Criticità legate alle installazioni sismometriche nell'uso dei dati ai fini dell'ingegneria sismica

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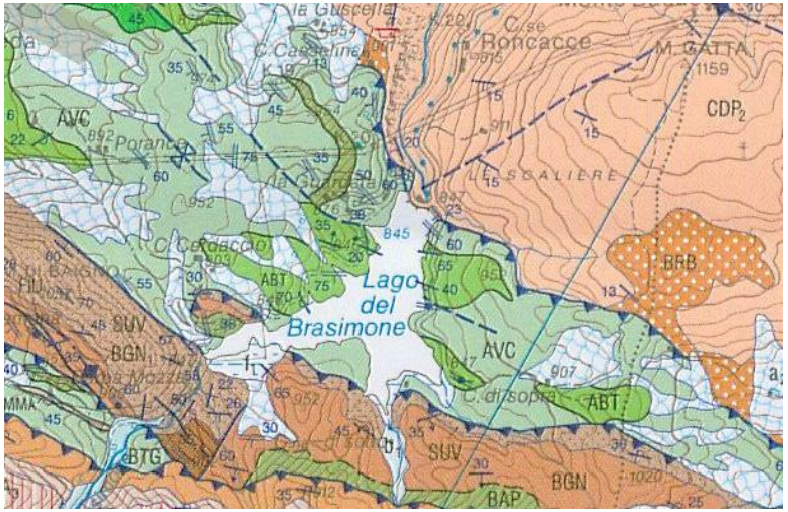
Il caso di studio

Nell'ambito del progetto INGV-DPC S2-2014 abbiamo avuto il compito di caratterizzare 11 stazioni:

Emilia Romagna	
BRM	Brasimone (BO)
FRN	Fornovo (PR)
MLD	Meldola (FC)
PNN	Pennabilli (RN)
STS	Santa Sofia (FC)

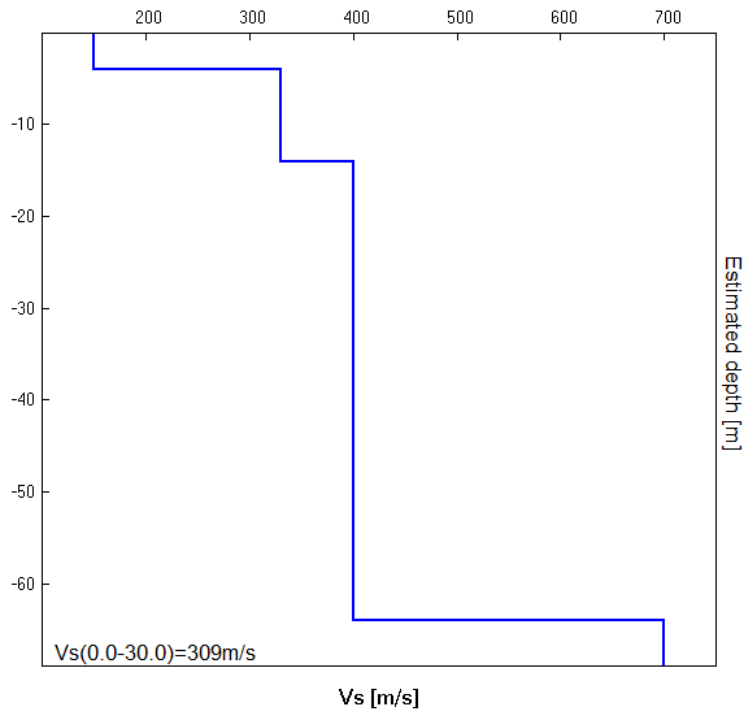
Sicilia	
CFL	Cefalù (PA)
CRL	Corleone (PA)
MZR	Mazara del Vallo (TP)
NAS	Naso (ME)
NCS	Nicosia (EN)
NSA	Nicosia 2 (EN)

Metodo di lavoro



Acquisizione dati esistenti
Osservazioni e rilievo geologico-geomorfologico
89 acquisizioni di microtremore a stazione singola
22 acquisizioni in array attivo/passivo

Classificazioni presunte vs. osservate



Stazione	Classe EC8 presunta	Classe EC8 osservata
BRM	B*	B
CFL	?	A
CRL	?	B
FRN	B*	C
MLD	A*	C
MZR	C*	B
NAS	B*	C
NCS	A*	B
NSA	A*	B
PNN	B*	C-B
STS	B*	B

Problemi

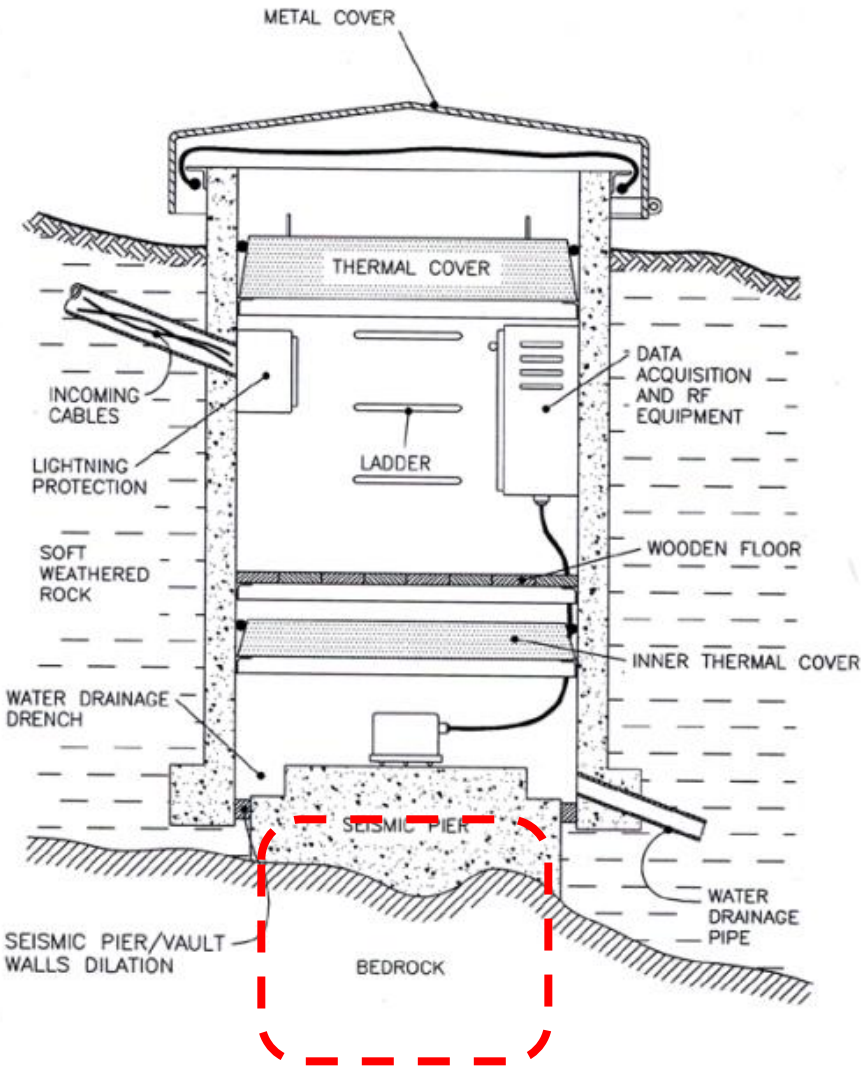
Interazione struttura-strumento

Risentimento del moto proprio della struttura ospitante la stazione (tipicamente cabina ENEL) nei sismogrammi registrati dalla stazione stessa

Interazione suolo-struttura

Riduzione dell'ampiezza spettrale delle componenti orizzontali del moto a causa della fondazione più rigida rispetta al sottosuolo

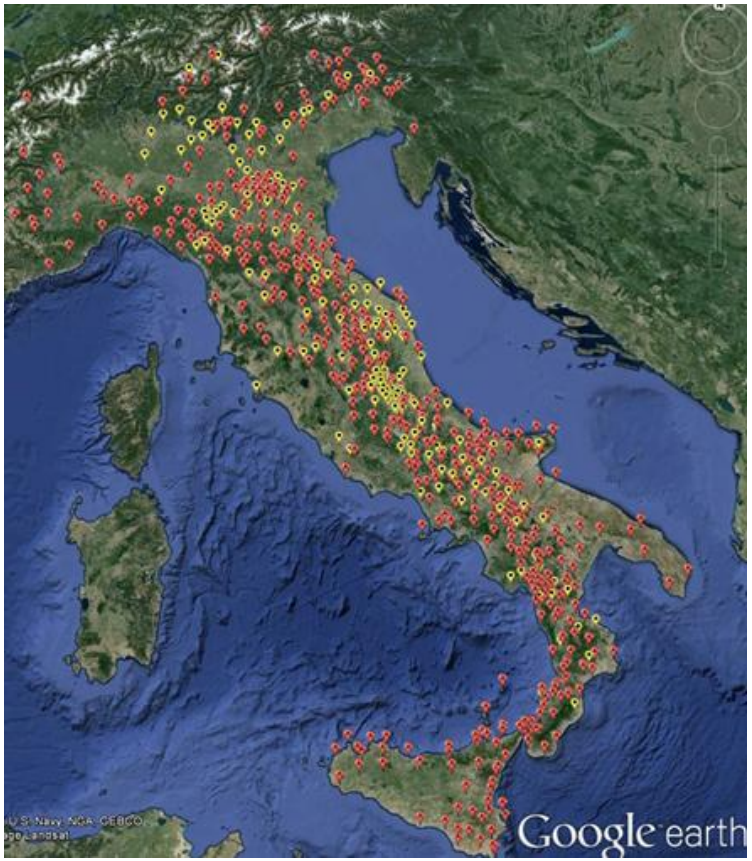
in teoria …



Trnkoczy, A. *et al.* (*in* Bormann, P., ***NMSOP-2,*** 2012)
DOI: http://doi.org/10.2312/GFZ.NMSOP-2_ch7

Bycroft G.N. (BSSA, 1978)
Crouse C.B. et al. (BSSA, 1984)
Crouse C.B., Hushmand B. (BSSA, 1989)
Steidl J.H.et.al. (BSSA, 1996)

…e pratica



Stazioni della Rete Accelerometrica Nazionale - 608 (DPC)

Stazioni della Rete Sismometrica Nazionale – 204 (INGV)

Fonte: ItacaNet

EC8 class	N° of stations – IT (RAN)	
A	**16**	**121**
A*	**105**	
B	**30**	**307**
B*	**277**	
C	**20**	**161**
C*	**141**	
D	**6**	**8**
D*	**2**	
E	**5**	**6**
E*	**1**	
	No information	**5**
	Total	**608**

A,B,C,D,E = classi verificate con misure in situ
A*, B*, C*, D*, E* = classificazione presunta su base geologica

… e pratica

CFL

NSA

Site type	N° of stations - IT (RAN)
Close to structure	**16**
Inside building	**35**
Free field	**529**
No information	**28**
Total	**608**

… e pratica

BRM

MLD

STS

FRN

PNN

CRL

MZR

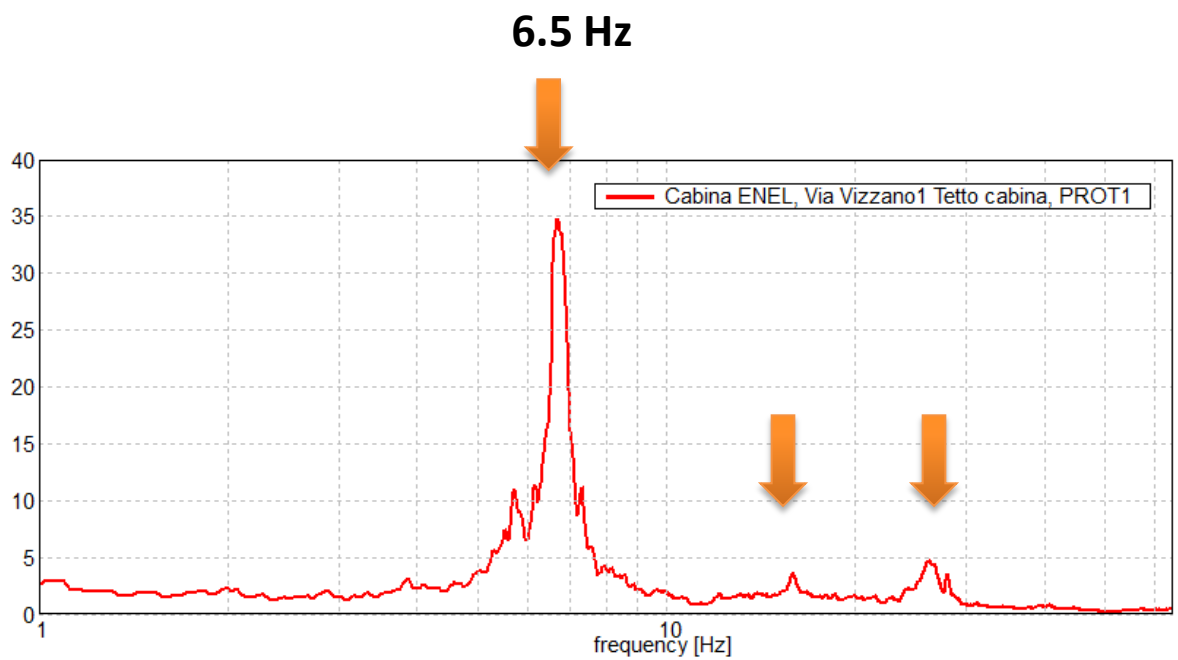
NAS

NCS

Interazione struttura-strumento

Cabina ENEL dismessa

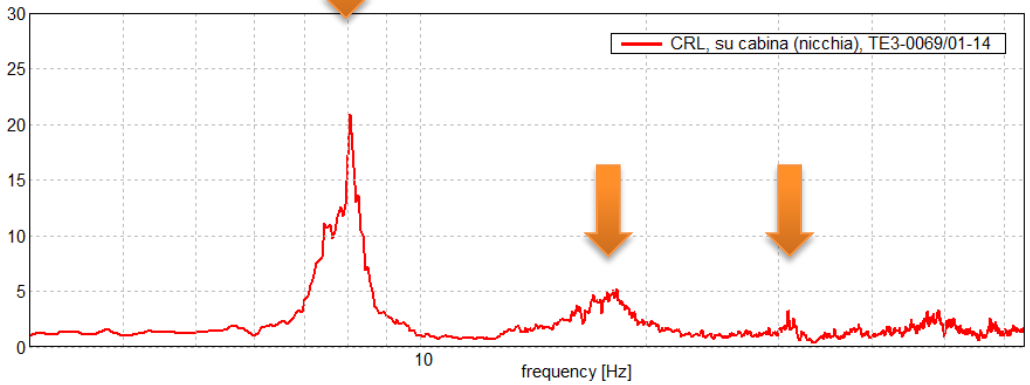
- Base 3 x 3 m
- Altezza 7 m
- Mattone pieno intonacato



CRL

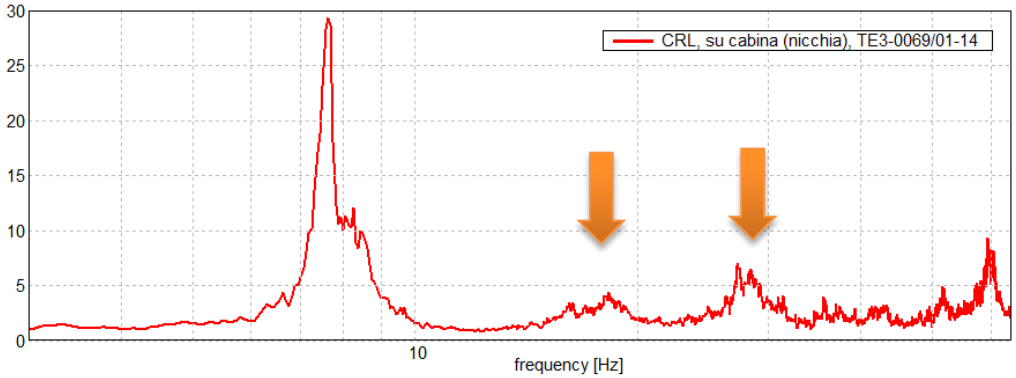
8 Hz

LONGITUDINALE

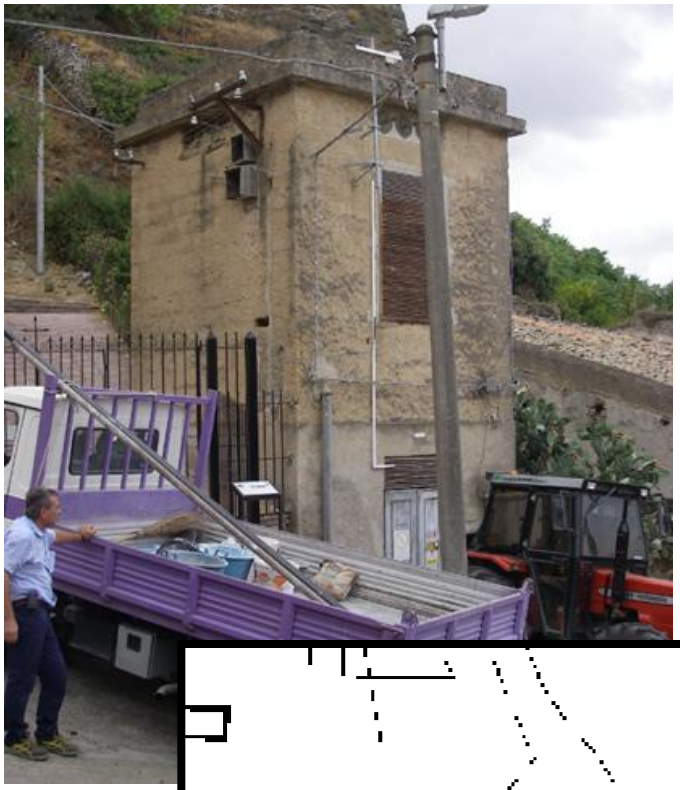


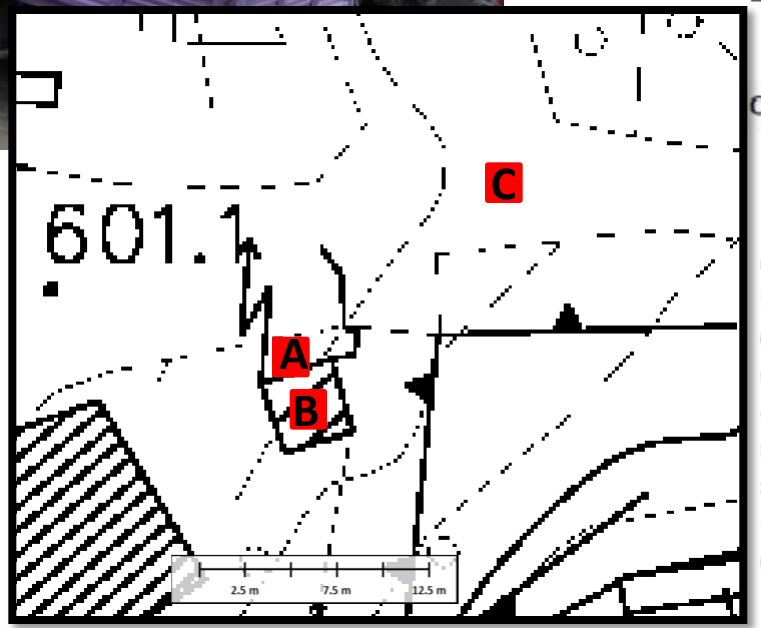
7.5 Hz

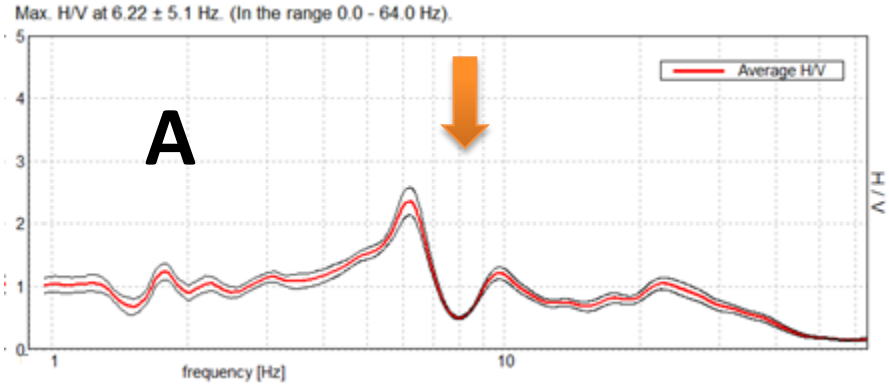
TRASVERSALE

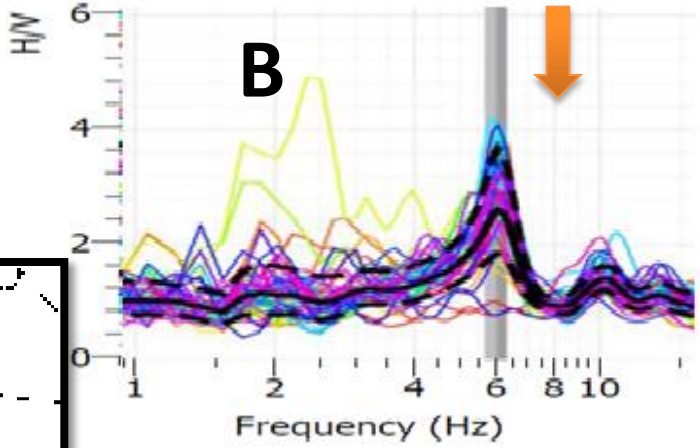


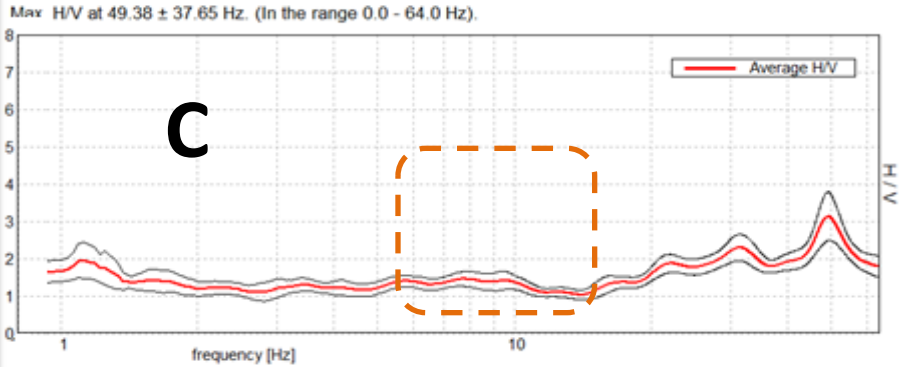
CRL



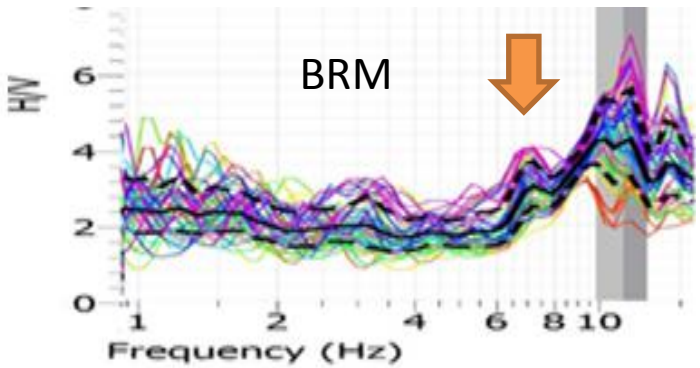

601.1
A
B
C
2.5 m
7.5 m
12.5 m

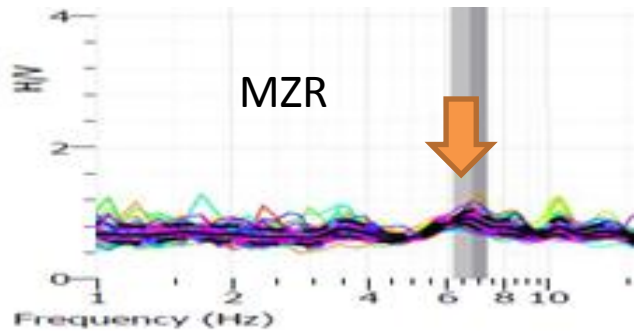

Max. H/V at 6.22 ± 5.1 Hz. (In the range 0.0 - 64.0 Hz).
Average H/V
A
H/V
frequency [Hz]

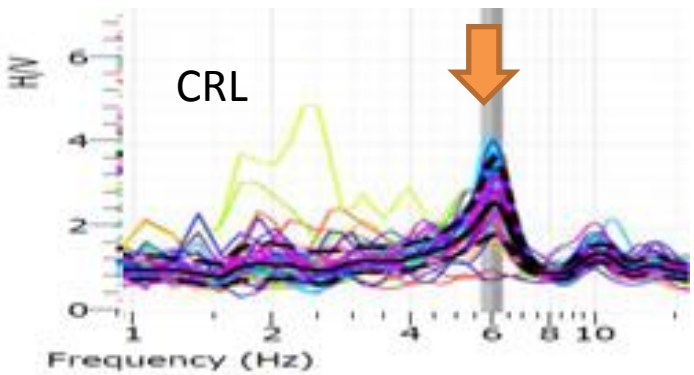

H/V
B
Frequency (Hz)

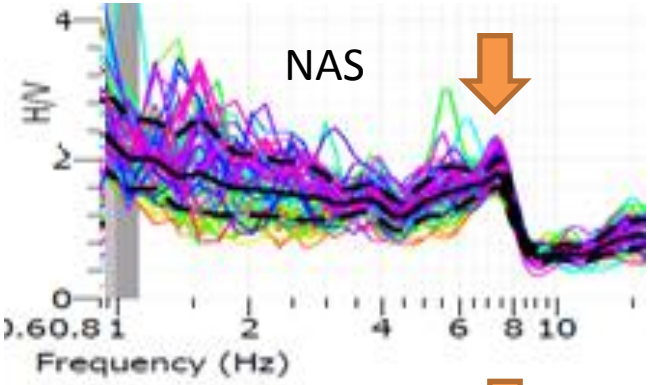

Max. H/V at 49.38 ± 37.65 Hz. (In the range 0.0 - 64.0 Hz).
Average H/V
C
H/V
frequency [Hz]

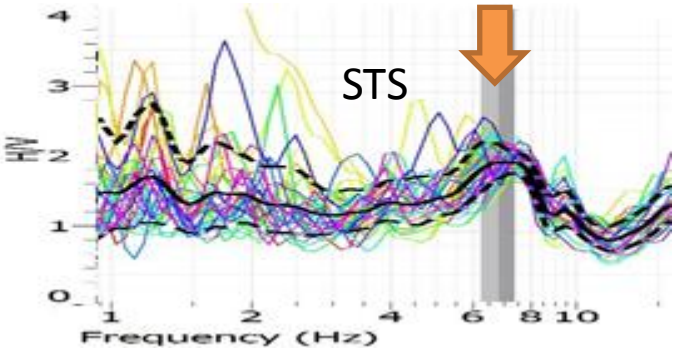
Interazione struttura-strumento

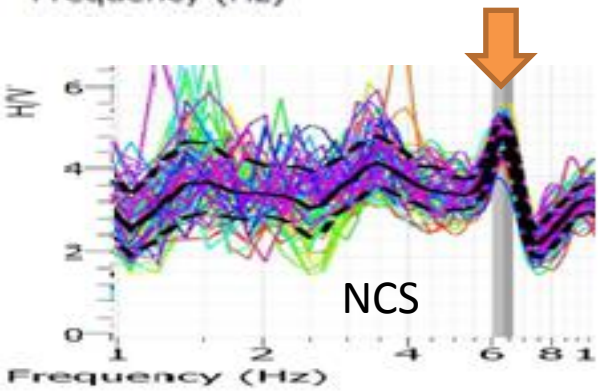












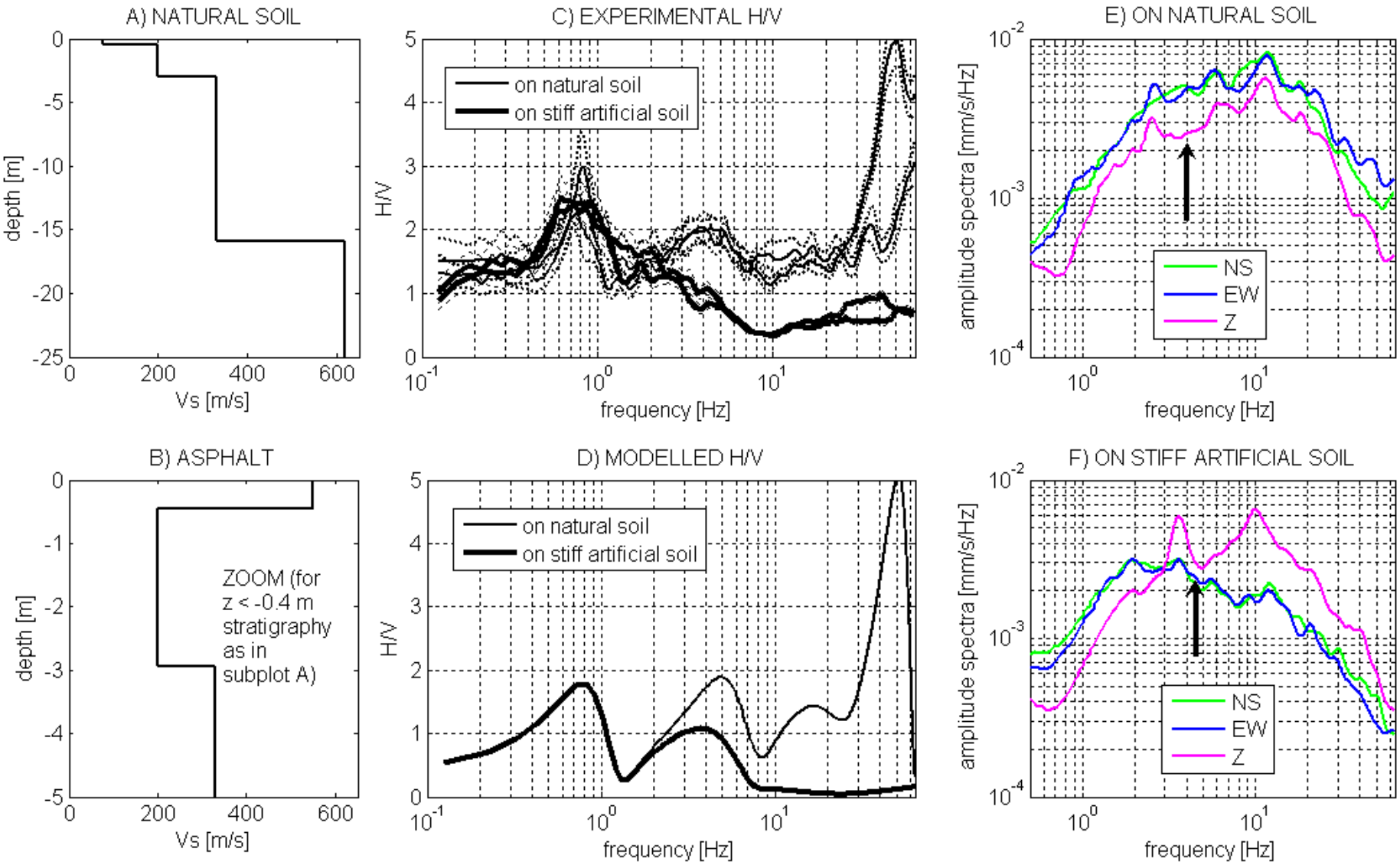
Interazione suolo-struttura

Fenomeni di inversione di velocità

Stazione	Categoria osservata
FRN	C
MLD	C
MZR	B
NAS	C
NSA	B
PNN	C-B

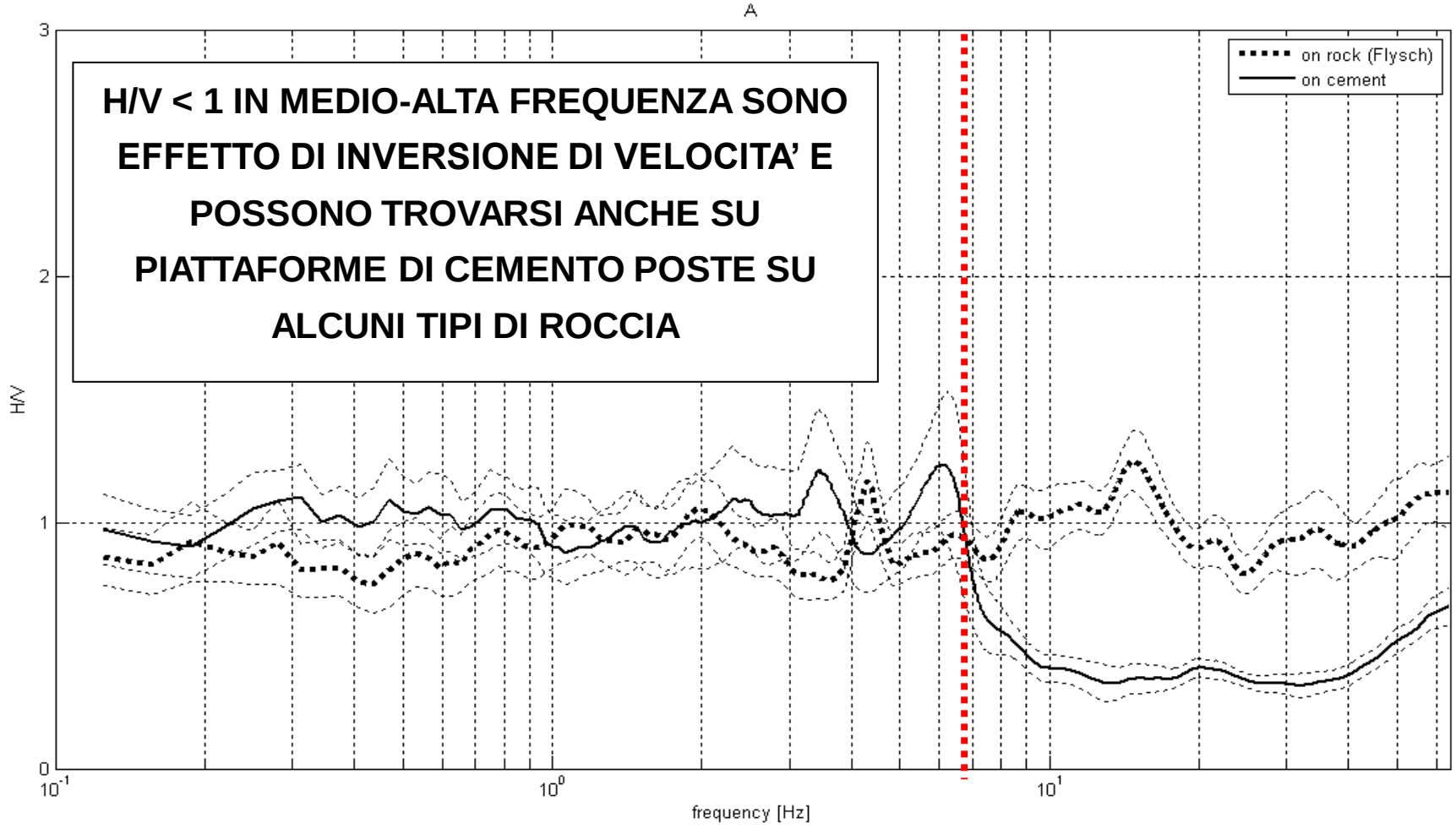
Sono stati osservati da 2 Hz in su e riguardano prevalentemente, ma non solo, i siti con categorie più basse.

Effetti delle inversioni di velocità



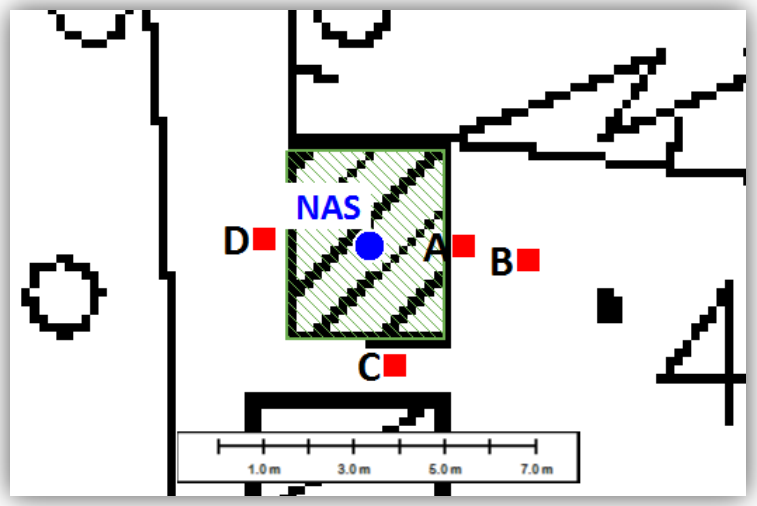
Da Castellaro e Mulargia (Pure Appl. Geophys., 2009)

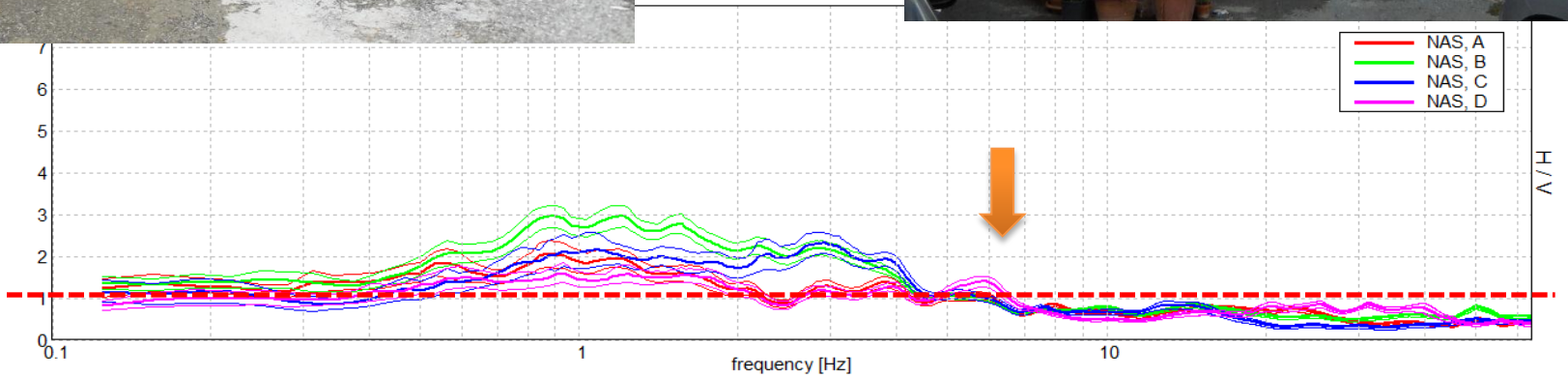
Effetti delle inversioni di velocità



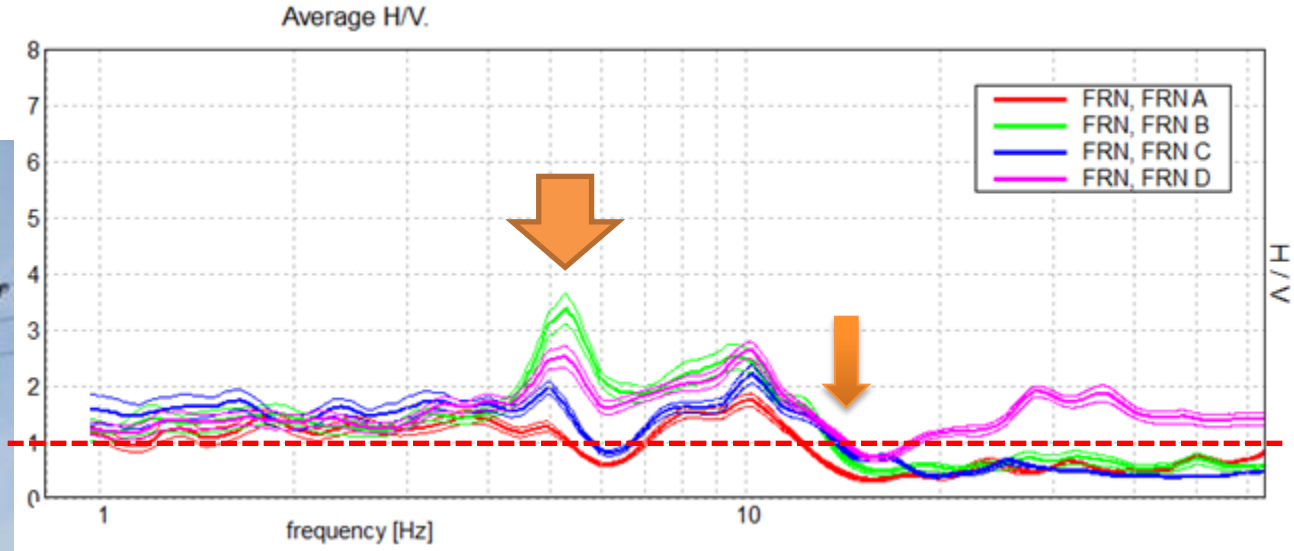
Da Castellaro e Mulargia (Pure Appl. Geophys., 2009)

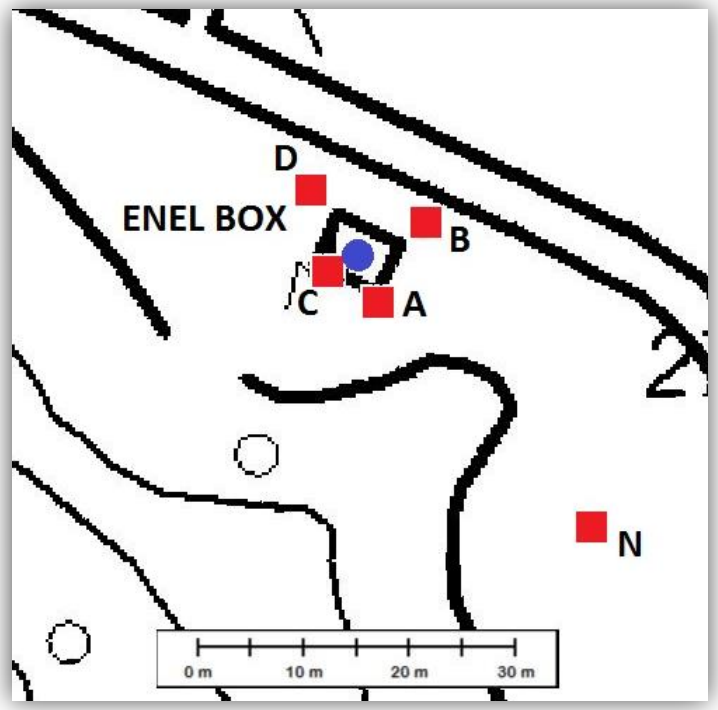
NAS


NAS
D
A
B
C
1.0 m
3.0 m
5.0 m
7.0 m

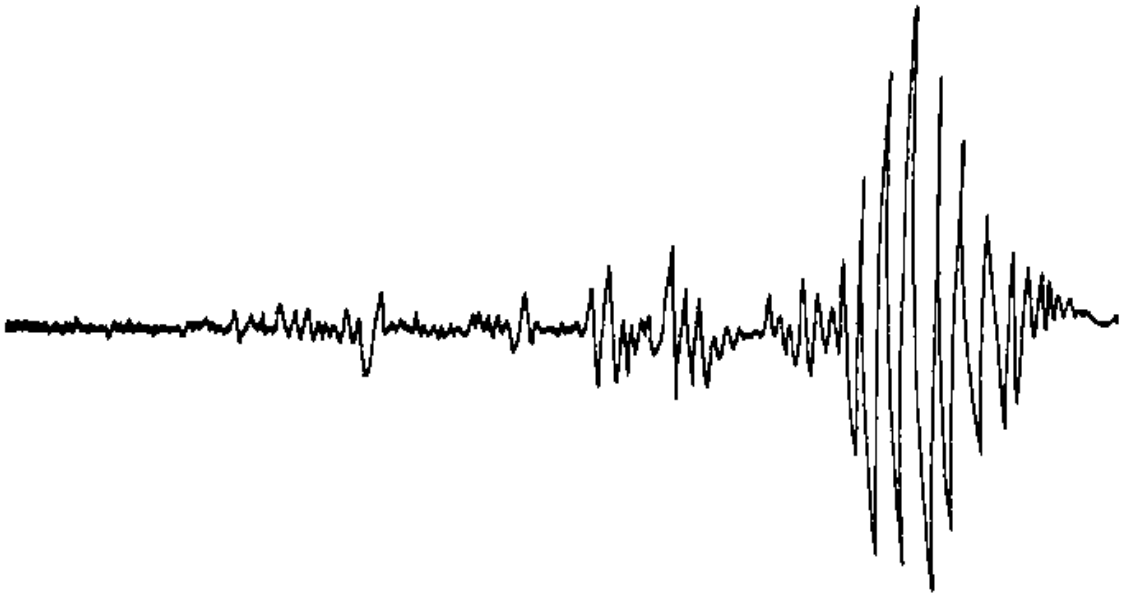

Average H/V.
NAS, A
NAS, B
NAS, C
NAS, D
H / V
frequency [Hz]
0.1
1
10
0
1
2
3
4
5
6
7

FRN


Average H/V.
FRN, FRN A
FRN, FRN B
FRN, FRN C
FRN, FRN D
H / V
frequency [Hz]
0
1
2
3
4
5
6
7
8
1
10


D
ENEL BOX
B
C
A
N
0 m
10 m
20 m
30 m

Conclusioni

Cosa stiamo misurando?

Grazie per l’attenzione