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Engineering Experiment Station

*no report rec'd*

PROJECT INITIATION

Date: Oct. 18, 1968

Project Title: Flexible Composite Fabrications

Project No.: A-1131

Project Director: W. R. Tooke

Sponsor: Mr. William J. Carter

Effective . . . . . October 11, 1968 . . . . . Estimated to run until: Approx. Mid November\* . . . . .

Type Agreement: . . Industrial Research Agreement . . . . . Amount: \$ ~~500.00~~ 520.00 . . . . .

Reports: Final - upon project completion

Contact Person: Mr. William J. Carter  
2200 First National Bank Building  
Atlanta, Georgia 30303

\*One month from start of work.

Assigned to CSMD . . . . . Division

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PROJECT TERMINATION

Date May 19, 1969

PROJECT TITLE: Flexible Composite Fabrications

PROJECT NO: A-1131

PROJECT DIRECTOR: W. R. Tooke

SPONSOR: Mr. William J. Carter

TERMINATION EFFECTIVE: November 15, 1968

CHARGES SHOULD CLEAR ACCOUNTING BY: All acceptable charges have cleared.

CSMD

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Mr. William J. Carter  
2200 First National Bank Building  
Atlanta, Georgia 30303

Subject: Final Report - Project A-1131  
"Flexible Composite Fabrication"



Dear Mr. Carter:

This project was aimed at developing suitable, economical materials for a "tree apron". This garden specialty product should be durable, flexible, and moisture resistant, and should serve as a barrier to prevent grass growth adjoining trees and posts where automatic lawnmowers are unable to cut. Rubber sheeting has been tested and found to be very satisfactory for this use, but high costs of this material rendered it economically unfeasible. Accordingly, a proposal was made to prepare a special resin-saturated paper felt stock, and to fabricate aprons therefrom in an effort to closely simulate the performance of rubber. This was done, and the preparation procedures are described below:

I. Experimental work

A. Materials

The research has been centered around 2-ply laminations of urethane-saturated jute rug backing and raw roofing felt, bonded with Pliobond 30, and painted as desired with a green acrylic grass paint. The several materials used and their sources are given in Table I.

B. Preliminary experiments

A determination of optimum conditions for saturation of fabrics was made in a series of preliminary experiments. Small squares of fabric were saturated by spreading a quantity of polyurethane solution on the surface with a spatula. Solutions of 100%, 50%, and 25% by volume of resin in toluene were used for these experiments.

After the treated specimens were cured by air drying 36 hours, they were checked for resin pickup by reweighing.

$$\text{Resin Pickup, \%} = \frac{\text{Final weight} - \text{Original weight}}{\text{Original weight}} \times 100$$

They were also checked for moisture adsorption by immersing the specimens in water overnight and reweighing.

Data from these preliminary experiments are given in Table II.

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TABLE I

List of Materials

<u>Material</u>	<u>Manufacturer</u>	<u>Local Supplier</u>
1 Jute Rug Backing	Lou Meltzer Co. Dalton, Georgia	--
2 Raw Felt Roofing	Fry Roofing Co. Atlanta, Georgia	--
3 Moisture Curing Urethane (SX-159-D-T)	Nopco Chemical Co.	Step Industries (Harry Steele)
4 Pliobond 30 Adhesive	Goodyear Tire & Rubber Company	Pye Barker Co.
5 Green Acrylic Grass Paint	Precision Paint Co. Chamblee, Georgia	--

TABLE II  
DATA FROM PRELIMINARY EXPERIMENTS

Heavy Felt (6" x 6")			
System	Weight (grams)	% Pick-Up Urethane	% Pick-Up Water
Control	15.96	0	--
100% on 1 side	25.87	62.1	--
50% on 1 side	27.28	70.9	26.9
25% on 1 side	27.39	71.6	25.9
100% on 1 side (premoistened)	26.06	63.3	--
100% on 2 sides	33.32	108.8	13.3

Light Felt (6" x 6")			
System	Weight (grams)	% Pick-Up Urethane	% Pick-Up Water
Control	7.82	0	--
100% on 1 side	16.10	105.9	--
50% on 1 side	12.62	61.4	24.9
25% on 1 side	11.27	44.1	25.8
100% on 1 side (premoistened)	13.55	73.3	--
100% on 2 sides	16.79	114.7	10.0

Jute (6" x 6")			
System	Weight (grams)	% Pick-Up Urethane	% Pick-Up Water
Control	7.18	.0	--
100% on 1 side	24.27	238.0	4.6
75% on 1 side	22.48	213.1	13.9
50% on 1 side	15.75	119.4	26.1
25% on 1 side	13.19	83.7	33.2

C. Preparation of "Tree Aprons"

On the basis of the data from Table II and the observed properties of the samples, light felt saturated to a 45% dry resin pickup and jute saturated to a 85% dry resin pickup were selected for use in the fabrication of the "tree aprons".

Jute rug backing and light felt were hand cut into 24 discs measuring 18" in diameter. The weight of these discs was recorded.

Calculations showed that the desired percentage dry resin pickup could be obtained by saturating the jute with 159 ml. and the light felt with 84.4 ml. of a 25% (vol.) urethane solution using toluol as a solvent. The calculations were as follows:

$$\begin{aligned} & \text{Volume of 25\% urethane solution for light felt (cc)} \\ & = \text{Resin pickup} \left( \frac{\text{g urethane}}{\text{g felt}} \right) \times \text{weight of light felt (g felt)} \\ & \text{Urethane solids by weight} \left( \frac{\text{g urethane}}{\text{g sol'n}} \right) \times \text{Sol'n density} \left( \frac{\text{g sol'n}}{\text{cc sol'n}} \right) \\ & = \frac{.45 \times 49.4}{.3 \times 0.88} \\ & = 84.4 \end{aligned}$$

$$\begin{aligned} & \text{Volume of 25\% urethane solution for jute fabric (cc)} \\ & = \frac{.85 \times 49.3}{.3 \times 0.88} \\ & = 159 \end{aligned}$$

The urethane solution was applied with a 3" short nap roller, rolling out the solution from the center of the disc. When the total amount of solution had been rolled evenly over the discs, they were uniformly saturated, with no evidence of excess liquid.

After air drying for approximately 96 hours, the discs were reweighed, and the percentage pickup was computed on a dry basis.

Average Saturation Results

(Basis: Discs 18 in. diameter, 2.25 ft.<sup>2</sup>)

<u>Material</u>	<u>Original weight, g.</u>	<u>Saturated &amp; dried weight, g.</u>	<u>Dry resin Pickup, %</u>
Light Felt	49.3	72.5	47.2
Jute	49.4	85.4	73.0

Although the initial goal was an 85% pickup for the jute and a 45% pickup for the light felt, the actual pickups were considered satisfactory.

The discs were slit as required to form the prescribed patterns using a razor blade as a cutting tool. Three 2-component laminations designated as jute-jute, jute-felt and felt-felt were used.

The laminating process was performed using a 3-inch rubber roller to spread the Pliobond 30 adhesive, but this technique did not yield an evenly distributed film. Dilution of the adhesive with methyl ethyl ketone caused a solvent attack on the roller. Brushing proved satisfactory, and spraying was very satisfactory.

Table III of this report gives a description of each of the twelve 2-component laminations produced.

The green acrylic grass paint was diluted to one part paint and nine parts water. The paint brushed easily and dried within 30 minutes on the felt and within 4 hours on the jute.

#### D. Tear Test evaluations

The Tear Test was designed to be as representative as possible of the normal tearing process. The test is useful for comparing the relative strengths of the samples.

All the tears were made at a  $45^{\circ}$  angle. This was accomplished by fastening a two by six inch strip of the material to a flat, horizontal surface in such a way that the paper edge made a  $45^{\circ}$  angle with the edge of the surface. A pan was attached to the over-hanging portion, and weights were carefully added to the pan until the material was torn.

The "load to tear" values given in Table IV were averages from three tests on single sheets.

The data display very clearly the poor strength characteristics of untreated felt, and the very detrimental effects of water on this material. Similarly, it shows the tremendous enhancement of strength imparted by the urethane resin, and the relative insensitivity to water that is also achieved by the treatment.

On the basis of these tests together with a knowledge of the ageing characteristics of the materials, it was concluded that the saturated felt should have an exterior durability of several years.

#### E. Preparation of plastic spikes

Spikes for securing tree aprons to the ground were made from  $3/8$ " O.D.,  $1/4$ " I.D., nylon tubing for demonstration purposes; however, linear polyethylene tubing would be more economical and equally durable. A piece of the tubing was cut to a  $6\ 1/4$ " length with one end blunt and the other end cut diagonally to give a sharp point. The blunt end was carefully heated until about  $1/4$ " of the plastic became soft. The spike was then pressed against a flat surface to form a head resembling that of a nail.

TABLE III  
 DESCRIPTION OF LAMINATIONS PRODUCED

Combination	Description			
	Painting	Center Hole Size, in.	Shape	Fingers Length, inches
Jute-Felt	Painted	3	round	2
Jute-Felt	Painted	3/8	round	1
Jute-Felt	Painted	3/4	round	1
Jute-Felt	Unpainted	1 $\frac{1}{4}$	round	1 $\frac{1}{4}$
Felt-Felt	Unpainted	3/8	round	1
Jute-Felt	Unpainted	1 $\frac{3}{4}$	round	3/4
Jute-Jute	Unpainted	$\frac{1}{2}$	round	3/4
Jute-Jute	Unpainted	3/4	round	1
Jute-Felt	Unpainted	3/4	round	1
Jute-Felt	Unpainted	2	square	3/4
Jute-Jute	Painted	3/8	round	1
Felt-Felt	Unpainted	3/4	round	1

TABLE IV  
DATA FROM TEAR SHEET

<u>Felt Grade</u>	<u>Load to tear, grams</u>					
	<u>Unsaturated</u>		<u>25% Urethane</u>		<u>50% Urethane</u>	
	<u>Dry</u>	<u>Wet</u>	<u>Dry</u>	<u>Wet</u>	<u>Dry</u>	<u>Wet</u>
Light	550	100	1300	1200	1650	1600
Medium	1100	150	2850	2300	--	--
Heavy	1850	150	3650	2900	--	--

In service use the tree aprons may be secured to the ground with the plastic nails here described. An 18" disc should require eight evenly spaced spikes.

## II. Economic considerations

Table V of this report gives a breakdown of the costs which make up the total cost estimate for each of the three 2-component laminations. The economic analysis was generated from experimental work and from prices quoted by materials distributors.


Although Pliobond 30 was used in all experimental work as a laminating adhesive, it was decided that the layers could be stapled at almost no cost, and this item was dropped from the cost calculations.

## III. Conclusions

Durable, inexpensive "tree aprons" have been produced from polyurethane saturated roofing felt, jute fabric and combination laminates. The felt-felt laminate appears to be physically satisfactory, and is most economical in cost. Appearance of the units is acceptable in an unpainted condition, but desired color may be obtained with an acrylic latex paint.

The prototype units were judged to be suitable for field testing.

Respectfully submitted,

  
W. R. Tooke, Jr.  
Project Director

Approved:


  
Frederick Bellinger, Chief,  
Chemical Sciences and Materials Division

TABLE V  
 APPROXIMATE MATERIALS COST OF ONE EIGHTEEN INCH DIAMETER "TREE APRON"

<u>Item and cost</u>	<u>Quantity</u>	<u>Jute-Jute cost</u>	<u>Quantity</u>	<u>Felt-Jute cost</u>	<u>Quantity</u>	<u>Felt-Felt cost</u>
Jute @ \$.022/ft <sup>2</sup> (\$85/ton)	4.5 ft. <sup>2</sup>	\$.100	2.25 ft <sup>2</sup>	\$.050	--	--
Felt @ \$.003/ft <sup>2</sup>	--	--	2.25 ft <sup>2</sup>	\$.007	4.5 ft <sup>2</sup>	\$.014
Paint @ \$4/gal.	.0005 gal.	\$.002	.0005 gal.	\$.002	.0005 gal.	\$.002
Urethane @ \$.30 #	.185 #	\$.056	.141 #	\$.043	.098 #	\$.030
Toluol @ \$.35/gal.	.0633 gal.	<u>\$.022</u>	.0487 gal.	<u>\$.017</u>	.0337 gal.	<u>\$.012</u>
Total - Aprons		\$.180		\$.119		\$.058
Linear Polyethylene Tubing @ \$40.00/1000 ft.	4 ft.	<u>\$.160</u>	4 ft.	<u>\$.160</u>	4 ft.	<u>\$.160</u>
GRAND TOTAL - Aprons and "Stakes"		\$.340		\$.279		\$.218