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NASA TECH BRIEF

Marshall Space Flight Center

Production of Circular Polymer-Glass Fabric Composites

The problem:

Following in the footsteps of the stone, bronze, and steel ages, the term polymer age may come to typify the most prevalent material of the years to come. Already, so many things are made partly or wholly of polymers that it is impossible to list them all. There are polymer cloths, polymer pens, polymer boats and cars, and polymer cups. Indeed, most anything manufactured today has at least been considered as a possible use for polymers. One class of polymers, composites of glass tape or fabric interplied with various resins, offers lightweight materials of considerable strength. But until structural elements utilizing composite materials can be economically produced, full scale integration of such composites in major construction will be severely limited. The main difficulty in manufacturing composite structures, especially curved ones, is aligning the individual filaments which make up the material in a way that gives the best properties for a given design.

The solution:

The most attractive way of fabricating aligned-filament composites is by pultrusion. The pultrusion of flat segments of glass reinforced polymers such as polyesters is fairly well established. But recent work has broken a "shape barrier" by providing a potentially automated pultrusion technique for the production of curved, glass-reinforced polyimide, epoxy, and graphite reinforced structures.

How it's done:

Conventional pultrusion, with the appropriate dies, can be modified for the pultrusion of composite materials. Specially designed apparatus has been manufactured for the production of curved structures. A prototype apparatus of this sort has been used to fabricate curved hat sections.

In one series of runs, the sections were made from preimpregnated epoxy/glass fabric cover-layers and slit strips with two layers of unidirectional tape immediately under each fabric outer-surface ply. The glass content of this composite system can be made to be 64% and higher.

One particular problem that arises during the pultrusion of composites is the jamming of the equipment by excess volatiles present in the prepreg. This occurs because most commercial epoxy prepregs have a 4 to 8% excess of volatiles. This is no problem in conventional technology where the volatile constituents are pressed out and collected in bleeder cloths, but anything over a 1 to 3% volatile content presents a serious problem in pultrusion.

Until a more suitable resin is commercially available, much of the excess volatile may be removed by baking in an oven at 99° C for about four hours. Also of interest is that the layup must be symmetrical about the mid-plane to avoid warping and bending from uncompensated stresses during cure.

The production of good quality curved hat sections of graphite polymide has proven the feasibility of this technique. The availability of such curved composite structures should open up new uses in virtually all areas of construction and transportation.

(continued overleaf)

Note:

Requests for further information should be directed to:

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Patent status:

NASA has decided not to apply for a patent.

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