Characterization of the elastic parameters of porous materials as function of the initial load

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The characterization of the elastic parameters is essential to feed the models and guarantee vibroacoustic performances. It is therefore necessary to have robust, comparable and reliable methods. Several characterization techniques exist and may lead to large differences between the results. Some inter-laboratory tests [1] have already been carried out in order to compare the methods. The main deviations are due to:

- the method used (quasi-static compression, resonant mass, dynamic torsion, Oberst beam). The material may not be excited the same way between the methods (traction/compression, bending, shearing, torsion). The results are strongly different between all methods especially if the material is anisotropic.
- the frequency range used. Since the mechanical properties depend on frequency, the characterization methods should be operated in the same frequency range. The viscous effect of the saturating fluid can also affect the results at high frequencies (over 100 Hz). This problem can be avoided measuring in vacuum.
- the initial loads imposed on the material. The load is either imposed on the stress or the strain depending on the method.
- the difference between apparent and intrinsic Young's moduli. Contrarily to the intrinsic Young's modulus, the apparent one depends on the shape factor of the sample and the Poisson's ratio of the material [2].

Recently, a more constrained Round Robin test was conducted with four laboratories in order to draw some guidelines [3]. On one hand, the goal of the characterization is to be able to compare the values between the laboratories. On the other hand, the load cases have to be close to the final application which can be significantly different between one material to another. The employed methods were based on uni-axial compression (quasi-static or spring mass methods). The intrinsic Young's modulus and the Poisson were systematically computed. The frequency range have been limited in the range 10-100 Hz while allowing an extrapolation. It has been pointed out that different initial loads or deformations can lead to large differences. They conclude that the compression rate and the initial load have to be estimated and clearly mentioned. An improvement could be to characterize the elastic properties for different compression rates.
The objective of this work is to investigate some methods to estimate the elastic parameters depending on the initial load (imposed stress or imposed deformation). Two methods are presented based on the quasi-static method and compared. The intrinsic properties are identified as the function of the initial stress or deformation. Then the results are compared and discussed.

References

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