Predictive large-eddy simulations of wind loading and natural ventilation

Catherine Gorlé

Associate Professor, Stanford University

Abstract:

Computational fluid dynamics (CFD) can inform sustainable design of buildings and cities in terms of optimizing pedestrian wind comfort, air quality, thermal comfort, energy efficiency, and resiliency to extreme wind events. An important challenge is that the accuracy of predictions can be compromised by the large natural variability and complex physics that are characteristic of urban flow problems. This talk will present an investigation of the potential of large-eddy simulations (LES) towards predicting (1) peak wind pressure loads on high rise-buildings, and (2) natural ventilation in building in complex urban environments. For the wind loading calculations, the emphasis is on quantifying the sensitivity of wind pressures to the turbulence in the incoming boundary layer wind through validation against both wind tunnel and field measurements. The validated LES are then employed to gain a better understanding of the flow physics that govern small-scale extreme suction events observed in specific locations on the buildings. For the natural ventilation simulations, the LES results will be validated against field experiments, and an efficient strategy to quantify natural ventilation flow rates under highly variable weather conditions is proposed. The talk will conclude with an overview of ongoing work on using LES for the design of sustainable and resilient urban areas.

Bio:

Catherine Gorlé is an Associate Professor of Civil and Environmental Engineering at Stanford University. Her research activities focus on the development of predictive computational fluid dynamics (CFD) simulations to support the design of sustainable buildings and cities. Specific topics of interest are: the coupling of large- and small-scale models and experiments to quantify uncertainties related to the variability of boundary conditions, the development of uncertainty quantification methods for low-fidelity models using high-fidelity data, and the use of data assimilation to improve CFD predictions.

Catherine received her BSc (2002) and MSc (2005) degrees in Aerospace Engineering from the Delft University of Technology, and her PhD (2010) from the von Karman Institute for Fluid Dynamics in cooperation with the University of Antwerp. She has been the recipient of a Stanford Center for Turbulence Research Postdoctoral Fellowship (2010), a Pegasus Marie Curie Fellowship (2012), and an NSF CAREER award (2018).

Monday, October 23rd, 2023   4:00 – 5:20 p.m.

1310 Yeh Student Center