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Experiments on rapid flow of dry granular materials down inclined chutes impinging on rigid walls

S. P. Pudasaini, K. Hutter

Institute for Fluid Mechanics (AG3), Darmstadt University of Technology , Hochschulstr. 1, D-64289 Darmstadt, Germany (pudasain@mechanik.tu-darmstadt.de/(+49)-(0)6151-16-4120)

We performed laboratory experiments of dry granular chute flows impinging an obstructing wall. Experiments are conducted for two positions of the obstructing wall, (i) 2 m below the exit gate and perpendicular to the inclined chute, and (ii) 0.63 m into the horizontal runout and then vertically oriented. The granular material moves rapidly down the chute and impinges on the obstructing wall. This leads to a sudden change in the flow regime from a fast moving supercritical thin layer to a stagnant thick heap with variable thickness and a surface dictated by the angle of repose typical for the material.

We conducted Particle Image Velocimetry (PIV) experiments by recording the moving material from the side. From this data velocities were deduced. The experiment was also video recorded. They allow exact determination of (i) the evolution of the geometry of the heap from its inception to its final form, (ii) the velocity distribution including its transition from the supercritical state in the upstream regime via the diffusive jump with the transition from the supercritical to the subcritical regime, and eventually standstill, (iii) the speed of the tip of the diffusive shock and the local geometry of the shock structure, (iv) the velocity distribution, including its boundary layer structure within the shock region and its attenuation to apparent standstill far below the free surface of the heap, (v) the transition of the basically uniform distribution of the supercritical velocity in the thin upstream layer to the nonuniform boundary layer flow within the shock regime, etc.

To clearly identify the above steps, further analysis with the recorded data are needed. The information gained by such work will, however, be significant. These experiments may provide detailed information of the flow characteristics when an obstructing wall is hit by a layer of rapidly moving grains. A clear understanding of this type of flow, in particular with regard to the mechanism of tractions exerted by the granular material on the obstructing walls is urgently needed, since depth integrated models do not provide us with satisfactory answers.