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加装格尼襟翼的自转旋翼气动特性研究

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Study on Aerodynamic Characteristics of Auto-rotating Rotors with Gurney Flaps

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摘要 为了研究格尼襟翼对自转旋翼气动特性的影响,首先建立了翼型加装格尼襟翼的二维气动特性计算模型,分析了NACA0012翼型及该翼型加装1%、2%弦长高度格尼襟翼的气动特性,理论计算结果与试验结果的对比表明了本计算模型的正确性。基于叶素理论建立了自转旋翼动力学模型,采用Pitt-Peters动态入流模型捕捉自转旋翼诱导速度沿桨盘的非均匀分布特性。最后进行了自转旋翼加装不同高度格尼襟翼的气动特性分析,结果表明:翼型加装1%弦长高度的格尼襟翼后,在20 m/s到35 m/s的来流速度下,自转旋翼的阻力平均减小可达26%;加装高度为2%弦长的格尼襟翼后,在20 m/s到35 m/s的来流速度下,自转旋翼的阻力平均减小达17%。自转旋翼的气动效率得到明显提高。

关键词： 格尼襟翼 自转旋翼 叶素理论 气动特性 升阻比

Abstract： In order to investigate the aerodynamic characteristics of auto-rotating rotors equipped with Gurney flaps, a numerical model of airfoils equipped with Gurney flaps is established. The aerodynamic characteristics of airfoil NACA0012 with Gurney flaps of the height of 1% and 2% of chord are calculated respectively. The validity of the model is also provided by the test data. The aerodynamic model of auto-rotating rotors is established based on the blade element theory, with a Pitt-Peters dynamic inflow model to capture the non-uniform induced velocity distribution on the rotor disk. The aerodynamic characteristics of auto-rotating rotors equipped with Gurney flaps with different heights are analyzed. The results show that from 20 m/s to 35 m/s forward flight velocity, the average drag reduction of auto-rotating rotors is up to 26% with the 1% chord height Gurney flap, and the average drag reduction of auto-rotating rotor is up to 17% with the 2% chord height Gurney flap. Thus, the aerodynamic efficiency of the autogiro rotor is improved significantly with Gurney flaps.

Keywords： Gurney flap auto-rotating rotor blade element theory aerodynamic characteristic lift drag ratio

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