DESCRIPTION FOR THE GENERAL PUBLIC

The development of modern structures requires scientific description of more and more accurate mathematical models. Their behavior is described with high accuracy in various dynamic conditions. Nowadays, a lot of attention is paid to nonlinear dynamics of beams under different boundary conditions, like clamped-clamped, cantilever, hinged-hinged, hinged-simply supported and so on. Despite the complexity of the problems, advanced software for mathematical manipulations, and more powerful hardware, allow us to analytically attack those models, by covering all geometrical effects and associated complex nonlinear and nonhomogeneous dynamic boundary conditions.

There is a large number of work done on beams, carried out with different levels of approximations, solved with different methods and only for some specific parameters. The aim of the project is systematic development and analysis of exact beam model with geometric nonlinearities, coupled bending longitudinal oscillations and pure non-dilatational strain (extended nonlinear Timoshenko model). Furthermore, it is assumed that one end of the beam is hinged (with inertia). The other end has the freedom of longitudinal movement and rotation, and can have attached an elastic element or/and a tip mass. Suggested studies describe the most refined way (to the best authors knowledge) of capturing all mechanical effects of extensible beam and allow very general modeling of non-ideal boundary conditions. This approach allows to understand in-depth behavior of the system, arrange conditions in proper way and then expand its applicability to innovative everyday objects.

The main goal of this project is to study nonlinear dynamics of a planar beam model, taking into account all geometrical nonlinearities. Offered model includes: axial, transversal, rotatory inertias; longitudinal, shear and bending deformations, wherein the shearing Timoshenko effect and curvature definition of extensible beam element are engaged. Proposed is exact planar beam model without any approximations, reductions or simplifications which allows to analyze large oscillations with a relatively good reflection of reality (in the linear elastic range of the material). Intention of the author is to pay attention on *free* and *forced-damped* oscillations of the hinged-simply supported beam like systems with arbitrary oriented linear springs (axially and/or rotatory) and inertias (translational and/or rotational) subjected to the beams ends. Furthermore, an investigation in deep of several aspects is possible, for instance: hardening/softening phenomena, coupled axial-transversal oscillations, multifrequency excitation, subharmonic/superharmonic (two to one and three to one) and internal resonances. The latter has not yet been examined for an initially straight hinged simply supported beam. A compendium of knowledge of nonlinear oscillations of mentioned system could be deployed in many applications as follows: mechanical, civil, structural, space, ocean, automotive, control electromechanical systems as well as microelectromechanical systems.

The elaborated mathematical model consists of the system of three governing partial differential equations of motion (including oscillations in axial, shear and bending directions) and associated boundary conditions. Analytical solutions will be determined by the multiple time scales method. The second-order approximate solution will be derived to obtain frequency response curves of forced-damped oscillations as well as backbone curves of free oscillations. Results from analytical approach will be empowered by comparison with numerical simulations. Reproduction of frequency response curves will be done by one of the finite element commercial software - Abaqus_CAE® in which *frequency linear perturbation* and *dynamic explicit* (for transient simulation) modules will be used. The last stage will be to carry out laboratory measurements, in which the beam system is fastened on slip table and by kinematic excitation in vicinity of the n-th bending mode drawing frequency response curves. Tests will be repeated for several types of boundary conditions in order to adjust the basic parameters of the mathematical model.