



航空学报 2013, Vol. 34 Issue (12) :2733-2739 DOI: 10.7527/S1000-6893.2013.0437

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航空发动机转子叶片振动方程及其频率计算

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Vibration Equation and Frequency Computation of an Aero-engine Rotor Blade

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摘要

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摘要

航空发动机工作过程中, 转子叶片的工作环境较为恶劣, 会无法避免地受到气动和机械等载荷的激励作用而引发强迫振动, 特别是当载荷频率与叶片的动频相同时就会使叶片共振、应力增大甚至造成叶片破坏, 故准确获得叶片在不同转速时的动频就显得尤为重要。根据叶片的受力分析, 通过引入叶片的变形系数, 建立了叶片的自由振动方程。然后利用Ritz-Galerkin方法得到了一种可以计算叶片静频和动频的数值方法, 计算结果与实验测量结果比较接近。本文方法与现有相关方法相比, 其特点在于所建立的叶片振动方程与实际情况更趋相符, 计算简便、结果可靠, 并具有一定的工程应用价值。

关键词: 航空发动机 转子叶片 振动方程 Ritz-Galerkin方法 振动频率

Abstract:

During the running process of an aero-engine, the working conditions of the blade are extremely poor. Aerodynamics and mechanical force would inevitably excite the blade continuously and cause its forced vibration. Especially when the load frequency equals the dynamic frequency of the blade, resonance will occur, which can increase the stress evidently and even damage the blade. Therefore it is particularly important to learn about the natural frequency of the blade at different rotational speeds. Based on the force analysis of the blade, we establish its free vibration equation by introducing a deformation coefficient. And then we develop a numerical method to calculate the static and dynamic frequencies of the blade, with the help of Ritz-Galerkin method. Compared with traditional methods, the present method is more convenient and closer to the actual condition and its results match well with the experimental data, which supplies a reasonable method of engineering importance.

Keywords: aero-engine rotor blade vibration equation Ritz-Galerkin method vibration frequency

Received 2013-09-10; published 2013-10-24

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引用本文:

李克安, 林左鸣, 杨胜群, 李松华, 万正苏. 航空发动机转子叶片振动方程及其频率计算[J]. 航空学报, 2013, 34(12): 2733-2739. DOI: 10.7527/S1000-6893.2013.0437

LI Kean, LIN Zuoming, YANG Shengqun, LI Songhua, WAN Zhengsu. Vibration Equation and Frequency Computation of an Aero-engine Rotor Blade[J]. Acta Aeronautica et Astronautica Sinica, 2013, 34(12): 2733-2739. DOI: 10.7527/S1000-6893.2013.0437

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