A real prototype of the proposed metamateria was produced. The material from which it was made from was HDPE. A picture of the prototype is shown in Figure 8.

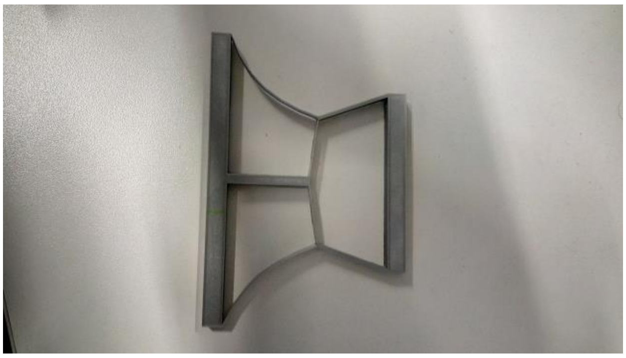

Fig 8. Real prototype of the proposed metamaterial

To evaluate the mechanical performance of the protorype in real conditions and compare the mechanical behaviour observed in simulation, the component was subjected to an external force, against a fixed wall. Figure 9 and 10 illustrate the mechanical test conducted.

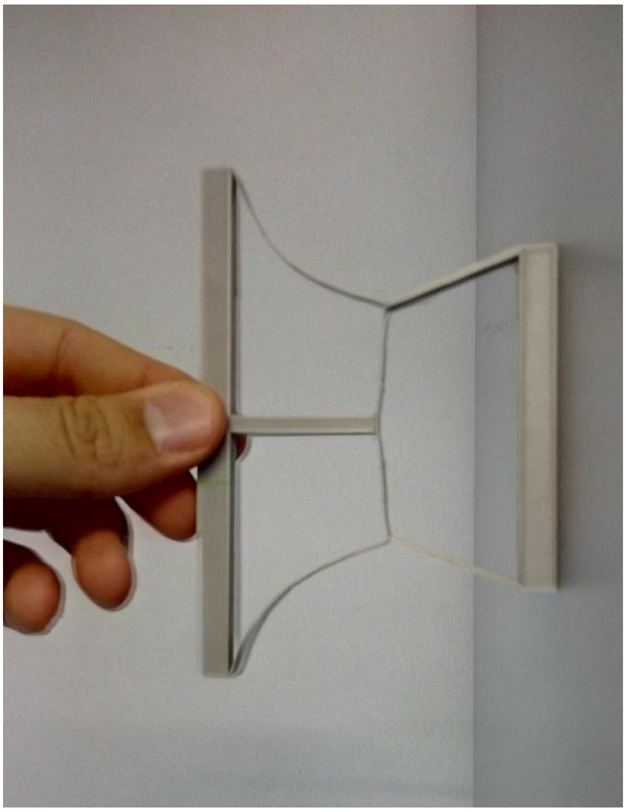

Fig 9. Metamaterial position prior to the execution of the experiment

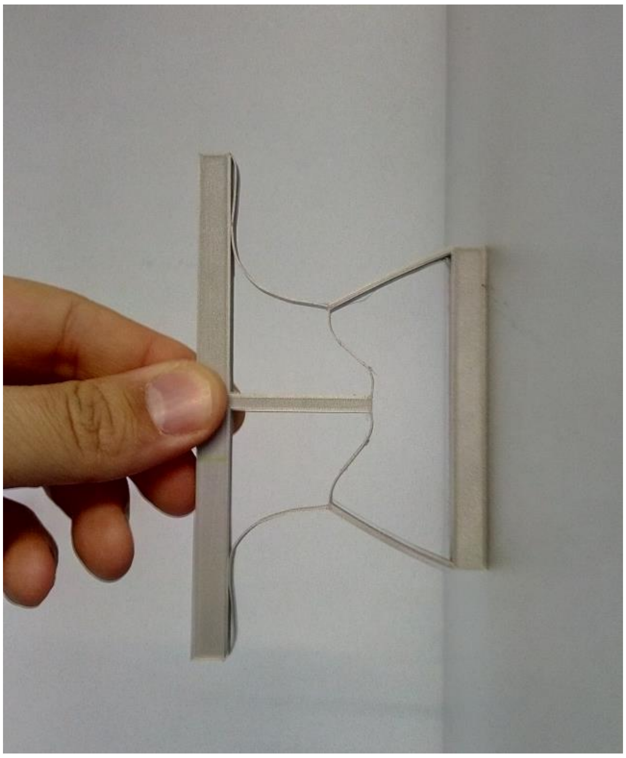

Fig 10. Metamaterial deformed position posterior to the execution of the experiment

As observed from Figures 3 and 10 the experimentally verified mechanical behaviour and the numerical results are aligned. It is highlighted that the contact area between elements 1 and 6 has increased and that elements 4 are deformed in exactly the same pattern. Thus, it can be concluded that the numerical results are accurate and the numerical model validated.

5 Conclusions

In this study the design of a novel acoustic metamaterial is presented. The proposed metamaterial is based on the concept of zero stiffness, where no vibrations can be transferred due to the extremely low equivalent spring constant of the structure.

The structure of the proposed metamaterial was developed based on the functional analysis of its parts, rather than on a finite element model.

However, its mechanical behavior under static and dynamic loads was studied in detail using the finite element software ANSYS Workbench Educational. In particular, the nonlinear mechanical behavior under static loads was investigated as well as a modal and frequency response analyses were conducted. The results of the nonlinear mechanical analysis show that indeed the metamaterial presents zero stiffness at increased static loads. Furthermore, the frequency response showed the effective vibration suppression for a wide range of frequencies as the ratio of output over input amplitude is always lower than that for zero frequency. Finally, the mechanical behavior of a real prototype of the metamaterial was tested. The measurements and the deformation pattern confirm the numerical results.

In the future, a more detailed investigation using state of the art modeling and optimization techniques will be conducted.

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