



TITLE: Towards calibration of permeability rigs: Benchmarking predictions with a controlled reference medium

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ABSTRACT:

Accurate permeability prediction is a key requirement for reliable simulation of Liquid Composite Moulding (LCM) processes. However, benchmarking permeability prediction approaches remains challenging due to the intrinsic variability of fibrous reinforcements, which often masks the influence of modelling assumptions [1]. To mitigate this limitation, this work introduces an engineered reference medium [2], [3] designed to provide a common and reproducible basis for benchmarking permeability predictions and, in a subsequent stage, for calibrating permeability measurement rigs.

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The engineered reference medium is defined by a controlled and repeatable architecture, enabling the formulation of well-posed flow problems with minimized material-induced variability. Based on this reference geometry, a benchmarking exercise is conducted in which participating teams independently predict permeability using their preferred modelling approaches. While no boundary conditions are imposed, participants apply best-practice recommendations regarding boundary condition formulation derived from previous benchmarking activities. This strategy preserves modelling freedom while promoting consistency and enabling meaningful comparison between predictions.

The present contribution focuses on the design rationale of the engineered reference medium and on the benchmarking framework established to analyse the resulting permeability predictions. Experimental permeability measurements using the same reference medium are planned as future work to support permeability rig calibration and inter-laboratory comparison. The proposed approach provides a structured pathway toward transparent benchmarking of permeability predictions and supports ongoing efforts toward standardized and traceable permeability characterization in composite manufacturing.

[1] E. Syerko *et al.*, "Benchmark exercise on image-based permeability determination of engineering textiles: Microscale predictions," *Compos Part A Appl Sci Manuf*, vol. 167, p. 107397, Apr. 2023, doi: 10.1016/j.compositesa.2022.107397.

[2] D. May *et al.*, "A new ISO standard for the experimental characterization of in-plane permeability of fibrous reinforcements," *Compos Part A Appl Sci Manuf*, vol. 190, p. 108592, Mar. 2025, doi: 10.1016/j.compositesa.2024.108592.

[3] M. Bodaghi, D. Ban, M. Mobin, C. H. Park, S. V. Lomov, and M. Nikzad, "Additively manufactured three dimensional reference porous media for the calibration of permeability measurement set-ups," *Compos Part A Appl Sci Manuf*, vol. 139, p. 106119, Dec. 2020, doi: 10.1016/j.compositesa.2020.106119.

Core theme:

- Numerical Simulation

Additional Themes

- Numerical Simulation
- Liquid Composite Moulding
- Permeability

The abstract should (a) address **at least one of the core themes**, (b) not exceed two A4 pages of text, and (c) not exceed two further sides of A4 for Figures/Tables