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Marshall Space Flight Center

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Boron Aluminum Composite Structures

Design, analysis and fabrication techniques have been developed for boron-aluminum composite structure technology and were compared with those of conventional metal structure technology to evaluate relative performance. In the developmental program, efforts were concentrated toward developing the capacity to design and analyze boron-aluminum structures and to fabricate the structures in a production shop. These efforts were based on a eutectic bonding process for joining of monolayer boron-aluminum foils into laminate composite parts.

The developmental program involved formulation of a material specification for the boron fibers, specifically for use in aluminum matrix composites and for the monolayer boron-aluminum foil sheets used as the starting material in the production process. Specifications were also initiated for the eutectic bonding methods. Various tools, machines and techniques were investigated that were needed to perform the drilling, counter-sinking, routing, machining, cutting and trimming required to fabricate the test panels. These investigations were performed to transfer information already developed in the laboratories to the production shop. Many tests were performed to determine the strength, elastic, and local instability as well as joint properties of the boron-aluminum composite fabricated in the production shop.

Additional studies were conducted to select the configuration and to proportion the elements of the test panel. These included investigation of stringer shape, thickness, and spacing; skin thickness and frame spacing; and configuration and material distribution. Results of the studies, in addition to those involving trade-offs in stringer shape vs. fastener requirements, in frame design to achieve shear transfer from the skin, in tension clip effects on the stringer, and requirements for joggles and in joints, were used in the design of a 48 inch by 61.5 inch (1.21 by 1.56 in) test panel. Tests were then conducted on the panel in two sequences, the first involving loading to 30% of design ultimate load at room temperature. The sequence was compression, unload, pure shear, unload, and combined compression and shear. The second sequence involved loading to failure in a stepped sequence at 500°F (260°C). Results of these studies show a high weight savings potential provided by the strength of boron aluminum structures. The developed composite structures are primarily for application on the Space Shuttle vehicles, but could be advantageous in other areas, particularly the aircraft industry.

Note:

Requests for further information may be directed to:
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No patent action is contemplated by NASA.

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