



White paper

Simulation
enabling technologies

Quadcopter - Wing Collision Simulation

A complete solution for Aerospace crash
simulations pre- and post- processing

Crash simulations are relative complex processes, considering all required steps, from model import and simplification, mesh generation, material description, to boundary conditions, contacts and initial conditions setup. Starting from a detailed CAD model, BETA CAE Systems provides all the necessary tools for Aerospace crash simulations pre- and post- processing.



With the UAV industry rapidly growing, there is an increasing need for simulation, either regarding the vehicle itself, or how it affects its environment. These last years there are reports, concerning damages caused to manned aircraft wings due to mid-air collisions with drones. Similar to the more traditional airborne hazard, mostly for aircraft engines, the bird strike, a collision with even a recreational, light-duty quadcopter can cause significant damage to the primary structure, or even penetration into the airframe. Computer modelling and simulation is naturally the first step in the course of investigating such cases. Analyses like these offer challenges not only in terms of model quality, but also in terms of meshing and quick and efficient handling of material and component representation. BETA CAE Systems provides all the necessary tools as a complete solution for crash simulations pre- and post-processing in the Aerospace industry.

CAD geometry import

The first step in such an analysis is the import of the CAD model. Including translators for most commercially available CAD software suites (CATIA, SolidWorks, PTC Creo, NX, Inventor, etc), but also accepting neutral files (.stp, .stl, .iges, etc), ANSA can accept a large variety of file formats. The included Geometry Checks can help the user detect issues that either existed in the design or were created during the translation. In most cases, such issues can be fixed automatically.



Figure 1: Quadcopter CAD model

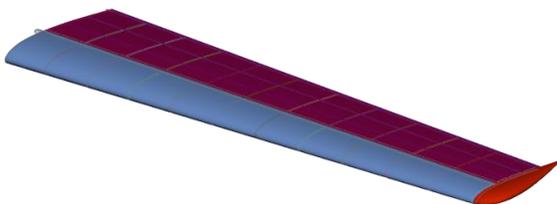


Figure 2: Wing model

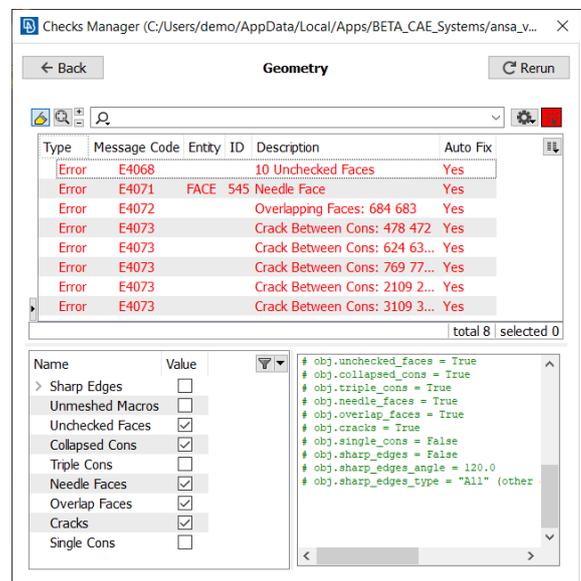


Figure 3: Geometry checks



Model simplification

The first thing to do after the model is imported, is to simplify it. Usually, most fasteners are small and they contain excessive detail for a typical crash analysis. Using the **Feature Manager**, the **DM Browser** and the **Connection Manager**, these fasteners can be defined, saved in a database, and recognized for the whole model. Then, they can be replaced with a much simpler FE representation. 3D representations of sheet composite parts can be converted to shells using the Skin function. Casting can also be used in cases with more complex shapes, to reduce model complexity.

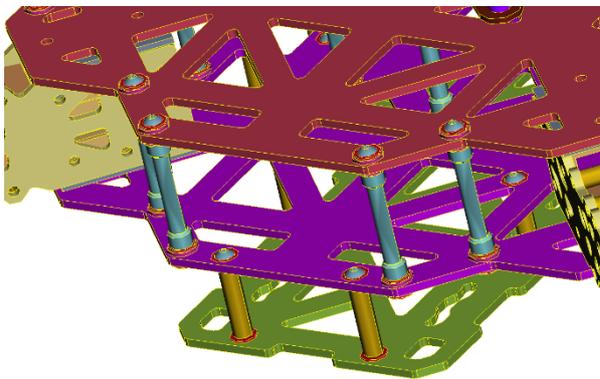


Figure 4: Initial model

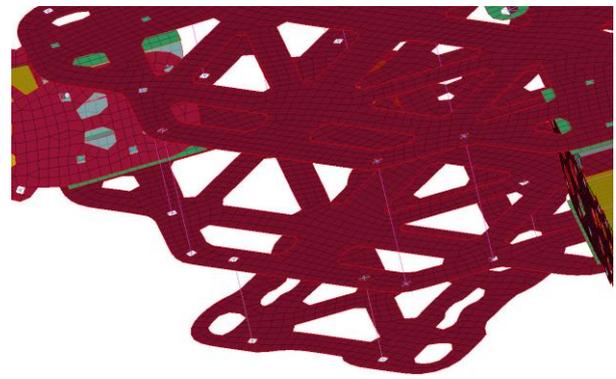


Figure 5: Simplified model

Meshing

Maybe the most important aspect in any simulation is the mesh characteristics and quality. Especially in a simulation that involves many different components, with various shapes and sizes that have to be treated differently, the meshing procedure becomes even more crucial. **Batch Mesh** can be used to define these different mesh scenarios and automatically improve the mesh in areas that violate some defined quality criteria.

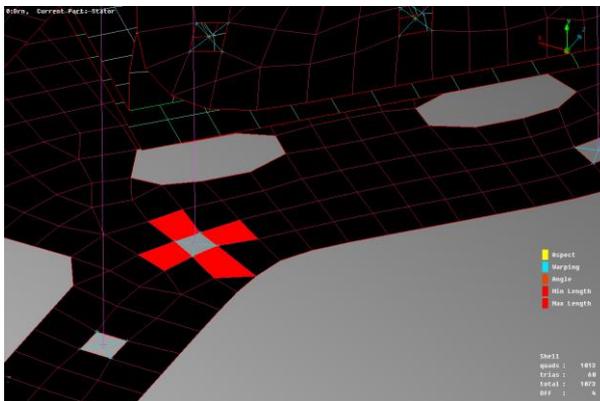


Figure 4: Elements violating quality criteria

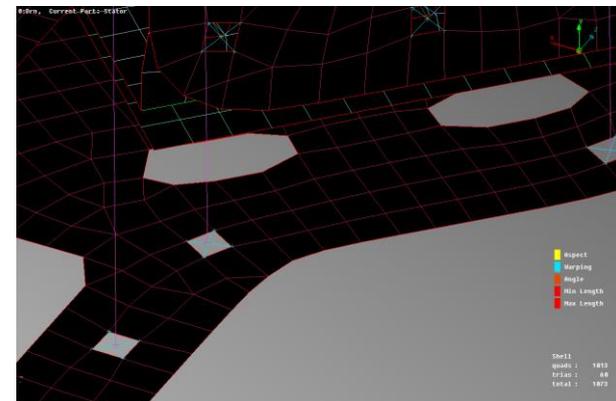


Figure 5: Elements Fixed

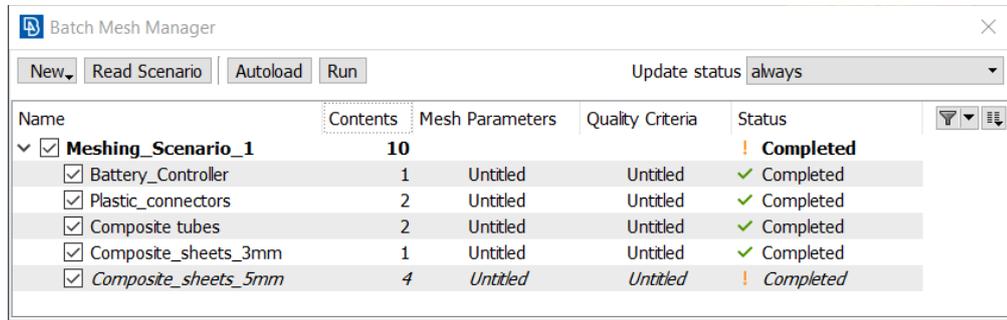


Figure 6: Batch mesh sessions

Composite material modeling

The **Laminate Tool** was used to define the properties of the composite sheet parts that make up the quadcopter's body. All actions, from adding or removing layers, to editing (material, orientation, thickness) can be carried out within the tool.

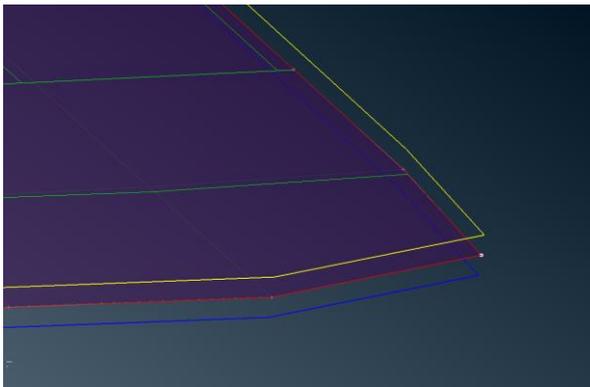


Figure 7: Laminate property with 3 layers

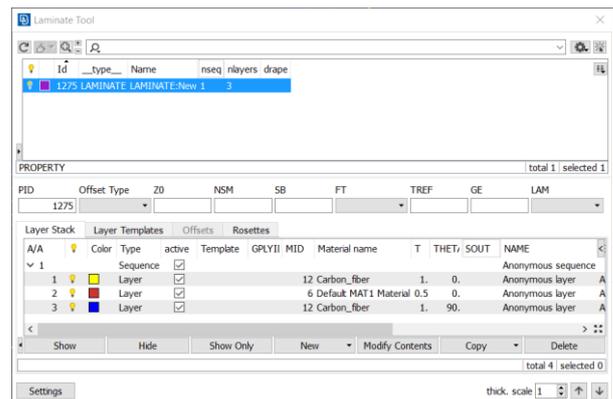


Figure 8: Laminate tool

Analysis preparation

After the model is meshed, the boundary and initial conditions have to be defined. The wind is fixed on its inner end and the quadcopter has an initial velocity of 250 mph.

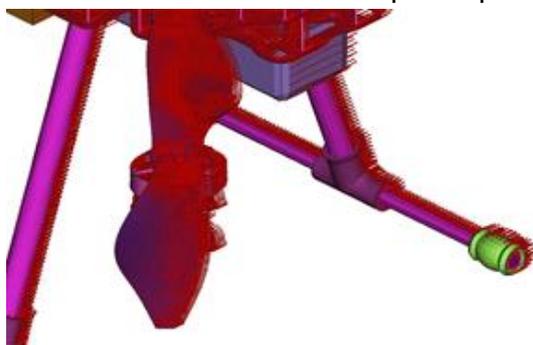


Figure 9: Initial velocity definition

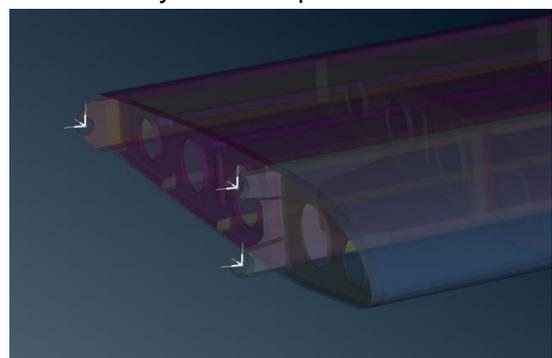


Figure 10: Fixed wing



Additionally, the contacts between the different parts have to be defined. In, this case, there are three different contact sets; two for the quadcopter and wing assemblies and one between the previous two.

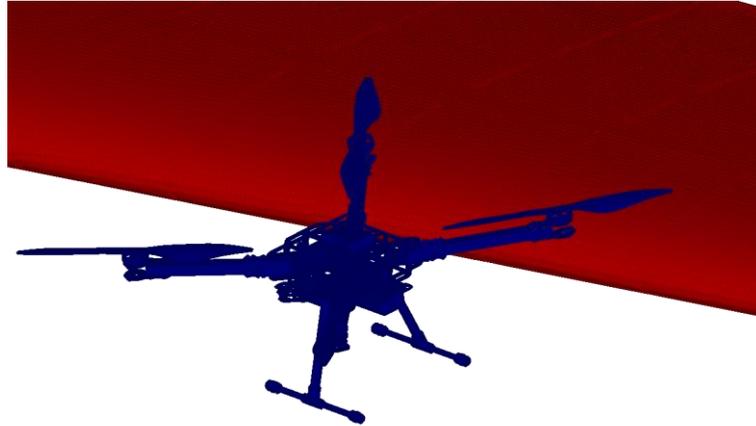


Figure 11: Contact definition between the quadcopter and the wing

Any other complicated task can be carried out using customized scripts. The incorporated ANSA API, an extension of the Python programming language, can be used to access the core ANSA functionality and data, allowing for execution of complex tasks, not available through the hard-coded, standard functions.

Results

After the analysis has run the results can be displayed in META. The user can browse through the different timestamps and view the results at each point. META also offers powerful options for 2D results handling and viewing through enhanced 2D plots. Comprehensive reports, including plots, images and spreadsheets can be created with the **Report Composer**. All executed actions can be recorded in session files and then reapplied in different run variations, highly increasing the efficiency and effort required for response extraction.



Figure 12: 32ms after impact

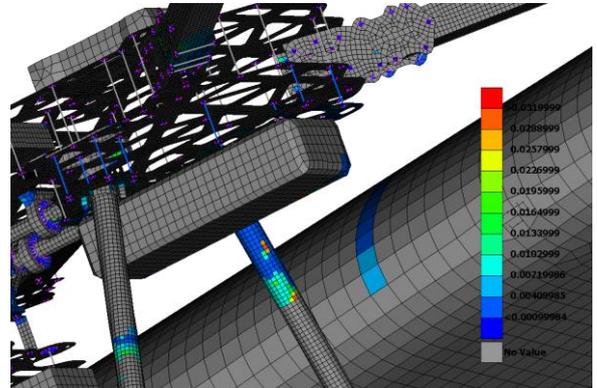


Figure 13: Time of failure of failed elements

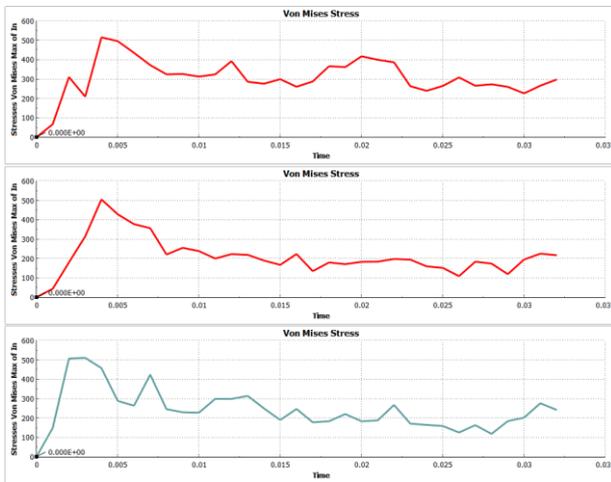


Figure 14: Von Mises Stresses plots

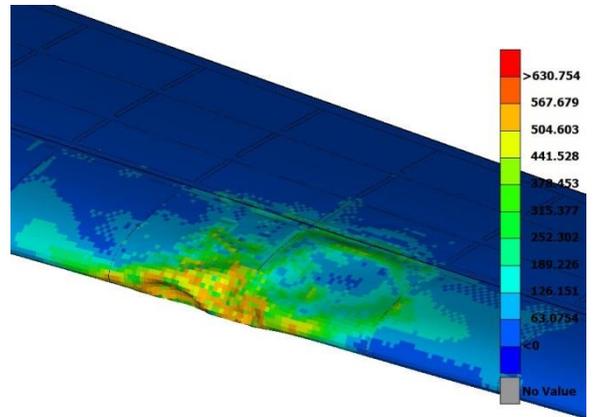


Figure 15: Von Mises Stresses fringe plot

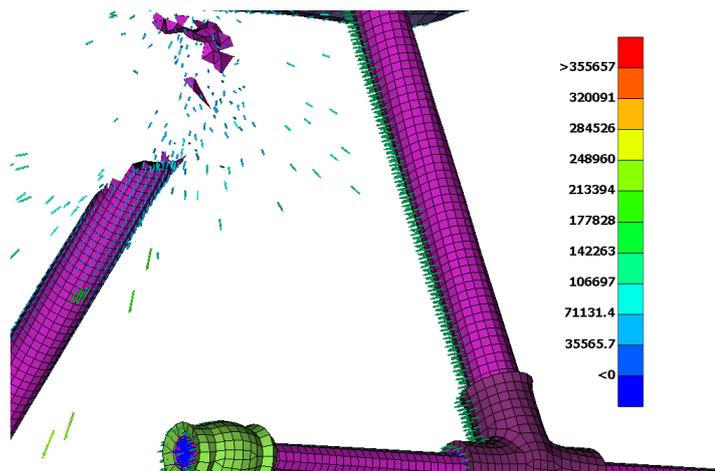


Figure 16: Velocities after impact



Conclusions

Aerospace crash simulations are multi-step, complex processes, starting from model import and geometry cleanup, to meshing and contact definition. Using the ANSA pre-processor, it is possible to handle all of these steps, taking advantage of many advanced, dedicated tools, with high automation capabilities, to set up and output a model, ready to run in any solver. The generated results can then be loaded in the META post-processor. Using a large variety of tools and functions, the results can be visualized and extracted in reports. Along with the capability to create customized tools and processes through scripting and the potential to automate most of the aforementioned steps, ANSA and META constitute a complete solution for aerospace industry simulations.

About BETA CAE Systems International AG

BETA is a simulation solutions provider, dedicated to the development of state of the art software systems for CAE. For almost 30 years, we have been developing tools and delivering services for the front-runners in numerous sectors by listening to their needs and taking up even the most demanding challenges. For more information on BETA CAE systems, our products, and our services, visit www.beta-cae.com

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physics on screen

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