Numerical framework for stress cycle assessment of cables under vortex shedding excitations

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In this paper a novel and efficient computational framework to estimate the stress range versus number of cycles curves experienced by a cable due to external excitations (e.g., seismic excitations, traffic and wind-induced vibrations, among others) is proposed. This study is limited to the wind-cable interaction governed by the Vortex Shedding mechanism which mainly rules cables vibrations at low amplitudes that may lead to their failure due to bending fatigue damage. The algorithm relies on a stochastic approach to account for the uncertainties in the cable properties, initial conditions, damping, and wind excitation which are the variables that govern the wind-induced vibration phenomena in cables. These uncertainties are propagated adopting Monte Carlo simulations and the concept of importance sampling, which is used to reduce significantly the computational costs when new scenarios with different probabilistic models for the uncertainties are evaluated. A high fidelity cable model is also proposed, capturing the effect of its internal wires distribution and helix angles on the cables stress. Simulation results on a 15 mm diameter high-strength steel strand reveal that not accounting for the initial conditions uncertainties or using a coarse wind speed discretization lead to an underestimation of the stress range experienced by the cable. In addition, parametric studies illustrate the computational efficiency of the algorithm at estimating new scenarios with new probabilistic models, running 3000 times faster than the base case.