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Produced by the NASA Center for Aerospace Information (CASI)

M. C. GILL CORPORATION

NASA CR-
147429

January 9, 1976

REPORT

INTEGRALLY RIGIDIZED ACOUSTIC

INTERIOR SPACECRAFT PANEL

PER

NASA CONTRACT NO. T-1743D

(NASA-CR-147429) INTEGRALLY RIGIDIZED ACOUSTIC INTERIOR SPACECRAFT PANEL (Gill (M. C.) Corp., El Monte, Calif.) 12 p HC $3.50 CSCL 22A
N76-16146
Unclas
G3/18 13390

1.0 OBJECTIVE:

The objective of this project is to develop the technology for producing light weight acoustic panels which incorporate monolithic fiber-reinforced thermoset plastic I-beams for the structural core. The materials used are to be very resistant to fire and possess low smoke generation properties.

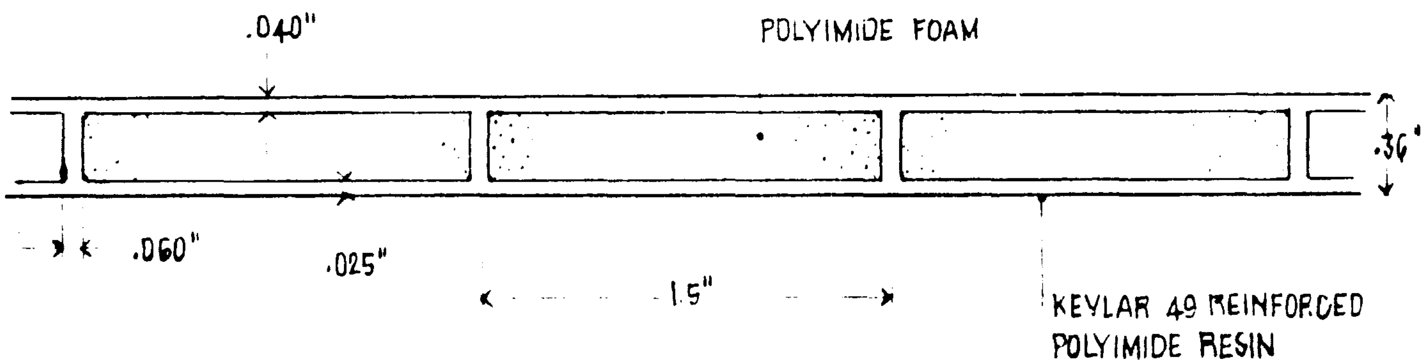
2.0 BACKGROUND:

The M. C. GILL CORPORATION, El Monte, California has patented a novel sandwich panel concept which utilizes a monolithic I-beam design as the core. The core and skins are integrally bonded with thermosetting resin into a homogeneous structure. See Figure 1.

In addition to possessing a high strength to weight ratio, the panel resists combustion, delamination, aging due to fatigue, localized stresses and exhibits good acoustic properties.

Since the basic panel concept has definite potential as a high flame retardant and low smoke emission panel with excellent structural integrity, new aerospace materials were tried in this contract in order to optimize the construction for highly demanding NASA space shuttle applications.

The specific materials of construction were chosen by NASA as a result of a funded NASA study program. Namely, for low flammability and off-gassing properties as well as for strength, light weight and sound dampening.



3.0 SPECIFIC CONTRACTOR ACTIVITY:

The M. C. GILL CORPORATION was directed to fabricate Style 5166 I-beam panels described above for the characterization of mechanical properties employing the following materials on a best efforts basis:

Kevlar 49 fiber reinforcement - DuPont
Skybond 703 polyimide resin - Monsanto
Skybond polyimide foam of 3 pcf density - Monsanto

4.0 RESULTS:

The panel was satisfactory in appearance. The test results were:

		Test Method	Target	Obtained
4.1	Thickness, inch	-	.40"	.358"
4.2	Weight, lb/ft^2	-	0.62 max.	0.60
4.3	8" flex - 2 pt. loading	Fed Std 401		
	ultimate load, lbs.		500	181
	deflection at 150 lbs., inch		0.1 max.	.16
4.4	20" flex - 2 pt. loading	Fed Std 401		
	ultimate load		(200)	104
	deflection at 100 lbs.		(.45)	.67
4.5	Compressive strength, psi	-	500 min.	230
4.6	2" dart impact	BMS 4-202	(35)	360

( ) targets in parenthesis are state-of-art, but were not specifically called out in this NASA contract.

5.0 DISCUSSION:

5.1 A .4" x 24" x 60" test panel, R534-3, is submitted to NASA for their testing and evaluation per the conditions of the contract.

5.2 The polyimide foam supplied to us by NASA through a contract with Monsanto was under-cut in thickness, being .30-.33" thick when we had wanted .37-40" thick. Consequently it was impossible for us to fabricate the panel to the target thickness of 0.4" and we made our panels .35" thick. This was approved by the NASA Contract Administrator. But rigidity increases to 3rd power with thickness and we feel no flooring should be thicker than 0.4".

5.0 Discussion

5.2 continued.
The polyimide foam gave us considerable trouble during fabrication. It was extremely fragile and had to be handled very carefully or it would break. In addition it had almost no compressive strength which made it very difficult to apply any pressure on the skins during curing, thereby increasing the volatile content of the face skins. However, the polyimide foam was stable when heated for the cure cycle and did not present any off-gassing problems.

5.3 Kevlar 49 was selected by NASA as the reinforcement because of its low weight and high tensile and impact properties, however, it is very poor in compressive strength and this characteristic was a serious defect in the finished panel. Our test results showed strength, but similar panels made with glass cloth at the same weight per square foot have passed the requirements of this contract. We have found this result before in similar applications. The Kevlar 49 is not a satisfactory material for the face skin of a sandwich panel. Its inherantly low compressive strength seriously reduces the flexural strength of the panel since the face skin is loaded in a compressive mode.

The Kevlar did impart excellent impact resistance, in fact, it has the highest impact readings we have seen for any panel weighing under 1 lb/sq.ft. The Kevlar also seemed to possess good vibration dampening characteristics and the panel seemed to have acoustic dampening properties, although we do not have the capability to test for sound dampening.

There has been some work done with weaving hybrids, such as combinations of S-glass and Kevlar, and it is quite possible that a hybrid cloth would enable us to meet the targets of this contract. Our results with a phenolic resin-glass cloth, shown below, indicate we could make a satisfactory laminate by using S-glass reinforcement in lieu of Kevlar.

5.0 Discussion (continued)

	Target	Polyimide-Kevlar (NASA Contract)	Phenolic-glass panel (Boeing-NASA)
Thickness, in weight,	.4	0.35	.4
lb/ft^2	.62 max.	0.60	.625
20" flex, 2 pt. load			
ultimate load	(200 min.)	104 lb.	.234 lb.
deflection at 100 lbs.	(.45" max.)	.67"	.37"
Compressive strength, psi	500 min.	230	520
2# dart impact, ft.-lbs.	(35 min.)	360	80

5.4 The polyimide resin used, Skybond 703, was not ideally suited for fabrication for a 5166 style panel. The prepreg was much too tacky, making the lay-up difficult. For future work we would recommend the following prepreg properties if using Skybond 703:

	R534-3	Recommended	Test Condition
resin solids	41%	39-3	Wt. of prepreg cured 20 min. @ 450°F compare to wt. of dry Kevlar fabric.
volatiles	18%	12-16	Wt. loss of 4" x 4" on exposure to 750°F for 2-1/2 min.
resin flow	45%	35-40	Wt. loss of 4 plys 4" x 4" after 10 min. at 15 psi and 450°F

The polyimide resin can be used, although all the polyimide resins we have worked with to date are difficult to fabricate. It is possible there are resins better suited for our application.

6.0 PROPOSALS:

6.1 Since only one set of materials was used in the manufacture of the 5166 panel, it is highly probably that we could improve the test properties by using alternate materials.

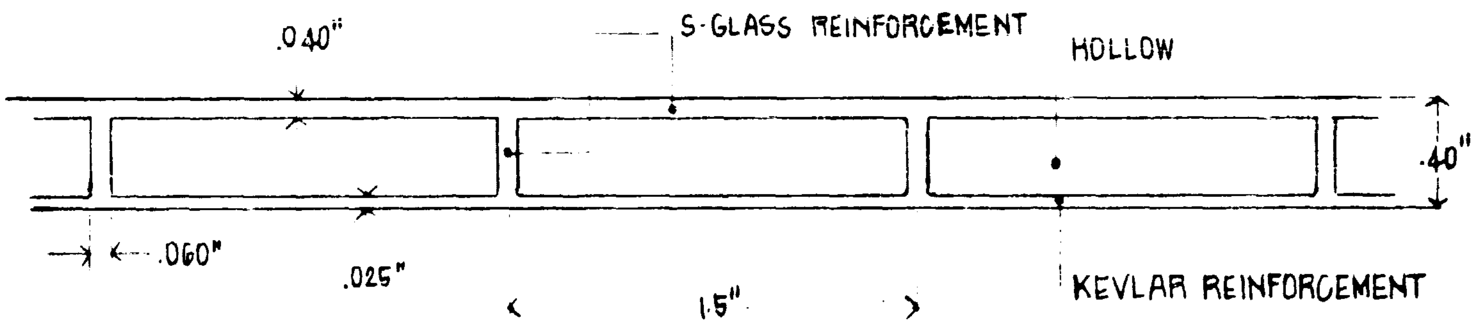
6.2 Face skin to be reinforced with S-glass or a combination of S-glass and graphite and/or Kevlar.

6.3 Mandrels to be wrapped with 6 mil thick glass cloth rather than Kevlar.

6.4 Kevlar is the recommended reinforcement for the back or bottom skin only.

6.0 PROPOSALS (continued)

6.5 The polyimide foam is very expensive and difficult to work with, and due to its low structural strength it contributes nothing to the strength of the finished panel. It is possible to make a 5166 panel without any foam between the I-beams. Such a hollow 5166 would be lighter in weight than a panel with the foam, but it would not have as good acoustic and thermal insulating properties. It would also cost less. Another possibility is to foam-in-place polyimide foam in the hollow spaces after the panel has been cured.



6.6 It may be possible to improve upon Skybond 703, which we used on this project as the thermosetting resin. We would have to consult with alternate resin manufacturers. We have been told of better resins systems, but we have no direct experience with these resin systems and at present many of the latest resin developments are shrouded in secrecy.

7.0 CONCLUSIONS:

While the panel made on this contract did not meet the target requirements, it would be possible to manufacture a similar, but lower cost, panel that would.

1.0 OBJECTIVE:

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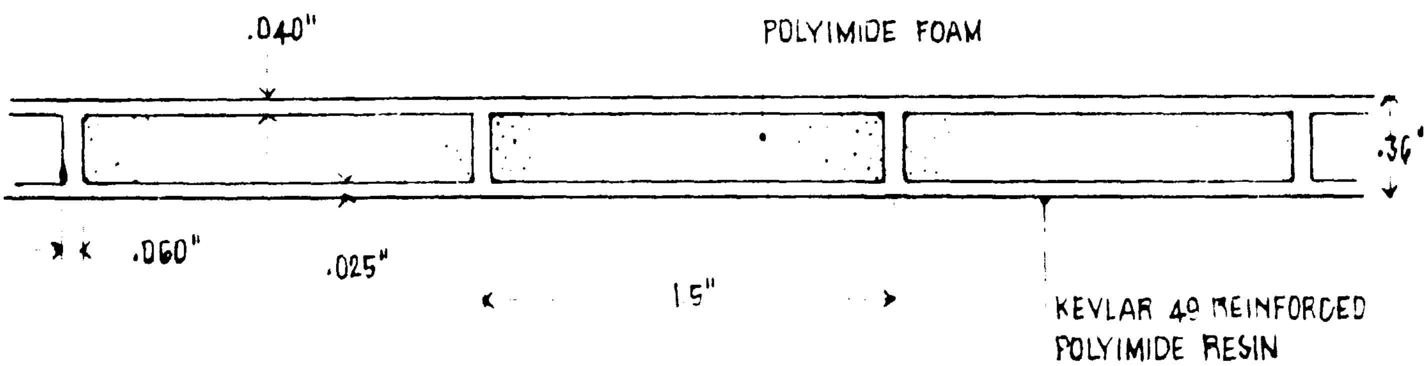

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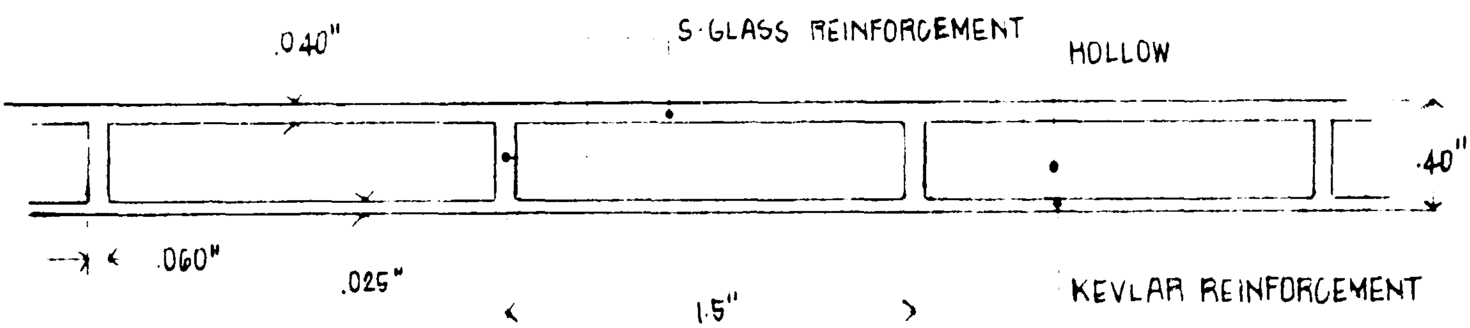

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