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THEORETICAL AND EXPERIMENTAL NONLINEAR DYNAMICS OF ELASTIC SAGGED CABLES

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Finite amplitude vibrations of *suspended cables* exhibit rich dynamic phenomena ensuing from also the planar/non-planar internal resonances associated with the inherent combination of quadratic and cubic nonlinearities. Understanding of overall nonlinear dynamics still suffers from a number of limitations concerned with consideration of approximate continuous models, of low-dimensional finite representations, of shallow horizontal or nearly taut inclined cables, as well as with performing partial analyses of the interaction phenomena occurring under various resonance conditions, with limited knowledge of transition scenarios to non-regular dynamics, incomplete cross-validation of analytical/numerical solutions, and lack of experimental results.

Present research is aimed at overcoming these issues. Various refined-order *continuous models* are considered, ranging from a general one based on exact kinematics – to be referred to in only purely numerical treatments – up to approximate, kinematically non-condensed or condensed, models to be possibly addressed via also asymptotic approaches. Attention is devoted to overcoming the limitations associated with cable shallowness or absence of inclination, by referring to *larger sag* profiles or to the actual *asymmetry*, associated with frequency veering and hybrid modes, which distinguishes the linear/nonlinear dynamics of inclined sagged configurations with respect to those of horizontal cables. *Multimode discretization* is pursued with the aim of highlighting meaningful involvement, in given externally/internally resonant dynamics, of also non-resonant and/or higher-order modes to be properly considered in the formulation of a reliable reduced-order model. Both continuous models and low-dimensional representations are validated through comparison with *numerical* techniques, along with the solutions provided by *asymptotic* approaches. Investigation of *regular nonlinear dynamics* is concerned with analyzing conditions for actual activation of internal resonances and the ensuing response features, as well as with determining *nonlinear normal modes* and space-time varying dynamic tensions of great significance for practical applications. Attention is also focused on quasiperiodically or chaotically modulated multi-harmonic responses, and to bifurcation scenarios to *quasiperiodicity* and *chaos*.

Using advanced techniques of *experimental* nonlinear analysis, meaningful information are obtained from also investigation of *physical models* aimed at characterizing system nonlinear response features and possible low-dimensionality of non-regular dynamics, and at interpreting experimentally observed transition mechanisms in the background of canonical *bifurcation scenarios* from dynamical systems theory. In particular, referring to an experimental hanging horizontal cable/mass system, which realizes a reliable model of bare sagged cable, bifurcation features to *complex dynamics* are analyzed based on a *feedback between experiments and theory* which allows us (i) to qualitatively trace the experimental results back to a canonical scenario, (ii) to exploit hints from the latter to improve and steer the experimental analyses, (iii) to pursue ahead the physical investigation by detailing the most robust features of system response, (iv) to improve cable theoretical modeling, and (v) to identify proper relevant *reduced order models* to be used for (partially) reproducing the experimental scenarios.