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High speed confined granular flows down inclines: numerical simulations

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Several works have been devoted to the effect of a lateral confinement on the properties of granular flows. Both experimental and numerical studies have pointed out that frictional lateral walls induce new flow regimes. For example, it has been shown that, at any inclination angle, there is a critical flow rate above which the flow occurs on a static heap, which forms along the base (Taberlet et al., 2003). Flows atop this side wall-stabilized heap (SSH) differ fundamentally from steady and fully developed (SFD) flows on rigid and bumpy bases as they occur over erodible bases. However, they still display SFD features. In a previous study of confined flows on an inclined rigid base (Brodu et al., 2015)), we explored extensively and systematically the effect of the variation of the inclination angle and of the mass holdup, for a given value of the gap (W=68D where D is the grain size) between side walls. We observed steady and fully developed flows (SFD flows) up to large angles of inclination where accelerated ones are usually expected. These SFD regimes present non-trivial features, including secondary flows (rolls) and heterogeneous volume fraction, flows with dense core supported by a very agitated dilute layer. Despite the diversity of the features of these states, the mass flow rate obeys a simple scaling law with the flow height. We investigate here the effect of the variation of W on the domain of existence of the SFD flow regimes and on the transition to the SSH regime for decreasing values of W. We also extend the scaling law of the mass flow rate with both the flow height and the gap distance W. Furthermore, we study some properties of the transient accelerating flow observed before reaching the SFD state. Taberlet et al. 2003, Phys. Rev. Lett., 2003, 91, 264301. Brodu et al., 2015, Journal of Fluid Mechanics, 2015, 769, 218-228.