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A comprehensive experimental and analytical study of fluid flow in a thin porous layer under indentation.[1] QIUYUN WANG, ZENGHAO ZHU, QIANHONG WU, Villanova University — In this paper, we report a novel experimental and theoretical approach to examine fluid flow in a thin porous layer during an indentation process. Experimentally, a custom-designed indenter with the precisely controlled nano-positioning system is developed where the local compression of the porous layer is captured by a high-speed camera. The indenter is fully instrumented with a laser displacement sensor to measure the indentation velocity and pressure transducers to measure the pore pressure distribution. Theoretically, a consolidation theory is developed where the local relative velocity between the fluid and solid phase is considered, and the local compression-dependent permeability of the porous layer is used. Excellent agreement between the experimental results and the theoretical predictions is observed under different running conditions, verifying the validity of the theory. The study precisely captures the detailed non-uniform compression of a thin porous layer under indentation. It provides a conclusive theoretical framework in the study of fluid flow in a soft porous media, laying the foundation for the study of soft porous matter in response to indentation.

[1]NSF CBET fluid dynamics program, #1511096

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