LOAD BEARING SANDWICH PANELS

A THESIS

PRESENTED TO

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SYNOPSIS

This thesis gives the results of an investigation of reinforced concrete sandwich panels subject to axial compression on one face only.

Panel height, load bearing thickness, reinforcement, and ultimate strength were investigated. Load-deflection characteristics and various failure patterns were also observed.

The test results showed that there was no marked change in the ultimate strength of panels which had variations in height of from 96 to 144 inches, or variations in height over total thickness ratios of from 12 to 27, or variations in the reinforcement ratio in the load bearing face of from 1 to 2 to 3.

Existing code restrictions and a possible design formula are also discussed.

ACKNOWLEDGEMENTS

The author hereby expresses his deepest gratitude to Professor R. Lazar, Department of Civil Engineering, University of Manitoba, for his helpful guidance and encouragement throughout the duration of the laboratory experimental work and the preparation of this thesis. Appreciation is expressed for helpful suggestions received from Dr. A. Lansdown, Head, Department of Civil Engineering, University of Manitoba.

The author is obliged to the Canadian Prestressed Concrete Institute, Supercrete Ltd., and Preco Ltd., who supported this investigation. He is also indebted to Mr. E. Lemke, Chief Technician, Structures Laboratory, Civil Engineering Department, University of Manitoba, and his staff for their help throughout the laboratory experimental work.

The author would also like to thank Mr. H. Meronek of Aerofoam Chemicals Ltd., who gave freely of his time when questioned on technical matters concerning the insulation, and Miss J. Ziprick, who has been of invaluable assistance in typing all of the thesis.

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I. OBJECT

The object of this thesis is to investigate the load bearing properties of reinforced concrete sandwich panels with variations in height, bearing thickness, and reinforcement. It was decided to use heights of 8, 10 and 12 feet, bearing thicknesses of 2 and 4 inches, and to vary the reinforcement in the load bearing face in a ratio of 1 to 2 to 3. The panels were designed by the author in conjunction with Professor R. Lazar, Professor of Civil Engineering, University of Manitoba, and were precast by Supercrete Co. Ltd. at their St. Boniface plant (plate 1). They were then delivered to the University of Manitoba, where they were tested to destruction.

II. MATERIALS

2.1 Panels

Ten different groups of panels were designed with variations in height, bearing thickness and reinforcement ratio. In order to have some comparison among the groups, themselves, it was decided to make three panels of each group, which resulted in a total of thirty panels. The panels are referred to by a series of two numbers. The first number relates to the panel group and the second number relates to the order in which it was tested.

GROUP NO.	HEIGHT (FEET)	BEARING THICKNESS (INCHES)	REINFORCEMENT RATIO
1	12	2	Min
2	12	4	Min
3	10	4	3 X Min
4	10	4	2 X Min
5	10	4	Min
6	10	2	3 X Min
7	10	2	2 X Min
8	10	2	Min
9	8	2	Min
10	8	4	Min

Each panel had an outside, non-load bearing face of $1\frac{1}{2}$ inches and an inside core of 2 inches of "Aerofoam" insulation. This gave an overall panel thickness of $5\frac{1}{2}$ or $7\frac{1}{2}$ inches. The width of each panel was held constant at 12 inches.

2.2 Concrete

Four thousand psi minimum concrete was ordered for all panels and a standard test cylinder was cast for each panel. Both the panels and the cylinders were air cured. Each cylinder was tested along with its corresponding panel. The actual average cylinder strength of all the panels was 6050 psi.

2.3 Reinforcement

The reinforcement used was welded wire mesh of 4 X 4 4/4 and 4 X 4 8/8, giving steel areas of 0.120 and 0.062 square inches, respectively. The 4 X 4 8/8 was used as minimum steel in both the load bearing and non-load bearing faces. Combinations of the two meshes were then used to give one, two, and three times the minimum amount of steel in the load bearing face.

2.4 Shear Connectors

The shear connectors used in all panels were designed solely for the purpose of carrying the weight of the non-bearing face should total delamination occur. Each panel had three pieces of #9 wire from the center of the non-bearing face to the center of the load bearing face. These three pieces of wire were situated at the center of the panel and at the top and bottom, 6 inches in from each edge.

2.5 Insulation

Two inches of "Aerofoam" insulation was used as the core material in all of the panels. Both "Styrofoam" and "Aerofoam" are trade names for polystyrene bead board. "Styrofoam" is a product of Dow Chemical of Canada Ltd., while "Aerofoam" is a product of Aerofoam Chemicals

Ltd.. The raw materials in both products are essentially the same but the manufacturing techniques are different. Polystyrene beads, in the form of a foam, are extruded through a nozzle and expand on contact with the air, in the production of "Styrofoam". "Aerofoam" is produced in a mold, where the polystyrene beads expand in the presence of steam, and are fused together. "Styrofoam" has a more honeycomb type structure than "Aerofoam", which allows deeper penetration of the concrete and results in a better and more uniform bond than with "Aerofoam".

III. TESTS ON INSULATION

Comparative compression, tensile, and shear tests were run on both "Aerofoam" and "Styrofoam" insulation, the results of which can be seen in figs. 1 to 6.

3.1 Compression Test

Four samples of each, "Styrofoam" and "Aerofoam", were cut to dimensions of 6 X 6 X 2 inches. The samples were then tested to their approximate yield points in a 300,000 lb. testing machine. The results were plotted on a stress-strain curve (fig. 1).

3.2 Tension Test

Four samples of each "Styrofoam and "Aerofoam", were cut to dimensions of 6 X 6 X 2 inches. The samples were then cast between two layers of 3000 psi concrete, into which two 9 inch lengths of #4 bar had been imbedded. The samples were then placed in the 300,000 lb. testing machine and tested to failure (plate 2). The results were plotted on a stress-strain curve (fig. 2).

3.3 Shear Test

Two pieces of each, "Styrofoam" and "Aerofoam", were cut to dimensions of 12 X 12 X 1, 12 X 12 X 2, and 12 X 12 X 3 inches. Two pieces of the same thickness were then cast between alternate layers of 3000 psi concrete. (There were intended to be three tests on each insulation, but the 3 inch thick sample of "Aerofoam" delaminated when stripping the forms. There was no apparent reason for the delamination. This left only two samples of the "Aerofoam".) The samples were then placed edgewise in the 300,000 lb. testing machine (plate 3) and, with the two outside layers of concrete being supported, the middle layer of concrete was loaded until the sample failed. The results of these tests were plotted for both total and unit stress-strain relationships (figs. 3 to 6).

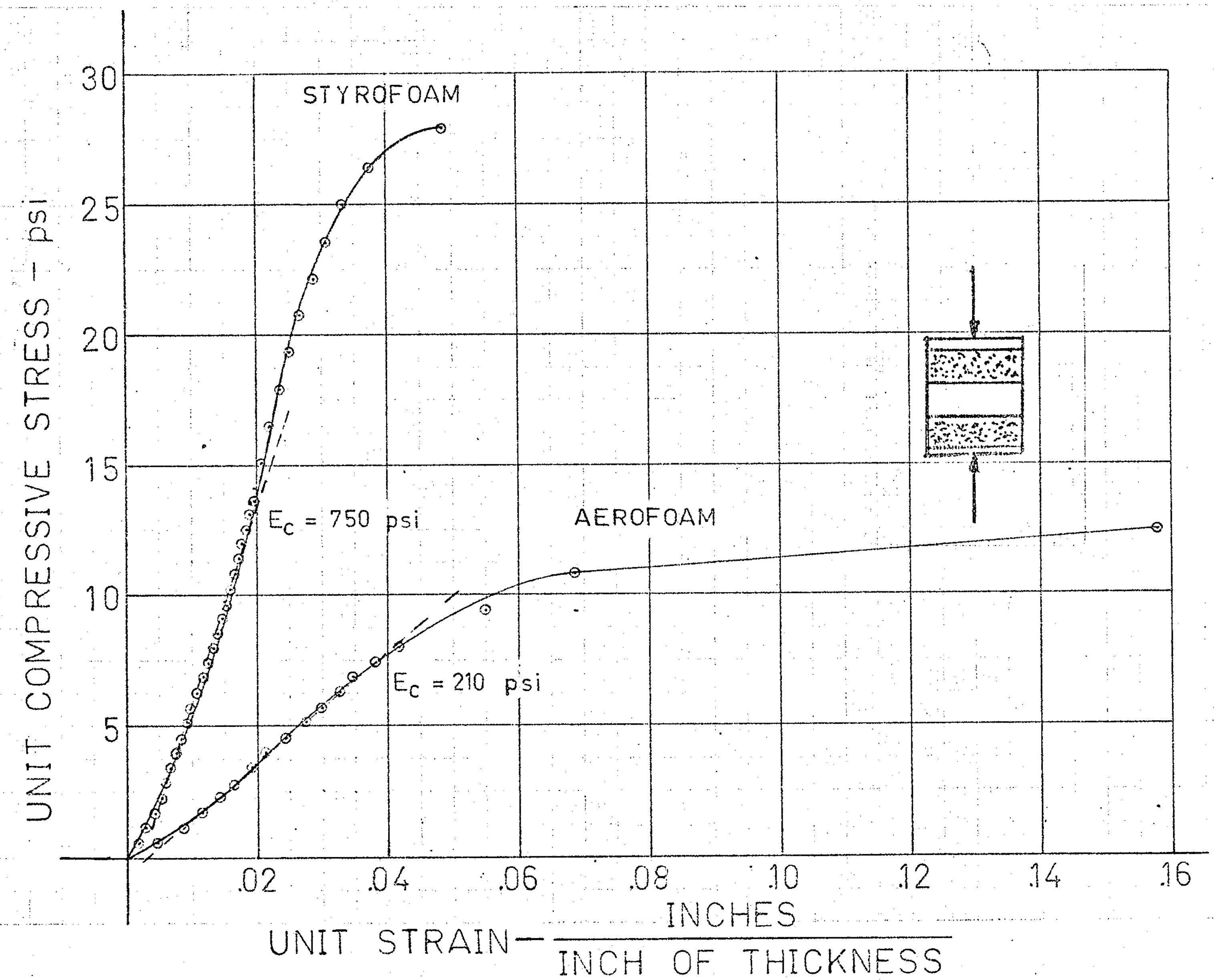

STYROFOAM
AEROFOAM
Ec = 750 psi
Ec = 210 psi
UNIT COMPRESSIVE STRESS – psi
30
25
20
15
10
5
.02
.04
.06
.08
.10
.12
.14
.16
UNIT STRAIN – INCHES / INCH OF THICKNESS

FIG. 1.

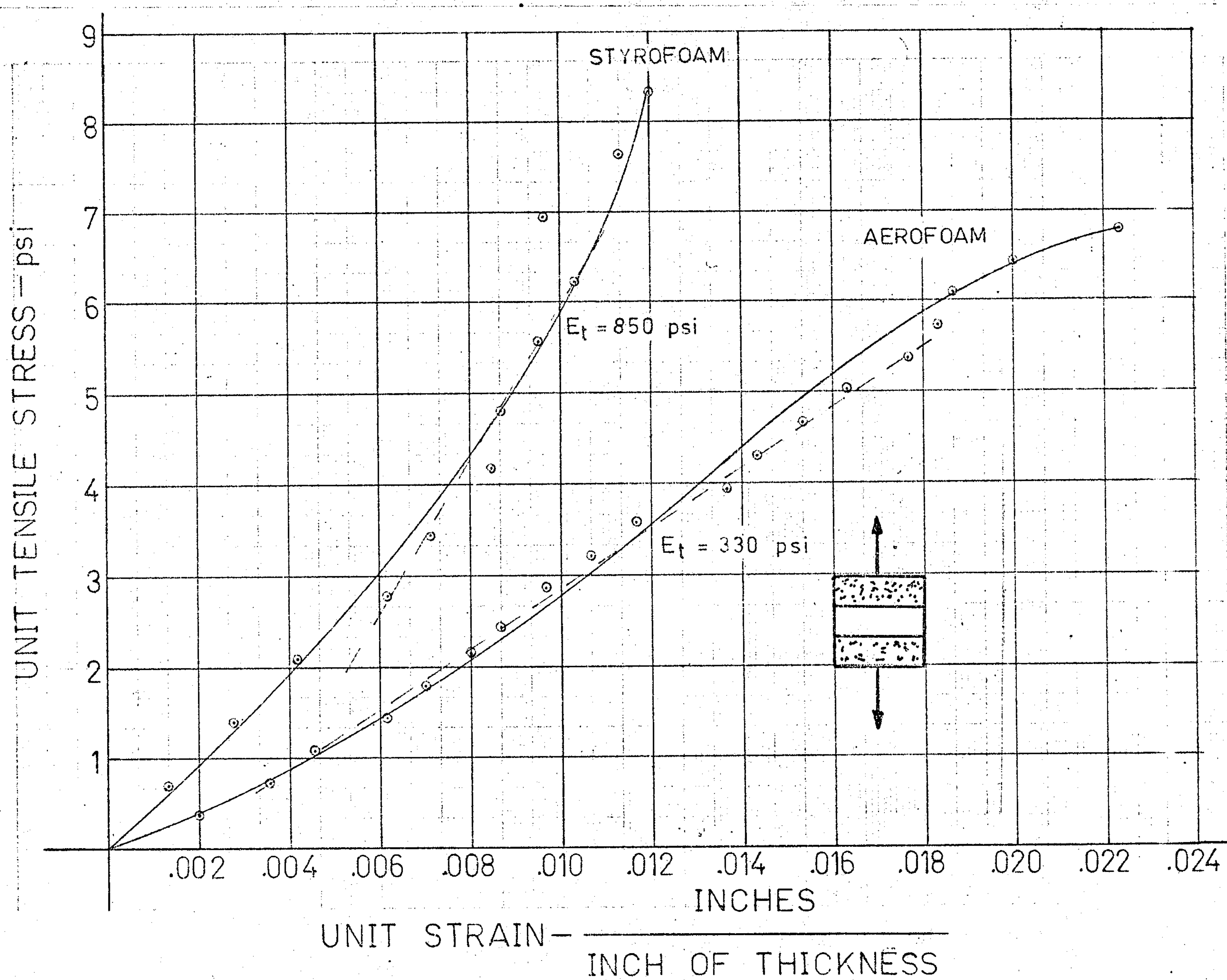

STYROFOAM
AEROFOAM
E_t = 850 psi
E_t = 330 psi
UNIT TENSILE STRESS — psi
1
2
3
4
5
6
7
8
9
.002
.004
.006
.008
.010
.012
.014
.016
.018
.020
.022
.024
UNIT STRAIN — INCHES / INCH OF THICKNESS

FIG 2

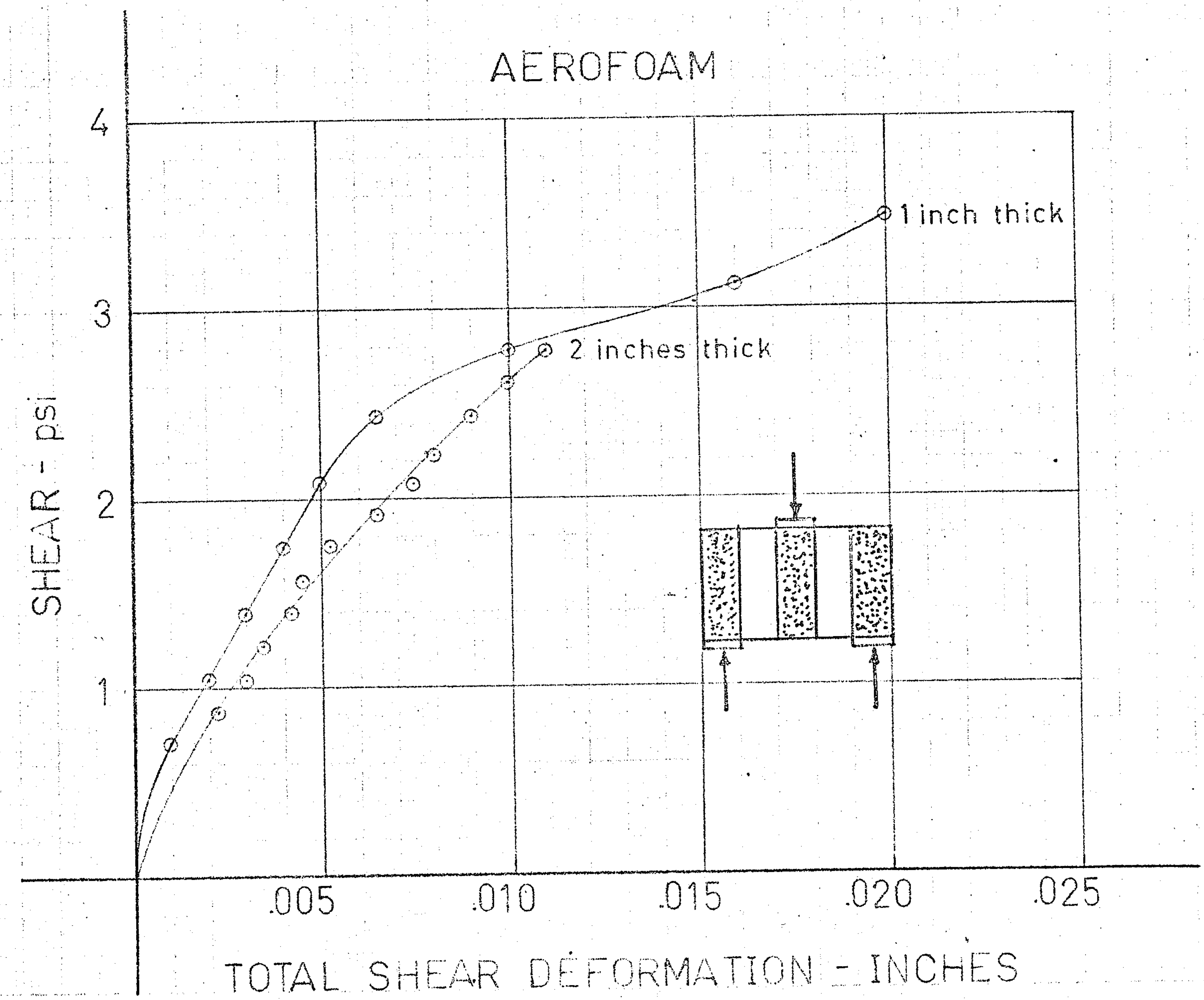
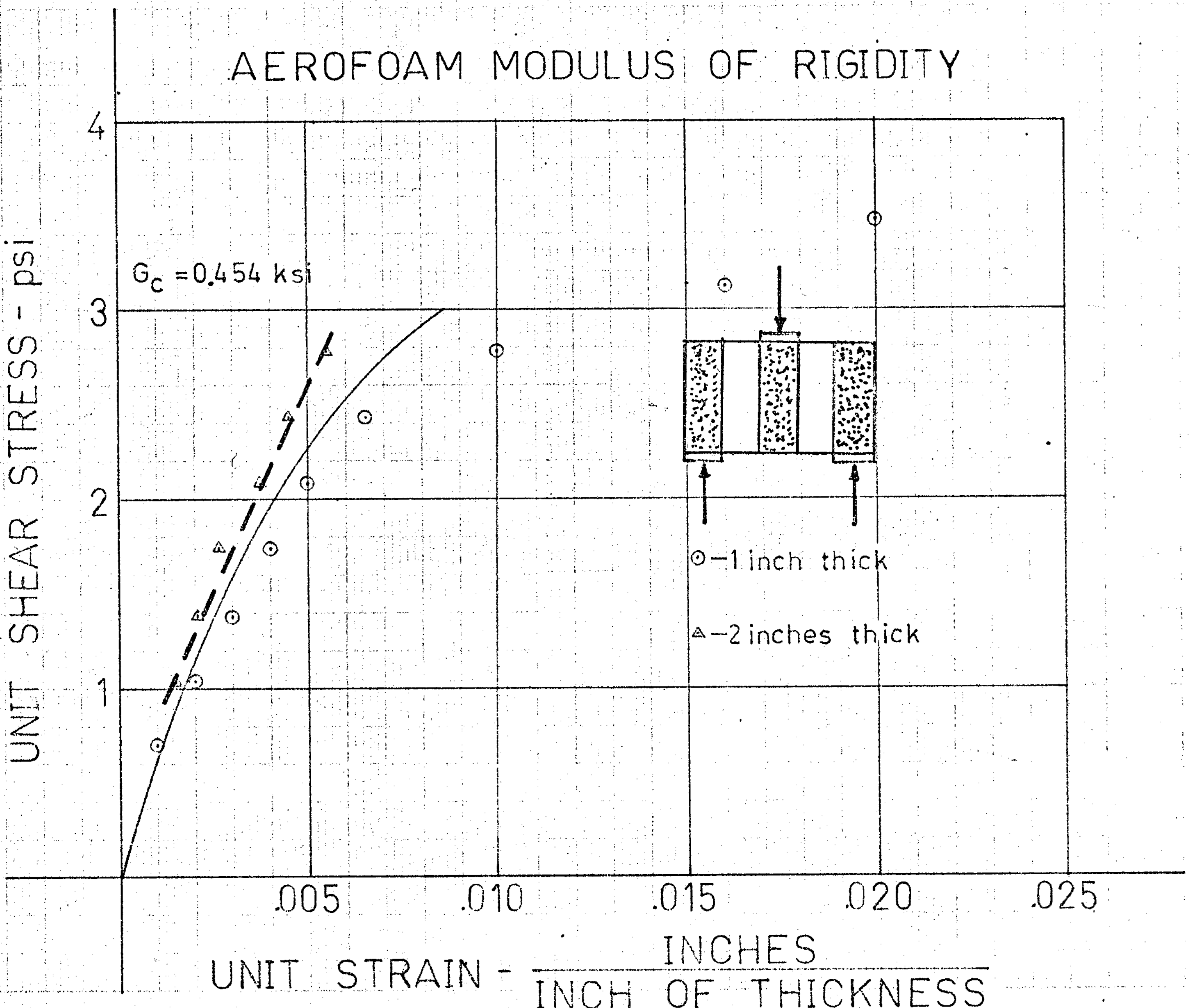

AEROFOAM
1 inch thick
2 inches thick
SHEAR - psi
4
3
2
1
.005
.010
.015
.020
.025
TOTAL SHEAR DEFORMATION - INCHES

FIG. 3.



AEROFOAM MODULUS OF RIGIDITY
G_c =0.454 ksi
⊙–1 inch thick
△–2 inches thick
UNIT SHEAR STRESS - psi
1
2
3
4
.005
.010
.015
.020
.025
UNIT STRAIN - INCHES / INCH OF THICKNESS

FIG 4

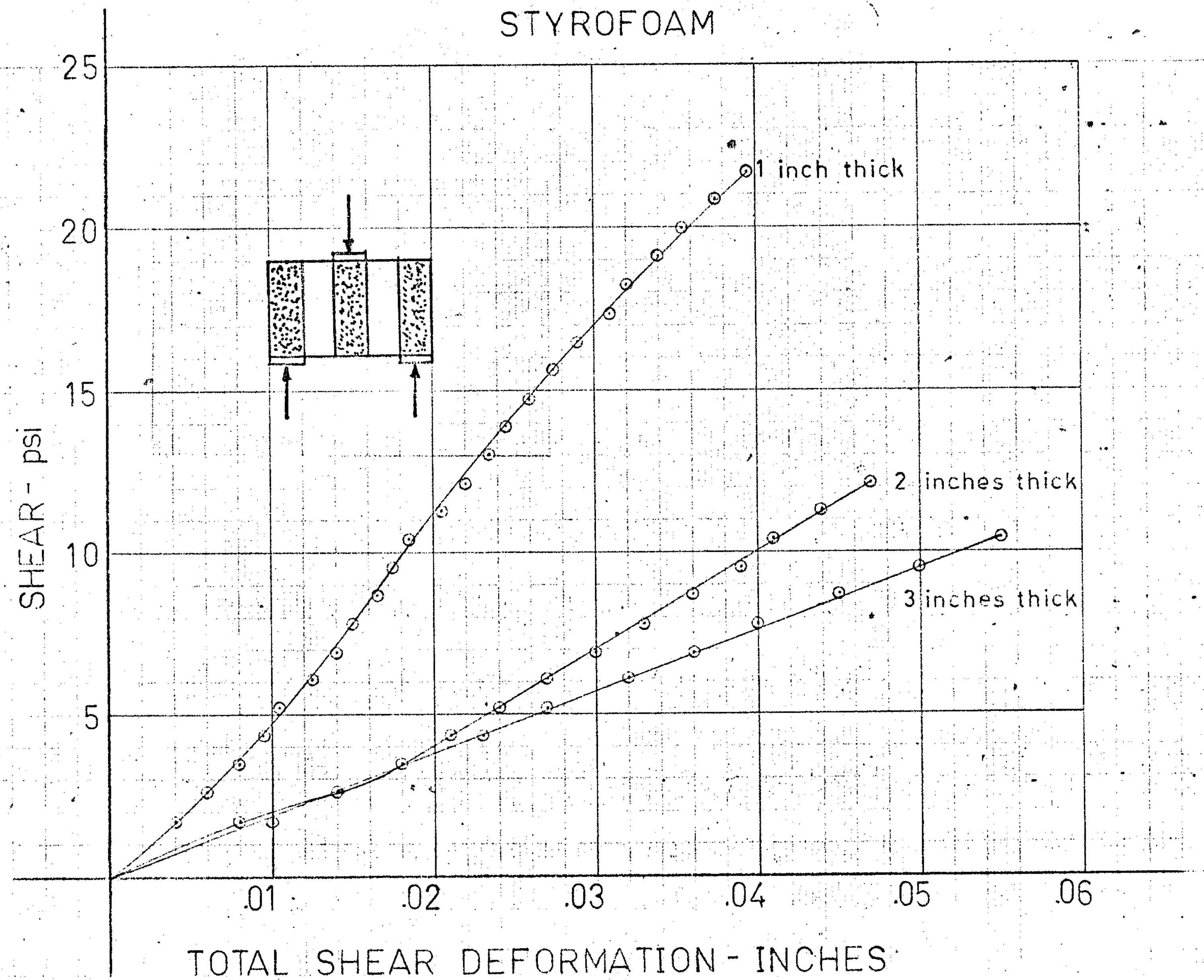
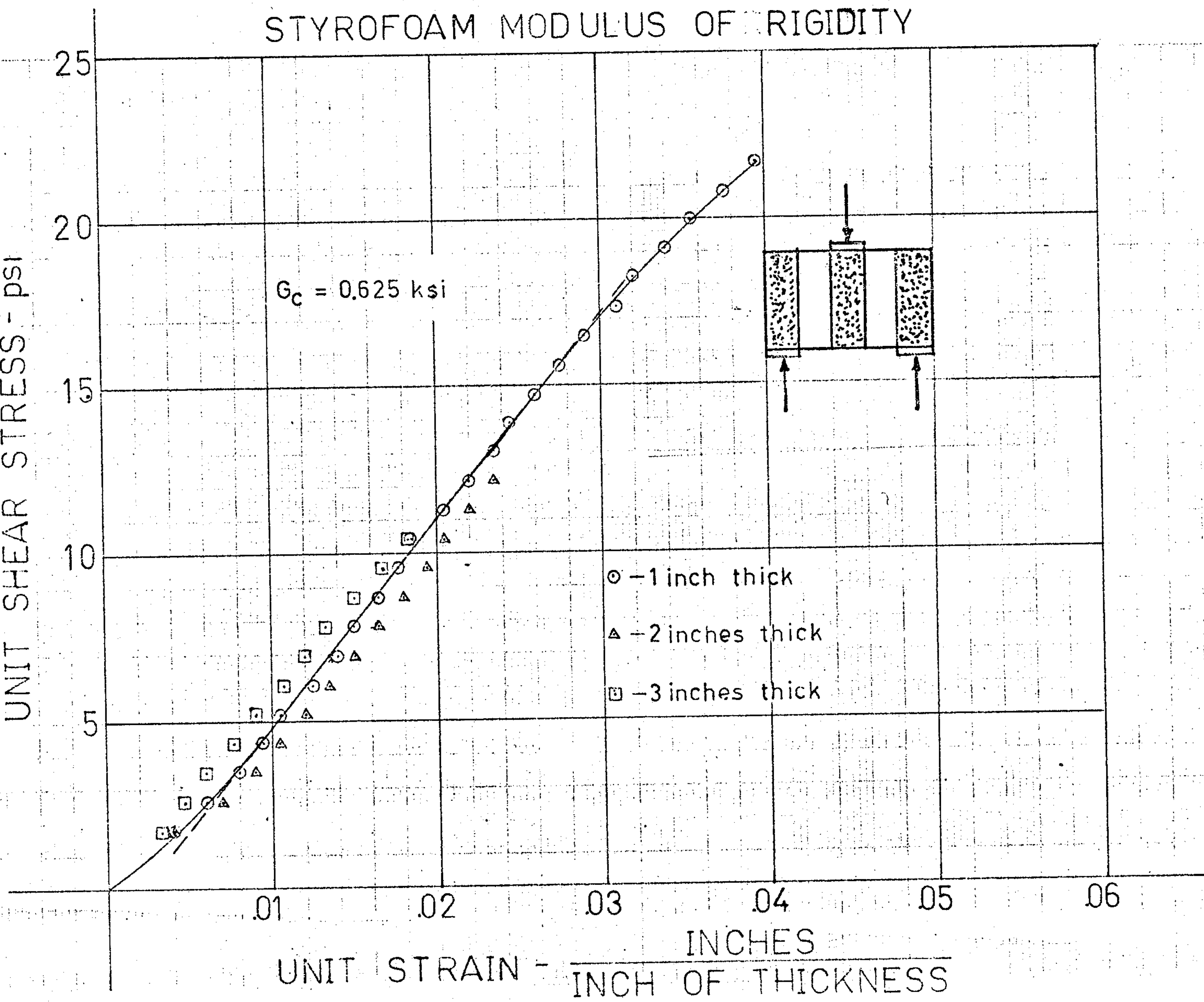

STYROFOAM
25
20
15
10
5
SHEAR - psi
.01
.02
.03
.04
.05
.06
TOTAL SHEAR DEFORMATION - INCHES
1 inch thick
2 inches thick
3 inches thick

FIG. 5.



STYROFOAM MODULUS OF RIGIDITY
25
20
15
10
5
UNIT SHEAR STRESS - psi
G_c = 0.625 ksi
⊙ –1 inch thick
△ –2 inches thick
⊡ –3 inches thick
.01
.02
.03
.04
.05
.06
UNIT STRAIN - INCHES / INCH OF THICKNESS

FIG. 6.

IV. TESTING APPARATUS AND PROCEDURE

4.1 Testing Apparatus

The panels were tested in a testing frame with a 200,000 lb. hydraulic jack and pressure guage to apply the load. The jack and pressure guage were calibrated against a 200,000 lb. universal testing machine, the results of which can be seen in fig. 7. The testing frame had a fixed WF beam, against which the top of the panels were loaded, and a movable WF beam which sat on the hydraulic jack. The apparatus can be seen in fig. 8.

4.2 Testing Procedure

The movable WF beam was placed on top of the hydraulic jack and, in order to facilitate loading the panel into the frame, it was rigidly fixed to the frame by means of two angle irons and four C - clamps. A piece of 1/8 inch hardboard, cut the length of the WF beam and approximately $\frac{1}{2}$ inch wider than the load bearing face, was then clamped to the WF beam, directly over its center. The panels were then tilted into the frame (manually for the 8 and 10 foot panels, and with the aid of a hydraulic fork lift for the 12 foot panels (plate 4)). The panels were placed so as to have the center of the load bearing face as close as possible over the center of the hydraulic jack and hardboard. This was done by marking the center of the movable WF beam with a felt pen and then leveling the WF beam along its length and width before clamping it to the test frame. An identical piece of hardboard was placed at the top of the panel, on the load bearing face, and the movable WF beam was unclamped from the test frame. The panel was then leveled vertically along its length and thickness with a 3 foot carpenter's level, and the jack was pumped up so that the panel was just bearing on the top piece of hardboard.

Six dial guages, each reading to 0.001 inches, were placed on the panel. One guage each, was placed at the top and bottom of both faces, 6 inches in from each edge. The other two were placed at the center of each face. The guages were rigidly attached to the frame with magnetic bases so that they would not move during the test itself (plate 5). They were then zeroed and the test started.

The panel was loaded until the hydraulic pressure guage reached its first reading of 400 psi, or an actual load of 10 kips. All guages were read and the findings recorded. The load was increased in increments of 200 psi on the hydraulic pressure guage, or a little over 4 kips of actual load, until it appeared that failure was imminent. At this point the guages were removed and the panel was loaded until it failed.

A graph of centerline lateral deflection versus stress on the load bearing face was drawn for each panel tested. The graphs were set up such that if the load bearing face deflected inwards, towards the non-load bearing face, the graph would run from left to right. The graphs run from right to left if the load bearing face deflected outwards, away from the non-load bearing face. The centerline delamination of the panel is also shown on the graphs. The plus sign indicates an actual separation of the core from the load bearing face and the minus sign indicates an actual compression of the "Aerofoam" center core.

CALIBRATION OF HYDRAULIC JACK AND PRESSURE GAUGE AGAINST 200,000 lb UNIVERSAL TESTING MACHINE

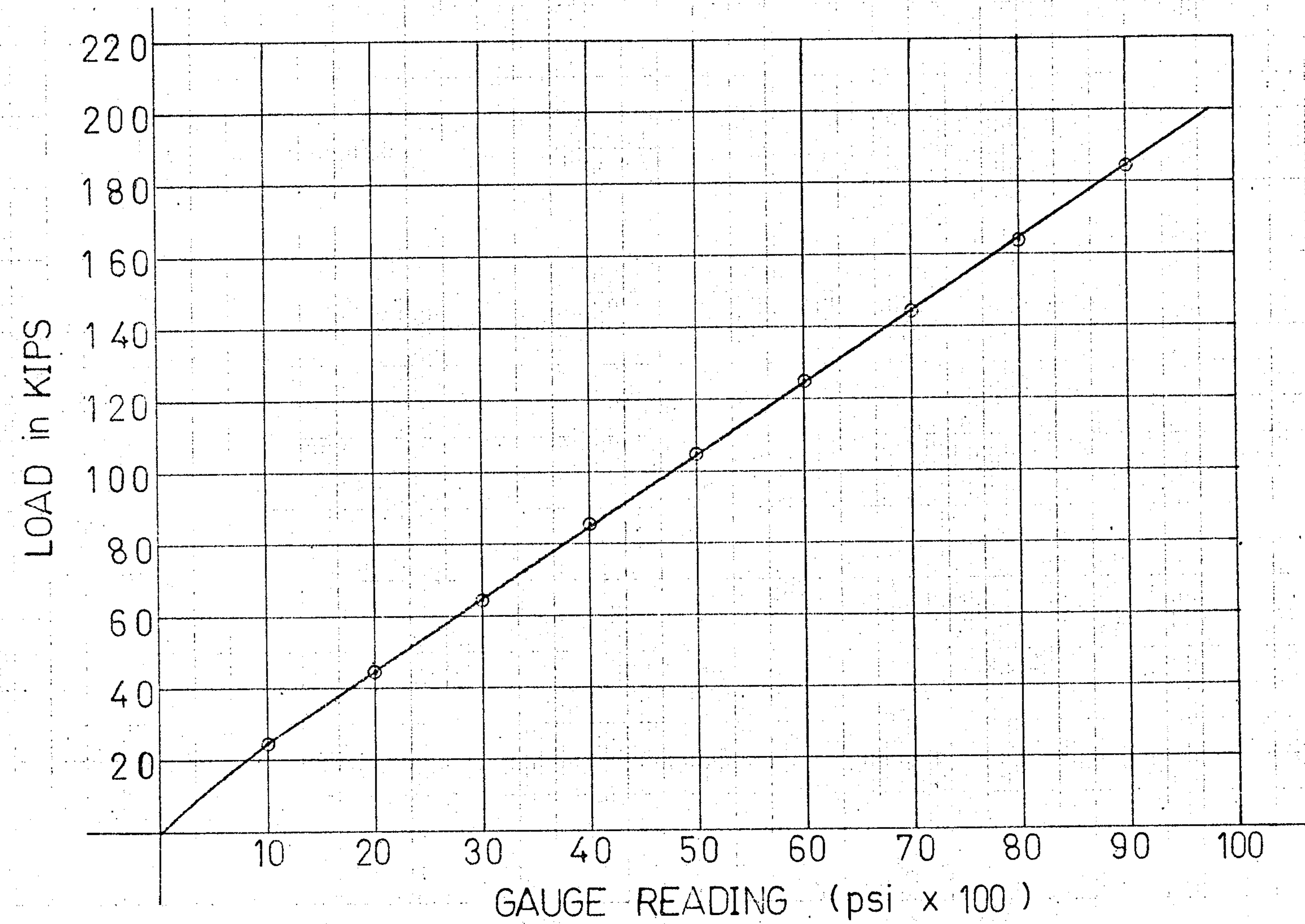


FIG. 7.

TESTING ARRANGEMENT in
200,000 lb TESTING FRAME

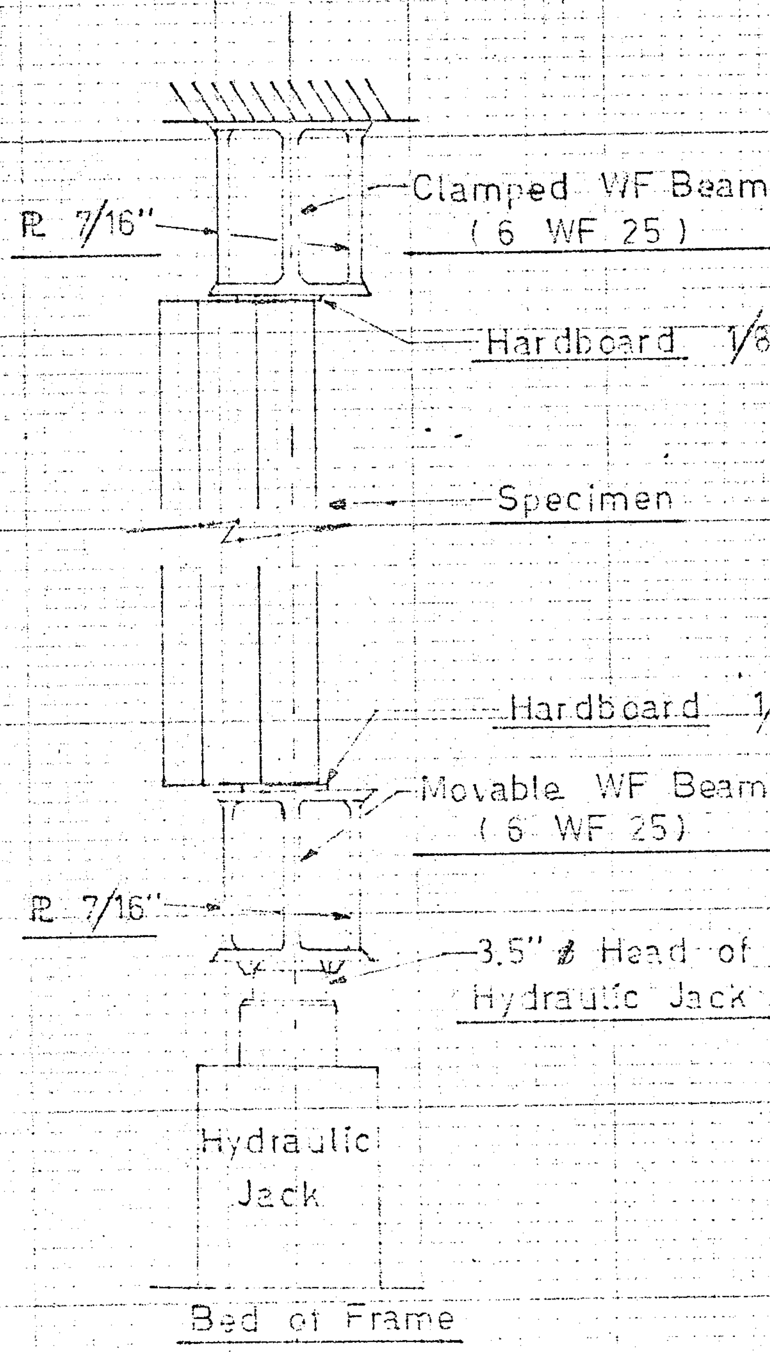


FIG. 8.

V. PREDICTION OF LOAD CARRYING ABILITIES

Since load bearing sandwich panels are a relatively new innovation in the Canadian-American construction field, there are very few publications available which deal with their behaviour. The ACI Publication SP - 11, Symposium on Precast Concrete Wall Panels[1], presents the following:

"Precast wall panels used as bearing walls or columns loaded in plane of panel—The allowable direct compressive stress in the concrete for concentric loads, based on working stress design, should not exceed the following for normal weight concrete:

$$F_a = 0.2 f'_c \left[1 - \left(\frac{h}{40\ t_e} \right)^3 \right]$$

where h = Height or distance (span) between supports (in.)

and t_e = Effective thickness of precast wall (in.)"

As has been stated, this formula was not intended for sandwich panels but rather for load bearing walls. Since this thesis deals with the load bearing abilities of sandwich panels, it was decided to apply the formula to the panels tested. The panels in question were loaded on one face only. Using the thickness of the load bearing face, as t_e in the formula, will result in a negative F_a for $\frac{h}{t_e}$ ratios greater than 40. The $\frac{h}{t_e}$ ratios, for all the panels with 2 inch load bearing faces, are greater than 40. The results of using the thickness of the load bearing face as t_e in the formula are given in Table 1. A more meaningfull F_a results if the entire thickness of the panel is used as t_e, or if the entire concrete thickness is used as t_e. These results are also shown in Table 1.

Dr. E. Krynicki, as part of this overall study sponsored by the Canadian Prestressed Concrete Institute, prepared an unpublished paper at the University of Manitoba, on theoretical equations for the critical load on sandwich panels. His equations were based on panels having the same thickness for the bearing and non-bearing faces. Since the test panels used did not have the same thickness for the bearing and non-bearing faces, some changes had to be made in the equation. His equation reads:

$$P_{cr} = \frac{(n\pi)^2 D S}{Sl^2 + (n\pi)^2 D}$$

in which:

P_{cr} = critical load per inch of width (kips/in.)

$D = \frac{B}{1 - V^2}$

$S = \frac{(c + t)^2}{c} G_c$

V = Poisson ratio

l = length or height of panel (in.)

B = Bending stiffness of panel

G_c = Modulus of rigidity of core

c = core thickness (in.)

t = face thickness (in.)

Equations for the bending stiffness B were found in Frederik J. Plantema's book, Sandwich

Construction[2]. These were:

$$B_c = \tfrac{1}{2} E_f \, t(c + t)^2 \qquad \text{core}$$

$$B_f = 1/12 \, E_f t^3 \qquad \text{face}$$

$$B_t = B_c + 2B_f \qquad \text{total}$$

where E_f = Modulus of elasticity of the concrete faces

These equations were also based on panels having the same thickness for bearing and non-bearing faces. The author, in conjunction with Dr. A. M. Lansdown, Head of the Dept. of Civil Engineering, University of Manitoba, modified these equations so that they would be applicable to panels in which the bearing and non-bearing thicknesses were not the same. The derivation is simply an extension of that used in the book[2] and the following equations result:

$$B_{f_1} = 1/12 \, E_f \, t_1^3 \qquad \text{face of thickness } t_1$$

$$B_{f_2} = 1/12 \, E_f \, t_2^3 \qquad \text{face of thickness } t_2$$

$$B_c = 1/8 \, E_f \left[2C^2 t_2 + 3C t_2^2 + 2C^2 t_1 + 3C t_1^2 + 2C t_1 t_2 + t_1 t_2^2 + t_1^3 + t_2^3 + t_1^2 t_2 \right] \qquad \text{core}$$

Upon substitution of $t_1 = t_2 = t$, the preceding equation becomes:

$$B = \tfrac{1}{2} E_f \, t(c + t)^2$$

$$B_t = B_c + B_{f_1} + B_{f_2} \qquad \text{total}$$

also S becomes $\dfrac{C + \left(\dfrac{t_1 + t_2}{2}\right)^2}{C} G_c$

The modulus of rigidity of the core, G_c, was obtained from tests described in sect. 3.3. From the graph fig. 4, G_c is approximately equal to 0.454 ksi.

The equation for the modulus of elasticity of the concrete faces, E_f, came from ACI 318 - 63 sect. 1102 a[3], which states:

$$E = w^{1.5} \, 33 \, f'_c \quad \text{psi}$$

for normal weight concrete this becomes,

$E = 57.4 \, f'_c$ ksi

The value of Poisson[4] ratio used was 0.15. Poisson ratios of 0.1 and 0.2 were also used in the equation to see what effect the change would have on the final f_{cr}, where $f_{cr} = P_{cr} / t_b$. The change in f_{cr} for V from 0.1 to 0.2 was less than 6 psi in all cases.

The value of n used was 1.

Table 1

PANEL	STEEL RATIO	HEIGHT (in)	THICKNESS BEAR. (in)	THICKNESS TOTAL (in)	f'_c (psi)	f_{ult} (psi)	$\frac{f_{ult}}{f'_c}$	$\frac{h}{t_{bear.}}$	F_a bear. (psi)	$\frac{h}{t_c}$	F_a conc. (psi)	$\frac{f_{ult}}{F_{a\,conc.}}$	$\frac{h}{t_{total}}$	F_a total (psi)	$\frac{f_{ult}}{F_{a\,total}}$	f_{cr} (psi)	$\frac{f_{ult}}{f_{cr}}$
9 - 1	Min	96	2	5.5	6440	2265	.352	48	- 935	27.43	872	2.60	17.45	1180	1.92	1524	1.49
9 - 2	Min	96	2	5.5	5360	2350	.438	48	- 780	27.43	726	3.24	17.45	984	2.39	1517	1.55
9 - 3	Min	96	2	5.5	5740	2015	.351	48	- 834	27.43	777	2.59	17.45	1052	1.91	1520	1.32
10- 1	Min	96	4	7.5	5800	2685	.463	24	907	17.45	1062	2.53	12.80	1122	2.39	1247	2.15
10- 2	Min	96	4	7.5	4385	3505	.798	24	686	17.45	805	4.35	12.80	848	4.13	1243	2.51
10- 3	Min	96	4	7.5	6150	3765	.612	24	963	17.45	1128	3.34	12.80	1189	3.16	1248	3.01
8 - 1	Min	120	2	5.5	5320	2770	.521	60	-2525	34.30	483	5.74	21.81	892	3.10	1476	1.88
8 - 2	Min	120	2	5.5	7930	2855	.360	60	-3765	34.30	720	3.96	21.81	1330	2.15	1496	1.90
8 - 3	Min	120	2	5.5	5810	2100	.362	60	-2760	34.30	528	3.97	21.81	975	2.15	1481	1.42
5 - 1_1	Min	120	4	7.5	7220	3850	.533	30	834	21.81	1209	3.19	16.00	1351	2.85	1235	3.12
5 - 1_2	Min	120	4	7.5	7220	3635	.510	30	834	21.81	1209	3.01	16.00	1351	2.69	1235	2.93
5 - 2	Min	120	4	7.5	7360	4090	.555	30	472	21.81	1232	3.32	16.00	1378	2.97	1235	3.30
5 - 3	Min	120	4	7.5	7430	2885	.389	30	333	21.81	1242	2.32	16.00	1391	2.07	1235	2.34
7 - 1	2XMin	120	2	5.5	5450	2350	.431	60	-2590	34.30	495	4.75	21.81	914	2.57	1477	1.59
7 - 2	2XMin	120	2	5.5	5980	2680	.448	60	-2840	34.30	543	4.93	21.81	1002	2.67	1482	1.81
7 - 3	2XMin	120	2	5.5	7505	2180	.290	60	-3565	34.30	681	3.20	21.81	1258	1.73	1494	1.46
4 - 1	2XMin	120	4	7.5	5980	2885	.482	30	691	21.81	1001	2.88	16.00	1120	2.57	1230	2.34
4 - 2	2XMin	120	4	7.5	5630	2275	.404	30	649	21.81	943	2.41	16.00	1052	2.16	1229	1.85
4 - 3	2XMin	120	4	7.5	5660	3720	.656	30	654	21.81	948	3.92	16.00	1060	3.51	1229	3.02
6 - 1	3XMin	120	2	5.5	5200	3975	.764	60	-2470	34.30	472	8.42	21.81	872	4.56	1475	2.69
6 - 2	3XMin	120	2	5.5	6340	3560	.562	60	-3005	34.30	575	6.19	21.81	1046	3.40	1485	2.39
6 - 3	3XMin	120	2	5.5	4455	1180	.265	60	-2120	34.30	404	2.92	21.81	746	1.58	1466	0.81
3 - 1	3XMin	120	4	7.5	4070	2030	.498	30	470	21.81	681	2.98	16.00	761	2.67	1220	1.66
3 - 2	3XMin	120	4	7.5	5480	2195	.400	30	633	21.81	918	2.39	16.00	1026	2.14	1228	1.78
3 - 3	3XMin	120	4	7.5	8060	2935	.363	30	931	21.81	1350	2.17	16.00	1510	1.94	1237	2.37
1 - 1	Min	144	2	5.5	5275	2515	.477	72	-5100	41.20	- 93		26.20	760	3.31	1428	1.76
1 - 2	Min	144	2	5.5	6975	2680	.384	72	-6740	41.20	-123		26.20	1004	2.67	1448	1.85
1 - 3	Min	144	2	5.5	6090	2680	.440	72	-5880	41.20	-107		26.20	876	3.00	1439	1.86
2 - 1	Min	144	4	7.5	7150	3420	.478	36	388	26.20	1027	3.33	19.20	1272	2.69	1215	2.81
2 - 2_1	Min	144	4	7.5	5275	3850	.730	36	386	26.20	757	5.08	19.20	939	4.10	1205	3.19
2 - 2_2	Min	144	4	7.5	5275	3805	.721	36	286	26.20	757	5.02	19.20	939	4.10	1205	3.15

VI. DISCUSSION OF TESTS

6.1 Individual Panel Investigations

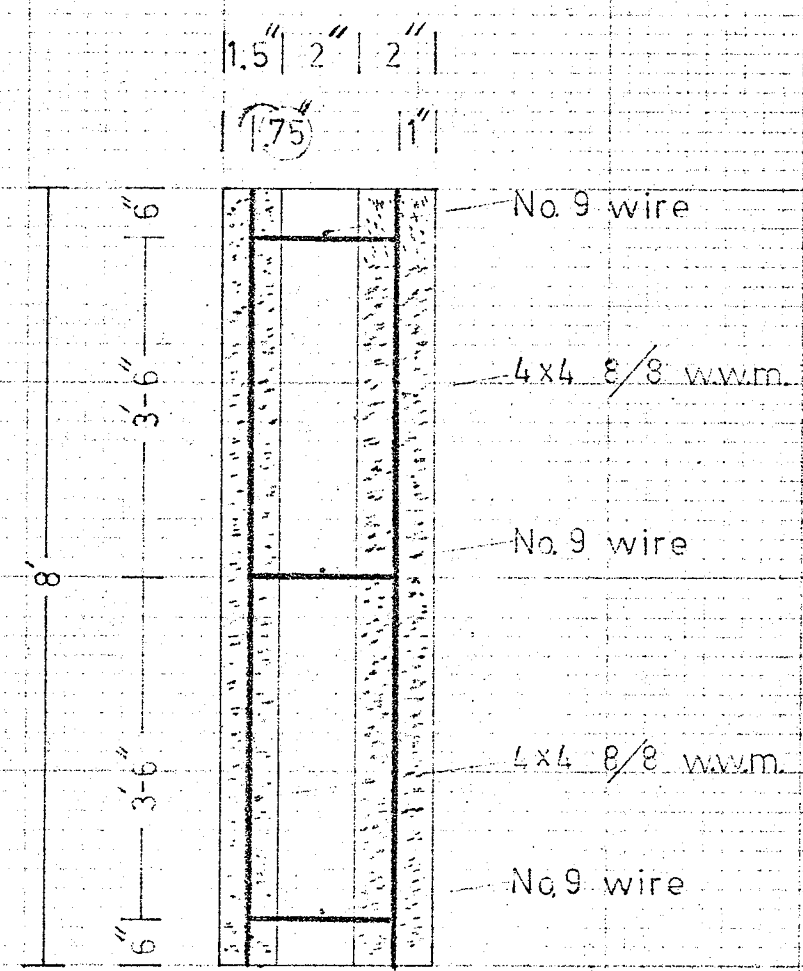
Panel 9 - 1

Refer to fig. 9 for dimensions and reinforcement, and fig. 10 for load-strain characteristics.

As the load was applied the panel started to deflect outwards, so that the outside surface of the load bearing face was being put into tension due to the lateral deflection. The panel started to creep slowly and the applied load began to drop off slowly as the stress neared 1.0 ksi. At a stress of 2.0 ksi (i.e. a load of 48 kips), the deflection continued while the load dropped off by approximately 8.5 kips. It was apparent that failure was imminent. The panel was loaded to 54 kips, or 2.26 ksi stress, at which time the loading was stopped and the panel was observed. The deflection increased for a period of about 15 minutes while the load dropped off and remained steady at

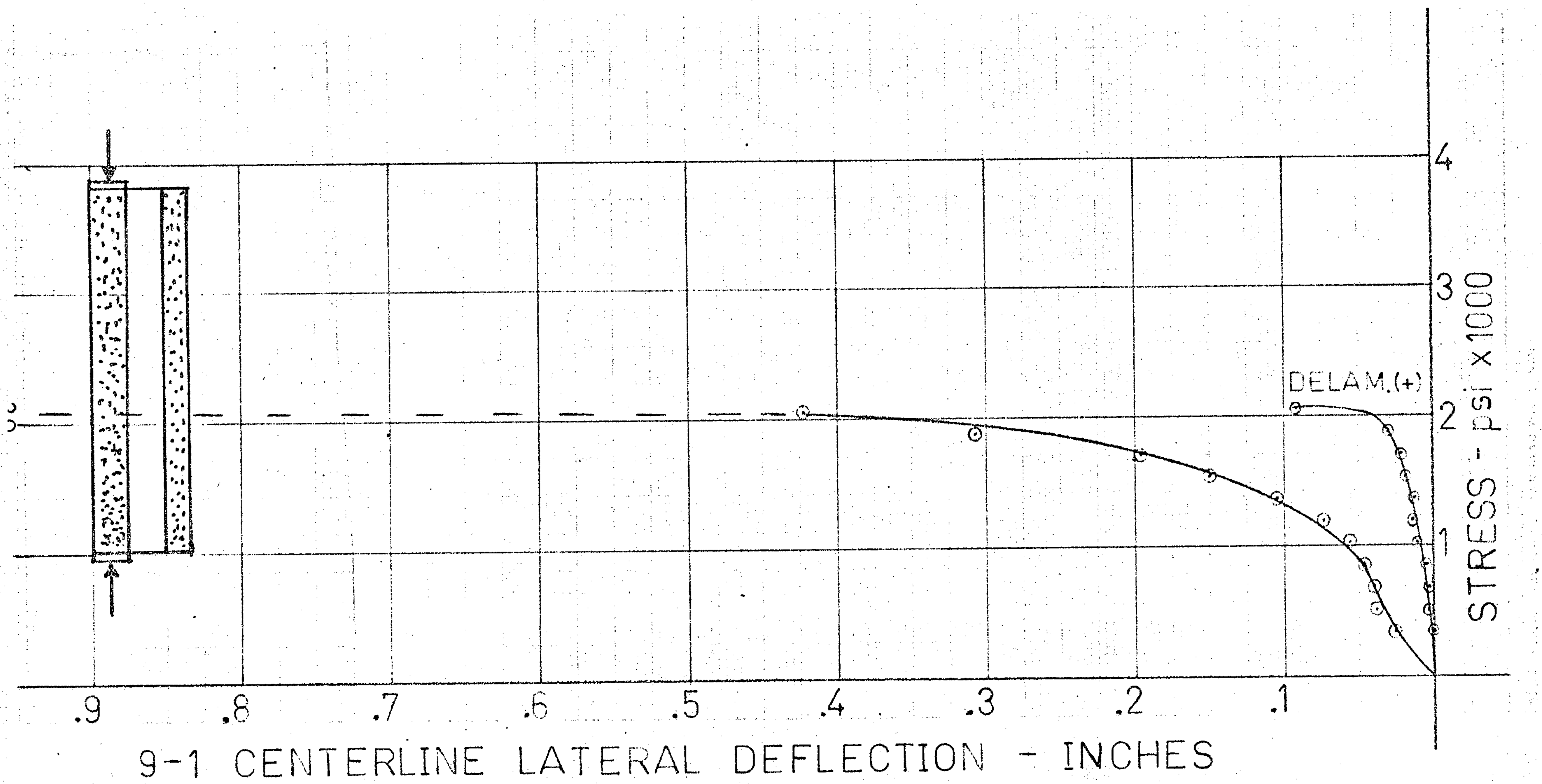
37.4 kips, or 1.56 ksi stress. The first cracks appeared on the panel during this 15 minute period. Four cracks were noticed on the load bearing face, slightly above the center of the panel. The panel was still deflecting slowly when the last readings were taken and the guages removed. The center of the panel had deflected more than an inch during the 15 minutes. The load was then increased very quickly. It reached 48 kips or 2.0 ksi stress, at which point the panel failed by buckling. Delamination of the load bearing face from the center core and non-load bearing face was visible for about 18 inches on both sides of the failure crack. The only crack on the non-load bearing face appeared at failure, at the center of the panel.

Group—9



1.5"
2"
2"
1.75"
1"
8'
6"
3'-6"
3'-6"
6"
No. 9 wire
4x4 8/8 w.w.m.
No. 9 wire
4x4 8/8 w.w.m.
No. 9 wire

FIG. 9.



DELAM.(+)
4
3
2
1
STRESS - psi x1000
.9
.8
.7
.6
.5
.4
.3
.2
.1
9-1 CENTERLINE LATERAL DEFLECTION - INCHES

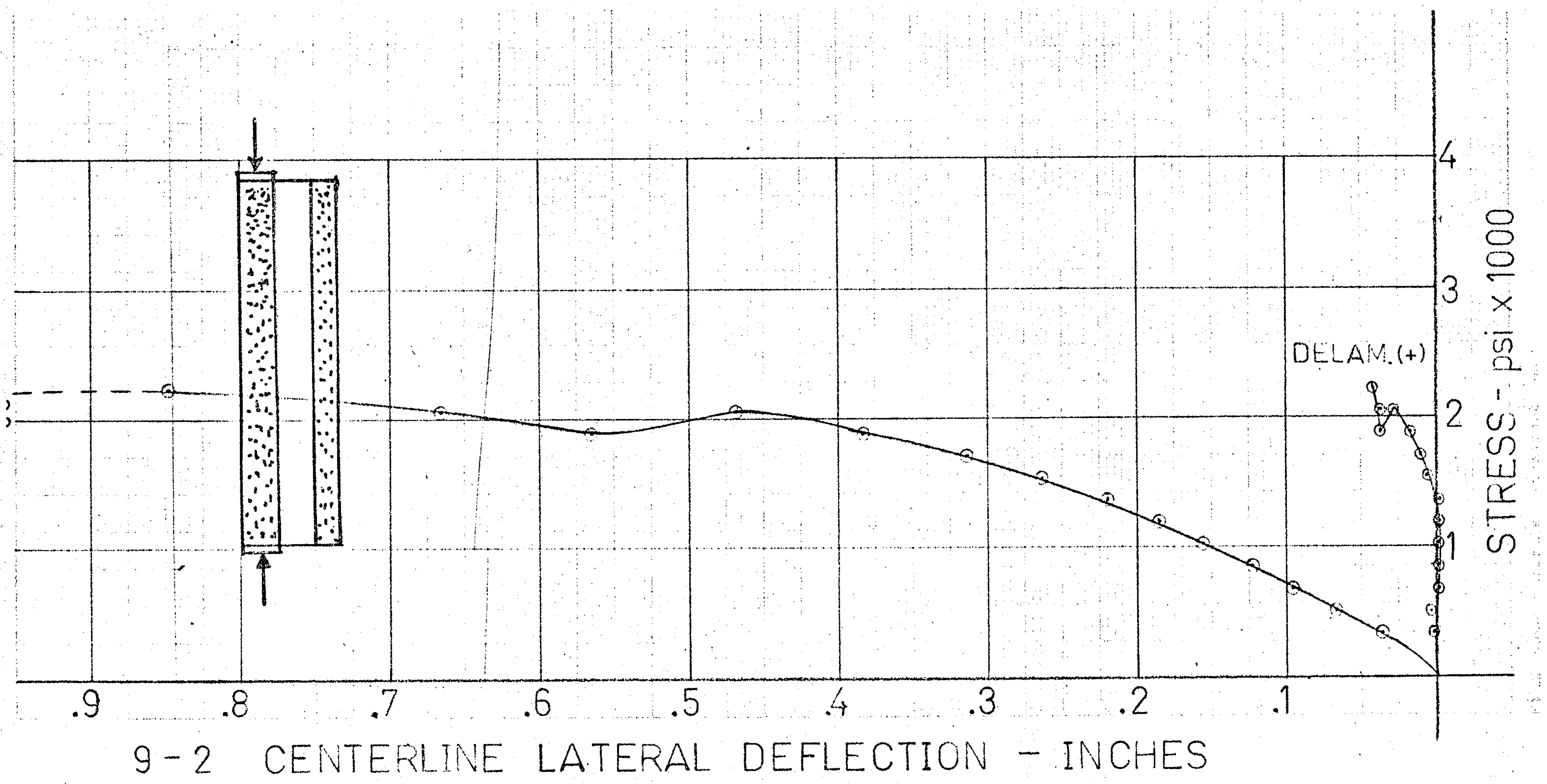
FIG. 10.

Panel 9 - 2

Refer to fig. 9 for dimensions and reinforcement, and fig. 11 for load-strain characteristics.

As the load was applied the panel started to deflect outwards so that the outside surface of the load bearing face was being put into tension due to the lateral deflection. The panel started to creep slowly and the applied load started to drop off slowly as the load approached 44 kips, or 1.80 ksi stress. The load was increased in 4 kips increments to 52 kips or 2.10 ksi stress, at which point the loading was stopped and the panel observed for more than two hours. During this time the load dropped off to 47.4 kips, or 1.97 ksi stress, and the panel deflected approximately 0.11 inches. The loading was increased first to 52.4 kips and then to 56.3 kips, as the deflection continued to increase. The panel was allowed to stand and the load dropped off to 48.4 kips in about 10 minutes. The deflection increased as the load dropped off.

The panel was again loaded to 52.4 kips, at which time the deflection increased very rapidly, while the load dropped off quickly. The hydraulic jack was continuously pumped to try and maintain a load of 52.4 kips, or 2.10 ksi stress, when the panel broke. A horizontal tension crack appeared 6 inches below the center of the panel immediately before failure, and the panel broke at this crack. The non-load bearing face did not crack through entirely. A separation of the "Aerofoam" and non-load bearing face from the load bearing face was visible for more than 2 feet on either side of the failure crack (plate 6).



4
3
2
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STRESS - psi x 1000
DELAM.(+)
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.8
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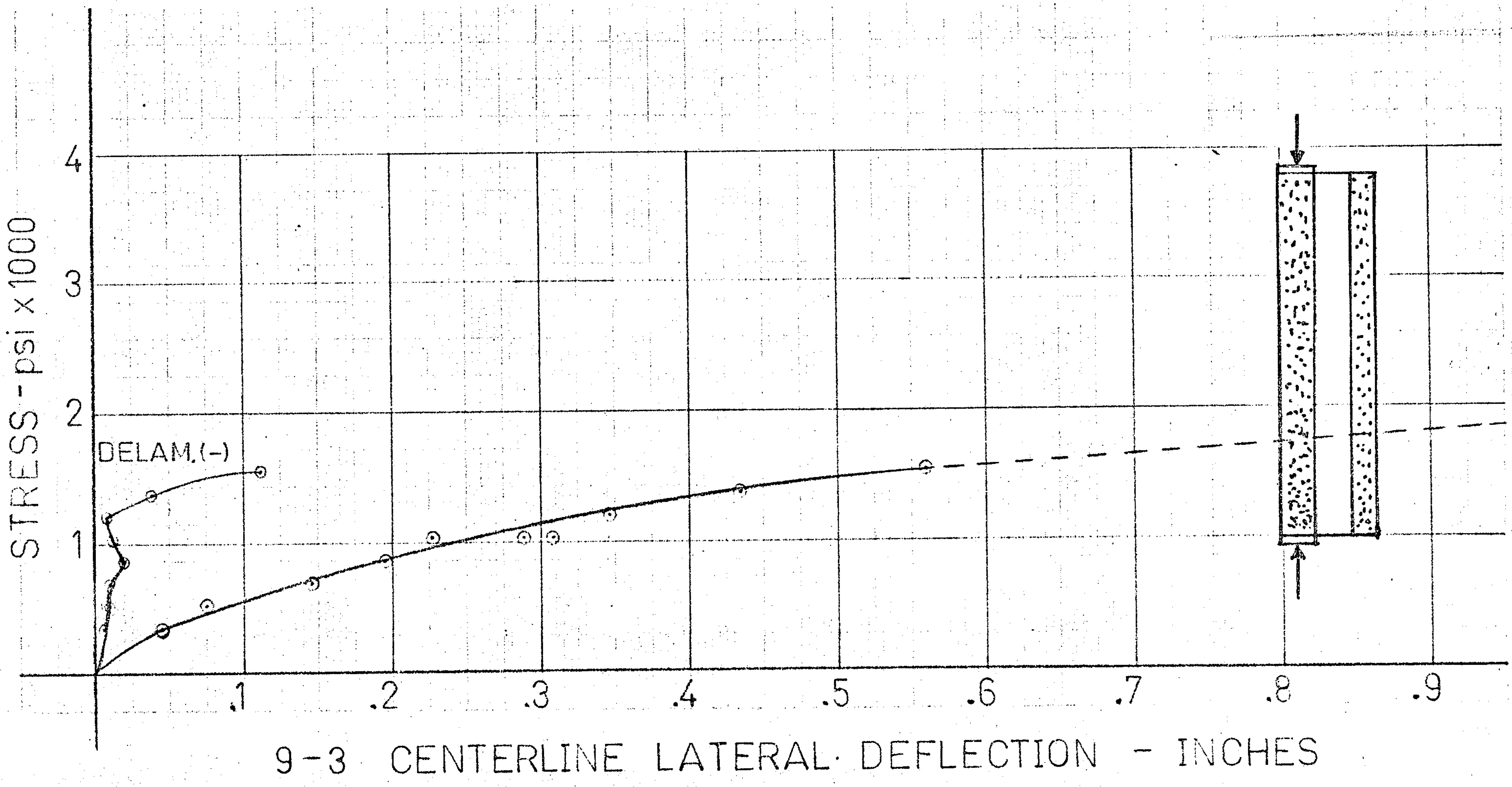
9 - 2 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 11.

Panel 9 - 3

Refer to fig. 9 for dimensions and reinforcement, and fig. 12 for load-strain characteristics.

As the load was applied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression due to the lateral deflection. The load was holding fairly steadily but the center guages started to creep as the applied load reached 24 kips, or 1.0 ksi stress. As the load approached 30 kips, or 1.25 ksi stress, a partial delamination failure occured when the bottom 3 feet of the panel separated. The non-load bearing face and "Aerofoam" broke from the load bearing face. The load dropped off to about 27 kips and remained steady as the deflection increased slowly. Two tension cracks appeared on the non-load bearing face—one 2 inches below the center and the other 22 inches above the center. The load was then increased to 40 kips, or 1.67 ksi stress, at which time another tension crack appeared on the non-load bearing face, 8 inches above the center. At a load of 44 kips, or 1.83 ksi stress the deflection of the bottom of the non-load bearing face had increased to the point at which it was being restrained by the bottom angle iron, which was clamped to the test frame. The load was increased to a little more than 48 kips, or 2.0 ksi stress, at which point the center of the non-load bearing face was being restrained from further deflection by the middle angle iron (plate 7). The load was then reduced to zero and the panel removed from the test frame. The load bearing face showed no evidence of cracking throughout the entire test.


STRESS - psi x1000
4
3
2
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DELAM.(-)
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.5
.6
.7
.8
.9
9-3 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 12.

Panel 10 - 1

Refer to fig. 13 for dimensions and reinforcement, and fig. 14 for load-strain characteristics.

As the load was applied the panel started to deflect outwards so that the outside surface of the load bearing face was being put into tension due to the lateral deflection. The load held well up until 64 kips, or 1.3 ksi stress, but the deflection had started to creep slowly at 48 kips, or 1.0 ksi stress. The panel was allowed to stand for one and a half hours at a load of 64 kips. During this time the load dropped off to about 57 kips, while the deflection increased by 0.012 inches. The panel was loaded to 101 kips, or 2.1 ksi stress before the appearance of any cracking. Two tension cracks appeared on the load bearing face at this load—one $4\frac{1}{2}$ inches long, 1 foot above the center and the other 4 inches long, 3 inches above the center. The load dropped off to 99 kips and the deflection increased 0.018 inches in the next 10 minutes. The panel was loaded to 129 kips, or 2.7 ksi stress and allowed to stand for 18 hours. The load drop-off was about 1 kip per minute for the first 5 or so minutes, along with an increase in deflection of 0.01 inches per minute. Many tension cracks appeared during this period. The load appeared to steady itself at about 103 kips during the 18 hour period. This was accompanied by a total increase in deflection of 0.455 inches. At the end of the 18 hour period the deflection and load drop-off could not be detected from the guages by eye but had to be timed. The load drop-off was 0.6 kips in 1 hour, along with an increase in deflection of 0.001 inches in 1 hour. The load was increased to 121 kips, or 2.5 ksi stress, at which point the panel failed drastically with a loud noise. It should be noted here that the failure load is lower than the previous maximum load. The bearing side cracked through, 14 inches below the center and total delamination occured between the load bearing face and the rest of the panel. There was no evidence of cracking on the non-load bearing face (plate 8).

Group -10

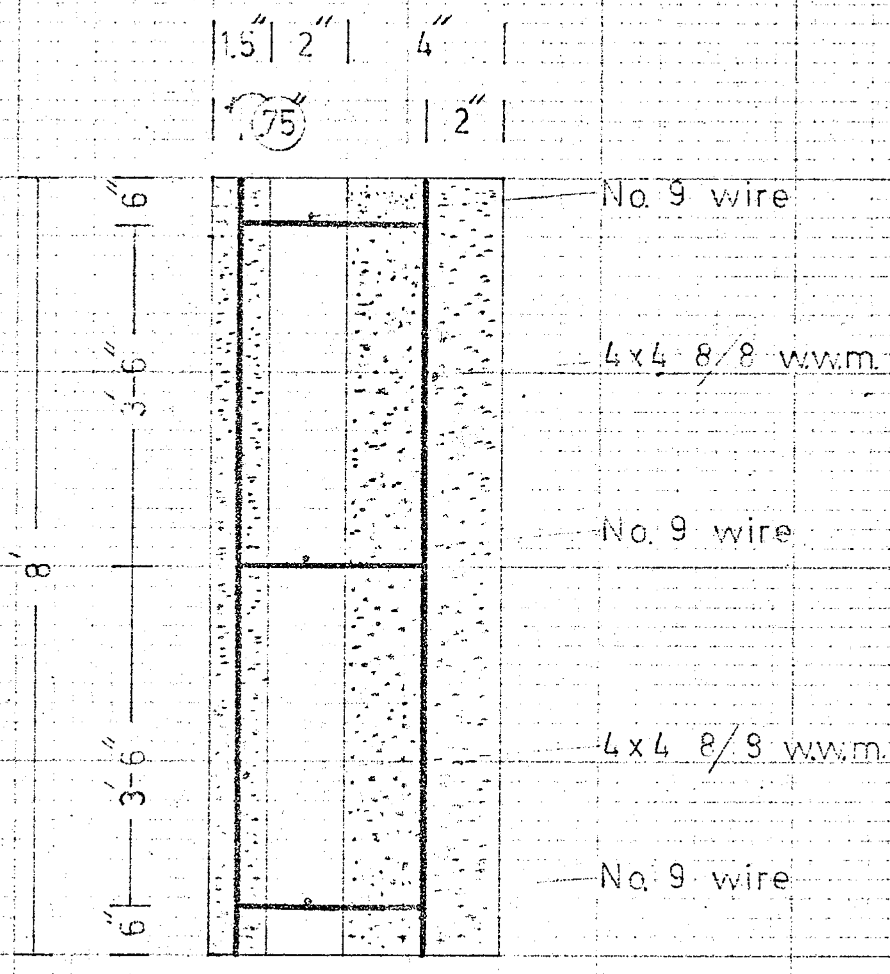
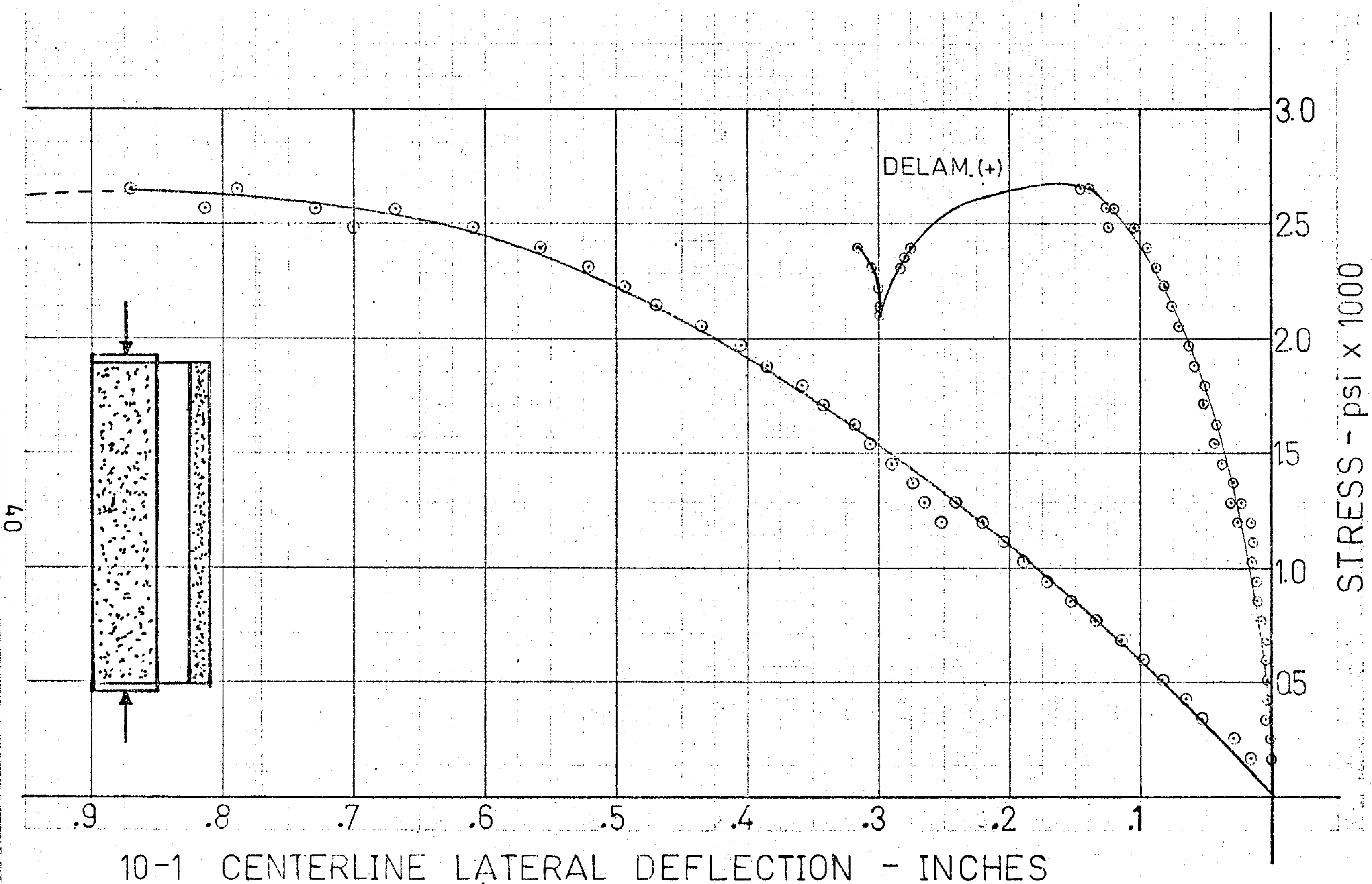


FIG. 13.



DELAM.(+)
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2.5
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STRESS - psi x 1000
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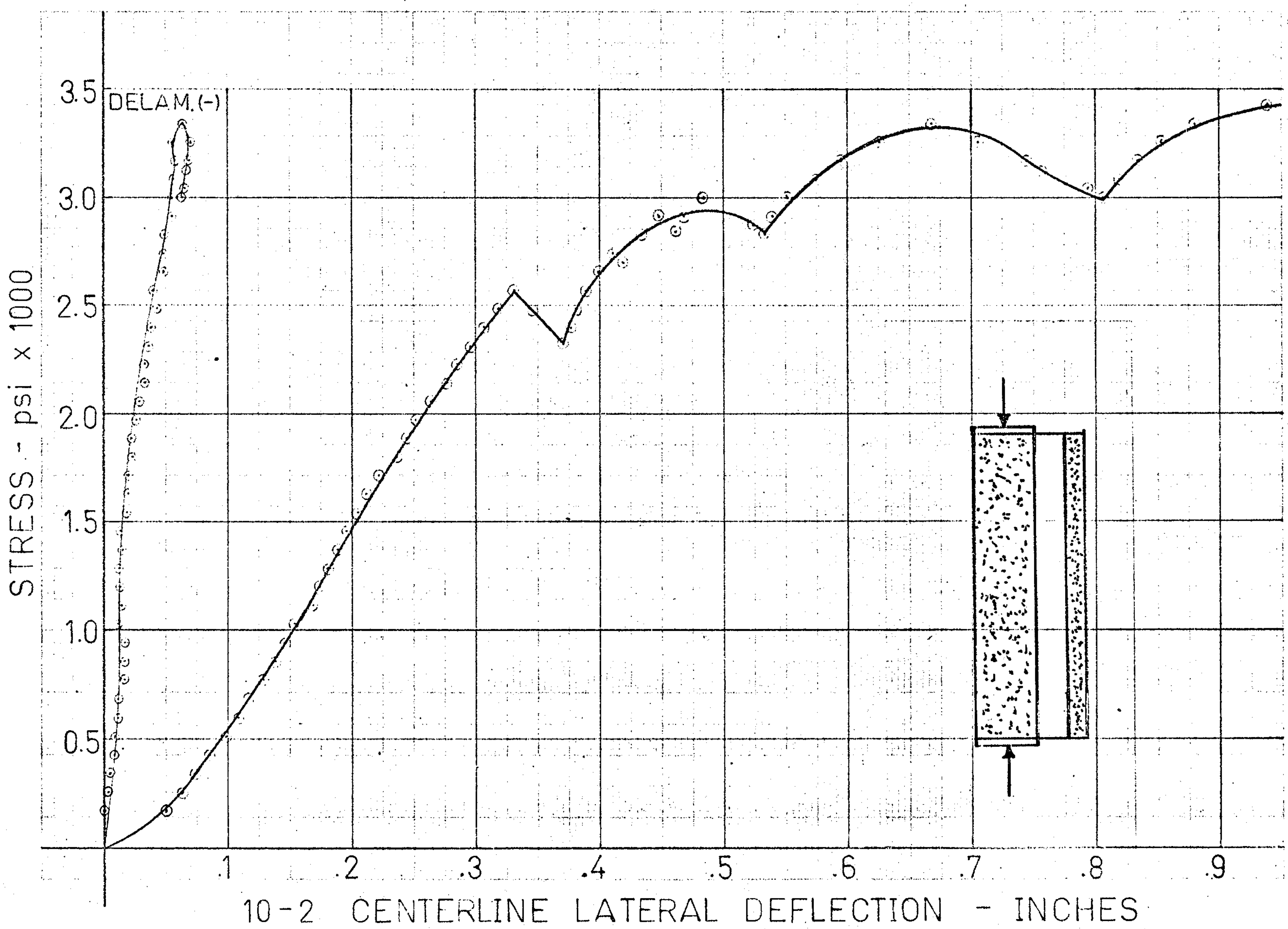
10-1 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 14.

Panel 10 - 2

Refer to fig. 13 for dimensions and reinforcement, and fig. 15 for load-strain characteristics.

As the load was applied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression due to the lateral deflection. Cracks appeared on the non-bearing tension face only as the load was increased. The first crack was noticed 1 inch up from the center, at a load of 85.4 kips. The second crack was noticed 6 inches below the center, at a load of 103 kips (plate 9). A third crack appeared 6 inches above the center, at a load of 119 kips. The load was increased to 144 kips, or 3 ksi stress when another crack appeared, 3 inches above the center. The panel was loaded to 160 kips and then observed, as the load was allowed to drop off. The deflection increased by 0.16 inches and the load dropped to 144 kips in 1 hour and 20 minutes. The panel was then reloaded very quickly to 168 kips, or 3.5 ksi stress, when failure occured. The panel cracked through, 6 inches above the center and delamination of the load bearing face from the "Aerofoam" and non-load bearing face occured from the failure crack to the bottom of the panel. Concrete on the load bearing face was blown out from 6 to 9 inches around the failure crack when the panel broke. There was one more tension crack noticed on the non-load bearing face at failure.


DELAM.(-)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
STRESS - psi x 1000
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10-2 CENTERLINE LATERAL DEFLECTION - INCHES

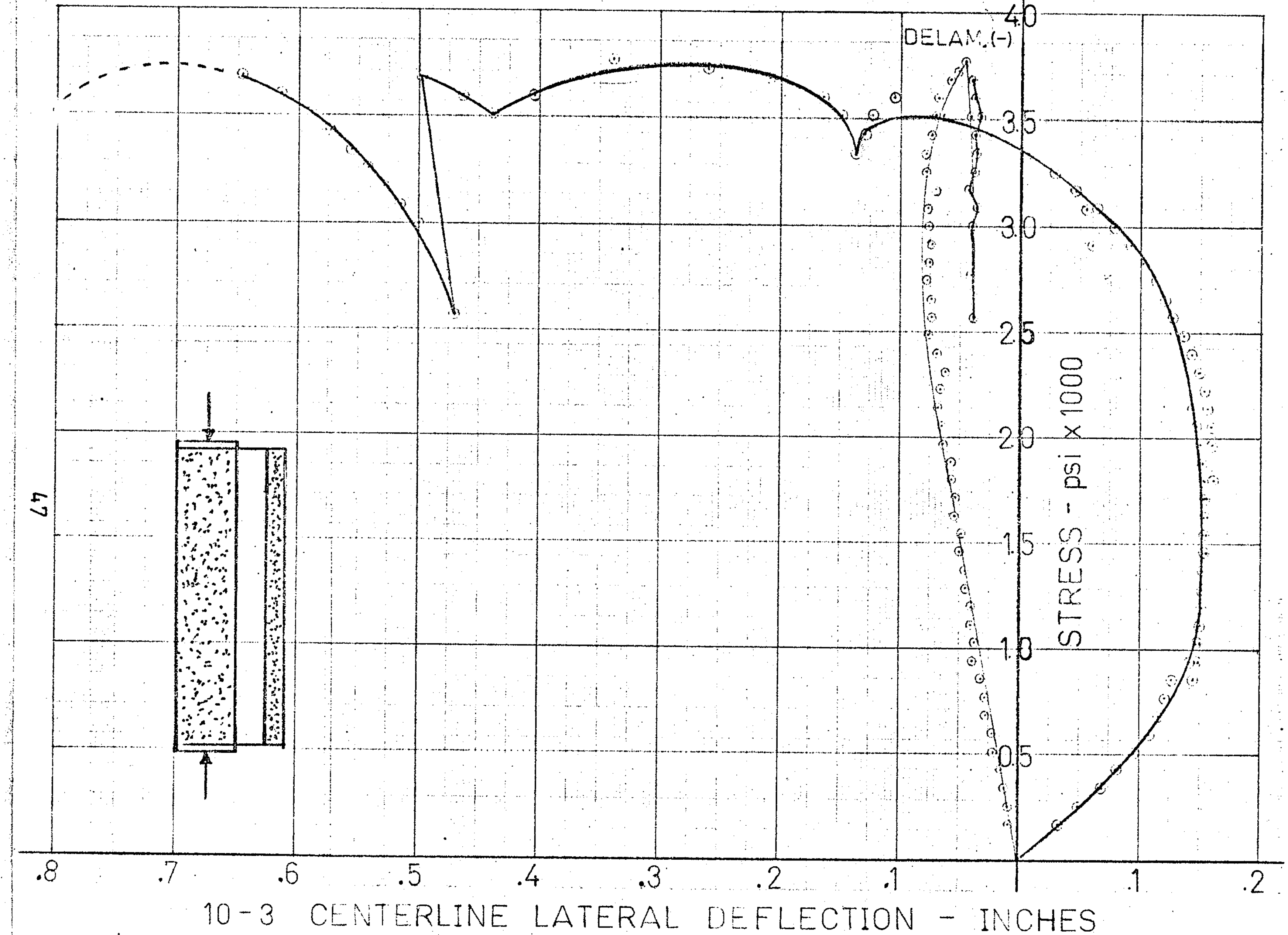
FIG. 15.

Panel 10 - 3

Refer to fig. 13 for dimensions and reinforcement, and fig. 16 for load-strain characteristics.

As the load was applied the panel started to deflect inwards, so that the outside surface of the load bearing face was being put into compresssion due to the lateral deflection. This trend continued, with a very small increase in center deflection, until a load of 48 kips, or 1 ksi stress, was reached. At this point the center deflection remained constant as further load was applied. Two tension cracks were noticed on the non-load bearing face at a load of 52 kips—one 18 inches above the center and the other 6 inches below the center. The center deflection remained constant until the loading reached 96 kips, or 2.0 ksi stress, at which point it changed direction and the center of the panel started to move back to its original position. This trend continued as further load was applied, and at a load of 160 kips, or 3.3 ksi stress the panel passed through its original position and the outside surface of the load bearing face changed from compression to tension due to the change in direction of the lateral deflection. The panel was loaded to 172 kips, or 3.6 ksi stress and allowed to stand for 45 minutes. The load dropped off to 160 kips and deflection increased 0.03 inches during this time. The load was increased to 180 kips but immediately dropped off to 178, then 168 kips. During this loading and dropping off process the deflection increased by 0.3 inches. The panel was reloaded to 176 kips and the deflection increased by 0.06 inches. It was then unloaded to 125 kips, or 2.6 ksi stress. During the unloading procedure the deflection decreased by 0.03 inches. Both the load and deflection held fairly steadily after the panel had been unloaded to 125 kips. The panel was reloaded to 176 kips, or 3.7 ksi stress. The load dropped off slightly while the panel crept slightly. The deflection increased 0.18 inches during reloading. The load was increased to about

178 kips, at which point a partial delamination failure occured and the load immediately started to drop off fairly quickly. The load had dropped off to about 168 kips when failure occured. Total delamination of the load bearing face from the "Aerofoam" and non-load bearing face occured. The load bearing face blew apart at about the center of the panel (plate 10).


DELAM.(-)
STRESS - psi x 1000
4.0
3.5
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10-3 CENTERLINE LATERAL DEFLECTION - INCHES

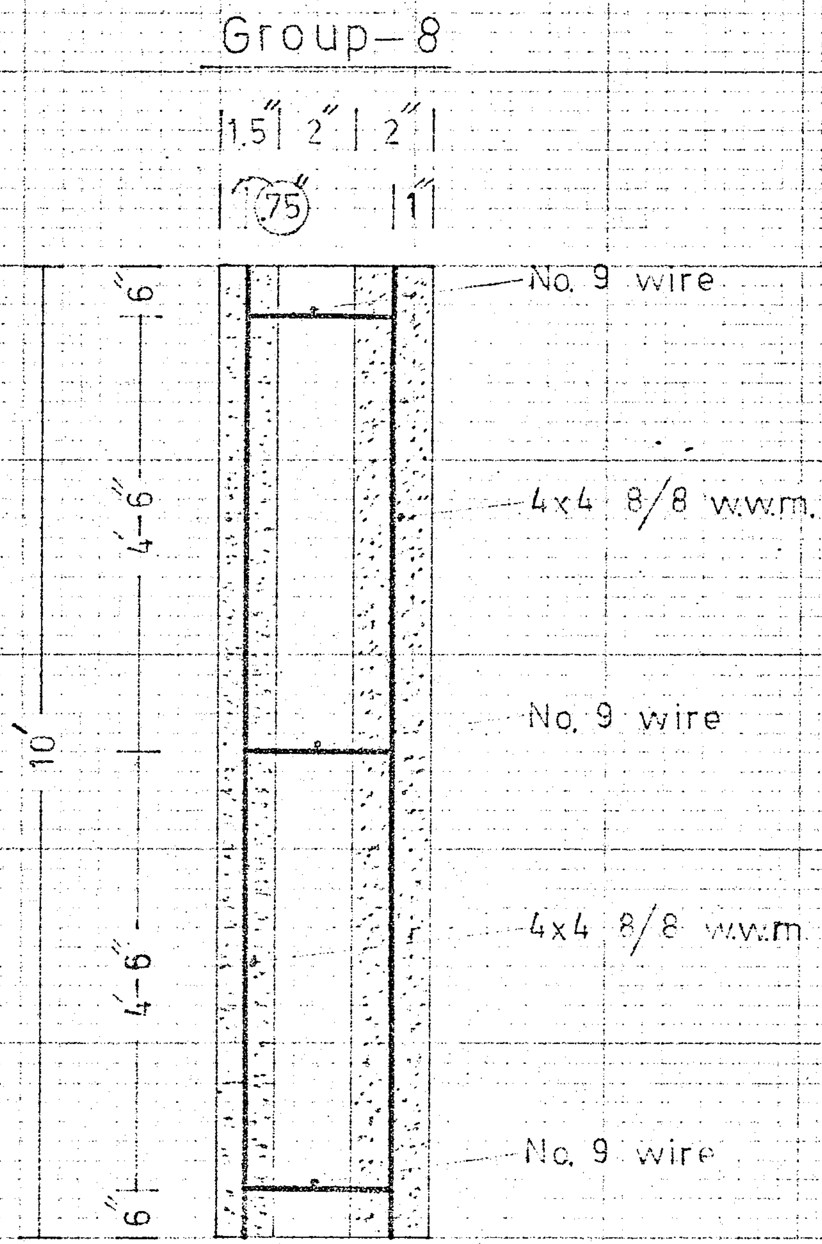
FIG. 16.

Panel 8 - 1

Refer to fig. 17 for dimensions and reinforcement, and fig. 18 for load-strain characteristics.

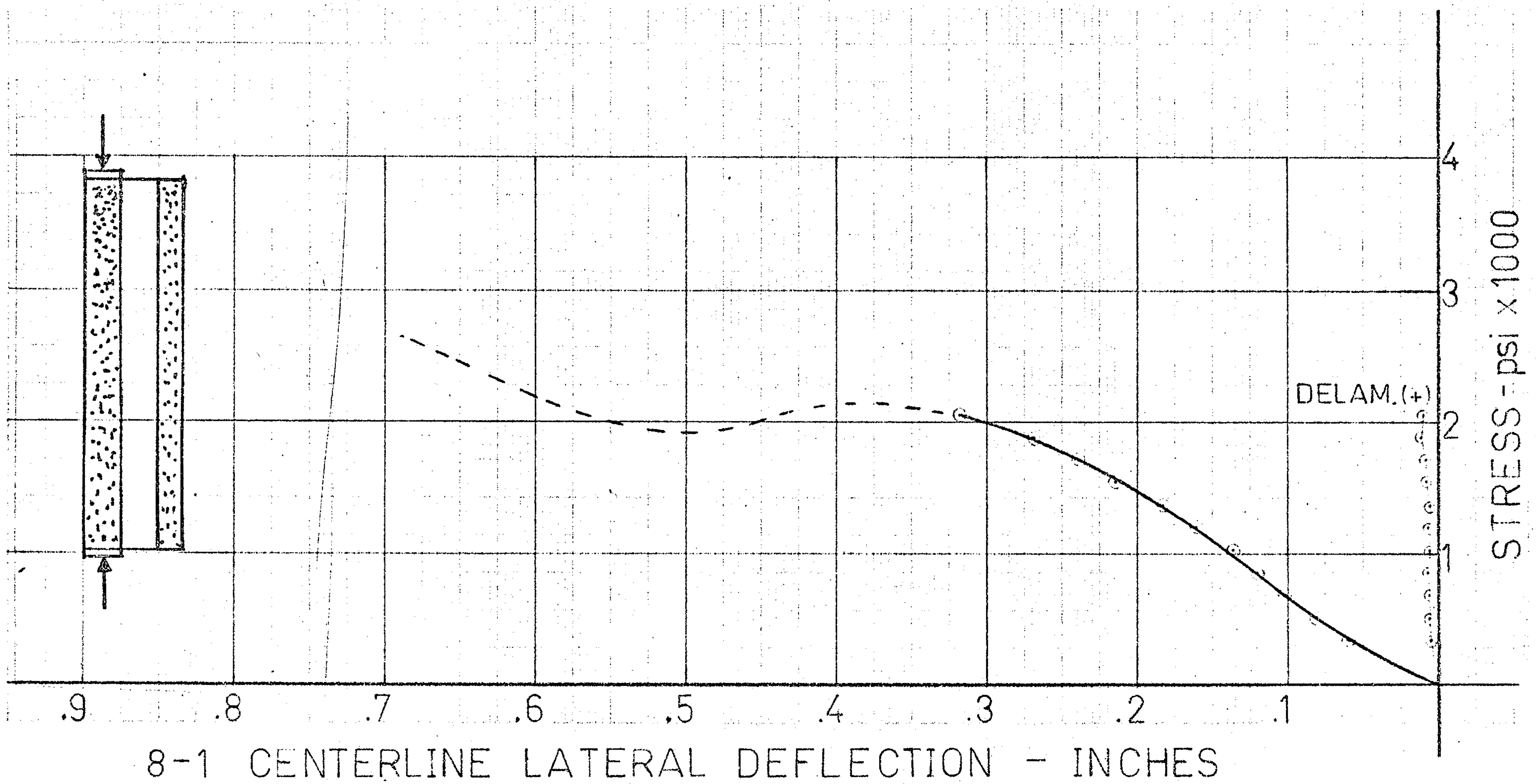
As the load was applied the panel started to deflect outwards so that the outside surface of the load bearing face was being put into tension due to the lateral deflection. The panel deflection started to creep slowly as the load reached 48 kips, but increased rapidly when the load was increased to 52 kips, or 2.2 ksi stress. No cracks had appeared to this point in the test. The panel was allowed to stand for about 5 minutes while the guages were removed. The load dropped to 48 kips during the 5 minutes. The load was then increased quite rapidly to 66.4 kips, or 2.7 ksi stress when failure occured. The failure was a combination of delamination and buckling. The panel cracked through its entire cross-section, with the failure crack situated 7 inches below center on the non-bearing face, and 10 inches below center on the load bearing face.

There were two other cracks on the load bearing face at 7 inches and 18 inches below center. The bottom half of the panel had completely delaminated, with the non-load bearing face and the "Aerofoam" separating from the load bearing face. There was no visible delamination of the top half of the panel (plate 11).



Group-8
1.5" 2" 2"
.75" 1"
No. 9 wire
4x4 8/8 w.w.m.
No. 9 wire
4x4 8/8 w.w.m.
No. 9 wire
10'
6"
4'-6"
4'-6"
6"

FIG. 17.



DELAM.(+)
STRESS - psi x 1000
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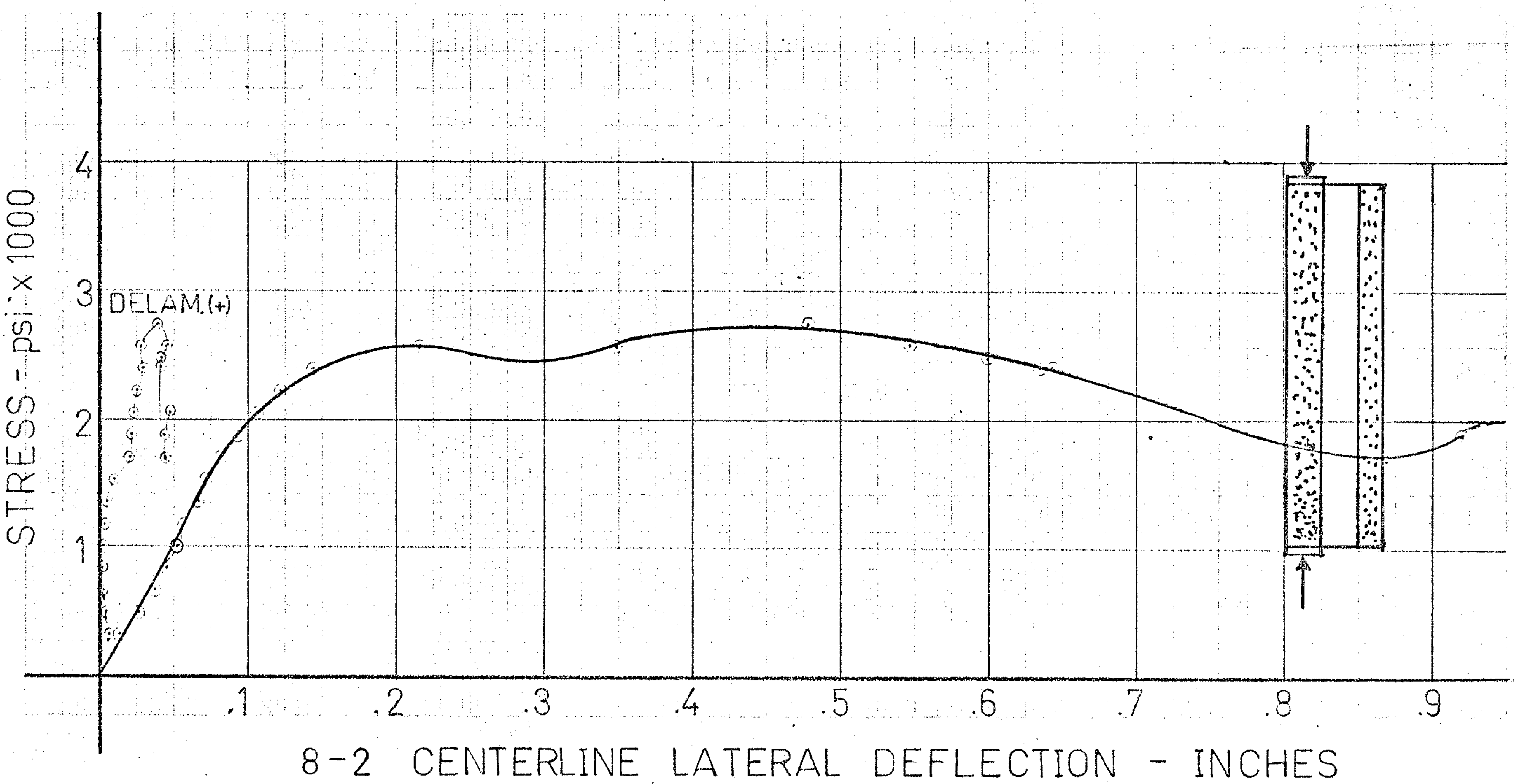
8-1 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 18.

Panel 8 - 2

Refer to fig. 17 for dimensions and reinforcement, and fig. 19 for load-strain characteristics.

As the load was applied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression due to the lateral deflection. The load held well and the deflection did not start to creep until a load of 64 kips, or 2.6 ksi stress was reached. A crack then appeared on the non-bearing face, 19 inches above the center. The load dropped off about 4 kips in 15 minutes and was again increased to 64 kips. Another crack appeared on the non-bearing face, 2 inches below the center. The panel was deflecting fairly slowly at this point, but the deflection increased rapidly as the loading reached 68 kips. Another crack appeared, 31 inches above the center on the non-bearing face, as the load started to drop off. The load dropped off to 60 kips and the deflection increased 0.20 inches during the next hour. The panel was allowed to stand for the next 3 days and 17 hours. At the end of this period, the load had dropped to 44 kips, or 1.8 ksi stress, and the deflection had increased more than 0.22 inches. The panel was reloaded to about 54.4 kips when the deflection increased very quickly and the guages were removed. Two tension cracks appeared on the non-bearing face during this time—one, 13 inches below the center, and the other 10 inches above the center. The load dropped off to about 48 kips in 15 minutes and was then increased to 52 kips, at which load failure occured. The panel did not seem to delaminate, but instead broke completely in two. The break was 10 inches above center on the non-bearing face, and 8 inches above center on the bearing face (plate 12).


DELAM.(+)
STRESS - psi x 1000
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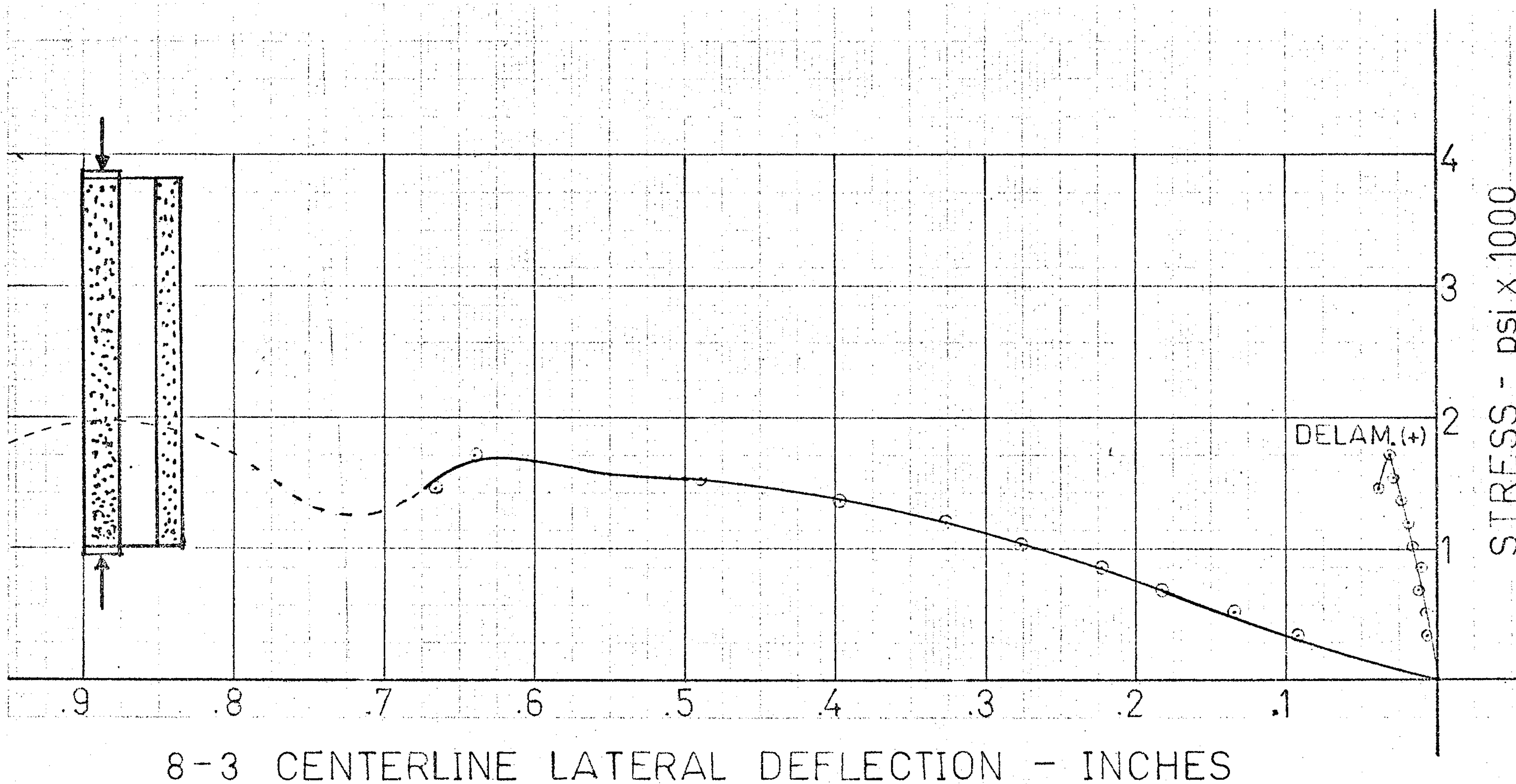
8-2 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 19.

Panel 8 - 3

Refer to fig. 17 for dimensions and reinforcement, and fig. 20 for load-strain characteristics.

This panel had some shrinkage and handling cracks on the non-bearing face. A major crack, 10 inches below the center, ran for the entire width of the panel. Two other cracks—one 2 inches above the center, and the other 17 inches below the center, did not run the entire width of the panel but stopped short of the edges. As the load was applied the panel started to deflect outwards so that the outside surface of the load bearing face was being put into tension due to the lateral deflection. The deflection started to creep at a load of 28 kips, or 1.2 ksi stress. The panel was loaded to 44.4 kips and allowed to stand for 15 minutes, while the guages were removed. The load dropped to 33.3 kips during this time. Load was then applied very quickly to 50.4 kips, where it stopped increasing while pumping continued. Pumping was stopped and the load dropped off to about 26 kips in 1 minute. The load drop-off was accompanied by a gradual increase in deflection, until the panel failed at 26 kips. The failure was a combination of buckling and delamination. The panel cracked through, 10 inches below the center. There was also another tension crack on the load bearing face, 14 inches below the center. Delamination occured on the bottom part of the panel, with the "Aerofoam" and non-bearing face separating from the load bearing face. There was no visible delamination of the upper part of the panel (plate 13).



DELAM.(+)
4
3
2
1
STRESS - psi x 1000
.9
.8
.7
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.5
.4
.3
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.1
8-3 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 20.

Panel 5 - 1_1

Refer to fig. 21 for dimensions and reinforcement, and fig. 22 for load-strain characteristics.

As the load was applied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression due to the lateral deflection. There was no noticeable deflection creep or load drop-off upon loading to 125 kips, or 2.6 ksi stress. Two tension cracks appeared on the non-bearing face at a load of 125 kips. One was 13 inches above the center and the other was 41 inches above the center. Another tension crack, 2 inches above the center was noticed, at a load of 154 kips. The deflection had started to creep with the appearance of this crack, and the guages were removed at a load of 156 kips. The load was increased to 184 kips, or 3.8 ksi stress. Three more tension cracks opened up during this loading stage. One crack was 30 inches up from the center and the other two were 14 and 26 inches down from the center. The load started to drop off with the appearance of these cracks. As it appeared that failure was immenent upon further loading, the panel was unloaded and the guages replaced, in order to retest the panel. There was no visible evidence of delamination.

Group -5

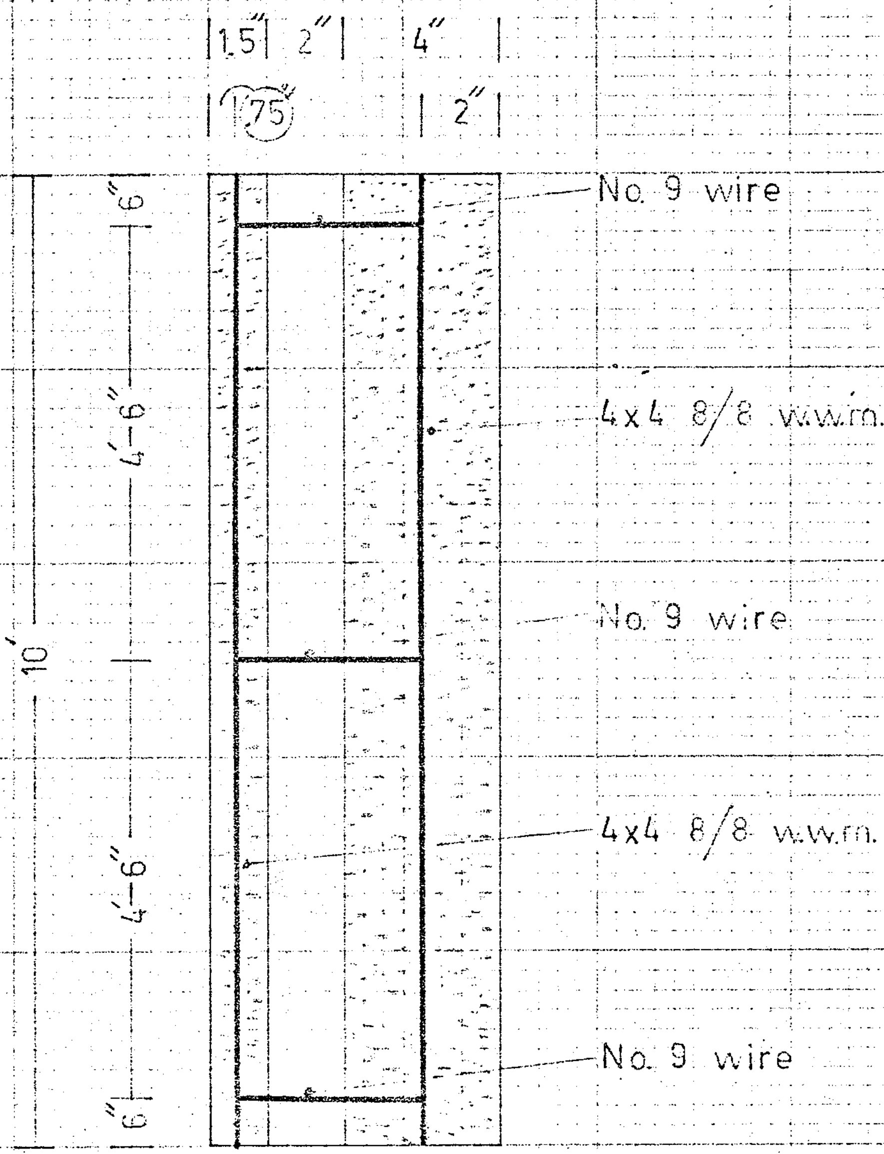
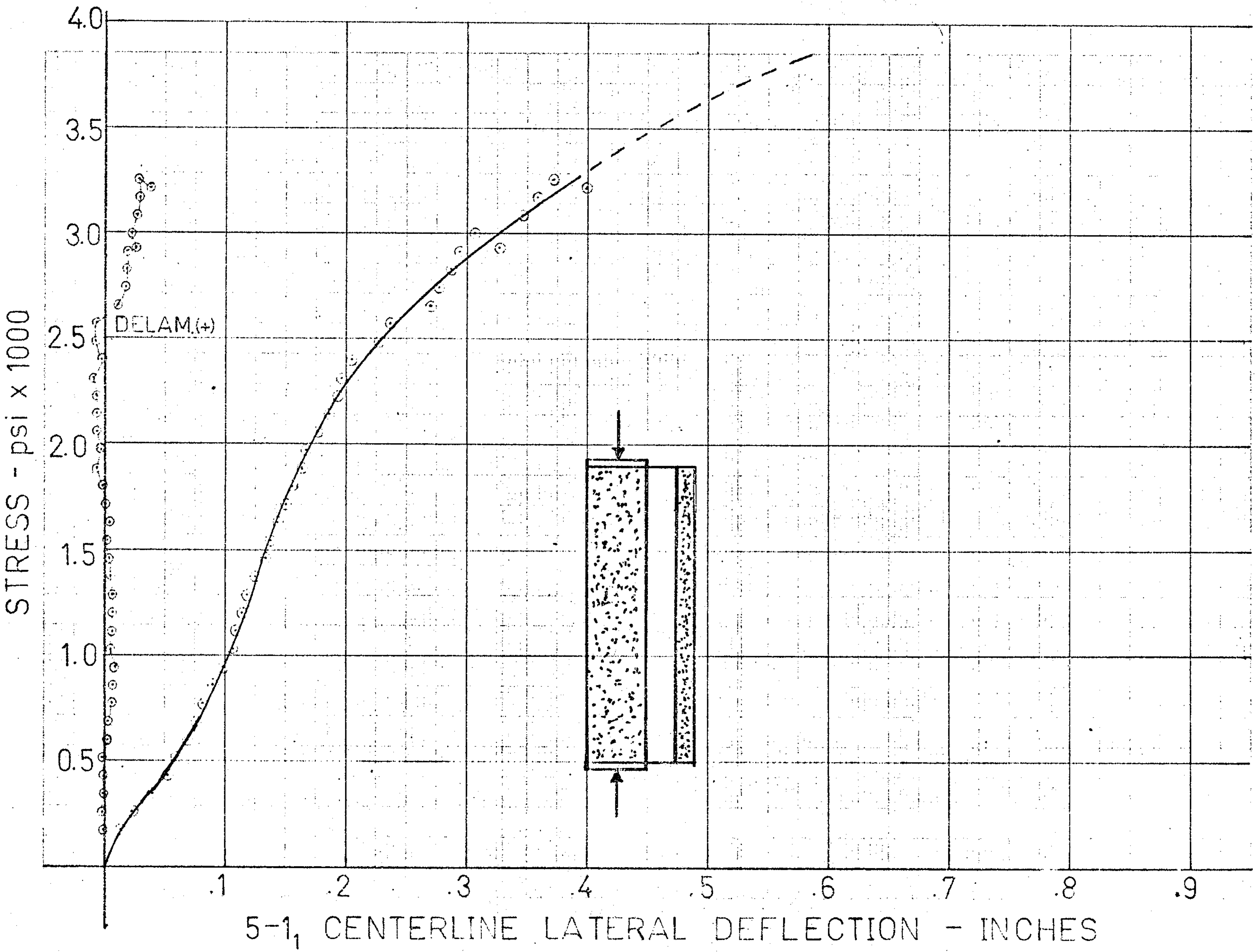


FIG. 21.


4.0
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STRESS - psi x 1000
DELAM.(+)
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.7
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.9
5-1₁ CENTERLINE LATERAL DEFLECTION - INCHES

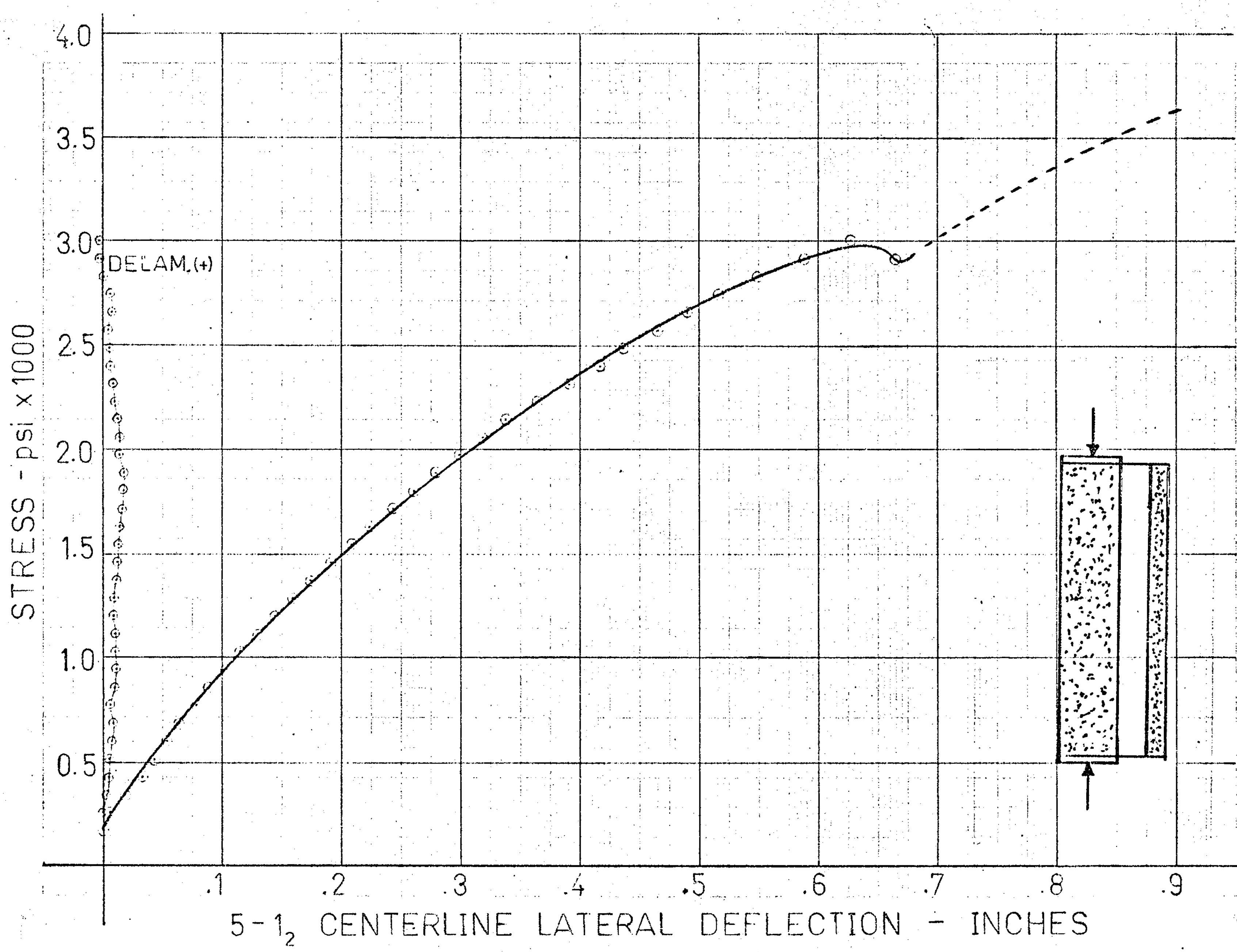
FIG. 22.

Panel 5 - 1_2

Refer to fig. 21 for dimensions and reinforcement, and fig. 23 for load-strain characteristics.

As the load was reapplied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression due to the lateral deflection. The panel was loaded to 144 kips, or 3.0 ksi stress, and allowed to stand. The load dropped to 140 kips in 10 minutes. The panel had started to creep at a load of 105 kips and the guages were removed after the 10 minute wait. The panel was loaded to 174 kips, or 3.6 ksi stress, when failure occured. The failure crack on the non-load bearing face appeared at failure and was 8 inches up from the center. Three cracks appeared on the bearing face--16 and 37 inches below the center, and the actual failure crack at 6 inches above the center. A small amount of concrete was blown out of the bearing face, around the failure crack, when the panel broke.

Delamination of the bearing face from the "Aerofoam" and non-bearing face occured on the top half of the panel only (plate 14).


4.0
3.5
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DELAM.(+)
STRESS - psi x 1000
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5-1₂ CENTERLINE LATERAL DEFLECTION - INCHES

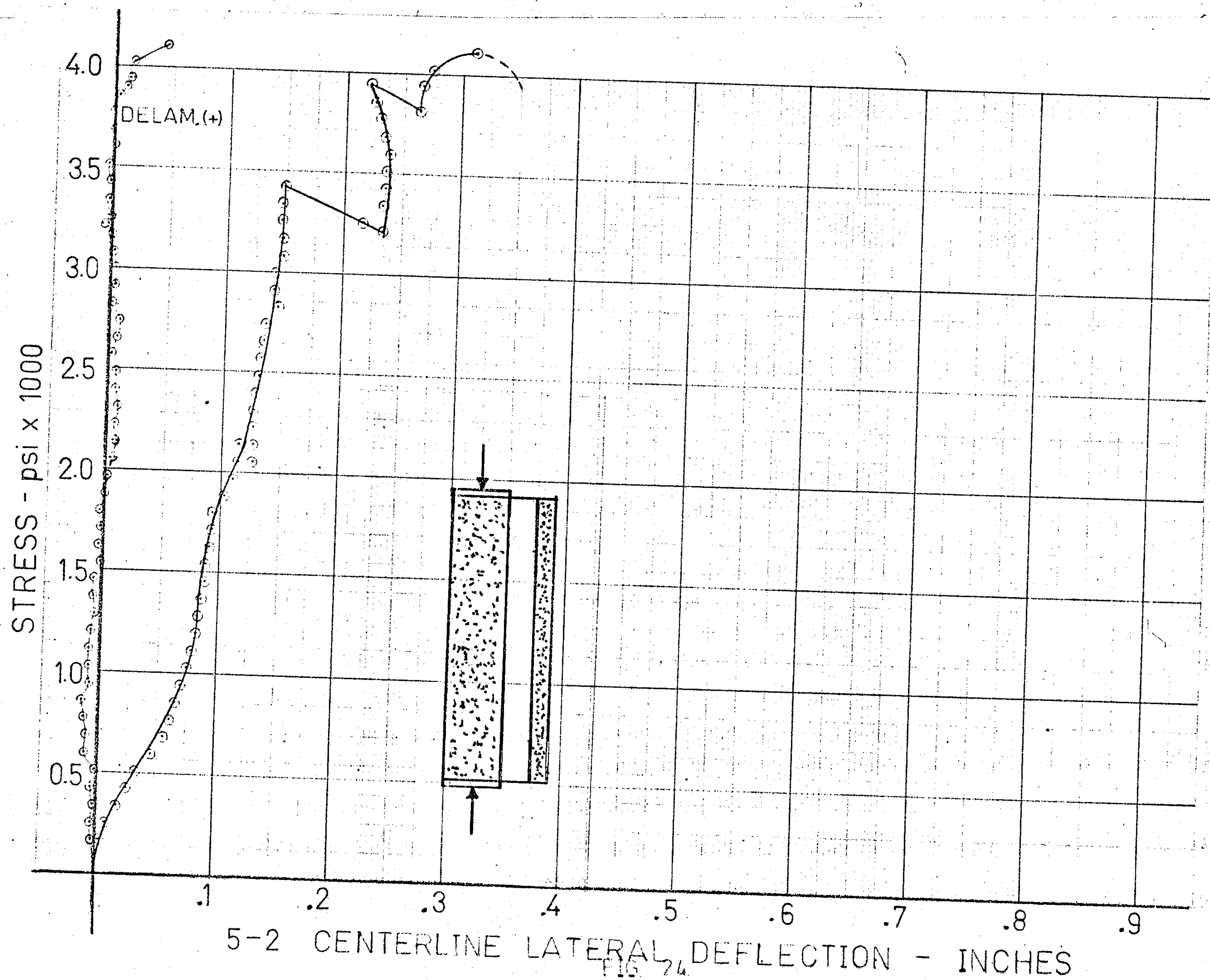
FIG. 23.

Panel 5 - 2

Refer to fig. 21 for dimensions and reinforcement, and fig. 24 for load-strain characteristics.

As the load was applied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression due to the lateral deflection. Two shrinkage cracks were noticed on the non-bearing face, 5 inches below the center and 14 inches above the center. These cracks did not run the entire width of the face, but stopped short of the edges. At a load of about 100 kips, it was noticed that these cracks had extended all the way to one edge of the panel, but still stopped short of the other edge. A vertical crack on the load bearing face was noticed at a load of 155 kips. The crack was 1 inch off center and 13 inches long, starting 2 inches from the bottom of the panel. The crack had extended 2 inches at 160 kips, another 2 inches at 187 kips, and a final 2 inches at 191 kips.

The crack had opened up to the bottom of the panel at 187 kips. As the load was increased to 196.6 kips, or 4.1 ksi stress, the bottom of the panel started to delaminate. The load immediately dropped off to 188.6 kips and the panel failed. The bottom of the load bearing face blew apart and delamination of the bearing face from the "Aerofoam" and non-bearing face was visible to within 2 feet of the top of the panel. The two tension cracks on the non-bearing face extended through the entire face at failure. There were also two cracks which appeared on the bearing face at failure—one 21 inches above the center, and the other 18 inches below the center (plate 15).



STRESS - psi x 1000
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DELAM.(+)
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5-2 CENTERLINE LATERAL DEFLECTION - INCHES

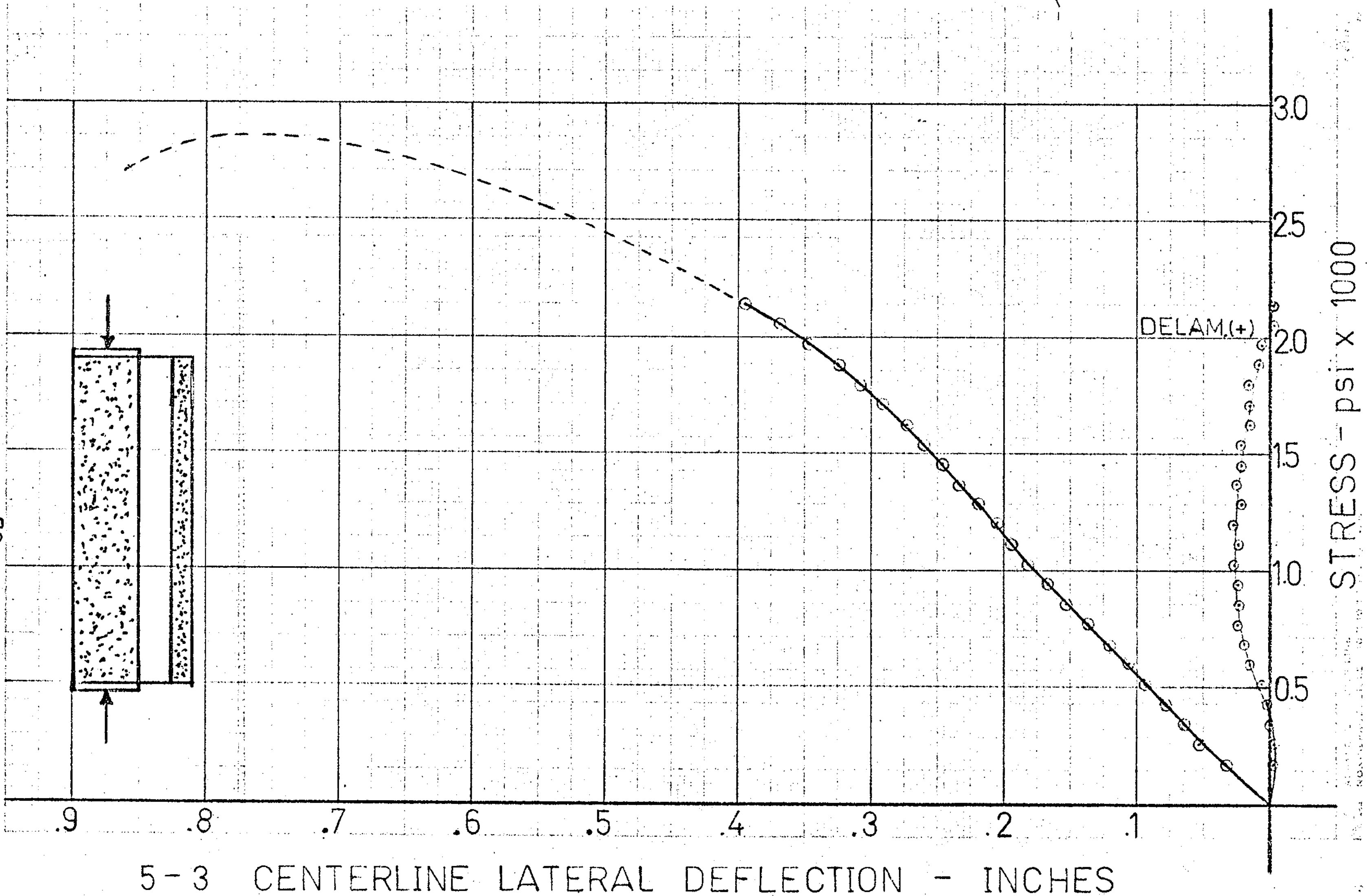
FIG. 24

Panel 5 - 3

Refer to fig. 21 for dimensions and reinforcement, and fig. 25 for load-strain characteristics.

As the load was applied the panel started to deflect outwards so that the outside surface of the load bearing face was being put into tension due to the lateral deflection. The load did not hold well during this test but quickly dropped off about 1 kip before holding steadily after each load increment. The panel started to creep fairly quickly at a load of 105 kips, or 2.2 ksi stress, and the guages were removed. Delamination of the non-bearing face and "Aerofoam" from the bearing face became visible at the bottom of the panel, at a load of 110 kips. The load was increased to 138.3 kips, and the loading was stopped. The load imediately dropped to 130.7 kips and failure occured. The panel buckled and totally delaminated. The failure crack on the bearing face was 6 inches above the center. There were two cracks on the non-bearing face—one

14 inches above the center, and the other 29 inches above the center. The panel delaminated with the bearing face separating from the "Aerofoam" and non-bearing face (plate 16).


3.0
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STRESS - psi x 1000
DELAM.(+)
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5-3 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 25.

Panel 7 - 1

Refer to fig. 26 for dimensions and reinforcement, and fig. 27 for load-strain characteristics.

As the load was applied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression due to the lateral deflection. Two tension cracks appeared on the non-bearing face at a load of 36 kips, or 1.5 ksi stress. The cracks were 5 inches and 25 inches below the center of the panel. The load started to drop off and the deflection started to creep when the cracks appeared. As the load was increased to 50 kips, or 2.1 ksi stress, two more tension cracks appeared on the non-bearing face. These cracks were 10 inches and 20 inches above the center of the panel. The guages were removed at 52.4 kips, as the panel was creeping fairly quickly. The load dropped to 46.4 kips in about 10 minutes. The panel was then loaded to 56.4 kips, or 2.35 ksi stress, when failure occured.

The panel broke completely in two. The failure was step-like, occuring 6 inches above the center on the bearing face and 9 inches above the center on the "Aerofoam" and non-bearing face. Delamination of the bearing face from the "Aerofoam" and non-bearing face was visible for 2 to 3 feet down from the break on the bottom part of the panel. There was no visible delamination on the top part of the panel (plate 17).

Group - 7

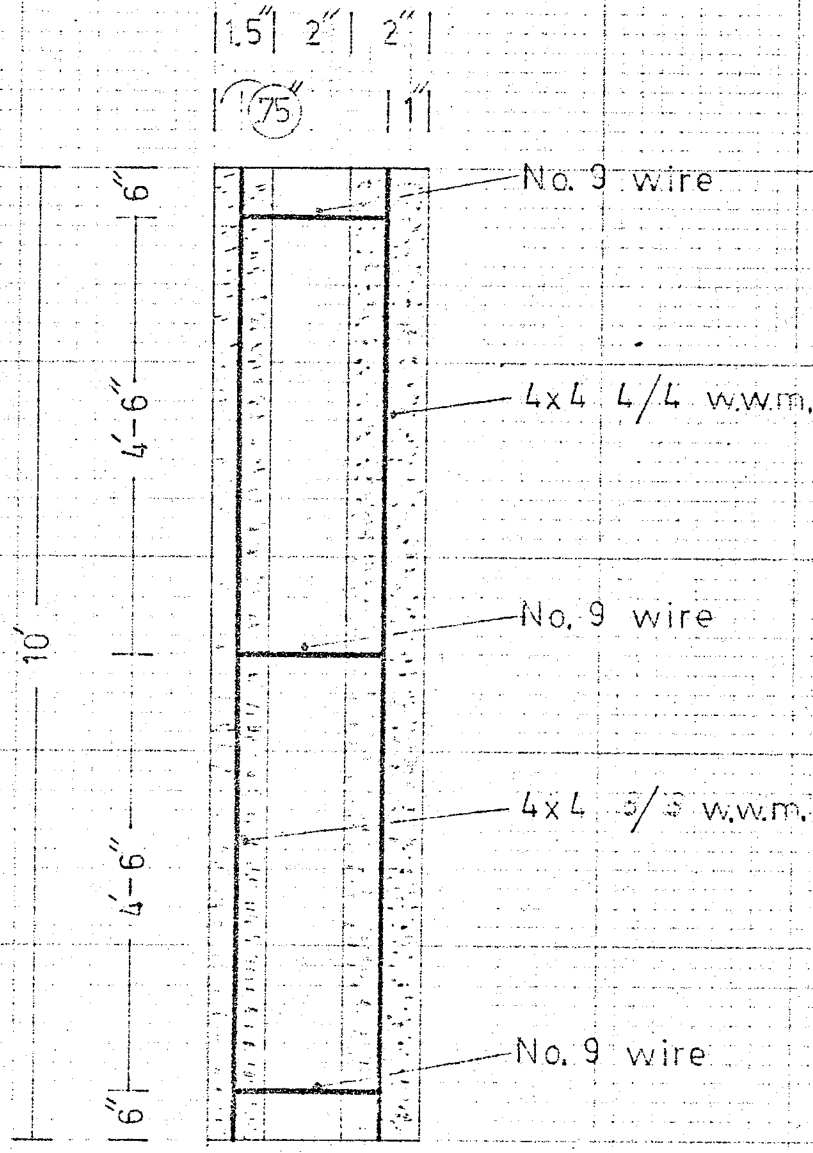
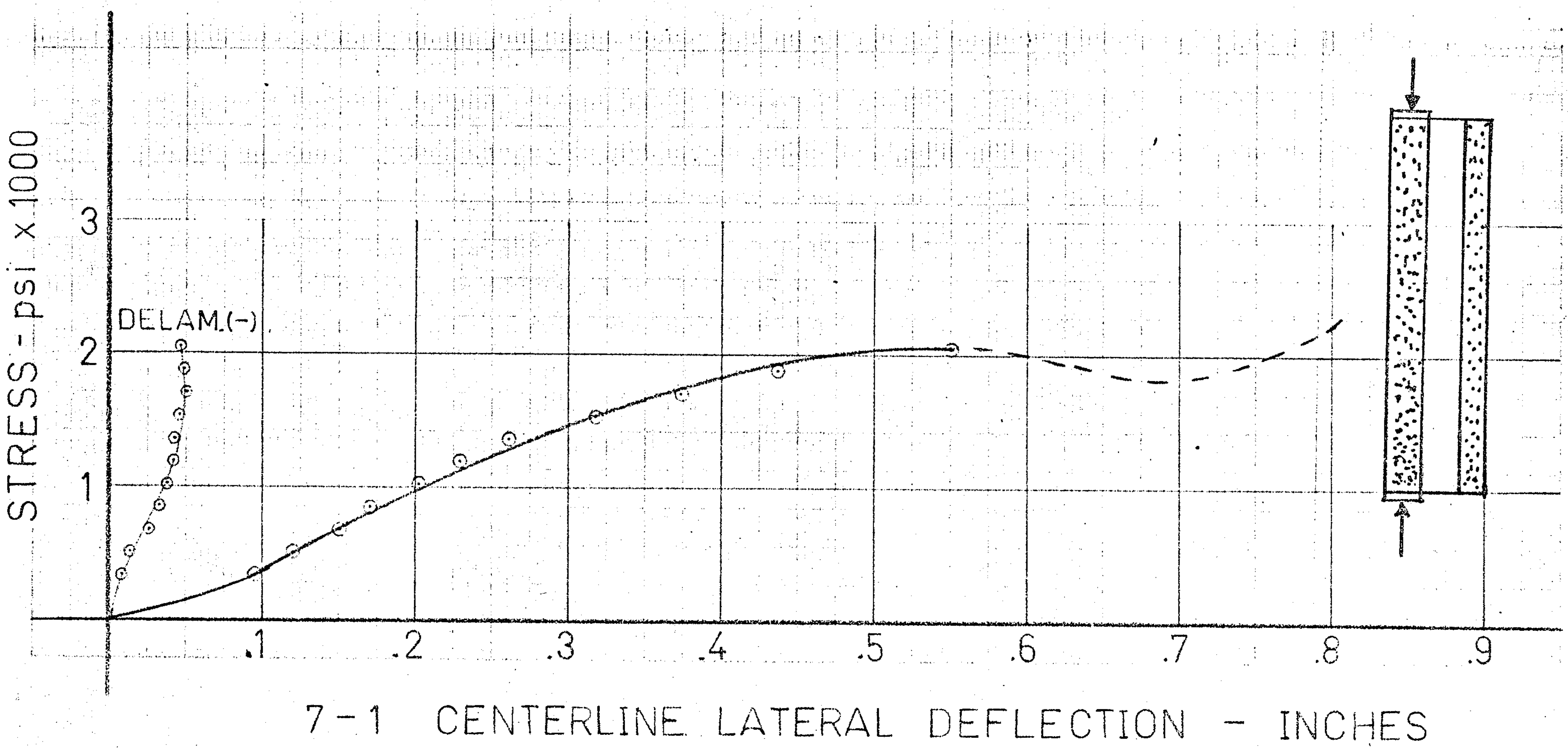


FIG. 26.



STRESS - psi x 1000
3
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DELAM.(-)
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.8
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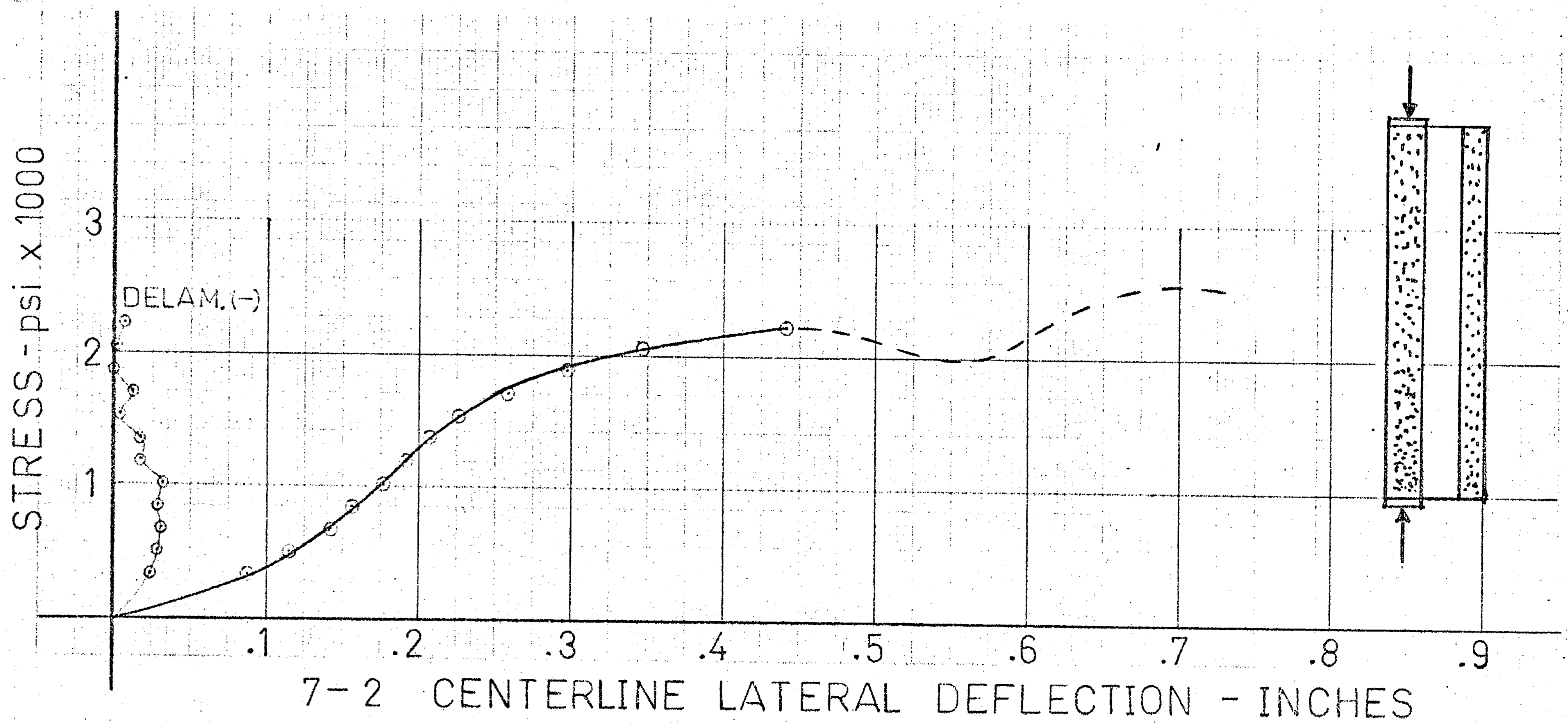
7-1 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 27.

Panel 7 - 2

Refer to fig. 26 for dimensions and reinforcement, and fig. 28 for load-strain characteristics.

As the load was applied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression due to the lateral deflection. The panel was loaded to 48 kips, or 2.0 ksi stress, when a tension crack appeared on the non-bearing face, 10 inches below the center of the panel. The load dropped to about 45 kips in 5 minutes, and was then increased to 56 kips. The guages were removed at this load, as the panel was creeping rather quickly. Two more tension cracks appeared on the non-bearing face at 56 kips. They were 2 inches above the center and 26 inches below the center. The load dropped to 51 kips in 12 minutes. The load was then increased to 64.3 kips, or 2.7 ksi stress, where it remained constant as pumping continued. When the pumping was stopped, the load immediately dropped to 60 kips and the panel failed. The panel broke completely in two at 10 inches below the center. Delamination of the bearing face from the "Aerofoam" and non-bearing face was visible on the lower part of the panel only (plate 18).



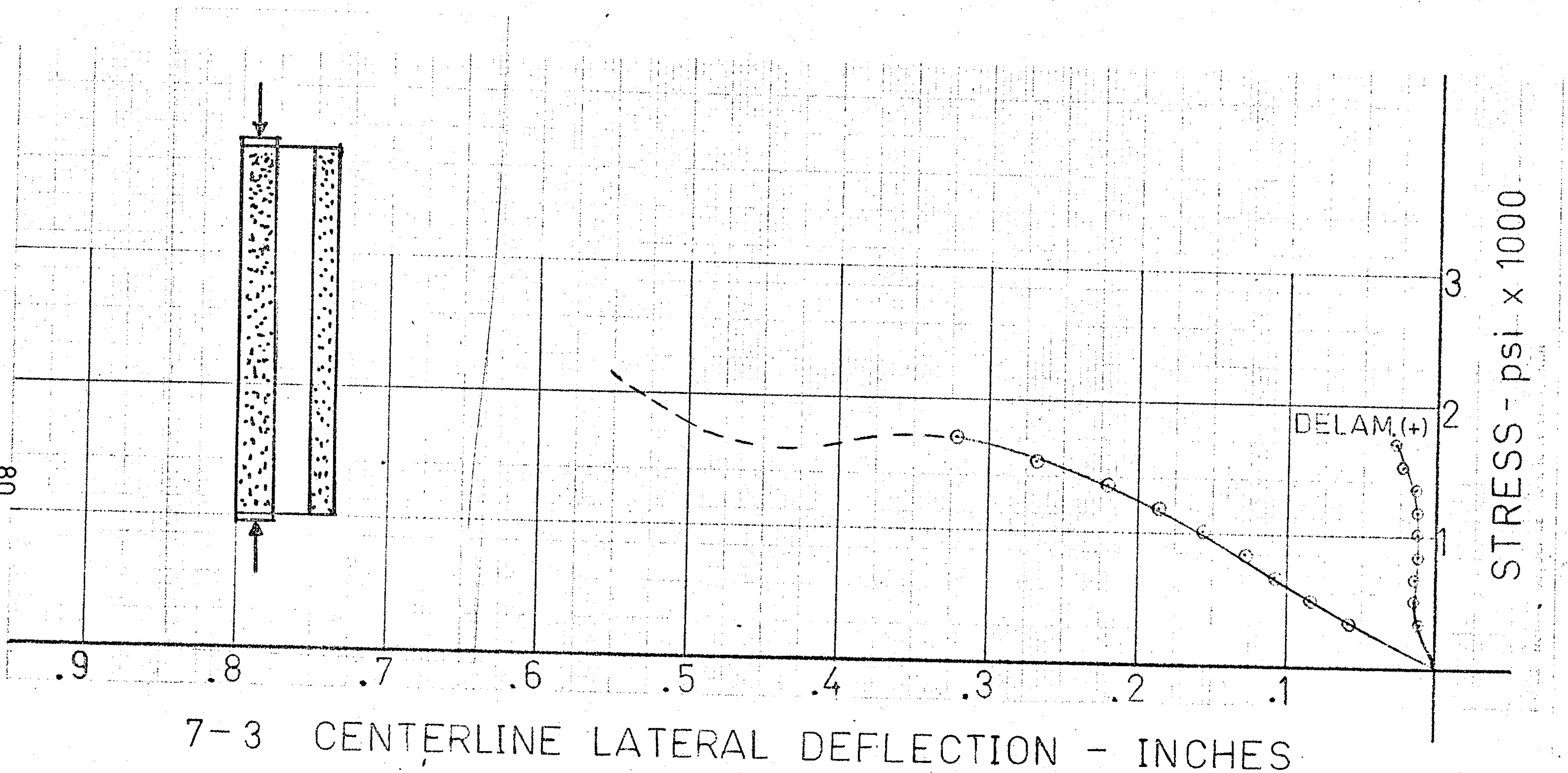
STRESS - psi x 1000
3
2
1
DELAM.(–)
.1
.2
.3
.4
.5
.6
.7
.8
.9
7-2 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 28.

Panel 7 - 3

Refer to fig. 26 for dimensions and reinforcement, and fig. 29 for load-strain characteristics.

As the load was applied the panel started to deflect outwards so that the outside surface of the load bearing face was being put into tension due to the lateral deflection. The panel was loaded to 44 kips, at which point the deflection started to creep fairly quickly and the guages were removed. The load had held fairly steadily up until this point, but dropped off to 40 kips during the next 10 minutes. The load was increased to 52.4 kips, or 2.2 ksi stress, and the panel failed. The failure was a combination of buckling and delamination. The failure crack was 1.5 inches above the center, on the bearing face and 8 inches above the center, on the non-bearing face. Numerous tension cracks appeared on the bearing face, immediately before failure. These cracks were situated from 3 feet below the center to 2.5 feet above the center. Delamination of the bearing face from the "Aerofoam" and non-bearing face occured for the bottom 6 feet of the panel only (plate 19).



DELAM.(+)
3
2
1
STRESS - psi x 1000
.9
.8
.7
.6
.5
.4
.3
.2
.1
7-3 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 29.

Panel 4 - 1

Refer to fig. 30 for dimensions and reinforcement, and fig. 31 for load-strain characteristics.

As the load was applied the panel started to deflect outwards so that the outside surface of the load bearing face was being put into tension due to the lateral deflection. The panel started to creep at a load of 77 kips, or 1.6 ksi stress. The load held fairly steadily up to 113 kips. The guages were removed at this point and the load dropped off to 109 kips in 5 minutes. The panel was loaded to 138.4 kips, or 2.9 ksi stress, and allowed to stand. The load immediately dropped off to 129 kips and the panel failed. The failure was a combination of delamination and buckling. The failure crack on the load bearing face was 6 inches above the center. Concrete was broken out of the load bearing face for a distance of 9 inches above the failure crack. About 2 inches of reinforcing steel was exposed in the vicinity of the break.

There were two cracks on the non-bearing face— one 8 inches below the center, and the other 2 feet above the center. Total delamination had occured. The bearing face separated from the "Aerofoam" and non-bearing face for all but 2 feet of the panel's length. The bearing face separated from the "Aerofoam" and non-bearing face for the bottom 2 feet of the panel. A joint in the "Aerofoam" occured at this point, and for the next 2 feet the non-bearing face separated from the "Aerofoam" and load bearing face. There was then a 6 inch transition zone, where the "Aerofoam" left the bearing face and joined the non-bearing face, for the rest of the panel's length (plate 20).

Group-4

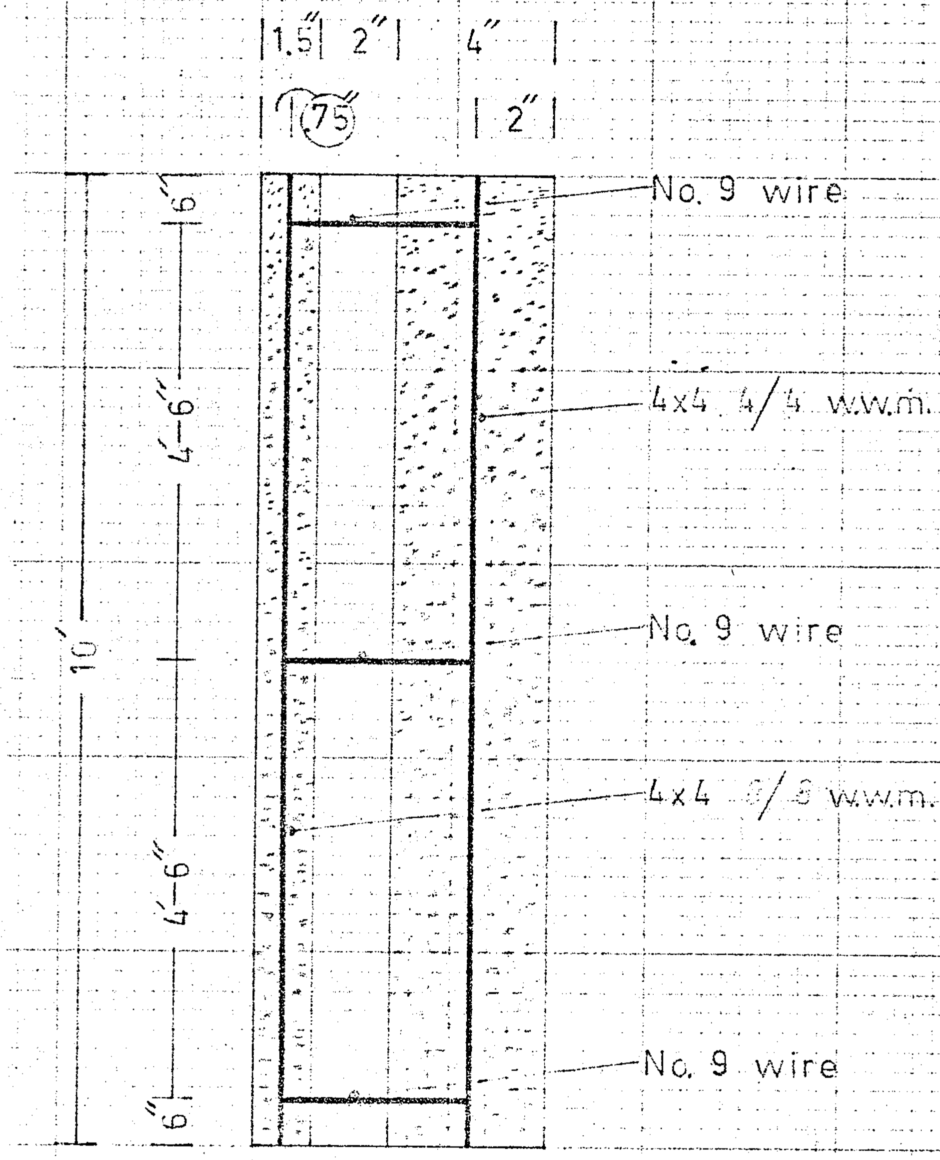


FIG. 30.

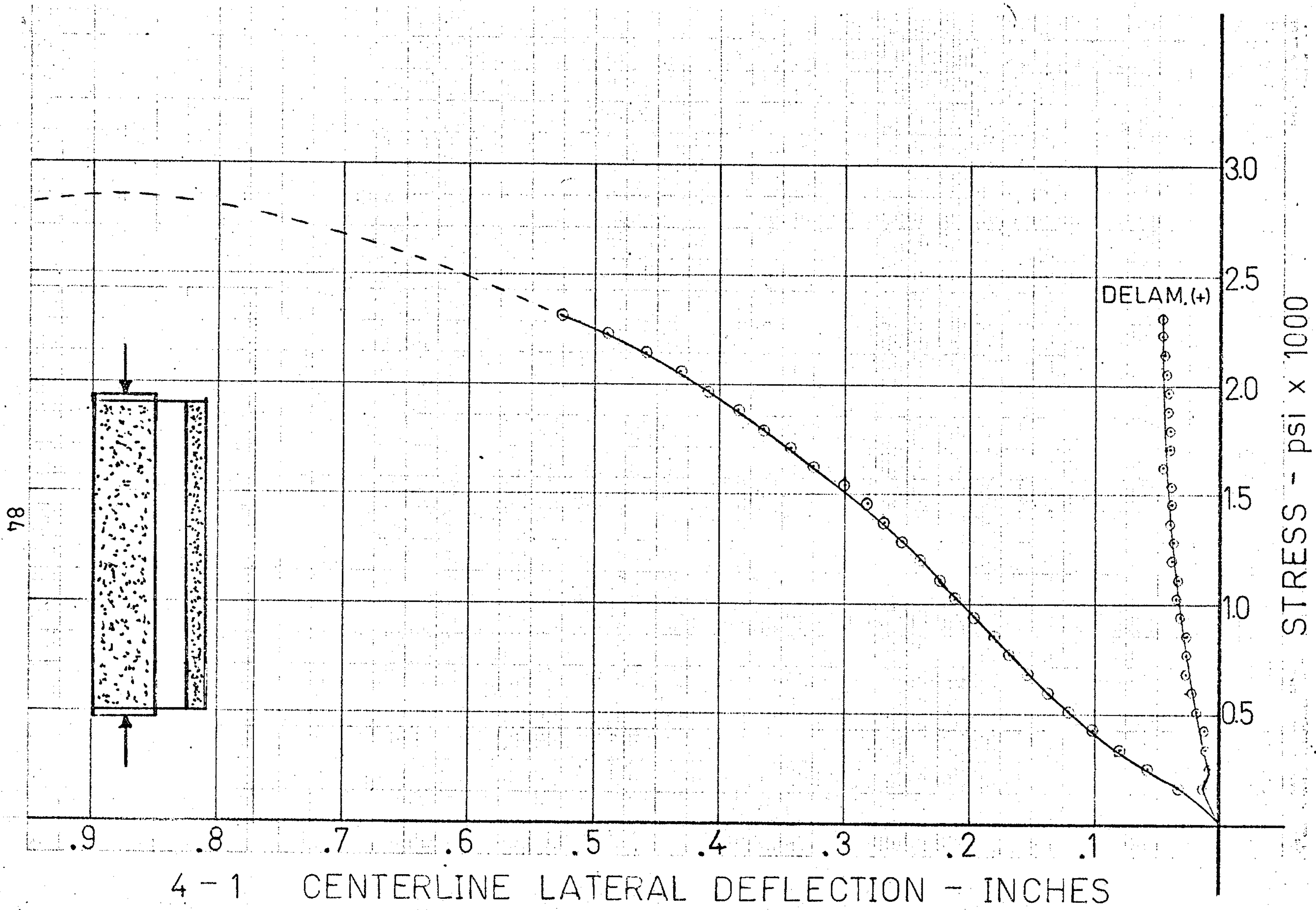

DELAM.(+)
3.0
2.5
2.0
1.5
1.0
0.5
STRESS - psi x 1000
.9
.8
.7
.6
.5
.4
.3
.2
.1
4 - 1 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 31.

Panel 4 - 2

Refer to fig. 30 for dimensions and reinforcement, and fig. 32 for load-strain characteristics.

As the load was applied the panel started to deflect outwards so that the outside surface of the load bearing face was being put into tension due to the lateral deflection. The panel was loaded to 109 kips, or 2.3 ksi stress, and allowed to stand. Delamination of the bearing face from the "Aerofoam" and non-bearing face was visible on the bottom 6 feet of the panel. The deflection was increasing at a good rate as the guages were removed. The load dropped off continuously and read 97 kips in 10 minutes. The load continued to drop off slowly and the panel failed 5 minutes later, at a load of about 93 kips. Failure was a combination of buckling and delamination. The failure crack was 9 inches up from the center on the bearing face and 10 inches up from the center on the non-bearing face. Total delamination occured with the bearing face separating from the "Aerofoam" and non-bearing face (plate 21).

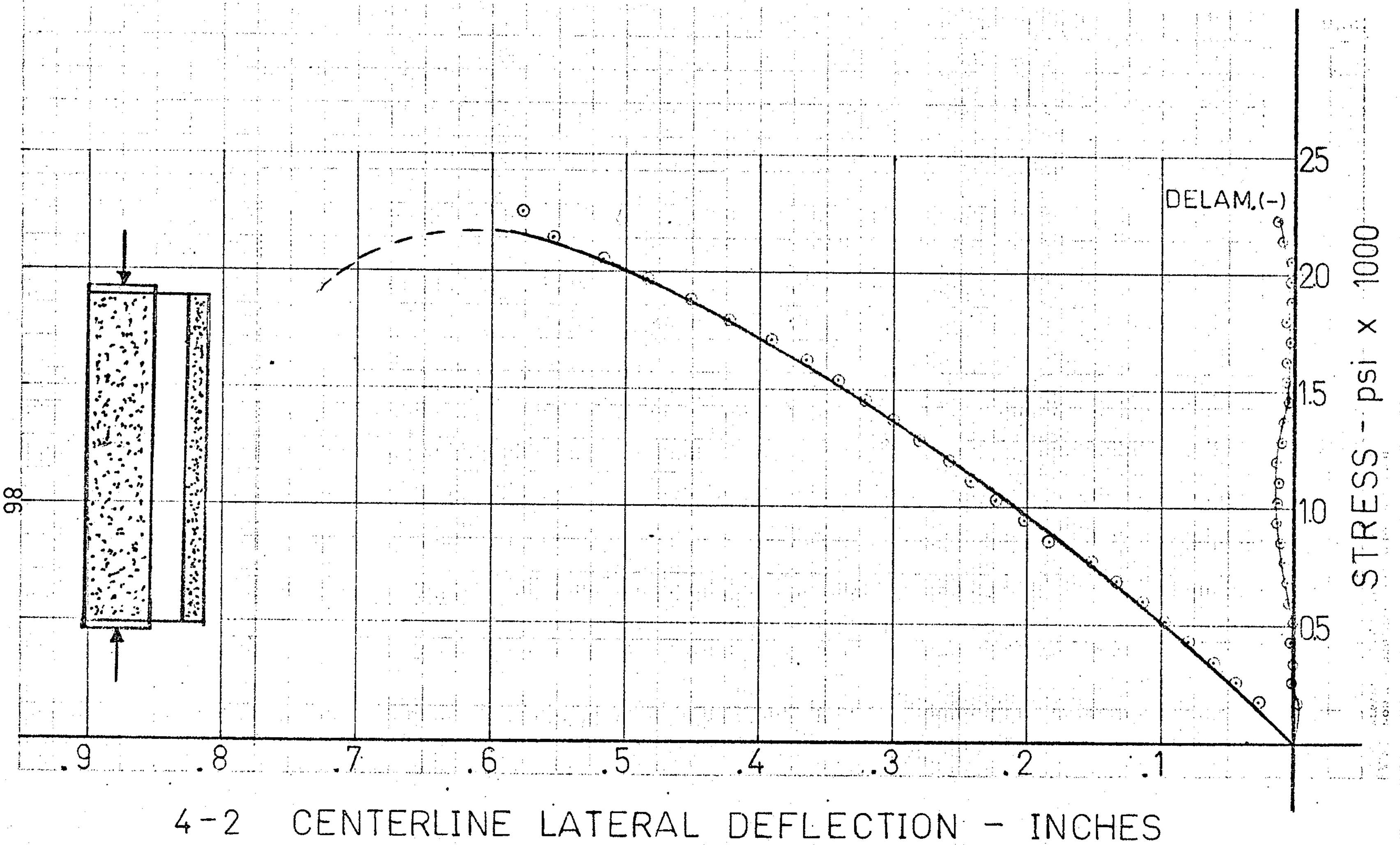

DELAM.(-)
25
20
1.5
1.0
0.5
STRESS - psi x 1000
.9
.8
.7
.6
.5
.4
.3
.2
.1
4-2 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 32.

Panel 4 - 3

Refer to fig. 30 for dimensions and reinforcement, and fig. 31 for load-strain characteristics.

As the load was applied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression due to the lateral deflection. The panel was loaded to 60 kips when two tension cracks were noticed on the non-bearing face. The first crack was 26 inches above the center and was through the entire section. The second crack was 2 inches above the center and was only 6 inches through the section. The load dropped to 56 kips in 10 minutes. The second tension crack had extended another 2 inches at 81 kips, and another inch at 105 kips. The crack was through the entire section at a load of 109 kips. The panel was loaded to 128.8 kips, or 2.7 ksi stress. At this load the panel started to creep rapidly and the guages were removed. The load was increased to 178.4 kips, or 3.7 ksi stress, and then dropped off to 172.2 kips, when the panel failed. There was no visible evidence of delamination in the panel. The failure appeared to be due wholly to buckling. The failure crack on the bearing face was 1 inch up from the center. One to two inches of concrete had been blown out of the bearing face, in the vicinity of the failure crack, for a distance of 8 inches up the panel. The failure crack on the non-bearing face was 11 inches above center.

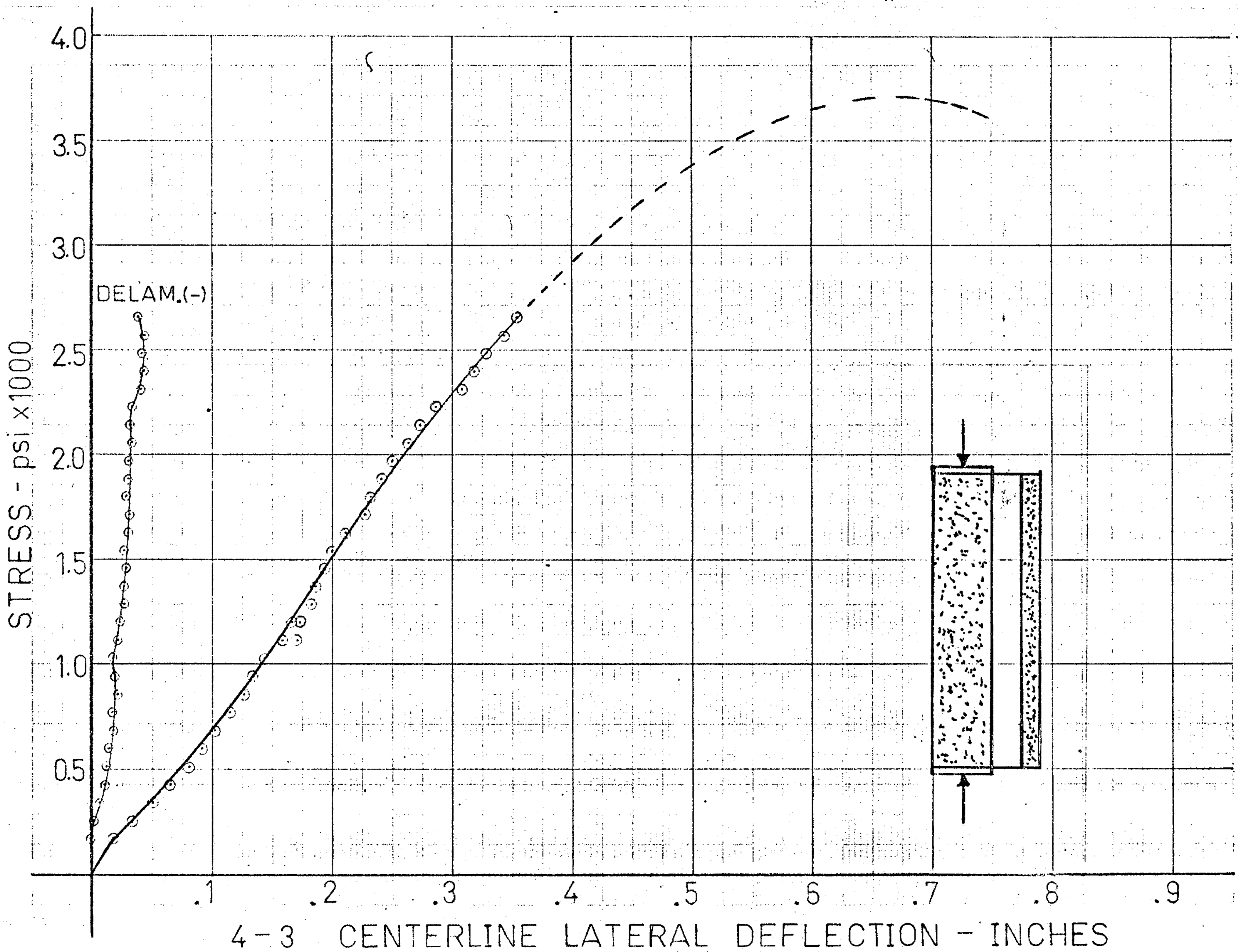

STRESS - psi x1000
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
DELAM.(-)
.1
.2
.3
.4
.5
.6
.7
.8
.9
4 - 3 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 33.

Panel 6 - 1

Refer to fig. 34 for dimensions and reinforcement, and fig. 35 for load-strain characteristics.

As the load was applied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression at first, due to the lateral deflection. This panel was cracked in two places on the non-bearing face, while being placed into the test frame. The cracks were 14 and 34 inches above the center. The panel was loaded to 85.4 kips, or 3.5 ksi stress. At this load, the panel was creeping fairly rapidly and the guages were removed. The load was increased to 95.3 kips, or 3.9 ksi stress, when failure occured. The failure was a combination of delamination and buckling. Total delamination occured with the bearing face separating from the "Aerofoan" and non-bearing face. The non-bearing face did not break through completely. The bearing face broke at 2 inches below the center. There were approximately 9 cracks on the bearing face, at a distance of from 5 to 8 feet from the bottom of the panel (plate 22). The reason for the cracks on the load bearing face was a reversal in deflection that occured near the end of the test. The guages were removed before the panel deflected back to its original position, but by the end of the test it had most probably passed through its original position and placed the outside surface of the load bearing face into tension due to the change in direction of the lateral deflection.

Group-6

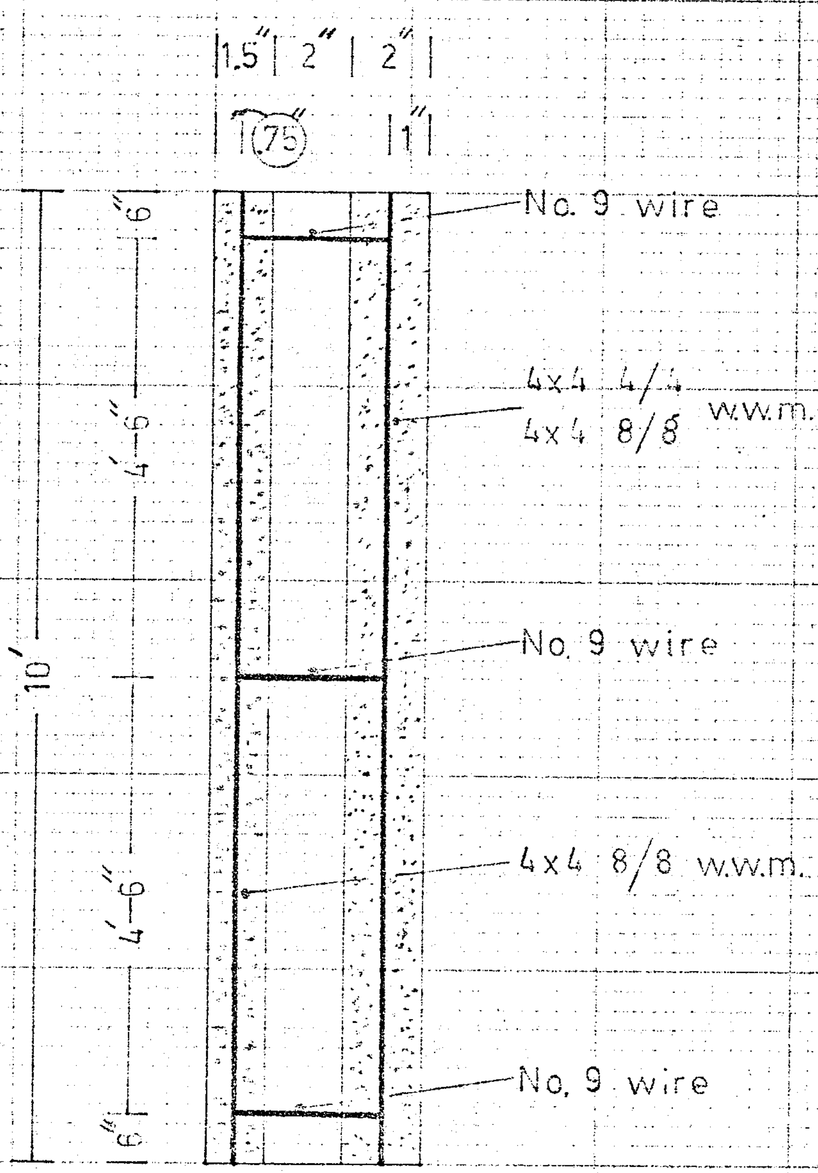
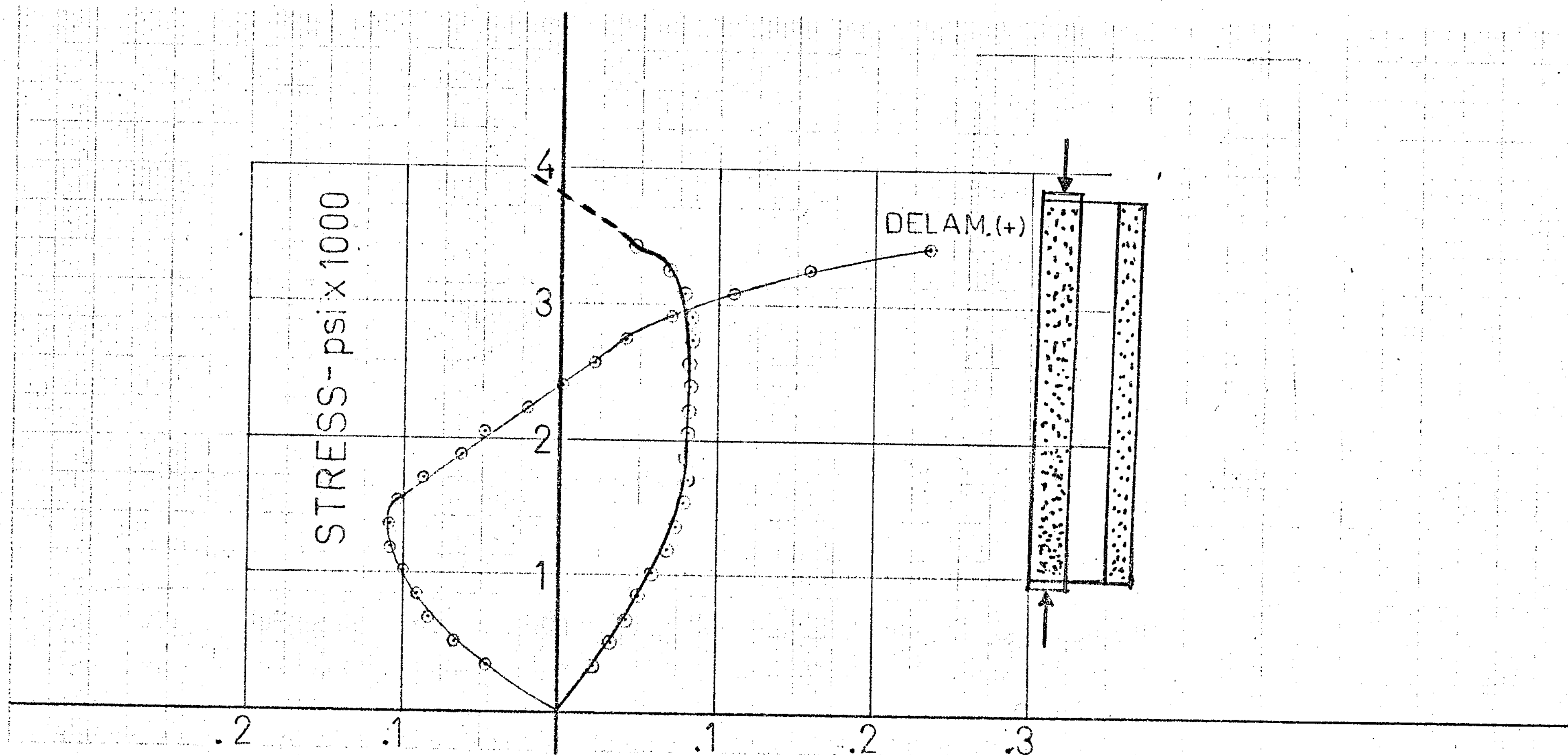


FIG. 34.



6-1 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 35.

Panel 6 - 2

Refer to fig. 34 for dimensions and reinforcement, and fig. 36 for load-strain characteristics.

As the load was applied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression due to the lateral deflection. There was less than 0.015 inches change in the center guages as the panel was loaded to 30 kips. The deflection then changed direction and the outside surface of the load bearing face went from compression to tension due to the change in the lateral deflection. The panel was loaded to 77 kips, or 3.2 ksi stress. The panel started to creep rapidly at this load and the guages were removed. The load dropped to 72.7 kips in about 5 minutes. The load was increased to 85.4 kips and failure occured. The non-bearing face did not crack through. The failure crack on the bearing face was 26 inches below center. Delamination occured from the bottom of the panel to about 6 inches below the center. The non-bearing face separated from the "Aerofoam" and bearing face for the bottom 6 inches of the panel. The bearing face then separated from the "Aerofoam" and non-bearing face for the next 15 inches. There was a joint in the "Aerofoam" at this position and the delamination again changed back to where the non-bearing face was alone. This type of separation continued until delamination was no longer visible (plate 23).

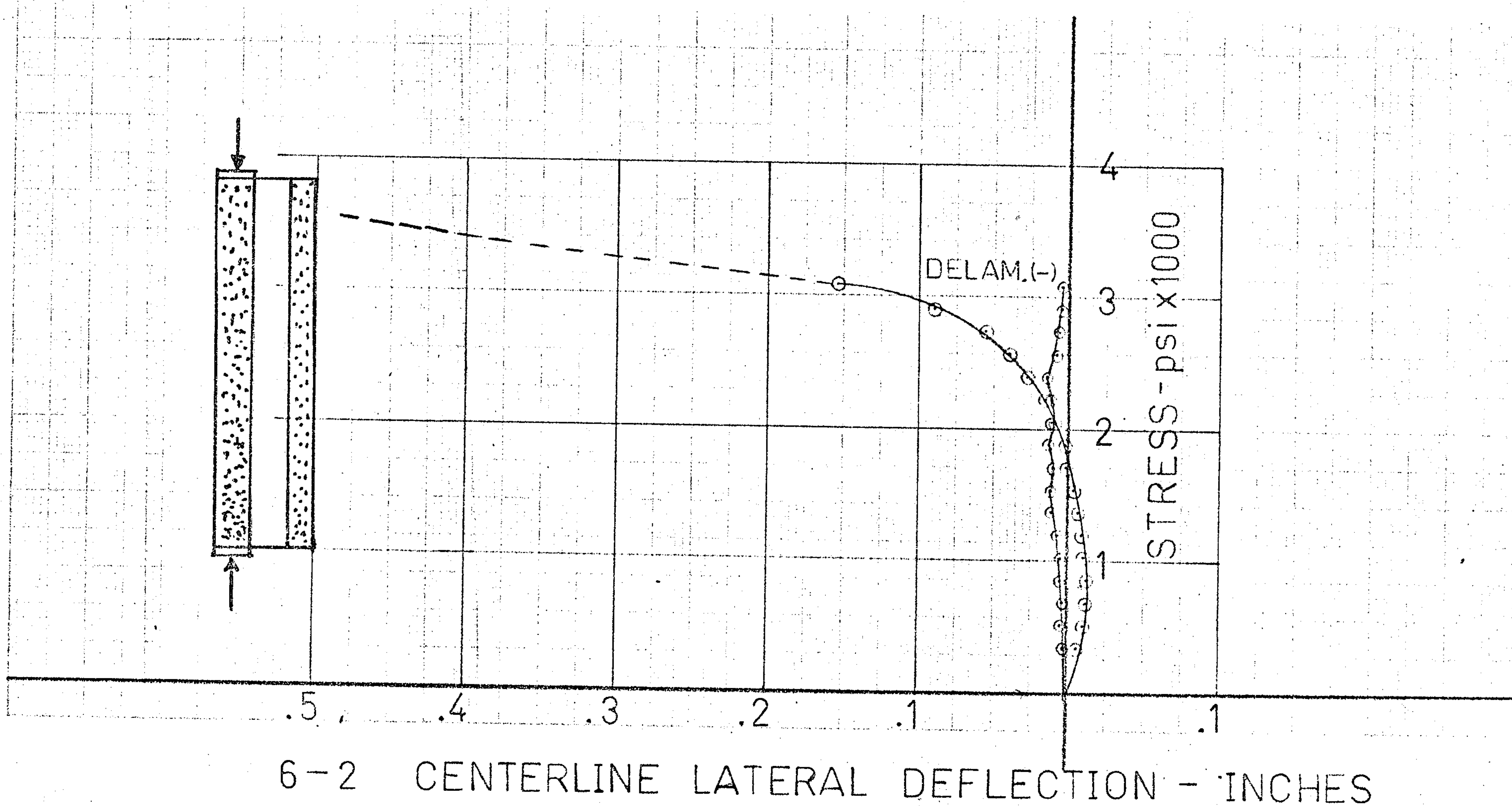

DELAM.(-)
STRESS - psi x1000
4
3
2
1
.5
.4
.3
.2
.1
.1
6-2 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 36.

Panel 6 - 3

Refer to fig. 34 for dimensions and reinforcement, and fig. 37 for load-strain characteristics.

As the load was applied the panel started to deflect outwards so that the outside surface of the load bearing face was being put into tension due to the lateral deflection. Delamination had started to occur, and was visible very early in the test. The deflection was greater than 0.46 inches at a load of 14.5 kips, or 0.6 ksi stress. Delamination of the bearing face from the "Aerofoam" and non-bearing face was visible from the center of the panel to the top. Numerous tension cracks appeared on the bearing face. These cracks were spaced from the center of the panel to within about 1 foot of the top. The deflection continued to increase rapidly as the load was applied. The guages were removed at a load of 24.3 kips, or 1.01 ksi stress. The deflection was greater than 0.7 inches at this load. The top part of the panel continued to delaminate and a gap of up to half an inch could be seen between the bearing face and the "Aerofoam". The panel failed in delamination at a load of 28.3 kips. At failure, there were as many as 14 tension cracks on the bearing face, none of which could be called a failure crack. There was no visible delamination of the bottom 4 feet of the panel (plate 24 and 25). The buckling of the panel was strictly from the center to the top, and all but one of the cracks on the load bearing face was above the center of the panel.

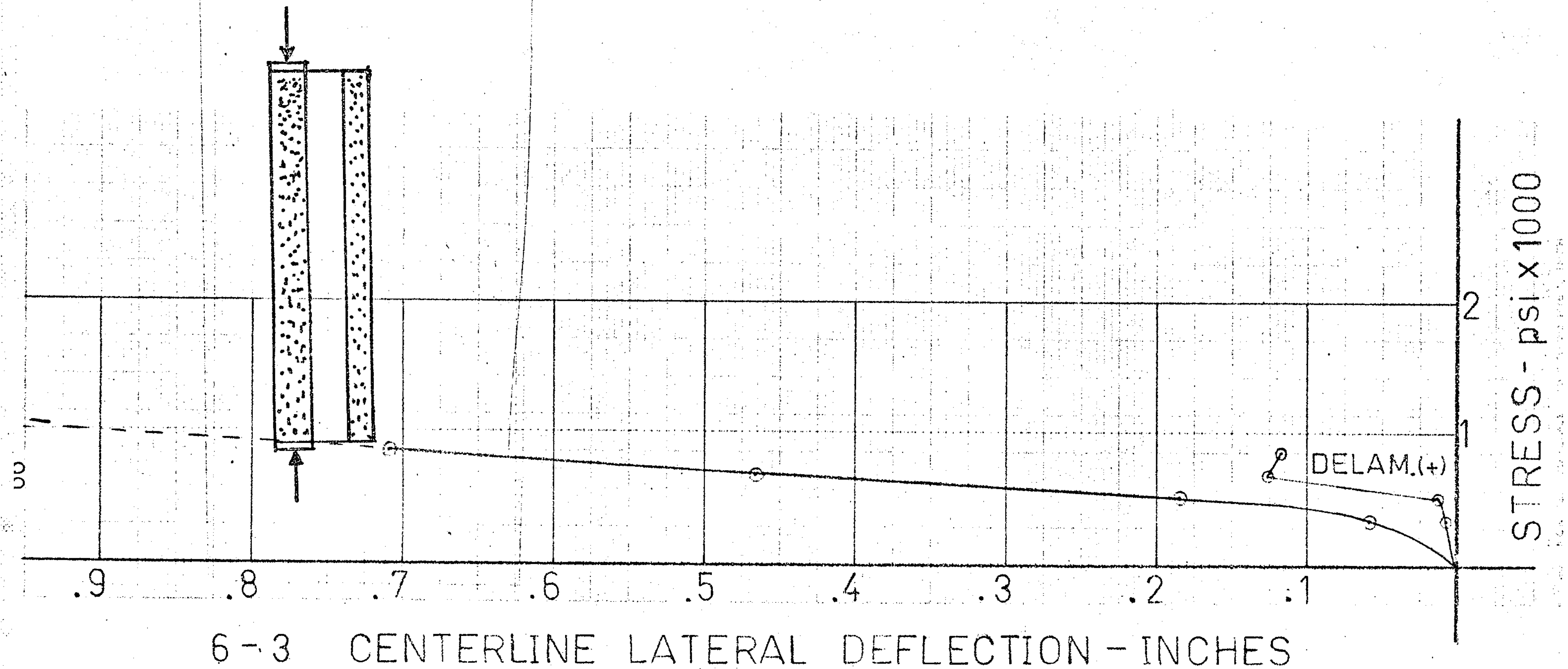

STRESS - psi x 1000
2
1
DELAM.(+)
.9
.8
.7
.6
.5
.4
.3
.2
.1
6-3 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 37.

Panel 3 - 1

Refer to fig. 38 for dimensions and reinforcement, and fig. 39 for load-strain characteristics.

As the load was applied the panel started to deflect outwards, so that the outside surface of the load bearing face was being put into tension due to the lateral deflection. The load started to drop off and the deflection started to creep, at a load of about 64 kips. The guages were removed at 72.7 kips, or 1.5 ksi stress. The load dropped off to 66.4 kips in 10 minutes. The panel was then loaded to 97.3 kips, or 2.0 ksi stress, at which load it failed. No cracks were noticed on the panel before failure. The panel completely delaminated, with the bearing face separating from the "Aerofoam" and non-bearing face. The bearing face broke through, 18 inches above the center. The non-bearing face did not break through, but did have two cracks—at 5 and 18 inches above the center (plate 26).

Group - 3

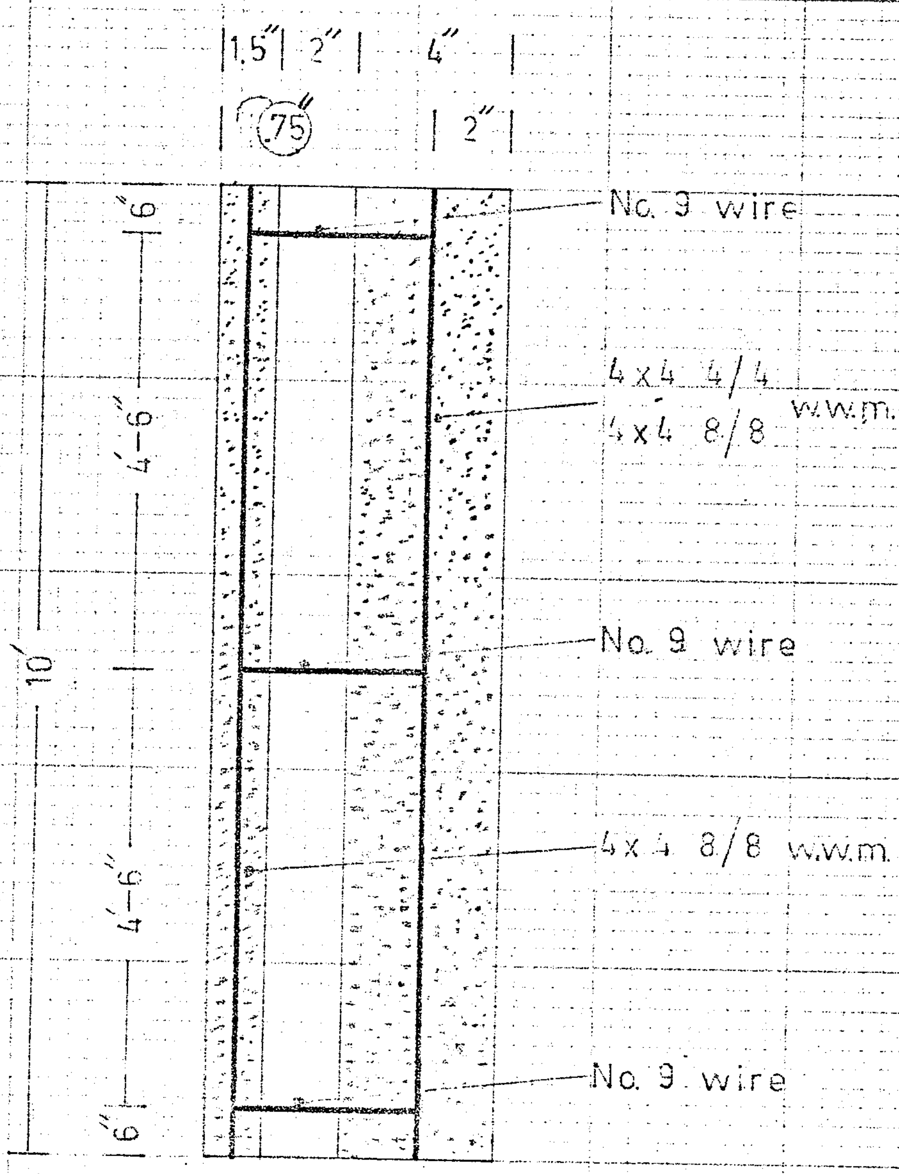
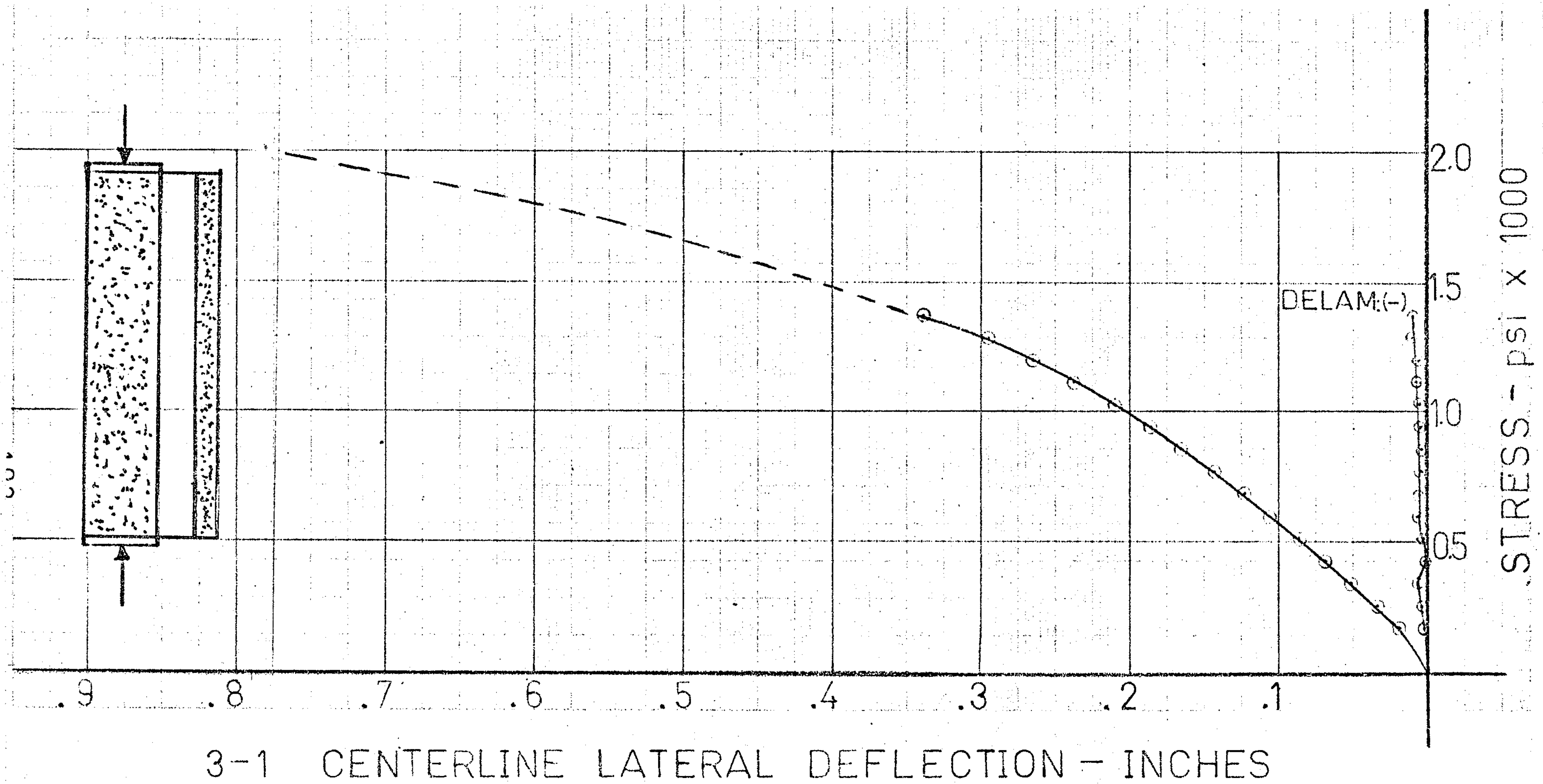


FIG. 38.



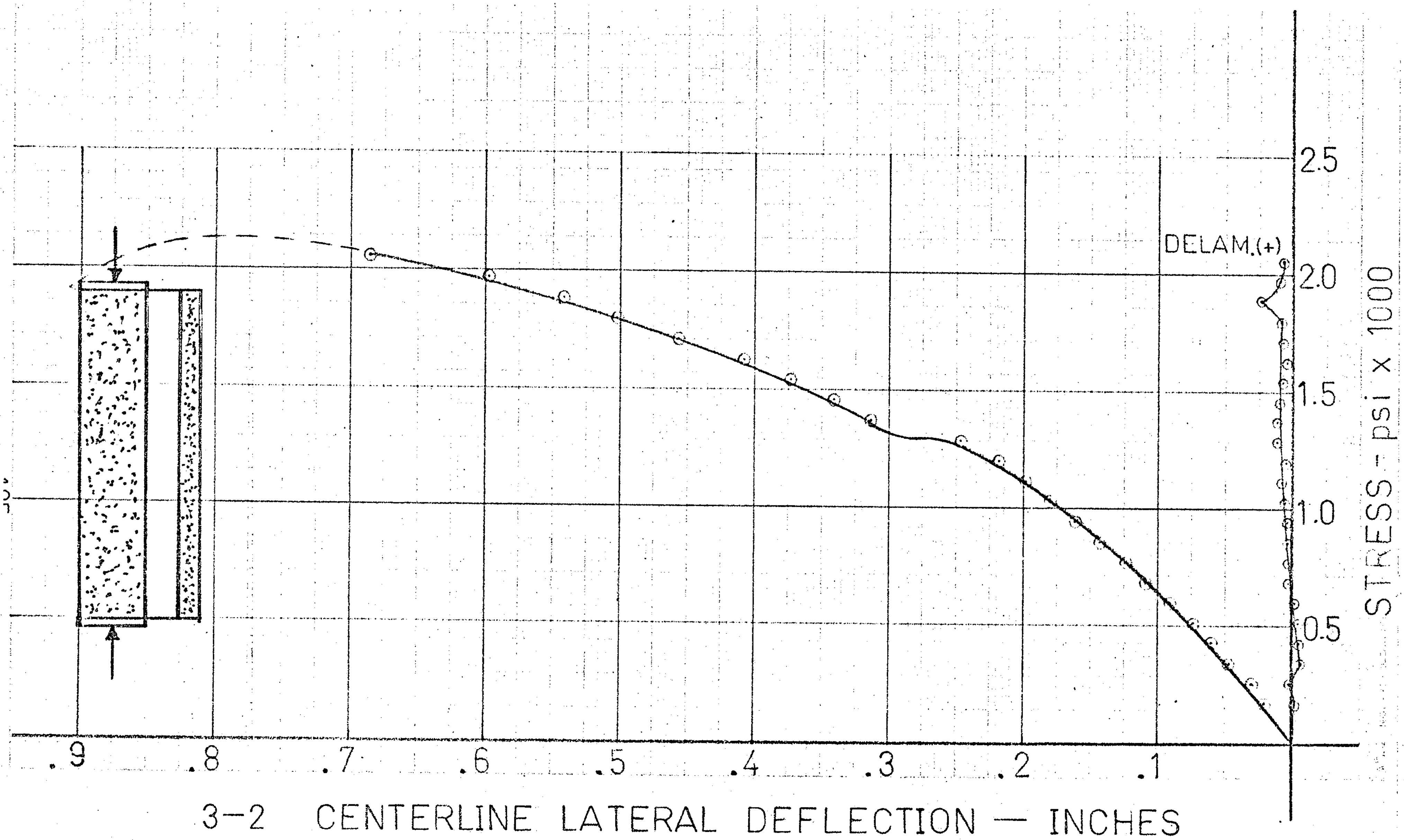
DELAM.(-)
2.0
1.5
1.0
0.5
STRESS - psi X 1000
.9
.8
.7
.6
.5
.4
.3
.2
.1
3-1 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 39.

Panel 3 - 2

Refer to fig. 38 for dimensions and reinforcement, and fig. 40 for load-strain characteristics.

As the load was applied the panel started to deflect outwards so that the outside surface of the load bearing face was being put into tension due to the lateral deflection. The load held well as the panel was loaded to 85 kips. The guages were removed at a load of 105.3 kips, or 2.2 ksi stress, as the deflection had started to increase rapidly. The deflection increased as the load continued to drop off. Numerous tension cracks appeared on the bearing face, from 1 foot below the center to 2 feet above the center. Delamination was visible at the top of the panel. The load dropped fairly quickly to 97.3 kips and then continued to drop off slowly. The load reached about 93.3 kips in 10 minutes, and the panel failed. Total delamination of the bearing face from the "Aerofoam" and non-bearing face occured. There were 18 tension cracks on the bearing face at failure. The failure crack was 10 inches above the center on the load bearing face. There were 4 cracks on the non-bearing face at 8 inches down from the center, and 4, 9, and 21 inches up from the center (plate 27).



DELAM.(+)
2.5
2.0
1.5
1.0
0.5
STRESS - psi x 1000
.9
.8
.7
.6
.5
.4
.3
.2
.1
3-2 CENTERLINE LATERAL DEFLECTION — INCHES

FIG. 40.

Panel 3 - 3

Refer to fig. 38 for dimensions and reinforcement, and fig. 41 for load-strain characteristics.

As the load was applied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression due to the lateral deflection. At a load of 64 kips, delamination of the top 2 to 3 feet of the panel became noticeable. The bearing face had separated from the "Aerofoam" and non-bearing face. The load was increased to 101 kips. A tension crack appeared on the non-bearing face, 6 inches above the center. The panel had started to creep at 101 kips and the guages were removed at 105 kips. The load was increased to 120 kips, or 2.5 ksi stress, and a picture was taken of the top part of the panel (plate 28). The load was then increased to 140.3 kips, at which load the panel failed. Total delamination occured with the bearing face separating from the "Aerofoam" and non-bearing face. The failure crack was 15 inches above center on the bearing face and 17 inches above center on the non-bearing face (plate 29).

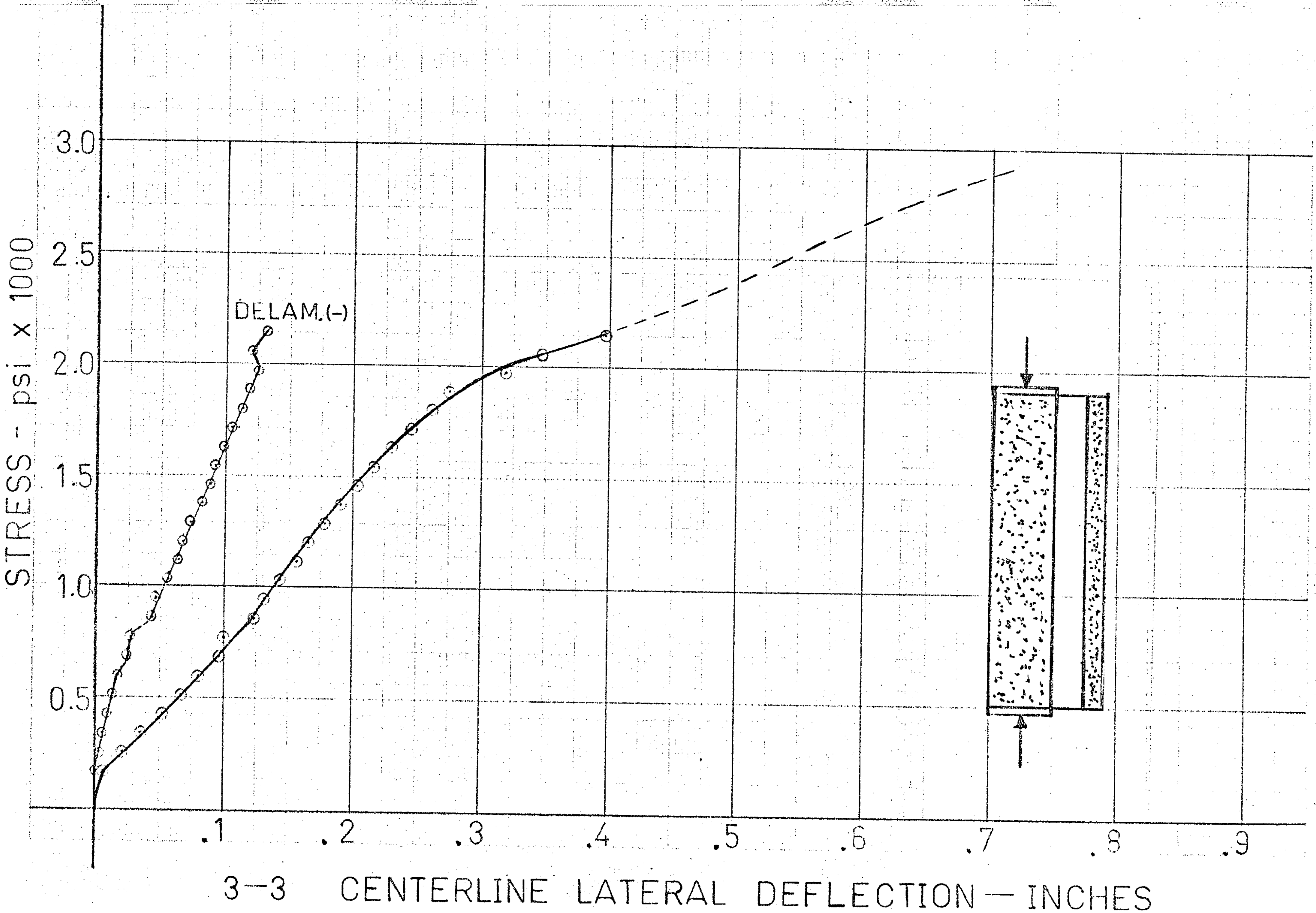

STRESS - psi x 1000
3.0
2.5
2.0
1.5
1.0
0.5
DELAM.(-)
.1
.2
.3
.4
.5
.6
.7
.8
.9
3—3 CENTERLINE LATERAL DEFLECTION — INCHES

FIG. 41.

Panel 1 - 1

Refer to fig. 42 for dimensions and reinforcement, and fig. 43 for load-strain characteristics.

As the load was applied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression due to the lateral deflection. A tension crack appeared, 10 inches up from the center on the non-bearing face, at a 25 kip load. The load was increased to 46 kips when another tension crack appeared on the non-bearing face, 21 inches above the center. The panel was then loaded to 60.3 kips, or 2.5 ksi stress. The deflection increased rapidly at this load. The guages were recorded and removed, while the panel was still creeping. Two tension cracks appeared on the non-bearing face, 7 and 22 inches below the center. The load dropped to 54.4 kips in 10 minutes, and the deflection appeared to have stopped. The panel was allowed to stand for one and a half hours.

The load had dropped to 49 kips by the end of this time. The load was then increased very quickly and the panel failed at a load of 52.4 kips. The panel buckled, with the failure crack occuring 1 inch above the center, on the non-bearing face, and right at the center on the bearing face. There was very slight visible delamination in the vicinity of the failure crack. A vertical crack ran between the bearing face and the "Aerofoam", for a distance of 1 to 2 feet on either side of the failure crack (plate 30).

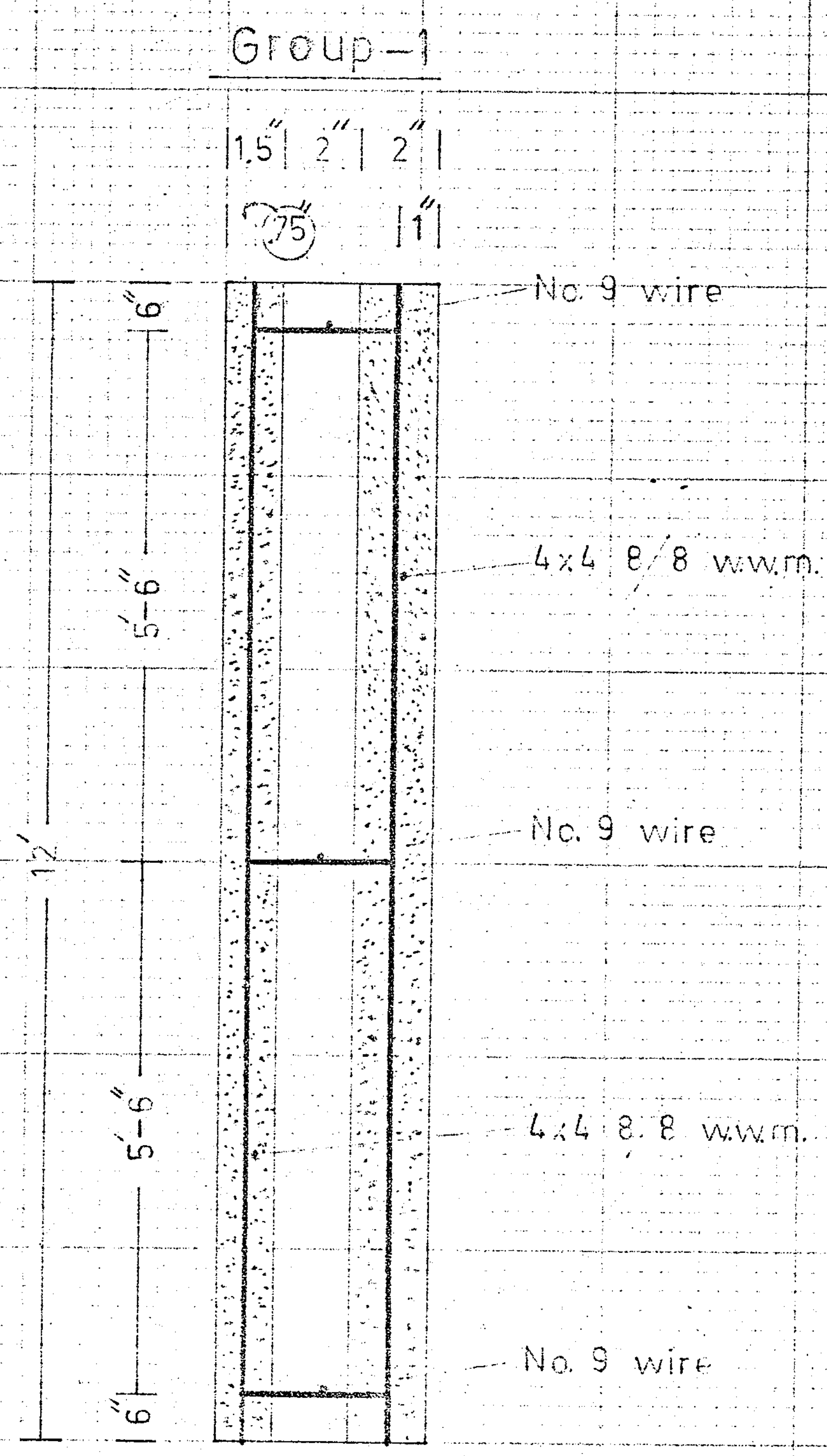

Group-1
1.5"
2"
2"
.75"
1"
6"
5'-6"
5'-6"
6"
12'
No. 9 wire
4x4 8/8 w.w.m.
No. 9 wire
4x4 8/8 w.w.m.
No. 9 wire

FIG. 42.

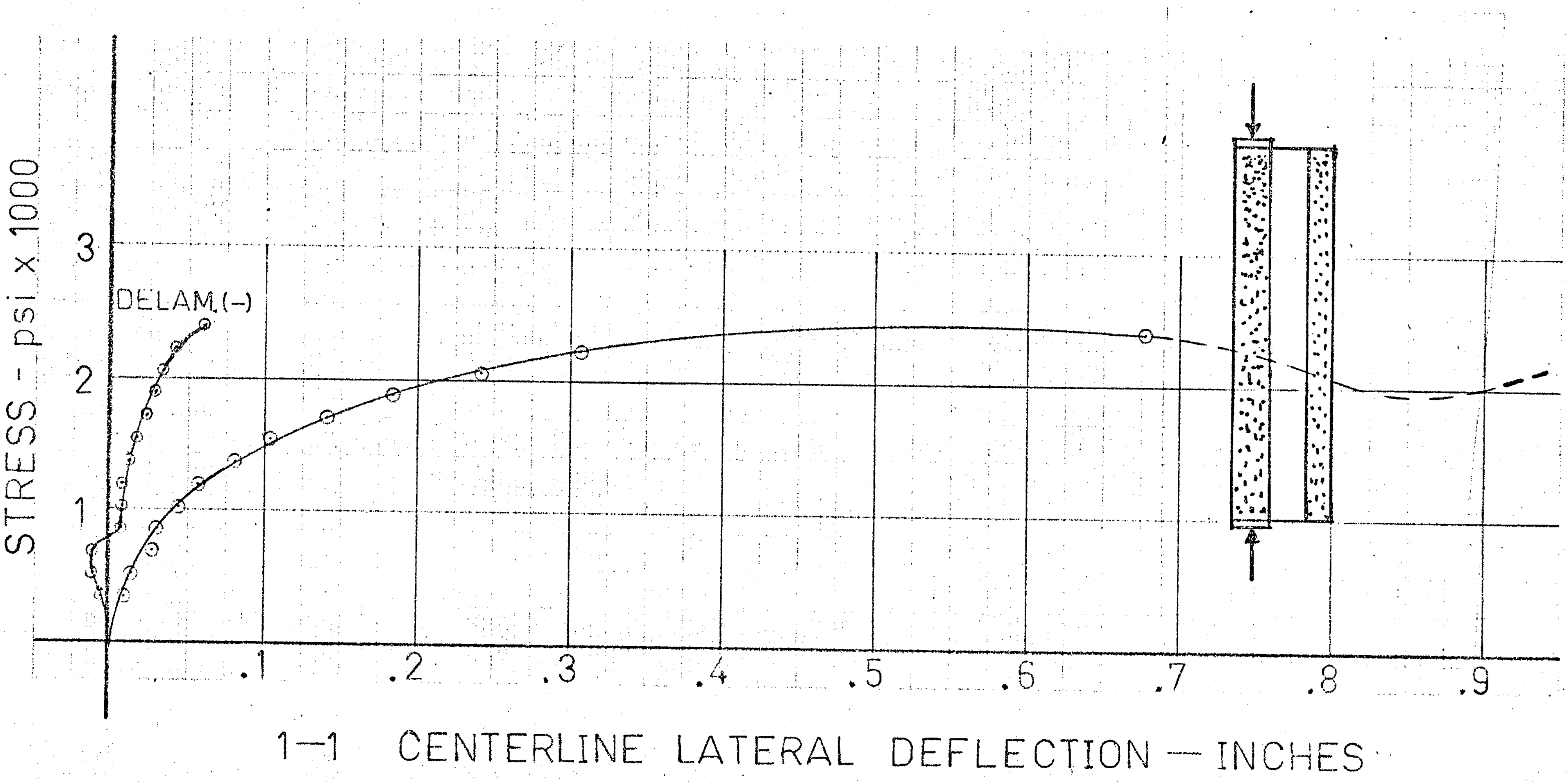
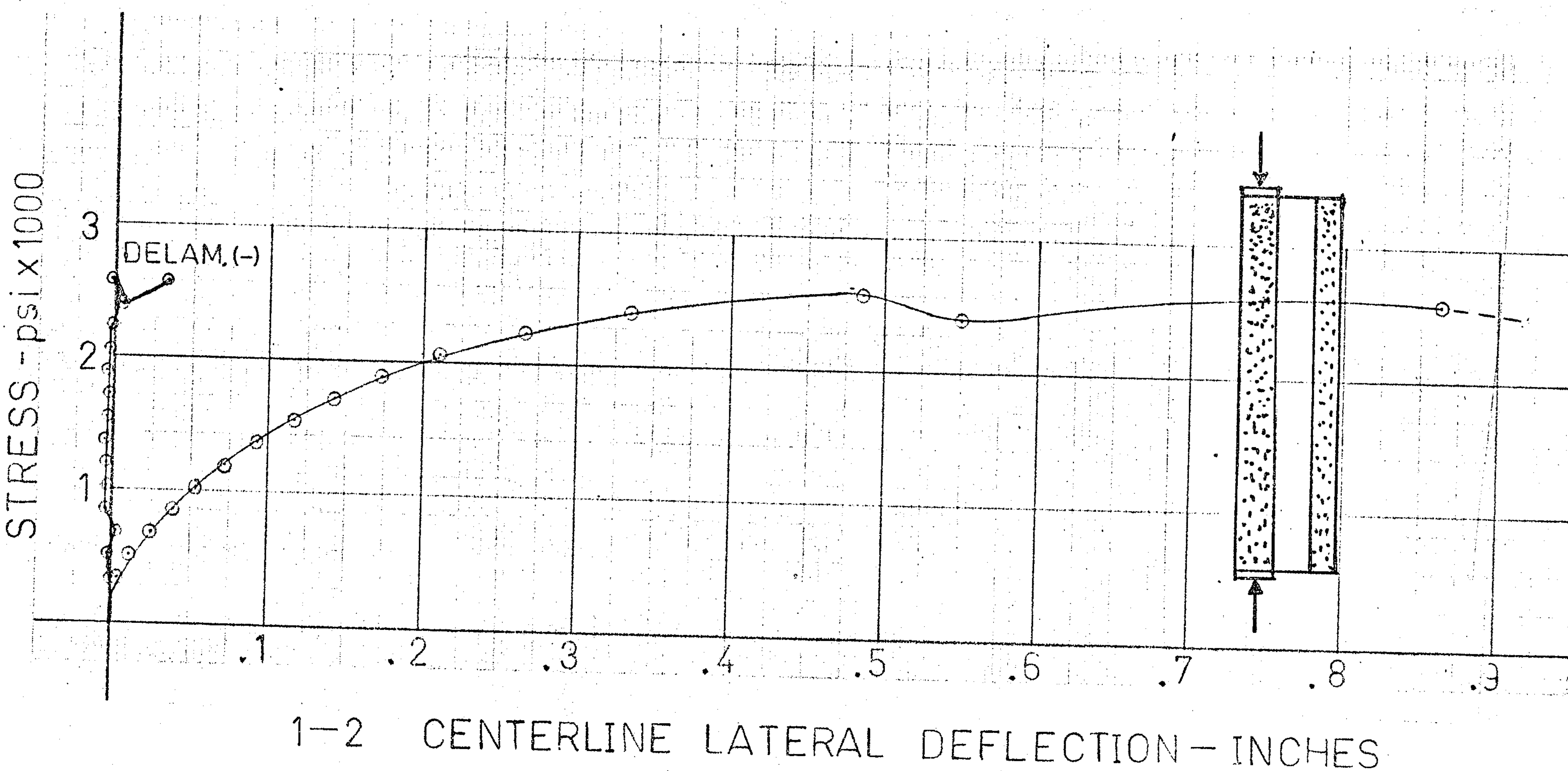

STRESS - psi x 1000
3
2
1
DELAM.(-)
.1
.2
.3
.4
.5
.6
.7
.8
.9
1—1 CENTERLINE LATERAL DEFLECTION — INCHES

FIG. 43.

Panel 1 - 2

Refer to fig. 42 for dimensions and reinforcement, and fig. 44 for load-strain characteristics.

As the load was applied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression due to the lateral deflection. The panel started to creep and the load started to drop off at a load of about 50 kips. The panel was loaded to 64.3 kips, or 2.7 ksi stress. Two tension cracks opened up on the non-bearing face, 14 inches on either side of the center. The load immediately dropped off and the panel began to creep quickly. The load dropped off to 61 kips in 10 minutes and was then reloaded to 64.3 kips. The deflection increased more than 0.3 inches during the reloading. Two more tension cracks appeared on the non-bearing face, 3 and 22 inches below the center. The top and bottom guages were removed, leaving only the center guages on the panel. The panel was allowed to stand for two hours. The load dropped to 52.4 kips and the guages increased by 0.3 inches during this time. The center guages were removed. The load was increased very quickly to 60 kips and the panel failed. Failure was mostly buckling along with some visible delamination. The failure crack was 3 inches below center on the bearing face and 2 inches below center on the non-bearing face. A splitting of the bearing face from the "Aerofoam" and non-bearing face was visible for about 3 feet up from the failure crack (plate 31).


STRESS - psi x 1000
3
2
1
DELAM.(-)
.1
.2
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.4
.5
.6
.7
.8
.9
1-2 CENTERLINE LATERAL DEFLECTION - INCHES

FIG. 44.

Panel 1 - 3

Refer to fig. 42 for dimensions and reinforcement, and fig. 45 for load-strain characteristics.

As the load was applied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression due to the lateral deflection. A tension crack was noticed on the non-bearing face, at a load of 36.4 kips. The crack was 13 inches above the center and only went half way through the section. A similar crack was noticed at a load of 52.4 kips. This crack was 15 inches below the center on the non-bearing face. As the load reached 60.3 kips, or 2.7 ksi stress, another crack opened on the non-bearing face. This crack went through the entire section and was 2 inches above the center. The two other cracks also cracked through the entire section at 60.3 kips. The load dropped off to 58.3 kips in 10 minutes. The panel was creeping fairly quickly and the guages were removed (plate 32). The load continued to drop to 53 kips. The panel was then reloaded to 64.3 kips, when failure occured. The panel broke completely in two. The failure cracks were 8 inches below center on the bearing face and 7 inches below center on the non-bearing face. There was no visible delamination in the bottom part of the panel. The top part of the panel appeared to be almost completely delaminated, with the bearing face splitting from the "Aerofoam" and non-bearing face.

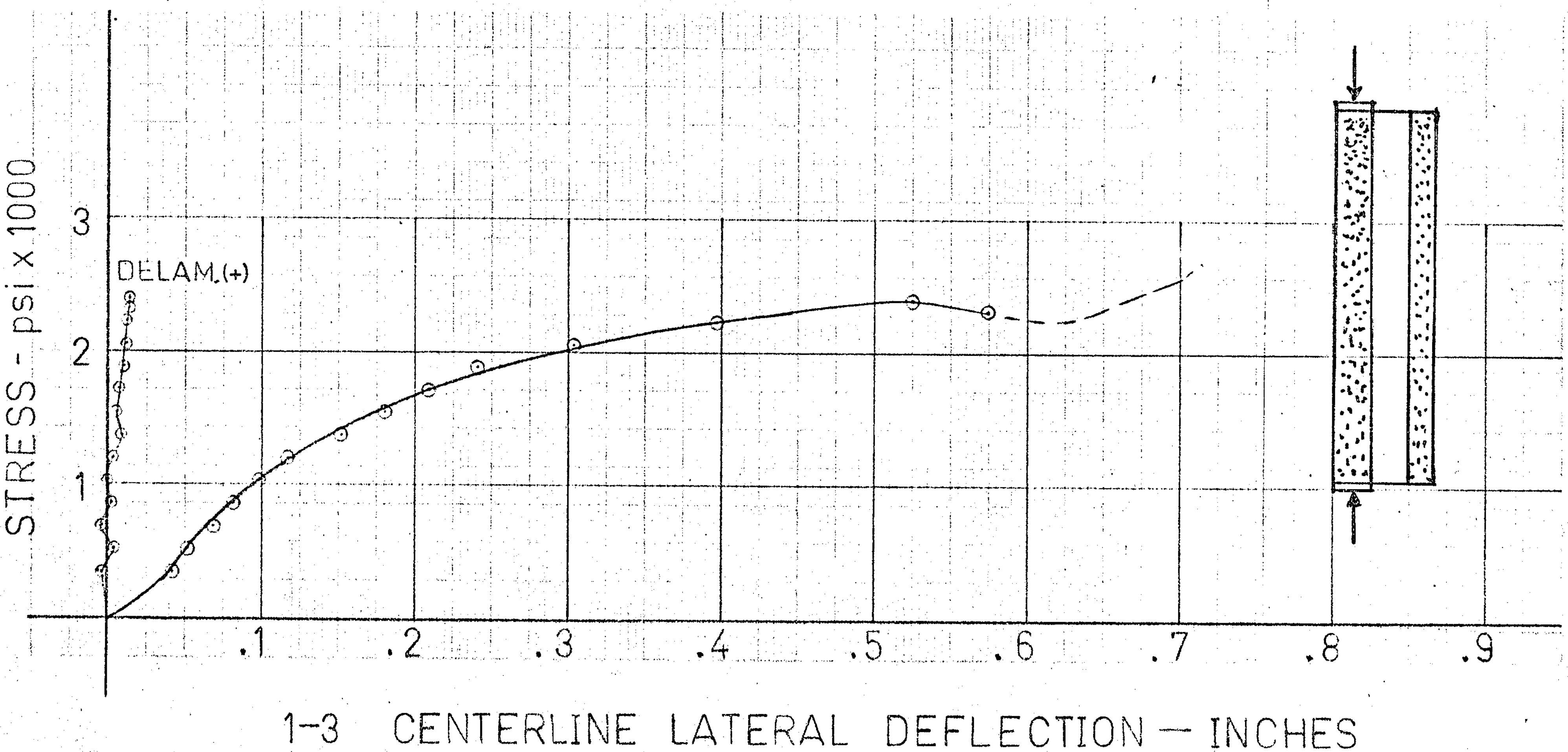

STRESS - psi x 1000
3
2
1
DELAM.(+)
.1
.2
.3
.4
.5
.6
.7
.8
.9
1-3 CENTERLINE LATERAL DEFLECTION — INCHES

FIG. 45.

Panel 2 - 1

Refer to fig. 46 for dimensions and reinforcement, and fig. 47 for load-strain characteristics.

This panel had a number of shrinkage cracks on the non-bearing face. These cracks were about half way through the section and did not run to either edge. They were situated at 40, 33, 25, and 13 inches below the center, and 7 inches above the center. As the load was applied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression due to the lateral deflection. At a load of 85.4 kips, the crack 7 inches above the center had cracked through to one edge. The cracks at 7 inches above center and 13 inches below center were cracked through the entire section, at a load of 152 kips (plate 33). The load was increased to 163.9 kips, or 3.4 ksi stress. All the original shrinkage cracks went through and another one opened up at 22 inches above the center, on the non-bearing face. The load dropped to 156 kips in 25 minutes. Another crack opened 2 inches below the center, on the non-bearing face. As soon as this crack opened, the deflection increased 0.04 inches. The load continued to drop off and had reached 150 kips in an hour and a half. The panel was then unloaded and removed from the frame.

Group - 2

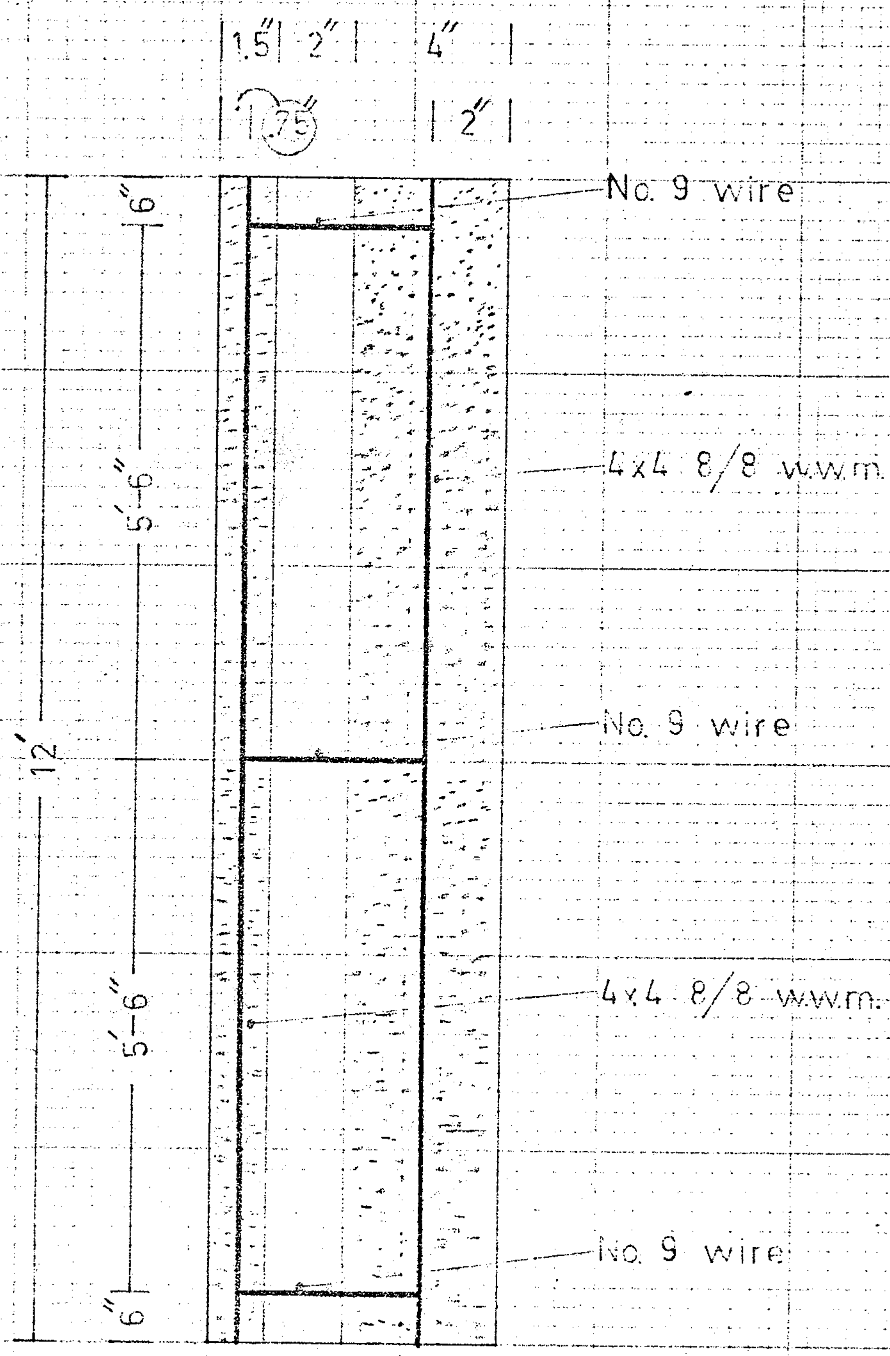


FIG. 46.

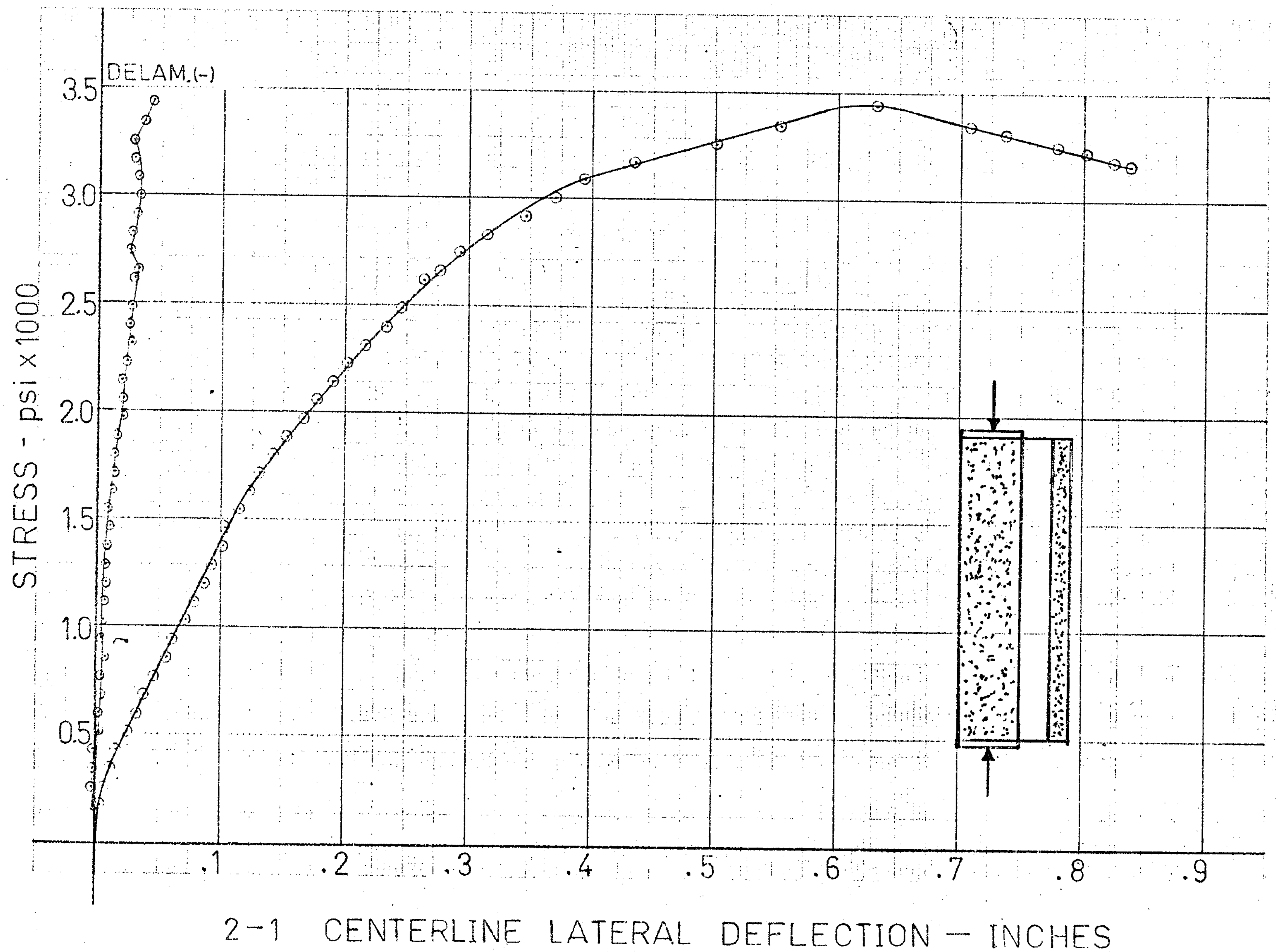

DELAM.(-)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
STRESS - psi x 1000
.1
.2
.3
.4
.5
.6
.7
.8
.9
2-1 CENTERLINE LATERAL DEFLECTION - INCHES

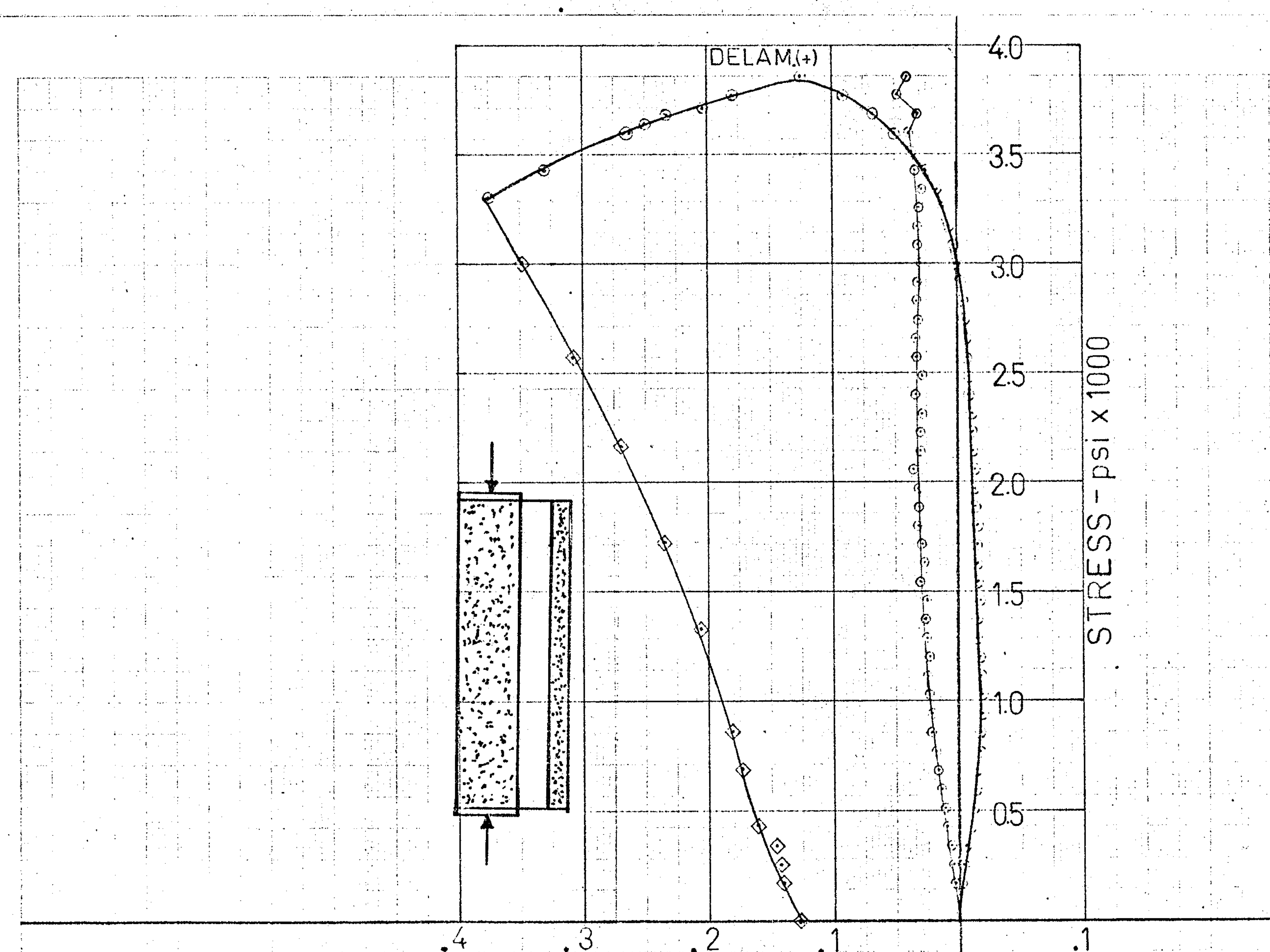
FIG. 47.

Panel 2 - 2_1

Refer to fig. 46 for dimensions and reinforcement, and fig. 48 for load-strain characteristics.

As the load was applied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression due to the lateral deflection. There was a very small increase in deflection as the panel was loaded. The deflection was less than 0.02 inches at a load of 44 kips, or 0.9 ksi stress. As the load was increased from 44 kips, the deflection changed direction and the panel started to move back towards the original position. The panel was still moving back towards the original position at a load of 105 kips. The load had started to drop off slightly, but the panel had not started to creep, at a load of 125 kips. The panel passed through its original position at a load of 144 kips, or 3.0 ksi stress. The panel began to creep very slowly at a load of 164 kips. The panel was loaded to

184.6 kips, or 3.85 ksi stress, and allowed to stand for 18 hours. The load dropped to 158 kips and the deflection increased 0.25 inches during the 18 hours. The panel was unloaded in 20 kip increments, and the deflection recorded. There was a permanent set of 0.125 inches at the center of the panel. There was no visible evidence of delamination having occured, and there were no cracks anywhere on the panel. The panel was taken out of the test frame, rotated 180° about the vertical axis, and replaced in the test frame to be retested as panel number $2 - 2_2$ (plate 34).



$2\text{--}2_1$ CENTERLINE LATERAL DEFLECTION — INCHES

FIG. 48.

Panel 2 - 2_2

Refer to fig. 46 for dimensions and reinforcement, and fig. 49 for load-strain characteristics.

As the load was applied the panel started to deflect inwards so that the outside surface of the load bearing face was being put into compression due to the lateral deflection. There was a fairly small increase in deflection, as the panel was loaded. The deflection was less than 0.06 inches at a load of 96 kips, or 2.0 ksi stress. As the load was increased from 96 kips, the deflection changed direction and the panel started to move back towards the original position. The load started to drop off slowly at a load of about 144 kips, or 3.0 ksi stress. The panel had started to creep slowly at a load of 154 kips. The panel passed through the original position at a load of 162 kips, or 3.4 ksi stress. The panel was loaded to 176.3 kips, or 3.7 ksi stress, and allowed to stand. The load dropped to 172.2 kips in 6 minutes, and the guages were removed. The load dropped off to 163.5 kips during the next hour and a half. The panel was quickly loaded to 182.5 kips, when failure occured. The failure was a combination of delamination and buckling. The bearing face separated from the "Aerofoam" and non-bearing face for the top 5 feet of the panel. The failure crack was 33 inches above the center on the non-bearing face, and 28 inches above center on the bearing face. A small amount of concrete blew out around the failure crack, on the bearing face.

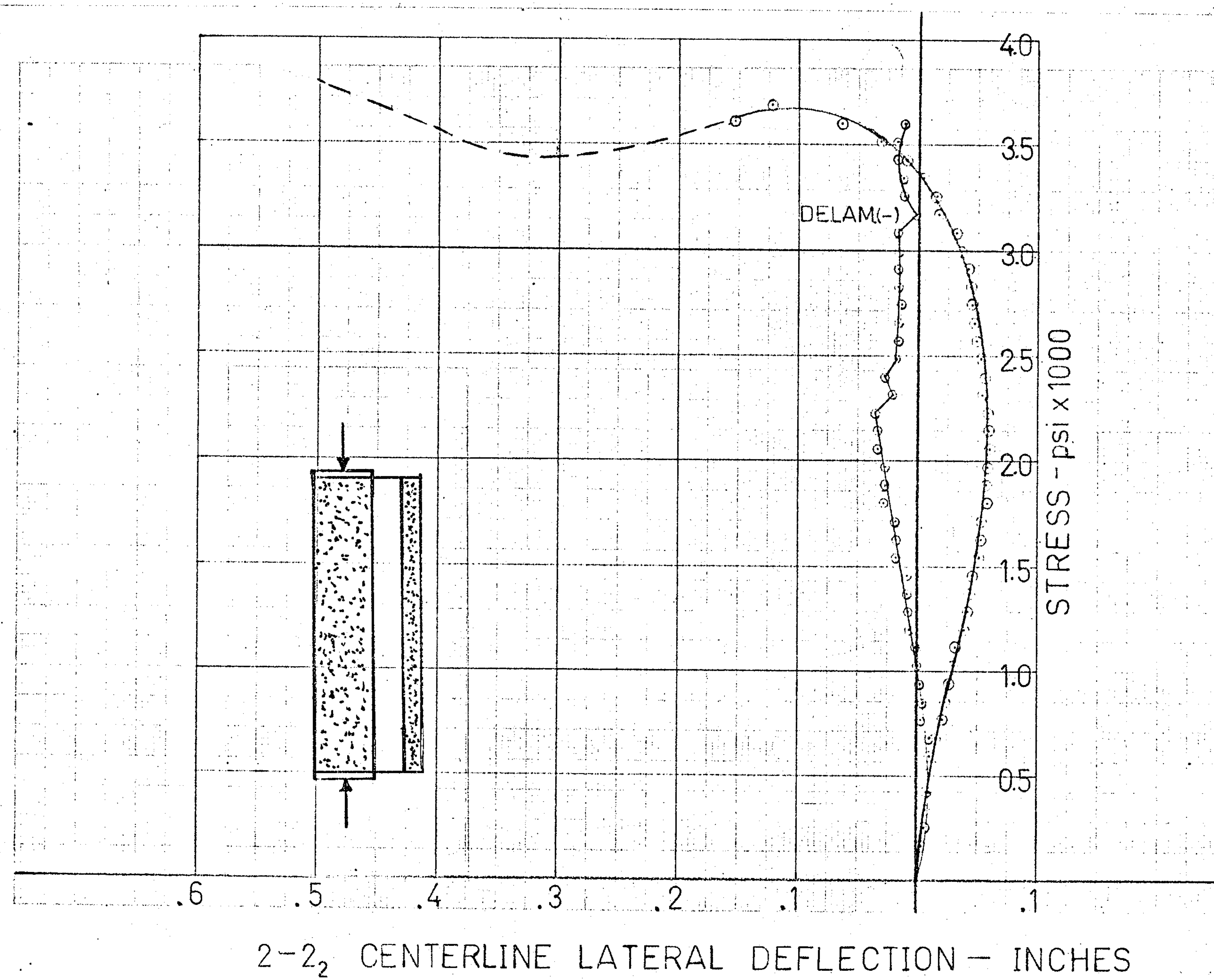

DELAM(-)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
STRESS - psi x 1000
.6
.5
.4
.3
.2
.1
.1
2-2₂ CENTERLINE LATERAL DEFLECTION — INCHES

FIG. 49.

6.2 Panel Deflection

Analyzing any one particular panel as a whole, one would expect the deflection to be away from the load bearing face due to the eccentric load, such that it would be put into compression due to the lateral deflection. As is evident from the Stress - Deflection graphs, this happened in only 15 of the 31 tests. In 12 of the 31 tests, the deflection was such that the load bearing face was put into tension and in the remaining 4 of the 31 tests, the deflection was such that the load bearing face went from compression to tension. This behaviour is perhaps best explained by looking at the load bearing face itself. As far as the load bearing face is concerned, it has no preference as to which way it will deflect. If we now look at the panel as a whole, it is evident that it will deflect into that shape which requires the least energy to assume. In order for the load bearing face to deflect inwards and be put into compression, a shear stress will be set up all along the interface between the load bearing face and the "Aerofoam" insulation. If the bond between the "Aerofoam" insulation and the concrete load bearing face is strong enough, a shear stress should be set up and the panel should deflect in, so that the load bearing face goes into compression. If, on the other hand, the bond between the "Aerofoam" insulation and the concrete load bearing face is, for some reason, not strong enough, it may require less energy to break the bond between the insulation and concrete rather than set up a shear stress all along it. This should result in a separation of the insulation from the load bearing face, at the center of the panel. The load bearing face should then deflect out, and the outside surface would thus be placed into tension due to the lateral deflection. This explanation appears to be backed up by a majority of the test results. Ten of the 12 panels that deflected out, such that the load bearing face went into tension, did actually separate at the interface between the "Aerofoam" insulation and the concrete load bearing face. Nine of the

15 panels that deflected in, such that the load bearing face went into compression, did actually compress the insulation between the two concrete faces. One of the panels that deflected in so that the load bearing face was put into compression had the insulation compressed at the start of the test, but it then separated from the concrete load bearing face as the panel deflection reversed direction. Three of the 4 panels that went from compression into tension had the insulation compressed.

As has already been stated in the discussion of each individual test, there was a fair amount of cracking in over half of the panels. In most cases cracks would appear on the non-bearing face well before the ultimate load was reached. These cracks, would in turn cause an increase in deflection. Yet, if loading had been ceased at the first appearance of cracking, the panels would easily have been able to maintain that load. This is backed up by the fact that, even with the cracking and deflection, the panels were still able to maintain increasing loads. The panels, as a whole, exhibited a fairly good ductile behaviour, being able to maintain fairly substantial loads, when conditions were such that there were many surface cracks and increasing deflections.

In a solid panel, when a crack appears on the tension surface the ultimate capacity of the panel is close at hand. If more load was applied, the crack would continue to get larger and failure would most certainly occur. This, however, is not necessarily the case with load bearing sandwich panels. If a sandwich panel has deflected (so that the outside surface of the load bearing face has been put into tension due to the lateral deflection), and a crack occurs on the load bearing face, the ultimate capacity of the panel may still be a long way off. As further load is applied, the deflection will continue to increase and the crack will go further into the concrete section. As this happens, the concrete area of the load bearing face through which the load is transferred, gets smaller. This increases the compressive stress in the vicinity of the crack. As the deflection increases, the bending stress in the vicinity of the crack also increases. (It is this type of action which in a solid panel causes failure immediately following the opening of a crack.)

The test panels deflected such that there were tension cracks on the load bearing face in 15 of the tests. In 12 of these tests the cracks did not appear until immediately before failure. In the remaining 3 tests however, (these being 9 - 1, 10 - 1, and 6 - 3) there was a difference of more than 400 psi between the stress at which the cracks opened and the stress at which the panels failed. This would seem to indicate that there was some sort of a stress transfer between the load bearing and non-bearing faces. It is most probable that some of the bending stress was transferred through the "Aerofoam" insulation and into the concrete non-bearing face in the vicinity of the cracks.

6.3 Panel Height

From the graphs of f_{ult}/f'_c vs h/t_b and h/t_t, figs. 50, and 51, the scatter makes it difficult to draw any one particular line. The same comment is applicable to the graphs of f_{ult}/F_a and f_{ult}/f_{cr} vs Height, Fig. 52. Bearing the results of these graphs in mind, the author believes it would be safe to assume that, in the height range of 8 to 12 feet, or h/t_t from 12 to 27, the change in height, or h/t_t ratio, did not make a very large difference in the ultimate stress that the panels took. The general downward trend that would be expected in the ultimate stress, as the h/t ratio increased did not appear to any great extent in the test results.

6.4 Reinforcement Ratio

From the results of the graph of f_{ult}/F_a and f_{ult}/f_{cr} vs Steel Ratio, fig. 53, the author believes it would be safe to assume that increasing the steel in the load bearing face does not increase the ultimate stress of the panel at all. The panels with minimum steel were as strong, if not stronger, than those with two and three times the steel in the load bearing face. The only difference, if any, that the increase in steel appeared to make was a slight reduction in the panel's deflection. In 19 of the 29 panels, cracks appeared long before the ultimate load was reached. Five of the six 8 foot panels and four of the five 12 foot panels, all having minimum steel, cracked early in the tests. Three of the six 10 foot panels, having minimum steel cracked early in the tests. Three of the six 10 foot panels having 2 times minimum steel cracked early in the tests, and two of the six 10 foot panels having 3 times minimum steel, cracked early in the tests.

6.5 Shear Connectors

The presence of only minimal shear connectors in all the test panels did not cause any problems, even with the fairly large loads. The shear connectors not only hold the two concrete faces together, they also act to control the location of cracks. In a large majority of the panels, the closest crack to the center of the panel was 2 inches, and in no case did failure occur within 1 inch of the center. In panel 6 - 3 (plate 24), the upper half of the panel delaminated and numerous cracks appeared on it. Both the delamination and cracking had pretty well ceased at the center of the panel. The control on the delamination and cracking is believed to have been caused by the presence of a shear connector at the center of the panel.

6.6 Insulation

As is evident from the graphs fig. 1, 2, 4, and 6, of which the results are shown in Table 3, "Styrofoam" has better qualities as a core material than "Aerofoam", for use in load bearing sandwich panels. It is the belief of the author that delamination of panels would be greatly reduced and the f_{ult} values much less scattered if "Styrofoam" had been used rather than "Aerofoam" in the test panels.

Table 3

	E_{comp} psi	G_c psi	$E_{tension}$ psi
"Styrofoam"	750	625	850
"Aerofoam"	210	454	330

The delamination, in all but two isolated cases, was such that the load bearing face separated from the "Aerofoam" insulation and the non-bearing face. The two exceptions happened for about 2 feet at the bottom of panels 4 - 1 and 6 - 2. In both cases, the "Aerofoam" insulation had a joint at the spot where it separated from the non-bearing face. It is for this reason that the author recommends the use of continuous pieces of insulation in the manufacturing of load bearing sandwich panels.

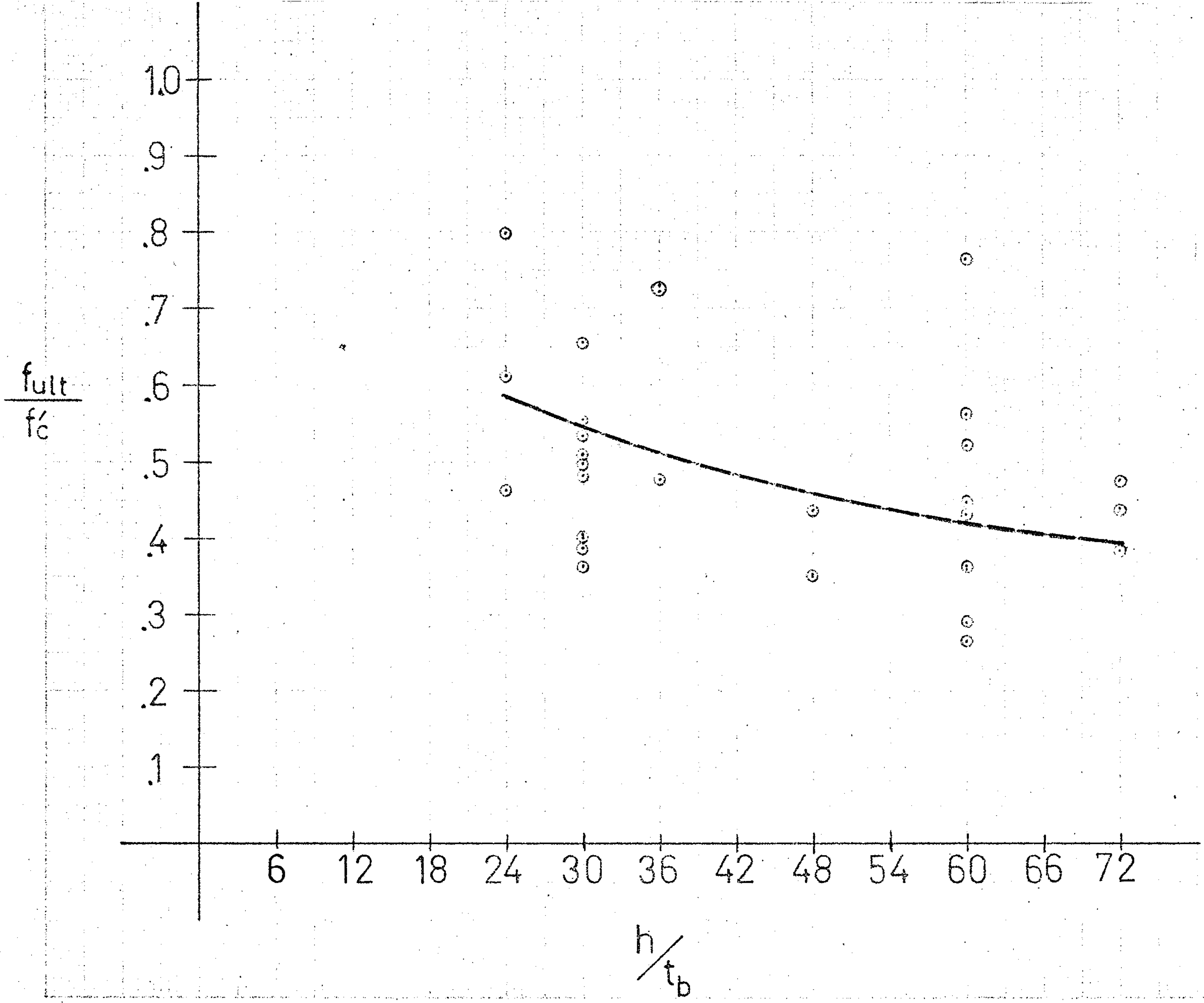


FIG. 50.

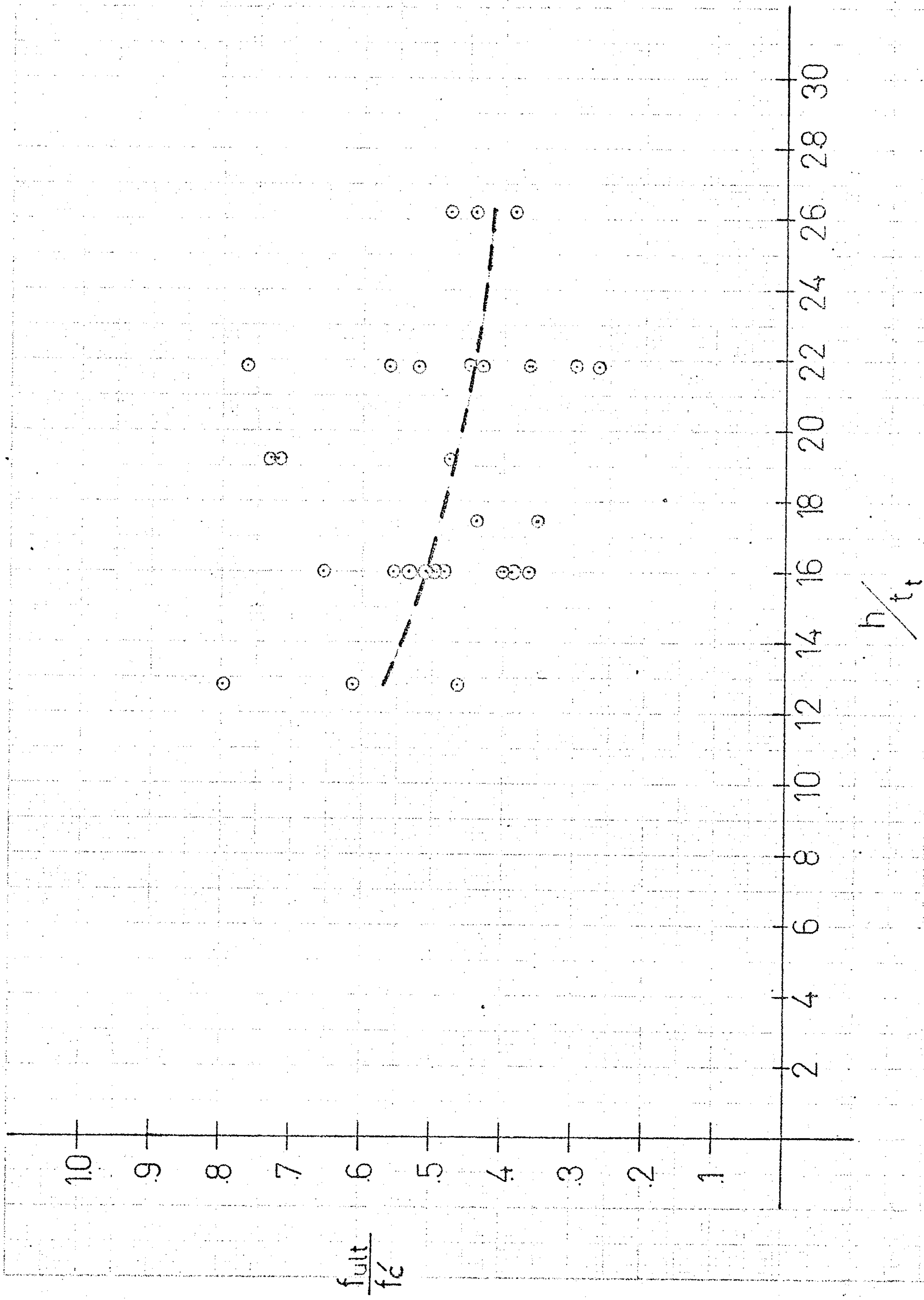
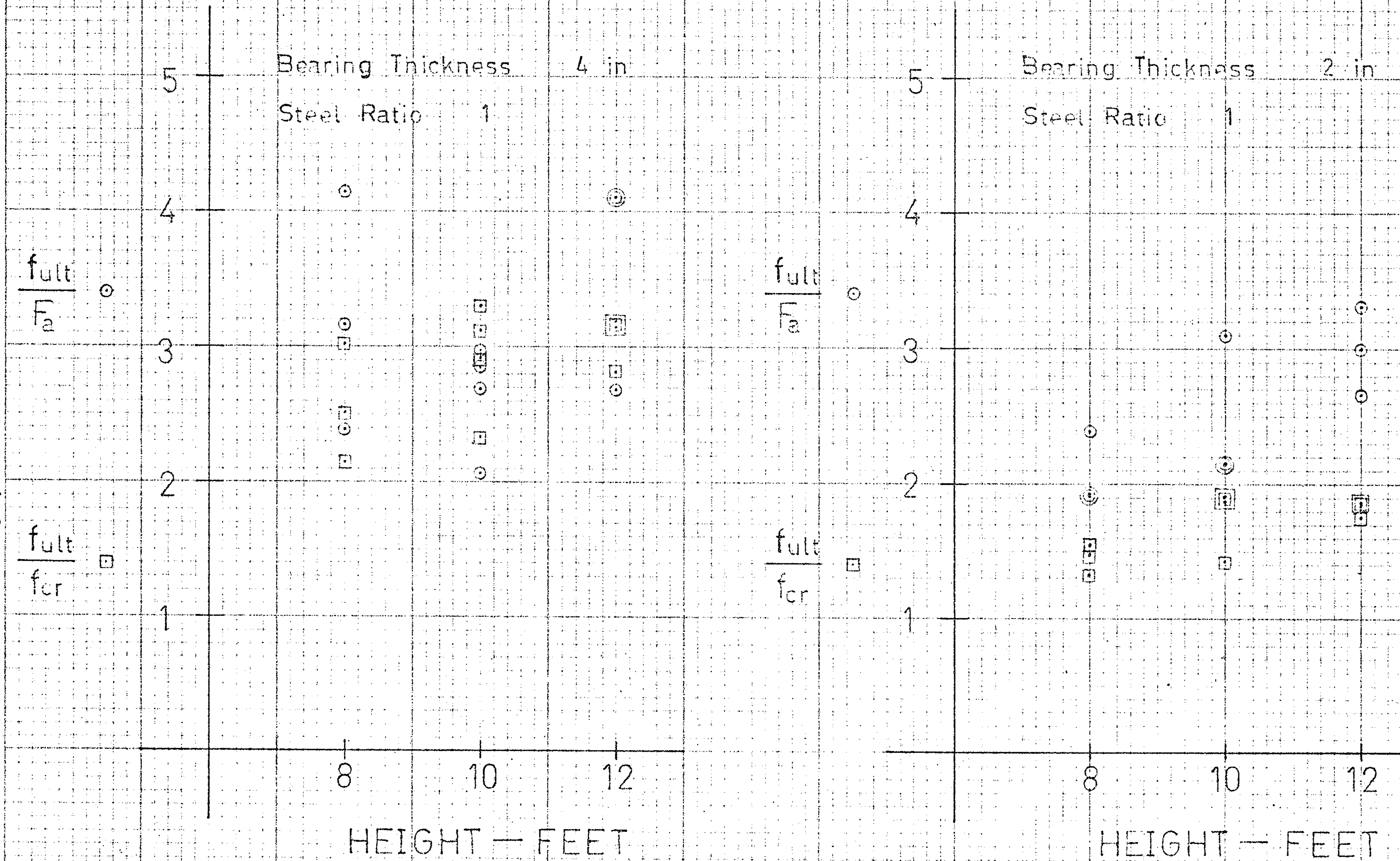


FIG. 51.



Bearing Thickness 4 in
Steel Ratio 1
$\frac{f_{ult}}{F_a}$
$\frac{f_{ult}}{f_{cr}}$
5
4
3
2
1
8
10
12
HEIGHT — FEET
Bearing Thickness 2 in
Steel Ratio 1
$\frac{f_{ult}}{F_a}$
$\frac{f_{ult}}{f_{cr}}$
5
4
3
2
1
8
10
12
HEIGHT — FEET

FIG. 52.

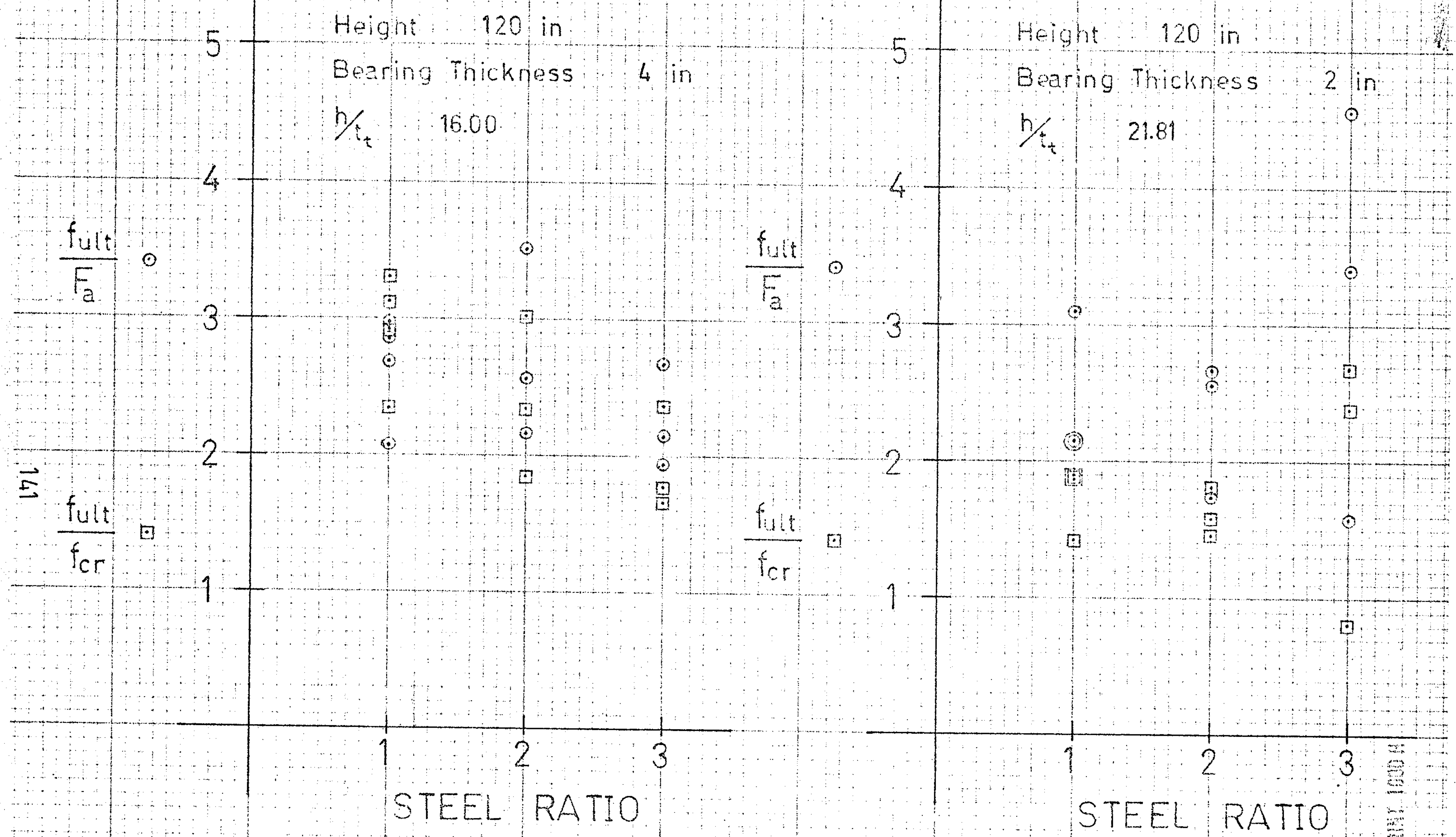

Height 120 in
Bearing Thickness 4 in
h/tt 16.00
fult/Fa
fult/fcr
5
4
3
2
1
1
2
3
STEEL RATIO
Height 120 in
Bearing Thickness 2 in
h/tt 21.81
fult/Fa
fult/fcr
5
4
3
2
1
1
2
3
STEEL RATIO

FIG. 53.

6.7 Load Prediction

It is the belief of the author that the A. C. I. formula, $F_a = .2\, f'_c \left[1 - \left(\frac{h}{40\, t_e}\right)^3\right]$, is really not applicable for design loads on load bearing sandwich panels. The results shown in Table 1, show that the only way to get reasonable values for F_a is to use the entire panel thickness as t_e in the formula. This leads to safety factors, $\frac{f_{ult}}{F_a}$, which vary from 1.58 to 4.10, with 20 of 31 falling under the value of 3.00.

The use of this formula for design purposes would raise the question as to what to use for the value of t_e. As has been stated, reasonable values of F_a result when the entire panel thickness is used as t_e. The $\frac{h}{t_e}$ values range from 12.80 to 26.20 for these cases. Carrying this idea to an extreme, it would be quite possible to design a panel which had a very thick insulation core, but relatively thin concrete face, and hence a fairly low $\frac{h}{t_e}$ ratio. This would lead to a fairly high F_a value, when, in fact, the panel may not be safe under that particular design load.

A more reasonable approach towards a design formula appears to be the use of a modified version of Dr. E. Krynick's formula for f_{cr}. Using one half of f_{cr} as a design loads yields safety factors as shown in Table 2. These values range from 1.62 to 6.60 where only 5 of 31 are below 3.00 and 4 of these five are above 2.60. The value of 1.62 comes from test panel 6 - 3, which as has been previously stated, delaminated and failed at a very low stress and is not believed to have been an average test panel.

The author would therefore like to propose, for design, the use of:

$$f_{design} = \frac{f_{cr}}{2}$$

which gives a mean safety factor of 4.31 for this series of tests.

Table 2

PANEL	f_{ult} psi	$.5\ f_{cr}$ psi	S. F.
9 - 1	2265	762	2.98
9 - 2	2350	759	3.10
9 - 3	2015	760	2.64
10- 1	2685	624	4.30
10- 2	3505	622	5.02
10- 3	3765	624	6.02
8 - 1	2770	738	3.76
8 - 2	2855	748	3.80
8 - 3	2100	741	2.84
5 -11	3850	618	6.24
5 -12	3635	618	5.86
5 - 2	4090	618	6.60
5 - 3	2885	618	4.68
7 - 1	2350	739	3.18
7 - 2	2680	741	3.62
7 - 3	2180	747	2.92
4 - 1	2885	615	4.68
4 - 2	2275	615	3.70
4 - 3	3720	615	6.04
6 - 1	3975	738	5.38
6 - 2	3560	743	4.78
6 - 3	1180	733	1.62
3 - 1	2030	610	3.32
3 - 2	2195	614	3.56
3 - 3	2935	618	4.74
1 - 1	2515	714	3.52
1 - 2	2680	724	3.70
1 - 3	2680	720	2.72
2 - 1	3420	608	5.62
2 -21	3850	603	6.38
2 -22	3805	603	6.30

6.8 Code Restrictions

Load bearing sandwich panels go unmentioned in both Canadian and American building codes. The closest the codes come to load bearing sandwich panels is to mention load bearing walls. The National Building Code of Canada 1965[5], places the following restrictions on load bearing walls:

"4.5.8.3 (1)

(a) for walls subject to compression over the whole of the critical section the average compressive stress shall not exceed

$$f_c = 0.225\ f'_c \left[1 - \left(\frac{h}{40\ t}\right)^3\right]$$

where h = vertical distance between supports

t = thickness of walls

(4) Bearing walls shall have a thickness of at least 1/25 of the unsupported height or width, whichever is the shorter."

The A. C. I. counterpart to the N. B. C. formula for compressive stress has been discussed in sections 5 and 6.7. These formulas differ by 12.5%, due strictly to the use of $0.200\ f'_c$ in the A. C. I. formula and $0.225\ f'_c$ in the N. B. C. formula. The comments made in sections 5 and 6.7 on the A. C. I. formula also apply to the N. B. C. formula.

In order to get a positive value from the $\left[1 - \left(\frac{h}{40\ t}\right)^3\right]$ part of the formula a minimum t of more than 2.4, 3.0, and 3.6 inches must be used on 8, 10, and 12 foot panels respectively. Using a t of 1/25 of the unsupported height results in minimum t values of 3.84, 4.80, and 5.76 inches for the 8, 10, and 12 foot panels respectively. This restriction alone would allow the use of only the three 8 foot panels which had a 4 inch load bearing face.

As is apparent from the panel test results, all of the panels carried substantial loads, and could definitely be used to advantage in the construction industry.

It appears to the author that the current code restrictions for load bearing walls are not strictly applicable to load bearing sandwich panels.

VII. CONCLUSIONS

The equation $F = (.2 \text{ or } .225)\ f'_c \left[1 - \left(\frac{h}{40\ t_e}\right)^3\right]$ is not applicable to load bearing sandwich panels. The results obtained are overly conservative and in some cases yield negative values to panels which had a fairly high ultimate strength.

A modified version of Dr. E. Krynicki's equation for the critical stress per running foot, $\frac{P_{cr}}{t_b} = \frac{(n\pi)^2\ D\ S}{Sl^2 + (n\pi)^2\ D}$, gave much more reasonable results when applied to the test panels. This equation can be readily applied after a simple lab test has been performed to obtain the value of the shear modulus of the core material, G_c.

The use of one half of the value obtained from Dr. E. Krynicki's equation, as a design stress, appeared to give relatively good safety factors to all panels tested.

The results of the tests performed on both the "Styrofoam" and "Aerofoam" core material suggest the use of "Styrofoam" in load bearing sandwich panels, due to its higher G_c value of 0.625 ksi, as compared to 0.454 ksi for "Aerofoam".

There was no marked change in the load carrying abilities of panels which had variations in height of from 96 to 144 inches, or variations in $\frac{h}{t_t}$ of from 12 to 27, or variations in the reinforcement ratio in the load bearing face of from 1 to 2 to 3.

The results of the panel tests themselves indicate the practicality of using load bearing sandwich panels.

VIII. RECOMMENDATIONS

It is the recommendation of the author that further tests on load bearing sandwich panels of similar and increased height, and $\frac{h}{t_t}$ ratios be conducted to:

Substantiate the use of $\frac{f_{cr}}{2}$ as the design stress per running foot.

Investigate panel behaviour with more and different kinds of shear connectors.

Investigate panel behaviour with steel ratios less than that allowed by the code.

Investigate the effect of creep and shrinkage on delamination and deflection of panels under long term loading.

Investigate the long term effect of high variations in termperature on the outside face of the panels.

The author would also like to recommend the consideration of adoption of load bearing sandwich panels into the codes along with their own set of design restrictions.

IX. APPENDICES

9.1 Appendix A: Load - Deflection Readings

Guages 1, 2, and 3, were on the load bearing face. Guages 4, 5, and 6, were on the non-load bearing face. Guages 1 and 4 were on the centerline of the panel, 6 inches down from the top. Guages 3 and 6 were on the centerline of the panel, 6 inches up from the bottom. Guages 2 and 5 were at the center of the panel.

The data had to be broken down before the stress vs deflection graphs could be drawn. The movement of guages 1 and 3 had to be averaged to see how their motion affected the movement of guage 2. If their motion was in the same direction as that of guage 2 the averaged value was subtracted from the guage 2 reading. If the averaged value of guages 1 and 3 was in the opposite direction as that of guage 2 it was added to the guage 2 reading. The same procedure was followed with guages 4, 5, and 6. The final difference between the guage 2 and guage 5 reading was also plotted on the stress vs deflectiom graphs.

Panel 9 - 1

Poured - July 25/69 Tested - August 7/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	5-00	10-00	6-00	5-00	15-00	3-00
400	10.00	.42	-03	-33	-10	4-98	14-69	2-91
600	15.00	.62	-06	-54	-27	-95	-50	-75
800	20.00	.83	-09	-65	-40	-94	-41	-63
1000	24.25	1.01	-12	-80	-54	-86	-26	-49
1200	28.28	1.18	-21	11-02	-70	-73	-02	-22
1400	32.32	1.35	-25	-24	-75	-68	13-82	-16
1600	36.36	1.51	-33	-62	-82	-56	-39	-05
1800	40.40	1.68	-41	12-14	-87	-44	12-88	1-94
2000	44.44	1.85	-49	-66	-92	-33	-34	-85
2200	48.41	2.02	-65	13-91	7-03	-05	11-05	-59
2400	52.38	2.18	5-81	15-23	7-18	3-77	9-73	1-31

Panel 9 - 2

Poured - July 29/69 Tested - August 11/69

LOAD			GUAGE READINGS					
PUMP psi	ACTUAL kips	STRESS ksi	(inches X 10^{-3}) 1	2	3	4	5	6
0	0	0	6-00	10-00	5-00	7-00	10-00	12-00
400	10.00	.42	-06	-40	-05	6-95	9-60	11-93
600	15.00	.62	-11	-77	-10	-89	-24	-85
800	20.00	.83	-15	11-13	-18	-83	8-83	-77
1000	24.25	1.01	-19	-44	-24	-78	-49	-68
1200	28.28	1.18	-23	-84	-32	-73	-09	-59
1400	32.32	1.35	-26	12-17	-38	-68	7-73	-50
1600	36.36	1.51	-29	-57	-45	-62	-30	-40
1800	40.40	1.68	-32	13-05	-53	-54	6-83	-25
2000	44.44	1.85	-37	-65	-65	-44	-19	-03
2200	48.41	2.02	-41	14-45	-80	-31	5-38	10-78
2400	52.38	2.18	-48	15-45	6-05	-15	4-38	-43
2200	48.41	2.02	-55	16-60	-34	-01	3-24	-03
2400	52.38	2.18	-59	17-62	-36	5-92	2-14	9-93
2600	56.35	2.35	6-65	19-62	6-63	5-77	0-10	9-55

Panel 9 - 3

Poured - July 28/69

Tested - August 12/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	7-00	12-00	20-00	1-00	5-00	5-00
400	10.00	.42	6-95	11-45	19-85	-08	-51	-16
600	15.00	.62	-87	-04	-71	-17	-91	-35
800	20.00	.83	-73	10-13	-46	-35	6-84	-61
1000	24.25	1.01	-64	9-50	-26	-46	7-43	-89
1200	28.28	1.18	-56	-02	-02	-55	8-02	6-19
1250	29.29	1.22	-45	8-21	18-52	-64	9-71	8-00
1200	28.28	1.18	-45	-10	-51	-65	-84	-05
1150	27.27	1.14	-44	-00	-48	-65	-95	-15
1100	26.26	1.10	-44	7-94	-46	-65	10-00	-20
1200	28.28	1.18	-43	-85	-45	-66	-08	-24
1400	32.32	1.35	-40	-42	-37	-70	-50	-54
1600	36.36	1.51	-34	6-42	-20	-77	11-48	9-28
1800	40.40	1.68	6-25	5-03	17-98	1-86	12-80	10-80

Panel 10 - 1

Poured - July 29/69 Tested - August 14/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	4-00	3-00	4-00	5-00	15-00	12-00
400	10.00	.21	-02	-18	-02	4-98	14-82	11-98
600	15.00	.31	-06	-38	-10	-95	-60	-87
800	20.00	.42	-10	-65	-24	-91	-32	-69
1000	24.25	.51	-14	-90	-34	-87	-09	-56
1200	28.28	.59	-18	4-13	-43	-83	13-86	-47
1400	32.32	.67	-21	-34	-49	-80	-66	-40
1600	36.36	.76	-24	-56	-57	-76	-43	-34
1800	40.40	.84	-28	-81	-64	-58	-16	-27
2000	44.44	.93	-31	5-03	-69	-51	12-94	-22
2200	48.41	1.01	-34	-27	-76	-44	-69	-14
2400	52.38	1.09	-36	-48	-83	-37	-47	-05
2600	56.35	1.17	-38	-68	-88	-31	-25	-00
2800	60.32	1.25	-40	-87	-94	-25	-03	10-90
3000	64.29	1.34	-42	6-09	-94	-20	11-86	-85
2800	60.32	1.25	-43	-25	5-02	-14	-69	-76
3000	64.29	1.34	-44	-38	-03	-12	-58	-72
3200	68.51	1.43	-45	-49	-05	-09	-44	-66
3400	72.73	1.52	-46	-66	-06	-06	-32	-62
3600	76.95	1.60	-47	-84	-08	-01	-13	-54
3800	81.17	1.69	-48	7-01	-15	3-96	10-93	-44
4000	85.39	1.78	-49	-27	-21	-89	-72	-34
4200	89.36	1.86	-51	-50	-31	-82	-43	-20
4400	93.34	1.94	-53	-80	-36	-75	-17	-11
4600	97.32	2.03	-54	8-05	-46	-69	9-90	9-96
4800	101.30	2.11	-55	-40	-55	-60	-56	-81
5000	105.27	2.20	-58	-84	-72	-48	-09	-56
5200	109.21	2.28	-58	9-12	-80	-42	8-82	-43
5400	113.15	2.36	-60	-48	-93	-34	-43	-21
5600	117.09	2.44	-61	-92	6-04	-27	7-99	8-99
5800	121.03	2.52	-62	10-50	-21	-18	-41	-71
6000	124.97	2.60	-63	11-19	-39	-07	6-75	-39
5800	121.03	2.52	-65	-60	-52	-02	-34	-21
6000	124.97	2.60	-65	-92	-61	2-97	5-98	-04
6200	128.81	2.68	-67	12-65	-84	-85	-26	7-67
6000	124.97	2.60	-67	13-12	-96	-80	4-77	-60
6200	128.81	2.68	-69	-60	7-10	-74	-30	-34
5600	117.09	2.44	-73	15-48	-64	-61	3-49	6-46
5500	115.12	2.40	-74	-80	-75	-58	-19	-31
5400	113.15	2.36	-74	16-12	-83	-58	2-90	-22
5375	113.00	2.36	-74	-32	-89	-57	-71	-13
4930	103.90	2.16	-77	17-09	8-14	-52	1-96	5-73

Panel 10 - 1 (con't)

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
4900	103.28	2.15	-77	-10	-14	-51	-95	-71
5000	105.27	2.20	-77	-22	-17	-50	-83	-67
5200	109.21	2.28	-78	-44	-22	-48	-59	-57
5400	113.15	2.36	-78	-97	-30	-43	-04	-41
5600	117.09	2.44	4-78	18-60	8-45	2-38	0-43	5-12

Panel 10 - 2

Poured - July 30/69 Tested - August 20/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	5-00	14-00	4-00	1-00	2-00	5-00
400	10.00	.21	4-95	13-29	3-63	-06	-61	-16
600	15.00	.31	-91	-14	-63	-11	-74	-20
800	20.00	.42	-81	12-99	-62	-15	-87	-22
1000	24.25	.51	-84	-88	-62	-19	-98	-23
1200	28.28	.59	-80	-73	-63	-23	3-11	-22
1400	32.32	.67	-77	-63	-64	-27	-20	-20
1600	36.36	.76	-75	-53	-65	-30	-31	-23
1800	40.40	.84	-72	-40	-66	-33	-39	-20
2000	44.44	.93	-70	-31	-69	-36	-46	-15
2200	48.41	1.01	-68	-25	-73	-37	-52	-09
2400	52.38	1.09	-66	-17	-77	-40	-64	-03
2600	56.35	1.17	-65	-03	-78	-42	-77	-01
2800	60.32	1.25	-64	11-98	-80	-43	-80	4-95
3000	64.29	1.34	-63	-92	-83	-44	-86	-90
3200	68.51	1.43	-62	-85	-86	-45	-90	-86
3400	72.73	1.52	-61	-78	-88	-46	-96	-81
3600	76.95	1.60	-60	-71	-91	-47	4-00	-80
3800	81.17	1.69	-59	-64	-94	-48	-05	-78
4000	85.39	1.78	-58	-56	-97	-49	-12	-72
4200	89.36	1.86	-57	-40	-97	-51	-25	-73
4400	93.34	1.94	-57	-35	4-00	-52	-31	-68
4600	97.32	2.03	-56	-27	-02	-53	-35	-67
4800	101.30	2.11	-55	-18	-07	-54	-41	-59
5000	105.27	2.20	-54	-05	-10	-55	-51	-59
5200	109.21	2.28	-54	10-99	-14	-56	-56	-53
5400	113.15	2.36	-53	-89	-18	-57	-63	-51
5600	117.09	2.44	-53	-81	-22	-58	-70	-45
5800	121.03	2.52	-52	-71	-26	-59	-76	-43
6000	124.97	2.60	-51	-59	-30	-59	-88	-35
5750	120.05	2.50	-51	-43	-28	-61	5-05	-37
5450	114.16	2.38	-50	-16	-24	-62	-35	-42
5600	117.09	2.44	-50	-10	-24	-63	-40	-41
5800	121.03	2.52	-50	-06	-25	-63	-43	-42
6000	124.97	2.60	-49	-00	-27	-63	-48	-35
6200	128.81	2.68	-48	9-90	-30	-64	-51	-36
6400	132.64	2.76	-48	-79	-35	-64	-61	-30
6300	130.73	2.72	-48	-73	-35	-64	-67	-31
6600	136.47	2.85	-48	-61	-40	-65	-78	-24
6800	140.30	2.93	-47	-47	-44	-66	-87	-22
6650	137.48	2.86	-47	-32	-41	-66	6-02	-25
6800	140.30	2.93	-47	-26	-41	-66	-09	-24

Panel 10 - 2 (con't)

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
7000	144.14	3.01	-46	-12	-45	-67	-22	-19
6700	138.38	2.88	-44	8-66	-36	-69	-73	-29
6600	136.47	2.85	-44	-56	-34	-69	-84	-32
6800	140.30	2.93	-44	-49	-34	-69	-90	-30
7000	144.14	3.01	-44	-38	-35	-70	7-01	-27
7200	148.09	3.09	-43	-15	-38	-71	-18	-26
7400	152.05	3.17	-43	7-97	-40	-71	-35	-23
7600	156.01	3.25	-42	-65	-40	-72	-66	-19
7800	159.97	3.33	-41	-22	-39	-73	8-04	-24
7600	156.01	3.25	-40	6-80	-29	-75	-40	-35
7400	152.05	3.17	-38	-32	-17	-76	-88	-48
7300	150.07	3.14	-38	-19	-14	-76	9-03	-51
7100	146.12	3.05	-36	5-77	-06	-78	-48	-62
7000	144.14	3.01	-36	-60	-03	-78	-64	-66
7200	148.09	3.09	-36	-48	-02	-79	-75	-66
7400	152.05	3.17	-35	-33	-02	-79	-90	-65
7600	156.01	3.25	-35	-14	-00	-79	10-10	-66
7800	159.97	3.33	-35	4-87	3-98	-80	-38	-67
8000	163.93	3.42	4-34	4-23	3-91	1-80	11-05	4-74

Panel 10 - 3

Poured - July 28/69 Tested - Aug. 21/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	4-00	15-00	4-00	7-00	10-00	15-00
400	10.00	.21	3-94	14-59	3-91	-11	-35	-08
600	15.00	.31	-91	-39	-86	-14	-54	-11
800	20.00	.42	-89	-14	-78	-20	-77	-18
1000	24.25	.51	-85	13-98	-73	-26	-90	-19
1200	28.28	.59	-81	-82	-75	-31	11-00	-19
1400	32.32	.67	-78	-71	-79	-35	-09	-10
1600	36.36	.76	-75	-63	-84	-39	-12	-07
1800	40.40	.84	-72	-60	-89	-42	-14	14-99
2000	44.44	.93	-70	-55	-95	-45	-14	-94
2200	48.41	1.01	-68	-43	-99	-48	-22	-91
2000	44.44	.93	-68	-38	-97	-48	-27	-92
2200	48.41	1.01	-67	-37	-97	-48	-27	-91
2400	52.38	1.09	-66	-40	4-05	-49	-25	-82
2200	48.41	1.01	-66	-36	-05	-49	-28	-83
2400	52.38	1.09	-66	-36	-05	-50	-28	-82
2600	56.35	1.17	-65	-38	-11	-50	-23	-76
2800	60.32	1.25	-64	-40	-18	-51	-19	-66
3000	64.29	1.34	-63	-43	-25	-52	-12	-60
3200	68.51	1.43	-62	-44	-31	-53	-10	-52
3400	72.73	1.52	-61	-47	-37	-53	-03	-48
3600	76.95	1.60	-60	-51	-45	-54	10-99	-38
3400	72.73	1.52	-60	-46	-43	-54	11-04	-39
3600	76.95	1.60	-60	-47	-44	-54	-03	-37
3800	81.17	1.69	-59	-51	-51	-55	10-94	-33
4000	85.39	1.78	-59	-56	-59	-55	-88	-21
3800	81.17	1.69	-59	-52	-58	-55	-92	-22
4000	85.39	1.78	-59	-53	-59	-55	-91	-21
4200	89.36	1.86	-58	-58	-65	-56	-83	-18
4400	93.34	1.94	-58	-63	-72	-56	-76	-07
4600	97.32	2.03	-58	-68	-78	-56	-66	-04
4800	101.30	2.11	-57	-75	-86	-56	-58	13-95
5000	105.27	2.20	-56	-81	-94	-56	-47	-86
4200	89.36	1.86	-56	-59	-84	-58	-73	-96
4600	97.32	2.03	-56	-59	-83	-57	-74	-96
4800	101.30	2.11	-56	-63	-87	-57	-68	-92
5000	105.27	2.20	-56	-68	-92	-57	-62	-85
5200	109.21	2.28	-56	-74	-99	-57	-53	-75
5400	113.15	2.36	-56	-82	5-06	-57	-41	-71
5600	117.09	2.44	-56	-92	-14	-57	-28	-60
5800	121.03	2.52	-55	14-03	-22	-57	-15	-55

Panel 10 - 3 (con't)

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
6000	124.97	2.60	-55	-15	-30	-57	-03	-44
6200	128.81	2.68	-55	-27	-39	-57	9-91	-32
6400	132.64	2.76	-55	-38	-46	-57	-77	-26
6600	136.47	2.85	-55	-54	-58	-57	-61	-11
6800	140.30	2.93	-55	-70	-69	-57	-44	12-97
7000	144.14	3.01	-54	-89	-80	-56	-24	-88
7200	148.09	3.09	-54	15-11	-93	-56	-01	-73
6800	140.30	2.93	-54	-13	-93	-56	-00	-72
7200	148.09	3.09	-54	-21	-98	-56	8-93	-65
7400	152.05	3.17	-54	-35	6-08	-56	-77	-54
7600	156.01	3.25	-53	-58	-19	-54	-50	-45
7800	159.97	3.33	-53	-87	-33	-54	-18	-27
8000	163.93	3.42	-53	16-27	-50	-53	7-79	-03
8200	168.06	3.50	-53	-77	-71	-51	-27	11-76
8400	172.20	3.59	-54	17-28	-92	-48	6-78	-54
8200	168.06	3.50	-54	-47	-95	-48	-59	-50
8000	163.93	3.42	-54	-55	-98	-48	-52	-46
7800	159.97	3.33	-54	-63	7-00	-46	-46	-43
8200	168.06	3.50	-54	-81	-10	-46	-25	-29
8400	172.20	3.59	-54	18-02	-21	-45	-02	-15
8600	176.34	3.68	-54	-54	-39	-42	5-49	10-88
8700	178.41	3.72	-55	19-19	-62	-39	4-85	-57
8800	180.48	3.76	-55	20-13	-93	-36	3-91	-18
8400	172.20	3.59	-56	-88	8-12	-36	-21	9-99
8200	168.06	3.50	-58	21-30	-24	-36	2-80	-86
8400	172.20	3.59	-58	-61	-38	-36	-47	-66
8600	176.34	3.68	-58	22-06	-56	-36	1-98	-47
6000	124.97	2.60	-58	21-39	7-81	-37	2-79	10-38
7000	144.14	3.01	-58	-80	8-01	-40	-37	-13
7200	148.09	3.09	-58	-99	-11	-39	-17	9-98
7400	152.05	3.17	-58	22-13	-22	-39	1-97	-87
7600	156.01	3.25	-58	-37	-32	-39	-77	-74
7800	159.97	3.33	-58	-57	-44	-38	-56	-59
8000	163.93	3.42	-59	-81	-58	-37	-30	-45
8200	168.06	3.50	-59	23-04	-71	-36	-06	-31
8400	172.20	3.59	-59	-37	-87	-36	0-72	-13
8600	176.34	3.68	3-60	23-79	9-03	7-35	0-27	8-93

Panel 8 - 1

Poured - July 23/69 Tested - Oct. 2/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	6-00	7-00	7-00	6-00	13-00	2-00
400	10.00	.42	-19	-78	-16	5-73	12-20	1-78
600	15.00	.62	-22	8-03	-22	-69	11-94	-69
800	20.00	.83	-25	-29	-29	-62	-64	-58
1000	24.25	1.01	-30	-52	-35	-55	-39	-48
1200	28.28	1.18	-36	-77	-43	-49	-12	-37
1400	32.32	1.35	-42	9-09	-55	-40	10-77	-22
1600	36.36	1.51	-52	-44	-69	-29	-39	-06
1800	40.40	1.68	-61	-84	-78	-18	9-95	0-86
2000	44.44	1.85	-68	10-12	-80	-11	-65	-79
2200	48.41	2.02	-75	-48	-83	-01	-28	-71
2400	52.38	2.18	6-86	11-08	7-93	4-86	8-63	0-56

Panel 8 - 2

Poured - July 22/69 Tested - Oct. 10/69

LOAD			GUAGE READINGS					
PUMP psi	ACTUAL kips	STRESS ksi	(inches X 10^{-3}) 1	2	3	4	5	6
0	0	0	2-00	14-00	6-00	5-00	6-00	6-00
400	10.00	.42	1-96	13-56	5-45	-00	-45	-50
600	15.00	.62	-94	-39	-36	4-97	-60	-62
800	20.00	.83	-93	-25	-30	-97	-72	-70
1000	24.25	1.01	-93	-15	-28	-93	-80	-75
1200	28.28	1.18	-94	-08	-25	-94	-88	-76
1400	32.32	1.35	-93	-00	-22	-92	-93	-76
1600	36.36	1.51	-94	12-92	-23	-90	7-03	-71
1800	40.40	1.68	-93	-86	-23	-88	-09	-67
2000	44.44	1.85	-91	-78	-30	-86	-20	-50
2200	48.41	2.02	-91	-71	-36	-85	-27	-40
2400	52.38	2.18	-90	-60	-42	-85	-38	-33
2600	56.35	2.35	-86	-45	-49	-86	-52	-24
2800	60.32	2.51	-81	-26	-58	-90	-72	-10
3000	64.29	2.68	-73	11-52	-63	-98	8-42	-00
3000	64.29	2.68	-56	10-08	-59	5-15	9-84	-01
3200	68.51	2.85	-40	8-70	-55	-32	11-35	-05
3000	64.29	2.68	-27	7-92	-52	-25	12-09	-06
2900	62.30	2.59	-22	-38	-51	-49	-69	-08
2825	60.82	2.53	-18	6-99	-49	-53	13-07	-10
2800	60.32	2.51	-17	-90	-49	-54	-16	-10
1975	43.93	1.83	0-96	4-49	-40	-82	15-65	-23
2200	48.41	2.02	-91	3-95	-39	-87	16-18	-23
2400	52.38	2.18	0-64	1-98	5-26	6-11	18-15	6-31

Panel 8 - 3

Poured - July 24/69 Tested - Oct. 8/69

LOAD			GUAGE READINGS					
PUMP psi	ACTUAL kips	STRESS ksi	(inches X 10^{-3}) 1	2	3	4	5	6
0	0	0	6-00	7-00	5-00	12-00	12-00	6-00
400	10.00	.42	-30	8-28	-42	11-67	10-70	5-50
600	15.00	.62	-40	-94	-78	-54	-04	-10
800	20.00	.83	-50	9-61	6-06	-40	9-38	4-78
1000	24.25	1.01	-62	10-15	-21	-25	8-78	-56
1200	28.28	1.18	-78	-83	-34	-06	-10	-36
1400	32.32	1.35	-90	11-44	-45	10-89	7-46	-20
1600	36.36	1.51	7-07	12-32	-62	-68	6-57	3-94
1800	40.40	1.68	-26	13-45	-85	-40	5-38	-60
2000	44.44	1.85	-55	15-30	7-25	-03	3-45	-05
1700	38.38	1.60	7-58	15-60	7-30	9-98	3-20	2-98

Panel 5 - 1_1

Poured - July 25/69 Tested - Sept. 4/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	6-00	11-00	5-00	2-00	9-00	6-00
400	10.00	.21	-00	10-82	4-91	-01	-16	-07
600	15.00	.31	-00	-70	-86	-01	-28	-10
800	20.00	.42	5-99	-48	-76	-02	-48	-16
1000	24.25	.51	-98	-33	-73	-03	-62	-20
1200	28.28	.59	-96	-23	-70	-05	-73	-22
1400	32.32	.67	-95	-13	-68	-05	-84	-23
1600	36.36	.76	-94	-05	-68	-06	-93	-24
1800	40.40	.84	-92	9-98	-68	-06	10-03	-23
2000	44.44	.93	-92	-90	-68	-07	-12	-22
2200	48.41	1.01	-90	-82	-70	-08	-20	-19
2400	52.38	1.09	-90	-77	-71	-10	-25	-16
2600	56.35	1.17	-90	-74	-75	-10	-27	-11
2800	60.32	1.25	-89	-72	-83	-12	-28	-03
3000	64.29	1.34	-88	-70	-89	-13	-29	5-94
3200	68.51	1.43	-88	-66	-94	-14	-31	-88
3400	72.73	1.52	-87	-60	-99	-15	-35	-83
3600	76.95	1.60	-86	-59	5-06	-16	-34	-75
3800	81.17	1.69	-86	-55	-10	-15	-39	-70
4000	85.39	1.78	-85	-50	-15	-16	-40	-64
4200	89.36	1.86	-83	-46	-19	-17	-42	-60
4400	93.34	1.94	-83	-39	-21	-18	-45	-58
4600	97.32	2.03	-83	-36	-26	-18	-50	-55
4800	101.30	2.11	-82	-30	-29	-19	-55	-51
5000	105.27	2.20	-82	-20	-30	-19	-65	-50
5200	109.21	2.28	-82	-15	-35	-20	-68	-45
5400	113.15	2.36	-82	-15	-41	-20	-69	-42
5600	117.09	2.44	-81	-08	-45	-20	-82	-40
5800	121.03	2.52	-80	8-85	-45	-20	-99	-39
6000	124.97	2.60	-81	-79	-50	-20	11-08	-35
6200	128.81	2.68	-80	-45	-50	-21	-45	-06
6400	132.64	2.76	-80	-39	-52	-22	-55	4-98
6600	136.47	2.85	-80	-31	-55	-22	-62	-95
6800	140.30	2.93	-80	-25	-58	-22	-70	-91
7000	144.14	3.01	-78	-14	-61	-24	-82	-85
6850	141.26	2.95	-78	7-92	-59	-24	12-09	-90
7200	148.09	3.09	-79	-74	-62	-23	-27	-85
7400	152.05	3.17	-79	-64	-64	-24	-40	-82
7600	156.01	3.25	-79	-50	-65	-25	-55	-84
7500	154.03	3.21	5-77	7-19	5-59	2-25	12-93	4-88

Panel 5 - 1_2

Poured - July 25/69

Tested - Sept. 5/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
400	10.00	.21	5-00	12-00	6-00	2-00	9-00	5-00
600	15.00	.31	-00	11-93	5-98	-00	-07	-02
800	20.00	.42	4-99	-73	-84	-02	-27	-10
1000	24.25	.51	-97	-53	-74	-03	-47	-15
1200	28.28	.59	-97	-40	-69	-04	-59	-17
1400	32.32	.67	-96	-28	-67	-04	-72	-18
1600	36.36	.76	-95	-16	-65	-05	-84	-18
1800	40.40	.84	-95	-02	-64	-06	-98	-18
2000	44.44	.93	-93	10-89	-64	-06	10-11	-18
2200	48.41	1.01	-92	-76	-65	-07	-25	-15
2400	52.38	1.09	-92	-64	-66	-08	-36	-14
2600	56.35	1.17	-91	-49	-68	-08	-50	-11
2800	60.32	1.25	-91	-36	-68	-08	-62	-10
3000	64.29	1.34	-91	-21	-69	-09	-76	-08
3200	68.51	1.43	-90	-05	-69	-09	-93	-07
3400	72.73	1.52	-90	9-89	-70	-09	11-10	-05
3600	76.95	1.60	-90	-71	-68	-09	-28	-05
3800	81.17	1.69	-89	-54	-67	-10	-45	-04
4000	85.39	1.78	-89	-35	-66	-10	-65	-02
4200	89.36	1.86	-88	-15	-65	-10	-84	-02
4400	93.34	1.94	-88	8-96	-62	-10	12-02	-02
4600	97.32	2.03	-88	-75	-60	-11	-21	-04
4800	101.30	2.11	-87	-55	-59	-11	-40	-05
5000	105.27	2.20	-87	-35	-58	-11	-58	-05
5200	109.21	2.28	-87	-07	-56	-11	-83	-07
5400	113.15	2.36	-86	7-79	-53	-12	13-09	-09
5600	117.09	2.44	-86	-51	-50	-12	-35	-11
5800	121.03	2.52	-86	-31	-49	-12	-54	-14
6000	124.97	2.60	-86	-01	-45	-12	-83	-16
6200	128.81	2.68	-85	6-74	-44	-14	14-08	-09
6400	132.64	2.76	-85	-47	-40	-13	-35	-12
6600	136.47	2.85	-85	-12	-37	-13	-68	-26
6800	140.30	2.93	-84	5-68	-28	-14	15-10	-33
7000	144.14	3.01	-84	-27	-24	-15	-49	-38
6800	140.30	2.93	4-83	4-85	5-17	2-15	15-91	5-45

Panel 5 - 2

Poured - July 23/69 Tested - Sept. 9/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	6-00	12-00	7-00	1-00	5-00	8-00
400	10.00	.21	-00	11-98	-01	-02	-01	-02
600	15.00	.31	5-99	-93	-03	-03	-04	-01
800	20.00	.42	-97	-84	-06	-05	-11	7-90
1000	24.25	.51	-95	-78	-11	-06	-15	-89
1200	28.28	.59	-94	-73	-15	-09	-25	-83
1400	32.32	.67	-90	-59	-21	-10	-27	-76
1600	36.36	.76	-89	-51	-25	-12	-33	-65
1800	40.40	.84	-88	-51	-35	-13	-34	-60
2000	44.44	.93	-87	-51	-45	-12	-32	-52
2200	48.41	1.01	-86	-50	-55	-15	-39	-42
2400	52.38	1.09	-85	-50	-62	-15	-39	-35
2600	56.35	1.17	-85	-48	-68	-17	-41	-28
2800	60.32	1.25	-84	-49	-76	-16	-40	-18
3000	64.29	1.34	-83	-49	-80	-17	-42	-14
3200	68.51	1.43	-83	-51	-90	-18	-41	-08
3400	72.73	1.52	-82	-53	8-01	-18	-39	6-97
3600	76.95	1.60	-81	-54	-06	-18	-40	-89
3800	81.17	1.69	-81	-55	-11	-19	-38	-83
4000	85.39	1.78	-80	-58	-22	-18	-35	-72
4200	89.36	1.86	-80	-62	-30	-20	-32	-66
4400	93.34	1.94	-80	-52	-32	-20	-43	-58
4600	97.32	2.03	-79	-50	-40	-20	-48	-54
4800	101.30	2.11	-80	-51	-48	-20	-48	-43
5000	105.27	2.20	-78	-52	-55	-21	-51	-35
4800	101.30	2.11	-78	-39	-51	-21	-63	-35
5000	105.27	2.20	-78	-40	-55	-21	-61	-38
5200	109.21	2.28	-78	-45	-63	-22	-58	-30
5400	113.15	2.36	-78	-48	-70	-22	-55	-21
5600	117.09	2.44	-77	-50	-80	-22	-50	-10
5800	121.03	2.52	-79	-54	-88	-22	-42	-02
6000	124.97	2.60	-78	-58	9-03	-22	-42	5-93
6200	128.81	2.68	-76	-56	-03	-23	-43	-82
6400	132.64	2.76	-76	-60	-14	-23	-40	-72
6600	136.47	2.85	-76	-55	-25	-25	-40	-60
6800	140.30	2.93	-75	-63	-32	-25	-33	-51
7000	144.14	3.01	-75	-68	-45	-25	-28	-40
7200	148.09	3.09	-75	-65	-52	-25	-28	-30
7400	152.05	3.17	-75	-72	-65	-25	-20	-20
7600	156.01	3.25	-75	-79	-75	-25	-12	-05
7800	159.97	3.33	-75	-85	-89	-25	-01	4-90

Panel 5 - 2 (con't)

LOAD			GUAGE READINGS					
PUMP	ACTUAL	STRESS	(inches X 10^{-3})					
psi	kips	ksi	1	2	3	4	5	6
8000	163.93	3.42	-75	-90	10-02	-25	4-95	-74
7500	154.03	3.21	-73	-15	9-93	-25	5-69	-82
7600	156.01	3.25	-73	-18	-98	-26	-68	-78
7500	154.03	3.21	-72	-01	-95	-26	-83	-82
7800	159.97	3.33	-72	-04	10-02	-26	-78	-72
8000	163.93	3.42	-72	-05	-09	-26	-76	-65
8200	168.06	3.50	-73	-12	-20	-26	-70	-52
8400	172.20	3.59	-72	-12	-28	-26	-72	-42
8600	176.34	3.68	-72	-24	-42	-28	-61	-28
8800	180.48	3.76	-72	-35	-58	-28	-49	-09
9000	184.62	3.85	-72	-48	-74	-28	-35	3-85
9200	188.63	3.93	-72	-62	-92	-28	-32	-65
8900	182.50	3.81	-71	-22	-99	-28	-65	-59
9200	188.63	3.93	-72	-29	11-16	-28	-60	-37
9400	192.64	4.02	-72	-29	-35	-28	-60	-14
9600	196.65	4.09	5-72	11-10	11-68	1-28	5-78	2-70

Panel 5 - 3

Poured - July 23/69

Tested - Sept. 11/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	3-00	5-00	6-00	6-00	11-00	7-00
400	10.00	.21	-05	-41	-10	5-94	10-48	6-73
600	15.00	.31	-06	-65	-18	-89	-20	-60
800	20.00	.42	-03	-77	-22	-85	-02	-50
1000	24.25	.51	-02	-92	-26	-80	9-83	-40
1200	28.28	.59	-00	6-09	-30	-75	-65	-30
1400	32.32	.67	-00	-25	-38	-71	-50	-12
1600	36.36	.76	-02	-46	-48	-66	-29	5-95
1800	40.40	.84	-05	-68	-57	-62	-07	-78
2000	44.44	.93	-09	-90	-65	-62	8-83	-65
2200	48.41	1.01	-14	7-09	-70	-54	-60	-52
2400	52.38	1.09	-18	-29	-75	-50	-42	-45
2600	56.35	1.17	-22	-45	-80	-47	-21	-35
2800	60.32	1.25	-28	-60	-81	-42	-07	-30
3000	64.29	1.34	-33	-80	-88	-40	7-82	-20
3200	65.51	1.43	-39	-98	-90	-35	-65	-14
3400	72.73	1.52	-45	8-15	-92	-32	-45	-05
3600	76.95	1.60	-50	-33	-94	-28	-25	-00
3800	81.17	1.69	-57	-50	-97	-24	-10	-12
4000	85.39	1.78	-65	-75	7-02	-19	6-85	-05
4200	89.36	1.86	-69	-95	-04	-15	-65	-00
4400	93.34	1.94	-79	9-18	-07	-10	-44	-12
4600	97.32	2.03	-90	-48	-10	-03	-12	-05
4800	101.30	2.11	4-03	-78	-15	4-97	5-82	-10
5000	105.27	2.20	4-12	10-12	7-22	4-90	5-50	5-03

Panel 7 - 1

Poured - July 18/69

Tested - Sept. 19/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	6-00	12-00	6-00	2-00	7-00	5-00
400	10.00	.42	5-38	10-70	5-92	-59	8-21	-10
600	15.00	.62	-35	-41	-88	-64	-44	-12
800	20.00	.83	-30	-04	-78	-67	-68	-22
1000	24.25	1.01	-29	9-82	-75	-68	-84	-26
1200	28.28	1.18	-26	-45	-68	-70	9-16	-35
1400	32.32	1.35	-24	-16	-65	-72	-44	-43
1600	36.36	1.51	-22	8-82	-64	-76	-75	-37
1800	40.40	1.68	-18	-21	-60	-80	10-32	-41
2000	44.44	1.85	-10	7-59	-54	-86	-90	-47
2200	48.41	2.02	-06	6-92	-52	-89	11-58	-50
2400	52.38	2.18	4-95	5-65	5-35	3-04	12-90	5-68

Panel 7 - 2

Poured - July 21/69 Tested - Sept. 29/69

LOAD			GUAGE READINGS					
PUMP psi	ACTUAL kips	STRESS ksi	(inches X 10^{-3}) 1	2	3	4	5	6
0	0	0	5-00	9-00	6-00	2-00	6-00	6-00
400	10.00	.42	4-40	7-74	5-85	-60	7-04	-20
600	15.00	.62	-42	-46	-80	-63	-34	-30
800	20.00	.83	-44	-18	-75	-63	-62	-40
1000	24.25	1.01	-35	6-97	-72	-62	-80	-43
1200	28.28	1.18	-35	-76	-70	-60	-98	-46
1400	32.32	1.35	-39	-65	-75	-55	8-24	-44
1600	36.36	1.51	-40	-48	-72	-53	-40	-45
1800	40.40	1.68	-45	-36	-80	-45	-64	-36
2000	44.44	1.85	-52	-06	-75	-42	-90	-46
2200	48.41	2.02	-50	5-60	-65	-40	9-43	-53
2400	52.38	2.18	-50	-05	-55	-36	-98	-65
2600	56.35	2.35	4-63	4-34	5-90	2-32	10-89	6-74

Panel 7 - 3

Poured - July 17/69 Tested - Oct. 1/69

LOAD			GUAGE READINGS					
PUMP psi	ACTUAL kips	STRESS ksi	(inches X 10^{-3}) 1	2	3	4	5	6
0	0	0	2-00	7-00	6-00	7-00	11-00	6-00
400	10.00	.42	-15	-68	-02	6-72	10-30	5-85
600	15.00	.62	-24	-99	-05	-60	9-99	-78
800	20.00	.83	-31	8-28	-07	-51	-68	-73
1000	24.25	1.01	-40	-55	-12	-43	-38	-64
1200	28.28	1.18	-48	-88	-15	-32	-04	-61
1400	32.32	1.35	-61	9-26	-20	-16	8-63	-54
1600	36.36	1.51	-74	-78	-41	-00	-06	-21
1800	40.40	1.68	-92	10-43	-58	5-78	7-38	4-87
2000	44.44	1.85	3-08	11-08	6-65	5-55	6-70	4-72

Panel 4 - 1

Poured - July 22/69

Tested Sept 12/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	1-00	6-00	5-00	5-00	11-00	8-00
400	10.00	.21	0-95	-38	-12	4-98	10-63	7-70
600	15.00	.31	-89	-58	-14	-98	-40	-80
800	20.00	.42	-85	-78	-12	5-02	-20	-77
1000	24.25	.51	-82	-96	-08	-02	-00	-75
1200	28.28	.59	-80	7-14	-05	-00	9-84	-74
1400	32.32	.67	-80	-28	-02	4-95	-68	-72
1600	36.36	.76	-82	-44	4-98	-90	-54	-72
1800	40.40	.84	-85	-58	-95	-84	-35	-68
2000	44.44	.93	-90	-72	-92	-74	-18	-69
2200	48.41	1.01	-95	-88	-90	-65	-02	-68
2400	52.38	1.09	1-00	8-04	-86	-55	8-84	-65
2600	56.35	1.17	-07	-20	-85	-46	-65	-65
2800	60.32	1.25	-11	-35	-79	-35	-52	-73
3000	64.29	1.34	-18	-52	-78	-25	-31	-71
3200	68.51	1.43	-25	-68	-76	-12	-15	-74
3400	72.73	1.52	-31	-86	-76	-01	7-92	-70
3600	76.95	1.60	-39	9-09	-80	3-90	-65	-62
3800	81.17	1.69	-46	-38	-80	-73	-40	-65
4000	85.39	1.78	-58	-65	-85	-58	-05	-57
4200	89.36	1.86	-68	-93	-89	-44	6-72	-50
4400	93.34	1.94	-75	10-18	-90	-30	-49	-54
4600	97.32	2.03	-85	-49	-95	-13	-12	-45
4800	101.30	2.11	-96	-80	5-00	2-98	5-80	-38
5000	105.27	2.20	2-08	11-15	-04	-84	-48	-40
5200	109.21	2.28	-18	-53	-09	-66	-05	-32
5400	113.15	2.36	2-38	12-05	5-18	2-42	4-50	7-20

Panel 4 - 2

Poured - July 21/69

Tested - Sept. 17/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	3-00	7-00	5-00	7-00	12-00	6-00
400	10.00	.21	2-84	-25	-13	-04	11-70	5-85
600	15.00	.31	-81	-45	-22	-12	-48	-75
800	20.00	.42	-73	-63	-29	-15	-29	-70
1000	24.25	.51	-67	-80	-33	-21	-11	-65
1200	28.28	.59	-64	-98	-38	-22	10-92	-58
1400	32.32	.67	-62	8-18	-47	-26	-70	-50
1600	36.36	.76	-62	-41	-55	-26	-43	-38
1800	40.40	.84	-62	-65	-63	-25	-16	-27
2000	44.44	.93	-68	9-04	-75	-15	9-71	-14
2200	48.41	1.01	-74	-30	-82	-08	-41	-07
2400	52.38	1.09	-78	-56	-86	-01	-15	-03
2600	56.36	1.17	-83	-79	-90	6-93	8-91	4-98
2800	60.32	1.25	-96	10-02	-92	-85	-67	-95
3000	64.29	1.34	-90	-23	-94	-75	-44	-95
3200	68.51	1.43	-95	-46	-96	-67	-21	-95
3400	72.73	1.52	3-00	-71	-98	-54	7-95	-91
3600	76.95	1.60	-07	-97	6-02	-45	-70	-92
3800	81.17	1.69	-12	11-23	-05	-35	-42	-92
4000	85.39	1.78	-19	-55	-08	-25	-11	-87
4200	89.36	1.86	-30	-95	-15	-11	6-68	-85
4400	93.34	1.94	-38	12-30	-18	-00	-34	-78
4600	97.32	2.03	-47	-70	-25	5-92	5-96	-76
4800	101.30	2.11	-55	13-11	-32	-80	-53	-68
5000	105.27	2.20	-70	-60	-40	-64	-05	-75
5200	109.21	2.28	3-94	14-25	7-02	5-35	4-40	4-28

Panel 4 - 3

Poured - July 18/69 Tested - Sept. 18/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	6-00	14-00	6-00	3-00	5-00	6-00
400	10.00	.21	-06	13-80	5-88	2-93	-20	-10
600	15.00	.31	-09	-60	-80	-91	-36	-18
800	20.00	.42	-15	-46	-76	-88	-49	-22
1000	24.25	.51	-20	-30	-70	-85	-65	-35
1200	28.28	.59	-28	-16	-66	-80	-79	-40
1400	32.32	.67	-30	-07	-66	-80	-88	-41
1600	36.36	.76	-35	-00	-68	-77	-94	-42
1800	40.40	.84	-39	12-90	-71	-75	6-08	-43
2000	44.44	.93	-40	-80	-73	-75	-15	-44
2200	48.41	1.01	-41	-75	-76	-73	-22	-40
2400	52.38	1.09	-44	-68	-80	-73	-33	-38
2600	56.35	1.17	-42	-55	-85	-72	-40	-35
2800	60.32	1.25	-43	-49	-86	-72	-44	-30
2600	56.35	1.17	-40	-41	-84	-78	-55	-31
2800	60.32	1.25	-40	-39	-85	-78	-58	-31
3000	64.29	1.34	-40	-32	-89	-76	-59	-30
3200	68.51	1.43	-41	-30	-92	-75	-60	-25
3400	72.73	1.52	-42	-25	-95	-75	-64	-21
3600	76.95	1.60	-42	-19	-96	-75	-71	-20
3800	81.17	1.69	-43	-10	6-00	-75	-78	-18
4000	85.39	1.78	-40	11-95	-03	-78	-93	-16
4200	89.36	1.86	-40	-90	-04	-78	7-00	-14
4400	93.34	1.94	-39	-81	-06	-80	-06	-10
4600	97.32	2.03	-38	-74	-10	-81	-14	-07
4800	101.30	2.11	-35	-62	-14	-85	-25	-05
5000	105.27	2.20	-35	-52	-15	-85	-35	-04
5200	109.21	2.28	-30	-38	-19	-90	-49	-02
5400	113.15	2.36	-25	-15	-21	3-04	-68	5-99
5600	117.09	2.44	-22	-04	-21	2-99	-78	-96
5800	121.03	2.52	-18	10-92	-25	3-01	-90	-92
6000	124.97	2.60	-16	-78	-25	-04	8-02	-90
6200	128.81	2.68	6-10	10-65	6-28	3-12	8-16	5-89

Panel 6 - 1

Poured - July 14/69

Tested - Aug. 26/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	2-00	5-00	2-00	4-00	1-00	6-00
400	10.00	.42	1-93	4-70	1-92	-06	0-76	5-94
600	15.00	.62	-90	-58	-91	-08	-66	-92
800	20.00	.83	-89	-48	-94	-09	-57	-86
1000	24.25	1.01	-88	-43	-98	-09	-53	-79
1200	28.28	1.18	-87	-37	2-05	-10	-48	-68
1400	32.32	1.35	-86	-32	-13	-11	-45	-59
1600	36.36	1.51	-86	-32	-26	-11	-44	-47
1800	40.40	1.68	-86	-33	-36	-11	-46	-33
2000	44.44	1.85	-85	-38	-53	-11	-56	-14
2200	48.41	2.02	-85	-50	-74	-11	-68	4-91
2400	52.38	2.18	-85	-56	-89	-10	-74	-73
2600	56.35	2.35	-85	-66	3-10	-10	-85	-41
2800	60.32	2.51	-85	-75	-28	-10	-95	-13
3000	64.29	2.68	-85	-83	-45	-09	1-04	3-94
3200	68.51	2.85	-85	-90	-63	-08	-14	-69
3400	72.73	3.03	-85	5-01	-84	-07	-27	-42
3600	76.95	3.21	-85	-19	4-08	-07	-47	-10
3800	81.17	3.38	-85	-40	-31	-07	-69	2-80
4000	85.39	3.56	1-85	5-76	4-62	4-06	2-06	2-42

Panel 6 - 2

Poured - July 16/69

Tested - Aug. 28/69

LOAD			GUAGE READINGS					
PUMP psi	ACTUAL kips	STRESS ksi	(inches X 10^{-3}) 1	2	3	4	5	6
0	0	0	6-00	11-00	5-00	2-00	11-00	6-00
400	10.00	.42	5-98	10-88	4-91	-02	-07	-06
600	15.00	.62	-98	-85	-91	-03	-07	-00
800	20.00	.83	-98	-85	-96	-03	-05	5-91
1000	24.25	1.01	-98	-91	5-07	-05	10-99	-78
1200	28.28	1.18	-99	-99	-20	-05	-90	-65
1400	32.32	1.35	6-00	11-10	-37	-05	-78	-48
1600	36.36	1.51	-00	-23	-58	-05	-62	-28
1800	40.40	1.68	-02	-38	-80	-06	-47	-04
2000	44.44	1.85	-02	-52	6-01	-06	-32	4-81
2200	48.41	2.02	-03	-67	-27	-06	-13	-50
2400	52.38	2.18	-04	-87	-50	-06	9-93	-23
2600	56.35	2.35	-05	12-05	-72	-06	-73	3-97
2800	60.32	2.51	-06	-30	-98	-05	-48	-76
3000	64.29	2.68	-08	-55	7-22	-05	-21	-34
3200	68.51	2.85	-10	-85	-48	-05	8-92	-02
3400	72.73	3.03	-11	13-36	-82	-04	-36	2-58
3600	76.95	3.21	6-15	14-20	8-17	2-02	7-48	2-13

Panel 6 - 3

Poured - July 15/69 Tested - Aug. 29/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	3-00	6-00	6-00	6-00	8-00	7-00
400	10.00	.42	-07	-65	-04	5-85	7-36	6-89
600	15.00	.62	-21	8-07	-23	-59	5-92	-69
800	20.00	.83	-53	11-25	-65	-00	3-77	-34
1000	24.25	1.01	3-71	13-90	6-93	4-67	0-98	6-12

Panel 3 - 1

Poured - July 15/69 Tested - Sept. 2/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	3-00	7-00	4-00	6-00	9-00	5-00
400	10.00	.21	-12	-30	-09	5-85	8-65	4-88
600	15.00	.31	-18	-29	-15	-77	-45	-85
800	20.00	.42	-24	-81	-36	-68	-10	-65
1000	24.25	.51	-29	8-06	-47	-60	7-84	-55
1200	28.28	.59	-32	-30	-54	-54	-61	-48
1400	32.32	.67	-35	-54	-61	-49	-33	-42
1600	36.36	.76	-38	-75	-66	-45	-12	-36
1800	40.40	.84	-40	-98	-70	-41	6-89	-32
2000	44.44	.93	-42	9-25	-75	-37	-62	-27
2200	48.41	1.01	-44	-47	-78	-33	-38	-24
2400	52.38	1.09	-45	-73	-81	-30	-12	-24
2600	56.35	1.17	-48	10-03	-85	-28	5-82	-23
2800	60.32	1.25	-50	-32	-84	-24	-54	-25
3000	64.29	1.34	-52	-68	-93	-22	-18	-23
3200	68.51	1.43	-55	11-18	5-03	-18	4-68	4-16
3400	72.73	1.52	3-57	11-90		5-20	3-95	

Panel 3 - 2

Poured - July 16/69

Tested - Sept. 3/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	3-00	10-00	5-00	7-00	12-00	6-00
400	10.00	.21	-03	-25	-05	6-97	11-72	5-91
600	15.00	.31	-05	-39	-13	-94	-62	-88
800	20.00	.42	-07	-59	-17	-91	-36	-87
1000	24.25	.51	-09	-75	-20	-87	-21	-85
1200	28.28	.59	-10	-91	-25	-85	-05	-81
1400	32.32	.67	-11	11-12	-30	-62	10-86	-70
1600	36.36	.76	-12	-31	-33	-79	-69	-70
1800	40.40	.84	-14	-48	-34	-75	-51	-70
2000	44.44	.93	-15	-68	-35	-71	-31	-71
2200	48.41	1.01	-16	-87	-35	-68	-14	-73
2400	52.38	1.09	-18	12-08	-36	-64	9-93	-72
2600	56.35	1.17	-19	-26	-38	-60	-75	-71
2800	60.32	1.25	-20	-48	-40	-57	-53	-71
3000	64.29	1.34	-22	-80	-44	-51	-21	-74
3200	68.51	1.43	-26	13-56	-60	-48	8-47	-62
3400	72.73	1.52	-29	-88	-64	-44	-13	-48
3600	76.95	1.60	-30	14-22	-69	-40	7-76	-44
3800	81.17	1.69	-31	-60	-72	-38	-35	-41
4000	85.39	1.78	-34	15-14	-81	-35	6-81	-38
4200	89.36	1.86	-34	-64	-90	-32	-34	-28
4400	93.34	1.94	-30	16-06	-97	-36	-06	-22
4600	97.32	2.03	-39	-73	6-10	-23	5-25	-12
4800	101.30	2.11	3-40	17-72	6-32	6-20	4-25	-03

Panel 3 - 3

Poured - July 17/69 Tested - Sept. 2/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	6-00	9-00	6-00	1-00	7-00	6-00
400	10.00	.21	5-97	8-89	5-96	-01	-09	-04
600	15.00	.31	-93	-71	-90	-10	-28	-11
800	20.00	.42	-91	-50	-79	-18	-49	-21
1000	24.25	.51	-89	-28	-71	-27	-70	-27
1200	28.28	.59	-88	-11	-68	-35	-86	-30
1400	32.32	.67	-86	7-95	-65	-45	8-01	-32
1600	36.36	.76	-87	-80	-65	-55	-15	-32
1800	40.40	.84	-84	-75	-65	-84	-29	-29
2000	44.44	.93	-82	-51	-68	-97	-41	-25
2200	48.41	1.01	-81	-45	-71	2-05	-46	-19
2400	52.38	1.09	-80	-35	-77	-15	-52	-15
2600	56.35	1.17	-79	-25	-82	-23	-59	-10
2800	60.32	1.25	-78	-18	-88	-33	-67	-05
3000	64.29	1.34	-77	-06	-91	-46	-79	-02
3200	68.51	1.43	-75	6-95	-96	-60	-87	5-98
3400	72.73	1.52	-75	-85	6-00	-70	-97	-95
3600	76.95	1.60	-75	-73	-04	-80	9-09	-90
3800	81.17	1.69	-72	-60	-08	-91	-20	-87
3800	85.39	1.78	-71	-46	-11	3-03	-33	-82
4000	89.36	1.86	-70	-31	-15	-15	-46	-80
4200	93.34	1.94	-70	-18	-17	-25	-59	-78
4400	97.32	2.03	-68	5-73	-15	-46	10-07	-81
4600	101.30	2.11	-65	-41	-11	-62	-42	-68
4800	105.27	2.20	5-65	4-90	6-10	3-83	10-92	5-69

Panel 1 - 1

Poured - July 10/69

Tested - Oct. 28/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	6-00	15-00	5-00	3-00	4-00	5-00
400	10.00	.42	-15	-00	-00	2-85	-06	-00
600	15.00	.62	-28	-01	-01	-75	-10	-00
800	20.00	.83	-34	14-93	-06	-69	-19	4-98
1000	24.25	1.01	-32	-84	4-96	-62	-22	6-35
1200	28.28	1.18	-35	-78	5-08	-58	-31	-30
1400	32.32	1.35	-37	-69	-15	-53	-41	-29
1600	36.36	1.51	-42	-46	-12	-48	-61	-33
1800	40.40	1.68	-44	-23	-08	-44	-85	-55
2000	44.44	1.85	-44	13-81	-02	-40	5-22	-68
2200	48.41	2.02	-45	-36	4-95	-37	-63	-79
2400	52.38	2.18	-45	12-73	-85	-36	6-21	-91
2600	56.35	2.35	-43	-02	-75	-39	-87	-74
2800	60.32	2.51	6-20	8-00	4-34	1-62	10-70	7-44

Panel 1 - 2

Poured - July 9/69

Tested - Oct. 29/69

LOAD			GUAGE READINGS					
PUMP psi	ACTUAL kips	STRESS ksi	(inches X 10^{-3}) 1	2	3	4	5	6
0	0	0	6-00	17-00	4-00	2-00	3-00	5-00
400	10.00	.42	-03	16-98	-00	1-96	-00	4-96
600	15.00	.62	-05	-89	3-96	-92	-08	-99
800	20.00	.83	-06	-73	-90	-89	-22	5-06
1000	24.25	1.01	-06	-54	-80	-86	-42	-12
1200	28.28	1.18	-06	-34	-71	-83	-60	-20
1400	32.32	1.35	-06	-12	-62	-80	-81	-30
1600	36.36	1.51	-06	15-86	-52	-78	4-07	-40
1800	40.40	1.68	-05	-58	-45	-77	-33	-48
2000	44.44	1.85	-05	-28	-38	-76	-62	-53
2200	48.41	2.02	-05	14-96	-35	-70	-91	-55
2400	52.38	2.18	-03	-54	-27	-71	5-30	-62
2600	56.35	2.35	-02	13-92	-16	-72	-92	-76
2800	60.32	2.51	-00	-15	-00	-73	6-66	-93
3000	64.29	2.68	5-90	11-45	2-73	-79	8-40	6-25
2800	60.32	2.51	-82	10-75	-68	-86	9-02	-29
3000	64.29	2.68	5-68	7-40	2-37	1-98	12-50	6-58
2800	60.32	2.51		6-60			13-20	
2700	58.34	2.43		5-95			-75	
2600	56.35	2.35		-18			14-54	
2400	52.38	2.18		4-50			15-22	

Panel 1 - 3

Poured - July 11/69

Tested - Nov. 3/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	5-00	12-00	6-00	3-00	8-00	7-00
400	10.00	.42	4-42	10-78	4-98	-62	9-16	-90
600	15.00	.62	-42	-63	-87	-62	-36	8-02
800	20.00	.83	-35	-40	-48	-63	-50	-08
1000	24.25	1.01	-32	-22	-76	-65	-72	-12
1200	28.28	1.18	-28	-03	-73	-66	-90	-18
1400	32.32	1.35	-25	9-78	-65	-68	10-15	-22
1600	36.36	1.51	-22	-38	-58	-72	-61	-30
1800	40.40	1.68	-21	-07	-54	-72	-87	-32
2000	44.44	1.85	-15	8-75	-52	-76	11-19	-31
2200	48.41	2.02	-11	-38	-47	-79	-55	-30
2400	52.38	2.18	-05	7-70	-41	-85	12-23	-32
2600	56.35	2.35	3-93	6-64	-30	-94	13-25	-40
2800	60.32	2.51	-81	5-25	-18	4-05	14-66	-85
2700	58.34	2.43	3-80	4-72	4-13	4-05	15-18	8-58

Panel 2 - 1

Poured - July 14/69 Tested - Nov. 4/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	4-00	16-00	6-00	6-00	4-00	6-00
400	10.00	.21	-10	15-96	5-89	5-86	-02	-08
600	15.00	.31	-16	-93	-81	-79	-05	-14
800	20.00	.42	-24	-86	-70	-69	-10	-26
1000	24.25	.51	-29	-80	-64	-63	-14	-32
1200	28.28	.59	-34	-71	-58	-56	-20	-38
1400	32.32	.67	-39	-61	-49	-50	-28	-44
1600	36.36	.76	-41	-54	-44	-47	-35	-50
1800	40.40	.84	-45	-43	-36	-42	-44	-60
2000	44.44	.93	-49	-33	-28	-39	-54	-68
2200	48.41	1.01	-51	-25	-21	-35	-62	-75
2400	52.38	1.09	-51	-09	-11	-36	-77	-85
2600	56.35	1.17	-52	-02	-08	-33	-84	-90
2800	60.32	1.25	-56	14-91	-00	-29	-93	-98
3000	64.29	1.34	-58	-84	4-96	-24	5-00	7-03
3200	68.51	1.43	-62	-77	-94	-20	-05	-05
3400	72.73	1.52	-62	-69	-82	-19	-10	-14
3600	76.95	1.60	-67	-57	-78	-14	-23	-19
3800	81.17	1.69	-65	-46	-74	-18	-34	-26
4000	85.39	1.78	-70	-40	-75	-16	-42	-31
4200	89.36	1.86	-72	-27	-68	-14	-55	-39
4400	93.34	1.94	-72	-13	-60	-15	-70	-49
4600	97.32	2.03	-75	13-96	-50	-14	-84	-59
4800	101.30	2.11	-76	-79	-40	-11	-98	-67
5000	105.27	2.20	-70	-60	-31	-15	6-60	-76
5200	109.21	2.28	-74	-45	-22	-11	-29	-89
5400	113.15	2.36	-68	-20	-06	-18	-53	8-05
5600	117.09	2.44	-68	12-98	3-95	-15	-75	-18
5800	121.03	2.52	-79	-82	-87	-14	-92	-29
6000	124.97	2.60	-69	-58	-75	-15	7-14	-43
6200	124.97	2.60	-69	-42	-70	-14	-28	-50
6400	132.64	2.76	-62	-14	-53	-20	-61	-65
6600	136.47	2.85	-61	11-85	-40	-18	-88	-80
6800	140.30	2.93	-58	-45	-25	-25	8-28	9-00
7000	144.14	3.01	-53	-11	-09	-30	-60	-16
7200	148.09	3.09	-51	10-78	2-94	-31	-94	-34
7400	152.05	3.17	-40	-13	-56	-40	9-60	-65
7600	156.01	3.25	-30	9-28	-28	-49	10-45	-96
7800	159.97	3.33	-19	8-59	-05	-59	11-09	10-24
8000	163.93	3.42	-00	7-54	1-71	-79	12-09	-63
7800	159.97	3.33	3-83	6-60	-54	-99	13-10	10-80

Panel 2 - 1 (con't)

LOAD			GUAGE READINGS					
PUMP psi	ACTUAL kips	STRESS ksi	(inches X 10^{-3}) 1	2	3	4	5	6
7700	157.99	3.29	-79	-26	-45	6-04	-45	-84
7600	156.01	3.25	-69	5-73	-32	-16	14-05	-96
7500	154.03	3.21	-66	-45	-28	-20	-33	11-01
7400	152.05	3.17	-62	-18	-24	-24	-60	-05
7400	152.05	3.17	3-60	4-99	1-14	6-27	14-75	11-10

Panel 2 - 2_1

Poured - July 9/69 Tested - Nov. 5/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	6-00	14-00	6-00	4-00	9-00	5-00
400	10.00	.21	5-96	13-97	-01	3-95	-00	4-95
600	15.00	.31	-94	-95	-01	-95	-02	-93
800	20.00	.42	-92	-92	-02	-94	-05	-90
1000	24.25	.51	-92	-89	-04	-95	-10	-88
1200	28.28	.59	-90	-83	-00	-96	-16	-90
1400	32.32	.67	-89	-82	-01	-95	-18	-87
1600	36.36	.76	-89	-82	-04	-92	-18	-82
1800	40.40	.84	-90	-82	-07	-90	-18	-76
2000	44.44	.93	-92	-85	-12	-85	-16	-69
2200	48.41	1.01	-93	-86	-16	-82	-13	-64
2400	52.38	1.09	-95	-90	-22	-79	-11	-58
2600	56.35	1.17	-96	-94	-26	-76	-06	-52
2800	60.32	1.25	-96	-97	-32	-76	-00	-45
3000	64.29	1.34	-98	14-03	-37	-73	8-97	-40
3200	68.51	1.43	6-01	-05	-40	-70	-93	-35
3400	72.73	1.52	-04	-09	-47	-65	-90	-31
3600	76.95	1.60	-04	-11	-48	-61	-89	-25
3800	81.17	1.69	-10	-16	-53	-58	-80	-18
4000	85.39	1.78	-10	-19	-58	-55	-78	-12
4200	89.36	1.86	-12	-21	-60	-51	-76	-08
4400	93.34	1.94	-12	-24	-62	-51	-72	-04
4600	97.32	2.03	-14	-27	-66	-50	-69	3-99
4800	101.30	2.11	-16	-30	-70	-50	-62	-95
5000	105.27	2.20	-18	-34	-74	-48	-61	-90
5200	109.21	2.28	-14	-35	-78	-42	-55	-86
5400	113.15	2.36	-20	-40	-82	-40	-51	-82
5600	117.09	2.44	-21	-44	-85	-36	-48	-75
5800	121.03	2.52	-17	-45	-90	-42	-45	-71
6000	124.97	2.60	-19	-49	-94	-40	-43	-66
6200	128.81	2.68	-21	-54	-99	-36	-38	-60
6400	132.64	2.76	-20	-57	7-03	-40	-33	-55
6600	136.47	2.85	-22	-61	-06	-38	-30	-50
6800	140.30	2.93	-25	-67	-11	-33	-22	-45
7000	144.14	3.01	-25	-72	-18	-33	-15	-39
7200	148.09	3.09	-28	-80	-23	-28	-08	-31
7400	152.05	3.17	-32	-87	-29	-24	-00	-24
7600	156.01	3.25	-34	-95	-34	-23	7-89	-16
7800	159.97	3.33	-38	15-05	-39	-20	-79	-11
8000	163.93	3.42	-45	-20	-46	-10	-64	-00
8200	168.06	3.50	-48	-40	-58	2-99	-43	2-88

Panel 2 - 2_1 (con't)

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
8400	172.20	3.59	-55	-60	-65	-90	-22	-75
8600	176.34	3.68	-62	-87	-78	-81	6-92	-63
8800	180.48	3.76	-74	16-23	-90	-68	-64	-45
9000	184.62	3.85	-90	-75	8-10	-50	-02	-24
8800	180.48	3.76	7-12	17-49	-25	-27	5-34	-07
8650	177.37	3.70	-24	-86	-32	-14	4-96	1-99
8600	176.34	3.68	-35	18-19	-38	-02	-66	-92
8500	174.27	3.63	-44	-44	-43	1-92	-40	-86
8400	172.20	3.59	-48	-59	-46	-87	-26	-83
8400	172.20	3.59	-51	-66	-47	-84	-18	-81
8000	163.93	3.42	-76	19-47	-59	-52	3-38	-68
			Nov. 6/69					
7700	157.99	3.29	-94	20-06	-68	-32	2-80	-60
6800	140.30	2.93	-77	19-65	-50	-53	3-15	-84
6000	124.97	2.60	-63	-05	-28	-74	-80	2-10
5000	105.27	2.20	-45	18-42	7-99	2-00	4-44	-44
4000	85.39	1.78	-28	17-83	-68	-28	5-06	-82
3100	66.40	1.39	-12	-33	-40	-54	-60	3-16
2000	44.44	.93	6-94	16-81	-07	-79	6-13	-56
1600	36.36	.76	-87	-64	6-93	-89	-37	-78
1000	24.25	.51	-80	-44	-85	3-05	-56	-95
800	20.00	.42	-75	-24	-69	-11	-68	4-05
600	15.00	.31	-72	-15	-71	-18	-80	-15
400	10.00	.21	-66	-04	-60	-26	-91	-28
0	0	0	6-62	15-85	6-52	3-28	7-15	4-41

Panel 2 - 2_2

Poured - July 9/69 Tested - Nov. 13/69

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
0	0	0	6-00	14-00	5-00	23-00	6-00	6-00
400	10.00	.21	-18	-02	4-94	22-81	5-99	-02
600	15.00	.31	-25	-02	-90	-70	-99	-08
800	20.00	.42	-33	-02	-85	-60	-99	-09
1000	24.25	.51	-40	-01	-79	-49	-98	-12
1200	28.28	.59	-46	-01	-75	-39	-98	-17
1400	32.32	.67	-54	-04	-77	-30	-96	-18
1600	36.36	.76	-62	-03	-75	-19	-96	-20
1800	40.40	.84	-72	-03	-76	-08	-94	-32
2000	44.44	.93	-81	-06	-78	21-96	-87	-22
2200	48.41	1.01	-89	-06	-76	-88	-85	-24
2400	52.38	1.09	-95	-04	-73	-80	-84	-28
2600	56.35	1.17	7-03	-03	-67	-72	-84	-34
2800	60.32	1.25	-10	13-98	-64	-64	-83	-39
3000	64.29	1.34	-17	-96	-59	-56	-84	-44
3200	68.51	1.43	-23	-95	-55	-49	-84	-48
3400	72.73	1.52	-31	-94	-50	-40	-83	-52
3600	76.95	1.60	-39	-90	-42	-31	-81	-65
3800	81.17	1.69	-46	-90	-40	-23	-80	-68
4000	85.39	1.78	-52	-90	-35	-16	-79	-71
4200	89.36	1.86	-60	-87	-29	-10	-76	-82
4400	93.34	1.94	-66	-89	-26	-04	-74	-85
4600	97.32	2.03	-74	-90	-23	20-94	-72	-87
4800	101.30	2.11	-84	-90	-15	-87	-68	-97
5000	105.27	2.20	-90	-92	-12	-80	-65	7-00
5200	109.21	2.28	8-00	-95	-08	-69	-60	-03
5400	113.15	2.36	-04	-95	3-95	-65	-71	-12
5600	117.09	2.44	-12	-96	-92	-55	-66	-18
5800	121.03	2.52	-20	-99	-82	-43	-67	-25
6000	124.97	2.60	-25	14-00	-72	-38	-69	-35
6200	128.81	2.68	-35	-04	-68	-25	-62	-38
6400	132.64	2.76	-41	-06	-60	-18	-62	-45
6600	136.47	2.85	-50	-09	-56	-08	-56	-49
6800	140.30	2.93	-60	-14	-53	19-97	-50	-52
7000	144.14	3.01	-66	-20	-45	-92	-45	-59
7200	148.09	3.09	-84	-29	-38	-71	-35	-68
7400	152.05	3.17	-92	-45	-32	-59	-30	-71
7600	156.01	3.25	9-06	-50	-25	-45	-14	-78
7800	159.97	3.33	-22	-68	-22	-27	4-95	-80
8000	163.93	3.42	-47	-93	-19	18-98	-66	-88
8200	168.06	3.50	-70	15-27	-20	-72	-30	-86

Panel 2 - 2_2 (con't)

LOAD			GUAGE READINGS (inches X 10^{-3})					
PUMP psi	ACTUAL kips	STRESS ksi	1	2	3	4	5	6
8400	172.20	3.59	10-02	-80	-30	-35	3-75	-68
8600	176.34	3.68	-50	16-70	-45	17-85	2-80	-55
8400	172.20	3.59	10-78	17-20	-57	-57	-30	-45
8400	172.20	3.59		-64	-63	17-40	1-95	-38
8300	170.13	3.55		-78	-67		-76	-34
8200	168.06	3.50		-97	3-70		-55	7-30
8200	168.06	3.50		18-40			-14	
8100	166.00	3.46		-72			0-82	
8000	163.93	3.42		19-01			0-53	

9.2 Appendix B: Pictures

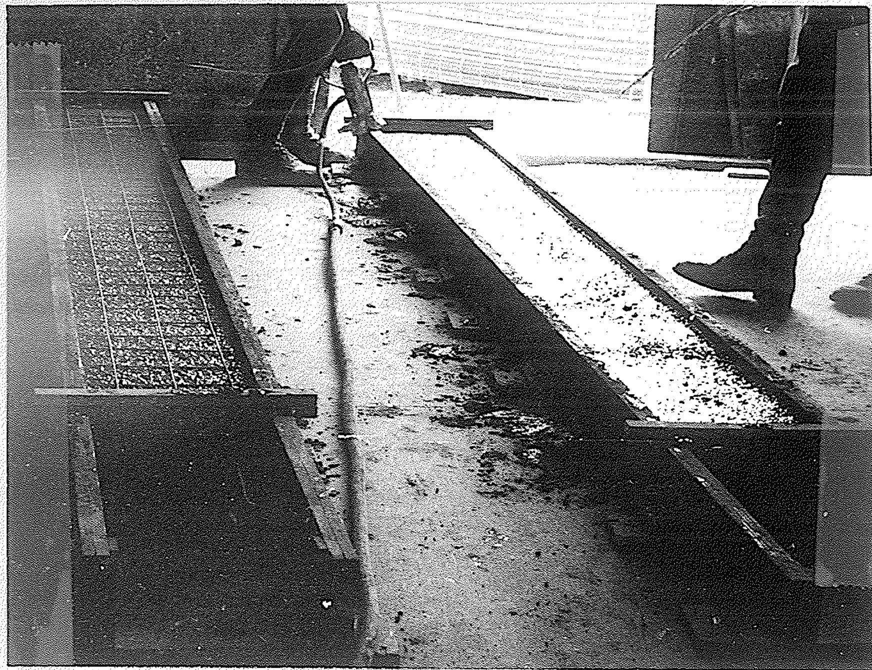


Plate No. 1. Showing panel production at the Supercrete plant.

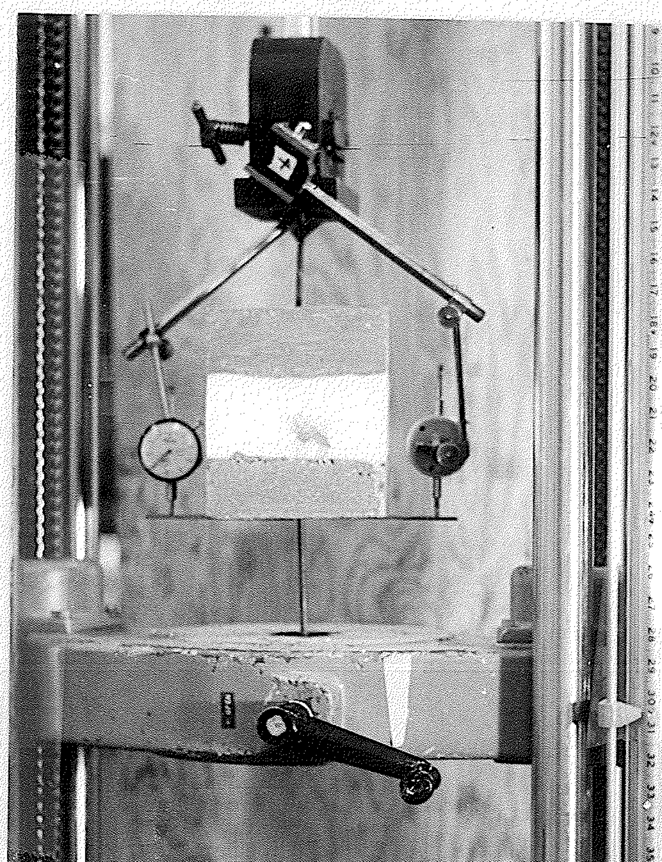


Plate No. 2. Showing tension test on 3 inch "Styrofoam" specimen.

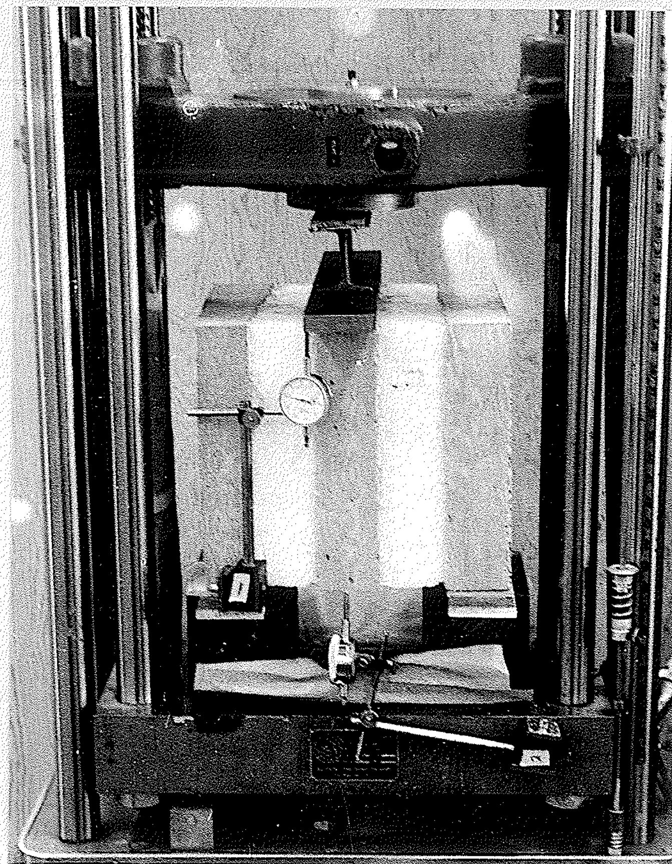


Plate No. 3. Showing shear test on 3 inch "Styrofoam" specimen.

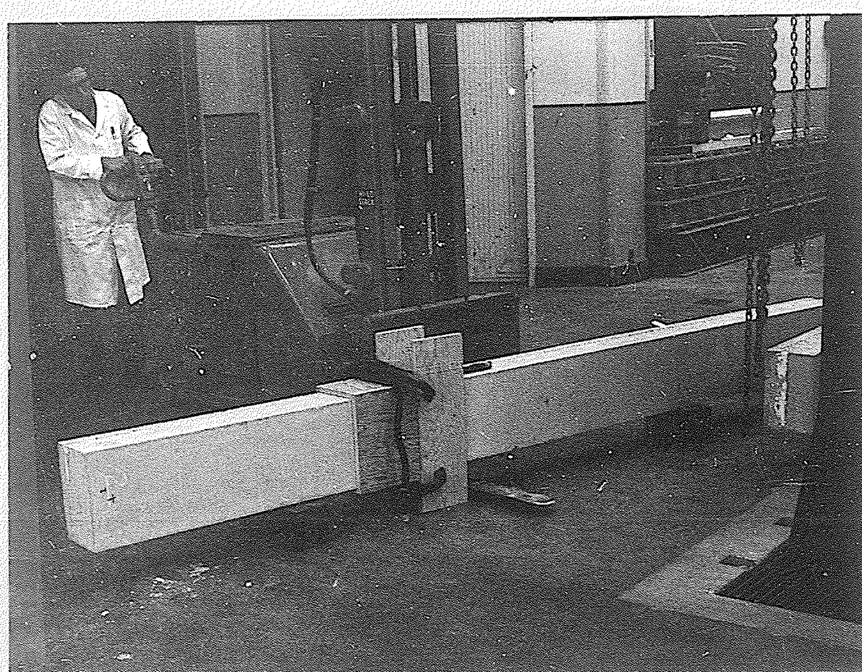


Plate No. 4. Showing a 12 foot panel being loaded into the test frame with the aid of a hydraulic fork lift.

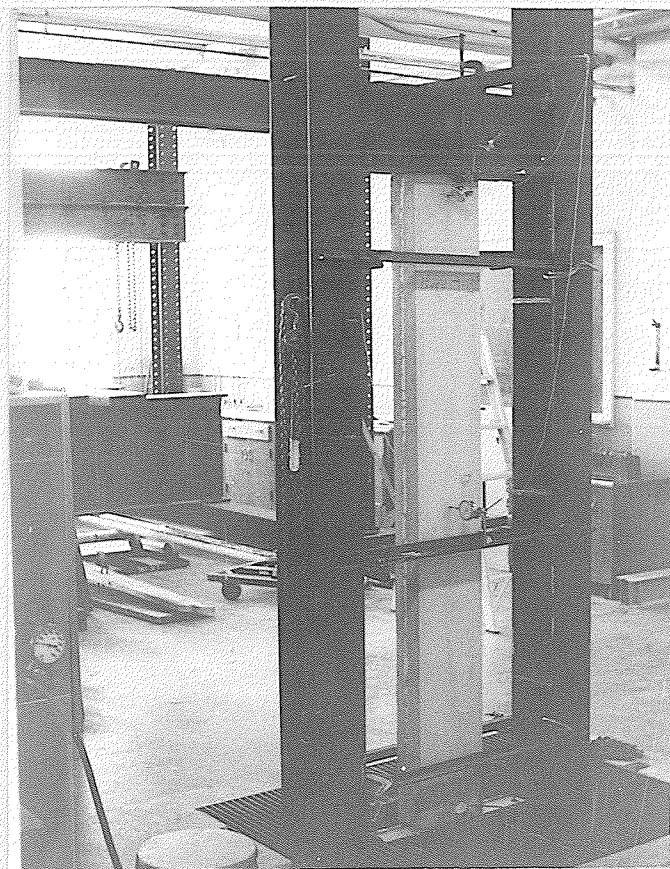


Plate No. 5. Showing the position of guages on the load bearing side of an 8 foot panel.

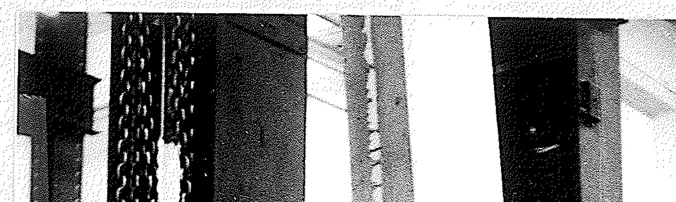


Plate No. 6. Showing panel 9 - 2 at failure.

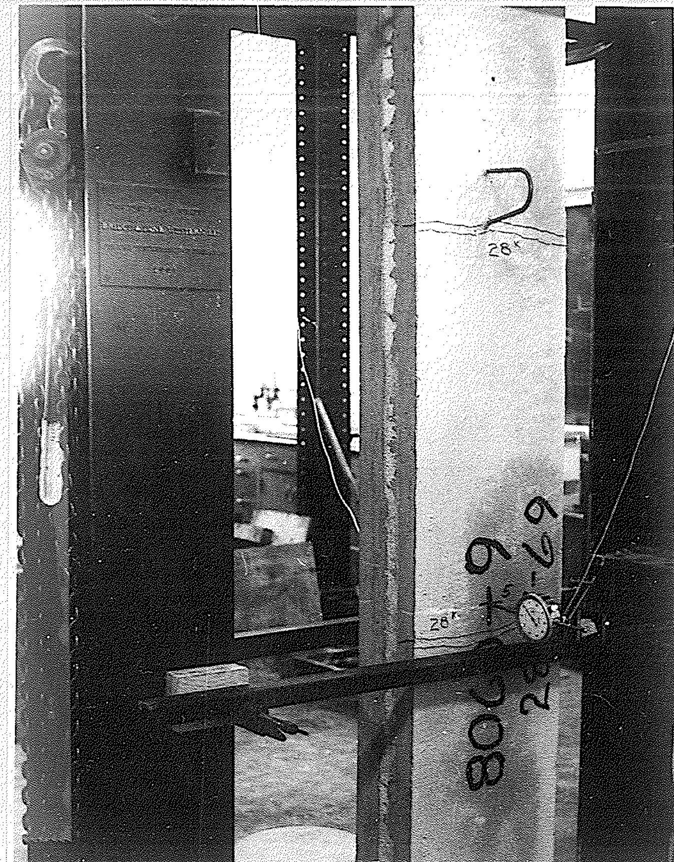


Plate No. 7. Showing panel 9 - 3 immediately before end of test.

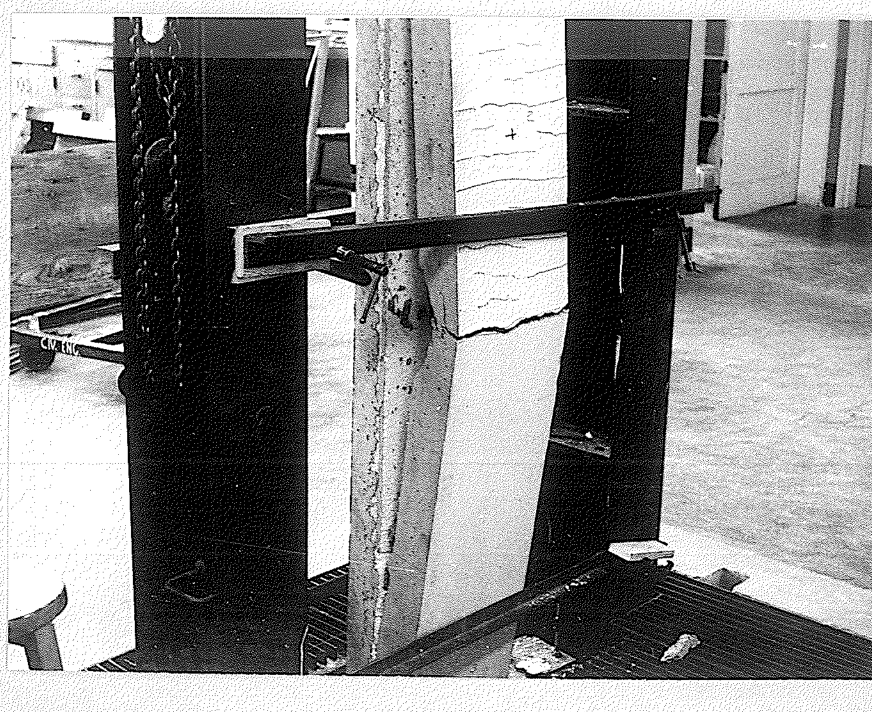


Plate No. 8. Showing panel 10 - 1 at failure.

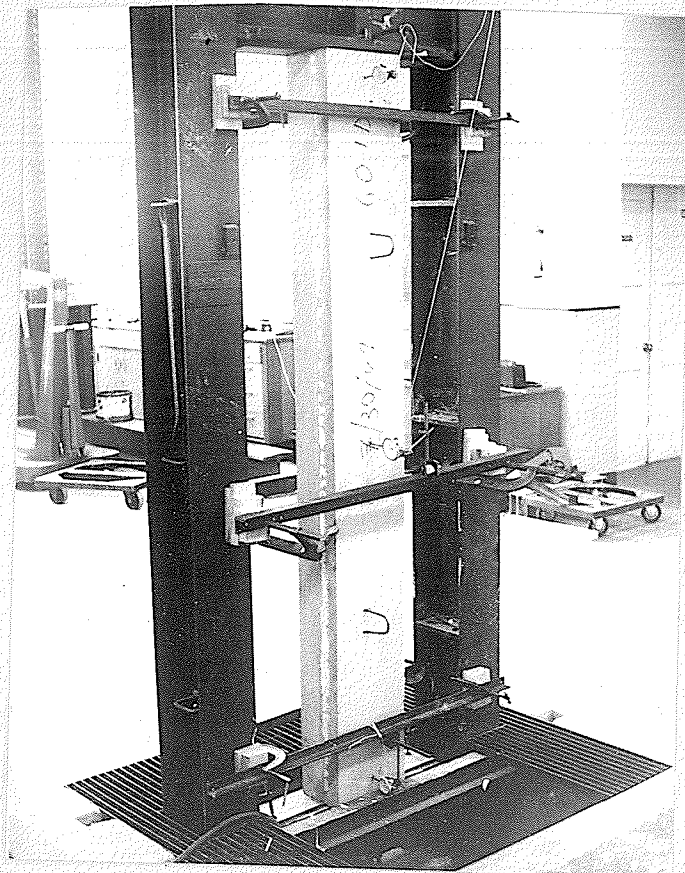


Plate No. 9. Showing panel 10 - 2 during test.

Plate No. 10. Showing panel 10 - 3 at failure.

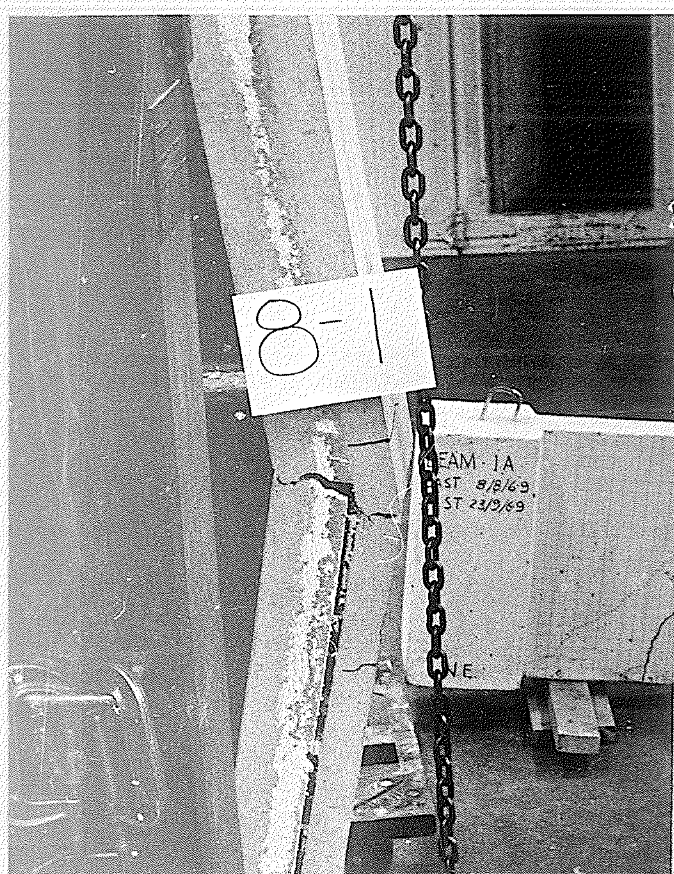


Plate No. 11. Showing panel 8 - 1 at failure.

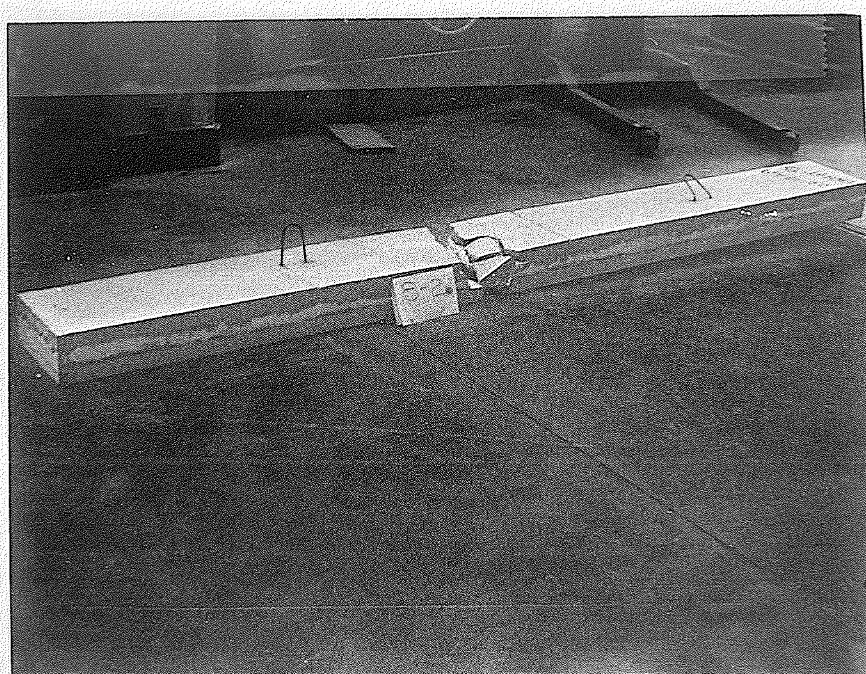


Plate No. 12. Showing panel 8 - 2 after removal from the test frame.

Plate No. 13. Showing panel 8 - 3 at failure.

Plate No. 14. Showing panel 5 - 1_2 at failure.

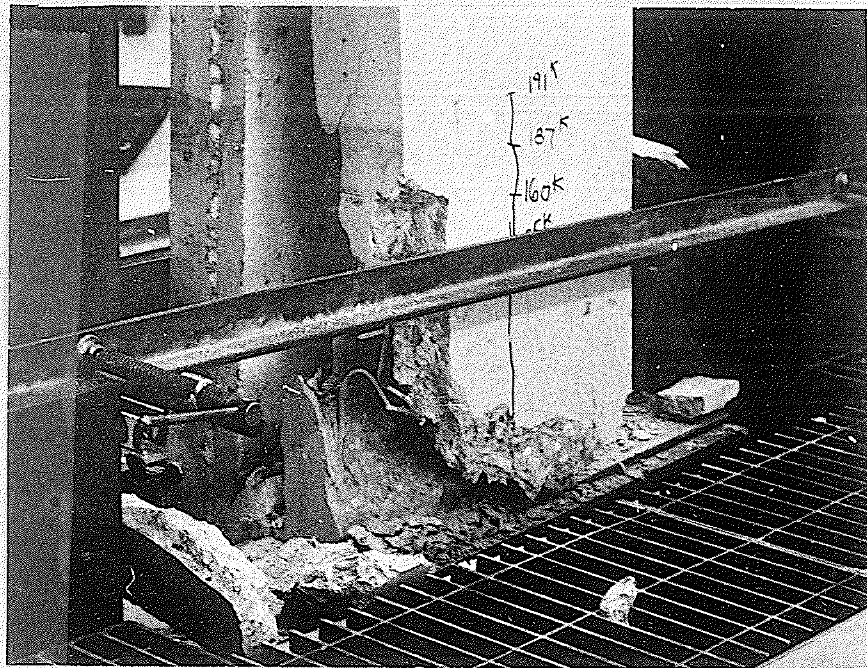


Plate No. 15. Showing panel 5 - 2 at failure.

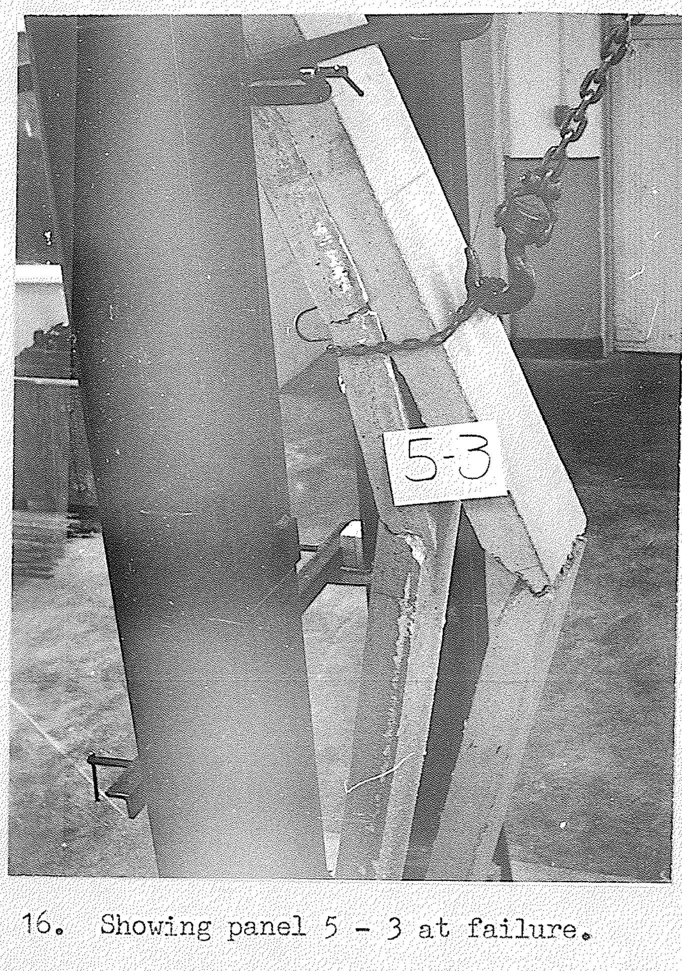


Plate No. 16. Showing panel 5 - 3 at failure.

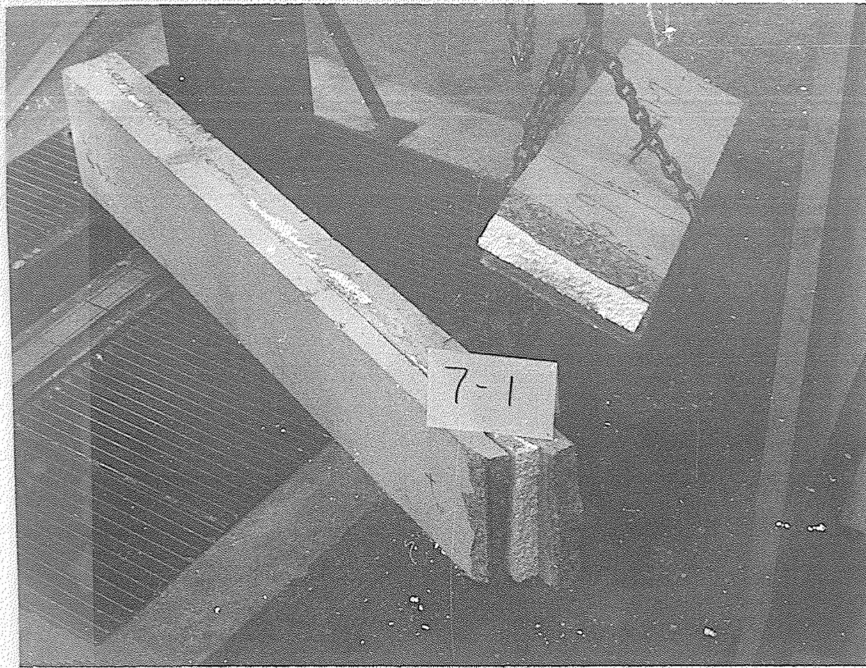


Plate No. 17. Showing panel 7 - 1 immediately after failure.

Plate No. 18. Showing panel 7 - 2 at failure.

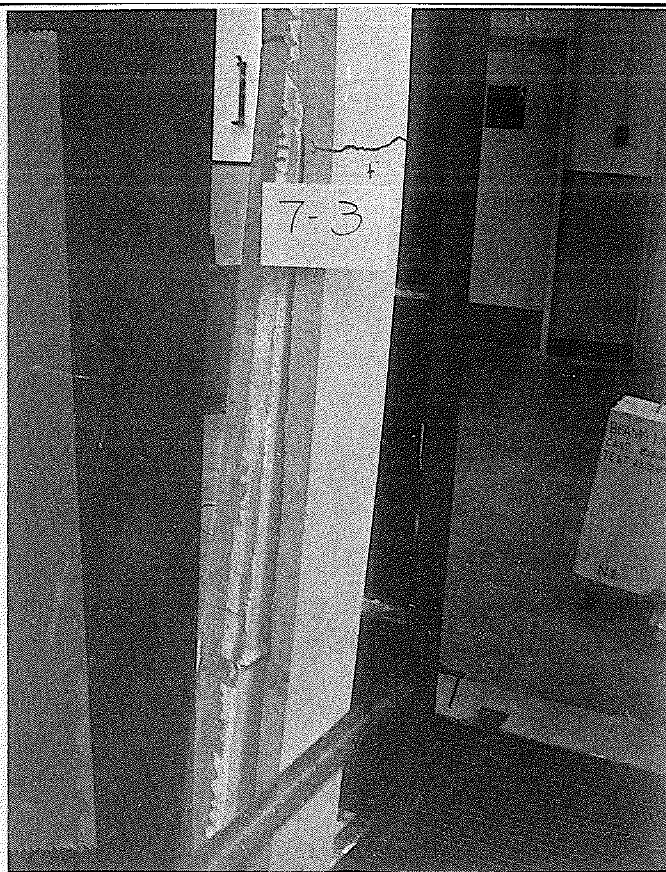


Plate No. 19. Showing panel 7 - 3 at failure.

Plate No. 20. Showing panel 4 - 1 at failure.

Plate No. 21. Showing panel 4 - 2 at failure.

Plate No. 22. Showing panel 6 - 1 at failure.

Plate No. 23. Showing panel 6 - 2 at failure.

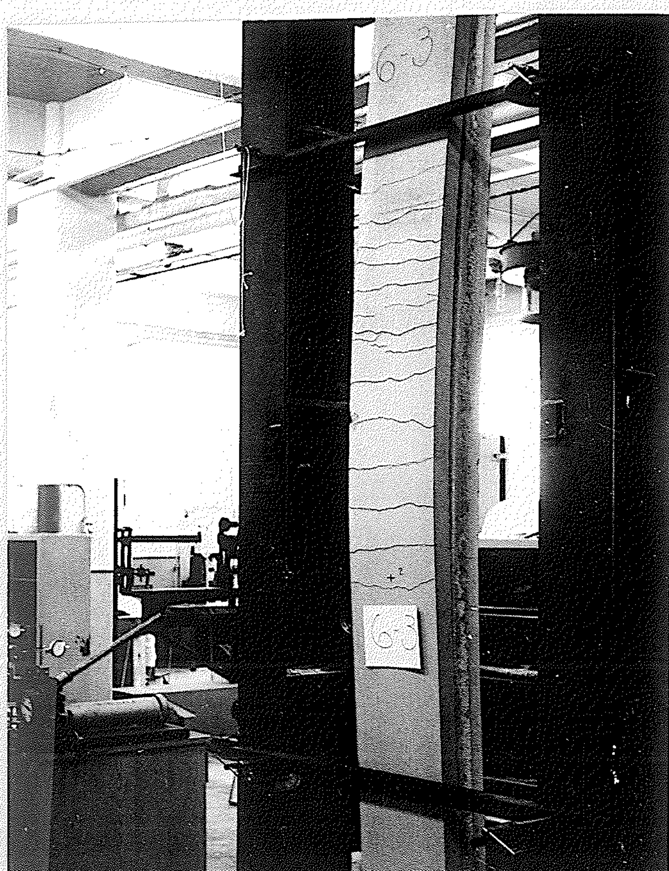


Plate No. 24. Showing panel 6 - 3 at failure.

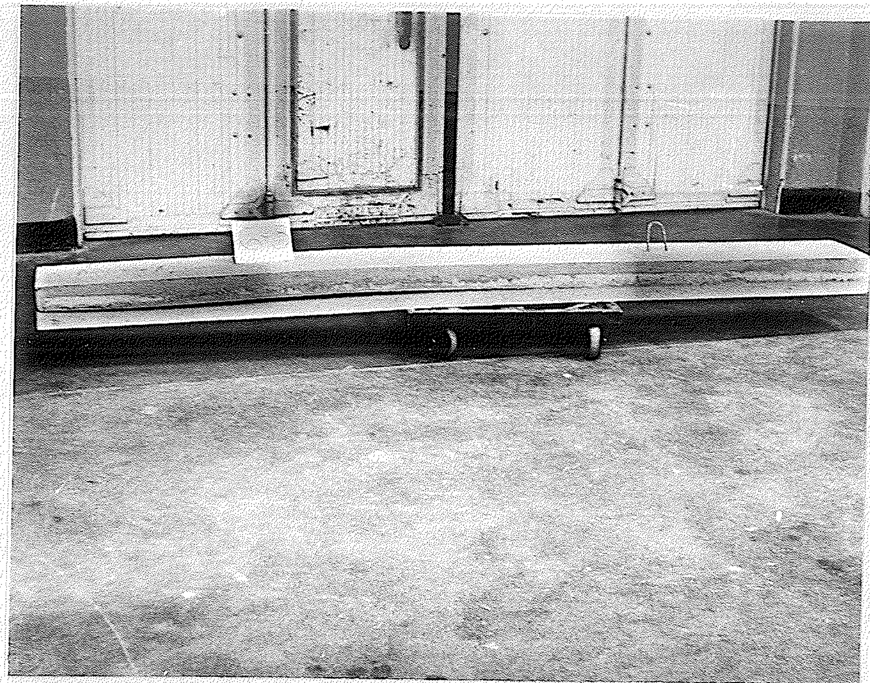


Plate No. 25. Showing panel 6 - 3 after removal from the test frame.

Plate No. 26. Showing panel 3 - 1 at failure.

Plate No. 27. Showing panel 3 - 2 at failure.

Plate No. 28. Showing panel 3 - 3 during test.

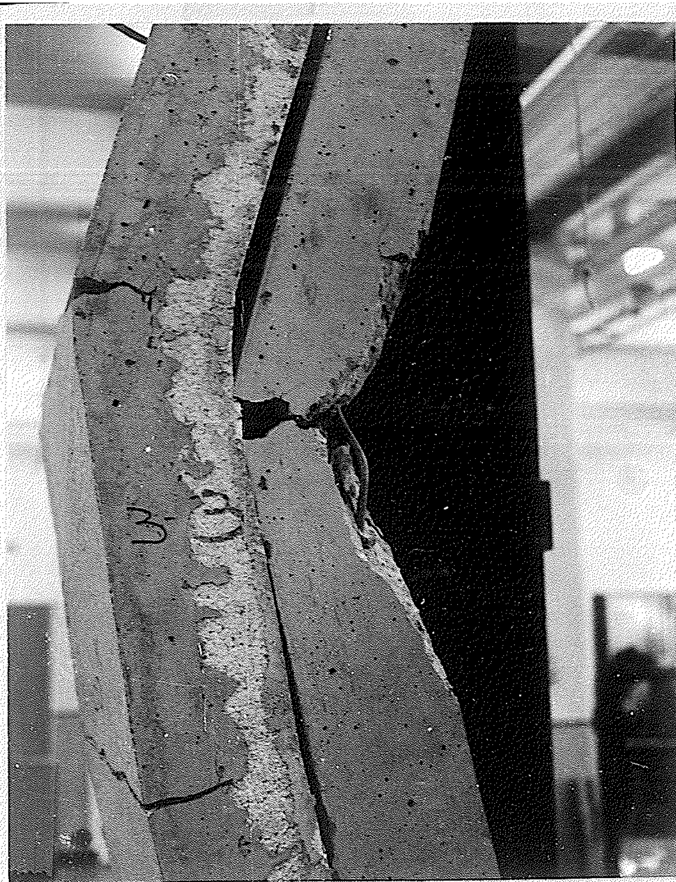


Plate No. 29. Showing panel 3 - 3 at failure.

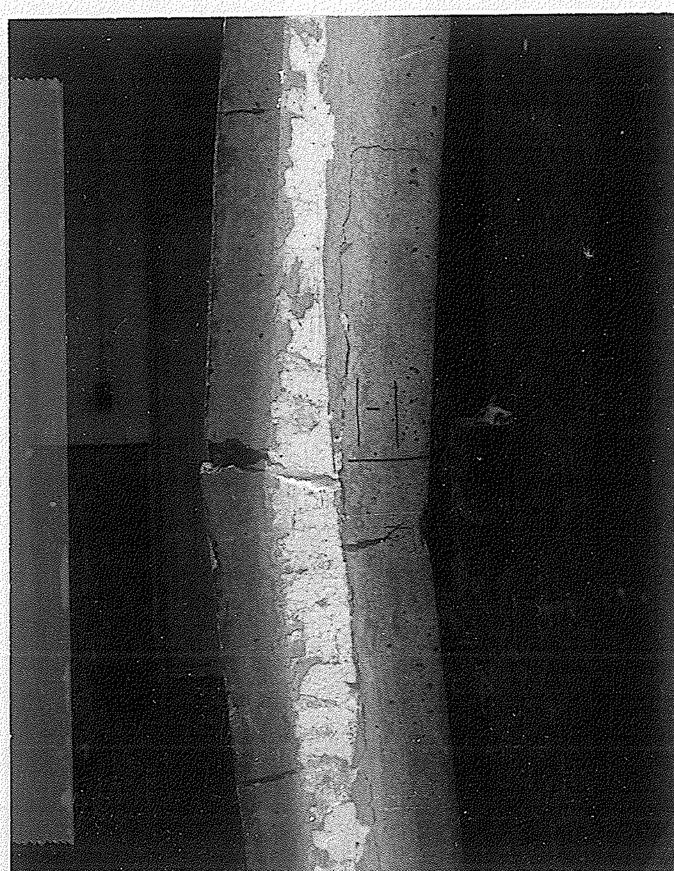


Plate No. 30. Showing panel 1 - 1 at failure.

Plate No. 31. Showing panel 1 - 2 at failure.

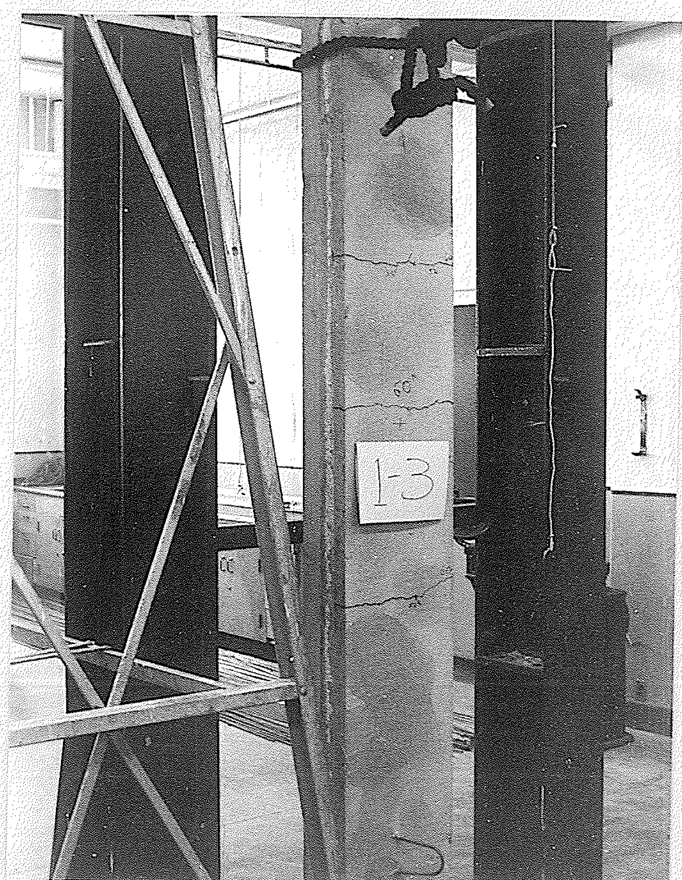


Plate No. 32. Showing panel 1 - 3 during test.

Plate No. 33. Showing panel 2 - 1 during test.

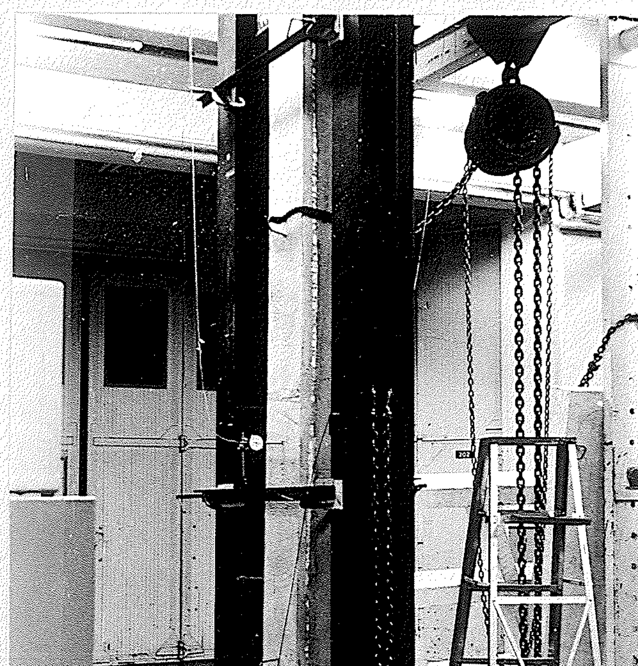


Plate No. 34. Showing panel 2 - 2_2 during test.

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4. Anson, M. and Newman, K.: "The effect of mix proportions and method of testing on Poisson's ratio for mortars and concretes", Magazine of Concrete Research, Vol. 18: Number 56: Sept. 1966.

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