Department of Aerospace and Mechanical Engineering

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Fluid-structure interactions of cylinders with flexible interfaces

Tuesday, April 1, 2014, 3:30P.M.

Lower Level Auditorium, Geddes Hall

Refreshments served at 2:45 p.m. in the AME Conference Room, 365C Fitzpatrick

Naturally-occurring structures such as wings, arteries, and plants are often very flexible and adapt to a wide range of flow conditions. Understanding how a flexible structure couples to its flow environment may present novel engineering insights, and help improve our understanding of many biological phenomena. I will describe two studies involving fluid-structure interactions with cylindrical bodies in cross-flow. First, I examine the vortex-induced vibrations (VIV) of a slender, flexible cantilevered cylinder at modest Reynolds numbers that typify biological flows, such as flow past sensory whiskers or plant stems. By decomposing the cylinder's structural oscillations onto Euler-Bernoulli beam eigenmodes, we are able to show a discrete progression of the structural dynamics with increasing flow speeds and describe how the structural dynamics may predict the wake response. In particular, we observe a high-energy wake mode that has not been observed previously in free vibration, in conjunction with cooperating structural modes. The results reveal fundamental differences between this system and canonical VIV approximations of a two-dimensional cylinder with restricted movement. Second, the no-slip boundary condition on a rigid cylinder is replaced by a thin, deformable liquid interface. A slip condition can modify the separation on a cylinder and reduce drag. Initial findings on the effect of the boundary condition on wake formation and forces on the cylinder are presented. Finally, applications and future research directions for cylinder fluid-structure interactions are discussed.

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