MSC.Software
Case Study

Case Study: Explicit Simulation with Dytran in Defense Industry

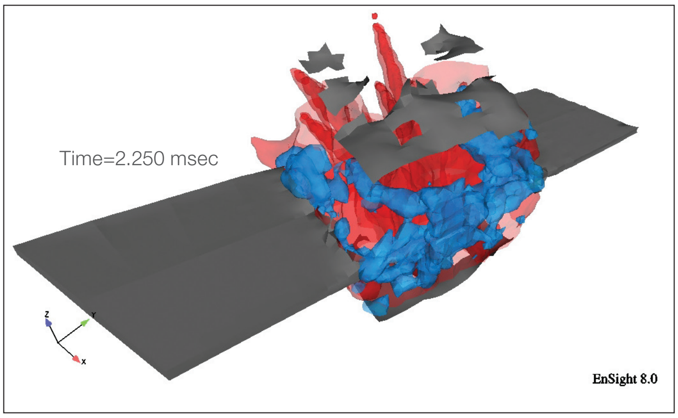
Agency for Defense Development Makes Great Strides in Airframe Survivability Research with MSC.Software

Company Profile

The Korean Agency for Defense Development (ADD) is the single national agency in Korea for the research and development of national defense technology. ADD focuses on the development of highly advanced technologies for core weapon systems.

Challenge

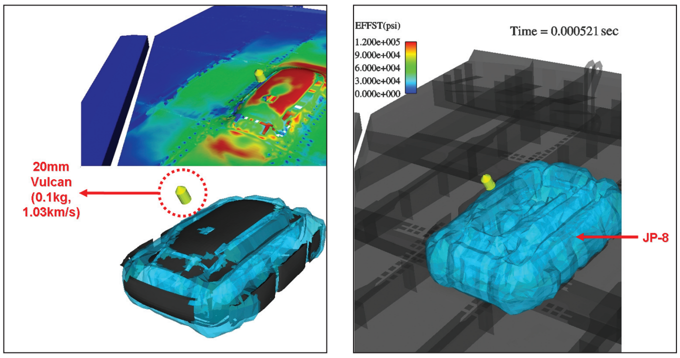
The Aeronautical technology directorate, one of the subordinate parts of ADD recently took on responsibility for the first step in airframe survivability design for future military aircraft. Dr. Jun, airframe structural team lead, says, "There are plenty of features to enhance aircraft survivability, but in order to make airframes more survivable against weapon threats, the first step has to be an understanding of the possible damage they can inflict on an aircraft."



ADD assigned Mr. Kim, a computational analysis specialist for this task. He simulated various threats that an aircraft might receive in a combat environment including hydrodynamic ram. Hydrodynamic ram effect is the damage that a projectile with high velocity inflicts upon a structure with inside fluid and the resulting blast wave as it penetrates. "Because there are a lot of possible threats and damage scenarios, it is virtually impossible to simulate each of them so Dr. Jun and I paid specific attention to hydrodynamic ram, which is one of representative threats and poses a great threat to fuel tank survivability," he says. The ballistic effect of hydrodynamic ram is comprised of complicated physics including penetration and detonation that occur in a mutually interactive series of events, which make it a difficult simulation challenge.

Solution

Mr. Kim turned to MSC.Software's Dytran product to address the challenge. He explains, "I found that previous studies regarding hydrodynamic ram are mostly limited to rudimentary analyses partly due to the absence of a computational tool that can simulate the interaction between fluid and structure with high fidelity.



MSC.Software's simulation tool Dytran was recently updated with a multi-material Euler solver feature that works with multiple coupling surfaces, through which mass can flow from one coupling surface to the other." That feature enabled Kim to simulate the variation of the Eulerian region of fluid and air as well as that of the Lagrangian region as the projectile progresses or explodes inside the tank. This was previously impossible when only the Arbitrary Lagrange-Euler (ALE) and limited general coupling were available. Aside from that feature, he employed the adaptive master-slave contact and the adaptive Euler mesh of Dytran to realize the structural rupture by a projectile and to make the matrix calculation more quickly. Applying the detonation analysis to a single bay of the Intermediate Complexity Wing (ICW) fuel tank proved successful and confidence-inspiring. ICW is one of the typical wing models used for the preliminary design and optimization research of wing structure.

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However, Kim needed another clue to advance his simulation to the application of a real fighter wing model. "A fuel tank is divided into many cells by spars and ribs that share adjacent tank bays. This makes defining coupling surfaces difficult," he says. But the fact that these tank partitions are holed in many locations to facilitate fuel flow led him to apply the multi-porosity algorithm of Dytran to solve this problem. He adds, "With this algorithm included in the analysis, volume transfer through coupling surface occurs during hydrodynamic ram event by pressure difference. This realization of fuel flow between bays enables simulation of interaction inside tank structure." By using Dytran to solve this problem, Kim was able to accurately simulate the results of this challenge.

Benefit

Hydrodynamic ram simulation still has plenty of room for improvement, but using MSC.Software's Dytran, Mr. Kim finds it is now possible to address its challenges. He concludes, "When I started this job, it looked like a long shot as there were so many uncertain parameters within this specific challenge. By using Dytran, I was able to take so much of the unknown out of hydrodynamic ram simulation. I'm confident that the evolution of MSC.Software's solutions will continue to provide the possibilities and the tools to help me simulate things that I never before thought possible."

Dytran is an explicit finite element analysis (FEA) solution for analyzing complex nonlinear behavior involving permanent deformation of material properties or the interaction of fluids and structures.

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