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Vibration analysis of rotating pretwisted tapered blades made of functionally graded materials

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Abstract

This paper presents a new structural dynamic model with which vibration characteristics of rotating blades made of functionally graded materials (FGMs) can be investigated. The equations of motion of a rotating pretwisted tapered blade made of FGM are derived using the Rayleigh-Ritz assumed mode method along with the Kane's method. After converting the equations of motion into dimensionless forms, dimensionless natural frequencies are obtained by solving the modal formulation of the dimensionless equations. Various dimensionless geometric parameters like pretwist angle, taper ratios, hub radius ratio and width-to-thickness ratio as well as continuous variation of material properties along the blade thickness are considered to obtain the new structural dynamic model. The accuracy and efficiency of the proposed model are verified through a comparison study first. Then, effects of the volume fraction index, Young's modulus ratio, hub radius ratio, pretwist angle, taper ratios, width-to-thickness ratio and angular speed upon the dimensionless natural frequencies of the FG blade are investigated using the proposed model. In addition, an algebraic condition under which dimensionless natural frequencies can be minimized is obtained.

Keywords

Vibration analysis, rotating blade, functionally graded material, pre-twist angle, taper ratio

Nomenclature

A	Rigid hub

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