SYMPOSIUM

School of Aeronautics and Astronautics

The 2014 Research Symposium Series

*** Free Pizza ***

Monday, March 10, 2014

4:30 pm in ARMS 1021

Crossflow Instability and Transition in a Mach-6 Quiet Tunnel

Christopher Ward

Hypersonic laminar-to-turbulent boundary-layer transition can have a significant impact on various boundary-layer properties, including heat transfer and skin friction. Boundary-layer transition prediction is inexact, and the uncertainty can significantly affect hypersonic vehicle design. Semi-empirical methods can be used to predict growth of instabilities and transition locations, but these methods are not reliable for a wide range of cases. A more basic understanding of the flow physics that cause transition is needed, thereby reducing empiricism. The crossflow instability is important for three-dimensional geometries, and occurs when a lateral pressure gradient exists. The crossflow instability manifests as streamwise vortices that can either be stationary or travelling laterally with respect to the surface. Low-speed experiments find that the stationary vortices are the dominant cause of crossflow-induced transition, but this may not be the case for hypersonic flow.

Experiments were conducted in a Mach-6 wind tunnel on a yawed cone. Both travelling and stationary crossflow vortices were measured with fast-pressure transducers and temperature-sensitive paint. It was shown that there is an interaction between the travelling and stationary vortices, but this interaction is currently poorly understood. Unlike low speeds, the travelling vortices and the travelling-stationary vortex interaction may be the significant cause of crossflow-induced transition.

Experimental Assessment of Fracture of Individual Sand Particles at Different Loading Rates

Niranjan D. Parab

Sand bags have been widely used for shock and impact resistance. However, the detailed failure process of the sand particles inside the aggregate sand under impact loading has not been characterized yet.

In this study, two sand particles (diameter = 0.6 mm) are impacted by a Hopkinson bar. The contact region of the two-particle specimen is monitored by synchrotron x-rays using high-speed x-ray phase contracting imaging (PCI). This method allows the particle fracturing behavior to be imaged through the specimen thickness without the disturbance from the impact-induced dust. To assess the effect of moisture on failure, particles are submerged in water prior to impact.

Under dynamic compressive loading of dry sand, one of the particles is pulverized while the other particle remained intact. Moisturized sand particles fail in large pieces followed by pulverization under dynamic compression.

3-D x-ray tomography is used to assess the failure of sand particles under static compressive loading. One of the particles breaks into large pieces which subsequently pulverize under static loading. Even under static loading, no damage is observed in second particle until first particle is completely pulverized. The order of pulverization for the particles is random in all experiments.

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