

Sikorsky Aircraft Corporation

Customer Profile: Michael Urban and Alan Dobyms

Michael Urban is Manager of Structural Methods and Alan Dobyms is Senior Engineer for Sikorsky Aircraft Corporation in Stratford, Connecticut. A subsidiary of United Technology Corporation, Sikorsky is a world leader in helicopter design, manufacture and service. Urban, Dobyms and their co-workers are responsible for ensuring the structural integrity of critical helicopter components. In the past, the company built many different versions of components such as tail rotors and tail covers and tested their ability to withstand bird strikes at a cost of \$1,000,000 per test.



Michael Urban



Alan Dobyms

Challenge

In the past, Sikorsky had to perform expensive bird strike test programs to certify critical helicopter components. These tests are expensive because they require building prototype components and testing them on a very elaborate rig. For example, the rig used to test the ability of a tail rotor to withstand bird strikes uses a hydrostatic drive system transmission to provide accurate speed control in driving the rotor and a gas cannon to fire gelatin projectiles.

Solution

MSC Dytran explicit finite element analysis software.

Benefit

Sikorski validated MSC Dytran simulation by showing that its predictions closely match physical testing. The company now uses Dytran simulations to optimize component design and then uses a single test to verify the analysis for certifications. This approach provides substantial cost savings and also makes it possible to provide a higher level of structural performance by evaluating more design alternatives than was possible in the past. The possibility also exists that it may be possible to eliminate testing as more experience is gained with simulation.

Case Study

"No structural analysis capability has in the past proved itself capable predicting the effects of bird strike events on helicopter components," Urban said. "So in the past we had to perform anywhere from a few to dozens of design/build/test iterations to meet design requirements. But MSC Dytran is specifically optimized for dynamic crash and impact events so we felt that it had a good chance of success. We set out to use it to simulate bird strike events on the S-92 Helibus helicopter."

Sikorski engineers created a finite element model consisting of beam elements for the flexbeam, torque tube and inboard rotor blade and with plate and hex elements for the outboard rotor blade at the bird impact point. The composite flexbeam makes it possible to change the pitch of the rotor without the need for bearings in the rotor by permitting motion in the flap and lag direction without the need for moving parts. The torque tube is used to provide torsional rigidity in the pitch axis.

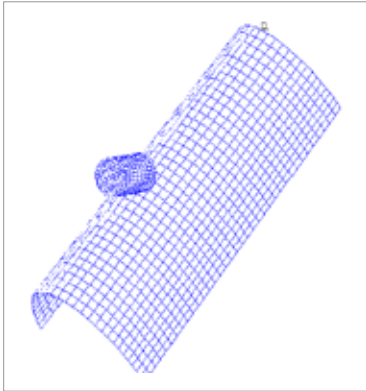
The structural model was constructed with Lagrangian finite elements. Two types of bird models were used in the analysis: a Lagrangian bird consisting of hex elements with the density and bulk modulus of water

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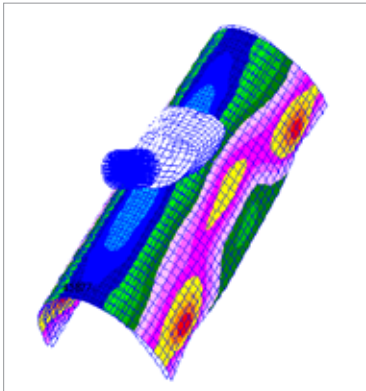
and a Eulerian fluid bird flowing through a finite difference mesh. The key difference between Eulerian and Lagrangian coordinates is that the Lagrangian description follows one particular particle while the Eulerian description of motion observes a parcel of material through space and time.

For the Lagrangian bird technique the bird elements are given an initial velocity that causes them to impact the structure finite element model. Master-slave contact interfaces apply bird element loads to the structure. Using the Eulerian technique, the bird elements apply loads to the structure elements using Dytran's general coupling option. The Eulerian bird model gave better correlation to the test data than the water bird model.

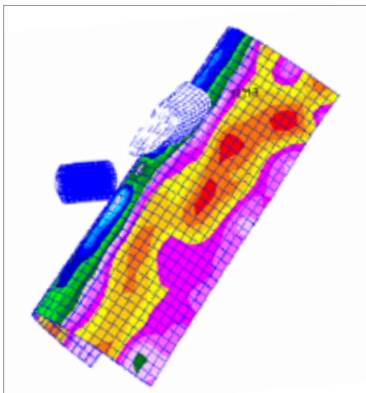
"The correlation between test and analysis was close enough to enable the successful design of rotors for bird strike," Dobyms said. "The calculated moments on the flexbeam ranged from right on to twice the test values while the calculated moments for the blades were to 2/3 of the test values. This level of accuracy is acceptable for component design since the rotor blade is normally much stronger than required for the bird strike load while the flexbeam is closer to being critical. Overpredicting the flexbeam loads will only make it stronger than necessary and underpredicting the blade moments can be adjusted for by maintaining a minimum margin of safety of 2.0 for the blade design."



Pylon and bird



Bird at 2 ms



Bird at 2 ms

MSC Products Used:

Dytran

- Explicit nonlinear solver technology for simulating short duration dynamic events
- Robust and efficient 3D contact
- Complete finite element model library that includes beams, shells, solids, springs and dampers
- Nonlinear material models
 - Metals
 - Composites
 - Soils
 - Foam rubber
 - Liquids
 - Gases
- Coupled fluid-structure interaction
- Parallel processing for improved productivity
 - Shared memory parallel
 - Distributed memory parallel

Company Profile

Sikorsky Aircraft Corp., based in Stratford, Conn., is a world leader in helicopter design, manufacture and service. Its Sikorsky Aerospace Services business designs and applies advanced logistics and supply chain solutions for commercial rotary, military rotary and fixed wing operators. United Technologies Corp., based in Hartford, Conn., provides a broad range of high technology products and support services to the aerospace and building systems industries worldwide. Sikorsky helicopters are used by all five branches of the United States armed forces, along with military services and commercial operators in 40 nations. Core U.S. military production programs are based on the Sikorsky H-60 aircraft: the BLACK HAWK helicopter for the U.S. Army and SEAHAWK® helicopter for the U.S. Navy. The CH-53E helicopter and MH-53E helicopter heavy-lift aircraft are flown by the U.S. Navy and Marine Corps to transport personnel and equipment, and in anti-mine warfare missions.

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