Analysis of Nonlinear Beam Vibration Using the Residue Harmonic Balance Method

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This paper investigates the nonlinear un-damped vibrations of flexible simply supported beams subject to external harmonic excitation. A multi-mode formulation of coupled differential equations is derived to represent the large amplitude beam vibration. An efficient analytical tool, namely, residue harmonic balance is employed to obtain the vibration amplitude solution. In fact, extensive studies about approximate analytical methods have been carried out for solving nonlinear vibration problems, incremental harmonic balance method (IHB). The increment harmonic balance method eliminates all nonlinear terms during the variational process. The residue harmonic balance method was firstly introduced by the third author and his research teammate. The main advantage of this method is that the higher level solutions to any desired accuracy can be obtained easily by solving a set of linear algebraic equations. In this study, the multi-level RHB is employed to obtain an accurate analytical solution of nonlinear coupled differential equations of a 2-DOF of simply supported beam with un-damped model. A multi-mode formulation is derived which represent the beam vibration subject to external excitation. The effects of various parameters on the nonlinear behaviors are examined; and the convergence study is conducted to verify the solution method.

Keywords: Nonlinear beam analysis, harmonic balance method, large amplitude vibration, un-damped model.