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BVI-noise generation by wing-shaped helicopter blade. (English) Zbl 1474.76076

Visn. Khark. Univ., Ser. Mat. Prykl. Mat. Mekh. 91, 21-35 (2020).

Summary: Aerodynamic noise includes a number of noise components, among which rotational noise and vortex noise (BVI-noise) make the largest contribution to the overall noise generated. Rotation noise depends on the magnitude of the velocity of the incoming blade and prevails over other noise components at significant Mach Mach numbers. Unlike rotation noise, vortex noise is evident at low helicopter flight speeds, moderate Mach numbers. In the formation of this type of noise, an important role is played by the longitudinal geometry. Therefore, recently the shape of the helicopter blade is chosen close to existing natural forms, which are as balanced as possible. One of these may be a wing-shaped blade. In this work, the problem of generating BVI noise by the wing shaped blade of a helicopter is posed and solved. The mathematical model of the problem is constructed on the previously proposed by the author and successfully tested system of aeroacoustic equations for the general case. Estimated features in this system are pulsations of sound pressure and sound potential. The calculated data of these quantities, as well as their derivatives, were used to study near and far sound fields. In particular, the dependence of the density ripple distribution is revealed from the blade geometry, the angle of attack and the blade angle to the oncoming flow. Increasing flow velocity contributes to the emergence of transverse ripples on the surface blades that dominate the longitudinal ripples by level. An interesting feature noticed in the calculations is that there are calculations for moderate Mach numbers $M = 0.2, 0.3$ situations, at certain angles of blade placement to the stream and angles of attack where rotation noise dominates eddy noise. For values Mach numbers $M > 0.4$ rotation noise plays a major role in blade noise generation. The noise level generated is in the range $50\,dB \leq L \leq 60\,db$, which is lower by $5 - 6\,dB$ for the Blue Edge blade, as well as the rounded blade. In addition, activation of the high-frequency region in the frequency spectrum of noise was observed $f \approx 840\,Hz$. The results of the calculations show that the blade of the wing-shaped is low-noise in the mode of maneuvers at small flight speeds.

MSC:

76Q05 Hydro- and aero-acoustics
76G25 General aerodynamics and subsonic flows

Keywords:

sound generation; wing-shaped helicopter blade; BVI-noise

Full Text: Link