Transient phenomena in vibro-impact and other strongly nonlinear systems

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Abstract

Essentially nonlinear behavior is common in traditional mechanical systems due to clearances, cracks, impacts, friction, material nonlinearities and plasticity. In many of the listed instances, such behavior is unwanted and may be even destructive. In the same time, in in last two decades it was realized that intentional use of strongly nonlinear elements in mechanical systems could bring about significant enhancements and advantages in their performance. In this respect, one can mention targeted energy transfer in essentially nonlinear systems with applications for energy absorption and harvesting, wave propagation in granular crystals, granular media and other systems with acoustic vacuum, acoustic metamaterials with essentially nonlinear elements.

All mentioned applications, traditional and modern, involve some form of energy transfers, transient processes and/or wave propagation. Essential nonlinearity poses major challenge for analytic exploration and understanding of these processes. Traditional methods stemming from quasilinear approximation have limited applicability for such problems, and often produce the results with uncontrolled inaccuracy. In certain important cases, for instance, when the impacts are involved, these traditional methods turn irrelevant for exploration of the transient responses.

The talk will cover a set of archetypal problems, in which the strong nonlinearity appears as the undesirable complication, or is introduced intentionally to improve the performance. Peculiar features of dynamic responses, and approaches to analytic treatment and qualitative understanding of these phenomena will be discussed. Among other issues, the analytic framework for treatment of transient responses and energy exchanges in regular vibro-impact systems and vibro-impact systems with compliance will be outlined and discussed.