Accepted Manuscript

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PII: S0263-8223(16)32041-4
DOI: http://dx.doi.org/10.1016/j.compstruct.2017.02.024
Reference: COST 8243

To appear in: *Composite Structures*

Received Date: 3 October 2016
Revised Date: 8 December 2016
Accepted Date: 3 February 2017

Please cite this article as: Yu, T-J., Zhou, S., Yang, X-D., Zhang, W., Global dynamics of composite panels with free-layer damping treatment in subsonic flow, *Composite Structures* (2017), doi: http://dx.doi.org/10.1016/j.compstruct.2017.02.024

Global dynamics of composite panels with free-layer damping treatment in subsonic flow

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Abstract: Global dynamics of excited composite panels with free layer damping treatment in subsonic flow near the first-order critical velocity is investigated. The canonical transformations and normal form theory are applied to reduce the equations of motion to near-integrable Hamiltonian standard forms considering zero to one internal resonance. The Energy-Phase method is employed to demonstrate the existence of chaotic dynamics by identifying the existence of multi-pulse jumping orbits in the perturbed phase space. In both the Hamiltonian and the dissipative perturbation case, the homoclinic trees which describe the repeated bifurcations of multi-pulse solutions are demonstrated. In the case of dissipative perturbation, the existence of generalized Šilnikov's type of orbits which are homoclinic to fixed points on the slow manifold are examined and the parameter region for which the dynamical system may exhibit chaotic motions in the sense of Smale horseshoes are obtained analytically. The present research illustrates that the existence of multi-pulse homoclinic orbits can provide a mechanism for how energy flow from the high-frequency mode to the low-frequency mode. The global results are finally interpreted in terms of the physical traveling wave motion of such gyroscopic continua.

Keywords: Global dynamics; Composite panel; Aeroelasticity; Gyroscopic system; Multi-pulse homoclinic orbits; Chaotic traveling wave motions

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