Nonlinear phenomena in mechanical systems dynamics

J Warminski, Lublin University of Technology

In many dynamical systems *nonlinear phenomena* may completely alter intuitively expected behaviour and can drastically change their dynamical responses. The scope of the paper covers theoretical and applications-based problems of *nonlinear dynamics* concerned with both lumped and distributed mass systems of civil, mechanical or aerospace engineering.

A particular attention is paid to the dynamics of *self- and parametrically excited systems*. Interactions between these two different vibration types result in a quasi-periodic response. However, in the selected domains of system's parameters the frequency quenching effect is observed. This phenomenon follows the Hopf's bifurcation of the second type. Moreover, if the system is additionally forced by a harmonic force, then an internal loop occurs inside a resonance zone. To get a proper system's decomposition a nonlinear normal modes (NNM) formulation is proposed.

Pendulums are often used as dynamic absorbers mounted on high buildings, bridges or chimneys. Geometrical nonlinearities introduced by motion of the pendulum may change the system’s dynamics, and due to *autoparametric coupling*, entail a rapid increase of the oscillations of both the structure and the pendulum, leading to full pendulum rotation or *chaotic dynamics*. To avoid such dangerous situations, the semi-active *magnetorheological* damping is proposed. The autoparametric coupling occurs also for the *L-shaped beam* structure. A new 3D nonlinear model of the coupled L-shaped beams is presented. Analytical results are compared to vibration modes obtained from FE analysis.

The nonlinear coupling effect can also be introduced to enhance possible control of structure dynamics. The application of Macro Fibre Composite actuators combined with a *nonlinear control algorithm* is presented for the effective vibrations suppression.