2nd stage
In this stage, we have chosen a series of materials that would bear the marine environment, however some of them do not comply the needed mechanical features [4]. The study of the material has been carried out using the initial design of the geophone and different materials: metallic, non-ferrite metallic and plastic.

Material	Maximum stress	Material elastic limit
S/steel_PH15-5 (Stainless steel) at 400 atm	263 MPa	860 MPa at Tª = 21ºC
S/steel_PH15-5 (Stainless steel at 600 atm	394 MPa	860 MPa at Tª = 21ºC
Titanium_Alloy at 400 atm	225 MPa	760 MPa at Tª = 21ºC
Titanium_Alloy at 600 atm	337 MPa	760 MPa at Tª = 21ºC
Aluminum_5083 at 400 atm	225 MPa	280 MPa
Aluminum_5083 at 490 atm	276 MPa	280 MPa
Polycarbonate_gf at 400 atm	223 MPa	65 MPa
Polycarbonate_gf at 100 atm	55 Mpa	65 MPa

Table I. Comparison of different materials with a high resistance to corrosion, their maximum load stress and yield strength.

3. Conclusions

The use of plastic material is completely rejected for this kind of application. Through this design technique, the maximum stress of the geophone has been increased by 20%. In the second design, for over 500atm pressure, a change of material is recommended.

4. References

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Model Characterization of Geophone Sensor

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1.Introduction

In applied instrumentation to oceanography and seismic prospecting, the equipment acquires the vibrations of the seabed. The waveforms can be either artificially generated at an oceanographic vessel on board or the OBS (Ocean Bottom Seismometer) can record natural seismicity. With appropriated mathematical algorithms, the cortical distribution can be deduced (speed, deepness), and also geological properties of the rocks and constitutive layers can be studied [1]. The OBS measures the vibrations refracted of the seabed with geophones in three orthogonal axis and frequency range from 0,1 to 100 Hz, in order to investigate the composition and stratification of oceanic subsoil.

In order to characterise the underwater geophone we need a precise model to obtain the correct simulated answer. The work is an approach to obtain a correct model of a geophone by measuring the sensor in a shake table and extracting the parameters that define the frequency performance in the model and simulate the equivalent circuit. The similar results of the two ways validate the model. The problems appear in the geophone with amplification when the ratio signal/noise is very low [2]. In order to prepare measure equipment with wanted specification and performances in range of frequency, ratio S/N [3] and good coupling seabed we need a simulation of a proposed model, the subsequent validation in the lab and the final test.

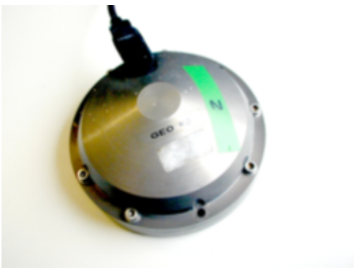

Figure 1. Structure of the coupling with triaxial geophones

Figure 2. Electromagnetic Geophone SM6 and GS-11D

The objective is validating the geophone models in order to obtain the performance of these sensors that get information of the subsoil movement about the frequency type, vibrations amplitude and axial origin of the signal.

2. Results and Discussion

The method is to calibrate the geophone in a shake table and the BERAN 455 instrument with a sensor of reference to obtain the results of the parameters such as the frequency cut-off, the damping and the gain in the bandwidth. We can work in velocity or acceleration inputs and the format of results are graphical, exportable data by software of BERAN and also with application with LABVIEW graphic program.

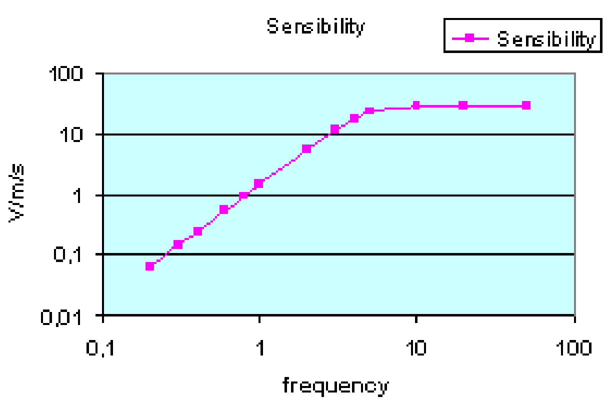

Figure 3. Graphic results of the calibration of the geophone sensibility (V/m/s)

The figure 3 shows the measure of the sensibility in units of velocity (V/m/s) respect to frequency and present behaviour of the second order high-pass filter. A data extract dates gets the sensibility in the bandwidth, Ho. the cut-off frequency ω_0, the damping ξ and ξ_0, the mobile mass of the geophone m , the spring constant, K, and the mechanical damping factor, D. We can obtain the value of the intern resistance of the coil Rs with a tester and put a resistance in the output Rp. Then we obtain the gain [4].

$$H_o = \frac{G \cdot Rp}{(Rs + Rp)} \quad (1)$$

Without output resistance we can obtain the value of ξ_0 damping and with a Rp the ξ damping only measuring the decrement of the Ho in the cut-off frequency.

$$Q = \frac{1}{2\xi} \quad (2)$$

We can obtain the mobile mass according to the equation (3)

$$\xi = \xi_o + \frac{G^2}{2m\,\omega_o (Rc + Rp)} \quad (3)$$

The constants K and D are deduced in the expressions (4) and (5).

$$K = m \cdot \omega_o^2 \quad (4)$$

$$\frac{D}{m} = 2 \cdot \xi_o \cdot \omega_o \quad (5)$$

Then the parameters are introduced in the equivalent model and simulate the response in order to validate the proposed models of the geophone with several configurations of amplifiers and all types of couplings.

$$Leq = \frac{G^2}{K} \quad \mathrm{Req} = \frac{G^2}{D} \quad Ceq = \frac{m}{G^2}$$

The values of the elements of the equivalent circuit for the geophone model we use the relations of the physical with the electrical parameters L, R, and C show in figure 4 before transformer.

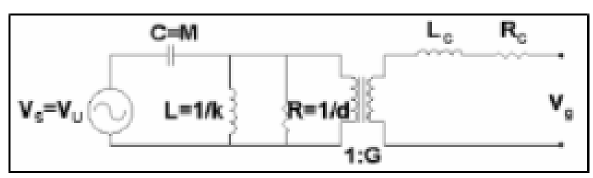

Figure 4. Acceleration geophone model and equivalent circuital elements.

The figure 4 shows the acceleration model of the geophone. We can simulate the input such as velocity or acceleration and see the frequency response of the output, for example with Pspice. In the figure 5 we show the comparative of the results of the measured sensibility and simulated, with maximum relative errors of 11%.

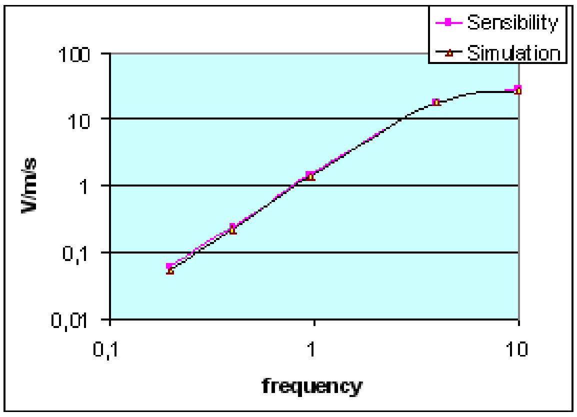

Figure 5. Measured and simulated sensibility of the velocity model.

The question is to find a model that follows the measure sensibility, but we have to consider other parameters such as the noise, interferences or coupling in this model.

3. Conclusions

This work calibrates a geophone and extracts his parameters to validate the behaviour of a l model. The results are the comparative of both dates and we can find the better equivalent geophone model by LABVIEW program.

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