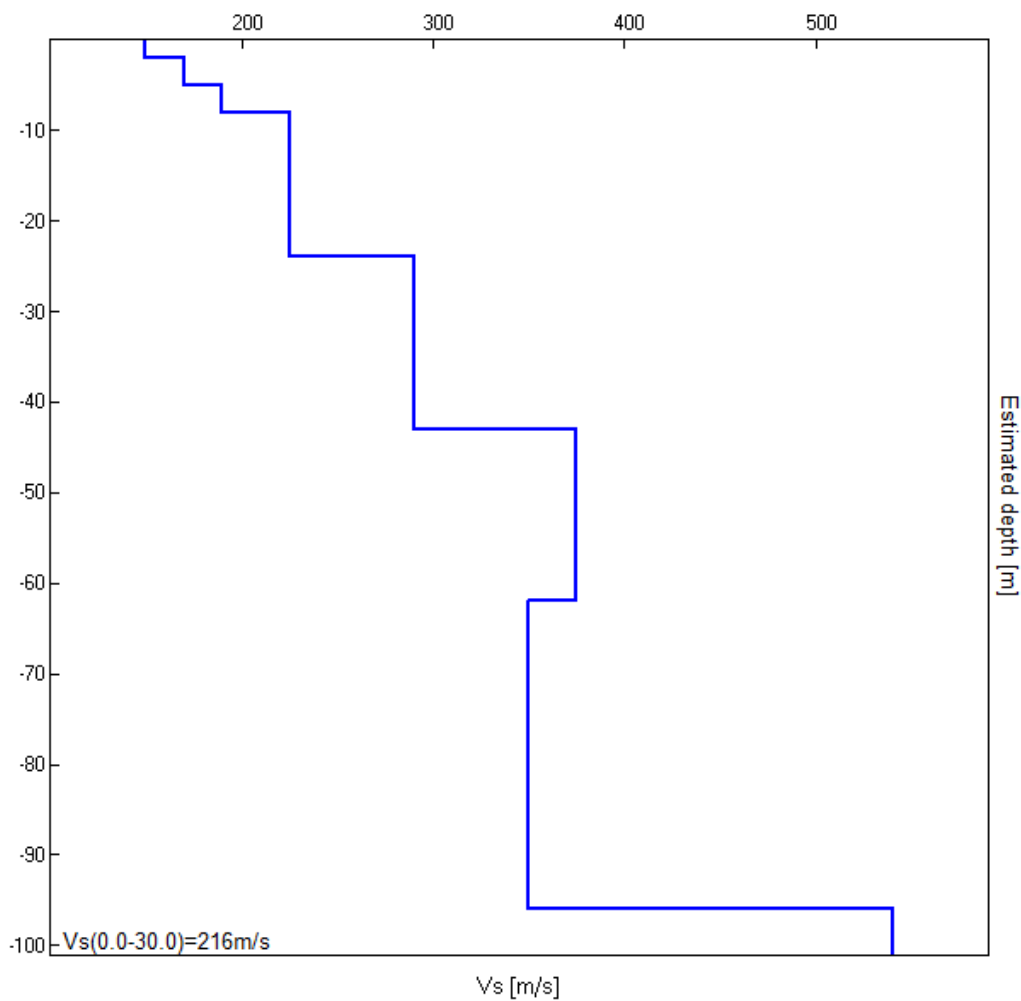


EXPERIMENTAL vs. SYNTHETIC H/V



Depth at the bottom of the layer [m]	Thickness [m]	Vs [m/s]
2.00	2.00	150
5.00	3.00	170
8.00	3.00	190
24.00	16.00	225
43.00	19.00	290
62.00	19.00	375
96.00	34.00	350
inf.	inf.	540

Vs(0.0-30.0)=216m/s



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

Max. H/V at 0.94 ± 0.04 Hz (in the range 0.2 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.94 > 0.50$	OK	
$n_c(f_0) > 200$	$843.8 > 200$	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 46 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 $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.688 Hz	OK	
$A_0 > 2$	$1.90 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01874 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01757 < 0.14063$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3864 < 2.0$	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

ESAC09

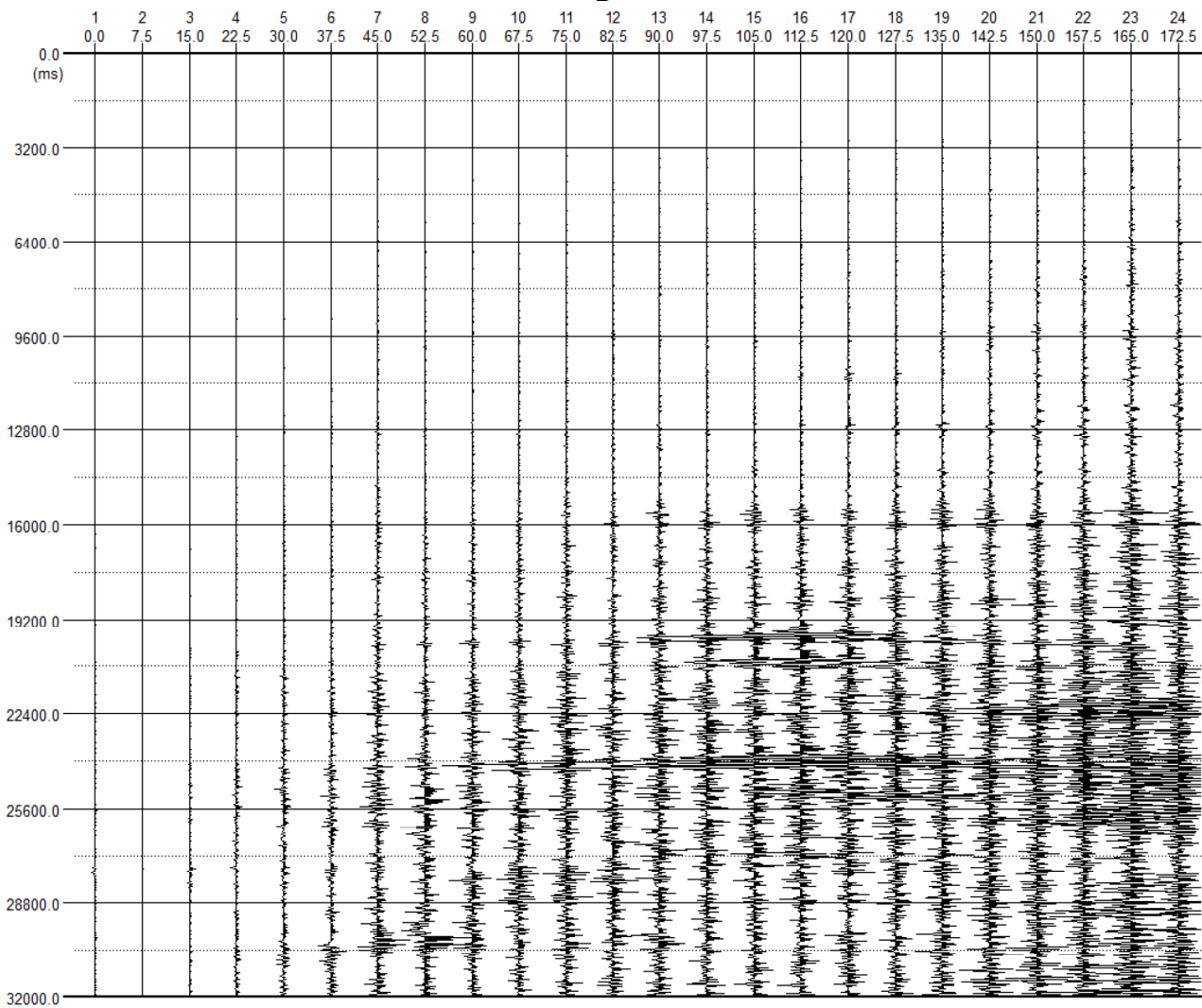
Comune di Castel Maggiore (BO) -

via Angelelli

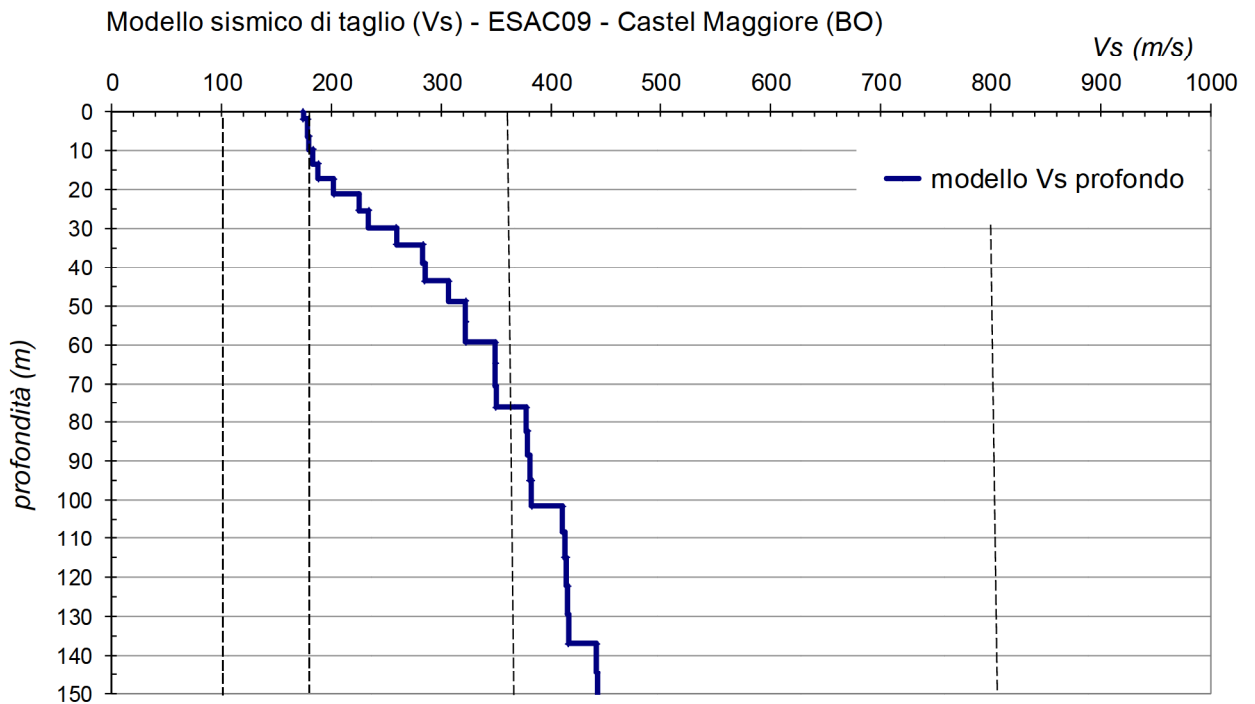
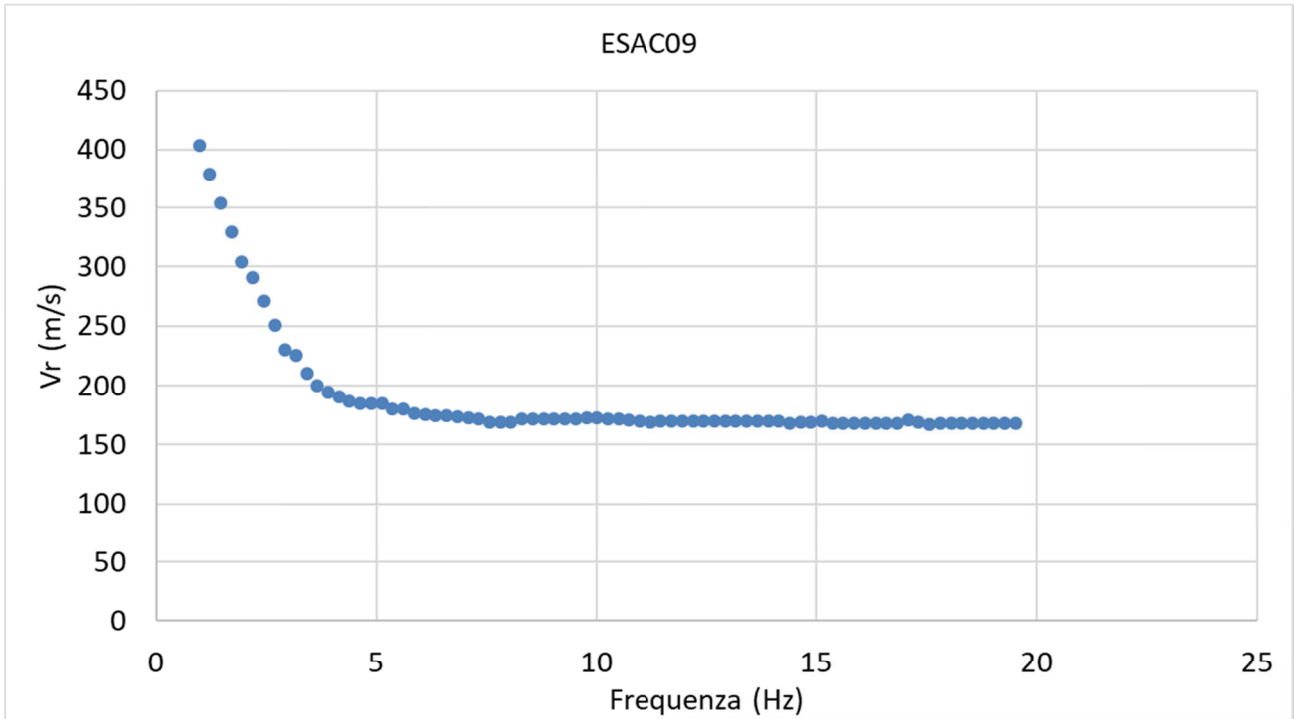
n° tracce	Δx (m)	L tot (m)	Δt (ms)	T (s)
24	7.5	172.5	2	32

Δx : interdistanza geofonica; L tot: lunghezza profilo; Δt : passo di campionamento; T: durata registrazione.

Sismogramma



Curva di dispersione



Modello Vs (1D)

PROFILO sismico fino a 150 metri			
ESAC09			
Vs30= 196 m/s ± 4.0 m/s (1.7 RMS:%)			
Sismo-strato	Profondità letto (m)	Velocità (m/s)	Spessore (m)
1	2.0	174.2	2.0
2	6.4	178.3	4.4
3	9.8	179.3	3.5
4	13.5	183.0	3.6
5	17.3	187.4	3.8
6	21.2	201.5	4.0
7	25.4	224.9	4.1
8	29.7	233.2	4.3
9	34.2	259.0	4.5
10	38.9	282.8	4.7
11	43.7	284.5	4.8
12	48.7	306.7	5.0
13	53.9	321.8	5.2
14	59.2	321.9	5.4
15	64.8	348.7	5.5
16	70.5	348.9	5.7
17	76.3	349.4	5.9
18	82.4	377.2	6.0
19	88.6	378.4	6.2
20	95.0	379.9	6.4
21	101.5	381.6	6.6
22	108.3	410.2	6.7
23	115.2	411.8	6.9
24	122.3	413.3	7.1
25	129.5	414.6	7.3
26	136.9	415.6	7.4
27	144.5	442.0	7.6
28	152.3	442.5	-

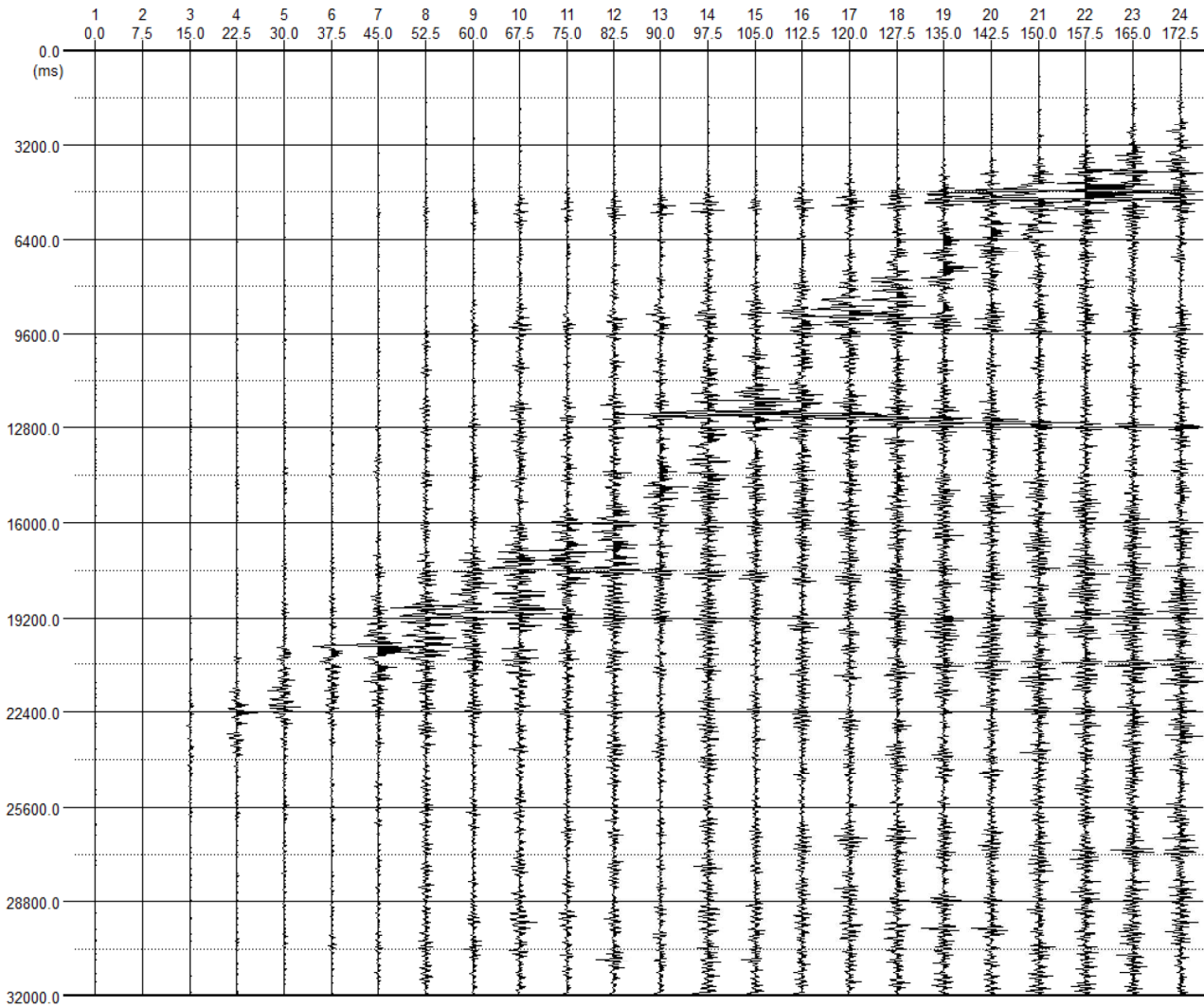
ESAC10

Comune di Castel Maggiore (BO) - Località Trebbo di Reno

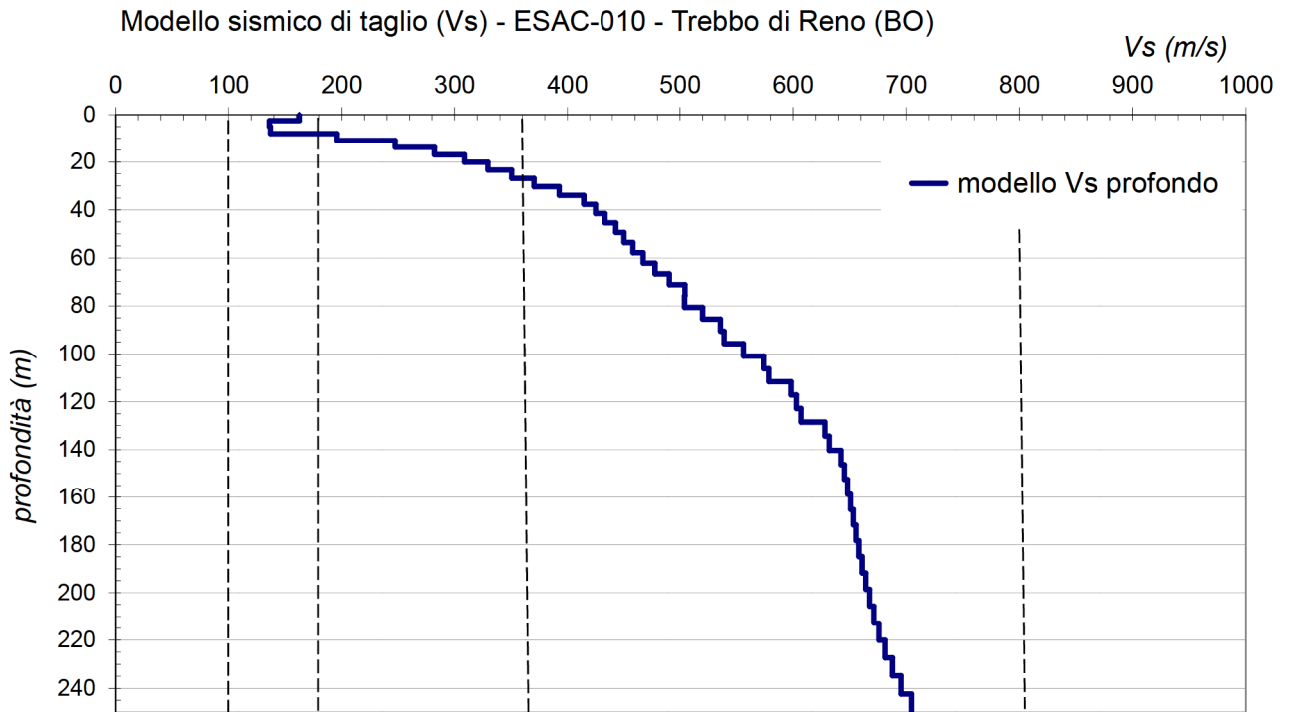
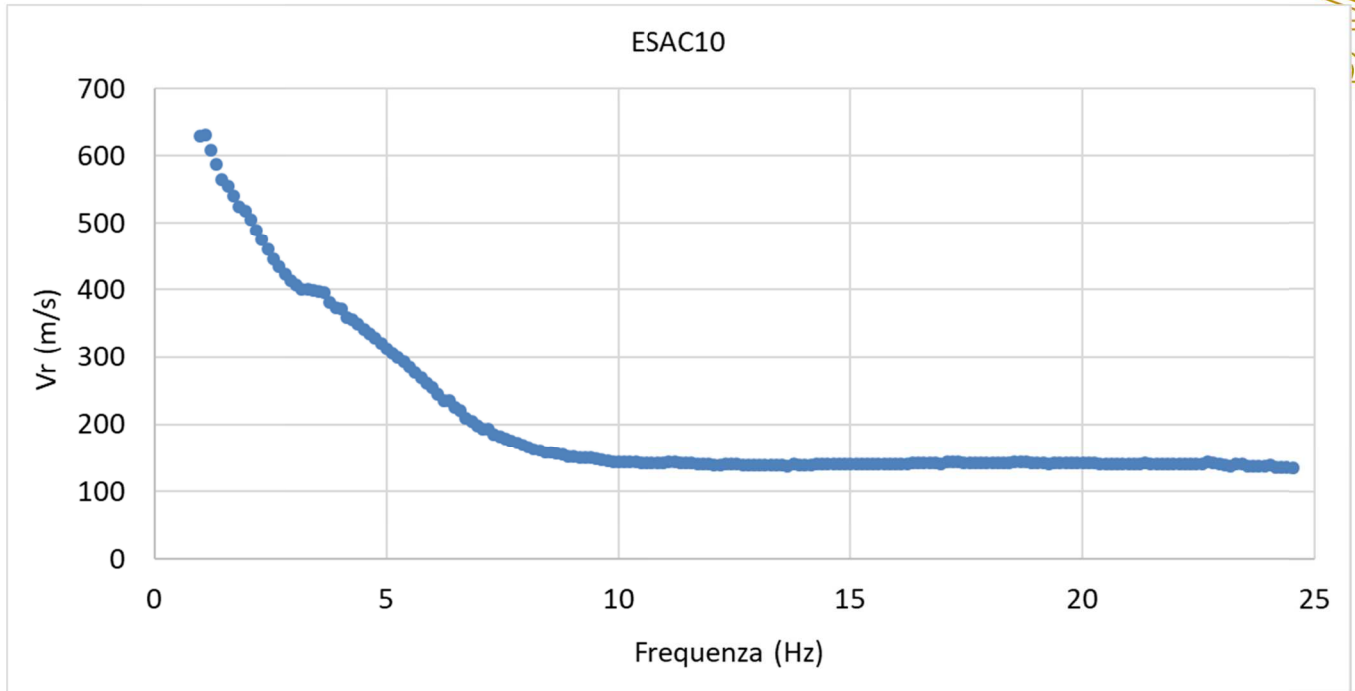
n° tracce	Δx (m)	L tot (m)	Δt (ms)	T (s)
24	7.5	172.5	2	32

Δx : interdistanza geofonica; L tot: lunghezza profilo; Δt : passo di campionamento; T: durata registrazione.

Sismogramma



Curva di dispersione



Modello Vs (1D)

PROFILO sismico fino a 250 metri			
Vs30= 228 m/s± 6 m/s (3.7 RMS:%)			
ESAC10			
Sismo-strato	Profondità letto (m)	Velocità (m/s)	Spessore (m)
1	2.6	162.7	2.6
2	5.0	136.1	2.4
3	8.0	137.1	3.0
4	10.8	195.7	2.9
5	13.8	247.4	3.0
6	16.9	282.1	3.1
7	20.1	308.8	3.2
8	23.4	329.4	3.3
9	26.8	350.5	3.4
10	30.3	370.4	3.5
11	33.9	392.7	3.6
12	37.6	414.6	3.7
13	41.5	425.0	3.8
14	45.4	433.4	3.9
15	49.4	443.0	4.0
16	53.6	450.3	4.1
17	57.8	458.2	4.3
18	62.2	467.3	4.4
19	66.6	478.0	4.5
20	71.2	490.5	4.6
21	75.9	504.5	4.7
22	80.7	504.1	4.8
23	85.6	520.0	4.9
24	90.6	536.0	5.0
25	95.7	539.1	5.1
26	100.9	556.2	5.2
27	106.2	574.2	5.3
28	111.6	578.7	5.4
29	117.1	598.3	5.5

PROFILO sismico ESAC10 cont.,,

Sismo-strato	Profondità letto (m)	Velocità (m/s)	Spessore (m)
30	122.8	602.9	5.6
31	128.5	607.2	5.7
32	134.4	628.3	5.8
33	140.3	631.9	6.0
34	146.4	642.3	6.1
35	152.5	645.3	6.2
36	158.8	648.1	6.3
37	165.2	650.7	6.4
38	171.7	653.2	6.5
39	178.3	655.7	6.6
40	184.9	658.2	6.7
41	191.8	661.0	6.8
42	198.7	664.1	6.9
43	205.7	667.5	7.0
44	212.8	671.4	7.1
45	220.0	675.9	7.2
46	227.4	681.3	7.3
47	234.8	687.7	7.4
48	242.3	695.4	-