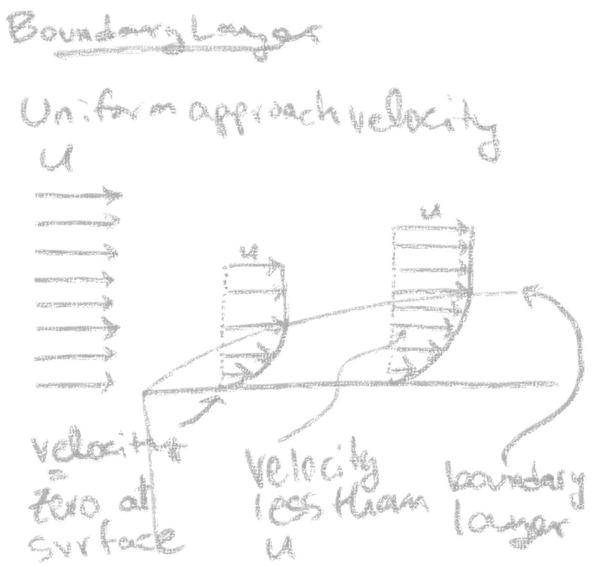
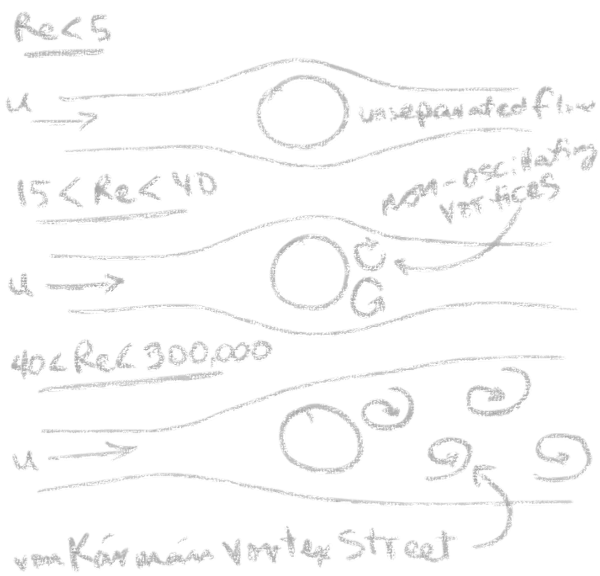
PHD SESSION 2020

September, 7th 2020





organized by

ANV-G

together with In-Vento2020 online event

inV

ANIV-G

ANIV-G is the group of young researchers within ANIV. Its goal is to promote cooperation in the Wind Engineering discipline, ease the exchange of ideas, support the spreading of knowledge, and favor contamination with other scientific communities. The group is open to students, PhDs, researchers, and practitioners who are interested in deepening their knowledge, sharing their experience and contributing to the development of Wind Engineering. Not limited to ANIV members and no membership fees required, ANIV-G is devoted to young researchers actively working in an Italian company or institution, or who has obtained a Ph.D. in an Italian university.

PHD SESSION 2020

During congresses it is usually very hard to convey to the public the complexity of the research performed during a Ph.D. ANIV-G, in collaboration with the In-Vento 2020 organizing committee, is thus organizing an informal session specially dedicated to the dissemination of the research performed by young members which are completing their last year or just obtained their Ph.D. Together with other initiatives that emerged in several research areas, the young researcher meeting marks the awareness and the desire of Ph.D. students, postdoctoral fellows, and young researchers to play a major role in scientific progress. The spirit of this session is to learn about each other's research projects and encouraging collaboration. The Ph.D. session is open also to other attendees of the In-Vento2020 online event.

GENERAL PROGRAM

The general program is organized as follows

9:00	Welcome by the Chairman of the day A. Zasso and ANIV President L. Bruno
9:15	PhD Session – Part I
10:55	Break
11:10	PhD Session – Part II
12:25	ANIV-G Meeting, promoted by C. Demartino, L. Patruno, A. Ricci

AFFILIATIONS OF SPEAKERS

UNIVERSITÀ DEGLI STUDI FIRENZE

UNIVERSITÀ DEGLI STUDI DI GENOVA

POLITECNICO DI TORINO

Northeastern University

POLITECNICO MILANO 1863

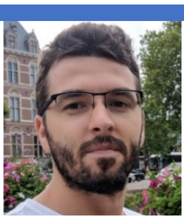
DETAILED PROGRAM

9:15 - Bernardo Nicese
University of Florence

Effects of cross-section details and angle of attack on VIV response of a bridge deck

9:40 - Federico Canepa
University of Genova

Physical investigation of downburst outflows embedded in ABL flow and thunderstorm translation

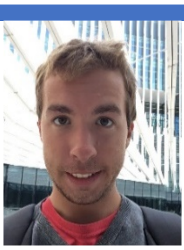


10:05 - Marko Horvat
Politecnico di Torino

Computational wind engineering simulations for design and performance assessment of sand mitigation measures

10:30 - Michela Damele
University of Genova

General method of wind-induced fatigue analysis of slender structures

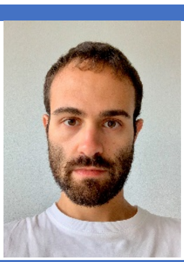


11:10 - Stefano Brusco
University of Genova

Transient aerodynamics and aeroelasticity of structures subjected to thunderstorm outflows

11:35 - Viet Le
Northeastern University

A performance-based wind engineering framework tailored to the analysis of vertical structures impacted by downburst and tornado wind loads



12:00 - Alessandro Fontanella
Politecnico di Milano

Wind Tunnel Hardware-in-the-loop experiments about floating offshore wind turbines

https://www.aniv-iawe.org/aniv-g

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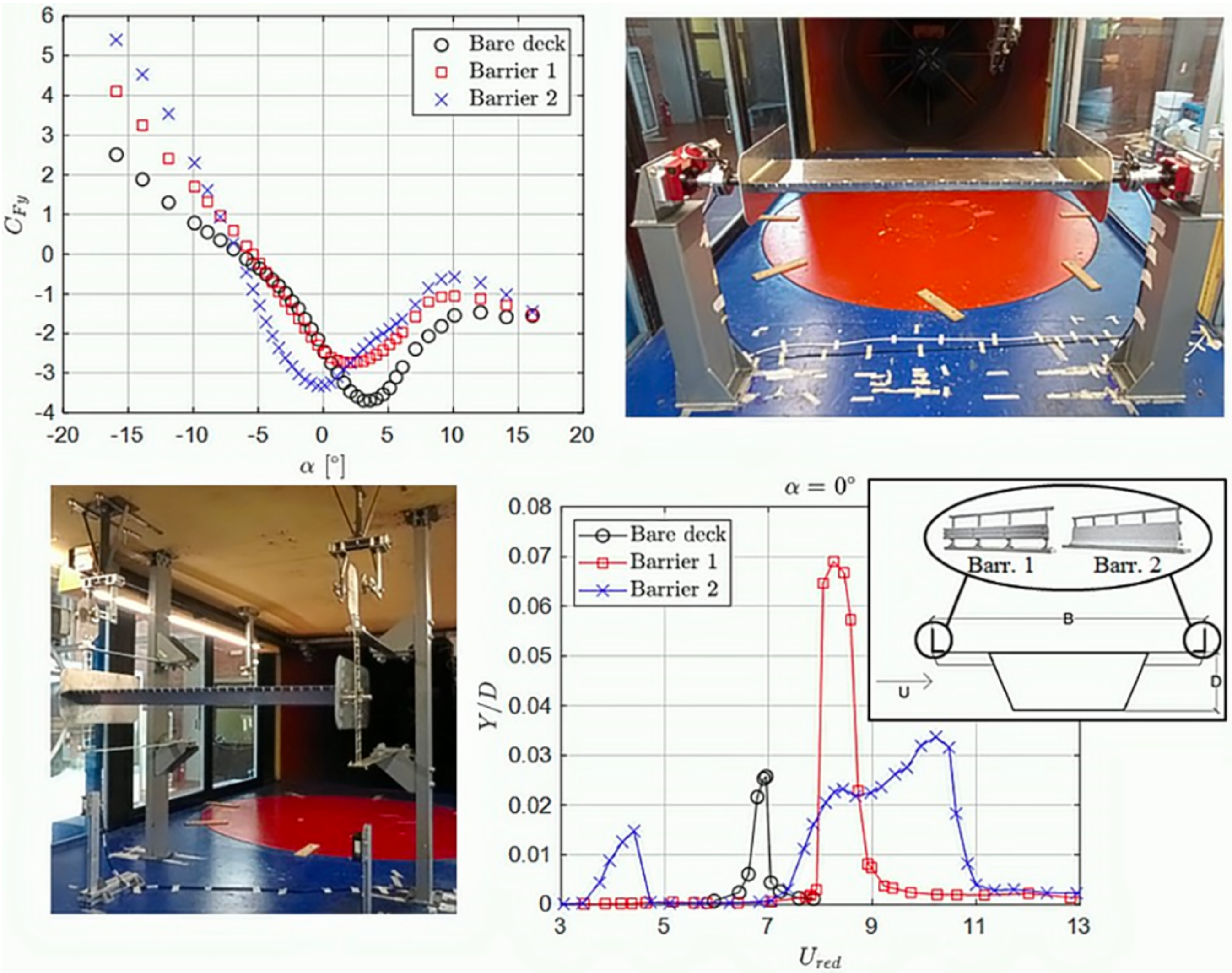
ABSTRACTS

Bernardo Nicese - *University of Florence*

Effects of cross-section details and angle of attack on VIV response of a bridge deck

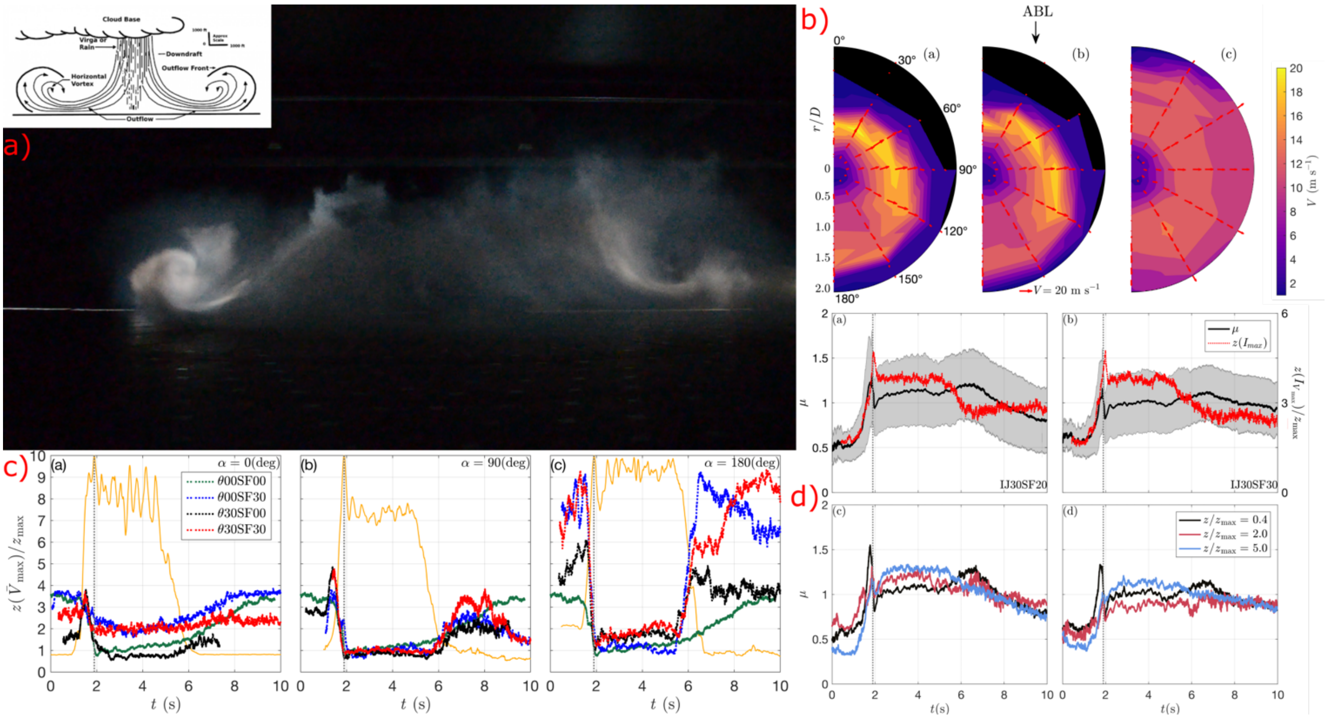
In this work, a wide experimental campaign has been carried out on a bridge deck sectional model. Model cross-section is inspired to the Volgograd Bridge deck, to have a strong similarity with a realistic bridge that has shown serious problems due to VIV. Both static force measurements and aeroelastic tests have been performed in wind tunnel. A systematic study about the influence of cross-section non-structural details and flow angle of attack on the bridge VIV response has been carried out. Model cross-section has been progressively altered: firstly, its lower corners have been modified, then two different realistic lateral barriers have been added to the deck. Selected lateral barriers are characterized by similar height and different transparency to the flow and openings distribution. Furthermore, the role played by the wind angle of attack (α) has been deeply investigated in a range of values typical for bridge decks study. A great variability of results has been found, in terms of aerodynamic force coefficients and aeroelastic behaviour. Different lock-in mechanisms have been observed, in terms of onset wind velocity, response curve shape and lock-in range. Response amplitude peak value has shown a very high sensitivity to the presence and the typology of lateral barriers and to angle of attack variations.



Federico Canepa - *University of Genova*

Physical investigation of downburst outflows embedded in ABL flow and thunderstorm translation

My Ph.D. research focuses on the experimental investigation of downburst winds. Downbursts are cold descending winds from thunderstorm clouds that spread vigorously on the horizontal upon impinging the ground. The generated near-surface flow is a result of the non-linear superposition of mainly three wind systems: isolated downburst downdraft/outflow (I), atmospheric boundary layer winds (II), and thunderstorm cell translation (III). Little research has been conducted on how these three flow components interact. An extensive experimental campaign was recently performed at the WindEEE Dome, at Western University (Canada), to tackle this question. This unique downburst simulator capable of simultaneously producing these three flow systems enabled us to investigate this interaction firstly in pairs—(I)-(II) and (I)-(III)—and, secondly, as the whole downburst system—(I)-(II)-(III). Results from a grid of Cobra probes are analyzed with respect to the benchmark case of an isolated vertical-axis downburst. Lastly, the effect of the terrain roughness on downburst velocity profiles will be addressed as well. The detailed characterization and physical evolution of the 3D downburst-like fields will be compared to full-scale records. Therefore, the first part of my Ph.D. research was also dedicated to the extraction and analysis of downbursts from LiDAR measurements along the Mediterranean coast.



a) Vis at WindEEE b) Hor outflow at 3 t_i c) Evolution of $z(V_{\max})$ and d) $z(I_{\max})$

Marko Horvat – *Politecnico di Torino*

Computational wind engineering simulations for design and performance assessment of sand mitigation measures

Desert railways locally disturb Windblown Sand (WbS) and induce sand accumulation around them. Accumulated sand causes a number of issues to railways, e.g. costly maintenance, loss of capacity, train derailments. To avoid such problems, Sand Mitigation Measures (SMMs) are mandatory.
My PhD Thesis revolves around the computational-based engineering approach to preliminary design and optimization of different types of SMMs. Depending on the relative position of SMM and infrastructure, two different scenarios are focused on in the framework of a multi-layer protection of the infrastructure. Most of the windblown sand is trapped by the so-called Path SMMs, applied between the sand source and the infrastructure. The remaining part of sand which crosses Path SMMs is handled by the so-called Receiver SMMs, applied close to the infrastructure.
These two scenarios obey to completely different design goals, i.e. promoting sand sedimentation by Path SMMs, and sand erosion by Receiver SMMs. However, both SMMs are based on aerodynamic working principles. Hence, the essential part of the design and of my Thesis is to understand the aerodynamics of the unmitigated railways and how SMMs influence the local wind flow around them. Computational Wind Engineering is adopted as the main tool to carry out the analysis of the railway aerodynamics, the conceptual design of the SMMs and their preliminary performance assessment.
My PhD Thesis is developed within the H2020/MSCA/ITN/European Industrial Doctorate project Sand Mitigation around Railway Track (SMaRT) under grant agreement No 721798.

Example of a Sand Mitigation Measure and its aerodynamic working principle

Michela Damele - *University of Genova*

General method of wind-induced fatigue analysis of slender structures

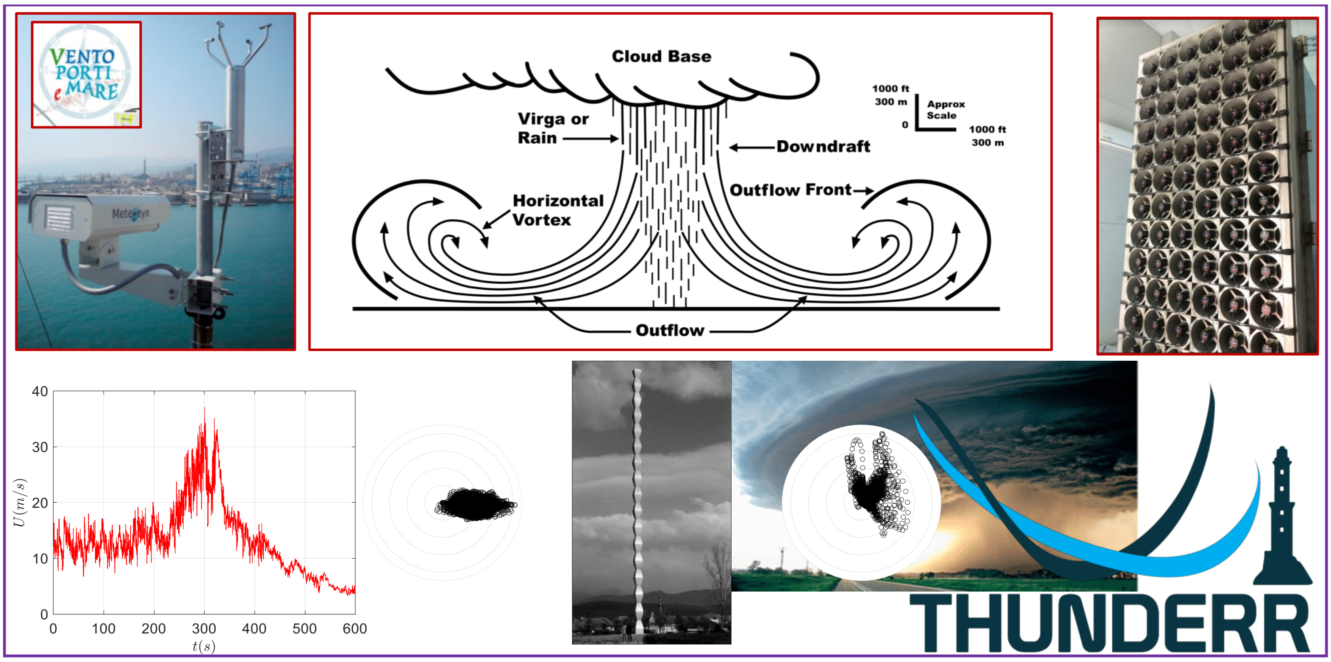
Wind-induced fatigue is a critical issue in design of many slender structures, but suitable engineering and standards procedures are still fragmentary. On the basis of the closed form solution proposed by Repetto and Solari, this PhD Thesis develops a complete and general procedure for determining the wind-induced fatigue damage of slender structures, suitable for engineering calculations and code provisions. A new generalization of the closed form solution is proposed, covering a wide range of resistance fatigue curve types, suitable for different materials and different cyclic loading conditions. The final formulation results in complete accordance with Eurocode format for wind induced Ultimate Limit State analysis.
The set of required input parameters is discussed, taking into account simultaneous along-wind and crosswind structural responses due to turbulence. Simple expressions coherent with standard format are defined for both along-wind and crosswind fatigue analysis. The significance of different contributions to crosswind-induced fatigue is examined. Although engineering procedures estimates separately crosswind maximum response to gust buffeting and to critical vortex shedding conditions, there's no guarantee such assumption would provide reliable fatigue predictions. Therefore, the possibility of separating the effects of the vortex shedding in fatigue analysis is investigated, as well as the role of parameters uncertainties in response and in fatigue evaluations, suggesting new formulations of the cycle number due to VIV. Finally, some case studies are discussed validating the proposed model.

A traffic signal support structure collapse due to wind-induced fatigue

Stefano Brusco - *University of Genova*

Transient aerodynamics and aeroelasticity of structures subjected to thunderstorm outflows

Modern wind codes and guidelines are dictated by the concepts proposed by the Davenport Chain, which links meteorology, climatology, aerodynamics, wind loading and structural dynamics. Formulated in the Sixties, is based on the studying of extra-tropical cyclones, events whose duration can be of order of days and extended for thousands of kilometres.
Nevertheless, the majority of the damage associated to wind suffered by low and medium-rise buildings is not due to such kind of events, but is consequence of a different phenomenon, the thunderstorms. Thunderstorm outflows are characterized by strongly different features than that the ones typical of synoptic events. Amongst them, the non-stationary character of the wind speed and the potentially irregular variation of the angle of attack stand out, since they represent characteristics which can strongly affect the traditional philosophy used to studying the structural dynamic response and possible aeroelastic effects (i.e. aerodynamic along-wind damping, vortex-shedding, galloping), which is based on strip and quasi-steady theory and constant direction of the flow. The aim of this thesis, which is inserted in the framework of the project THUNDERR, “Detection, simulation, modeling and loading of thunderstorm outflows to design wind-safer and cost-efficient structures” [5], funded by the European Research Council, is to investigate the effects of thunderstorm and its peculiar aspects on structures by employing analytical model (based on the applicability of the strip and quasi-steady theory), and a wind tunnel campaign carried out at the Multifan Wind Tunnel at Tamkang University, in Taipei.



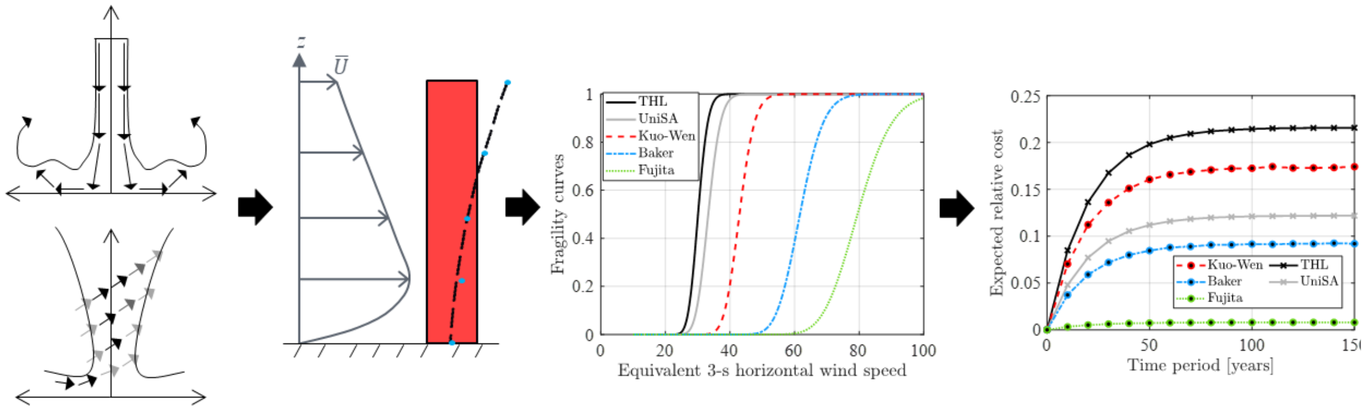
Investigation of thunderstorm-induced effects on structures

Viet Le - *Northeastern University*

A performance-based wind engineering framework tailored to the analysis of vertical structures impacted by downburst and tornado wind loads

In the current day, the methodology of performance-based wind engineering (PBWE) has been substantially refined to enable the multi-faceted risk assessment of synoptic wind phenomena. However, its development is still deficient for the consideration of short-duration, non-synoptic, rapidly evolving thunderstorm downbursts and tornadoes. Because of their unique properties, which render conventional approaches to wind engineering inadequate, research is ongoing to better understand these windstorms. In particular, attention should be devoted to properly defining their hazard probabilities and the aerodynamic forces that they impart onto structures. These gaps in knowledge have impeded the further implementation of PBWE for the analysis of these nonstationary wind phenomena.

The purpose of this study is to advance performance-based design by outlining a framework to evaluate performance metrics and consequences of vertical structures (a monopole structure and a tall building) subjected to downburst and tornado wind loads. Risks are calculated with information gathered from physical experimentation and numerical simulations conducted with several wind velocity field models. Results are used to examine the accumulation of intervention costs related to repair and maintenance, needed after failure of performance objectives. Fragility, hazard and loss analyses are thus adapted in the computational framework for the consideration of downbursts and tornadoes.

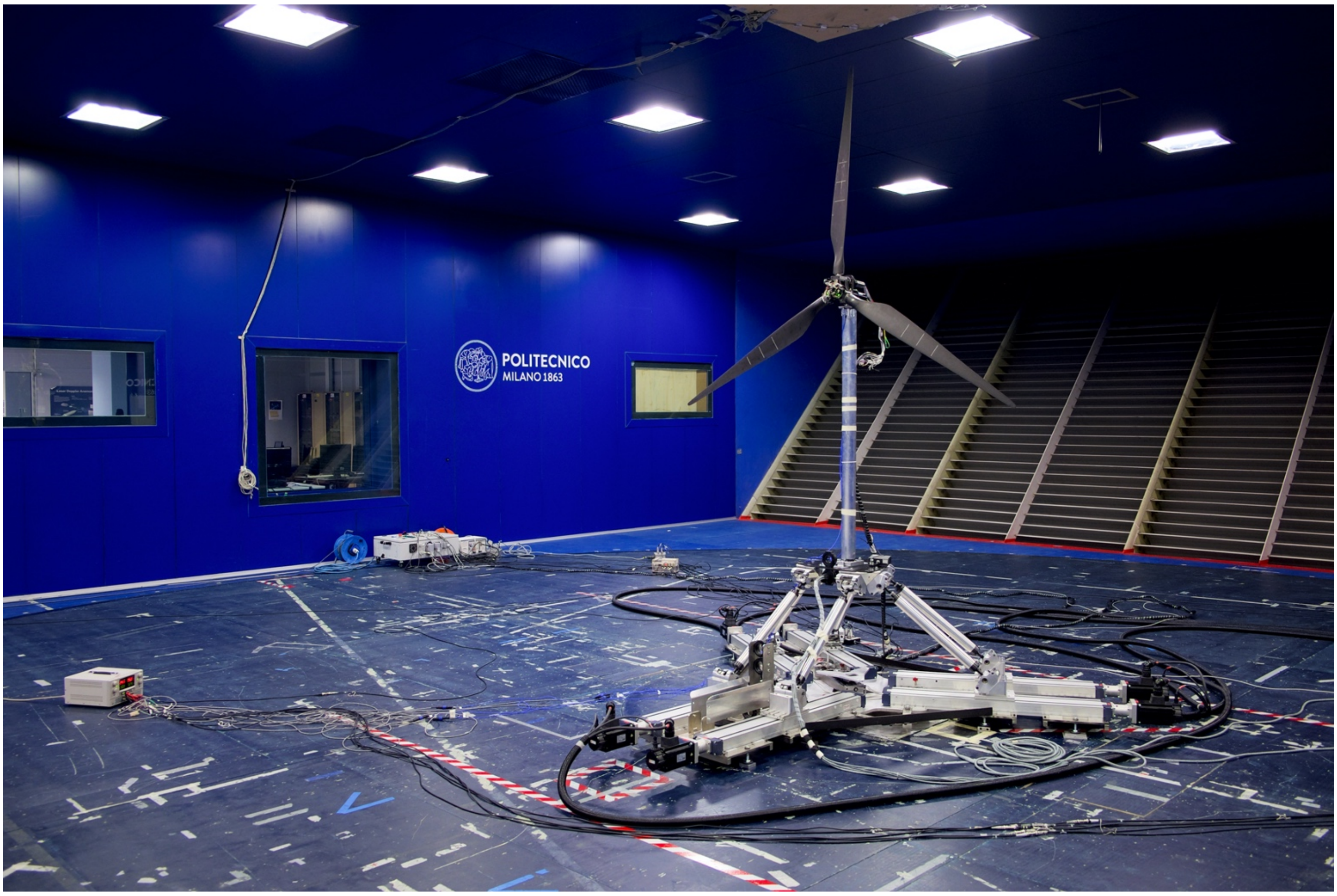


Nonstationary wind loading effects evaluated with fragility and cost curves

Alessandro Fontanella - *Politecnico di Milano*

Wind Tunnel Hardware-in-the-loop experiments about floating offshore wind turbines

Floating offshore is a promising technology for the exploitation of the vast wind energy resource of many coastal areas with waters deeper greater than 50 meters. Although few utility-scale floating farms were recently deployed around the world, floating wind energy is still young, and several engineering challenges are to be addressed. Scale-model experiments can play a crucial role in making this technology more effective. However, the simultaneous emulation of the wind turbine rotor loads, wind environment, platform hydrodynamics, mooring system, and structural flexible dynamics is quite difficult to achieve relying on conventional scale-model experiments.
The wind-tunnel hardware-in-the-loop experimental methodology solves the issue by dividing the floating wind turbine into two complementary subdomains and relying on different techniques for their small-scale emulation. The wind turbine is reproduced by means of a physical scale model that is operated in a realistic wind environment generated by the wind tunnel. Realistic control strategies are also implemented. The waves, the floating platform and the mooring system are instead simulated by means of a numerical model that is integrated in real-time. The physical and numerical parts of the experiment are tied together by measurements and a six-degrees of freedom robot.



The HIL system for hybrid wind tunnel experiments about floating wind turbines