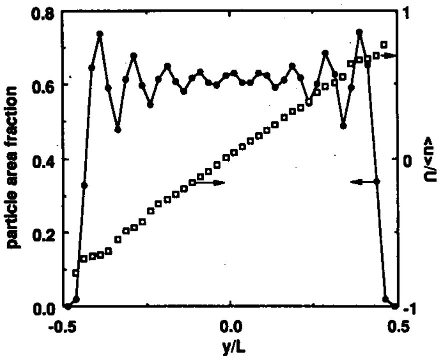
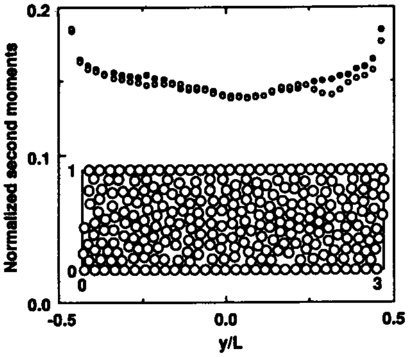
Louge M., Jenkins J.T. and Hopkins M.: “Computer Simulations of Rapid Granular Shear Flows between Parallel Bumpy Boundaries,” *Phys. Fluids A* **2** (6), 1042-44 (1990).

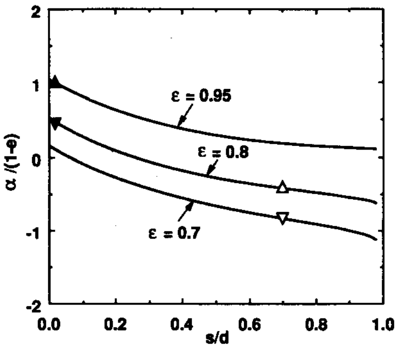
This paper compares the results of numerical simulations for the rapid, steady shear flow of identical disks with the recent predictions of Hanes, et al. for the shear stress, normal stress and gap width. The smooth and nearly elastic disks are driven by identical, parallel, bumpy boundaries. The variations of the dynamic friction coefficient are confirmed by the simulations. The coefficient may be made large or small by suitably preparing the boundaries of the cell. The simulations also indicate that the predictions of kinetic theory apply to gaps as small as three particle diameters in width.



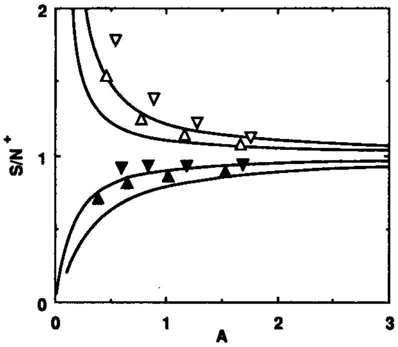
The solid circles represent the time-averaged transverse profile of particle area fraction $\langle \nu \rangle$ for the conditions: $e=\varepsilon=0.95$, $L/\sigma \approx 10$, $s/d \approx 0$. The values of $\langle \nu \rangle$ were obtained by averaging 500 consecutive realizations separated by a time interval $t^+ = 0.1$. The oscillations of $\langle \nu \rangle$ have a wavelength of the order of the particle diameter. The open squares are the time-averaged velocity profile $\langle u \rangle/U$. The width of each averaging strip is L/40.



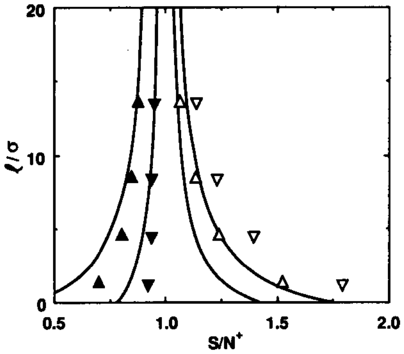
Normalized time-averaged profiles of the second moments of the velocity fluctuations. The solid circles represent $\langle uu \rangle/U^2$ and the open circles $\langle vv \rangle/U^2$. Conditions are found in Fig. 1. The insert shows typical positions of the disks in the simulation of Fig.1. Only one periodic cell is shown.



Summary of flow conditions for $\bar{\nu}$ = 60% and e=0.95. The solid triangles represent $\varepsilon=0.95$ and $k^2>0$; the inverted solid triangles $\varepsilon=0.8$ and $k^2>0$; the open triangles $\varepsilon=0.8$ and $k^2<0$; the inverted open triangles $\varepsilon=0.7$ and $k^2<0$. The lines are plots of $\alpha/(1-e)$ *vs.* s/d.



Normalized shear to normal stress ratio S/N^+ *vs.* $A \equiv (\rho_d \nu U^2/N)^{1/2}$. The symbols and conditions are found in Fig. 3. The solid lines are the corresponding theoretical predictions of Hanes, et al. (1988).



Dimensionless flow width ℓ/σ *vs.* normalized shear to normal stress ratio S/N^+. The symbols and conditions are found in Fig. 3. The solid lines are the corresponding theoretical predictions of Hanes, et al. (1988).