Identification of aeroelastic forces and static drag coefficients of a twin cable bridge stay from full-scale ambient vibration measurements - DTU Orbit (31/12/2018)

Despite much research in recent years, large amplitude vibrations of inclined cables continue to be of concern for cable-stayed bridges. Various excitation mechanisms have been suggested, including rain-wind excitation, dry inclined cable galloping, high reduced velocity vortex shedding and excitation from the deck and/or towers. Although there have been many observations of large cable vibrations on bridges, there are relatively few cases of direct full-scale cable vibration and wind measurements, and most research has been based on wind tunnel tests and theoretical modelling. This paper presents results from full-scale measurements on the special arrangement of twin cables adopted for the Øresund Bridge. The monitoring system records wind and weather conditions, as well as accelerations of certain cables and a few locations on the deck and tower. Using the Eigenvalue Realization Algorithm (ERA), the damping and stiffness matrices are identified for different vibration modes of the cables, with sufficient accuracy to identify changes in the total effective damping and stiffness matrices due to the aeroelastic forces acting on the cables. The damping matrices identified from the full-scale measurements are compared with the theoretical damping matrices based on the quasi-steady theory, using three different sets of wind tunnel measurements of static force coefficients on similar shaped twin or single cables, with good agreement. The damping terms are found to be dependent on Reynolds number rather than reduced velocity, indicating that Reynolds number governs the aeroelastic effects in these conditions. There is a significant drop in the aerodynamic damping in the critical Reynolds number range, which is believed to be related to the large amplitude cable vibrations observed on some bridges in dry conditions. Finally, static drag coefficients are back-calculated from the full-scale vibration measurements, for the first time, with reasonable agreement with direct wind tunnel measurements. The remaining discrepancies are believed to be due to the higher turbulence intensity on site than in the wind tunnel. © 2013 Elsevier Ltd.

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