Modelling the elastodynamics of a thin flexible aerogel layer

Weibo Xiong[1], Danila Prikazchikov*[2], Rasul Abdusalamov[1], and Mikhail Itskov[1]

[1]Department of Continuum Mechanics, RWTH Aachen University – Germany
[2]School of Computer Science and Mathematics, Keele University [Keele] – United Kingdom

Abstract

Aerogels are extremely lightweight materials known for their multifunctional properties, having wide engineering applications (1). Their mechanical properties have been mostly studied within the context of elastostatics. In this contribution, we study dynamics of a thin super-flexible hybrid silica aerogel layer modelled as elastic with density-dependent Young's modulus, relying on the recently developed model (2). The presence of the variable Young's modulus accounts for the effect of porosity at the macro-scale, further developing the results in (3), and, at the same time being significantly less computationally expensive than the approach relying on the microstructure (4). The layer is assumed to have one fixed face, with the other one subject to prescribed vertical displacement, in absence of shear stress. An asymptotic weakly nonlinear procedure is constructed, leading to a two-term expansion, which is then compared to numerical solution.

Acknowledgement

This research was supported by the DFG grant № 520432297 "Multiscale Dynamics of Aerogel and Aerogel Composite Matching Layers".

References

(1) Rege, A. (2023). A perspective on methods to computationally design the morphology of aerogels. *Advanced Engineering Materials*, *25*(1), 2201097.

(2) Erbaş, B., Kaplunov, J., Rajagopal, K. R. (2024). Elastic bending and transverse compression of a thin plate with density-dependent Young's modulus. *International Journal of Non-Linear Mechanics*, *160*, 104651.

(3) Prikazchikova, L., Rege, A., Kaplunov, J., Prikazchikov, D. (2024). Low-frequency propagating and evanescent waves in strongly inhomogeneous sandwich plates. *ZAMP*, *75*(6), 1-14.

(4) R. Abdusalamov, M. Itskov, J. Kaplunov, D. Prikazchikov. (2023) Adjustment of microstructure parameters of aggregated structures for dynamic modelling of silica aerogels. In "*Mechanics of High-Contrast Elastic Solids: Contributions from Euromech Colloquium 626*", 1-11. Springer.

*Speaker