



The Critical Link<sup>®</sup>

October 4, 1994

93N3D-41791D, RD 1031154  
WATTS BAR NUCLEAR PLANT  
STATIC PHYSICAL TESTING OF  
THERMO-LAG SUBLIMING MATERIAL  
USED IN THE FABRICATION OF  
FIRE BARRIER ENCLOSURES

SL REPORT 209-041-027A

PREPARED FOR:  
TENNESSEE VALLEY AUTHORITY  
WATTS BAR NUCLEAR PLANT  
P.O. Box 2000  
Spring City, TN 37381  
As Requested By: J. Rochelle

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APPROVED BY: C. B. [Signature]

All work contained in this report was conducted by SINGLETON LABORATORIES in accordance with the requirements of United Energy Services Corporation QUALITY ASSURANCE MANUAL, REVISION 8, DATED February 1, 1993.

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## INTRODUCTION

Singleton Laboratories has completed static physical testing as requested by Tennessee Valley Authority (TVA) on Thermo-lag subliming material and related materials used to fabricate fire barrier enclosures. Test specimens were supplied and where required, fabricated by TVA. These specimens were removed from 6-ft by 4-ft sheets incorporating 3/8-in. high stiffening ridges located approximately 6-1/2-in. apart on the stress skin side of the 5/8-in. nominal thickness sheets. Most specimens were removed from the area of the sheet between the ridges. Specimens received with ridges, located in areas that would affect test set-up, were carefully flattened by hammer on a flat surface as instructed by TVA. The 3/8-in. nominal thickness sheets and specimens did not have ribs. Additional test specimens that included bonding and overlap assembly required a minimum 30-day cure period. These specimens were sent to Singleton Laboratories when the required curing period was complete. Test specimen configurations along with the specified physical testing and related ASTM test method is summarized in Attachment A. Due to the unique nature of the Thermo-lag subliming sheeting, material specific test methods were not available. The following methods were adopted with concurrence by TVA to test the Thermo-lag subliming sheet material:

- ASTM D 1037 - Standard Methods of Evaluating the Properties of Wood-Base Fiber and Particle Panel Materials
- ASTM D 2339 - Standard Test Method for Strength Properties of Adhesives in Two-Ply Wood Construction in Shear by Tension Loading
- ASTM 4255 - Standard Guide for Testing Inplane Shear Properties of Composites Laminates

Test procedures were modified as required to allow for testing of the requested specimen configuration.

The tensile strength of related materials including stainless steel wire mesh (8x8; i.e., 8 openings per inch in both directions), standard stress skin (8x8), stainless steel tie wire, and stainless steel tie wire with a three-twist and six-twist joint was determined in a single wire configuration in accordance with the following method:

- ASTM A 370 Standard Methods and Definitions for Mechanical Testing of Steel Products

The original test plan specified that the Thermo-lag 330 subliming material specimens be environmentally conditioned for 24-hr at 140°F  $\pm$ 3°F prior to testing. A revision of the test plan per discussion with Jim Rochelle of TVA's Watts Bar Nuclear Plant (WBN) on September 13, 1994, following the receipt of the first shipment of test specimens, included additional physical testing of the Thermo-lag 330 subliming material conditioned for 24-hrs at 70°F  $\pm$ 3°F. Due to the concern of a shortage of test specimens, it was decided that testing at the elevated temperatures would be the priority, with any extra specimens to be used for 70° testing.

Thermocouple-controlled heat lamps were used to maintain test specimen temperatures between 120°F and 140°F during the actual testing following removal from the environmental oven.

Related steel wire products were conditioned at 72°F for a minimum of 24-hrs prior to tensile testing. These products were tensile tested only at 72°F as specified.

A minimum of three specimens per configuration were tested for the properties specified. Load cells of varying capacities with an accuracy of  $\pm$ 2.5% were used in conjunction with a Tinius Olsen Super L Universal Testing machine for all testing. Displacements were measured using dial extensometers.

#### PROCEDURE

All test procedures and loading rates were in accordance with the referenced ASTM Standards outlined in Attachment A. Modifications or deviations to the referenced standards due to non-standard sized specimens or as requested by TVA are included below.

Flexural strength specimens were nominally dimensioned 3-in. wide by 17-in. long (15-in. simply supported span) and 3-in. wide by 11-in. long (9-in. simply supported span) for 5/8-in. thick and 3/8-in. thick Thermo-lag 330 material, respectively. The 5/8-in. thick butt-joint Thermo-lag 330 specimens with the steel wire mesh overlaps were flexure tested with the mesh in the tensile face (down) only. Displacement data was recorded at mid-span during all flexural strength testing using an extensometer.

Compressive strength specimens were re-sized to 1-in. high by 1-in. wide by the nominal Thermo-lag 330 material thickness (as requested by Jim Rochelle and John Hughes of TVA on September 16, 1994). These unlaminated and laterally unsupported specimens were compressed in-plane while recording the loading head displacement. Stress-strain data from compression testing was used to determine the modulus of elasticity.

A jig saw was used by Singleton Laboratories to final-cut the 2-in. by 14-in. Thermo-lag 330 specimens used for tensile testing. The reduced section of the specimens was cut as specified in the respective test method. Butt-joint specimens with steel wire mesh overlaps were tensile tested at full size (2-in. wide by 18-in. long) by using a spiked grip adapter outside of the mesh overlap. Elongation measurements were recorded at maximum load between the upper and lower specimen grips. Tensile strength determination of the standard carbon steel and stainless steel stress skin mesh required the removal and testing of single wire strands. Stainless steel tie wires with three and six twists were tested in a standard wire testing fixture with the twists centrally located between the grips.

In-plane shear strength testing was performed by placing 6-in. by 6-in. Thermo-lag 330 specimens in a double shearing frame as described in Method B per ASTM D 4255. In-plane shear strength testing was used to determine the shear modulus. The 18-in. by 18-in. non-standard butt-joint Thermo-lag 330 specimens were shear tested in a single shearing frame with one frame edge set within 2-in. of the butt-joint and the other frame edge set approximately 1/2-in. outside the end of the mesh overlap. The 6-in. by 6-in. punching shear specimens were pull tested with 1.5-in. dia fender washers under a 3/8-in. bolt as a punching device and a specimen fixture with an opening of 2.75-in. Where applicable the fender washer was located such that it was against the specimen surface lacking the standard carbon steel stress skin. Deflection information was recorded during testing from an extensometer measuring loading head travel.

Bond shear strength specimens consisting of 5/8-in. thick Thermo-lag 330 sheeting bonded with trowel grade material to 12-gauge galvanized sheet metal was aligned using spacers and a combination level-square. These 18-in. long by 2-in. wide non-standard specimens with a 6-in. bonded overlap were vertically pull tested while recording loading head travel from an extensometer.

## RESULTS

Test results are summarized in Attachment B, C, D, E, F, and G. Extra specimens not required to complete testing at elevated temperatures were tested at 72°F. Initially all specimens, except for a few used for compression testing, were conditioned at 140°F for 24-hrs due to the limited number of specimens and a priority on elevated temperature testing. Specimens tested at 72°F were conditioned at this temperature for 24-hrs following the initial conditioning at 140°F at 24-hrs unless otherwise noted.

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Typically, air voids were observed throughout the cross-section of most samples as were thickness variations as much as 1/8-in. Other factors affecting test repeatability in addition to the non-homogeneous nature of the material include flattened ridges on specimens in critical areas and material cure.

Lower compressive strength test results of specimens tested at 72°F which were not initially conditioned at 140°F is indicative of incomplete material curing and hydration. Results from the testing of bonded and overlap specimens may also indicate some material curing effects that would explain test discrepancies. The material appears to become stronger as the curing (ageing) process continues. This process is accelerated by exposure to elevated temperatures within reasonable limits.

Modulus of elasticity and shear modulus determination are subject to interpretation and may be calculated as much as approximately 15 percent below the values shown. Specimen stability and behavior was a factor in fitting modulus lines to stress versus strain data. Individual test results, load displacement data and plots with accompanying photographs are included in Attachment H.

SINGLETON LABORATORIES

Louisville, Tennessee

# ATTACHMENT A

## SPECIMEN CONFIGURATION, PROPERTY AND TEST METHOD

### TEST SPECIMEN CONFIGURATION

### PROPERTY AND TEST METHODS

<ol style="list-style-type: none"> <li>1. Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin (carbon steel wire mesh, 8 x 8)</li> <li>2. Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side and stainless steel wire mesh stress skin (8 x 8) applied on the opposite side</li> <li>3. Stock Thermo-Lag 330 sheet 3/8 inch thick with standard stress skin (carbon steel wire mesh)</li> <li>4. Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin removed</li> </ol>	<p>FLEXURAL STRENGTH – (ASTM D 1037, sections 11 through 20) plus and minus bending about weak axis</p> <p>COMPRESSIVE STRENGTH – (ASTM D 1037, method A modified, sections 34 through 40) in-plane</p> <p>TENSILE STRENGTH – (ASTM D 1037, sections 21 through 27) in-plane</p> <p>SHEAR STRENGTH – (ASTM D 4255, Method B) in-plane and (ASTM D 1037 modified, sections 54 through 60) punching shear</p> <p>ELONGATION – (ASTM D 1037, sections 21 through 27) in-plane</p> <p>MODULUS OF ELASTICITY – (ASTM D 1037, sections 34 through 40) in-plane</p> <p>SHEAR MODULUS – (ASTM D 4255, Method B) in-plane</p>
<ol style="list-style-type: none"> <li>5. Two stock Thermo-Lag 330 sheets 5/8 inch thick with standard stress skin on one side joined by a butt joint of Thermo-Lag 330 trowel grade overlapped with steel wire mesh on one side with overlaps of 6, 10 and 12 inches</li> </ol>	<p>FLEXURAL STRENGTH – (ASTM D 1037, sections 11 through 20)</p> <p>TENSILE STRENGTH – (ASTM D 1037 modified, sections 21 through 27)</p> <p>SHEAR STRENGTH – (ASTM D 4255 modified for single shear, sections 81 through 85)</p>
<ol style="list-style-type: none"> <li>6. Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side bonded (on stress skin side) to galvanized steel metal (12 gauge) by Thermo-Lag 330 trowel grade material</li> </ol>	<p>BOND SHEAR STRENGTH – (ASTM D 2339 modified)</p>
<ol style="list-style-type: none"> <li>7. Stainless steel wire mesh (type 304)</li> <li>8. Standard stress skin mesh removed from 5/8 inch thick sheet</li> <li>9. Stainless steel tie wire (annealed 304, 16 gauge)</li> <li>10. Stainless steel tie wires (annealed 304 16 gauge) joined by a 3 twist joint and a 6 twist joint</li> </ol>	<p>TENSILE STRENGTH – (ASTM A 370)</p>

# ATTACHMENT B

## AVERAGE TEST RESULTS

CONDITIONED AT 140° F FOR 24 HOURS, TESTED AT 127° F

TEST SPECIMEN CONFIGURATION		FLEXURAL STRENGTH psi	COMPRESSIVE STRENGTH psi	TENSILE STRENGTH psi	PUNCHING SHEAR SHEAR STRENGTH psi	ELONGATION in./in.	BOND SHEAR STRENGTH psi	MODULUS OF ELASTICITY psi	SHEAR MODULUS psi
Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin (carbon steel wire mesh)		333.4 s.s. up			80.4	0.016	-	13,477	4,238
		440.1 s.s. down	279.0	344.7	73.4				
Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side and stainless steel wire mesh stress skin applied to opposite side		444.3 s.s.s. up			116.0	0.024	-	14,028	3,644
		704.4 s.s.s. down	318.8	487.8	132.0				
Stock Thermo-Lag 330 sheet 3/8 inch thick with standard stress skin		279.9 s.s. up			150.6	0.024	-	21,948	7,279
		822.9 s.s. down	377.7	787.1	176.0				
Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin removed		199.1	306.4	51.7	52.9	0.009	-	17,991	4,300
					56.4				
Two stock Thermo-Lag 330 sheets 5/8 inch thick with standard stress skin on one side joined by a butt joint of Thermo-Lag 330 trowel grade overlapped with steel wire mesh on one side with overlaps of 6 inches, 10 inches and 12 inches (s.s.s. down in flex.)	6 in.	186.3	-	26.6	14.0	-	-	-	-
	10 in.	232.0	-	119.8	8.0	-	-	-	-
	12 in.	384.7	-	141.9	7.3	-	-	-	-
Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side bonded (on stress skin side) to galvanized sheet metal (12 gauge) by Thermo-Lag 330 trowel grade material		-	-	-	-	-	12.2	-	-

CONDITIONED AT 73° F FOR 24 HOURS AND TESTED

Stainless steel wire mesh (type 304) - single wire		-	-	110,333	-	-	-	-	-
Standard stress skin mesh removed from 5/8 inch sheet - single wire		-	-	68,222	-	-	-	-	-
Stainless steel tie wire (annealed 304, 16 gauge)		-	-	97,789	-	-	-	-	-
Stainless steel tie wires (annealed 304, 16 gauge) joined by a 3 twist joint and a 6 twist joint	3 tw.	-	-	182.1 lbs	-	-	-	-	-
	6 tw.	-	-	134.1 lbs	-	-	-	-	-

NOTE: s.s. = stress skin, s.s.s. = stainless stress skin

# ATTACHMENT C

## MINIMUM TEST RESULTS

CONDITIONED AT 140° F FOR 24 HOURS, TESTED AT 127° F

TEST SPECIMEN CONFIGURATION	FLXURAL STRENGTH psi	COMPRESSIVE STRENGTH psi	TENSILE STRENGTH psi	PUNCHING SHEAR SHEAR STRENGTH psi	ELONGATION in./in.	BOND SHEAR STRENGTH psi	MODULUS OF ELASTICITY psi	SHEAR MODULUS psi
Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin (carbon steel wire mesh)	293.6 ss up	271.9	337.0	69.4	0.010	-	9,726	3,000
	357.7 ss down			49.4				
Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side and stainless steel wire mesh stress skin applied to opposite side	431.3 sss up	306.2	445.5	109.5	0.024	-	13,514	2,333
	586.1 sss down			115.9				
Stock Thermo-Lag 330 sheet 3/8 inch thick with standard stress skin	220.5 ss up	363.9	723.2	126.2	0.014	-	17,857	5,588
	707.6 ss down			119.9				
Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin removed	176.7	294.4	21.6	47.7	0.005	-	15,000	3,700
				52.7				
Two stock Thermo-Lag 330 sheets 5/8 inch thick with standard stress skin on one side joined by a butt joint of Thermo-Lag 330 trowel grade overlapped with steel wire mesh on one side with overlaps of 6 inches, 10 inches, and 12 inches (sss down in flex)	6 in.	134.6	-	25.0	9.5	-	-	-
	10 in.	261.4	-	Bond Failure	111.9	5.6	-	-
	12 in.	354.4	-	135.7	5.8	-	-	-
Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side bonded (on stress skin side) to galvanized sheet metal (12 gauge) by Thermo-Lag 330 trowel grade material	-	-	-	-	-	8.9	-	-

CONDITIONED AT 73° F FOR 24 HOURS AND TESTED

Stainless steel wire mesh (type 304) - single wire	-	-	110,000	-	-	-	-	-
Standard stress skin mesh removed from 5/8 inch sheet - single wire	-	-	59,333	-	-	-	-	-
Stainless steel tie wire (annealed 304, 16 gauge)	-	-	97,167	-	-	-	-	-
Stainless steel tie wires (annealed 304, 16 gauge) joined by a 3 twist joint and a 6 twist joint	3 tw.	-	134.6 lbs	-	-	-	-	-
	6 tw.	-	133.1 lbs	-	-	-	-	-

NOTE: ss = stress skin, sss = stainless stress skin

# ATTACHMENT D

## AVERAGE TEST RESULTS

CONDITIONED AT 140° F FOR 24 HOURS BEFORE CONDITIONING AT 72° F FOR 24 HOURS AND TESTED

TEST SPECIMEN CONFIGURATION	(ONE TEST)	COMPRESSIVE STRENGTH psi	(ONE TEST)
	FLEXURAL STRENGTH psi		SHEAR STRENGTH psi
Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin (carbon steel wire mesh)	690.4 – s.s. up 840.2 – s.s. down	425.7	109.7
Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side and stainless steel wire mesh stress skin applied to opposite side		413.7	98.5
Stock Thermo-Lag 330 sheet 3/8 inch thick with standard stress skin	1272.6 – s.s. up 1351.9 – s.s. down	417.3	250.1
Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin removed	566.8	326.0	42.8

**NOTE:** *s.s.* = *stress skin*

# ATTACHMENT E

## MINIMUM TEST RESULTS

*CONDITIONED AT 140° F FOR 24 HOURS BEFORE CONDITIONING AT 72° F FOR 24 HOURS AND TESTED*

TEST SPECIMEN CONFIGURATION	FLEXURAL STRENGTH psi	COMPRESSIVE STRENGTH psi	SHEAR STRENGTH psi
Stock Thermo—Lag 330 sheet 5/8 inch thick with standard stress skin (carbon steel wire mesh)		421.6	
Stock Thermo—Lag 330 sheet 5/8 inch thick with standard stress skin on one side and stainless steel wire mesh stress skin applied to opposite side		384.2	
Stock Thermo—Lag 330 sheet 3/8 inch thick with standard stress skin		401.7	
Stock Thermo—Lag 330 sheet 5/8 inch thick with standard stress skin removed		317.2	

# ATTACHMENT F

## AVERAGE TEST RESULTS

*CONDITIONED AT 72° F FOR A MINIMUM OF 24 HOURS*

TEST SPECIMEN CONFIGURATION	FLEXURAL STRENGTH psi	COMPRESSIVE STRENGTH psi	SHEAR STRENGTH psi
Stock Thermo—Lag 330 sheet 5/8 inch thick with standard stress skin (carbon steel wire mesh)		214.8	
Stock Thermo—Lag 330 sheet 5/8 inch thick with standard stress skin on one side and stainless steel wire mesh stress skin applied to opposite side		207.4	
Stock Thermo—Lag 330 sheet 3/8 inch thick with standard stress skin		272.5	
Stock Thermo—Lag 330 sheet 5/8 inch thick with standard stress skin removed		147.9	

no conditioning at 140°F

# ATTACHMENT G

## MINIMUM TEST RESULTS

*CONDITIONED AT 72° F FOR A MINIMUM OF 24 HOURS*

TEST SPECIMEN CONFIGURATION	FLEXURAL STRENGTH psi	COMPRESSIVE STRENGTH psi	SHEAR STRENGTH psi
Stock Thermo—Lag 330 sheet 5/8 inch thick with standard stress skin (carbon steel wire mesh)		181.4	
Stock Thermo—Lag 330 sheet 5/8 inch thick with standard stress skin on one side and stainless steel wire mesh stress skin applied to opposite side		200.1	
Stock Thermo—Lag 330 sheet 3/8 inch thick with standard stress skin		248.0	
Stock Thermo—Lag 330 sheet 5/8 inch thick with standard stress skin removed		142.8	

no conditioning at 140°F

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ATTACHMENT H

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CALCULATIONS

The following formulas were used in the calculation of the specified properties.

Flexural Strength, psi

$$F_s = \frac{3 PL}{2 bd^2}$$

P = maximum mid-point load (lb)  
L = supporting span (in.)  
b = specimen width (in.)  
d = specimen thickness (in.)

Compressive Strength, psi

$$C_s = \frac{P}{b \cdot d}$$

P = maximum compressive load (lb)  
b = specimen width (in.)  
d = specimen thickness (in.)

Tensile Strength, psi

$$T_s = \frac{P}{bd}$$

P = maximum tensile load (lb)  
b = specimen width (in.)  
d = specimen thickness (in.)

Punching shear strength, psi

$$S_p = \frac{P}{t \cdot c}$$

P = maximum load (lb)  
t = material thickness (in.)  
c = punching circumference (in.)

Shear Strength, psi

ASTM D 4255, double shear stock specimens:

$$S_s = \frac{P}{2bh}$$

P = maximum shear load (lb)  
b = length (in.)  
h = thickness (in.)

ASTM D 4255, single shear butt-joint specimens

$$S_s = \frac{P}{bh}$$

Elongation in/in

$$E = \frac{\Delta L_m}{G_L}$$

$\Delta L_m$  = elongation at maximum load (in.)  
 $G_L$  = gauge length (in.)

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Modulus of Elasticity, psi

$$E_m = \frac{\Delta S_c}{\Delta e}$$

$\Delta S_c$  = Slope of compressive stress (psi)  
 $\Delta e$  = versus compressive strain (in/in)

Shear Modulus, psi

ASTM D 4255 double shear

$$G = \frac{\Delta S_s}{\Delta e}$$

$\Delta S_s$  = Slope of shear stress (psi)  
 $\Delta e$  = versus shear strain (in/in)

where:

$$e = \frac{2D}{(6/5)L}$$

D = displacement (in.)  
L = distance between supports

and:

$$S_s = \frac{P}{2(t)(h)}$$

P = center point load (lb)  
t = specimen thickness (in.)  
h = specimen height (in.)

Bond Shear Strength, psi

$$B_s = \frac{P}{bw}$$

P = maximum tensile load (lbs)  
b = length (in.)  
w = width (in.)

SINGLETON LABORATORIES

Equipment Usage Log

Report: 209-041-027A

Date : 10/04/94

Item	ID	Model No.	Accuracy	Calibrated	Due Re-calibratio
UNIVERSAL TESTING MACHINE	1484	SUPER L	+/-1%READING	12/07/93	12/07/94
CALIPER, 12" DIAL	2215	505-645-50	+/-0.001 IN	08/13/94	02/13/95
LOAD CELL (250LB)W/RDT 1504	2549	SSM-AJ-250	+/-1%RANGE	10/15/93	10/15/94
THERMOCOUPLE W/READOUT 2583	2523	TYPE J	+/-0.3% RDG	03/17/94	03/17/95
EXTENSOMETER 2"	2176	LC-10	+/-0.001 IN	01/21/94	01/21/95
LOAD CELL (1K)	2594	SM-1000	+/-1%RDG	09/08/94	09/08/95
LOAD CELL (1K)	2424	SM-1000	+/-1%READING	09/28/94	09/28/95
EXTENSOMETER 2"	2218	25-2041	+/-0.001 IN	01/21/94	01/21/95

Reviewed By: *R. J. [Signature]*

Date: 10/4/94

PROPERTY: Flexural Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin (up)

SPECIMEN NUMBER:                    1                    2                    3                    4

WIDTH (in.):	3.005	3.027	2.925	2.935
THICKNESS (in.):	0.726	0.708	0.608	0.722
AREA (in <sup>2</sup> ):	2.182	2.143	1.778	2.119

DEFLECTION (inches)	LOAD (lbs)	LOAD	LOAD	LOAD
0	0	0	0	0
0.02	5.7	5.7	5.9	9.3
0.04	11.3	10.1	9.3	11.9
0.06	12.7	11.6	11.6	15.6
0.08	14.2	15.2	12.1	19.2
0.10	21.1	17.9	13.9	22.4
0.12	18.1	19.3	15.9	24.3
0.14	12.2	19.8	16.9	25.2
0.16	-	19.3	17.3	25.9
0.18	-	17.9	17.3	25.1
0.20	-	16.1	16.8	24.1
0.22	-	14.0	15.4	22.4
0.24	-	12.2	13.7	20.3

**FAILURE:** Material tensile failure on bottom face at midspan for all specimens

MAXIMUM LOAD (lbs):	21.1	19.8	17.3	25.9
FLEXURAL STRENGTH (psi): (15 inch span)	299.8	293.6	360.0	380.0

PROPERTY: Flexural Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin (down)

SPECIMEN NUMBER:	1	2	3	4
WIDTH (in.):	3.00	2.920	3.010	2.951
THICKNESS (in.):	0.720	0.708	0.755	0.655
AREA (in <sup>2</sup> ):	2.160	2.067	0.655	1.933

DEFLECTION (inches)	LOAD (lbs)	LOAD	LOAD	LOAD
0	0	0	0	0
0.10	7.1	11.5	26.3	11.7
0.20	10.7	16.3	33.6	18.1
0.30	12.7	19.1	37.5	20.8
0.40	14.0	20.4	39.1	22.4
0.50	14.8	21.4	39.5	23.4
0.60	15.4	22.1	39.2	24.2
0.70	15.8	22.7	37.7	24.6
0.80	16.1	23.0	36.5	24.8
0.90	16.2	23.3	36.0	24.9
1.00	16.4	23.4	-	24.7
1.10	16.4	23.4	-	24.3
1.20	16.4	23.3	-	-
1.30	16.3	23.2	-	-
1.40	16.2	22.7	-	-

**FAILURE:** Material compression failure on top face at midspan for all specimens

MAXIMUM LOAD (lbs):	16.4	23.4	39.5	24.9
FLEXURAL STRENGTH (psi): (15 inch span)	237.3	359.7	518.0	442.5

PROPERTY: Flexural Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side and stainless steel wire mesh stress skin applied to opposite side - stainless steel stress skin up

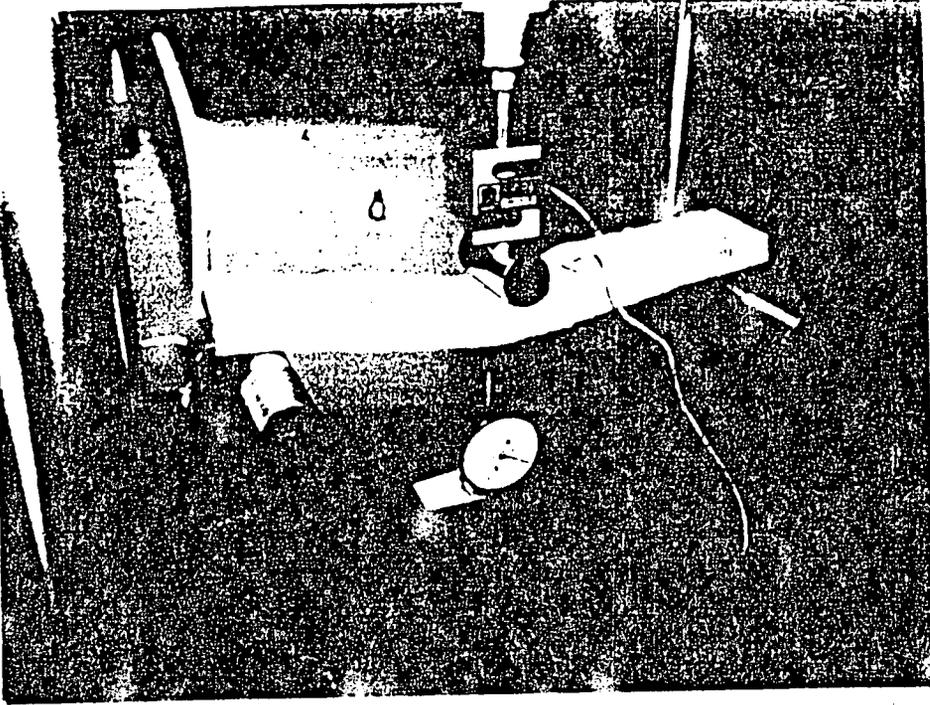
SPECIMEN NUMBER:                    1                    2                    3

WIDTH (in.):	3.066	2.936	2.976
THICKNESS (in.):	0.870	0.910	0.942
AREA (in <sup>2</sup> ):	2.667	2.672	2.803

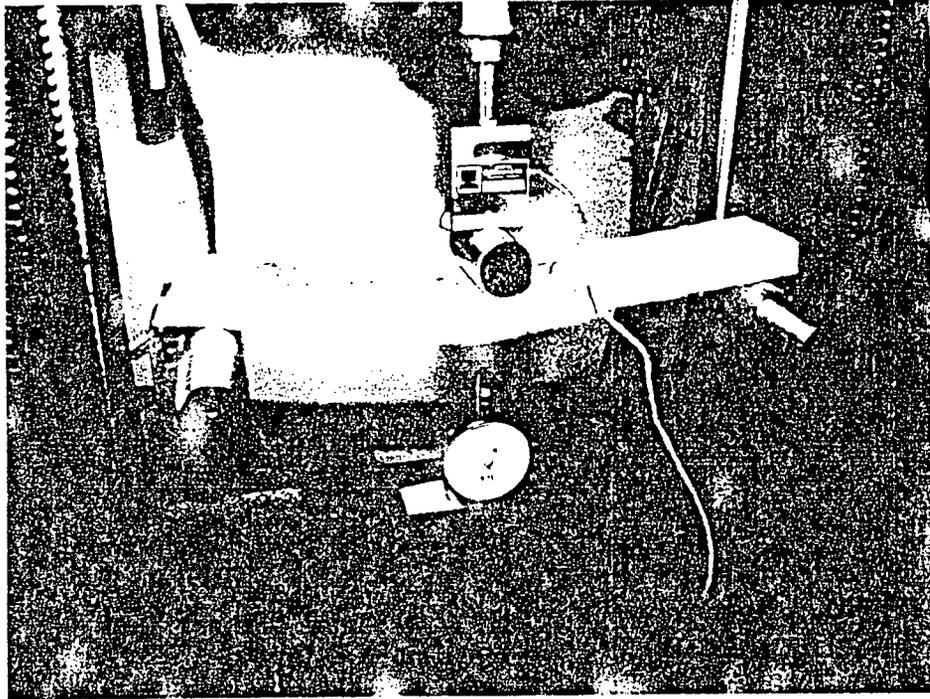
DEFLECTION (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.05	7.6	24.3	29.4
0.10	19.7	38.3	44.9
0.15	33.5	42.1	48.6
0.20	39.8	44.8	51.1
0.25	43.5	46.2	51.8
0.30	45.8	46.6	52.1
0.35	46.9	46.3	51.6
0.40	47.2	45.3	50.8
0.45	46.7	44.3	49.3
0.50	45.7	43.4	49.0
0.55	44.7	42.5	48.4
0.60	43.8	41.8	47.7
0.65	43.2	41.4	47.2
0.70	42.8	41.4	46.4
0.75	42.5	40.9	45.6

**FAILURE:** Compression bond failure of stainless steel stress skin on top face for all specimens

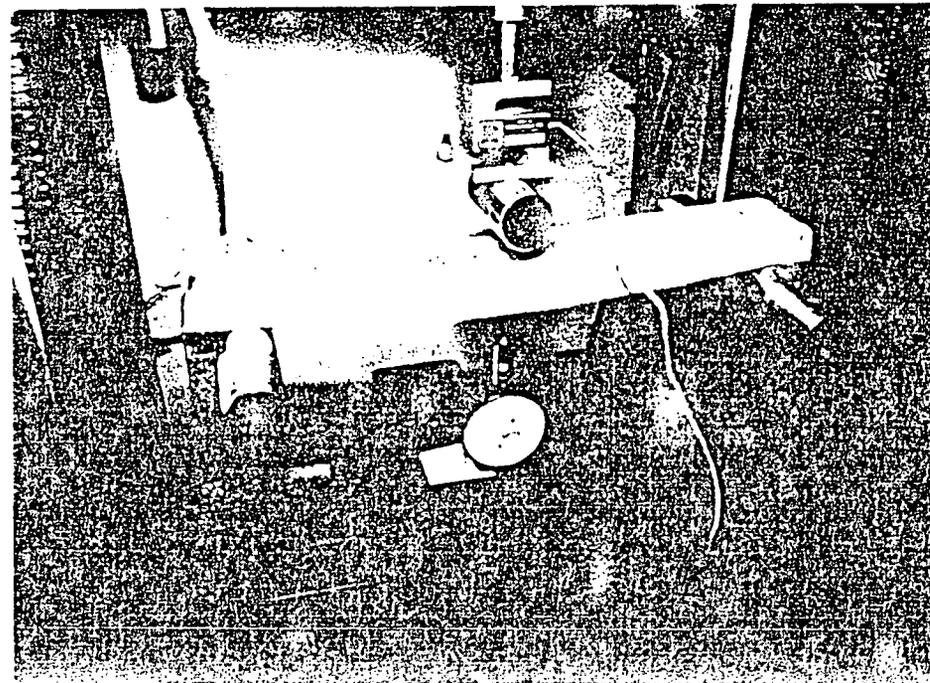
MAXIMUM LOAD (lbs):	47.2	46.6	52.1
FLEXURAL STRENGTH (psi): (15 inch span)	457.6	431.3	443.9



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Flexural Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side and stainless steel wire mesh stress skin applied to opposite side - stainless steel stress skin down

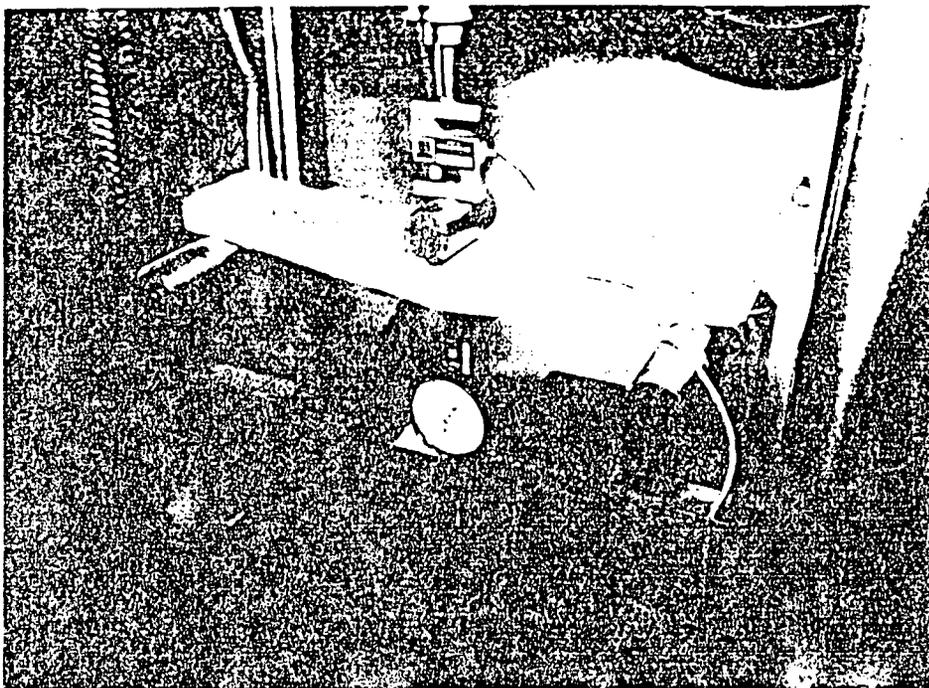
SPECIMEN NUMBER:                    1                                    2                                    3

WIDTH (in.):	3.030	2.850	3.066
THICKNESS (in.):	0.990	0.980	0.838
AREA (in <sup>2</sup> ):	2.999	2.793	2.569

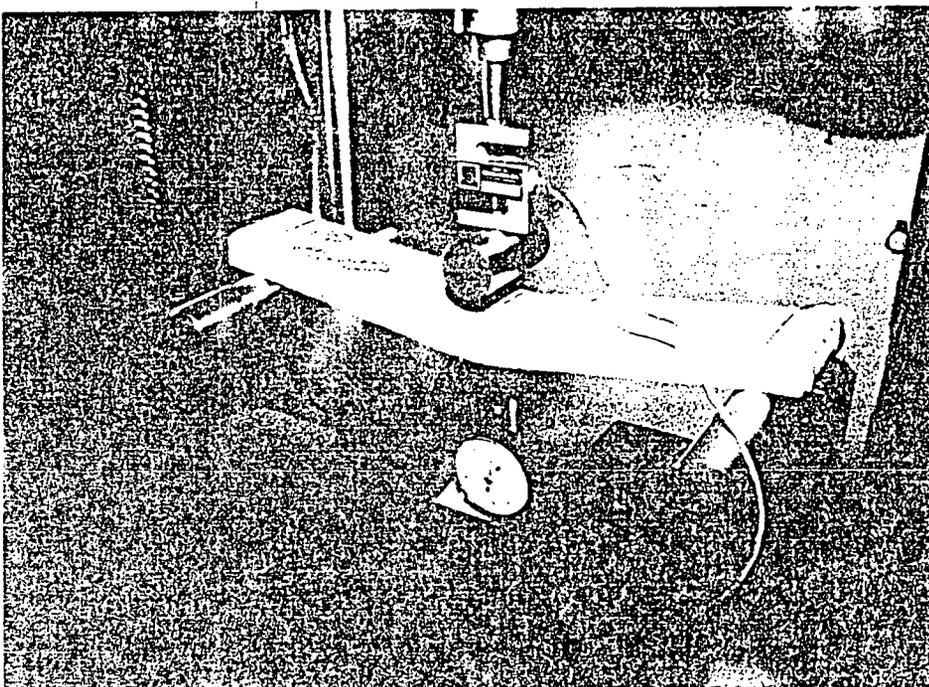
DEFLECTION (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.05	35.6	29.9	30.1
0.10	61.6	52.3	54.8
0.15	77.8	67.6	72.8
0.20	80.3	71.3	83.4
0.25	75.0	69.3	87.9
0.30	68.2	65.8	88.9
0.35	50.4	59.3	87.7
0.40	39.1	53.0	85.1
0.45	34.7	34.1	82.4
0.50	31.8	28.7	80.7

**FAILURE:** Tensile bond failure of stainless steel stress skin on bottom face for all specimens

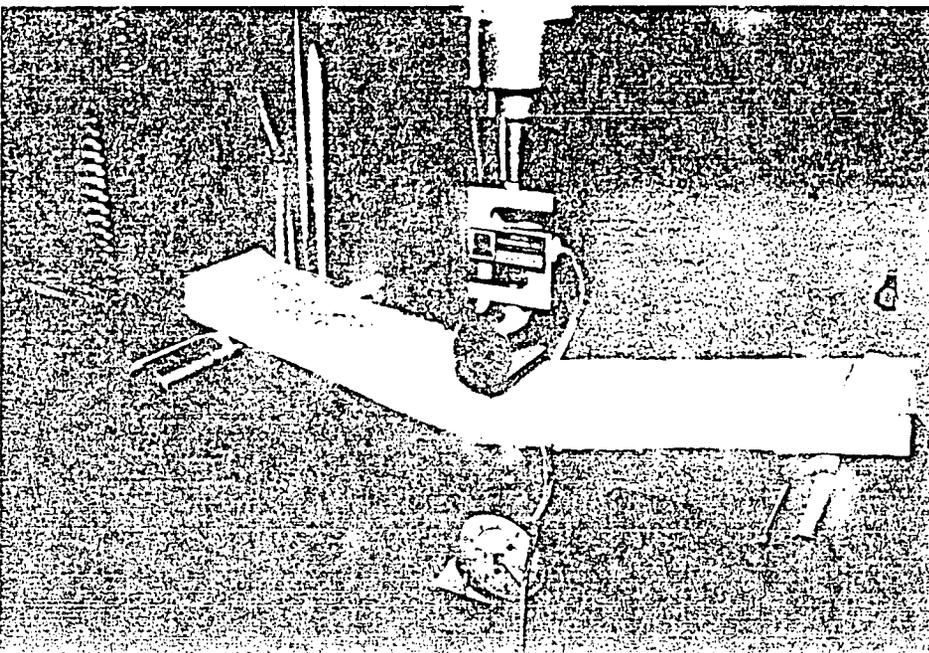
MAXIMUM LOAD (lbs):	80.3	71.3	87.9
FLEXURAL STRENGTH (psi): (15 inch span)	608.4	586.1	918.6



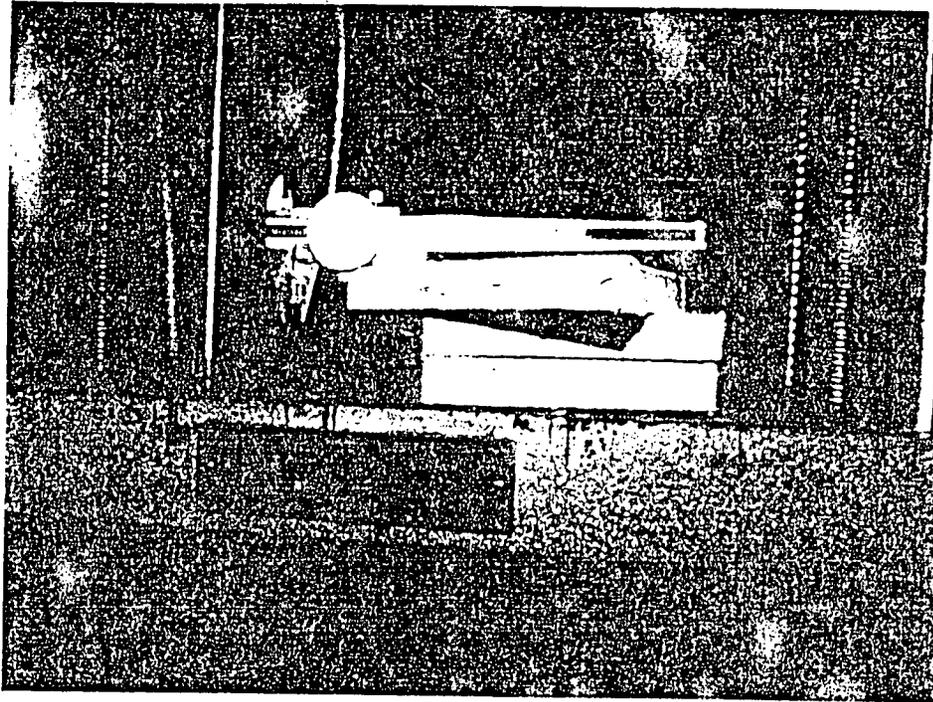
SPECIMEN 1



SPECIMEN 2



SPECIMEN 3



Voids shown on typical 5/8-in. thick thermo-lag 330 sheet specimens with standard and stainless steel mesh.

PROPERTY: Flexural Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 3/8 inch thick with stress skin (up)

SPECIMEN NUMBER: 1 2 3

WIDTH (in.):	3.017	3.000	3.017
THICKNESS (in.):	0.382	0.412	0.455
AREA (in <sup>2</sup> ):	1.153	1.236	1.373

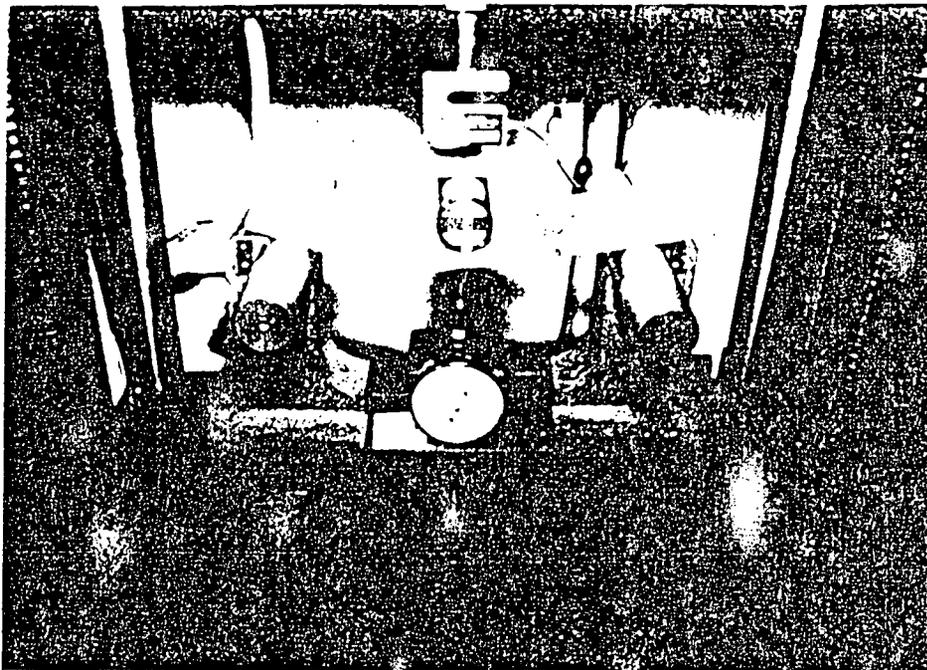
DEFLECTION (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.02	2.8	3.9	6.3
0.04	5.4	7.3	8.8
0.06	6.7	9.2	10.1
0.08	7.8	10.8	10.2
0.10	8.7	11.7	9.0
0.12	9.4	11.9	7.4
0.14	9.8	11.9	6.5
0.16	9.9	11.9	5.6
0.18	9.8	11.8	5.0
0.20	9.5	11.8	4.6
0.22	9.0	11.8	—
0.24	8.4	10.6	—
0.26	7.7	8.5	—

**FAILURE:**

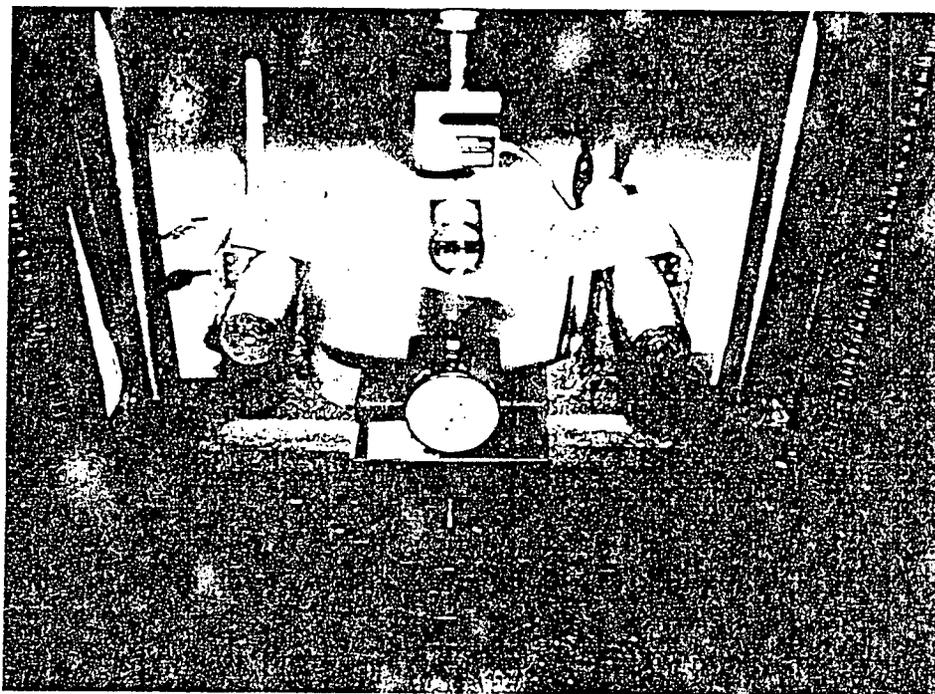
Material tension failure @ third point on bottom face	Material tension failure near mid point on bottom face	Material tension failure at mid point on bottom face
9.9	11.9	10.2
303.6	315.5	220.5

MAXIMUM LOAD (lbs):

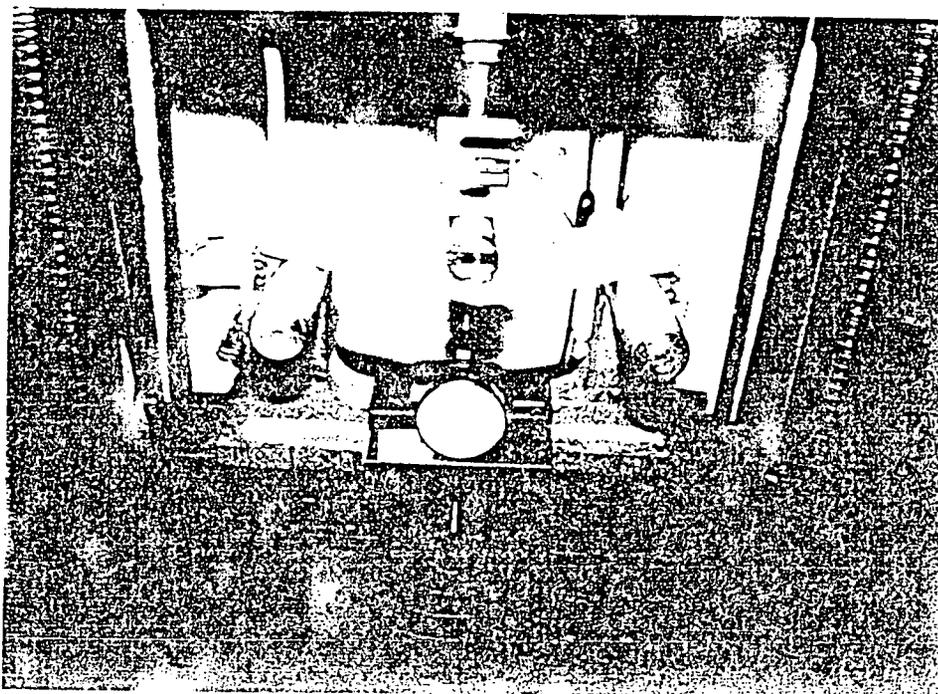
FLEXURAL STRENGTH (psi):  
(9 inch span)



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Flexural Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 3/8 inch thick with stress skin (down)

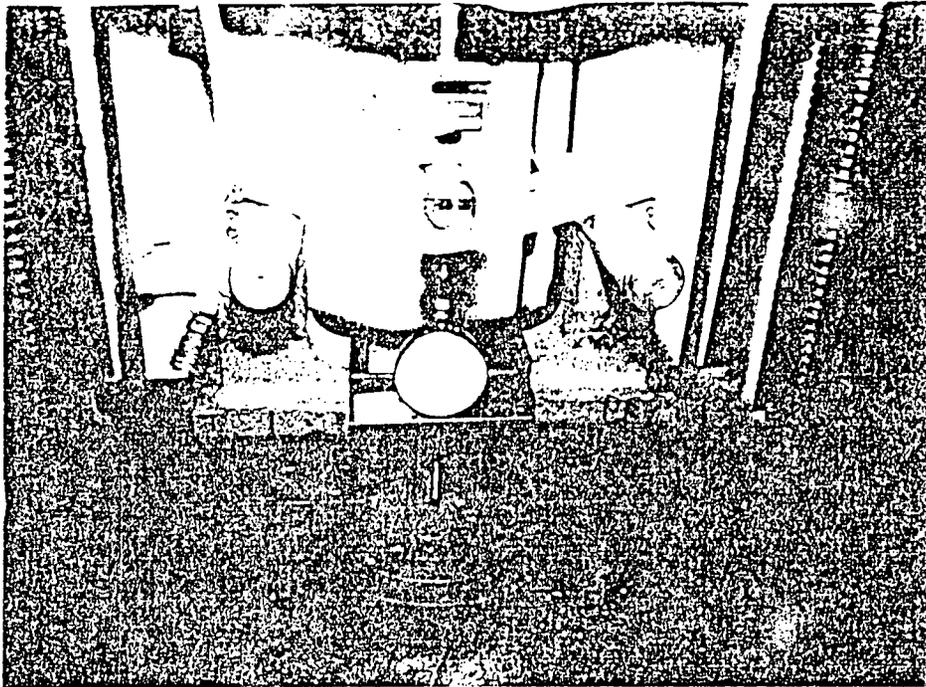
SPECIMEN NUMBER: 1 2 3

WIDTH (in.):	3.003	3.003	3.003
THICKNESS (in.):	0.492	0.418	0.444
AREA (in <sup>2</sup> ):	1.478	1.255	1.330

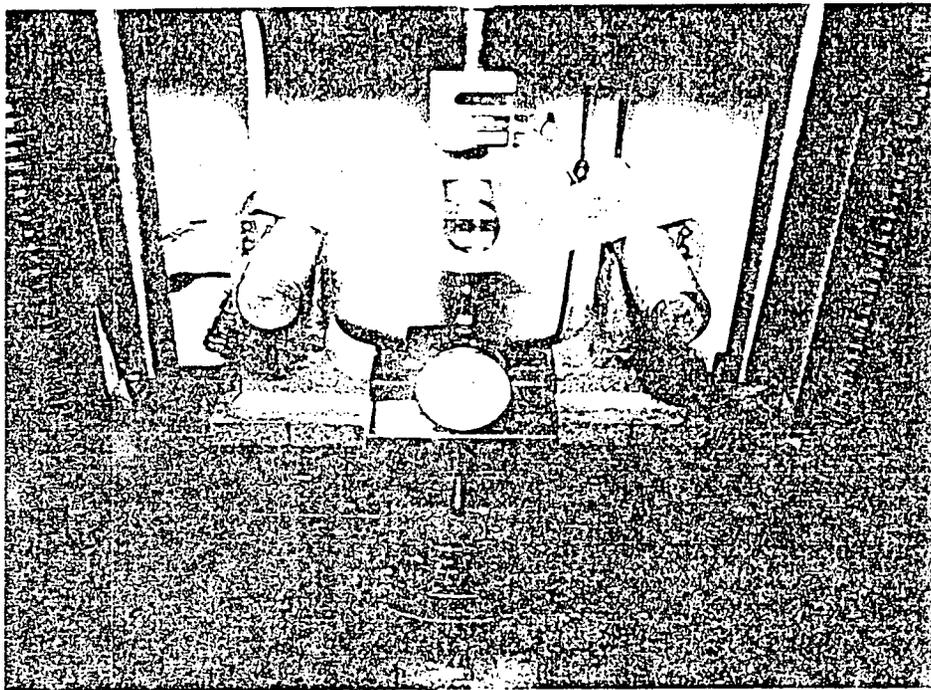
DEFLECTION (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.05	11.7	12.0	13.7
0.10	22.3	22.1	25.5
0.15	29.5	28.4	28.9
0.20	33.9	31.1	32.5
0.25	36.4	32.6	34.8
0.30	37.7	33.4	36.3
0.35	38.1	33.8	37.4
0.40	38.1	33.7	38.3
0.45	38.0	33.2	38.9
0.50	38.0	32.6	39.1
0.55	37.9	31.7	39.0
0.60	37.0	30.6	38.7
0.65	36.4	29.8	38.1
0.70	-	-	37.4

**FAILURE:** Material compression failure on top face at midspan for all specimens

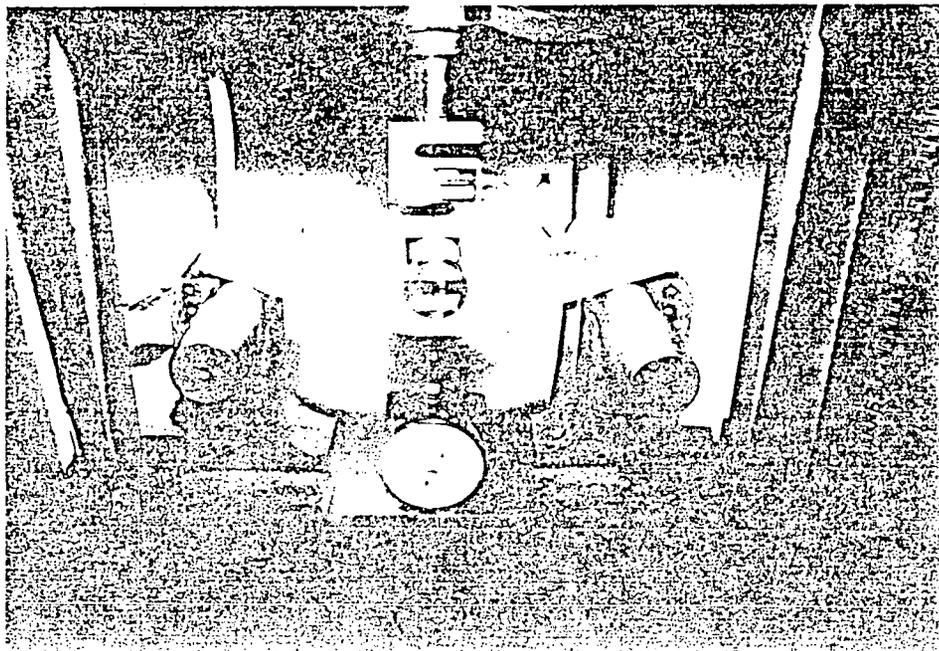
MAXIMUM LOAD (lbs):	38.1	33.8	39.1
FLEXURAL STRENGTH (psi): (9 inch span)	707.6	869.6	891.6



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Flexural Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with stress skin removed

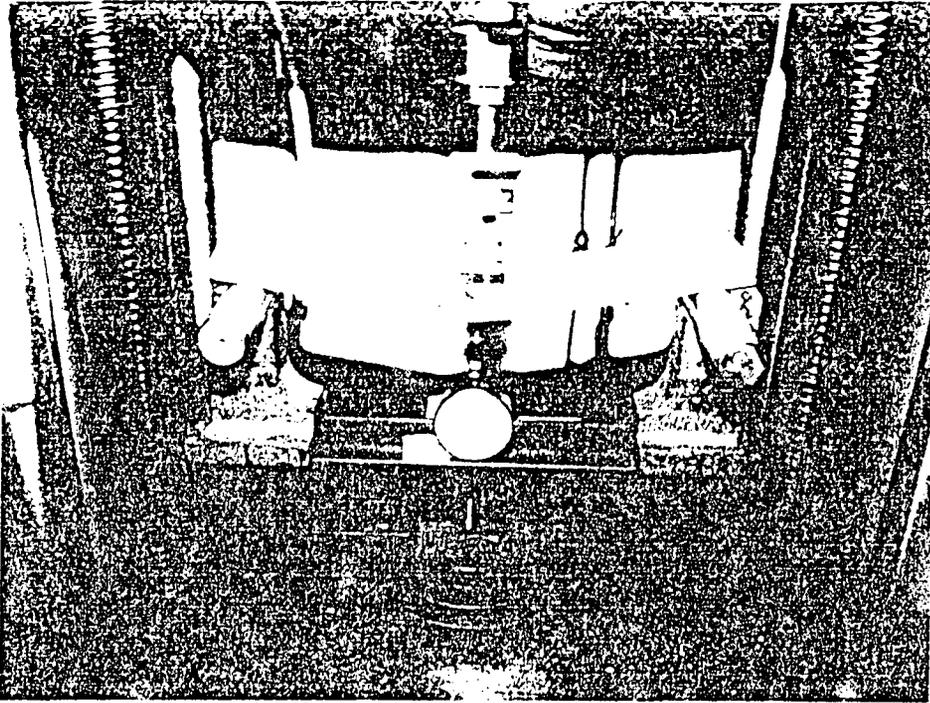
SPECIMEN NUMBER:                    1                    2                    3

WIDTH (in.):	2.942	2.907	2.920
THICKNESS (in.):	0.589	0.644	0.587
AREA (in <sup>2</sup> ):	1.733	0.587	1.714

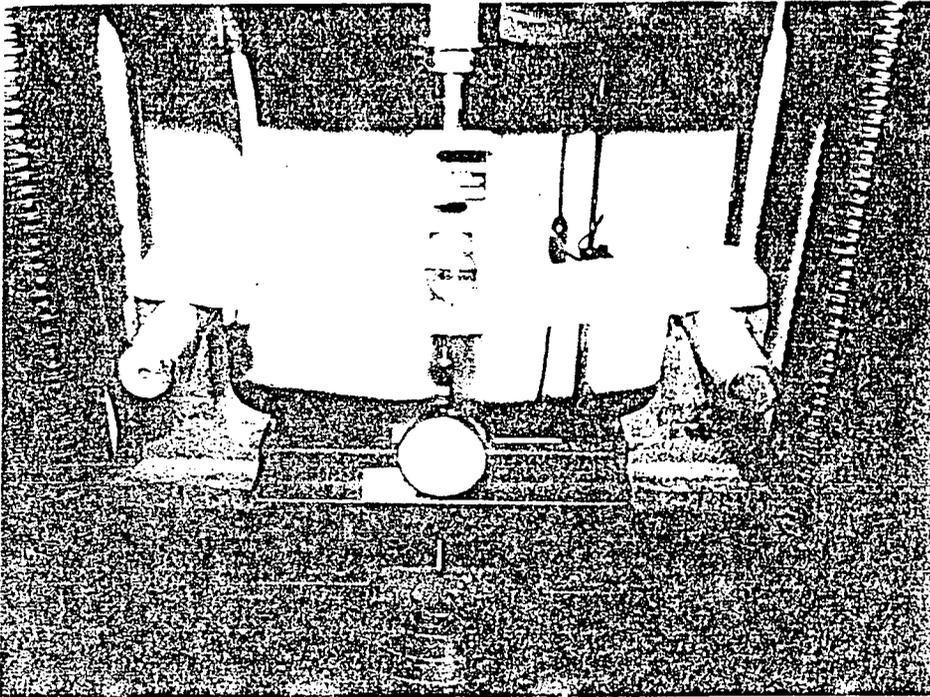
DEFLECTION (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.02	3.9	2.7	2.4
0.04	5.1	4.3	3.3
0.06	5.9	5.6	4.0
0.08	6.7	6.7	4.6
0.10	7.3	7.7	5.2
0.12	7.9	8.4	5.7
0.14	8.8	9.1	6.1
0.16	8.8	9.6	6.5
0.18	9.2	10.1	6.8
0.20	9.5	10.4	7.1
0.22	9.7	10.6	7.3
0.24	9.9	10.6	7.5
0.26	10.1	10.6	7.6
0.28	10.1	10.5	7.8
0.30	10.1	10.3	7.9
0.32	10.1	9.9	7.9
0.34	10.0	9.5	7.9
0.36	9.8	8.8	7.9
0.38	9.6	-	7.8

**FAILURE:** Material tension failure on bottom face at midspan for all specimens

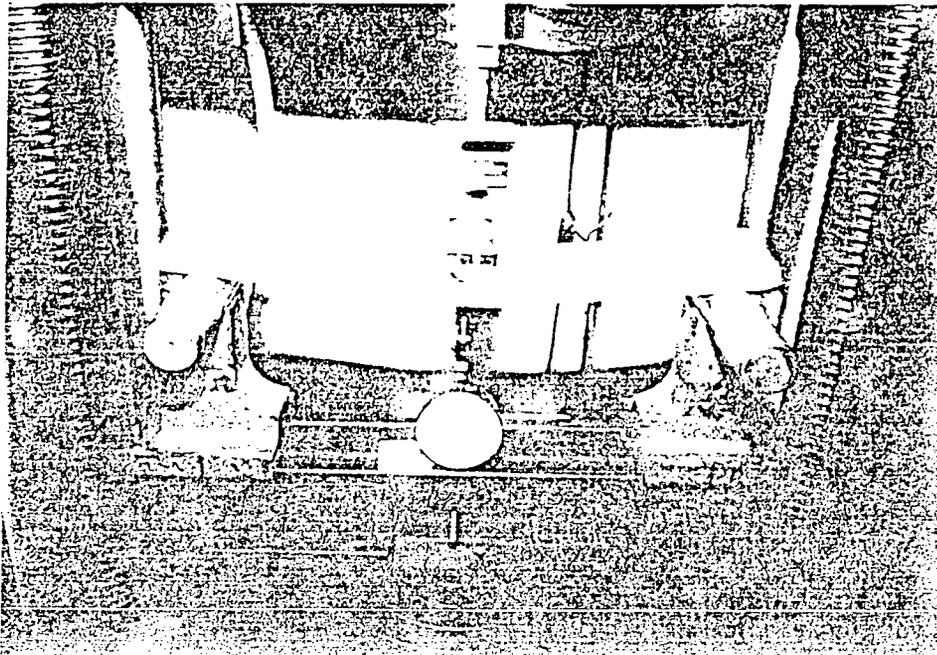
MAXIMUM LOAD (lbs):	10.1	10.6	7.9
FLEXURAL STRENGTH (psi): (15 inch span)	222.7	197.8	176.7



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Flexural Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Two stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side joined by a butt joint of Thermo-Lag 330 trowel grade overlapped with steel wire mesh on one side with an overlap of 6 inches - stainless steel stress skin down

SPECIMEN NUMBER:

	1	2	3
WIDTH (in.):	2.987	3.082	3.080
THICKNESS (in.):	0.903	0.770	0.884
AREA (in <sup>2</sup> ):	2.697	2.373	2.723

DEFLECTION (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.05	7.7	6.6	5.6
0.10	10.7	10.1	9.4
0.15	16.3	12.1	11.5
0.20	19.9	13.1	11.6
0.25	22.1	15.2	13.8
0.30	23.7	15.7	14.4
0.35	24.7	15.6	14.3
0.40	25	14.1	14.0
0.45	22.1	11.3	13.5
0.50	11.8	9.2	13.0

**FAILURE:**

S.S. stress skin lap bond failure on one side of joint	Thermo-Lag 330 material failure at 1/3 span	S.S. stress skin lap bond failure on one side of joint
--	---	--

MAXIMUM LOAD (lbs):

25.0

15.7

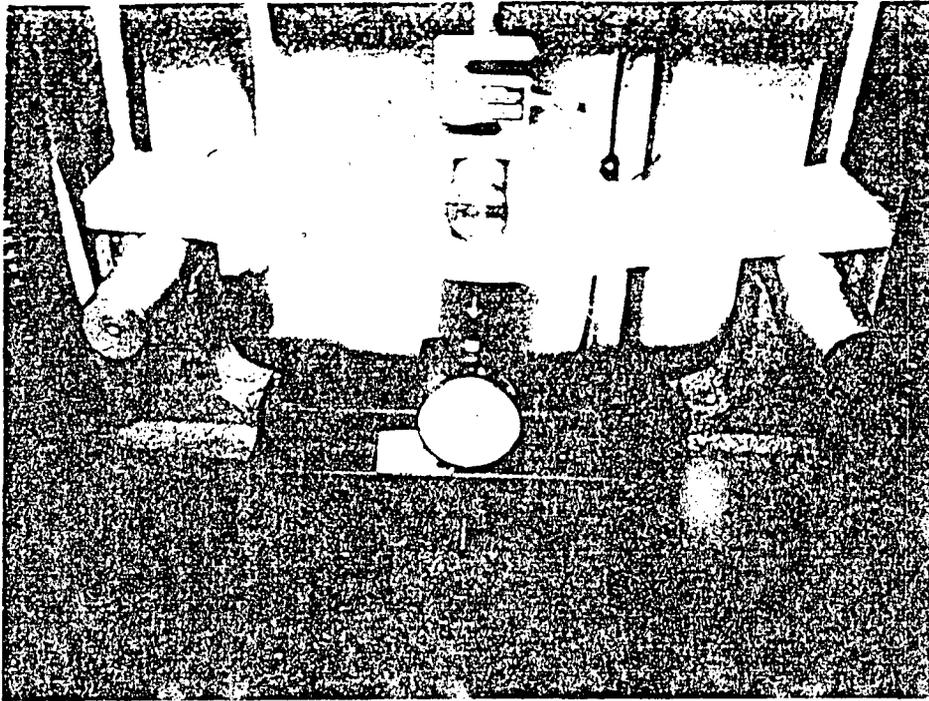
14.4

FLEXURAL STRENGTH (psi):  
(15 inch span)

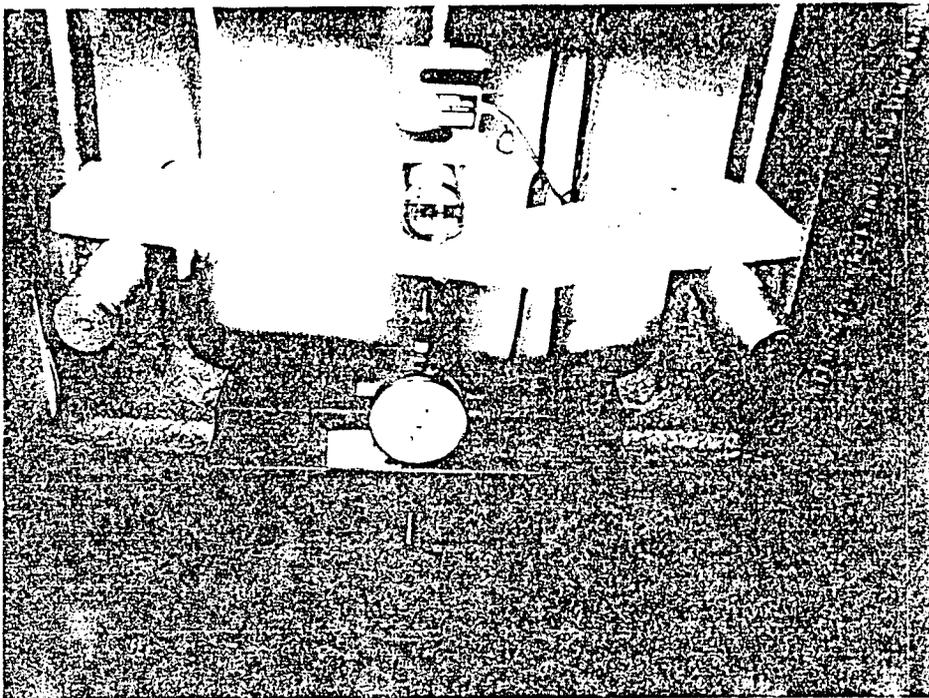
230.9

193.3

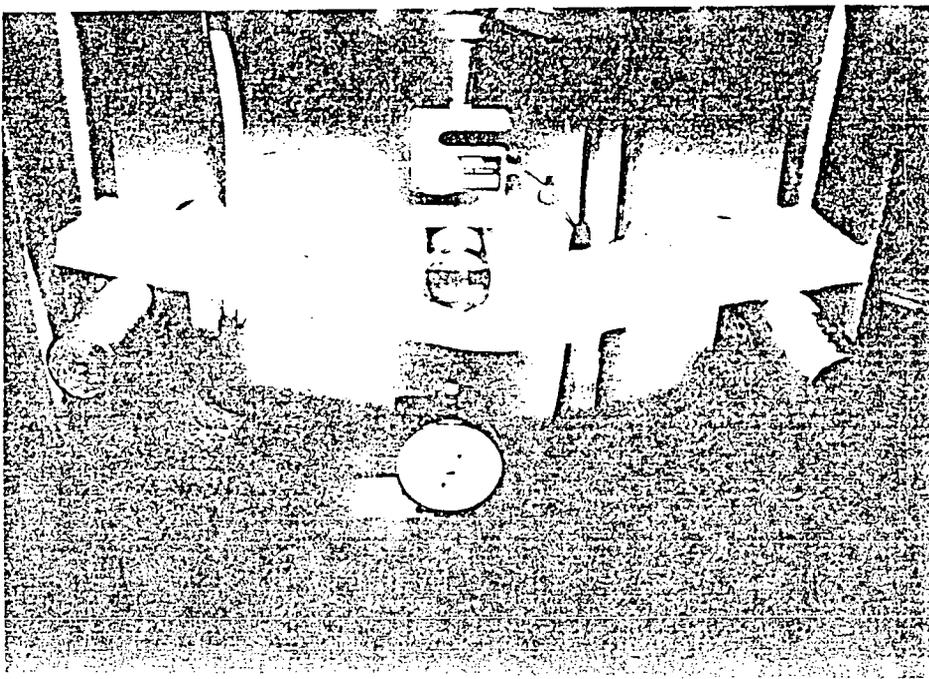
134.6



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Flexural Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Two stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side joined by a butt joint of Thermo-Lag 330 trowel grade overlapped with steel wire mesh on one side with an overlap of 10 inches - stainless steel stress skin down

SPECIMEN NUMBER: 1 2 3

WIDTH (in.):	2.903	2.953	2.971
THICKNESS (in.):	0.893	0.810	0.899
AREA (in <sup>2</sup> ):	2.592	2.392	2.671

DEFLECTION (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.05	9.6	10.6	9.4
0.10	14.7	17.6	14.9
0.15	19.9	23.4	17.6
0.20	23.4	28.1	23.6
0.25	26.1	31.6	26.1
0.30	28.0	34.1	27.5
0.35	29.6	36.1	27.9
0.40	30.8	37.2	27.0
0.45	31.7	38.3	22.6
0.50	32.3	39.1	14.3
0.55	32.9	39.6	11.7
0.60	33.2	39.7	-
0.65	33.4	38.4	-
0.70	33.4	30.4	-
0.75	33.2	21.6	-
0.80	32.7	16.2	-

**FAILURE:** S.S. stress skin lap bond failure on one side of joint      S.S. stress skin lap bond failure on one side of joint      Thermo-Lag 330 material failure at 1/3 span

MAXIMUM LOAD (lbs):

33.4

39.7

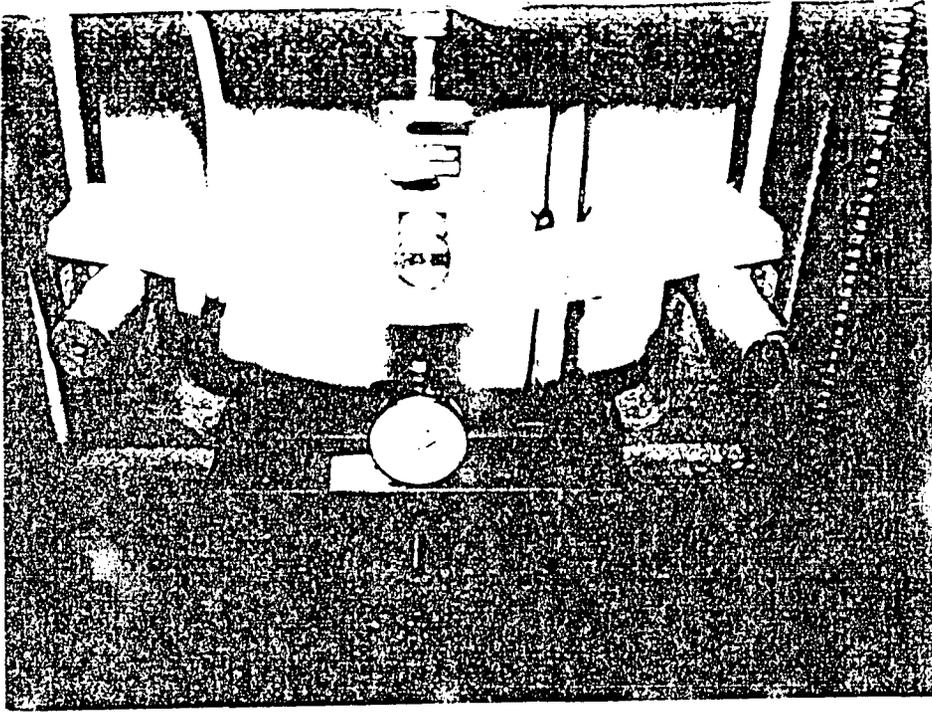
27.9

FLEXURAL STRENGTH (psi):  
(15 inch span)

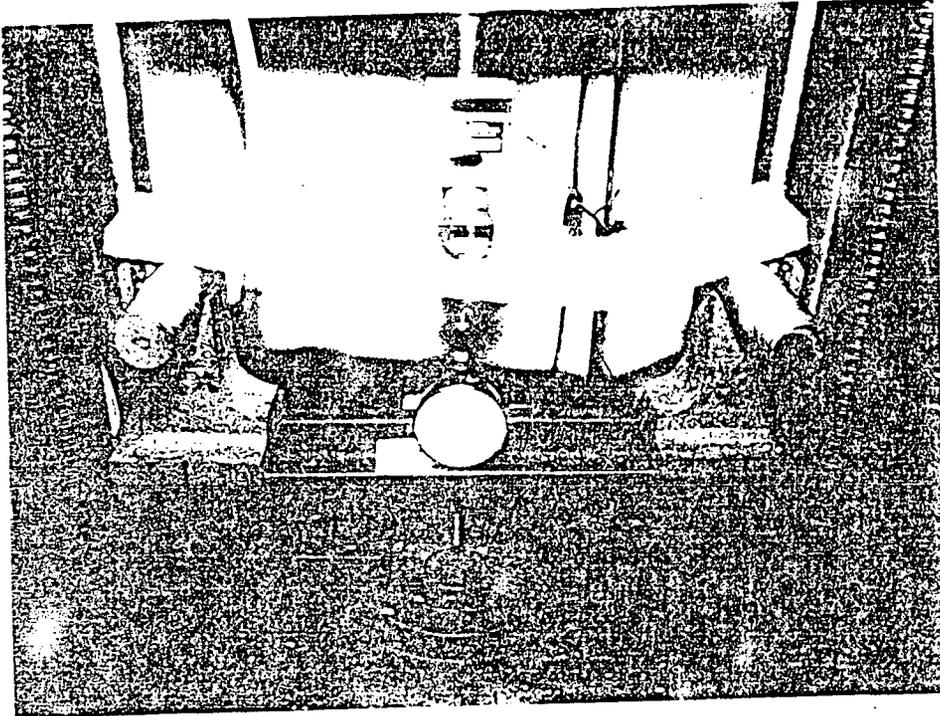
325.4

382.3

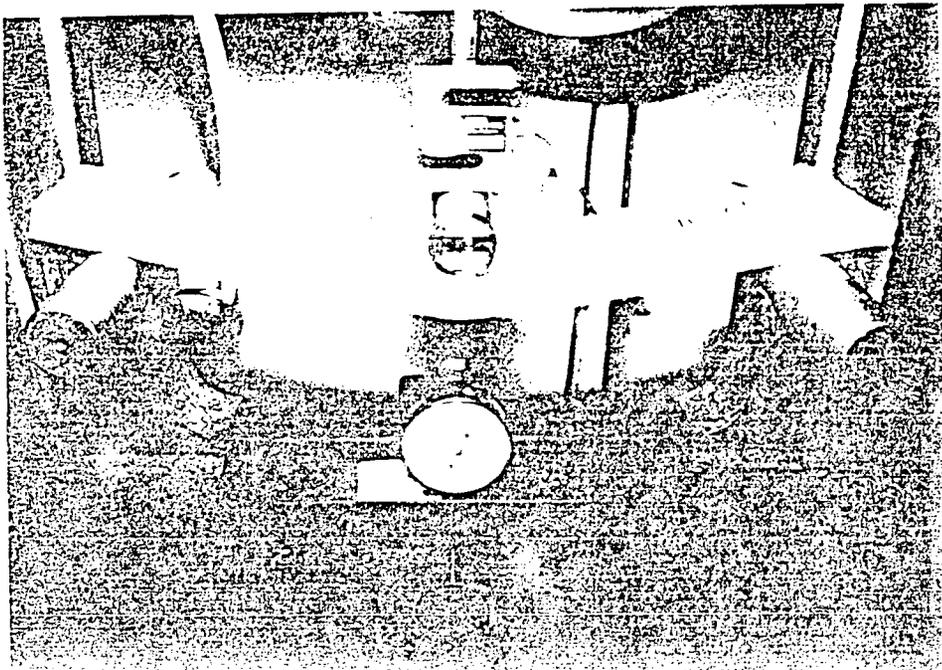
261.4



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Flexural Strength

CONDITIONING/TEST TEMPERATURE: 127° F

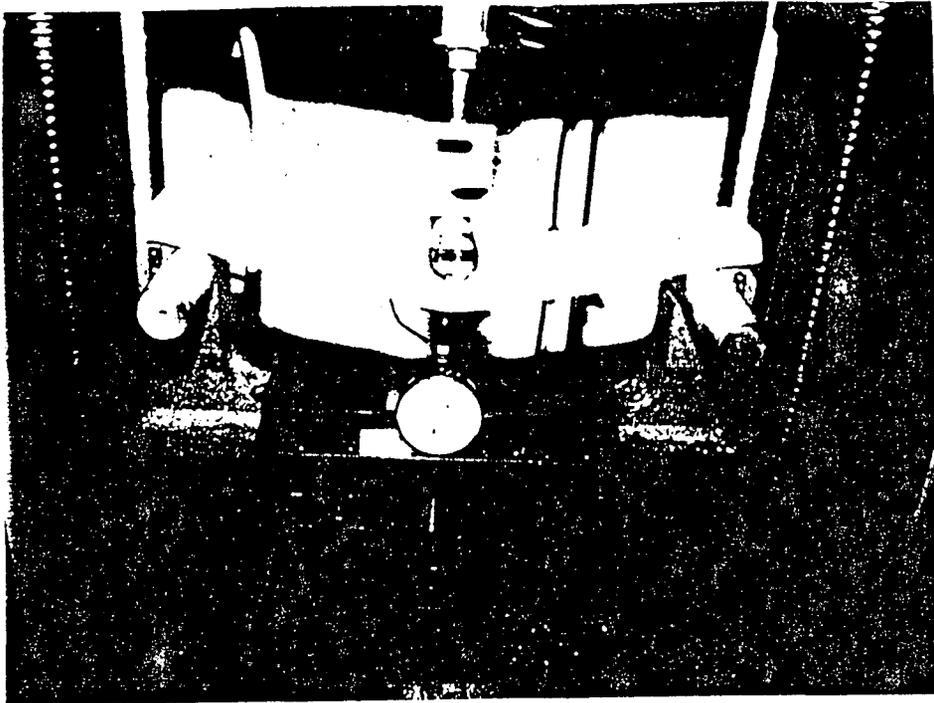
SPECIMEN CONFIGURATION: Two stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side joined by a butt joint of Thermo-Lag 330 trowel grade overlapped with steel wire mesh on one side with an overlap of 12 inches - stainless steel stress skin down

SPECIMEN NUMBER:                    1                    2                    3

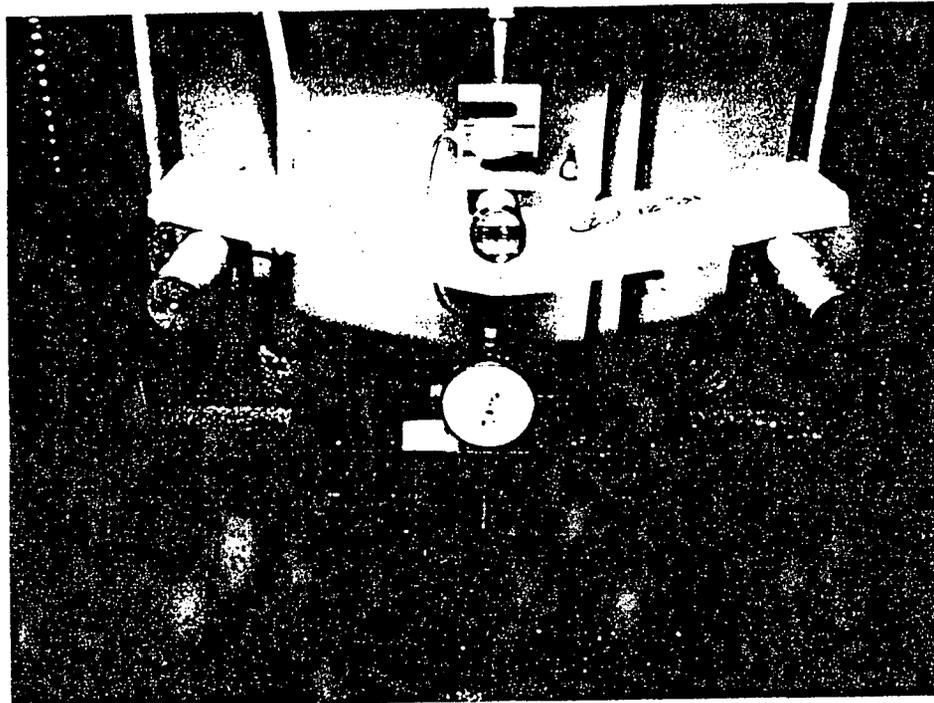
WIDTH (in.):	2.911	3.131	2.912
THICKNESS (in.):	0.881	0.879	0.886
AREA (in <sup>2</sup> ):	2.565	2.752	2.580

DEFLECTION (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.05	10.3	12.2	10.7
0.10	17.1	20.3	18.1
0.15	22.9	24.9	25.8
0.20	27.1	28.8	31.3
0.25	30.4	31.8	35.2
0.30	32.6	33.9	37.9
0.35	34.5	35.6	40.1
0.40	35.7	36.7	41.3
0.45	36.6	37.6	42.7
0.50	37.4	37.9	43.1
0.55	37.5	38.1	43.3
0.60	37.3	38.0	43.1
0.65	36.9	37.8	42.6
0.70	36.4	37.1	42.8
0.75	36.0	34.0	41.3
0.80	34.9	25.2	40.6

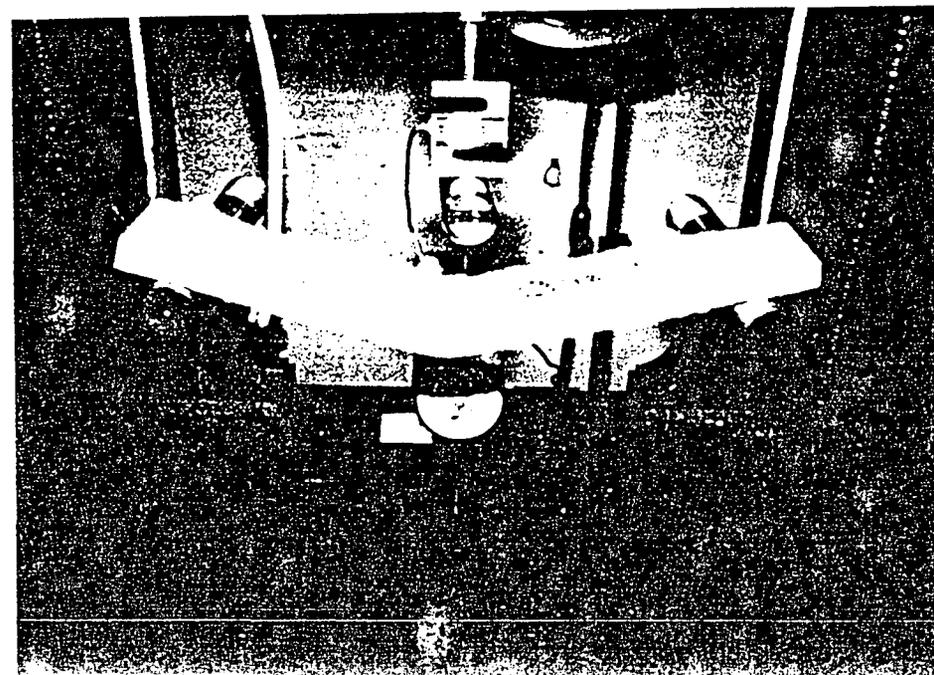
<b>FAILURE:</b>	S.S. stress skin lap bond failure on one side of joint	S.S. stress skin lap bond failure on one side of joint	Compression failure at top surface of butt joint
MAXIMUM LOAD (lbs):	37.5	38.1	43.3
FLEXURAL STRENGTH (psi): (15 inch span)	373.4	354.4	426.2



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Compressive Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin

SPECIMEN NUMBER:	1	2	3
WIDTH (in.):	1.022	1.056	1.016
THICKNESS (in.):	0.808	0.710	0.816
AREA (in <sup>2</sup> ):	0.826	0.750	0.829
HEIGHT (in.):	1.022	1.015	1.023

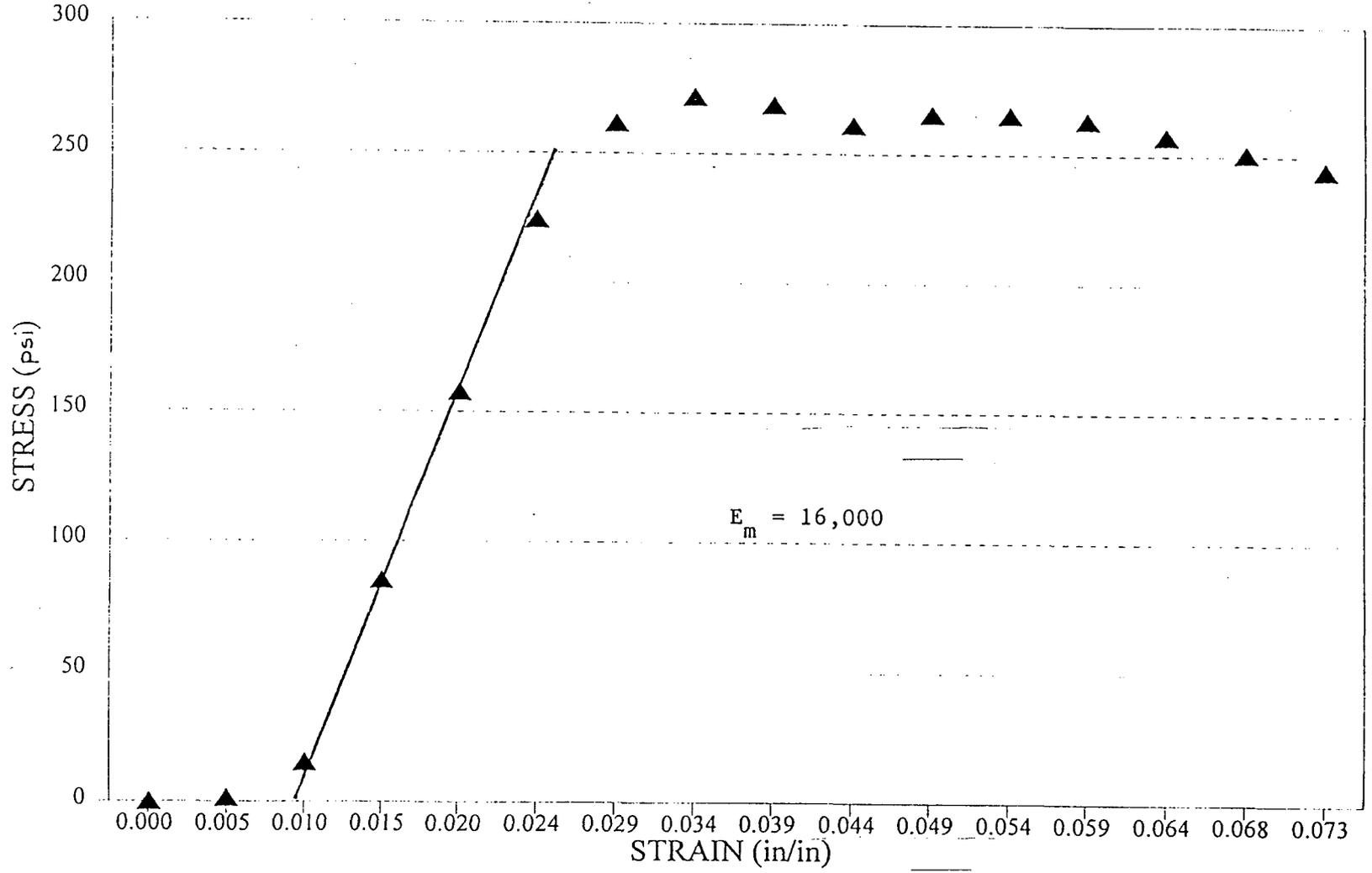
DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.005	1.2	1.2	1.8
0.010	12.6	4.7	4.0
0.015	70.1	13.2	15.1
0.020	130.2	46.5	39.0
0.025	185.6	94.0	75.4
0.030	216.0	154.7	109.1
0.035	224.6	193.0	152.3
0.040	222.1	210.3	185.8
0.045	215.7	214.9	207.5
0.050	219.2	215.0	221.8
0.055	219.1	212.3	230.8
0.060	217.5	209.3	228.3
0.065	212.6	204.2	221.9
0.070	207.1	196.0	217.1
0.075	202.0	185.7	208.0

FAILURE: Unequal compression failure - maximum compression on non-stress skin side for all specimens

MAXIMUM LOAD (lbs):	224.6	215.0	230.8
COMPRESSIVE STRENGTH (psi):	271.9	286.7	278.4

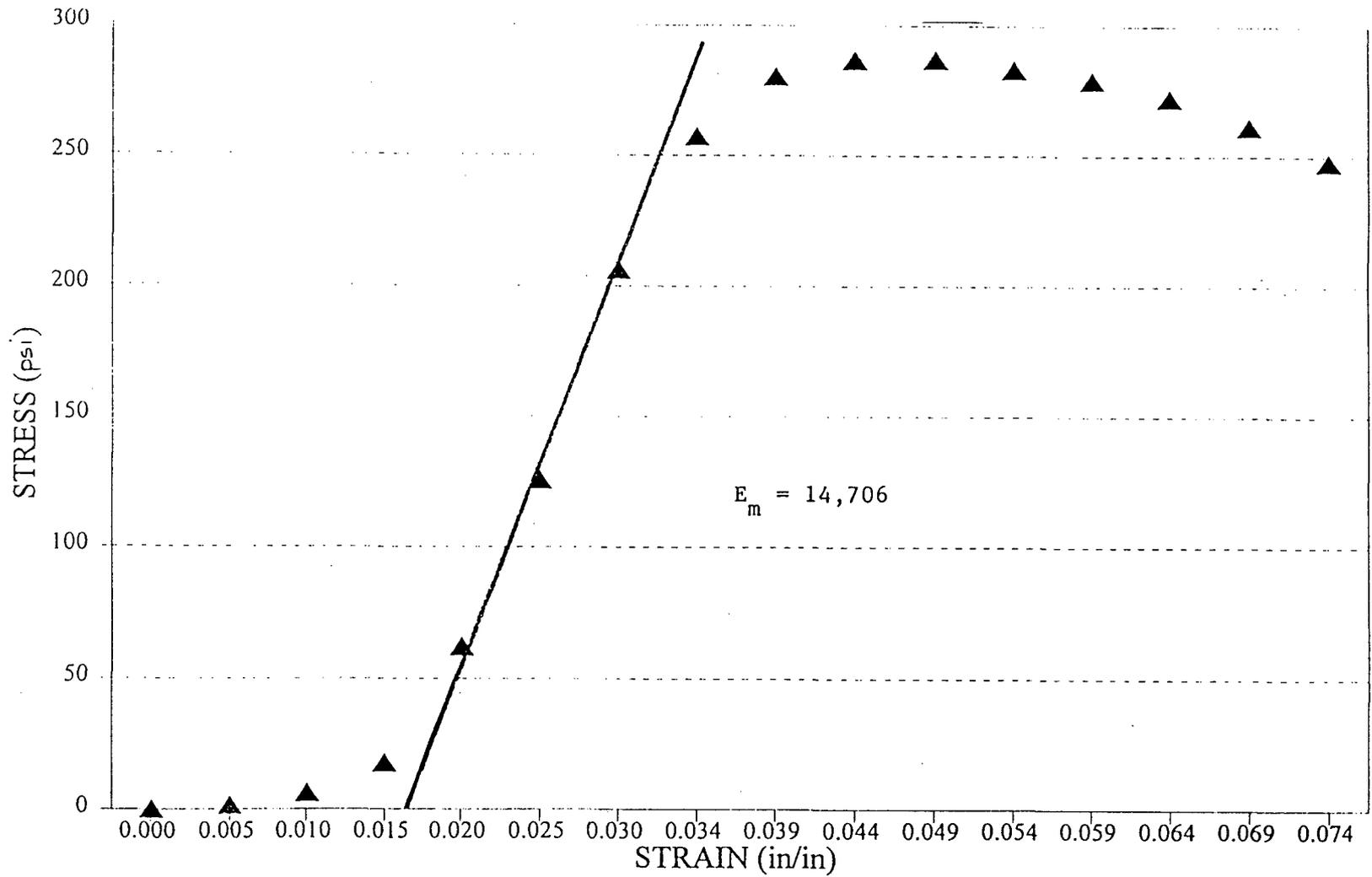
# Modulus of Elasticity

5/8" w/Std S.S. @ 127 F (Sample 1)



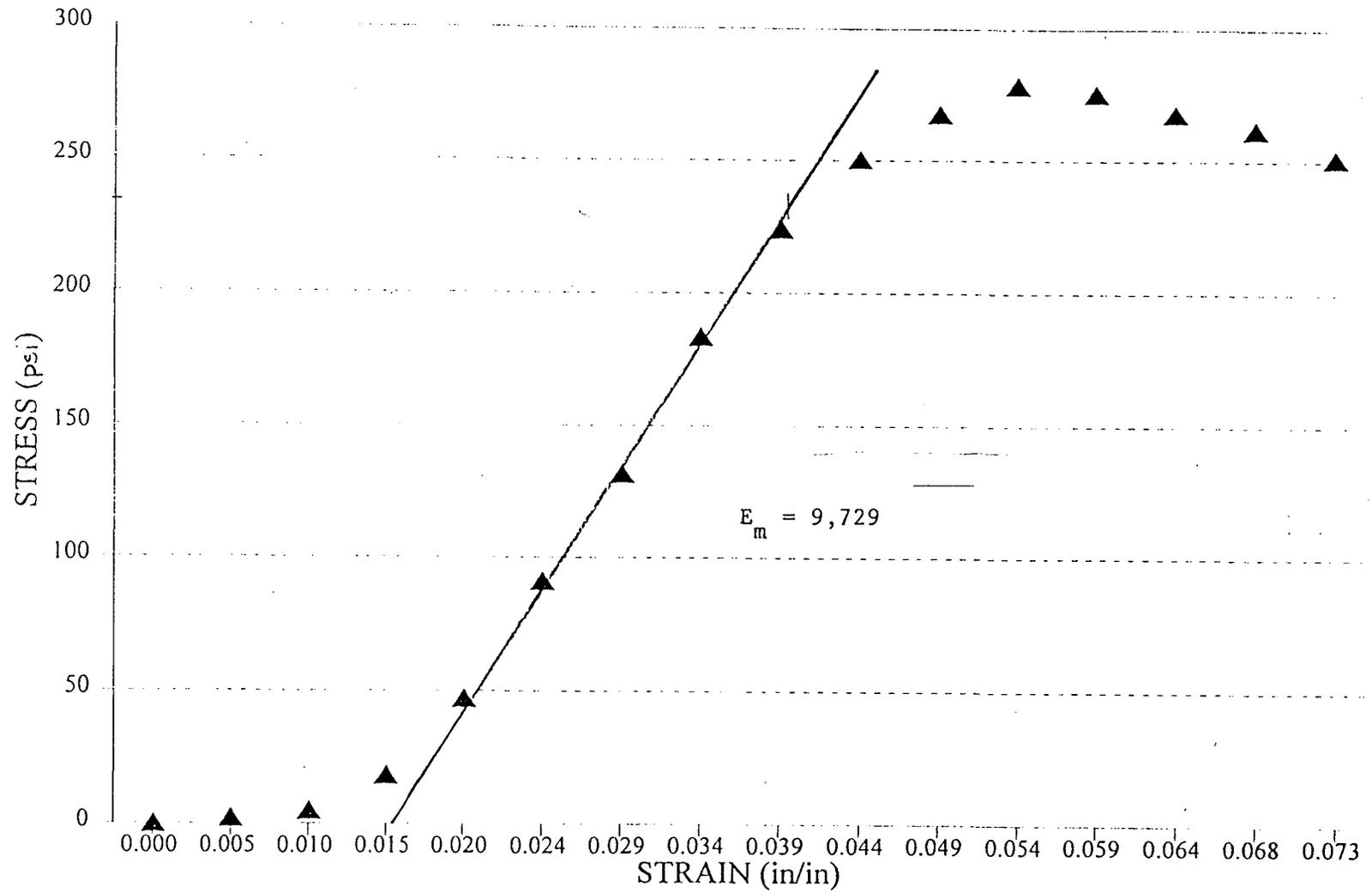
# Modulus of Elasticity

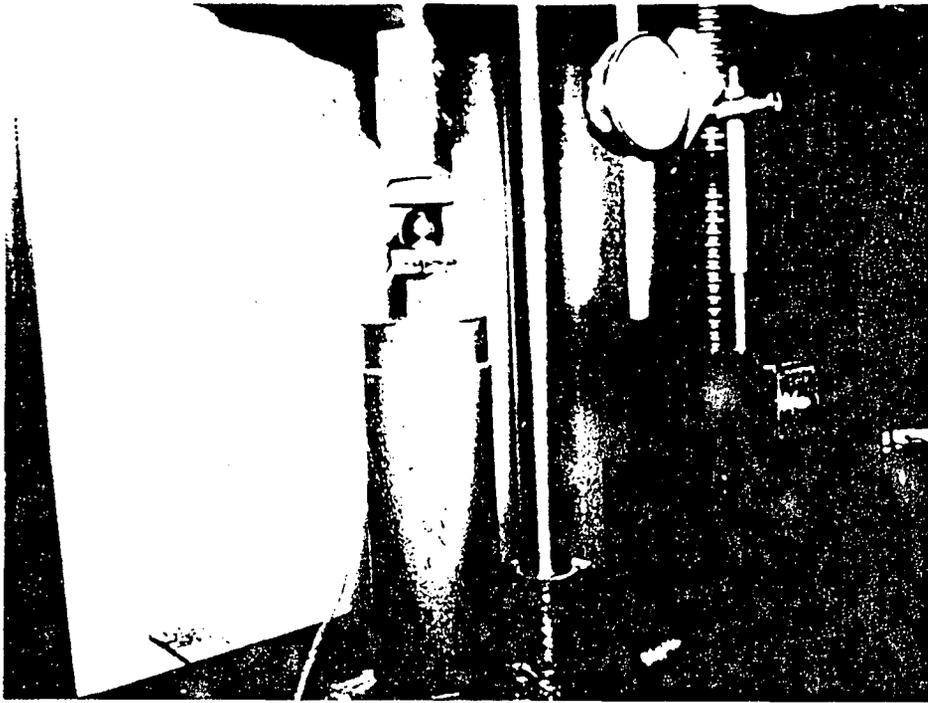
5/8" w/Std S.S. @ 127 F (Sample 2)



# Modulus of Elasticity

5/8" w/Std S.S. @ 127 F (Sample 3)





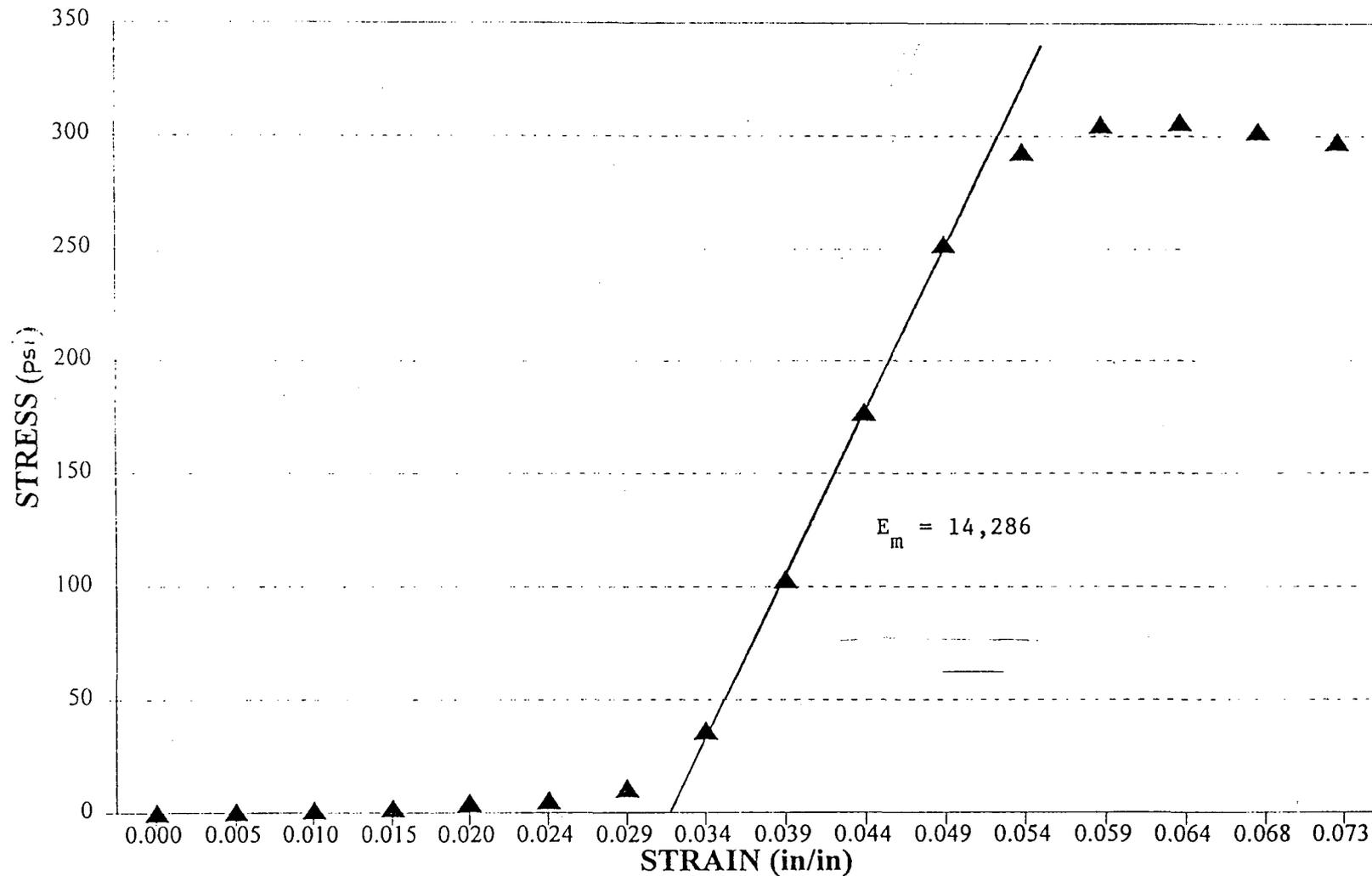
SPECIMEN 1  
(TYPICAL)



# Modulus of Elasticity

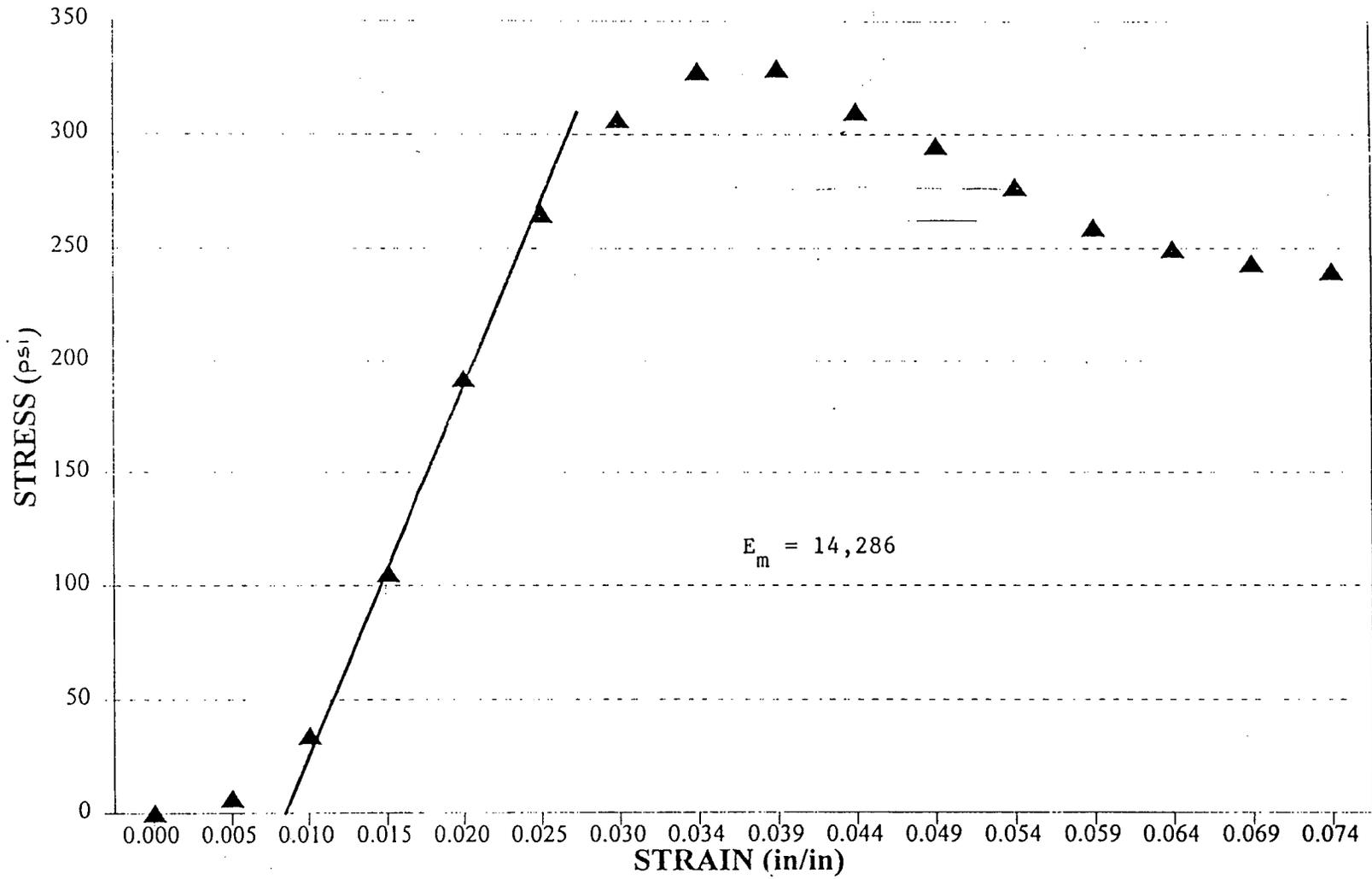
5/8" w/Std S.S. @ 127 F (Sample 1)

‡ S.S.S.



# Modulus of Elasticity

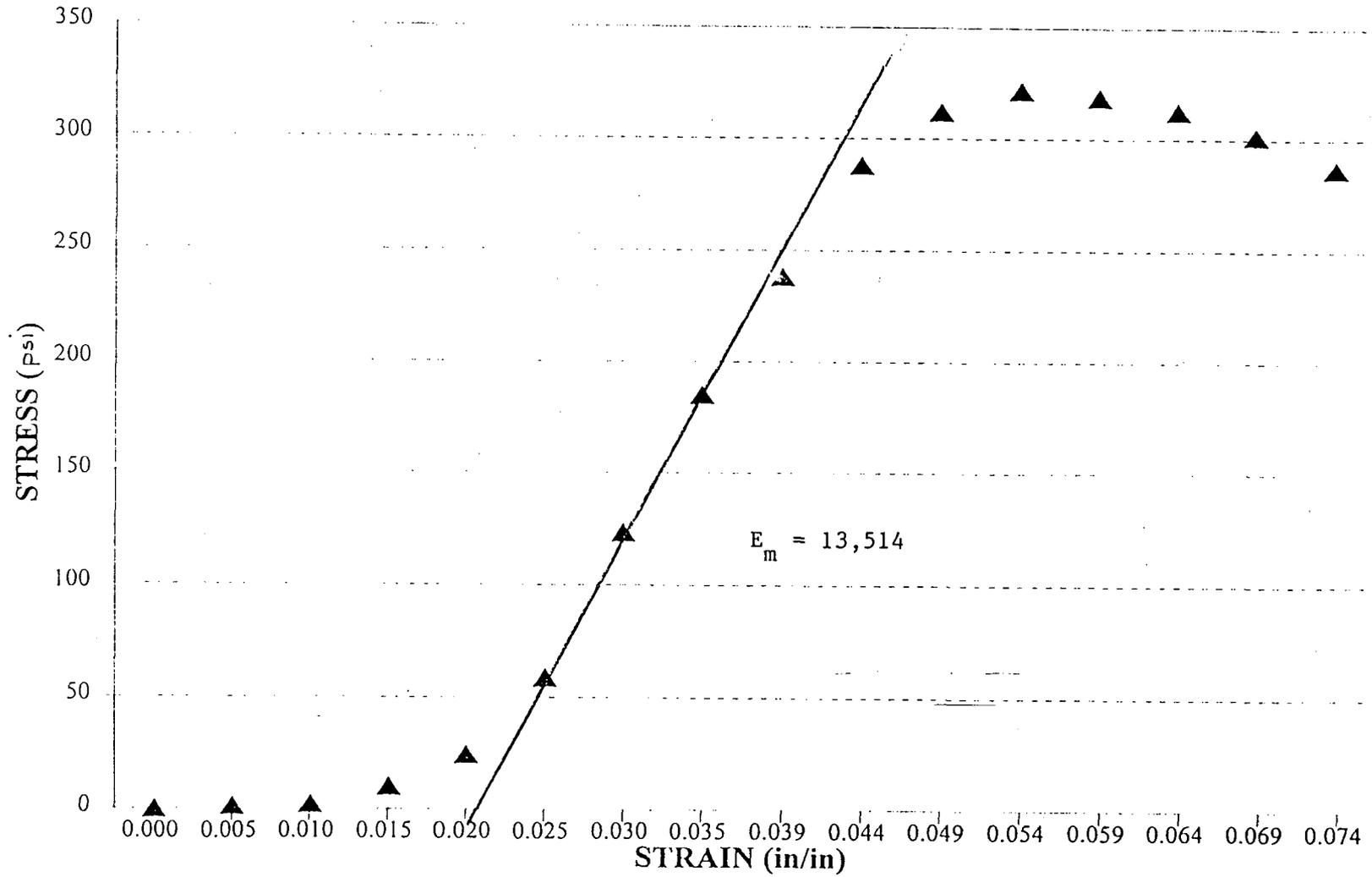
5/8" w/Std S.S. @ 127 F (Sample 2)  
‡ S.S.S.



# Modulus of Elasticity

5/8" w/Std S.S. @ 127 F (Sample 3)

φ 3.3.3.



PROPERTY: Compressive Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 3/8 inch thick with standard stress skin

SPECIMEN NUMBER: 1 2 3

WIDTH (in.):	0.932	0.937	0.933
THICKNESS (in.):	0.496	0.487	0.495
AREA (in <sup>2</sup> ):	0.462	0.456	0.462
HEIGHT (in.):	1.008	1.018	1.013

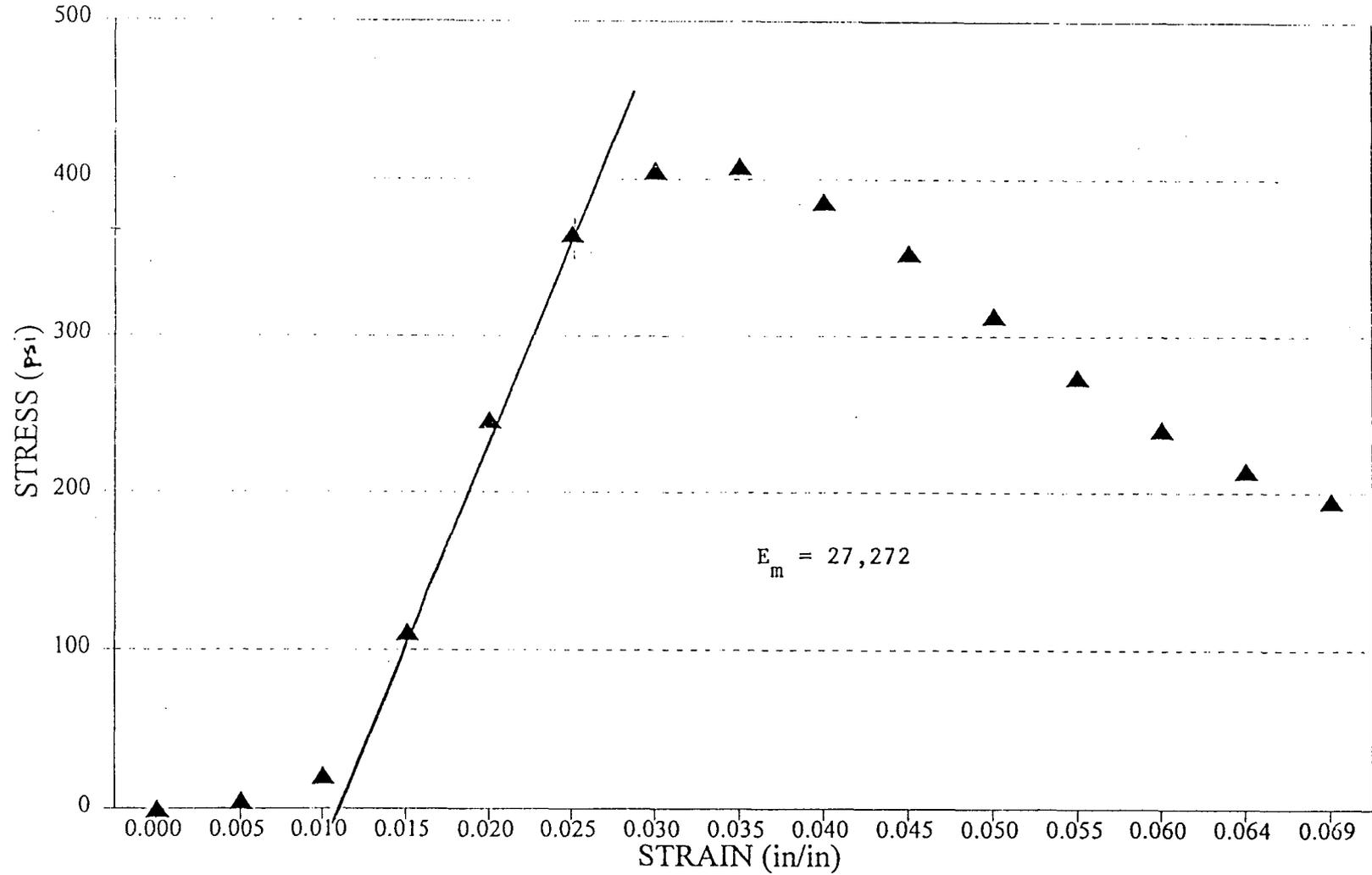
DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.005	2.3	2.6	4.1
0.010	9.5	12.0	8.0
0.015	51.2	40.9	31.7
0.020	113.8	83.6	75.7
0.025	168.6	129.5	112.4
0.030	187.1	153.7	148.2
0.035	188.5	165.1	166.3
0.040	178.3	156.4	168.1
0.045	163.1	152.7	158.2
0.050	144.6	160.1	144.1
0.055	126.5	167.7	127.9
0.060	111.2	164.2	113.9
0.065	99.0	153.4	99.8
0.070	90.1	144.8	89.3

FAILURE: Uneven compression failure - maximum compression on non-stress skin side for all specimens

MAXIMUM LOAD (lbs):	185.5	167.7	168.1
COMPRESSIVE STRENGTH (psi):	401.5	367.8	363.9

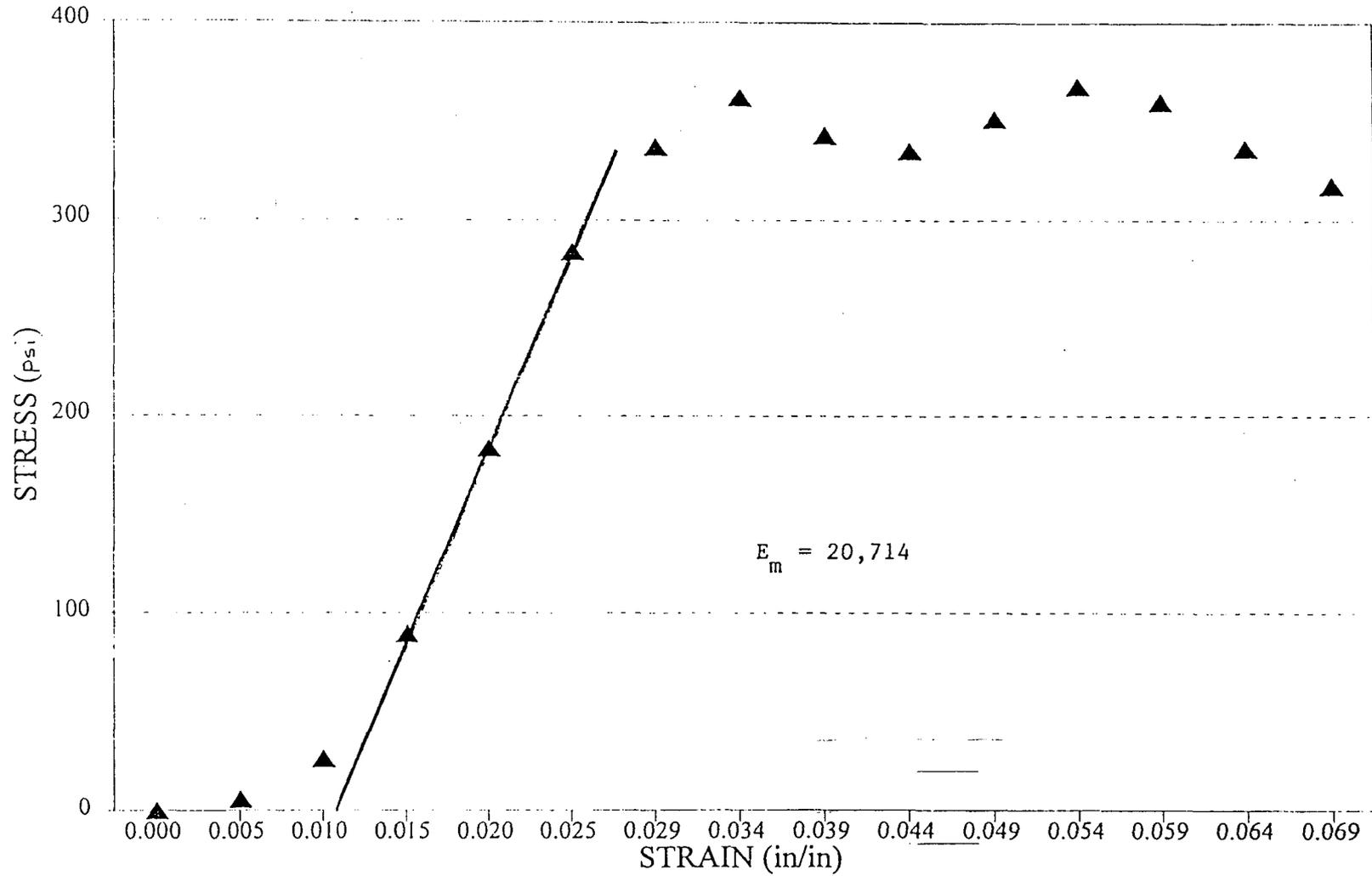
# Modulus of Elasticity

3/8" w/Std S.S. @ 127 F (Sample 1)



# Modulus of Elasticity

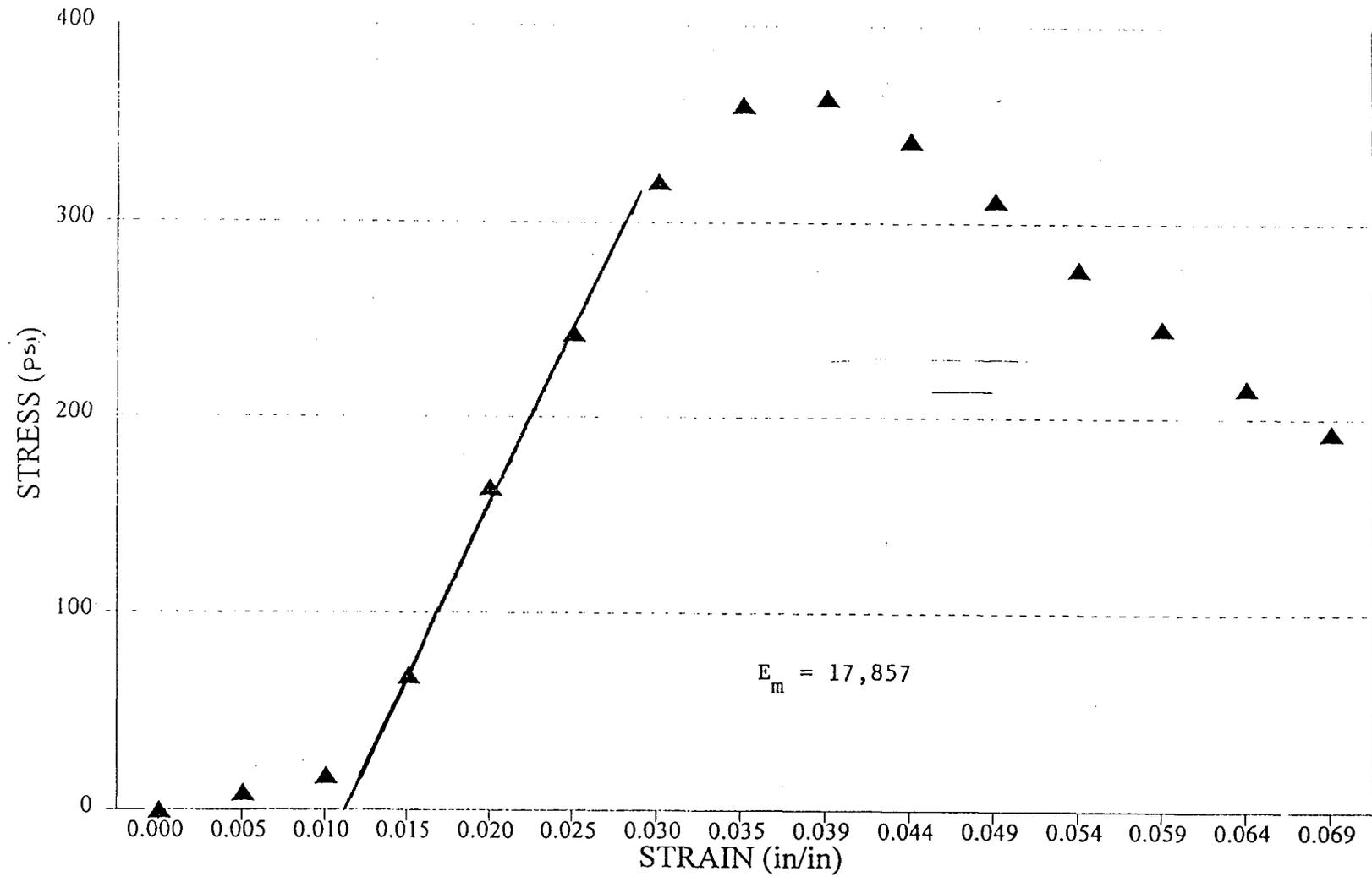
3/8" w/Std S.S. @ 127 F (Sample 2)



410

# Modulus of Elasticity

3/8" w/Std S.S. @ 127 F (Sample 3)



PROPERTY: Compressive Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin removed

SPECIMEN NUMBER:                    1                    2                    3

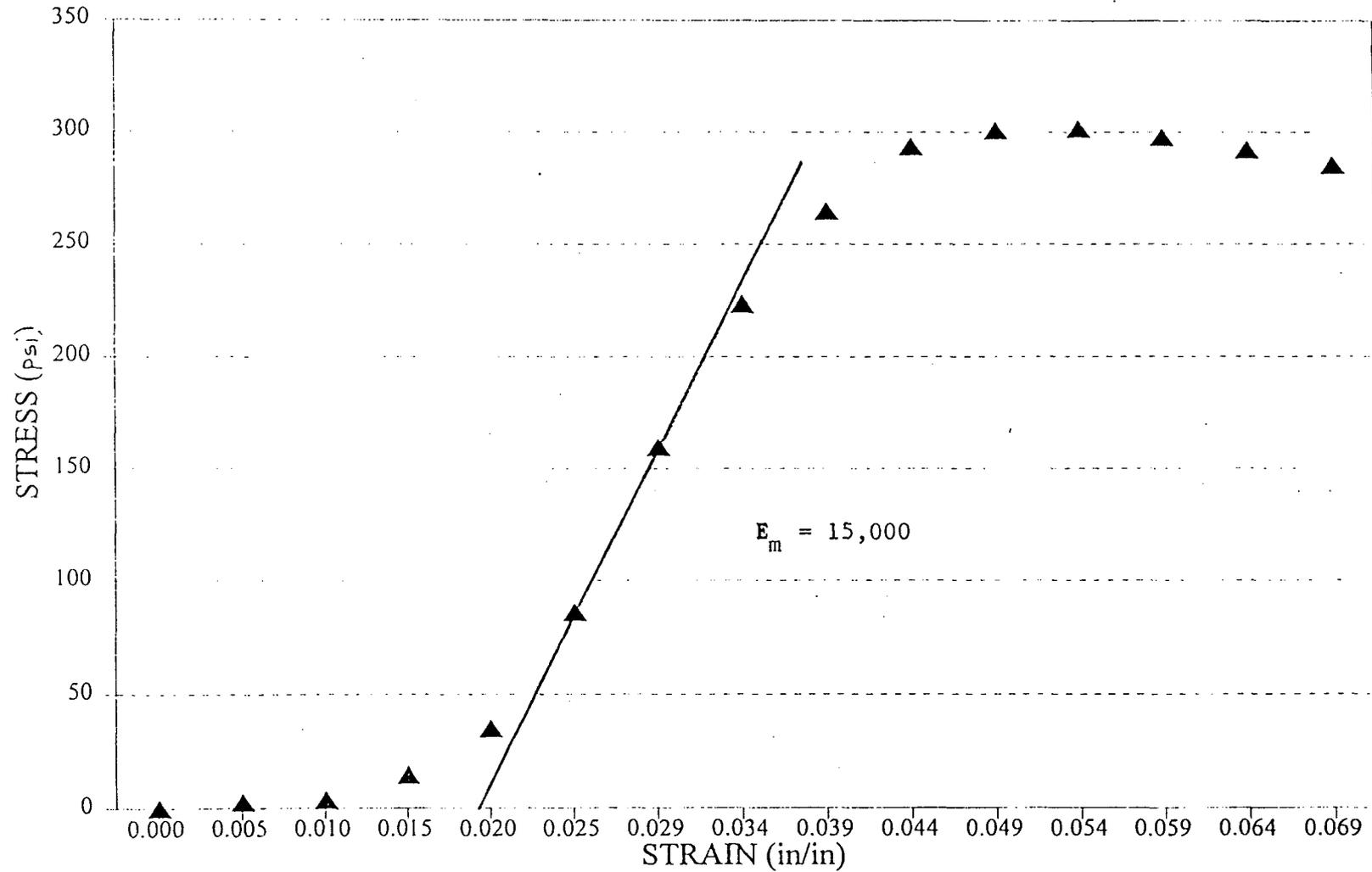
WIDTH (in.):	0.995	0.969	1.009
THICKNESS (in.):	0.645	0.631	0.658
AREA (in <sup>2</sup> ):	0.642	0.611	0.664
HEIGHT (in.):	1.019	1.018	1.025

DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.005	1.7	1.3	2.4
0.010	2.3	2.2	2.6
0.015	9.4	2.6	7.9
0.020	22.5	15.7	53.6
0.025	55.0	47.7	120.6
0.030	102.5	92.1	167.0
0.035	143.5	130.4	199.2
0.040	170.1	161.4	212.2
0.045	188.5	177.2	214.6
0.050	193.1	179.9	209.0
0.055	193.6	178.3	202.7
0.060	191.2	173.8	194.1
0.065	187.5	167.8	188.7
0.070	183.2	161.7	181.1
<b>FAILURE:</b>	Even compression failure	Even compression failure	Slightly more compressed on one side

MAXIMUM LOAD (lbs):	193.6	179.9	214.6
COMPRESSIVE STRENGTH (psi):	301.6	294.4	323.2

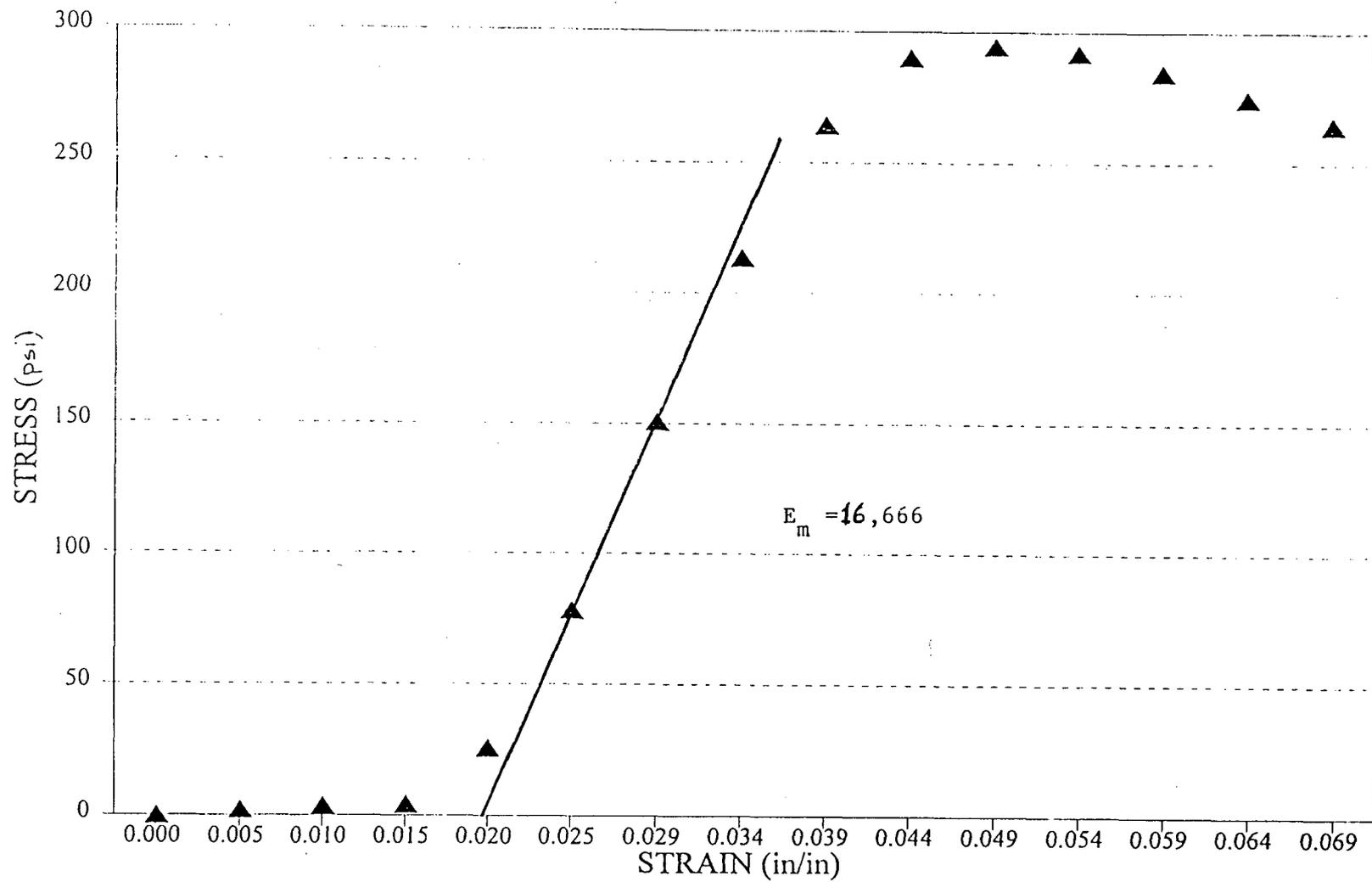
# Modulus of Elasticity

5/8" w/o Std S.S. @ 127 F (Sample 1)



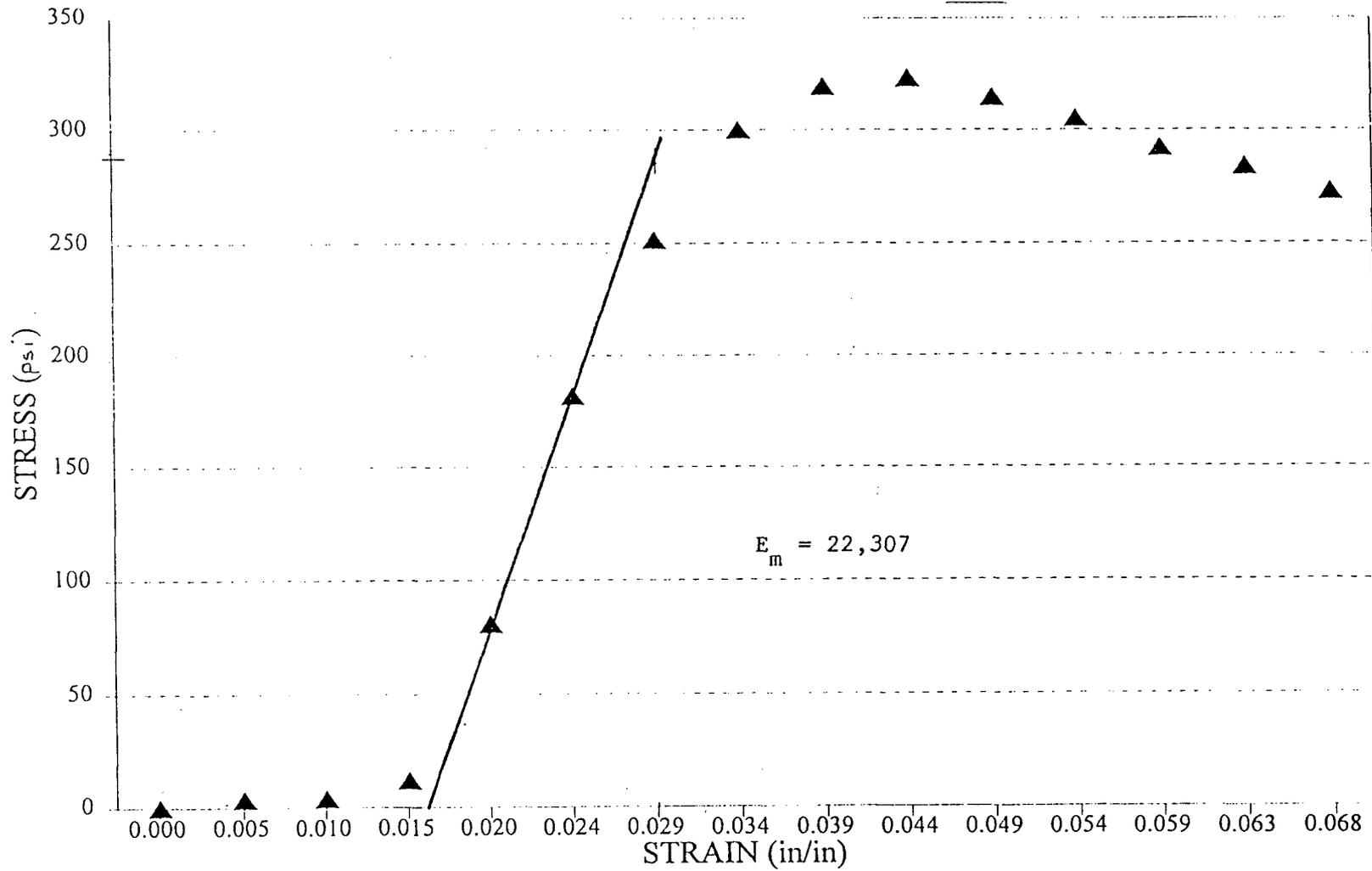
# Modulus of Elasticity

5/8" w/o Std S.S. @ 127 F (Sample 2)



# Modulus of Elasticity

5/8" w/o Std S.S. @ 127 F (Sample 3)



PROPERTY: Tensile Strength

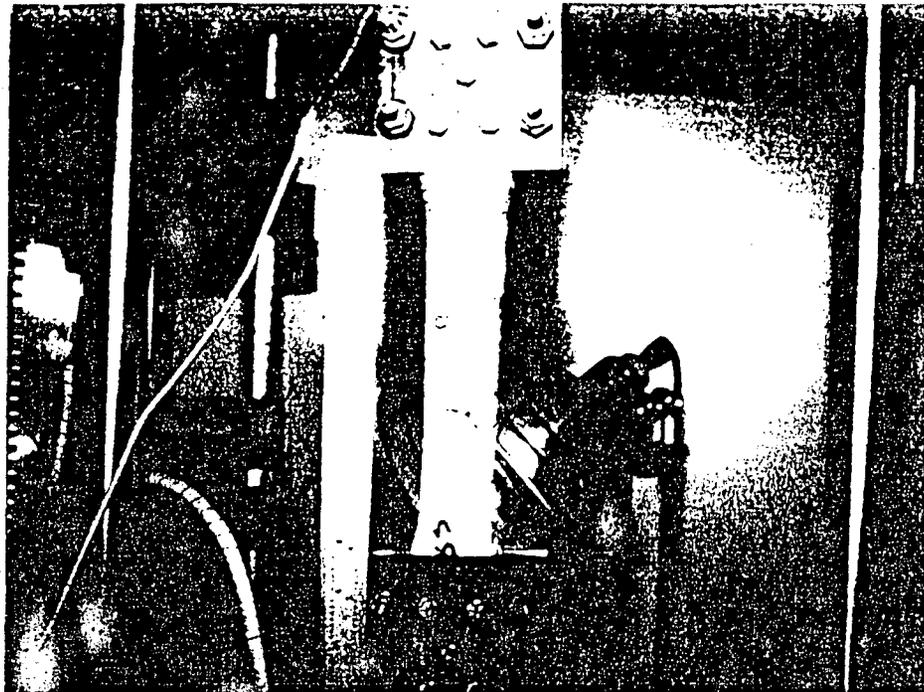
CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin  
- reduced section

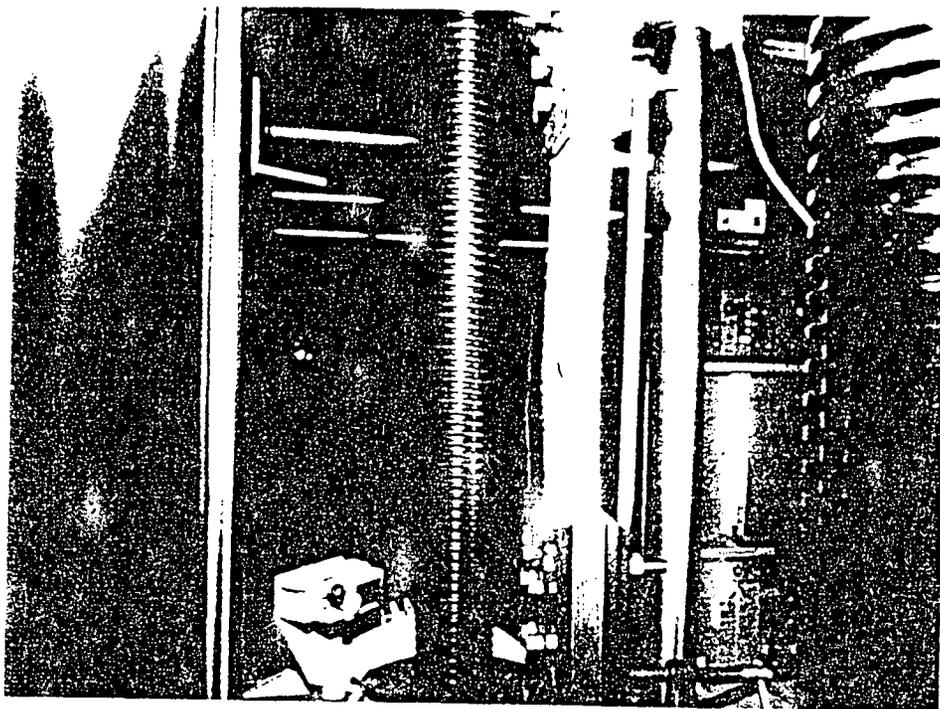
SPECIMEN NUMBER:	1	2	3
WIDTH (in.):	1.376	1.255	1.245
THICKNESS:	0.718	0.740	0.736
REDUCED AREA (in <sup>2</sup> ):	0.988	0.929	0.916

FAILURE:	Initial material failure in reduced section	Initial material failure in reduced section	Initial material failure in reduced section
MAXIMUM LOAD (lbs):	339.8	328.2	308.7
TENSILE STRENGTH (psi):	343.9	353.3	337.0
ELONGATION (in/in):	0.010	0.021	0.016

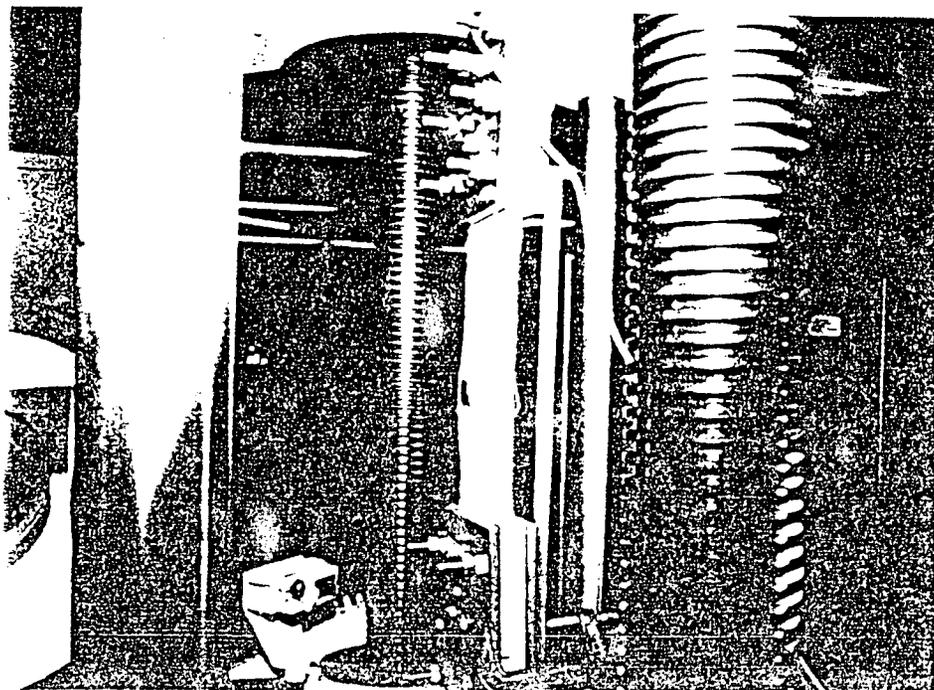
MAXIMUM LOAD (lbs):  
TENSILE STRENGTH (psi):  
ELONGATION (in/in):



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Tensile Strength

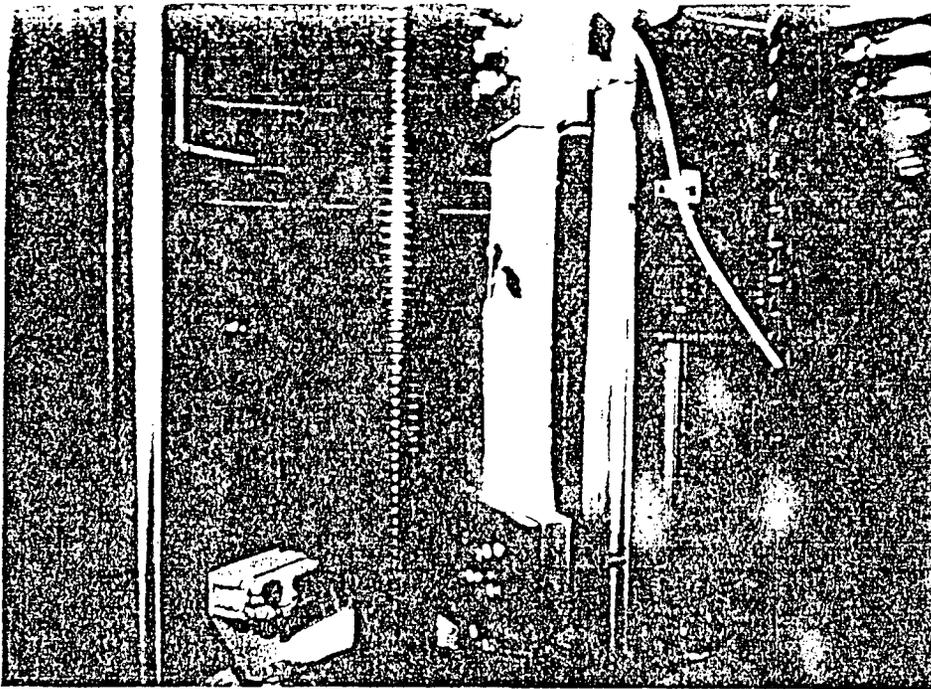
CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side and stainless steel wire mesh stress skin applied on opposite side - reduced section

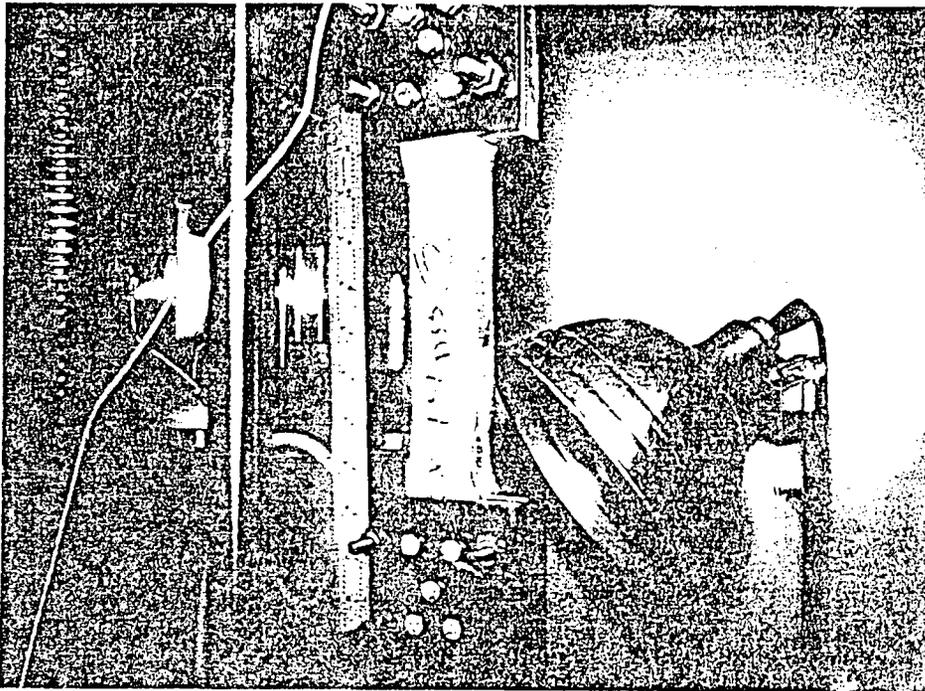
SPECIMEN NUMBER:	1	2	3
WIDTH (in.):	1.512	1.526	1.541
THICKNESS:	0.840	0.914	0.847
REDUCED AREA (in <sup>2</sup> ):	1.270	1.395	1.305

FAILURE: Carbon stress skin failed initially, stainless steel stress skin bond failed (did not break), material tensile cracking in reduced area (all specimens)

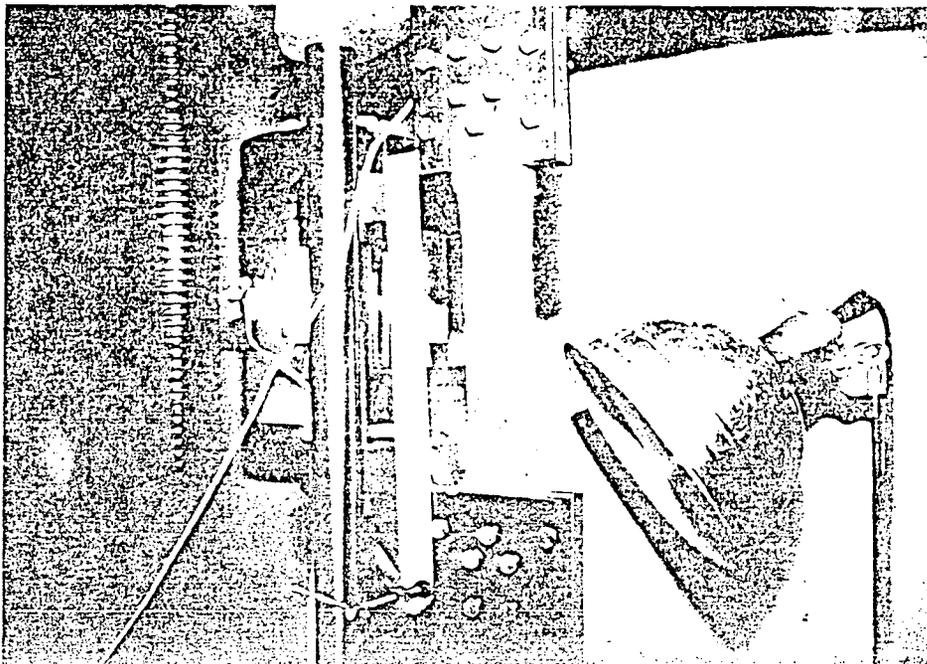
MAXIMUM LOAD (lbs):	652.4	621.3	658.2
TENSILE STRENGTH (psi):	513.7	445.5	504.3
ELONGATION (in/in):	0.024	0.024	0.024



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Tensile Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 3/8 inch thick with standard stress skin  
- reduced section

SPECIMEN NUMBER:

1

2

3

WIDTH (in.):	1.400	1.240	1.318
THICKNESS:	0.478	0.446	0.527
REDUCED AREA (in <sup>2</sup> ):	0.669	0.553	0.695

FAILURE:

	Initial material failure in reduced area	Initial material failure in reduced area	Initial material failure in reduced area
MAXIMUM LOAD (lbs):	567.7	399.9	548.5
TENSILE STRENGTH (psi):	848.3	723.2	789.7
ELONGATION (in/in):	0.024	0.034	0.014

PROPERTY: Tensile Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin removed  
- reduced section

SPECIMEN NUMBER:	1	2	3	4
WIDTH (in.):	1.655	1.44	1.598	1.571
THICKNESS:	0.588	0.602	0.597	0.592
REDUCED AREA (in <sup>2</sup> ):	0.973	0.867	0.954	0.930

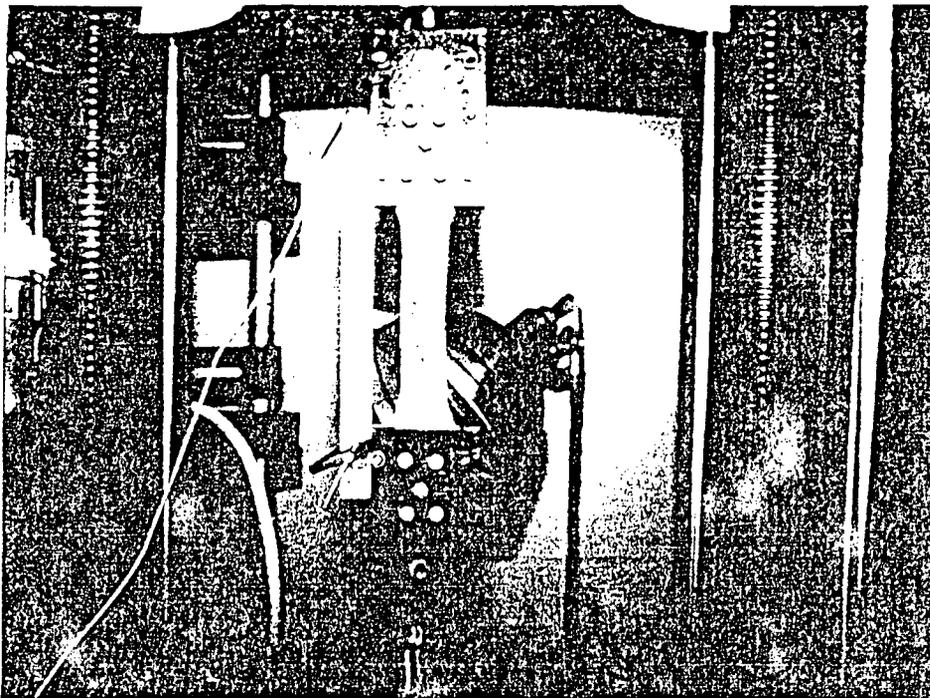
FAILURE:

| Material failure<br>in reduced area |
|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| 71.0                                | 43.1                                | 20.6                                | 58.1                                |
| 73.0                                | 49.7                                | 21.6                                | 62.5                                |
| 0.010                               | 0.010                               | 0.010                               | 0.005                               |

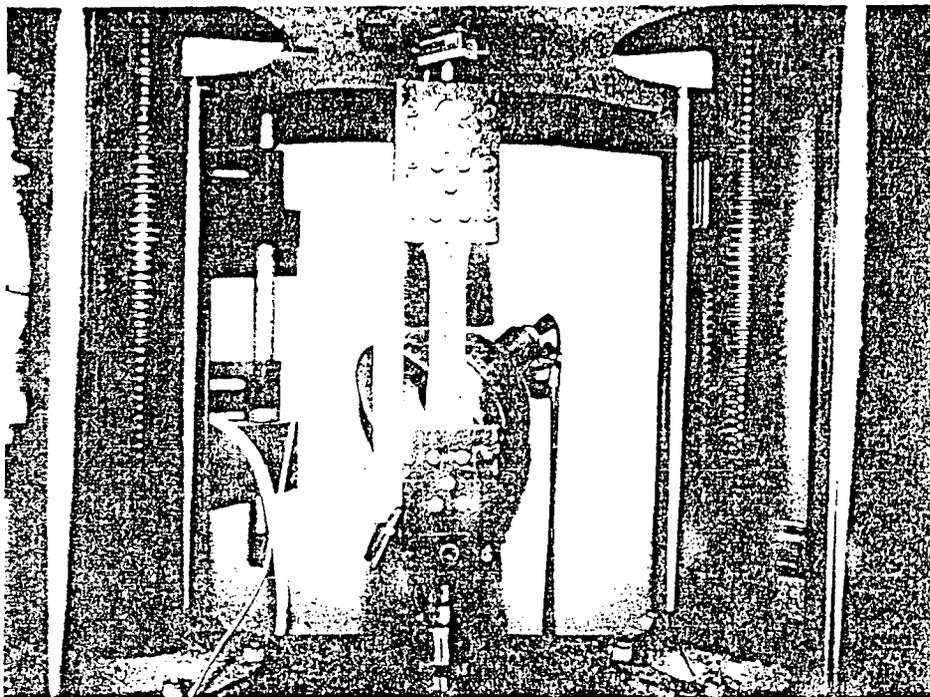
MAXIMUM LOAD (lbs):

TENSILE STRENGTH (psi):

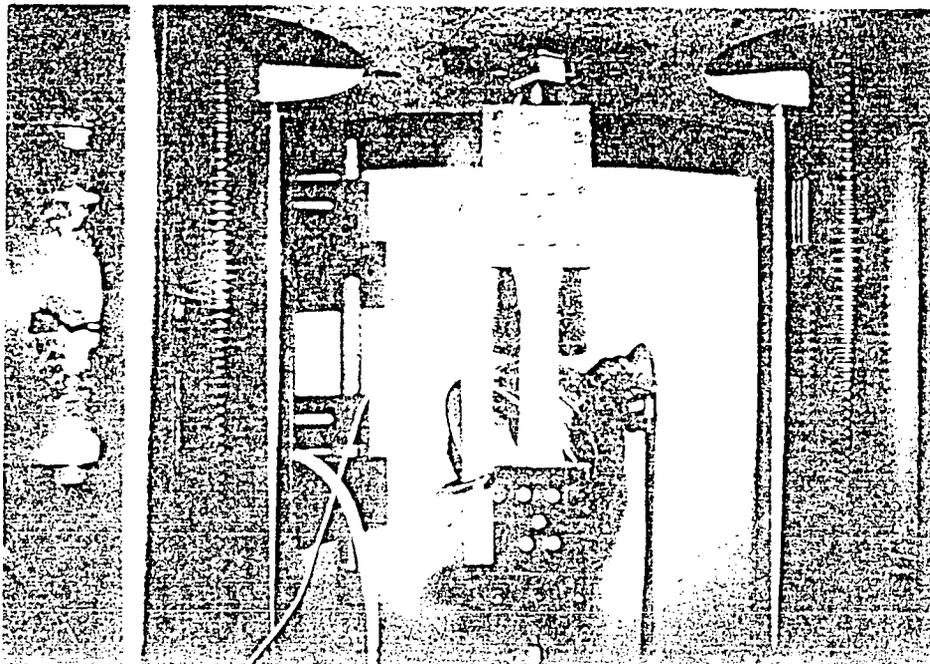
ELONGATION (in/in):



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

(TYPICAL)

PROPERTY: Tensile Strength

CONDITIONING/TEST TEMPERATURE: 127° F

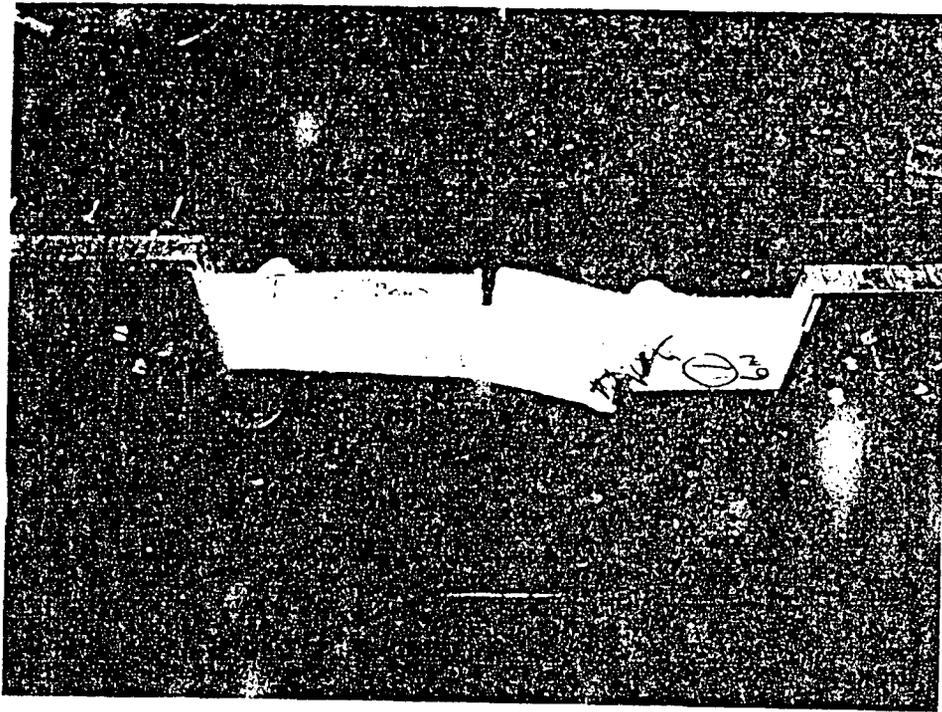
SPECIMEN CONFIGURATION: Two stock Thermo-Lag 330 sheets 5/8 inch thick with standard stress skin on one side joined by a butt-joint of thermo-lag 330 trowel grade overlapped with steel wire mesh on one side with an overlap of 6 inches

SPECIMEN NUMBER:	1	2	3
BOND WIDTH:	1.865	1.875	1.880
OVERLAP:	3.0	3.0	3.0
BOND AREA (in <sup>2</sup> ):	5.6	5.6	5.6

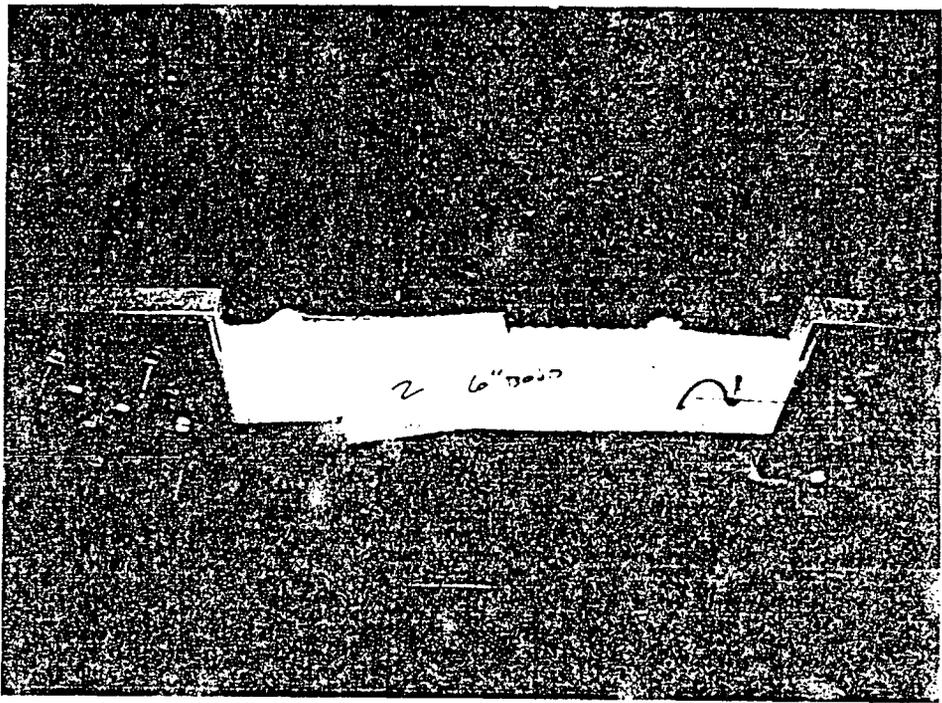
DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.01	13.0	20.0	23.0
0.02	27.0	50.0	65.0
0.03	51.0	81.0	98.0
0.04	74.0	105.0	118.0
0.05	88.0	123.0	132.0
0.06	95.0	134.0	142.0
0.07	103.0	142.0	148.0
0.08	112.0	147.0	152.0
0.09	123.0	149.0	156.0
0.10	130.0	150.0	155.0
0.11	136.0	146.6	146.0
0.12	139.0	140.0	113.0
0.13	137.0	130.0	85.0
0.14	132.0	25.0	70.0
0.15	134.0	-	-
0.16	137.0	-	-
0.17	139.0	-	-
0.18	140.0	-	-
0.19	131.0	-	-
0.20	104.0	-	-

FAILURE: Mesh overlap bond failure initiating from butt joint for all specimens

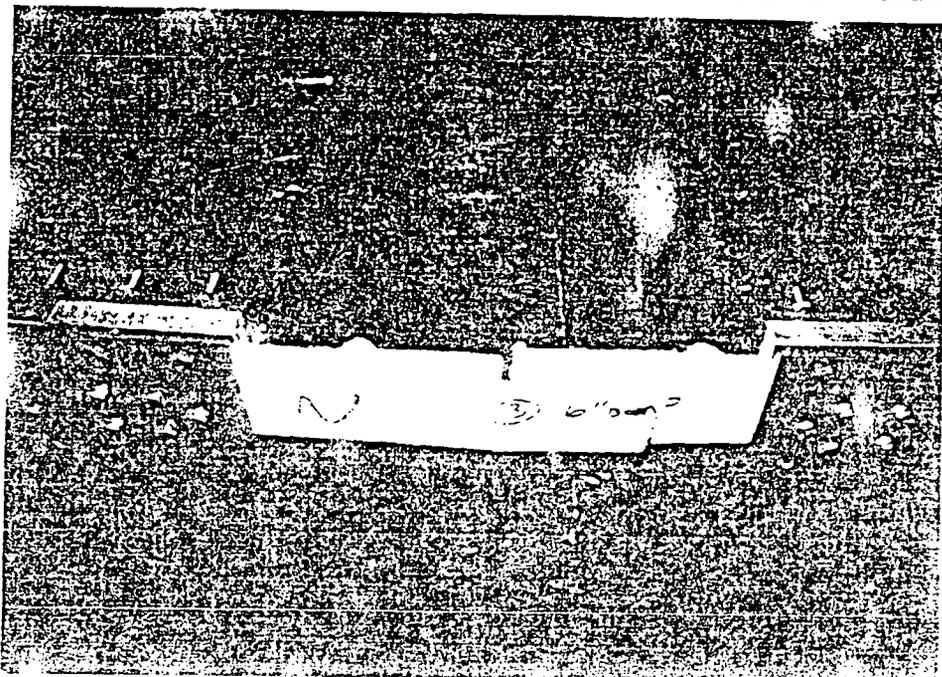
MAXIMUM LOAD (lbs):	140.0	150.0	156.0
BOND STRENGTH (psi):	25.0	26.8	27.9



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Tensile Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Two stock Thermo-Lag 330 sheets 5/8 inch thick with standard stress skin on one side joined by a butt-joint of thermo-lag 330 trowel grade overlapped with steel wire mesh on one side with an overlap of 10 inches

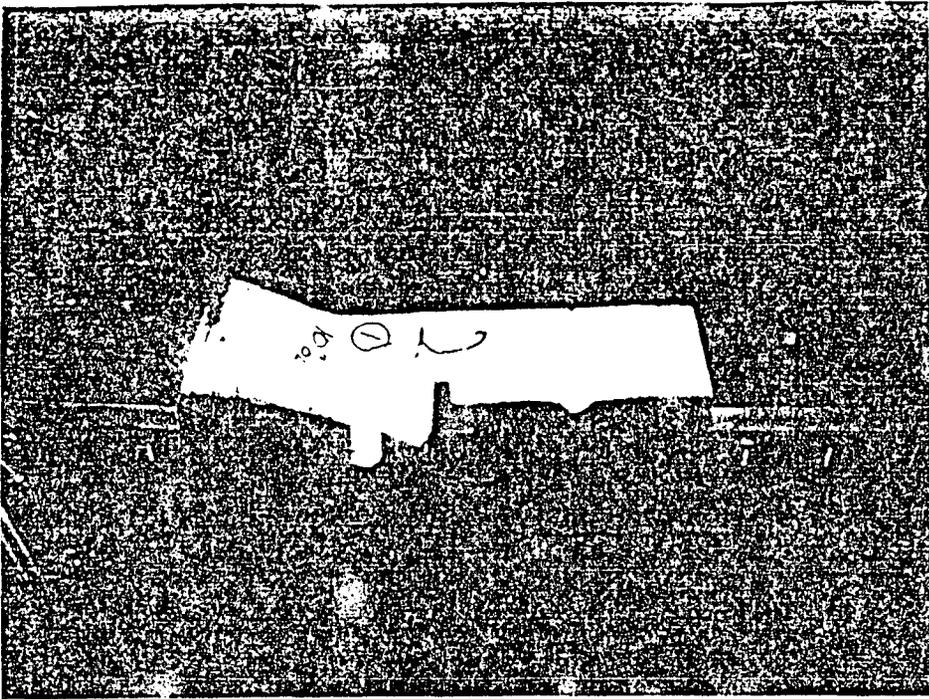
SPECIMEN NUMBER: 1 2 3

WIDTH:	1.904	1.897	1.900
THICKNESS:	0.683	0.672	0.710
AREA (in <sup>2</sup> ):	1.30	1.27	1.35

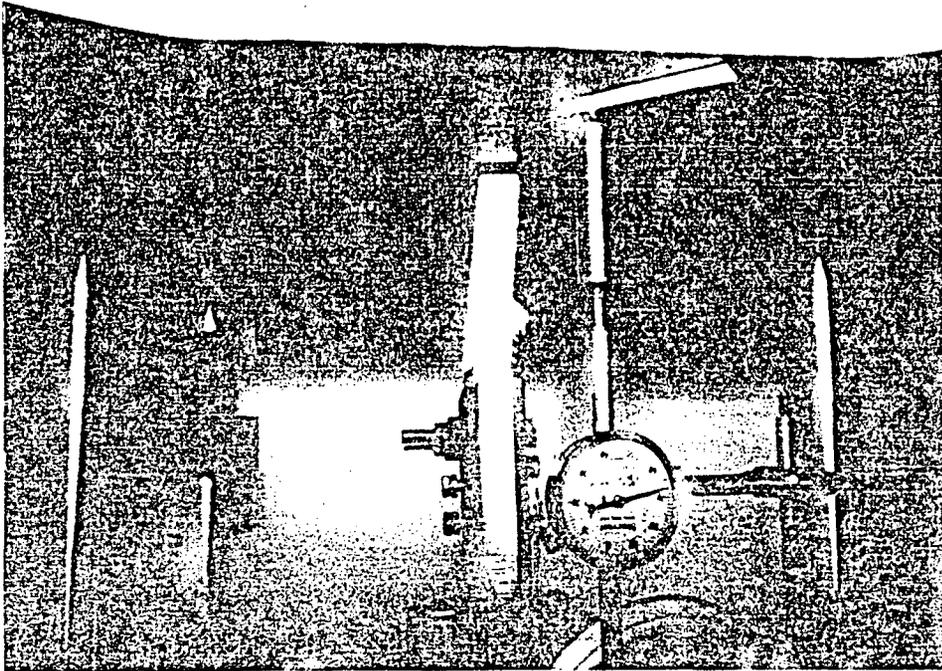
DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.01	39.0	58.0	49.0
0.02	94.0	84.0	94.0
0.03	144.0	103.0	115.0
0.04	168.0	120.0	134.0
0.05	169.0	134.0	151.0
0.06	156.0	145.0	50.0
0.07	145.0	154.0	60.0
0.08	152.0	161.0	67.0
0.09	155.0	163.0	71.0
0.10	154.0	149.0	74.0

**FAILURE:** Material failure at end of stress skin overlap followed by a stress skin bond failure initiating at butt joint for all specimens

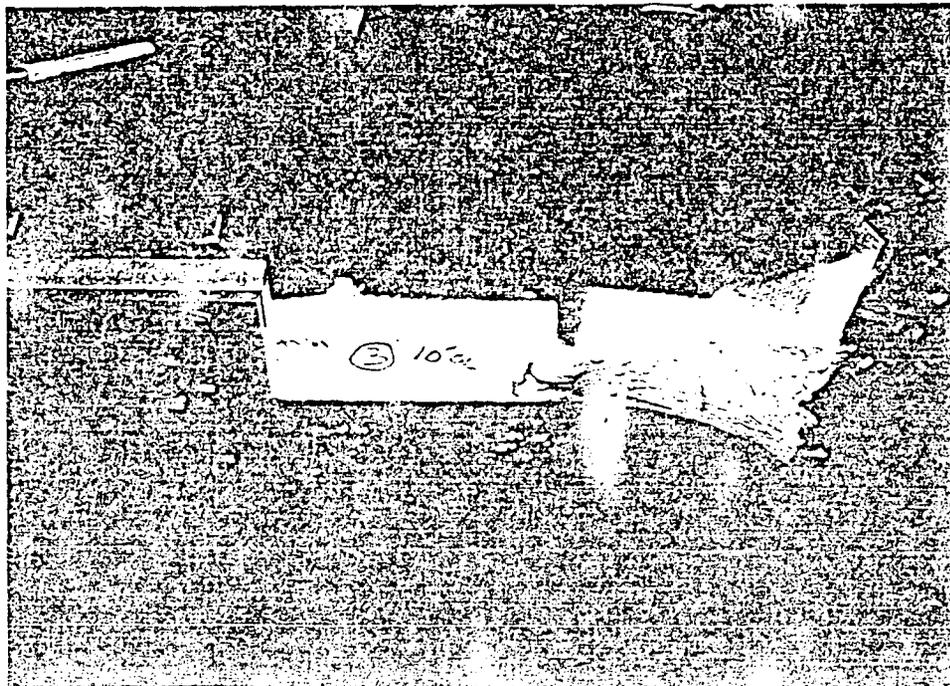
MAXIMUM LOAD (lbs):	155.0	163.0	151.0
TENSILE STRENGTH (psi):	119.2	128.3	111.9



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Tensile Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Two stock Thermo-Lag 330 sheets 5/8 inch thick with standard stress skin on one side joined by a butt-joint of thermo-lag 330 trowel grade overlapped with steel wire mesh on one side with an overlap of 12 inches

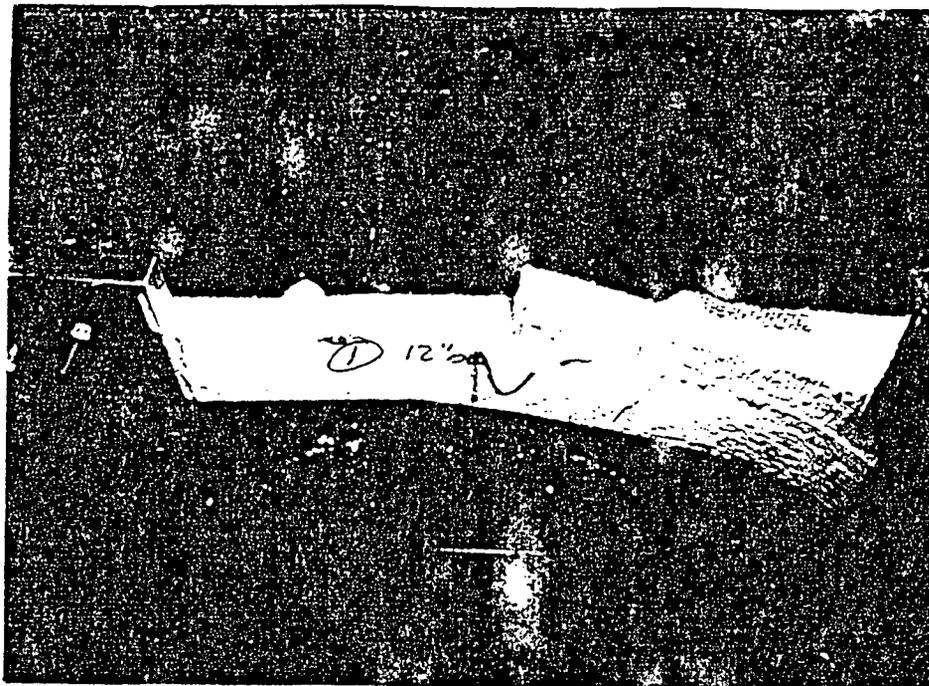
SPECIMEN NUMBER: 1 2 3

WIDTH:	1.895	1.910	0.860
THICKNESS:	0.702	0.732	0.708
AREA (in <sup>2</sup> ):	1.33	1.40	1.32

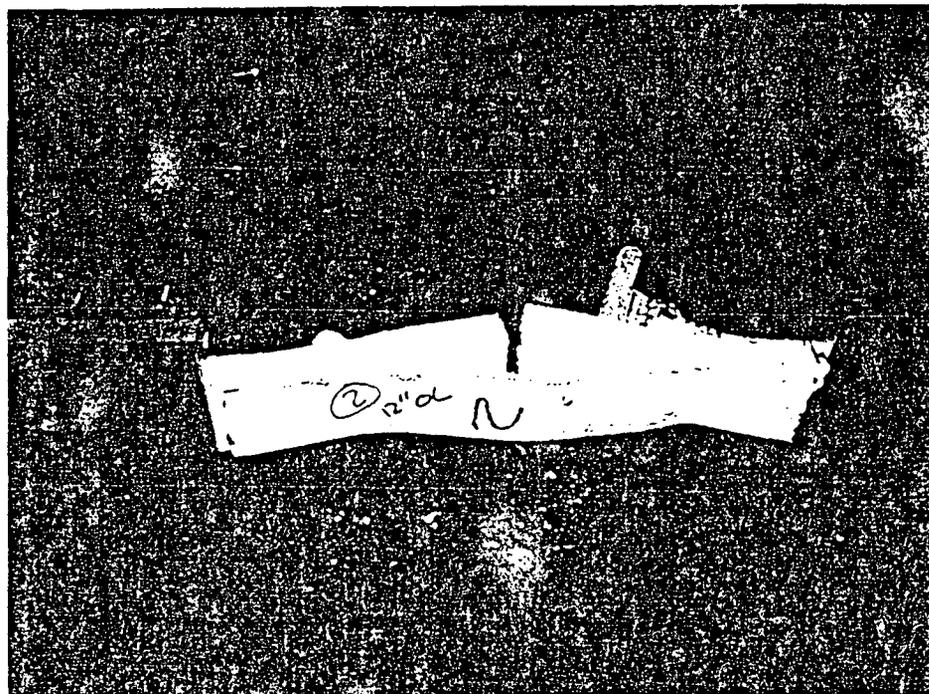
DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.01	20.0	5.0	19.0
0.02	30.0	8.0	39.0
0.03	46.0	12.0	80.0
0.04	98.0	21.0	106.0
0.05	136.0	45.0	130.0
0.06	159.0	73.0	154.0
0.07	175.0	109.0	172.0
0.08	180.0	141.0	182.0
0.09	185.0	162.0	188.0
0.10	188.0	175.0	190.0
0.11	189.0	182.0	191.0
0.12	190.0	187.0	192.0
0.13	191.0	190.0	190.0
0.14	192.0	190.0	186.0
0.15	192.0	188.0	181.0
0.16	192.0	183.0	170.0
0.17	192.0	171.0	-
0.18	192.0	168.0	-
0.19	191.0	172.0	-
0.20	191.0	172.0	-

**FAILURE:** Material failure at end of stress skin overlap followed by a stress skin bond failure initiating at butt joint for all specimens

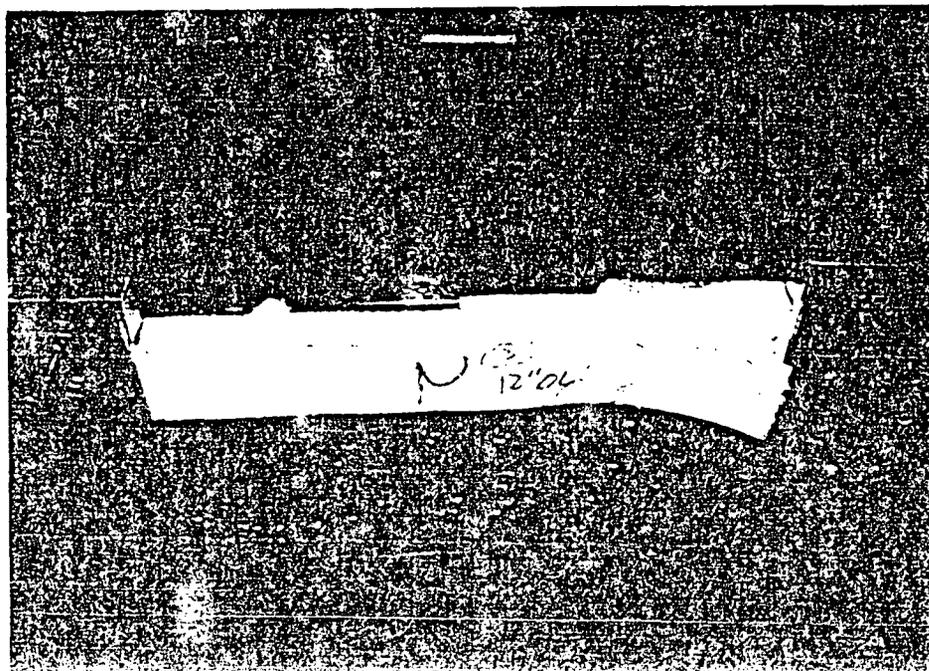
MAXIMUM LOAD (lbs):	192.0	190.0	192.0
TENSILE STRENGTH (psi):	144.4	135.7	145.5



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Punching Shear Strength

CONDITIONING/TEST TEMPERATURE: 127° F

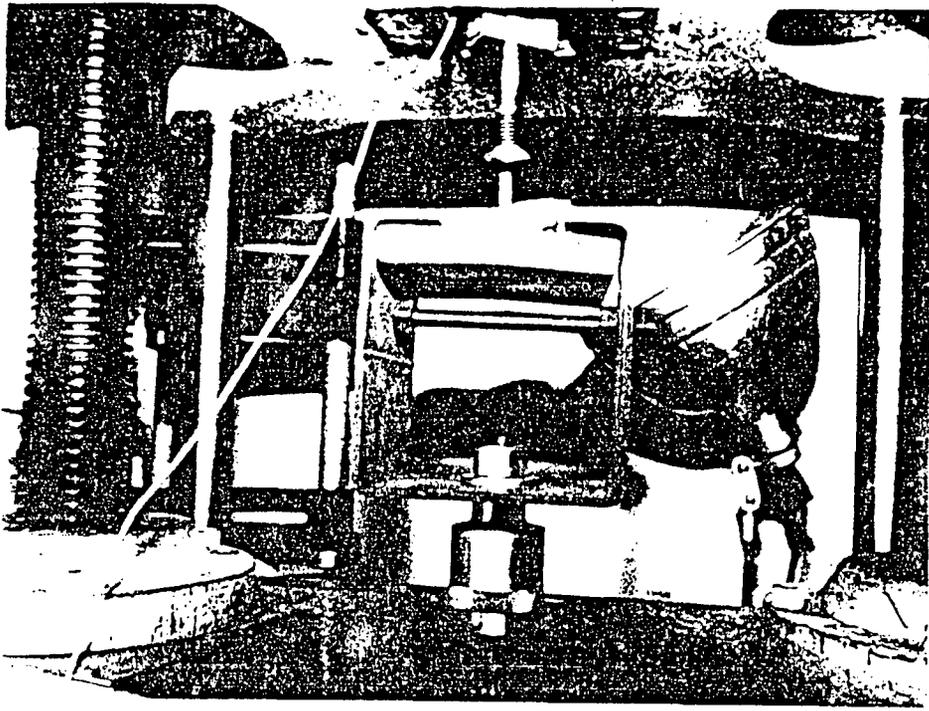
SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with stress skin up

SPECIMEN NUMBER: 1 2 3

THICKNESS (in.):	0.707	0.707	0.707
PUNCHING CIRCUMFERENCE:	4.71	4.71	4.71
PUNCHING AREA (in <sup>2</sup> ):	3.330	3.330	3.330

DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.05	75.9	48.7	95.3
0.10	238.4	159.8	157.1
0.15	292.2	236.9	193.9
0.20	285.3	229.0	186.2
0.25	284.0	223.3	185.2
0.30	282.0	227.2	182.5
0.35	-	229.6	180.5
0.40	-	232.1	186.6
0.45	-	238.7	199.8
0.50	-	255.9	211.7
0.55	-	272.0	225.9
0.60	-	279.9	231.1
0.65	-	243.1	231.2
0.70	-	195.2	219.3
0.75	-	163.1	210.1
0.80	-	159.5	195.8

<b>FAILURE:</b>	Punching Shear failure	Punching Shear failure	Punching Shear failure
<b>MAXIMUM LOAD (lbs):</b>	292.2	279.9	231.2
<b>PUNCHING SHEAR STRENGTH: (psi)</b>	87.7	84.1	69.4



SPECIMEN 1  
(TYPICAL)

PROPERTY: Punching Shear Strength

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CONDITIONING/TEST TEMPERATURE: 127° F

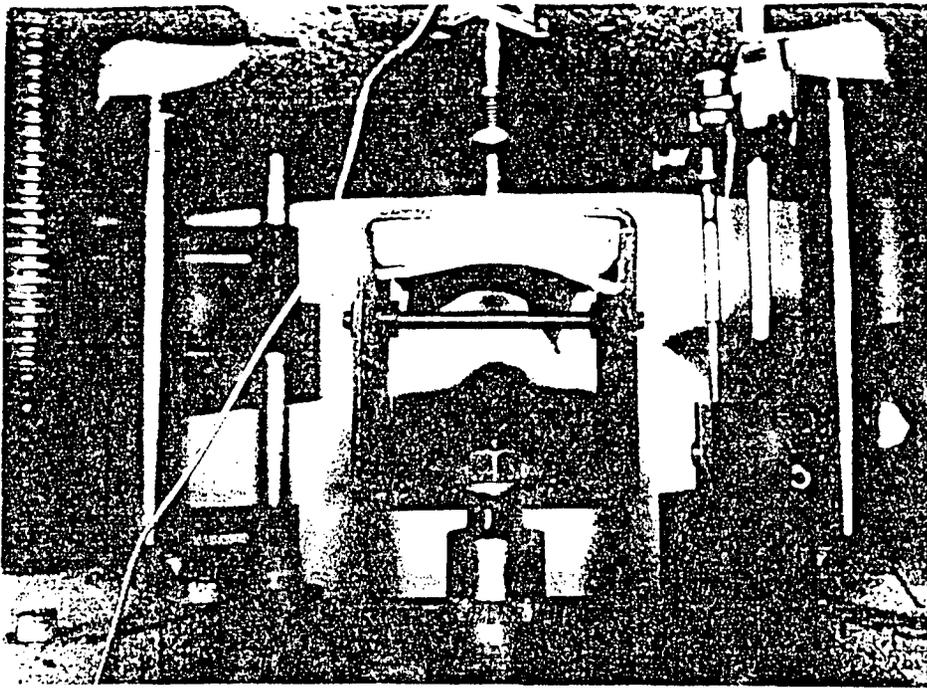
SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side and stainless steel wire mesh stress skin applied to opposite side - stainless steel stress skin down

SPECIMEN NUMBER:                    1                    2                    3

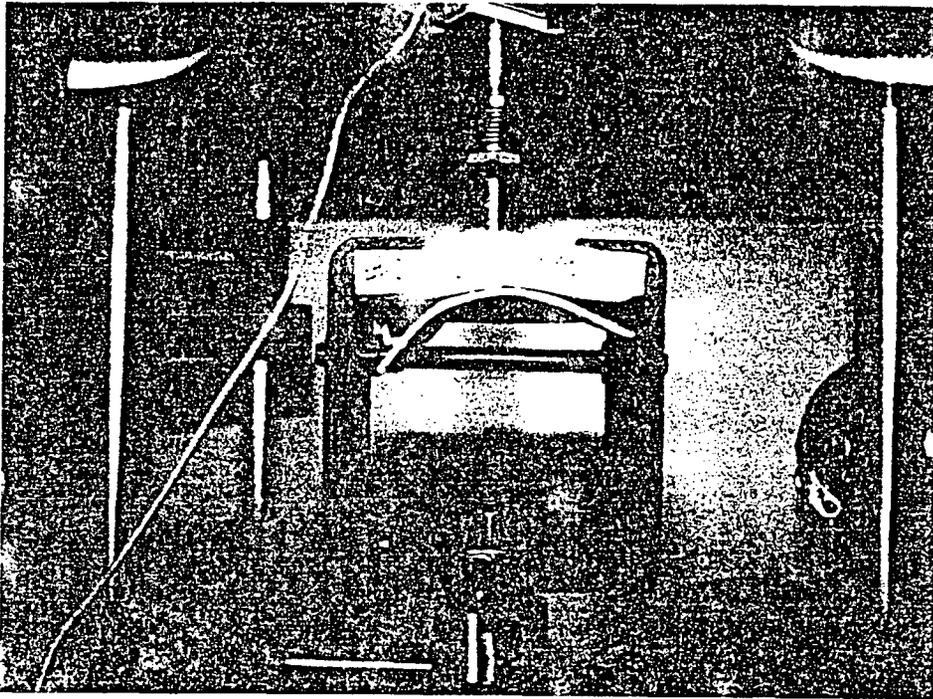
THICKNESS (in.):	0.919	0.821	0.805
PUNCHING CIRCUMFERENCE:	4.71	4.71	4.71
PUNCHING AREA (in <sup>2</sup> ):	4.329	3.869	3.792

DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.05	104.2	114.3	110.5
0.10	224.0	225.3	194.7
0.15	284.9	283.9	211.6
0.20	317.8	288.1	211.8
0.25	343.3	299.7	224.7
0.30	379.9	328.7	256.7
0.35	419.8	357.6	309.6
0.40	460.3	389.5	327.1
0.45	497.6	400.5	353.5
0.50	532.1	422.5	385.7
0.55	497.2	443.8	411.7
0.60	484.8	447.3	403.1
0.65	486.9	408.7	415.3
0.70	436.3	403.5	391.0

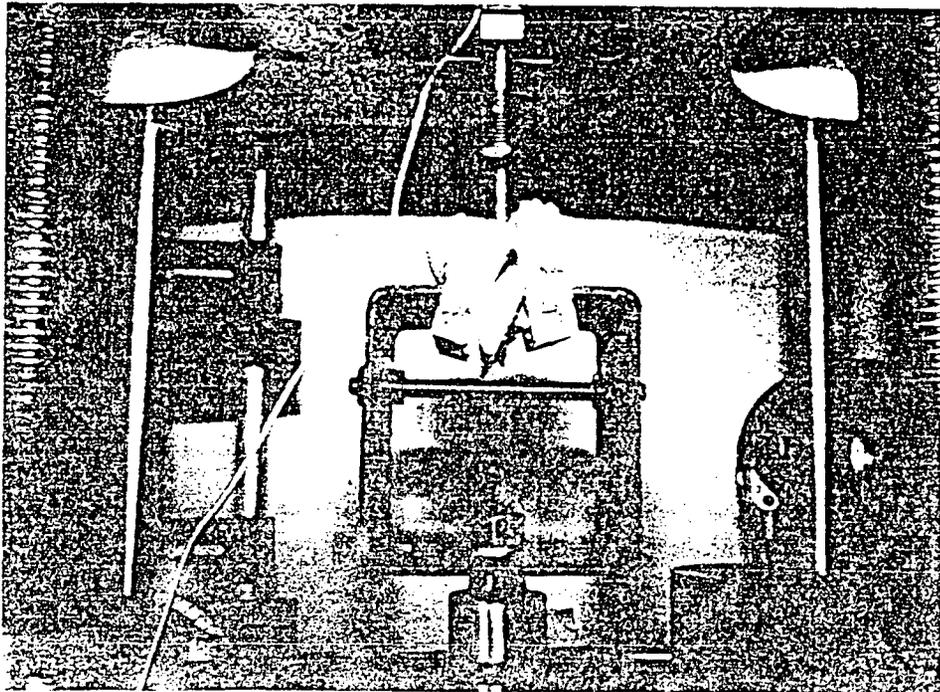
<b>FAILURE:</b>	S.S. Stress skin bond failure	S.S. Stress skin bond failure	S.S. Stress skin bond failure
MAXIMUM LOAD (lbs):	532.1	447.3	415.3
PUNCHING SHEAR STRENGTH: (psi)	122.9	115.7	109.5



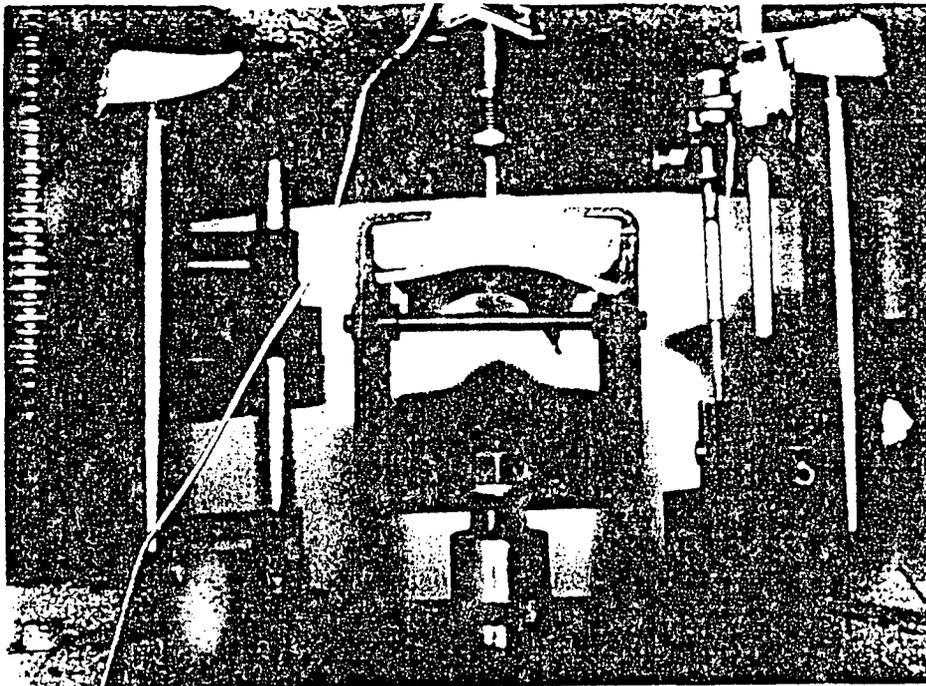
SPECIMEN 1



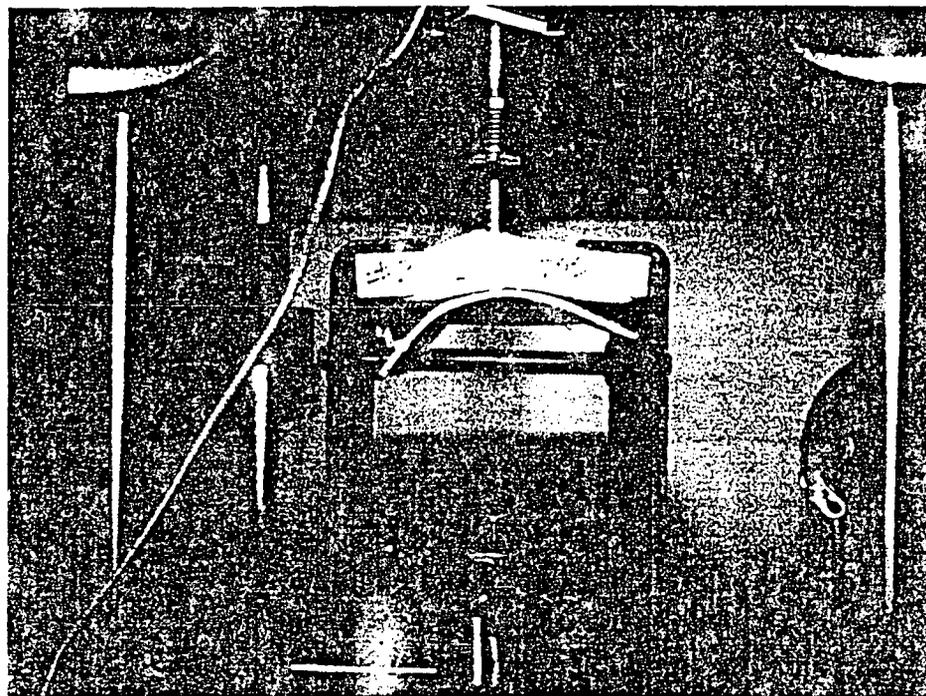
SPECIMEN 2



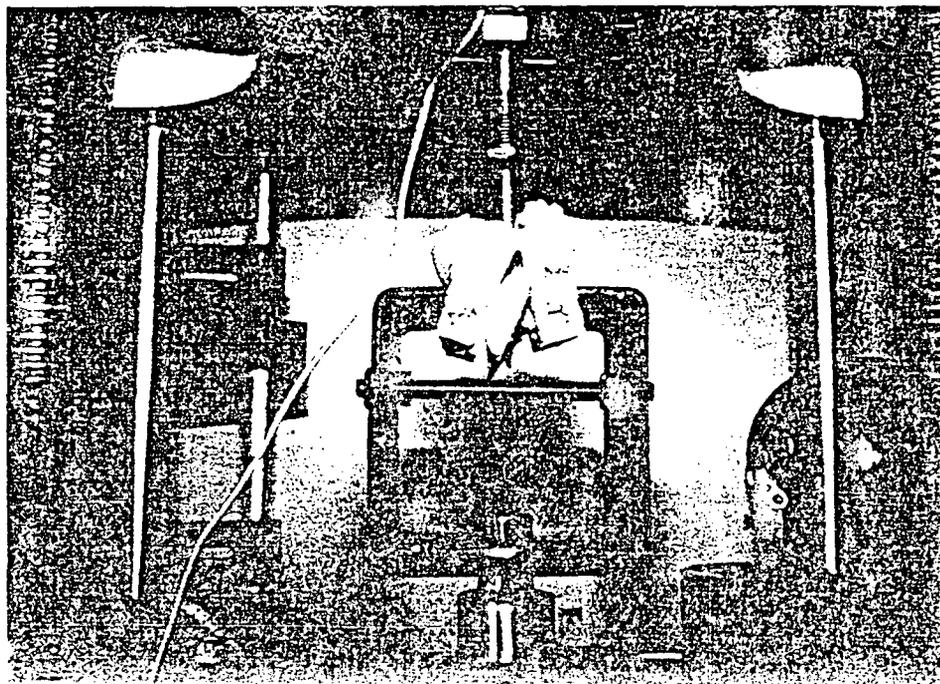
SPECIMEN 3



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Punching Shear Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 3/8 inch thick with standard stress skin up

SPECIMEN NUMBER: 1 2 3

THICKNESS (in.):	0.467	0.490	0.462
PUNCHING CIRCUMFERENCE:	4.71	4.71	4.71
PUNCHING AREA (in <sup>2</sup> ):	2.200	2.308	2.171

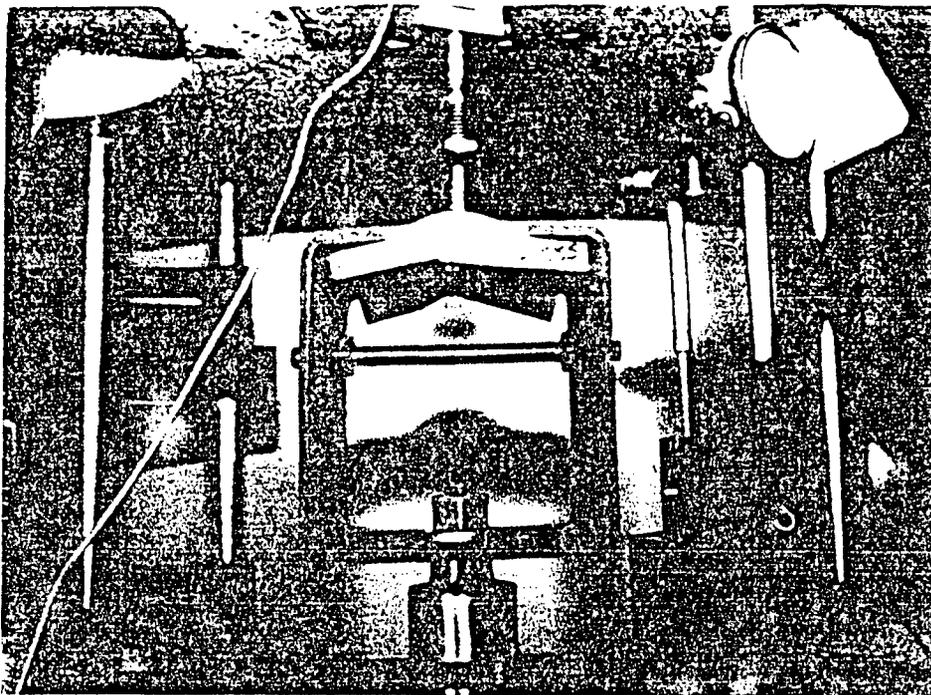
DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.05	46.1	14.0	39.2
0.10	128.9	92.6	111.6
0.15	224.4	195.2	166.4
0.20	226.1	228.6	199.2
0.25	271.2	219.7	204.4
0.30	292.1	228.8	223.9
0.35	320.9	252.6	251.4
0.40	355.7	276.9	276.9
0.45	385.7	291.2	300.3
0.50	402.7	282.8	307.2
0.55	405.0	284.2	276.2
0.60	397.8	250.0	229.0
0.65	392.0	199.0	199.3
0.70	364.7	186.9	190.5

**FAILURE:**

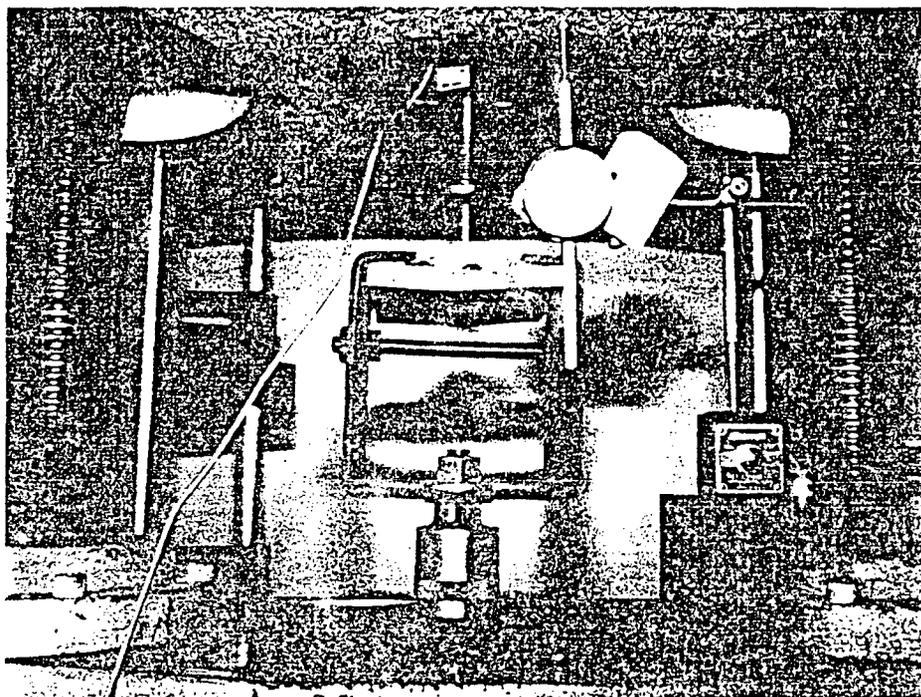
Punching shear failure	Punching shear failure	Punching shear failure
405.0	291.2	307.2
184.1	126.2	141.5

MAXIMUM LOAD (lbs):

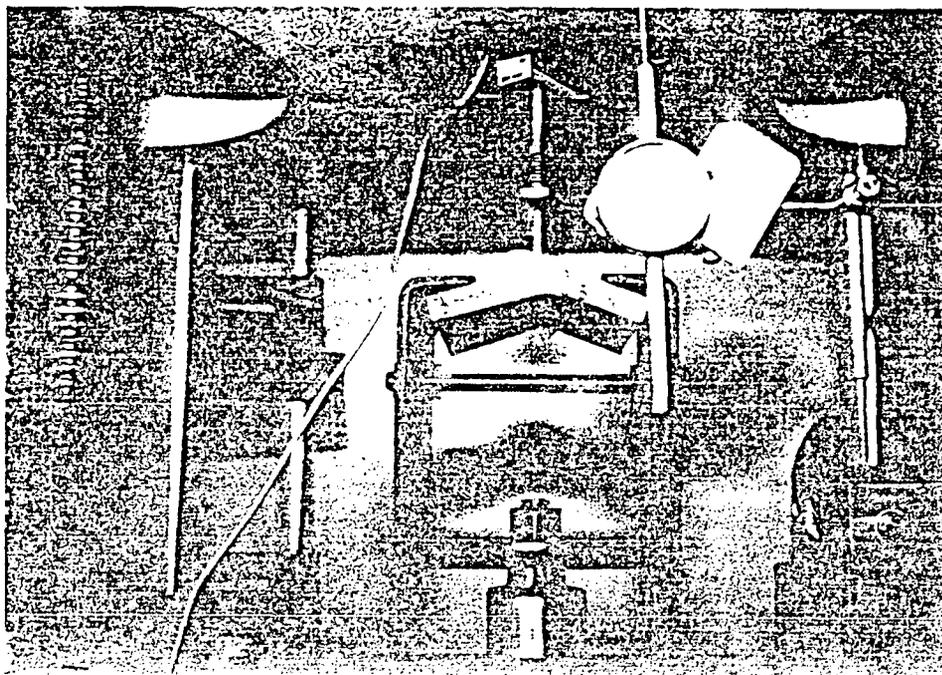
PUNCHING SHEAR STRENGTH:  
(psi)



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Punching Shear Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with stress skin removed

SPECIMEN NUMBER: 1 2 3

THICKNESS (in.):	0.610	0.615	0.623
PUNCHING CIRCUMFERENCE:	4.71	4.71	4.71
PUNCHING AREA (in <sup>2</sup> ):	2.875	2.898	2.936

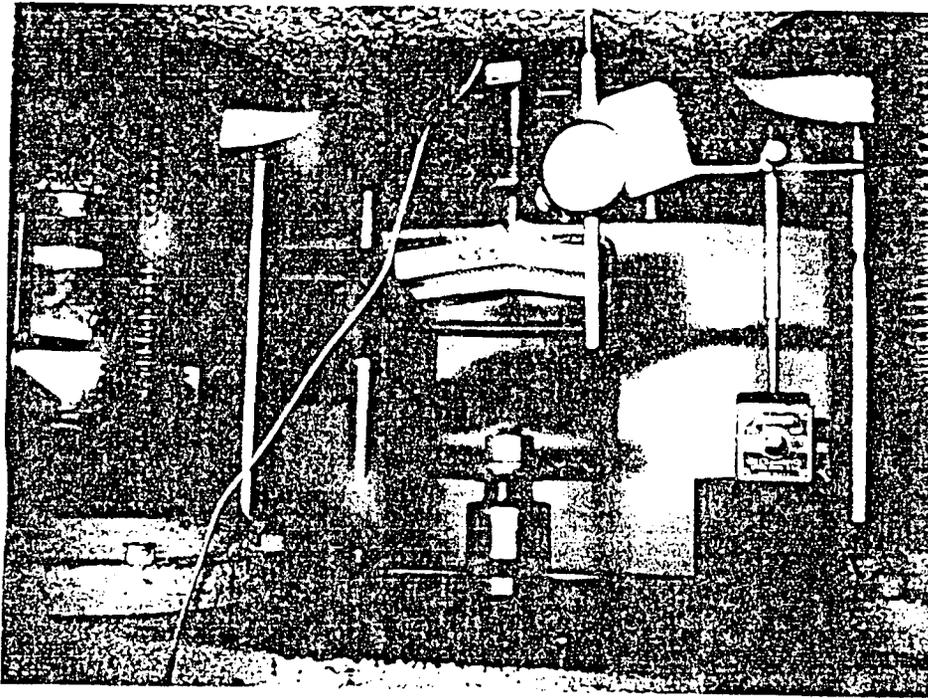
DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.05	35.1	28.7	64.3
0.10	82.3	73.3	108.6
0.15	106.9	116.6	152.3
0.20	155.2	138.1	130.3
0.25	170.0	115.3	87.2
0.30	149.5	89.4	63.5
0.35	120.3	70.8	41.5
0.40	102.3	56.4	25.0
0.45	84.2	44.2	13.2

**FAILURE:**

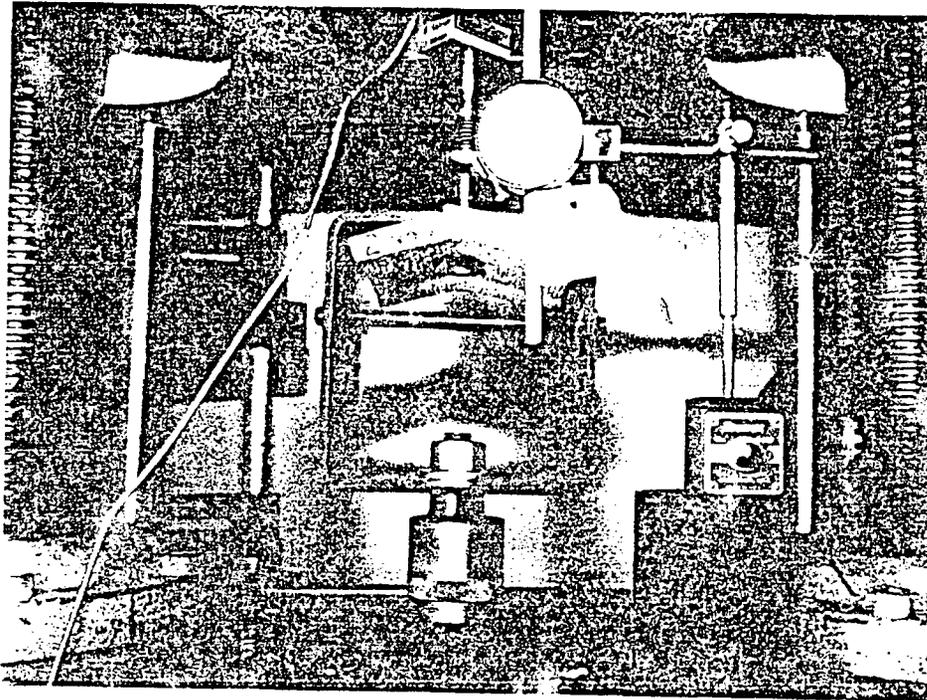
Initial material flexure cracking on top face	Initial material flexure cracking on top face	Punching Shear failure
170.0	138.1	152.3
59.1	47.7	51.9

MAXIMUM LOAD (lbs):

PUNCHING SHEAR STRENGTH:  
(psi)



SPECIMEN 1



SPECIMEN 2

PROPERTY: Shear Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin

SPECIMEN NUMBER:	1	2	3
WIDTH:	5.968	6.015	6.056
THICKNESS:	0.764	0.683	0.748
SHEAR AREA (in <sup>2</sup> ):	4.560	4.108	4.530

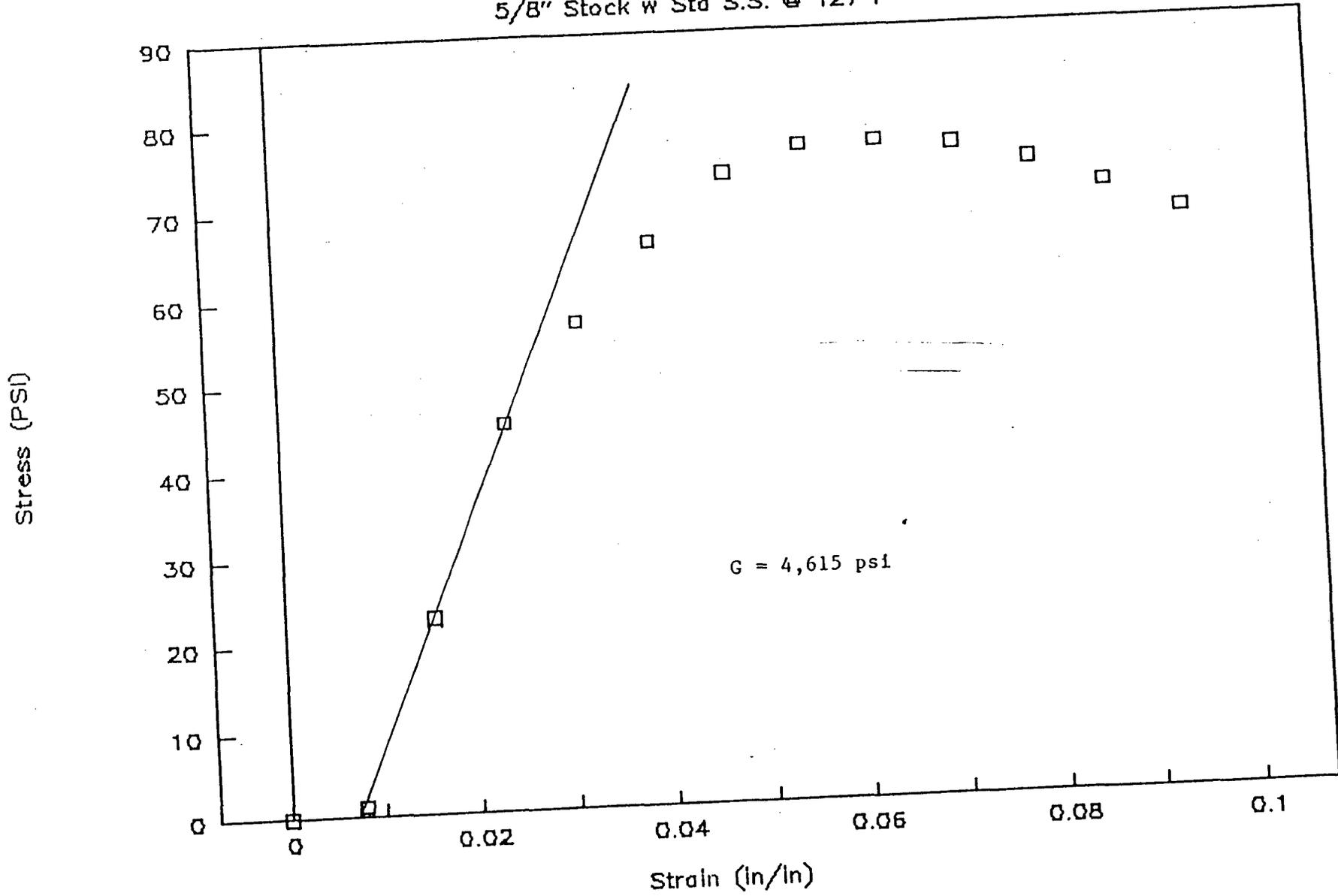
DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.02	11	342	215
0.04	208	509	345
0.06	412	539	386
0.08	516	623	425
0.10	598	701	440
0.12	669	750	448
0.14	696	769	447
0.16	698	776	439
0.18	693	769	433
0.20	674	753	424
0.22	647	726	416
0.24	616	700	409

**FAILURE:** Material shear failure with stress skin bond failure for all specimens – flattened ridge on specimen 3 in shear plane

MAXIMUM LOAD (lbs):	698	776	448
SHEAR STRENGTH (psi):	76.5	94.4	49.4

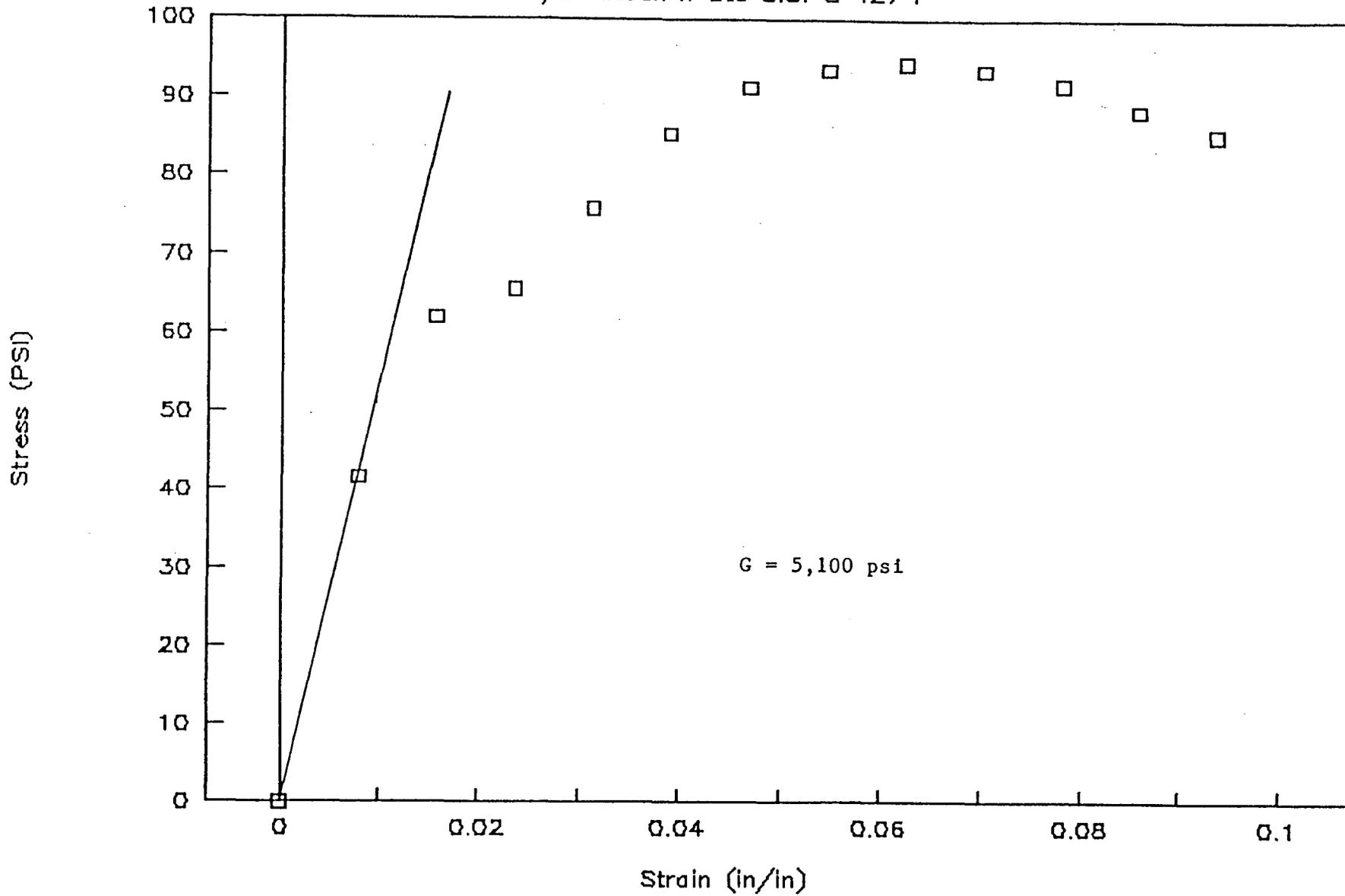
# Shear Modulus (Sample 1)

5/8" Stock w Std S.S. @ 127 F



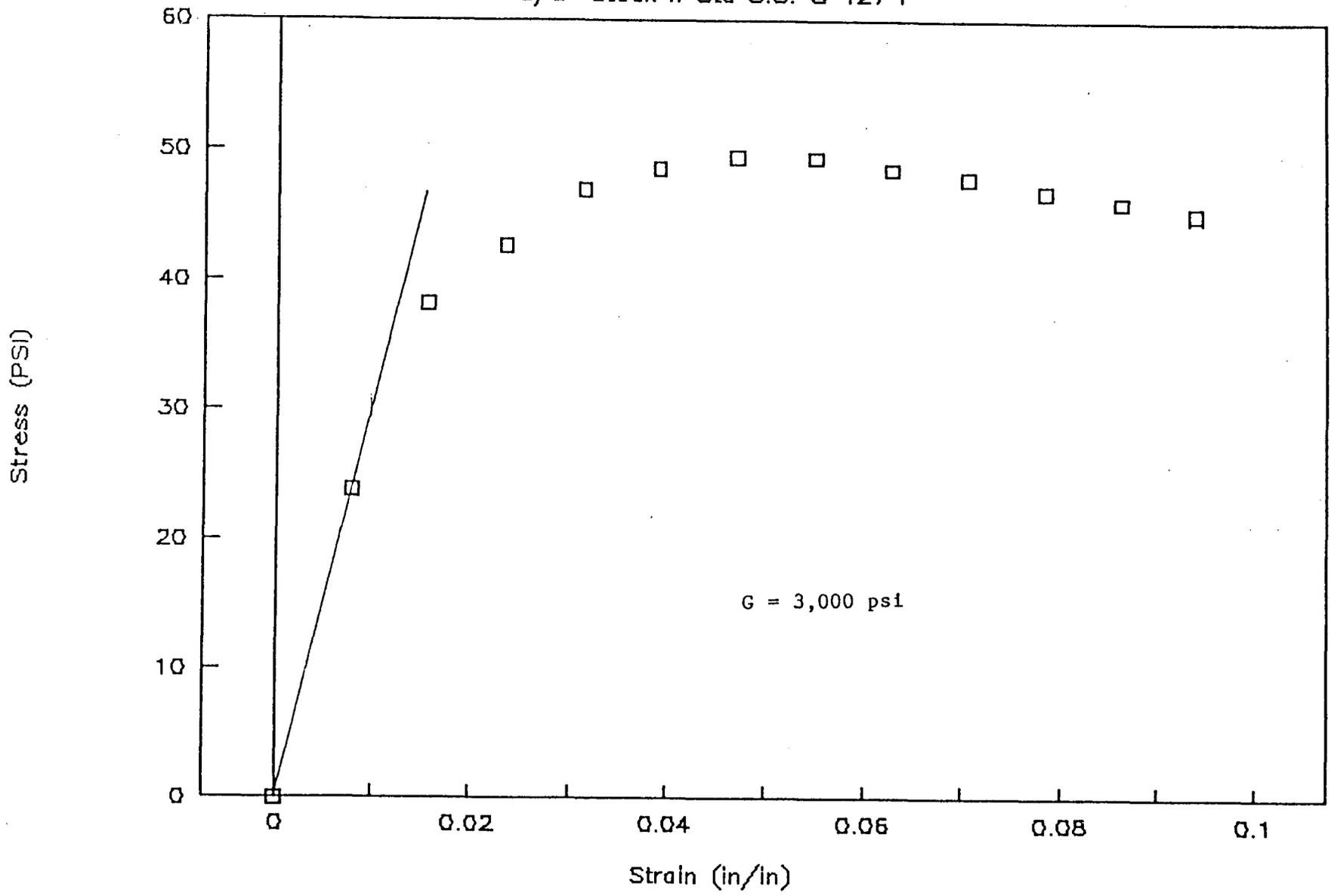
# Shear Modulus (Sample 2)

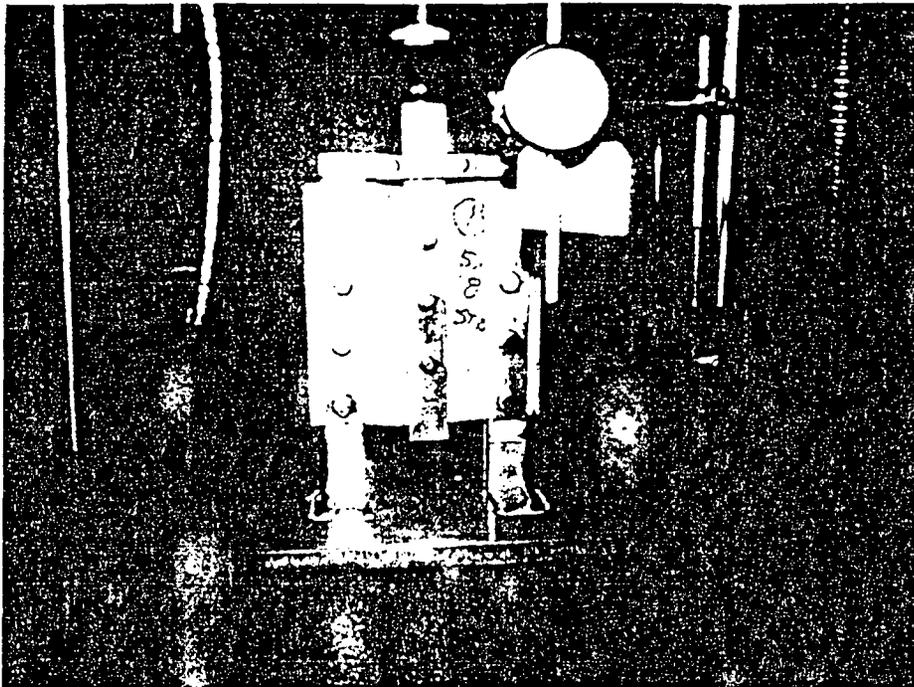
5/8" Stock w Std S.S. @ 127 F



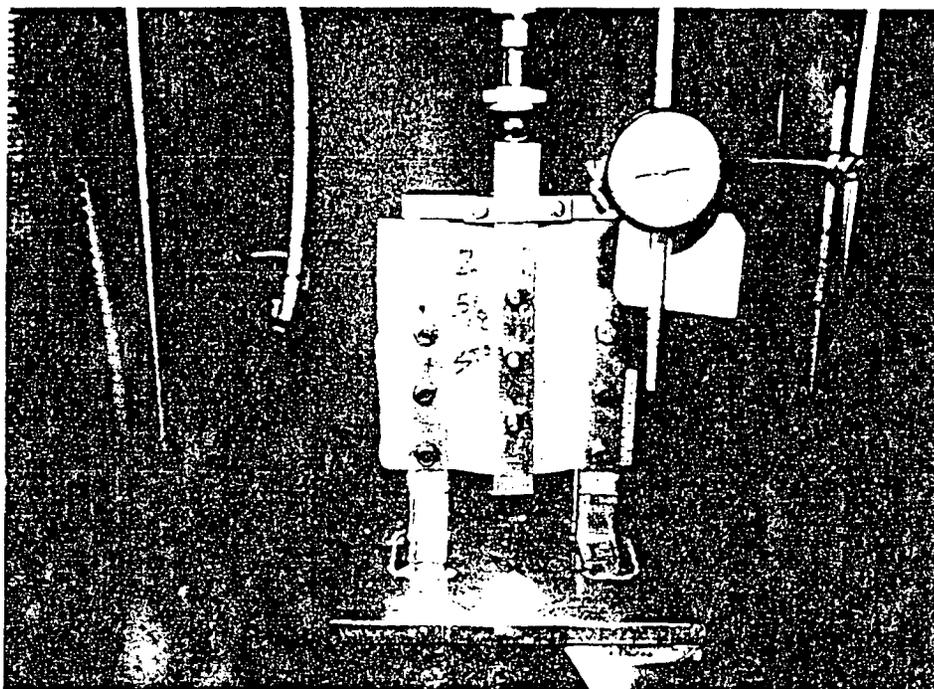
# Shear Modulus (Sample 3)

5/8" Stock w Std S.S. @ 127 F

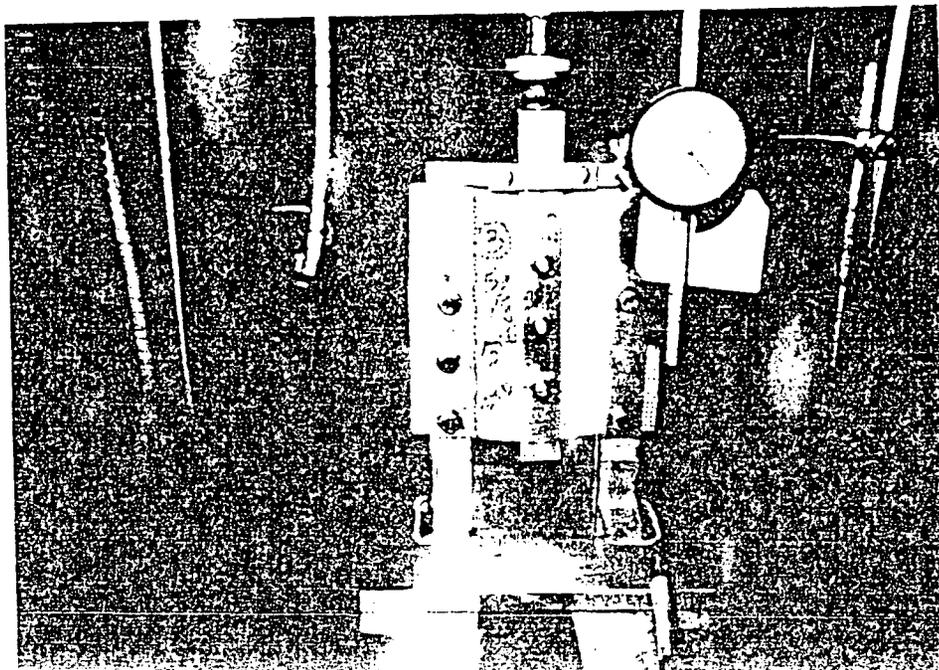




SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Shear Strength

79

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side and stainless steel wire mesh stress skin on the opposite side

SPECIMEN NUMBER:

1

2

3

WIDTH:	5.980	6.023	6.023
THICKNESS:	0.762	0.819	0.916
SHEAR AREA (in <sup>2</sup> ):	4.557	4.933	5.517

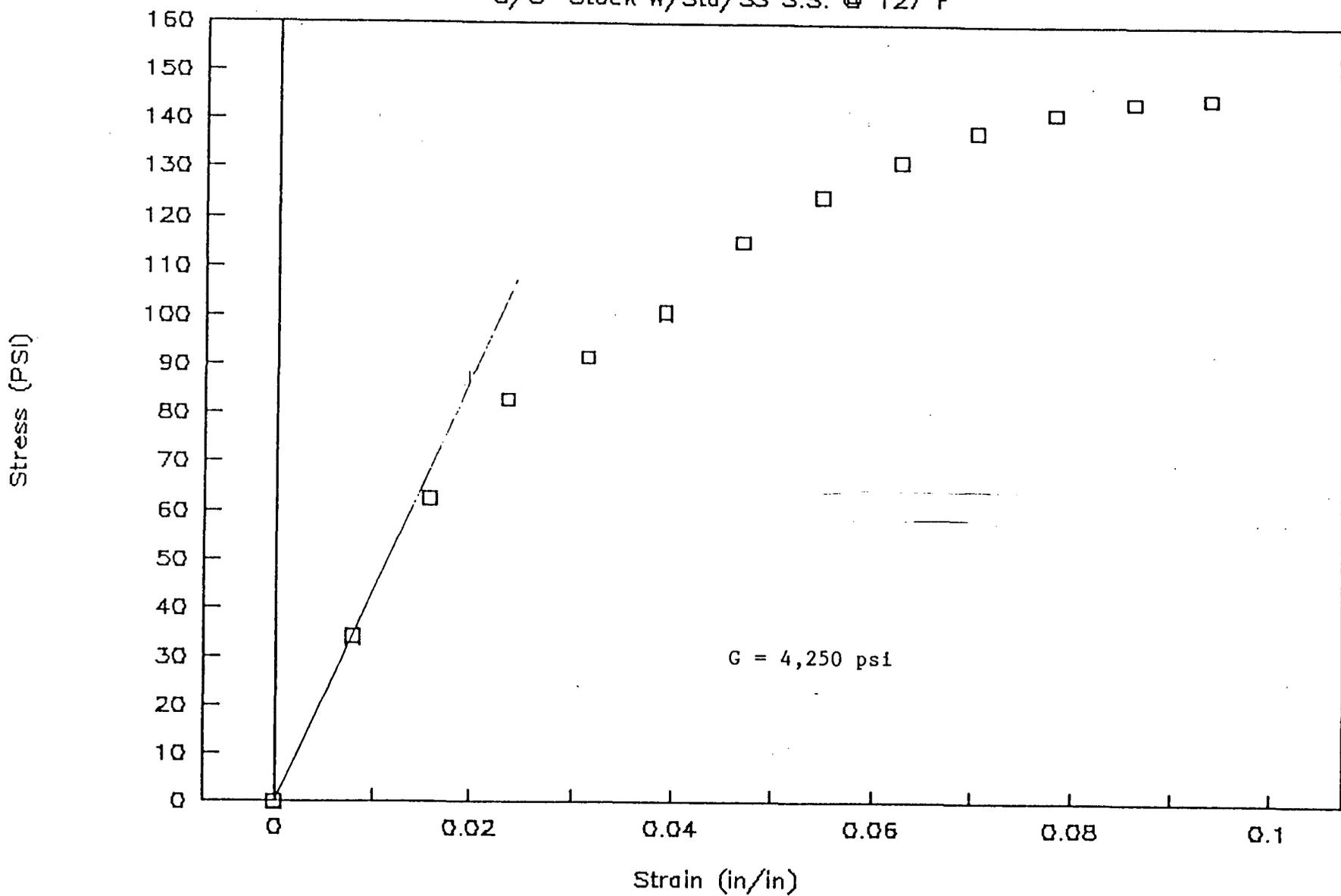
DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.02	312	343	201
0.04	569	651	253
0.06	755	852	337
0.08	835	976	475
0.10	921	1023	695
0.12	1049	1077	859
0.14	1133	1143	993
0.16	1200	1205	1185
0.18	1257	1263	1236
0.20	1292	1302	1265
0.22	1314	1326	1278
0.24	1320	1336	1279
0.26	1315	1328	1268
0.28	1298	1311	1251
0.30	1270	1289	1221

FAILURE: Material shear failure with standard and stainless steel stress skin bond failure for all specimens

MAXIMUM LOAD (lbs):	1320	1336	1279
SHEAR STRENGTH (psi):	144.8	135.4	115.9

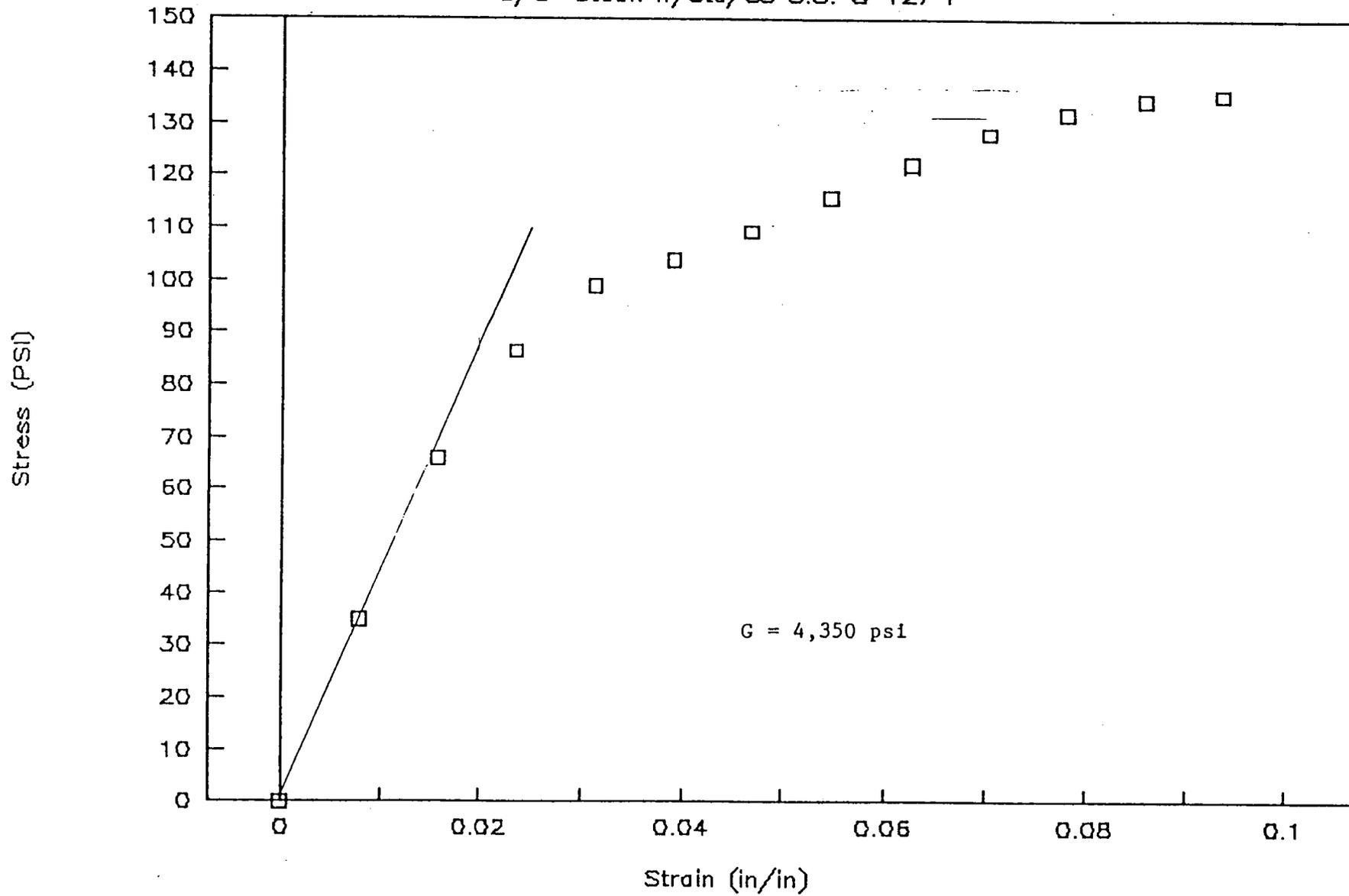
# Shear Modulus (Sample 1)

5/8" Stock w/Std/SS S.S. @ 127 F



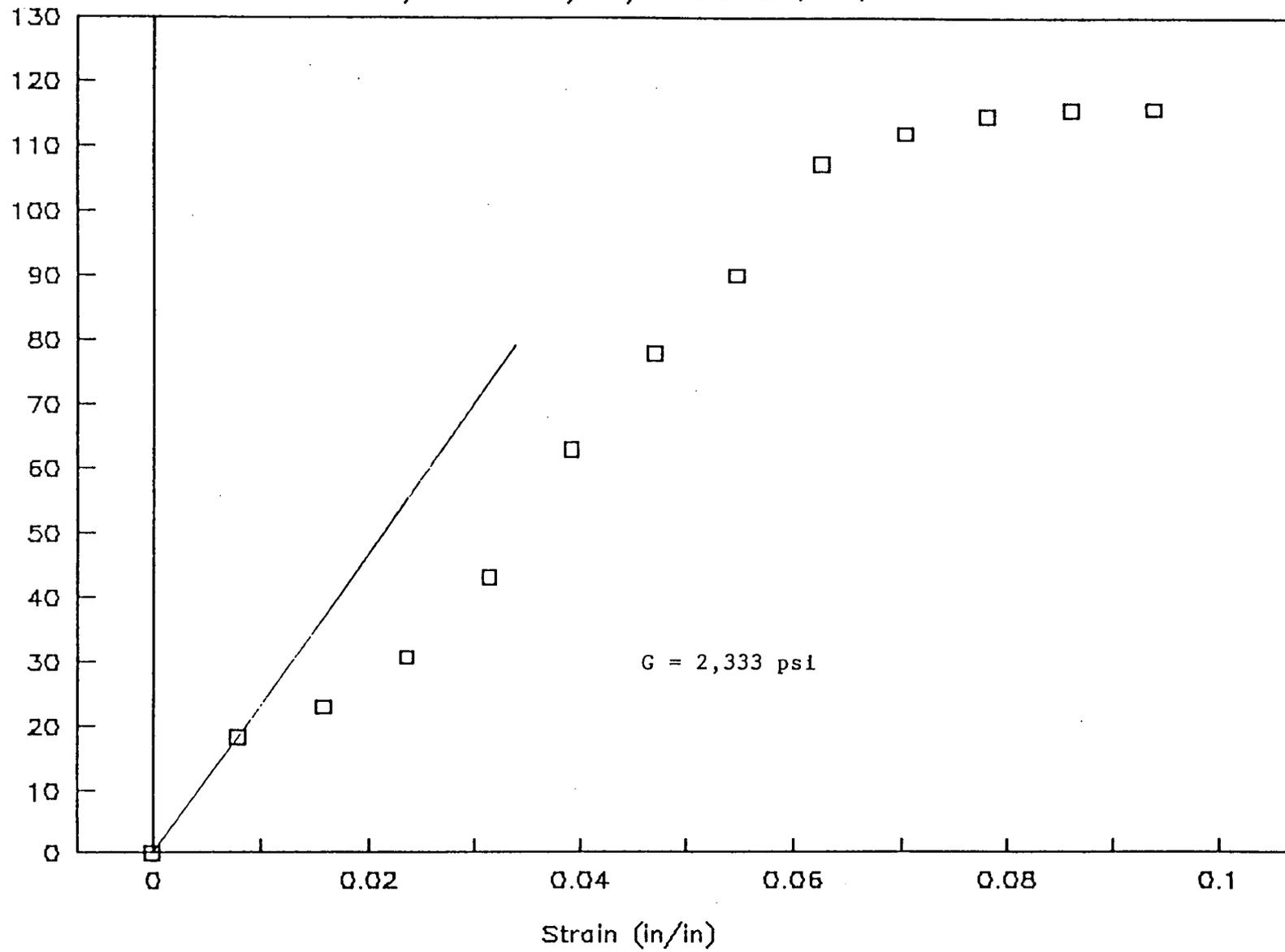
# Shear Modulus (Sample 2)

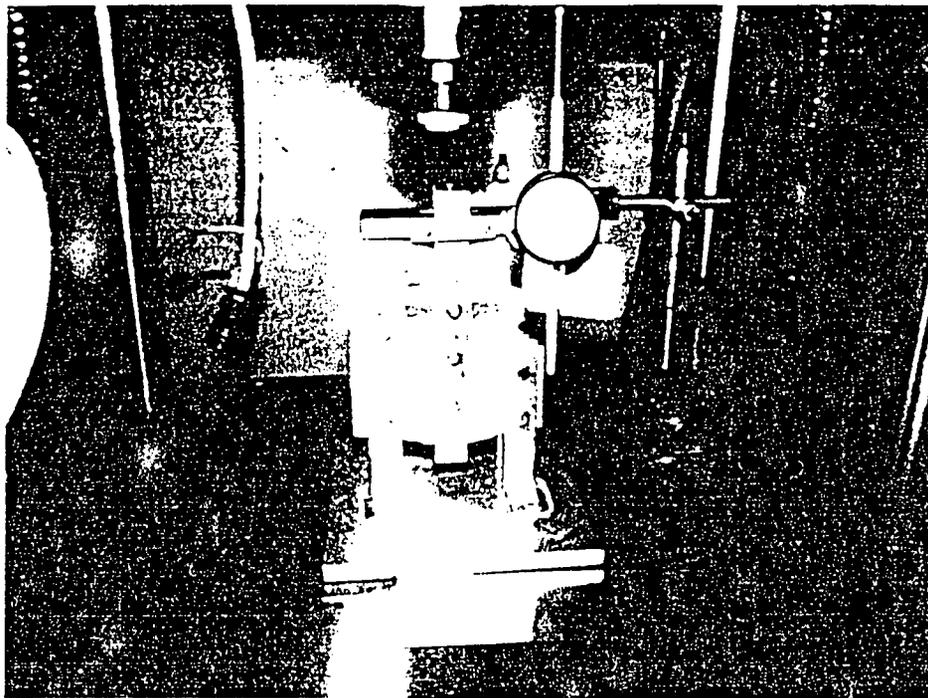
5/8" Stock w/Std/SS S.S. @ 127 F



# Shear Modulus (Sample 3)

5/8" Stock w/Std/SS S.S. @ 127 F





SPECIMEN 1  
(TYPICAL)

PROPERTY: Shear Strength

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 3/8 inch thick with standard stress skin

SPECIMEN NUMBER:	1	2	3
WIDTH:	6.025	6.028	6.025
THICKNESS:	0.499	0.500	0.466
SHEAR AREA (in <sup>2</sup> ):	3.007	3.014	2.808

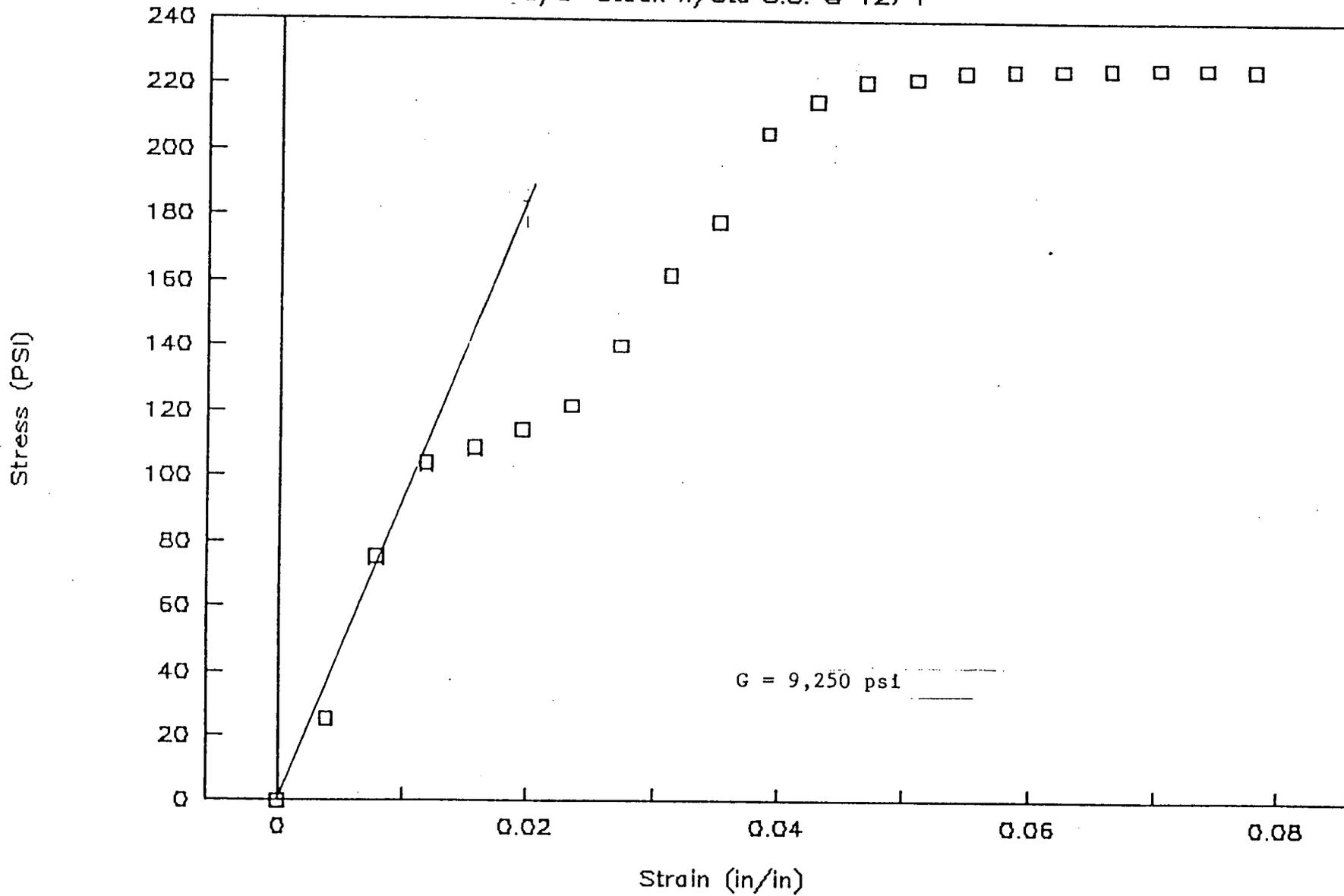
DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.01	152	125	18
0.02	452	310	125
0.03	625	515	272
0.04	653	662	373
0.05	686	682	428
0.06	732	705	486
0.07	842	782	538
0.08	975	882	578
0.09	1070	942	611
0.10	1235	1002	633
0.11	1293	1042	643
0.12	1329	1068	653
0.13	1336	1087	664
0.14	1347	1100	669
0.15	1351	1102	670
0.16	1353	1095	673
0.17	1355	1081	671
0.18	1357	1064	670
0.19	1356	1044	668
0.20	1355	1014	664

**FAILURE:** Material shear failure for all specimens

MAXIMUM LOAD (lbs):	1357	1100	673
SHEAR STRENGTH (psi):	225.7	182.5	119.9

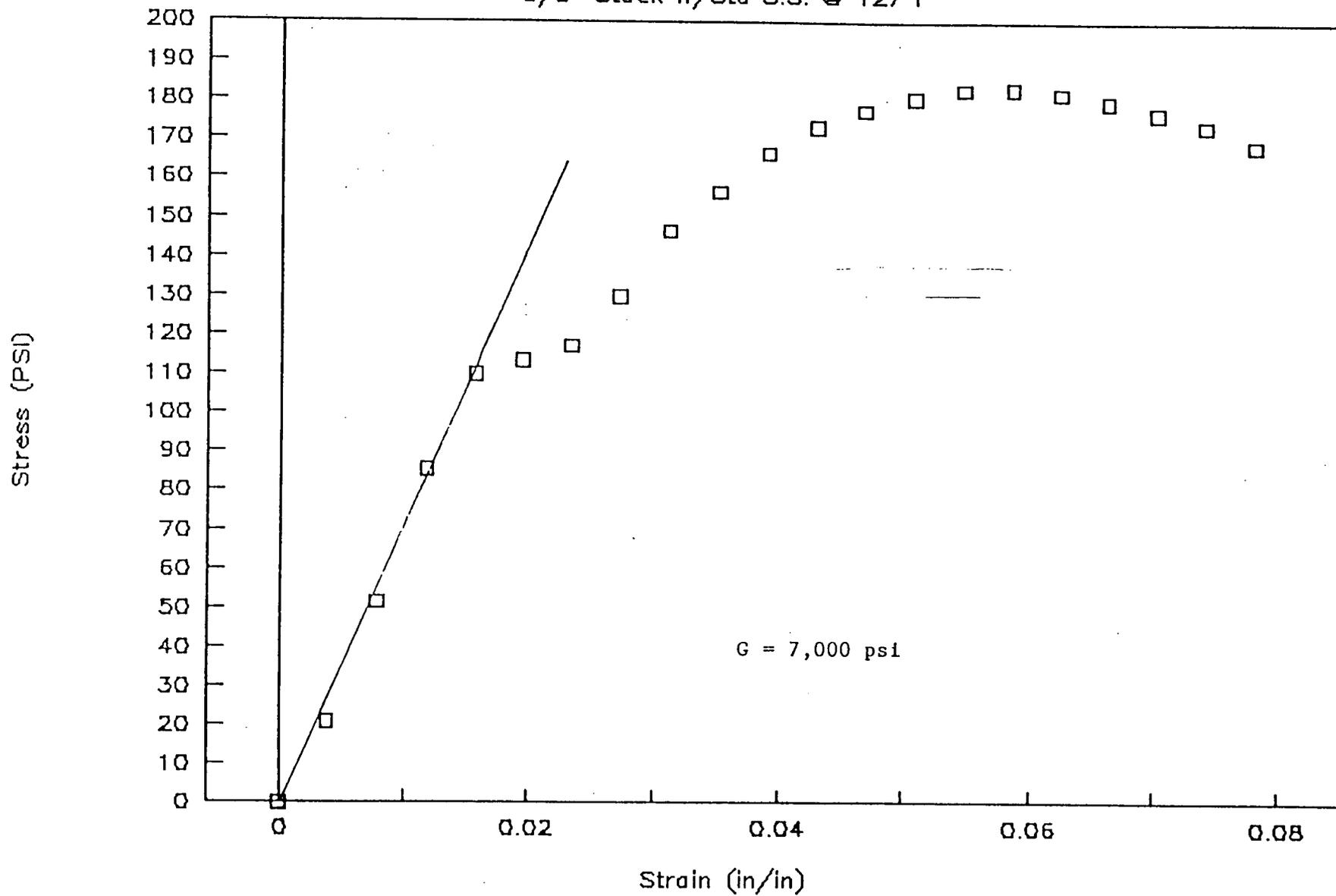
# Shear Modulus (Sample 1)

3/8" Stock w/Std S.S. @ 127 F



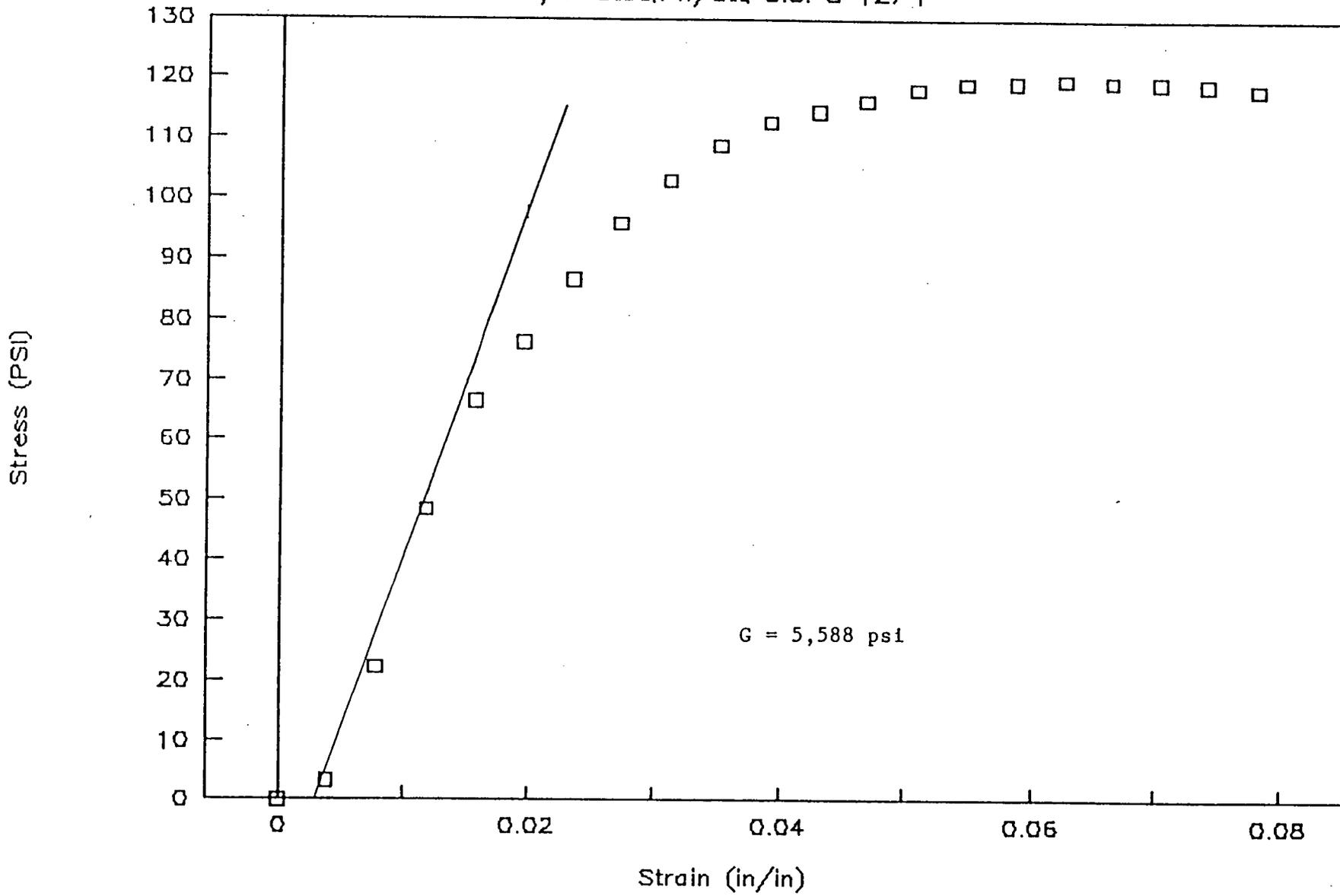
# Shear Modulus (Sample 2)

3/8" Stock w/Std S.S. @ 127 F



# Shear Modulus (Sample 3)

3/8" Stock w/Std S.S. @ 127 F



PROPERTY: Shear Strength

88

CONDITIONING/TEST TEMPERATURE: 127° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin removed

SPECIMEN NUMBER:	1	2	3
WIDTH:	6.000	5.932	5.894
THICKNESS:	0.625	0.624	0.658
SHEAR AREA (in <sup>2</sup> ):	3.750	3.702	3.878

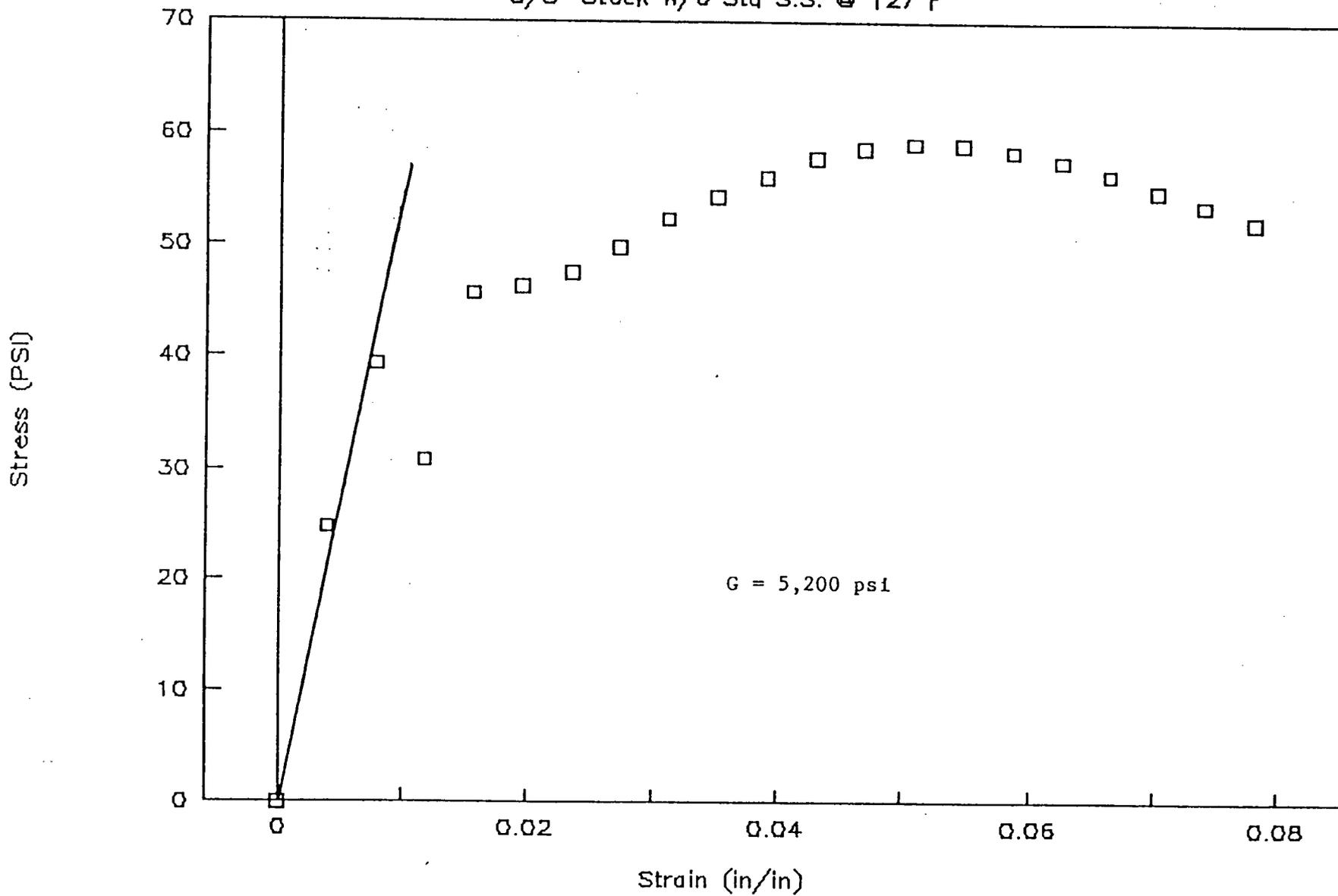
DISPLACEMENT (inches)	LOAD (lbs)	LOAD (lbs)	LOAD (lbs)
0	0	0	0
0.01	185	108	136
0.02	295	225	243
0.03	231	235	266
0.04	342	371	293
0.05	347	382	315
0.06	356	388	334
0.07	373	390	348
0.08	392	389	373
0.09	407	384	406
0.10	420	380	425
0.11	433	378	441
0.12	440	380	445
0.13	443	381	446
0.14	442	381	443
0.15	438	379	432
0.16	431	372	430
0.17	422	366	404
0.18	411	358	384
0.19	401	343	365
0.20	390	337	345

**FAILURE:** Material shear failure for all specimens – flattened ridge on specimen 2 in shear plane

MAXIMUM LOAD (lbs):	443	390	446
SHEAR STRENGTH (psi):	59.1	52.7	57.5

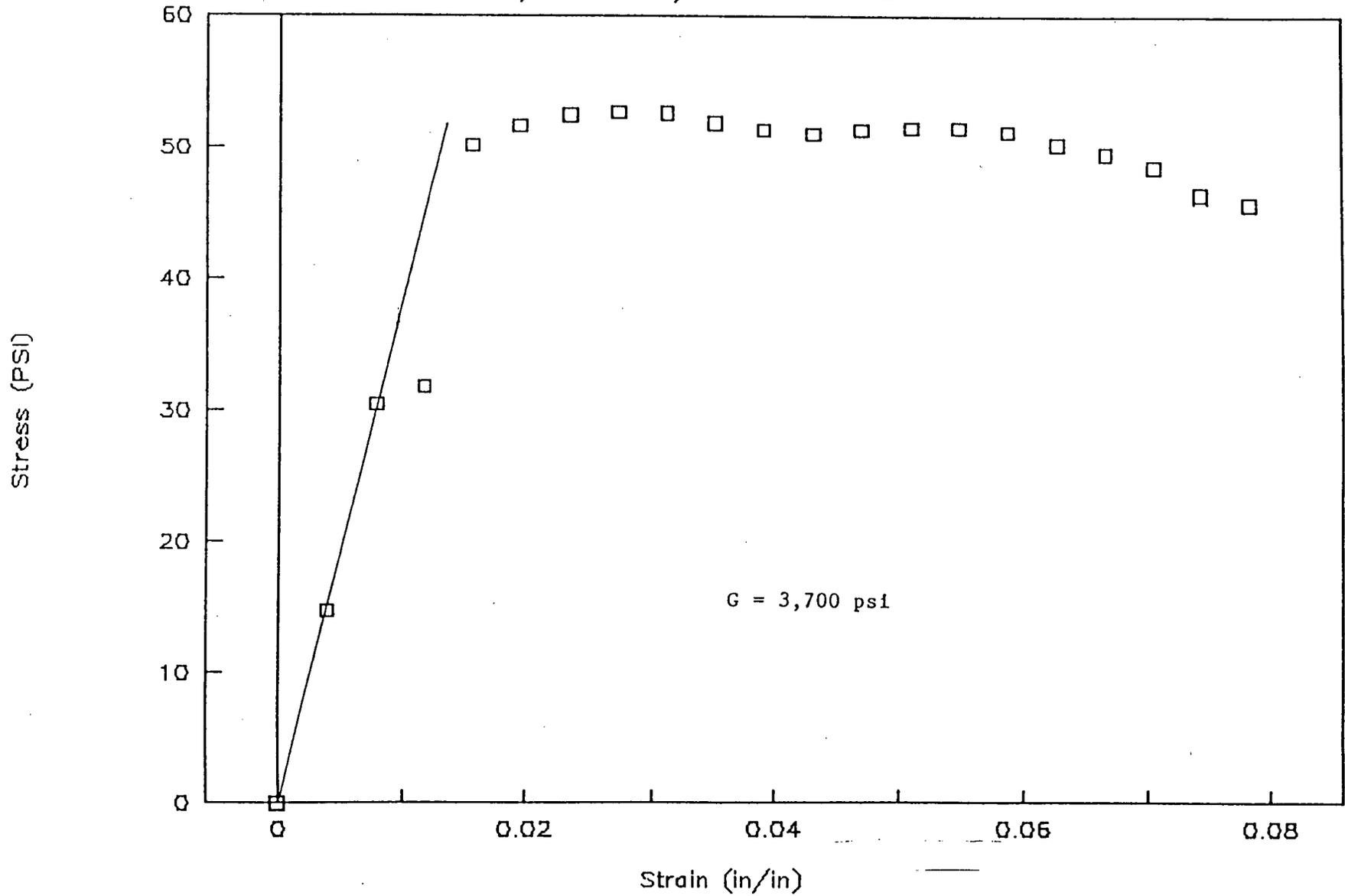
# Shear Modulus (Sample 1)

5/8" Stock w/o Std S.S. @ 127 F



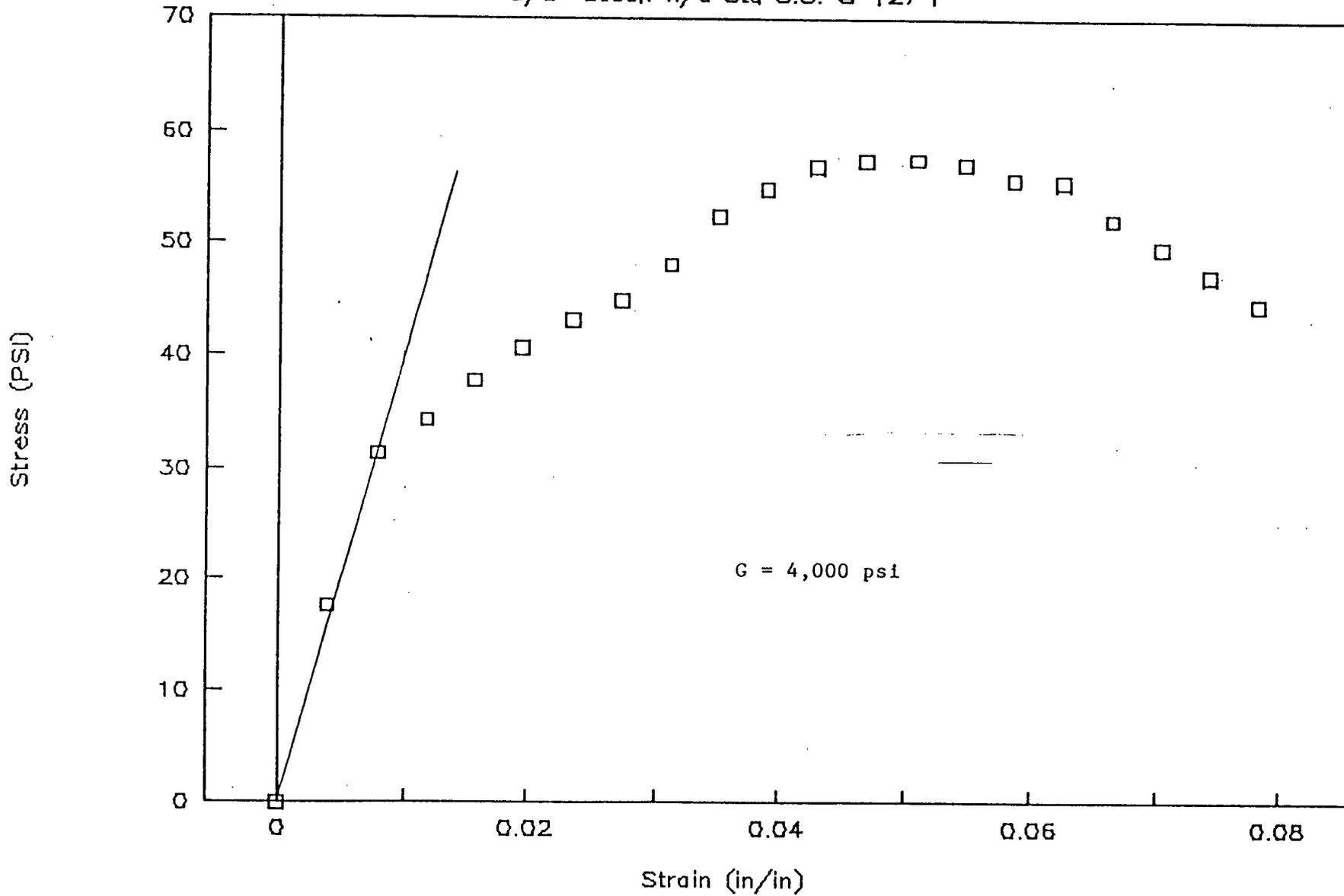
# Shear Modulus (Sample 2)

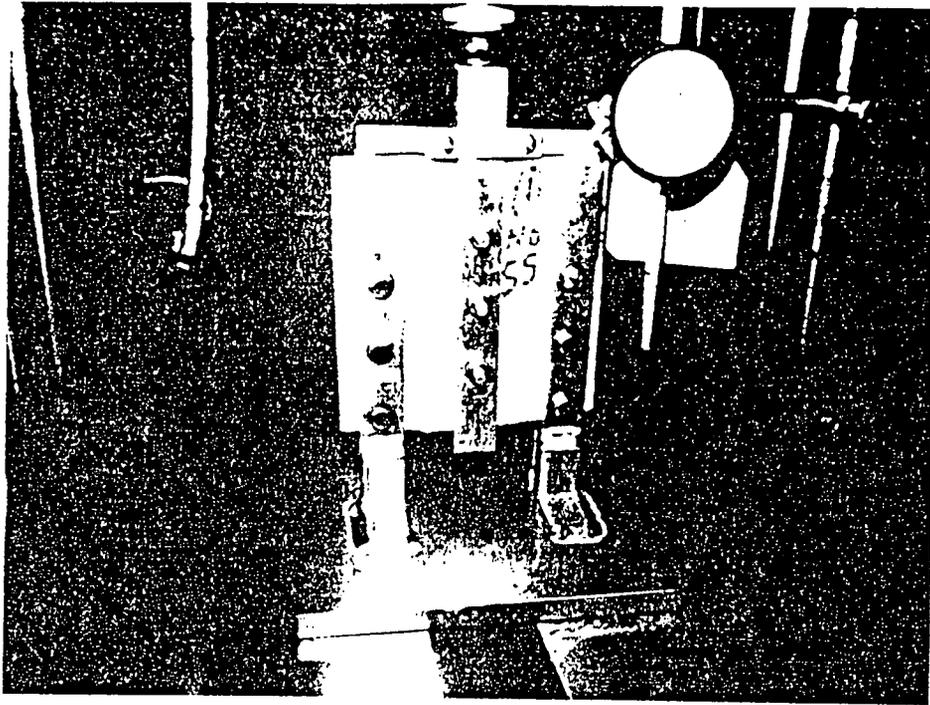
5/8" Stock w/o Std S.S. @ 127 F



# Shear Modulus (Sample 3)

5/8" Stock w/o Std S.S. @ 127 F





SPECIMEN 1  
(TYPICAL)

PROPERTY: Shear Strength

93

CONDITIONING/TEST TEMPERATURE: 127° F

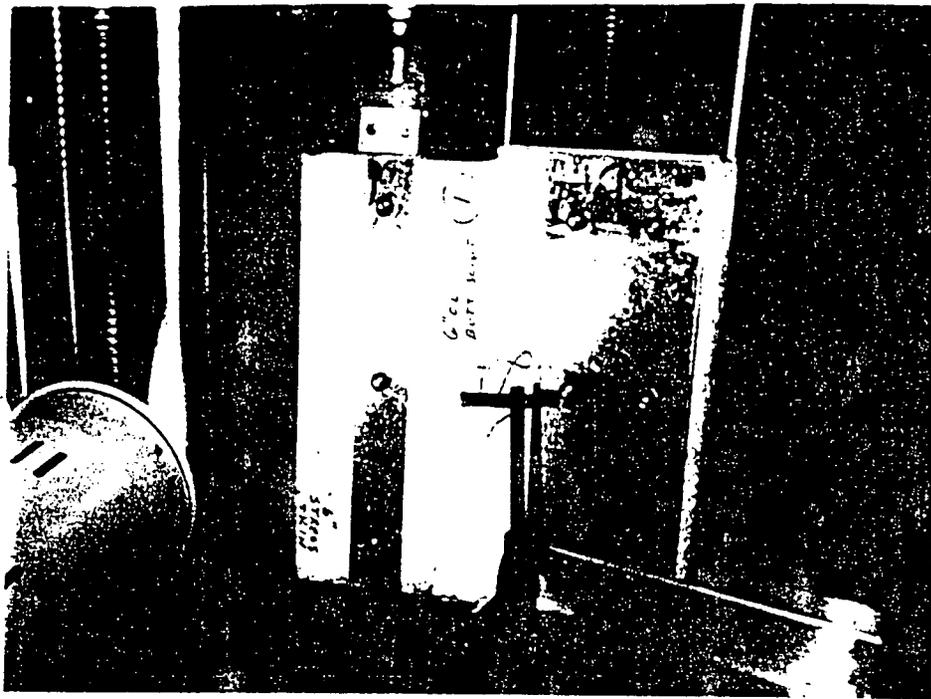
SPECIMEN CONFIGURATION: Two stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side joined by a butt joint of Thermo-Lag 330 trowel grade overlapped with steel wire mesh on one side with an overlap of 6 inches

SPECIMEN NUMBER:	1	2	3
WIDTH OF OVERLAP:	3.0	3.0	3.0
LENGTH OF OVERLAP:	18.1	18.1	18.1
AREA OF OVERLAP (in <sup>2</sup> ):	54.3	54.3	54.3

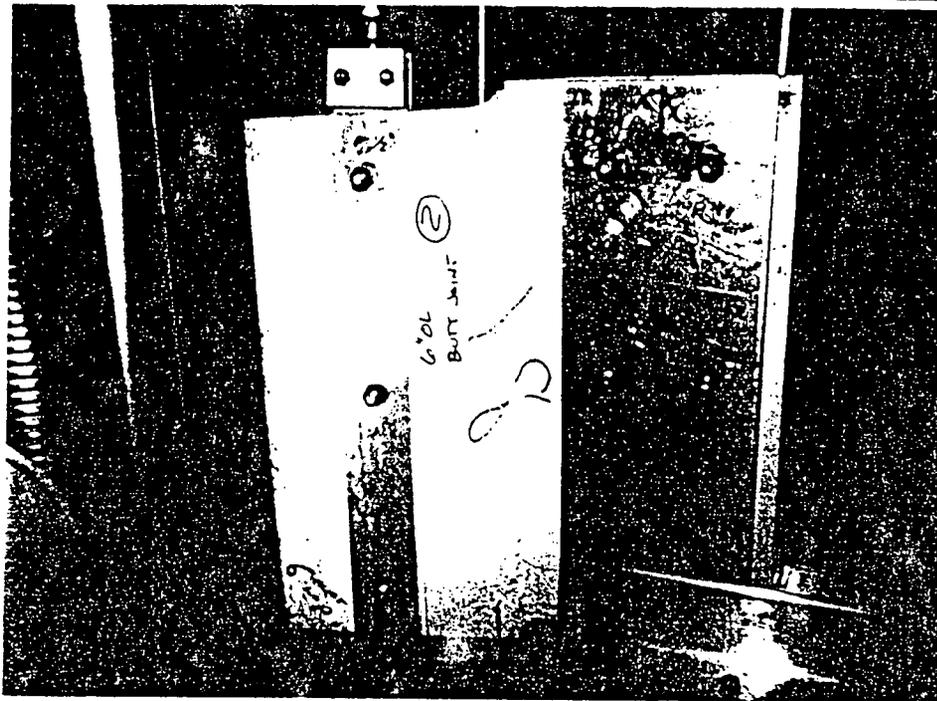
DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.10	266	269	250
0.20	359	473	281
0.30	447	612	345
0.40	592	757	443
0.50	671	881	484
0.60	702	965	507
0.70	677	1019	516
0.80	629	1051	500
0.90	556	1064	448
1.00	-	1066	-
1.10	-	1048	-
1.20	-	1110	-

FAILURE: Steel wire mesh bond failure and stretching for all specimens

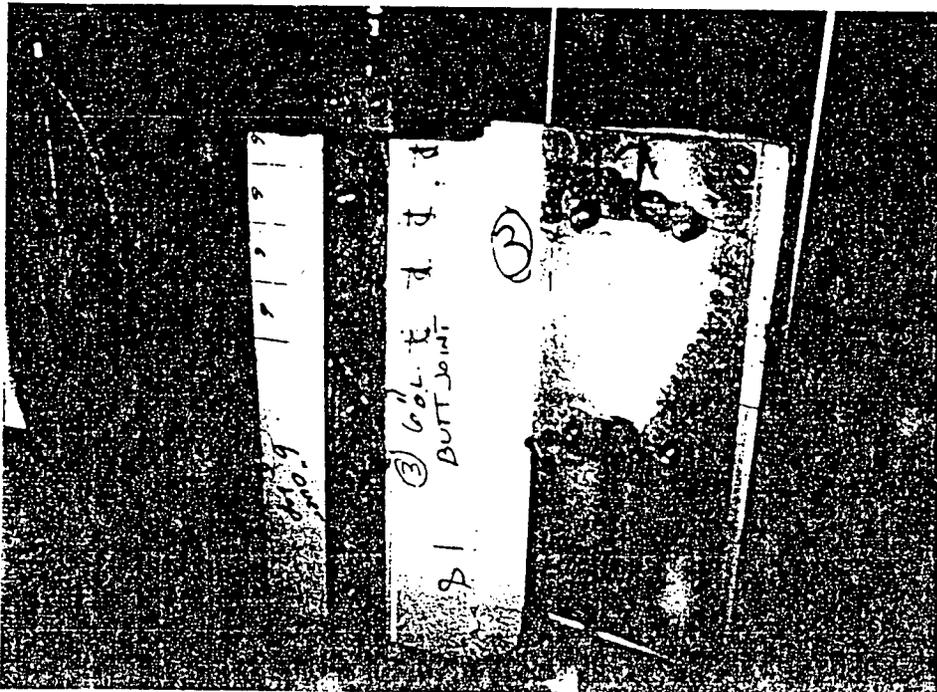
MAXIMUM LOAD (lbs):	702	1066	516
SHEAR STRENGTH OF OVERLAP (psi):	13.0	19.6	9.5



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Shear Strength

CONDITIONING/TEST TEMPERATURE: 127° F

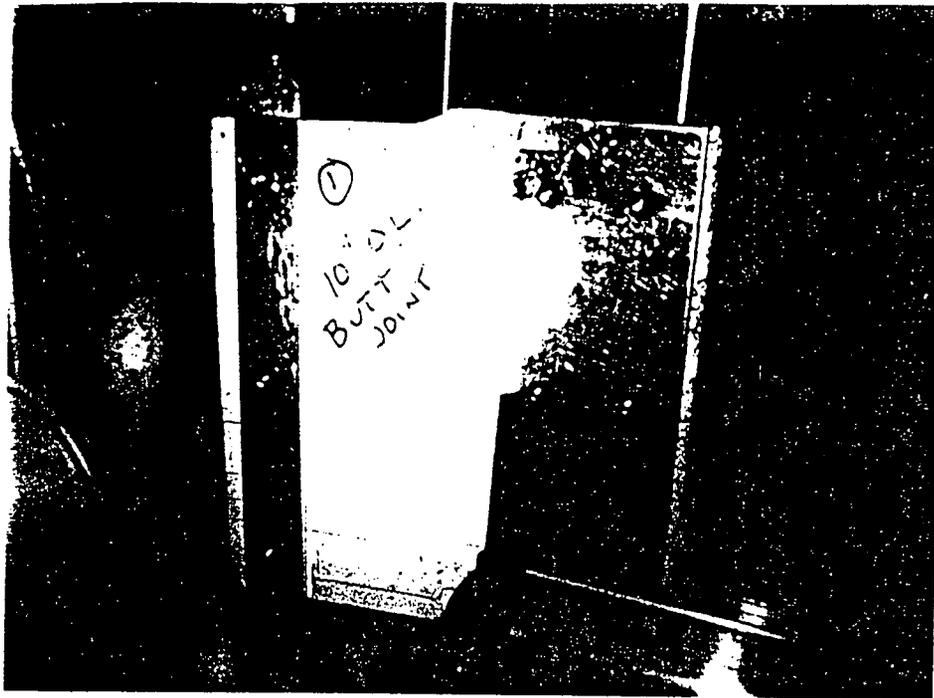
PECIMEN CONFIGURATION: Two stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side joined by a butt joint of Thermo-Lag 330 trowel grade overlapped with steel wire mesh on one side with an overlap of 10 inches

SPECIMEN NUMBER:	1	2	3
WIDTH OF OVERLAP:	5.0	5.0	5.0
LENGTH OF OVERLAP:	18.1	17.8	18.0
AREA OF OVERLAP (in <sup>2</sup> ):	90.5	89.0	90.0

DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.10	218	128	211
0.20	476	203	360
0.30	619	222	476
0.40	669	247	552
0.50	765	224	518
0.60	824	330	600
0.70	842	386	678
0.80	835	435	724
0.90	820	468	774
1.00	818	487	805
1.10	-	496	818
1.20	-	486	824
1.30	-	456	812
1.40	-	-	794

FAILURE: Steel wire mesh bond failure and stretching for all specimens. Partial bending at butt joint of specimen 2 due to warped specimen

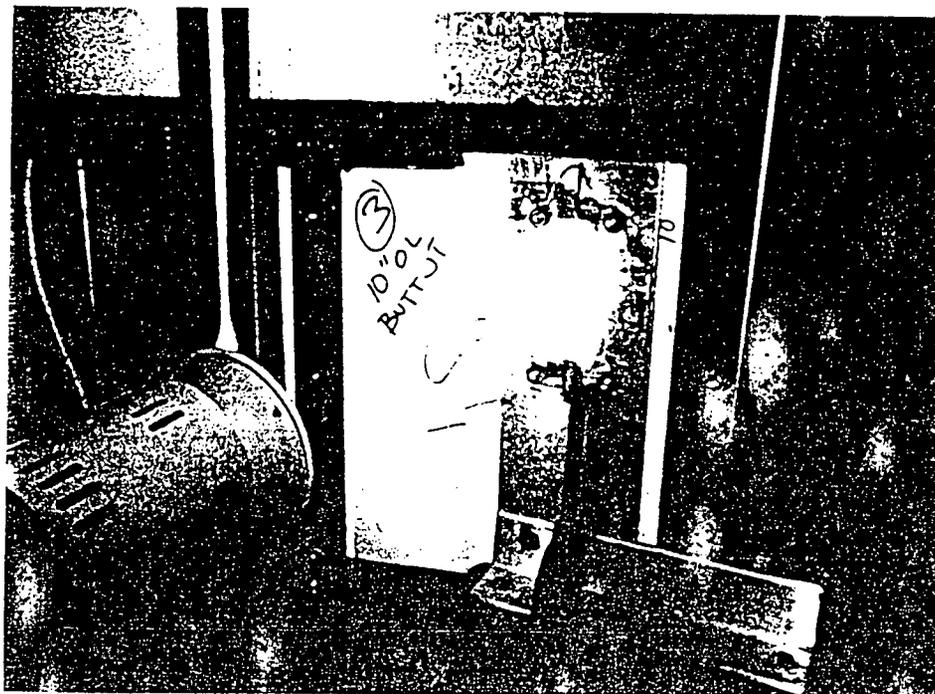
MAXIMUM LOAD (lbs):	842	496	824
SHEAR STRENGTH OF OVERLAP (psi):	9.3	5.6	9.2



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Shear Strength

CONDITIONING/TEST TEMPERATURE: 127° F

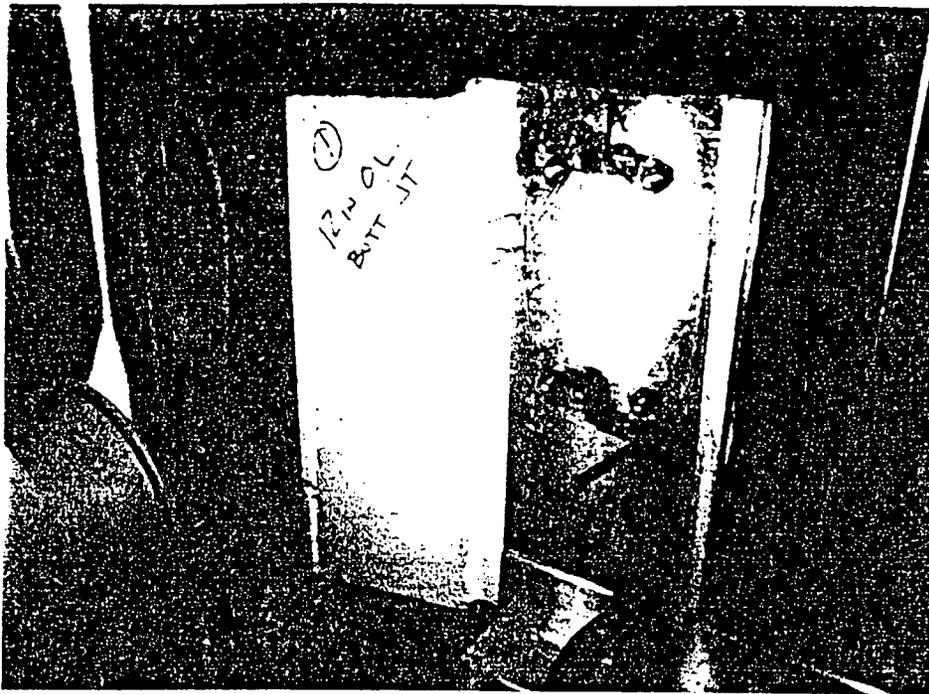
SPECIMEN CONFIGURATION: Two stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side joined by a butt joint of Thermo-Lag 330 trowel grade overlapped with steel wire mesh on one side with an overlap of 12 inches

SPECIMEN NUMBER:	1	2	3
WIDTH OF OVERLAP:	6.0	6.0	6.0
LENGTH OF OVERLAP:	18.0	17.9	17.7
AREA OF OVERLAP (in <sup>2</sup> ):	108.0	107.4	106.2

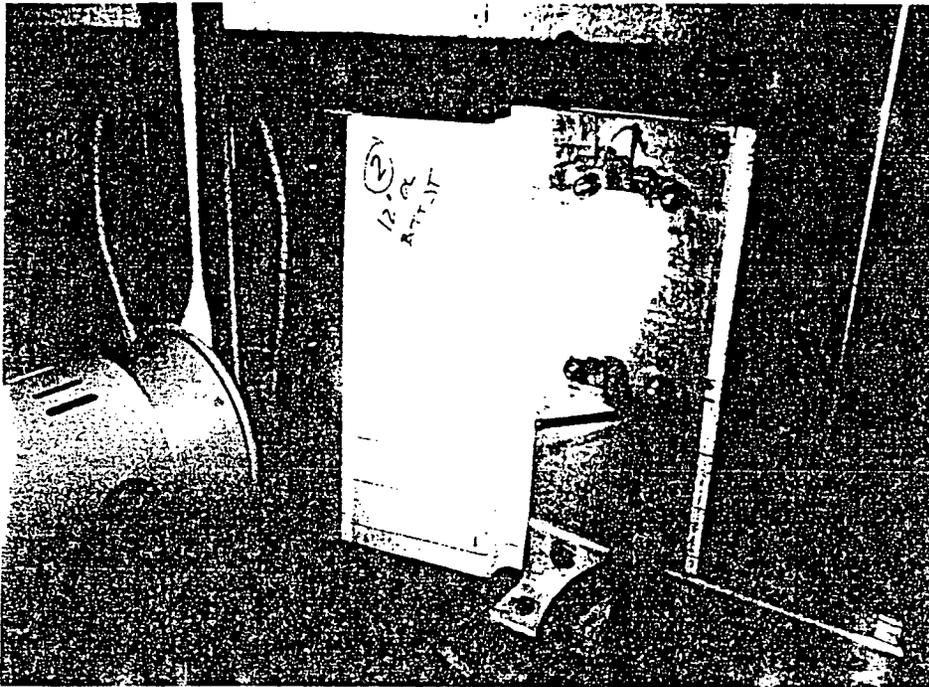
DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.10	134	146	113
0.20	246	256	174
0.30	338	323	243
0.40	430	346	294
0.50	484	400	336
0.60	529	557	440
0.70	556	501	560
0.80	604	536	661
0.90	663	562	735
1.00	699	584	790
1.10	731	601	835
1.20	763	621	863
1.30	792	626	879
1.40	812	612	880
1.50	841	602	860
1.60	846	-	846
1.70	843	-	-
1.80	838	-	-

FAILURE: Steel wire mesh bond failure and stretching for all specimens.

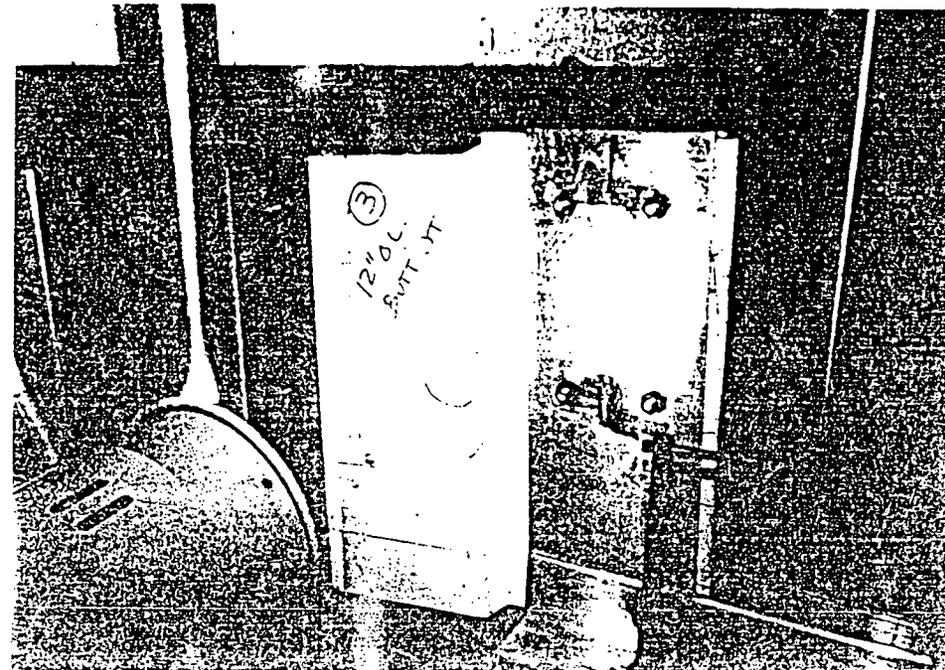
MAXIMUM LOAD (lbs):	846	626	880
SHEAR STRENGTH OF OVERLAP (psi):	7.8	5.8	8.2



SPECIMEN 1



SPECIMEN 2



SPECIMEN 3

PROPERTY: Bond Shear Strength

99

CONDITIONING/TEST TEMPERATURE: 127° F

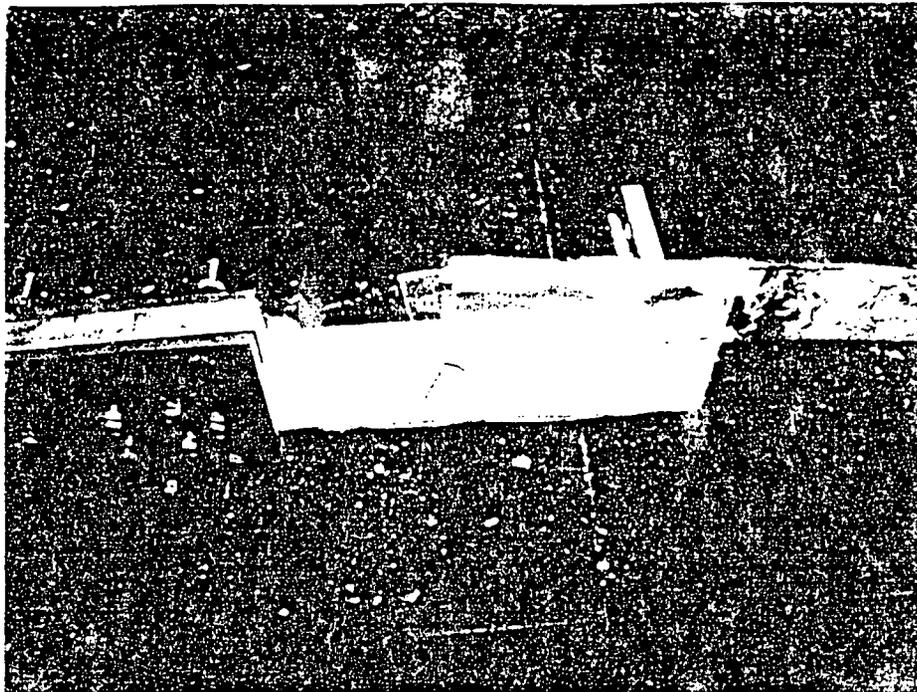
SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side bonded (on stress skin side) to galvanized sheet metal (12 gauge) by thermo-lag 330 trowel grade material

SPECIMEN NUMBER:	1	2	3
BOND WIDTH (in.):	2.230	1.808	2.022
BOND LENGTH (in.):	6.015	6.020	6.060
BOND AREA (in <sup>2</sup> ):	13.414	10.884	12.253

DEFLECTION (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.01	18	13	68
0.02	25	79	118
0.03	93	113	140
0.04	120	147	154
0.05	51	161	120
0.06	42	163	75
0.07	-	132	52
0.08	-	92	37
0.09	-	65	30
0.10	-	45	25

FAILURE: Bond failure between sheet metal and thermo-lag in all specimens

MAXIMUM LOAD (lbs):	120	163	154
BOND SHEAR STRENGTH (psi):	8.9	15.0	12.6



SPECIMEN 1  
(TYPICAL)

PROPERTY: Tensile Strength

101

CONDITIONING/TEST TEMPERATURE: 72° F

SPECIMEN CONFIGURATION: Standard carbon steel stress skin mesh removed from 5/8 inch sheet - single wire

SPECIMEN NUMBER:	1	2	3
DIAMETER (in.):	0.018	0.018	0.018
AREA (in <sup>2</sup> ):	0.0003	0.0003	0.0003
GAUGE LENGTH (in.):	3.0	3.0	3.0

DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.05	1.6	2.6	1.2
0.10	4.1	6.4	3.4
0.15	11.6	7.7	2.0
0.20	16.1	9.2	4.8
0.25	20.4	10.9	7.5
0.30	-	12.1	10.1
0.35	-	13.4	11.9
0.40	-	15.3	13.9
0.45	-	16.9	16.1
0.50	-	17.8	18.3
0.55	-	-	20.6
0.60	-	-	21.9
0.65	-	-	23.2

FAILURE: Tensile failure between grips for all specimens

MAXIMUM LOAD (lbs):	20.4	17.8	23.2
TENSILE STRENGTH (psi):	68,000	59,333	77,333

NOTE: Mesh consists of 8 wires per inch

PROPERTY: Tensile Strength

102

CONDITIONING/TEST TEMPERATURE: 72° F

SPECIMEN CONFIGURATION: Stainless steel wire mesh (type 304) – single wire

SPECIMEN NUMBER:                    1                    2                    3

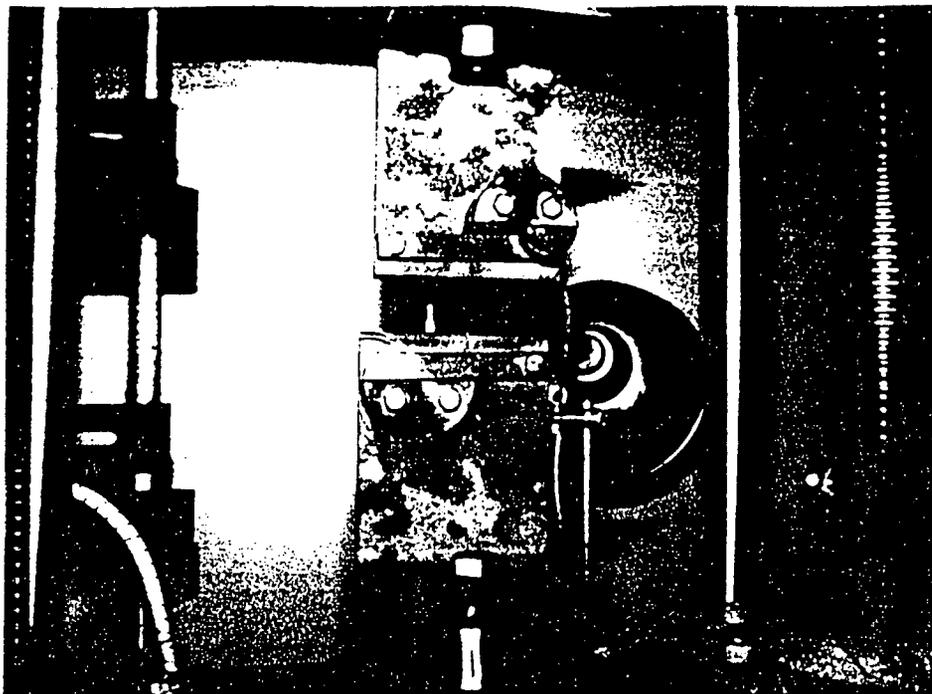
AVERAGE DIAMETER (in.):	0.015	0.015	0.015
AREA (in <sup>2</sup> ):	0.0002	0.0002	0.0002
GAUGE LENGTH (in.):	2.75	2.69	2.63

DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.10	8.7	5.8	15.4
0.20	15.3	12.6	18.9
0.30	18.4	18.3	19.9
0.40	19.3	19.4	20.5
0.50	19.9	20.2	21.0
0.60	20.5	20.7	21.4
0.70	20.9	21.1	21.7
0.80	21.2	21.4	22.0
0.90	21.4	21.7	22.1
1.00	21.7	21.9	22.2
1.20	21.8	22.0	–
1.30	21.9	22.0	–
1.40	22.0	–	–

FAILURE: Tensile failure between grips for all specimens

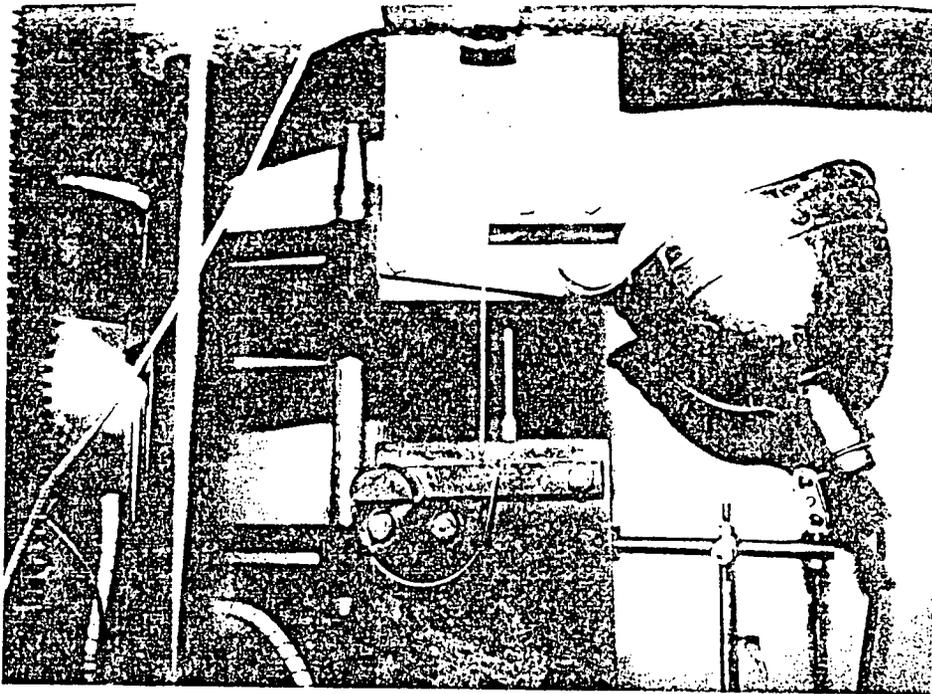
MAXIMUM LOAD (lbs):	22.0	22.0	22.2
TENSILE STRENGTH PER WIRE (psi):	110,000	110,000	111,000

NOTE: Mesh consists of 8 wires per inch



SPECIMEN 1  
(TYPICAL)





SPECIMEN 1  
(TYPICAL)

PROPERTY: Tensile Strength

106

CONDITIONING/TEST TEMPERATURE: 72° F

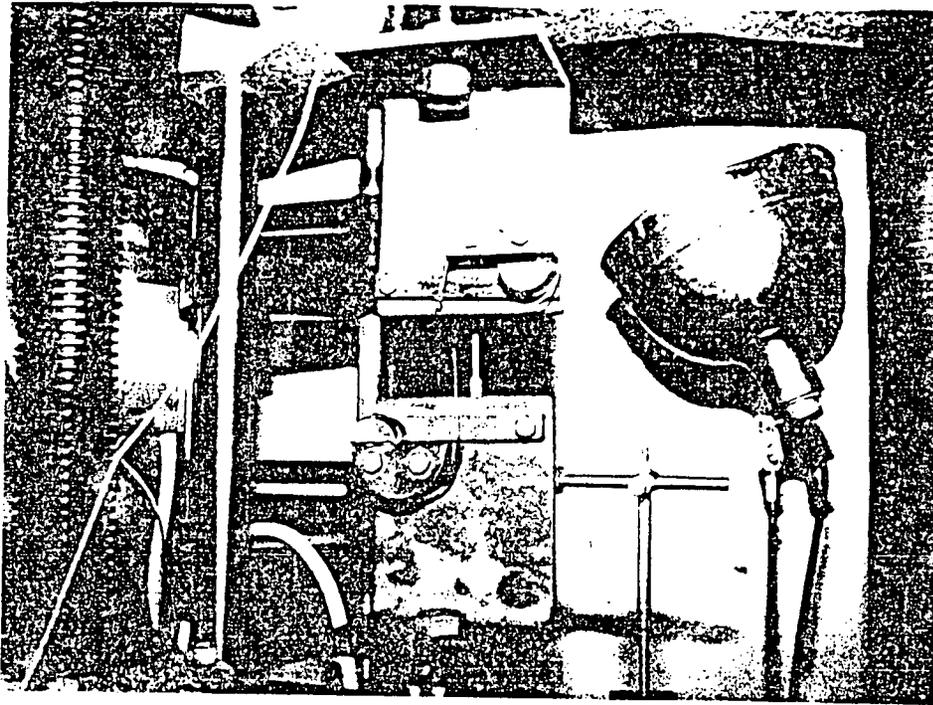
SPECIMEN CONFIGURATION: Stainless Steel tie wire (annealed 304, 16 gauge) joined by a 3 twist joint

SPECIMEN NUMBER:	1	2	3
DIAMETER (in.):	0.062	0.062	0.062
GAUGE LENGTH (in.):	3.0	3.0	3.0

DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.1	24.6	23.4	27.4
0.2	34.4	29.8	40.1
0.3	50.4	36.1	53.1
0.4	69.9	48.1	69.1
0.5	91.8	62.9	95.5
0.6	123.4	80.4	135.3
0.7	145.1	110.4	161.7
0.8	117.8	114.8	174.7
0.9	116.1	115.7	185.2
1.0	107.4	124.8	194.5
1.1	84.6	132.5	201.4
1.2	-	134.6	210.3
1.3	-	131.7	217.5
1.4	-	128.7	223.9
1.5	-	-	230.4
1.6	-	-	236.4
1.7	-	-	242.7
1.8	-	-	247.2
1.9	-	-	251.5
2.0	-	-	255.7
2.1	-	-	260.0
2.2	-	-	266.6

FAILURE: Unwrapping of twists for all specimens

MAXIMUM TENSILE LOAD (lbs):	145.1	134.6	266.6
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SPECIMEN 1  
(TYPICAL)

PROPERTY: Tensile Strength

108

CONDITIONING/TEST TEMPERATURE: 72° F

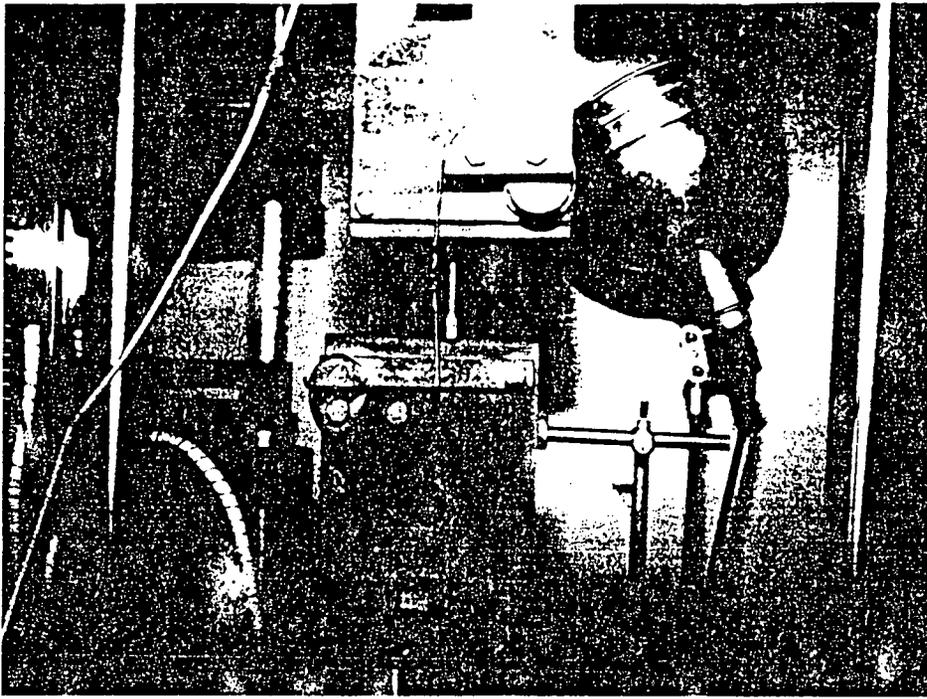
SPECIMEN CONFIGURATION: Stainless Steel tie wire (annealed 304, 16 gauge) joined by a 6 twist joint

SPECIMEN NUMBER:	1	2	3
DIAMETER (in.):	0.062	0.062	0.062
GAUGE LENGTH (in.):	3.0	3.0	3.0

DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.1	12.6	27.1	22.1
0.2	16.6	46.7	36.9
0.3	26.3	60.3	54.6
0.4	37.5	76.4	74.9
0.5	47.5	88.3	95.0
0.6	58.0	109.8	112.0
0.7	69.1	117.1	111.3
0.8	97.5	116.0	113.5
0.9	116.9	120.3	123.8
1.0	119.0	123.9	129.3
1.1	123.1	123.3	130.7
1.2	129.7	123.9	130.3
1.3	133.2	128.5	131.7
1.4	133.6	134.0	133.1
1.5	-	135.7	-

FAILURE: Unwrapping of twists for all specimens

MAXIMUM TENSILE LOAD (lbs):	133.6	135.7	133.1
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SPECIMEN 1  
(TYPICAL)

PROPERTY: Flexural Strength

CONDITIONING/TEST TEMPERATURE: 72° F (conditioned at 140° F for 24 hours before conditioning at 72° F for 24 hours)

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with stress skin - up

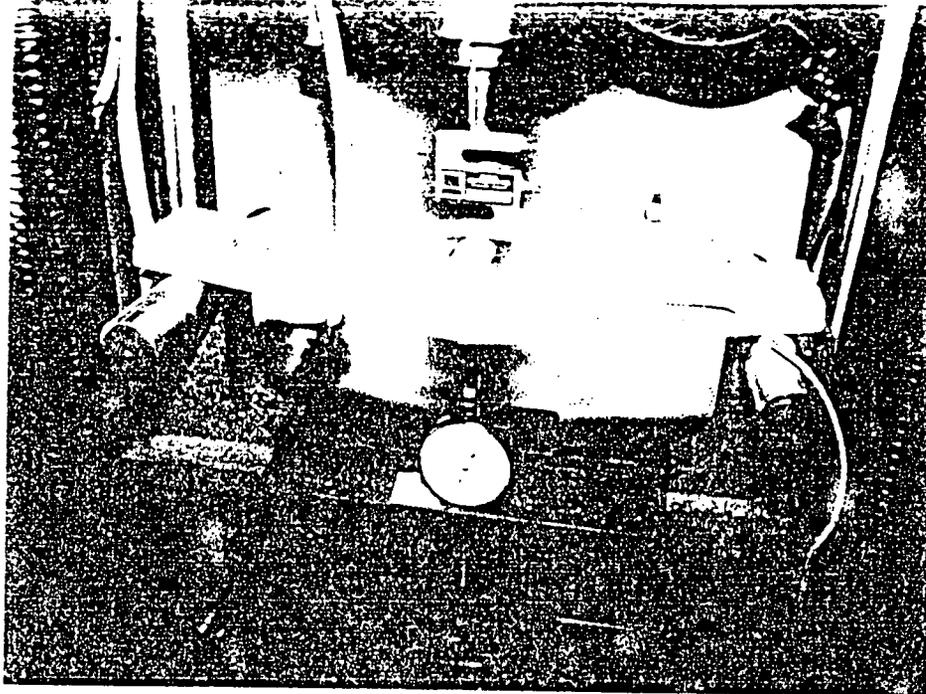
SPECIMEN NUMBER: 1

WIDTH (in.):	2.916
THICKNESS (in.):	0.717
AREA (in <sup>2</sup> ):	2.091

DEFLECTION (inches)	LOAD (lbs)
0	0
0.5	11.7
0.10	21.5
0.15	28.4
0.20	34.3
0.25	38.3
0.30	41.8
0.35	44.2
0.40	45.4
0.45	46.0
0.50	45.9
0.55	45.0

FAILURE: Material tensile failure on bottom face at mid-span

MAXIMUM LOAD (lbs):	46.0
FLEXURAL STRENGTH (psi): (15 inch span)	690.4



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SPECIMEN 1  
(TYPICAL)

PROPERTY: Flexural Strength

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CONDITIONING/TEST TEMPERATURE: 72° F (conditioned at 140° F for 24 hours before conditioning at 72° F for 24 hours)

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with stress skin - down

SPECIMEN NUMBER: 1

WIDTH (in.):	2.926
THICKNESS (in.):	0.703
AREA (in <sup>2</sup> ):	2.057

DEFLECTION (inches)	LOAD (lbs)
0	0
0.10	15.9
0.20	28.1
0.30	36.9
0.40	43.6
0.50	48.0
0.60	50.9
0.70	52.7
0.80	53.6
0.90	54.0
1.00	53.8

FAILURE: Material compression failure on top face at mid-span

MAXIMUM LOAD (lbs): 54.0

FLEXURAL STRENGTH (psi): 840.2  
(15 inch span)

PROPERTY: Flexural Strength

CONDITIONING/TEST TEMPERATURE: 72° F (conditioned at 140° F for 2-hours before conditioning at 72° F for 24 hours)

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 3/8 inch thick with standard stress skin - up

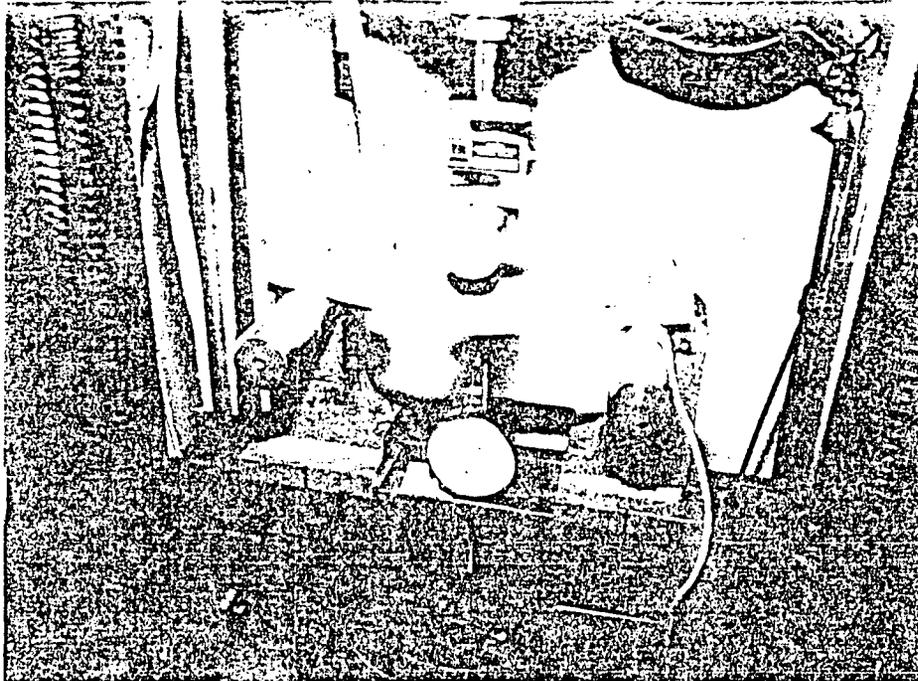
SPECIMEN NUMBER: 1

WIDTH (in.):	3.005
THICKNESS (in.):	0.372
AREA (in <sup>2</sup> ):	1.118

DEFLECTION (inches)	LOAD (lbs)
0	0
0.05	13.6
0.10	22.8
0.15	28.3
0.20	33.3
0.25	36.8
0.30	38.5
0.35	39.2
0.40	38.1
0.45	37.9

FAILURE: Material tensile failure on bottom face at mid-span

MAXIMUM LOAD (lbs):	39.2
FLEXURAL STRENGTH (psi): (9 inch span)	1272.6



SPECIMEN 1  
(TYPICAL)

PROPERTY: Flexural Strength

CONDITIONING/TEST TEMPERATURE: 72° F (conditioned at 140° F for 24 hours before conditioning at 72° F for 24 hours)

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 3/8 inch thick with standard stress skin -- down

SPECIMEN NUMBER: 1

WIDTH (in.):	2.987
THICKNESS (in.):	0.464
AREA (in <sup>2</sup> ):	1.386

DEFLECTION (inches)	LOAD (lbs)
0	0
0.05	18.0
0.10	28.3
0.15	38.9
0.20	45.7
0.25	51.9
0.30	56.9
0.35	60.0
0.40	61.8
0.45	63.3
0.50	64.1
0.55	64.4
0.60	64.3

FAILURE: Material compression failure on top face at mid-span

MAXIMUM LOAD (lbs):	64.4
FLEXURAL STRENGTH (psi): (9 inch span)	1351.9

PROPERTY: Flexural Strength

CONDITIONING/TEST TEMPERATURE: 72° F (conditioned at 140° F for 24 hours before conditioning at 72° F for 24 hours)

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with no stress skin

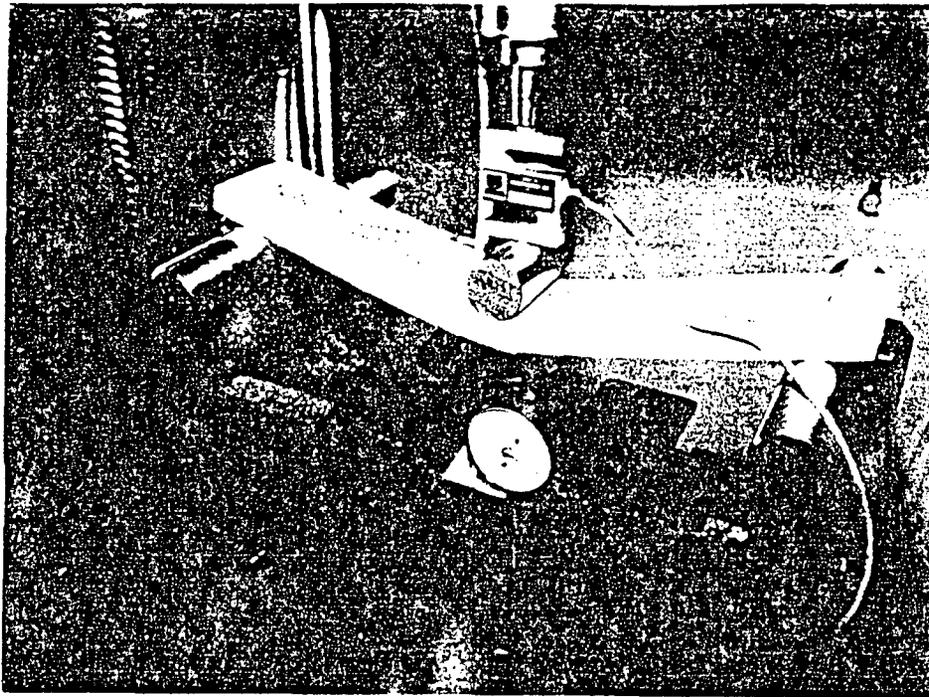
SPECIMEN NUMBER: 1

WIDTH (in.):	2.883
THICKNESS (in.):	0.707
AREA (in <sup>2</sup> ):	2.038

DEFLECTION (inches)	LOAD (lbs)
0	0
0.10	12.8
0.20	20.8
0.30	26.9
0.40	31.0
0.50	33.9
0.60	35.8
0.66	36.3
0.70	36.3
0.80	35.4

FAILURE: Material tensile failure on bottom surface at mid-span

MAXIMUM LOAD (lbs):	36.3
FLEXURAL STRENGTH (psi): (15 inch span)	566.8



SPECIMEN 1  
(TYPICAL)

PROPERTY: Compressive Strength

CONDITIONING/TEST TEMPERATURE: 72° F (initially conditioned at 140° F for 24 hours before conditioning at 72° F for 24 hours)

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin

SPECIMEN NUMBER:                    1                    2

WIDTH (in.):	1.012	0.970
THICKNESS (in.):	0.676	0.716
AREA (in <sup>2</sup> ):	0.684	0.695
HEIGHT (in.):	0.998	0.995

DISPLACEMENT (inches)	LOAD (lbs)	LOAD
0	0	0
0.005	40	1
0.010	68	7
0.015	157	15
0.020	189	34
0.025	220	68
0.030	252	93
0.035	269	134
0.040	286	179
0.045	294	216
0.050	294	251
0.055	285	289
0.060	269	293
0.065	252	291
0.070	—	285
0.075	—	278

**FAILURE:** Unequal compression failure toward non-stress skin side for both specimens

MAXIMUM LOAD (lbs):	294	293
COMPRESSIVE STRENGTH (psi):	429.8	421.6

PROPERTY: Compressive Strength

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CONDITIONING/TEST TEMPERATURE: 72° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side and stainless steel wire mesh stress skin applied to the opposite side

SPECIMEN NUMBER:                      1                      2

WIDTH (in.):	1.016	0.890
THICKNESS (in.):	0.825	0.880
AREA (in <sup>2</sup> ):	0.838	0.783
HEIGHT (in.):	0.990	1.070

DISPLACEMENT (inches)	LOAD (lbs)	LOAD
0	0	0
0.005	25	45
0.010	62	98
0.015	128	156
0.020	196	218
0.025	242	268
0.030	287	311
0.035	311	324
0.040	320	347
0.045	322	345
0.050	320	337
0.055	317	331
0.060	316	—
0.065	307	—
0.070	321	—
0.075	289	—
0.080	279	—

**FAILURE:** Even compression failure, stainless steel stress skin debonding for both specimens

MAXIMUM LOAD (lbs):	322	347
COMPRESSIVE STRENGTH (psi):	384.2	443.2

PROPERTY: Compressive Strength

CONDITIONING/TEST TEMPERATURE: 72° F (initially conditioned at 140° F for 24 hours before conditioning at 72° F for 24 hours)

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 3/8 inch thick with standard stress skin

SPECIMEN NUMBER: 1 2

WIDTH (in.):	0.930	0.940
THICKNESS (in.):	0.457	0.487
AREA (in <sup>2</sup> ):	0.425	0.458
HEIGHT (in.):	0.984	0.992

DISPLACEMENT (inches)	LOAD (lbs)	LOAD
0	0	0
0.005	28	7
0.010	64	13
0.015	100	37
0.020	124	65
0.025	145	96
0.030	161	123
0.035	176	142
0.040	184	162
0.045	183	179
0.050	178	182
0.055	—	184
0.060	—	183
0.065	—	181
0.070	—	179

**FAILURE:** Uneven compression failure toward non-stress skin side for both specimens

MAXIMUM LOAD (lbs):	184	184
COMPRESSIVE STRENGTH (psi):	432.9	401.7

PROPERTY: Compressive Strength

CONDITIONING/TEST TEMPERATURE: 72° F (initially conditioned at 140° F for 24 hours before conditioning at 72° F for 24 hours)

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with out standard stress skin

SPECIMEN NUMBER:	1	2
WIDTH (in.):	1.045	1.032
THICKNESS (in.):	0.712	0.715
AREA (in <sup>2</sup> ):	0.744	0.738
HEIGHT (in.):	0.992	0.990

DISPLACEMENT (inches)	LOAD (lbs)	LOAD
0	0	0
0.005	2	1
0.010	7	2
0.015	23	5
0.020	41	18
0.025	68	47
0.030	98	79
0.035	127	119
0.040	159	158
0.045	185	198
0.050	205	221
0.055	223	235
0.060	232	245
0.065	235	247
0.070	236	245
0.075	223	240

FAILURE: Even compression failure for both specimens

MAXIMUM LOAD (lbs):	236	247
COMPRESSIVE STRENGTH (psi):	317.2	334.7

PROPERTY: Shear Strength

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CONDITIONING/TEST TEMPERATURE: 72° F (conditioned at 140° F for 24 hours before conditioning at 72° F for 24 hours)

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin

SPECIMEN NUMBER: 1

WIDTH (in.):	6.045
THICKNESS (in.):	0.758
SHEAR AREA (in <sup>2</sup> ):	4.582

DEFLECTION (inches)	LOAD (lbs)
0	0
0.02	275
0.04	525
0.06	718
0.08	839
0.10	904
0.12	927
0.14	947
0.16	975
0.18	996
0.20	1005
0.22	1002
0.24	990
0.26	970
0.28	-
0.30	-
0.32	-

FAILURE: Material shear failure with stress skin debonding

MAXIMUM LOAD (lbs):	1005
SHEAR STRENGTH (psi):	109.7

PROPERTY: Shear Strength

CONDITIONING/TEST TEMPERATURE: 72° F (conditioned at 140° F for 24 hours before conditioning at 72° F for 24 hours)

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side and stainless steel wire mesh stress skin applied to the opposite side

SPECIMEN NUMBER: 1

WIDTH (in.):	5.974
THICKNESS (in.):	0.851
SHEAR AREA (in <sup>2</sup> ):	5.084

DEFLECTION (inches)	LOAD (lbs)
0	0
0.02	258
0.04	416
0.06	516
0.08	616
0.10	685
0.12	752
0.14	835
0.16	890
0.18	938
0.20	964
0.22	987
0.24	997
0.26	1002
0.28	1000
0.30	998
0.32	993

FAILURE: Material shear failure with standard and stainless steel stress skin debonding

MAXIMUM LOAD (lbs):	1002
SHEAR STRENGTH (psi):	98.5

PROPERTY: Shear Strength

CONDITIONING/TEST TEMPERATURE: 72° F (conditioned at 140° F for 24 hours before conditioning at 72° F for 24 hours)

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 3/8 inch thick with standard stress skin

SPECIMEN NUMBER: 1

WIDTH (in.):	6.036
THICKNESS (in.):	0.474
SHEAR AREA (in <sup>2</sup> ):	2.861

DEFLECTION (inches)	LOAD (lbs)
0	0
0.02	362
0.04	624
0.06	906
0.08	1124
0.10	1179
0.12	1218
0.14	1264
0.16	1300
0.18	1326
0.20	1349
0.22	1374
0.24	1407
0.26	1423
0.28	1431
0.30	1425
0.32	1430

FAILURE: Material shear failure with stress skin debonding

MAXIMUM LOAD (lbs):	1431
SHEAR STRENGTH (psi):	250.1

PROPERTY: Shear Strength

CONDITIONING/TEST TEMPERATURE: 72° F (conditioned at 140° F for 24 hours before conditioning at 72° F for 24 hours)

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin removed

SPECIMEN NUMBER: 1

WIDTH (in.):	5.968
THICKNESS (in.):	0.707
SHEAR AREA (in <sup>2</sup> ):	4.219

DEFLECTION (inches)	LOAD (lbs)
0	0
0.02	183
0.04	278
0.06	317
0.08	339
0.10	350
0.12	357
0.14	361
0.16	360
0.18	358
0.20	356
0.22	--
0.24	--
0.26	--
0.28	--
0.30	--
0.32	--

FAILURE: Material shear failure

MAXIMUM LOAD (lbs):	361
SHEAR STRENGTH (psi):	42.8

PROPERTY: Compressive Strength

CONDITIONING/TEST TEMPERATURE: 72° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin

SPECIMEN NUMBER: 1 2 3

WIDTH (in.):	1.048	1.058	1.049
THICKNESS:	0.620	0.693	0.677
AREA (in <sup>2</sup> ):	0.650	0.733	0.710
HEIGHT:	1.017	1.010	1.013

DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.005	3.3	6.5	1.3
0.010	18.2	26.2	5.4
0.015	35.3	57.4	22.7
0.020	51.6	89.7	58.1
0.025	68.4	116.9	92.0
0.030	79.9	139.9	127.2
0.035	84.9	149.7	153.8
0.040	87.3	150.3	168.8
0.045	88.7	158.3	175.4
0.050	94.1	157.2	174.4
0.055	102.7	153.8	170.9
0.060	110.7	-	165.1
0.065	114.8	-	-
0.070	117.3	-	-
0.075	117.9	-	-
0.080	116.7	-	-

FAILURE: Unequal compression failure toward non-stress skin side for all specimens

MAXIMUM LOAD (lbs):	117.9	158.3	175.4
COMPRESSIVE STRENGTH (psi):	181.4	216.0	247.0

PROPERTY: Compressive Strength

CONDITIONING/TEST TEMPERATURE: 72° F

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin on one side and stainless steel wire mesh stress skin applied to the opposite side

SPECIMEN NUMBER:                    1                                    2                                    3

WIDTH (in.):	1.037	1.052	0.943
THICKNESS (in.):	0.941	0.935	0.978
AREA (in <sup>2</sup> ):	0.976	0.984	0.922
HEIGHT (in.):	1.025	1.010	1.015

DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.005	2.0	2.1	1.5
0.010	7.9	4.0	2.0
0.015	33.2	12.9	2.9
0.020	66.9	42.3	16.2
0.025	97.2	83.8	52.6
0.030	123.5	132.1	93.4
0.035	155.8	176.2	130.1
0.040	181.2	199.1	158.2
0.045	196.6	210.4	176.2
0.050	202.3	209.5	183.3
0.055	203.3	203.7	184.5
0.060	201.6	194.8	183.7
0.065	198.4	-	180.6
0.070	194.2	-	176.0
0.075	188.5	-	-

FAILURE:

Uneven compression failure toward stainless steel stress skin side	Even compression failure	Even compression failure
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MAXIMUM LOAD (lbs):

203.3	210.4	184.5
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COMPRESSIVE STRENGTH (psi):

208.3	213.8	200.1
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PROPERTY: Compressive Strength

CONDITIONING/TEST TEMPERATURE: 72° F

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LAST PAGE

SPECIMEN CONFIGURATION: Stock Thermo-Lag 330 sheet 5/8 inch thick with standard stress skin removed

SPECIMEN NUMBER:                    1                    2                    3

WIDTH (in.):	0.965	1.000	1.001
THICKNESS (in.):	0.639	0.665	0.663
AREA (in <sup>2</sup> ):	0.617	0.665	0.664
HEIGHT (in.):	1.015	1.015	1.023

DISPLACEMENT (inches)	LOAD (lbs)	LOAD	LOAD
0	0	0	0
0.005	0.6	1.0	2.2
0.010	7.9	4.2	14.7
0.015	24.0	17.4	34.8
0.020	39.1	46.5	55.5
0.025	60.2	71.1	72.0
0.030	74.2	87.2	82.5
0.035	83.1	95.2	88.1
0.040	88.9	98.7	90.3
0.045	91.7	99.8	91.2
0.050	92.9	99.9	91.8
0.055	92.8	99.0	89.2
0.060	90.9	97.5	91.1
0.065	89.2	95.8	94.3
0.070	-	96.0	94.8
0.075	-	-	93.9

FAILURE: Uneven compression failure for all specimens

MAXIMUM LOAD (lbs):

COMPRESSIVE STRENGTH (psi):

92.9	99.9	94.8
150.6	150.2	142.8

ENCLOSURE 1

WATTS BAR NUCLEAR PLANT UNIT 1  
REQUEST FOR ADDITIONAL INFORMATION

AVAILABLE EQUIPMENT BY FIRE ZONES/AREAS