Influence of a fibrous material compression on the sound transmission loss of a covered panel

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Industrial context and objective:

The general context of this study is the reduction of aircraft internal noise[1]. During installation, glass wool blankets used as thermo-phonic insulation are compressed to a certain degree between equipments, cables, ventilation grids and fuselage panels.

The aim of this research is to determine the influence of compressing a poro-elastic material lined with an aluminium plate on the sound transmission loss (TL)[2]. For this purpose the difference of the compressed and uncompressed TL (Delta TL) are compared both analytically and experimentally.

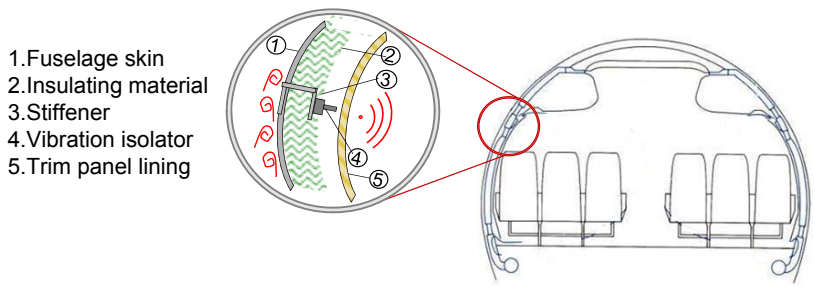
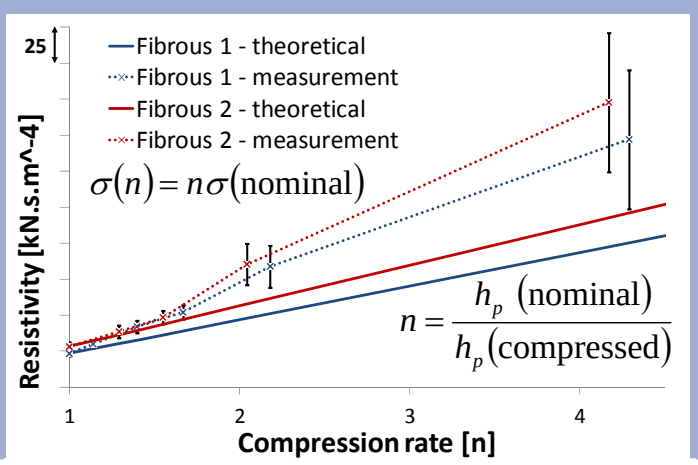
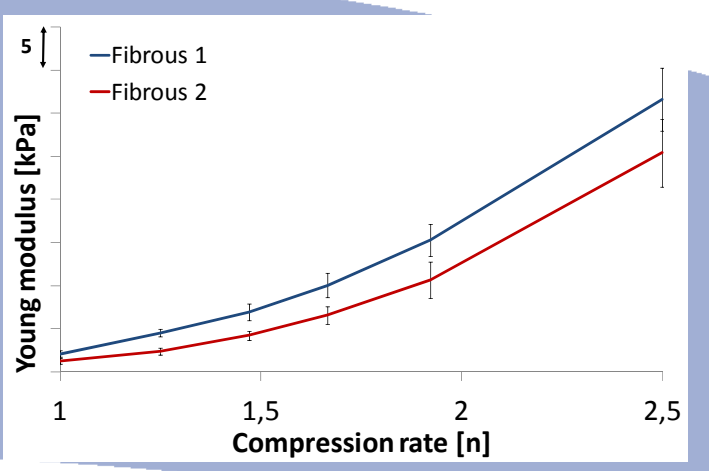


Figure: aircraft sidewall fuselage section.

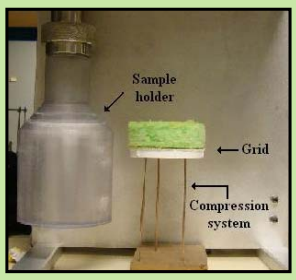
Assessment of porous material properties under compression

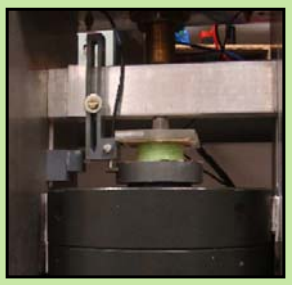
- Measurements of airflow resistivity (σ) under compression shows the limits of the theoretical model [3].
- The Young modulus is assessed experimentally [4] and shows a non-linear behaviour as a function of the compression rate.
- The remaining properties are assessed theoretically [3,5].



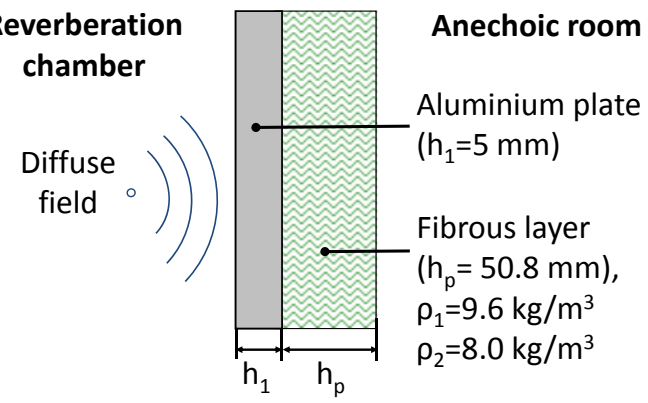


Measurement of porous properties under compression

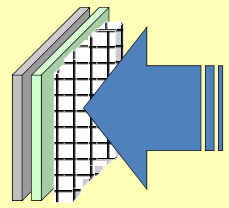




Studied structure

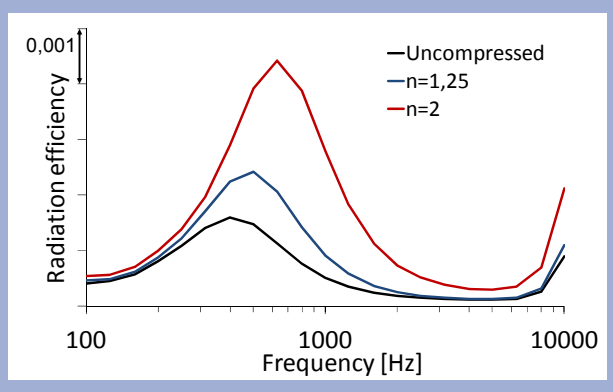


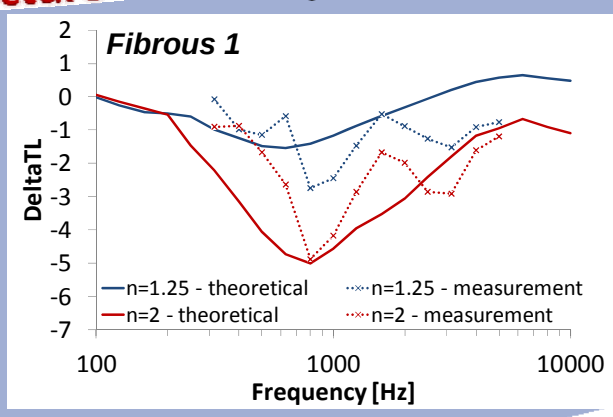
Transmission loss measurements under compression by a rigid grid

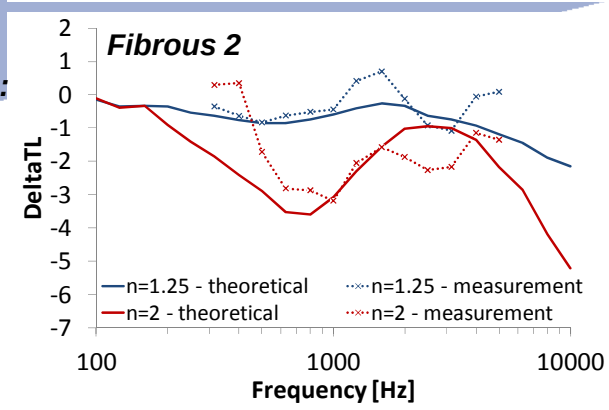


Influence of compression on the TL of the structure

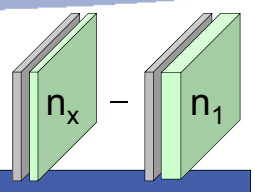
- Same trends obtained by the transfer matrix method and measurements.
- Compression shifts the quarter-wavelength resonance in the thickness of the porous to higher frequencies
- Compression increases the radiation efficiency and consequently causes a degradation of the TL in the mid-frequency range.







Delta Transmission loss:



- Reduced effect for an aircraft (compression rate is low and occurs locally). Moreover, the research could be extended to the double wall case (compression influence in terms of absorption and transmission.)

References:
[1] B. Campolina, N. Atalla, N. Dauchez, P. Neple, Validation of a four-pole modelling for coupling loss factor between two plates connected via vibration isolators under mechanical excitation, Proceedings of Noise-Con (2011), Portland, USA.
[2] B. Campolina, N. Dauchez, N. Atalla. Effect of porous material compression on the sound transmission of a covered single leaf panel (Submitted to Applied Acoustics).
[3] B. Castagnède, A. Aknine, B. Brouard, V. Tarnow, Effects of compression on the sound absorption of fibrous materials, Applied Acoustics 61 (2) (2000) 173 – 182.
[4] N. Dauchez, M. Etchessahar, S. Sahraoui, On measurement of mechanical properties of sound absorbing materials,2nd Biot Conference on Poromechanics.
[5] C.-N. Wang, Y.-M. Kuo, S.-K. Chen, Effects of compression on the sound absorption of porous materials with an elastic frame, Applied Acoustics 69 (1) (2008) 31 – 39.