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INSTALLATION OF A BOREHOLE VERTICAL ARRAY IN THE VAR VALLEY, NICE, FRANCE

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Nathalie DUFOUR[1], Jean-Baptiste PAYEUR[2], Etienne BERTRAND[2], Diego MERCERAT[2], Julie REGNIER[2], Vincent VANCRAENENBROECK[3], Morgan ALLIAUME[3], Frédéric CAPELLE[3], Philippe LANGLAUDE[2], Michel PERNOUD[2], Hélène CALISSANO[1], Laurent BATILLIOT[1], Marlène COUDERT[1]

[1] Cerema, UMR 7329 GEOAZUR, Aix-en-Provence, France, [2] Cerema, UMR 7329 GEOAZUR, Sophia-Antipolis, France, [3] Cerema, Saint Quentin, France

Abstract

An instrumentation combining accelerometric or velocimetric will be set up in the sediments of the lower Var valley (sand – rubbles – clay), in Nice, one of the french metropolitan area which is the most subject to earthquake hazard. It will provide long-term recordings in-between and during seismic crisis. Geotechnical parameters of the site and the future seismological network are presented.

Soil	Em_moy (MPa)	pl*_moy (MPa)
Sand and rubble	7.8	1.7
Lsilt - Organic clay	3.8	0.7
Sand and rubble	19.9	2.1

Table 2. Pressiometric parameters.

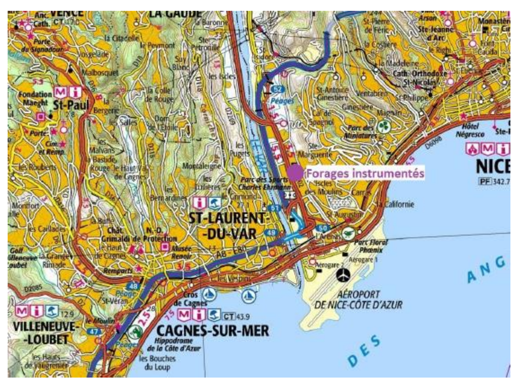

Figure 1. The future Nice borehole test site (IGN).

Introduction

In France, only three sites have been equipped with surface and downhole sensors (Guéguen et al. 2015) :
(1)Montbonnot borehole close to Grenoble :
(2)Belle-Plaine borehole in Guadeloupe Island (French Antilles):
(3)Cadarache borehole in South-East France.
Within the framework of the PORTE project, supported by the PACA (Provence Alpes Côte d'Azur) region and the European Regional Development Fund, a fourth vertical seismological network will be installed in Nice, in the lower Var valley. Il will be part of a technical and innovation platform dedicated to environmental observation of natural risks in Nice area.

The borehole site

The vertical array will be located in the lower Var valley in Nice, Alpes Maritimes, the highest seismic hazard zone in metropolitan France (see Figure 1).
The Var river delta is an alluvial area with soft soil surrounded by thick formations of Pliocene conglomerate, and older marly limestones. The alluvial plain of the Var consists of several tens of meters of coarse alluvium with great sandy and gravely lenses (Table 1). Generally, the quaternary sediment thickness has been estimated between 40 and 60 meters over a Pliocene conglomerate considered as bedrock.

Soil	Depth (m)	Description
Sand and rubble	0.0- 12.5	Very heterogeneous layer which contains recent Var sediments from clean sand to rubble characterized by a maximum diameter of 120 mm.
Silt - Organic clay	12.5- 17.5	Sandy silt and organic silty clay which contains wood elements.
Sand and rubble	17.5- 28.5	Very heterogeneous layer which contains recent Var sediments from sand to rubble characterized by a maximum diameter of 100 mm.

Table 1. Soil description from the top surface..

Investigations

Geotechnical and geophysical investigations were carried out to define the subsoil structure at the borehole site.

- Some Pressure Meter Tests (PMT) (Tableau 2).

- Geophysical measurements to obtain a Vs velocity model (Figure 2) :
    - ambient noise arrays of eleven velocimetric stations (Le3D 5sec) set up in two circular concentric arrays of 5 m - 20 m and 20 m - 50 m radius (see Figure 7) recording during an hour with a sampling frequency of 150 Hz
    - classical MASW profile with a linear array of twenty-four geophones (corner frequency of 4.5 Hz) with inter-geophone distances of 1.5 m (total length of 34.5 m) and 3 m (total array length of 69 m) and a sampling frequency of 500 Hz. A sledgehammer of 10 kg has been used as seismic source.
- Laboratory tests :
    - Des essais d'identification,
    - Cyclic triaxial laboratory testings : The test consists in applying several successive sequences of undrained cycles in a range of axial strain between 10^{-4} and 10^{-2} to obtain degradation curves (Figure 3).

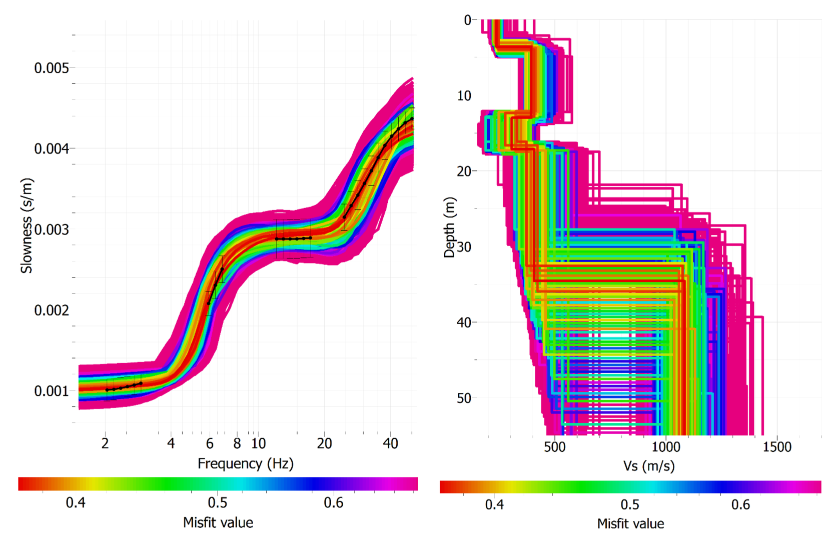

Figure 2. Left: Measured dispersion curve for the site (black dots) with calculated dispersion curves for each model (color scale depending on the misfit level). Right: Vs velocity models with satisfactory misfit values (< 0.6). Parameterization by five homogeneous layers including the velocity inversion around 12 m depth.

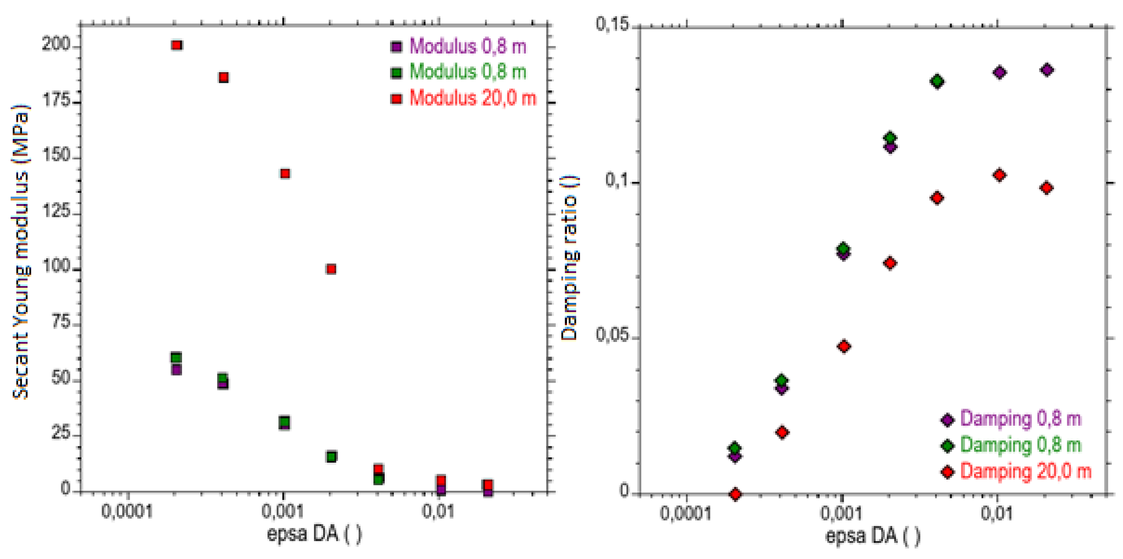

Figure 3. Degradation curves - Left : Relationships between secant modulus and axial strain – Right : Relationships between hysteretic damping ratio and axial strain.
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The future station…

The future station consists in a vertical arrays of three sensors as shown in figure 4.
For the moment, two boreholes have been drilled, in order to locally investigate the geotechnical conditions and to enable the installation of downhole sensors.

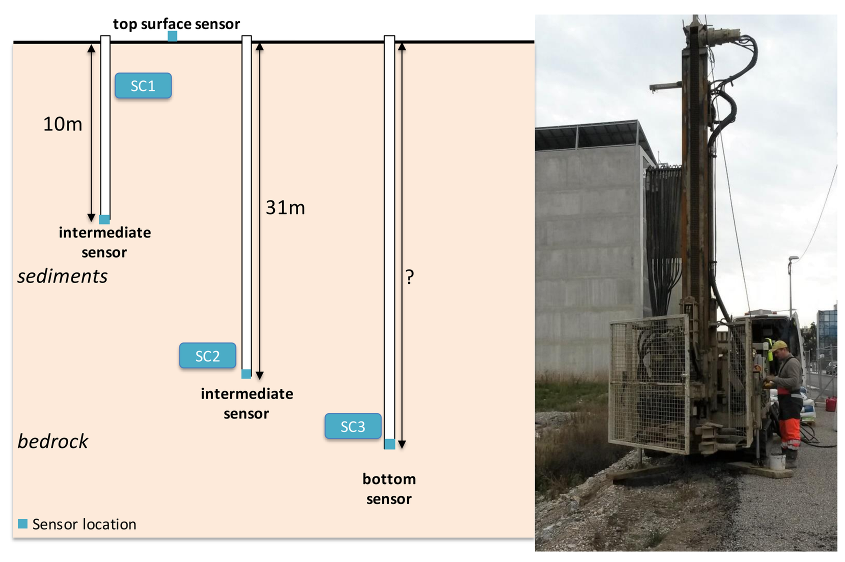

Figure 4. Left : Scheme of the future installation. Right : drilling
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whose the goal will be …

The recordings will help to study the wave propagation through the soil column in order to better assess the seismic response of the soil and the sedimentary basin.

Contact

Nathalie Dufour
Cerema Méditerranée
Nathalie.dufour@cerema.fr
https://www.cerema.fr/fr/innovation-recherche/recherche/equipes/mouvgs-mouvements-gravitaires-sismiques-sols-roches

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