Chaotic and noisy-chaotic dynamics of slender structures

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In this work we study mathematical models of continuous structural members (beams and plates) under harmonic load and under white noise. The applied numerical procedures are verified and validated. Spatial-temporal chaotic vibrations of a plate and two/three beams coupled only by boundary conditions are analyzed. Novel transition scenarios from regular to chaotic dynamics of the mentioned deterministic systems are reported. We illustrate why the wavelet analysis is needed while studying chaotic vibrations. The modifications of classical three scenarios of transition from regular vibrations to deterministic spatial-temporal chaos are proposed and validated.. We present a few numerical examples showing that the added noisy components do not only yield the quantitative changes in the system dynamics, but also cause the qualitative, and sometimes surprising changes in the system vibration regimes. We illustrate how the white noise lowers the threshold for transition into spatial-temporal chaotic dynamics and how it significantly reduces occurrence of periodic vibrations. Scenario of transition into chaos of the studied mechanical structures essentially depends on the control parameters, and it can be different in different zones of the constructed charts of vibration kinds (control parameter planes). Furthermore, we found two interesting non-linear phenomena, when increase of the noise intensity yields surprisingly the vibrational characteristics with a lack of noisy effect (chaos is destroyed by noise and windows of periodicity appear) and when the symmetric dynamical regime of the investigated system loses its symmetry due to action of a small white noise symmetrically distributed.