RECEIVED BY DTIE JAN 18 1971

308

**Kansas City
Division**

REPRODUCTION OF THIS DOCUMENT IS UNLAWFUL

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

THIS DOCUMENT CONFIRMED AS
UNCLASSIFIED
DIVISION OF CLASSIFICATION
BY J.H. Kahn Jamh
DATE 1/25/71

SPLIT
FIBERGLASS
HOLDER

MASTER
BDX-613-198

August, 1970

Prepared by:
H. F. Darbyshire
Department 812

—LEGAL NOTICE—

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

P8141

Technical Communications

**Kansas City
Division**

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

This report was

Prepared by:

H. F. Darbyshire
D/812

Approved by:

E. A. Kroencke
D/812

KANSAS CITY DIVISION
BENDIX AEROSPACE-ELECTRONICS COMPANY
KANSAS CITY, MISSOURI
A prime contractor for the Atomic Energy Commission
Contract Number AT(29-1)-613 USAEC

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Atomic Energy Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

ABSTRACT

Fabrication techniques were developed and six fiberglass holder assemblies (Holder, Split Fiberglass K65006) were manufactured. One test part and several material specimens were made and test results are given.

CONTENTS

Section		Page
1	SUMMARY	1
2	DISCUSSION	3
	FABRICATION MATERIALS	3
	<u>Fiberglass Cloth</u>	3
	<u>Fiberglass Roving</u>	4
	<u>Epoxy Resin System</u>	5
	FABRICATION PROCEDURE	5
	<u>Aluminum Ring</u>	5
	<u>Cloth Impregnation</u>	5
	<u>Layup</u>	7
	<u>Cure</u>	7
	<u>Finishing Operations</u>	7
	PART PHYSICAL CHARACTERISTICS	8
	RECOMMENDATIONS	8
	DISTRIBUTION	15

ILLUSTRATIONS

Figure		Page
1	Split Fiberglass Holder, Half Section	2
2	Material Orientation	6
3	Cloth Section Being Placed on Mandrel (P-65443)	9
4	Wrapping With Dry Roving to Pull Material Into Grooves (P-65442)	10
5	Overwrapping Lower Portion With Nylon Tape (P-65445).	11
6	Final Wrapping With 20-End Roving (P-65352)	12
7	Half Section Fiberglass Holder (P-65687)	13
8	Fiberglass Holder Assembly (P-65688)	14

TABLES

Number		Page
1	Flexural Data From 4-Inch Glass Cloth - Epoxy Laminate Specimens	3
2	Tensile Data From 9-Inch Glass Cloth - Epoxy Laminate Specimens	4
3	NOL Ring D-Test Data (ASTM D-2290)	4
4	Analysis of Samples From Three-Layer Cloth Section of Preliminary Unit.	8

Section 1

SUMMARY

Order number 92-4455 from Sandia Livermore was for the development of fabrication techniques and the manufacture of six fiberglass holder assemblies (K65006). Figure 1 shows a cross section of one half of the assembly. The other half is identical except for the joint on the aluminum ring. The holder is being evaluated for use as a support structure.

One part was manufactured for testing and six parts were manufactured for delivery. Fabrication techniques were designed to keep the void content as low as possible. Void content on the test part was around 1 percent, about the best that could be expected with the layup fabricating method required.

Figure 1. Split Fiberglass Holder, Half Section

Section 2

DISCUSSION

FABRICATION MATERIALS

Fiberglass Cloth

The cloth used for layup is woven from Owens Corning 901 sized S-glass material in a 181 style pattern. The 181 style has essentially the same number of fibers in both the warp and fill directions (57 per inch by 54 per inch). Flat panels were fabricated for machining into flexure and tensile specimens (ASTM D-790). The glass content of the panels was 61 percent by weight and 43 percent by volume. The panels were 1/8 inch thick and were made with 12 layers of cloth. An epoxy resin system consisting of ERL 2256 and Epon Z was used. All specimens were machined from the principal fiber direction. Tables 1 and 2 list the data that was gathered from the panels. Poisson's ratio was determined by mounting two strain gages (axial and transverse) on three of the tensile bars, plotting a curve of the two strains, and then measuring the change in strains for given increments on the curve.

Table 1. Flexural Data From 4-Inch Glass Cloth - Epoxy Laminate Specimens

Panel	Sample	Flexure Strength (psi)	Modulus (psi x 10 ⁶)
1	3	103,600	3.38
1	4	105,900	3.43
1	5	97,100	2.61
1	6	105,300	3.38
2	1	103,400	3.32
2	2	102,200	3.30
2	6	102,100	3.32

Table 2. Tensile Data From 9-Inch Glass Cloth - Epoxy Laminate Specimens

Panel	Sample	Ultimate Tensile Strength (psi)	Modulus (psi x 10 ⁶)	Maximum Strain (%)	Poisson's Ratio
1	7	86,003	7.37	1.57	0.100
1	8	89,171	NA	NA	
1	9	88,277	7.57	1.77	
1	10	87,068	7.37	1.60	
1	11	87,711	7.30	1.43	0.108
2	7	85,677	6.47	1.71	
2	8	85,682	7.23	1.71	0.118
2	9	83,464	7.43	1.37	
2	10	81,569	7.47	1.47	
2	11	87,833	7.26	1.58	

Fiberglass Roving

The hoop wrapping is done with Owens Corning 901 sized, 20-end, S-glass roving. The material used in the fabrication of the six assemblies was evaluated using NOL rings. The tensile strengths obtained from eight NOL rings are shown in Table 3.

Table 3. NOL Ring D-Test Data (ASTM D-2290)

Sample	Tensile Strength (psi)	Sample	Tensile Strength (psi)
1	221,093	5	225,989
2	230,071	6	207,156
3	220,653	7	225,989
4	215,003	8	224,661

Epoxy Resin System

The resin system used and the formulation was:

<u>Component</u>	<u>Manufacturer</u>	<u>Formulation</u>
ERL 2256	Union Carbide	100 parts by weight
Epon Z	Shell	27 parts by weight

The following average properties for this resin system were determined from previous projects. The properties were obtained from 9-inch tensile bars machined from cast resin slabs. The cure cycle was 24 hours at 165°F.

Tensile Strength - 14,000 psi

Modulus - 6×10^5 psi

Strain Maximum - 3.5%

FABRICATION PROCEDURE

Aluminum Ring

The portion of the aluminum ring surface that comes in contact with the glass-epoxy material is coated with Epon 956 to increase the bond between the aluminum ring and the composite material. The aluminum surface is vapor blasted prior to spray coating the Epon 956 and cured for 1 hour at 150°F after coating.

Cloth Impregnation

The fiberglass cloth is impregnated with the epoxy resin system between layers of Mylar and is partially cured for 4 hours at 120°F. The resin is then in a tacky condition so that the material can be worked with during layup and will undergo complete flow during the cure cycle. This particular resin system is only usable for a period of about 48 hours after impregnating the cloth. A template is used to cut the sections of cloth with the fiber direction as shown in Figure 2.

Figure 2. Material Orientation

Layup

The quarter sections of cloth are laid up on the mandrel with 1 inch overlap between sections. A total of three layers of cloth are used, with the overlaps in each layer being staggered by 30°. The fold-back material overhangs each end of the mandrel. Figure 3 shows a cloth section and the material on a mandrel. The material is pulled down in the grooves by wrapping with dry roving under high tension (Figure 4). When the material is adequately pulled down, this dry roving is removed. The groove at the small end is then wet-wrapped with 48 revolutions of 20-end roving. To eliminate wrinkles, the four layers of fold-back material are split every 4 inches. The splits are staggered 1 inch apart in each layer so that complete separation does not occur through the entire thickness of the fold-back portion. The material is then folded back and overwrapped with wet 20-end roving to hold it in place.

The lower portion of the layup is overwrapped with 3/4-inch-wide nylon textile tape as shown in Figure 5. This material will shrink during cure and compact the layup while acting as a bleeder cloth to absorb the excess resin which flows out of the part.

The groove in the large end is wet-wrapped with 30 revolutions of 20-end roving. The fold-back material is split every 3 inches through the three layers together and then folded back. Roving is wrapped as shown to compact the overlapped material and to build up a section which will later be machined. Figure 6 shows the final wrapping and the aluminum stops that are used around the mandrel to keep the roving from slipping.

Cure

The mandrel is then placed on a rotating cure fixture and cured for 1 hour at 150°F plus 6 hours at 250°F.

Finishing Operations

After cure, the nylon tape is removed and the large end next to the aluminum is template-machined to final configuration. The cloth section and small end are sanded to remove any resin-rich areas on the outside. To seal the machined areas and give a protective coating to the outside, the composite portion is coated with Epon 956. Prior to coating, some filling is done on the outside of the small end with epoxy resin so that the contour is smooth. The final products are shown in Figures 7 and 8.

PART PHYSICAL CHARACTERISTICS

The thickness through the three layers of cloth was about 0.050 inch. Optimum compaction of the material would have yielded a thickness of about 0.030 inch. Four samples from a preliminary part were checked for glass/resin and specific gravity. Table 4 lists these values along with the void content calculated for each sample. The values of void content are low and probably about as good as can be obtained with a layup method. Optimum compaction could be obtained by using more of the nylon tape, by vacuum-bag molding, or by using matched molding techniques.

Table 4. Analysis of Samples from Three-Layer Cloth Section of Preliminary Unit

Sample	Percent Glass by Weight	Specific Gravity	Percent Glass by Volume	Void Content (%)
1	42.34	1.543	26.19	-.45*
2	43.39	1.546	27.02	.06
3	43.97	1.528	27.48	1.61
4	42.05	1.521	25.95	.78
*Obvious error in density assumption or measurement, but usually indicates void content below 1 percent.				

RECOMMENDATIONS

The exact configuration of the small end of the part as shown in Figure 1 was not obtained and would be difficult unless molded. It is suggested that this be changed to a gradual taper from the thin section to the thicker portion. No other major problems were encountered during the fabrication of these units.

Figure 3. Cloth Section Being Placed on Mandrel

Figure 4. Wrapping With Dry Roving to Pull Material Into Grooves

UNCLASSIFIED

~~TOP SECRET~~ JUL 27 1970

P67569

Figure 5. Overwrapping Lower Portion With Nylon Tape

Figure 6. Final Wrapping With 20-End Roving

Figure 7. Half Section Fiberglass Holder

Figure 8. Fiberglass Holder Assembly

UNCLASSIFIED

P6 7 5 7 0 OCT 0 5 1970