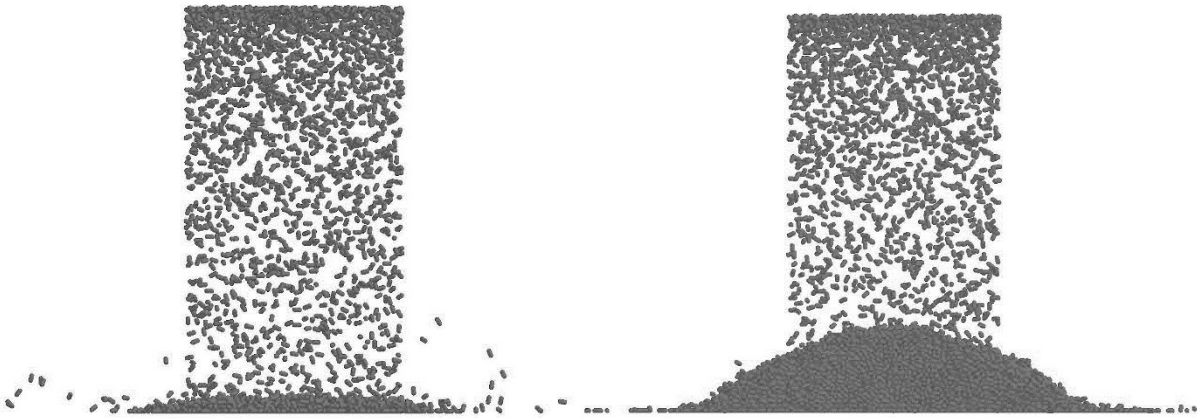
Appendix

Formation of the piles

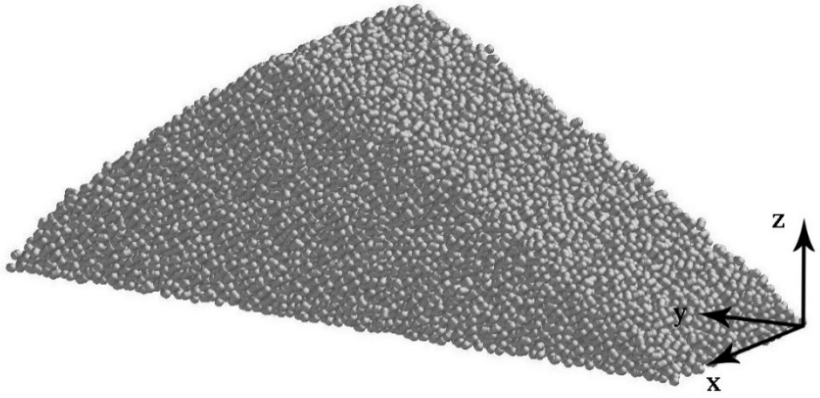
The way of pile formation has a significant effect on the dip phenomenon of piles. In this study, sphero-cylindrical particles were generated randomly from a rectangular region (30 d_v × 15 d_v) which was 60 d_v above a plane at a rate 5000 particles per second. The particles fell under gravity on the plate to form a pile. When the total kinetic energy of the particles was less than 10^{-10} J, the pile was considered formed. The periodic boundary condition was applied to the x-direction (back and front) which has a thickness of 15 d_v to minimise the effect of walls. So the formed piles had a wedge-shape. Four runs of simulations were conducted for each case and the final results were averaged. The time step of the simulation was small enough, 2.3×10^{-5} - 4.3×10^{-5} s depending on the aspect ratio of the particles, to ensure the accuracy of the simulation results.

The following figures show the piling process at different time (Suppl. Fig. 1) and the final pile (Suppl. Fig. 2).



(a) (b)

Suppl. Fig. 1 Snapshot of the "rainfall-like" piling method at different time, where: (a) 0.5 s; and (b) 3 s with the aspect ratio of the spherocylinder AR = 1.5.



Suppl. Fig. 2 A final wedge-shaped pile with the periodic boundary condition in the x direction when AR = 1.2