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Granular force on obstacles in low Froude number flow regimes

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Both small-scale laboratory tests and discrete numerical simulations related to the drag experienced by various objects inside granular flows showed a large enhancement in drag coefficient when the Froude number of the undisturbed incident flow decreased. This behaviour is also observed on full-scale snow avalanches impacting structures in the slow regime. The present paper describes an elementary model that can catch the transition from a purely inertial regime for which the force is proportional to the square of the velocity towards a regime for which we observe the independence from velocity of the drag force. Accounting for a correlation length related to the presence of the obstacle, it is possible to derive a generalized drag coefficient. This drag coefficient increases sharply when the correlation length diverges in the low Froude number regime. The model is carefully calibrated on existing data in literature about objects on dry and cohesive dense granular flows, which gives crucial information on the correlation length associated with the network of force chains near the obstacle.