MINUTES of the SESAME Task C Meeting

Zurich (Switzerland), August 29-30 2001

Summary of Task C objectives:

Physical background and numerical modelling: on the upstream side, the project will try and fill the gap concerning the understanding of the real nature of noise, especially in urban areas, and develop and validate numerical tools to generate noise synthetics for arbitrary geological structures, which can in turn be used to assess the ability of the H/V and array techniques to provide relevant information on site conditions.

- **WP08**[Nature of noise wavefield] is intended to increase our knowledge on the actual consistency of the noise wavefield, a key point in the deep understanding of the H/V and array techniques. It will be based on the analysis of noise data recorded with arrays at several sites, in order to identify the composition (nature, proportion and origin of surface and body waves) of noise wavefield in urban areas.
- **WP09** [Numerical simulation of seismic noise] focuses on the development and validation of numerical models producing realistic noise synthetics. It will mainly use Finite-Difference techniques (FD) with spatially and temporally random surface sources, and include parameter studies to investigate the ability of H/V and array techniques, applied on synthetics, to recover the information on the structure.
- **WP10** [Simulation for real sites] will consist in a final cross-checking between actual noise observations, noise synthetics from numerical simulations, and the known geological structure and local site effects for a few well-known test-sites.

I Partners attending the meeting

Pierre-Yves Bard	LGIT Grenoble;	*WP08*
Peter Moczo, Jozef Kristek, Miriam Kristekova	GPI SAS Bratislava;	*WP09*
Donat Faëh, Fortunat Kind, Ivo Oprsal	ETH Zurich;	*WP10*

II Programme of the meeting

1. Review of modelling experience and available numerical tools for modelling seismic noise
2. Available computing facilities
3. Defining seismic noise generation
4. Defining canonical models of local surface geological structures
5. Review of the available methods of the time-frequency analysis
6. Future meetings of TASK C

III Scientific matters

III.1 Review of modelling experience and available numerical tools for modelling seismic noise

Pierre-Yves Bard summarised his numerical experience and results obtained using 3D modelling of seismic noise in 1D layered surface structures by the discrete-wavenumber method. Similarly, Donat Faëh summarised his numerical experience and main results obtained using 2D P-SV modeling of seismic noise in 1D layered structures and 2D models of sediment-filled valleys by the finite-difference method. There is no previous experience with simulation of seismic noise in the Bratislava team.

Available numerical tools for simulating seismic noise:

- **Grenoble team**
  - code Axitra (by O.Coutant) based on the discrete-wavenumber method, 1D medium, 3D wavefield,
  - modified code Axitra (by Y.Hisada), sources much closer to the free surface,
  - code Cesar (by LCPC) based on the finite-element method, 3D medium, 3D wavefield,
- **Bratislava team**
  - code DVS5.0 (by J. Kristek and P. Moczo) based on the 4th-order staggered-grid displacement-velocity-stress finite-difference scheme, 3D medium, 3D wavefield, powerful memory optimization procedures applicable; this code is likely to be the most important in the planned 3D numerical simulations for both canonical models and real sites
- **Zuerich team**
  - code by D. Faëh based on the 2nd-order staggered-grid velocity-stress finite-difference scheme, 2D medium, 2D P-SV wavefield,
  - code by I. Oprsal based on the 2nd-order displacement finite-difference scheme on conventional grid with varying size of grid spacings, 3D medium, 3D wavefield,
  - code by I. Oprsal based on the hybrid modeling combining the finite-diference method with the discrete-wavenumber or ray method.

III.2 Available computing facilities

Available computing facilities in LGIT Grenoble, GPI SAS Bratislava and ETH Zurich allow numerical modeling of seismic noise in canonical models. However, access to a multiprocessor computer would be important for speed-up of computations, especially for modeling of real sites. Therefore, Peter Moczo will inquire at INGV Rome (Antonio Rovelli) and University of Potsdam (Frank Scherbaum).

III.3 Defining seismic noise generation

~~An algorithm of seismic noise generation in numerical simulations was discussed in detail.~~

Algorithm

- point sources (PS) regularly distributed in a "source volume" of the whole computational region (spacing approximately 10 m)
- miminum and maximum # of acting PS - MN and MX
- at each time level: rnd NS; MN =< NS =< MX
  - ↳ if NS > MX: no selection of a PS
  - ↳ if NS < MN: rnd of a PS
    - ⇒ the PS is acting : find other PS
    - ⇒ the PS is not acting : rnd of a time function, rnd of a direction

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Time function

- amplitude : <0,1>
- Gabor signal (harmonic carrier with the Gaussian envelope)

$$s(t) = \exp\{-[\omega(t - t_s)/\gamma]^2\}\cos[\omega(t - t_s) + \theta]$$

$\omega = 2\pi f_p,\ t \in \langle 0, 2t_s \rangle,\ f_p$ is the predominant frequency, γ controls the width of the signal, θ is a phase shift and $t_s = 0.45\gamma / f_p$

- γ will be rnd generated over a range whose first half will correspond to pulses and second half to signals with dominant frequencies ("monochromatic" signals)

Source volumes

Five different depth intervals define five different source volumes in a model of a single layer (with thickness *h*) over half-space:

1. thin surface layer,
2. layer centred around half-depth of the sediment layer,
3. layer centred around a sediment-bedrock interface- <3*h*/4, 5*h*/4>,
4. layer below the sediment-bedrock interface - <2*h*, 3*h*>,
5. layer covering the interval <0, 3h>.

Implementation

This algorithm will be implemented in the Bratislava FD code DVS5.0, and tested within the next months, so as to deliver in due time the first deliverable of the task (D02.09, due at the end of first year, i.e., April 30, 2002)

III.4 Defining canonical models of local surface geological structures

The following set of basic canonical models has been defined:

Type of model	# of models
Homogeneous halfspace	1
Single layer over halfspace	9
Dipping layer	4
Semiinfinite layer over halfspace	2
Single layer with a rough layer-halfspace interface	6
Deep sediment valley	1
Shallow sediment valley	2
Single layer with a trough at the bottom	2
Burried fault	1
Two layers over halfspace	1
Low-velocity layer	2
Gradient layer	2

A detailed documentation of models will be prepared and made available for all SESAME partners.

III.5 Review of the available methods of the time-frequency analysis

Miriam Kristekova made a detailed presentation of several methods of the time-frequency analysis including her generalization of the MPD (Matching Pursuit Decomposition) method
For all methods there are computer codes written in programming language Fortran 95.

III.6 Future meetings of TASK C

Jozef Kristek and Miriam Kristekova will visit ETH for two weeks at the end of May 2002 in order to start preparation of models of real sites. Pierre-Yves Bard and Peter Moczo will join them for last three days. The visit will be concluded by a meeting of *WP08*, *WP09* and *WP10*.