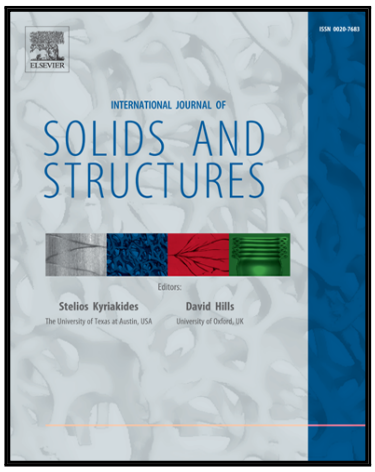

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Eulher Chaves Carvalho , Paulo Batista Gonçalves , Giuseppe Rega

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MULTIPLE INTERNAL RESONANCES AND NONPLANAR DYNAMICS OF A CRUCIFORM BEAM WITH LOW TORSIONAL STIFFENESS

Eulher Chaves Carvalho[a], Paulo Batista Gonçalves[b*] and Giuseppe Rega[c]

[a] Federal Institute of Education, Science and Technology of Goiás, IFG-Go, Jatai, GO, 75804-714, Brazil, e-mail: eulher.carvalho@ifg.edu.br

[b] Department of Civil Engineering, Pontifical Catholic University of Rio de Janeiro, PUC-Rio, Rio de Janeiro, RJ, 22451-900, Brazil, e-mail: paulo@puc-rio.br

[c] Dipartimento di Ingegneria Strutturale e Geotecnica, Sapienza Università di Roma, Roma, 00197, Italy, e-mail: giuseppe.rega@uniroma1.it

[*] Corresponding author

ABSTRACT

The three-dimensional motion of a slender clamped-free beam with a cruciform cross-section of low torsional stiffness, subject to lateral harmonic excitation, is investigated. Special attention is given to the nonlinear oscillations at multiple internal resonances, and to its influence on the bifurcations and instabilities of the structure, a problem not tackled in the previous literature on the subject. The nonlinear integro-differential equations describing the flexural-flexural-torsional coupling of the beam are used, together with the Galerkin method, to obtain a minimal (three-degree-of-freedom) reduced order model, whose response is investigated through continuation of the relevant ordinary differential equations. Both inertial and geometric nonlinearities are considered. By varying the stiffness parameters of the beam and using tools of nonlinear dynamics, a complex dynamic behavior is observed around 1:1:1 resonance, where a variety of local bifurcations lead to multiple coexisting solutions which include planar and nonplanar motions. Notwithstanding the topologically involved portraits of the attractor-basin response, the analysis of system global dynamics may provide hints for safe structural design.

Keywords: cruciform cross-section, low torsional stiffness, nonlinear oscillations, bifurcations, instabilities, multiple internal resonances, nonlinear interactions.