THE X-37 HOT STRUCTURE CONTROL SURFACE TESTING

Summary

Thermal-structural testing of three hot structure control surface subcomponent test articles (STA) designed for the X-37 (Boeing Phantom Works, Huntington Beach, California) Orbital Vehicle (OV) has been completed. The test articles were subcomponents of the X-37 OV bodyflap and flaperon control surfaces (figs. 1 and 2).

Figure 1. The X-37 Orbital Vehicle subcomponent test articles.

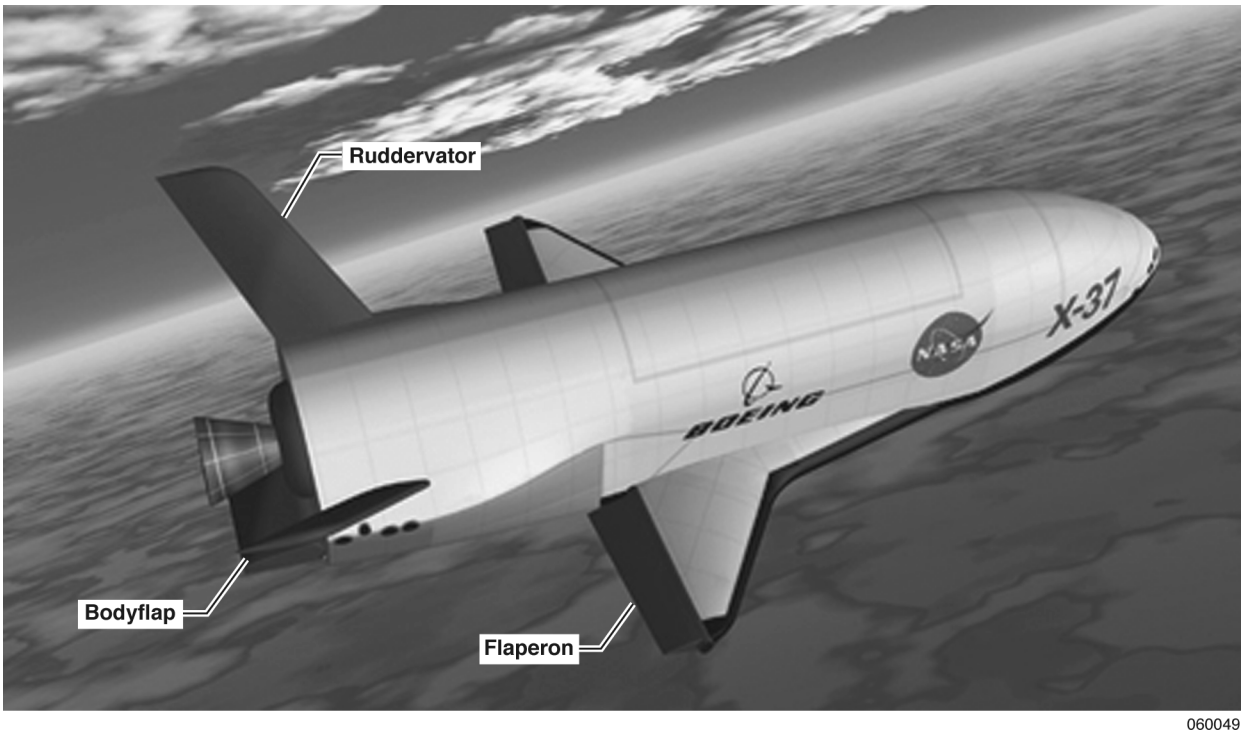

Figure 2. The X-37 Orbital Vehicle hot structure control surfaces.

The bodyflap STA was fabricated using carbon-silicon carbide (C/SiC). It had overall dimensions of approximately 24 in. L x 20 in. W x 4 in. H. The bodyflap STA was tested under combined thermal and structural loading to approximately 2100 °F and 100 percent of the design limit load (DLL) with no observable damage.

A C/SiC and carbon-carbon (C/C) flaperon STA was also tested under thermal and structural loading. Each STA utilized the same X-37 OV aerodynamic heating and loading profile information. Each STA also included a titanium spindle and an Inconel® Huntington Alloy Products Division, International Nickel Company, Huntington, West Virginia, outboard hinge pin.

The C/SiC Flaperon STA had overall dimensions of approximately 14 in. L x 30 in. W with a leading edge to trailing edge taper of 5 in. to 2 in. The STA was thermally and structurally loaded to 2400 °F and 100 percent DLL, respectively. It was also tested under combined structural and thermal loading and experienced 50 percent DLL at approximately 1800 °F. A final test to failure was performed at room temperature, which resulted in the C/SiC STA failing at 170 percent DLL.

The C/C flaperon STA had overall dimensions of approximately 19 in. L x 37 in. W with a leading edge to trailing edge taper of 5 in. to 1 in. The C/C STA was thermally and structurally loaded to 2300 °F and 100 percent DLL, respectively. A final test to 200 percent DLL was performed at room temperature, which resulted in the C/C STA showing no indications of failure.

Objective

The overall objective of the STA testing was to acquire structural ground test data on the performance of C/SiC and C/C hot structure control surfaces while being subjected to the simulated re-entry thermal and structural loading associated with the X-37 OV. The test data was used to verify the structural model and finite element analyses of each STA design.

Approach

Each STA was tested thermally in a nitrogen purged atmosphere (fig. 3). Structural loading was performed in air when not combined with thermal loading. Each STA was instrumented with high-temperature fiber optic strain sensors and thermocouples, both of which were bonded to the C/SiC and C/C substrates using the NASA Dryden Flight Research Center developed thermal-spraying techniques.

EC03-0275-03

EC04-0151-09

Photo courtesy of Larry Hudson

Figure 3. The X-37 Orbital Vehicle subcomponent test articles under test at NASA Dryden Flight Research Center.

Status

All STA testing has been completed and the test results have been documented, with the flaperon STA results being incorporated into the X-37 Flaperon Qualification Unit test program planned for completion in fiscal year 2005.

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