

Fatigue Analysis and Life Estimation of the Helicopter Horizontal Tail under Cyclic Loading by Using Finite Element Method

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Abstract : Horizontal Tail of helicopter is exposed to repeated oscillatory loading generated by aerodynamic and inertial loads, and bending moments depending on operating conditions and maneuvers of the helicopter. In order to ensure that maximum stress levels do not exceed certain fatigue limit of the material and to prevent damage, a numerical analysis approach can be utilized through the Finite Element Method. Therefore, in this paper, fatigue analysis of the Horizontal Tail model is studied numerically to predict high-cycle and low-cycle fatigue life related to defined loading. The analysis estimates the stress field at stress concentration regions such as around fastener holes where the maximum principal stresses are considered for each load case. Critical element identification of the main load carrying structural components of the model with rivet holes is performed as a post-process since critical regions with high-stress values are used as an input for fatigue life calculation. Once the maximum stress is obtained at the critical element and the related mean and alternating components, it is compared with the endurance limit by applying Soderberg approach. The constant life straight line provides the limit for several combinations of mean and alternating stresses. The life calculation based on S-N (Stress-Number of Cycles) curve is also applied with fully reversed loading to determine the number of cycles corresponds to the oscillatory stress with zero means. The results determine the appropriateness of the design of the model for its fatigue strength and the number of cycles that the model can withstand for the calculated stress. The effect of correctly determining the critical rivet holes is investigated by analyzing stresses at different structural parts in the model. In the case of low life prediction, alternative design solutions are developed, and flight hours can be estimated for the fatigue safe operation of the model.

Keywords : fatigue analysis, finite element method, helicopter horizontal tail, life prediction, stress concentration

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