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Abstract

The general equations of motion of a flexible spinning missile under thrust in the powered flight phase are established and the stability of the motion of the missile is analyzed. The spinning missile is approximated to the unconstrained flexible rotor. Moreover, the thrust in the powered flight phase is deemed as a follower load when the factors of gyroscopic effect, aeroelastic effect, and axial force are considered under the mean axis condition. The equations of motion and stability of the flexible spinning missile in the powered flight phase are then deduced. The stability and dynamic response of the flexible spinning missile under thrust is analyzed through numerical calculation. Calculation results show that thrust, spinning speed, and dynamic pressure exert different influences on the stability of the spinning missile. These factors should be considered and analyzed comprehensively.

Keywords: follower thrust; flexible spinning missile; nonspinning coordinate system; stability; Timoshenko beam

Nomenclature

A	=	cross section area
a_i , b_i	=	generalized coordinates in y , z directions
$\{\boldsymbol{a}\}$, $\{\boldsymbol{b}\}$	=	generalized coordinate vectors in y , z directions
$[\boldsymbol{C}_D]$	=	damping matrix
d	=	diameter of missile
F_{Ay} , F_{Az}	=	lateral aerodynamic forces in y , z directions
F_{D_1}	=	concentrated drag force at nose
F_{Gx} , F_{Gy} , F_{Gz}	=	components of gravity in x , y , z directions
f_{Ay} , f_{Az}	=	distributed lateral aerodynamic forces in y , z directions
$f_{D_2}(x,t)$	=	distributed drag along longitudinal axis of missile
$\boldsymbol{i}$, $\boldsymbol{j}$, $\boldsymbol{k}$	=	base vectors of nonspinning coordinate system
$\boldsymbol{i}_0$, $\boldsymbol{j}_0$, $\boldsymbol{k}_0$	=	base vectors of Earth-fixed coordinate system
$\boldsymbol{i}'$, $\boldsymbol{j}'$, $\boldsymbol{k}'$	=	base vectors of thin disk coordinate system