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Discrete tonal noise of NACA0015 airfoil at low Reynolds number

(Article)

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Abstract

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This paper is a pilot study of the effect of external forcing and passive control on the generation of airfoil whistle noise . Interaction between instability travelling inside laminar boundary layer with the airfoil trailing edge produces discrete tonal noise . This phenomenon commonly found at low -to-moderate Reynolds numbers. The characteristics and behavior of tonal emissions at low Reynolds number differs from that at higher Reynolds number . Therefore, the purpose of this work is to study the discrete tonal noise generated by laminar boundary layer instability at low Reynolds number as well as at a variation of angle of attack. Experimental testing on NACA0015 was done in the anechoic wind tunnel to measure the sound spectrum at Reynolds number of Re~10^4 and angle of attack of $0° \leq \alpha \leq 5°$. This work is intended to provide additional information to the tonal behavior of NACA series airfoil . Flow separation without reattachment occurs on the suction side within the selected Reynolds number and angle of attack. No tonal sound was found if fs falls below 40dB. At low Reynolds number , airfoil discrete tone consists of high intensity f_s accompanied by more pronounced f_n as freestream velocity increases. Airfoil tonal noise gradually decreases as angle of attack increases from α=0^° before disappearing beyond α=5°. Moreover, previously proposed empirical models to predict fs were found to have limitation in predicting tonal frequency at low Reynolds number at a variation of angle of attack. In addition, general observation shows f_n has a velocity dependency of ~$U^{0.8}$ while f_s is prone to exhibit ladder structure behavior with velocity dependency of ~$U^{1.3}$. © 2019 Penerbit Akademia Baru.

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