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Determination of the effectiveness of high-speed cameras for identifying ejection particles during splash with regard to the sticky paper method

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The phenomenon of splash caused by water drop has been widely studied in recent years. There are many measurement methods, including the method based on the use of so-called high-speed cameras. Due to the possibility of recording of the phenomenon with a high time frequency (thousands of recorded frames per second), this method provides detailed information about the process of splashed particles, which were previously unavailable. These include, among others, precise tracking of single ejected particles, determination of their ejection angle, displacement distance, and division of splashed elements into groups depending on the place or moment of ejection from the particle bedding. Despite the numerous advantages of the method, there is no information about the percentage of splashed particles that the cameras are able to detect and identify. In order to determine such effectiveness, it is necessary to have a reference method that guarantees 100% identification of splashed particles.

The aim of this work was to determine the effectiveness of high-speed cameras in identification of particles ejected from the granular bedding during the water drop impact. Sticky paper was used as a reference method.

Dry spherical glass beads (425–600 μm size range), which were placed into an aluminium ring (30mm diameter, 10mm height) were used in the experiments. The aluminum ring was placed in a drilled hole (only slightly larger than the ring) in a horizontal wooden plate, and therefore, the surface of the beads was at the same level as the surrounding plane. Drops (d=4.2mm) of distilled water were created in a peristaltic pump and fell free from 1.5m. The final velocity of each drop was 4.98 m/s.

Three synchronized Phantom Miro M310 cameras were used to register the splash phenomenon (307 μs time interval, 1280x800 px resolution). The camera calibration process facilitated analysis of the trajectories of the splashed particles and determination of their velocities, ejection angles, and displacement distances. The analysis of the recorded images was carried out using the Dantec Dynamics Studio software. The particles were tracked by the Volumetric 3DPTV module, and the trajectories were further analyzed by our script written in LabVIEW.

A hole (30mm diameter) was cut out of a piece of sticky paper, and the paper was placed concentrically over the ring. This allowed recording of all splashed particles while avoiding their rebounding or rolling from the plane. Following the impact, the beads were photographed using a Nikon D7100 camera, and images were analyzed using ImageJ software. The number of particles and the distance from the geometrical center of the drop impact were recorded.

Measurements using the high-speed cameras and the sticky paper method were carried out in 16 repetitions.

The results obtained with both methods were compared with each other. Regarding the sticky paper method as a reference, the efficiency of identification with the high-speed cameras for the splash of glass beads was determined, which was estimated at 53%.

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