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TENSILE TESTS ON ARTICULATED CONCRETE MATTRESS SPECIMENS.(U)
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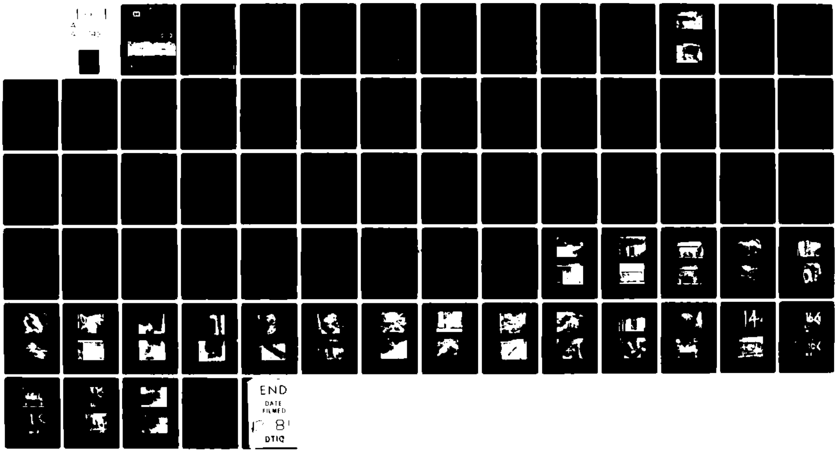

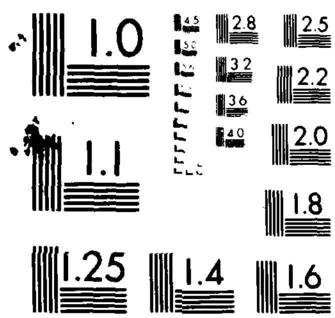
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MISCELLANEOUS PAPER SL-81-28

TENSILE TESTS ON ARTICULATED CONCRETE MATTRESS SPECIMENS

by

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October 1981
Final Report

Prepared for U. S. Army Engineer District, New Orleans
New Orleans, La. 70160

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An investigation was undertaken to determine the feasibility of using crimps in the reinforcement in fabrication of articulated concrete mattress. The crimps would maintain the reinforcement in proper position during casting, thus eliminating the support system currently being used.

In contrast to the straight reinforcing, crimps in the reinforcing caused cracking/spalling of the concrete in each panel tested. Overall, the

(Continued)

4/11

(lbf)

20. ABSTRACT (Continued).

initial concrete cracking/spalling load averaged 2449 lbf or approximately 47 percent less than the ultimate load as determined on panels with straight reinforcing.

Overall, the ultimate tensile load of bracket wires with crimps averaged 50 lbf higher than bracket wires without crimps. Similarly, the ultimate tensile load of longitudinal wires with crimps averaged 84 lbf higher than longitudinal wires without crimps.

Preface

The tests described herein were performed by the Structures Laboratory (SL) of the U. S. Army Engineer Waterways Experiment Station (WES) under the sponsorship of the U. S. Army Engineer District, New Orleans. The study was authorized by DA Form 2544 dated 18 September 1980. Mr. Robert P. Ziegler, Value Engineering Officer, New Orleans District, served as the point of contact.

The study was conducted under the general supervision of Mr. Bryant Mather, Chief, SL, and Mr. John M. Scanlon, Chief, Engineering Mechanics Division, SL, and under the direct supervision of Mr. James E. McDonald, Chief, Evaluation and Monitoring Group, SL. The Project Leader for this work was Mr. Dale Glass, who prepared this report with the assistance of Mr. McDonald.

COL N. P. Conover, CE, and COL T. C. Creel, CE, were Directors of WES during the study and the publication of this report. Mr. F. R. Brown was Technical Director.

Contents

Conversion Factors, Inch-Pound to Metric (SI) Units of Measurement

Inch-pound units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
cubic feet	0.02831685	cubic metres
inches	25.4	centimetres
pounds (force)	4.448222	newtons
pounds (force) per minute	4.448222	newtons per minute
pounds (force) per square inch	6.894757	kilonewtons
pounds (mass)	0.45359237	kilograms
tons (mass)	907.18474	kilograms

TENSILE TESTS ON ARTICULATED CONCRETE MATTRESS SPECIMENS

Purpose

1. The investigation described in this report was undertaken as part of a study to determine the feasibility of using crimps in the reinforcement in fabrication of articulated concrete mattress. The crimps would maintain the reinforcement in proper position during casting, thus eliminating the support system currently being used.

Scope

2. Reinforcing details to be evaluated were developed by the New Orleans District, and 20 test panels of articulated concrete mattress were fabricated at the St. Francisville, La., casting plant. Each panel was tested at the U. S. Army Engineer Waterways Experiment Station (WES) to determine crack pattern, ultimate tensile load, and mode of failure associated with the various reinforcing details.

Specimens

3. Reinforcing details for each test panel are shown in Appendix A. Briefly, the reinforcing in panels 1-6 was not crimped and thus represented current practice. Panels 7-10 contained reinforcing with 60-deg crimps in the bracket wire. Panels 11-20 contained reinforcing with 45-deg crimps in either the bracket or longitudinal reinforcing. Beginning with panel 11, which had crimped bracket wire, the crimps alternated between the bracket and the longitudinal reinforcing.

4. The test panels were cast on 8 September 1980 at the St. Francisville casting plant. Concrete mixture proportions were as follows:

Material	Saturated Surface Dry Weight lb	Solid Volume cu ft
Portland cement, Type 1	260.8	1.327
25 percent fly ash	60.4	0.442
CaCl 1 percent	3.2	
Fine aggregate	1286.3	7.868
Coarse aggregate	1928.1	12.311
WRA	16.1	
Water	222.6	3.567
TOTAL	3777.5	27.000

Flexural and compressive strengths at 90 days age averaged 460 and 3090 psi,* respectively.

5. Test panels were shipped by truck to WES on 13 November 1980 and stored in the laboratory until testing was initiated at approximately 90 days age.

Test Apparatus

6. A testing frame was fabricated using 6-in.-square tubing and 2-in.-diam steel rod. Holes were drilled in the upper member of the frame to coincide with the location of the reinforcing in the test panels, and two 5/8-in.-diam rods were installed. A short section of square tubing was fitted to the lower end of the rod for mounting the wire chucks which were used to grip the reinforcing in the test panels. A hydraulic pump with metering system was used in conjunction with two 10-ton hydraulic cylinders mounted on top of the frame to apply tensile loads. Load cells were mounted on the bottom of the frame to determine applied loads. The testing frame as mounted on the structural test floor is shown in Figure 1.

* A table of factors for converting inch-pound units of measurement to metric (SI) units is presented on page 3.

Figure 1. Testing frame

Instrumentation

7. Tensile loads were measured using two 5000-lb universal load cells with conditioners. A two-pen strip chart recorder was used to plot load versus time for each load cell. An overall view of the hydraulic power supply and instrumentation is shown in Figure 2.

Figure 2. Testing equipment

Test Procedure

8. In general, the panels were testing according to the following procedure:

- a. Place specimen in the testing frame and install wire chucks on the reinforcing to be stressed.
- b. Photograph specimen.
- c. Zero instrumentation.
- d. Apply tensile load at a rate of approximately 500 lb/min until initial cracking.
- e. Photograph specimen as necessary to document crack pattern.
- f. Resume load application to ultimate failure.
- g. Photograph failure mode.
- h. Remove test specimen.

Results

9. Detailed results of tensile tests on the 20 articulated concrete mattress panels are given in Table 1 and summarized in Table 2. Load-time relationships for the specimens are given in Plates 1-20. Photographs of the panels during and following test are included in Appendix B.

10. Six specimens without crimped reinforcing were tested, three each for both bracket and longitudinal reinforcing. Ultimate tensile loads for the bracket wires ranged from 3000 to 3700 lbf with an average of 3333 lbf. In comparison, ultimate tensile loads for the longitudinal wires ranged from 3800 to 3950 lbf with an average of 3883 lbf. There was no cracking or spalling of concrete in any of the panels where the reinforcing was not crimped.

11. Four specimens with 60-deg crimps in the bracket wire were tested. In general, these specimens failed according to the following sequence:

- a. The outside bend in the crimp straightened, causing a small section of concrete near the scarf box to spall.
- b. The middle bend and, in some cases, the inside bend in the crimp straightened, causing additional concrete cracking and spalling back to the longitudinal wire.

_c_. The bracket wire failed within the concrete.

The tensile load at which initial concrete cracking/spalling occurred ranged from 2250 to 2825 lbf with an average of 2646 lbf. In the three specimens which exhibited the second stage of concrete cracking/spalling, tensile loads at this point ranged from 2150 to 3120 lbf and averaged 2690 lbf. Ultimate tensile loads for the bracket wires with 60-deg crimps ranged from 2800 to 3780 lbf and averaged 3245 lbf.

12. Five specimens with 45-deg crimps in the bracket wire were tested. In general, the failure mechanism was similar to that previously described for the bracket wires with 60-deg crimps. Initial concrete cracking/spalling loads ranged from 1950 to 2700 lbf with an average of 2235 lbf. Tensile loads at the second stage of concrete cracking/spalling averaged 3300 lbf. Ultimate tensile loads ranged from 3250 to 3725 lbf with an average of 3494 lbf.

13. Five specimens with 45-deg crimps in the longitudinal wire were tested. There appeared to be more variation in the failure mechanisms associated with this series of panels than that with the other groups of panels. This variation was probably due in part to the fact that the crimped reinforcing wire in two of the panels had been rotated approximately 90 deg from the desire orientation prior to or during concrete casting. Initial concrete cracking/spalling loads varied from 1800 to 3175 lbf with an average of 2505 lbf. Second stage concrete cracking/spalling occurred at an average load of 3415 lbf. Ultimate tensile loads in the longitudinal wire with 45-deg crimps ranged from 3875 to 4035 lbf with an average of 3967 lbf.

14. In addition to the tensile tests on the mattress panels, three approximately 12-in.-long specimens of the longitudinal reinforcing were removed from the panels and tested in direct tension. Ultimate tensile load (Plates 21-23) for these specimens ranged from 4170 to 4450 lbf with an average of 4343 lbf.

Discussion

15. Ultimate tensile loads of longitudinal reinforcing tested in

the concrete panels averaged 3883 lbf, approximately 12 percent less than the ultimate load of wire specimens removed from the panels and tested. This difference is attributed to the gripping mechanisms used in the two tests. In each of the panel tests, the reinforcing failed inside the chuck. The wire specimens were tested in a universal testing machine, and only that specimen (L-2) exhibiting the lower ultimate load failed inside the grip.

16. In contrast to the straight reinforcing, crimps in the reinforcing caused cracking/spalling of the concrete in each panel tested. Overall, the initial concrete cracking/spalling load averaged 2449 lbf or approximately 47 percent less than the ultimate load as determined on panels with straight reinforcing.

17. A 45-deg crimp in the bracket wire resulted in an initial concrete cracking/spalling load approximately 18 percent lower than that of 60-deg crimps. However, the ultimate loads averaged slightly higher for the 45-deg crimp. Initial concrete cracking/spalling loads averaged approximately the same for 60-deg crimps in the bracket wire and 45-deg crimps in the longitudinal wire.

18. Overall, the ultimate tensile load of bracket wires with crimps averaged 50 lbf higher than bracket wires without crimps. Similarly, the ultimate tensile load of longitudinal wires with crimps averaged 84 lbf higher than longitudinal wires without crimps.

TABLE 1

Detailed Testing Results

Panel No.	Type Crimp	Type Test	Concrete Cracking/Spalling Load, lbf	Ultimate Tensile Load, lbf	Remarks
1	None	Bracket	--	3700	Bracket wire failure at upper edge of panel.
3	None	Bracket	--	3000	Bracket wire failure inside concrete.
5	None	Bracket	--	3300	Bracket wire failure inside concrete.
2	None	Longitudinal	--	3900	Longitudinal wire failure inside gripping chuck.
4	None	Longitudinal	--	3800	Longitudinal wire failure inside gripping chuck.
6	None	Longitudinal	--	3980	Longitudinal wire failure inside gripping chuck.
7	60^{o}	Bracket	2800	--	Straightening of the outside bend in the crimp broke off corner of the panel near the scarf box.
			3120	--	Straightening of the middle bend in the crimp, also concrete failure along the longitudinal wire.
			--	3780	Bracket wire failure near end of specimen opposite crimp.
8	60^{o}	Bracket	2825	--	Middle bend in the crimp straightened and broke off corner of panel near the scarf box.
			--	3125	Bracket wire failed inside the concrete panel at the end opposite the crimp.
9	60^{o}	Bracket	2710	--	Outside bend in the crimp straightened and broke off corner of the panel near the scarf box.
			2800	--	Middle and inside bends in the crimp straightened, larger pieces of concrete broke off.
			--	2800	Bracket wire failed inside the concrete.

TABLE 1 (Continued)

Panel No.	Type Crimp	Type Test	Concrete Cracking/Spalling Load, lbf	Ultimate Tensile Load, lbf	Remarks
10	60^{o}	Bracket	2250	--	Outside bend in the crimp straightened and broke small section of concrete near the scarf box.
			2150	--	Middle and inside bend in the crimp straightened and broke off a section of concrete ranging from the scarf box to the longitudinal reinforcing.
			--	3275	Bracket wire failed inside the concrete.
11	45^{o}	Bracket	2700	--	Outside bend in the crimp straightened and small section of concrete near scarf box broke off.
			3399	--	Partial straightening of middle and inside bend in the crimp caused concrete on the bottom surface of the panel as cast to pop off.
			--	3725	Bracket wire failed inside the concrete.
13	45^{o}	Bracket	1950	--	Outside bend in the crimp straightened causing small section of concrete near the scarf box to break off.
			--	3250	Bracket wire failed inside concrete near end of the panel opposite the crimp.

TABLE 1 (Continued)

Panel No.	Type Crimp	Type Test	Concrete Cracking/Spalling Load, lbf	Ultimate Tensile Load, lbf	Remarks
12	45°	Longitudinal	2350	--	Outside bend in the crimp straightened causing a corner of the panel from the scarf box to the longitudinal wire to break off. Crimp appeared to have been rotated 90° from desired orientation prior to or during casting.
			2899	--	Middle bend in the crimp straightened with additional concrete spalling.
			--	3900	Longitudinal wire failed inside the gripping chuck.
14	45°	Longitudinal	3000	--	Large crack paralleling the longitudinal wire from the edge of the panel near the crimp approximately half way across the panel.
			3950	--	Crack opened wider and extended completely across the panel.
			--	4025	Longitudinal wire failed inside the gripping chuck.
16	45°	Longitudinal	3175	--	Outside bend in the crimp straightened causing a corner of the panel from the longitudinal wire to the scarf box to break off. Crimp appeared to have been rotated 90° from desired orientation prior to or during casting.
			3775	--	Large crack originating at the crimp and going diagonally across the panel.
			--	4000	Longitudinal wire failed inside the gripping chuck.

TABLE 1 (Continued)

Panel No.	Type Crimp	Type Test	Concrete Cracking/Spalling Load, lbf	Ultimate Tensile Load, lbf	Remarks
15	45°	Bracket	2250	--	Outside bend in the crimp straightened breaking a small section of concrete near the scarf box.
			2975	--	Middle and inside bends in the crimp straightened causing a crack across the panel coinciding with the longitudinal wire. Approximately one half of the concrete section outside the longitudinal wire broke off.
			--	3275	Bracket wire failed inside the concrete.
17	45°	Bracket	2000	--	Outside bend in the crimp straightened causing a small section of concrete near the scarf box to break off.
			3375	--	Middle and inside bends in the crimp straightened causing the section of concrete outside the longitudinal wire to break off.
			--	3710	Bracket wire failed 1-in. outside the concrete on the end of the panel opposite the crimp.
19	45°	Bracket	2275	--	Outside bend in the crimp straightened causing a small section of concrete near the scarf box to break off.
			3450	--	Middle and inside bends in the crimp straightened causing a large crack diagonally across the panel from the scarf box to a point 3 in. inside the longitudinal wire.
			--	3510	Bracket wire failed inside the concrete.

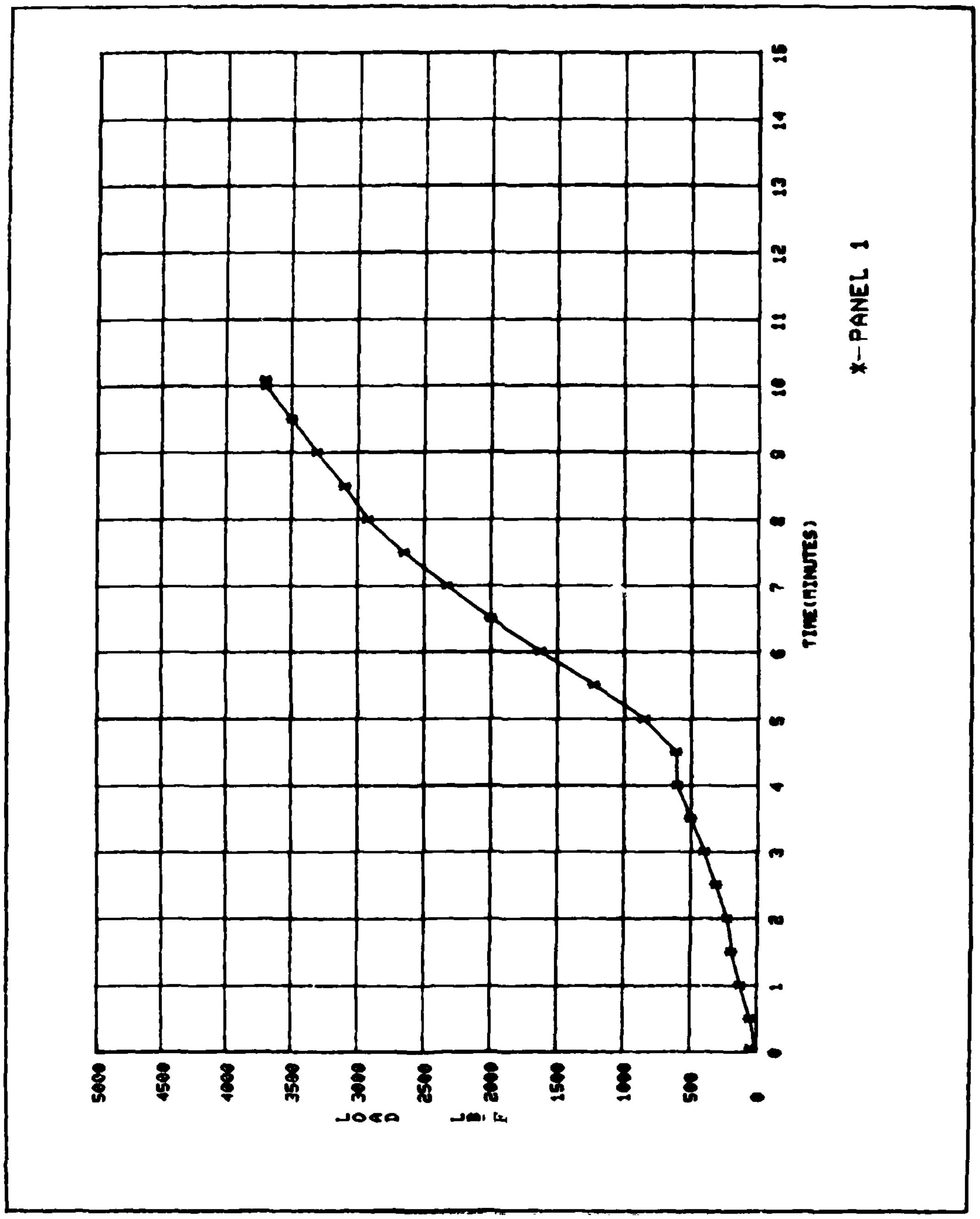
TABLE 1 (Concluded)

Panel No.	Type Crimp	Type Test	Concrete Cracking/Spalling Load, lbf	Ultimate Tensile Load, lbf	Remarks
18	45°	Longitudinal	2200	--	Outside bend in the crimp straightened causing a small section of concrete to spall.
			3750	--	Concrete along the leg of the crimp between the middle and inside bend spalled.
			--	4035	Longitudinal wire failed outside the panel edge opposite the crimp.
20	45°	Longitudinal	1800	--	Outside bend in the crimp straightened spalling a small section of concrete.
			2700	--	Middle bend in the crimp straightened causing additional concrete spalling.
			--	3875	Longitudinal wire failed outside the panel edge opposite the crimp.

TABLE 2

Summary of Test Data

Panel No.	Concrete Cracking/Spalling Load, lb Initial	Concrete Cracking/Spalling Load, lb 2nd Stage	Ultimate Tensile Load, lb	Remarks
1	--	--	3700	No crimp-Bracket
3	--	--	3000	
5	--	--	3300	
Avg			3333	
2	--	--	3900	No crimp-Longitudinal
4	--	--	3800	
6	--	--	3950	
Avg			3883	
7	2800	3120	3780	60° crimp-Bracket
8	2825	--	3125	
9	2710	2800	2800	
10	2250	2150	3275	
Avg	2646	2690	3245	
11	2700	3399	3725	45° crimp-Bracket
13	1950	--	3250	
15	2250	2975	3275	
17	2000	3375	3710	
19	2275	3450	3510	
Avg	2235	3300	3494	
12	2350	2899	3900	45° crimp-Longitudinal
14	3000	3950	4025	
16	3175	3775	4000	
18	2200	3750	4035	
20	1800	2700	3875	
Avg	2505	3415	3967	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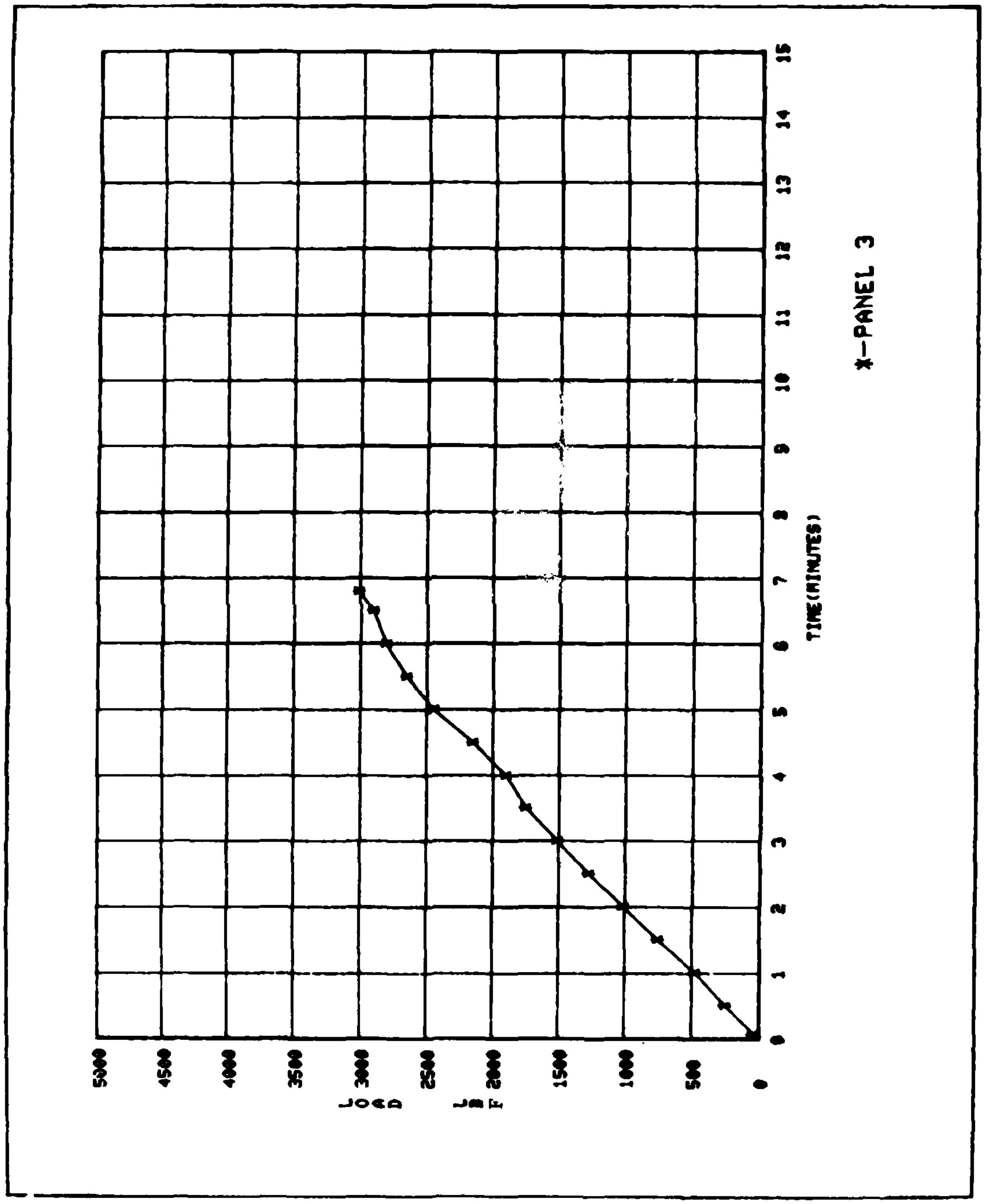
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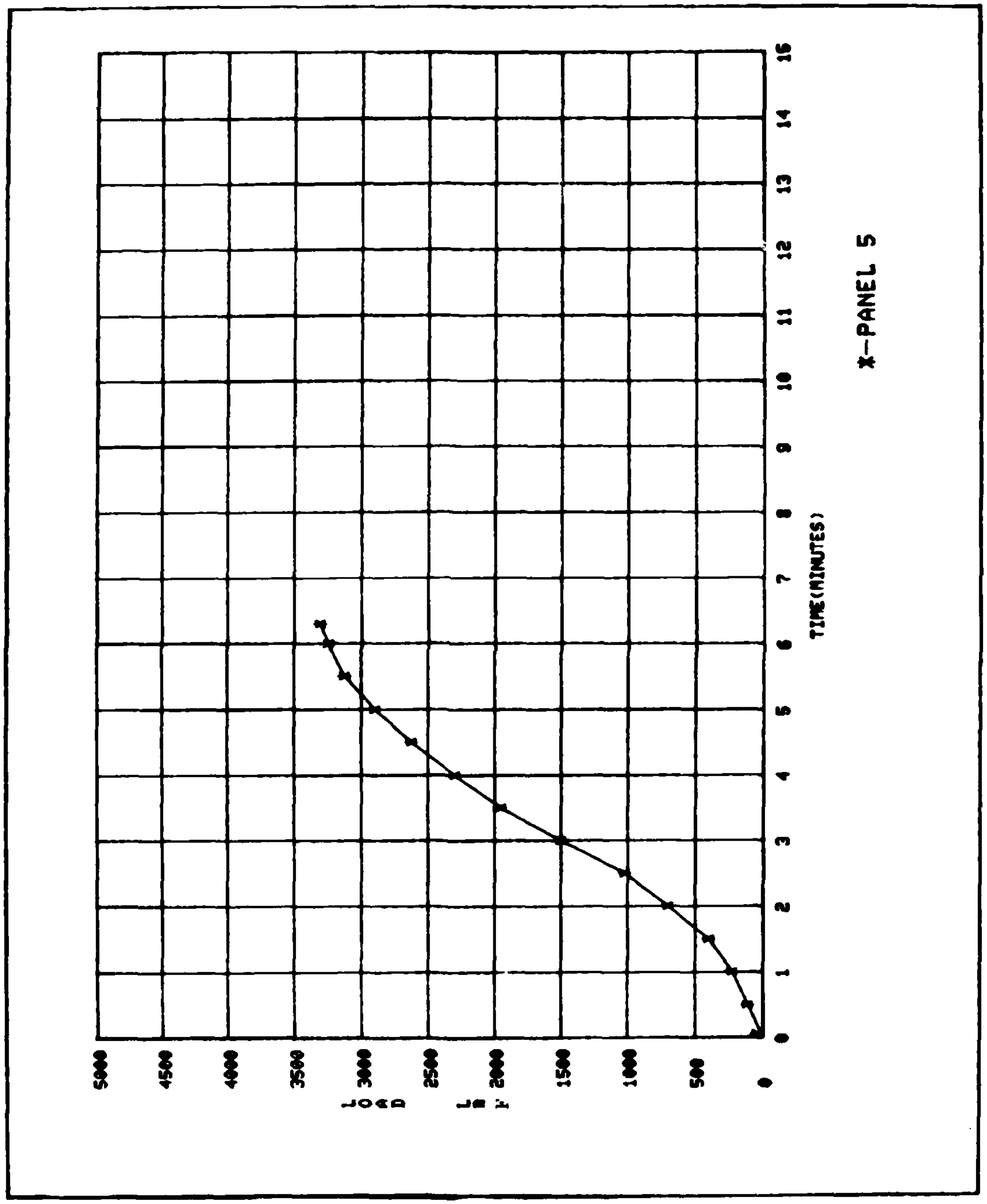
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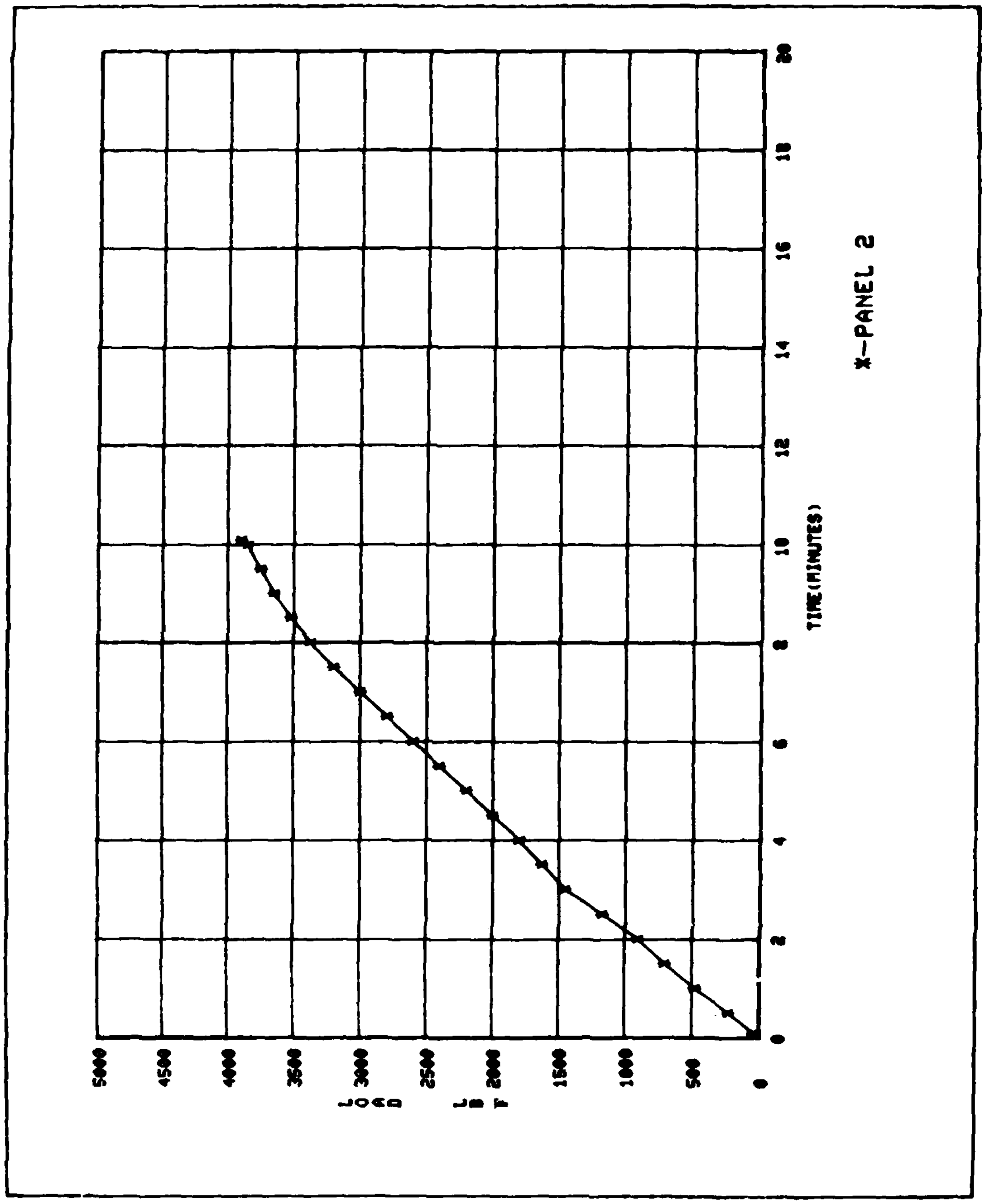
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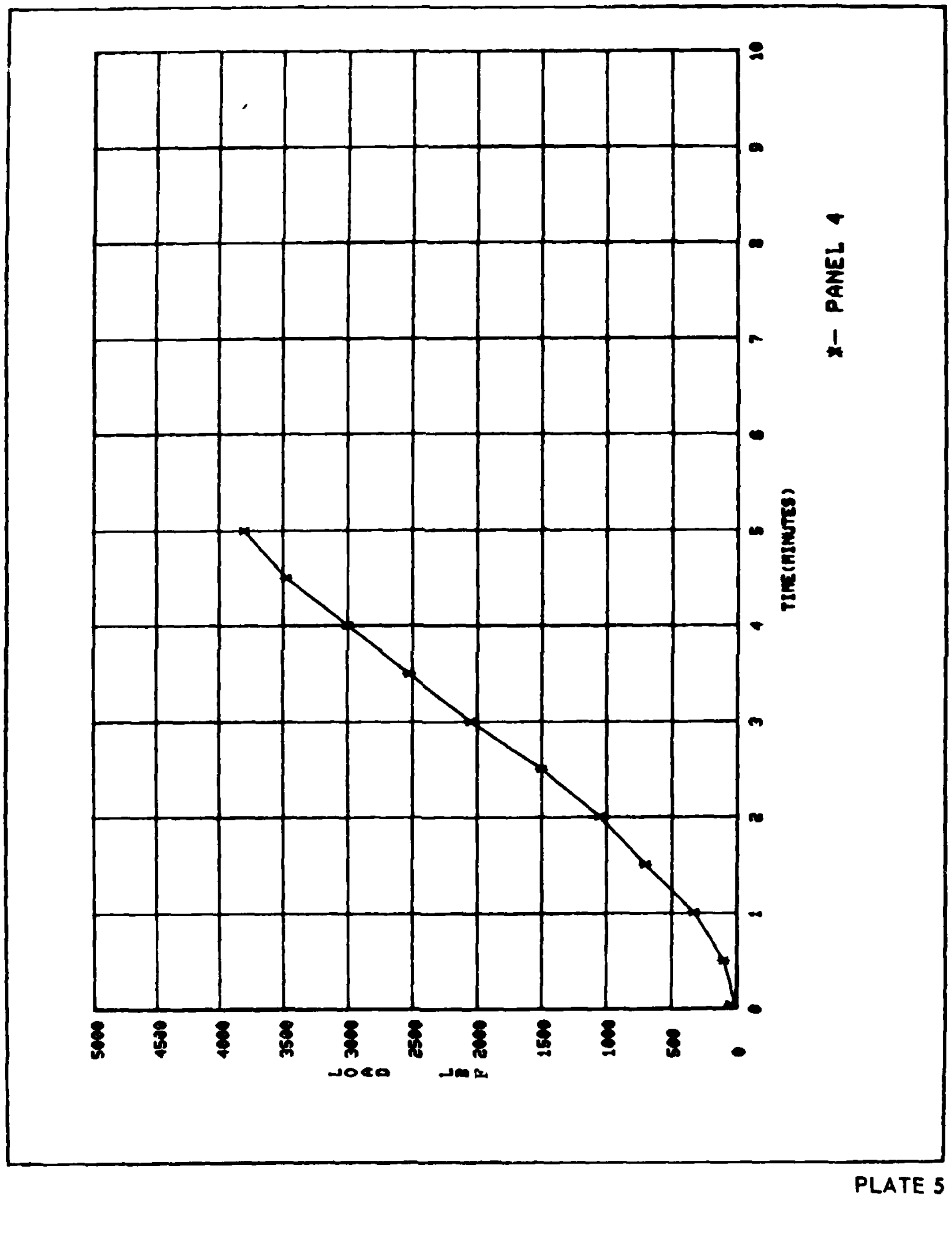
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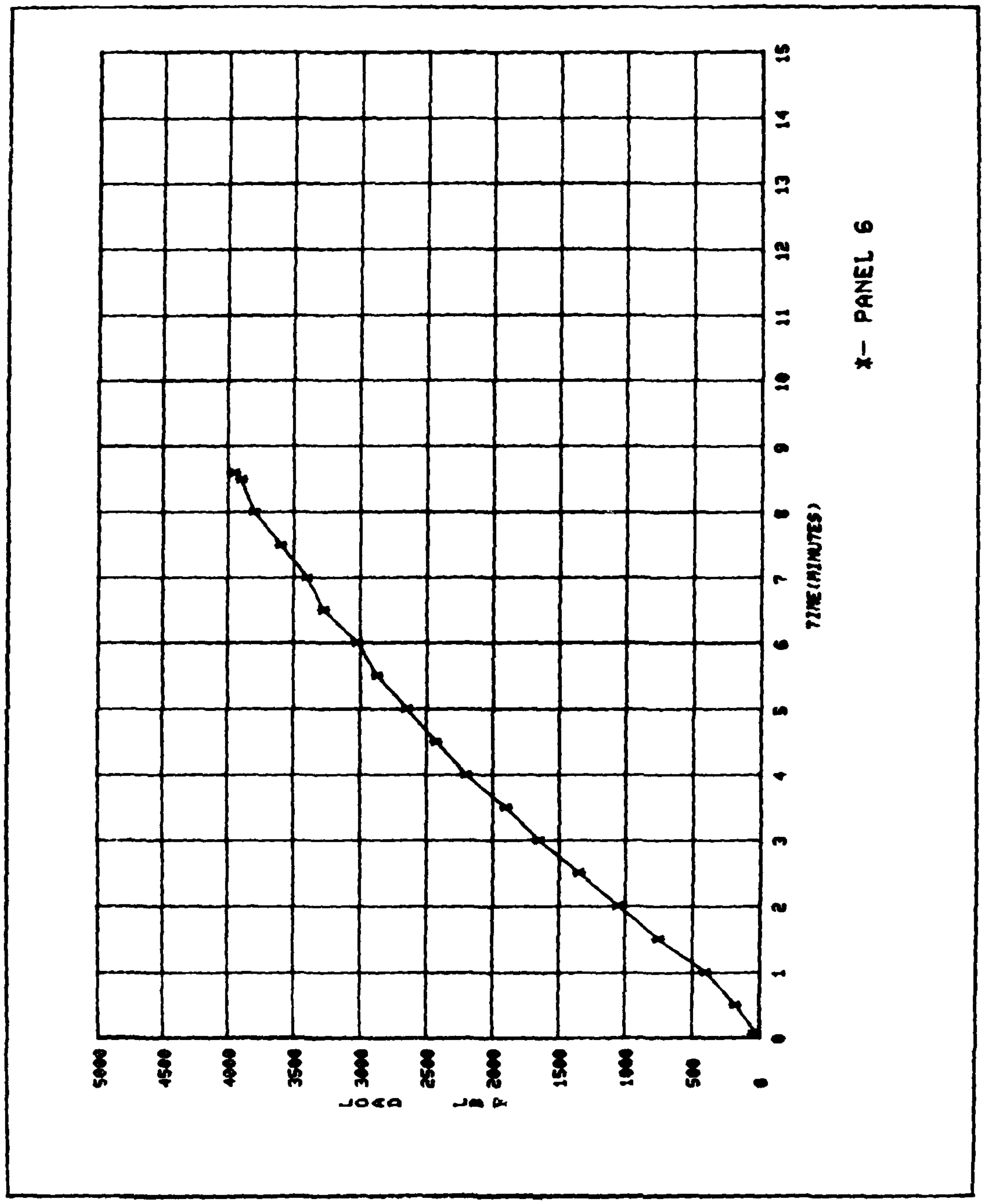

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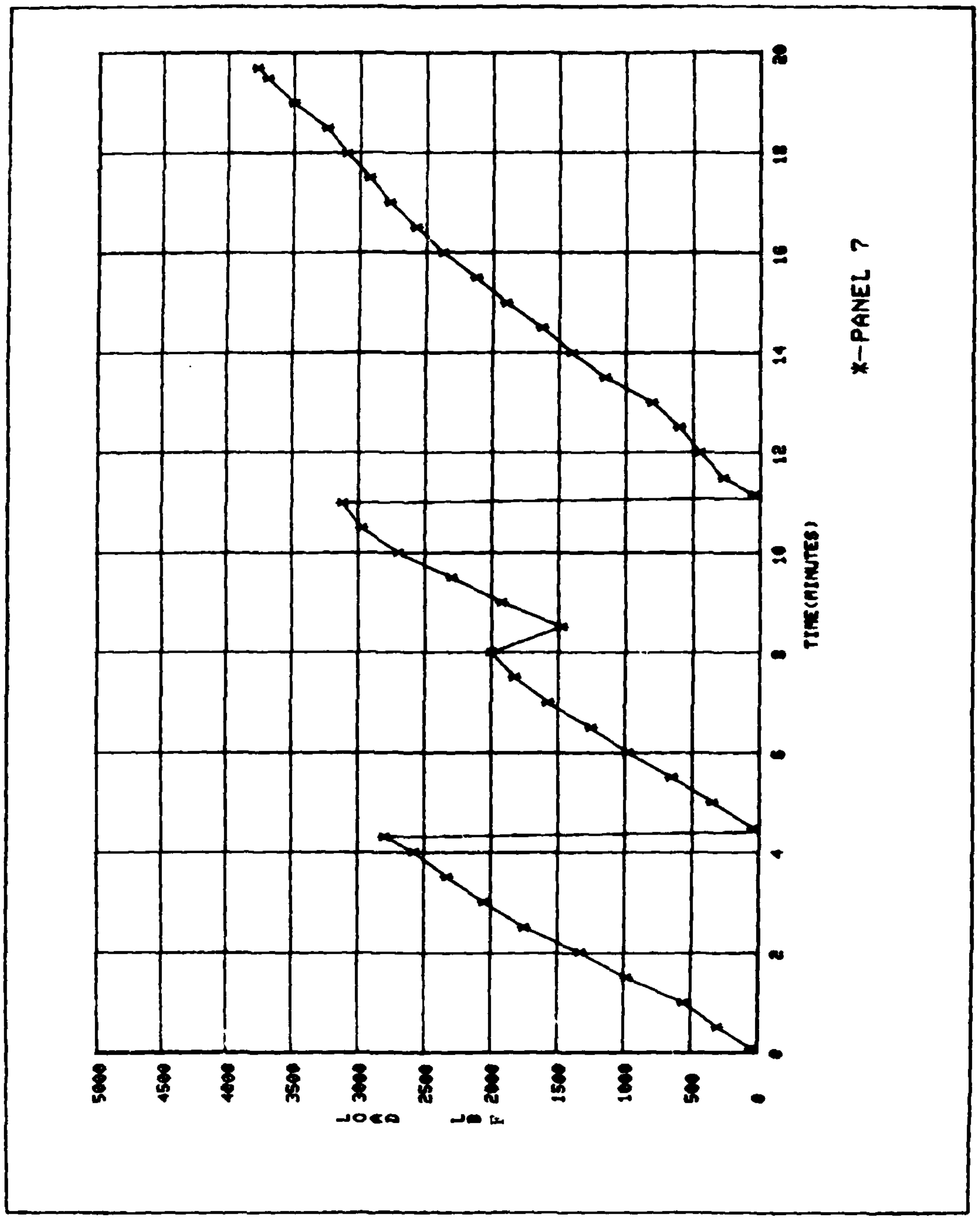

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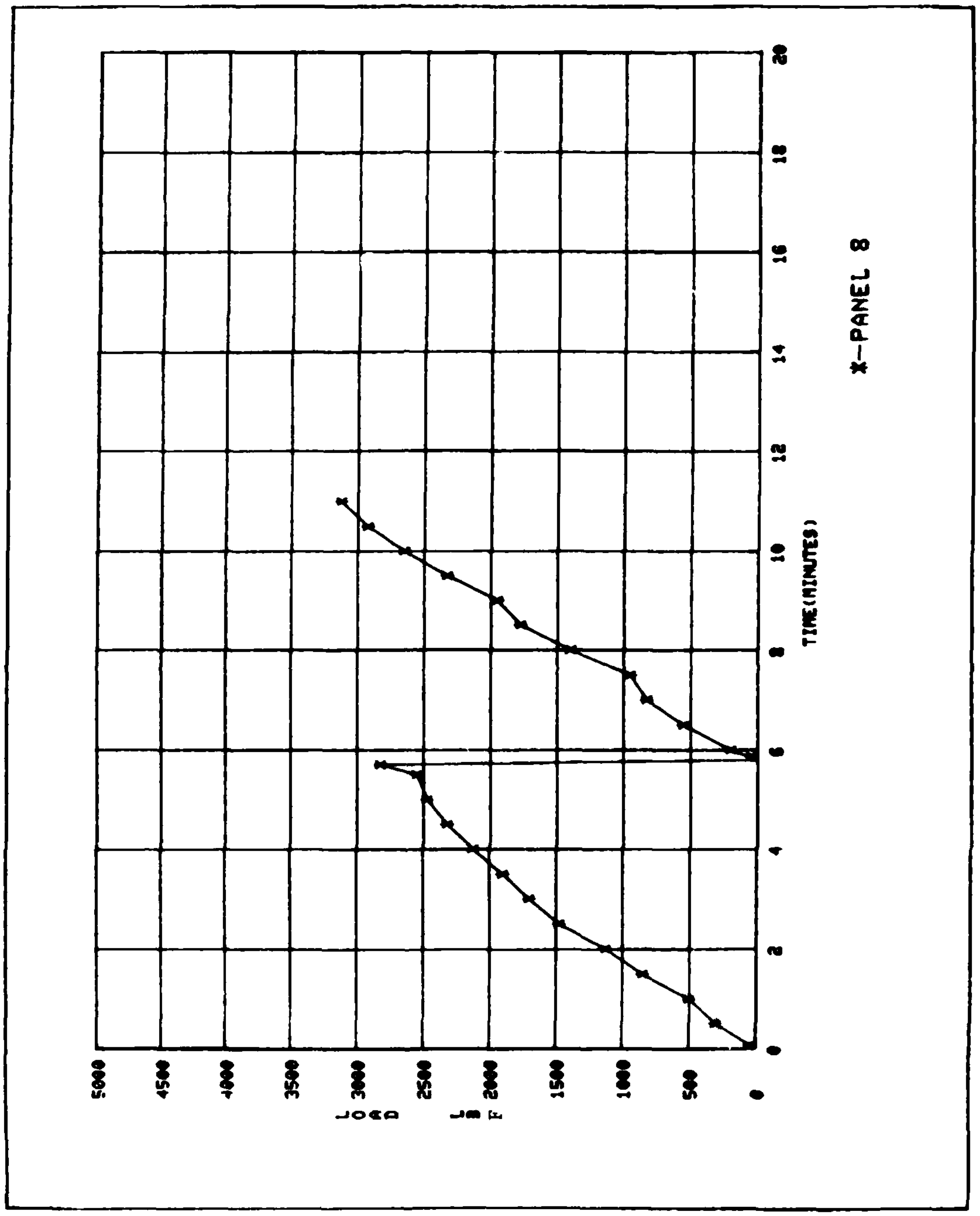
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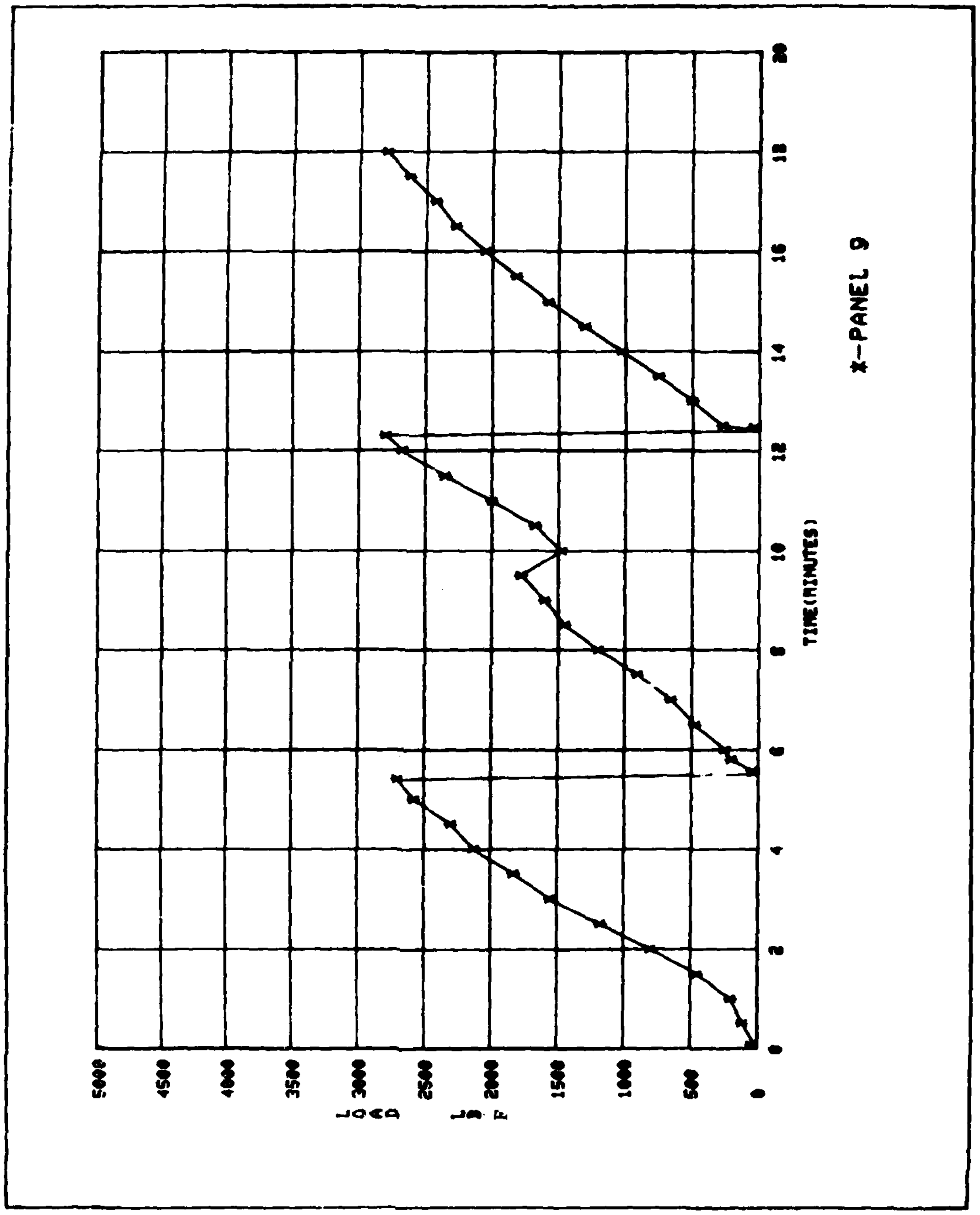
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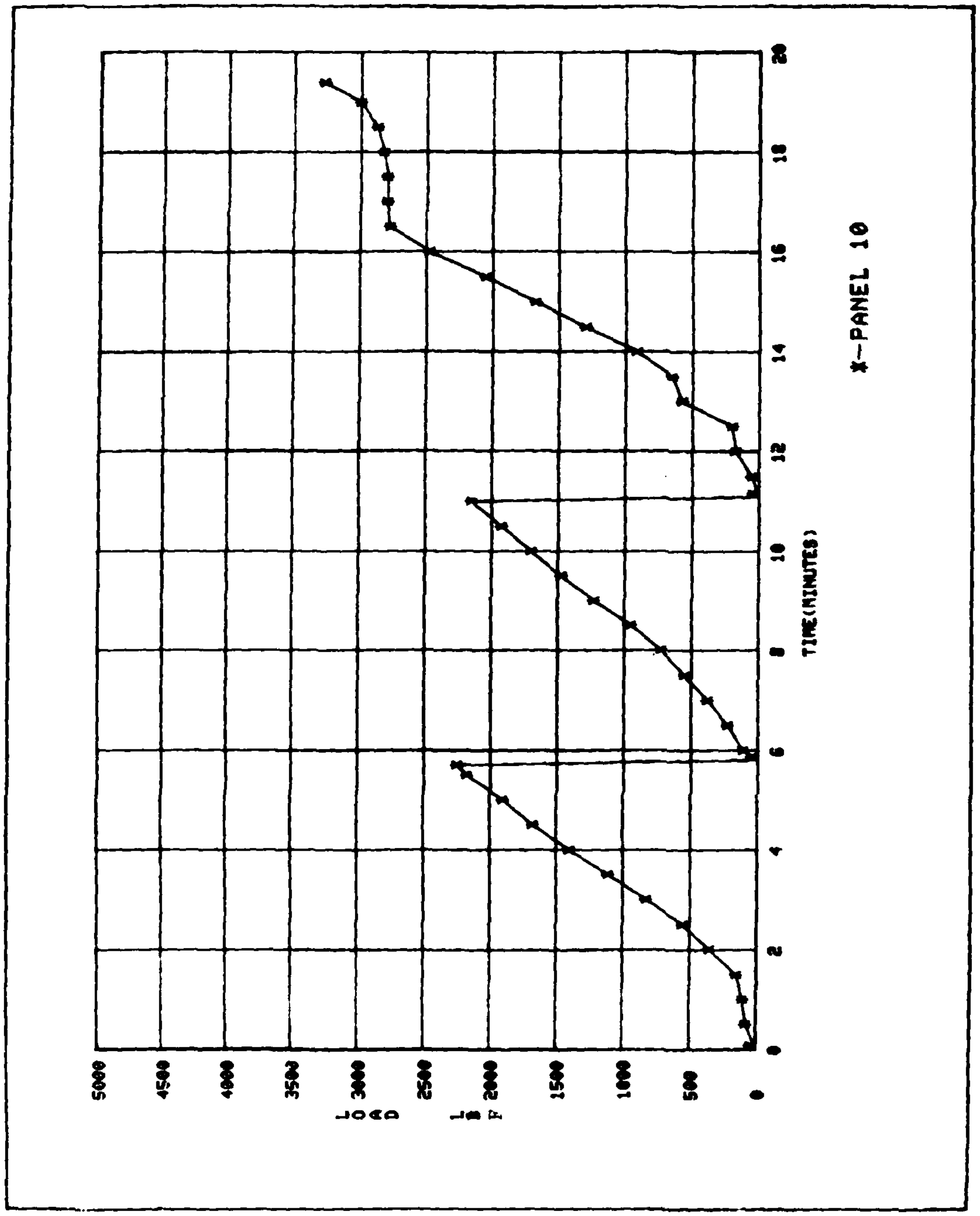
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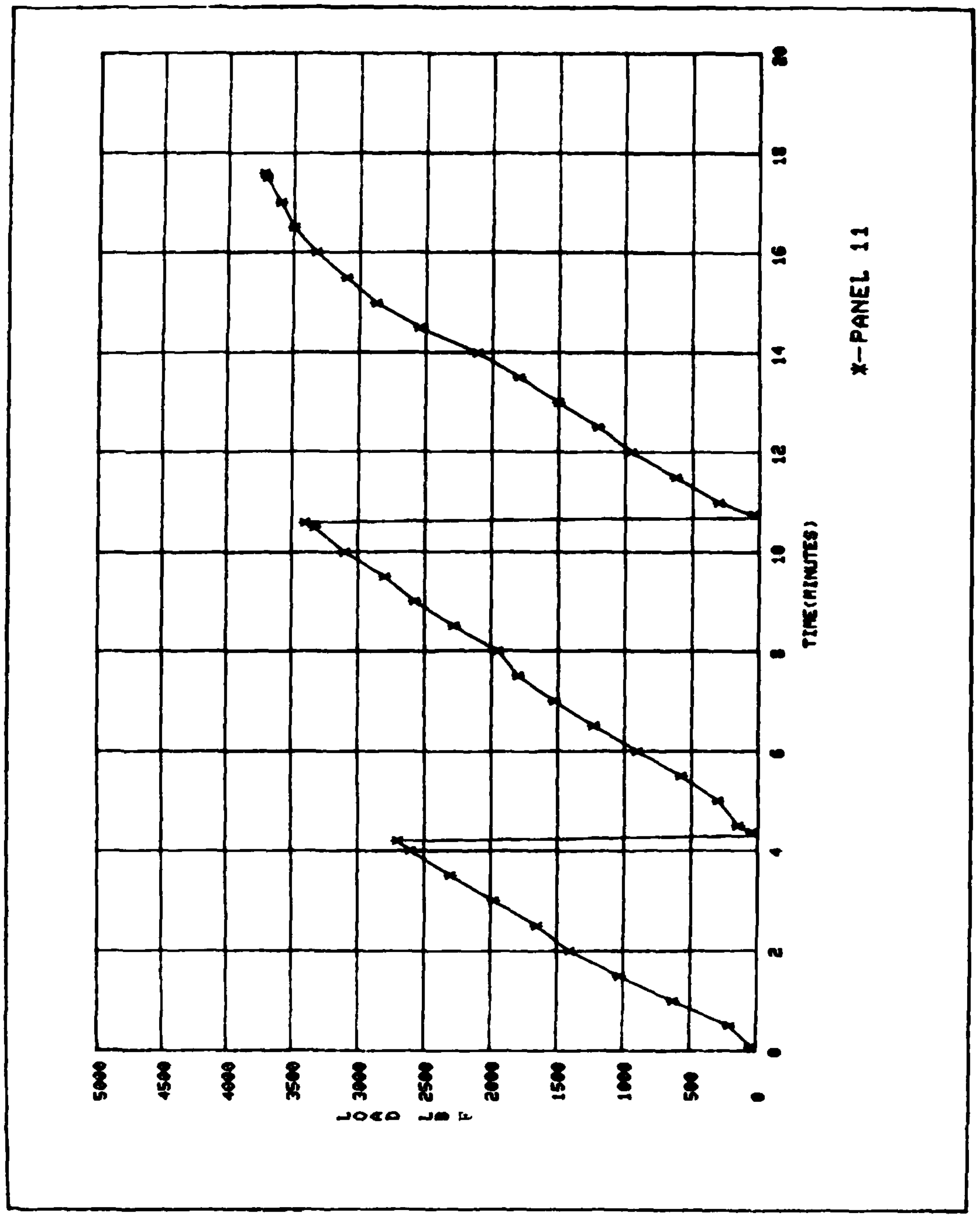
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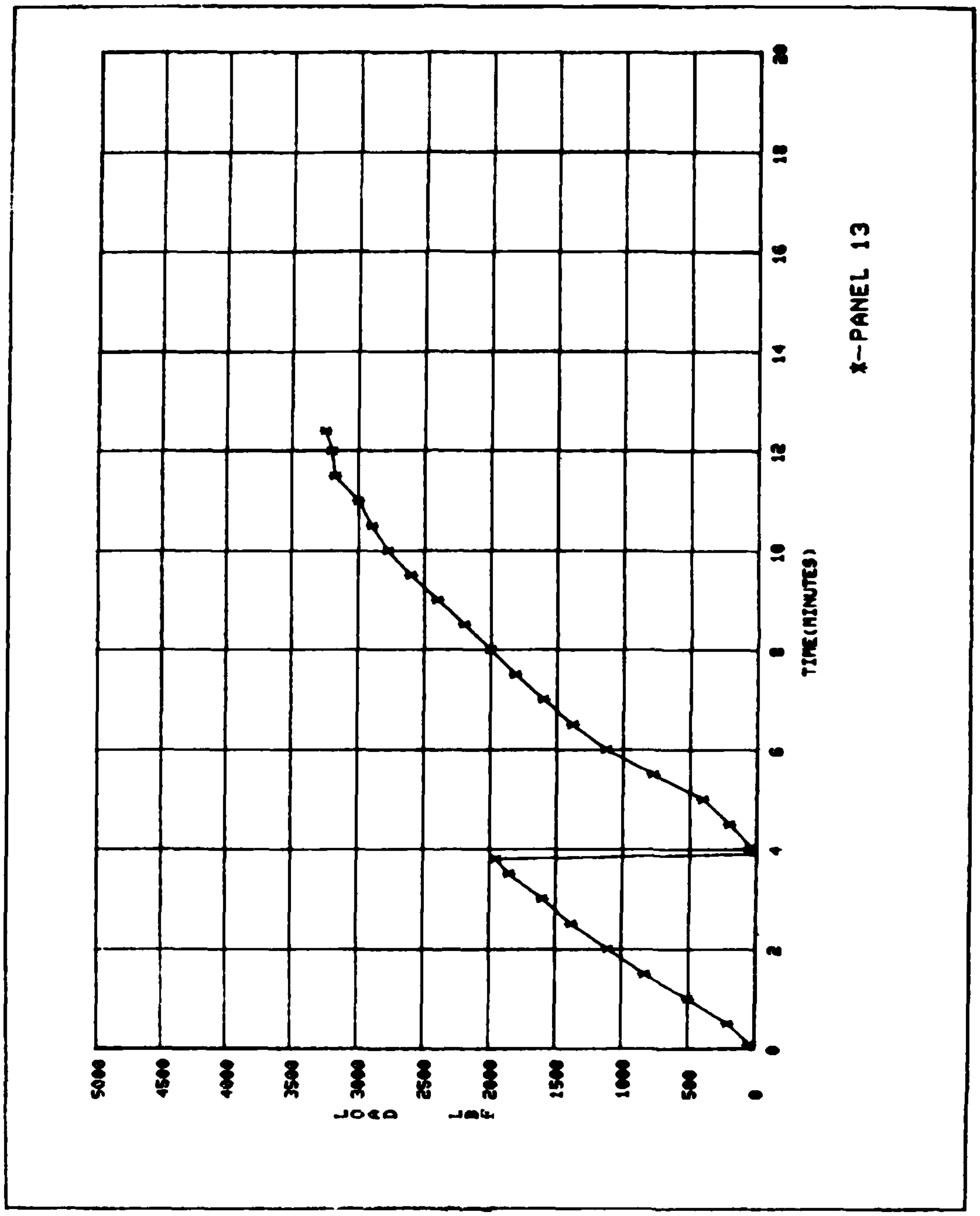
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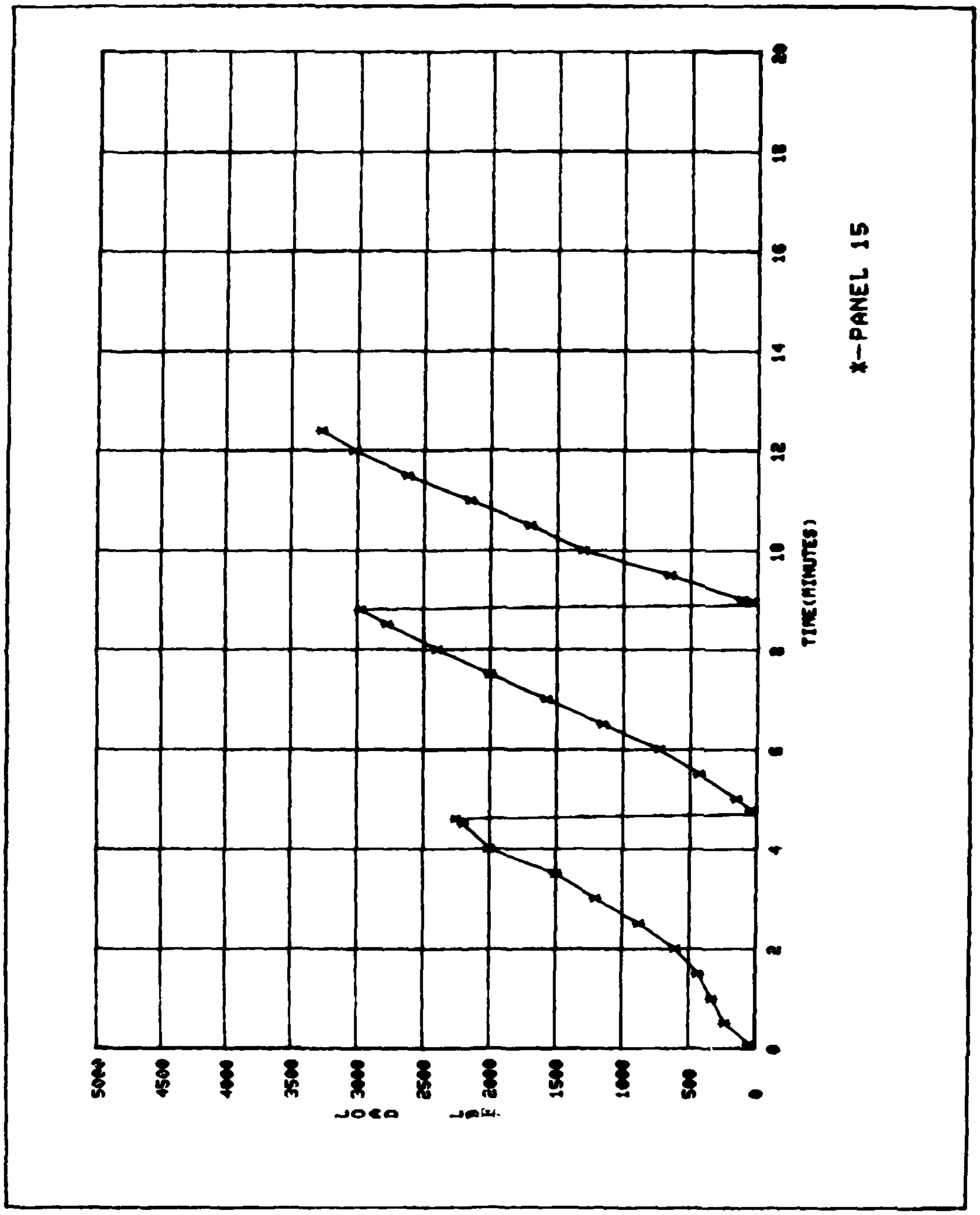

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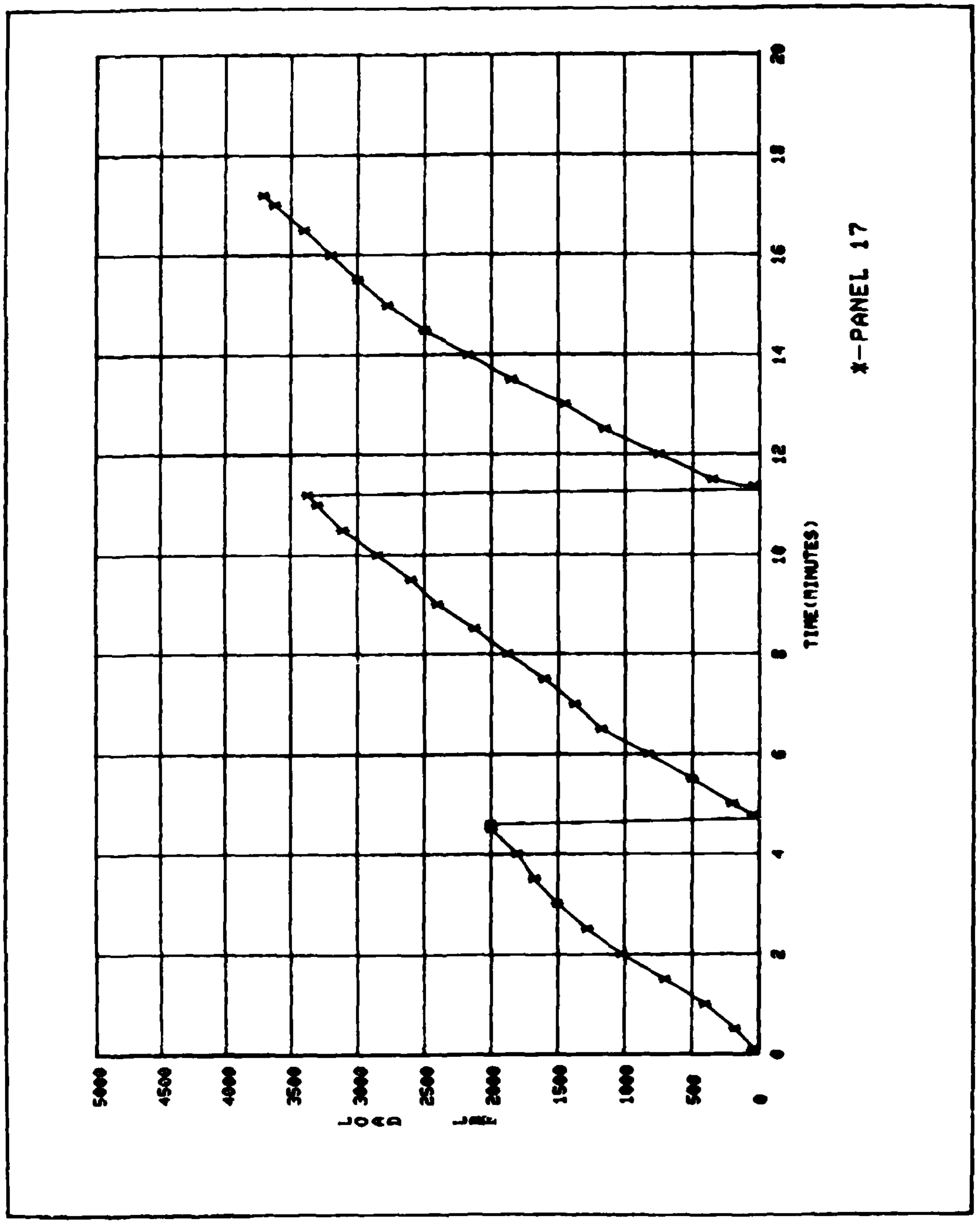
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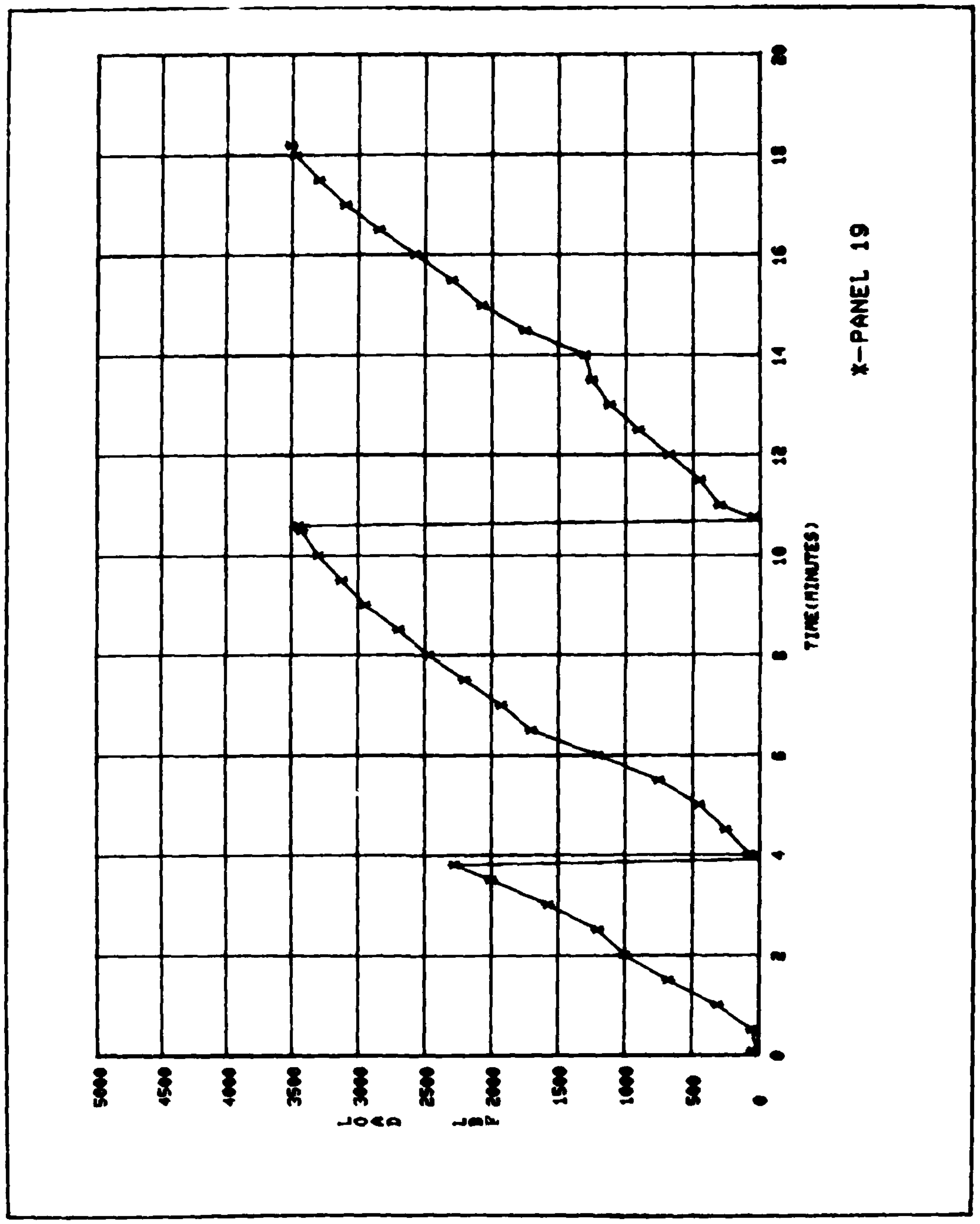
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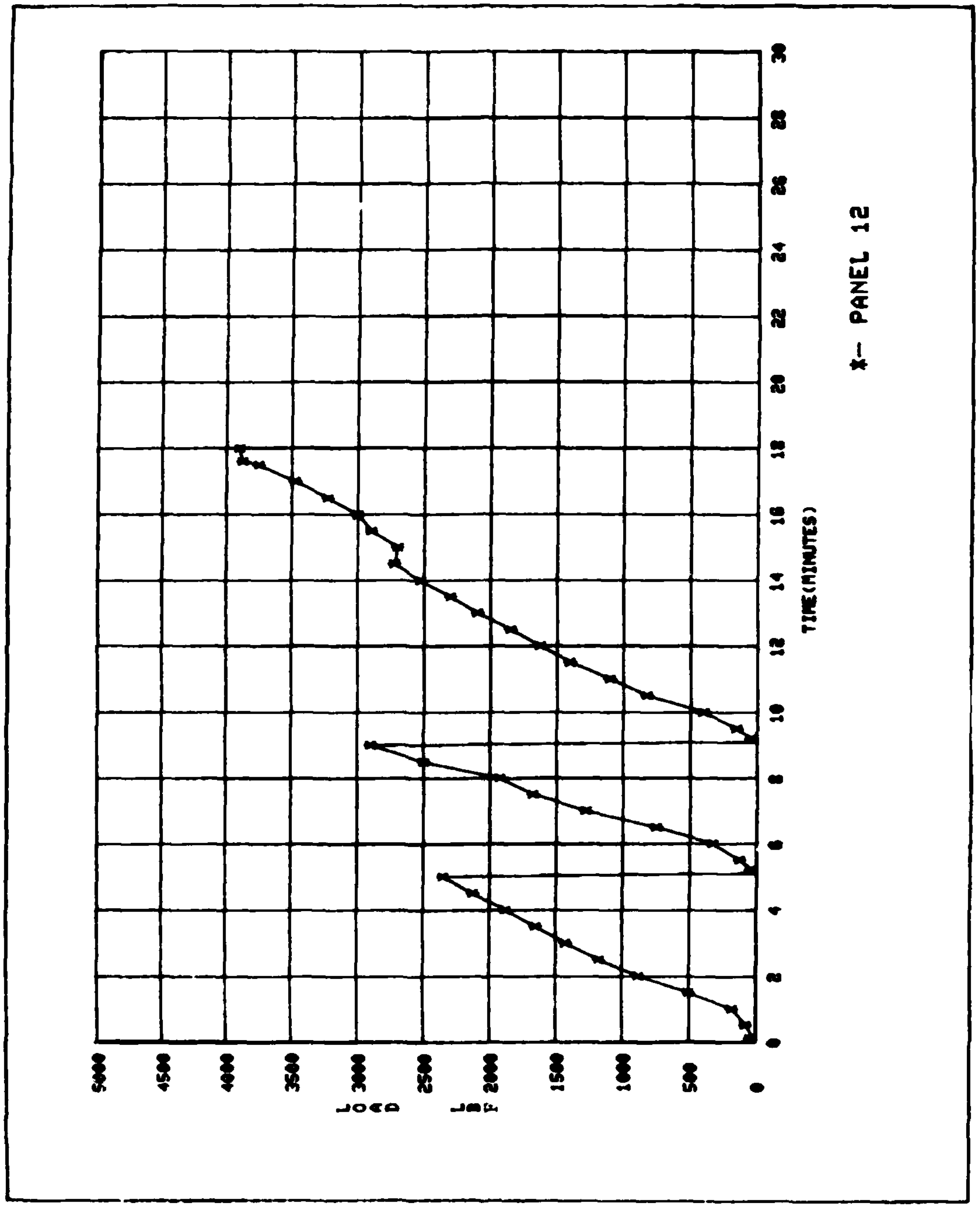
20

PLATE 15



*— PANEL 12
TIME (MINUTES)
LOAD LBF
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30

PLATE 16

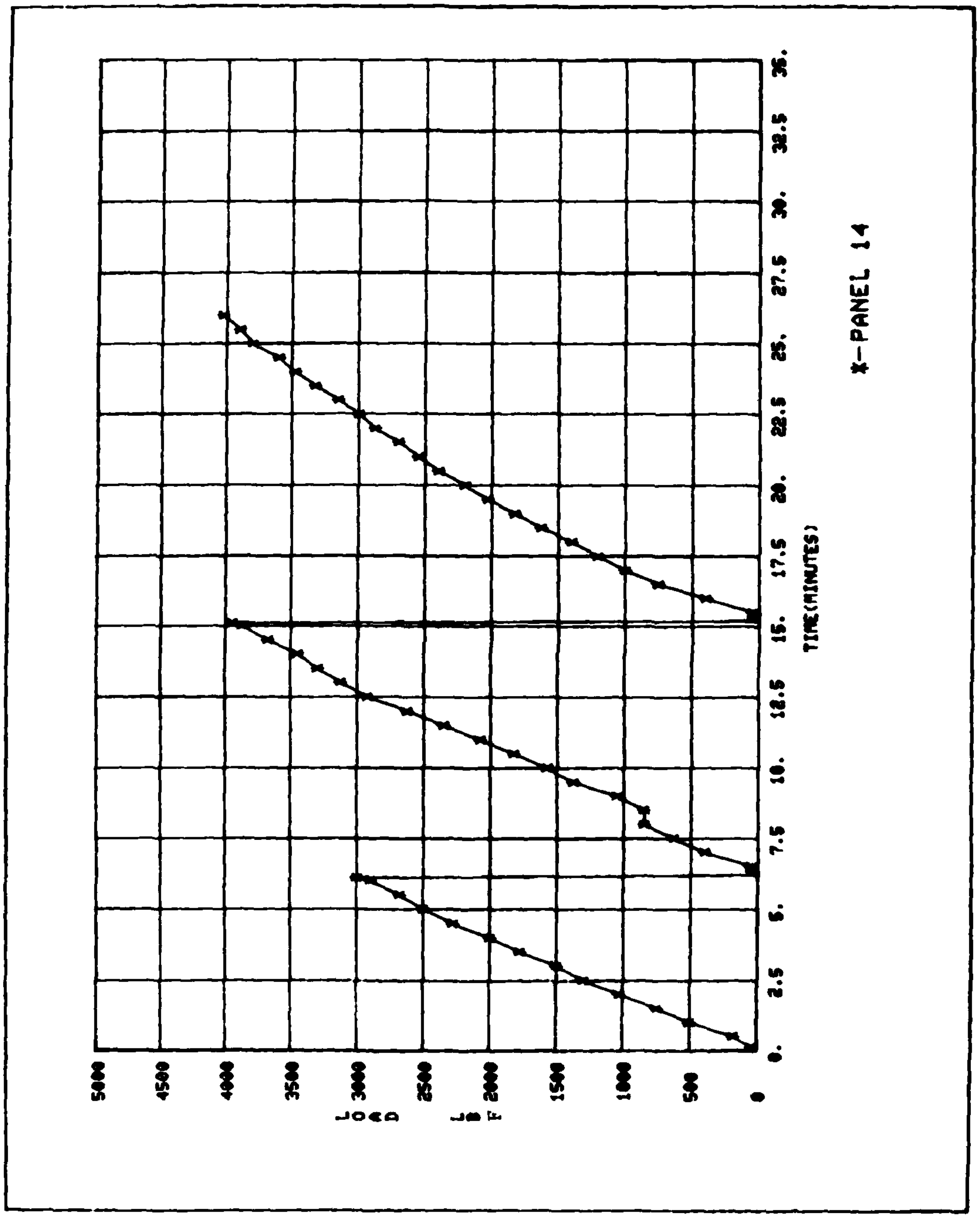

X-PANEL 14
TIME(MINUTES)
LOAD LBF
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25. 27.5 30. 32.5 35.
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000

PLATE 17

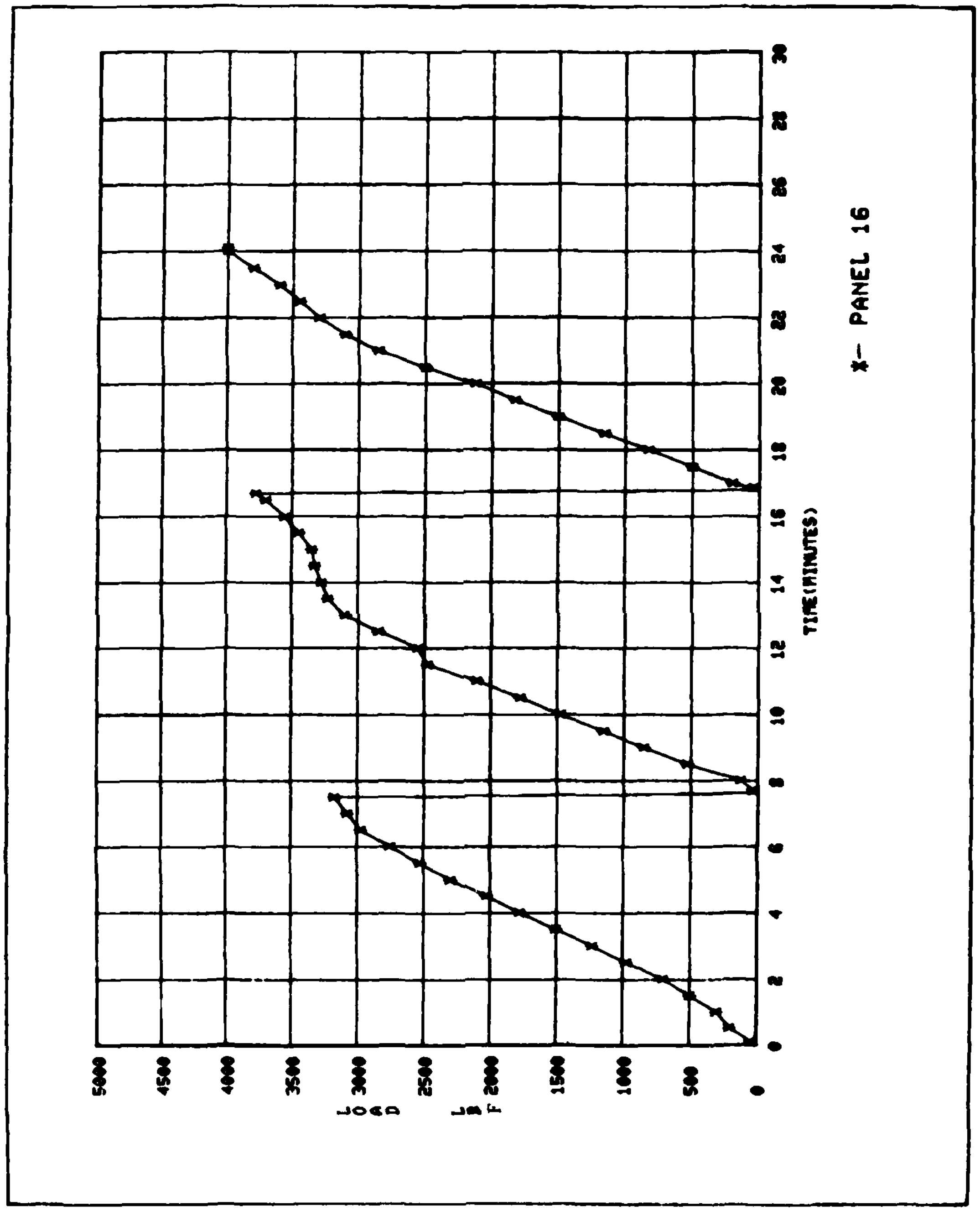
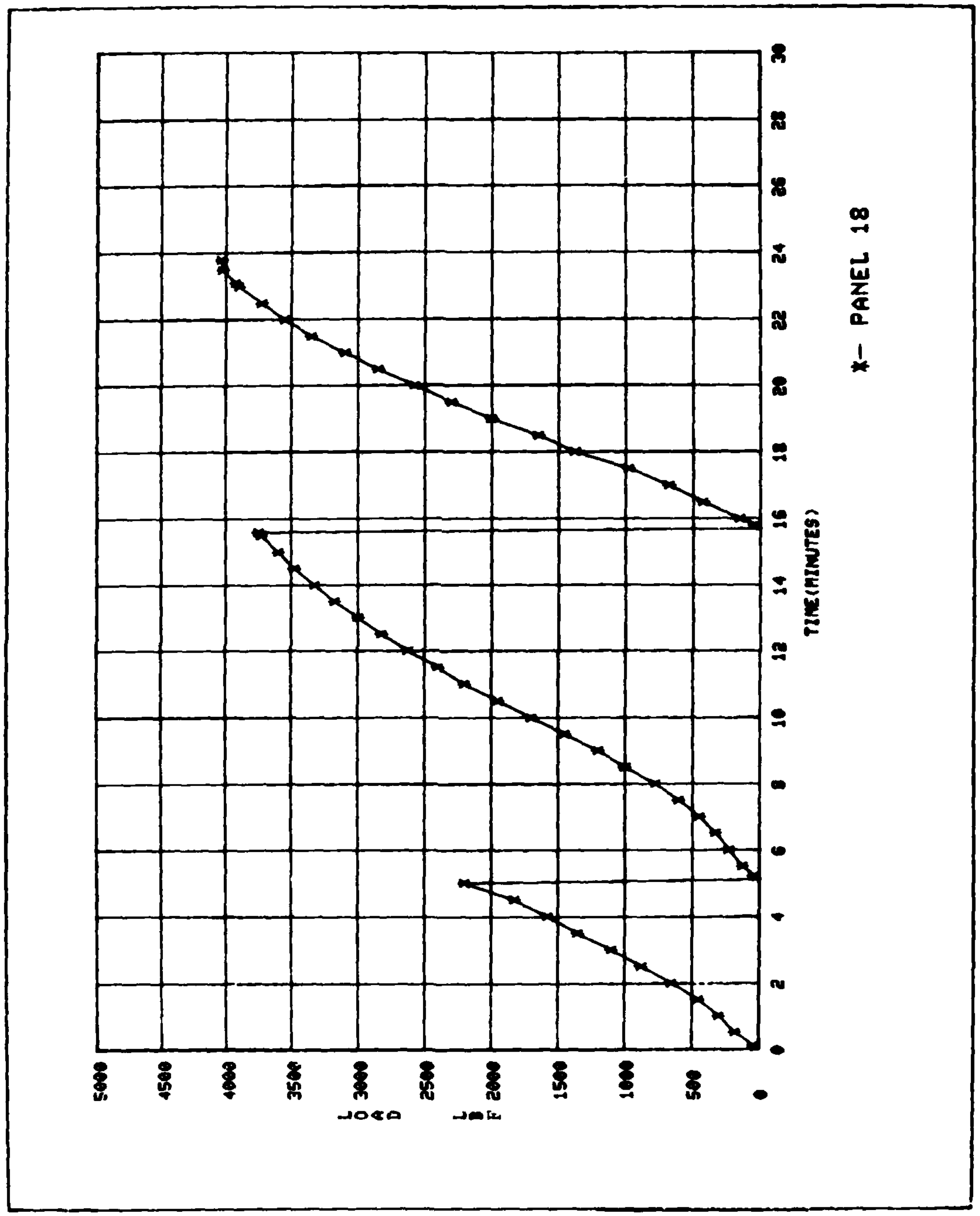
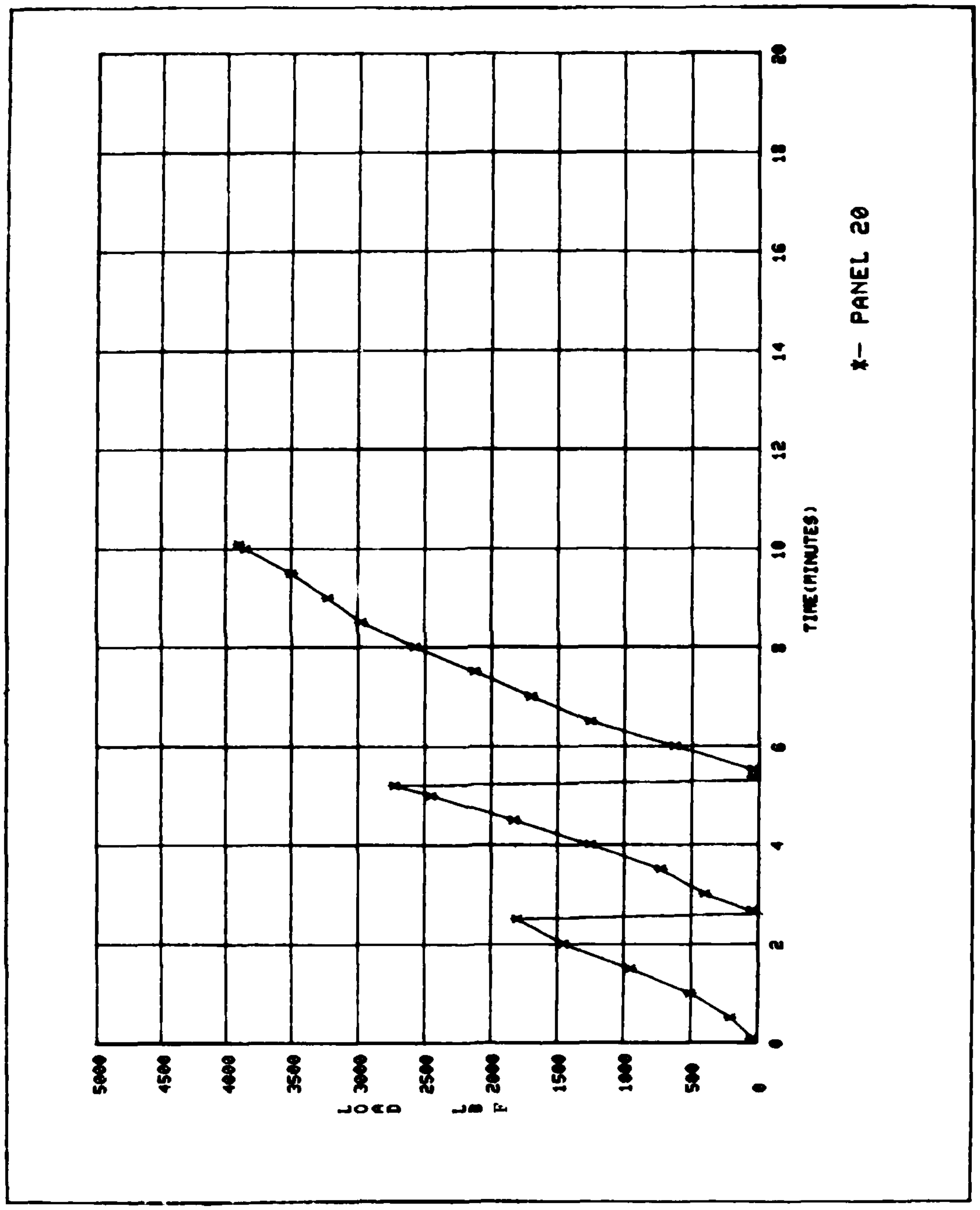

*- PANEL 16
TIME(MINUTES)
LOAD LBF
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30

PLATE 18



*— PANEL 18
LOAD LBF
TIME (MINUTES)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30

PLATE 19



0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
0
2
4
6
8
10
12
14
16
18
20
TIME(MINUTES)
*- PANEL 20

PLATE 20

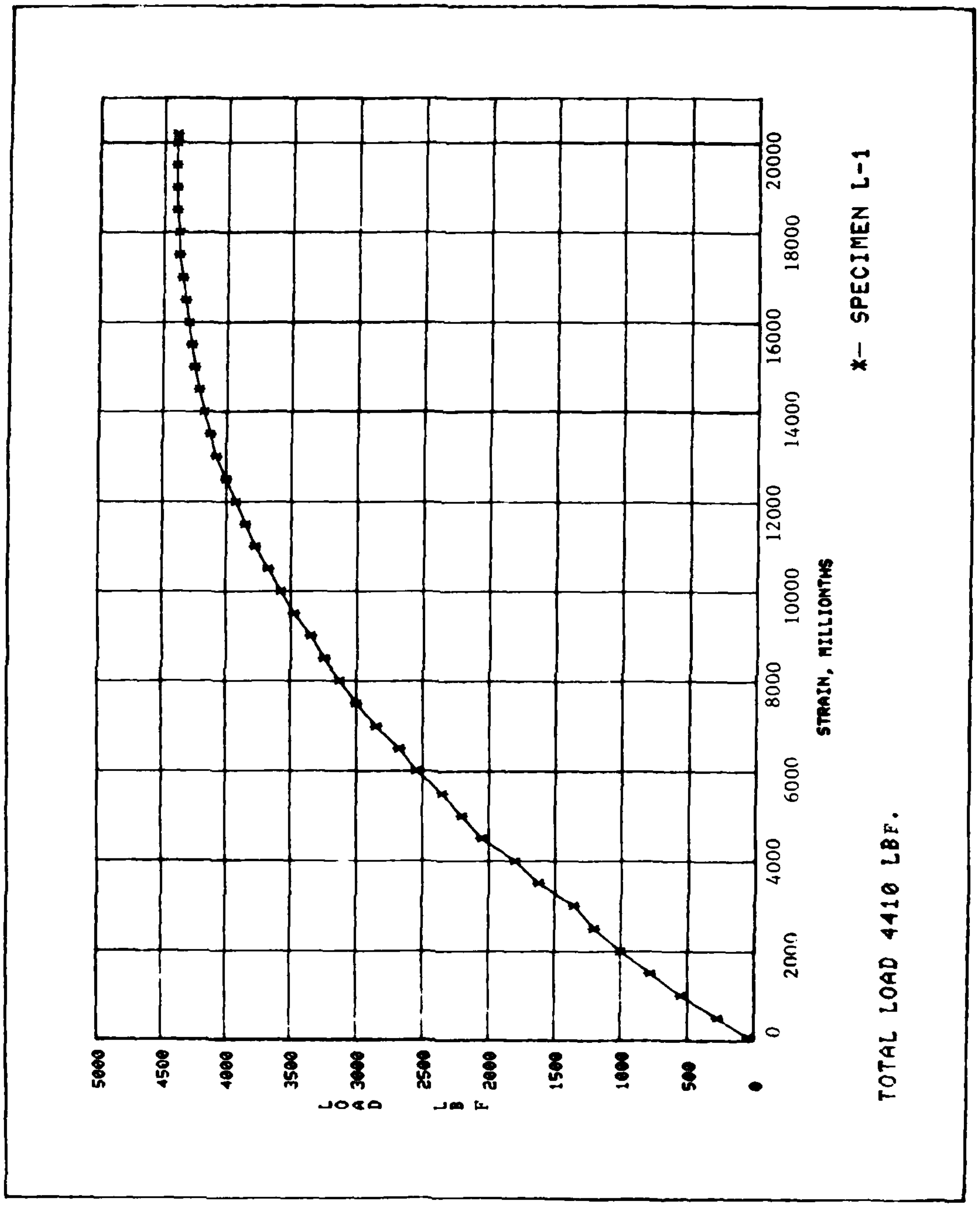
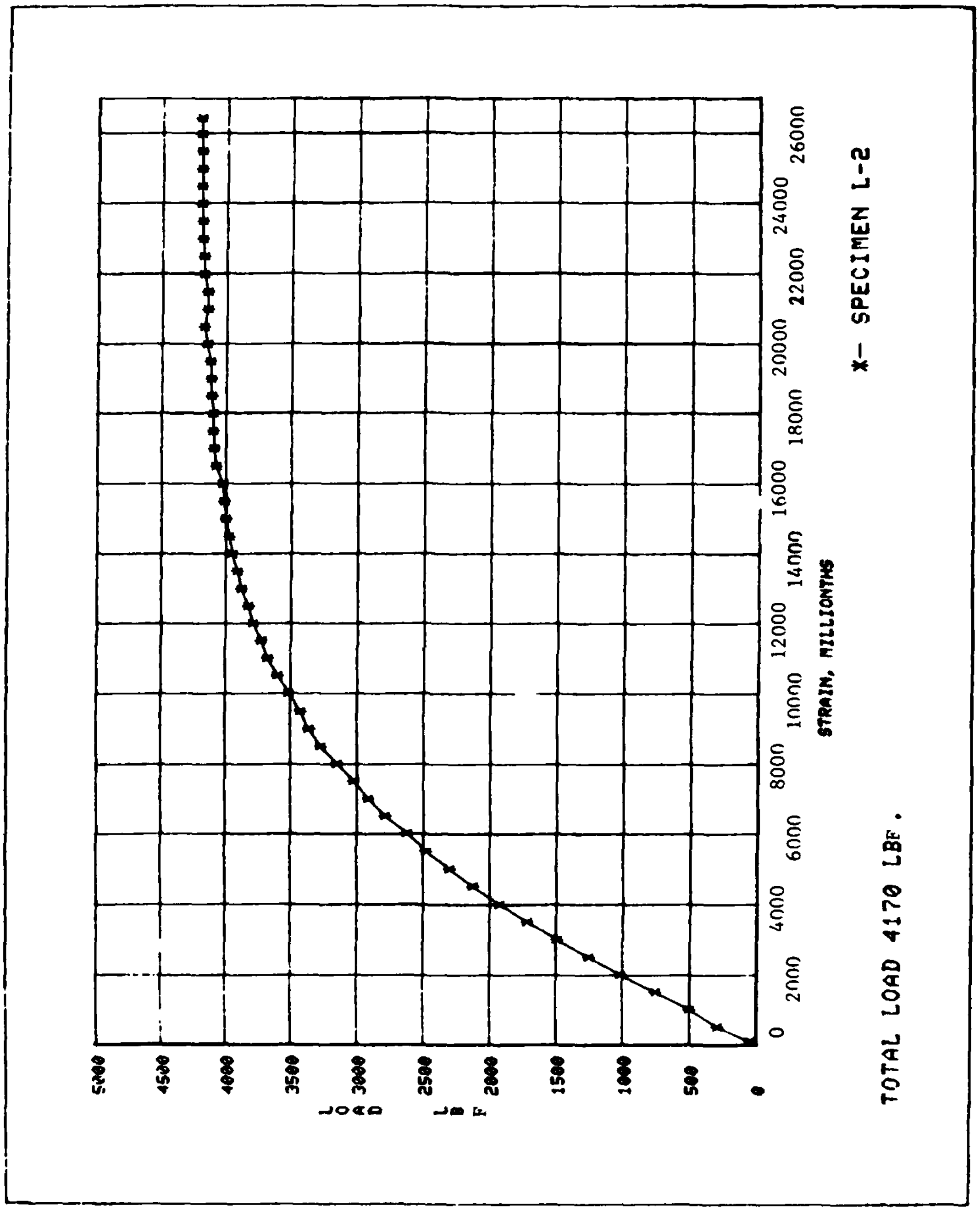
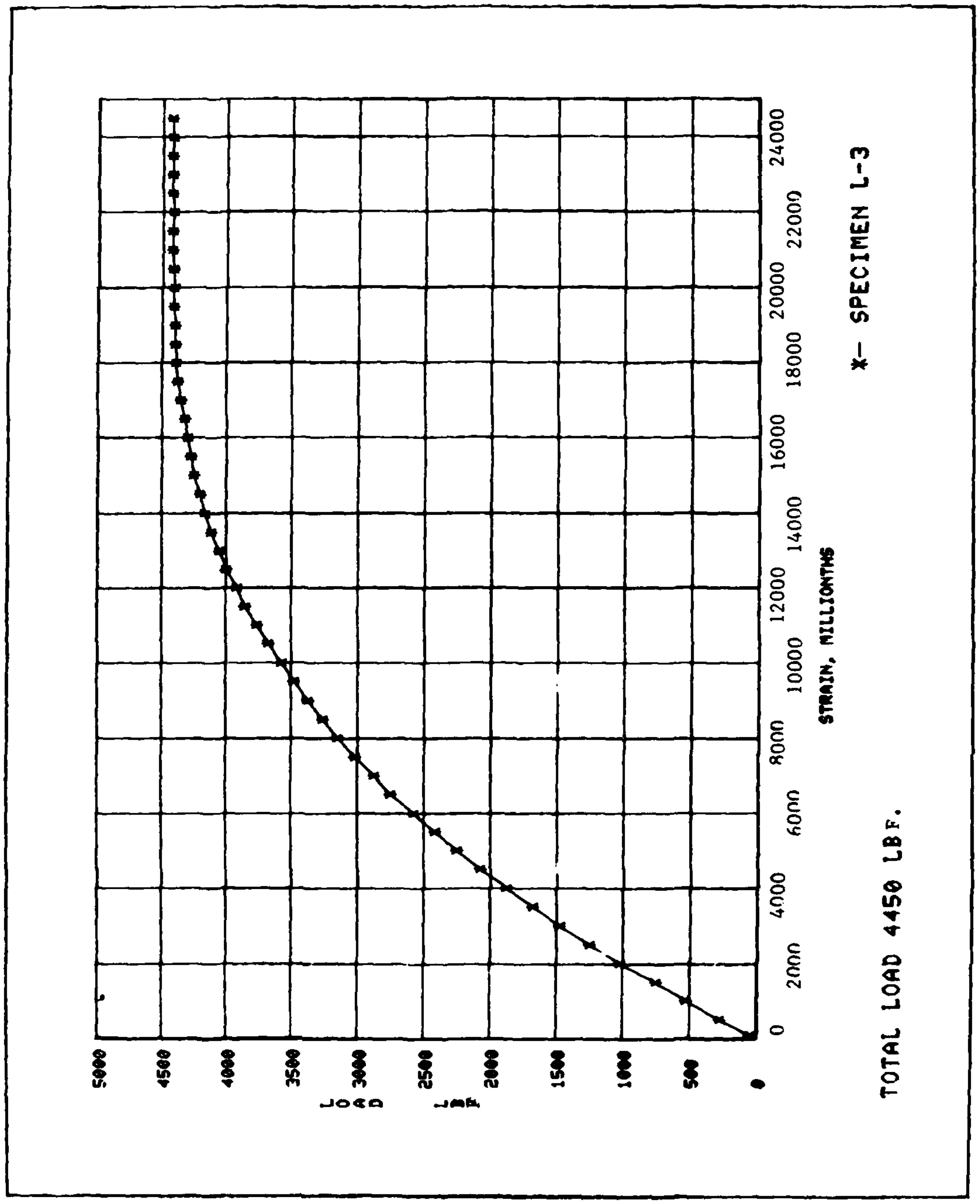

LOAD LBF
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
STRAIN, MILLIONTHS
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
*– SPECIMEN L-1
TOTAL LOAD 4410 LBF.

PLATE 21



LOAD LBF
STRAIN, MILLIONTHS
X- SPECIMEN L-2
TOTAL LOAD 4170 LBF.

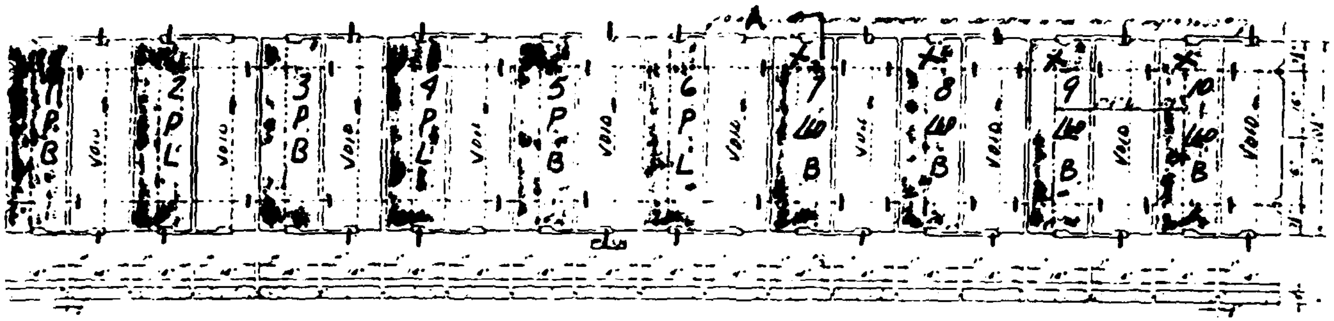
PLATE 22



LOAD LBF
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
STRAIN, MILLIONTHS
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
22000
24000
TOTAL LOAD 4450 LBF.
*- SPECIMEN L-3

PLATE 23

APPENDIX A: REINFORCING DETAILS



SECTION
ONE SQUARE ARTICULATED CONCRETE MATTRESS

LEGEND

1, 2 etc.	BLOCK NUMBER
P	PLAIN, NO CRIMPS
$\angle 60$	TYPE OF CRIMP
B	CRIMP ON BRACKET WIRES, OR TYPE TEST BLOCK
L	CRIMP ON LONGITUDINAL WIRES, OR TYPE TEST BLOCK
x	LOCATION OF CRIMP
I	LOCATION TO CUT FABRIC WIRE

TWENTY (20) TEST BLOCKS

BLOCK NOS.	TYPE CRIMP	TYPE TEST
1, 3, 5	NONE, PLAIN	BRACKET
2, 4, 6	NONE, PLAIN	LONGITUDINAL
7, 8, 9, 10	$\angle 60°$	BRACKET
11, 13, 15, 17, 19.	$\angle 45°$	BRACKET
12, 14, 16, 18, 20	$\angle 45°$	LONGITUDINAL

SKETCH #1
CRIMP FABRIC TEST BLOCKS

SKETCH #2
CRIMP FABRIC
TEST BLOCKS

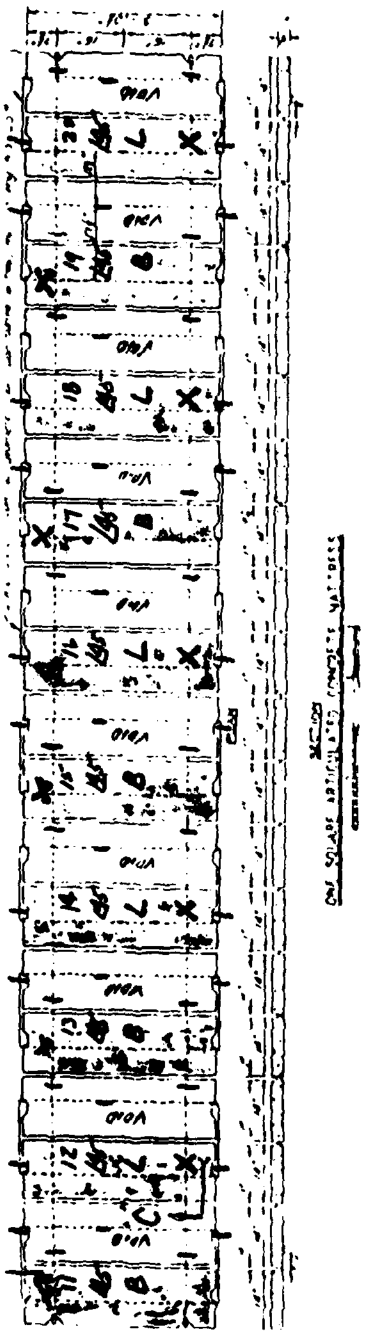
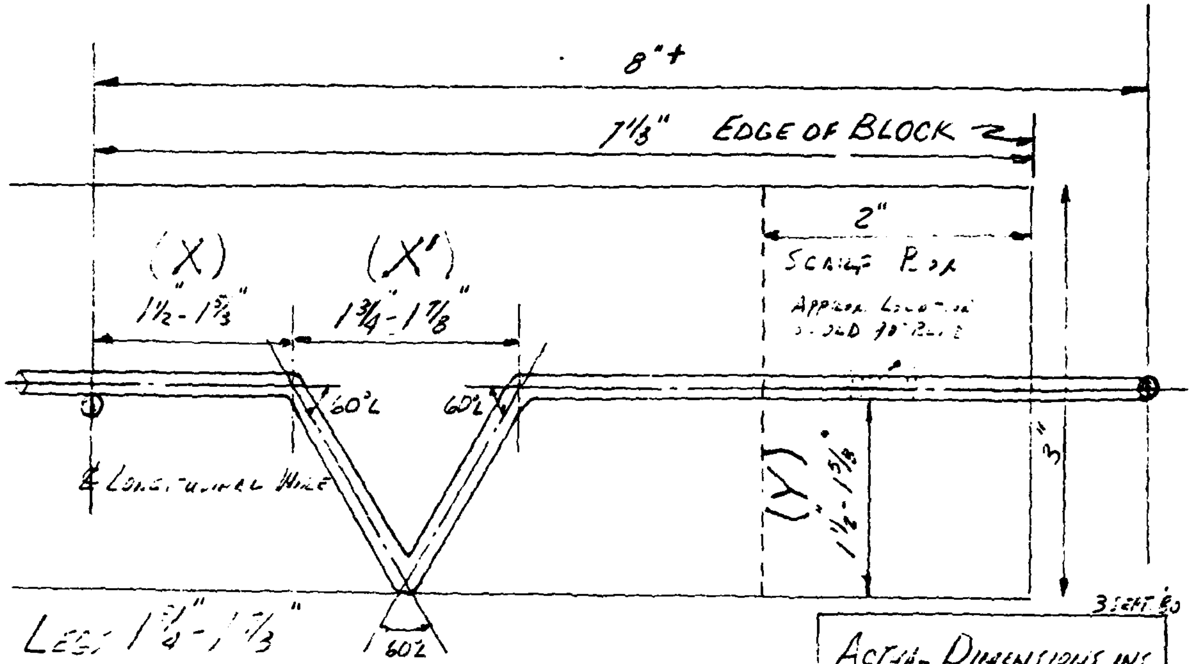


PLATE A2

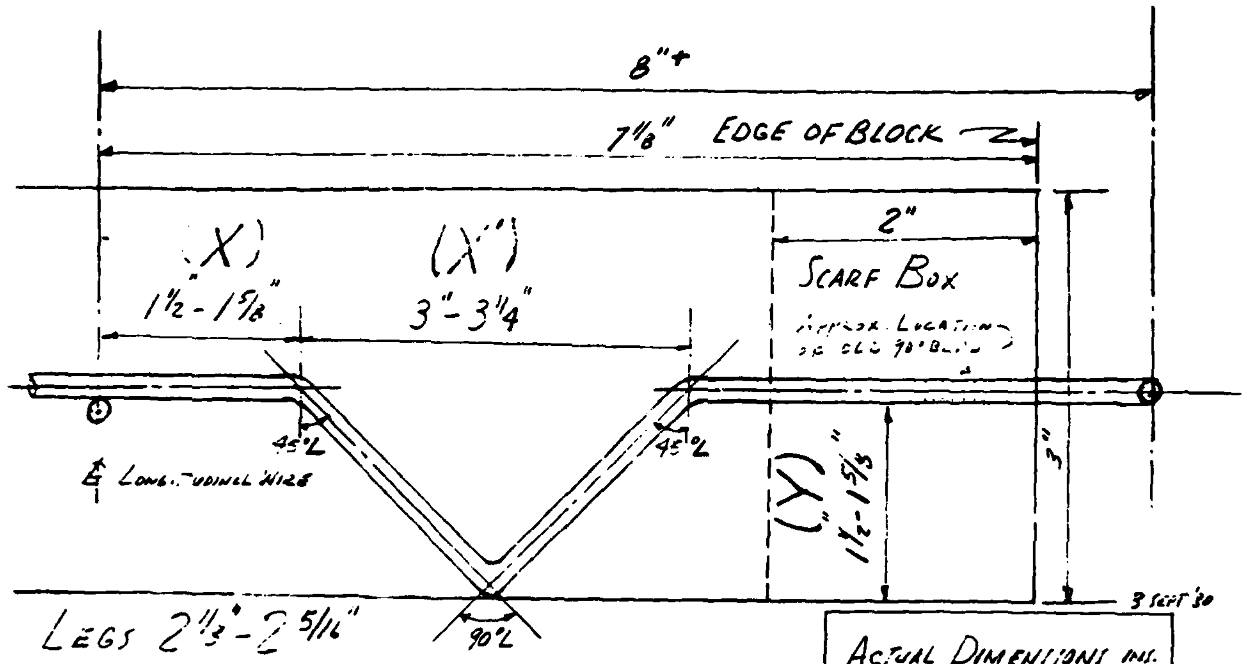


ACTUAL DIMENSIONS INS.				
BLOCK No	X	X'	Y	WELD
7	1⅝	2⅓	1⅝	✓
8	1⅞	1⅞	1[illegible]	✓
9	1½	2⅓	1⅝	✓
10	1½	2	1 9/16	✓

SEC. "A" 60° FABRIC CRIMP IN BRACKET WIRE

SKETCH #3

PLATE A3

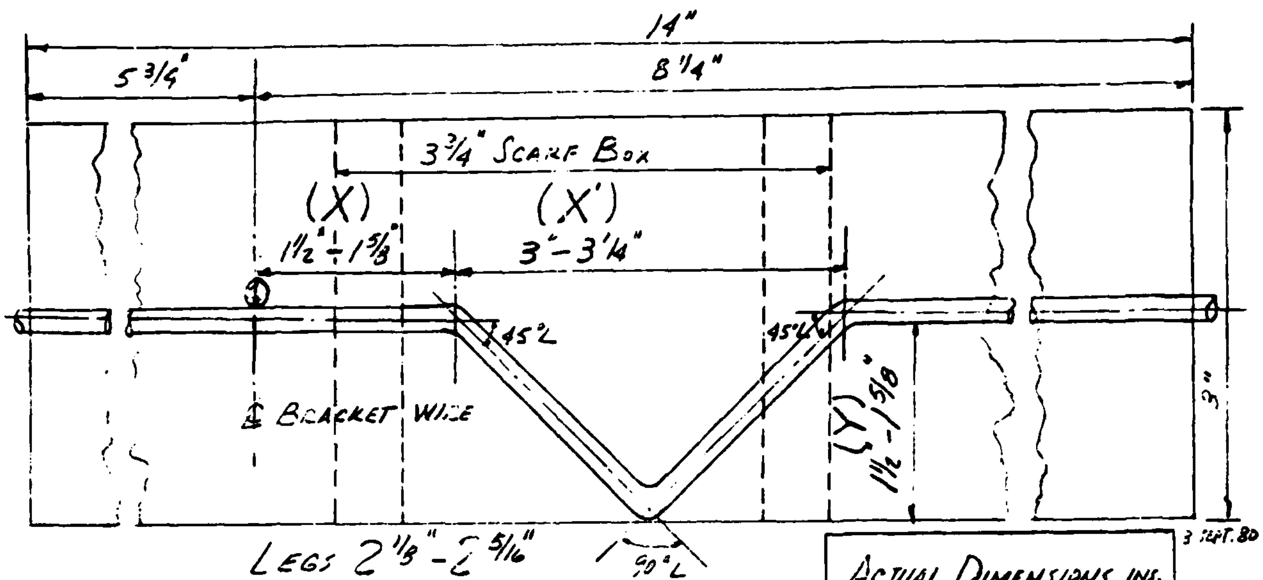


ACTUAL DIMENSIONS INS.				
BLOCK No.	X	X'	Y	WELD
11	1½	3¼	1 9/16	
13	1½	3¼	1½	✓
15	1¾	3¼	1½	✓
17	1 9/16	3½	1½	
19	1½	3⅜	1½	✓

SEC. "B" 45° FABRIC CRIMP IN BRACKET WIRE

SKETCH #4

PLATE A4



ACTUAL DIMENSIONS INS.				
BLOCK No.	X	X'	Y	FIELD
12	1 5/8	3 5/8	1 1/2	
14	1 1/2	3 1/2	1 7/16	
16	1 1/2	3 1/2	1 1/2	✓
18	1 1/2	3 5/8	1 5/8	
20	1 5/8	3 3/8	1 1/2	

SEC. "C"

45° FABRIC CRIMP IN LONGITUDINAL WIRE

SKETCH #5

PLATE A5

APPENDIX B: PHOTOGRAPHS OF TEST SPECIMENS

Figure B1. Panel 1, 3700-lbf load (ultimate)

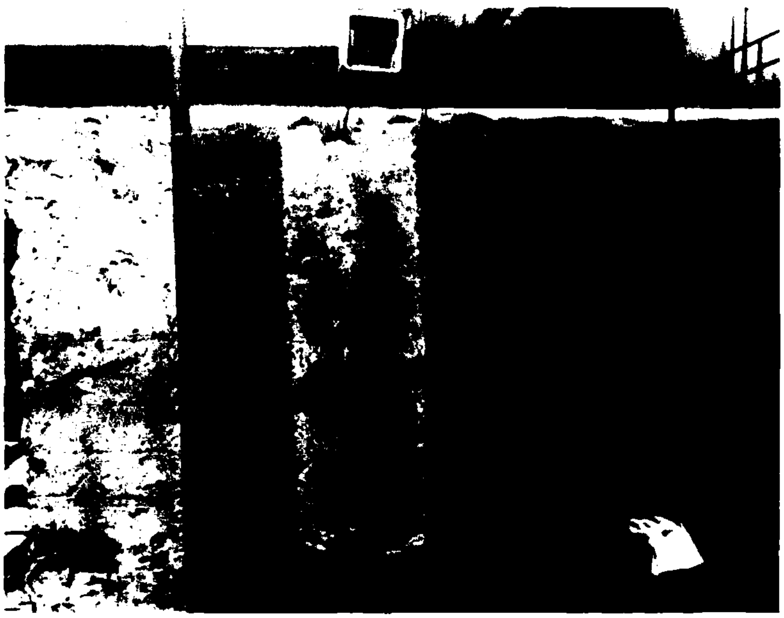


Figure B2. Panel 3, 3000 lbf load (ultimate)

Figure B3. Panel 5, 3300 lbf load (ultimate)

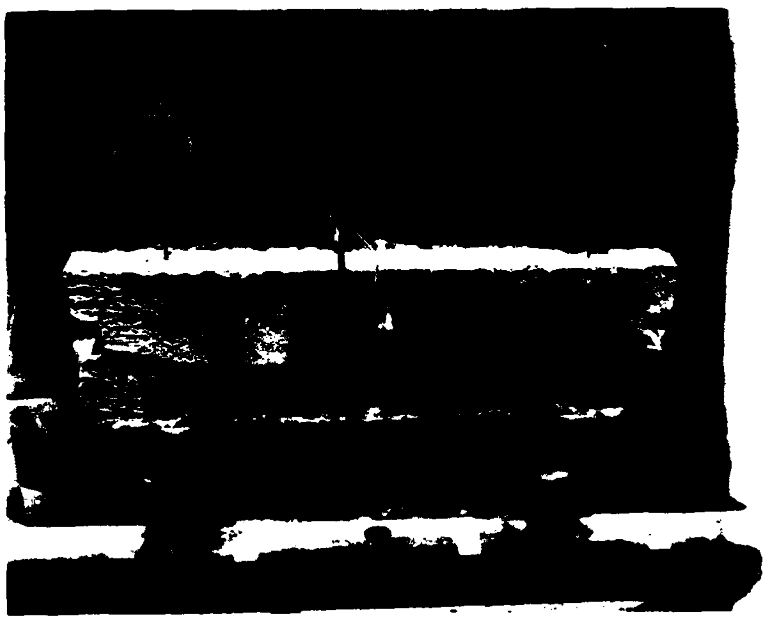


Figure B4. Panel 2, 3900 lbf load (ultimate)

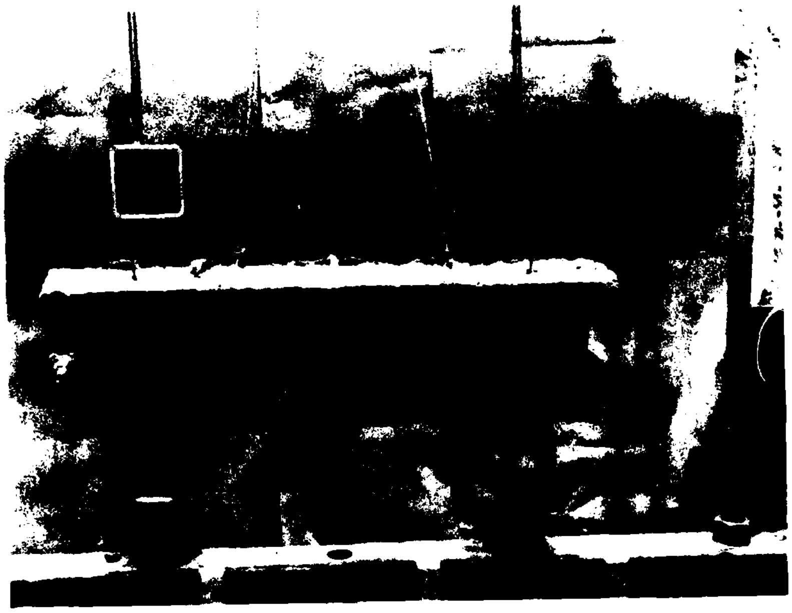


Figure B5. Panel 4, 3700 lbf load (ultimate)

Figure B6. Panel 6, 3950 lbf load (ultimate)

Figure B7. Panel 7, 2800 lbf load

Figure B8. Panel 7, 3120 lbf load

Figure B9. Panel 7, 3780 lbf load (ultimate)

Figure B10. Panel 8, 2825 lbf load

Figure B11. Panel 8, 3125 lbf load (ultimate)

Figure B12. Panel 9, 2710 lbf load

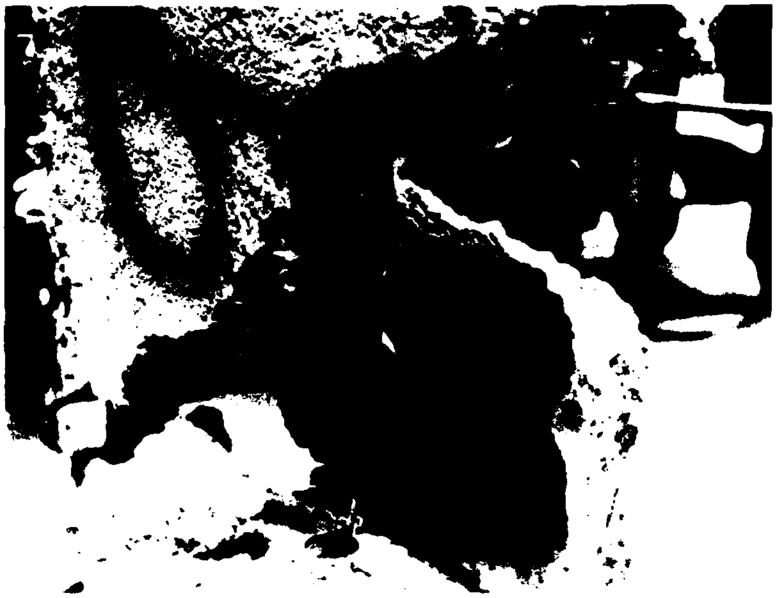


Figure B13. Panel 9, 2800 lbf load

Figure 14. Panel 9, 2800 lbf load (ultimate)

Figure B15. Panel 10, 2250 lbf load

Figure B16. Panel 10, 2150 lbf load

Figure B17. Panel 10, 3275 lbf load (ultimate)

Figure B18. Panel 11, 2700 lbf load

Figure B19. Panel 11, 3399 lbf load

Figure B20. Panel 11, 3725 lbf load (ultimate)

Figure B21. Panel 13, 1950 lbf load

Figure B22. Panel 13, 3250 lbf load (ultimate)

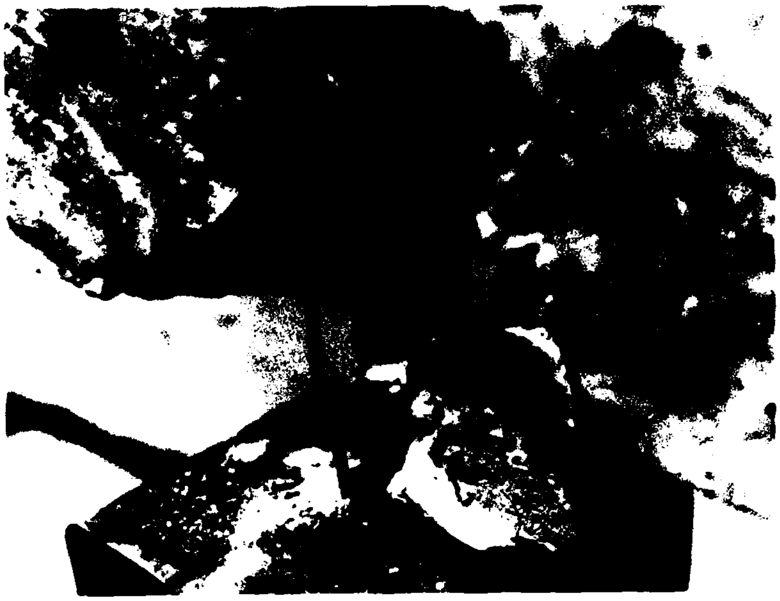


Figure B23. Panel 15, 2250 lbf load

Figure B24. Panel 15, 2975 lbf load

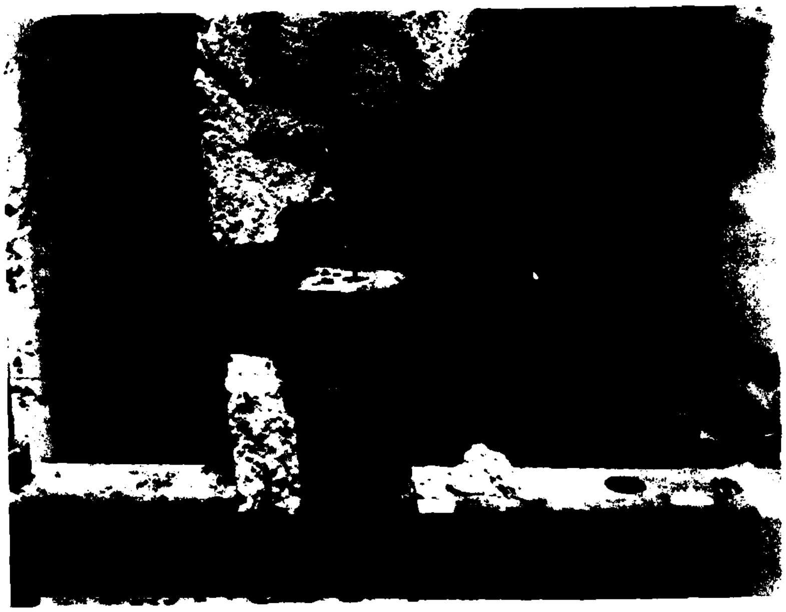


Figure B25. Panel 15, 3275 lbf load (ultimate)

Figure B26. Panel 17, 2000 lbf load

Figure B27. Panel 17, 3375 lbf load

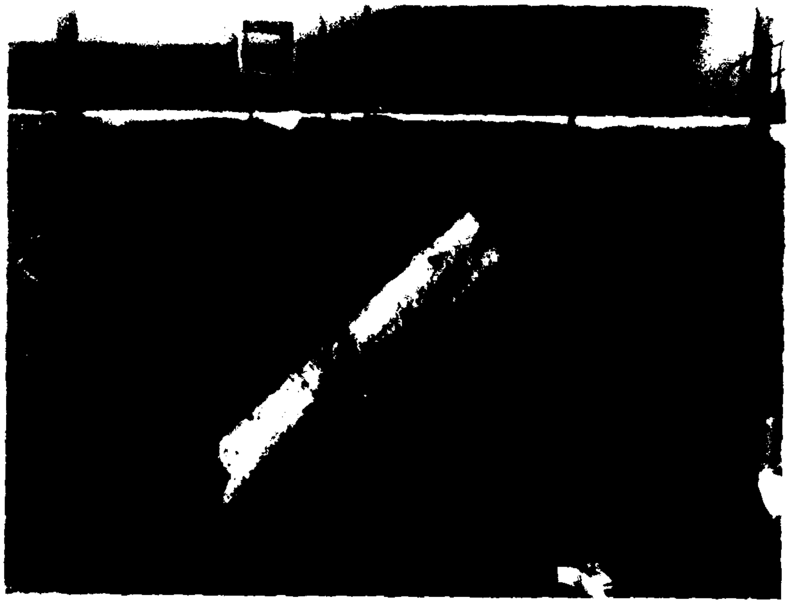


Figure B28. Panel 17, 3710 lbf load (ultimate)

Figure B29. Panel 19, 2275 lbf load

Figure B30. Panel 19, 3450 lbf load

Figure B31. Panel 19, 3510 lbf load (ultimate)

Figure B32. Panel 12, 2350 lbf load

Figure B33. Panel 12, 2899 lbf load

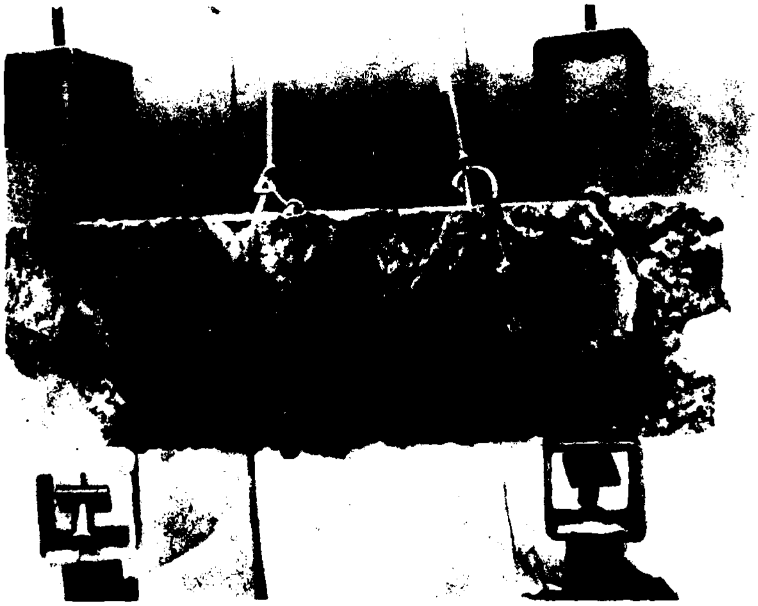


Figure B34. Panel 12, 3900 lbf load (ultimate)

Figure B35. Panel 14, 3000 lbf load

Figure B36. Panel 14, 4025 lbf load (ultimate)

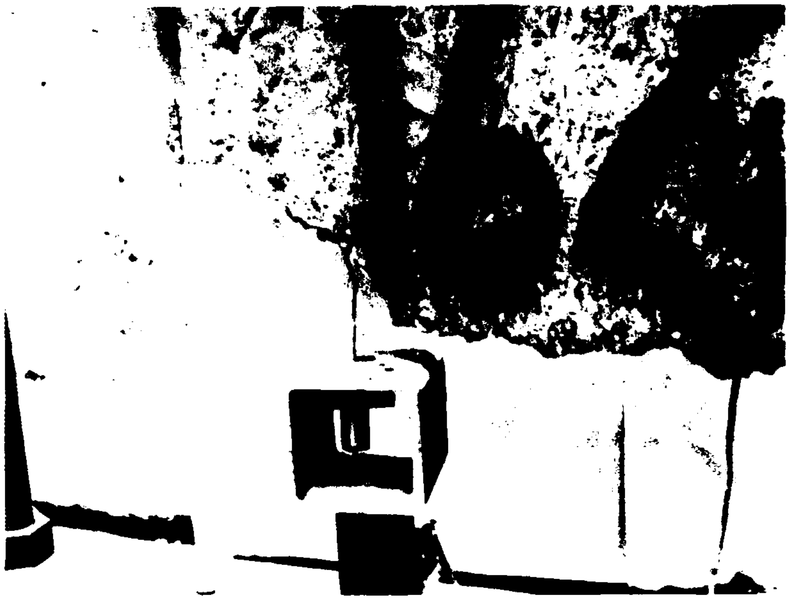


Figure B37. Panel 16, 3175 lbf load

Figure B38. Panel 16, 3775 lbf load

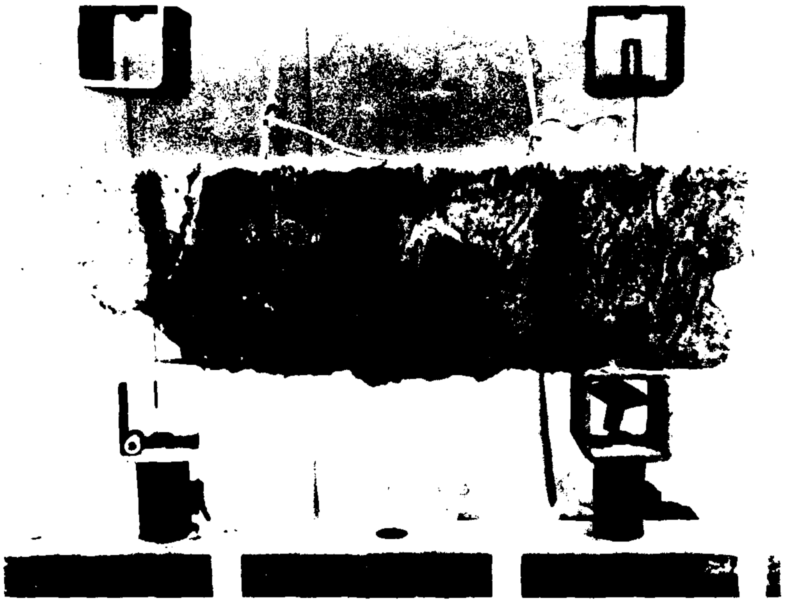


Figure 39. Panel 16, 4000 lbf load (ultimate)

Figure B40. Panel 18, 2200 lbf load

Figure B41. Panel 18, 3750 lbf load

Figure B42. Panel 18, 4035 lbf load (ultimate)

Figure B43. Panel 20, 1800 lbf load

Figure B44. Panel 20, 2700 lbf load

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Glass, Dale
Tensile tests on articulated concrete mattress specimens / by Dale Glass (Structures Laboratory, U.S. Army Engineer Waterways Experiment Station). -- Vicksburg, Miss. : The Station ; Springfield, Va. ; available from NTIS, 1981.
39 p. in various pagings, 28 p. of plates : ill. ; 27 cm. -- (Miscellaneous paper / U.S. Army Engineer Waterways Experiment Station ; SL-81-28)
Cover title.
"October 1981."
Final report.
"Prepared for U.S. Army Engineer District, New Orleans."

1. Concrete--Testing. 2. Concrete construction. 3. Concrete products. 4. Shore protection. I. United States. Army. Corps of Engineers. New Orleans District. II. U.S. Army Engineer Waterways Experiment Station.

Glass, Dale
Tensile tests on articulated concrete mattress : ... 1981.
(Card 2)

Structures Laboratory. III. Title VI. Series: Miscellaneous paper (U.S. Army Engineer Waterways Experiment Station) ; SL-81-28.
TA7.W34m no.SL-81-28