

Model 3 (shallow seismics)

Layer with depth-dependent properties over homogeneous halfspace

Coordinate System

Left handed cartesian coordinate system (see Fig. 1).

All vector components point into the direction of the corresponding coordinate axis. (For example a positive force acts downwards and vertical velocity seismograms are positive for downward movement.)

All coordinates are in meters.

The free surface coincides with the plane $z=0$.

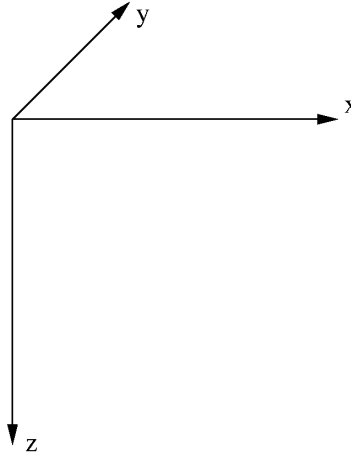


Figure 1: Used coordinate system.

Material Properties

The material parameters are defined in table 1. The values vary piecewise linearly with depth. At identical depth values with different model parameters, the structure has a first-order discontinuity.

The subsurface model used in this benchmark test was derived from a field data set by a joint inversion of Fourier-Bessel expansion coefficients and first arrival P-wave travel-times. A more detailed description as well as a plot of the subsurface model is given on <http://www.opentoast.de/Bietigheim.php>. Please note, that although the subsurface model was derived from field data, this benchmark calculation is not a simulation of recorded data. Purely elastic wave propagation is used for the benchmark test, while field data is significantly attenuated by anelasticity.

Source

Vertical point force with the force time function:

$$s(t) = \begin{cases} 0 & \text{for } t \leq Ts, \\ F_0 \sin^3 \left(\frac{\pi(t-Ts)}{Td} \right) & \text{for } Ts < t < Ts + Td, \\ 0 & \text{for } t \geq Ts + Td. \end{cases}$$

with the following parameters used for the modellings:

$T_s=0$ s (time of source onset)

$T_d=32$ ms (duration of source signal)

$F_0=1$ N (scalar force)

The used source time function (without including the factor F_0) and the corresponding amplitude spectrum are plotted in Fig. 2.

The source is located at the origin of the coordinate system.

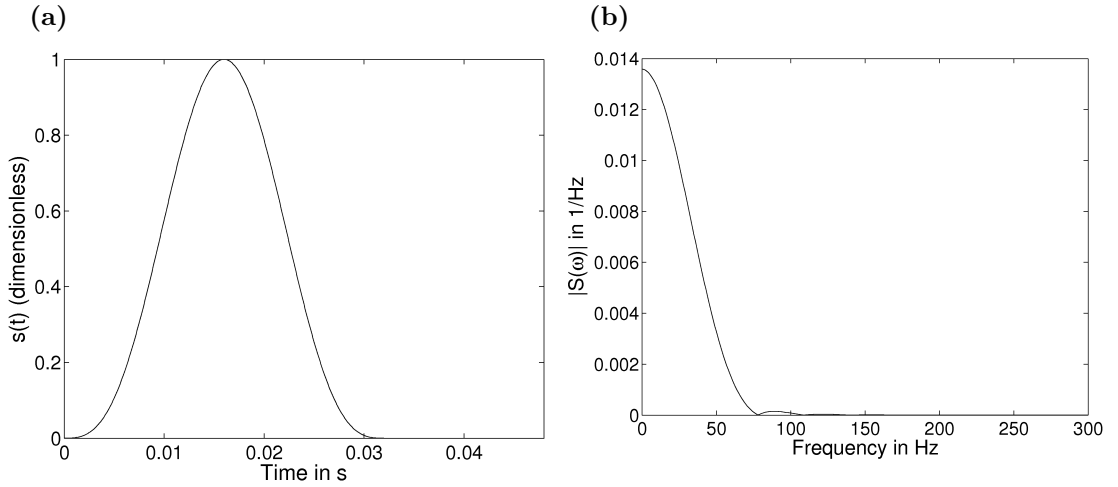


Figure 2: Force time function used for the modellings. In (a) the wavelet is plotted in the time domain and in (b) the corresponding amplitude spectrum is shown.

Receivers

24 equidistant receivers with a minimum offset (source receiver distance) of 1 m and a maximum offset of 70 m. The receiver distance is 3 m. The receivers are located at the free surface.

The explicit coordinates are given in Tab. 2.

Time Window

Time window for all receivers is 0 s to 0.6995 s.

Frequency Range

The modellings should be accurate for the whole frequency range given by the source time function.

Output Information

Time histories of particle velocities for x , y and z component (in m/s) for all receivers.

Required time step is 0.5 ms.

depth in m	density in kg/m ³	v_p m/s	v_s in m/s	Q_p	Q_s
0.0000	1600.0	131.2	71.0	inf	inf
0.5329	1600.0	245.3	156.3	inf	inf
1.0657	1600.0	337.8	217.9	inf	inf
1.5986	1600.0	408.5	255.8	inf	inf
2.1314	1600.0	457.5	270.1	inf	inf
2.6643	1600.0	484.8	260.8	inf	inf
2.6643	1600.0	483.0	258.8	inf	inf
3.2607	1600.0	493.3	267.6	inf	inf
3.8571	1600.0	503.6	276.3	inf	inf
4.4535	1600.0	513.9	285.0	inf	inf
5.0499	1600.0	524.2	293.8	inf	inf
5.6463	1600.0	534.5	302.5	inf	inf
6.2427	1600.0	544.8	311.2	inf	inf
6.8391	1600.0	555.1	320.0	inf	inf
7.4355	1600.0	565.4	328.7	inf	inf
8.0319	1600.0	575.7	337.4	inf	inf
8.6283	1600.0	586.1	346.2	inf	inf
9.2247	1600.0	596.4	354.9	inf	inf
9.8210	1600.0	606.7	363.6	inf	inf
10.4174	1600.0	617.0	372.4	inf	inf
11.0138	1600.0	627.3	381.1	inf	inf
11.6102	1600.0	637.6	389.8	inf	inf
12.2066	1600.0	647.9	398.6	inf	inf
12.8030	1600.0	658.2	407.3	inf	inf
13.3994	1600.0	668.5	416.1	inf	inf
13.9958	1600.0	678.8	424.8	inf	inf
14.5922	1600.0	689.1	433.5	inf	inf
15.1886	1600.0	699.4	442.3	inf	inf
15.7850	1600.0	709.7	451.0	inf	inf
16.3814	1600.0	720.0	459.7	inf	inf
16.3814	2300.0	3702.4	2150.8	inf	inf
25.0000	2300.0	3702.4	2150.8	inf	inf
25.0000	2300.0	3702.4	2150.8	inf	inf

Table 1: Material parameters vary piecewise linearly with depth (between given depth values) and have first-order discontinuities where two different values are given for the same depth.

No.	x in m	y in m	z in m	No.	x in m	y in m	z in m
1	1	0	0	13	37	0	0
2	4	0	0	14	40	0	0
3	7	0	0	15	43	0	0
4	10	0	0	16	46	0	0
5	13	0	0	17	49	0	0
6	16	0	0	18	52	0	0
7	19	0	0	19	55	0	0
8	22	0	0	20	58	0	0
9	25	0	0	21	61	0	0
10	28	0	0	22	64	0	0
11	31	0	0	23	67	0	0
12	34	0	0	24	70	0	0

Table 2: Receiver coordinates.