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Numerical Investigation of Iced-Conductors Oscillations in the Wake of Windward Conductors

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Wake-induced oscillations of bluff bodies in the wake of others and their effects on structures are of great interest in many fields. In the present study, oscillations of bundled overhead line conductors with ice accretion are examined, with a view to develop a predictive computational model for conductor galloping. The experimental study of galloping of bundled conductors requires set-ups that are expensive and it is often difficult and sometimes impossible to simulate realistic conditions. Also, quasi-steady computations based on the aerodynamic coefficients determined from wind tunnel tests are not valid for conductors placed in the wake. In this paper, large oscillations of a pair of elastically mounted iced-conductors in horizontal bundle are studied in 2D with 3 degrees of freedom in horizontal, vertical and torsional directions. A computational fluid dynamics (CFD) approach based on the Unsteady Reynolds-Averaged Navier-Stokes (URANS) equations, along with the Spalart-Allmaras turbulence model is implemented via the finite element code, FENSAP-ICE, resulting in a detailed flow field around and in the wake of the iced conductors at each time step. A computational structural dynamics (CSD) module is used to determine the dynamic response of the conductors based on the loading and structural characteristics. A conservative algorithm is adopted to transfer the fluid load to the cylinders and, in return, shift the displacements of the cylinders to the fluid surface nodes along with an Arbitrary Lagrangian Eulerian (ALE) method within the CFD module to handle the moving nodes on the boundary and determine the new positions of internal nodes. Different bundle configurations in the subcritical range of Reynolds numbers are considered to investigate the structure of vortex shedding and wake, and study their effect on the oscillations of windward and leeward conductors. Frequency responses and maximum amplitude of the motion of the two conductors are studied and quasi-resonance effects resulting from frequency coincidence between the conductors' natural frequency and the vortex shedding frequency in the stationary configuration are discussed. Plots of maximum displacement amplitude versus reduced velocity are presented and discussed for the two conductors with different incident wind velocities (i.e. different Reynolds numbers).