Bird Strike Simulation for BA609 Spinner and Rotor Controls

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Abstract

Bird strike incidents are not uncommon and cost the U.S. civil aviation industry approximately $495 millions and 631,341 hours of downtime annually [1]. The development test to meet the bird strike certification requirements is very costly and time-consuming. This paper presents the bird strike analysis using the Arbitrary Lagrangian-Eulerian (ALE) technique in LS-DYNA for the BA609 spinner and rotor controls assembly shown in Figure 1. The objective is to reduce the development costs and cycle time while achieving weight-efficient resistant design by accurately predicting the composite failures and structural impact performance – with the ultimate goal of certifying by analysis only.

The spinner assembly provides the swashplate drive load path and aerodynamic fairing for the rotor hub and controls. The failure of the spinner assembly could result in loss of the aircraft. Therefore the assembly must show compliance with "continued safe flight and landing" requirements following the high-energy bird impact. An idealized cylinder with hemispherical ends surrounded by air, which is modeled as 1-point ALE solid elements, is used to represent the bird model. The bird strike finite element model is validated through correlation with the tests conducted at the Southwest Research Institute of San Antonio in February 2005.

This paper analyzes three most load-critical test conditions and evaluates the structural failures of the spinner assembly subjected to the bird strike dynamic loads. Figure 2 shows the correlation of one of the airplane mode shots for a 4.0-lb [1.8-kg] bird fired from a compressed gas gun at 240 kts [127.3 m/s] impact velocity targeting at the upper spoke of the spinner controls. Numerical results showed favorable correlation in terms of composite failure modes on the spinner cone, and the secondary impact fracture of the controls components such as upper spoke and cyclic link. The validated analytical model is used as a design support tool to produce useful information on the load mechanisms to guide the program for redesign.

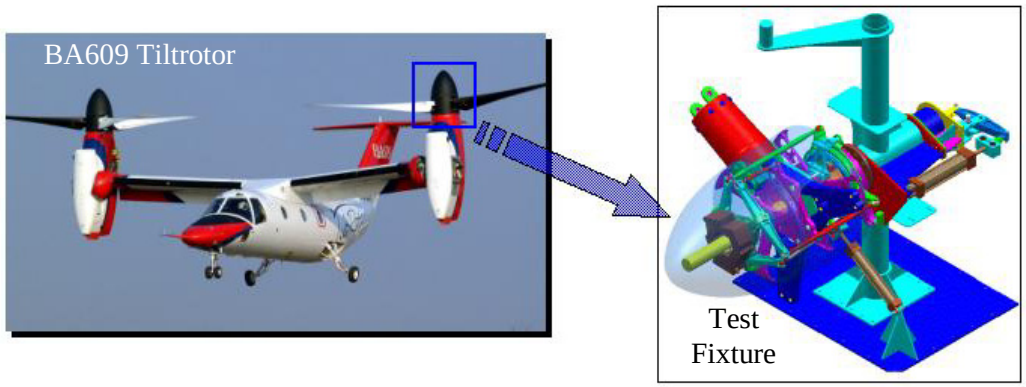

Figure 1. BA609 Rotor and Spinner Controls

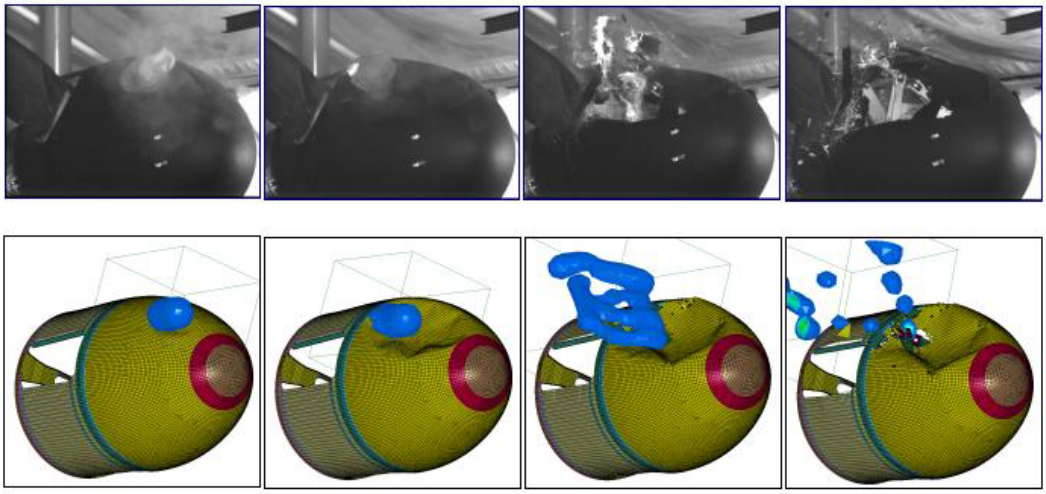

Figure 2. LS-DYNA Correlation for Shot Targeting the Upper Spoke

References

1. Edward Cleary et. al., Wildlife Strikes to Civil Aircraft in the United States 1990-2004, Federal Aviation Administration National Wildlife Strike Database, No. 11, 2005.