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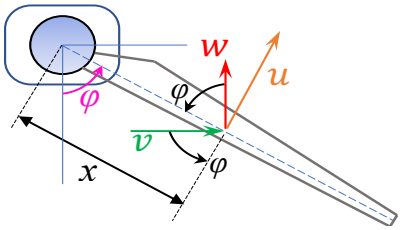
Flow-Induced Instability of Wind Turbine Blades under Stochastic Turbulence and Load Perturbation

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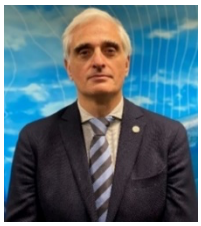
Abstract: Offshore wind turbine manufacturers have been working on the design of tall, low-mass towers and long, flexible blades (up to 100 m and beyond) to optimize wind energy extraction. Long, flexible blades are sensitive to wind load effects, either during operational conditions or extreme events. The interaction between the rotating blade and the flow can lead to dynamic vibrations, aeroelastic interactions and flow-induced instability.

This presentation will present recent studies on flow-induced instabilities of the blades. The presentation will focus on coupled-mode "classical" flutter, which involves the interaction between flap-wise and torsional vibrations of the blade at moderate amplitudes, and "stall flutter" at larger amplitudes and flow recirculation with nonlinear aeroelastic effects. Both flutter types may lead to system malfunctions and damage to the blades. Numerical investigations on "classical flutter" will analyze various perturbation sources, e.g., wind turbulence (with partially correlated field), experimental load measurement errors and blade's structural modeling simplifications. Investigations on large-amplitude stall flutter will focus on preliminary results that are part of an ongoing investigation. Both stochastic differential equations and Monte Carlo methods will be used for simulation.



Although coupled blade flutter may be less important for shorter blades, the presentation will show that flutter probability cannot be ignored in the case of long blades. Specifically, a verification by wind tunnel experiments will be presented.

The presentation will focus on the NREL (National Renewable Energy Laboratory) 5MW standard offshore wind turbine blade under various wind load scenarios.



Luca Caracoglia is a Full Professor in the Department of Civil and Environmental Engineering of Northeastern University, Boston, Massachusetts, USA. Luca Caracoglia's research and professional interests are in structural dynamics, random vibrations, fluid-structure interaction of civil engineering structures, nonlinear cable network dynamics, wind engineering, wind energy and wind-based energy harvesting systems. He has been author or co-author of about 125 peer-reviewed journal publications and book chapters. He was granted the title of "Fellow ASCE" (American Society of Civil Engineers) in 2020 for his career accomplishments. He serves as the President of the American Association for Wind Engineering (AAWE), and he is currently a member of the Executive Board of the Italian National Association for Wind Engineering (ANIV). He also currently serves as Associate Editor for the Journal of Fluids and Structures-Elsevier and the ASCE Journal of Bridge Engineering.

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