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激波控制鼓包提高翼型跨声速抖振边界

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Using Shock Control Bump to Improve Transonic Buffet Boundary of Airfoil

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摘要 翼型抖振边界是仅次于升阻比的一项重要气动指标。采用定常雷诺平均Navier-Stokes方程,以升力线斜率平缓及激波位置振荡作为基本判据确定了RAE2822翼型在指定跨声速来流条件下的抖振边界。通过大量计算流体力学(CFD)验证,针对RAE2822翼型设计了一种特定外形的激波控制鼓包并确定了其具体安装位置。该激波控制鼓包在抖振迎角附近可以显著降低激波强度、稳定激波位置并推迟抖振现象发生,最终达到扩大抖振边界的目的,其在设计跨声速来流条件下可将抖振升力系数提高5%～10%;而当迎角较小或超过抖振迎角后该激波控制鼓包不会对基本翼型的气动性能产生较大影响。

关键词: 激波 流动控制 跨声速流动 抖振 计算流体力学

Abstract: Airfoil buffet boundary is an important aerodynamic parameter which is second only to the lift-drag ratio. By using various steady aerodynamic parameters of the lift curve, the trailing edge pressure deviation and reversal in shock movement as the basic criteria, the buffet boundary of transonic airfoil RAE2822 in the specified flow conditions can be determined by solving steady Reynolds-averaged Navier-Stokes equations. A specific shape and position of the shock control bump is designed for airfoil RAE2822 by testing many computational fluid dynamics (CFD) solutions. The study finds that the shock control bump can significantly reduce the shock strength near the buffet onset angle, stabilize shock position and deter the occurrence of buffet, thereby achieving the purpose of expanding the buffet boundary. The buffet onset lift coefficient in the transonic flow conditions can be increased by 5%-10%. When the angle of attack is small or when it is larger than the buffet onset angle, the shock control bump has little effect on the dynamics of the airfoil.

Keywords: shock wave flow control transonic flow buffet computational fluid dynamics

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