

Deformation upon impact of a drop of concentrated suspension

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A century of studies have led to a good knowledge of the rheology of non-Brownian granular suspensions, from the linear Einstein's law in the very dilute limit to more recent works in the very concentrated regime [1]. The law relating the effective viscosity to the solid fraction ϕ has been established experimentally and theoretically. The effective viscosity is Newtonian-like and increases with the solid fraction up to a critical value ϕ_c where it diverges, although ϕ_c is strictly less than the random packing fraction. This peculiarity is interpreted as a Reynolds dilatancy mechanism, where the particle assembly is jammed and has to dilate to be able to flow.

The present work focuses on the deformation of a drop of concentrated suspension upon impact on a solid surface. Indeed, the assumption that the laws established for viscous Newtonian fluids [2] also apply for viscous suspensions seems reasonable, and it was verified for solid fractions up to roughly 50% [3,4]. However, it obviously fails when $\phi > \phi_c$ where no viscosity is defined.

From experiments covering a wide range of solid fractions, close to and even above the jamming fraction ϕ_c , and using particles of different sizes, we demonstrate how the dilatation of the particle pile in concentrated suspensions affects the deformation of the drops upon impact, even above the jamming fraction ϕ_c [4].

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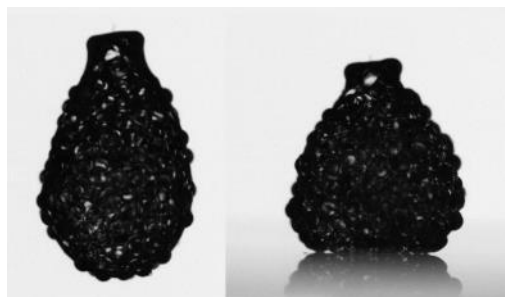


Figure 1 : Drop of diameter $D \approx 5$ mm just before (left) and just after (right) impact on a glass surface. The suspension is made of $550 \mu\text{m}$ polystyrene spheres in a Newtonian fluid of viscosity $\eta = 190$ mPa.s at a solid volume fraction $\phi \approx 60\%$. The impact speed is $V = 4$ m/s.