On the identification of axial force in stay cables anchored to flexible supports

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Identification of the axial force in stay cables is of paramount importance for health monitoring and safety assessment purposes. Vibration based testing techniques provide the ground for quick and cheap identification strategies, based on the knowledge of (a) a set of identified natural frequencies, and (b) a structural model that relates natural frequencies to the axial force value. Reliability of results, hence, is inherently related to the predictive capabilities of the underlying structural model. Errors may arise, in particular, from the modeling of boundary conditions.

Ideal boundary conditions are often introduced, in the form of either perfectly hinged or perfectly clamped cable end sections, to simplify the analytical treatment of the problem. As a first step towards a quantitative assessment of the effect of unknown boundary conditions on the modal properties of stay cables, the present paper focuses on a taut cable with small bending stiffness anchored to flexible supports. Asymptotically accurate closed form equations for the natural frequencies of the cable are firstly obtained, generalizing a well-known result of the literature valid in the particular case of perfectly clamped end sections (Morse and Ingard, 1968; Caetano, 2007).

Starting from the theoretical results obtained on this archetypal structural model, a simple but effective procedure to simultaneously identify the axial force,the bending stiffness and a support flexibility parameter of the stay cable is presented and validated through numerical testing. Parametric analyses are then carried out to assess the effects of uncertainties in the definition of the degree-of-fixity of the cable restraints on the accuracy of the identified axial force in the case of frequencies contaminated by measurement errors.

References

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