- Tabulati di calcolo ed elaborati grafici dell'indagine sismica di superficie combinata (Onde di Rayleigh e onde P) realizzata in sito (*Dott. Ciulli L., Febbraio 2014*).

Indagine sismica di tipo MASW per onde di Rayleigh (superficiali)

REPORT SINTETICO DELL'INDAGINE SISMICA DI TIPO MASW REALIZZATA LUNGO LA SP47 IN LOCALITA' MICCIANO, POMARANCE (PI)

SECTION N. 1

==========

dataset: micciano-masw_zero.sgy
minimum offset (m): 4
geophone spacing (m): 2
sampling (ms): 0.131
Dispersion curve: zero_1.cdp
Number of individuals: 30
Number of generations: 41

Adopted search space (minimum Vs & thickness): 100 1 100 1 100 1 150 5 200
Adopted search space (maximum Vs & thickness): 300 25 250 25 350 3 450 10 1500
Adopted Poisson values: 0.35 0.4 0.35 0.25 0.25

SECTION N. 2

==========

Rayleigh wave analysis
Optimizing Vs & Thickness - generation: 1; average & best misfits: -178.0801 -154.1503
Optimizing Vs & Thickness - generation: 2; average & best misfits: -176.9023 -141.1382
Optimizing Vs & Thickness - generation: 3; average & best misfits: -169.5082 -141.1382
Optimizing Vs & Thickness - generation: 4; average & best misfits: -175.2816 -141.1382
Optimizing Vs & Thickness - generation: 5; average & best misfits: -177.8076 -135.9365
Optimizing Vs & Thickness - generation: 6; average & best misfits: -169.8852 -129.0939
Optimizing Vs & Thickness - generation: 7; average & best misfits: -166.7547 -97.59249
Optimizing Vs & Thickness - generation: 8; average & best misfits: -151.4028 -95.33151
Optimizing Vs & Thickness - generation: 9; average & best misfits: -141.0518 -62.11861
Optimizing Vs & Thickness - generation: 10; average & best misfits: -128.4793 -50.46346
Optimizing Vs & Thickness - generation: 11; average & best misfits: -126.4453 -48.45728
Optimizing Vs & Thickness - generation: 12; average & best misfits: -123.6262 -46.38025
Optimizing Vs & Thickness - generation: 13; average & best misfits: -119.3484 -46.38025
Optimizing Vs & Thickness - generation: 14; average & best misfits: -134.151 -46.07402
Optimizing Vs & Thickness - generation: 15; average & best misfits: -126.3402 -46.07402
Optimizing Vs & Thickness - generation: 16; average & best misfits: -132.6007 -45.04255
Optimizing Vs & Thickness - generation: 17; average & best misfits: -121.9521 -45.04255
Optimizing Vs & Thickness - generation: 18; average & best misfits: -112.0945 -45.04255
Optimizing Vs & Thickness - generation: 19; average & best misfits: -127.7189 -45.04255
Optimizing Vs & Thickness - generation: 20; average & best misfits: -128.1092 -45.04255
Optimizing Vs & Thickness - generation: 21; average & best misfits: -102.013 -45.04255
Optimizing Vs & Thickness - generation: 22; average & best misfits: -112.9472 -43.02342
Optimizing Vs & Thickness - generation: 23; average & best misfits: -127.1971 -43.02342
Optimizing Vs & Thickness - generation: 24; average & best misfits: -128.7704 -43.02342
Optimizing Vs & Thickness - generation: 25; average & best misfits: -116.9287 -42.16416
Optimizing Vs & Thickness - generation: 26; average & best misfits: -116.8614 -42.16416
Optimizing Vs & Thickness - generation: 27; average & best misfits: -131.3685 -42.16416
Optimizing Vs & Thickness - generation: 28; average & best misfits: -115.7881 -42.16416
Optimizing Vs & Thickness - generation: 29; average & best misfits: -132.337 -42.16416
Optimizing Vs & Thickness - generation: 30; average & best misfits: -124.584 -42.16416
Optimizing Vs & Thickness - generation: 31; average & best misfits: -127.2809 -42.16416
Optimizing Vs & Thickness - generation: 32; average & best misfits: -117.6846 -42.06633
Optimizing Vs & Thickness - generation: 33; average & best misfits: -115.5267 -41.72856

Optimizing Vs & Thickness - generation: 34; average & best misfits: -121.854 -41.72856
Optimizing Vs & Thickness - generation: 35; average & best misfits: -127.6588 -41.72856
Optimizing Vs & Thickness - generation: 36; average & best misfits: -104.9824 -41.72856
Optimizing Vs & Thickness - generation: 37; average & best misfits: -115.2366 -41.64177
Optimizing Vs & Thickness - generation: 38; average & best misfits: -117.8387 -41.64177
Optimizing Vs & Thickness - generation: 39; average & best misfits: -120.5093 -41.64177
Optimizing Vs & Thickness - generation: 40; average & best misfits: -120.0995 -40.21487
Optimizing Vs & Thickness - generation: 41; average & best misfits: -118.6845 -40.21487

Checking the new search space (for the finer search)
Now a finer search around the most promising search space area
Rayleigh wave analysis
Optimizing Vs & Thickness - generation: 1; average & best misfits: -129.3398 -40.21487
Optimizing Vs & Thickness - generation: 2; average & best misfits: -124.5479 -40.21487
Optimizing Vs & Thickness - generation: 3; average & best misfits: -116.0269 -40.21487
Optimizing Vs & Thickness - generation: 4; average & best misfits: -108.395 -40.21487
Optimizing Vs & Thickness - generation: 5; average & best misfits: -125.9606 -40.21487
Optimizing Vs & Thickness - generation: 6; average & best misfits: -126.043 -40.21487
Optimizing Vs & Thickness - generation: 7; average & best misfits: -128.6125 -40.21487
Optimizing Vs & Thickness - generation: 8; average & best misfits: -124.3223 -40.21487
Optimizing Vs & Thickness - generation: 9; average & best misfits: -107.064 -40.21487
Optimizing Vs & Thickness - generation: 10; average & best misfits: -103.8348 -40.21487
Optimizing Vs & Thickness - generation: 11; average & best misfits: -113.5496 -40.21487

Model after the Vs & Thickness optimization (fixed Poisson values):
Vs (m/s): 295 207 194 404 1108
Poisson: 0.35 0.4 0.35 0.25 0.25
Thickness (m): 3.8 2 2.3 6.2

Number of models considered to calculate the average model: 51

##
RESULTS winMASW Pro
##

Dataset: micciano-masw_zero.sgy
Analyzed curve: zero_1.cdp

SECTION N. 3
==========
MEAN MODEL

VS (m/s): 289 206 198 406 1040
Standard deviations (m/s): 28 7 19 15 86

Thickness (m): 3.6 2.0 2.3 6.5
Standard deviations (m): 0.5 0.1 0.1 0.5

Approximate values for Vp, density & elastic moduli
Vp (m/s): 602 505 412 703 1801
Density (gr/cm3): 1.93 1.89 1.84 1.97 2.20
Vp/Vs ratio: 2.08 2.45 2.08 1.73 1.73
Poisson: 0.35 0.40 0.35 0.25 0.25
Young modulus (MPa): 436 224 195 811 5940
Sjear modulus (MPa): 161 80 72 324 2376
Lamé (MPa): 377 321 168 324 2374
Bulk modulus (MPa): 485 375 216 540 3958

Fundamental mode
Mean model
f(Hz) VR(m/s)
2.975 894.8483

9.24052 522.031
16.8681 235.2441
28.0371 238.636
38.6612 243.0344
49.9664 233.8055
60.1819 222.8138
65.6302 218.899
70.2612 216.332

First higher mode
Mean model
15.0974 482.2234
23.406 398.3627
37.1629 300.1716
48.0595 263.4275
57.0491 261.0205

Second higher mode)
Mean model
17.2767 784.1075
22.044 636.7585
27.4922 521.0631
33.2129 428.7327
37.9802 373.7373
42.7474 351.6505
46.8336 340.2915
52.4181 325.7192

Third higher mode)
Mean model
25.3129 915.3958
31.306 690.8137
34.9836 633.655
40.9767 540.0184
46.0164 461.385
52.6905 390.9182

SECTION N. 4
==========
BEST MODEL

Vs (m/s): 295.29715 207.12394 194.05393 404.08117 1108.1649
thickness (m): 3.8214 2.0061 2.3451 6.1884

Approximate values for Vp, density & elastic moduli
Vp (m/s): 615 507 404 700 1919
Density (gr/cm3): 1.94 1.89 1.83 1.97 2.21
Vp/Vs ratio: 2.08 2.45 2.08 1.73 1.73
Poisson: 0.35 0.40 0.35 0.25 0.25
Young modulus (MPa): 455 227 186 803 6790
Shear modulus (MPa): 168 81 69 321 2716
Lamé (MPa): 395 324 161 322 2715
Bulk modulus (MPa): 508 378 207 536 4526

dispersion curve (frequency - Rayleigh phase velocity)
Fundamental mode)
best model
F(Hz) VR(m/s)
2.975 956.6132
9.24052 496.8204
16.8681 237.5813
28.0371 243.2288

38.6612 246.7036
49.9664 232.8968
60.1819 221.0921
65.6302 217.0403
70.2612 214.3856

First higher mode)
best model
15.0974 493.1162
23.406 405.4629
37.1629 299.3985
48.0595 267.6151
57.0491 266.2109

Second higher mode)
best model
17.2767 815.3382
22.044 648.0182
27.4922 525.7435
33.2129 424.2375
37.9802 369.0675
42.7474 347.6678
46.8336 336.4547
52.4181 322.1501

Third higher mode)
best model
25.3129 947.2632
31.306 689.5327
34.9836 630.3014
40.9767 537.7248
46.0164 454.2361
52.6905 384.0001

VS5 (mean model): 259 m/s
VS5 (best model): 268 m/s

VS20 (mean model): 362 m/s
VS20 (best model): 363 m/s

VS30 (mean model): **462 m/s**
VS30 (best model): **468 m/s**

SECTION N. 6
==========
Possible Soil Type: B
(based on the mean model)

For the Italian Users:
Dalla normativa (modifiche del D.M. 14/09/2005 Norme Tecniche per le Costruzioni, emanate con D.M. Infrastrutture del 14/01/2008, pubblicato su Gazzetta Ufficiale Supplemento ordinario n° 29 del 04/02/2008):
A - Ammassi rocciosi affioranti o terreni molto rigidi,caratterizzati da valori di VS30 superiori a 800 m/s, eventualmente comprendenti in superficie uno strato di alterazione, con spessore massimo di 3 m.
B - Rocce tenere e depositi di terreni a grana grossa molto addensati o terreni a grana fine molto consistenti, con spessori superiori a 30 m, caratterizzati da graduale miglioramento delle proprietà meccaniche con la profondità e valori del VS30 compresi tra 360 m/s e 800 m/s (ovvero NSPT30 > 50 nei terreni a grana grossa e cu30> 250 kPa nei terreni a grana fina).
C - Depositi di terreni a grana grossa mediamente addensati o terreni a grana fine mediamente consistenti, con spessori superiori a 30 m caratterizzati da graduale miglioramento delle proprietà meccaniche con la profondità e valori del VS30 compresi tra 180 m/s e 360 m/s

(ovvero 15 < NSPT30 < 50 nei terreni a grana grossa e 70 < cu30 < 250 kPa nei terreni a grana fina).
D - Depositi di terreni a grana grossa scarsamente addensati o terreni a grana fine scarsamente consistenti, con spessori superiori a 30 m caratterizzati da graduale miglioramento delle proprietà meccaniche con la profondità e valori del VS30 inferiori a 180 m/s (ovvero NSPT30 < 15 nei terreni a grana grossa e cu30 < 70 kPa nei terreni a grana fina).
E - Terreni dei sottosuoli dei tipi C o D per spessori non superiori a 20 m, posti sul substrato di riferimento (con VS > 800 m/s).
S1 - Depositi di terreni caratterizzati da valori di VS30 inferiori 100 m/s (ovvero 10 < cuS30 < 20 kPa) che includono uno strato di almeno 8 m di terreni a grana fina di bassa consistenza, oppure che includano almeno 3 m di torba o argille altamente organiche.
S2 - Depositi di terreni suscettibili di liquefazione, di argille sensitive, o qualsiasi altra categoria di sottosuolo non classificabile nei tipi precedenti.

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winMASW 4.2 Pro
Surface Wave Analysis
via MASW - Multichannel Analysis of Surface Waves
www.eliosoft.it

Postazione di acquisizione dati nell'ambito dell'indagine sismica superficiale di tipo combinato (onde di Rayleigh e onde P).

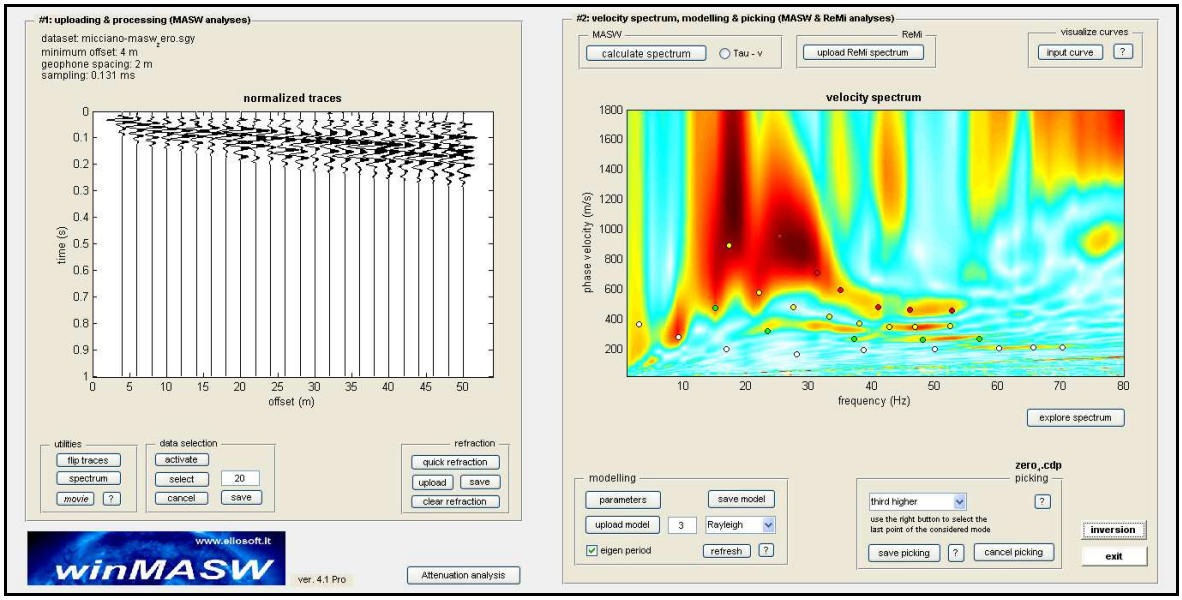
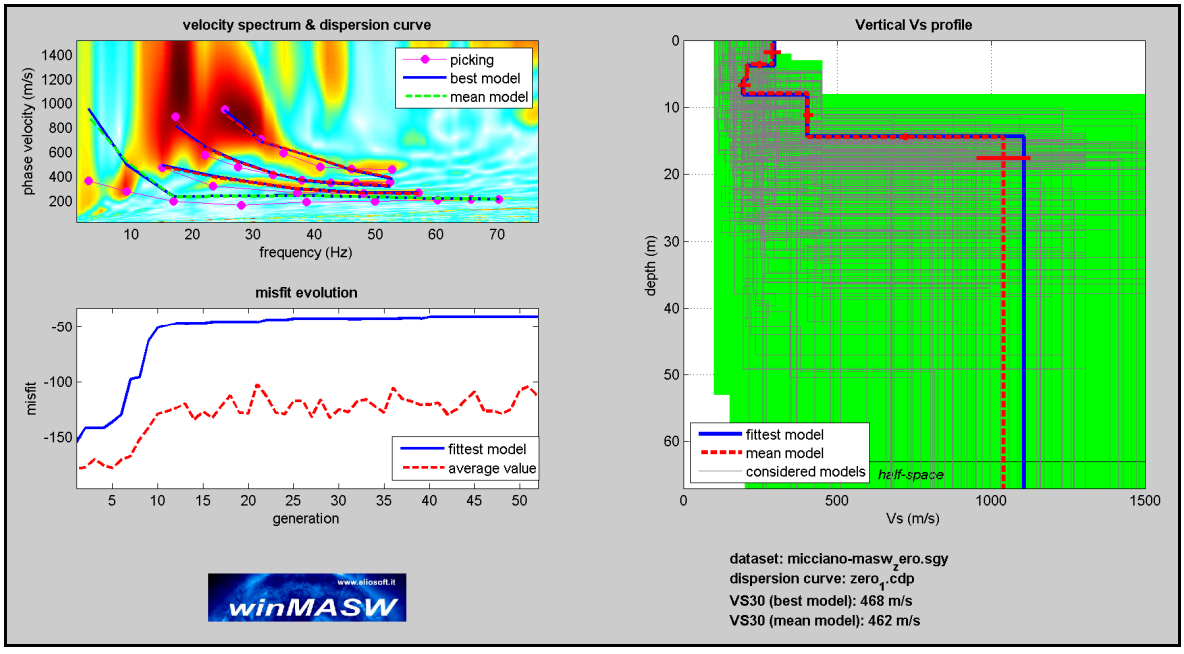
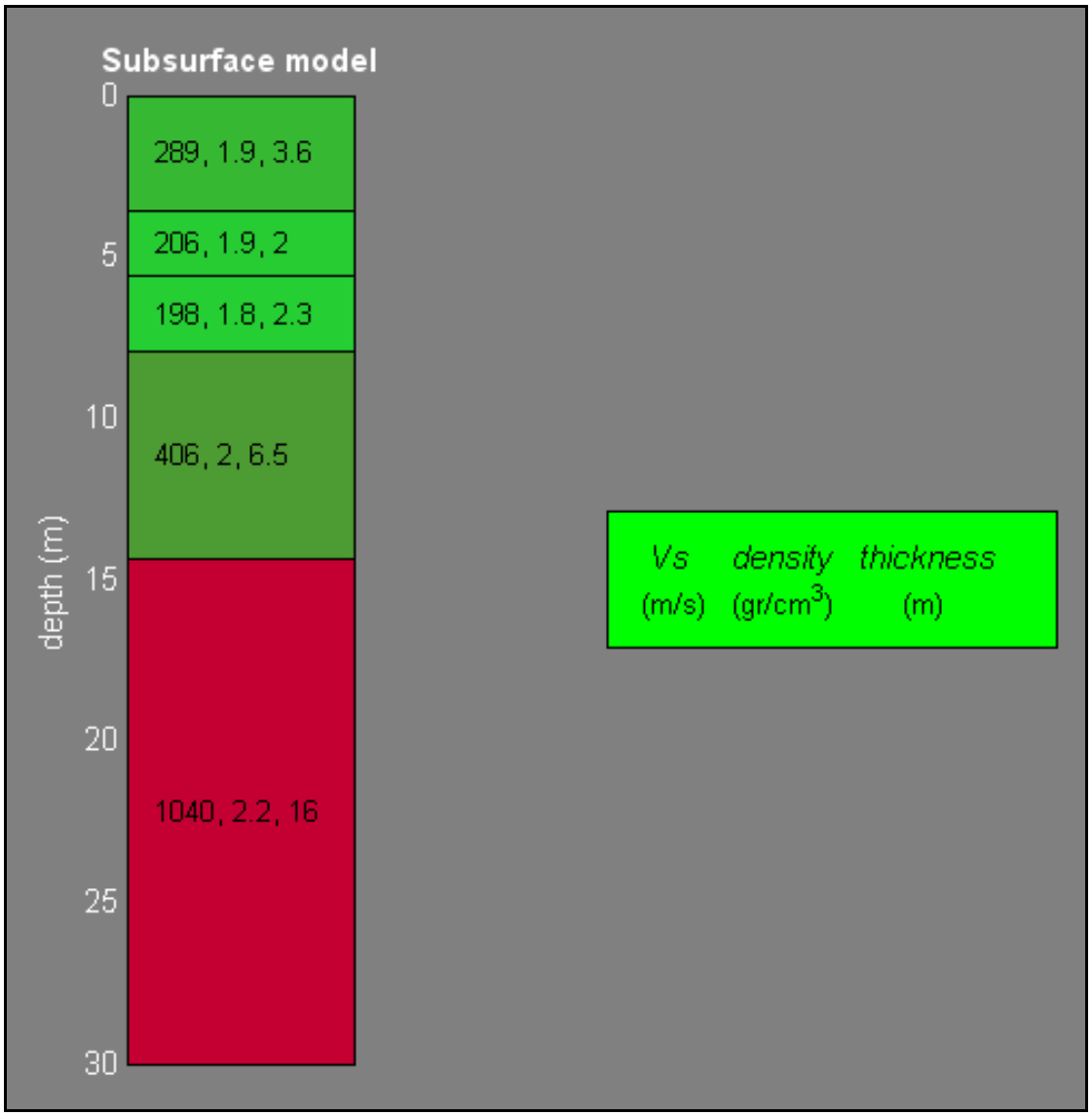


Diagramma acquisizione dati e spettro delle velocità



Curva di dispersione e profilo delle velocità



Stratigrafia ricostruita sulla base dell'andamento delle velocità delle onde di taglio