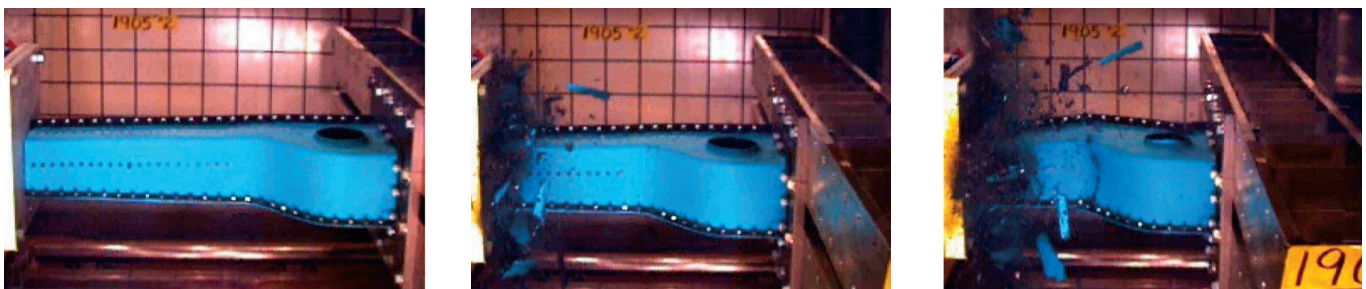


CZone for Abaqus

Advanced crush simulation for energy-absorbing structures made from laminated composites



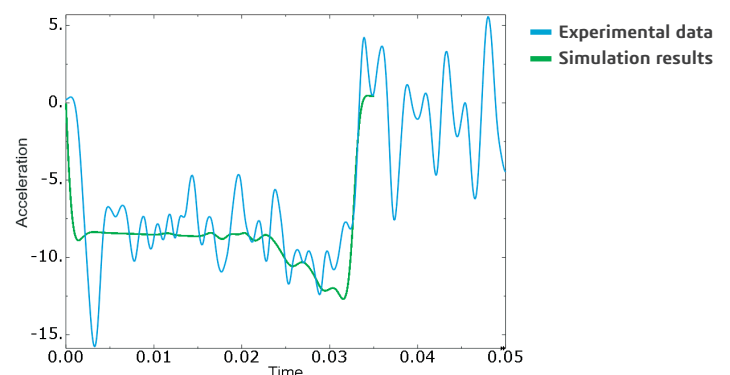
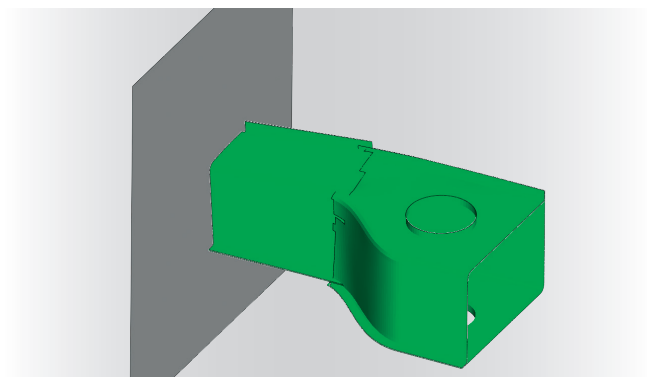
A mass of 1150 kg. moving at an initial velocity of 9.1 m/s impacts a complex composite cone structure in an experimental sled test. Crushing of the cone progresses to a point where a large fracture develops suddenly in the transition region between the cone and its backup structure.

Overview

Crushable structures that absorb energy during impact are used in automobiles, helicopters, aircraft, trains, and other transport vehicles to help protect occupants and cargo from shock and injury during a crash. Composite materials hold great potential for providing increased energy absorption in lower-weight crushable structures as compared to conventional heavier metallic designs. A lack of commercial, industry-standard methods to simulate and accurately predict the crushing of these materials during impact has impeded the widespread application of composite materials in crushable structures.

CZone for Abaqus is a new add-on capability to Abaqus/Explicit that provides access to a state-of-the-art methodology for crush simulation. Based on CZone technology from Engenuity Ltd., and targeted toward the design of composite components and assemblies in the Automotive and Aerospace industries, CZone for Abaqus provides for inclusion of material crush behavior in FEA simulations of composite structures subjected to impact.

Right, CZone for Abaqus results predict well both the crushing response and the sudden fracture outside the crush front. Acceleration histories of the sled mass correlate well when comparing experimental data (blue) against simulation results (green).



CZone for Abaqus

Features & Benefits

CZone technology provides direct implementation of crush-based element force generation and failure in defined “crush zones,” typically located at the forward edges of the structure in direct contact with the impactor. CZone for Abaqus simulations determine the extent of material crushing and other modes of composite failure, the energy absorbed in the crush zone, and the forces generated by material crushing. The behavior of the composite structure outside the crush zone is simulated utilizing existing Abaqus capabilities to account for possible delamination, damage, fracture, and buckling.

With CZone for Abaqus results as a guide, a proposed design can be altered to optimize the placement, thickness, construction, and geometry of crush structures to maximize their energy-absorbing capacity.

Crush properties for candidate materials can be obtained in a cost-effective manner from coupons cut from flat panel specimens. Such crush testing and calibration services are available directly from Engenuity; other test laboratories are also developing this capability. This information can also help in screening and selecting appropriate materials to use in a structure and evaluate whether candidate materials behave well or poorly during crushing.

Crash Simulation with Abaqus

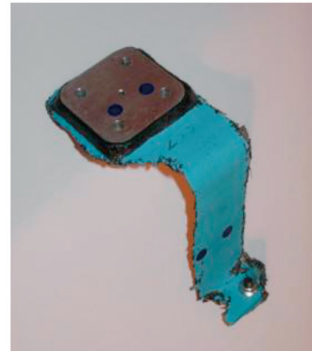
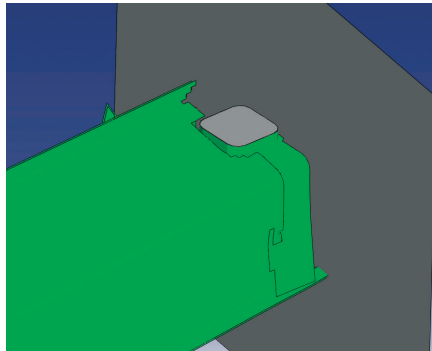
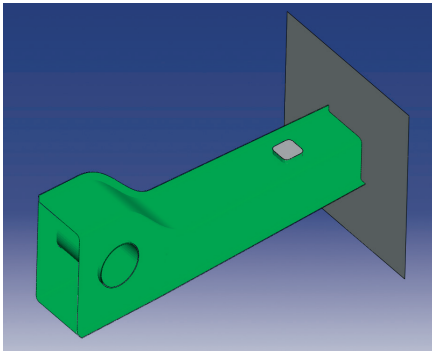
As a foundation for supporting the CZone technology, Abaqus provides extensive capabilities to address crashworthiness and occupant safety simulation for the Automotive and Aerospace industries. This has been an ongoing strategic focus for several years, and Abaqus has been adopted as the primary tool for such design simulation at the OEM level.

CZone for Abaqus represents the next step in extending crash simulation capabilities with Abaqus to include the prediction of the crushing behavior of composite structures. It also complements existing Abaqus capabilities for composite failure analysis, including damage mechanics for material degradation and failure, VCCT for brittle delamination, cohesive element technology for failure in adhesively bonded regions, and specialized woven composite material models.

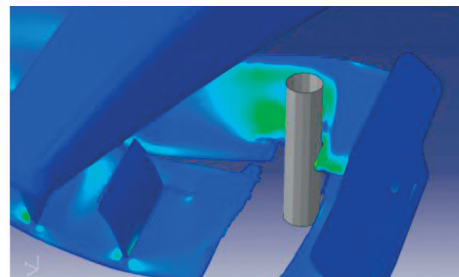
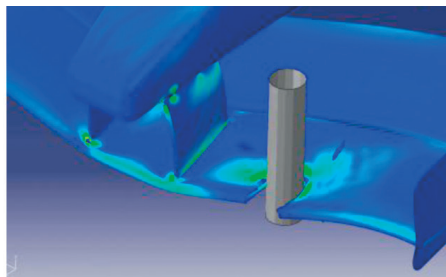
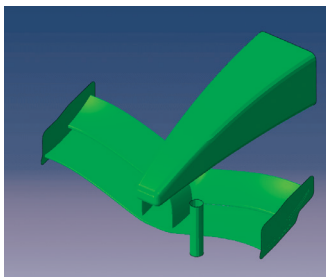
For More Information

To learn how CZone for Abaqus can add value to your composite design processes, contact your local SIMULIA Center for Simulation Excellence.

www.3ds.com/simulia



Crushing of a composite cone structure with a rigid insert bonded into a cutout in the cone is simulated in CZone for Abaqus. As the impactor reaches the bonded insert, a fragment including the insert and portion of the cone breaks away from the structure, comparing well against a similar fragment that is produced in the experimental test.



The composite front wing for an F1 race car is impacted against a rigid pole. Progressive crushing of the wing occurs as the pole penetrates through the wing. Significant forces are also transferred through the structure, causing the wing to then break away from the vehicle.