

Analysis of the wing box with spliced skin and estimation of the fatigue life for the wing box

Aircraft is symbol of a high performance mechanical structure with a very high structural safety record. Safety and the structural weight are important parameters to be considered in the design phase. Rarely an aircraft will fail due to a static overload during its service life. For the continued airworthiness of an aircraft during its entire economic service life, fatigue and damage tolerance design, analysis, testing and service experience correlation play a pivotal role.

The attachment joints are inevitable in any large structure like an airframe. Splicing is normally used to retain a clean aerodynamic surface of the wing skin. The wings are the most important lift-producing part of the aircraft. Wings vary in design depending upon the aircraft type and its purpose. The wing box has two crucial joints, the skin splice joint and spar splice joint. Top and bottom skins of inboard and outboard portions are joined together by means of skin splicing. Front and rear spars of inboard and outboard are joined together by means of spar splicing. The skins resist much of the bending moment in the wing and the spars resist the shear force.

In this study the chord-wise splicing of wing skin is considered for a detailed analysis. The splicing is considered as a multi row riveted joint under the action of tensile in plane load due to wing bending.

Stress analysis of the joint is carried out to compute the stresses at rivet holes due to by-pass load and bearing load. The stresses are estimated using the finite element approach.

In a structure like airframe, a fatigue crack will appear at the location of high tensile stress. Further these locations are invariably the sites of high stress concentration. Life prediction requires a model for fatigue damage accumulation, constant amplitude S-N data for various stress ratios and local stress history at the stress concentration. Such life prediction methodologies are empirical in nature and therefore require test validation. In this project the fatigue life to crack initiation is evaluated under a realistic service load spectrum using a local stress strain approach.

Keywords: Aircraft, Wing box, Spliced skin, Stress analysis, FEM, Fatigue life, Load spectrum.