CZ.1.05/1.1.00/02.0060: The simulation of an ice formation and rain drops on surface cables of cables supported bridges and stability measurements of dynamic response

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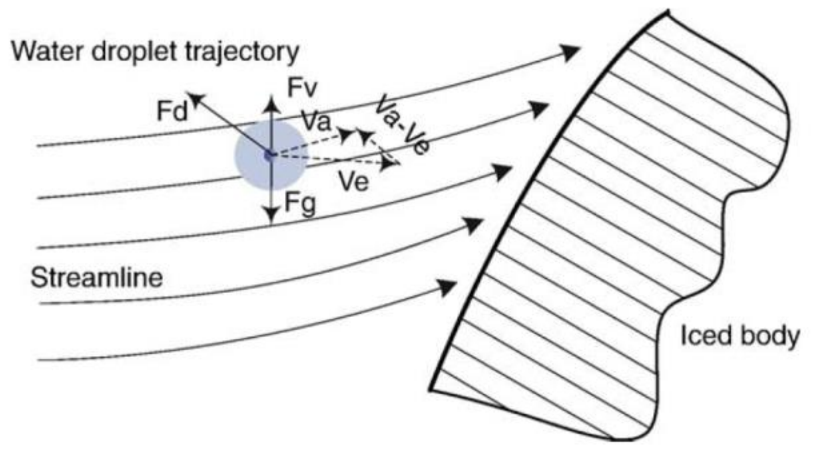
Past few decades were influenced by a significant development in structural engineering with particular emphasis on tall buildings and long-span bridges. This development only intensified some problems, which were present even in much smaller bridges, one of them for sure being wind influence. Based on available data, wind effects on structures create damage considerably larger than any other environmental influence. Of all engineering structures, long and slender bridges proved to be perhaps the most sensitive to the wind-induced structural load and fatigue.



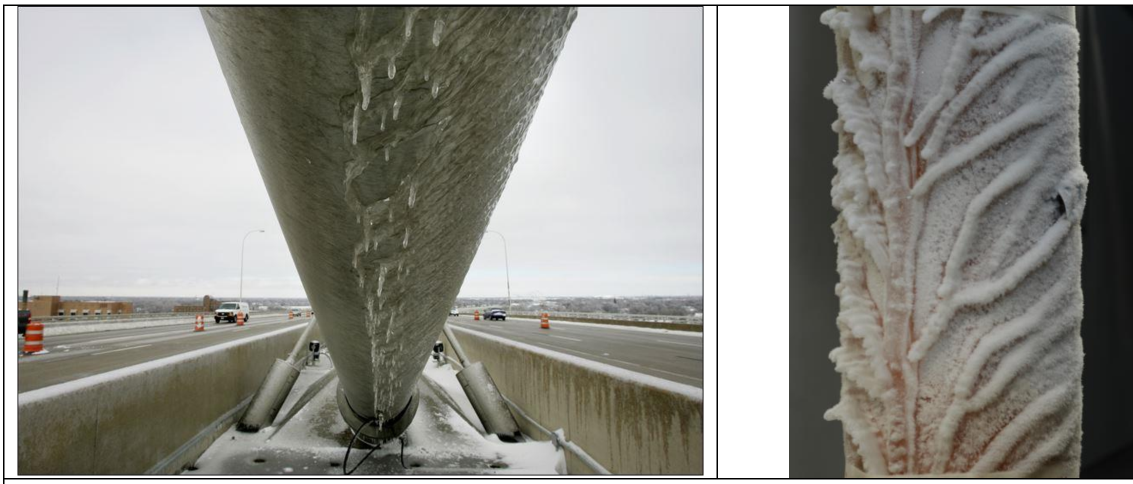
Droplet kinematics simulation

Although overall considered to be relatively stable when exposed to atmospheric wind and turbulence, cable-stayed bridges are particularly sensitive with respect to the long and flexible cables. In the past, numerous excitation mechanisms were identified causing different types of cable vibrations, whereas a particular difficulty is in creating water rivulets during the rain and ice accretion on bridge cables. Both phenomena considerably change cable aerodynamics due to altered surface roughness and cross section of the cables. The scope of this thesis is on aerodynamic behavior and oscillation characteristics of bridge cables in icing conditions.

A comprehensive experimental study of wind effects on cables with ice coatings was carried out. As the existing literature on this topic is very sparse, it was important to dedicate attention to the whole process, from ice accretion to cable response and vibrations. Ice accretion in freezing-rain conditions was simulated in a climatic wind-tunnel. Obtained ice forms were used to produce digital 3D models, and thereafter the scaled sectional models of the cable were printed on a 3D printer. These models were consequently used for testing in an aerodynamic section of the wind tunnel Aerodynamic and aeroelastic tests encompassed the flow visualization, wind force measurements on the inhouse developed force balance, and the measurements focused on galloping according to Den Hartog model and vortex-shedding. The vortex shedding was recorded with the constant temperature anemometry probes. The experimental results indicate some new and interesting features as compared to the data available in the literature.

Even though this study does not focus on the computational modelling of the ice accretion on bridge cables, the obtained experimental results may be used as a very valuable validation tool for some future computational studies.

Frame construction including model fragment of cable cover suspension bridge in climatic section and the test result of the ice accretion



Real situation ice formation, unassisted ice accretion in the wind tunnel