GENETIC ALGORITHM OPTIMIZATION OF HELICOPTER BLADES VIBRATION TRANSITION

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1. Abstract.

Helicopters suffer from high vibration relative to fixed wing aircraft because of a highly unsteady aerodynamic environment and rapidly rotating flexible blades. High vibration causes passenger discomfort, fatigue in rotor system components and increases likelihood of damage to critical avionics components in the helicopter. Vibratory hub loads are a major source of helicopter vibration and involve higher harmonic forces and moments. Passive vibration devices are often used to suppress vibration levels at some selected places in the helicopter body, such as the pilot's seat. Passive devices include pendulum absorbers, anti-resonance systems and other vibration absorbers. A drawback of passive devices is the large weight penalty and rapid performance degradation away from the tuned flight condition. [1]

In this paper, the focus is on optimizing a full three-dimensional helicopter blade structure. The passive optimization that is employed here is based on energy flow analysis models combined with Genetic Algorithm (GA) optimization technique [2]. The mentioned subject structure consists of a composite main part and a steel beam that connects main part to the hub which is completely modeled and analyzed by ANSYS. The optimization parameters include the number of layers, layer thickness, fiber orientation and the type of material for the composite constituents. These parameters are optimized with Genetic Algorithm (GA) to guarantee a minimum vibration transition from the vibratory loaded blade to the blade hub. Here, Genetic Algorithm (GA) which is a general optimization tool for searching of large, nonlinear, discrete, and poorly-understood design spaces that arise in many areas of science and engineering like the design and optimization of laminated composite structures is utilized. However, constrained optimization via the Genetic Algorithm (GA) is often a challenging endeavor, as the GA is most directly suited to unconstrained optimization problems. Note that, traditionally, external penalty functions are used to convert a constrained optimization problem into an unconstrained problem for GA-based optimization studies [3]. Therefore, here, the death, static, linear-dynamic, and a newly developed penalty function that is so called two-part penalty are employed for the GA design optimization of bending and lagging vibration transition with the minimum blade weight.

2. References

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