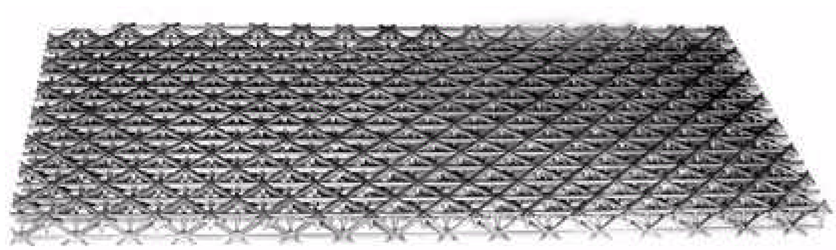
Initial Mechanical Testing of Superalloy Lattice Block Structures Conducted

The first mechanical tests of superalloy lattice block structures produced promising results for this exciting new lightweight material system. The testing was performed in-house at NASA Glenn Research Center's Structural Benchmark Test Facility, where small subelement-sized compression and beam specimens were loaded to observe elastic and plastic behavior, component strength levels, and fatigue resistance for hundreds of thousands of load cycles.

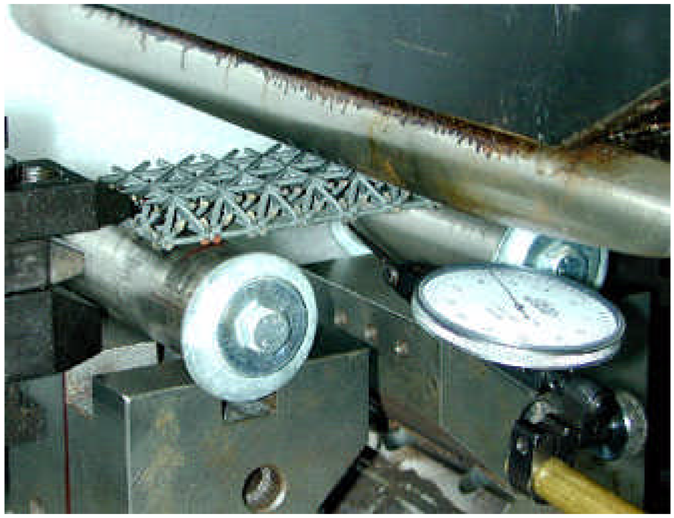
Current lattice block construction produces a flat panel composed of thin ligaments arranged in a three-dimensional triangulated trusslike structure. Investment casting of lattice block panels has been developed and greatly expands opportunities for using this unique architecture in today's high-performance structures. In addition, advances made in NASA's Ultra-Efficient Engine Technology Program have extended the lattice block concept to superalloy materials. After a series of casting iterations, the nickel-based superalloy Inconel 718 (IN 718, Inco Alloys International, Inc., Huntington, WV) was successfully cast into lattice block panels; this combination offers light weight combined with high strength, high stiffness, and elevated-temperature durability.



Cast Inconel 718 lattice block panel, approximately 130 by 300 by 12 mm (5 by 12 by 0.5 in.).

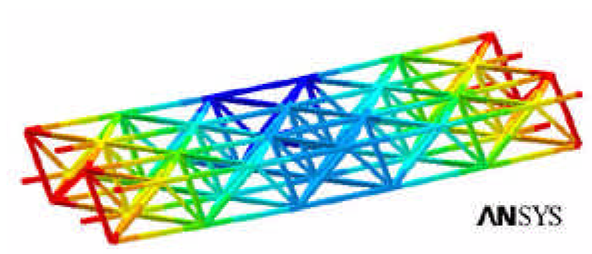
For tests to evaluate casting quality and configuration merit, small structural compression and bend test specimens were machined from the 5- by 12- by 0.5-in. panels. Linear elastic finite element analyses were completed for several specimen layouts to predict material stresses and deflections under proposed test conditions. The structural specimens were then subjected to room-temperature static and cyclic loads in Glenn's Life Prediction Branch's material test machine. Surprisingly, the test results exceeded analytical predictions: plastic strains greater than 5 percent were obtained, and fatigue lives did not depreciate relative to the base material. These assets were due to the formation of plastic hinges and the redundancies inherent in lattice block construction, which were not considered in the simplified computer models. The fatigue testing proved the value of redundancies since specimen strength was maintained even after the fracture of one or two ligaments.

This ongoing test program is planned to continue through high-temperature testing. Also scheduled for testing are IN 718 lattice block panels with integral face sheets, as well as specimens cast from a higher temperature alloy.



Lattice block specimen installed in test machine for bending fatigue test.

The initial testing suggests the value of this technology for large panels under low and moderate pressure loadings and for high-risk, damage-tolerant structures. Potential aeropropulsion uses for lattice blocks include turbine-engine actuated panels, exhaust nozzle flaps, and side panel structures.



Finite element model of a bend test specimen showing contours of expected deflections.
Long description : Photograph showing the bend test specimen supported by rollers on each end and loaded at its centerline through a round bar fixture; a dial indicator accurately measures the center deflection.

Find out more about this research:
Ultra Efficient Engine Technology http://www.ueet.nasa.gov/
Glenn's Life Prediction Branch http://www.grc.nasa.gov/WWW/LPB/

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