NUMERICAL SIMULATIONS OF BIDIMENSIONAL SITE EFFECTS

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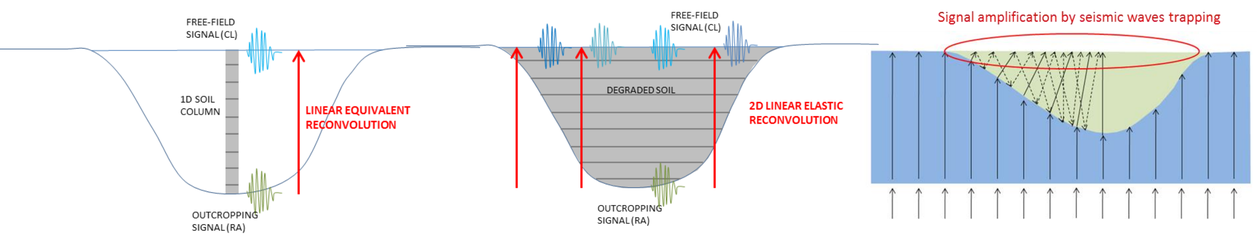
- Numerical simulations with **Code_Aster**
- Geological alluvial basins
- **2D wave propagation** in frequency or time domain
- Input signal defined for outcropping rock condition

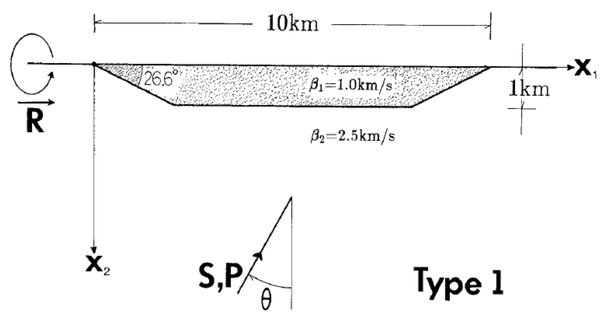
→ Identification of 2D amplification on the free-field signal

METHODOLOGY FOR LINEAR EQUIVALENT 2D PROCEDURE

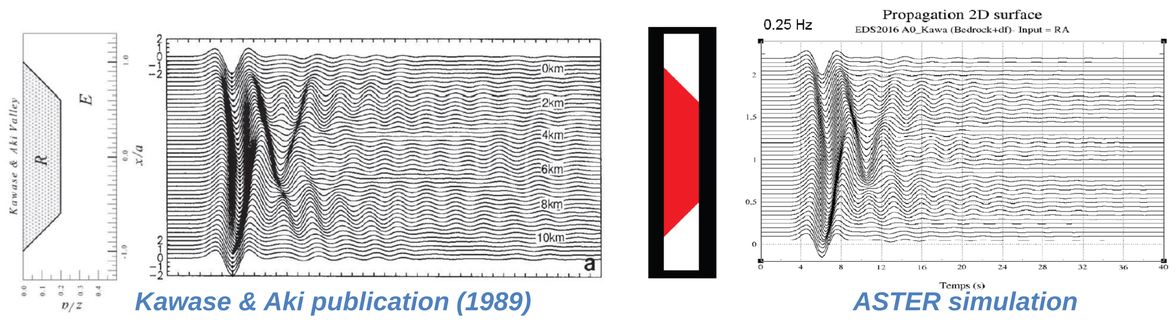
1) Determination of **effective soil properties** compatible with the sollicitation (1D soil columns linear equivalent computations)
2) **Linear** Propagation of the outcropping signal through the **2D numerical model**
3) **Verification** of the developped **shear strains** in the model (validity of the simulation)
4) Computation of the free-field accelerations obtained at several points of the basin surface
5) **Identification of 2D site effects** and of the most amplified areas



VALIDATION OF THE 2D SIMULATION BASED ON KAWASE & AKI (1989)

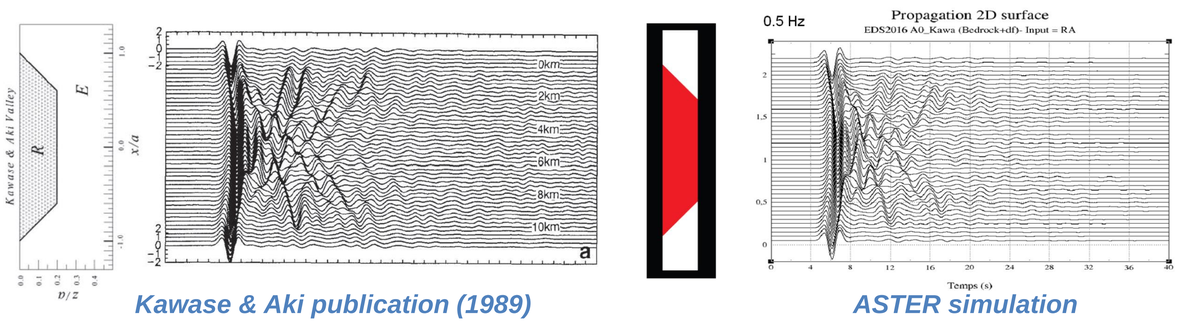


- **Ricker signal** propagation (0.25Hz and 0.5Hz)
- Highlighting the **wave propagation** depending on the position in the basin
- Highlighting the **reflection** on the edge of the basin



Kawase & Aki publication (1989) — *ASTER simulation*

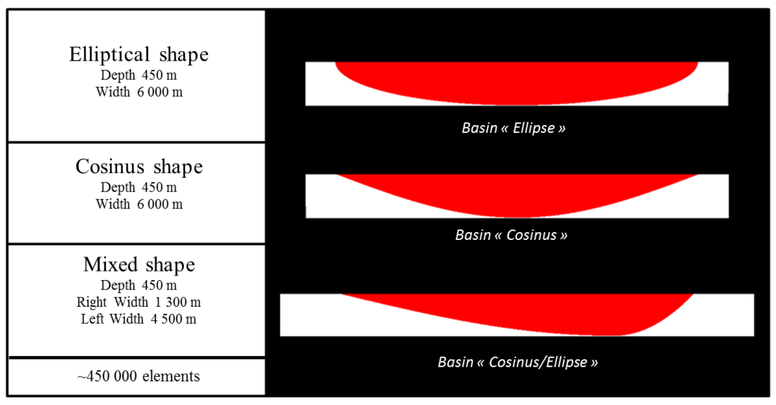
Time histories of horizontal component for a vertically incident SV wave (Ricker wavelet of 0.25Hz)

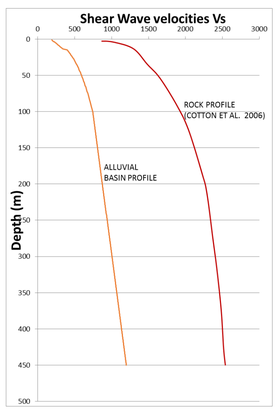


Kawase & Aki publication (1989) — *ASTER simulation*

Time histories of horizontal component for a vertically incident SV wave (Ricker wavelet of 0.5Hz)

APPLICATION OF REALISTIC TEST-CASES

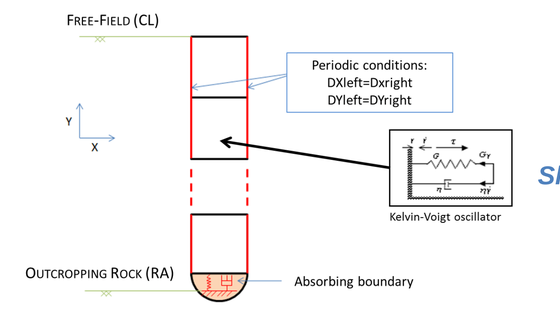




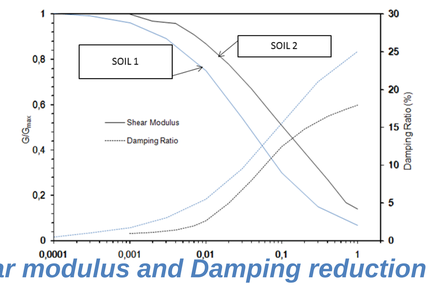
Description of the different test-cases sampled for the application

Calulation of **effective soil properties**

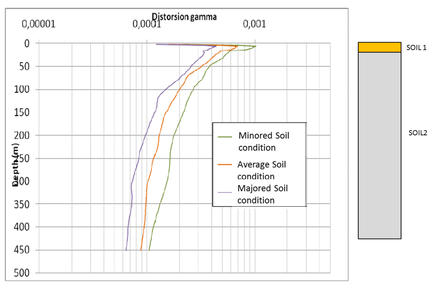
- 1D site response with operator DEFI_SOL_EQUI
- Linear equivalent method
- Based on G-D/gamma reduction curves



Boundary conditions for 1D and 2D models



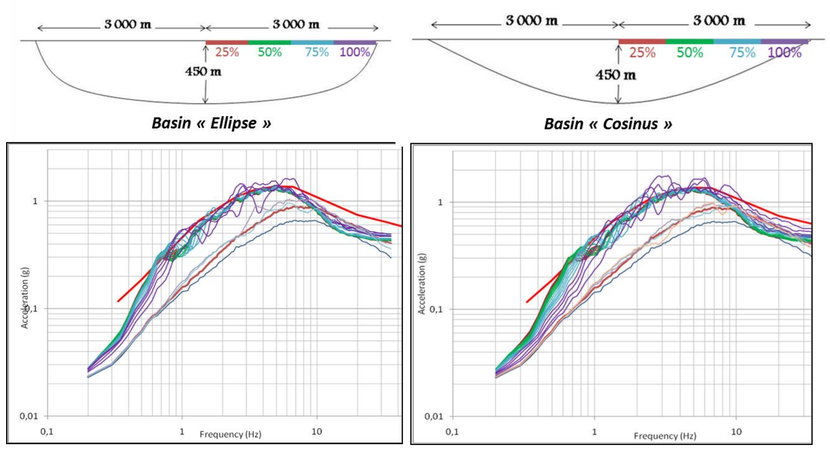
Shear modulus and Damping reduction curves



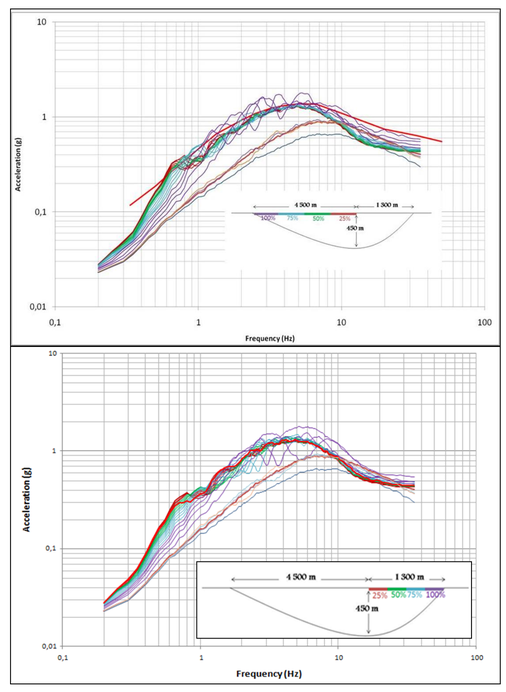
Maximal shear strains – 1D site response

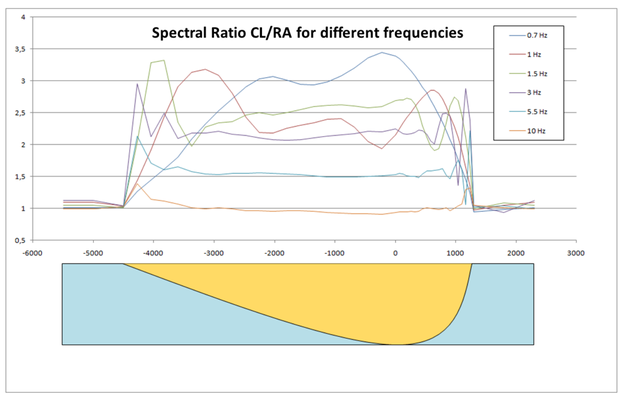
2D amplification of the free-field signal is observed related to :

- the **shape** of the basin,
- the shear wave velocity **contrast** between alluvial soil and rock
- the **frequency content** of the signal
- the **position** in the surface of the basin

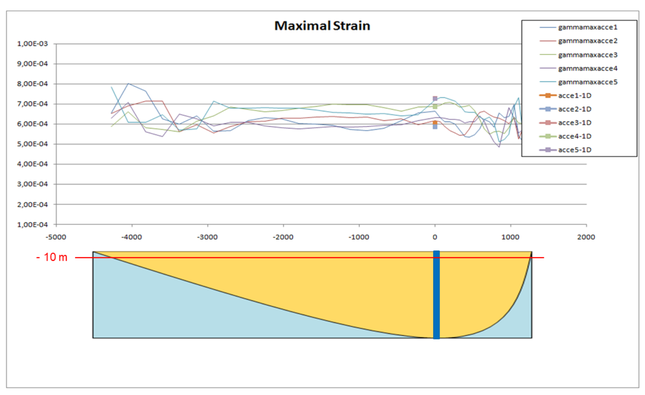


2D Free-field Spectra for several locations in the basin surface and for several shape of the basin





Identification of the 2D Amplification at the surface of the basin for different frequencies



Verification of the maximal shear strain obtained in 2D model at 10m depth, for several signals

POTENTIAL APPLICATIONS

- **2D large scale site response models** can be implemented with Code_Aster when **linear equivalent** condition is respected (maximal shear strain < a few 10^{-3})
- **Further developpments on Code_Aster** are ongoing in order to compute **3D models** and **non lateral periodic models**