GEOPHONE CALIBRATION PROCEDURE FOR OCEAN BOTTOM SEISMOMETERS (OBS)

Xavier Roset[1], Albert Garcia-Benadí[2], A. Mànuel[1]
1-SARTI Research Group. Electronics Dept. Universitat Politècnica de Catalunya (UPC)
2-Laboratori de Metrologia i Calibratge, Centre Tecnològic de Vilanova i la Geltrú, Universitat Politècnica de Catalunya (UPC), Rambla exposició, 24 , 08800 Vilanova i la Geltrú, Barcelona, Spain. Phone: +(34) 938967200, Fax: +(34) 938967201

Abstract- This is a new calibration procedure for geophones using the expanded uncertainly [1] [2] of null-correction created in our laboratories.

Introduction

The geophone under study is the sensor used in an ocean bottom seismometer (OBS), with three orthogonal velocity transducers. It has been designed to work on the seabed, and has an external structure (Figures 1 and 2) designed especially to resist a pressure of up to 6000 m of water and to have good coupling to the sea bottom.

Figures 1-2. Geophone structure.

In oceanographic instrumentation and seismic prospecting, this equipment acquires the vibrations of the seabed, which can be either artificially generated (for example, compressed air-guns on board of an oceanographic vessels), or be natural seismic activity.

Development

Sensor calibration methods

The velocity sensor is a GS-11D at 4000 Ohms (with natural frequency of 4.5 Hz and 85.8 V/m/s of sensibility). The specification of the sensor is according to Geospace manufacturer.

Although we know the characteristics of the sensor working alone, this sensor is inside a structure which consequently modifies its seismic mass, and the coupling can modify the global specifications [3] [4]. For this reason we have developed a systematic calibration procedure for the geophones which can help to overcome this problem.

The calibration methods consist of repeating some frequency and amplitude sweeps, for every axis, to determine the following factors:

- Contribution to repeatability [2].
- Systematic error.

With this method we determine a constant value with an associated uncertainty [1][2].

Calibration Results

The results obtained after 4 repetitions of frequency sweeps, between 8 to 100 Hz in a range of 5 amplitudes, allow the determination of a sensibility in every axis X-Y of the geophone.

Figure 3 shows the results of the stability of the sensibility along the frequency when the frequency sweep operates in the X axis. In the other hand, Figure 4 shows the sensibility of the transversal axis when the movement is produced in the X axis.

Seeing the great variability of the sensibility from 64 Hz, we detailed the sensibility account of the axis between 12 to 64 Hz like a single value, with an extended uncertainty of the null global correction.

The sensibility of the device under test in the X axis is (85,78 ± 2,52 V/m•s-1)

Explanation: The study is centered on the interval between 12 to 64 Hz; this range has been selected because it covers the ranges of the input signals acquired by the geophone in a seismic earth prospecting.

Conclusion

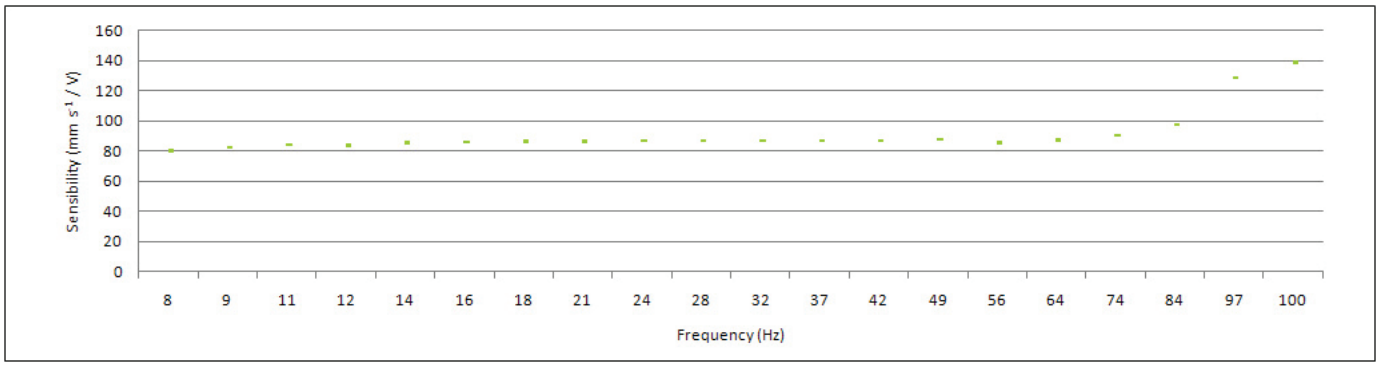
We have developed a new procedure to calibrate geophones. With this method is possible to obtain the sensibility of each measured axis, and its extended uncertainty of the null global correction. In fact, the magnitude and direction of the velocity in the X-Y axis have been obtained.

References

[1] EA 4/02 Expression of the Uncertainty of Measurement in Calibration, 1999, European co-operation for Accreditation

[2] International Vocabulary of Basic and General Terms in Metrology, second edition, 1993, International Organization for Standardization (Geneva, Switzerland).

[3] X.Roset, M.Nogueras, A.Garcia, J.del Rio and S.Sarria "Geophone Calibration by means of hyperbaric chamber" OCEANS 09 May 11-14, 2009, Bremen, Germany

[4] X.Roset, A.Manuel and S.Shariat-Panahi "Contributions to calibrations of geophones beyond standard available" IMEKO 08, September 3-5, 2008, Annecy France.

(below) Figure 3. Geophone X axis sensibility.