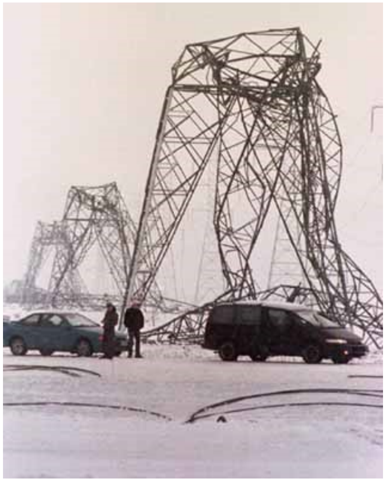
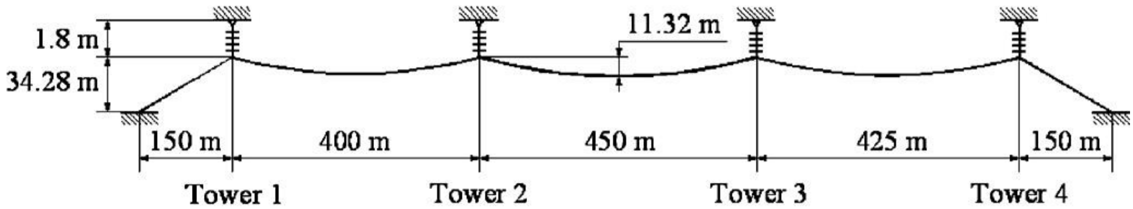
Vibration of overhead transmission line cables



Transmission line cables are exposed to dynamic loads under severe ambient conditions. These dynamic loads arise due to such phenomena as strong wind, shedding of ice accumulated on the cable, or impact load acting on the cable. High-amplitude cable vibration and excessive dynamic forces may result in severe damage to some elements of the transmission line. In order to understand these phenomena and reduce their destructive effects, they are studied numerically and experimentally. Numerical models have been developed using the finite element method; and they predict vibration amplitude, the developing stresses in the cable, and the forces acting on the cable and at the suspension during the vibration. Small-scale and full-scale experimental models have also been constructed to study the problem and to validate the numerical models.

Numerical model of a full-scale test line



Main achievements

- Numerical models have been developed using the finite-element software Adina to simulate cable vibration following sudden ice shedding from the cable. The model can predict vibration of a single conductor, vibration of conductor bundles, and bundle rotation during the vibration. A small-scale laboratory model has also been constructed to validate the numerical model. Simulation results showed that the application of spacers, and thereby the formation of conductor bundles, reduces the cable jump height during the vibration. However, a higher number of spacers in the same span does not decrease the angle of bundle rotation [1].

- Former finite-element models have been improved to simulate cable vibration following propagating ice shedding from the cable. Simulation results have been validated by comparing them to observations on a full-scale transmission line. The developed models are applicable to compare the dynamic effects of different shedding processes [2].

- Stresses developing in cable-ice structures and the conditions leading to ice fracture have been estimated during wind-induced conductor motion. The finite-element software Abaqus was used to calculate the stress in the ice and in the cable, and some stresses in the ice were also measured by a material test machine. Results show that ice failure does not occur in most of the cases during aeolian vibration; however, ice may fail during galloping when the wind velocity is high enough [3, 4].

Selected publications on the topic

1. Kollar, L. E., Farzaneh, M., Modeling Sudden Ice Shedding from Conductor Bundles, *IEEE Transactions on Power Delivery,* Vol. 28, No. 2, pp. 604-611, 2013. IF (2013): 1.657
2. Kollar, L. E., Farzaneh, M., Van Dyke, P., Modeling Ice Shedding Propagation on Transmission Lines with or without Interphase Spacers, *IEEE Transactions on Power Delivery,* Vol. 28, No. 1, pp. 261-267, 2013. IF (2013): 1.657
3. Kermani, M., Farzaneh, M., Kollar, L. E., The Effects of Wind Induced Conductor Motion on Accreted Atmospheric Ice, *IEEE Transactions on Power Delivery,* Vol. 28, No. 2, pp. 540-548, 2013. IF (2013): 1.657
4. Kermani, M., Farzaneh, M., Kollar, L. E., Estimation of stresses in atmospheric ice during aeolian vibration of power transmission lines, *Journal of Wind Engineering and Industrial Aerodynamics,* Vol. 98, No. 10-11, pp. 592-599, 2010. IF (2010): 1.213