National Aeronautics and
Space Administration

TECHNOLOGY SOLUTION

Aerospace

Lightweight Energy Absorbing Composite Airframe Subfloor

Conical energy absorbing design for use in attenuating crash/impact loads

NASA Langley Research Center has developed a novel design for a lightweight energy absorbing (EA) composite subfloor structure. The technology's primary application is to increase occupant survivability in the event of an aircraft crash. Current airframe subfloors unpredictably buckle, splay, and collapse under crash loads. This technology exploits the inherent stability associated with a conusoidal geometry and material combination of carbon and aramid fibers to allow the structure to bend and fold in a controlled manner at a particular load level.

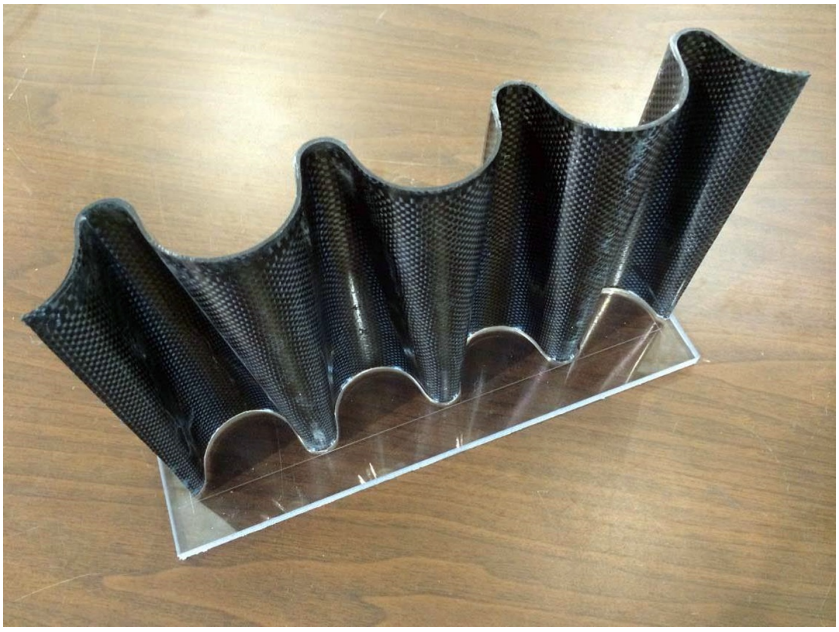
BENEFITS

- Is more lightweight than metallic airframe alternatives
- Has better lateral loading effects compared to traditional metallic structures that are less stable and can buckle or break
- Simple to manufacture
- Will be tested under full-scale helicopter conditions, providing additional comparison data

THE TECHNOLOGY

This technology's conusoidal geometry is based on right-side-up and up-side down halfcones placed in an alternating and repeating pattern. This geometry combines a simple cone design with a sinusoidal beam geometry to create a structure that utilizes the advantages of both designs. The first major advantage of the conusoidal design is it provides crush trigger mechanisms due to dissimilar conical radii dimensions on the crash front. This is consistent with many energy absorbing (EA) designs which contain trigger mechanisms to limit the peak crush load and achieve acceptable crush initiation behavior. Second, because the conical walls are formed at an inward angle relative to the geometric centerline of each cone, the crushing is self-stabilizing. Finally, as the graphic below shows, the dissimilar radii create an inherent forward leaning angle, which offers advantages when examining loading conditions with a multi-axial component of loading.

Many potential materials and layup combinations were candidates for the fabrication of the conusoidal EA. Specific interest was given to both the conventional and hybrid families of woven fabrics. Hybrid material systems consisting of carbon and aramid fibers were considered for use since they would potentially contain desirable characteristics that would serve as an advantage for energy absorbing performance. These material systems would offer both stiffness characteristics from the carbon fibers and deformation/ductility characteristics from the aramid fibers.



Conusoidal specimen

APPLICATIONS

The technology has several potential applications:

- Aircraft
- Rotocraft
- Spacecraft re-entry vehicles
- Automobiles
- Packaging containers

PUBLICATIONS

Patent No: 9,616,988

Littell, Justin D., The Development of a Conical Composite Energy Absorber for Use in the Attenuation of Crash/Impact Loads., Sept 08, 2014 Conference Paper, NASA Langley Research Center, Hampton, VA, http://ntrs.nasa.gov/search.jsp?R=20150001245

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LAR-18463-1, LAR-TOPS-171

More Information

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NP-2015-08-2006-HQ