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BULLETIN NO. 14, NOVEMBER, 1968—BEHAVIOR OF STEEL BUILDING CONNECTIONS
Popov and Pinkney SUBJECTED TO INELASTIC STRAIN REVERSALS—Experimental Data

STEEL RESEARCH for construction

BEHAVIOR OF STEEL BUILDING CONNECTIONS SUBJECTED TO INELASTIC STRAIN REVERSALS—Experimental Data

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Committee of Structural Steel Producers • Committee of Steel Plate Producers

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BEHAVIOR OF STEEL BUILDING CONNECTIONS SUBJECTED TO INELASTIC STRAIN REVERSALS

—Experimental Data

by

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PREFACE

This report is a companion volume to American Iron and Steel Institute Bulletin 13 entitled "Behavior of Steel Building Connections Subjected to Repeated Inelastic Strain Reversals". Detailed results are presented herein of load-reversal tests of twenty-three steel beam-column connections. It is believed that many engineers may wish to examine these results and reach their own conclusions. The authors have attempted throughout to be factual without interjecting their opinions or interpretations; these have been expressed in the preceeding report. It is hoped that the information contained in this volume will prove useful and be a guide to better design in structural steel.

As with the companion report, it is a pleasure to acknowledge with gratitude, the financial support provided by the Committee of Structural Steel Producers and Committee of Steel Plate Producers, American Iron and Steel Institute. The suggestions of the AISI Advisory Committee and the Committee on Seismology of the Structural Engineers' Association of California were most helpful and much appreciated. Members of the committee were

V. V. Bertero	H. S. Kellam
R. W. Clough	L. A. Napper
A. L. Collin	C. W. Pinkham
H. J. Degenkolb	C. A. Zwissler, Chairman

The advice of R. Binder and I. M. Viest is also gratefully acknowledged.

CONTENTS

BEHAVIOR OF STEEL BUILDING CONNECTIONS SUBJECTED TO REPEATED INELASTIC STRAIN REVERSAL
EXPERIMENTAL DATA

Introduction

This report contains experimental data for each of the specimens tested as a part of the American Iron and Steel Institute Project No. 120. Also included are photographs of all specimens at failure.

Before the presentation of this data, however, some discussion is necessary concerning such matters as fabrication and inspection of the specimens, determination of material properties, and the methods of data reduction.

Fabrication and Inspection of Specimens

The principal philosophy of this experimental program has been to provide information useful to the designer. Thus detailing, fabrication and inspection were required, in general, to follow standard industry practice.

During the course of the program, specimens were ordered and fabricated in five different lots, referred to subsequently as Group I, Group II, etc., as given in Table I. Because of this, there was a lack of uniformity of material properties and member sizes, even among specimens of the same type.

The connection designs were selected in consultation with an AISI Task Force comprising consulting structural engineers and representatives from major steel companies; they are discussed in detail in the companion report (AISI Bulletin 13).

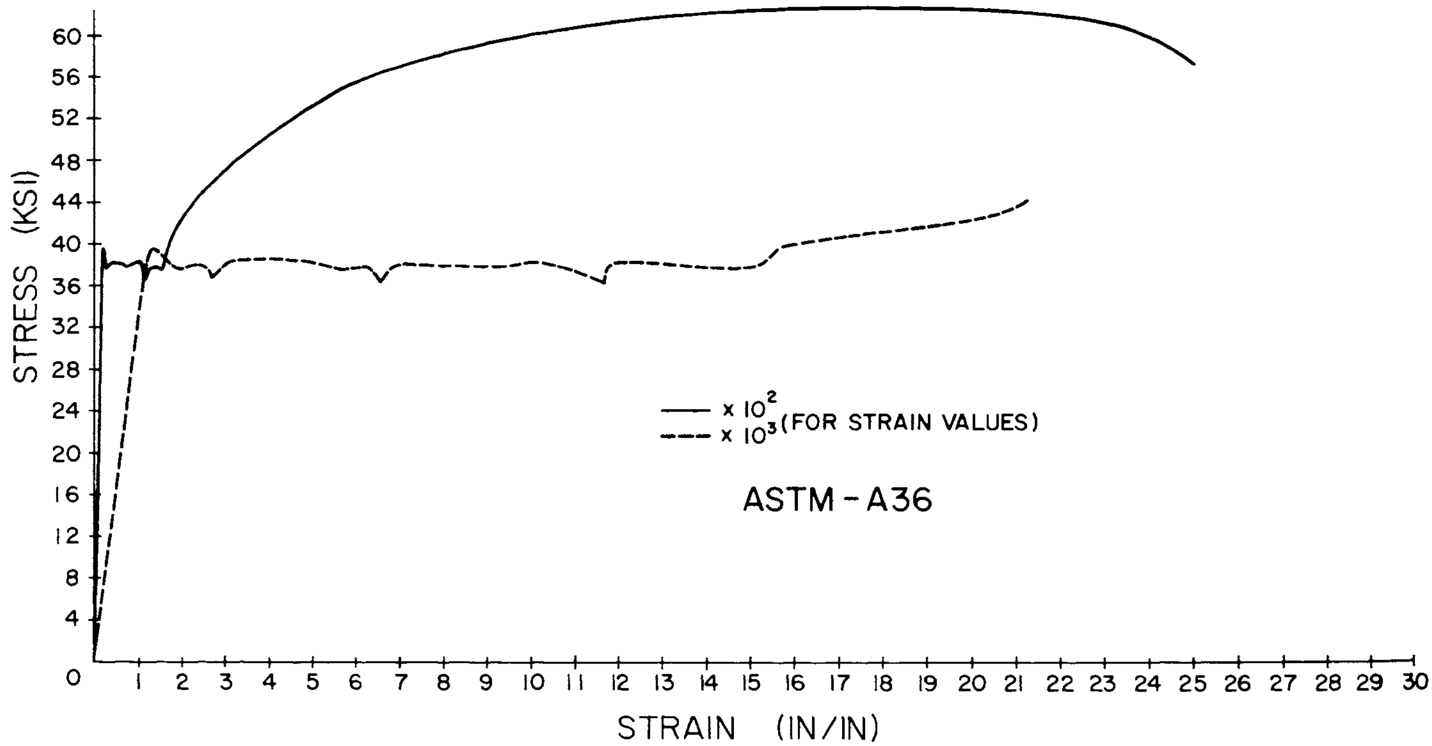


FIGURE 1

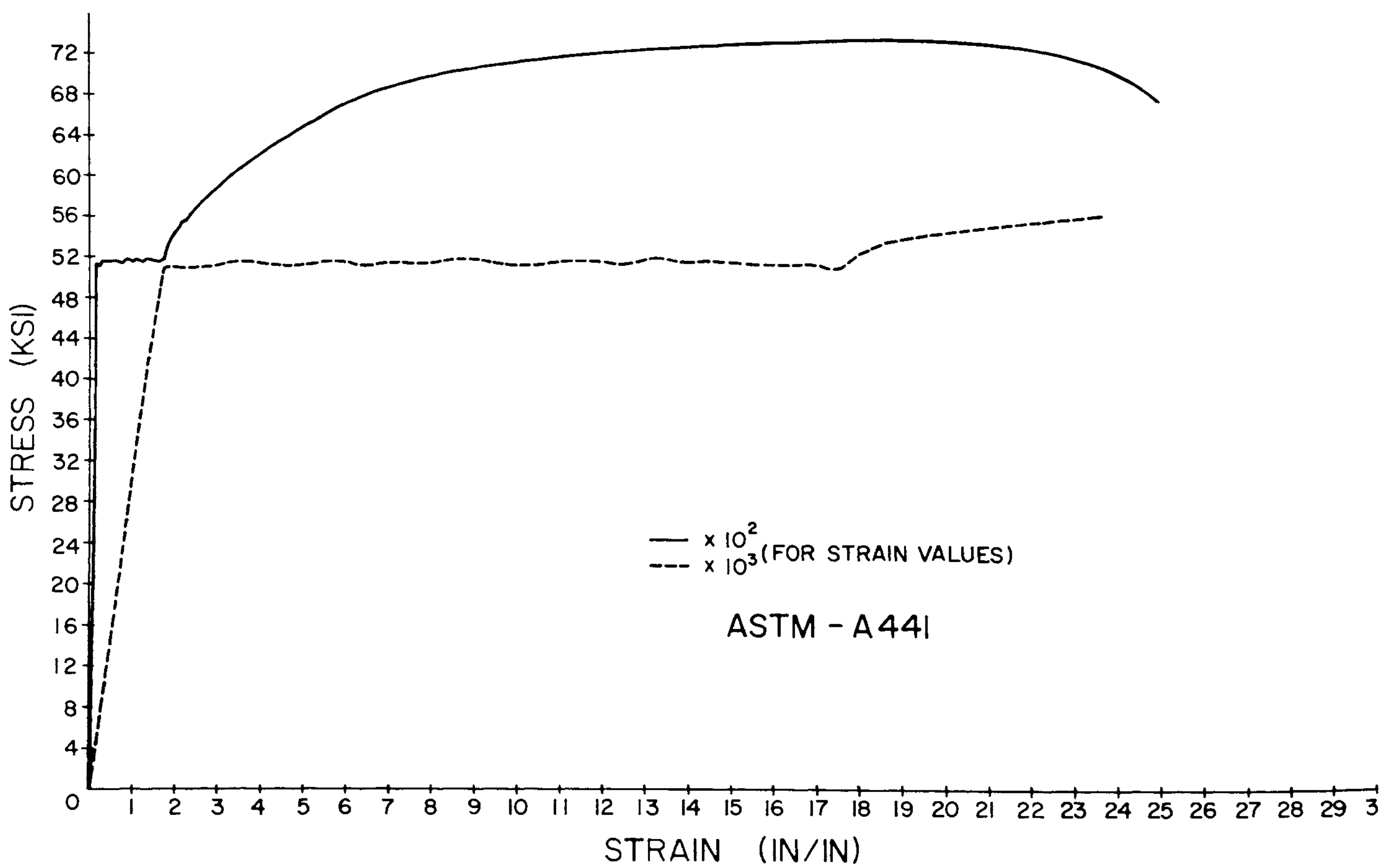


FIGURE 2

TABLE II. SPECIMEN TYPE F1

DIMENSIONS OF WF SECTION

DEPTH	8.14	INCHES
TOP FLANGE WIDTH	5.268	INCHES
BOTTOM FLANGE WIDTH	5.268	INCHES
TOP FLANGE THICKNESS	0.378	INCHES
BOTTOM FLANGE THICKNESS	0.378	INCHES
WEB THICKNESS	0.248	INCHES
ELASTIC MODULUS	30000.	KSI
YIELD STRESS	36.000	KSI

WF SECTION PROPERTIES

AREA, A	5.90	INCHES**2
LOCATION OF CENTROID*, YE	4.07	INCHES
MOMENT OF INERTIA, I	69.5	INCHES**4
SECTION MODULUS, TOP, ST	17.1	INCHES**3
SECTION MODULUS, BOTTOM, SB	17.1	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.07	INCHES
PLASTIC MODULUS, Z	19.2	INCHES**3
SHAPE FACTOR	1.122	
YIELD MOMENT, MY	51.23	KIP-FT.
PLASTIC MOMENT, MP	57.47	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

BEAM PROPERTIES

LENGTH, L	66.0	INCHES
ELASTIC STIFFNESS, P/DELTA	21.76	KIPS/IN.
YIELD DEFLECTION, DELTAY	0.428	INCHES
YIELD LOAD, PY	9.32	KIPS
PLASTIC LOAD, PP	10.45	KIPS

TABLE III. SPECIMEN TYPE F2

DIMENSIONS OF WF SECTION

DEPTH	8.14	INCHES
TOP FLANGE WIDTH	5.268	INCHES
BOTTOM FLANGE WIDTH	5.268	INCHES
TOP FLANGE THICKNESS	0.378	INCHES
BOTTOM FLANGE THICKNESS	0.378	INCHES
WEB THICKNESS	0.248	INCHES
ELASTIC MODULUS	30000.	KSI
YIELD STRESS	36.000	KSI

DIMENSIONS AND PROPERTIES OF TOP PLATE

LENGTH, LP	14.00	INCHES
WIDTH AT END AWAY FROM COLUMN, M	2.50	INCHES
WIDTH AT END OF WELD, R	4.44	INCHES
AVERAGE LOCATION OF END OF WELD*, N	4.00	INCHES
THICKNESS, T	0.500	INCHES
ELASTIC MODULUS	30000.	KSI
YIELD STRESS	36.000	KSI

*MEASURED FROM FACE OF COLUMN

DIMENSIONS AND PROPERTIES OF BOTTOM PLATE

LENGTH, LP	14.00	INCHES
WIDTH, B	6.25	INCHES
AVERAGE LOCATION OF COLUMN END OF WELD*, Q	3.00	INCHES
AVERAGE LOCATION OF OUTER END OF WELD*, P	13.00	INCHES
THICKNESS, T	0.375	INCHES
ELASTIC MODULUS	30000.	KSI
YIELD STRESS	36.000	KSI

*MEASURED FROM FACE OF COLUMN

DEPTH OUT-TO-CUT OF PLATES . . . . 9.01 INCHES

WF SECTION PROPERTIES

AREA, A	5.90	INCHES**2
LOCATION OF CENTROID*, YE	4.07	INCHES
MOMENT OF INERTIA, I	69.5	INCHES**4
SECTION MODULUS, TOP, ST	17.1	INCHES**3
SECTION MODULUS, BOTTOM, SB	17.1	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP	4.07	INCHES
PLASTIC MODULUS, Z	19.2	INCHES**3
SHAPE FACTOR	1.122	
YIELD MOMENT, MY	51.23	KIP-FT.
PLASTIC MOMENT, MP	57.47	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

TABLE III. (CONTINUED)

SECTION PROPERTIES AT SELECTED CROSS-SECTIONS

X	A	YE	I	ST	SB
52.00	5.90	4.44	69.5	17.1	17.1
52.00	7.15	5.20	88.8	23.3	18.4
52.50	7.20	5.22	89.4	23.6	18.4
53.00	7.25	5.25	90.0	23.9	18.5
53.00	9.59	4.01	135.4	27.1	33.7
57.50	10.03	4.22	144.8	30.2	34.3
62.00	10.47	4.41	153.5	33.3	34.8
62.00	8.28	3.38	111.8	19.8	33.1
62.50	8.32	3.41	113.2	20.2	33.2
63.00	8.37	3.44	114.6	20.6	33.3
63.00	6.18	4.45	90.6	19.8	20.4
64.50	6.33	4.55	93.2	20.9	20.5
66.00	6.47	4.64	95.8	21.9	20.6

X	YP	Z	F	MY	MP
52.00	4.62	16.8	1.098	51.23	56.27
52.00	7.14	22.4	1.215	55.20	67.08
52.50	7.24	22.4	1.217	55.31	67.31
53.00	7.34	22.5	1.219	55.41	67.52
53.00	2.61	33.7	1.247	81.17	101.19
57.50	3.49	36.2	1.200	90.58	108.67
62.00	4.37	38.3	1.151	99.94	115.00
62.00	0.72	25.2	1.268	59.53	75.46
62.50	0.72	25.5	1.264	60.62	76.63
63.00	0.72	25.9	1.261	61.70	77.80
63.00	4.39	22.3	1.125	59.53	66.97
64.50	4.68	22.9	1.119	61.48	68.82
66.00	4.98	23.5	1.140	61.86	70.54

X = DISTANCE FROM CONCENTRATED LOAD, INCHES
A = AREA OF CROSS-SECTION, INCHES**2
YE = DIST. FROM OUTSIDE OF BOTTOM PLATE TO CENTROID, INCHES
I = MOMENT OF INERTIA, INCHES**4
ST = SECTION MODULUS FOR TOP FLANGE, INCHES**3
SB = SECTION MODULUS FOR BOTTOM FLANGE, INCHES**3
YP = DIST. FROM OUTSIDE OF BOTTOM PLATE TO PLASTIC N.A., IN.
Z = PLASTIC MODULUS, INCHES**3
F = SHAPE FACTOR
MY = YIELD MOMENT, KIP-FEET
MP = PLASTIC MOMENT, KIP-FEET

BEAM PROPERTIES

LENGTH, L . . . . 66.0 INCHES
ELASTIC STIFFNESS, P/DELTA . . . . 27.80 KIPS/IN.
YIELD DEFLECTION, DELTAY . . . . 0.405 INCHES
YIELD LOAD, PY . . . . 11.25 KIPS
PLASTIC LOAD, PP . . . . 12.76 KIPS
LOCATION OF CRITICAL SECTION FOR PY* . . . . . 66.00 INCHES
LOCATION OF CRITICAL SECTION FOR PP* . . . . . 63.00 INCHES
* MEASURED FROM CONCENTRATED LOAD

TABLE IV. SPECIMEN TYPE F3

DIMENSIONS OF WF SECTION

DEPTH	8.14	INCHES
TOP FLANGE WIDTH	5.268	INCHES
BOTTOM FLANGE WIDTH	5.268	INCHES
TOP FLANGE THICKNESS	0.378	INCHES
BOTTOM FLANGE THICKNESS	0.378	INCHES
WEB THICKNESS	0.248	INCHES
ELASTIC MODULUS	30000.	KSI
YIELD STRESS	36.000	KSI

DIMENSIONS OF CONNECTION ELEMENTS

DEPTH OUT-TO-OUT OF PLATES	9.26	INCHES
THICKNESS OF FILLER PLATE	0.125	INCHES
HOLE DIAMETER	0.750	INCHES

TOP PLATE

LENGTH OF PLATE, LP	10.50	INCHES
WIDTH OF PLATE, B	5.50	INCHES
LOCATION OF FIRST ROW OF BOLTS*, C	1.88	INCHES
LOCATION OF LAST ROW OF BOLTS*, D	9.38	INCHES
THICKNESS OF PLATE, T	0.500	INCHES
ELASTIC MODULUS	30000.	KSI
YIELD STRESS	36.000	KSI

BOTTOM PLATE

LENGTH OF PLATE, LP	10.50	INCHES
WIDTH OF PLATE, B	5.50	INCHES
LOCATION OF FIRST ROW OF BOLTS*, C	1.88	INCHES
LOCATION OF LAST ROW OF BOLTS*, D	9.38	INCHES
THICKNESS OF PLATE, T	0.500	INCHES
ELASTIC MODULUS	30000.	KSI
YIELD STRESS	36.000	KSI

*MEASURED FROM FACE OF COLUMN

TABLE IV. (CONTINUED)

PROPERTIES OF GROSS SECTION OF WF

AREA, A	5.90	INCHES**2
LOCATION OF CENTROID*, YE	4.07	INCHES
MOMENT OF INERTIA, I	69.5	INCHES**4
SECTION MODULUS, TOP, ST	17.1	INCHES**3
SECTION MODULUS, BOTTOM, SB	17.1	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.07	INCHES
PLASTIC MODULUS, Z	19.2	INCHES**3
SHAPE FACTOR	1.122	
YIELD MOMENT, MY	51.23	KIP-FT.
PLASTIC MOMENT, MP	57.47	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

PROPERTIES OF NET SECTION OF WF (AISC SPECIFICATION 1.10.1)

AREA, A	5.37	INCHES**2
LOCATION OF CENTROID*, YE	4.07	INCHES
MOMENT OF INERTIA, I	61.4	INCHES**4
SECTION MODULUS, TOP, ST	15.1	INCHES**3
SECTION MODULUS, BOTTOM, SB	15.1	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.07	INCHES
PLASTIC MODULUS, Z	17.1	INCHES**3
SHAPE FACTOR	1.131	
YIELD MOMENT, MY	45.27	KIP-FT.
PLASTIC MOMENT, MP	51.22	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

PROPERTIES OF GROSS SECTION OF PLATED WF

AREA, A	11.40	INCHES**2
LOCATION OF CENTROID*, YE	4.60	INCHES
MOMENT OF INERTIA, I	175.3	INCHES**4
SECTION MODULUS, TOP, ST	37.6	INCHES**3
SECTION MODULUS, BOTTOM, SB	38.1	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.75	INCHES
PLASTIC MODULUS, Z	42.8	INCHES**3
SHAPE FACTOR	1.140	
YIELD MOMENT, MY	112.72	KIP-FT.
PLASTIC MOMENT, MP	128.55	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

TABLE IV. (CONTINUED)

PROPERTIES OF NET SECTION OF PLATED WF (AISC SPEC. 1.10.1)

AREA, A	10.19	INCHES**2
LOCATION OF CENTROID*, YE	4.60	INCHES
MOMENT OF INERTIA, I	154.2	INCHES**4
SECTION MODULUS, TOP, ST	33.1	INCHES**3
SECTION MODULUS, BOTTOM, SB	33.5	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.75	INCHES
PLASTIC MODULUS, Z	37.8	INCHES**3
SHAPE FACTOR	1.144	
YIELD MOMENT, MY	99.15	KIP-FT.
PLASTIC MOMENT, MP	113.43	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

PROPERTIES OF GROSS SECTION OF PLATES ALONE

AREA, A	5.50	INCHES**2
LOCATION OF CENTROID*, YE	4.63	INCHES
MOMENT OF INERTIA, I	105.7	INCHES**4
SECTION MODULUS, TOP, ST	22.8	INCHES**3
SECTION MODULUS, BOTTOM, SB	22.8	INCHES**3
YIELD MOMENT, MY	72.31	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

PROPERTIES OF NET SECTION OF PLATES ALONE (AISC SPEC. 1.14.3)

AREA, A	4.00	INCHES**2
LOCATION OF CENTROID*, YE	4.63	INCHES
MOMENT OF INERTIA, I	76.9	INCHES**4
SECTION MODULUS, TOP, ST	16.6	INCHES**3
SECTION MODULUS, BOTTOM, SB	16.6	INCHES**3
YIELD MOMENT, MY	52.59	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

BEAM PROPERTIES

LENGTH, L	66.0	INCHES
ELASTIC STIFFNESS, P/DELTA	26.61	KIPS/IN.
YIELD DEFLECTION, DELTAY	0.361	INCHES
YIELD LOAD, PY	9.59	KIPS
PLASTIC LOAD, PP	9.84	KIPS
LOCATION OF CRITICAL SECTION FOR PY*	56.63	INCHES
LOCATION OF CRITICAL SECTION FOR PP*	64.13	INCHES

* MEASURED FROM CONCENTRATED LOAD

TABLE V. SPECIMEN TYPE W1

DIMENSIONS OF WF SECTION

DEPTH	8.14	INCHES
TOP FLANGE WIDTH	5.268	INCHES
BOTTOM FLANGE WIDTH	5.268	INCHES
TOP FLANGE THICKNESS	0.378	INCHES
BOTTOM FLANGE THICKNESS	0.378	INCHES
WEB THICKNESS	0.248	INCHES
ELASTIC MODULUS	30000.	KSI
YIELD STRESS	36.000	KSI

WF SECTION PROPERTIES

AREA, A	5.90	INCHES**2
LOCATION OF CENTROID*, YE	4.07	INCHES
MOMENT OF INERTIA, I	69.5	INCHES**4
SECTION MODULUS, TOP, ST	17.1	INCHES**3
SECTION MODULUS, BOTTOM, SB	17.1	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP	4.07	INCHES
PLASTIC MODULUS, Z	19.2	INCHES**3
SHAPE FACTOR	1.122	
YIELD MOMENT, MY	51.23	KIP-FT.
PLASTIC MOMENT, MP	57.47	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

BEAM PROPERTIES

LENGTH, L	66.0	INCHES
ELASTIC STIFFNESS, P/DELTA	21.71	KIPS/IN.
YIELD DEFLECTION, DELTAY	0.429	INCHES
YIELD LOAD, PY	9.31	KIPS
PLASTIC LOAD, PP	10.44	KIPS

TABLE VI. SPECIMEN TYPE W2A

DIMENSIONS OF WF SECTION

DEPTH	8.14 INCHES
TOP FLANGE WIDTH	5.268 INCHES
BOTTOM FLANGE WIDTH	5.268 INCHES
TOP FLANGE THICKNESS	0.378 INCHES
BOTTOM FLANGE THICKNESS	0.378 INCHES
WEB THICKNESS	0.248 INCHES
ELASTIC MODULUS	30000. KSI
YIELD STRESS	36.000 KSI

DIMENSIONS AND PROPERTIES OF PLATES

LENGTH OF TOP PLATE*, LTP	5.61 INCHES
THICKNESS OF TOP PLATE, TTP	0.375 INCHES
LENGTH OF BOTTOM PLATE*, LBP	5.61 INCHES
THICKNESS OF BOTTOM PLATE, TBP	0.375 INCHES
THICKNESS OF WEB PLATE, TWP	0.250 INCHES
ELASTIC MODULUS OF PLATES, EP	30000. KSI
YIELD STRESS OF PLATES, SYP	36.000 KSI

*MEASURED FROM FACE OF COLUMN WEB

WF SECTION PROPERTIES

AREA, A	5.90 INCHES**2
LOCATION OF CENTROID*, YE	4.07 INCHES
MOMENT OF INERTIA, I	69.5 INCHES**4
SECTION MODULUS, TOP, ST	17.1 INCHES**3
SECTION MODULUS, BOTTOM, SB	17.1 INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.07 INCHES
PLASTIC MODULUS, Z	19.2 INCHES**3
SHAPE FACTOR	1.122
YIELD MOMENT, MY	51.23 KIP-FT.
PLASTIC MOMENT, MP	57.47 KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

TABLE VI. (CONTINUED)

SECTION PROPERTIES AT SELECTED CROSS-SECTIONS

X	A	YE	I	ST	SB
64.44	5.90	4.07	69.5	17.1	17.1
64.44	5.89	4.07	69.2	17.0	17.0
65.32	6.11	3.93	72.4	17.2	18.4
66.19	6.33	3.80	75.4	17.4	19.9
66.57	6.49	3.78	77.7	17.8	20.5
66.90	6.73	3.84	81.5	18.9	21.3
67.12	7.03	3.95	86.3	20.6	21.9
67.19	7.29	4.07	90.3	22.2	22.2

X	YP	Z	F	MY	MP
64.44	4.07	19.2	1.122	51.23	57.47
64.44	4.07	19.1	1.122	50.98	57.21
65.32	3.62	19.9	1.157	51.57	59.66
66.19	3.18	20.6	1.187	52.09	61.81
66.57	3.10	21.2	1.188	53.43	63.49
66.90	3.26	22.2	1.171	56.84	66.56
67.12	3.64	23.5	1.139	61.80	70.39
67.19	4.07	24.5	1.105	66.54	73.52

X = DISTANCE FROM CONCENTRATED LOAD, INCHES
A = AREA OF CROSS-SECTION, INCHES**2
YE = DIST. FROM OUTSIDE OF BOTTOM PLATE TO CENTROID, INCHES
I = MOMENT OF INERTIA, INCHES**4
ST = SECTION MODULUS FOR TOP FLANGE, INCHES**3
SB = SECTION MODULUS FOR BOTTOM FLANGE, INCHES**3
YP = DIST. FROM OUTSIDE OF BOTTOM PLATE TO PLASTIC N.A., IN.
Z = PLASTIC MODULUS, INCHES**3
F = SHAPE FACTOR
MY = YIELD MOMENT, KIP-FEET
MP = PLASTIC MOMENT, KIP-FEET

BEAM PROPERTIES

LENGTH, L . . . . 67.2 INCHES
ELASTIC STIFFNESS, P/DELTA . . . . 20.80 KIPS/IN.
YIELD DEFLECTION, DELTAY . . . . 0.454 INCHES
YIELD LOAD, PY . . . . 9.44 KIPS
PLASTIC LOAD, PP . . . . 10.65 KIPS
LOCATION OF CRITICAL SECTION FOR PY* . . . . 66.19 INCHES
LOCATION OF CRITICAL SECTION FOR PP* . . . . 64.44 INCHES
* MEASURED FROM CONCENTRATED LOAD

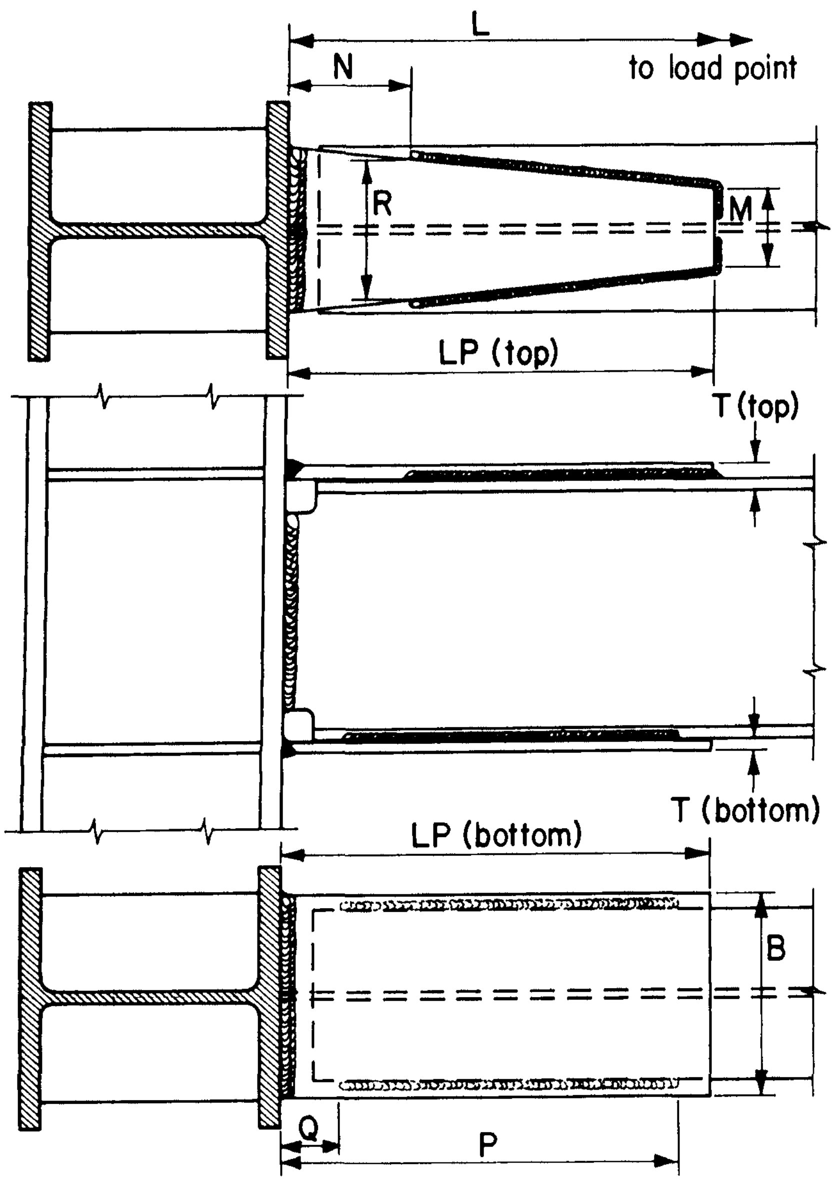


FIGURE 3: TYPE F2

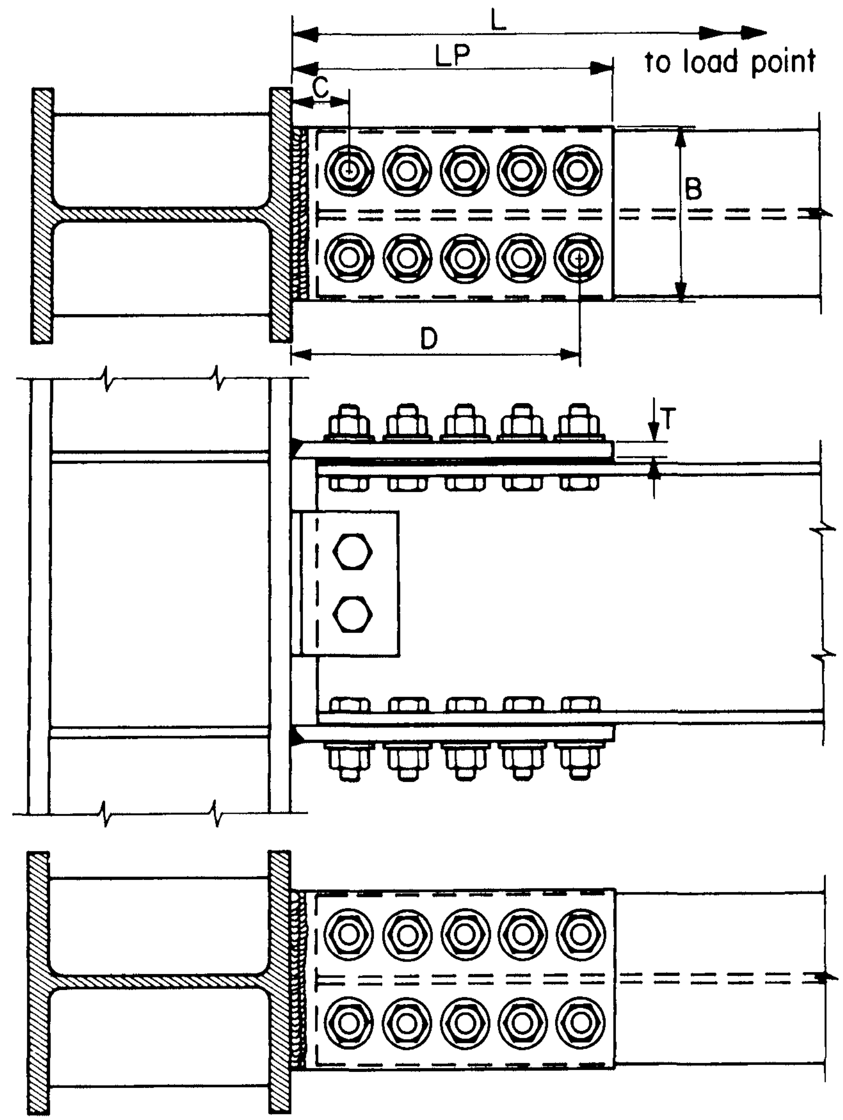


FIGURE 4: TYPE F3

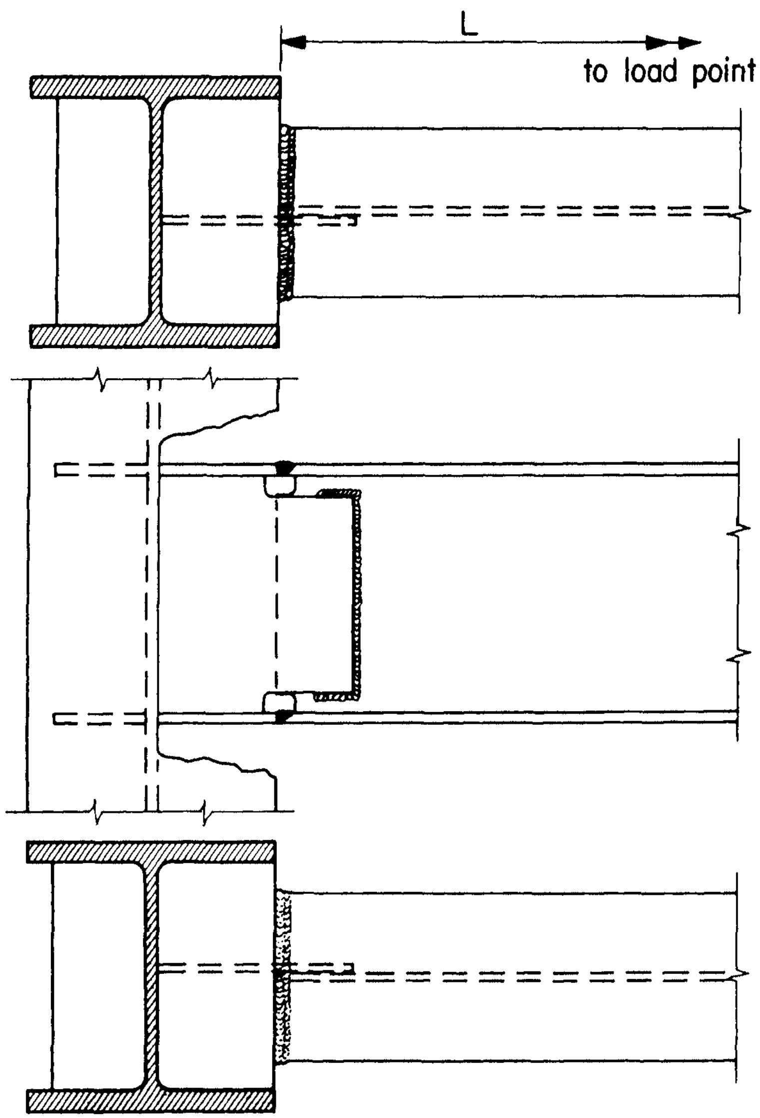


FIGURE 5: TYPE WI

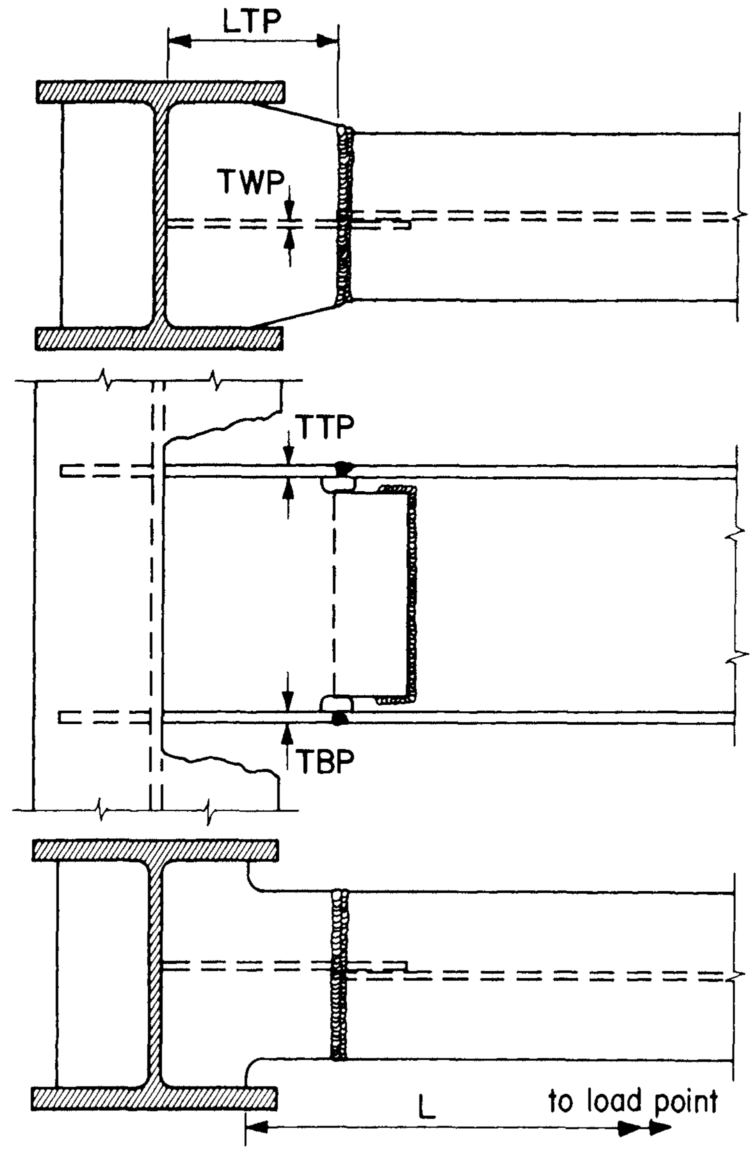


FIGURE 6: TYPE W2

questionable value and so are not presented herein; however, a brief description follows.

Most of the specimens were instrumented with strain gages to a greater or lesser degree. Preliminary investigations were carried out to determine a suitable combination of gage and cement, which could withstand the extremely large cyclic strains to be imposed. A combination was found which was satisfactory for a limited number of reversals, but in no case did a severely strained gage endure an entire test. One useful piece of information which was derived from the strain gages concerned onset of buckling of the flanges. By placing two gages at the same location, one on each face of the flange, it was possible, by observing the divergence of the two strain readings, to determine whether buckling had occurred. The other significant application of strain gages was in connection with test control; this will be discussed later.

Because of the wide use of movement-curvature relationships, an attempt was made to record curvatures. This was done by mounting dial gages on brackets attached to the columns and by measuring the horizontal movement of "targets" mounted on threaded studs tack-welded to the beam flanges. Again, this proved to be less than satisfactory because of the large buckling distortions encountered except very early in a test.

Another difficulty, with both strain and curvature instrumentation, was the inherent instability of readings beyond the elastic limit. Continuous recording of readings seems virtually mandatory under such circumstances, and the necessary equipment was not available. In an attempt to minimize the problem, strain readings were generally taken at no load, except during the initial cycles, and the curvature dials were photographed at preselected intervals, usually at peak- and no-load conditions.

Some means of test control was necessary for standardization and comparison purposes. The influence of a similar previous investigation[2] led to an attempt to control the experiments by means of strain. Although the control strain was always measured on the centerline of the face of a flange or connecting plate, the choice of the cross-section location at which it was measured was somewhat arbitrary, in that the control gage was positioned to try to avoid regions of high residual stress and stress concentration (for example, near the welds) and yet to be within a region of large cyclic strain. Uniformity in this regard was impossible to achieve in view of the different connection types tested. The latter consideration was further complicated, in the case of plated connections, by the uncertainty of whether first yielding would occur in the plates or in the WF beam.

Once these questions had been resolved, the strain gage chosen was connected either to a Baldwin SR-4 strain indicator or, more often, to the horizontal input of a graphical "X-Y" recorder. The specimen was loaded until a predetermined amplitude of control strain was reached, and then the load was reversed. As has been noted, however, the control gage could not be relied upon throughout the test, so a technique

[2] Bertero, V. V. and E. P. Popov, "Effect of Large Alternating Strains on Steel Beams", Journal of the Structural Division, ASCE, Vol. 91, No. ST1, February, 1965, pp. 1-12.

was developed whereby a curvature dial was selected and its reading recorded when the desired amplitude of control strain was reached. This curvature reading was then used to determine subsequent points of load reversal. The tests performed in this manner have been designated "strain control" tests.

In every test, the deflection of the end of the cantilever, at the point of application of load, was recorded. Referred to as the "tip-deflection" it was usually recorded continuously on the horizontal axis of an X-Y recorder but, particularly in the earlier tests, was sometimes measured by means of dial gages. Continuous recording was made possible by the use of a multi-turn, electrically linear potentiometer.

Because of the eventual deterioration in reliability of curvature measurements, and hence of the "strain control", it was often necessary to resort to control by means of tip-deflection amplitude. Furthermore, it became apparent that this was the only sensible way of standardizing tests of entirely different connection configurations, so in the later tests, deflection control was used exclusively.

Regardless of whether strain or deflection was recorded on the horizontal axis, the load was recorded on the vertical axis of the X-Y recorder. The load was measured by means of a transducer placed in series with the hydraulic cylinder and the end of the beam. Two outputs were available, so the load was also monitored on a Baldwin SR-4 strain indicator. The load-cell was calibrated before and after each test.

The graphical records obtained as described above are very illuminating of the behavior and history of each specimen. They have therefore been included in this report in reduced size. As a cursory inspection will show, characteristic hysteresis loops were regularly obtained.

Identification of Specimens

Each specimen has been designated by a name conveying the connection type and the type of cycling imposed. This information is summarized in Table VII:

TABLE VII. SPECIMEN DESIGNATION

Type of Connection	F1	direct butt-welded (flange-connected)
	F2	welded connecting plates (flange-connected)
	F3	bolted connecting plates (flange-connected)
	W1	flush connecting plates (web-connected)
	W2	tapered and filleted connecting plates (web-connected)
Type of Cycling	C1	five cycles each at nominal $\pm \frac{1}{2}$% control strain increments
	C2	constant nominal $\pm 1\frac{1}{2}$% control strain
	C3	100 cycles at constant nominal $\pm \frac{1}{2}$% control strain followed by constant $\pm 1\frac{1}{2}$% nominal control strain
	C4	constant nominal $\pm$ 1% control strain
	C5	constant $\pm \frac{1}{2}$% nominal control strain
	C6	two cycles each at $\pm \frac{1}{4}$% nominal control strain increments
	C7	fifteen cycles each at $\pm \frac{1}{2}$" nominal tip-deflection increments starting from $\pm$ 1"
	C8	same as C7
	C9	same as C7, except preceded by two cycles at $\pm$ 2" nominal tip deflection
	C10	same as C7, except preceded by five cycles at $\pm$ 2" nominal tip deflection
	C11	same as C7, except preceded by five cycles at $\pm 2\frac{1}{2}$" nominal tip deflection

In certain instances, the letter "A" or "B" has been appended to the connection type. For types F2 and F3, this indicates the use of thinner connection plates. Type W2 had different connection plate configurations at the top and bottom flanges, respectively, and since all tests commenced with a down stroke, the two type W2 specimens were fabricated in such a way that each type of plate yielded initially in tension. Thus type W2B was identical to type W2A, except that it was inverted.

It will be noted that cycle programs C1 through C6 were strain-controlled while programs C7 through C11 were deflection-controlled. Programs C7 and C8 were identical.

The word "nominal" has been used in the descriptions in the above table because (1) in the case of strains, uniformity of control was impossible to achieve, and (2) in the case of deflections, support rotation had not been eliminated.

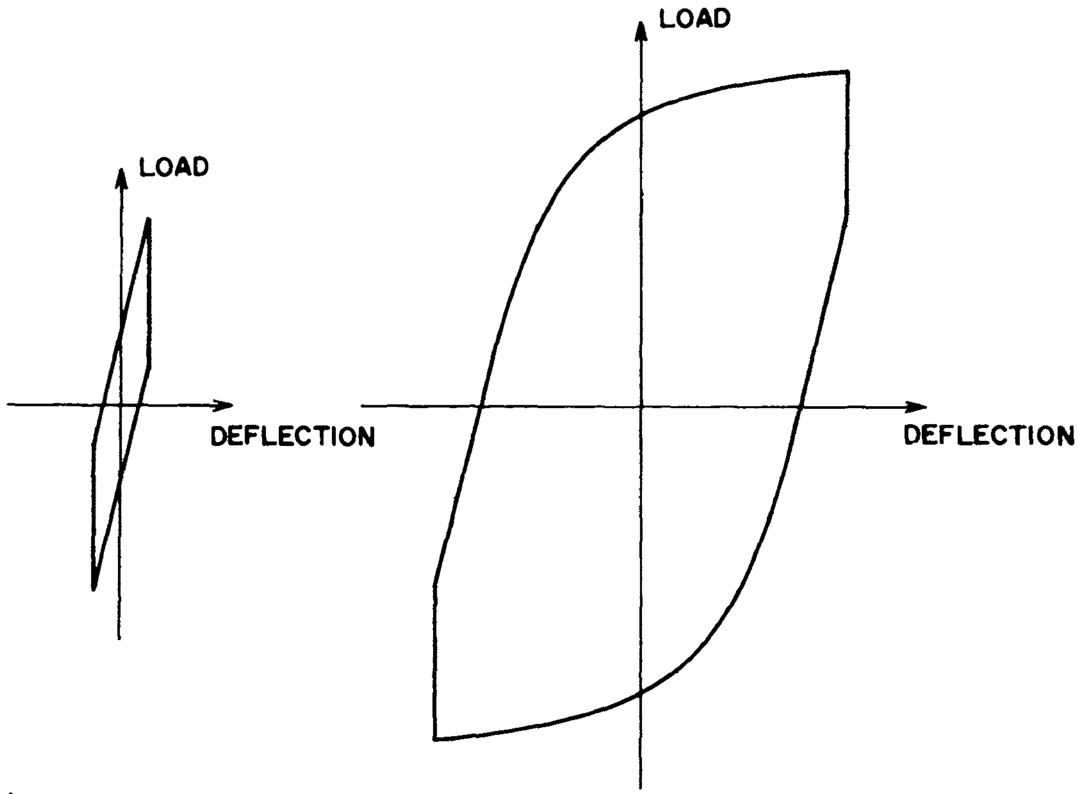
Reduction of Data

Of the variety of data mentioned above, the most useful were found to be the load-deflection relationships. In addition to providing a continuous record of both load and deflection, they permit the determination of the energy absorption. Along with the total number of cycles to failure, these appear to be the most significant parameters for evaluating the performance of each specimen. With this in mind, only the pertinent data has been reduced for inclusion in this report. A discussion of the treatment of the raw data follows.

Perhaps the most important source of experimental error was the presence of a certain amount of support rotation. A difficulty arises here in defining "support" and determining its precise location. The most obvious definition is the face of the column. This is largely satisfactory for the flange-connected specimens, but becomes obscure for the web-connected ones. Even in the former case, however, the face of the column is not rigid, and therefore permits distortion of the adjacent beam cross-section, especially after yielding. For these reasons, direct measurement of the support rotation, although attempted, was not so successful as had been hoped. In an attempt to maintain uniform treatment of all data, therefore, the elastic stiffness, as computed from the measured section and material properties, was used for each specimen. Deflections were corrected in such a way that the apparent elastic slope, as graphically recorded, was made the same as the computed elastic slope. That is, corrections linearly proportional to load were applied to all deflections.

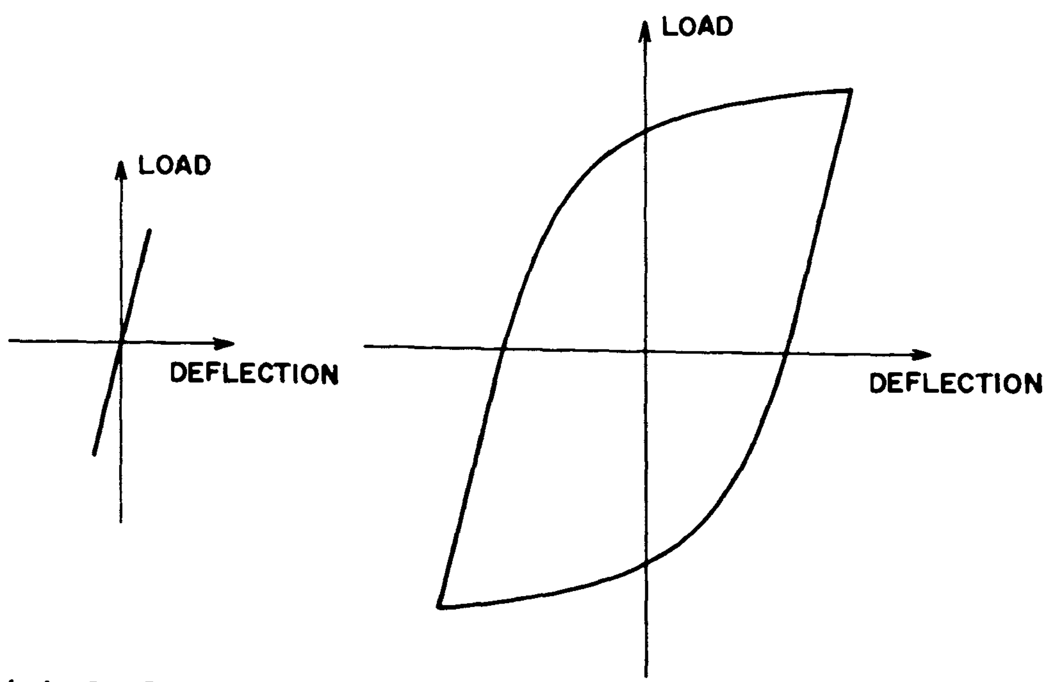
Errors were also introduced into the load readings because of friction developed at the guides provided for lateral support of the beam, and in the hydraulic cylinder. Characteristic experimental load-deflection diagrams are shown in idealized form in Figure 7, with the effects of friction exaggerated. Figure 8 shows the same diagrams in the absence of friction.

In an attempt to rationalize the presence of the small vertical increments in load at the extremities of the curves of Figure 7, the simple model shown in Figure 9 was used.



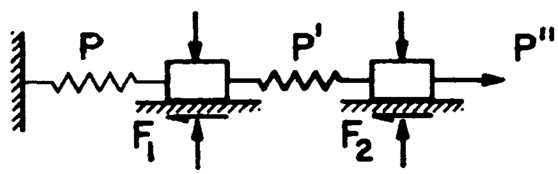
(a) ELASTIC (b) POST-ELASTIC

FIGURE 7



(a) ELASTIC (b) POST-ELASTIC

FIGURE 8



P ≡ force applied to beam
F_1 ≡ friction force developed at lateral guide
P' ≡ load as measured by transducer
F_2 ≡ friction force developed in hydraulic cylinder
P'' ≡ load developed by hydraulic pressure

FIGURE 9

Suppose now that the program of loading shown in Figure 10a is applied to the load P'', here plotted, for convenience, against a linear time scale. The resulting values of the forces F_2, P', F_1, and P would then be as shown in Figures 10b, c, d and e, respectively. Assuming the deflection Δ to be given as a function of the load P by Figures 8a and b, respectively, the relationship between the load P' and deflection Δ can be plotted. When this is done, the resulting diagrams are found to have precisely the forms shown in Figure 7. The three loads, P'', P' and P have been plotted against the deflection Δ in Figure 11. The points designated "a" correspond to the system at rest, with no hydraulic pressure. If the actual experimental hysteresis loops are examined, this lag in the load can be clearly seen, as can the vertical load increments at the extremities.

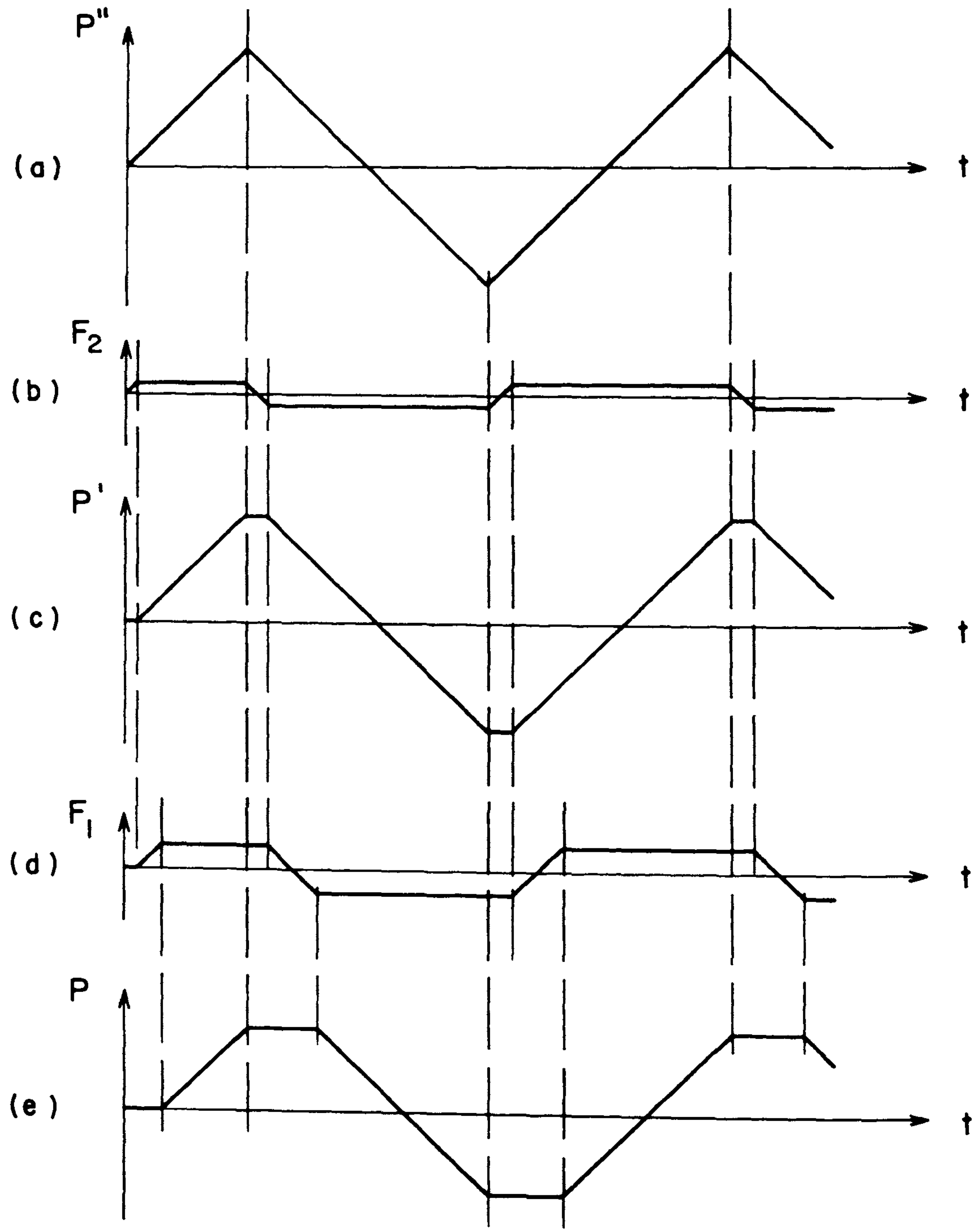


FIGURE 10

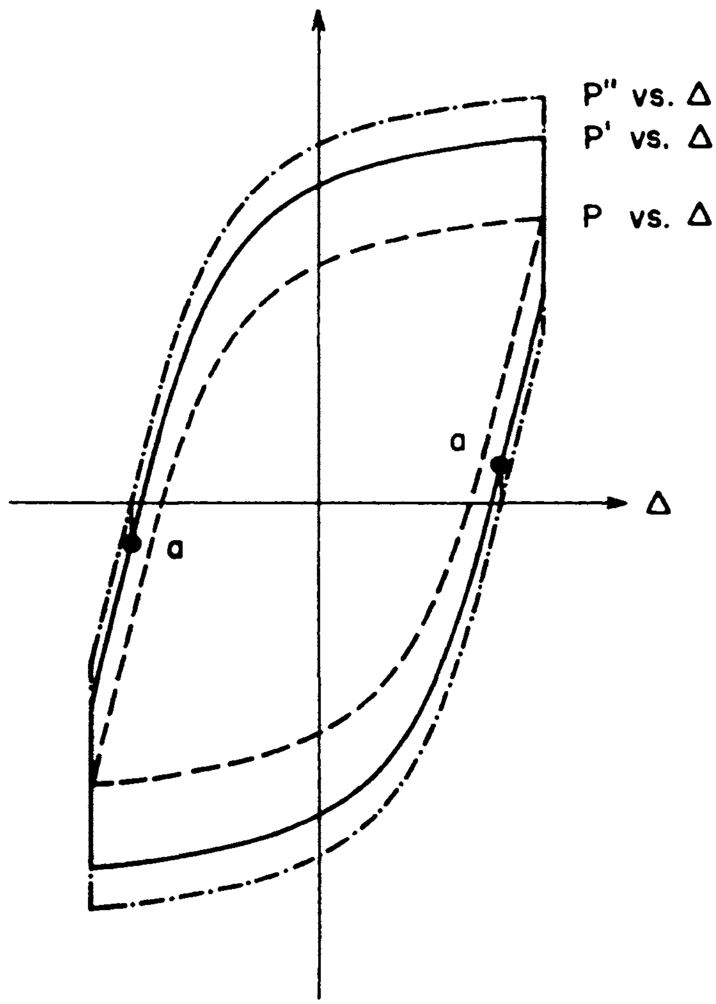


FIGURE 11

Applying this reasoning to the elastic case of Figure 7a, it is possible to compute, from the horizontal width of the loop, the approximate friction force. The horizontal width is used because it can be measured more accurately from the experimental curves. This correction has been included in the peak loads tabulated for each specimen.

The energy absorption was determined by measuring the areas of the hysteresis loops. Since the support rotation causes only a rigid body displacement, no correction to the areas of the hysteresis loops was required on this basis. It is obvious from Figure 11, however, that the correction for friction must also be applied to the hysteresis area. Since the friction forces have been assumed constant, the correction is made simply by deducting the area of a rectangle whose sides are twice the friction force F_1, and the peak-to-peak deflection, respectively.

Only one other minor correction was made, to account for the errors introduced in the base line when the pen of the X-Y recorder was reset to fresh paper.

In the tabulated data, both corrected and non-dimensionalized corrected data have been presented. Non-dimensionalization has been carried out by dividing loads by the theoretical plastic load P_p, deflections by a "characteristic" deflection Δ_p (see Figure 12), and

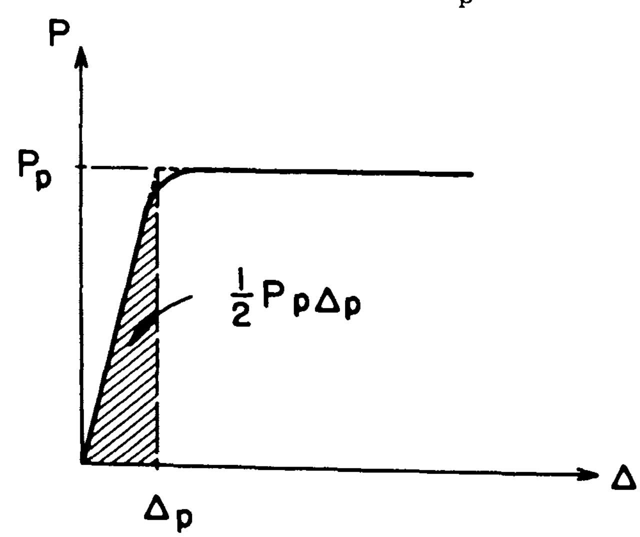


FIGURE 12

the energies by the elastic energy corresponding to the theoretical plastic load. Non-dimensionalized data has been denoted by placing a bar over the appropriate symbol. Figure 13 shows the symbols used:

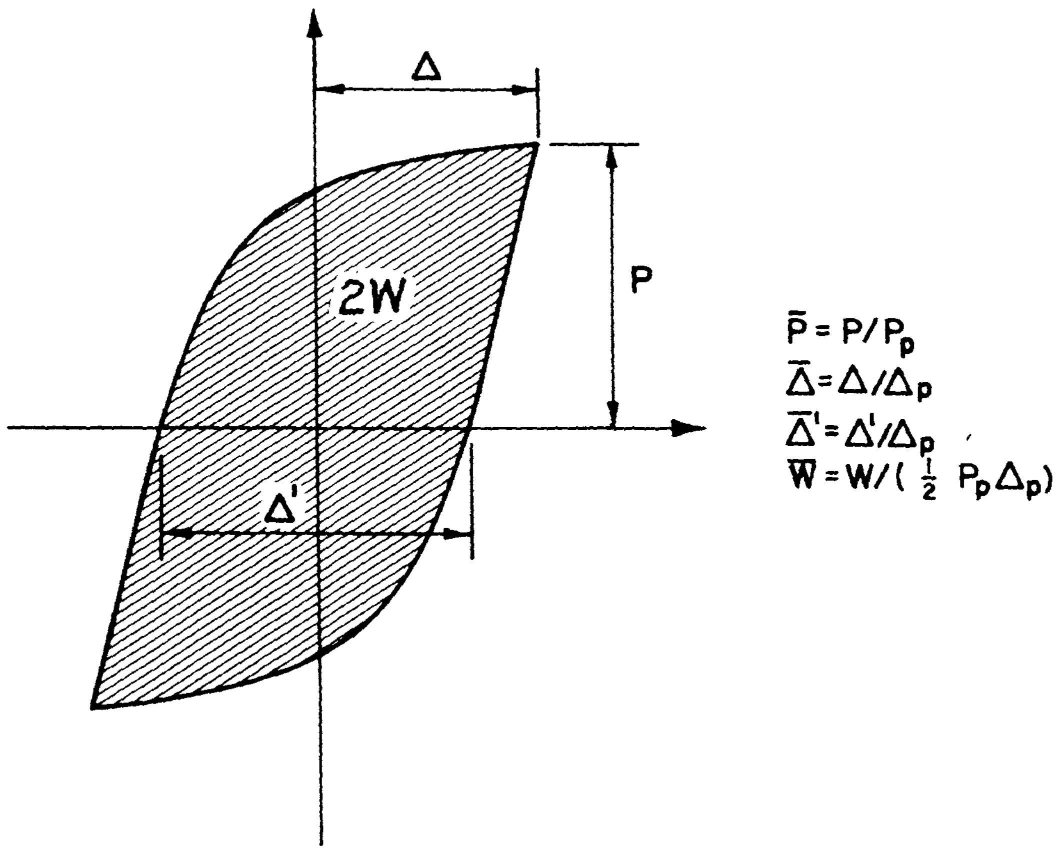


FIGURE 13

Organization of Data

The remainder of this report has been organized into sections according to specimens. Each section contains specific information on the particular specimen, its dimensions and structural properties, the available graphical records, failure photographs and reduced loads, deflections and energies. The program of cycling has been given in terms of tip-deflection for each specimen. The total number of cycles to failure has been denoted as N. A single cycle comprises one down-stroke and one up-stroke or, alternatively, two "reversals".

SPECIMEN F1-S

Description: The beam was butt-welded directly to the column flange. The specimen was commercially fabricated; there was no visually apparent departure from the detail drawings. Ultrasonic inspection disclosed no significant weld defects.

Program of Loading: This was a one-directional static test, with trial instrumentation.

Remarks: Buckling of the compression flange was observed at a tip deflection of about two inches. The specimen was unloaded and reloaded in the same direction three times during the test. The test was terminated after the load had reached a maximum and had begun to decrease. The maximum recorded tip deflection was $9\frac{1}{2}$ inches, corrected for support rotation. No actual fracture occurred.

SPECIMEN TYPE F1-S

DIMENSIONS OF WF SECTION

DEPTH	8.26	INCHES
TOP FLANGE WIDTH	5.150	INCHES
BOTTOM FLANGE WIDTH	5.300	INCHES
TOP FLANGE THICKNESS	0.373	INCHES
BOTTOM FLANGE THICKNESS	0.344	INCHES
WEB THICKNESS	0.273	INCHES
ELASTIC MODULUS	29800.	KSI
YIELD STRESS	38.900	KSI

WF SECTION PROPERTIES

AREA, A	5.89	INCHES**2
LOCATION OF CENTROID*, YE	4.18	INCHES
MOMENT OF INERTIA, I	69.4	INCHES**4
SECTION MODULUS, TOP, ST	17.0	INCHES**3
SECTION MODULUS, BOTTOM, SB	16.6	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.29	INCHES
PLASTIC MODULUS, Z	19.0	INCHES**3
SHAPE FACTOR	1.144	
YIELD MOMENT, MY	53.80	KIP-FT.
PLASTIC MOMENT, MP	61.57	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

BEAM PROPERTIES

LENGTH, L	66.0	INCHES
ELASTIC STIFFNESS, P/DELTA	21.59	KIPS/IN.
YIELD DEFLECTION, DELTAY	0.453	INCHES
YIELD LOAD, PY	9.78	KIPS
PLASTIC LOAD, PP	11.19	KIPS

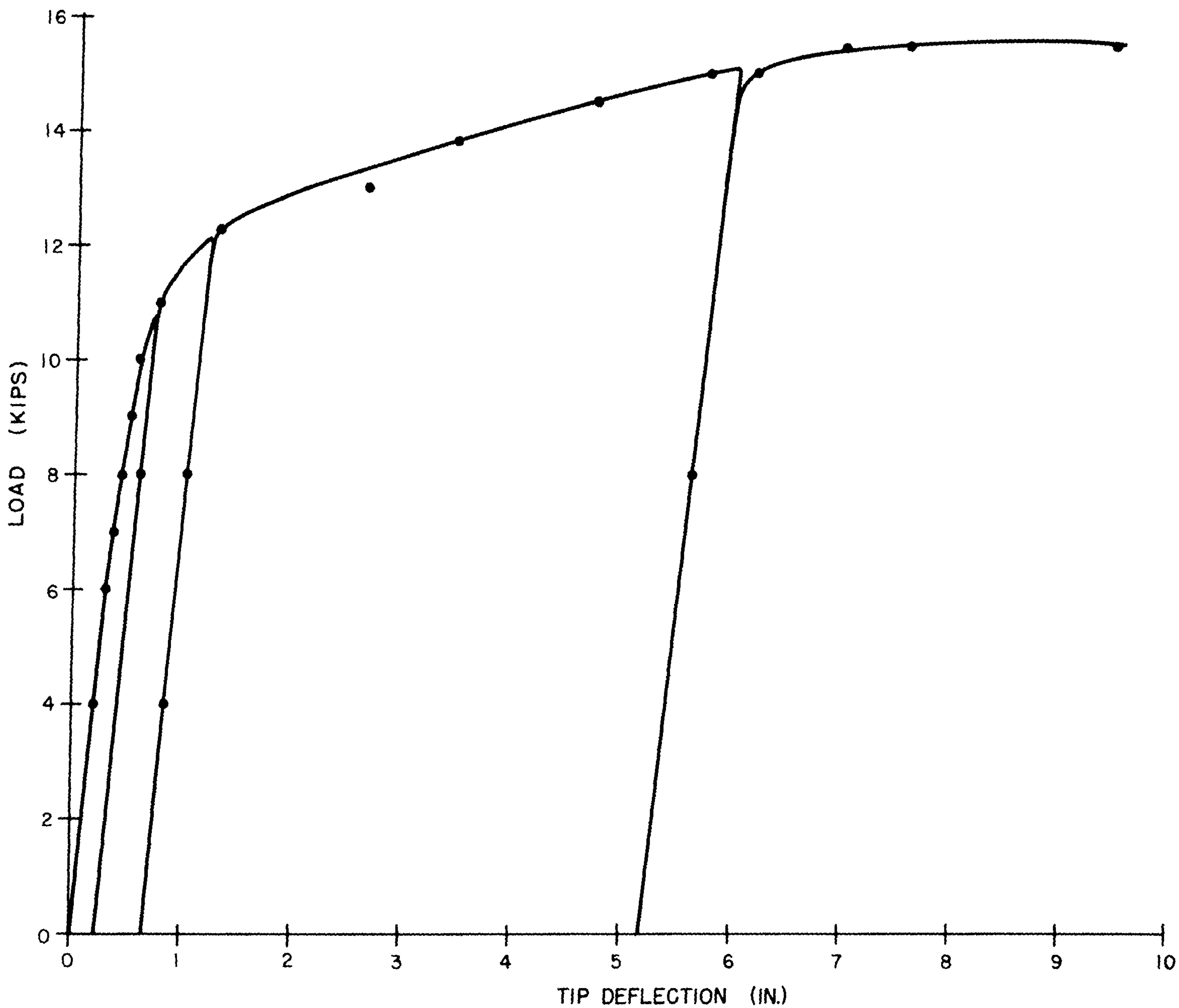


PLATE I. LOAD vs DEFLECTION - FI-S

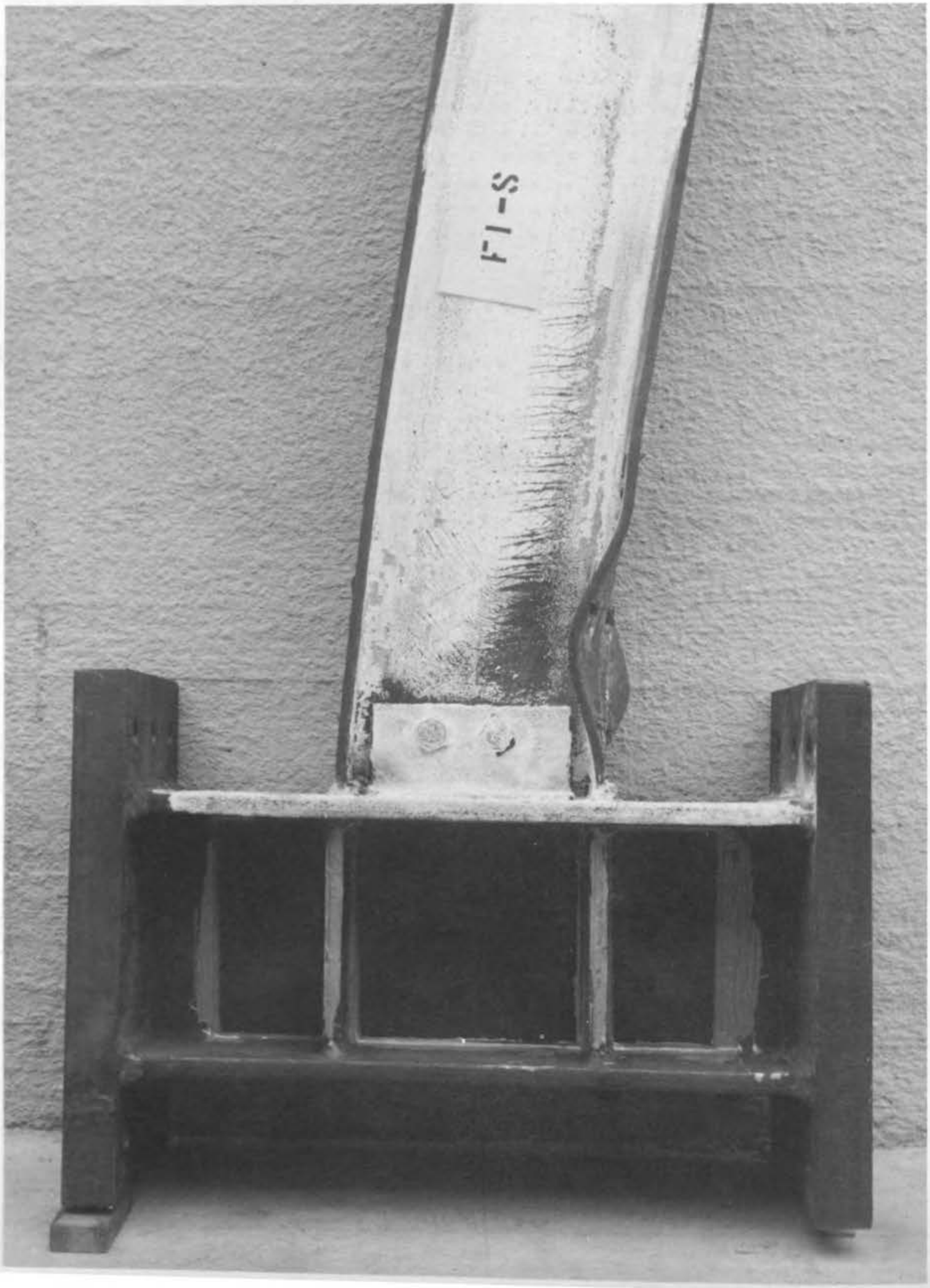
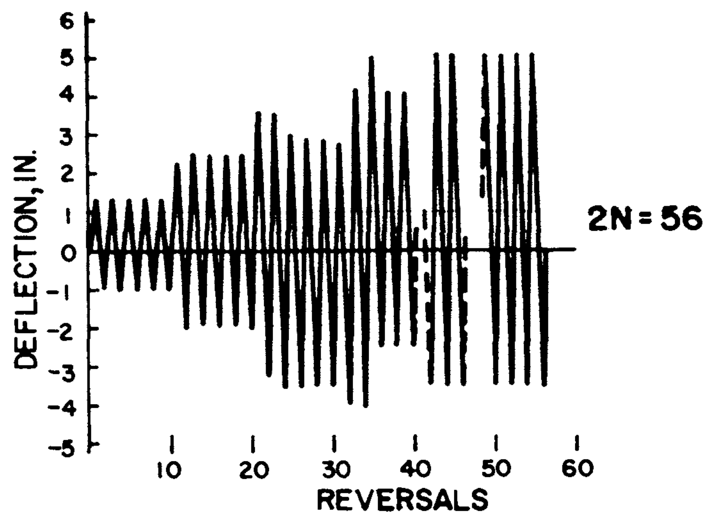


FIGURE 14. F1-S

SPECIMEN F1-C1

Description: This specimen was similar to specimen F1-S in detailing, fabrication and inspection. Threaded studs were tack-welded to both flanges to support rotation measuring devices.

Program of Cycling:



Test Control: Strain, as measured on the top flange 5.54 inches from the column face.

Raw Data Included: Graphical load-strain data for the control strain.

Total Energy Absorption: Not available.

Plastic Load Reversals to Failure: 56 (28 cycles)

Remarks: Plastic buckling of the flanges was first detected, by strain measurements, after the first two plastic cycles. The control strain at this time was varying from -0.1% to +0.4%. Buckling of the bottom flange became visible after $10\frac{1}{2}$ plastic cycles, with a control strain range of from -0.7% to +1.85%. The top flange was visibly buckled after the next reversal (i.e., after 11 plastic cycles). As cycling continued, the flanges alternately straightened and buckled under tension and compression, respectively.

A small crack was first observed in the top flange weld after 15½ plastic cycles. Small cracks were found in the bottom flange weld after 23 cycles. Severe buckles had by now developed, the ones nearest the column being at precisely the same cross-section as the studs which were welded to the flanges. Cracks were observed at the bottom flange stud weld, as well as a field of hair cracks across the concave face of the buckle. A similar situation was found on the top flange after 25½ cycles. These cracks began to propagate, until finally the bottom flange cracked all the way through, and a rapid decrease in load ensued. This occurred after 28 plastic cycles, and was regarded as failure.

SPECIMEN TYPE F1-C1

DIMENSIONS OF WF SECTION

DEPTH	8.26	INCHES
TOP FLANGE WIDTH	5.170	INCHES
BOTTOM FLANGE WIDTH	5.280	INCHES
TOP FLANGE THICKNESS	0.375	INCHES
BOTTOM FLANGE THICKNESS	0.349	INCHES
WEB THICKNESS	0.261	INCHES
ELASTIC MODULUS	29800.	KSI
YIELD STRESS	38.900	KSI

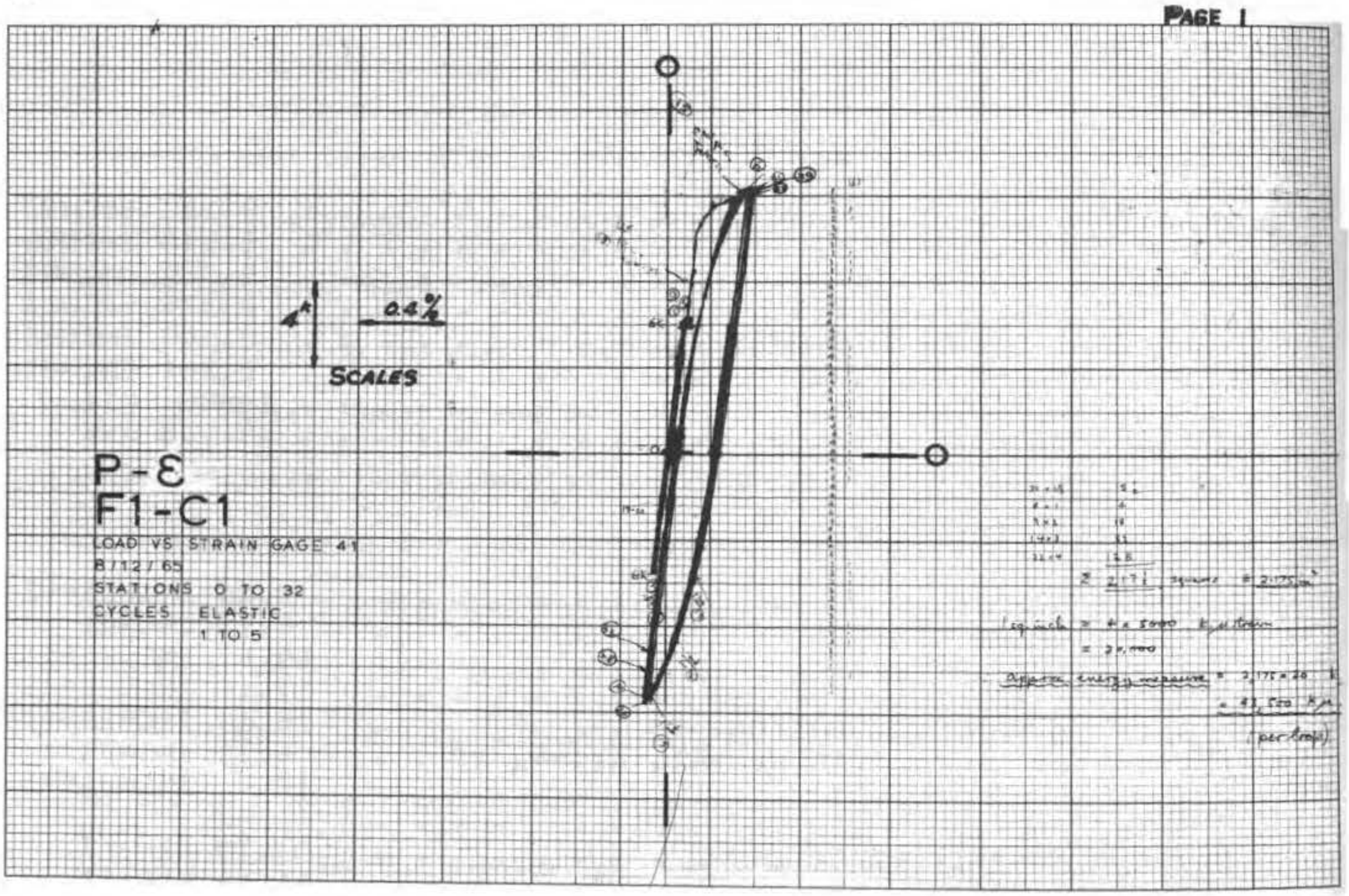
WF SECTION PROPERTIES

AREA, A	5.84	INCHES**2
LOCATION OF CENTROID*, YE	4.19	INCHES
MOMENT OF INERTIA, I	69.5	INCHES**4
SECTION MODULUS, TOP, ST	17.1	INCHES**3
SECTION MODULUS, BOTTOM, SB	16.6	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.31	INCHES
PLASTIC MODULUS, Z	19.0	INCHES**3
SHAPE FACTOR	1.142	
YIELD MOMENT, MY	53.79	KIP-FT.
PLASTIC MOMENT, MP	61.44	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

BEAM PROPERTIES

LENGTH, L	66.0	INCHES
ELASTIC STIFFNESS, P/DELTA	21.61	KIPS/IN.
YIELD DEFLECTION, DELTAY	0.453	INCHES
YIELD LOAD, PY	9.78	KIPS
PLASTIC LOAD, PP	11.17	KIPS



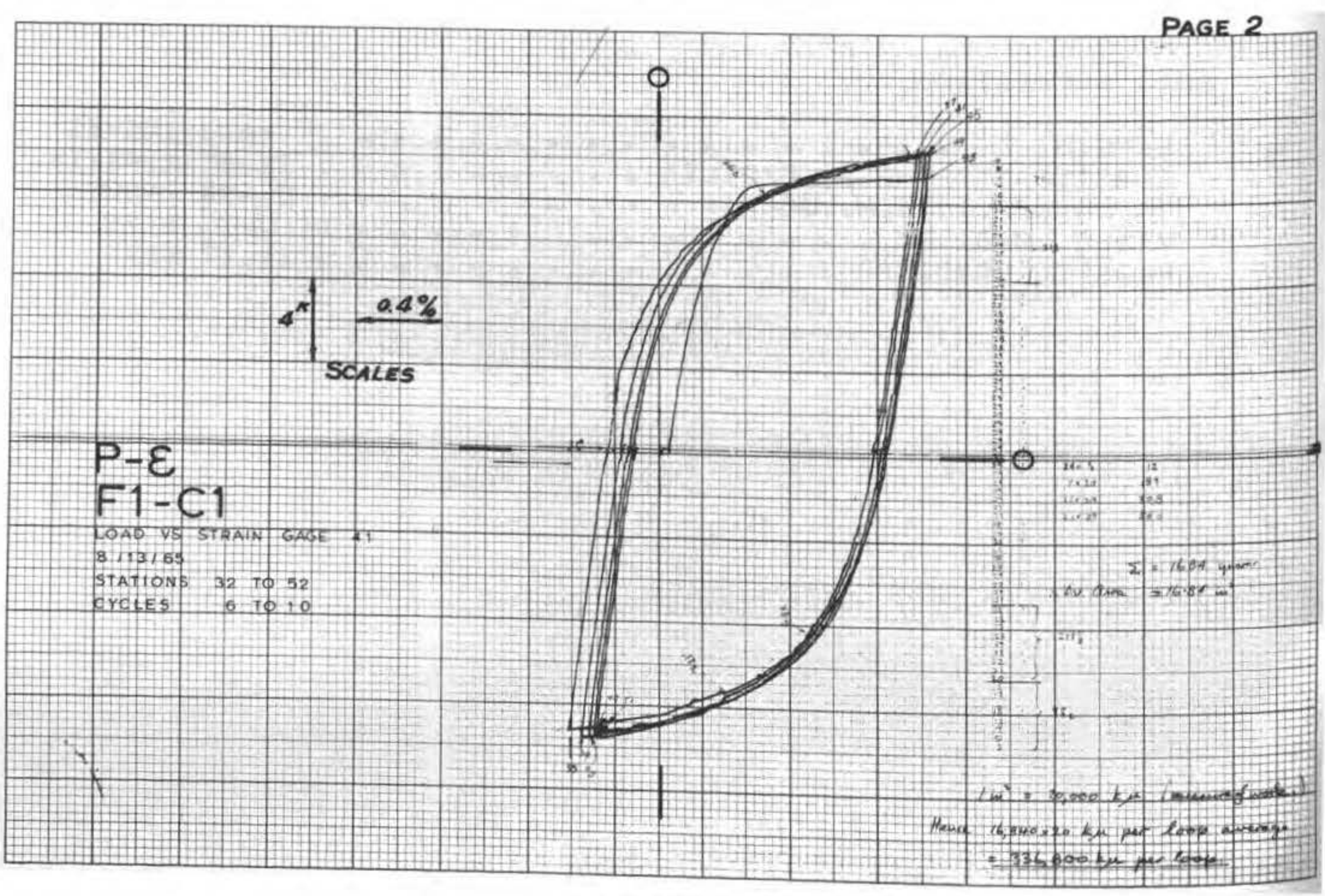
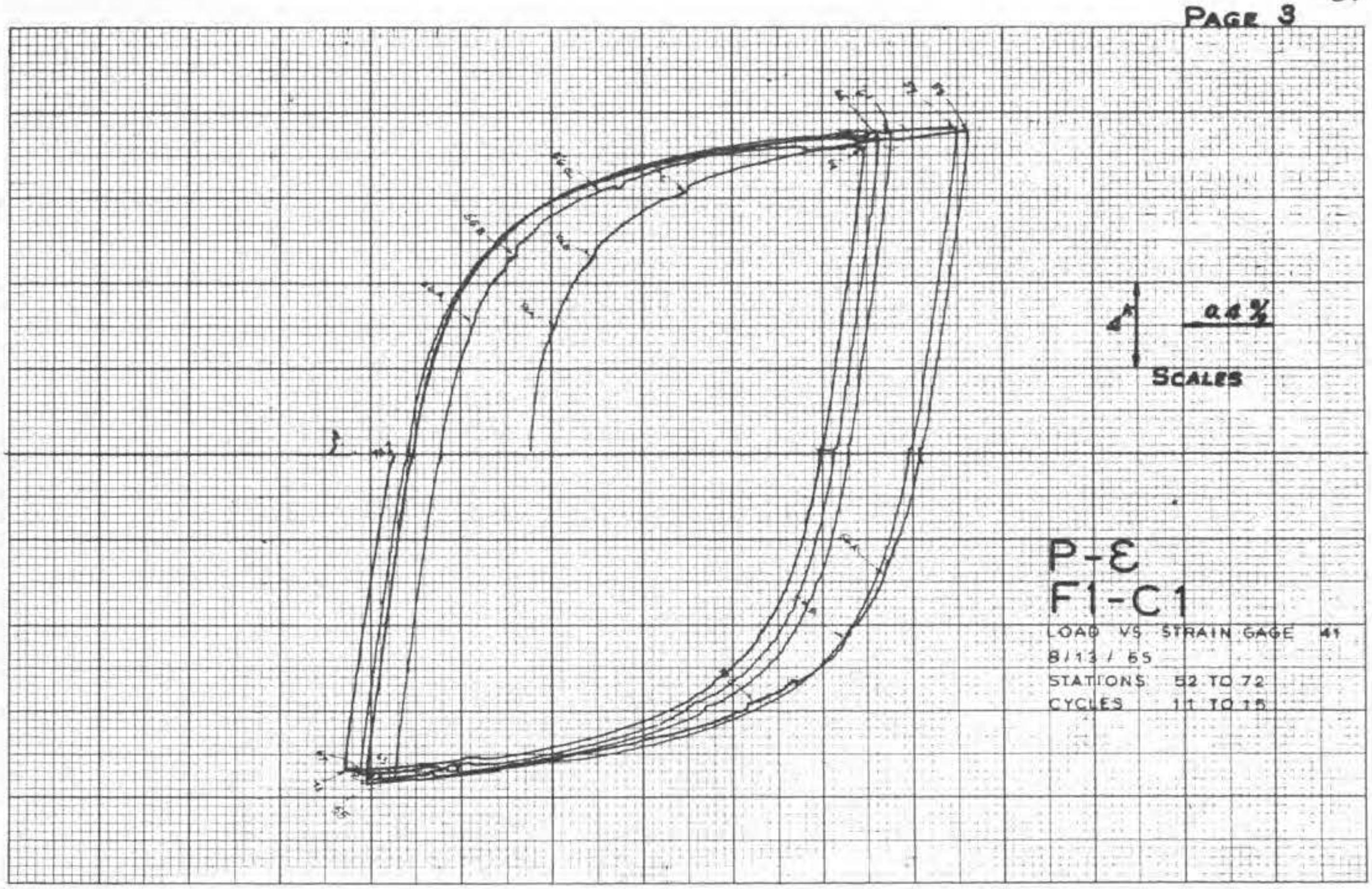


PLATE 2. LOAD VS. STRAIN - F1-C1



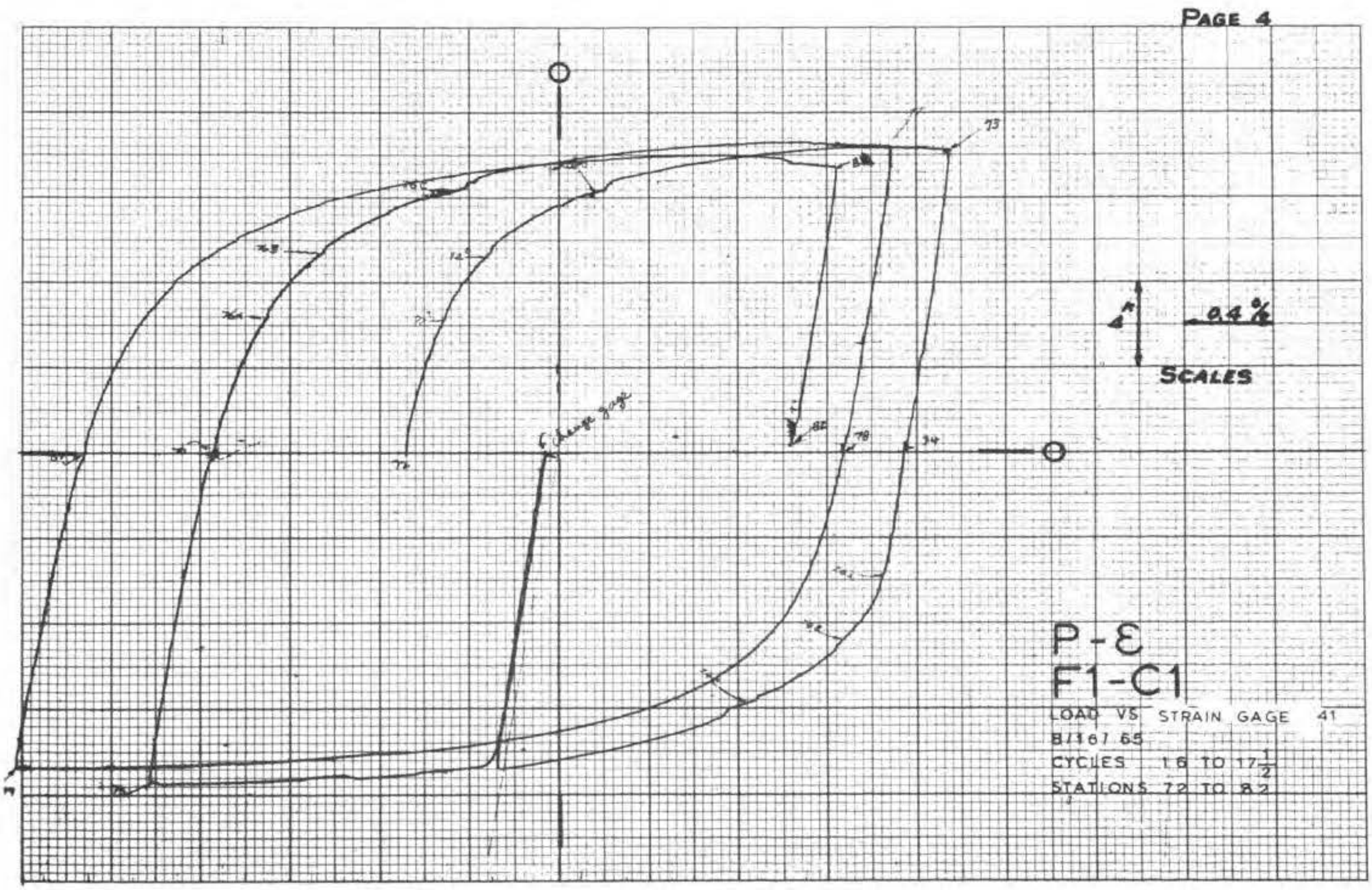
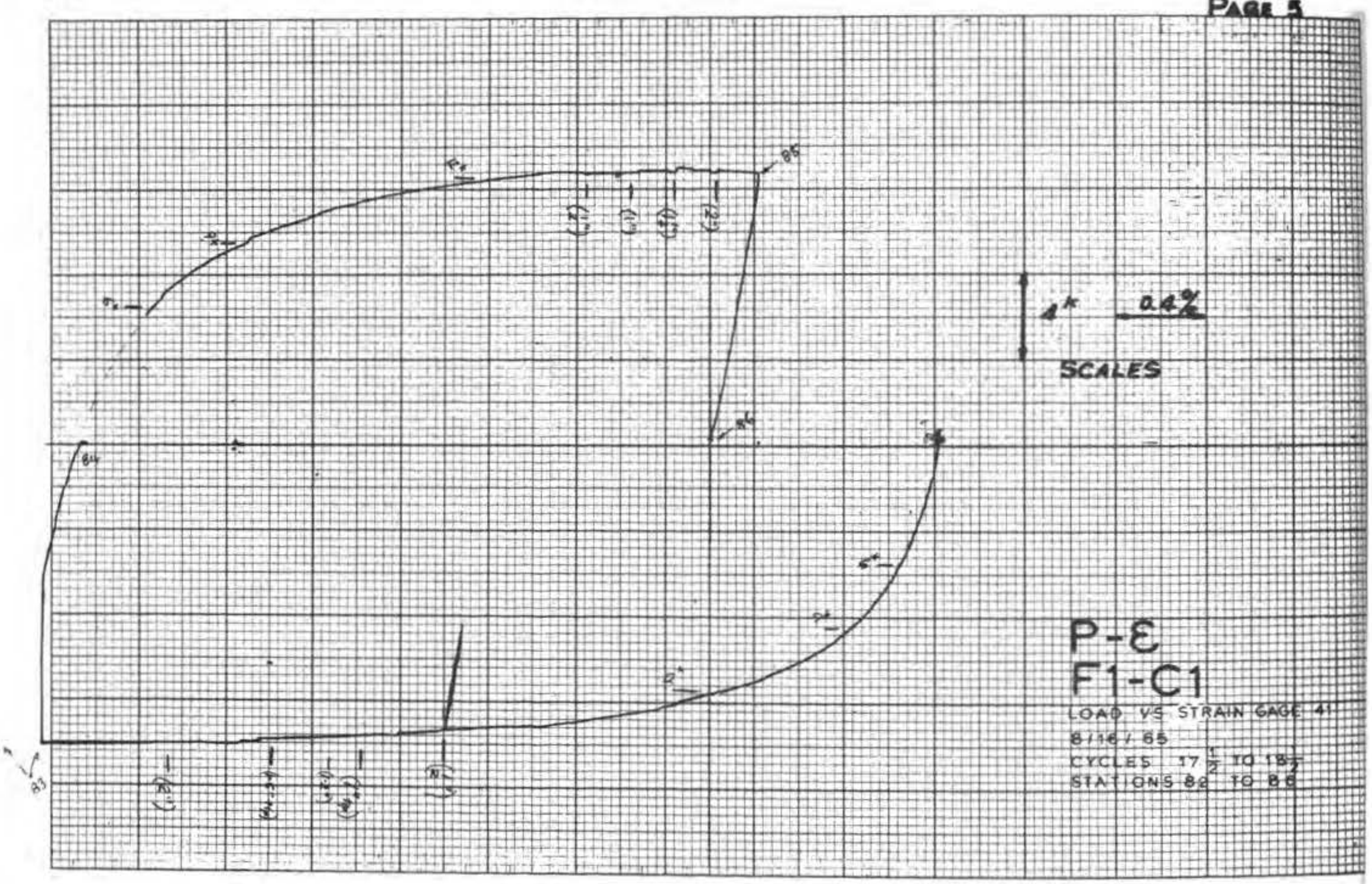


PLATE 2. (continued)



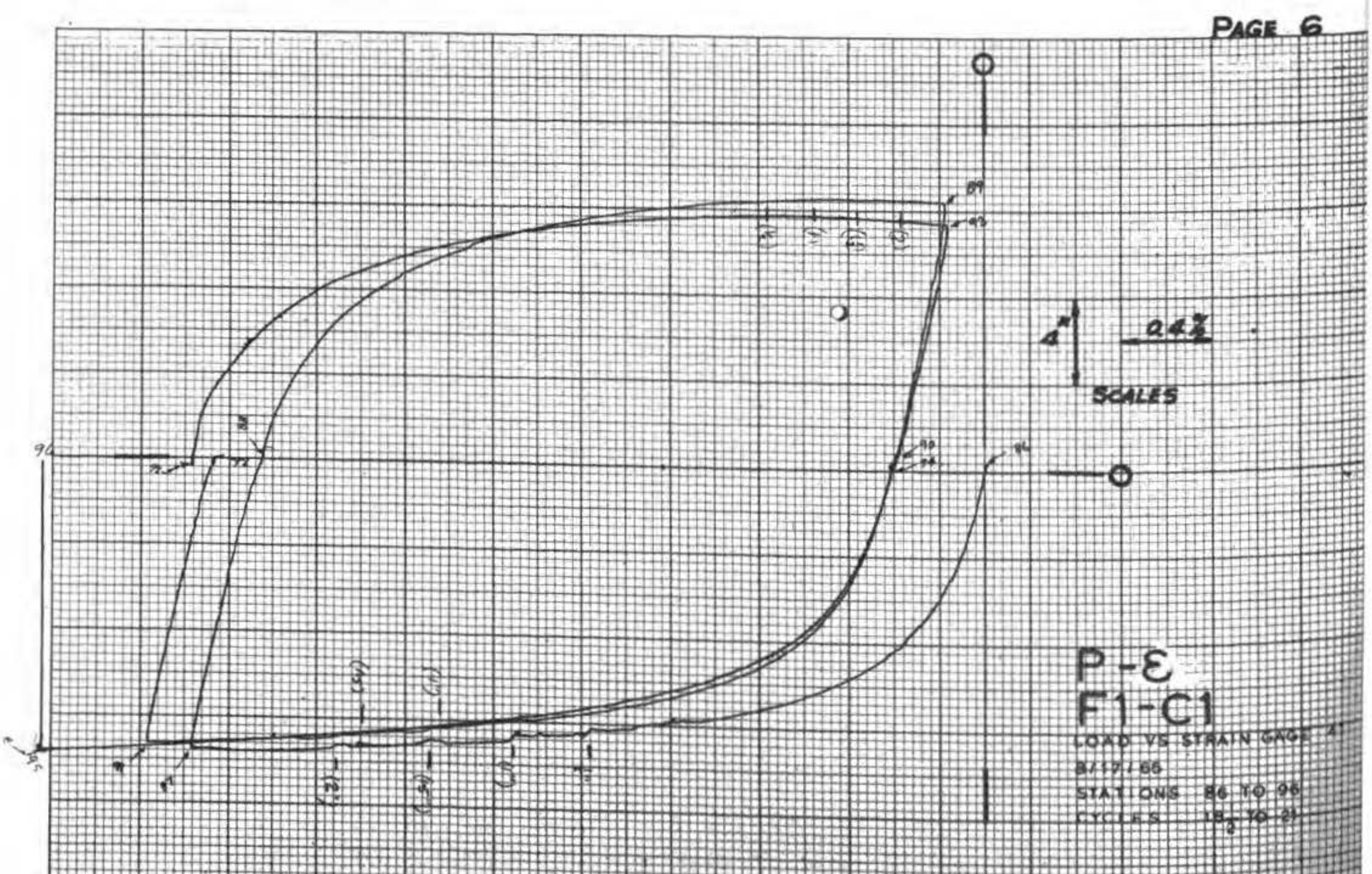


PLATE 2. (continued)

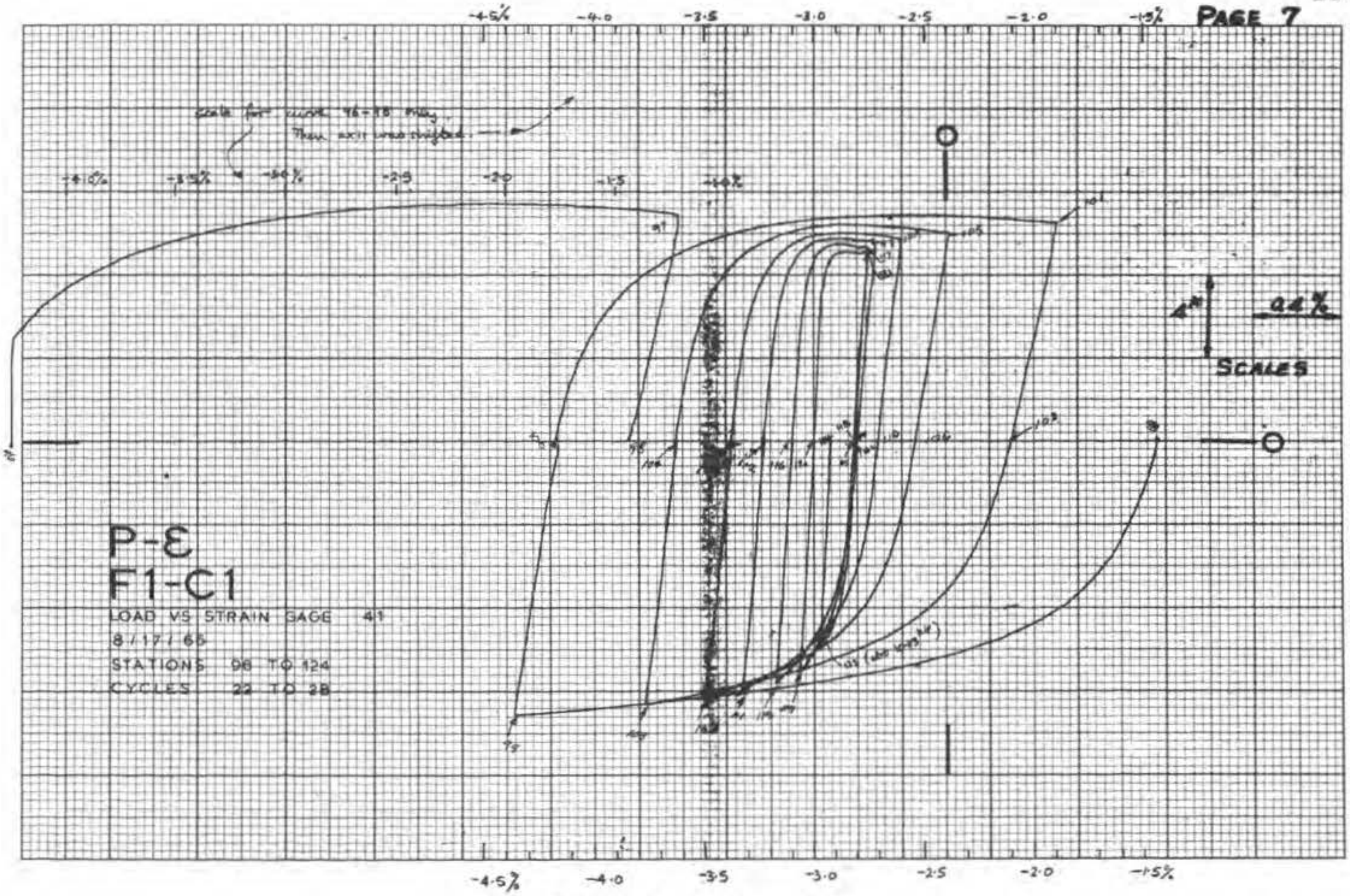


PLATE 2. (continued)

FIGURE 15. F1-C1

SPECIMEN F1-C1

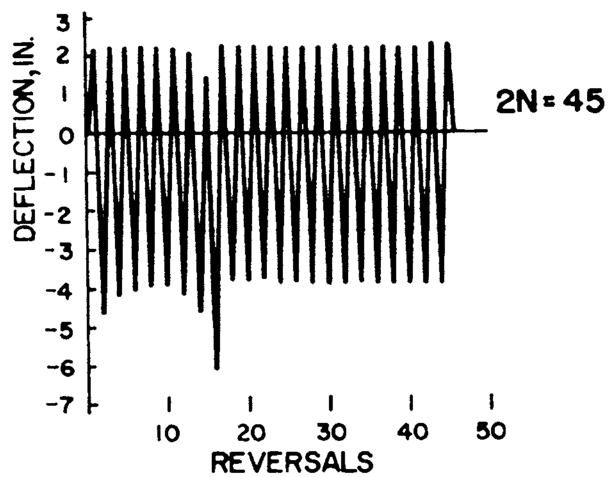
Half-Cycle	P KIPS	Δ IN.	Δ' IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$
1	11.89	1.27	0.39	1.065	2.46	0.76
2	-11.69	-0.96	0.37	-1.046	-1.86	0.71
3	12.11	1.29	0.37	1.084	2.50	0.71
4	-11.67	-0.99	0.38	-1.045	-1.91	0.73
5	12.06	1.31	0.39	1.080	2.54	0.75
6	-11.67	-1.00	0.38	-1.045	-1.93	0.73
7	12.06	1.32	0.38	1.080	2.56	0.73
8	-11.72	-1.00	0.38	-1.049	-1.93	0.73
9	12.11	1.32	0.38	1.084	2.56	0.73
10	-11.72	-1.01	0.38	-1.049	-1.95	0.73
11	13.03	2.21	1.20	1.166	4.28	2.32
12	-13.54	-2.02	2.02	-1.212	-3.91	3.90
13	13.82	2.45	2.17	1.238	4.74	4.19
14	-13.86	-1.93	2.05	-1.241	-3.73	3.96
15	13.82	2.42	2.02	1.238	4.68	3.90
16	-13.96	-1.96	2.01	-1.250	-3.79	3.88
17	13.87	2.43	2.02	1.242	4.70	3.90
18	-13.91	-1.92	2.02	-1.246	-3.71	3.90
19	13.77	2.43	2.02	1.233	4.70	3.90
20	-13.81	-1.92	2.01	-1.237	-3.71	3.88
21	14.70	3.59	3.09	1.316	6.95	5.97
22	-15.14	-3.21	4.23	-1.355	-6.21	8.18
23	14.89	3.53	4.14	1.333	6.83	8.00
24	-15.38	-3.52	4.43	-1.377	-6.81	8.56
25	14.58	2.98	3.90	1.306	5.77	7.54
26	-15.26	-3.48	3.87	-1.367	-6.73	7.48
27	14.29	2.86	3.77	1.280	5.53	7.29
28	-14.97	-3.44	3.74	-1.341	-6.65	7.23
29	13.98	2.81	3.70	1.252	5.44	7.15
30	-14.78	-3.43	3.70	-1.323	-6.63	7.15
31	13.85	3.74	4.59	1.240	7.24	8.87
32	-15.36	-3.97	5.13	-1.376	-7.68	9.92
33	13.81	4.16	5.51	1.237	8.05	10.65
34	-14.92	-3.99	5.49	-1.336	-7.72	10.62
35	12.80	4.99	6.33	1.146	9.66	12.24
36	-14.30	-2.44	6.28	-1.281	-4.72	12.14
37	12.12	4.06	6.25	1.085	7.86	12.09
38	-13.77	-2.44	6.25	-1.233	-4.72	12.09
39	12.36	4.07	6.25	1.106	7.88	12.09
40	-13.48	-2.45	4.79	-1.207	-4.74	9.26
41	11.11	4.03	5.02	0.995	7.80	9.71
42	-13.43	-3.45	6.00	-1.203	-6.67	11.60
43	10.54	5.07	5.92	0.944	9.81	11.45
44	-13.04	-3.44	5.91	-1.168	-6.65	11.43
45	10.05	5.06	5.86	0.900	9.79	11.33
46	-12.61	-3.43	5.88	-1.129	-6.63	11.37
47	9.58	5.03	5.88	0.858	9.73	11.37
48	-12.16	-1.45	5.92	-1.089	-2.80	11.45
49	9.25	5.06	5.92	0.828	9.79	11.45
50	-11.89	-3.45	5.93	-1.065	-6.67	11.47
51	8.99	5.06	5.98	0.805	9.79	11.56

Half-Cycle	P KIPS	Δ IN.	Δ' IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$
52	−11.65	−3.44	6.00	−1.043	−6.65	11.60
53	8.85	5.06	5.95	0.793	9.79	11.51
54	−11.12	−3.44	5.95	−0.996	−6.65	11.51
55	8.61	5.07	5.95	0.771	9.81	11.51
56	−10.44	−3.47	5.75	−0.935	−6.71	11.12

SPECIMEN F1-C2

Description: This specimen was similar to specimen F1-C1 in detailing, fabrication and inspection.

Program of Cycling:



Test Control: Strain, as measured on the top flange 5.50 inches from the column face.

Raw Data Included: Graphical load-control strain data
Graphical load-deflection data

Total Energy Absorption: 2,411 kip-inches.

Plastic Load Reversals to Failure: 45 ($22\frac{1}{2}$ cycles).

Remarks: Plastic buckling of both flanges was visible after the first inelastic cycle. A small crack was noted in the top flange weld after three cycles. Buckling of the top flange was severe after 5 cycles and the web began to buckle with the top flange at about 7 cycles. The bottom flange and web showed similar distortion by the time $8\frac{1}{2}$ cycles had been applied. A crack was found at the bottom cope after 15 cycles.

A similar crack was noted in the top cope after $18\frac{1}{2}$ cycles. These cracks propagated, until the bottom flange cracked through, causing failure after $22\frac{1}{2}$ cycles.

SPECIMEN TYPE F1-C2

DIMENSIONS OF WF SECTION

DEPTH	8.36	INCHES
TOP FLANGE WIDTH	5.160	INCHES
BOTTOM FLANGE WIDTH	5.160	INCHES
TOP FLANGE THICKNESS	0.375	INCHES
BOTTOM FLANGE THICKNESS	0.366	INCHES
WEB THICKNESS	0.276	INCHES
ELASTIC MODULUS	29000.	KSI
YIELD STRESS	40.500	KSI

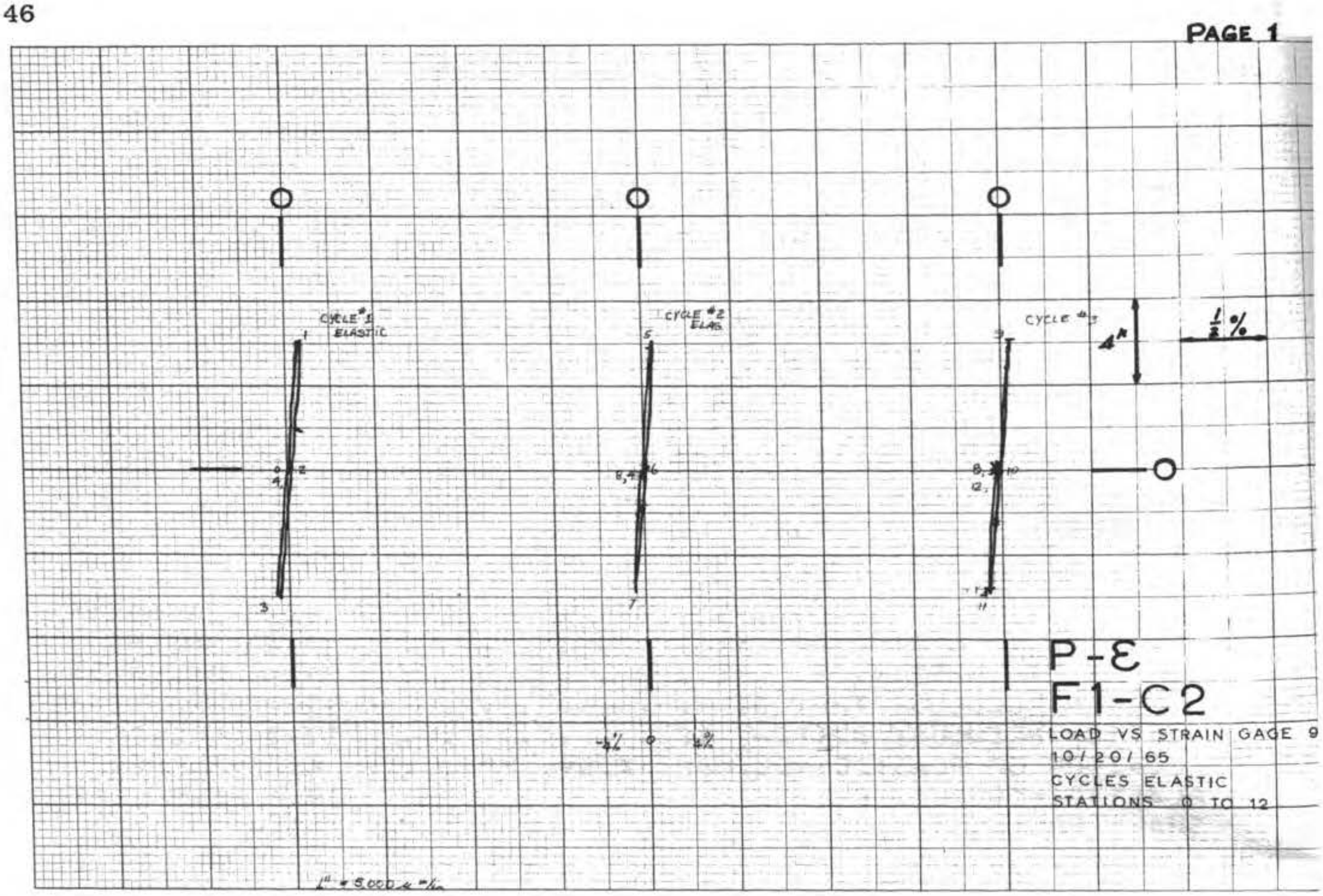
WF SECTION PROPERTIES

AREA, A	6.01	INCHES**2
LOCATION OF CENTROID*, YE	4.21	INCHES
MOMENT OF INERTIA, I	72.4	INCHES**4
SECTION MODULUS, TOP, ST	17.4	INCHES**3
SECTION MODULUS, BOTTOM, SB	17.2	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP	4.26	INCHES
PLASTIC MODULUS, Z	19.6	INCHES**3
SHAPE FACTOR	1.139	
YIELD MOMENT, MY	58.06	KIP-FT.
PLASTIC MOMENT, MP	66.14	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

BEAM PROPERTIES

LENGTH, L	66.0	INCHES
ELASTIC STIFFNESS, P/DELTA	21.90	KIPS/IN.
YIELD DEFLECTION, DELTAY	0.482	INCHES
YIELD LOAD, PY	10.56	KIPS
PLASTIC LOAD, PP	12.02	KIPS



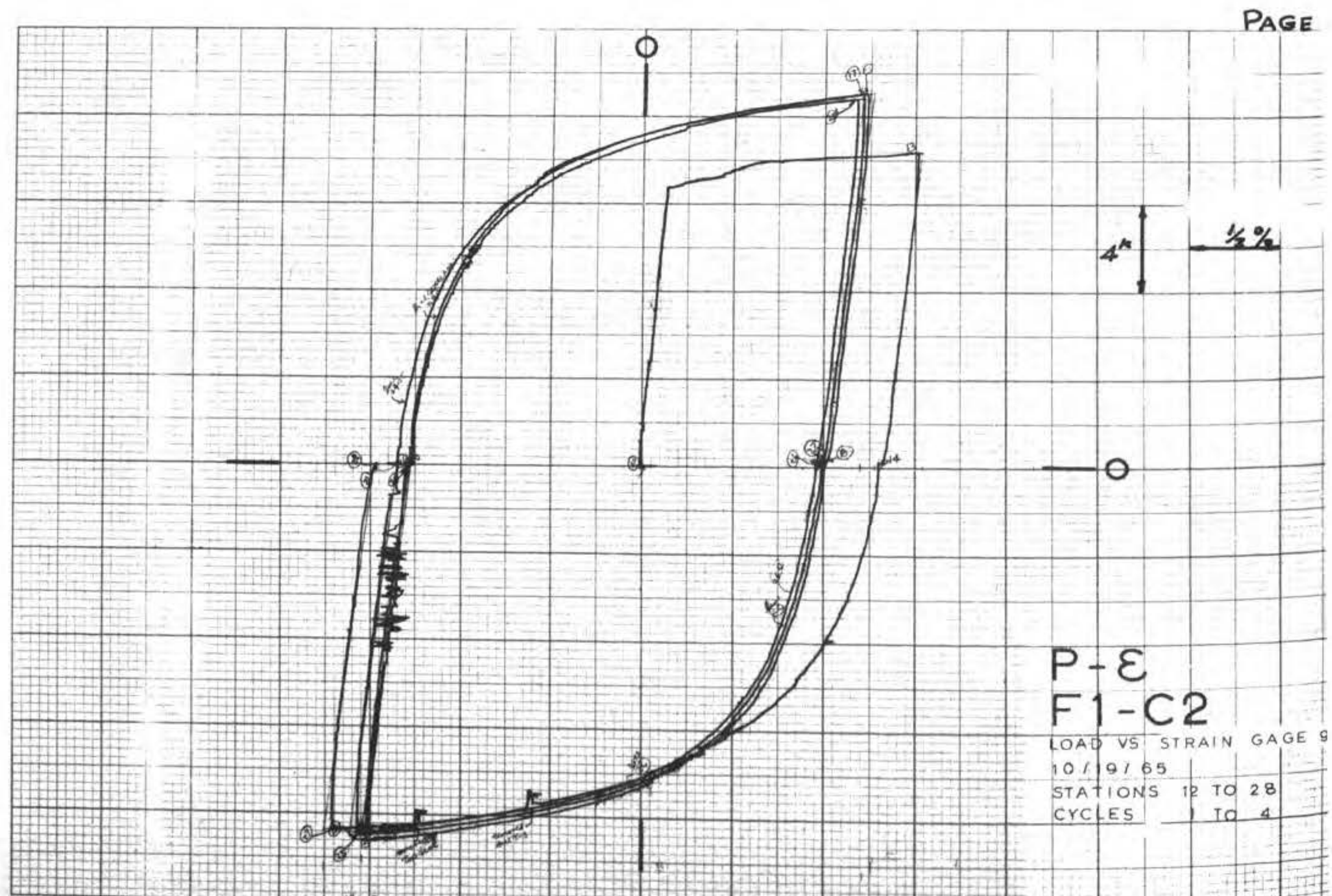
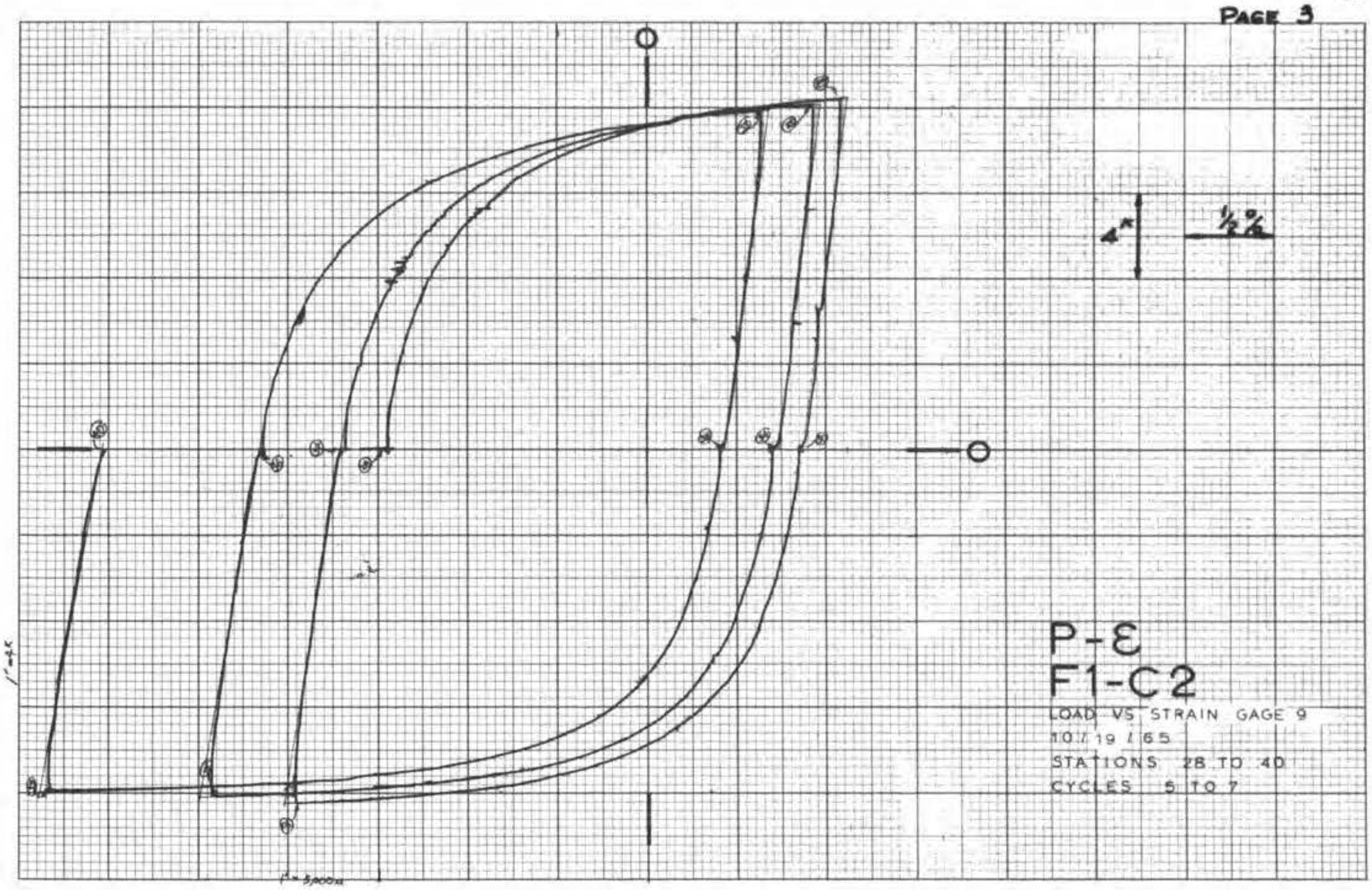


PLATE 3. LOAD VS. STRAIN - F1-C2



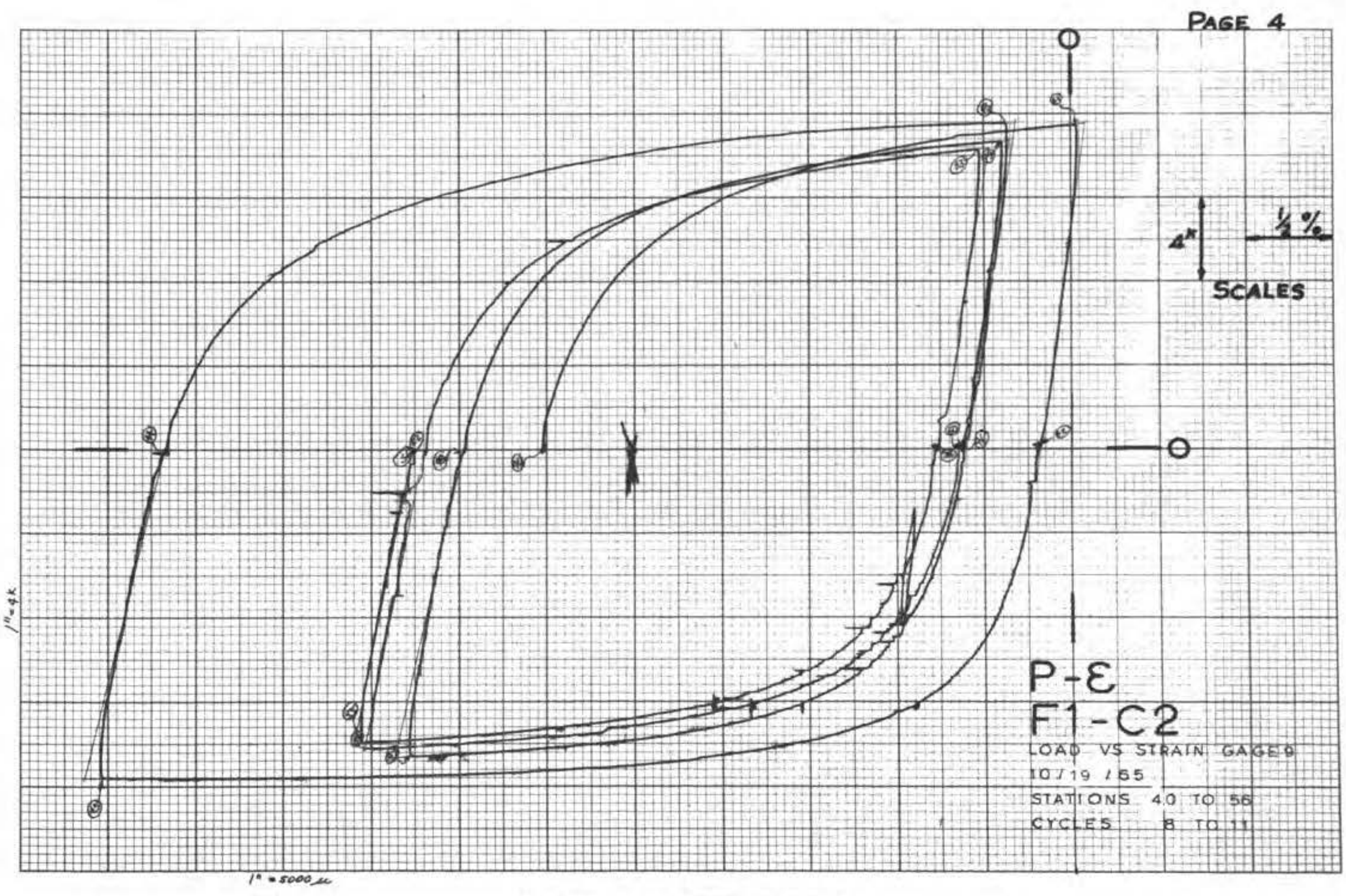


PLATE 3. (continued)

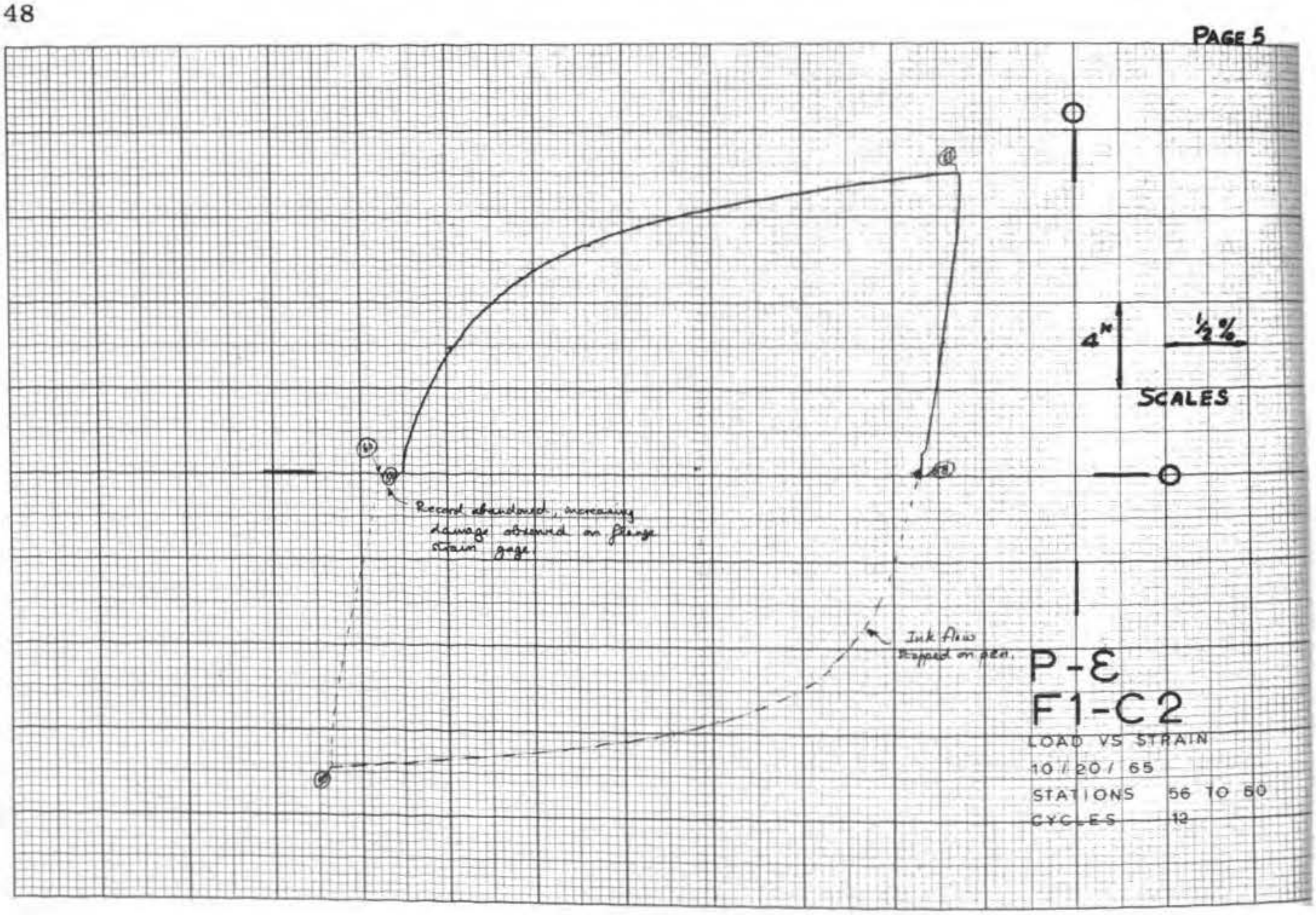
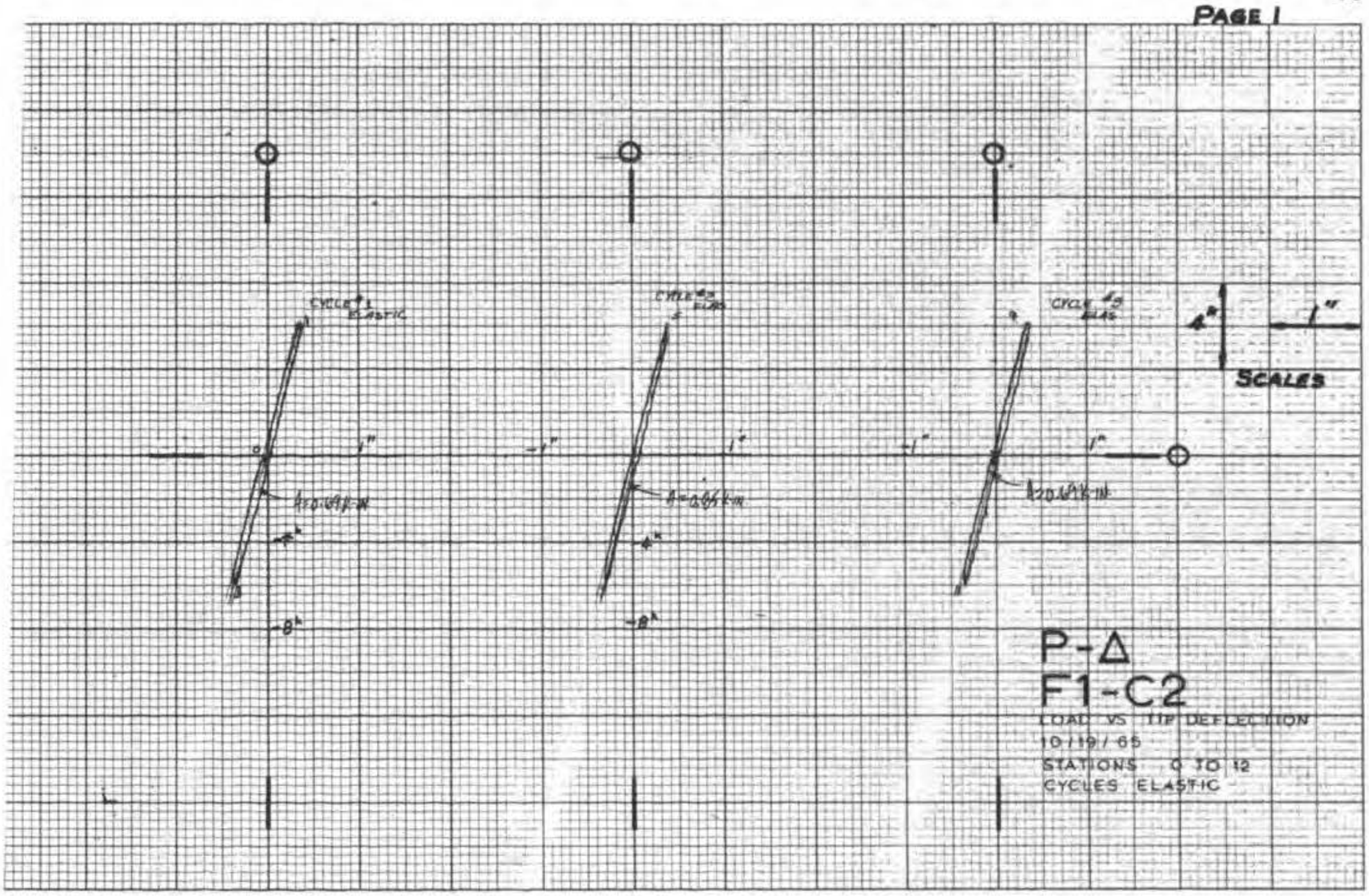


PLATE 3. (continued)



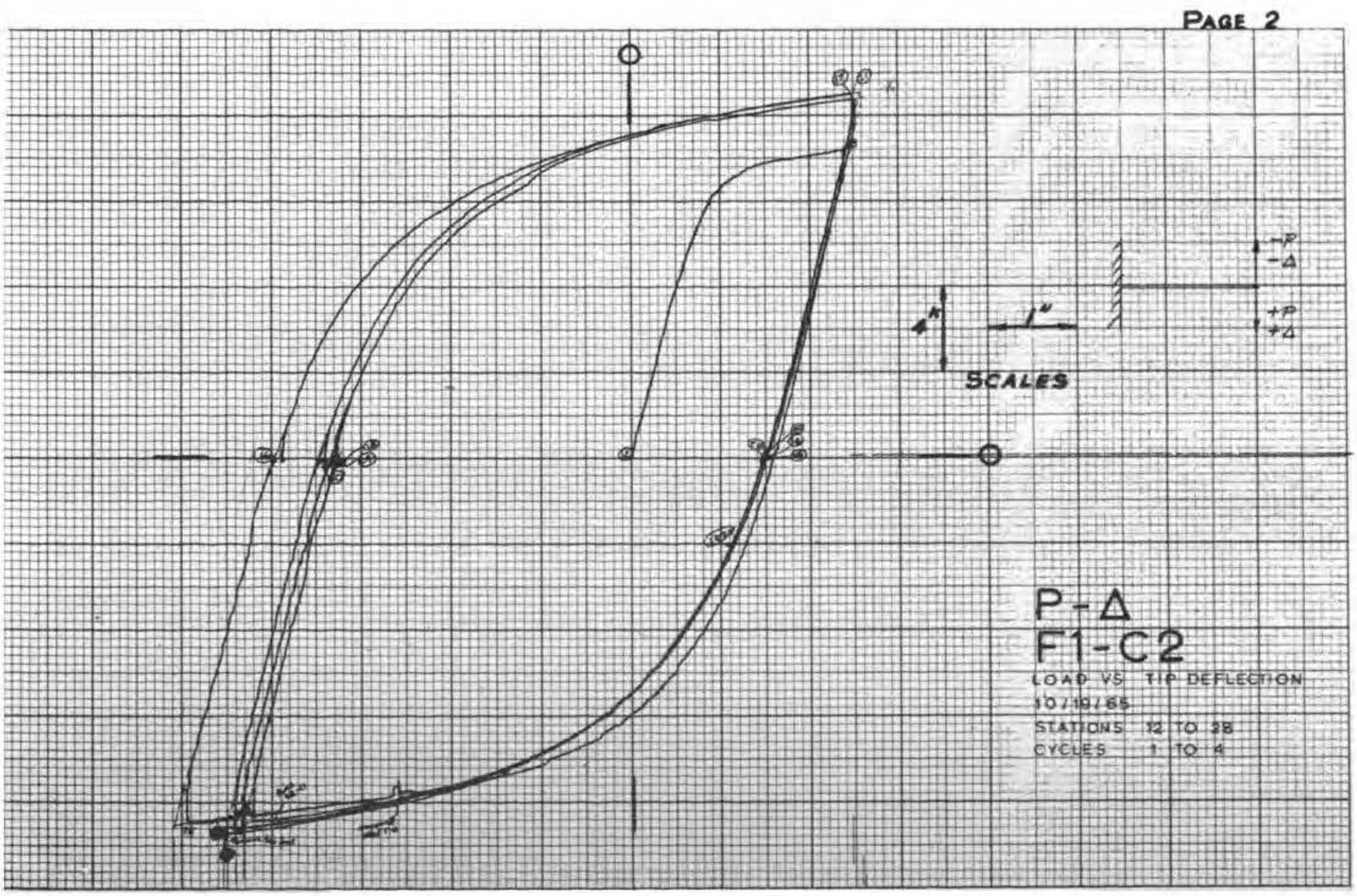
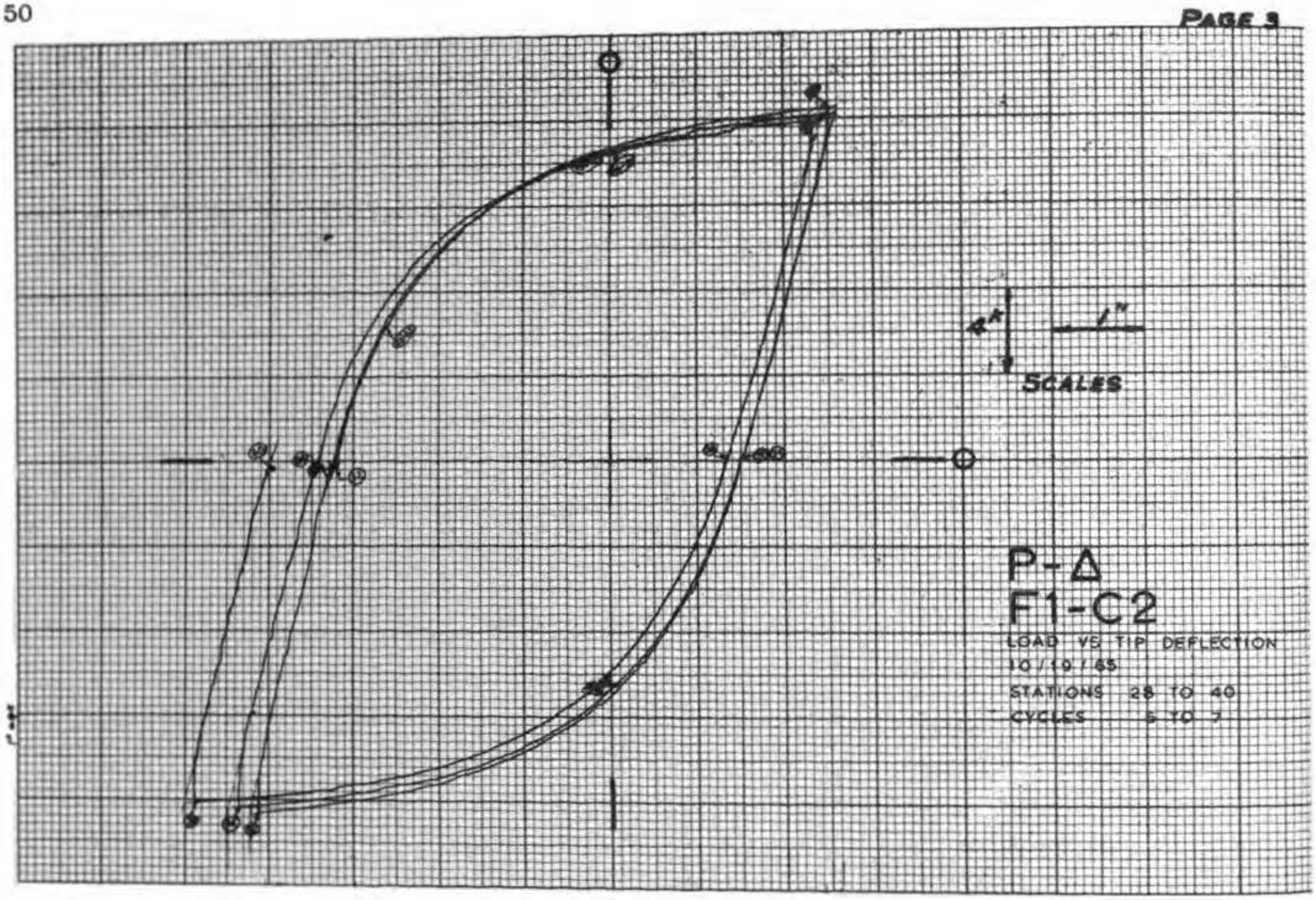


PLATE 4. LOAD VS. DEFLECTION - F1-C2



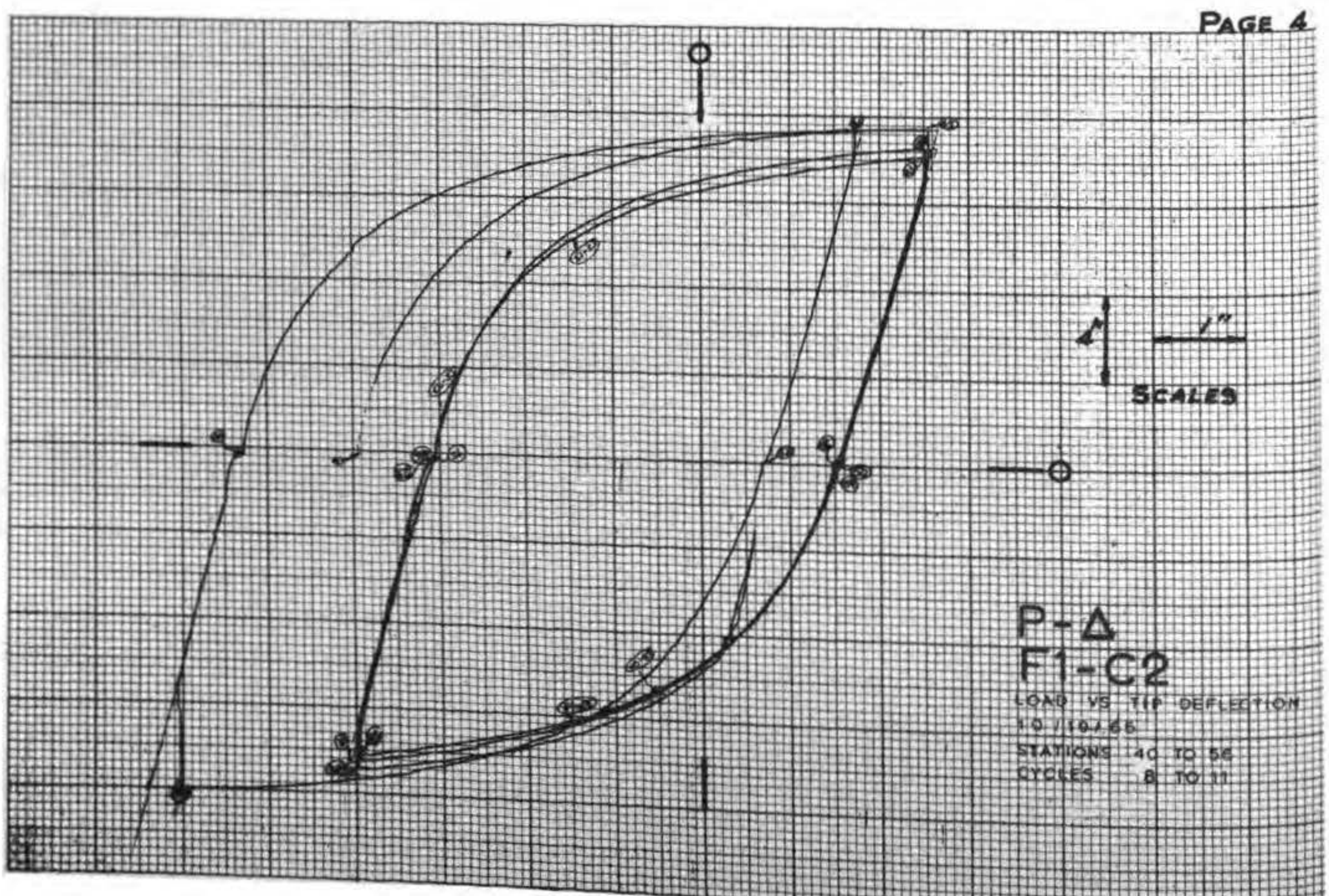
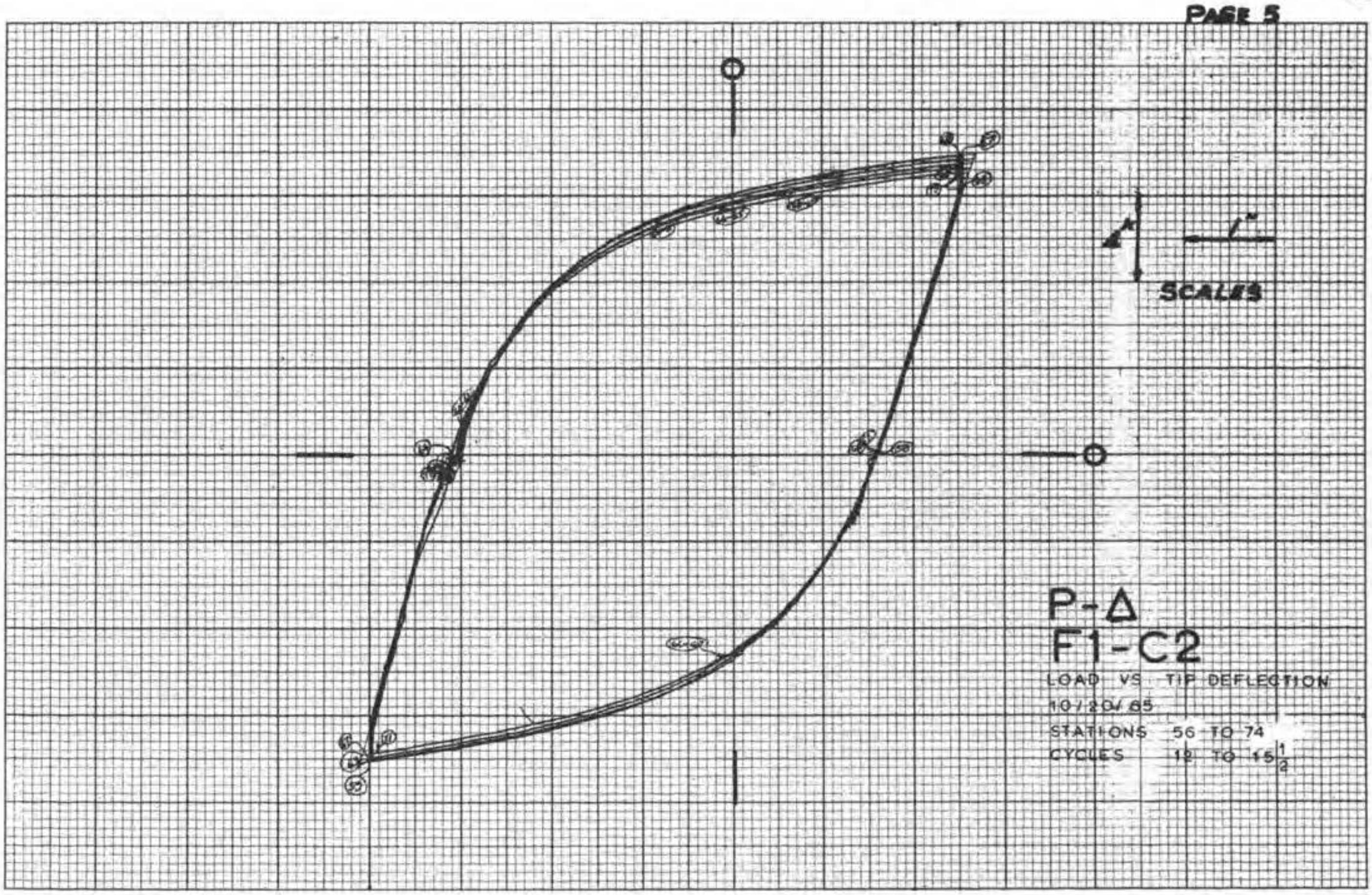


PLATE 4. (continued)



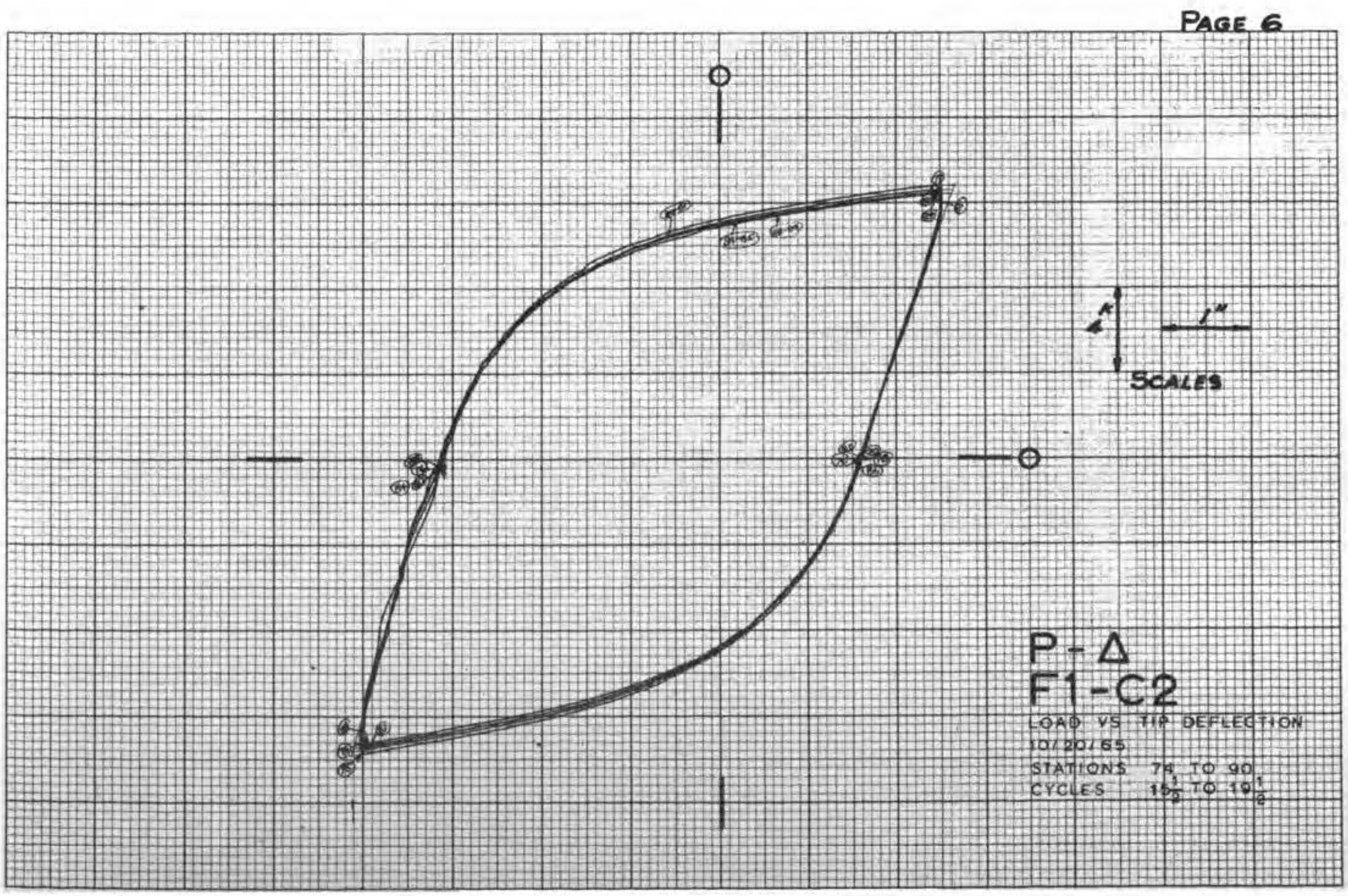


PLATE 4. (continued)

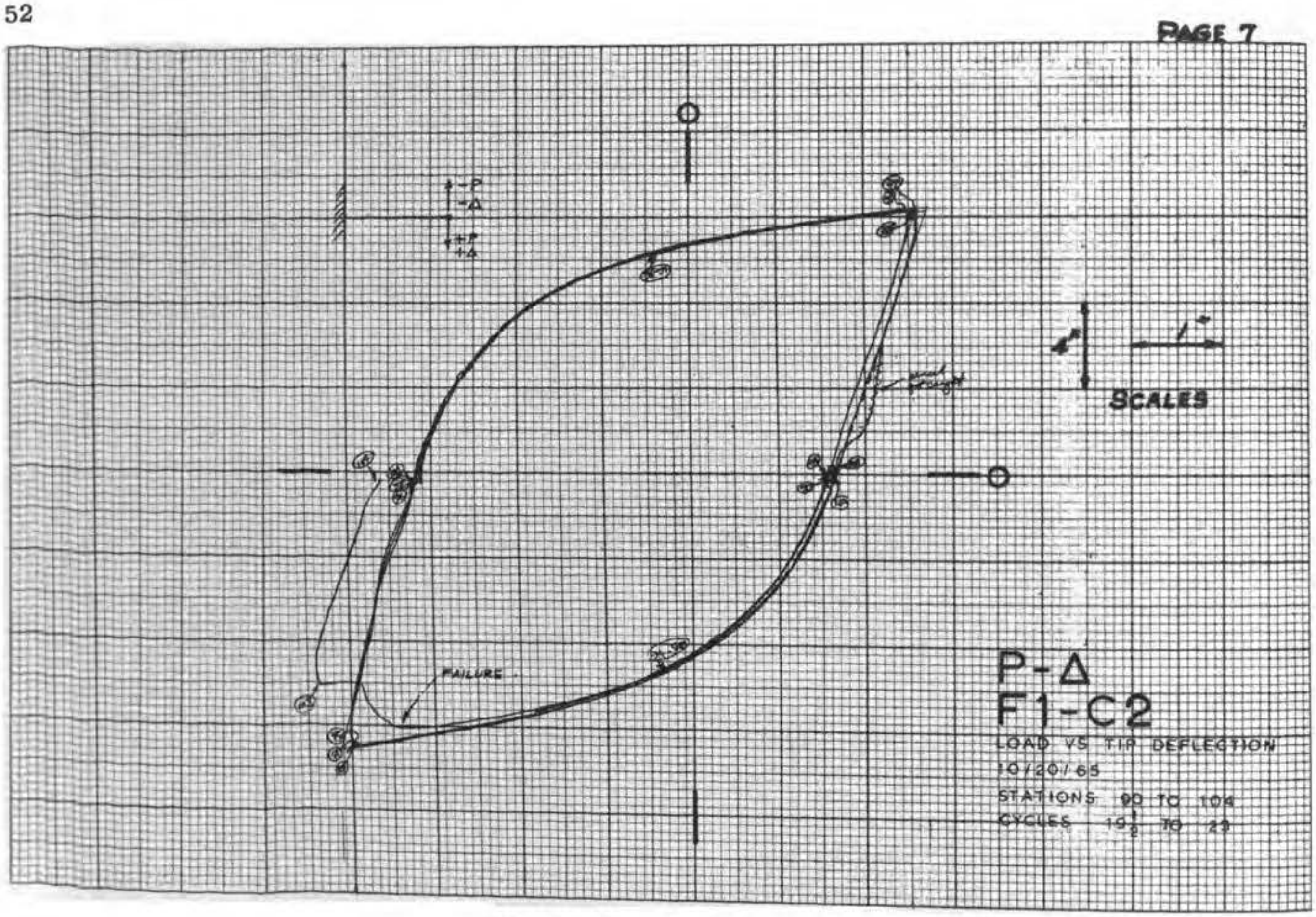


PLATE 4. (continued)

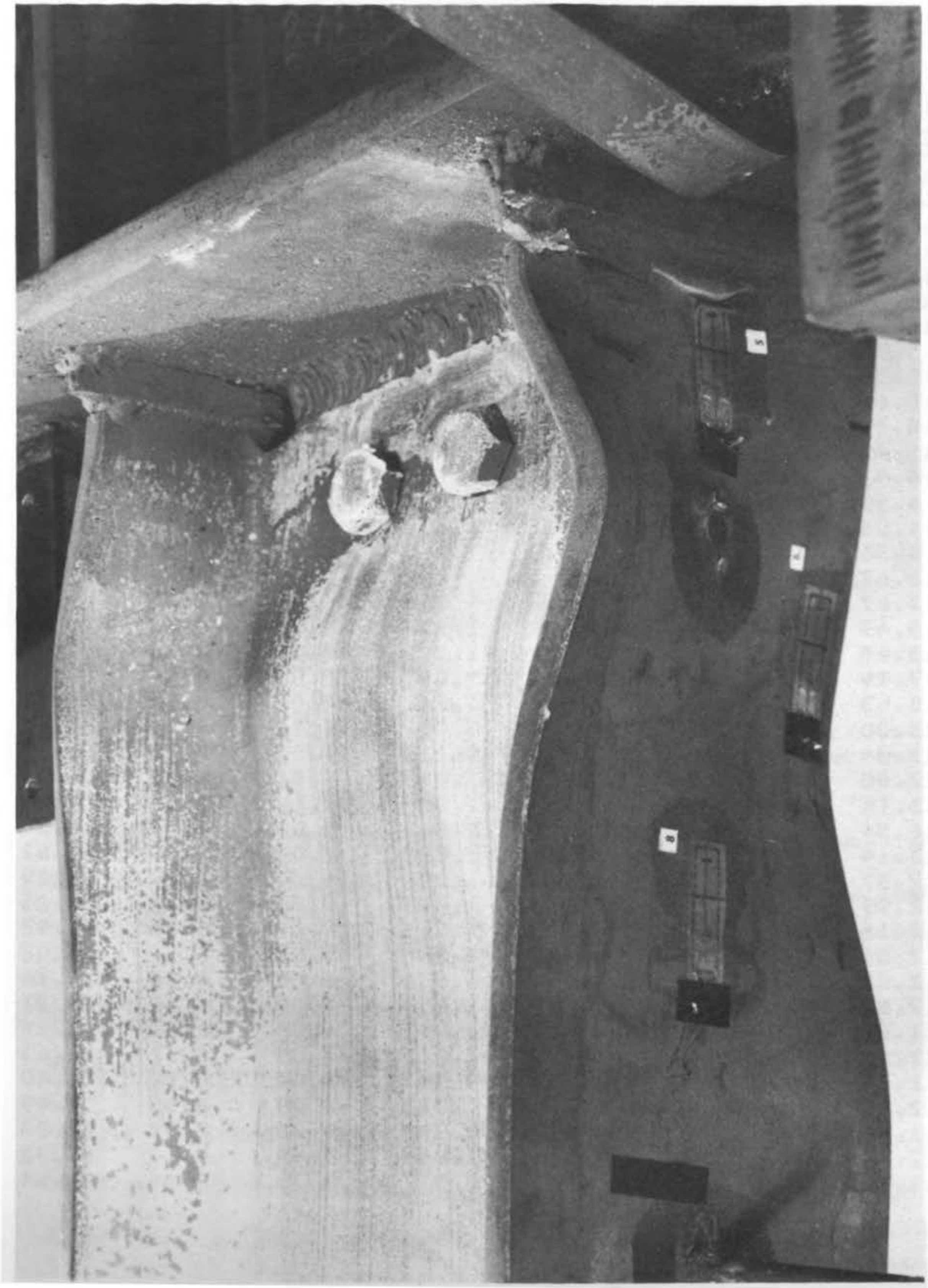


FIGURE 16. F1-C2

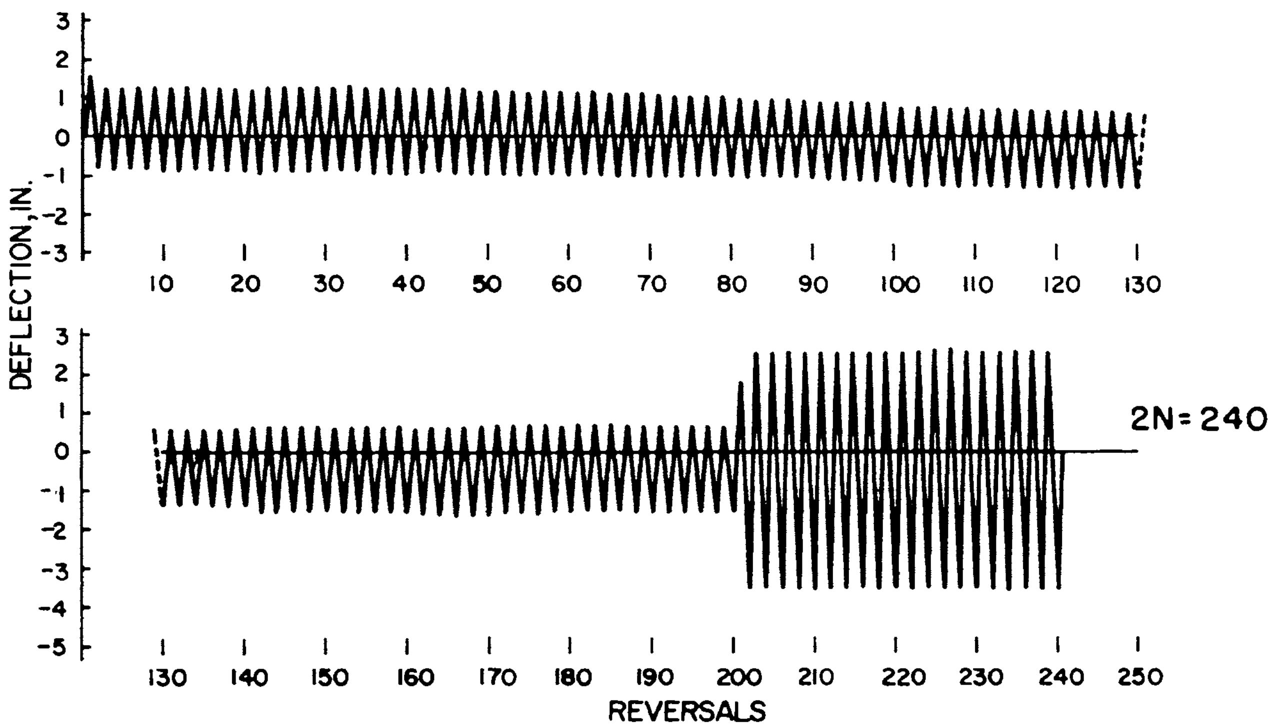
SPECIMEN F1-C2

Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	13.80	2.16	1.47	18.9	1.148	3.93	2.67	5.73
2	-16.55	-4.67	5.42	76.4	-1.377	-8.50	9.87	23.17
3	16.45	2.22	5.39	70.8	1.368	4.05	9.83	21.45
4	-16.98	-4.14	4.89	66.1	-1.412	-7.54	8.92	20.05
5	16.40	2.22	4.89	64.9	1.364	4.05	8.92	19.66
6	-16.69	-4.04	4.74	66.0	-1.388	-7.37	8.64	20.00
7	16.16	2.26	4.76	63.0	1.344	4.11	8.68	19.08
8	-16.39	-3.94	4.70	62.4	-1.364	-7.17	8.57	18.93
9	15.89	2.20	4.67	61.4	1.322	4.01	8.51	18.61
10	-16.09	-3.89	4.70	61.4	-1.338	-7.09	8.57	18.63
11	15.58	2.20	4.70	59.4	1.296	4.00	8.57	18.00
12	-15.79	-4.14	4.85	63.0	-1.314	-7.53	8.84	19.09
13	15.26	2.03	4.68	59.2	1.270	3.70	8.53	17.96
14	-15.60	-4.67	5.26	68.2	-1.298	-8.51	9.59	20.69
15	14.83	1.44	4.64	57.6	1.234	2.62	8.46	17.46
16	-15.41	-6.09	5.95	77.7	-1.282	-11.10	10.83	23.55
17	14.93	2.27	6.75	87.1	1.242	4.13	12.29	26.41
18	-14.35	-3.79	4.51	52.0	-1.194	-6.90	8.22	15.76
19	14.06	2.24	4.53	53.1	1.170	4.09	8.26	16.11
20	-13.96	-3.80	4.56	49.9	-1.162	-6.93	8.32	15.13
21	13.67	2.25	4.54	51.1	1.137	4.10	8.28	15.49
22	-13.67	-3.77	4.51	48.4	-1.137	-6.87	8.23	14.68
23	13.43	2.24	4.54	49.9	1.117	4.09	8.28	15.11
24	-13.48	-3.86	4.63	49.2	-1.122	-7.04	8.44	14.91
25	13.19	2.23	4.63	49.2	1.097	4.06	8.44	14.92
26	-13.43	-3.85	4.56	48.5	-1.117	-7.02	8.32	14.71
27	13.00	2.23	4.56	48.3	1.082	4.06	8.32	14.64
28	-13.34	-3.86	4.56	47.5	-1.110	-7.04	8.32	14.41
29	12.80	2.23	4.56	47.6	1.065	4.07	8.32	14.43
30	-13.14	-3.86	4.56	47.6	-1.093	-7.03	8.32	14.44
31	12.56	2.24	4.56	46.5	1.045	4.07	8.32	14.09
32	-13.14	-3.89	4.66	47.9	-1.093	-7.09	8.50	14.51
33	12.37	2.22	4.67	46.8	1.029	4.04	8.52	14.19
34	-12.95	-3.87	4.64	47.0	-1.078	-7.06	8.46	14.25
35	12.18	2.22	4.64	45.9	1.013	4.05	8.46	13.92
36	-12.81	-3.89	4.63	46.2	-1.066	-7.08	8.44	14.02
37	12.03	2.22	4.63	45.4	1.001	4.05	8.44	13.76
38	-12.66	-3.89	4.62	45.5	-1.053	-7.09	8.42	13.81
39	11.98	2.23	4.60	45.0	0.997	4.05	8.39	13.64
40	-12.52	-3.89	4.67	45.0	-1.042	-7.09	8.52	13.63
41	11.79	2.22	4.66	44.2	0.981	4.04	8.50	13.40
42	-12.47	-3.89	4.66	44.5	-1.038	-7.09	8.50	13.49
43	11.89	2.31	4.76	45.3	0.989	4.20	8.68	13.73
44	-12.42	-3.89	4.76	45.3	-1.033	-7.09	8.68	13.72
45	11.74	2.30	4.76	44.7	0.977	4.19	8.68	13.54

SPECIMEN F1-C3

Description: This specimen was similar to specimen F1-C1 in detailing, fabrication and inspection.

Program of Cycling:



Test Control: Strain, as measured on the top flange 5.52 inches from the column face. The strain was read on a Baldwin SR-4 strain indicator.

Raw Data Included: Graphical load-deflection data.

Total Energy Absorption: 3,734 kip-inches.

Plastic Load Reversals to Failure: 240 (120 cycles).

Remarks: One hundred cycles were applied to the specimen in the range ±0.5% strain without any apparent damage. There was but a hint of flange buckling as visually observed. The strain range was then increased to ±1.5%. After the first cycle in this range (i.e., after 101 plastic cycles) both flanges had developed distinct buckles. Fine cracks appeared at the ends of the top flange weld, and after 102 cycles, similar cracks were found in the bottom flange weld. After 106 cycles a fine crack was observed in the bottom flange at the web cope; by the 110th cycle, this crack was enlarging. At this time similar cracks were discovered in the top flange. Failure finally occurred after the 120th cycle when the latter cracks propagated through the top flange.

SPECIMEN TYPE F1-C3

DIMENSIONS OF WF SECTION

DEPTH	8.26 INCHES
TOP FLANGE WIDTH	5.160 INCHES
BOTTOM FLANGE WIDTH	5.160 INCHES
TOP FLANGE THICKNESS	0.373 INCHES
BOTTOM FLANGE THICKNESS	0.369 INCHES
WEB THICKNESS	0.272 INCHES
ELASTIC MODULUS	29000. KSI
YIELD STRESS	40.500 KSI

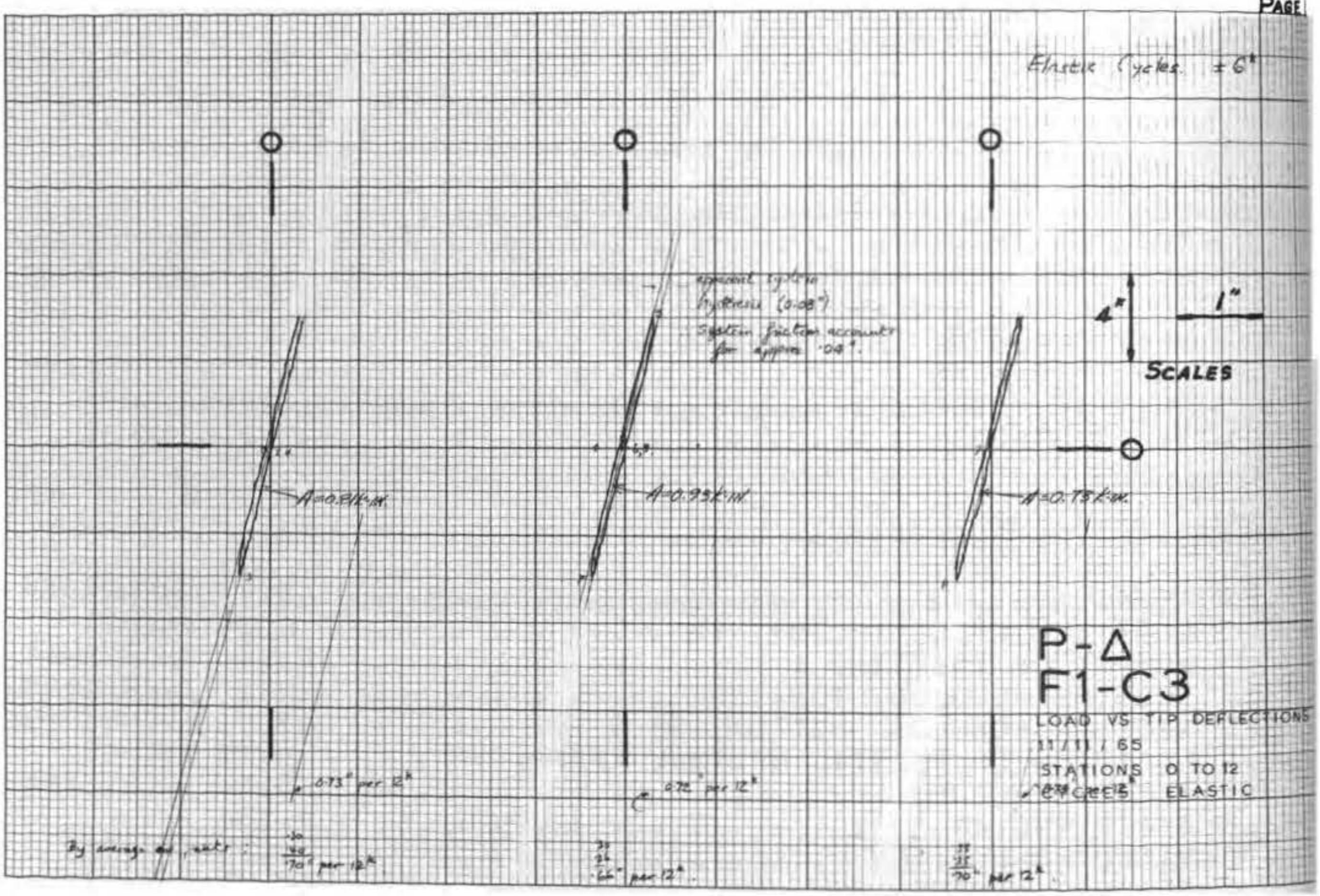
WF SECTION PROPERTIES

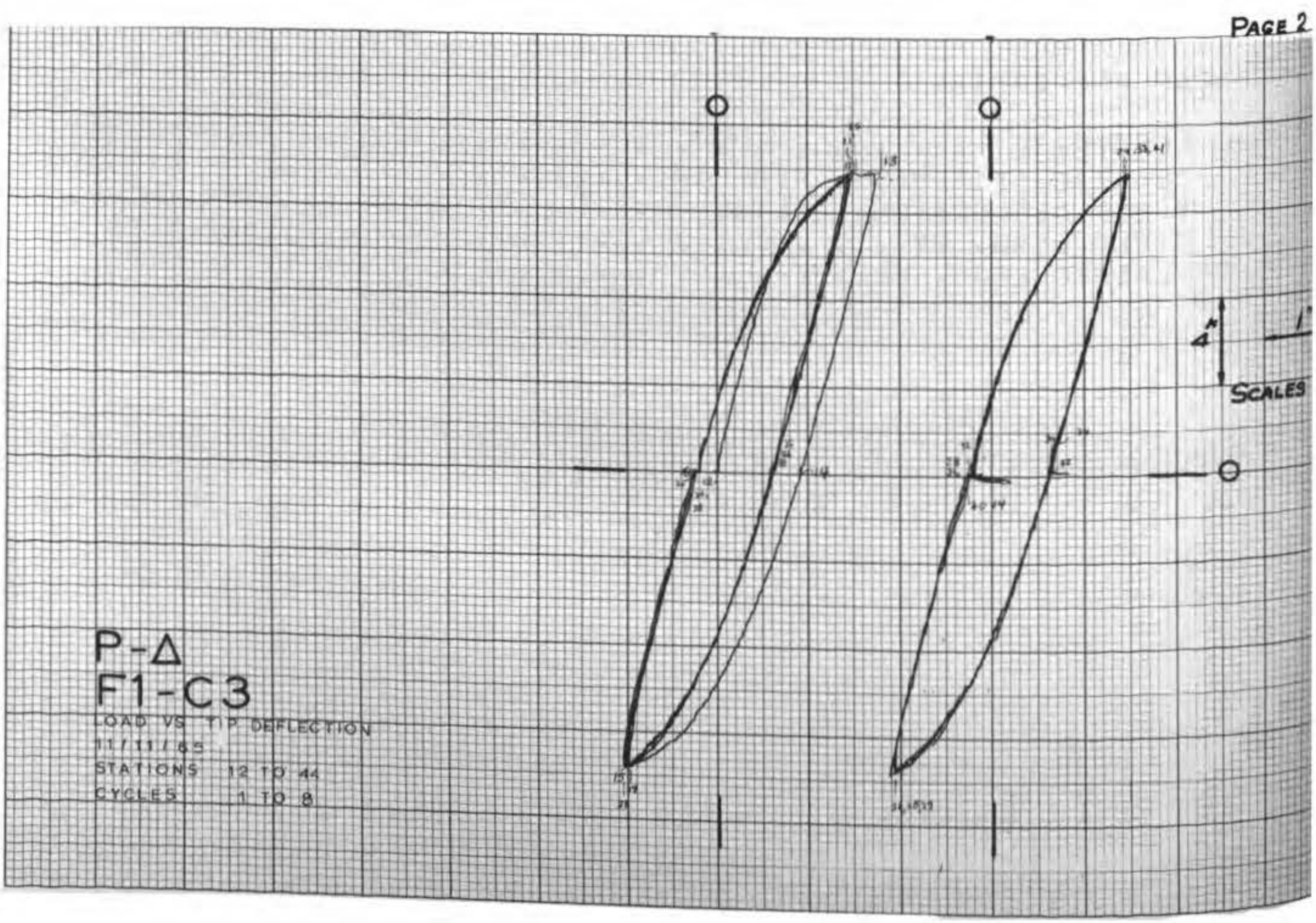
AREA, A	5.96 INCHES**2
LOCATION OF CENTROID*, YE	4.14 INCHES
MOMENT OF INERTIA, I	70.4 INCHES**4
SECTION MODULUS, TOP, ST	17.1 INCHES**3
SECTION MODULUS, BOTTOM, SB	17.0 INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP	4.17 INCHES
PLASTIC MODULUS, Z	19.3 INCHES**3
SHAPE FACTOR	1.134
YIELD MOMENT, MY	57.34 KIP-FT.
PLASTIC MOMENT, MP	65.01 KIP-FT.

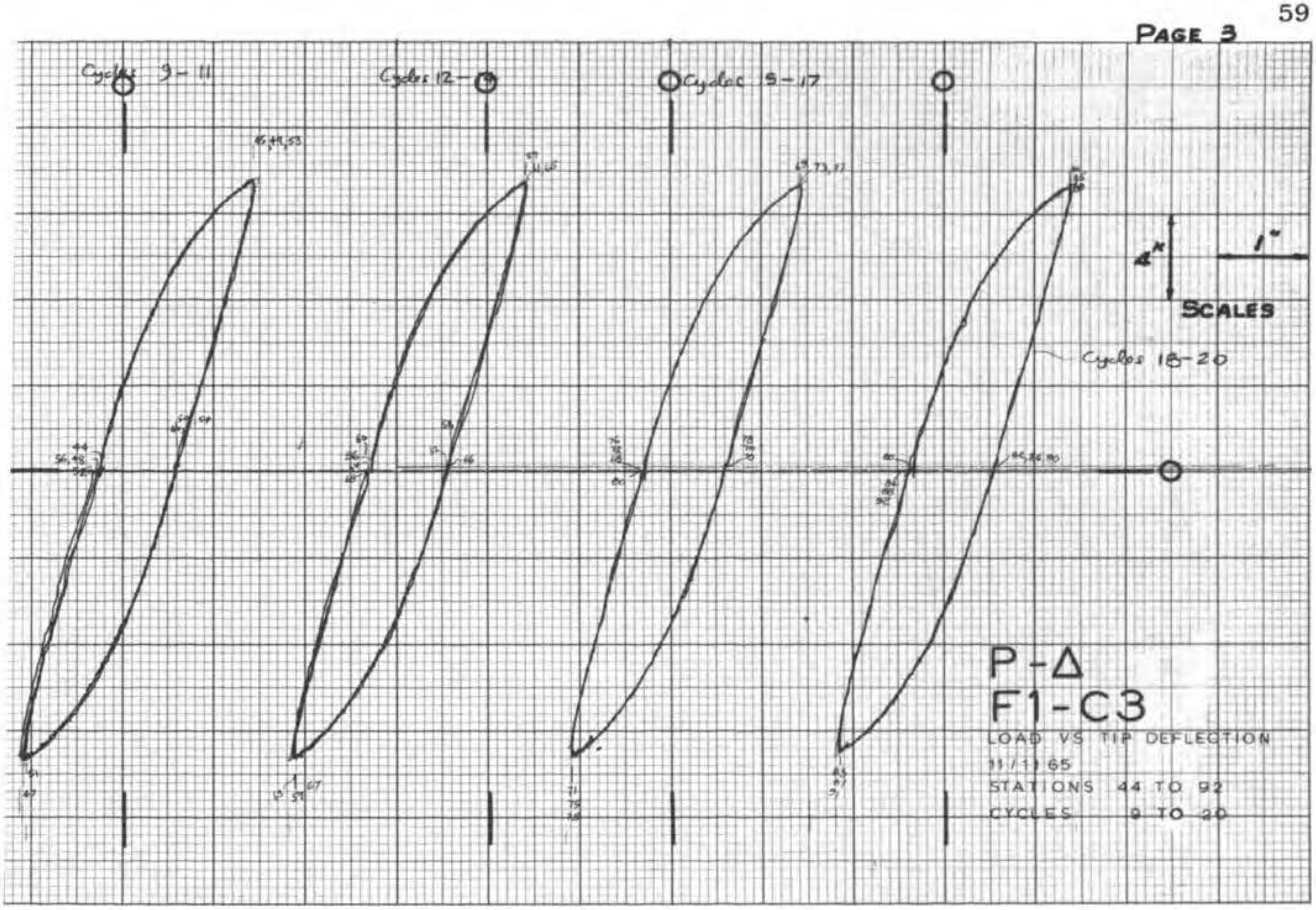
*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

BEAM PROPERTIES

LENGTH, L	66.0 INCHES
ELASTIC STIFFNESS, P/DELTA	21.30 KIPS/IN.
YIELD DEFLECTION, DELTAY	0.489 INCHES
YIELD LOAD, PY	10.42 KIPS
PLASTIC LOAD, PP	11.82 KIPS


PAGE 1
Elastic Cycles ± 6"
apparent system hysteresis (0.08")
System friction accounts for approx. ·08".
4"
1"
SCALES
A=0.81k·in.
A=0.93k·in.
A=0.75k·in.
P-Δ
F1-C3
LOAD VS TIP DEFLECTIONS
11/11/65
STATIONS 0 TO 12
CYCLES ELASTIC
.73" per 12k
.72" per 12k
.70" per 12k
.66" per 12k
.70" per 12k


PAGE 2
4"
1"
SCALES
P-Δ
F1-C3
LOAD VS TIP DEFLECTION
11/11/65
STATIONS 12 TO 44
CYCLES 1 TO 8



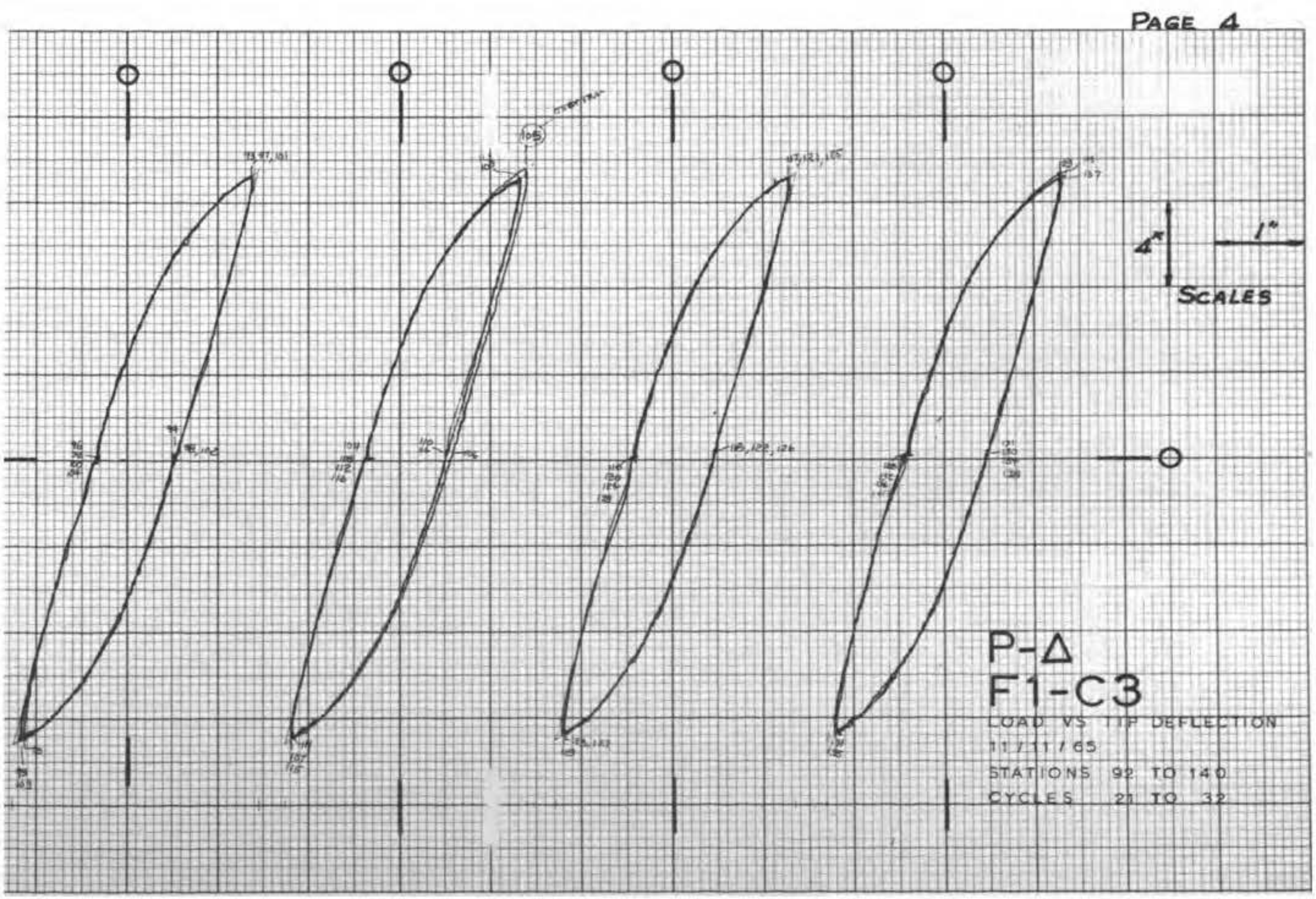
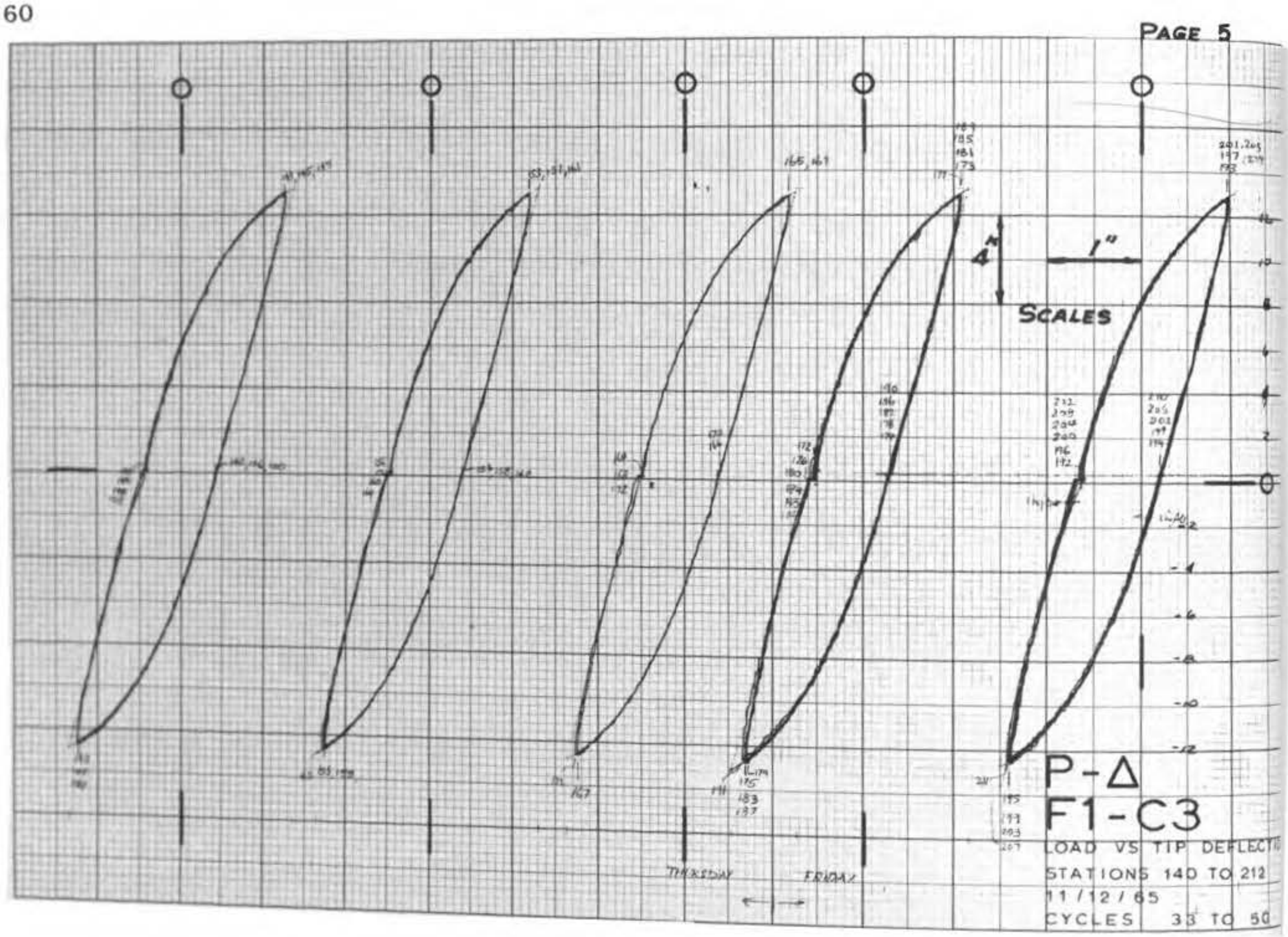


PLATE 5. (continued)



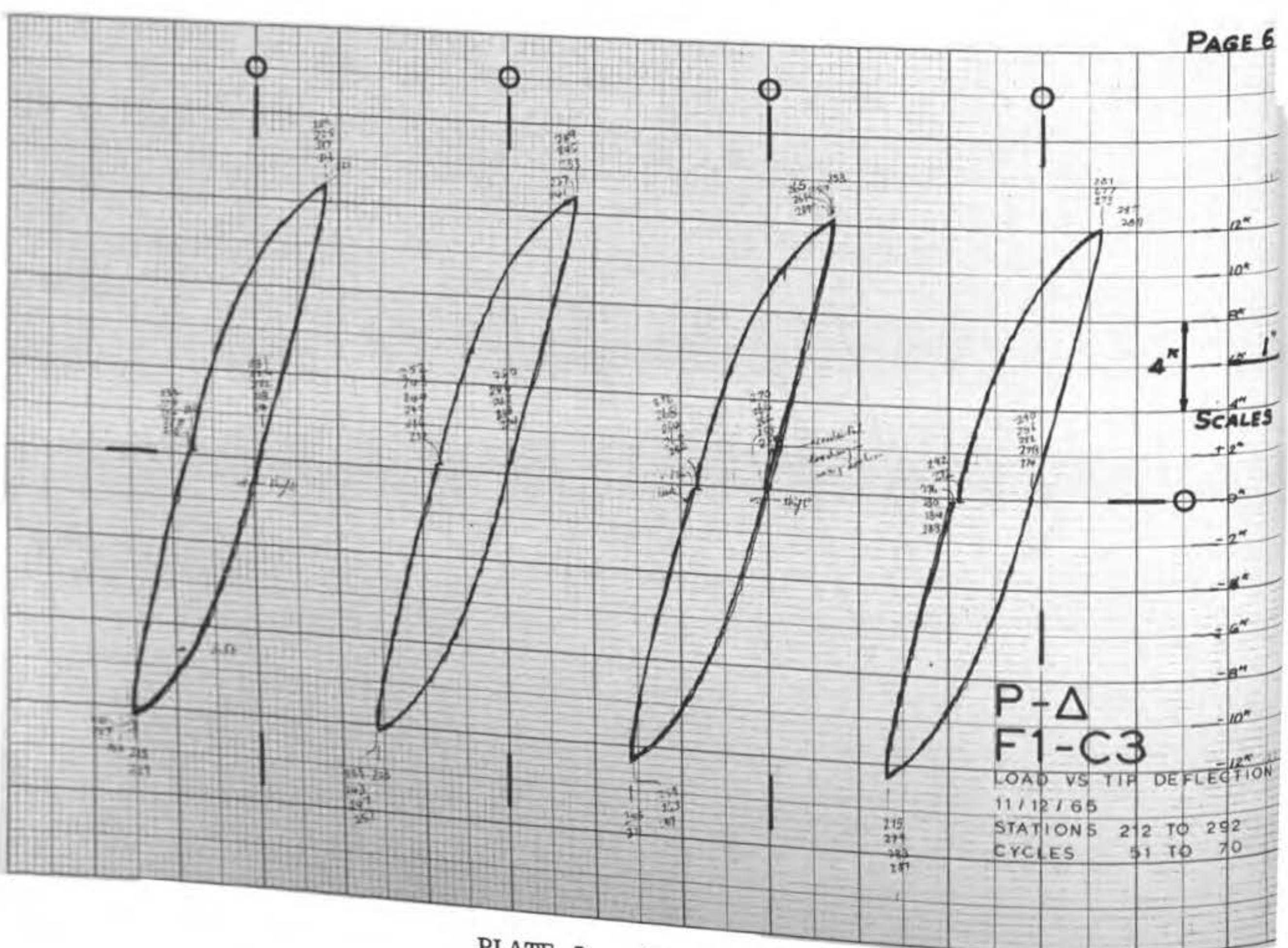
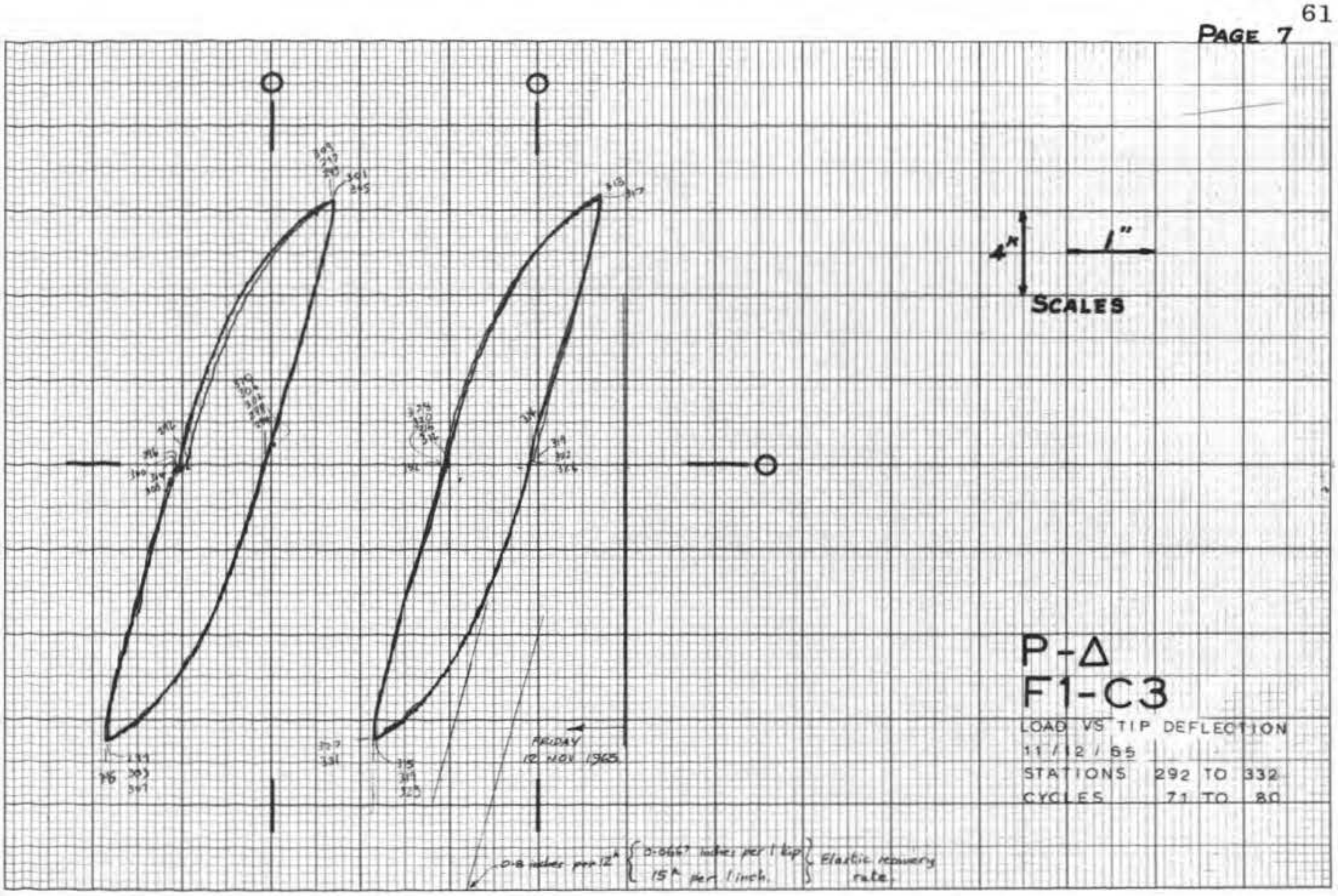


PLATE 5. (continued)



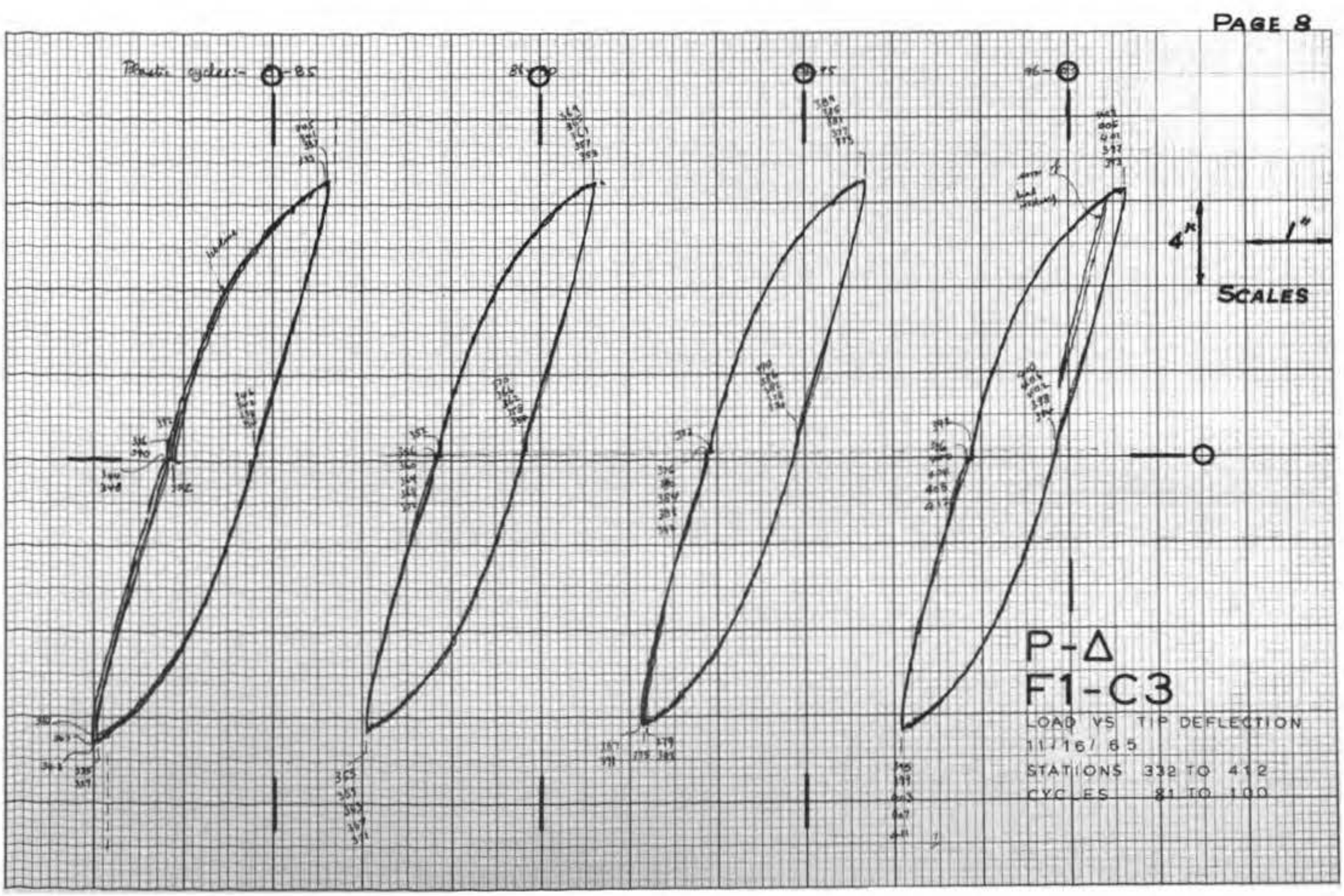
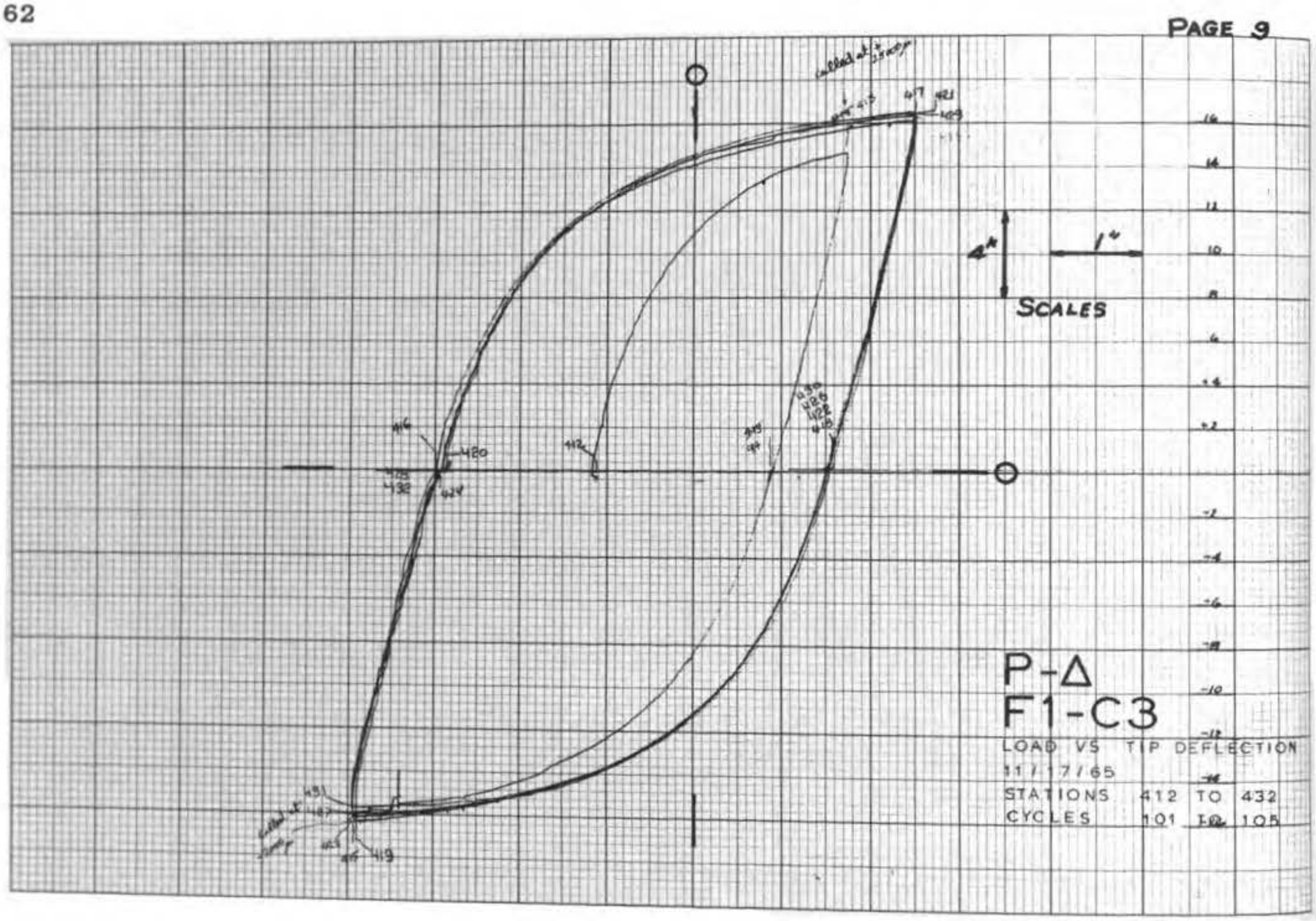


PLATE 5. (continued)



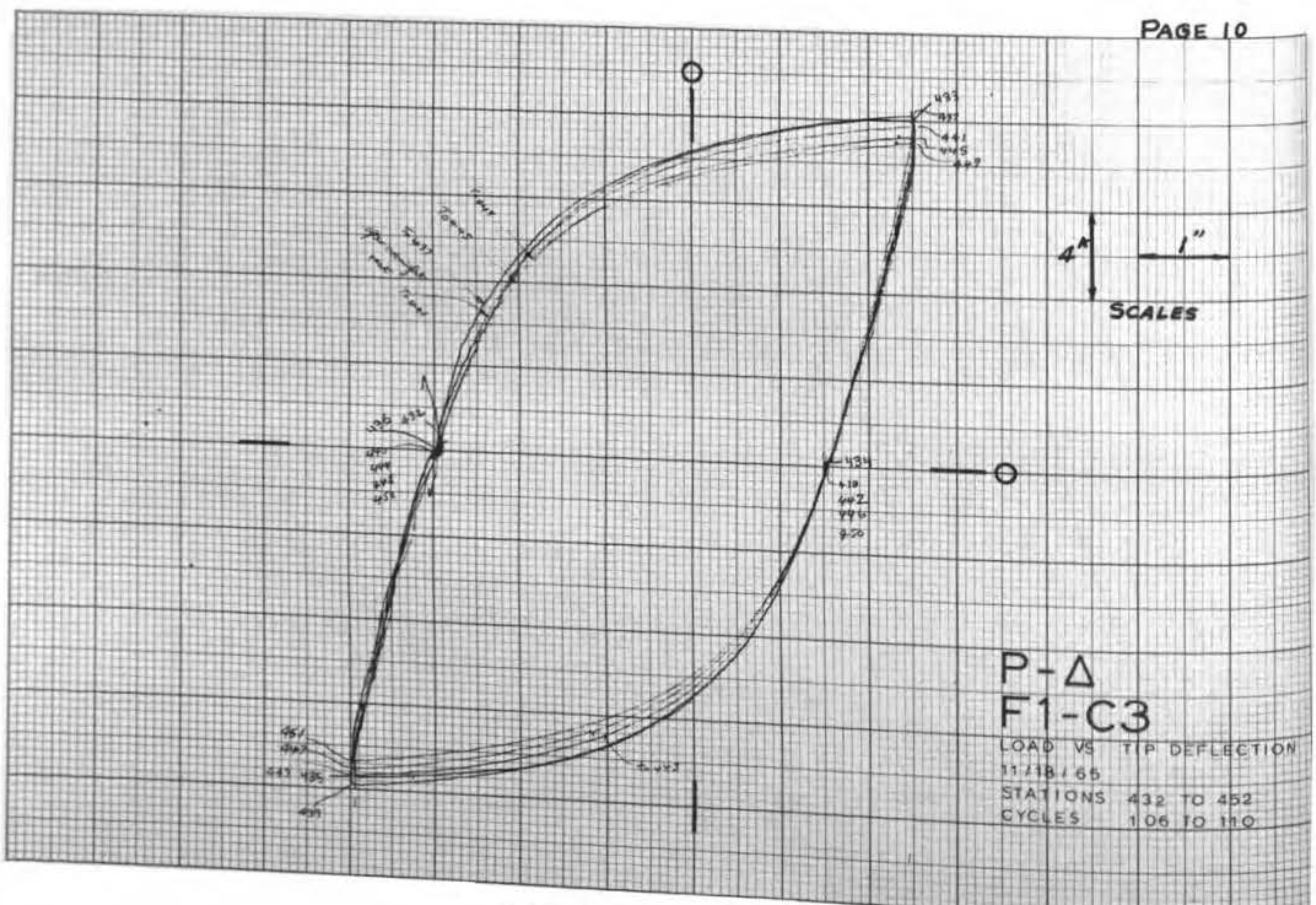
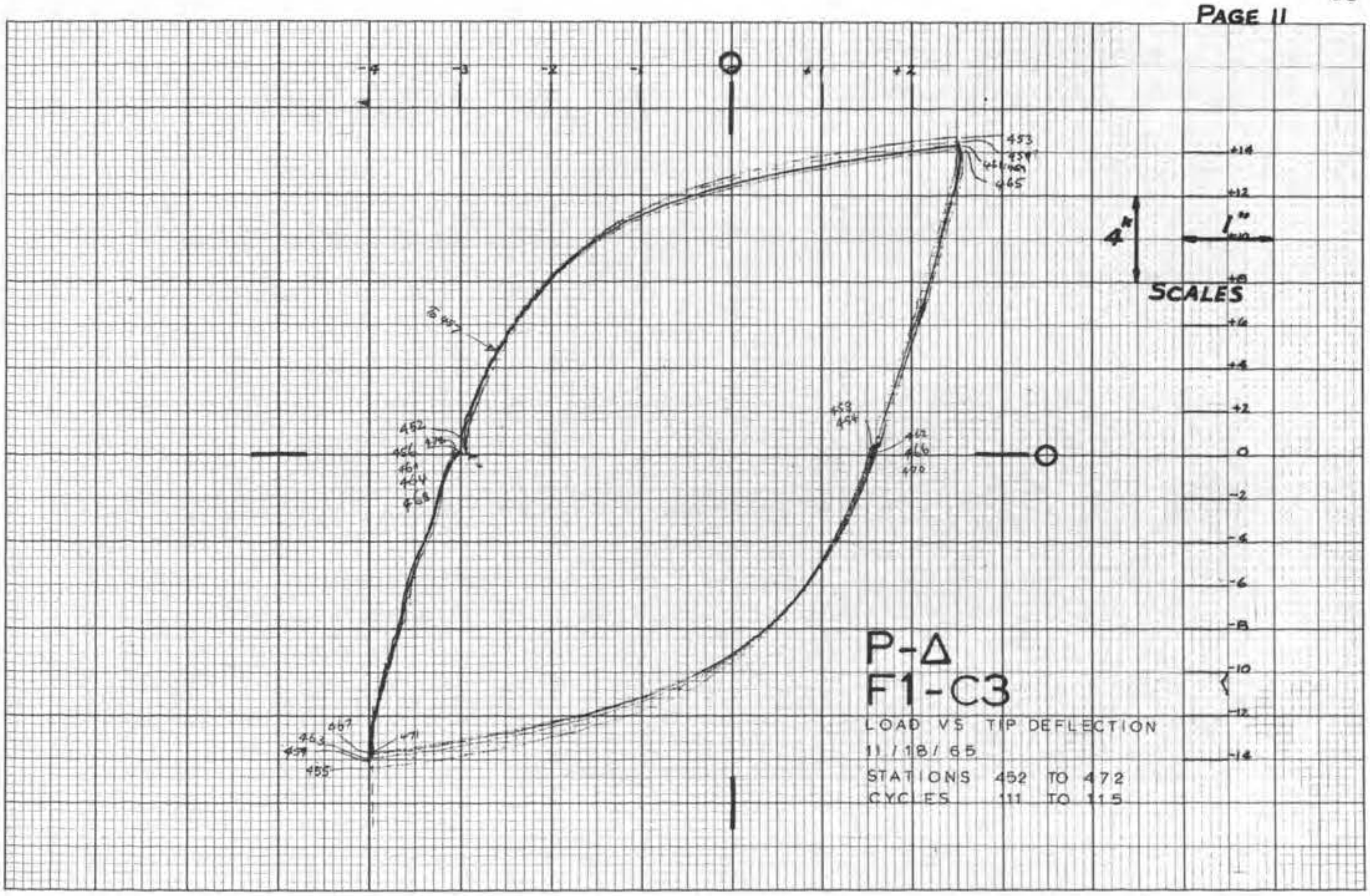


PLATE 5. (continued)



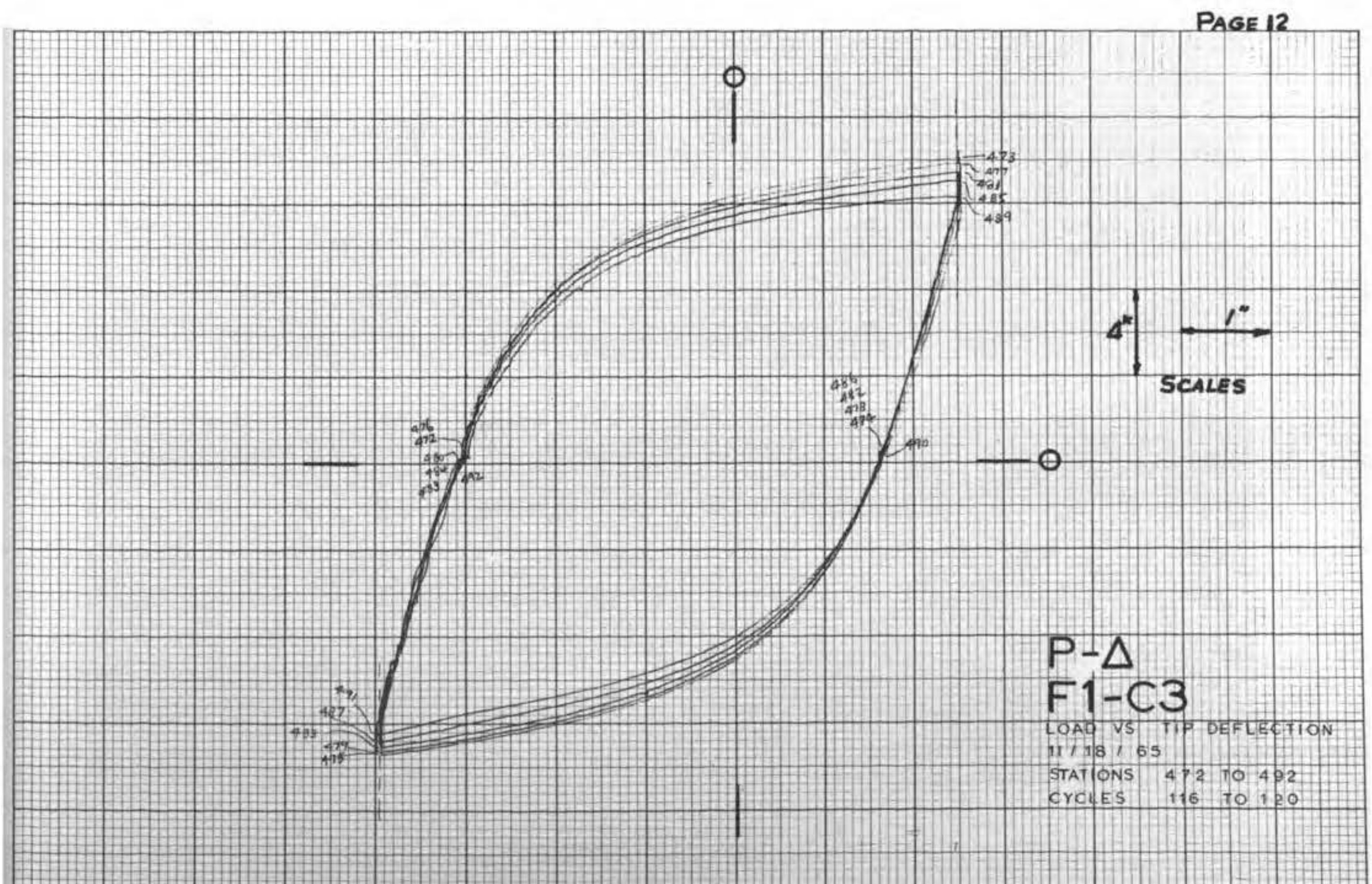


PLATE 5. (continued)

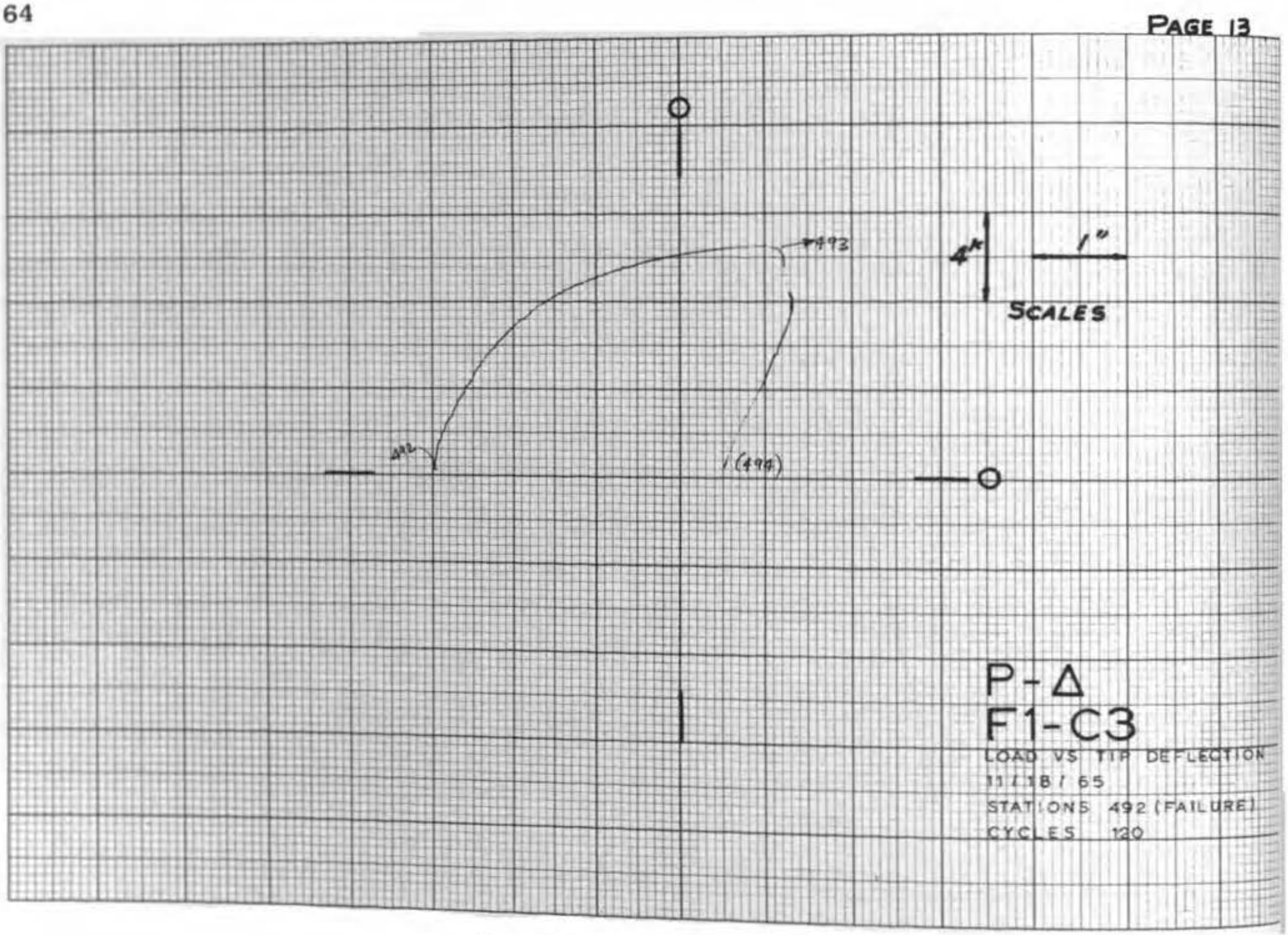


PLATE 5. (continued)

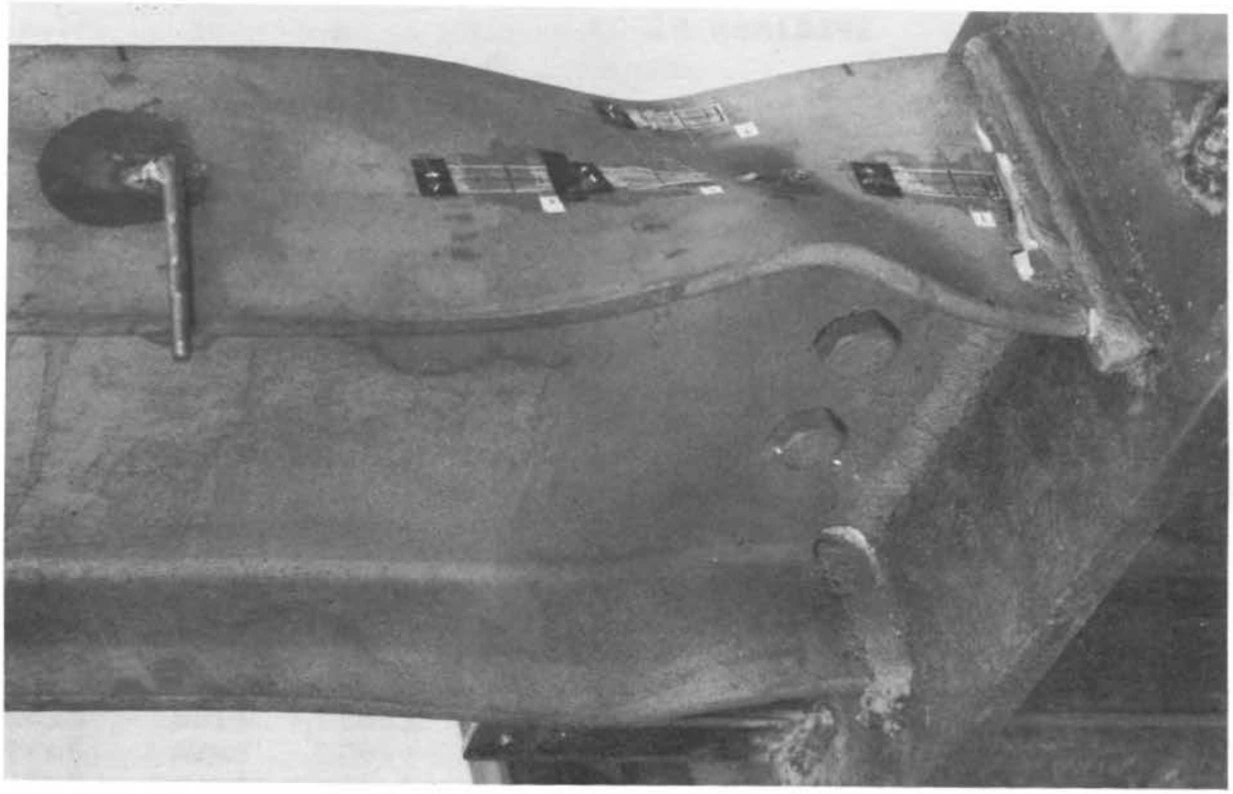


FIGURE 17. F1-C3

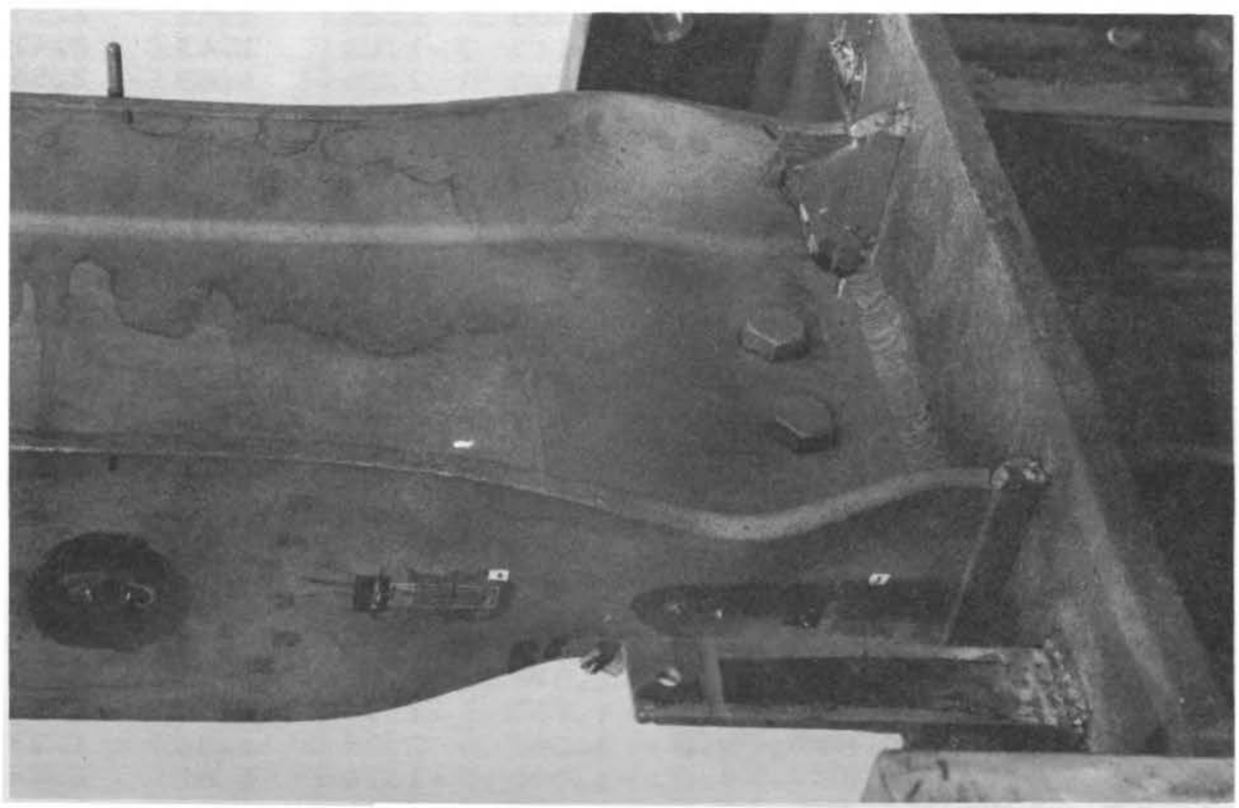


FIGURE 18. F1-C3

SPECIMEN F1-C3

Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	13.38	1.53	0.86	11.1	1.132	2.76	1.55	3.39
2	-13.43	-0.81	1.09	8.2	-1.136	-1.47	1.97	2.51
3	12.98	1.21	0.78	7.4	1.098	2.17	1.41	2.25
4	-13.59	-0.85	0.80	8.4	-1.150	-1.53	1.44	2.55
5	13.11	1.23	0.80	7.6	1.109	2.22	1.44	2.33
6	-13.54	-0.85	0.80	8.3	-1.146	-1.53	1.44	2.54
7	13.16	1.26	0.80	7.9	1.114	2.28	1.44	2.41
8	-13.51	-0.85	0.80	8.3	-1.143	-1.53	1.44	2.53
9	13.14	1.25	0.81	8.1	1.112	2.26	1.46	2.46
10	-13.52	-0.90	0.81	8.7	-1.144	-1.63	1.46	2.64
11	13.12	1.25	0.81	8.1	1.110	2.26	1.46	2.46
12	-13.48	-0.90	0.81	8.6	-1.140	-1.63	1.46	2.63
13	13.14	1.25	0.81	8.1	1.112	2.26	1.46	2.46
14	-13.43	-0.90	0.81	8.6	-1.136	-1.63	1.46	2.62
15	13.14	1.25	0.81	8.1	1.112	2.26	1.46	2.46
16	-13.38	-0.90	0.81	8.6	-1.132	-1.63	1.46	2.61
17	13.08	1.23	0.79	8.3	1.107	2.23	1.42	2.52
18	-13.36	-0.91	0.80	8.5	-1.130	-1.65	1.44	2.59
19	13.05	1.23	0.80	8.2	1.104	2.23	1.44	2.51
20	-13.29	-0.88	0.79	7.9	-1.124	-1.59	1.43	2.41
21	12.98	1.23	0.79	8.2	1.098	2.23	1.43	2.50
22	-13.25	-0.95	0.79	8.9	-1.121	-1.70	1.43	2.72
23	13.02	1.26	0.80	8.5	1.102	2.26	1.44	2.58
24	-13.18	-0.91	0.79	7.9	-1.115	-1.63	1.43	2.42
25	13.03	1.26	0.79	8.5	1.103	2.26	1.43	2.58
26	-13.15	-0.91	0.79	7.9	-1.113	-1.63	1.43	2.42
27	12.91	1.26	0.79	8.4	1.093	2.26	1.43	2.56
28	-13.20	-0.91	0.79	8.0	-1.117	-1.63	1.43	2.42
29	12.92	1.27	0.83	8.5	1.093	2.28	1.50	2.58
30	-13.18	-0.89	0.83	8.3	-1.115	-1.60	1.50	2.52
31	12.86	1.27	0.83	8.4	1.088	2.28	1.50	2.57
32	-13.14	-0.89	0.83	8.2	-1.112	-1.60	1.50	2.51
33	12.89	1.27	0.83	8.5	1.091	2.28	1.50	2.58
34	-13.06	-0.89	0.83	8.3	-1.105	-1.60	1.50	2.52
35	12.75	1.24	0.78	8.6	1.079	2.23	1.41	2.61
36	-13.04	-0.96	0.86	8.6	-1.103	-1.73	1.55	2.63
37	12.72	1.24	0.86	8.5	1.076	2.23	1.55	2.59
38	-13.04	-0.96	0.86	8.6	-1.103	-1.73	1.55	2.63
39	12.68	1.24	0.86	8.5	1.073	2.23	1.55	2.58
40	-12.97	-0.96	0.86	8.6	-1.098	-1.73	1.55	2.62
41	12.68	1.23	0.83	8.2	1.073	2.22	1.50	2.51
42	-12.94	-0.96	0.80	8.5	-1.095	-1.73	1.44	2.59
43	12.75	1.23	0.80	8.3	1.079	2.22	1.44	2.53
44	-12.89	-0.92	0.80	8.3	-1.090	-1.66	1.44	2.52
45	12.70	1.23	0.80	8.3	1.074	2.22	1.44	2.52
46	-12.89	-0.96	0.80	8.5	-1.091	-1.73	1.44	2.58
47	12.57	1.25	0.84	9.0	1.064	2.25	1.52	2.73
48	-12.97	-0.98	0.89	9.0	-1.098	-1.76	1.61	2.74
49	12.52	1.17	0.83	8.2	1.059	2.11	1.50	2.51
50	-12.86	-0.98	0.83	8.4	-1.088	-1.76	1.50	2.56
51	12.53	1.17	0.83	8.2	1.060	2.11	1.50	2.51

Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
52	−12.86	−0.98	0.83	8.4	−1.088	−1.76	1.50	2.56
53	12.54	1.14	0.78	8.2	1.061	2.06	1.41	2.49
54	−12.83	−1.00	0.84	8.3	−1.085	−1.80	1.52	2.54
55	12.46	1.14	0.84	8.1	1.054	2.06	1.52	2.46
56	−12.83	−0.98	0.84	8.4	−1.086	−1.77	1.52	2.55
57	12.45	1.14	0.84	8.1	1.053	2.06	1.52	2.46
58	−12.82	−0.98	0.84	8.4	−1.084	−1.77	1.52	2.55
59	12.45	1.14	0.86	8.3	1.053	2.06	1.55	2.52
60	−12.72	−0.99	0.84	8.6	−1.076	−1.79	1.52	2.62
61	12.65	1.15	0.84	8.4	1.070	2.08	1.52	2.56
62	−12.79	−0.99	0.84	8.6	−1.082	−1.79	1.52	2.63
63	12.38	1.14	0.84	8.2	1.047	2.06	1.52	2.51
64	−12.75	−0.99	0.84	8.6	−1.079	−1.79	1.52	2.62
65	12.35	1.09	0.79	8.0	1.045	1.97	1.43	2.44
66	−12.68	−1.03	0.81	8.4	−1.073	−1.86	1.46	2.57
67	12.29	1.09	0.81	8.0	1.040	1.97	1.46	2.43
68	−12.75	−1.03	0.81	8.5	−1.079	−1.86	1.46	2.59
69	12.35	1.09	0.81	8.0	1.045	1.97	1.46	2.44
70	−12.75	−1.03	0.81	8.5	−1.079	−1.86	1.46	2.59
71	12.36	1.05	0.78	8.2	1.046	1.90	1.41	2.49
72	−12.73	−1.06	0.82	8.5	−1.077	−1.92	1.48	2.59
73	12.32	1.05	0.82	8.1	1.042	1.90	1.48	2.47
74	−12.70	−1.06	0.82	8.5	−1.074	−1.92	1.48	2.59
75	12.11	1.05	0.82	8.0	1.024	1.90	1.48	2.43
76	−12.65	−1.06	0.82	8.5	−1.070	−1.92	1.48	2.58
77	12.23	1.04	0.81	8.1	1.035	1.87	1.46	2.48
78	−12.62	−1.03	0.83	8.3	−1.068	−1.86	1.50	2.54
79	12.28	1.04	0.83	8.1	1.039	1.87	1.50	2.48
80	−12.62	−1.06	0.83	8.3	−1.068	−1.92	1.50	2.53
81	12.37	0.96	0.75	7.9	1.046	1.72	1.35	2.42
82	−12.70	−1.06	0.80	7.8	−1.074	−1.91	1.45	2.37
83	12.31	0.96	0.80	7.9	1.041	1.72	1.45	2.40
84	−12.70	−1.06	0.80	7.8	−1.074	−1.91	1.45	2.37
85	12.28	0.96	0.80	7.8	1.039	1.72	1.45	2.39
86	−12.60	−1.06	0.80	7.7	−1.066	−1.91	1.45	2.35
87	12.26	0.96	0.80	7.8	1.037	1.72	1.45	2.39
88	−12.65	−1.06	0.80	7.7	−1.070	−1.91	1.45	2.36
89	12.21	0.96	0.80	7.8	1.033	1.72	1.45	2.38
90	−12.60	−1.09	0.80	7.8	−1.066	−1.97	1.45	2.38
91	12.21	0.87	0.72	7.8	1.033	1.56	1.30	2.39
92	−12.60	−1.17	0.81	8.2	−1.066	−2.10	1.46	2.51
93	12.16	0.87	0.81	7.7	1.029	1.56	1.46	2.36
94	−12.60	−1.17	0.81	8.2	−1.066	−2.10	1.46	2.51
95	12.11	0.87	0.81	7.7	1.024	1.56	1.46	2.35
96	−12.50	−1.17	0.81	8.2	−1.057	−2.10	1.46	2.49
97	12.11	0.87	0.81	7.7	1.024	1.56	1.46	2.35
98	−12.55	−1.17	0.81	8.2	−1.062	−2.10	1.46	2.50
99	12.09	0.87	0.81	7.7	1.023	1.56	1.46	2.35
100	−12.53	−1.19	0.81	8.2	−1.060	−2.14	1.46	2.49
101	12.06	0.72	0.67	7.7	1.020	1.30	1.21	2.34
102	−12.50	−1.30	0.78	8.2	−1.057	−2.34	1.41	2.50
103	12.06	0.72	0.78	7.6	1.020	1.30	1.41	2.31
104	−12.50	−1.30	0.78	8.2	−1.057	−2.34	1.41	2.50

Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
105	12.11	0.72	0.78	7.6	1.024	1.30	1.41	2.32
106	-12.48	-1.30	0.78	8.2	-1.056	-2.34	1.41	2.49
107	12.01	0.72	0.78	7.5	1.016	1.30	1.41	2.30
108	-12.45	-1.30	0.78	8.2	-1.053	-2.34	1.41	2.51
109	11.96	0.72	0.78	7.5	1.012	1.30	1.41	2.29
110	-12.48	-1.30	0.78	8.2	-1.056	-2.34	1.41	2.51
111	11.92	0.71	0.77	7.5	1.008	1.28	1.39	2.28
112	-12.45	-1.31	0.77	7.9	-1.053	-2.35	1.39	2.41
113	11.94	0.71	0.77	7.5	1.010	1.28	1.39	2.28
114	-12.40	-1.31	0.77	7.9	-1.049	-2.35	1.39	2.40
115	11.96	0.71	0.77	7.5	1.012	1.28	1.39	2.28
116	-12.38	-1.31	0.77	7.9	-1.047	-2.35	1.39	2.39
117	11.87	0.71	0.77	7.4	1.004	1.28	1.39	2.27
118	-12.43	-1.31	0.77	7.9	-1.052	-2.35	1.39	2.40
119	11.87	0.71	0.77	7.4	1.004	1.28	1.39	2.27
120	-12.43	-1.31	0.77	7.9	-1.052	-2.35	1.39	2.40
121	11.92	0.65	0.75	7.1	1.008	1.17	1.36	2.18
122	-12.35	-1.33	0.78	7.5	-1.045	-2.39	1.41	2.28
123	11.77	0.64	0.76	7.1	0.996	1.16	1.37	2.16
124	-12.38	-1.31	0.76	7.5	-1.047	-2.36	1.37	2.30
125	11.77	0.64	0.76	7.1	0.996	1.16	1.37	2.16
126	-12.35	-1.31	0.76	7.6	-1.045	-2.36	1.37	2.31
127	11.77	0.63	0.76	7.2	0.996	1.14	1.37	2.18
128	-12.35	-1.31	0.76	7.6	-1.045	-2.36	1.37	2.31
129	11.70	0.62	0.76	7.1	0.990	1.12	1.37	2.17
130	-12.31	-1.33	0.76	7.6	-1.041	-2.40	1.37	2.32
131	11.72	0.59	0.72	6.8	0.991	1.07	1.30	2.07
132	-12.33	-1.37	0.72	7.4	-1.043	-2.46	1.30	2.26
133	11.72	0.59	0.72	6.8	0.991	1.07	1.30	2.07
134	-12.28	-1.37	0.73	7.4	-1.039	-2.46	1.32	2.26
135	11.57	0.59	0.73	6.7	0.979	1.07	1.32	2.04
136	-12.28	-1.37	0.75	7.5	-1.039	-2.47	1.35	2.28
137	11.62	0.60	0.75	6.8	0.983	1.07	1.35	2.06
138	-12.26	-1.37	0.77	7.5	-1.037	-2.47	1.39	2.28
139	11.65	0.60	0.77	6.8	0.986	1.07	1.39	2.07
140	-12.33	-1.37	0.79	7.6	-1.043	-2.47	1.43	2.31
141	11.97	0.67	0.83	7.7	1.013	1.20	1.50	2.36
142	-12.72	-1.54	0.93	9.3	-1.076	-2.78	1.68	2.84
143	12.06	0.67	0.93	8.8	1.020	1.20	1.68	2.69
144	-12.65	-1.51	0.95	9.3	-1.070	-2.73	1.71	2.84
145	12.09	0.67	0.95	8.8	1.023	1.20	1.71	2.70
146	-12.65	-1.51	0.93	9.3	-1.070	-2.73	1.68	2.83
147	12.11	0.67	0.93	8.9	1.024	1.20	1.68	2.70
148	-12.65	-1.51	0.93	9.3	-1.070	-2.73	1.68	2.83
149	12.09	0.67	0.93	8.8	1.023	1.20	1.68	2.70
150	-12.67	-1.51	0.93	9.3	-1.072	-2.73	1.68	2.84
151	12.35	0.65	0.89	8.8	1.045	1.18	1.61	2.68
152	-12.65	-1.54	0.89	9.0	-1.070	-2.78	1.61	2.73
153	12.21	0.64	0.89	8.9	1.033	1.15	1.61	2.70
154	-12.65	-1.54	0.89	9.0	-1.070	-2.78	1.61	2.73
155	12.21	0.64	0.89	8.9	1.033	1.15	1.61	2.70
156	-12.65	-1.54	0.89	9.0	-1.070	-2.78	1.61	2.73
157	12.11	0.64	0.89	8.9	1.024	1.15	1.61	2.70

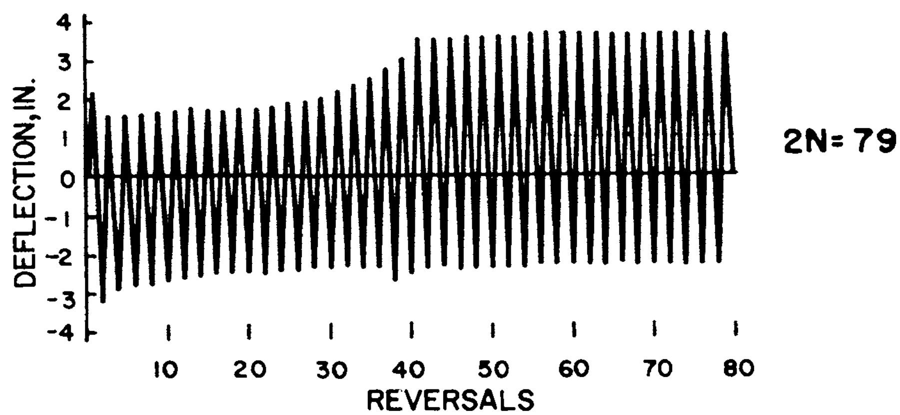
Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
158	-12.53	-1.54	0.89	8.9	-1.060	-2.78	1.61	2.71
159	12.16	0.64	0.89	8.9	1.029	1.15	1.61	2.71
160	-12.62	-1.54	0.89	8.9	-1.068	-2.78	1.61	2.73
161	12.45	0.60	0.85	9.0	1.053	1.09	1.53	2.75
162	-12.96	-1.61	0.93	9.3	-1.096	-2.90	1.68	2.85
163	12.55	0.62	0.93	9.0	1.062	1.12	1.68	2.73
164	-13.04	-1.61	0.93	9.4	-1.103	-2.90	1.68	2.86
165	12.53	0.62	0.93	8.9	1.060	1.12	1.68	2.73
166	-13.28	-1.64	0.95	10.1	-1.123	-2.96	1.71	3.08
167	12.40	0.62	0.95	8.8	1.049	1.12	1.71	2.70
168	-13.09	-1.65	0.95	10.2	-1.107	-2.97	1.71	3.10
169	12.40	0.62	0.95	8.8	1.049	1.12	1.71	2.70
170	-12.84	-1.61	0.85	9.0	-1.086	-2.90	1.53	2.75
171	12.18	0.63	0.87	8.9	1.031	1.13	1.57	2.70
172	-12.73	-1.57	0.89	9.3	-1.077	-2.83	1.61	2.83
173	12.22	0.63	0.89	8.9	1.034	1.13	1.61	2.70
174	-12.65	-1.57	0.90	9.2	-1.070	-2.83	1.62	2.82
175	12.16	0.63	0.90	8.8	1.029	1.13	1.62	2.69
176	-12.65	-1.57	0.90	9.2	-1.070	-2.83	1.62	2.82
177	12.11	0.63	0.90	8.8	1.025	1.13	1.62	2.68
178	-12.68	-1.57	0.90	9.3	-1.073	-2.83	1.62	2.82
179	12.12	0.63	0.90	8.8	1.025	1.13	1.62	2.68
180	-12.62	-1.57	0.90	9.2	-1.068	-2.83	1.62	2.81
181	12.11	0.67	0.93	8.8	1.024	1.20	1.68	2.68
182	-12.65	-1.52	0.93	9.1	-1.070	-2.74	1.68	2.78
183	12.06	0.67	0.93	8.8	1.020	1.20	1.68	2.67
184	-12.55	-1.50	0.93	9.2	-1.062	-2.71	1.68	2.80
185	12.11	0.67	0.93	8.8	1.024	1.20	1.68	2.68
186	-12.55	-1.50	0.93	9.2	-1.062	-2.71	1.68	2.80
187	12.06	0.67	0.93	8.8	1.020	1.20	1.68	2.67
188	-12.55	-1.55	0.93	9.2	-1.062	-2.80	1.68	2.79
189	12.06	0.67	0.93	8.8	1.020	1.20	1.68	2.67
190	-12.53	-1.55	0.93	9.1	-1.060	-2.80	1.68	2.79
191	12.06	0.63	0.91	8.9	1.020	1.13	1.64	2.72
192	-12.55	-1.57	0.91	9.3	-1.062	-2.84	1.64	2.83
193	12.09	0.63	0.91	9.0	1.023	1.13	1.64	2.73
194	-12.57	-1.57	0.91	9.3	-1.063	-2.84	1.64	2.83
195	12.06	0.63	0.91	8.9	1.020	1.13	1.64	2.72
196	-12.50	-1.57	0.91	9.2	-1.057	-2.84	1.64	2.82
197	12.11	0.63	0.91	9.0	1.024	1.13	1.64	2.74
198	-12.45	-1.57	0.91	9.2	-1.053	-2.84	1.64	2.81
199	12.06	0.63	0.91	8.9	1.021	1.13	1.64	2.73
200	-12.43	-1.57	0.91	9.2	-1.052	-2.84	1.64	2.80
201	14.22	1.77	2.02	24.1	1.203	3.19	3.64	7.35
202	-15.55	-3.49	3.82	48.4	-1.315	-6.28	6.89	14.76
203	15.57	2.50	4.43	59.7	1.317	4.50	7.99	18.20
204	-16.01	-3.44	4.38	59.3	-1.354	-6.20	7.90	18.09
205	15.92	2.49	4.38	58.0	1.347	4.49	7.90	17.69
206	-15.85	-3.49	4.38	58.8	-1.341	-6.28	7.89	17.92
207	15.75	2.52	4.42	57.3	1.332	4.53	7.97	17.48
208	-15.67	-3.49	4.42	58.8	-1.326	-6.29	7.97	17.94
209	15.82	2.49	4.38	57.7	1.338	4.49	7.89	17.58
210	-15.43	-3.49	4.38	58.6	-1.305	-6.29	7.89	17.86

Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
211	15.53	2.54	4.43	58.8	1.314	4.58	7.99	17.93
212	−15.14	−3.48	4.43	57.5	−1.281	−6.27	7.98	17.54
213	15.51	2.56	4.43	58.5	1.312	4.61	7.98	17.84
214	−15.15	−3.51	4.46	56.8	−1.282	−6.33	8.04	17.31
215	14.96	2.56	4.46	56.0	1.266	4.62	8.04	17.06
216	−14.78	−3.48	4.46	54.6	−1.250	−6.27	8.04	16.65
217	14.41	2.57	4.46	53.5	1.219	4.63	8.04	16.32
218	−14.47	−3.48	4.46	53.4	−1.225	−6.28	8.04	16.27
219	14.09	2.57	4.46	52.3	1.192	4.64	8.04	15.95
220	−14.18	−3.51	4.46	51.8	−1.199	−6.32	8.04	15.81
221	13.79	2.56	4.45	51.4	1.167	4.61	8.02	15.67
222	−13.93	−3.54	4.49	51.4	−1.179	−6.38	8.09	15.68
223	13.55	2.58	4.52	50.7	1.147	4.65	8.15	15.45
224	−13.69	−3.53	4.52	50.9	−1.159	−6.37	8.15	15.52
225	13.35	2.60	4.54	49.9	1.130	4.68	8.18	15.21
226	−13.55	−3.52	4.54	50.5	−1.147	−6.34	8.18	15.40
227	13.16	2.63	4.56	49.4	1.113	4.73	8.22	15.07
228	−13.35	−3.53	4.56	50.0	−1.130	−6.36	8.22	15.25
229	13.16	2.59	4.57	49.2	1.113	4.66	8.24	15.00
230	−13.41	−3.51	4.59	50.2	−1.135	−6.33	8.27	15.30
231	12.96	2.54	4.55	49.4	1.096	4.58	8.20	15.08
232	−13.18	−3.54	4.55	49.0	−1.115	−6.38	8.20	14.94
233	12.74	2.55	4.55	48.4	1.078	4.59	8.20	14.75
234	−13.07	−3.60	4.62	48.6	−1.106	−6.49	8.33	14.82
235	12.33	2.54	4.62	47.3	1.043	4.58	8.33	14.41
236	−12.84	−3.54	4.59	47.3	−1.087	−6.37	8.27	14.42
237	11.94	2.55	4.59	45.8	1.010	4.59	8.27	13.98
238	−12.57	−3.57	4.58	45.5	−1.064	−6.43	8.26	13.87
239	11.17	2.56	4.60	43.3	0.945	4.61	8.29	13.19
240	−12.24	−3.56	4.59	43.8	−1.036	−6.42	8.27	13.34

SPECIMEN F1-C4

Description: This specimen was similar to specimen F1-C1, except that it was fabricated in a University shop and was not ultrasonically inspected.

Program of Cycling:



Test Control: Strain, as measured on the top flange 5.46 inches from the column face. The strain was read on a Baldwin SR-4 strain indicator.

Raw Data Included: Graphical load-deflection data.

Total Energy Absorption: 2,837 kip-inches.

Plastic Load Reversals to Failure: 79 ($39\frac{1}{2}$ cycles).

Remarks: The specimen was immediately loaded to the ±1% strain range. According to visual observation, buckling of both the top and bottom flanges had occurred by the end of the first three reversals. The first cracks were noted after the 14th cycle, at the stud weld nearest the column on the top flange. Small cracks also developed at the extremities of the flange butt-welds, and from the web copes during subsequent cycles. After 25 cycles, cracks at both top and bottom flange studs were seen to be penetrating into the flange thickness. The crack at the bottom stud began to propagate through and across the bottom flange until at termination of the test, it measured $3\frac{1}{2}$ inches long in the flange and had penetrated $1\frac{1}{2}$ inches into the web.

SPECIMEN TYPE F1-C4

DIMENSIONS OF WF SECTION

DEPTH	8.24	INCHES
TOP FLANGE WIDTH	5.280	INCHES
BOTTOM FLANGE WIDTH	5.310	INCHES
TOP FLANGE THICKNESS	0.350	INCHES
BOTTOM FLANGE THICKNESS	0.347	INCHES
WEB THICKNESS	0.247	INCHES
ELASTIC MODULUS	29400.	KSI
YIELD STRESS	35.900	KSI

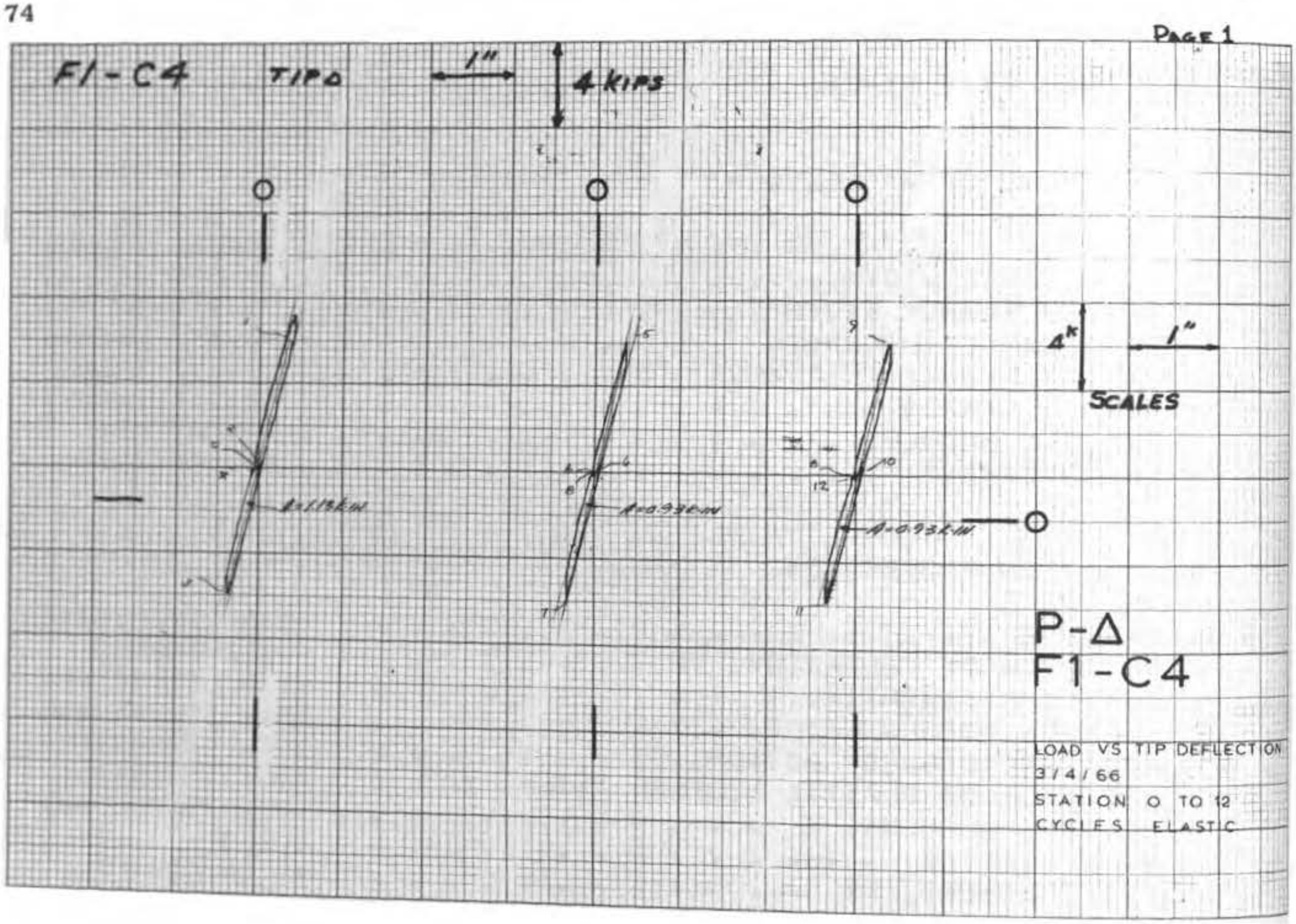
WF SECTION PROPERTIES

AREA, A	5.64	INCHES**2
LOCATION OF CENTROID*, YE	4.12	INCHES
MOMENT OF INERTIA, I	67.6	INCHES**4
SECTION MODULUS, TOP, ST	16.4	INCHES**3
SECTION MODULUS, BOTTOM, SB	16.4	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.12	INCHES
PLASTIC MODULUS, Z	18.4	INCHES**3
SHAPE FACTOR	1.123	
YIELD MOMENT, MY	49.05	KIP-FT.
PLASTIC MOMENT, MP	55.07	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

BEAM PROPERTIES

LENGTH, L	66.0	INCHES
ELASTIC STIFFNESS, P/DELTA	20.73	KIPS/IN.
YIELD DEFLECTION, DELTAY	0.430	INCHES
YIELD LOAD, PY	8.92	KIPS
PLASTIC LOAD, PP	10.01	KIPS



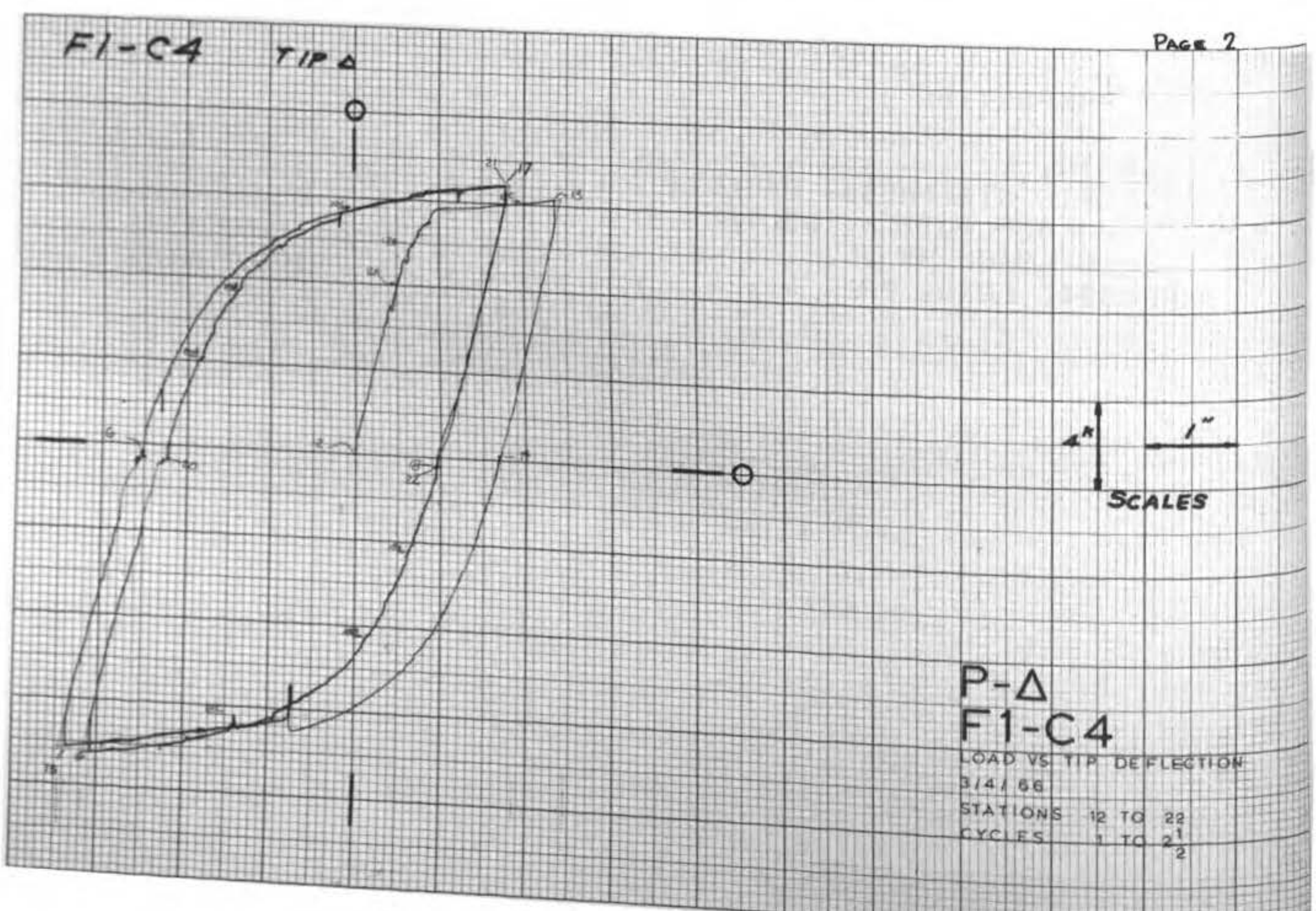
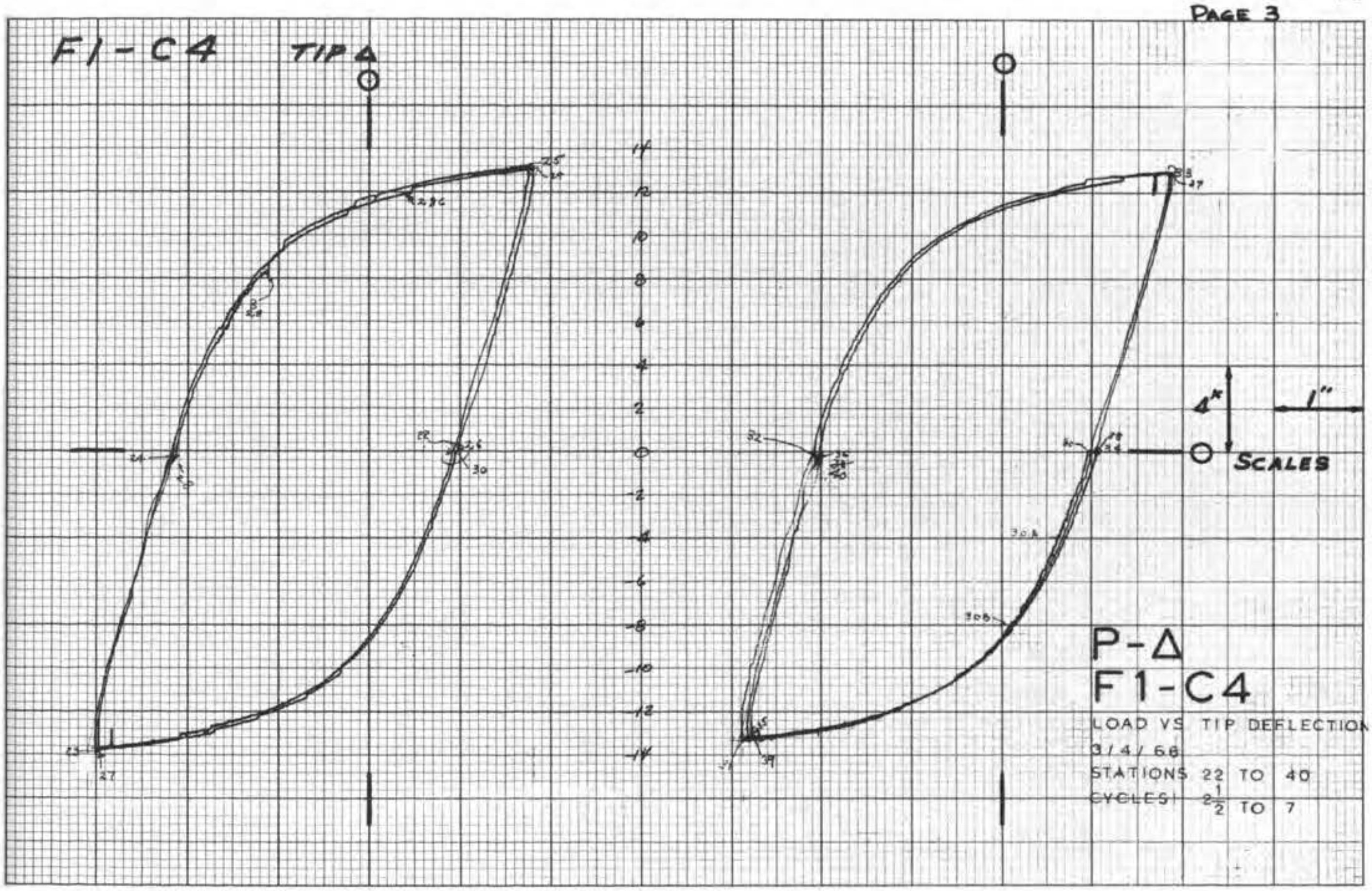


PLATE 6. LOAD VS. DEFLECTION - F1-C4



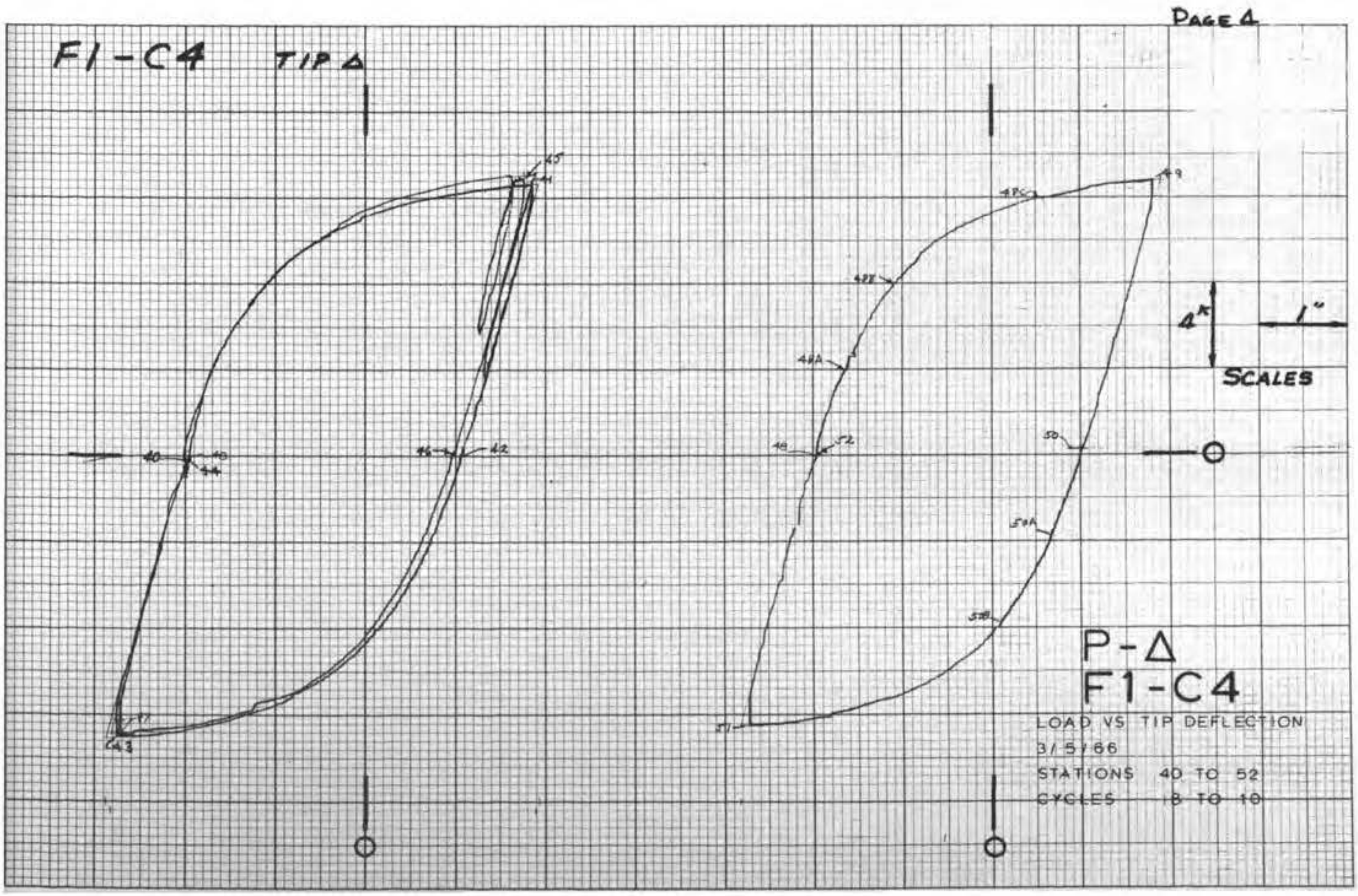
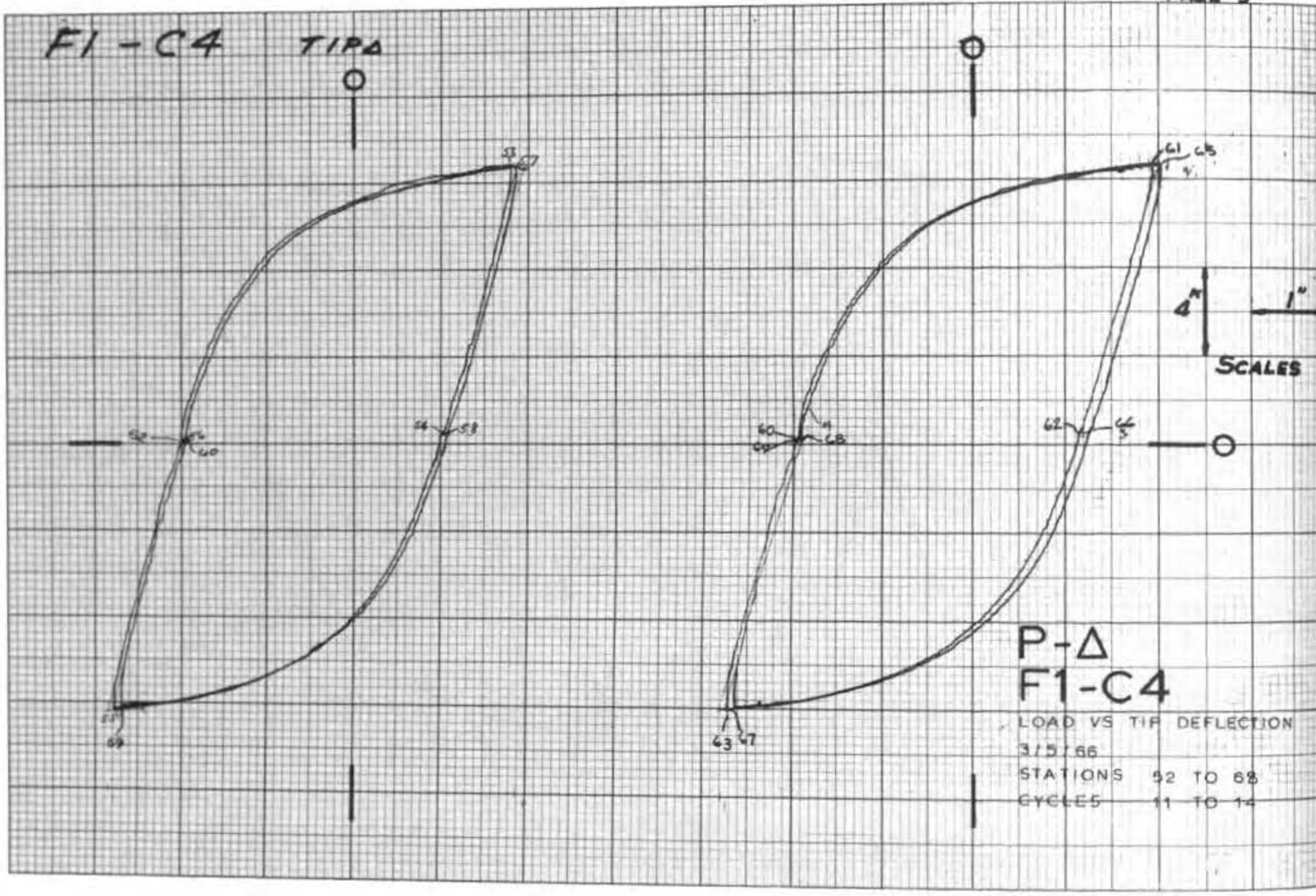


PLATE 6. (continued)



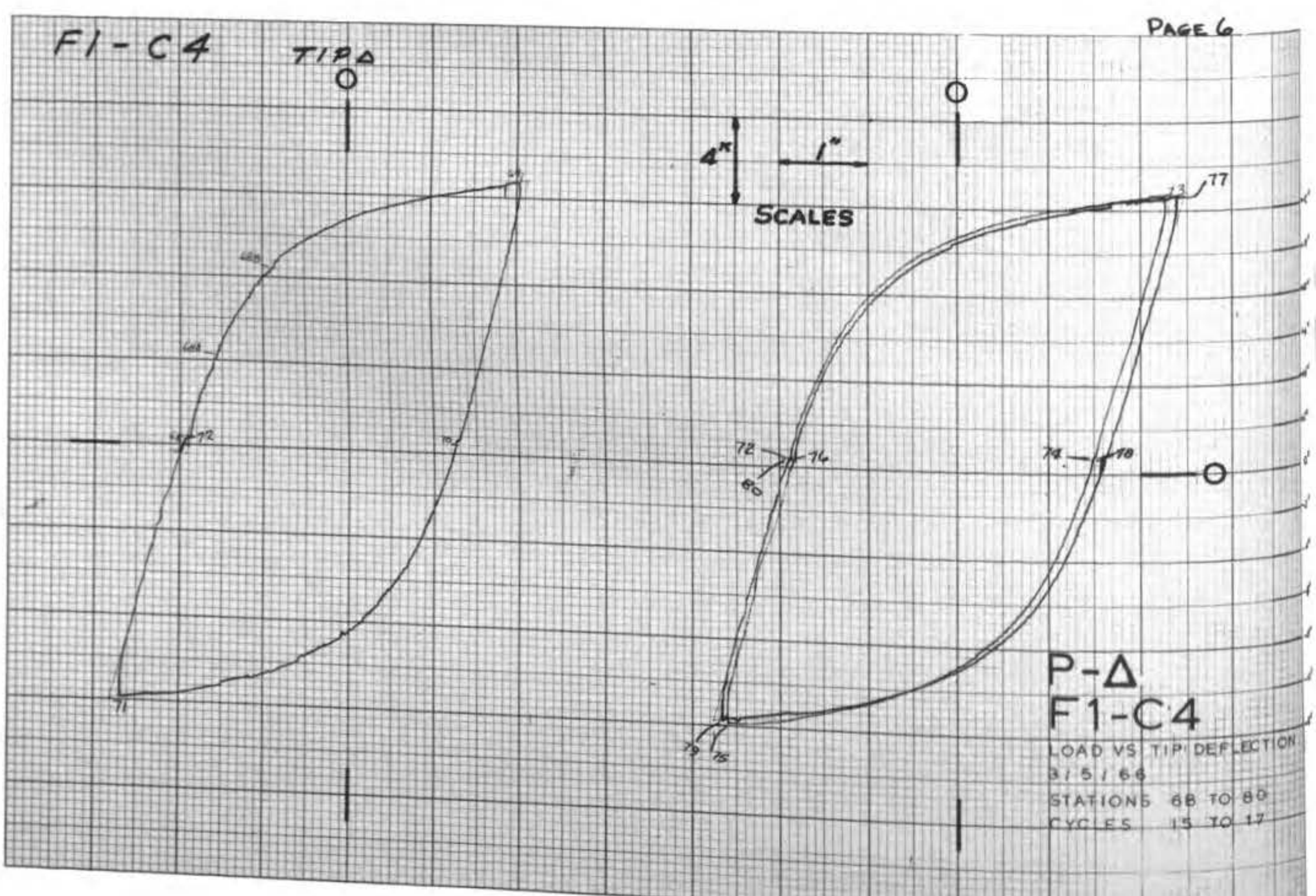
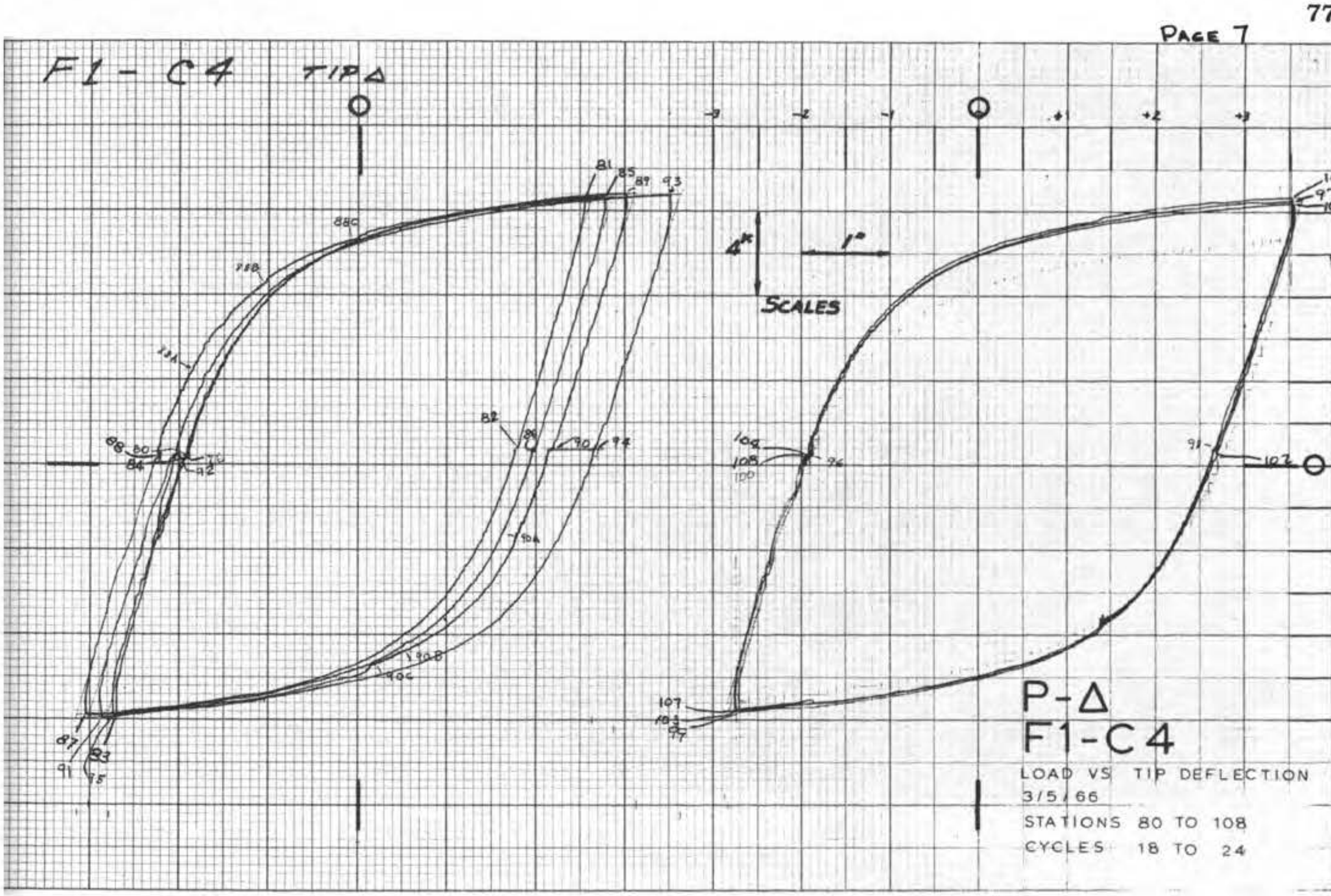


PLATE 6. (continued)



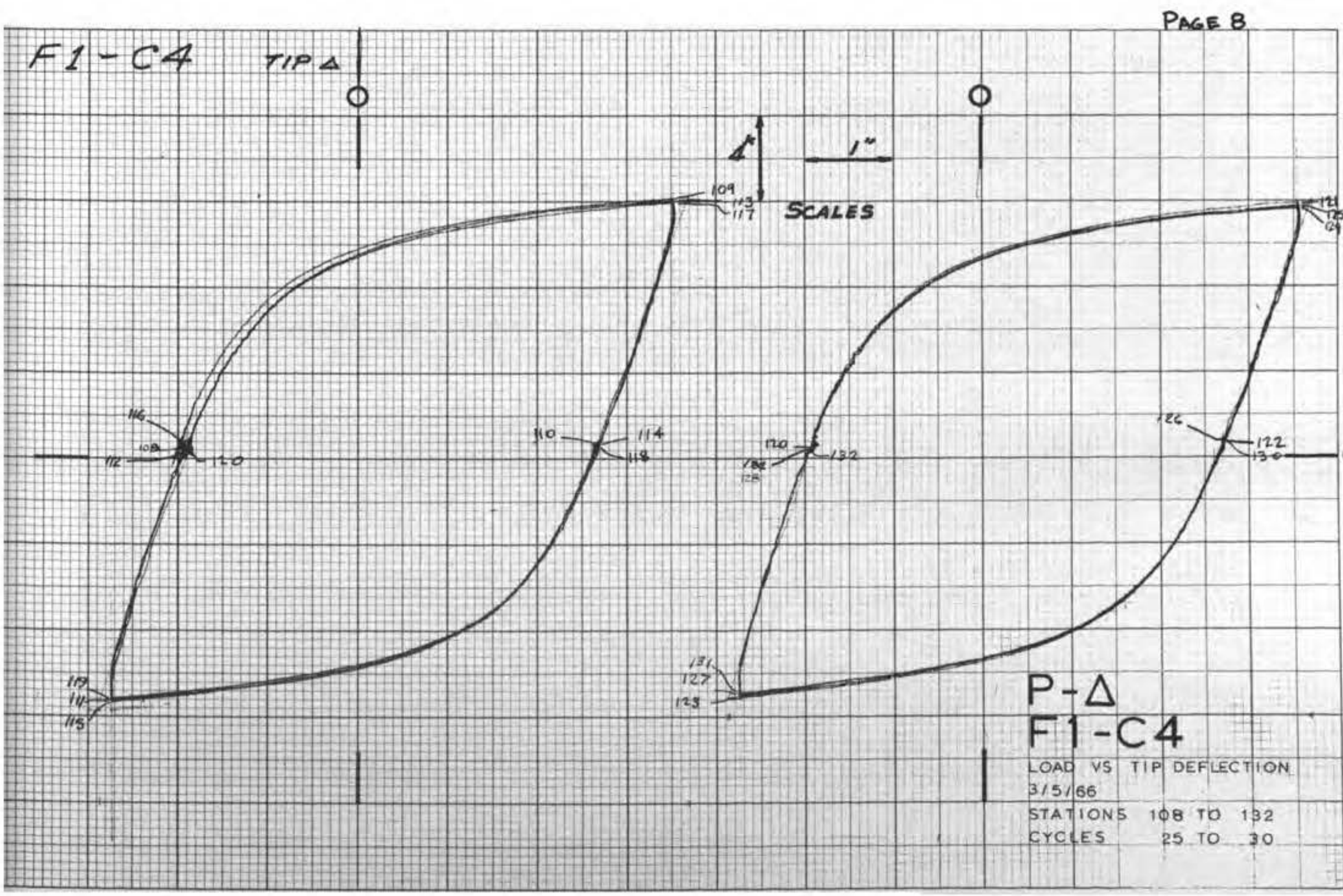
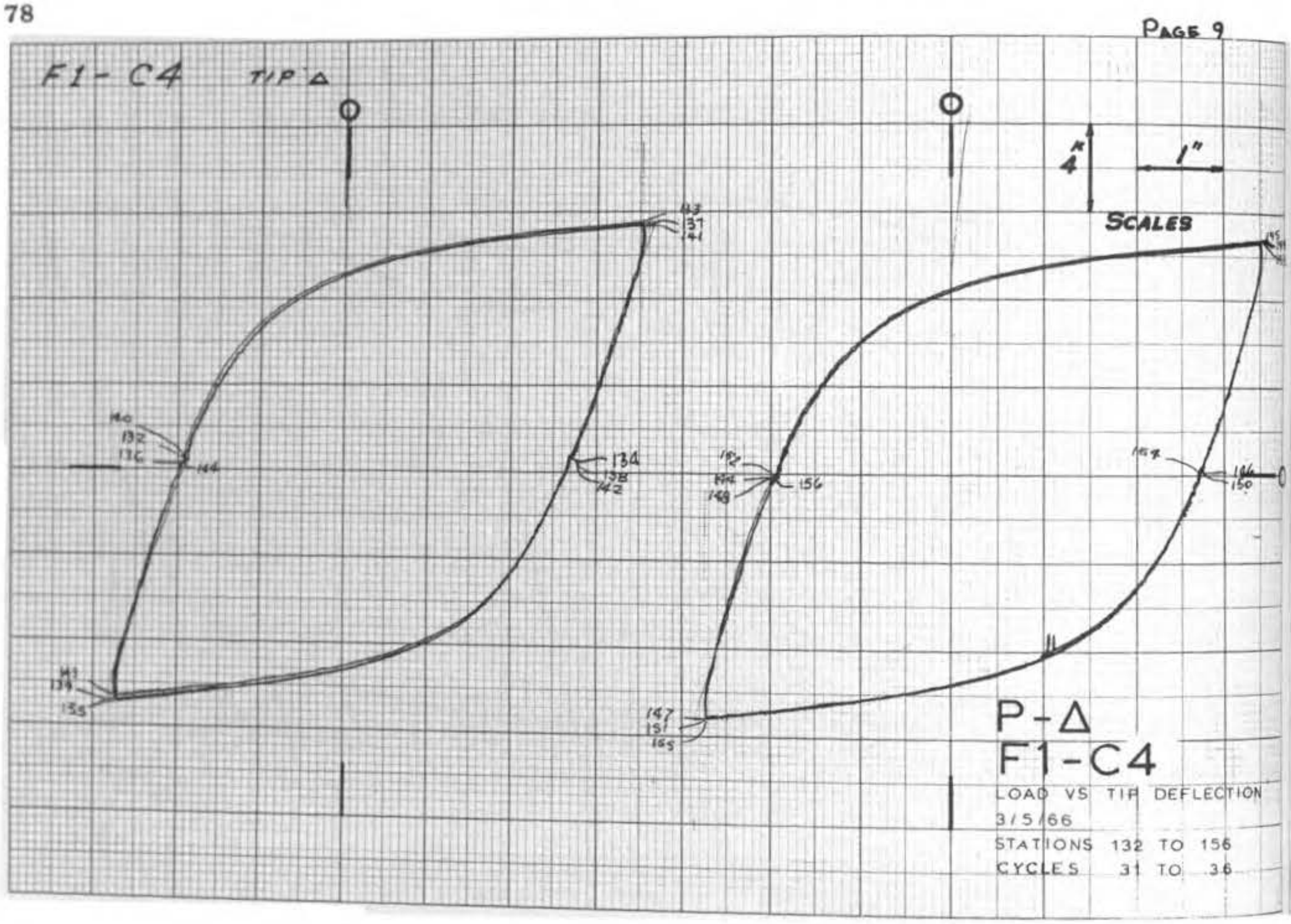
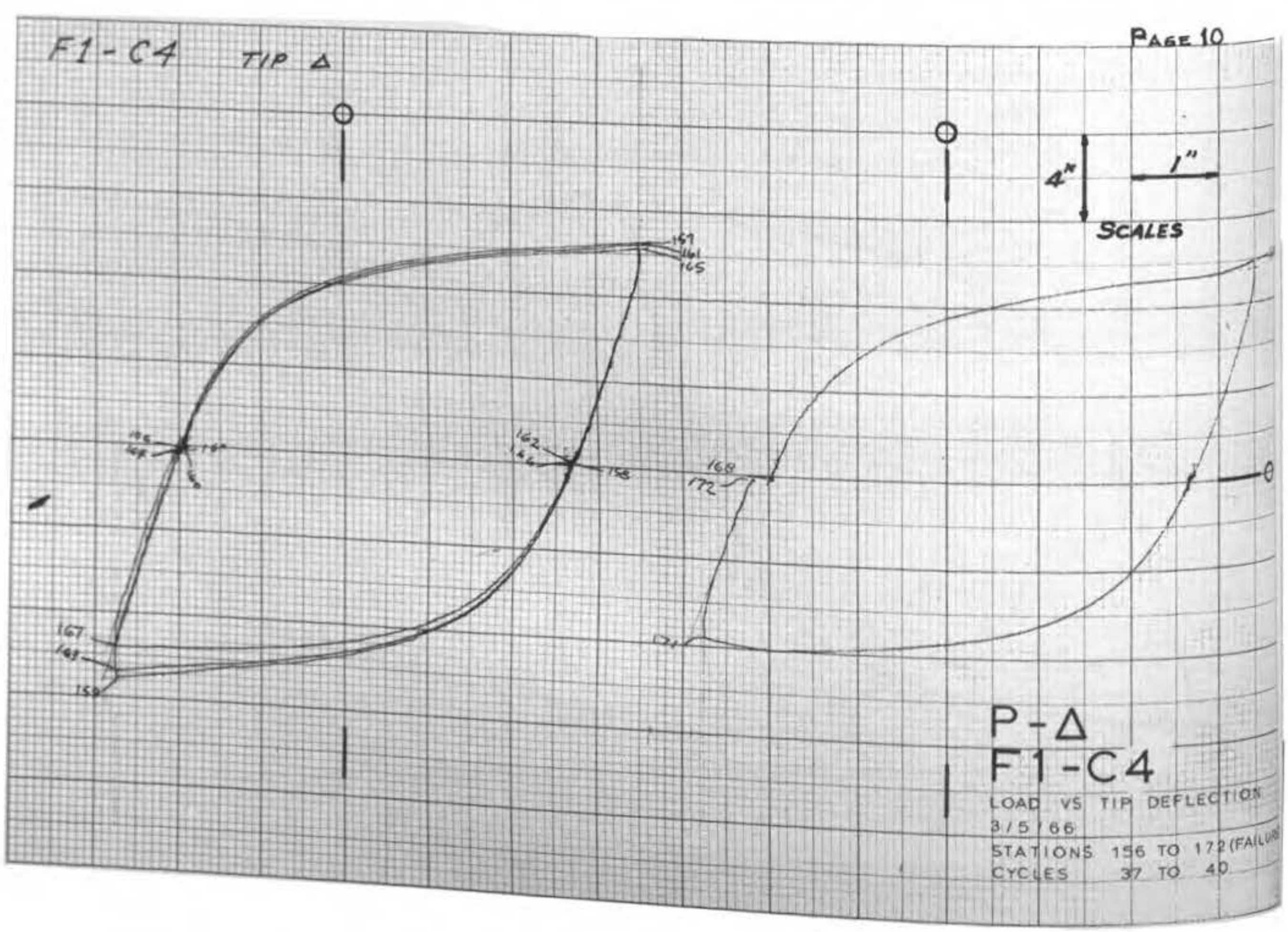


PLATE 6. (continued)


PAGE 9
F1-C4 TIP Δ
4"
1"
SCALES
P-Δ
F1-C4
LOAD VS TIP DEFLECTION
3/5/66
STATIONS 132 TO 156
CYCLES 31 TO 36


PAGE 10
F1-C4 TIP Δ
4"
1"
SCALES
P-Δ
F1-C4
LOAD VS TIP DEFLECTION
3/5/66
STATIONS 156 TO 172 (FAILURE)
CYCLES 37 TO 40

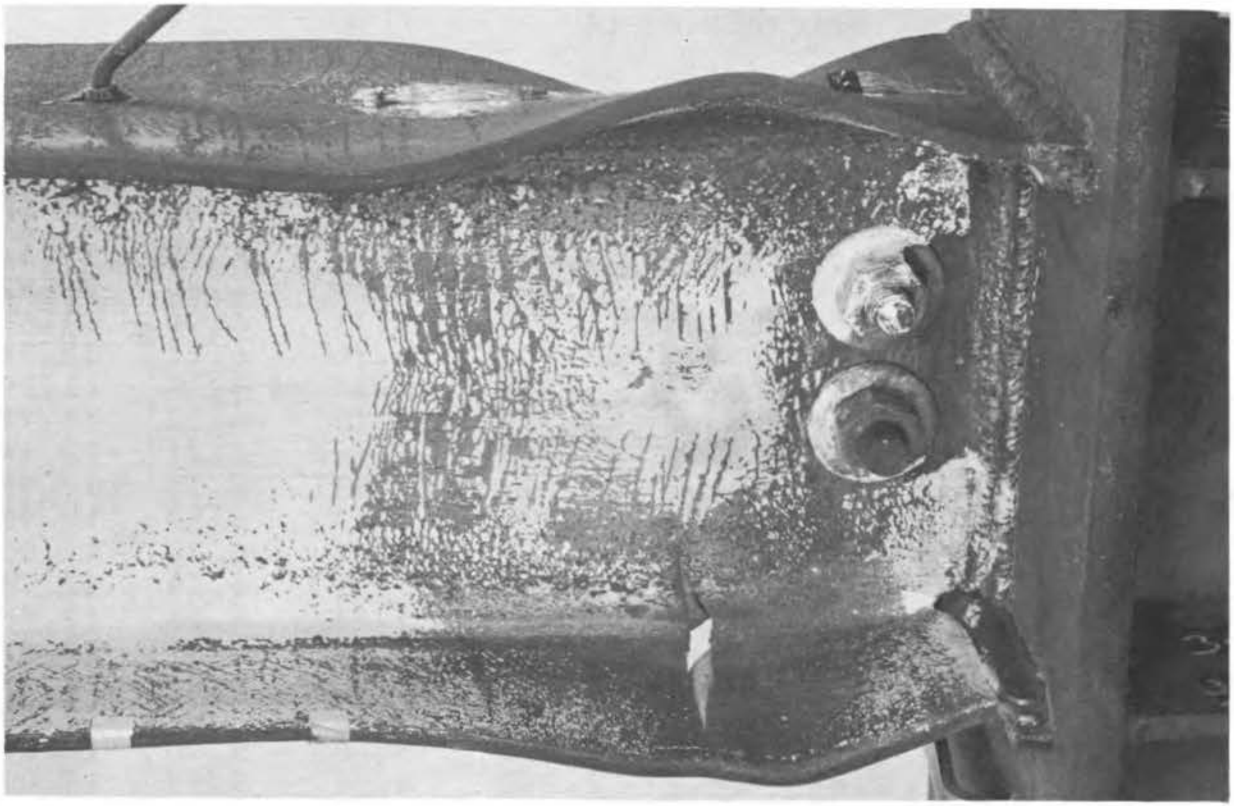


FIGURE 19. F1-C4

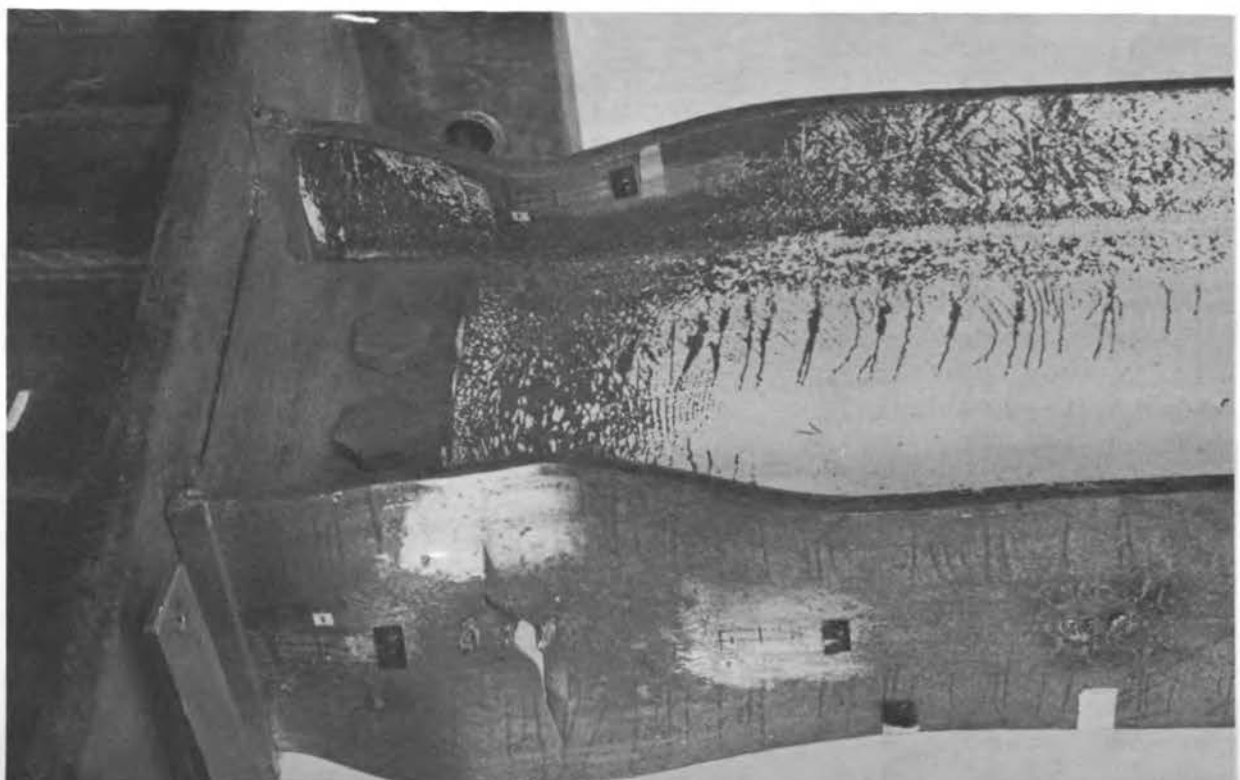


FIGURE 20. F1-C4

SPECIMEN F1-C4

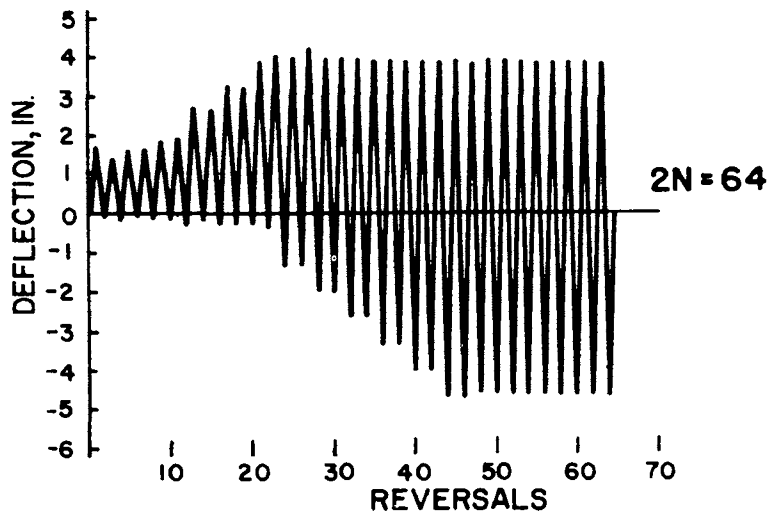
Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	12.44	2.18	1.63	19.3	1.243	4.52	3.38	8.00
2	-13.03	-3.19	4.10	46.4	-1.301	-6.61	8.49	19.19
3	12.90	1.60	3.35	36.5	1.289	3.31	6.95	15.11
4	-13.28	-2.89	3.09	35.1	-1.326	-5.99	6.40	14.52
5	12.94	1.60	3.09	37.9	1.293	3.31	6.40	15.68
6	-13.02	-2.78	3.00	32.7	-1.300	-5.76	6.21	13.54
7	12.80	1.61	3.05	32.1	1.279	3.33	6.32	13.29
8	-12.97	-2.75	3.00	33.2	-1.296	-5.70	6.22	13.73
9	12.68	1.66	3.00	31.8	1.267	3.44	6.21	13.14
10	-12.58	-2.67	2.97	31.3	-1.256	-5.53	6.14	12.95
11	12.53	1.69	2.99	31.3	1.252	3.50	6.18	12.97
12	-12.70	-2.60	2.90	31.5	-1.269	-5.39	6.00	13.05
13	12.49	1.75	2.95	30.8	1.248	3.63	6.10	12.75
14	-12.29	-2.57	2.93	30.4	-1.228	-5.33	6.06	12.56
15	12.14	1.76	2.99	30.5	1.213	3.64	6.19	12.64
16	-12.27	-2.50	2.94	30.1	-1.225	-5.18	6.08	12.45
17	12.39	1.67	2.85	29.7	1.238	3.46	5.90	12.28
18	-12.27	-2.46	2.85	29.0	-1.226	-5.10	5.90	11.99
19	12.13	1.72	2.87	29.2	1.212	3.56	5.93	12.09
20	-12.02	-2.47	2.86	28.5	-1.201	-5.11	5.93	11.80
21	12.02	1.74	2.89	29.5	1.200	3.60	5.98	12.19
22	-11.98	-2.50	2.89	29.2	-1.197	-5.17	5.98	12.07
23	11.89	1.80	2.94	28.9	1.188	3.73	6.08	11.98
24	-11.90	-2.42	2.91	29.2	-1.189	-5.01	6.02	12.08
25	11.75	1.88	2.99	29.2	1.174	3.90	6.20	12.10
26	-11.83	-2.42	3.00	29.4	-1.182	-5.01	6.20	12.17
27	11.69	1.97	3.10	29.7	1.168	4.09	6.42	12.27
28	-11.78	-2.33	3.03	30.0	-1.177	-4.83	6.28	12.40
29	11.70	2.04	3.11	29.6	1.169	4.23	6.44	12.23
30	-11.69	-2.34	3.11	29.9	-1.167	-4.85	6.43	12.36
31	11.64	2.22	3.26	31.2	1.163	4.61	6.76	12.89
32	-11.77	-2.31	3.21	30.9	-1.176	-4.79	6.64	12.80
33	11.58	2.35	3.23	31.0	1.157	4.86	6.68	12.85
34	-11.71	-2.38	3.28	32.7	-1.170	-4.94	6.80	13.53
35	11.58	2.56	3.58	34.1	1.157	5.29	7.41	14.10
36	-11.64	-2.36	3.58	34.8	-1.163	-4.89	7.41	14.40
37	11.58	2.79	3.79	36.2	1.156	5.77	7.84	14.97
38	-11.72	-2.71	4.10	40.5	-1.170	-5.62	8.48	16.76
39	11.74	3.01	4.28	42.2	1.173	6.24	8.85	17.47
40	-11.91	-2.55	4.11	40.9	-1.190	-5.28	8.50	16.93
41	11.64	3.53	4.62	45.2	1.163	7.30	9.56	18.70
42	-11.79	-2.39	4.45	43.6	-1.178	-4.95	9.21	18.03
43	11.55	3.56	4.46	43.1	1.154	7.37	9.25	17.84
44	-11.60	-2.33	4.46	43.2	-1.159	-4.83	9.24	17.89
45	11.42	3.57	4.46	42.6	1.141	7.38	9.24	17.63
46	-11.58	-2.38	4.49	43.3	-1.157	-4.94	9.31	17.91
47	11.28	3.60	4.51	42.1	1.127	7.45	9.35	17.44
48	-11.51	-2.38	4.52	43.1	-1.150	-4.94	9.37	17.82
49	11.07	3.58	4.52	42.1	1.106	7.42	9.36	17.42
50	-11.30	-2.34	4.47	42.0	-1.129	-4.84	9.26	17.38
51	10.97	3.58	4.49	40.5	1.096	7.42	9.30	16.75

Half-Cycle	P KIPS	Δ IN.	Δ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}$	$\bar{W}$
52	-11.23	-2.34	4.48	41.1	-1.122	-4.84	9.28	17.02
53	10.91	3.59	4.48	40.2	1.090	7.43	9.28	16.63
54	-11.17	-2.34	4.43	41.4	-1.116	-4.85	9.18	17.15
55	10.88	3.69	4.54	40.3	1.087	7.64	9.39	16.67
56	-11.08	-2.28	4.53	41.0	-1.107	-4.72	9.39	16.95
57	10.67	3.70	4.53	39.4	1.066	7.66	9.39	16.28
58	-11.00	-2.28	4.53	40.5	-1.099	-4.73	9.39	16.76
59	10.58	3.70	4.53	38.9	1.057	7.66	9.39	16.09
60	-10.92	-2.28	4.53	40.2	-1.091	-4.73	9.39	16.65
61	10.49	3.66	4.52	38.7	1.048	7.58	9.36	16.03
62	-10.82	-2.26	4.52	39.6	-1.081	-4.69	9.37	16.38
63	10.42	3.67	4.52	38.1	1.041	7.61	9.36	15.77
64	-10.75	-2.29	4.52	39.4	-1.074	-4.73	9.37	16.30
65	10.34	3.67	4.52	38.1	1.033	7.61	9.37	15.77
66	-10.68	-2.27	4.48	39.2	-1.067	-4.70	9.28	16.23
67	10.21	3.67	4.55	38.4	1.020	7.59	9.42	15.91
68	-10.61	-2.30	4.55	38.8	-1.060	-4.76	9.42	16.06
69	10.15	3.67	4.55	37.3	1.014	7.60	9.42	15.44
70	-10.62	-2.30	4.55	38.7	-1.061	-4.76	9.42	16.03
71	10.08	3.67	4.55	37.0	1.007	7.60	9.42	15.33
72	-10.58	-2.30	4.55	38.6	-1.057	-4.76	9.42	15.98
73	10.00	3.68	4.55	37.7	0.999	7.62	9.43	15.58
74	-10.45	-2.28	4.56	37.9	-1.044	-4.72	9.43	15.67
75	9.95	3.68	4.56	37.0	0.994	7.62	9.43	15.31
76	-10.10	-2.29	4.56	37.5	-1.009	-4.73	9.44	15.52
77	9.79	3.68	4.56	36.3	0.978	7.63	9.43	15.02
78	-8.99	-2.30	4.60	35.1	-0.898	-4.77	9.52	14.53
79	9.41	3.65	4.51	33.3	0.940	7.55	9.35	13.77

SPECIMEN F1-C6

Description: This specimen was similar to specimen F1-C4 with respect to detailing, fabrication and inspection.

Program of Cycling:



Test Control: Strain, as measured on the top flange 5.50 inches from the column face.

Raw Data Included: Graphical load-strain data for the control strain.
Grahpical load-deflection data.

Total Energy Absorption: 2,574 kip-inches.

Plastic Load Reversals to Failure: 64 (32 cycles).

Remarks: A crack was found at the innermost top flange stud weld after $7\frac{1}{2}$ cycles. Buckling of the top flange became visible after 9 cycles. By the 21st cycle, the above crack was beginning to penetrate into the top flange. After $27\frac{1}{2}$ cycles, numerous fine cracks were noted in the concave face of the top flange buckle, possibly originating from a scribe mark for strain gage positioning. Necking of the web became apparent after 29½ cycles, and the first-mentioned crack penetrated into the web in the next cycle. At termination of the test, the top flange crack extended across virtually the entire flange.

SPECIMEN TYPE F1-C6

DIMENSIONS OF WF SECTION

DEPTH	8.24	INCHES
TOP FLANGE WIDTH	5.300	INCHES
BOTTOM FLANGE WIDTH	5.300	INCHES
TOP FLANGE THICKNESS	0.345	INCHES
BOTTOM FLANGE THICKNESS	0.352	INCHES
WEB THICKNESS	0.262	INCHES
ELASTIC MODULUS	29400.	KSI
YIELD STRESS	35.900	KSI

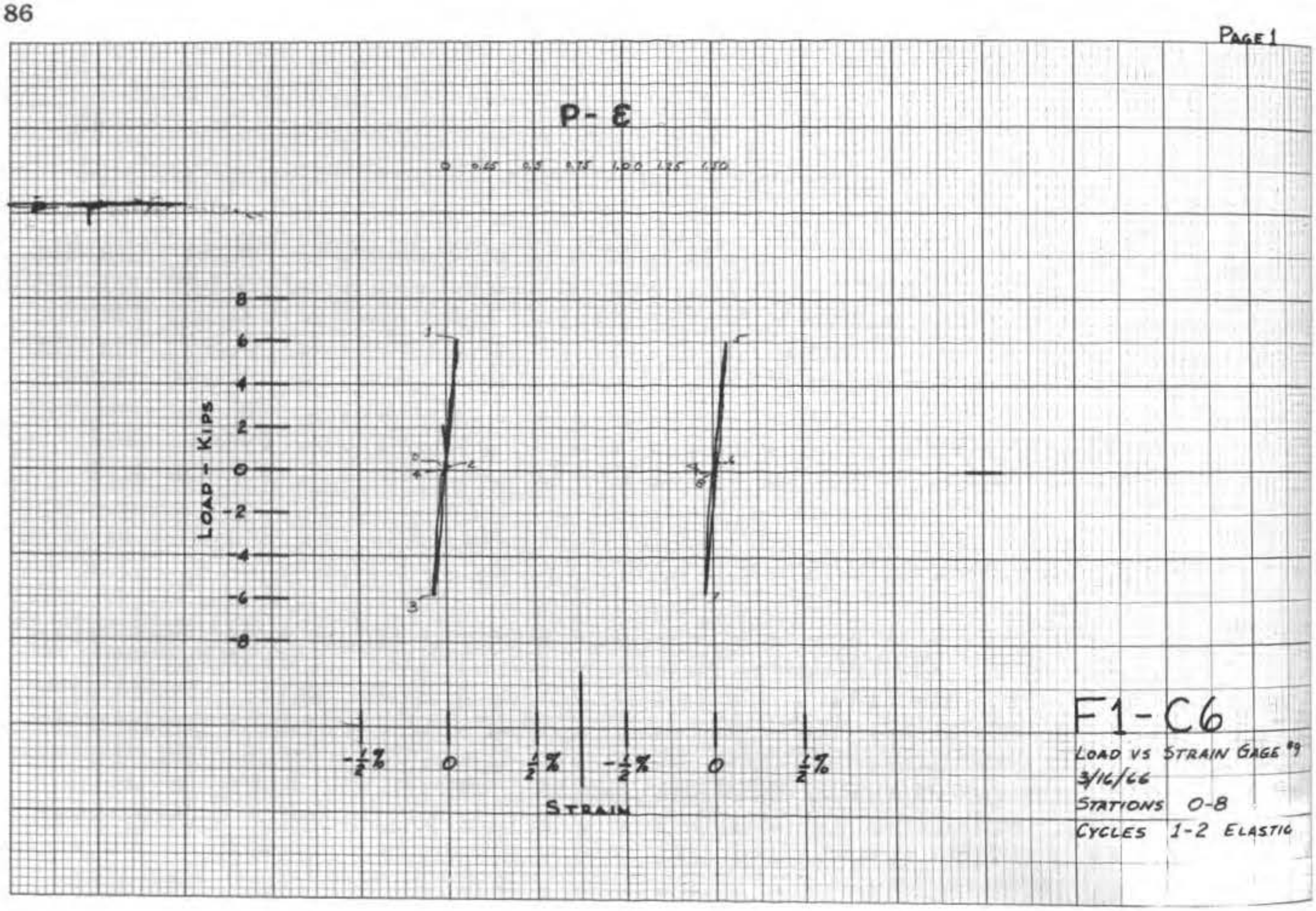
WF SECTION PROPERTIES

AREA, A	5.76	INCHES**2
LOCATION OF CENTROID*, YE	4.10	INCHES
MOMENT OF INERTIA, I	68.1	INCHES**4
SECTION MODULUS, TOP, ST	16.5	INCHES**3
SECTION MODULUS, BOTTOM, SB	16.6	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.06	INCHES
PLASTIC MODULUS, Z	18.6	INCHES**3
SHAPE FACTOR	1.132	
YIELD MOMENT, MY	49.21	KIP-FT.
PLASTIC MOMENT, MP	55.71	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

BEAM PROPERTIES

LENGTH, L	66.0	INCHES
ELASTIC STIFFNESS, P/DELTA	20.89	KIPS/IN.
YIELD DEFLECTION, DELTAY	0.428	INCHES
YIELD LOAD, PY	8.95	KIPS
PLASTIC LOAD, PP	10.13	KIPS



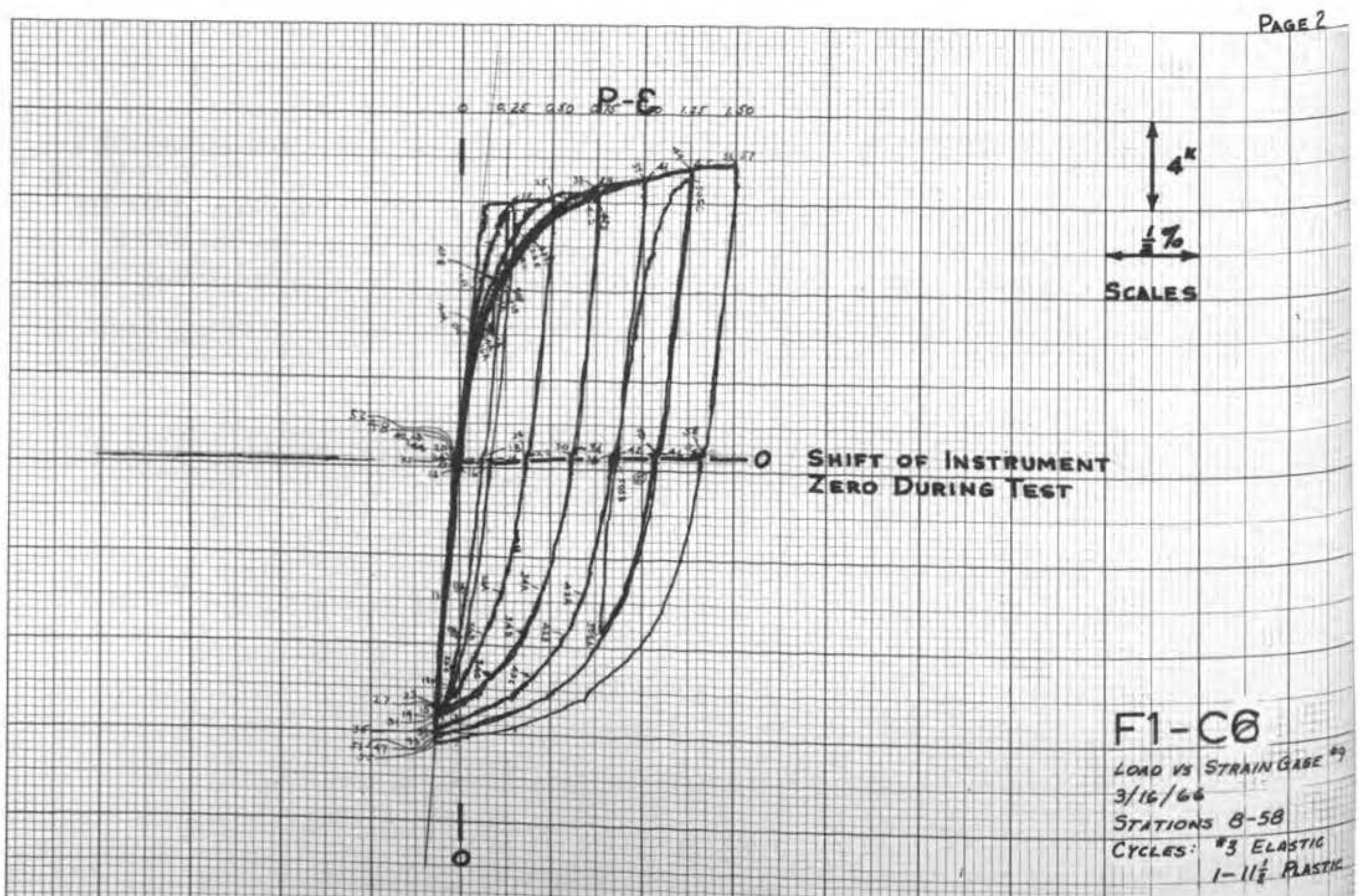


PLATE 7. LOAD VS. STRAIN - F1-C6

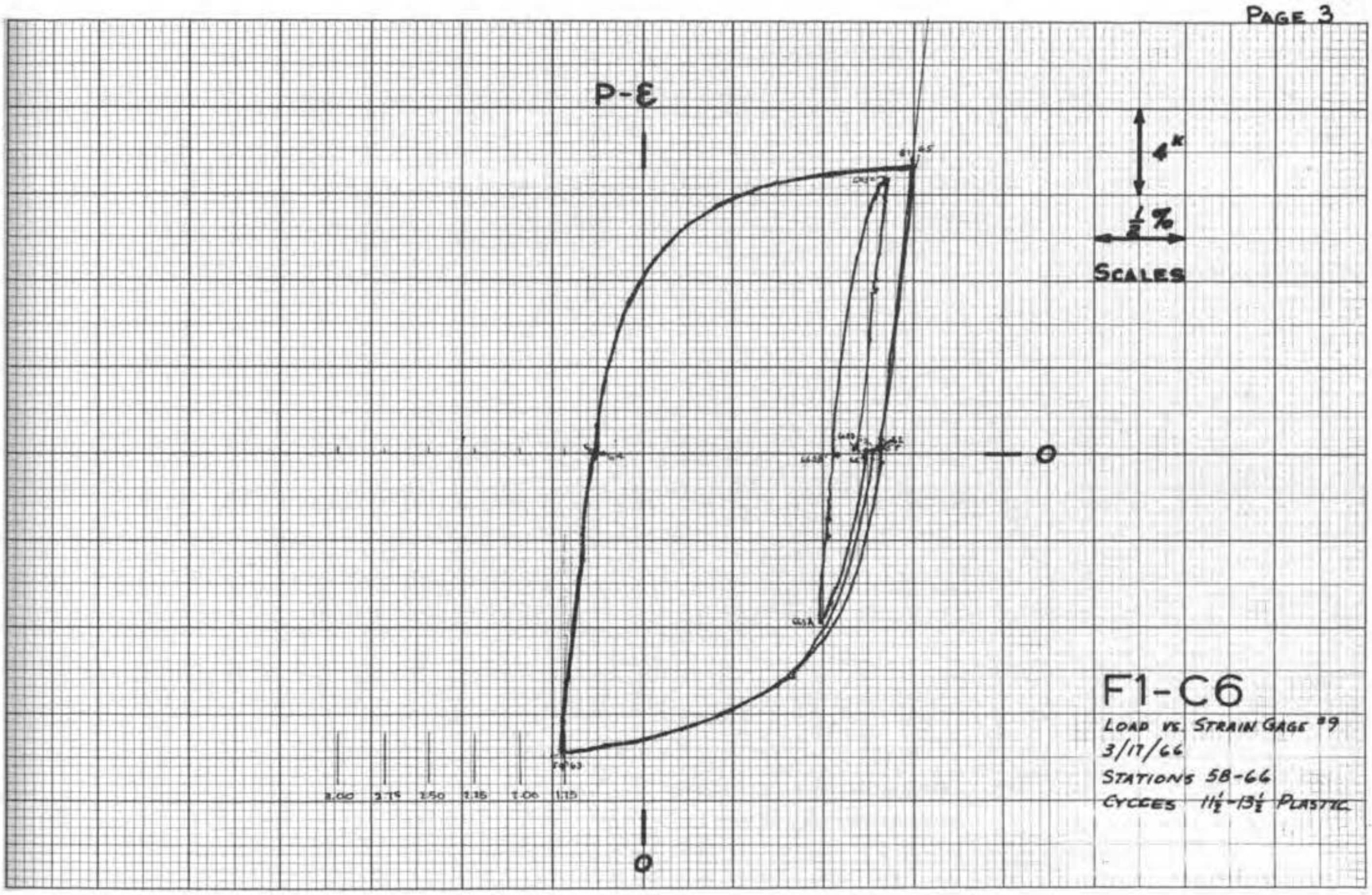
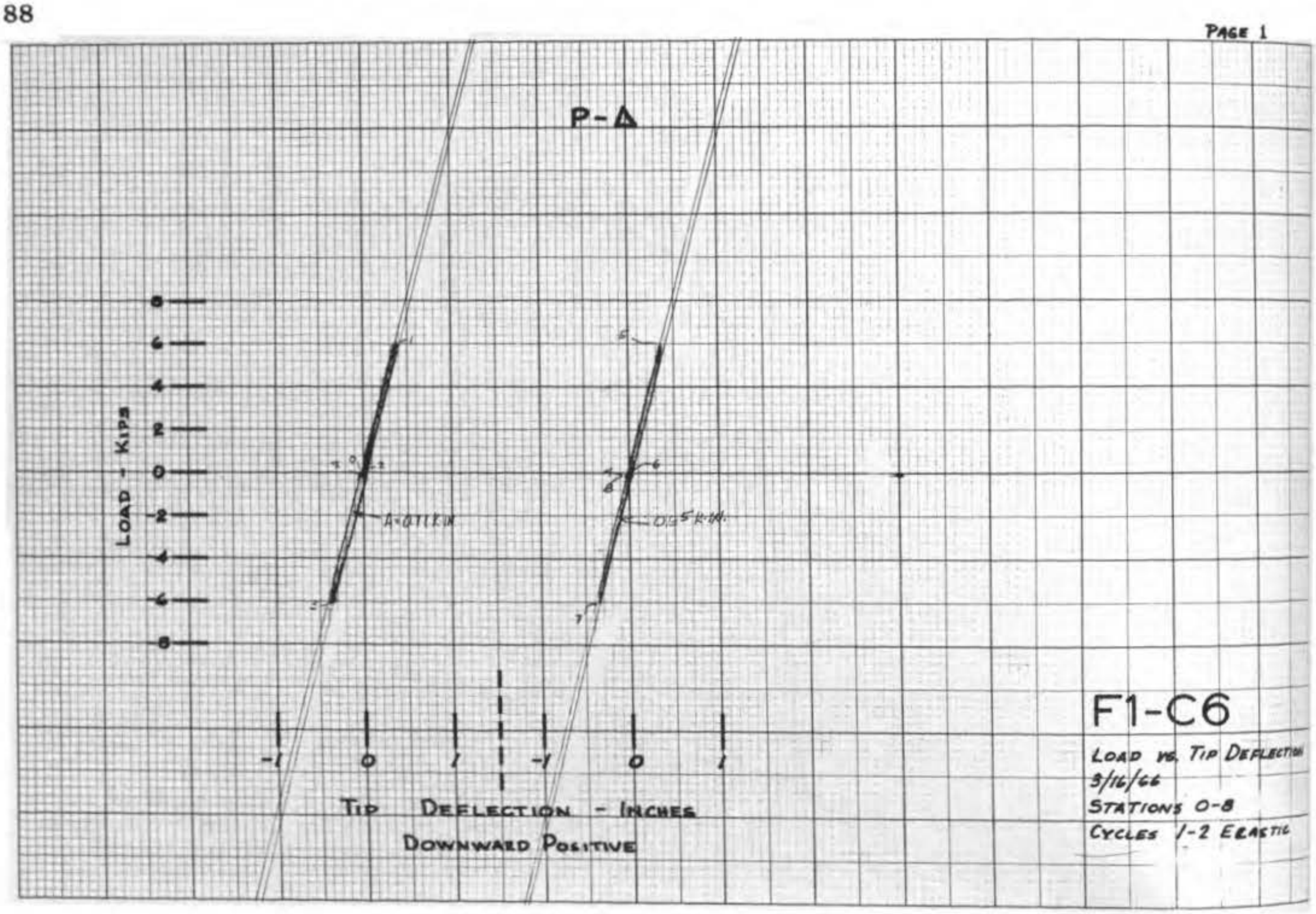
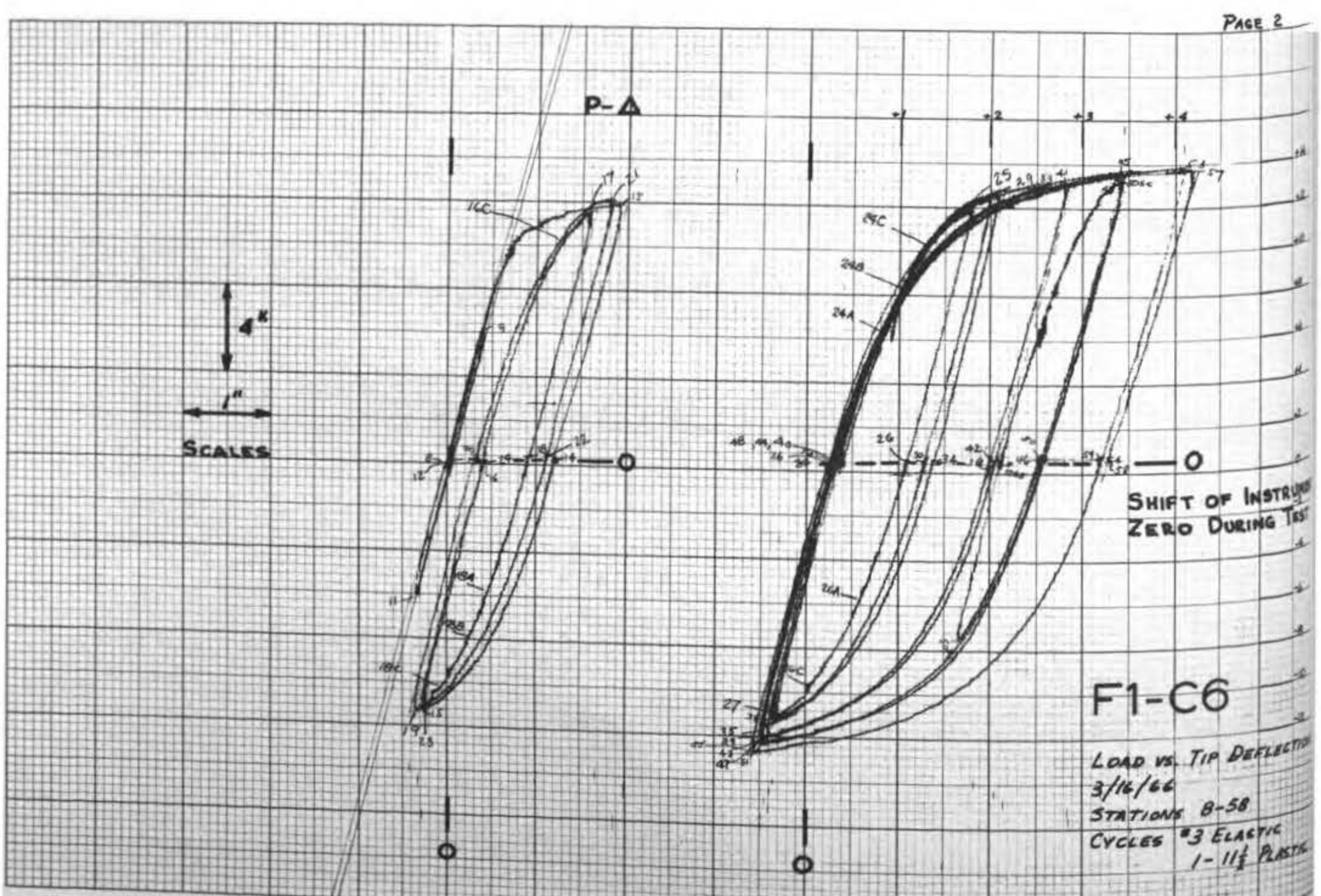
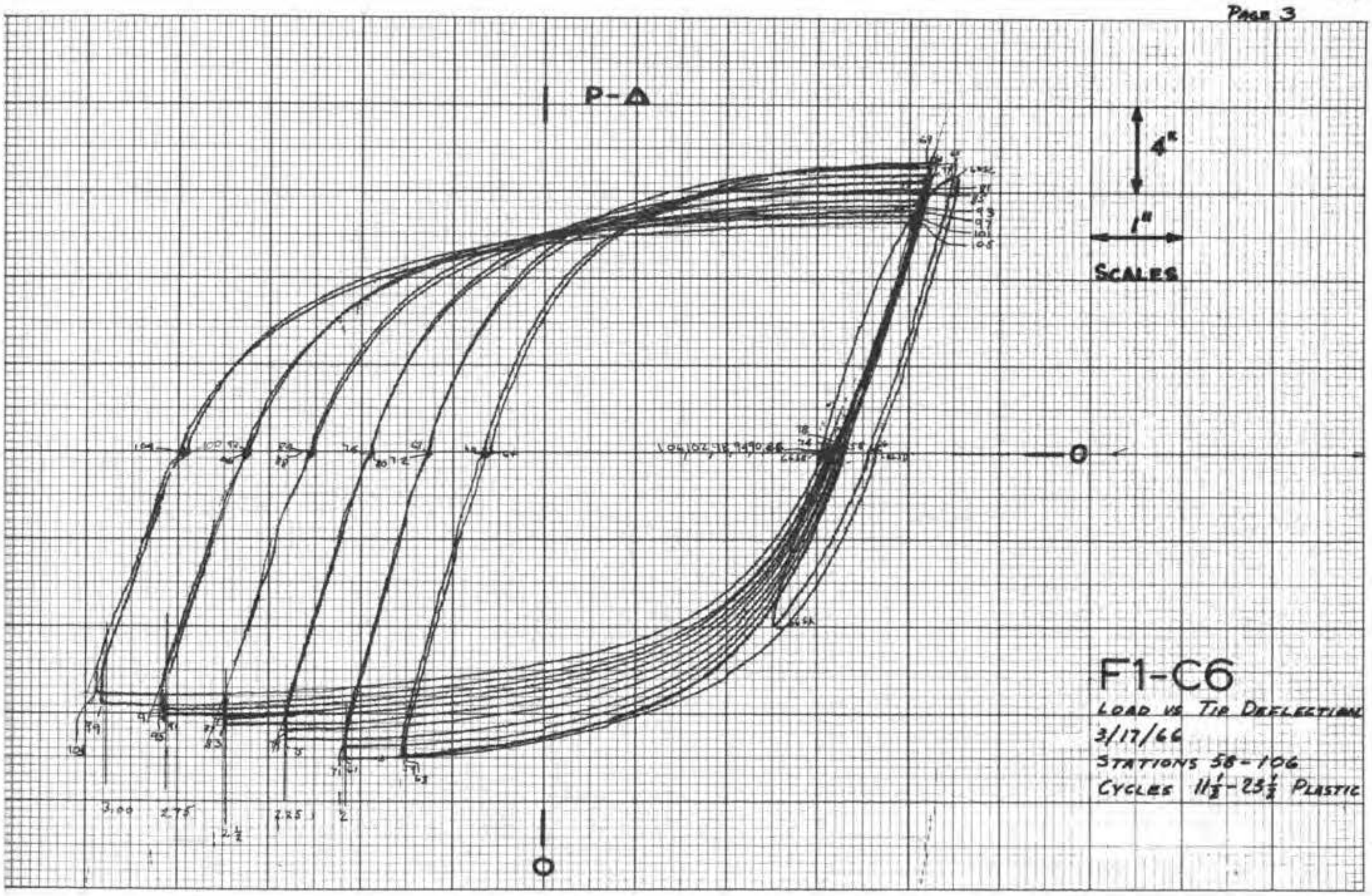


PLATE 7. (continued)


PAGE 1
P-Δ
LOAD - KIPS
TIP DEFLECTION - INCHES
DOWNWARD POSITIVE
F1-C6
LOAD VS. TIP DEFLECTION
3/16/66
STATIONS 0-8
CYCLES 1-2 ELASTIC


PAGE 2
P-Δ
4ᴷ
1"
SCALES
SHIFT OF INSTRUMENT ZERO DURING TEST
F1-C6
LOAD VS. TIP DEFLECTION
3/16/66
STATIONS 8-58
CYCLES #3 ELASTIC
1-11½ PLASTIC



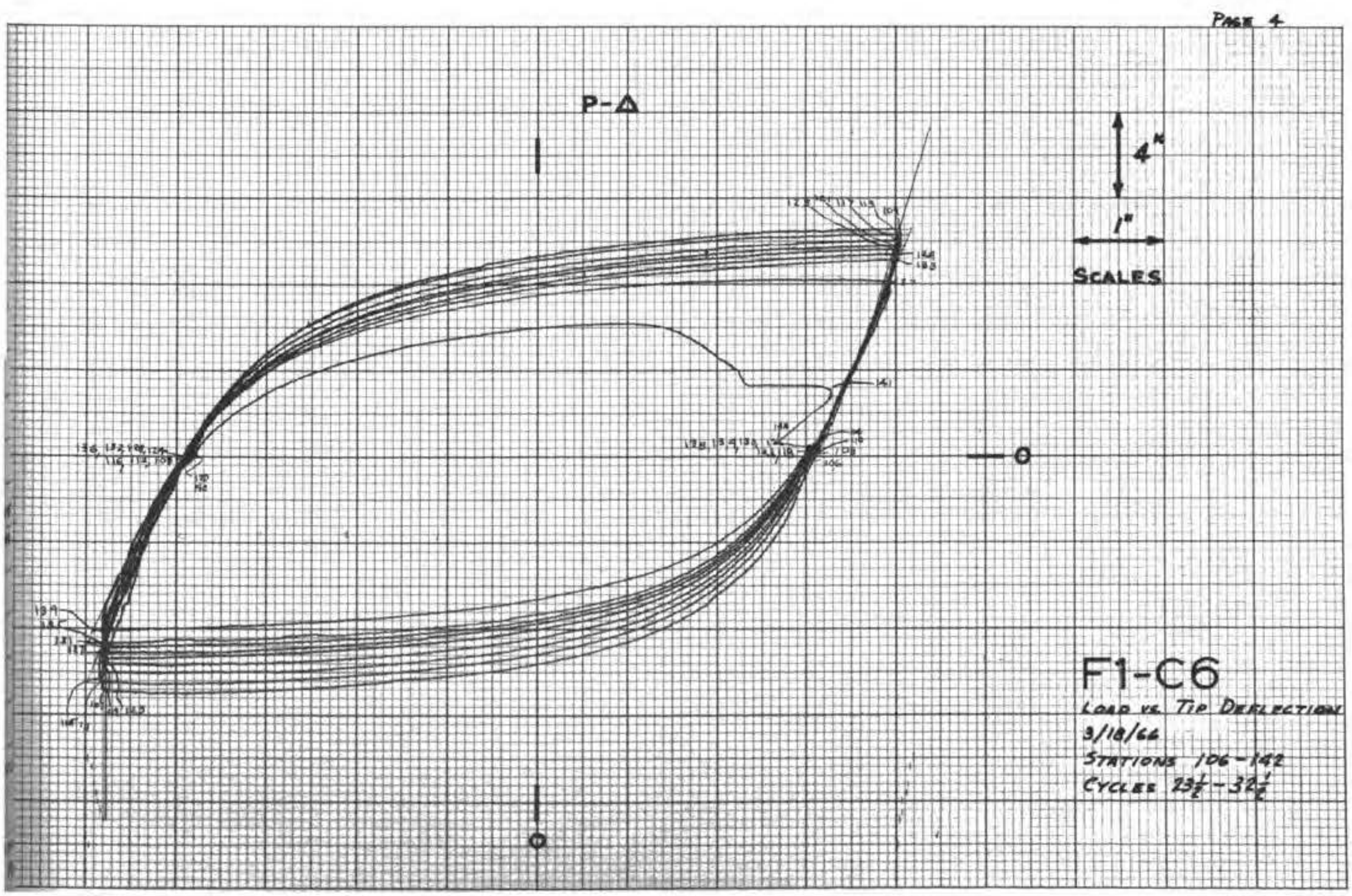


PLATE 8. (continued)

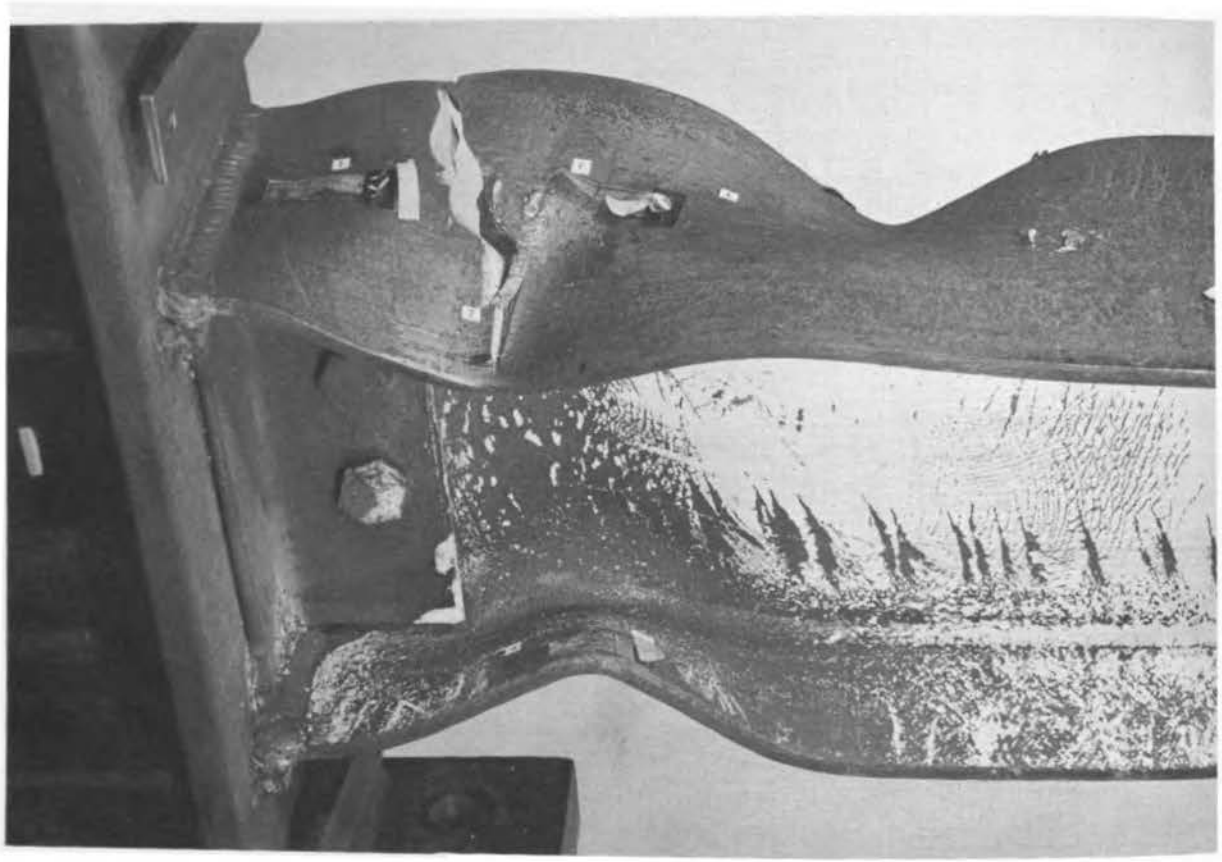
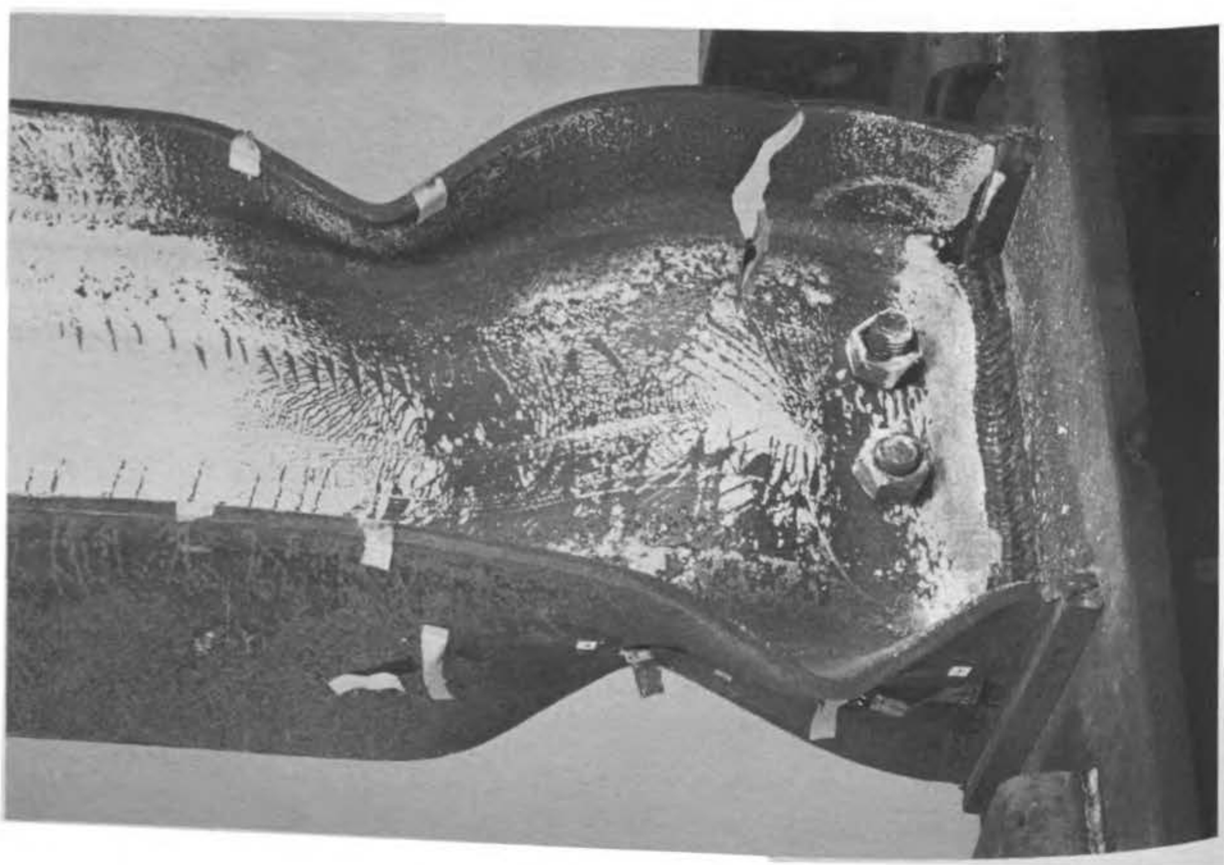


FIGURE 21. F1-C6



SPECIMEN F1-C6

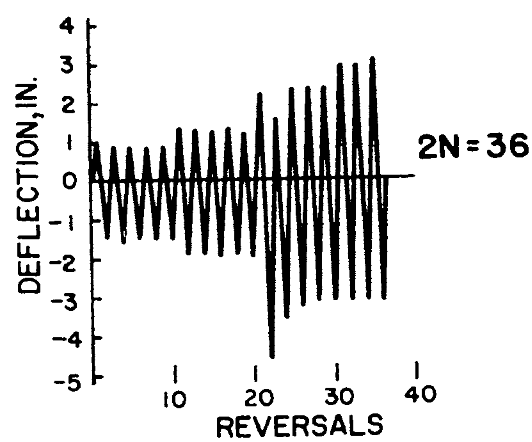
Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	11.51	1.72	1.17	12.3	1.137	3.55	2.42	5.01
2	-11.02	-0.11	0.72	6.5	-1.088	-0.22	1.48	2.63
3	10.89	1.41	0.43	3.9	1.075	2.91	0.89	1.59
4	-11.18	-0.19	0.54	4.6	-1.104	-0.39	1.11	1.88
5	11.48	1.63	0.75	6.8	1.133	3.37	1.54	2.77
6	-11.06	-0.07	0.65	5.4	-1.092	-0.15	1.34	2.21
7	11.46	1.65	0.62	5.4	1.132	3.39	1.28	2.21
8	-11.05	-0.12	0.67	5.8	-1.091	-0.25	1.38	2.35
9	11.83	1.83	0.87	8.1	1.167	3.77	1.80	3.28
10	-11.09	-0.16	0.89	7.8	-1.095	-0.32	1.83	3.20
11	12.36	1.93	0.99	9.6	1.220	3.98	2.04	3.89
12	-11.57	-0.26	1.02	9.6	-1.143	-0.54	2.09	3.90
13	12.35	2.71	1.69	16.7	1.220	5.59	3.49	6.79
14	-12.05	-0.19	1.68	16.5	-1.190	-0.40	3.47	6.72
15	12.34	2.63	1.64	16.3	1.218	5.42	3.39	6.65
16	-12.13	-0.27	1.66	16.3	-1.198	-0.56	3.42	6.65
17	12.81	3.24	2.20	23.9	1.264	6.69	4.54	9.73
18	-12.46	-0.28	2.20	22.4	-1.230	-0.57	4.54	9.13
19	12.76	3.22	2.17	23.5	1.260	6.65	4.48	9.57
20	-12.51	-0.26	2.14	22.9	-1.235	-0.53	4.42	9.33
21	12.98	3.91	2.81	31.2	1.282	8.06	5.80	12.72
22	-12.91	-0.35	2.89	30.3	-1.275	-0.73	5.96	12.32
23	12.91	4.00	2.96	32.7	1.275	8.25	6.11	13.31
24	-13.59	-1.37	3.92	44.5	-1.342	-2.83	8.08	18.12
25	13.05	3.98	3.92	44.2	1.288	8.21	8.08	18.00
26	-13.60	-1.34	3.84	43.6	-1.342	-2.76	7.91	17.74
27	12.95	4.22	4.14	46.6	1.278	8.70	8.53	18.97
28	-13.72	-2.02	4.81	55.2	-1.355	-4.16	9.91	22.47
29	12.86	3.98	4.49	50.6	1.270	8.21	9.26	20.60
30	-13.16	-2.03	4.49	50.2	-1.300	-4.18	9.25	20.42
31	12.52	3.95	4.44	48.6	1.236	8.14	9.16	19.79
32	-12.86	-2.66	5.06	56.6	-1.270	-5.49	10.43	23.04
33	12.19	3.94	5.08	53.6	1.203	8.13	10.47	21.82
34	-12.42	-2.67	5.08	54.0	-1.226	-5.51	10.47	21.99
35	11.83	3.90	5.05	51.6	1.168	8.04	10.41	21.01
36	-12.20	-3.34	5.69	60.1	-1.205	-6.89	11.74	24.47
37	11.65	3.90	5.67	56.9	1.150	8.04	11.68	23.18
38	-11.90	-3.35	5.64	57.7	-1.175	-6.90	11.64	23.47
39	11.33	3.90	5.63	55.1	1.118	8.04	11.60	22.42
40	-11.78	-4.03	6.35	64.2	-1.163	-8.31	13.09	26.14
41	11.04	3.87	6.31	59.5	1.090	7.98	13.01	24.24
42	-11.48	-4.05	6.32	62.5	-1.133	-8.36	13.03	25.43
43	10.79	3.87	6.31	58.5	1.065	7.99	13.01	23.80
44	-11.30	-4.70	6.98	68.4	-1.116	-9.69	14.39	27.83
45	10.57	3.83	6.93	63.0	1.043	7.89	14.29	25.63
46	-10.73	-4.76	7.00	65.7	-1.060	-9.82	14.43	26.74
47	10.27	3.82	7.04	61.1	1.014	7.88	14.53	24.88
48	-10.49	-4.63	6.88	65.3	-1.036	-9.54	14.19	26.59
49	10.13	3.90	6.92	56.6	1.000	8.05	14.26	23.04
50	-10.12	-4.67	6.91	61.8	-0.999	-9.64	14.26	25.17
51	9.83	3.88	6.87	56.6	0.971	8.00	14.18	23.04

Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
52	-9.67	-4.64	6.87	59.8	-0.954	-9.57	14.18	24.34
53	9.50	3.87	6.87	53.7	0.938	7.98	14.16	21.85
54	-9.35	-4.65	6.79	57.3	-0.923	-9.58	14.01	23.32
55	9.24	3.87	6.77	51.3	0.913	7.97	13.96	20.88
56	-9.13	-4.64	6.85	54.2	-0.901	-9.57	14.13	22.08
57	8.96	3.86	6.87	49.2	0.885	7.96	14.16	20.04
58	-8.90	-4.64	6.84	53.1	-0.879	-9.57	14.11	21.64
59	8.71	3.85	6.84	47.7	0.860	7.95	14.10	19.42
60	-8.70	-4.65	6.85	51.6	-0.859	-9.58	14.13	21.02
61	8.46	3.83	6.83	46.4	0.835	7.89	14.09	18.91
62	-8.51	-4.65	6.84	50.3	-0.840	-9.59	14.11	20.49
63	7.52	3.81	6.83	43.0	0.742	7.86	14.09	17.53
64	-7.95	-4.68	6.72	45.4	-0.785	-9.65	13.86	18.48

SPECIMEN F2-C1

Description: The beam flanges were attached to the column by means of welded connecting plates. The top plate was narrower in width than the flange, while the bottom plate was wider, in order that only down-hand welding be required. The web was butt-welded directly to the column. The specimen was commercially fabricated; there was no visually apparent departure from the detail drawings. Ultrasonic inspection disclosed no significant weld defects. Threaded studs were tack-welded to both plates and flanges to support rotation measuring devices.

Program of Cycling:



Test Control: Strain, as measured on the top flange 16.0 inches from the face of the column.

Raw Data Included: Graphical load-strain data as measured on the top plate 6.0 inches from the face of the column.

Graphical load-strain data for the control strain.

Total Energy Absorption: Not available.

Plastic Load Reversals to Failure: 36 (18 cycles)

Remarks: Buckling of the beam flanges beyond the plates was indicated as early as the 4th plastic cycle, by means of strain measurements. This buckling became visible after about 13 cycles. In the next cycle, a crack appeared in the top plate at the end of one of the plate-to-beam flange welds, nearest the column. After 16 cycles, a longitudinal crack was found in one of the bottom plate-to-flange welds, but away from the column. A crack had also formed at the bottom web cope. During the next cycle the crack in the top plate extended, and necking of the plate was observed. The bottom flange plate was buckling between the column and the near ends of the welds. Failure occurred at 18 cycles with transverse rupture of the top plate at its critical section.

SPECIMEN TYPE F2-C1

DIMENSIONS OF WF SECTION

DEPTH	8.26	INCHES
TOP FLANGE WIDTH	5.320	INCHES
BOTTOM FLANGE WIDTH	5.290	INCHES
TOP FLANGE THICKNESS	0.375	INCHES
BOTTOM FLANGE THICKNESS	0.376	INCHES
WEB THICKNESS	0.274	INCHES
ELASTIC MODULUS	29800.	KSI
YIELD STRESS	38.900	KSI

DIMENSIONS AND PROPERTIES OF TOP PLATE

LENGTH, LP	14.00	INCHES
WIDTH AT END AWAY FROM COLUMN, M	2.53	INCHES
WIDTH AT END OF WELD, R	4.53	INCHES
AVERAGE LOCATION OF END OF WELD*, N	3.49	INCHES
THICKNESS, T	0.520	INCHES
ELASTIC MODULUS	29600.	KSI
YIELD STRESS	38.700	KSI

*MEASURED FROM FACE OF COLUMN

DIMENSIONS AND PROPERTIES OF BOTTOM PLATE

LENGTH, LP	14.00	INCHES
WIDTH, B	6.38	INCHES
AVERAGE LOCATION OF COLUMN END OF WELD*. Q .	2.20	INCHES
AVERAGE LOCATION OF OUTER END OF WELD*, P . .	12.91	INCHES
THICKNESS, T	0.309	INCHES
ELASTIC MODULUS	29100.	KSI
YIELD STRESS	39.100	KSI

*MEASURED FROM FACE OF COLUMN

DEPTH OUT-TO-OUT OF PLATES	9.13	INCHES

WF SECTION PROPERTIES

AREA, A	6.13	INCHES**2
LOCATION OF CENTROID*, YE	4.14	INCHES
MOMENT OF INERTIA, I	72.9	INCHES**4
SECTION MODULUS, TOP, ST	17.7	INCHES**3
SECTION MODULUS, BOTTOM, SB	17.6	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.15	INCHES
PLASTIC MODULUS, Z	19.9	INCHES**3
SHAPE FACTOR	1.130	
YIELD MOMENT, MY	57.11	KIP-FT.
PLASTIC MOMENT, MP	64.51	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

SPECIMEN TYPE F2-C1

SECTION PROPERTIES AT SELECTED CROSS-SECTIONS

X	A	YE	I	ST	SB
52.00	6.13	4.47	72.9	17.6	17.5
52.00	7.44	5.24	93.8	24.1	19.0
52.54	7.49	5.27	94.5	24.4	19.1
53.09	7.55	5.29	95.2	24.8	19.1
53.09	9.47	4.25	135.7	27.8	32.0
57.80	9.93	4.46	145.1	31.1	32.5
62.51	10.40	4.66	153.7	34.4	33.0
62.51	8.19	3.66	115.2	21.0	31.5
63.16	8.25	3.70	116.9	21.5	31.6
63.80	8.31	3.74	118.6	22.0	31.7
63.80	6.11	4.88	88.3	20.8	18.1
64.90	6.22	4.95	90.0	21.5	18.2
66.00	6.32	5.02	91.6	22.3	18.2

X	YP	Z	F	MY	MP
52.00	4.64	19.5	1.115	56.70	63.21
52.00	7.02	23.5	1.228	61.99	76.11
52.54	7.12	23.6	1.230	62.13	76.42
53.09	7.22	23.7	1.232	62.26	76.72
53.09	3.60	34.1	1.233	89.60	110.51
57.80	4.45	36.3	1.175	100.26	117.79
62.51	5.29	38.2	1.151	107.55	123.80
62.51	1.10	27.0	1.292	67.88	87.68
63.16	1.21	27.5	1.286	69.40	89.28
63.80	1.33	28.0	1.281	70.92	90.85
63.80	5.35	21.9	1.205	58.90	71.00
64.90	5.55	22.3	1.220	59.18	72.20
66.00	5.74	22.6	1.233	59.45	73.33

X = DISTANCE FROM CONCENTRATED LOAD, INCHES
A = AREA OF CROSS-SECTION, INCHES**2
YE = DIST. FROM OUTSIDE OF BOTTOM PLATE TO CENTROID, INCHES
I = MOMENT OF INERTIA, INCHES**4
ST = SECTION MODULUS FOR TOP FLANGE, INCHES**3
SB = SECTION MODULUS FOR BOTTOM FLANGE, INCHES**3
YP = DIST. FROM OUTSIDE OF BOTTOM PLATE TO PLASTIC N.A., IN.
Z = PLASTIC MODULUS, INCHES**3
F = SHAPE FACTOR
MY = YIELD MOMENT, KIP-FEET
MP = PLASTIC MOMENT, KIP-FEET

BEAM PROPERTIES

LENGTH, L . . . . 66.0 INCHES
ELASTIC STIFFNESS, P/DELTA . . . . 28.68 KIPS/IN.
YIELD DEFLECTION, DELTAY . . . . 0.377 INCHES
YIELD LOAD, PY . . . . 10.81 KIPS
PLASTIC LOAD, PP . . . . 13.33 KIPS
LOCATION OF CRITICAL SECTION FOR PY* . . . . . 66.00 INCHES
LOCATION OF CRITICAL SECTION FOR PP* . . . . . 66.00 INCHES
* MEASURED FROM CONCENTRATED LOAD

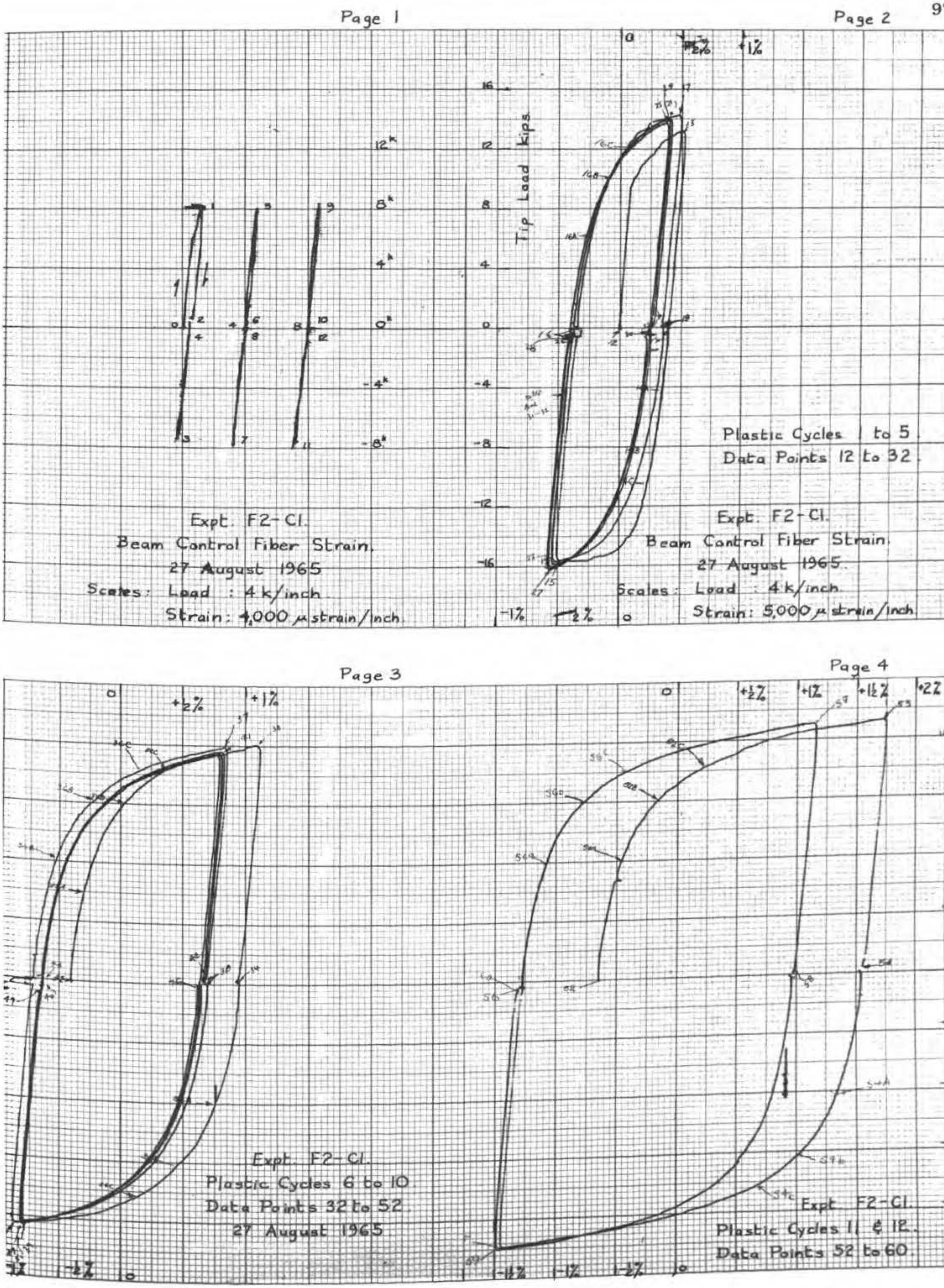


PLATE 9. LOAD VS. STRAIN - F2-C1

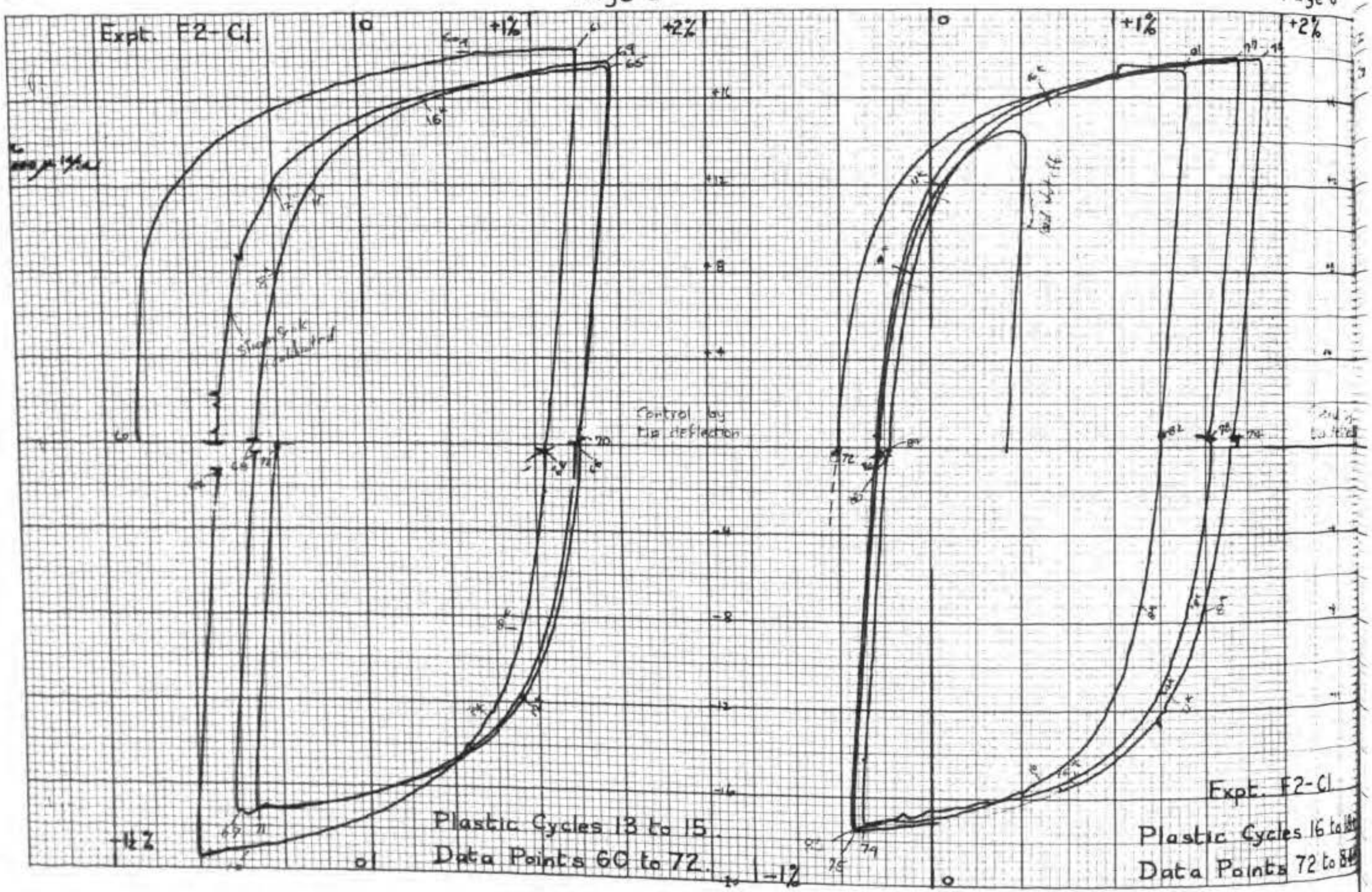
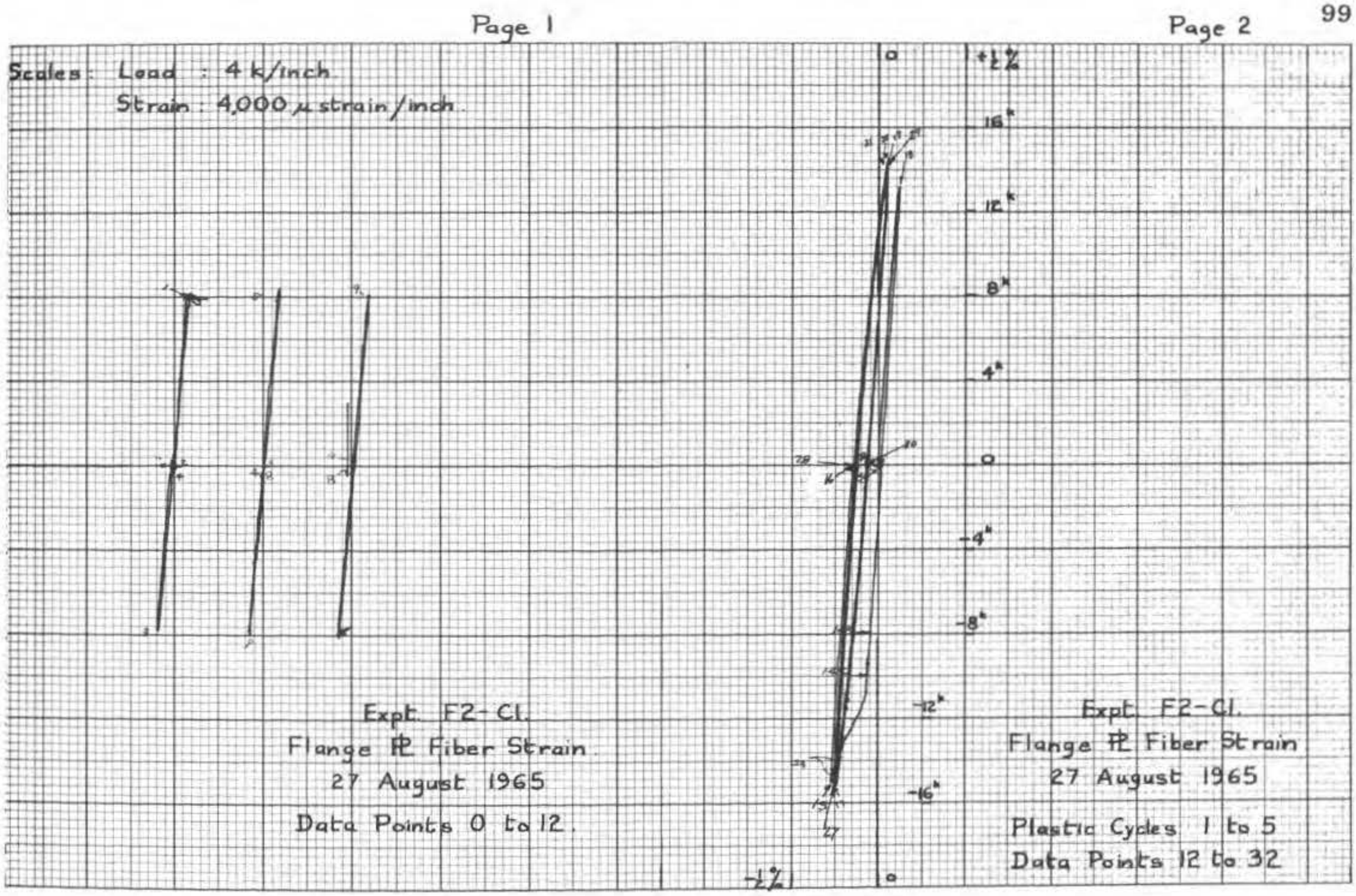


PLATE 9. (continued)



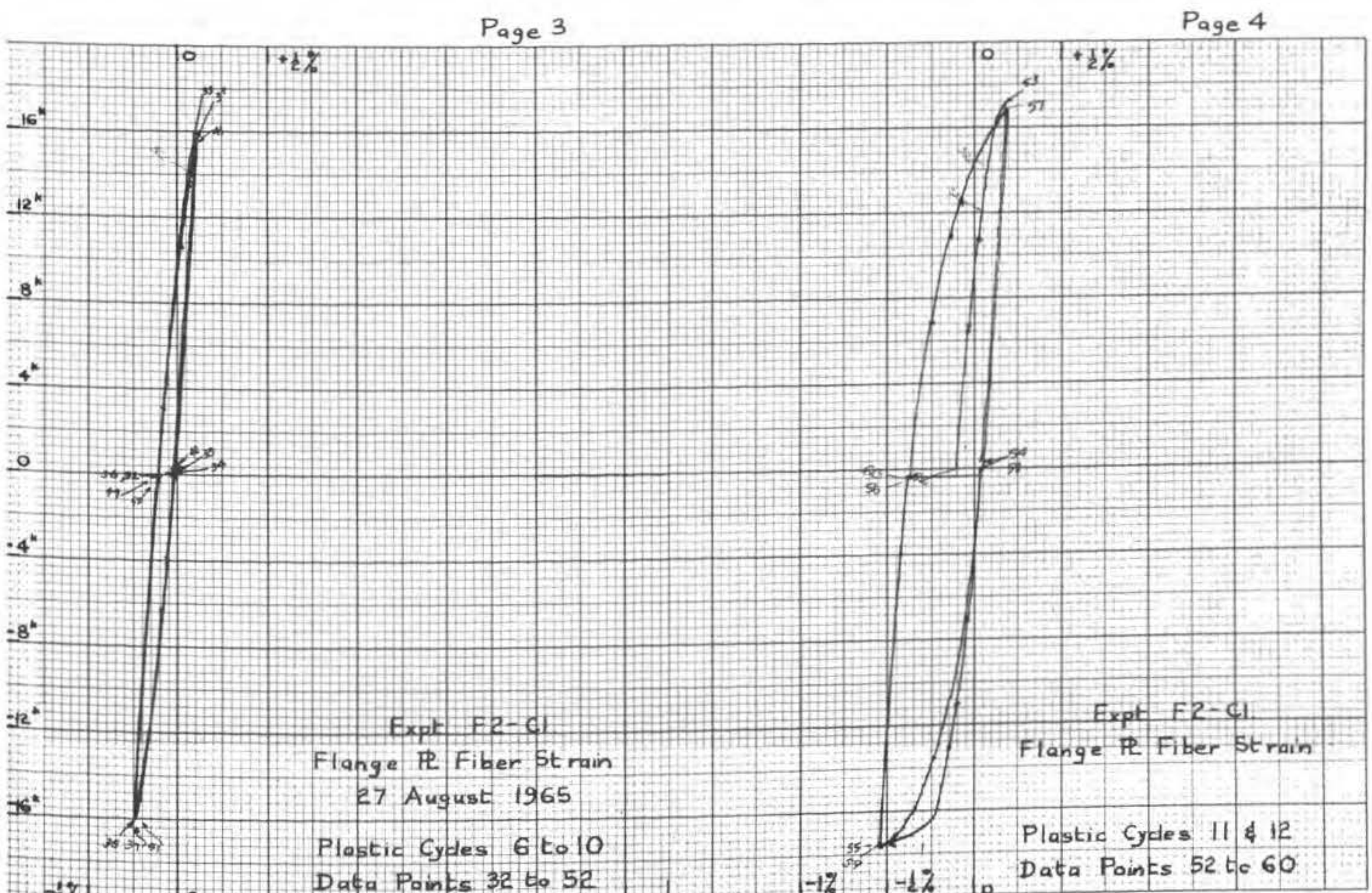


PLATE 10. LOAD VS. STRAIN - F2-C1

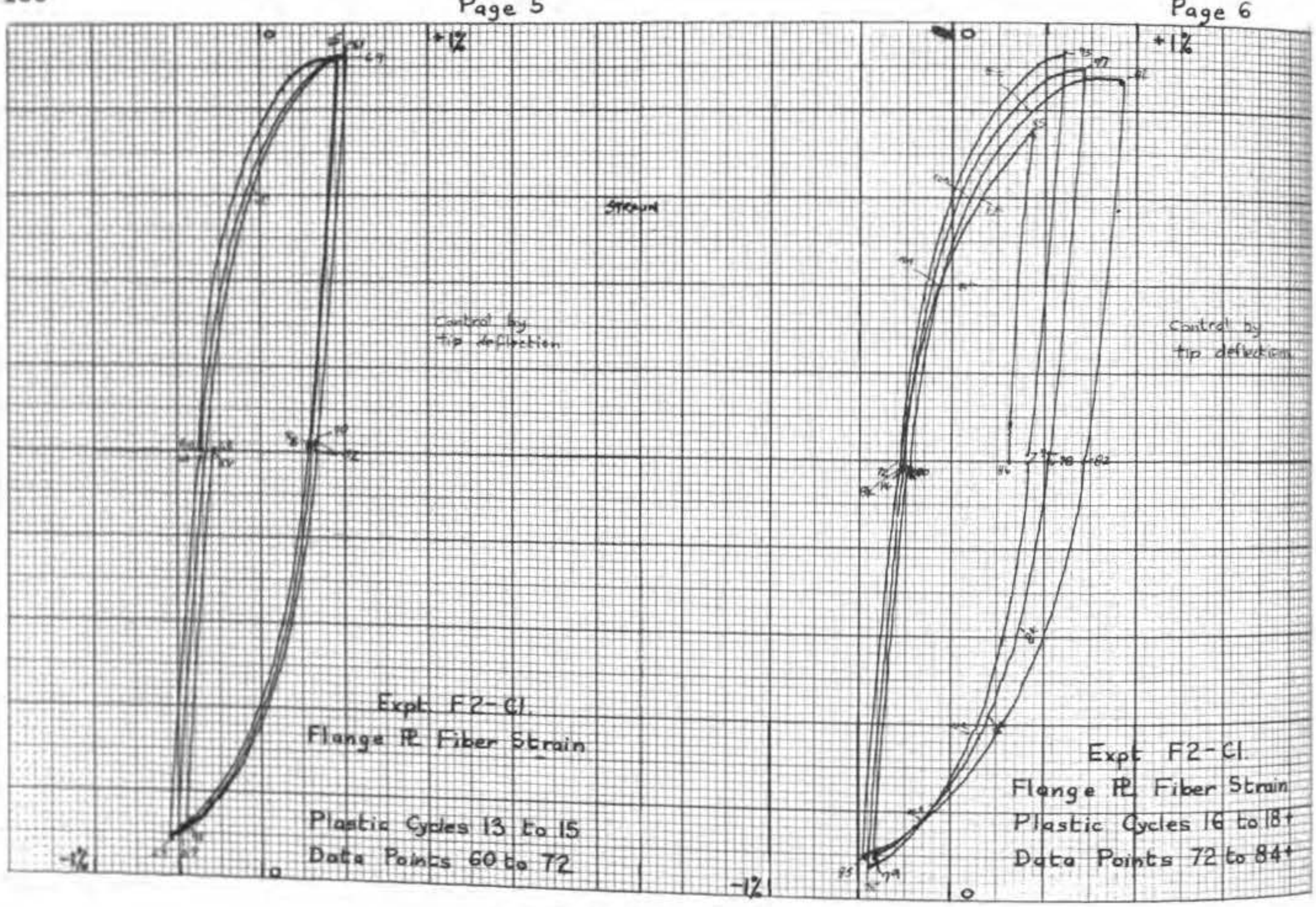


PLATE 10. (continued)

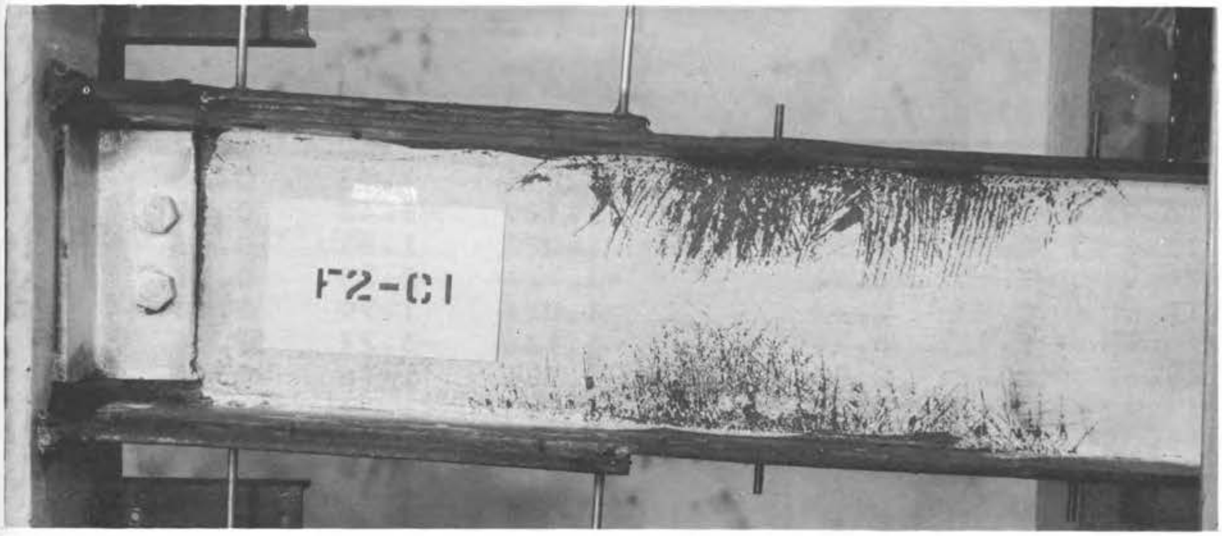


FIGURE 23. F2-C1

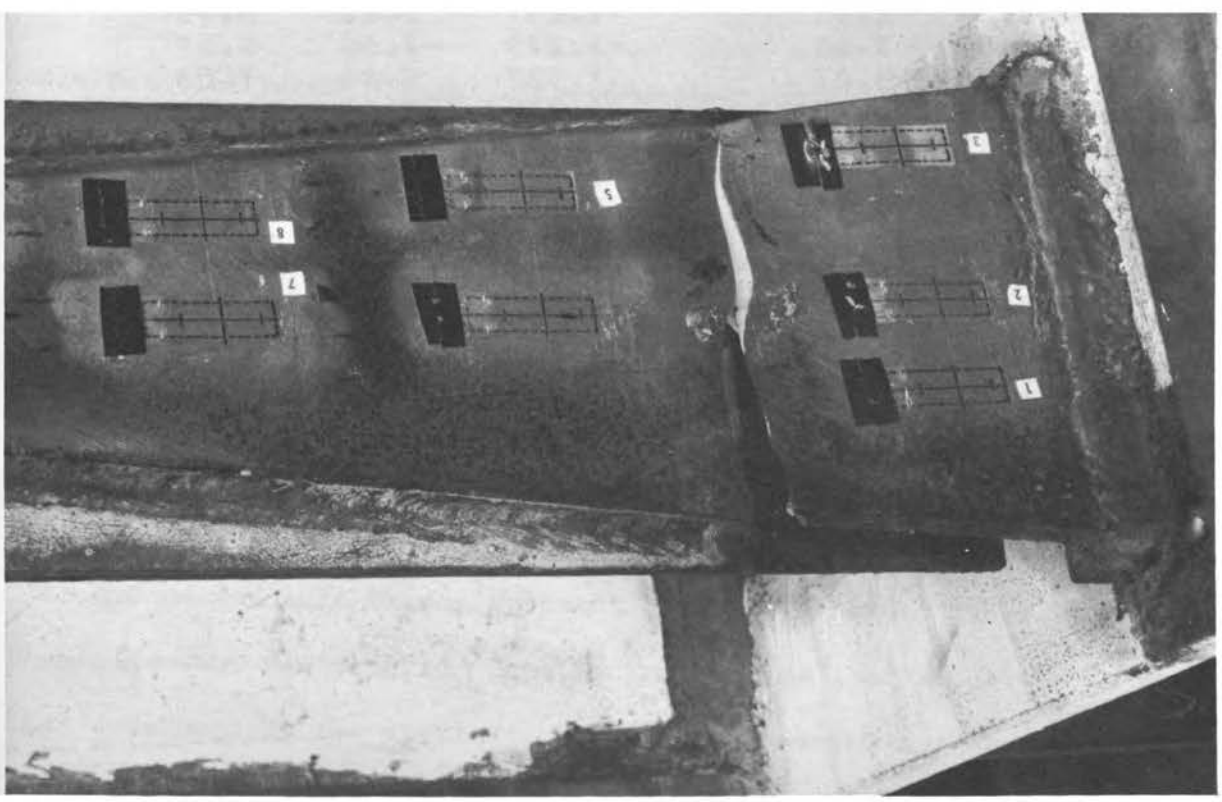


FIGURE 24. F2-C1

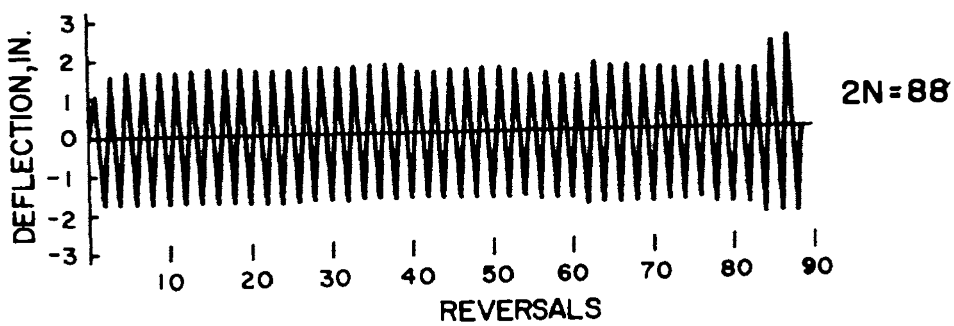
SPECIMEN F2-C1

Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$
1	12.55	0.98	0.14	0.942	2.11	0.30
2	-14.64	-1.44	0.50	-1.098	-3.10	1.07
3	13.48	0.85	0.31	1.011	1.83	0.66
4	-14.93	-1.58	0.33	-1.120	-3.40	0.70
5	13.63	0.84	0.39	1.022	1.81	0.83
6	-14.98	-1.50	0.41	-1.124	-3.23	0.87
7	13.68	0.83	0.42	1.026	1.79	0.90
8	-14.93	-1.52	0.44	-1.120	-3.27	0.94
9	13.68	0.82	0.45	1.026	1.76	0.96
10	-14.93	-1.53	0.46	-1.120	-3.29	0.98
11	15.02	1.33	0.76	1.127	2.86	1.63
12	-15.62	-1.90	1.06	-1.172	-4.09	2.27
13	15.14	1.24	0.96	1.136	2.67	2.06
14	-15.60	-1.89	0.95	-1.170	-4.07	2.04
15	15.07	1.21	0.92	1.130	2.60	1.97
16	-15.65	-1.93	0.95	-1.174	-4.15	2.04
17	14.37	1.28	0.95	1.078	2.75	2.04
18	-18.25	-1.94	0.97	-1.369	-4.17	2.08
19	13.02	1.18	0.94	0.977	2.54	2.01
20	-15.66	-1.96	0.96	-1.175	-4.22	2.06
21	16.39	2.18	1.89	1.230	4.69	4.06
22	-17.16	-4.54	3.35	-1.287	-9.77	7.20
23	16.48	1.54	2.66	1.237	3.31	5.71
24	-17.05	-3.56	2.64	-1.279	-7.66	5.67
25	17.69	2.26	3.27	1.327	4.86	7.03
26	-17.47	-3.27	3.19	-1.310	-7.04	6.85
27	17.65	2.33	3.27	1.324	5.01	7.03
28	-17.36	-3.12	2.90	-1.302	-6.71	6.23
29	17.55	2.32	2.90	1.316	4.99	6.23
30	-17.26	-3.12	2.90	-1.295	-6.71	6.23
31	17.74	2.93	3.47	1.331	6.30	7.46
32	-17.37	-3.12	3.47	-1.303	-6.71	7.46
33	17.54	2.93	3.48	1.316	6.30	7.48
34	-17.26	-3.12	3.47	-1.295	-6.71	7.46
35	17.02	3.03	4.59	1.277	6.52	9.87
36	-17.26	-3.12	1.00	-1.295	-6.71	2.14

SPECIMEN F2-C4

Description: This specimen was similar to specimen F2-C1 with respect to detailing, fabrication and inspection.

Program of Cycling:



Test Control: Strain, as measured on the top flange 16.01 inches from the face of the column. The strain was read on a Baldwin SR-4 strain indicator.

Raw Data Included: Graphical load-deflection data.

Total Energy Absorption: 2,495 kip-inches.

Plastic Load Reversals to Failure: 88 (44 cycles).

Remarks: Slight buckling appeared in the beam flanges during the first plastic cycle. Small cracks began to appear at the ends of the plate-to-beam welds at about the 5th cycle. These cracks propagated very slowly as cycling continued. Necking of one edge of the top plate at the end of the weld became apparent after 16 cycles. The weld on the opposite edge was cracking longitudinally. By the 39th cycle, a crack had developed in the plate at the point of necking and extended about one inch into the plate in the next cycle. During the 44th cycle, this crack rapidly widened, precipitating failure.

SPECIMEN TYPE F2-C4

DIMENSIONS OF WF SECTION

DEPTH	8.25	INCHES
TOP FLANGE WIDTH	5.160	INCHES
BOTTOM FLANGE WIDTH	5.160	INCHES
TOP FLANGE THICKNESS	0.373	INCHES
BOTTOM FLANGE THICKNESS	0.368	INCHES
WEB THICKNESS	0.273	INCHES
ELASTIC MODULUS	29000.	KSI
YIELD STRESS	40.500	KSI

DIMENSIONS AND PROPERTIES OF TOP PLATE

LENGTH, LP	14.36	INCHES
WIDTH AT END AWAY FROM COLUMN, M	2.70	INCHES
WIDTH AT END OF WELD, R	4.52	INCHES
AVERAGE LOCATION OF END OF WELD*, N	4.46	INCHES
THICKNESS, T	0.470	INCHES
ELASTIC MODULUS	29600.	KSI
YIELD STRESS	40.500	KSI

*MEASURED FROM FACE OF COLUMN

DIMENSIONS AND PROPERTIES OF BOTTOM PLATE

LENGTH, LP	14.23	INCHES
WIDTH, B	6.45	INCHES
AVERAGE LOCATION OF COLUMN END OF WELD*, Q .	2.10	INCHES
AVERAGE LOCATION OF OUTER END OF WELD*, P . .	12.88	INCHES
THICKNESS, T	0.370	INCHES
ELASTIC MODULUS	29600.	KSI
YIELD STRESS	38.100	KSI

*MEASURED FROM FACE OF COLUMN

DEPTH CUT-TO-CUT OF PLATES	9.05	INCHES

WF SECTION PROPERTIES

AREA, A	5.96	INCHES**2
LOCATION OF CENTROID*, YE	4.14	INCHES
MOMENT OF INERTIA, I	70.2	INCHES**4
SECTION MODULUS, TOP, ST	17.1	INCHES**3
SECTION MODULUS, BOTTOM, SB	16.9	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP	4.18	INCHES
PLASTIC MODULUS, Z	19.2	INCHES**3
SHAPE FACTOR	1.135	
YIELD MOMENT, MY	57.18	KIP-FT.
PLASTIC MOMENT, MP	64.89	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

SPECIMEN TYPE F2-C4

SECTION PROPERTIES AT SELECTED CROSS-SECTIONS

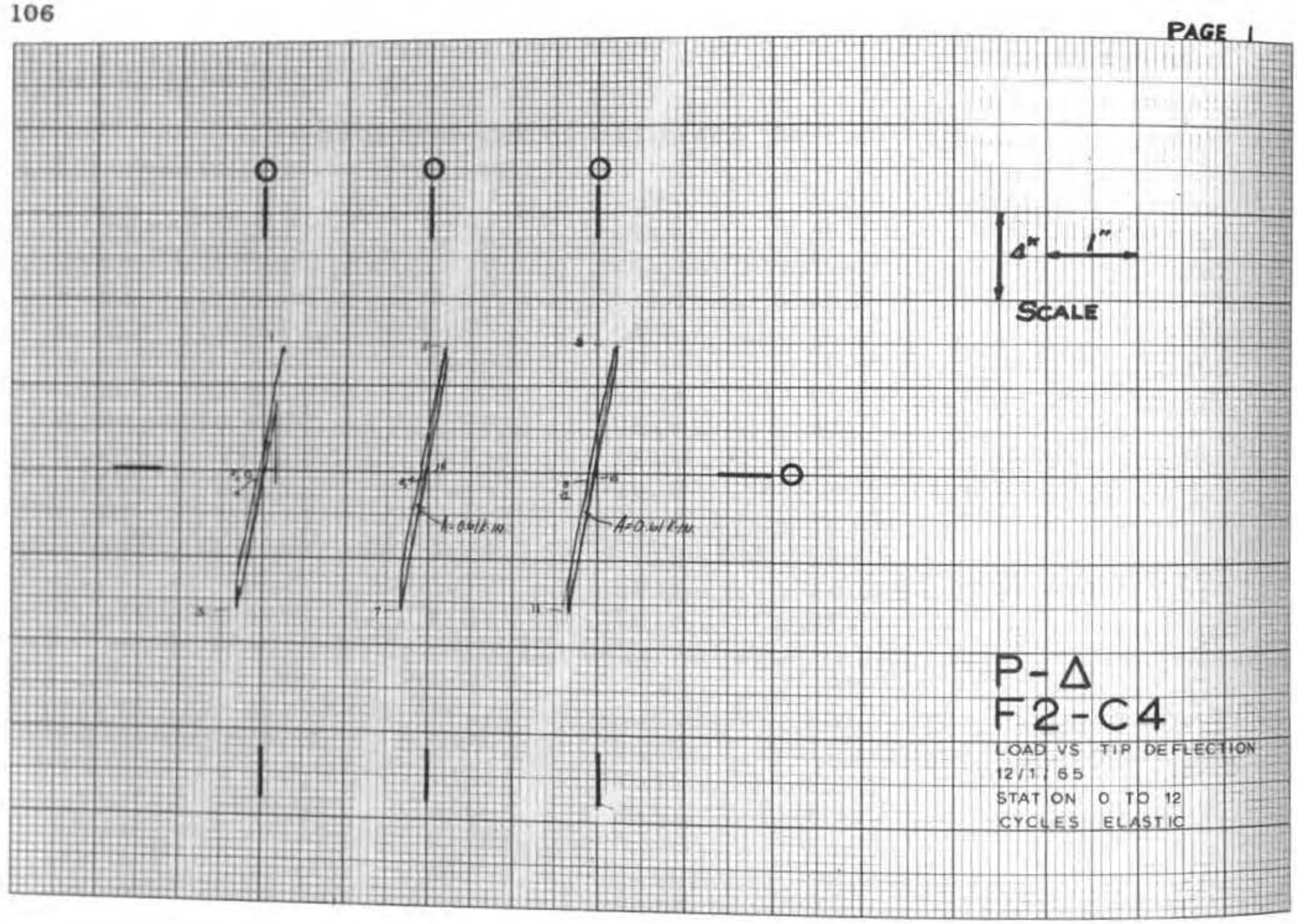
X	A	YE	I	ST	SB
51.64	5.96	4.49	70.2	17.2	17.0
51.64	7.26	5.26	90.1	23.8	18.4
52.38	7.32	5.30	90.9	24.2	18.5
53.13	7.39	5.33	91.7	24.6	18.5
53.13	9.82	4.05	140.2	28.0	34.6
57.33	10.19	4.23	148.3	30.7	35.1
61.54	10.56	4.39	155.8	33.4	35.5
61.54	8.42	3.37	113.2	19.9	33.5
62.72	8.53	3.44	116.3	20.7	33.8
63.90	8.63	3.51	119.2	21.5	34.0
63.90	6.52	4.45	95.2	20.7	21.4
64.95	6.61	4.52	97.0	21.4	21.5
66.00	6.70	4.57	98.6	22.0	21.6

X	YP	Z	F	MY	MP
51.64	4.69	18.8	1.175	54.04	63.53
51.64	7.01	22.6	1.305	58.43	76.23
52.38	7.13	22.7	1.308	58.59	76.61
53.13	7.25	22.8	1.310	58.73	76.96
53.13	3.13	34.0	1.214	94.64	114.88
57.33	3.80	36.0	1.171	103.72	121.45
61.54	4.47	37.7	1.128	112.77	127.19
61.54	0.71	25.2	1.264	67.32	85.09
62.72	0.72	26.0	1.256	69.95	87.88
63.90	0.76	26.9	1.249	72.59	90.65
63.90	4.63	22.4	1.114	67.87	75.59
64.95	4.79	22.8	1.127	68.17	76.84
66.00	4.96	23.1	1.140	68.46	78.04

X = DISTANCE FROM CONCENTRATED LOAD, INCHES
A = AREA OF CROSS-SECTION, INCHES**2
YE = DIST. FROM OUTSIDE OF BOTTOM PLATE TO CENTROID, INCHES
I = MOMENT OF INERTIA, INCHES**4
ST = SECTION MODULUS FOR TOP FLANGE, INCHES**3
SB = SECTION MODULUS FOR BOTTOM FLANGE, INCHES**3
YP = DIST. FROM OUTSIDE OF BOTTOM PLATE TO PLASTIC N.A., IN.
Z = PLASTIC MODULUS, INCHES**3
F = SHAPE FACTOR
MY = YIELD MOMENT, KIP-FEET
MP = PLASTIC MOMENT, KIP-FEET

BEAM PROPERTIES

LENGTH, L . . . . 66.0 INCHES
ELASTIC STIFFNESS, P/DELTA . . . . 27.44 KIPS/IN.
YIELD DEFLECTION, DELTAY . . . . 0.454 INCHES
YIELD LOAD, PY . . . . 12.45 KIPS
PLASTIC LOAD, PP . . . . 14.19 KIPS
LOCATION OF CRITICAL SECTION FOR PY* . . . . . 66.00 INCHES
LOCATION OF CRITICAL SECTION FOR PP* . . . . . 66.00 INCHES
* MEASURED FROM CONCENTRATED LOAD



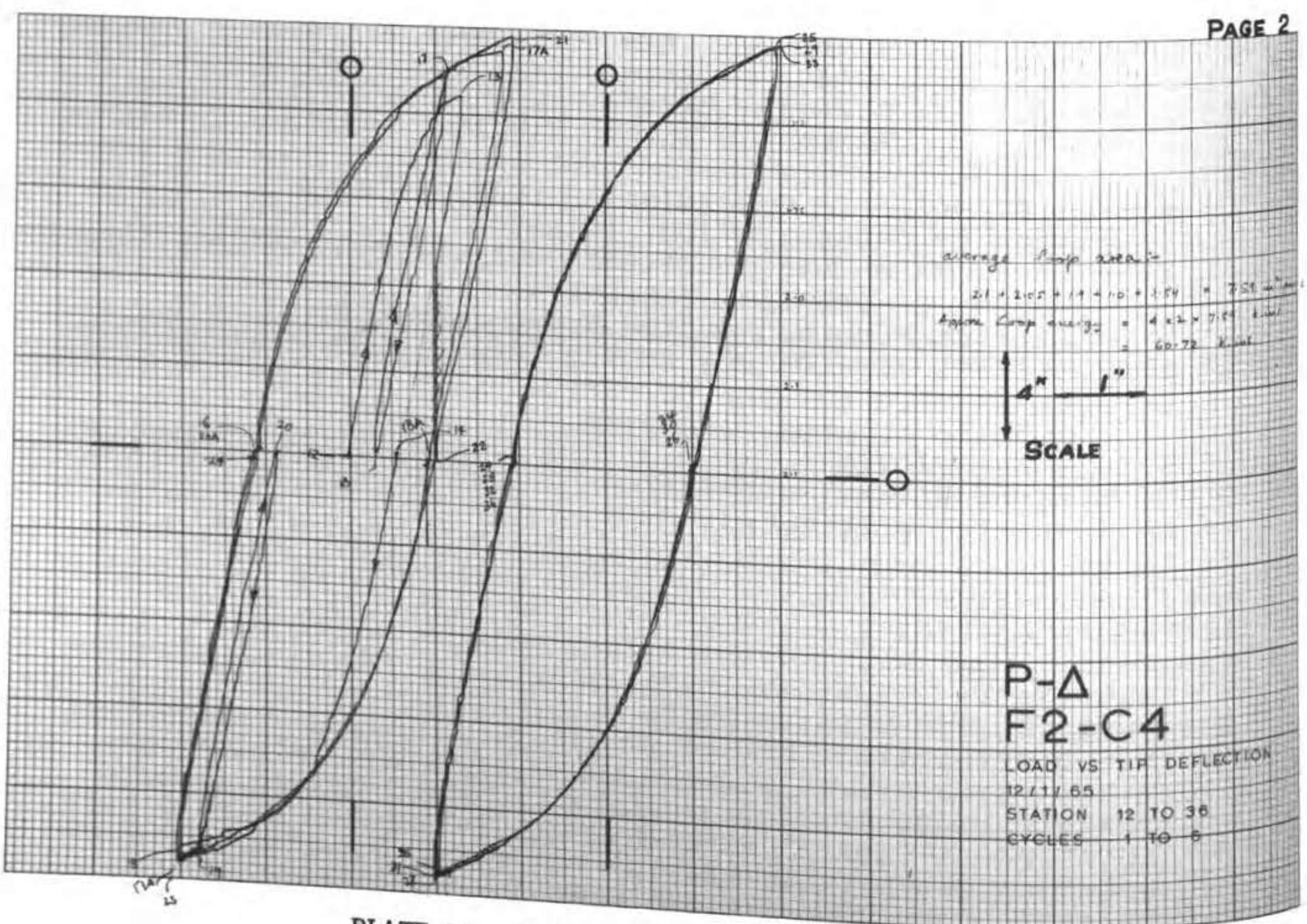
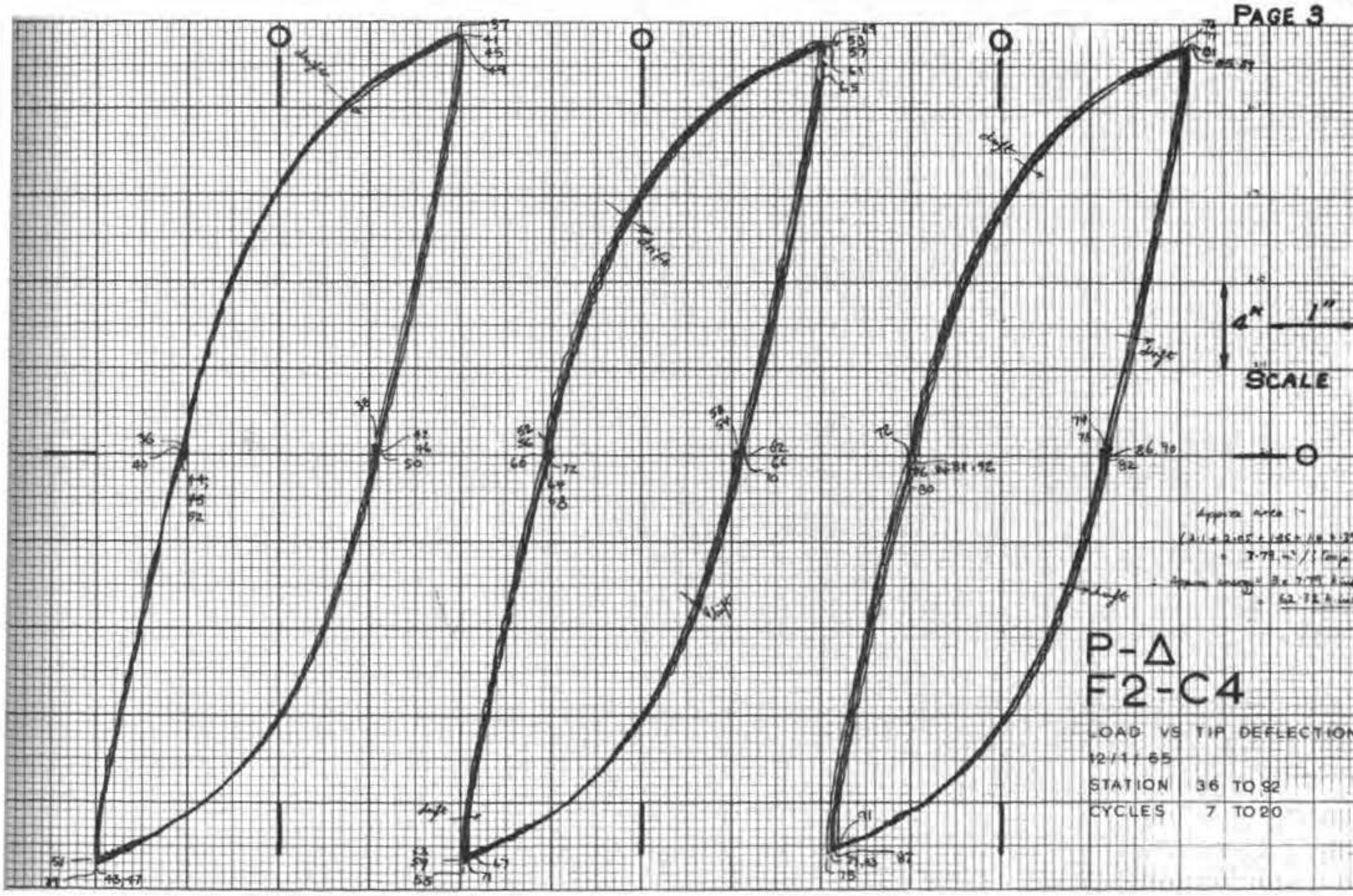


PLATE 11. LOAD VS. DEFLECTION - F2-C4



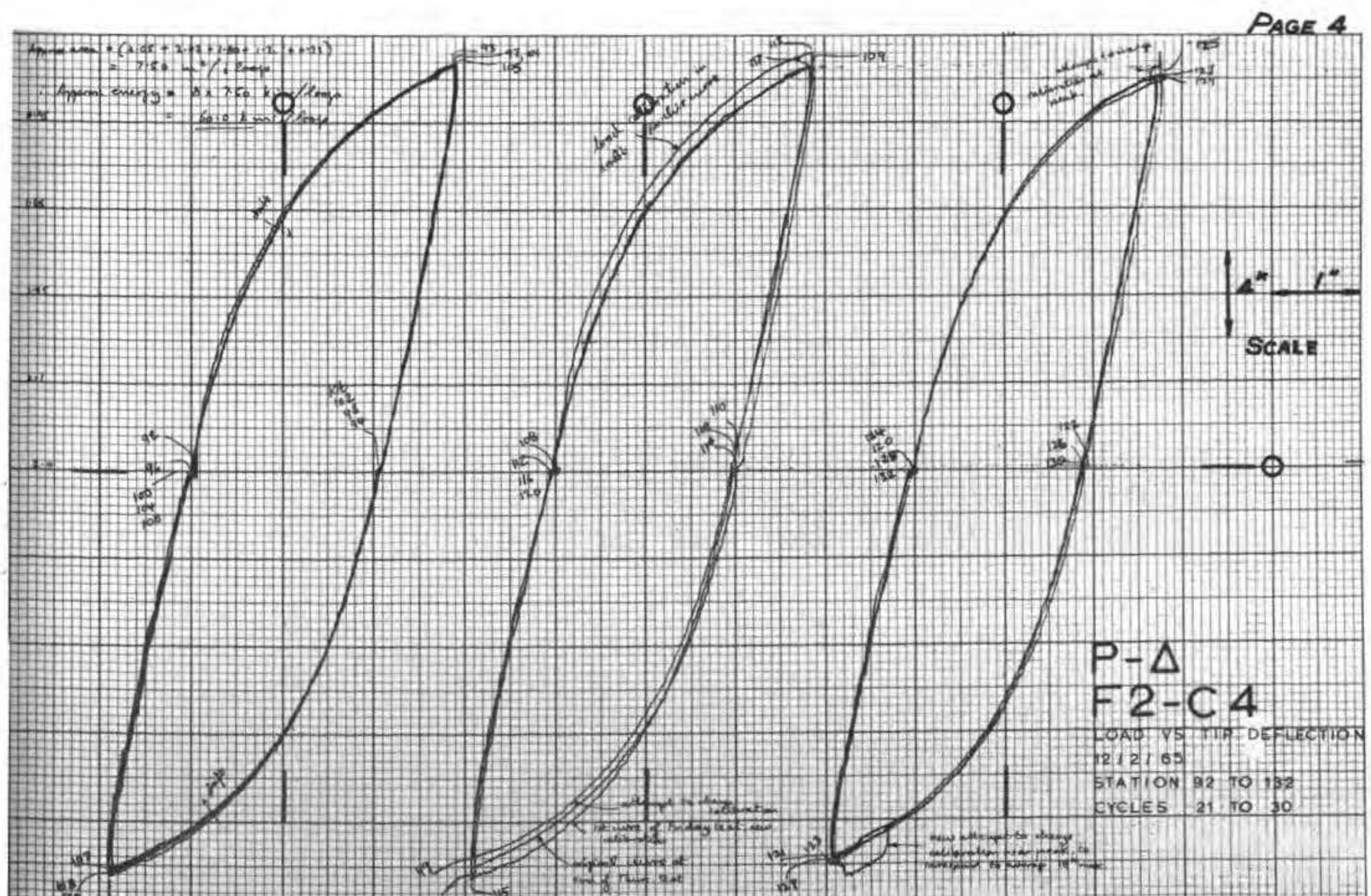
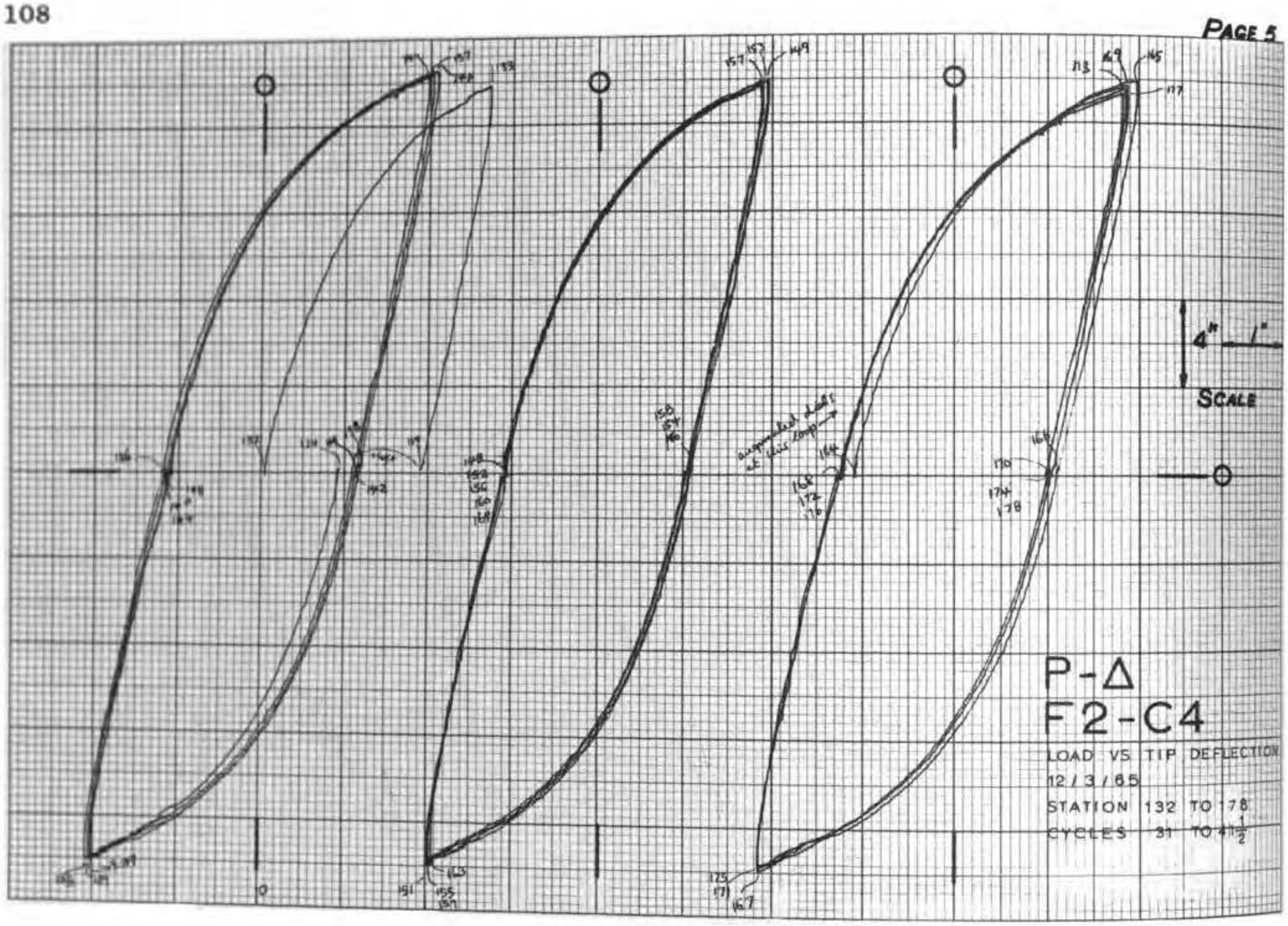


PLATE 11. (continued)



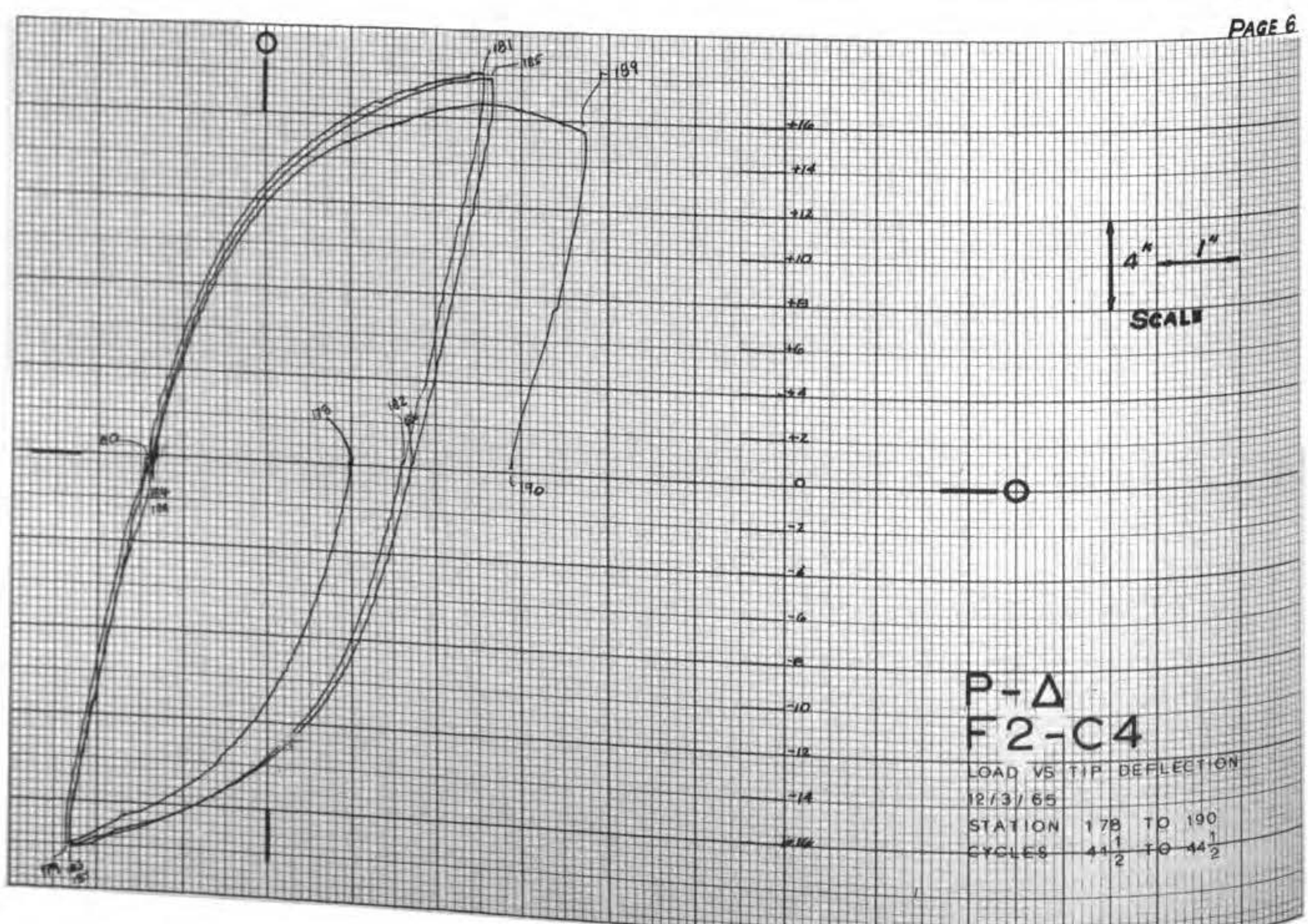


PLATE 11. (continued)

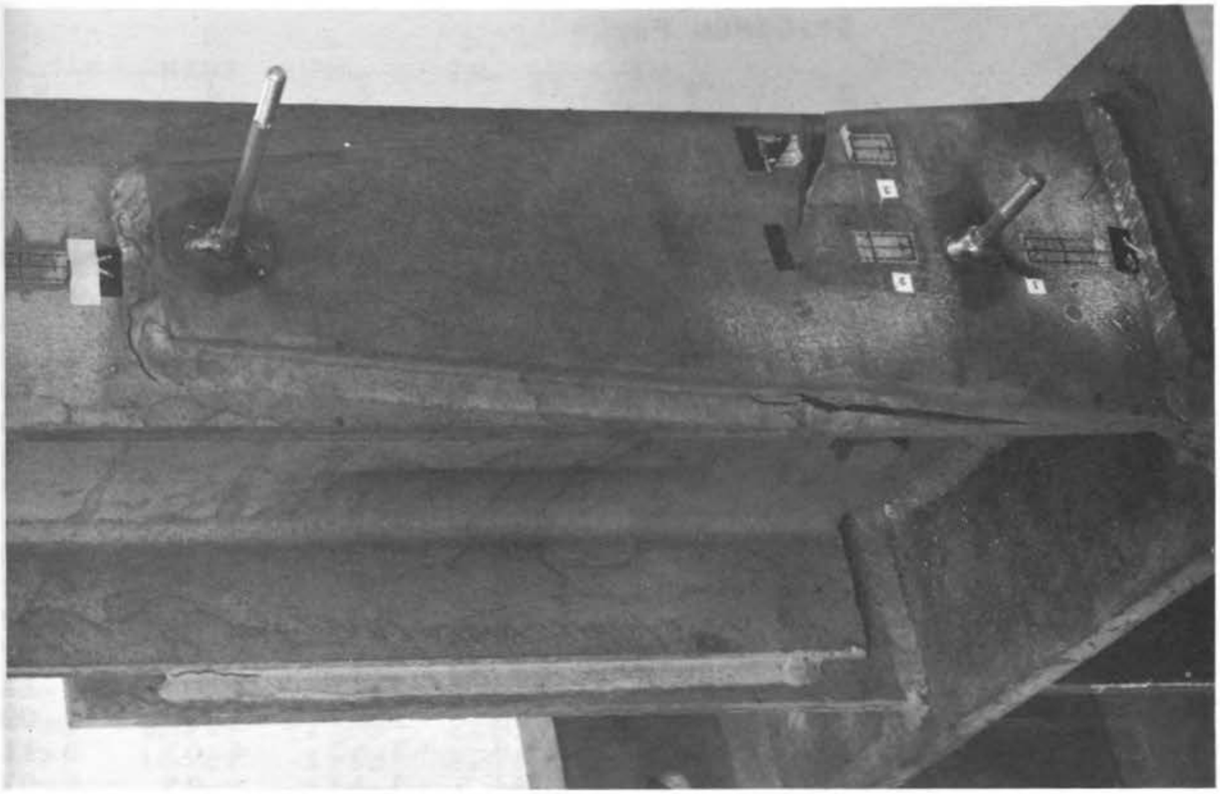


FIGURE 25. F2-C4

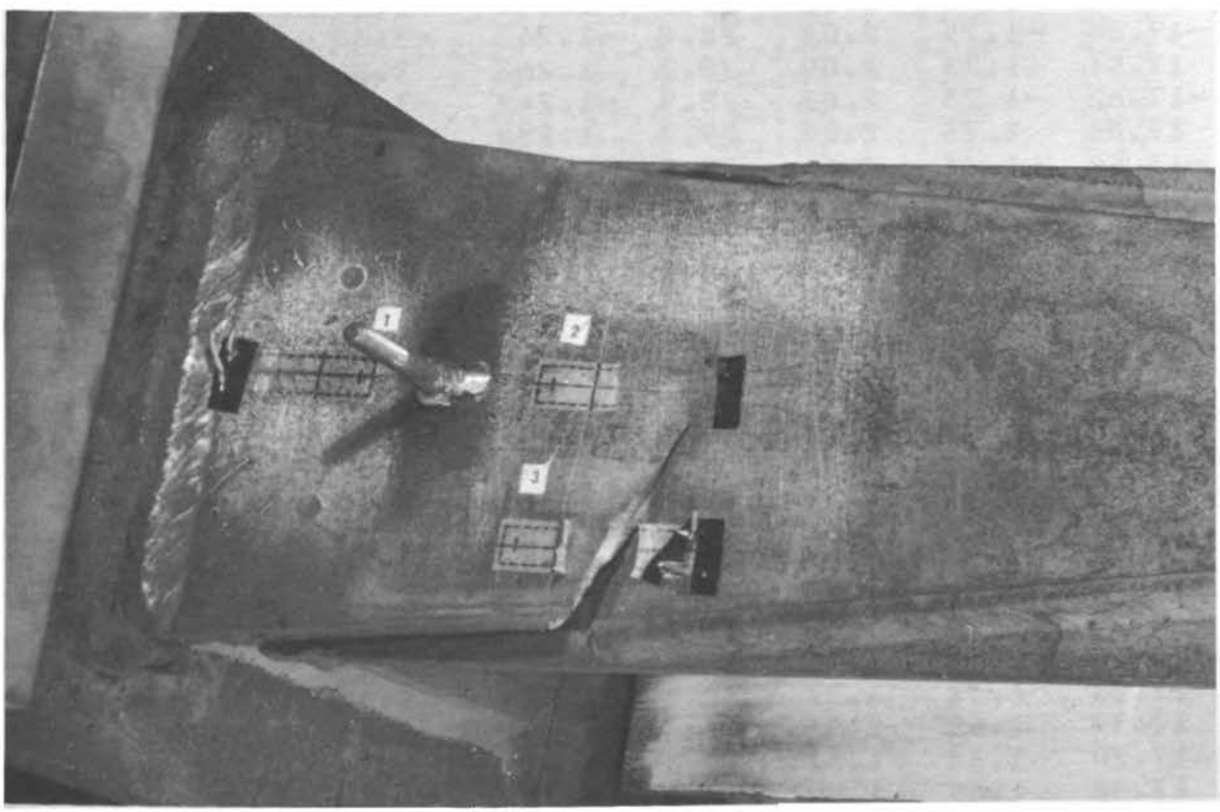


FIGURE 26. F2-C4

SPECIMEN F2-C4

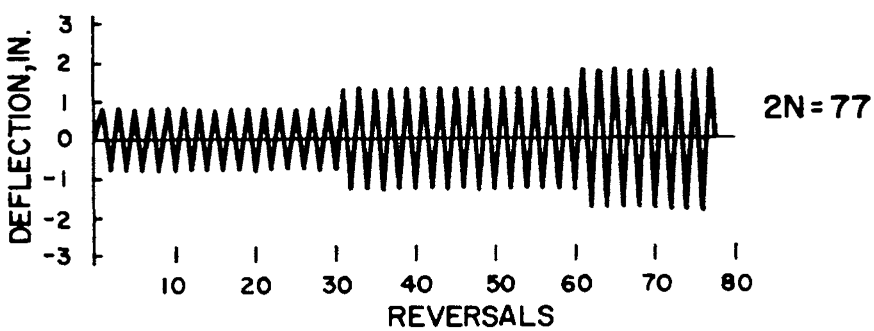
Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	15.80	1.11	0.55	7.9	1.114	2.15	1.07	2.14
2	-17.71	-1.75	1.61	25.6	-1.248	-3.38	3.12	6.97
3	17.72	1.59	2.00	28.5	1.249	3.07	3.86	7.77
4	-18.40	-1.78	1.99	30.5	-1.297	-3.44	3.84	8.31
5	18.34	1.69	2.07	30.2	1.293	3.27	4.00	8.23
6	-18.47	-1.75	2.03	30.1	-1.302	-3.38	3.92	8.20
7	18.36	1.71	2.02	29.0	1.294	3.31	3.90	7.89
8	-18.45	-1.78	2.02	28.9	-1.300	-3.44	3.90	7.89
9	18.39	1.69	2.01	29.2	1.296	3.27	3.88	7.96
10	-18.34	-1.77	2.01	29.2	-1.292	-3.42	3.88	7.97
11	18.34	1.67	1.99	29.1	1.292	3.23	3.84	7.94
12	-18.29	-1.74	1.99	29.4	-1.289	-3.37	3.84	8.00
13	18.28	1.71	2.03	29.7	1.288	3.31	3.92	8.11
14	-18.15	-1.77	2.03	29.7	-1.279	-3.43	3.92	8.08
15	18.13	1.75	2.07	29.6	1.277	3.39	4.00	8.07
16	-18.10	-1.75	2.07	29.7	-1.275	-3.39	4.00	8.11
17	18.17	1.75	2.09	29.7	1.280	3.39	4.03	8.09
18	-18.00	-1.76	2.09	29.7	-1.268	-3.40	4.03	8.11
19	18.13	1.77	2.10	29.6	1.277	3.43	4.05	8.07
20	-17.86	-1.75	2.10	29.7	-1.258	-3.38	4.05	8.09
21	18.03	1.69	2.00	29.3	1.270	3.28	3.86	7.99
22	-17.86	-1.80	2.00	28.7	-1.258	-3.47	3.86	7.84
23	18.05	1.70	2.01	29.3	1.272	3.30	3.88	8.00
24	-17.76	-1.80	2.06	28.9	-1.251	-3.48	3.98	7.89
25	17.91	1.73	2.10	29.2	1.262	3.34	4.05	7.97
26	-17.64	-1.75	2.08	28.8	-1.243	-3.38	4.02	7.84
27	17.91	1.73	2.09	29.3	1.262	3.34	4.04	7.98
28	-17.62	-1.73	2.03	28.9	-1.242	-3.35	3.92	7.87
29	17.86	1.75	2.05	29.2	1.258	3.38	3.96	7.96
30	-17.52	-1.73	2.06	28.9	-1.234	-3.35	3.98	7.87
31	17.81	1.75	1.96	28.5	1.255	3.38	3.79	7.77
32	-17.52	-1.75	1.96	28.3	-1.234	-3.39	3.79	7.72
33	17.76	1.76	1.98	28.6	1.251	3.40	3.82	7.79
34	-17.42	-1.71	1.98	28.4	-1.227	-3.31	3.82	7.73
35	17.74	1.79	2.00	28.5	1.250	3.46	3.86	7.77
36	-17.33	-1.71	2.00	28.2	-1.221	-3.31	3.86	7.69
37	17.71	1.81	2.14	28.5	1.248	3.50	4.13	7.77
38	-17.23	-1.68	2.08	28.1	-1.214	-3.26	4.01	7.67
39	17.71	1.82	2.10	28.5	1.248	3.51	4.05	7.78
40	-17.23	-1.64	2.10	28.3	-1.214	-3.16	4.05	7.73
41	17.86	1.60	1.92	27.6	1.258	3.09	3.70	7.53
42	-17.37	-1.72	1.97	27.1	-1.224	-3.33	3.80	7.37
43	17.76	1.62	1.97	27.4	1.251	3.13	3.80	7.47
44	-17.28	-1.72	1.97	27.2	-1.218	-3.33	3.80	7.42
45	17.62	1.62	1.97	27.4	1.242	3.13	3.80	7.46
46	-17.23	-1.72	1.97	27.1	-1.214	-3.33	3.80	7.40
47	17.57	1.63	1.97	27.3	1.238	3.15	3.80	7.43
48	-17.20	-1.68	1.97	27.3	-1.212	-3.24	3.81	7.44
49	17.38	1.65	1.99	26.8	1.225	3.19	3.85	7.31
50	-17.13	-1.68	2.00	26.6	-1.207	-3.24	3.86	7.25
51	17.57	1.64	1.95	27.2	1.238	3.18	3.77	7.41

Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{F}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
52	−17.13	−1.70	1.95	26.4	−1.207	−3.29	3.76	7.20
53	17.47	1.61	1.92	25.6	1.231	3.12	3.71	6.97
54	−17.03	−1.69	1.92	25.6	−1.200	−3.27	3.70	6.98
55	17.38	1.45	1.85	24.0	1.225	2.80	3.58	6.54
56	−17.03	−1.74	1.85	24.6	−1.200	−3.36	3.57	6.71
57	16.94	1.52	1.83	23.8	1.194	2.93	3.53	6.48
58	−16.89	−1.74	1.83	24.0	−1.190	−3.37	3.53	6.54
59	16.84	1.46	1.81	23.3	1.187	2.82	3.49	6.36
60	−16.82	−1.74	1.81	24.1	−1.185	−3.37	3.49	6.56
61	16.70	1.41	1.80	23.3	1.177	2.73	3.49	6.36
62	−17.11	−1.97	2.03	28.0	−1.206	−3.80	3.92	7.64
63	17.33	1.77	2.29	30.9	1.221	3.43	4.42	8.42
64	−17.25	−1.92	2.24	31.5	−1.215	−3.70	4.33	8.57
65	17.18	1.72	2.19	29.6	1.210	3.32	4.23	8.07
66	−17.20	−1.89	2.19	30.4	−1.212	−3.65	4.23	8.29
67	17.11	1.67	2.15	28.6	1.206	3.22	4.15	7.81
68	−17.08	−1.89	2.13	29.3	−1.203	−3.65	4.11	7.98
69	16.99	1.64	2.10	27.1	1.197	3.17	4.05	7.38
70	−16.99	−1.88	2.10	27.7	−1.197	−3.63	4.05	7.54
71	16.87	1.61	2.09	27.1	1.189	3.11	4.03	7.38
72	−16.87	−1.85	2.09	27.7	−1.189	−3.58	4.04	7.54
73	16.75	1.57	2.04	26.0	1.180	3.04	3.94	7.08
74	−16.77	−1.85	2.04	26.1	−1.182	−3.58	3.94	7.12
75	16.60	1.55	2.02	25.8	1.170	3.00	3.90	7.02
76	−16.74	−1.82	2.02	26.4	−1.179	−3.52	3.90	7.20
77	16.84	1.65	2.11	27.7	1.187	3.19	4.07	7.56
78	−17.03	−1.95	2.25	30.2	−1.200	−3.76	4.35	8.24
79	16.60	1.55	2.19	27.4	1.170	3.00	4.23	7.46
80	−16.94	−1.95	2.19	29.5	−1.194	−3.77	4.23	8.04
81	16.45	1.52	2.16	26.6	1.159	2.95	4.17	7.24
82	−16.79	−1.95	2.16	28.5	−1.183	−3.77	4.17	7.77
83	16.26	1.50	2.16	26.3	1.146	2.89	4.17	7.18
84	−17.03	−2.24	2.32	32.0	−1.200	−4.33	4.50	8.71
85	16.99	2.22	2.93	40.0	1.197	4.29	5.66	10.89
86	−17.20	−2.20	2.87	40.2	−1.212	−4.25	5.54	10.96
87	16.75	2.33	2.97	40.4	1.180	4.51	5.74	11.02
88	−17.18	−2.20	2.95	41.2	−1.210	−4.25	5.70	11.23

SPECIMEN F2A-C7

Description: This specimen was similar to specimen F2-C1 with the following exceptions. The suffix "A" denotes the use of top and bottom plates each nominally 1/16 inch thinner than the corresponding plates of specimen type F2. The specimen was fabricated in a University shop, and was not ultrasonically inspected.

Program of Cycling:



Test Control: Tip deflection.

Raw Data Included: Graphical load-strain data, with the strain measured on the top plate at 1.89 inches from the column face.

Graphical load-deflection data.

Total Energy Absorption: 1,054 kip-inches.

Plastic Load Reversals to Failure: 77 ($38\frac{1}{2}$ cycles).

Remarks: The first crack appeared at the end of a top plate-to-beam weld during the 17th cycle. Similar cracks had appeared at the ends of all plate-to-beam welds by the end of the 22nd cycle. After 25 cycles, the top plate was observed to be buckling between the ends of the weld and the column. Similar buckling of the lower flange plate was very apparent after 33 cycles, as was buckling of the lower flange beyond the free end of the plate. Cracks had also developed at the ends of the vertical web-to-column welds. Necking of the top plate could be seen after 34 cycles. By the 35th cycle, surface cracks had developed in the concave face of the lower plate buckle, and during this cycle, these cracks penetrated the plate and extended about one inch in from the edge. In the next cycle, the crack at the end of a top plate weld also penetrated the thickness of the plate, extending about 3/16 inch in from the edge. Failure finally occurred after $38\frac{1}{2}$ cycles with the rapid opening of the crack in the bottom plate.

SPECIMEN TYPE F2A-C7

DIMENSIONS OF WF SECTION

DEPTH	8.16	INCHES
TOP FLANGE WIDTH	5.290	INCHES
BOTTOM FLANGE WIDTH	5.300	INCHES
TOP FLANGE THICKNESS	0.357	INCHES
BOTTOM FLANGE THICKNESS	0.354	INCHES
WEB THICKNESS	0.258	INCHES
ELASTIC MODULUS	29400.	KSI
YIELD STRESS	35.900	KSI

DIMENSIONS AND PROPERTIES OF TOP PLATE

LENGTH, LP	14.00	INCHES
WIDTH AT END AWAY FROM COLUMN, M	2.54	INCHES
WIDTH AT END OF WELD, R	4.50	INCHES
AVERAGE LOCATION OF END OF WELD*, N	3.88	INCHES
THICKNESS, T	0.460	INCHES
ELASTIC MODULUS	27900.	KSI
YIELD STRESS	35.500	KSI

*MEASURED FROM FACE OF COLUMN

DIMENSIONS AND PROPERTIES OF BOTTOM PLATE

LENGTH, LP	14.12	INCHES
WIDTH, B	6.25	INCHES
AVERAGE LOCATION OF COLUMN END OF WELD*, Q .	2.68	INCHES
AVERAGE LOCATION OF OUTER END OF WELD*, P . .	12.85	INCHES
THICKNESS, T	0.290	INCHES
ELASTIC MODULUS	29400.	KSI
YIELD STRESS	46.300	KSI

*MEASURED FROM FACE OF COLUMN

DEPTH OUT-TO-OUT OF PLATES	8.92	INCHES

WF SECTION PROPERTIES

AREA, A	5.77	INCHES**2
LOCATION OF CENTROID*, YE	4.09	INCHES
MOMENT OF INERTIA, I	67.4	INCHES**4
SECTION MODULUS, TOP, ST	16.5	INCHES**3
SECTION MODULUS, BOTTOM, SB	16.5	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.10	INCHES
PLASTIC MODULUS, Z	18.6	INCHES**3
SHAPE FACTOR	1.127	
YIELD MOMENT, MY	49.33	KIP-FT.
PLASTIC MOMENT, MP	55.59	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

SPECIMEN TYPE F2A-C7

SECTION PROPERTIES AT SELECTED CROSS-SECTIONS

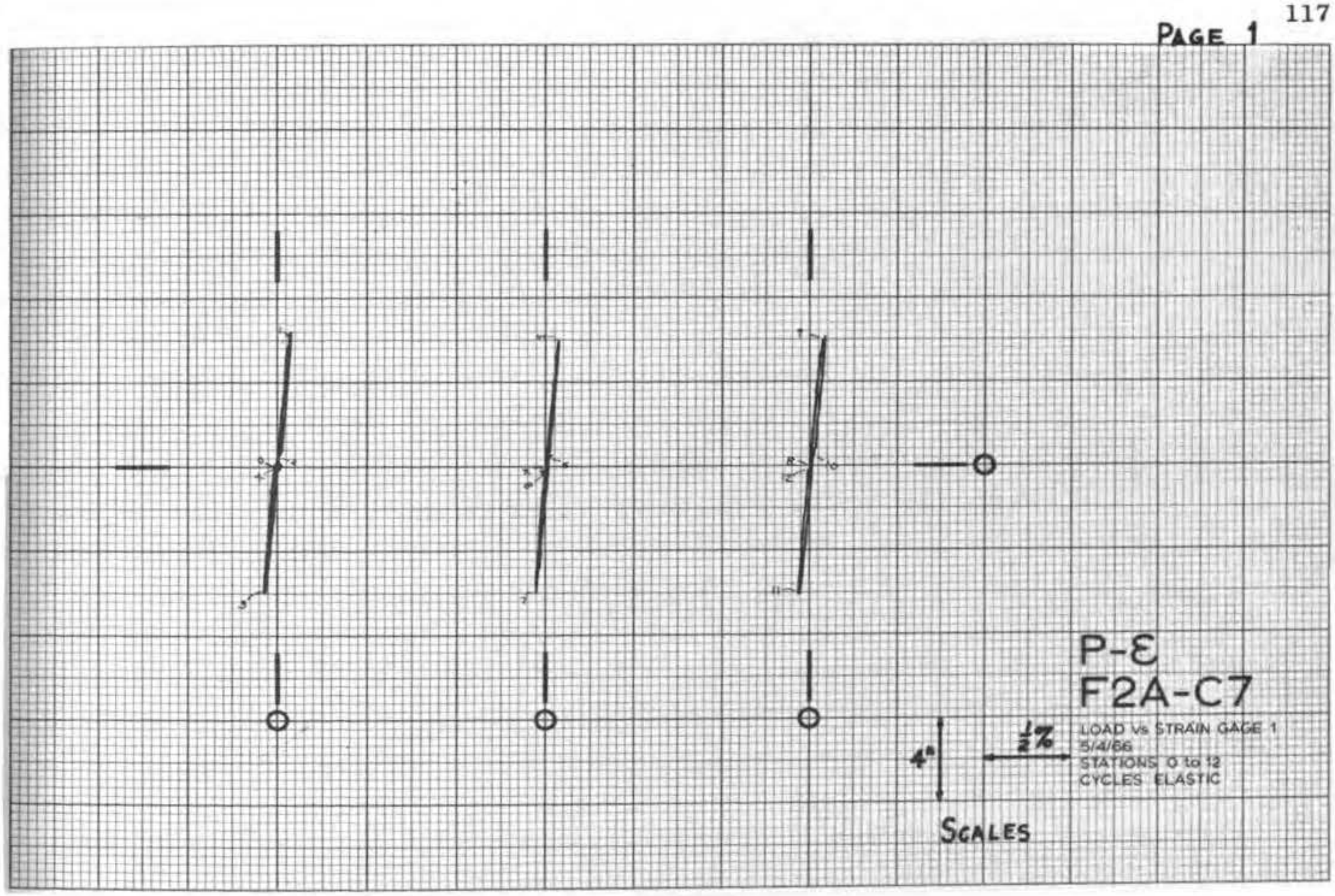
X	A	YE	I	ST	SB
52.00	5.77	4.38	67.4	16.5	16.5
52.00	6.88	5.08	84.7	22.0	17.7
52.57	6.93	5.10	85.3	22.3	17.7
53.15	6.98	5.13	85.9	22.7	17.8
53.15	8.79	4.10	121.6	25.2	29.7
57.63	9.17	4.29	129.3	27.9	30.1
62.12	9.55	4.46	136.4	30.6	30.5
62.12	7.45	3.40	98.2	17.8	28.8
62.72	7.50	3.44	99.6	18.2	28.9
63.32	7.55	3.47	101.0	18.5	29.1
63.32	5.47	4.60	75.7	17.5	16.4
64.66	5.58	4.69	77.5	18.3	16.5
66.00	5.69	4.77	79.3	19.1	16.6

X	YP	Z	F	MY	MP
52.00	4.57	18.2	1.113	48.89	54.41
52.00	6.81	21.7	0.994	65.17	64.79
52.57	6.90	21.8	0.985	66.09	65.07
53.15	7.00	21.8	0.975	67.01	65.33
53.15	2.47	32.6	1.305	74.65	97.45
57.63	3.24	34.9	1.263	82.61	104.35
62.12	4.00	36.9	1.219	90.54	110.34
62.12	0.61	23.9	1.361	52.64	71.63
62.72	0.62	24.4	1.356	53.75	72.90
63.32	0.62	24.8	1.352	54.85	74.18
63.32	4.02	21.6	1.245	51.87	64.59
64.66	4.25	22.1	1.222	54.18	66.20
66.00	4.47	22.6	1.199	56.49	67.73

X = DISTANCE FROM CONCENTRATED LOAD, INCHES
A = AREA OF CROSS-SECTION, INCHES**2
YE = DIST. FROM OUTSIDE OF BOTTOM PLATE TO CENTROID, INCHES
I = MOMENT OF INERTIA, INCHES**4
ST = SECTION MODULUS FOR TOP FLANGE, INCHES**3
SB = SECTION MODULUS FOR BOTTOM FLANGE, INCHES**3
YP = DIST. FROM OUTSIDE OF BOTTOM PLATE TO PLASTIC N.A., IN.
Z = PLASTIC MODULUS, INCHES**3
F = SHAPE FACTOR
MY = YIELD MOMENT, KIP-FEET
MP = PLASTIC MOMENT, KIP-FEET

BEAM PROPERTIES

LENGTH, L . . . . 66.0 INCHES
ELASTIC STIFFNESS, P/DELTA . . . . 25.45 KIPS/IN.
YIELD DEFLECTION, DELTAY . . . . 0.386 INCHES
YIELD LOAD, PY . . . . 9.83 KIPS
PLASTIC LOAD, PP . . . . 12.24 KIPS
LOCATION OF CRITICAL SECTION FOR PY* . . . . . 63.32 INCHES
LOCATION OF CRITICAL SECTION FOR PP* . . . . . 63.32 INCHES
* MEASURED FROM CONCENTRATED LOAD



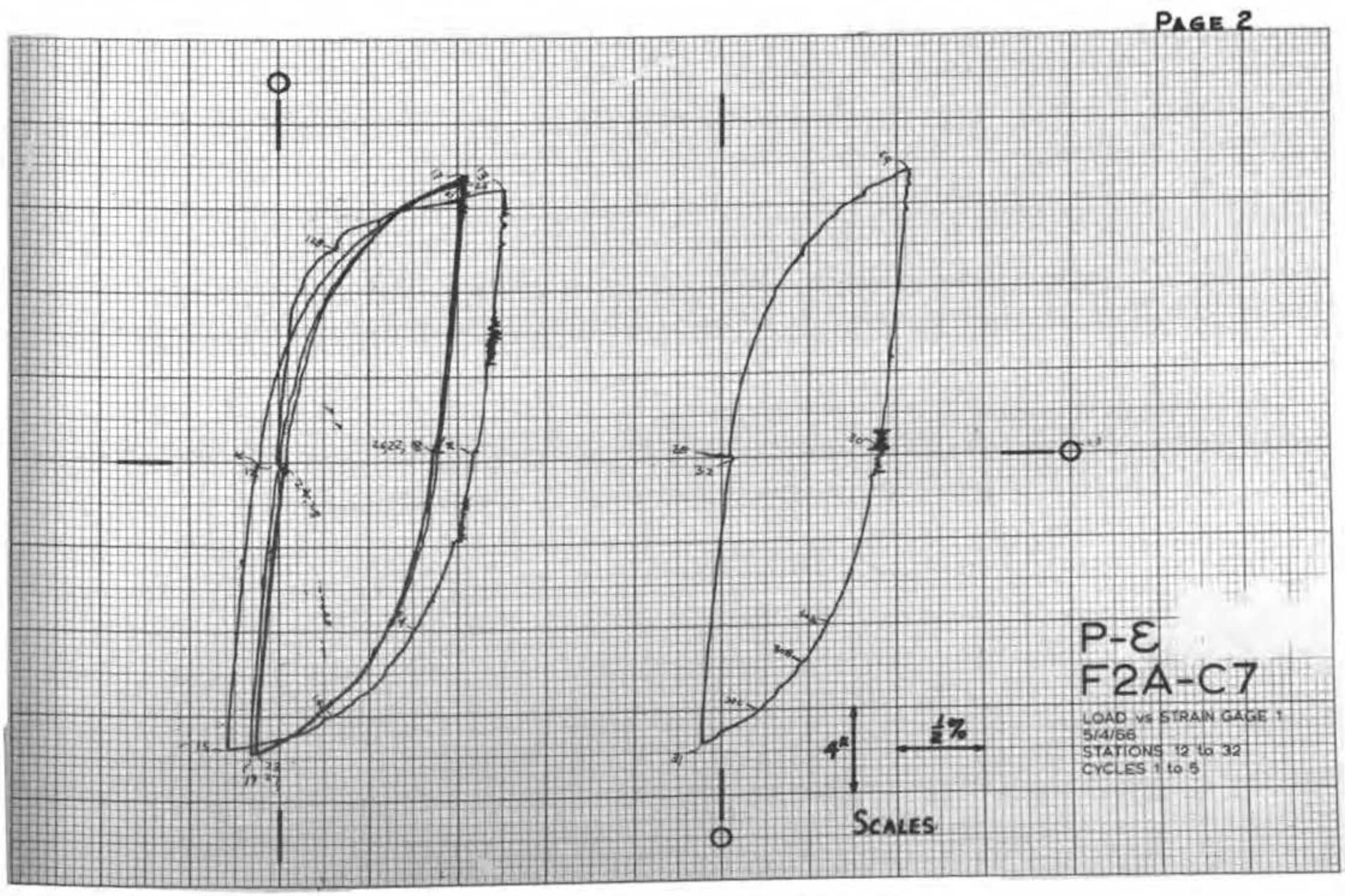
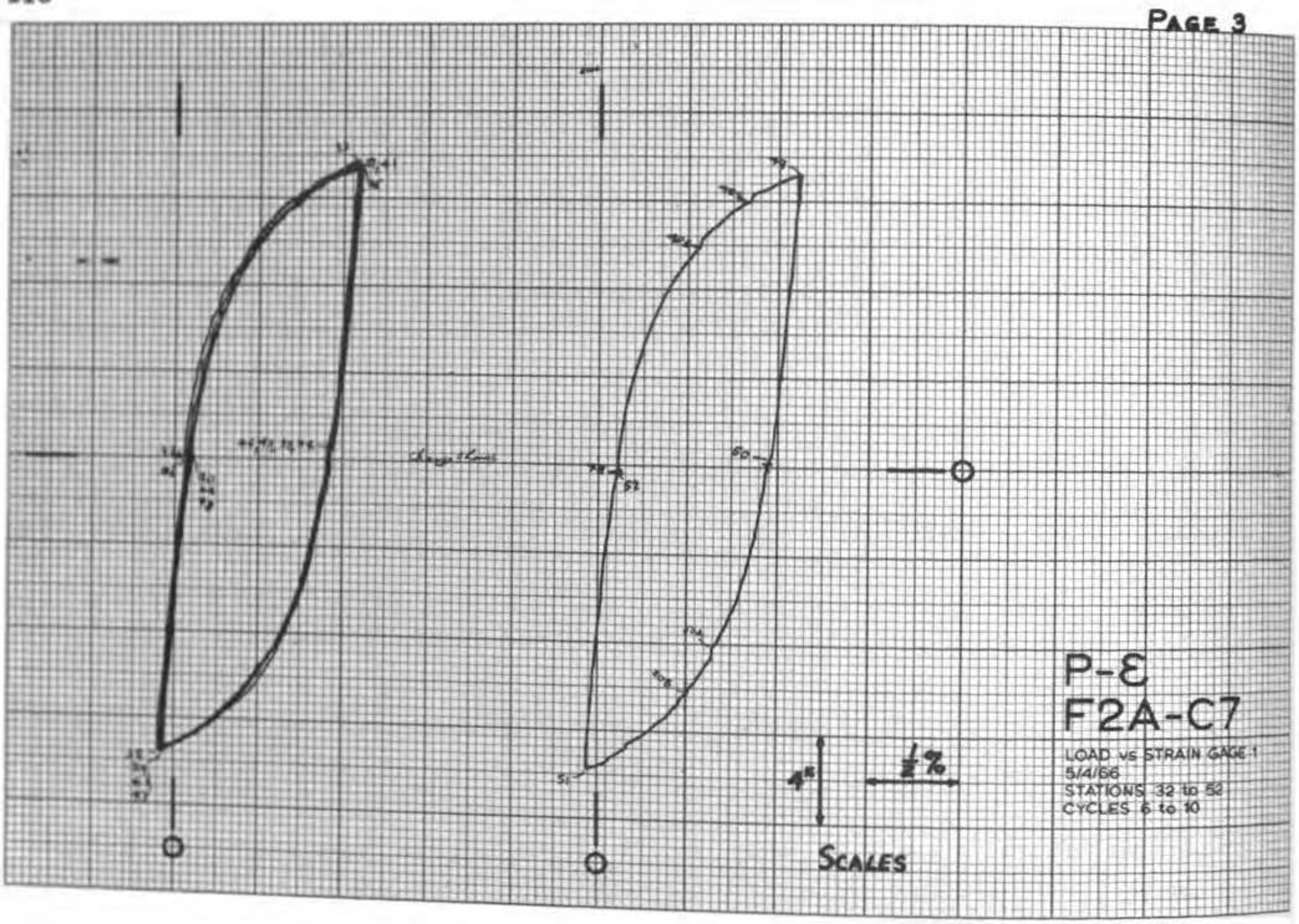


PLATE 12. LOAD VS. STRAIN - F2A-C7



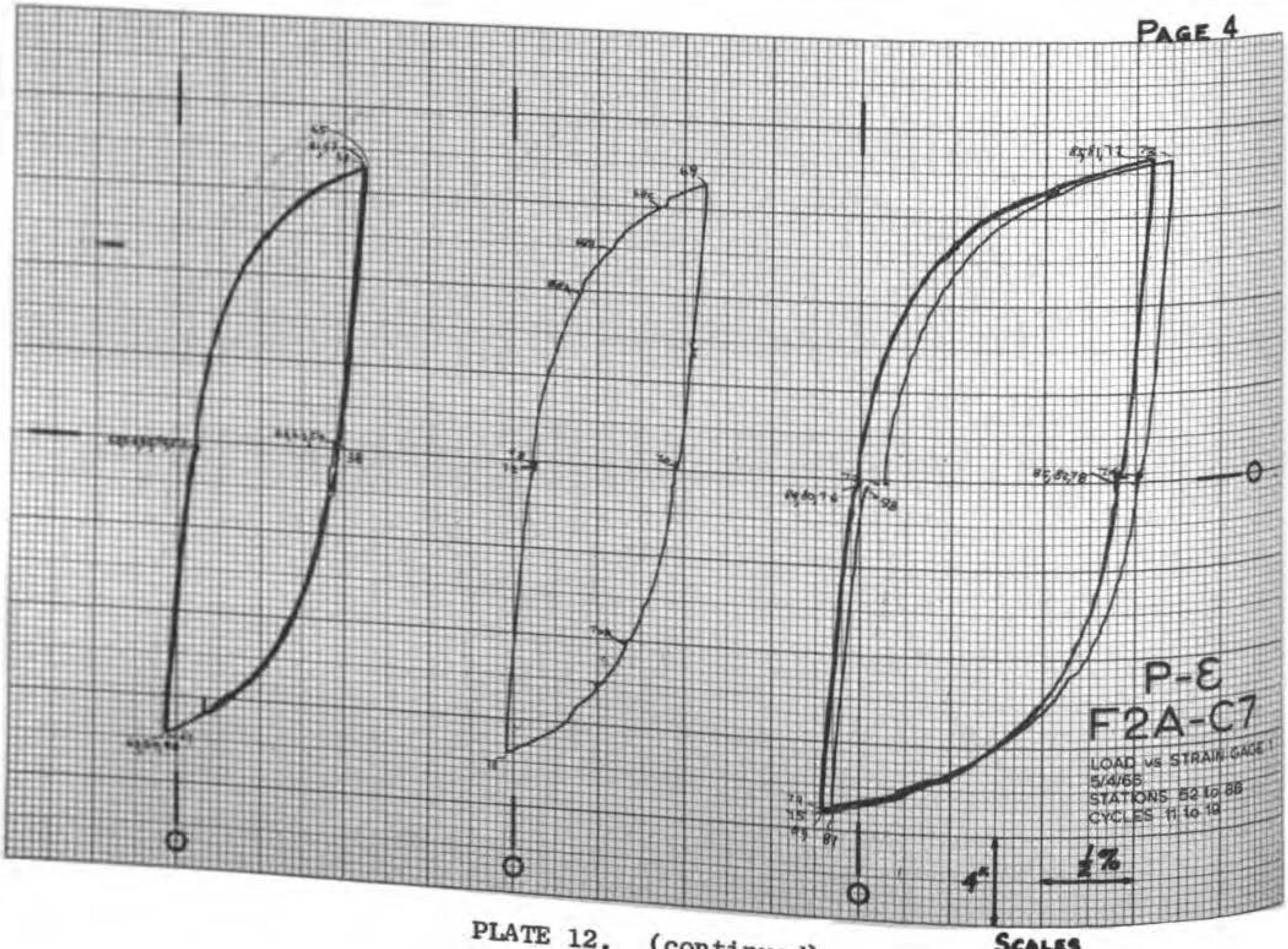
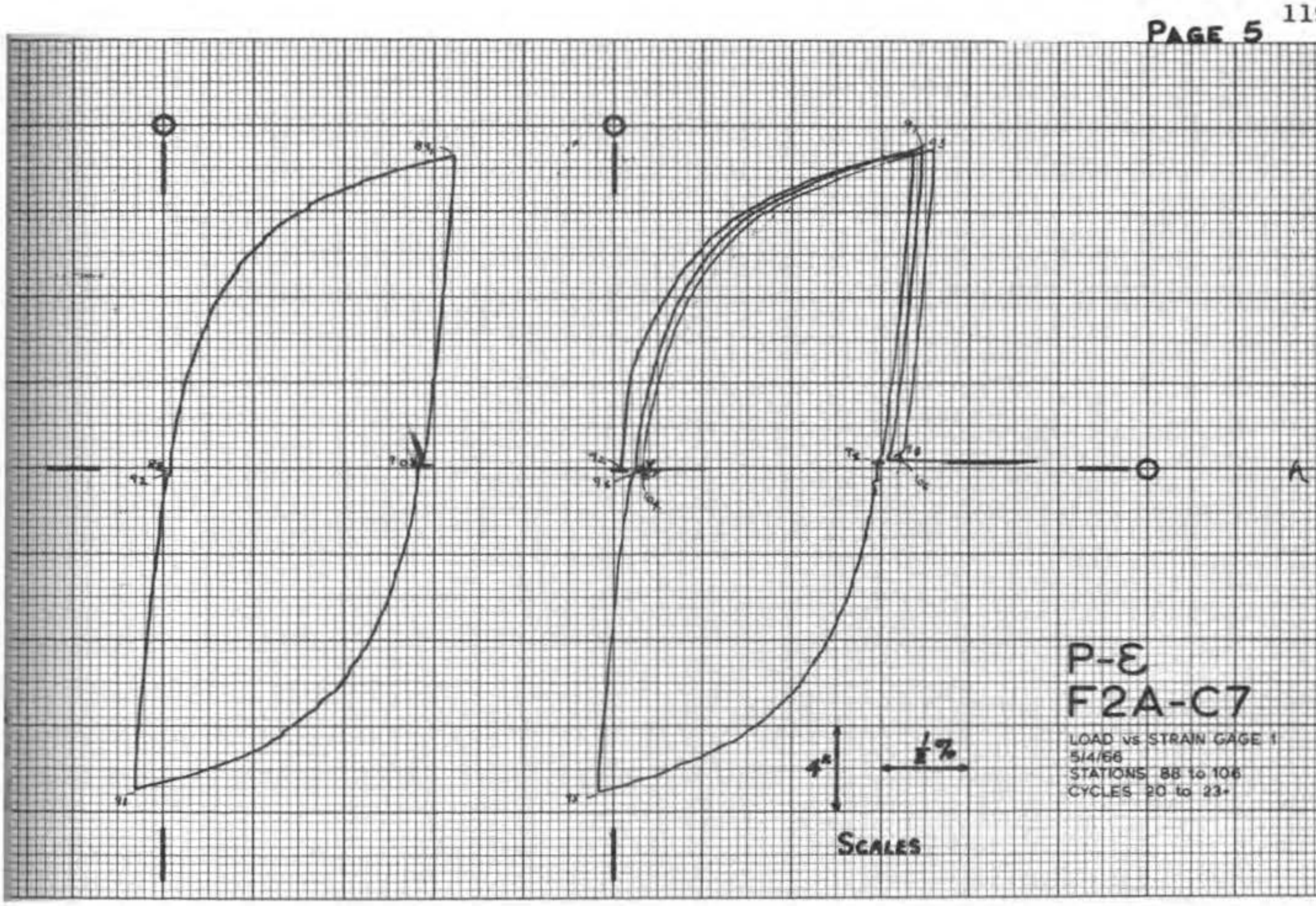


PLATE 12. (continued)



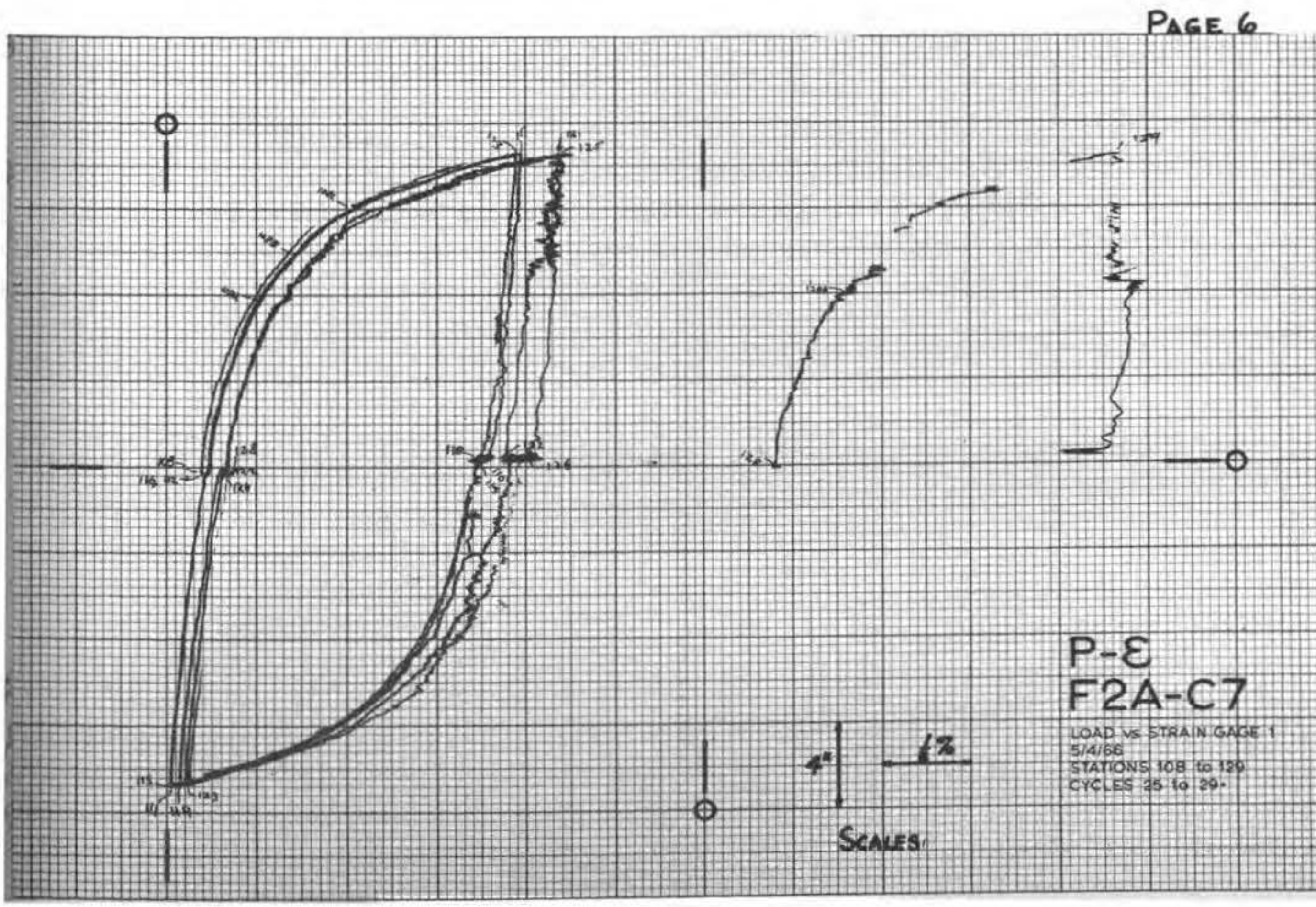
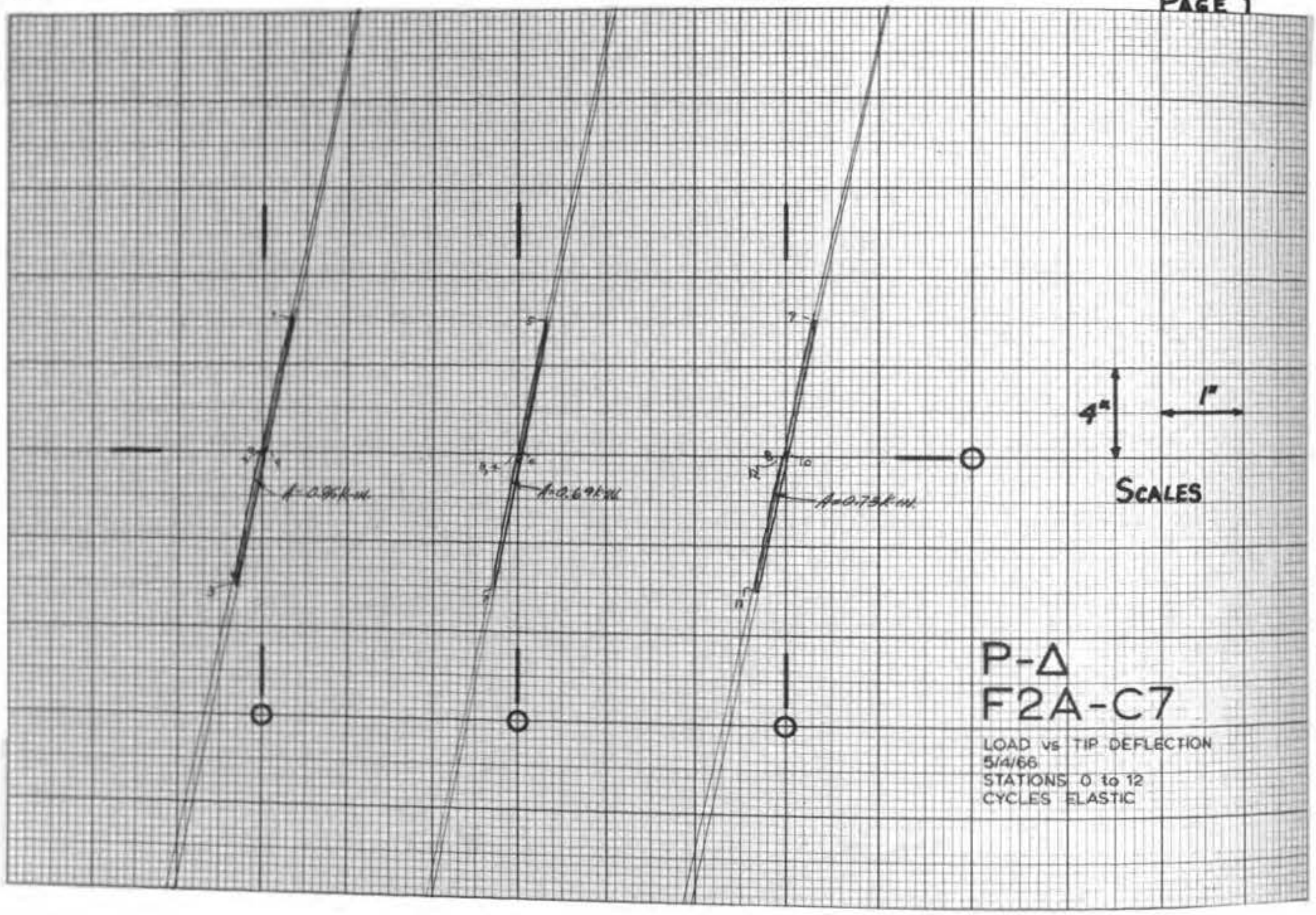
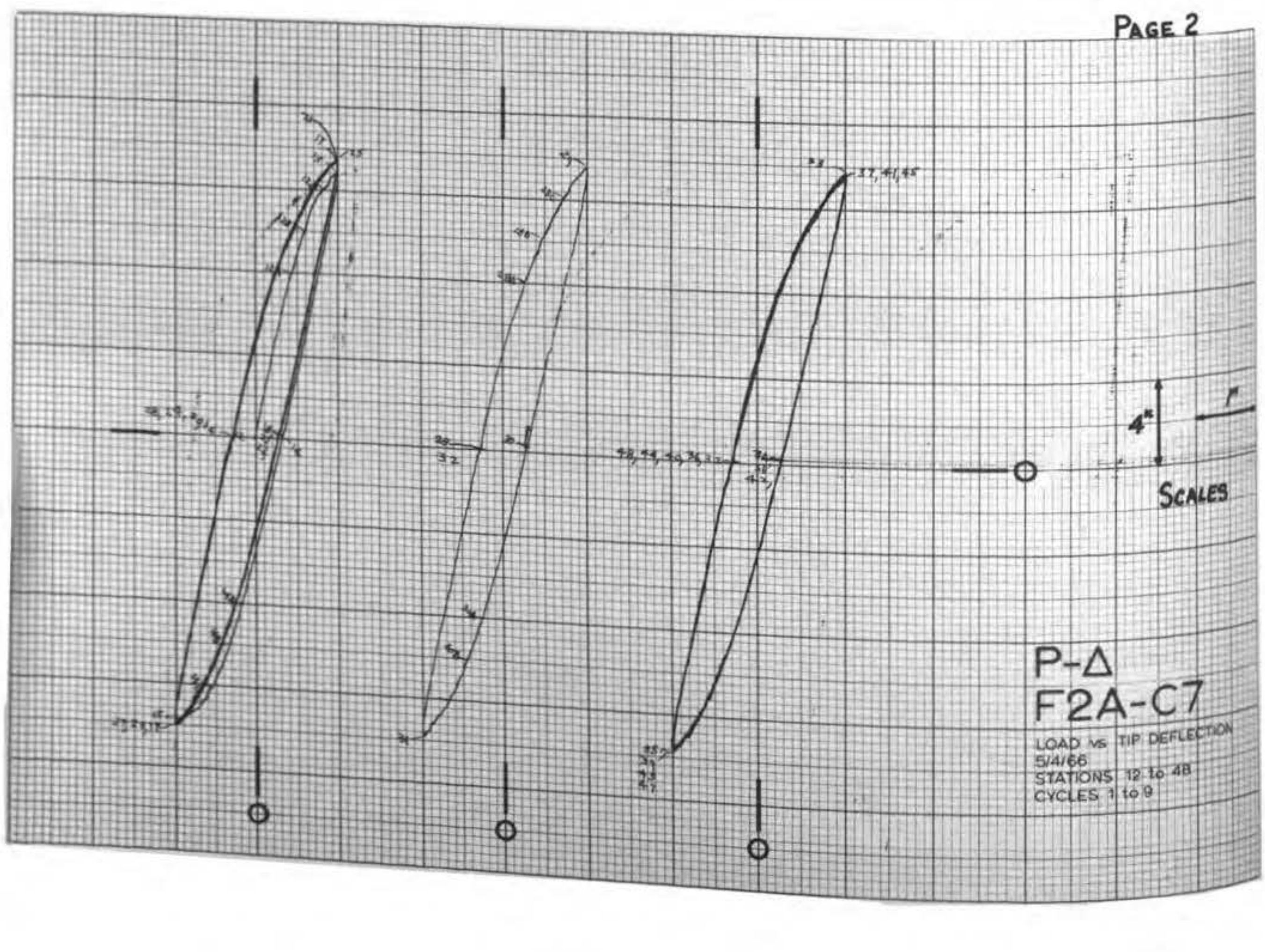
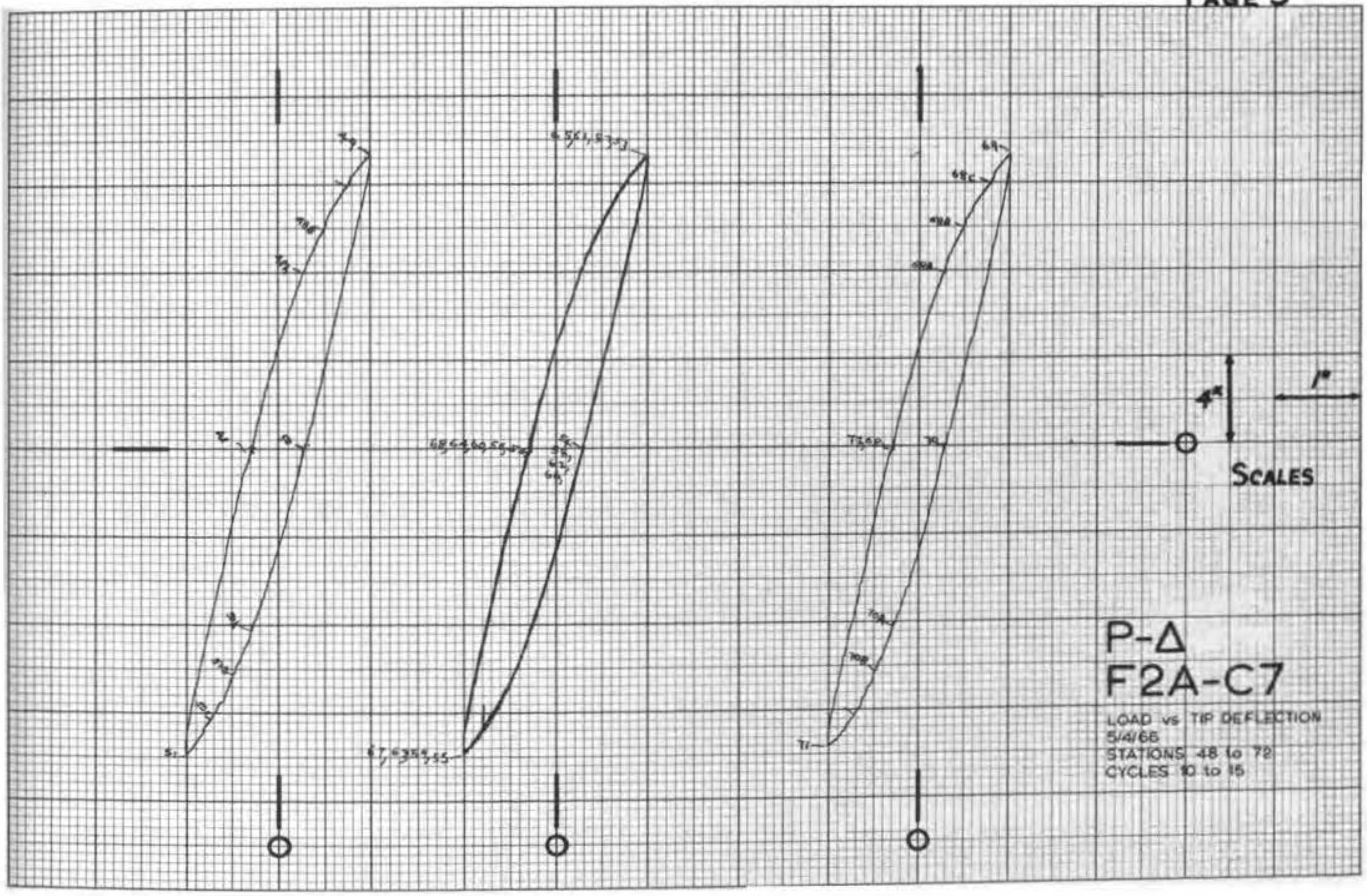


PLATE 12. (continued)


PAGE 1
4"
1"
SCALES
P-Δ
F2A-C7
LOAD vs TIP DEFLECTION
5/4/66
STATIONS 0 to 12
CYCLES ELASTIC


PAGE 2
4"
1"
SCALES
P-Δ
F2A-C7
LOAD vs TIP DEFLECTION
5/4/66
STATIONS 12 to 48
CYCLES 1 to 9

PAGE 3



PAGE 4

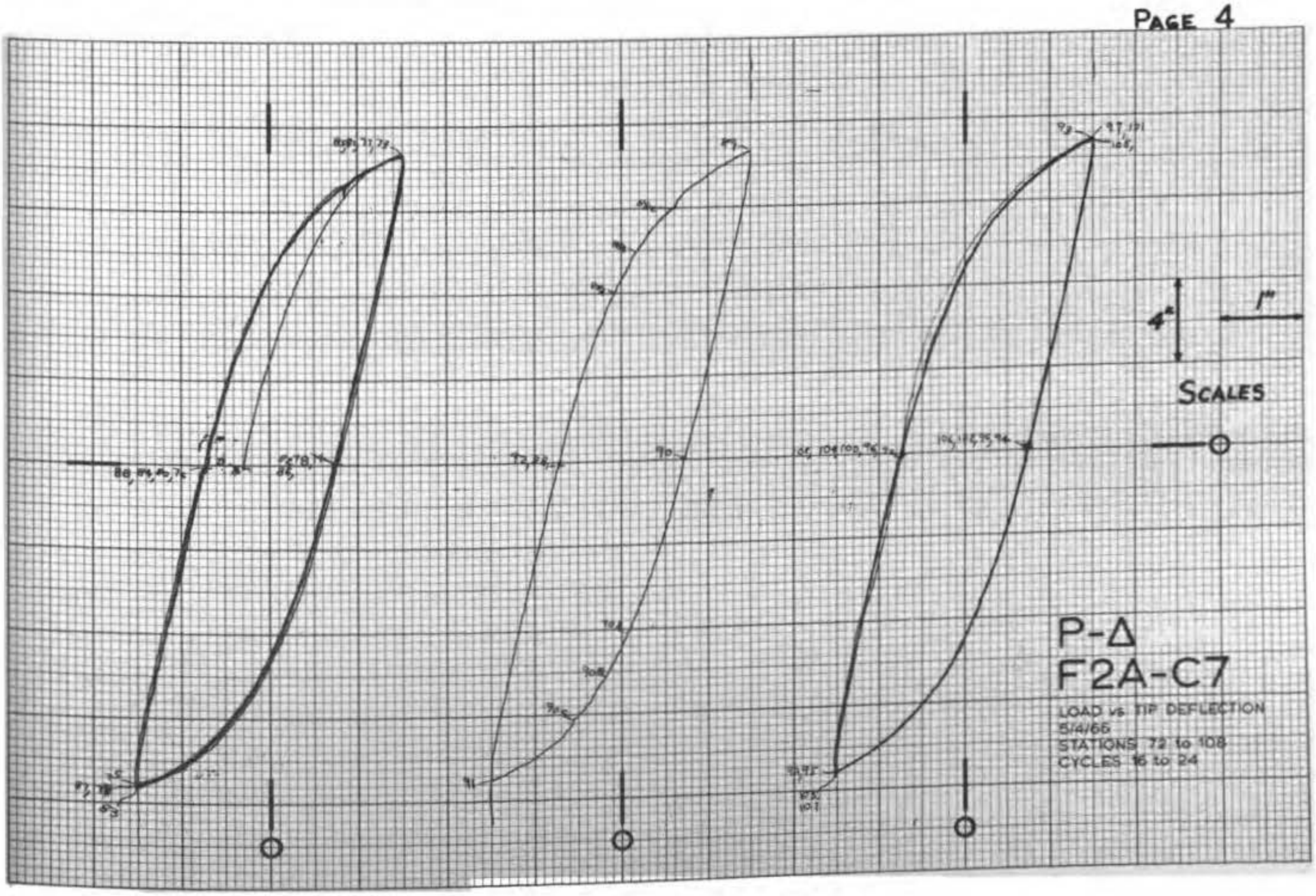
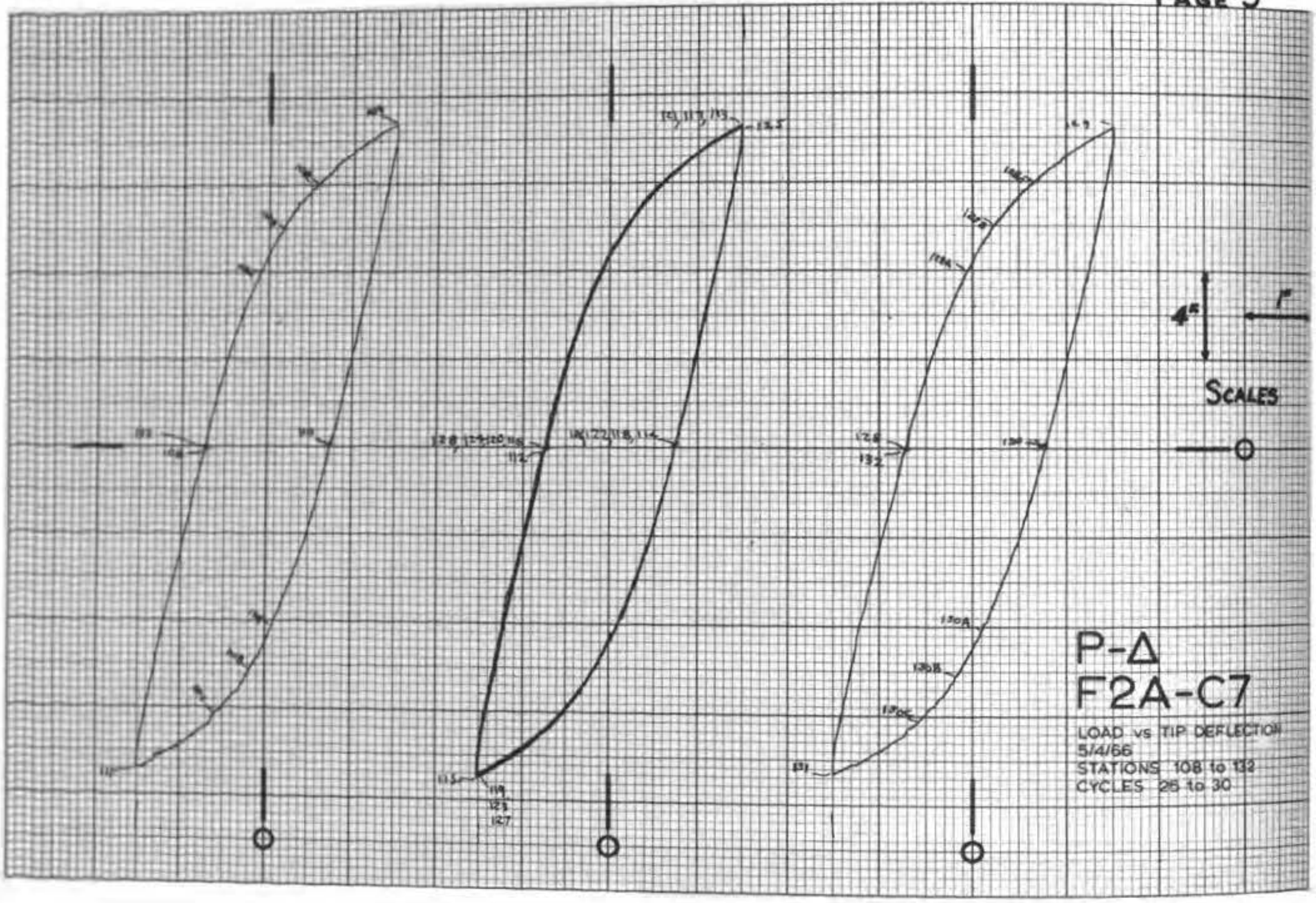
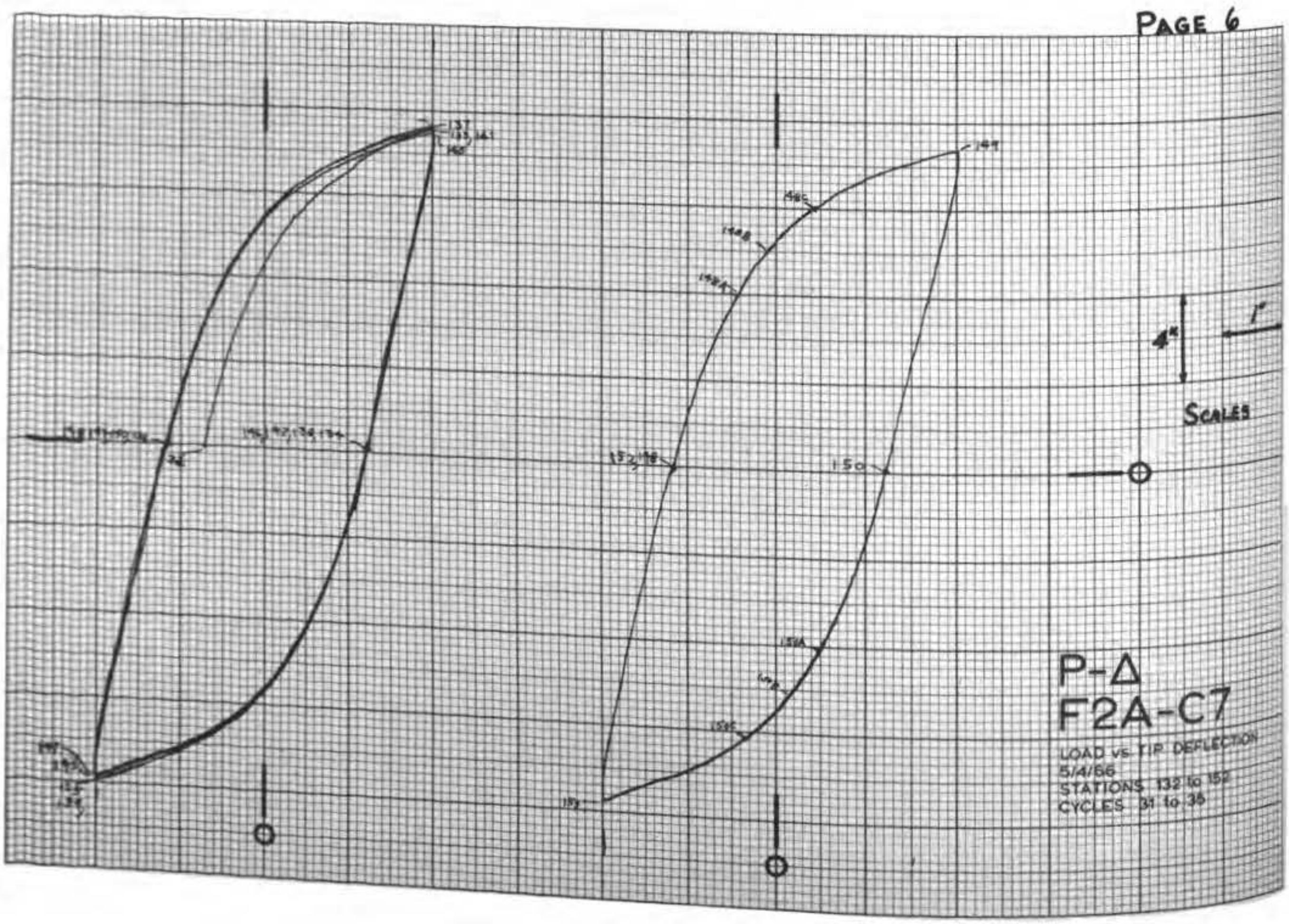


PLATE 13. (continued)

PAGE 5


4"
1"
SCALES
P-Δ
F2A-C7
LOAD vs TIP DEFLECTION
5/4/66
STATIONS 108 to 132
CYCLES 26 to 30

PAGE 6


4"
1"
SCALES
P-Δ
F2A-C7
LOAD vs TIP DEFLECTION
5/4/66
STATIONS 132 to 152
CYCLES 31 to 35

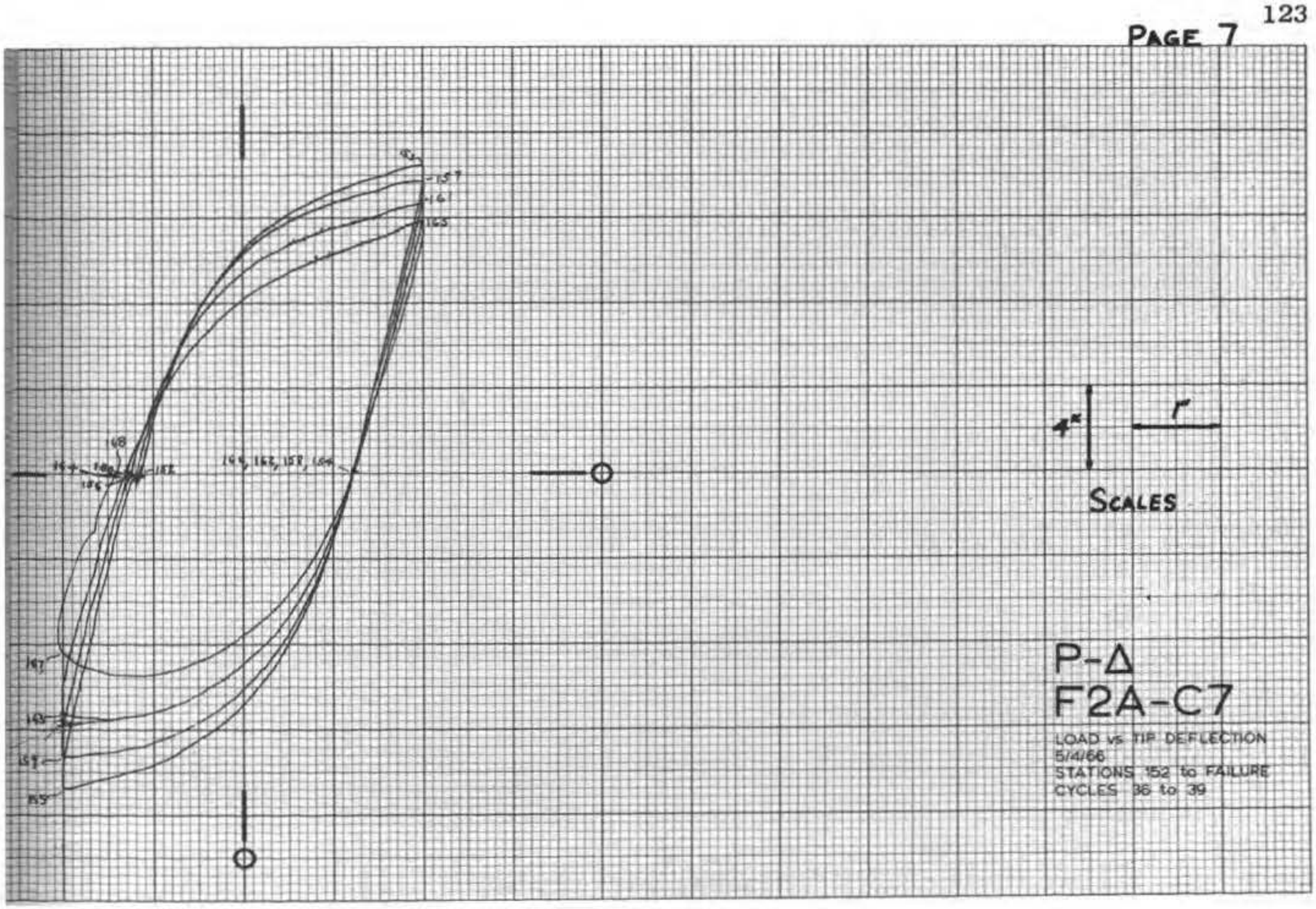


PLATE 13. (continued)

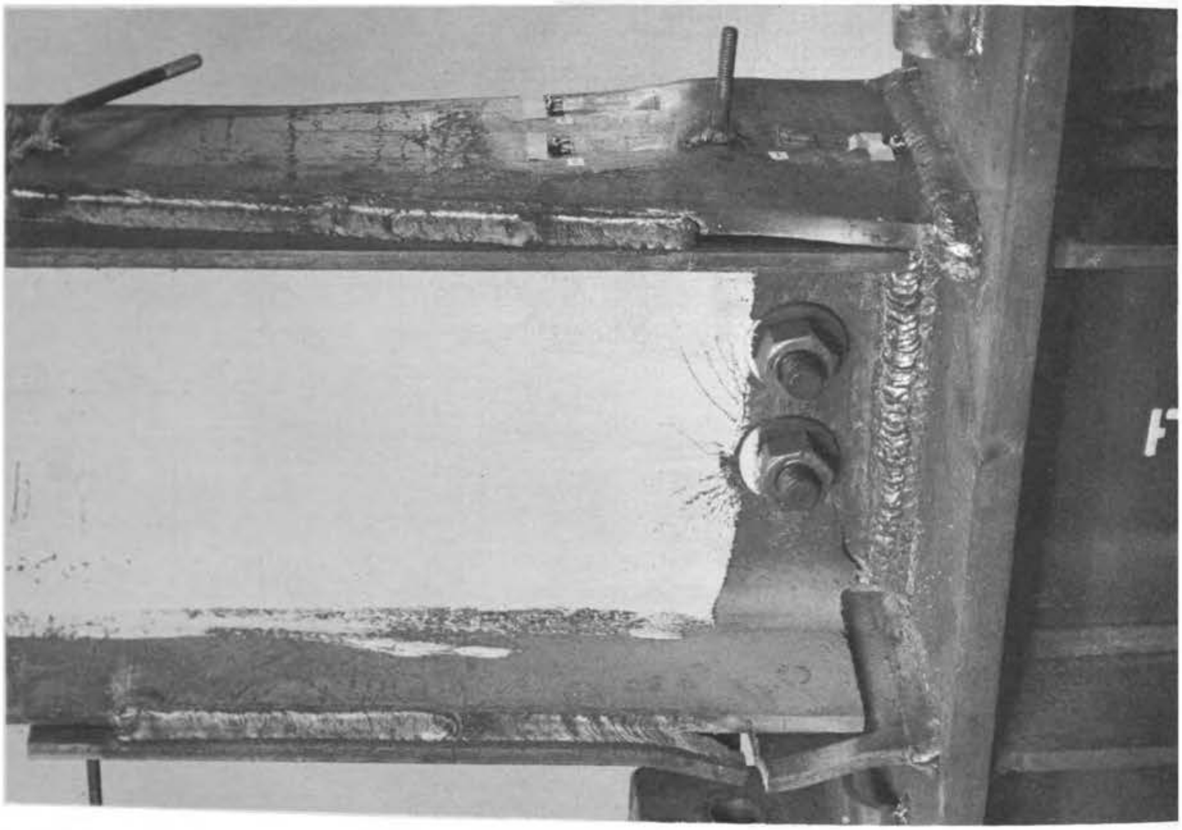


FIGURE 27. F2A-C7

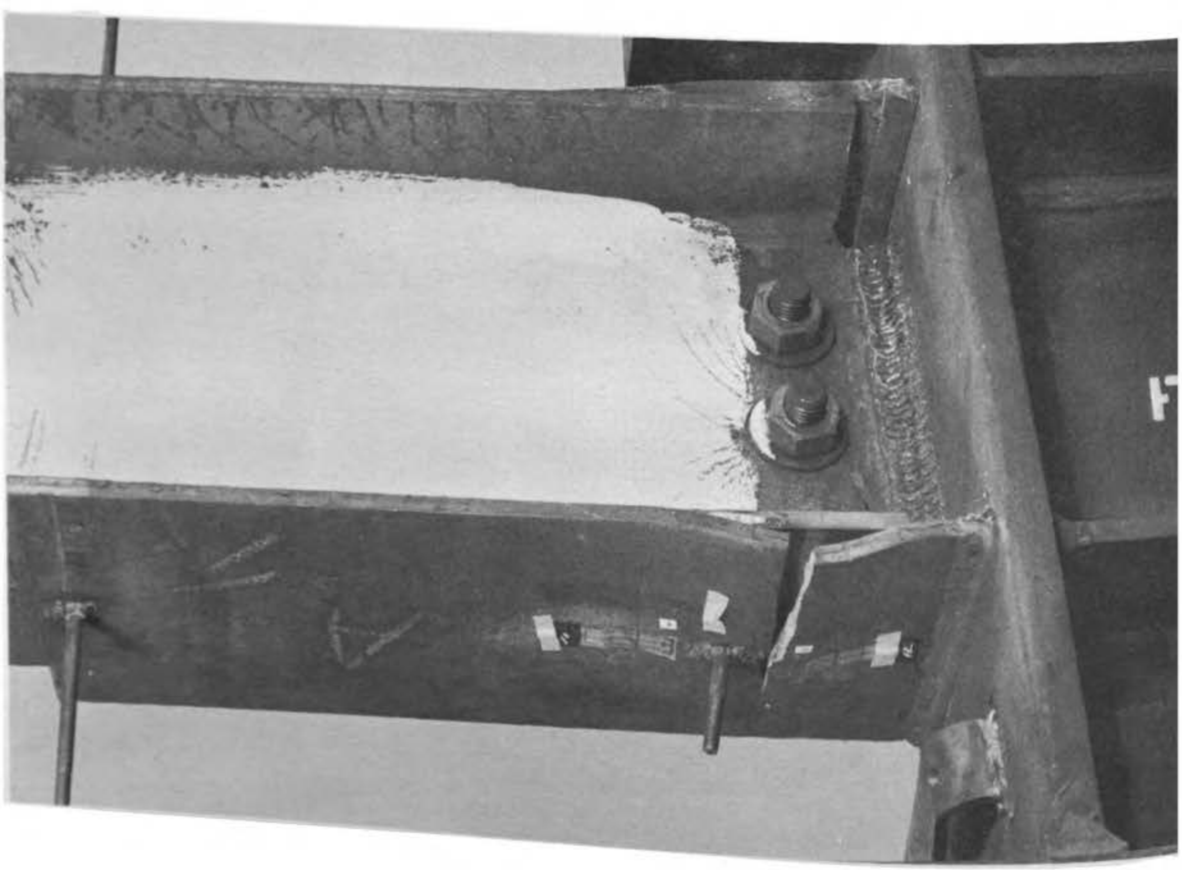


FIGURE 28. F2A-C7

SPECIMEN F2A-C7

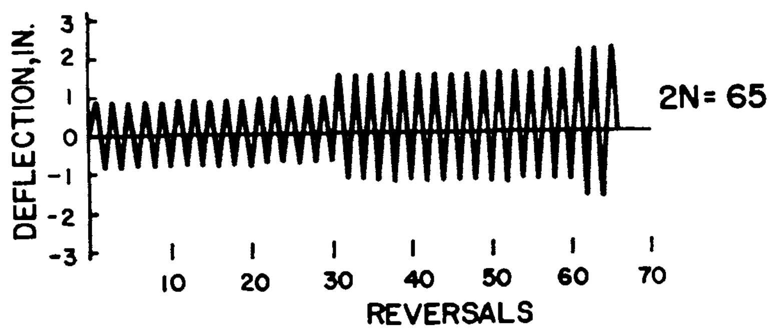
Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	12.36	0.82	0.29	3.1	1.010	1.71	0.60	1.05
2	-13.25	-0.81	0.54	6.2	-1.082	-1.69	1.13	2.10
3	12.81	0.81	0.50	4.9	1.046	1.69	1.04	1.67
4	-13.53	-0.81	0.50	5.0	-1.105	-1.68	1.04	1.71
5	12.93	0.81	0.50	4.9	1.056	1.68	1.04	1.68
6	-13.48	-0.81	0.50	5.0	-1.101	-1.68	1.04	1.71
7	12.97	C.81	0.50	5.0	1.060	1.68	1.04	1.68
8	-13.51	-C.81	0.50	5.0	-1.104	-1.68	1.04	1.71
9	13.01	C.81	0.51	4.9	1.063	1.68	1.06	1.68
10	-13.28	-0.80	0.51	4.9	-1.085	-1.67	1.06	1.65
11	13.13	C.81	0.51	5.0	1.073	1.68	1.06	1.72
12	-13.26	-0.80	0.51	4.8	-1.083	-1.67	1.06	1.64
13	12.95	0.81	0.51	4.7	1.058	1.68	1.06	1.61
14	-13.27	-C.80	0.51	4.8	-1.084	-1.67	1.06	1.64
15	12.92	0.81	0.51	4.8	1.055	1.69	1.07	1.62
16	-13.30	-0.80	0.51	4.8	-1.087	-1.67	1.07	1.65
17	12.84	C.81	0.51	4.8	1.049	1.69	1.07	1.62
18	-13.18	-0.80	0.51	4.8	-1.076	-1.67	1.07	1.64
19	12.89	0.81	0.51	5.0	1.053	1.69	1.06	1.71
20	-13.28	-0.81	0.51	5.0	-1.085	-1.69	1.06	1.70
21	12.81	0.81	0.52	4.9	1.047	1.69	1.09	1.67
22	-13.29	-0.80	0.53	5.0	-1.086	-1.67	1.11	1.70
23	12.85	0.81	0.53	4.9	1.050	1.69	1.11	1.68
24	-13.30	-0.80	0.53	5.0	-1.087	-1.67	1.11	1.70
25	12.79	0.81	0.53	4.9	1.045	1.69	1.11	1.67
26	-13.24	-0.80	0.53	5.0	-1.082	-1.67	1.11	1.69
27	12.82	0.81	0.53	4.9	1.047	1.69	1.11	1.67
28	-13.19	-0.81	0.53	5.0	-1.077	-1.67	1.11	1.70
29	12.82	0.81	0.53	5.0	1.047	1.69	1.10	1.70
30	-13.06	-0.81	0.53	5.1	-1.067	-1.68	1.11	1.72
31	14.15	1.28	0.94	11.7	1.156	2.67	1.96	3.98
32	-14.46	-1.30	1.35	15.8	-1.181	-2.69	2.81	5.37
33	14.24	1.28	1.37	15.7	1.163	2.66	2.85	5.34
34	-14.60	-1.29	1.39	16.4	-1.193	-2.69	2.89	5.58
35	14.32	1.28	1.41	15.8	1.170	2.66	2.94	5.37
36	-14.78	-1.32	1.43	17.2	-1.208	-2.75	2.98	5.86
37	14.27	1.28	1.41	15.7	1.166	2.66	2.94	5.35
38	-14.52	-1.29	1.39	16.3	-1.187	-2.69	2.89	5.55
39	14.21	1.28	1.37	15.4	1.161	2.67	2.85	5.24
40	-14.46	-1.30	1.37	15.1	-1.181	-2.70	2.85	5.13
41	14.23	1.30	1.41	16.4	1.162	2.70	2.94	5.57
42	-14.56	-1.27	1.39	16.0	-1.190	-2.65	2.89	5.42
43	14.41	1.30	1.39	15.5	1.178	2.70	2.89	5.25
44	-14.55	-1.27	1.39	15.9	-1.189	-2.65	2.89	5.42
45	14.39	1.30	1.39	15.4	1.176	2.70	2.89	5.25
46	-14.64	-1.27	1.41	16.1	-1.196	-2.65	2.94	5.46
47	14.22	1.30	1.41	15.4	1.162	2.70	2.94	5.22
48	-14.64	-1.30	1.41	16.0	-1.196	-2.71	2.94	5.45
49	14.20	1.28	1.40	15.6	1.160	2.67	2.91	5.31
50	-14.25	-1.30	1.40	16.0	-1.164	-2.70	2.91	5.43
51	14.05	1.28	1.38	15.2	1.148	2.67	2.87	5.17

Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
52	-14.50	-1.32	1.39	15.7	-1.185	-2.74	2.89	5.33
53	14.03	1.28	1.39	15.2	1.147	2.67	2.89	5.16
54	-14.33	-1.30	1.39	15.1	-1.171	-2.70	2.89	5.14
55	14.01	1.28	1.39	15.3	1.145	2.67	2.89	5.19
56	-14.34	-1.30	1.39	15.1	-1.172	-2.70	2.89	5.15
57	13.90	1.29	1.39	15.3	1.136	2.67	2.89	5.19
58	-14.33	-1.30	1.39	15.1	-1.171	-2.70	2.90	5.14
59	13.90	1.29	1.43	15.1	1.136	2.67	2.98	5.14
60	-14.07	-1.31	1.43	15.5	-1.150	-2.73	2.98	5.27
61	14.62	1.78	1.87	21.5	1.194	3.69	3.89	7.31
62	-15.29	-1.80	2.33	28.9	-1.249	-3.75	4.85	9.83
63	14.78	1.77	2.33	27.2	1.208	3.69	4.85	9.23
64	-15.33	-1.80	2.33	28.9	-1.253	-3.75	4.85	9.83
65	14.69	1.77	2.33	26.9	1.200	3.69	4.85	9.14
66	-15.18	-1.80	2.33	28.5	-1.240	-3.73	4.85	9.69
67	14.45	1.78	2.33	26.1	1.181	3.69	4.85	8.88
68	-15.15	-1.80	2.33	28.5	-1.238	-3.74	4.85	9.69
69	14.28	1.79	2.32	25.9	1.167	3.72	4.83	8.82
70	-14.92	-1.80	2.32	27.2	-1.219	-3.74	4.83	9.25
71	14.00	1.75	2.31	25.8	1.144	3.65	4.81	8.76
72	-14.15	-1.83	2.34	27.3	-1.156	-3.80	4.87	9.29
73	13.25	1.77	2.34	25.3	1.082	3.67	4.87	8.59
74	-12.67	-1.86	2.40	25.6	-1.035	-3.87	4.99	8.70
75	12.22	1.78	2.40	23.1	0.998	3.70	5.00	7.85
76	-11.19	-1.88	2.45	23.2	-0.914	-3.92	5.10	7.89
77	11.37	1.80	2.45	20.4	0.929	3.75	5.10	6.94

SPECIMEN F2B-C8

Description: This specimen was similar to specimen F2A-C7, except that the suffix "B" denotes the use of top and bottom plates each nominally 1/8 inch thinner than the corresponding plates of specimen type F2.

Program of Cycling:



Test Control: Tip deflection.

Raw Data Included: Graphical load-strain data, with strain measured on the top plate 1.88 inches from the column face.

Graphical load-deflection data.

Total Energy Absorption: 533 kip-inches.

Plastic Load Reversals to Failure: 65 (32½ cycles).

Remarks: Buckling of the top plate became obvious during the 5th cycle; that of the bottom plate, during the 6th. In the 9th cycle cracks appeared on both sides of the bottom plate at the ends of the longitudinal welds near the column. During the 14th cycle a small crack appeared in the top flange plate near the column at the end of one of the longitudinal welds. A similar crack developed on the opposite side of the plate in the 16th cycle. At the same time a crack about

3/8 inch long was found in the corner of the bottom cope. During the 18th cycle the same crack enlarged to approximately one inch in length.

A small surface crack was observed during the 20th cycle on the concave side of the lower plate buckle. It was also noted that closing the web crack on the down stroke coincided with the sudden load increase near the end of the stroke. One of the cracks at the lower flange weld began to propagate rapidly during this cycle. In the next cycle, the same phenomenon was observed on the top plate. Fracture occurred at the buckle in the bottom plate and at the weld to the column, during the 33rd cycle.

SPECIMEN TYPE F2B-C8

DIMENSIONS OF WF SECTION

DEPTH	8.22	INCHES
TOP FLANGE WIDTH	5.310	INCHES
BOTTOM FLANGE WIDTH	5.310	INCHES
TOP FLANGE THICKNESS	0.354	INCHES
BOTTOM FLANGE THICKNESS	0.356	INCHES
WEB THICKNESS	0.256	INCHES
ELASTIC MODULUS	29400.	KSI
YIELD STRESS	35.900	KSI

DIMENSIONS AND PROPERTIES OF TOP PLATE

LENGTH, LP	13.95	INCHES
WIDTH AT END AWAY FROM COLUMN, M	2.50	INCHES
WIDTH AT END OF WELD, R	4.41	INCHES
AVERAGE LOCATION OF END OF WELD*, N	3.92	INCHES
THICKNESS, T	0.370	INCHES
ELASTIC MODULUS	28400.	KSI
YIELD STRESS	36.500	KSI

*MEASURED FROM FACE OF COLUMN

DIMENSIONS AND PROPERTIES OF BOTTOM PLATE

LENGTH, LP	14.09	INCHES
WIDTH, B	6.28	INCHES
AVERAGE LOCATION OF COLUMN END OF WELD*, Q .	2.54	INCHES
AVERAGE LOCATION OF OUTER END OF WELD*, P . .	12.81	INCHES
THICKNESS, T	0.250	INCHES
ELASTIC MODULUS	30000.	KSI
YIELD STRESS	37.900	KSI

*MEASURED FROM FACE OF COLUMN

DEPTH OUT-TO-OUT OF PLATES	8.88	INCHES

WF SECTION PROPERTIES

AREA, A	5.78	INCHES**2
LOCATION OF CENTROID*, YE	4.10	INCHES
MOMENT OF INERTIA, I	68.6	INCHES**4
SECTION MODULUS, TOP, ST	16.7	INCHES**3
SECTION MODULUS, BOTTOM, SB	16.7	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.09	INCHES
PLASTIC MODULUS, Z	18.8	INCHES**3
SHAPE FACTOR	1.126	
YIELD MOMENT, MY	49.87	KIP-FT.
PLASTIC MOMENT, MP	56.16	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

SPECIMEN TYPE F2B-C8

SECTION PROPERTIES AT SELECTED CROSS-SECTIONS

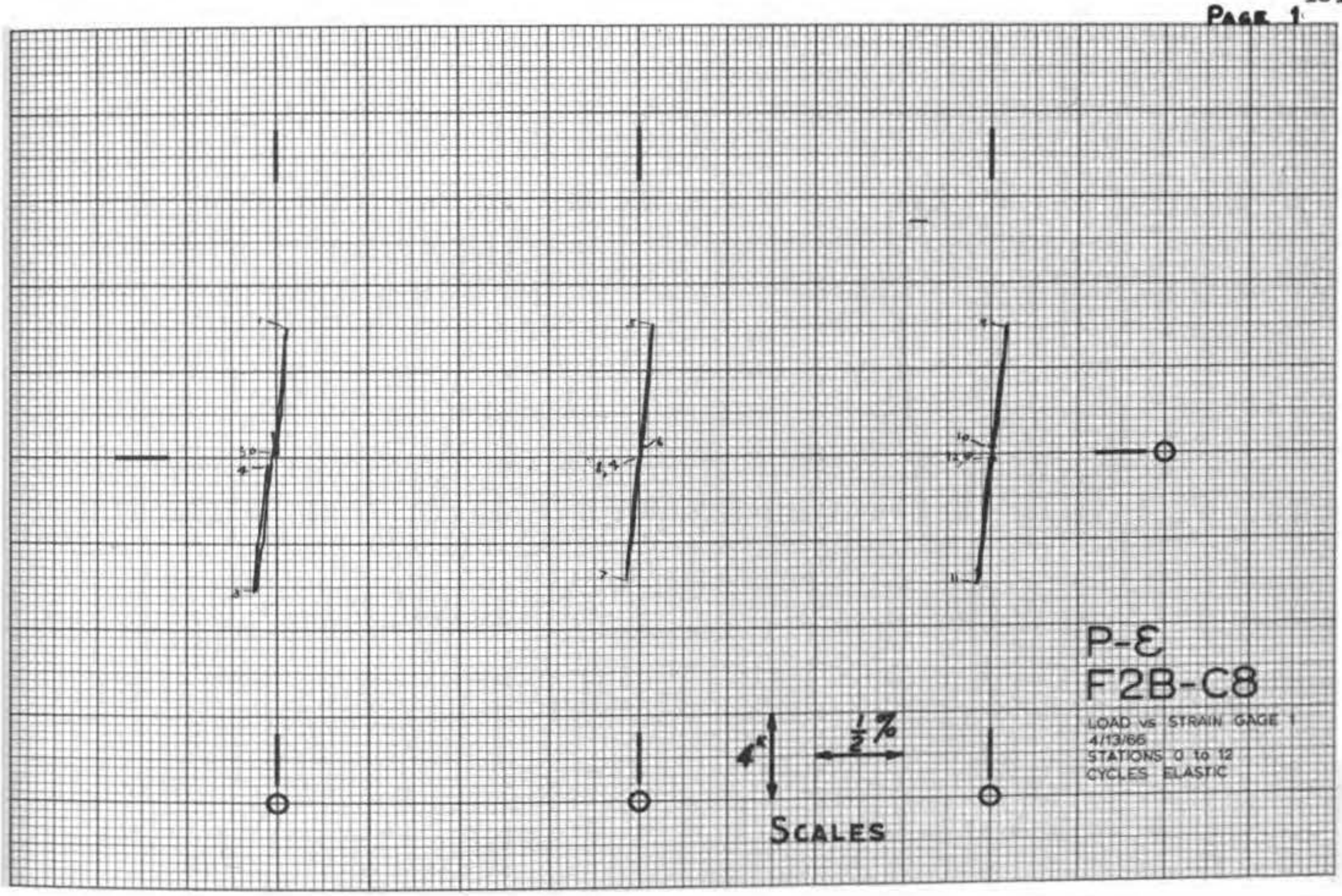
X	A	YE	I	ST	SB
52.05	5.78	4.37	68.6	16.6	16.6
52.05	6.68	4.95	83.1	21.1	17.7
52.62	6.72	4.97	83.6	21.4	17.7
53.18	6.75	4.99	84.2	21.7	17.7
53.18	8.36	4.06	114.9	23.8	28.3
57.63	8.66	4.22	121.1	26.0	28.7
62.08	8.96	4.37	127.0	28.2	29.0
62.08	6.87	3.19	85.6	15.0	26.8
62.77	6.92	3.23	87.0	15.4	27.0
63.46	6.97	3.26	88.4	15.7	27.1
63.46	4.86	4.46	65.2	14.8	14.6
64.73	4.95	4.53	66.7	15.4	14.7
66.00	5.04	4.61	68.2	16.0	14.8

X	YP	Z	F	MY	MP
52.05	4.53	18.4	1.090	50.45	54.99
52.05	6.37	21.4	1.149	55.82	64.12
52.62	6.45	21.5	1.152	55.92	64.40
53.18	6.53	21.6	1.154	56.03	64.67
53.18	3.29	29.5	1.219	72.50	88.39
57.63	3.91	31.2	1.178	79.12	93.24
62.08	4.53	32.6	1.137	85.73	97.51
62.08	0.62	20.6	1.346	45.74	61.59
62.77	0.62	21.0	1.341	46.80	62.78
63.46	0.63	21.4	1.336	47.86	63.97
63.46	4.58	17.1	1.140	44.88	51.16
64.73	4.75	17.5	1.124	46.50	52.26
66.00	4.93	17.8	1.139	46.79	53.31

X = DISTANCE FROM CONCENTRATED LOAD, INCHES
A = AREA OF CROSS-SECTION, INCHES**2
YE = DIST. FROM OUTSIDE OF BOTTOM PLATE TO CENTROID, INCHES
I = MOMENT OF INERTIA, INCHES**4
ST = SECTION MODULUS FOR TOP FLANGE, INCHES**3
SB = SECTION MODULUS FOR BOTTOM FLANGE, INCHES**3
YP = DIST. FROM OUTSIDE OF BOTTOM PLATE TO PLASTIC N.A., IN.
Z = PLASTIC MODULUS, INCHES**3
F = SHAPE FACTOR
MY = YIELD MOMENT, KIP-FEET
MP = PLASTIC MOMENT, KIP-FEET

BEAM PROPERTIES

LENGTH, L . . . . 66.0 INCHES
ELASTIC STIFFNESS, P/DELTA . . . . 24.74 KIPS/IN.
YIELD DEFLECTION, DELTAY . . . . 0.343 INCHES
YIELD LOAD, PY . . . . 8.49 KIPS
PLASTIC LOAD, PP . . . . 9.67 KIPS
LOCATION OF CRITICAL SECTION FOR PY* . . . . . 63.46 INCHES
LOCATION OF CRITICAL SECTION FOR PP* . . . . . 63.46 INCHES
* MEASURED FROM CONCENTRATED LOAD



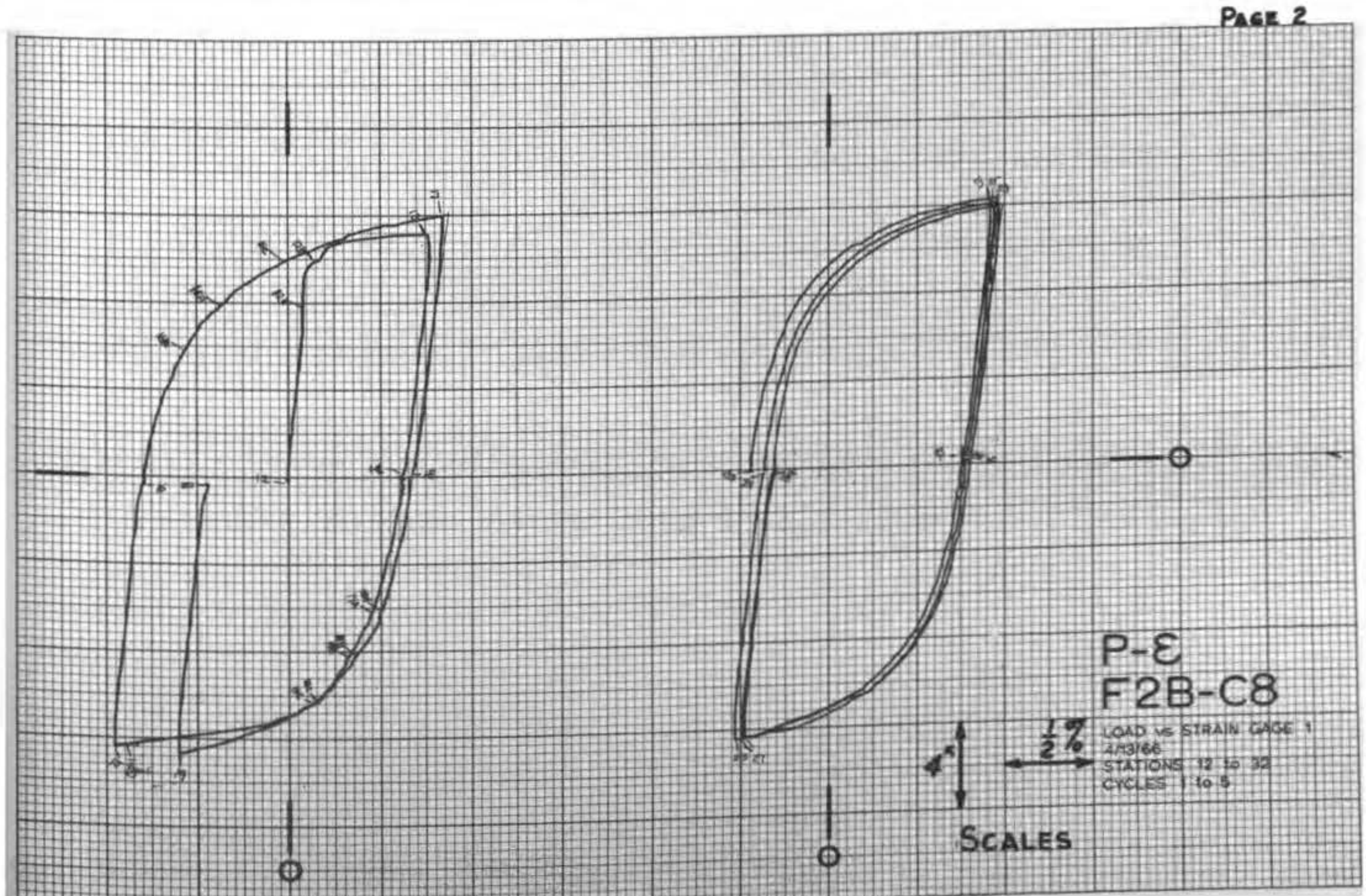
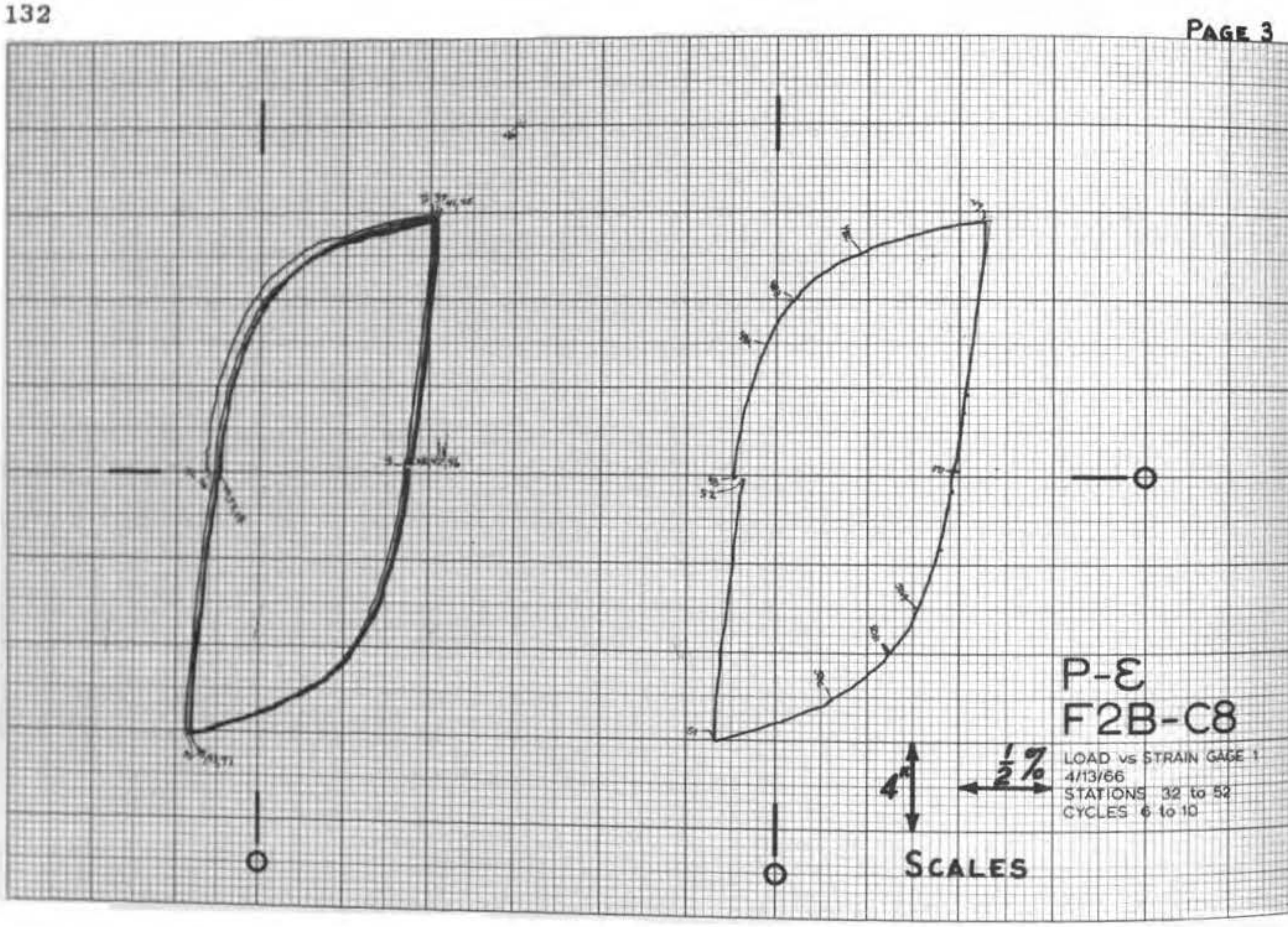
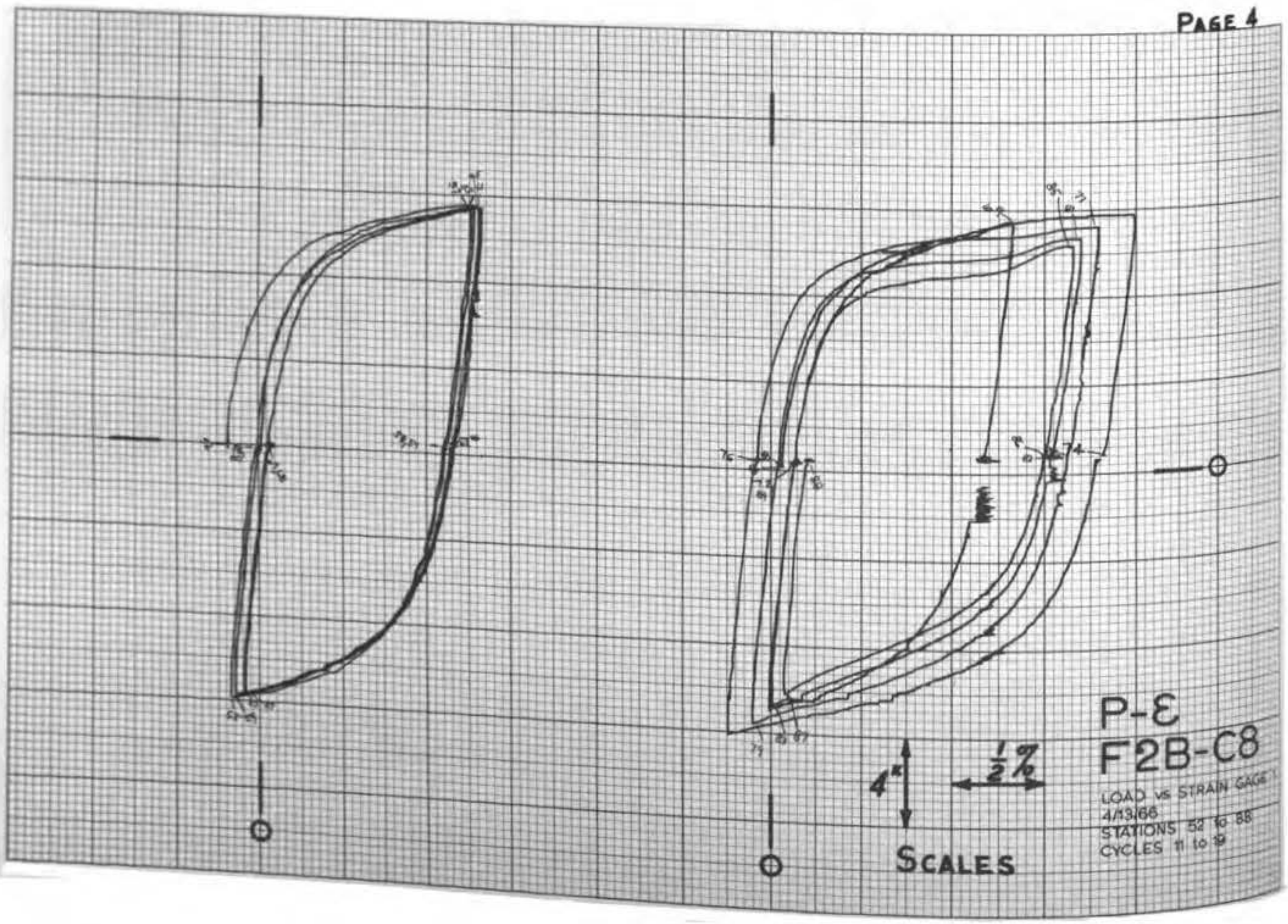
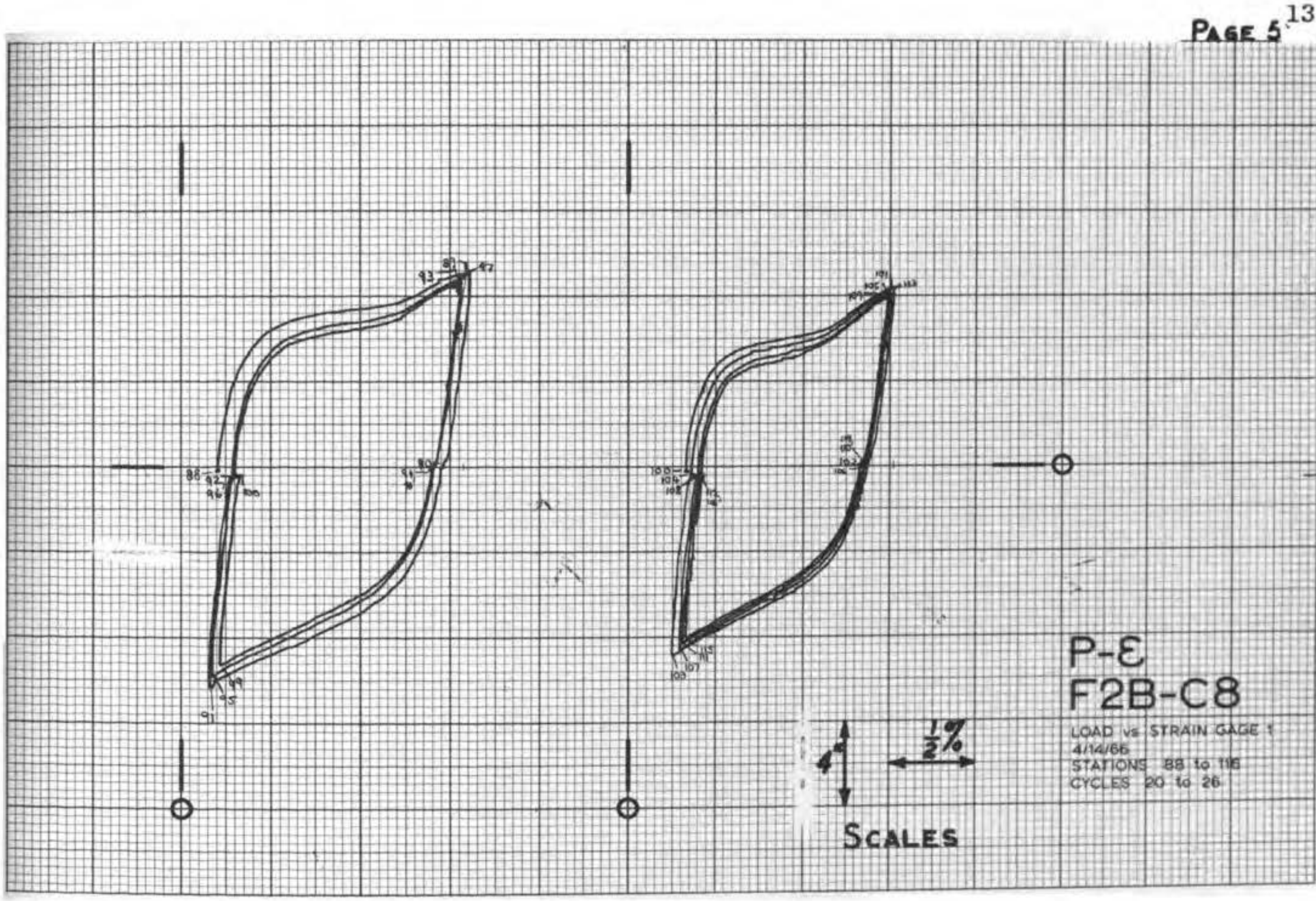


PLATE 14. LOAD VS. STRAIN - F2B-C8


PAGE 3
P-Ɛ
F2B-C8
LOAD vs STRAIN GAGE 1
4/13/66
STATIONS 32 to 52
CYCLES 6 to 10
4"
1/2 %
SCALES


PAGE 4
P-Ɛ
F2B-C8
LOAD vs STRAIN GAGE
4/13/66
STATIONS 52 to 88
CYCLES 11 to 19
4"
1/2 %
SCALES



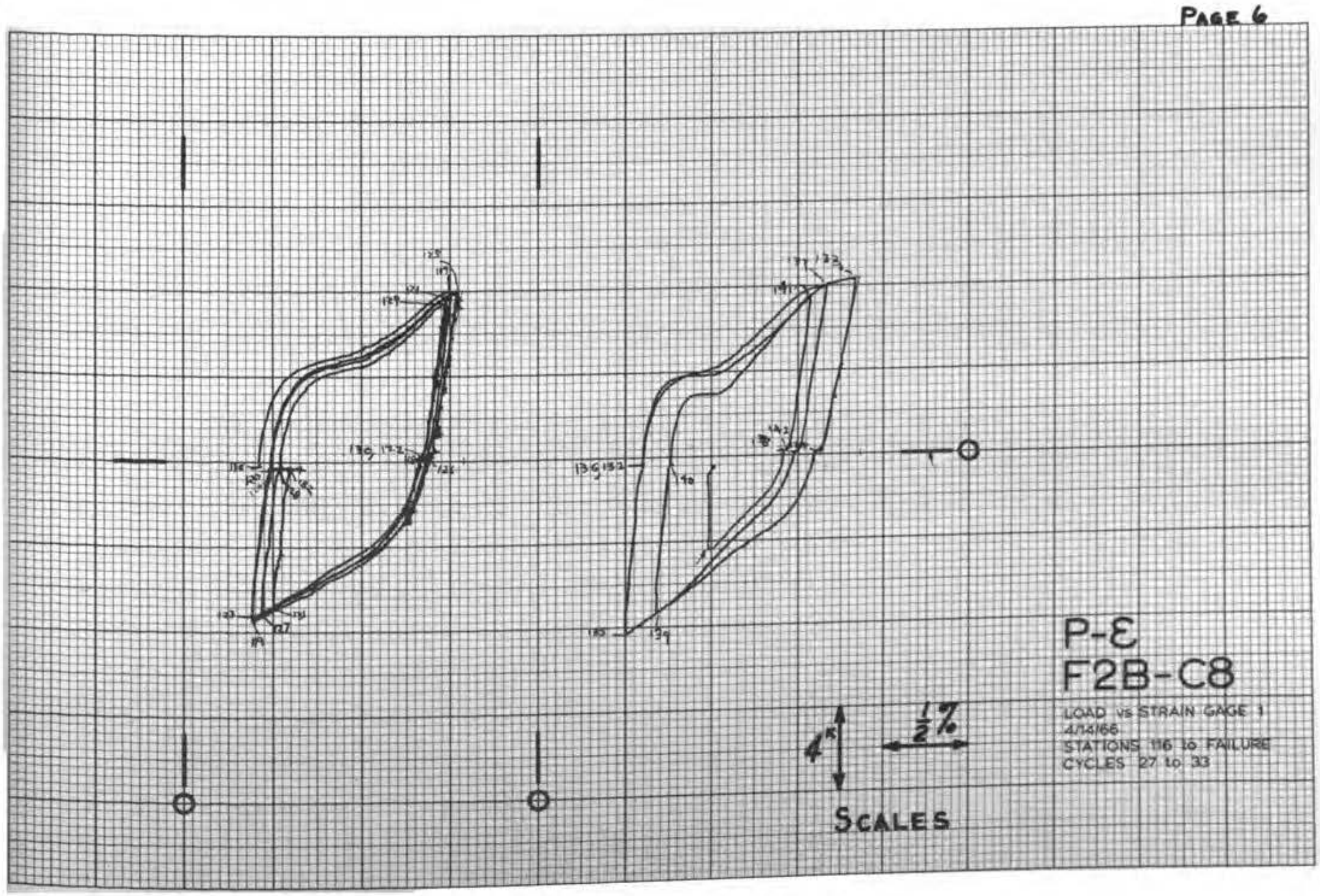
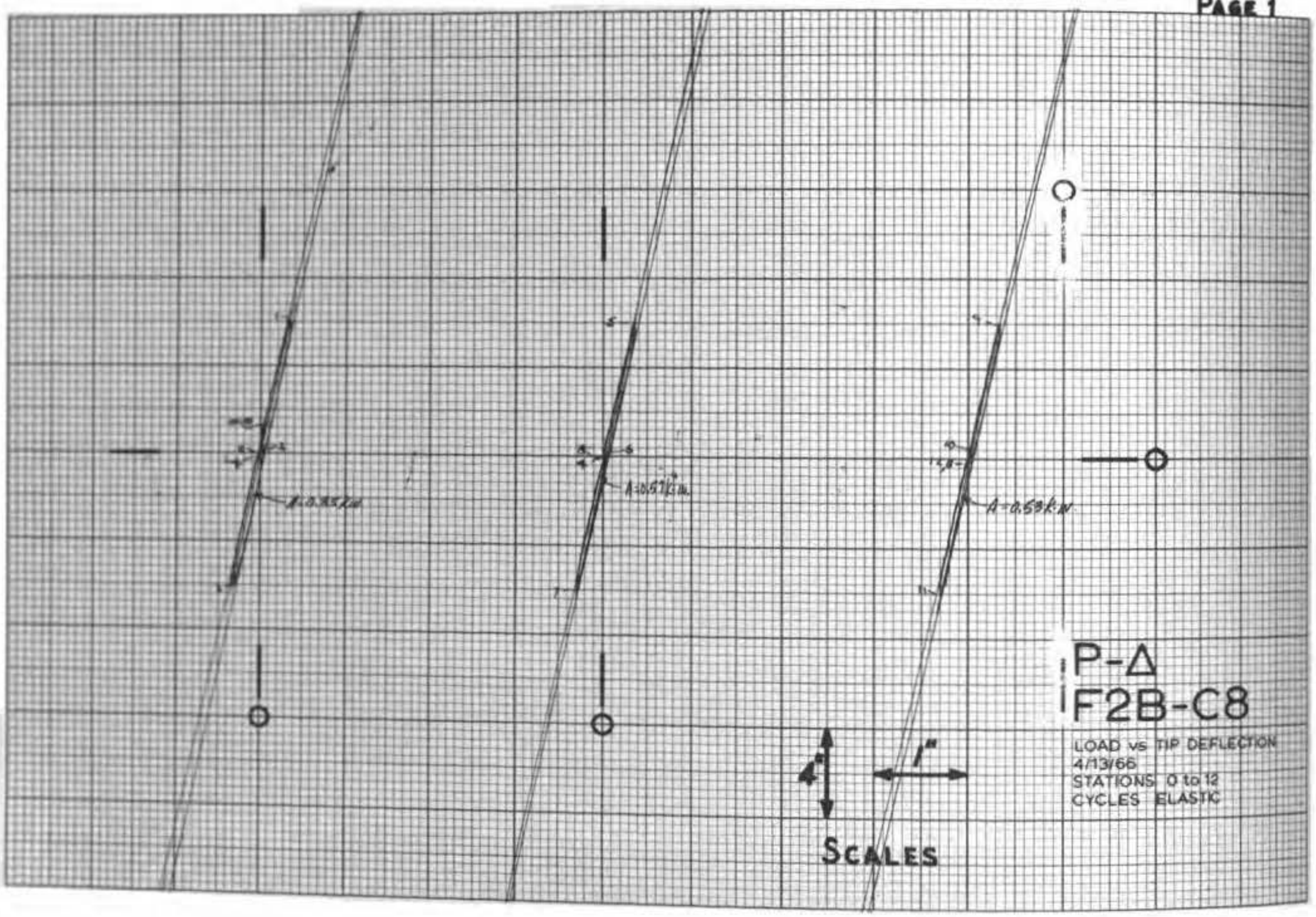
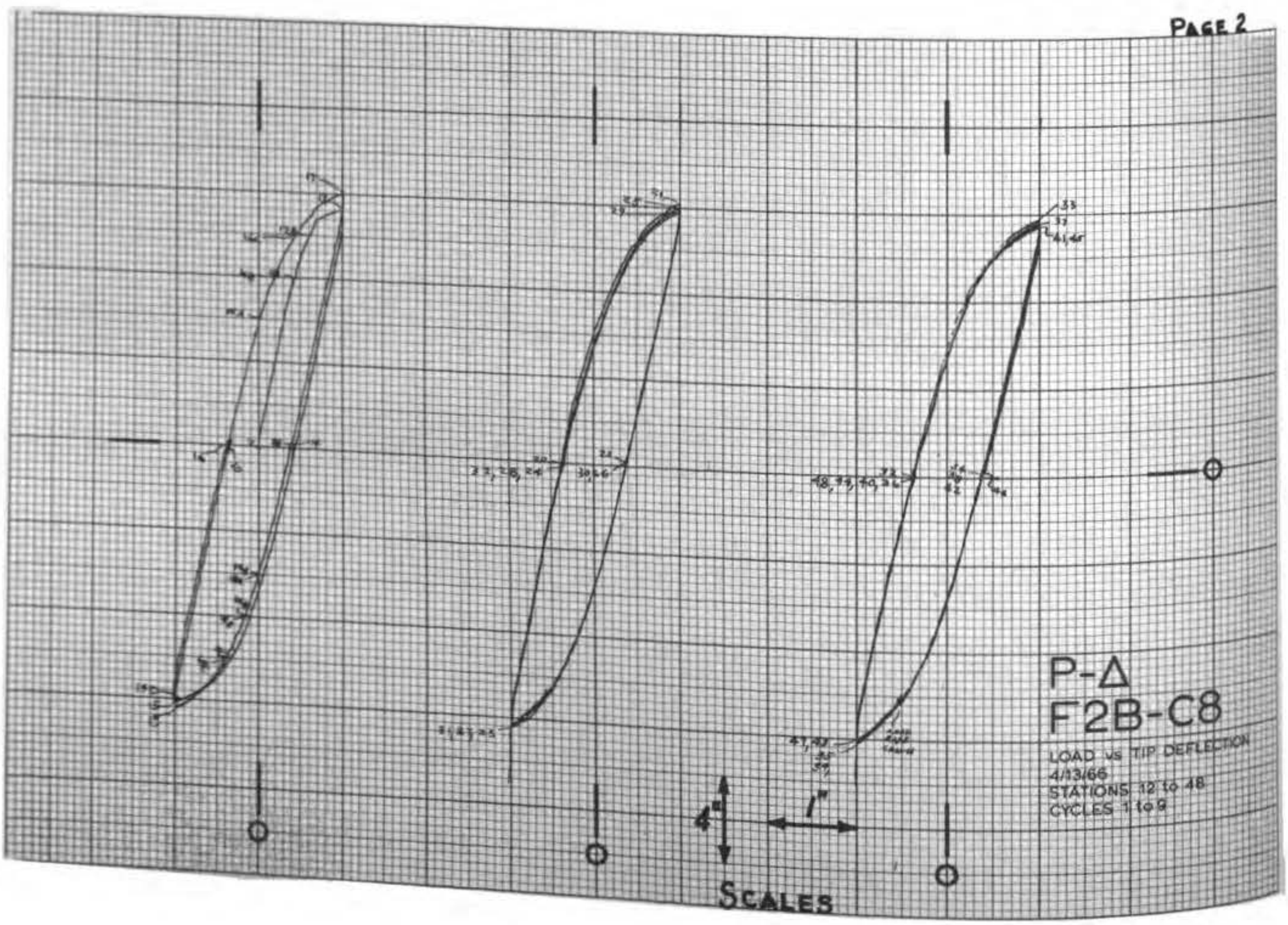
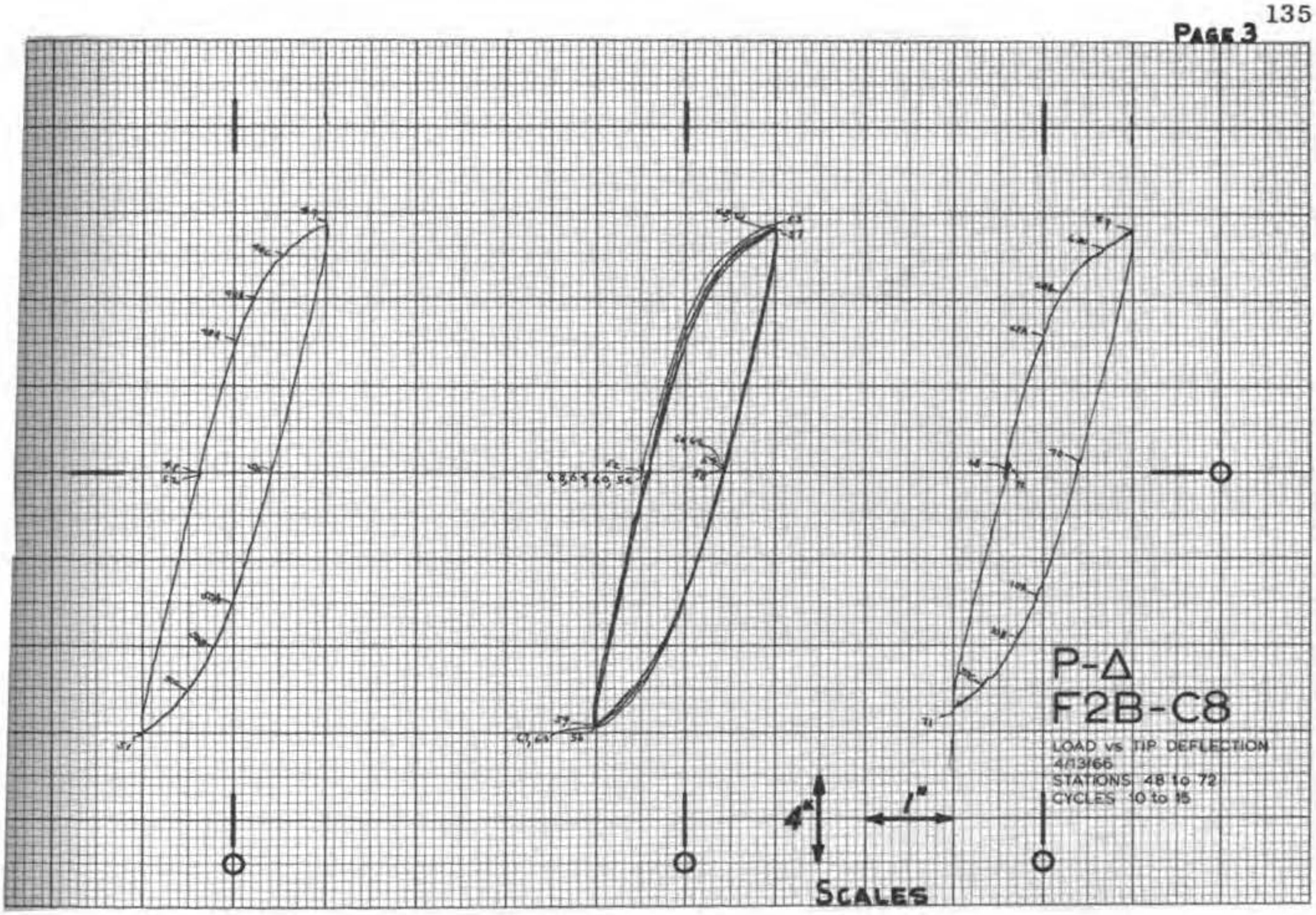


PLATE 14. (continued)


PAGE 1
P-Δ
F2B-C8
LOAD vs TIP DEFLECTION
4/13/66
STATIONS 0 to 12
CYCLES ELASTIC
4"
1"
SCALES


PAGE 2
P-Δ
F2B-C8
LOAD vs TIP DEFLECTION
4/13/66
STATIONS 12 to 48
CYCLES 1 to 9
4"
1"
SCALES



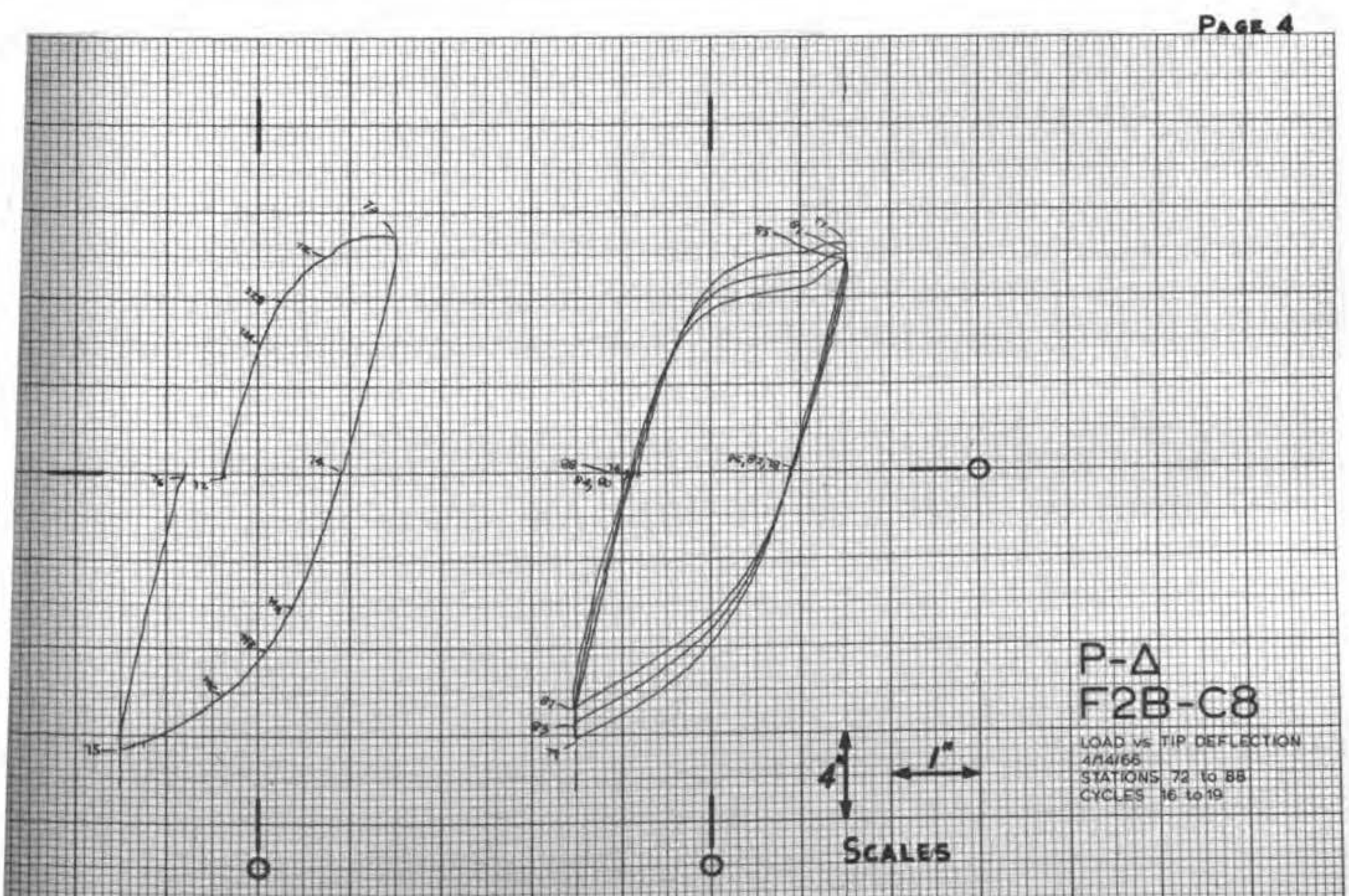
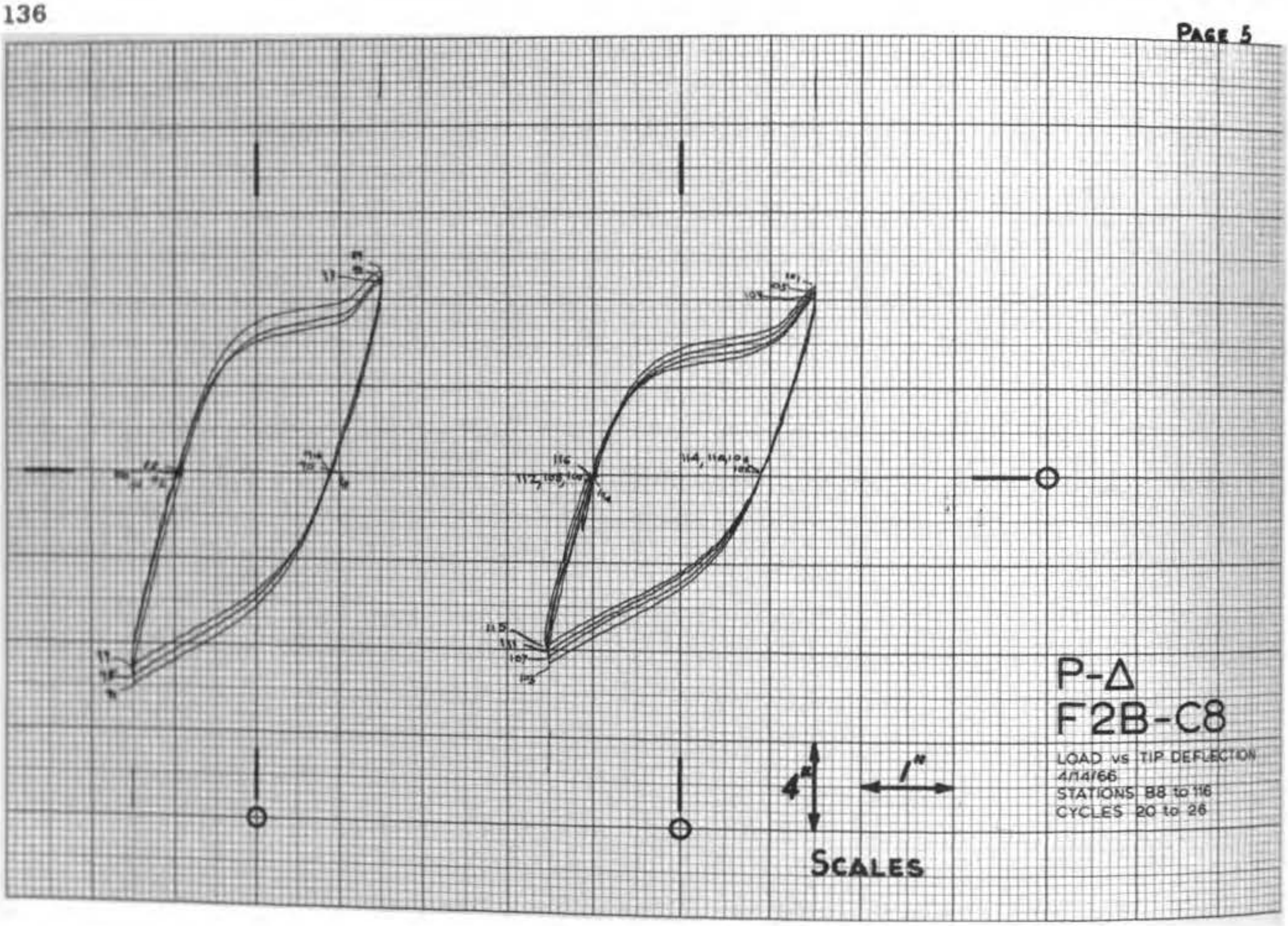


PLATE 15. (continued)


PAGE 5
P-Δ
F2B-C8
LOAD vs TIP DEFLECTION
4/14/66
STATIONS 88 to 116
CYCLES 20 to 26
4"
1"
SCALES

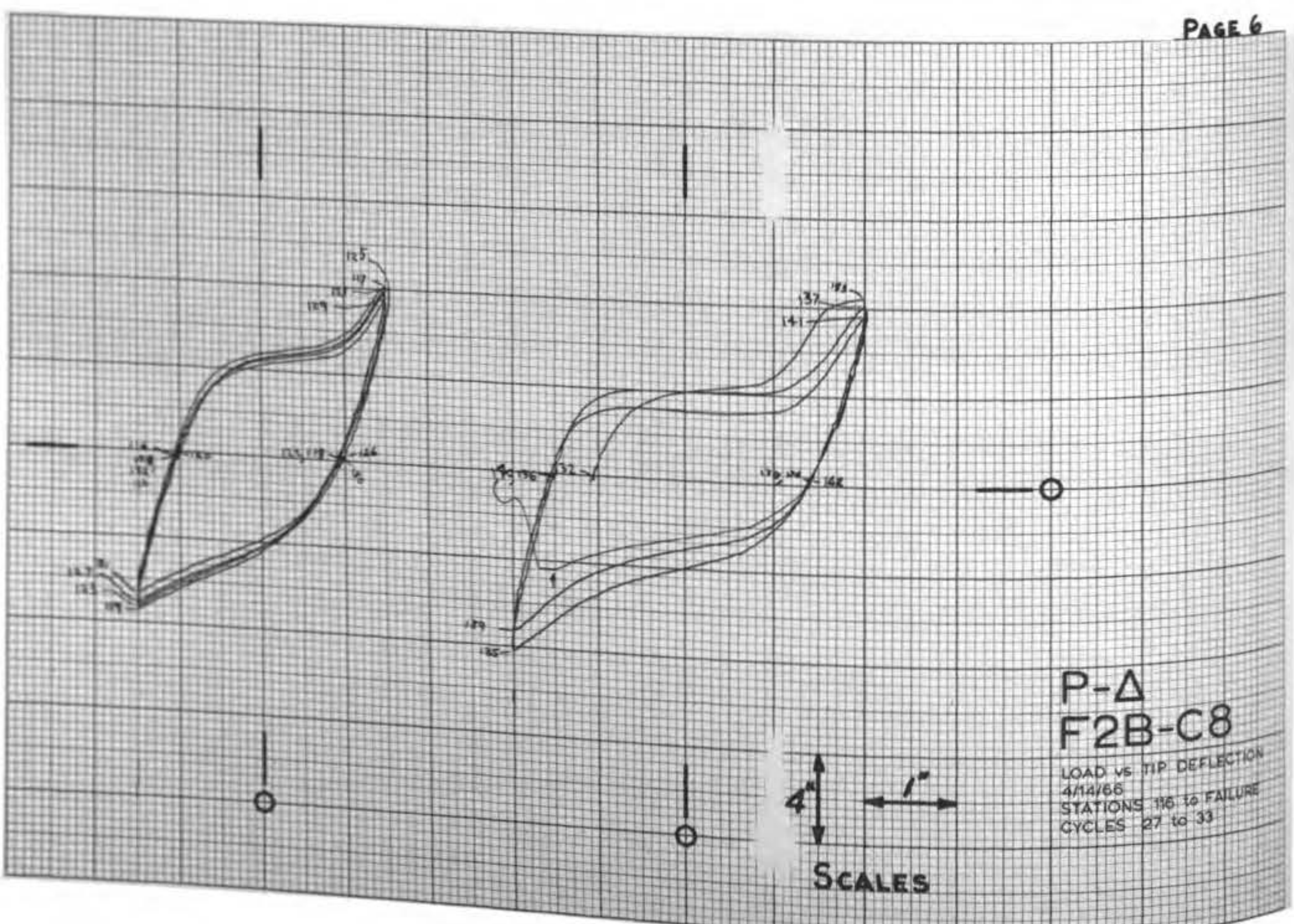

PAGE 6
P-Δ
F2B-C8
LOAD vs TIP DEFLECTION
4/14/66
STATIONS 116 to FAILURE
CYCLES 27 to 33
4"
1"
SCALES

FIGURE 29. F2B-C8

SPECIMEN F2B-C8

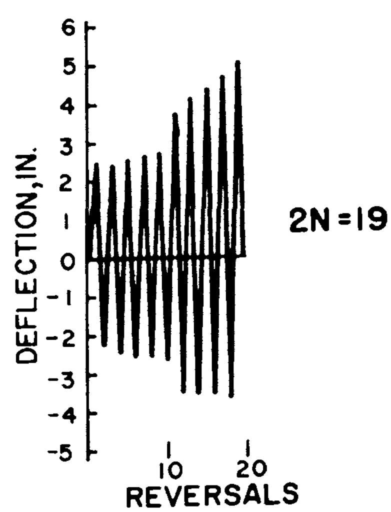
Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	10.56	0.85	0.40	3.8	1.092	2.17	1.02	2.03
2	-11.58	-0.85	0.73	7.5	-1.198	-2.19	1.87	3.96
3	11.38	0.85	0.68	6.2	1.177	2.17	1.74	3.30
4	-11.83	-0.83	0.65	6.5	-1.224	-2.13	1.66	3.43
5	11.54	0.85	0.65	6.3	1.193	2.16	1.66	3.33
6	-11.87	-0.82	0.65	5.7	-1.228	-2.10	1.66	3.03
7	11.31	0.85	0.65	5.8	1.170	2.17	1.66	3.09
8	-11.77	-0.82	0.65	5.7	-1.217	-2.10	1.66	3.03
9	11.13	0.85	0.65	5.7	1.151	2.18	1.66	3.01
10	-11.74	-0.82	0.65	5.7	-1.214	-2.10	1.66	3.02
11	11.06	0.87	0.67	6.1	1.144	2.24	1.71	3.24
12	-11.66	-0.80	0.67	5.9	-1.206	-2.06	1.72	3.14
13	10.95	0.88	0.67	5.8	1.132	2.24	1.72	3.05
14	-11.60	-0.80	0.67	5.9	-1.199	-2.06	1.72	3.13
15	10.84	0.88	0.67	5.7	1.121	2.24	1.72	3.02
16	-11.52	-0.80	0.67	5.8	-1.192	-2.06	1.72	3.09
17	10.76	0.88	0.67	5.7	1.113	2.25	1.72	3.03
18	-11.49	-0.81	0.67	5.9	-1.189	-2.06	1.72	3.11
19	10.77	0.90	0.70	6.3	1.114	2.30	1.79	3.33
20	-11.41	-0.81	0.70	6.2	-1.180	-2.06	1.79	3.26
21	10.79	0.98	0.82	7.3	1.116	2.50	2.10	3.85
22	-11.26	-0.71	0.74	6.5	-1.164	-1.81	1.89	3.43
23	10.59	0.99	0.74	6.3	1.095	2.53	1.89	3.33
24	-11.11	-0.71	0.74	6.0	-1.149	-1.82	1.89	3.17
25	10.54	0.98	0.74	6.7	1.090	2.51	1.89	3.56
26	-11.20	-0.73	0.74	6.2	-1.158	-1.87	1.89	3.28
27	10.44	0.98	0.74	6.7	1.079	2.51	1.89	3.53
28	-11.17	-0.73	0.74	6.2	-1.155	-1.87	1.89	3.27
29	10.19	1.00	0.73	6.2	1.054	2.57	1.87	3.28
30	-10.60	-0.69	0.71	5.5	-1.097	-1.76	1.82	2.93
31	10.34	1.50	1.22	11.2	1.070	3.85	3.13	5.90
32	-11.92	-1.18	1.62	15.5	-1.233	-3.01	4.15	8.19
33	9.86	1.51	1.63	14.3	1.020	3.86	4.16	7.55
34	-11.50	-1.20	1.69	14.6	-1.190	-3.08	4.33	7.71
35	9.35	1.52	1.69	13.3	0.967	3.88	4.33	7.03
36	-10.77	-1.22	1.71	13.3	-1.114	-3.11	4.38	7.06
37	9.07	1.54	1.71	12.4	0.938	3.94	4.38	6.56
38	-10.14	-1.24	1.75	12.6	-1.049	-3.16	4.48	6.67
39	8.70	1.55	1.75	11.8	0.900	3.96	4.49	6.25
40	-9.25	-1.22	1.72	10.9	-0.956	-3.11	4.40	5.75
41	8.38	1.53	1.72	10.6	0.867	3.92	4.40	5.63
42	-8.93	-1.24	1.77	10.7	-0.923	-3.18	4.53	5.66
43	8.21	1.54	1.77	10.1	0.849	3.95	4.53	5.35
44	-8.45	-1.24	1.77	9.8	-0.874	-3.17	4.53	5.19
45	7.99	1.55	1.79	9.8	0.826	3.96	4.58	5.18
46	-8.04	-1.22	1.81	9.5	-0.831	-3.11	4.64	5.01
47	7.77	1.55	1.81	9.2	0.804	3.97	4.64	4.84
48	-7.77	-1.22	1.82	9.1	-0.804	-3.12	4.66	4.80
49	7.61	1.55	1.82	8.8	0.787	3.97	4.66	4.64
50	-7.52	-1.24	1.83	8.5	-0.778	-3.18	4.69	4.51
51	7.46	1.55	1.83	8.2	0.772	3.98	4.69	4.35

Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	W
52	-7.32	-1.28	1.85	8.4	-0.757	-3.27	4.73	4.44
53	7.53	1.57	1.88	8.3	0.778	4.02	4.81	4.41
54	-6.76	-1.22	1.83	7.8	-0.699	-3.13	4.67	4.12
55	7.31	1.57	1.83	7.4	0.756	4.01	4.68	3.92
56	-6.63	-1.23	1.84	7.6	-0.686	-3.14	4.70	4.04
57	7.43	1.61	1.90	8.1	0.768	4.13	4.85	4.30
58	-6.50	-1.23	1.91	7.7	-0.672	-3.14	4.87	4.09
59	6.98	1.58	1.86	7.3	0.722	4.05	4.76	3.88
60	-6.09	-1.23	1.86	6.9	-0.630	-3.16	4.75	3.66
61	7.78	2.11	2.35	10.1	0.805	5.40	6.02	5.35
62	-7.64	-1.68	2.80	10.9	-0.790	-4.30	7.17	5.77
63	7.54	2.13	2.80	10.4	0.779	5.46	7.17	5.50
64	-6.69	-1.68	2.85	8.6	-0.692	-4.29	7.30	4.53
65	7.03	2.13	2.86	7.6	0.727	5.45	7.31	4.04

SPECIMEN F3-C1

Description: The beam was attached to top and bottom flange connecting plates and a web clip angle by means of 5/8 inch diameter high strength bolts. The connecting plates and the clip angle were welded to the column. The specimen was commercially fabricated, and there was no visually apparent departure from the detail drawing. All holes were punched and were 1/16 inch larger in diameter than the bolts. The torque in all bolts was checked and found to conform to AISC specifications. Ultrasonic inspection disclosed no significant weld defects. Threaded studs were tack-welded to both plates and flanges to support rotation measuring devices.

Program of Cycling:



Test Control: Strain, as measured on the top flange 12.02 inches from the column face.

Raw Data Included: Graphical load-strain data for the control strain.

Total Energy Absorption: Not available.

Plastic Load Reversals to Failure: 19 ($9\frac{1}{2}$ cycles).

Remarks: During the first plastic cycle, slip between the lower plate and the beam flange was observed by noting that the white-wash had separated from the bolt heads. Slipping of the plates was accompanied by loud banging. Slight buckles appeared in the flanges beyond the ends of the plates during the 3rd cycle. The buckle in the bottom flange became more pronounced when the control strain was increased in the 6th cycle. Necking and cracking of the bottom flange at the outer line of bolts was observed after 9 cycles. Failure occurred at the beginning of the 10th cycle when the top flange fractured at the outer bolt line, the crack extending well into the web.

SPECIMEN TYPE F3-C1 PUNCHED HOLES 11/16 IN. NOMINAL DIAMETER

DIMENSIONS OF WF SECTION

DEPTH	8.27	INCHES
TOP FLANGE WIDTH	5.260	INCHES
BOTTOM FLANGE WIDTH	5.140	INCHES
TOP FLANGE THICKNESS	0.350	INCHES
BOTTOM FLANGE THICKNESS	0.375	INCHES
WEB THICKNESS	0.275	INCHES
ELASTIC MODULUS	29800.	KSI
YIELD STRESS	38.900	KSI

DIMENSIONS OF CONNECTION ELEMENTS

DEPTH OUT-TO-OUT OF PLATES	9.30	INCHES
THICKNESS OF FILLER PLATE	0.125	INCHES
HOLE DIAMETER	0.750	INCHES
TOP PLATE		
LENGTH OF PLATE, LP	10.60	INCHES
WIDTH OF PLATE, B	5.61	INCHES
LOCATION OF FIRST ROW OF BOLTS*, C	1.90	INCHES
LOCATION OF LAST ROW OF BOLTS*, D	9.37	INCHES
THICKNESS OF PLATE, T	0.510	INCHES
ELASTIC MODULUS	29600.	KSI
YIELD STRESS	38.700	KSI
BOTTOM PLATE		
LENGTH OF PLATE, LP	10.60	INCHES
WIDTH OF PLATE, B	5.59	INCHES
LOCATION OF FIRST ROW OF BOLTS*, C	1.88	INCHES
LOCATION OF LAST ROW OF BOLTS*, D	9.44	INCHES
THICKNESS OF PLATE, T	0.540	INCHES
ELASTIC MODULUS	29600.	KSI
YIELD STRESS	38.700	KSI

*MEASURED FROM FACE OF COLUMN

SPECIMEN TYPE F3-C1 PUNCHED HOLES 11/16 IN. NOMINAL DIAMETER

PROPERTIES OF GROSS SECTION OF WF

AREA, A	5.93	INCHES**2
LOCATION OF CENTROID*, YE	4.08	INCHES
MOMENT OF INERTIA, I	70.0	INCHES**4
SECTION MODULUS, TOP, ST	16.7	INCHES**3
SECTION MODULUS, BOTTOM, SB	17.1	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	3.99	INCHES
PLASTIC MODULUS, Z	19.1	INCHES**3
SHAPE FACTOR	1.144	
YIELD MOMENT, MY	54.23	KIP-FT.
PLASTIC MOMENT, MP	62.03	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

PROPERTIES OF NET SECTION OF WF (AISC SPECIFICATION 1.10.1)

AREA, A	5.41	INCHES**2
LOCATION OF CENTROID*, YE	4.10	INCHES
MOMENT OF INERTIA, I	61.8	INCHES**4
SECTION MODULUS, TOP, ST	14.8	INCHES**3
SECTION MODULUS, BOTTOM, SB	15.1	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.03	INCHES
PLASTIC MODULUS, Z	17.1	INCHES**3
SHAPE FACTOR	1.152	
YIELD MOMENT, MY	48.05	KIP-FT.
PLASTIC MOMENT, MP	55.34	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

PROPERTIES OF GROSS SECTION OF PLATED WF

AREA, A	11.77	INCHES**2
LOCATION OF CENTROID*, YE	4.55	INCHES
MOMENT OF INERTIA, I	182.6	INCHES**4
SECTION MODULUS, TOP, ST	38.4	INCHES**3
SECTION MODULUS, BOTTOM, SB	40.1	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.34	INCHES
PLASTIC MODULUS, Z	44.4	INCHES**3
SHAPE FACTOR	1.162	
YIELD MOMENT, MY	123.81	KIP-FT.
PLASTIC MOMENT, MP	143.89	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

SPECIMEN TYPE F3-C1 PUNCHED HOLES 11/16 IN. NOMINAL DIAMETER

PROPERTIES OF NET SECTION OF PLATED WF (AISC SPEC. 1.10.1)

AREA, A	10.56	INCHES**2
LOCATION OF CENTROID*, YE	4.56	INCHES
MOMENT OF INERTIA, I	161.1	INCHES**4
SECTION MODULUS, TOP, ST	33.9	INCHES**3
SECTION MODULUS, BOTTOM, SB	35.4	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.42	INCHES
PLASTIC MODULUS, Z	39.3	INCHES**3
SHAPE FACTOR	1.164	
YIELD MOMENT, MY	109.45	KIP-FT.
PLASTIC MOMENT, MP	127.42	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

PROPERTIES OF GROSS SECTION OF PLATES ALONE

AREA, A	5.84	INCHES**2
LOCATION OF CENTROID*, YE	4.54	INCHES
MOMENT OF INERTIA, I	112.6	INCHES**4
SECTION MODULUS, TOP, ST	23.6	INCHES**3
SECTION MODULUS, BOTTOM, SB	24.8	INCHES**3
YIELD MOMENT, MY	81.01	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

PROPERTIES OF NET SECTION OF PLATES ALONE (AISC SPEC. 1.14.3)

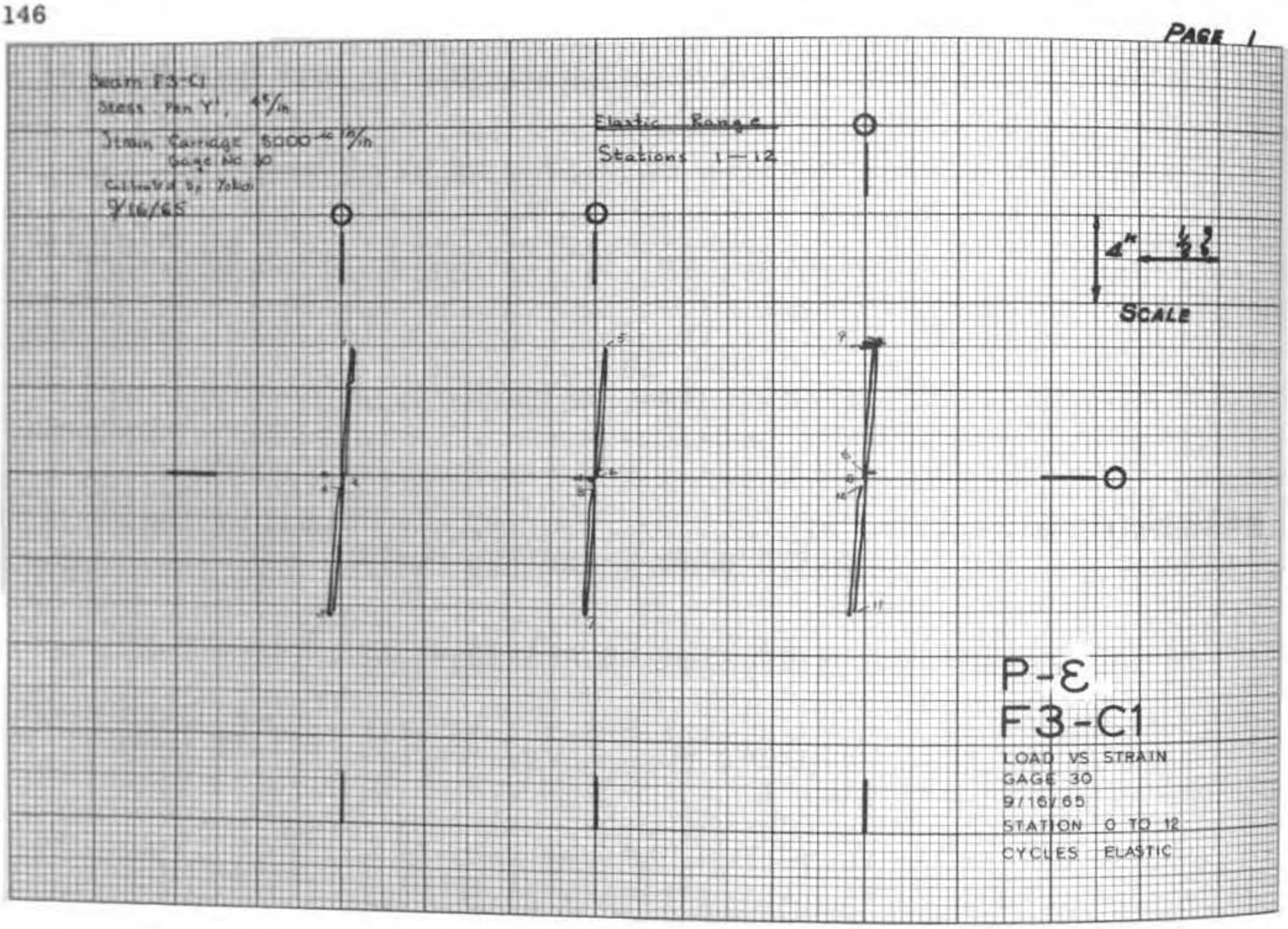
AREA, A	4.28	INCHES**2
LOCATION OF CENTROID*, YE	4.55	INCHES
MOMENT OF INERTIA, I	82.4	INCHES**4
SECTION MODULUS, TOP, ST	17.3	INCHES**3
SECTION MODULUS, BOTTOM, SB	18.1	INCHES**3
YIELD MOMENT, MY	59.35	KIP-FT.

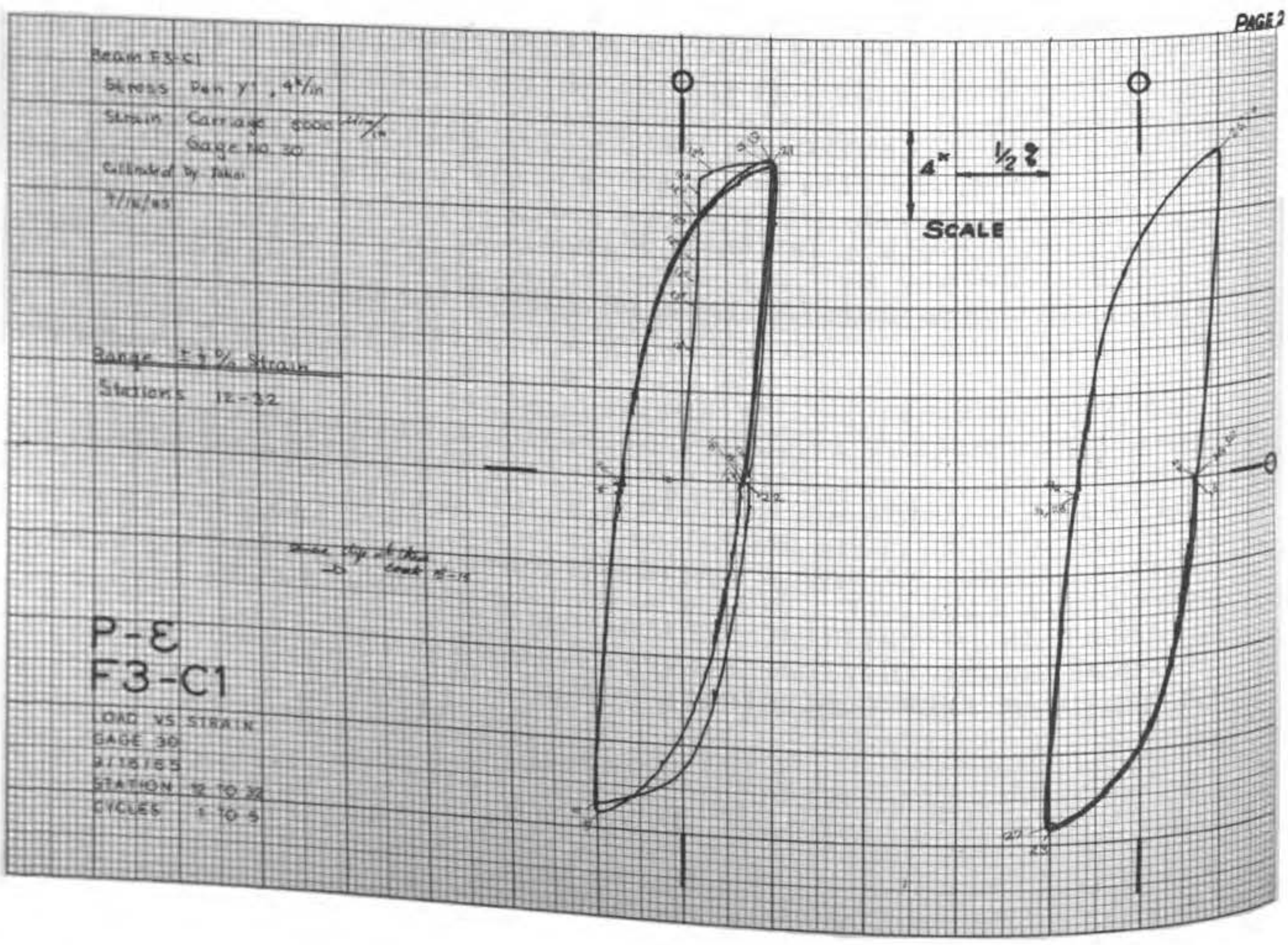
*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

BEAM PROPERTIES

LENGTH, L	66.0	INCHES
ELASTIC STIFFNESS, P/DELTA	26.87	KIPS/IN.
YIELD DEFLECTION, DELTAY	0.379	INCHES
YIELD LOAD, PY	10.19	KIPS
PLASTIC LOAD, PP	11.11	KIPS
LOCATION OF CRITICAL SECTION FOR PY*	56.59	INCHES
LOCATION OF CRITICAL SECTION FOR PP*	64.11	INCHES

* MEASURED FROM CONCENTRATED LOAD


PAGE 1
Beam F3-C1
Elastic Range
Stations 1—12
SCALE
P-ε
F3-C1
LOAD VS STRAIN
GAGE 30
9/16/65
STATION 0 TO 12
CYCLES ELASTIC


PAGE 2
Beam F3-C1
SCALE
Stations 12-32
P-ε
F3-C1
LOAD VS STRAIN
GAGE 30
9/16/65

PAGE 3

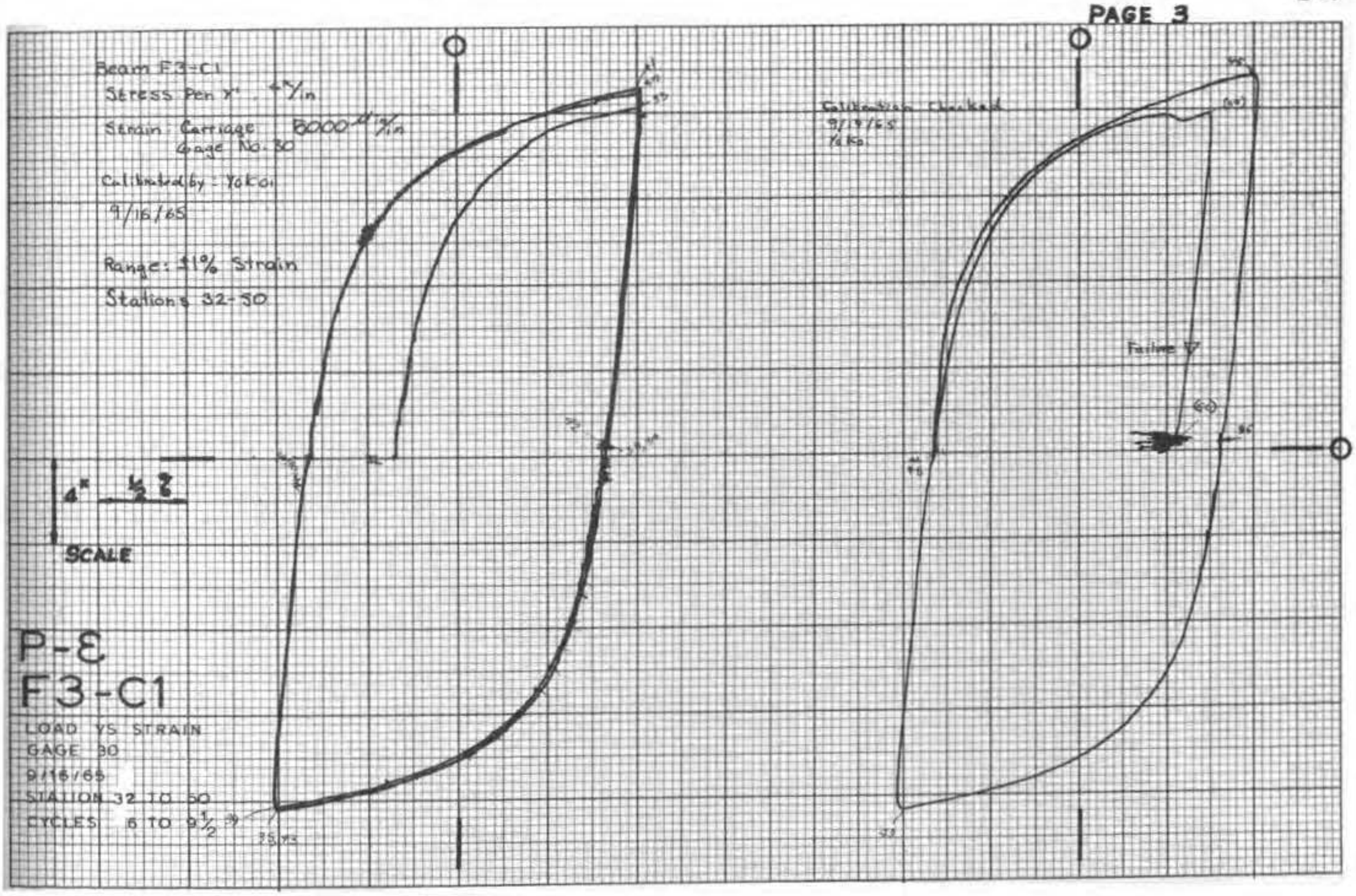


PLATE 16. (continued)

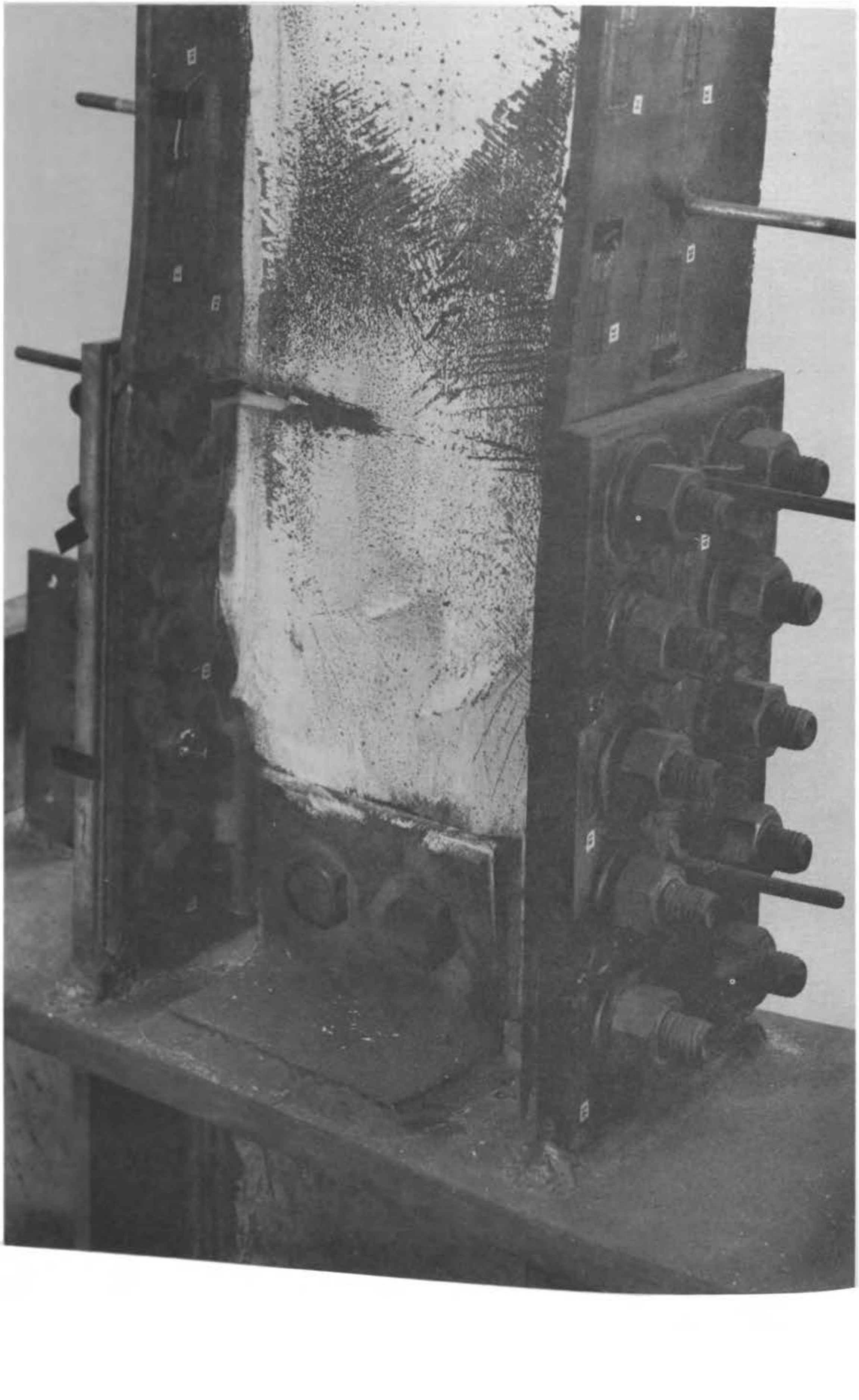


FIGURE 30. F3-C1

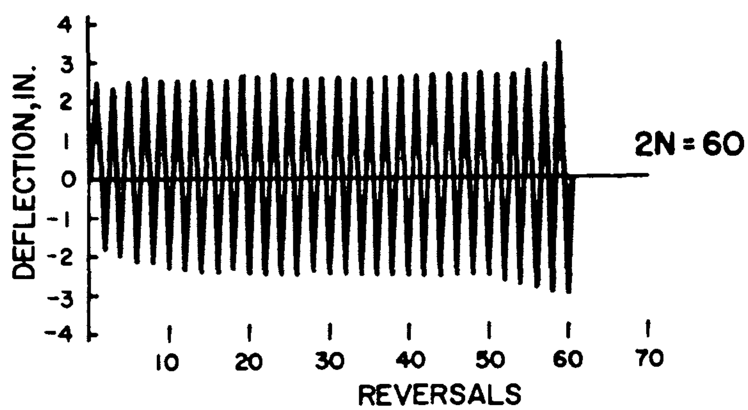
SPECIMEN F3-C1

Half-Cycle	P KIPS	Δ IN.	Δ' IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$
1	14.08	2.47	1.54	1.268	5.99	3.73
2	-14.17	-2.26	2.63	-1.276	-5.45	6.35
3	14.26	2.40	2.53	1.284	5.82	6.11
4	-14.56	-2.43	2.69	-1.311	-5.87	6.50
5	14.46	2.56	2.81	1.302	6.20	6.79
6	-14.71	-2.56	2.89	-1.324	-6.18	6.98
7	14.46	2.62	2.95	1.301	6.35	7.13
8	-14.60	-2.56	2.94	-1.314	-6.18	7.10
9	14.62	2.71	3.01	1.316	6.57	7.27
10	-14.74	-2.61	3.06	-1.327	-6.30	7.39
11	15.70	3.73	3.91	1.413	9.03	9.45
12	-16.07	-3.49	4.94	-1.447	-8.43	11.94
13	16.31	4.12	5.34	1.468	9.98	12.91
14	-16.31	-3.53	5.07	-1.468	-8.53	12.25
15	16.55	4.35	5.28	1.490	10.53	12.76
16	-16.31	-3.54	5.28	-1.468	-8.55	12.76
17	16.81	4.65	5.51	1.513	11.26	13.32
18	-16.49	-3.61	5.54	-1.484	-8.72	13.39
19	14.98	5.01	6.29	1.348	12.13	15.21

SPECIMEN F3-C5

Description: This specimen was similar to specimen F3-C1 in detailing, fabrication and inspection. Ultrasonic inspection indicated three suspected weld defects, but bolt hole geometry confused the readings and prevented verification. No action was taken as a result.

Program of Cycles:



Test Control: Strain, as measured on the top flange 11.99 inches from the column face. The strain was read on a Baldwin SR-4 strain indicator.

Raw Data Included: Graphical load-deflection data.

Total Energy Absorption: 1,533 kip-inches.

Plastic Load Reversals to Failure: 60 (30 cycles).

Remarks: A slight buckle was observed in the lower flange during the 3rd plastic cycle. In the 12th cycle a small crack was found in the top of the web angle-to-column weld. Commencing with approximately the 14th cycle, loud banging sounds were heard during loading. At about the same time, inspection showed that necking had occurred at the cross-section through the outer row of bolts in the bottom flange. This was less obvious in the top flange. At the 21st cycle, crack propagation was apparent along the weld of the angle leg at the column face. A crack appeared in the bottom flange at the outer bolt line during the 25th cycle, and remained open at no load.

During the 26th cycle, the top flange showed distinct necking at the end bolt line. Two cycles later, a crack appeared in the top flange. During the succeeding five cycles this crack became enlarged and penetrated into the beam web causing complete failure after a total of 30 cycles.

SPECIMEN TYPE F3-C5 PUNCHED HOLES 11/16 IN. NOMINAL DIAMETER

DIMENSIONS OF WF SECTION

DEPTH	8.25	INCHES
TOP FLANGE WIDTH	5.160	INCHES
BOTTOM FLANGE WIDTH	5.170	INCHES
TOP FLANGE THICKNESS	0.374	INCHES
BOTTOM FLANGE THICKNESS	0.368	INCHES
WEB THICKNESS	0.272	INCHES
ELASTIC MODULUS	29000.	KSI
YIELD STRESS	40.500	KSI

DIMENSIONS OF CONNECTION ELEMENTS

DEPTH CUT-TO-OUT OF PLATES	9.39	INCHES
THICKNESS OF FILLER PLATE	0.125	INCHES
HOLE DIAMETER	0.750	INCHES

TOP PLATE

LENGTH OF PLATE, LP	10.56	INCHES
WIDTH OF PLATE, B	5.63	INCHES
LOCATION OF FIRST ROW OF BOLTS*, C	1.85	INCHES
LOCATION OF LAST ROW OF BOLTS*, D	9.38	INCHES
THICKNESS OF PLATE, T	0.480	INCHES
ELASTIC MODULUS	29600.	KSI
YIELD STRESS	41.000	KSI

BOTTOM PLATE

LENGTH OF PLATE, LP	10.58	INCHES
WIDTH OF PLATE, B	5.63	INCHES
LOCATION OF FIRST ROW OF BOLTS*, C	1.88	INCHES
LOCATION OF LAST ROW OF BOLTS*, D	9.42	INCHES
THICKNESS OF PLATE, T	0.510	INCHES
ELASTIC MODULUS	29600.	KSI
YIELD STRESS	41.000	KSI

*MEASURED FROM FACE OF COLUMN

SPECIMEN TYPE F3-C5 PUNCHED HOLES 11/16 IN. NOMINAL DIAMETER

PROPERTIES OF GROSS SECTION OF WF

AREA, A	5.96	INCHES**2
LOCATION OF CENTROID*, YE	4.14	INCHES
MOMENT OF INERTIA, I	70.2	INCHES**4
SECTION MODULUS, TOP, ST	17.1	INCHES**3
SECTION MODULUS, BOTTOM, SB	17.0	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP	4.16	INCHES
PLASTIC MODULUS, Z	19.2	INCHES**3
SHAPE FACTOR	1.133	
YIELD MOMENT, MY	57.30	KIP-FT.
PLASTIC MOMENT, MP	64.95	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

PROPERTIES OF NET SECTION OF WF (AISC SPECIFICATION 1.10.1)

AREA, A	5.42	INCHES**2
LOCATION OF CENTROID*, YE	4.14	INCHES
MOMENT OF INERTIA, I	61.9	INCHES**4
SECTION MODULUS, TOP, ST	15.1	INCHES**3
SECTION MODULUS, BOTTOM, SB	15.0	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP	4.16	INCHES
PLASTIC MODULUS, Z	17.1	INCHES**3
SHAPE FACTOR	1.144	
YIELD MOMENT, MY	50.51	KIP-FT.
PLASTIC MOMENT, MP	57.80	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

PROPERTIES OF GROSS SECTION OF PLATED WF

AREA, A	11.65	INCHES**2
LOCATION OF CENTROID*, YE	4.62	INCHES
MOMENT OF INERTIA, I	182.8	INCHES**4
SECTION MODULUS, TOP, ST	38.3	INCHES**3
SECTION MODULUS, BOTTOM, SB	39.6	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP	4.54	INCHES
PLASTIC MODULUS, Z	43.9	INCHES**3
SHAPE FACTOR	1.133	
YIELD MOMENT, MY	130.82	KIP-FT.
PLASTIC MOMENT, MP	148.21	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

SPECIMEN TYPE F3-C5 PUNCHED HOLES 11/16 IN. NOMINAL DIAMETER

PROPERTIES OF NET SECTION OF PLATED WF (AISC SPEC. 1.10.1)

AREA, A	10.45	INCHES**2
LOCATION OF CENTROID*, YE	4.61	INCHES
MOMENT OF INERTIA, I	161.3	INCHES**4
SECTION MODULUS, TOP, ST	33.8	INCHES**3
SECTION MODULUS, BOTTOM, SB	35.0	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.56	INCHES
PLASTIC MODULUS, Z	38.9	INCHES**3
SHAPE FACTOR	1.136	
YIELD MOMENT, MY	115.46	KIP-FT.
PLASTIC MOMENT, MP	131.21	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

PROPERTIES OF GROSS SECTION OF PLATES ALONE

AREA, A	5.69	INCHES**2
LOCATION OF CENTROID*, YE	4.57	INCHES
MOMENT OF INERTIA, I	112.5	INCHES**4
SECTION MODULUS, TOP, ST	23.3	INCHES**3
SECTION MODULUS, BOTTOM, SB	24.6	INCHES**3
YIELD MOMENT, MY	82.12	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

PROPERTIES OF NET SECTION OF PLATES ALONE (AISC SPEC. 1.14.3)

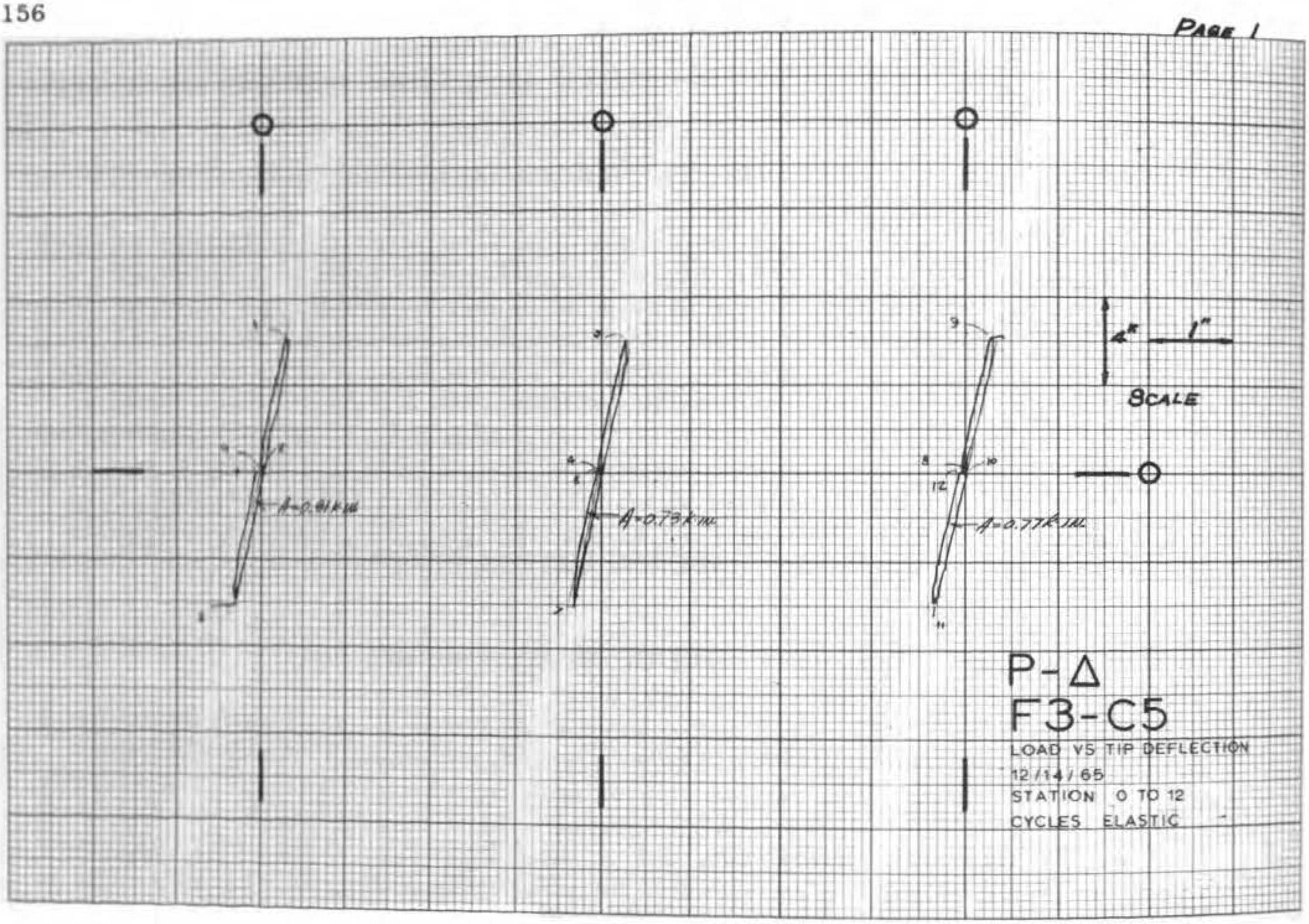
AREA, A	4.17	INCHES**2
LOCATION OF CENTROID*, YE	4.57	INCHES
MOMENT OF INERTIA, I	82.5	INCHES**4
SECTION MODULUS, TOP, ST	17.1	INCHES**3
SECTION MODULUS, BOTTOM, SB	18.1	INCHES**3
YIELD MOMENT, MY	60.24	KIP-FT.

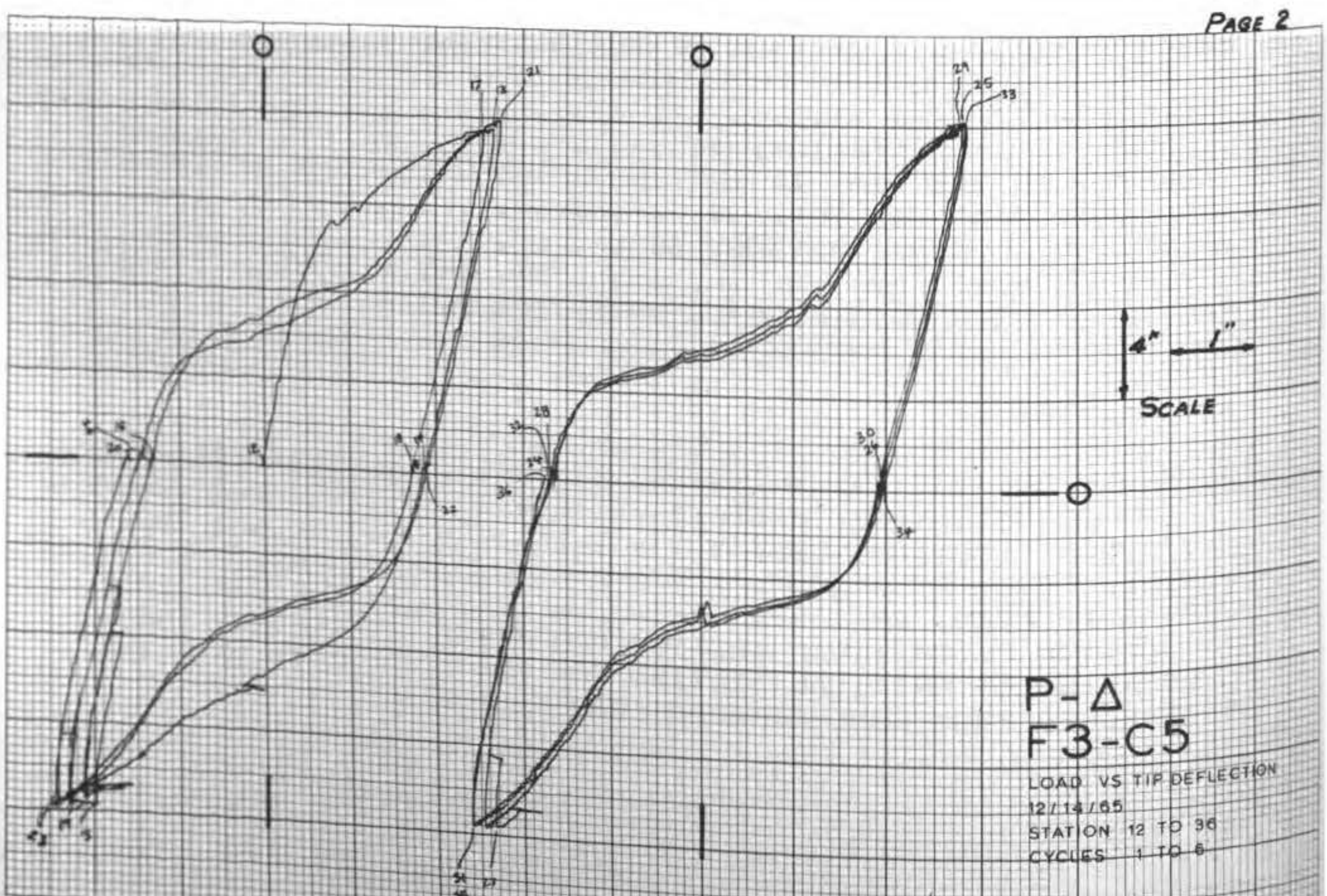
*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

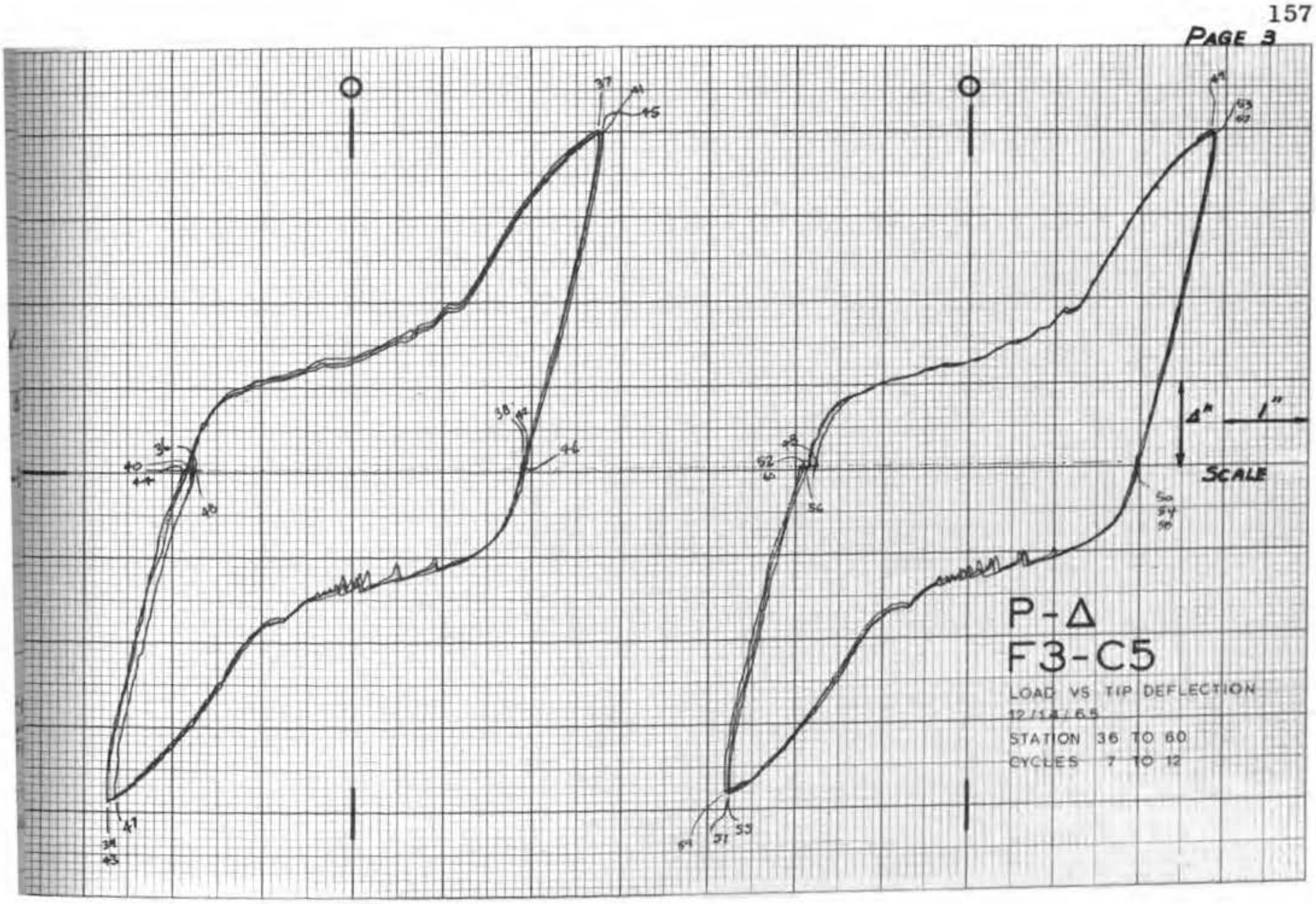
BEAM PROPERTIES

LENGTH, L	66.0	INCHES
ELASTIC STIFFNESS, P/DELTA	26.24	KIPS/IN.
YIELD DEFLECTION, DELTAY	0.408	INCHES
YIELD LOAD, PY	10.71	KIPS
PLASTIC LOAD, PP	11.27	KIPS
LOCATION OF CRITICAL SECTION FOR PY*	56.60	INCHES
LOCATION OF CRITICAL SECTION FOR PP*	64.13	INCHES

* MEASURED FROM CONCENTRATED LOAD


PAGE 1
A=0.81K/IN
A=0.79K/IN
A=0.77K/IN
4K
1"
SCALE
P-Δ
F3-C5
LOAD VS TIP DEFLECTION
12/14/65
STATION 0 TO 12
CYCLES ELASTIC


PAGE 2
4K
1"
SCALE
P-Δ
F3-C5
LOAD VS TIP DEFLECTION
12/14/65
STATION 12 TO 36
CYCLES 1 TO 6



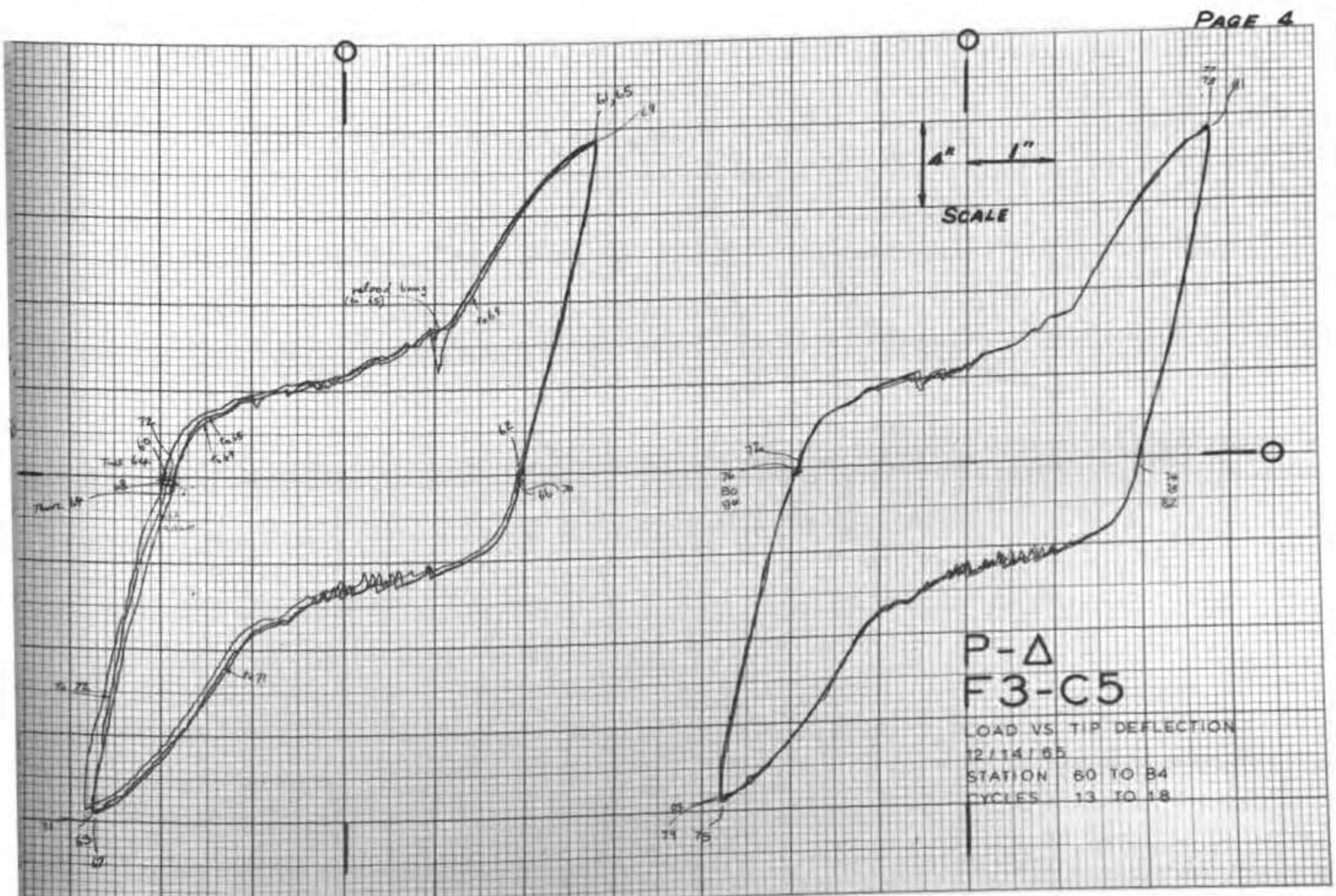
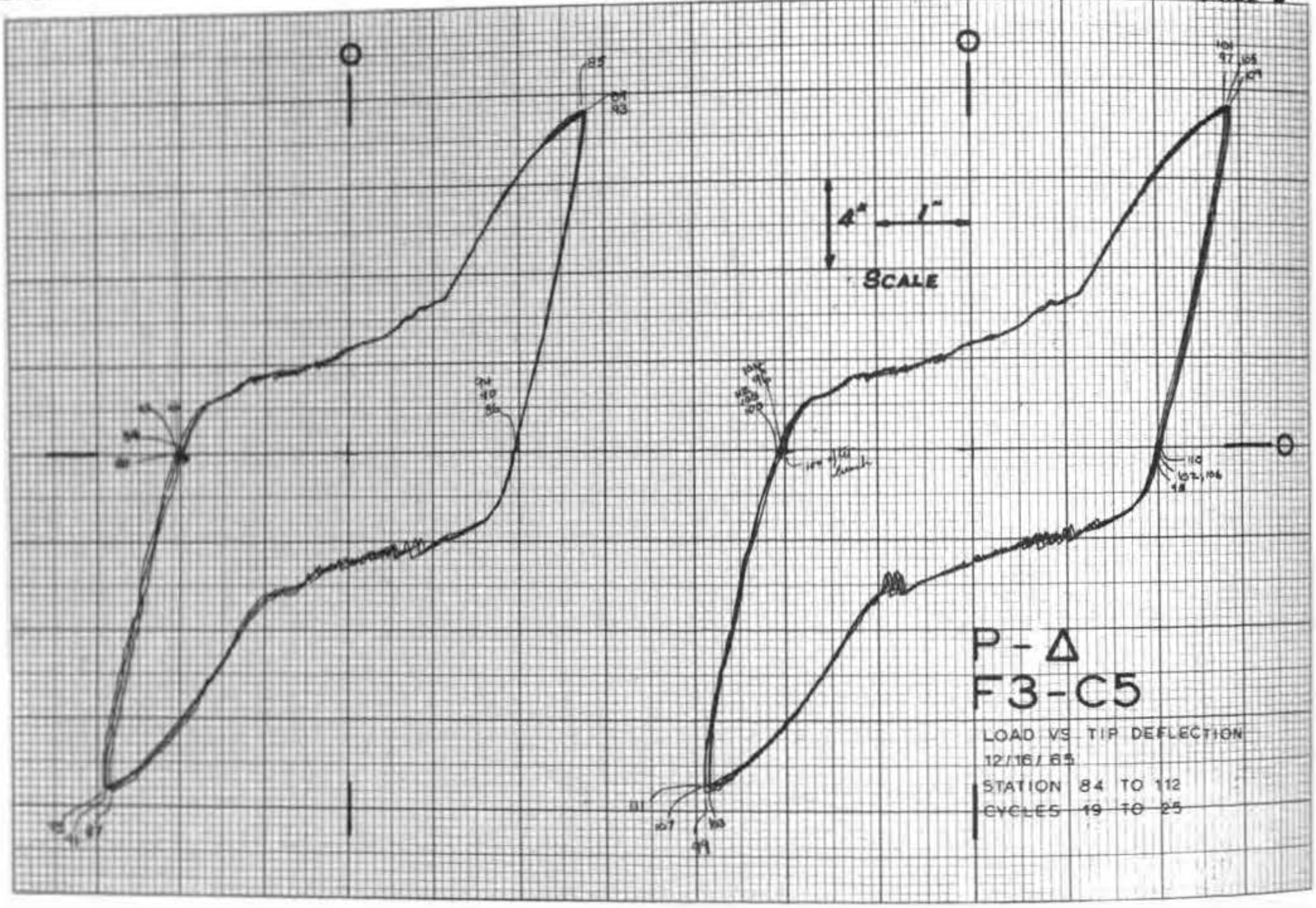
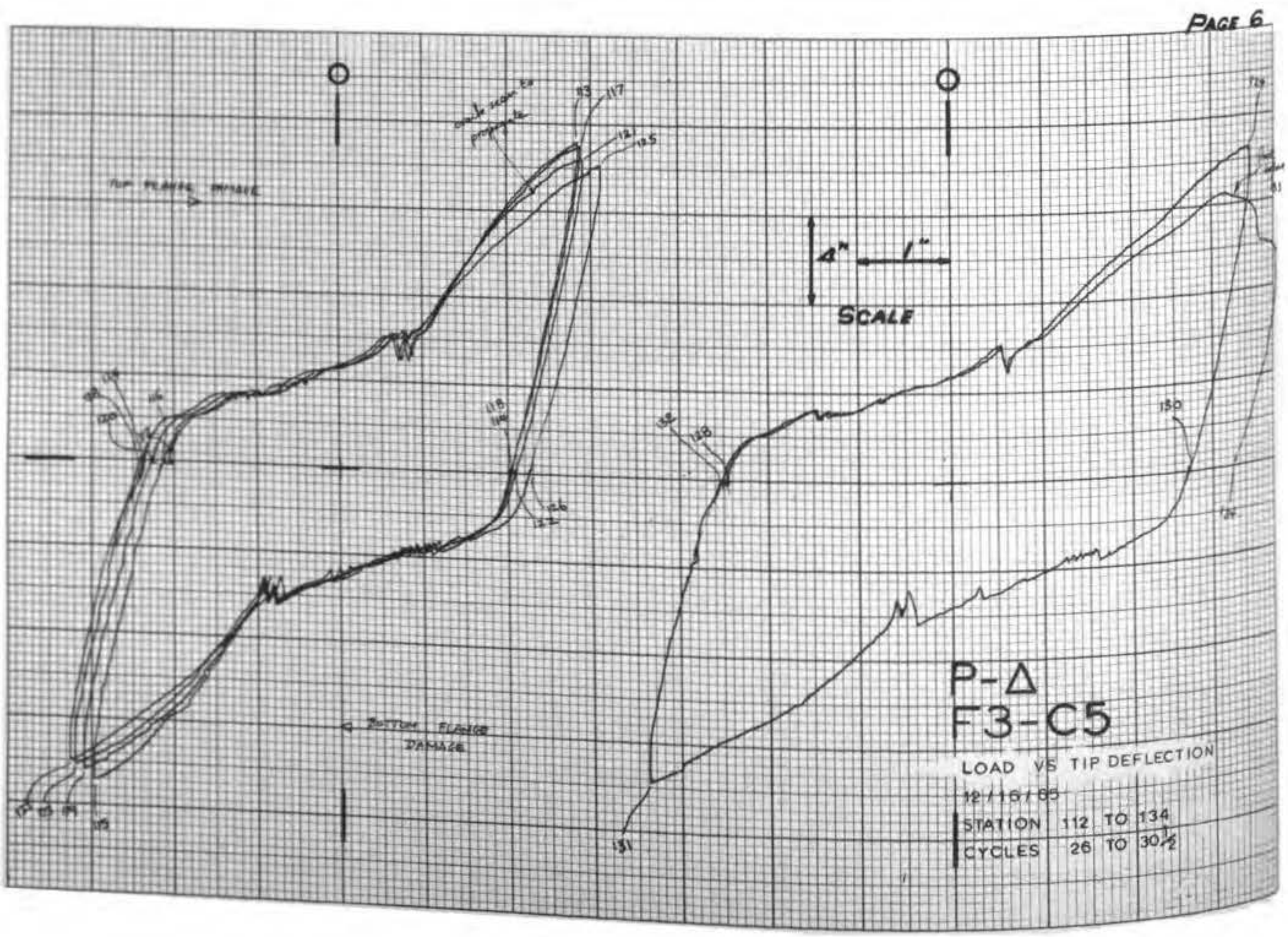


PLATE 17. (continued)


PAGE 5
4"
1"
SCALE
P - Δ
F3-C5
LOAD VS TIP DEFLECTION
12/16/85
STATION 84 TO 112
CYCLES 19 TO 25


PAGE 6
4"
1"
SCALE
P-Δ
F3-C5
LOAD VS TIP DEFLECTION
12/16/85
STATION 112 TO 134
CYCLES 26 TO 30½

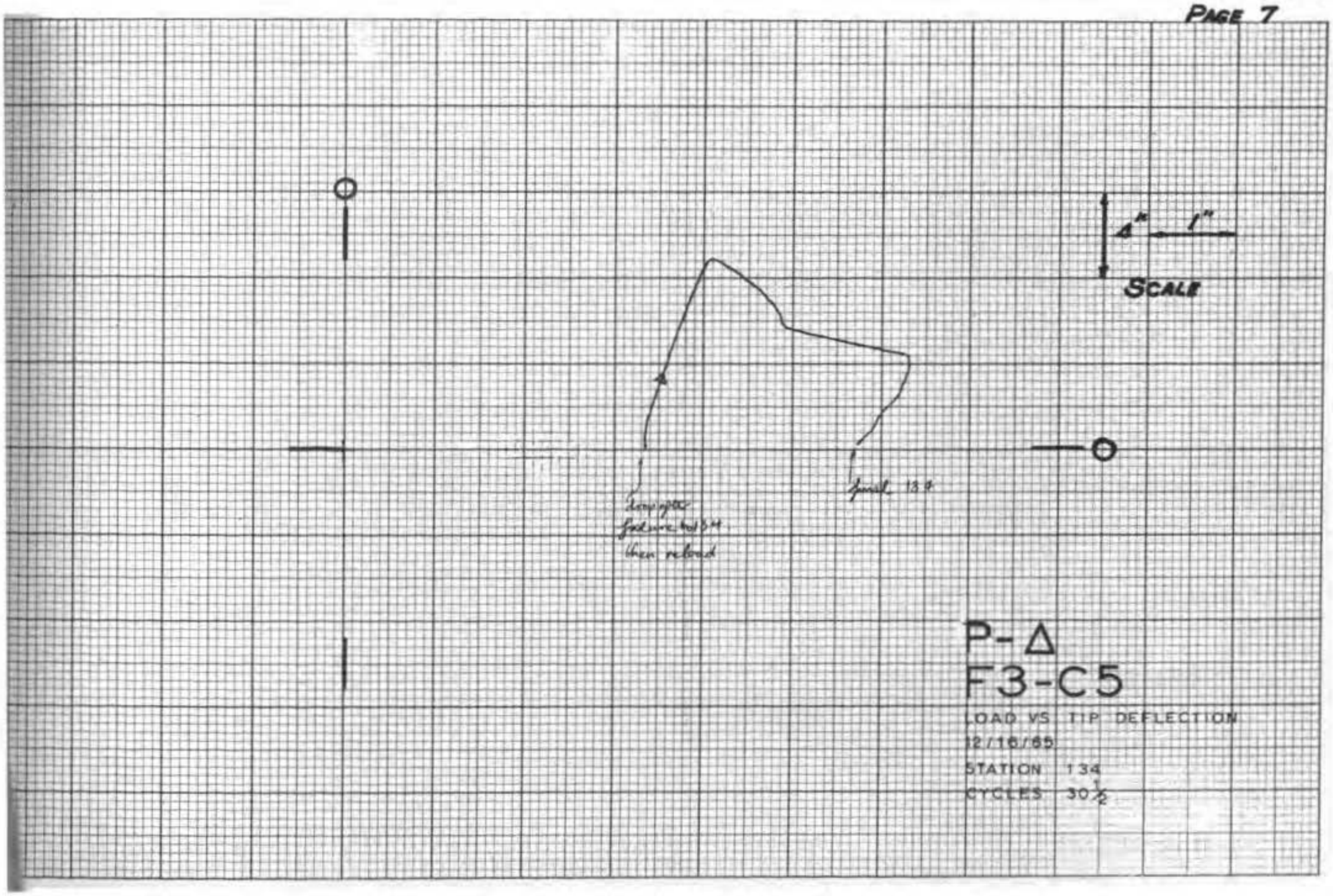


PLATE 17. (continued)

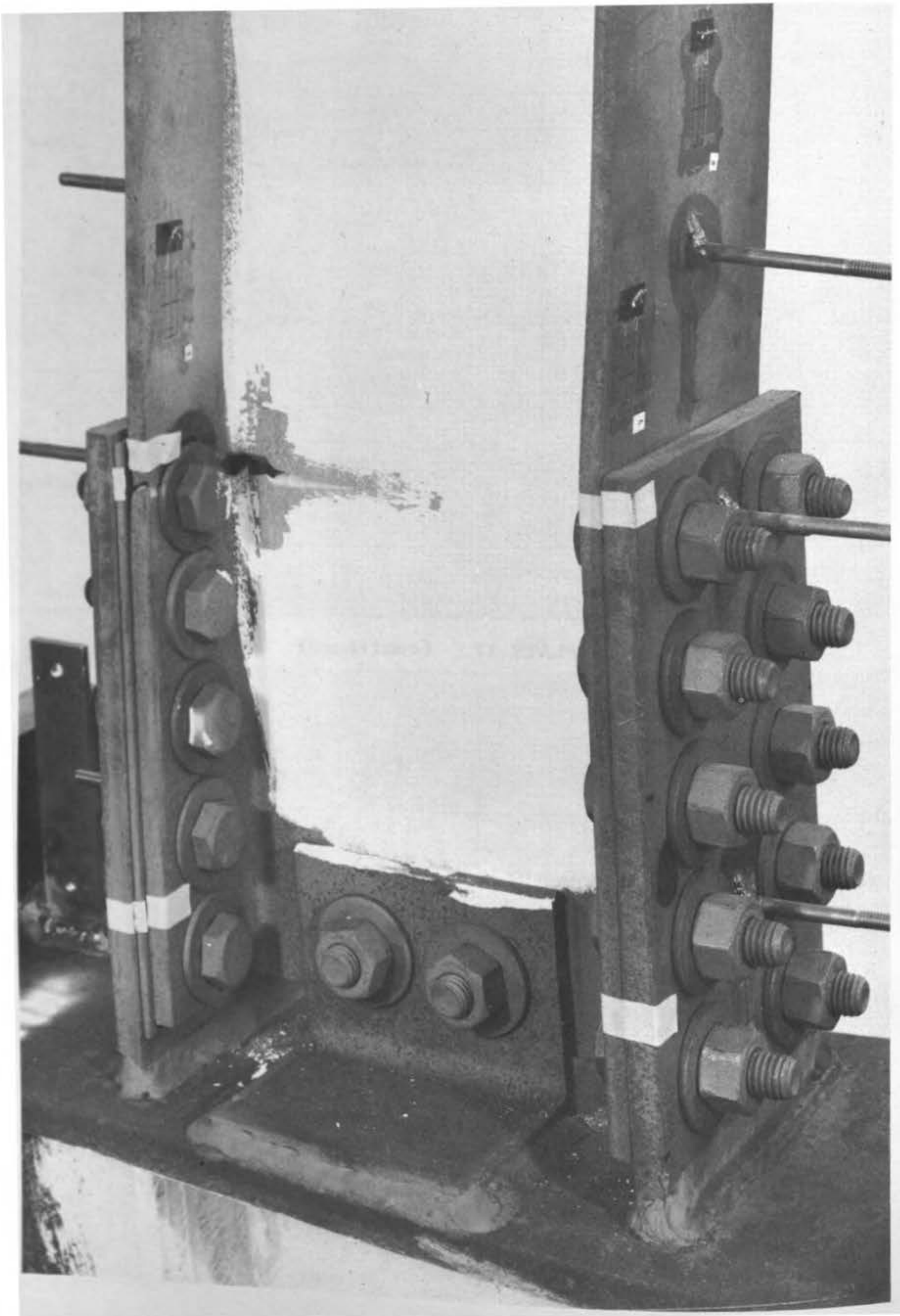


FIGURE 31. F3-C5

SPECIMEN F3-C5

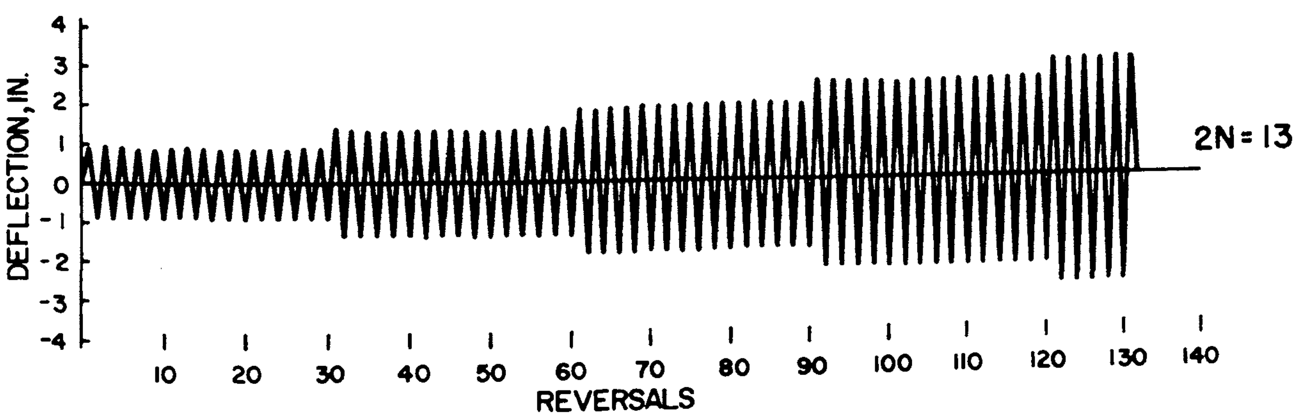
Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	14.83	2.44	1.85	22.9	1.316	5.67	4.30	9.48
2	-14.56	-1.85	3.09	30.1	-1.292	-4.31	7.19	12.44
3	14.67	2.31	2.97	23.3	1.302	5.37	6.92	9.62
4	-15.05	-2.02	3.13	25.7	-1.335	-4.71	7.29	10.61
5	15.10	2.50	3.29	24.8	1.340	5.82	7.66	10.24
6	-15.36	-2.15	3.44	28.0	-1.363	-5.01	8.01	11.55
7	15.39	2.59	3.48	25.0	1.366	6.02	8.10	10.32
8	-15.34	-2.20	3.52	27.7	-1.361	-5.12	8.20	11.44
9	15.49	2.56	3.50	25.6	1.375	5.95	8.15	10.58
10	-15.34	-2.33	3.53	27.2	-1.361	-5.42	8.22	11.24
11	15.34	2.60	3.58	24.6	1.361	6.05	8.33	10.15
12	-15.29	-2.33	3.64	26.7	-1.357	-5.42	8.48	11.03
13	15.34	2.55	3.61	24.6	1.361	5.93	8.40	10.16
14	-15.24	-2.43	3.66	26.7	-1.353	-5.66	8.52	11.04
15	15.20	2.56	3.66	24.1	1.349	5.96	8.52	9.94
16	-15.14	-2.43	3.71	26.7	-1.344	-5.66	8.64	11.05
17	15.29	2.59	3.73	24.1	1.357	6.03	8.69	9.95
18	-15.09	-2.34	3.60	25.3	-1.339	-5.45	8.38	10.46
19	15.20	2.65	3.65	23.8	1.349	6.17	8.50	9.83
20	-15.05	-2.47	3.79	26.7	-1.336	-5.76	8.82	11.02
21	15.07	2.66	3.81	24.2	1.338	6.20	8.87	10.01
22	-15.00	-2.45	3.77	25.9	-1.331	-5.71	8.78	10.70
23	15.05	2.68	3.77	24.2	1.336	6.25	8.78	10.00
24	-14.95	-2.50	3.85	26.8	-1.327	-5.83	8.97	11.08
25	15.00	2.60	3.80	24.5	1.331	6.06	8.84	10.11
26	-14.90	-2.52	3.80	25.6	-1.322	-5.86	8.86	10.56
27	15.12	2.60	3.85	24.6	1.342	6.06	8.96	10.18
28	-14.85	-2.41	3.73	25.2	-1.318	-5.62	8.68	10.42
29	15.10	2.60	3.75	23.3	1.340	6.06	8.73	9.65
30	-14.78	-2.44	3.80	25.5	-1.312	-5.69	8.85	10.52
31	15.03	2.60	3.77	23.5	1.334	6.06	8.78	9.70
32	-14.92	-2.46	3.80	25.9	-1.324	-5.73	8.85	10.68
33	14.95	2.60	3.80	23.3	1.327	6.06	8.85	9.65
34	-14.75	-2.48	3.80	25.9	-1.309	-5.76	8.85	10.70
35	14.83	2.63	3.80	23.3	1.316	6.11	8.85	9.62
36	-14.68	-2.48	3.80	25.9	-1.303	-5.77	8.85	10.72
37	14.81	2.64	3.83	23.1	1.314	6.14	8.91	9.55
38	-14.71	-2.47	3.83	25.0	-1.306	-5.74	8.92	10.34
39	14.78	2.65	3.83	23.0	1.312	6.16	8.92	9.51
40	-14.56	-2.53	3.88	25.5	-1.292	-5.89	9.03	10.54
41	14.78	2.66	3.88	23.6	1.312	6.18	9.03	9.74
42	-14.49	-2.57	3.90	26.0	-1.286	-5.99	9.09	10.75
43	14.71	2.65	3.92	23.5	1.306	6.17	9.12	9.71
44	-14.56	-2.57	3.97	26.1	-1.292	-5.98	9.24	10.77
45	14.71	2.66	3.98	23.5	1.306	6.19	9.27	9.69
46	-14.42	-2.52	3.93	25.5	-1.280	-5.87	9.15	10.52
47	14.76	2.70	3.94	23.9	1.310	6.28	9.17	9.89
48	-14.34	-2.52	3.99	25.5	-1.273	-5.88	9.29	10.53
49	14.66	2.73	4.01	24.2	1.301	6.35	9.33	10.00
50	-14.25	-2.57	4.01	25.2	-1.265	-5.99	9.34	10.42
51	14.64	2.68	4.00	24.5	1.299	6.24	9.31	10.12

Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
52	-14.17	-2.68	4.07	27.1	-1.258	-6.23	9.48	11.22
53	14.42	2.71	4.07	24.2	1.280	6.31	9.48	10.01
54	-13.72	-2.79	4.23	28.0	-1.217	-6.51	9.85	11.55
55	13.78	2.75	4.28	24.9	1.223	6.41	9.96	10.28
56	-13.56	-2.90	4.38	28.7	-1.203	-6.74	10.20	11.84
57	13.55	2.96	4.55	26.8	1.203	6.88	10.59	11.06
58	-13.33	-2.98	4.58	29.1	-1.183	-6.94	10.66	12.04
59	13.90	3.48	5.06	32.3	1.233	8.11	11.78	13.33
60	-13.22	-3.03	5.10	32.9	-1.173	-7.06	11.87	13.60

SPECIMEN F3A-C7

Description: This specimen was similar to specimen F3-C1, except as follows. The suffix "A" denotes the use of connecting plates nominally 1/16 inch thinner than those of specimen type F3. The specimen was fabricated in a University shop; all bolt holes were drilled to a diameter of 41/64 inch. Of the 20 flange bolts, 14 were tightened to 200 foot-pounds using a torque wrench. The remaining 6 bolts (3 in each flange) were inaccessible to the torque wrench so they were tightened with a box wrench using the turn-of-the-nut method. There was no ultrasonic inspection.

Program of Cycling:



Test Control: Tip deflection.

Raw Data Included: Graphical load-strain data, with strain measured in the center of the top plate 1.81 inches from the column face.

Grahpical load-deflection data.

Total Energy Absorption: 2,488 kip-inches.

Plastic Load Reversals to Failure: 131 (65½ cycles).

Remarks: During the 14th plastic cycle, yield lines had developed in the flanges beyond the ends of the bottom flange plates. Some necking occurred in the top plate at the line of bolts nearest the column during the 32nd cycle. At the 58th cycle a crack was discovered in the same location. In the next cycle a crack was observed in a similar location in the bottom plate.

During the 61st cycle a small crack was found in the weld of the bottom plate to the column. In the following cycle, necking and a crack were observed in the bottom flange at the outer line of bolts. Failure was due to simultaneous propagation of the crack in the bottom flange at the outermost line of bolts, and the crack in the top connecting plate at the innermost bolt line.

SPECIMEN TYPE F3A-C7 HOLES DRILLED 41/64 IN. DIA.

DIMENSIONS OF WF SECTION

DEPTH	8.22	INCHES
TOP FLANGE WIDTH	5.310	INCHES
BOTTOM FLANGE WIDTH	5.310	INCHES
TOP FLANGE THICKNESS	0.355	INCHES
BOTTOM FLANGE THICKNESS	0.358	INCHES
WEB THICKNESS	0.230	INCHES
ELASTIC MODULUS	29400.	KSI
YIELD STRESS	35.900	KSI

DIMENSIONS OF CONNECTION ELEMENTS

DEPTH OUT-TO-OUT OF PLATES	9.19	INCHES
THICKNESS OF FILLER PLATE	0.125	INCHES
HOLE DIAMETER	0.641	INCHES

TOP PLATE

LENGTH OF PLATE, LP	10.62	INCHES
WIDTH OF PLATE, B	5.45	INCHES
LOCATION OF FIRST ROW OF BOLTS*, C	1.82	INCHES
LOCATION OF LAST ROW OF BOLTS*, D	9.33	INCHES
THICKNESS OF PLATE, T	0.390	INCHES
ELASTIC MODULUS	31200.	KSI
YIELD STRESS	38.100	KSI

BOTTOM PLATE

LENGTH OF PLATE, LP	10.62	INCHES
WIDTH OF PLATE, B	5.50	INCHES
LOCATION OF FIRST ROW OF BOLTS*, C	1.82	INCHES
LOCATION OF LAST ROW OF BOLTS*, D	9.36	INCHES
THICKNESS OF PLATE, T	0.430	INCHES
ELASTIC MODULUS	31200.	KSI
YIELD STRESS	38.100	KSI

*MEASURED FROM FACE OF COLUMN

SPECIMEN TYPE F3A-C7 HOLES DRILLED 41/64 IN. DIA.

PROPERTIES OF GROSS SECTION OF WF

AREA, A	5.60	INCHES**2
LOCATION OF CENTROID*, YE	4.10	INCHES
MOMENT OF INERTIA, I	67.8	INCHES**4
SECTION MODULUS, TOP, ST	16.5	INCHES**3
SECTION MODULUS, BOTTOM, SB	16.5	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.08	INCHES
PLASTIC MODULUS, Z	18.4	INCHES**3
SHAPE FACTOR	1.120	
YIELD MOMENT, MY	49.27	KIP-FT.
PLASTIC MOMENT, MP	55.17	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

PROPERTIES OF NET SECTION OF WF (AISC SPECIFICATION 1.10.1)

AREA, A	5.25	INCHES**2
LOCATION OF CENTROID*, YE	4.10	INCHES
MOMENT OF INERTIA, I	62.5	INCHES**4
SECTION MODULUS, TOP, ST	15.2	INCHES**3
SECTION MODULUS, BOTTOM, SB	15.2	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.08	INCHES
PLASTIC MODULUS, Z	17.1	INCHES**3
SHAPE FACTOR	1.126	
YIELD MOMENT, MY	45.39	KIP-FT.
PLASTIC MOMENT, MP	51.11	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

PROPERTIES OF GROSS SECTION OF PLATED WF

AREA, A	10.36	INCHES**2
LOCATION OF CENTROID*, YE	4.46	INCHES
MOMENT OF INERTIA, I	159.6	INCHES**4
SECTION MODULUS, TOP, ST	33.8	INCHES**3
SECTION MODULUS, BOTTOM, SB	35.7	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.16	INCHES
PLASTIC MODULUS, Z	38.9	INCHES**3
SHAPE FACTOR	1.086	
YIELD MOMENT, MY	107.19	KIP-FT.
PLASTIC MOMENT, MP	116.42	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

SPECIMEN TYPE F3A-C7   HOLES DRILLED 41/64 IN. DIA.

PROPERTIES OF NET SECTION OF PLATED WF (AISC SPEC. 1.10.1)

AREA, A	9.62	INCHES**2
LOCATION OF CENTROID*, YE	4.46	INCHES
MOMENT OF INERTIA, I	146.5	INCHES**4
SECTION MODULUS, TOP, ST	31.0	INCHES**3
SECTION MODULUS, BOTTOM, SB	32.8	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.20	INCHES
PLASTIC MODULUS, Z	35.8	INCHES**3
SHAPE FACTOR	1.089	
YIELD MOMENT, MY	98.40	KIP-FT.
PLASTIC MOMENT, MP	107.12	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

PROPERTIES OF GROSS SECTION OF PLATES ALONE

AREA, A	4.77	INCHES**2
LOCATION OF CENTROID*, YE	4.37	INCHES
MOMENT OF INERTIA, I	91.6	INCHES**4
SECTION MODULUS, TOP, ST	19.0	INCHES**3
SECTION MODULUS, BOTTOM, SB	21.0	INCHES**3
YIELD MOMENT, MY	59.25	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

PROPERTIES OF NET SECTION OF PLATES ALONE (AISC SPEC. 1.14.3)

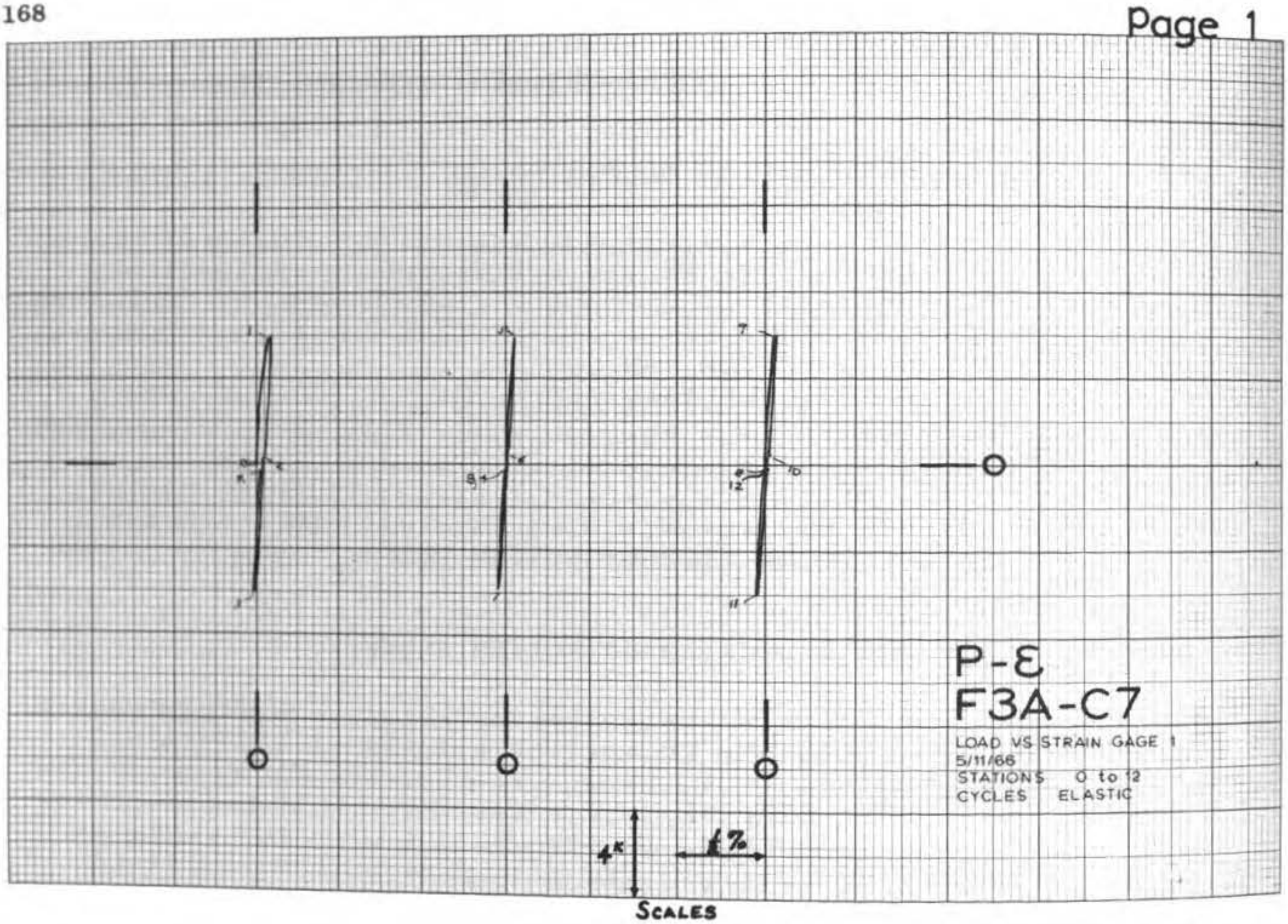
AREA, A	3.65	INCHES**2
LOCATION OF CENTROID*, YE	4.36	INCHES
MOMENT OF INERTIA, I	70.2	INCHES**4
SECTION MODULUS, TOP, ST	14.5	INCHES**3
SECTION MODULUS, BOTTOM, SB	16.1	INCHES**3
YIELD MOMENT, MY	45.32	KIP-FT.

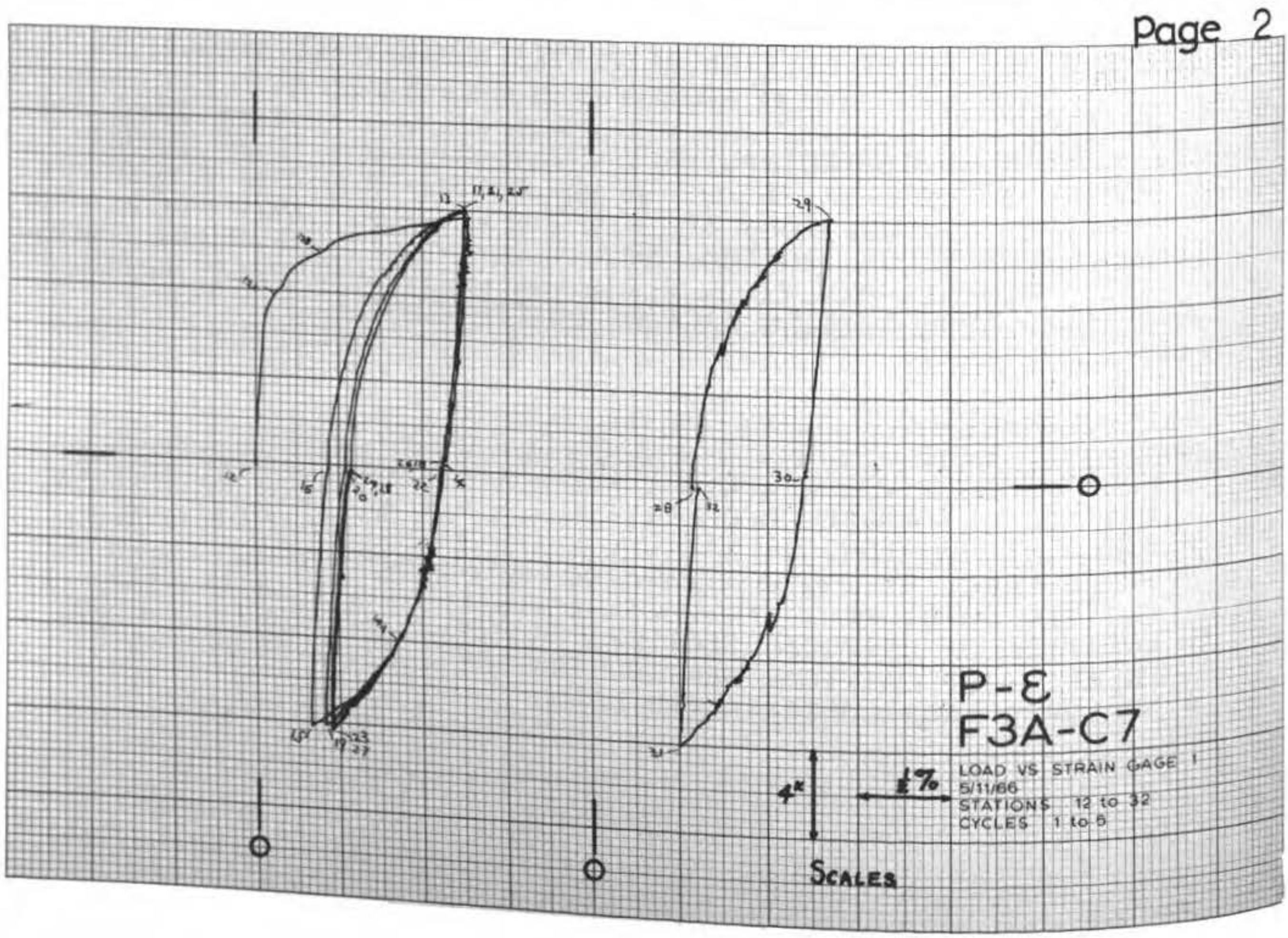
*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

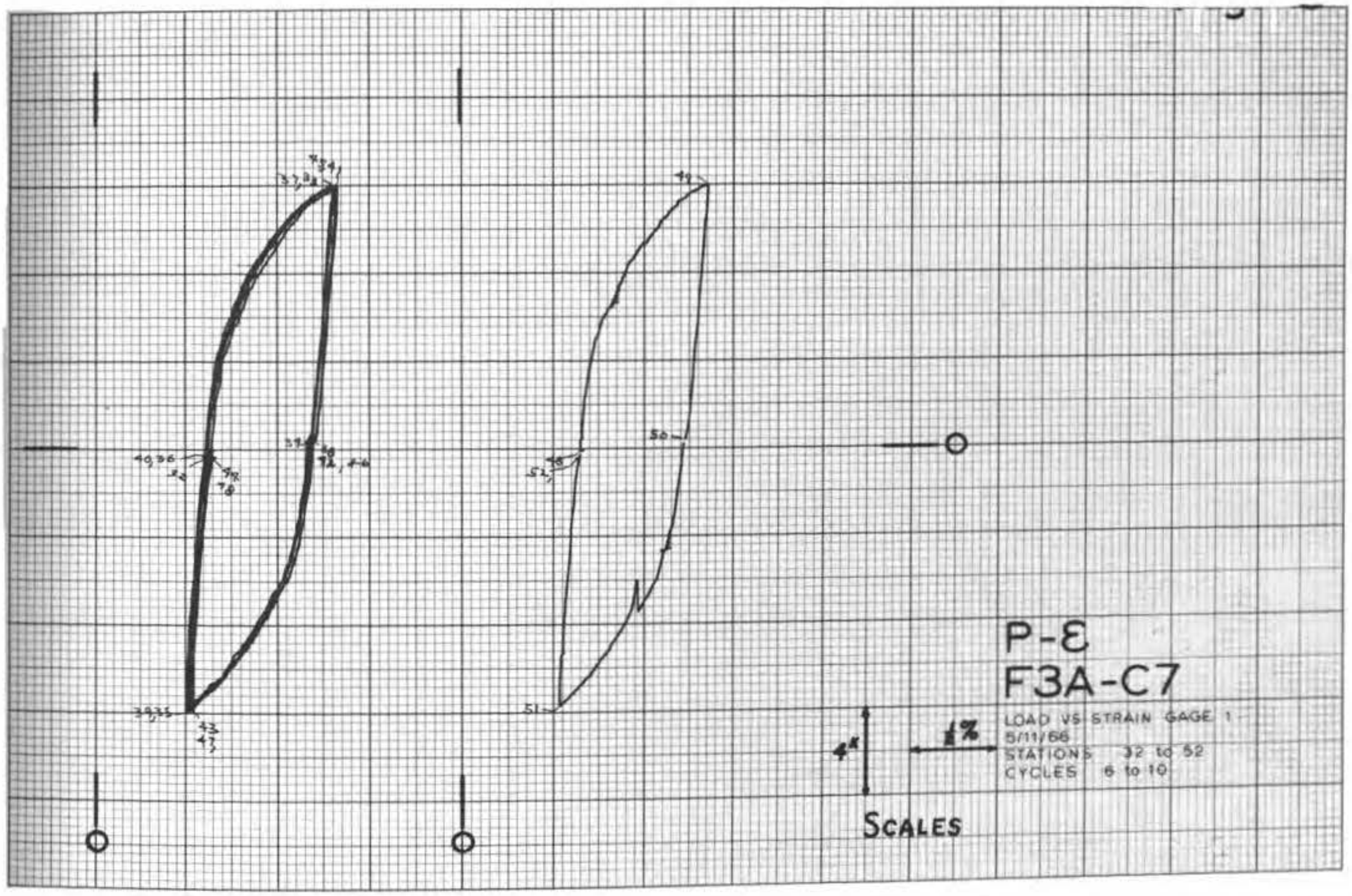
BEAM PROPERTIES

LENGTH, L	66.0	INCHES
ELASTIC STIFFNESS, P/DELTA	25.12	KIPS/IN.
YIELD DEFLECTION, DELTAY	0.337	INCHES
YIELD LOAD, PY	8.47	KIPS
PLASTIC LOAD, PP	8.47	KIPS
LOCATION OF CRITICAL SECTION FOR PY*	64.18	INCHES
LOCATION OF CRITICAL SECTION FOR PP*	64.18	INCHES

* MEASURED FROM CONCENTRATED LOAD


Page 1
P-ε
F3A-C7
LOAD VS STRAIN GAGE 1
5/11/66
STATIONS 0 to 12
CYCLES ELASTIC
4^k
1%
SCALES


Page 2
P-ε
F3A-C7
LOAD VS STRAIN GAGE 1
5/11/66
STATIONS 12 to 32
CYCLES 1 to 5
4^k
1%
SCALES



Page 4

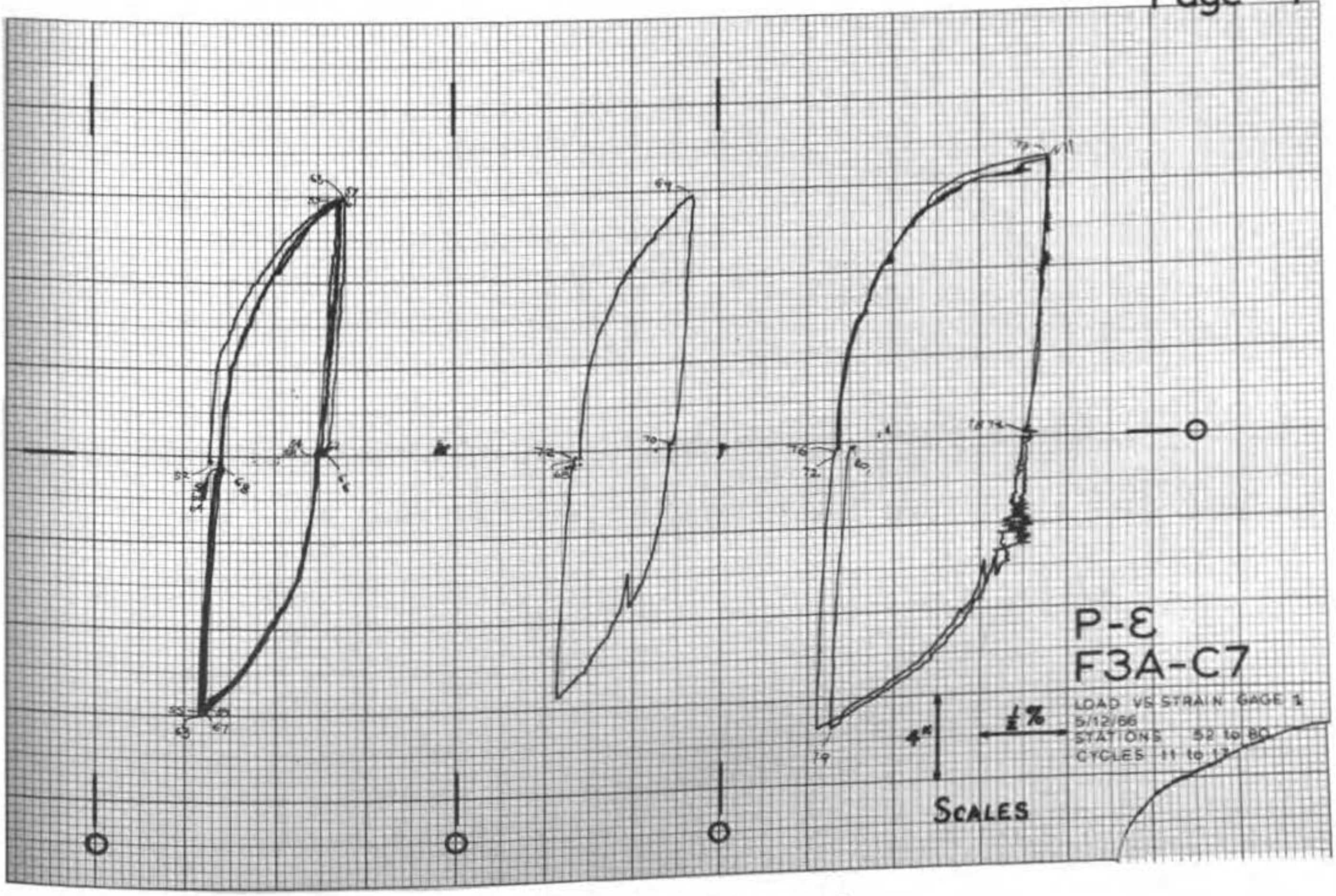
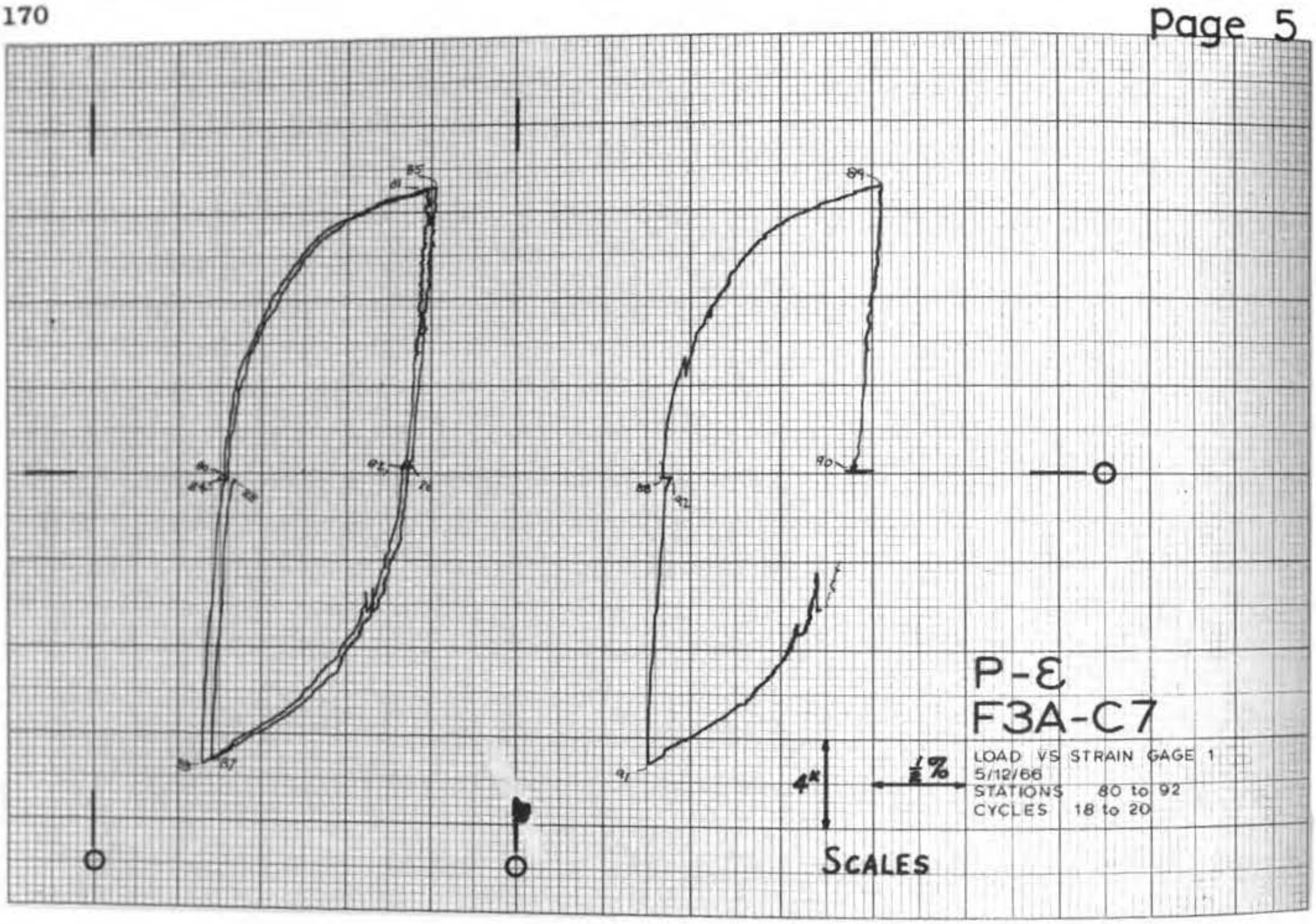
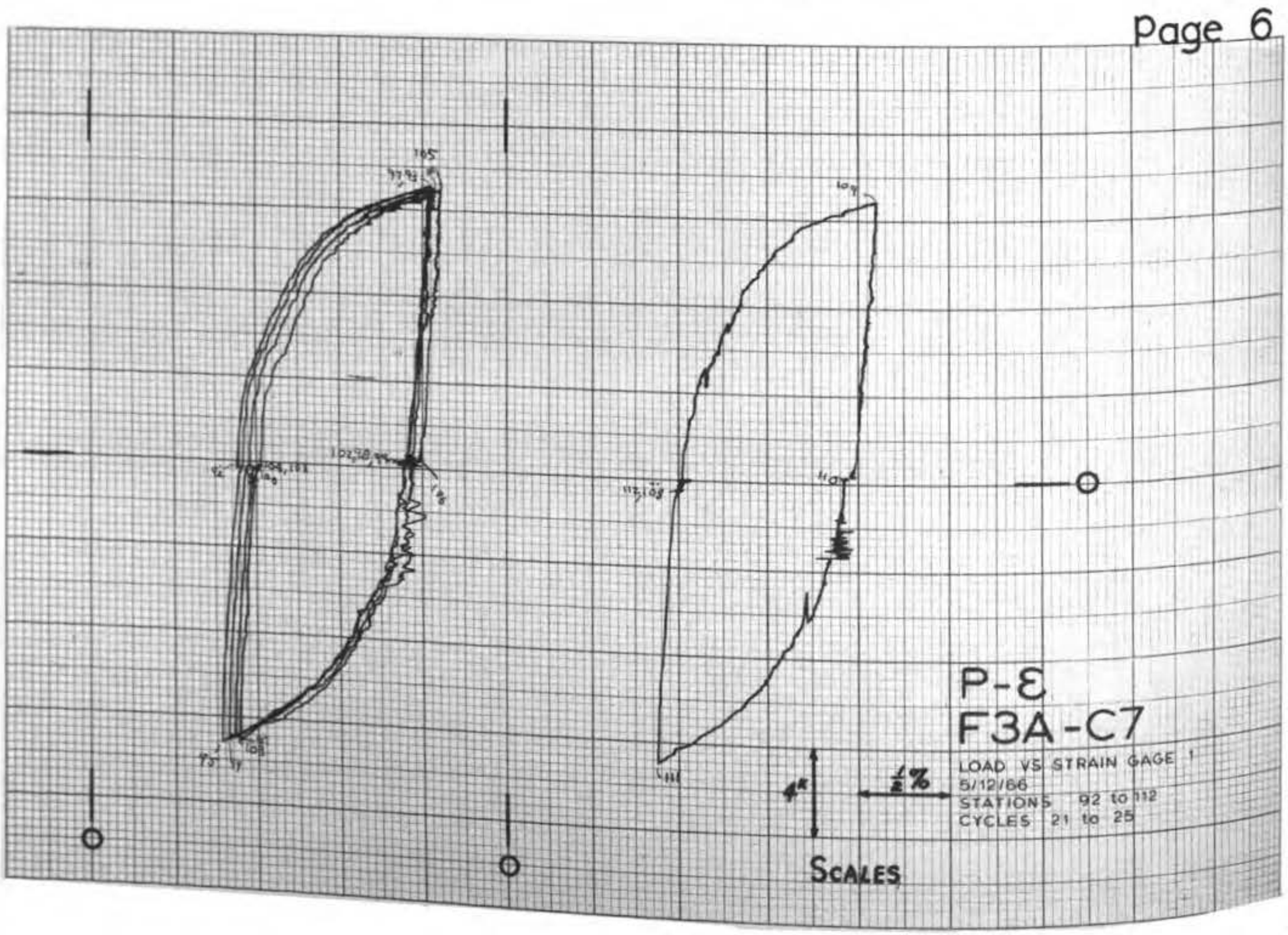


PLATE 18. (continued)


Page 5
P-ε
F3A-C7
LOAD VS STRAIN GAGE 1
5/12/66
STATIONS 80 to 92
CYCLES 18 to 20
4k
1/2%
SCALES


Page 6
P-ε
F3A-C7
LOAD VS STRAIN GAGE 1
5/12/66
STATIONS 92 to 112
CYCLES 21 to 25
4k
1/2%
SCALES

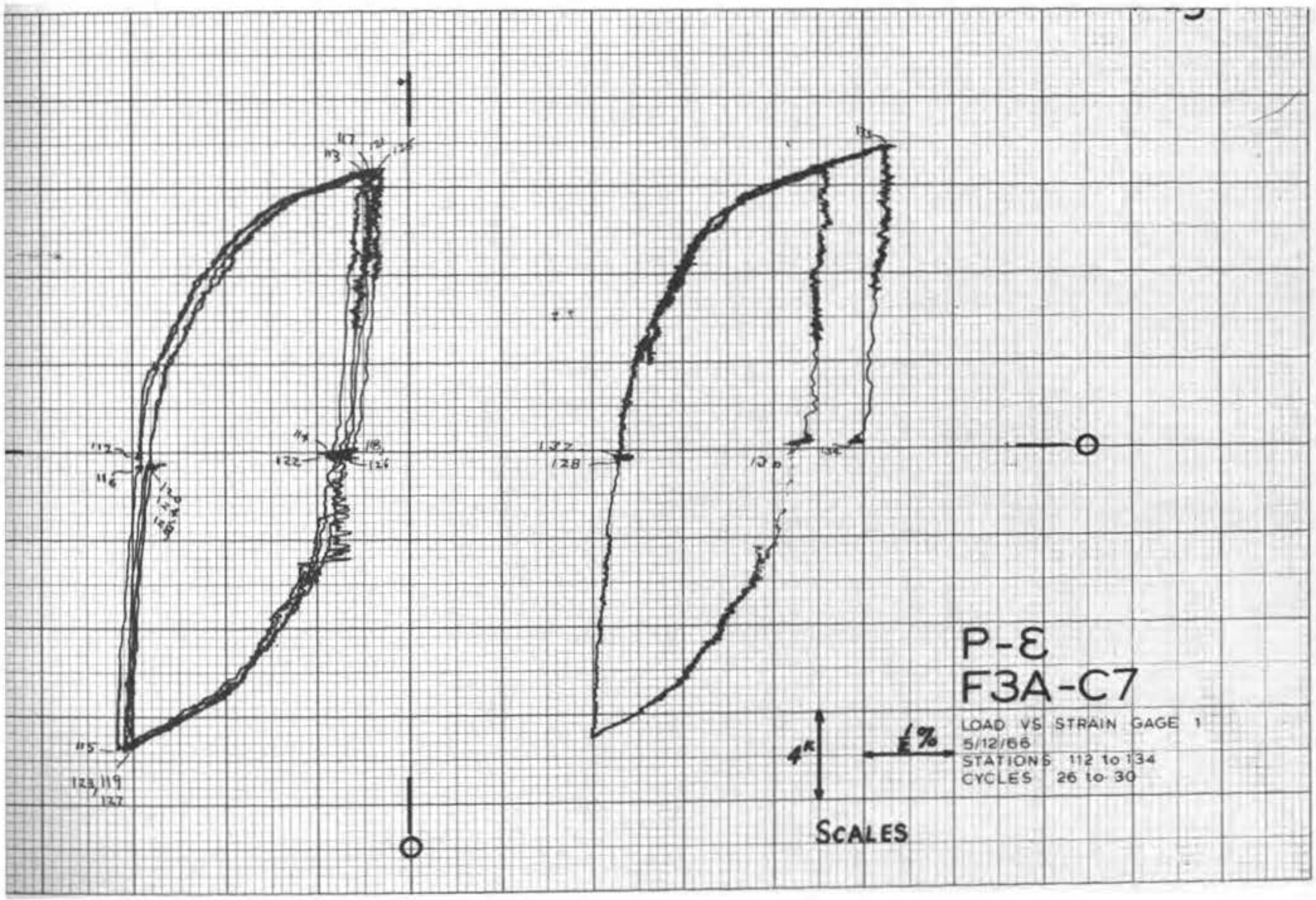
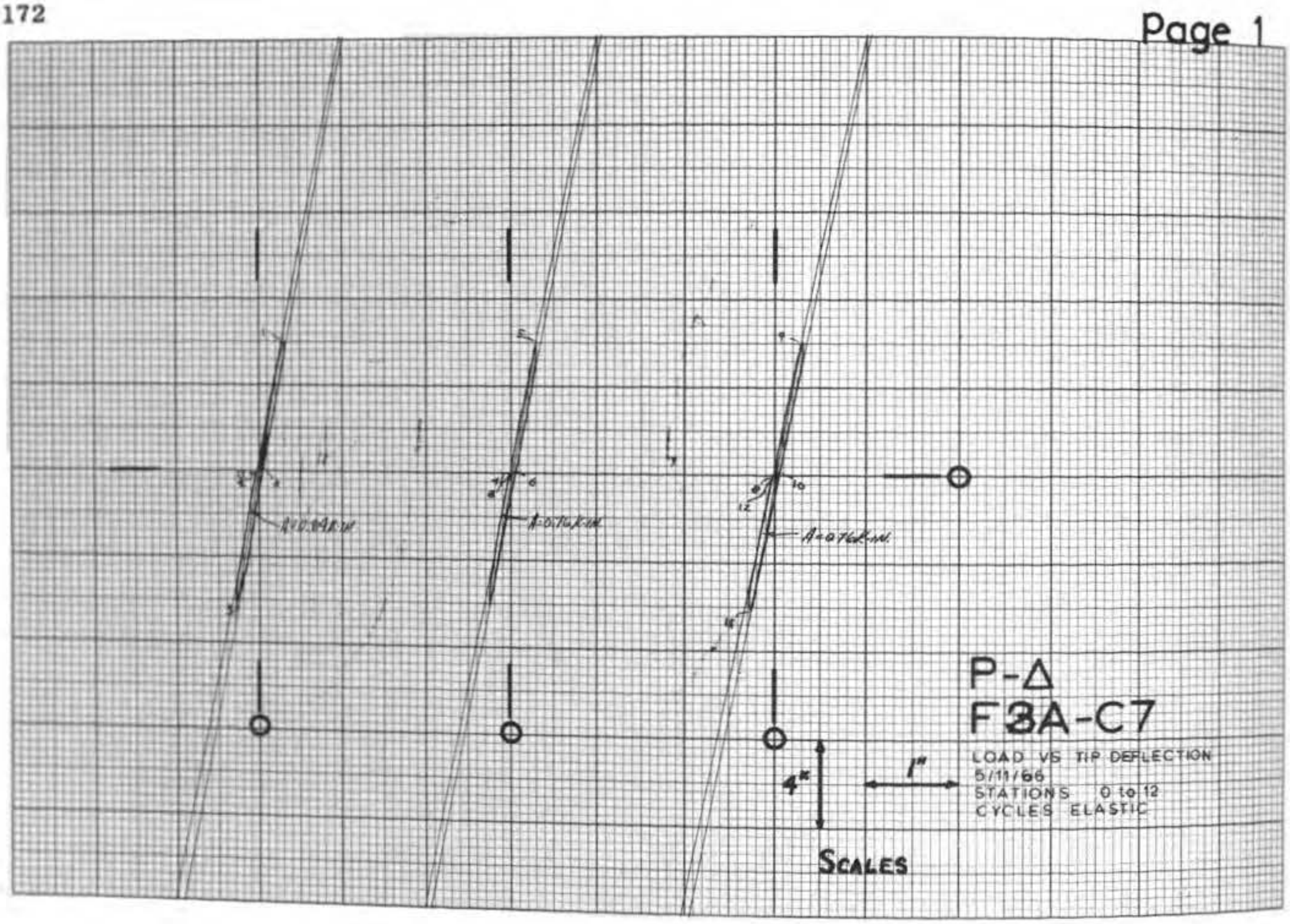
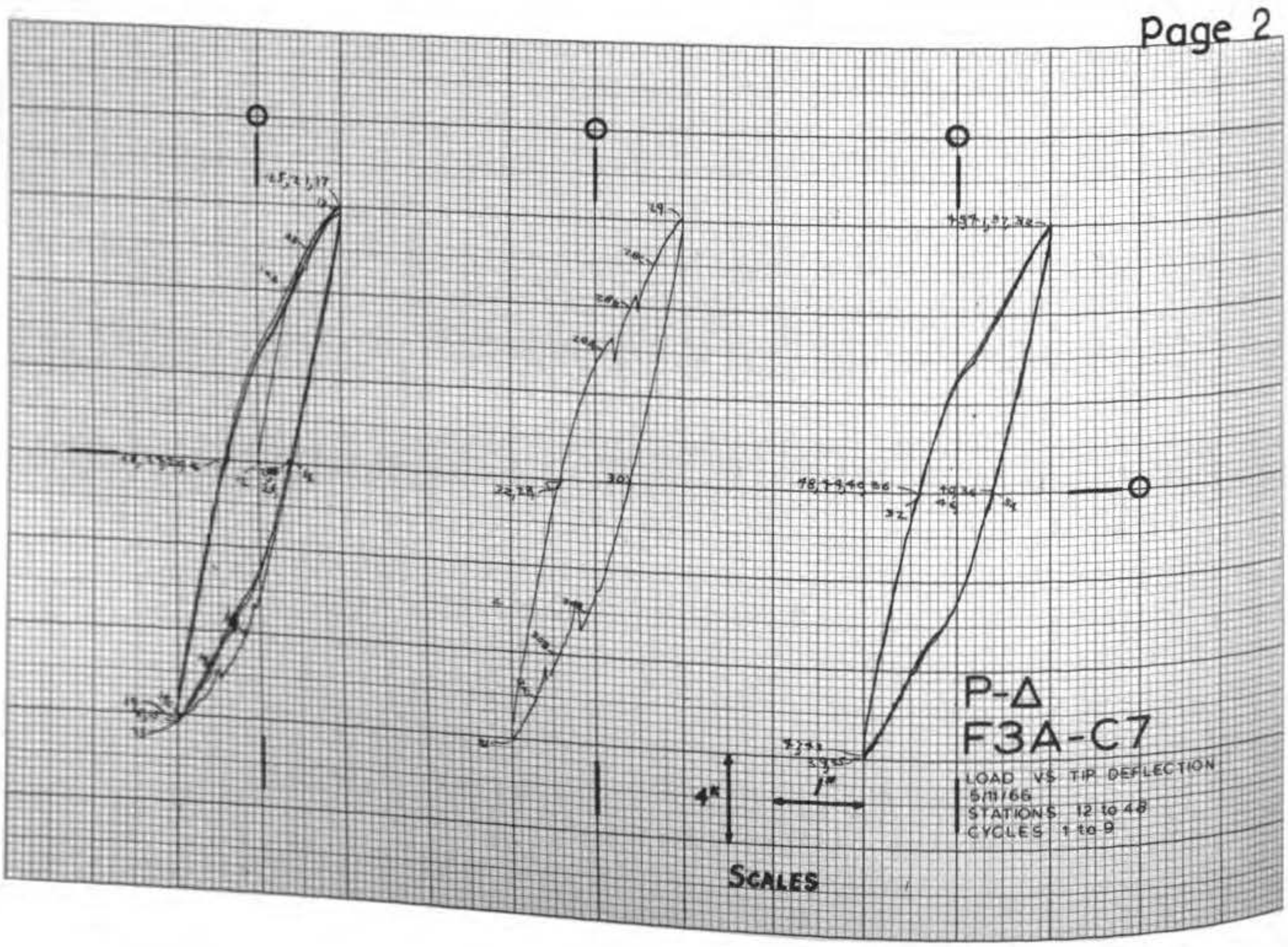
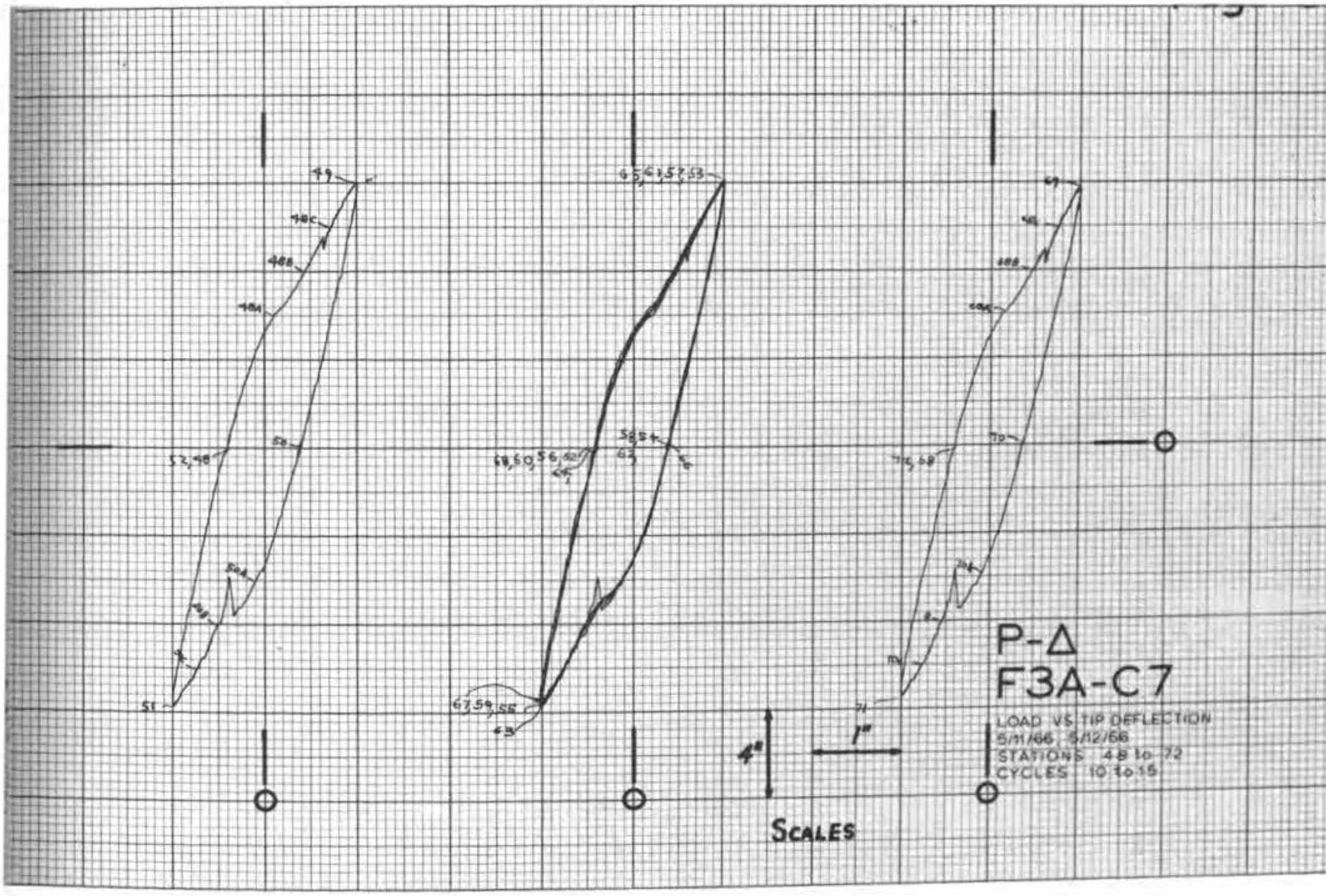


PLATE 18. (continued)


Page 1
P-Δ
F3A-C7
LOAD VS TIP DEFLECTION
5/11/66
STATIONS 0 to 12
CYCLES ELASTIC
4"
1"
SCALES


Page 2
P-Δ
F3A-C7
LOAD VS TIP DEFLECTION
5/11/66
STATIONS 12 to 48
CYCLES 1 to 9
4"
1"
SCALES



Page 4

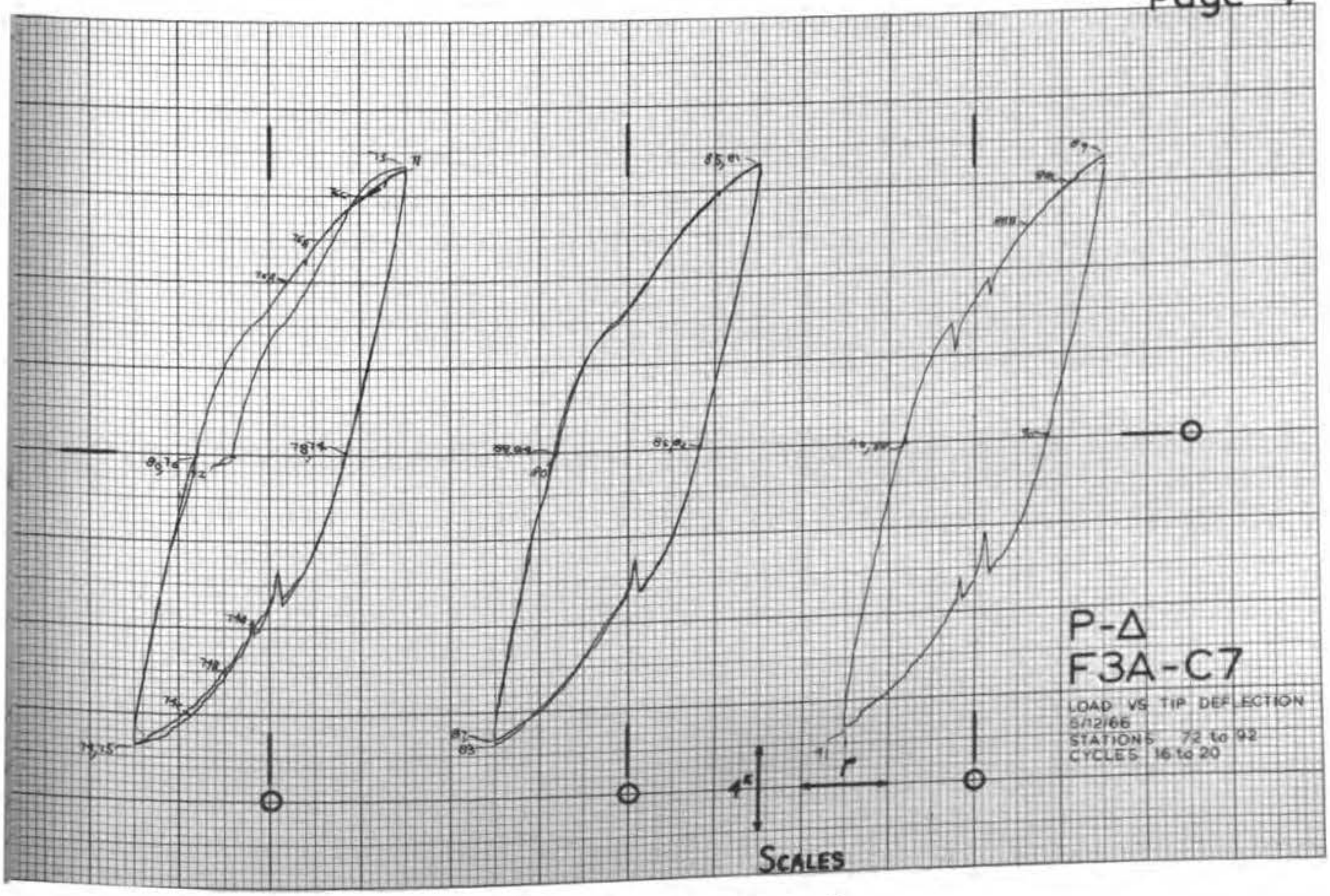
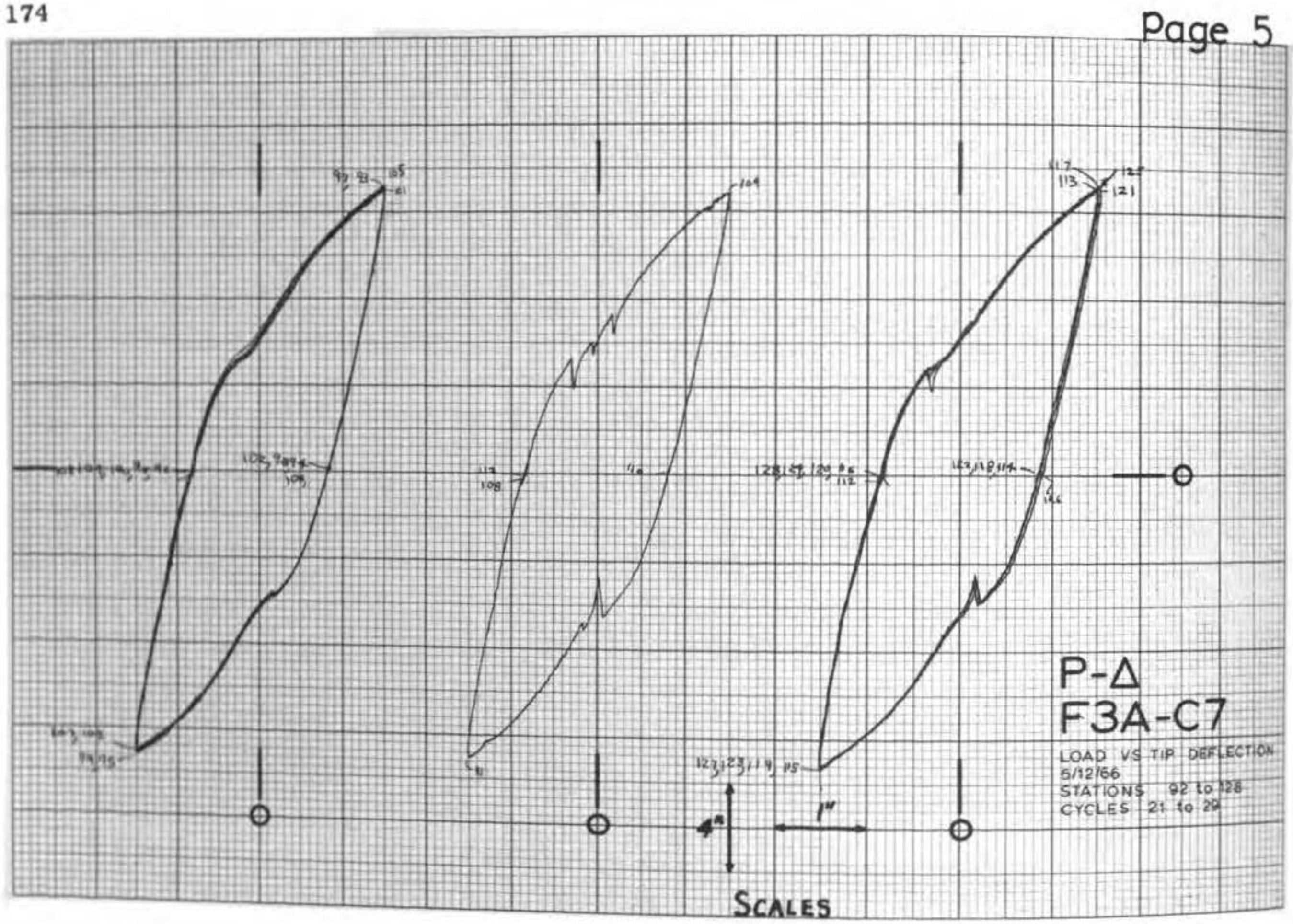
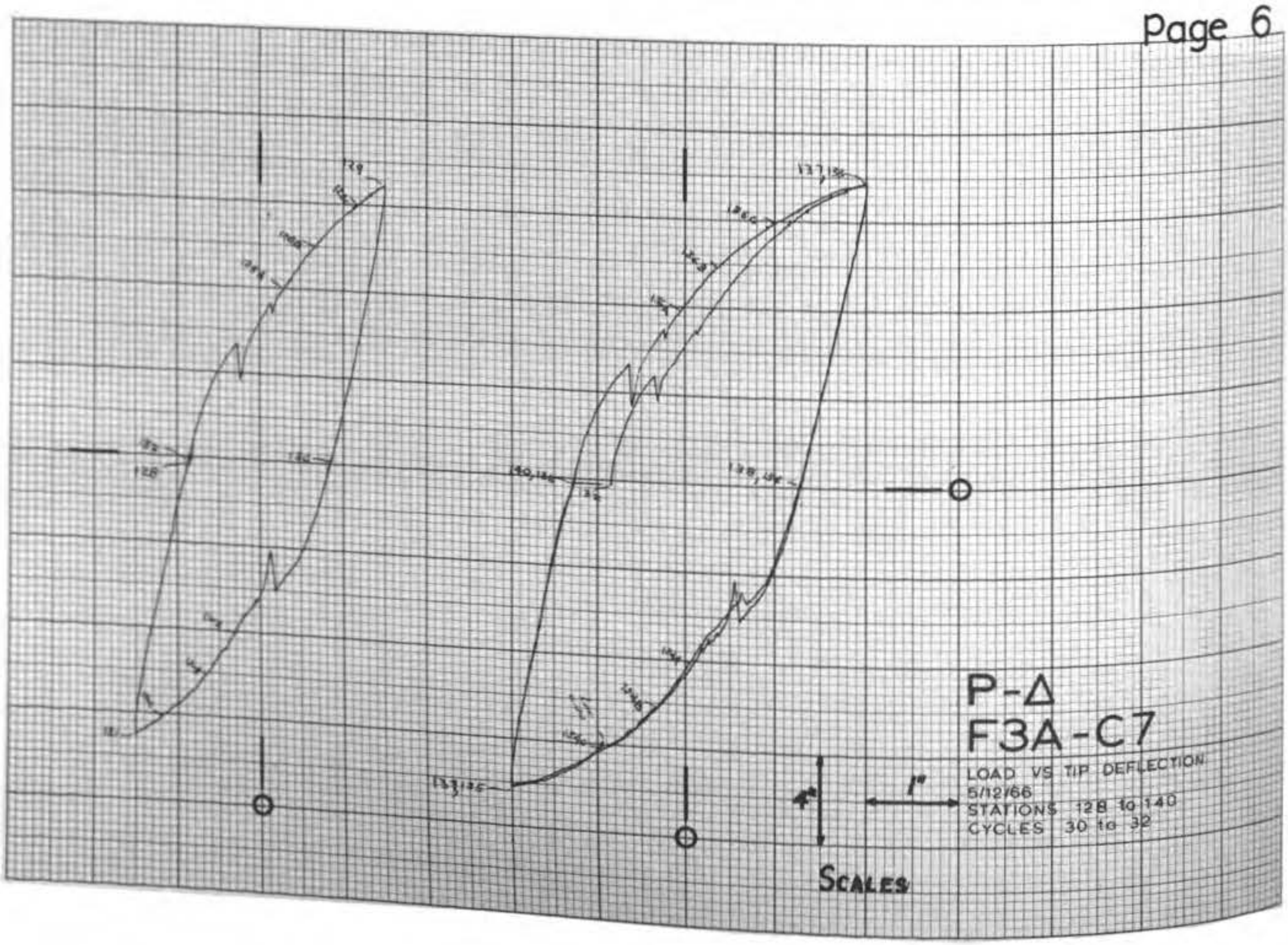
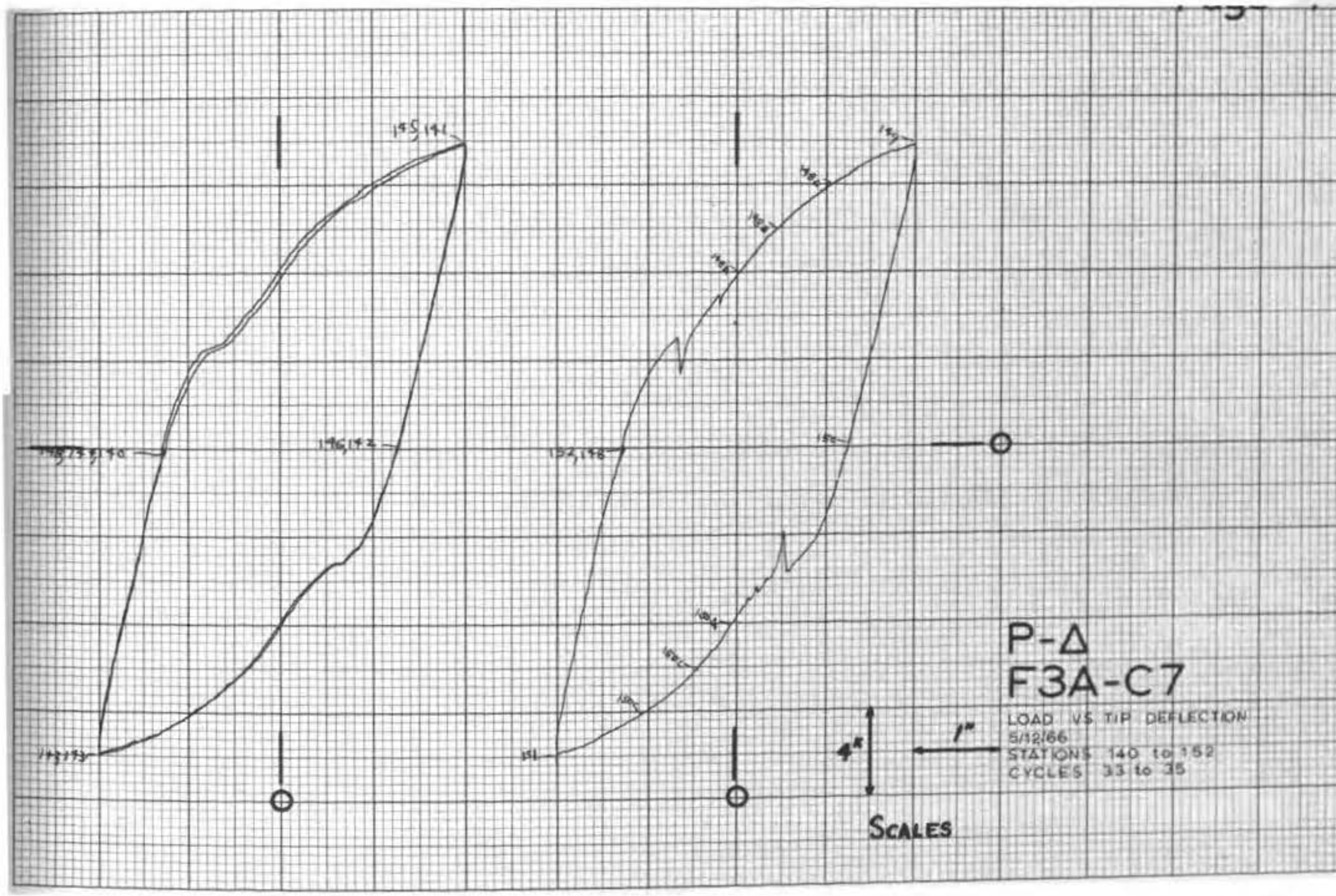


PLATE 19. (continued)


Page 5
P-Δ
F3A-C7
LOAD VS TIP DEFLECTION
5/12/66
STATIONS 92 to 128
CYCLES 21 to 29
4"
1"
SCALES


Page 6
P-Δ
F3A-C7
LOAD VS TIP DEFLECTION
5/12/66
STATIONS 128 to 140
CYCLES 30 to 32
4"
1"
SCALES



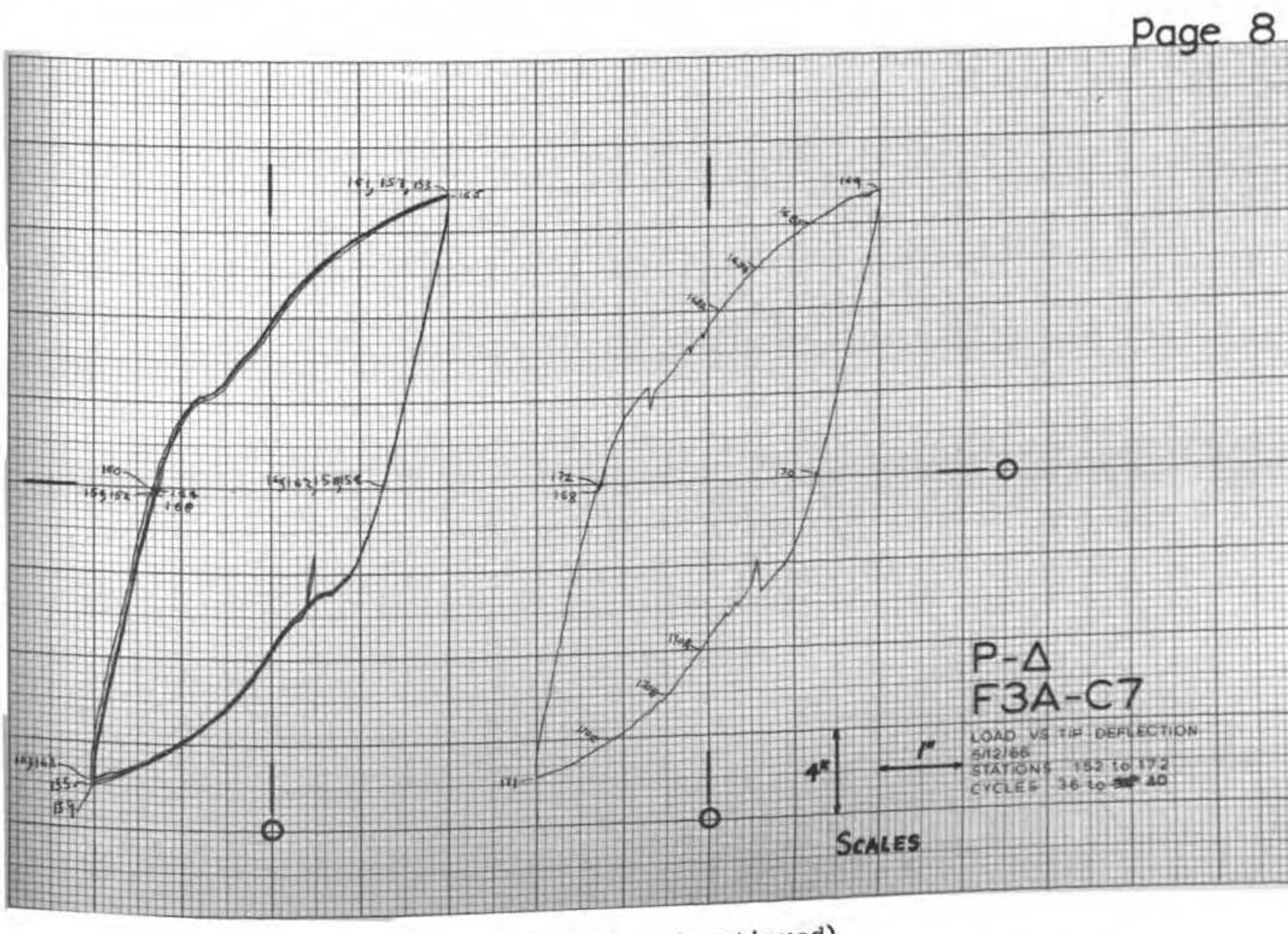
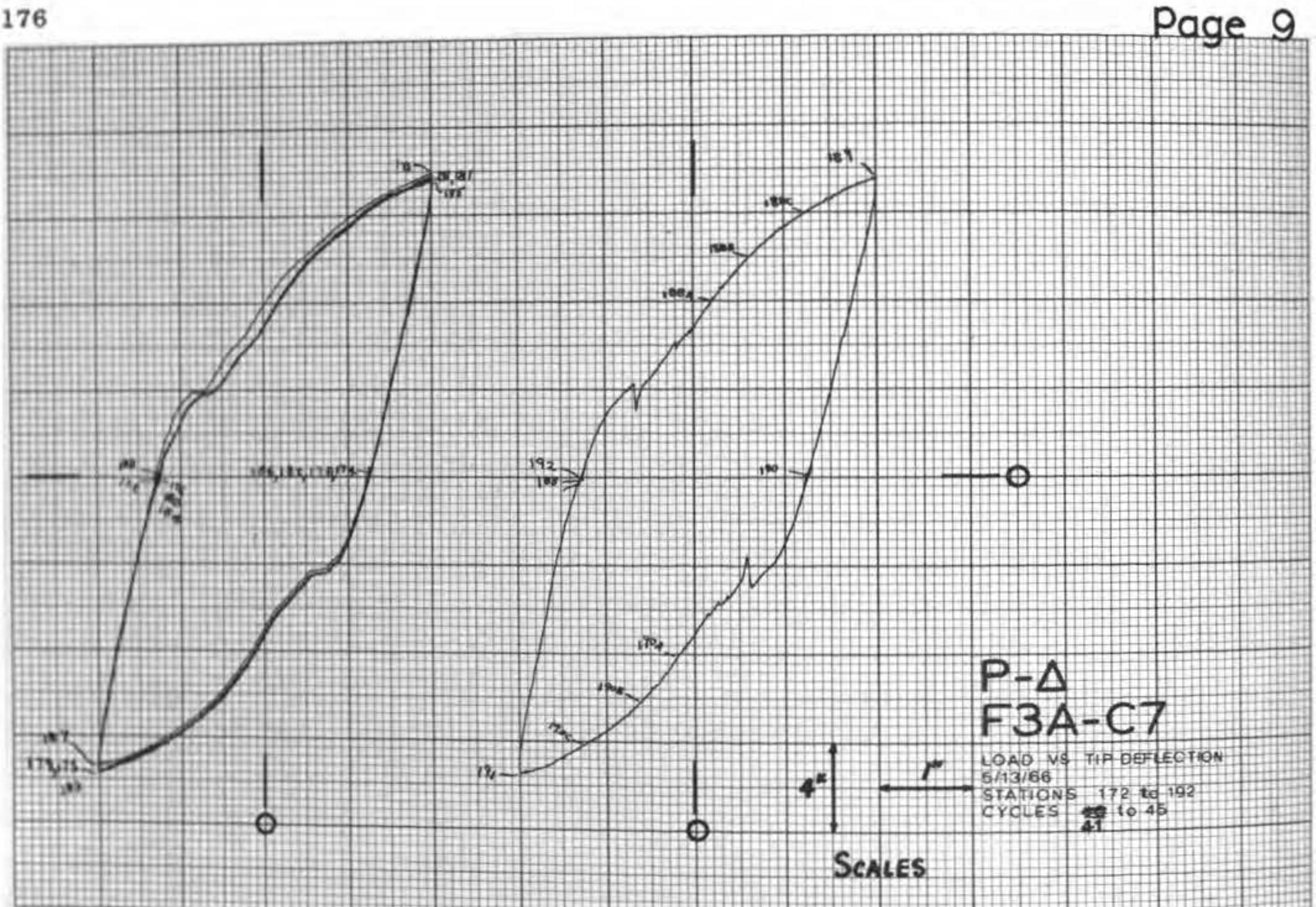
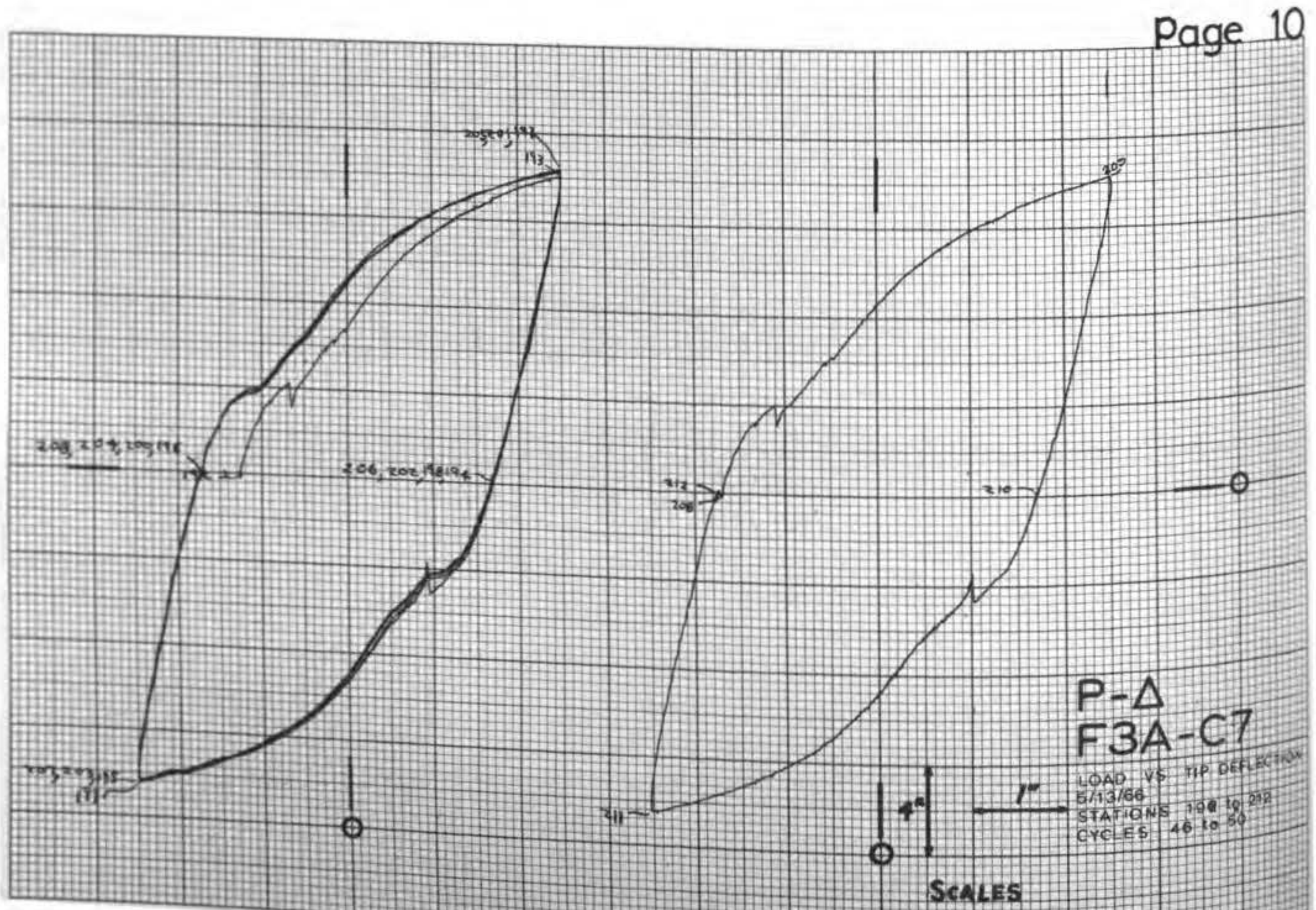
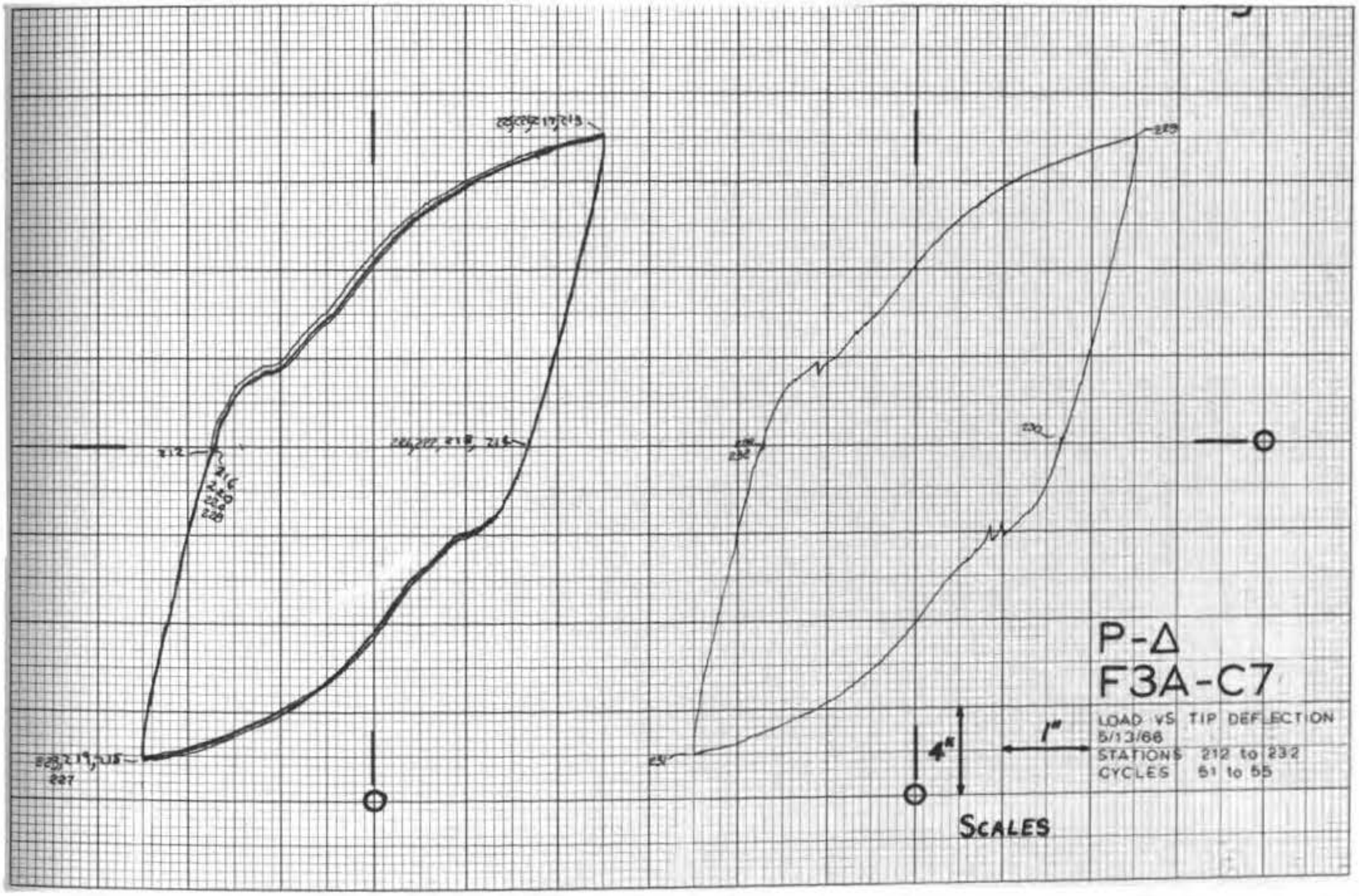


PLATE 19. (continued)


Page 9
P-Δ
F3A-C7
LOAD VS TIP DEFLECTION
5/13/66
STATIONS 172 to 192
CYCLES 41 to 45
4"
1"
SCALES


Page 10
P-Δ
F3A-C7
LOAD VS TIP DEFLECTION
5/13/66
STATIONS 193 to 212
CYCLES 46 to 50
4"
1"
SCALES



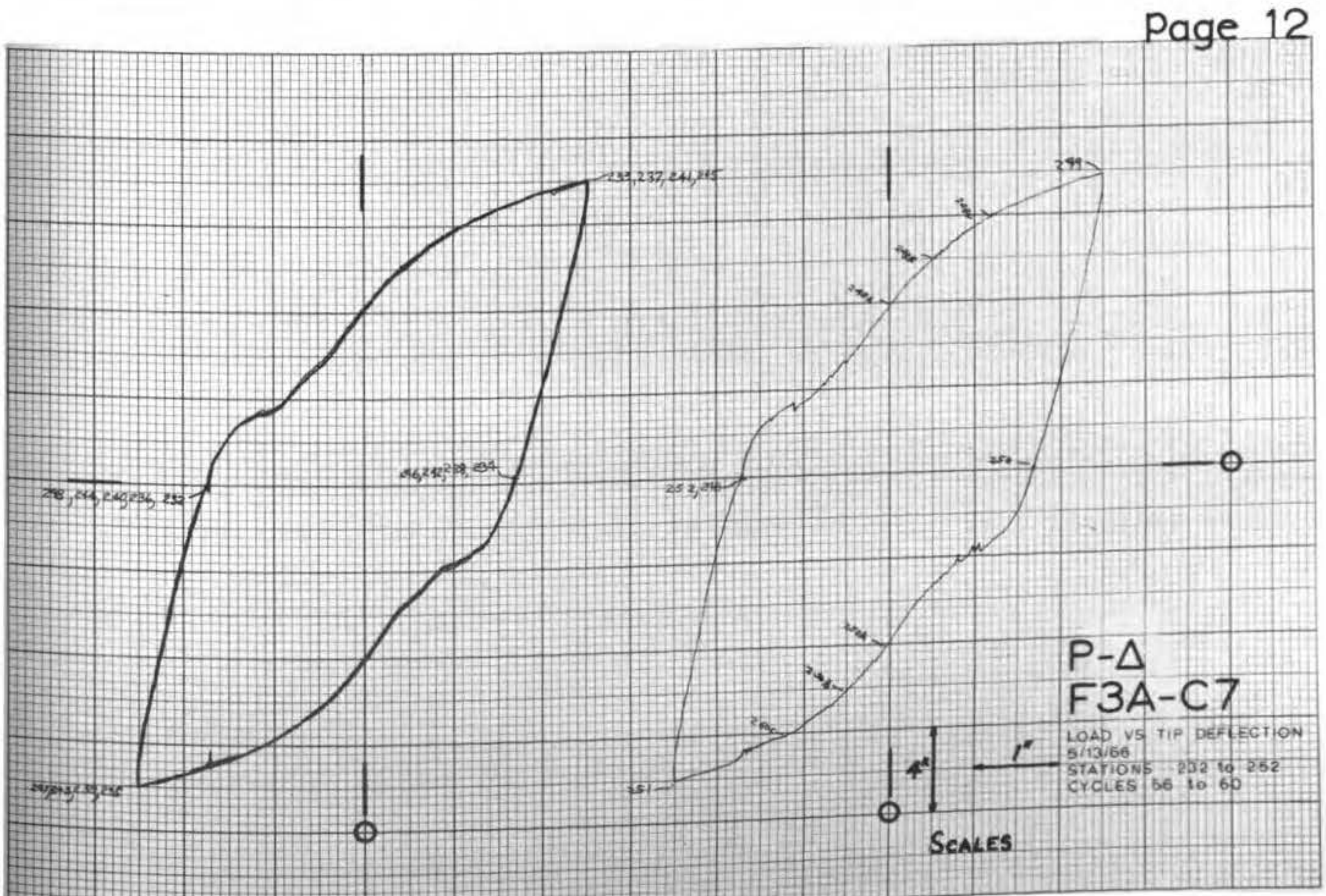
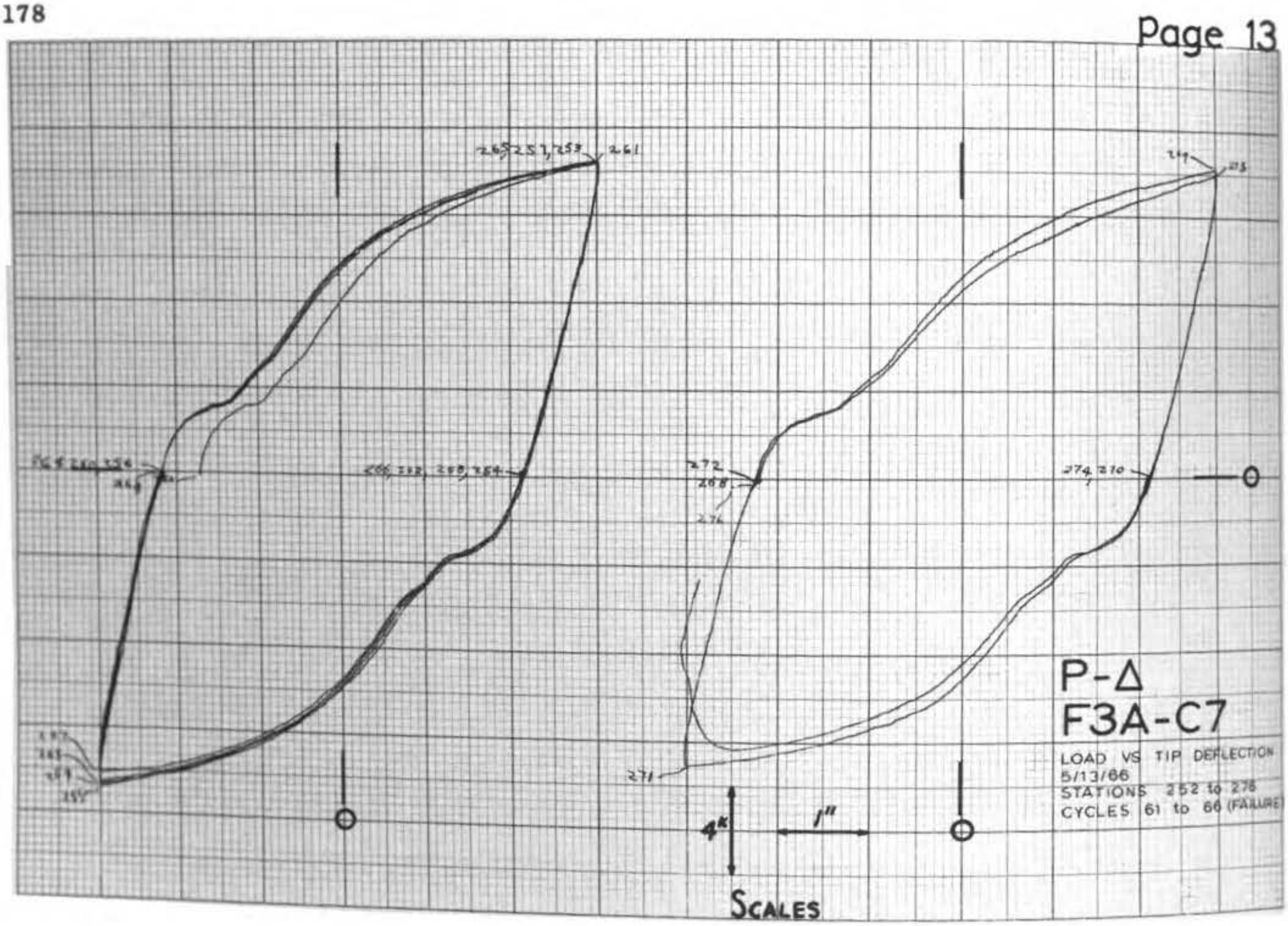


PLATE 19. (continued)



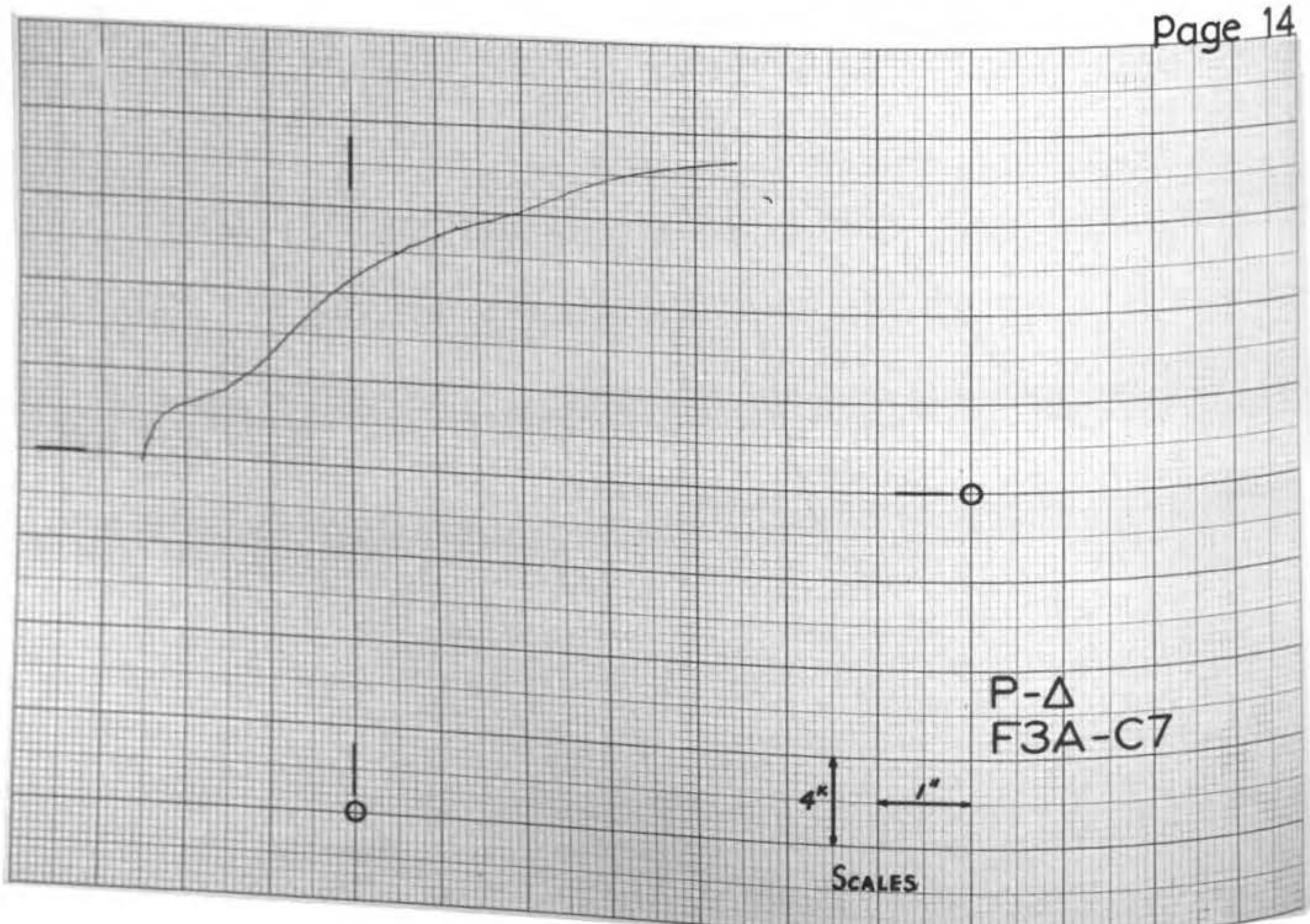


PLATE 19. (continued)

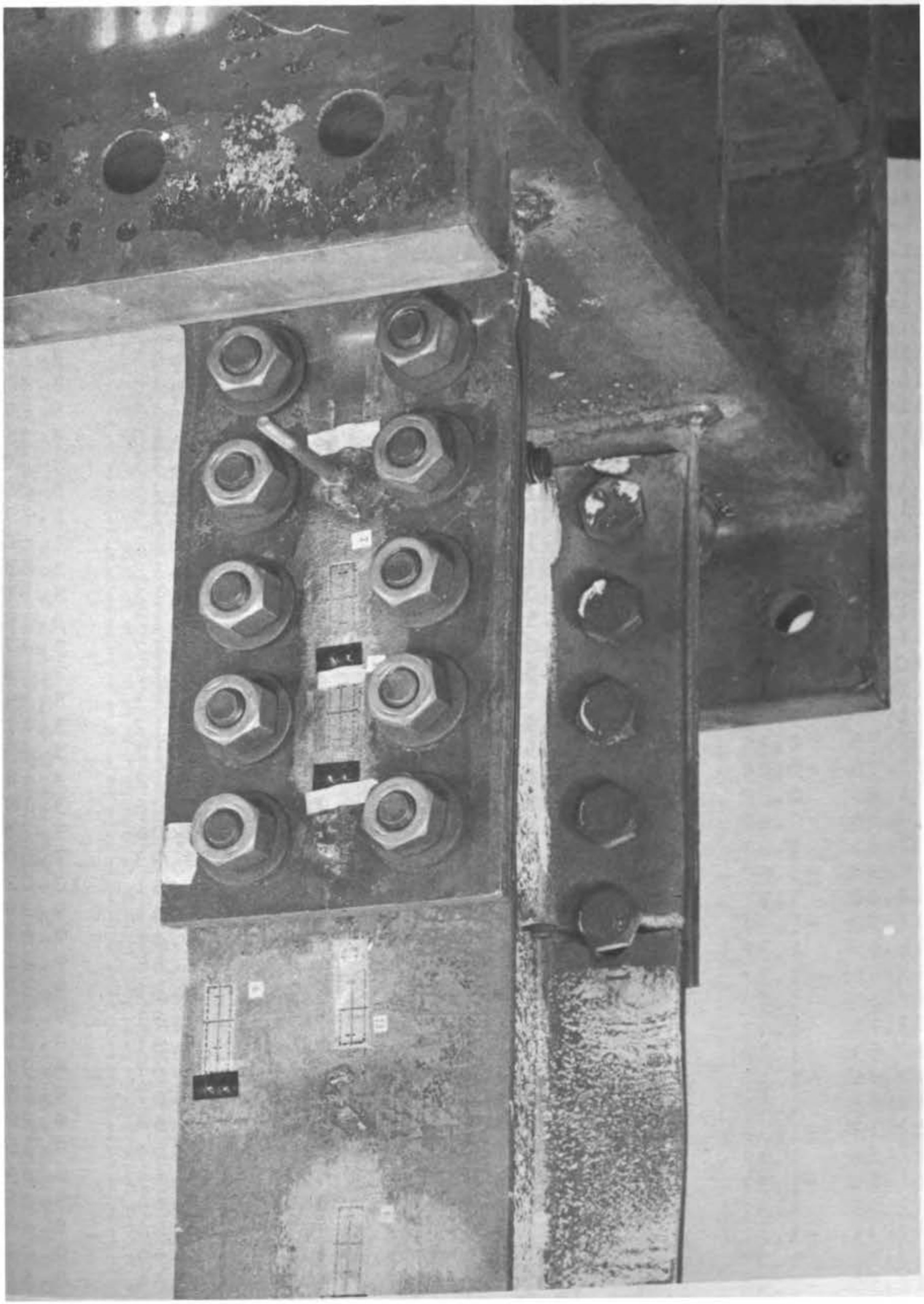


FIGURE 32. F3A-C7

SPECIMEN F3A-C7

Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	11.07	0.89	0.37	3.5	1.308	2.63	1.09	2.44
2	-11.58	-0.88	0.73	6.5	-1.368	-2.61	2.15	4.59
3	11.46	0.88	0.71	5.4	1.353	2.62	2.09	3.79
4	-11.55	-0.88	0.71	5.4	-1.364	-2.62	2.09	3.81
5	11.44	0.88	0.71	5.0	1.351	2.62	2.09	3.48
6	-11.81	-0.88	0.71	5.3	-1.394	-2.61	2.09	3.72
7	11.38	0.88	0.71	4.9	1.344	2.62	2.09	3.43
8	-11.57	-0.88	0.71	5.2	-1.367	-2.61	2.09	3.65
9	11.55	0.88	0.71	5.2	1.364	2.62	2.09	3.66
10	-11.52	-0.88	0.71	4.9	-1.361	-2.62	2.09	3.46
11	11.33	0.90	0.73	5.0	1.338	2.65	2.15	3.50
12	-11.45	-0.87	0.73	4.7	-1.352	-2.59	2.15	3.31
13	11.30	0.90	0.73	4.7	1.335	2.65	2.15	3.30
14	-11.47	-0.87	0.73	4.7	-1.354	-2.59	2.15	3.29
15	11.36	0.90	0.73	4.7	1.342	2.65	2.15	3.31
16	-11.31	-0.88	0.73	4.7	-1.336	-2.60	2.15	3.27
17	11.25	0.90	0.73	4.7	1.328	2.65	2.15	3.28
18	-11.26	-0.88	0.73	4.6	-1.330	-2.60	2.15	3.23
19	11.42	0.88	0.71	5.1	1.349	2.62	2.12	3.60
20	-11.14	-0.89	0.71	5.1	-1.315	-2.63	2.12	3.55
21	11.56	0.89	0.71	5.0	1.365	2.65	2.12	3.51
22	-11.00	-0.88	0.72	4.5	-1.298	-2.60	2.12	3.18
23	11.50	0.89	0.72	5.0	1.358	2.65	2.12	3.47
24	-10.90	-0.88	0.72	4.5	-1.287	-2.60	2.12	3.13
25	11.52	0.89	0.72	4.9	1.360	2.65	2.12	3.44
26	-11.26	-0.90	0.71	4.9	-1.330	-2.66	2.12	3.41
27	11.53	0.89	0.71	4.9	1.362	2.65	2.12	3.42
28	-10.98	-0.88	0.71	4.5	-1.296	-2.61	2.12	3.18
29	11.23	0.89	0.70	4.5	1.326	2.63	2.06	3.18
30	-10.86	-0.89	0.69	4.8	-1.282	-2.64	2.06	3.33
31	12.81	1.37	1.16	10.6	1.513	4.06	3.43	7.40
32	-12.88	-1.37	1.55	14.3	-1.521	-4.06	4.61	10.02
33	12.61	1.37	1.55	13.4	1.489	4.07	4.61	9.39
34	-12.90	-1.37	1.55	13.8	-1.524	-4.06	4.61	9.68
35	12.65	1.37	1.53	13.2	1.493	4.07	4.55	9.22
36	-12.98	-1.37	1.56	13.3	-1.532	-4.06	4.61	9.32
37	12.62	1.37	1.56	13.1	1.490	4.07	4.61	9.19
38	-12.73	-1.37	1.56	13.1	-1.503	-4.06	4.61	9.21
39	12.59	1.38	1.57	12.7	1.487	4.10	4.67	8.92
40	-12.78	-1.37	1.57	13.1	-1.509	-4.06	4.67	9.15
41	12.66	1.37	1.56	13.1	1.495	4.07	4.64	9.20
42	-12.73	-1.37	1.56	13.1	-1.503	-4.06	4.64	9.15
43	12.64	1.37	1.56	12.6	1.492	4.07	4.64	8.84
44	-12.64	-1.37	1.56	13.2	-1.492	-4.07	4.64	9.24
45	12.43	1.37	1.56	12.4	1.467	4.07	4.64	8.66
46	-12.44	-1.37	1.56	12.9	-1.469	-4.07	4.64	9.04
47	12.36	1.37	1.56	12.2	1.460	4.08	4.64	8.51
48	-12.50	-1.40	1.56	16.9	-1.476	-4.16	4.64	11.81
49	12.23	1.37	1.55	12.2	1.443	4.05	4.60	8.55
50	-12.41	-1.36	1.55	12.7	-1.465	-4.04	4.61	8.88
51	12.40	1.38	1.59	12.6	1.464	4.10	4.70	8.81

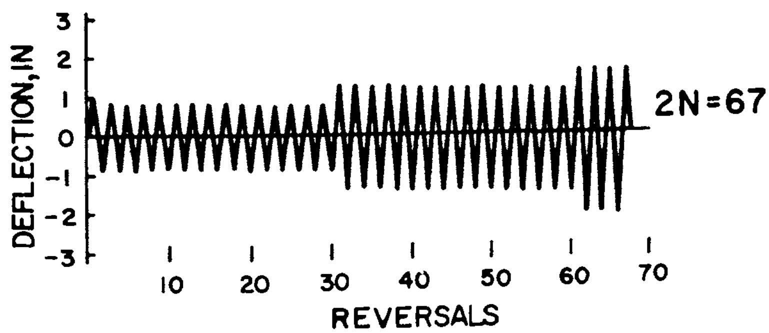
Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
52	-12.60	-1.36	1.60	13.2	-1.488	-4.04	4.73	9.24
53	12.56	1.39	1.60	12.6	1.483	4.13	4.73	8.81
54	-12.53	-1.36	1.61	13.2	-1.479	-4.04	4.76	9.23
55	12.42	1.38	1.61	12.5	1.466	4.10	4.76	8.73
56	-12.65	-1.36	1.61	13.1	-1.493	-4.04	4.76	9.19
57	12.61	1.42	1.65	13.0	1.489	4.22	4.91	9.10
58	-12.55	-1.36	1.65	13.4	-1.482	-4.04	4.91	9.37
59	12.29	1.39	1.61	12.7	1.451	4.11	4.76	8.92
60	-12.40	-1.36	1.61	13.2	-1.464	-4.04	4.76	9.23
61	13.16	1.87	2.05	18.4	1.554	5.53	6.07	12.90
62	-13.46	-1.86	2.47	23.1	-1.589	-5.52	7.34	16.21
63	13.24	1.87	2.47	22.4	1.563	5.53	7.34	15.68
64	-13.44	-1.86	2.47	24.3	-1.587	-5.53	7.34	16.99
65	13.27	1.88	2.49	22.5	1.567	5.59	7.37	15.74
66	-13.32	-1.84	2.44	22.4	-1.573	-5.47	7.25	15.68
67	13.24	1.90	2.44	21.5	1.563	5.62	7.25	15.09
68	-13.23	-1.84	2.45	22.4	-1.562	-5.47	7.25	15.66
69	13.18	1.93	2.46	21.5	1.557	5.71	7.31	15.05
70	-13.22	-1.80	2.47	22.1	-1.561	-5.35	7.31	15.45
71	13.13	1.95	2.48	21.5	1.551	5.77	7.34	15.04
72	-13.23	-1.80	2.45	22.2	-1.563	-5.33	7.25	15.57
73	13.17	1.95	2.45	21.3	1.555	5.77	7.25	14.93
74	-13.12	-1.81	2.48	22.3	-1.549	-5.38	7.34	15.61
75	13.12	1.95	2.48	21.4	1.549	5.77	7.34	14.96
76	-13.11	-1.79	2.46	21.7	-1.547	-5.30	7.28	15.21
77	13.04	1.95	2.46	20.5	1.540	5.77	7.28	14.35
78	-13.07	-1.79	2.45	21.7	-1.544	-5.30	7.25	15.17
79	12.89	1.95	2.47	20.7	1.522	5.78	7.31	14.48
80	-13.12	-1.79	2.46	21.8	-1.550	-5.30	7.31	15.25
81	13.26	1.97	2.46	21.4	1.566	5.83	7.29	15.00
82	-13.06	-1.77	2.42	21.2	-1.542	-5.24	7.16	14.85
83	13.09	1.97	2.42	19.8	1.545	5.83	7.16	13.88
84	-13.06	-1.77	2.42	21.1	-1.542	-5.24	7.16	14.80
85	12.99	1.97	2.42	19.7	1.534	5.83	7.16	13.82
86	-13.01	-1.77	2.42	21.0	-1.537	-5.24	7.16	14.69
87	12.87	1.97	2.42	19.6	1.520	5.84	7.16	13.75
88	-12.90	-1.77	2.42	20.9	-1.524	-5.25	7.16	14.62
89	12.92	1.96	2.44	16.0	1.525	5.81	7.24	11.21
90	-12.86	-1.75	2.44	21.2	-1.518	-5.19	7.25	14.82
91	13.38	2.48	2.89	25.6	1.580	7.37	8.56	17.91
92	-13.73	-2.24	3.32	32.3	-1.621	-6.64	9.83	22.65
93	13.71	2.48	3.32	31.1	1.619	7.35	9.83	21.75
94	-13.85	-2.24	3.32	32.1	-1.635	-6.64	9.83	22.49
95	13.60	2.48	3.32	30.6	1.606	7.36	9.83	21.40
96	-13.80	-2.24	3.32	31.5	-1.630	-6.64	9.83	22.03
97	13.55	2.48	3.32	30.1	1.600	7.36	9.83	21.05
98	-13.80	-2.24	3.32	31.0	-1.629	-6.64	9.83	21.74
99	13.59	2.49	3.32	29.7	1.604	7.39	9.83	20.79
100	-13.85	-2.27	3.36	31.5	-1.635	-6.73	9.98	22.08
101	13.53	2.47	3.36	30.2	1.598	7.33	9.96	21.14
102	-13.60	-2.25	3.32	30.6	-1.606	-6.68	9.83	21.42
103	13.46	2.47	3.32	28.9	1.589	7.33	9.83	20.24
104	-13.62	-2.25	3.32	30.2	-1.608	-6.68	9.83	21.17

Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
105	13.39	2.47	3.32	28.9	1.581	7.33	9.83	20.26
106	-13.55	-2.25	3.32	29.8	-1.600	-6.68	9.83	20.88
107	13.34	2.47	3.32	28.3	1.575	7.34	9.83	19.80
108	-13.52	-2.25	3.32	29.8	-1.596	-6.68	9.84	20.84
109	13.33	2.48	3.30	28.8	1.574	7.37	9.79	20.14
110	-13.42	-2.24	3.31	29.1	-1.584	-6.65	9.80	20.37
111	13.30	2.51	3.33	28.4	1.570	7.43	9.87	19.86
112	-13.45	-2.24	3.33	29.3	-1.588	-6.65	9.86	20.54
113	13.24	2.51	3.33	28.2	1.563	7.43	9.86	19.78
114	-13.49	-2.24	3.33	29.4	-1.593	-6.65	9.86	20.60
115	13.19	2.51	3.33	28.3	1.557	7.43	9.86	19.85
116	-13.48	-2.24	3.33	29.4	-1.591	-6.65	9.86	20.58
117	13.21	2.51	3.33	28.4	1.560	7.43	9.86	19.88
118	-13.46	-2.24	3.33	29.3	-1.589	-6.65	9.86	20.55
119	13.22	2.48	3.32	28.1	1.561	7.34	9.83	19.68
120	-13.38	-2.26	3.32	28.6	-1.580	-6.71	9.83	20.03
121	13.76	2.99	3.80	34.4	1.624	8.87	11.26	24.12
122	-14.14	-2.74	4.26	41.1	-1.669	-8.11	12.62	28.80
123	13.90	2.99	4.24	39.7	1.642	8.86	12.56	27.83
124	-14.01	-2.74	4.24	40.5	-1.654	-8.12	12.56	28.38
125	13.86	2.99	4.24	38.9	1.636	8.86	12.56	27.27
126	-13.92	-2.74	4.24	42.0	-1.643	-8.12	12.56	29.42
127	13.77	2.99	4.24	38.3	1.626	8.86	12.56	26.79
128	-13.42	-2.74	4.24	39.4	-1.585	-8.13	12.56	27.57
129	13.63	3.02	4.26	38.0	1.610	8.96	12.65	26.64
130	-12.39	-2.75	4.31	36.9	-1.463	-8.16	12.77	25.87
131	13.34	3.00	4.29	35.7	1.576	8.91	12.71	25.03

SPECIMEN F3B-C7

Description: This specimen was similar to specimen F3A-C7 except that the suffix "B" denotes the use of connecting plates nominally 1/8 inch thinner than those of specimen type F3.

Program of Cycling:



Test Control: Tip deflection.

Raw Data Included: Graphical load-strain data, with strain measured in the center of the top plate 1.96 inches from the column face.

Graphical load deflection data.

Total Energy Absorption: 704 kip-inches.

Plastic Load Reversals to Failure: 67 ($33\frac{1}{2}$ cycles).

Remarks: Slip first occurred during the second plastic cycle. No distress was observed until the 30th cycle, when necking became apparent in both top and bottom flange plates at the bolt line nearest the column. Failure was due ultimately to a crack in the bottom plate at the bolt line, and occurred during the 34th cycle.

SPECIMEN TYPE F3B-C7 HOLES DRILLED 41/64 IN. DIA.

DIMENSIONS OF WF SECTION

DEPTH	8.34	INCHES
TOP FLANGE WIDTH	5.290	INCHES
BOTTOM FLANGE WIDTH	5.290	INCHES
TOP FLANGE THICKNESS	0.356	INCHES
BOTTOM FLANGE THICKNESS	0.354	INCHES
WEB THICKNESS	0.253	INCHES
ELASTIC MODULUS	29400.	KSI
YIELD STRESS	35.900	KSI

DIMENSIONS OF CONNECTION ELEMENTS

DEPTH OUT-TO-OUT OF PLATES	9.00	INCHES
THICKNESS OF FILLER PLATE	0.125	INCHES
HOLE DIAMETER	0.641	INCHES
TOP PLATE		
LENGTH OF PLATE, LP	10.62	INCHES
WIDTH OF PLATE, B	5.50	INCHES
LOCATION OF FIRST ROW OF BOLTS*, C	1.82	INCHES
LOCATION OF LAST ROW OF BOLTS*, D	9.33	INCHES
THICKNESS OF PLATE, T	0.370	INCHES
ELASTIC MODULUS	29100.	KSI
YIELD STRESS	39.000	KSI
BOTTOM PLATE		
LENGTH OF PLATE, LP	10.62	INCHES
WIDTH OF PLATE, B	5.50	INCHES
LOCATION OF FIRST ROW OF BOLTS*, C	1.82	INCHES
LOCATION OF LAST ROW OF BOLTS*, D	9.36	INCHES
THICKNESS OF PLATE, T	0.380	INCHES
ELASTIC MODULUS	29100.	KSI
YIELD STRESS	39.000	KSI

*MEASURED FROM FACE OF COLUMN

SPECIMEN TYPE F3B-C7   HOLES DRILLED 41/64 IN. DIA.

PROPERTIES OF GROSS SECTION OF WF

AREA, A	5.78	INCHES**2
LOCATION OF CENTROID*, YE	4.18	INCHES
MOMENT OF INERTIA, I	70.5	INCHES**4
SECTION MODULUS, TOP, ST	16.9	INCHES**3
SECTION MODULUS, BOTTOM, SB	16.9	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.19	INCHES
PLASTIC MODULUS, Z	19.0	INCHES**3
SHAPE FACTOR	1.126	
YIELD MOMENT, MY	50.48	KIP-FT.
PLASTIC MOMENT, MP	56.85	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

PROPERTIES OF NET SECTION OF WF (AISC SPECIFICATION 1.10.1)

AREA, A	5.43	INCHES**2
LOCATION OF CENTROID*, YE	4.18	INCHES
MOMENT OF INERTIA, I	64.9	INCHES**4
SECTION MODULUS, TOP, ST	15.6	INCHES**3
SECTION MODULUS, BOTTOM, SB	15.6	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.19	INCHES
PLASTIC MODULUS, Z	17.6	INCHES**3
SHAPE FACTOR	1.133	
YIELD MOMENT, MY	46.52	KIP-FT.
PLASTIC MOMENT, MP	52.71	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

PROPERTIES OF GROSS SECTION OF PLATED WF

AREA, A	9.86	INCHES**2
LOCATION OF CENTROID*, YE	4.45	INCHES
MOMENT OF INERTIA, I	146.4	INCHES**4
SECTION MODULUS, TOP, ST	32.2	INCHES**3
SECTION MODULUS, BOTTOM, SB	32.9	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.52	INCHES
PLASTIC MODULUS, Z	37.9	INCHES**3
SHAPE FACTOR	1.085	
YIELD MOMENT, MY	104.55	KIP-FT.
PLASTIC MOMENT, MP	113.48	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

SPECIMEN TYPE F3B-C7   HOLES DRILLED 41/64 IN. DIA.

PROPERTIES OF NET SECTION OF PLATED WF (AISC SPEC. 1.10.1)

AREA, A	9.17	INCHES**2
LOCATION OF CENTROID*, YE	4.45	INCHES
MOMENT OF INERTIA, I	134.6	INCHES**4
SECTION MODULUS, TOP, ST	29.6	INCHES**3
SECTION MODULUS, BOTTOM, SB	30.3	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.53	INCHES
PLASTIC MODULUS, Z	34.9	INCHES**3
SHAPE FACTOR	1.088	
YIELD MOMENT, MY	96.10	KIP-FT.
PLASTIC MOMENT, MP	104.55	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

PROPERTIES OF GROSS SECTION OF PLATES ALONE

AREA, A	4.08	INCHES**2
LOCATION OF CENTROID*, YE	4.44	INCHES
MOMENT OF INERTIA, I	76.0	INCHES**4
SECTION MODULUS, TOP, ST	16.7	INCHES**3
SECTION MODULUS, BOTTOM, SB	17.1	INCHES**3
YIELD MOMENT, MY	57.04	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

PROPERTIES OF NET SECTION OF PLATES ALONE (AISC SPEC. 1.14.3)

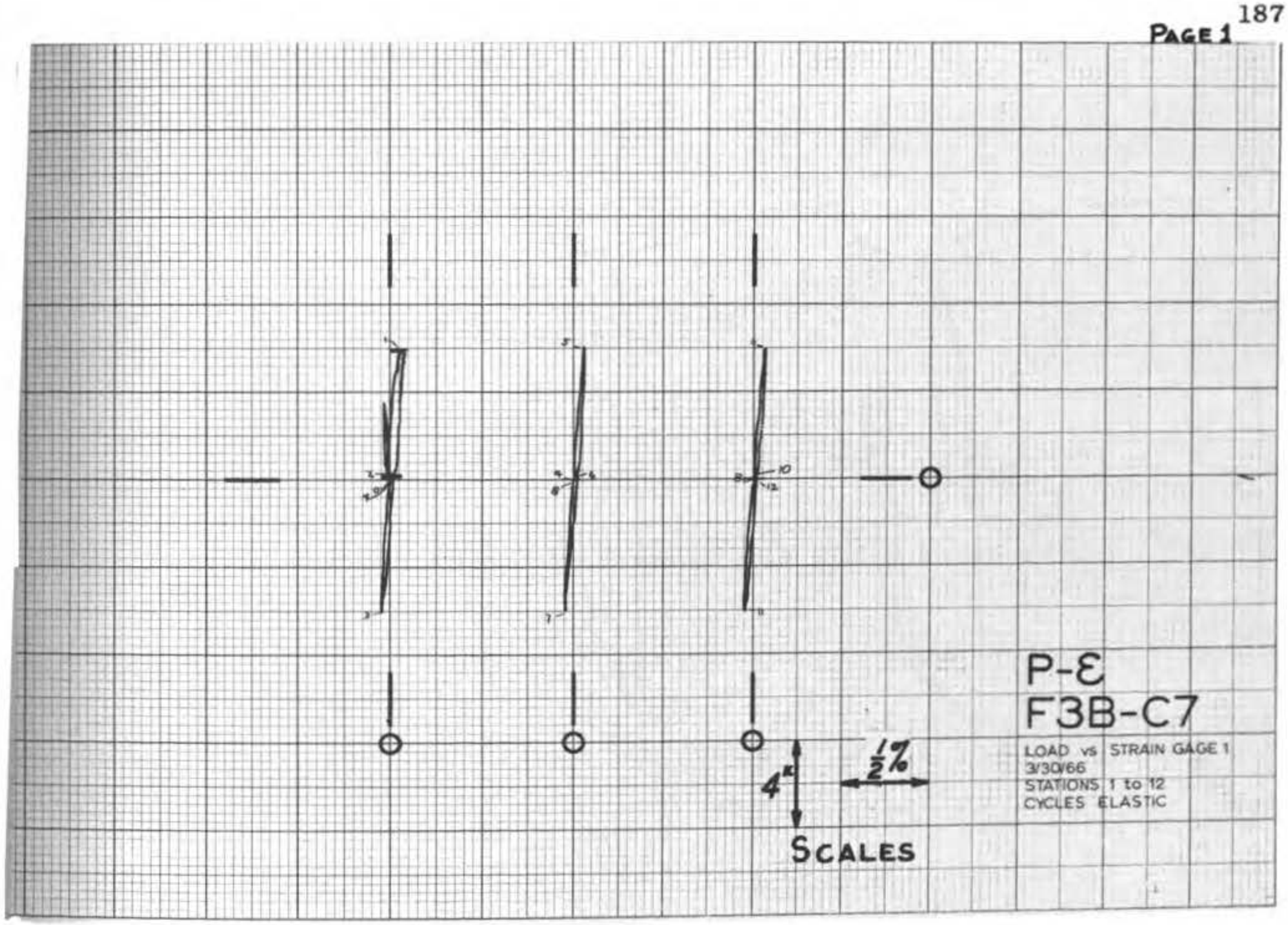
AREA, A	3.13	INCHES**2
LOCATION OF CENTROID*, YE	4.44	INCHES
MOMENT OF INERTIA, I	58.3	INCHES**4
SECTION MODULUS, TOP, ST	12.8	INCHES**3
SECTION MODULUS, BOTTOM, SB	13.1	INCHES**3
YIELD MOMENT, MY	43.76	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM PLATE

BEAM PROPERTIES

LENGTH, L	66.0	INCHES
ELASTIC STIFFNESS, P/DELTA	25.09	KIPS/IN.
YIELD DEFLECTION, DELTAY	0.326	INCHES
YIELD LOAD, PY	8.18	KIPS
PLASTIC LOAD, PP	8.18	KIPS
LOCATION OF CRITICAL SECTION FOR PY*	64.18	INCHES
LOCATION OF CRITICAL SECTION FOR PP*	64.18	INCHES

* MEASURED FROM CONCENTRATED LOAD



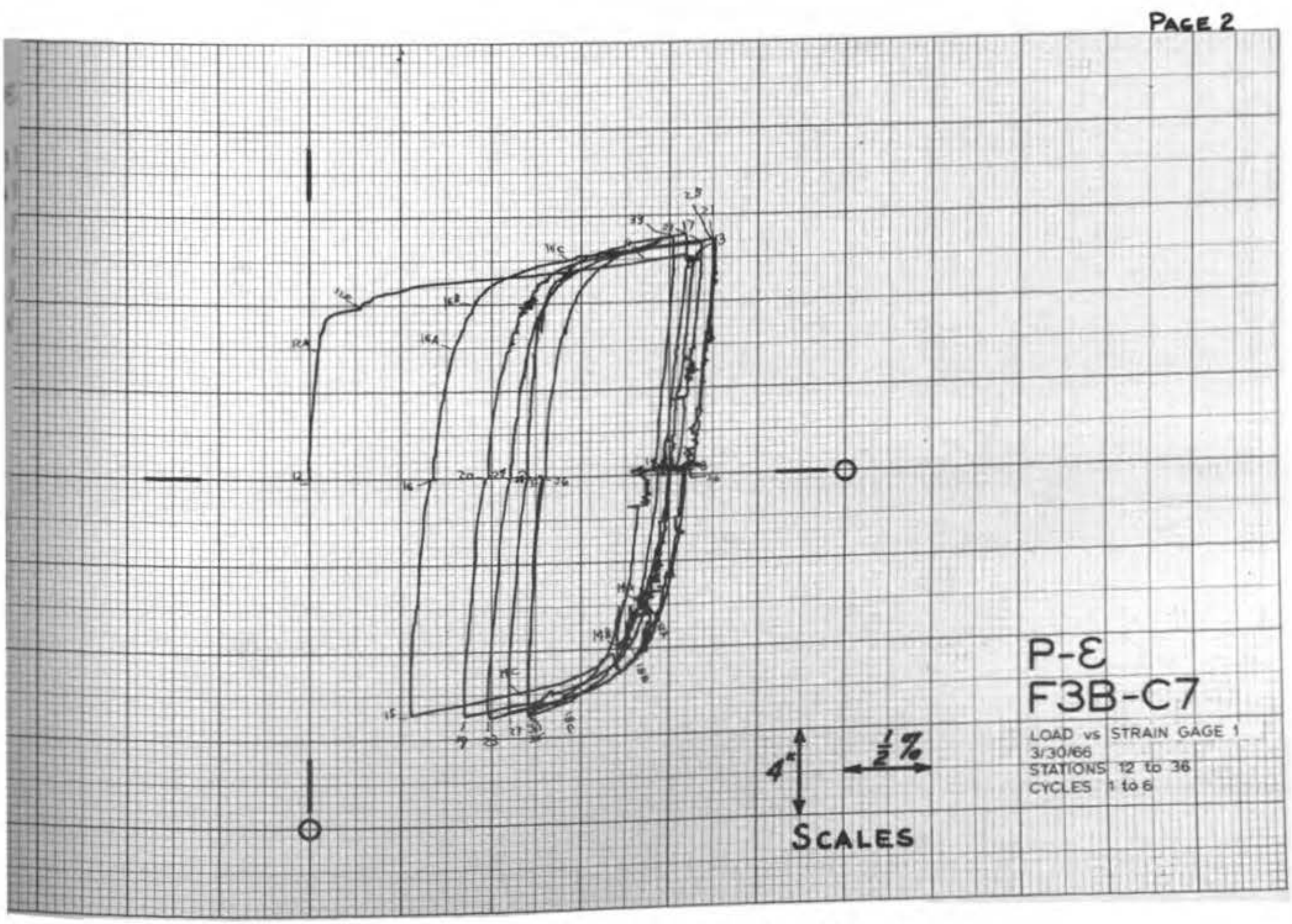


PLATE 20. LOAD VS. STRAIN - F3B-C7

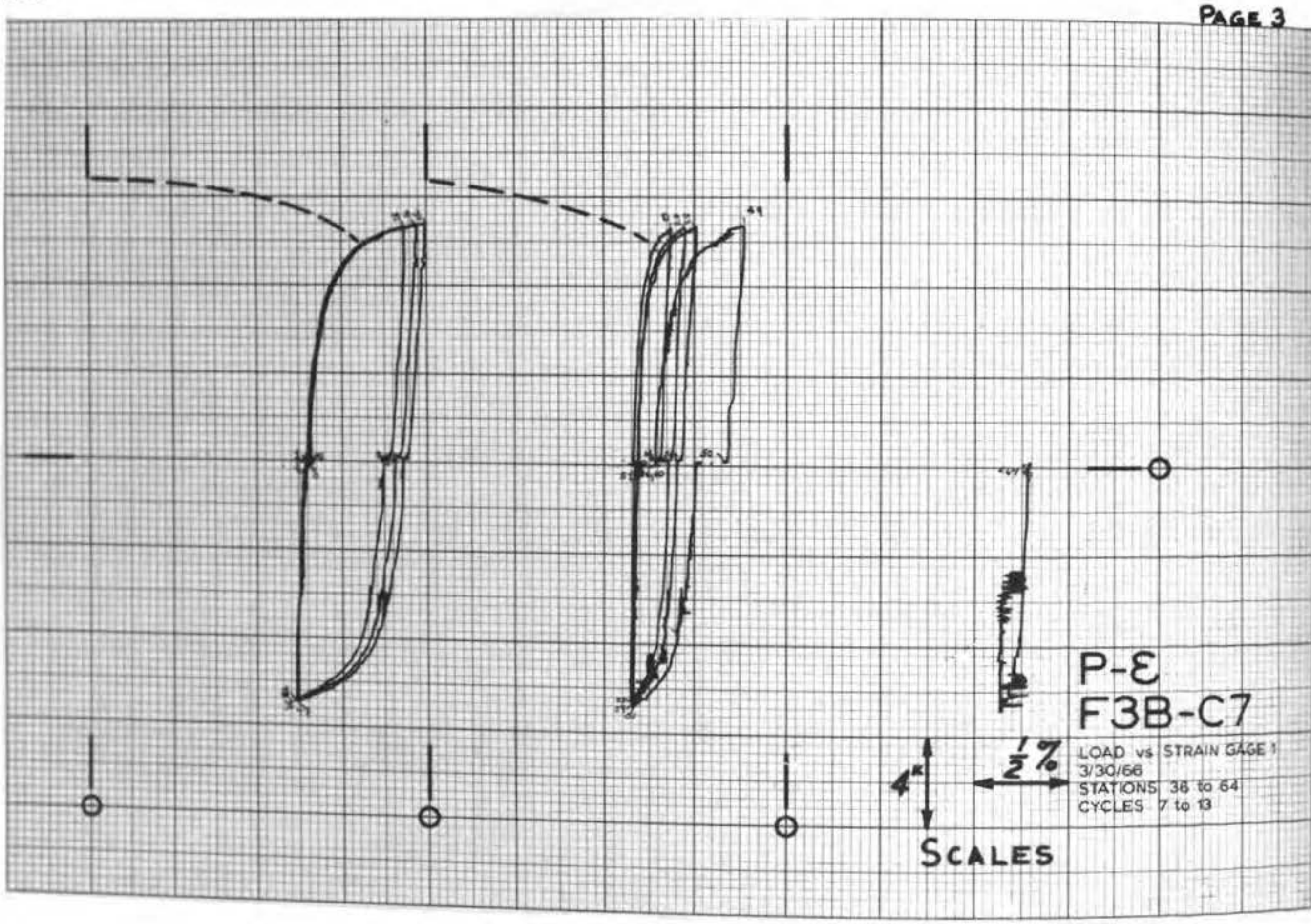
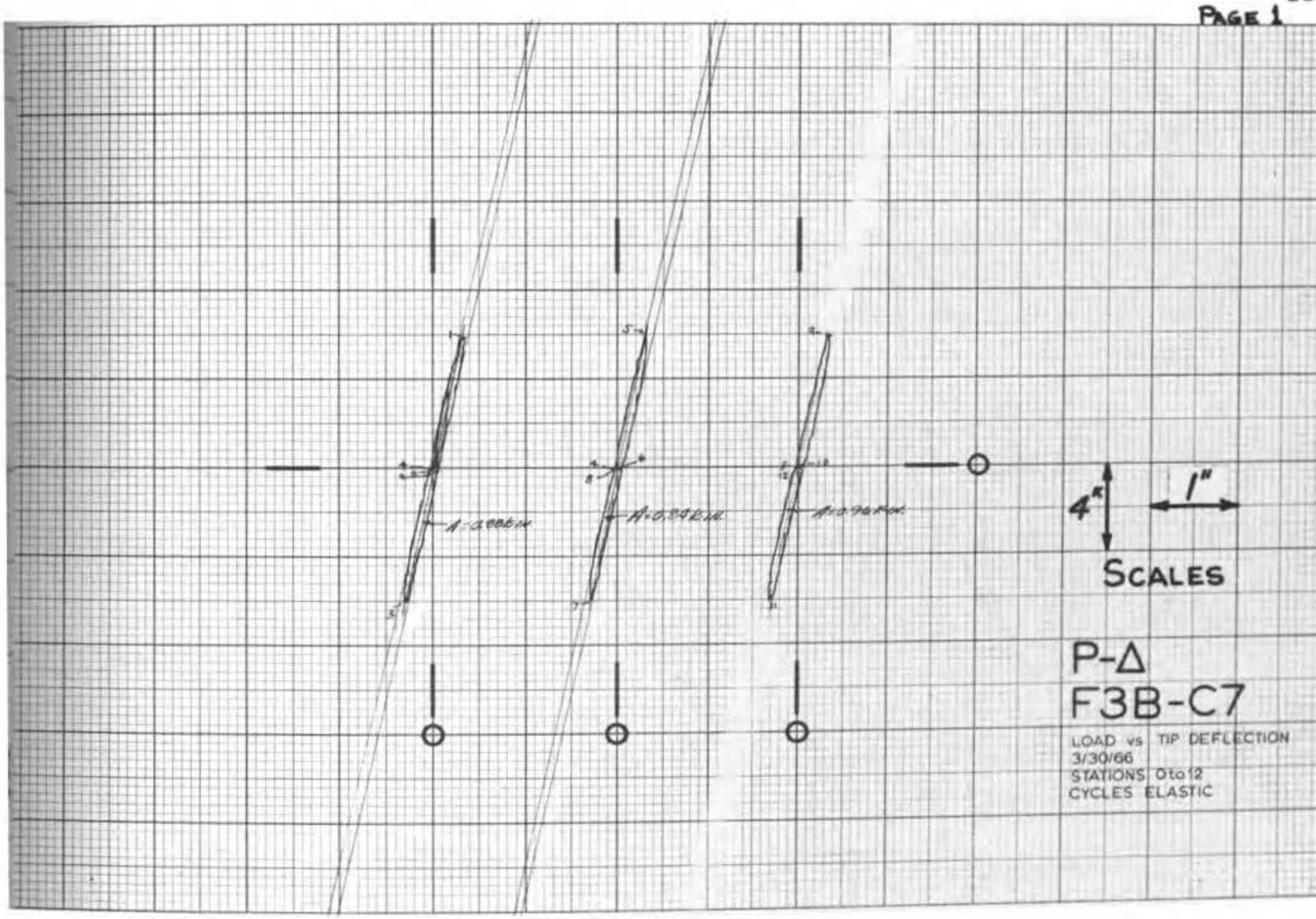


PLATE 20. (continued)

PAGE 1



PAGE 2

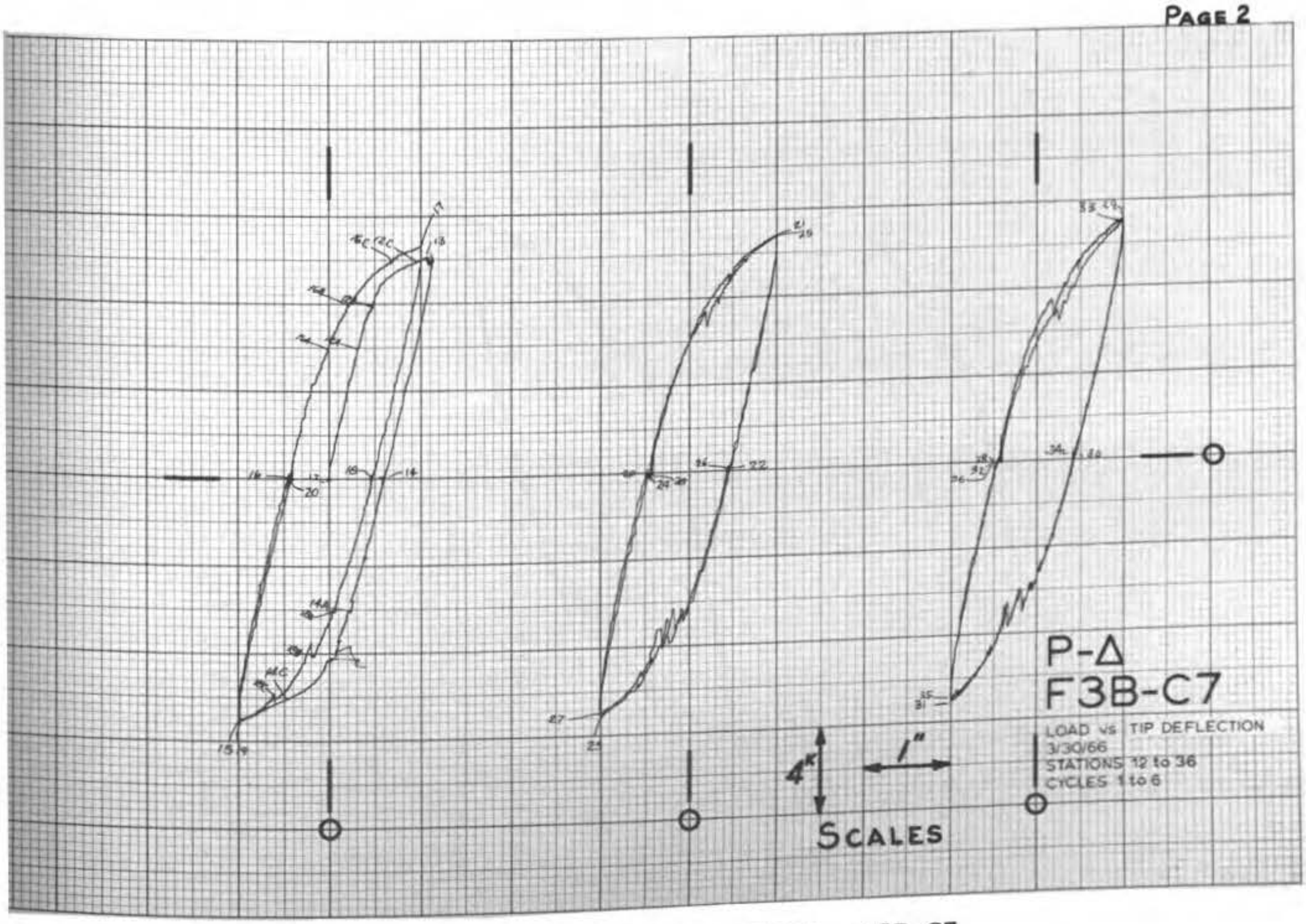
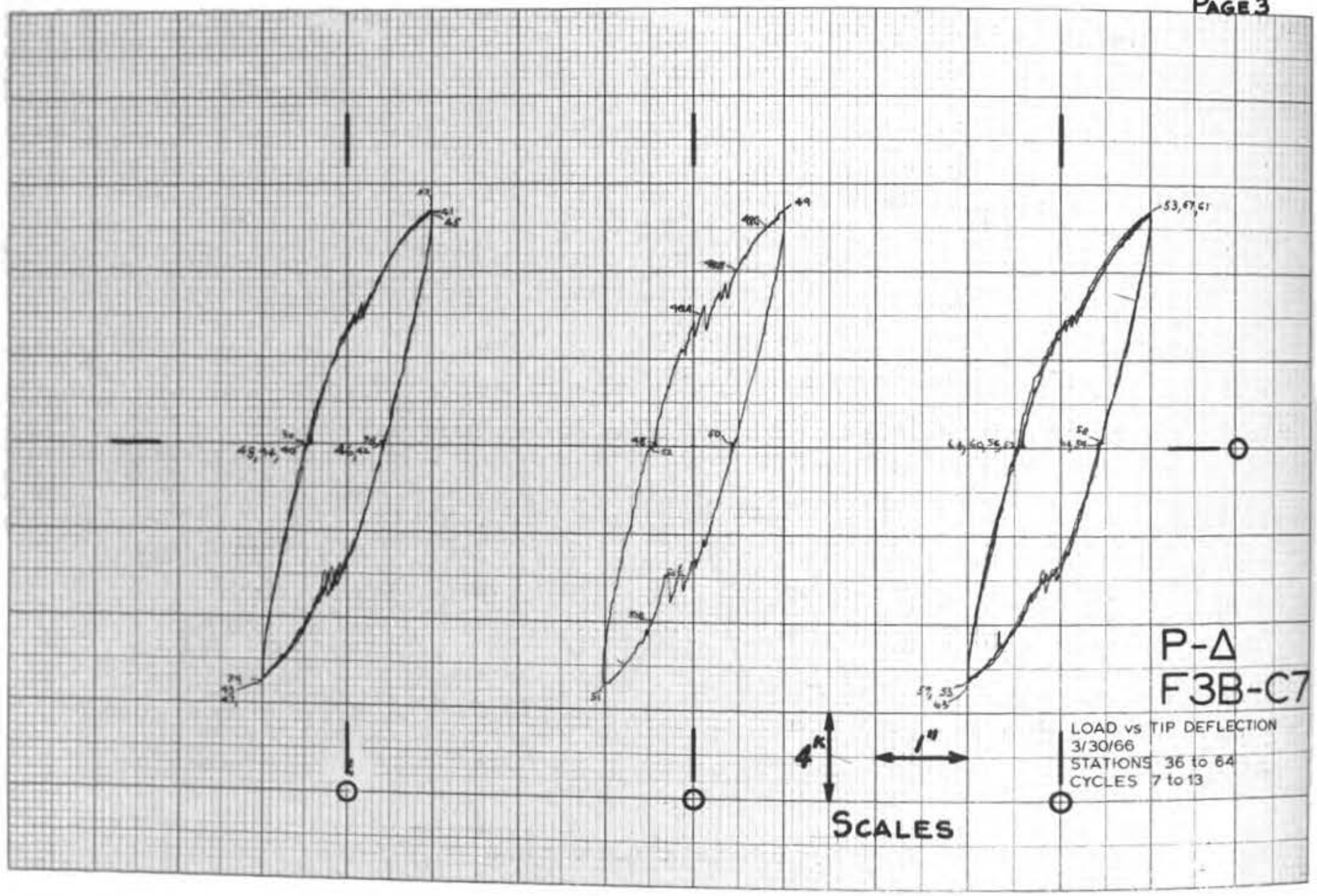
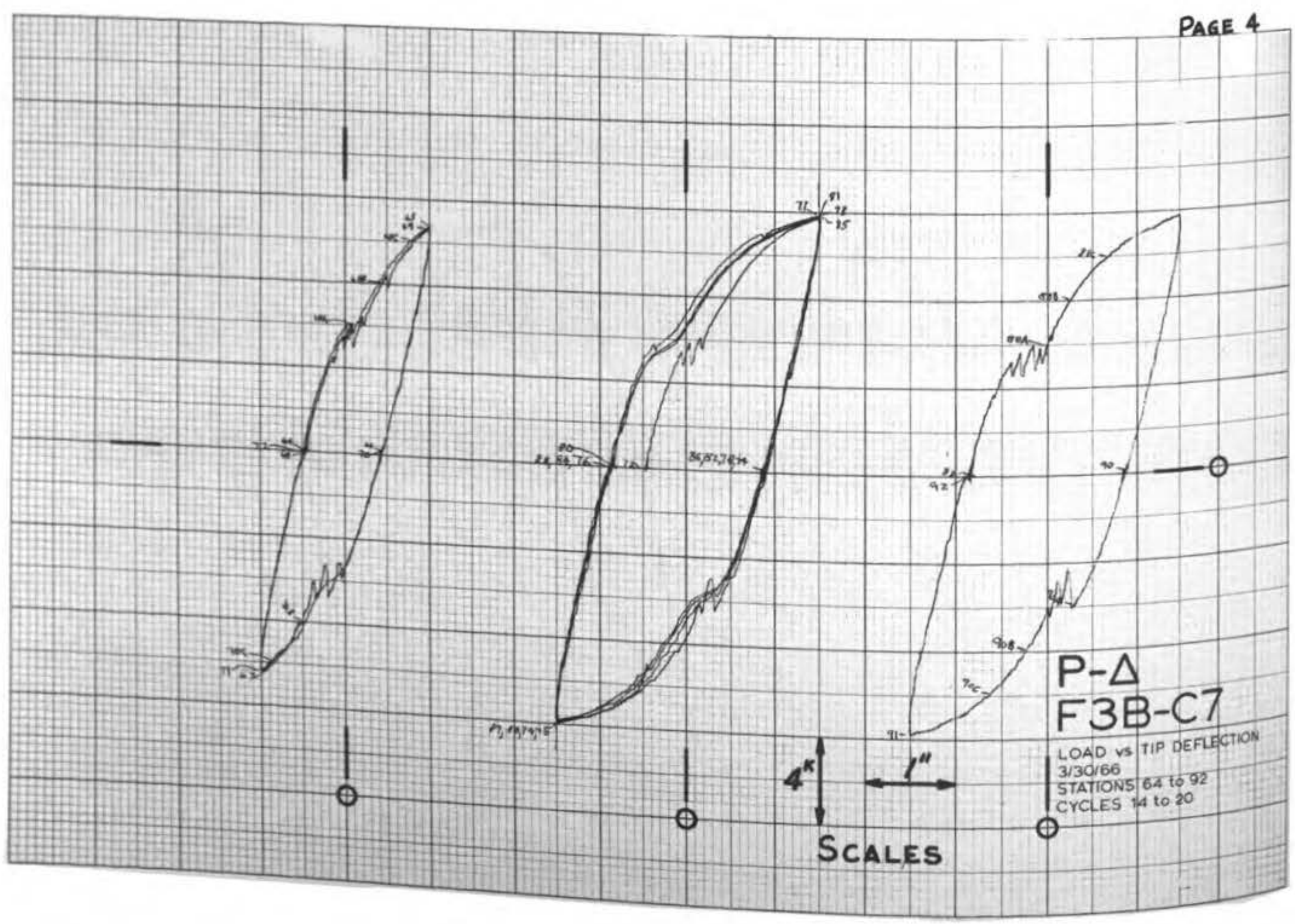
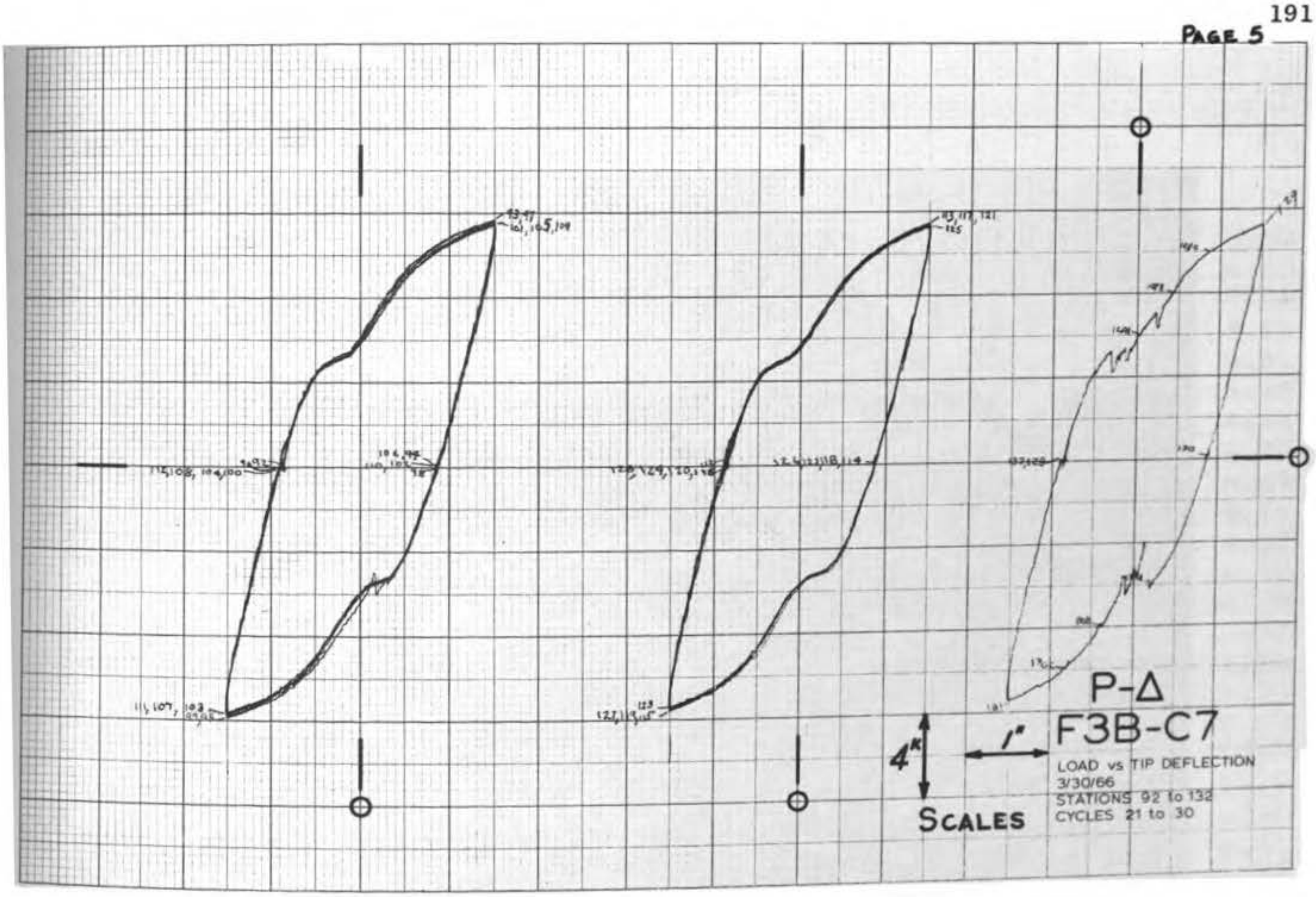


PLATE 21. LOAD VS. DEFLECTION - F3B-C7


PAGE 3
P-Δ
F3B-C7
LOAD vs TIP DEFLECTION
3/30/66
STATIONS 36 to 64
CYCLES 7 to 13
4K
1"
SCALES


PAGE 4
P-Δ
F3B-C7
LOAD vs TIP DEFLECTION
3/30/66
STATIONS 64 to 92
CYCLES 14 to 20
4K
1"
SCALES



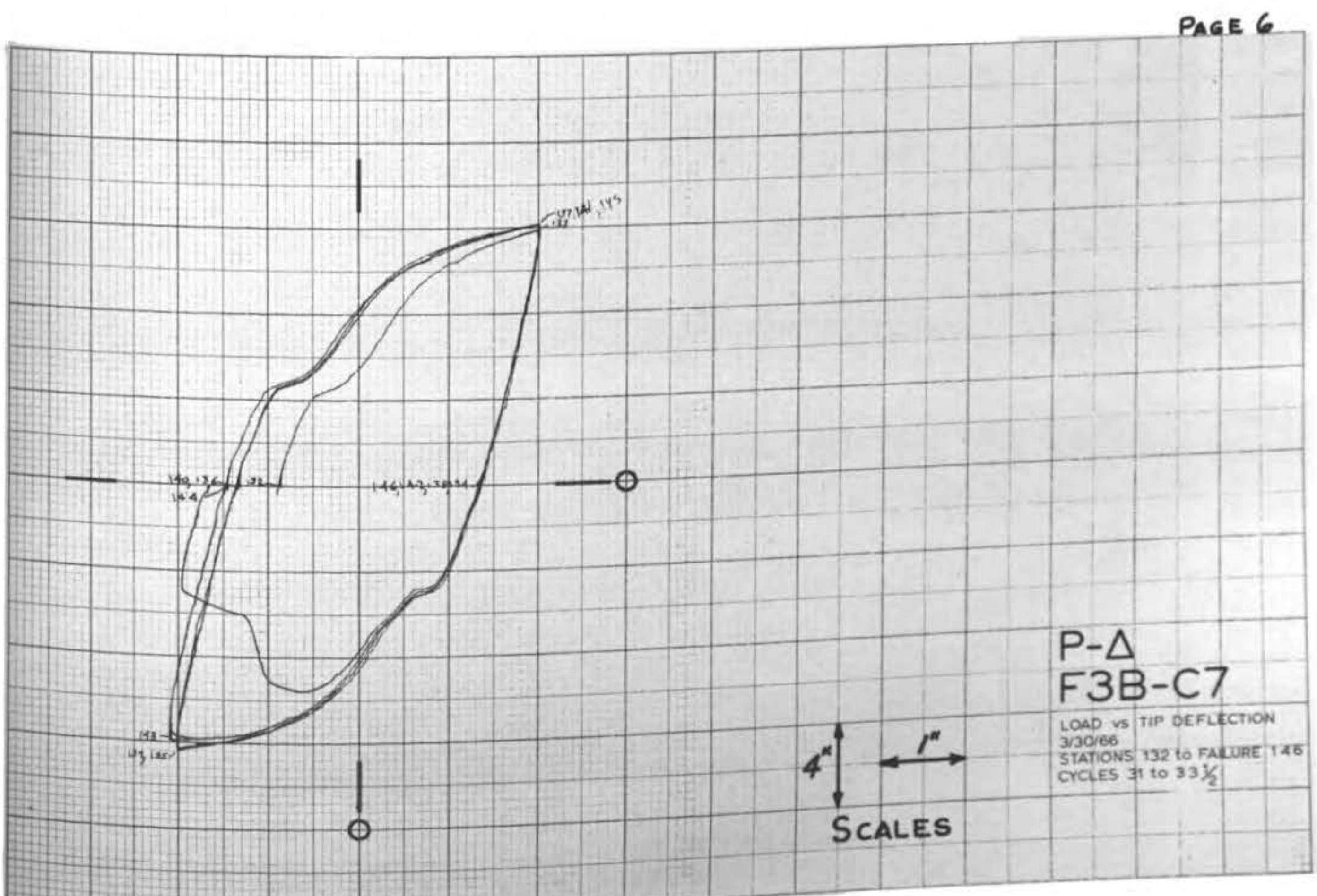


PLATE 21. (continued)

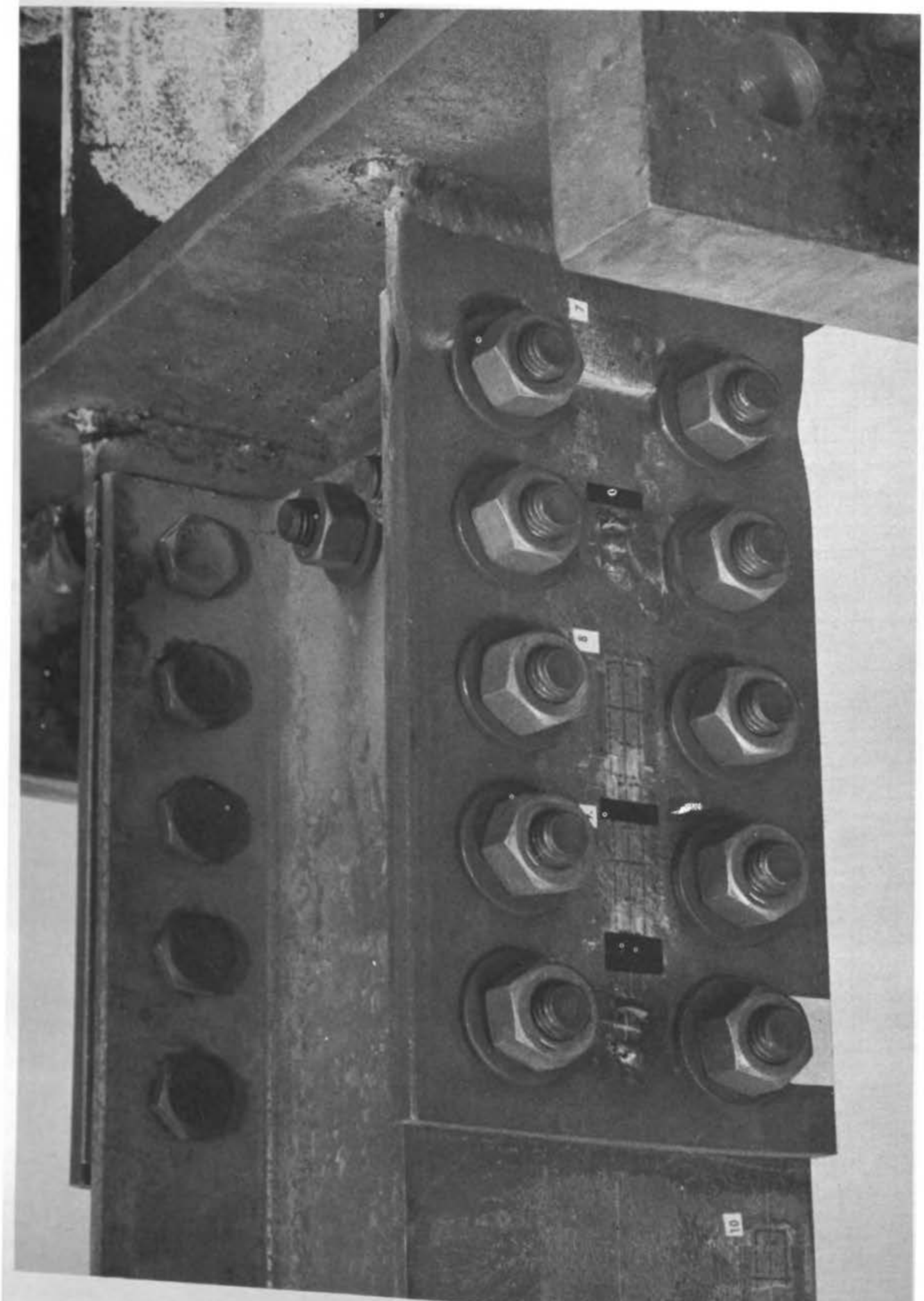


FIGURE 33. F3B–C7

SPECIMEN F38-C7

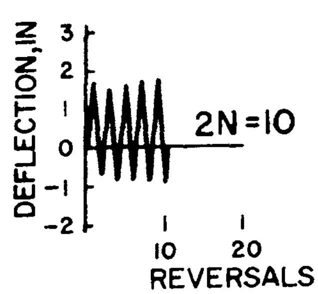
Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	9.28	0.97	0.55	4.7	1.135	2.98	1.68	3.50
2	-10.38	-0.84	0.93	8.7	-1.268	-2.57	2.84	6.55
3	9.96	0.84	0.81	6.8	1.218	2.59	2.48	5.06
4	-10.46	-0.84	0.84	6.8	-1.279	-2.57	2.57	5.13
5	10.01	0.82	0.81	6.2	1.224	2.52	2.48	4.61
6	-10.68	-0.86	0.85	6.3	-1.306	-2.62	2.61	4.69
7	9.98	0.82	0.83	6.2	1.220	2.52	2.54	4.63
8	-10.49	-0.86	0.81	6.3	-1.282	-2.63	2.47	4.75
9	10.43	0.83	0.79	6.2	1.275	2.54	2.42	4.65
10	-10.50	-0.85	0.79	5.5	-1.284	-2.59	2.42	4.11
11	10.27	0.82	0.79	5.4	1.255	2.51	2.42	4.07
12	-10.42	-0.85	0.79	5.5	-1.273	-2.60	2.42	4.12
13	10.15	0.83	0.80	5.5	1.241	2.55	2.45	4.09
14	-10.32	-0.85	0.80	5.6	-1.262	-2.60	2.45	4.22
15	10.09	0.83	0.80	5.5	1.233	2.56	2.45	4.14
16	-10.26	-0.85	0.80	5.6	-1.254	-2.60	2.45	4.20
17	10.01	0.83	0.80	5.5	1.224	2.56	2.45	4.15
18	-10.27	-0.85	0.80	5.6	-1.256	-2.60	2.45	4.17
19	10.07	0.81	0.80	5.6	1.231	2.49	2.45	4.19
20	-10.29	-0.89	0.85	6.2	-1.258	-2.73	2.60	4.68
21	10.03	0.80	0.82	5.4	1.226	2.46	2.51	4.07
22	-10.04	-0.88	0.81	5.8	-1.228	-2.71	2.48	4.36
23	9.95	0.80	0.81	5.2	1.216	2.47	2.48	3.90
24	-10.09	-0.88	0.81	5.8	-1.233	-2.71	2.48	4.38
25	9.88	0.81	0.81	5.2	1.208	2.47	2.48	3.89
26	-10.18	-0.88	0.81	5.8	-1.244	-2.70	2.48	4.35
27	10.02	0.78	0.80	6.0	1.225	2.40	2.45	4.48
28	-10.01	-0.90	0.83	5.6	-1.223	-2.77	2.54	4.22
29	9.97	0.79	0.83	5.3	1.218	2.41	2.54	3.99
30	-9.84	-0.91	0.83	5.6	-1.203	-2.78	2.54	4.20
31	11.08	1.26	1.29	10.5	1.354	3.86	3.95	7.87
32	-11.45	-1.39	1.71	11.0	-1.400	-4.27	5.24	8.25
33	11.17	1.26	1.70	14.0	1.366	3.85	5.21	10.50
34	-11.50	-1.39	1.69	14.5	-1.406	-4.27	5.18	10.84
35	11.10	1.26	1.66	13.2	1.357	3.85	5.09	9.91
36	-11.39	-1.39	1.66	13.9	-1.392	-4.27	5.09	10.42
37	11.10	1.26	1.64	13.0	1.357	3.85	5.03	9.72
38	-11.32	-1.39	1.63	13.7	-1.384	-4.27	4.99	10.27
39	11.11	1.23	1.62	12.8	1.358	3.76	4.96	9.61
40	-11.25	-1.42	1.67	13.1	-1.375	-4.37	5.12	9.84
41	11.03	1.21	1.66	12.7	1.348	3.70	5.09	9.52
42	-11.29	-1.44	1.68	13.5	-1.380	-4.43	5.15	10.15
43	10.96	1.21	1.68	12.6	1.340	3.71	5.15	9.45
44	-11.24	-1.44	1.68	13.2	-1.374	-4.43	5.15	9.89
45	10.90	1.21	1.68	12.5	1.333	3.71	5.15	9.40
46	-11.13	-1.45	1.68	13.0	-1.361	-4.43	5.15	9.76
47	10.81	1.21	1.68	12.3	1.322	3.72	5.15	9.23
48	-11.08	-1.45	1.68	13.7	-1.354	-4.43	5.15	10.26
49	10.83	1.21	1.68	12.3	1.324	3.72	5.15	9.24
50	-11.08	-1.45	1.68	12.8	-1.355	-4.43	5.15	9.60
51	10.77	1.17	1.64	12.0	1.317	3.60	5.03	9.03

Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
52	-11.03	-1.49	1.65	12.3	-1.348	-4.56	5.06	9.21
53	10.74	1.17	1.65	12.0	1.313	3.60	5.06	8.99
54	-10.95	-1.49	1.66	12.2	-1.339	-4.57	5.09	9.14
55	10.65	1.17	1.66	11.7	1.302	3.60	5.09	8.79
56	-10.88	-1.49	1.67	11.9	-1.330	-4.57	5.12	8.96
57	10.65	1.17	1.67	11.6	1.302	3.60	5.12	8.69
58	-10.87	-1.49	1.68	12.2	-1.329	-4.57	5.15	9.14
59	10.58	1.15	1.64	11.7	1.294	3.51	5.03	8.76
60	-10.87	-1.53	1.67	12.3	-1.329	-4.69	5.12	9.26
61	11.23	1.61	2.18	16.9	1.373	4.95	6.68	12.66
62	-11.79	-2.04	2.67	23.4	-1.441	-6.24	8.18	17.53
63	11.50	1.62	2.62	21.5	1.406	4.97	8.03	16.13
64	-11.75	-2.04	2.62	22.6	-1.436	-6.24	8.03	16.98
65	11.51	1.62	2.61	21.2	1.407	4.97	8.00	15.87
66	-11.15	-2.12	2.72	23.2	-1.363	-6.51	8.34	17.38
67	11.51	1.62	2.72	22.3	1.407	4.97	8.34	16.71

SPECIMEN W1-C1

Description: The beam was indirectly connected to the web of the column through two short flange plates and a web plate. The flange plates were fitted as column stiffeners and were welded to the column web and flanges. The free edges were flush with the edges of the column flanges. The beam flanges were butt-welded to the free edges of the plates. The web plate served also as an erection clip, extending past the edges of the flanges, and the beam web was fillet-welded to it. There was no visually apparent departure from the detail drawings in the specimen as delivered. No significant weld defects were detected by means of ultrasonic inspection. Threaded studs were tack-welded to both flanges to support rotation measuring devices.

Program of Cycling:



Test Control: Strain, as measured in the center of the top flange 7.50 inches from the face of the column web.

Raw Data Included: Graphical load-control strain data.
Graphical load-deflection data.

Total Energy Absorption: 129 kip-inches.

Plastic Load Reversals to Failure: 10 (5 cycles).

Remarks: At the 5th cycle, inspection showed a deep crack at one edge of the top flange weld next to the connecting plate. On the second half of the same cycle, a crack could be clearly seen on the other end of the same weld. The butt-weld of the top flange failed at the beginning of the 6th cycle.

The failure revealed that the butt weld had penetrated to only about one-half the thickness of the flange.

SPECIMEN TYPE W1-C1

DIMENSIONS OF WF SECTION

DEPTH	8.26	INCHES
TOP FLANGE WIDTH	5.170	INCHES
BOTTOM FLANGE WIDTH	5.170	INCHES
TOP FLANGE THICKNESS	0.368	INCHES
BOTTOM FLANGE THICKNESS	0.376	INCHES
WEB THICKNESS	0.280	INCHES
ELASTIC MODULUS	29000.	KSI
YIELD STRESS	40.500	KSI

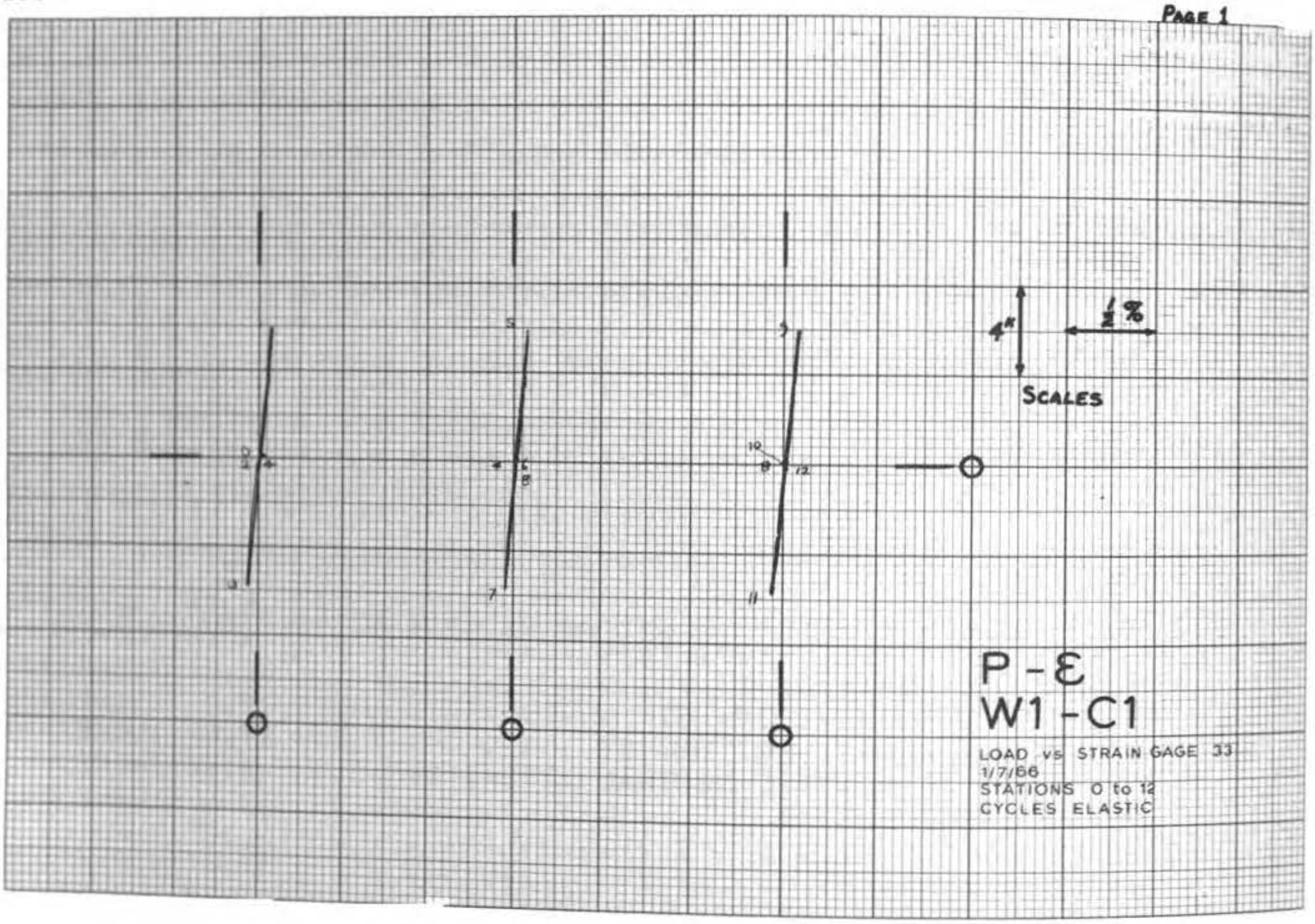
WF SECTION PROPERTIES

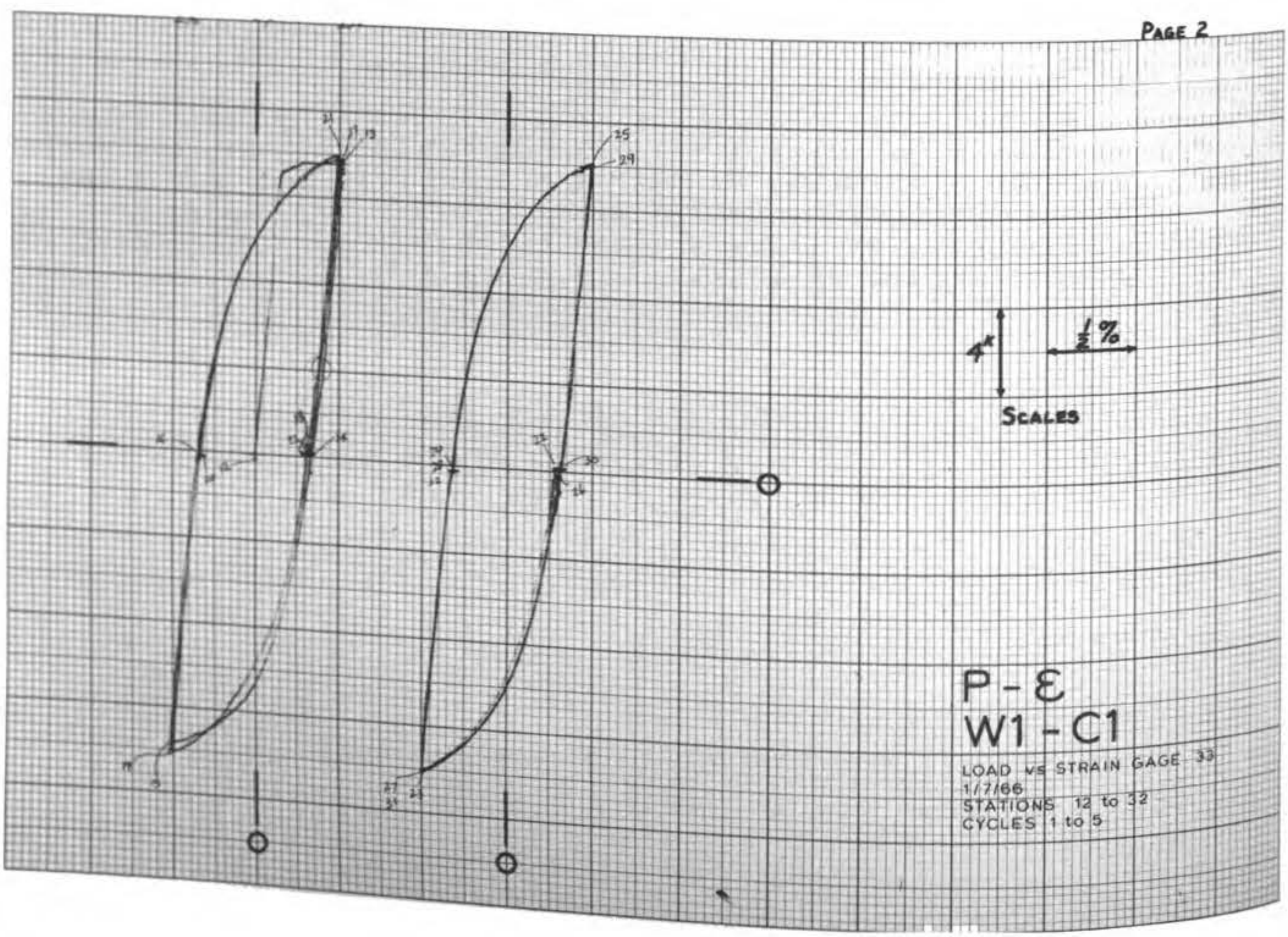
AREA, A	6.04	INCHES**2
LOCATION OF CENTROID*, YE	4.10	INCHES
MOMENT OF INERTIA, I	70.9	INCHES**4
SECTION MODULUS, TOP, ST	17.1	INCHES**3
SECTION MODULUS, BOTTOM, SB	17.3	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.06	INCHES
PLASTIC MODULUS, Z	19.4	INCHES**3
SHAPE FACTOR	1.138	
YIELD MOMENT, MY	57.60	KIP-FT.
PLASTIC MOMENT, MP	65.57	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

BEAM PROPERTIES

LENGTH, L	66.1	INCHES
ELASTIC STIFFNESS, P/DELTA	21.34	KIPS/IN.
YIELD DEFLECTION, DELTAY	0.490	INCHES
YIELD LOAD, PY	10.46	KIPS
PLASTIC LOAD, PP	11.90	KIPS


PAGE 1
4"
1/2 %
SCALES
P - ε
W1 - C1
LOAD vs STRAIN GAGE 33
1/7/66
STATIONS 0 to 12
CYCLES ELASTIC


PAGE 2
4"
1/2 %
SCALES
P - ε
W1 - C1
LOAD vs STRAIN GAGE 33
1/7/66
STATIONS 12 to 32
CYCLES 1 to 5

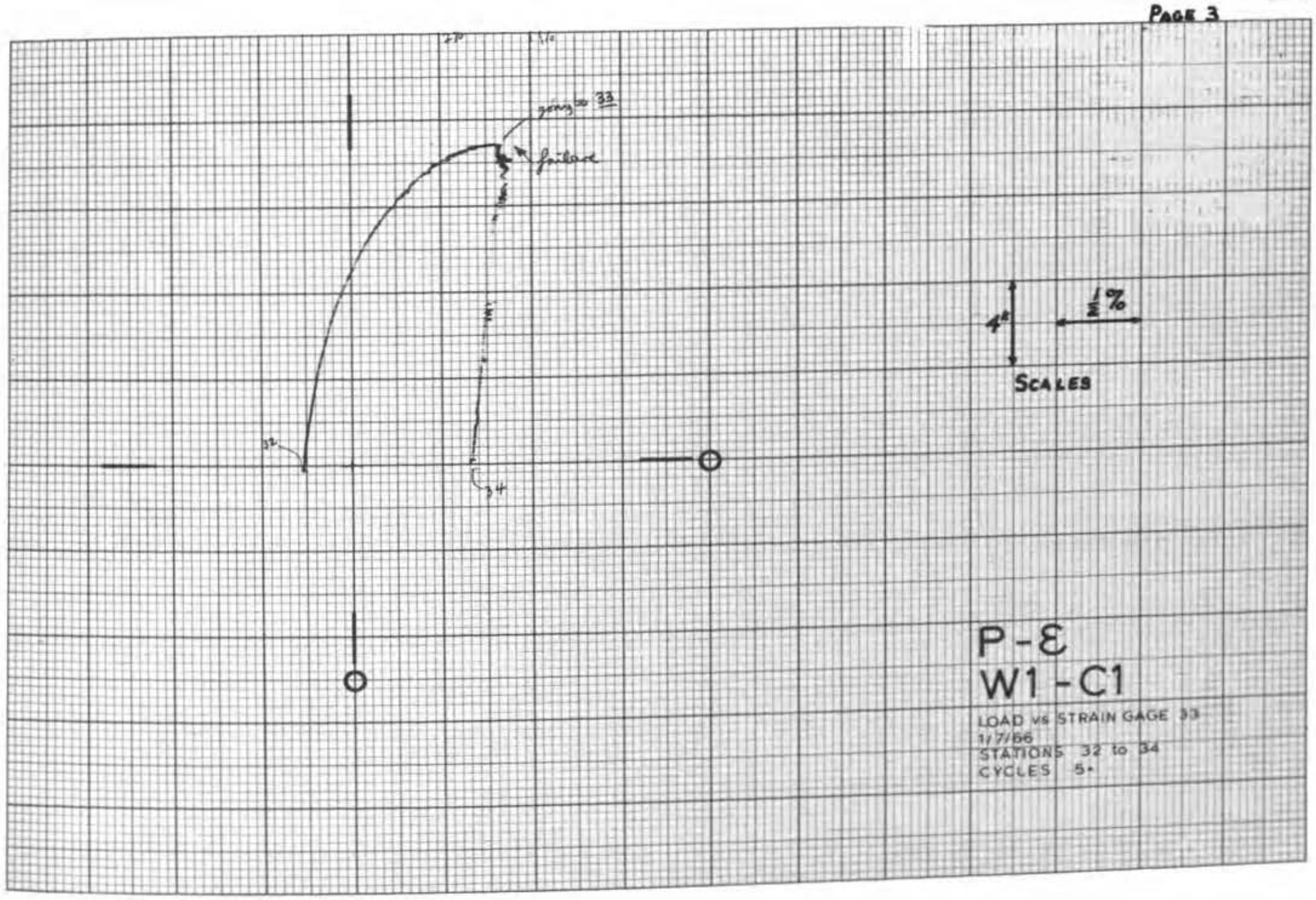
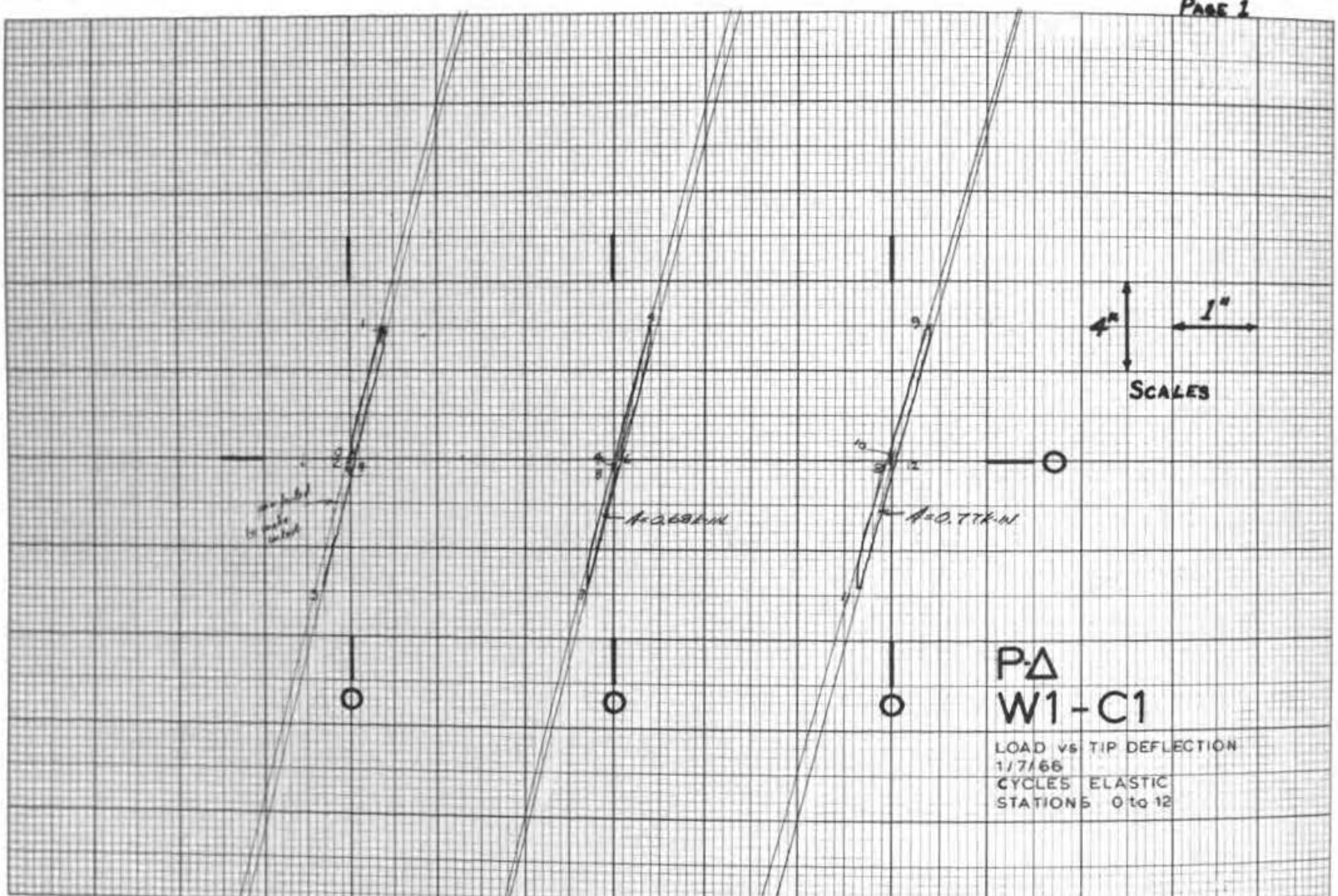


PLATE 22. (continued)



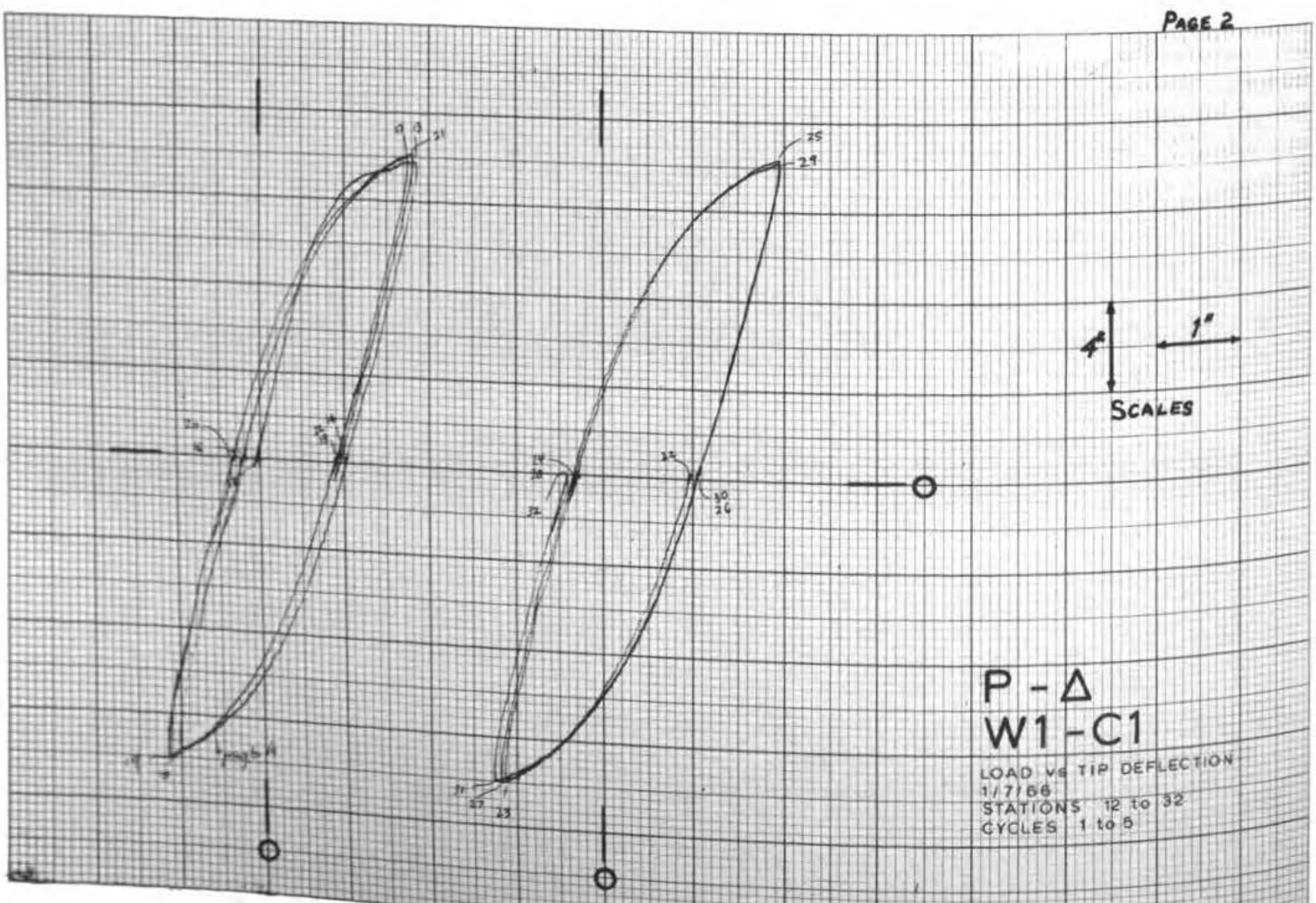


PLATE 23. LOAD VS. DEFLECTION - W1-C1

PAGE 3

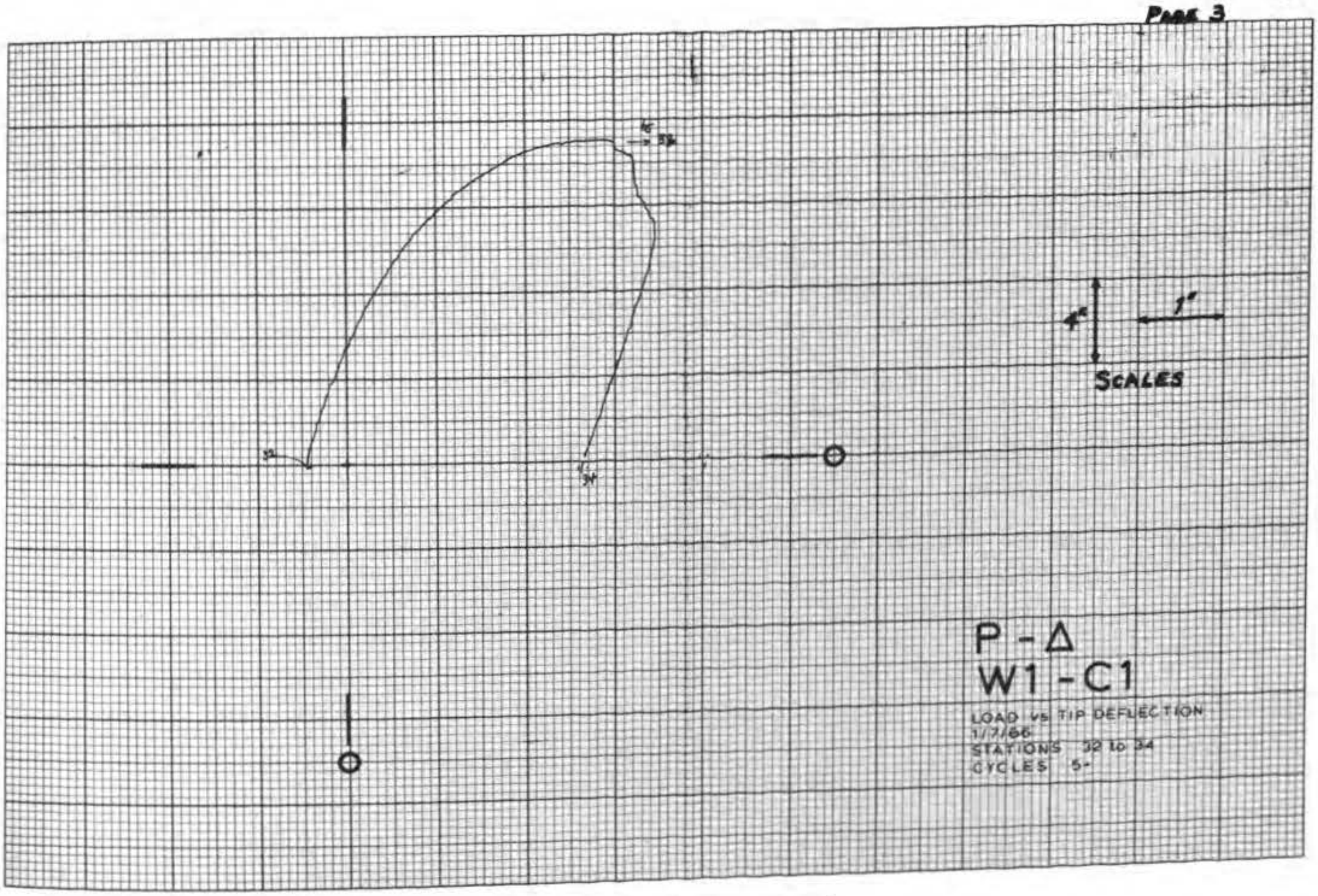


PLATE 23. (continued)

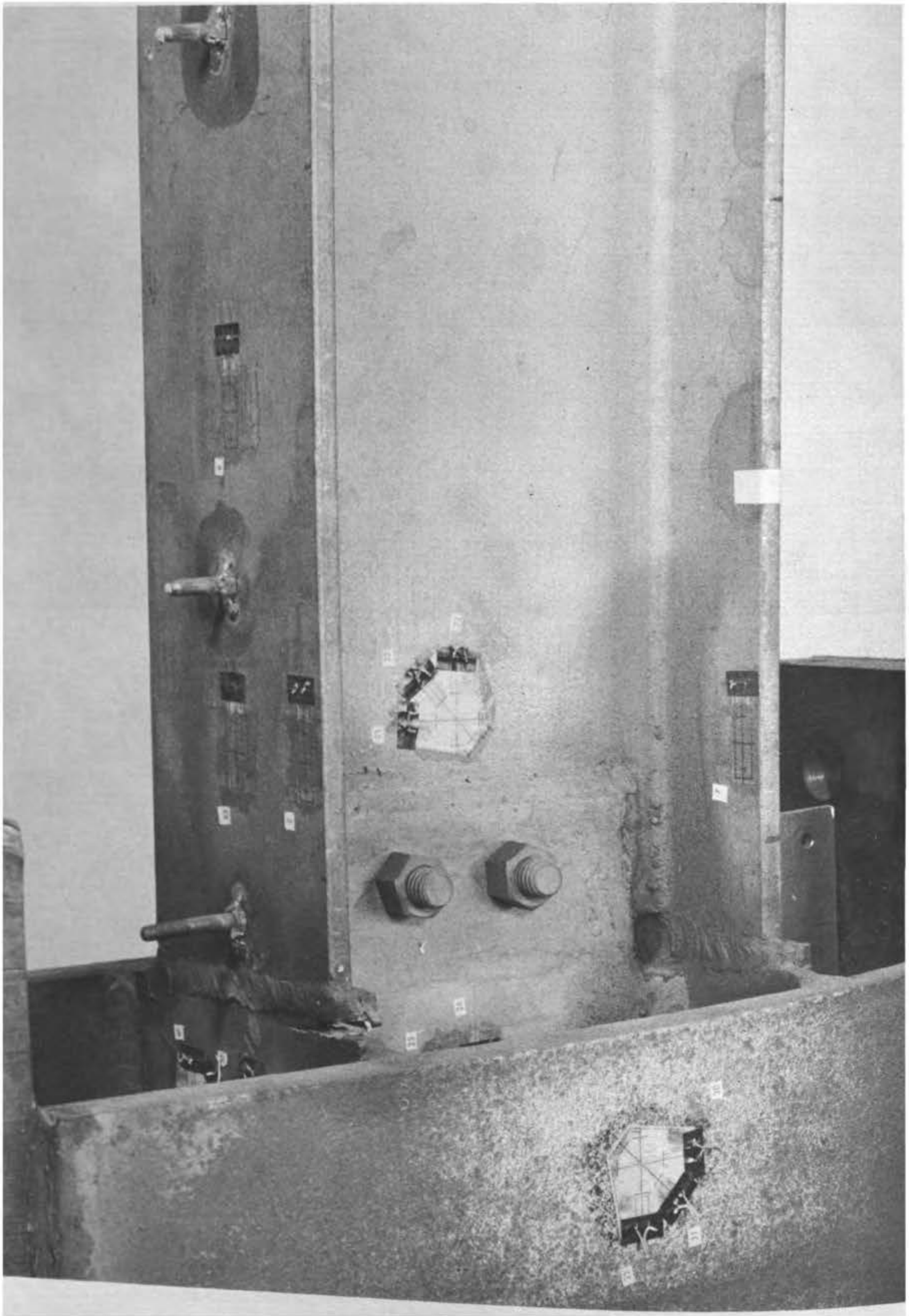


FIGURE 34. W1-C1

SPECIMEN W1-C1

Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	13.43	1.67	1.11	12.4	1.129	3.00	1.99	3.75
2	-13.26	-0.71	1.14	12.0	-1.114	-1.28	2.05	3.62
3	13.63	1.56	1.02	11.4	1.145	2.79	1.84	3.44
4	-13.65	-0.85	1.13	12.3	-1.147	-1.52	2.04	3.70
5	13.79	1.62	1.18	12.6	1.159	2.91	2.12	3.81
6	-13.60	-0.84	1.18	12.5	-1.143	-1.50	2.11	3.76
7	13.96	1.74	1.25	13.8	1.173	3.12	2.23	4.16
8	-13.67	-0.90	1.28	13.6	-1.149	-1.61	2.29	4.10
9	13.84	1.74	1.28	14.1	1.163	3.13	2.29	4.25
10	-13.62	-0.98	1.35	14.6	-1.145	-1.75	2.41	4.41

SPECIMEN W1-C4

Description: This specimen was similar to specimen W1-C1 with respect to detailing, fabrication and inspection.

Program of Cycling: 2N = 1

Inasmuch as the specimen failed during the first cycle, no cycling diagram is presented.

Test Control: Strain, as measured in the center of the top flange 7.54 inches from the face of the column web.

Raw Data Included: Graphical load-deflection data.

Total Energy Absorbed: Not measured.

Plastic Load Reversals to Failure: 1 ($\frac{1}{2}$ cycle)

Remarks: Sudden failure of the entire bottom flange butt-weld occurred in the second half of the first plastic cycle. The failure revealed that the bottom flange had been beveled only to approximately one-half of its thickness and that there had been no root opening at all. Except for the end returns, the weld had penetrated uniformly to about half the flange thickness, instead of being a full-penetration butt-weld as specified.

SPECIMEN TYPE W1-C4

DIMENSIONS OF WF SECTION

DEPTH	8.26 INCHES
TOP FLANGE WIDTH	5.175 INCHES
BOTTOM FLANGE WIDTH	5.177 INCHES
TOP FLANGE THICKNESS	0.367 INCHES
BOTTOM FLANGE THICKNESS	0.378 INCHES
WEB THICKNESS	0.281 INCHES
ELASTIC MODULUS	29000. KSI
YIELD STRESS	40.500 KSI

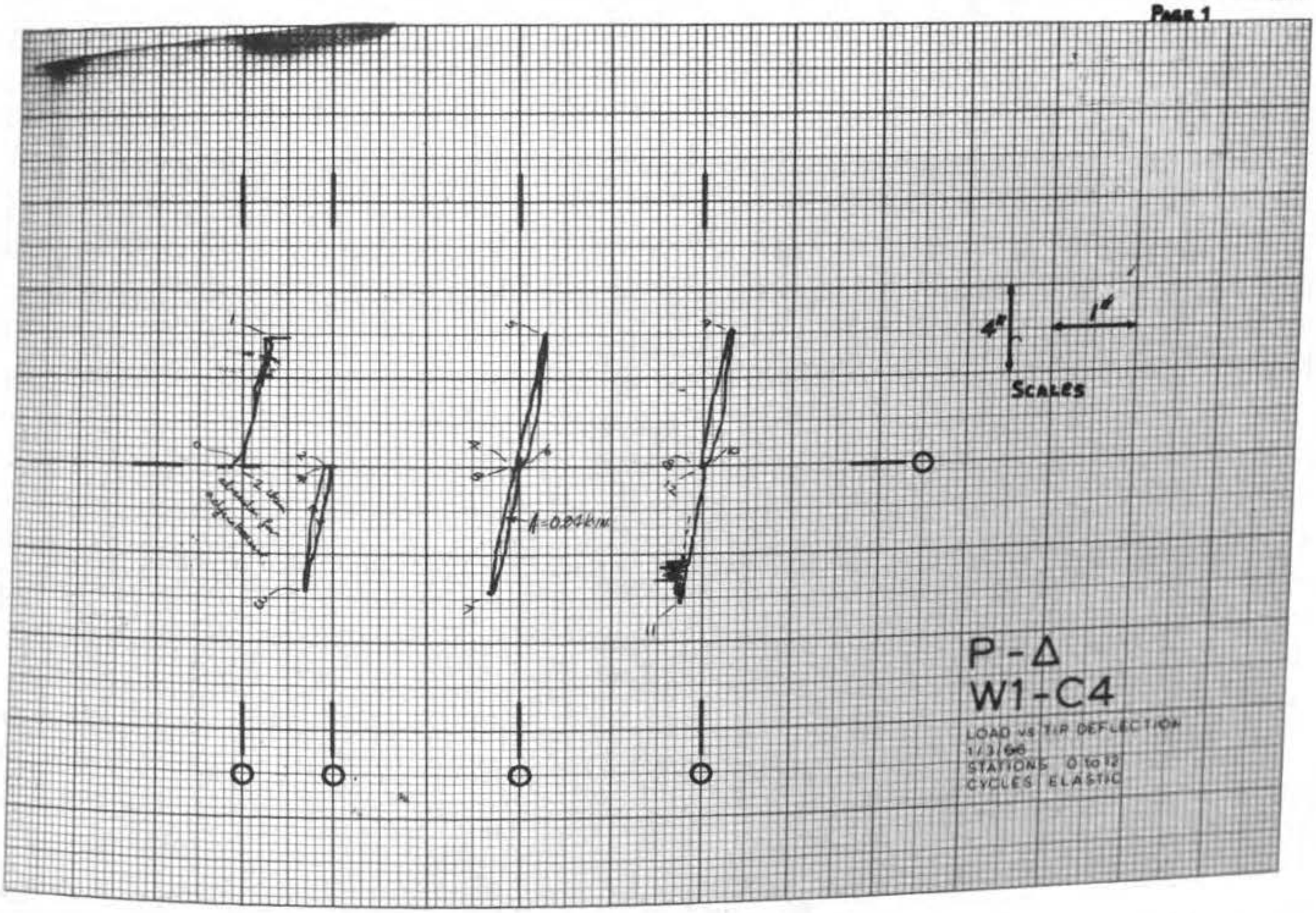
WF SECTION PROPERTIES

AREA, A	6.06 INCHES**2
LOCATION OF CENTROID*, YE	4.10 INCHES
MOMENT OF INERTIA, I	71.2 INCHES**4
SECTION MODULUS, TOP, ST	17.1 INCHES**3
SECTION MODULUS, BOTTOM, SB	17.4 INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.04 INCHES
PLASTIC MODULUS, Z	19.5 INCHES**3
SHAPE FACTOR	1.141
YIELD MOMENT, MY	57.72 KIP-FT.
PLASTIC MOMENT, MP	65.84 KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

BEAM PROPERTIES

LENGTH, L	66.3 INCHES
ELASTIC STIFFNESS, P/DELTA	21.29 KIPS/IN.
YIELD DEFLECTION, DELTAY	0.491 INCHES
YIELD LOAD, PY	10.45 KIPS
PLASTIC LOAD, PP	11.92 KIPS



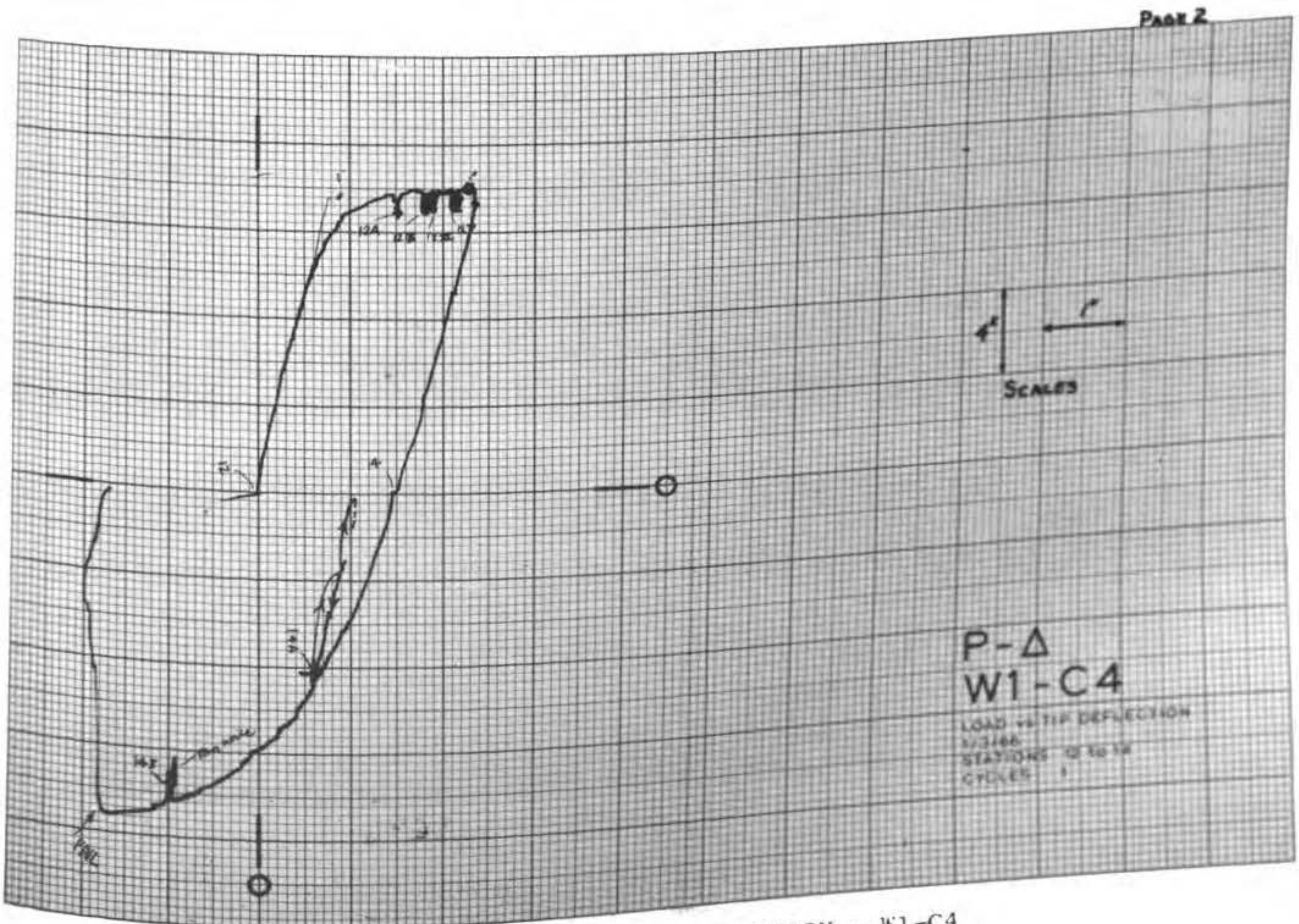


PLATE 24. LOAD VS. DEFLECTION - W1-C4

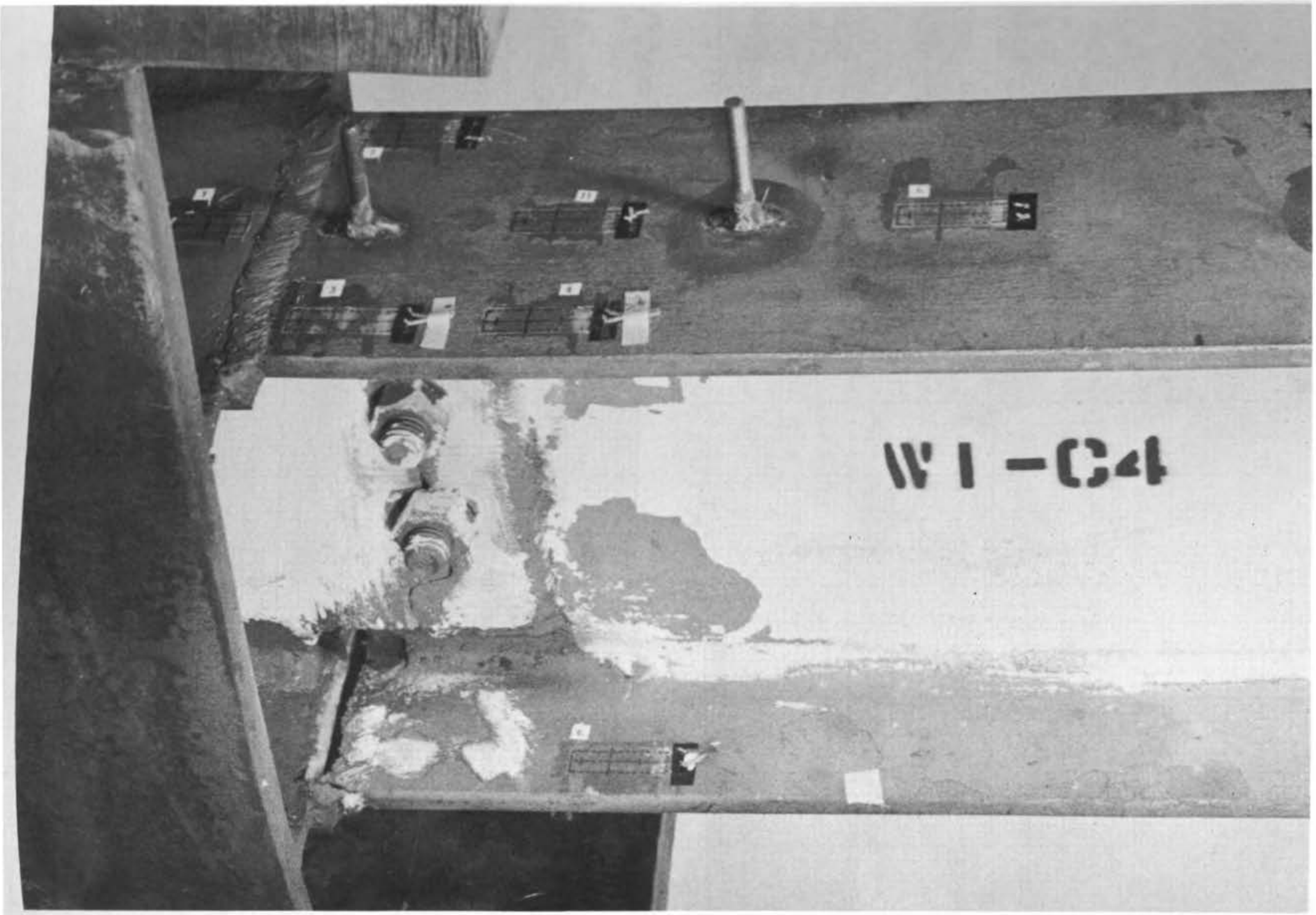
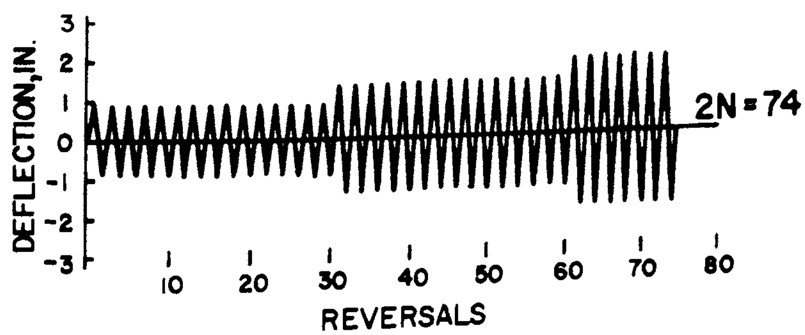


FIGURE 35. W1–C4

SPECIMEN W1-C7

Description: This specimen was similar to specimen W1-C1 except as follows. The only visually apparent departure from the detail drawing was that the web connection plate was centered in the column web, with the result that the beam was off-center relative to the vertical center-line of the column. The specimen was commercially fabricated, and professional inspection was conducted throughout fabrication. Ultrasonic inspection of the finished welds indicated a two-inch flaw in a stiffener to column flange weld. The weld was repaired, and no further significant defects were found.

Program of Cycling:



Test Control: Tip deflection.

Raw Data Included: Graphical load-strain data with strain measured in the center of the bottom flange 5.05 inches from the face of the column web.

Graphical load-deflection data.

Total Energy Absorption: 926 kip-inches.

Plastic Load Reversals to Failure: 74 (37 cycles).

<u>Remarks</u>: Buckling of the bottom flange became evident during the 18th plastic cycle. At the end of the 20th cycle, a crack 1/16 inch long appeared at the edge of the top weld in the middle of the flange. One cycle later a fine crack appeared at the end of the same weld. This was followed by a similar crack at the bottom flange weld. After the 28th cycle, and more noticeably during the 33rd cycle, the edge crack at the top flange slowly propagated. At about the same time, some buckling of the top flange also became apparent. Failure occurred when the top flange crack rapidly propagated into the connecting plate.

SPECIMEN TYPE W1-C7

DIMENSICNS CF WF SECTION

DEPTH	8.18 INCHES
TOP FLANGE WIDTH	5.340 INCHES
BOTTOM FLANGE WIDTH	5.340 INCHES
TOP FLANGE THICKNESS	0.353 INCHES
BOTTOM FLANGE THICKNESS	0.354 INCHES
WEB THICKNESS	0.260 INCHES
ELASTIC MODULUS	29200. KSI
YIELD STRESS	44.100 KSI

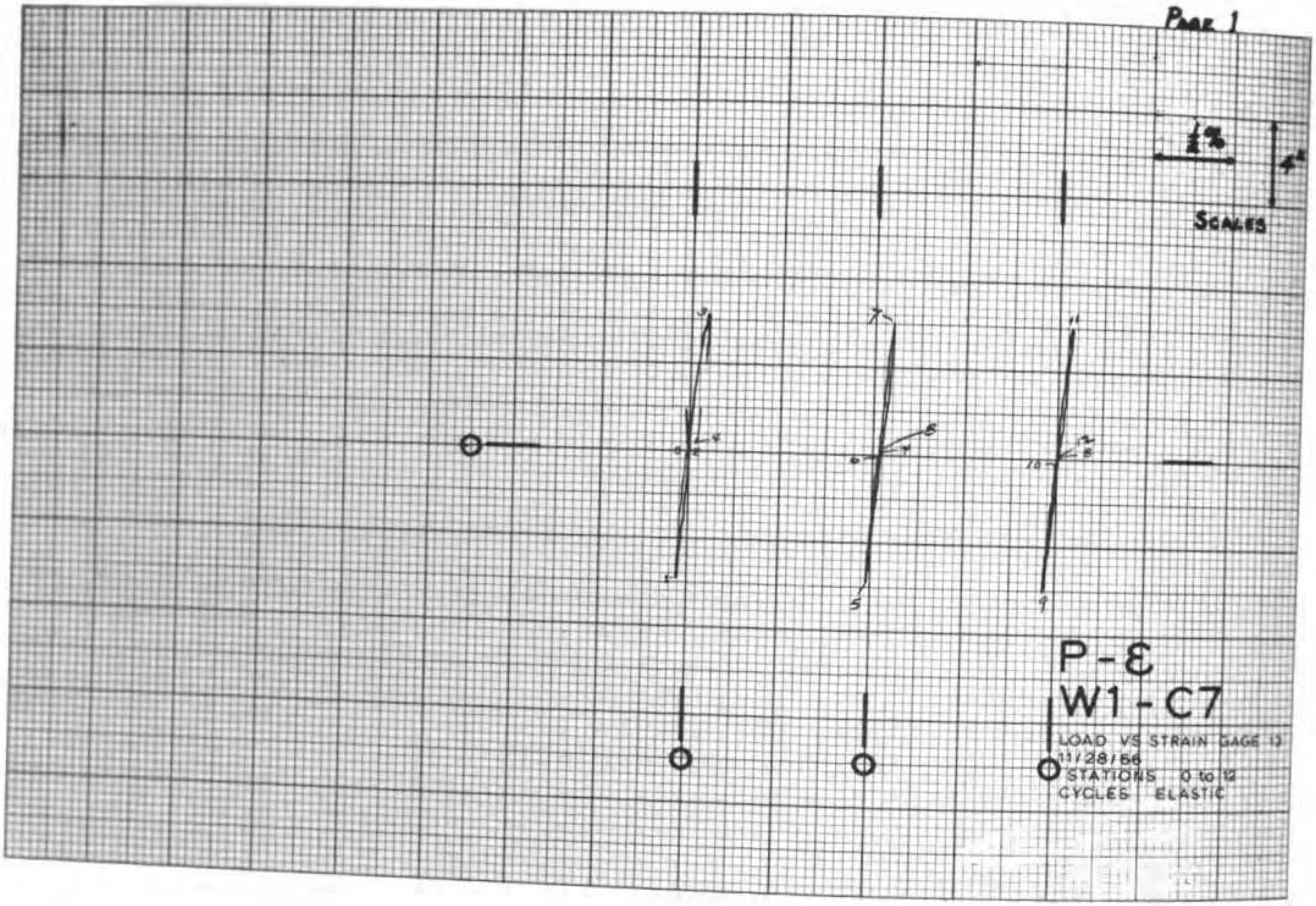
WF SECTICN PRCPERTIES

AREA, A	5.81 INCHES**2
LOCATION OF CENTROID*, YE	4.09 INCHES
MOMENT OF INERTIA, I	68.1 INCHES**4
SECTION MODULUS, TOP, ST	16.6 INCHES**3
SECTION MODULUS, BOTTOM, SB	16.7 INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.08 INCHES
PLASTIC MODULUS, Z	18.7 INCHES**3
SHAPE FACTOR	1.126
YIELD MOMENT, MY	61.12 KIP-FT.
PLASTIC MOMENT, MP	68.82 KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

BEAM PRCPERTIES

LENGTH, L	66.2 INCHES
ELASTIC STIFFNESS, P/DELTA	20.57 KIPS/IN.
YIELD DEFLECTION, DELTAY	0.539 INCHES
YIELD LOAD, PY	11.08 KIPS
PLASTIC LOAD, PP	12.48 KIPS



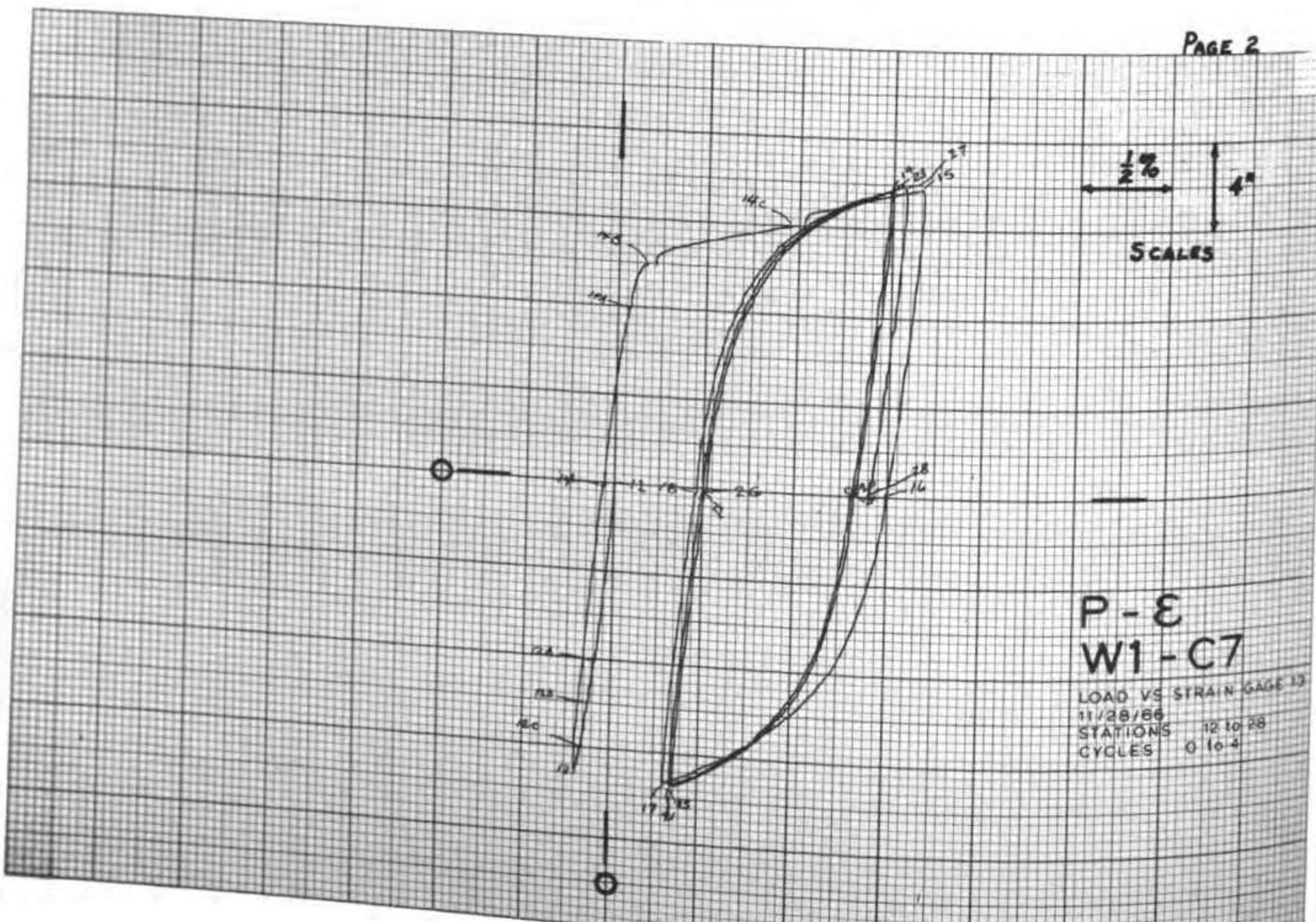
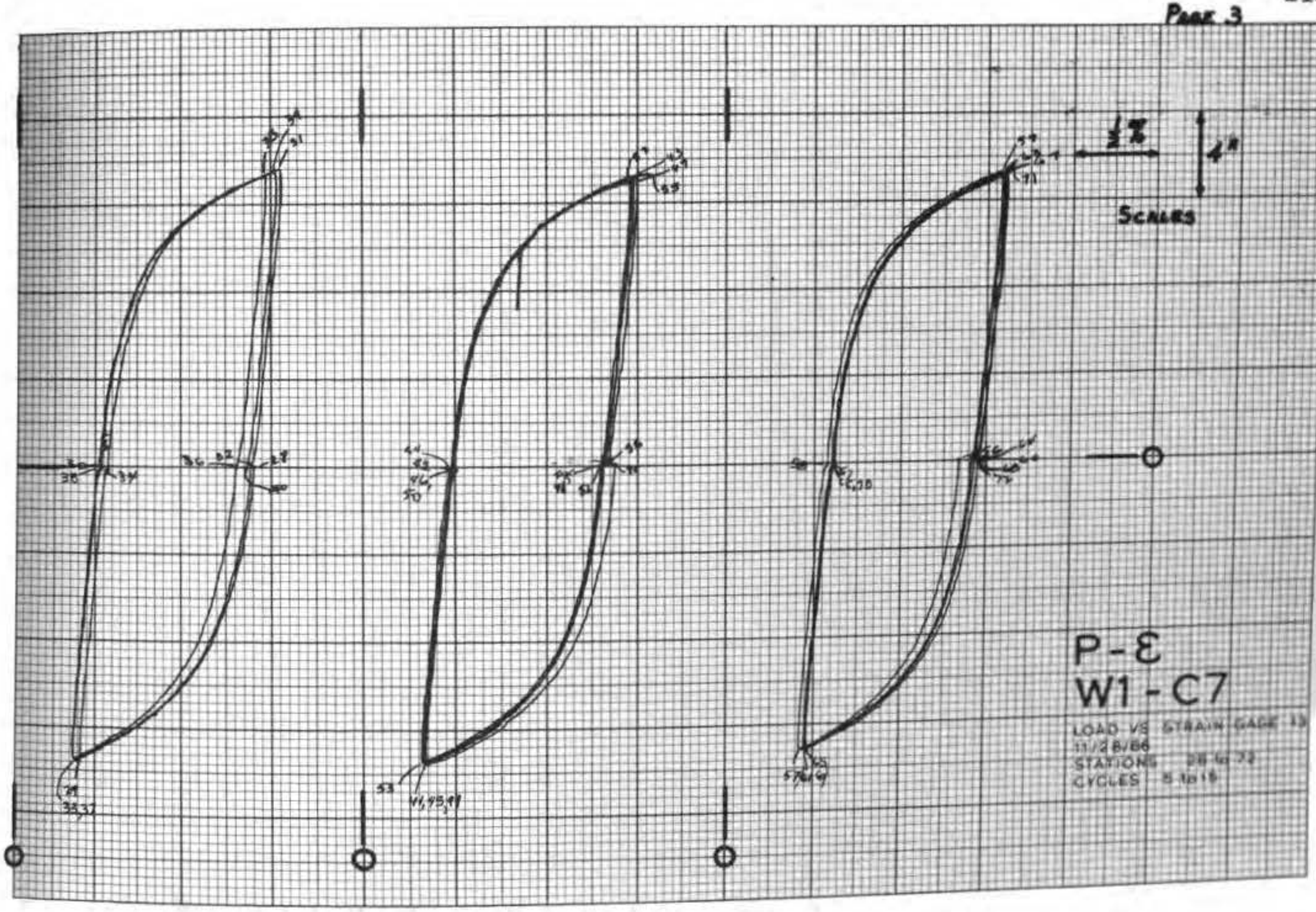


PLATE 25. LOAD VS. STRAIN - W1-C7



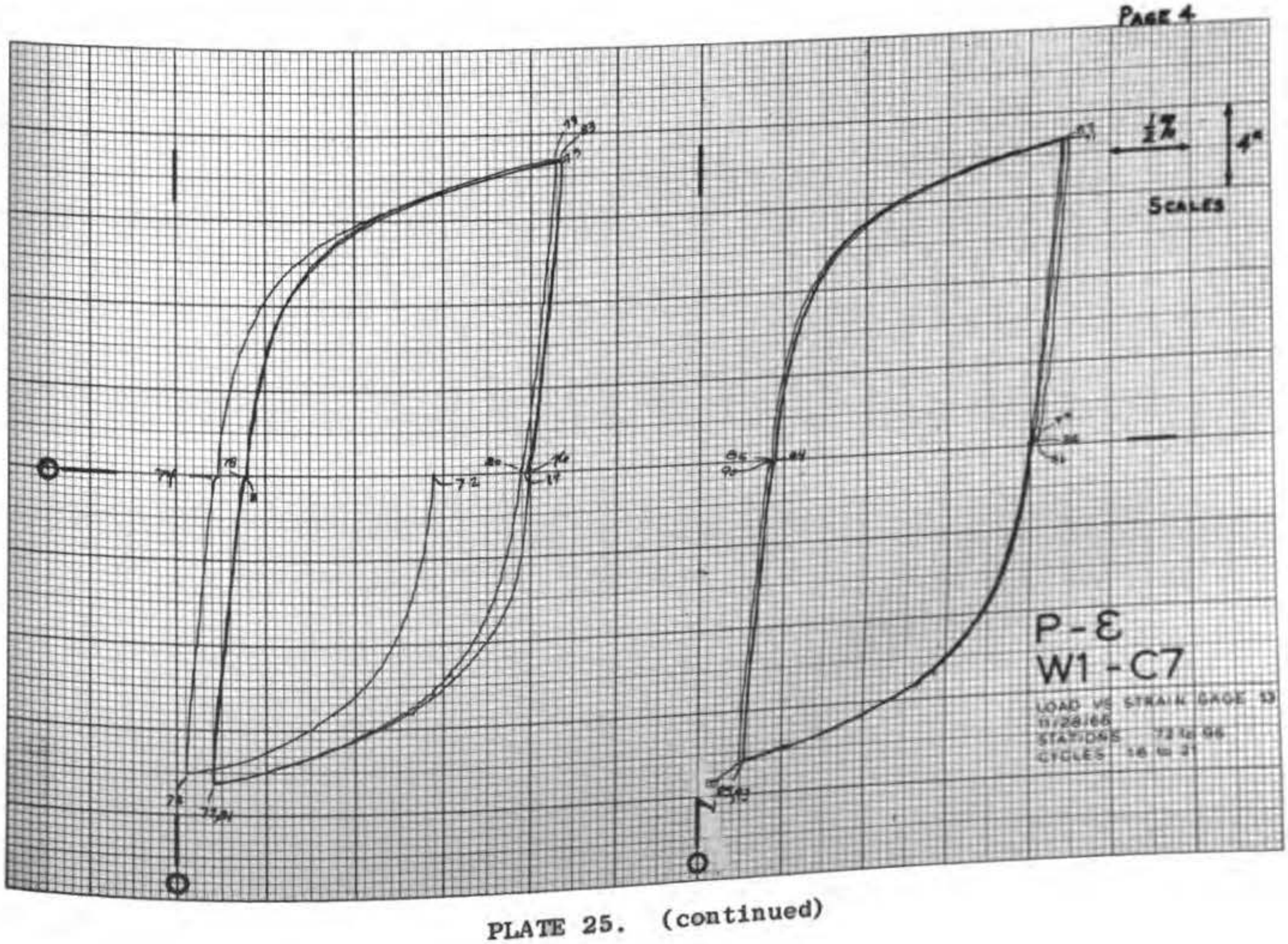
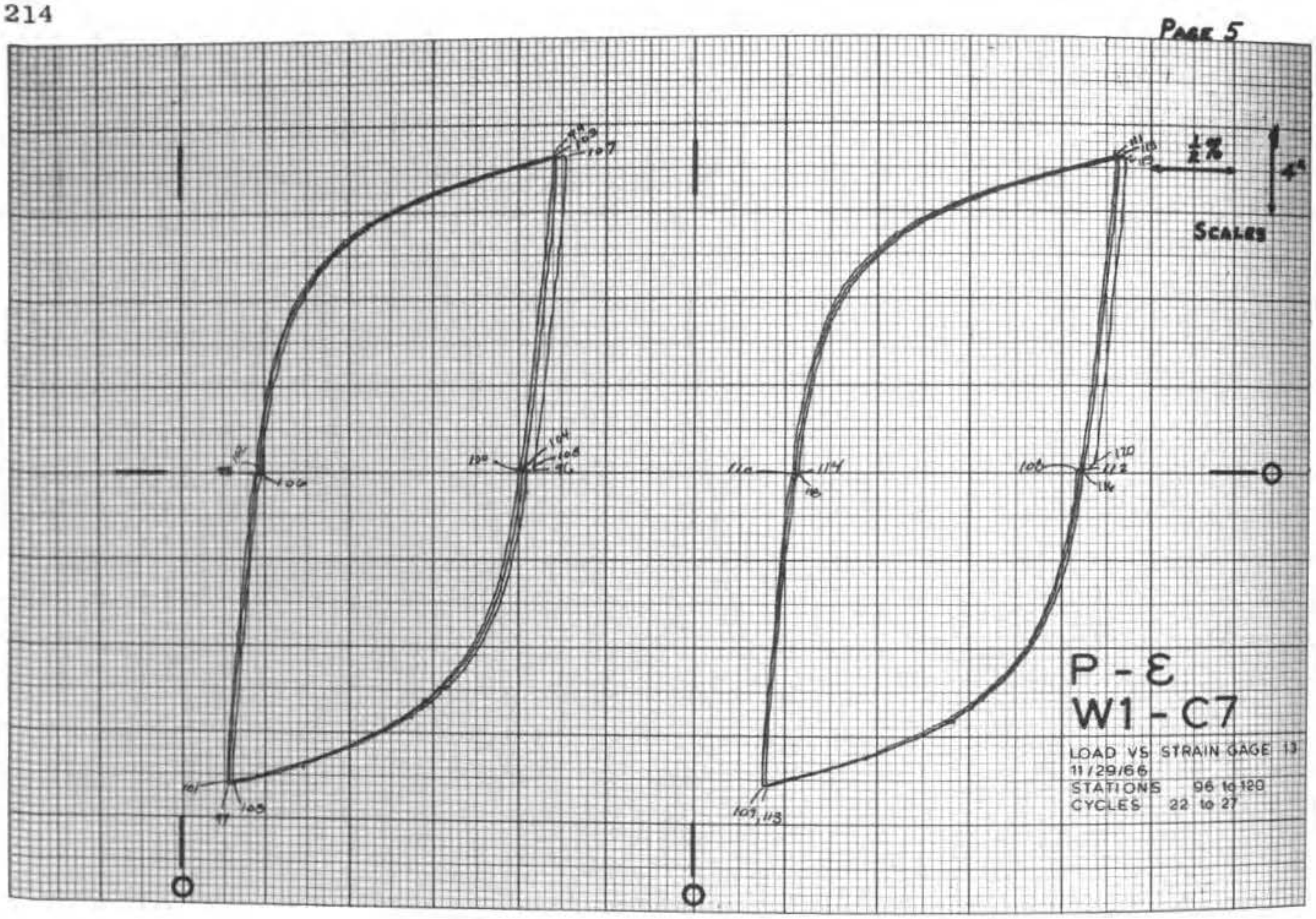


PLATE 25. (continued)



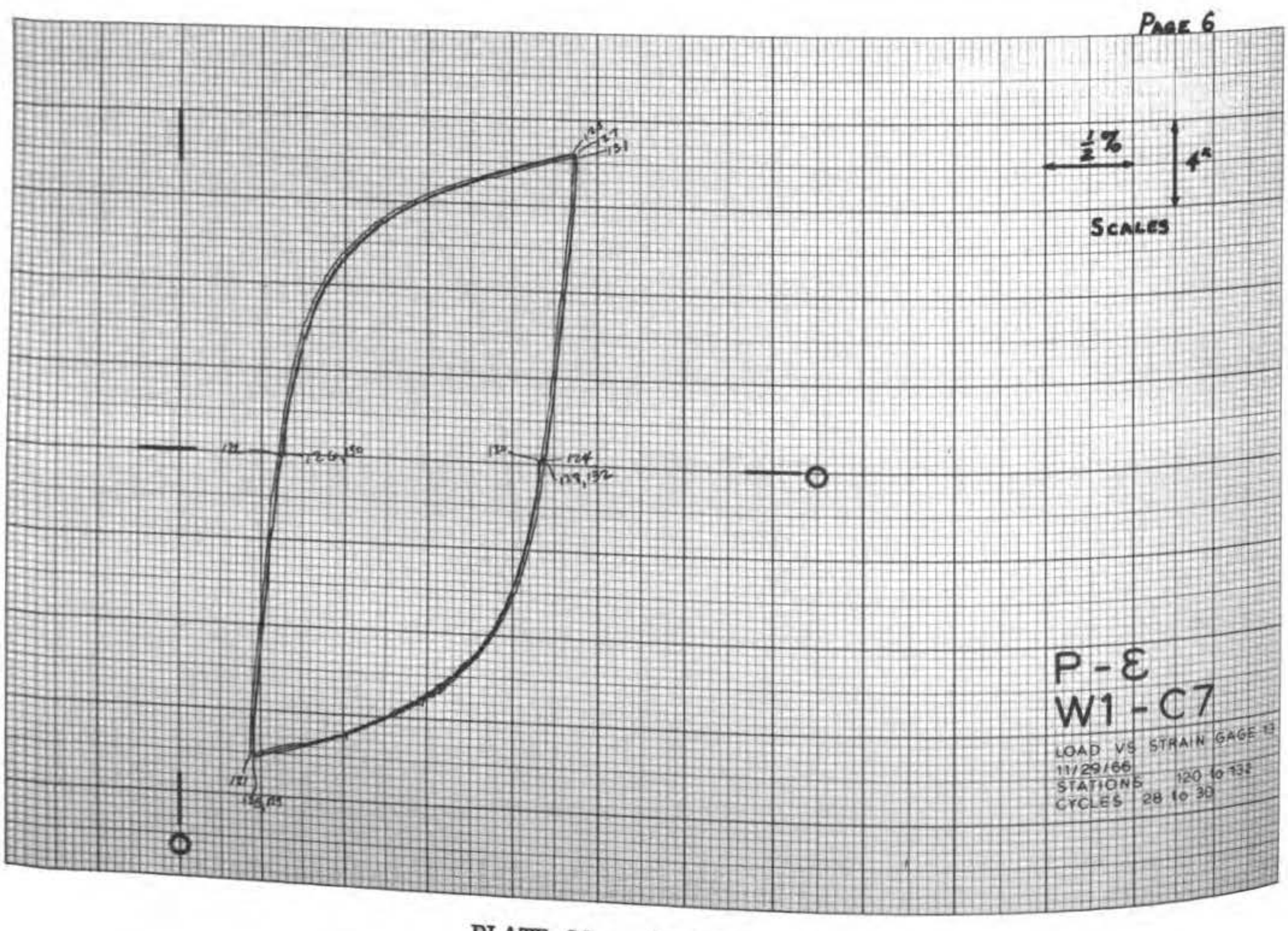
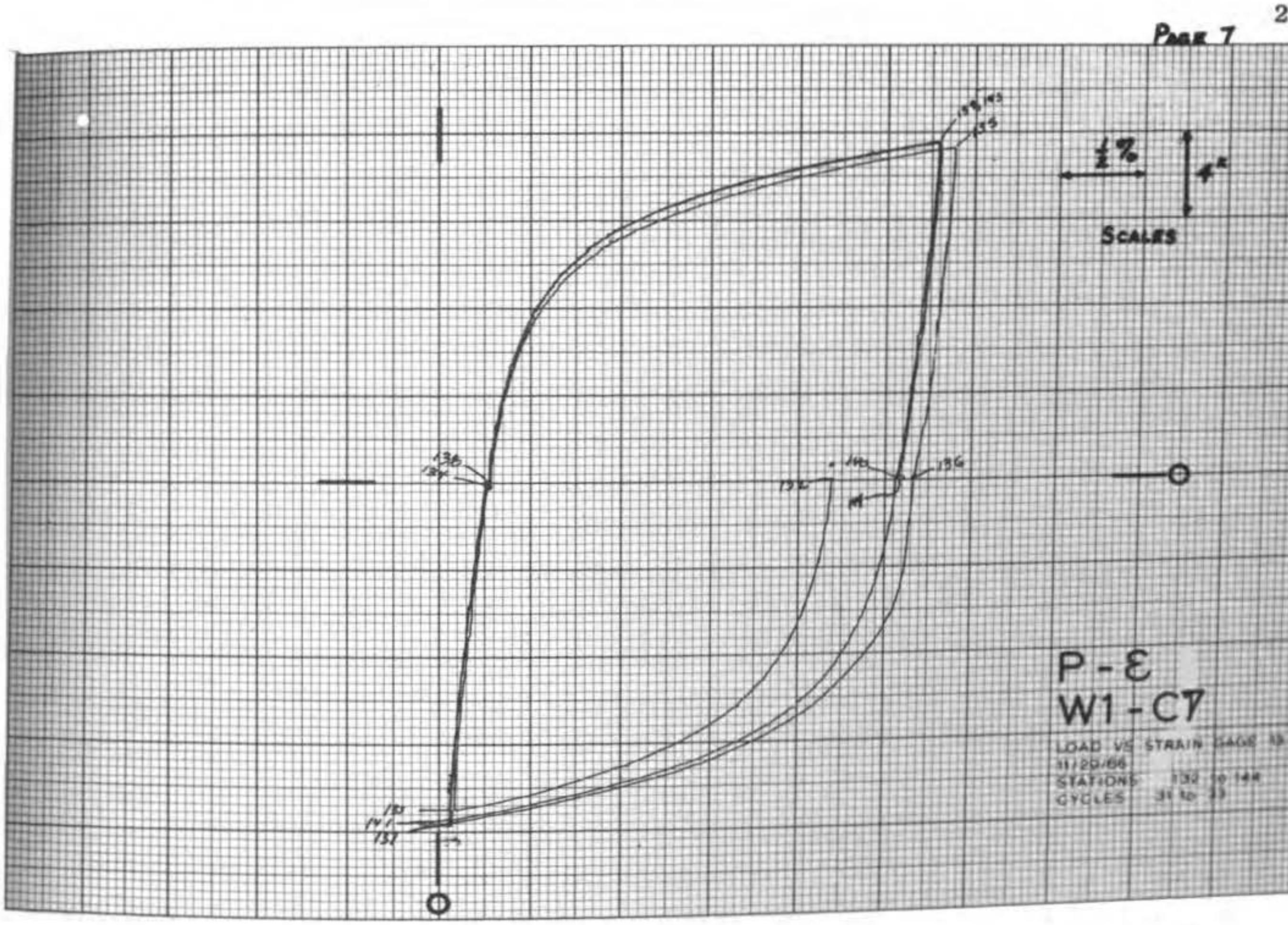


PLATE 25. (continued)



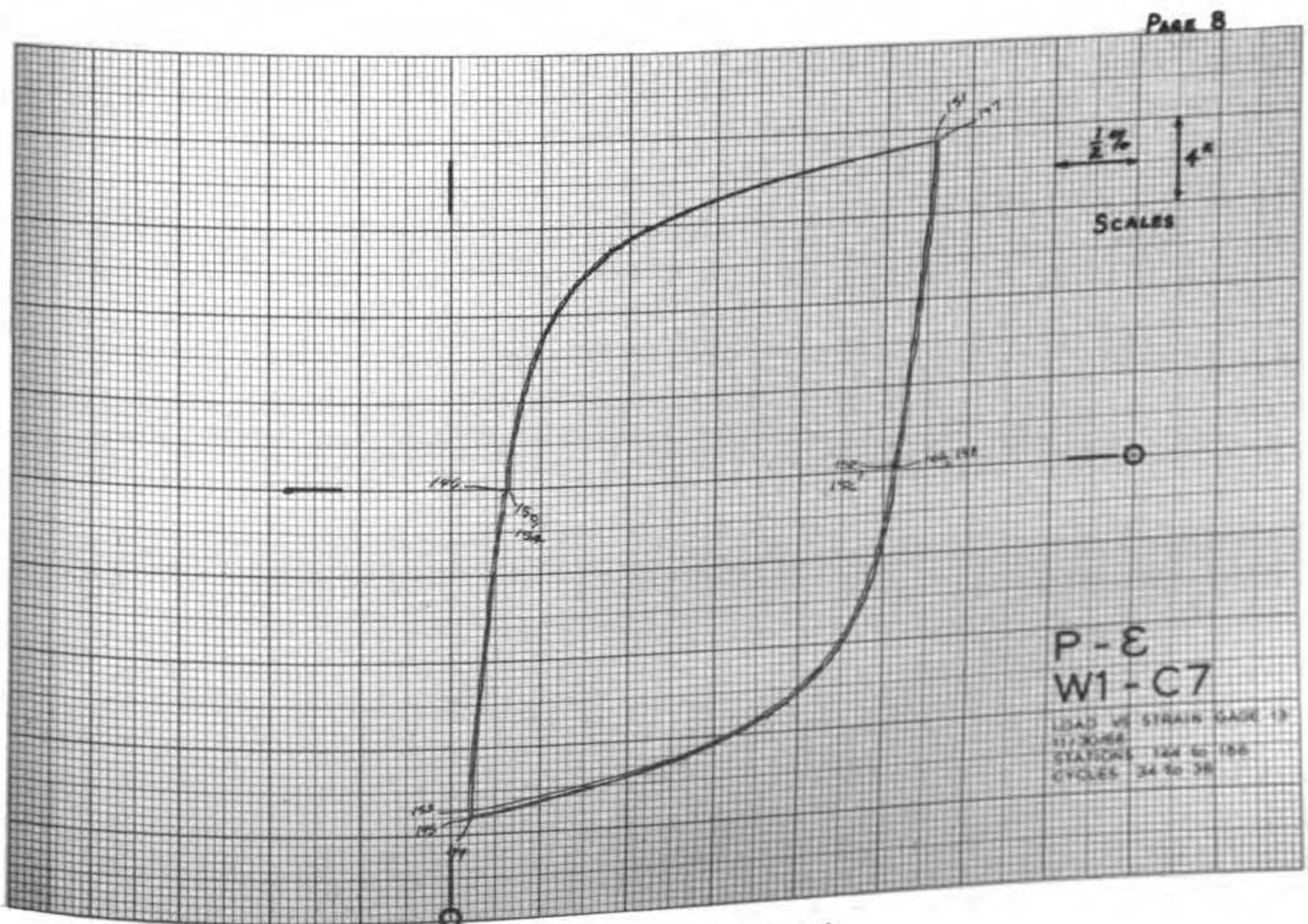


PLATE 25. (continued)

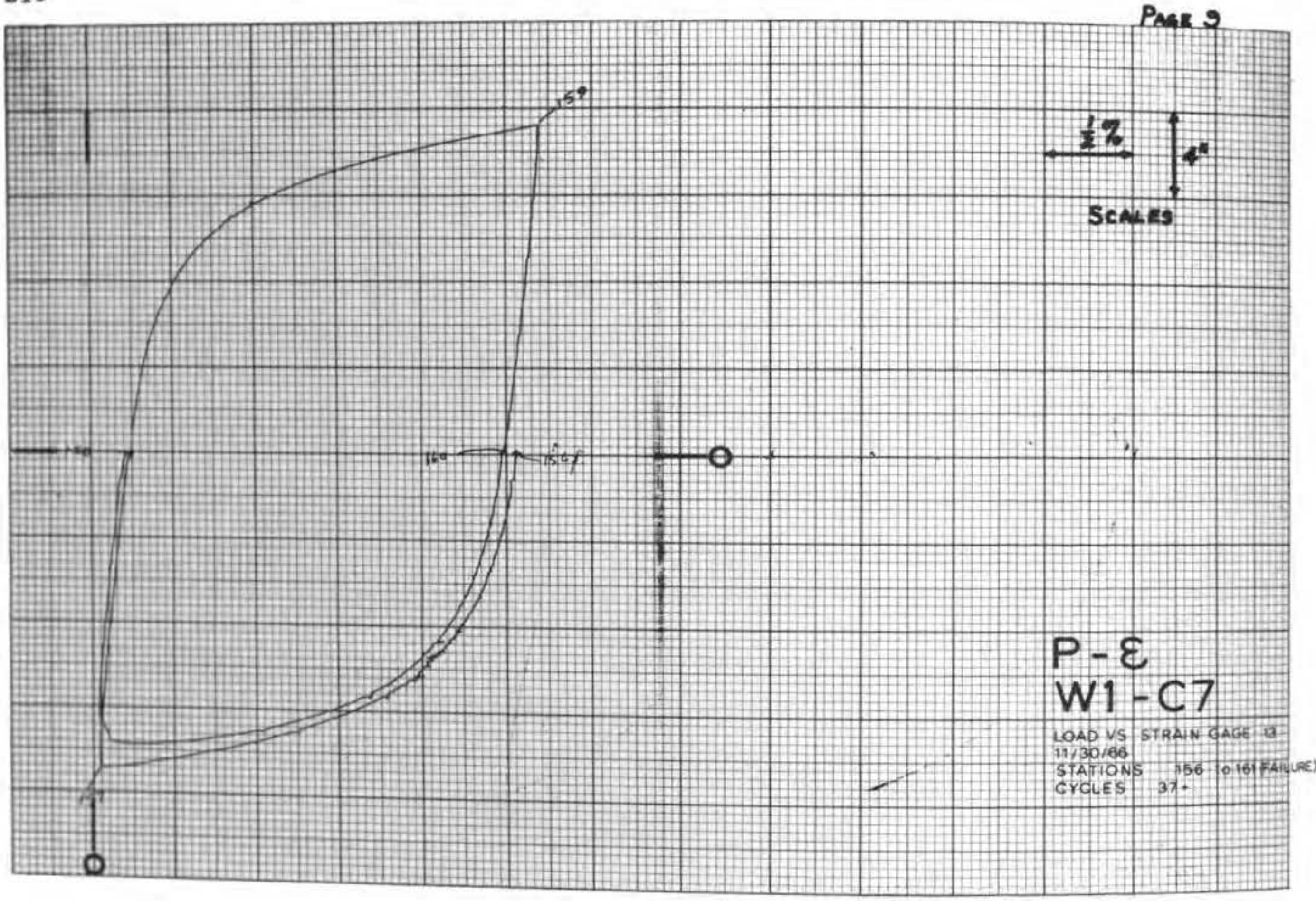
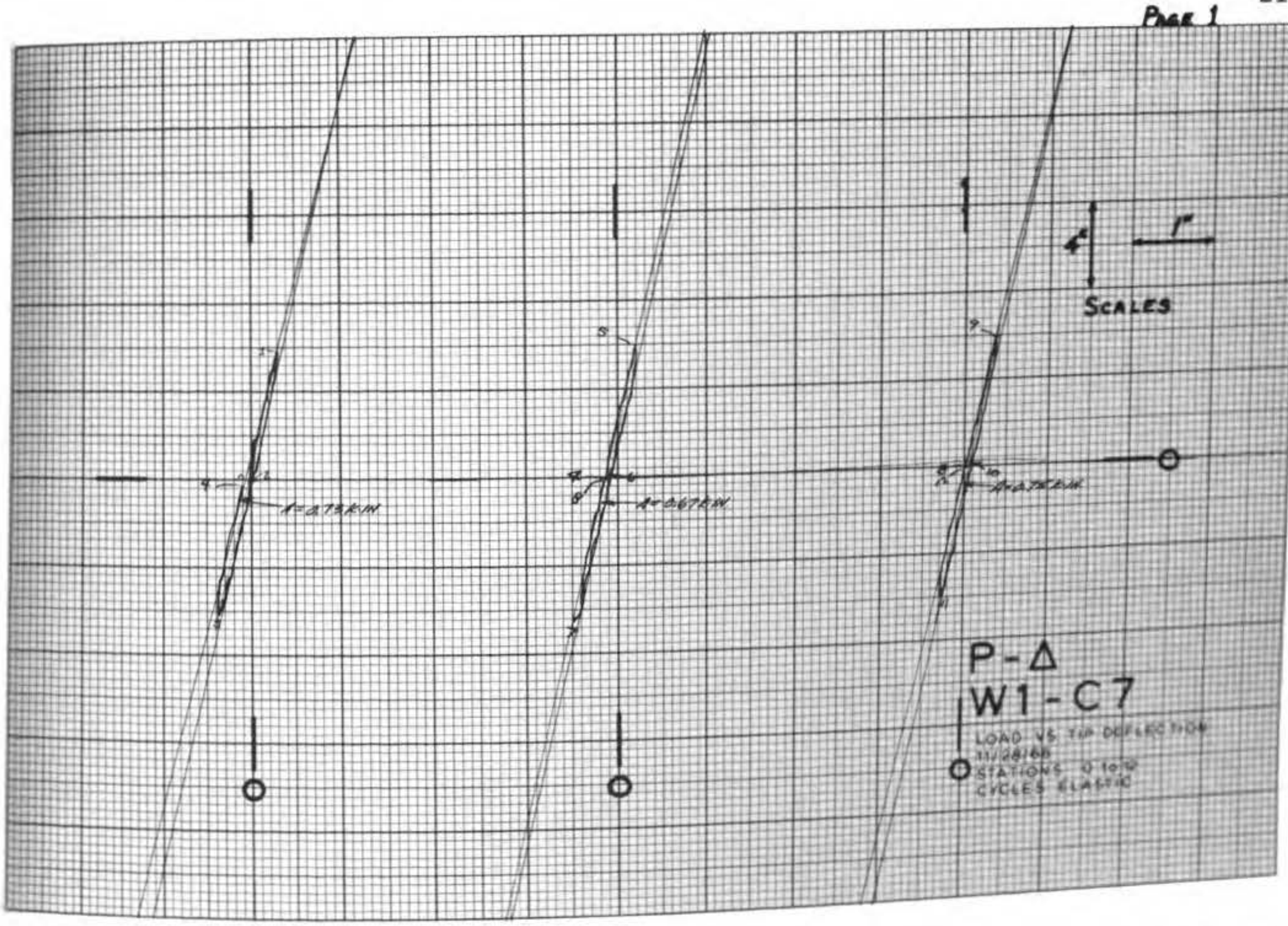


PLATE 25. (continued)



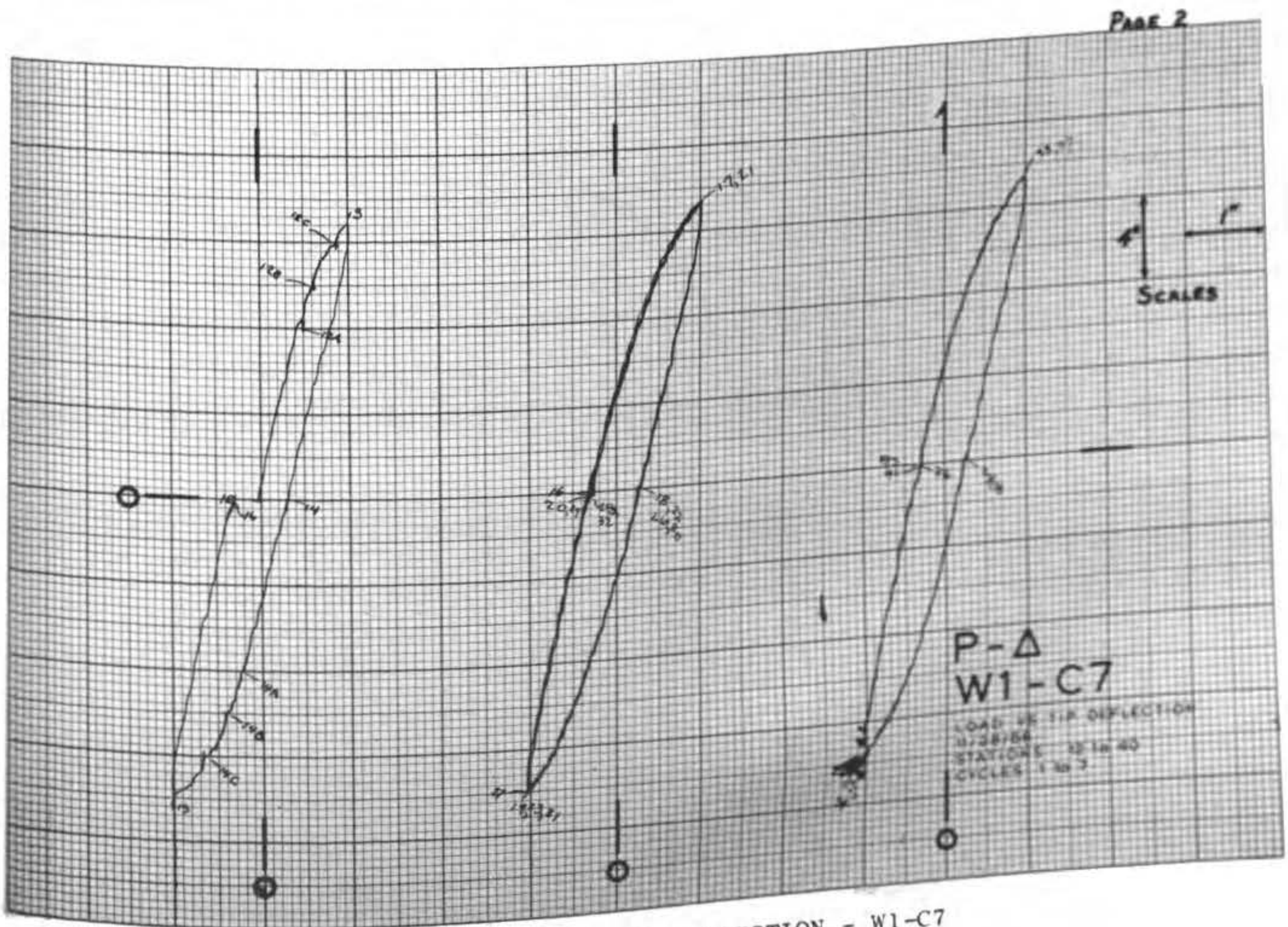
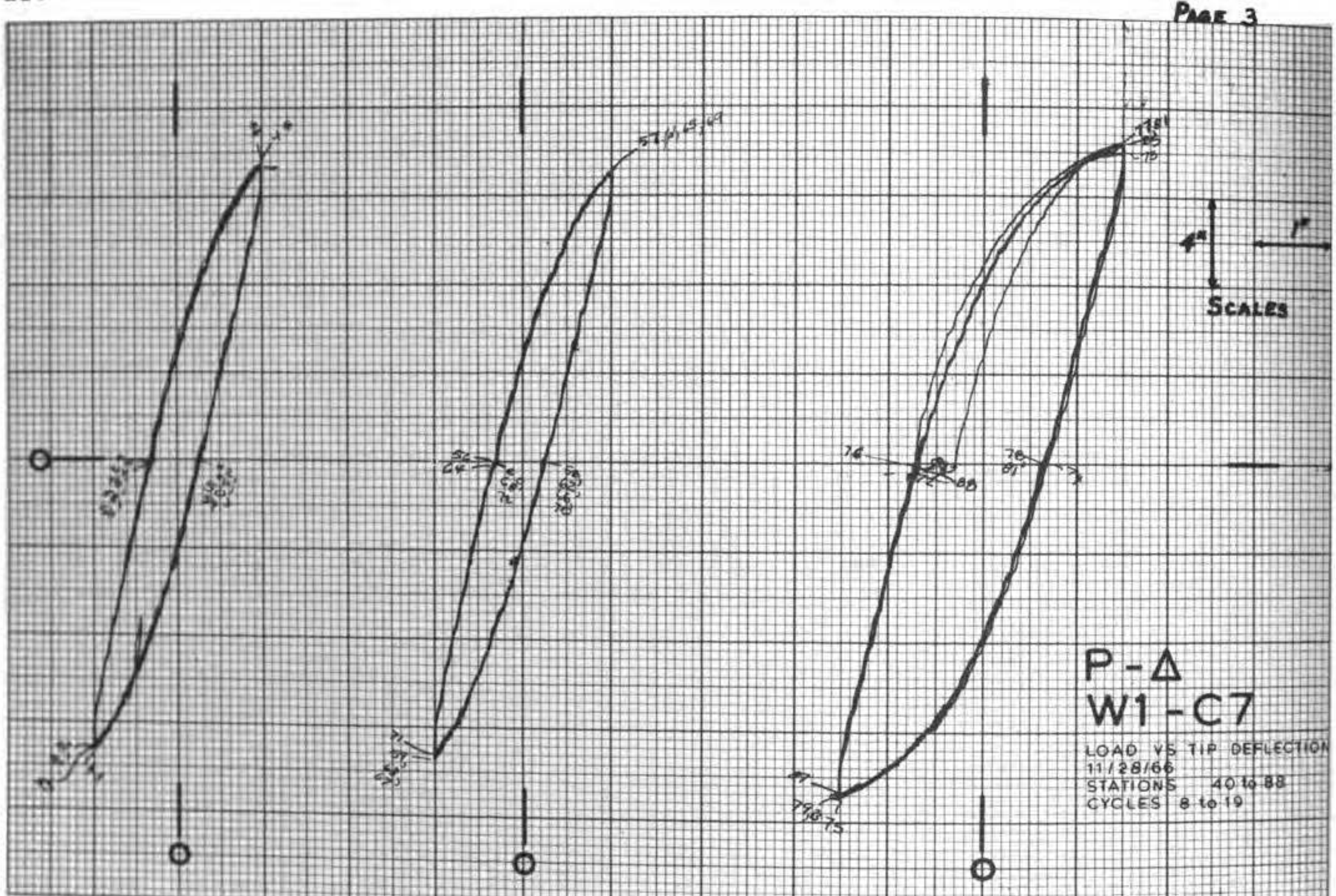


PLATE 26. LOAD VS. DEFLECTION - W1-C7



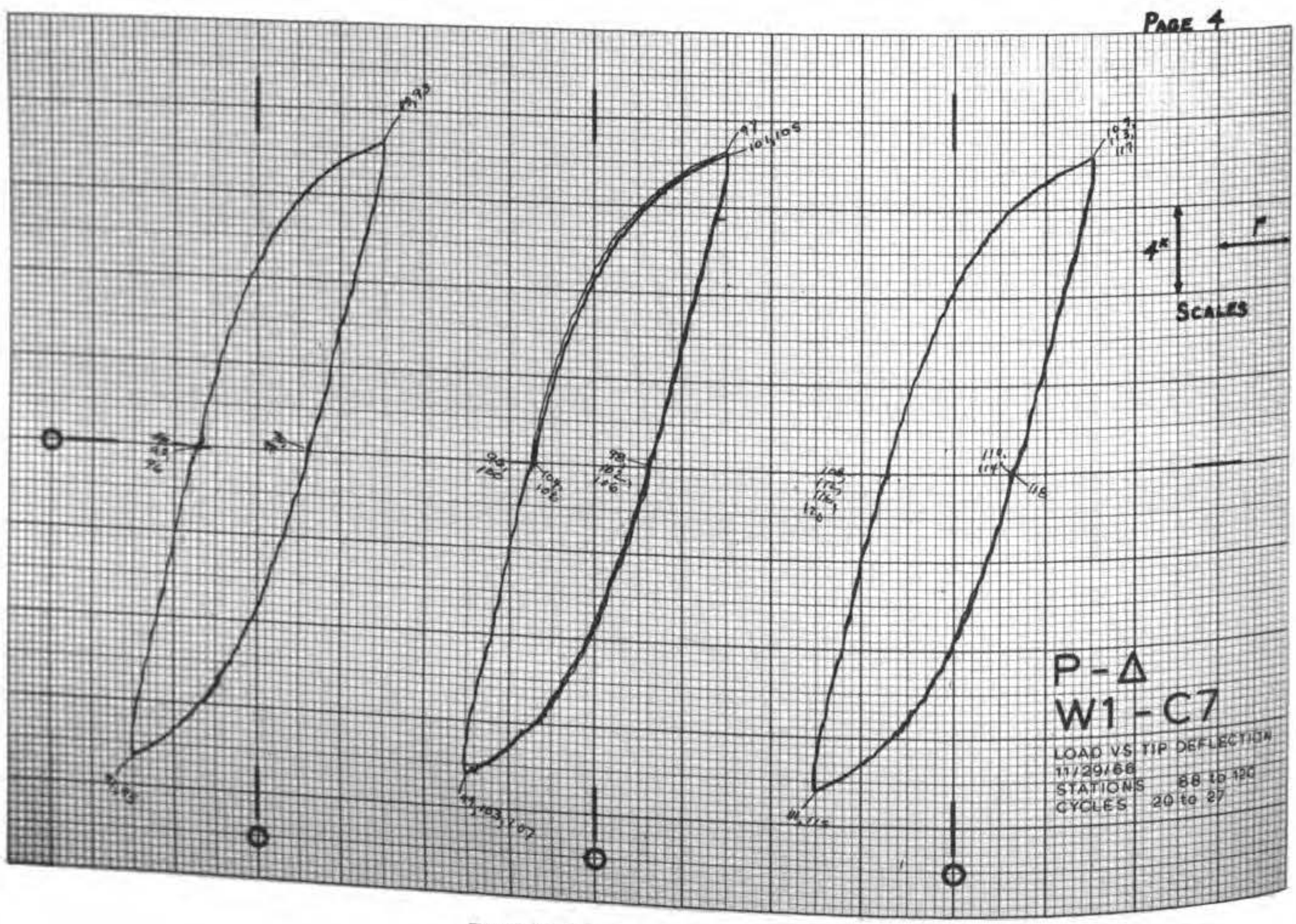
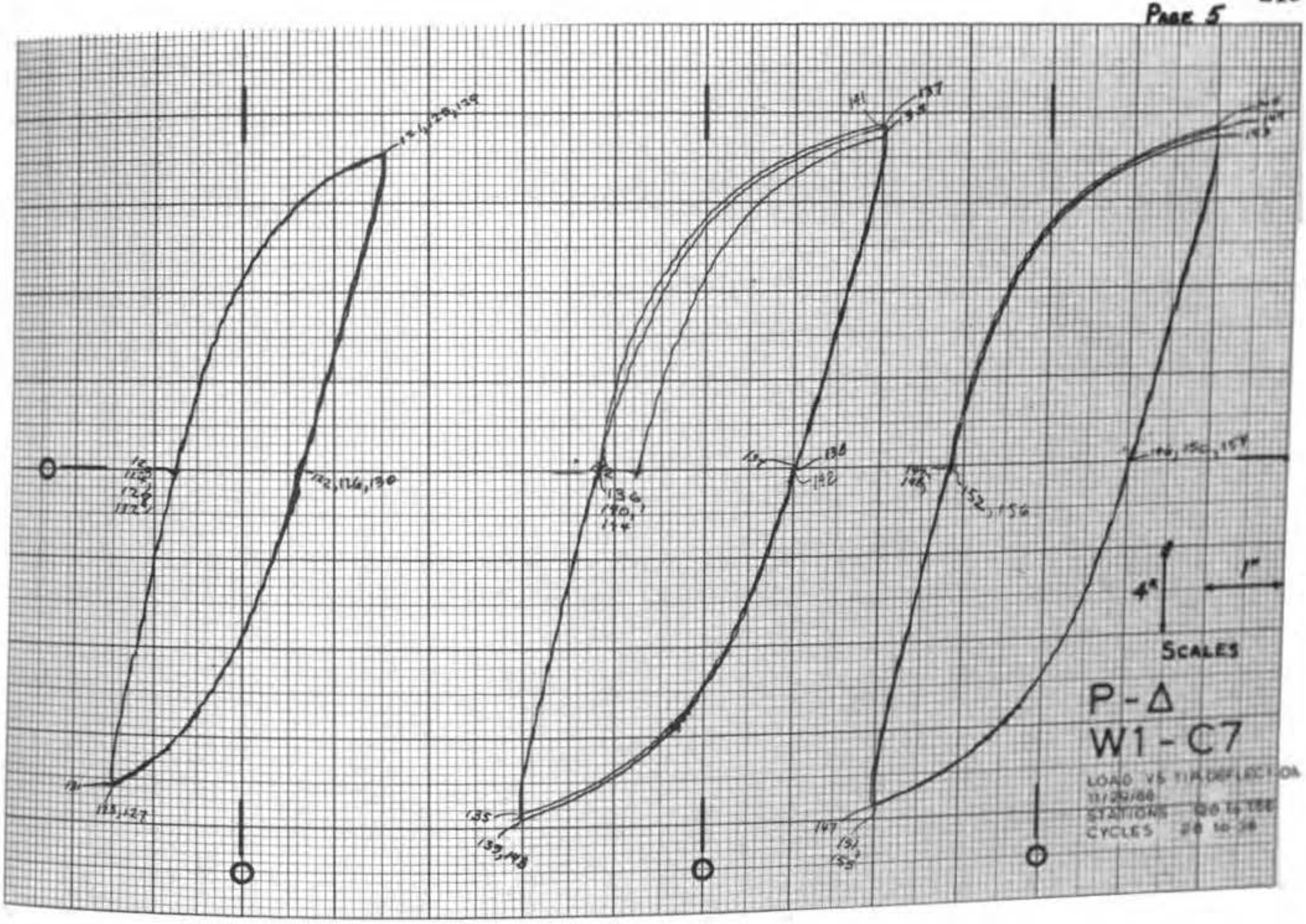


PLATE 26. (continued)



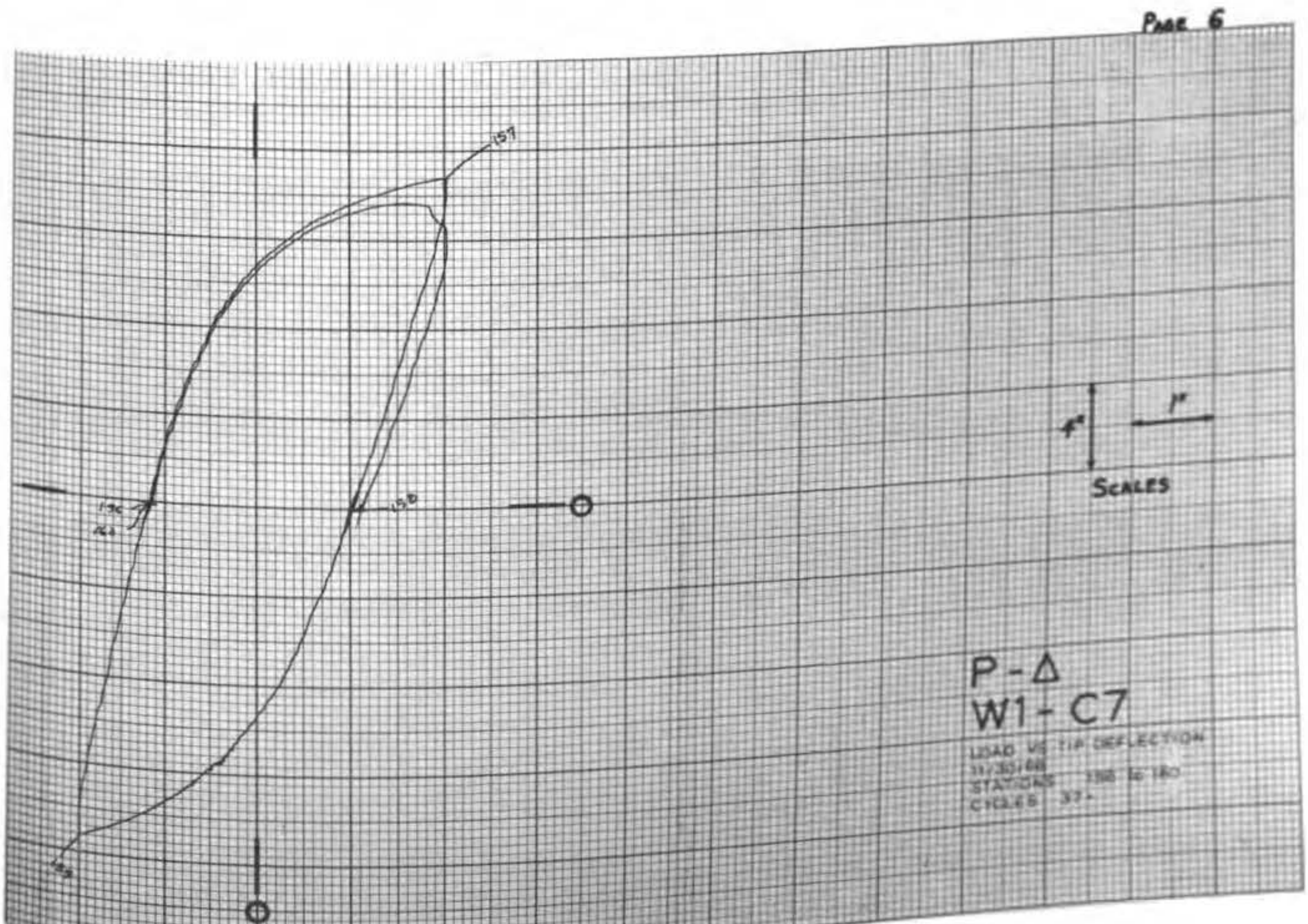


PLATE 26. (continued)

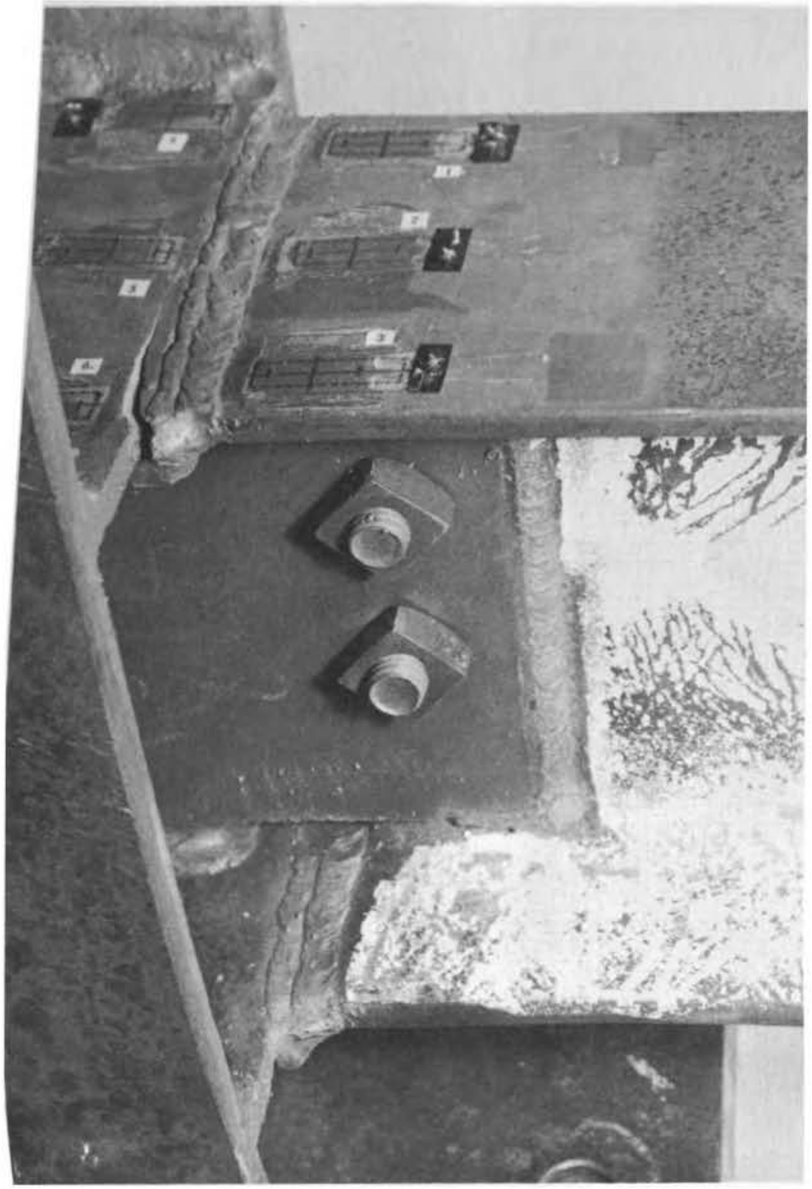


FIGURE 36. W1-C7

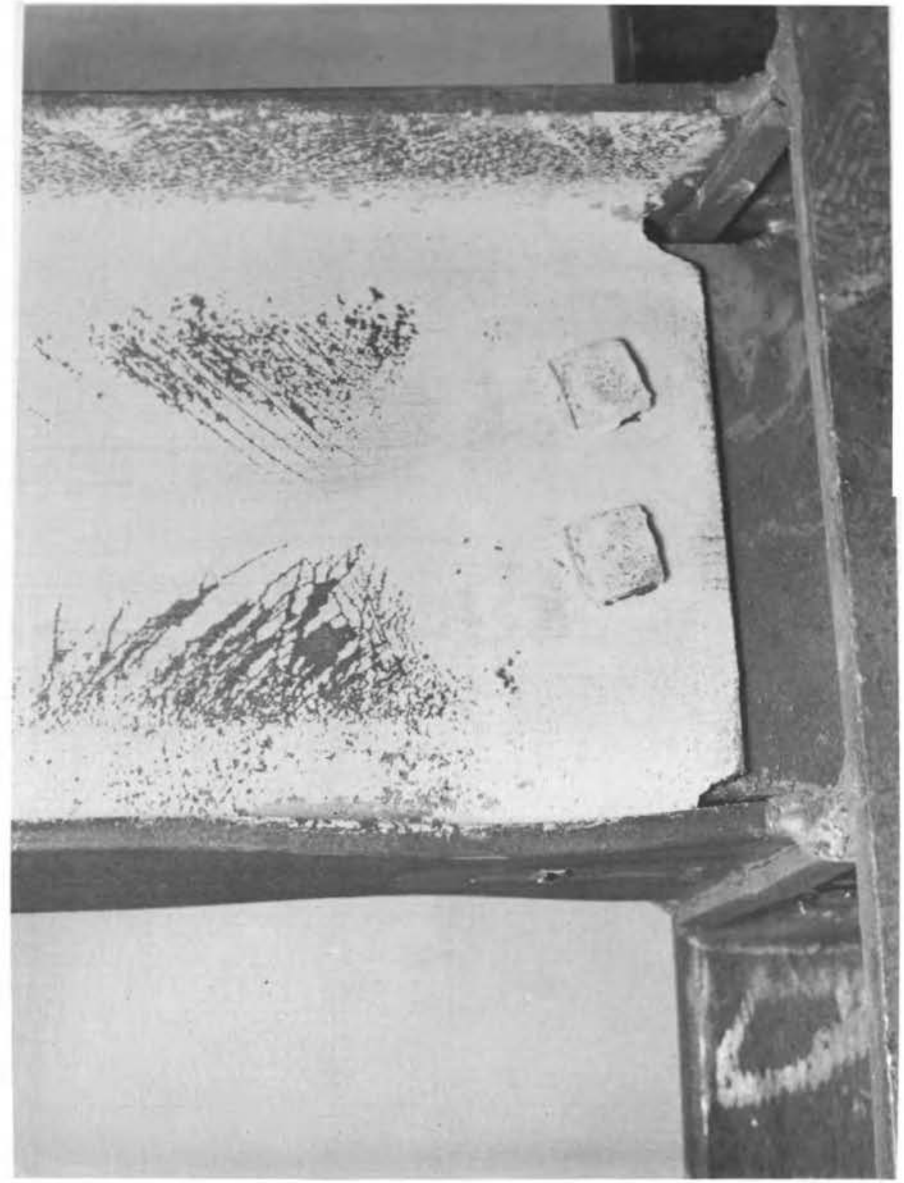


FIGURE 37. W1-C7

SPECIMEN W1-C7

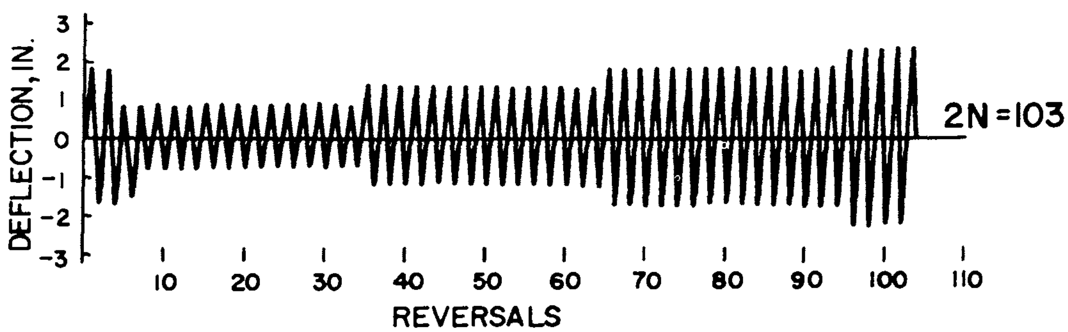
Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	12.53	0.94	0.35	3.2	1.004	1.54	0.57	0.84
2	-13.38	-0.86	0.53	6.0	-1.072	-1.42	0.87	1.58
3	13.02	0.89	0.40	5.1	1.043	1.47	0.75	1.34
4	-13.27	-0.90	0.50	5.0	-1.063	-1.48	0.82	1.32
5	13.11	0.89	0.50	5.0	1.050	1.47	0.82	1.33
6	-13.33	-0.90	0.50	5.0	-1.068	-1.48	0.82	1.32
7	13.15	0.89	0.50	5.1	1.053	1.47	0.82	1.33
8	-13.55	-0.93	0.50	5.3	-1.085	-1.53	0.82	1.39
9	12.98	0.89	0.50	5.0	1.040	1.47	0.82	1.33
10	-13.27	-0.90	0.50	5.0	-1.063	-1.48	0.82	1.31
11	13.17	0.89	0.49	5.3	1.055	1.47	0.81	1.41
12	-12.95	-0.89	0.47	4.8	-1.037	-1.47	0.77	1.27
13	13.10	0.89	0.47	5.3	1.049	1.47	0.78	1.39
14	-13.13	-0.89	0.50	4.9	-1.052	-1.47	0.82	1.29
15	13.23	0.89	0.47	5.8	1.060	1.47	0.78	1.52
16	-12.83	-0.89	0.48	5.3	-1.028	-1.47	0.78	1.39
17	13.15	0.89	0.48	5.4	1.053	1.47	0.78	1.44
18	-12.61	-0.89	0.48	5.1	-1.010	-1.48	0.78	1.35
19	13.12	0.89	0.48	5.1	1.051	1.47	0.78	1.35
20	-12.69	-0.89	0.48	5.1	-1.017	-1.48	0.78	1.34
21	13.10	0.89	0.48	4.9	1.050	1.47	0.78	1.31
22	-12.79	-0.89	0.48	4.9	-1.025	-1.47	0.78	1.30
23	12.85	0.89	0.48	4.8	1.029	1.47	0.78	1.28
24	-12.93	-0.89	0.48	4.7	-1.036	-1.47	0.78	1.23
25	12.77	0.89	0.48	4.9	1.023	1.47	0.78	1.29
26	-12.84	-0.89	0.48	4.7	-1.029	-1.47	0.78	1.23
27	12.72	0.89	0.48	4.9	1.019	1.47	0.78	1.30
28	-12.81	-0.89	0.48	4.7	-1.026	-1.47	0.78	1.24
29	12.81	0.89	0.48	4.9	1.026	1.47	0.78	1.30
30	-12.70	-0.89	0.48	4.7	-1.018	-1.48	0.78	1.24
31	13.84	1.39	0.90	11.4	1.109	2.28	1.48	3.00
32	-14.20	-1.38	1.31	14.5	-1.138	-2.28	2.15	3.82
33	14.28	1.38	1.27	15.6	1.144	2.28	2.09	4.12
34	-14.37	-1.38	1.26	14.4	-1.151	-2.27	2.07	3.80
35	14.29	1.38	1.26	14.2	1.145	2.28	2.07	3.75
36	-14.31	-1.38	1.26	14.3	-1.147	-2.27	2.07	3.78
37	14.16	1.38	1.26	14.1	1.134	2.28	2.07	3.74
38	-14.16	-1.38	1.26	14.3	-1.135	-2.28	2.07	3.78
39	14.23	1.40	1.27	14.8	1.140	2.31	2.09	3.90
40	-14.22	-1.37	1.27	13.7	-1.139	-2.26	2.09	3.63
41	14.20	1.40	1.27	14.7	1.138	2.31	2.09	3.88
42	-14.18	-1.37	1.27	13.7	-1.136	-2.26	2.09	3.62
43	14.25	1.44	1.30	15.2	1.142	2.38	2.14	4.02
44	-14.06	-1.34	1.29	13.4	-1.127	-2.21	2.12	3.55
45	14.09	1.45	1.29	14.4	1.129	2.40	2.12	3.80
46	-14.02	-1.34	1.29	13.4	-1.123	-2.21	2.12	3.53
47	14.10	1.45	1.29	14.3	1.129	2.40	2.12	3.79
48	-14.07	-1.34	1.29	13.4	-1.127	-2.21	2.12	3.55
49	14.02	1.42	1.29	14.7	1.123	2.35	2.12	3.89
50	-14.04	-1.37	1.29	14.2	-1.125	-2.26	2.12	3.74
51	14.02	1.43	1.29	14.7	1.123	2.36	2.12	3.88

Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
52	-14.00	-1.37	1.29	14.1	-1.122	-2.26	2.12	3.73
53	14.00	1.44	1.29	14.6	1.122	2.38	2.12	3.87
54	-14.00	-1.38	1.29	14.1	-1.121	-2.28	2.12	3.71
55	13.87	1.44	1.30	14.8	1.111	2.37	2.14	3.91
56	-13.94	-1.33	1.30	13.7	-1.117	-2.20	2.14	3.62
57	13.94	1.45	1.30	14.8	1.117	2.38	2.14	3.91
58	-13.91	-1.33	1.30	13.8	-1.115	-2.20	2.14	3.63
59	13.91	1.46	1.30	14.8	1.115	2.40	2.14	3.90
60	-13.80	-1.34	1.30	13.7	-1.106	-2.20	2.14	3.63
61	14.64	1.94	1.68	21.2	1.173	3.20	2.78	5.59
62	-14.90	-1.85	2.12	24.2	-1.194	-3.04	3.49	6.40
63	15.14	1.96	2.12	27.9	1.213	3.24	3.49	7.36
64	-15.01	-1.84	2.12	24.5	-1.203	-3.04	3.49	6.47
65	15.08	1.96	2.12	26.6	1.208	3.24	3.49	7.02
66	-15.00	-1.84	2.12	24.4	-1.202	-3.04	3.49	6.45
67	14.97	1.93	2.11	26.5	1.199	3.17	3.47	6.99
68	-14.92	-1.86	2.11	24.5	-1.196	-3.06	3.47	6.47
69	14.88	1.93	2.11	26.0	1.193	3.18	3.47	6.86
70	-14.82	-1.83	2.11	24.3	-1.188	-3.01	3.47	6.43
71	14.61	1.93	2.11	25.7	1.171	3.18	3.47	6.78
72	-14.84	-1.86	2.11	24.3	-1.189	-3.06	3.47	6.43
73	14.51	1.93	2.09	26.1	1.162	3.18	3.45	6.90
74	-14.75	-1.85	2.10	24.1	-1.182	-3.04	3.45	6.36

SPECIMEN W1-C9

Description: This specimen was similar to specimen W1-C7 in detailing, fabrication and inspection except that no significant weld defects were found by ultrasonic inspection.

Program of Loading:



Test Control: Tip deflection.

Raw Data Included: Graphical load-deflection data.

Graphical load-strain data measured by gage No. 2 on the top flange at a distance of 5.00 inches from the face of the column web.

Graphical load-strain data measured by gage No. 7 in the center of the bottom flange at a distance of 5.05 inches from the face of the column web.

Graphical load-transverse strain data measured by gage No. 9 located at right angles to gage No. 7.

Total Energy Absorption: 1,500 kip-inches.

Plastic Load Reversals to Failure: 103 ($51\frac{1}{2}$ cycles).

Remarks: At the end of the first plastic cycle there was no visible buckling; nor were any cracks found. During the second cycle, there was a hint of buckling of the lower flange. After the 5th cycle a crack was observed at the edge of the bottom flange butt-weld. During the 10th cycle, a new crack appeared on the opposite end of that weld. A hair crack was found at an edge of the top flange butt-weld during the 17th cycle. At about the same time propagation of the two edge cracks at the bottom flange weld became noticeable. Buckling of the lower flange had also increased. Much later, during the 43rd cycle, some top flange buckling became evident. Just before applying a $2\frac{1}{2}$ inch tip deflection (after 47 cycles), no cracks longer than $\frac{1}{2}$ inch had been observed; however, the bottom flange was markedly buckled. During the 48th cycle a new crack in the middle of the bottom flange butt-weld was observed. Failure occurred with rupture of the bottom flange.

SPECIMEN TYPE W1-C9

DIMENSIONS OF WF SECTION

DEPTH	8.19 INCHES
TOP FLANGE WIDTH	5.330 INCHES
BOTTOM FLANGE WIDTH	5.300 INCHES
TOP FLANGE THICKNESS	0.361 INCHES
BOTTOM FLANGE THICKNESS	0.349 INCHES
WEB THICKNESS	0.279 INCHES
ELASTIC MODULUS	29200. KSI
YIELD STRESS	44.100 KSI

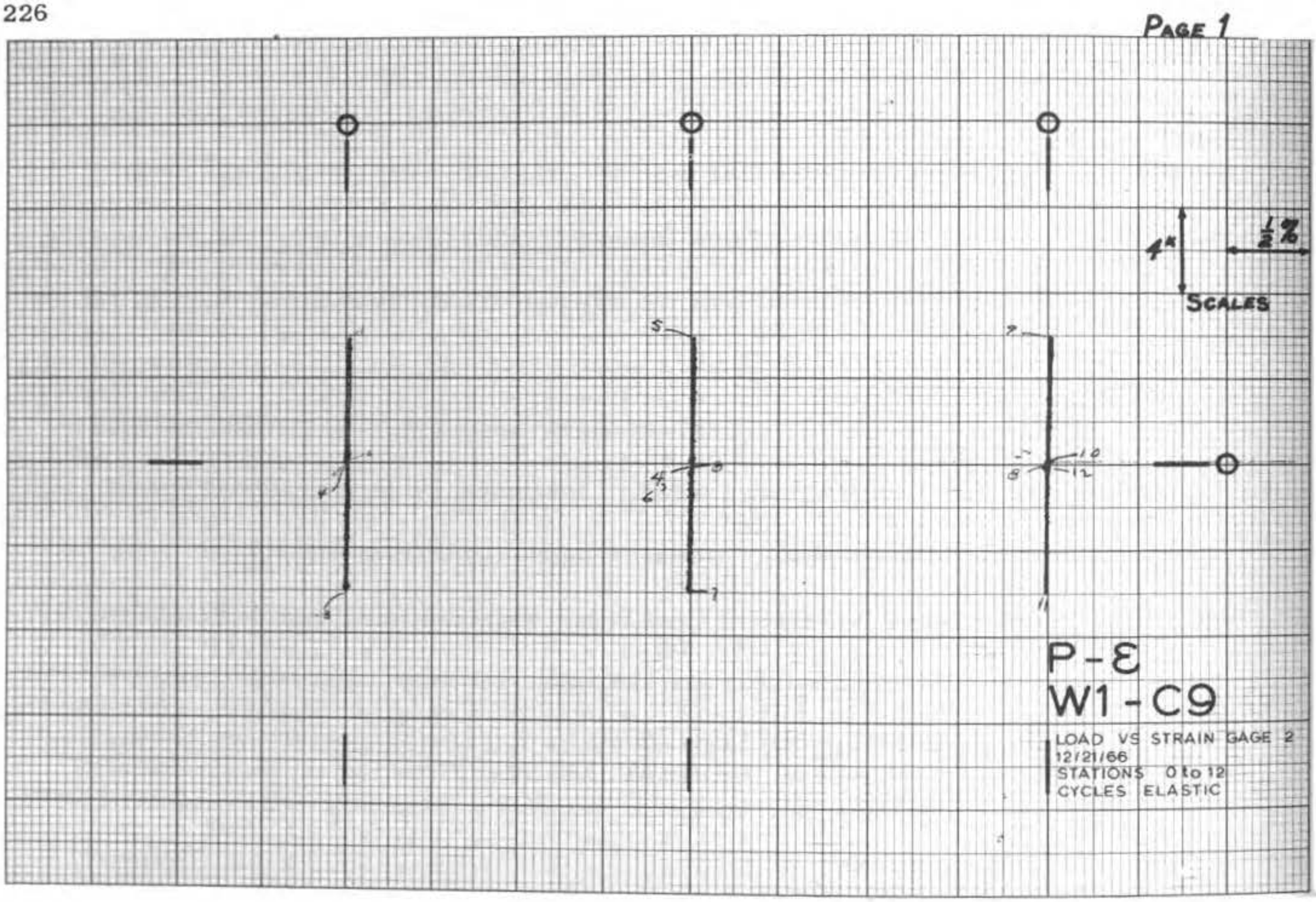
WF SECTION PROPERTIES

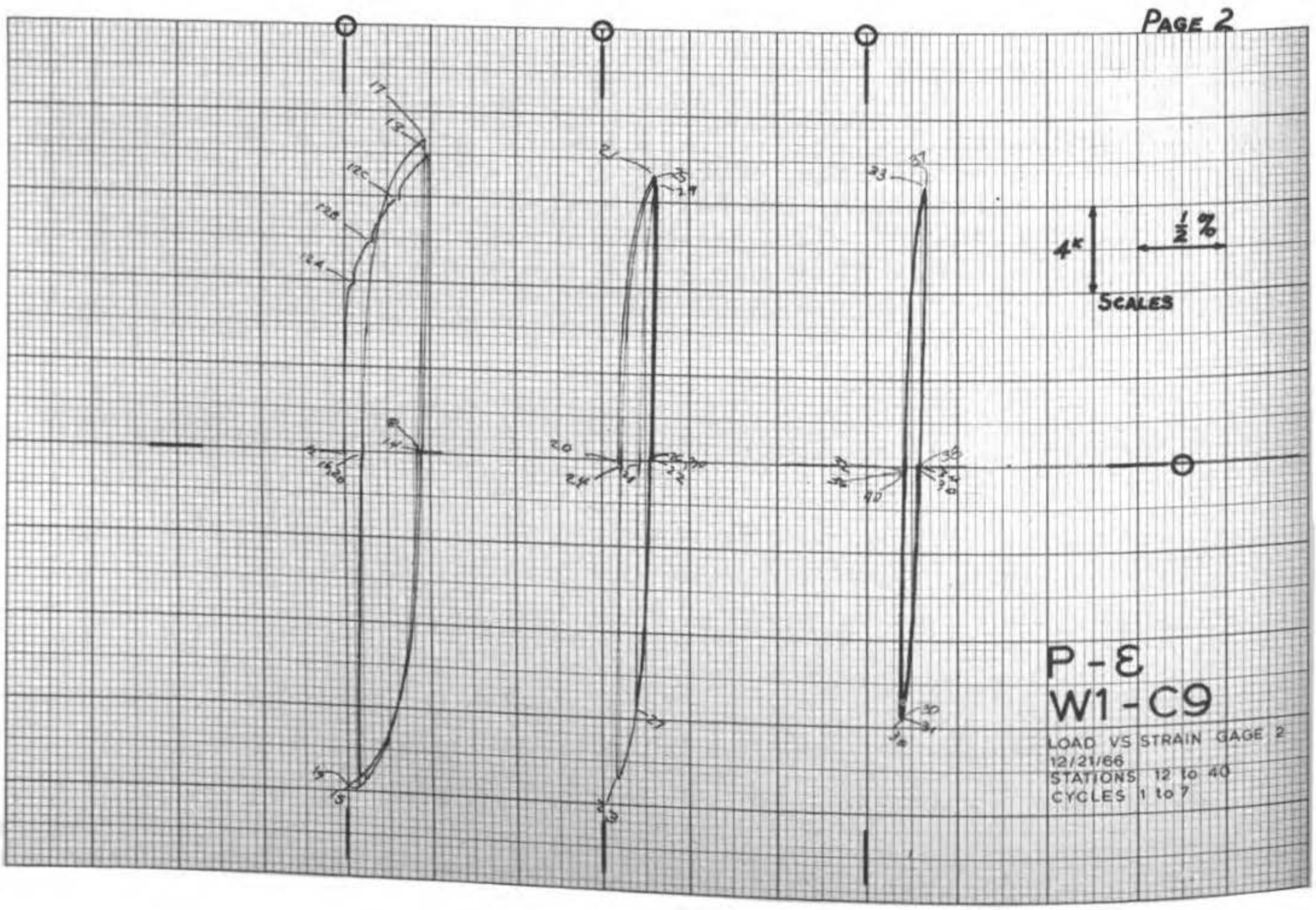
AREA, A	5.95 INCHES**2
LOCATION OF CENTROID*, YE	4.14 INCHES
MOMENT OF INERTIA, I	68.9 INCHES**4
SECTION MODULUS, TOP, ST	17.0 INCHES**3
SECTION MODULUS, BOTTOM, SB	16.6 INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP	4.22 INCHES
PLASTIC MODULUS, Z	19.0 INCHES**3
SHAPE FACTOR	1.143
YIELD MOMENT, MY	61.12 KIP-FT.
PLASTIC MOMENT, MP	69.84 KIP-FT.

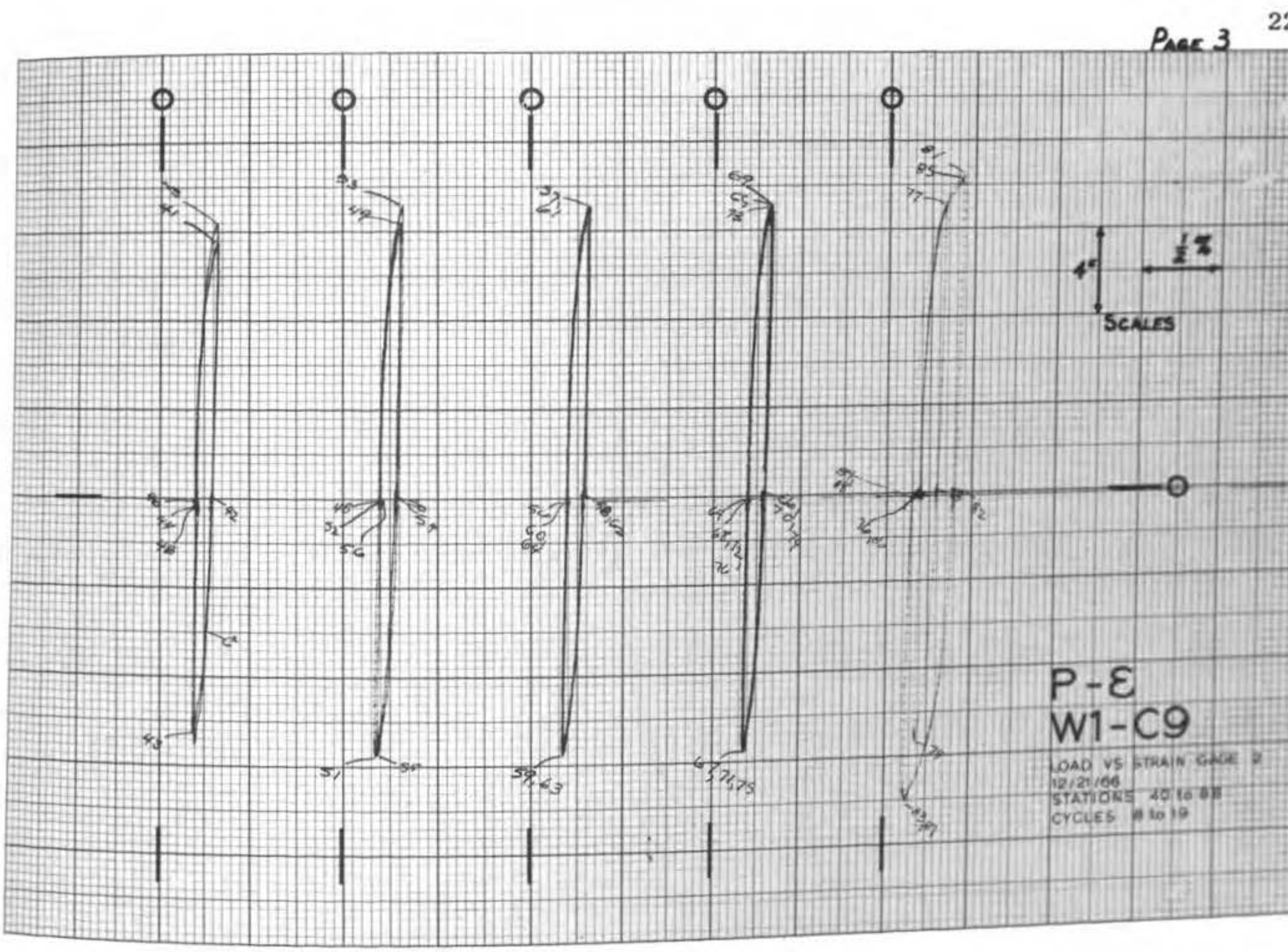
*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

BEAM PROPERTIES

LENGTH, L	66.5 INCHES
ELASTIC STIFFNESS, P/DELTA	20.49 KIPS/IN.
YIELD DEFLECTION, DELTAY	0.538 INCHES
YIELD LOAD, PY	11.03 KIPS
PLASTIC LOAD, PP	12.60 KIPS


PAGE 1
4k
1/2 %
SCALES
P - ε
W1 - C9
LOAD VS STRAIN GAGE 2
12/21/66
STATIONS 0 to 12
CYCLES ELASTIC


PAGE 2
4k
1/2 %
SCALES
P - ε
W1 - C9
LOAD VS STRAIN GAGE 2
12/21/66
STATIONS 12 to 40
CYCLES 1 to 7



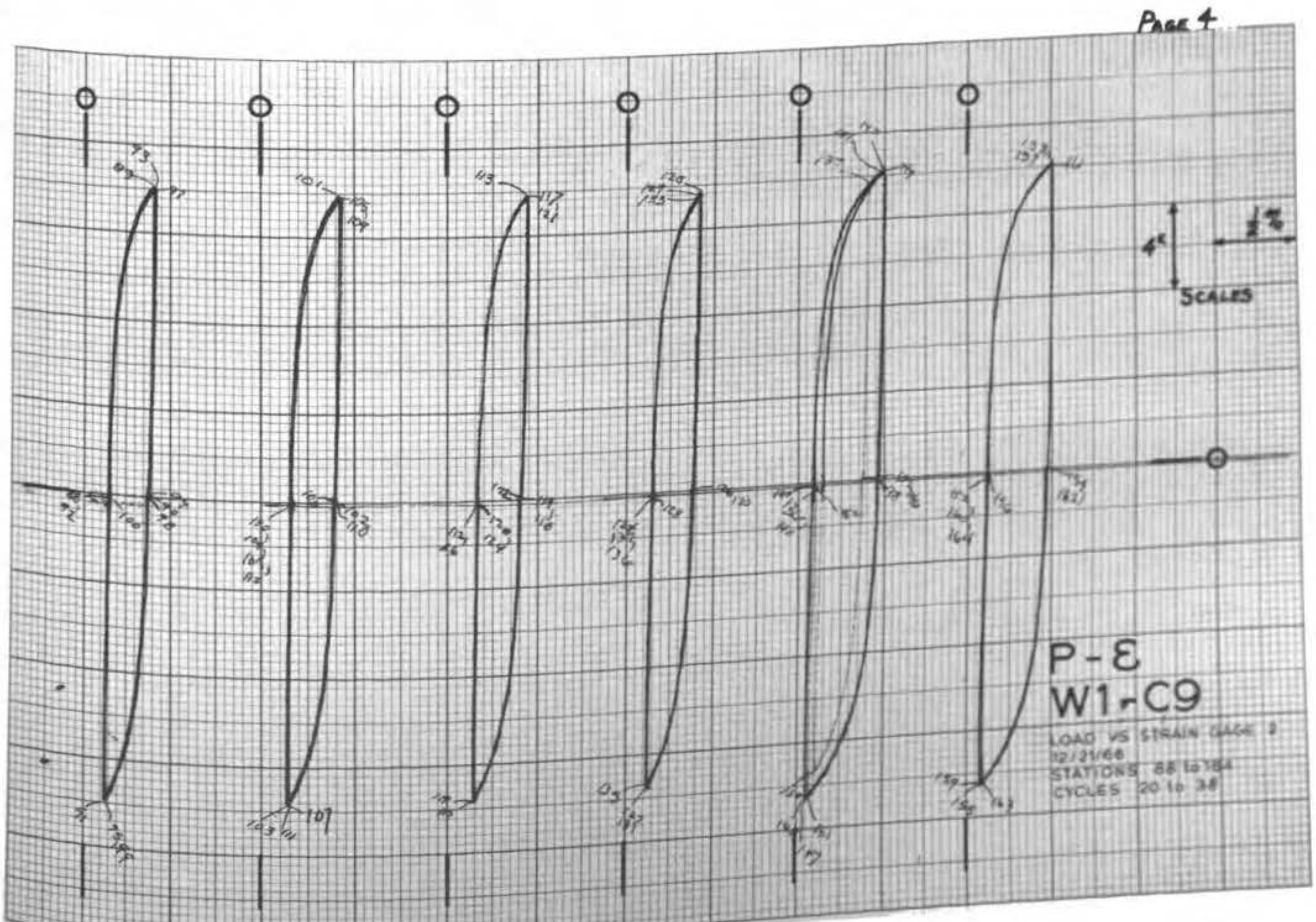


PLATE 27. (continued)

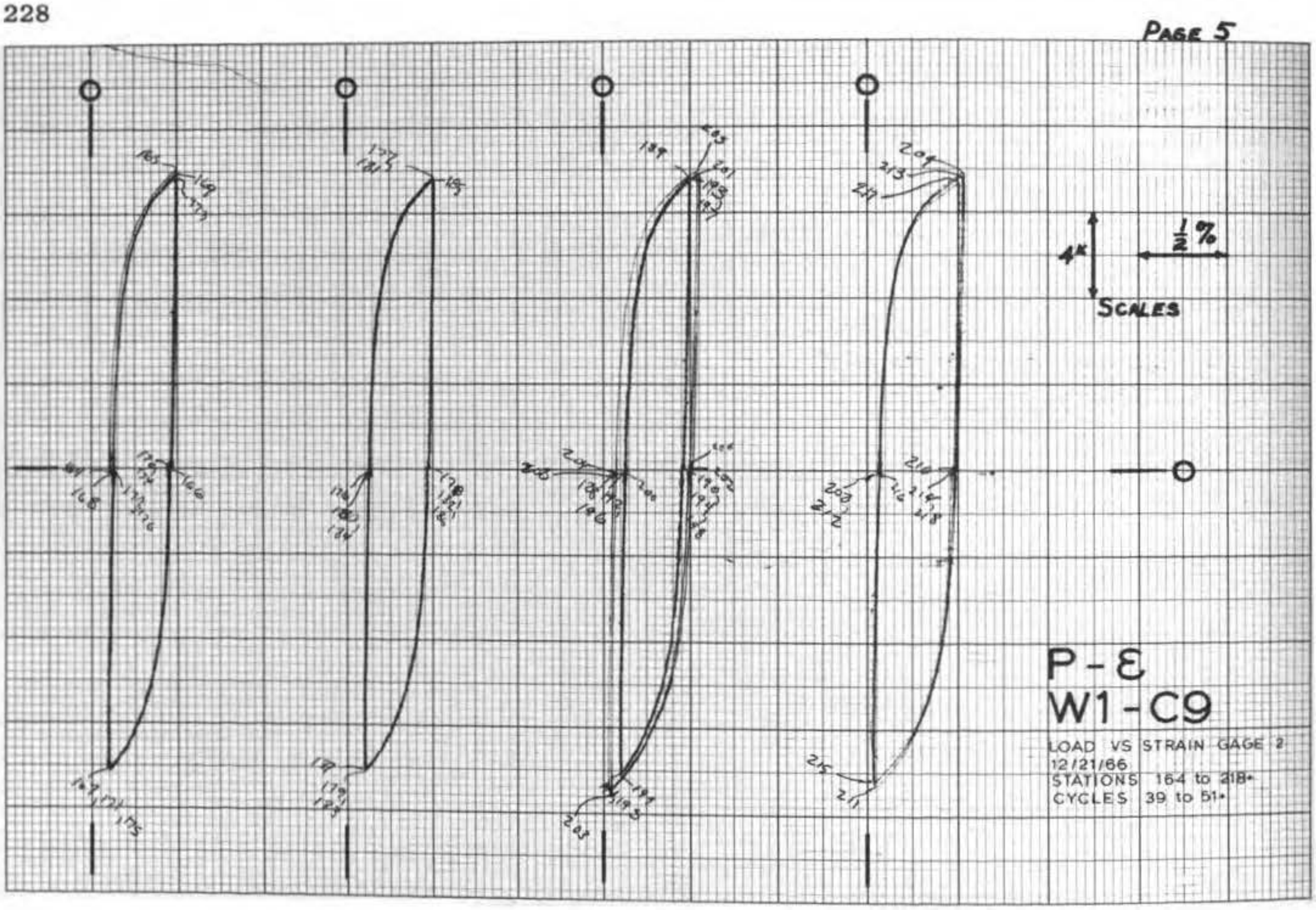
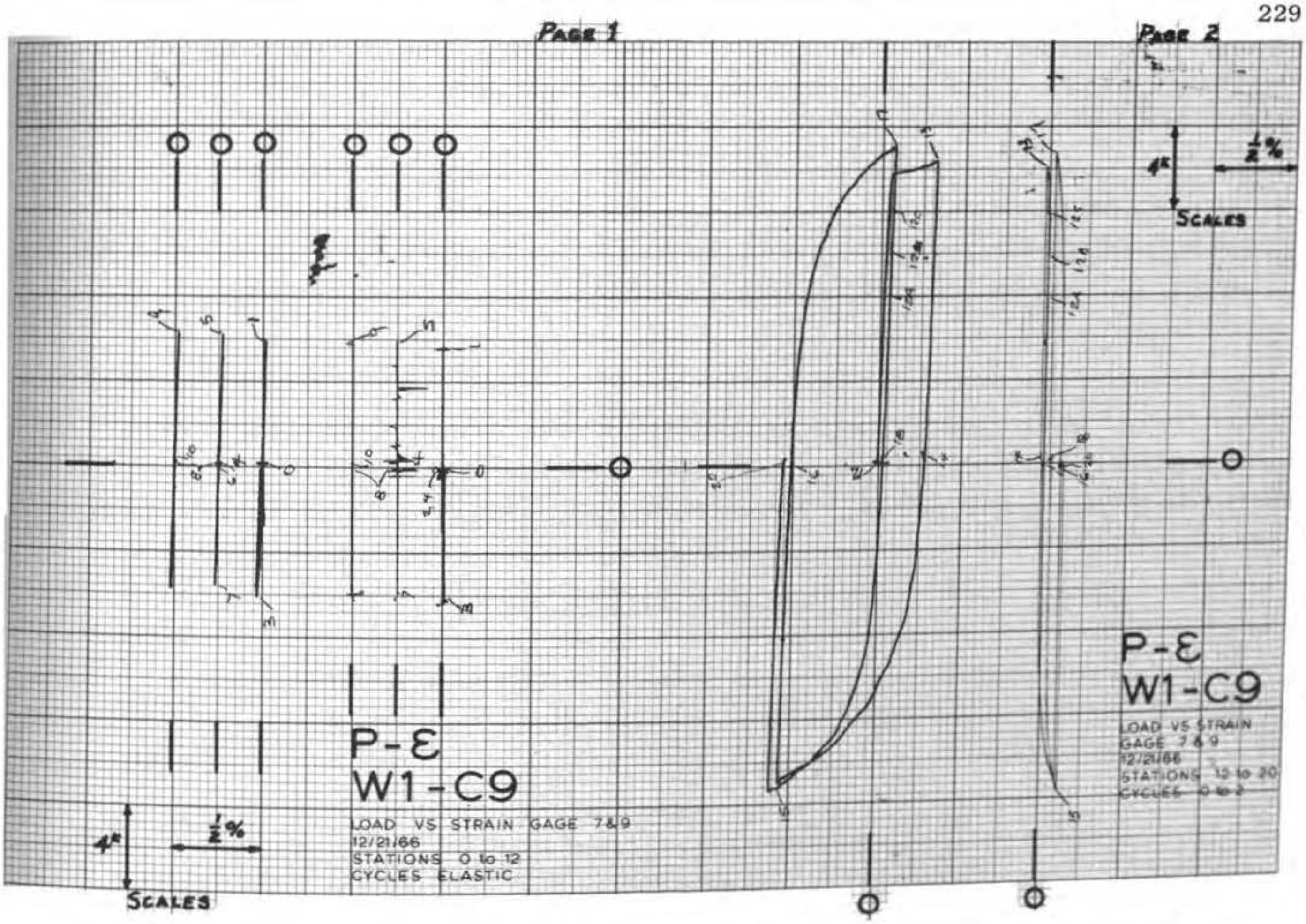


PLATE 27. (continued)



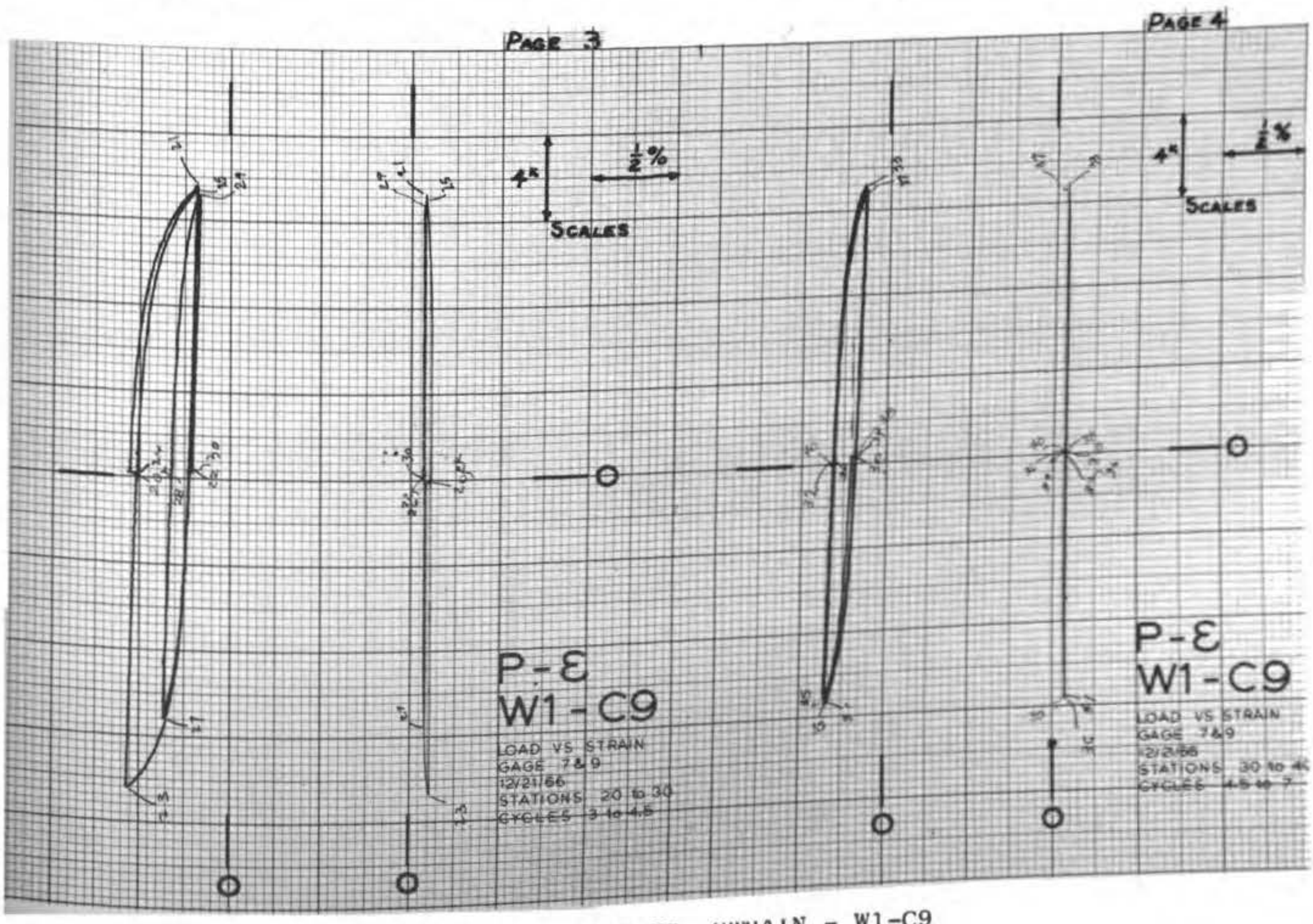
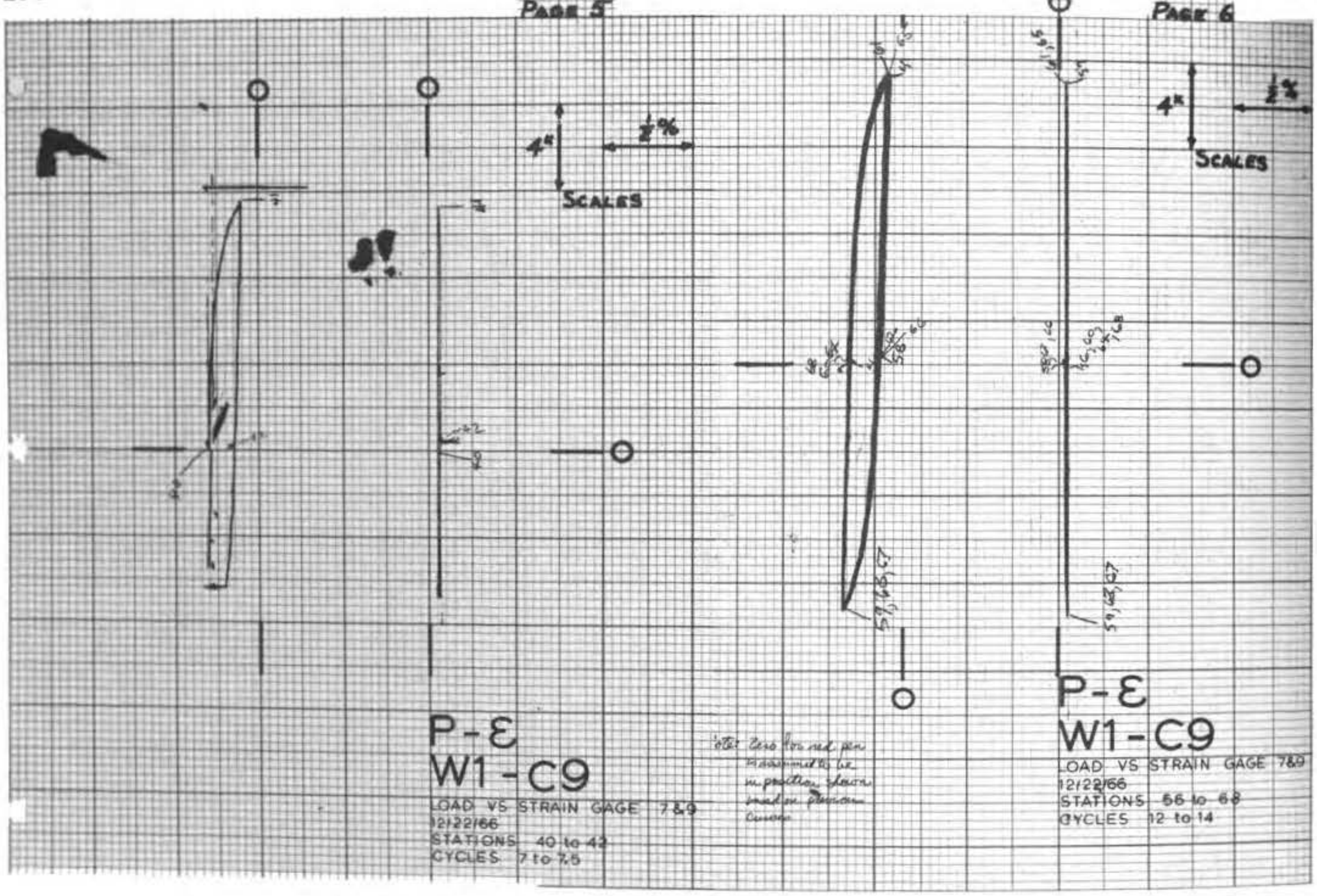


PLATE 28. LOAD VS. STRAIN - W1-C9



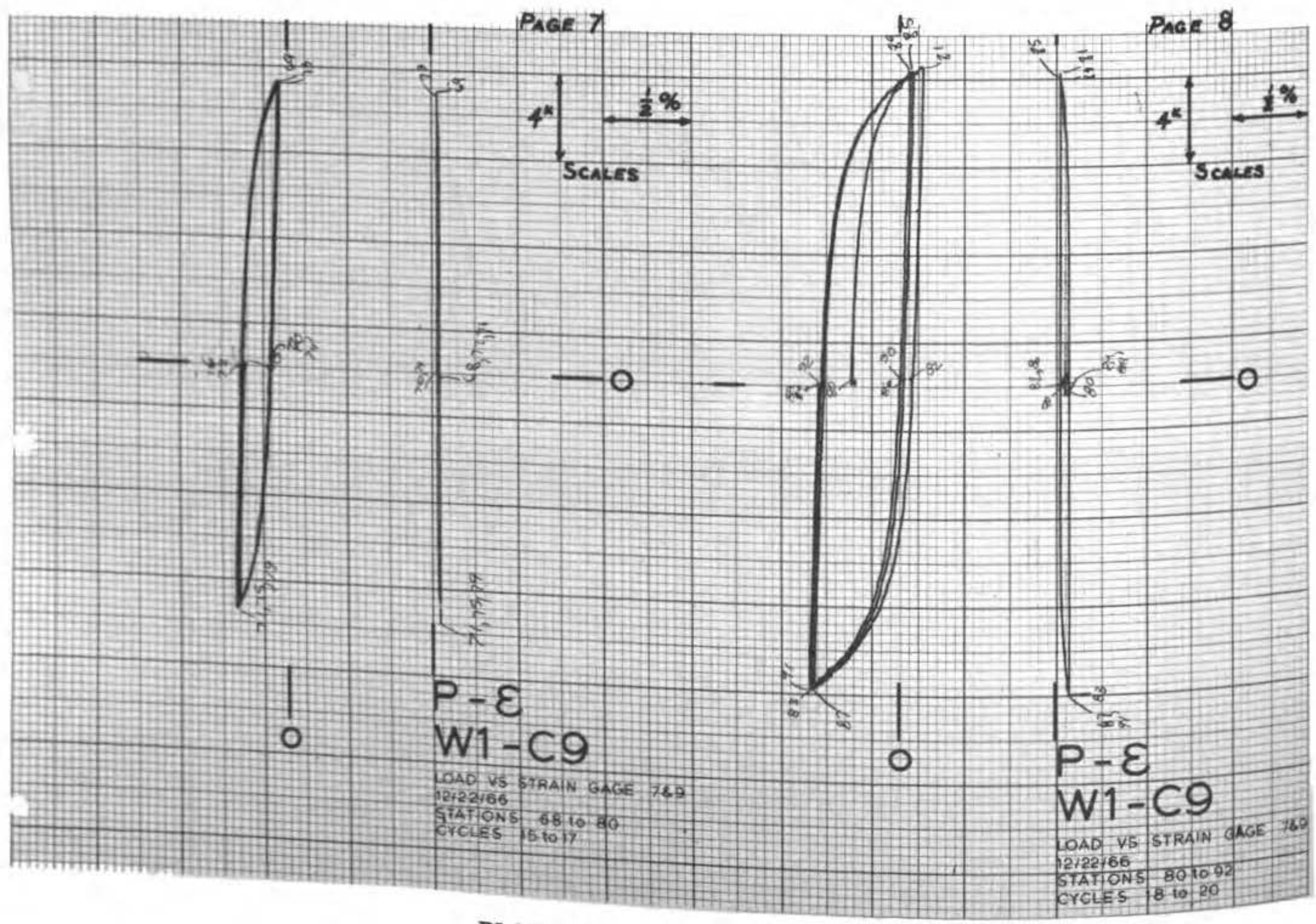
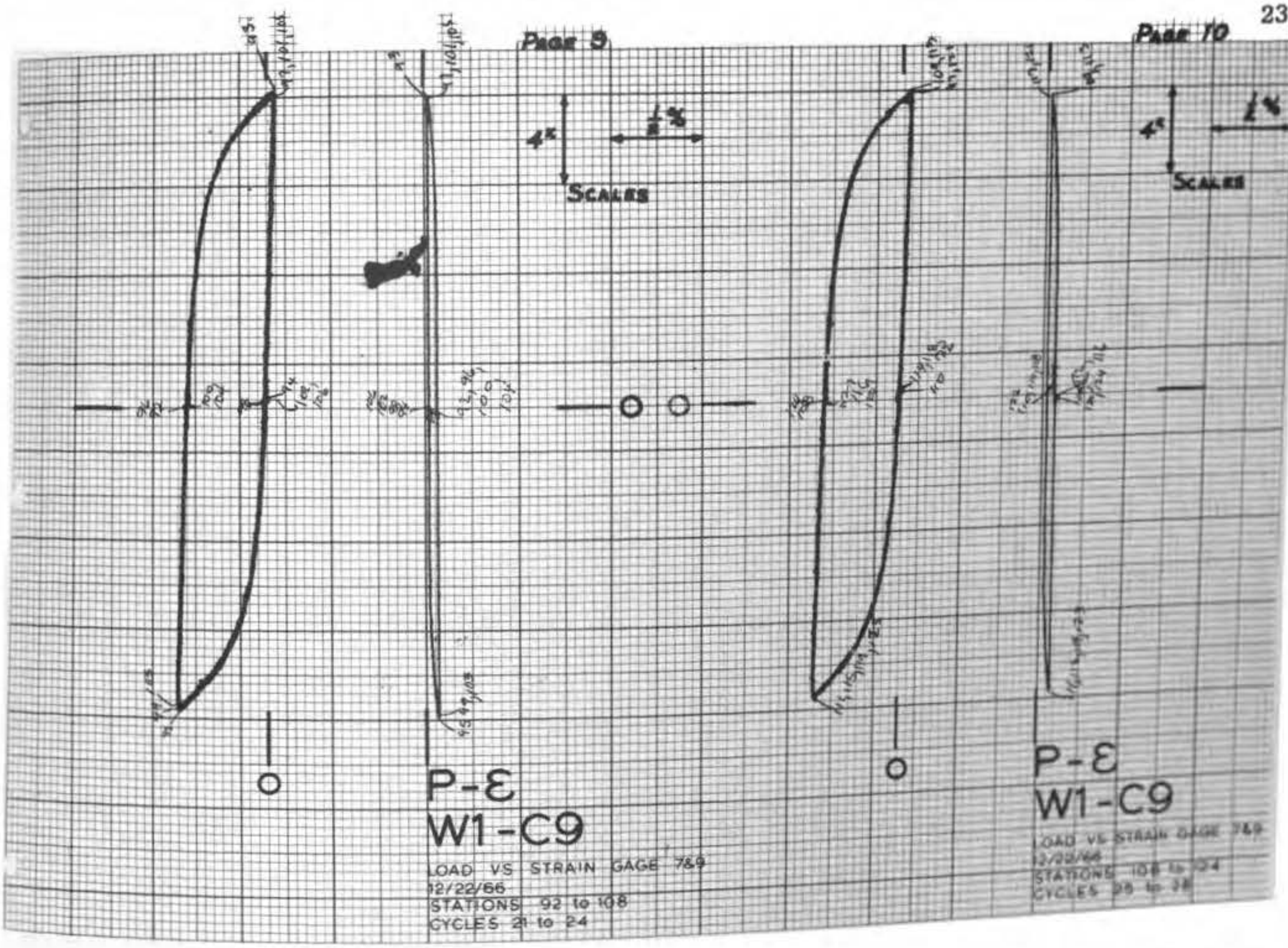


PLATE 28. (continued)



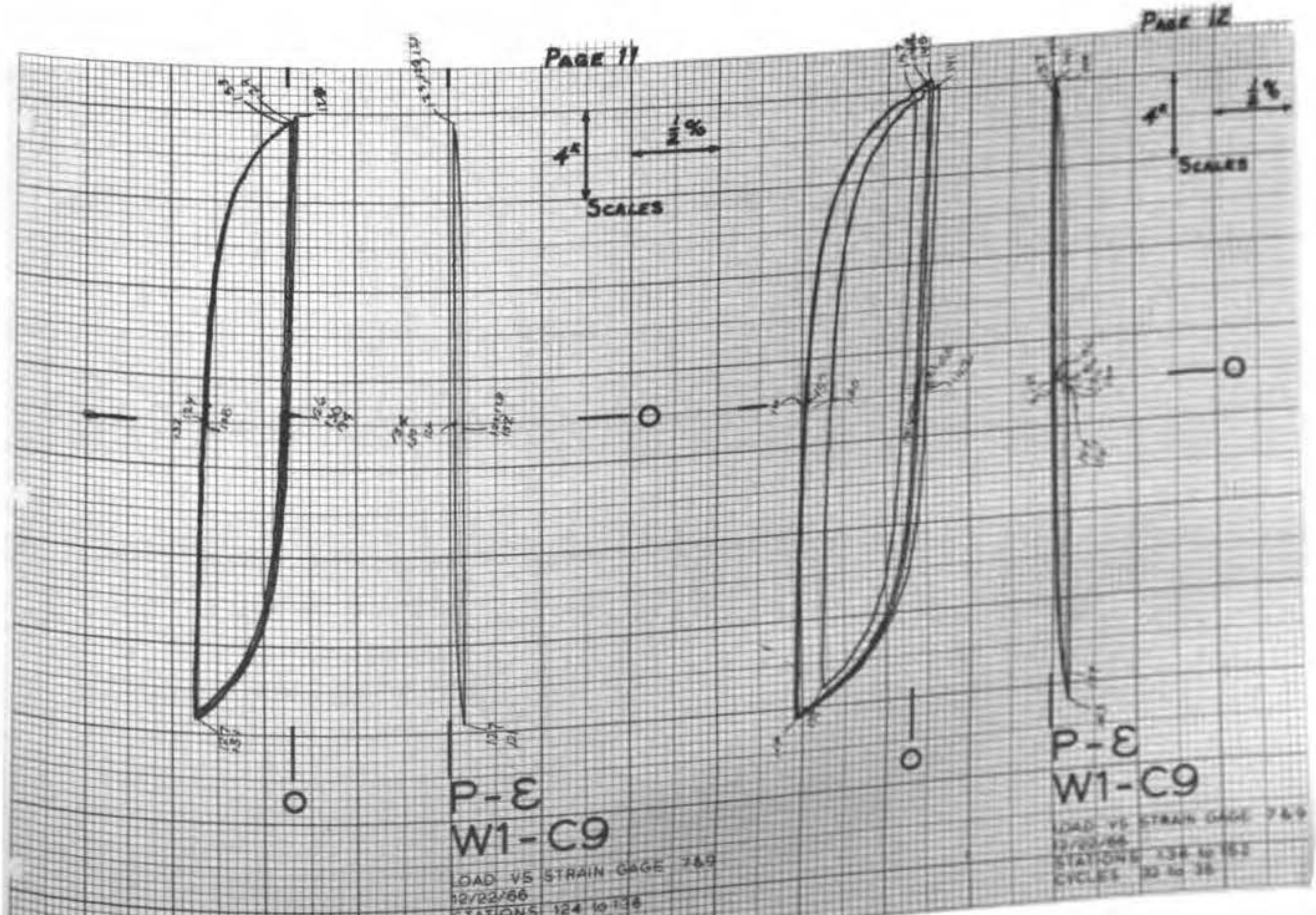
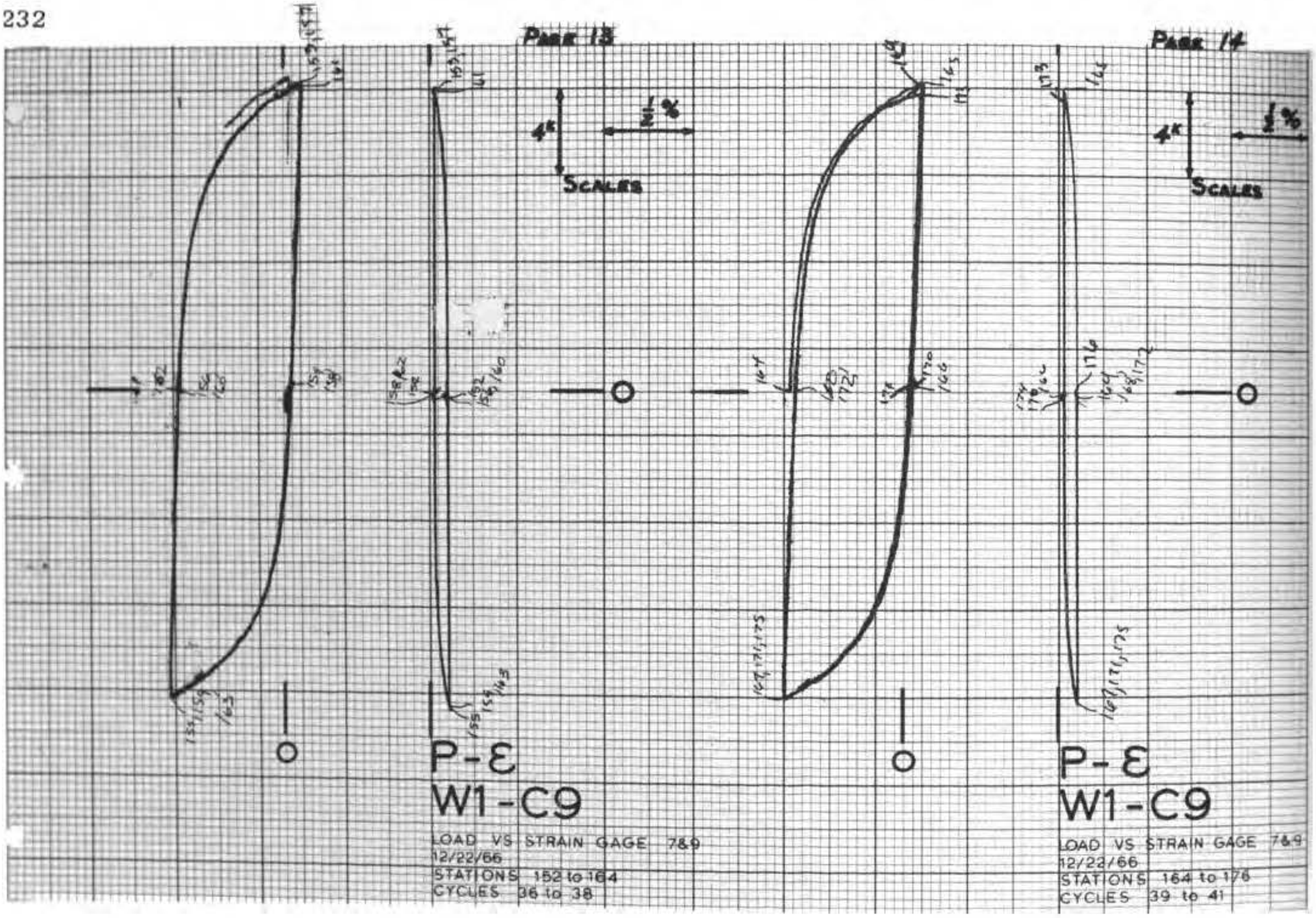


PLATE 28. (continued)



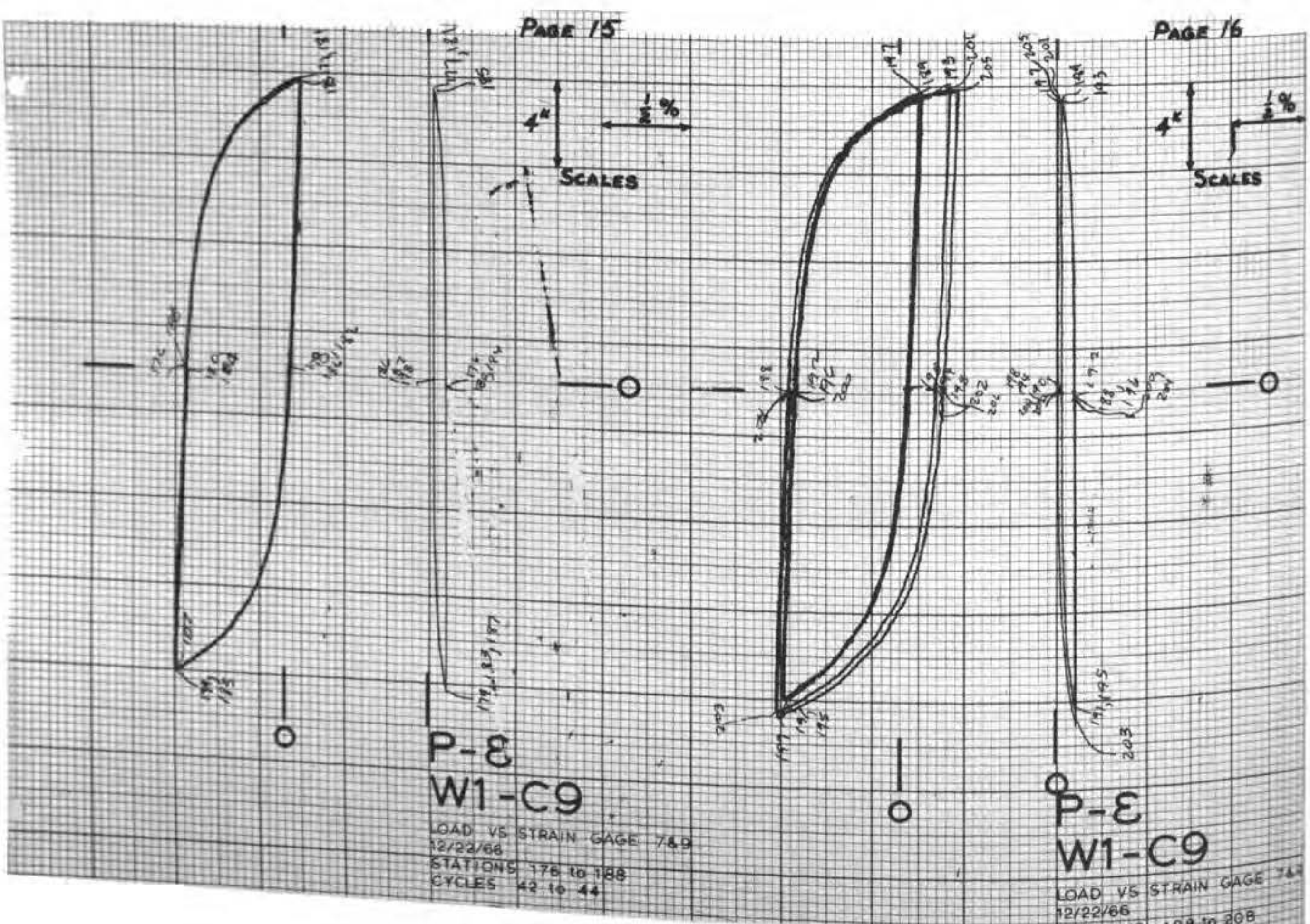
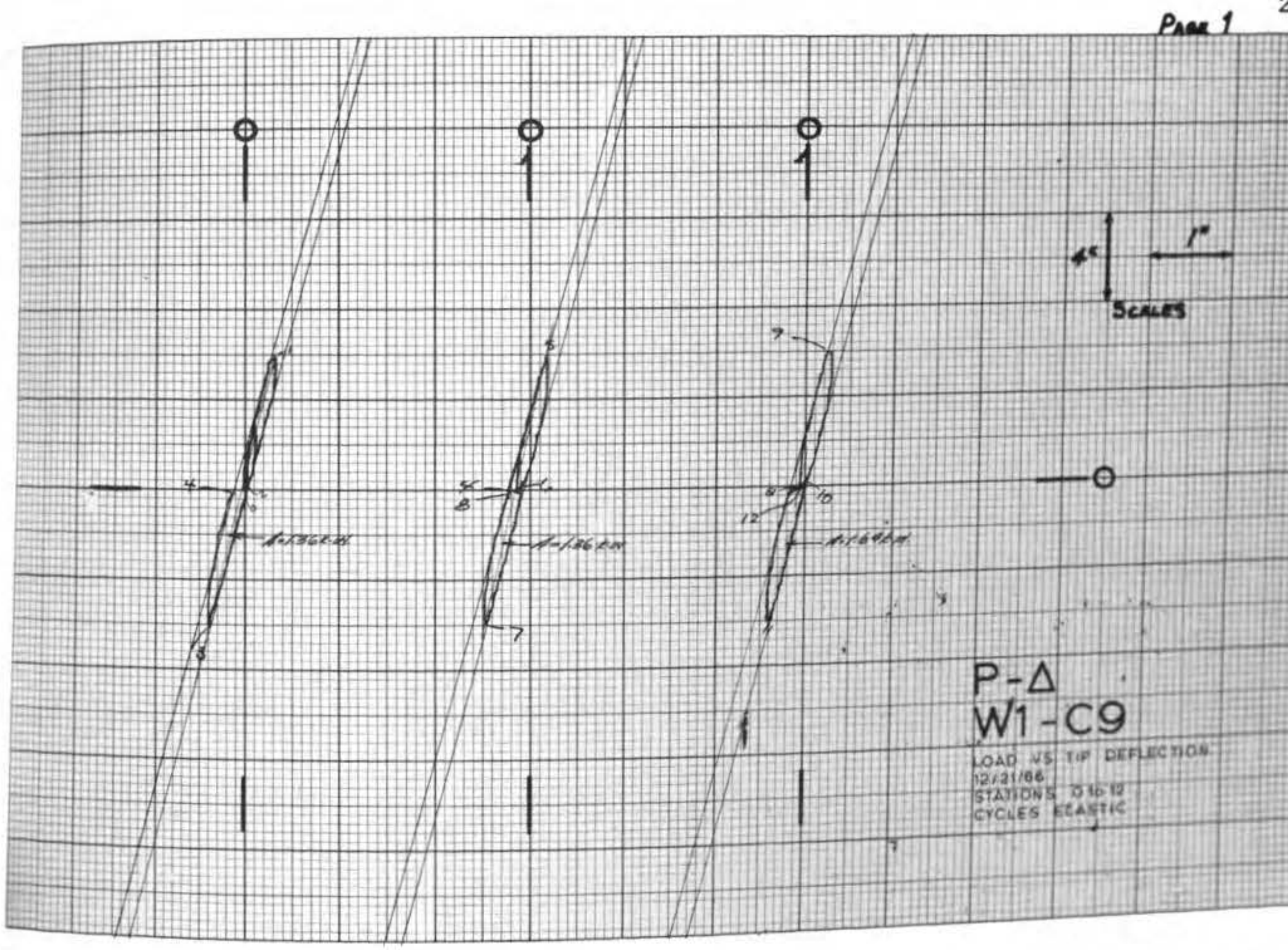


PLATE 28. (continued)



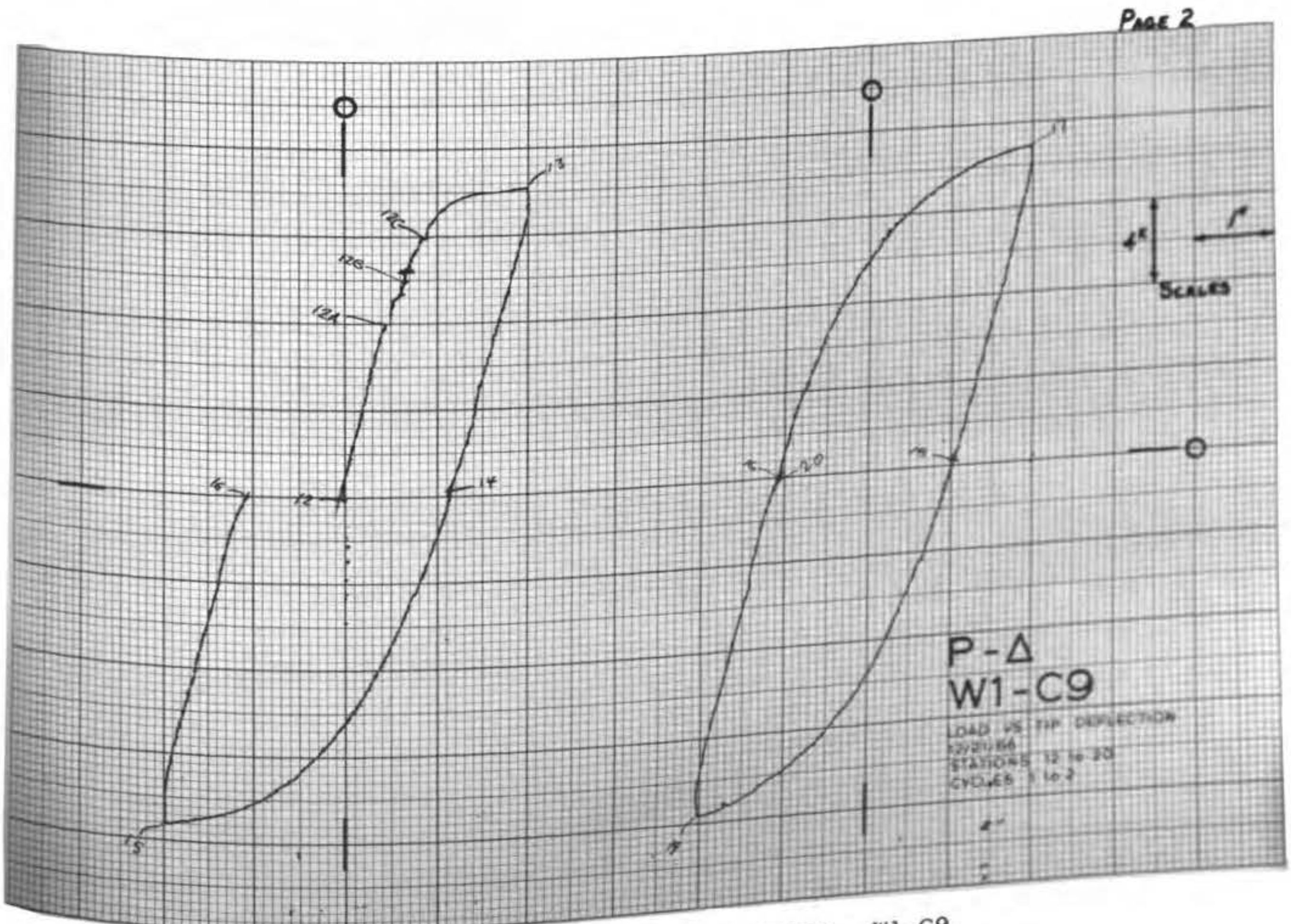
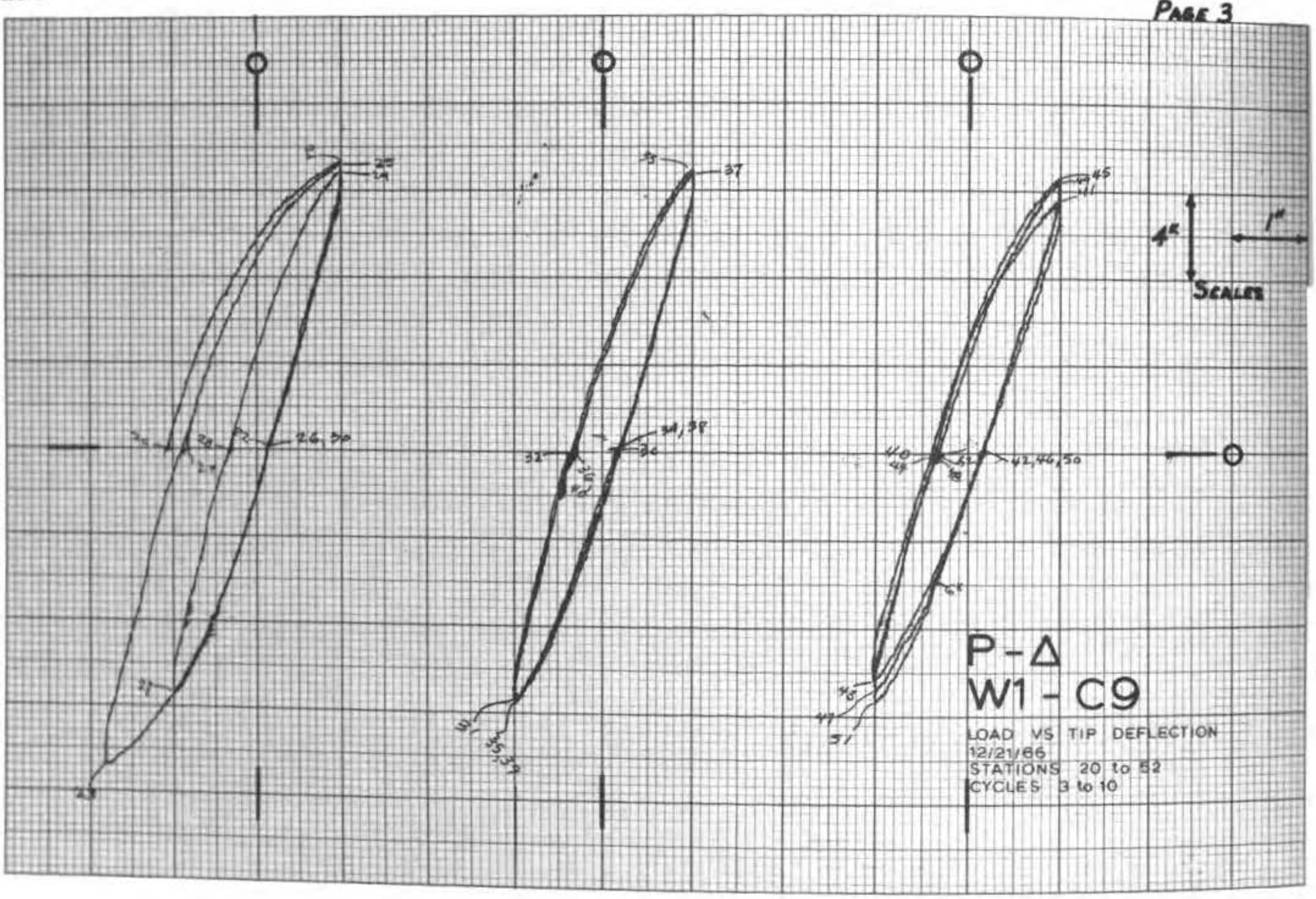


PLATE 29. LOAD VS. DEFLECTION - W1-C9



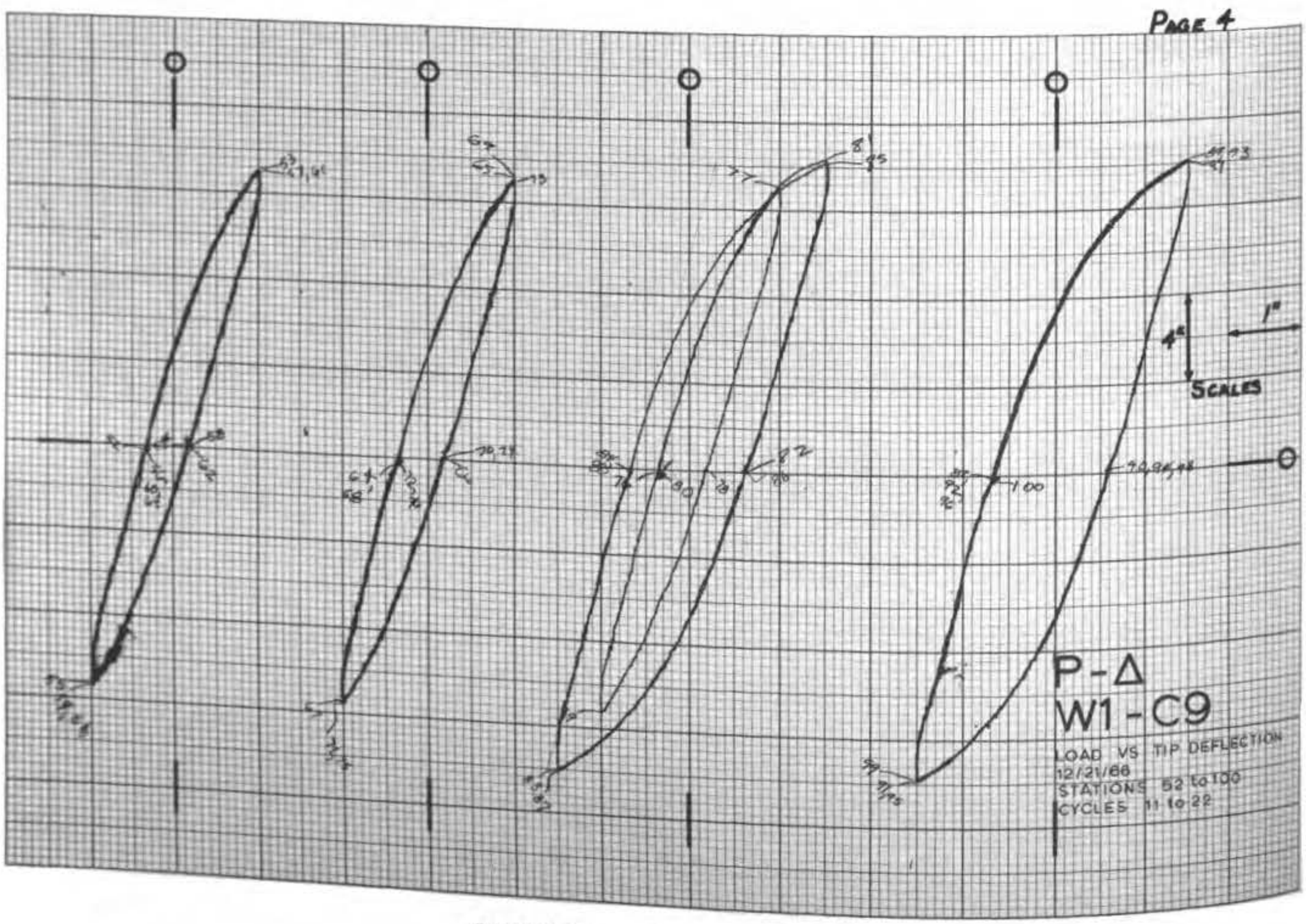
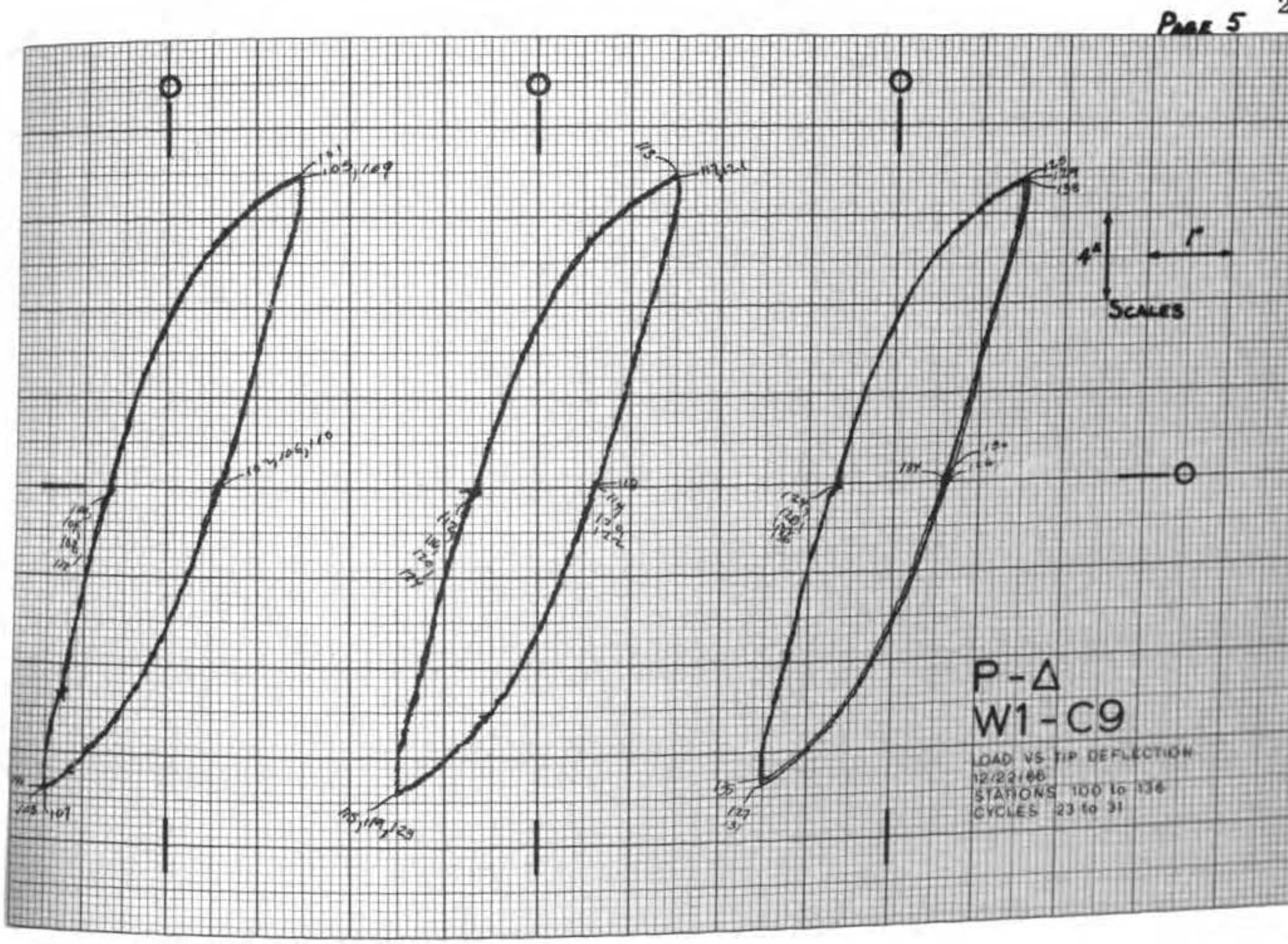


PLATE 29. (continued)



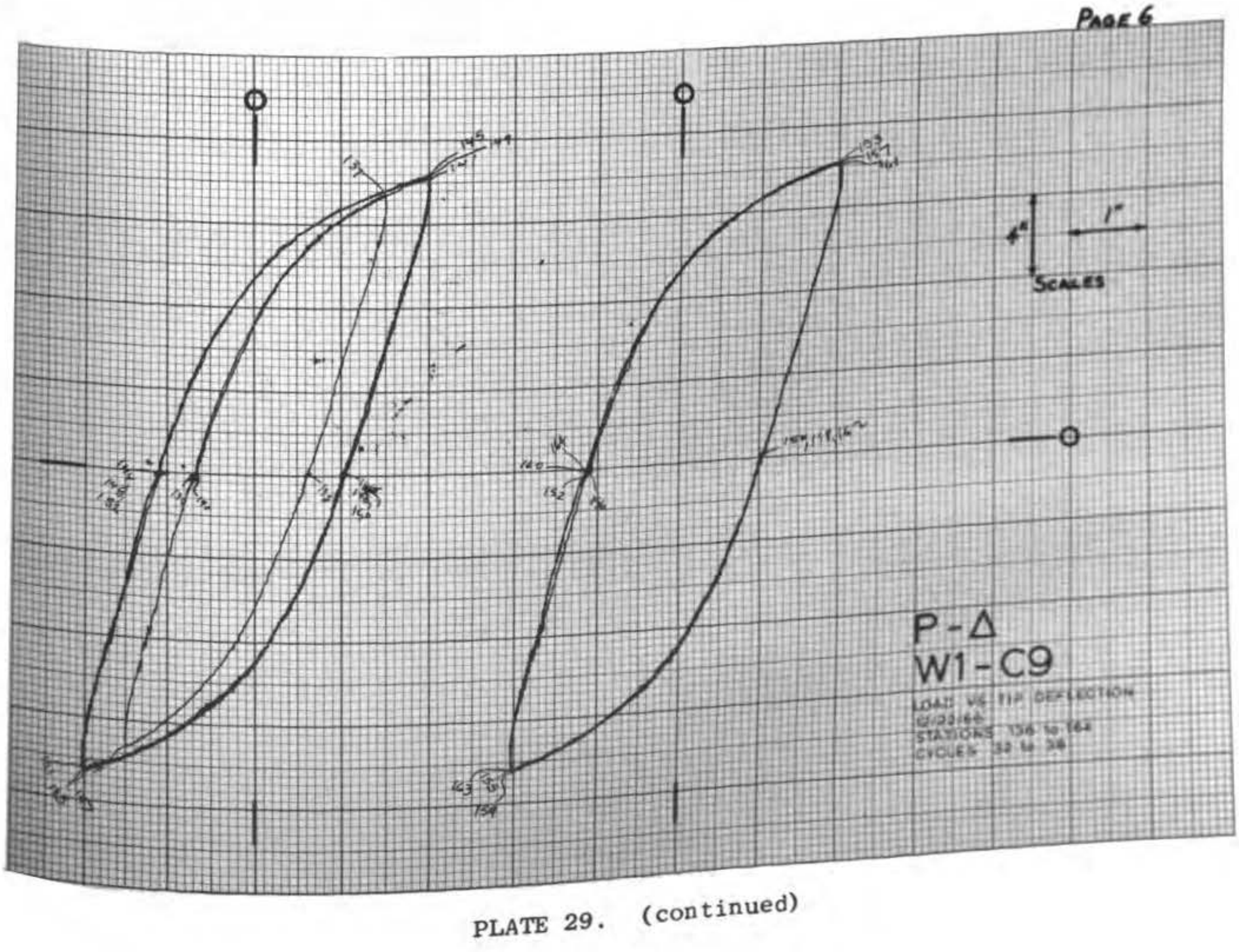
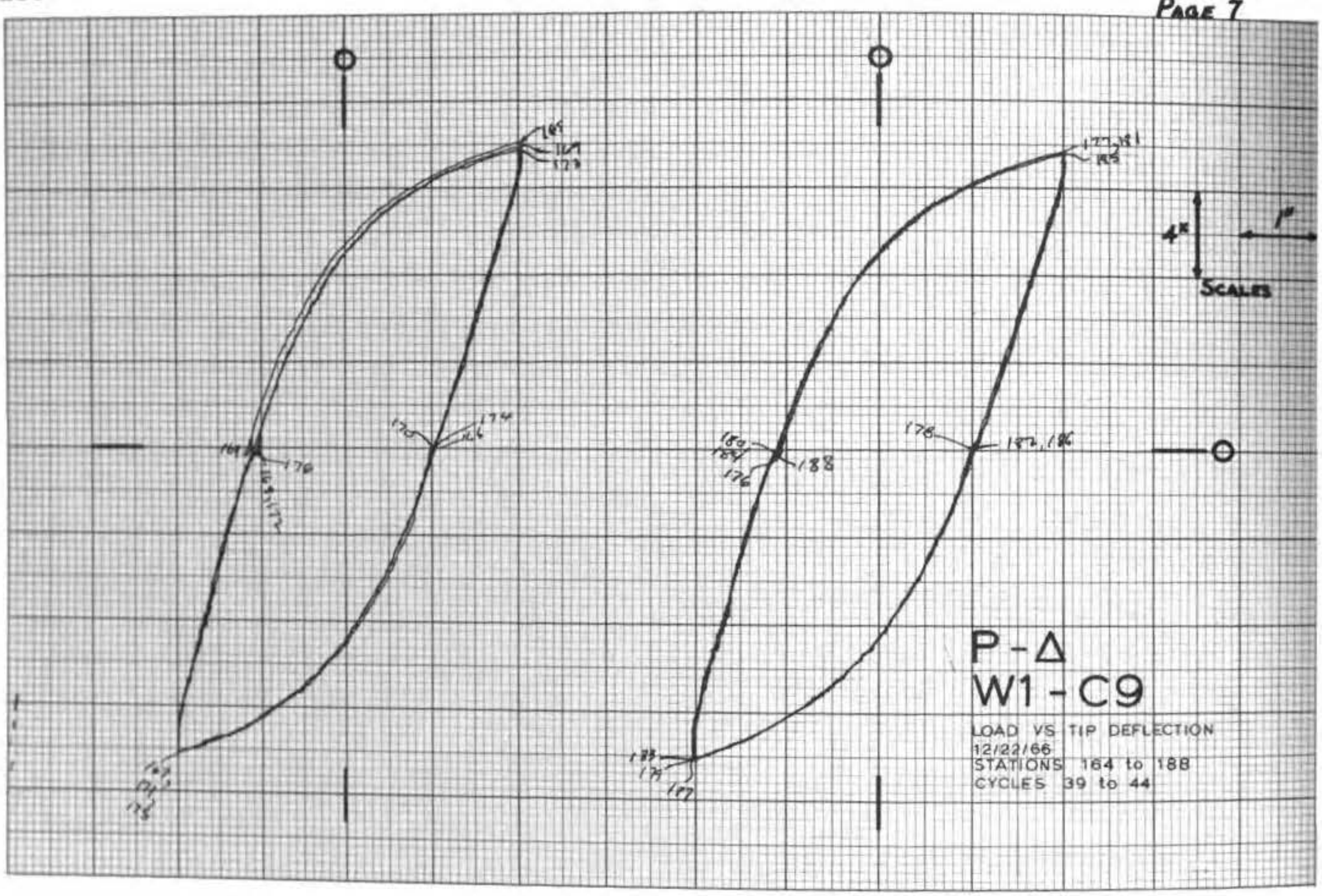


PLATE 29. (continued)



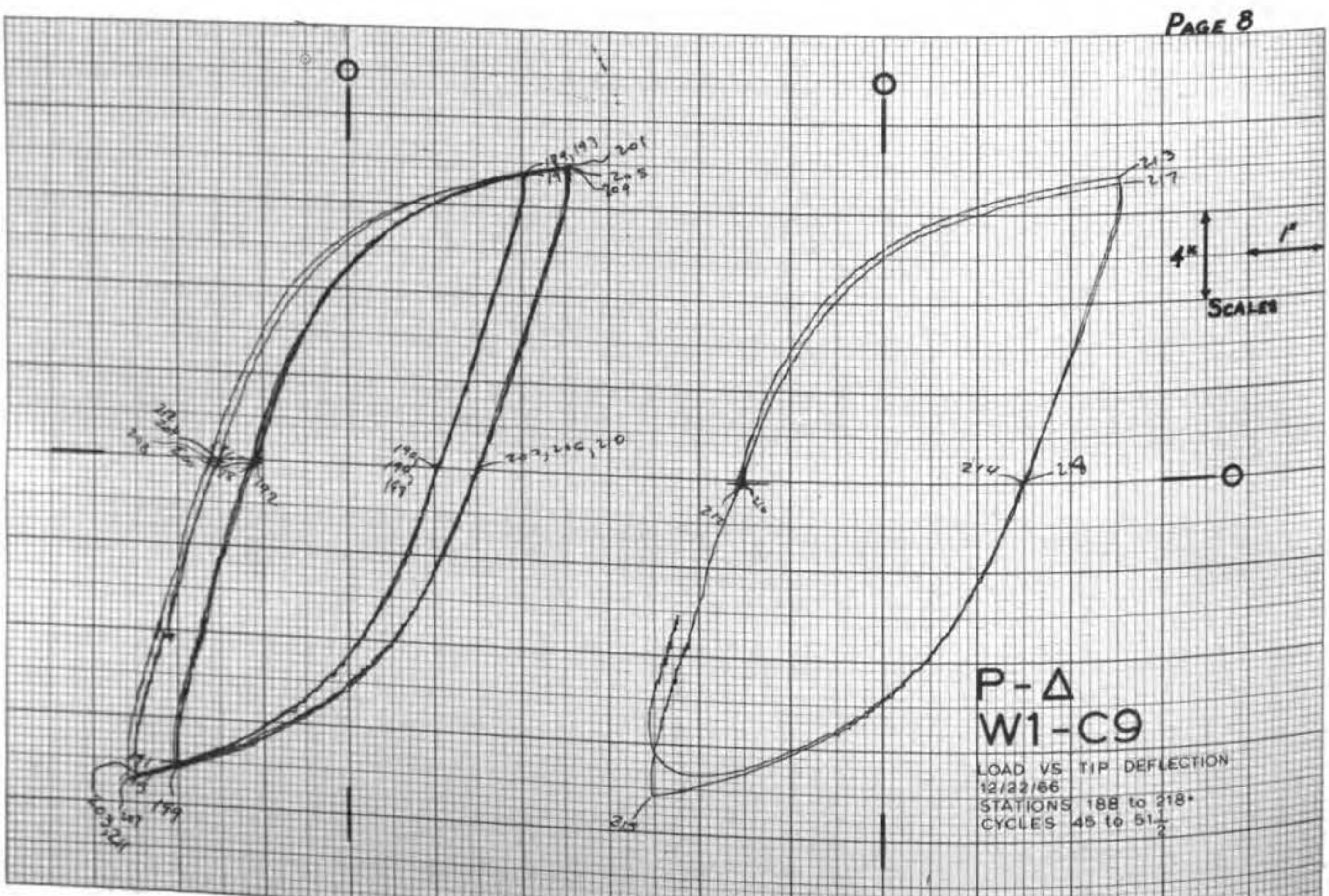


PLATE 29. (continued)

FIGURE 38. W1-C9

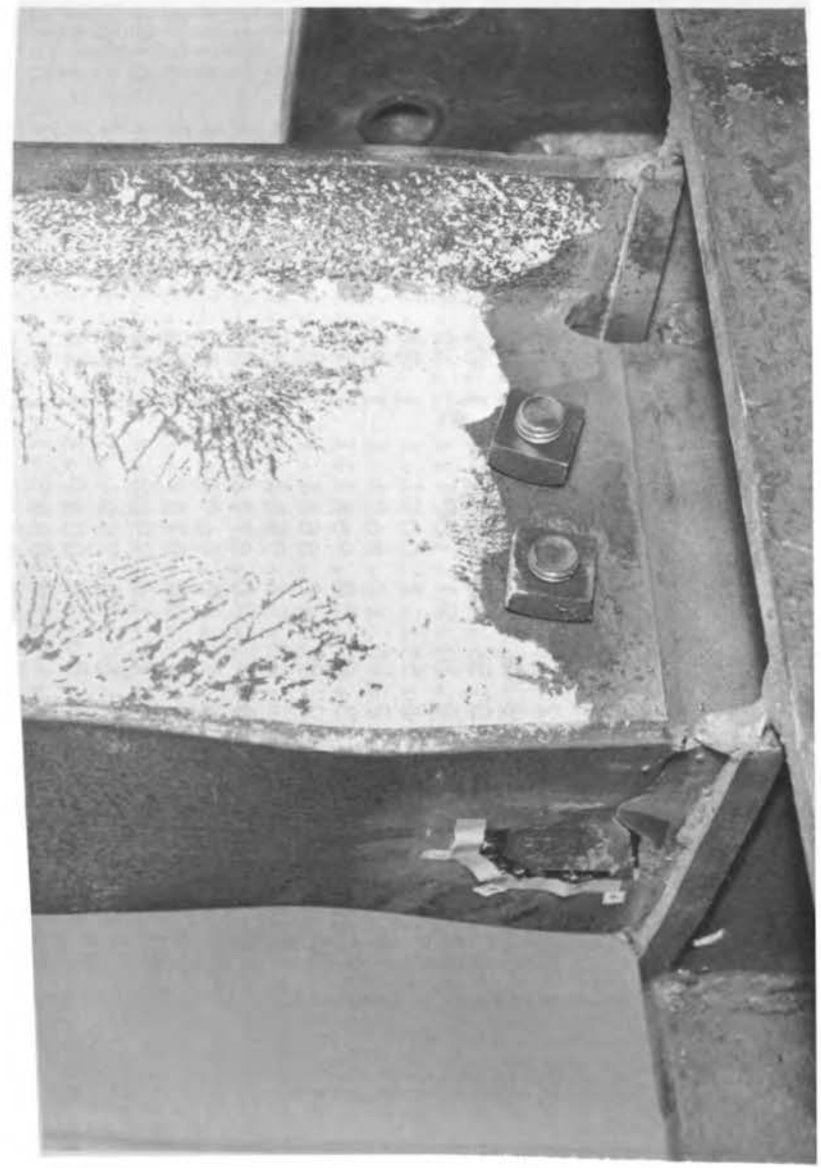


FIGURE 39. W1-C9

SPECIMEN W1-C9

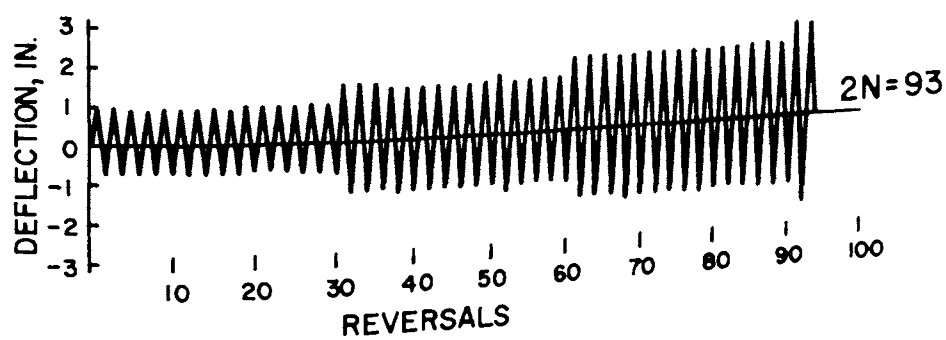
Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	13.45	1.83	1.19	13.7	1.067	2.98	1.93	3.54
2	-14.61	-1.68	2.05	25.2	-1.160	-2.73	3.34	6.50
3	14.16	1.81	1.95	22.5	1.124	2.94	3.16	5.80
4	-15.12	-1.70	1.96	23.0	-1.200	-2.77	3.18	5.93
5	12.80	0.85	1.07	10.5	1.016	1.38	1.74	2.70
6	-13.89	-1.52	0.89	10.1	-1.102	-2.47	1.44	2.60
7	12.66	0.85	0.89	8.5	1.005	1.38	1.44	2.19
8	-10.84	-0.76	0.31	2.9	-0.860	-1.23	0.50	0.74
9	12.40	0.86	0.31	3.6	0.984	1.39	0.50	0.93
10	-10.76	-0.76	0.33	2.8	-0.854	-1.24	0.54	0.72
11	12.51	0.85	0.39	3.8	0.993	1.38	0.64	0.99
12	-11.05	-0.76	0.35	3.0	-0.877	-1.23	0.58	0.78
13	12.21	0.85	0.36	3.4	0.969	1.39	0.58	0.87
14	-11.06	-0.76	0.36	3.0	-0.878	-1.23	0.58	0.78
15	12.50	0.91	0.38	3.7	0.992	1.47	0.62	0.97
16	-10.06	-0.76	0.42	2.6	-0.799	-1.23	0.68	0.66
17	12.66	0.89	0.41	4.3	1.005	1.44	0.67	1.11
18	-10.56	-0.73	0.34	2.4	-0.838	-1.18	0.56	0.62
19	12.42	0.89	0.34	3.3	0.986	1.45	0.56	0.85
20	-10.63	-0.72	0.35	2.5	-0.844	-1.17	0.56	0.65
21	12.72	0.89	0.36	3.8	1.010	1.44	0.58	0.97
22	-10.61	-0.73	0.35	2.7	-0.842	-1.19	0.57	0.71
23	12.50	0.89	0.35	3.7	0.992	1.45	0.57	0.96
24	-10.68	-0.73	0.35	2.7	-0.848	-1.19	0.58	0.69
25	12.41	0.89	0.35	3.7	0.985	1.45	0.58	0.94
26	-10.67	-0.73	0.35	2.7	-0.847	-1.19	0.57	0.69
27	12.63	0.92	0.40	4.1	1.002	1.49	0.66	1.07
28	-10.74	-0.70	0.40	2.9	-0.852	-1.14	0.66	0.75
29	12.57	0.92	0.40	4.1	0.997	1.49	0.66	1.06
30	-10.84	-0.70	0.40	2.9	-0.860	-1.13	0.66	0.75
31	12.41	0.92	0.40	4.1	0.985	1.50	0.66	1.05
32	-10.72	-0.70	0.41	2.9	-0.851	-1.13	0.66	0.74
33	12.46	0.87	0.40	3.3	0.989	1.41	0.65	0.85
34	-10.57	-0.69	0.40	2.7	-0.839	-1.13	0.65	0.69
35	13.94	1.42	0.83	10.0	1.106	2.30	1.36	2.59
36	-13.28	-1.14	1.15	10.9	-1.054	-1.86	1.88	2.82
37	13.80	1.42	1.16	12.5	1.095	2.31	1.88	3.24
38	-13.39	-1.14	1.15	11.0	-1.063	-1.86	1.88	2.83
39	13.69	1.38	1.11	12.4	1.087	2.24	1.80	3.19
40	-13.33	-1.16	1.12	11.1	-1.058	-1.89	1.83	2.86
41	13.69	1.38	1.13	12.0	1.086	2.24	1.83	3.09
42	-13.32	-1.16	1.13	11.0	-1.057	-1.89	1.83	2.85
43	13.61	1.38	1.13	11.8	1.080	2.25	1.83	3.04
44	-13.34	-1.16	1.13	11.0	-1.058	-1.89	1.83	2.85
45	13.60	1.37	1.12	12.0	1.079	2.24	1.83	3.10
46	-13.16	-1.18	1.15	10.9	-1.045	-1.92	1.86	2.81
47	13.52	1.38	1.15	12.0	1.073	2.24	1.86	3.10
48	-13.24	-1.18	1.15	10.9	-1.051	-1.92	1.86	2.82
49	13.55	1.38	1.15	12.0	1.076	2.24	1.86	3.10
50	-13.24	-1.18	1.15	10.9	-1.051	-1.92	1.86	2.81
51	13.61	1.36	1.17	12.2	1.080	2.22	1.90	3.14

Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
52	−13.24	−1.19	1.16	11.3	−1.051	−1.94	1.89	2.93
53	13.50	1.37	1.16	12.1	1.071	2.22	1.89	3.13
54	−13.20	−1.19	1.16	11.3	−1.047	−1.94	1.89	2.92
55	13.56	1.37	1.16	12.2	1.076	2.22	1.89	3.14
56	−13.16	−1.19	1.16	11.2	−1.044	−1.94	1.89	2.90
57	13.53	1.39	1.16	12.6	1.074	2.26	1.88	3.25
58	−13.20	−1.21	1.19	12.0	−1.048	−1.97	1.93	3.09
59	13.39	1.36	1.17	12.2	1.062	2.21	1.89	3.16
60	−13.16	−1.21	1.17	11.7	−1.044	−1.97	1.89	3.02
61	13.23	1.33	1.15	11.9	1.050	2.17	1.86	3.08
62	−12.98	−1.22	1.14	11.2	−1.030	−1.98	1.86	2.90
63	13.36	1.34	1.15	12.0	1.060	2.18	1.88	3.09
64	−13.06	−1.23	1.15	10.7	−1.037	−1.99	1.88	2.77
65	14.14	1.83	1.57	17.8	1.122	2.97	2.55	4.60
66	−14.35	−1.73	1.98	21.6	−1.139	−2.81	3.23	5.59
67	14.35	1.83	1.98	22.9	1.139	2.97	3.23	5.92
68	−11.39	−1.73	1.98	17.2	−0.904	−2.81	3.23	4.43
69	14.27	1.83	1.98	22.6	1.132	2.97	3.23	5.83
70	−14.40	−1.73	1.98	21.7	−1.143	−2.81	3.23	5.59
71	14.38	1.85	1.99	22.9	1.141	3.01	3.23	5.92
72	−14.42	−1.75	1.98	21.9	−1.145	−2.84	3.23	5.66
73	14.38	1.85	1.98	23.1	1.141	3.01	3.23	5.96
74	−14.55	−1.74	2.03	22.0	−1.155	−2.84	3.30	5.68
75	14.29	1.85	2.03	22.9	1.134	3.01	3.30	5.90
76	−14.43	−1.75	2.03	21.9	−1.145	−2.84	3.29	5.66
77	14.31	1.89	2.06	23.2	1.135	3.08	3.35	5.99
78	−14.23	−1.68	1.97	21.3	−1.129	−2.73	3.20	5.49
79	14.12	1.87	1.97	22.1	1.120	3.05	3.20	5.70
80	−14.22	−1.68	1.97	21.2	−1.128	−2.73	3.20	5.47
81	13.96	1.87	1.97	21.7	1.108	3.04	3.20	5.60
82	−14.24	−1.68	1.97	21.2	−1.130	−2.73	3.20	5.48
83	13.91	1.86	1.94	21.5	1.104	3.02	3.15	5.56
84	−14.23	−1.70	1.98	21.2	−1.129	−2.76	3.21	5.48
85	13.91	1.86	2.00	21.5	1.104	3.02	3.25	5.56
86	−14.23	−1.72	2.00	21.2	−1.129	−2.80	3.24	5.46
87	13.84	1.86	2.00	21.5	1.098	3.02	3.25	5.56
88	−14.22	−1.72	2.00	21.1	−1.128	−2.80	3.25	5.46
89	13.84	1.82	1.96	22.2	1.098	2.96	3.18	5.72
90	−14.21	−1.74	1.99	21.9	−1.128	−2.83	3.23	5.64
91	13.78	1.82	1.99	22.1	1.093	2.96	3.23	5.71
92	−14.24	−1.74	2.01	21.9	−1.130	−2.83	3.26	5.65
93	13.75	1.84	2.01	22.3	1.092	3.00	3.27	5.76
94	−14.29	−1.78	2.03	27.0	−1.134	−2.90	3.30	6.96
95	14.09	2.32	2.51	29.2	1.119	3.77	4.08	7.55
96	−14.94	−2.23	2.88	33.3	−1.186	−3.63	4.69	8.60
97	14.21	2.34	2.89	33.8	1.128	3.80	4.69	8.72
98	−15.19	−2.32	2.99	33.1	−1.206	−3.77	4.86	8.53
99	14.13	2.34	2.99	34.8	1.122	3.80	4.86	8.97
100	−14.85	−2.23	2.89	35.0	−1.178	−3.63	4.69	9.02
101	13.97	2.40	2.93	34.1	1.108	3.90	4.77	8.80
102	−14.56	−2.20	2.87	32.0	−1.156	−3.58	4.67	8.27
103	13.66	2.41	2.89	32.5	1.084	3.92	4.69	8.38

SPECIMEN W2A-C7

Description: This specimen was similar to specimen W1-C7 with exceptions as noted. The flange connecting plates had special geometries; one plate was tapered from the inside depth of the column to the width of the beam flange, while the other achieved the same width reduction in a single step with one-inch radius fillets. The suffix "A" indicates that the tapered plate was at the top flange and the filleted plate at the bottom flange, of the beam. All three plates extended past the edges of the column flanges, with the web plate extending past the edges of the flange plates. The off-center web plate caused misalignment of flanges and flange plates. Ultrasonic inspection disclosed no significant weld defects.

Program of Cycling:



Test Control: Tip deflection.

Raw Data Included: Graphical load-deflection data.

Graphical load-strain data measured by gage No. 15 in the center of the top flange at a distance of 6.94 inches from the column web face.

Graphical load-strain data measured by gage No. 16 in the center of the bottom flange at a distance of 6.86 inches from the column web face.

Total Energy Absorption: 1,189 kip-inches.

Plastic Load Reversals to Failure: 93 ($46\frac{1}{2}$ cycles).

Remarks: No cracks were visible after the first half-cycle at $1\frac{1}{2}$ inch tip deflection (16th plastic cycle); however, there was slight buckling of the lower flange. During the 18th cycle, upward buckling of one edge of the bottom connecting plate was noted. About the 24th cycle, a crack was observed at one end of the weld between the column flange and the top connecting plate, as well as between the same connecting plate and the beam flange. After 30 cycles, two cracks became visible in the fillet or curved part of the bottom plate; one of these initiated at a cutting torch gouge. Failure was caused by the propagation of the latter crack across the flange connecting plate and into the web plate.

SPECIMEN TYPE W2A-C7

DIMENSIONS OF WF SECTION

DEPTH	8.17	INCHES
TOP FLANGE WIDTH	5.330	INCHES
BOTTOM FLANGE WIDTH	5.310	INCHES
TOP FLANGE THICKNESS	0.353	INCHES
BOTTOM FLANGE THICKNESS	0.352	INCHES
WEB THICKNESS	0.274	INCHES
ELASTIC MODULUS	29200.	KSI
YIELD STRESS	44.100	KSI

DIMENSIONS AND PROPERTIES OF PLATES

LENGTH OF TOP PLATE*, LTP	5.36	INCHES
THICKNESS OF TOP PLATE, TTP	0.370	INCHES
LENGTH OF BOTTOM PLATE*, LBP	5.34	INCHES
THICKNESS OF BOTTOM PLATE, TBP	0.370	INCHES
THICKNESS OF WEB PLATE, TWP	0.250	INCHES
ELASTIC MODULUS OF PLATES, EP	29200.	KSI
YIELD STRESS OF PLATES, SYP	43.700	KSI

*MEASURED FROM FACE OF COLUMN WEB

WF SECTION PROPERTIES

AREA, A	5.89	INCHES**2
LOCATION OF CENTROID*, YE	4.10	INCHES
MOMENT OF INERTIA, I	68.1	INCHES**4
SECTION MODULUS, TOP, ST	16.7	INCHES**3
SECTION MODULUS, BOTTOM, SB	16.6	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . . .	4.11	INCHES
PLASTIC MODULUS, Z	18.8	INCHES**3
SHAPE FACTOR	1.131	
YIELD MOMENT, MY	61.12	KIP-FT.
PLASTIC MOMENT, MP	69.15	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

SPECIMEN TYPE W2A-C7

SECTION PROPERTIES AT SELECTED CROSS-SECTIONS

X	A	YE	I	ST	SB
64.71	5.89	4.10	68.1	16.7	16.6
64.71	5.89	4.09	69.8	17.1	17.1
65.46	6.09	4.22	72.8	18.4	17.3
66.20	6.29	4.34	75.6	19.7	17.4
66.59	6.45	4.36	77.9	20.4	17.9
66.91	6.70	4.30	81.8	21.1	19.0
67.13	6.99	4.19	86.6	21.7	20.6
67.20	7.23	4.09	90.2	22.1	22.1

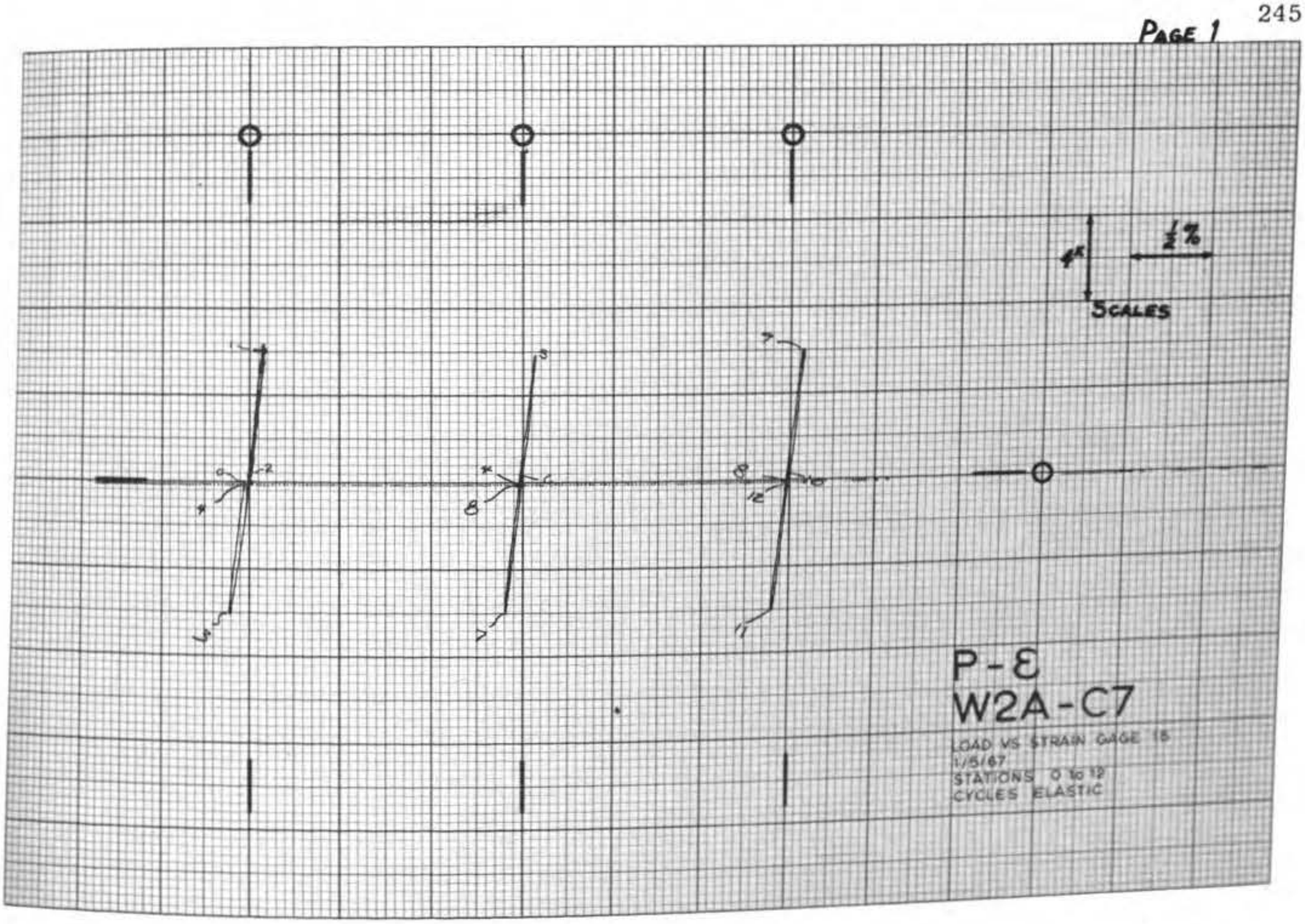
X	YP	Z	F	MY	MP
64.71	4.11	18.8	1.131	61.12	69.15
64.71	4.09	19.2	1.122	62.23	69.80
65.46	4.49	19.9	1.153	62.88	72.50
66.20	4.89	20.6	1.180	63.46	74.90
66.59	4.98	21.1	1.183	65.10	77.02
66.91	4.83	22.2	1.167	69.21	80.75
67.13	4.47	23.4	1.135	75.19	85.36
67.20	4.09	24.4	1.105	80.35	88.77

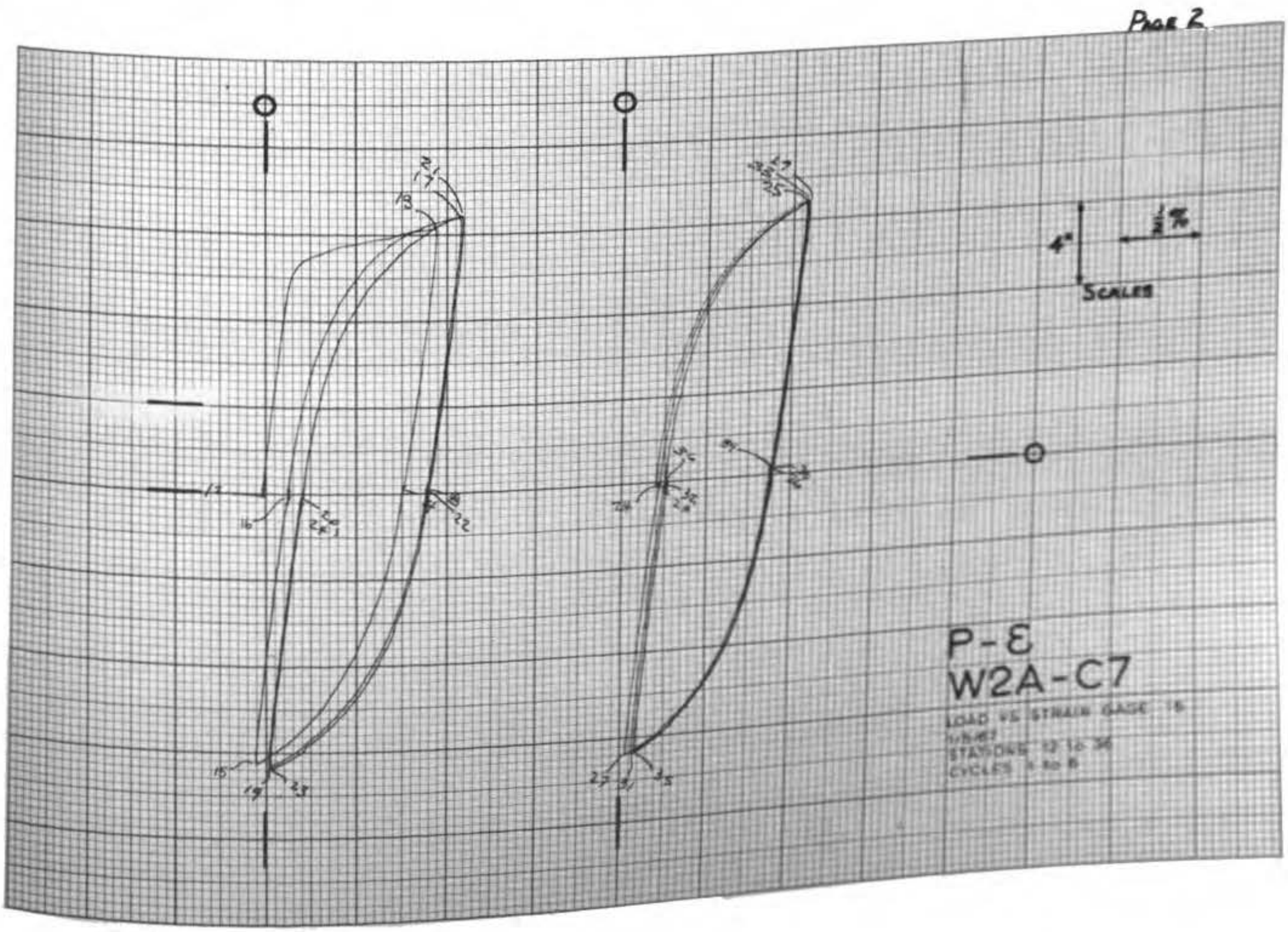
X = DISTANCE FRCM CONCENTRATED LOAD, INCHES
A = AREA OF CRCSS-SECTION, INCHES**2
YE = DIST. FROM CUTSIDE OF BOTTOM PLATE TO CENTROID, INCHES
I = MOMENT OF INERTIA, INCHES**4
ST = SECTICN MCDULUS FOR TOP FLANGE, INCHES**3
SB = SECTICN MCDULUS FOR BOTTOM FLANGE, INCHES**3
YP = DIST. FROM OUTSIDE OF BOTTOM PLATE TO PLASTIC N.A., IN.
Z = PLASTIC MCDULUS, INCHES**3
F = SHAPE FACTCR
MY = YIELD MCMENT, KIP-FEET
MP = PLASTIC MCMENT, KIP-FEET

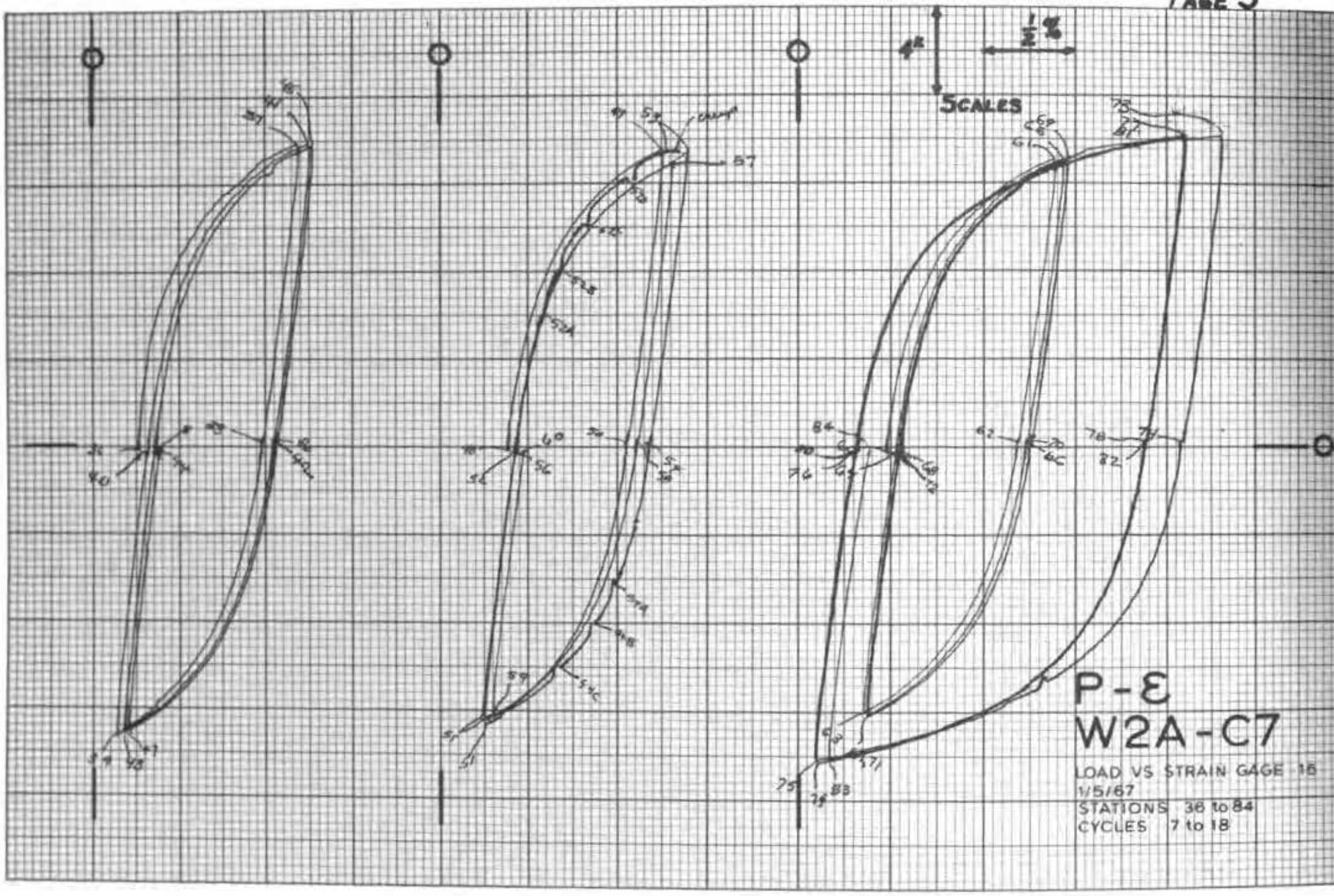
BEAM PROPERTIES

LENGTH, L	67.2	INCHES
ELASTIC STIFFNESS, P/DELTA	19.87	KIPS/IN.
YIELD DEFLECTION, DELTAY	0.570	INCHES
YIELD LOAD, PY	11.33	KIPS
PLASTIC LOAD, PP	12.82	KIPS
LOCATION OF CRITICAL SECTION FOR PY*	64.71	INCHES
LOCATION CF CRITICAL SECTION FOR PP*	64.71	INCHES

* MEASURED FROM CONCENTRATED LOAD


PAGE 1
SCALES
4k
½ %
P-ε
W2A-C7
LOAD VS STRAIN GAGE 15
1/5/67
STATIONS 0 to 12
CYCLES ELASTIC


PAGE 2
SCALES
4k
P-ε
W2A-C7
LOAD VS STRAIN GAGE 15
STATIONS 12 to 36



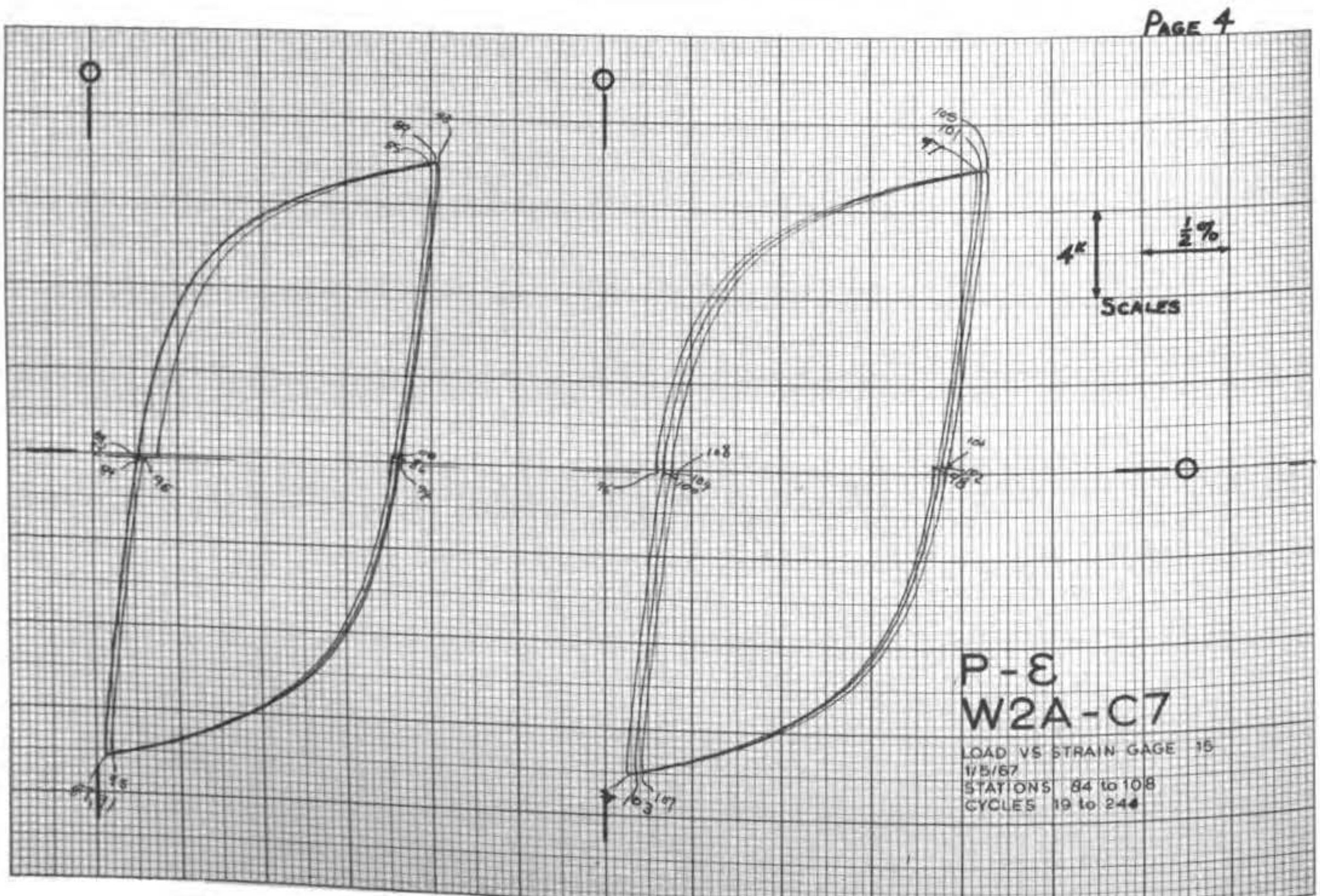
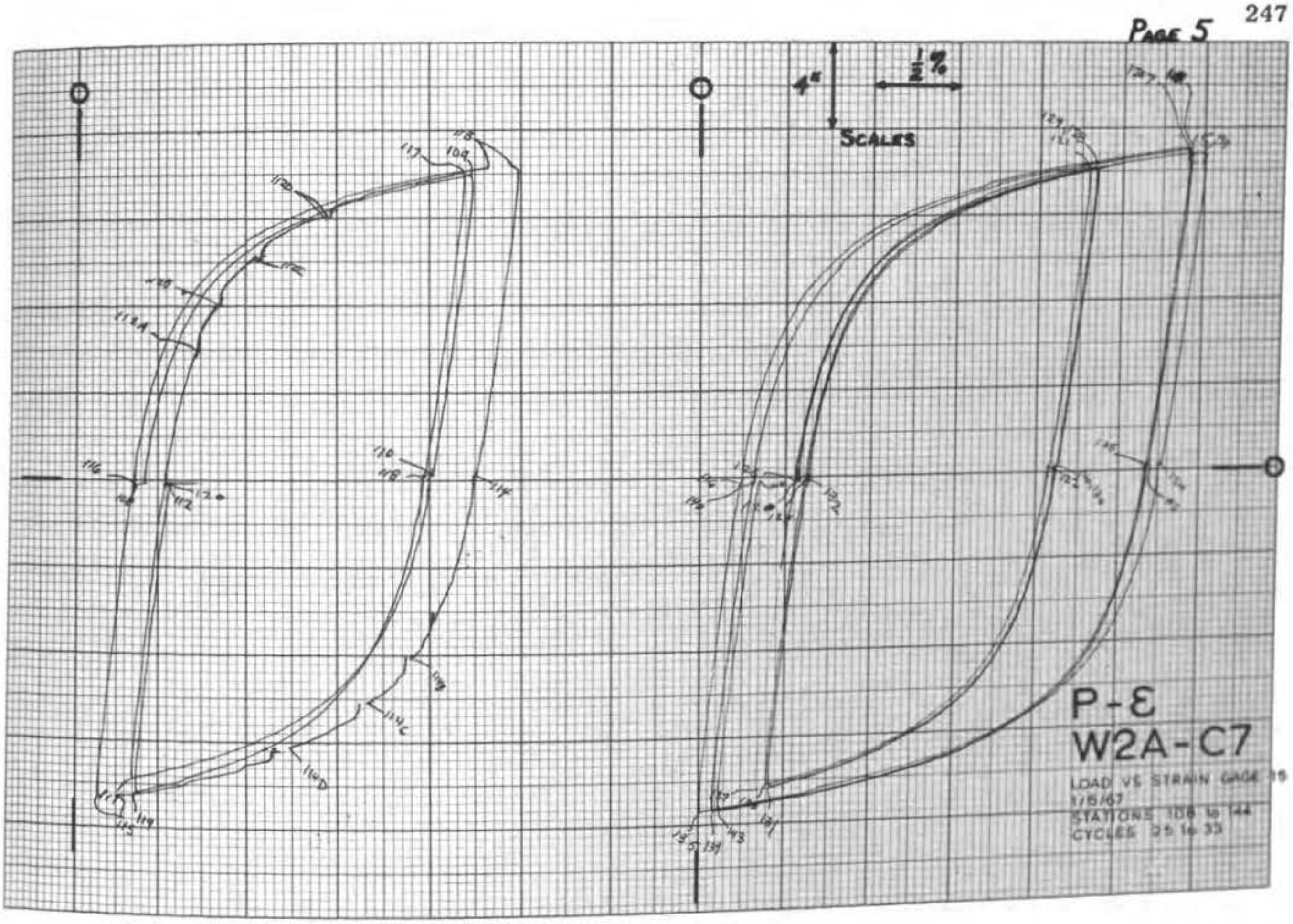


PLATE 30. (continued)



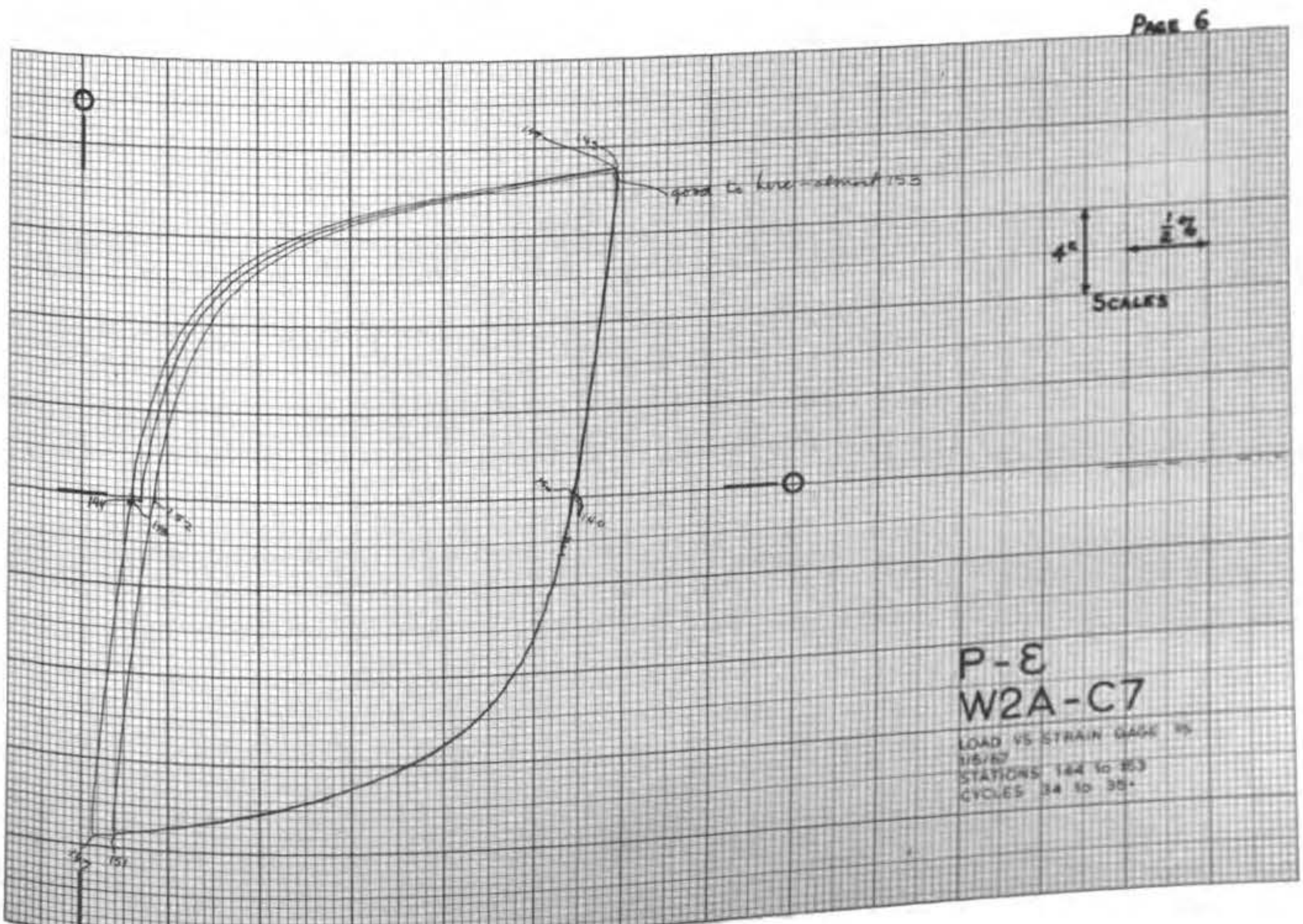
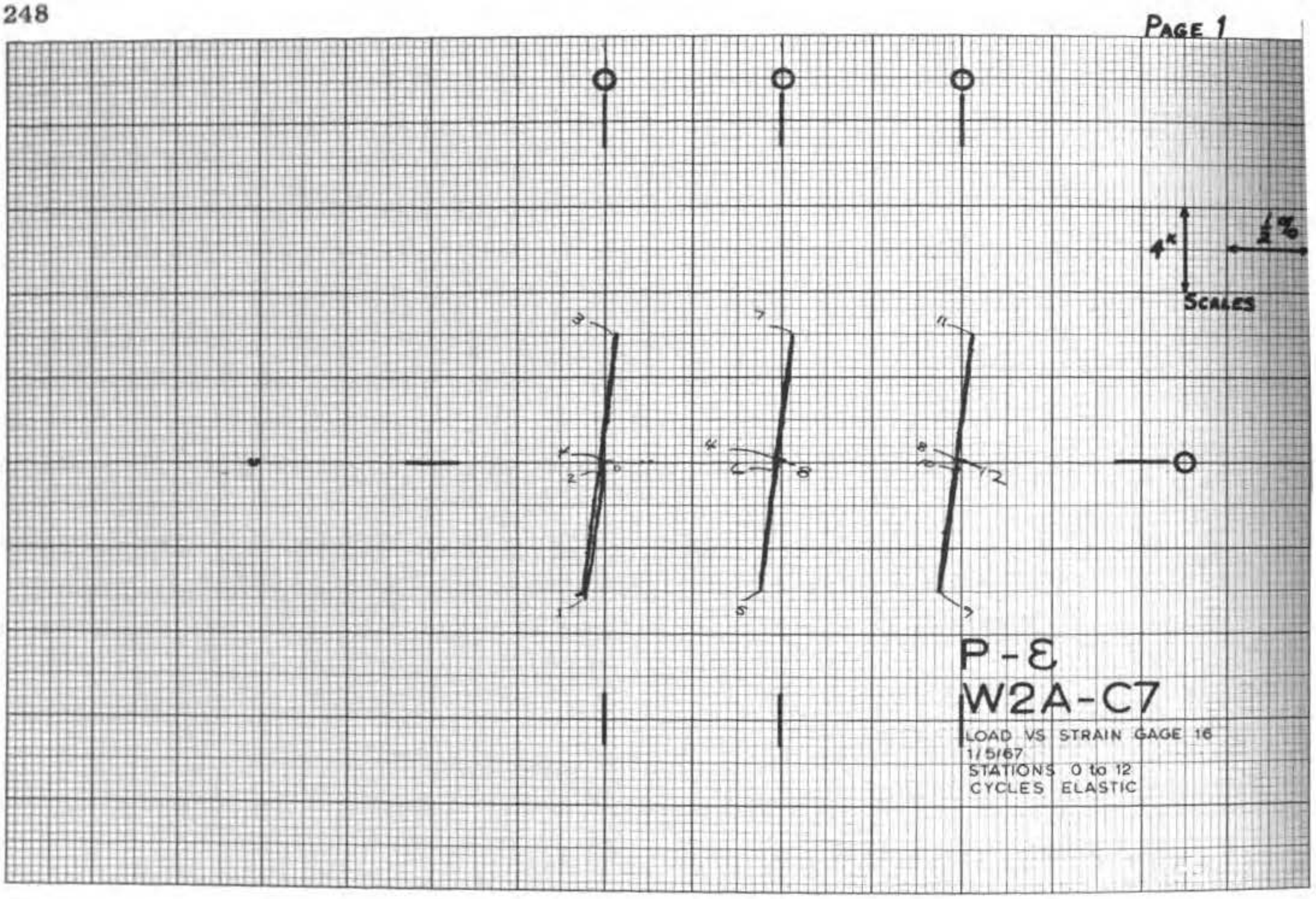


PLATE 30. (continued)



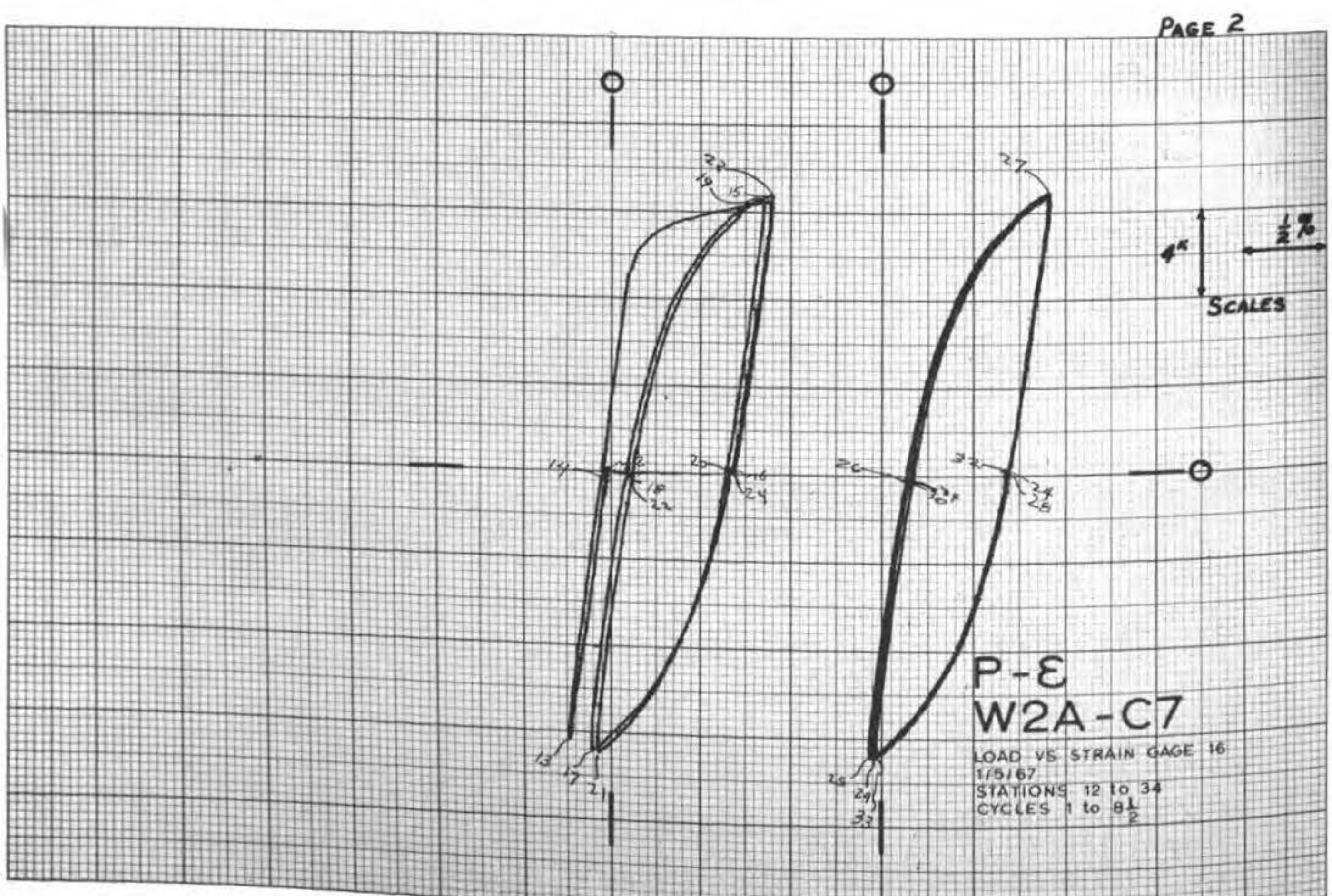
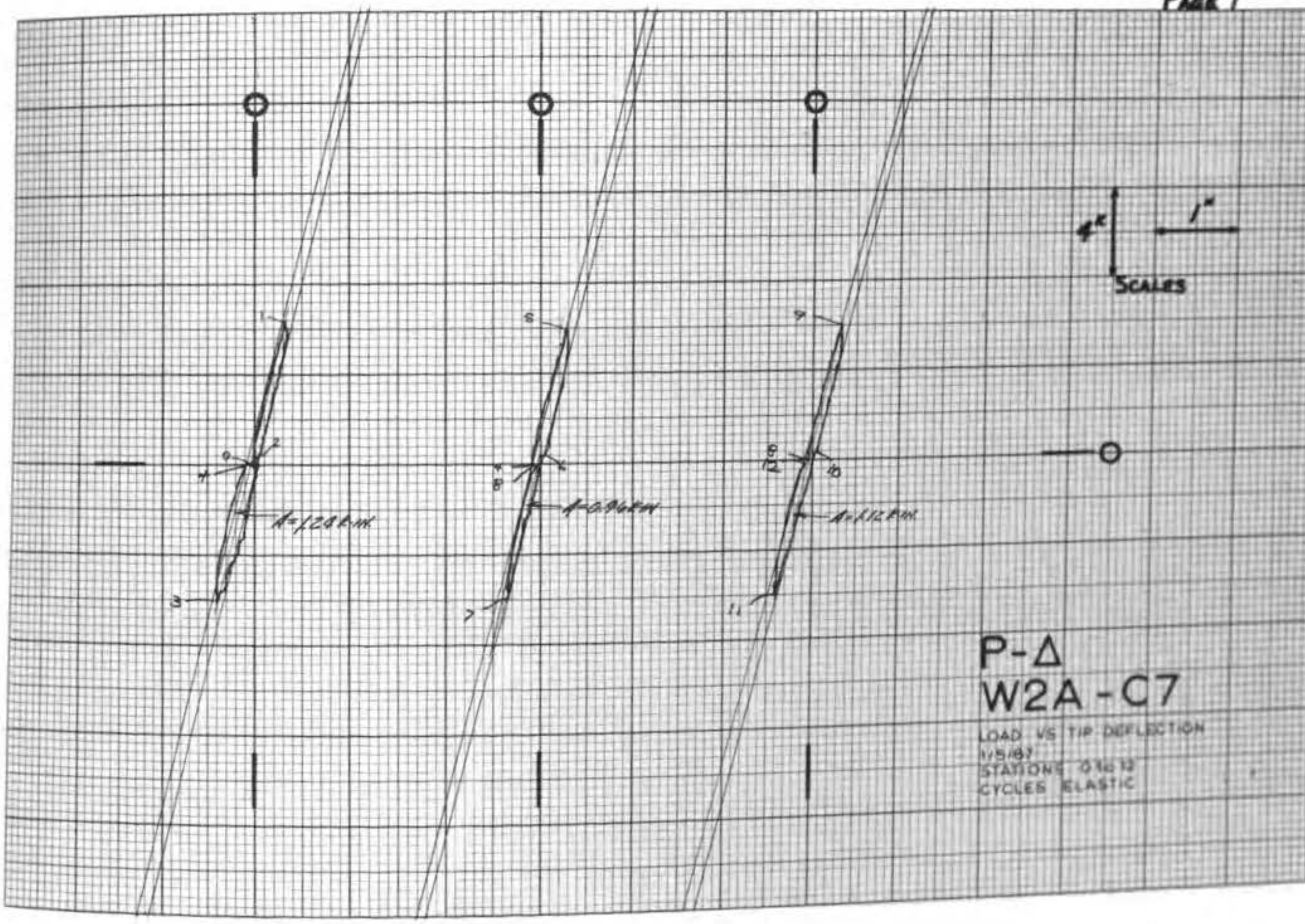


PLATE 31. LOAD VS. STRAIN - W2A-C7



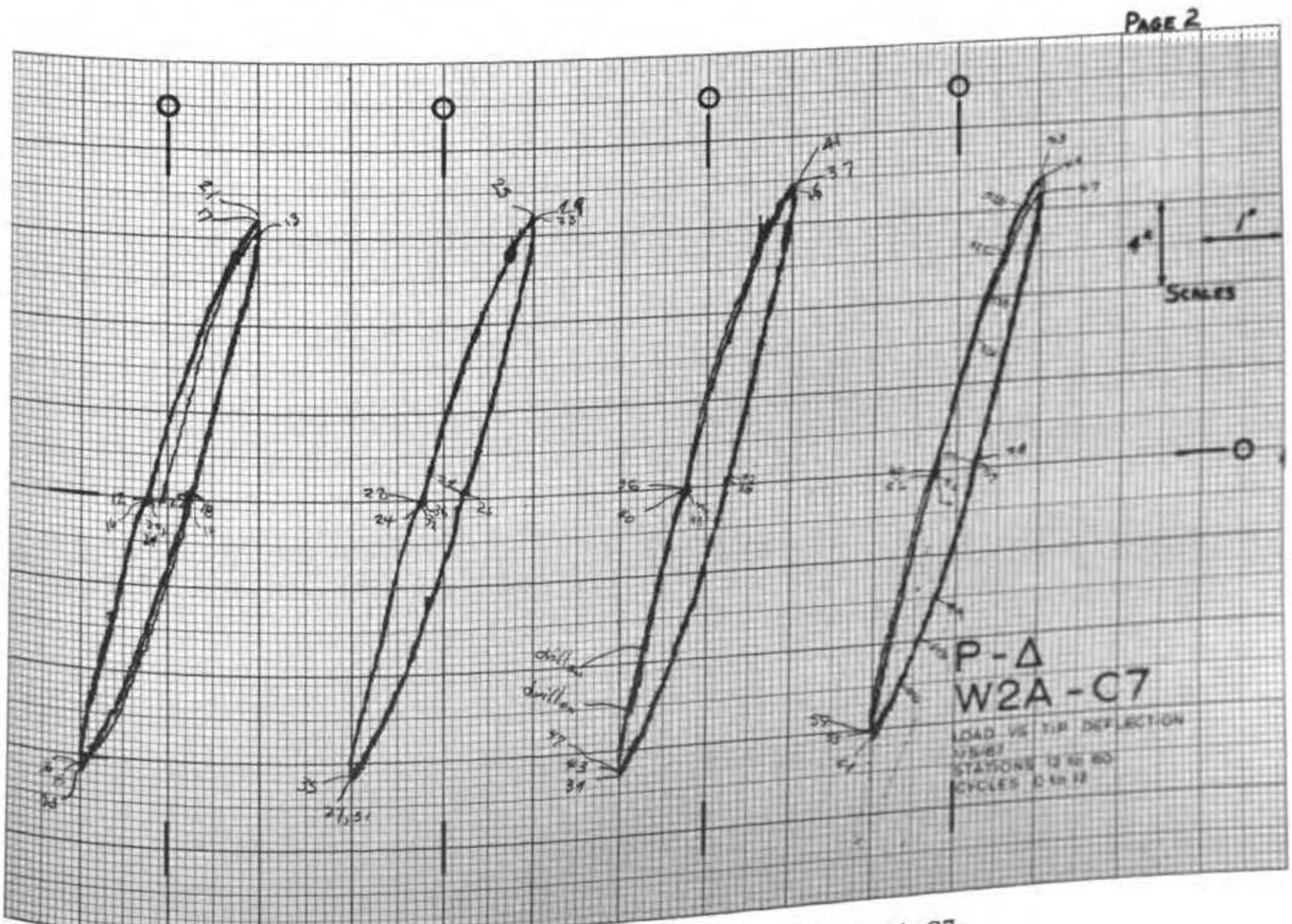
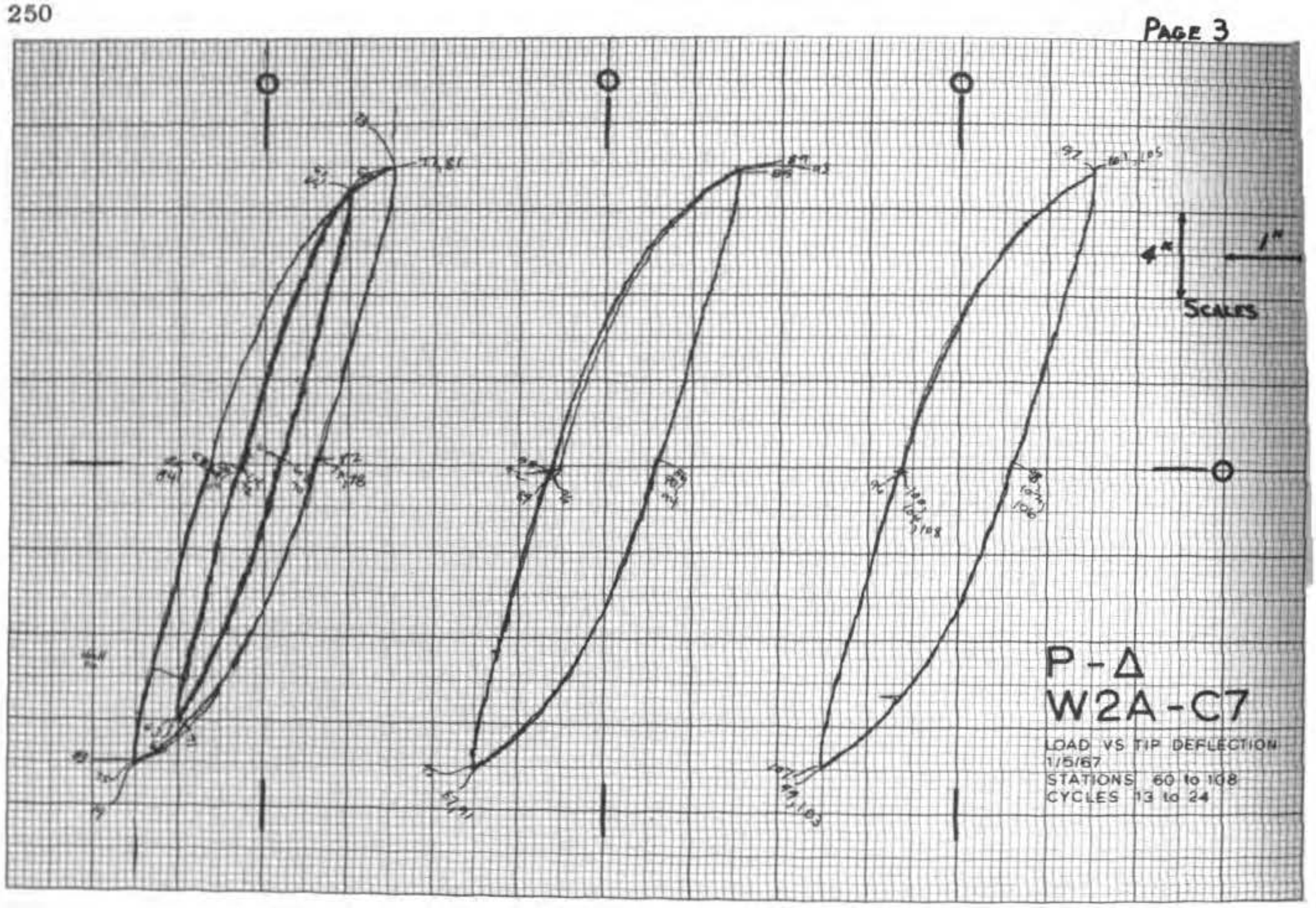


PLATE 32. LOAD VS. DEFLECTION - W2A-C7



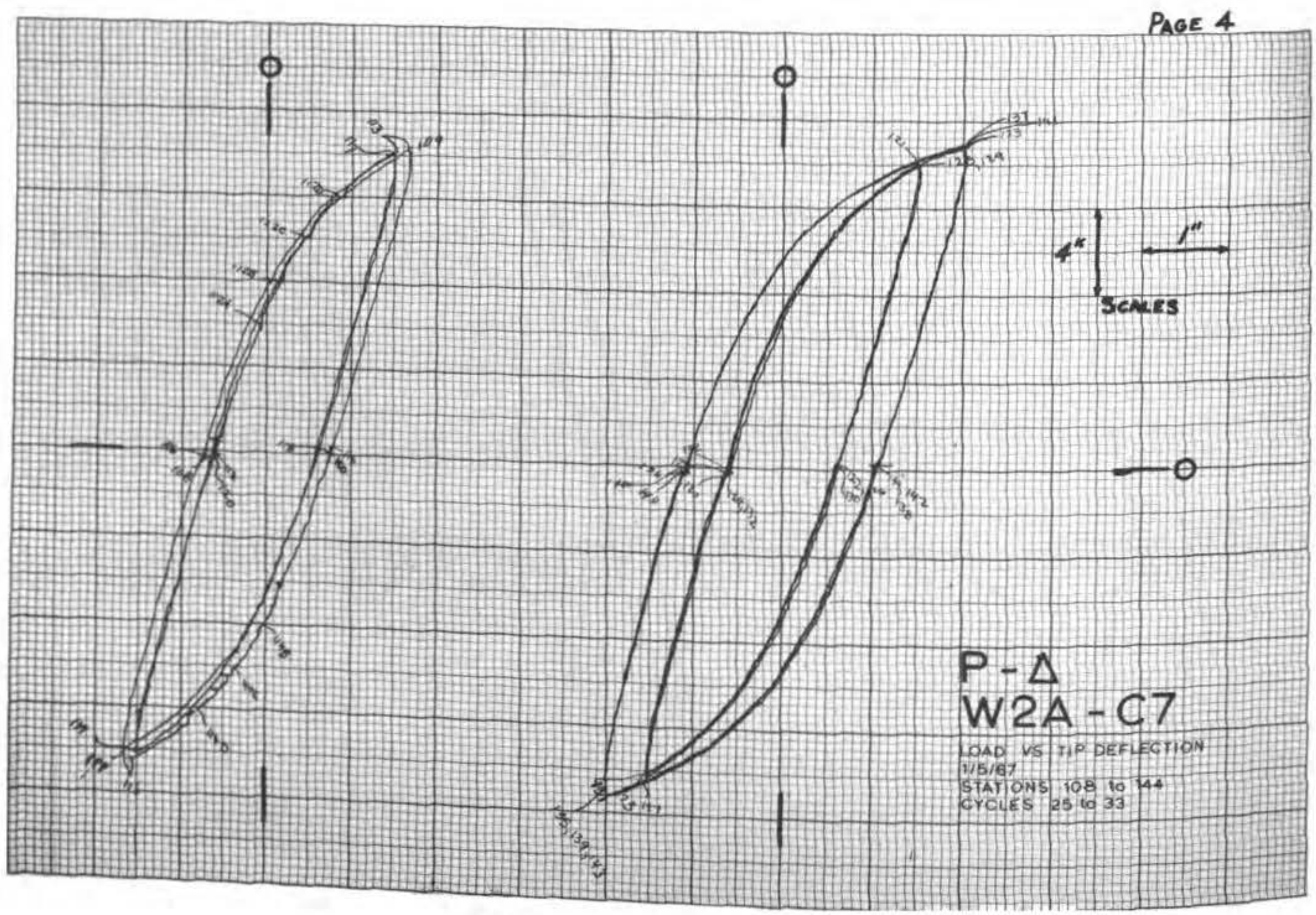
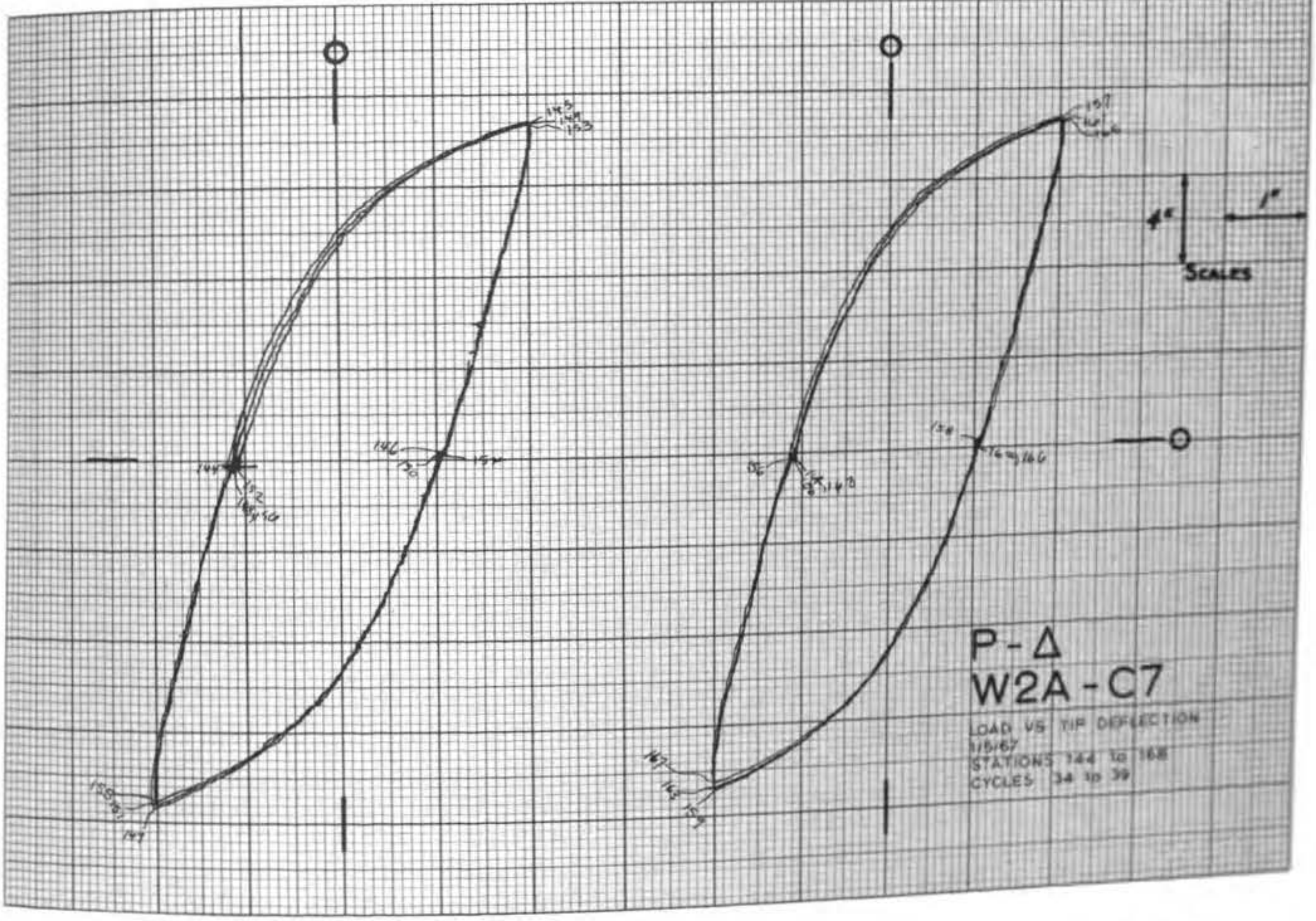


PLATE 32. (continued)

PAGE 5



PAGE 6

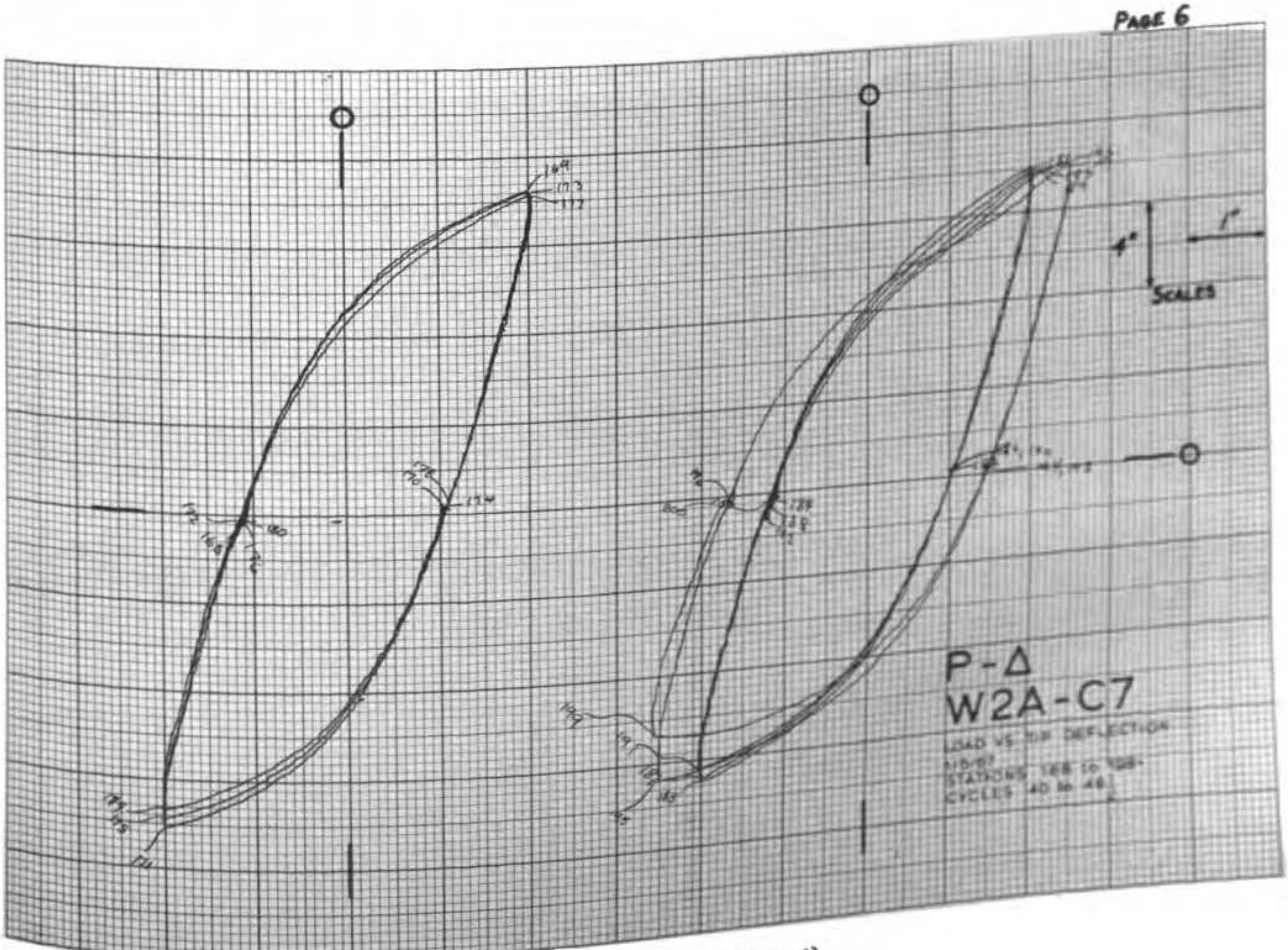


PLATE 32. (continued)

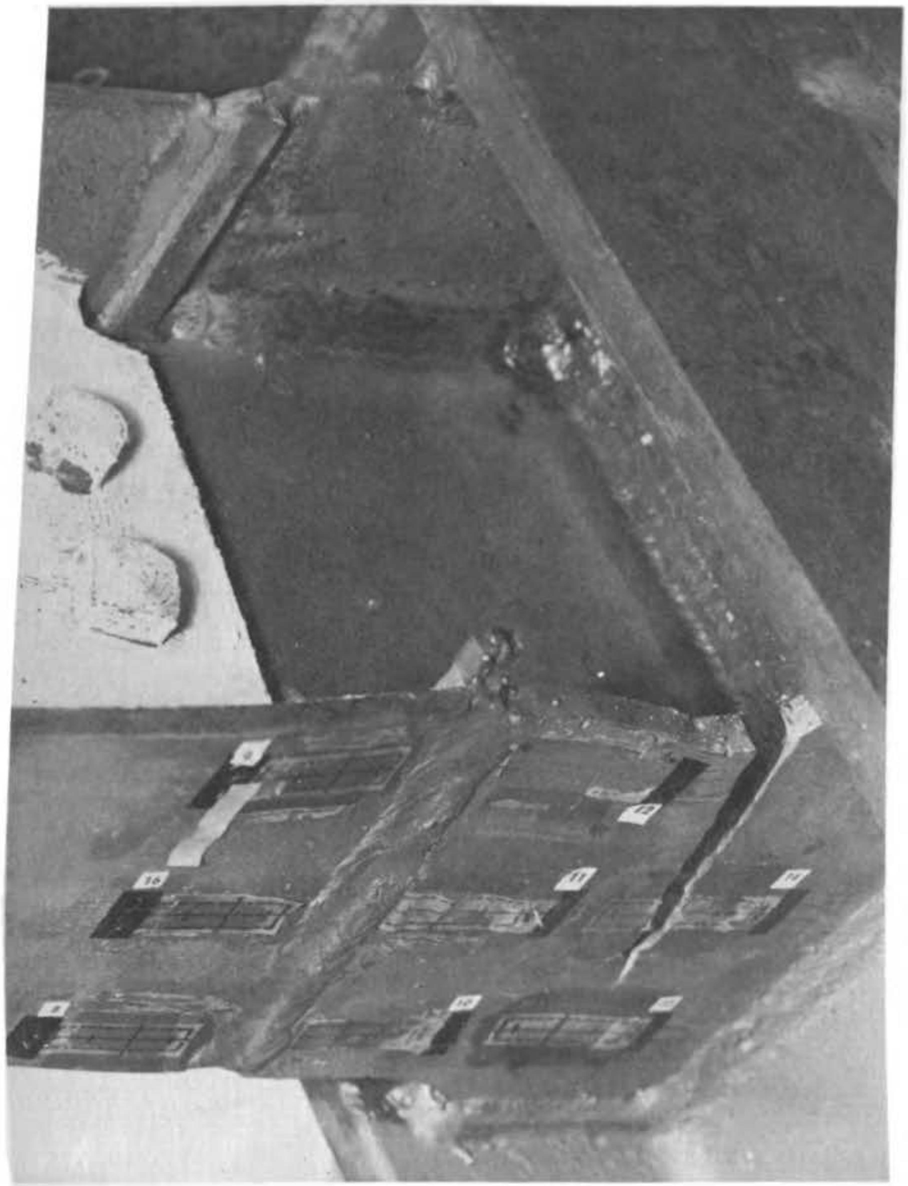


FIGURE 40. W2A-C7

FIGURE 41. W2A-C7

SPECIMEN W2A-C7

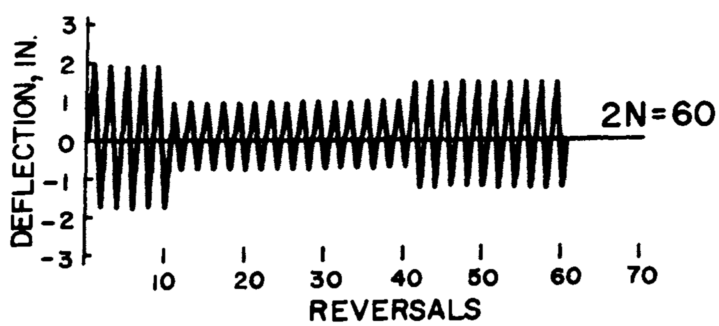
Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	11.72	0.93	0.35	1.9	0.915	1.45	0.54	0.47
2	-11.97	-0.79	0.40	4.2	-0.934	-1.22	0.61	1.01
3	12.22	0.93	0.36	3.5	0.953	1.44	0.55	0.84
4	-12.10	-0.79	0.33	3.5	-0.944	-1.23	0.50	0.84
5	12.32	0.93	0.33	3.5	0.961	1.44	0.50	0.85
6	-12.24	-0.79	0.33	3.4	-0.955	-1.22	0.50	0.83
7	12.31	0.93	0.33	3.6	0.960	1.44	0.50	0.87
8	-12.26	-0.79	0.37	3.2	-0.957	-1.22	0.57	0.77
9	12.23	0.93	0.37	3.5	0.954	1.44	0.57	0.86
10	-12.29	-0.79	0.37	3.2	-0.959	-1.22	0.57	0.77
11	12.23	0.93	0.37	3.5	0.954	1.44	0.57	0.85
12	-12.12	-0.79	0.37	3.2	-0.945	-1.22	0.57	0.77
13	12.67	0.93	0.40	3.9	0.988	1.44	0.61	0.94
14	-12.17	-0.77	0.36	3.2	-0.950	-1.19	0.55	0.77
15	12.77	0.95	0.36	3.6	0.996	1.47	0.55	0.87
16	-12.10	-0.77	0.36	3.2	-0.944	-1.20	0.55	0.77
17	12.70	0.93	0.36	3.6	0.991	1.44	0.55	0.88
18	-12.08	-0.77	0.36	3.2	-0.942	-1.20	0.55	0.77
19	12.45	0.98	0.37	3.3	0.971	1.52	0.57	0.81
20	-11.73	-0.72	0.35	3.0	-0.915	-1.12	0.54	0.73
21	12.50	1.03	0.36	3.6	0.975	1.59	0.55	0.88
22	-11.69	-0.73	0.37	3.6	-0.912	-1.14	0.57	0.88
23	12.43	0.99	0.39	3.1	0.969	1.53	0.60	0.75
24	-11.81	-0.73	0.42	3.6	-0.921	-1.14	0.65	0.88
25	12.67	0.96	0.35	3.6	0.988	1.48	0.54	0.86
26	-11.60	-0.77	0.35	2.9	-0.904	-1.19	0.54	0.70
27	12.62	0.96	0.35	3.5	0.985	1.48	0.54	0.85
28	-11.72	-0.77	0.35	2.9	-0.914	-1.19	0.54	0.70
29	12.57	0.96	0.35	3.5	0.980	1.48	0.54	0.85
30	-11.77	-0.77	0.35	2.9	-0.918	-1.19	0.54	0.71
31	13.78	1.45	0.78	9.5	1.075	2.25	1.20	2.29
32	-13.82	-1.25	1.14	12.1	-1.078	-1.94	1.76	2.93
33	13.79	1.45	1.14	12.3	1.076	2.25	1.76	2.98
34	-14.00	-1.25	1.14	12.4	-1.092	-1.94	1.76	3.00
35	13.80	1.45	1.14	12.3	1.076	2.25	1.76	2.97
36	-13.83	-1.25	1.14	12.1	-1.079	-1.94	1.76	2.93
37	13.50	1.35	1.01	10.7	1.053	2.09	1.56	2.58
38	-14.00	-1.36	1.11	11.5	-1.092	-2.11	1.72	2.78
39	13.66	1.35	1.11	11.6	1.065	2.08	1.71	2.79
40	-14.01	-1.36	1.11	11.5	-1.093	-2.11	1.71	2.78
41	13.60	1.35	1.11	11.5	1.061	2.08	1.71	2.77
42	-13.91	-1.36	1.11	11.5	-1.085	-2.11	1.72	2.77
43	13.54	1.35	1.12	11.7	1.056	2.09	1.74	2.83
44	-13.86	-1.35	1.13	11.5	-1.081	-2.10	1.75	2.78
45	13.55	1.35	1.13	11.4	1.057	2.09	1.75	2.75
46	-13.78	-1.35	1.13	11.4	-1.075	-2.10	1.75	2.76
47	13.55	1.35	1.13	11.4	1.057	2.09	1.75	2.75
48	-13.72	-1.35	1.13	11.4	-1.070	-2.10	1.75	2.76
49	13.65	1.37	1.15	12.0	1.065	2.12	1.78	2.89
50	-13.49	-1.33	1.11	11.1	-1.052	-2.06	1.71	2.69
51	13.45	1.54	1.27	13.2	1.049	2.39	1.96	3.19

Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
52	-13.70	-1.49	1.40	14.7	-1.069	-2.30	2.17	3.55
53	13.49	1.36	1.22	12.3	1.052	2.11	1.90	2.98
54	-13.61	-1.32	1.10	11.2	-1.062	-2.05	1.70	2.70
55	13.54	1.38	1.10	11.4	1.056	2.14	1.71	2.76
56	-13.50	-1.32	1.09	11.1	-1.053	-2.05	1.68	2.69
57	13.50	1.37	1.11	11.9	1.053	2.13	1.71	2.88
58	-13.76	-1.33	1.13	11.5	-1.073	-2.06	1.75	2.77
59	13.46	1.37	1.11	11.9	1.050	2.13	1.71	2.87
60	-13.62	-1.33	1.09	11.2	-1.063	-2.06	1.69	2.70
61	14.22	1.88	1.55	18.2	1.109	2.92	2.40	4.40
62	-14.67	-1.80	2.05	22.7	-1.144	-2.79	3.17	5.50
63	14.44	1.88	2.05	23.0	1.126	2.92	3.17	5.57
64	-14.69	-1.80	2.05	22.8	-1.146	-2.79	3.17	5.51
65	14.37	1.88	2.05	23.1	1.121	2.92	3.17	5.59
66	-14.67	-1.80	2.05	22.7	-1.144	-2.79	3.17	5.49
67	14.35	1.86	2.03	24.3	1.119	2.89	3.14	5.89
68	-14.86	-1.86	2.12	23.5	-1.159	-2.88	3.28	5.68
69	14.38	1.86	2.12	23.4	1.122	2.89	3.28	5.65
70	-14.73	-1.83	2.06	23.2	-1.149	-2.83	3.19	5.61
71	14.26	1.86	2.06	22.6	1.112	2.89	3.19	5.46
72	-14.55	-1.83	2.06	22.8	-1.135	-2.83	3.19	5.51
73	14.29	1.87	2.06	23.9	1.114	2.91	3.19	5.79
74	-14.36	-1.80	2.03	22.2	-1.120	-2.79	3.14	5.37
75	14.22	1.89	2.02	23.2	1.109	2.92	3.14	5.61
76	-14.29	-1.80	2.03	22.3	-1.114	-2.80	3.14	5.39
77	14.14	1.90	2.03	22.8	1.103	2.94	3.14	5.51
78	-14.03	-1.81	2.02	22.3	-1.094	-2.80	3.14	5.40
79	14.07	1.89	2.06	22.4	1.097	2.92	3.19	5.41
80	-13.61	-1.79	2.04	21.8	-1.062	-2.77	3.16	5.28
81	13.99	1.90	2.04	22.0	1.091	2.94	3.16	5.33
82	-13.19	-1.79	2.05	21.2	-1.029	-2.78	3.17	5.12
83	13.83	1.91	2.05	21.2	1.079	2.96	3.17	5.13
84	-12.86	-1.80	2.06	20.7	-1.003	-2.79	3.19	5.02
85	13.59	1.92	2.05	20.2	1.060	2.98	3.17	4.88
86	-12.57	-1.80	2.05	19.3	-0.981	-2.80	3.17	4.67
87	13.55	1.93	2.05	19.7	1.057	3.00	3.17	4.77
88	-12.36	-1.81	2.05	22.9	-0.964	-2.80	3.17	5.53
89	13.38	1.94	2.05	18.7	1.043	3.00	3.17	4.52
90	-11.94	-1.82	2.05	18.4	-0.931	-2.82	3.17	4.46
91	13.68	2.41	2.47	23.6	1.067	3.74	3.82	5.71
92	-12.20	-2.30	2.99	28.4	-0.951	-3.56	4.63	6.86
93	13.64	2.41	2.99	27.6	1.064	3.74	4.63	6.67

SPECIMEN W2B-C10

Description: This specimen was similar to specimen W2A-C7, except that the suffix "B" indicates that the filleted plate was at the top flange and the tapered plate at the bottom flange, of the beam.

Program of Cycling:



Test Control: Tip deflection.

Raw Data Included: Graphical load-deflection data.

Graphical load-strain data measured by gage No. 1 at the center of the top flange at a distance of 7.01 inches from the face of the column web.

Graphical load-strain data measured by gage No. 2 at the center of the bottom flange at a distance of 7.01 inches from the face of the column web.

Total Energy Absorption: 651 kip-inches.

Plastic Load Reversals to Failure: 60 (30 cycles).

Remarks: There was a possible hint of buckling at the juncture of the connecting plate and the bottom beam flange during the first downward loading. A similar situation was observed at the top flange during the first upward loading. By the 15th cycle, a crack had initiated at a small cutting torch gouge in the fillet of the upper connecting plate. During the 20th cycle, a crack was observed in the plate at one end of the bottom flange butt weld; by the 23rd cycle, this crack had fully penetrated the thickness of the plate. A crack suddenly appeared in the center of the flange adjacent to the butt-weld during the 28th cycle. Propagation of this crack precipitated the final failure, at which time several slag inclusions were observed in the cracked weld.

SPECIMEN TYPE W28-C10

DIMENSIONS OF WF SECTION

DEPTH	8.18	INCHES
TOP FLANGE WIDTH	5.330	INCHES
BOTTOM FLANGE WIDTH	5.320	INCHES
TOP FLANGE THICKNESS	0.349	INCHES
BOTTOM FLANGE THICKNESS	0.333	INCHES
WEB THICKNESS	0.264	INCHES
ELASTIC MODULUS	29200.	KSI
YIELD STRESS	44.100	KSI

DIMENSIONS AND PROPERTIES OF PLATES

LENGTH OF TOP PLATE*, LTP	5.18	INCHES
THICKNESS OF TOP PLATE, TTP	0.370	INCHES
LENGTH OF BOTTOM PLATE*, LBP	5.29	INCHES
THICKNESS OF BOTTOM PLATE, TBP	0.350	INCHES
THICKNESS OF WEB PLATE, TWP	0.250	INCHES
ELASTIC MODULUS OF PLATES, EP	29200.	KSI
YIELD STRESS OF PLATES, SYP	43.700	KSI

*MEASURED FROM FACE OF COLUMN WEB

WF SECTION PROPERTIES

AREA, A	5.70	INCHES**2
LOCATION OF CENTROID*, YE	4.15	INCHES
MOMENT OF INERTIA, I	66.3	INCHES**4
SECTION MODULUS, TOP, ST	16.4	INCHES**3
SECTION MODULUS, BOTTOM, SB	16.0	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . . .	4.25	INCHES
PLASTIC MODULUS, Z	18.3	INCHES**3
SHAPE FACTOR	1.142	
YIELD MOMENT, MY	58.75	KIP-FT.
PLASTIC MOMENT, MP	67.11	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

SPECIMEN TYPE W28-C10

SECTION PROPERTIES AT SELECTED CROSS-SECTIONS

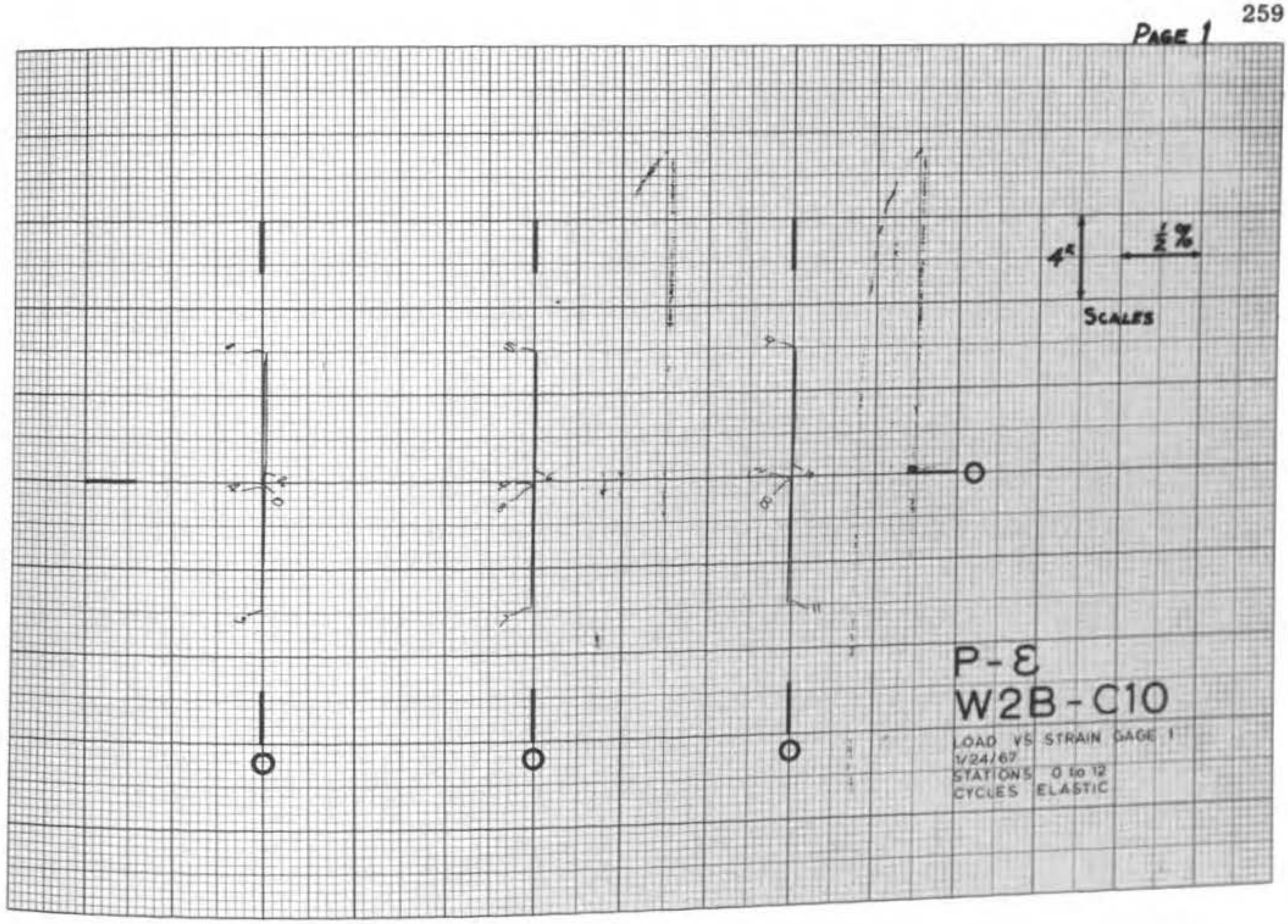
X	A	YE	I	ST	SB
64.70	5.70	4.15	66.3	16.4	16.0
64.70	5.79	4.16	68.5	17.0	16.5
65.39	5.97	4.03	71.3	17.2	17.7
66.08	6.16	3.92	73.9	17.4	18.9
66.47	6.31	3.90	76.3	17.8	19.6
66.79	6.56	3.95	80.2	18.9	20.3
67.01	6.86	4.06	84.9	20.6	20.9
67.08	7.09	4.16	88.4	22.0	21.2

X	YP	Z	F	MY	MP
64.70	4.25	18.3	1.142	58.75	67.11
64.70	4.30	18.8	1.141	59.96	68.39
65.39	3.93	19.5	1.134	62.63	71.03
66.08	3.56	20.2	1.162	63.21	73.42
66.47	3.47	20.8	1.165	64.86	75.59
66.79	3.62	21.8	1.149	68.98	79.25
67.01	3.98	23.0	1.116	74.95	83.68
67.08	4.37	23.9	1.124	77.31	86.90

X = DISTANCE FROM CONCENTRATED LOAD, INCHES
A = AREA OF CROSS-SECTION, INCHES**2
YE = DIST. FROM OUTSIDE OF BOTTOM PLATE TO CENTROID, INCHES
I = MOMENT OF INERTIA, INCHES**4
ST = SECTION MODULUS FOR TOP FLANGE, INCHES**3
SB = SECTION MODULUS FOR BOTTOM FLANGE, INCHES**3
YP = DIST. FROM OUTSIDE OF BOTTOM PLATE TO PLASTIC N.A., IN.
Z = PLASTIC MODULUS, INCHES**3
F = SHAPE FACTOR
MY = YIELD MOMENT, KIP-FEET
MP = PLASTIC MOMENT, KIP-FEET

BEAM PROPERTIES

LENGTH, L . . . . 67.1 INCHES
ELASTIC STIFFNESS, P/DELTA . . . . 19.44 KIPS/IN.
YIELD DEFLECTION, DELTAY . . . . 0.560 INCHES
YIELD LOAD, PY . . . . 10.90 KIPS
PLASTIC LOAD, PP . . . . 12.45 KIPS
LOCATION OF CRITICAL SECTION FOR PY* . . . . . 64.70 INCHES
LOCATION OF CRITICAL SECTION FOR PP* . . . . . 64.70 INCHES
* MEASURED FROM CONCENTRATED LOAD



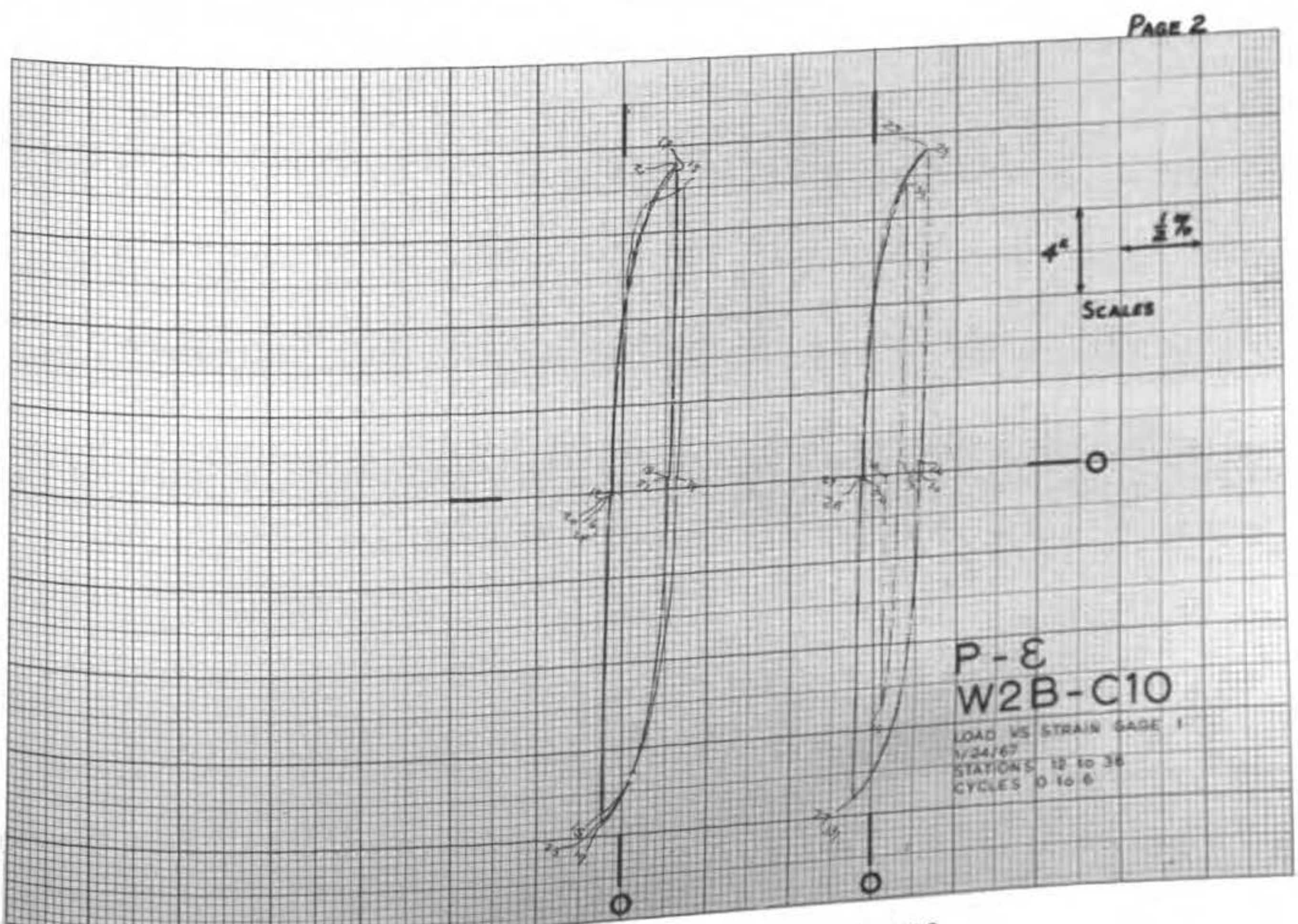
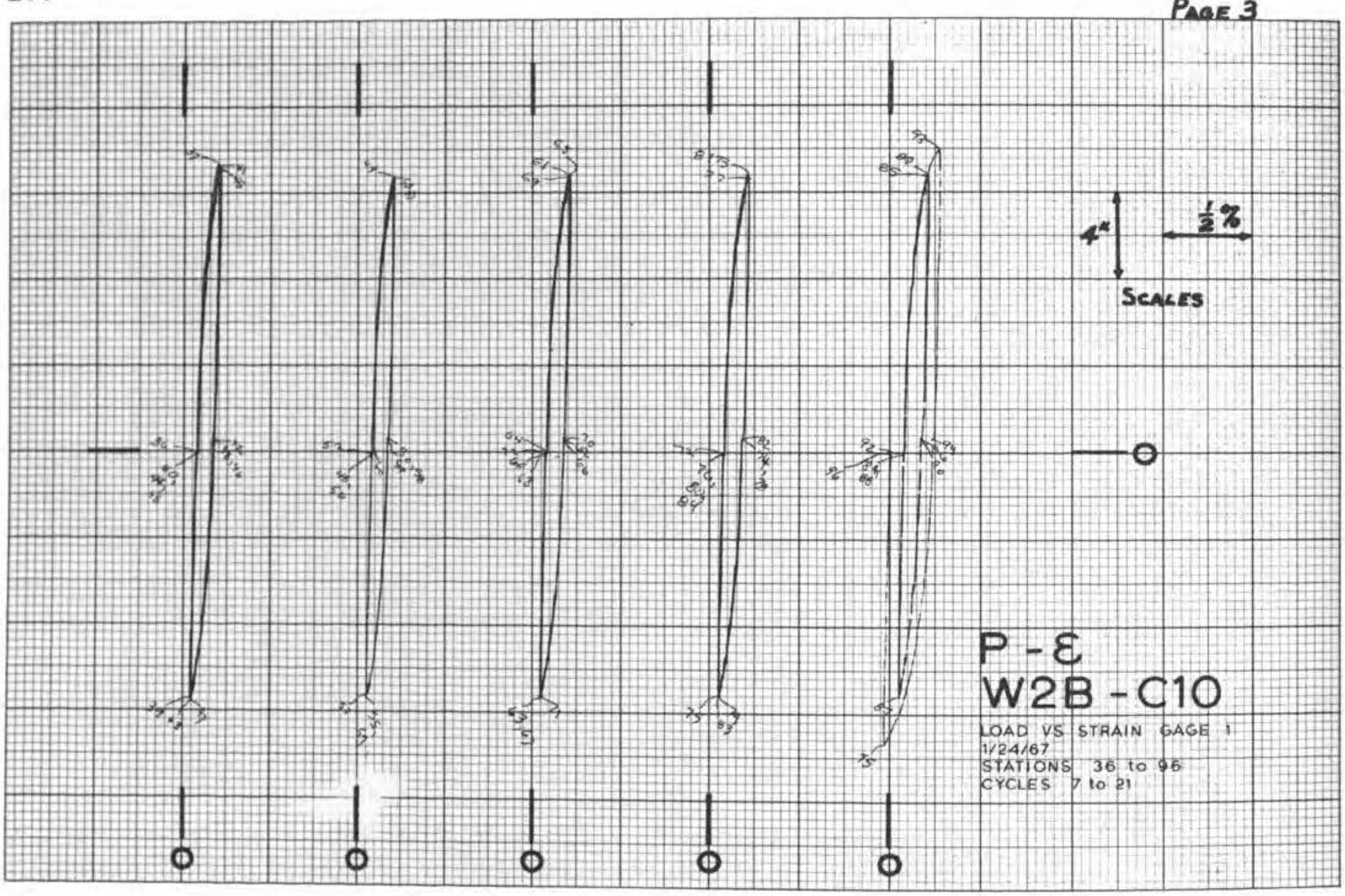


PLATE 33. LOAD VS. STRAIN - W2B-C10



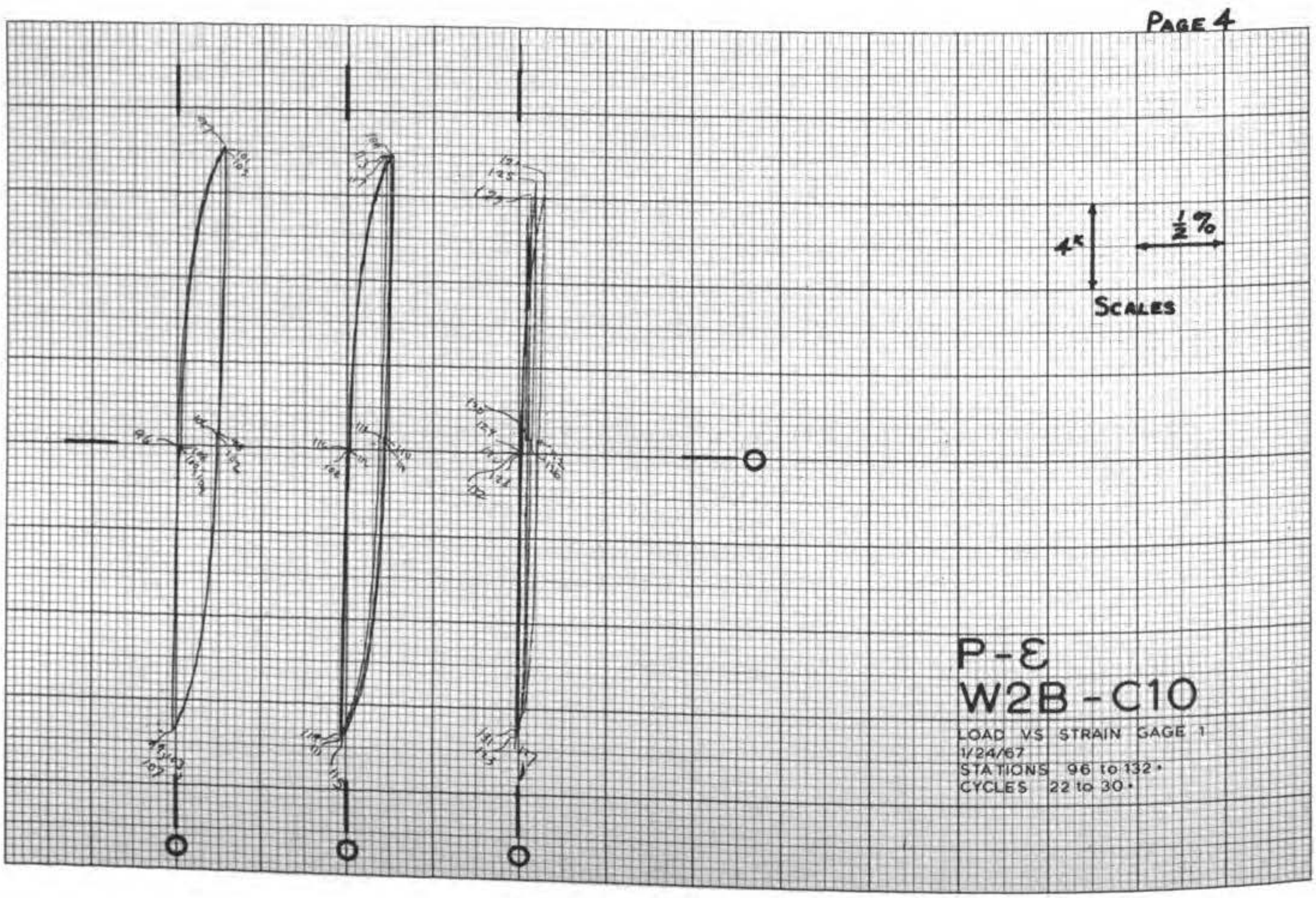
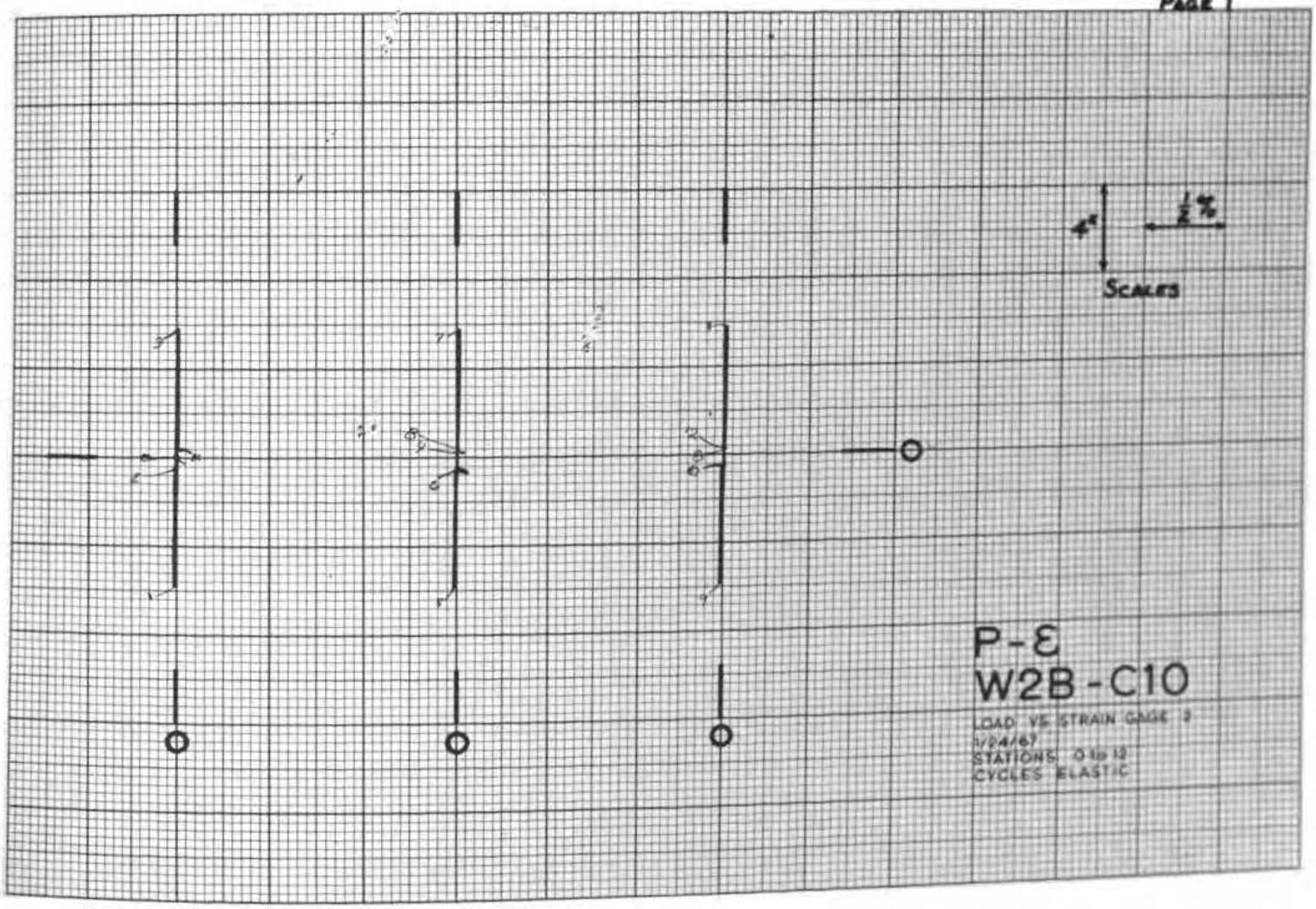


PLATE 33. (continued)



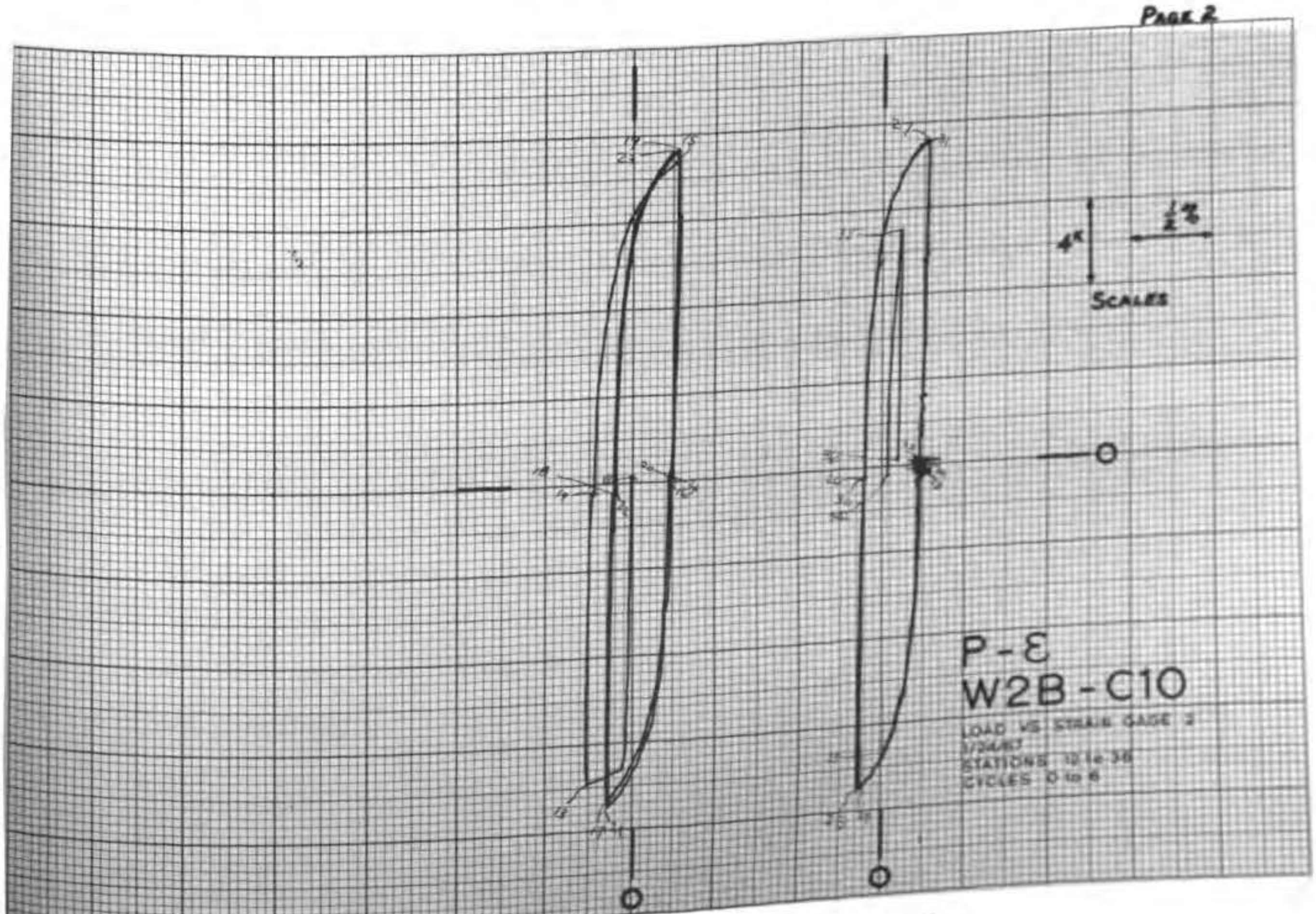
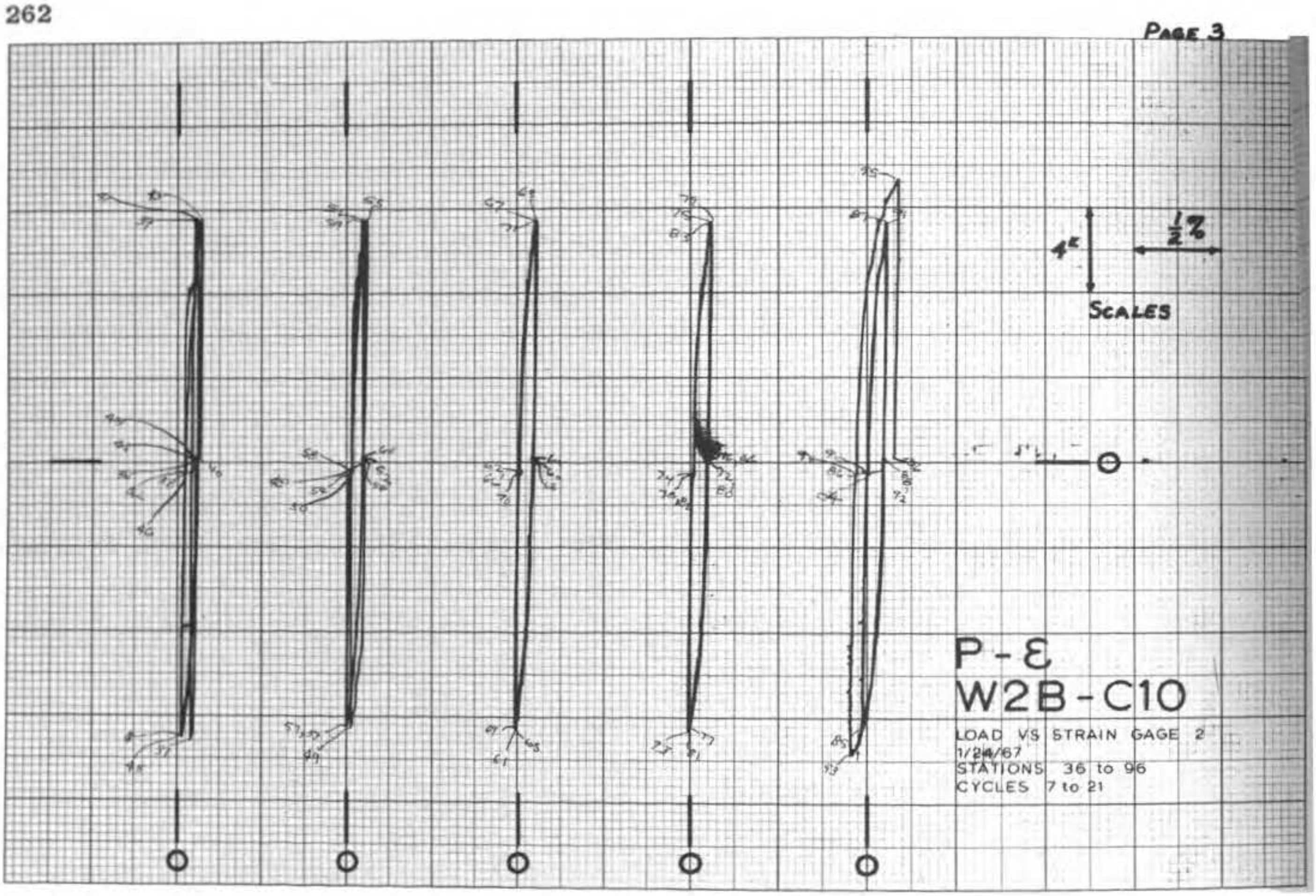


PLATE 34. LOAD VS. STRAIN - W2B-C10



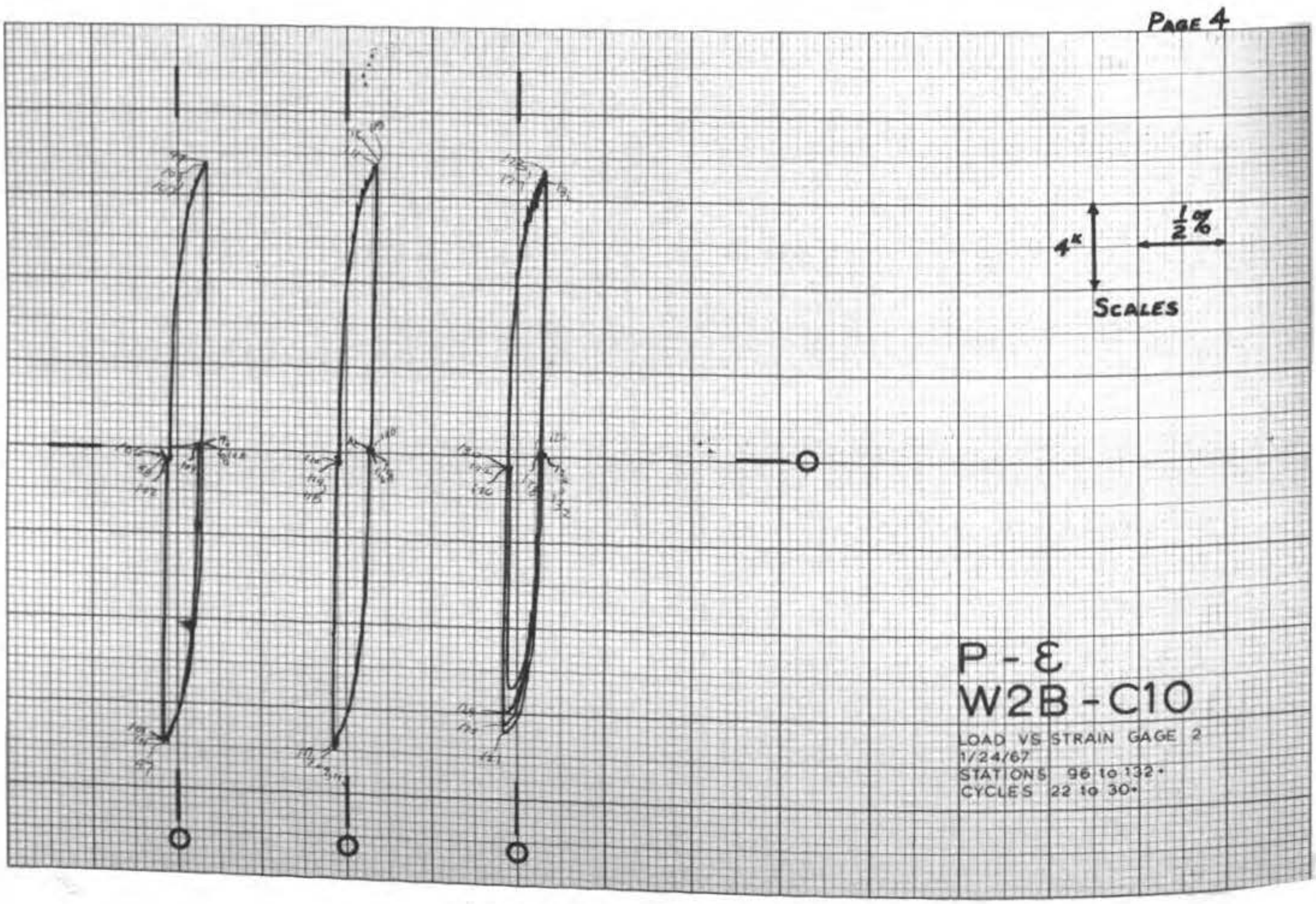
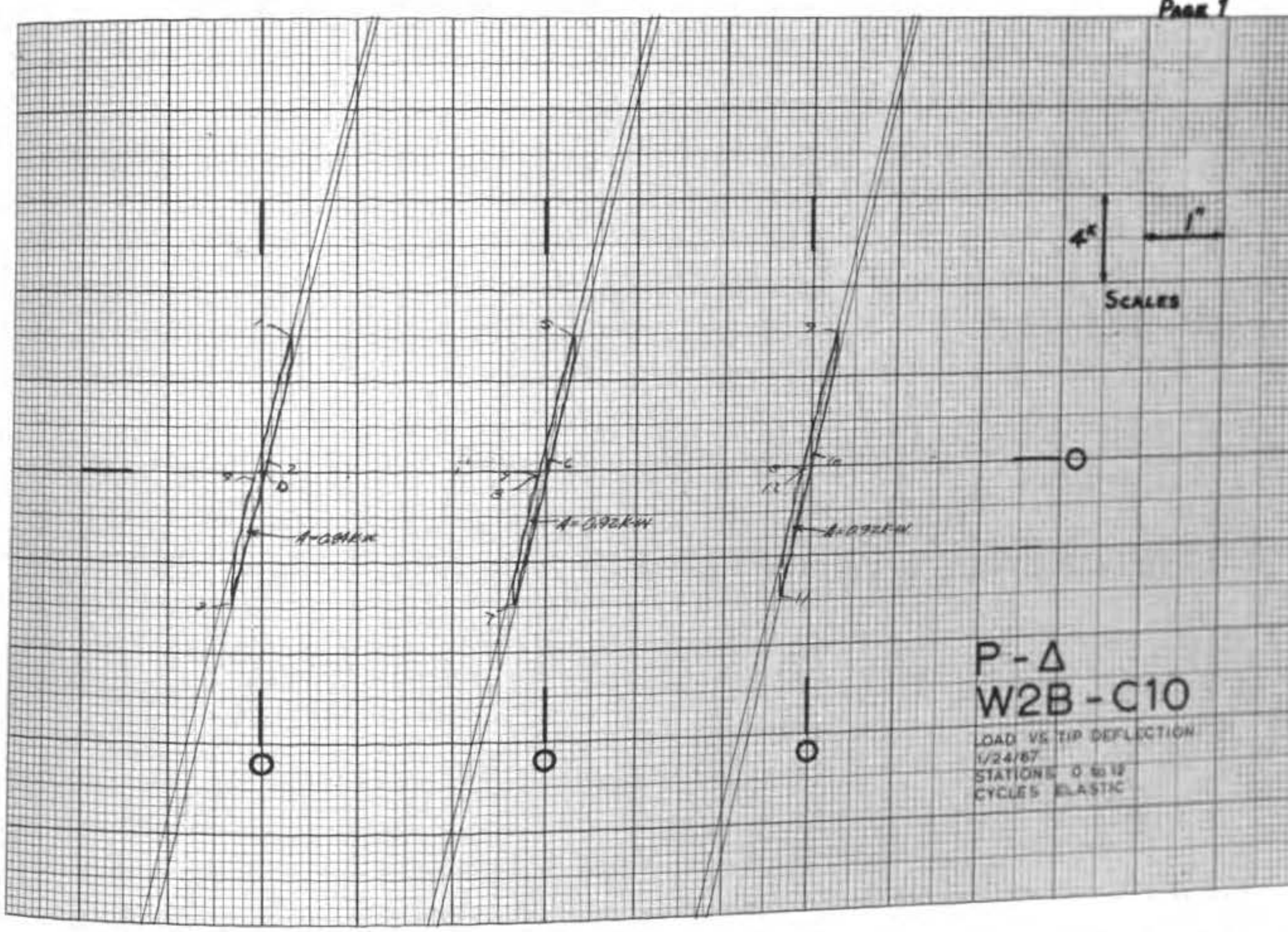


PLATE 34. (continued)



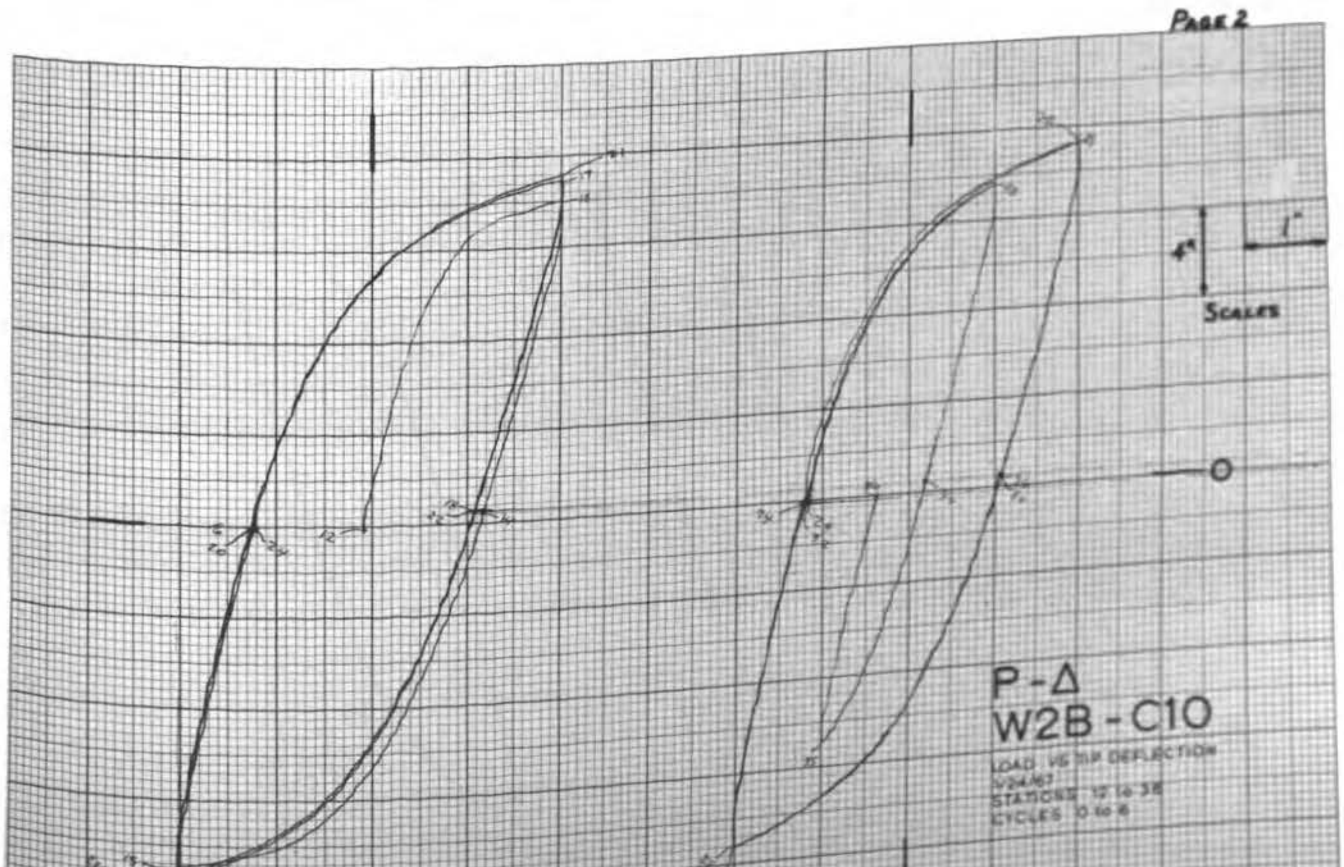
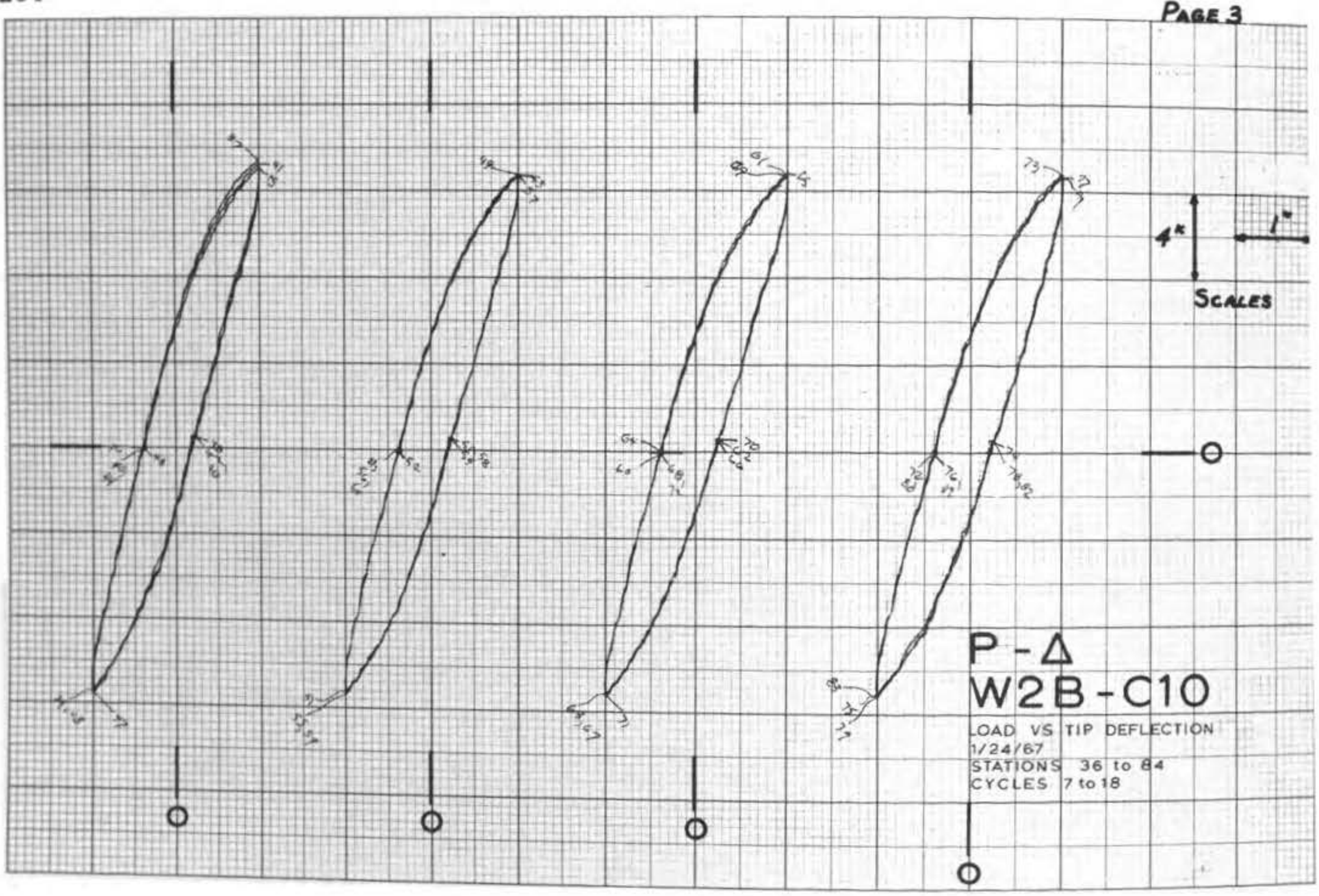


PLATE 35. LOAD VS. DEFLECTION - W2B-C10



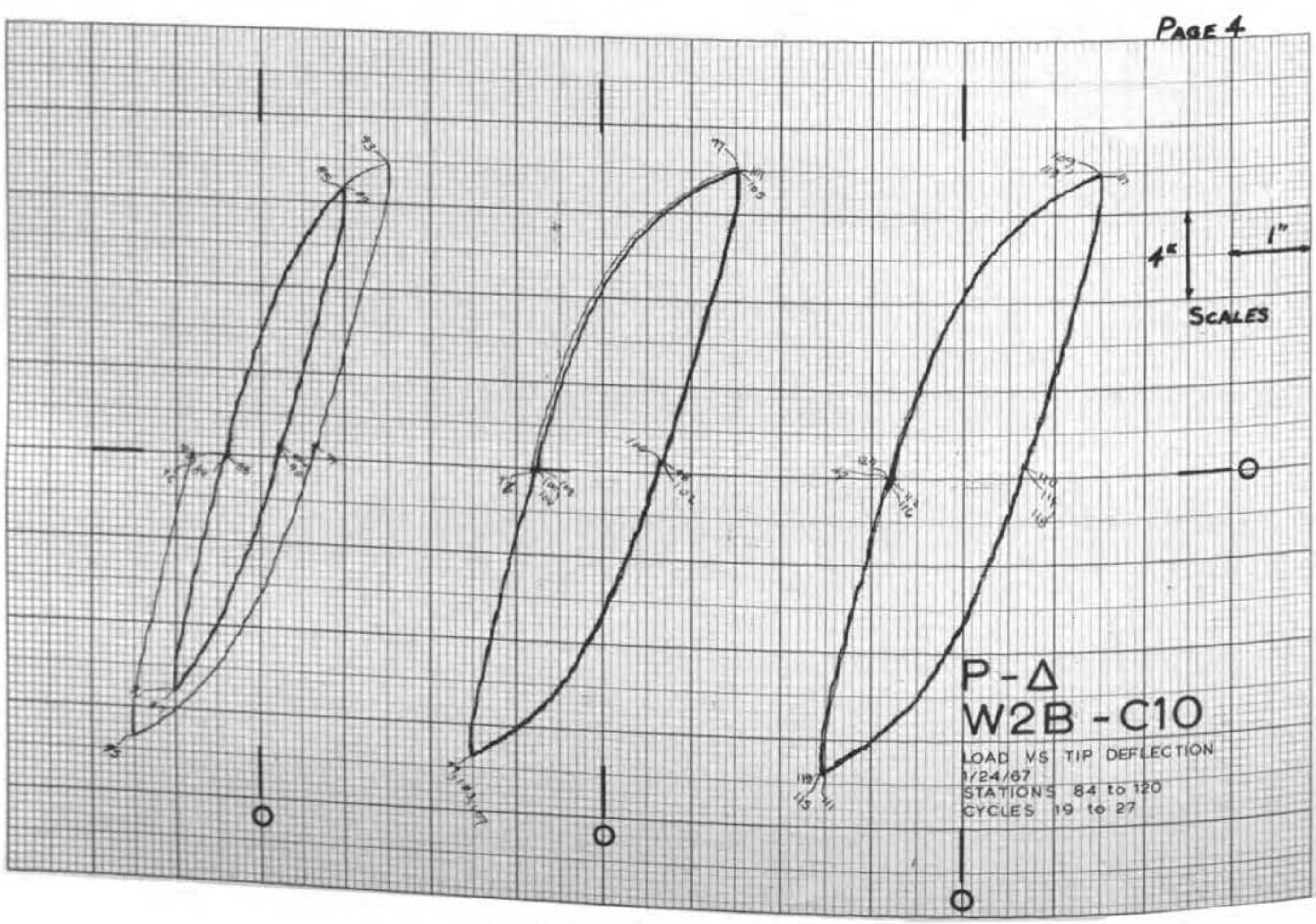


PLATE 35. (continued)

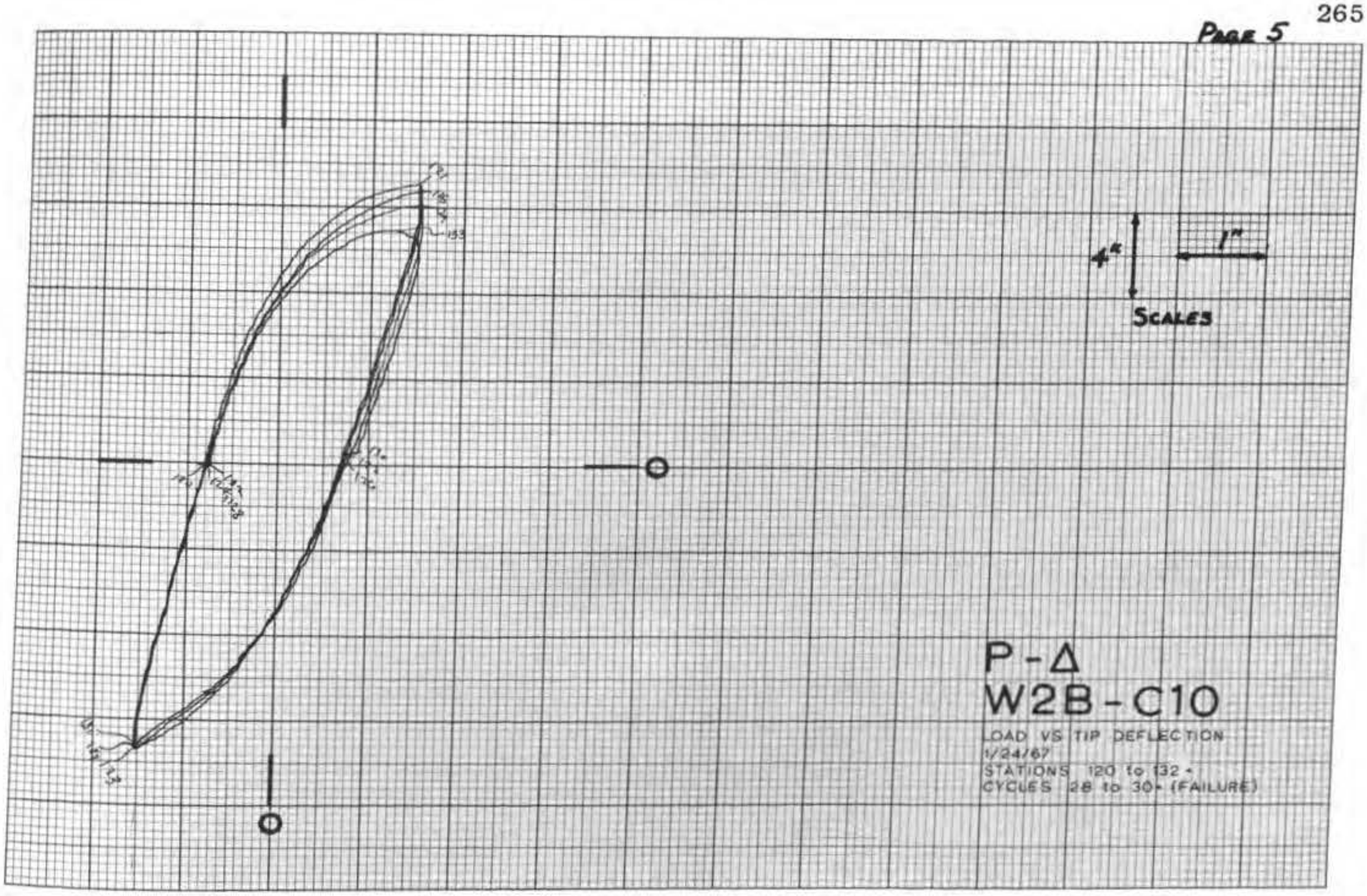


PLATE 35. (continued)

FIGURE 42. W2B-C10

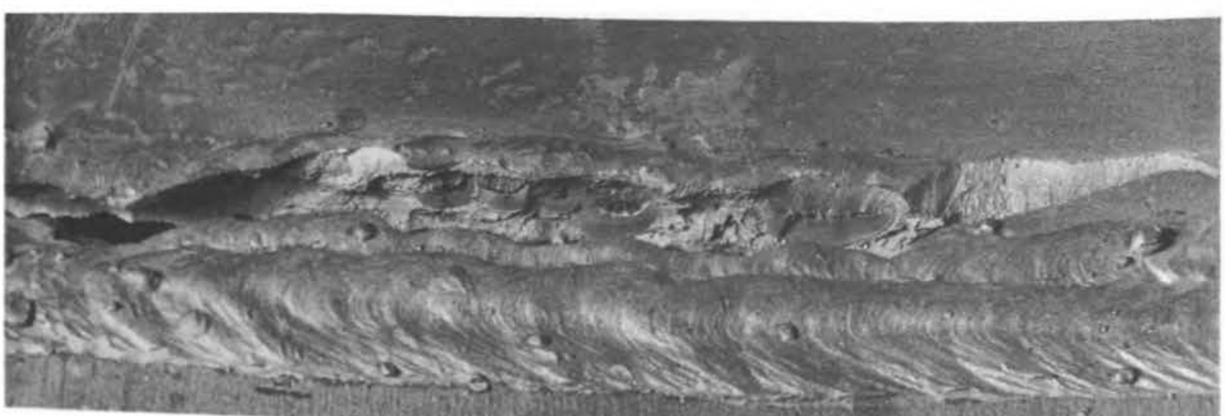


FIGURE 43. W2B-C10

SPECIMEN W2B-C10

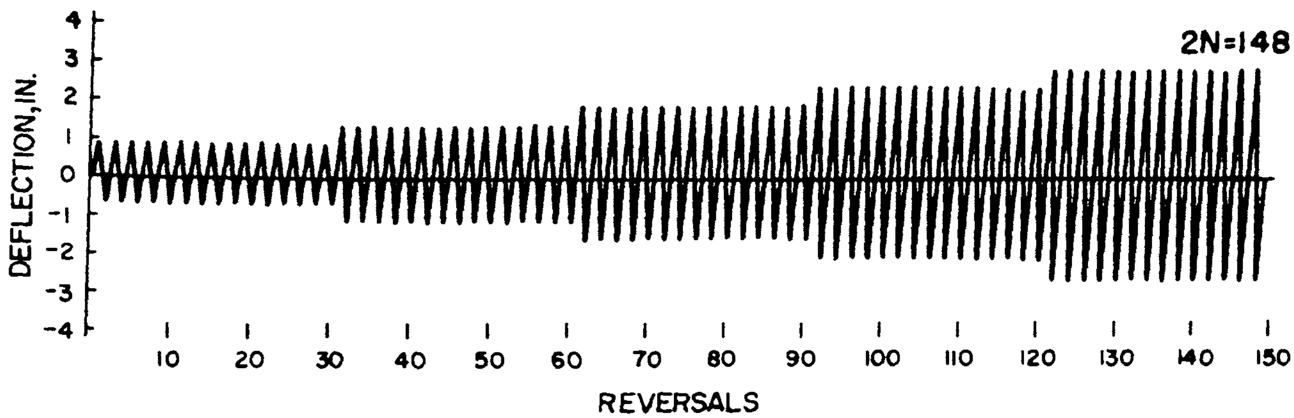
Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	13.45	1.98	1.29	14.5	1.080	3.10	2.02	3.65
2	-14.63	-1.80	2.31	27.3	-1.175	-2.81	3.60	6.84
3	14.30	1.98	2.20	25.6	1.149	3.08	3.44	6.43
4	-15.13	-1.81	2.20	25.4	-1.215	-2.82	3.44	6.37
5	14.51	1.98	2.20	25.9	1.166	3.10	3.44	6.49
6	-14.98	-1.81	2.16	25.0	-1.203	-2.82	3.37	6.27
7	14.65	1.97	2.15	26.6	1.177	3.08	3.36	6.68
8	-14.89	-1.80	2.11	24.4	-1.196	-2.81	3.29	6.13
9	14.63	1.97	2.11	25.4	1.175	3.08	3.29	6.37
10	-14.93	-1.80	2.11	24.5	-1.199	-2.81	3.29	6.15
11	12.90	0.99	1.26	12.8	1.036	1.54	1.96	3.21
12	-10.61	-0.82	0.45	3.6	-0.852	-1.29	0.71	0.91
13	12.78	1.01	0.50	5.3	1.026	1.57	0.77	1.32
14	-11.08	-0.80	0.50	4.1	-0.890	-1.25	0.78	1.03
15	12.57	1.01	0.50	5.1	1.009	1.58	0.78	1.28
16	-11.12	-0.80	0.50	4.1	-0.893	-1.25	0.78	1.04
17	12.38	1.01	0.50	5.1	0.994	1.58	0.78	1.27
18	-11.29	-0.80	0.50	4.1	-0.907	-1.25	0.78	1.04
19	12.01	0.99	0.49	5.1	0.964	1.55	0.76	1.29
20	-10.97	-0.82	0.49	3.8	-0.881	-1.28	0.76	0.96
21	11.96	0.99	0.49	5.2	0.961	1.55	0.76	1.30
22	-11.09	-0.82	0.49	3.8	-0.891	-1.28	0.76	0.96
23	11.96	0.99	0.49	5.1	0.960	1.55	0.76	1.29
24	-11.02	-0.82	0.49	3.8	-0.885	-1.28	0.76	0.95
25	12.08	1.00	0.52	5.1	0.970	1.57	0.81	1.28
26	-10.89	-0.81	0.52	3.7	-0.874	-1.27	0.81	0.92
27	12.11	1.00	0.52	5.1	0.973	1.57	0.81	1.28
28	-10.95	-0.81	0.52	3.7	-0.880	-1.27	0.81	0.93
29	12.01	1.00	0.52	5.1	0.964	1.57	0.81	1.27
30	-10.95	-0.81	0.52	3.7	-0.879	-1.27	0.81	0.93
31	12.11	1.01	0.52	5.2	0.972	1.58	0.81	1.30
32	-10.84	-0.81	0.52	4.0	-0.871	-1.27	0.81	1.01
33	11.99	1.01	0.52	4.9	0.963	1.58	0.81	1.23
34	-10.95	-0.81	0.52	4.0	-0.879	-1.27	0.81	1.02
35	11.97	1.01	0.52	4.8	0.962	1.58	0.81	1.21
36	-10.89	-0.81	0.52	4.0	-0.875	-1.27	0.81	1.00
37	11.96	1.02	0.52	5.1	0.961	1.60	0.81	1.28
38	-10.82	-0.79	0.52	4.3	-0.869	-1.24	0.81	1.07
39	12.01	1.02	0.52	5.1	0.965	1.60	0.81	1.28
40	-10.90	-0.79	0.52	4.3	-0.876	-1.24	0.81	1.08
41	13.23	1.53	0.93	10.5	1.063	2.40	1.45	2.63
42	-13.12	-1.29	1.33	10.6	-1.054	-2.02	2.08	2.67
43	13.56	1.53	1.34	14.9	1.089	2.39	2.09	3.74
44	-13.12	-1.29	1.31	12.6	-1.054	-2.02	2.04	3.15
45	13.40	1.53	1.31	14.1	1.077	2.39	2.04	3.53
46	-13.15	-1.29	1.31	12.6	-1.056	-2.02	2.04	3.16
47	13.31	1.53	1.31	14.0	1.069	2.39	2.04	3.50
48	-13.18	-1.29	1.31	12.6	-1.058	-2.02	2.04	3.16
49	13.23	1.52	1.31	14.0	1.062	2.38	2.04	3.52
50	-13.22	-1.29	1.34	12.7	-1.062	-2.02	2.09	3.19
51	13.17	1.52	1.34	13.9	1.058	2.38	2.09	3.49

Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
52	-13.31	-1.32	1.34	12.8	-1.069	-2.07	2.09	3.20
53	13.07	1.52	1.34	13.9	1.050	2.38	2.09	3.50
54	-13.25	-1.32	1.34	12.7	-1.064	-2.07	2.09	3.18
55	12.43	1.53	1.41	14.9	0.998	2.39	2.20	3.73
56	-13.06	-1.31	1.40	13.1	-1.049	-2.05	2.18	3.30
57	12.04	1.53	1.42	13.7	0.967	2.39	2.21	3.44
58	-13.12	-1.31	1.42	13.1	-1.054	-2.05	2.21	3.28
59	11.35	1.54	1.45	13.9	0.911	2.40	2.26	3.49
60	-12.89	-1.32	1.45	13.0	-1.035	-2.06	2.26	3.26

SPECIMEN F1HS-C7

Description: This specimen was similar to specimen F1-S in detailing and fabrication. The letters "HS" appended to the specimen type signify the use of high strength (ASTM A441) steel. Professional inspection was carried out throughout fabrication, and ultrasonic inspection disclosed no significant weld defects.

Program of Cycling:



Test Control: Tip deflection.

Raw Data Included: Graphical load-deflection data.

Graphical load-curvature data. The curvature data was found by reading the combined output of gages No. 1 and No. 2 connected in series. Gage No. 1 was located at the center of the top flange 2.00 inches from the column face; gage No. 2 was in the same location on the bottom flange.

Total Energy Absorption: 3,597 kip-inches.

Plastic Load Reversals to Failure. 148 (74 cycles)

Remarks: During the 23rd cycle a fine crack was found on one side of the bottom flange at the column face. There was pronounced buckling by the 31st cycle. A new crack was initiated at the center of the top flange weld during the 40th cycle. On the 48th cycle, a new crack appeared at one end of the top weld. Almost immediately following, a similar crack formed in the bottom flange. Spread of the crack from the end of the top weld caused failure.

SPECIMEN TYPE F1HS-C7

DIMENSIONS OF WF SECTION

DEPTH	8.19	INCHES
TOP FLANGE WIDTH	5.220	INCHES
BOTTOM FLANGE WIDTH	5.270	INCHES
TOP FLANGE THICKNESS	0.368	INCHES
BOTTOM FLANGE THICKNESS	0.371	INCHES
WEB THICKNESS	0.257	INCHES
ELASTIC MODULUS	30600.	KSI
YIELD STRESS	51.200	KSI

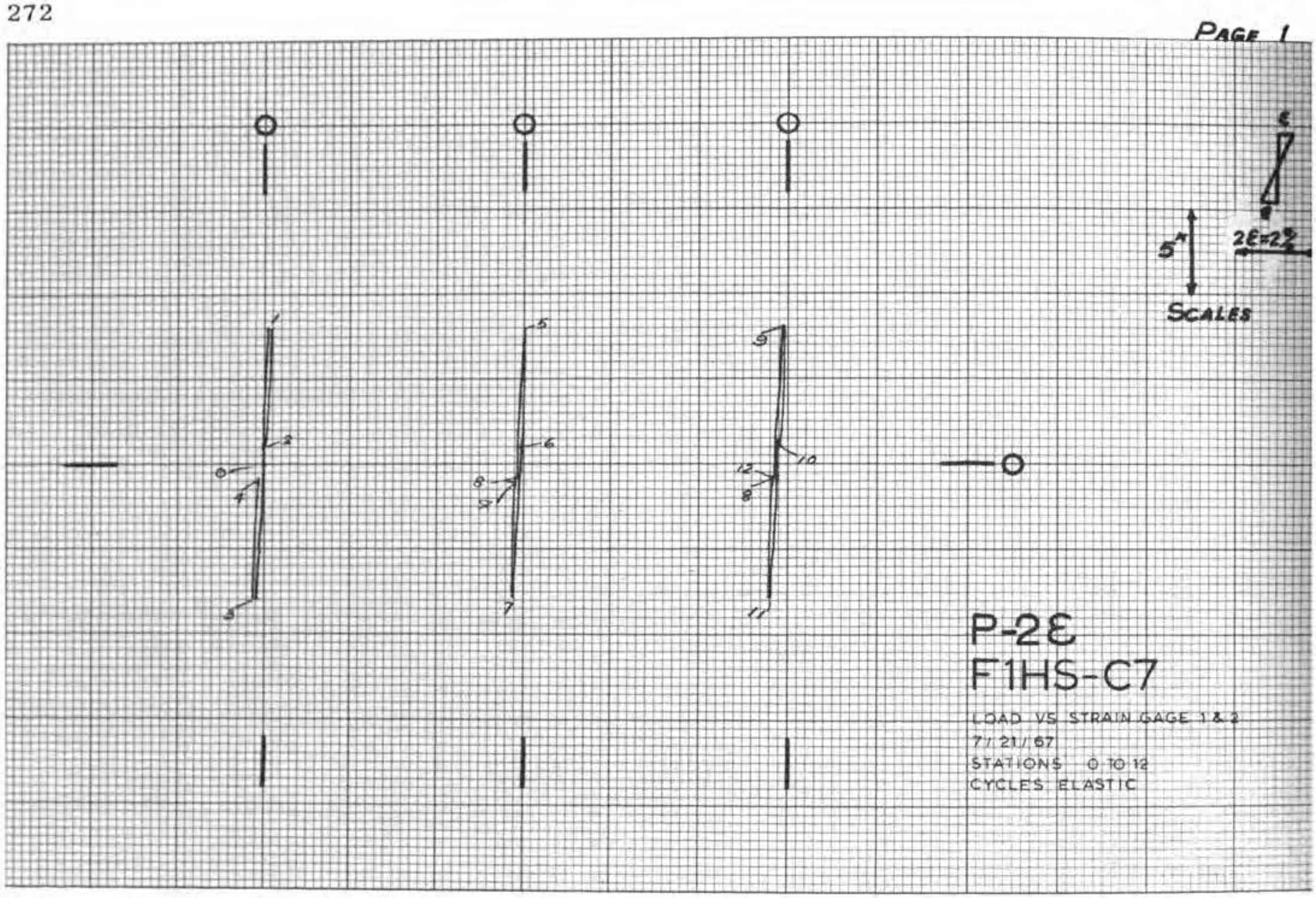
WF SECTION PROPERTIES

AREA, A	5.88	INCHES**2
LOCATION OF CENTROID*, YE	4.07	INCHES
MOMENT OF INERTIA, I	69.3	INCHES**4
SECTION MODULUS, TOP, ST	16.8	INCHES**3
SECTION MODULUS, BOTTOM, SB	17.0	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.03	INCHES
PLASTIC MODULUS, Z	19.0	INCHES**3
SHAPE FACTOR	1.131	
YIELD MOMENT, MY	71.87	KIP-FT.
PLASTIC MOMENT, MP	81.25	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

BEAM PROPERTIES

LENGTH, L	66.0	INCHES
ELASTIC STIFFNESS, P/DELTA	22.14	KIPS/IN.
YIELD DEFLECTION, DELTAY	0.590	INCHES
YIELD LOAD, PY	13.07	KIPS
PLASTIC LOAD, PP	14.77	KIPS



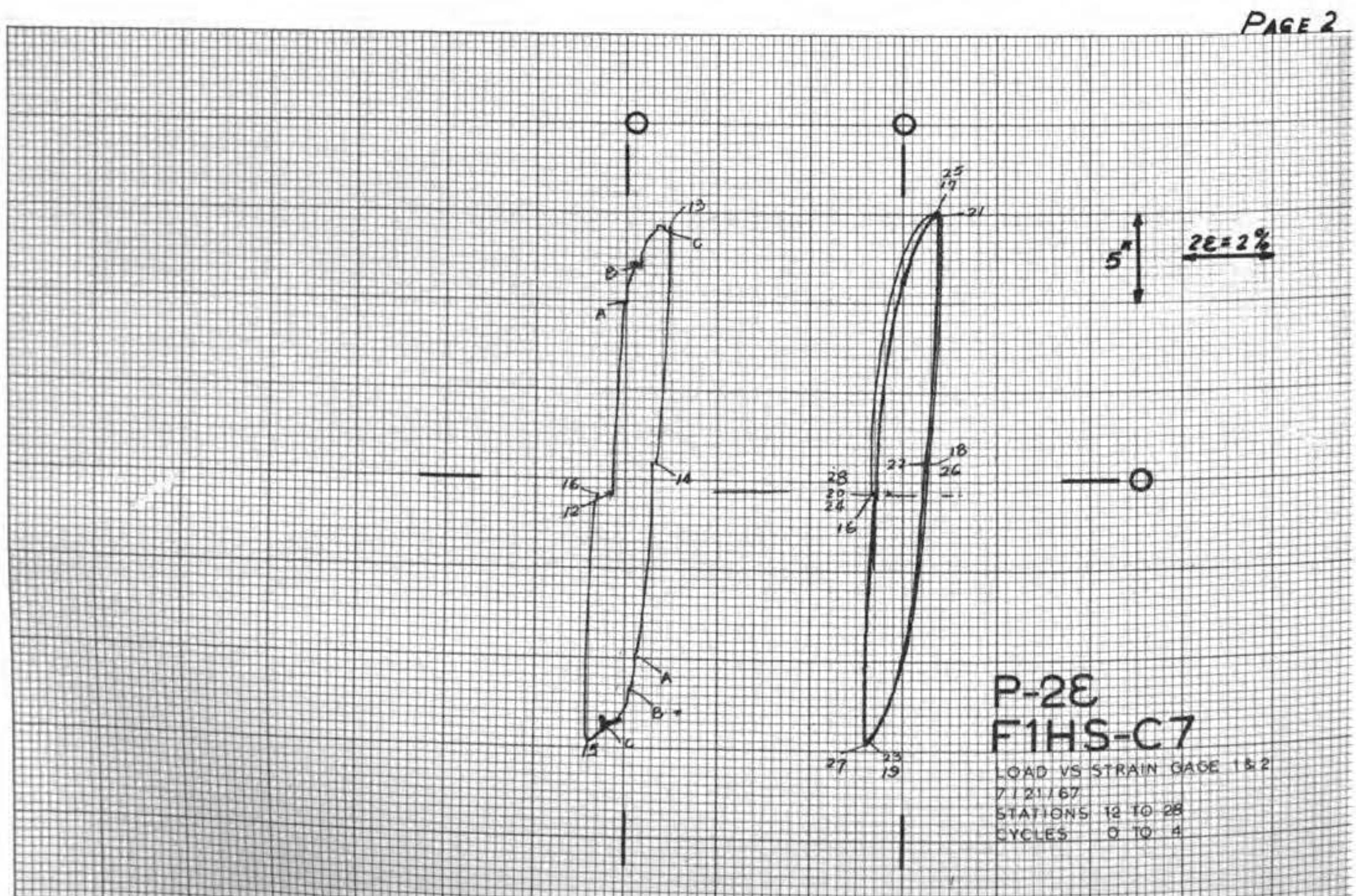
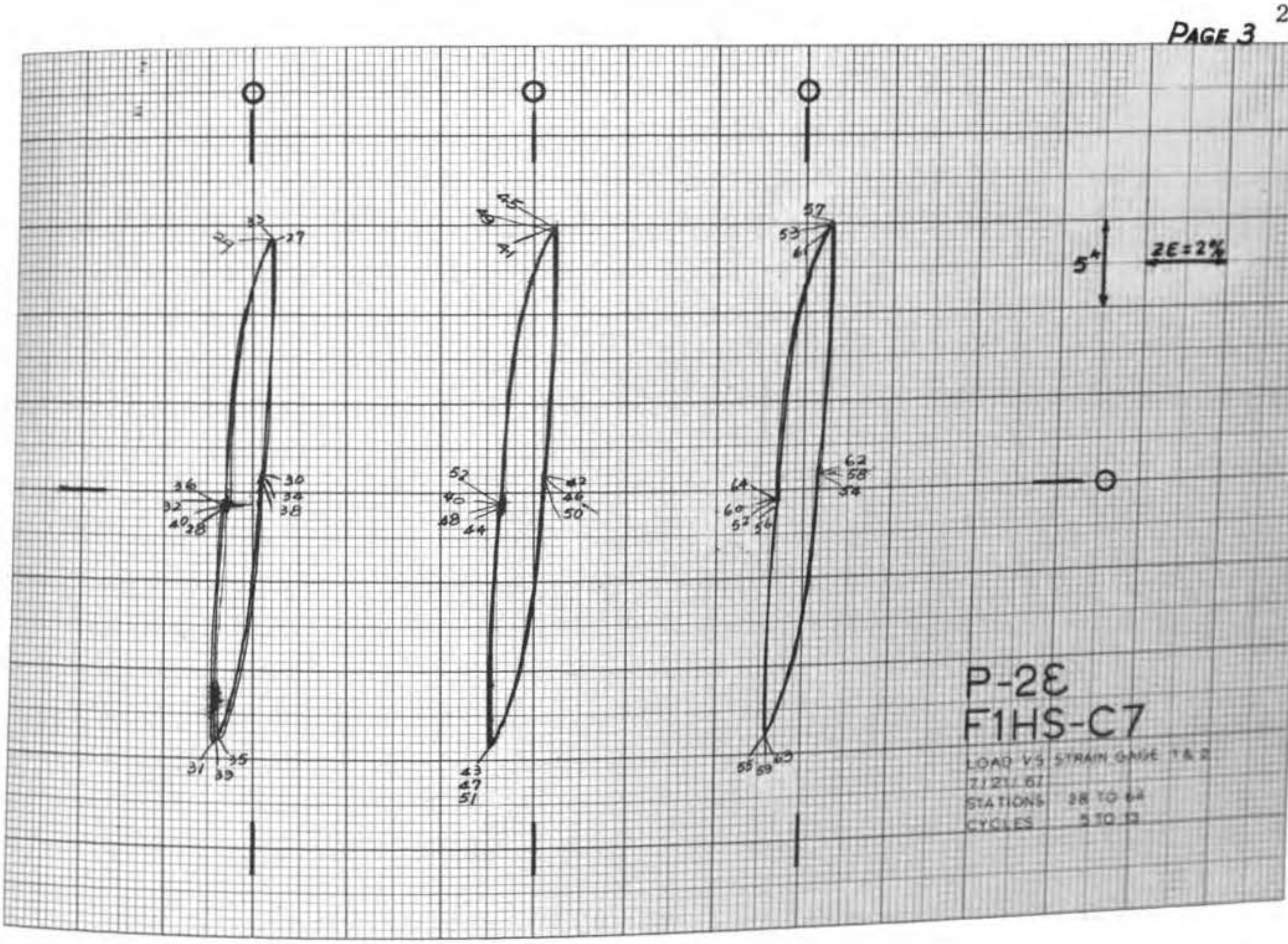


PLATE 36. LOAD VS. STRAIN - F1HS-C7



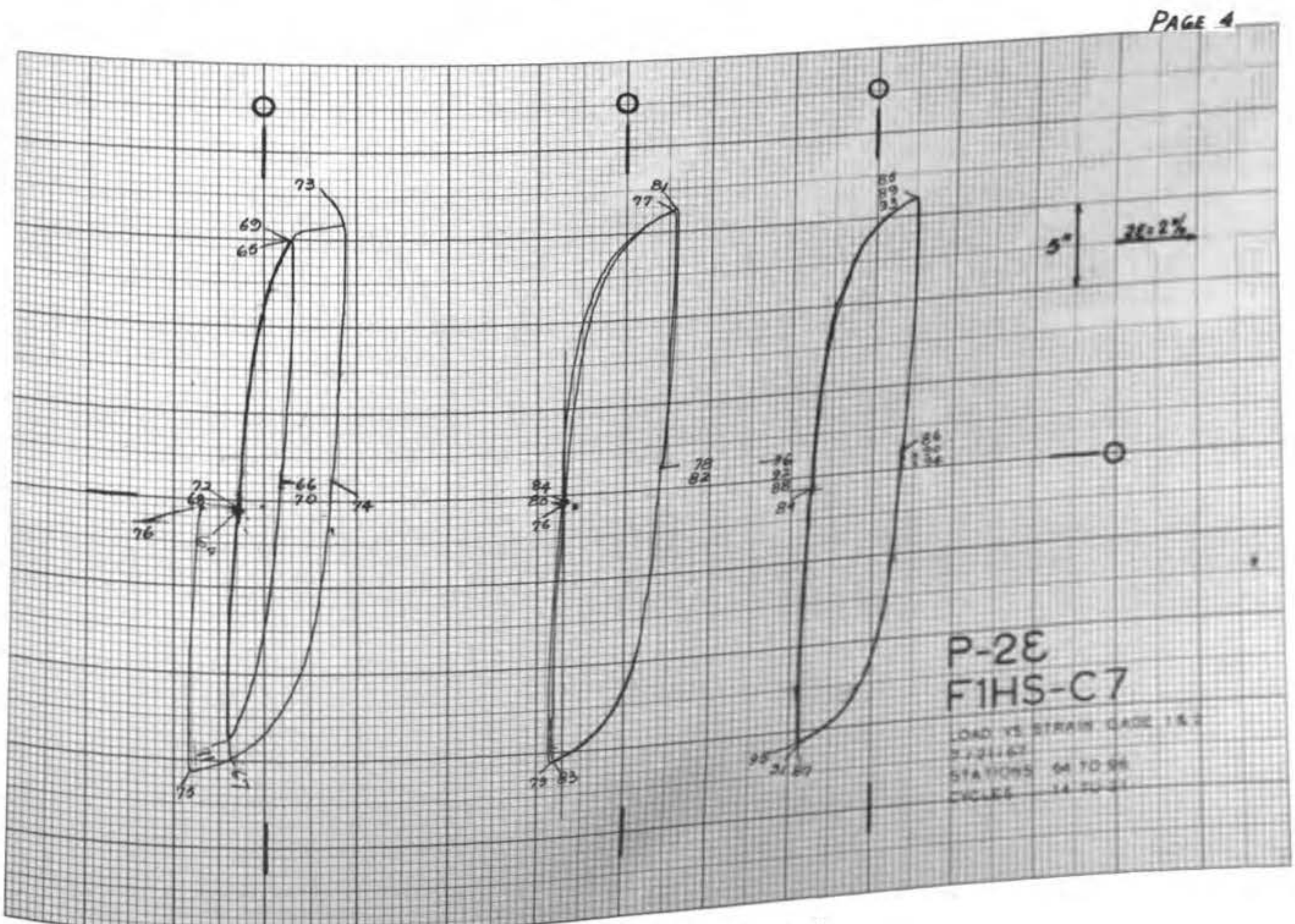
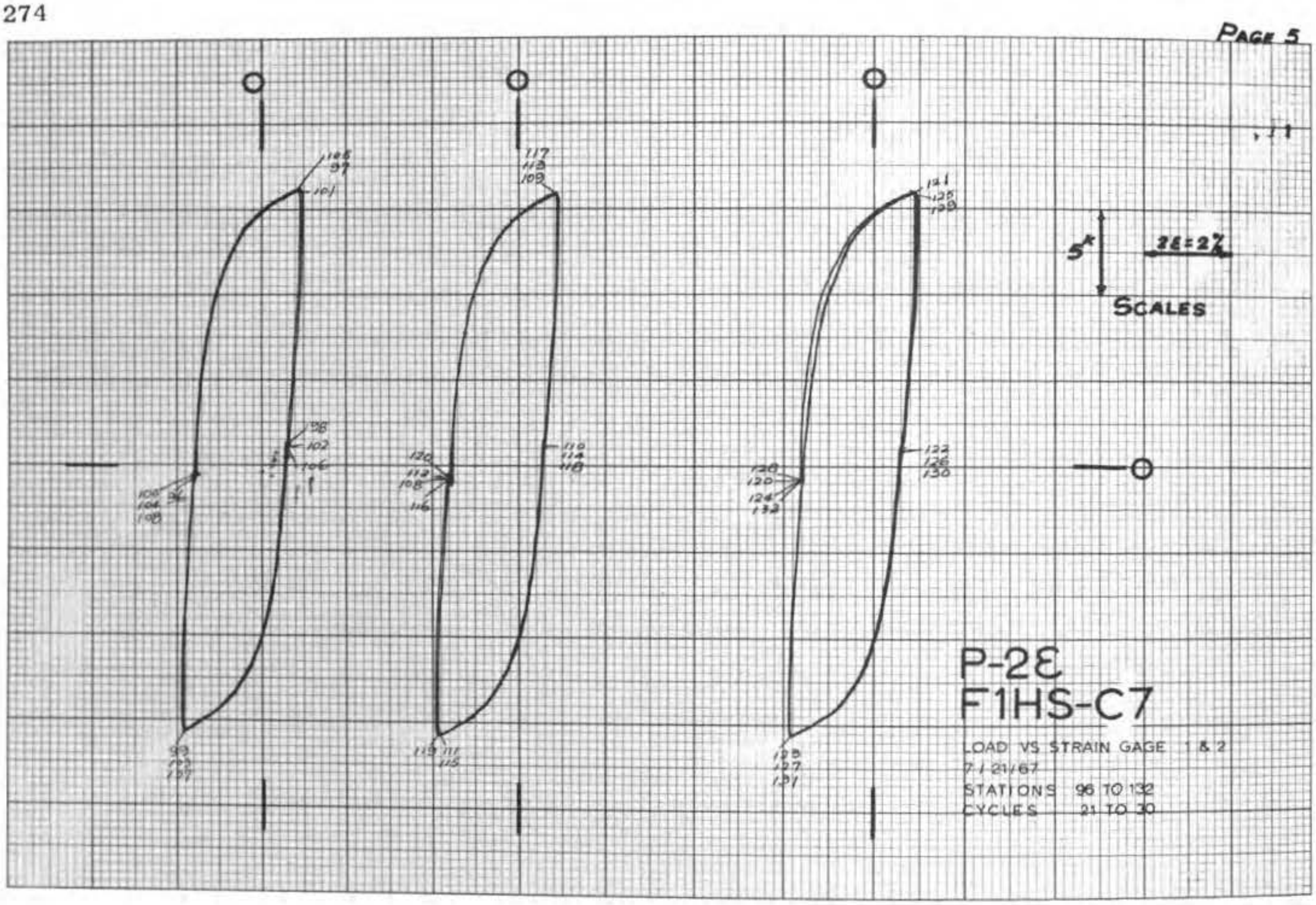


PLATE 36. (continued)



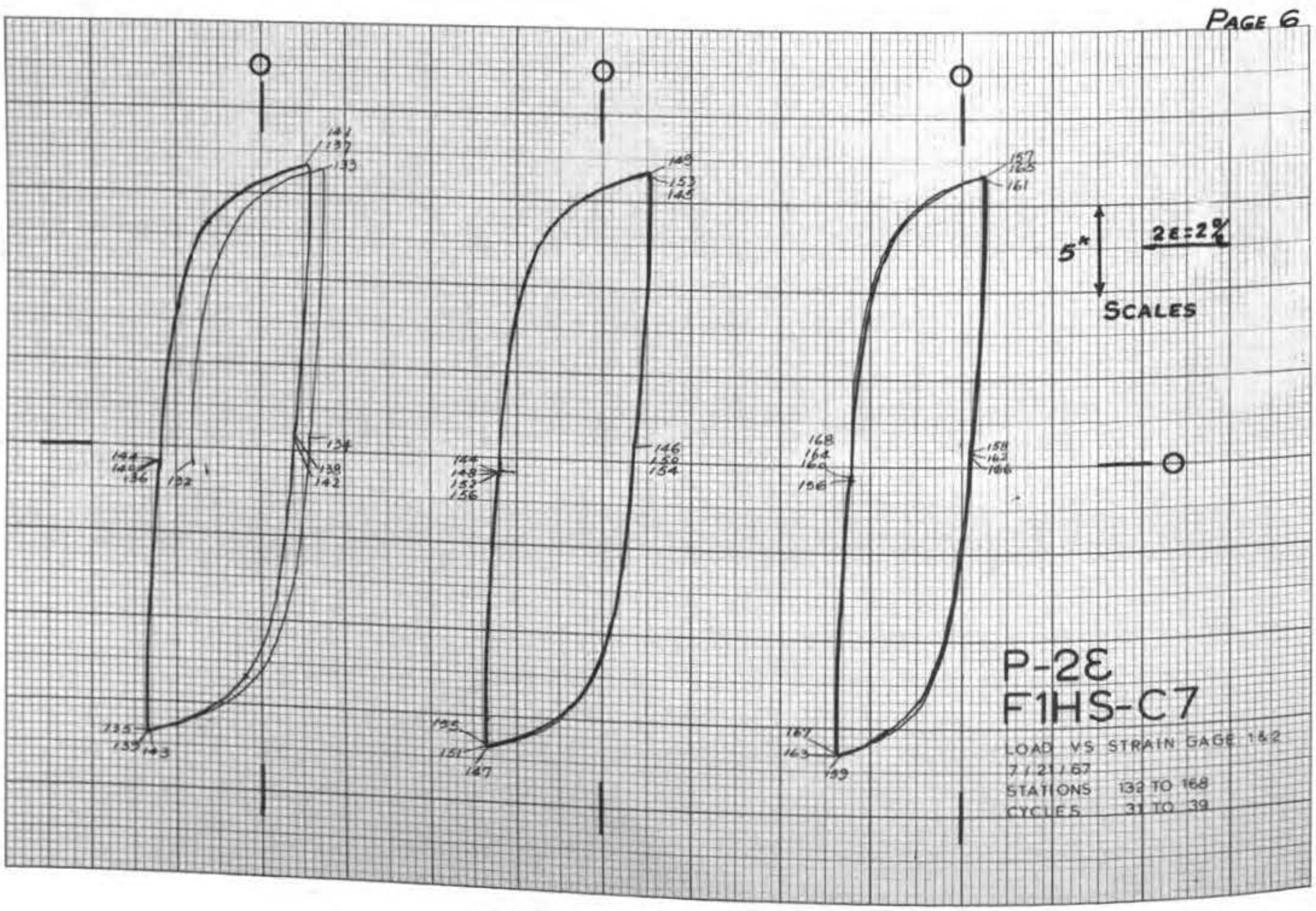
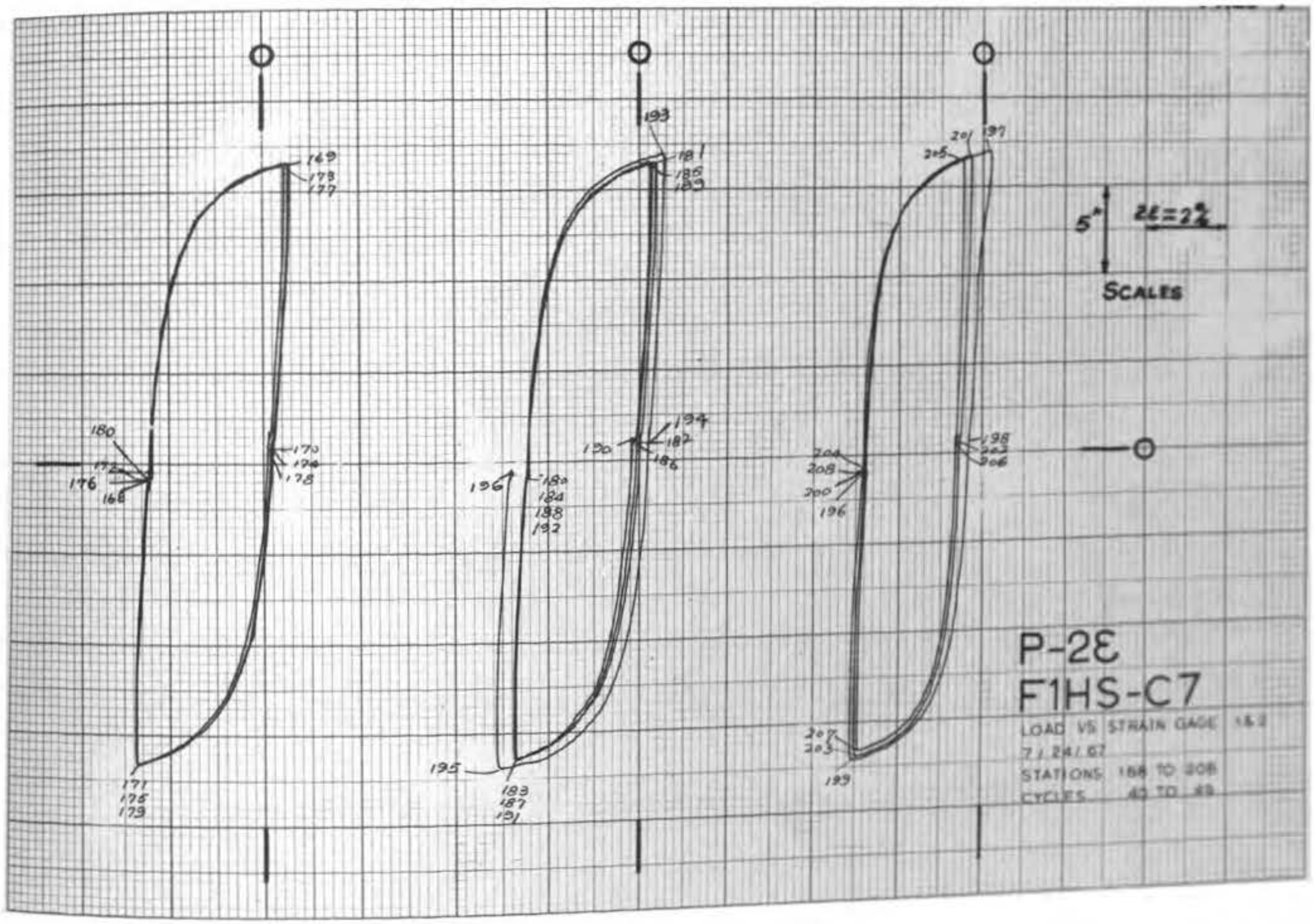


PLATE 36. (continued)



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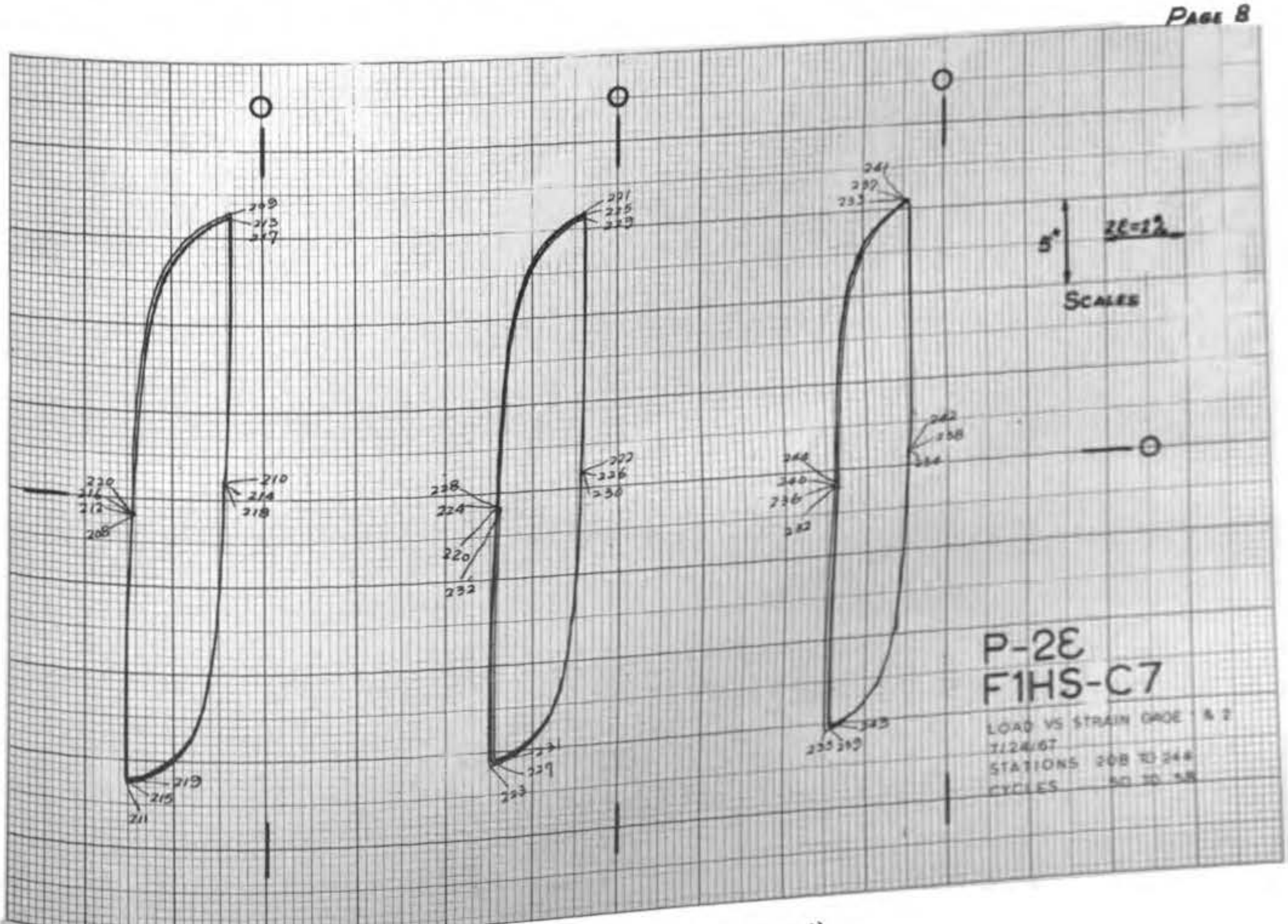


PLATE 36. (continued)

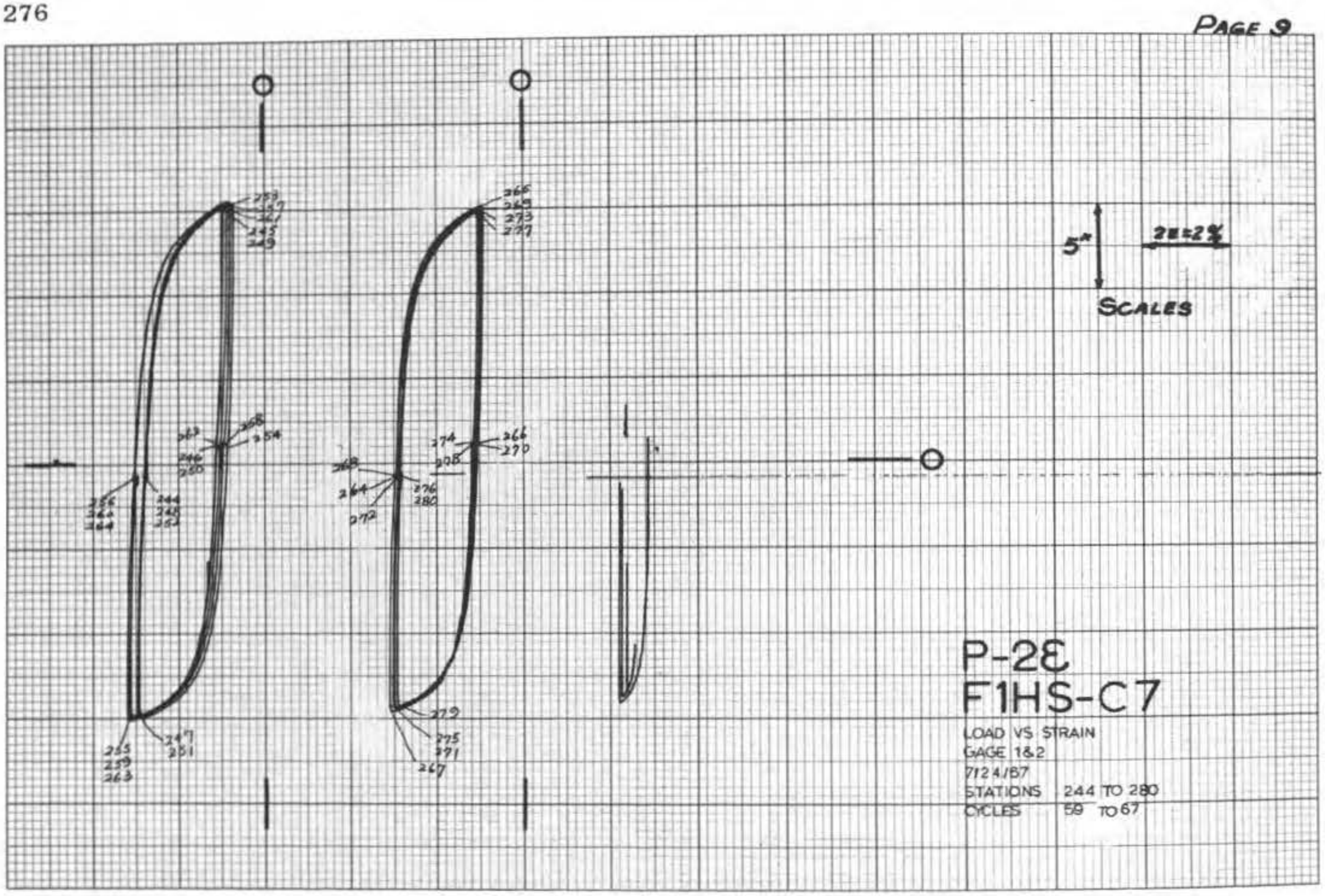


PLATE 36. (continued)

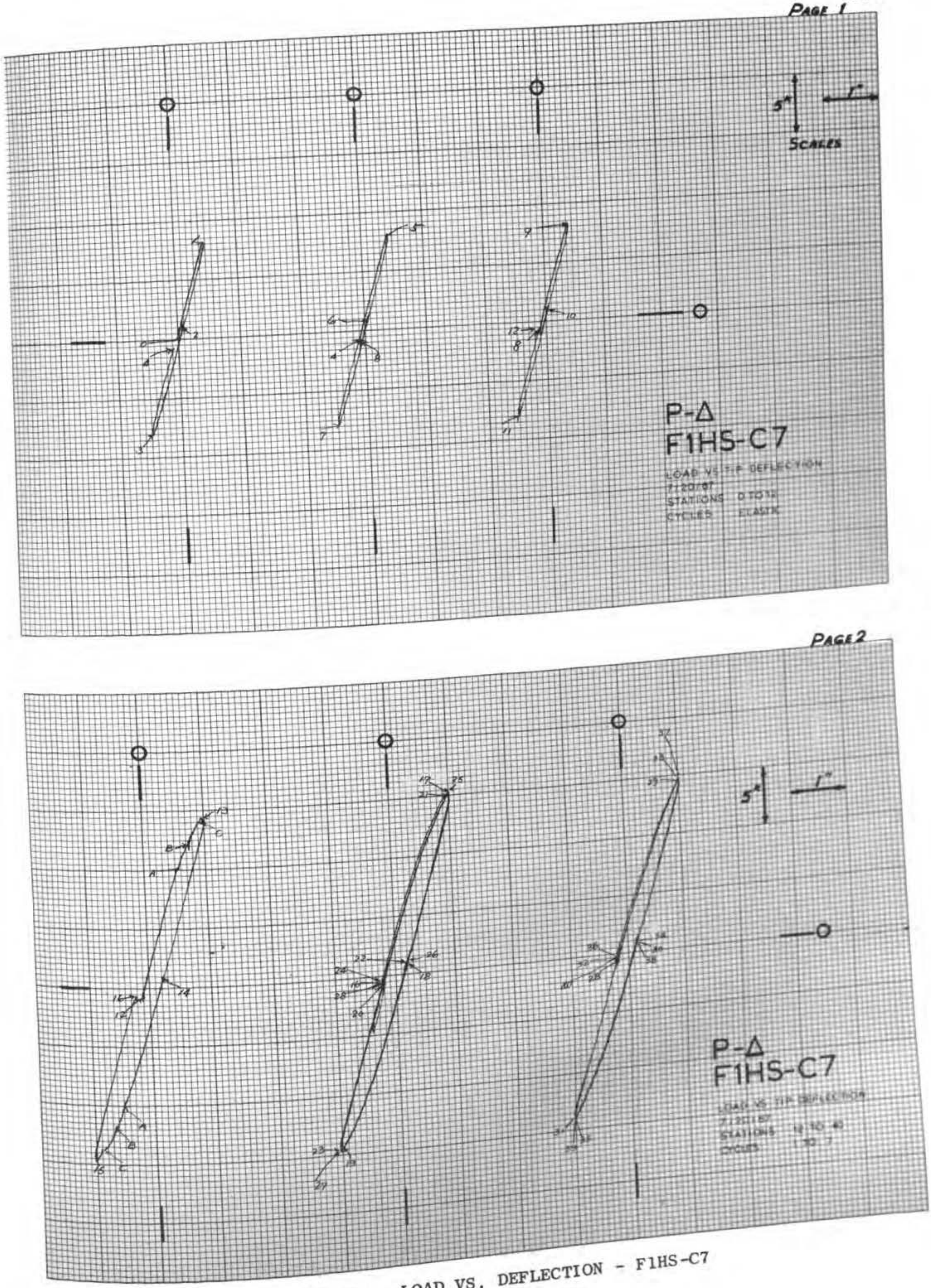
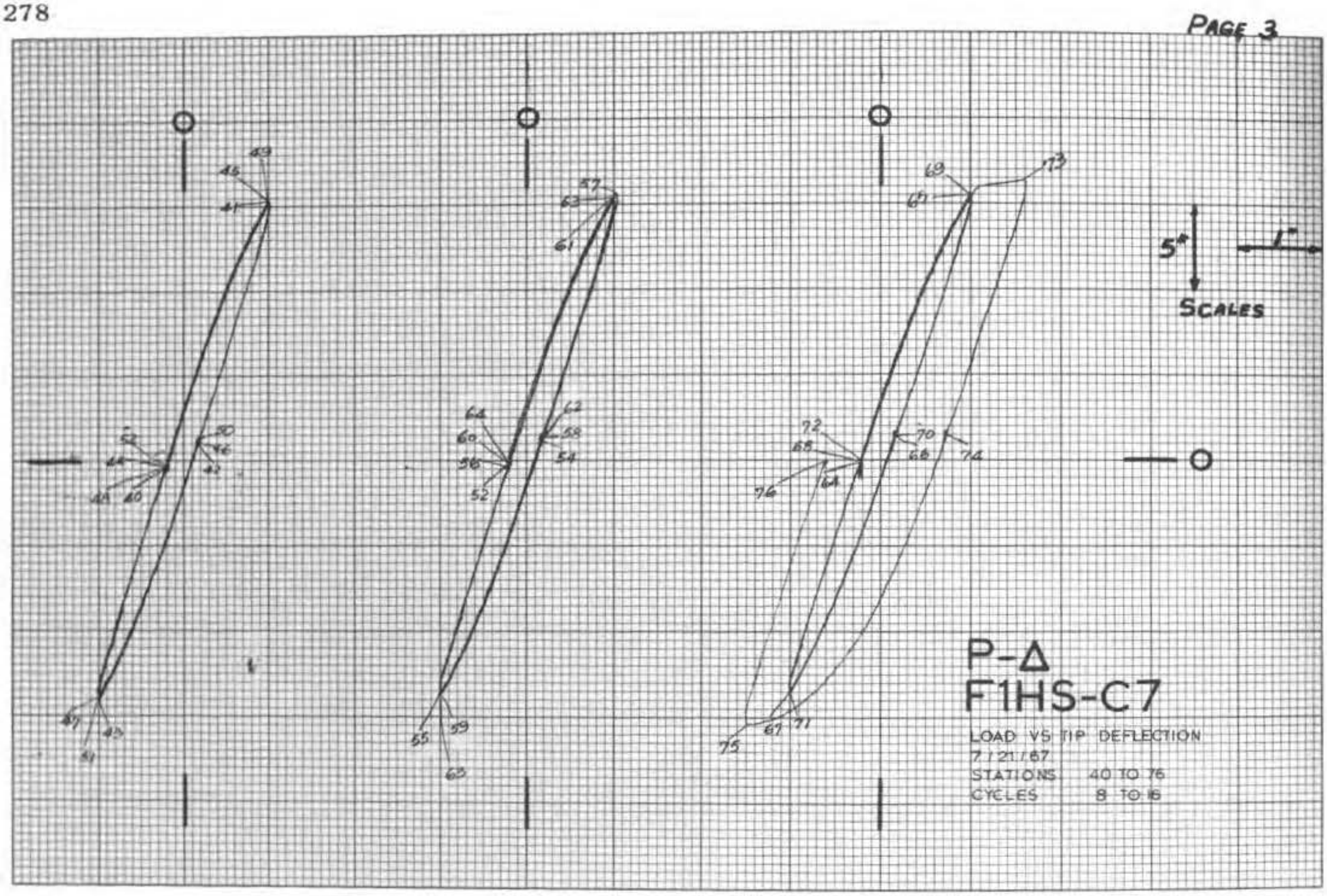


PLATE 37. LOAD VS. DEFLECTION - F1HS-C7



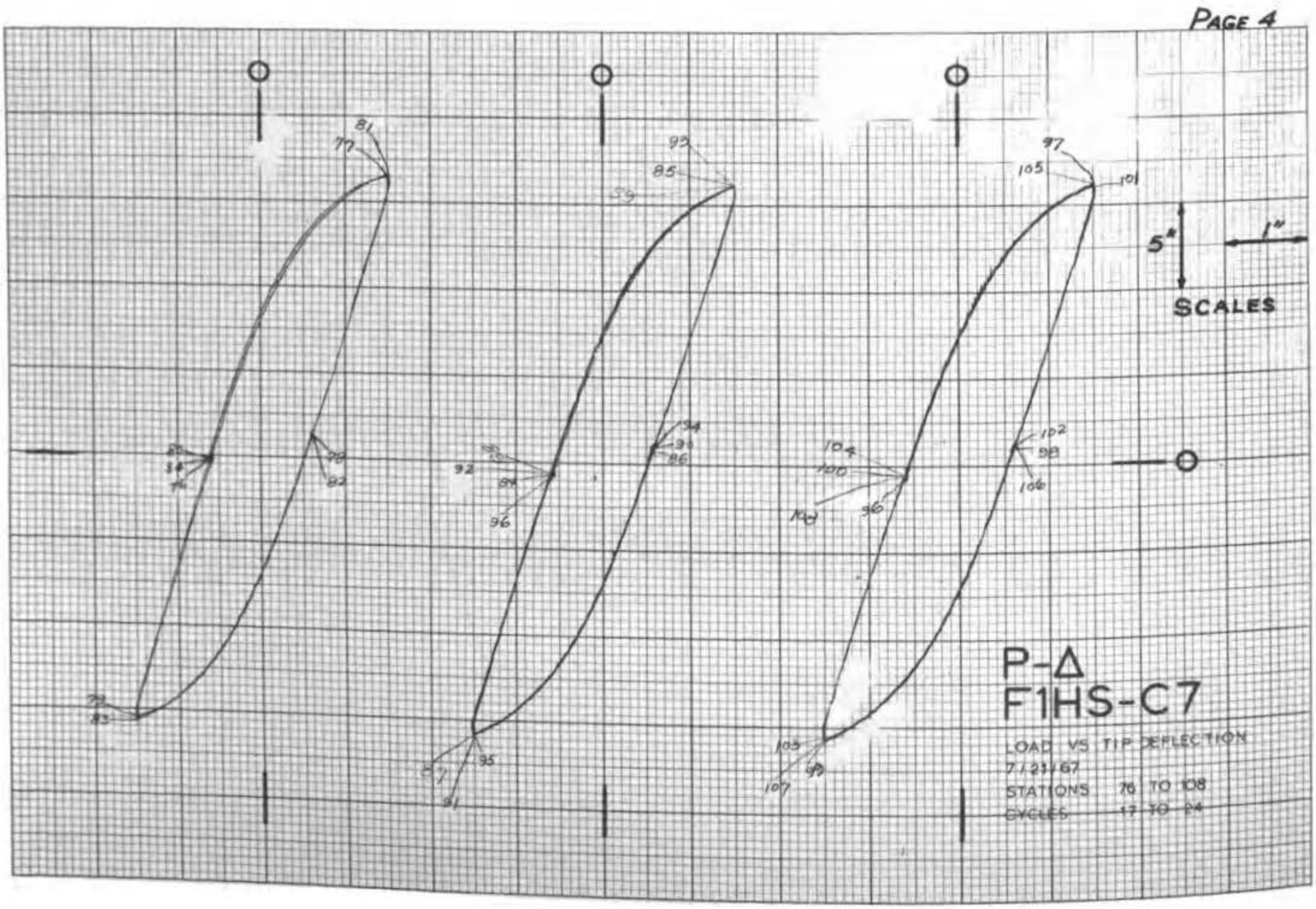
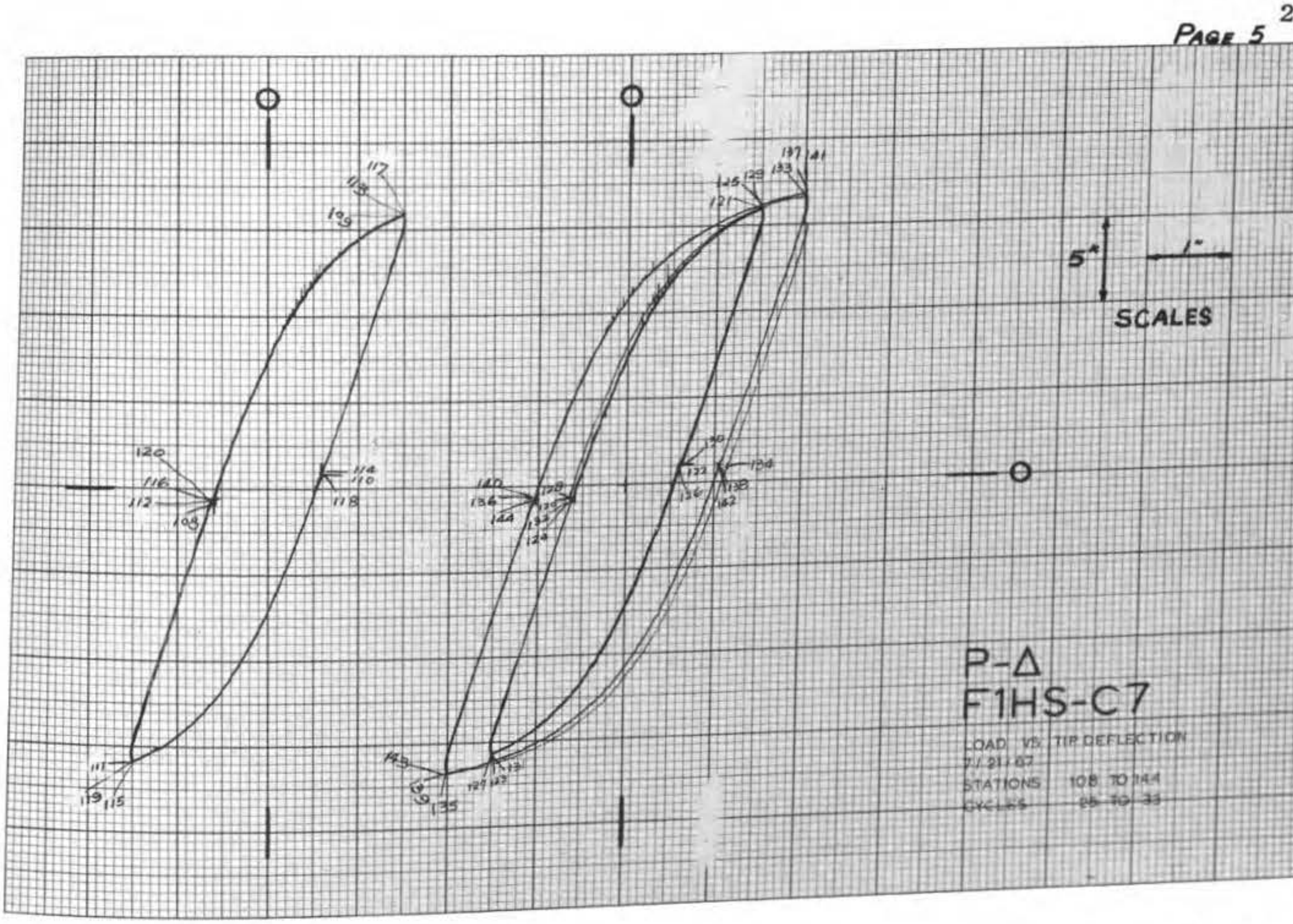


PLATE 37. (continued)



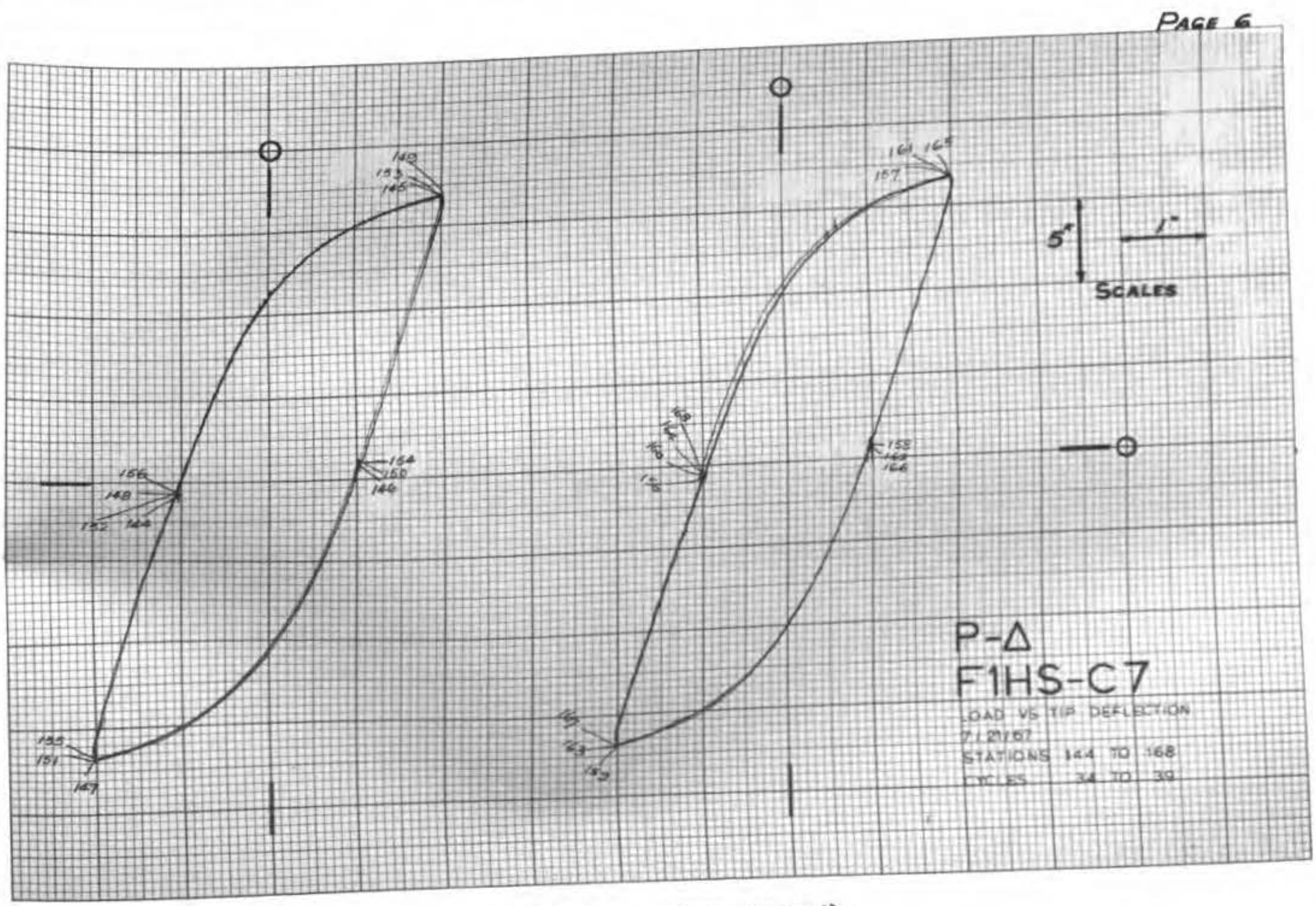
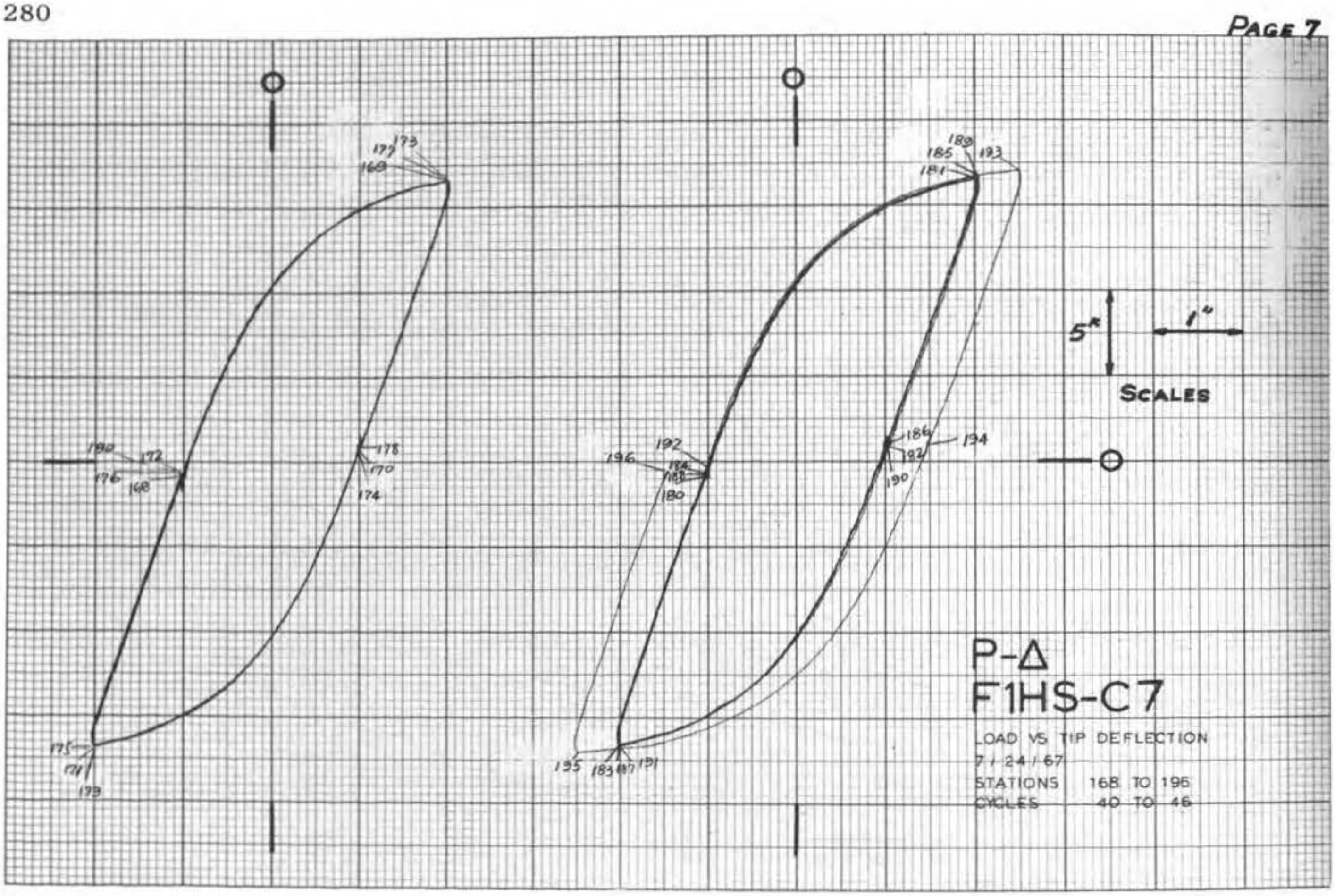


PLATE 37. (continued)



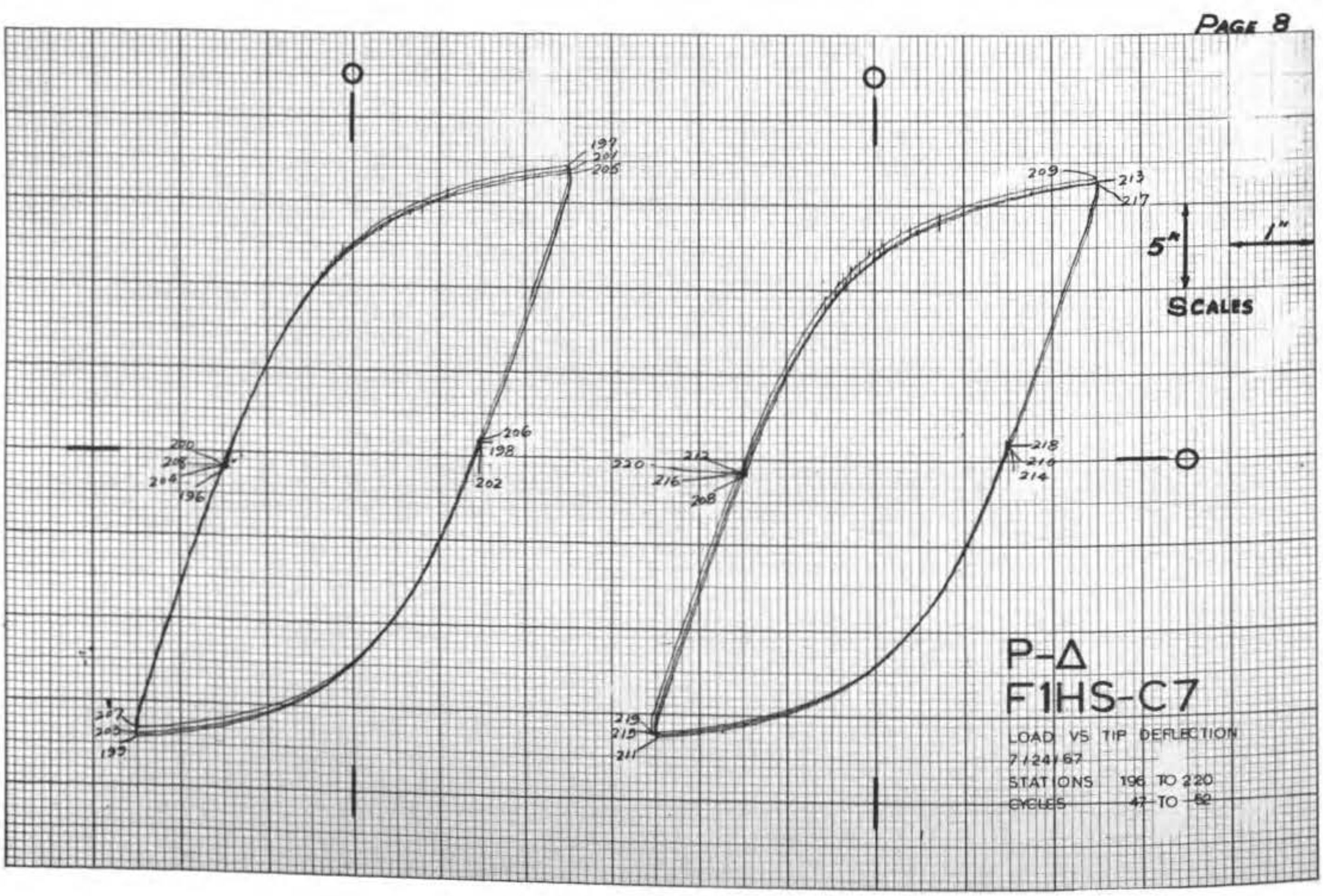
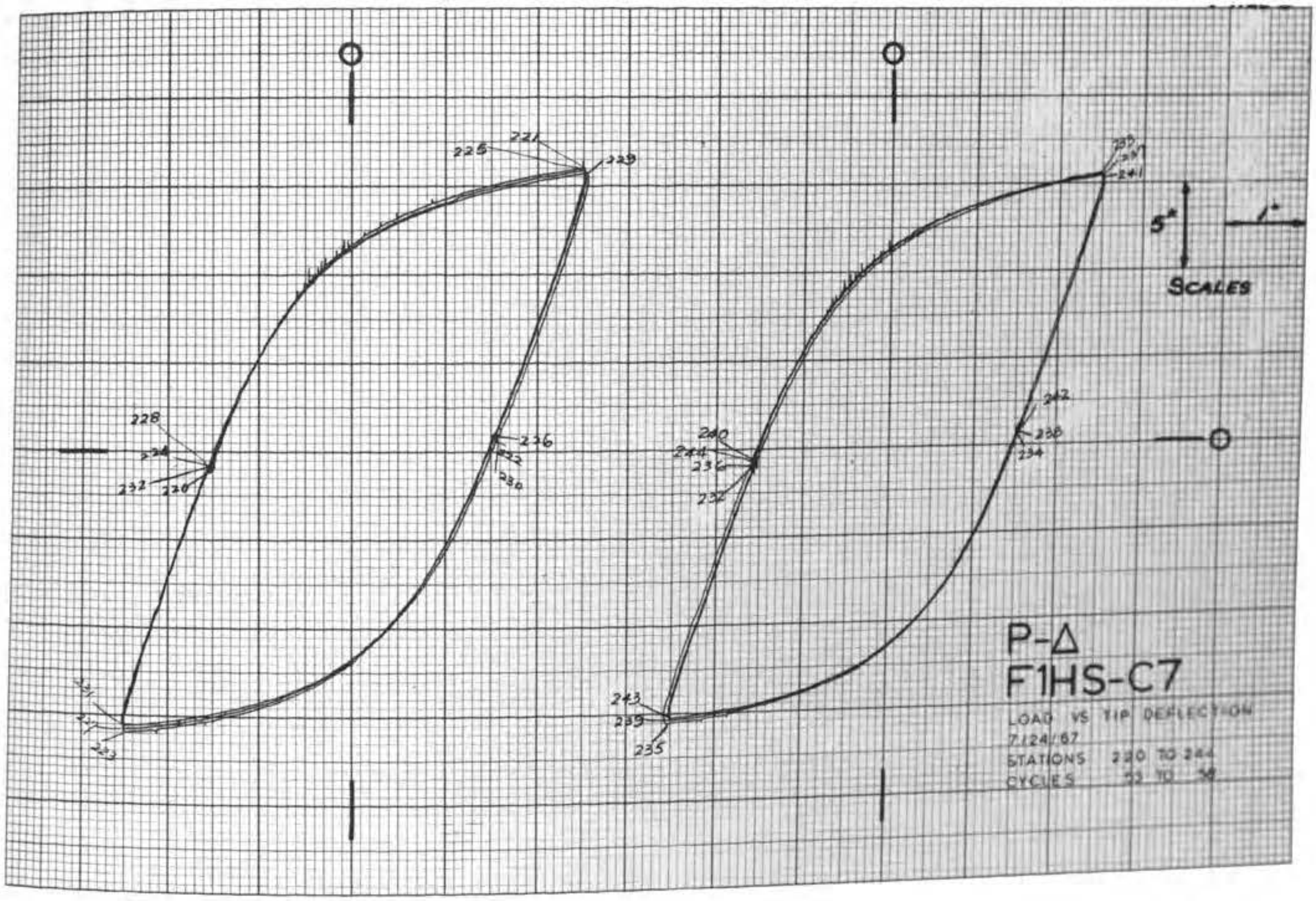


PLATE 37. (continued)



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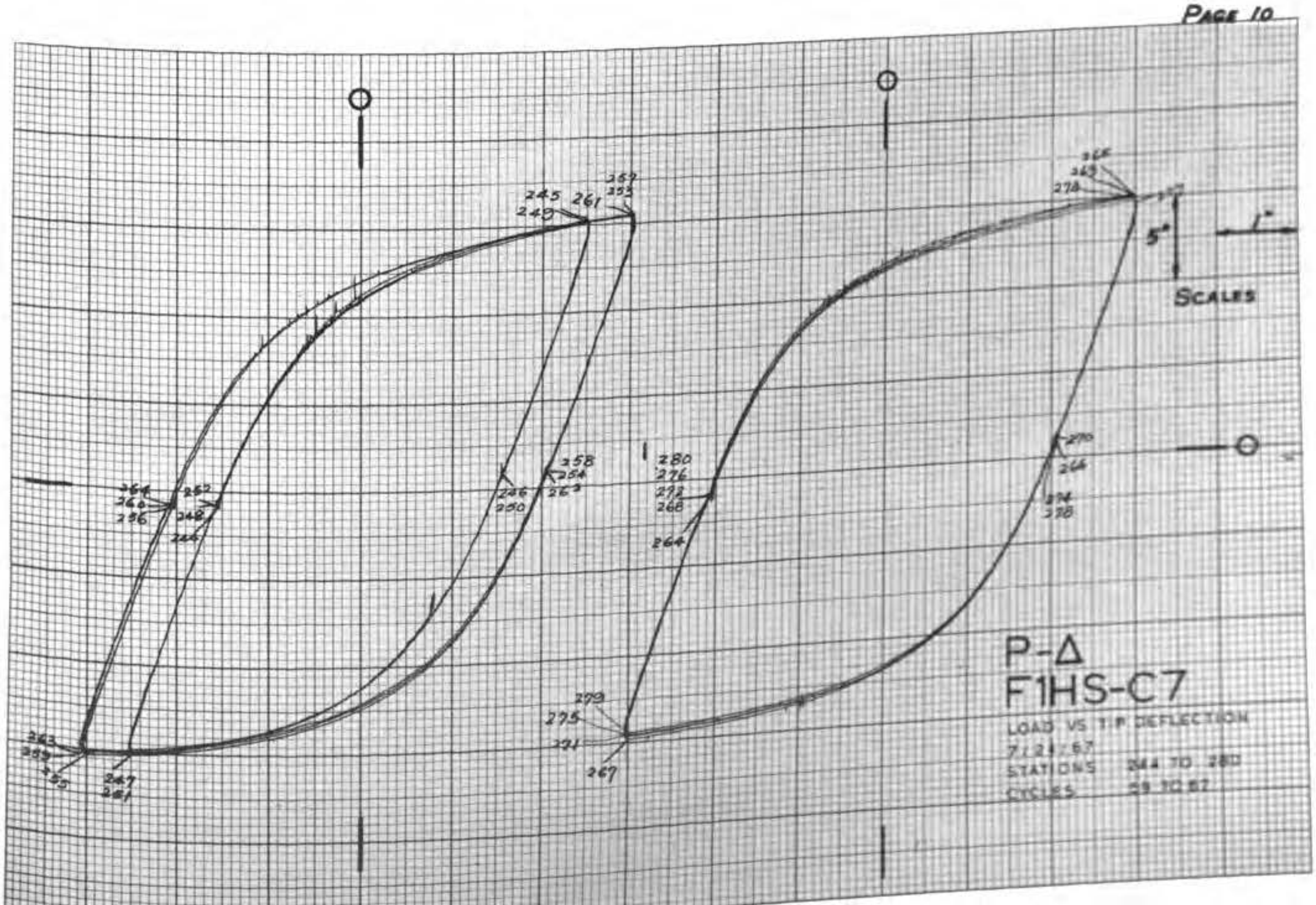


PLATE 37. (continued)

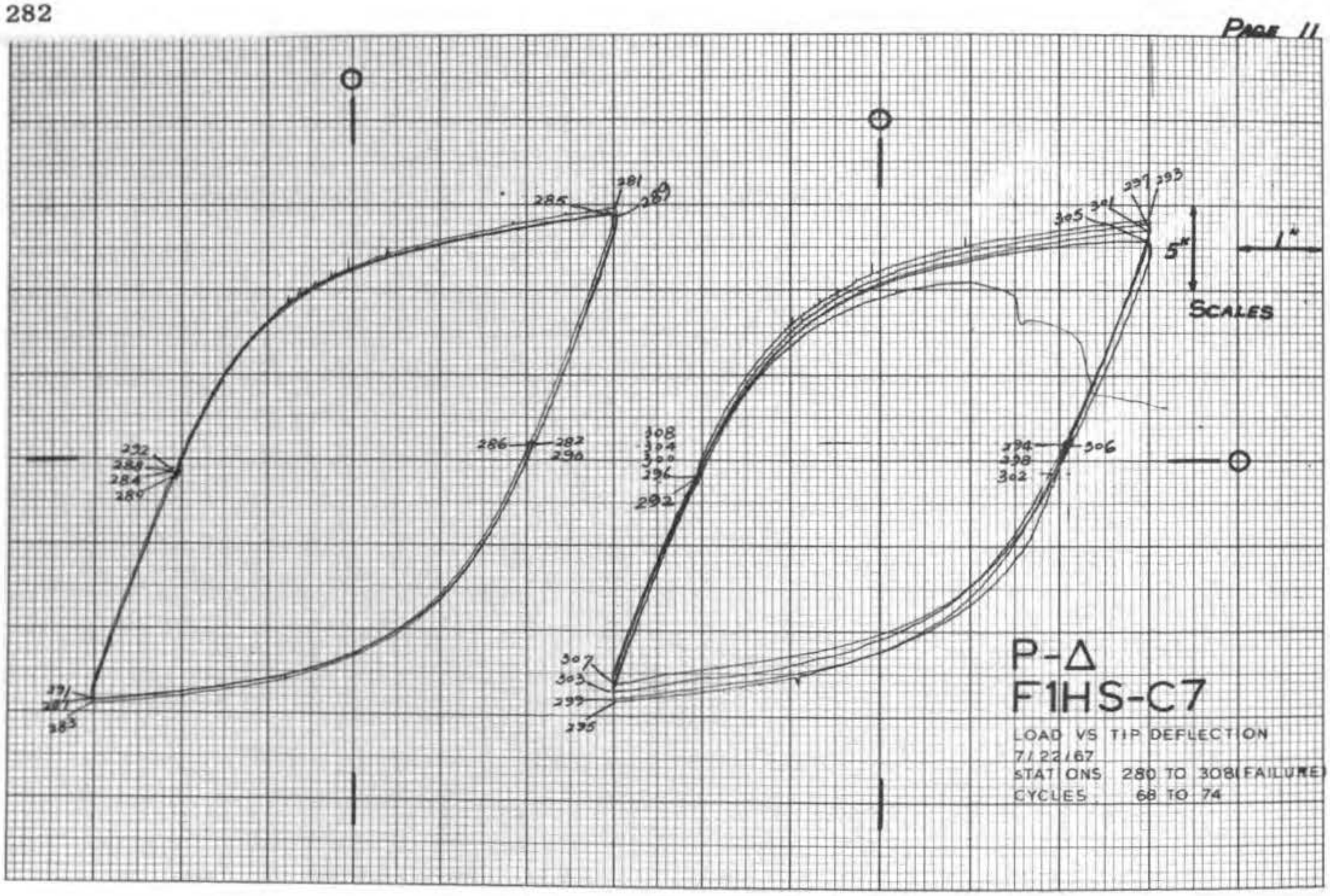


PLATE 37. (continued)

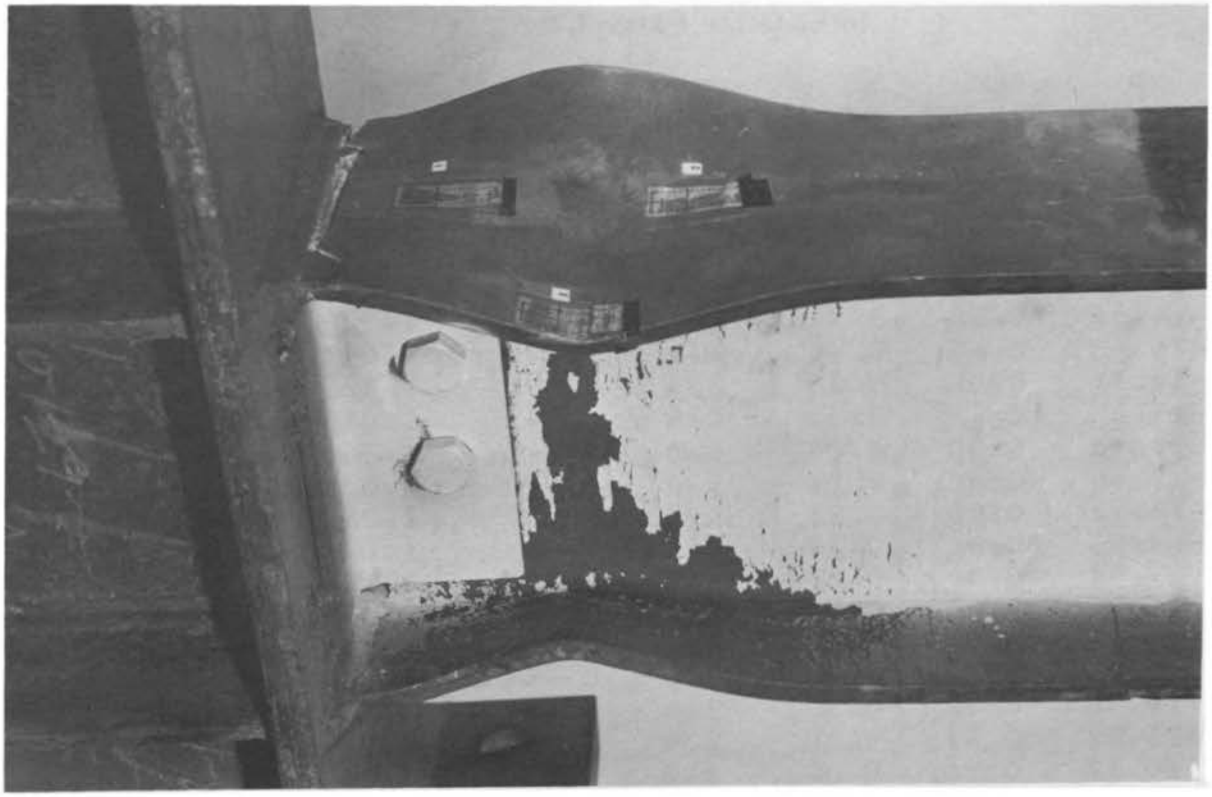


FIGURE 44. F1HS-C7

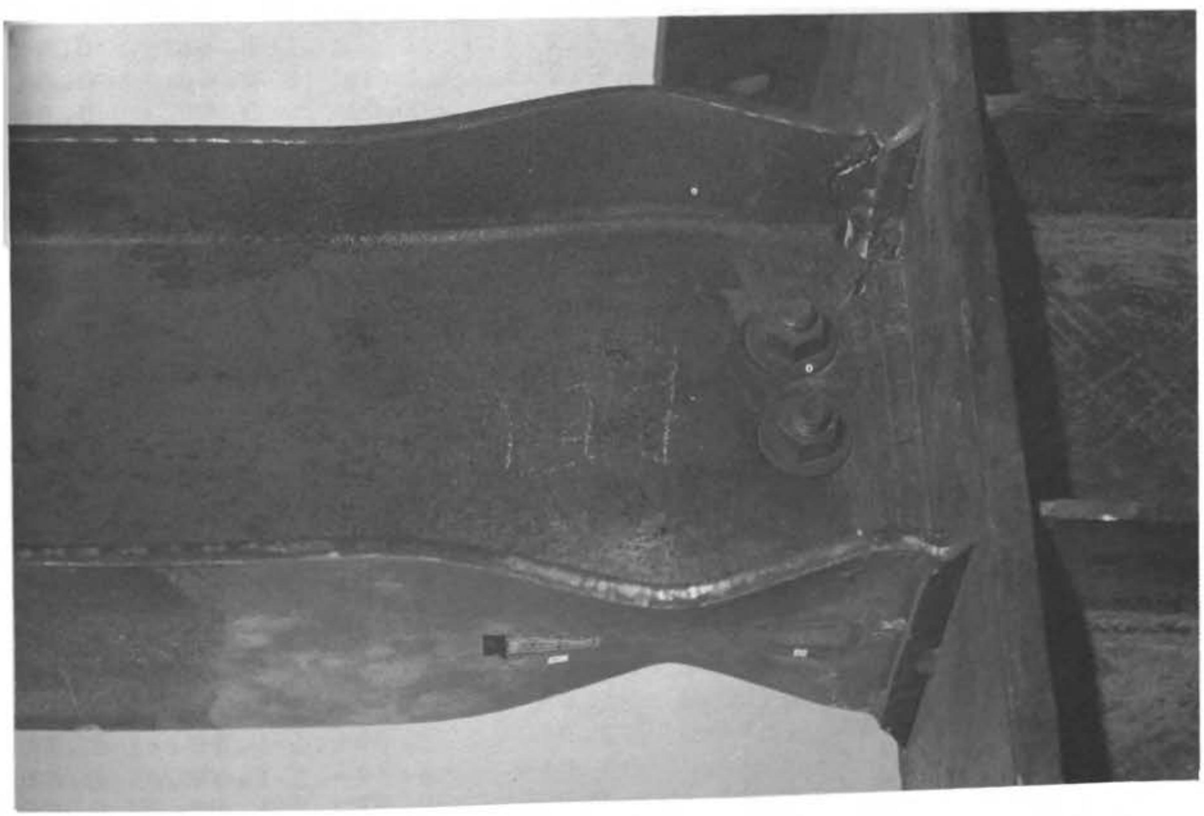


FIGURE 45. F1HS-C7

SPECIMEN F1HS-C7

Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	13.98	0.89	0.42	2.6	0.947	1.33	0.63	0.53
2	-14.44	-0.68	0.36	3.6	-0.978	-1.03	0.55	0.73
3	14.78	0.88	0.35	3.2	1.001	1.32	0.52	0.66
4	-14.30	-0.69	0.34	3.0	-0.968	-1.03	0.51	0.61
5	14.66	0.88	0.34	2.8	0.993	1.32	0.51	0.56
6	-14.63	-0.69	0.34	3.0	-0.991	-1.04	0.51	0.62
7	14.71	0.88	0.34	2.8	0.996	1.32	0.51	0.56
8	-14.51	-0.68	0.33	2.9	-0.982	-1.02	0.50	0.60
9	13.98	0.90	0.29	2.3	0.946	1.34	0.44	0.48
10	-13.88	-0.68	0.27	2.0	-0.940	-1.02	0.41	0.40
11	13.92	0.90	0.27	1.9	0.943	1.34	0.41	0.39
12	-13.93	-0.68	0.27	2.0	-0.943	-1.02	0.41	0.40
13	13.97	0.90	0.27	2.1	0.946	1.34	0.41	0.43
14	-14.04	-0.68	0.27	2.2	-0.951	-1.02	0.41	0.44
15	14.61	0.90	0.31	2.6	0.989	1.35	0.46	0.52
16	-13.93	-0.67	0.30	2.2	-0.943	-1.00	0.45	0.45
17	14.58	0.90	0.30	2.6	0.987	1.35	0.45	0.52
18	-13.92	-0.67	0.30	2.4	-0.943	-1.00	0.45	0.48
19	14.32	0.90	0.30	3.0	0.970	1.35	0.45	0.60
20	-14.03	-0.67	0.30	2.7	-0.950	-1.00	0.45	0.54
21	14.62	0.90	0.31	3.0	0.990	1.35	0.47	0.60
22	-13.69	-0.67	0.31	2.4	-0.927	-1.01	0.47	0.48
23	14.74	0.92	0.31	2.7	0.998	1.38	0.47	0.55
24	-13.74	-0.67	0.30	2.4	-0.930	-1.01	0.46	0.49
25	14.47	0.90	0.31	2.6	0.980	1.36	0.47	0.53
26	-13.84	-0.67	0.31	2.4	-0.937	-1.01	0.46	0.48
27	14.52	0.90	0.31	2.7	0.983	1.35	0.46	0.54
28	-13.73	-0.67	0.30	2.3	-0.930	-1.01	0.45	0.46
29	14.54	0.90	0.30	2.5	0.985	1.35	0.45	0.52
30	-13.83	-0.67	0.30	2.2	-0.937	-1.01	0.45	0.45
31	15.29	1.39	0.84	11.0	1.036	2.08	1.27	2.24
32	-15.80	-1.14	1.24	15.4	-1.070	-1.71	1.86	3.12
33	15.67	1.39	1.13	14.2	1.061	2.08	1.69	2.88
34	-15.77	-1.15	1.14	13.4	-1.068	-1.72	1.71	2.72
35	15.77	1.39	1.14	13.9	1.068	2.09	1.71	2.82
36	-15.80	-1.14	1.14	13.0	-1.070	-1.71	1.71	2.64
37	15.79	1.37	1.11	12.9	1.069	2.06	1.67	2.61
38	-15.70	-1.16	1.11	12.1	-1.063	-1.74	1.66	2.45
39	15.80	1.37	1.11	12.6	1.069	2.06	1.66	2.56
40	-15.79	-1.16	1.11	12.5	-1.069	-1.74	1.66	2.54
41	15.66	1.37	1.11	13.3	1.060	2.06	1.66	2.71
42	-15.79	-1.16	1.11	13.0	-1.069	-1.74	1.66	2.64
43	15.77	1.37	1.13	13.3	1.068	2.06	1.70	2.70
44	-15.80	-1.16	1.12	13.1	-1.070	-1.74	1.69	2.65
45	15.73	1.38	1.13	13.2	1.065	2.06	1.69	2.68
46	-15.72	-1.16	1.13	13.1	-1.065	-1.74	1.69	2.66
47	15.77	1.38	1.13	13.5	1.068	2.06	1.69	2.74
48	-15.79	-1.16	1.13	13.2	-1.069	-1.74	1.69	2.67
49	15.71	1.38	1.12	13.1	1.064	2.07	1.68	2.66
50	-15.76	-1.16	1.13	12.9	-1.067	-1.74	1.69	2.61
51	15.62	1.38	1.13	13.1	1.058	2.07	1.69	2.65

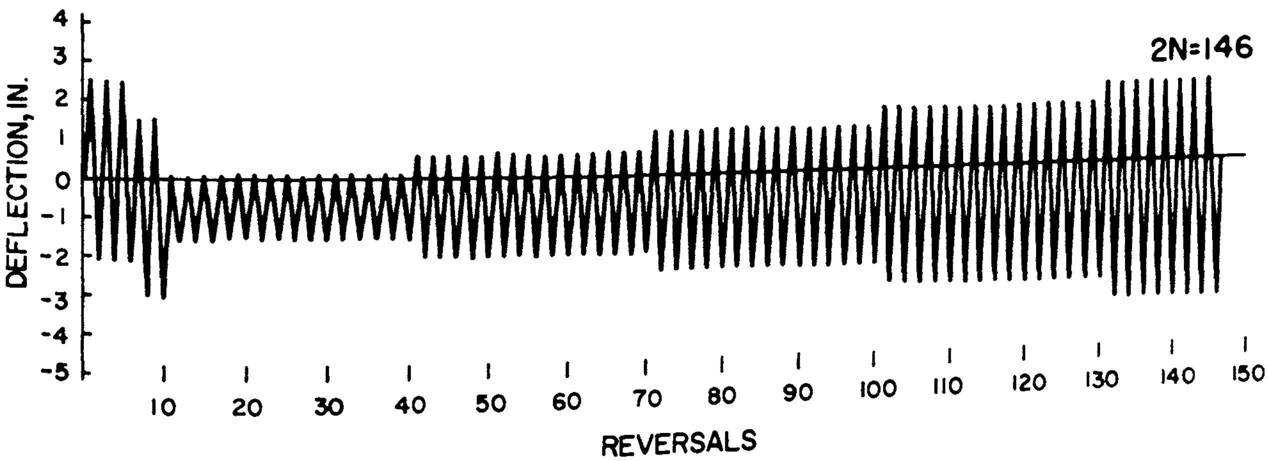
Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
52	−15.75	−1.16	1.13	12.9	−1.067	−1.73	1.69	2.63
53	15.66	1.38	1.13	13.1	1.060	2.07	1.69	2.67
54	−15.88	−1.16	1.13	12.8	−1.075	−1.73	1.69	2.61
55	15.77	1.40	1.15	13.3	1.068	2.10	1.73	2.69
56	−15.60	−1.14	1.13	12.9	−1.056	−1.71	1.69	2.61
57	15.74	1.40	1.13	13.4	1.066	2.10	1.69	2.71
58	−15.65	−1.14	1.13	13.0	−1.060	−1.71	1.69	2.65
59	15.72	1.40	1.13	13.6	1.064	2.10	1.69	2.77
60	−15.66	−1.14	1.13	12.9	−1.061	−1.71	1.69	2.63
61	16.37	1.89	1.67	16.9	1.108	2.83	2.50	3.43
62	−16.66	−1.62	2.09	28.4	−1.128	−2.43	3.13	5.77
63	16.50	1.89	1.99	25.6	1.117	2.83	2.98	5.20
64	−16.70	−1.62	1.99	26.7	−1.131	−2.43	2.98	5.42
65	16.56	1.89	1.99	26.0	1.122	2.83	2.98	5.28
66	−16.75	−1.62	1.99	26.5	−1.134	−2.43	2.98	5.39
67	16.46	1.92	1.98	26.0	1.115	2.87	2.97	5.27
68	−16.69	−1.59	1.98	25.6	−1.130	−2.38	2.97	5.20
69	16.61	1.92	2.01	26.4	1.125	2.88	3.01	5.37
70	−16.77	−1.59	2.01	26.3	−1.135	−2.39	3.01	5.33
71	16.48	1.92	2.03	26.6	1.116	2.87	3.04	5.39
72	−16.70	−1.59	2.03	25.8	−1.131	−2.39	3.04	5.24
73	16.31	1.91	1.95	25.4	1.105	2.87	2.93	5.16
74	−16.50	−1.59	1.90	23.8	−1.117	−2.39	2.84	4.84
75	16.23	1.92	1.90	24.1	1.099	2.87	2.85	4.90
76	−16.52	−1.59	1.90	23.9	−1.119	−2.39	2.85	4.86
77	16.15	1.91	1.90	24.0	1.094	2.87	2.85	4.86
78	−16.46	−1.59	1.90	24.1	−1.115	−2.39	2.84	4.90
79	16.24	1.94	1.94	24.8	1.099	2.90	2.91	5.03
80	−16.43	−1.58	1.94	25.2	−1.112	−2.38	2.90	5.11
81	16.13	1.94	1.94	24.6	1.092	2.90	2.90	4.99
82	−16.45	−1.58	1.94	25.0	−1.114	−2.38	2.90	5.08
83	16.15	1.94	1.94	24.8	1.094	2.90	2.90	5.03
84	−16.38	−1.58	1.94	25.0	−1.109	−2.38	2.90	5.08
85	16.22	1.93	1.94	25.4	1.098	2.89	2.90	5.15
86	−16.32	−1.59	1.93	24.5	−1.105	−2.38	2.90	4.97
87	16.05	1.94	1.94	25.5	1.086	2.90	2.91	5.17
88	−16.28	−1.59	1.94	24.9	−1.102	−2.38	2.91	5.04
89	16.05	1.95	1.94	24.6	1.087	2.92	2.92	5.00
90	−16.38	−1.59	1.94	25.8	−1.109	−2.38	2.91	5.23
91	16.46	2.42	2.42	33.0	1.115	3.63	3.63	6.69
92	−16.83	−2.08	2.85	38.9	−1.139	−3.11	4.27	7.89
93	16.74	2.41	2.84	38.8	1.134	3.61	4.26	7.88
94	−16.76	−2.08	2.88	40.1	−1.135	−3.12	4.32	8.14
95	16.53	2.43	2.92	39.9	1.119	3.64	4.38	8.10
96	−17.11	−2.08	2.92	40.4	−1.159	−3.12	4.37	8.20
97	16.14	2.43	2.92	38.1	1.093	3.65	4.38	7.73
98	−16.25	−2.09	2.91	38.1	−1.100	−3.13	4.37	7.73
99	16.21	2.43	2.92	38.0	1.098	3.64	4.37	7.72
100	−16.04	−2.08	2.89	37.2	−1.086	−3.12	4.33	7.55
101	15.97	2.43	2.88	36.2	1.081	3.64	4.32	7.35
102	−16.00	−2.09	2.90	37.5	−1.083	−3.14	4.35	7.62
103	15.89	2.43	2.90	36.4	1.076	3.64	4.35	7.39
104	−15.94	−2.11	2.92	38.0	−1.079	−3.17	4.37	7.72

Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
105	15.74	2.41	2.94	37.4	1.066	3.62	4.40	7.59
106	-15.65	-2.12	2.95	37.5	-1.060	-3.17	4.42	7.61
107	15.59	2.42	2.96	36.7	1.056	3.62	4.43	7.46
108	-15.47	-2.12	2.95	37.0	-1.047	-3.18	4.43	7.50
109	15.50	2.44	3.00	37.2	1.049	3.66	4.50	7.55
110	-15.27	-2.12	3.00	37.3	-1.034	-3.18	4.50	7.57
111	15.32	2.42	2.94	35.9	1.037	3.63	4.41	7.29
112	-15.20	-2.14	2.97	36.9	-1.029	-3.21	4.45	7.48
113	15.26	2.42	2.98	36.7	1.033	3.63	4.46	7.45
114	-15.08	-2.13	2.98	35.8	-1.021	-3.19	4.46	7.26
115	15.06	2.42	2.98	35.0	1.020	3.63	4.46	7.11
116	-15.01	-2.13	3.03	35.8	-1.016	-3.19	4.54	7.27
117	15.02	2.37	3.01	34.7	1.017	3.56	4.51	7.05
118	-14.89	-2.18	3.00	36.2	-1.008	-3.27	4.50	7.35
119	14.92	2.37	3.00	35.7	1.010	3.56	4.50	7.25
120	-14.78	-2.18	3.00	35.5	-1.001	-3.27	4.49	7.21
121	15.03	2.88	3.49	42.6	1.018	4.32	5.23	8.65
122	-14.93	-2.69	3.96	49.0	-1.011	-4.03	5.94	9.95
123	14.96	2.88	3.96	47.8	1.013	4.32	5.93	9.70
124	-14.86	-2.71	4.00	47.9	-1.006	-4.06	6.00	9.72
125	14.92	2.87	4.00	48.7	1.010	4.31	5.99	9.89
126	-14.81	-2.71	4.00	48.4	-1.003	-4.06	5.99	9.83
127	14.61	2.86	3.99	47.2	0.989	4.29	5.98	9.59
128	-14.67	-2.70	4.00	44.6	-0.993	-4.05	5.99	9.05
129	14.49	2.86	4.00	46.6	0.981	4.29	6.00	9.45
130	-14.45	-2.71	4.00	46.8	-0.978	-4.06	5.99	9.50
131	14.49	2.86	4.00	46.1	0.981	4.29	5.99	9.36
132	-14.41	-2.71	4.00	46.8	-0.976	-4.06	5.99	9.50
133	14.30	2.87	4.00	45.1	0.968	4.30	5.99	9.15
134	-14.25	-2.71	4.00	46.5	-0.965	-4.06	5.99	9.43
135	14.35	2.88	4.01	45.6	0.971	4.31	6.02	9.26
136	-14.18	-2.72	4.02	46.8	-0.960	-4.07	6.02	9.50
137	14.12	2.86	3.96	43.5	0.956	4.29	5.94	8.83
138	-13.93	-2.71	3.96	44.7	-0.943	-4.06	5.94	9.07
139	14.03	2.88	4.02	45.0	0.950	4.32	6.02	9.13
140	-14.02	-2.71	4.02	45.0	-0.949	-4.06	6.02	9.13
141	13.74	2.87	4.00	43.7	0.930	4.31	5.99	8.86
142	-13.90	-2.71	3.97	42.5	-0.941	-4.06	5.96	8.63
143	13.53	2.88	3.98	42.5	0.916	4.32	5.96	8.62
144	-13.63	-2.71	3.97	43.8	-0.923	-4.07	5.96	8.88
145	13.03	2.88	3.97	40.9	0.882	4.32	5.95	8.29
146	-13.40	-2.72	3.96	41.6	-0.908	-4.08	5.94	8.44
147	12.34	2.90	4.02	40.6	0.836	4.34	6.03	8.24
148	-13.02	-2.73	3.97	41.6	-0.882	-4.10	5.95	8.44

SPECIMEN F1HS-C11

Description: This specimen was similar to specimen F1HS-C7 in detailing, fabrication and inspection. Ultrasonic inspection indicated a possible defect in the top flange butt-weld. The back-up bar was therefore removed and a weld made on the underside of the flange. Subsequent ultrasonic re-inspection indicated the weld to be satisfactory.

Program of Cycling:



Test Control: Tip deflection.

Raw Data Included: Graphical load-deflection data.

Graphical load-curvature data. The curvature data was found by reading the combined output of gages No. 1 and No. 2 connected in series. Gage No. 1 was located at the center of the top flange 2.00 inches from the column face; gage No. 2 was in the same location on the bottom flange.

Total Energy Absorption: 3,539 kip-inches.

Plastic Load Reversals to Failure: 146 (73 cycles).

Remarks: Buckling of the flanges was clearly visible during the first plastic cycle. At the end of the 3rd cycle, an error was made by the operator in interpreting the load-deflection output record, resulting in displacement of the hysteresis loops along the deflection axis. At the end of the 24th cycle, a crack was discovered in the middle of the top flange at the edge of the weld. A similar fine crack formed in the bottom butt-weld during the 52nd cycle. Cracks developed at one end of first the bottom and then the top butt-weld, during the 61st and 65th cycles, respectively. Failure occurred when the two cracks just outside the weld in the top flange met.

SPECIMEN TYPE F1HS-C11

DIMENSIONS OF WF SECTION

DEPTH	8.14 INCHES
TOP FLANGE WIDTH	5.250 INCHES
BOTTOM FLANGE WIDTH	5.300 INCHES
TOP FLANGE THICKNESS	0.371 INCHES
BOTTOM FLANGE THICKNESS	0.370 INCHES
WEB THICKNESS	0.261 INCHES
ELASTIC MODULUS	30600. KSI
YIELD STRESS	51.200 KSI

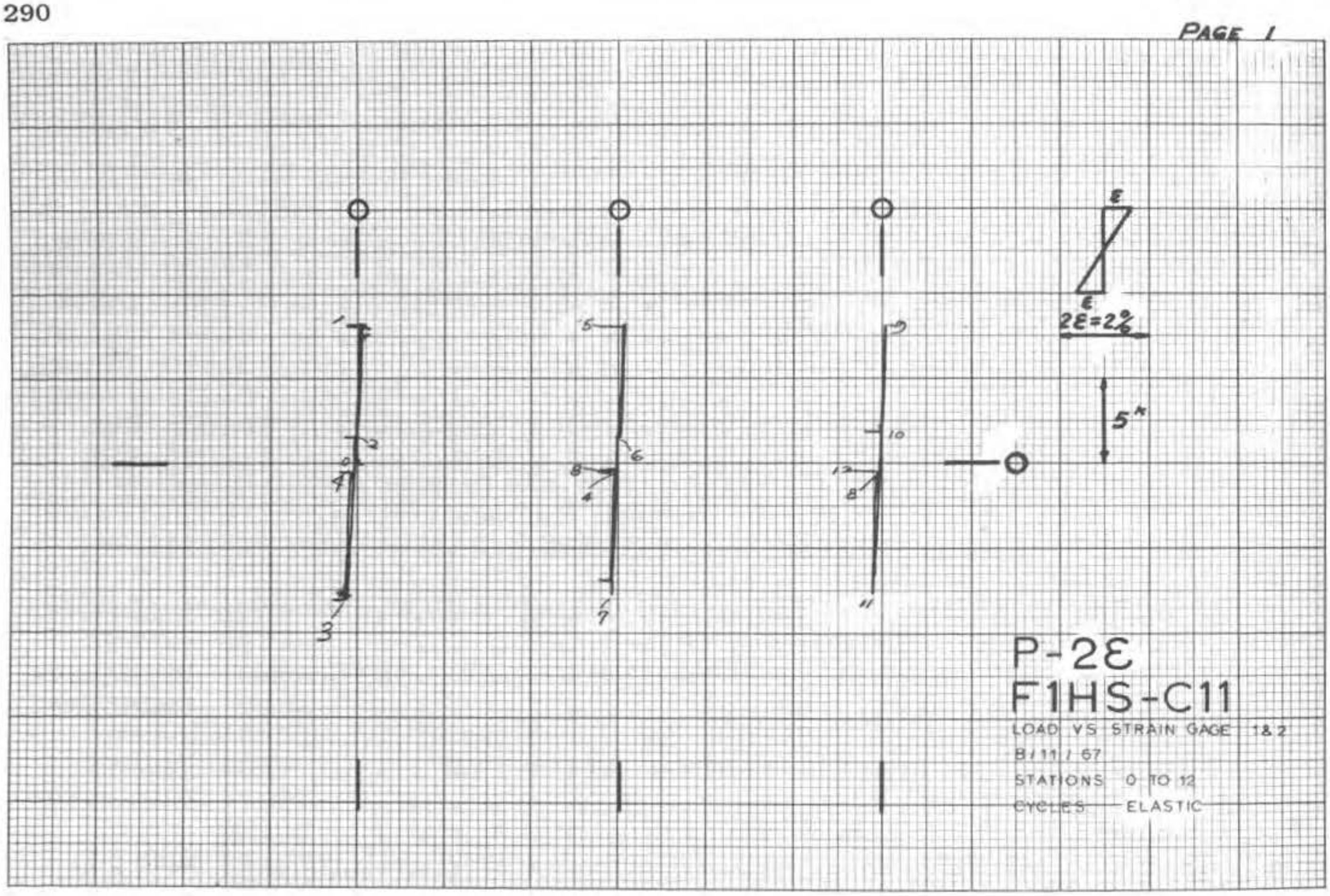
WF SECTION PROPERTIES

AREA, A	5.93 INCHES**2
LOCATION OF CENTROID*, YE	4.06 INCHES
MOMENT OF INERTIA, I	69.0 INCHES**4
SECTION MODULUS, TOP, ST	16.9 INCHES**3
SECTION MODULUS, BOTTOM, SB	17.0 INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS* YP . .	4.04 INCHES
PLASTIC MODULUS, Z	19.1 INCHES**3
SHAPE FACTOR	1.128
YIELD MOMENT, MY	72.17 KIP-FT.
PLASTIC MOMENT, MP	81.39 KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

BEAM PROPERTIES

LENGTH, L	66.0 INCHES
ELASTIC STIFFNESS, P/DELTA	22.03 KIPS/IN.
YIELD DEFLECTION, DELTAY	0.596 INCHES
YIELD LOAD, PY	13.12 KIPS
PLASTIC LOAD, PP	14.80 KIPS



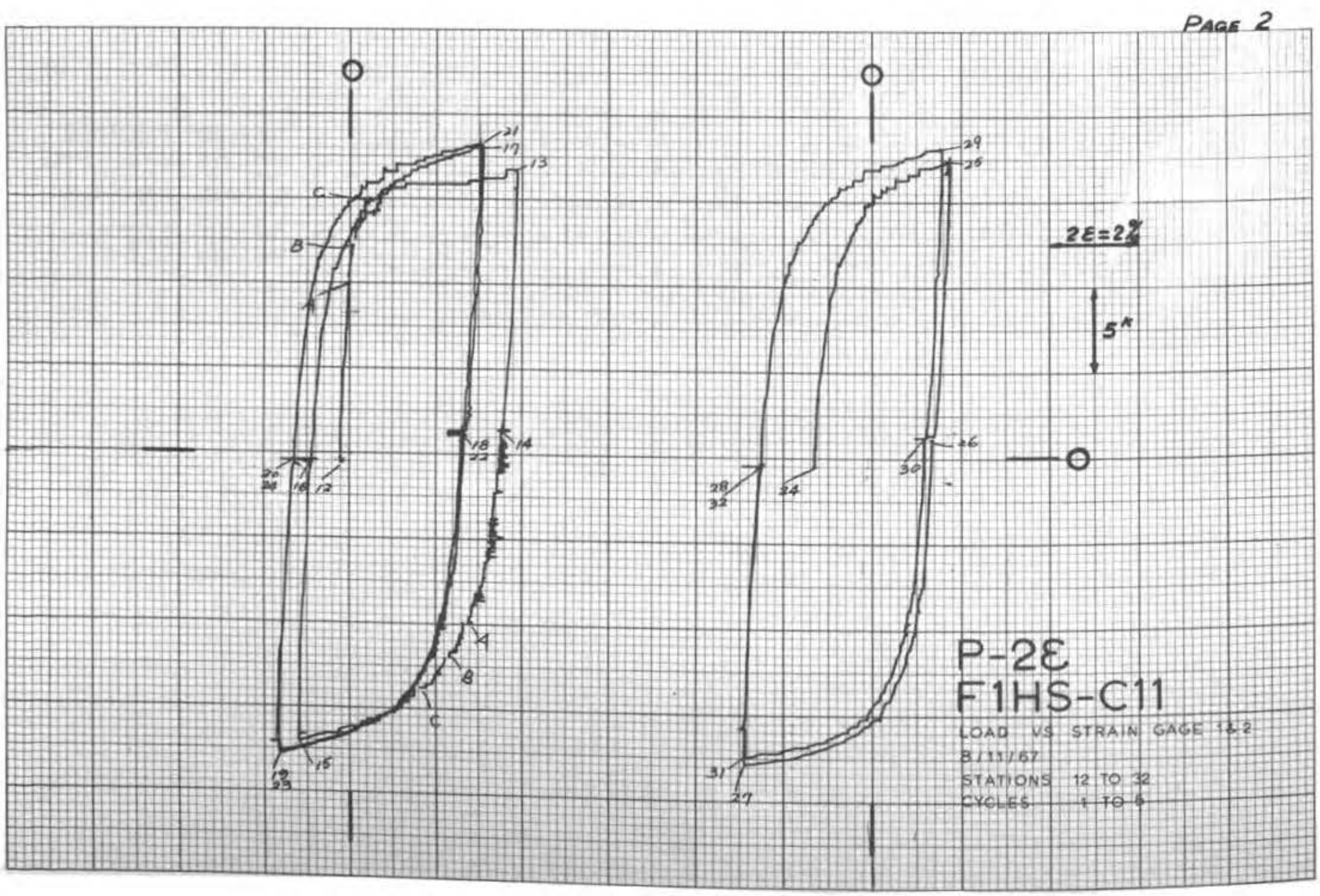


PLATE 38. LOAD VS. STRAIN - F1HS-C11

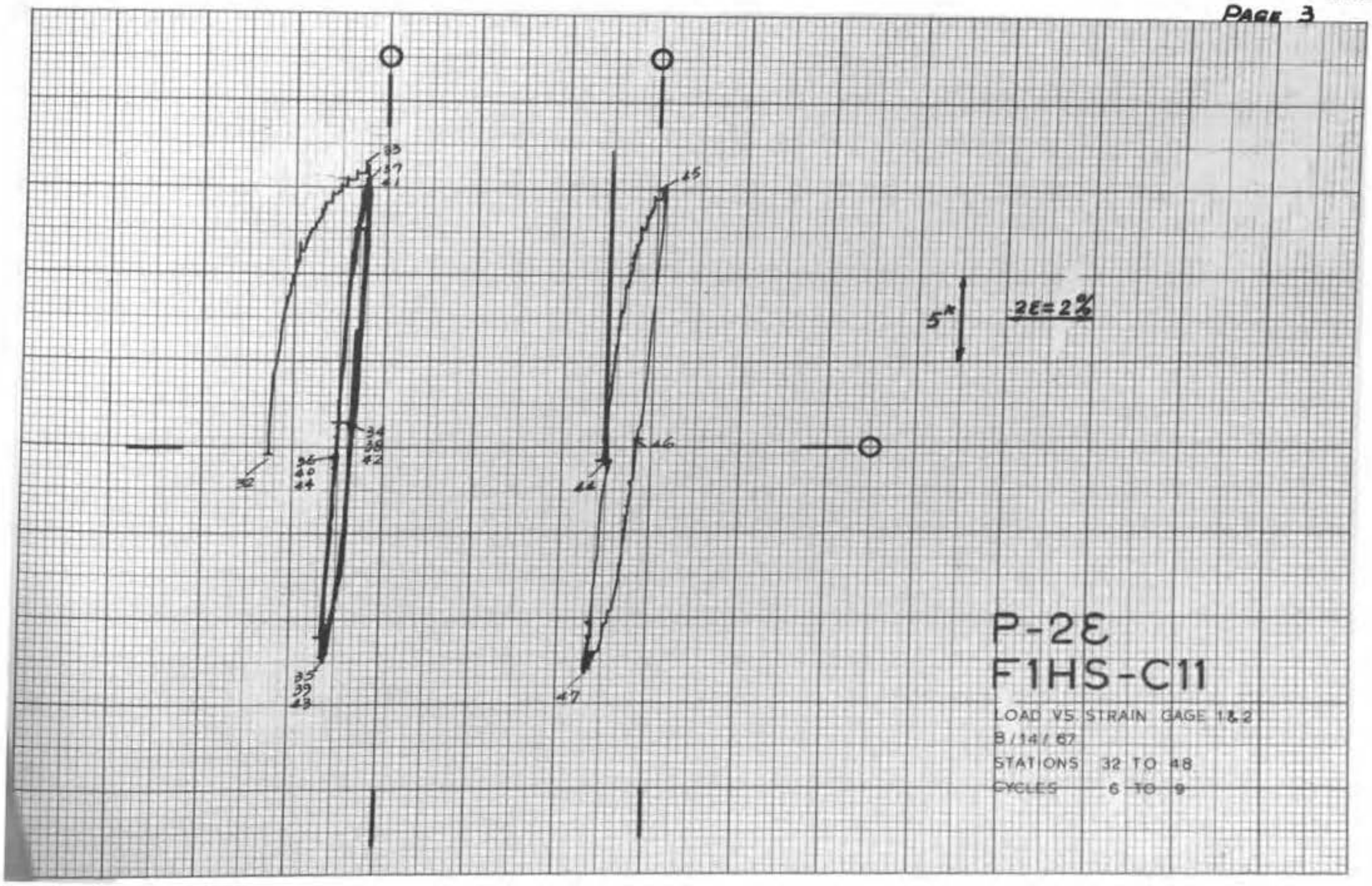
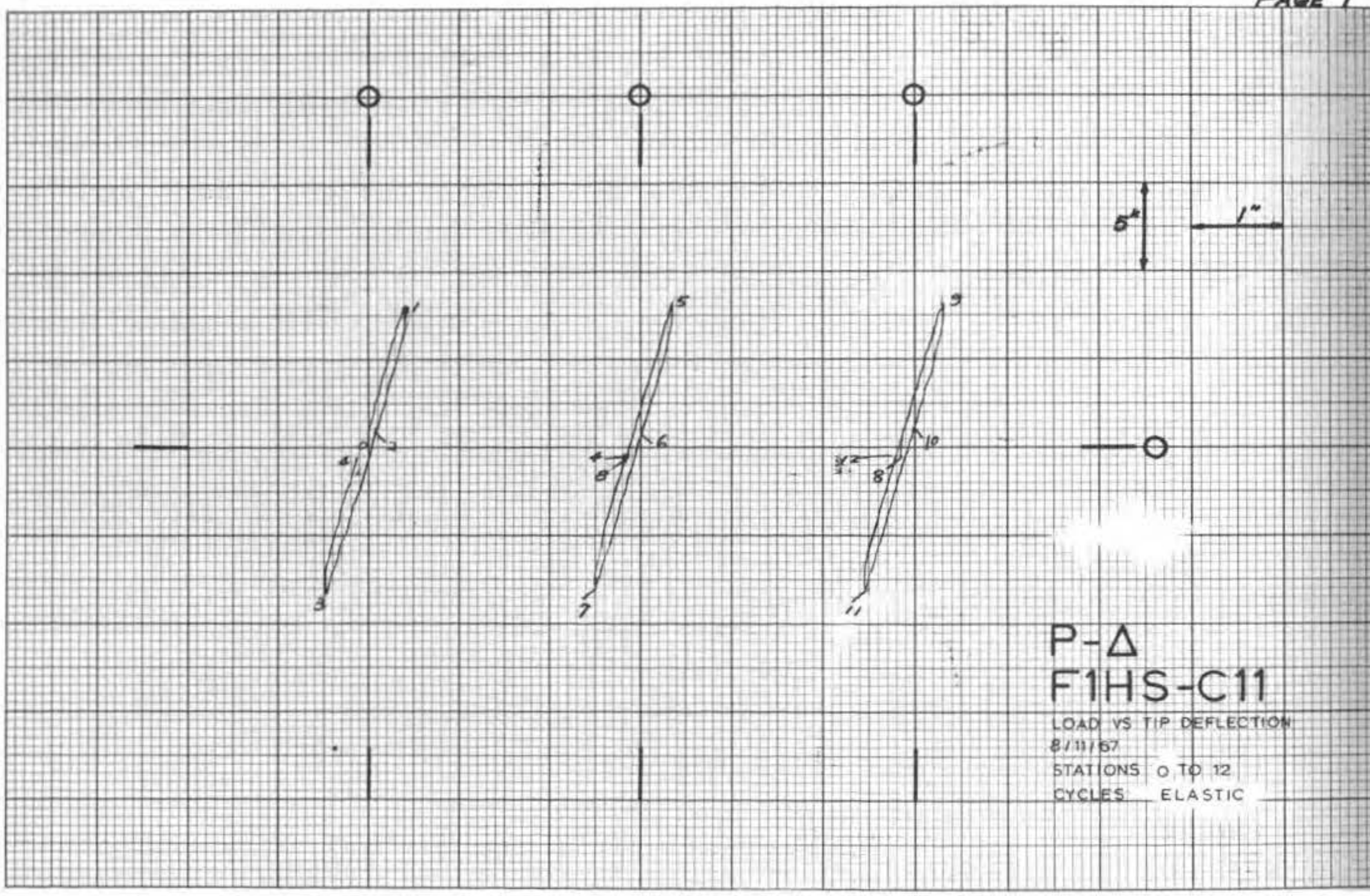


PLATE 38. (continued)



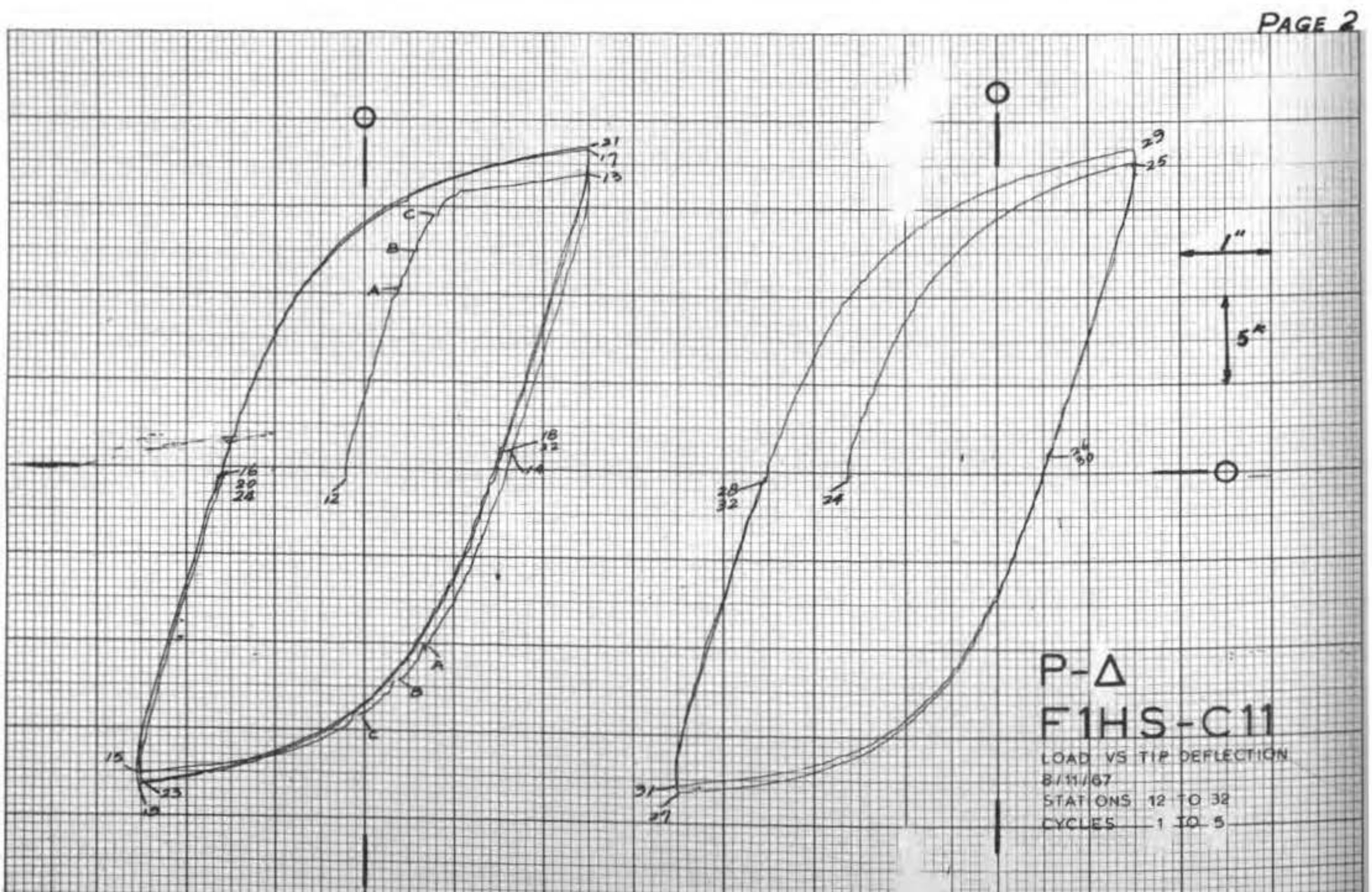


PLATE 39. LOAD VS. DEFLECTION - F1HS-C11

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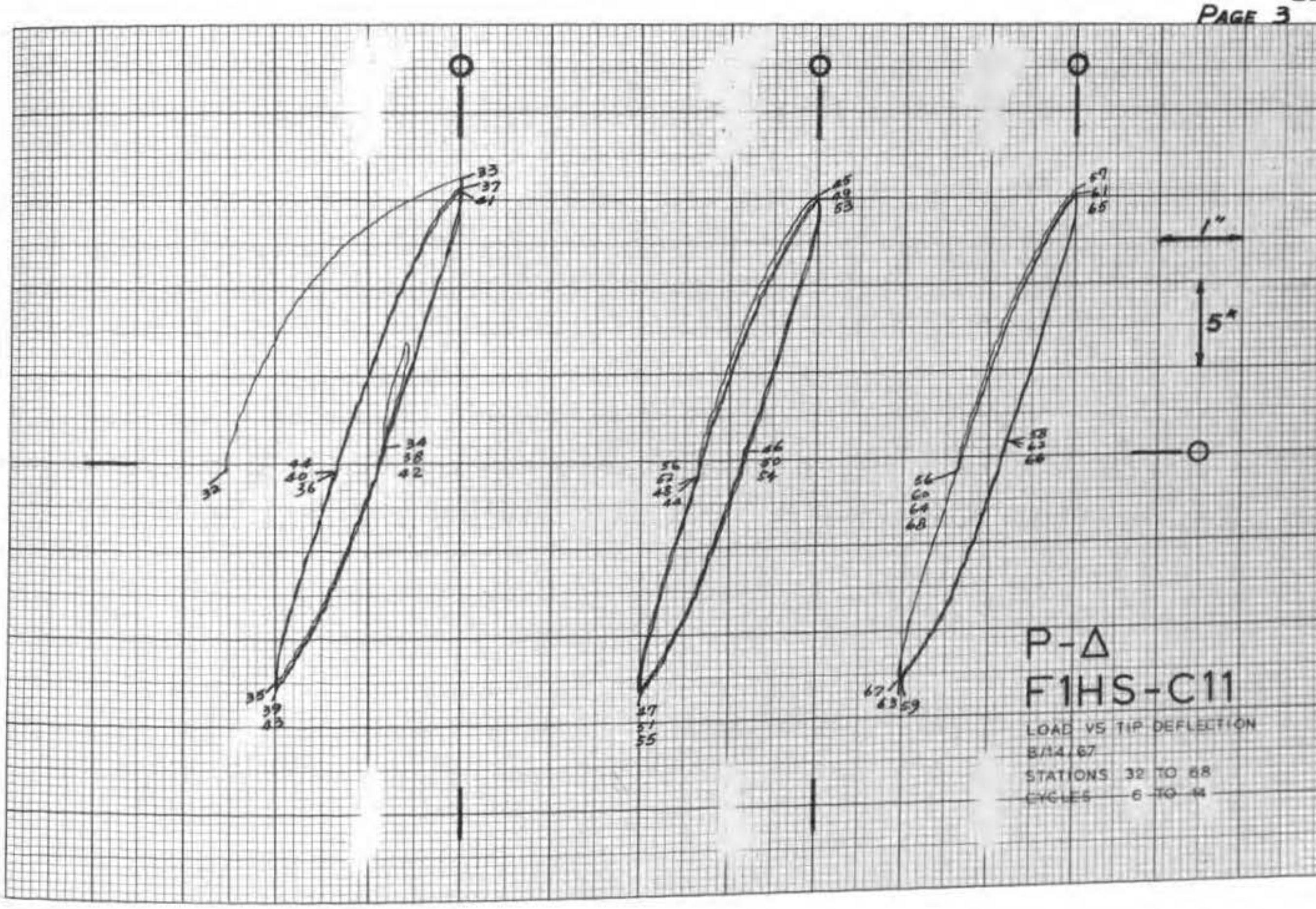

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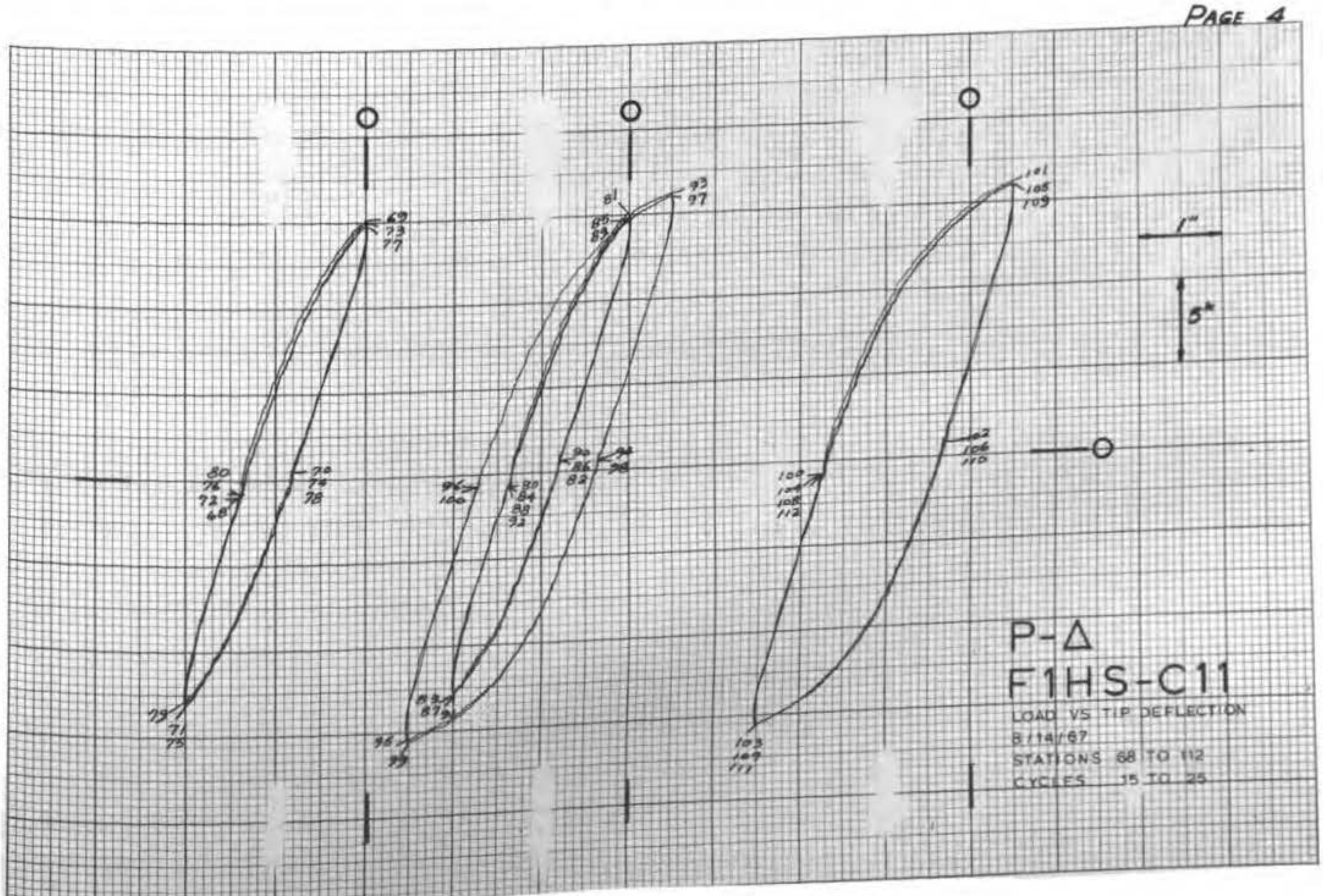
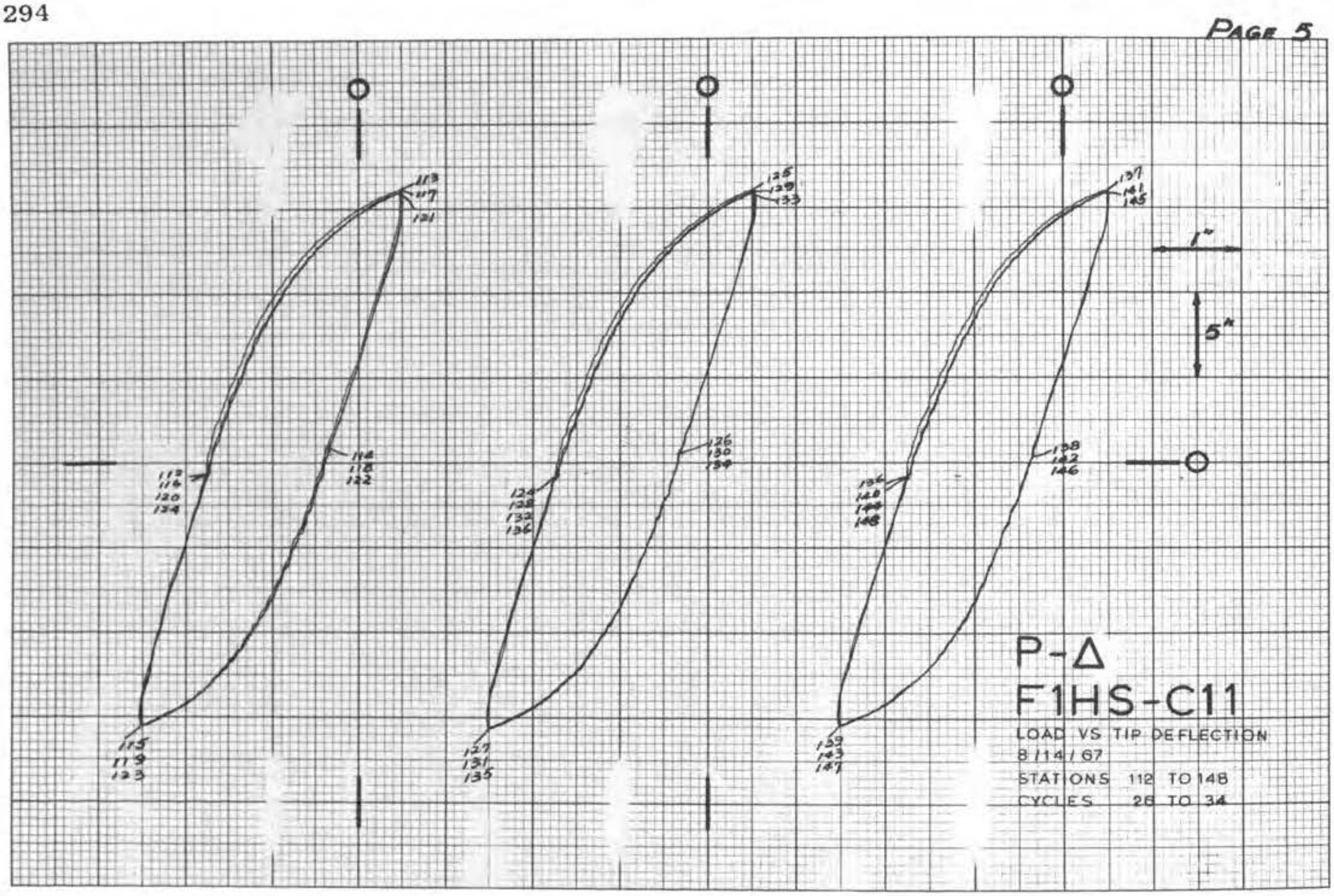


PLATE 39. (continued)



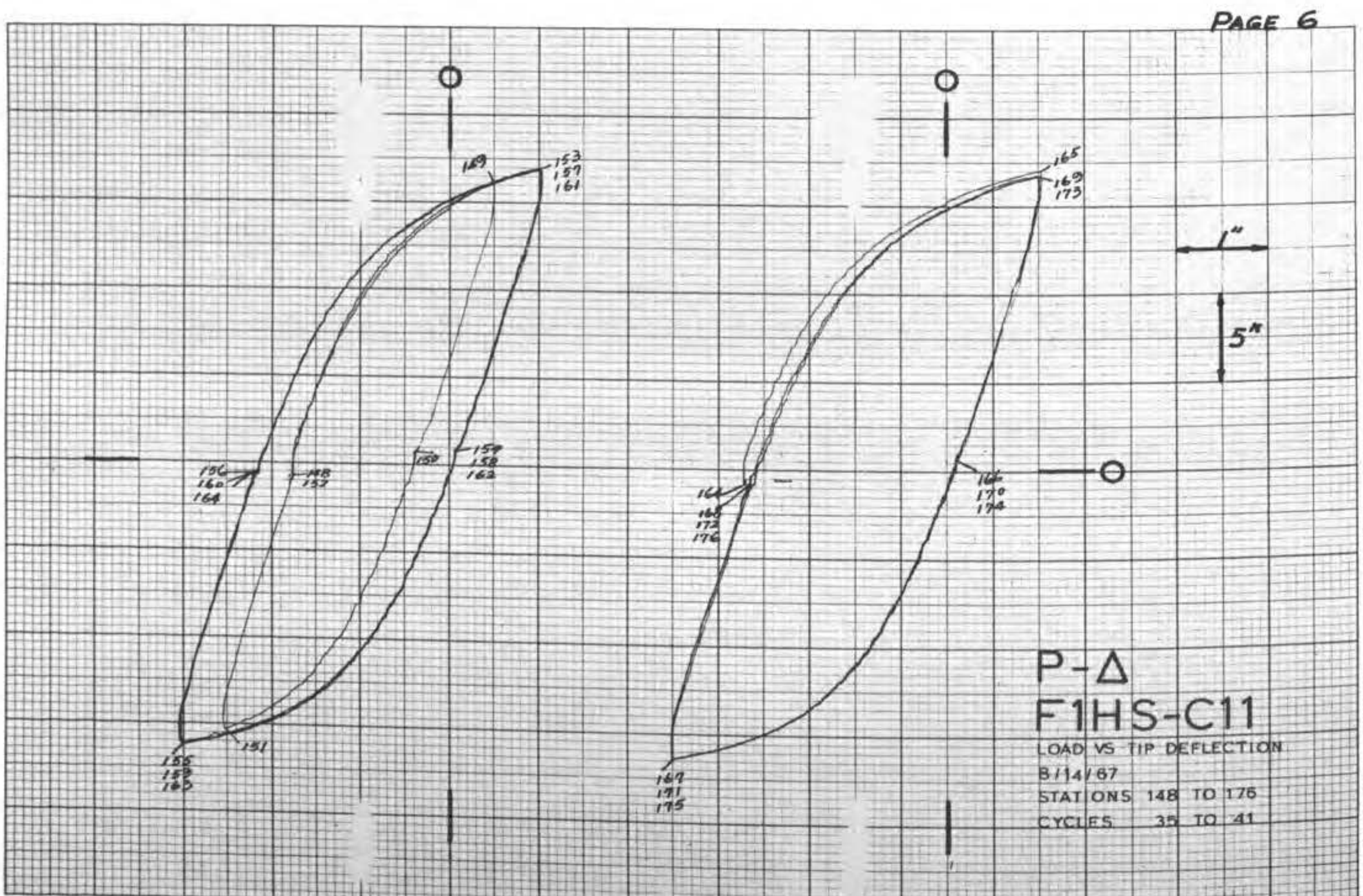
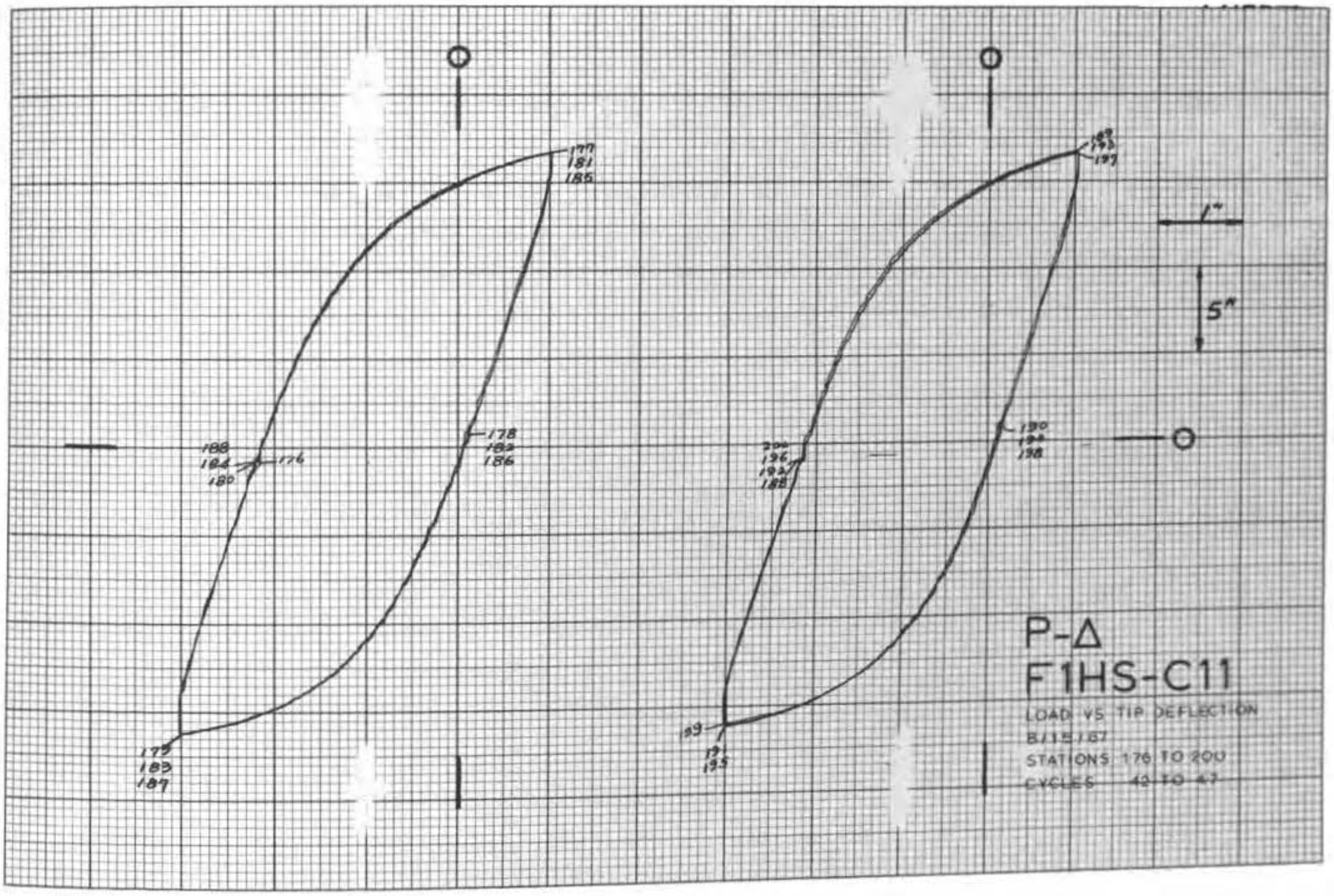


PLATE 39. (continued)



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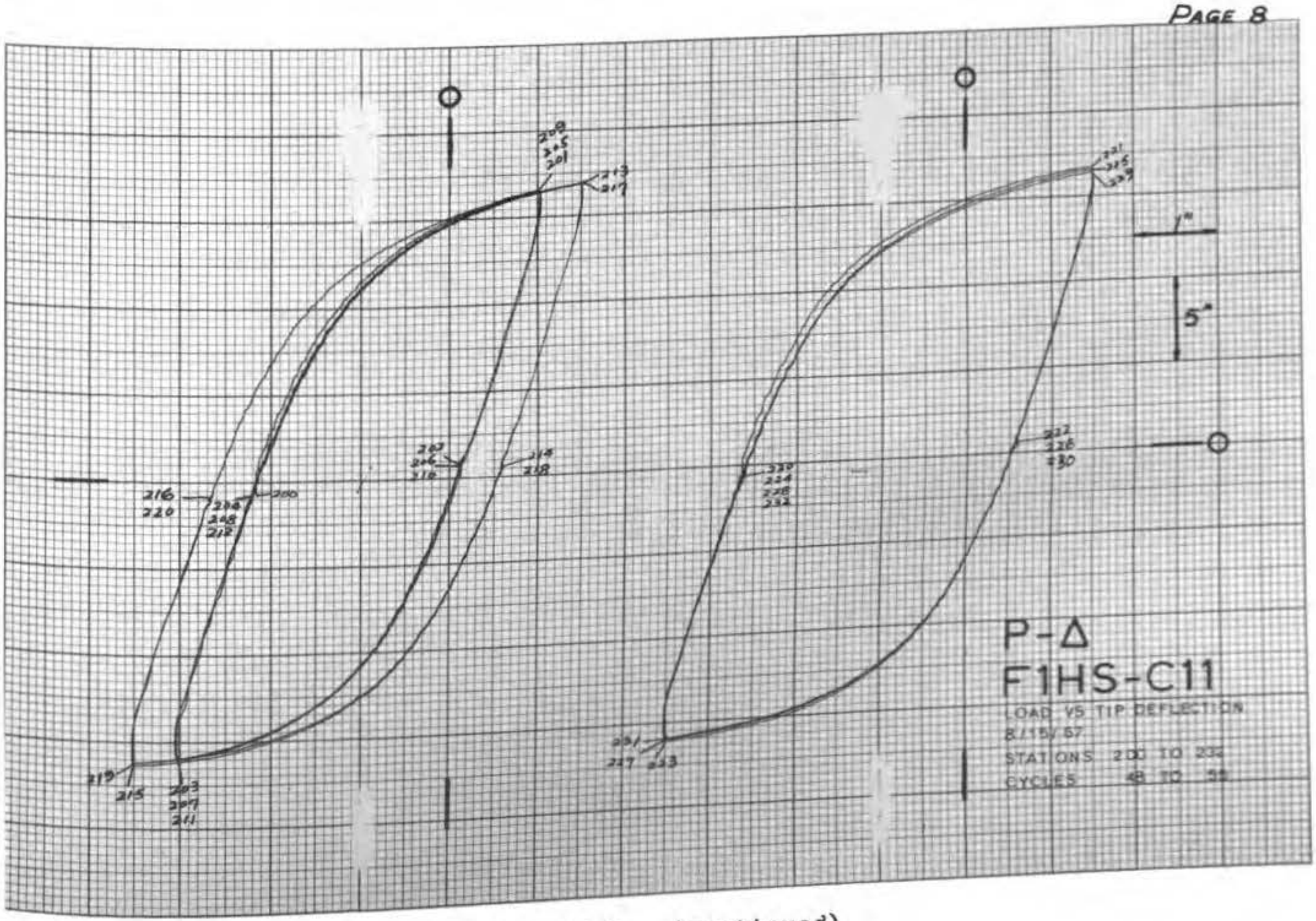
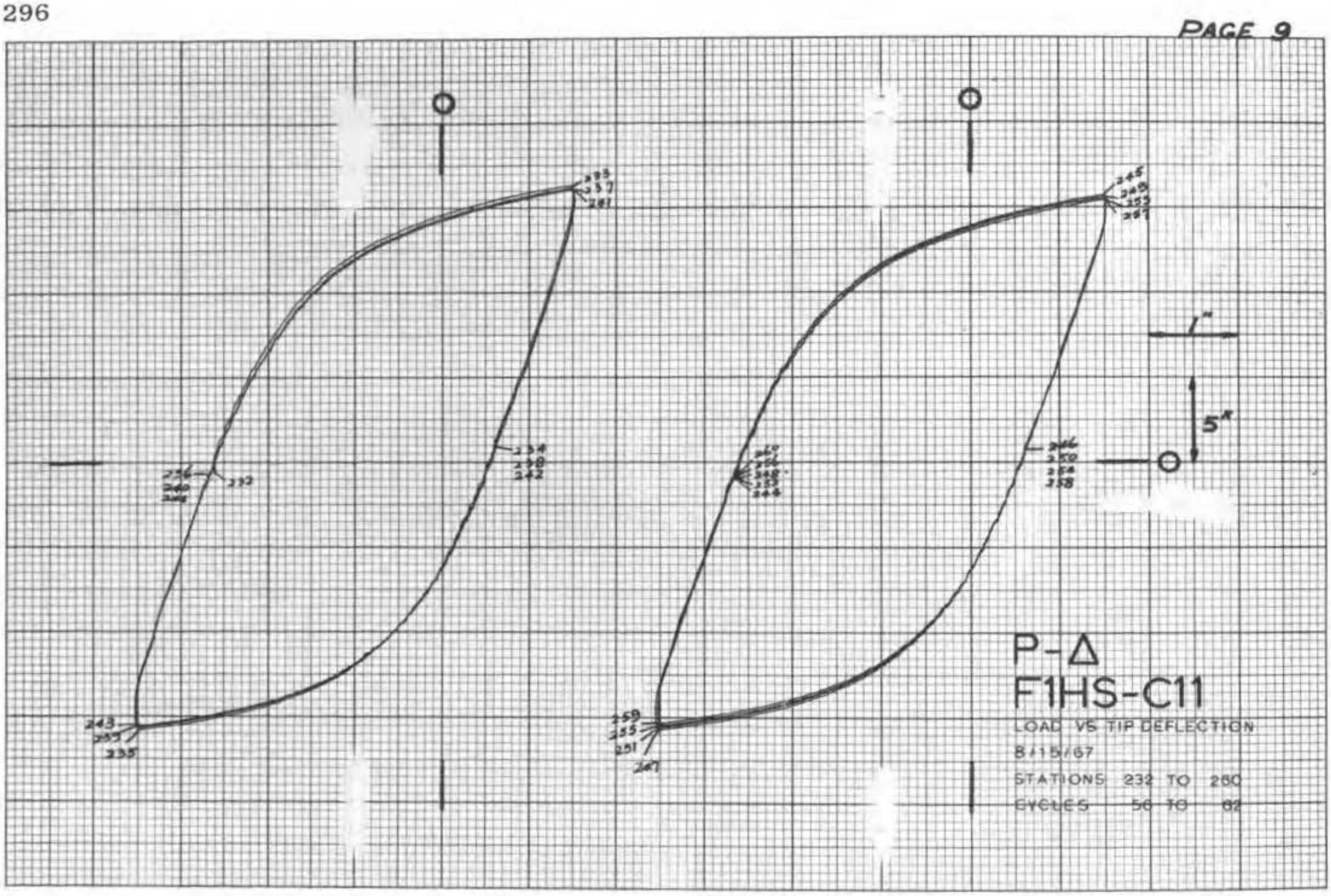


PLATE 39. (continued)



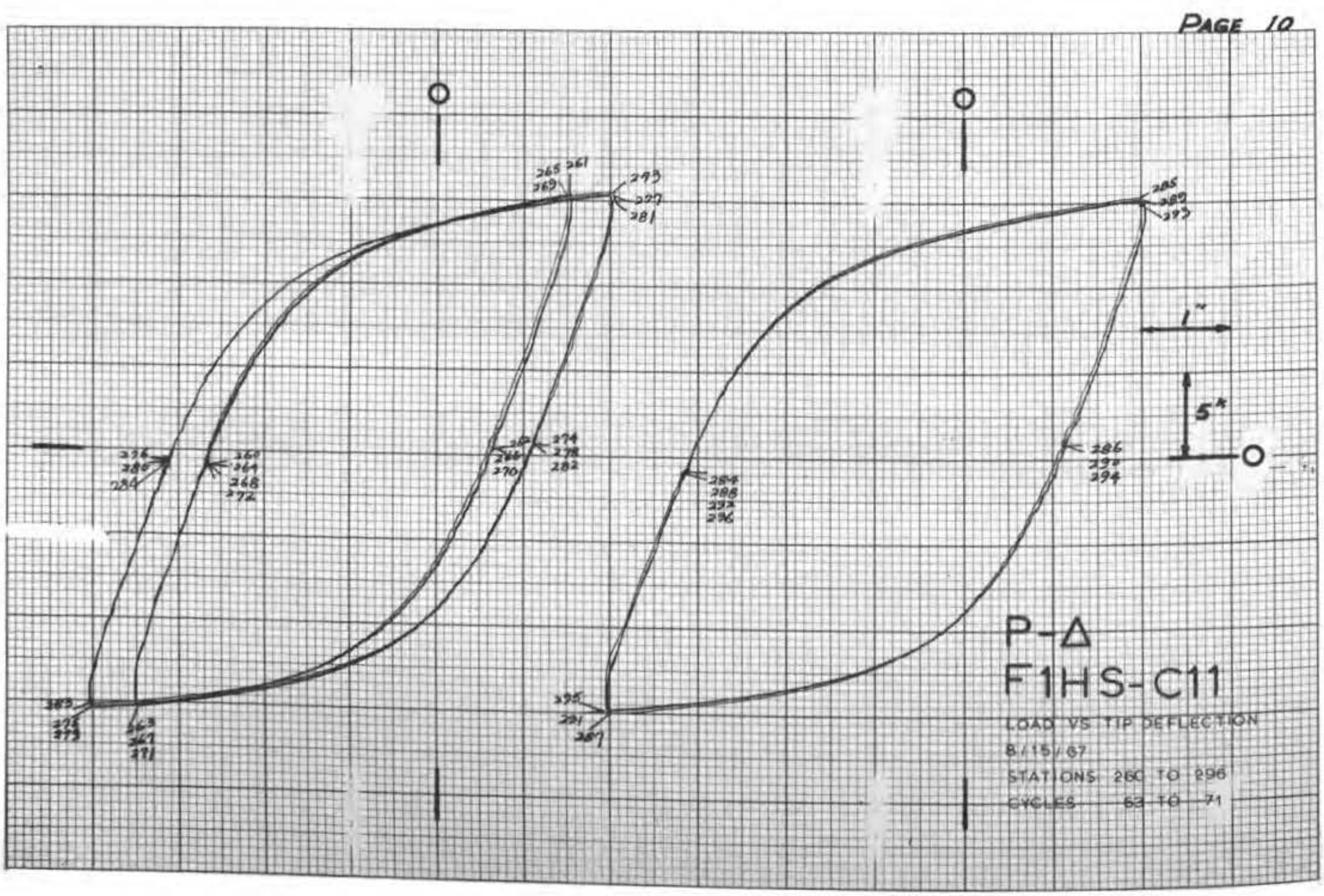


PLATE 39. (continued)

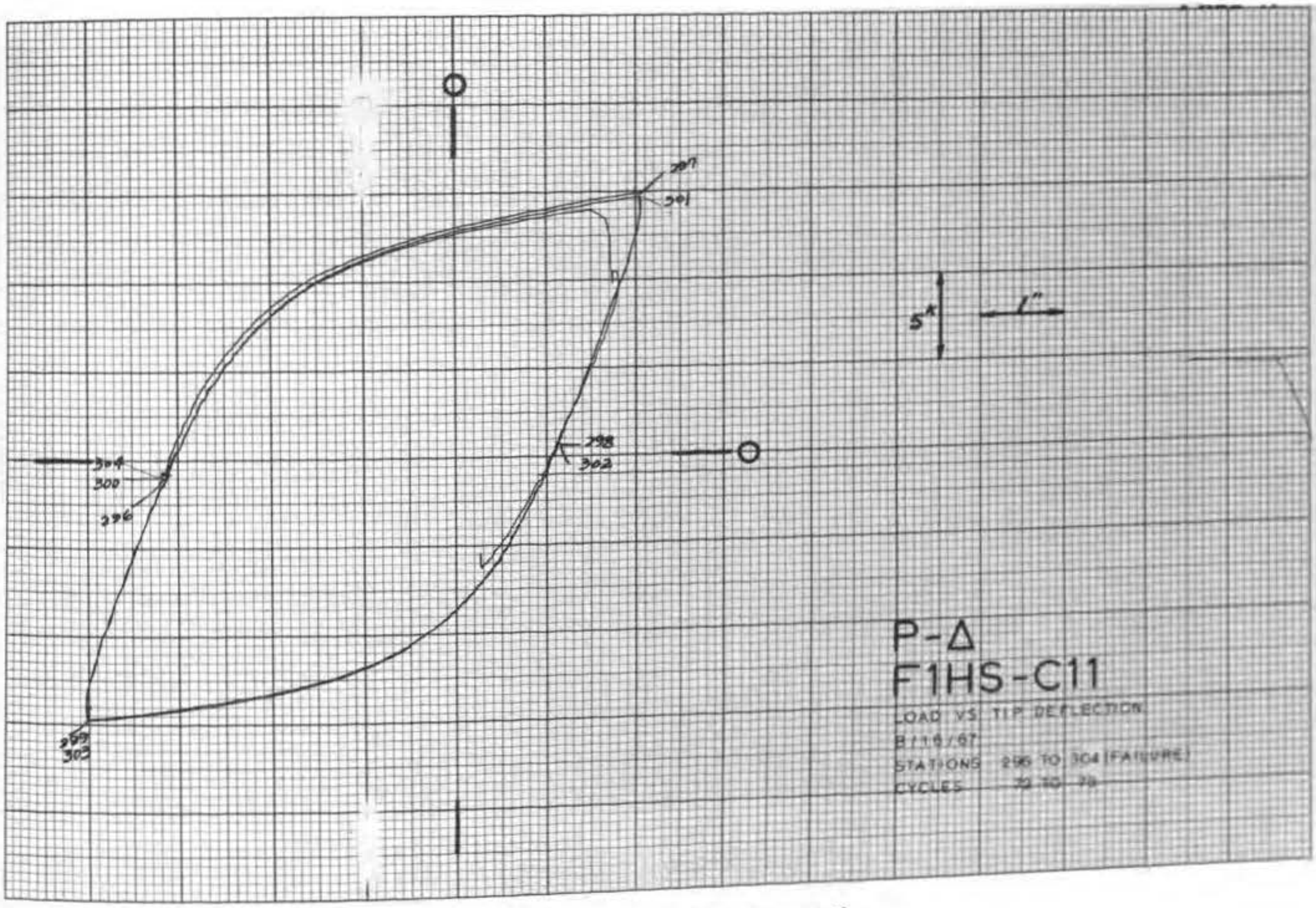


PLATE 39. (continued)

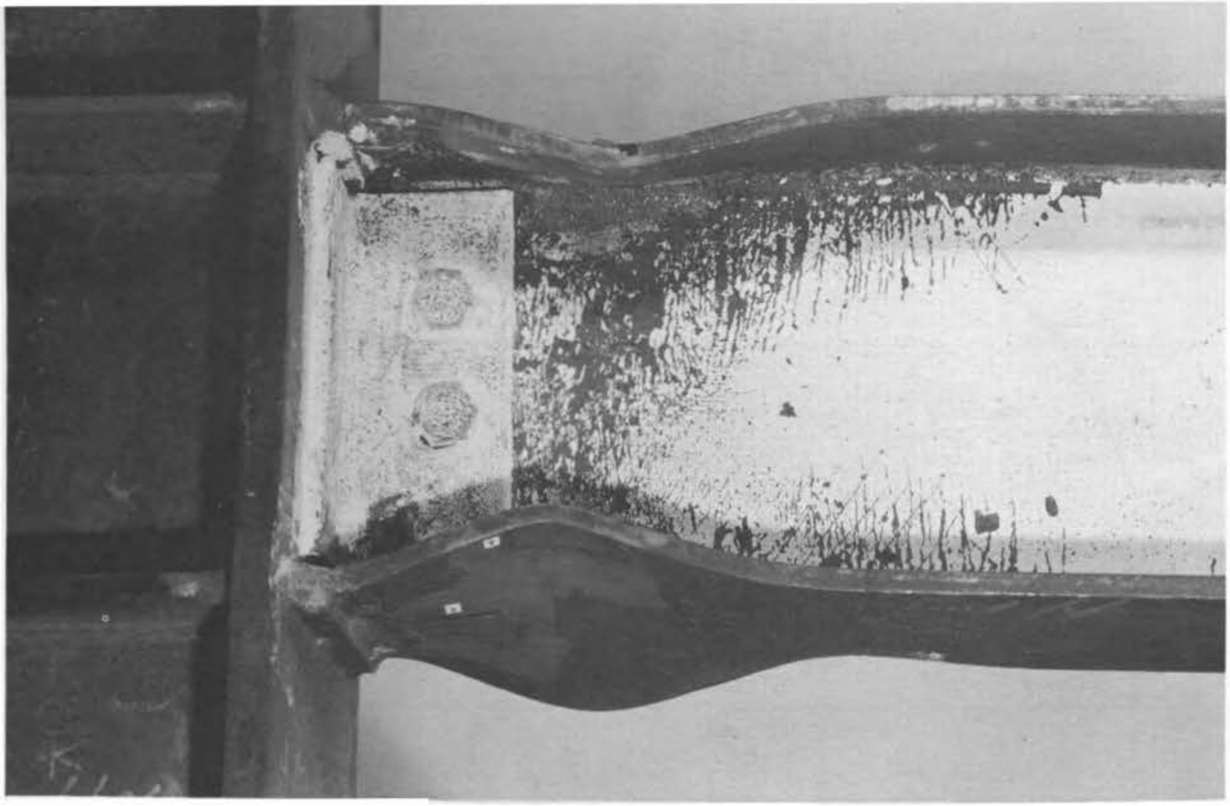


FIGURE 46. F1HS-C11

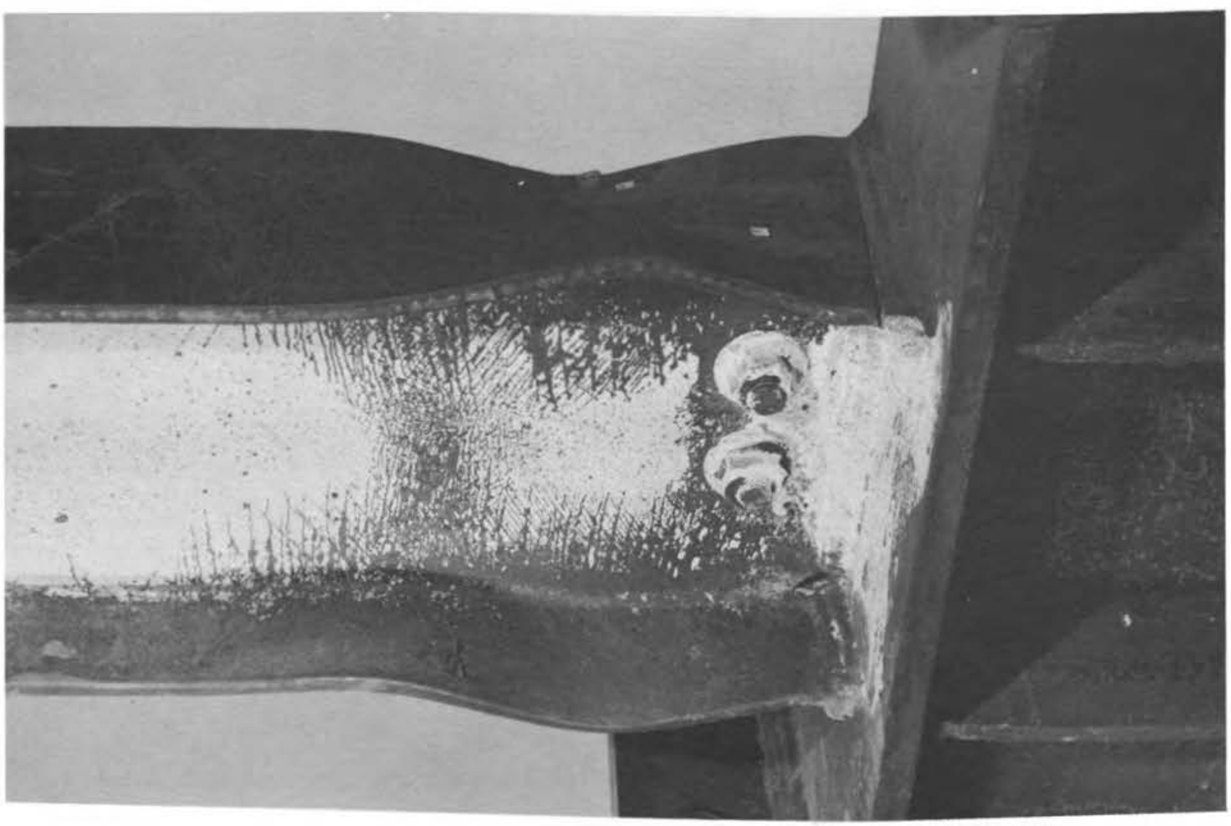


FIGURE 47. F1HS-C11

SPECIMEN F1HS-C11

Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	15.60	2.49	2.04	25.3	1.054	3.71	3.03	5.10
2	-16.65	-2.08	3.14	43.3	-1.125	-3.09	4.67	8.71
3	16.91	2.47	3.02	44.0	1.143	3.68	4.49	8.84
4	-17.38	-2.09	3.02	42.6	-1.174	-3.11	4.49	8.56
5	16.97	2.47	2.99	42.6	1.147	3.68	4.45	8.56
6	-17.12	-2.07	2.93	42.1	-1.157	-3.08	4.37	8.46
7	16.25	1.55	2.06	27.2	1.098	2.31	3.06	5.48
8	-17.21	-3.00	2.99	43.6	-1.163	-4.46	4.45	8.78
9	17.03	1.54	2.99	39.6	1.150	2.29	4.45	7.96
10	-16.93	-3.00	2.99	42.6	-1.144	-4.47	4.44	8.57
11	14.95	0.05	1.51	18.5	1.010	0.08	2.24	3.73
12	-11.42	-1.60	0.31	2.7	-0.772	-2.38	0.46	0.55
13	14.50	0.06	0.39	4.3	0.980	0.09	0.59	0.86
14	-11.99	-1.59	0.40	2.9	-0.810	-2.36	0.59	0.58
15	14.34	0.06	0.40	3.9	0.969	0.09	0.59	0.79
16	-11.94	-1.59	0.40	2.7	-0.807	-2.36	0.59	0.54
17	14.56	0.08	0.41	5.1	0.984	0.12	0.62	1.02
18	-11.96	-1.57	0.42	3.6	-0.808	-2.34	0.62	0.72
19	14.48	0.08	0.42	3.7	0.978	0.12	0.62	0.75
20	-11.83	-1.57	0.42	3.1	-0.800	-2.34	0.62	0.62
21	14.23	0.08	0.42	4.3	0.962	0.12	0.62	0.87
22	-12.01	-1.57	0.42	3.0	-0.812	-2.33	0.62	0.61
23	14.33	0.08	0.44	4.7	0.968	0.12	0.65	0.94
24	-11.77	-1.57	0.44	3.2	-0.795	-2.34	0.65	0.64
25	14.11	0.08	0.44	4.1	0.954	0.12	0.65	0.82
26	-11.90	-1.57	0.44	3.6	-0.804	-2.34	0.65	0.72
27	14.09	0.08	0.44	4.1	0.952	0.13	0.65	0.82
28	-12.04	-1.58	0.44	3.5	-0.813	-2.34	0.65	0.69
29	14.29	0.09	0.44	5.5	0.966	0.14	0.66	1.11
30	-11.74	-1.56	0.45	3.1	-0.793	-2.32	0.67	0.63
31	14.13	0.09	0.45	4.7	0.955	0.14	0.67	0.95
32	-11.93	-1.56	0.45	3.3	-0.806	-2.32	0.67	0.67
33	14.03	0.10	0.45	4.5	0.948	0.14	0.67	0.91
34	-11.91	-1.56	0.45	2.9	-0.805	-2.33	0.67	0.58
35	14.12	0.09	0.45	4.9	0.954	0.14	0.67	0.98
36	-11.88	-1.56	0.47	3.9	-0.803	-2.33	0.70	0.78
37	13.83	0.09	0.47	4.3	0.934	0.14	0.70	0.86
38	-11.81	-1.56	0.47	3.9	-0.798	-2.33	0.70	0.78
39	13.92	0.09	0.47	4.3	0.940	0.14	0.70	0.87
40	-11.76	-1.56	0.47	3.6	-0.795	-2.33	0.70	0.73
41	15.17	0.58	0.92	11.0	1.025	0.86	1.36	2.22
42	-14.31	-2.03	1.26	14.0	-0.967	-3.02	1.87	2.81
43	15.11	0.58	1.26	14.4	1.021	0.86	1.87	2.90
44	-14.38	-2.03	1.26	13.9	-0.971	-3.02	1.87	2.79
45	15.16	0.57	1.29	14.7	1.024	0.85	1.92	2.95
46	-14.34	-2.04	1.28	13.8	-0.969	-3.03	1.91	2.78
47	15.13	0.57	1.29	14.2	1.022	0.85	1.91	2.85
48	-14.40	-2.04	1.29	13.9	-0.973	-3.03	1.91	2.80
49	14.99	0.57	1.29	14.0	1.013	0.85	1.91	2.81
50	-14.41	-2.04	1.28	13.9	-0.974	-3.03	1.91	2.80
51	15.14	0.61	1.30	16.3	1.023	0.91	1.93	3.28

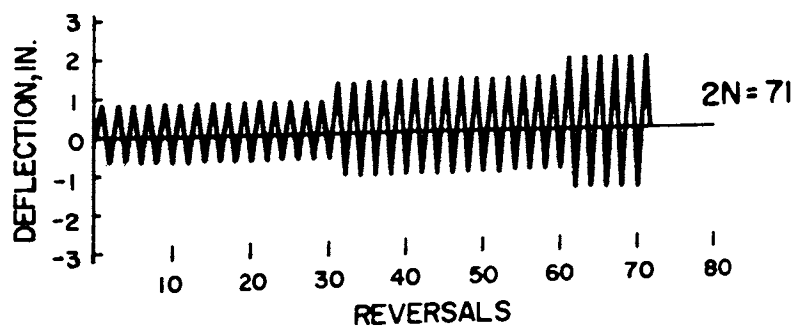
Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
52	-14.45	-2.00	1.30	14.2	-0.976	-2.97	1.93	2.86
53	14.98	0.61	1.30	14.7	1.012	0.91	1.93	2.95
54	-14.50	-2.00	1.30	13.8	-0.980	-2.97	1.93	2.78
55	14.91	0.60	1.28	14.8	1.007	0.90	1.90	2.98
56	-14.38	-2.00	1.28	13.0	-0.971	-2.97	1.91	2.61
57	15.14	0.59	1.28	15.1	1.023	0.87	1.91	3.03
58	-14.43	-2.02	1.29	14.3	-0.975	-3.00	1.92	2.88
59	15.06	0.59	1.29	14.3	1.017	0.88	1.92	2.87
60	-14.38	-2.02	1.29	14.1	-0.971	-3.00	1.92	2.83
61	14.97	0.60	1.29	15.0	1.011	0.90	1.92	3.02
62	-14.43	-2.02	1.29	14.3	-0.975	-3.00	1.92	2.87
63	15.01	0.61	1.29	14.8	1.014	0.90	1.92	2.98
64	-14.34	-2.01	1.29	13.8	-0.969	-2.99	1.92	2.78
65	14.92	0.61	1.29	13.9	1.008	0.91	1.92	2.80
66	-14.36	-2.01	1.29	13.7	-0.971	-2.99	1.92	2.76
67	14.91	0.61	1.29	13.7	1.007	0.91	1.92	2.75
68	-14.31	-2.01	1.29	13.8	-0.967	-2.99	1.92	2.78
69	15.18	0.61	1.26	15.9	1.025	0.91	1.88	3.19
70	-14.12	-2.01	1.26	13.6	-0.954	-2.99	1.88	2.74
71	15.64	1.10	1.72	21.9	1.057	1.64	2.56	4.41
72	-15.08	-2.49	2.15	25.6	-1.019	-3.70	3.20	5.14
73	15.79	1.10	2.15	26.0	1.067	1.64	3.20	5.22
74	-15.10	-2.49	2.15	25.4	-1.020	-3.70	3.20	5.10
75	15.77	1.10	2.15	26.3	1.066	1.64	3.20	5.30
76	-15.14	-2.49	2.15	25.7	-1.023	-3.70	3.20	5.16
77	15.86	1.14	2.20	28.6	1.072	1.69	3.27	5.76
78	-15.14	-2.46	2.08	25.5	-1.023	-3.66	3.10	5.13
79	15.65	1.13	2.08	26.1	1.057	1.68	3.10	5.25
80	-15.08	-2.46	2.14	25.4	-1.019	-3.66	3.18	5.12
81	15.70	1.13	2.14	25.4	1.061	1.68	3.18	5.12
82	-15.14	-2.46	2.14	25.3	-1.023	-3.66	3.18	5.10
83	15.55	1.13	2.14	26.7	1.050	1.68	3.19	5.38
84	-15.05	-2.46	2.19	26.2	-1.017	-3.66	3.26	5.27
85	15.57	1.13	2.19	26.5	1.052	1.69	3.26	5.32
86	-15.04	-2.46	2.19	25.9	-1.017	-3.66	3.26	5.21
87	15.52	1.13	2.19	26.2	1.049	1.69	3.26	5.27
88	-15.08	-2.46	2.19	26.0	-1.019	-3.66	3.26	5.22
89	15.60	1.09	2.19	26.7	1.054	1.63	3.26	5.38
90	-15.05	-2.51	2.18	26.2	-1.017	-3.73	3.25	5.26
91	15.58	1.09	2.18	26.0	1.053	1.63	3.25	5.22
92	-14.98	-2.51	2.18	25.8	-1.012	-3.73	3.25	5.20
93	15.53	1.08	2.18	25.5	1.049	1.61	3.25	5.13
94	-14.85	-2.51	2.19	25.4	-1.003	-3.74	3.25	5.10
95	15.46	1.10	2.16	27.9	1.045	1.64	3.22	5.61
96	-14.86	-2.49	2.21	26.3	-1.004	-3.71	3.29	5.29
97	15.29	1.10	2.21	27.0	1.033	1.64	3.29	5.43
98	-14.97	-2.49	2.21	25.7	-1.012	-3.71	3.29	5.17
99	15.19	1.10	2.21	26.3	1.027	1.64	3.29	5.29
100	-14.92	-2.48	2.21	24.7	-1.008	-3.70	3.29	4.96
101	15.60	1.60	2.69	33.3	1.054	2.38	4.00	6.70
102	-15.22	-2.99	3.17	37.9	-1.028	-4.45	4.72	7.63
103	15.61	1.60	3.17	38.5	1.055	2.38	4.72	7.75
104	-15.10	-2.99	3.17	38.0	-1.020	-4.45	4.72	7.65

Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
105	15.45	1.57	3.14	38.9	1.044	2.34	4.67	7.82
106	-15.02	-3.02	3.14	37.9	-1.015	-4.50	4.67	7.62
107	15.26	1.57	3.14	36.8	1.031	2.34	4.67	7.39
108	-14.89	-3.02	3.14	37.1	-1.006	-4.50	4.67	7.46
109	15.13	1.58	3.14	36.5	1.022	2.34	4.67	7.34
110	-14.82	-3.02	3.14	36.9	-1.002	-4.50	4.67	7.41
111	14.99	1.53	3.10	37.4	1.013	2.28	4.61	7.53
112	-14.75	-3.07	3.16	37.9	-0.997	-4.57	4.70	7.63
113	14.86	1.53	3.16	36.4	1.004	2.28	4.70	7.33
114	-14.51	-3.07	3.16	36.9	-0.981	-4.58	4.70	7.42
115	14.74	1.53	3.16	36.0	0.996	2.28	4.70	7.25
116	-14.47	-3.08	3.16	36.6	-0.978	-4.58	4.70	7.37
117	14.56	1.53	3.16	35.7	0.984	2.28	4.70	7.18
118	-14.43	-3.09	3.16	36.3	-0.975	-4.59	4.70	7.30
119	14.50	1.53	3.16	35.6	0.980	2.28	4.70	7.15
120	-14.35	-3.08	3.16	35.6	-0.970	-4.58	4.70	7.16
121	14.45	1.54	3.16	34.8	0.976	2.29	4.70	7.00
122	-14.17	-3.08	3.14	35.7	-0.957	-4.58	4.67	7.19
123	14.38	1.54	3.14	34.7	0.971	2.29	4.67	6.98
124	-14.05	-3.08	3.14	35.7	-0.950	-4.59	4.67	7.17
125	14.16	1.56	3.18	35.9	0.956	2.32	4.73	7.23
126	-14.05	-3.08	3.21	36.2	-0.949	-4.59	4.78	7.29
127	14.17	1.56	3.21	35.4	0.957	2.32	4.78	7.13
128	-13.93	-3.08	3.21	35.7	-0.941	-4.59	4.77	7.18
129	14.17	1.54	3.16	34.5	0.958	2.29	4.70	6.93
130	-13.95	-3.08	3.16	34.9	-0.943	-4.59	4.70	7.02
131	14.31	2.04	3.68	42.3	0.967	3.03	5.48	8.50
132	-14.15	-3.58	4.12	47.3	-0.956	-5.33	6.14	9.52
133	14.22	2.04	4.13	45.5	0.961	3.03	6.14	9.16
134	-14.05	-3.58	4.13	47.0	-0.949	-5.33	6.14	9.46
135	14.19	2.04	4.13	45.2	0.959	3.03	6.14	9.09
136	-13.86	-3.58	4.12	46.5	-0.937	-5.33	6.14	9.35
137	14.05	2.04	4.11	45.8	0.950	3.04	6.12	9.20
138	-13.85	-3.58	4.10	46.8	-0.936	-5.33	6.11	9.41
139	13.95	2.04	4.13	45.4	0.942	3.04	6.15	9.13
140	-13.71	-3.59	4.13	46.3	-0.927	-5.34	6.15	9.32
141	13.78	2.04	4.13	43.8	0.931	3.04	6.15	8.82
142	-13.62	-3.59	4.14	45.6	-0.920	-5.34	6.17	9.17
143	13.73	2.05	4.12	45.2	0.928	3.06	6.14	9.09
144	-13.53	-3.60	4.11	44.7	-0.914	-5.36	6.12	9.00
145	13.51	2.06	4.12	42.8	0.913	3.06	6.13	8.62
146	-13.46	-3.60	4.12	43.3	-0.909	-5.36	6.13	8.71

SPECIMEN F2HS-C7

Description: This specimen was similar to specimen F2-C1, with exceptions as noted. The letters "HS" appended to the connection type signify the use of high strength steel. Inspection was as for specimen F1HS-C7. The only significant departure from the detail drawing was that the fillet welds between the bottom connecting plate and the flange extended to the outer end of the plate, instead of stopping short of that point as shown on the drawing. In spite of this, no end returns were provided, in accordance with a note on the drawing.

Program of Cycling:



Test Control: Tip deflection.

Raw Data Included: Graphical load-deflection data.

Total Energy Absorption: 897 kip-inches.

Plastic Load Reversals to Failure: 71 ($35\frac{1}{2}$ cycles).

Remarks: A small buckle appeared after the 15th cycle in the top flange outside the connecting plate. The bottom plate buckled next to the column during the 21st cycle. The initiation of a crack was found at the end of the bottom plate on one side of the flange after the 28th cycle. Another crack appeared in the same weld at the end nearest the column during the 30th cycle. Failure occurred suddenly with a loud report at $35\frac{1}{2}$ cycles when the two cracks noted above met, resulting in a longitudinal crack of the entire fillet weld.

SPECIMEN TYPE F2HS-C7

DIMENSIONS OF WF SECTION

DEPTH	8.16 INCHES
TOP FLANGE WIDTH	5.260 INCHES
BOTTOM FLANGE WIDTH	5.280 INCHES
TOP FLANGE THICKNESS	0.372 INCHES
BOTTOM FLANGE THICKNESS	0.371 INCHES
WEB THICKNESS	0.264 INCHES
ELASTIC MODULUS	30600. KSI
YIELD STRESS	51.200 KSI

DIMENSIONS AND PROPERTIES OF TOP PLATE

LENGTH, LP	14.03 INCHES
WIDTH AT END AWAY FROM COLUMN, M	2.50 INCHES
WIDTH AT END OF WELD, R	4.44 INCHES
AVERAGE LOCATION OF END OF WELD*, N	3.91 INCHES
THICKNESS, T	0.509 INCHES
ELASTIC MODULUS	31100. KSI
YIELD STRESS	56.000 KSI

*MEASURED FROM FACE OF COLUMN

DIMENSIONS AND PROPERTIES OF BOTTOM PLATE

LENGTH, LP	14.06 INCHES
WIDTH, B	6.27 INCHES
AVERAGE LOCATION OF COLUMN END OF WELD*, Q .	3.70 INCHES
AVERAGE LOCATION OF OUTER END OF WELD*, P . .	14.06 INCHES
THICKNESS, T	0.366 INCHES
ELASTIC MODULUS	32100. KSI
YIELD STRESS	56.000 KSI

*MEASURED FROM FACE OF COLUMN

DEPTH OUT-TO-OUT OF PLATES	9.12 INCHES

WF SECTION PROPERTIES

AREA, A	5.96 INCHES**2
LOCATION OF CENTROID*, YE	4.08 INCHES
MOMENT OF INERTIA, I	69.6 INCHES**4
SECTION MODULUS, TOP, ST	17.0 INCHES**3
SECTION MODULUS, BOTTOM, SB	17.1 INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS*, YP . .	4.08 INCHES
PLASTIC MODULUS, Z	19.2 INCHES**3
SHAPE FACTOR	1.126
YIELD MOMENT, MY	72.72 KIP-FT.
PLASTIC MOMENT, MP	81.91 KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

SPECIMEN TYPE F2HS-C7

SECTION PROPERTIES AT SELECTED CROSS-SECTIONS

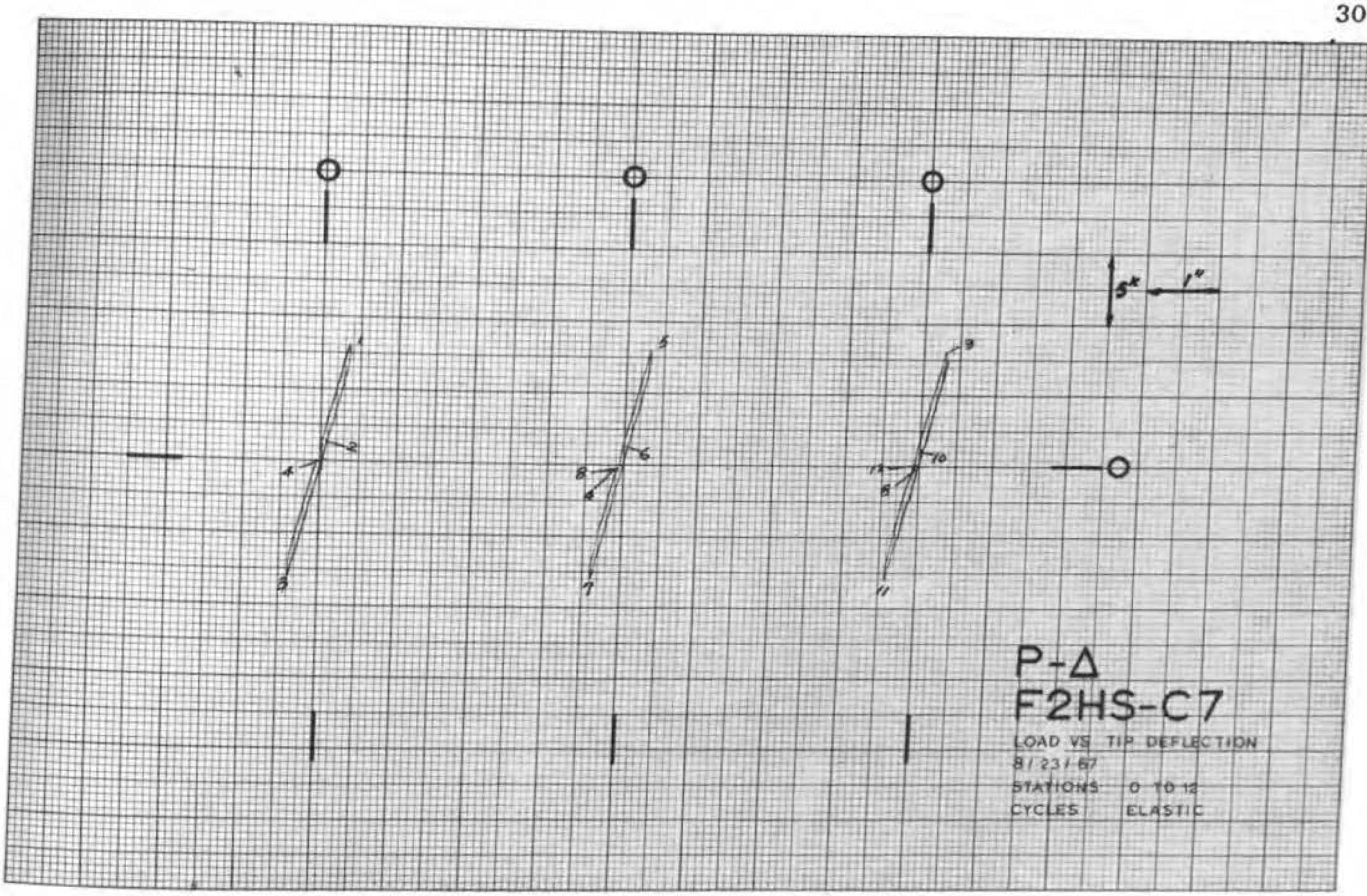
X	A	YE	I	ST	SB
51.97	5.96	4.49	69.6	16.9	16.9
51.97	7.25	5.27	90.0	23.4	18.4
51.95	7.25	5.27	90.0	23.3	18.4
51.94	7.25	5.27	89.9	23.3	18.4
51.94	9.66	4.00	136.7	26.7	34.2
57.01	10.16	4.24	148.0	30.3	34.9
62.09	10.67	4.46	158.3	33.9	35.5
62.09	8.55	3.50	118.2	21.0	33.8
62.19	8.57	3.50	118.5	21.1	33.8
62.30	8.58	3.51	118.8	21.2	33.9
62.30	6.44	4.47	95.1	20.4	21.3
64.15	6.62	4.59	98.6	21.8	21.5
66.00	6.81	4.70	101.9	23.1	21.7

X	YP	Z	F	MY	MP
51.97	4.65	18.8	1.019	78.71	80.20
51.97	7.29	22.8	1.137	85.66	97.41
51.95	7.28	22.8	1.137	85.66	97.40
51.94	7.28	22.8	1.137	85.65	97.38
51.94	2.53	34.7	1.188	124.53	147.94
57.01	3.55	37.8	1.140	141.52	161.40
62.09	4.58	40.4	1.089	158.43	172.49
62.09	0.77	28.3	1.231	98.11	120.82
62.19	0.77	28.4	1.231	98.47	121.20
62.30	0.77	28.5	1.230	98.83	121.59
62.30	4.50	24.5	1.096	95.38	104.59
64.15	4.87	25.3	1.078	100.32	108.12
66.00	5.25	26.1	1.101	101.11	111.33

X = DISTANCE FROM CONCENTRATED LOAD, INCHES
A = AREA OF CROSS-SECTION, INCHES**2
YE = DIST. FROM OUTSIDE OF BOTTOM PLATE TO CENTROID, INCHES
I = MOMENT OF INERTIA, INCHES**4
ST = SECTION MODULUS FOR TOP FLANGE, INCHES**3
SB = SECTION MODULUS FOR BOTTOM FLANGE, INCHES**3
YP = DIST. FROM OUTSIDE OF BOTTOM PLATE TO PLASTIC N.A., IN.
Z = PLASTIC MODULUS, INCHES**3
F = SHAPE FACTOR
MY = YIELD MOMENT, KIP-FEET
MP = PLASTIC MOMENT, KIP-FEET

BEAM PROPERTIES

LENGTH, L . . . . 66.0 INCHES
ELASTIC STIFFNESS, P/DELTA . . . . 28.97 KIPS/IN.
YIELD DEFLECTION, DELTAY . . . . 0.627 INCHES
YIELD LOAD, PY . . . . 18.18 KIPS
PLASTIC LOAD, PP . . . . 18.52 KIPS
LOCATION OF CRITICAL SECTION FOR PY* . . . . . 51.97 INCHES
LOCATION OF CRITICAL SECTION FOR PP* . . . . . 51.97 INCHES
* MEASURED FROM CONCENTRATED LOAD



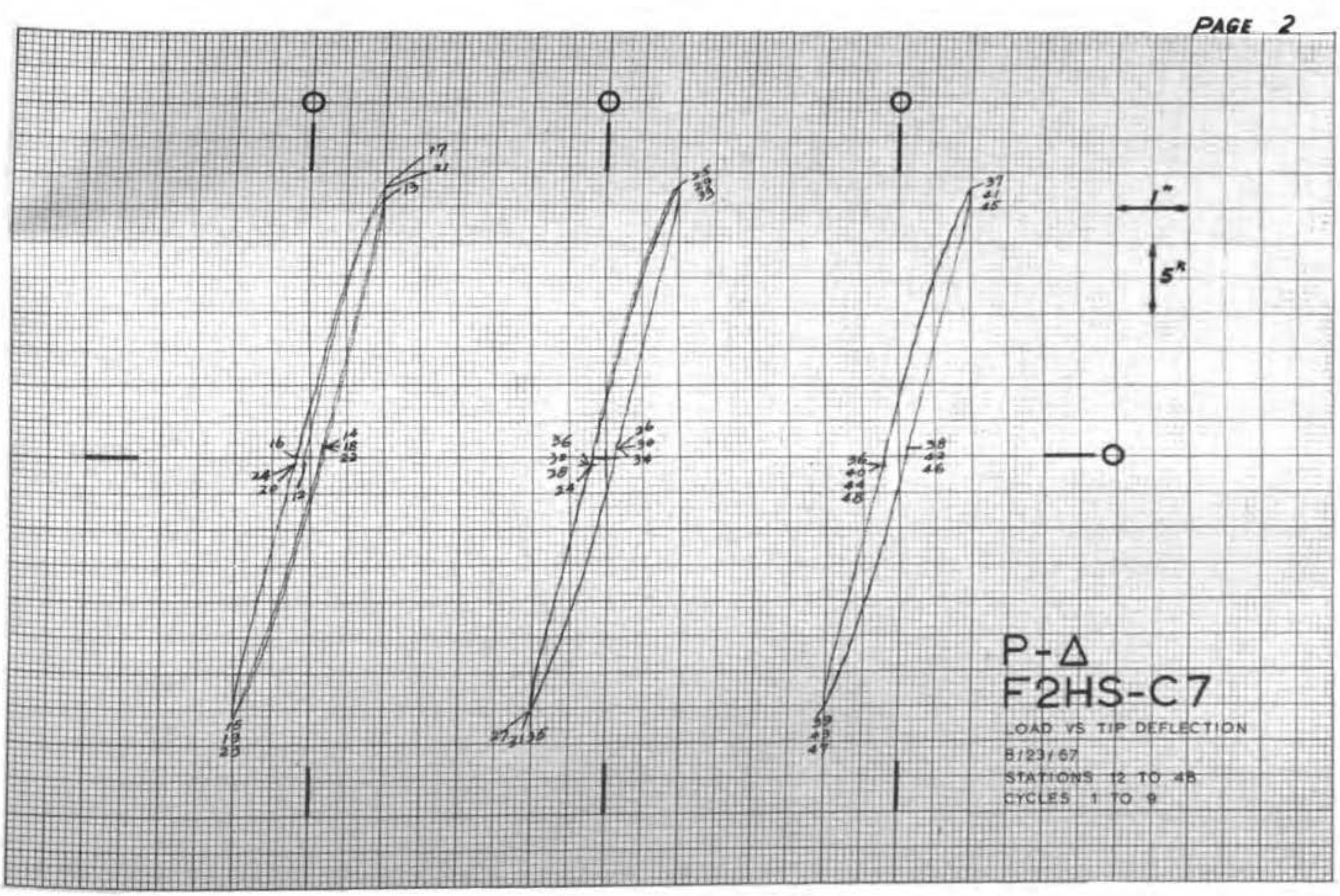
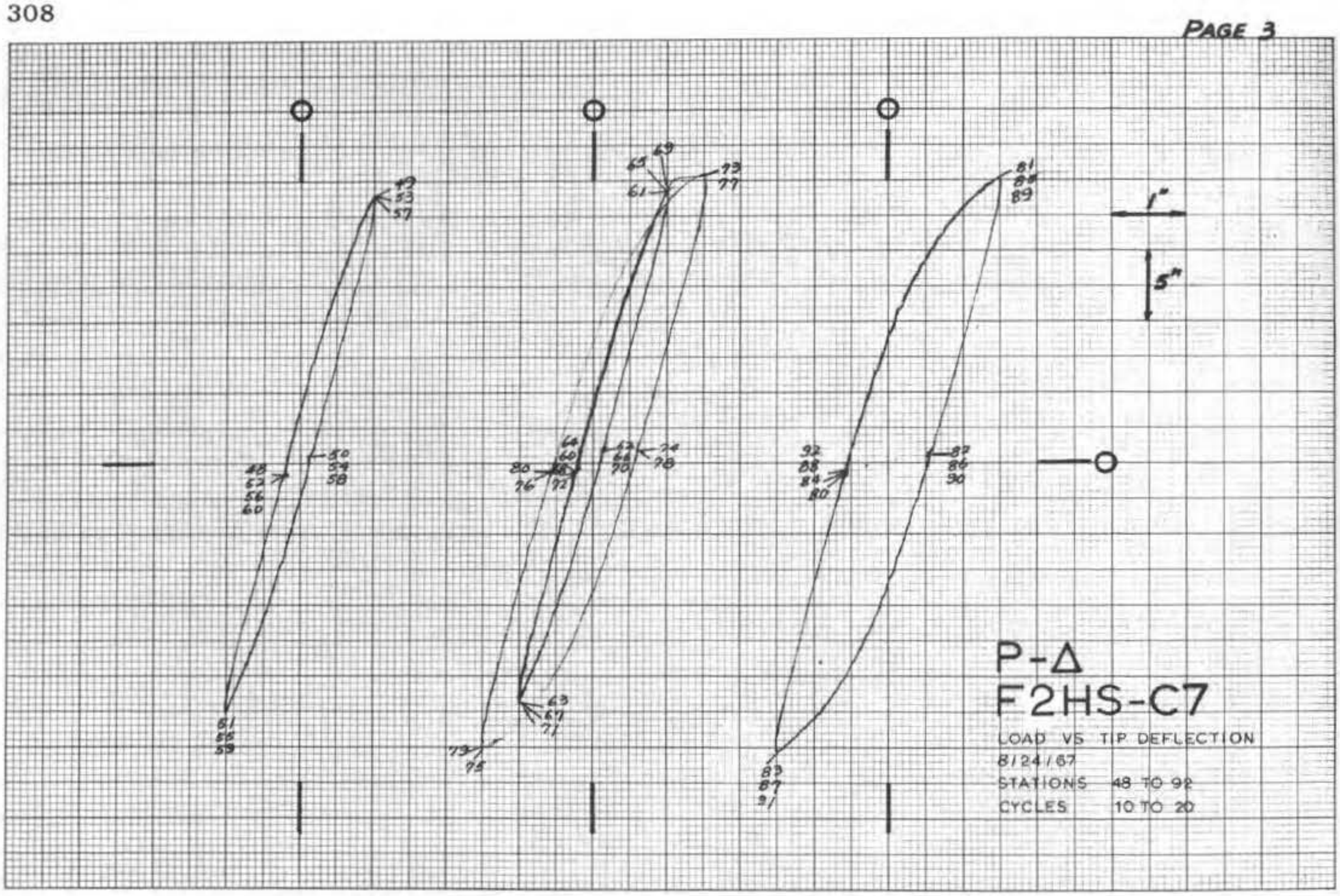


PLATE 40. LOAD VS. DEFLECTION - F2HS-C7



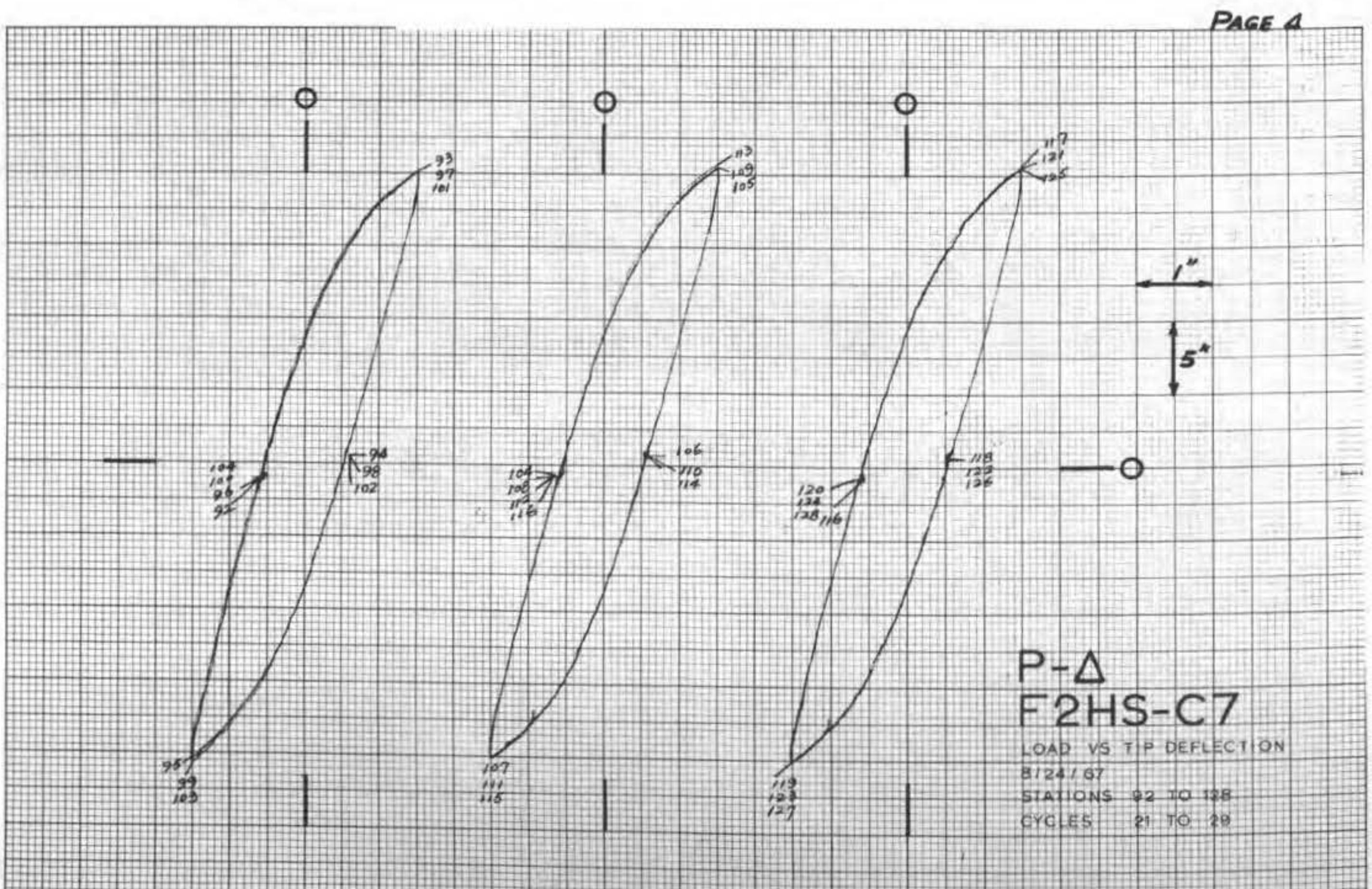


PLATE 40. (continued)

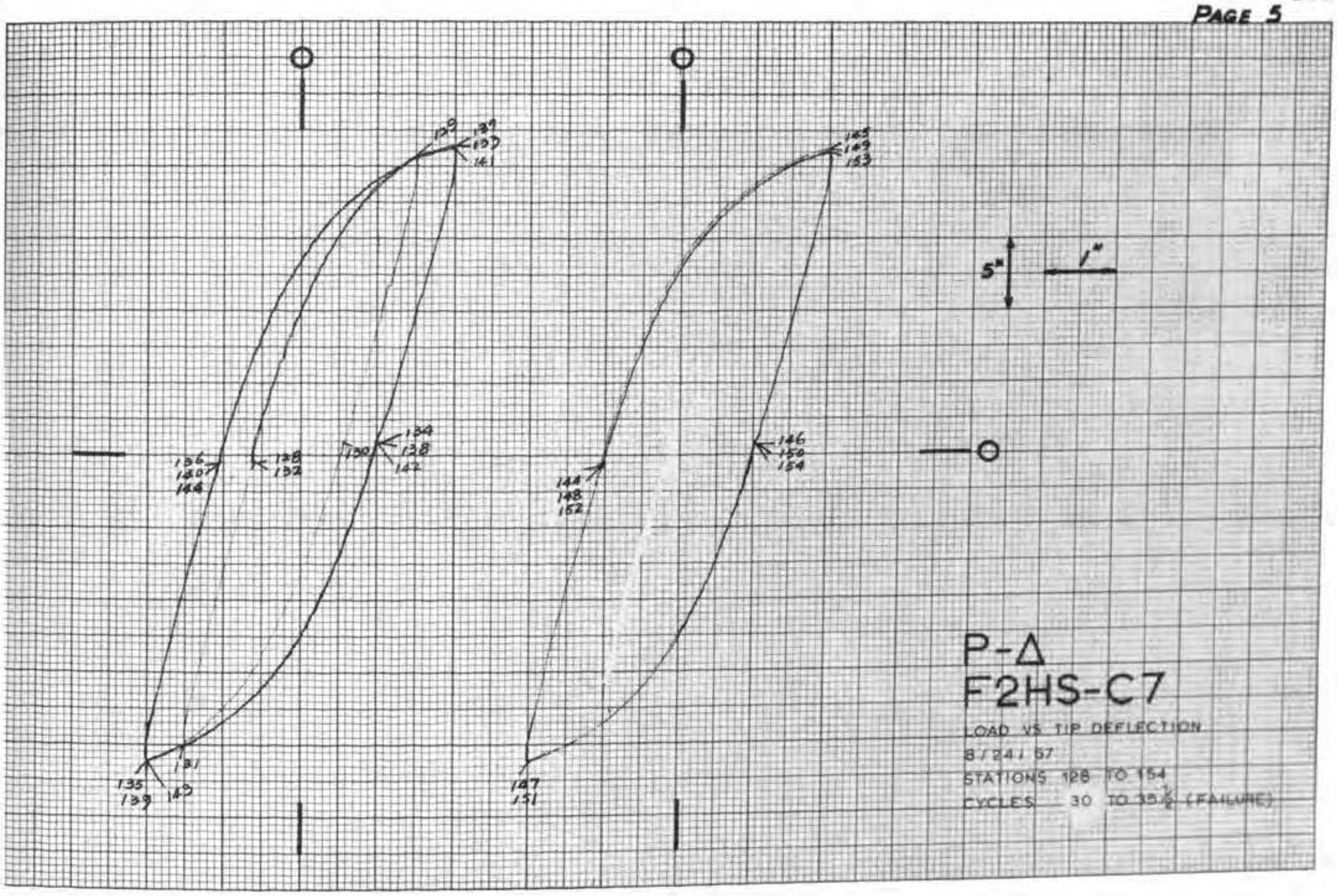


PLATE 40. (continued)

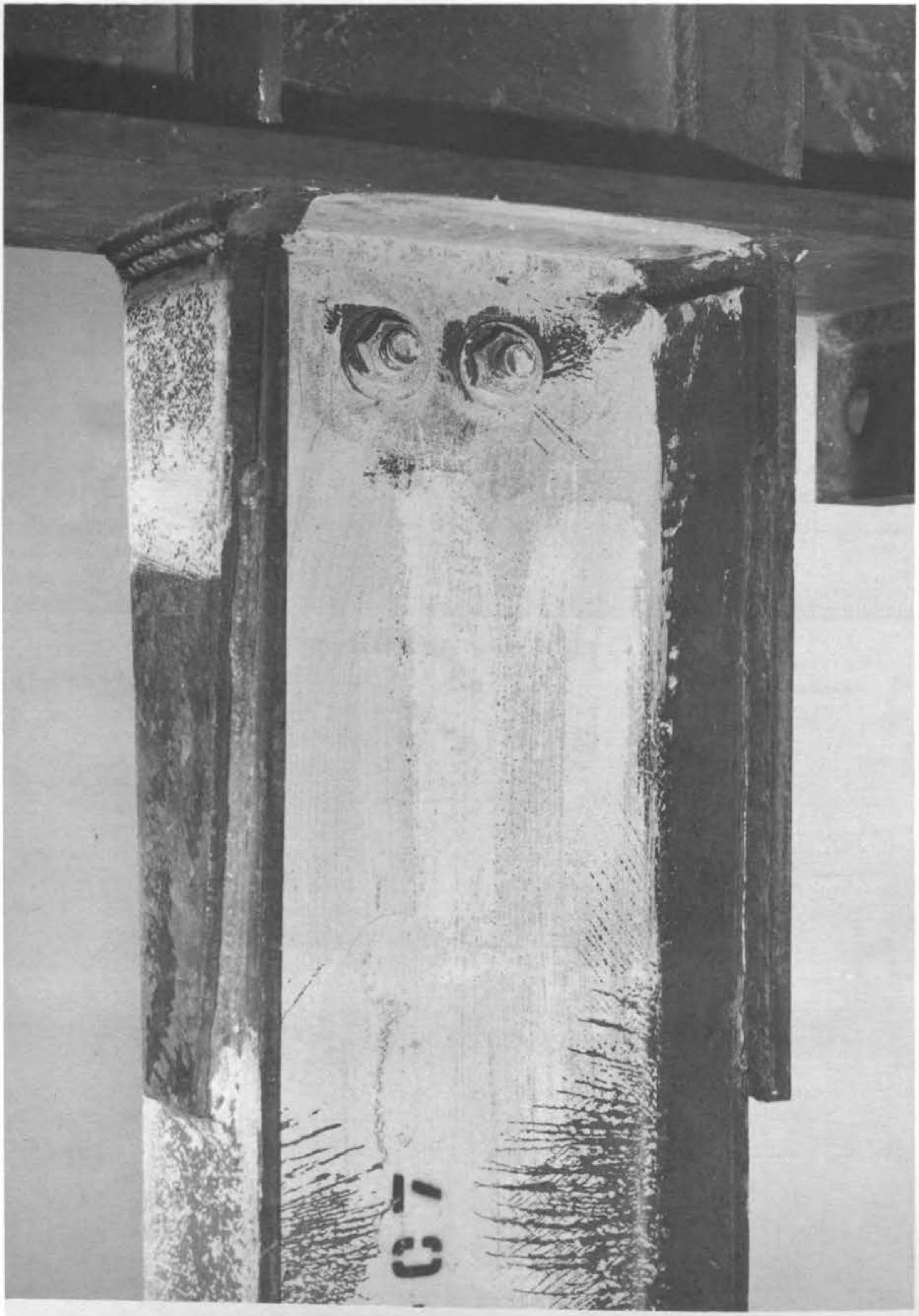


FIGURE 48. F2HS-C7

SPECIMEN F2HS-C7

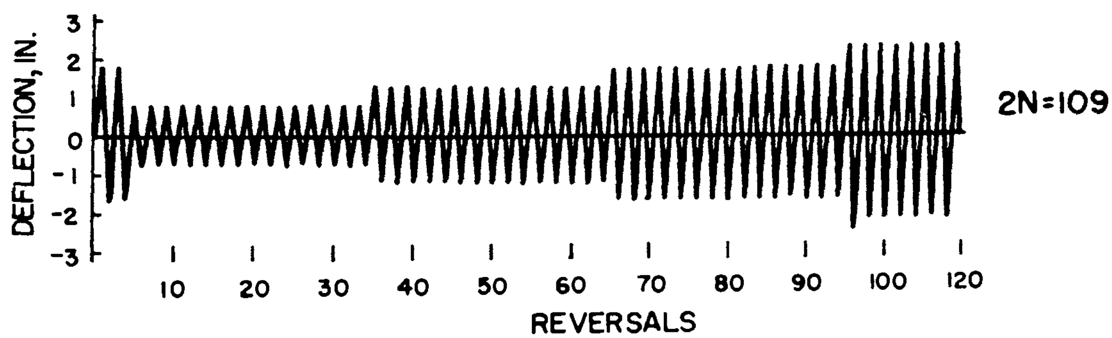
Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	18.56	0.86	0.34	3.0	1.002	1.34	0.53	0.51
2	-17.80	-0.65	0.27	2.9	-0.961	-1.01	0.43	0.49
3	17.96	0.85	0.31	4.4	0.970	1.33	0.48	0.75
4	-17.75	-0.65	0.33	3.8	-0.958	-1.02	0.52	0.64
5	18.23	0.84	0.32	3.9	0.984	1.32	0.50	0.65
6	-17.74	-0.65	0.32	3.7	-0.958	-1.02	0.50	0.63
7	18.57	0.84	0.26	4.0	1.003	1.31	0.41	0.68
8	-16.98	-0.66	0.26	3.2	-0.917	-1.03	0.41	0.53
9	18.63	0.84	0.26	3.3	1.006	1.31	0.41	0.56
10	-17.00	-0.66	0.26	3.2	-0.918	-1.03	0.41	0.55
11	18.69	0.84	0.26	3.4	1.009	1.31	0.41	0.58
12	-16.98	-0.66	0.26	3.1	-0.917	-1.03	0.41	0.52
13	18.43	0.86	0.24	3.2	0.995	1.35	0.38	0.53
14	-16.75	-0.64	0.24	3.0	-0.904	-1.00	0.38	0.51
15	18.49	0.86	0.24	3.2	0.999	1.35	0.38	0.54
16	-16.81	-0.64	0.24	2.9	-0.908	-1.00	0.38	0.50
17	18.47	0.86	0.24	2.9	0.997	1.35	0.38	0.50
18	-16.82	-0.64	0.24	2.9	-0.908	-1.00	0.38	0.50
19	18.81	0.86	0.27	3.2	1.016	1.34	0.42	0.54
20	-16.83	-0.64	0.26	3.0	-0.909	-1.00	0.41	0.50
21	18.88	0.86	0.26	3.1	1.020	1.35	0.41	0.52
22	-16.67	-0.64	0.26	2.9	-0.900	-1.00	0.41	0.50
23	18.69	0.86	0.26	3.5	1.009	1.35	0.41	0.59
24	-16.81	-0.64	0.26	3.0	-0.908	-1.01	0.41	0.51
25	18.61	0.86	0.26	3.3	1.005	1.34	0.41	0.55
26	-16.22	-0.65	0.26	2.7	-0.876	-1.01	0.41	0.45
27	18.48	0.86	0.26	3.1	0.998	1.34	0.41	0.52
28	-16.20	-0.65	0.26	2.4	-0.874	-1.02	0.41	0.40
29	18.54	0.86	0.26	3.3	1.001	1.34	0.41	0.56
30	-16.14	-0.65	0.26	2.7	-0.871	-1.02	0.41	0.46
31	19.49	1.34	0.74	12.5	1.052	2.10	1.16	2.10
32	-19.54	-1.10	1.10	16.3	-1.055	-1.72	1.72	2.76
33	19.65	1.34	1.10	15.7	1.061	2.10	1.72	2.66
34	-19.74	-1.08	1.10	16.6	-1.066	-1.69	1.73	2.81
35	19.65	1.34	1.05	15.6	1.061	2.10	1.64	2.63
36	-19.56	-1.10	1.05	15.1	-1.056	-1.72	1.65	2.56
37	19.93	1.34	1.05	15.7	1.076	2.10	1.65	2.66
38	-19.61	-1.10	1.05	15.2	-1.059	-1.72	1.65	2.56
39	19.73	1.34	1.05	15.5	1.065	2.10	1.65	2.62
40	-19.58	-1.10	1.05	15.1	-1.057	-1.72	1.64	2.55
41	19.77	1.36	1.08	15.7	1.067	2.13	1.68	2.66
42	-19.58	-1.09	1.06	14.8	-1.057	-1.70	1.66	2.50
43	19.78	1.36	1.06	15.3	1.068	2.13	1.66	2.59
44	-19.22	-1.08	1.05	14.2	-1.038	-1.69	1.65	2.39
45	19.65	1.36	1.05	15.1	1.061	2.13	1.65	2.56
46	-19.12	-1.08	1.04	13.9	-1.033	-1.69	1.63	2.35
47	19.94	1.39	1.08	15.3	1.077	2.17	1.69	2.58
48	-19.12	-1.06	1.08	15.4	-1.033	-1.65	1.69	2.60
49	19.79	1.39	1.09	15.1	1.068	2.17	1.71	2.55
50	-19.10	-1.06	1.09	15.3	-1.031	-1.65	1.71	2.59
51	19.83	1.38	1.09	15.5	1.071	2.17	1.71	2.61

Half-Cycle	P KIPS	Δ IN.	Δ' IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
52	−19.12	−1.06	1.09	15.5	−1.033	−1.65	1.71	2.62
53	19.73	1.39	1.05	15.7	1.065	2.17	1.64	2.65
54	−19.28	−1.06	1.06	15.7	−1.041	−1.65	1.66	2.65
55	19.65	1.39	1.06	15.6	1.061	2.17	1.66	2.63
56	−19.14	−1.06	1.06	15.4	−1.034	−1.65	1.66	2.61
57	19.71	1.39	1.06	15.9	1.064	2.17	1.66	2.68
58	−19.24	−1.06	1.06	15.6	−1.039	−1.65	1.66	2.63
59	19.94	1.38	1.09	17.0	1.077	2.16	1.71	2.87
60	−18.99	−1.07	1.09	14.5	−1.025	−1.67	1.71	2.45
61	20.57	1.87	1.52	26.3	1.111	2.92	2.38	4.45
62	−20.70	−1.55	1.97	30.8	−1.118	−2.42	3.09	5.20
63	20.67	1.87	1.97	32.6	1.116	2.92	3.09	5.51
64	−20.67	−1.55	1.97	30.7	−1.116	−2.42	3.09	5.19
65	20.65	1.87	1.97	32.5	1.115	2.93	3.09	5.49
66	−20.69	−1.55	1.97	30.2	−1.117	−2.42	3.09	5.11
67	20.78	1.87	1.99	32.9	1.122	2.92	3.12	5.56
68	−20.54	−1.55	1.97	31.1	−1.109	−2.42	3.08	5.25
69	20.63	1.87	1.97	31.6	1.114	2.92	3.08	5.34
70	−20.50	−1.55	1.97	31.1	−1.107	−2.42	3.08	5.26
71	20.49	1.87	1.97	31.2	1.107	2.93	3.08	5.27

SPECIMEN F2HS-C9

Description: This specimen was similar to specimen F2HS-C7 in detailing, fabrication and inspection. In particular, the remarks concerning the bottom plate weld also apply here.

Program of Cycling:



Test Control: Tip deflection.

Raw Data Included: Graphical load-deflection data.

Total Energy Absorption: 2,149 kip-inches.

Plastic Load Reversals to Failure: 109 ($54\frac{1}{2}$ cycles).

Remarks: Cracks developed at the column face at both ends of the top plate butt-weld during the first half of the first cycle. No buckling was visible, however. After two cycles, fine cracks were found at the bottom cope, and at the outer end of one of the bottom plate fillet welds, respectively. Buckling of the top flange was apparent after the 8th cycle. During the next cycle, a crack appeared at the outer end of the other bottom plate fillet weld. About the 42nd cycle, several new cracks developed, in the upper cope and in the ends nearest the column, of both fillet welds of both connecting plates. The bottom plate butt-weld cracked through during the 50th cycle, precipitating failure of the connection.

SPECIMEN TYPE F2HS-C9

DIMENSIONS OF WF SECTION

DEPTH	8.15	INCHES
TOP FLANGE WIDTH	5.250	INCHES
BOTTOM FLANGE WIDTH	5.280	INCHES
TOP FLANGE THICKNESS	0.371	INCHES
BOTTOM FLANGE THICKNESS	0.371	INCHES
WEB THICKNESS	0.269	INCHES
ELASTIC MODULUS	30600.	KSI
YIELD STRESS	51.200	KSI

DIMENSIONS AND PROPERTIES OF TOP PLATE

LENGTH, LP	13.90	INCHES
WIDTH AT END AWAY FROM COLUMN, M	2.52	INCHES
WIDTH AT END OF WELD, R	4.47	INCHES
AVERAGE LOCATION OF END OF WELD*, N	3.80	INCHES
THICKNESS, T	0.501	INCHES
ELASTIC MODULUS	31100.	KSI
YIELD STRESS	56.000	KSI

*MEASURED FROM FACE OF COLUMN

DIMENSIONS AND PROPERTIES OF BOTTOM PLATE

LENGTH, LP	14.01	INCHES
WIDTH, B	6.27	INCHES
AVERAGE LOCATION OF COLUMN END OF WELD* Q	3.77	INCHES
AVERAGE LOCATION OF OUTER END OF WELD*, P	14.01	INCHES
THICKNESS, T	0.359	INCHES
ELASTIC MODULUS	32100.	KSI
YIELD STRESS	56.000	KSI

*MEASURED FROM FACE OF COLUMN

DEPTH OUT-TO-OUT OF PLATES	9.19	INCHES

WF SECTION PROPERTIES

AREA, A	5.99	INCHES**2
LOCATION OF CENTROID*, YE	4.07	INCHES
MOMENT OF INERTIA, I	69.4	INCHES**4
SECTION MODULUS, TOP, ST	17.0	INCHES**3
SECTION MODULUS, BOTTOM, SB	17.1	INCHES**3
LOCATION OF PLASTIC NEUTRAL AXIS* YP	4.05	INCHES
PLASTIC MODULUS, Z	19.2	INCHES**3
SHAPE FACTOR	1.129	
YIELD MOMENT, MY	72.55	KIP-FT.
PLASTIC MOMENT, MP	81.94	KIP-FT.

*MEASURED FROM OUTSIDE FACE OF BOTTOM FLANGE

SPECIMEN TYPE F2HS-C9

SECTION PROPERTIES AT SELECTED CROSS-SECTIONS

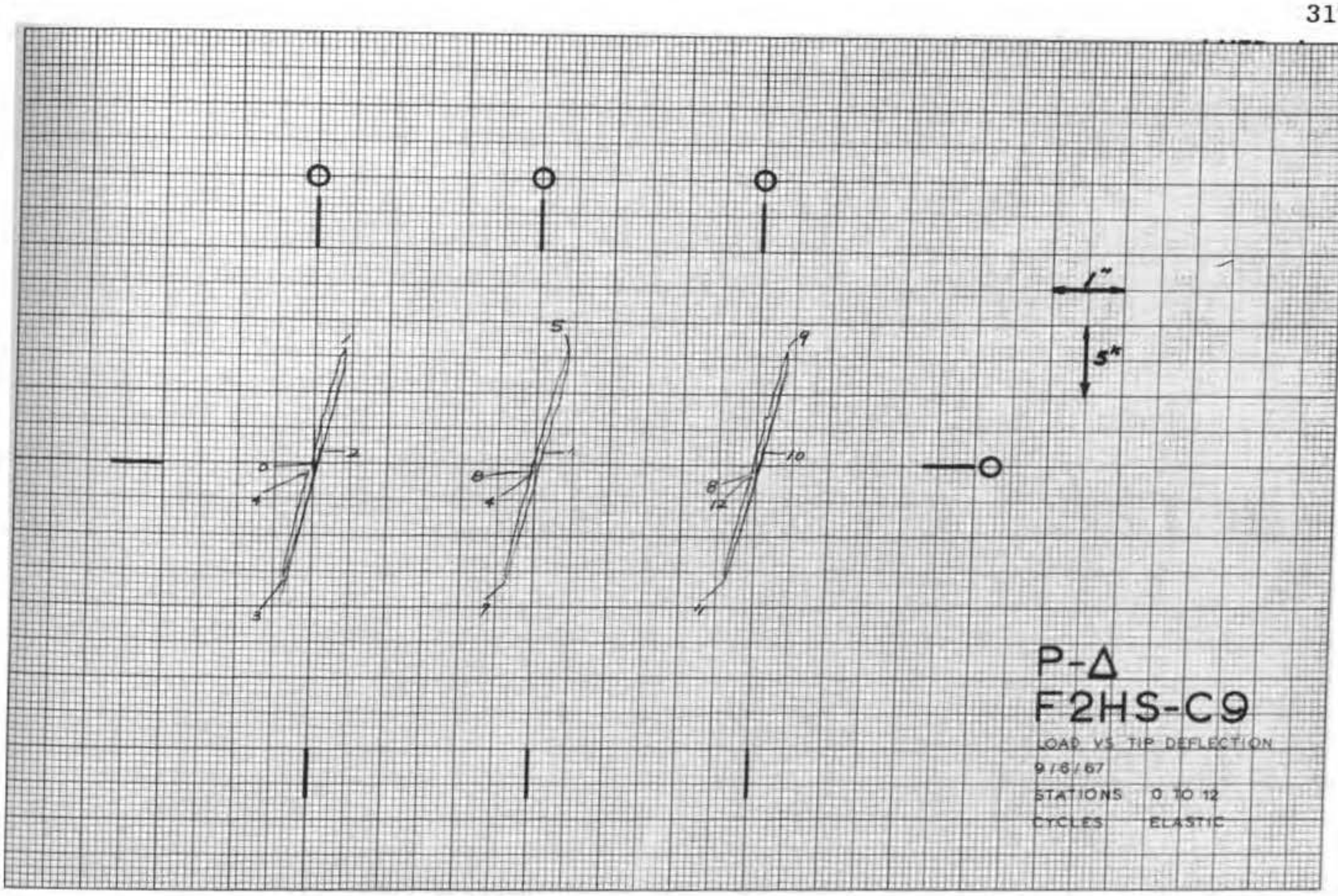
X	A	YE	I	ST	SB
52.10	5.99	4.52	69.4	16.6	16.7
52.10	7.27	5.30	90.1	23.1	18.2
52.04	7.27	5.29	90.0	23.1	18.2
51.99	7.26	5.29	90.0	23.1	18.2
51.99	9.62	4.04	136.6	26.5	33.8
57.09	10.12	4.28	148.0	30.2	34.6
62.20	10.62	4.50	158.4	33.8	35.2
62.20	8.51	3.54	118.6	21.0	33.5
62.21	8.52	3.54	118.7	21.0	33.5
62.22	8.52	3.54	118.7	21.0	33.5
62.22	6.37	4.51	95.1	20.3	21.1
64.11	6.56	4.63	98.6	21.6	21.3
66.00	6.74	4.75	102.0	23.0	21.5

X	YP	Z	F	MY	MP
52.10	4.67	18.8	1.033	77.64	80.22
52.10	7.23	22.9	1.149	85.16	97.83
52.04	7.22	22.9	1.149	85.14	97.79
51.99	7.21	22.9	1.148	85.11	97.75
51.99	2.64	34.6	1.193	123.68	147.58
57.09	3.64	37.7	1.144	140.71	160.95
62.20	4.64	40.3	1.091	157.65	172.01
62.20	0.81	28.4	1.235	97.96	121.02
62.21	0.82	28.4	1.235	98.00	121.06
62.22	0.82	28.4	1.235	98.04	121.11
62.22	4.55	24.3	1.096	94.69	103.73
64.11	4.92	25.2	1.080	99.37	107.31
66.00	5.29	25.9	1.104	100.18	110.58

X = DISTANCE FROM CONCENTRATED LOAD, INCHES
A = AREA OF CROSS-SECTION, INCHES**2
YE = DIST. FROM OUTSIDE OF BOTTOM PLATE TO CENTROID, INCHES
I = MOMENT OF INERTIA, INCHES**4
ST = SECTION MODULUS FOR TOP FLANGE, INCHES**3
SB = SECTION MODULUS FOR BOTTOM FLANGE, INCHES**3
YP = DIST. FROM OUTSIDE OF BOTTOM PLATE TO PLASTIC N.A., IN.
Z = PLASTIC MODULUS, INCHES**3
F = SHAPE FACTOR
MY = YIELD MOMENT, KIP-FEET
MP = PLASTIC MOMENT, KIP-FEET

BEAM PROPERTIES

LENGTH, L . . . . 66.0 INCHES
ELASTIC STIFFNESS, P/DELTA . . . . 28.89 KIPS/IN.
YIELD DEFLECTION, DELTAY . . . . 0.619 INCHES
YIELD LOAD, PY . . . . 17.88 KIPS
PLASTIC LOAD, PP . . . . 18.48 KIPS
LOCATION OF CRITICAL SECTION FOR P/* . . . . . 52.10 INCHES
LOCATION OF CRITICAL SECTION FOR PP* . . . . . 52.10 INCHES
* MEASURED FROM CONCENTRATED LOAD



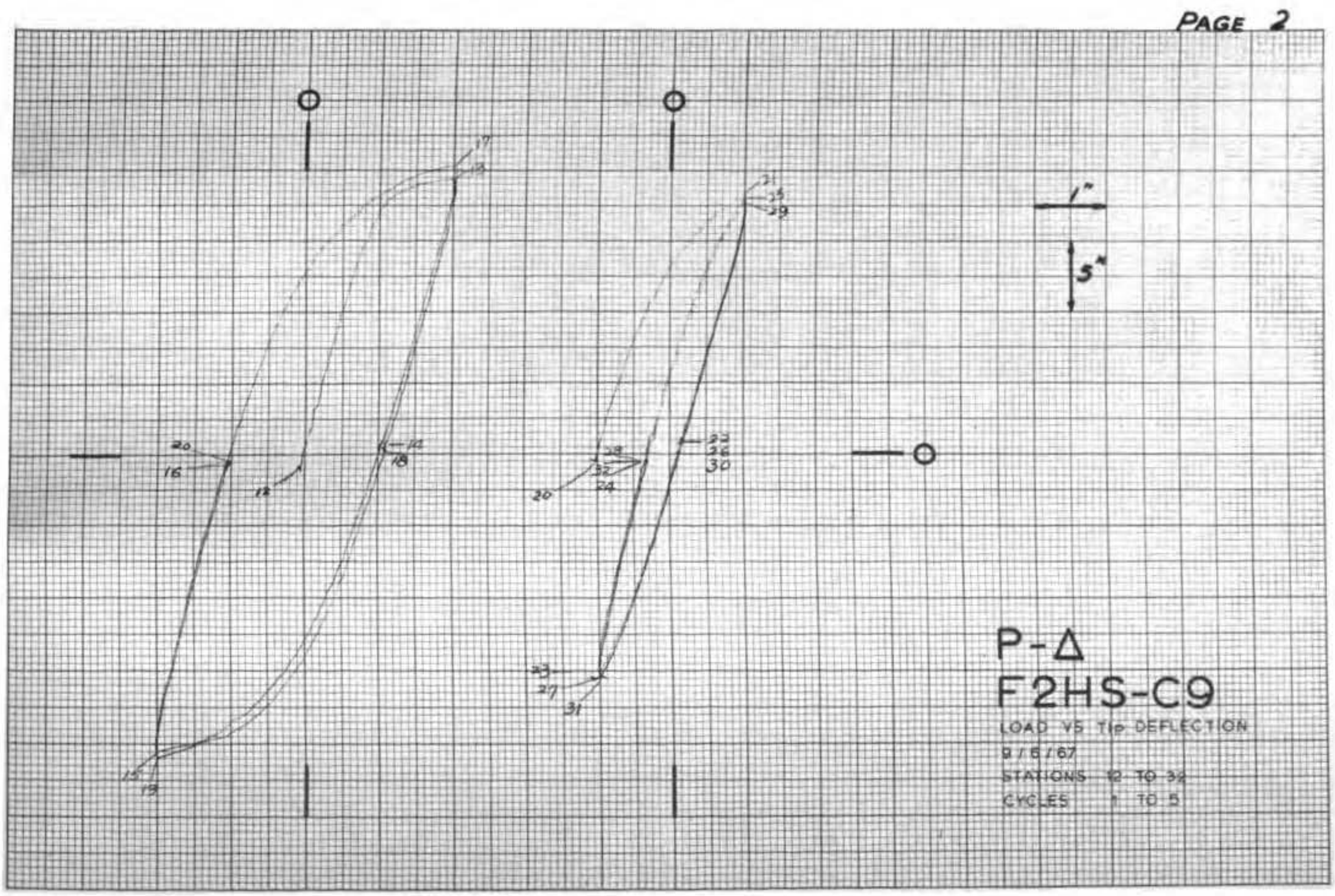
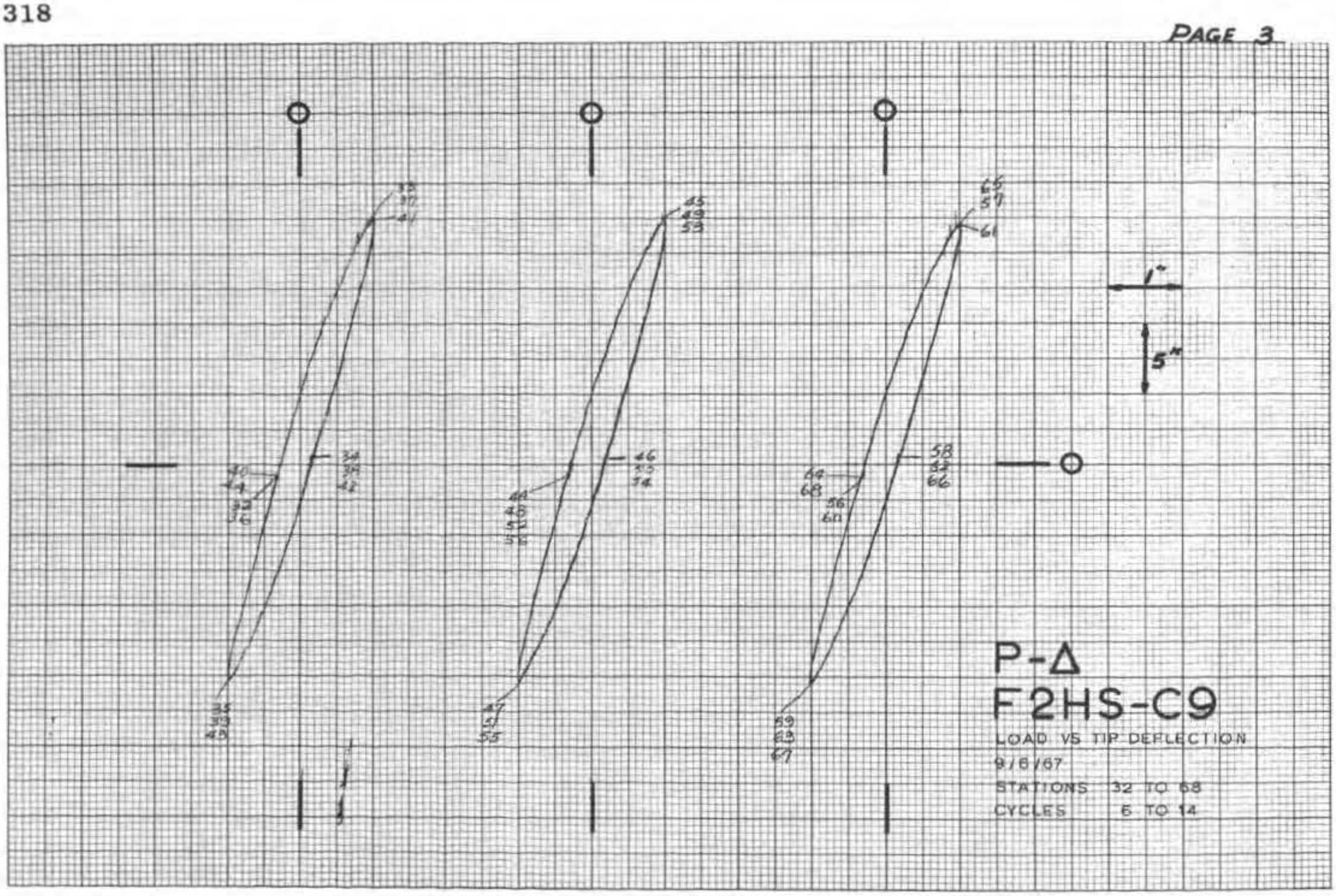


PLATE 41. LOAD VS. DEFLECTION - F2HS-C9



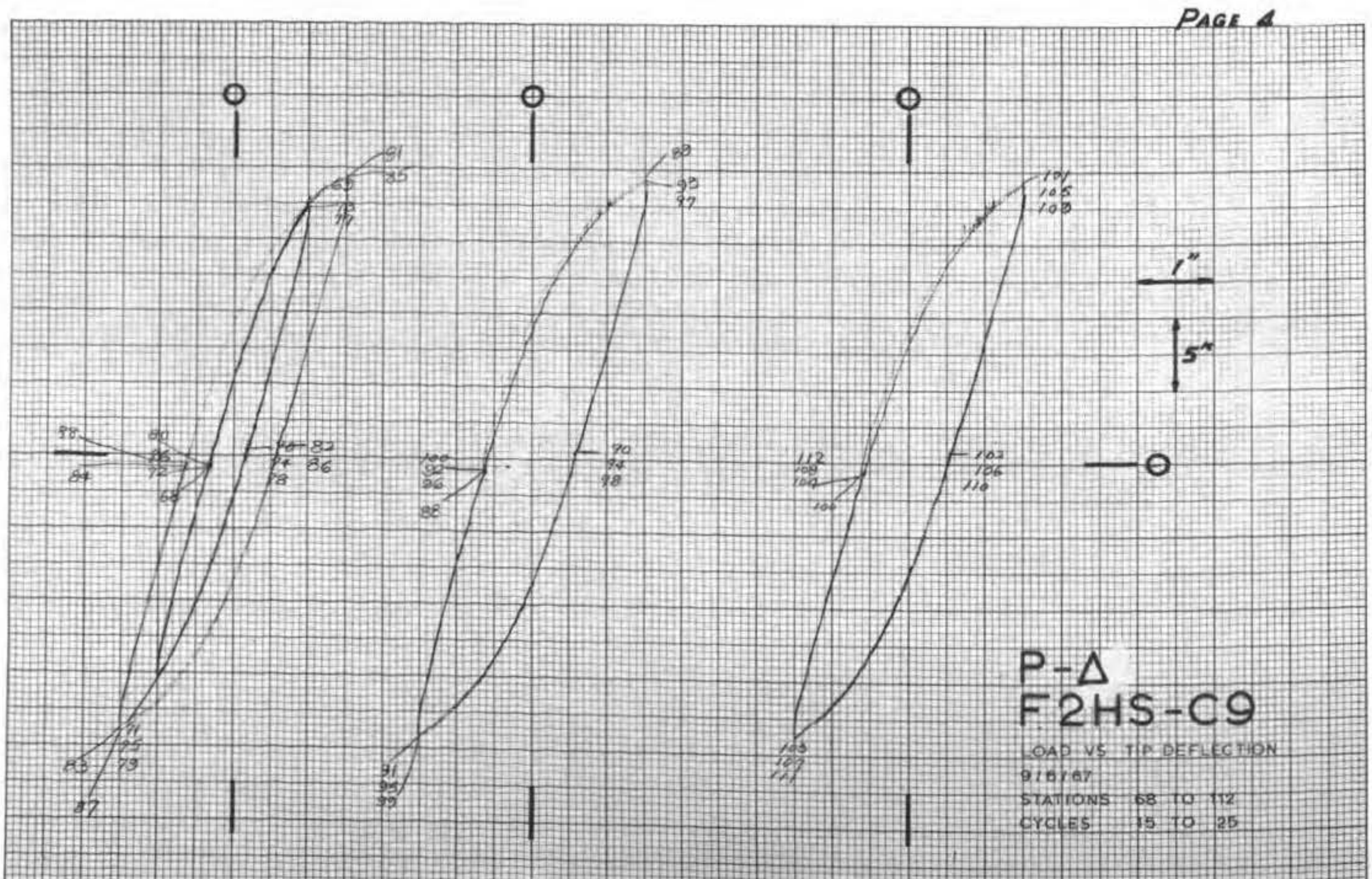
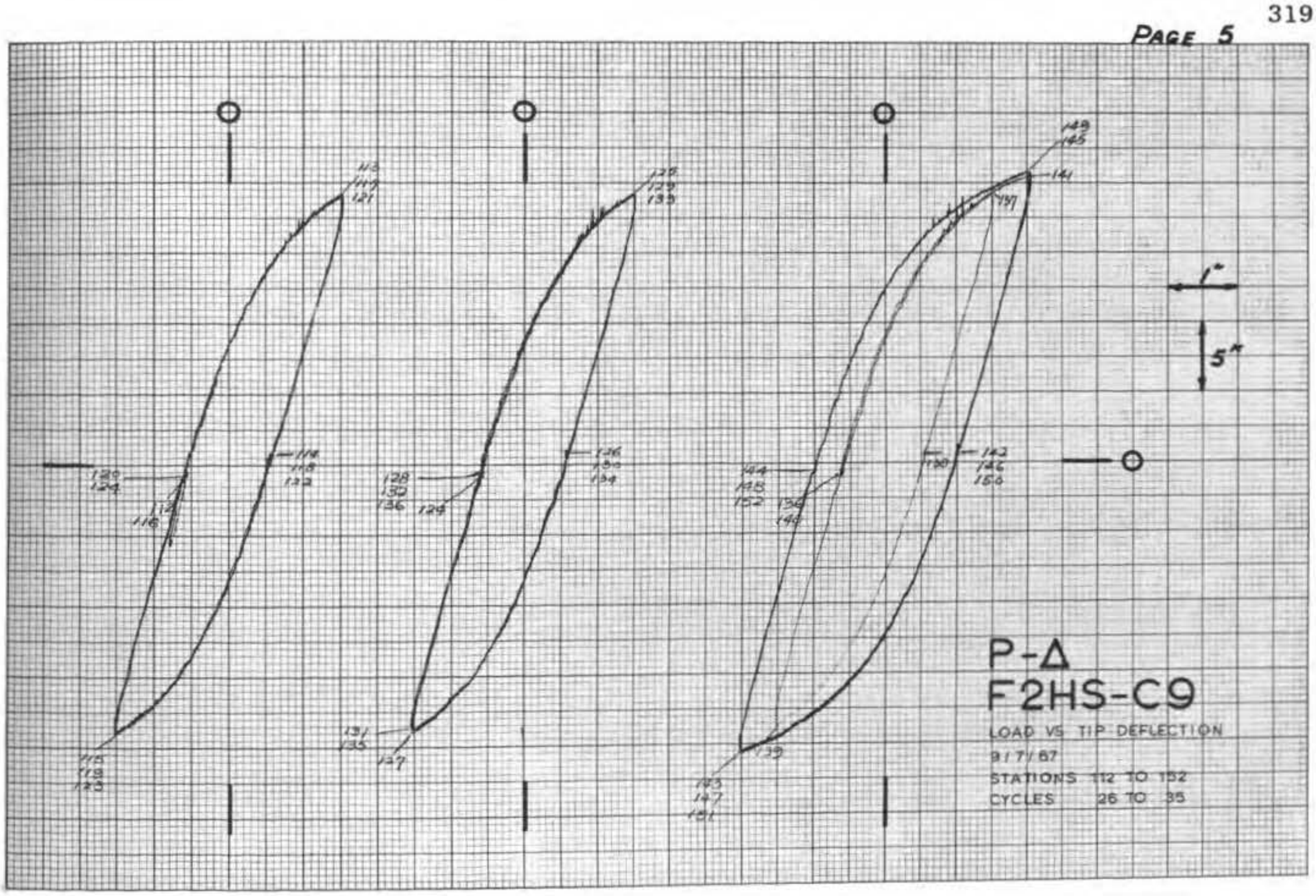


PLATE 41. (continued)



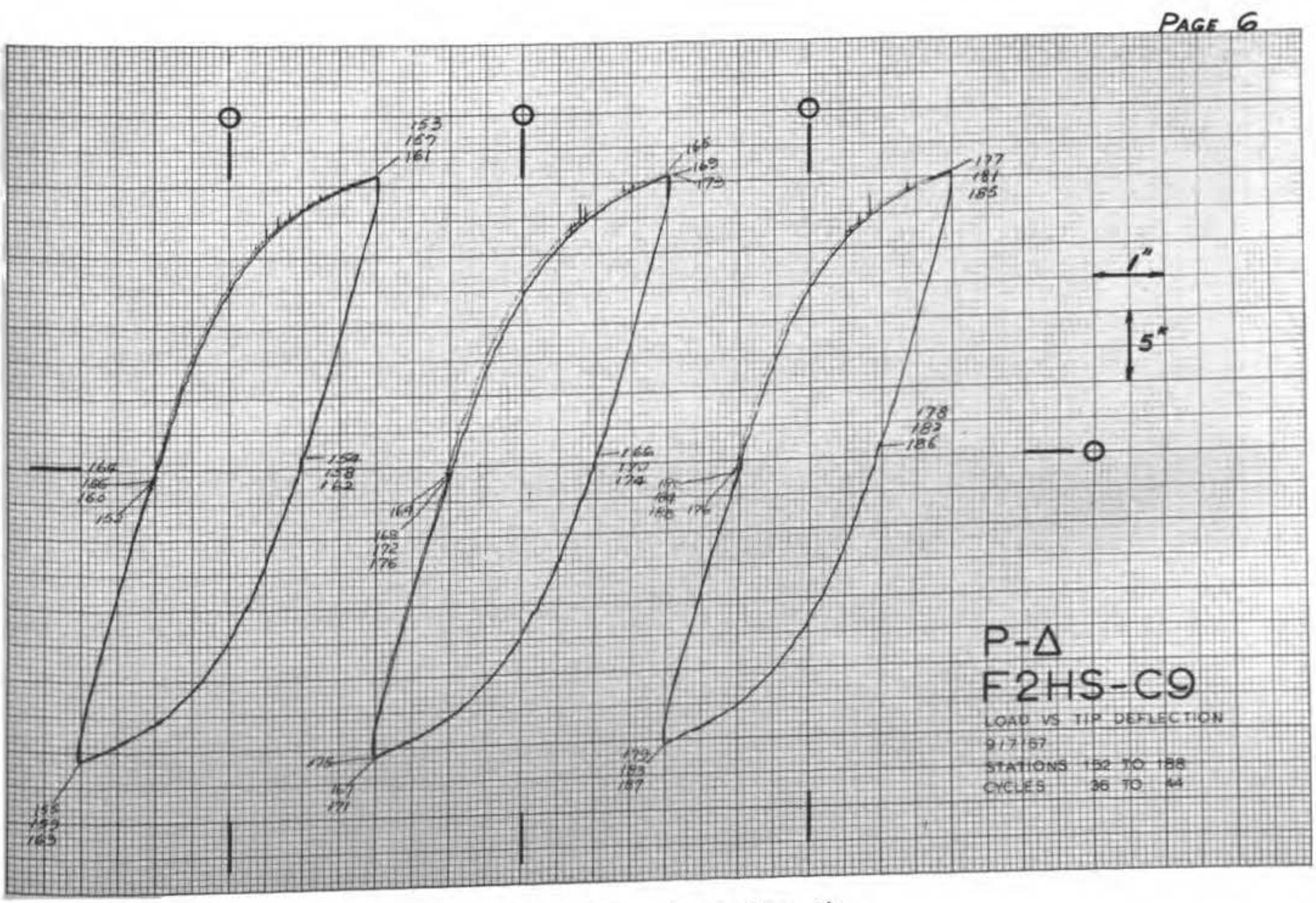


PLATE 41. (continued)

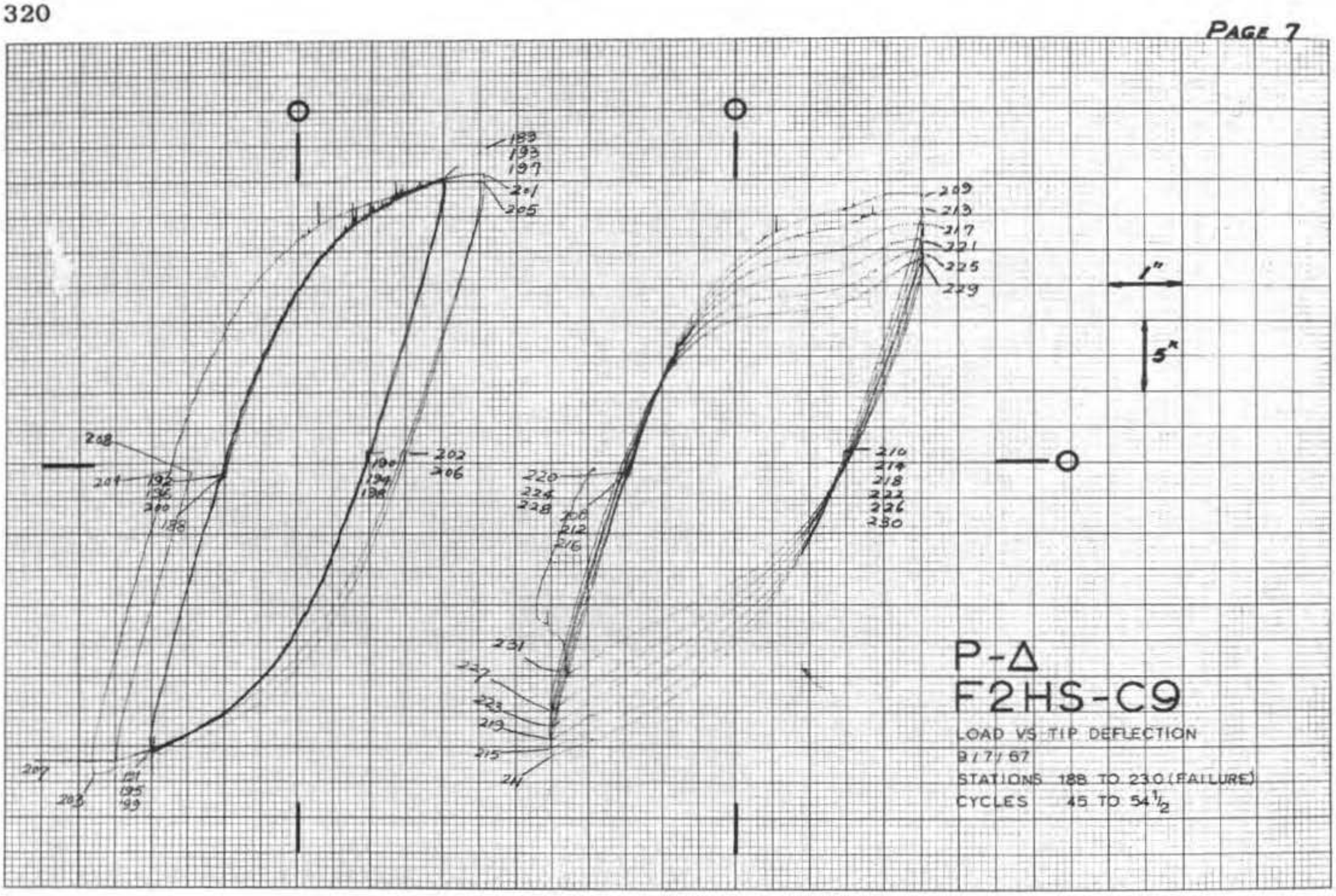


PLATE 41. (con inued)

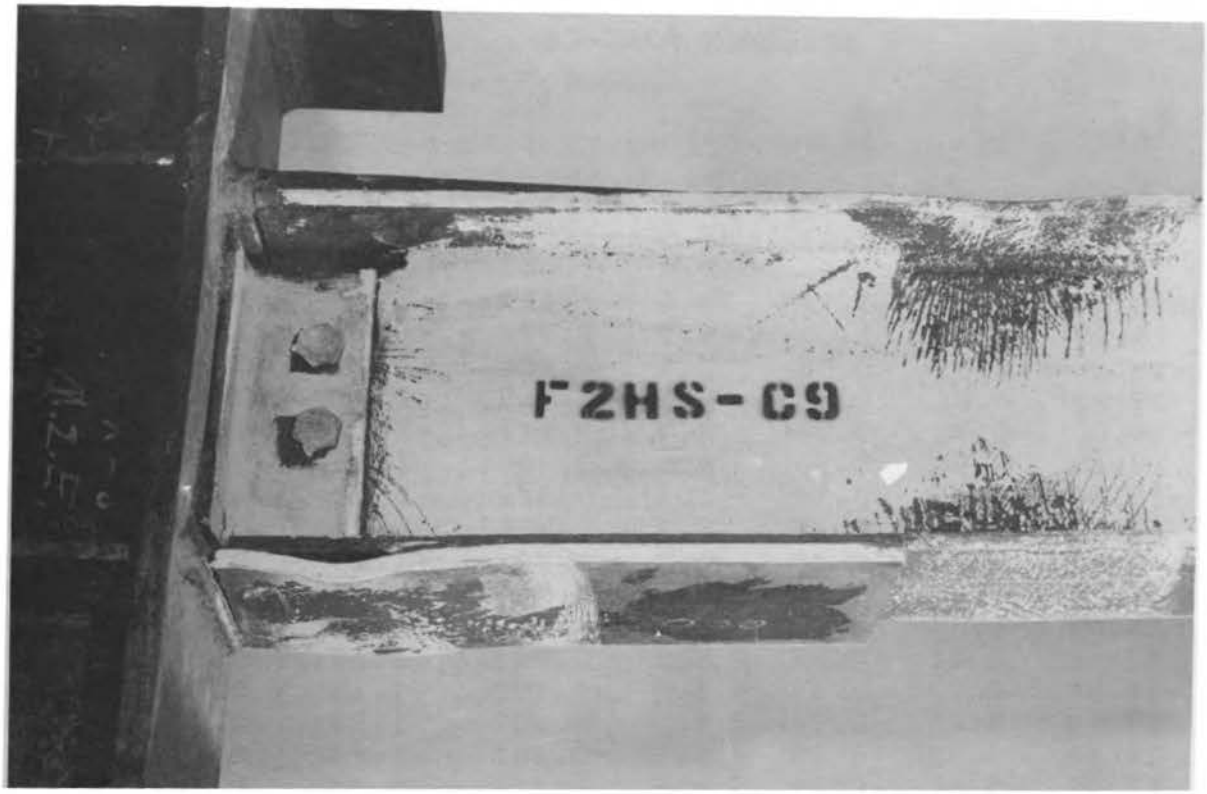


FIGURE 49. F2HS-C9

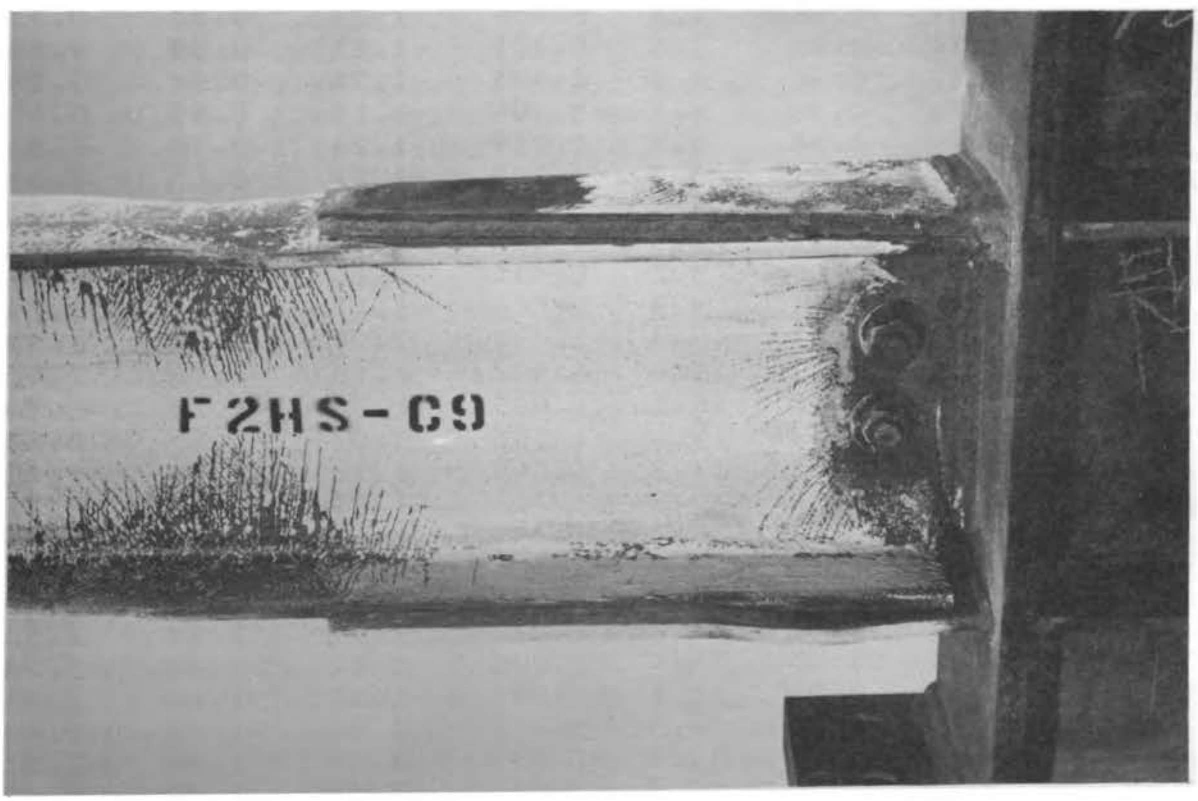


FIGURE 50. F2HS-C9

SPECIMEN F2HS-C9

Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
1	19.16	1.79	1.20	18.6	1.037	2.80	1.88	3.14
2	-20.09	-1.65	2.03	33.5	-1.087	-2.58	3.18	5.66
3	20.08	1.80	1.96	32.0	1.087	2.81	3.06	5.41
4	-20.67	-1.65	1.91	32.0	-1.119	-2.57	2.99	5.42
5	18.07	0.81	1.08	14.5	0.978	1.26	1.68	2.45
6	-14.89	-0.73	0.38	3.4	-0.806	-1.14	0.60	0.57
7	17.83	0.81	0.38	5.1	0.965	1.27	0.60	0.86
8	-14.99	-0.72	0.39	3.7	-0.811	-1.13	0.60	0.63
9	17.37	0.82	0.36	4.6	0.940	1.28	0.56	0.78
10	-15.19	-0.72	0.36	3.2	-0.822	-1.13	0.56	0.54
11	17.81	0.81	0.39	5.7	0.964	1.27	0.60	0.97
12	-14.62	-0.73	0.38	2.9	-0.791	-1.14	0.60	0.50
13	17.75	0.81	0.36	4.9	0.960	1.27	0.57	0.83
14	-14.67	-0.73	0.36	3.0	-0.794	-1.14	0.57	0.51
15	17.42	0.81	0.37	5.2	0.943	1.27	0.57	0.89
16	-14.64	-0.73	0.37	3.0	-0.792	-1.14	0.57	0.50
17	17.59	0.81	0.38	4.6	0.952	1.27	0.60	0.79
18	-14.83	-0.73	0.39	3.7	-0.802	-1.14	0.60	0.62
19	17.45	0.81	0.39	4.5	0.944	1.27	0.60	0.77
20	-14.89	-0.73	0.39	3.5	-0.806	-1.14	0.60	0.59
21	17.48	0.81	0.39	4.8	0.946	1.27	0.60	0.81
22	-14.83	-0.73	0.39	3.5	-0.802	-1.14	0.60	0.60
23	16.99	0.81	0.37	4.3	0.919	1.26	0.57	0.73
24	-14.82	-0.74	0.37	3.2	-0.802	-1.15	0.57	0.55
25	16.80	0.81	0.37	4.3	0.909	1.27	0.57	0.73
26	-14.80	-0.74	0.38	3.5	-0.801	-1.15	0.59	0.60
27	17.10	0.82	0.38	4.3	0.925	1.28	0.59	0.73
28	-14.85	-0.74	0.38	3.5	-0.804	-1.15	0.59	0.60
29	17.35	0.79	0.38	4.8	0.939	1.24	0.60	0.81
30	-14.74	-0.75	0.41	3.7	-0.798	-1.17	0.63	0.62
31	17.29	0.79	0.41	5.4	0.935	1.24	0.63	0.91
32	-14.88	-0.75	0.41	3.3	-0.805	-1.17	0.63	0.56
33	17.08	0.79	0.40	5.2	0.924	1.24	0.62	0.87
34	-14.89	-0.75	0.41	3.3	-0.806	-1.17	0.64	0.55
35	19.07	1.27	0.83	12.9	1.032	1.98	1.29	2.18
36	-18.42	-1.20	1.12	14.4	-0.997	-1.88	1.76	2.44
37	19.13	1.27	1.12	16.2	1.035	1.98	1.76	2.75
38	-18.62	-1.20	1.13	14.6	-1.008	-1.87	1.76	2.47
39	19.32	1.27	1.13	17.3	1.045	1.98	1.76	2.92
40	-18.56	-1.19	1.12	15.5	-1.004	-1.87	1.74	2.62
41	19.26	1.27	1.12	16.2	1.042	1.99	1.74	2.74
42	-18.58	-1.19	1.12	15.0	-1.006	-1.87	1.74	2.54
43	19.19	1.27	1.12	16.6	1.039	1.99	1.74	2.81
44	-18.71	-1.19	1.12	15.0	-1.013	-1.87	1.74	2.53
45	18.85	1.26	1.06	16.4	1.020	1.97	1.66	2.78
46	-18.31	-1.21	1.05	13.1	-0.991	-1.89	1.64	2.22
47	18.79	1.26	1.05	14.4	1.017	1.98	1.64	2.43
48	-18.34	-1.21	1.05	12.2	-0.993	-1.89	1.64	2.07
49	18.78	1.26	1.05	14.3	1.016	1.98	1.64	2.42
50	-18.35	-1.21	1.05	12.8	-0.993	-1.89	1.64	2.17
51	18.91	1.24	1.07	15.2	1.024	1.94	1.68	2.58

Half-Cycle	P KIPS	Δ IN.	Δ′ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
52	−18.39	−1.22	1.09	13.8	−0.995	−1.91	1.71	2.34
53	18.31	1.24	1.09	14.4	0.991	1.94	1.71	2.43
54	−18.51	−1.22	1.09	14.1	−1.001	−1.91	1.71	2.39
55	18.95	1.25	1.09	15.2	1.025	1.95	1.71	2.57
56	−18.51	−1.22	1.09	13.5	−1.001	−1.91	1.71	2.28
57	18.85	1.24	1.10	15.7	1.020	1.94	1.71	2.65
58	−18.73	−1.23	1.09	14.1	−1.014	−1.93	1.71	2.39
59	18.73	1.24	1.09	15.1	1.014	1.94	1.71	2.55
60	−18.58	−1.24	1.09	13.9	−1.006	−1.93	1.71	2.36
61	18.72	1.24	1.09	14.8	1.013	1.94	1.71	2.50
62	−18.52	−1.23	1.09	13.9	−1.002	−1.92	1.71	2.35
63	18.86	1.26	1.06	15.3	1.021	1.97	1.66	2.59
64	−18.58	−1.21	1.07	14.0	−1.006	−1.89	1.67	2.37
65	20.02	1.74	1.52	22.9	1.084	2.73	2.38	3.88
66	−20.24	−1.68	1.89	28.9	−1.095	−2.63	2.96	4.89
67	20.43	1.76	1.89	30.9	1.105	2.75	2.96	5.22
68	−20.14	−1.68	1.89	28.7	−1.090	−2.63	2.96	4.85
69	20.47	1.76	1.89	30.5	1.108	2.75	2.96	5.17
70	−20.29	−1.68	1.89	29.3	−1.098	−2.63	2.96	4.95
71	20.54	1.76	1.92	31.7	1.112	2.75	3.00	5.37
72	−20.33	−1.66	1.91	29.7	−1.100	−2.59	2.99	5.03
73	20.46	1.76	1.91	30.3	1.107	2.75	2.99	5.12
74	−20.29	−1.66	1.91	29.8	−1.098	−2.59	2.99	5.05
75	20.44	1.76	1.91	30.7	1.106	2.76	2.99	5.19
76	−20.47	−1.66	1.92	29.9	−1.108	−2.60	2.99	5.06
77	20.42	1.77	1.93	30.9	1.105	2.77	3.02	5.23
78	−20.15	−1.66	1.91	29.4	−1.090	−2.60	2.99	4.97
79	20.35	1.76	1.91	29.5	1.101	2.76	2.99	4.99
80	−20.18	−1.66	1.91	29.1	−1.092	−2.60	2.99	4.92
81	19.27	1.76	1.91	27.9	1.043	2.76	2.99	4.73
82	−19.44	−1.68	1.91	27.9	−1.052	−2.63	2.99	4.72
83	20.09	1.80	1.90	29.8	1.087	2.81	2.98	5.05
84	−19.96	−1.63	1.88	28.2	−1.080	−2.55	2.93	4.77
85	20.31	1.80	1.88	29.2	1.099	2.81	2.93	4.95
86	−19.76	−1.63	1.88	27.5	−1.069	−2.55	2.93	4.65
87	20.04	1.80	1.88	29.1	1.084	2.81	2.93	4.92
88	−19.84	−1.63	1.88	27.9	−1.073	−2.55	2.93	4.72
89	20.05	1.81	1.88	29.5	1.085	2.83	2.95	4.99
90	−20.05	−1.64	1.92	27.8	−1.085	−2.57	3.00	4.70
91	20.01	1.81	1.92	29.8	1.083	2.83	3.00	5.03
92	−20.11	−1.64	1.92	28.8	−1.088	−2.57	3.00	4.87
93	19.75	1.80	1.92	30.0	1.069	2.81	3.00	5.07
94	−20.01	−1.64	1.92	28.3	−1.083	−2.57	3.00	4.78
95	20.15	2.32	2.42	39.4	1.091	3.63	3.78	6.67
96	−20.82	−2.42	3.15	50.8	−1.127	−3.78	4.92	8.59
97	19.57	2.29	3.10	51.6	1.059	3.58	4.85	8.73
98	−20.68	−2.13	2.81	42.5	−1.119	−3.34	4.39	7.19
99	18.46	2.31	2.86	43.3	0.999	3.61	4.47	7.33
100	−20.30	−2.14	2.87	40.9	−1.099	−3.35	4.48	6.91
101	17.35	2.32	2.89	41.4	0.939	3.63	4.52	7.00
102	−19.77	−2.15	2.89	39.4	−1.070	−3.36	4.51	6.67
103	16.31	2.34	2.91	38.5	0.882	3.65	4.55	6.51
104	−19.12	−2.16	2.94	36.9	−1.035	−3.37	4.59	6.24

Half-Cycle	P KIPS	Δ IN.	Δ IN.	W K-IN.	$\bar{P}$	$\bar{\Delta}$	$\bar{\Delta}'$	$\bar{W}$
105	15.35	2.35	2.96	35.9	0.831	3.68	4.63	6.07
106	-18.23	-2.17	2.99	32.7	-0.986	-3.39	4.67	5.53
107	14.50	2.36	3.01	32.4	0.784	3.70	4.71	5.49
108	-17.06	-2.19	3.06	31.0	-0.923	-3.42	4.79	5.24
109	13.89	2.37	3.08	30.0	0.751	3.71	4.82	5.07