Development and Applications of a Coupled CFD/CSD Methodology using an Embedded CSD Approach

Joseph D. Baum, Eric L. Mestreau, Hong Luo, Rainald Löhner, Daniele Pelessone and Charles Charman

Center for Applied Computational Sciences, ASG
SAIC, 1710 SAIC Drive, MS 2-6-9, McLean, VA 22102, USA
e-mail: baum@apo.saic.com

Michael E. Giltrud

Defense Threat Reduction Agency/TDACS, Alexandria, VA 22310 USA
e-mail: mike.giltrud@dtra.mil

1. Abstract

This paper describes recent algorithm developments and select applications of a program that couples parallel Computational Fluid Dynamics (CFD) and Computational Structural Dynamics (CSD) methodologies. FEFLO98 is the CFD code used while DYNA3D handles the CSD portion. FEFLO98 solves the time-dependent, compressible Euler and Reynolds-Averaged Navier-Stokes equations on an unstructured mesh of tetrahedral elements. DYNA3D solves explicitly the large deformation, large strain formulation equations on an unstructured grid composed of bricks and hexahedral elements.

While the initial coupled algorithm used the so-called "glued-mesh" approach, where the CFD and CSD faces match identicaly, failure of this approach to model severe structural deformation, as well as crack propagation in steel and concrete, led us to the development of the so-called "embedded-mesh" approach. Here, the CSD objects float through the CFD domain. While each approach has it's own advantages, limitations and deficiencies, the embedded approach was proven to be superior for the class of problems modeled here. Critical applications of both approaches are described, including weapon detonation and fragmentation, airblast interaction with a reinforced concrete wall, and fragment/airblast interaction with a steel wall. The final application models the interaction of an external airblast with a generic steel ship hull.