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Density inversion in rapid flows: the supported regime

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This paper presents numerical findings on a transient regime of rapid granular flows on a bumpy base. In the supported regime studied here, a strongly sheared, dilute and agitated layer spontaneously appears at the base of the flow and supports a compact packing of grains moving as a whole. We show that, in this regime, the flow behaves like a sliding block on the bumpy base. In particular, we show that for flows on a horizontal base, the average velocity decreases linearly in time and that the average kinetic energy decreases linearly with the travelled distance, those features being characterictic of solid-like friction. This allows us to define and measure an effective friction coefficient, which is independent of the mass and velocity of the flow. This coefficient only loosely depends on the value of the micromechanical friction coefficient whereas the influence of the bumpiness of the base is strong. We show that the basal, agitated and dilute layer does not lead to a lubrication of the flow. Finally, we show that a steady regime of supported flows can exist on inclines whose angle is carefully chosen.