Bauhaus-Universität Weimar

Institute of Structural engineering
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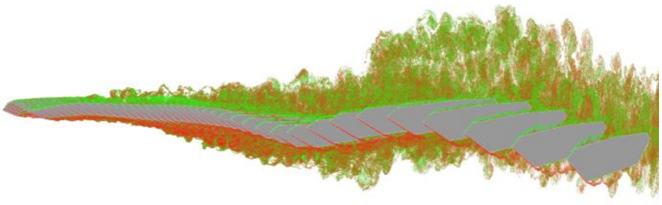
Development and Assessment of Models in Bridge Aerodynamics

Research

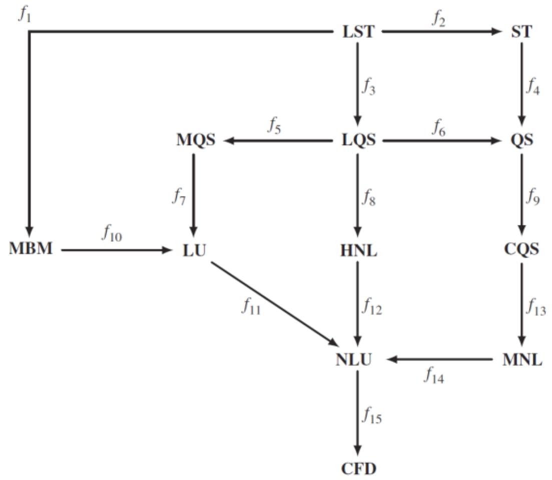
Long-span bridges are prone to wind-induced vibrations. Therefore, a reliable representation of the aerodynamic forces acting on a bridge deck is of major significance for the design of such structures. Multiple separation and reattachment points, a high Reynolds number and complex geometries are only few of the many reasons why modeling of the wind-bridge interaction has been an active research field in the last few decades. Traditionally, modeling of the aerodynamic forces has been approached by means of semi-analytical models. A multitude of semi-analytical models have been developed through the years, which mainly rest on the linear unsteady or quasi-steady assumptions. However, with longer spans and complex deck geometries, these assumptions are challenged and the need for their validation and development of new models becomes apparent.

In last two decades, models based on Computational Fluid Dynamics (CFD) models have also gained considerable attention as an alternative to the semi-analytical models. These models are able to capture aerodynamic phenomena, otherwise untraceable by the semi-analytical models. Thus, the research focus is shifting towards the CFD models. However, their limitations in terms of reliability and high computational demand make the application for CFD models not yet readily available for practical applications without validation. As the present state of computer technology limits the possibility of using CFD models for highly resolved flows, there is a necessity of development of reduced CFD models that are able to produce sufficiently accurate results at a reasonable computational cost.

In light of the previous statements, several research loci are considered as a part this project, including: (i) a categorical modeling approach for aerodynamic model evaluation; (ii) turbulent Pseudo-3D vortex method for buffeting and flutter analyses of bridges; (iii) a synergistic comparison framework for CFD and semi-analytical models; (iv) comparison metrics for time-histories, tailored to identify and quantify features certain features of the time-dependent aeroelastic response and forces; (v) a method for determination of the complex form of the aerodynamic admittance by simulating deterministic gusts.



Aeroelastic analysis of the Great Belt Bridge by the Pseudo-3D vortex method.



Aerodynamic modeling via Category theory

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Related publications

[1] Kavrakov, I., Morgenthal, G., Aeroelastic analyses of bridges using a Pseudo-3D vortex method and velocity-based turbulence generation, Engineering Structures, 176 (2018), pp. 825-839

[2] Kavrakov, I., Legatiuk, D., Gürlebeck K., Morgenthal, G., A categorical perspective towards aerodynamic models for aeroleastic analyses of bridge decks, Royal Society Open Science, 6 (2019), pp. 181848.

[3] Kavrakov, I., Morgenthal, G., A Synergistic Study of a CFD and Semi-analytical Models for Aeroelastic Analysis of Bridges in Turbulent Wind Conditions, Journal of Fluids and Structures, 82 (2018), pp. 59–85

[4] Kavrakov, I., Morgenthal, G., Comparative Assessment of Aerodynamic Models for Buffeting and Flutter of Long-span Bridges, Engineering, 3 (2017), pp. 823–838