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NUMERICAL SIMULATION OF UNSTEADY WIND-INDUCED CONDUCTOR OSCILLATIONS

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A stable wind can cause the galloping phenomenon — high-amplitude low-frequency oscillations of overhead transmission lines [1]. Galloping causes high dynamic loads which can damage overhead line, therefore a number of studies are dedicated to numerical and experimental modeling of the conductor dynamics (e.g., [2, 3]).

To determine the aerodynamic loads acting on the conductor the flat cross-section method is generally adopted, i.e. the flow around each conductor cross-sections is assumed to be plane-parallel and the distributed aerodynamic loads are obtained as a result of loads acting on the set of separate cross-sections interpolation. Moreover, the aerodynamic loads at each cross-section are generally assumed to be quasi-steady — proportional to the preliminarily determined stationary aerodynamic drag, lift and moment coefficients. It hasn't been investigated yet if this assumption is always adequate. Though in many cases the agreement between numerical and experimental results is good, it is not clear how the real unsteadiness of the aerodynamic forces influences the conductor motion. In this research an unsteady approach is proposed which is based on numerical simulation of the flow around conductor cross-sections (Fig. 1).

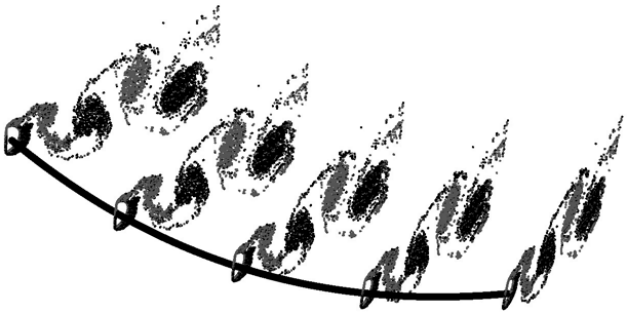

Figure 1: Flat cross-section method illustration

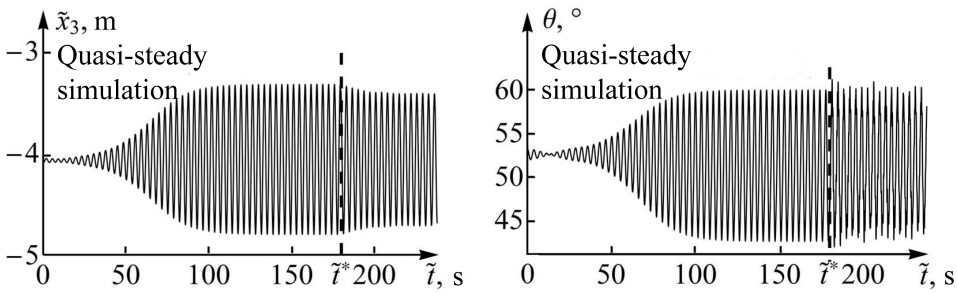

Figure 2: Vertical $\tilde{x}_3$ and angular θ positions of the central point of the span

The conductor motion equations are solved using Bubnov — Galerkin method; the basis functions for the coordinates are the eigenmodes of the conductor small free oscillations. The flow around conductor cross-sections is simulated using meshfree lagrangian viscous vortex domains (VVD) method [4]. Computer program PROVOD for numerical simulation of the unsteady aeroelastic conductor's oscillations is developed. It is based on MPI technology usage for parallel computations. The possibility of the quasi-steady aerodynamic loads usage is provided. The results of test computations using this approach are in good agreement with known experimental and numerical results.

The stationary aerodynamic coefficients of the typical conductor cross-section were calculated by VVD method and approximated by smooth curves. The wind-induced motion of the overhead line conductor with the above mentioned cross-section was simulated. Quasi-steady simulation was performed until time moment $\tilde{t}^* = 180$ s, then unsteady aerodynamic loads were used. The time dependence of vertical $\tilde{x}_3$ and angular θ positions of the central point of the span are shown of Fig. 2. It can be seen that the amplitude of vertical oscillations reduces by 12 % and becomes finally 0.65 m whereas the amplitude of angular oscillations — approximately 9° — practically doesn't change.

The developed algorithm and program can be used to simulate the dynamics of the cable exposed to essentially unsteady aerodynamic loads.

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